Hermosa Project – Trench Camp Property

Aquifer Protection Permit
SIGNIFICANT Amendment Application

P-512235

Santa Cruz County, Arizona

Prepared for:
ARIZONA MINERALS, INC.
2210 E. Ft. Lowell
Tucson, AZ 85719

Prepared by:
CLEAR CREEK ASSOCIATES, LLC
221 N. Court Avenue
Tucson, AZ 85719

August 14, 2020

ARIZONA MINERALS

2210 E Fort Lowell Rd
Tucson, AZ 85719
Tel: 520-485-1300

August 14, 2020

Mr. Vimal Chauhan
Project Manager
Groundwater Aquifer Protection Permit Unit
Arizona Department of Environmental Quality
1110 West Washington St.
Phoenix, AZ 85007

Re: Aquifer Protection Permit Significant Amendment P-512235
Hermosa Project Trench Camp

Dear Mr. Chauhan:

Enclosed please find Arizona Minerals, Inc.'s (AMI) significant amendment application for APP No. P-512235.

The primary reasons for this amendment are to:

- Add a second surface discharge location, Arizona Pollutant Discharge Elimination System (AZPDES) Outfall 002. A new water treatment plant (WTP2) will be constructed that will discharge to ephemeral Harshaw Creek. The best available demonstrated control technology for this proposed discharge is the treatment provided by WTP2, which is designed to treat influent water to applicable standards. AMI is also submitting an AZPDES permit application for this discharge.
- Revise the TSF design by increasing the maximum elevation to 5175 ft and revising the stacking geometry. No expansion of the currently permitted footprint is proposed in this amendment application.
- Revise the Pollutant Management Area (PMA) and Discharge Impact Area (DIA) to reflect the surface discharge from WTP2.
- Update closure costs and the financial assurance mechanism.

If you have any questions or need additional information, please do not hesitate to contact me at (520) 485-1300 or brent.musslewhite@south32.net.

Sincerely,

Brent Musslewhite

Brent Musslewhite
Director, Environment and Permitting

Encl.

Aquifer Protection Permit Application

ADEQ Arizona Department of Environmental Quality

GENERAL INFORMATION

1. **Application to obtain [A.R.S. 49-241]:**
   New APP no
   Amendment to a current APP Inventory No. P-512235 LTF No. 71251
   Description of all amendment requests and justification included in Report Section/Appendix _____
   A copy of the current permit, annotated with any inconsistencies between the permit requirements and the existing facilities or operation, included in Report Section/Appendix _____
   NOTE: ADEQ can provide the permit in WORD file format upon request.

2. **Applicant/Permittee Name [A.A.C. R18-1-503(1)] (see Definitions):**
   Company/Government/Entity Name: (RESPONSIBLE FOR ALL PERMIT CONDITIONS)
   Arizona Minerals, Inc.

3. **Applicant/Permittee - Certification Statement [A.A.C. R18-9-A201(B)(7)]:**
   I certify under penalty of law that this Aquifer Protection Permit application and all attachments were prepared under my direction or authorization and all information is, to the best of my knowledge, true, accurate and complete. I also certify that the APP discharging facilities described in this form is or will be designed, constructed, operated, and/or closed in accordance with the terms and conditions the Aquifer Protection Permit and applicable requirements of Arizona Revised Statutes Title 49, Chapter 2, and Arizona Administrative Code Title 18, Chapter 9 regarding aquifer protection permits. I am aware that there are significant penalties for submitting false information, including permit revocation as wells as the possibility of fine and imprisonment for knowing violations.

   Authorized person signature:
   Name: Brent Musslewhite
   Title: Director - Environment and Permitting
   Signature Musslewhite, Brent (South32) Digitally signed by Musslewhite, Brent (South32) Date: 2020.08.17 07:55:41 -07'00'
   Date: August 14, 2020

4. **Applicant/Permittee Address**
   Mailing Address: 2210 East Fort Lowell Road, Tucson, AZ 85719
   Billing Address: same
   Email Address: Brent.Musslewhite@south32.net
   Phone Number: 520-485-1300

5. **Authorized Agent [A.A.C. R18-1-503(3)] (Optional, see Definitions):**

Name: NA

Firm Name ______

Mailing Address: ______

Email Address: ______

Phone Number: ______

6. **Facility Information [A.A.C. R18-1-503(2), A.A.C. R18-9-201(B)(1)]**

Name: Hermosa Project - Trench Camp Property

Address: 749 Harshaw Road

County: Santa Cruz

Latitude: 31 ° 27 ' 59.4 " Longitude: 110 ° 43 ' 35.8 "

Coordinate System used for Latitude and Longitude: ☐ NAD27 ☑ NAD83

Township 22S Range 16E Section: 32 T22S, R16E, sec 32 and T23S R16E; unsurveyed sections 3 and 4

Driving directions from a major intersection: ______

7. **Facility Notices of Violation, Consent Orders or Compliance Orders in the last 2 years [A.A.C. R18-9-A202(A)(11), included in Report Section/Appendix** Section 2.3

8. **Facility Owner**

Company/Government/Entity Name: Arizona Minerals, Inc.

Contact Person Name Brent Musslewhite

Mailing Address: 2210 E. Fort Lowell Road, Tucson, AZ 85719

Email Address: Brent.Musslewhite@south32.net

Phone Number: 520-485-1300

9. **Contact Person for Facility Emergencies [A.A.C. R18-9-A202(A)(11)]**

Name: Brent Musslewhite Title: Director--Environment and Permitting

Mailing Address: 2210 E. Fort Lowell Road, Tucson, AZ 85719

Email Address: Brent.Musslewhite@south32.net

Phone Numbers landline: 520-485-1300 mobile phone: 505-801-2977

10. Contact Person(s) for Permit Compliance Schedule Items Notifications (Optional)
ADEQ has developed a tool to track compliance schedule items (CSIs) 30 and 5 days before they are due, and 5 days after they become overdue. The person(s) identified, will receive email notifications in addition to the Applicant/Permittee.

Name(s): Sarah Richman

Email Address(es): sarah.richman@south32.net

11. Landowner

Company/Government/Entity Name: Arizona Minerals Inc.

Contact Person Name Brent Musslewhite

Mailing Address: 2210 E. Fort Lowell Road, Tucson, AZ 85719

Email Address: Brent.Musslewhite@south32.net

Phone Number: 520-485-1300

12. Expected operational life of the Facility [A.A.C. R18-9-A201(B)(1)]
(Start date) 1/8/2018 (Close Date) 2048

13. Facility discharge or influent per day in gallons [A.A.C. R18-14-104, A.R.S. 49-242]: 6,652,000 **(gallons)**
6.480 mgd from WTP2 and 172,000 gpd from WTP1

14. All other federal or state environmental permits issued to the Applicant for the Facility or site, including type and identification number [A.A.C. R18-9-A201(B)(1)], included in Report Section/~~Appendix~~ 11

15. Are you required to file a certificate of disclosure according to A.R.S. §49-109?

☐ Yes, attached in Report Section/Appendix _____

☑ No, not required

16. Evidence that the facility complies with applicable municipal or county zoning ordinances, codes and regulations [A.A.C. R18-9-A201(B)(3)], included in Report Section/~~Appendix~~ 2.11

The proposed activities at the Property are in compliance with zoning laws. ARS 11-812 (county code provisions) does not allow county codes to "Prevent, restrict or otherwise regulate the use or occupation of land or improvements for railroad, mining, metallurgical, grazing or general agricultural purposes, if the tract concerned is five or more contiguous commercial acres."

17. Evidence of technical capability to carry out the terms of the permit (design, construction, and operation) including licenses, certifications, training, and work experience [A.A.C. R18-9-A202(B)] Attached in Report Section/~~Appendix~~ 2.12

Cost Estimates and Financial Assurance Demonstration [A.A.C. R18-9-A201(B)(5) and R18-9-A203]

Is this application for:

1) A new permit?	YES___ NO x
2) Significant Amendment?	YES X NO___

NOTE: Updated cost estimates may be required for a significant amendment as defined by rule if required to address incremental changes in the cost estimate that result from the significant amendment, A.R.S. § 49-243(N)(2)(b).

3) Other Amendment for permit transfer?	YES___ NO x
4) Cost Estimate/Financial Demonstration update?	YES x NO___
5) Estimate/Financial Demonstration at the direction of ADEQ?	YES___ NO x
6) A permit that has not been amended in the last five years?	YES___ NO x

If you answered "YES" to ANY of the above questions, provide updated cost estimates and a financial assurance demonstration. If you answered "NO" to ALL of the above questions, skip this section and continue to the "Technical Information" Section.

18. Cost Estimates provided in Report Section/~~Appendix~~ Section 8 & Attachment D

Closure costs and a financial demonstration are required even if the Applicant does not intend to close the facility in the near future. The closure and post-closure cost estimates must be based on the closure and post-closure plan/strategy (required by Application Item 32, below). Please see checklists for closure plans/strategies and cost estimate on the ADEQ website: http://www.azdeq.gov/node/542

NOTE: Cost estimates must be derived by an engineer, controller or accountant. Except as exempted by A.R.S. § 32-144.A.7 (employees of mining companies), professional documents, such as reports, plans and specifications, are to be signed by an Arizona registered engineer or geologist (A.R.S. § 32-125). Cost estimates prepared by an engineer, design documents and engineering analysis must be signed and sealed by an Arizona Registered Professional Engineer, and must not include labels such as "Draft", "Preliminary", or "Not for Construction" per A.R.S. § 32-101(B)(10 and 11) and 32-125.

Provide the cost estimates in the spaces provided below and attach supporting documentation for the cost estimates.

a. Construction $ NA
b. Operation $ NA
c. Maintenance $ NA
d. Closure $ NA
e. Post-Closure $ NA

See Attachment D

19. Financial Assurance Demonstration for either (a) non-government or (b) government:

Indicate which financial assurance demonstration will be provided to cover the cost of Closure and Post-closure. It is preferable to wait for ADEQ to review and approve the cost estimates prior to submitting the finalized financial demonstration required by Item 19; simply indicating the type of demonstration is adequate for submittal of the application. Please see the ADEQ website for financial assurance mechanism templates and instructions at http://azdeq.gov/financial-responsibility-options-apps

Provide information based on whether the Applicant/Permittee is a non-government or government entity:

a. A non-government entity:
   i. Financial Assurance Mechanism selected Letter of credit
   ii. Details of any financial mechanism held by another government agency for the purpose of closure and post-closure activities described in the closure plan/strategy, provided in Report Section/Appendix _____
   iii. A letter on Company letterhead signed by the Chief Financial Officer, as required by A.A.C. R18-9-A203, is attached in Report Section/Appendix _____

b. A government entity:
   i. A statement that indicates how the entity is capable of meeting the costs listed in the Cost Estimate section above is included in Report Section/Appendix _____

APPLICATION TECHNICAL INFORMATION

20. Facility description, including the following information, is provided in Report Section/~~Appendix~~ Attachments A, B, C and Section 2

a. A general description of what the facility does. Section 2

b. When operations began or are estimated to begin. 2018 per Section 2

c. A general description of the facility process as it relates to the discharge, including: Section 2.13

    i. Operating, proposed and closed discharging facilities, or activities that discharge, Section 2.13, Figure 5

    ii. source(s) of wastewaters/waste, and Figure 5

    iii. facility or location where the wastewater/waste is discharged. Figure 3

NOTE: see the Definitions section for "discharging facility" and "discharge"

21. Process flow diagram that shows the activity producing the discharge (e.g. wastewater treatment, cooling, manufacturing), including the pertinent elements that affect the quality of the discharge, is included as Report Section/Appendix Figure 5 and Attachment A

22. List the discharging facilities and activities that discharge in the table below. Indicate whether they are currently operating/existing, are proposed as new, or are to be closed as part of this permit application, and provide their location [A.R.S. 49-241]. Additional facilities listed in Report Section/Appendix NA

Facility or Activity Name (e.g. Evaporation Pond 1)	Existing, Proposed or to be closed	Latitude	Longitude
Lined Tailing Storage facility	existing	31 ° 27 ' 59.4 "	110 ° 43 ' 35.8 "
Underdrain Collection Pond	existing	31 ° 27 ' 59 "	110 ° 43 ' 39.2 "
AZPDES Outfall 1	existing	31 ° 28 ' 15 "	110 ° 43 ' 43.43 "
AZPDES Outfall 002	proposed	31° 27' 56.62"N	110° 43' 11.51"W

23. Map(s) [A.A.C. R18-9-A202(A)(1)], included in Report Section/Appendix Figures Section in main text

Include the following:

1) North arrow All Figures
2) Scale All Figures
3) Topography with sufficient resolution and legible elevations of contours for the facility Figure 2, Attachments B and C
4) Facility location Figures 1,3
5) Property line(s) and use of adjacent property Figure 2
6) Overlay of State or Federal land Figure 2
7) All known water wells within 1/2 mile of property boundary Table 1, Figure 4
8) Labeled with ADWR Well Number, latitude and longitude Table 1 in Section 2.4, Figure 4
9) Provide the uses and well construction details of the water wells, if known, water level elevations in the wells, and highlight/identify the nearest downgradient well. Tabulation of this data to prevent excessive labeling on the site plan itself is preferred.) Table 1 in Section 2.4

24. Site Plan [A.A.C. R18-9-A202(A)(2), (4) and (8), A.R.S. 49-244], included in Report Section/Appendix Figures Section

Include the following:

1) North arrow Figures 1-4
2) Scale igures 1-4
3) Property lines Figures 1-4
4) Structures NA
5) Water wells Figure 4
6) Injection Wells none
7) Drywells and their uses none
8) Topography Figure 2. Detail provided in Attachments B and C
9) All known borings exploratory borings are plugged and abandoned
10) 100-year floodplain (FEMA Flood Insurance Rate Map (FIRM) 100-year showing floodplain boundary preferred) ZONE D per original application
11) Surface water bodies Harshaw Creek and Alum Gulch shown on Figures 2, 3 and 6
12) Surface water flow direction(s) Figure 3
13) Groundwater flow direction(s) Figure 3. Detail provided in Figure 10 of original application
14) Pollutant Management Area (PMA) Figure 6

NOTE: In cases where the site is very large, there are multiple PMAs or there is an excessive amount of information that would make the site plan indecipherable, it may be clearer to provide site plans for discrete areas or provide a separate site plan with the PMA, DIA and POC wells.

15) Discharge Impact Area (DIA). Figure 6

Also, include the following with the latitude and longitude:

1) Discharging facilities/discharge locations and existing and proposed Point of Compliance (POC) locations and/or wells Section 2.13
2) Tabulation of this data to prevent excessive labeling on the site plan itself is preferred.
    a. ***For open pit mine facilities***, show the delineation of the passive containment capture zone (PCCZ) and the open pit boundary, if relying on this for BADCT.
    b. ***For Sewage Treatment Facilities*** include effluent sampling and effluent discharge location(s) with latitude and longitude, and setback distance(s) measured from the treatment and disposal components within the sewage treatment facility to the nearest property line of an adjacent dwelling, workplace, or private property.

- **Is this application for a Sewage Treatment Facility (STF)? YES___ NO_x_**
- **If you answered "YES" to the question above, skip items #25 through 27, and proceed to item #28.**

25. Characterization of discharge [A.A.C. R18-9-A202(A)(4)], included in Report Section/~~Appendix~~ Attachments A & B

For all non-STF facilities: provide characterization of discharge to include a summary of known past and proposed facility discharge activities. Provide estimated discharge characteristics or results of actual discharge characterization, and quantities/flow rate. Tabulated data is preferred with laboratory results included as an appendix.

Professional Document Requirements

Please note that, except as exempted by A.R.S. § 32-144.A.7 (employees of mining companies), professional documents, such as reports, plans and specifications, are to be signed by an Arizona registered engineer or geologist (A.R.S. § 32-125). Cost estimates prepared by an engineer, design documents and engineering analysis must be signed and sealed by an Arizona Registered Professional Engineer, and must not include labels such as "Draft", "Preliminary", or "Not for Construction" per A.R.S. § 32-101(B)(10 and 11) and 32-125.

The following application sections are typically considered professional documents: Application Items 26 through 32 (Design Documents, BADCT Description, Hydrogeologic Study, Demonstration of Compliance with AWQS at POC, Monitoring Proposal, Contingency Plan, and Closure/Post-closure Plan/Strategy) and Item 35, 36 and 39 for Sewage Treatment Facilities (Design Report, Engineering Plans and Specifications, and Sludge Treatment facilities).

26. Design Documents [A.A.C. R18-9-A202(A)(3)], included in Report ~~Section/Appendix~~ Attachments A, B, C

For all non-STF facilities: provide facility design documents, proposed or as-built, indicating the configuration or other engineered elements of the facility affecting discharge. Drawings must be legible with readable font sizes and include sufficient detail to indicate the key design features. When formal as-built plans are not available, provide documentation sufficient to allow evaluation of those elements of the facility affecting discharge, following the demonstration requirements of A.R.S. 49-243(B).
Provide construction specifications and a quality control/quality assurance plan for new facilities.

27. Best Available Demonstrated Control Technology "BADCT" Description[5] [A.A.C. R18-9-A202(A)(5)], included in Report Section/~~Appendix~~ Sections 3 and 4, Attachments A, B, C

For all non-STF facilities: provide design information pertaining to all discharging facilities including all calculations/analyses to demonstrate that all facilities are designed per BADCT guidance or rule.

Examples include: facility sizing, stability analyses, water balance, freeboard calculations, liner leakage rate calculations

For further specifics, please see the Mining and Industrial APP Engineering Substantive Checklist on the ADEQ website: http://www.azdeq.gov/node/542.

28. Hydrogeologic Study or justification that a limited study or no study is required [A.A.C. R18-9-A202(A)(8)], included in Report Section/Appendix See Sec. 5 of original APP Application and Attachment E
For further specifics, please see the Hydrology Substantive Review Checklist on the ADEQ website: http://www.azdeq.gov/node/542. due to TSF being constructed using prescriptive BADCT and AZPDES discharge meeting all surface and groundwater standards, limited hydro study was conducted.

29. Demonstration of Compliance with AWQS at POCs [A.A.C. R18-9-A202(A)(6)], included in Report Section/~~Appendix~~ 6
For further specifics, please see the Hydrology Substantive Review Checklist on the ADEQ website: http://www.azdeq.gov/node/542.

30. Monitoring Proposal [A.A.C. R18-9-A202(A)(9)], included in Report Section/~~Appendix~~ 7

A detailed proposal indicating the alert levels, discharge limitations, monitoring requirements, compliance schedules, and temporary cessation or plans that the Applicant will use to satisfy the requirements of A.R.S. Title 49, Chapter 2, Article 3 and Articles 1 and 2 of Chapter 9. Include as applicable, discharge and groundwater monitoring and operational/inspections. Indicate sampling point(s) with latitude and longitude (e.g. effluent, discharge, groundwater monitoring or other sampling points)

31. Contingency Plan [A.A.C. R18-9-A202(A)(7) and R18-9-A204], included in Report Section/~~Appendix~~ Revisions in Section 12 of Attachment C

32. Closure and Post-closure Plan/Strategy [A.A.C. R18-9-A202(A)(10)], included in Report ~~Section/Appendix~~ ~~NA~~ Attachment D

For further specifics, please see the Closure and Post-closure Plan/Strategy and Cost Estimate Checklist on the ADEQ website http://www.azdeq.gov/node/542

Sewage Treatment Facility Applications ONLY (Items 33 through 39)

33. For Sewage Treatment Facilities (STFs), indicate the effluent disposal method(s) to be utilized and the disposal capacity for each method [A.A.C. R18-9-B202]:

Disposal Method	Flow capacity (gal/day)
☐ Beneficial reuse under a Recycled Water Permit	
☐ Surface impoundment primarily for evaporation	
☐ Surface impoundment primarily for recharge to groundwater	
☐ Discharge to a Water of the U.S. under a Clean Water Act Permit (NPDES/AZPDES)	
☐ Vadose zone injection wells	
☐ Injection wells directly into groundwater	
☐ Land application for disposal; not reuse	
☐ Other, describe: ________________________ __________	

34. Documentation that the Sewage Treatment Facility is in conformance with the Area-wide 208 Quality Management Plan for Sewage Treatment Facilities [A.A.C. R18-9-A201(B)(6)]. Included in Report Section/Appendix _____

For further information on the 208 requirements, please see the ADEQ website http://www.azdeq.gov/208-review

35. Sewage Treatment Facility Design Report [A.A.C. R18-9-B202], attached in Report Section/Appendix _____

Include information pertaining to all discharging facilities including all calculations/analysis to demonstrate that all facilities are designed per BADCT treatment performance requirements in rule. In addition, include facility sizing, stability analyses, water balance, freeboard calculations, and liner leakage rate calculations. An Arizona registered engineer shall seal the design report.

For further specifics please see the WWTP engineering review checklist on the ADEQ website http://www.azdeq.gov/node/542.

36. Sewage Treatment Facility Engineering Plans and Specifications [A.A.C. R18-9-B203], included in Report Section/Appendix _____

The documents may include manufacturer's specifications and cut sheets and shall be sealed by an Arizona registered engineer.

37. Sewage Treatment Facility Recycled Water classification [A.A.C. R18-11, Article 3]: Select

38. Sewage Treatment Facility Set-back map [A.A.C. R18-9-B201(I)], included in Report Section/Appendix _____

39. Sewage Treatment Facility sludge treatment and disposal description [A.A.C. R18-9-B202]. Included in Report Section/Appendix _____

If treatment or disposal at the facility includes discharging facilities, include the Design and BADCT information required by Items 26 and 27 above. Example of a discharging facility is a sludge drying bed.

END OF APPLICATION FORM

REGISTERED GEOLOGIST
CERTIFICATE NO.
44511
ALISON H.
JONES
Date Signed 8/14/20
ARIZONA, U.S.A.
Expires 06/30/ 2021

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AMI	Arizona Minerals, Inc.
APP	Aquifer Protection Permit
A.R.S.	Arizona Revised Statutes
ASARCO	ASARCO LLC
AWQS	Aquifer Water Quality Standard
AZPDES	Arizona Pollutant Discharge Elimination System
BADCT	Best Available Demonstrated Control Technology
B&V	Black & Veatch
BMP	Best Management Practice
BQE	BQE Water
Clear Creek	Clear Creek Associates, LLC
cy	cubic yards
Mcy	million cubic yards
DIA	Discharge Impact Area
DL	Discharge Limit
ELG	Effluent Limitation Guideline
EPA	Environmental Protection Agency
ERC	Ecological Resources Consultants, Inc.
ET	evapotranspiration
ft	feet
ft/day	feet per day
gpm	gallons per minute
MIW	mining influenced water
NOV	Notice of Violation
mg/L	milligrams per liter
MSGP	multi-sector general permit
PAG	Potentially Acid Generating

pCi/L	picocuries per liter
PE	Professional Engineer
PMA	Pollutant Management Area
POC	Point of Compliance
RG	Registered Geologist
SRCE	Standardized Reclamation Cost Estimator
SWPPP	stormwater pollution prevention plan
SWQS	surface water quality standard
TSF	tailing storage facility
UCP	Underdrain Collection Pond
VRP	Voluntary Remediation Program
WTP	Water Treatment Plant

1 INTRODUCTION

1.1 APP Background

Arizona Minerals, Inc. (AMI) is the applicant to the Arizona Department of Environmental Quality (ADEQ) for a significant amendment to Aquifer Protection Permit (APP) P-512235. AMI submitted the initial permit application to ADEQ in June 2017. The permit was issued in January 2018 and amended in April 2019 and August 2020.

An "other" amendment application was submitted to ADEQ on May 29, 2020. That amendment was prepared to upgrade the treatment technology in Water Treatment Plant (WTP) 1 and to allow placement of solids (solids from WTP1 and core cutting, as well as potentially acid-generating (PAG) material from surface construction) on the lined tailing storage facility (TSF).

1.2 Proposed Permit Amendment Objectives

The purpose of this significant amendment is to make the following revisions to the APP:

- Add a second surface discharge location, Arizona Pollutant Discharge Elimination System (AZPDES) Outfall 002. A new water treatment plant (WTP2) will be constructed with a proposed discharge to a channel that will convey the discharge to ephemeral Harshaw Creek. The best available demonstrated control technology (BADCT) for this proposed discharge is the treatment provided by WTP2, which is designed to treat influent water to applicable standards (Section 3). AMI is submitting an AZPDES permit application for this discharge.
- Authorize a revision to the TSF design. Under the current version of the APP, the TSF is not permitted to exceed an elevation of 5110 feet (ft) above mean sea level. This amendment updates the TSF design by increasing the maximum elevation by 65 ft to 5175 ft and revising the stacking geometry. No expansion of the currently permitted footprint is proposed in this amendment application (Section 4).
- Revise the Pollutant Management Area (PMA) and Discharge Impact Area (DIA) to reflect the additional surface discharge (Section 6).
- Correct a minor permit condition that was included in error in the original permit (Section 5).
- Update closure costs and financial assurance mechanism.

2 PROJECT INFORMATION

2.1 Project Location

The project location is shown on Figure 2. The Trench Camp, Josephine, Hardshell, Alta, Norton, and January Mine patented claims (Property) are part of the Hermosa Project, which is located approximately 5 miles south of the Town of Patagonia, Arizona (Figure 2). The property is in T22S, 16E Sec 32 and T23S, R16E unsurveyed sections 4 and 5, Gila and Salt River Meridian, in Santa Cruz County, Arizona. The January and the Norton mine claims are recognized under a single property designation by the Santa Cruz County Recorder, having been assigned parcel number 105-50-001B. The Trench Camp and Josephine Mine claims make up parcel 105-50-001A. The Alta claim is parcel no. 105-49-002 and the Hardshell claim is parcel 105-49-003A. AMI owns additional parcels in the area as shown on Figure 2. The U.S. Forest Service manages the surrounding adjacent lands, as part of the Coronado National Forest.

2.2 Project Background

Mining activity has taken place intermittently at the site since the early 1870s. It was last operated by the American Smelting and Refining Company, precursor to ASARCO LLC (ASARCO) from 1925 to 1949. AMI acquired the property in 2016 from ASARCO and the ASARCO Multi State Environmental Custodial Trust.

In 2017, AMI applied to the VRP, and submitted applications for an APP and an AZPDES permit, to build and operate the following facilities:

- A TSF with a geomembrane liner to receive historical tailings and development rock. Construction of this facility began in 2018. By October 2019, all of the historic tailings were moved to the lined TSF.
- An underdrain collection pond (UCP) to collect tailing seepage. Construction of this facility was completed in October 2018.
- A water treatment plant (WTP1) to treat underdrain seepage and storm runoff from the TSF and water from the January Adit mine workings prior to discharging to Alum Gulch. Construction of this facility was completed in July 2018 and it became operational in October 2018. No discharge has yet occurred to Alum Gulch, however, as AMI has reused the treated water on-site.

The locations of these facilities are shown on Figure 3.

AMI, a Nevada corporation doing business in Arizona, is an independent company whose ultimate parent is South32, a mining company organized under Australian law. South32 purchased the stock of AMI via a subsidiary in 2018 from its previous corporate parent, Arizona Mining, Inc.

AMI submitted an "other" amendment to the APP to ADEQ on May 29, 2020. The amended permit allowed:

- upgrades to the treatment technology in WTP1, and
- placement of solids from WTP1, solids from cutting of exploration core, and material from construction (including material that may be PAG), on the TSF.

2.3 Current Project Status

The Hermosa Project is currently in the pre-feasibility phase, and exploration drilling is ongoing.

Construction of twin exploration declines was started at around the time the VRP project was approved. Progression of the declines was paused early in the construction phase of the VRP project. AMI currently has plans to restart development of the exploration declines.

The following activities are required to support the construction of the exploration declines and exploration activities:

- Depressurization of rock units (i.e. dewatering) that will be intersected by subsurface exploration is required for safety. Developing the exploration decline without advanced dewatering presents a risk of uncontrollable groundwater inflows entering the decline.

- Treatment and discharge of groundwater from a new water treatment plant (WTP2).

- Stormwater controls, core cutting activities, and exploration drilling are all required for continued exploration. Water from each would potentially be treated and discharged at WTP2.

- Placement of exploration decline development rock, PAG construction rock, water treatment solids, sediment from stormwater best management practices (BMPs), and drill cuttings on the TSF.

This significant APP amendment application was prepared to permit the discharges (as defined in Arizona Revised Statutes [A.R.S.] 49-201(12)) related to these activities.

Seepage from the TSF and water from the January Adit will continue to be treated by WTP1 according to the original APP and the "other" amendment.

2.4 Well Inventory

Water supply wells within ½ mile of the project boundary are shown on Figure 4. Information regarding these wells is provided in Table 1 below. Wells are labeled with the registration number assigned by Arizona Department of Water Resources (ADWR). ADWR classifies wells as exempt or non-exempt. An exempt well is a well having a pump with a maximum capacity of not more than thirty-five gallons per minute (gpm) which is used to withdraw groundwater pursuant to A.R.S. § 45-454. A non-exempt well is a well having a pump with a maximum capacity of **more** than thirty-five gpm which is used to withdraw groundwater. Borings classified as monitor wells, exploration boreholes, and geotechnical borings by ADWR are not shown on Figure 4. The nearest downgradient well is well 64276, which is a stockwater well owned by the US Forest Service.

The non-exempt wells shown on Figure 4 are owned by AMI.

Wells classified by ADWR as monitor or geotechnical wells are not shown on Figure 4.

Table 1: Exempt and Non-exempt Wells Within One-Half Mile of Project Site

ADWR Well Registry ID	Well Name	Well Type (ADWR designation)	AMI Well?	Use	Well Depth (ft)	Latitude (degrees)	Longitude (degrees)
226139	MW-2	EXEMPT	y	monitor	1005	31.464672	-110.7287
226398	HDS-349	EXEMPT	y	monitor	1045	31.459331	-110.7287
226902	JA-2	EXEMPT	y	pumping for treatment per VRP	125	31.472245	-110.72993
227120	WW-1	NON-EXEMPT	y	production	1325	31.459542	-110.71294
515312	USFS	EXEMPT	n	domestic	140	31.451319	-110.72871
620838	"Welch Well Shaft"	NON-EXEMPT	y	Not in use. Historically used for Trench Mine (non-AMI)	412	31.461992	-110.71172
620839	"Josephine Shaft"	NON-EXEMPT	y	abandoned	750	31.466041	-110.72764
642746	USFS	EXEMPT	n	stockwater, wildlife	0	31.476623	-110.73529
910210	JA-1	EXEMPT	y	pumping for treatment per VRP	110	31.472245	-110.72993
913354	HDS-130	NON-EXEMPT	y	monitor	550	31.464667	-110.71383
913499	HDS-188	EXEMPT	y	monitor	800	31.464703	-110.71809
920323	HDS-356	EXEMPT	y	monitor	3576	31.462033	-110.7181
920459	HT-1	NON-EXEMPT	y	production	3700	31.461578	-110.71932
921646	AW-1	NON-EXEMPT	y	monitor	1006	31.451323	-110.72659

2.5 Facility Compliance History

There are no outstanding compliance issues. One NOV was issued to AMI in the past two years. ADEQ issued an NOV on April 10, 2019 to AMI alleging (1) inadequate and insufficient control measures to manage on-site erosion, sediment and stormwater runoff, (2) a failure to minimize erosion and sedimentation according to the MSGP, and (3) failure to control discharge as necessary to not cause or contribute to an exceedance of an applicable water quality standard. After AMI responded, ADEQ closed the NOV based upon a determination that AMI met the "Documenting Compliance" provisions of the NOV.

2.6 Applicant and Permittee

Arizona Minerals, Inc., 2210 E. Ft. Lowell, Tucson, AZ 85719.

2.7 Landowners

Arizona Minerals, Inc. Same address as above.

2.8 Facility's Emergency Contact Person

Primary Contact – Emergency Response Coordinator:

Contact Name: Brent Musslewhite

Job Title: Director, Environment and Permitting

Address: 2210 East Fort Lowell Road Tucson, Arizona 85719

Office Number: 520-485-1300

Site Security Office: 520-539-8082

Email: Brent.Musslewhite@south32.net

Secondary Contacts – Back up for Emergency Response Coordinator:

Contact Name: Sarah Richman

Job Title: Principal, Environment and Permitting

Address: 2210 East Fort Lowell Road Tucson, Arizona 85719

Office Number: 520-485-1300

Site Security Office: 520-539-8082

Email: Sarah.Richman@south32.net

Contact Name: Kara Haas

Title: Principal, Environment

Address: 749 Harshaw Road, Patagonia, AZ 85624

Email: Kara.Haas@south32.net

Site Security Office: 520-539-8082

2.9 Physical Address

749 Harshaw Road, Patagonia, AZ 85624

2.10 Legal Description

The Property consists of parcel numbers 105-50-001A (253.23 acres), 105-50-001B (41.23 acres), and 105-49-003 (14.3 acres) and 105-49-002 (20.11 acres) as shown on Figure 2.

2.11 Zoning

Mining activities are not subject to local zoning requirements pursuant to A.R.S. § 11-812(A)(2).

2.12 Technical Capability

2.12.1 Arizona Minerals, Inc.

- Brent Musslewhite. Director, Environment & Permitting, has over 26 years of experience in environmental, permitting and remediation projects associated with mining. He received a BS in Soil Science in 1994 and MS in Soil Science in 2002.
- Sarah Richman. Principal, Environment & Permitting, has over 7 years of permitting experience with 5 years focused on mining in Arizona. She received a MS in Environmental Science and Management in 2013.
- Dennis Bailey. Hermosa Site Engineering Manager has over 30 years of engineering experience, in the design, development, and construction of mining industrial facilities. He received a BS degree in Mechanical Engineering in 1989 and an MBA in 2000.
- Kara Haas. Principal, Environment, has over 17 years of environmental experience, and has worked on a variety of projects including environmental permitting, compliance and reclamation at mining sites. She received a BS degree in Geology in 2000 and a MS degree in Hydrogeology in 2002.

2.12.2 Clear Creek Associates, LLC

As the hydrogeological consultant on the Project, Clear Creek Associates LLC (Clear Creek), is registered with the Arizona Board of Technical Registration to perform work that falls within the statutory definition of Geological practice. The Clear Creek team includes the following individuals:

- Douglas Bartlett, Registered Geologist (R.G.) Arizona Registered Geologist No. 25059. Principal Hydrogeologist for Clear Creek. Mr. Bartlett has over 30 years of technical experience. He received a BS degree in Geology in 1977 and an MS degree in Geology in 1984.
- Alison Jones, R.G. Arizona Registered Geologist No. 44511. She is a Senior Associate at Clear Creek where she manages mining support and environmental projects. She has over 25 years of technical experience. Ms. Jones received a BS degree in Geology in 1979 and an MS degree in Geology in 1983.
- James Norris, R.G. Arizona Registered Geologist No 30842. Mr. Norris is a Senior Associate for Clear Creek where he manages water supply, mining support and other projects. He has over 40 years of technical experience. Mr. Norris received a BS degree in Geology in 1976, an MS in Geosciences in 1981, and an MS in Hydrology in 1989.

2.12.3 NewFields

As the engineering consultant for the TSF and UCP at the Property, NewFields personnel are registered Professional Civil Engineers capable of performing civil design work. The NewFields team includes the following individual:

- Craig Thompson, P.E. Registered Professional Engineer (P.E.) in Arizona (License No. 63431) and Colorado (License No. 49559). Project Engineer for NewFields. Mr. Thompson has over 9 years of engineering experience. He received a BS degree in Civil Engineering in 2009.
- R Michael Smith, P.E. Registered P.E. in Colorado (License No. 28114), Nevada (License No. 16194) and Alaska (License No. CE8785). In addition, Mr. Smith formerly held PE licenses in Arizona, and Wyoming. Mr. Smith has over 37 years of professional Civil Engineering experience, the last 32 of which have been focused on civil design and construction for the mining industry. Mr. Smith received a BS in Civil Engineering in 1983 (University of Colorado).

2.12.4 BQE Water

BQE Water (BQE) was directly contracted by Black and Veatch (B&V) to provide process engineering and process design for this project.

- David Kratochvil is President and CEO of BQE. He is a Professional Engineer registered in British Columbia, Canada (license # 24214) and has over 25 years of experience in mine water management and treatment including permitting, treatment options assessment, bench/pilot testing, engineering design, plant commissioning, and long term operations. David holds a doctorate degree in chemical engineering from the McGill University in Montreal, is a named co-inventor on four patents issued by the US and Canadian patent offices, and is the author of more than 40 peer reviewed technical papers published globally.

2.12.5 Black & Veatch

B&V is the primary contractor, responsible for detail design and procurement for WTP2.

- Kevin Lee, P.E. Professional Engineer No. 19104 in the State of Kansas. Mr. Lee is a Project Manager with a civil engineering background. He has nearly 20 years of experience in water and wastewater treatment for both municipal and industrial plants. Mr. Lee received a BS degree in Civil Engineering in 2002 and an MCE degree in Civil Engineering in 2012.
- Erick Bevington, P.E. Professional Civil Engineer No. 47558 in the State of Arizona. Mr. Bevington is Director of Engineering for B&V's Water Mining Business. He has nearly 20 years of experience in process study, preliminary design, detailed design, construction, startup, and commissioning of complex water and wastewater treatment plants for municipal and municipal/industrial uses. Mr. Bevington received a BSE in Civil Engineering from Arizona State University in 2002.

2.12.6 Ecological Resources Consultants, Inc.

Ecological Resources Consultants, Inc. (ERC) provided hydrologic expertise to delineate the extent of surface flows in Harshaw Creek.

- Troy Thompson, PE is the co-founder and president of Ecological Resource Consultants, Inc. Mr. Thompson received a Bachelor's degree in Civil and Environmental Engineering from Cornell University in 1993 and a Master's degree in Civil Engineering from the University of Colorado in 1997. He is a professional engineer licensed in the State of Colorado (#32913) and has over 25 years of experience specializing in hydrology, hydraulics, geomorphology, and stream restoration.

2.13 Permitted Discharging Facilities

The currently permitted APP facilities are listed in Table 2 below.

Table 2: APP-Permitted Facilities

Facility	Latitude	Longitude
Lined Tailing Storage Facility (TSF)	31° 27’ 59.4” N	110° 43’ 35.8” W
Underdrain Collection Pond (UCP)	31° 27’ 59” N	110° 43’ 39.2” W
AZPDES Outfall 001	31° 28’ 15” N	110° 43’43” W

The proposed new facility in this amendment is AZPDES Outfall 002. This outfall will be located at Latitude 31° 27’ 56.62”N, Longitude 110° 43’11.51”W.

2.14 Financial Capability

The proposed changes to the APP for this amendment require revisions to the closure costs for the TSF. These are included in Attachment D. A letter of credit will be provided as the financial assurance mechanism for this permit.

3 BADCT--AZPDES OUTFALL 002

AMI is the applicant for an AZPDES permit for a discharge to Harshaw Creek. The AZPDES permit application was submitted concurrently with this significant APP amendment. Discharges to Harshaw Creek are required to meet Aquifer Water Quality Standards (AWQSs) under the APP program, as well as effluent limits based on applicable surface water quality standards (SWQS) and technology-based effluent limitation guidelines (ELGs) (40 C.F.R. Part 440, Subpart J) that will be specified in an AZPDES permit. A design document prepared by BQE documenting that the WTP2 effluent is expected to meet all applicable standards is provided in Attachment A.

3.1 Influent Sources and Water Quality

WTP2 was designed by BQE to meet the most stringent of applicable SWQSs, AWQSs, and ELGs. Influent water chemistry predictions are discussed in Section 2 of Attachment A.

BQE used influent water quality provided by AMI to design WTP2. WTP2 will treat water from the following sources:

- Groundwater pumped from a wellfield to depressurize and dewater the fractured rock aquifer.
- Groundwater and operational water pumped from underground workings
- Tailing seepage and January Adit water
- Treated water from WTP1
- Drilling water and core cutting water
- Water from stormwater BMPs

AMI has estimated the concentration ranges of metals and other constituents expected in influent to WTP2 based on (a) groundwater samples from a well in the area where depressurization and dewatering will take place, (b) water samples from the UCP and January Adit, (c) stormwater samples, and (d) leaching test results for the rock types in exploration decline.

A range of expected water quality exists for influent source to WTP2 because the proportions of different inflows will vary over time. The primary source is groundwater from the depressurization wells, which is expected to initially make up 85% of the water reporting to WTP2. As the depressurization wells yields decline, the amount of water reporting to WTP2 will decline accordingly.

The table below lists the expected maximum and minimum concentrations of inorganic constituents expected to be present in WTP2 influent as compared with the AWQSs.

Table 3: Expected WTP2 Influent Chemistry

ANALYTE	UNIT	MINIMUM (1)	MAXIMUM (1)	AWQS
Antimony	mg/L	0.0039	0.004	0.006
Arsenic	mg/L	0.073	0.075	0.05
Barium	mg/L	0.024	0.025	2
Beryllium	mg/L	<0.000013	<0.002	0.004
Cadmium	mg/L	0.0009	0.0012	0.005
Chromium	mg/L	0.0046	0.0048	0.1
Fluoride	mg/L	0.17	0.18	4
Lead	mg/L	0.042	0.059	0.05
Mercury (2)	mg/L	0.0000051	0.0000051	0.002
Nickel	mg/L	0.008	0.009	0.1
Selenium	mg/L	0.027	0.029	0.05
Thallium	mg/L	0.0003	0.00033	0.002
Nitrate-N	mg/L	Nitrogen species not estimated		10
Nitrite-N	mg/L	Nitrogen species not estimated		1
Cyanide (free)	mg/L	<0.0039	<0.1	0.2

(1) numbers preceded by "<" indicate the constituent was not detected.

(2) Mercury was not detected at Method Detection Levels ranging from 0.00003 to 0.002 milligram per Liter (mg/L), a single detection at 0.0000051 mg/L occurs in a groundwater sample analyzed with a Method Detection Level of 0.0000002 mg/L.

With the exception of lead and arsenic, influent concentrations to WTP2 are expected to be below AWQSs.

3.2 Design Basis

WTP2 is designed and will be constructed to treat up to 4500 gpm. Three parallel treatment trains, each capable of treating 1500 gpm, allow the throughput to be scaled back for lower flows while maintaining efficiency. It is currently anticipated that discharge may be near 4500 gpm in early stages of depressurization, but will drop as depressurization advances.

The process flow diagram (Figure 5) graphically shows the treatment technologies, which are described in detail in Attachment A. WTP2 will have two treatment circuits. The first circuit will remove suspended solids (TSS) and metals. The second circuit will remove will remove selenate (a species of selenium not removed in the first circuit) and consists of an ion exchange column circuit and an Electro Reduction Circuit. Several treatment alternatives were evaluated to identify the BADCT design. Those alternatives are discussed in Attachment A.

3.3 Outfall Structure

The WTP2 outfall structure design by Fluor is provided in Attachment B. The structure is designed to convey discharge water to Harshaw Creek and minimize erosion by slowing the flow velocity of treated water as it is discharged to the land surface.

A 30-inch diameter pipeline will convey the design flow of 4,500 gpm from WTP2 to the outfall structure. The pipe will be installed on steep slope (average slope 22%). The pipe material will be HDPE DR 11 installed in an earth berm to avoid excess excavation on the steep slope. The pipe will be anchored to stabilize and prevent movement. The end of pipe will be connected to the top of the outfall chamber.

The outfall structure/ chamber will be a precast concrete unit having approximate dimensions of 17 ft long x 6 ft wide x 8 ft deep. The chamber will act as an energy dissipater by bringing the flow velocity to zero in the chamber before the overflow at the downstream side of the chamber. The 30-inch diameter pipe discharges water to the existing channel (a tributary to Harshaw Creek). The inlet to the existing channel will be lined with non-woven geotextile and a layer of Class 10 Riprap.

3.4 Operation

Operation of WTP2 is discussed in Section 12 of Attachment A.

3.5 Closure

At closure, the contributors of flow reporting to WTP2 will cease. Therefore, closure of WTP2 will consist of turning off the system, which will stop the APP-permitted discharge. WTP2 will not be needed to treat TSF seepage, which is expected to be minimal and will be treated by WTP1 or the passive treatment system envisioned for development within the UCP at/after closure. Decommissioning of WTP2, including removal of unused reagents or other fluids, will be included in the mine reclamation costs.

4 BADCT AMENDMENT—TAILING STORAGE FACILITY

The TSF was designed as a lined permanent storage area for placement of historic tailings and development rock, some of which may be PAG. It was constructed using prescriptive BADCT. The current TSF is permitted to store historic tailings from Tailings Piles 1 through 4, development rock from the Exploration Decline, filter cake from Water Treatment Plant 1 (WTP1), core cutting material from exploration core sample preparation, and construction PAG.

To date, all the historic ASARCO tailings from unlined Tailings Piles 1 through 4 have been relocated permanently to the geomembrane-lined TSF. The current TSF has approximately 506,000 cubic yards (cy) of remaining storage for permitted materials up to the currently-permitted elevation of 5,110 ft.

AMI has identified additional materials that will require storage on the lined TSF. With the proposed elevation increase, AMI proposes to add solids from WTP2, drilling, and stormwater BMPs as materials authorized for placement on the TSF. The relative quantities of materials to be placed in the TSF are summarized in Table 1.1 of the NewFields design report in Attachment C.

In addition to placing additional materials in the TSF, AMI proposes to increase the height of the TSF from the currently permitted crest elevation height of 5110 ft to 5175 ft. The stacking geometry will also change. The proposed height and stacking geometry changes will result in a total increase in the TSF storage capacity from approximately 1.7 million cubic yards (Mcy) to 2.7 Mcy. The footprint, and therefore the geomembrane liner, of the TSF will not change.

Other elements of the TSF BADCT are provided in Attachment C. Many are unchanged from the original BADCT design. They include design components such as horizontal drains, an underdrain collection system, rock armoring, stormwater management, operational and maintenance practices, and a closure strategy.

4.1 Additional Material Streams

AMI proposes to deposit solids from WTP2, drilling, and stormwater BMPs on the TSF, as needed. These materials are described below.

4.1.1 Solids from WTP2

Physical properties of WTP2 filter cake are described in Section 5.12 and 7.2.2 of Attachment C. This material is anticipated to be hauled and placed in the TSF at a rate of approximately 4,380 cy per year from the stage one filter press and approximately 146 cy per year from the stage two filter press for an aggregate total of approximately 4,526 cy per year. The WTP2 filter cake material properties are assumed to be similar in nature to the WTP1 filter cake and therefore the placement criteria outlined in the Technical Specifications will be the same for both filter cake products.

Toxicity characteristic leaching procedure analyses conducted on material generated in bench tests indicate the filter cake is non-hazardous (Section 11 of Attachment A).

4.1.2 Drilling Solids

Drilling solids (or cuttings) are described in Sections 5.14 and 7.2.2 of Attachment C. This material is a de minimis material, as less than one cy/year is anticipated to be placed on the TSF.

4.1.3 Sediments from Stormwater BMPs

Sediments from stormwater BMPs are described in sections 5.15 and 7.2.2 of Attachment C. Approximately 1,800 cy per year are anticipated to be hauled and placed in the TSF.

4.2 Stability and Discharge Reduction

Placement of the additional materials in the TSF will not adversely impact stability of the TSF. A geotechnical evaluation, including an evaluation of stability, is provided in Section 7 of Attachment C. Inspection requirements for height, structural integrity, and piezometric head in the TSF piezometers, as required in Table 4.2.1, will not change under this amendment.

The basin liner system that was installed for the TSF will not require alteration for the proposed TSF design revisions. This amendment will not result in the TSF extending outside of the existing liner footprint. The geomembrane liner component consists of a double-sided textured 60-mil HDPE geomembrane. The geomembrane was anchored on the edge of the perimeter road at a setback of 3 ft from the upstream hinge point of the perimeter road crest.

For further details, see the leakage rate calculation presented in Section 5.4.1 and Appendix E.1 of the NewFields report (Attachment C).

4.3 Closure

The TSF closure strategy is provided in Section 13 in the Attachment C and in Attachment D. A closure configuration drawing (Drawing A500) is also provided in Attachment C.

The closure strategy includes capping the Dry Stack TSF with 1-2 ft of reseeded growth media underlain by a capillary break created by the rock armor berms placed during construction. The side slopes of the final TSF will have a 3H:1V compound slope with 2.5H:1V open slopes broken every 25 ft in vertical elevation rise by a 12.5 ft wide bench. The external detention pond will be backfilled with engineered fill and capped and reseeded with growth media.

It is expected that the post-closure underdrain flows from the TSF will be minimal. The flows will continue to be collected and transmitted to the WTP1 until a passive treatment system (i.e. an evapotranspiration [ET] cell) can be constructed in the UCP.

Post closure will require maintenance of the closure cap until a vegetated surface can be established. The closure surface will be monitored, inspected and repaired, if needed, to address water and wind erosion. In addition to the closure cap, the access roads, stormwater diversion channels and UCP areas will also be monitored, inspected and repaired, if needed.

Closure Costs are discussed in Section 8 and Attachment D.

5 OTHER PROPOSED REVISIONS

The proposed revisions to the APP are provided in Attachment F of this application. In addition to the administrative details, the authorization for additional materials to be placed on the TSF, and the text related to the BADCT provided by WTP2, the following minor clarifying revisions are proposed:

- Section 2.6.2.7: remove “and UCP” from the section title. This was an error that was not identified in the initial draft of the permit. The UCP piezometer is not installed within a liner, and therefore the 1.5-foot alert level is not applicable to the piezometers downgradient of the UCP.
- Section 2.2.1.2: These piezometers are not within a liner, and thus the 1.5 ft of saturation is not relevant. Revise the last paragraph of this section accordingly.
- Contingency plan revisions as noted in Section 4 of Attachment C.
- Revisions to the Compliance Schedule as noted in Section 10.

6 POLLUTANT MANAGEMENT AREA, DISCHARGE IMPACT AREA AND POINTS OF COMPLIANCE

The PMA and DIA will be revised as shown on Figure 6.

6.1 Pollutant Management Area

The PMA was drawn to circumscribe the APP-regulated facilities, including the TSF, the UCP, the estimated extent of surface flows of the discharge from WTP1 in Alum Gulch, and the estimated extent of surface flow of the discharge from WTP2 in Harshaw Creek. The infiltration calculations and resultant area predicted to be inundated are based on the maximum predicted discharge rates from the WTPs, and they exclude any losses due to ET. At times when the WTPs are operating below capacity and when ET is occurring, the extents of inundation are expected to be less than presented in this analysis. The discharge and stream flow are assumed to be constant and at steady state; the analysis does not assess transient events or changes in streambed or aquifer storage over time. The estimated extent of surface flow at 4500 gpm was determined by ERC (Attachment E). Surface flow is predicted to flow 9.4 miles from the discharge point down Harshaw Creek. The extent of flow in Alum Gulch (at 120 gpm) was also delineated by ERC in 2017. ERC's memorandum describing the methodology was provided in Attachment E of the initial (2017) APP application.

6.2 Points of Compliance

The current version of the APP has 3 Points of Compliance (POCs), as shown on Figure 6. Two are conceptual and one is an actual well. These will continue to be POCs in the amended permit.

A conceptual POC (POC-1) is downgradient of the TSF.

Latitude:	31° 28' 15.21" N
Longitude:	110° 43' 48.83" W

POC-2 (MW-3) is located 200 ft downgradient of the AZPDES discharge.

Latitude:	31° 28' 18.91" N
Longitude:	110° 43' 48.83" W

POC-3 is a conceptual location approximately one mile to the north-northwest and downgradient of the WTP outfall.

Latitude: 31° 29' 1.7" N

Longitude: 110° 44' 16.4" W

AMI proposes to add a conceptual POC at the estimated downgradient extent of surface flow in Harshaw Creek, as shown on Figure 6. The coordinates are as follows:

Latitude: 31° 32' 2.4" N

Longitude: 110° 43' 29.3" W

Because it is anticipated that the APP will impose discharge limits (DLs) equal to AWQS at the point of discharge from WTP2, identification of the POC well as a conceptual well is appropriate.

6.3 Discharge Impact Area

Clear Creek delineated the DIA for the Harshaw Creek discharge based on the PMA identified by ERC. ERC used the anticipated discharge rate and infiltration rates for Harshaw Creek to calculate the length of flow in Harshaw Creek downstream from the WTP. The reach encompassing this length of flow equates to the PMA and it is 9.4 miles in length.

The majority of the PMA is within the stream channel of Harshaw Creek that is bounded by bedrock. Consequently, the DIA is defined as the lateral extent of the alluvium between the stream channel and the bedrock boundaries, as estimated from aerial imagery and USGS topographic maps. Due to the relatively high hydraulic conductivity values of typical stream channel sediments and adjacent alluvium, compared to the hydraulic conductivity of the bounding bedrock, pollutants in the surface discharge would likely follow the dominant hydraulic gradient and remain within the alluvial material. The unlikely migration of pollutants into the bedrock would require groundwater to flow contrary to the dominant hydraulic gradient and into a unit with much lower hydraulic conductivity.

Near the downstream limit of the discharge in Harshaw Creek, the flow is expected to enter a reach that is not bounded by bedrock; this reach overlies basin fill sediments, based on a geologic mapping (Graybeal et al, 2015). In this area, Clear Creek used a combination of an analytical (Theis) model and Darcy's Law to estimate groundwater velocity and calculate the total distance of groundwater flow over a 30-year period. The 30-year period for the DIA is consistent with the DIA along Alum Gulch previously calculated for the existing APP. Clear Creek obtained the aquifer data used in the analysis from Nasserredin (1967). The data included the following:

Transmissivity (T): 9,500 gallons per day per foot (1270 feet squared per day [ft^2/d])

Specific Yield (S_Y): 0.05

Porosity: 0.30

Aquifer Thickness: 160 ft

Nasserredin (1967) reported the transmissivity from aquifer testing near Sonoita Creek in Section 5 of Township 22 South, Range 16 East for a shallow well test in that area. Clear Creek used the storage value of 0.05 also reported by Nasserredin along with the reported porosity of the geologic materials penetrated by the tested wells. Clear Creek inferred the aquifer thickness from the reported depths of the tested wells, the geologic units reportedly encountered by the tested wells, and drillers' logs for other wells in the area.

The Theis analytical model was necessary to estimate future hydraulic gradients generated by recharge of the infiltrating surface flows on Harshaw Creek. Clear Creek constructed the model using the forward simulation option in Aqtesolv© Version 4.50 by HydroSOLVE, Inc. The analytical model was based on the Theis equation, which calculates responses to aquifer stresses using aquifer transmissivity and storage properties as input. Output from the model was contoured using Golden Surfer©.

Clear Creek applied the following inputs to the analytical model:

$T = 1{,}270\ ft^2/d$

$S_Y = 0.05$

Aquifer thickness = 160 ft

Recharge rate = 132 gpm for 30 years

The recharge rate into the aquifer was assumed to equal the flow rate in the stream. ERC estimated that the flow rate at the beginning of the final 0.31 miles of the PMA would be 132 gpm. The entire 132 gpm flow rate was applied to the analytical model. This conservative assumption is based on the limited length of the continuous stream flowing into the basin fill (less than 0.1 mile).

Using these inputs, the analytical model predicted the recharge mound would have a hydraulic gradient of 0.0047. The maximum mound height predicted at the simulated area of injection was approximately 15 ft after 30 years of continuous recharge.

The hydraulic gradient calculated from the analytical model was superimposed on the existing hydraulic gradient, which is oriented to the northwest, roughly parallel to Harshaw Creek. The existing hydraulic gradient to the northwest was calculated using 2016 and 2020 Arizona Groundwater Site Inventory (GWSI) water level data from wells D-22-16 08BAD and D-22-16 09CDD, respectively. These wells are located roughly 0.53 miles downstream and 0.57 miles upstream, respectively, from the anticipated end of surface flow. The difference in water levels at these two wells equates to a hydraulic gradient of 0.02.

The hydraulic gradients obtained from the analyses described above were then used in Darcy's Law to calculate groundwater velocity:

$V = (K/n) * dh/dl$

where:

V = groundwater velocity (ft/d)

K = hydraulic conductivity (ft/d)

n = porosity (dimensionless)

dh/dl = hydraulic gradient (dimensionless).

Clear Creek used a value of 8 ft/d for hydraulic conductivity. This value was calculated from the relationship K= T/b,

Where:

T = aquifer transmissivity (ft^2/d)

b = aquifer thickness (ft).

Assuming an aquifer thickness at the aquifer test location of 160 ft, K was calculated as follows:

K = (1270 ft^2/d) / (160 ft) = 8 ft/d

As discussed above, porosity was assumed to be 0.30.

The future hydraulic gradients were calculated to be:

0.02 + 0.0047 = 0.0247 to the northwest, and

0.0047 to the northeast and southwest.

Using these inputs, groundwater velocities and 30-year travel distances were calculated as follows:

To the northwest:

Velocity = (K/n) * dh/dl = (8 ft/d ÷ 0.30)*0.0247 = 0.66 ft/d

Distance = velocity * days = 0.66 ft/d * 30 years * 365 days/year = 7,227 ft

To the northeast and southwest:

Velocity = (K/n) * dh/dl = (8 ft/d ÷ 0.30)*0.0047 = 0.13 ft/d

Distance = velocity * days = 0.13 ft/d * 30 years * 365 days/year = 1,424 ft

The DIA is shown on Figure 6.

7 PROPOSED MONITORING REQUIREMENTS

7.1 Compliance Discharge Monitoring

Monitoring of the WTP2 effluent and the associated sampling, reporting and recordkeeping requirements will be specified in the AZPDES and APP permits. The discharge location will be located at a discharge structure in an unnamed tributary that flows to Harshaw Creek at 31° 27' 56.62"N, 110° 43'11.51" W.

AMI recommends that compliance discharge monitoring for WTP2 be conducted for the same parameters used for WTP1 in Table 4.2.2 of the APP and as shown in table 4 below.

Table 4: Recommended Compliance Discharge Monitoring

Sampling Point	Sampling Point Identification			Latitude	Longitude
3	AZPDES Outfall 002			31° 27' 56.62" N	110° 43'
Parameter	Alert Level	Discharge	Units	Monitoring	Reporting
Flow	N/A	6.480	mgd[1]	Daily[2]	Quarterly
Temperature	Monitor[3]	Monitor	Degrees	Quarterly	Quarterly
pH (field)	Monitor	Monitor	S.U.	Quarterly	Quarterly
Specific Conductance	Monitor	Monitor	μmhos/cm	Quarterly	Quarterly
Nitrate (as N)	8.0	10.0	mg/L	Quarterly	Quarterly
Nitrite (as N)	0.8	1.0	mg/L	Quarterly	Quarterly
Nitrate-Nitrite as N	8.0	10.0	mg/L	Quarterly	Quarterly
Total Dissolved Solids	Monitor	Monitor	mg/L	Quarterly	Quarterly
Total Alkalinity	Monitor	Monitor	mg/L	Quarterly	Quarterly
Sulfate	Monitor	Monitor	mg/L	Quarterly	Quarterly
Antimony	0.0048	0.006	mg/L	Quarterly	Quarterly
Arsenic	0.04	0.05	mg/L	Quarterly	Quarterly
Beryllium	0.0032	0.004	mg/L	Quarterly	Quarterly
Barium	1.60	2.00	mg/L	Quarterly	Quarterly
Cadmium	0.008	0.010	mg/L	Quarterly	Quarterly
Chromium	0.08	0.1	mg/L	Quarterly	Quarterly
Cyanide (free)	0.16	0.2	mg/L	Quarterly	Quarterly
Fluoride	3.2	4.0	mg/L	Quarterly	Quarterly
Lead	0.04	0.05	mg/L	Quarterly	Quarterly
Mercury	0.0016	0.002	mg/L	Quarterly	Quarterly
Nickel	0.08	0.1	mg/L	Quarterly	Quarterly
Selenium	0.04	0.05	mg/L	Quarterly	Quarterly
Thallium	0.0016	0.002	mg/L	Quarterly	Quarterly
Iron	Monitor	Monitor	mg/L	Quarterly	Quarterly
Copper	Monitor	Monitor	mg/L	Quarterly	Quarterly
Manganese	Monitor	Monitor	mg/L	Quarterly	Quarterly
Zinc	Monitor	Monitor	mg/L	Quarterly	Quarterly
Gross Alpha	Monitor	Monitor	pCi/L	Quarterly	Quarterly
Radium 226+228	Monitor	Monitor	pCi/L	Quarterly	Quarterly

[1] Mgd=Million gallons per day

[2] "Daily" means the days that effluent from the Water Treatment Plant is discharged to the AZPDES Outfall 002. On the days effluent from the Water Treatment Plant is NOT being discharged to the AZPDES Outfall 002, indicate "No Flow" on the SMRF reporting form.

[3] Monitor = Analysis is required but limits are not established.

7.2 Operational Monitoring

7.2.1 TSF

The TSF will be operated and inspected according to Section 11 of Attachment C, prepared by NewFields. Detailed operation and maintenance information regarding the TSF and UCP are provided in Appendix I of Attachment C.

7.2.2 WTP2

WTP2 will utilize on-site operators and 24-hour remote monitoring of the process using systems incorporated into the design of WTP2, as described in Section 12 of Attachment A.

WTP2 effluent will be monitored, as discussed in Section 12 of Attachment A, to maintain optimal plant performance and to meet the requirements in the applicable permits.

7.3 Groundwater Monitoring

Groundwater monitoring is required at POC-2 under the current permit. The TSF crest elevation increase is not expected to affect discharge characteristics or groundwater flow, and therefore does not necessitate additional POCs. No changes to current groundwater monitoring requirements (Table 4.2.4) are proposed. As discussed above, a conceptual POC well location is proposed at the estimated furthest downstream extent of flow from WTP2 (i.e., the edge of the PMA associated with that discharge). Installation and monitoring of groundwater at that location should not be necessary if aquifer water quality limits are imposed as DLs at the point of discharge.

8 CLOSURE AND POST CLOSURE COSTS

Closure strategies are provided in Attachment D for each of the APP-regulated facilities. Closure and post-closure costs were estimated using the Standardized Reclamation Cost Estimator (SRCE), as documented in Attachment D.

Updated closure strategies are provided for the TSF (including the external detention pond), the UCP, and WTP1, which is the BADCT mechanism for AZPDES Discharge 001. A closure strategy and cost was not provided for WTP2 because AZPDES Discharge 002 to Harshaw Creek will end as soon as activities stop and WTP2 is turned off. Unlike WTP1, WTP2 is not needed for treatment of draindown or other post-closure activities.

All SRCE model outputs are provided in Attachment D. The final closure/post-closure cost estimate was calculated by SRCE to be $13,920,872.

AMI plans to use a letter of credit as a financial assurance mechanism.

9 CONTINGENCY PLAN

Proposed changes to the Contingency Plan are provided in Section 12 of Attachment C.

10 COMPLIANCE SCHEDULE

AMI proposes including the following additions to the APP Compliance Schedule:

Action	Completed by:
Submit updated Contingency and Emergency Response Plan	Within 30 days of issuance of amended APP.
WTP2 As-Builts: The permittee shall submit as-built drawings for WTP2.	Within 90 days of commissioning of WTP2.

The proposed revisions to the APP, including the revised Compliance Schedule, are shown in the redlined APP in Attachment F.

11 PERMITTING AND LEGAL REQUIREMENTS

AMI currently has the following authorizations/permits:

- Mining Multi-Sector General Permit Authorization AZMS-81380;
- Arizona State Mine Inspector State ID# 13-03295;
- ADEQ Voluntary Remediation Program Site Code #505143-02.
- APP No. P-512235.
- AZPDES Permit No. AZ0026387.

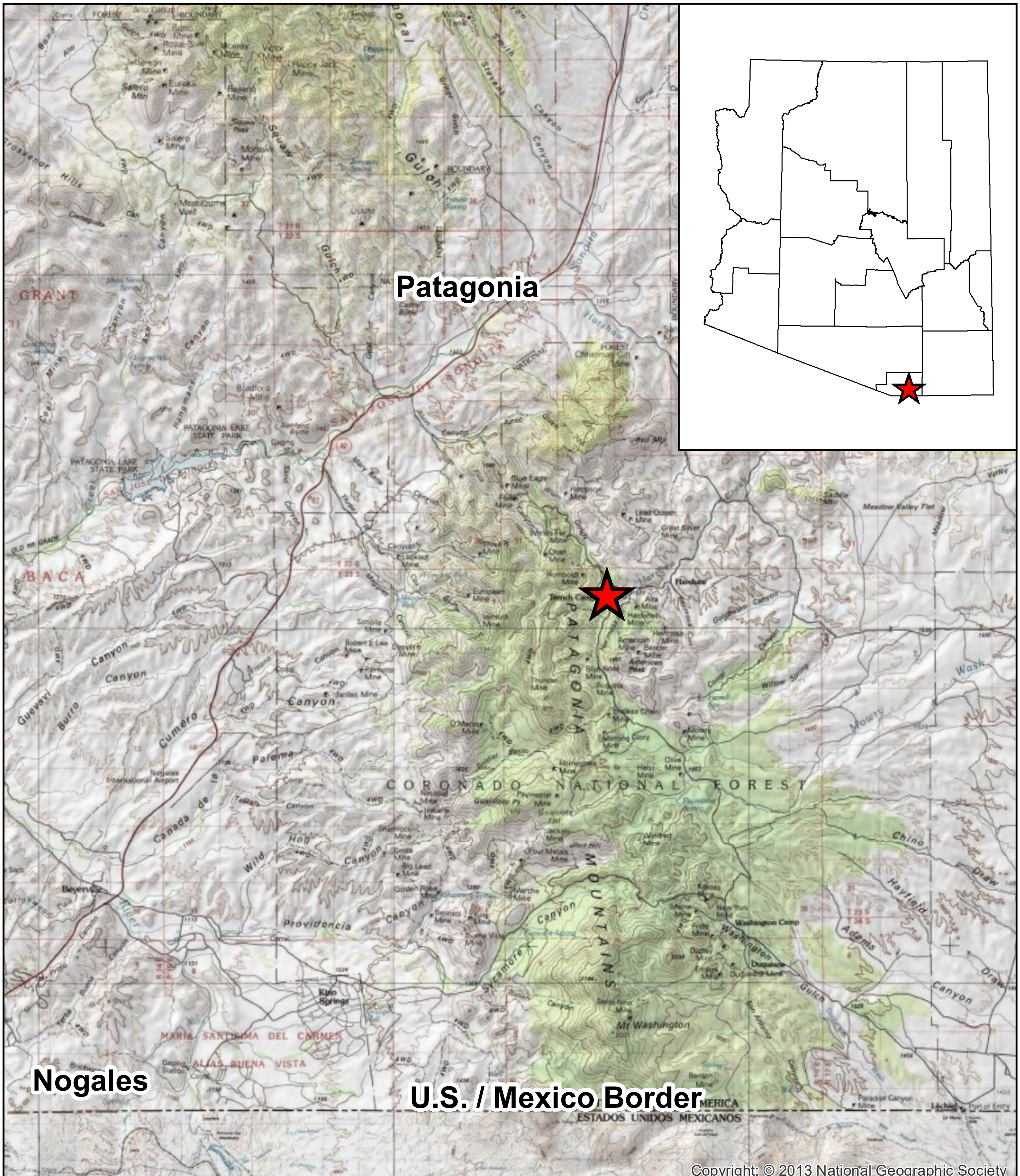
12 REFERENCES

Arizona Minerals, Inc., 2017. ASARCO January Adit (Norton Mine) Aquifer Protection Permit Application, Santa Cruz County, Arizona. Submitted to Arizona Department of Environmental Quality, June 5.

Graybeal, F.T., Moyer, L.A., Vikre, P.G., Dunlap, P., and Wallis, J.C., 2015, Geologic map of the Patagonia Mountains, Santa Cruz County, Arizona: U.S. Geological Survey Open-File Report 2015–1023, 10 p., 1 sheet, scale 1:48,000, http://dx.doi.org/10.3133/ofr20151023.

Nassereddin, M.T., 1967. Hydrogeological Analysis of Groundwater Flow in Sonoita Creek Basin, Santa Cruz County, Arizona. University of Arizona Masters thesis.

FIGURES



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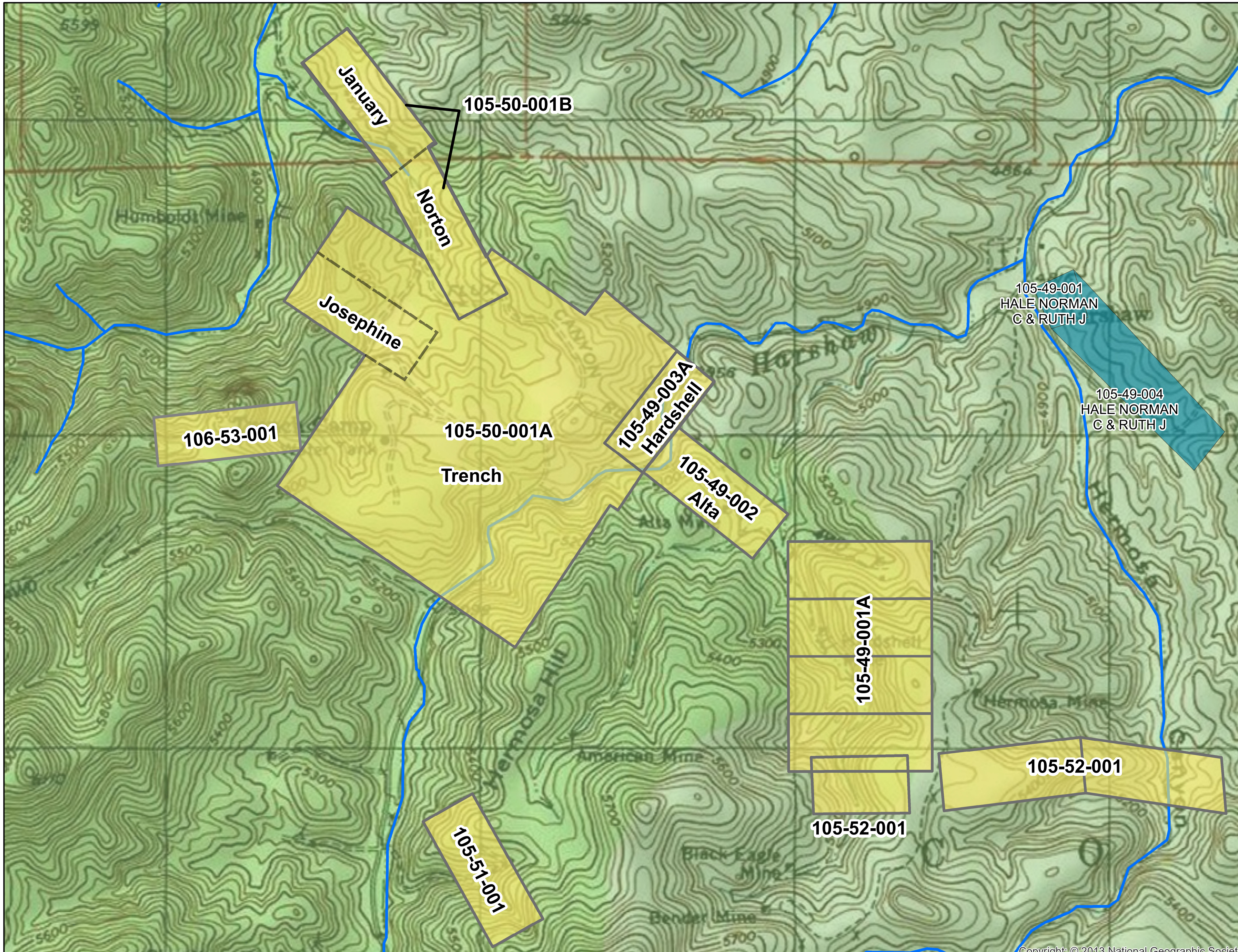
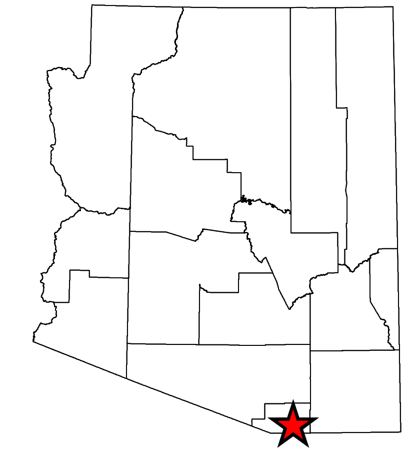
Miles

CLEAR CREEK ASSOCIATES

File ID	AZM-132
Date	7/17/2020

Figure 1
Project Location Map





Legend

- Arizona Minerals Inc. Properties with Parcel #
- USFS - Coronado National Forest
- Private Property

105-52-001 = Parcel #

0 500 1,000 2,000

Feet

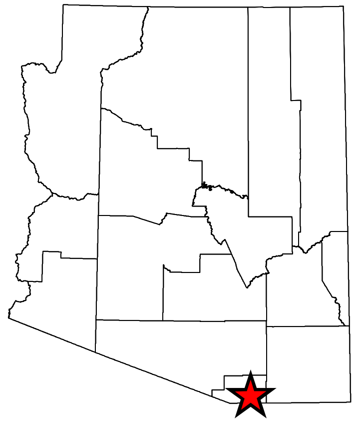
Projection: UTM Zone 12N NAD83

Source: https://gis.santacruzcountyaz.gov/arcgis/rest/services/ParcelSearch/Parcels/MapServer

Date	File ID
7/23/2020	AZM-014A

CLEAR CREEK ASSOCIATES

FIGURE 2
Land Ownership
Hermosa Project
APP No. P-512235



Legend

- Project Area
- Conceptual POC
- Existing POC
- January Adit
- Discharge Outfall

0 500 1,000 2,000

Feet

Projection: UTM Zone
12N NAD83

Date	File ID
8/10/2020	AZM-013B

N

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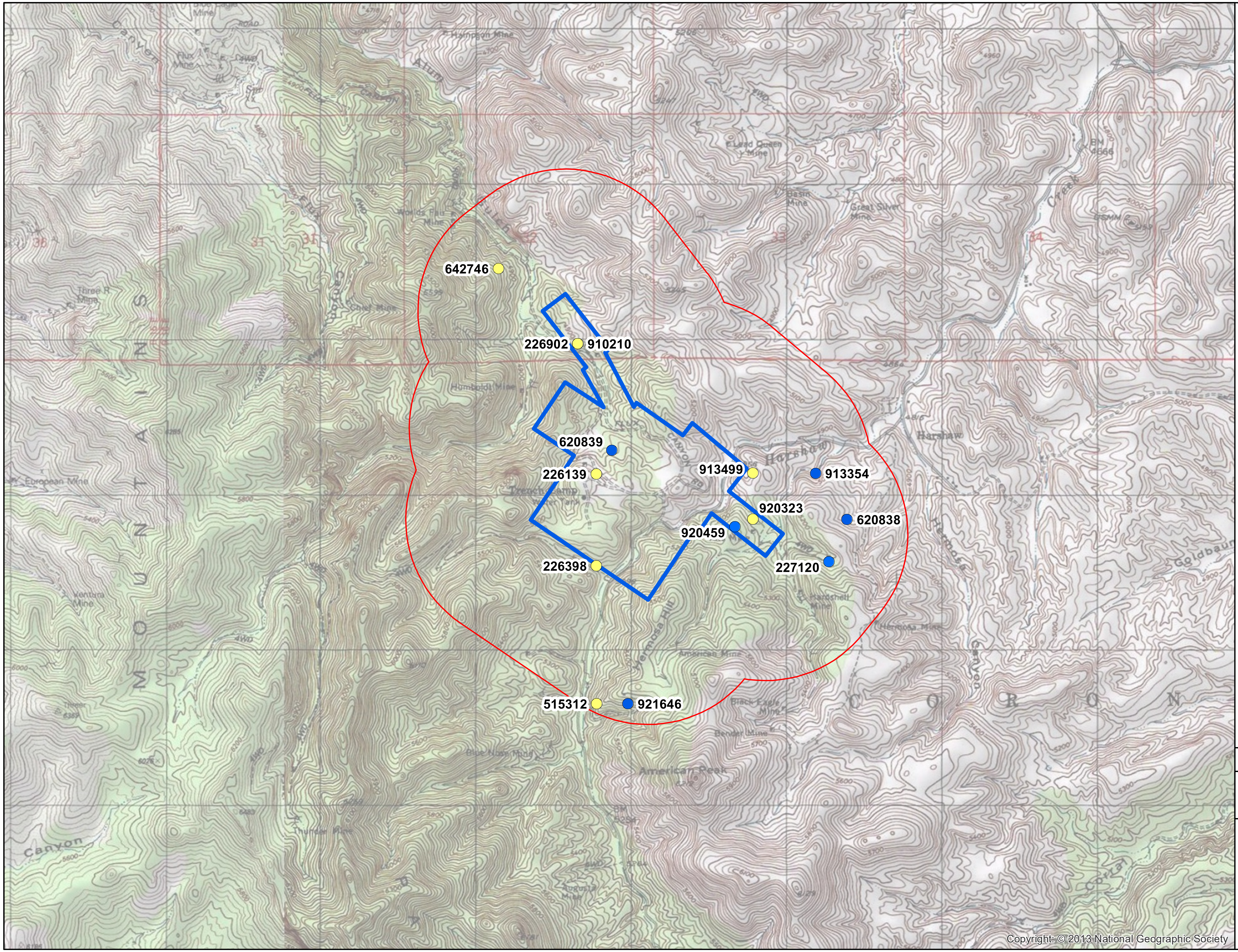
FIGURE 3
Site Plan
Hermosa Project
APP No. P-512235



Legend

- Project Area
- 1/2 Mile from Project Area
- Exempt Well
- Non-Exempt Well

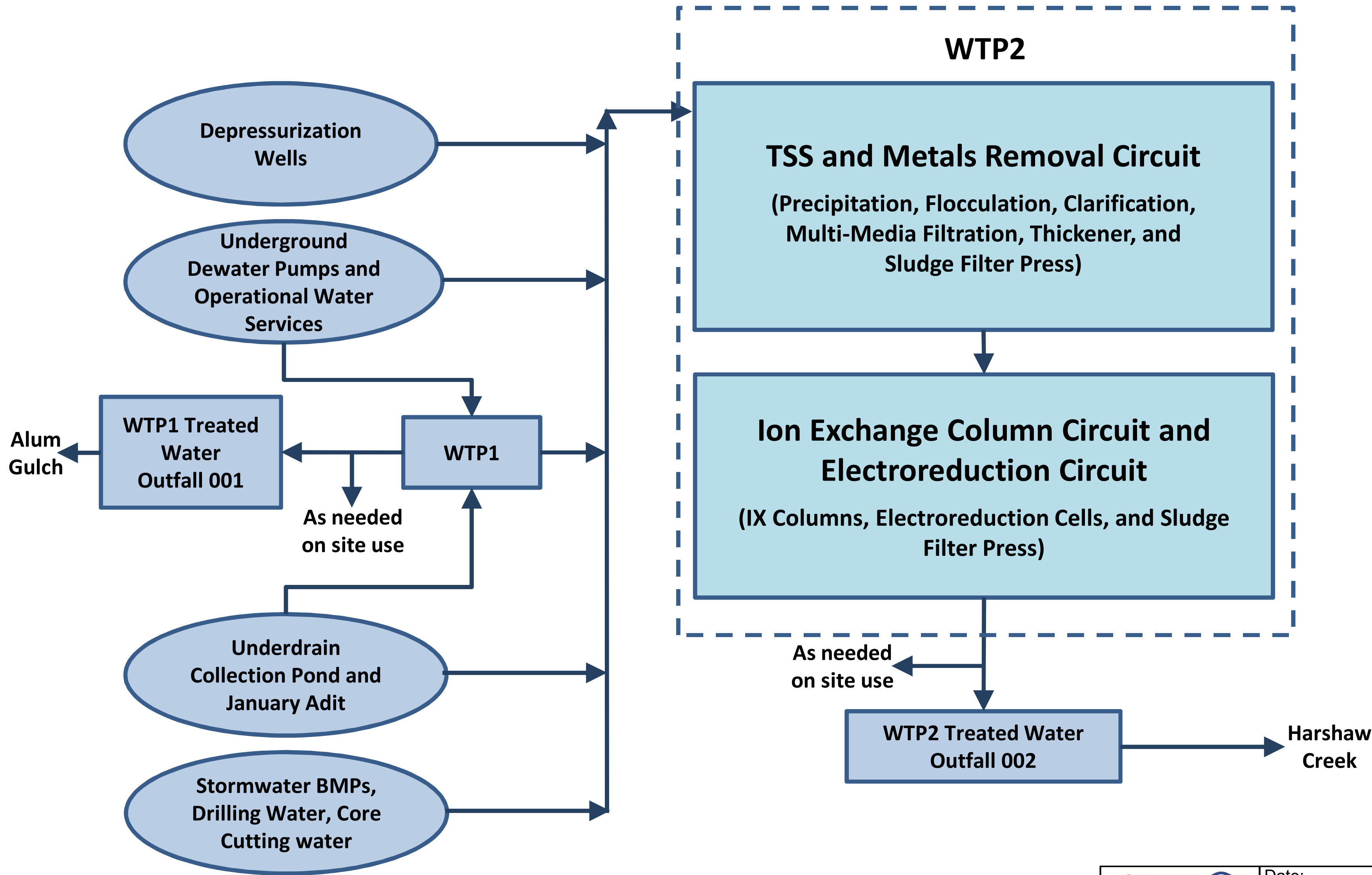
0 2,000 4,000

Feet

Projection: UTM Zone 12N NAD83

Date 7/28/2020	File ID AZM-131
N	CLEAR CREEK ASSOCIATES

FIGURE 4
Exempt and Non-Exempt Wells within One-Half Mile

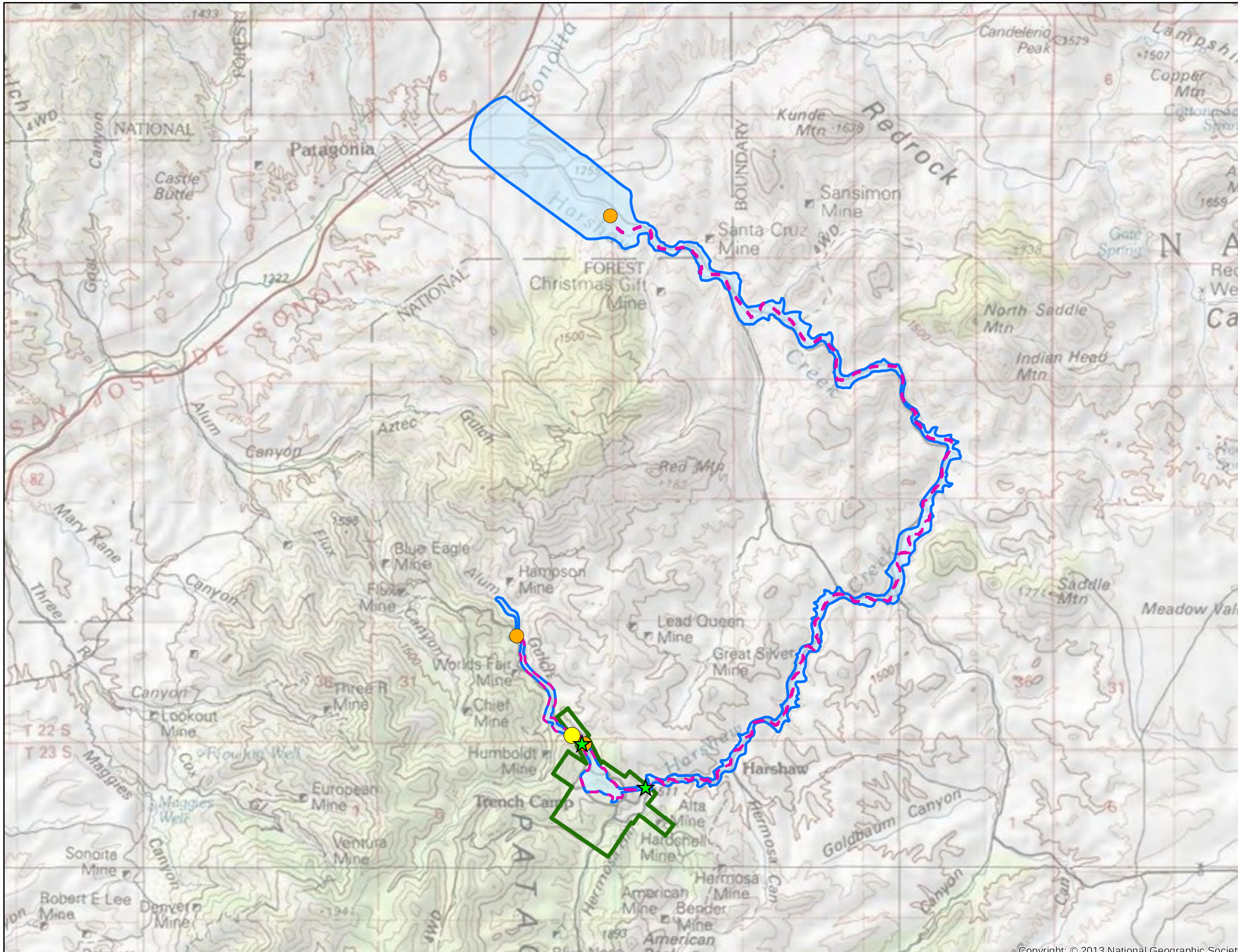


CLEAR CREEK ASSOCIATES

Date: 7/16/2020

File ID: PPAZM-001

Figure 5
WTP2 Process Flow Diagram
Hermosa Project



Legend

- Conceptual POC
- Existing POC
- WTP Discharge Point
- Project Area
- Pollutant Management Area
- Discharge Impact Area

0 4,000 8,000
Feet

Projection: UTM Zone 12N NAD83

Date 7/30/2020	File ID AZM-033C-gsh

CLEAR CREEK ASSOCIATES

Figure 6
Pollutant Management Area, Discharge Impact Area, and Point of Compliance (POC)

ATTACHMENT A

Environmental Permitting Support Document

Water Treatment Plant 2 – Hermosa Project

by

BQE Water

and

Black & Veatch

ENVIRONMENTAL PERMITTING SUPPORT DOCUMENT

Water Treatment Plant 2 – Hermosa Project

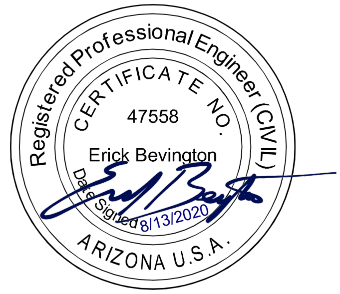
AMI PROJECT NO. AMI-165
BQE PROJECT NO. 18033
B&V PROJECT NO. 404218

DOCUMENT NO. 404218-GN-RPT-0005

PREPARED FOR

Arizona Minerals, Inc.

13 AUGUST 2020



The text in this document has been prepared by BQE Water, Inc. as the process designer for this project and as owner of the proprietary Selen-IX™ process which is an integral part of the overall treatment process. Process design, including mass balance calculations validating the successful achievement of treatment goals has been completed and reviewed by BQE Water, Inc. according to their internal quality management procedures.	Black & Veatch Corporation (B&V), as prime consultant responsible for overall design of the project, has reviewed the information prepared and presented by BQE Water, Inc. and find the quality of work satisfactory for the purposes of this environmental support document. Black & Veatch makes no guarantees regarding the process design completed by BQE Water, Inc. in support of this report.

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SUPPLEMENTAL DOCUMENTS

1 Project Overview

A new water treatment plant, designated WTP2, will be constructed at the Hermosa Project Site located in the mountainous regions of Santa Cruz County, Arizona.

The equipment and facilities will be designed to handle feed flowrates of up to 4,500 gpm and the facility is envisaged as consisting of a main process building housing the majority of the equipment, an adjacent electrical building, and some isolated equipment just outside the process building.

Off-site fabrication of equipment and structures will be used to the most practical extent possible in order to minimize on-site construction and traffic. To accomplish this, much of the process equipment will be factory skidded to limit piping connections and wiring to devices in the field, a pre-fabricated electrical room is considered, and a pre-engineered metal building will be utilized to enclose the space.

At the conclusion of the project, WTP2 will not be required and discharges from WTP2 will be terminated. Reagents and fluids, if any remain, will be removed as part of the decommissioning.

1.1 PURPOSE

This document serves as a summary of the WTP2 facility and is provided to support Aquifer Protection Permit (APP) and Arizona Pollutant Discharge Elimination System (AZPDES) applications. The information contained herein has been provided by BQE Water Inc. (BQE) as the treatment plant process designer with coordination and other inputs by Black & Veatch Corp. (B&V) as the overall facility prime engineering and procurement contractor; Arizona Minerals, Inc. (AMI); and other separate consultants to AMI. WTP2 is designed to meet the applicable Surface Water Quality Standards (SWQS), Aquifer Water Quality Standards (AWQS) and technology based effluent limit guidelines (reference Table 3.1).

2 Water Chemistry

AMI has provided estimates of key constituents anticipated to be in the feed water, which are summarized in Table 2.1.

Table 2.1 - WTP2 Feed Water Chemistry Predictions

ANALYTE	UNIT	MINIMUM	MAXIMUM
Antimony	mg/L	0.0039	0.004
Arsenic	mg/L	0.073	0.075
Barium	mg/L	0.024	0.025
Beryllium	mg/L	Constituent Not Detected at Reporting Levels Ranging from 0.000013 to 0.002 mg/L	
Boron	mg/L	0.049	.05
Cadmium	mg/L	0.0009	0.0012
Chromium	mg/L	0.0046	0.0048
Copper	mg/L	0.044	0.045
Fluoride	mg/L	0.17	0.18
Iron	mg/L	1.1	1.2
Lead	mg/L	0.042	0.059
Manganese	mg/L	0.48	1.02
Mercury[1]	mg/L	0.0000051	0.0000051
Nickel	mg/L	0.008	0.009
Selenium	mg/L	0.027	0.029
Silver	mg/L	0.0003	0.0021
Sulfate	mg/L	32	152
Thallium	mg/L	0.0003	0.00033
Uranium	mg/L	0.0016	0.0018
Zinc	mg/L	0.23	0.43
pH	SU	7.12	7.16
TSS	mg/L	0	44
Hardness[2]	mg/L $CaCO_3$	258	340
Ammonia/Nitrate-N	mg/L	0.25	3.5
Cyanide (total)	mg/L	Constituent Not Detected at Reporting Levels Ranging from 0.1 to 0.0039 mg/L	

Notes: mg/L = milligrams per liter; SU = Standard Units

1 Mercury was not detected at Method Detection Levels ranging from 0.00003 to 0.002 mg/L. A single detection at 0.0000051 mg/L occurred in a groundwater sample analyzed with a Method Detection Level of 0.0000002 mg/L

2 The treatment process is not expected to change the hardness of the water.

3 Applicable Water Quality Standards

In order to establish the overall treatment approach and process design criteria, local (APP and AZPDES) water quality standards, shown in Table 3.1, were considered.

Table 3.1 - Applicable Surface Water Quality Standards for Harshaw Creek and Aquifer Water Quality Standards

PARAMETER	UNITS	MOST STRINGENT SWQS		DESIGNATED USE	AWQS*
pH	SU	6.5 - 9.0		SWQS	
Antimony	mg/L	0.6	T	A&Wedw chronic	0.0060
Arsenic	mg/L	0.15	D	PBC	0.050
Barium	mg/L	186.667	T	PBC	2.0
Beryllium	mg/L	0.0053	D	A&Wedw chronic	0.0040
Boron	mg/L	187	T	PBC	
Cadmium	mg/L	0.00143	D	hardness based for A&Wedw chronic	0.005
Chromium	mg/L	1	T	AgL	0.10
Chromium III	mg/L	0.157	D	hardness based for A&Wedw chronic	
Chromium VI	mg/L	0.011	D	A&Wedw chronic	
Copper	mg/L	0.01959	D	hardness based for A&Wedw chronic	
Lead	mg/L	0.00672	D	hardness based for A&Wedw chronic	0.050
Manganese	mg/L	130.667	T	PBC	
Mercury	mg/L	0.00001	D	A&Wedw chronic	0.0020
Nickel	mg/L	0.113	D	hardness based for A&Wedw chronic	0.1
Iron	mg/L	1	D	A&Wedw chronic	
Selenium	mg/L	0.002	T	A&Wedw chronic	0.050
Silver	mg/L	0.01556	D	hardness based for A&Wedw acute	
Thallium	mg/L	0.009	T	PBC	0.0020
Uranium	mg/L	2.8	T	PBC	
Zinc	mg/L	0.2547	D	Hardness based A&Wedw chronic	
Total Suspended Solids	mg/L	20	T	ELG (BPT)	
Nitrogen, Nitrate (as N)	mg/L	3733	T	PBC	10
Nitrogen, Nitrite (as N)	mg/L	233	T	PBC	1

PARAMETER	UNITS	MOST STRINGENT SWQS		DESIGNATED USE	AWQS*
Ammonia N, summer	mg/L	3.7 @ pH 7	T	A&Wedw chronic	
Ammonia N, winter	mg/L	16 @ pH 7	T	A&Wedw chronic	
Cyanide	mg/L	0.0097	T	A&Wedw chronic	0.2
Fluoride	mg/L	140	T	PBC	4
Adjusted Gross Alpha	pCi/L				15
Radium 226+228	pCi/L				5
Whole Effluent Toxicity	TUc	No Toxicity		narrative toxic standard	

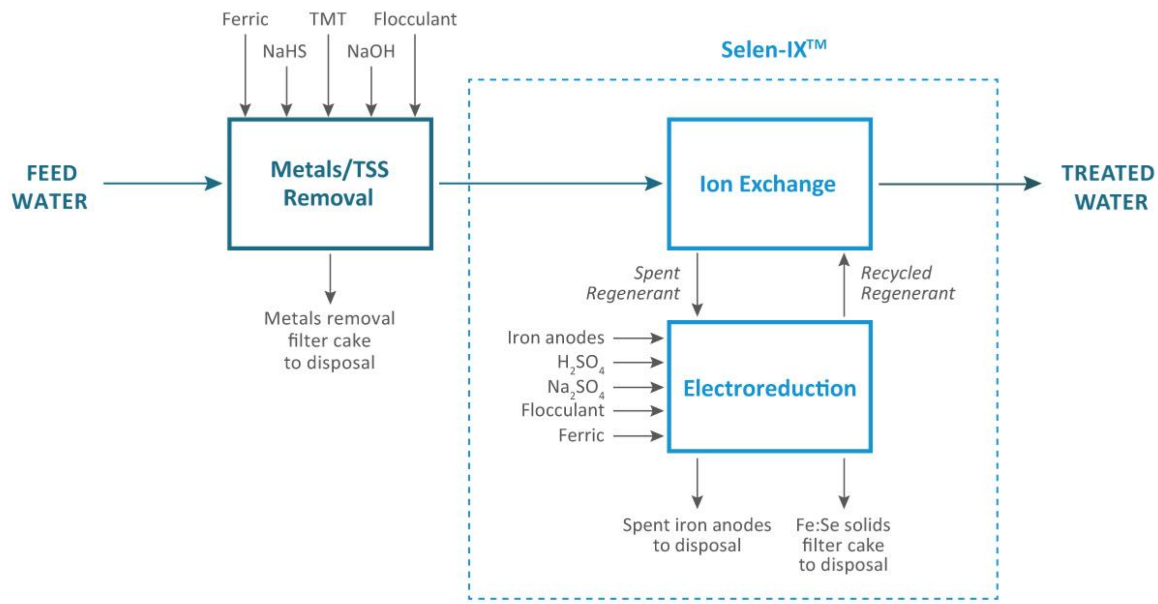
Notes:
mg/L = milligrams per liter
TUc = Toxicity Unit Chronic
SWQS = Arizona Surface Water Quality Standard
AZPDES = Arizona Pollutant Discharge Elimination System
AgL = Agricultural and Livestock
A&Wedw = Aquatic and Wildlife effluent-dependent water
*AWQS = Aquifer Water Quality Standard are dissolved concentrations
PBC = Partial Body Contact
T = Total
D = Dissolved
ELG = Technology Based Effluent Limit Guideline
BPT = Best Practicable Technology
Assumptions:
1. Hardness based standards calculated for 250 mg/L hardness
2. Per A.A.C. R18-11-113(d), the water quality standards that apply to effluent-dependent waters (EDWs) will be applied to discharge limitations for any point source discharge of wastewater to an ephemeral water.

4 Process and Technology Description

4.1 HIGH LEVEL DESCRIPTION

The schematic block diagram of the treatment process for Hermosa WTP2 is depicted in Figure 4.1.

Figure 4.1 - Block Diagram of Proposed Treatment Process for Hermosa WTP2



As can be seen from Figure 4.1, there are two major steps involved in the overall treatment process:

- Removal of Total Suspended Solids (TSS), dissolved arsenic, selenite, and metals.
- Selenate removal by BQE's Selen-IX™ process.

These two systems work in conjunction to achieve the overall treatment objectives. Each one of these steps is described in more detail in sections below. Detailed process flow diagrams and mass balance tables are included in Appendix A and B, respectively and should be referenced in conjunction with the following process description.

4.1.1 TSS and Metals Removal Circuit

This circuit involves the addition of ferric, flocculant, and sulfide reagents (if required) to precipitate selenite, dissolved arsenic and metal species, and separates the precipitates along with suspended solids (TSS) from the treated water in a sand-ballasted clarifier system. The overflow from the clarifier is directed to polishing multimedia filters to remove any remaining fine suspended solids. Filter backwash water is directed to the plant feed such that suspended solids are captured and exit the system via the same process stream as the underflow of the sand-ballasted clarifier. To concentrate the waste solids, the underflow is directed first to a thickener and then a conventional plate and frame filter press for dewatering. The cake produced by the filter press represents one of two solid residue streams that will be produced. The other stream is produced in the Selen-IX™ stage. The filter cake produced in the TSS/metals removal stage represents by far the most significant residue stream in terms of volume, tonnage, and downstream handling requirements.

Key features of the proposed design:

- *As-needed pH adjustment* as all targeted constituents are removed efficiently at circum-neutral pH and the feed water contains significant buffering capacity. This reduces reagents consumption.
- *Superior effluent water quality* compared to conventional precipitation with lime or caustic. Sulfide is very selective for a wide range of heavy metals and can produce lower effluent metal concentrations by orders of magnitude with significantly less reagent being added. This also reduces the volume of residue that would be generated with lime or caustic.
- *Robust design* capable of producing target effluent quality over a wide range of plant feed water quality.
  - Ferric addition helps with removal of selenite, arsenic, and other metal oxyanions that may be present
  - Sulfide removes a wide range of dissolved heavy metals

4.1.2 Selenate Removal by Selen-IX™

The Selen-IX™ process was developed by BQE specifically for the removal of selenate from water. Selenate is not removed through ferric co-precipitation or lime neutralization processes; so alternative methods of managing this contaminant must be applied.

The Selen-IX™ process comprises two circuits operating in tandem:

- Ion Exchange (IX)
- Electroreduction (ERC)

The IX circuit serves two main functions. First, it removes selenate from feed water selectively by adsorption onto IX resin and generates treated water containing less than 2.0 ppb selenium suitable for discharge. Second, the IX circuit concentrates the selenium removed from plant feed into a small volume of spent regenerant produced during resin regeneration and directed for further processing to the ERC circuit. The ERC removes selenium from the spent regenerant solution and fixes it into stable solids suitable for disposal. The ERC includes a solid-liquid separation step which enables the solids free and selenium regenerant solution to be recycled back to the IX circuit. The continuous re-use of regenerant eliminates the production of waste brine and is one of the key features of the Selen-IX™ process which differentiates it from conventional IX.

The selenium-laden solids are dewatered using a conventional plate and frame filter press. These solids pass Toxicity Characteristic Leaching Procedure (TCLP) tests (see Section 11). Moreover, advanced residue stability testing completed as part of mining projects have shown that the Selen-IX™ solids are highly refractory with respect to selenium release under a wide range of conditions and can be safely co-mingled with tailings and waste rock. The ERC circuit comprises electrocells with sacrificial iron anodes. Thus, the main consumable in the ERC circuit is iron. Most of the iron reports to the selenium laden residue. A small portion becomes scrap iron that can be recycled or disposed of on site.

In summary, with IX and ERC working in tandem, selenium is removed from a large volume of water and is converted into a small volume of stable solid by-product.

Key features of Selen-IX™:

- Ability to meet < 2.0 ppb in final effluent.
- Ability to handle large fluctuations in flow and concentration of selenium in the feed water
- Purely physico-chemical process which brings the following advantages:
  - Insensitivity to typical ground water temperature ranges. This includes the relatively quick resumption of on-spec discharge following extreme events such as freeze-ups.
  - Easy to start/stop and absorb hydraulic shocks.
  - Easy to correct if/when effluent is off spec, unlike control of biomass in biological process.
- Zero risk of unintended consequences caused by nutrients causing biological growth in equipment

4.2 DETAILED PROCESS DESCRIPTION

The two main circuits within WTP2 are metals removal via precipitation and selenium removal via Selen-IX™. The following sub-sections provide a detailed description of these treatment circuits as well as the sparing philosophy and turndown. For additional information and reference, detailed process flow diagrams are contained in Appendix A.

4.2.1 Cooling System

Feed water will enter the WTP2 battery limits into a cooling tower comprising eight cells (EQ-090 A-H) arranged in parallel, where the water temperature will be reduced. Effluent from the cooling towers is collected in the WTP2 Feed Tank (TK-095) from which the cooled feed water is then pumped into the WTP2 building via the WTP2 Feed Pumps (P-099 A/B/C) for treatment.

4.2.2 Metal Removal Treatment

Downstream of the WTP2 Feed Tank and WTP2 Feed Pumps, caustic (to adjust the pH), ferric, and both sulfide reagents (sodium hydrosulfide and TMT) are injected into the main feed line. The chemically treated water then enters three sand ballasted clarifiers arranged in parallel. Each sand ballasted clarifier system consists of four compartments through which the water flows:

- Mixing Tank (TK-110 A/B/C)
- Flocculation Tank (TK-111 A/B/C)
- Maturation Tank (TK-112 A/B/C)
- Clarification Tank (TK-113 A/B/C)

Flocculant, as well as sand, is injected into flocculation tank as an aid to settling. Precipitated metals through the clarifier system will be separated from the clarified liquid and thickened in the underflow.

The clarified liquid overflows into the Filter Feed Tank (TK-120) and is then pumped using the Filter Feed Pumps (P-121/122/123) through the Multimedia Filters (F-130 to 137 A/B/C) to further remove suspended solids uncaptured by the clarifier. These multimedia filters (MMF) are arranged in three banks of eight filters each. The effluent from the filters is considered as the IX circuit feed.

The underflow from the clarification tank is pumped to a hydrocyclone (EQ-116 A/B/C) via Hydrocyclone Feed Pumps (P-114/115 A/B/C) within the sand ballasted clarifier system. The hydrocyclone separates the sand from the sludge, returning the sand to the flocculation tank and discharging the sludge to the Metals Removal Thickener (TK-160). The Metals Removal Thickener consists of a rake mechanism to further thicken the clarifier underflow sludge. The thickened sludge is directed via the Metals Removal Filter Press Feed Pump (P-161) through the Metals Removal Filter Press (FP-170) from which the filtrate is collected in the Decant Tank (TK-180) and the filter cake is collected in a roll off bin (EQ-171) for disposal. The overflow from the Metals Removal Thickener is directed to the filter feed tank (TK-120). The filtrate from the filter press, as well as backwash water and solids from the MMFs are all discharged into the Decant Tank prior to being pumped back to the WTP2 Feed Tank via the Decant Tank Pump (P-181).

4.2.3 Selen-IX™ Treatment

Ion Exchange (IX) Circuit and Effluent Discharge

Upstream of the IX columns, a Cartridge Filter (F-205 A/B) polishes the IX circuit feed of any residual solids.

The effluent from the Cartridge Filters reports to the IX Feed Tank (TK-210) from which it is pumped with the IX Feed Pumps (P-211/P-212/P-213) through packed bed IX columns (TK-215 to 220). These columns contain strong base anion (SBA) exchange resin, in sulfate form, which selectively removes selenate from the influent water down to <2.0 ppb selenium. The IX columns are arranged in 3 trains of 2 columns each of them and operate in parallel.

Treated effluent from the IX columns is directed to the Effluent Tank (TK-250) and then discharged from WTP2 to Harshaw Creek via gravity). TK-250 will be a key point for both online monitoring as well as WTP2 effluent sampling to ensure that treated water is suitable for discharge. Effluent from WTP2 is either discharged to environment, recycled to back to the WTP2 Feed Tank if any key performance indicators (KPIs) of the plant indicate that the treated effluent is out of specification, or used onsite as needed. A portion of the treated WTP2 effluent in TK-250 is also used as IX wash water, utility water/reagent makeup water via pumps P-231, and P-670, respectively.

The IX resin has a finite capacity for selenium removal and so once a column is saturated with selenium it is taken out of the load cycle and is regenerated. The resin is regenerated using a concentrated sodium sulfate brine solution which is pumped from the Recycled Regenerant Tank (TK-245) and the Shoulder Regenerant Tank (TK-240) through the column being regenerated using the Regenerant Pump (P-246) and Shoulder Regenerant Pump (P-241) respectively. During regeneration, selenium loaded on the resin is exchanged with sulfate from the sodium sulfate brine, transferring selenium from the resin to the brine solution and making the resin ready to treat influent water once again. A portion of the regeneration is conducted using partially used regenerant from the Shoulder Regenerant Tank, improving overall process efficiency. The regeneration generates a low volume brine stream that contains the selenium removed from the influent water. The selenium rich brine is collected in the Spent Regenerant Tank (TK-235).

Following regeneration, the IX resin is washed using treated water from TK-250 using the Wash Water Pump (P-231). Spent wash water is directed to either the Spent Regenerant Tank (TK-235) or to the IX Feed Tank (TK-210) depending on the sulfate concentration of the stream.

In total, there are six IX columns arranged in three parallel trains. While at least one IX column in each train receives feed water and removes selenium, the other columns are either undergoing regeneration, wash, or act as another column removing selenium in series. When the plant feed water quality matches the design criteria, each train operates with two IX columns removing selenium in series, i.e. in lead-lag configuration, approximately 80% of the time.

Another notable piece of equipment that is part of the IX circuit is the Resin Backwash System (EQ-255), which comprises an eductor and a tank sized to hold an entire column worth of resin. It is used both to load resin into the IX columns during installation as well as to backwash the IX resin periodically as required during the initial fill procedure and annual planned maintenance events.

Electroreduction Circuit

Treatment of the regenerant in the ERC circuit starts with selenium-rich regenerant being pumped from the Spent Regenerant Tank (TK-235) via the Spent Regenerant Pump (P-236) to Recirculation Tanks (TK-300 & TK-310). The regenerant is recirculated from the recirculation tanks through electrocells (EC-1 to 60) that are arranged in four parallel banks of 15 cells using Recirculation Pumps (P-301 & P-311). In these electrocells, iron anodes are dissolved into solution to introduce iron into the selenium-rich regenerant. This causes iron and selenium to precipitate from solution as an inorganic iron oxyhydroxide laden with selenium (hereafter referred to as Selen-IX™ solids).

During electrocell operation, sulfuric acid is used to control the pH in the recirculation tanks. The recirculation tanks are sealed and maintained under lightly positive pressure using a nitrogen blanket line from the nitrogen generator (EQ-640) and a gas manometer (TK-320). Hydrogen gas produced in the electrocells and evolving out of solution in the recirculation tanks will be contained and confined to the recirculation tank headspaces and off-gas header. Sweep Air blowers (BL-300 A/B) will be used to provide continuous and constant flow of sweep air passing through the ducting (enclosing the recirculation tanks headspace and gas manometer) to dilute hydrogen at the exhaust point to environment. Hydrogen gas safety and management is discussed further in Section 10.2.10 of this document. The two air blowers will be installed in parallel with flow detection to ensure continuous sweep air. One blower will be in active duty operating at 100% with the other on standby in the event that the primary blower goes out of operation.

The recirculation tanks and associated electrocell banks are operated in batch mode. Once the regenerant brine is treated and selenium has been precipitated, electrocell operation is temporarily turned off while the recirculation tank discharges the slurry of treated regenerant brine and Selen-IX™ solids into the Aging Tank (TK-350). Once the recirculation tank is drained into the aging tank, it is filled with the next batch of selenium-rich regenerant, from the spent regenerant tank, for treatment in the electrocells. Electrocell operation is then restarted and regenerant is recirculated through the electrocells. During the downtime in electrocell operation, spent anodes that are no longer usable in the process (~80% of the anode has been consumed in the process) are removed from the electrocells for recycling or disposal.

The aging tank buffers the flow from the recirculation tanks and allows the Aging Pump (P-351) to produce a steady flow into the Electroreduction Clarifier (TK-355). Flocculant is added into the discharge of P-351 upstream of the clarifier feed-well. Solids settle in the clarifier and solution overflows into the Polishing Reactor (TK-360). The clarifier underflow containing the Selen-IX™ solids is conveyed by the Electroreduction Clarifier U/F Pump (P-356) to the Electroreduction Filter Press Stock Tank (TK-385). Flocculant is added in this tank to aid in the filtration process. Slurry is then pumped from TK-385, using the Electroreduction Filter Press Feed Pump (P-386), into the Electroreduction Filter Press (FP-390) where the Selen-IX™ solids are dewatered and washed. The solid filter cake is collected in a roll off bin (EQ-391) for disposal and the filtrate is collected in the Filtrate Tank (TK-395).

A small dose of ferric sulfate is added to the Polishing Reactor (TK-360) to remove alloying metal impurities that are released from anodes into solution in the electrocells. Sulfuric acid and caustic are used to control the pH in this reactor. A small quantity of ferric oxyhydroxide solids is generated in this process, which is then settled and thickened in the downstream Polishing Clarifier (TK-365). Flocculant is added to TK-365 as well to aid settling. A portion of the Polishing Clarifier underflow is recycled to the Polishing Reactor via the Polishing Reseed Pump (P-367) to provide seed material to improve reaction efficiency and solids settling in the clarifier. The remainder of the underflow is directed to the Filter Press Stock Tank (TK-385) for blending with Selen-IX™ solids from TK-355 prior to filtration.

The treated selenium and impurity-free regenerant overflows from the Polishing Clarifier into the Polishing Clarifier Overflow Tank (TK-370). Here, sodium sulfate is added via the Sodium Sulfate Solids Addition System (EQ-580) to make up the regenerant strength following losses incurred during IX washing and losses to filter cake pore water. This solution is further aerated to ensure no residual iron remains in solution and is then polished for any remaining solids by being pumped by the Polishing MMF Feed Pump (P-371) through a bank of two Polishing MMFs (F-375 A/B) as well as subsequent Polishing Cartridge Filters (F-380 A/B). The regenerant solution is then directed to the Recycled Regenerant Tank (TK-245) for re-use in the IX circuit. External backwash is required for the MMFs (F-375A/B), which comes from the Recycled Regenerant Tank (TK-245) by means of pump P-247. The backwash from the Polishing Multimedia Filters is collected in the Filtrate Tank (TK-395), with filtrate from the Electroreduction Filter Press. This solid laden solution is directed to the Polishing Reactor using the Filtrate Pump (P-396).

4.2.4 Reagents and Utilities

There are a number of reagents that will be used at the Hermosa WTP2. This section describes their integration in the process, while Section 10.2 describes the associated equipment used in more detail. The increase in the concentration of chemical constituents in the water caused by chemical reagent addition has been taken into account in ensuring compliance with effluent water quality standards.

There are two flocculant preparation and dosing systems that are used in the process, one servicing the metals removal system and ERC Polishing demand, and the other servicing the majority of the ERC system. Anionic flocculant is made up in the Flocculant 1 Mix Tank (TK-501), stored in the subsequent storage tank (TK-502), and dosed into the process using pumps P-504 and P-505. Cationic flocculant is made up in the Cationic Flocculant Make-up Tank (TK-510), stored in the subsequent storage tank (TK-511), and dosed into the process using pumps P-512 and P-513. Both flocculants are made up from dry flocculant powder and reagent make-up water from the WTP2 Effluent Tank (TK-250) via the Reagent Make-up Water Pump (P-671).

Ferric chloride is delivered to site in liquid form and stored in TK-520. It is dosed into the process using the Ferric Chloride Dosing Pump (P-521). Ferric sulfate may also be used in place of ferric chloride.

Ferric sulfate is delivered to site in liquid form in drums. It is dosed into the process using the Ferric sulfate Dosing Pump (P-526).

TMT is received as a liquid in Intermediate Bulk Containers (IBC) totes and is dosed using the TMT Pump (P-531).

Sodium hydrosulfide (NaHS) is received as a liquid in IBC totes and is dosed using the Sodium Hydrosulfide Pump (P-536). The headspace of the Sodium Hydrosulfide tote is vented via a Dry Scrubber (EQ-537).

Caustic (NaOH) is delivered to site in liquid form and stored in TK-540 before being dosed into the process using three Caustic Pumps (P-541, P-542, P-543).

Concentrated sulfuric acid (H_2SO_4) is received in IBC totes as a liquid. Sulfuric acid is dosed into the process using three Sulfuric Acid Pumps (P-556, P-557, P-558, P-559).

Sodium sulfate (Na_2SO_4) is received as dry solid in bulk bags and added directly into the process using the Sodium Sulfate Solids Addition System (EQ-580).

Hydrogen peroxide (H_2O_2) is received as a liquid in IBC totes and is used as needed via the Hydrogen Peroxide Pumps (P-560, P-561).

An Air Compressor (AC-620) serves the Plant Air Receiver (TK-625) and most of the plant's air requirements. Instrument air is dried in the Instrument Air Drier (EQ-630) and stored in the Instrument Air Receiver (TK-635). Instrument air services the plant and also feeds the Nitrogen Generator (EQ-640) for use in the ERC circuit.

4.2.5 Sparing Philosophy and Turndown

WTP2 is designed to treat and discharge a peak flow of 4,500 GPM with the ability to turn down to <1,500GPM.

In general, the main process flow through the plant is separated into three trains (A/B/C), each capable of treating 1,500 GPM. This means that when the predicted flow reduces below 3,000 GPM, the main flow through the plant will have two trains operating and one train in standby. Because an entire train will be in standby for the majority of the operating life of the plant, installed spare equipment is not considered on the main process flow. Installed spare pumps are included on the regenerant processing and ERC circuits of the plant to ensure high availability of this circuit.

5 Treatability Assessments

BQE has conducted two laboratory studies to inform the WTP2 treatment technology:

- Metals Removal Reference Site Assessment (Q3, 2020)
- Selen-IX™ Laboratory Treatability Assessment (Q2, 2019)

The treatability assessments are provided in Appendix C and D, respectively.

5.1 METALS REMOVAL REFERENCE SITE ASSESSMENT

The metals removal reference site assessment provides a comparison of feed and effluent water chemistry at water treatment plants in North America that BQE is involved with. The focus of the reference site assessment is metals other than selenate selenium that may require removal at Hermosa. Table 5.1 provides the summary of feed/effluent water compositions at the reference sites compared to Hermosa.

Table 5.1 – Comparison of existing plant metals concentrations with treatment target design criteria for WTP2

	FEED QUALITY		TREATED WATER QUALITY/TARGET	
Analyte, mg/L	Ranges from Reference Sites (mg/L)	Maximum Predicted for WTP2 (mg/L)	Range from Reference Sites (mg/L)	WTP2 Treatment Target (mg/L)
Arsenic	0.00063 - 0.015	0.075	0.0001 - 0.005	0.05
Copper	0.005 - 0.128	0.045	0.001 - 0.005	0.01959
Iron	0.0477 - 0.08	1.2	0.005 – 0.05	1
Lead	0.0002 - 0.005	0.059	0.0002 - 0.005	0.00672
Selenium	0.00466 - 0.015	0.029	0.00014 - 0.011	0.002
Zinc	0.005 – 2.3	0.43	0.007 - 0.017	0.2547

5.2 SELEN-IX™ LABORATORY TREATABILITY ASSESSMENT

The laboratory treatability assessment conducted in 2019 successfully demonstrated consistent removal of selenium below the treatment objective of 2.0 ppb as well as ERC performance for treatment of the spent IX regenerant and stability of the treatment residue, using the Selen-IX™ process applied to synthetic solution that mimicked future Hermosa WTP2 water. This study formed the engineering design basis including the hydraulic capacity of 4,500 gpm and feed sulfate concentration of 30 ppm.

IX performance for selenium removal was evaluated at three different flow rates, 12, 24, and 48 BV/h. BV (Bed volume) refers to the volume of resin in the IX column, 60 mL. IX was able to remove selenium to less than 0.002 ppm consistently.

Table 5.2 shows the criteria used for the design of the Selen-IX™ treatment plant at Hermosa WTP2 based on the results of this laboratory test campaign.

Table 5.2 – Key Process Parameters used for Design

PARAMETER	VALUE
IX load	2100 BV
IX regeneration	4 BV
IX concentration factor	525
IX loading rate	48 BV/h
IX regeneration rate	1.5 BV/h
Electrocell iron consumption	5 kg/m3 of IX regenerant

6 Alternative Technologies

Several alternative technologies were evaluated prior to selection of Selen-IX™ for implementation at Hermosa WTP2. The following sections describe the alternates considered.

6.1 POSSIBLE TREATMENT APPROACHES

From the process flowsheet standpoint, the removal of TSS, arsenic, and dissolved metals can all be combined into one treatment stage which is conventional. In contrast, the regulatory requirement to remove selenium to levels below 2.0 ppb demands special considerations that fundamentally influence the final selection of the overall treatment flowsheet. Furthermore, the treatment approach for selenium depends on selenium speciation because different forms of selenium exhibit different chemical properties which make them respond differently to different types of treatment. Based on the information provided by AMI, the selenium contained in the depressurization well water is 100% hexavalent selenium (selenate). Even if there are traces of tetravalent selenium (selenite), these could be removed very effectively along with other dissolved metals, arsenic, and TSS in the first treatment stage by using ferric iron co-precipitation.

Therefore, the following discussion of treatment options presented is focused on the removal of selenate downstream of metals removal:

- Biological selenium reduction,
- Membrane treatment such as Reverse Osmosis (RO) or Nanofiltration (NF),
- Zero Valent Iron (ZVI), and
- Selective ion exchange combined with Electro-reduction (Selen-IX™)

Biological selenium reduction systems, and ZVI systems cannot, by themselves, meet the SWQS of less than 2.0 ppb at the end-of-pipe. While membrane systems can meet this standard, they will also generate large flow of waste liquid stream/retentate concentrated in selenium. Selen-IX™ can meet the SWQS of 2.0 ppb directly without generating liquid waste. Consequently, the approaches to selenium removal at Hermosa WTP2 could include either Selen-IX™ or a combination of membrane system with either biological reduction or ZVI system applied to the treatment of the retentate.

BQE Water and B&V do not consider Zero Valent Iron (ZVI) to be a good fit for selenium removal at Hermosa WTP2 due to the large volume of water that must be treated and the water treatment time horizon. One of the main shortcomings of ZVI is surface passivation where the adsorptive capacity of ZVI for selenium declines over time and the spent ZVI cannot be regenerated. Another disadvantage is the slow kinetics of removal leading to large contact vessels and large inventory of ZVI which then needs to be replaced when passivated. These disadvantages would result in high capital and operating costs of ZVI system at Hermosa WTP2.

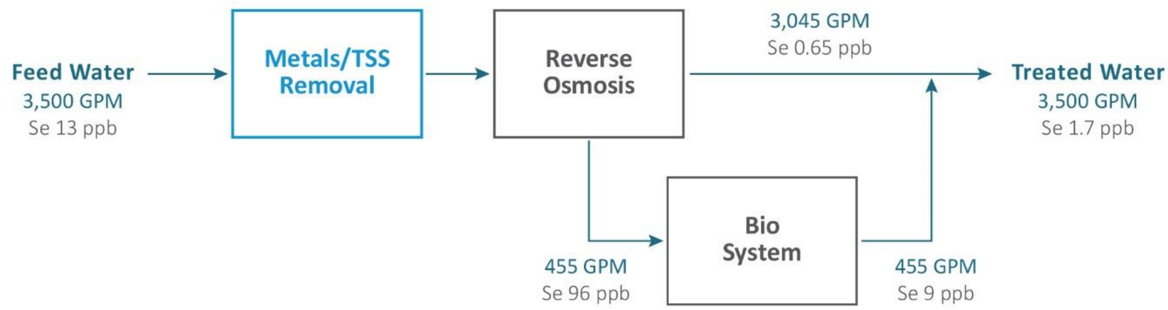
Based on the discussion presented above, the short list of treatment options that BQE evaluated for Hermosa WTP2 include the following:

- Combination of membrane with biological reduction, and
- Selen-IX™

6.2 REVERSE OSMOSIS COMBINED WITH BIOLOGICAL SELENIUM REDUCTION

The block diagram of this treatment option is shown in Figure 6.1 below.

Figure 6.1 – Combined RO and Biological Treatment System for Selenium Removal
Feed Se = 13 ppb, Example flow rate of 3,500GPM



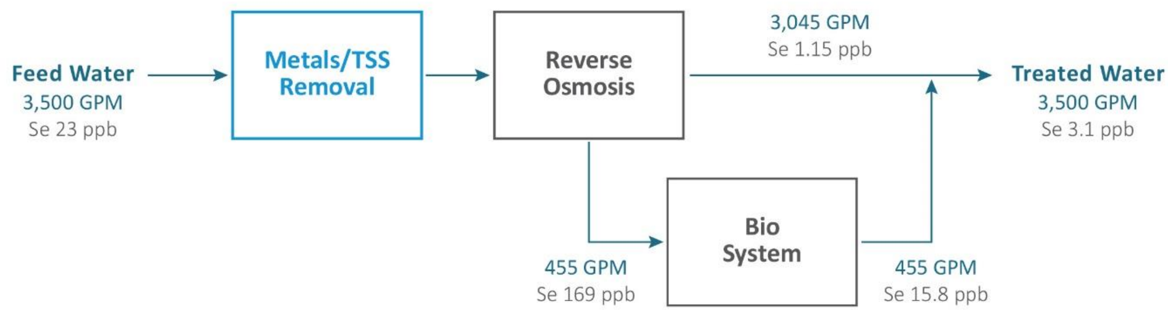
In this treatment option, reverse osmosis (RO) is relied upon to produce discharge water quality with selenium below the SWQS of 2.0 ppb. The role of the biological system in this flowsheet is to remove the majority of selenium reporting to the treatment plant from solution into bio-solid residue. Crucially, biological systems treating water with ~ 100 ppb as shown in Figure 6-1 produce effluents with residual selenium concentrations several times greater than the SWQS of 2.0 ppb. Based on professional experience and technical information publicly available[1] about the performance of RO and biological systems, the key design parameters that inform the split of flows and determination of selenium concentrations in individual streams including the final effluent in Figure 6.1 include the following:

- 95% selenate rejection by RO
- 87% water recovery in RO
- 92% removal of selenium across biological system or a minimum total selenium concentration in monthly average samples of 9.0 ppb, whichever yields a lower effluent selenium number

As can be seen from Figure 6.1, the system could meet the SWQS of 2.0 ppb but with virtually no margin of safety considering the possible variability of selenium concentration in the feed and the accuracy of selenium assays in the effluent which at the ultralow levels are known to be on the order of +/-10% or 0.2 ppb. The risk of non-compliance with the SWQS using the RO-biosystem treatment combination becomes more evident when the feed concentration of selenium is increased from 13 ppb to 23 ppb. Although it is not clear whether this would occur during the plant operation, it is nevertheless our understanding (and common experience from other projects) that an uncertainty exists related to the feed water quality predictions. Consequently, it is instructive to observe the extent of the change in the system performance in response to the increase in plant feed selenium concentration. This is shown in Figure 6.2 below.

[1] Hatch. (2014). Study to Identify BATEA for the Management and Control of Effluent Quality from Mines. MEND.

Figure 6.2 - Combined RO and Biological Treatment System for Selenium Removal
Feed Se = 23 ppb, Example flow rate of 3,500GPM



The major advantage of the RO-Biosystem treatment option is that both RO and biological selenium reduction systems have been applied in large scale industrial settings. However, BQE Water is aware of only one large scale plant which combines RO with a Biosystem for selenium removal and the final effluent limit is greater than 2.0 ppb, which would not be able to meet the SWQS.

The major potential disadvantages and limitations of the RO-Biosystem treatment option can be grouped based on whether the limitation is related to either RO or the biological system or the combination of the two as follows:

RO:

- Membrane scaling caused by elevated level of silica. Water collected from depressurization wells is expected to come directly from the formation and contain dissolved silica concentrations corresponding to saturation at the given temperature. This could negatively impact hydraulic throughput of a RO system, increasing both capital and operating costs. It should be noted that power plants in the Tucson area that use ground water for cooling report issues with silica in the cooling tower circuits.

Biosystem:

- Inability to deal with sudden changes in flow or water composition
- Dependence on water temperature and susceptibility to upsets caused by temperature changes
- Long acclimation times during start-up and/or re-start causing inability to discharge for extended periods of time
- Elevated risk of H_2S gas generation compared to the proposed treatment approach
- Complex process requiring frequent manual adjustments to achieve consistent results
- Biological growth in unintended areas of the overall treatment train caused by excess nutrients.
- Biosolids residue odor causing nuisance for site personnel and neighbors during storage and transport off site

Combined RO – Biosystem:

- Inability to cost effectively provide the required turn-up and turn-down in treatment capacity
- Limited ability to deliver the required turn-down in treatment capacity without upsetting the biological treatment system
- Risk of non-compliance if the selenium concentration in the plant feed increases
- Risk of upsets in biological system caused by antiscalants added to protect the RO membrane

6.3 RATIONALE FOR FINAL SELECTION

The treatment solution selected for Hermosa WTP2 is based on using Selen-IX™ to meet the SWQS of 2.0 ppb. Table 6.1 shows how this selection meets the selection criteria.

Table 6.1 - Match with Selection Criteria

SELECTION CRITERIA	DESCRIPTION OF CRITERIA MATCH
Technical Fit	Able to meet the 2.0 ppb selenium SWQS Able to handle turn-up and turn-down requirements cost effectively Process adapts fast to changes in feed water quality
Demonstrated on waters similar to Hermosa WTP2	BQE Water completed bench scale testing on simulated Hermosa WTP2 water. Several pilot campaigns of Selen-IX™ were run successfully on waters much more difficult to treat than WTP2 feed water. This includes the commercial scale Selen-IX™ plant for the Kemess Project, located in British Columbia, Canada.
Residue generation/handling	Stable inorganic residue with no odor, easy to handle, and meets TCLP
Ease of deployment	All Selen-IX™ equipment is modular, minimizing site erection and installation cost. Fast start-up due to purely physico-chemical nature of the treatment process
Minimization of risks	Relative to the alternate flowsheet, the risks associated with Selen-IX™ are significantly smaller.

The following major risks associated with the RO-Biosystem's flowsheet influenced the final decision not to pursue this treatment option for Hermosa WTP2:

- Inability to handle turn-down/turn-up requirements
- Inability to handle sudden shocks such as starting/stopping and/or temperature changes
- Significant risk of off spec discharge caused by upsets and/or prolonged periods of biomass adaptation and re-adaptation

7 Battery Limits & Key Assumptions

WTP2 battery limits and key assumptions are defined in Table 7.1. For a visual representative of process battery limits, see the process flow diagrams contained in Appendix A.

Table 7.1 – Battery Limits and Key Assumptions

ITEM	BATTERY LIMIT/ASSUMPTION
Feed	■ All feed to be brought to termination flanges near WTP2 building via a pressurized line
Discharge	■ WTP2 discharge meeting specifications will be reused on site with excess water conveyed to the termination flanges of WTP2 for discharging to the Harshaw Creek. ■ Off-spec WTP2 discharge to be pumped to the concrete feed tank for reprocessing
Metals Removal Solids	■ Dewatered filter cake is collected in a roll-off bin within the WTP2 building for final disposal by AMI in the tailings storage facility
Iron-Selenium Solids	■ Dewatered filter cake is collected in a roll-off bin within the WTP2 building for final disposal by AMI in the tailings storage facility
Off Gases	■ The Selen-IX™ process produces hydrogen gas as a by-product, which will exit the plant via a vent stack on the outdoor recirculation tank ■ The sodium hydrosulfide storage tank will have a dry scrubber to remove any odor associated with the reagent. This scrubbed air will be sent to the environment via a vent on the WTP building side wall
Utility Water	■ A portion of WTP2 effluent is to be used as utility water to facilitate reagent makeup and any other general water needs within the plant
Reagents	■ Flocculant is delivered as powder in bags. Battery limit is the solids hopper of the make-up system. ■ Ferric Chloride is delivered as liquid. Battery limit is a camlock connection on the storage tank fill line ■ Ferric Sulfate is delivered as liquid in drums. Battery limit is the reagent storage platform. ■ Caustic is delivered as liquid. Battery limit is a camlock connection on the storage tank fill line ■ Sulfuric acid, sodium hydrosulfide, and TMT are delivered as liquid in IBC totes. Battery limit is the tote storage platform. ■ Sodium sulfate is delivered as dry solid in super-sacks. Battery limit is the bag unloading system.
Spill Containment	■ Secondary containment for chemical reagents will be included in the WTP2 building floor slab. Drainage collection trenches will also be installed in the floor slab to collect other process water spills inside of the battery limits. Drainage collection trenches report to sump pumps that will bring spills back into the process for treatment.

8 Major Equipment Descriptions

The following section describes the equipment used within the Hermosa WTP2.

8.1 PROCESS TANKS

In WTP2, most reactors and storage vessels are made from HDPE. This is due to their chemical compatibility as well as lower weight and cost of HDPE tanks compared to steel or other materials. As HDPE tanks are generally much lighter than steel tanks, these have been specified for most situations where additional wall strength is not required and where solutions are at ambient pressures and temperatures.

8.2 CLARIFIERS

Clarification in the metals removal circuit is performed in a sand ballasted clarifier. The sand ballasted clarifier consists of four compartments: mixing tank, flocculation tank, maturation tank, and clarification tank. These compartments collectively accomplish flocculation, coagulation, maturation, and settling with sufficient mixing and residence time. As an aid to settling, sand is added with flocculant to the flocculation tank, creating very dense flocs which settle substantially faster than standard flocs. After a period of mixing where flocs mature, they are separated in the clarification tank which is aided by tube settlers to increase the settling surface area. The flocs (underflow) are pumped to a hydrocyclone which separates the sand from the sludge, returning the sand to the flocculation tank and discharging the sludge.

The clarification stages in the ERC circuit for the Selen-IX™ regenerant treatment will consist of a clarifier-reactor module including the ERC Clarifier, Polishing Reactor, Polishing Clarifier and Polishing Clarifier Overflow Tank in series. The regenerant overflows from one tank to the next by gravity. The two clarifiers in the ERC circuit will also include internal still wells, rake mechanisms and overflow weirs. The clarifier tanks and rake mechanisms are constructed from stainless steel.

8.3 FILTER PRESSES

Filter presses are used to separate the liquid and solids in the sludge produced in both the metals removal and ERC circuits. During normal operation, sludge is periodically removed from each clarifier to maintain the sludge density at the desired set-point. When sludge removal from a clarifier is required, it will be manually initiated by starting the respective clarifier underflow pump.

In the metals removal circuit, underflow sludge from the Metals Removal Clarifier is pumped to the Metals Removal Thickener which includes a rake mechanism to further thicken the sludge prior to the Metals Removal Filter Press.

In the ERC circuit, underflow sludge from both ERC and polishing clarifiers is combined in the ERC Filter Press Stock Tank, where the solids are stored prior to being pumped to the Electroreduction Filter Press. The filter feed pump is an AODD type with variable air regulator.

As the slurry containing the sludge is pumped through the filter press, solids build up on the filter cloth, within the chambers (space between filter plates), forming the filter cake. Filtrate exits the filter plates through the corner ports into the manifold, combining into the filtrate outlet. Once the chambers are full, the filter press cycle is complete, and the filter cakes are discharged by performing core blow and air blow down operations. The filter cakes drop by gravity into roll off bins ready to be transported for disposal. Each filter press cycle lasts approximately one hour.

The filter presses thicken the sludge from a solids content of approximately 5 - 15% to filter cake at 55% solids content.

8.4 MULTIMEDIA FILTERS

The multimedia filters used within the plant all consist of a number of cylindrical tanks arranged in parallel trains, built of epoxy coated carbon steel, and packed with four types of inert filtration media. The filters receive flow in parallel from a common inlet manifold, remove solids down to an average of 5 microns, and discharge effluent to a common discharge manifold. As the filters operate, they eventually remove enough material that they need to be cleaned by backwashing, as determined by a differential pressure through the media bed greater than 10 psi.

A backwash cycle is started automatically when the differential pressure set point is exceeded. During a backwash sequence, a three-way valve on the inlet port of a single filter switches position and open to the common backwash manifold. This allows a portion of the effluent from the other filters to back flow through the dirty filter releasing solids entrained in the filter media.

8.5 ION EXCHANGE (IX) COLUMNS

For Hermosa WTP2, the packed bed IX columns are 10’ in diameter and 8’ inside wall height. These vessels will be of epoxy lined carbon steel construction.

The design of Selen-IX™ columns follows the same principles as the design of other industrial sized IX systems. Scale up is done based on the bulk loading rate (BV/hr) and linear velocity/surface loading rate (m/hr). Further, the bed height is limited to maintain an overall pressure drop across the resin bed below that specified by the resin manufacturer for the resin used. For the strong base anionic (SBA) type resin used in the Selen-IX™ process, all of these parameters for the full-scale plant have been set at the same, or similar, values as used within previous pilot plants.

As this system is employing packed IX columns, there is no internal height allowance for backwashing within the column. Instead the system will use an external backwash tank which will service all 6 columns on an as-needed basis, as dictated by the differential pressure through a column bed. The frequency of external backwash is expected to be on the order of once every 6 to 12 months.

The IX columns will each be packaged on a skid containing feed and discharge valves, stainless steel piping headers, as well as instrument and valve control junction boxes.

8.6 ELECTROREDUCTION (ERC) SYSTEM

The ERC comprises electrocells and recirculation tanks. There are in total 60 cylindrical shape Emew style electrocells arranged in four banks of 15 cells each operating in parallel. Each of the cells houses an 8” diameter anode, weighing approximately 840 lbs. During operation, the recirculation pumps move solution between the electrocells and the recirculation tanks while DC current passes between anodes and cathodes. Iron is released from the anodes and reacts with selenium in solution. Hydrogen gas is produced on the cathode and accumulates in the headspace of the recirculation tanks.

The hydrogen gas release from the recirculation tank head space is regulated by gas manometer tank (TK-320), where the inlet gas lines are submerged below the water level to maintain a pressure 5" water column (w.c.). The recirculation tank cover and gas manometer are enclosed in ducting that is constantly swept with air to ensure that the low-density hydrogen gas continues to move upward if it leaks from the sealed tanks and the hydrogen concentration does not exceed 1% (25% of the 4% lower explosive limit concentration). A flanged pressure transmitter installed on the recirculation tank headspace will act as a secondary safety measure ensuring that electrocell operation would be shut off if the pressure in the recirculation tank headspace exceeds a high pressure setpoint.

Since the ERC uses sacrificial anodes, they must be replaced periodically using an overhead crane.

8.7 PLANT COMPRESSED AIR AND NITROGEN

Compressed air will be produced at site via a 100 hp rotary screw compressor. The air compressor will be provided as a complete system with air filtration, and compressed air storage. Specifically, the filters will include standard particulate filters, refrigerated air dryer, and oil removal filters.

The air receiver will accept the compressed gases; to supply instrument air to the plant (i.e. spargers in the polishing reactors, filter press, AODD pumps) and to the nitrogen PSA generator.

Nitrogen, used as a ballast gas with the electroreduction recirculation tank and aging tank, will be produced on site via a pressure swing adsorption type nitrogen generator. The system will be fed from the instrument air receiver, with the resulting compressed nitrogen stored in its own nitrogen gas receiver.

8.8 PROGRAMMABLE LOGIC CONTROLLER (PLC)

The control system for WTP2 will consist of a PLC and associated remote I/O modules to make the plant fully automated with minimal operator intervention. With a largely pre-fabricated/modularized approach, each process module will contain its own remote I/O panel which will house all required I/O for the respective module. This will allow a large component of wiring to be completed by the module manufacturer.

9 Process Instrumentation

This section provides a summary of the process instruments that will be used at Hermosa WTP2. These instruments include:

- Level instruments
- Pressure instruments
- Flow instruments
- pH and Oxidative-Reductive Potential (ORP) instruments
- Gas Sensors
- Conductivity instruments
- Turbidity instruments

The following are additional details on the use of process instrumentation in the plant:

- Insertion mounts (retractable assemblies) will be used for pH, ORP, turbidity, and conductivity measurements.
- Isolation valves will be used on process instruments wherever practical.
- Electrical supply to transmitters and switches will be AC line-powered. 24VDC will be used for loop powered instruments.
- Transmitter enclosures rated for NEMA 4X
- Local indication will be provided for all flow and pH/ORP probes.

10 Chemical Usage

10.1 REAGENT CONSUMPTION

Daily consumptions for the reagents are estimated and provided in Table 10.1. The consumption rates are based on the design WTP2 feed flow rate of 4,500 gpm and will vary based on influent water composition.

Table 10.1 – Example Reagent Consumption

REAGENT	DAILY CONSUMPTION[1]	UNIT	AS DOSED	
			DAILY CONSUMPTION	UNIT
TMT (15%)	27	lb/d	2.9	gal/d
Sodium Hydrosulfide (35%)	77	lb/d	8.2	gal/d
Caustic (25%)	3,415	lb/d	322	gal/d
Ferric Chloride (37%)	2,125	lb/d	190	gal/d
Ferric Sulfate (50%)	44	lb/d	3.5	gal/d
Sulfuric Acid (93%)	330	lb/d	89.2	gal/d
Sodium Sulfate (dry)	1,860	lb/d	84	lb/d
Flocculant	55	lb/d	5,210	gal/d

Notes:
1. Consumptions are at as-delivered concentrations

The storage durations of the reagent holding tanks is given in Table 10.2 below.

Table 10.2 – Reagent Tank Capacity

REAGENT	TANK CAPACITY	TANK INVENTORY (DAYS)
TMT (15%)	264 gal tote	90
Sodium Hydrosulfide (35%)	264 gal tote	40
Caustic Soda (10%)	6,000 gal	20
Ferric Chloride (37%)	6,000 gal	30
Ferric Sulfate (50%)	55 gal drum	16
Sulfuric Acid (93%)	264 gal tote	12
Sodium Sulfate (dry)	1,750 lb	1
Flocculant	55 gal	0.1[1]

Notes:
1. Solid flocculant continuously dosed into makeup tank

All reagents dosed into the process as a liquid (i.e., all reagents aside from sodium sulfate) utilize the same type of dosing pump. The pump chosen for this application has an internal pressure sensor, and a digitally controlled brushless motor which precisely controls the discharge stroke, eliminating line pulsation, as typically seen on lines serviced by diaphragm pumps. Due to the 'smart' controls of this pump, it has a turndown ratio of 800:1 and is able to service all the required flowrates for dosing reagents within the plant. The positive aspect of using the same pump for all dosing is a large reduction in spare parts and pump repair knowledge base.

10.2 REAGENT SPECIFIC HANDLING, STORAGE, AND MAKE-UP PROCEDURES

The following sub sections detail specific handling, storage and makeup procedures for each reagent used within the process, as well as their respective chemical specific concerns.

10.2.1 TMT

TMT is a trisodium salt of trimercapto-triazine, or Na_3TMT, and is delivered to site in 1 m^3 (265 gal) IBC totes as a liquid reagent containing 15% TMT. This solution is used as-is in the process.

TMT is used in the metals removal circuit and is dosed inline, just upstream of the feed static mixer, using a single pump to dose the solution. If the pump requires replacement, there will be an available shelf spare.

10.2.2 Sodium Hydrosulfide

Sodium hydrosulfide, NaHS, is delivered to site in 1 m^3 (265 gal) IBC totes as a liquid reagent containing 35% NaHS. This solution is used as-is in the process.

NaHS is used in the metals removal step and is dosed inline, just upstream of the feed static mixer, using a single pump to dose the solution. If a pump requires replacement, there will be an available shelf spare.

10.2.3 Caustic Soda

Caustic soda, NaOH, is delivered to site in 3,600 gal bulk truck as a liquid reagent containing 25% NaOH. This solution is used as-is in the process.

The delivery truck is emptied in the Caustic Storage Tank (TK-540), which has been sized to fit 1.5 times the volume of a delivery truck.

Caustic is used in the metals removal circuit as well as the ERC circuit. There will be three pumps installed, all as duty pumps. If a pump requires replacement, there will be an available shelf spare.

10.2.4 Ferric

Ferric Sulfate, $Fe_2(SO_4)_3$, is delivered to site in 55 gal drums as a liquid reagent containing 50% $Fe_2(SO_4)_3$. This reagent is used as-is in the process.

Ferric sulfate is used in the ERC circuit, dosed into the polishing reactor. There will be one pump installed to dose the solution. If a pump requires replacement, there will be an available shelf spare.

Ferric Chloride, $FeCl_3$, is delivered to site in 3,600 gal bulk truck as a liquid reagent containing 37% $FeCl_3$. This solution is used as-is in the process.

The delivery truck is emptied in the Ferric Chloride Tank (TK-520), which has been sized to fit 1.5 times the volume of a delivery trck.

Ferric Chloride is used in the metals removal circuit, dosed upstream of the feed static mixer. There will be one pump installed to dose the solution. If a pump requires replacement, there will be an available shelf spare.

10.2.5 Sulfuric Acid

Sulfuric acid, H_2SO_4, is delivered to site in 1 m^3 (265 gal) IBC totes as a liquid reagent containing ~93% H_2SO_4. This solution is used at the delivered concentration in the process.

H_2SO_4 is used in the ERC circuit for pH control. There are two pumps installed, both duty pumps. If a pump requires replacement, there will be an available shelf spare.

10.2.6 Sodium Sulfate

Sodium sulfate, Na_2SO_4, is delivered to site in 800 kg (1,750 lb) super-sacks as a dry reagent. A super-sack is raised above the Na_2SO_4 hopper and emptied into the hopper. The hopper transfers the Na_2SO_4 as a powder via the screw feeder attached at the bottom to a small intermediate hopper. A volumetric feeder attached to the bottom of the intermediate hopper doses sodium sulfate into the system. Sodium sulfate is dosed into the polishing clarifier overflow tank as a powder rather than a solution, as the volume of water added to the system from making up a brine solution would negatively affect the water balance of the regenerant system. The reagent system is sized to require one super sack (1,750 lb) approximately every five days.

10.2.7 Flocculant System

WTP2 uses two different types of dry polymer flocculants; one for the Metals Removal stage and ERC clarifier, and one for the Selen-IX regenerant processing. Due to the different flocculants being used, each is made up into a liquid suspension separately.

The larger-capacity system is a vendor-supplied package for the flocculant used for metals removal and consists of equipment for solid flocculant handling and wetting, tank and agitator for flocculant mixing/ maturation, and a second tank for flocculant solution storage.

Dry flocculant is supplied in bags and mixed with utility water to a concentration of 0.125 wt% using an automated polymer feed and mixing system. The flocculant mix tank is located immediately above the storage tank. Once the solution has suitably matured, it is transferred to the storage tank by gravity through an automated valve. Flocculant solution is discharged from the storage tank by variable speed metering pumps.

Each flocculant pump continuously adds flocculant solution to their respective injection points based on a feed:flocculant ratio. The metals removal flocculant injection point is upstream of an inline feed static mixer. This mixer has been designed to operate at a low differential pressure, and to provide gentle but complete mixing to ensure good flocculation of solids. The flocculant used in the Selen-IX™ circuit is injected into a floc box upstream of the ERC clarifier. This floc box creates a gentle but meandering flow through, allowing the flocculant to be equally dispersed throughout, and build large, better settling flocs.

When relying on a mixer/agitator to disperse flocculant solution, a large portion of the polymer is destroyed by the large shear forces seen at the agitator blade. By calmly dispersing the flocculant solution in the manner described above, the flocculant is gently mixed into the solution with little shear to destroy the long polymer chains.

A simpler, smaller capacity system is designed for the flocculant used in the Selen-IX™ regenerant processing, which consists simply of an agitated mix tank and storage tank. Operators will manually open a valve to feed makeup water through an eductor and into the mix tank. While the tank is filling, the operator will slowly add dry powder flocculant into the eductor until the desired concentration has been achieved.

10.2.8 Hydrogen Peroxide

Hydrogen peroxide, H_2O_2, is delivered to site in 1 m^3 (265 gal) IBC totes as a liquid reagent containing 10% H_2O_2. This solution is used as-is in the process.

The H_2O_2 system is not expected to be used but is included in the plant design as a contingency for manganese removal in the ERC clarifier and polishing clarifier overflow tank. H_2O_2 will be dosed directly from the IBC tote using two installed pumps, both duty pumps. If the pump requires replacement, there will be an available shelf spare.

These materials must be kept away from other chemical reagents. Refer to the H_2O_2 safety data sheet (SDS) for further information on proper handling, storage and other EHS information.

10.2.9 Hydrogen Sulfide

Hydrogen sulfide, H_2S, is not a plant reagent, however, there is potential for H_2S to be present if sulfide reagents are improperly handled. Hydrogen Sulfide is both toxic and flammable. Its chemical formula is H_2S, two-parts hydrogen and one-part sulfur. All personnel must wear personal gas detectors. At high gas concentrations where evacuation is not possible or personnel must remain, use of a self-contained breathing apparatus (SCBA) is required. If the plant H_2S detectors cause a plant alarm, all personnel must evacuate the plant following the evacuation procedures outlined in the WTP2 Emergency Response Plan, which will be prepared prior to plant startup.

10.2.10 Hydrogen Gas Generated by Electroreduction Cells

During the selenium electroreduction process taking place in the ERC, hydrogen gas is produced on the surface of cathodes similar to gas evolution associated with copper electrowinning at SX-EW and copper refining operations, and/or water treatment plants using electrocoagulation, which needs to be managed safely.

The following are the key elements of the Selen-IX™ plant engineering design that provide safe hydrogen management at the Hermosa WTP2:

- The recirculation tank will be located outside of the building, with ducting (enclosing the top of the recirculation tank and gas manometer) which vents through an exhaust stack (off-gas header) into the atmosphere.
- Excess gas from the recirculation tank headspace (mixture of hydrogen and nitrogen) will be released through the gas manometer into the ducting and off-gas header.
- The headspace of the recirculation tanks will be sealed and maintained under a nitrogen blanket and slightly positive pressure of 5" w.c. by means of connection to the gas manometer. A pressure transmitter will be installed on the recirculation tank as a secondary safety measure to the gas

manometer. If the pressure in the recirculation tanks exceeds the high pressure setpoint, the electrocells will automatically be de-energized.

- Continuous constant flow of sweep air will be passing through the ducting to dilute and convey gases released through the gas manometer up through the off-gas header and exhaust stack to ensure hydrogen concentrations remain below 1%, i.e. one quarter of the lower explosive limit (LEL) concentration of 4% v/v inside the enclosure.
- The sweep air blowers will run confirmation signals and the flow detection signal will be interlocked to de-energize the electrocells, stopping hydrogen generation if sweep air is lost. To ensure that the blowers continue to evacuate hydrogen in the event of power failure, they will be connected to the plant emergency power source.
- No spark-generating equipment will be located in the recirculation tanks area, ducting or near the exhaust stack outlet.
- All instruments installed in the impacted area shall be of "intrinsically safe" classification. The gas containment area has a Class I division II electrical area classification.
- Hydrogen lower explosive limit (LEL) detectors will be located strategically in areas where hydrogen may be present
- Hydrogen monitors located in the ducting, stack and general plant area will automatically de-energize the electrocells if hydrogen concentration exceeds 1%. Leak detection in in the form of level and pressure measurements will be installed on each bank of electrocells, interlocked to de-energize the electrocells and recirculation pump if a leak is detected. The exhaust fan will also be interlocked to prevent operation of the electrocells if the exhaust fan is not operating.

11 Waste Characterization

The by-products of the Hermosa WTP2 operation will be:

- TSS removed from feed water along with precipitated metal solids generated in the metals removal circuit
- A highly stable cake consisting of iron-selenium precipitates generated in the selenium removal circuit
- "Spent" electroreduction cell anodes that have been consumed to a size no longer efficient to use in the electrocell

Production of filter cake will vary depending on influent water composition. An example production rate of filter cake is summarized in Table 11.1. Metal removal efficiencies from other operating plants were used to calculate the extents of reaction of each metal.

Table 11.1 – Example By-product Production Estimates for the Various Treatment Circuits

PARAMETER	VALUE	UNIT
WTP2 Feed Flow Rate	4,500	gpm
Metals Removal Solids		
Cake Percent solids	55%	wt%
Cake Production	5.23	dry ton/d
	0.0018	dry lb/gal treated
Iron-Se Solids		
Cake Percent solids	55%	wt%
Cake Production	1.20	dry ton/d
Spent Anodes		
Production Rate	130	lb/d
Disposal Location for all residue	Site Disposal	

The spent anodes can be taken off-site as scrap metal to avoid impoundment on-site.

The metals removal solids and iron-selenium solids are stored in roll-off bins within the building prior to disposal on site. Based on BQE's previous project experience and extensive long-term stability testing under conditions representative of sub-aqueous co-disposal with tailings, these solids are expected to be stable. The filter cake from previous pilot campaigns has undergone TCLP testing and been designated non-hazardous. Table 11.2 shows the elemental composition of the washed iron-Se solids residues generated by the ERC as part of the bench scale testing conducted in 2020 on feed water that matched Hermosa WTP2 water quality (described in Appendix D).

Table 11.2 – Elemental Composition of Washed Solids Residue Generated by ERC

PARAMETER	UNIT	VALUE
Al	%	0.02
Ca	%	0.01
Fe	%	49.1
K	%	0.01
Mg	%	0.11
Na	%	0.64
S	%	3.32
Ag	mg/kg	0.22
As	mg/kg	29.5
Cd	mg/kg	0.02
Co	mg/kg	20.5
Cr	mg/kg	139
Cu	mg/kg	121
Mn	mg/kg	1680
Mo	mg/kg	9.16
Ni	mg/kg	58.7
P	mg/kg	80
Pb	mg/kg	0.5
Sb	mg/kg	3.58
Se	mg/kg	401
Sn	mg/kg	9.4
Zn	mg/kg	5
Zr	mg/kg	<0.5

It is apparent from the bench scale study results that iron, sodium and sulfur were the most dominant constituents of the solids generated after ERC. The source of sodium and sulfur in the solids was the spent regenerant which is made of brine sodium sulfate solution. These results are in line with BQE's experience from previous lab, pilot, and demo campaigns.

12 Operations and Monitoring

12.1 ON-SITE OPERATING LABOR

Table 12-1 shows the expected staffing requirements during operations once installation of WTP2 is complete.

Table 12.1 – Estimated Labor Requirements for Hermosa WTP2

POSITION	NO. PER DAY SHIFT	NO. PER NIGHT SHIFT	NO. OFF-SITE
Plant Manager	1	0	0
Operators	2	1	3

The plant manager is expected to work on a Monday to Friday day shift basis while the operators will work on a 2-weeks on, 2-weeks off rotation. The following sections briefly describe the duties of each staff member:

Plant Manager

- Responsible for all aspects of WTP2 O&M and performance including safety
- Directs and oversees all activities at the WTP2
- Schedules manpower and manages support from the Owner and Contractor off-site
- Manages inventories of Materials and coordinates with the Owner's procurement to ensure adequate inventory of Materials is maintained at all times
- Ensures site safety by operating within the guidelines of the site
- Ensures staff training is adequate and up to date
- Reports WTP2 performance/status to senior Owner representatives

Control Room Operator

- Monitors and controls the process through the HMI
- Updates WTP2 targets through the HMI as directed by the plant engineer
- Directs floor operator to troubleshoot process upsets
- Coordinates communication between WTP2 and the Owner environmental department and process plant control room

Floor Operator

- Performs general WTP2 housekeeping
- Operates the fork lift and crane as required
- Collects and submits WTP2 samples as directed by the plant engineer
- Monitors the process and implements process changes as directed by the control room operator
- Monitors WTP2 equipment, performs preventative maintenance, submits work orders for outside help as required, and assists with activities performed during scheduled maintenance shut-down.

12.2 OPERATOR-PLC INTERFACE – THE HMI

The HMI is a computer program designed to clearly display information from the programmable logic controller (PLC), connecting the operator to the PLC, and runs on a stand-alone computer monitor. This computer communicates with the PLC via the WTP2 control network, which is separate from any office networks running at the site.

The HMI is configured such that it automatically logs and stores the plant's operating and run-time data, where it can be displayed and trended in real time to ensure effective plant operations. As the data are stored within the HMI, they can be accessed at later dates for reporting purposes. The information displayed by the HMI includes:

- Instrument readings (real time, daily averages and 24 hr totals)
- Motor status (online/offline)
- Valve status (open/closed)
- Alarms (real time and historical)
- Trends (real time and historical)

The HMI has the following additional capabilities:

- Data export
- Report creation and export
- Email alarms to key personnel
- Web server to display HMI pages in a web browser from a remote location

Using the HMI, the operator can interact with the process in the following ways:

- Place equipment and valves in stop, manual or automatic mode
- Enable/disable automatic control loops
- Enter set points for automatic control loops
- Start/stop equipment and open/close valves in manual mode
- Enter motor speeds and valve positions in manual mode
- Acknowledge alarms

12.3 UNINTERRUPTIBLE POWER SUPPLY (UPS)

The uninterruptible power supply system provides emergency power to critical loads in the event that main power is lost. Critical loads for the plant include the control system, safety instrumentation and the sweep air blowers.

12.4 PLANT PERFORMANCE MONITORING – PLANT HISTORIAN

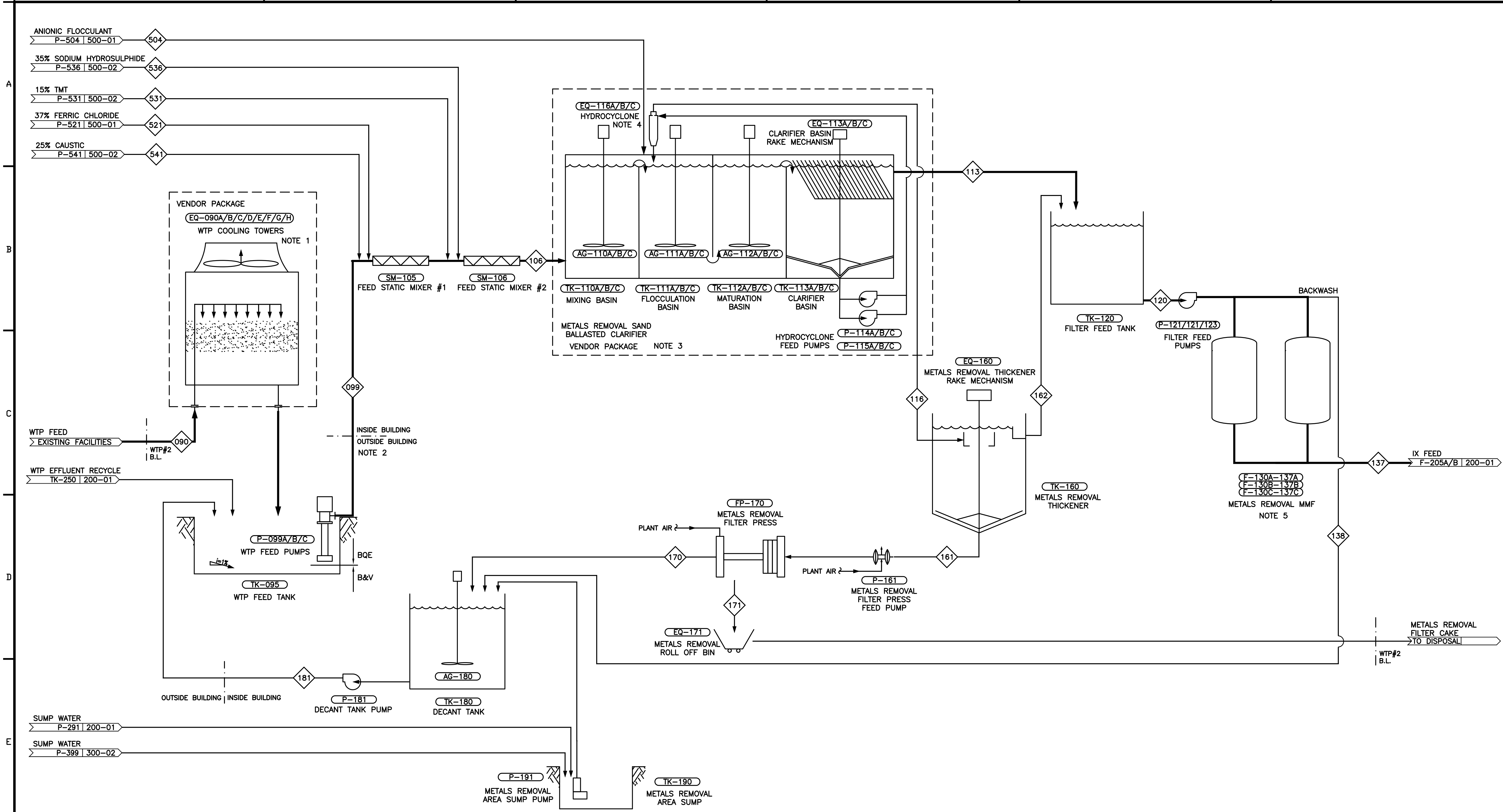
To access the data logged and stored within the HMI, a software package with a Historian is installed along with the HMI. The plant historian is an important component for successful plant operations: it provides access to the plant operating data which is useful not only for troubleshooting, but also for data compilation and storage, as well as demonstrating compliance.

The HMI and plant historian will be configured so that long distance plant monitoring capabilities are available to BQE Water from Vancouver.

12.5 MONITORING AND ANALYTICAL REQUIREMENTS

Periodic samples will be collected from the influent, metals removal effluent (prior to treatment to remove selenium), WTP2 effluent (IX effluent, following the selenium removal circuit), and other locations as required for internal monitoring purposes and to assess plant performance. At minimum, plant discharge will be sampled at a frequency necessary to comply with applicable permit requirements.

APPENDIX A
PROCESS FLOW DIAGRAMS



NOTES:

1. COOLING TOWERS DESIGNED BY BLACK & VEATCH.
2. TK-095 AND FEED PUMPS P-099A/B/C WILL BE LOCATED OUTSIDE THE MAIN PLANT BUILDING. CONNECTIONS WILL BE RUN THROUGH THE BUILDING WALL AND CONNECTED TO THE MAIN FEED LINE.
3. SAND BALLASTED CLARIFIER SYSTEM TO BE A VENDOR PACKAGE COMPLETE WITH MIXING BASIN, FLOCCULATION BASIN, MATURATION BASIN, CLARIFIER, HYDROCYCLONE, AND RECIRCULATION PUMPS. 3 UNITS OPERATING IN PARALLEL.
4. HYDROCYCLONE UNDERFLOW RETURNS CLEAN SAND BALLAST TO CLARIFIER, HYDROCYCLONE OVERFLOWS PROCESS SLURRY TO TK-160.
5. MULTIMEDIA FILTERS TO BE A VENDOR PACKAGE, CURRENTLY SET AS 3 BANKS WITH 8 FILTERS PER BANK, WITH A TOTAL OF 24 FILTER VESSELS. FINAL NUMBER OF UNITS TO BE DETERMINED BASED ON VENDOR INPUT.

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BQE Water

REV.	REVISION ISSUED FOR:	DATE	DRAWN	DESIGNED	REVIEWED	APPROVED
F	ISSUED FOR DETAILED DESIGN	2020 JULY 21	M. CASTELLVI			
E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P.PATEL	M. CASTELLVI	J. REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: METALS REMOVAL CIRCUIT

CLIENT DWG. NO:	BQE WATER DWG. No.
404218-PR-DWG-0001	18033-PFD-100-01

SCALE:	DIM:	SIZE:	REV:
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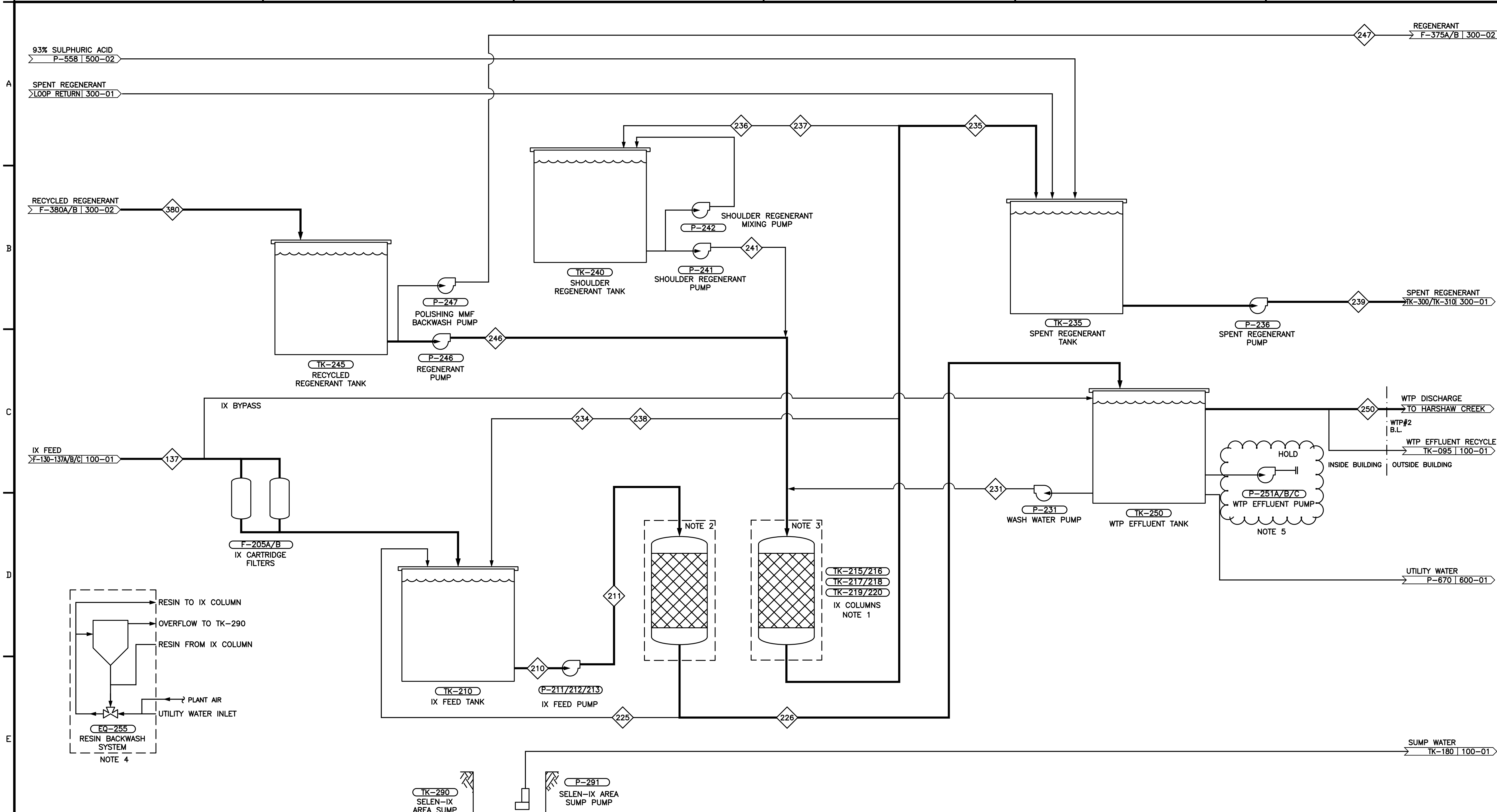

NOTES:

1. BOTH COLUMNS TOGETHER REPRESENT 1 TRAIN OF IX COLUMNS. THERE WILL BE 3 TRAINS OPERATING IN PARALLEL, EACH WITH 2 COLUMNS, FOR A TOTAL OF 6 COLUMNS
2. LOADING STAGE: 1 COLUMN
3. REGENERATION/WASHING STAGE; 1 COLUMN.
4. RESIN BACKWASH SYSTEM TO BE FIXED IN PLACE, AND IN CLOSE PROXIMITY TO THE IX TRAINS. IT CONSISTS OF A SINGLE CONE BOTTOM TANK AND EDUCTOR.
5. NEED OF EFFLUENT PUMPS P-251A/B/C ON HOLD PENDING SOUTH32 INPUT ON USERS/LOCATIONS

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BQE Water

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E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P. PATEL	M. CASTELLVI	J. REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: ION EXCHANGE CIRCUIT

CLIENT DWG. NO:	BQE WATER DWG. No.
404218-PR-DWG-0002	18033-PFD-200-01

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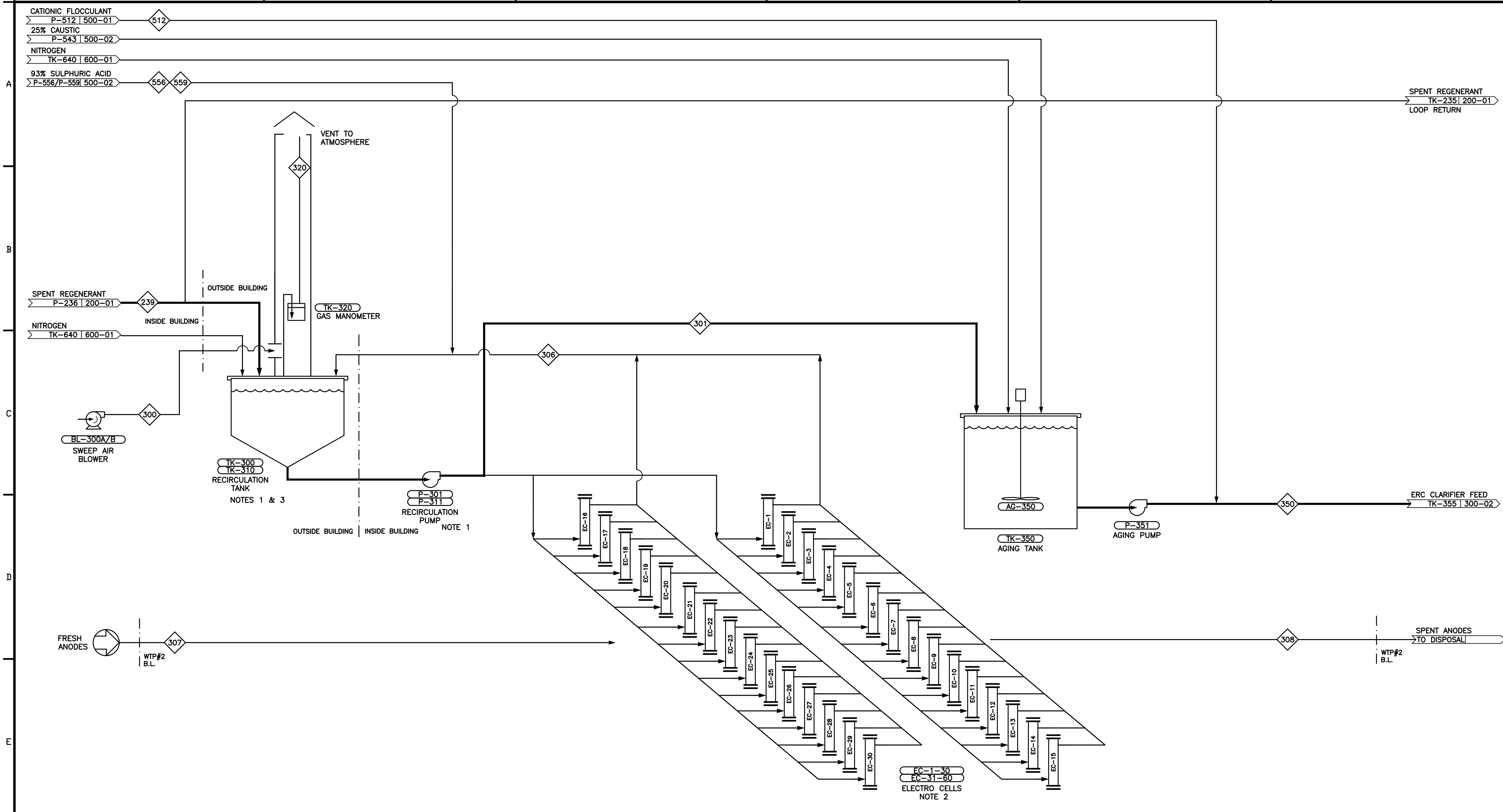

NOTES:

1. THERE WILL BE 2 ELECTROREDUCTION SYSTEMS INSTALLED OPERATING IN PARALLEL. EACH SYSTEM IS COMPOSED OF 1 RECIRCULATION TANK (TK-300/310), 1 RECIRCULATION PUMP (P-301/311) AND 1 TRAIN OF 30 ELECTROCELLS (EC-1 to 30/31 to 60).
2. EACH ELECTORCELL TRAIN (EC-1 to 30/31 to 60) IS COMPOSED OF 30 INDIVIDUAL ELECTROCELLS INSTALLED IN 2 ROWS/BANKS OF 15 IN EACH BANK, ALL OPERATING IN PARALLEL.
3. RECIRCULATION TANKS TK-300 & TK-310 ARE LOCATED OUTSIDE PLANT BUILDING.

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BQE Water

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F	ISSUED FOR DETAILED DESIGN	2020 JULY 21	M. CASTELLVI			
E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P. PATEL	M. CASTELLVI	J.REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: ELECTROREDUCTION CIRCUIT

CLIENT DWG. NO:	BQE WATER DWG. No.
404218-PR-DWG-0004	18033-PFD-300-01

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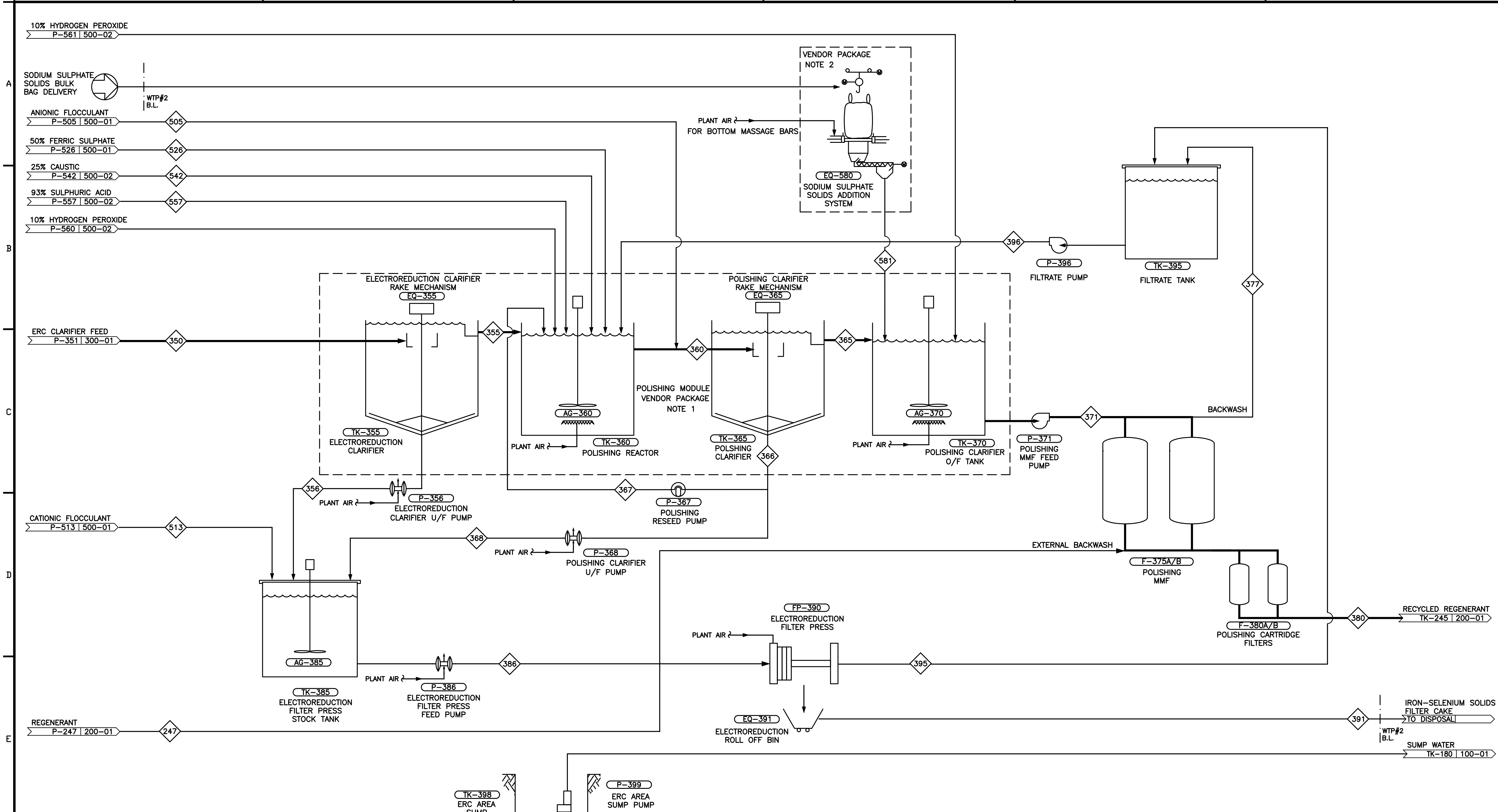

NOTES:

1. THE TANKS, CLARIFIERS AND ASSOCIATED EQUIPMENT/INSTRUMENTATION THAT MAKE UP THE POLISHING MODULE IS PACKAGED AS A COMBINED TANK UNIT.
2. SODIUM SULPHATE SOLIDS ADDITION SYSTEM TO BE VENDOR PACKAGE COMPLETE WITH LIFT MECHANISM, BAG MASSAGE, DISCHARGE SCREW AND CHUTE.

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BQE Water

REV.	REVISION ISSUED FOR:	DATE	DRAWN	DESIGNED	REVIEWED	APPROVED
F	ISSUED FOR DETAILED DESIGN	2020 JULY 21	M. CASTELLVI			
E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P. PATEL	M. CASTELLVI	J. REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: ELECTROREDUCTION CIRCUIT

CLIENT DWG. NO: 404218-PR-DWG-0005

BQE WATER DWG. No. 18033-PFD-300-02

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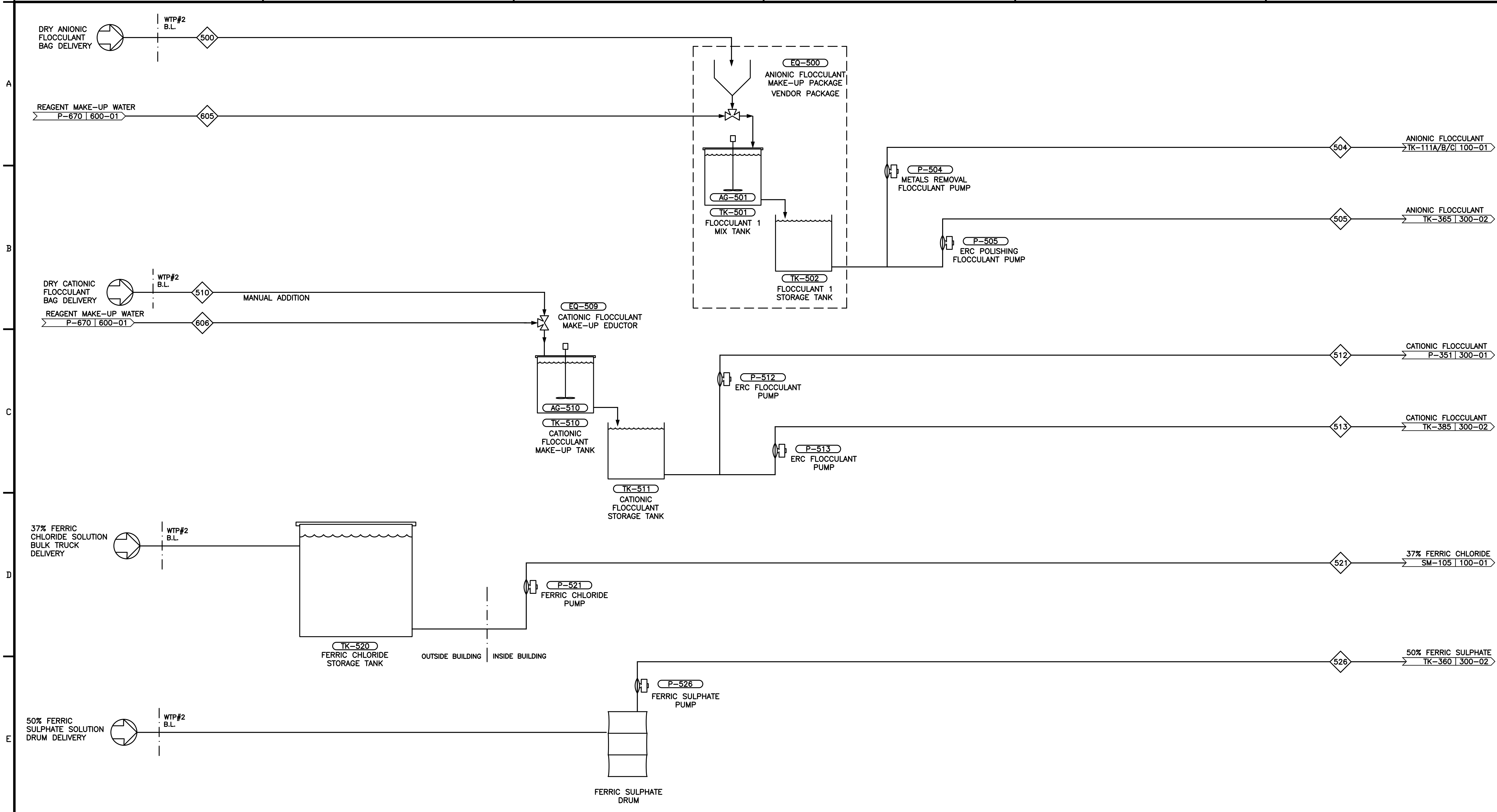

NOTES:

1. FERRIC CHLORIDE, SODIUM HYDROSULPHIDE, SULPHURIC ACID, CAUSTIC AND HYDROGEN PEROXIDE REAGENTS TANKS/TOTES WILL BE LOCATED OUTSIDE THE MAIN PLANT BUILDING. CONNECTIONS WILL BE RUN THROUGH THE BUILDING WALL AND CONNECTED TO THE DOSING PUMPS

ALL OF THE INFORMATION CONTAINED IN THIS DRAWING IS THE PROPERTY OF BQE WATER AND IS CONFIDENTIAL. NO REPRODUCTION, TRANSMISSION, OR USE IN WHOLE OR IN PART MAY BE MADE WITHOUT THE PRIOR WRITTEN PERMISSION OF BQE WATER.

BQE Water

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E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P. PATEL	M. CASTELLVI	J. REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: REAGENTS CIRCUIT

CLIENT DWG. NO:	BQE WATER DWG. No.
404218-PR-DWG-0006	18033-PFD-500-01

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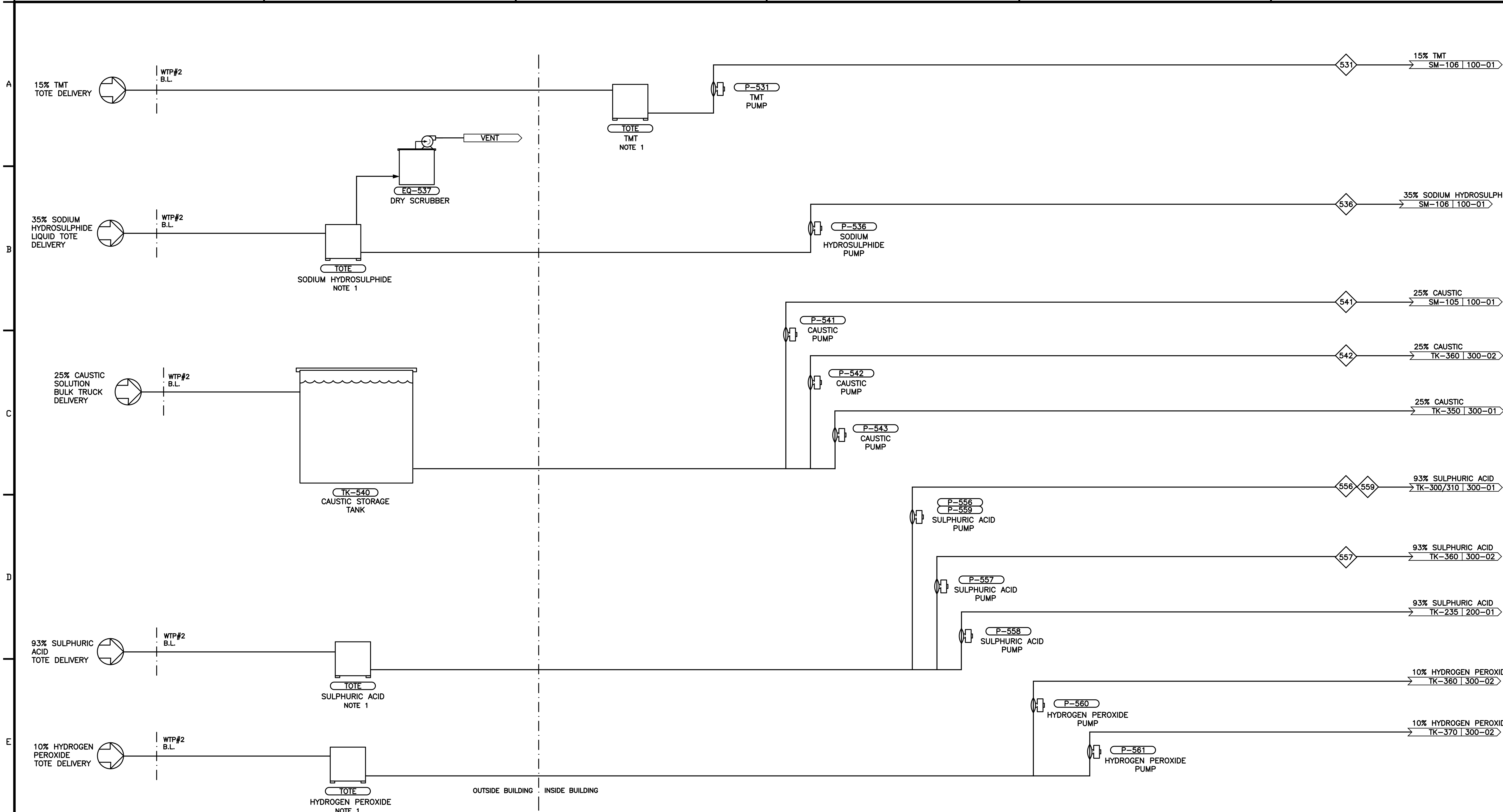

NOTES:

1. SODIUM HYDROSULPHIDE, SULPHURIC ACID, TMT AND HYDROGEN PEROXIDE TO BE DELIVERED TO SITE IN IBC TOTES. DOSING PUMPS WILL BE CONNECTED DIRECTLY TO THE TOTES.
2. FERRIC CHLORIDE, SODIUM HYDROSULPHIDE, SULPHURIC ACID, CAUSTIC AND HYDROGEN PEROXIDE REAGENTS TANKS/TOTES WILL BE LOCATED OUTSIDE THE MAIN PLANT BUILDING. CONNECTIONS WILL BE RUN THROUGH THE BUILDING WALL AND CONNECTED TO THE DOSING PUMPS

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BQE Water

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E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P. PATEL	M.CASTELLVI	J. REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: REAGENTS CIRCUIT

CLIENT DWG. NO:	BQE WATER DWG. No.
404218-PR-DWG-0007	18033-PFD-500-02

SCALE:	DIM:	SIZE:	REV:
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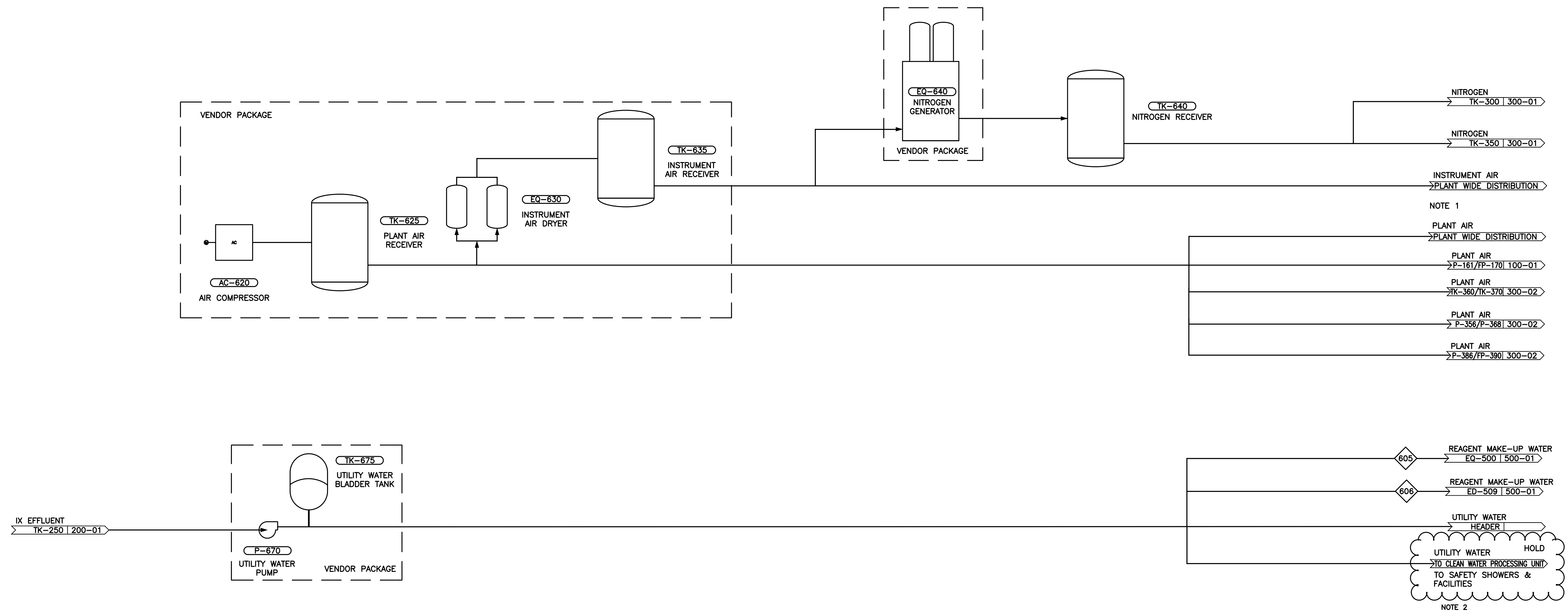

NOTES:

1. PLANT AIR & INSTRUMENT AIR TO BE DISTRIBUTED PLANT WIDE, WITH TAKE-OFFS LOCATED IN CONVENIENT LOCATIONS CLOSE TO DUTY POINTS.
2. SHOWS ALLOCATION FOR FUTURE CLEAN WATER PROCESSING UNIT TO PROVIDE CLEAN WATER FOR SAFETY SHOWERS & FACILITIES

ALL OF THE INFORMATION CONTAINED IN THIS DRAWING IS THE PROPERTY OF BQE WATER AND IS CONFIDENTIAL. NO REPRODUCTION, TRANSMISSION, OR USE IN WHOLE OR IN PART MAY BE MADE WITHOUT THE PRIOR WRITTEN PERMISSION OF BQE WATER.

BQE Water

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F	ISSUED FOR DETAILED DESIGN	2020 JULY 21	M. CASTELLVI			
E	ISSUED FOR DESIGN	2020 JUNE 26	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
D	ISSUED FOR HAZOP	2020 JUNE 02	M. CASTELLVI	M. CASTELLVI	S. GOVENDER	M. CASTELLVI
C	ISSUED FOR BASIC DESIGN	2020 MAR 27	J. HUXTABLE	J. HUXTABLE	M. CASTELLVI	J. REYNOLDS
B	ISSUED FOR REVIEW	2020 FEB 07	P. PATEL	P. PATEL	M. CASTELLVI	J. REYNOLDS
A	ISSUED FOR PROPOSAL	2019 JUL 17	V. SUNDAR	–	–	–

PROJECT TITLE: WTP2 – HERMOSA PROJECT

DRAWING TITLE: UTILITIES CIRCUIT

CLIENT DWG. NO:	BQE WATER DWG. No.
404218-PR-DWG-0008	18033-PFD-600-01

SCALE:	DIM:	SIZE:	REV:
NTS	–	11x17	F

APPENDIX B
MASS BALANCE

BQE Water

Mass Balance Stream Table - Design Conditions

Project: **WTP2 - Hermosa Project**
Location: **Patagonia, Arizona - USA**
Document number (BQE): **18033-ST-001**
Document number (BV): **404218-PR-LST-0001**

DATE	REVISION ISSUED FOR:	CREATOR	REVIEWER	APPROVER	REV
25-02-2020	ISSUED FOR REVIEW	V.SUNDAR	S.GOVENDER	B.BAKER	A
27-03-2020	ISSUED FOR BASIC DESIGN	M. CASTELLVI	J. HUXTABLE	J. REYNOLDS	B
26-06-2020	ISSUED FOR DESIGN	M. CASTELLVI	S.GOVENDER	M. CASTELLVI	C
16-07-2020	ISSUED FOR DETAILED DESIGN	M. CASTELLVI	E. AFABOR	M. CASTELLVI	D

				STREAM PROPERTIES								STREAM FLOW							
				FLUID PHASE				Solids	Liq SG	Stream	pH	"ON" time	design flow rate					Notes	Rev
Stream #	Service	From	To	L	SL	S	G	% w/w		SG		hrs/d	ton/day	gpm	gpd	kmoles/d	scfm		
Area 100 - Metals Removal Circuit																			
090	Feed Water	Outside WTP B.L.	EQ-090A/B/C/D/E/F/G/H	X		X		0.020%	0.000	1.000	6.5	24	27,036	4,500	6,479,295			29ppb Selenium, 30ppm Sulphate	
099	Feed Water	P-099A/B/C	SM-105	X		X		0.020%	0.000	1.000	6.5	24	27,036	4,500	6,479,295				
106	Treated Feed Water	SM-106	TK-110A/B/C	X		X		0.022%	0.000	1.000	9.0	24	27,654	4,602	6,626,351				
113	Metals removal Clarifier O/F	TK-113A/B/C	TK-120	X				0.001%	0.000	1.000	9.0	24	26,934	4,481	6,452,456				
116	Metals removal Clarifier U/F	EQ-116A/B/C	TK-160	X		X		0.80%	1.000	1.005	9.0	24	719	119	171,477				
120	Metals removal MMF feed	TK-120	P-121/122/123	X		X		0.001%	0.000	1.000	9.0	24	27,625	4,596	6,617,907				
137	Metals removal Effluent - IX Feed	F-130-137A F-130-137B F-130-137C	F-205A/B	X				0.0%	0.000	1.000	9.0	24	27,050	4,596	6,480,243				
138	Metals removal MMF Backwash	F-130-137A F-130-137B F-130-137C	TK-180	X		X		0.053%	1.000	1.001	9.0	9.6	575	239	137,664				
162	Metals removal Thickener O/F	TK-160	TK-120	X				0.0%	0.000	1.000	9.0	24	691	115	165,452				
161	Metals removal Thickener U/F	TK-160	P-161		X			20%	1.000	1.145	9.0	6	29	17	6,025				
170	Metals removal Filtrate	FP-170	TK-180	X				0.0%	0.000	1.000	9.0	6	18	12	4,387				
171	Metals removal Filter Cake	FP-170	EQ-171			X		55%	1.000	1.531	9.0	6	10	4.6	1,638				
181	Metals Removal Decant	P-181	TK-095	X		X		0.05%	1.000	1.001	8.9	24	593	99	142,051				
Area 200 - Ion Exchange Circuit																			
210	IX Feed Water	TK-210	P-211/212/213	X				0.0%		1.000	7.8	24	27,083	4,506	6,488,029				
211	IX Feed Water, each train	P-211/212/213	TK-215 to 220	X				0.0%		1.000	7.8	24	9,028	1,502	2,162,676				
225	IX Pre-Load discharge, Step 101, total	TK-215 to 220	TK-210	X				0.0%		1.005	5.2	0.012	14	1,509	3,244				
226x	IX Effluent, Step 102, each train	TK-215 to 220	Tee Stream 226x	X				0.0%		1.000	7.8	23.99	9,023	1,509	2,161,604				
226	IX Effluent, Step 102, total	Tee Stream 226x	TK-250	X				0.0%		1.000	7.8	24	27,069	4,503	6,484,813				
231	IX Wash Water, total	P-231	TK-215 to 220	X				0.0%		1.000	7.8	0.1	19	206	4,542				
237	IX Pre-Wash Water, Step 301, total	TK-215 to 220	TK-240	X				0.0%		1.086	3.9	0.1	10	206	2,271				
238	IX Spent Wash Water, Step 302, total	TK-215 to 220	TK-210	X				0.0%		1.006	5.1	0.1	10	206	2,271				
241	IX Shoulder Regenerant, total	P-241	TK-215 to 220	X				0.0%		1.084	3.6	0.3	47	206	10,381				
234	IX Pre-Regen, Step 201, total	TK-215 to 220	TK-210	X				0.0%		1.009	4.6	0.1	10	206	2,271				
235	IX Spent Regenerant, Step 202, total	TK-215 to 220	TK-235	X				0.0%		1.077	3.6	0.2	36	206	8,110				
246	IX Regenerant, total	P-246	TK-215 to 220	X				0.0%		1.078	4.2	0.2	36	206	8,057				
236	IX Weak Spent Regenerant, Step 203, total	TK-215 to 220	TK-240	X				0.0%		1.083	3.9	0.2	37	206	8,110				
239	Spent Regenerant to ERC, total	P-236	TK-300/TK-310	X				0.0%		1.077	3.6	0.34	36	396	8,110				
250	WTP Effluent - Plant Discharge	TK-250	Outise B.L. - Harshaw Creek	X				0.0%		1.000	7.8	24	27,027	4,496	6,474,632			1.6ppb Selenium, 35ppm Sulphate	
Area 300 - Electroreduction Circuit														gph					
300	Sweep air	BL-300A/B	TK-300/TK-310 exhaust stack				X					22				2,776	1,700		D
301	Electroreduced Slurry, total	P-301/P-311	TK-350		X			0.8%	1.078	1.083	9.0	22	140	23,775	30,859				D
N/A	Electroreduced Slurry, each train	P-301/P-311	Tee Stream 301		X			0.8%	1.078	1.083	9.0	22	70	23,775	15,429				D
306	Electrocells Recirculation, each train	EC-1 to 30/31 to 60	TK-300/TK-310		X			0.8%	1.078	1.083	9.0	22	70	23,775	15,429				D
N/A	Electrocells Recirculation, each cell	P-301/P-311	EC-1 to 60		X			0.8%	1.078	1.083	9.0	22		752					D
307	Fresh Iron Anodes	Source	EC-1 to 60			X		100%		7.850		24	0.65						D
308	Spent Iron Anodes	EC-1 to 60	Disposal			X		100%		7.850		24	0.06						D
320	Off-gases, total	TK-320	Environment				X			1.898		22				10.8	5.9		D
N/A	Off Gases, each train	TK-300/TK-310	TK-320				X			1.898		22				5.4	3.0		D
350	ERC Clarifier Feed	P-351	TK-355		X			0.8%	1.078	1.083	9.0	24	140	1,287	30,882				D
355	ERC Clarifier O/F	TK-355	TK-360	X				0.0%		1.078	9.0	24	132	1,221	29,314				D
356	ERC Clarifier U/F	P-356	TK-385		X			15%	1.078	1.192	9.0	8.0	7.8	196	1,568				D
360	Polishing Clarifier Feed	TK-360	TK-365		X			1.3%	1.078	1.087	4.2	24	152	1,392	33,419				D
365	Polishing Clarifier O/F	TK-365	TK-370	X				0.0%		1.078	4.2	24	138	1,280	30,729				D
366	Polishing Clarifier U/F, total	TK-365	P-367/P-368		X			15%	1.078	1.192	4.2	24	13.4	112	2,690				D
367	Polishing Re-seed	P-367	TK-360		X			15%	1.078	1.192	4.2	24	13.2	110	2,650				D
368	Polishing Clarifier U/F to filtration	P-368	TK-385		X			15%	1.078	1.192	4.2	8.0	0.20	5.0	40				D
371	Polishing MMF Feed	P-371	F-375A/B	X				0.0%		1.078	4.2	24	138	1,280	30,729				D
247	Polishing MMF Backwash	P-247	F-375A/B	X		X		0.0%		1.078	4.2	0.1	0.49	1,620	108				D

BQE Water

Mass Balance Stream Table - Design Conditions

Project: **WTP2 - Hermosa Project**
Location: **Patagonia, Arizona - USA**
Document number (BQE): **18033-ST-001**
Document number (BV): **404218-PR-LST-0001**

DATE	REVISION ISSUED FOR:	CREATOR	REVIEWER	APPROVER	REV
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16-07-2020	ISSUED FOR DETAILED DESIGN	M. CASTELLVI	E. AFABOR	M. CASTELLVI	D

				STREAM PROPERTIES								STREAM FLOW							
				FLUID PHASE				Solids	Liq SG	Stream	pH	"ON" time	design flow rate					Notes	Rev
Stream #	Service	From	To	L	SL	S	G	% w/w		SG		hrs/d	ton/day	gpm	gpd	kmoles/d	scfm		
380	Recycled Regenerant	F-380A/B	TK-245	X				0.0%		1.078	4.2	24	139	1,284	30,828				D
386	Electroreduction Filter Press Feed	P-386	FP-390		X			15%	1.078	1.192	9.0	8.0	8.0	201	1,610				D
391	Iron-Se Solids Cake	EQ-391	To Disposal			X		55%	1.078	1.664	9.0	8.0	2.2	39	314			1.5 lb/d Selenium content	D
395	Electroreduction Filtrate	FP-390	TK-395	X				0.0%		1.078	9.0	8.0	5.8	162	1,295				D
396	Filtrate Recycle	P-396	TK-360	X				0.0%		1.078	9.0	24	6.3	58	1,403				D
Area 500 - Reagent Circuit													**lb/day**	**gph**					
500	Dry Anionic Flocculant	Source	EQ-500			X		100%				on demand	54					1 bag of 55 lb in 1 day	
504	Anionic Flocculant	P-504	TK-111A/B/C	X						1.001	7.8	24	43,258	216	5,177				
505	Anionic Flocculant	P-505	TK-365	X						1.001	7.8	24	196	0.98	23				D
510	Dry Cationic Flocculant	Source	ED-509			X		100%				on demand	0.27					1 bag of 55 lb in 204 days	D
512	Cationic Flocculant	P-512	P-351	X				0.0%		1.001	7.8	24	206	1.03	25				D
513	Cationic Flocculant	P-513	TK-385	X				0.0%		1.001	7.8	8	10.5	0.16	1.25				D
521	37% Ferric Chloride solution	P-521	SM-105	X				0.0%		1.368	1.0	24	2,122	7.7	186			4,500 lb truck load in 19 days	D
526	50% Ferric Sulphate solution	P-526	TK-360	X				0.0%		1.500	1.0	24	44	0.15	3.5			55 gal drum in 91 days	D
531	15% TMT	P-531	SM-106	X				0.0%		1.120	12.3	24	27	0.12	2.9			264 gal tote in 16 days	
536	35% Sodium Hydrosulphide	P-536	SM-106	X				0.0%		1.130	12.3	24	77	0.34	8.2			264 gal tote in 32 days	
N/A	25% Caustic Solution	45,000lb delivery truck	TK-540	X				0.0%		1.270	>12	on demand		1,800				4,500 lb truck load in 11 days	D
541	25% Caustic Solution	P-541	SM-105	X				0.0%		1.270	>13	24	3,148	12	297				D
542	25% Caustic Solution	P-542	TK-360	X				0.0%		1.270	>13	24	269	1.06	25				D
N/A	25% Caustic Solution	P-543	TK-350	X				0.0%		1.270	>13	on demand		1.06					D
N/A	93% Sulphuric Acid	55 lb drum	P-556/557/558/559	X				0.0%		1.000	<1	on demand	328	1.154	21			55 gal drum in 12 days	D
556	93% Sulphuric Acid	P-556	TK-300	X				0.0%		1.840	<1	24	164	0.44	10.7				D
557	93% Sulphuric Acid	P-557	TK-360	X				0.0%		1.840	<1	24	0.68	0.002	0.044				D
N/A	93% Sulphuric Acid	P-558	TK-235	X				0.0%		1.840	<1	on demand		0.26					D
559	93% Sulphuric Acid	P-559	TK-310	X				0.0%		0.930	<1	24	164	0.44	11				D
N/A	10% Hydrogen Peroxide	P-560	TK-355	X				0.0%		1.030	5	on demand		0.26				Included as a contingency (not expected to use)	
N/A	10% Hydrogen Peroxide	P-561	TK-370	X				0.0%		1.030	5	on demand		0.26				Included as a contingency (not expected to use)	
581	Sodium Sulphate solids	EQ-580	TK-370			X		100%		2.664	0.0	24	1,860	3.49	84			1,750 lb bulk bag in 1 day	D
Area 600 - Utilitites Circuit																			
N/A	Utility Water	P-670	Plant Wide Distribution	X						1.00	7.8	on demand	22	300	5,226				D
605	Reagent make-up Water for Anionic Floc	P-670	EQ-500	X						1.00	7.8	0.3	22	300	5,200				D
606	Reagent make-up Water for Cationic Floc	P-670	ED-509	X						1.00	7.8	0.02	0.11	22	25.9				D

APPENDIX C
METALS REMOVAL REFERENCE SITE ASSESSMENT

BQE Water

TO: Dennis Bailey

CC:

FROM: Farzad Mohamm, Jon Reynolds

DATE: July 9, 2020

SUBJECT: **Reference Site Water Quality and Metal/Metalloid Removal Performance for WTP2 at Hermosa**

BQE Water (BQE) is carrying out the engineering design of water treatment plant 2 (WTP2) at Hermosa as part of the overall project development activities. Water at Hermosa requires treatment for heavy metals/metalloids removal including selenium. The proposed treatment for selenium removal is based on ion exchange. This process was tested at the bench scale at the onset of the design project to evaluate and demonstrate its performance and establish the design basis [1]. However, the process used for removal of metals/metalloids other than selenium is based on common treatment with ferric iron and sulphide reagents to precipitate the metals followed by solids/liquid separation using multimedia filtration (MMF). Many existing operations use this treatment process for metals/metalloids removal. This memo provides water quality and treatment performance information from existing sites that demonstrate the ability and robustness of the metals/metalloids treatment process for a variety of water chemistries and operating conditions. This information was used to establish the design basis for WTP2.

WTP2 Influent Water Quality and Treatment Objectives

The maximum predicted concentrations of contaminants in water feeding WTP2 are shown in Table 1. The treatment targets for each contaminant are also included in this table and were developed from the most stringent of applicable surface water quality standards, aquifer water quality standards, and effluent limitation guidelines. Only species for which anticipated influent concentration exceeds the treatment target are included in this table. Because other metals are not predicted to exceed the proposed treatment target, a treatment method has not been designed for them.

Table 1 Maximum predicted concentration of contaminants and the corresponding treatment targets for WTP2 (Source: Arizona Minerals, Inc.).

Analyte	UNIT	Feed Water Chemistry	Treatment Target*
Arsenic	mg/L	0.075	0.050
Copper	mg/L	0.045	0.0196
Iron	mg/L	1.2	1.0
Lead	mg/L	0.059	0.0067
Selenium	mg/L	0.029	0.0020
Zinc	mg/L	0.43	0.2547

* Where treatment target is based on surface water quality standards and the most stringent standard is hardness-dependent, the treatment target is based on assumed effluent hardness of 250 mg/l

As shown in Table 1, the concentration of contaminants in the feed water are in the low ppm range (almost all are sub ppm). This will improve the effectiveness of the treatment because precipitation of metals/metalloids is more efficient when the total dissolved solids (TDS) content of the feed water is low, which is the case for WTP2 that will be treating feed water with relatively low sulphate in comparison to most other operations where the feed water is gypsum saturated.

Selenium is included in Table 1 as a contaminant because its concentration in feed water exceeds the discharge target but will be excluded from the discussion of this memo because it is described in Reference [1].

Metal and Metalloid Concentrations from Existing Sites

This section provides example feed and effluent metals/metalloids concentration data from water treatment plants in North America that BQE is involved with. Please note the following about the data presented in this section:

- While the treatment processes employed are based on treatment with either ferric iron or sulphide or their combination, the sequence of treatment and operating conditions vary
- Water quality data are from discrete grab samples and as expected the detection limits and the list of metals reported vary from site to site
- Sites are not referred to by name due to confidentiality agreements with BQE's customers

Table 2 shows example ICP scans of feed/effluent water from four reference sites in North America.

Table 2 Feed water/effluent quality (ICP - dissolved metals) for four reference sites in North America.

Case Number	1		2		3		4	
Treatment Type	Sulphide		Sulphide		Sulphide / NaOH		Lime/ferric	
Solid-Liquid Separation Step	Multimedia Filtration		Multimedia Filtration		Multimedia Filtration		Clarifier	
Analyte, mg/L	Feed	Effluent	Feed	Effluent	Feed	Effluent	Feed	Effluent
Arsenic	0.00063	0.00010	N/A	N/A	<0.005	<0.005	0.015	0.003
Copper	0.0439	0.00239	0.128	0.001	<0.005	<0.005	0.005	0.002
Iron	0.0477	0.0050	0.08	0.05	N/A	N/A	N/A	0.02
Lead	0.00020	0.00020	0.001	0.001	<0.005	<0.005	0.004	0.001
Selenium	0.00466	0.00014	N/A	N/A	<0.001	<0.001	0.015	0.011
Zinc	0.0050	0.0072	0.298	0.007	2.300	0.017	0.008	0.006

It is apparent from Table 2 that the effluent quality for all four reference sites exceeds (i.e., metals are present at levels lower than) the treatment objectives for WTP2. Table 3 provides a summary of the range of feed/effluent values from Table 2 with salient data from WTP2 for better comparison.

Table 3 Comparison of existing plant metals concentrations with treatment targets for WTP2.

	Feed Quality		Treated Water Quality/Target	
Analyte, mg/L	**Ranges from Reference Sites**	**Maximum Predicted for WTP2**	**Range from Reference Sites**	**WTP2 Treatment Target***
Arsenic	0.00063 - 0.015	0.075	0.0001 - 0.005	0.05
Copper	0.005 - 0.128	0.045	0.001 - 0.005	0.0196
Iron	0.0477 - 0.08	1.2	0.005 – 0.05	1.0
Lead	0.0002 - 0.005	0.059	0.0002 - 0.005	0.0067
Selenium	0.00466 - 0.015	0.029	0.00014 - 0.011	0.0020
Zinc	0.005 – 2.3	0.43	0.007 - 0.017	0.2547

* Where treatment target is based on surface water quality standards and the most stringent standard is hardness-dependent, the treatment target is based on assumed effluent hardness of 250 mg/l

It is apparent from the data that influent concentrations of contaminants to WTP2 are within the range of influent concentrations to WTP at reference sites. Comparing the range of treated water quality from reference sites and the treatment targets for WTP2 also confirms that other than selenium, for which an additional treatment step will be implemented, treatment targets for all metals/metalloids can be readily met using the proposed ferric and sulphide treatment process.

References

[1] Selenium Removal at the Hermosa Project using Selen-IX™, Laboratory Treatability Assessment, Final Report – Rev. 01, July 3, 2020

APPENDIX D
SELEN-IX™ LABORATORY TREATABILITY ASSESSMENT

BQE Water

Selenium Removal at the Hermosa Project using Selen-IX™

Laboratory Treatability Assessment

Final Report – Rev. 01

July 3, 2020

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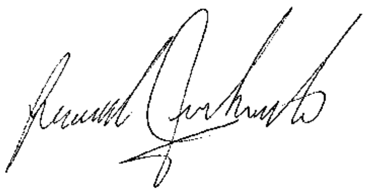

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1. Executive Summary

Arizona Minerals, Inc. (AMI) is the owner of the Hermosa Project in Arizona. As part of this project, water will have to be collected and treated to meet applicable water quality standards. Aside from suspended solids and several heavy metals, the treatment will have to target the removal of selenium to 0.002 mg/L. Conventional treatment can be expected to meet the needs for TSS and heavy metals removal; however, selenium removal requires a special consideration. The focus of this report is on the treatability assessment of the Selen-IX™ process for selenium control at Hermosa.

As the global leader in selenium treatment, BQE Water was engaged by AMI to evaluate application of Selen-IX™ for selenium removal at Hermosa. Selen-IX™ combines ion exchange (IX) with electro-reduction of selenium (ERC). The process can achieve concentrations as low as 0.0005 mg/L in the treated water and generate a small quantity of stable solid residue suitable for landfill disposal in most cases. Upon review of the water chemistry, BQE Water identified that Selen-IX™ would be a good fit and that the water quality at Hermosa is a textbook example of water that can be successfully treated with IX. BQE Water proposed to demonstrate the efficiency of the process through bench-scale testing.

Feed water for testing was prepared synthetically in BQE Water's lab to match the anticipated source water quality provided by AMI. Testing was done in locked cycles, meaning that both IX and ERC unit processes were tested in sequence and internal streams were recycled multiple times to monitor the process as a whole and verify the impact of unit processes on one another but the two units were not operated simultaneously due to the limitations of bench-scale testing equipment.

Test results confirmed that:

- Selen-IX™ was able to remove selenium consistently to well below 0.002 mg/L.
- IX resin was fully regenerated and its selenium removal capacity was fully regained after multiple cycles of load/regeneration indicating no fatal flaws with the use of IX.
- The duration of IX load cycle was significantly longer than the duration of IX regeneration cycle creating an exceptionally high concentration factor (525x) across this unit process. This means that the ERC circuit will be sized to treat a flow that is 525x smaller than the flow to the IX circuit, which reduces the volume of treatment residue generated proportionally as well as plant footprint and treatment costs. It is very unlikely that alternative treatment processes can achieve even a fraction of such concentration factor.
- ERC performance for treatment of the spent IX regenerant solution was demonstrated in multiple cycles. No fatal flaws were identified in the operation of the ERC unit process.
- Stability of the treatment residue was tested using the toxicity characteristic leaching procedure (TCLP) and it was demonstrated that the residue is suitable for landfill disposal as per the Environmental Protection Agency's (EPA) guidelines. Given the stability of the treatment residue, management options can vary widely from co-mingling with tailings to using as feedstock for iron manufacturing.

Based on the test results, Selen-IX™ process as depicted in Figure 1-1 was verified for selenium treatment at Hermosa, and key design parameters as well as reagent consumption rates were identified.

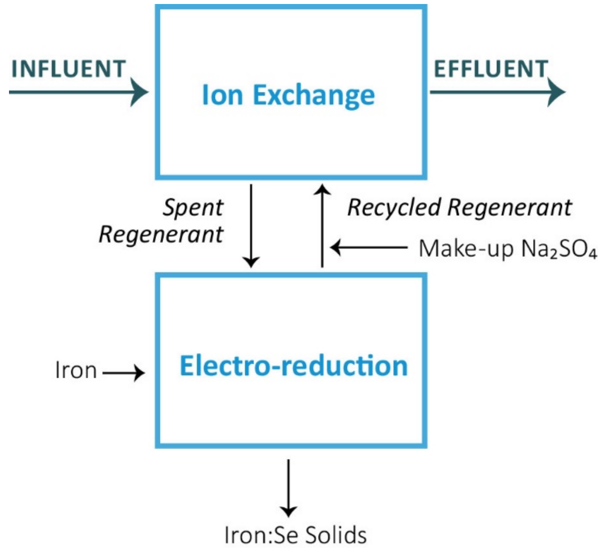

Figure 1-1 Schematic flowsheet for full scale implementation of Selen-IX™.

2. Background and Terms of Reference

The Hermosa property located in Arizona is home to high-grade base metal deposits. Water must be treated for base metals and selenium to meet water quality standards. A conventional water treatment plant (WTP) based on chemical precipitation of metals can treat the water to meet water quality standards except for selenium. As such, AMI engaged BQE Water to evaluate application of Selen-IX™ for selenium removal downstream of a conventional WTP to concentrations below 0.002 mg/L in the treated water.

BQE Water is a global leader in selenium removal. Among other selenium treatment processes, BQE Water offers a proprietary IX based selenium removal process, Selen-IX™. This process utilizes IX to remove selenium to below 0.0005 mg/L (0.5 µg/L). The process combines IX with electro-reduction that fixes selenium in a stable solid treatment residue suitable for landfill disposal in most cases.

BQE Water's preliminary review of the water quality data from Hermosa indicated that the stream in question is a good fit for treatment using Selen-IX™. BQE Water proposed to complete a treatability testing campaign to identify any fatal flaws for selenium removal. This document summarizes the findings of the bench-scale treatability test program.

3. Objectives

The objectives of this laboratory test program included the following:

- Demonstrate ability of Selen-IX™ to treat water and achieve selenium concentrations as low or lower than 0.002 mg/L.
- Characterize and test the stability of selenium-bearing solid residue generated by the treatment process.

These objectives were achieved in the program.

4. Experimental Methodology

In this chapter, laboratory procedures and testing methodology used during the test campaign are presented and discussed.

4.1 Feed Water Preparation

Due to the fact that the source water does not exist at this point, for this lab testing campaign 800 L of feed water was prepared synthetically in BQE Water's lab to match the predicted water quality provided by AMI. Table 4-1 lists the reagents that were used to prepare the synthetic feed solution.

Table 4-1 Reagents and respective stock solution concentrations used for preparation of the synthetic feed water.

Analyte, mg/L	Reagents Source	Stock Solution Analyte Concentration, g/L
Iron	Fe2(SO4)3*7H2O	4.4
Selenium	(Na2SeO4)	2.1
Zinc	ZnSO4*7H2O	1.2
Manganese	MnSO4.H2O	6.9
Sulfate	Na2SO4	n/a

Table 4-2 compares the concentration of major constituents in the synthetic feed over the course of this test program to the predicted values provided by AMI.

Table 4-2 Feed water quality (predicted and synthetically prepared in BQE lab). Feed water was stable over the course of the testing campaign.

Analyte, mg/L	Estimated Influent Water Quality (Provided by AMI)	Synthetic Feed Prepared in BQE Water Lab			
		Sampled on 2019-05-29	Sampled on 2019-06-13	Sampled on 2019-06-28	Sampled on 2019-07-02
Antimony	0.0006	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic	0.0002	<0.00050	<0.00050	<0.00050	<0.00050
Cadmium	0.0001	0.000045	<0.000010	0.000017	0.000022
Copper	0.008	0.0916	0.00946	0.0459	0.00897
Iron	0.22	0.249	0.239	0.258	0.259
Lead	0.0001	0.00053	<0.00020	<0.00020	<0.00020
Manganese	0.344	0.33	0.315	0.323	0.325
Nickel	0.0011	0.00064	<0.00040	<0.00040	<0.00040
Selenium	0.0077	0.00847	0.00826	0.00798	0.00826
Silver	0.00006	0.00072	0.000084	<0.000050	0.000059
Zinc	0.06	0.0684	0.0584	0.0606	0.0592
Sulfate	32.8	35.5	34.8	34.1	34.3

As evident from the results, preparation of the synthetic feed water was successful and target concentrations were achieved (bold text in Table 4-2). Synthetic feed water was prepared in 200-L drums and was stored in BQE Water's lab at room temperature during the test program. Feed water was sampled periodically and analysed for anions and dissolved metals to ensure its chemistry had not changed. Other than sulfate, all other contaminants were added after their respective stock solutions of known concentrations were prepared (Table 4-1). The target pH was 7 but no pH adjustment was needed after the water was spiked with contaminants.

4.2 Selen-IX™

A schematic block flow diagram of Selen-IX™ is shown in Figure 4-1. Selen-IX™ combines selenium removal by selective IX with ERC of selenium from IX regenerant. The IX circuit is designed to selectively remove selenate from solution with a high efficiency. Similar to any conventional IX process, the IX step of Selen-IX™ comprises load, regeneration and wash cycles. The selenium captured by IX resin reports to a small volume of IX regenerant which is directed to the ERC. In the ERC, selenium is removed from the regenerant solution and the resultant treated regenerant solution, now free of selenium, is recycled back to IX. The regenerant solution recycle is an intrinsic feature of Selen-IX™, which avoids the production of liquid brine waste typically associated with conventional IX.

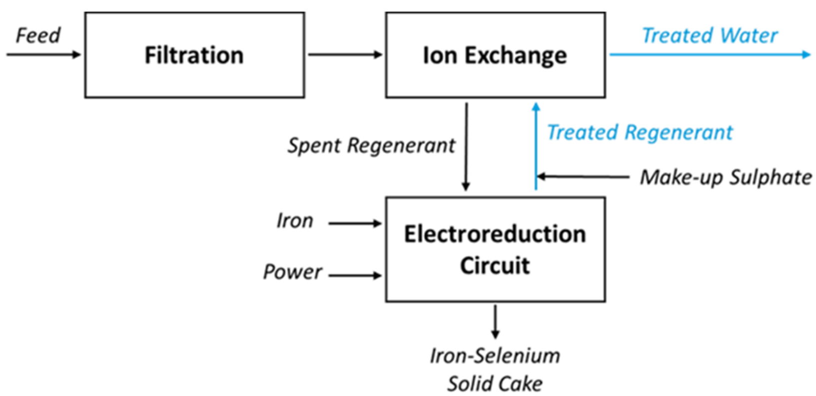

Figure 4-1 Selen-IX™ block flow diagram.

All of the tests completed in this campaign were done in locked cycles. This means that the spent IX regenerant solution was treated by ERC and subsequently recycled for reuse in IX just as it would be in full-scale operations. However, since all unit processes were not operated simultaneously, the testing is referred to as locked cycle testing.

Ion Exchange

The IX tests were carried out in a down-flow configuration using commercially available strongly basic anionic resin (SBA) in packed bed columns with 0.5" diameter made of a clear PVC. The column was filled with 60 mL of resin. The volume of resin held in the column is referred to as one Bed Volume (BV). The column was loaded and regenerated using a peristaltic pump. The loading cycle was performed at 12, 24, and 48 BV/h flow rates while both regeneration and wash cycles were completed at 1.5 BV/hr.

Grab samples were taken from the IX effluent (treated solution) at certain intervals and submitted for anion and dissolved metal analysis. After the load cycle, the column was regenerated using a brine solution. Grab and composite samples were collected from the spent regenerant and submitted for anion and dissolved metal analysis. Immediately following the regeneration cycle the washing cycle was performed on the column using DI water.

Electro Reduction Circuit

The electro reduction process removes selenium by reducing and precipitating selenium with iron generated by electrocells. A schematic of the ERC used in this testing campaign is presented in Figure 4-2. The electrocell system used in this program consists of a reactor tank, a centrifugal pump, and the cylindrical emew® type electrocell. The system was monitored via pH meter and flow meter.

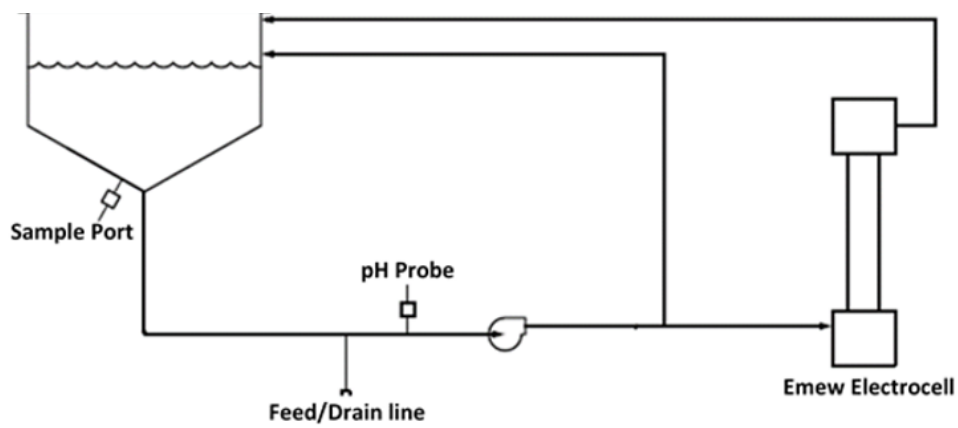

Figure 4-2: Schematic representation of bench scale electrocell system.

ERC is operated in batch mode using synthetically prepared spent IX regenerant solution since the volume of the spent regenerant produced by IX is not sufficient for operation of the ERC due to limitations of the bench-scale testing equipment. The synthetically prepared solution simulated the actual IX spent regenerant solution chemistry. A fixed volume of feed for each batch was taken from well mixed synthetically prepared regenerant solution and transferred to the ERC via feed line. Then, the power was turned on applying 12 A current to the cell while the solution was mixed in the system. At different time intervals, samples were collected and filtered using a 0.45 micron filter.

Target of Treatment for ERC

Recycle and reuse of the IX regenerant after treatment in ERC is an intrinsic feature of the Selen-IX™ process. As such, the performance of the ERC can affect the performance of the IX circuit. In particular, the residual selenium concentration in the recycled regenerant has a direct impact on the ability to meet the final plant treatment target. Figure 4-3 depicts this relationship for Selen-IX™ established by BQE Water from previous laboratory, pilot, and demonstration scale operations data. As illustrated, residual selenium in the recycled regenerant prevents complete regeneration of the resin, which in turn, prevents complete removal of selenium from water during the subsequent load cycle.

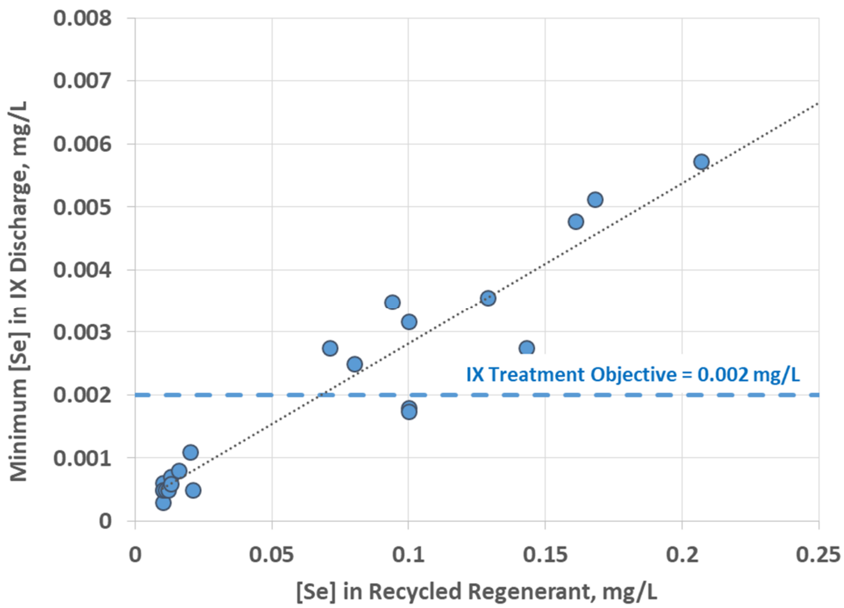

Figure 4-3: Selenium in IX discharge vs. selenium in recycled regenerant treated by ERC.

Given that IX treatment objective for selenium is 0.002 mg/L and based on the graph in Figure 4-3, an ERC treatment target of ~ 0.05 mg/L seems to be both conservative and appropriate. However, for projects that are in early stages such as Hermosa, BQE Water prefers to use more conservative ERC targets. As such, the ERC treatment target for this test campaign was set to 0.01 mg/L.

4.3 Reagents

Table 4-3 shows the reagents used during this lab testing program, including chemicals for metals removal and HDS, as well as the reagents for the IX regeneration and ERC testing.

Table 4-3: Reagent used during the test program.

Reagent	Purity (bulk)	Source	Stock Concentration	Purpose
Iron(III) Sulfate Hydrate	21-23% Fe	Sigma Aldrich	Powder	Used for Spiking
Sodium Selenate	99.8+%	Alfa Aesar	2.07 g/L Se	Used for Spiking
Sulphuric Acid	95.0-98.0 %	Anachemia	5% wt./wt.	Used in the treatment
Zinc Sulfate Heptahydrate	99-103%	Anachemia	Powder	Used for Spiking
Sodium bicarbonate	Reagent Grade	Wards's Science	Powder	Used for Spiking
Magnesium Sulfate, anhydrous	99.0%	Anachemia	Powder	Used for Spiking
Sodium sulfate	99.4%	Univar	Powder	Used for Spiking and treatment

4.4 Analytical Measurements

Table 4-4 lists analytical methods that were used by for sample analysis throughout the test campaign. Metals were analysed by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS), anions by Ion Chromatography (IC) and ammonia by automated colorimetry. All assay results used for data analysis and results interpretation by BQE Water were completed by CARO and ALS.

Table 4-4: List of assays and standard methods used by CARO and ALS for analysis of samples

Analyte	Method	Assay Provider	Standard Method Used	Preservative
Alkalinity	Titration with H_2SO_4	CARO	SM 2320 B (2011)	None
Anions	Ion Chromatography	CARO	SM 4110 B (2011)	None
Dissolved elements incl. Se	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	CARO	EPA 200.8 / EPA 6020B	HNO_3
Hardness	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	CARO	SM 2340 B (2011)	None
Total Metals	HNO_3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	CARO	EPA 200.2 / EPA 6020B	HNO_3
TCLP	20:1 Leach for 18h / HNO_3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	CARO	EPA 1311/ EPA 200.2 / EPA 6020 B	None
Metals in solid	Dry (105 °C), Sieve (180 um) Soil / Four Acid (HNO_3 + $HClO_4$ + HF + HCl) Digestion With ICP-MS Finish	ALS	-	None

4.5 Selenium Measurement Uncertainty

The limit of reporting for the IX effluent stream was 0.0002 mg/L while the limit of reporting for the IX regenerant stream was 0.002 mg/L. The limit of reporting for the IX regenerant was one order of magnitude higher than that of the IX effluent because the high sulfate content in the regenerant interferes with selenium analysis through ICP-MS.

Special attention was paid to the reproducibility of selenium analysis when analyzing solution containing low concentrations of selenium. There were two points in the process where this is particularly relevant: the IX discharge which had a target of 0.002 mg/L selenium, and the recycled regenerant, with its target of 0.01 mg/L selenium. The nature of these solutions meant that the values that were to be measured for were close to the measurement limits of the analytical technique.

Blank and duplicate samples were analyzed and results were compared and confirmed that the error associated with the measurements did not exceed ±10% of the reported values. This is well in line with BQE's experience from analysis of more than 10,000 selenium samples over the years with variety of background electrolytes.

4.6 QA/QC

BQE Water lab maintains rigorous QA/QC for sampling to avoid contamination and ensure confidence in the assay results.

IX and ERC tests were performed by trained laboratory staff. All glassware was cleaned, acid washed with 10% v/v HCl, and rinsed thoroughly with DI water. Standard sample handling, filtration, and preservation procedures were followed to ensure sample integrity. All samples were collected in sealed sterile sample bottles provided by CARO Analytical Serveries. Standard sample handling, filtration and preservation procedures were followed to ensure sample integrity. Feed water samples were sent out for assay periodically to monitor the feed composition over the campaign. Split and duplicate samples were sent out during the campaign to ensure assay accuracy.

The following is the QC reported by CARO analytical for different samples submitted for the analysis. Groups of samples were prepared in batches and analyzed in conjunction with QC samples that ensure the data was of the highest quality.
Common QC types include:

- Method Blank (Blk): A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- Duplicate (Dup): An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- Blank Spike (BS): A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- Matrix Spike (MS): A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- Reference Material (SRM): A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

In-house pH, ORP and cyanate analyses were conducted following the Standard Methods for the Examination of Water and Wastewater, 21st Edition. Clesceri, L. S., A. E. Greenberg, A. E., and Eaton, A. D. Rice, E.U., eds. American Public Health Association; Washington DC; 2005.

Each instrument was operated by trained staff members. The instruments were calibrated according to manufacturer guidelines and in accordance with the relevant SOPs. Analytical balance, pipettes, micro-pumps, and other measuring devices were calibrated frequently.

5. Results and Discussion

As described earlier, Selen-IX™ combines IX and ERC processes. In this section, results of the locked cycle IX testwork will be discussed first. ERC treatment results will then follow along with treatment residue characterization and stability testing results. An overview of the test cycles completed for each circuit is presented in Table 5-1. A total of four IX load cycles, three IX regeneration cycles, and two ERC treatment cycles were completed during this test program.

Table 5-1 Overview of the test cycles completed during this testing program.

Cycle #	IX Load	IX Regeneration	ERC
1	*	*	*
2	*	*	*
3	*	*	
4	*		

5.1 Ion Exchange

Similar to all conventional IX processes, the IX unit of Selen-IX™ comprises three stages: load, regeneration, and wash. Only the results of load and regeneration cycles will be discussed in this section. This is because the wash stage is conventional and the efficiency is well understood from previous projects. As such the wash stage does not have any bearing on the treatability assessment.

Resin Loading

Figure 5-1 shows the results of three IX load cycles completed at 12, 24, and 48 BV/h loading rates. Dashed lines represent selenium concentration in the feed to the IX and the treatment objective, 0.002 mg/L. This curve is referred to as the “selenium breakthrough” curve. It is apparent from the results that selenium was removed from the water for ~ 1000 BVs to well below the detection limit of ICP-MS, 0.0002 mg/L. Beyond this point in the load cycle, selenium breaks through the column gradually up to ~ 2000 BVs where selenium concentration in the treated water exceeds the treatment objective. Full breakthrough of selenium occurred at ~ 3500 BVs. Total resin capacity for selenium removal in the water quality tested was calculated to be ~ 22 mg/L of resin.

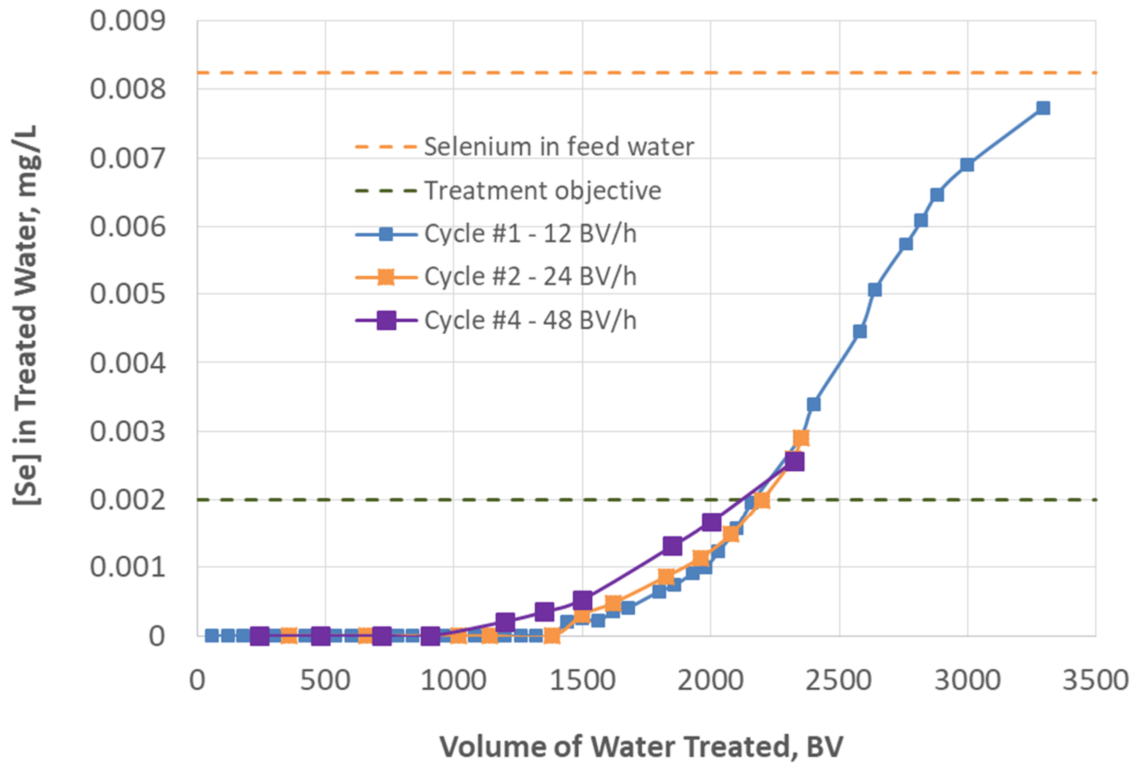

Figure 5-1: Selenium breakthrough curve at different flow rates, 1 BV = 60 mL.

As apparent from the results and as expected, an increase in the IX loading rate resulted in a decrease in the efficiency of the IX for selenium removal. This effect is more pronounced in the case of the cycle at 48 BV/h where selenium concentration in the treated water increased more rapidly than at lower loading rates. ~ 2200 BVs of water was treated at 12 BV/h before selenium concentration in the treated water exceeded the treatment objective. This amount dropped slightly to ~ 2100 BVs when water was treated at the 4x faster flow rate of 48 BV/h.

In order to ensure results were reproducible and the resin performance was not affected over multiple locked cycles of loading and regeneration, load cycle #3 was completed using the same conditions as load cycle #2 at 24 BV/h. These results are depicted in Figure 6-2. This load cycle was not continued to full breakthrough and was interrupted after selenium broke through the column and exceeded the treatment objective. As apparent from the results, for both cycles selenium concentration in the treated water was below the detection limit of ICP-MS up to ~ 1300 BV and selenium breakthrough for both cycles occurred at ~ 2100 BV confirming consistency of resin's performance.

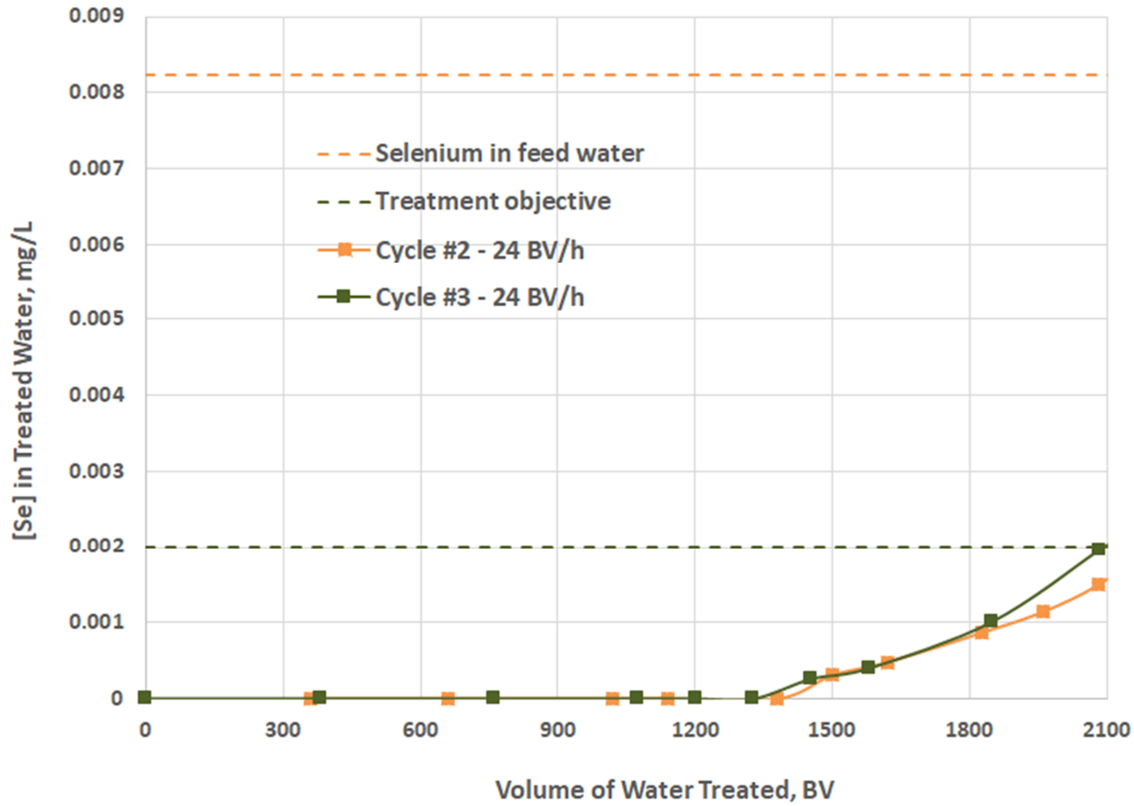

Figure 5-2 Selenium breakthrough curves for cycles #2 and #3 (duplicate), 1 BV = 60 mL, loading rate = 24 BV/h.

Resin Regeneration

Three regeneration cycles were completed during the laboratory testing program after load cycles # 1, 2, and 3 as shown in Figure 5-3. The IX resin bed was not regenerated after load cycle #4. As apparent, IX resin was fully regenerated after ~ 5 BVs of regenerant solution was passed through the IX column. This conclusion is further confirmed by the repeatability of results between load cycles #2 and #3 as shown in Figure 5-2. That the resin performance did not change between these load cycles confirms that the resin was fully regenerant and regained its full capacity for selenium removal after regeneration.

Knowing the volume of water treated during each IX load cycle, the volume of regenerant solution used to subsequently regenerate the resin, and the respective selenium concentrations in the composite samples of these solution, mass of selenium loaded and regenerated by the resin was calculated and is shown in Table 5-2.

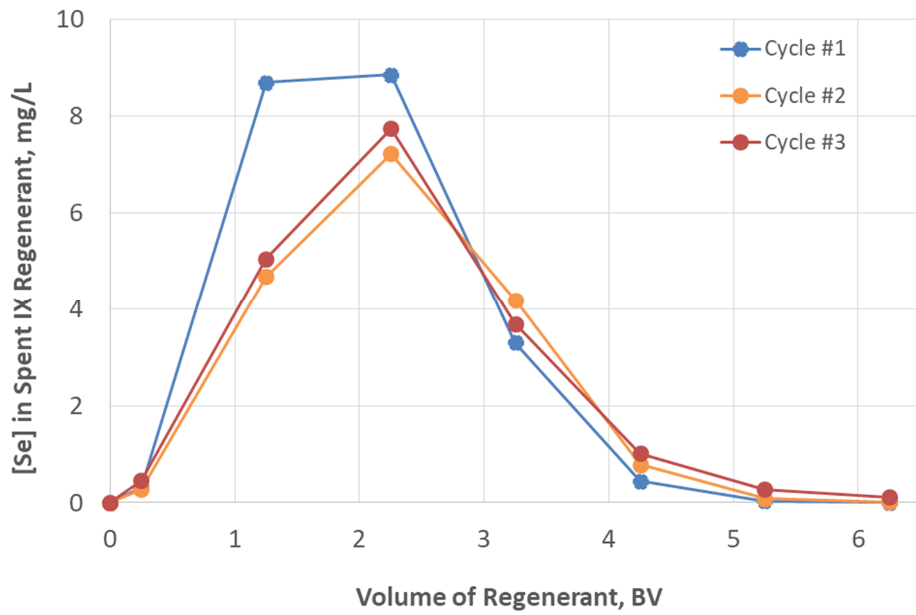

Figure 5-3: Selenium regeneration profile for cycles #1, #2, and #3.

The difference between the mass of selenium loaded vs. the mass regenerated was less than 10% for all cycles. Given the inherent ± 10% inaccuracy associated with all analytical procedures, these results confirm further that the regeneration cycle was efficient and the resin capacity was fully restored after each regeneration cycle and prior to the subsequent load cycle. Also evident from the data is the lower amount of selenium loaded by the resin during cycles #2 and #3 relative to cycle #1. This is a result of faster loading rate that shortens the duration of the load cycle as also mentioned in the discussion of Figure 5-1.

Table 5-2: Selenium regeneration efficiency.

Load/Regeneration Cycle	Se Loaded mg	Se Regenerated mg	Difference mg
#1	1.284±0.12	1.285±0.13	~ 0.001±0.25
#2	1.099±0.10	1.023±0.10	~0.076±0.20
#3	1.026±0.10	1.080±0.10	~ 0.054±0.20

It is also evident from Figure 5-3 that more than 98% of the selenium that was loaded by the resin was regenerated within ~ 4 BVs spanning from 0.5 BV to 4.5 BV on the regeneration curves. Although a total of ~ 5 BVs regenerant solution is needed for complete IX regeneration, only the selenium-rich portion of the regenerant solution needs treatment by ERC and the remainder is recycled without ERC treatment. Therefore, the concentration factor across the IX unit of Selen-IX™ can be calculated by dividing the volume of water treated during the load cycle (2100 BV) by the volume of spent IX regenerant produced during the regeneration cycle (4 BV) and is **525x**. This means that for every 525 m^3 of water treated by IX 1 m^3 of spent regenerant solution will be generated that will be treated by the ERC.

Such high concentration factors are only achievable by IX and only when the TDS in water is low. Water chemistry at Hermosa is a textbook example of such a scenario. It is unlikely that alternative treatment processes will achieve even a fraction of 525x concentration factor. This means that the treatment plant based on IX will likely have a significantly smaller footprint compared to a treatment plant based on alternative processes.

5.2 ERC

Major constituents in the spent IX regenerant are shown in Table 5-3. This is the chemistry of the solution that was treated by ERC. As apparent, the feed to ERC contained 5.7 mg/L selenium. The target of treatment in ERC was 0.01 mg/L as discussed in Section 4. This is a removal of more than 99.8% of selenium from the spent IX regenerant that is required to make it reusable for IX regeneration.

Table 5-3: Chemistry of IX spent regenerant solution treated by ERC.

Selenium mg/L	Sulfate g/L	Alkalinity mg/L	Chloride mg/L
5.7	55	138	60

Results of the two cycles of ERC treatment are shown in Figure 5-4.

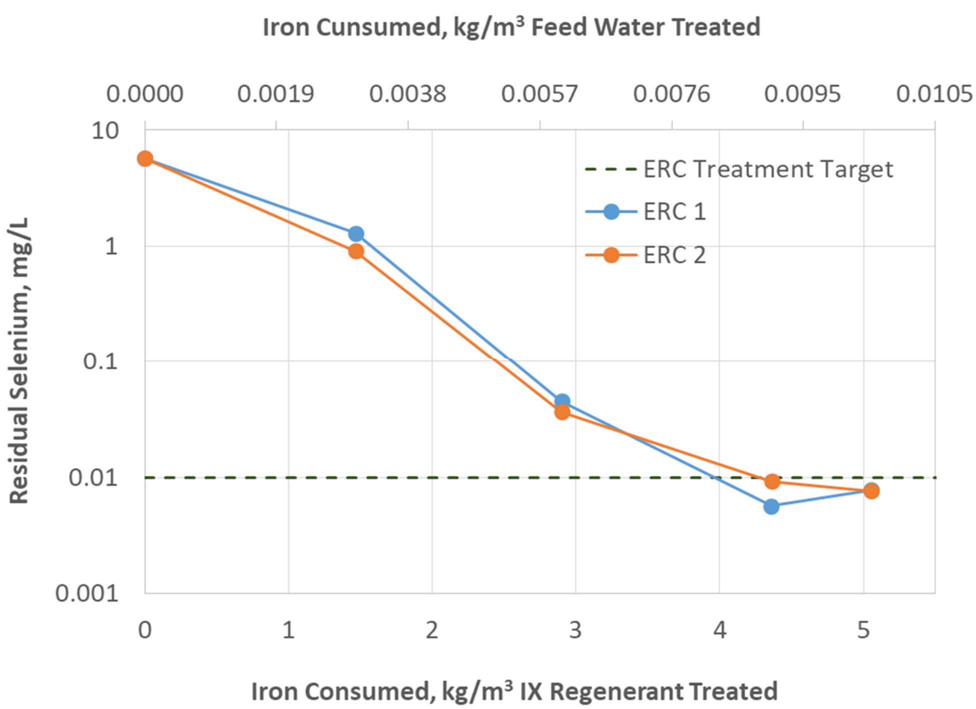

Figure 5-4: Selenium removal from spent regenerant solution in ERC.

As apparent from the results, ERC was able to remove selenium from the spent IX regenerant solution to below the ERC treatment target of 0.01 mg/L using ~ 5 g/L iron for every cubic meter of the spent regenerant solution treated. The secondary horizontal axis on Figure 5-4 shows the same amount of iron consumed for every cubic meter of the feed water that was treated. As apparent, approximately 10 mg of iron will be consumed by ERC for every cubic meter of the feed water that is treated owing to the high concentration factor across the IX unit.

Although the main consumables of the ERC are iron and power, the results presented in Figure 5-4 focus on iron consumption only. This is because power consumption by the full-scale ERC is estimated based on direct measurements done during the full-scale ERC operation from previous projects treating spent IX regenerant solution with similar chemistry and conductivity.

5.3 Treatment Residue Characterization

Figure 5-5 shows two pictures of the treatment residue generated by the ERC treatment. The picture on the left shows the thickened solids slurry in the Buckner funnel for filtration after the supernatant solution was decanted. The picture on the right shows the filter cake produced after vacuum filtration of the thickened slurry. Approximately 15 g of wet treatment residue at ~ 70% moisture was generated by the direct ERC treatment for every liter of spent IX regenerant solution that was treated to meet the 0.01 mg/L treatment target. The filter cake generated in this way was sent to the analytical labs for elemental digestion and TCLP tests. Results of these tests are presented and discussed in this section.

Figure 5-5 Thickened and filtered solid residue samples generated during the ERC tests.

5.3.1 Elemental Analysis of the Treatment Residue

Table 5-4 illustrates composition of the washed solids generated by the ERC. Only the major species and trace elements of interest are shown in this table.

Table 5-4: Elemental composition of the washed solids residues generated by ERC.

Parameter	Unit	ERC Solid-Cycle #1
Al	%	0.02
Ca	%	0.01
Fe	%	49.1
K	%	0.01
Mg	%	0.11
Na	%	0.64
S	%	3.32
Ag	mg/kg	0.22
As	mg/kg	29.5
Cd	mg/kg	0.02
Co	mg/kg	20.5
Cr	mg/kg	139
Cu	mg/kg	121
Mn	mg/kg	1680
Mo	mg/kg	9.16
Ni	mg/kg	58.7
P	mg/kg	80
Pb	mg/kg	0.5
Sb	mg/kg	3.58
Se	mg/kg	401
Sn	mg/kg	9.4
Zn	mg/kg	5
Zr	mg/kg	<0.5

It is apparent from the results that as expected the solid residue was mainly composed of iron. These results are in line with BQE's experience from previous lab, pilot, and demo campaigns.

5.3.2 Treatment Residue Stability - TCLP

Washed ERC filter cake from the laboratory testing was sent to the analytical lab where it was subjected to the standard TCLP procedure. This procedure is commonly used to classify solids as either hazardous or non-hazardous under the Resource Conservation and Recovery Act (RCRA) based on their potential to leach certain listed metals at levels exceeding specified criteria. The results of this analysis are shown in Table 5-5.

Table 5-5 TCLP results for ERC treatment residue.

Parameter	EPA TCLP Limits* ppm	ERC Treatment Residue TCLP Results ppm
Arsenic	5	<0.010
Barium	100	<1.0
Cadmium	1	<0.001
Chromium	5	<0.050
Lead	5	<0.010
Mercury	0.2	<0.002
Selenium	1	0.11
Silver	5	<0.002

***TCLP limits from 40 C.F.R. 261.24**

The ERC solids did not leach metals in excess of the specified TCLP limits, indicating the material is non-hazardous waste. This is in line with BQE's experience from all previous lab, pilot, and demo scale testing of the process on a variety of wastewater chemistries. Options for treatment of the solids previously evaluated by BQE Water for other projects vary significantly from mixing with tailings due to the stable nature of the residue and based on the results of saturated humidity cell tests to using as feedstock for steel manufacturing due to the high iron content of the residue.

5.4 Key Process Design Criteria

The results generated through the laboratory test campaign were used to inform the full scale design of Selen-IX™ for the Hermosa project. Table 5-6 shows a list of these key process parameters.

Table 5-6 Key process parameters used for design.

Parameter	Value
IX load	2100 BV
IX regeneration	4 BV
IX concentration factor	525
IX loading rate	48 BV/h
IX regeneration rate	1.5 BV/h
Electrocell iron consumption	5 kg/m^3 of IX regenerant

6. Conclusions

Conclusions from this laboratory testing program are summarized below:

- Selenium treatment objective of 0.002 mg/L was consistently met using Selen-IX™.
- No fatal flaws were identified for the use of Selen-IX™. This includes both IX and ERC unit processes.
- The IX unit process of Selen-IX™ is able to take full advantage of the inherent low TDS of the feedwater, which creates an exceptionally high concentration factor of 525x. This means that all other components of the circuit including ERC will be sized to treat a flow that is 525x smaller than the feed flow rate and therefore reduce the footprint, treatment residue volume, and treatment costs proportionally.
- Based on TCLP tests, the treatment residue is non-hazardous under RCRA.
- Key design parameters as well as reagent consumption rates were identified that will inform the engineering design of the treatment plant.

ATTACHMENT B

Fluor Outfall Design

No.	DRAWING TITLE	DRAWING NUMBER
1	WATER TREATMENT PLANT (WTP2) GENERAL ARRANGEMENT PLAN	A9HR-PF-14300-210-PLN-B-0001
2	WATER TREATMENT PLANT (WTP2) FINAL GRADING PLAN	A9HR-PF-14300-210-PLN-G-0001
3	WATER TREATMENT PLANT (WTP2) WATER DISCHARGE STRUCTURE FINAL GRADING PLAN	A9HR-PF-14300-210-PLN-G-0002
4	WATER TREATMENT PLANT (WTP2) WATER DISCHARGE STRUCTURE ACCESS ROAD PLAN AND PROFILE	A9HR-PF-14300-210-PLN-R-0001
5	WATER TREATMENT PLANT (WTP2) STORMWATER MANAGEMENT PLAN	A9HR-PF-14300-210-PLN-W-0001
6	WATER TREATMENT PLANT (WTP2) EROSION SEDIMENT CONTROL - WTP2 PLANT SITE	A9HR-PF-14300-210-PLN-W-0002
7	WATER TREATMENT PLANT (WTP2) EROSION SEDIMENT CONTROL - OUTFALL DISCHARGE AREA	A9HR-PF-14300-210-PLN-W-0003
8	WATER TREATMENT PLANT (WTP2) FINAL GRADING SECTIONS	A9HR-PF-14300-210-LYD-G-0001
9	WATER TREATMENT PLANT (WTP2) WATER DISCHARGE STRUCTURE FINAL GRADING SECTIONS	A9HR-PF-14300-210-LYD-G-0002
10	WATER TREATMENT PLANT (WTP2) EARTHWORKS ISOPACH PLAN	A9HR-PF-14300-210-DTL-0-0001
11	WATER TREATMENT PLANT (WTP2) WATER DISCHARGE STRUCTURE EARTHWORKS ISOPACH PLAN	A9HR-PF-14300-210-DTL-0-0002
12	WATER TREATMENT PLANT (WTP2) CIVIL MISCELLANEOUS DETAILS SHEET 1	A9HR-PF-14300-210-DTL-0-0003
13	WATER TREATMENT PLANT (WTP2) CIVIL MISCELLANEOUS DETAILS SHEET 2	A9HR-PF-14300-210-DTL-0-0004
14	WATER TREATMENT PLANT (WTP2) CIVIL MISCELLANEOUS DETAILS SHEET 3	A9HR-PF-14300-210-DTL-0-0005

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B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS								
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

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PROJECT MANAGER R. DYNAN		Date: 2020.06.23 09:30:17 -07'00'
CLIENT		

SOUTH32

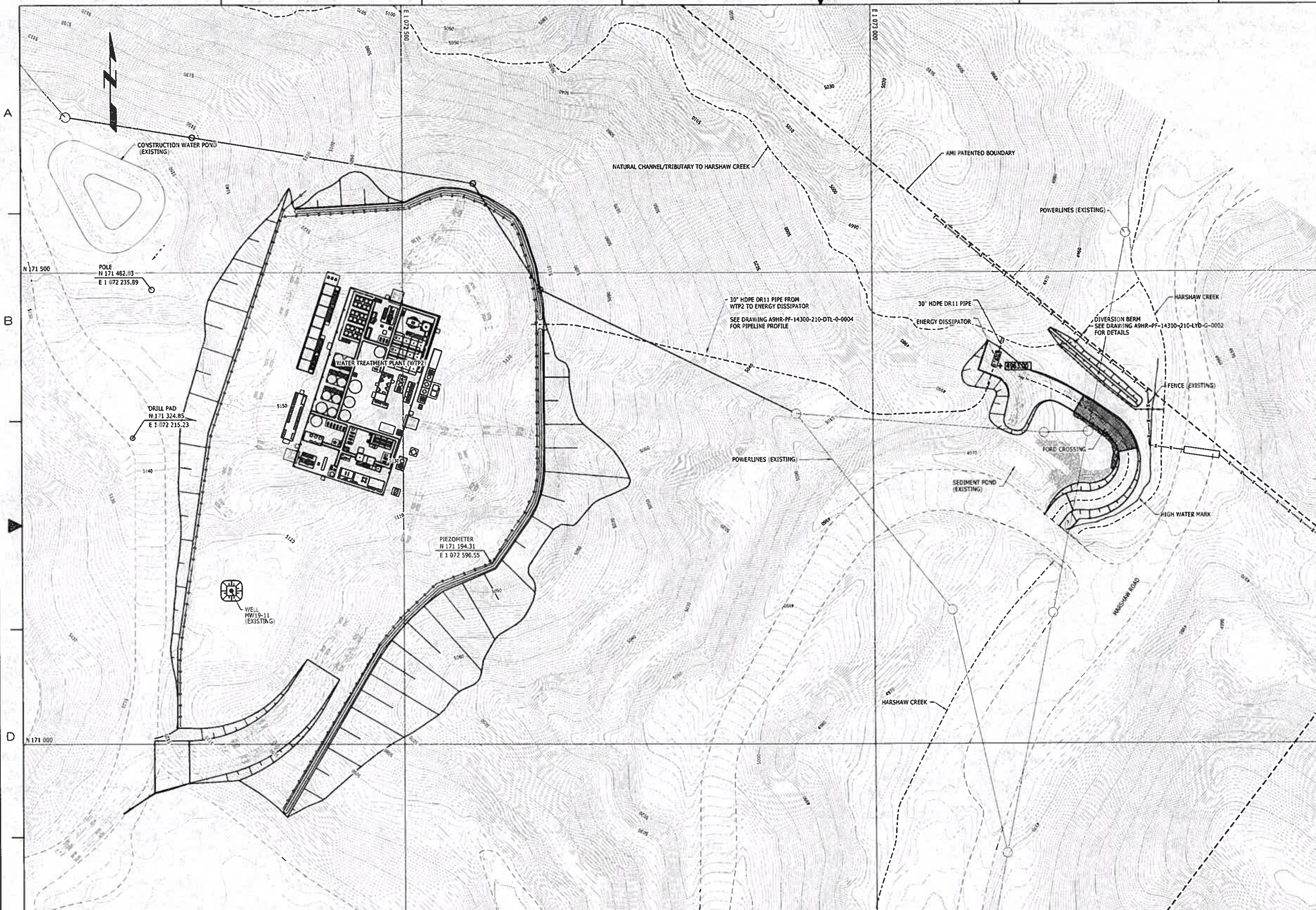
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
COVER SHEET

SCALE:

DRAWING NUMBER A9HR-PF-14300-210-LST-0-0001

REV C



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LEGEND:

- CONTOUR (10' INTERVAL)
- CONTOUR (1' INTERVAL)
- PAD/ROAD
- CUT/FILL SLOPE
- O/H POWERLINE/POLE (EXISTING)
- O/H POWERLINE/POLE (NEW)
- DITCH

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0 50' 100' 150' 200' 250'
SCALE: 1" = 50'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
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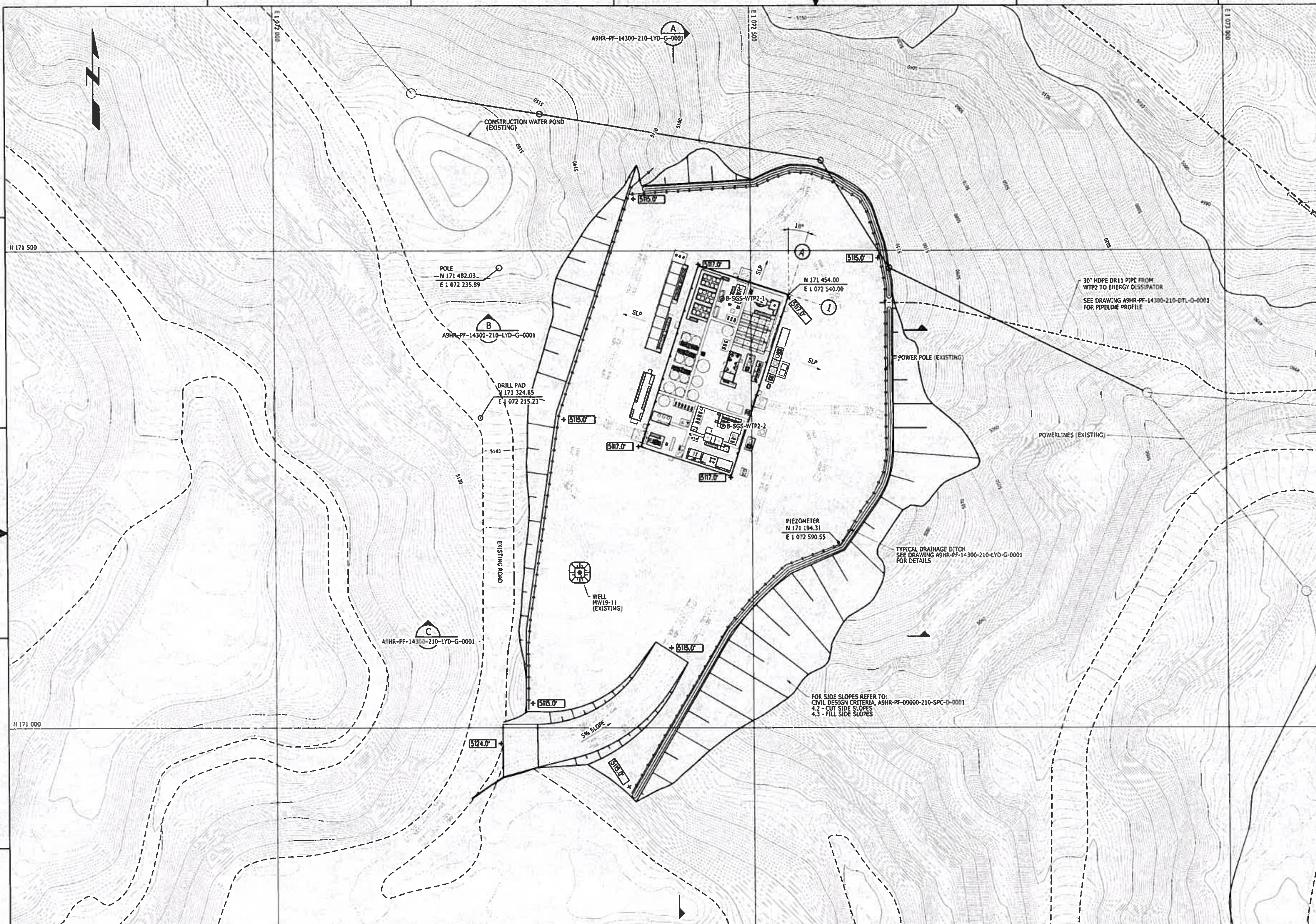
ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 10:51:09 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 11:34:04 -07'00'
CLIENT		

SOUTH32

HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) GENERAL ARRANGEMENT PLAN

SCALE: 1"=50'
DRAWING NUMBER: A9HR-PF-14300-210-PLN-B-0001
REV: C



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4. DESIGN VEHICLE USED: INTERMEDIATE SEMITRAILER WB-50

LEGEND:

- CONTOUR (10' INTERVAL)
- CONTOUR (1' INTERVAL)
- PAD/ROAD
- CUT/FILL SLOPE
- O/H POWERLINE/POLE (EXISTING)
- O/H POWERLINE/POLE (NEW)
- DITCH

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0 50 100 150 200 250'

SCALE: 1" = 50'

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B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS						
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS						

REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A9HR-PF-14300-210-LYD-G-0001	WATER TREATMENT PLANT (WTP2) FINAL GRADING SECTIONS

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ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 10:55:02 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 11:17:25 -07'00'
CLIENT		

SOUTH32

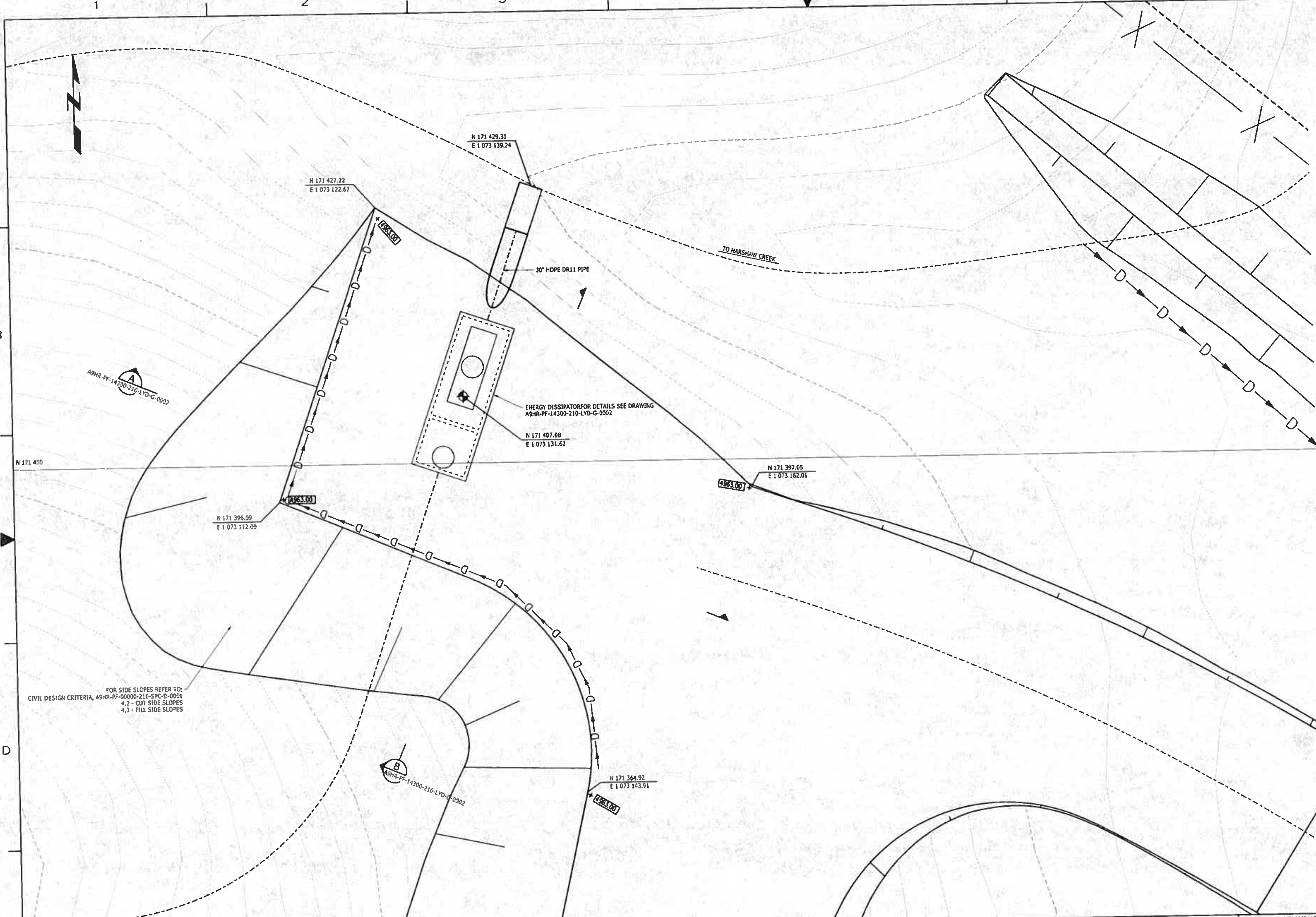
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) FINAL GRADING PLAN

SCALE: 1"=50'

DRAWING NUMBER: A9HR-PF-14300-210-PLN-G-0001

REV: C



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LEGEND:

- CONTOUR (10' INTERVAL)
- CONTOUR (1' INTERVAL)
- PAD ROAD
- CUT/FILL SLOPE
- + 4963.00 FINISHED GRADE ELEVATIONS
- DITCH
- FENCE (EXISTING)

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0 5' 10' 20' 25'
SCALE: 1" = 5'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS							A9HR-PF-14300-210-LYD-G-0002	WATER TREATMENT PLANT (WTP2) WATER DISCHARGE SECTIONS
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ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 08:46:11 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 09:26:37 -07'00'
CLIENT		

SOUTH32

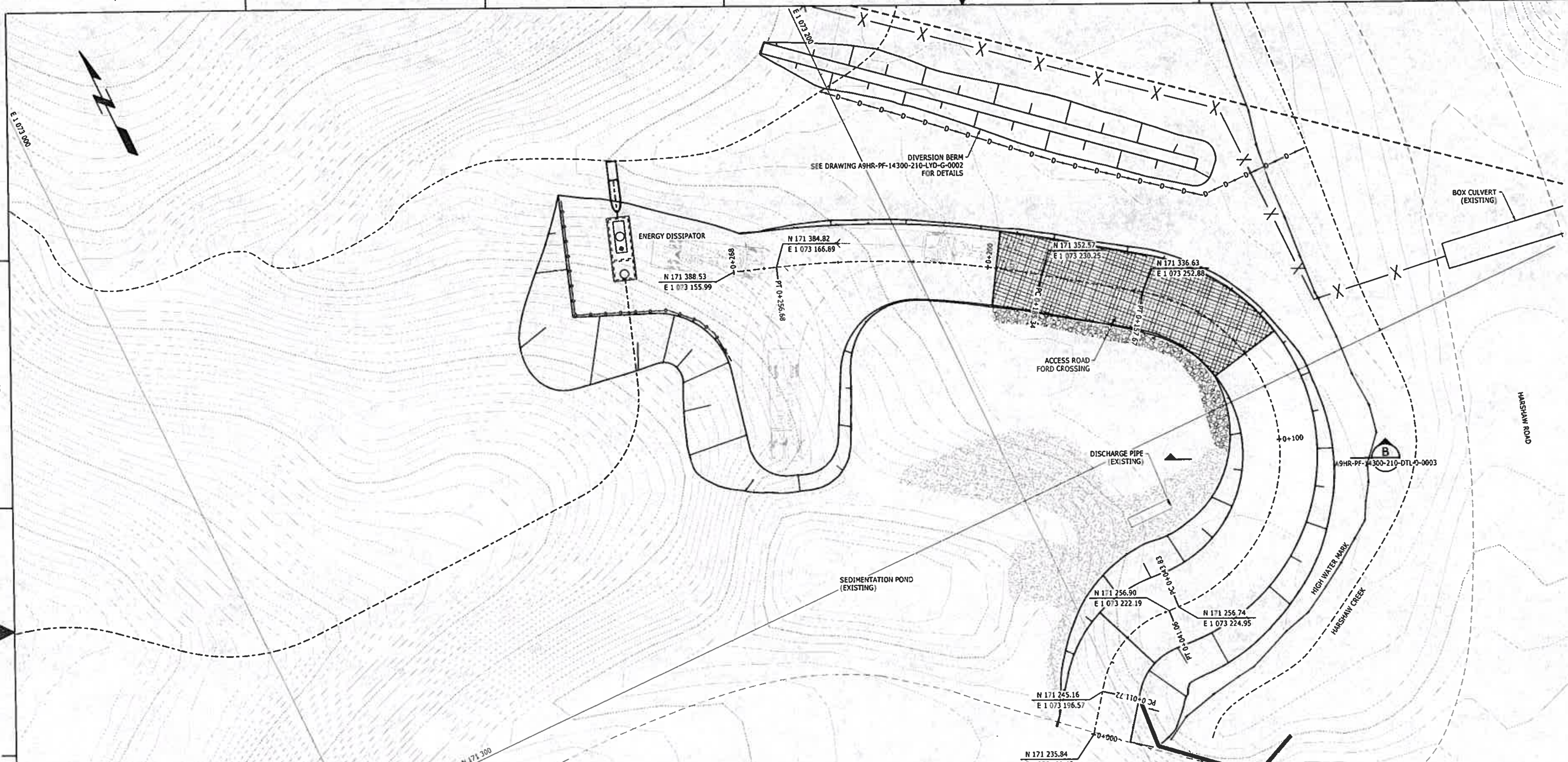
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
WATER DISCHARGE STRUCTURE
FINAL GRADING PLAN

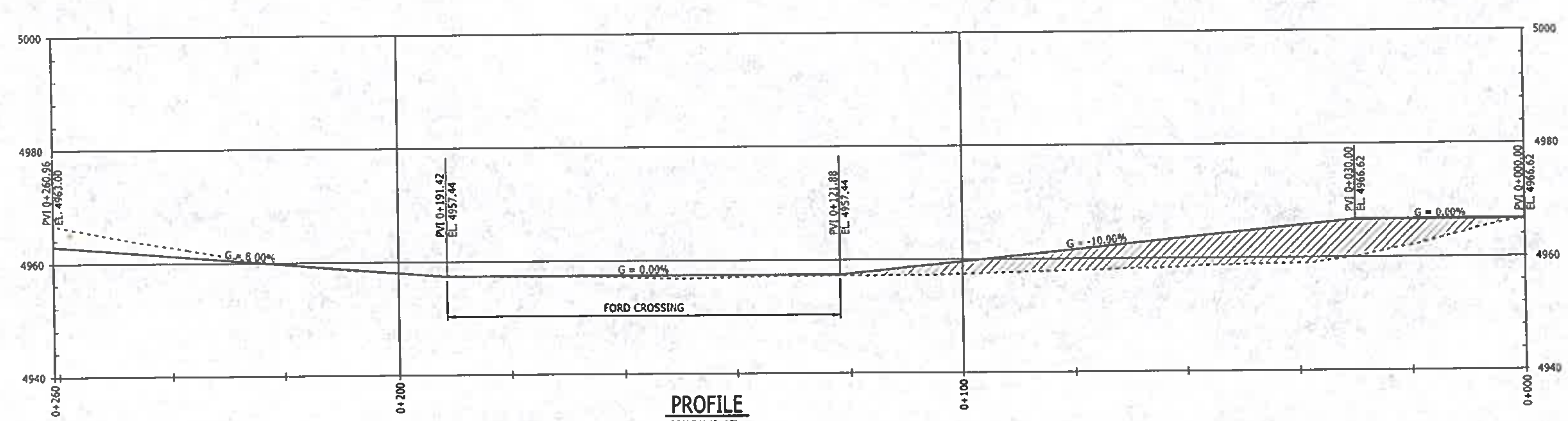
SCALE: 1"=5'

DRAWING NUMBER: A9HR-PF-14300-210-PLN-G-0002

REV: C



PLAN
SCALE 1"=15'



PROFILE
SCALE H 1"=15'
V 1"=15'

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LEGEND:

- CONTOUR (10' INTERVAL)
- CONTOUR (1' INTERVAL)
- PAD/ROAD
- CUT/FILL SLOPE
- DITCH
- FENCE (EXISTING)

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0 15' 30' 45' 60' 75'
SCALE: 1" = 15'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS						
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS						
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS						

REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A9HR-PF-14300-210-DTL-0-0003	CIVIL MISCELLANEOUS DETAILS SHEET 1
A9HR-PF-14300-210-LYD-G-0002	WATER DISCHARGE STRUCTURE FINAL GRADING SECTIONS

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DESIGNED BY		2020.06.22 21:44:00 -07'00'
CHECK DESIGN BY		2020.06.24 13:13:32 -07'00'
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ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 08:49:59 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 09:27:51 -07'00'
CLIENT		

SOUTH32

HERMOSA PRE-FEASIBILITY STUDY

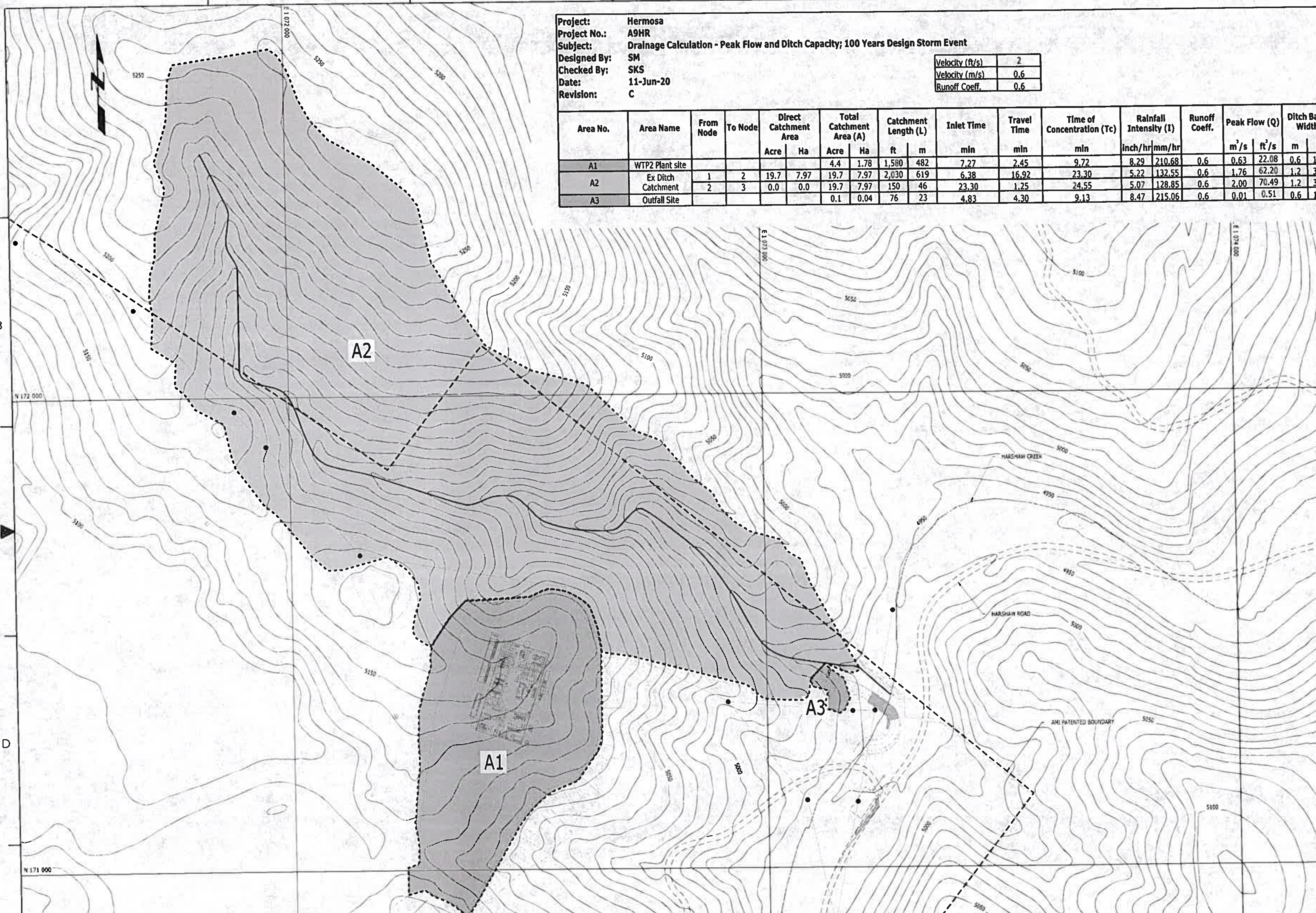
WATER TREATMENT PLANT (WTP2) WATER DISCHARGE STRUCTURE ACCESS ROAD PLAN AND PROFILE

SCALE: 1"=15'
DRAWING NUMBER: A9HR-PF-14300-210-PLN-R-0001
REV: C

Project: Hermosa
Project No.: A9HR
Subject: Drainage Calculation - Peak Flow and Ditch Capacity; 100 Years Design Storm Event
Designed By: SM
Checked By: SKS
Date: 11-Jun-20
Revision: C

Velocity (ft/s)	2
Velocity (m/s)	0.6
Runoff Coeff.	0.6

Area No.	Area Name	From Node	To Node	Direct Catchment Area		Total Catchment Area (A)		Catchment Length (L)		Inlet Time	Travel Time	Time of Concentration (Tc)	Rainfall Intensity (I)		Runoff Coeff.	Peak Flow (Q)		Ditch Base Width		Side Slope	Ditch Bed Slope	Manning Coeff.	Water Depth		Ditch Capacity (Q)	
				Acre	Ha	Acre	Ha	ft	m	min	min	min	inch/hr	mm/hr		m^3/s	ft^3/s	m	ft		ft/ft		m	ft	m3/s	ft3/s
A1	WTP2 Plant site					4.4	1.78	1,580	482	7.27	2.45	9.72	8.29	210.68	0.6	0.63	22.08	0.6	1.97	2H:1V	0.005	0.045	0.6	1.97	0.81	28.57
A2	Ex Ditch Catchment	1	2	19.7	7.97	19.7	7.97	2,030	619	6.38	16.92	23.30	5.22	132.55	0.6	1.76	62.20	1.2	3.94	2H:1V	0.005	0.045	0.75	2.46	1.85	65.33
		2	3	0.0	0.0	19.7	7.97	150	46	23.30	1.25	24.55	5.07	128.85	0.6	2.00	70.49	1.2	3.94	2H:1V	0.005	0.045	0.8	2.62	2.12	74.87
A3	Outfall Site					0.1	0.04	76	23	4.83	4.30	9.13	8.47	215.06	0.6	0.01	0.51	0.6	1.97	2H:1V	0.005	0.045	0.1	0.33	0.02	0.81



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LEGEND:

- CONTOUR (10' INTERVAL)
- NATURAL CHANNEL
- HARSHAW CREEK

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0 100 200 300 400 500
SCALE: 1" = 100'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV
A	07JUN20	ISSUED FOR CLIENT REVIEW	CH		SS
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE

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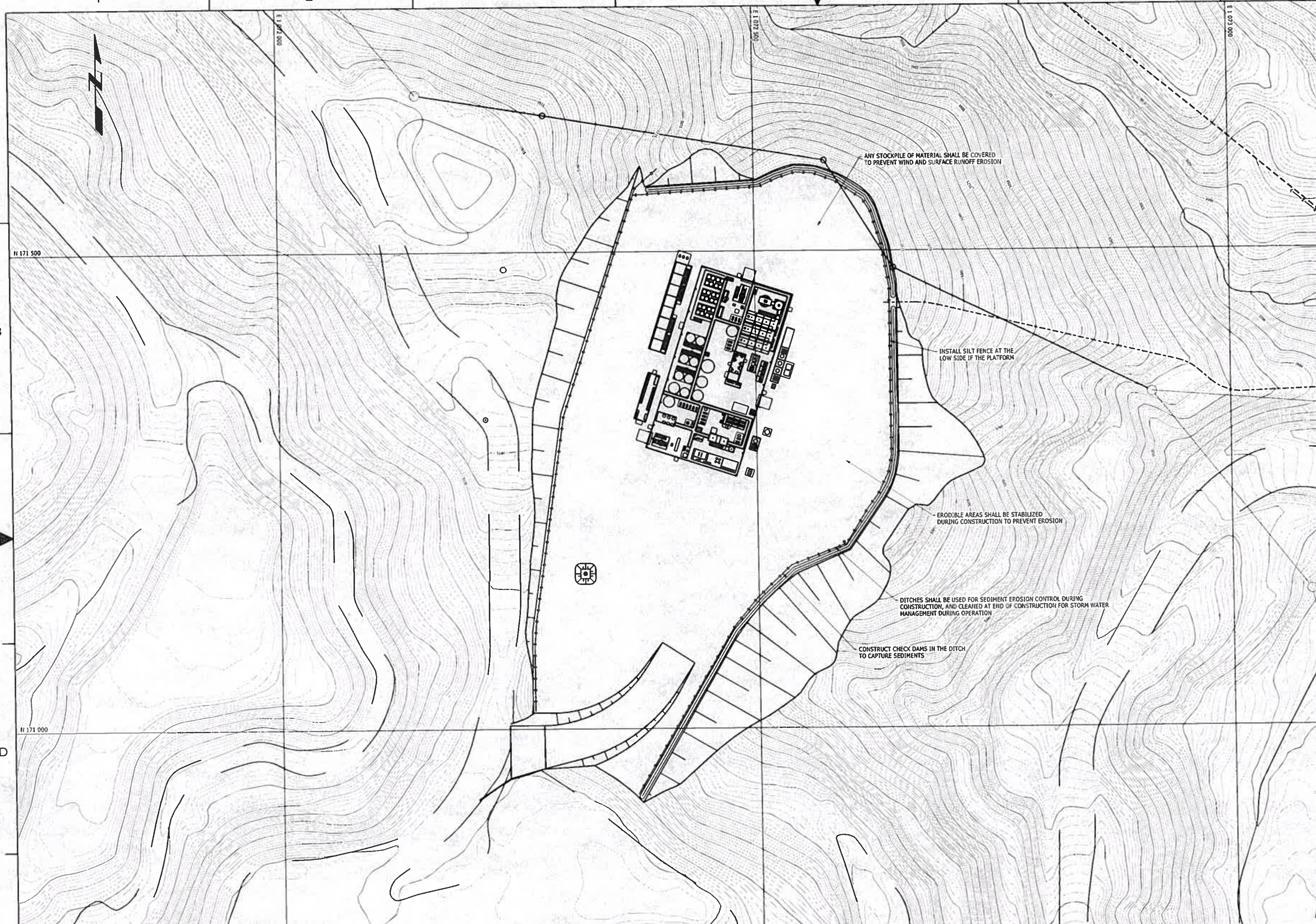
DISCIPLINE LEAD	S. SAFAR	2020.06.22 19:02:30 -07'00'
ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 08:26:20 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 09:17:01 -07'00'
CLIENT		

HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) STORM WATER MANAGEMENT PLAN

SCALE: 1:100'
DRAWING NUMBER: A9HR-PF-14300-210-PLN-W-0001
REV: C



NOTES:

1. THE COORDINATE SYSTEM IS NAD 83 ARIZONA STATE PLANE CENTRAL INTERNATIONAL FEET. THE DATUM IS NAVD88.
2. TOPOGRAPHICAL MAPPING PROVIDED BY THE CLIENT AND IS FOR REFERENCE ONLY, ITS ACCURACY IS NOT GUARANTEED.
3. ALL COORDINATES, DIMENSIONS AND ELEVATIONS ARE IN FEET UNLESS NOTED OTHERWISE.
4. DESIGN VEHICLE USED: INTERMEDIATE SEMITRAILER WB-62

LEGEND:

CONTOUR (10' INTERVAL)
CONTOUR (1' INTERVAL)
PAD/ROAD
CUT/FILL SLOPE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 67200
GRAHAM HILL
Date Signed: 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

0 50 100 150 200 250'
SCALE: 1" = 50'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS								
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS								
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

FLUOR.

NOTE: THIS DRAWING HAS NOT BEEN PUBLISHED AND IS THE SOLE PROPERTY OF FLUOR AND IS LENT TO THE BORROWER FOR THEIR CONFIDENTIAL USE ONLY, AND IN CONSIDERATION OF THE LOAN OF THIS DRAWING, THE BORROWER PROMISES AND AGREES THAT IT WILL NOT BE REPRODUCED, COPIED, LENT OR OTHERWISE DISPOSED OF DIRECTLY OR INDIRECTLY, NOR USED FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS FURNISHED.

DRAWN BY	C. HAJDU	2020.06.22 16:28:32 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 22:04:35 -07'00'
CHECK DESIGN BY		2020.06.24 13:14:29 -07'00'
DISCIPLINE LEAD	S. SAFAR	2020.06.22 22:06:24 -07'00'
ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 10:56:41 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23
CLIENT		Date: 2020.06.23 11:46:30 -07'00'

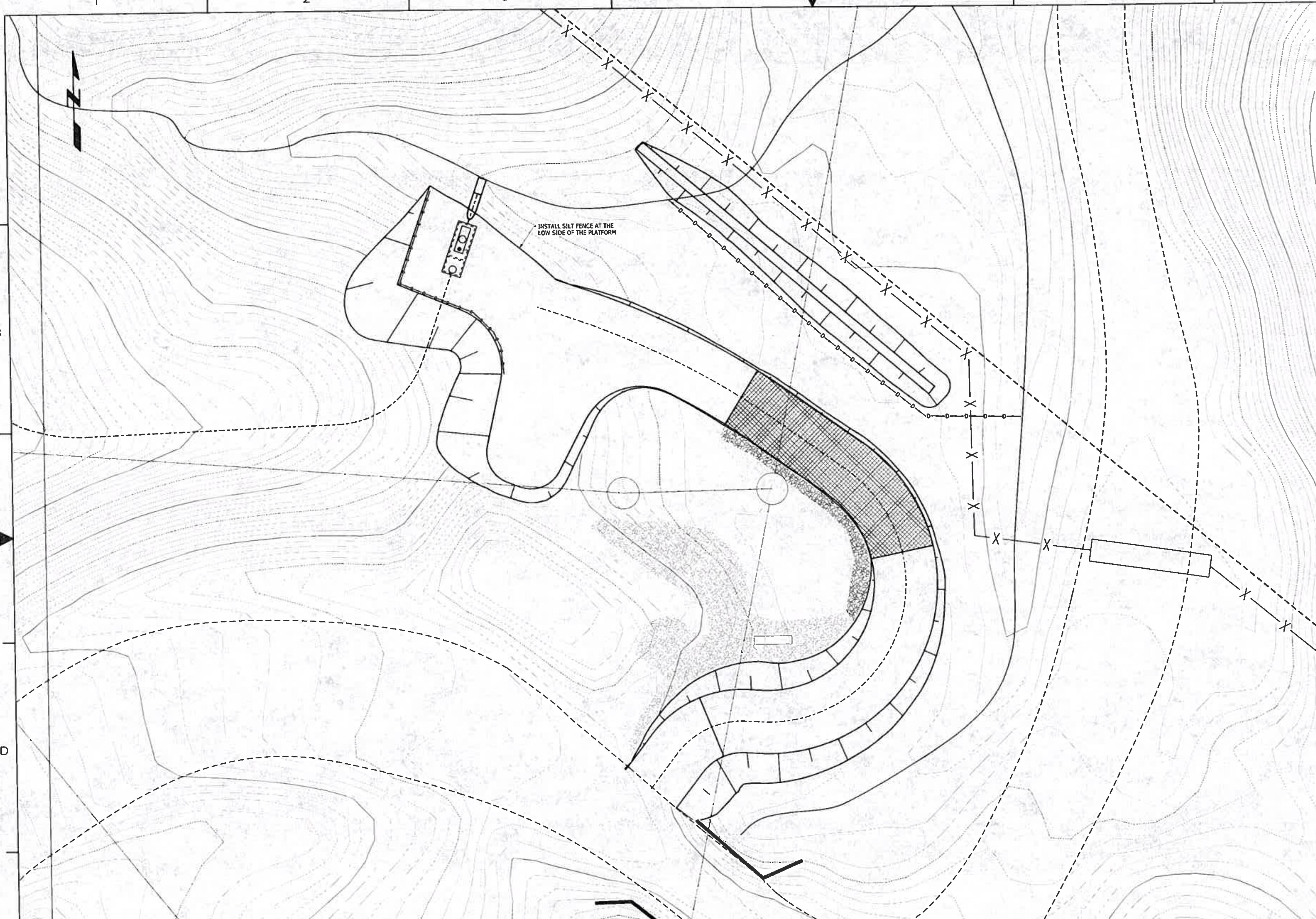
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) EROSION SEDIMENT CONTROL WTP2 PLANT SITE

SCALE: 1:50'

DRAWING NUMBER: A9HR-PF-14300-210-PLN-W-0002

REV: C



NOTES:

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LEGEND:

- CONTOUR (10' INTERVAL)
- CONTOUR (1' INTERVAL)
- PAD/ROAD
- CUT/FILL SLOPE

Registered Professional Engineer (Civil) CERTIFICATE NO. 67200 GRAHAM HILL Date Signed: 6/24/2020 ARIZONA, U.S.A.

EXPIRES 9/30/2021

0 15' 30' 60' 75'

SCALE: 1" = 15'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS								
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS								
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

FLUOR.

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DRAWN BY C. HAJDU		2020.06.22 16:27:53 -0700'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 21:31:36 -0700'
CHECK DESIGN BY		2020.06.24 13:15:00 -0700'
DISCIPLINE LEAD S. SAFAR		2020.06.22 21:32:14 -0700'
ENGINEERING MANAGER R. AKINTEMI		Date: 2020.06.23 08:29:41 -0700'
PROJECT MANAGER R. DYNAN		Date: 2020.06.23 09:18:56 -0700'
CLIENT		

SOUTH32

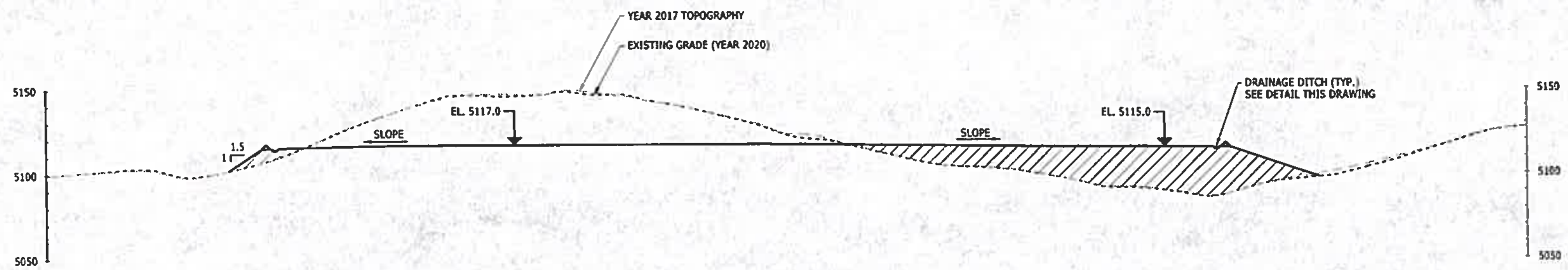
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) EROSION SEDIMENT CONTROL OUTFALL DISCHARGE AREA

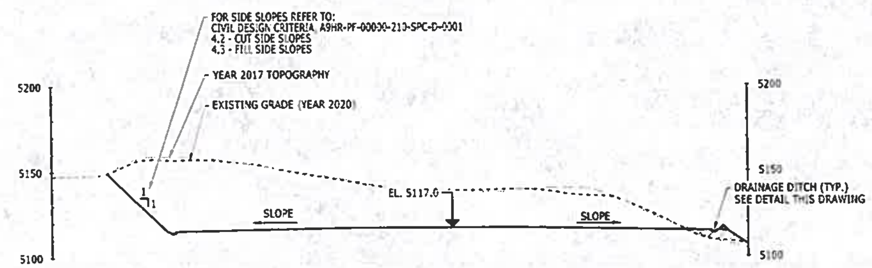
SCALE: 1:15'

DRAWING NUMBER: A9HR-PF-14300-210-PLN-W-0003

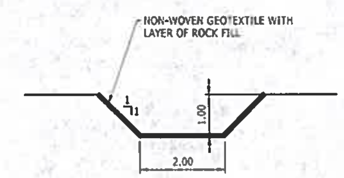
REV: C



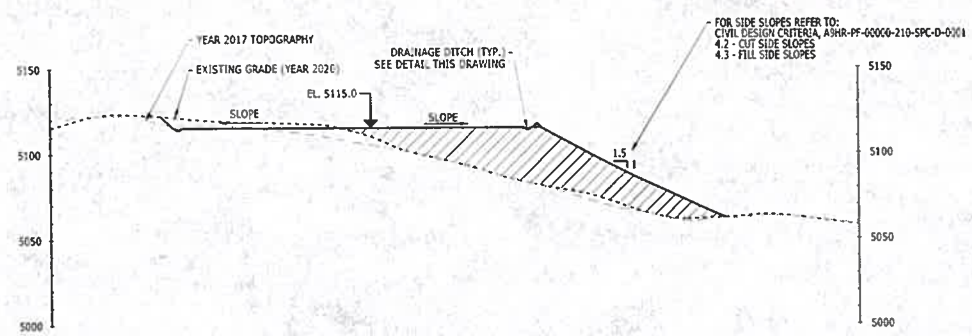
SECTION (A)
SCALE= 1"=50 A9HR-PF-14300-210-PLN-G-0001



SECTION (B)
SCALE= 1"=50 A9HR-PF-14300-210-PLN-G-0001



TYPICAL DRAINAGE DITCH - DETAIL



SECTION (C)
SCALE= 1"=50 A9HR-PF-14300-210-PLN-G-0001

NOTES:

1. THE COORDINATE SYSTEM IS NAD 83 ARIZONA STATE PLANE CENTRAL INTERNATIONAL FEET. THE DATUM IS NAVD88.
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0 50' 100' 150' 200' 250'
SCALE: 1" = 50'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS							A9HR-PF-14300-210-PLN-G-0001	WATER TREATMENT PLANT (WTP2) FINAL GRADING PLAN
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS							A9HR-PF-14300-210-PLN-B-0001	WATER TREATMENT PLANT (WTP2) GENERAL ARRANGEMENT PLAN
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

FLUOR.

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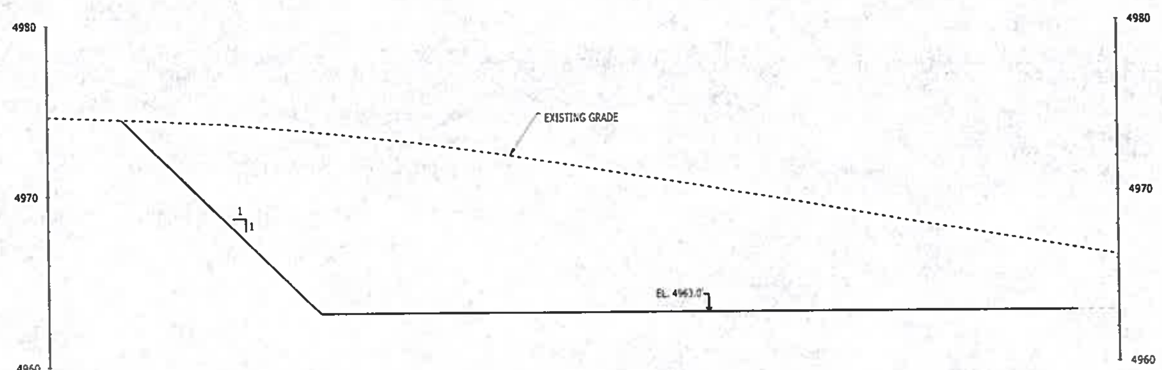
DRAWN BY C. HAJDU		2020.06.22 16:21:21 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 21:39:28 -07'00'
CHECK DESIGN BY		2020.06.24 13:15:23 -07'00'
DISCIPLINE LEAD S. SAFAR		2020.06.22 21:40:04 -07'00'
ENGINEERING MANAGER R. AKINTEMI		Date: 2020.06.23 08:42:21 -07'00'
PROJECT MANAGER R. DYNAN		Date: 2020.06.23 09:25:31 -07'00'
CLIENT		

SOUTH32

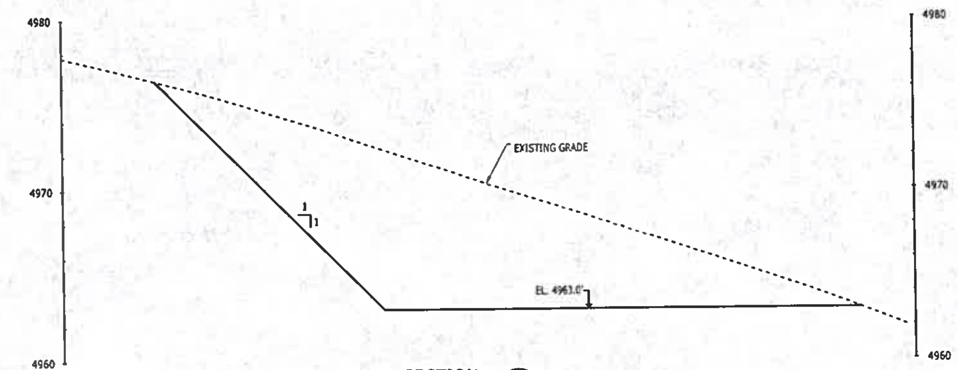
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
FINAL GRADING
SECTIONS

SCALE: 1"=50' | DRAWING NUMBER A9HR-PF-14300-210-LYD-G-0001 | REV C



SECTION A
A9HR-PF-14300-210-PLN-G-0002



SECTION B
A9HR-PF-14300-210-PLN-G-0002

NOTES:

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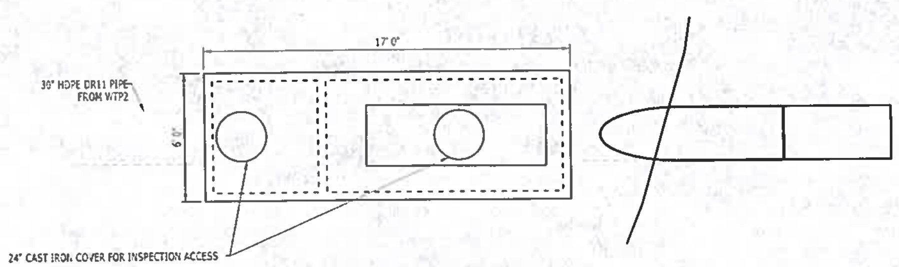
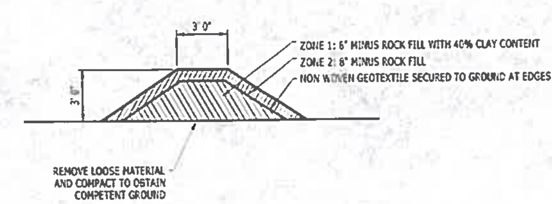
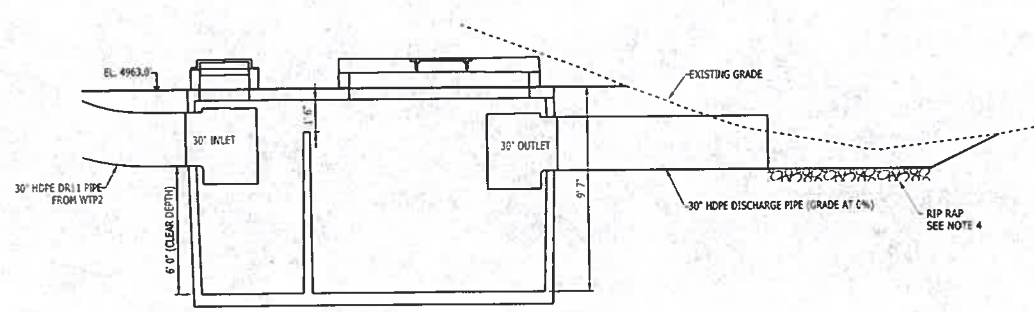
3. ALL COORDINATES, DIMENSIONS AND ELEVATIONS ARE IN FEET UNLESS NOTED OTHERWISE.
4. RIP RAP SHALL BE CLASS 55lb WITH THE FOLLOWING:
   - NOMINAL THICKNESS= 18"
   - 85% OF RIP RAP MIX IS LARGER THAN 5.5lb
   - 50% OF RIP RAP MIX IS LARGER THAN 55lb
   - 15% OF RIP RAP MIX IS LARGER THAN 165lb



ENERGY DISSIPATOR - PLAN



DIVERSION BERM - DETAIL



ENERGY DISSIPATOR - ELEVATION

Registered Professional Engineer (Civil)
CERTIFICATE No. 67200
GRAHAM HILL
Date Signed 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

0 5' 10' 15' 20' 25'
SCALE: 1" = 5'-0"

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS							A9HR-PF-14300-210-PLN-G-0001	WATER TREATMENT PLANT (WTP2) FINAL GRADING PLAN
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS							A9HR-PF-14300-210-PLN-B-0001	WATER TREATMENT PLANT (WTP2) GENERAL ARRANGEMENT PLAN
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS							A9HR-PF-14300-210-PLN-G-0002	WATER DISCHARGE STRUCTURE FINAL GRADING PLAN

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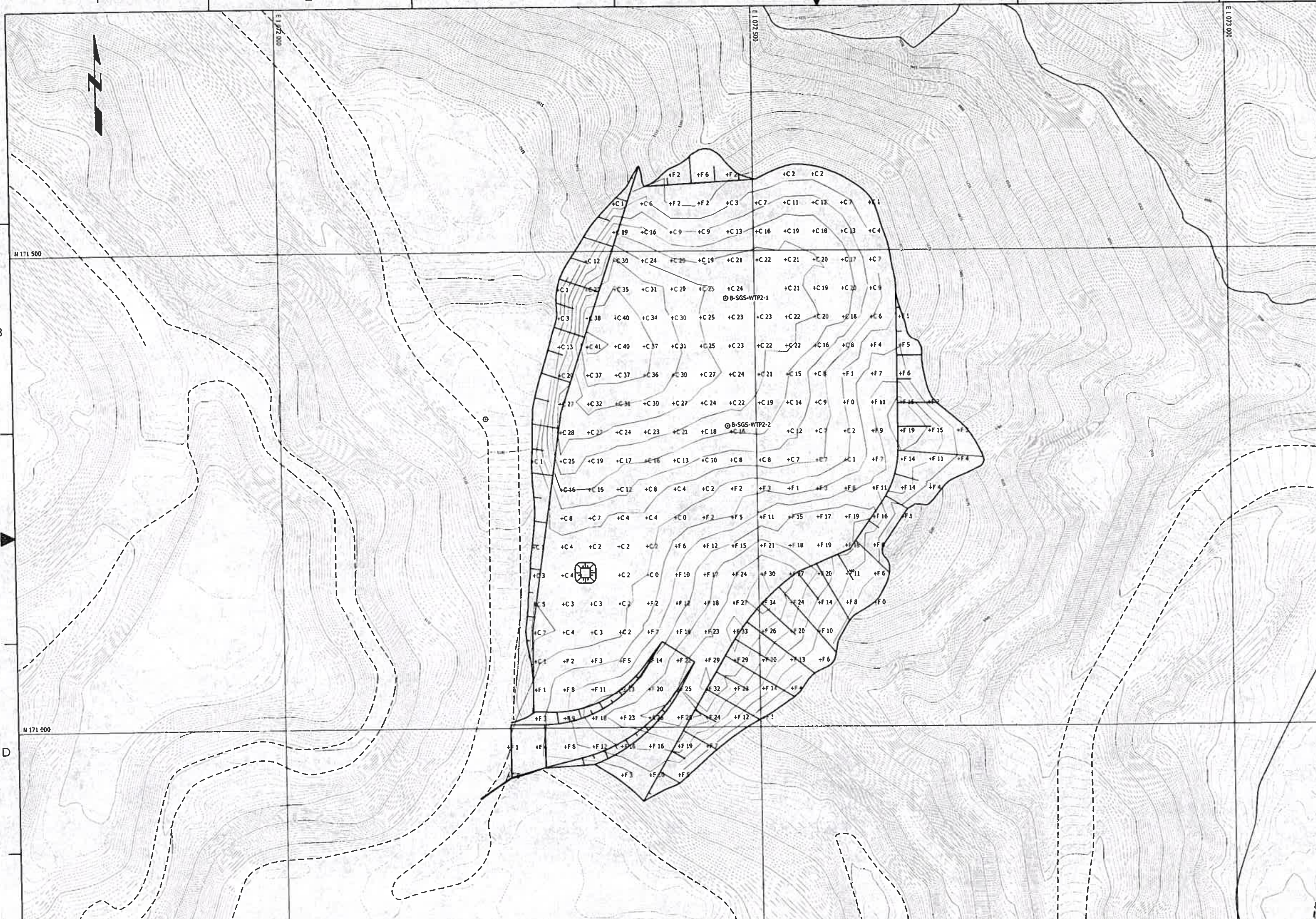
DRAWN BY C. HAJDU		2020.06.22 16:25:30 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 21:50:15 -07'00'
CHECK DESIGN BY		2020.06.24 13:16:17 -07'00'
DISCIPLINE LEAD S. SAFAR		2020.06.22 21:52:02 -07'00'
ENGINEERING MANAGER R. AKINTEMI		Date: 2020.06.23 10:19:26 -07'00'
PROJECT MANAGER R. DYNAN		Date: 2020.06.23 10:38:33 -07'00'
CLIENT		

SOUTH32

HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
WATER DISCHARGE STRUCTURE
FINAL GRADING SECTIONS

SCALE:	DRAWING NUMBER	REV
1"=5'-0"	A9HR-PF-14300-210-LYD-G-0002	C



NOTES:

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LEGEND:

(line)	CONTOUR (10' INTERVAL)
(line)	CONTOUR (1' INTERVAL)
(line)	PAD/ROAD
(line)	CUT/FILL SLOPE
+C 2.0	DEPTH OF EXCAVATION
+F 5.0	HEIGHT OF BACKFILL
⊙B-SGS-WTP2-1	BOREHOLES BY SAGUARO GEOSERVICES, INC (SGS)

Registered Professional Engineer (Civil)
CERTIFICATE NO. 67200
GRAHAM HILL
Date Signed: 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

0 50 100 150 200 250'
SCALE: 1" = 50'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW										A9HR-PF-14300-210-PLN-G-0001	WATER TREATMENT PLANT (WTP2) FINAL GRADING PLAN
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS							A9HR-PF-14300-210-LYD-G-0001	WATER TREATMENT PLANT (WTP2) FINAL GRADING SECTIONS
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

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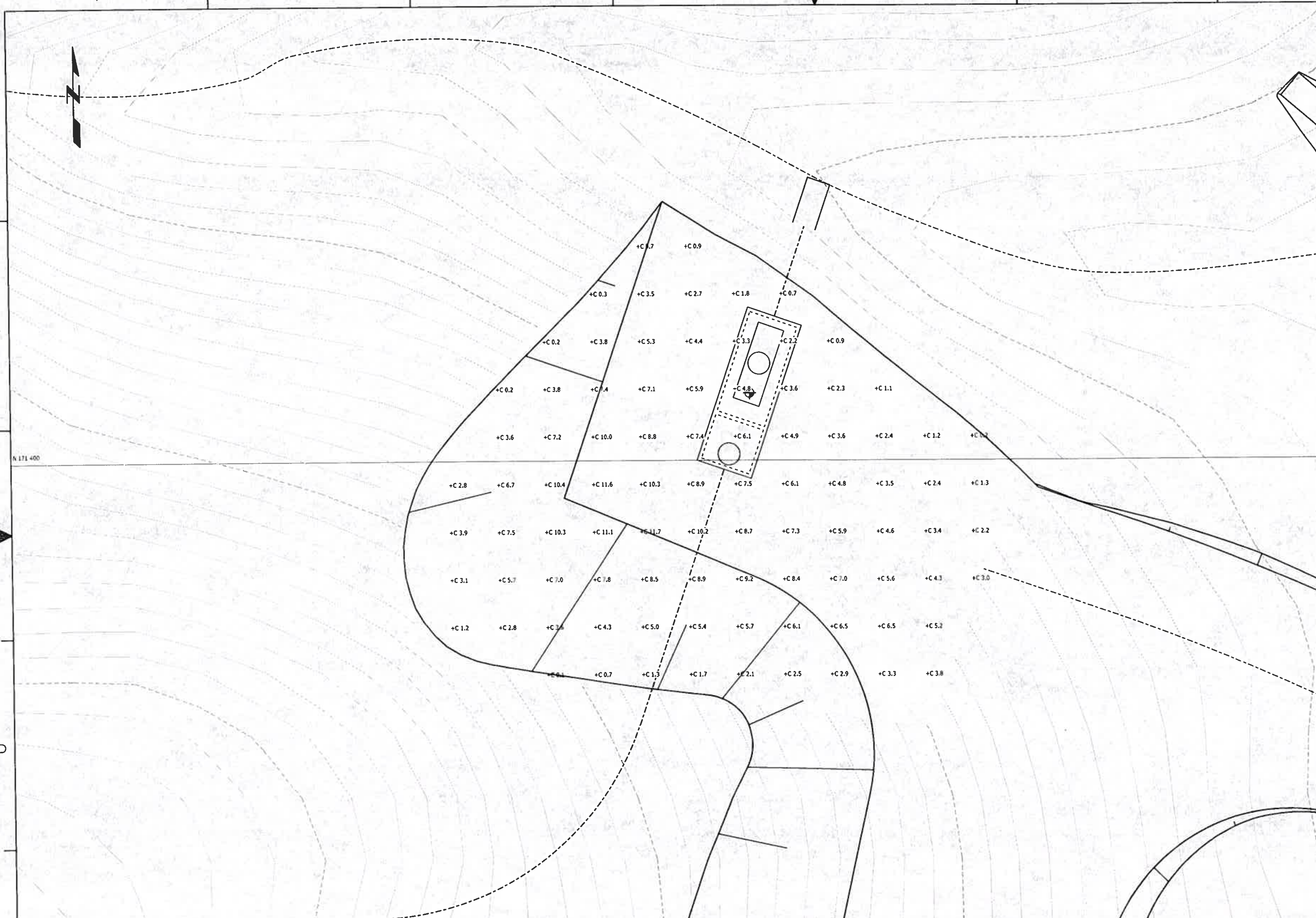
DRAWN BY	C. HAIDU	2020.06.22 16:07:46 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 21:55:01 -07'00'
CHECK DESIGN BY		2020.06.24 13:16:45 -07'00'
DISCIPLINE LEAD	S. SAFAR	2020.06.22 21:55:51 -07'00'
ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 10:48:24 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 11:32:32 -07'00'
CLIENT		

SOUTH32

HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) EARTHWORKS ISOPACH PLAN

SCALE:	DRAWING NUMBER	REV
1"=50'	A9HR-PF-14300-210-DTL-0-0001	C



NOTES:

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LEGEND:

Symbol	Description
(thin line)	CONTOUR (10' INTERVAL)
(light line)	CONTOUR (1' INTERVAL)
(heavy line)	PAD/ROAD
(tick line)	CUT/FILL SLOPE
+C 2.0	DEPTH OF EXCAVATION
+F 5.0	HEIGHT OF BACKFILL

Registered Professional Engineer (Civil)
CERTIFICATE NO.
67200
GRAHAM HILL
Date Signed: 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

0 5' 10' 15' 20' 25'
SCALE: 1" = 5'

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW										A9HR-PF-14300-210-PLN-G-0002	WATER DISCHARGE STRUCTURE FINAL GRADING PLAN
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS							A9HR-PF-14300-210-LYD-G-0002	WATER DISCHARGE STRUCTURE FINAL GRADING SECTIONS
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

FLUOR

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Role	Name	Signed
DRAWN BY	C. HAJDU	2020.06.22 16:06:15 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 18:54:46 -07'00'
CHECK DESIGN BY		2020.06.24 13:17:09 -07'00'
DISCIPLINE LEAD	S. SAFAR	2020.06.22 18:55:38 -07'00'
ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 08:23:45 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 09:20:51 -07'00'
CLIENT		

SOUTH32

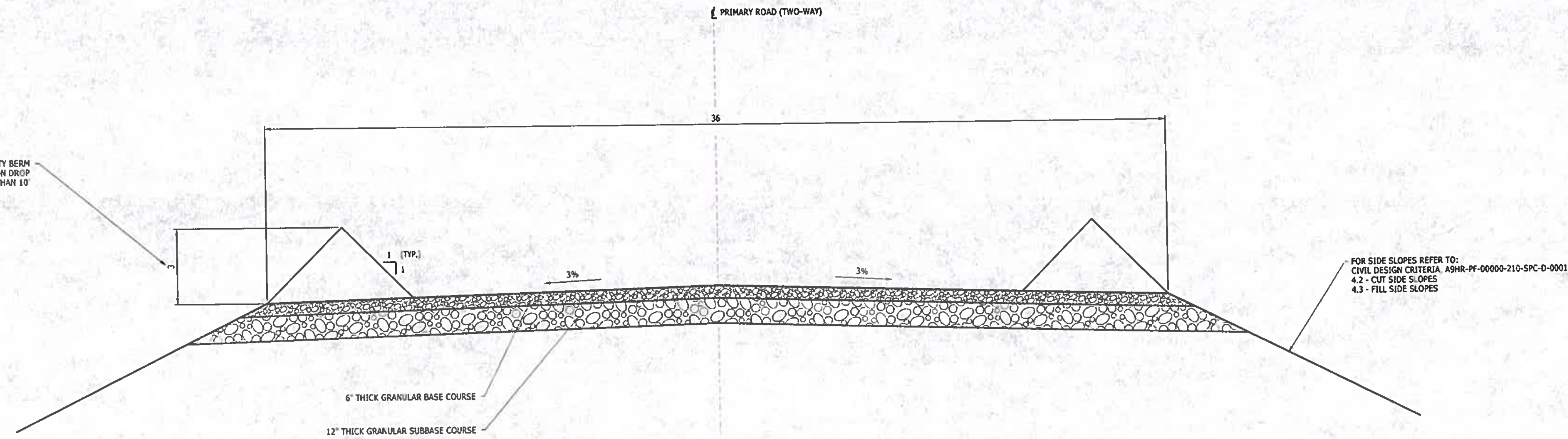
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2) WATER DISCHARGE STRUCTURE EARTHWORKS ISOPACH PLAN

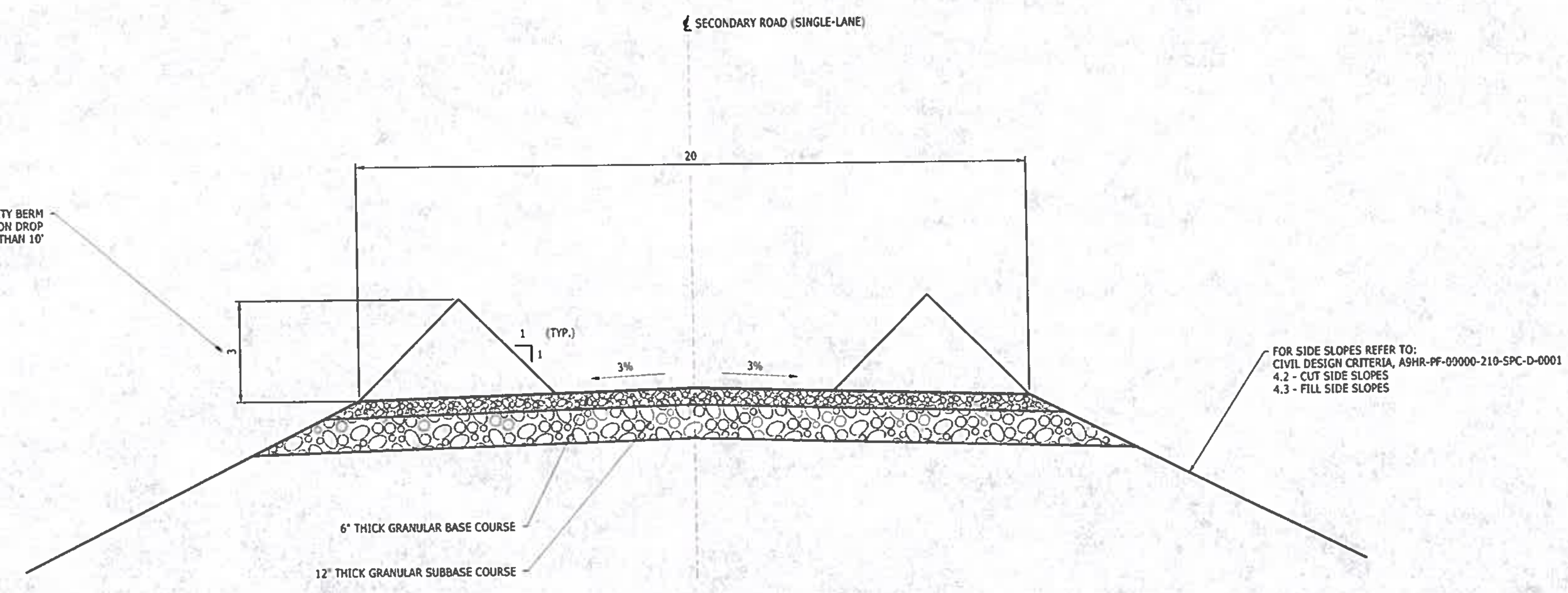
SCALE: 1"=5'

DRAWING NUMBER: A9HR-PF-14300-210-DTL-0-0002

REV: C



SECTION (A)



SECTION (B)
A9HR-PF-14300-210-PLN-R-0001

Registered Professional Engineer (Civil)
CERTIFICATE NO.
67200
GRAHAM
HILL
Date Signed: 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS							A9HR-PF-14300-210-PLN-R-0001	WATER DISCHARGE STRUCTURE ACCESS ROAD PLAN AND PROFILE
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS								
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

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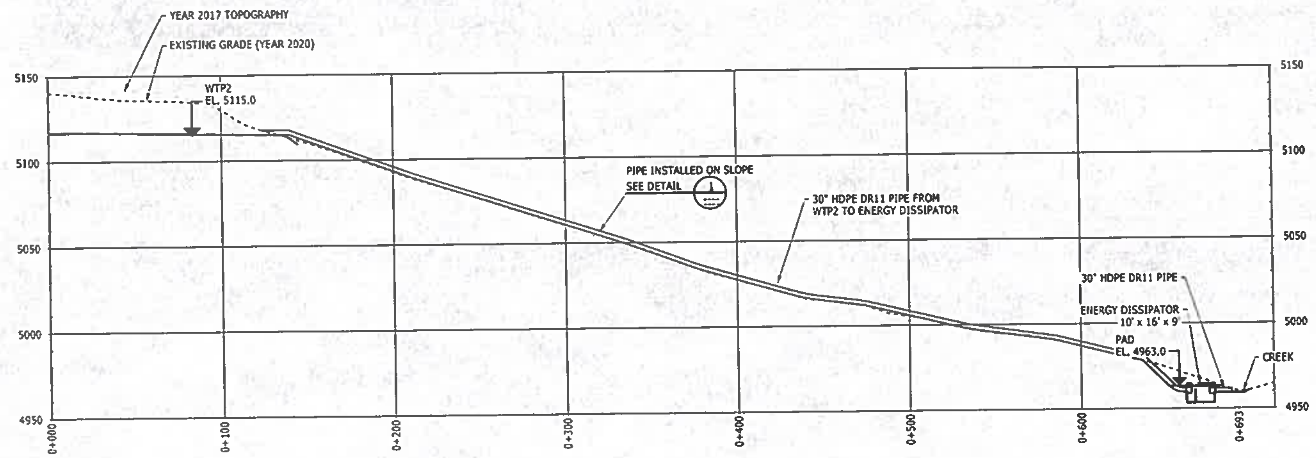
DRAWN BY C. HAJDU		2020.06.22 16:05:41 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 21:47:34 -07'00'
CHECK DESIGN BY		2020.06.24 13:17:44 -07'00'
DISCIPLINE LEAD S. SAFAR		2020.06.22 21:48:14 -07'00'
ENGINEERING MANAGER R. AKINTEMI		Date: 2020.06.23 08:56:46 -07'00'
PROJECT MANAGER R. DYNAN		Date: 2020.06.23 09:29:03 -07'00'
CLIENT		

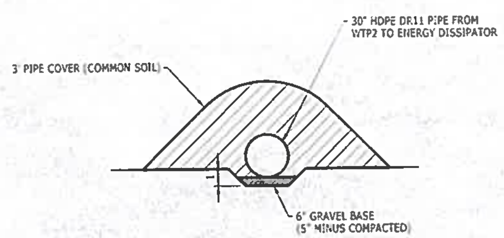
SOUTH32 HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
CIVIL MISCELLANEOUS DETAILS
SHEET 1

SCALE:	DRAWING NUMBER	REV
1:2.5	A9HR-PF-14300-210-DTL-0-0003	C



DISCHARGE PIPELINE - PROFILE
SCALE 1"=50'



DETAIL 1
NTS

Project:		Hermosa
Project No. :		A9HR
Subject:		WTP2 - Outfall Pipeline
Designed By:		SM
Checked By:		SKS
Rev.: B	Date:	29-May-20
Document Number:		A9HR-PF-14300-210-CAL-0-0005

Calculation for Outfall Pipeline Upstream of Energy Dissipater:

Flow Conditions:

Design Flow	4500 gpm
	1022 m^3/h
	0.2839 m^3/s

Site Topographic Conditions:

Elevation @ Start Point	5115 ft
	1559 m
Elevation @ Discharge Point	4963 ft
	1513 m
Assumed Velocity for fitting Friction Losses	2 m/s
Pipe Length (Civil Portion)	660 ft
	201 m
Static Head	-152 ft
	-46 m
Pipe Slope	23.03%

Flow Calculation:

Pipe Section	Unit		Notes
NPS	inch	30	
NPS - Unit Conversion	mm	762	
Material	n/a	HDPE	
Pipe Schedule/SDR	n/a	11	
Outside Diameter	mm	762	
Wall Thickness	mm	69	
Inside Diameter	mm	623	
Inside Diameter (Unit Conversion)	m	0.62	
Flow	m3/h	1022.06	
k (Conversion Factor)	n/a	0.85	*Constant in SI unit*
C (Roughness Coefficient)	n/a	150	*Reference Table 1*
R (Hydraulic Radius)	m	0.1559	
A (Pipe cross sectional Area)	m2	0.3051	
S (Hydraulic Grade Line Slope) - Required	m/m	0.0010	
Hydraulic Grade Line with Contingency 10%	m/m	0.0011	10% safety factor
Velocity - Design	m/s	0.9366	
Velocity - At Capacity	m/s	17.8891	
Velocity (Unit Conversion) - Design	ft/s	3.0729	
Velocity - At Capacity	fps	58.6911	
Flow - Design	m3/s	0.2858	
Flow - Capacity	m3/s	5	
Flow (Unit Conversion) - Design	gpm	4530	
Flow - Capacity	gpm	86521	
Total Length	ft	660	
Head Losses	m	1	
	ft	2	

TDH Calculation:

Static Head	-152 ft
	-46 m
Σ Friction Losses (Losses calculated using Hazen Williams)	2 ft
	1 m
Downstream Head Loss (N/A)	0 kPa
	0 ft
	0 m
Upstream Head Loss (N/A)	0 kPa
	0 ft
	0 m
Total Dynamic Head TDH Required	-150 ft
	-46 m

Project:		Hermosa
Project No. :		A9HR
Subject:		WTP2 Discharge Pipeline
Designed By:		SM
Checked By:		SKS
Rev.: B	Date:	29-May-20
Calculation Number:		A9HR-PF-14300-210-CAL-0-0005

Calculation for Discharge Pipeline Downstream of the Energy Dissipater:

Flow Conditions:

Required Flow	4500 gpm
	1022 m^3/h
	0.2839 m^3/s

Site Topographic Conditions:

Elevation @ Start Point	4960 ft
	1512 m
Elevation @ Discharge Point	4960 ft
	1512 m
Assumed Velocity for fitting Friction Losses	2 m/s
Pipe Length (Civil Portion)	15 ft
	5 m
Static Head	-0.15 ft
	0 m

Flow Calculation:

Pipe Section	Unit	I	Notes
NPS	inch	30	
NPS - Unit Conversion	mm	762	
Material	n/a	HDPE	
Pipe Schedule/SDR	n/a	11	
Outside Diameter	mm	762	
Wall Thickness	mm	69	
Inside Diameter	mm	623	
Inside Diameter (Unit Conversion)	m	0.62	
Flow	m3/h	1022.06	
k (Conversion Factor)	n/a	0.85	*Constant in SI unit*
C (Roughness Coefficient)	n/a	150	*Reference Table 1*
R (Hydraulic Radius)	m	0.1559	
A (Pipe cross sectional Area)	m2	0.3051	
S (Hydraulic Grade Line Slope)	m/m	0.0010	
Hydraulic Grade Line with Contingency 10%	m/m	0.0011	10% safety factor
Velocity	m/s	0.9366	
Velocity (Unit Conversion)	ft/s	3.0729	
Flow	m3/s	0.2858	
Flow (Unit Conversion)	gpm	4530	
Total Length	ft	15	
Head Losses	m	0	
	ft	0	

TDH Calculation:

Static Head	0 ft
	0 m
Σ Friction Losses (Losses calculated using Hazen Williams)	0 ft
	0 m
Downstream Head Loss (N/A)	0 kPa
	0 ft
	0 m
Upstream Head Loss (N/A)	0 kPa
	0 ft
	0 m
Total Dynamic Head TDH Required	0 ft
	0 m

Registered Professional Engineer (Civil)
CERTIFICATE NO.
67200
GRAHAM
HILL
Date Signed: 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS								
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS								
C	16JUN20	ISSUED FOR TENDER	CH	SKS	SS								

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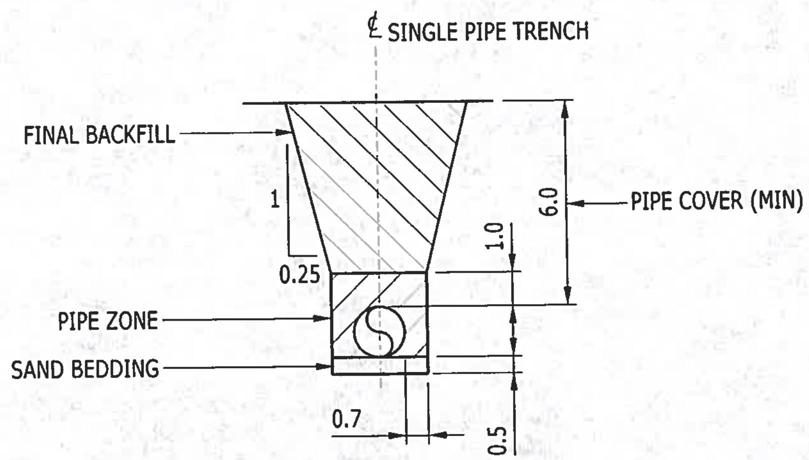
CHECK DRAWING BY	
DESIGNED BY	2020.06.22 21:34:24 -07'00'
CHECK DESIGN BY	2020.06.24 13:18:12 -07'00'
DISCIPLINE LEAD S. SAFAR	2020.06.22 21:35:12 -07'00'
ENGINEERING MANAGER R. AKINTEMI	Date: 2020.06.23 08:31:18 -07'00'
PROJECT MANAGER R. DYNAN	Date: 2020.06.23 09:22:37 -07'00'
CLIENT	

SOUTH32

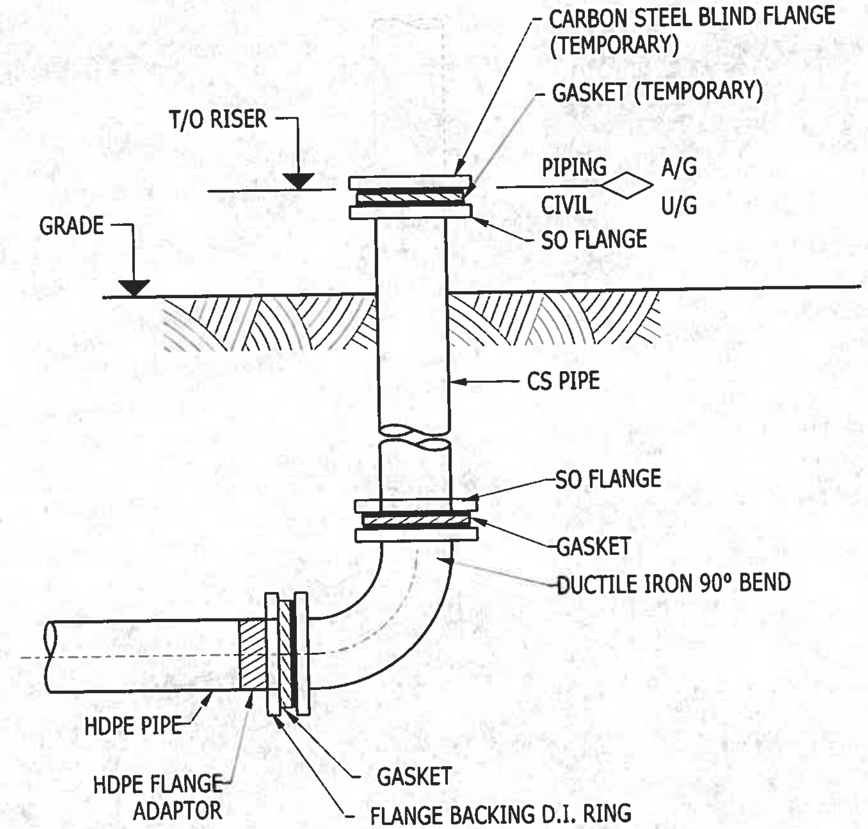
HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
CIVIL MISCELLANEOUS DETAILS
SHEET 2

SCALE: 1"= 50' | DRAWING NUMBER A9HR-PF-14300-210-DTL-0-0004 | REV C



PIPE TRENCHING DETAIL



U/G TO A/G TIE-IN DETAIL

Registered Professional Engineer (Civil)
CERTIFICATE NO. 67200
GRAHAM HILL
Date Signed: 6/24/2020
ARIZONA, U.S.A.
EXPIRES 9/30/2021

REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REV	DATE	REVISION DESCRIPTION	BY	CHK	APPV	REFERENCE DRAWING NUMBER	REFERENCE DRAWING TITLE
A	07MAY20	ISSUED FOR CLIENT REVIEW	CH		SS								
B	10JUN20	ISSUED FOR ENVIRONMENTAL REVIEW	CH		SS								
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Role	Name	Date
DRAWN BY	C. HAJDU	2020.06.22 16:18:18 -07'00'
CHECK DRAWING BY		
DESIGNED BY		2020.06.22 21:36:54 -07'00'
CHECK DESIGN BY		2020.06.24 13:18:33 -07'00'
DISCIPLINE LEAD	S. SAFAR	2020.06.22 21:37:29 -07'00'
ENGINEERING MANAGER	R. AKINTEMI	Date: 2020.06.23 08:35:28 -07'00'
PROJECT MANAGER	R. DYNAN	Date: 2020.06.23 09:24:02 -07'00'
CLIENT		

SOUTH32

HERMOSA PRE-FEASIBILITY STUDY

WATER TREATMENT PLANT (WTP2)
CIVIL MISCELLANEOUS DETAILS
SHEET 3

SCALE:

DRAWING NUMBER A9HR-PF-14300-210-DTL-0-0005

REV C

ATTACHMENT C

Hermosa Lined TSF Design Amendment By

NewFields

HERMOSA LINED TSF DESIGN AMENDMENT
AQUIFER PROTECTION PERMIT (APP)
BEST AVAILABLE DEMONSTRATED CONTROL TECHNOLOGY (BADCT) DESIGN
PATAGONIA, ARIZONA

Prepared for:
Arizona Minerals Inc
2210 East Fort Lowell Road
Tucson, AZ 85719

Prepared by:
NewFields Mining Design & Technical Services
9400 Station Street, Suite 300
Lone Tree, CO 80124

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
8/13/20
Date Signed
ARIZONA, U.S.A.
EXPIRES 3/31/23

NewFields Job No. 475.0014.022
August 13, 2020

NewFields
Perspective. Vision. Solutions.

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1. INTRODUCTION

NewFields Mining Design and Technical Services, LLC (NewFields) was commissioned by Arizona Minerals, Inc (AMI) to complete an "Issued for Tender" amended design of the permitted Voluntary Remediation Program (VRP) Tailings Storage Facility (TSF), hereafter referred to as the "Hermosa Lined TSF Design Amendment" or "TSF Amended Design". The VRP project was submitted as the "Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project" dated June 5, 2017 (NewFields, 2017) and is currently permitted under the Aquifer Protection Permit (APP) Program (No. P-512235) issued by the Arizona Department of Environmental Quality (ADEQ). The VRP work addresses relocation of historic tailings formerly stored in unlined areas onto a BADCT (Best Available Demonstrated Control Technology) compliant geomembrane lined dry stack TSF (hereafter referred to as the VRP TSF). The VRP authorization and APP also allow placement of development rock from the proposed Exploration Declines and other materials onto the VRP TSF.

It should be noted that construction of the Exploration Declines was paused fairly early in the construction phase of the VRP project. As a result, development rock that was expected from construction of the Exploration Declines was not completely captured as part of the VRP construction. This has resulted in an interim TSF geometry on the VRP TSF. The current or interim VRP TSF configuration can be referenced in the "Hermosa Project Tailings and Potentially Acid Generating (PAG) Material, Remediation, Placement and Storage Project Tailings Storage Facility (TSF) Interim Record of Construction Report" dated April 6, 2020 (NewFields, 2020) and submitted electronically to ADEQ on June 1, 2020.

The proposed TSF Amended Design utilizes the remaining capacity in the current VRP TSF as well as expanded capacity detailed herein. The additional storage capacity is achieved through lateral and vertical expansion of the VRP TSF stacking while remaining entirely within the permitted and constructed geomembrane lined VRP TSF basin. As such, no new lateral disturbance associated with the permitted TSF footprint is expected with the proposed TSF Amended Design.

The current VRP TSF is permitted to store historic tailings from Tailings Piles 1 through 4, development rock from the Exploration Declines, filter cake from Water Treatment Plant 1 (WTP1), core cutting material from exploration core sample preparation, and construction PAG. To date, all the historic tailings from Tailings Pile 1 through 4 have been relocated permanently to the geomembrane lined VRP TSF. The current VRP TSF has approximately 506,000 cubic yards (cy) of remaining storage for exploration decline development rock, WTP1 filter cake, core cutting material and construction PAG up to the permitted elevation of 5,110 ft.

Since permitting the VRP project, AMI has identified additional new materials that will require storage on a lined containment. With the proposed TSF Amended Design, AMI would like to permit additional storage for both existing and new materials based on the relative quantities summarized in Table 1.1.

TABLE 1.1 DESIGN CRITERIA (PERMITTED AND NEW MATERIALS)

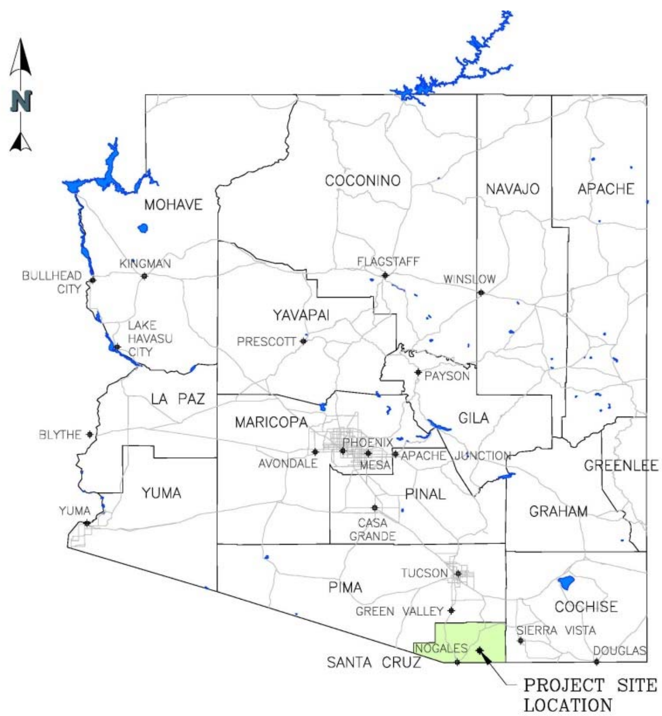
DESCRIPTION	VALUE	COMMENT
Exploration Decline Development Rock (permitted material)	825,092 tons equating to 488,943 cubic yards expansion potential up to 1,572,906 tons equating to 932,092 cubic yards	The TSF Amended Design is sized to include as much as 932,092 cy of exploration decline development rock, at a placed density of 125pcf. Values provided by AMI.
WTP1 Filter Cake (permitted material)	20,097 cy	Estimated quantity is based on 3,650 cubic yards per year for ~5 years. Includes a 10% contingency increase. Value provided by AMI.
Core Cutting Material (permitted material)	105 cy	Estimated quantity is based on 14 cubic yards per year for ~5 years. Includes a 50% contingency. Value provided by AMI.
Construction PAG rock cut (permitted material)	385,051 cy	Estimated quantity is for construction rock cut (some of which may be PAG) and is based on estimated future construction work. Value provided by AMI.
WTP2 Filter Cake (new material)	14,949 cy	Estimated quantity is based on 4,526 cubic yards per year for ~3 years. Includes a 10% contingency. Value provided by AMI.
Drill Cuttings (new material)	5 cy	Estimated quantity is based on less than 1 cubic yard per year for ~5 years. Value provided by AMI.
Sediment from Stormwater BMPs (new material)	9,000 cy	Estimated quantity is based on 1,800 cubic yards per year for ~5 years. Value provided by AMI.

Storage capacity provided by the proposed TSF Amended Design (constructed interim VRP TSF geometry to proposed TSF Amended Design geometry) totals 1.4 million cubic yards (Mcy). Required storage based on all materials (permitted and new) highlighted above is 1,361,299 cy. When actual storage capacity is compared to required storage capacity the TSF Amended Design geometry offers a small amount of additional storage to account for variations in density or slight escalation of material quantities.

The Hermosa Lined TSF Design Amendment is presented in this report along with supporting "Issued for Tender" design documents. The design is being submitted in accordance with requirements outlined in the APP Program administered by ADEQ.

The project location is approximately 50 miles southeast of Tucson, Arizona in Santa Cruz County, and approximately 8 miles north of the U.S.-Mexico border. The site is accessed via Harshaw Road. The location of the project is identified on Drawing A000 and shown in Figure 1.1.

FIGURE 1.1 PROJECT VICINITY MAP



For clarity, much of the engineering analyses (particularly geotechnical laboratory testing and the Seismic Hazard Analysis) completed for the VRP project is presented with this design effort for completeness. The design parameters derived from these analyses are relevant to the TSF Amended Design and are applied to the new TSF Amended Design stacking geometry.

1.1. Scope of Work

NewFields design scope for the Hermosa Lined TSF Design Amendment project included the following civil elements:

- Hermosa Lined TSF Design Amendment design
- Update the water balance for the Hermosa Lined TSF Design Amendment

- Design TSF water management system to meet the Australia Committee on Large Dams (ANCOLD) standards as well as the state of Arizona Best Available Design and Control Technology (BADCT) design guidance document.

NewFields Hermosa Lined TSF Design Amendment project deliverables include the following:

- Final Design Report
- Issued for Tender Drawing Set
- Technical Specifications
- Material Take-Offs (MTOs)
- Construction Capital Cost Estimate
- Closure Cost Estimate

In order to complete the scope of work, a set of design criteria was created for the project and can be referenced in Appendix A. The set of design criteria covers general information, meteorological/climatological data, the TSF, borrow sources, roads, stormwater diversion channels and culverts, and the Underdrain Collection Pond.

1.2. Hermosa Lined TSF Design Amendment

The Hermosa Lined TSF Design Amendment is a stacking expansion to the VRP TSF currently approved under ADEQ APP program (No. P-512235). During construction of the VRP TSF, a permanent geomembrane lined TSF was constructed for relocation of the existing historic tailings piles (Tailings Pile 1 through 4) located on Trench Camp property utilizing Arizona prescriptive BADCT standards. The approved VRP project included a TSF, Underdrain Collection Pond, stormwater management system and other associated infrastructure. Refer to Drawing A050 for a project general arrangement plan view and Drawing A100 for all constructed features of the VRP project. The approved VRP project design documents can be referenced under the permit number cited above and are titled as follows:

- NewFields' "Tailings and Potentially Acid Generating (PAG) Material, Remediation, Placement and Storage Project, Aquifer Protection Permit (APP), Best Available Demonstrated Control Technology (BADCT) Design Report" dated June 5, 2017 (NewFields, 2017).
- NewFields' "Hermosa Project, Tailings and Potentially Acid Generating (PAG) Material, Remediation, Placement and Storage Project, Tailings Storage Facility (TSF), Interim Record of Construction Report" dated April 6, 2020 (NewFields, 2020).

It is important to note, the TSF Amended Design resides wholly inside the geomembrane lined basin for the approved VRP TSF project, cited above. No additional area of disturbance is required for the TSF Amended Design. The expansion extends the VRP TSF stacking geometry laterally (toward the perimeter road) within the lined TSF basin and increases the maximum stacking elevation to 5,175 ft above mean sea level (amsl). This results in an increase to the permitted stacking elevation of approximately 65 ft. The TSF Amended Design results in adequate storage to contain all materials (permitted and new), referenced in Section 1.0.

1.2.1. Exploration Declines

Construction of the Exploration Declines was started at around the time the VRP project was approved. Progression was paused during construction of the VRP project by AMI. Due to the work being paused, the development rock quantity anticipated to be stored on the VRP TSF was not generated concurrent with the VRP construction and as a result the VRP TSF has not yet been fully stacked to design configuration. It is the intent of AMI to restart the Exploration Declines and store development rock generated in the approved VRP TSF configuration. Dependent on the Exploration Decline orientation selected by AMI, the permitted VRP TSF storage geometry may or may not be sufficient to contain the estimated development rock quantity. Currently, the permitted stacking geometry yields approximately 506,000 cy of remaining capacity.

AMI is considering several Exploration Decline orientations. The lower and upper bounds of development rock quantity anticipated for the various decline orientation options are presented in Table 1.1 and range between 488,943 cy and 932,092 cy, depending on the final configuration. All exploration decline development rock determined to be PAG will be placed hauled and placed in the TSF. At this point in time, all exploration decline development rock is assumed to be PAG material.

1.2.2. Tailings Storage Facility

The VRP TSF is sited in the northeast portion of the Trench Camp property and utilizes the existing access road as the western and southern boundary of the facility. The focus of this design submittal is to provide additional storage by expanding the VRP TSF stacking both laterally and vertically while staying entirely within the permitted footprint of the VRP TSF. The top elevation of the reconfigured TSF stacking is raised from 5,110 ft amsl (VRP current permitted top elevation) to 5,175 ft amsl. The lateral expansion that occurs as part of the TSF Amended Design is limited to the existing geomembrane lined basin, permitted as part of the VRP project. As reconfigured, the TSF Amended Design offers 1.4 Mcy of additional storage capacity for the various materials requiring storage. The additional storage capacity is defined as the storage available between the interim VRP TSF configuration shown in Drawing A100, established at the end of the interim VRP TSF construction and the TSF Amended Design geometry shown in Drawing A120.

Based on quantities provided by AMI, the required additional volume to store all materials ranges between approximately 1 Mcy and 1.4 Mcy. It should be noted that this design conservatively assumes that all development rock from the Exploration Declines is potentially acid generating (PAG) and must be stored on a geomembrane lined containment. In reality, a portion of the development rock will be non-acid generating (NAG). As such, this portion of the development rock could be stored or used outside of the lined containment.

The TSF Amended Design makes maximum use of the existing design elements of the VRP TSF. These design elements do not require alteration to capture the additional storage available in the proposed TSF Amended Design. The design elements of the VRP TSF that will remain unchanged with the proposed TSF Amended Design include the following:

- TSF basin liner system consisting of a 60-mil HDPE double sided textured geomembrane overlying either 12 inches of low permeability ($k \leq 1 \times 10^{-6}$ cm/sec) soil layer or a geosynthetic clay liner (GCL).
- Underdrain system immediately above the geomembrane liner to reduce hydraulic gradient on the composite liner system. The underdrain system consists of a network of perforated CPe pipes surrounded by free draining gravel which is then encapsulated by a 10 oz/yd^2 non-woven geotextile.
- An 18 inch thick protective layer material that overlies the geomembrane to protect it as well as provide drainage by collecting and transmitting seepage to the underdrain system.
- Underdrain outlet works consisting of two 36-inch diameter concrete encased pipes that transmit flow from the TSF to the constructed Underdrain Collection Pond.
- An elevated perimeter road which fully encompasses the TSF basin area that provides light vehicle access around the TSF.
- An internal water management system that is capable of capturing, detaining and conveying the design storm event.

These elements can be referenced in the approved APP BADCT Design Report (NewFields, 2017) as well as the TSF Interim ROC Report (NewFields, 2020). The only construction on the TSF that will be required as part of the TSF Amended Design is the completion of the underdrain collection system and protective layer to the full extent of the currently permitted TSF basin area. This area is highlighted on Drawing A110 for clarity.

1.2.3. Underdrain Collection Pond

The Underdrain Collection Pond will also remain unchanged with the proposed TSF Amended Design. As presented in the APP BADCT Design Report (NewFields, 2017), the Underdrain Collection Pond was sized to contain stormwater runoff from the 100-yr/24-hr storm event on the TSF and pond area as well as underdrainage flow from the TSF while maintaining 2 ft of freeboard to the spillway invert. The Underdrain Collection Pond is also fitted with a spillway that was designed to safely pass the routed peak flow from the ¼ PMF and maintain a freeboard of 3 ft.

The Underdrain Collection Pond was fully constructed as part of the VRP project. The UDCP is double geomembrane lined with a leak collection and recovery system (LCRS) located between the primary and secondary liners. In the unlikely event of leakage through the primary liner, the LCRS will convey leakage to a sump for removal thereby reducing hydraulic head and the propensity for seepage beyond the secondary liner system. Water collected in the Underdrain Collection Pond is pumped to the existing Water Treatment Plant (WTP1) for treatment. Details regarding the Underdrain Collection Pond and any appurtenant structures can be referenced in the TSF Interim ROC Report (NewFields, 2020).

1.2.4. Stormwater Management

Stormwater management will remain unchanged with the proposed TSF Amended Design. The intent of stormwater management is to prevent damage to the infrastructure, in particular the TSF, Underdrain Collection Pond and downstream receiving points when meteoric events occur. External stormwater conveyance structures are currently in place that divert surface water flows around the facilities through engineered diversion channels with armoring to minimize erosion and sediment transport. The existing diversions are capable of safely passing peak flow from the 100-yr / 24-hr storm event while maintaining a minimum of 1 ft of freeboard. The stormwater diversion channels constructed during the VRP project that will remain unchanged with the TSF Amended Design include the following:

- TSF Stormwater Diversion Channel located on the west side of the existing access road. The channel parallels the road and outlets near WTP1 protecting the TSF and Underdrain Collection Pond from stormwater run-on.
- Underdrain Collection Pond Stormwater Diversion Channel located on the south and east sides of the Underdrain Collection Pond. The channel follows the crest of the pond and outlets downstream of the Underdrain Collection Pond embankment and spillway. The channel protects the Underdrain Collection Pond from stormwater run-on.

Details of the stormwater diversion channel design cited above can be referenced in the APP BADCT Design Report (NewFields, 2017) and as-built information can be referenced in the TSF Interim ROC Report (NewFields, 2020). It should be noted, the existing stormwater management system is adequate for the TSF Amended Design and will not require alteration.

1.3. Use of This Report

This report has been prepared exclusively for AMI. No third party, other than the design team (NewFields), shall be entitled to rely on any information, conclusions, opinions or other information contained herein without the express written consent of AMI.

2. PROJECT SETTING

The project area was evaluated to develop an understanding of the design setting and inherent site conditions. The following sections address conditions associated with the project required for the design.

2.1. Site Conditions

The project is on patented (private) land within the Sierra Vista District of the Coronado National Forest in the Patagonia Mountains due west of Harshaw, Arizona, and is accessible by Harshaw Road and Flux Canyon Road. Forest vegetation in this area generally consists of juniper, Mexican pinyon and mesquite trees with several different species of grasses and shrubs. Area elevations range from approximately 4,800 to 5,300 feet amsl. The main drainages in the area are Alum Gulch, which flows northwest and Harshaw Creek, which flows northeast. Both drainages empty into Sonoita Creek. Alum Gulch and Harshaw Creek are ephemeral drainages that experience flows during the summer monsoon precipitation events. The area experienced over a century of historical underground mining activities with evidence still observable by open adits and shafts.

2.2. Climate

2.2.1. Temperature

The project is located at 31 degrees latitude and approximately 5,200 feet amsl. The average temperatures range from 65-96 degrees Fahrenheit during the day and 28-65 degrees Fahrenheit at night. The average monthly temperatures for Patagonia, Arizona, approximately 5 miles northwest of the site, are presented in Table 2.1 (ERC, 2017).

TABLE 2.1 – AVERAGE MONTHLY TEMPERATURES FOR PATAGONIA, ARIZONA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High (°F)	65	67	72	79	87	96	94	92	90	83	73	65
Low (°F)	28	30	34	39	46	55	65	64	57	44	33	28

2.2.2. Precipitation

Precipitation and evaporation values for the project site were determined based on measured site-specific data and data from three regional meteorological stations. Regional data was collected from the Western Regional Climate Center (WRCC) for stations Nogales 6N, Patagonia, and Canelo 1. The site-specific data record is considered the most representative and the primary source for determining the average monthly precipitation values. The estimated precipitation values for the project location are shown in Table 2.2 (ERC, 2017).

TABLE 2.2 – PRECIPITATION STATISTICS AT HERMOSA PROJECT SITE

Month	Estimated Monthly Precipitation	
	Avg (in)	Std Dev (in)
January	1.66	1.84
February	0.88	0.97
March	2.51	1.65
April	0.35	0.33
May	0.38	0.46
June	0.87	1.24
July	5.66	1.88
August	5.59	1.57
September	4.38	1.80
October	0.63	0.82
November	0.63	0.60
December	1.64	0.81
Annual	25.18	5.00

Further details regarding climatic conditions at the site can be found in Appendix B in the ERC Technical Memorandum Arizona Mine Site Meteorological Analysis (ERC, 2017).

2.2.3. 24 Hour Storm Precipitation Depth

Determination of precipitation associated with the various frequency storm events was obtained from the National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server. Reported precipitation values are for Latitude 31° 27’ 20” N, Longitude 110° 42’ 47” W, and are shown in Table 2.3 (ERC, 2017) and presented in Appendix A (design criteria).

TABLE 2.3 – POINT PRECIPITATION FREQUENCY ESTIMATES

Frequency (yr)	Duration (hr)	Precipitation Depth (in)
1	24	1.86
2	24	2.31
5	24	2.87
10	24	3.32
25	24	3.93
50	24	4.40
100	24	4.88
500	24	6.02

2.3. Geology

2.3.1. Regional Geology

The site is located in the Patagonia Mountains within the Basin and Range Physiographic Province near the USA-Mexico border. This area of the Basin and Range is characterized by Drewes (1979) as Precambrian deformed basement with Mesozoic granitic intrusives widely placed in conjunction with block faulting. Compressional stresses during the North American Cordillera building events within the region occurred over a 37 million years (Ma) period, which produced two large scale thrust faults having a total estimated displacement of 124 miles. Subsequent crustal extension during Basin and Range formation produced a series of northwest trending normal and strike-slip faults. Rocks within the region generally consist of Precambrian basement, Paleozoic sedimentary sequences, Mesozoic igneous intrusive and extrusive rocks and sedimentary rocks, and Cenozoic volcaniclastic and sedimentary rocks.

2.3.2. Local Geology

The Patagonia Mountains are comprised of Precambrian igneous juxtaposed with Paleozoic sedimentary and Triassic to Late Cretaceous igneous rocks by faulting. The Mesozoic igneous rocks consist of similar chemical composition: intrusives are dominantly monzonite, diorite, and granodiorite; and extrusives consist of latite, andesite and rhyolite (Simons, 1972). The project site is located within an area dominated by andesite (Cretaceous) and rhyolite (Tertiary or Upper Cretaceous) as tuff, tuffaceous sandstone and breccia. The andesite is several thousand feet thick and the rhyolite are estimated to be 800 feet thick (Simons, 1972). Faulting generally maintains a northwest trend throughout the area. The Harshaw Creek and Guajolote Faults are the dominant normal faults through the mountains with smaller normal and reverse faults present throughout. These faults are not considered active. The Harshaw Creek Fault is concealed by the rhyolite flows near the project site.

2.4. Seismic Hazard

A seismic hazard assessment (SHA) was completed to determine ground motions experienced at the project site associated with the maximum credible earthquake (MCE) and maximum probable earthquake (MPE), based on regional seismicity and the probable 100, 475 and 2,475-year return events. A deterministic seismic hazard assessment was performed using available historic earthquake data from several national and international earthquake catalogs and regional active faults from the United States Geological Survey (USGS) and the Arizona Geological Survey (AZGS) within a 124 mile (200 km) radius of the project. Attenuation calculations were applied to these events and fault sources to determine the peak ground acceleration (PGA) at the project site. A probabilistic assessment was also completed using the USGS interactive deaggregation tool, based on the published 2008 national seismic hazard map.

Based on the study, the MCE for the deterministic and probabilistic assessments results in seismic design or horizontal pseudostatic earthquake coefficients of 0.11 gravity (g) and 0.10 g, respectively. The complete SHA report is presented in Appendix C.

3. GEOTECHNICAL INVESTIGATION

3.1. Field Investigation

Three geotechnical site investigations (January 2017, June 2017 and January 2018) were performed at the project site in association with VRP TSF design and construction at the Trench Camp Site. These three geotechnical programs along with observations and laboratory results can be referenced in the following documents:

- NewFields' "Tailings and Potentially Acid Generating (PAG) Material, Remediation, Placement and Storage Project, Aquifer Protection Permit (APP), Best Available Demonstrated Control Technology (BADCT) Design Report" dated June 5, 2017 (NewFields, 2017).
    - Section 3.0 (Geotechnical investigation summary) (pages 10 – 17)
    - Drawing A030 (Geotechnical investigation plan view)
    - Appendix D (January 2017 borehole and test pit logs)
    - Appendix E (January 2017 geophysical data)
    - Appendix F (January 2017 laboratory data)
- Appendix D (this document)
    - Appendix D.1.1 (January 2017 borehole and test pit logs)
    - Appendix D.1.2 (June 2017 test pit logs)
    - Appendix D.1.3 (January 2018 test pit logs)
    - Appendix D.2.1 (January 2017 laboratory data)
    - Appendix D.2.2 (June 2017 laboratory data)
    - Appendix D.2.3 (January 2018 laboratory data)

For completeness, all borehole and test pit locations performed during the various geotechnical investigations are shown on Drawing A070.

In addition to the three geotechnical programs that were conducted for the VRP design, confirmatory laboratory and field testing was conducted during construction of the VRP facilities. The confirmatory testing included compaction, strength and liner interface friction testing. All relevant confirmatory laboratory and field testing results performed during the construction of the VRP project are presented in Appendix D.3. These parameters along with the geotechnical investigation and test work associated with the VRP design are relevant to the TSF Amended Design with the exception of the geophysical work performed to define the historic tailing pile thickness. The historic tailings were completely removed and placed in the VRP TSF so that information is no longer relevant.

The goals of the three geotechnical field investigations included the following:

- Characterize the existing tailings piles (1 through 4) on the Trench Camp property.
- Characterize the near surface natural soil and rock materials globally across the project site.
- Assess subsurface material characteristics to determine their suitability for use as construction materials.
- Assess likely excavation requirements for site grading and construction materials.
- Identify and quantify volume of potential low permeability soil layer borrow sources for use as LPSL in the TSF composite liner system. Note, LPSL material was exhausted during the VRP TSF construction. Any LPSL requirement for closure will need to be imported or created through a screening and bentonite amendment operation.
- Identify potential aggregate sources for production of concrete aggregate, riprap, drainage aggregate and protective layer. Note, protective layer and drainage aggregate will likely be imported to complete the VRP TSF construction.
- Perform laboratory testing to define engineering characteristics of the on-site borrow materials for potential use during construction.

3.1.1. Boreholes

Boreholes completed as part of the VRP design were drilled to depths ranging between 17 and 57 feet below ground surface (bgs) with a track-mounted CME 850 drill rig. Details of sampling procedures and wireline coring performed can be referenced in the APP BADCT Design Report (NewFields, 2017).

Eight of the 16 boreholes (borings BH-01 through BH-08) were advanced in Tailings Piles 1 through 4 and are not relevant to the TSF Amended Design. The other 8 test borings (boring BH-09 through BH-16) are useful in characterize general subsurface conditions in the vicinity of the project. Details of the work performed can be referenced in Appendix D of the APP BADCT Design Report (NewFields, 2017) as well as Appendix D.1.1 (this report). Please note, the information presented in the APP BADCT Design Report (NewFields, 2017) is the same as presented in Appendix D.1.1 and is included in this report for completeness.

3.1.2. Test Pits

A total of 123 test pits were excavated to assess potential borrow sources for the VRP construction materials. Most of the borrow sources on site were exhausted during the VRP construction. The relatively small quantity of construction materials required for the TSF Amended Design will likely be imported. Details of the test pitting work performed can be referenced in Appendix D of the APP BADCT Design Report (NewFields, 2017) as well as Appendix D.1.1 through D.1.3 (this report). Please note, the information presented in the APP BADCT Design Report (NewFields, 2017) is the same as presented in Appendix D.1.1 and is included in this report for completeness. The information presented in Appendix D.1.2 and Appendix D.1.3 was obtained after the APP BADCT Design Report (NewFields, 2017) submittal.

3.2. Laboratory Test Work

Samples obtained during the field investigations for the VRP project were sent to NewFields' laboratory in Elko, Nevada where the majority of the testing was completed. The test results from the VRP design program are relevant to the TSF Amended Design. Details of the testing can be referenced in Appendix F of the APP BADCT Design Report (NewFields, 2017) as well as in Appendix D.2.1 through D.2.3 (this report). Please note, the information presented in the APP BADCT Design Report (NewFields, 2017) is the same as presented in Appendix D.2.1 and is included in this report for completeness. The information presented in Appendix D.2.1 and Appendix D.2.3 was obtained after the APP BADCT Design Report (NewFields, 2017) submittal.

Samples obtained during construction for quality assurance were tested in a NewFields' onsite laboratory. Relevant laboratory test work performed during construction of the VRP facilities can be referenced in Appendix D.3. Specialty testing such as triaxial shear strength and interface friction testing was performed by subcontractors. Laboratory testing included the following:

- Classification and index tests
  - Sieve Analysis to No. 200 Sieve (ASTM D6913)
  - Atterberg Limits (ASTM D4318)
  - Specific Gravity (ASTM D854/C127)
- Natural Density and Moisture (ASTM D2937)
- Soil Compaction Tests
  - Standard Proctor (ASTM D698)
  - Modified Proctor (ASTM D1557)
- Aggregate Characteristics (ASTM C131)

- Hydraulic Conductivity (ASTM D5084 / USBR 5800)
- Direct Shear (ASTM D3080)
- Unconfined Compressive Strength (ASTM D2166)
- Triaxial Shear Testing (ASTM D7181)
- Soil Liner Interface Direct Shear Testing (ASTM D5321)

3.2.1. Index Properties

The index properties of soils were evaluated using particle size analyses and Atterberg limits. These parameters were used to divide the soils into groups with similar engineering properties. Each sample was subsequently categorized according to the Unified Soil Classification System (USCS).

Index properties from construction quality control testing are summarized in Table 3.1.

TABLE 3.1 – INDEX PROPERTIES TEST DATA

Material	Material Classification	Gradation	Plasticity
Historic Tailings	Multiple classifications	Minus 6” Avg 35.5% passing #200	Majority of samples were non-plastic (75%)
Engineered Fill	Mainly GP or GC	Minus 8” Avg 11.4% passing #200	Avg PI was 11 (medium plasticity)
Low Permeability Soil Layer	SC	Minus 2” Avg 29.2% passing #200	Avg PI was 23 (high plasticity)
Friction Layer	GP	Minus 0.375” Avg 0.9% passing #200	Non-plastic
Protective Layer	Mainly GW or GP	Minus 1.5” Avg 5.4% passing #200	Mostly non-plastic (if plasticity, sample had low fines content)
Drainage Aggregate	GP	Minus 1.5” Avg 1.6% passing #200	Non-plastic
Rock Armor	GP, GW, GC	Minus 8” Avg 8.7% passing #200	Avg PI was 13 (medium plasticity)

3.2.2. Permeability

During VRP construction, confirmatory flex wall and rigid wall permeability testing was performed for the historic tailings, low permeability soil layer, protective layer and drainage aggregate material. Permeability data from construction quality control testing is summarized in Table 3.2.

TABLE 3.2 – PERMEABILITY TEST DATA

Material	Low (cm/sec)	High (cm/sec)	Average (cm/sec)
Historic Tailings	1.0×10^{-7}	1.4×10^{-4}	1.7×10^{-5}
Low Permeability Soil Layer	6.2×10^{-8}	7.2×10^{-7}	3.9×10^{-7}
Protective Layer	5.9×10^{-3}	1.4×10^{-1}	5.3×10^{-2}
Drainage Aggregate	2.2×10^{-2}	1.6×10^{-1}	9.2×10^{-2}

3.2.3. Direct Shear

As a basis for the VRP TSF design, consolidated drained direct shear tests (ASTM D3080) were conducted on materials collected during the field investigations as well as confirmatory tests collected and performed during VRP construction. Mohr-Coulomb strength parameters developed from the test data are summarized in Table 3.3. For additional information regarding the testing, refer to Appendix D.

TABLE 3.3 – DIRECT SHEAR TEST DATA

Location	Depth (feet bgs)	Sample Type	Material Type	USCS Group Symbol	Friction Angle (deg)	Cohesion (psf)
TP-24	4 - 7	Remolded	Tailings	ML	30.6	564
TP-25	8 - 10	Remolded	Tailings	CH	16.4	173
TP-33	1 - 20.5	Remolded	Tailings	SP	31.8	0
TF-28-R	N/A	Remolded	Tailings	SM	37.9	101
TP-38	0 - 7	Remolded	Natural	ML	32.2	0
EF-17-R (VRP engineered fill sample)	-	Remolded	Natural	GC	39.3	1008
EF-39-R (VRP engineered fill sample)	-	Remolded	Natural	GC	37.8	1357

“-R” indicates a record sample

3.2.4. Consolidated Undrained Triaxial Compression

During VRP construction, samples were obtained for consolidated undrained triaxial compression testing (ASTM D4767). Strength parameters were developed from the test data and are summarized in Table 3.4. For additional information regarding the testing, refer to Appendix D.3.

TABLE 3.4 – CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST DATA

Location	Sample Type	Material Type	USCS Group Symbol	Friction Angle (deg)	Cohesion (psf)
Combination of TF-002-R / TF-003-R / TF-004-R	Remolded	Tailings	SP/SC	34.6	0
TF-077-R FC-001-C	Remolded	Tailings / FC mixture (3 TF :1 FC ratio)	SM	37.8	154

3.2.5. Interface Shear Strength

A large-scale direct shear (LSDS) testing was used to evaluate the interface shear strength of select samples placed in intimate contact with the AGRU 60 mil double sided textured HDPE microspike geomembrane under a range of anticipated loads (ASTM D5321) at the site. The following samples were evaluated to represent the constructed VRP TSF facility:

- Soil – Geosynthetic interface
    - LPSL vs Agru 60 mil double sided textured HDPE microspike geomembrane
    - LPSL was bentonite amended (2% by weight) and a friction layer was applied to the LPSL at the interface
- Geosynthetic – Geosynthetic
    - Cetco Bentomat DN-9 (15 lb peel) GCL vs Agru 60 mil double sided textured HDPE microspike geomembrane

A 12 inch by 12 inch shear box was used for the test. LPSL samples were obtained from the LPSL stockpile as well as in place record samples during the VRP TSF construction. The soil was placed in the upper shear box and compacted to 95% of the maximum modified proctor dry unit weight as determined by (ASTM D1557). Subsequently, the geomembrane was fixed to a rigid aluminum plate on the bottom half of the shear box apparatus, and the upper and lower portions were fit together. The specimen was loaded under a nominal stress, and then inundated for 24 hours. The specimen was then consolidated at normal loads of 5, 10, and 20 kips per square foot (ksf) for 24 hours before being sheared.

In the tests using LPSL, a thin friction layer consisting of rock crushed to sand and gravel sized particles was placed between the HDPE liner and soil specimen to represent the actual constructed LPSL/geomembrane interface. Interpreted peak and residual strength values are shown in Table 3.5 and the laboratory data sheets can be referenced in Appendix D.

TABLE 3.5 – INTERFACE SHEAR STRENGTH TEST RESULTS

Sample	USCS	Geomembrane	Peak Strength		Residual Strength	
			Φ (deg)	C (psf)	$Φ_{Residual}$ (deg)	$C_{Residual}$ (psf)
LPSL-020-C (VRP LPSL Stockpile)	SC with 2% bentonite and friction layer	Agru 60 mil double sided textured microspike HDPE	30	680	26	660
LPSL-006-R	SC with 2% bentonite and friction layer	Agru 60 mil double sided textured microspike HDPE	28	665	21	275
Hydrated Bentomat DN-9 (15 lb peel) GCL	NA	Agru 60 mil double sided textured microspike HDPE	21	1045	11	620
Hydrated Bentomat DN-9 (15 lb peel) GCL	NA	Agru 60 mil double sided textured microspike HDPE	20	1340	11	745

3.2.6. Liner Integrity Testing

Two geomembrane liner integrity tests were performed as part of the construction quality assurance testing. The test parameters and results are shown in Table 3.6 and the laboratory data sheets can be referenced in Appendix D.3.

TABLE 3.6 – LINER INTEGRITY TEST DATA

Substrate	Geomembrane	Superstrate	Normal Load (psf)	Duration (hrs)	Result
Bentomat DN-9 (15 lb peel) GCL	Agru 60 mil double sided textured microspike HDPE	Protective layer (placed to Specification)	16,500	24	Pass
Low permeability soil layer (placed to Specification)	Agru 60 mil double sided textured microspike HDPE	Protective layer (placed to Specification)	16,500	24	Pass

3.3. Field Test Work

3.3.1. Compaction Tests

During construction of the VRP TSF, compaction testing was performed on in place materials, where required, until passing results were achieved. Compaction testing was also performed on historic tailings during placement in the VRP TSF. The tailings had a specified minimum compaction of 90% of the maximum density as determined by ASTM D-698 (Standard Proctor). Based on construction compaction records (404 density tests) on the historic tailings, the actual compaction achieved averaged approximately 97%.

4. ARIZONA AQUIFER PROTECTION PERMIT PROGRAM

The State of Arizona Aquifer Protection Permit (APP) Program requires a permit for the TSF Amended Design. Permitting of the TSF Amended Design on the Trench Camp property will be an amendment to the existing APP permit for the VRP TSF. This report presents the design in support of the APP amendment application and as such, includes all requisite design elements of an APP application for review by ADEQ.

5. TSF DESIGN

The Trench Camp TSF Amended Design is designed as a lateral and vertical stacking expansion to the constructed VRP TSF that remains within the currently permitted TSF footprint. The stacking expansion is designed to contain additional exploration decline development rock, PAG construction cut, filter cake from WTP1 and WTP2, core cutting and drill cutting material, and sediment from stormwater BMPs. The TSF stacking expansion is sited within the constructed VRP TSF geomembrane footprint and does not require additional lined area.

It is important to note that the VRP TSF is currently in an interim state due to a pause in the Exploration Decline construction activities. The following elements were approved for construction during the permitting and VRP approval process and will be constructed in accordance with the State of Arizona APP No. P-512235 after the restart of the Exploration Decline construction activities:

- Completion of the protective layer
- Completion of the drainage aggregate (as part of the underdrain collection system)
- Completion of the underdrain collection piping (as part of the underdrain collection system)
- Completion of the 10 oz/yd^2 non-woven geotextile (as part of the underdrain collection system)
- Placement of the Exploration Decline Development Rock

During the VRP construction, a portion of the underdrain collection system (protective layer, drainage aggregate, underdrain collection pipe and non-woven geotextile) was not installed in the VRP TSF basin on the exposed geomembrane slopes. These elements were not placed due to the risk of sliding on top of the geomembrane interface in areas that were left in an open or unconfined condition (stacking did not occur). It should be noted that if underdrain elements slide on top of the geomembrane, there is a significant chance of damage to the geomembrane. During the TSF Amended Design, AMI will progressively install the remaining underdrain collection system immediately ahead of the stacking.

5.1. TSF Sizing

As currently permitted, the constructed VRP TSF has approximately 506,000 cubic yards of remaining capacity for exploration decline development rock, WTP1 filter cake, core cutting material and construction PAG material. The proposed TSF Amended Design was sized to increase the capacity based on the following criteria.

- Increase the remaining storage volume based on the Interim VRP TSF geometric configuration to approximately 1.4 million cubic yards (reference Table 1.1 for material quantity breakdown) to store the following materials:
  - Exploration decline development rock
  - WTP1 filter cake
  - Core cutting material
  - Construction PAG
  - WTP2 filter cake
  - Drill cuttings
  - Sediments from stormwater BMPs
- Average in-place target material (dry) density
  - 125 pcf for the TSF Amended Design materials based on an estimated density for the material placed at a target density of 90% of the maximum dry density as defined by ASTM D698 (standard proctor density).
- Compound tailings slope of 3H:1V
  - 25 vertical foot 2.5H:1V open slopes
  - 12.5 foot bench every 25 vertical feet
- Stacking of tailings and development rock material to be generally configured based on an approximate 50 ft internal offset from the interior edge of the perimeter road or the limit of the geomembrane liner.

5.2. VRP TSF Design Components

The VRP TSF consists of a perimeter road surrounding an internal geomembrane lined basin. The basin consists of a composite liner system consisting of either a LPSL or GCL overlain by a 60 mil double sided textured HDPE geomembrane. To protect the geomembrane, reduce head/hydraulic gradient on the liner and to facilitate long-term drainage of the dry stack, a granular protective layer is installed over the geomembrane and augmented by a dendritic CPe pipe network placed in topographic lows. The pipe network, referred to as the underdrain collection system, conveys flow to the Trench Camp Underdrain Collection Pond.

Reference the APP BADCT Design Report (NewFields, 2017) and the VRP TSF Interim Record of Construction Report (NewFields, 2020) for detailed information regarding the design as well as the constructed features of the existing VRP project. In summary, the VRP TSF consists of the following elements:

- Perimeter Road
  - Foundation preparation and removal of all low strength and/or deleterious material
  - Constructed from cut/fill operations with upstream (internal) slopes of 2.5H:1V and downstream (external) slopes of 2.0H:1V in fill conditions and 1.5H:1V in cut conditions
  - TSF perimeter road has 1.5 ft high safety berms, wearing course and stormwater diversion channels as required (light vehicle access only)
  - Composite lined interior face of the TSF perimeter road consisting of 60 mil HDPE geomembrane placed over a 12 inch thick LPSL (with a friction layer) or GCL
- Basin
  - Foundation preparation and removal of low strength and/or deleterious material
  - Composite lined system consisting of 60 mil HDPE geomembrane overlying either 12 inches of LPSL (with a friction layer) or GCL
  - 18 inches of PL material with drainage pipe augmentation over the geomembrane liner (not complete)
  - Underdrain system consisting of principal CPe pipe underdrain collectors in topographic lows and a dendritic system of 4 inch diameter collector CPe pipe peripheral to the primary collectors (not complete)
- Tailings Stack
  - 3.0H:1V compound slope comprised of 25 ft high 2.5H:1V open slopes in combination with a 12.5 ft benches to be placed at 25 ft vertical intervals
  - Internal stormwater diversion channel to pass the 100-yr/24-hr storm event with a minimum of 2 ft of freeboard
  - Internal detention ponds with detention outfall pipes to pass the 100-yr/24-hr storm event with a minimum of 2 ft of freeboard

- Rock armored exterior to minimize water and wind erosion of the dry stack TSF

- Instrumentation
  - Piezometers to monitor performance
- Stormwater Management
  - External stormwater diversion channels located upstream and along the periphery of the TSF to collect and transmit runoff from meteoric storm events around the TSF to an outfall downstream of the TSF
  - External stormwater diversion channel to pass 100-yr/24-hr storm event with 1 ft of freeboard

5.3. VRP TSF Construction (Remaining Construction to be Completed in Accordance with Approved APP No. P-512235)

As cited above, the VRP construction was not completed to design geometry due to the pause in advancement of the Exploration Declines. However, the following elements have been approved for construction and will be installed in accordance with the State of Arizona APP No. P-512235 after the re-start of the Exploration Decline construction activities:

- Protective layer – approximately 16,000 yards
  - Reference Drawings A110 (plan) and A210 (sections/details)
  - Reference Appendix G for placement criteria in the earthwork Technical Specifications.
- Drainage aggregate – approximately 700 yards
  - Reference Drawings A110 (plan) and A210 (sections/details)
  - Reference Appendix G for placement criteria in the earthwork Technical Specifications.
- Underdrain collection piping – Approximately 4,300 ft of 4-inch and 450 ft of 8-inch perforated CPe pipe
  - Reference Drawings A110 (plan) and A210 (sections/details)
  - Reference Appendix G for placement criteria in the CPeP Technical Specifications.
- 10 oz/yd^2 non-woven geotextile – Approximately 45,000 square feet
  - Reference Drawings A110 (plan) and A210 (sections/details)
  - Reference Appendix G for placement criteria in the geotextile Technical Specifications.

5.4. VRP TSF Basin

5.4.1. Liner System

It should be noted that the basin liner system that was constructed for the VRP TSF will not require alteration for the proposed TSF Amended Design. The TSF Amended Design will reside entirely within the existing liner footprint. The basin liner system is a composite liner, containing either a soil liner LPSL with friction layer (or GCL) overlain by a geomembrane liner (60 mil double sided textured HDPE). The soil component, 12 inches of low permeability soil, has a coefficient of permeability that is less than or equal to 1.0 x 10^{-6} cm/sec. The LPSL was placed, moisture conditioned and compacted to produce a smooth, unyielding surface prior to geomembrane liner deployment. To enhance the stability of the composite liner system where LPSL is used, a friction layer consisting of a ⅛ to ¼ inch thick layer of finely crushed aggregate was cast over the compacted LPSL. The friction layer was smooth drum rolled into the LPSL surface to enhance the interface friction value at the contact between the geomembrane and LPSL. The geomembrane was placed directly on top of the friction layer. A GCL (Cetco Bentomat DN9) was accepted as an alternative to the 12-inch LPSL but geotechnical considerations prevented its use throughout the entire facility. For additional information regarding the placement of LPSL and GCL refer to the TSF Interim ROC Report (NewFields, 2020).

The geomembrane liner component overlies the LPSL/GCL component of the composite liner system and consists of a double sided textured 60 mil HDPE geomembrane. The geomembrane was anchored on the edge of the perimeter road at a setback of 3 ft from the upstream hinge point of the perimeter road crest. The liner anchor trench is continuous with dimensions of 3 ft deep by 2 ft wide. The as-built liner limit is presented on Drawing A100 and the as-built liner sections and details are presented in the TSF Interim ROC Report (NewFields, 2020). All geomembrane has been installed for the VRP TSF and no additional geomembrane installation is planned as part of the amended design.

Using the inputs in Table 5.1, the leakage flow rate was re-calculated based on the as-built area of deployed geomembrane. For further details, see the leakage rate calculation presented in Appendix E.1.

TABLE 5.1 – TSF LEAKAGE FLOW RATE

Location	TSF Amended Design
Number of Defects	2 per acre
Contact Quality Factor	0.21
Area of Circular Defect	1.08E-3 ft^2 (1 cm^2)
Hydraulic Head Above Geomembrane	1.5 ft
Area of Geomembrane	1,238,580 ft^2
Permeability of Underlying Soil Layer	3.28E-8 ft/sec min (1.0E-6 cm/s min)
Leakage Rate	0.0448 gpm

5.4.2. Protective Layer (PL)

There are no proposed changes to the protective layer (PL) design from what is currently permitted. The composite liner system with an overlying PL component is designed to protect the geomembrane and convey any seepage through the base of the TSF to the underdrain collection system. The PL will serve to prevent damage to the geomembrane during material placement and to act as a drainage layer to reduce head or hydraulic gradient on the geomembrane by collecting and transmitting tailings seepage to the underdrain collection system. An 18 inch thick PL zone composed of 1½ inch minus granular material was placed over the geomembrane to the extents shown on Drawing A100. For additional as-built information regarding the PL placement refer to the TSF Interim ROC Report (NewFields, 2020). The remainder of the PL for the VRP TSF will be placed in accordance with APP No. P-512235 in concert with the stacking. Typical TSF PL sections and details are presented on Drawing A210 and placement criteria is presented in the earthwork Technical Specifications.

5.4.3. Underdrain Collection System

There are no proposed changes to the underdrain collection system design from what is currently permitted. The underdrain collection system, consisting of a series of pipes located in topographic lows, was installed at the base of the facility to collect and convey flow to the Underdrain Collection Pond via concrete encased underdrain outlet pipes. The underdrain pipe system augments the performance of the PL and reduces hydraulic head over the liner. The underdrain collection pipes are perforated CPe pipe surrounded by drainage aggregate and wrapped in non-woven needle punched geotextile. The pipes and drainage aggregate wrapped in non-woven geotextile are designed to enhance drainage and increase flow transference from beneath the TSF. In addition, the geotextile wrap will minimize migration of the tailings material into the underdrain system.

The piping is designed to limit hydraulic head on the liner to a height less than the values specified in the BADCT Guidance Document (Part 2.5.2.4). For additional design information, refer to the APP BADCT Design Report (NewFields, 2017). As-built pipe alignments and pipe sizes for the underdrain collection system can be referenced on Drawing A110. For additional as-built information regarding the underdrain collection system installation refer to the TSF Interim ROC Report (NewFields, 2020).

The remainder of the underdrain collection system for the VRP TSF will be placed in accordance with APP No. P-512235 in concert with the stacking. Typical TSF underdrain collection system sections and details are presented on Drawing A210 for the remaining construction and placement criteria is presented in the piping, geotextile and earthwork Technical Specifications.

5.4.4. TSF Basin Underdrain Outlet

There are no proposed changes to the underdrain outlet from what was constructed during the VRP project. The underdrain outlet for the VRP TSF was constructed as part of the initial relocation of historic tailings onto the lined VRP TSF. At the underdrain inlet (upstream toe of the perimeter road), the perforated underdrain collection pipes transition to solid reinforced concrete encased HDPE pipe. The geomembrane liner at the upstream embankment face is attached to the concrete encasement by heat fusing the liner to an HDPE embedment placed in the concrete pipe encasement. The concrete encased outlet pipe is routed under the perimeter road where it transitions to a geomembrane lined pipe corridor to provide double containment of contact water between the end of the concrete encasement and the Underdrain Collection Pond.

5.5. Underdrain Collection Pond Design

There are no proposed changes to the Underdrain Collection Pond from what was constructed during the VRP project. The Underdrain Collection Pond was constructed downstream of the VRP TSF during initial construction. Specific information about the Underdrain Collection Pond design can be referenced in Section 5.6 of the APP BADCT Design Report (NewFields, 2017) and information about the Underdrain Collection Pond construction can be referenced in the TSF Interim ROC Report (NewFields, 2020). In summary, the Underdrain Collection Pond was constructed with the following design components:

- 25 ft wide perimeter access road around crest with 50 ft wide access to the LRCS and pumpback system

- 1.5H:1V daylight rock cut slope around the pond
- 2.0H:1V maximum daylight fill slope around the pond (flatter in most areas)
- 2.0H:1V internal pond slope
- Pond bottom graded at 1.0% minimum to pond sump
- Liner system consisting of geonet sited between two 60 mil HDPE double sided textured geomembrane layers overlying a GCL
- Dual sloping decant structures each housing a submersible pump for water extraction (120 gpm to the Water Treatment Plant)
- LCRS for recovery of seepage flows in the unlikely event of primary liner leakage (it should be noted that the LCRS has not recorded any seepage flows through the primary liner to date)
- Emergency spillway

The Underdrain Collection Pond was sized to store the following:

- 100-yr/24-hr storm event runoff from the TSF
- 100-yr/24-hr direct precipitation over the pond area
- Drain down from the TSF
  - Given the tailings were placed as a compacted earthen material, at water contents significantly below saturation, minimal seepage water is expected at the base of the dry stack tailings material. Tailings were disked to promote drying and to achieve target placement moisture content. The well-compacted tailings material placed near optimum moisture content generally produced hydraulic conductivities less than 1×10^{-6} cm/sec. The tailings mass as a whole will be unsaturated. Some fluids may be generated at the base of the facility from consolidation of the tailings over time and percolation of direct precipitation through the tailing mass, but it is expected to be minimal.
- Minimum of 5 feet of total freeboard and/or the IDF (1/4 PMF) maximum water depth above the spillway invert crest plus 3 feet, whichever is greatest
- Minimum of 2 feet of freeboard from the spillway invert to contain the 100-yr/24-hr storm event, 100-yr/24-hr direct precipitation over the pond area and the maximum operational volume
- Spillway designed to safely pass the routed 1/4 PMF inflow design storm (IDF) while maintaining a 3 ft freeboard requirement above the maximum water level in the spillway

The Underdrain Collection Pond is designed to remain functional with the TSF Amended Design. This is because the expansion does not increase the watershed area reporting to the Underdrain Collection Pond. It only changes the material properties of the watershed. Detailed information regarding the modeling of the stormwater management within the TSF and Underdrain Collection Pond is presented in Section 8 (water balance) and Section 9 (stormwater management). See Table 5.2 for the Underdrain Collection Pond as-built storage capacities and required TSF Amended Design storm storage capacity.

TABLE 5.2 – UNDERDRAIN COLLECTION POND STORAGE CAPACITY

Underdrain Collection Pond Elevation (ft amsl)	Storage Capacity (gallons)
Pond Crest Elevation (4,965.06’)	12.6 M
Spillway Invert (4,960.06’)	9.9 M
Freeboard Elevation (4,958’)	8.9 M
100 yr / 24 hr Storm Event (4939.7’)	2.7 M

The Underdrain Collection Pond employs a spillway designed to safely pass flows resulting from the routed IDF (1/4 PMF) while maintaining a minimum 3 ft of freeboard in the spillway assuming the pond is full to the spillway invert. The spillway geometry does not need to be adjusted to account for the TSF Amended Design. For the Underdrain Collection Pond spillway calculations refer to Appendix E.2.

5.6. TSF Horizontal Drain

Prior to placement of additional material on the interim VRP TSF footprint, the current or interim tailings surface will be graded to drain at a minimum of 3% from the center on the tailings mass down toward the existing underdrain. In order to augment drainage, horizontal drains will be installed at the interface between the reclaimed historic tailings surface and the exploration decline development rock. The horizontal drains will consist of 4-inch diameter perforated CPe pipes surrounded by free draining gravel (drainage aggregate) which is encapsulated by a 10 oz/yd^2 non-woven geotextile. The horizontal drains will daylight into the existing underdrain collection system. The combination of the sloped historic tailings surface and TSF horizontal drains will promote drainage of meteoric water, which infiltrates through the development rock, into the existing underdrain system. By collecting and conveying infiltration water reporting to the horizontal drain system to the underdrain system, the existing compacted historic tailings mass will remain unsaturated.

5.7. Rock Armoring

As the TSF Amended Design progresses, rock armoring will be placed on the exterior slopes of the dry stack TSF in an identical manner to the rock armoring placed on the existing VRP TSF. The rock armoring materials will consist of exploration decline development rock or other suitable material. Typical sections of the rock armor can be referenced on Drawings A200 and A220. This material will be initially placed as rock berms that are approximately 5 ft high around the perimeter of the dry stack as material is placed in the TSF. As the stacking reaches the top of a given rock berm, a new 5 ft high berm will be placed around the perimeter of the dry stack and the new berm will coalesce with the rock berm beneath it in a manner that produces a continuous external rock face. The rock armor will reduce the potential for wind and water erosion. Additionally, the rock armoring will act as a capillary break between the dry stack and growth media placed at closure.

For information regarding the rock armoring placement to date refer to the TSF Interim ROC Report (NewFields, 2020).

5.8. Instrumentation and Facility Performance Monitoring

There are no proposed changes to the instrumentation from what was constructed during the VRP project. Instrumentation installed in TSF included four piezometers to measure hydraulic head on the liner system. The piezometers were installed on the geomembrane surface in the PL adjacent to an underdrain collection pipe. Piezometers and settlement monuments were also installed in the Underdrain Collection Pond embankment. As-built instrument locations along with details of the instrument installation can be referenced in the TSF Interim ROC Report (NewFields, 2020). It should be noted that all instrumentation is functioning and performing as designed. No additional instrumentation is required as part of the TSF Amended Design.

5.9. Exploration Decline Development Rock (Permitted Material)

Exploration decline development rock determined to be PAG will be hauled and placed in the TSF as a compacted standard earthen fill placement operation. This approach to placement is paramount to the long-term stability of the TSF and to the storage capacity cited in this design. Due to the unknown gradation of the exploration decline development rock and a potential for variation during the construction of the Exploration Declines, the placement procedures outlined in the Technical Specifications address a wide range of material. It is anticipated that the exploration decline development rock will generally be a 12-inch minus rock fill (with varying ranges of oversize material) containing trace amounts of sands and fine grain soil material.

The following range of development rock quantity is expected from the Exploration Declines:

- Lower bound: 825,092 tons (488,943 cubic yards at 125 pcf)
  - Adequate storage capacity exists in the current approved VRP TSF geometry to hold the lower bound development rock quantity (~506,000 cubic yard storage capacity remains).
- Upper bound: 1,572,906 tons (932,092 cubic yards at 125 pcf)
  - Adequate storage capacity does not exist in the current approved VRP TSF geometry to hold the upper bound development rock quantity.

Detailed placement criteria for the exploration decline development rock can be referenced in the Technical Specifications presented in Appendix G. AMI desires to expand the TSF beyond the currently permitted height to accommodate the upper bound (largest) development rock quantity currently estimated.

5.10. Construction Cut (Permitted Material)

PAG material from construction activities will be hauled and placed in the TSF as a compacted standard earthen fill placement operation. This approach to placement is paramount to the long-term stability of the TSF and to the storage capacity cited in this design. The construction cut may be generated as a result of various construction projects performed on site. Due to a fairly similar lithology across the property, the material properties for the construction cut material are assumed to be similar to the properties of the engineered fill which was placed during cut to fill operations during VRP TSF construction. The construction cut material is anticipated to be mainly a poorly graded gravel (GP) or clayey gravel (GC) which is 8-inch minus, averaging ~10% passing the no. 200 sieve with a low to medium plasticity. The design accounts for a minimum of 385,000 cubic yards of PAG construction cut material. More space is available for PAG construction cut material depending on the quantity of development rock created from the Exploration Declines.

Detailed placement criteria for the construction cut material can be referenced in the Technical Specifications presented in Appendix G.

5.11. WTP1 Filter Cake (Permitted Material)

WTP1 filter cake is anticipated to be hauled and placed in the TSF at a rate of approximately 3,650 cubic yards per year (10 yards per day). It will be hauled to the TSF in approximately 20 cubic yard increments. The anticipated material properties are as follows based on a control sample obtained November 2019:

- 100 percent passing (by dry weight) the no. 200 sieve.
- Non-plastic soil.
- Moisture content was 363% (based on dry weight of solids) upon arrival to the TSF.

Upon placement in the TSF, the WTP filter cake will be spread and dried to reduce the material moisture content. The filter cake will then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (filter cake). After mixing, the material will be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. The WTP1 filter cake placement is geometrically constrained within the TSF footprint as shown on Drawing A130 (plan view) and Drawings A230 through A250 (sections). Detailed placement criteria for the filter cake material can be referenced in the Technical Specifications presented in Appendix G.

5.12. WTP2 Filter Cake (New Material)

WTP2 filter cake is anticipated to be hauled and placed in the TSF at a rate of approximately 4,380 cubic yards per year from the stage one filter press and approximately 146 cubic yards per year from the stage two filter press for an aggregate total of approximately 4,526 cubic yards per year. It will be hauled to the TSF in approximately 20 cubic yard increments. The WTP2 filter cake material properties are assumed to be similar in nature to the WTP1 filter cake and therefore the placement criteria outlined in the Technical Specifications will be the same for both filter cake products.

5.13. Core Cutting Material (Permitted Material)

The core cutting material that is generated from trimming rock core samples for metallurgical testing is anticipated to be hauled and placed in the TSF at a rate of approximately 12 cubic yards per year. It will be hauled to the TSF in 55 gallon drums. The anticipated material properties are as follows based on a control sample obtained January 2019:

- Particle Size Distribution (by dry weight)
  - 100 percent passing the 1-inch sieve
  - 76.1 percent passing the no. 4 sieve
  - 72.3 percent passing the no. 10 sieve
  - 68.8 percent passing the no. 40 sieve
  - 64.4 percent passing the no. 200 sieve
- Material will be saturated upon arrival to the TSF.

Upon placement in the TSF, the core cutting material will be spread and dried to reduce the material moisture content. The core cutting material will then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (core cutting material). After mixing, the material will be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. The core cutting material will be placed within the WTP filter cake zone specified on Drawing A130. Detailed placement criteria for the core cutting material can be referenced in the Technical Specifications presented in Appendix G.

5.14. Drill Cuttings (New Material)

The drill cutting material that is generated from exploration activities is anticipated to be hauled and placed in the TSF at a rate of less than 1 cubic yard per year. Upon placement in the TSF, the drill cutting material will be spread and dried to reduce the material moisture content. The drill cutting material will then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (drill cutting material). After mixing, the material will be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. The drill cutting material will be placed within the WTP filter cake zone specified on Drawing A130. Detailed placement criteria for the drill cutting material can be referenced in the Technical Specifications presented in Appendix G.

5.15. Sediments from Stormwater BMPs (New Material)

The sediments generated from site stormwater BMPs is anticipated to be hauled and placed in the TSF at a rate of approximately 1,800 cubic yards per year. The material is assumed to be a CL or ML. Upon placement in the TSF, the sediments will be spread and dried to reduce the material moisture content. The sediments will then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (sediment). After mixing, the material will be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. The sediments will be placed within the WTP filter cake zone specified on Drawing A130. Detailed placement criteria for the sediments can be referenced in the Technical Specifications presented in Appendix G.

6. CONSTRUCTION MATERIALS

6.1. Engineered Fill

Engineered fill materials will be generated from cut to fill grading activities or borrowed from other material stockpile locations. The fill will consist primarily of fractured rock and near surface overburden soil after removal of any growth media and/or deleterious materials. Engineered fill materials (generated from cut to fill) are expected to be generated as a result of ripping with a dozer (up to approximately 25 ft in depth). Significant variability in engineered fill should be expected due to varying degrees of fracturing and weathering. However, it should be noted that the majority of the near surface soils will be acceptable as engineered fill. Engineered fill will be placed, compacted and tested in accordance with the requirements outlined in the Technical Specifications (Appendix G).

6.2. Low Permeability Soil Layer (LPSL)

LPSL material is not required to construct the TSF Amended Design but would be required as part of closure of the TSF. The LPSL will consist of predominantly fine-grained soils with a coefficient of permeability (k_v) less than or equal to 1 x 10^{-6} cm/sec. The LPSL will be placed in 6 inch lifts, moisture conditioned and compacted to produce a smooth, unyielding surface. Any rocks protruding from the finished LPSL will be removed through hand picking and the voids will be filled with replacement fine grained low permeability material and recompacted. The material will be placed, compacted, and tested in accordance with the requirements outlined in the Technical Specifications (Appendix G).

Although LPSL borrow sites were identified on the Trench Camp property through various geotechnical investigations, each was developed and utilized in the VRP TSF construction. As part of the closure construction, the LPSL material will now be imported from off-site sources or created through a screening and bentonite amendment operation. Processing various material stockpiles and bentonite amending the processed material proved to be an effective method for creating LPSL during the VRP TSF construction.

6.3. Protective Layer / Drainage Layer

The remaining protective / drainage layer (PL) material will be placed in accordance with the approved APP No. P-512235. The current and final limits of the PL can be referenced on Drawing A110. The PL will consist of 1½ inch minus granular material with less than 10% passing the No. 200 sieve. The PL material will be placed directly on the geomembrane liner at a minimum thickness of 18-inches. Due to the relatively low quantity of remaining PL to finish the VRP TSF construction, it is assumed the remaining PL will be imported. This material will be placed and tested in accordance with the requirements outlined in the Technical Specifications (Appendix G).

6.4. Drainage Aggregate

The remaining drainage aggregate (DA) material for the underdrain collection system will be placed in accordance with the approved APP No. P-512235. The current and final limits of the underdrain collection system can be referenced on Drawing A110. DA will also be placed in the TSF horizontal drains that are sited between the interface of the reclaimed historic tailings and the TSF Amended Design stacking. The TSF horizontal drains can be referenced in plan view on Drawing A110. Due to the relative low quantity of DA required to complete the construction, it is assumed the remaining DA will be imported. Requirements for the DA material can be referenced in the Technical Specifications (Appendix G). Placement geometry of the DA can be referenced on Drawing A210 for both the underdrain collection system and horizontal drains.

6.5. Road Wearing Course

Road Wearing Course will be processed from an acceptable on-site borrow or a local import source. Requirements for the road wearing course material can be referenced in the Technical Specifications (Appendix G). Placement geometry of the road wearing course can be referenced on Drawings A150 and A200.

6.6. Pipe Bedding

Pipe bedding is not required to construct the TSF Amended Design but would be required as part of closure of the TSF. Pipe bedding will be placed to the springline around the base of culverts shown in Drawing A550 and densified in accordance with the requirements outlined in the Technical Specifications (Appendix G). This material can be generated from a local borrow or imported C - 33 concrete sand.

6.7. Pipe Backfill

Pipe backfill is not required to construct the TSF Amended Design but would be required as part of closure of the TSF. Pipe backfill will be placed after the pipe bedding, in accordance with the requirements outlined in the Technical Specifications (Appendix G). This material can consist of on-site native sand or sand and gravel with a maximum particle size of 3 inches. Placement geometry of the pipe backfill can be referenced on Drawing A550. This material can be sourced from an on-site borrow located on the Trench Camp Property.

6.1. Riprap

Riprap is not required to construct the TSF Amended Design but would be required as part of closure of the TSF. Riprap will be processed from an acceptable on-site borrow or a local import source. Requirements for the riprap material can be referenced in the Technical Specifications (Appendix G). Placement geometry of the riprap can be referenced on Drawings A510 and A550.

6.2. Rock Armor

The rock armor material will consist of exploration decline development rock or suitable construction cut material. Typical sections of the rock armor can be referenced on Drawings A200 and A220. This material will be initially placed as rock berms that are approximately 5 ft high around the perimeter of the dry stack as material is placed in the TSF. As the stacking reaches the top of a given rock berm, a new 5 ft high berm will be placed around the perimeter of the dry stack and the new berm will coalesce with the rock berm beneath it in a manner that produces a continuous external rock face. The rock armor will reduce the potential for wind and water erosion. Additionally, the rock armoring will act as a capillary break between the dry stack and growth media placed at closure. Requirements for rock armor can be referenced in the Technical Specifications (Appendix G).

6.3. Geosynthetics

6.3.1. HDPE Geomembrane

All geomembrane has been installed as part of the VRP project. No new geomembrane installation is required for the TSF Amended Design. Agru 60 mil double sided textured microspike geomembrane was utilized during the construction of the VRP project.

6.3.2. Geotextile

Non-woven geotextile will be installed around the drainage aggregate which encapsulates the underdrain collection pipes in the TSF basin as well as the TSF horizontal drains. Non-woven geotextile will also be utilized for material separation during closure in the stormwater diversion channels. The geotextile is a 10 oz/yd^2 non-woven needle punched fabric conforming to the requirements summarized in the Technical Specifications (Appendix G). Typical sections for geotextile can be referenced on Drawing A210 (underdrain collection system and TSF horizontal drains) and Drawings A510 and A550 (closure).

6.3.3. Geosynthetic Clay Liner

All GCL has been installed as part of the VRP project. No new GCL installation is required for the TSF Amended Design. Cetco Bentomat DN-9 (15 lb peel) was utilized for the construction of the VRP TSF and Agru GeoClay N66 GCL was utilized for the construction of the Underdrain Collection Pond.

7. GEOTECHNICAL EVALUATION

A geotechnical evaluation was completed to model the TSF Amended Design using engineering characteristics of the existing facility and candidate construction materials. These materials properties were generated as part of the on-site geotechnical investigations and construction quality assurance testing performed as part of the VRP project. As cited previously, the majority of the laboratory testing was completed at the NewFields Geotechnical Laboratory in Elko, Nevada during the geotechnical investigations and at a NewFields field laboratory during construction. Other specialty testing such as triaxial shear strength and interface friction testing was performed by subcontractors. The material strength characteristics were used to complete both static and pseudostatic slope stability analyses for critical sections of the TSF Amended Design.

7.1. Stability Evaluation

Stability analyses for the TSF was performed using the computer program Slide 7 by RocScience. Slide is a two-dimensional slope stability program for evaluating circular or noncircular failure surfaces in soil or rock slopes using limit equilibrium methods. Spencer's method of slope stability analysis is the approach used within the stability model and assumes all interslice forces are parallel and have the same inclination. The factor of safety can be defined as the resisting forces along a potential failure plane divided by the gravitational and dynamic driving forces. Factors of safety in excess of 1.0 indicate stability.

Minimum acceptable factors of safety for static and pseudostatic conditions are established as 1.3 and 1.0, respectively for the TSF Amended Design.

7.2. Design Ground Motions

To assess the stability of slopes during seismic loadings, pseudostatic analyses were completed. These analyses apply an additional destabilizing horizontal force to the sliding mass that represents the effects of earthquake motions and is related to the Peak Ground Acceleration (PGA) from expected seismic loading at the site. Simply stated, the seismic force is the weight of the sliding mass multiplied by a horizontal pseudostatic earthquake coefficient (k_h).

The k_h value is typically considered as a portion of the PGA due to the fact that during an earthquake the acceleration within the potential sliding mass is cyclic and varies over the duration of the earthquake. Therefore, an average horizontal coefficient is assigned that is typically less than the PGA experienced at the base of the structure. Hynes-Griffin and Franklin (1984) identified one-half of the PGA as an appropriate value to model the average condition for the horizontal pseudostatic earthquake coefficient. This will accurately model expected long term deformation in earthen structures and its continued use was recommended by Kramer (1996).

These analyses have adopted this convention so based on the PGA determined in the SHA completed for the project (see Section 2.5 and Appendix C), the k_h for these analyses is selected as 0.055 g, which is one-half of the PGA (0.11g) associated with the MCE.

7.2.1. Stability Model Development

The stability of the TSF Amended Design was evaluated for the sections presented on Figure 1 in Appendix F. Four sections were selected as representing the most critical sections for evaluation of the TSF Amended Design. Critical sections were selected at locations and orientations based on the following criteria:

- Maximum tailings stacking height to model the maximum load of the facility.
- Perpendicular to tailings stacking contours to capture the steepest tailings slope.
- At locations where the TSF basin base grades slope towards the facility toe which increases driving forces along the composite liner interface placed in the TSF basin.

Each of the four stability sections are briefly described below.

- Section A – TSF Amended Design configuration through the TSF embankment on the north side of facility where base grades slope toward facility toe
- Section B - TSF Amended Design configuration on the southeast side of the facility through the existing External Detention Pond
- Section C – TSF Amended Design configuration through the TSF embankment on the north side of facility where the embankment is smallest and there is the most basin GCL area
- Section D – TSF Amended Design configuration through the TSF embankment on the west side of facility

The TSF embankment geometry was modeled using the as-built surface created as part of the VRP TSF construction. The TSF embankment generally consists of a 2.5H:1V upstream slope and a 2.0H:1V downstream slope with a crest elevation of approximately 5,040 feet amsl. In the critical geotechnical sections evaluated for the TSF Amended Design, historic tailings stacked within the TSF are modeled from aerial topography data and have a maximum stacking elevation of approximately 5,108 ft amsl. Future exploration decline development rock, construction cut, WTP1 filter cake, WTP2 filter cake, core and drill cutting material and sediment from stormwater

BMPs are modeled on top of the remediated tailings at a 3.0H:1V compound slope to a maximum elevation of 5,175 ft amsl.

The TSF basin was modeled using the as-built surface for the geomembrane liner and the limits of the composite liner system composed of HDPE geomembrane underlain by either LPSL (with friction layer) or GCL. It is important to make a limit distinction between the soil–geosynthetic and geosynthetic–geosynthetic interfaces because the two composite liner systems have different strength parameters. A piezometric surface was applied approximately 1.5 feet above the liner to simulate what is considered to be a worst case condition (PL fully saturated) within the dry stack TSF. Natural groundwater was not considered in the stability evaluations as groundwater levels within the site were not observed during geotechnical field investigations.

7.2.2. Material Properties

Material properties utilized in the stability assessment are based on the results of the subsurface exploration, laboratory test results, and NewFields' familiarity with similar materials and applications. The material properties are summarized in the following paragraphs and in Table 7.1.

Reclaimed (Historic) Tailings: The reclaimed tailings strength is modeled with a phi angle of 28 degrees. This value is based on index, direct shear, triaxial and compaction testing of material obtained from historic Tailings Piles 1, 2, 3 and 4 during the previous geotechnical investigations and during construction. Results of remolded tailings strength testing can be referenced in Appendix D.

HDPE/LPSL Interface (with Friction Layer): The HDPE/LPSL composite liner system interface was assigned a friction angle of 20 degrees. This value is based on soil-liner interface shear testing completed on the installed liner type, LPSL borrow and placed material, and a Friction Layer composed of finely crushed rock placed between the geomembrane and LPSL. This Friction Layer was used in the analysis to increase shearing resistance or frictional resistance to sliding, at the interface between the geomembrane and the LPSL. All LPSL placed in the VRP project was installed with a Friction Layer. Results of the interface shear strength testing can be referenced in Appendix D.4.

HDPE/GCL Interface: The interface frictional value of the composite liner system of HDPE geomembrane / GCL was assigned a friction angle of 11 degrees. This value is based on published data by CETCO (2009) that indicates the shear strength of HDPE/GCL interface ranges between peak values (low strain) of 15 and 25 degrees and residual values (large strain) between 8 and 12 degrees for both interface and internal strength. The HDPE is textured, which laboratory testing indicates increased interface friction values between the geomembrane and the GCL. Also, higher shear resistance values are reported for GCL products with greater peel strengths (ASTM D6496), such as the GCL utilized in construction (15 lb peel). A friction angle of 11 degrees is considered a conservative design value, as this assumes that significant strain has occurred in the TSF to reduce the frictional strength to a residual value. This value was confirmed by liner interface shear testing completed on the installed geomembrane and GCL products. Results of the interface shear strength testing can be referenced in Appendix D.4.

Engineered Fill: Strength properties for engineered fill were determined based on direct shear test results of the borrow sources and in place materials. A friction angle of 32 degrees was assigned to the material. This value is conservative given that the majority of the engineered fill will be generated from native fractured rock. It is NewFields opinion that this value represents a lower bound value for engineered fill at the site. Engineered fill control and record samples compacted to the Technical Specifications during the VRP TSF construction project produced measured shear strength test results of 32.2, 37.8 and 39.3. As result, it is our opinion that the value of 32 degrees used in the slope stability analysis is conservative. Results of the remolded engineered fill strength testing can be referenced in Appendix D.

Foundation: The material properties used for the foundation beneath the TSF are assumed. Based on field observations during the geotechnical field investigation, a very thin veneer of generally granular soil overlying bedrock is typical of the entire area to be developed. A frictional strength of 38 degrees was assumed for foundation materials.

Exploration Decline Development Rock: The shear strength for the exploration decline development rock was modeled using the lower bound Leps non-linear shear strength envelop. The low bound Leps shear strength envelop is representative of a poorly graded rock fill with low density and weak particles (Leps, 1970).

Exploration Decline Development Rock / Construction Cut: Strength properties for the zone of exploration decline development rock and/or construction cut are assumed. A friction angle of 34 degrees was assigned to this material zone.

WTP1/WTP2 Filter Cake Material (mixed with tailings, on-site construction cut material and/or exploration decline development rock): Strength properties of the filter cake materials were based on measured values derived from a consolidated undrained triaxial compression test performed on a 3:1 mixture (by volume) of reclaimed tailings and WTP1 filter cake, respectively. Reclaimed tailings were selected as the mixing material to define the lower bound strength of all the potential mixing scenarios. This is because mixing with a coarser material such as on-site construction cut material or exploration decline development rock would produce a higher strength. The WTP filter cake mixture was conservatively modeled with a phi angle of 26 degrees.

This value was derived from test results presented in Appendix D. Filter cake produced from the existing WTP1 is assumed to be similar to the filter cake which will be produced from WTP2 in the future.

Core Cutting Material (mixed with tailings, on-site construction cut material and/or exploration decline development rock): Strength properties of the core cutting material is assumed based on the measured values derived from the consolidated undrained triaxial compression test performed on the WTP1 filter cake mixture. An additional strength test was not performed for the core cutting material because the total quantity of core cutting material reporting to the TSF is nominal (12 cubic yards per year). Also, applying the WTP1 filter cake strength value is conservative because the material properties for the core cutting material are more favorable than the material properties of the WTP filter cake when evaluating material strength. The core cutting material mixture was modeled with a phi angle of 26 degrees and will be placed in the WTP1/WTP2 filter cake zone.

Drill Cutting Material (mixed with tailings, on-site construction cut material and/or exploration decline development rock): Strength properties of the drill cutting material is assumed based on the measured values derived from the consolidated undrained triaxial compression test performed on the WTP1 filter cake mixture. Additional testing was not performed for the drill cutting material because the total quantity of drill cutting material reporting to the TSF is nominal (less than 1 cubic yard per year). The core cutting material mixture was modeled with a phi angle of 26 degrees and will be placed in the WTP1/WTP2 filter cake zone.

Sediment from Stormwater BMPs (mixed with tailings, on-site construction cut material and/or exploration decline development rock): Strength properties of the sediment from stormwater BMPs is assumed based on the measured values derived from the consolidated undrained triaxial compression test performed on the WTP1 filter cake mixture. Additional testing was not performed for the sediments because the material properties for the sediments were assumed to be more favorable than the material properties of the WTP filter cake when evaluating material strength. The sediments from stormwater BMPs was modeled with a phi angle of 26 degrees and will be placed in the WTP1/WTP2 filter cake zone.

TABLE 7.1 - MATERIAL PROPERTIES USED IN THE STABILITY ANALYSES

Material	Moist Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)
Reclaimed Tailings	120	28	0
HDPE/LPSL Interface	135	20	0
HDPE/GCL Interface	120	11	0
Engineered Fill	120	32	0
Foundation	120	38	0
Exploration Decline Development Rock	120	Leps	
Exploration Decline Development Rock / Construction Cut	120	34	0
Filter Cake (WTP1 and WTP2) / Core Cutting / Drill Cutting / Sediment from Stormwater BMPs Material Mixture (3:1 ratio)	120	26	0

Note: Cohesion was assumed to be zero in all cases. This also adds a measure of additional conservatism to the analyses.

7.2.3. Stability Evaluation Results

Stability analysis results indicate the TSF will remain stable under both static and pseudostatic conditions. Factor of safety results are shown in Table 7.2 and Slide stability calculation sheets are included in Appendix F. The results document the minimum static and pseudostatic, factors of safety and the critical failure mode. In general, block failure surfaces were determined to be the most critical for the TSF.

TABLE 7.2 - CALCULATED MINIMUM FACTORS OF SAFETY

Section	Condition	Critical Failure Mode	Minimum Factor of Safety	
			Static	Pseudostatic
A	TSF Amended Design (north side), base grades slope toward toe	Block	1.6	1.3
B	TSF Amended Design (southeast side), through existing External Detention Pond	Block	1.6	1.3
C	TSF Amended Design (north side), GCL interface strength, smallest embankment	Block	1.5	1.2
D	TSF Amended Design (west side), flat base grades	Block	1.5	1.3

7.3. Settlement Evaluation

A settlement evaluation was performed for the VRP project to estimate potential settlement in the subgrade beneath the TSF. The estimated settlement is based on elastic theory and the results were used to verify that the geomembrane liner has adequate strain compatibility and that drainage and outlet structures underlying the embankment will not be subjected to excessive deflections. It was assumed that any compression of embankment fill materials will occur during construction and will not influence the long-term performance of the facility. Results from the geotechnical investigations were used to develop a generalized subsurface stratigraphy and to identify appropriate compressibility parameters for the materials. The estimated maximum potential settlements beneath the TSF embankments are approximately 1 inch underneath the crest of the maximum embankment section. Less settlement is expected underneath the smaller embankment sections where fill volumes are reduced. This magnitude of potential settlement holds true for the TSF Amended Design. Small settlements expected will not compromise the liner system and/or the ability for the TSF to function as designed.

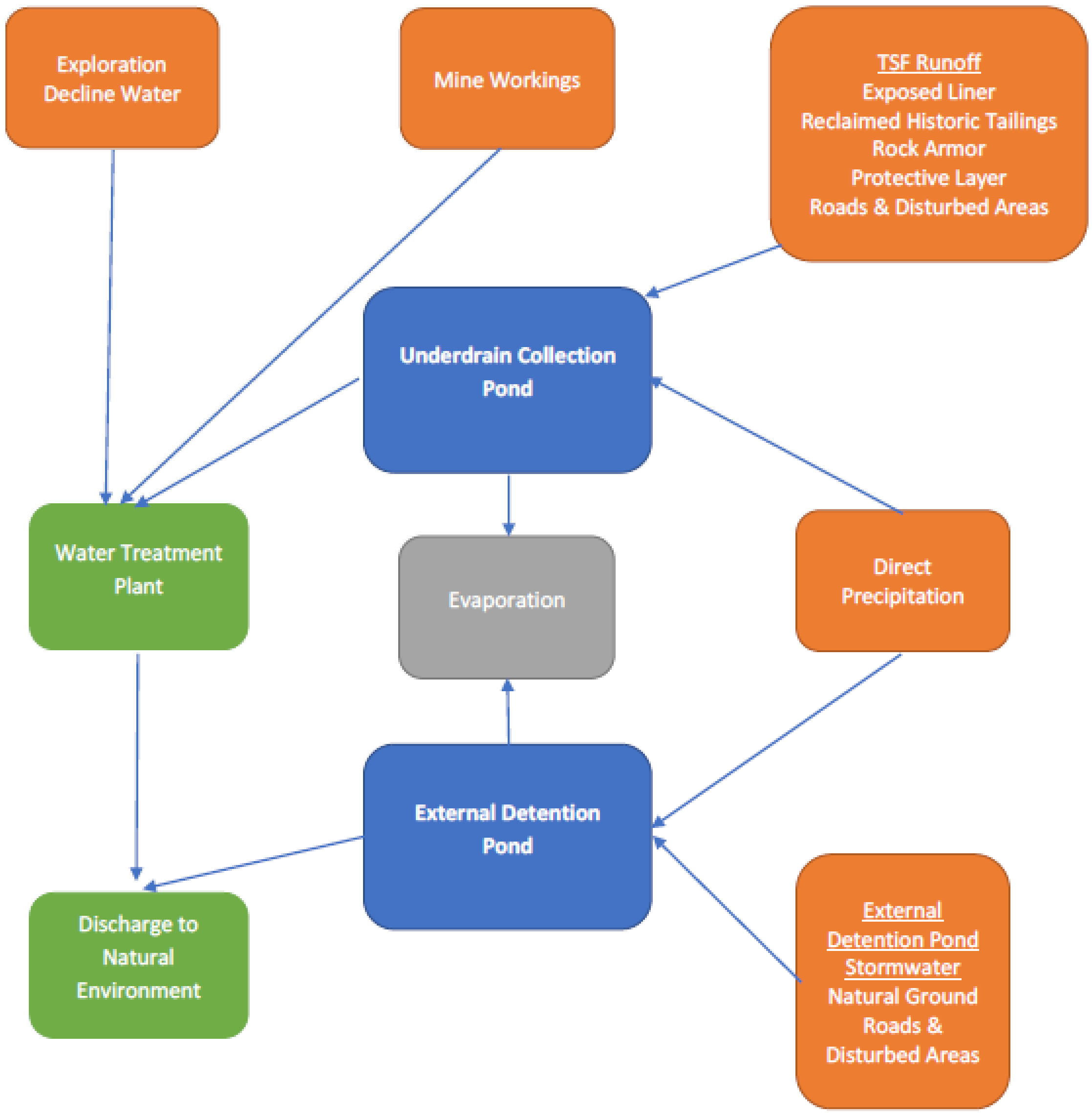
8. WATER BALANCE (ERC)

An update to the water balance was completed by Ecological Resource Consultants, Inc. (ERC) using a standard interactive spreadsheet approach to modeling the contact and non-contact water regime at the Trench Camp site. The focus of the water balance was to confirm the existing WTP1, Underdrain Collection Pond and External Detention Pond are adequately sized. The water balance considers the current interim TSF geometry and final geometry for the TSF Amended Design. The model was developed using a daily time-step and includes meteoric inputs/outputs (precipitation and evaporation) as these parameters can have a significant impact on Underdrain Collection Pond and External Detention Pond. In addition, the model includes inflow from the historic underground works (referred to as the January Adit), inflow from the Exploration Decline and outflows to WTP1.

Modeling and management of two principal categories of water, contact and non-contact, were addressed as part of the water balance. Contact water is defined as any water that comes in contact with the TSF, Underdrain Collection Pond, water from the historic underground works and dewatering water from the Exploration Decline. Non-contact water, pre-closure, is defined as the meteoric water that falls outside of the TSF footprint that can be safely captured in the External Detention Pond and diverted around the TSF through pumping. Post-closure non-contact water is defined as non-contact stormwater falling on the watershed upstream of the TSF and direct precipitation on the closure cap that does not come in direct contact with the stacking. Non-contact stormwater will bypass the Underdrain Collection Pond and will be directed to the natural environment downstream of the Underdrain Collection Pond.

ERC’s analysis utilized historic site precipitation data (2008 – 2019) and the BADCT prescriptive design storm (100-yr/24-hr event) as shown in Appendix H. A flow diagram showing the inputs and outputs is presented in Figure 8.1.

FIGURE 8.1 WATER BALANCE MODEL SCHEMATIC



8.1. Model Development

The water balance incorporates water inputs into the TSF system based on the current interim VRP TSF geometry as well as the TSF Amended Design modifications. It is important to note that the TSF, Underdrain Collection Pond, External Detention Pond and upstream watershed areas remain unchanged throughout both scenarios. The only modifications are to the material specific properties within each watershed which occurs during stacking.

Inputs to the Underdrain Collection Pond include direct precipitation on the Underdrain Collection Pond as well as meteoric runoff from the TSF. Water losses from the Underdrain

Collection Pond include evaporation and pumping to the WTP1. Inputs to the External Detention Pond include direct precipitation on the External Detention Pond as well as meteoric runoff upgradient of the TSF (non-contact water). Water losses from the External Detention Pond include evaporation and pumping releases to the natural environment.

The model specifically tracks normal daily runoff to the Underdrain Collection Pond and External Detention Pond. Pond water storage volumes are tracked against capacities. The model also calculates the amount of runoff that could be expected were the 100-yr/24-hr storm to occur at any point. This value is used to determine if runoff from the 100-yr/24-hr storm can be stored on any given day in addition to the normal operating volume expected in the ponds. External Detention Pond and Underdrain Collection Pond capacities detailed in this section are consistent with pond capacities presented in the filling curves on as-built Drawing A230 and Drawing A400 presented in the TSF Interim ROC Report (NewFields, 2020), respectively.

Operating decisions such as the pumping capacities to the WTP1 from the various sources greatly influence the TSF water balance. WTP1 includes miscellaneous water such as historic mine underground workings water and Exploration Decline water in addition to the inflow from the Underdrain Collection Pond. Gains to and losses from the system are summarized in Table 8.1.

TABLE 8.1 TSF WATER BALANCE MODELING COMPONENTS

Hermosa Lined TSF Design Amendment	
Underdrain Collection Pond Water Gains	**Underdrain Collection Pond Water Losses**
Direct Precipitation	Evaporation
Meteoric Runoff from TSF	Pumping to WTP1
Underdrainage flow (nominal)	
External Detention Pond Water Gains	**External Pond Water Losses**
Direct Precipitation	Evaporation
Runoff from Upland Basin	Pumping to Natural Environment
WTP1 Water Gains	**WTP1 Water Losses**
Pumping from Underdrain Collection Pond	WTP1 effluent
Underground Mine Workings (January Adit) Dewatering	
Exploration Declines Dewatering	

8.2. Water Balance Results Summary

The ERC water balance results and analysis can be referenced in detail in Appendix H. In summary, the water balance analysis utilized historic precipitation data to model the Underdrain Collection Pond, TSF and External Detention Pond system. The results showed the Underdrain

Collection Pond, TSF and External Detention Pond system has sufficient storage to contain all flows through the modeled period of record (12 years of daily site precipitation data recorded from 2008 through 2019) for the current interim VRP TSF geometry as well as the TSF Amended Design. In one case, the Underdrain Collection Pond freeboard was exceeded which was the extreme 2017 monsoon season. In 2017, the site recorded 4.56 inches of precipitation in a single day, 12.39 inches in a 7-day period and 18.1 inches in a 30-day period. For comparison, the 24-hour duration 25-year, 50-year and 100-year storm events for the site are 3.93 inches, 4.40 inches and 4.88 inches, respectively (ERC 2017). It is important to note, the 7-day (12.39 inches) and 30-day period (18.1 inches) storms values exceed the 7-day/30-day 1,000-year storm events. These types of short term storm events are the controlling factor in the water balance.

Furthermore, in both phases of TSF construction (current interim VRP TSF geometry and TSF Amended Design), the Underdrain Collection Pond, TSF and External Detention Pond system showed sufficient capacity to the contain peak daily flows (referenced in paragraph above) in addition to the runoff from a 100-yr / 24-hr storm (excluding the 7-day/30-day 1,000-year storm event condition in 2017). An empty External Detention Pond has sufficient capacity to contain the 100-yr / 24-hr storm event but the water balance shows in the worst case scenario that the External Detention Pond spills into the TSF east internal detention pond (which reports to the Underdrain Collection Pond) when considering the peak daily flows in addition to the runoff from the 100-yr / 24-hr storm. This was accounted for in the ERC water balance and again, does not result in a freeboard exceedance at the Underdrain Collection Pond (excluding the 7-day/30-day 1,000-year storm event condition in 2017).

9. STORMWATER MANAGEMENT

The intent of the stormwater management plan is to prevent damage to the site infrastructure and to preserve the environmental setting in the proximity of the site in particular the TSF, Underdrain Collection Pond and downstream receiving points. As part of the VRP project the following stormwater management structures were constructed and can be referenced in the VRP TSF Interim Record of Construction Report (NewFields, 2020):

- External stormwater conveyance structures
  - Collect and convey surface water flows around the facilities through engineered diversion channels and culverts
  - Armor sections of channels or outlet points to minimize erosion and sediment transport
- Internal TSF stormwater conveyance structures
  - Internal diversion channels located at the perimeter of the TSF stacking to convey surface water runoff from the dry stack facility to the internal detention ponds
  - Internal detention pond area to collect flow from the internal diversion channels
  - Detention pond outfall pipes to convey surface water runoff from the internal detention ponds to the Underdrain Collection Pond
- Underdrain Collection Pond to manage runoff and underdrain flow from the TSF

The stormwater conveyance structures are designed considering the following criteria (refer to Section 5.5 for Underdrain Collection Pond design criteria):

- External stormwater conveyance structures
  - Pass peak flows from 100-yr/24-hr storm event
  - Maintain 1 ft of freeboard
- TSF internal stormwater conveyance structures
  - Pass peak flows from 100-yr/24-hr storm event
  - Maintain 2 ft of freeboard

9.1. Hydrologic Model

The hydrological modeling system HEC-HMS (version 4.4), a precipitation-runoff simulation computer program developed by the Army Corps of Engineers, was used to calculate the magnitude and timing of the peak flows as well as volumes resulting from specified storm events. HEC-HMS was used to simulate water flow through a network of interconnected drainage basins.

The watershed areas were divided into sub-basins such that flows and volumes could be calculated at various points within the watershed where design elements were located. Peak flows and volumes were developed for the 100-yr/24-hr storm event and are used to complete the design calculations.

9.2. Watershed Delineation

In order to evaluate the hydraulic structures controlling runoff, site-wide watershed maps were developed to establish inputs for a hydrologic model. Based on the as-built facility layouts, a watershed map was established to determine the catchment areas contributing to each design element and the information was input into HEC-HMS. The site wide watershed maps were created for the TSF Amended Design and TSF closure scenario. See Appendices E.2 (TSF Amended Design) and E.3 (closure) for the watershed maps.

9.2.1. Watershed Characteristics

Specific watershed characteristics such as area, land/drainage average slope, infiltration/runoff capacity and lag time, were used to estimate peak flows. Areas, average slope, initial abstraction and lag time values within each sub-basin are included in Appendices E.2 (TSF Amended Design) and E.3 (closure).

Infiltration and runoff characteristics of the soils within the catchment area were estimated by using the National Resource Conservation Service (NRCS, 1997) curve number (CN) method. A higher CN value represents a higher runoff potential and vice versa for a lower CN. Selection of an appropriate CN to represent the watershed area was based on the type of soil, in-situ soil moisture content, ground cover, and rainfall intensity as described below.

- **Natural Ground:** The Natural Resources Conservation Service maps for the area indicate that soils in the watershed area are primarily classified as hydrologic soil group D. Type D soils are classified as having the potential for low infiltration and high runoff rates. Vegetation is typical of the Pinyon-Oak-Juniper Woodland and a CN of 72 was used to represent the existing ground surface. It was calculated as an average between the “oak-aspen” and “pinyon-juniper” cover types, fair ground cover condition and soil group D from NRCS Urban Hydrology for Small Watersheds TR-55 Table 2-2d.

FIGURE 11.1: PHOTO OF TYPICAL LANDSCAPE

- **Disturbed areas (including roads):** Any disturbed areas or roadways were assigned a CN of 95 in general accordance with "newly graded areas" and soil group D from NRCS Urban Hydrology for Small Watersheds TR-55 Table 2-2a.
- **Dry stack tailings with rock armored face:** The granular nature of the rock armoring on the exterior slope of the dry stack tailings will help to absorb precipitation and/or delay its release as runoff. A CN of 85 was assigned to the dry stack tailings surface.
- **Protective Layer:** The protective layer (drainage layer) will absorb precipitation and delay its release as runoff due to its granular nature and free draining properties. A CN of 72 was assigned to the protective layer.
- **Geomembrane:** The geomembrane surfaces were assigned a CN of 100 because no absorption will occur on the geomembrane surface.

Lag time and unit hydrograph development: The time component of the unit hydrograph (runoff versus time) is a function of the topography, average watershed slope and infiltration characteristics of the watershed. The lag time (time from the rainfall midpoint to the outlet of the watershed), which can be calculated based on geometric and physiographic characteristics of the watershed, is integral to developing the NRCS unit hydrograph. For this model, the lag time is estimated using the equation below.

$$L = \frac{\ell^{0.8}\,(S+1)^{0.7}}{1900\,Y^{0.5}}$$ (NRCS, 2010)

L = Lag time in hours

ℓ = Hydraulic length of watershed in ft

S = (1000/CN) - 10, where CN is the hydrologic soil cover complex number

Y = Average watershed land slope in percent

Refer to Appendices E.2 (TSF Amended Design) and E.3 (closure) for lag time inputs and results for individual basins.

9.3. Design Storm Event and Distribution

Precipitation values and design storms were developed by ERC using NOAA for frequencies up to the 500-yr/24-hr storm event and are shown in Section 2.2.3. Precipitation characteristic of this upland desert region is variable and cyclic. Approximately 50 percent of the rainfall comes during the period from June through August in cyclonic, often torrential "monsoonal" thunderstorms, which are often accompanied by strong winds. Design storm events are assigned to each design element on the project and are consistent with BADCT guidance document requirements.

9.4. Peak Flow and Volume Results

The peak discharges and storage volumes were estimated using HEC-HMS and are included in the Tables 9.1 and 9.2. Detailed design calculations can be referenced in Appendix E.2 (TSF Amended Design) and E.3 (closure).

TABLE 9.1: HYDROLOGIC MODEL RESULTS (CONVEYANCE STRUCTURES)

Conveyance Structure Trench Camp TSF (Hermosa Lined TSF Design Amendment)	Peak Discharge 100-yr/24-hr (cfs)
West Internal Stormwater Diversion Channel (TSF Amended Design) Haul Road Station 32+00 – 44+00 (Northwest TSF)	45.1
East TSF Internal Stormwater Diversion Channel (TSF Amended Design) Haul Road Station 0+00 – 9+50 (Northeast TSF)	34.3
East TSF Internal Stormwater Diversion Channel (TSF Amended Design) Haul Road Station 9+50 –21+50 (Southeast TSF)	34.9
East TSF Internal Stormwater Diversion Channel (TSF Amended Design) Haul Road Station 21+50 – 32+00 (Southeast TSF)	22.1
West TSF Internal Stormwater Diversion Channel (Closure)	85.5
East TSF Internal Stormwater Diversion Channel (Closure)	76.7
TSF Closure Spillway (Closure)	108.6
West Detention Outfall Pipes (TSF Amended Design)	53.5
East Detention Outfall Pipes (TSF Amended Design)	49.2
Discharge to Underdrain Collection Pond (TSF Amended Design)	84.2

TABLE 9.2: HYDROLOGIC MODEL RESULTS (DETENTION PONDS)

Detention Structure Trench Camp TSF (TSF Amended Design)	Max Stored Water Volume 100-yr/24-hr (ac-ft)	Max Water Elevation 100-yr/24-hr (ft amsl)	Freeboard 100-yr/24-hr (ft)	Max Detention Pond Outfall Discharge (cfs)
West TSF Internal Detention Pond (TSF Amended Design)	0.5	5025.1	14.9	53.5
East TSF Internal Detention Pond (TSF Amended Design)	0.2	5062.6	15.4	49.2
External Detention Pond (TSF Amended Design)	6.8	5074.1	2.4	0.0

9.5. Stormwater Diversion Channel Sizing

The stormwater diversion channels are sized to convey the peak flow utilizing a trapezoidal cross section. The channel depths are determined based on the flow depths calculated using Manning's formula for open channel flow utilizing the computer program FlowMaster. A Manning's roughness "n" coefficient is estimated using the output from HEC-15 modeling for a riprap armored channels. Table 9.3 presents the stormwater diversion channel sizing results. Detailed design calculations can be referenced in Appendix E.2 (TSF Amended Design) and E.3 (closure).

TABLE 9.3: DIVERSION CHANNEL SIZING RESULTS

Conveyance Structure	Design Storm	Peak Flow (cfs)	Channel Side Slopes (xH:1V)	Channel Bottom Width (ft)	Min. Channel Slope (%)	Depth (ft)
West TSF Internal Stormwater Diversion Channel (TSF Amended Design) Sta. 32+00-44+00	100-yr/ 24-hr	45.1	2.5	0 (triangular channel)	1.6%	2.37
East TSF Internal Stormwater Diversion Channel (TSF Amended Design) Sta. 0+00 – 9+50	100-yr/ 24-hr	34.3	2.5	0 (triangular channel)	13.2%	1.49
East TSF Internal Stormwater Diversion Channel (TSF Amended Design) Sta. 9+50 – 21+50	100-yr/ 24-hr	34.9	2.5	0 (triangular channel)	0.5%	2.39
East TSF Internal Stormwater Diversion Channel (TSF Amended Design) Sta. 21+50 – 32+00	100-yr/ 24-hr	22.1	2.5	0 (triangular channel)	0.5%	2.36
West TSF Internal Stormwater Diversion Channel (Closure)	100-yr/ 24-hr	85.5	2.5	15	1.5%	1.23
East TSF Internal Stormwater Diversion Channel (Closure)	100-yr/ 24-hr	76.7	2.5	15	0.5%	1.40
TSF Closure Spillway (Closure)	100-yr/ 24-hr	108.6	2.5	15	7.3%	1.11

Please note, the constructed stormwater diversion channel results can be referenced in Appendix E.3 (closure) in the HEC-HMS and HEC-RAS result sheets.

9.6. Pipe Sizing

Pipes (needed during closure only) are sized to convey flow from the 100-yr/24-hr storm event. The pipes are sized using the Bentley computer program CulvertMaster. Table 9.4 presents the pipe sizing results. Detailed design calculations can be referenced in Appendix E.3.

TABLE 9.4: PIPE SIZING RESULTS

Conveyance Structure	Design Storm	Peak Flow (cfs)	Slope (%)	Number of Pipes	Pipe Diameter (ft)
TSF Closure Spillway (Closure)	100-yr/ 24-hr	108.6	2.1	2	3.5

9.7. Riprap Revetment

The riprap revetment (needed during closure only) was designed using the Flexible Lining Method outlined by the Federal Highway Administration (FHWA, 2005). Riprap revetment was designed for the 100-yr/24-hr storm event to minimize erosion. Plan view locations of the riprap can be referenced on Drawings A500, A520 and A550. The channel sections and details showing riprap sizing can be referenced on Drawings A510 and A550. Detailed design calculations can be referenced in Appendix E.3.

9.8. VRP Stormwater Construction

During the VRP project construction, external stormwater conveyance structures were constructed and are listed below:

- The TSF Stormwater Diversion Channel which protects the TSF and Underdrain Collection Pond from stormwater run-on at the southern and western reaches of the facility
- Underdrain Collection Pond Stormwater Diversion Channel which protects the Underdrain Collection Pond from stormwater run-on at the southern and eastern reaches of the facility

Additional information on the as-built stormwater diversion channels can be referenced in the VRP TSF Interim Record of Construction Report (NewFields, 2020). As constructed, the external stormwater conveyance structures will function with the TSF Amended Design without alteration. The TSF Amended Design will not require additional external stormwater conveyance structures.

10. CONSTRUCTION SEQUENCING

In general terms the Hermosa Lined TSF Design Amendment project will be constructed in compliance with the Design Drawings and Technical Specifications by third party contractors. The construction sequencing provides the anticipated order for construction elements and major components associated with the completion of the VRP TSF construction and the TSF Amended Design.

10.1. Construction Schedule

- **VRP TSF Construction Completion**
  - Grade reclaimed historic tailings surface to grade to the underdrain collection system (Drawing A110)
  - Install horizontal drain pipes on reclaimed historic tailings surface (Drawings A110 and A210)
    - Perforated CPe underdrain collection pipe
    - Drainage aggregate
    - 10 oz/yd^2 non-woven geotextile
  - Complete underdrain collection piping system (Drawings A110 and A210) incrementally
    - Perforated CPe underdrain collection pipe
    - Drainage aggregate
    - 10 oz/yd^2 non-woven geotextile
  - Incremental PL placement (Drawing A110)
  - Placement of exploration decline development rock, PAG construction cut, WTP1 filter cake, and core cutting material up to the approved stacking elevation of 5,110 ft amsl (Drawings A120 and A220)
  - Placement of the rock armor (Drawings A200 and A220)

- **Hermosa Lined TSF Design Amendment**
  - Placement of exploration decline development rock in the TSF Amended Design (Drawings A120 and A220)
  - Placement of the rock armor in the TSF Amended Design (Drawing A200 and A220)
  - Placement of PAG construction cut in the TSF Amended Design (Drawing A120 and A220)

- Placement of WTP1 filter cake in the TSF Amended Design (Drawing A130, A230, A240 and A250)
- Placement of WTP2 filter cake in the TSF Amended Design (Drawing A130, A230, A240 and A250)
- Placement of core cutting material in the TSF Amended Design (Drawing A130, A230, A240 and A250)
- Placement of drill cuttings material in the TSF Amended Design (Drawing A130, A230, A240 and A250)
- Placement of sediments from stormwater BMPs in the TSF Amended Design (Drawing A130, A230, A240 and A250)

➢ **Trench Camp TSF Closure**

- Grade the top of the TSF to form a swale that flows to the TSF haul road stormwater diversion channel (Drawing A500)
- Construct permanent closure channels at the dry stack toe consisting of low permeability soil layer, geotextile and riprap (Drawings A500 through A530)
- Place closure cap over the entire area of the TSF and hydroseed (Drawings A500 through A520)
- Maintain closure cap as necessary
- Construct a closure spillway and series of culverts though the existing access road (Drawing A550)
- Fill in External Detention Pond to promote positive drainage to the permanent closure channel at the dry stack toe (Drawing A540)
- TSF Underdrain Collection Pond to be converted to a passive treatment system (Drawing A500)

11. FACILITY OPERATIONS

The dry stack TSF will be stacked in general compliance with the approved geometry shown in the APP BADCT Design Report (NewFields, 2017) up to 5,110 ft amsl and to the geometry shown on Drawing A120 for the TSF Amended Design. The current concept is to deliver exploration decline development rock, PAG construction cut, filter cake (WTP1 and WTP2) and remaining materials with haulage equipment. The material will be spread, moisture conditioned if necessary and compacted in accordance with the Technical Specifications. This approach to material placement is paramount to the long-term stability of the dry stack TSF, to the storage capacity cited in this design and to minimize future infiltration and therefore underdrainage post closure.

As cited above, the exterior faces will be constructed of rock armoring to provide erosion protection as an ongoing part of the construction of this facility. This rock armor will also serve as a capillary break between the tailings and the growth media at closure. The final slopes on the TSF will be a composite open slope benched arrangement to break up continuous slope lengths and thereby reduce sheet flow velocities with the intent to minimize the initiation and/or propagation of surface erosion.

During construction and on daily, weekly, monthly and yearly intervals thereafter or after major storm or surface water events, the TSF and Underdrain Collection Pond will be inspected to identify damage, degeneration and/or potential discharges. Each inspection will include a visual inspection to identify unusual scour or degradation of materials, sloughing, rolling rock or visible seepage in addition to a physical inspection to verify design capacities are not exceeded. All inspection records will remain on-site or at an approved location. For detailed operation and maintenance information regarding the TSF and Underdrain Collection Pond refer to Appendix I.

If the inspection identifies damage, degeneration and/or an accidental discharge, the Contingency Plan should be utilized to determine the next course of action.

12. CONTINGENCY PLAN

The Contingency Plan presented below is the same as presented in the APP BADCT Design Report (NewFields, 2017) with the following revisions (shown in red):

- Section 12.1 "Primary Contact – Emergency Response Coordinator" was changed to Brent Musslewhite and the contact information was changed accordingly. Additionally, "Secondary Contact – Back up ERC" was changed to Sarah Richman and Kara Haas and the contact information was changed accordingly.
  - "Primary Contact – Emergency Response Coordinator (ERC):

    Contact Name: Brent Musslewhite

    Job Title: Director of Environmental and Permitting

    Address: 2210 East Fort Lowell Road, Tucson, AZ 85719

    Office Number: 520-485-1300

    Site Security Office: 520-539-8082"
  - "Secondary Contact – Back up ERC:

    Contact Name: Sarah Richman

    Job Title: Principal, Environment and Permitting

    Address: 2210 East Fort Lowell Road, Tucson, AZ 85719

    Office Number: 520-485-1300

    Site Security Office: 520-539-8082"
  - "Secondary Contact – Back up ERC:

    Contact Name: Kara Haas

    Job Title: Principal, Environment

    Address: 749 Harshaw Road, Patagonia, AZ 85624

    Office Number: 520-485-1300

    Site Security Office: 520-539-8082"
- Section 12.3 removed the words "construction and" from the first sentence because the Underdrain Collection Pond is constructed
  - "During ~~construction and~~ operation of the Underdrain Collection Pond, AMI will monitor the freeboard level which is defined as two feet below the spillway invert."
- Section 12.6 added the words "of the APP BADCT Design Report (NewFields, 2017)"
  - "Additional information regarding AL1 details can be referenced in Section 5.6 of the APP BADCT Design Report (NewFields, 2017)."

- "Additional information regarding AL2 details can be referenced in Section 5.6 of the APP BADCT Design Report (NewFields, 2017)."

- Section 12.10.1 added the words "as defined in A.R.S 49-201(12)", "the ADEQ Groundwater Value Protection Stream at (602) 771-4999 and", and "AWQS or"
  - "In the event of an unauthorized discharge as defined in A.R.S 49-201(12) of suspected hazardous substances or toxic pollutants on the facility site, AMI will promptly isolate the area and attempt to identify the spilled material. If the discharge is first recognized by a subcontractor, the subcontractor must contact an AMI representative immediately to report the discharge. AMI must record the name, nature of exposure and follow-up medical treatment, if necessary, of persons who may have been exposed during the incident. AMI must notify the ADEQ Groundwater Value Protection Stream at (602) 771-4999 and the ADEQ SRO at (520) 628-6733 within 24-hours upon discovering the discharge of hazardous material which: a) has the potential to cause or contribute to an AWQS or AQL being exceeded; or b) could pose an endangerment to public health or the environment."
- Section 12.10.2 added the words "the ADEQ Groundwater Value Protection Stream at (602) 771-4999 and"
  - "In the event of any unauthorized discharge of non-hazardous materials from the facility, AMI will promptly attempt to cease the discharge and isolate the discharged material. Discharged material will be removed and the site cleaned up as soon as possible. AMI will notify the ADEQ Groundwater Value Protection Stream at (602) 771-4999 and the ADEQ SRO at (520) 628-6733, within 24 hours upon discovering the discharge of non-hazardous material which: a) has the potential to cause an AQL to be exceeded; or b) could pose an endangerment to public health or the environment."
- Section 12.11 added the words "With the exception of contingency measures specifically approved in the facility APP (No. P-512235) and emergency response actions taken pursuant to Part 2.6.5 of that permit,"
  - "With the exception of contingency measures specifically approved in the facility APP (No. P-512235) and emergency response actions taken pursuant to Part 2.6.5 of that permit, AMI must receive written approval from the Water Permits Section prior to implementing a corrective action to accomplish any of the following goals in response to exceeding an AL or violation of an AQL, discharge limit, or other permit condition:"
- Section 12.12 added the words "taken under Part 2.6.6 of the facility APP"
  - "AMI must submit a written report to the ADEQ WQCS within 30 days of completion of any corrective action taken under Part 2.6.6 of the facility APP."

The Contingency Plan was prepared for the Underdrain Collection Pond and TSF in accordance with AAC. R18-9-A204 to define the actions if a discharge results in any of the following:

- A violation of an Aquifer Water Quality Standard (AWQS) or an Acceptable Quality Limit (AQL)
- A violation of a discharge limitation
- A violation of any other permit condition
- An exceedance of an Alert Level (AL), or
- An imminent and substantial endangerment to the public health or the environment occurs

At least one copy of the Contingency Plan is to be maintained where day-to-day decisions regarding the operation of the facilities are made. All employees responsible for the operation of the facility must be made aware of the location of this plan. This Contingency Plan will be updated and submitted to ADEQ within 30 days of the effective date of the APP, to ensure that it is consistent with the terms of the permit.

12.1. Emergency Response Coordinators

AMI's Emergency Response Coordinator (ERC) should be contacted immediately in the event of an emergency and is responsible for implementing the contingency plan. A primary and secondary contact including name, job title, address, office number and site security office number is listed below:

Primary Contact – Emergency Response Coordinator (ERC):
Contact Name: Brent Musslewhite
Job Title: Director of Environmental and Permitting
Address: 2210 East Fort Lowell Road, Tucson, AZ 85719
Office Number: 520-485-1300
Site Security Office: 520-539-8082

Secondary Contact – Back up ERC:
Contact Name: Sarah Richman
Job Title: Principal, Environment and Permitting
Address: 2210 East Fort Lowell Road, Tucson, AZ 85719
Office Number: 520-485-1300
Site Security Office: 520-539-8082

Secondary Contact – Back up ERC:
Contact Name: Kara Haas
Job Title: Principal, Environment
Address: 749 Harshaw Road, Patagonia, AZ 85624
Office Number: 520-485-1300
Site Security Office: 520-539-8082

12.2. Agency Contacts

ADEQ contacts for Emergency Response, Water Quality Division and the Southern Regional Office (SRO) are listed below:

ADEQ Emergency Response:
Phone Number: 602-771-2330 or 800-234-5677

ADEQ Water Quality Division:
Address: 1110 W. Washington Street
Phoenix, AZ 85007
Phone Number: 602-771-2300 or 800-234-5677

ADEQ SRO:
Address: 400 W. Congress Street, Suite 433
Tucson, AZ 85701
Phone Number: 520-628-6733 or 888-271-9302

12.3. Underdrain Collection Pond Freeboard

During operation of the Underdrain Collection Pond, AMI will monitor the freeboard level which is defined as two feet below the spillway invert. In the event that the Underdrain Collection Pond freeboard is not maintained, AMI will take the following actions:

1. Immediately reduce or cease discharging to the Underdrain Collection Pond. All inflows other than the TSF underdrain collection pipe outlets should be reduced or ceased first. If the underdrain collection pipe outlet valves are to be closed, the engineer will be notified prior to closing. Shutting the valves has a potential to create an elevated phreatic surface which could compromise the stability of the dry stack.
2. Remove and treat or recycle, back to the TSF, the fluid in the Underdrain Collection Pond until the water level is restored at or below the maximum operational level.
3. Within 5 days of discovery, evaluate the cause and adjust operational conditions to avoid future occurrences.
4. Records documenting each freeboard incident and actions taken to correct the problem shall be included in the facility log.

12.4. Underdrain Collection Pond Spillway Activation

If the freeboard is exceeded to the point of spillway activation and results in an unauthorized discharge pursuant to ARS. § 49-201(12), AMI will take the following actions:

1. As soon as practicable, reduce or cease discharging to the Underdrain Collection Pond to prevent any further releases to the environment. All inflows other than the TSF underdrain collection pipe outlets should be reduced or ceased first. If the underdrain collection pipe outlet valves are to be closed, the engineer will be notified prior to closing. Shutting the valves has a potential to create an elevated phreatic surface which could compromise the stability of the dry stack.
2. As soon as practicable, remove and treat or recycle, back to the TSF, the fluid in the Underdrain Collection Pond until the water level is restored to the maximum operational level. Record in the facility log a description of the removal method. The facility log/recordkeeping file shall be maintained according to the APP and Dam Safety permit requirements.
3. Notify the ADEQ Water Quality Compliance Section (WQCS) within 24 hours.
4. Within 5 days, collect representative samples of the fluid contained in the Underdrain Collection Pond. Samples shall be analyzed for the parameters listed in the permit. Within 30 days of the incident, submit a copy of the analytical results to the ADEQ WQCS.
5. Within 30 days of discovery, evaluate the circumstances that resulted in the activation of the spillway. Implement corrective actions and adjust operational conditions as necessary to prevent any future occurrences.
6. Within 30 days of discovery of the spillway activation, submit a report to ADEQ. Include a description of the actions performed in steps 1 through 5 listed above. Upon review of the report, ADEQ may request additional monitoring or remedial actions.
7. Within 60 days of discovery, conduct an assessment of the impacts to the subsoil and/or groundwater resulting from the incident. If soil or groundwater is impacted such that it could cause or contribute to an exceedance of an AQL at the applicable POC, submit to ADEQ, for approval, a corrective action plan to address problems identified in the assessment, including identification of releases to the environment, remedial actions and/or monitoring, and a schedule for completion of activities. At the direction of ADEQ, implement the approved plan.
8. Within 30 days of completion of corrective actions, submit a written report to ADEQ.

12.5. Underdrain Collection Pond Unexpected Loss of Fluid

In the event of a liner failure, containment structure failure or unexpected loss of fluid, AMI will take the following actions:

1. As soon as practicable, cease discharging to the Underdrain Collection Pond to prevent any further releases to the environment.
2. Notify the ADEQ WQCS within 24 hours.
3. Within 24 hours, collect representative samples of the fluid remaining in the Underdrain Collection Pond. Samples shall be analyzed for the parameters listed in the permit. Within 30 days of the incident, submit a copy of the analytical results to the ADEQ WQCS.
4. Within 15 days of discovery, initiate an evaluation to determine the cause of the incident. Identify the circumstances that resulted in the failure and assess the condition of the facility and liner system. Implement corrective actions as necessary to resolve the problems identified in the evaluation. Initiate repairs to any failed liner system components, embankment structure, or other component as needed to restore proper functioning of the facility. Do not resume discharging to the Underdrain Collection Pond until repairs of any failed design elements are completed. Repair procedures, methods, and materials used to restore the system(s) to proper operating condition shall be described in the facility log/recordkeeping file and available for ADEQ review.
5. Record in the facility log/recordkeeping file the amount of fluid removed, a description of the removal method, and other disposal arrangements. The facility log/recordkeeping file shall be maintained according to permit requirements.
6. Within 30 days of discovery of the incident, submit a report to ADEQ. Include a description of the actions performed in steps 1 through 5 listed above. Upon review of the report, ADEQ may request additional monitoring or remedial actions.
7. Within 60 days of discovery, conduct an assessment of the impacts to the subsoil and/or groundwater resulting from the incident. If soil or groundwater is impacted such that it could cause or contribute to an exceedance of an AQL at the applicable POC, submit to ADEQ, for approval, a corrective action plan to address problems identified in the assessment, including identification of releases to the environment, remedial actions and/or monitoring, and a schedule for completion of activities. At the direction of ADEQ, implement the approved plan.
8. Within 30 days of completion of corrective actions, submit a written report to ADEQ.

Upon review of the report, ADEQ may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions, or other actions.

12.6. Underdrain Collection Pond LCRS Alert Levels

The Underdrain Collection Pond has a double geomembrane liner with a Leakage Collection and Recovery System (LCRS). If a LCRS AL is exceeded, AMI will take the following actions:

Alert Level 1 (AL1):

Should be considered a low level trigger that indicates the presence of a small hole or defect in the primary geomembrane. AMI will monitor to determine if flow rate increases without any operational changes. Additional information regarding AL1 details can be referenced in Section 5.6 of the APP BADCT Design Report (NewFields, 2017). AL1 is defined as 2.4 gallons per minute (gpm).

Alert Level 2 (AL2):

AL2 indicates the presence of a larger hole or defect in the primary geomembrane. Additional information regarding AL2 details can be referenced in Section 5.6 of the APP BADCT Design Report (NewFields, 2017). AL2 is defined as 15.9 gallons per minute (gpm).

1. Remove and treat or recycle to the TSF fluid in the Underdrain Collection Pond to minimize hydraulic head on the liner.
2. Within 5 days of discovery, compare the water in the LCRS sump and the Underdrain Collection Pond by measuring the pH and conductivity of each fluid. Notify ADEQ WQCS and include in the notification an assessment of the type of water in the sump. Monitor fluid removal from the LCRS on a daily basis until the daily volume remains below the AL2 for 30 days.
3. Within 15 days of discovery, assess the condition of the liner system using visual methods, electrical leak detection, or other methods as applicable to determine the location of leaks in the primary liner. If liner damage is evident, the permittee shall complete liner repairs and submit documentation of the repairs in the initial report discussed in step 4 below.
4. Within 30 days of discovery of exceeding AL2, the permittee shall submit an initial report to ADEQ WQCS to include the results of the initial liner evaluation, methods used to locate the leak(s) if applicable, source of the fluid, any repair procedures implemented to restore the liner and any remedial actions taken to minimize a future occurrence.
5. For leakage rates that continue to exceed AL2, a Liner Leakage Assessment Report shall be included in the next annual report of the permit.

ADEQ will review the Liner Leakage Assessment Report and may require additional action, including repair of the liner or addressing and controlling infiltration of water detected in the LCRS not from the Underdrain Collection Pond.

12.7. TSF Slope Conditions

AMI will monitor the TSF perimeter road and dry stack TSF for general slope conditions to identify unusual scour or degradation of materials, sloughing, rolling rocks or visible seepage. If the TSF exhibits any signs that require maintenance, AMI will take the following actions:

1. After discovery prevent vehicle and/or foot traffic in the area.
2. Notify the design engineer.
3. If necessary, perform remedial actions approved by the engineer.
4. Monitor the area for signs of decreasing slope stability.
5. Record in the facility log, the slope condition, the location of the area in question and a description of the maintenance activity.

12.8. TSF Piezometric Head

The TSF has piezometers placed within the protective layer on the geomembrane to measure hydraulic head on the liner system. If the piezometers read a phreatic surface in excess of 1.5 ft AMI will take the following actions:

1. Notify the design engineer.
2. Monitor the phreatic surface within the TSF.
3. Initiate an evaluation to determine the cause of the incident. Identify the circumstances that resulted in the elevated phreatic surface. Implement corrective actions, if necessary, to resolve the problems identified in the evaluation.
4. If necessary, perform a slope stability analysis on the dry stack TSF with the elevated phreatic surface to determine if any reduction in safe operation of the facility has occurred.
5. Record in the facility log, the piezometer number, reading and location. Hydrographs of this and all other piezometers will be recorded on at least a monthly basis to allow quick inspection and evaluation of historic facility operations.

12.9. TSF Slope Failure

If the dry stack slope becomes unstable to the point of failure and results in material overtopping the perimeter road, AMI will take the following actions:

1. Immediately after discovery, prevent vehicle and/or foot traffic in the area.
2. Notify the ADEQ WQCS within 24 hours.
3. Notify the design engineer immediately.
4. Within 15 days of discovery, initiate an evaluation to determine the cause of the incident. Identify the circumstances that resulted in the failure and assess the condition of the facility and liner system. Implement corrective actions as necessary to resolve the problems identified in the evaluation. Initiate repairs to the dry stack TSF slope and/or any failed liner. Repair procedures, methods, and materials used to restore the system(s) to proper operating condition shall be described in the facility log/recordkeeping file and available for ADEQ review.
5. Within 30 days of discovery of the incident, submit a report to ADEQ. Include a description of the actions performed in the steps listed above. Upon review of the report, ADEQ may request additional monitoring or remedial actions.
6. Within 60 days of discovery, conduct an assessment of the impacts to the subsoil and/or groundwater resulting from the incident. If soil or groundwater is impacted such that it could cause or contribute to an exceedance of an AQL at the applicable POC, submit to ADEQ, for approval, a corrective action plan to address problems identified in the assessment, including identification of releases to the environment, remedial actions and/or monitoring, and a schedule for completion of activities. At the direction of ADEQ, implement the approved plan.
7. Within 30 days of completion of corrective actions, submit a written report to ADEQ.

Upon review of the report, ADEQ may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions, or other actions.

12.10. Unauthorized Discharge

AMI will take immediate action to correct any condition resulting from a discharge pursuant to ARS. §49-201(12) if that condition poses an imminent and substantial endangerment to public health or the environment.

12.10.1. Hazardous Substances or Toxic Pollutants:

In the event of an unauthorized discharge as defined in A.R.S 49-201(12) of suspected hazardous substances or toxic pollutants on the facility site, AMI will promptly isolate the area and attempt to identify the spilled material. If the discharge is first recognized by a subcontractor, the subcontractor must contact an AMI representative immediately to report the discharge. AMI must record the name, nature of exposure and follow-up medical treatment, if necessary, of persons who may have been exposed during the incident. AMI must notify the ADEQ Groundwater Value Protection Stream at (602) 771-4999 and the ADEQ SRO at (520) 628-6733 within 24-hours upon discovering the discharge of hazardous material which: a) has the potential to cause or contribute to an AWQS or AQL being exceeded; or b) could pose an endangerment to public health or the environment.

12.10.2. Non-Hazardous Materials:

In the event of any unauthorized discharge of non-hazardous materials from the facility, AMI will promptly attempt to cease the discharge and isolate the discharged material. Discharged material will be removed and the site cleaned up as soon as possible. AMI will notify the ADEQ Groundwater Value Protection Stream at (602) 771-4999 and the ADEQ SRO at (520) 628-6733, within 24 hours upon discovering the discharge of non-hazardous material which: a) has the potential to cause an AQL to be exceeded; or b) could pose an endangerment to public health or the environment.

12.11. Corrective Actions

With the exception of contingency measures specifically approved in the facility APP (No. P-512235) and emergency response actions taken pursuant to Part 2.6.5 of that permit, AMI must receive written approval from the Water Permits Section prior to implementing a corrective action to accomplish any of the following goals in response to exceeding an AL or violation of an AQL, discharge limit, or other permit condition:

- Control of the source of an unauthorized discharge.
- Soil cleanup.
- Cleanup of affected surface waters.
- Cleanup of affected parts of the aquifer.
- Mitigation to limit the impact of the pollutants on existing uses of the aquifer.

Within 30 days of completion of any corrective action, the operator shall submit to the ADEQ WQCS, a written report describing the causes, impacts, and actions taken to resolve the problem.

12.12. Reporting

AMI must submit a written report to the ADEQ WQCS within 30 days of completion of any corrective action taken under Part 2.6.6 of the facility APP. The report should summarize the event, including any human exposure and facility response activities. The report must also document the following:

- Identification and description of the permit condition for which there has been a violation and a description of its cause.
- The period of violation including exact date(s) and time(s), if known, and the anticipated time period during which the violation is expected to continue.
- Any corrective action taken or planned to mitigate the effects of the violation, or to eliminate or prevent recurrence of the violation.
- Any monitoring activity or other information which indicates that any pollutants would be reasonably expected to cause a violation of an AWQS.
- Proposed changes to the monitoring which include changes in constituents or increased frequency of monitoring.
- Description of any malfunction or failure of pollution control devices or other equipment processes.

13. FACILITY CLOSURE STRATEGY

The closure strategy generally remains the same as the closure strategy outlined in the approved VRP project (APP No. P-512235) and is summarized in Section 13.1. The closure strategy was updated to incorporate the following revisions:

- Standardized Reclamation Cost Estimator (SRCE) was utilized to update estimated closure costs. The VRP closure estimate was performed using Excel spreadsheets created by various consultants. A discussion of the SRCE model can be referenced in Section 13.2 and the SRCE model results can be referenced in detail in Attachment D of the APP Hermosa Lined TSF Design Amendment document.
- The SRCE model utilizes updated closure material quantities based on the as-built configuration of the constructed Underdrain Collection Pond, TSF and External Detention Pond. In addition, the updated material quantities include any changes associated with the proposed TSF Amended Design. The most significant quantity updates were as follows:
  - Additional engineered fill to provide positive drainage around the TSF during closure. The additional engineered fill is due to the increased stacking geometry.
  - Removal of the installed wildlife fence at the External Detention Pond.
  - Removal of a 3-inch pipeline installed on grade from the External Detention Pond to north side of the Underdrain Collection Pond.
- The SRCE model assumes low permeability soil layer is processed on site from an existing material stockpile located at the Infrastructure Pad. Bentonite amendment is assumed to be added to the low permeability soil layer material at the stockpile at a rate of approximately 2 percent by weight. This process worked well during the past VRP construction. The VRP estimate accounted for low permeability soil layer material being sourced off site from a borrow area located approximately 4 miles east of the Trench Camp property.
- The SRCE model assumes post closure cover maintenance cost based on 25% of revegetation area requiring reseeding and 10% of growth media volume requiring replacement. The VRP estimate assumed post closure cover maintenance as 10% (year 1) and 5% (year 2) of the TSF reclamation cost.
- The SRCE model assumes reclamation monitoring by a field geologist/engineer, 10 hours per day (includes field work, reporting and travel time), 12 days per year (once per month) for a total duration of 30 years. Additionally, water sample analysis is performed semiannually for 30 years including cost for laboratory testing of $631.90/sample (based on quote received July 2, 2020) and 10 hours per sampling day for a field geologist/engineer which includes field work and reporting. The VRP estimate accounted for AMI personnel (technician) for 10 hours per week to perform

closure monitoring and reporting activities for 10 years and $3,000 per quarter for laboratory testing.

- The SRCE model assumes the constructed Underdrain Collection Pond (double geomembrane lined with geonet and LCRS system) is converted to a passive treatment system in year 5 of closure. The VRP closure estimate converted the Underdrain Collection Pond to a passive treatment system in year 10. Please note, the passive treatment system design is unchanged from the approved VRP closure strategy.
- The SRCE model uses WTP1 labor costs calculated as factored costs based on actual costs experienced to date.
  - The SRCE model assumes WTP1 labor costs are 100% of actual labor costs for year 1 and year 2 of closure. After year 2, the quantity of water treatment is reduced because TSF closure cap and January Adit plug are assumed to be installed and the WTP1 labor cost is reduced to 23.7% of actual labor cost in years 3 through 7. The reduction to 23.7% accounts for a reduction in man-hours from a 24 hours/day and 7 days/week schedule to 8 hours/day and 5 days/week schedule. SRCE labor costs details can be referenced in Attachment D under the “User 9” Section.
  - The VRP closure estimate assumed 24 hours/day for 10 days/month for 8 months/year for 10 years and 24 hours/day for 30 days/month for 4 months/year (monsoon season) for 10 years.
- The SRCE model uses WTP1 operation costs calculated as a dollar/gallon based on actual costs experienced to date. The VRP closure estimate utilized projected operating costs. SRCE operational costs details can be referenced in Attachment D under the “User 9” Section.
- The SRCE model estimates WTP1 throughput based on assumed flow rates from the January Adit dewatering, TSF runoff, draindown and closure cap infiltration, and direct precipitation over the Underdrain Collection Pond. The flow rates are based on the construction timelines for the January Adit plug (complete year 2 of closure), TSF closure cap (complete year 2 of closure), and passive treatment system in the UDCP (complete year 5 of closure). The VRP closure estimate assumed the WTP1 throughput would be at 120 gpm for every hour of operation. SRCE throughput calculation details can be referenced in Attachment D under the “User 9” Section.
- The SRCE model estimates WTP1 laboratory sample costs based on quarterly ($910/quarter) and annual ($5,672/year) testing with costs informed by recent quotes. The VRP closure estimate assumed monthly monitoring at $1,500/month. SRCE laboratory sample details can be referenced in Attachment D under the “User 9” Section.
- The SRCE model accounts for a January Adit plug installed during closure contemplated as a concrete bulkhead with additional costs for an injection grouting campaign. The

VRP closure estimate did not consider a January Adit plug but assumed the January Adit would be pumped continuously and actively treated through closure year 10 and passively treated thereafter.

- The SRCE model utilizes built in labor (Davis-Bacon July 2019), equipment (Cashman July 2019) and material (various suppliers) rates. The VRP closure estimate utilized rental rates and operating costs for equipment based on rates provided to the State of Nevada Department of Environmental Protection (NDEP) by “Cashman” dated July 2016 with some adjustments and labor rates based on 2017 Davis-Bacon for Santa Cruz County.

13.1. Closure Strategy Description

As stated above, the closure strategy generally remains the same as the closure strategy outlined in the approved VRP project (APP No. P-512235) and is summarized below:

A closure configuration is presented on Drawing A500. The closure strategy includes capping the dry stack TSF with 1 to 2 feet of reseeded growth media underlain by a capillary break created by the rock armor berms placed during construction. The side slopes of the final TSF will have a 3H:1V compound slope with 2.5H:1V open slopes broken every 25 ft in vertical elevation rise by a 12.5 ft wide bench. The compound slope configuration will aid in reducing meteoric water runoff velocities, thereby reducing the propensity for erosion of the closure cap on the sides of the TSF. The top of the TSF will be graded to form a swale that flows to an outfall along the haul road, where flows from the top of the reclaimed TSF will be directed to the base of the TSF. Flows reporting to the base of the TSF from this outfall and from the TSF slope areas will be collected in a closure channel (located inside of the TSF perimeter berm) and conveyed around the TSF base where they will be directed, via the TSF spillway, to a permanent stormwater diversion channel. Layout of the closure channel can be referenced on Drawing A520, a closure channel profile on Drawing A530 and closure channel details on Drawing A510.

It should be noted that meteoric flow collected in the closure channel will be separated from the underdrain by a low permeability soil layer to minimize infiltration of the surface flows into the underdrain system. Surface water flow reporting to the closure surface will exit the TSF via the TSF spillway and will be passed under the existing access road via (2) 42-inch diameter corrugated polyethylene (CPe) culverts. The TSF Spillway will be armored with 24 inches of D_{50} 12-inch riprap and will direct flows to the existing stormwater diversion channel. The existing stormwater diversion channel was constructed with grouted riprap at the culvert outlet and therefore will not require additional revetment to address erosion. A spillway plan view, sections and details can be referenced on Drawing A550.

The External Detention Pond will be backfilled with engineered fill and capped with growth media and reseeded. The External Detention Pond area will be graded to provide positive drainage to the closure stormwater diversion channel to encourage stormwater runoff flows to exit the facility. In addition, the External Detention Pond liner will be perforated prior to backfill placement, the existing wildlife fence around the pond will be removed and the existing 3-inch diameter pipeline that is currently located on grade on the north side of the TSF from the External Detention Pond to the downstream side of the Underdrain Collection Pond will also be removed. A plan view and sections of the External Detention Pond closure strategy can be referenced on Drawing A540.

It is expected that the post-closure underdrain flows from the TSF will be minimal because the closure cap will minimize infiltration and little water is expected to be entrained within the TSF at closure. The flows will continue to be collected and transmitted to WTP1 until a passive treatment system can be constructed in the Underdrain Collection Pond area. This will allow the engineer to evaluate post closure underdrain water chemistry and expected flow rate ranges to effectively design a passive treatment system.

The closure strategy for siting a passive treatment system remains unchanged from the approved closure strategy for the VRP project. The approach is to reduce the Underdrain Collection Pond size post closure by reducing the north embankment height, fill the remaining pond storage area with a passive treatment substrate that effectively addresses the remaining underflow water chemistry, site an effluent delivery system that feeds the bottom of the substrate, and design an appropriate outfall to the natural drainage downstream of the pond/passive treatment system. The specific mix of substrate will be developed through observation of pilot scale passive treatment cells during the post-closure period for a duration of 1 year. Results of the pilot scale testing, post closure effluent chemistry variability, and flow rate variability will form the design basis for the permanent passive treatment system to be sited. Until an effective passive treatment approach can be demonstrated, active treatment of underdrain flows will continue. It is currently anticipated that active treatment will continue for up to 5 years, at which time the passive treatment system will be constructed. An additional 2 years of active treatment will be continued while the passive treatment system is established.

Post closure will require maintenance of the closure cap until a vegetated surface can be established. The closure surface will be monitored, inspected and repaired, if needed, to address water and wind erosion. In addition to the closure cap, the access roads, stormwater diversion channels and Underdrain Collection Pond areas will also be monitored, inspected and repaired, if needed.

If January Adit ground water is not pumped down in post-closure, the water level will rise over time in the January Norton Workings. Once the water level returns to the January Adit surface elevation, it would begin to discharge on the surface. As part of the closure strategy, a concrete bulkhead will be constructed in the January Adit and an injection grouting program will be performed in competent rock around the adit. It is assumed injection grouting would be performed in concentric circles with radii of 10 ft, 20 ft and 30 ft. The injection grouting holes are assumed to be drilled at 10 ft intervals around the circumference of each circle. The concrete bulkhead in conjunction with the injection grouting is the conceptual closure strategy to prevent a discharge from the January Adit after the water levels return during closure. If the January Adit plug does not prevent discharging at closure, flow from the January Adit mine workings would be treated at the passive treatment system established in the repurposed Underdrain Collection Pond as a backup contingency. Please note, treatment of January Adit water at the passive treatment system is consistent with the approved VRP closure strategy.

13.2. Standardized Reclamation Cost Estimator (SRCE)

NewFields has prepared a SRCE model (version 1.4.1) to estimate closure costs associated with the "Issued for Tender" Hermosa Lined TSF Design Amendment. The SRCE model is software that was developed as a collaborative effort between the Nevada Division of Environmental Protection (NDEP) Bureau of Mining Regulation and Reclamation (BMRR), the US Department of Interior Bureau of Land Management (BLM) and the Nevada Mining Association (NvMA). The SRCE model was developed by these agencies to provide a template for the calculation of mine site reclamation costs in an effort to provide consistent, complete and accurate estimates. ADEQ recommends (but does not require) that applicants use the SRCE model to estimate closure costs as can be seen on the "Individual Aquifer Protection Permit Closure and Post-Closure Plan/Strategy and Cost Estimate Checklist" (p. 1) (available at https://static.azdeq.gov/forms/app_cost_est_checklist_mining_indust.pdf).

NewFields prepared the SRCE model for the elements identified as APP discharging facilities in the current permit amendment. The following facilities were included in the model:

- Existing Water Treatment Plant 1 (WTP1)
- Existing Underdrain Collection Pond
- Existing Tailings Storage Facility (TSF) based on the TSF amended design stacking geometry
- Existing External Detention Pond
- Proposed Water Treatment Plant 2 (WTP2)

Model inputs were developed based on existing aerial topography (collected February 2020), as-built data from the VRP project construction, and the proposed Hermosa Lined TSF Design Amendment. Conceptual closure drawings for the TSF amended design, created to show the closure strategy, can be referenced in the Drawings A500 through A550. A technical memo summarizing the SRCE model assumptions, inputs and results as well as SRCE model outputs can be referenced in Attachment D of this APP Significant Amendment Application document.

REFERENCES

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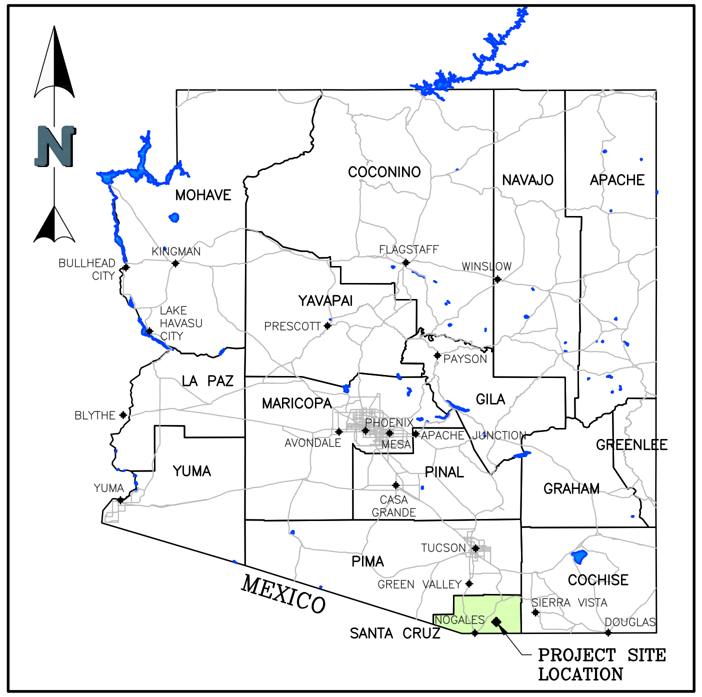
DESIGN DRAWINGS

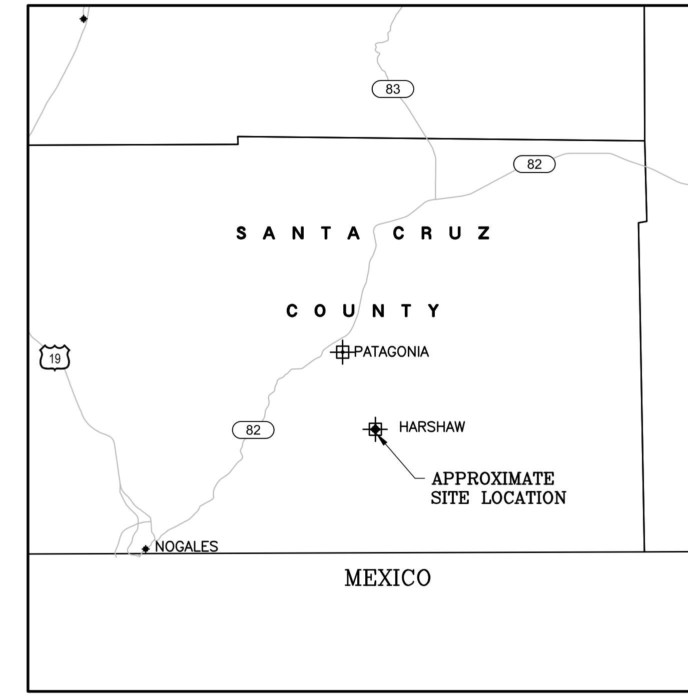


COUNTY MAP

ARIZONA MINERALS INC

HERMOSA LINED TSF DESIGN AMENDMENT

ISSUED FOR TENDER JULY 27, 2020



VICINITY MAP

DRAWING LIST		
REV	TITLE	DWG #
0	COVER SHEET	A000
0	GENERAL ARRANGEMENT	A050
0	GEOTECHNICAL INVESTIGATION PLAN	A070
0	EXISTING VRP TSF PLAN VIEW	A100
0	TSF PIPING PLAN VIEW	A110
0	TSF STACKING PLAN VIEW	A120
0	FILTER CAKE PLAN VIEW	A130
0	TSF HAUL ROAD PLAN AND PROFILE	A140
0	TSF HAUL ROAD INTERSECTION PLAN AND PROFILE	A150
0	TYPICAL SECTIONS AND DETAILS (1 OF 3)	A200
0	TYPICAL SECTIONS AND DETAILS (2 OF 3)	A210
0	TYPICAL SECTIONS AND DETAILS (3 OF 3)	A220
0	TSF STACKING SECTIONS (1 OF 3)	A230
0	TSF STACKING SECTIONS (2 OF 3)	A240
0	TSF STACKING SECTIONS (3 OF 3)	A250
0	WEST INTERNAL DETENTION POND	A300
0	EAST INTERNAL DETENTION POND	A310
0	CONCEPTUAL CLOSURE PLAN VIEW	A500
0	CONCEPTUAL CLOSURE SECTIONS AND DETAILS	A510
0	CLOSURE STORMWATER DIVERSION CHANNEL PLAN	A520
0	CLOSURE STORMWATER DIVERSION CHANNEL PROFILE	A530
0	CLOSURE EXTERNAL DETENTION POND FILL AREA	A540
0	CLOSURE SPILWAY PLAN AND PROFILE	A550

TEXT ABBREVIATIONS:

TSF – TAILINGS STORAGE FACILITY
DIA – DIAMETER
MIN – MINIMUM
CPeP – CORRUGATED POLYETHYLENE PIPE

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
7/27/20
Date Signed
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EXPIRES 3/31/23

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9400 Station Street, Suite 300, Lone Tree, CO 80124
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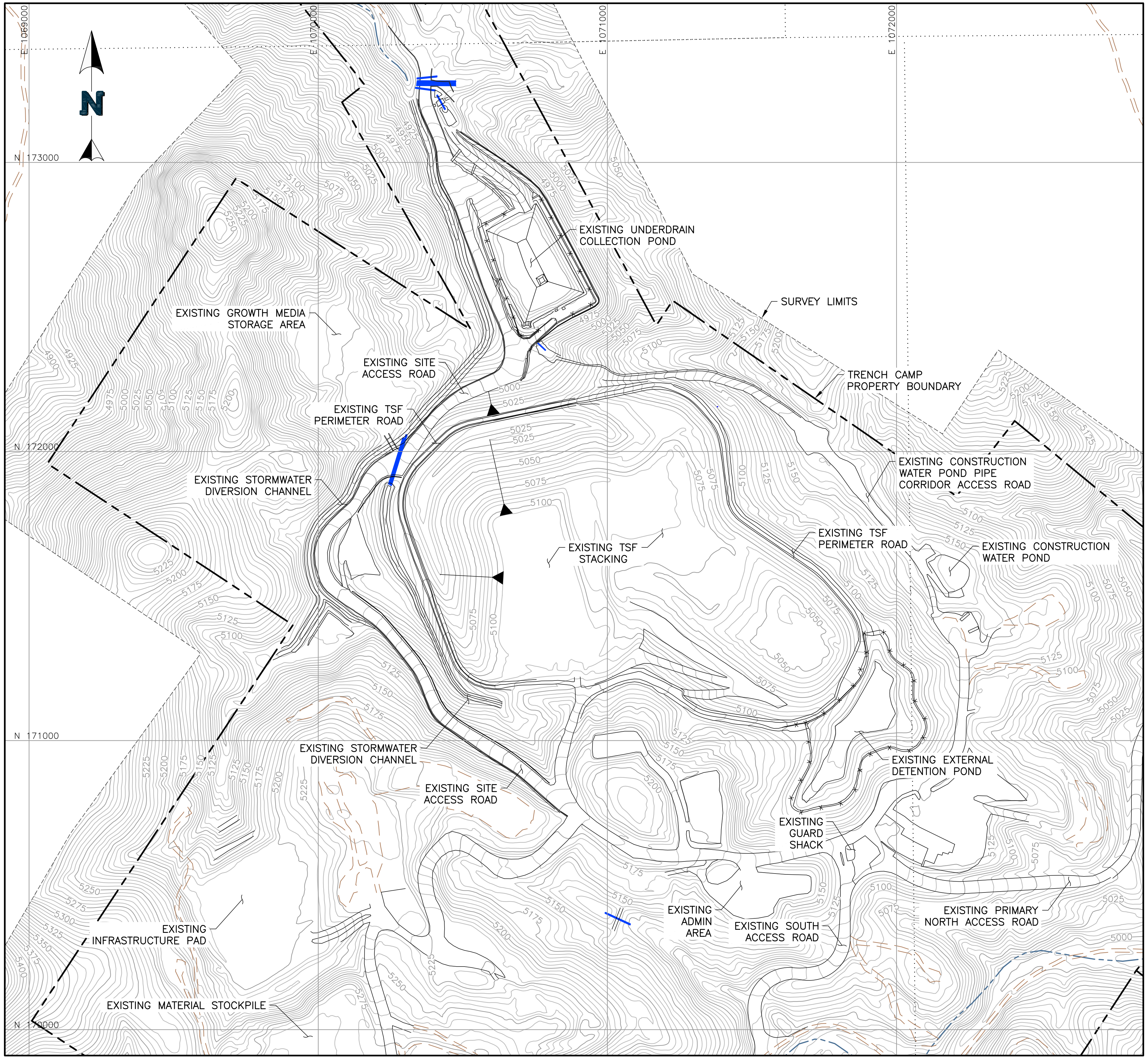

LEGEND:

- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING DRAINAGE

0 200 400 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

NEWFIELDS PRODUCED THE INFORMATION PRESENTED ON THIS DRAWING THROUGH THE USE OF AVAILABLE TECHNICAL INFORMATION AND EXPERIENCE. RECEIVING THIS DRAWING DOES NOT GUARANTEE ANY RIGHTS TO EITHER SUCH TECHNICAL INFORMATION OR EXPERIENCE. ANY MODIFICATION OR ADAPTATION OF THE DATA OR DRAWING SHALL BE AT USER'S RISK AND WITHOUT ANY LIABILITY OR LEGAL RESPONSIBILITY TO NEWFIELDS.

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: GENERAL ARRANGEMENT

FILENAME: 14.022.001M

DRAWING NO.: A050

REVISION: 0

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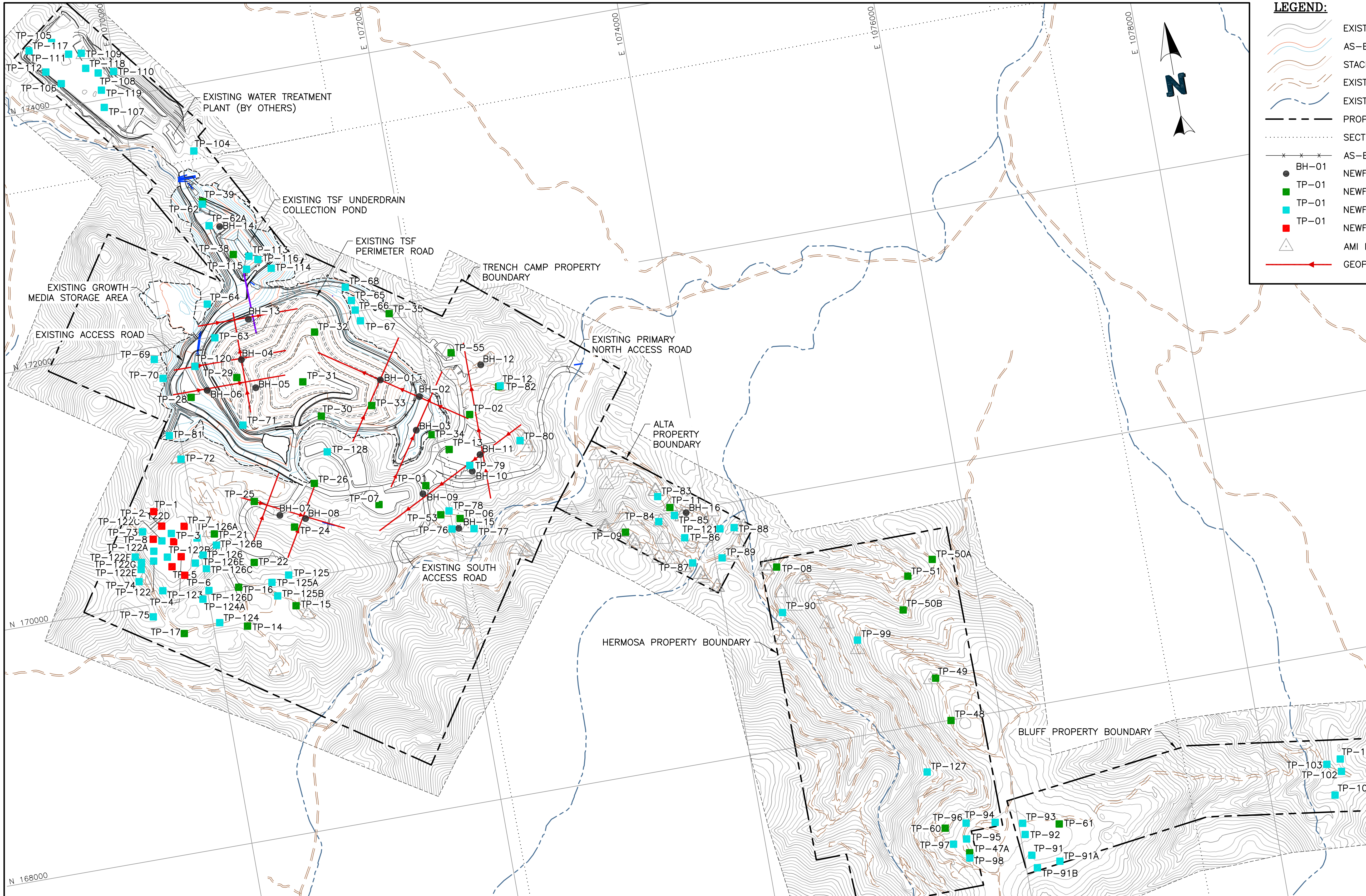

0 400 800 FEET

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: GEOTECHNICAL INVESTIGATION PLAN

FILENAME: 14.022.027M

DRAWING NO.: A070

REVISION: 0

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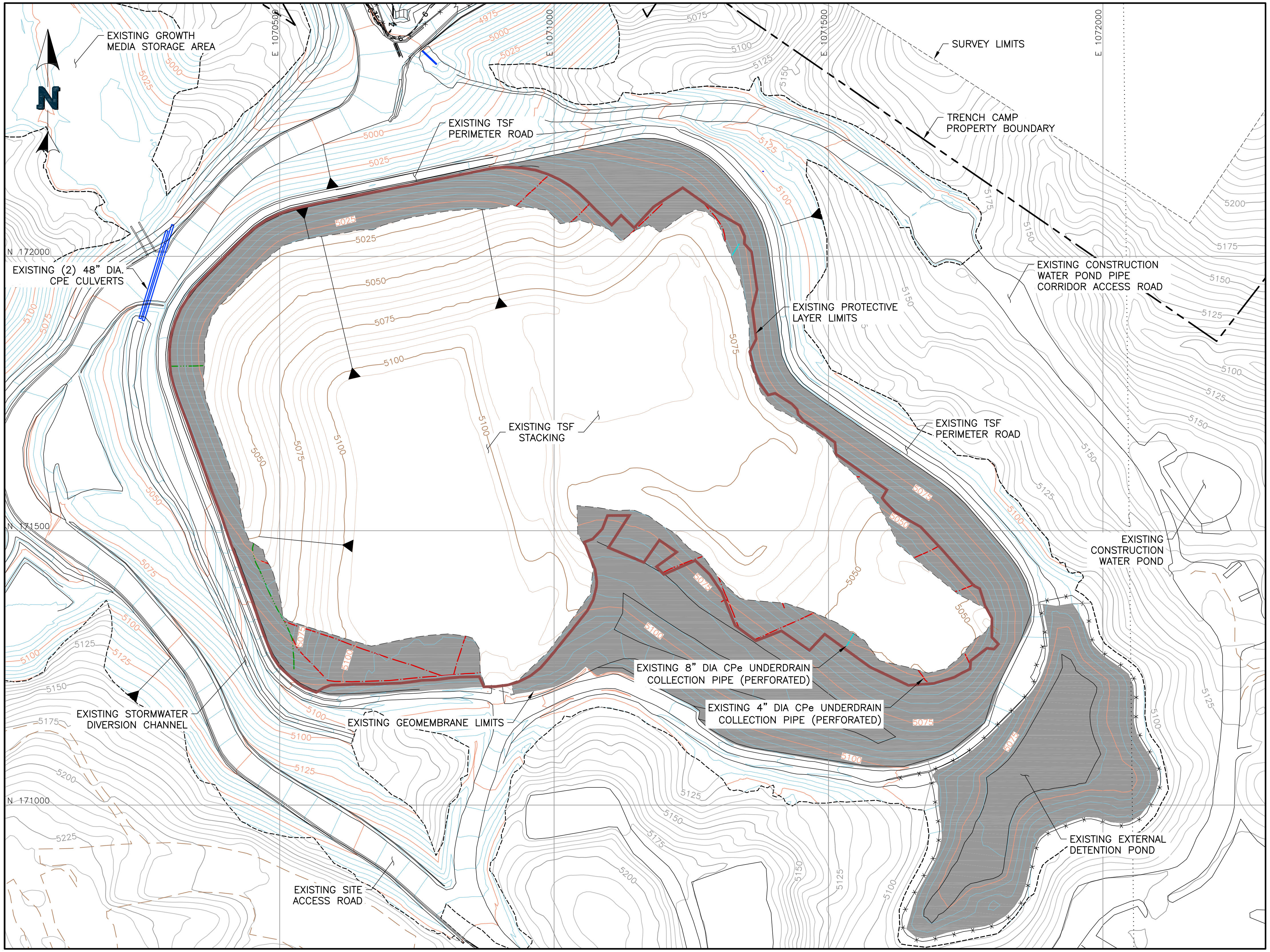

0 100 200 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- EXISTING TSF STACKING CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE
- EXISTING 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED)
- EXISTING 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- EXISTING 12" DIA CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- EXISTING PROTECTIVE LAYER LIMITS
- EXISTING GEOMEMBRANE LIMITS

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: EXISTING VRP TSF PLAN VIEW

FILENAME: 14.022.002M

DRAWING NO.: A100

REVISION: 0

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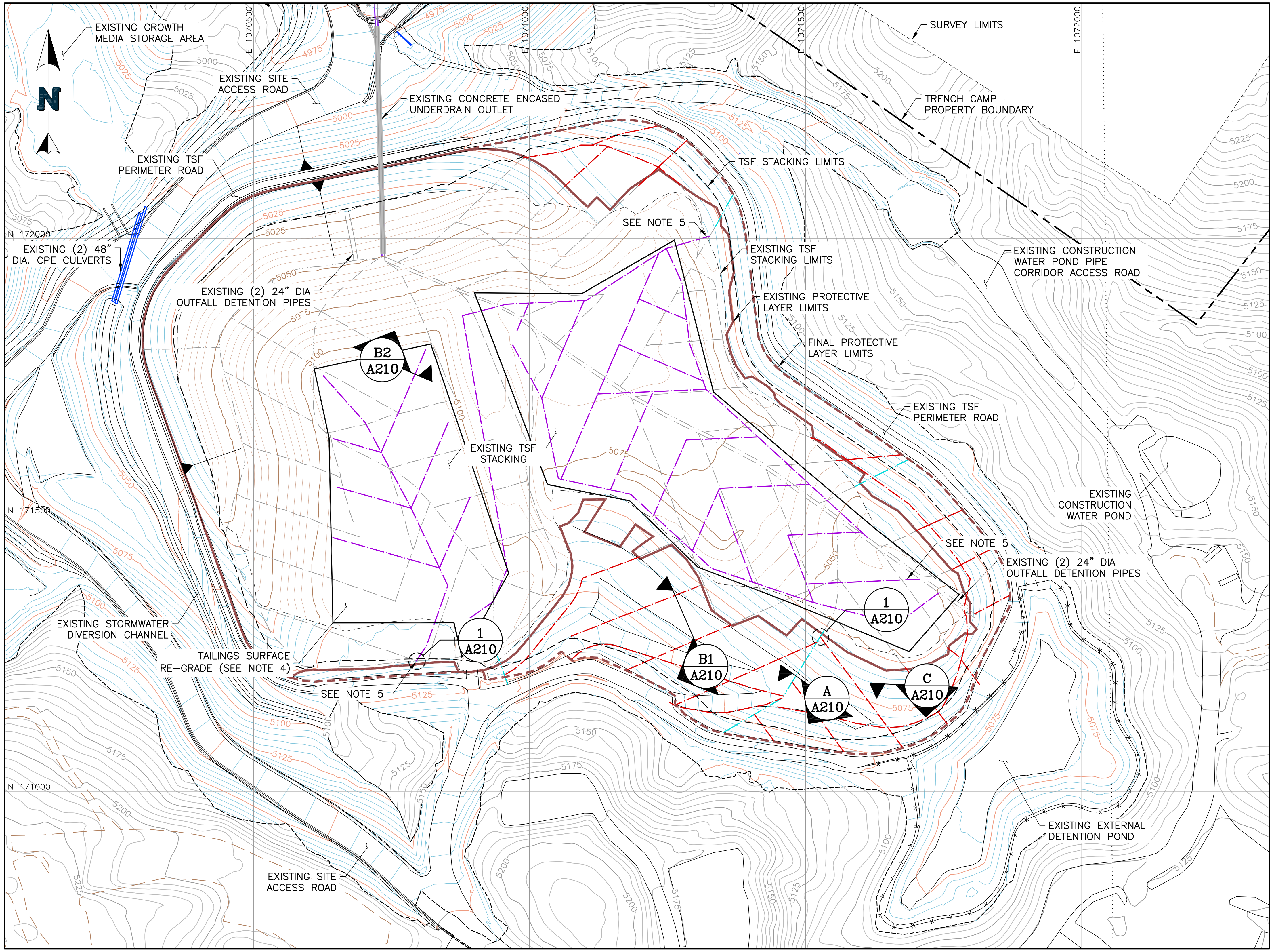

0 100 200 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- EXISTING TSF STACKING CONTOURS (SEE NOTE 4)
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE
- EXISTING 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED)
- EXISTING CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- EXISTING 36" DIA. HDPE DR11 UNDERDRAIN PIPE (SOLID)
- EXISTING CONCRETE ENCASED UNDERDRAIN
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED) (SEE NOTE 3)
- 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED) (SEE NOTE 3)
- 4" DIA. CPe HORIZONTAL DRAIN PIPE (PERFORATED) (SEE NOTE 5)
- EXISTING PROTECTIVE LAYER LIMITS
- FINAL PROTECTIVE LAYER LIMITS (SEE NOTE 3)

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. ALL UPSTREAM OPEN ENDS OF EXISTING PIPES WERE CAPPED.
3. THE UNDERDRAIN COLLECTION PIPING AND PROTECTIVE LAYER INSTALLATION SHOWN HAS ALREADY BEEN APPROVED AND WILL INSTALLED IN ACCORDANCE WITH THE STATE OF ARIZONA, AQUIFER PROTECTION PERMIT NO P-512235 APPROVED JANUARY 8TH, 2018.
4. TAILINGS SURFACE GRADING TO DRAIN AT MINIMUM 3%.
5. PIPING LAYOUT ON TOP OF EXISTING TAILINGS SURFACE IS CONCEPTUAL AND MUST TIE INTO EXISTING UNDERDRAIN COLLECTION PIPES. PIPING LAYOUT TO BE UPDATED BASED ON FINAL TAILINGS SURFACE GRADING TO BE COMPLETED PRIOR TO STACKING ADDITIONAL MATERIAL.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: CMT
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TSF PIPING PLAN VIEW

FILENAME: 14.022.003M

DRAWING NO.: A110

REVISION: 0

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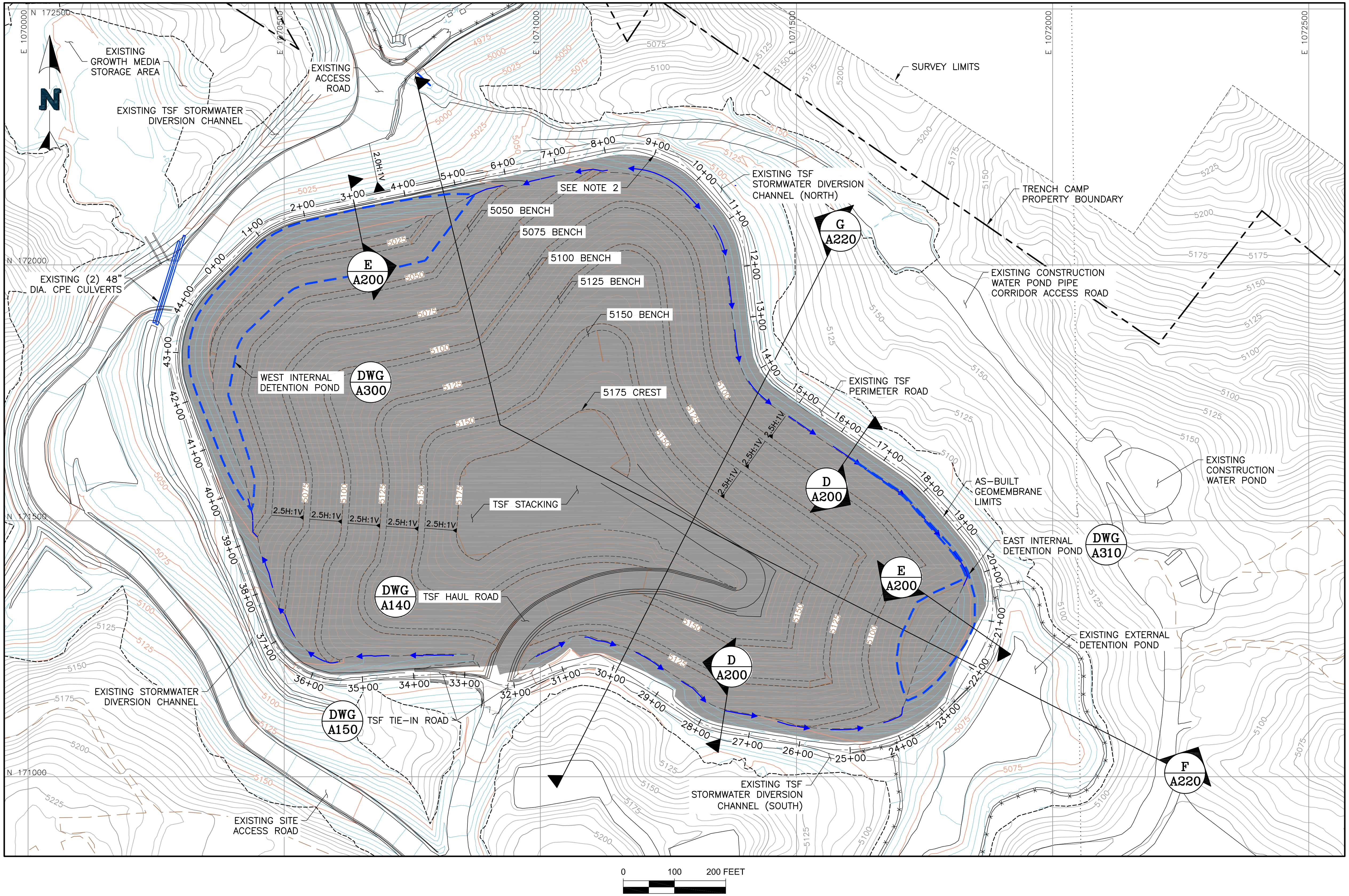

LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. MAXIMUM STACKING ELEVATION AT APPROXIMATE STATION 9+00 SHALL BE 5079FT.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

NEWFIELDS PRODUCED THE INFORMATION PRESENTED ON THIS DRAWING THROUGH THE USE OF AVAILABLE TECHNICAL INFORMATION AND EXPERIENCE. RECEIVING THIS DRAWING DOES NOT GUARANTEE ANY RIGHTS TO EITHER SUCH TECHNICAL INFORMATION OR EXPERIENCE. ANY MODIFICATION OR ADAPTATION OF THE DATA OR DRAWING SHALL BE AT USER'S RISK AND WITHOUT ANY LIABILITY OR LEGAL RESPONSIBILITY TO NEWFIELDS.

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TSF STACKING PLAN VIEW

FILENAME: 14.022.006M
DRAWING NO.: A120
REVISION: 0

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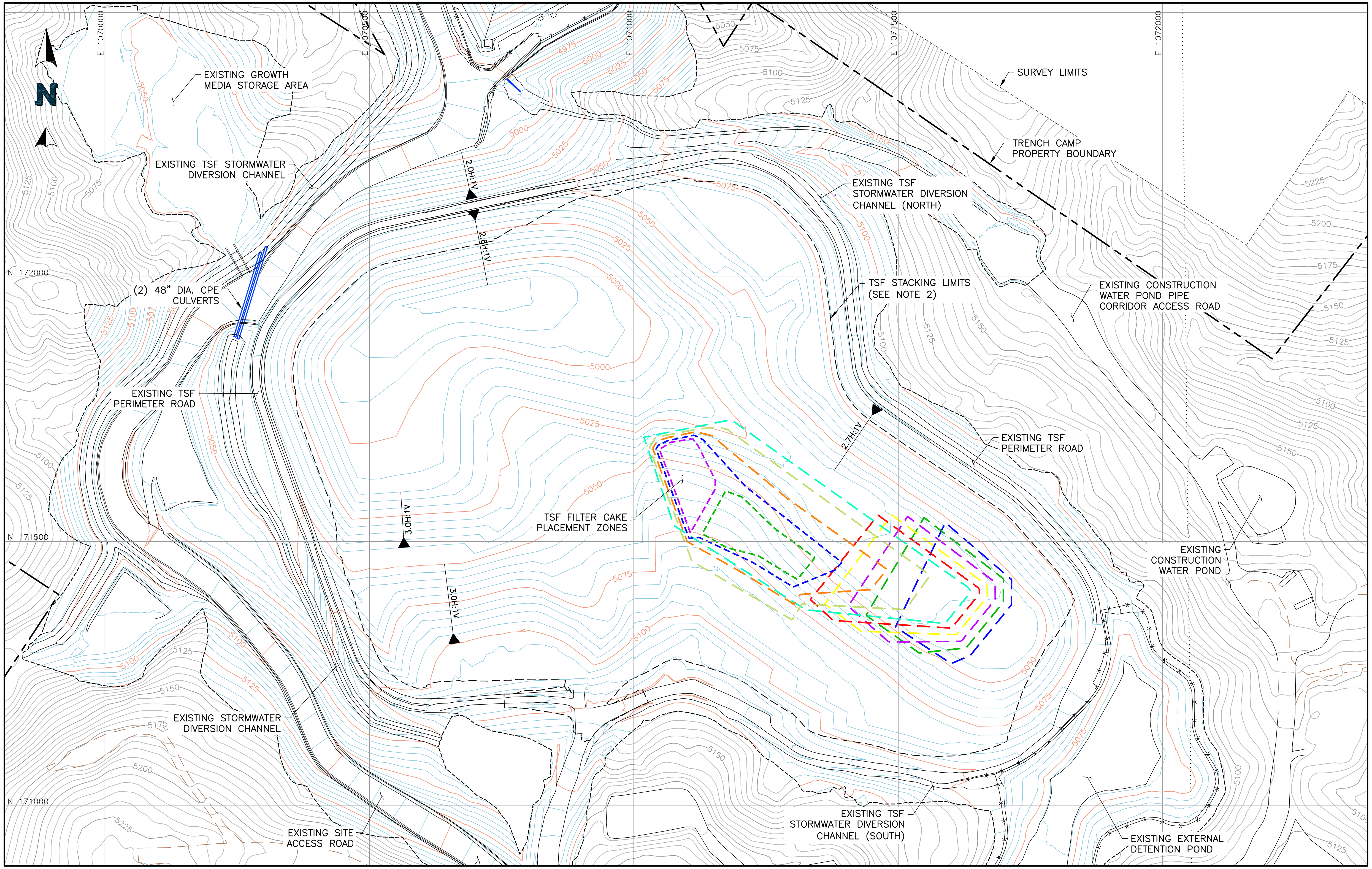

0 100 200 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE
- BELOW ELEV. 5,050'
- ELEV. 5,055' TO 5,050'
- ELEV. 5,060' TO 5,055'
- ELEV. 5,065' TO 5,060'
- ELEV. 5,070' TO 5,065'
- ELEV. 5,075' TO 5,070'
- ELEV. 5,100' TO 5,075'
- ELEV. 5,125' TO 5,100'
- ELEV. 5,150' TO 5,125
- ELEV. 5,165' TO 5,150'
- ELEV. 5,175' TO 5,165'

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. TSF STACKING NOT SHOWN FOR CLARITY.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

P:\Projects\0014.022 Hermosa VRP TSF Expansion\A-CAD\DWGS\14.022.021M.dwg-7/23/2020 10:22 AM

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

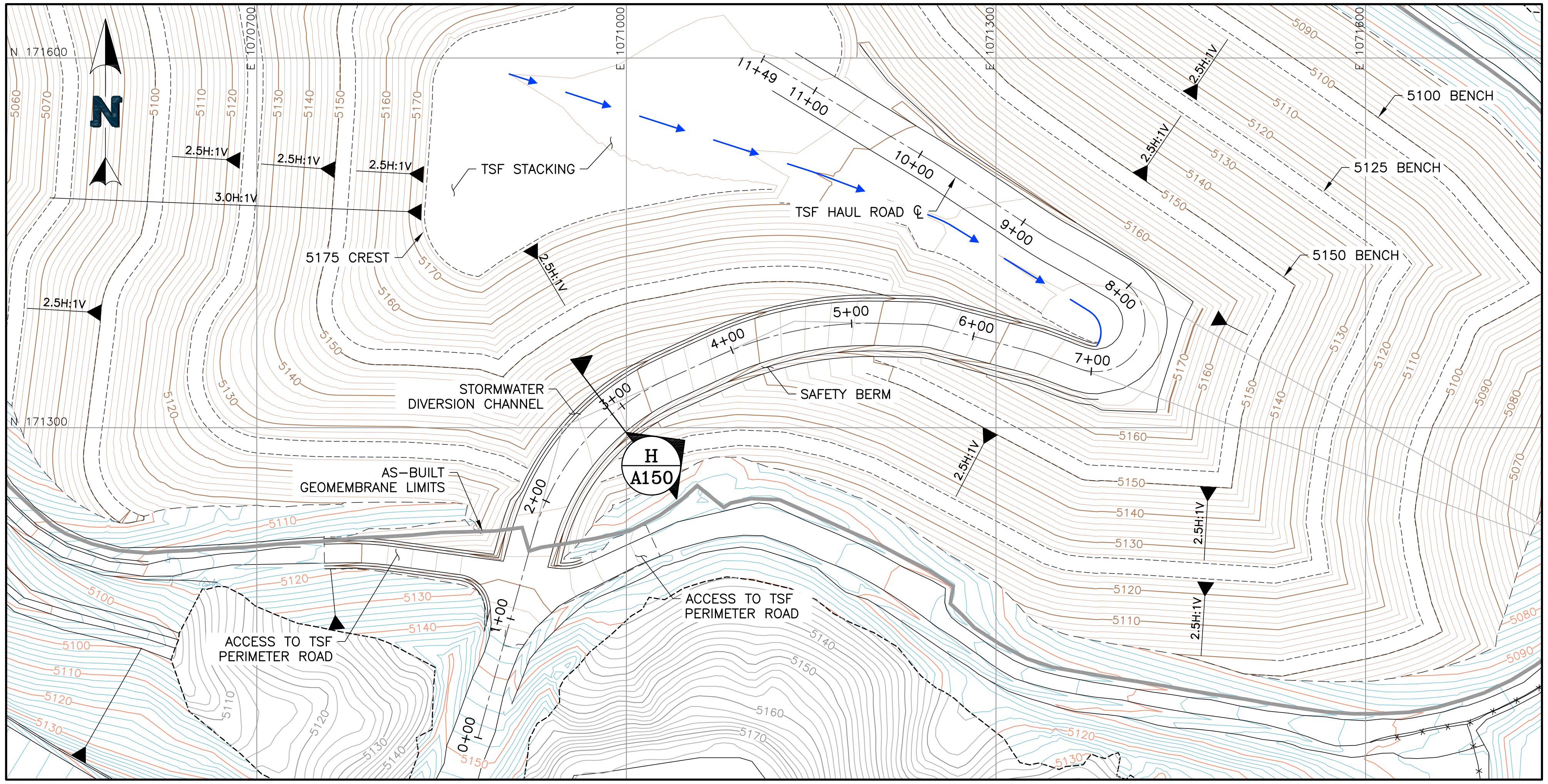
PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: FILTER CAKE PLAN VIEW

FILENAME: 14.022.021M

DRAWING NO.: A130

REVISION: 0

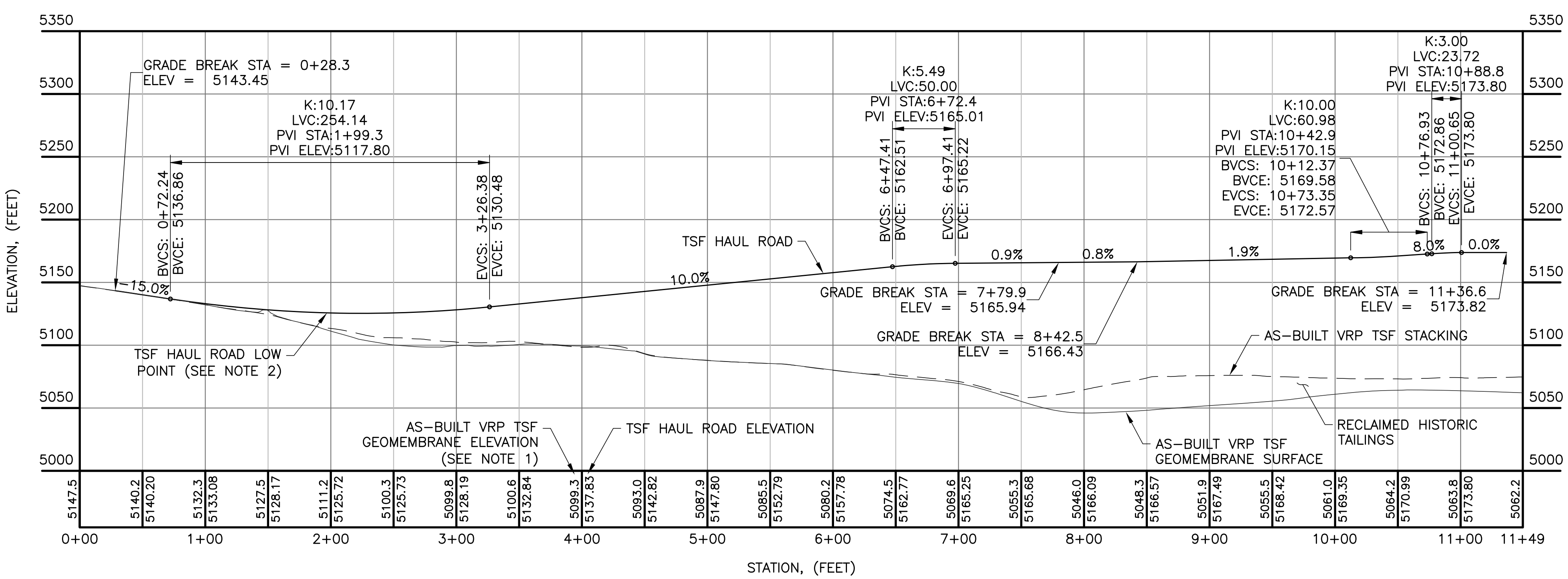


LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- AS-BUILT GEOMEMBRANE LIMITS

0 60 120 FEET

	TSF HAUL ROAD ALIGNMENT TABLE					
	STATION	NORTHING	EASTING	DELTA (D-M-S)	LENGTH (FT)	RADIUS (FT)
BP	0+00.00	171,048.33	1,070,879.62			
PC	1+68.15	171,210.51	1,070,923.99	050-12-20	175.25	200.00
PT	3+43.40	171,339.74	1,071,033.98			
PC	3+86.88	171,357.77	1,071,073.55	025-53-44	135.59	300.00
PT	5+22.47	171,384.68	1,071,205.27			
PC	5+55.78	171,383.86	1,071,238.57	013-29-23	14.13	60.00
PT	5+69.91	171,381.87	1,071,252.52			
PC	6+50.82	171,361.08	1,071,330.71	005-20-09	5.59	60.00
PT	6+56.40	171,359.39	1,071,336.03			
PC	6+89.54	171,347.93	1,071,367.13	169-59-06	118.67	40.00
PT	8+08.22	171,420.02	1,071,401.11			
PC	8+37.51	171,434.78	1,071,375.80	001-05-30	2.38	125.00
PT	8+39.89	171,435.96	1,071,373.73			
PC	8+69.05	171,450.16	1,071,348.27	004-36-42	16.10	200.00
PT	8+85.15	171,458.56	1,071,334.54			
PC	9+81.24	171,511.96	1,071,254.65	002-37-09	5.71	125.00
PT	9+86.95	171,515.02	1,071,249.83			
EP	11+49.48	171,599.08	1,071,110.73			



NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. THE TSF HAUL ROAD LOW POINT SHALL BE OVER THE GEOMEMBRANE LINED SURFACE TO PREVENT STROMWATER RUNOFF FROM EXISTING THE TSF ON THE HAUL ROAD.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

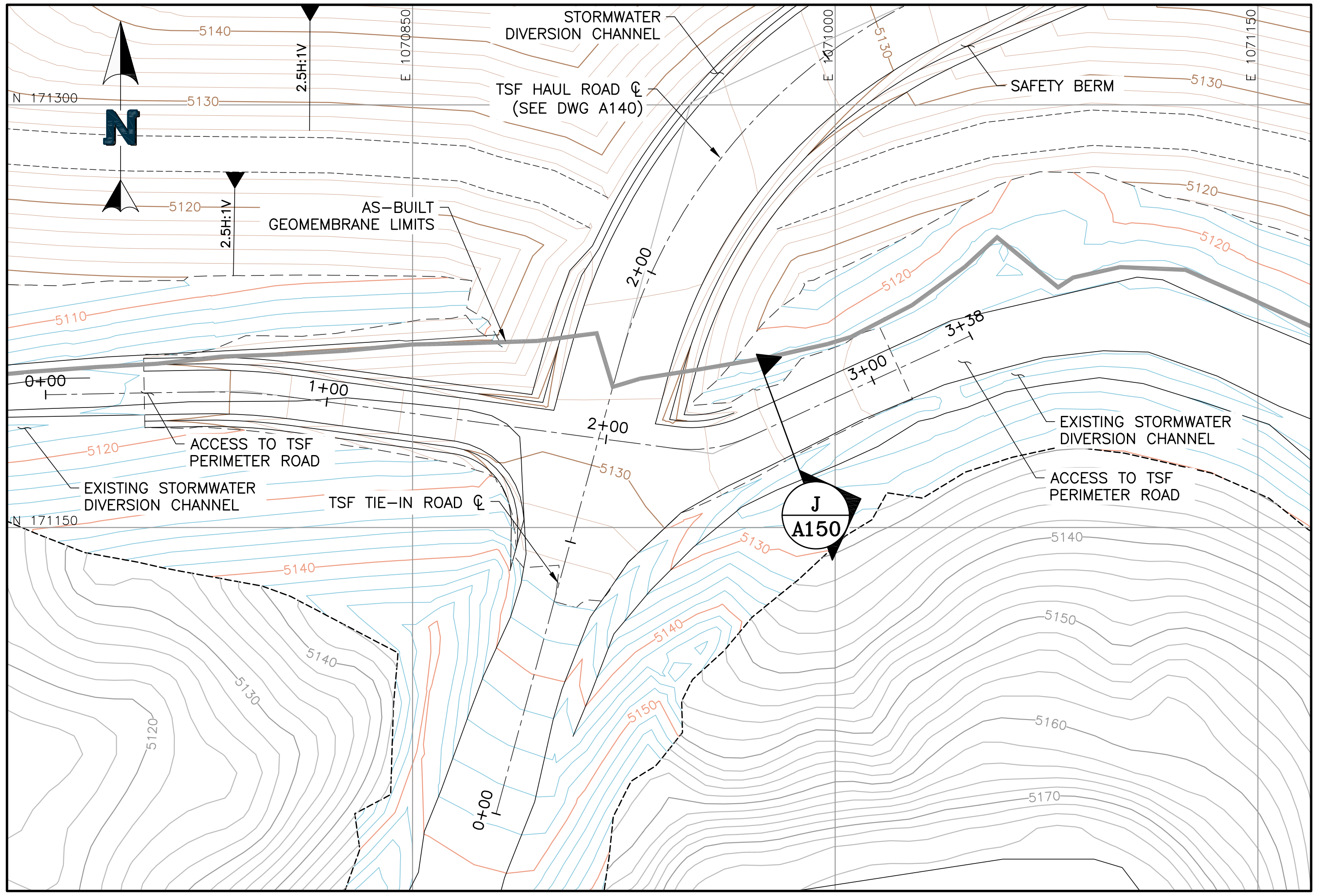
TITLE: TSF HAUL ROAD PLAN AND PROFILE

FILENAME: 14.022.017P

DRAWING NO.: A140

REVISION: 0

P:\Projects\0014.022 Hermosa VRP TSF Expansion\A-CAD\DWGS\14.022.017P.dwg-7/31/2020 9:46 AM

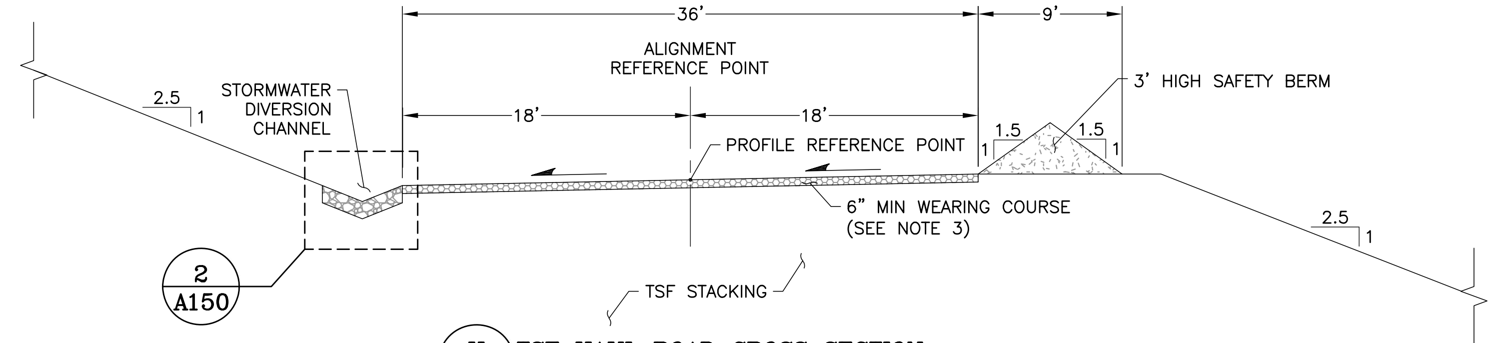


LEGEND:

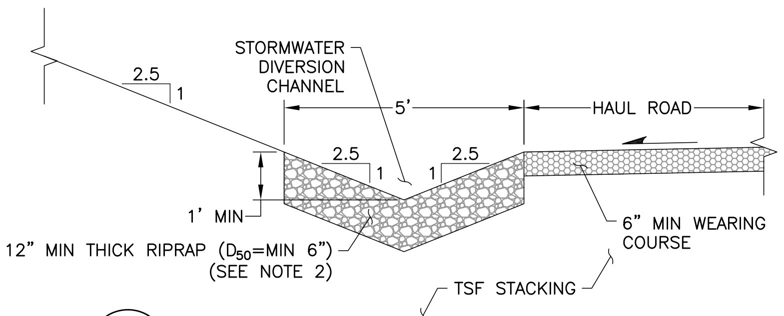
- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- AS-BUILT GEOMEMBRANE LIMITS

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. THE STORMWATER DIVERSION CHANNEL RIPRAP SHOULD BE GENERATED FROM PLACEMENT OF SELECT EXPLORATION DECLINE DEVELOPMENT ROCK THAT FITS THE MINIMUM RIPRAP GRADATION.
3. WEARING COURSE MAY BE GENERATED FROM PLACEMENT OF SELECT EXPLORATION DECLINE DEVELOPMENT ROCK THAT FITS THE WEARING COURSE TECHNICAL SPECIFICATION REQUIREMENTS.

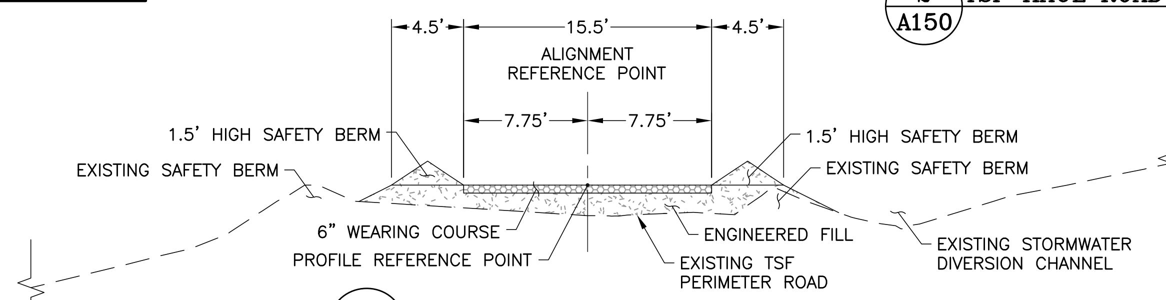


H A140 TSF HAUL ROAD CROSS SECTION

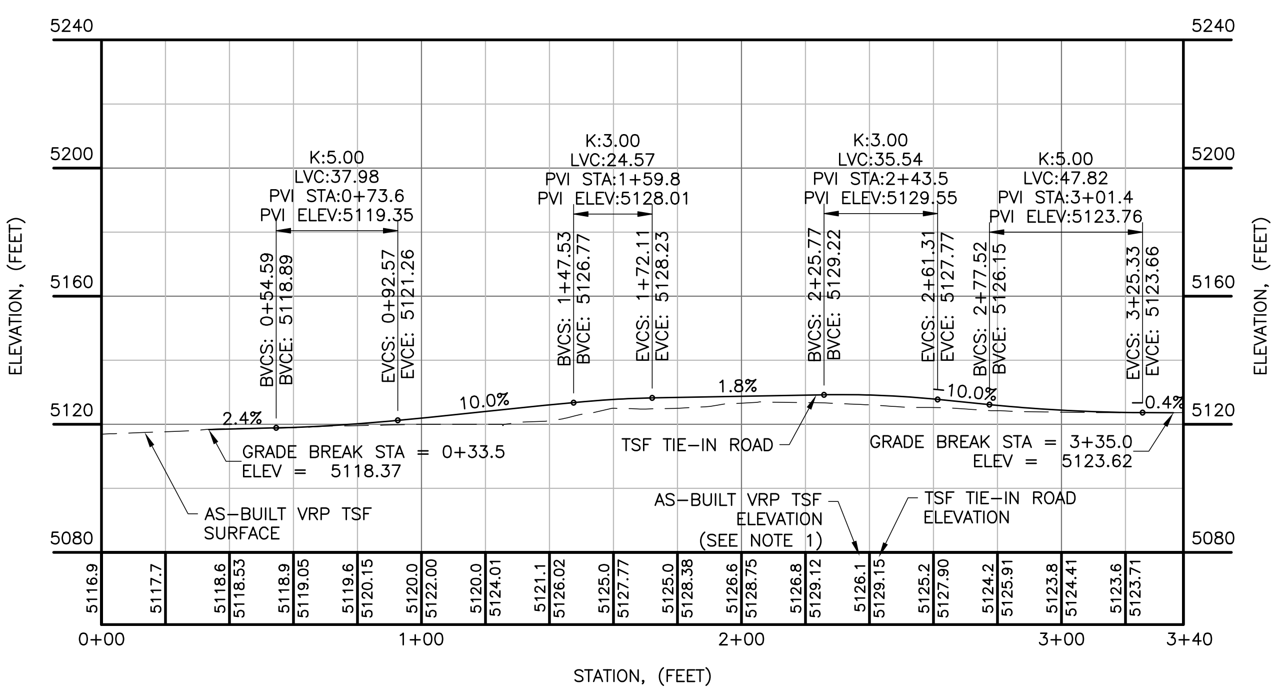


0 30 60 FEET

2 A150 TSF HAUL ROAD STORMWATER DIVERSION CHANNEL



J A150 TSF TIE-IN ROAD CROSS SECTION



0 30 60 FEET HORIZONTAL — 0 30 60 FEET VERTICAL

NO EXAGGERATION

TSF TIE-IN ROAD ALIGNMENT TABLE						
	STATION	NORTHING	EASTING	DELTA (D-M-S)	LENGTH (FT)	RADIUS (FT)
BP	0+00.00	171,197.11	1,070,719.77			
PC	0+54.11	171,198.10	1,070,773.87	008-41-13	34.11	225.00
PT	0+88.23	171,196.14	1,070,807.89			
PC	2+23.77	171,178.12	1,070,942.23	032-14-36	28.14	50.00
PT	2+51.90	171,182.22	1,070,969.70			
EP	3+38.11	171,218.11	1,071,048.08			

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

REFERENCE:

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REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TSF HAUL ROAD INTERSECTION PLAN AND PROFILE

FILENAME: 14.022.018P
DRAWING NO.: A150
REVISION: 0

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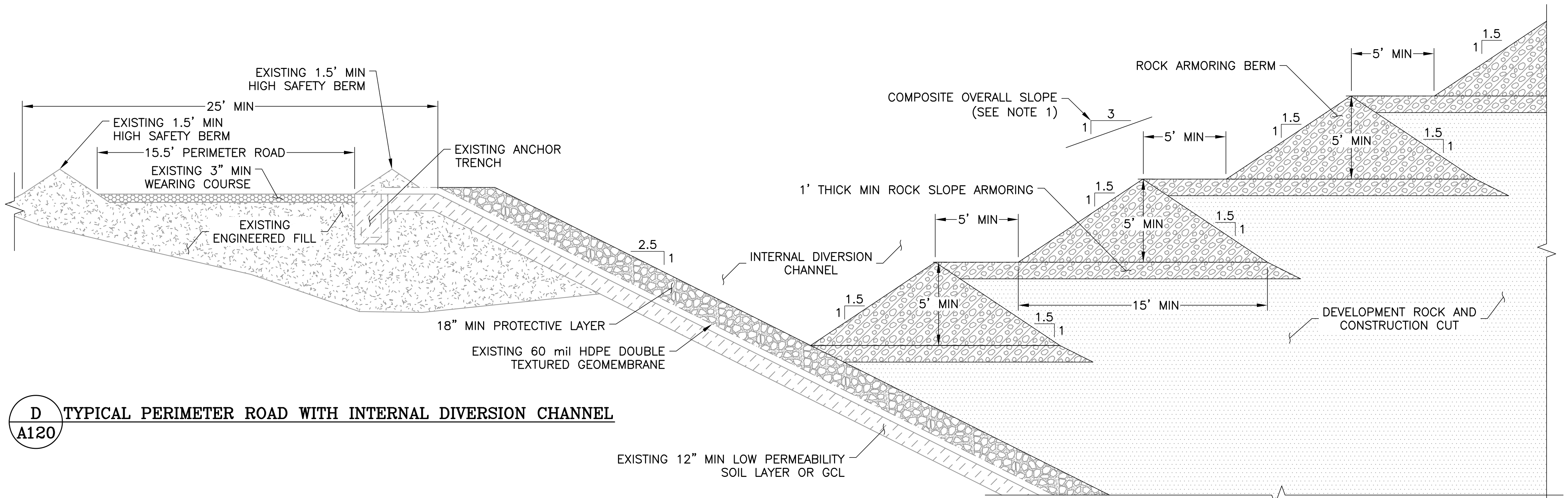
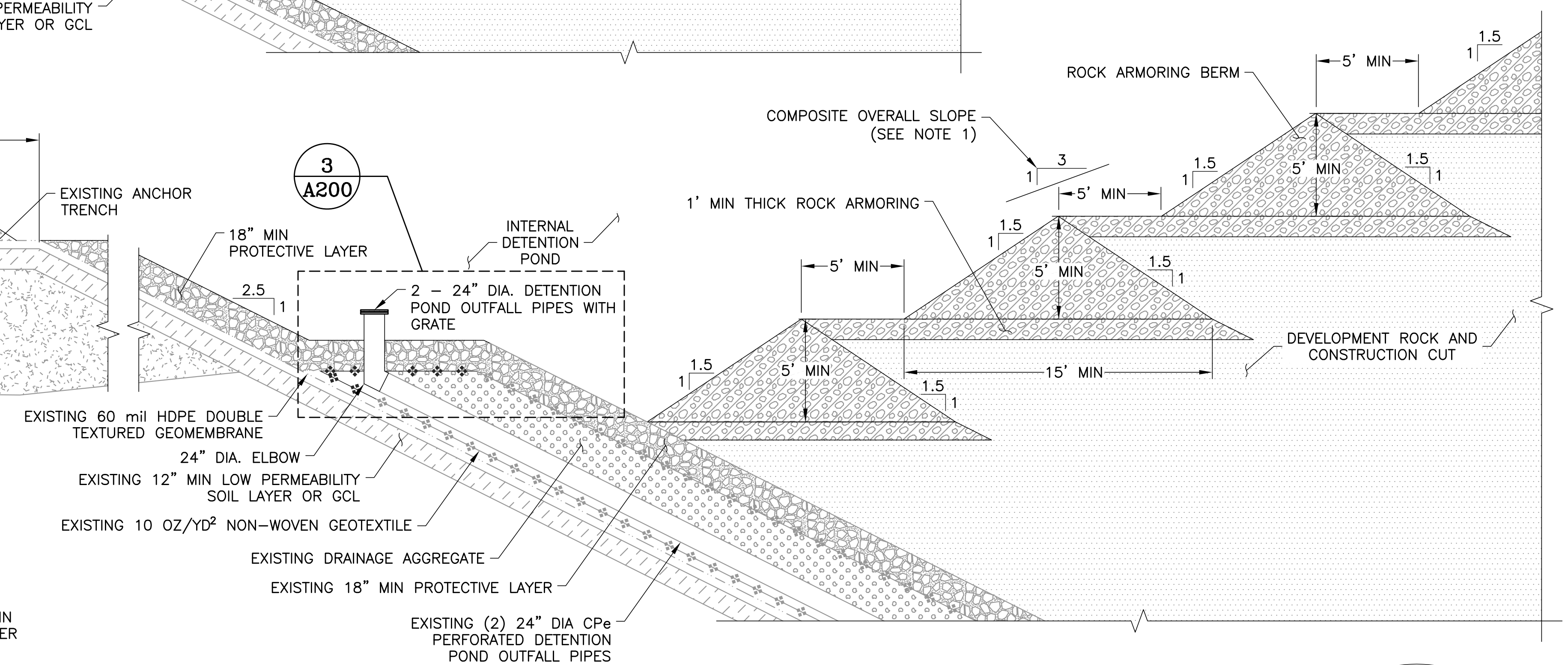


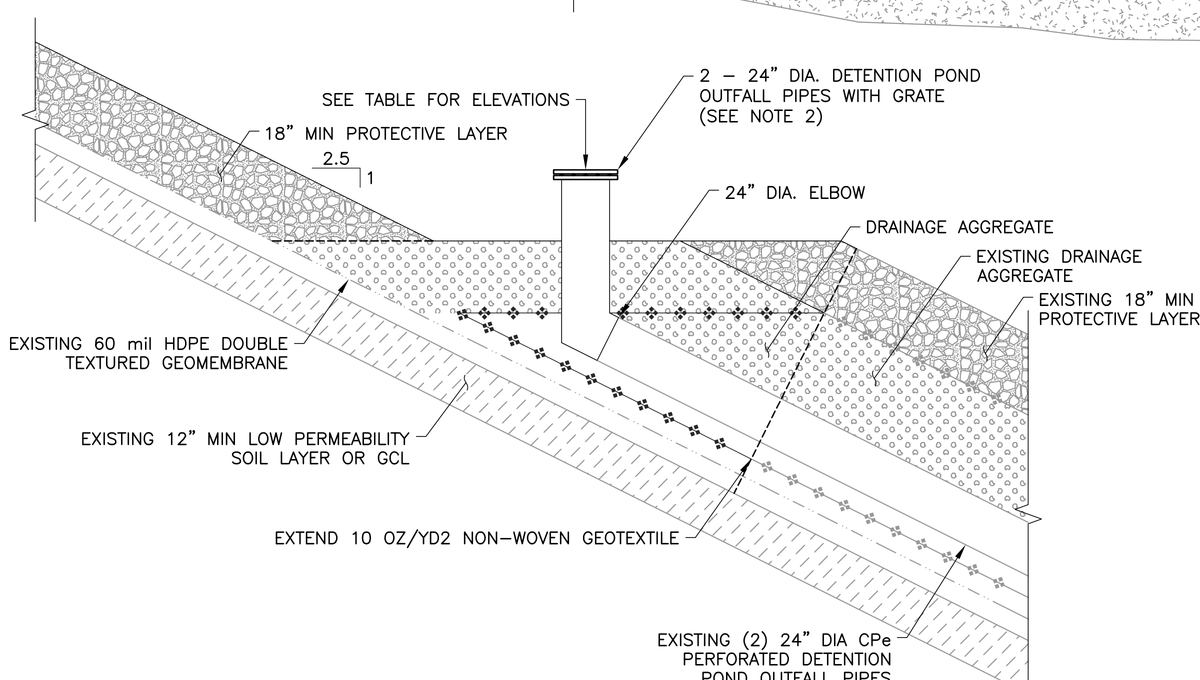
D
A120
TYPICAL PERIMETER ROAD WITH INTERNAL DIVERSION CHANNEL

NOTES:

1. 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FT HIGH 2.5H:1V SLOPES IN COMBINATION WITH A 12.5 FT BENCH (SEE DRAWING A220).
2. THE PIPING AND PROTECTIVE LAYER INSTALLATION SHOWN HAS ALREADY BEEN APPROVED AND WILL BE INSTALLED IN ACCORDANCE WITH THE STATE OF ARIZONA, AQUIFER PROTECTION PERMIT NO P-512235 APPROVED JANUARY 8TH, 2018.



E
A120
TYPICAL PERIMETER ROAD WITH INTERNAL DETENTION POND



3
A200
2 – 24" DIA DETENTION POND OUTFALL PIPE RISERS

INTERNAL DETENTION POND OUTFALL PIPES		
POND NAME	PIPE INLET ELEVATION (FT)	NOTES
WEST INTERNAL DETENTION POND (DRAWING A300)	5022	RISER PIPES ARE CURRENTLY INSTALLED. INLET ELEVATION TO BE VERIFIED.
EAST INTERNAL DETENTION POND (DRAWING A310)	5060	RISER PIPES TO BE INSTALLED AS DETAILED ON THIS SHEET.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: CMT
DRAWN BY: SEB

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TYPICAL SECTIONS AND DETAILS (1 OF 3)

FILENAME: 14.022.004D
DRAWING NO.: A200
REVISION: 0

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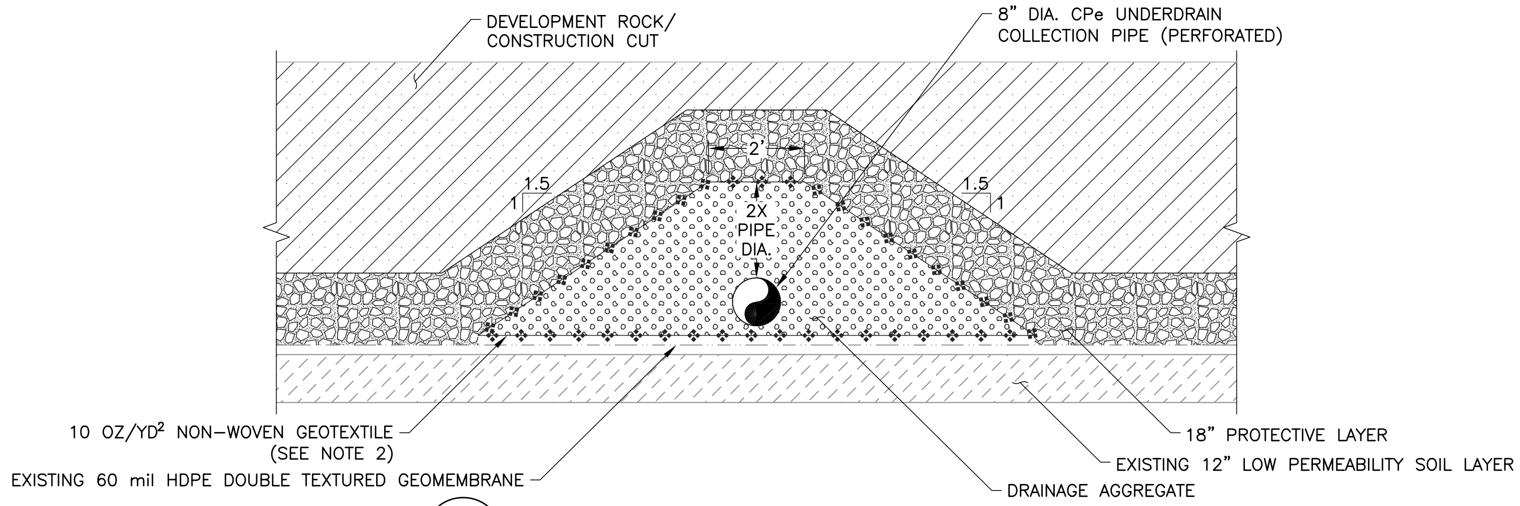
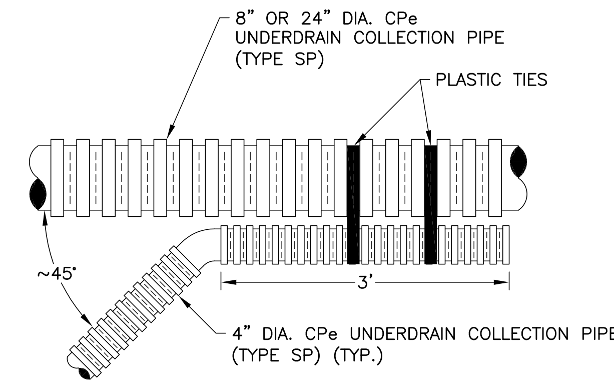


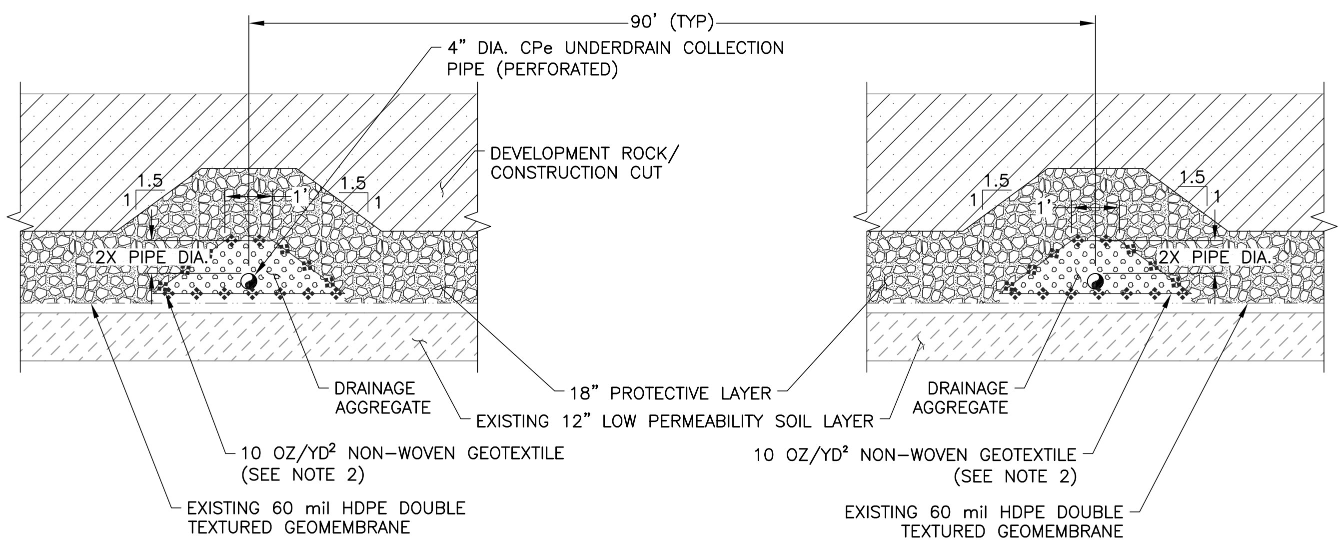
A
A110
UNDERDRAIN BASIN HEADER – 8" PIPE



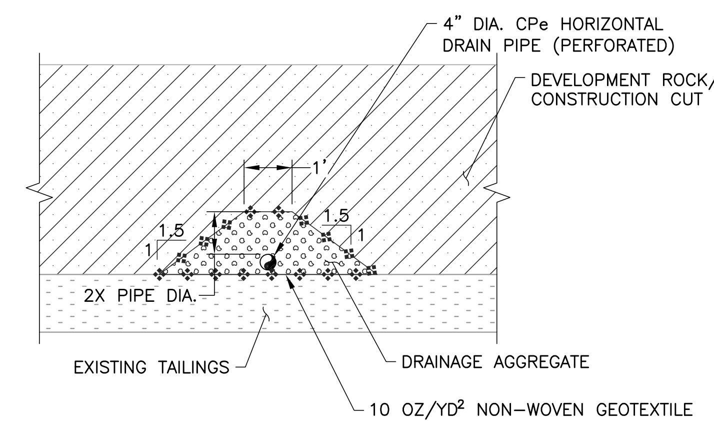
1
A110
UNDERDRAIN COLLECTION PIPE INTERSECTION

NOTES:

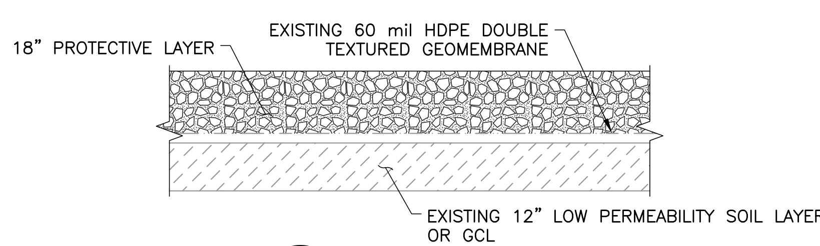
1. ALL UPSTREAM OPEN ENDS OF PIPES TO BE CAPPED.
2. WHEN EXTENDING PREVIOUSLY INSTALLED UNDERDRAIN COLLECTION PIPING, REMOVE ALL PREVIOUSLY INSTALLED NON–WOVEN GEOTEXTILE THAT IS EXPOSED. AFTER THE EXPOSED NON–WOVEN GEOTEXTILE IS REMOVED, THE BURIED PORTION OF THE PREVIOUSLY INSTALLED NON–WOVEN GEOTEXTILE CAN BE UNCOVERED AND THE NEW NON–WOVEN GEOTEXTILE CAN BE TIED IN.



B1
A110
UNDERDRAIN BASIN HEADER– 4" PIPE



B2
A110
HORIZONTAL DRAIN PIPE – 4" PIPE



C
A110
TYPICAL BASIN SECTION

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER
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NewFields

CLIENT: ARIZONA MINERALS INC
PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: TYPICAL SECTIONS AND DETAILS (2 OF 3)
FILENAME: 14.022.005D
DRAWING NO.: A210
REVISION: 0

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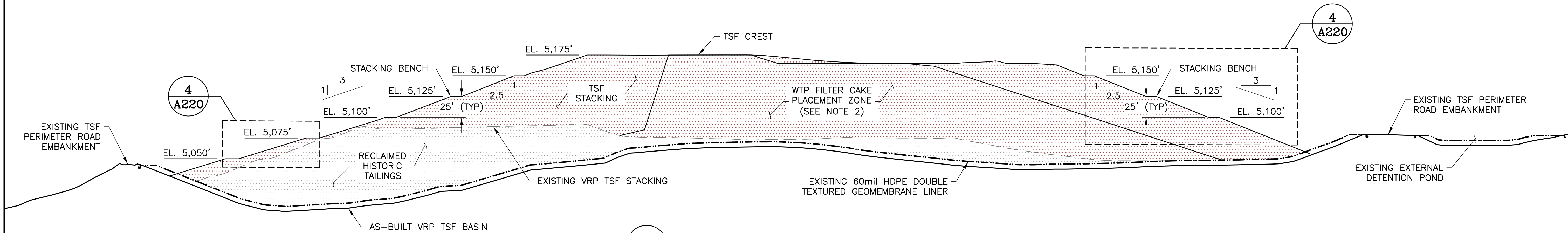
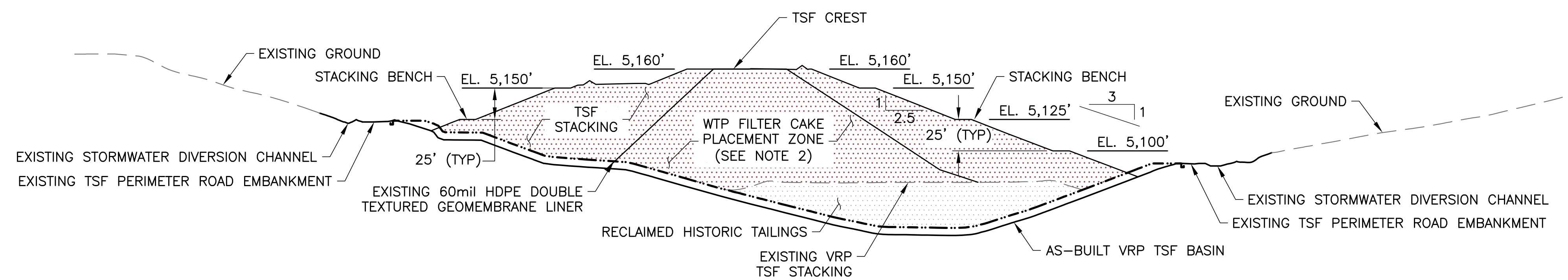
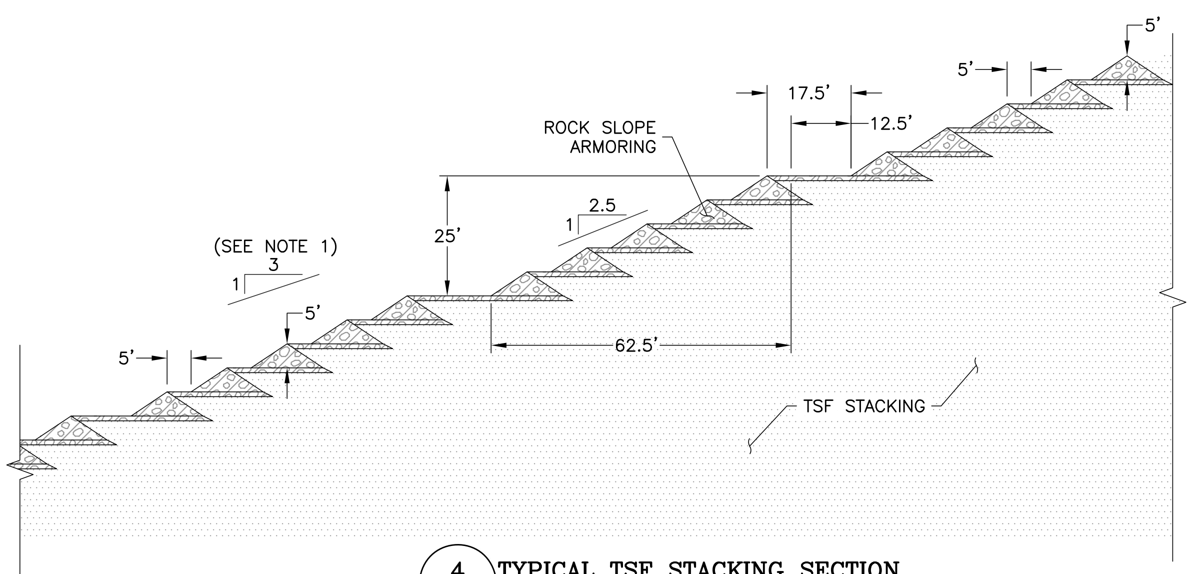


F
A120
TSF STACKING SECTION



G
A120
TSF STACKING SECTION



4
A220
TYPICAL TSF STACKING SECTION

NOTES:

1. TAILINGS 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FOOT HIGH 2.5H:1V SLOPES IN COMBINATION WITH A 12.5 FOOT BENCH.
2. THE WTP FILTER CAKE PLACEMENT ZONE LIMITS (WHICH INCLUDES CORE CUTTING MATERIAL, DRILL CUTTINGS AND SEDIMENTS FROM STORMWATER BMPS) WERE SET INTERNAL TO THE STACKING. THE ZONE IDENTIFIED AS WTP FILTER CAKE PLACEMENT ZONE IS LARGER THAN THE ESTIMATED MATERIAL QUANTITIES TO PROVIDE SOME OPERATIONAL FLEXIBILITY. EXPLORATION DECLINE DEVELOPMENT ROCK AND CONSTRUCTION CUT SHALL BE PLACED IN THE WTP FILTER CAKE PLACEMENT ZONE TO OCCUPY THE REMAINDER OF THE UNUSED VOLUME. ONLY MATERIAL SPECIFIED IN THE WTP FILTER CAKE ZONE IS LIMITED BY A GEOMETRIC AREA.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER
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NewFields

CLIENT: ARIZONA MINERALS INC
PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: TYPICAL SECTIONS AND DETAILS (3 OF 3)
FILENAME: 14.022.007D
DRAWING NO.: A220
REVISION: 0

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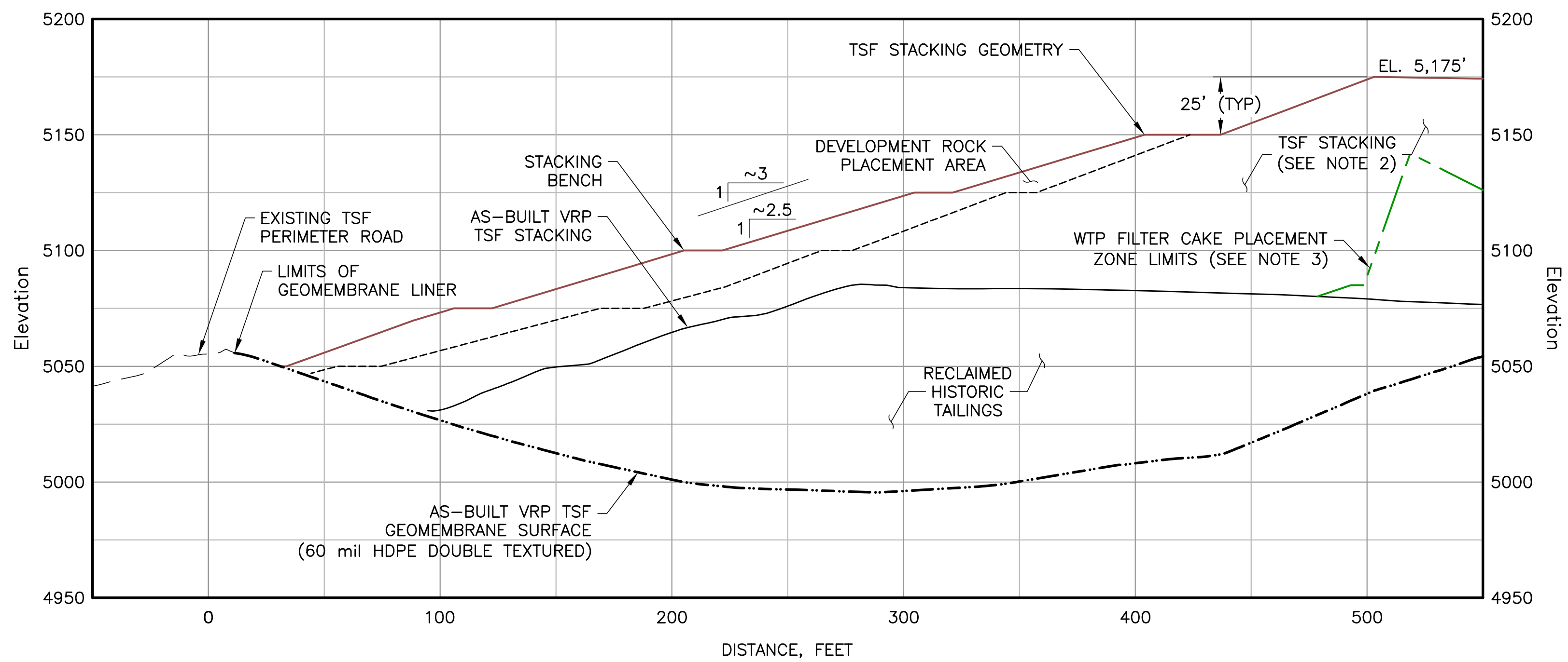
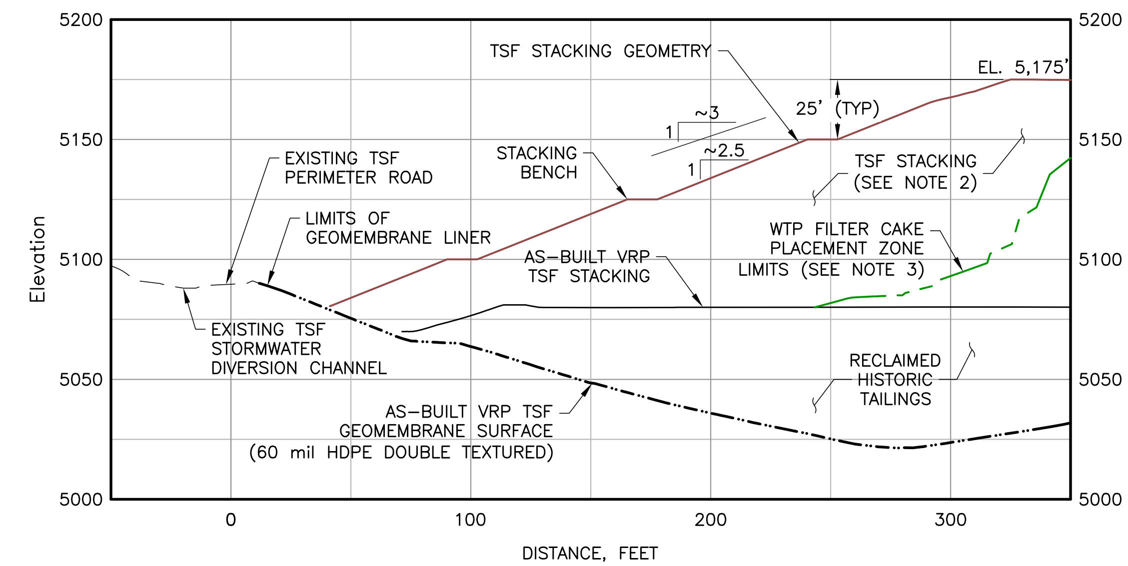
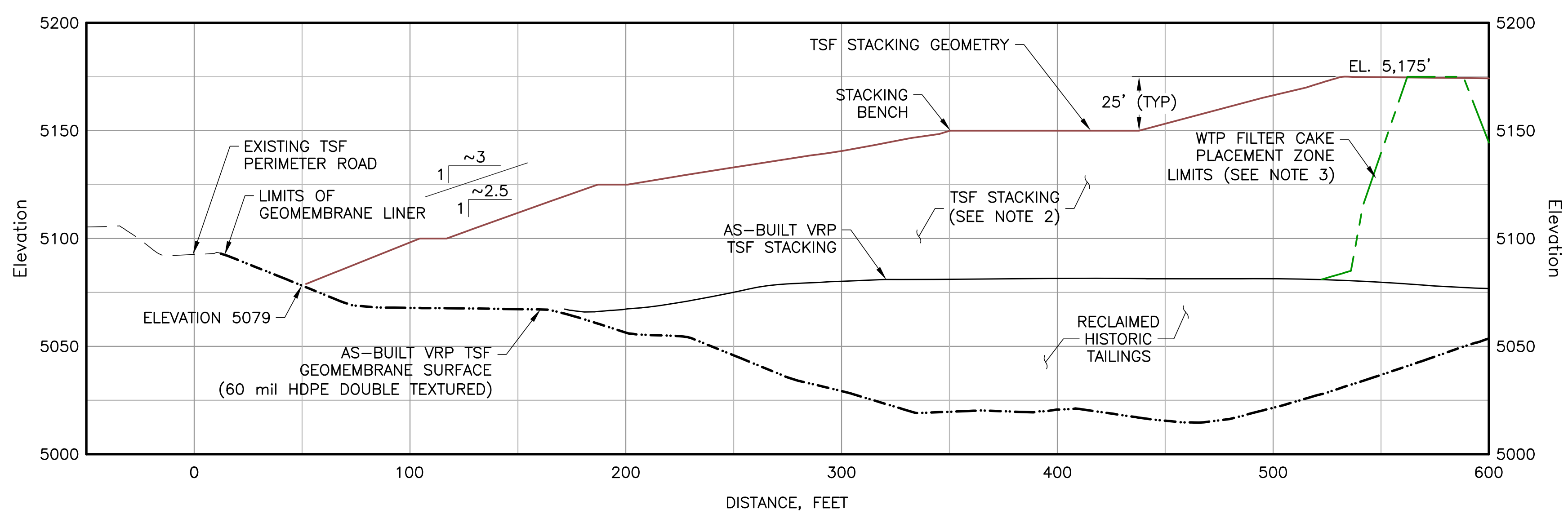


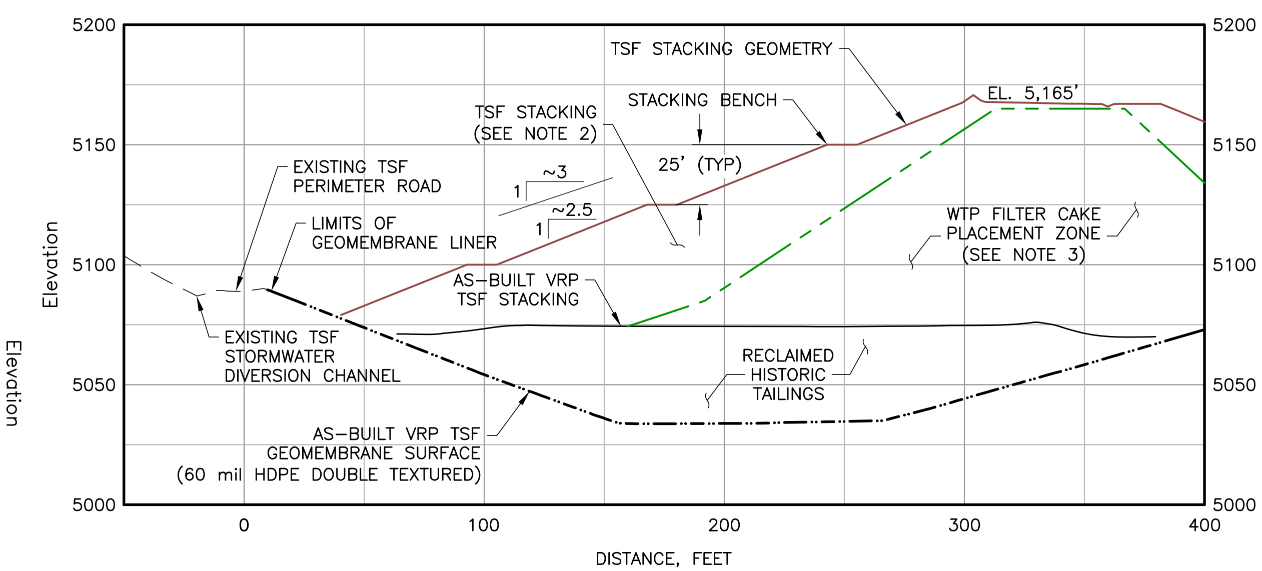
TSF STACKING SECTION (STATION 6+00)



TSF STACKING SECTION (STATION 13+80)



TSF STACKING SECTION (STATION 9+00)



TSF STACKING SECTION (STATION 15+00)

NOTES:

1. REFER TO DRAWING A120 FOR TSF PERIMETER ROAD ALIGNMENT STATIONING SHOWN IN PLAN VIEW THAT IS ASSOCIATED WITH EACH SECTION.
2. THE TSF STACKING CONSISTS OF THE FOLLOWING MATERIALS:
   - EXPLORATION DECLINE DEVELOPMENT ROCK
   - CONSTRUCTION CUT
   - WTP FILTER CAKE
   - MATERIAL FROM CORE CUTTING
   - DRILL CUTTINGS
   - SEDIMENTS FROM STORMWATER BMPS
3. THE WTP FILTER CAKE PLACEMENT ZONE LIMITS (WHICH INCLUDES CORE CUTTING MATERIAL, DRILL CUTTINGS AND SEDIMENTS FROM STORMWATER BMPS) WERE SET INTERNAL TO THE STACKING. THE ZONE IDENTIFIED AS WTP FILTER CAKE PLACEMENT ZONE IS LARGER THAN THE ESTIMATED MATERIAL QUANTITIES TO PROVIDE SOME OPERATIONAL FLEXIBILITY. EXPLORATION DECLINE DEVELOPMENT ROCK AND CONSTRUCTION CUT SHALL BE PLACED IN THE WTP FILTER CAKE PLACEMENT ZONE TO OCCUPY THE REMAINDER OF THE UNUSED VOLUME. ONLY MATERIAL SPECIFIED IN THE WTP FILTER CAKE ZONE IS LIMITED BY A GEOMETRIC AREA.

0 40 80 FEET HORIZONTAL — 0 40 80 FEET VERTICAL

NO EXAGGERATION

Registered Professional Engineer (Civil) — CERTIFICATE NO. 63431 — CRAIG M. THOMPSON — Date Signed 7/27/20 — ARIZONA, U.S.A. — EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER

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CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TSF STACKING SECTIONS (1 OF 3)

FILENAME: 14.022.015D

DRAWING NO.: A230

REVISION: 0

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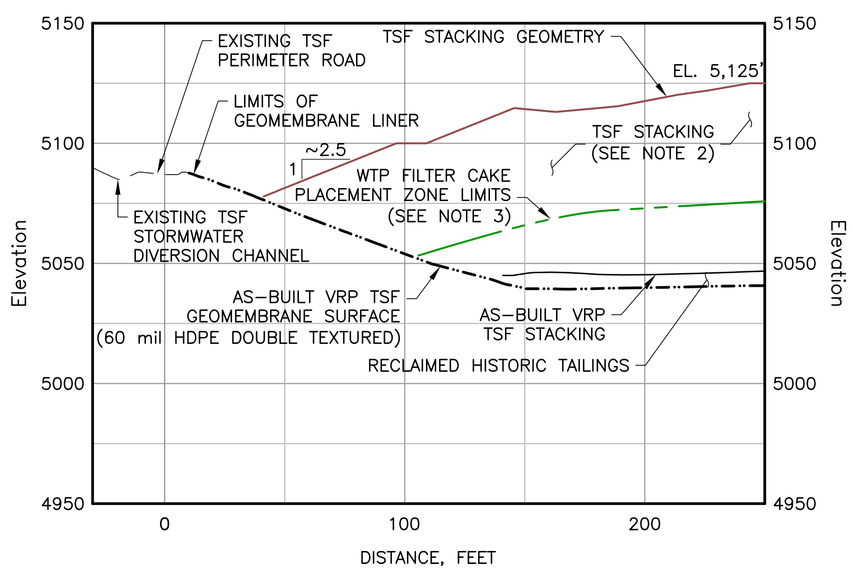
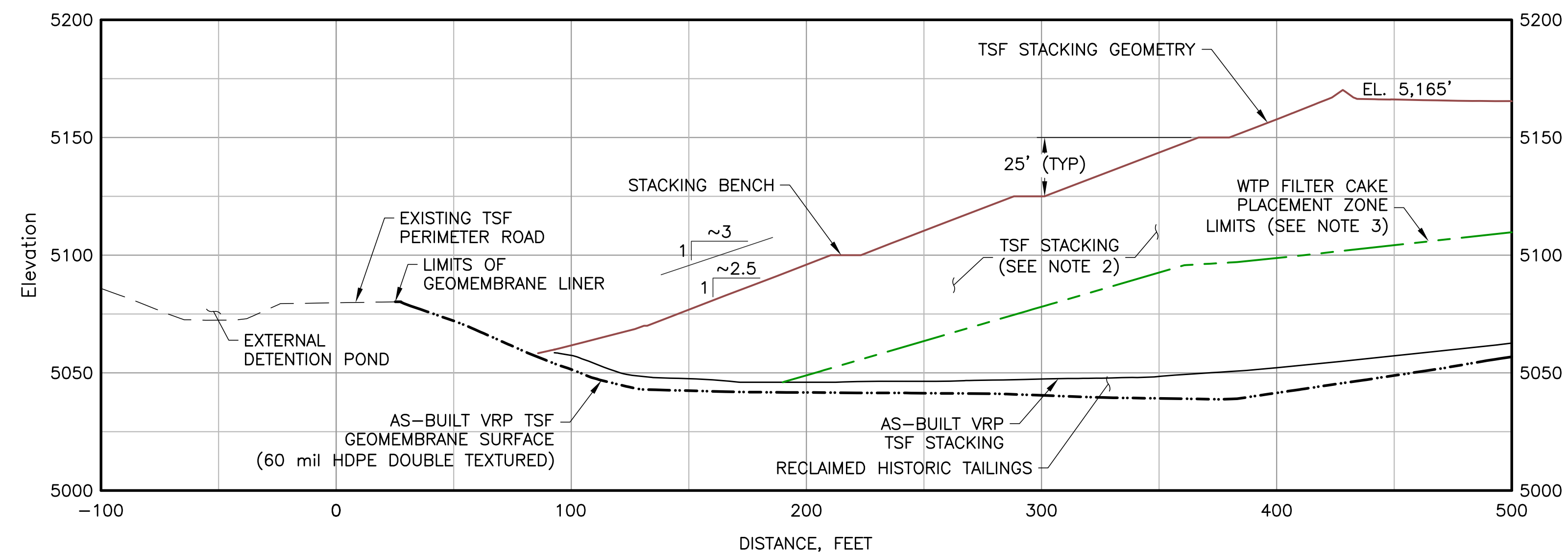
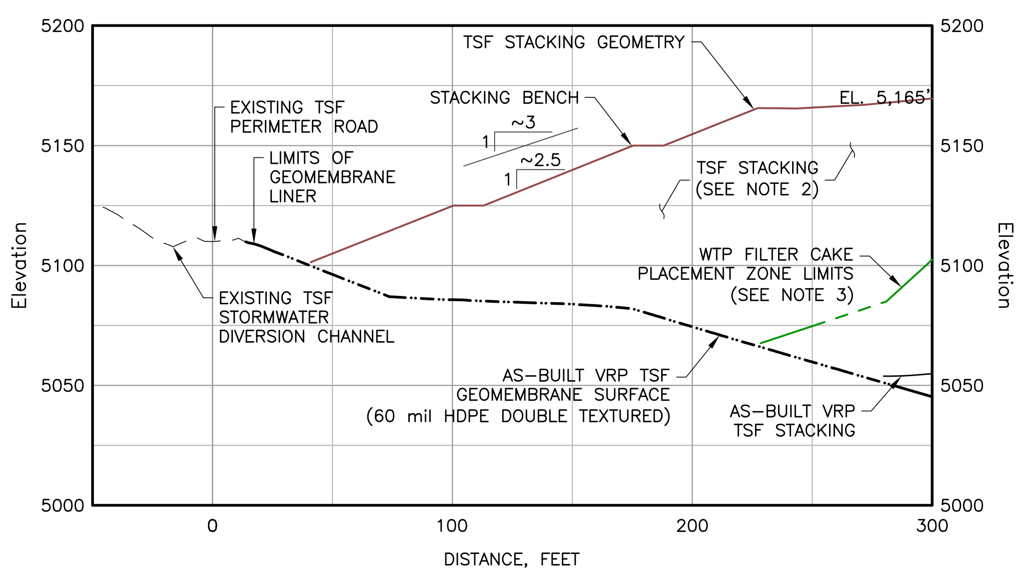


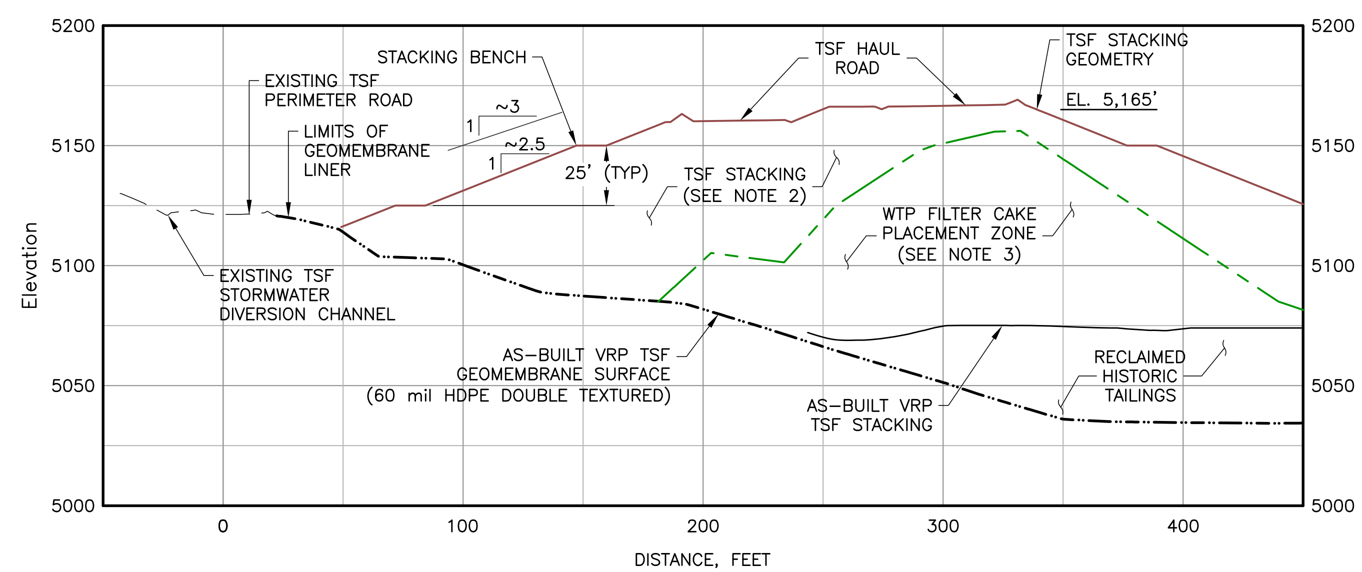
TSF STACKING SECTION (STATION 18+50)



TSF STACKING SECTION (STATION 21+00)



TSF STACKING SECTION (STATION 27+00)



TSF STACKING SECTION (STATION 29+50)

NOTES:

1. REFER TO DRAWING A120 FOR TSF PERIMETER ROAD ALIGNMENT STATIONING SHOWN IN PLAN VIEW THAT IS ASSOCIATED WITH EACH SECTION.
2. THE TSF STACKING CONSISTS OF THE FOLLOWING MATERIALS:
   - EXPLORATION DECLINE DEVELOPMENT ROCK
   - CONSTRUCTION CUT
   - WTP FILTER CAKE
   - MATERIAL FROM CORE CUTTING
   - DRILL CUTTINGS
   - SEDIMENTS FROM STORMWATER BMPS
3. THE WTP FILTER CAKE PLACEMENT ZONE LIMITS (WHICH INCLUDES CORE CUTTING MATERIAL, DRILL CUTTINGS AND SEDIMENTS FROM STORMWATER BMPS) WERE SET INTERNAL TO THE STACKING. THE ZONE IDENTIFIED AS WTP FILTER CAKE PLACEMENT ZONE IS LARGER THAN THE ESTIMATED MATERIAL QUANTITIES TO PROVIDE SOME OPERATIONAL FLEXIBILITY. EXPLORATION DECLINE DEVELOPMENT ROCK AND CONSTRUCTION CUT SHALL BE PLACED IN THE WTP FILTER CAKE PLACEMENT ZONE TO OCCUPY THE REMAINDER OF THE UNUSED VOLUME. ONLY MATERIAL SPECIFIED IN THE WTP FILTER CAKE ZONE IS LIMITED BY A GEOMETRIC AREA.

0 40 80 FEET — HORIZONTAL
0 40 80 FEET — VERTICAL
NO EXAGGERATION

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

DISCLAIMER
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NewFields

CLIENT: ARIZONA MINERALS INC
PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: TSF STACKING SECTIONS (2 OF 3)
FILENAME: 14.022.015D
DRAWING NO.: A240
REVISION: 0

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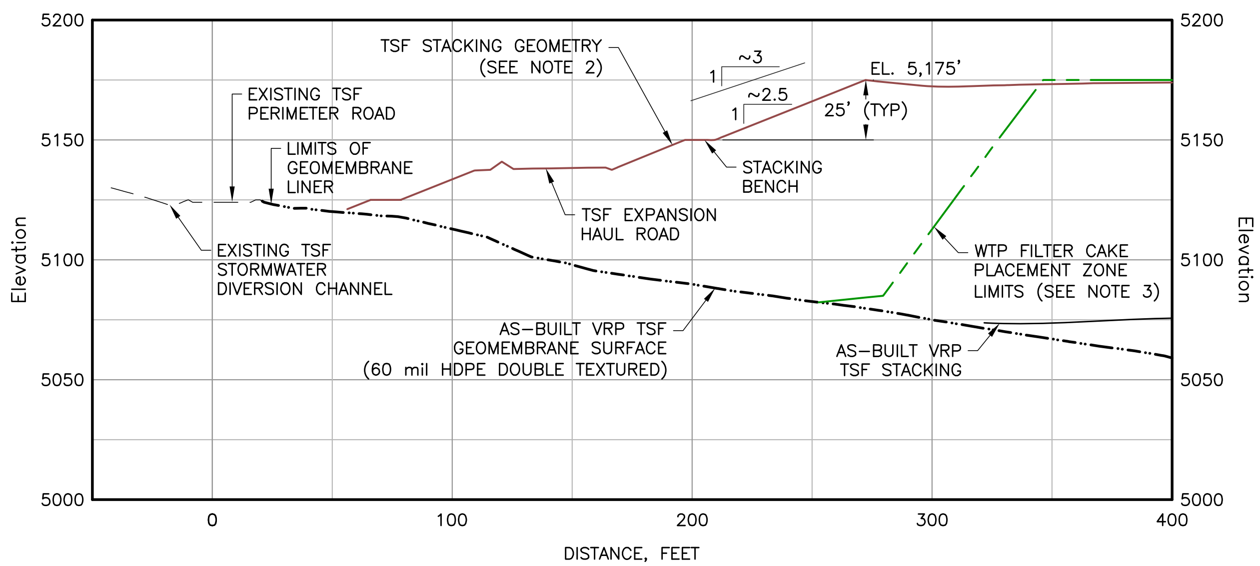
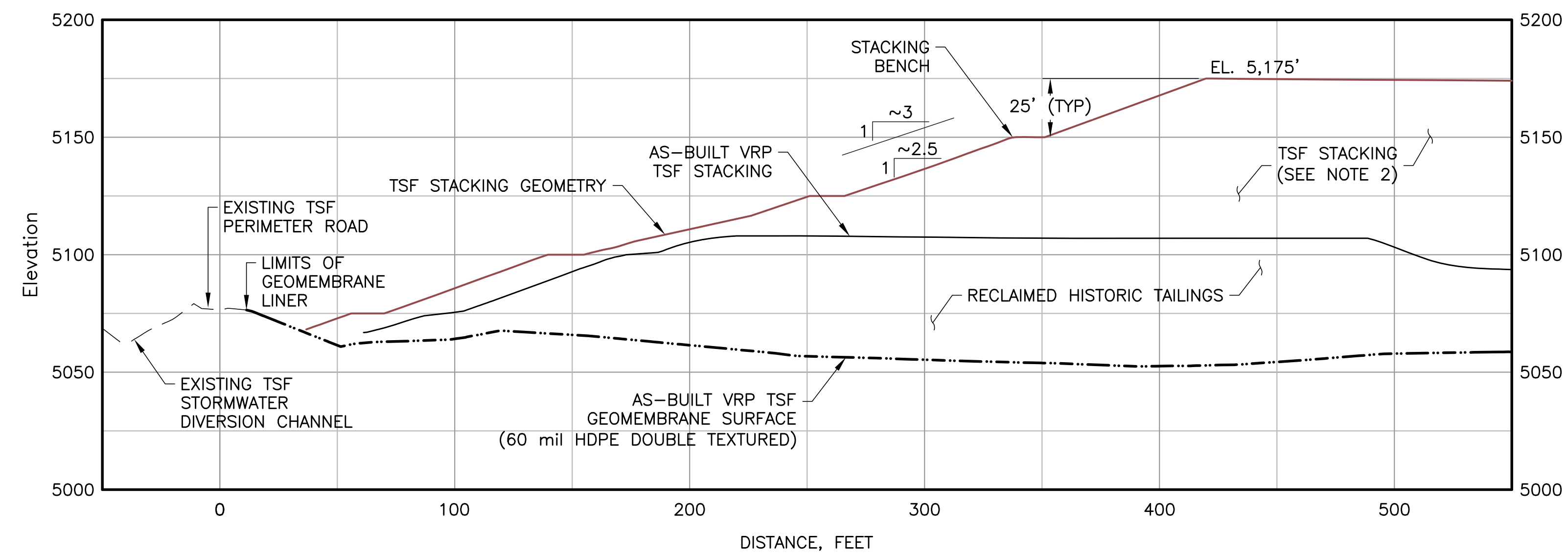
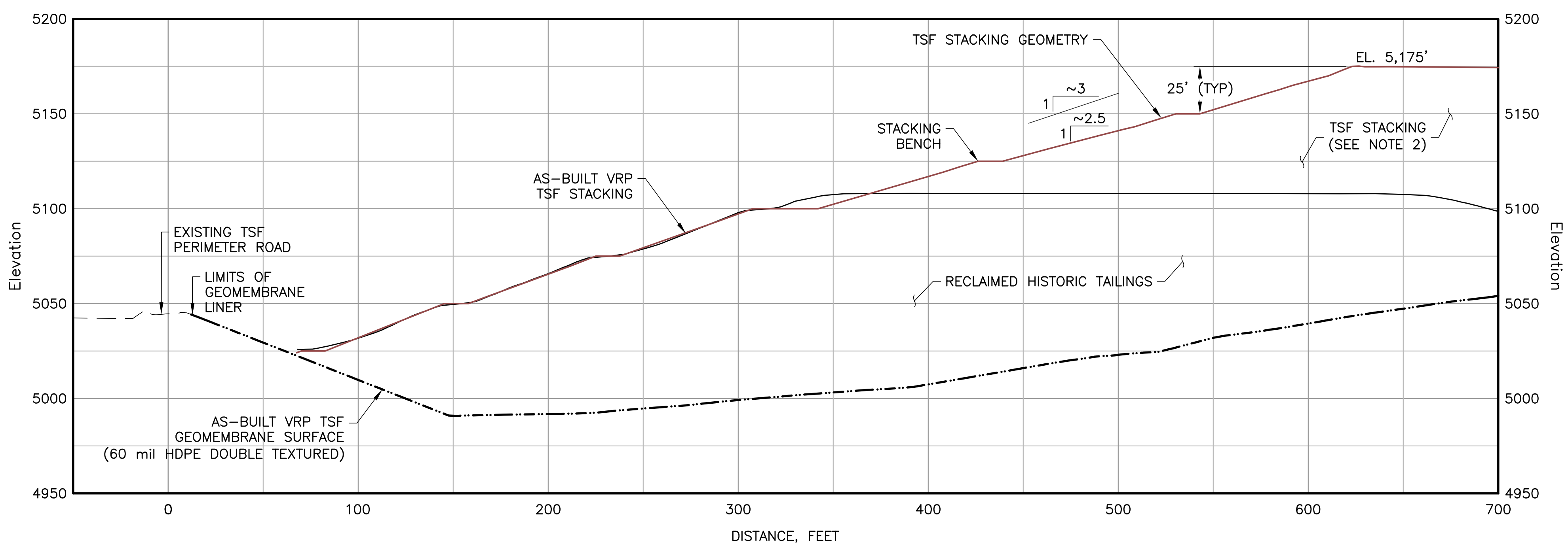


TSF STACKING SECTION (STATION 30+50)



TSF STACKING SECTION (STATION 38+00)



TSF STACKING SECTION (STATION 44+00)

NOTES:

1. REFER TO DRAWING A120 FOR TSF PERIMETER ROAD ALIGNMENT STATIONING SHOWN IN PLAN VIEW THAT IS ASSOCIATED WITH EACH SECTION.
2. THE TSF STACKING CONSISTS OF THE FOLLOWING MATERIALS:
   - EXPLORATION DECLINE DEVELOPMENT ROCK
   - CONSTRUCTION CUT
   - WTP FILTER CAKE
   - MATERIAL FROM CORE CUTTING
   - DRILL CUTTINGS
   - SEDIMENTS FROM STORMWATER BMPS
3. THE WTP FILTER CAKE PLACEMENT ZONE LIMITS (WHICH INCLUDES CORE CUTTING MATERIAL, DRILL CUTTINGS AND SEDIMENTS FROM STORMWATER BMPS) WERE SET INTERNAL TO THE STACKING. THE ZONE IDENTIFIED AS WTP FILTER CAKE PLACEMENT ZONE IS LARGER THAN THE ESTIMATED MATERIAL QUANTITIES TO PROVIDE SOME OPERATIONAL FLEXIBILITY. EXPLORATION DECLINE DEVELOPMENT ROCK AND CONSTRUCTION CUT SHALL BE PLACED IN THE WTP FILTER CAKE PLACEMENT ZONE TO OCCUPY THE REMAINDER OF THE UNUSED VOLUME. ONLY MATERIAL SPECIFIED IN THE WTP FILTER CAKE ZONE IS LIMITED BY A GEOMETRIC AREA.

0 40 80 FEET — HORIZONTAL; 0 40 80 FEET — VERTICAL
NO EXAGGERATION

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

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NewFields
CLIENT: ARIZONA MINERALS INC
PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: TSF STACKING SECTIONS (3 OF 3)
FILENAME: 14.022.015D
DRAWING NO.: A250
REVISION: 0

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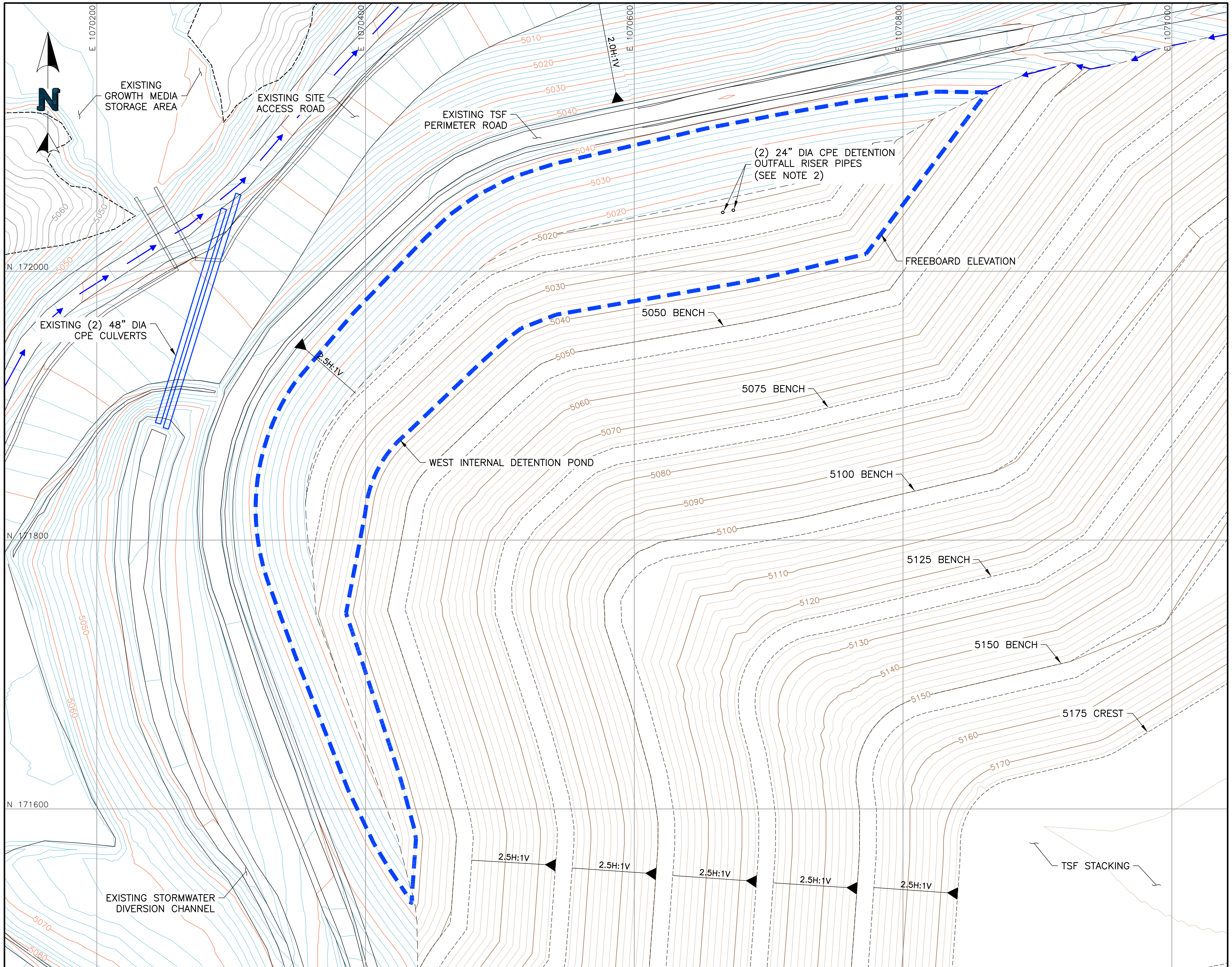


LEGEND:

EXISTING GROUND CONTOURS

PROPOSED STACKING CONTOURS

AS-BUILT GROUND CONTOURS

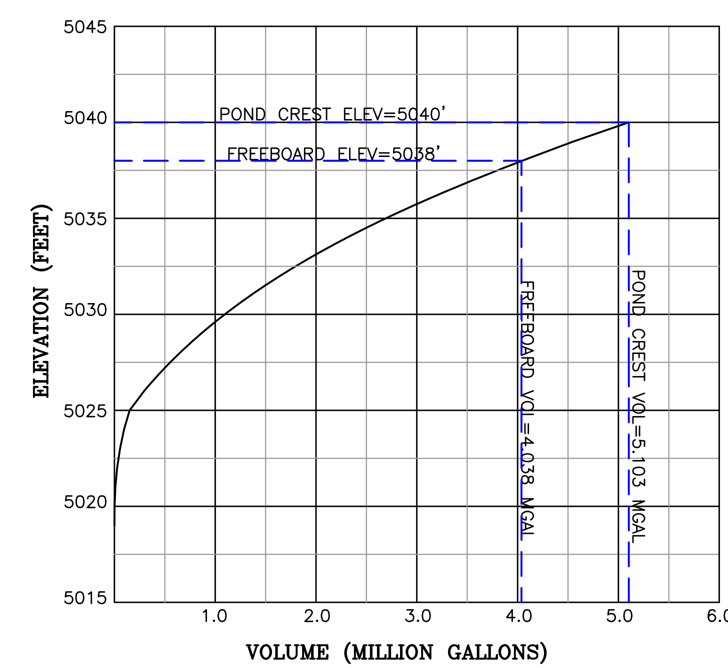
DIVERSION CHANNEL FLOW DIRECTION

0 40 80 FEET

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. DETENTION OUTFALL PIPES COLLECT AND CONVEY STORMWATER RUNOFF FROM THE WEST INTERNAL DETENTION POND TO THE UNDERDRAIN COLLECTION POND WHICH IS LOCATED DOWNSTREAM OF THE TSF.

WEST INTERNAL DETENTION POND FILLING CURVE



Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: WEST INTERNAL DETENTION POND

FILENAME: 14.022.014M

DRAWING NO.: A300

REVISION: 0

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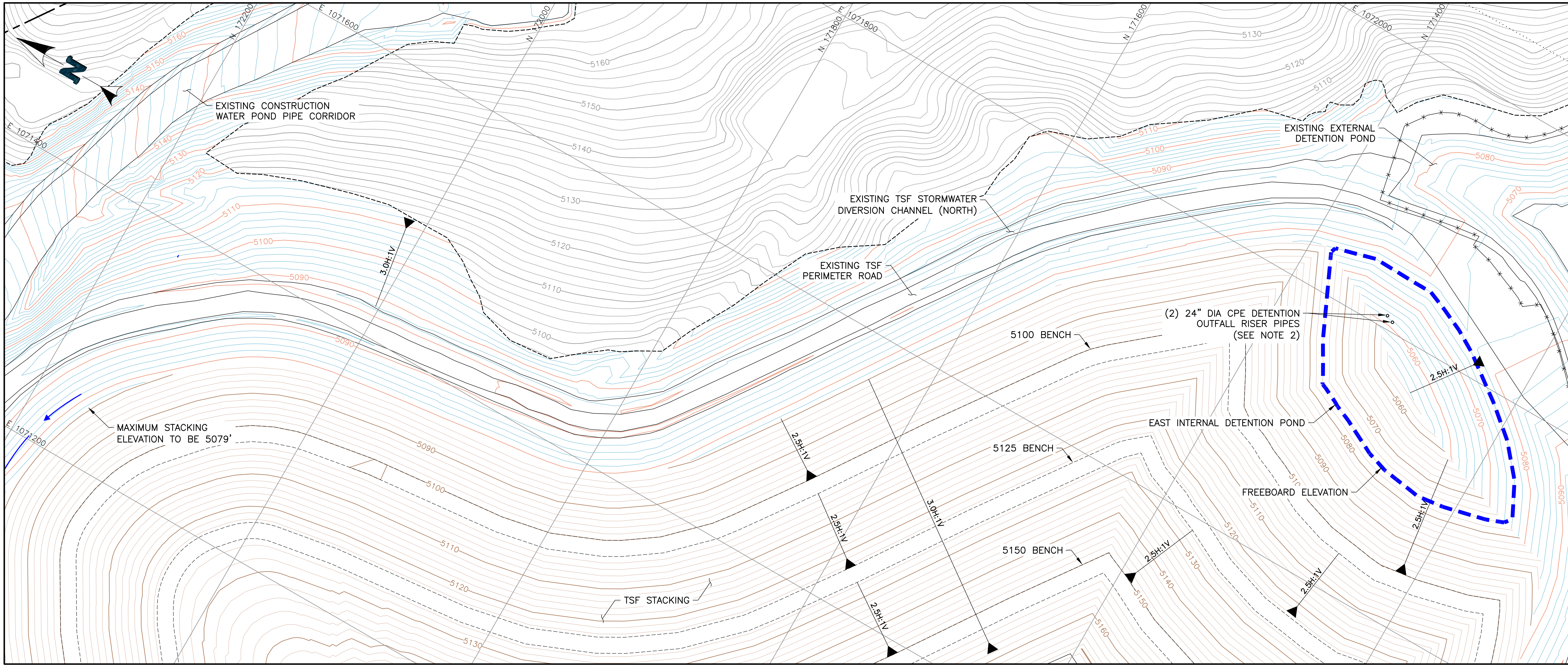
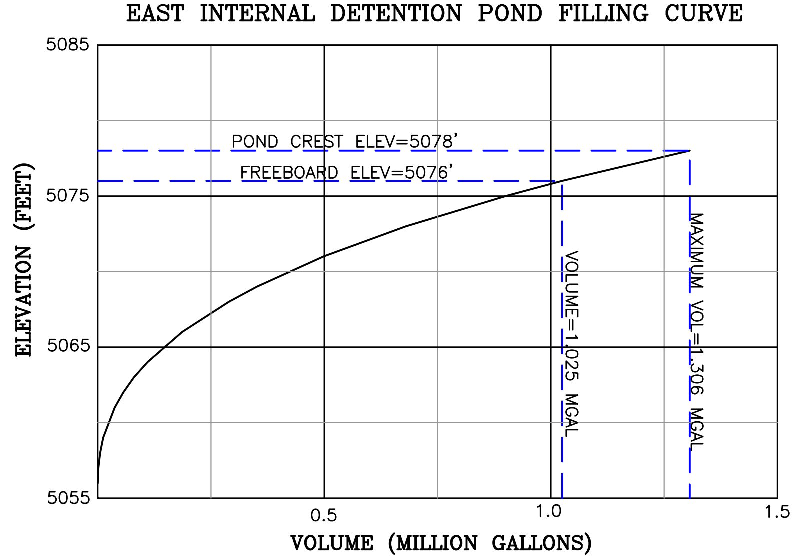


0 40 80 FEET

EAST INTERNAL DETENTION POND FILLING CURVE



REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED STACKING CONTOURS
- AS-BUILT GROUND CONTOURS
- PROPERTY BOUNDARY
- DIVERSION CHANNEL FLOW DIRECTION
- AS-BUILT WILDLIFE FENCE

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. DETENTION OUTFALL PIPES COLLECT AND CONVEY STORMWATER RUNOFF FROM THE WEST INTERNAL DETENTION POND TO THE UNDERDRAIN COLLECTION POND WHICH IS LOCATED DOWNSTREAM OF THE TSF.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: EAST INTERNAL DETENTION POND

FILENAME: 14.022.016M

DRAWING NO.: A310

REVISION: 0

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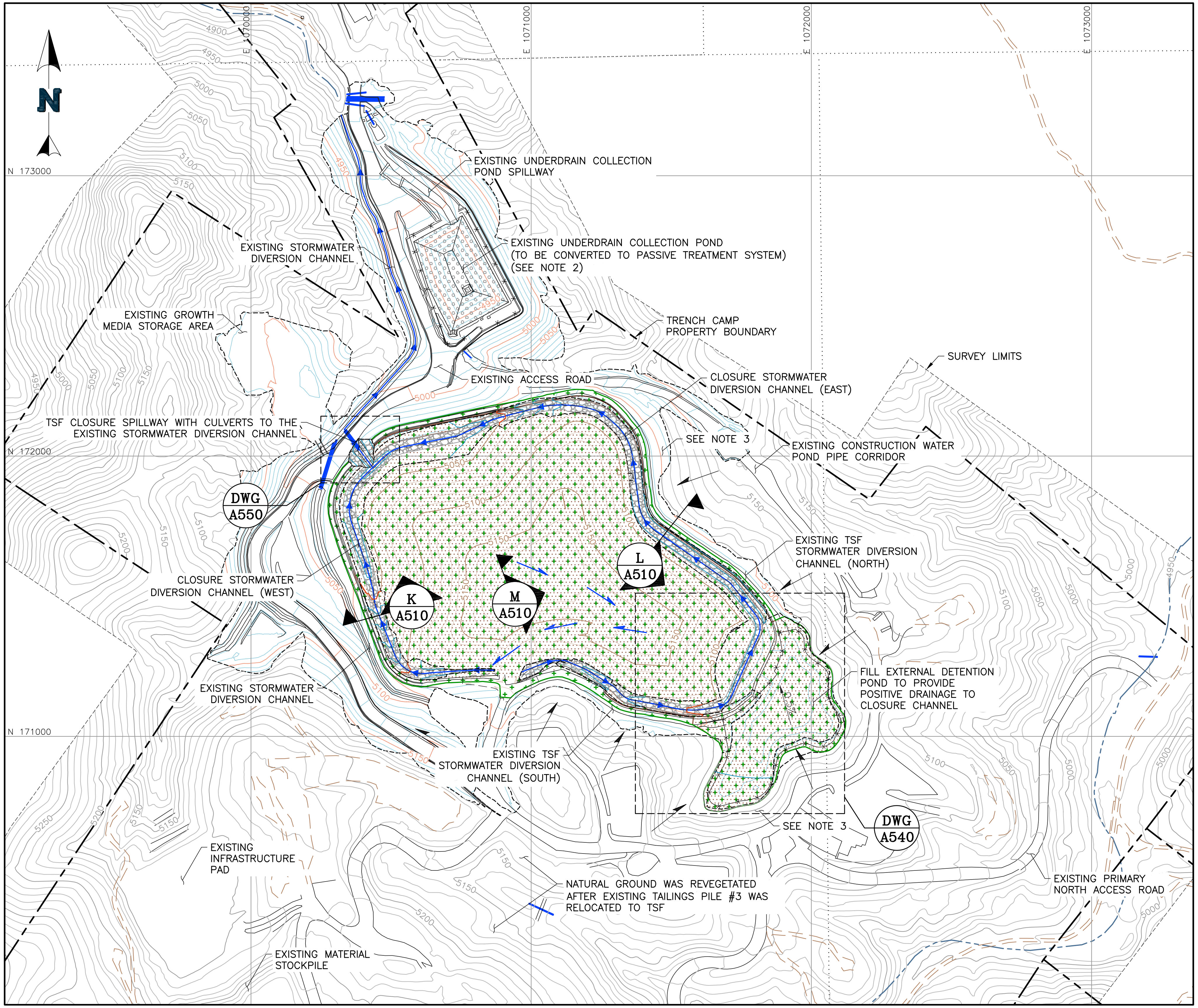

LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- TSF CLOSURE CONTOURS
- STACKING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- PASSIVE TREATMENT SYSTEM AREA
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION

NOTES:

1. COVER MATERIAL TO BE HYDROSEEDED.
2. THE PASSIVE TREATMENT SYSTEM IS TO BE DESIGNED BASED ON POST CLOSURE WATER CHEMISTRY AND EXPECTED FLOW RATES. ACTIVE TREATMENT OF UNDERDRAIN FLOW WILL BE CONTINUED UNTIL AN APPROPRIATE PASSIVE SYSTEM CAN BE ESTABLISHED. AFTER ~2 YEARS OF SUCCESSFUL PASSIVE TREATMENT HAS BEEN COMPLETED, THE ACTIVE TREATMENT SYSTEM WILL BE DISCONTINUED.
3. ALL CUT SLOPES LOCATED ALONG THE EXTERIOR OF THE TSF PERIMETER ROAD AND EXTERNAL DETENTION POND WERE HYDROSEEDED AS PART OF THE VRP TSF CONSTRUCTION.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

0 200 400 FEET

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: CONCEPTUAL CLOSURE PLAN VIEW

FILENAME: 14.022.019M
DRAWING NO.: A500
REVISION: 0

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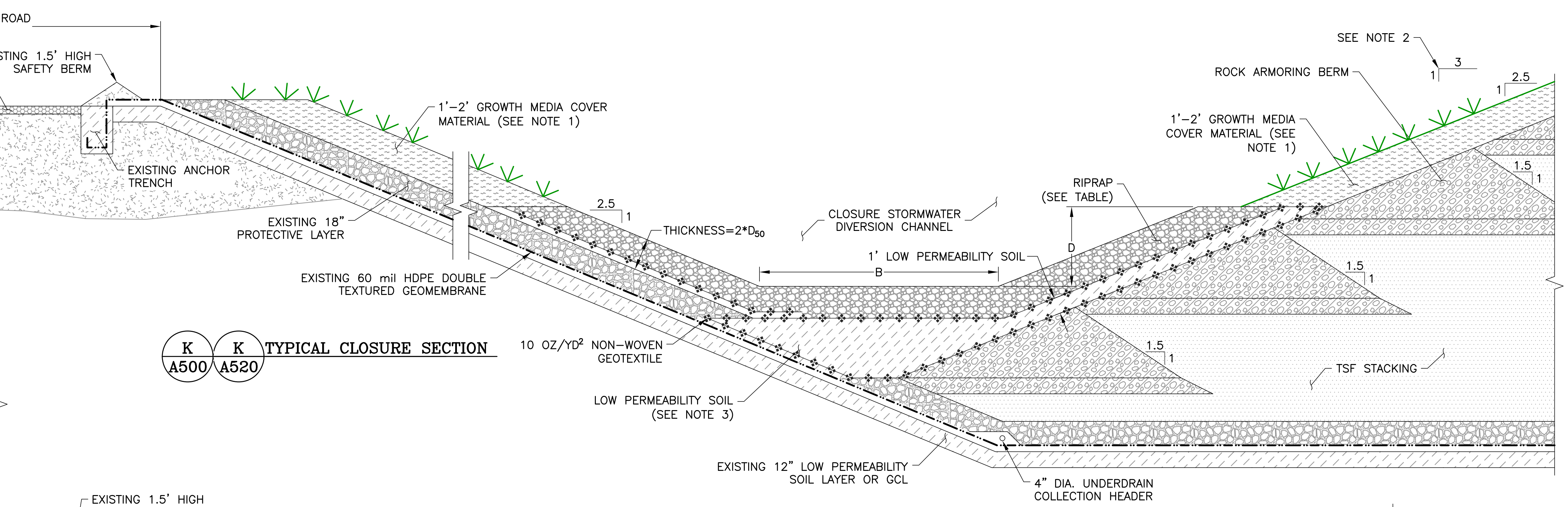
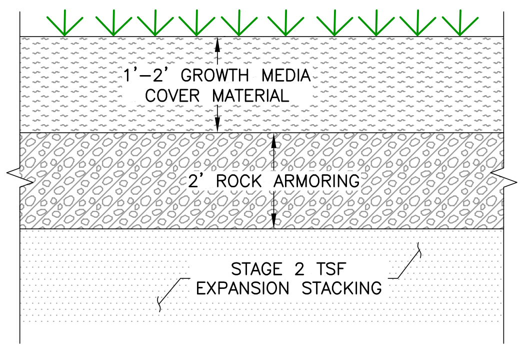
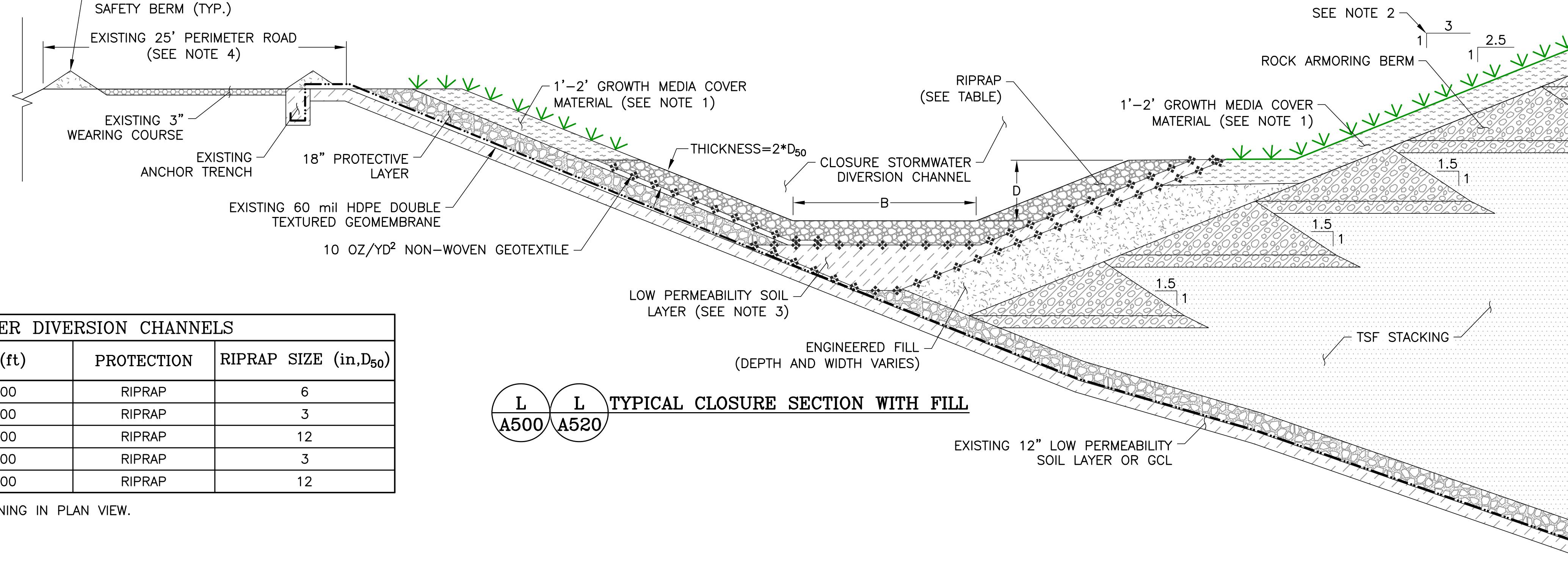


K/A500 K/A520 TYPICAL CLOSURE SECTION



M/A500 M/A520 CLOSURE SECTION



L/A500 L/A520 TYPICAL CLOSURE SECTION WITH FILL

CLOSURE STORMWATER DIVERSION CHANNELS				
STATION	B (ft)	D (ft)	PROTECTION	RIPRAP SIZE (in,D_{50})
0+00 – 6+40	15	4.00	RIPRAP	6
6+40 – 20+67	15	6.00	RIPRAP	3
20+67 – 23+79	15	5.00	RIPRAP	12
23+79 – 32+51	15	6.00	RIPRAP	3
32+51 – 37+00	15	4.00	RIPRAP	12

REFERENCE DRAWING A520 FOR ALIGNMENT STATIONING IN PLAN VIEW.

NOTES:

1. GROWTH MEDIA COVER MATERIAL TO BE HYDROSEEDED.
2. 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FT HIGH 2.5H:1V SLOPE IN COMBINATION WITH A 12.5 FT BENCH.
3. LOW PERMEABILITY SOIL TO BE PLACED AT CHANNEL BOTTOM DURING CLOSURE TO PREVENT POTENTIAL RECHARGE OF THE UNDERDRAIN SYSTEM.
4. PERIMETER ROAD TO BE RIPPED UP AT CLOSURE.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 7/27/20 ARIZONA, U.S.A. EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

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CLIENT: ARIZONA MINERALS INC
PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: CONCEPTUAL CLOSURE SECTIONS AND DETAILS
FILENAME: 14.022.022D
DRAWING NO.: A510
REVISION: 0

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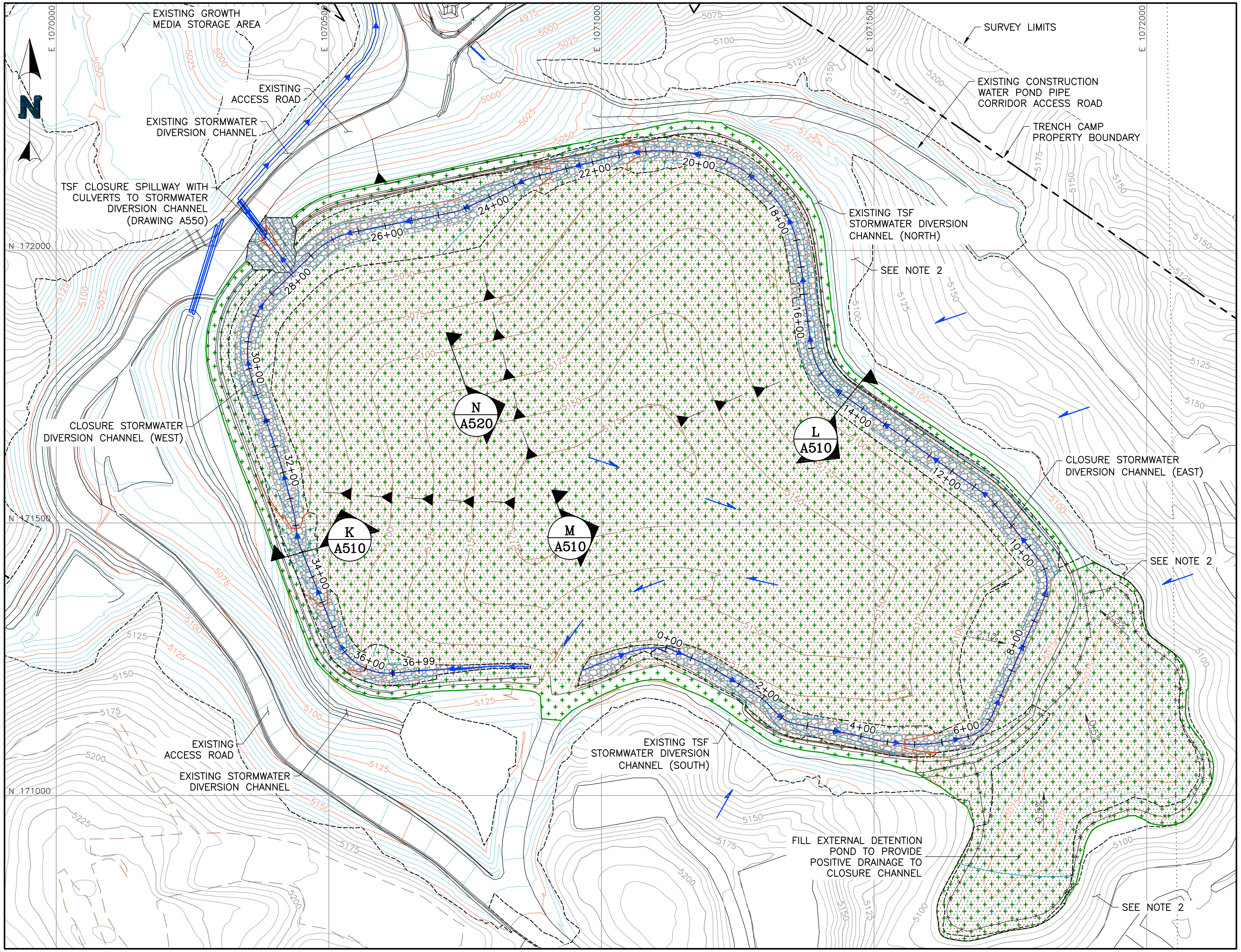
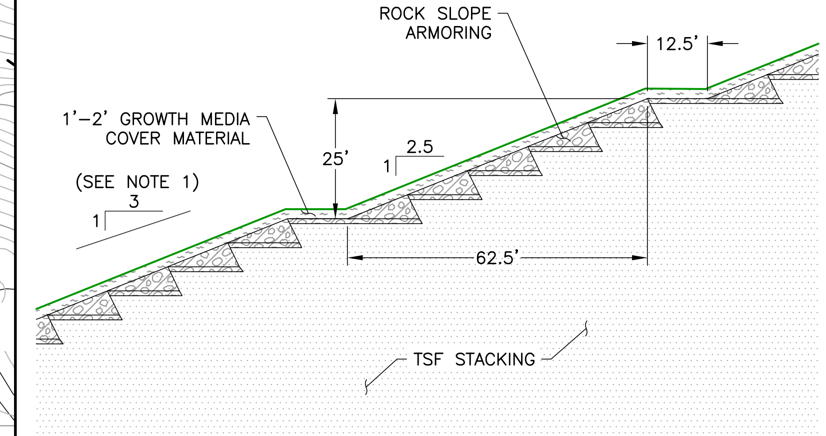


0 100 200 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION



N A520 CLOSURE STACKING

NOTE:

1. EXISTING TAILINGS 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FOOT HIGH 2.5H:1V SLOPES IN COMBINATION WITH A 12.5 FOOT BENCH.
2. ALL CUT AND FILL SLOPES LOCATED ALONG THE EXTERIOR OF THE TSF PERIMETER ROAD AND EXTERNAL DETENTION POND WERE HYDROSEEDED AS PART OF THE VRP TSF CONSTRUCTION.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

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REV	DATE	DESCRIPTION	TECH	ENG
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APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

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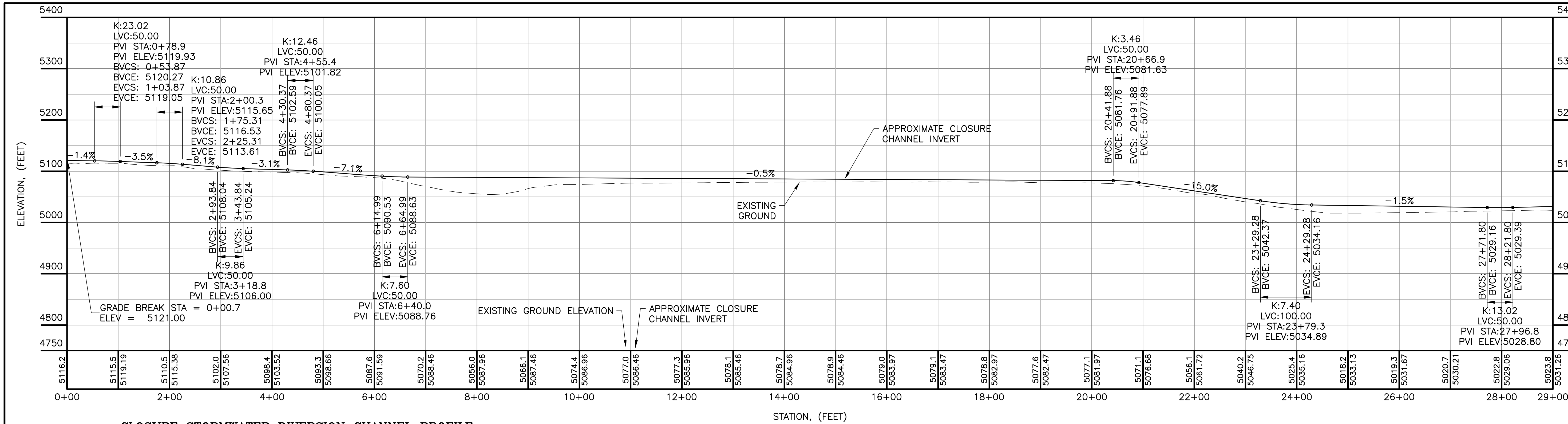
NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: CLOSURE STORMWATER DIVERSION CHANNEL PLAN

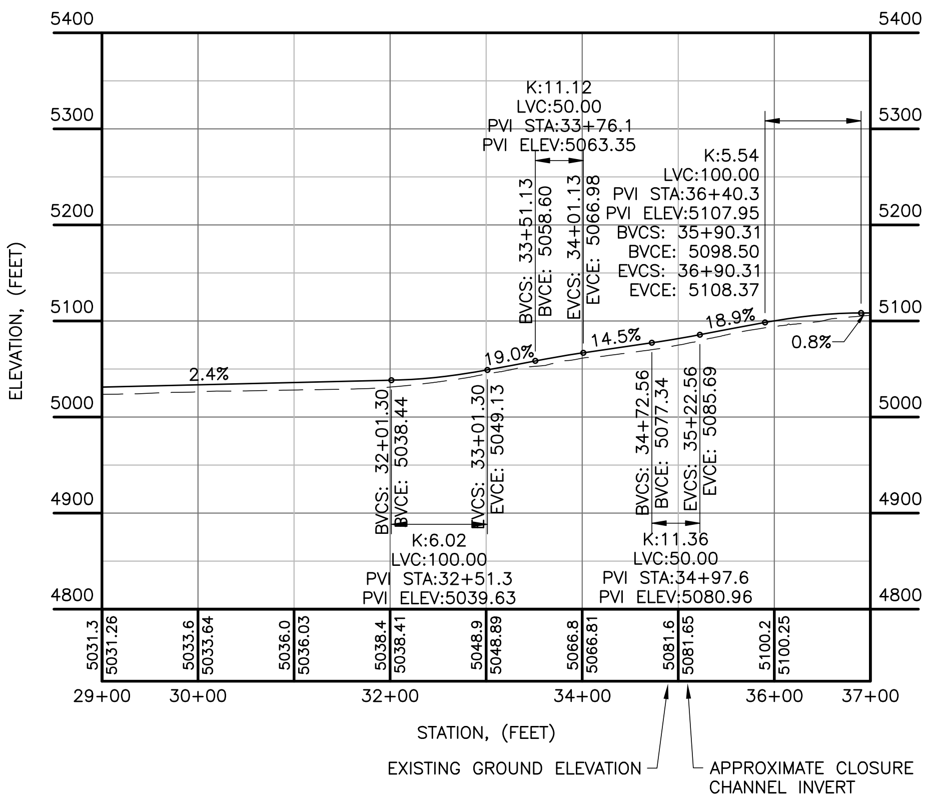
FILENAME: 14.022.023M
DRAWING NO.: A520
REVISION: 0



CLOSURE STORMWATER DIVERSION CHANNEL PROFILE
(STATIONS 0+00 TO 29+00)

0 100 200 FEET — HORIZONTAL; 0 100 200 FEET — VERTICAL

NO EXAGGERATION



CLOSURE STORMWATER DIVERSION CHANNEL PROFILE
(STATIONS 29+00 TO 37+00)

0 100 200 FEET — HORIZONTAL; 0 100 200 FEET — VERTICAL

NO EXAGGERATION

CLOSURE STORMWATER DIVERSION CHANNEL ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D−M−S)	LENGTH (FT)	RADIUS (FT)
BP	0+00.00	171,271.69	1,071,118.99			
PC	0+78.27	171,241.00	1,071,191.00	008−16−22	7.22	50.00
PT	0+85.49	171,237.70	1,071,197.41			
PC	1+93.75	171,181.37	1,071,289.86	014−48−55	12.93	50.00
PT	2+06.68	171,173.30	1,071,299.92			
PC	2+38.38	171,150.43	1,071,321.87	036−08−18	43.44	68.88
PT	2+81.82	171,130.31	1,071,359.56			
PC	3+64.33	171,115.94	1,071,440.81	002−17−25	2.00	50.00
PT	3+66.33	171,115.55	1,071,442.77			
PC	4+34.45	171,101.02	1,071,509.32	025−31−16	138.10	310.04
PT	5+72.55	171,102.07	1,071,646.27			
PC	5+99.35	171,108.19	1,071,672.36	052−50−22	56.99	61.80
PT	6+56.34	171,143.26	1,071,714.72			
PC	8+92.65	171,359.21	1,071,810.69	062−35−29	80.10	73.33
PT	9+72.76	171,434.76	1,071,800.97			
PC	11+09.94	171,541.93	1,071,715.32	016−23−46	14.31	50.00
PT	11+24.25	171,551.69	1,071,704.92			
PC	14+49.74	171,738.25	1,071,438.21	047−01−13	105.22	128.22
PT	15+54.96	171,825.46	1,071,384.73			
PT	16+50.48	171,920.04	1,071,371.43			
PC	16+76.42	171,945.91	1,071,369.47	004−48−10	8.38	100.00
PT	16+84.80	171,954.23	1,071,368.49			
PC	17+35.41	172,004.20	1,071,360.45	038−37−37	123.88	183.76

CLOSURE STORMWATER DIVERSION CHANNEL ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D−M−S)	LENGTH (FT)	RADIUS (FT)
PT	18+59.30	172,111.07	1,071,302.54			
PC	18+88.93	172,130.99	1,071,280.60	033−37−23	103.09	175.67
PT	19+92.02	172,174.62	1,071,188.83			
PC	20+19.40	172,178.72	1,071,161.76	023−12−09	146.58	361.95
PT	21+65.97	172,171.13	1,071,016.38			
PC	23+14.48	172,133.73	1,070,872.66	010−21−51	9.04	50.00
PT	23+23.53	172,130.67	1,070,864.16			
PC	24+55.34	172,075.06	1,070,744.65	013−37−37	11.89	50.00
PT	24+67.23	172,071.37	1,070,733.38			
PC	26+59.88	172,033.54	1,070,544.48	032−44−20	82.16	143.78
PT	27+42.03	171,995.87	1,070,472.72			
PC	28+46.46	171,923.24	1,070,397.69	064−59−59	174.99	154.25
PT	30+21.45	171,762.02	1,070,359.17			
PC	31+78.26	171,613.82	1,070,410.39	004−13−00	7.36	100.00
PT	31+85.62	171,606.78	1,070,412.54			
PC	32+73.70	171,521.63	1,070,435.11	006−56−33	12.12	100.00
PT	32+85.82	171,509.76	1,070,437.50			
PC	33+23.34	171,472.60	1,070,442.66	013−49−13	12.06	50.00
PT	33+35.40	171,460.97	1,070,445.74			
PC	35+21.45	171,288.14	1,070,514.60	073−20−20	129.88	101.47
PT	36+51.32	171,224.63	1,070,617.82			
EP	36+99.10	171,228.85	1,070,665.41			

NOTE:

1. REFERENCE DRAWING A520 FOR THE CLOSURE STORMWATER DIVERSION CHANNEL ALIGNMENT PLAN VIEW.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REV	DATE	DESCRIPTION	TECH	ENG
0	07/27/20	ISSUED FOR TENDER	SEB	CMT

APPROVED BY: RMS
CHECKED BY: CMT
DESIGNED BY: JTC
DRAWN BY: SEB

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CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: CLOSURE STORMWATER DIVERSION CHANNEL PROFILE

FILENAME: 14.022.024P
DRAWING NO.: A530
REVISION: 0

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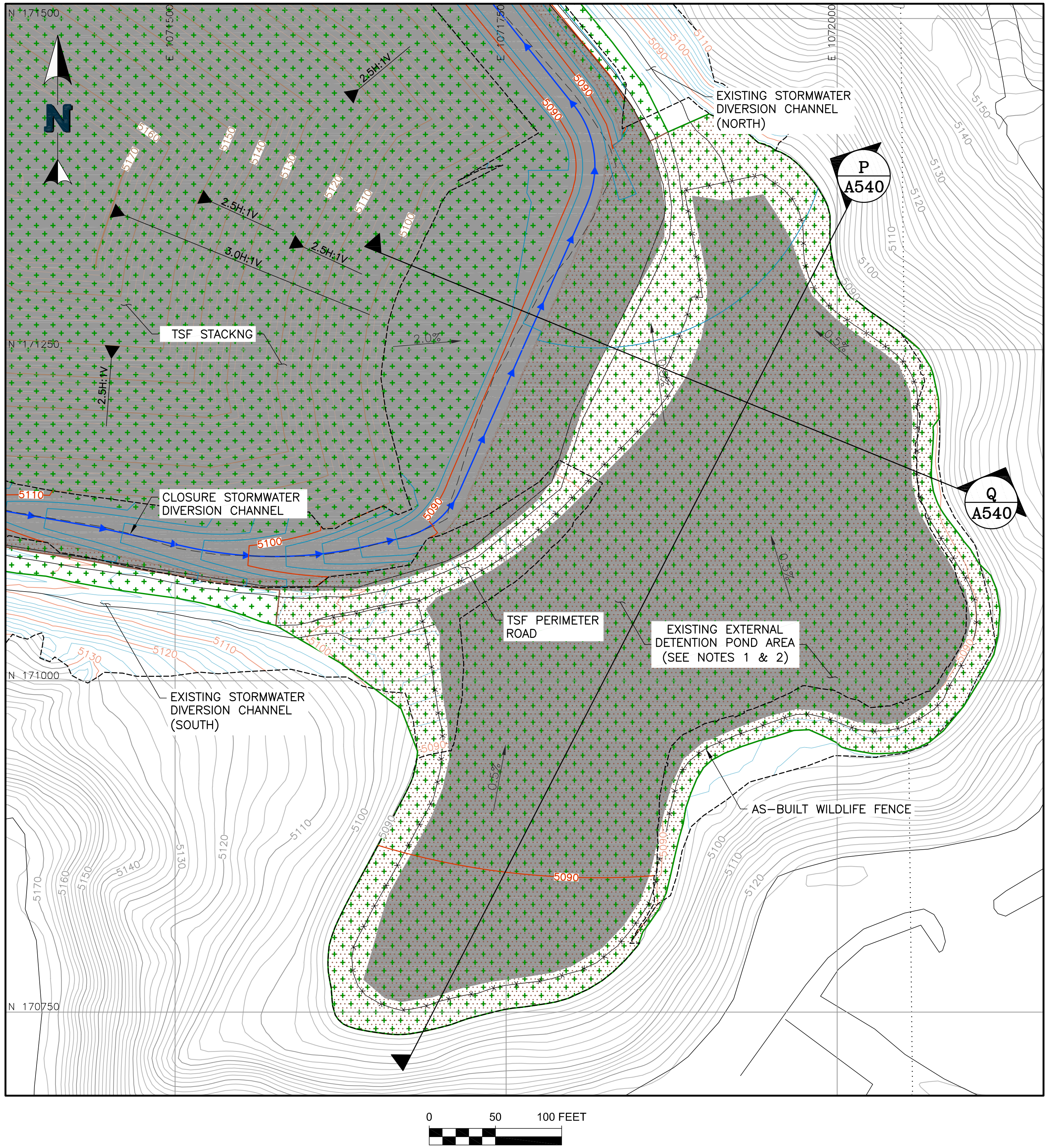
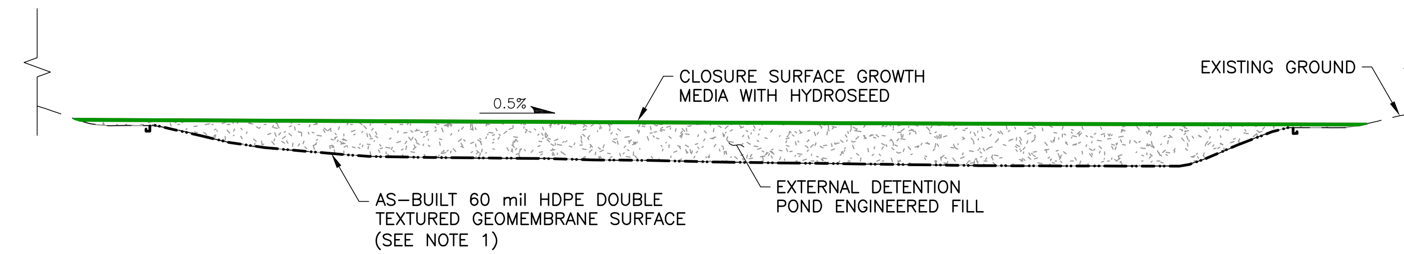


LEGEND:

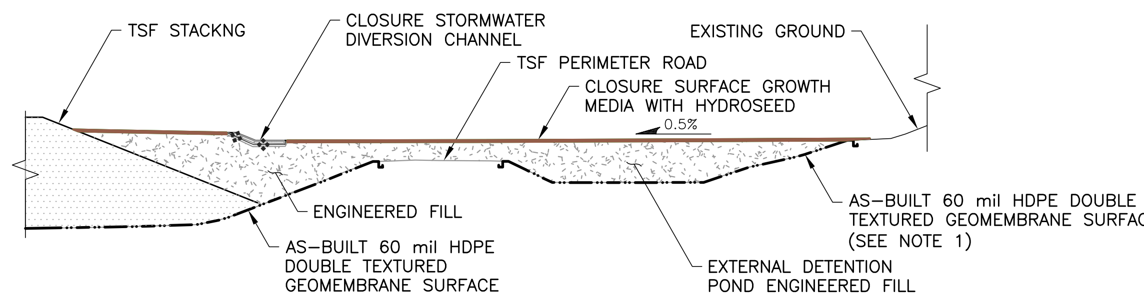
- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- AS-BUILT WILDLIFE FENCE
- SECTION LINES
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION
- LIMITS OF AS-BUILT GEOMEMBRANE (SEE NOTE 1)

NOTES:

1. EXTERNAL DETENTION POND LINER TO BE PERFORATED PRIOR TO CLOSURE FILL AND CLOSURE CAP PLACEMENT.
2. EXISTING EXTERNAL DETENTION POND TO BE BACKFILLED WITH ENGINEERED FILL TO PROVIDE POSITIVE DRAINAGE TO THE CLOSURE STORMWATER DIVERSION CHANNEL



P / A540 CLOSURE TSF SPILLWAY SECTION



Q / A540 CLOSURE TSF SPILLWAY SECTION

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 7/27/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

REV	DATE	DESCRIPTION	TECH	ENG
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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: CLOSURE EXTERNAL DETENTION POND FILL AREA

FILENAME: 14.022.025M

DRAWING NO.: A540

REVISION: 0

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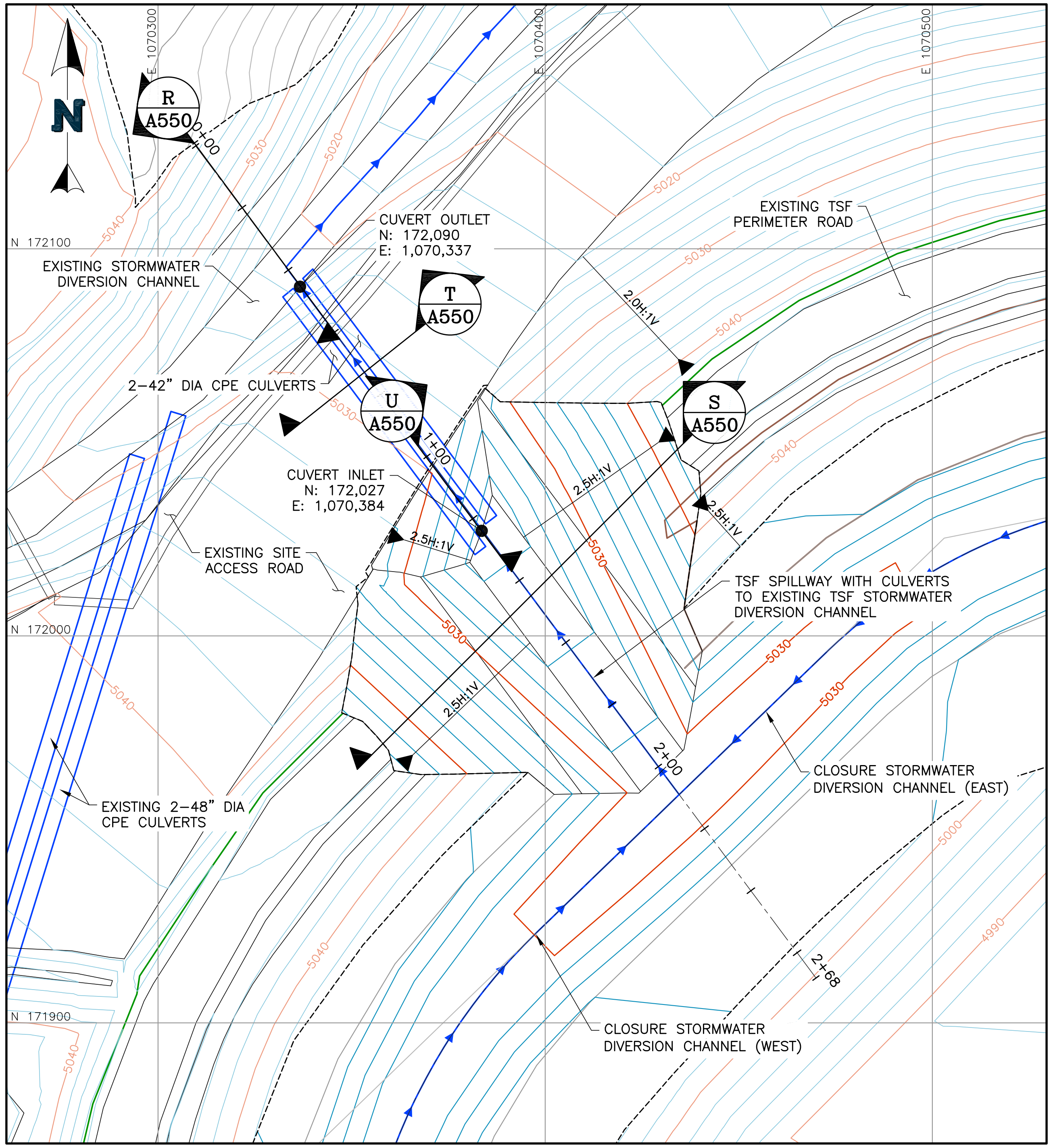
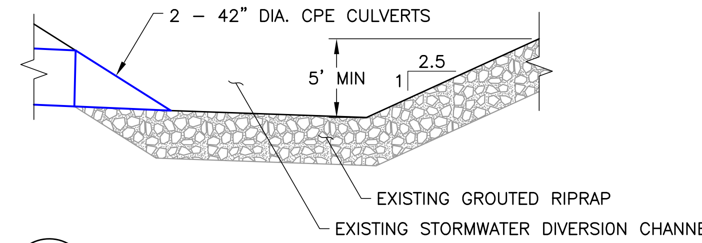


LEGEND:

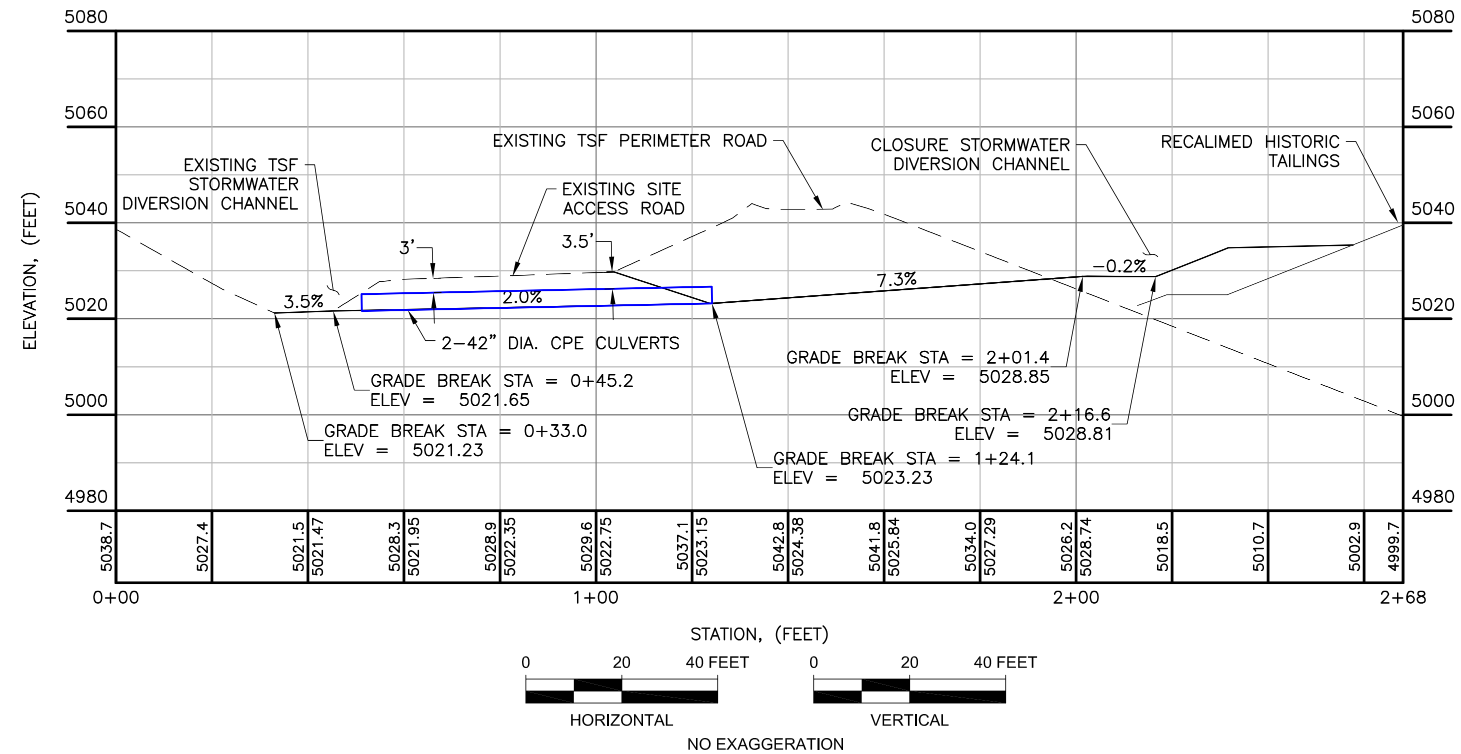
- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- TSF CLOSURE CONTOURS
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION

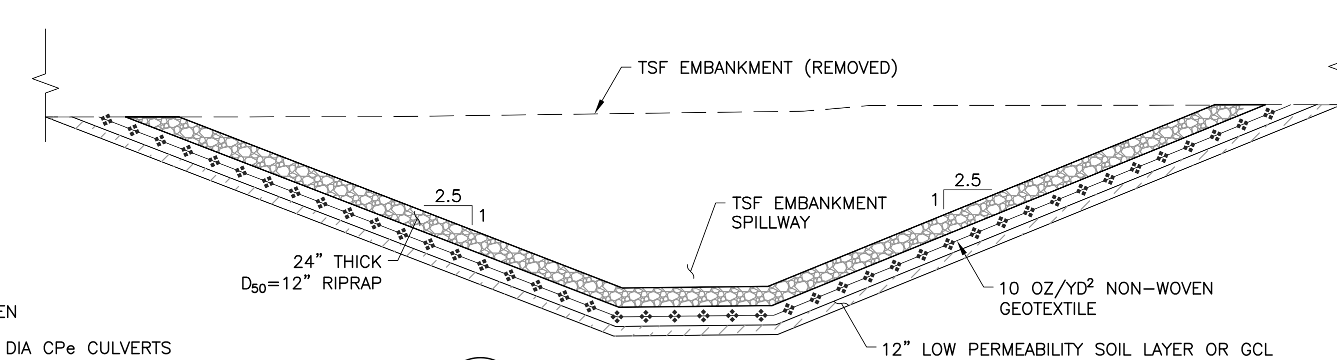
NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF FINISHED GROWTH MEDIA AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. BED PIPE BEDDING TO SPRINGLINE OF PIPE WITH A MINIMUM OF 6" BENEATH PIPE.



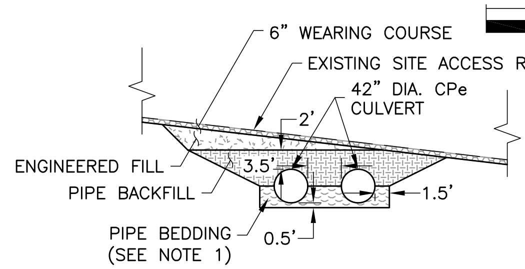
R A550 GROUTED RIPRAP AT TSF SPILLWAY OUTLET



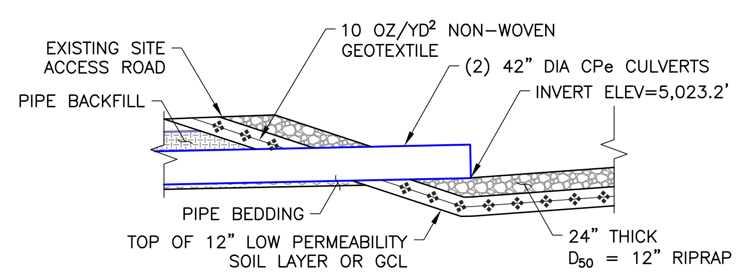


S A550 CLOSURE TSF SPILLWAY SECTION

0 20 40 FEET



T A550 CLOSURE TSF CULVERT INLET



U A550 CLOSURE CULVERT INLET SECTION

REFERENCE:

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CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: CLOSURE SPILWAY PLAN AND PROFILE

FILENAME: 14.022.026M

DRAWING NO.: A550

REVISION: 0

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APPENDIX A

Design Criteria

Arizona Minerals Inc
Hermosa Project
Hermosa Lined TSF Design Amendment
Design Criteria

General Information

DESCRIPTION	VALUE	COMMENT
SITE LOCATION		
General Project Location	50 miles southeast of Tucson, Arizona, approximately 8 miles north of the U.S. border with Mexico, in Santa Cruz County	
Site Access	Harshaw Road through the town of Patagonia	
Project Name	Hermosa Lined TSF Design Amendment	
BASE MAPPING		
Projection System	NAD 83, Arizona State Plane Central International Feet	Veritical Datum is NAVD88
Units	English	
Topographic Files	2453 MINE 2-20.dwg	Received from South32 on 03/05/20
CODES AND STANDARDS		
ADEQ	Arizona Department of Environmental Quality	
ADWR Dam Safety	Arizona Department of Water Resources Dam Safety	
ANCOLD	Austrailian National Committee On Large Dams	
ASTM	American Society for Testing and Materials	
AZPDES	Arizona Pollutant Discharge Elimination System	
BADCT	Best Available Demonstrated Control Technology	Arizona Mining BADCT Guidance Manual (Auquifer Protection Program)
GRI	Geosynthetic Research Institute	
MSHA	Mine Health and Safety Administration	
WRCC	Western Regional Climate Center	

Arizona Minerals Inc
Hermosa Project
Hermosa Lined TSF Design Amendment
Design Criteria

Meteorological/Climatological Data

DESCRIPTION	VALUE	COMMENT
CLIMATOLOGICAL FACTORS		
Average annual precipitation	21.5 in	Ecological Resource Consultants Inc (ERC)
Average annual evaporation	47.3 in	ERC
Average winter minimum temperature	28 °F	ERC
Average daily maximum temperature	96 °F	ERC
24-HOUR STORM EVENTS (inches)		
Recurrence Interval (years)	Precipitation (in)	
2	2.31	NOAA Atlas 14
5	2.87	NOAA Atlas 14
10	3.32	NOAA Atlas 14
25	3.93	NOAA Atlas 14
50	4.40	NOAA Atlas 14
100	4.88	NOAA Atlas 14
500	6.02	NOAA Atlas 14
AVERAGE MONTHLY PRECIPITATION DATA (inches)		
January	1.66 in	ERC
February	0.88 in	ERC
March	2.51 in	ERC
April	0.35 in	ERC
May	0.38 in	ERC
June	0.87 in	ERC
July	5.66 in	ERC
August	5.59 in	ERC
September	4.38 in	ERC
October	0.63 in	ERC
November	0.63 in	ERC
December	1.64 in	ERC
AVERAGE MONTHLY PAN EVAPORATION DATA (inches)		
January	3.13 in	ERC
February	3.76 in	ERC
March	5.47 in	ERC
April	6.22 in	ERC
May	8.94 in	ERC
June	10.41 in	ERC
July	5.16 in	ERC
August	4.72 in	ERC
September	4.63 in	ERC
October	5.93 in	ERC
November	4.35 in	ERC
December	2.98 in	ERC
AVERAGE MONTHLY POND EVAPORATION DATA (inches)		
January	2.26 in	ERC
February	2.71 in	ERC
March	3.94 in	ERC
April	4.48 in	ERC
May	6.44 in	ERC
June	7.5 in	ERC
July	3.72 in	ERC
August	3.40 in	ERC
September	3.33 in	ERC
October	4.27 in	ERC
November	3.13 in	ERC
December	2.14 in	ERC

Hermosa Lined TSF Design Amendment

DESCRIPTION	VALUE	COMMENT
GENERAL		
Exploration Decline Development Rock	Basis of Design: 825,092 tons expansion potential to 1,572,906 tons	Values provided by AMI from current planning. Permitted material as part of VRP TSF.
WTP1 Filter Cake	20,097 cy	Value provided by AMI from historical WTP data and projected treatment rates. 3,650 cubic yards per year for ~5 years. Includes a 10% contingency increase. Permitted material.
Core Cutting Material	105 cy	Value provided by AMI from historical data and projected rates. 14 cubic yards per year for ~5 years. Includes a 50% contingency increase. Permitted material.
WTP2 Filter Cake (stage one and stage two filter presses)	14,949 cy	Value provided by AMI. 4,526 cubic yards per year for ~3 years. Includes a 10% contingency increase. New material.
Construction cut (to be stored on lined containment)	385,000 cy	Value provided by AMI for current estimated construction work. Permitted material.
Drill Cuttings	5 cy	Value provided by AMI. Estimated quantity is based on less than 1 cubic yard per year for ~5 years.
Sediments from Stormwater BMPs	9,000 cy	Value provided by AMI. Estimated quantity is based on 1,800 cubic yard per year for ~5 years.
Trench Camp TSF Expansion	~0.91 Mcy (lower bound) ~1.36 Mcy (upper bound)	Stage 2 TSF Expansion for upper bound material requirement
EXPLORATION DECLINE DEVELOPMENT ROCK		
Dry density of development rock	125 pcf	Estimated by NewFields
WTP1 FILTER CAKE		
Dry density	TBD	
Material properties	100% passing the no. 200 sieve and non-plastic	Data from control sample obtained 11/20/2019.
Moisture content	~360% moisture content upon arrival	Based on dry weight of solids
WTP2 FILTER CAKE		
Dry density	Estimate same as WTP1 filter cake	
Material properties	Estimate same as WTP1 filter cake	
Moisture content	Estimate same as WTP1 filter cake	
CONSTRUCTION CUT		
Dry density of construction material	125 pcf	Estimated by NewFields
FACILITY FEATURES		
Embankment type	Rockfill/earthfill	
Embankment construction method	Downstream construction	Contractor placed
Final embankment crest width	25 feet	Minimum
Downstream embankment slope	2.0H:1V	Maximum
Upstream embankment slope	2.5H:1V	Maximum
Lining Requirement	Composite liner (60 mil HDPE geomembrane placed over 12" low permeability soil material or a geosynthetic soil liner)	Prescriptive BADCT
Maximum basin slope	2.5H:1V	
Minimum basin slope	1%	
Basin Underdrain System	Protective/drainage layer with a minimum thickness of 18 inches. Underdrain collection system consisting of perforated drain pipe encapsulated in a drainage aggregate and placed within topographic lows (drainages)	Individual BADCT
Stacking Slope	3.0H:1V compound slope	

Borrow Sources

DESCRIPTION	VALUE	COMMENT
Materials		
	Source	
Engineered Fill	Local soils and rock	As Required
Wearing Course	Local soils and rock (processed on site) or import	As Required
Protective Layer	Local soils and rock (processed on site) or import	As Required
Rock Armoring	Local soils and rock (processed on site) or import	As Required
Drainage Aggregate	Local soils and rock (processed on site) or import	As Required
Low Permeability Soil Liner	Local soils and rock (processed on site) or import	As Required

Roads

DESCRIPTION	VALUE	COMMENT
HAUL/CONSTRUCTION ROAD (PERMANENT)		
Maximum road grade	10%	
Minimum road width	36 ft	Clear distance between berms
Minimum road turning radius	125 ft	Measured from centerline
Safety berm height	Equal to the axle height of the largest piece of equipment on the road	MSHA
Design vehicle	745 articulated haul truck	
Traffic pattern	Right hand traffic	
FACILITY PERIMETER ROAD		
Maximum road grade	15%	
Minimum road width	25 ft	Including safety berms
Safety berm height	Equal to the axle height of the largest piece of equipment on the road	MSHA
Design vehicle	Light vehicle	
Traffic pattern	Right hand traffic	One way (limited traffic on facility perimeter roads)

Stormwater Diversion Channels and Culverts

DESCRIPTION	VALUE	COMMENT
Permanent Diversion Channels		
Storm event for depth sizing	100-yr/24-hr storm	
Storm event for erosion control design	100-yr/24-hr storm	If cut into bedrock, erosion control may not be necessary
Freeboard	1 ft	
Erosion protection	Riprap, bedrock or vegetated	
Temporary Construction Diversion Channels		
Storm event for depth sizing	25-yr/24-hr storm	
Storm event for erosion control design	25-yr/24-hr storm	
Freeboard	1 ft	
Erosion protection	As-Required	
Culverts		
Storm event for size requirements	Match Channel Size	
Diameter requirement	As-Required	
Material type	CPeP or HDPE	
Maximum headwater	1.5:1 HW/D	
Runoff Collection Ponds		
Impacted Construction Runoff	Per ADEQ	Employ Best Management Practices in accordance with BADCT
Sediment Basin Sizing	Sized per acre of distrubed area	Based on NRCS Conservation Practice Standard Arizona

Stability Analysis

DESCRIPTION	VALUE	COMMENT
Stability Analysis		
Static Factor of Safety (Minimum)	1.3 (permanent Slope) 1.5 (permanent slope)	BADCT minimum requirement ANCOLD minimum requirement
Psuedostatic Factor of Safety (Minimum)	≥ 1.0 or acceptable deformation	
Maximum Design Earthquake	1/2 of the Peak Ground Acceleration (PGA)	
Seismic Hazard Assessment	MCE for deterministic and probabilistic assessments are 0.11 gravity (g) and 0.10 g, respectively	Completed by NewFields (March 2017)

Arizona Minerals Inc
Hermosa Project
Hermosa Lined TSF Design Amendment
Design Criteria

Underdrain Collection Pond

DESCRIPTION	VALUE	COMMENT
GENERAL		
Required draindown volume	24-hr	
Required storm event volume	100-yr/24-hr	BADCT
Freeboard (Minimum)	2 ft residual freeboard (to spillway invert) 7 ft freebard to crest 3 ft freeboard above maximum level in spillway during IDF	Spillway designed to safely pass the routed 1/4 PMF inflow design flood (IDF) while maintaining 3 ft of freeboard
Embankment type	Rockfill/earthfill	Contractor placed
Final embankment crest width	25 feet	Minimum
Downstream embankment slope	2.0H:1V	Maximum
Upstream embankment slope	2.0H:1V	Maximum
Minimum basin slope	3%	BADCT
Lining System	Double liner system with an LCRS sited between the two 60 mil HDPE geomembranes. Secondary liner shall be a composite liner consisting of a 60 mil HDPE geomembrane placed over 6" low permeability soil material or GCL.	Geonet sited between the primary and secondary geomembranes.

Water Balance

DESCRIPTION	VALUE	COMMENT
WATER BALANCE SIMULATION		
Method of Simulation	Excel Model	
Model Time-step	Daily	
Design Storm	100-yr/24-hr	BADCT
Underdrain Collection Pond Freeboard to Spillway Invert (Residual Freeboard)	2 ft	Freeboard to Underdrain Collection Pond crest is 7 ft Freeboard to Underdrain Collection Pond spillway invert is 2 ft (residual freeboard)
Minimum Pond Operating Depth	Depth sufficient for pump actuation	
Maximum Pond Operating Depth	To be determined based on maintaining available storage for the 100-yr/24-hr storm event plus freeboard	

APPENDIX B

Climate Memorandum (Ecological Resource Consultants)

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Technical Memorandum

Date: **March 13, 2017**

To: **Johnny Pappas, Arizona Minerals**

From: **Troy Thompson**

Re: **Arizona Mine Site Meteorological Analysis**

1.0 Introduction

Ecological Resource Consultants Inc. (ERC) has evaluated available climate data for Arizona Minerals' proposed Mine Site located in Santa Cruz County, Arizona. The evaluation was conducted to determine precipitation and evaporation values that should be used to define climate related design criteria for mine planning and design. The proposed mine is located at roughly Latitude 31o 27' 20" N, Longitude 110o 42' 47" W at an elevation of approximately 5,200 feet.

A previous climatological analysis was completed by ERC in March of 2013 (ERC 2013). This new evaluation utilized information presented in ERC's 2013 technical memo along with updated site specific information to derive more refined parameters that we recommend be used for future design and permitting work.

2.0 Available Precipitation and Evaporation Data

Precipitation and evaporation data used for this analysis were determined based on review of data from three regional meteorological stations as well as data recorded at the mine site. Regional data was collected from the Western Regional Climate Center (WRCC) which maintains an online database (http://www.wrcc.dri.edu/summary/Climsmaz.html) of climate date from monitoring stations throughout the western United States. A list of regional stations considered as part of this analysis is presented in Table 1. A location map showing the different sites relative to the proposed mine is presented in **Figure 1**.

Table 1 – Regional/Local Meteorological Stations

Site	Distance from Mine	Station Elevation (ft)	Precipitation Data Available	Pan Evaporation Data Available
Nogales 6N (ID:25924)	15 miles (W)	3,460	October 1952 - December 2016	1952-2005
Patagonia (ID:26280)	7 miles (NW)	4,189	June 1922 – December 2016	NA
Canelo 1 (ID:21231)	13 miles (NE)	5,009	January 1910 - December 2012	NA
Site Station	NA	5,436	Oct 2007 – Dec 2016	2015

Figure 1 – Station Locations (from Google Earth)

3.0 Monthly Precipitation Data

3.1 Site Data

Since there is a reasonably long period-of-record of available site data (over 9 years), this data was used as the primary source for estimating monthly precipitation values. A summary of available monthly site data along with pertinent statistics are presented in **Table 2**. Site data for 2016 was derived based on data recorded at the meteorological station as well as the Trench and Alta sites. Given that each of the three sources provided partial data, the maximum precipitation recorded during each month at an individual site was used as estimate the total at the mine for that month.

Table 2 – Recorded Monthly Site Precipitation (inches)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2007										0.00	1.18	1.8	NA
2008	0.87	0.90	3.44	0.00	0.89	0.49	7.19	4.66	2.63	0.33	0.60	1.03	23.03
2009	0.25	0.71	2.42	0.18	0.45	0.90	2.53	3.26	3.92	0.85	0.04	1.00	16.51
2010	4.78	2.82	3.44	0.63	0.00	0.00	6.51	5.47	3.6	0.72	0.05	1.08	29.1
2011	0.27	0.40	2.01	0.48	0.00	0.00	6.34	4.09	5.00	0.09	1.37	2.96	23.01
2012	0.17	0.04	2.92	0.13	0.48	0.53	4.61	7.13	1.64	0.00	0.19	1.71	19.55
2013	1.54	0.72	0.35	0.00	1.00	0.35	4.1	2.7	2.95	0.00	1.09	0.65	15.45
2014	0.01	0.12	4.02	0.03	0.00	0.01	5.74	5.82	6.96	1.90	0.00	1.17	25.78
2015	2.79	0.17	0.94	0.63	0.19	3.44	4.44	4.95	2.97	1.62	0.77	0.84	23.75
2016	2.30	1.00	0.10	0.62	0.00	1.05	2.85	5.65	4.60	0.01	0.20	2.05	20.43
Average	1.44	0.76	2.18	0.30	0.33	0.75	4.92	4.86	3.81	0.55	0.55	1.43	21.90
St. Dev.	1.60	0.85	1.43	0.28	0.40	1.08	1.63	1.37	1.56	0.71	0.52	0.70	4.35
Correlation	-0.267	0.786	0.146	-0.359	-0.709	-0.048	-0.378	0.192	-0.028	0.474	-0.414	0.343	NA

Data indicates that from October 2007 through the end of 2016, average annual precipitation has been approximately 21.9 inches. The site experiences defined wet and dry seasons with an average of over 60% of the annual precipitation occurring during the summer monsoon period of July through September. July and August are the wettest months while April is the driest, averaging only about 0.3 inches of rainfall. A great majority of precipitation falls in the form of rain; however, minor amounts of snow does occur.

While the site data provides a good indication of precipitation, the area is known to have been drier during the past decade than is typical. To account for this, ERC utilized data from the regional sites to determine the long-term mean precipitation that should be expected at the site.

3.2 Regional Data

When considering the three regional sites, ERC first evaluated available data for completeness. All three regional stations were found to have incomplete data (> 5 days per month with missing data) in various months throughout their respective periods of record. ERC also looked at which stations have a period of record that overlap with the period of record at the site. This is important as an overlapping period of record is helpful when comparing data from different sites. The completeness and overlapping period of record for the three regional sites are summarized in **Table 3**.

Table 3 – Overlapping Period of Record and Evaluation of Incomplete Data

Site	Overlapping Period of Record with Mine?	# of Months Data is Incomplete in Overlapping POR	# of Months Data is Incomplete in Full Dataset
Nogales 6N	Yes	7 months (6% incomplete)	18 months (2% incomplete)
Patagonia	Yes	13 months (15% incomplete)	35 months (3% incomplete)
Canelo 1	No No Data for 2013 - 2014	55 months (63% incomplete)	92 months (7% incomplete)

Since Canelo 1 does not have data after 2012 and the available dataset is largely incomplete from October 2007 through the end 2014, it was not used for further evaluation.

Of the remaining two regional sites, the Nogales 6N site is favorable for use given the completeness of its dataset while the Patagonia site is favorable given its proximity to the site and similarities in elevation between it and the site. Given that there are advantages of both sites, additional analysis was performed on data from both locations.

In order to complete further evaluations of Nogales 6N and Patagonia precipitation data, the months with missing or incomplete data were first filled. The greater of the mean monthly precipitation for the given missing month or the amount of precipitation recorded at the site during the partial month when precipitation was measured was assumed. This is not a rigorous method for filling missing data, however, since the data from these two sites was only being used to evaluate long-term annual average precipitation versus averages from October 2007 through 2016, this method is believed to be adequate.

Once this data filling was complete, the average annual precipitation at each of the two stations was determined over different periods. Average annual precipitation values from both sites was determined from October 2007 through December 2016 to facilitate a direct comparison to site data. Average annual precipitation values from both sites was also determined from 1953 through 2016 as this is the longest concurrent period of record for the Nogales 6N and the Patagonia stations and represents the full period of record at the Nogales 6N site. Lastly the average annual precipitation at the Patagonia station was determined over its full period of record. Results of this evaluation are given in **Table 4**. For the October 2007 through December 2016 period, the values listed below are based on the sum of the mean monthly values due to the use of partial years.

Table 4 – Average Annual Precipitation Over Different Periods of Record (inches)

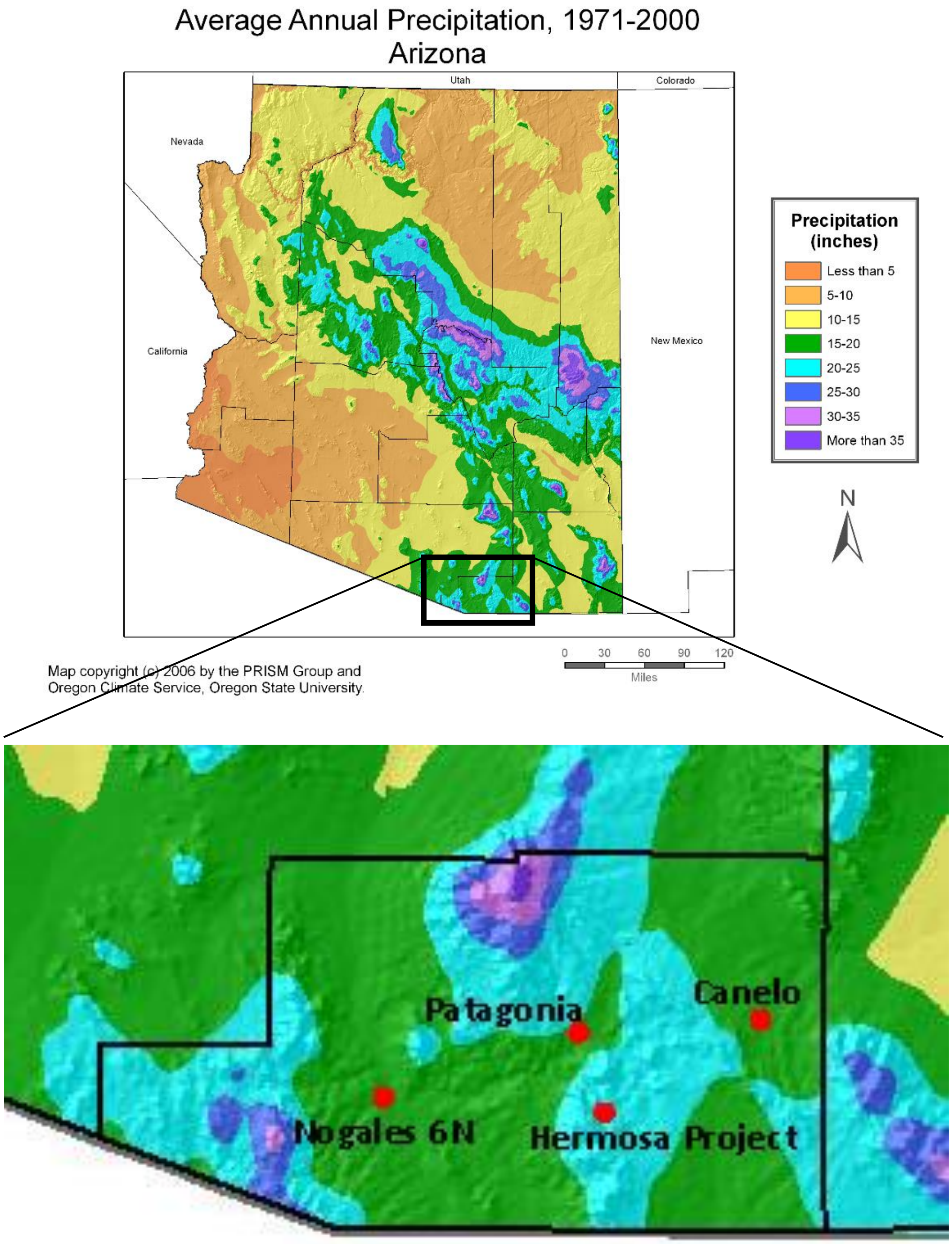
Period	Site Data	Nogales 6N	Patagonia
October 2007 – December 2016	21.90	13.98 (64% of site)	16.05 (73% of site)
1953 - 2016	NA	16.88 (21% greater than 2008 - 2014)	17.92 (12% greater than 2008 - 2014)
1923 - 2016	NA	NA	17.84 (11% greater than 2008 - 2014)

Based on the evaluation of historic records at the Nogales 6N and Patagonia sites, it is likely that site precipitation recorded from late 2007 through 2016 underestimates long-term precipitation. Given that the amount of precipitation at Nogales 6N was about 20% greater from 1953 through 2016 than from late 2007 through 2016 and precipitation at Patagonia over extended periods was roughly 10% greater than from late 2007 through 2016, long-term precipitation at the site is expected to be on the order of 15% greater than has been recorded since 2007. The would equate to a long-term annual precipitation of approximately 25.2 inches at the site.

3.3 PRISM Model

The final step for verifying estimates of site precipitation data was the review of annual estimates from other sources. A precipitation map for Arizona based on average annual precipitation from a period of 1971-2000 was created using the Parameter-elevation Regressions on Independent Slope Model (PRISM) developed by Utah State University. PRISM utilizes observed precipitation values, elevation, orographic effects and aspect to estimate precipitation at unknown site. The PRISM model for Arizona was obtained and expanded in the region of the site to show computer model estimates of long-term average annual precipitation. **Figure 2** shows PRISM results for the State and the mine area including the regional precipitation sites used in our analysis. PRISM results generally confirm conclusions based on the raw data and show that the site is expected to receive more precipitation than any of the regional sites. Effects of elevation on precipitation can be clearly seen from this map. While not matching the exact values recorded at the different stations, PRISM results support the overall estimates above.

Figure 2 – Estimates of Annual Precipitation (from PRISM)



The PRISM map suggests that average annual precipitation at Nogales 6N is between 15” and 18” (ERC’s estimate from data is about 17”), annual precipitation at Patagonia is between 18” and 19” (ERC’s estimate from data is about 18”) and precipitation at the site is between 20” and 25” (ERC’s estimate is about 25”). The PRISM data generally fits with ERC’s estimates, therefore ERC’s estimate including a 15% increase over values recorded at site from late 2007 – 2016 appear to be reasonable. We suggest that the mine continue to monitor precipitation data on site. In the future, as additional site and regional data is collected estimates of long-term precipitation averages can be updated.

Based on the evaluations above, ERC has developed the following recommendations for monthly precipitation values to be used in analysis. As the site continues to collect additional data, these values can be further refined.

Table 5 – Recommended Precipitation Statistics Site Evaluations

Month	Average Precip (in)	Standard Deviation (in)	Monthly Correlation
January	1.66	1.84	-0.267
February	0.88	0.97	0.786
March	2.51	1.65	0.146
April	0.35	0.33	-0.359
May	0.38	0.46	-0.709
June	0.87	1.24	-0.048
July	5.66	1.88	-0.378
August	5.59	1.57	0.192
September	4.38	1.80	-0.028
October	0.63	0.82	0.474
November	0.63	0.60	-0.414
December	1.64	0.81	0.343
Annual	25.18	5.00	NA

4.0 24-Hour Storm Depths

Determination of precipitation associated with the various frequency storm events was obtained from the National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server. Short-duration storm depths are determined from NOAA by entering site location. Reported precipitation values are for Latitude 31o 27’ 20” N, Longitude 110o 42’ 47” W. The resultant 1 – through 500-year 24-hour storm events are presented on **Table 6**.

Table 6 – Point Precipitation Frequency Estimates

Frequency (yr.)	Duration (hr)	Precipitation Depth (in)
1	24	1.86
2	24	2.31
5	24	2.87
10	24	3.32
25	24	3.93
50	24	4.40
100	24	4.88
500	24	6.02

5.0 Probable Maximum Precipitation

5.1 Methodology

ERC followed the methodology outlined in Hydrometeorological Report No. 49 (HMR 49), Probable Maximum Precipitation – Colorado River and Great Basin Drainages. Note that the procedures and inputs for the PMP have not changed since ERC completed the analysis in 2013, so all results presented herein are taken from the 2013 report.

5.2 Assumptions

The following assumptions were incorporated into the PMP calculations based on satellite imaging.

- Site Location: 31o 27’ 20” N, 110o 42’ 47” W
- Drainage Basin Area: 2.0 square miles
- Lowest Basin Elevation: 5,200 feet above mean sea level (AMSL)

5.3 General Storm Calculations

General storms derived from HMR 49 are 72-hour duration events. General Storms are calculated as the combination of two types of storm drivers: convergence storms and orographic storms. Research into historical precipitation data indicates that the magnitude of the General Storm within this region is dependent upon the month in which it occurs. PMP estimates were therefore calculated independently for every month following procedures outlined in HMR 49.

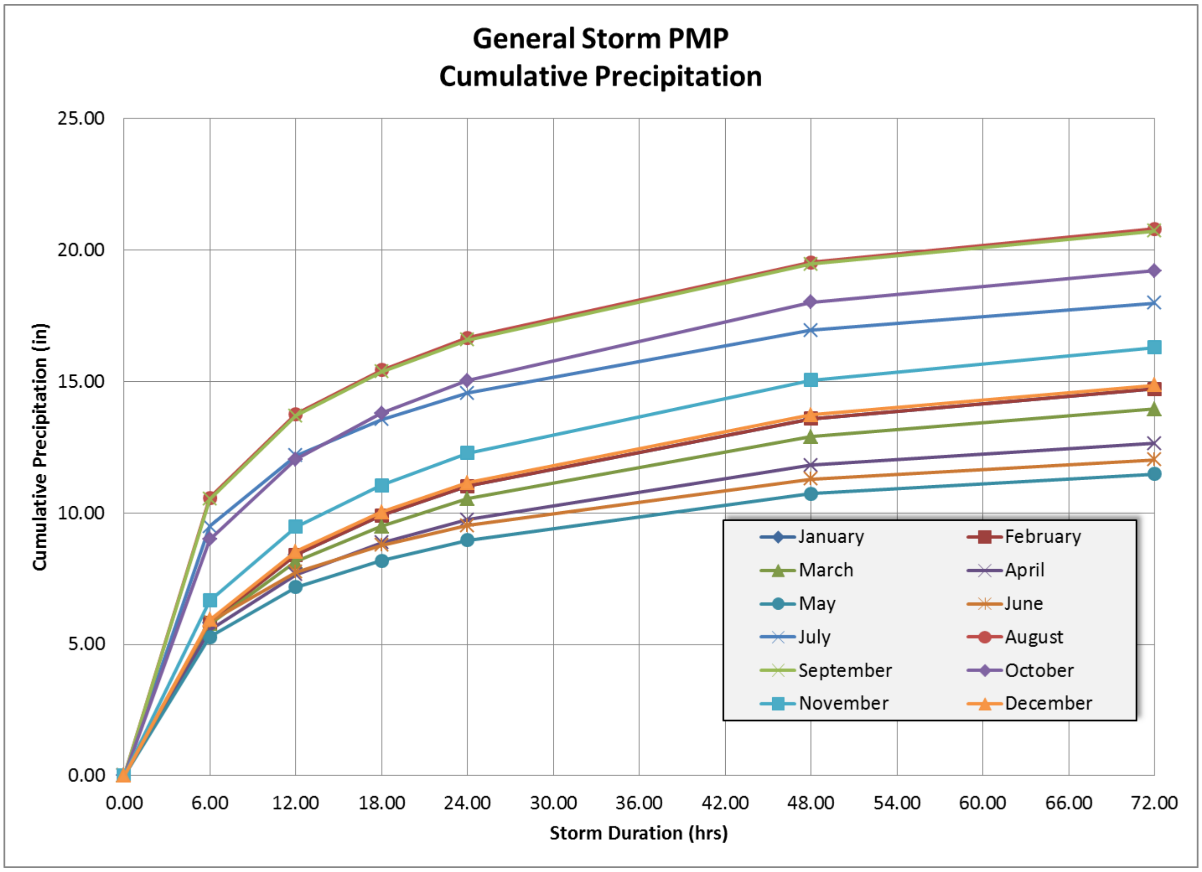
Graphical and tabular data from HMR 49 used in the calculation of the General Storm are presented in **Appendix A**. Calculations are given in **Appendix B**.

Results of the General Storm PMP calculation produce cumulative precipitation distributions for each month. **Figure 3** presents these results. Cumulative precipitation estimated for the General Storm PMP ranges from a low of 11.48 inches in the month of May to a high of 20.81 inches in August. In general, the temporal distribution of each monthly PMP is similar. General Storm PMP values calculated by month are provided in **Table 7**.

Table 7 – Monthly General Storm PMP Estimates (inches)

Month	PMP Estimates (inches)
January	14.71
February	14.71
March	13.95
April	12.66
May	11.48
June	12.02
July	18.00
August	20.81
September	20.73
October	19.22
November	16.30
December	14.87

Figure 3 – General Storm PMP Cumulative Precipitation

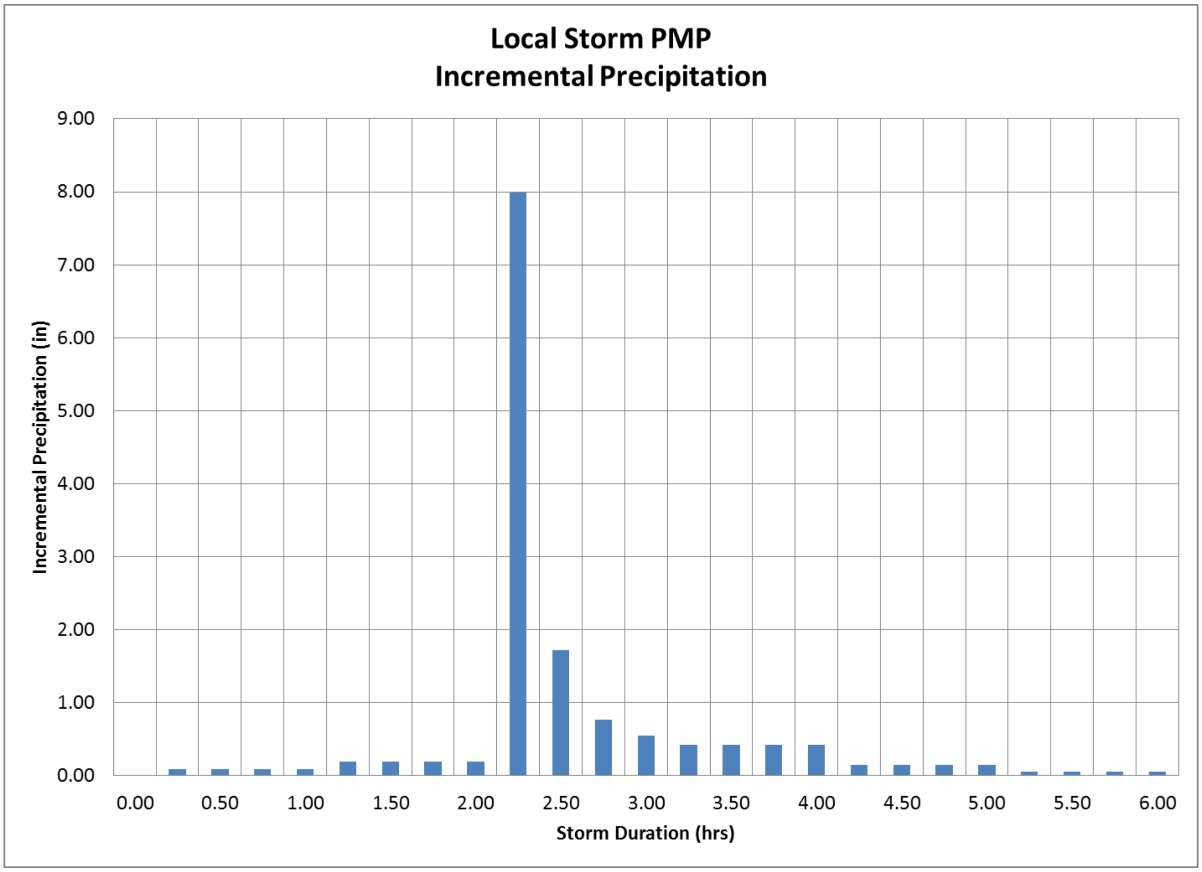


5.4 *Local Storm Calculations*

Local storms derived in HMR 49 are 6-hour duration events typical of isolated thunderstorms. Unlike General Storms, a single value is generated for the Local Storm to be used for all months. Graphical and tabular data from HMR 49 used in the calculation of the Local Storm are presented in **Appendix C**. Calculations are given in **Appendix D**.

Results of the Local Storm PMP calculation produce incremental precipitation values for time intervals down to 15-minutes during the storm peak. Figure 4 presents these results. The estimated total rainfall produced by the Local Storm is 14.63 inches in a six-hour period. The greatest 15-minute incremental rainfall predicted by the Local Storm is 7.99 inches which equates to a peak rainfall intensity of approximately 31.96 inches per hour for 15 minutes.

Figure 4 – Local Storm PMP Incremental Precipitation

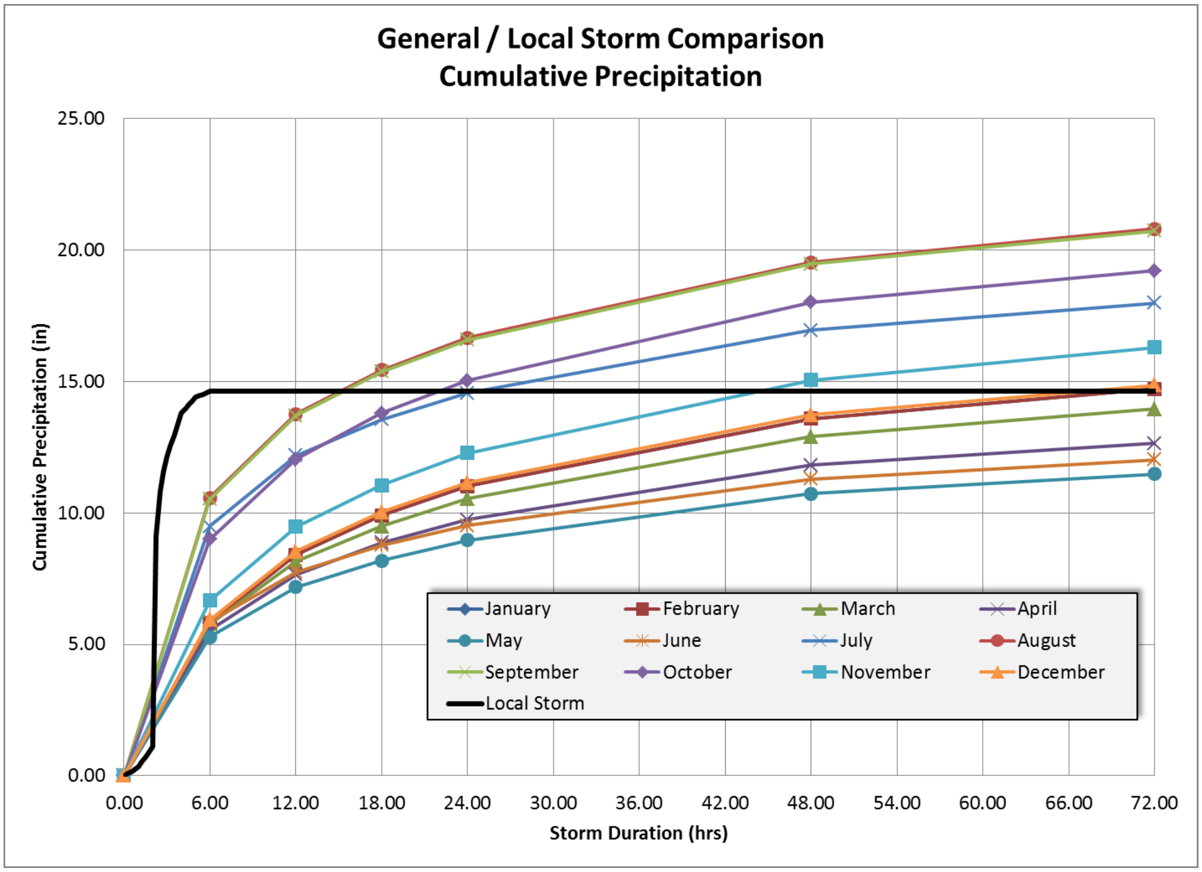


5.5 Comparison of General and Local Storm PMPs

ERC converted incremental precipitation predicted for the Local Storm PMP to a cumulative distribution to compare General and Local Storm PMPs. To do so, ERC assumed that no precipitation occurred in the 66 hours following the 6-hour Local Storm PMP. In the comparison, both storms were assumed to begin at the same time. **Figure 5** presents the comparison between the different PMPs. Results show the local storm produces less rainfall than the general storm during initial 2 hours. Between hours 2 and 4 the Local Storm PMP produces significantly greater rainfall. Between hours 4 and 6 the Local Storm rainfall intensities are lower than General Storm intensities. After hour 6 no additional precipitation is predicted for the Local Storm whereas precipitation is assumed to continue through hour 72 for the General Storm.

Total precipitation produced by the General Storm PMP is approximately 40% greater than precipitation produced by the Local Storm. In general, the Local Storm will produce higher peak flows due to higher rainfall intensities and the General Storm will produce higher rainfall volumes due to a greater amount of total precipitation. In general, the Local Storm would be more critical when sizing facilities that convey water and the General Storm would be more critical when sizing facilities that store water.

Figure 5 – Comparison between Local and General Storm PMPs



6.0 Evaporation Data

Pan evaporation data has been collected at the site starting in late 2007. ERC compiled monthly evaporation data from quarterly meteorological reports prepared by various consultants. Raw reported monthly total site pan evaporation data is presented in **Table 8**. Review of the monthly summary reports show that evaporation data has not been recovered for all periods. The percentage of time that pan evaporation data has been collected at the site is included in the quarterly reports and is summarized in Table 9. To account for this missing data, ERC estimated the site pan evaporation rates by dividing the measured evaporation rates in **Table 8** by the data completeness in **Table 9**. The results, shown in **Table 10**, represent adjusted estimates of site pan evaporation.

Table 8 – Pan Evaporation Recorded at the Site (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	2.91	3.79	5.50	7.93	8.99	9.89	5.31	3.96	5.38	5.12	3.92	2.92	65.60
2009	1.38	1.68	2.85	4.50	3.55	4.85	4.11	2.84	4.08	3.33	3.12	1.57	37.86
2010	1.81	2.92	4.50	4.00	5.78	4.81	3.19	4.90	4.96	2.45	1.75	1.44	42.50
2011	2.36	2.46	4.26	3.93	5.39	7.30	4.20	4.38	4.18	6.02	4.07	2.35	50.89
2012	3.08	2.80	5.52	5.72	8.08	7.89	5.21	5.58	3.94	5.24	3.21	2.92	59.18
2013	2.03	2.75	2.87	0.78	7.73	8.06	5.30	2.76	4.87	6.40	3.76	2.65	49.96
2014	3.75	4.32	6.41	7.91	10.92	13.29	5.69	4.94	4.06	4.28	3.48	2.50	71.55
2015	2.42	3.73	4.30	4.87	2.26	3.04	1.82	2.45	2.54	3.24	3.53	2.70	36.90
Average	2.47	3.05	4.53	4.95	6.59	7.39	4.35	3.98	4.25	4.51	3.35	2.38	51.80
St. Dev	0.76	0.85	1.26	2.32	2.88	3.25	1.32	1.17	0.87	1.42	0.72	0.57	12.77

Table 9 – Completeness of Pan Evaporation Recorded at the Site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	95.4%	95.0%	92.5%	90.1%	89.1%	90.4%	92.6%	91.3%	95.3%	90.9%	93.5%	93.0%	92.4%
2009	97.4%	91.7%	93.0%	97.8%	94.6%	91.9%	95.7%	97.4%	95.7%	93.5%	96.3%	98.2%	95.3%
2010	98.8%	99.1%	99.1%	98.0%	98.8%	98.3%	100.0%	100.0%	99.7%	98.1%	98.2%	99.6%	99.0%
2011	99.2%	98.9%	99.6%	100.0%	98.9%	97.5%	99.2%	91.8%	94.2%	96.4%	84.9%	90.2%	95.9%
2012	85.3%	77.4%	85.9%	76.7%	77.6%	77.6%	88.7%	88.4%	85.4%	80.8%	80.4%	93.4%	83.1%
2013	89.1%	90.6%	83.3%	69.4%	67.9%	61.0%	87.9%	77.3%	87.5%	83.1%	85.0%	88.6%	80.9%
2014	82.8%	80.8%	87.0%	81.7%	83.9%	82.9%	88.0%	87.8%	91.9%	83.3%	80.1%	87.5%	84.8%
2015	81.6%	90.6%	80.0%	76.7%	68.8%	65.6%	68.8%	66.6%	82.6%	74.0%	81.4%	85.3%	76.8%

Table 10 – Adjusted Site Pan Evaporation Estimates based on Data Completeness (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	3.05	3.99	5.94	8.80	10.09	10.94	5.74	4.33	5.65	5.63	4.19	3.14	71.48
2009	1.42	1.83	3.07	4.60	3.75	5.28	4.29	2.91	4.26	3.56	3.24	1.60	39.81
2010	1.83	2.95	4.54	4.08	5.85	4.89	3.19	4.90	4.98	2.50	1.79	1.44	42.92
2011	2.38	2.49	4.27	3.93	5.45	7.49	4.23	4.77	4.43	6.25	4.79	2.60	53.08
2012	3.61	3.62	6.42	7.45	10.41	10.16	5.87	6.32	4.62	6.48	3.99	3.12	72.08
2013	2.28	3.03	3.45	1.12	11.39	13.22	6.02	3.58	5.57	7.70	4.43	2.99	64.76
2014	4.53	5.34	7.37	9.69	13.01	16.03	6.47	5.63	4.42	5.14	4.34	2.85	84.82
2015	2.97	4.12	5.38	6.35	3.28	4.63	2.65	3.68	3.08	4.38	4.34	3.17	48.01
Average	2.76	3.42	5.05	5.75	7.90	9.08	4.81	4.51	4.63	5.20	3.89	2.61	59.62
St. Dev	1.00	1.09	1.49	2.85	3.74	4.22	1.42	1.13	0.82	1.68	0.96	0.70	16.06

Adjusted values suggest that the average annual precipitation at the mine site is approximately 60 inches. May and June are the months with the greatest pan evaporation while the least amount of evaporation is expected to occur in December and January.

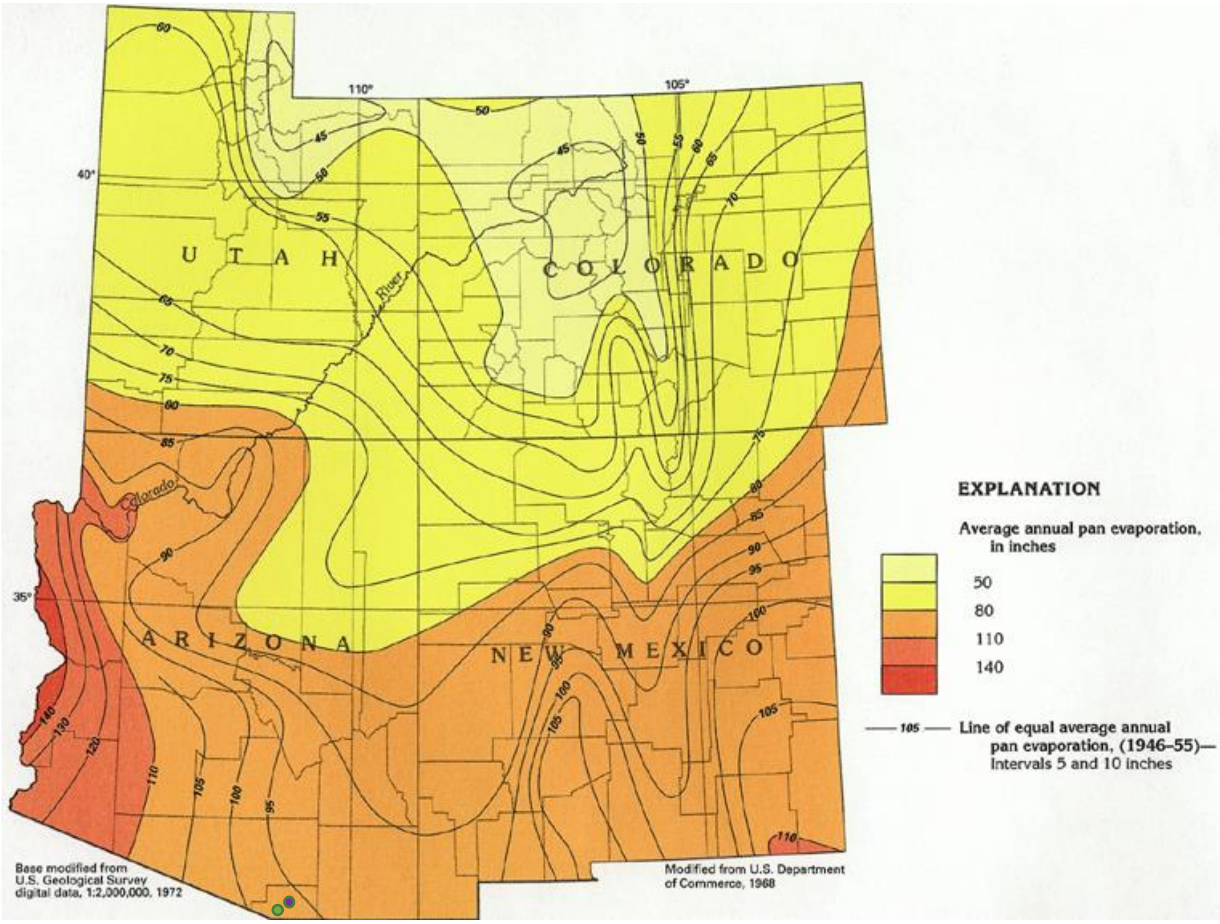
In an attempt to verify site data, ERC considered available regional pan evaporation data. From a regional basis, evaporation data is not available from the Canelo or Patagonia stations. The nearest meteorological station with available evaporation data is the Nogales 6N Station located in Nogales, AZ, approximately 15 miles west of the proposed mine site. The period of record for the Nogales 6N Station evaporation data is 1952 to 2005. The annual total pan evaporation is approximately 92 inches with nearly 40% of the annual evaporation total occurring over the three-month period of May through July. The average monthly and annual pan evaporation rates based on data recorded at the Nogales 6N site are provided in **Table 11**.

Table 11 – Pan Evaporation Based on Data from the Nogales 6N Site

Month	Pan Evaporation (inches)
January	3.6
February	4.7
March	7.0
April	9.4
May	11.9
June	13.3
July	10.0
August	8.3
September	8.1
October	7.2
November	4.5
December	3.6
Annual	91.6

To verify the Nogales 6N data, ERC evaluated regional evaporation estimates for comparison. The United States Geologic Service (USGS) publishes maps showing average annual evaporation. The approximate location of the Nogales 6N station and the site were plotted on a USGS evaporation of Arizona and surrounding areas, shown in Figure 6. Nogales 6N is identified by the green circle while the site is shown by the purple circle. The USGS figure suggests that annual evaporation at Nogales 6N is likely on the order of 97-98 inches while annual evaporation at the site is approximately 96 inches.

Figure 6 – Estimates of Annual Pan Evaporation Rates (from USGS)



The regional data suggests that pan evaporation on site would be significantly (roughly 50%) higher than estimated based on site data. Inspection of the site pan evaporation data suggests that evaporation is highly variable from year to year. As an example, evaporation in 2009 and 2010 were recorded to be approximately 40 inches per year while evaporation in 2015 was under 50 inches. These extreme low values raised concern in the integrity of the site collected data. Due to this highly variable site data and the discrepancy between site and regional data, ERC completed additional analysis in an attempt to verify the site pan evaporation data.

Given all of the meteorological data collected on site, it is possible to calculate evaporation estimates using other measured parameters. One simple method is the Energy Balance Method, which calculates daily evaporation based on net solar radiation (Chow 1988). The standard Energy Balance equation is:

$$Er = 0.0353Rn$$

where Er is evaporation measured in millimeters per day and Rn is solar radiation in Watts per square meter. This simple equation assumes that air temperature is 20°C, which is not the case for the site. Given this temperature issue, the standard Energy Balance equation is not expected to provide absolute evaporation rates for the site. It can, however, be used to compare the relative amount of evaporation from year-to-year and highlight potential anomalies in the data set.

Site measured mean monthly solar radiation is provided in **Table 12** while the corresponding calculated monthly and annual evaporation rates at site are given in **Table 13**.

Table 12 – Site Recorded Solar Radiation (W/m2)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	320.7	384.8	492.9	518.6	515.7	477.6	342.7	354.8	376.5	409.9	294.5	217.2
2009	272.3	370.7	464.4	512.8	450.2	428	374.4	402	387.9	389.8	267.1	238.3
2010	231.4	297.5	468.7	456	544.7	520.4	326.2	377.8	412.3	365	296.4	204.5
2011	264.6	341.7	495.4	493.7	540.2	530.3	328.3	343.2	396.9	369.2	248.3	198.3
2012	273.6	404.5	474.9	554.5	621.4	474.6	328	446.5	365.8	419.3	250.6	222.8
2013	236.4	374.1	454.4	580.4	508	502.9	316.8	363.5	401.6	427.4	254.7	221
2014	265.3	379.1	449.2	622.3	665	655.5	395.5	420.9	338.5	417.4	321	219.8
2015	98.4	169.9	207.8	285.5	291.7	254.7	193.6	209.5	181	157.5	123.5	98.1

Table 13 – Site Evaporation Calculates Based on Recorded Solar Radiation (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2008	13.82	16.58	21.24	22.34	22.22	20.58	14.76	15.29	16.22	17.66	12.69	9.36	202.74
2009	11.73	15.97	20.01	22.09	19.40	18.44	16.13	17.32	16.71	16.79	11.51	10.27	196.37
2010	9.97	12.82	20.19	19.65	23.47	22.42	14.05	16.28	17.76	15.73	12.77	8.81	193.91
2011	11.40	14.72	21.34	21.27	23.27	22.85	14.14	14.79	17.10	15.91	10.70	8.54	196.03
2012	11.79	17.43	20.46	23.89	26.77	20.45	14.13	19.24	15.76	18.06	10.80	9.60	208.37
2013	10.18	16.12	19.58	25.01	21.89	21.67	13.65	15.66	17.30	18.41	10.97	9.52	199.96
2014	11.43	16.33	19.35	26.81	28.65	28.24	17.04	18.13	14.58	17.98	13.83	9.47	221.85
2015	4.24	7.32	8.95	12.30	12.57	10.97	8.34	9.03	7.80	6.79	5.32	4.23	97.85
Average	10.57	14.66	18.89	21.67	22.28	20.70	14.03	15.72	15.40	15.92	11.07	8.72	189.63
St. Dev	2.81	3.28	4.08	4.39	4.87	4.86	2.58	3.09	3.23	3.82	2.58	1.89	38.17

Site evaporation calculated by the Energy Balance Method produces monthly and annual values that greatly exceed recorded pan evaporation and regional evaporation estimates. ERC does not recommend using these calculated values. Calculated evaporation rates are, however, helpful in evaluating data recorded at the site. Review of the calculated data suggest that in 2009 and 2010, solar radiation at the site was approximately average whereas in 2015 it was only about 50% of average. This suggests that evaporation in 2009 and 2010 should have been near the average annual evaporation whereas evaporation in 2015 is expected to below average. Pan evaporation data recorded at the site (see **Table 10**), however, show that recorded evaporation in 2009 and 2010 are the two lowest years of record. Given how much the 2009 and 2010 data are lower than other years and even lower than regional data, ERC suggests that these values not be used at this time. Low pan evaporation rates from 2015 are supported by low solar radiation and ERC feels that this data should be considered. Based on this information, ERC recommends that monthly site pan evaporation be based on values recorded at site in 2008 and from 2011-2015. When estimating evaporation from a pond surface, ERC recommended that a pan coefficient of 0.72 be applied to pan evaporation. Recommended pan and pond monthly evaporation rates are presented in **Table 14**. We feel that moving forward additional evaluations of evaporation data is warranted given the significant differences in site and regional data.

Table 14 – Recommended Pan and Pond Evaporation for Use at Site

Month	Pan Evaporation (inches)	Pond Evaporation (inches)
January	3.13	2.26
February	3.76	2.71
March	5.47	3.94
April	6.22	4.48
May	8.94	6.44
June	10.41	7.50
July	5.16	3.72
August	4.72	3.40
September	4.63	3.33
October	5.93	4.27
November	4.35	3.13
December	2.98	2.14
Annual	65.70	47.31

7.0 References

American Meteorological Society, Glossary of Meteorology, Boston, MA, 1959.

Chow, Maidment and Mays, Applied Hydrology, McGraw-Hill, Inc., 1988.

Ecological Resource Consultants, Inc., Technical Memo to NewFields – Wildcat Pre-feasibility Meteorological Analysis. March 1, 2013.

Hansen, et al., Hydrometeorological Report No. 49 (HMR 49), Probable Maximum Precipitation – Colorado River and Great Basin Drainages, National Weather Service, Silver Spring, MD, reprinted 1984.

NOAA's National Weather Service Hydrometeorological Design Studies Center Precipitation Frequency Data Server, hdsc.nws.noaa.gov/hdsc.pfds

PRISM Climate Data, prism.oregonstate.edu

Western Regional Climate Center, wrcc.dri.edu

Appendices

Appendix A – Graphical and Tabular Data for General Storm PMP

Appendix B –General Storm PMP Calculations

Appendix C – Graphical and Tabular Data for Local Storm PMP

Appendix D – Local Storm PMP Calculations

Appendix A

Graphical and Tabular Data for General Storm PMP

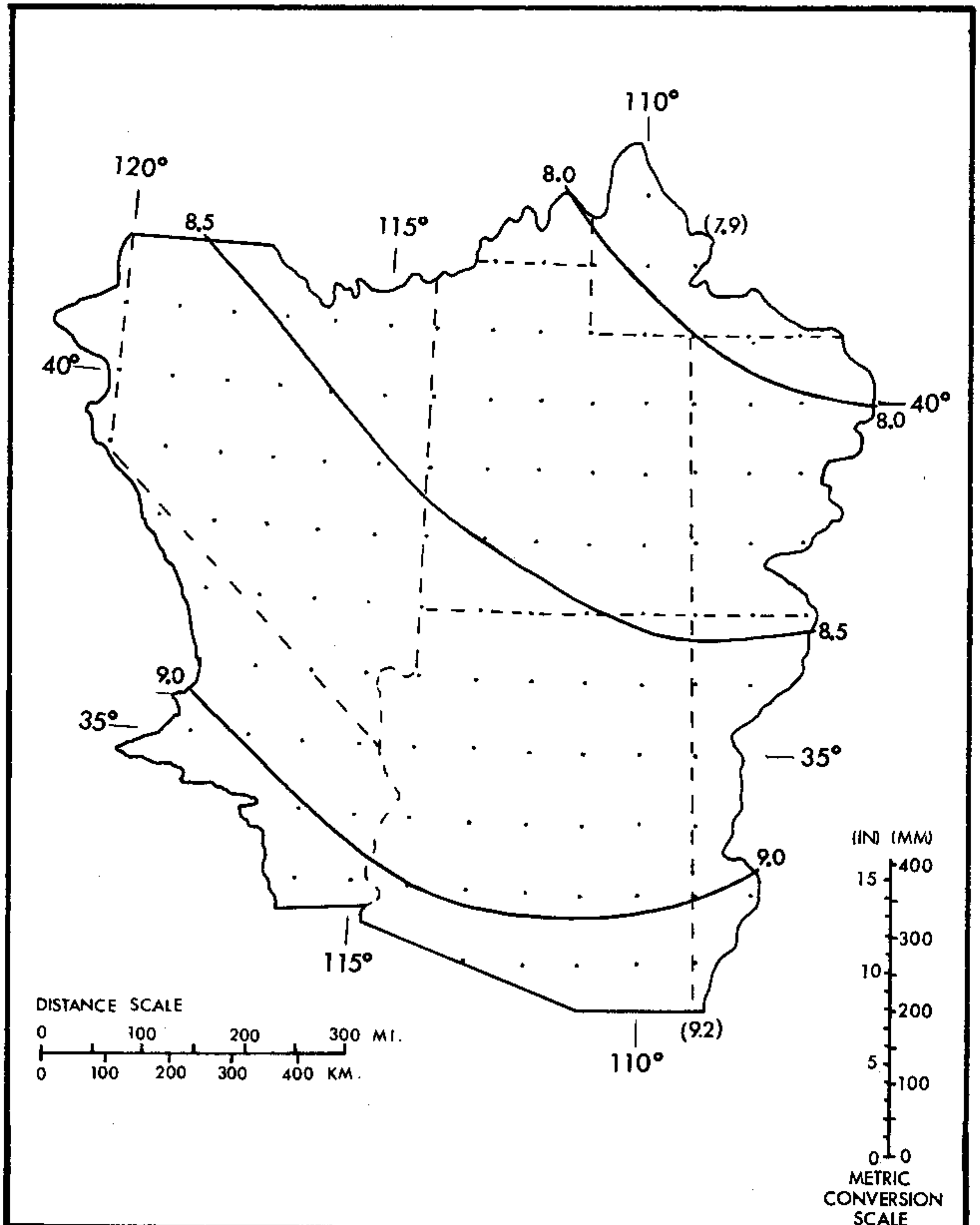


Figure 2.5.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for January. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

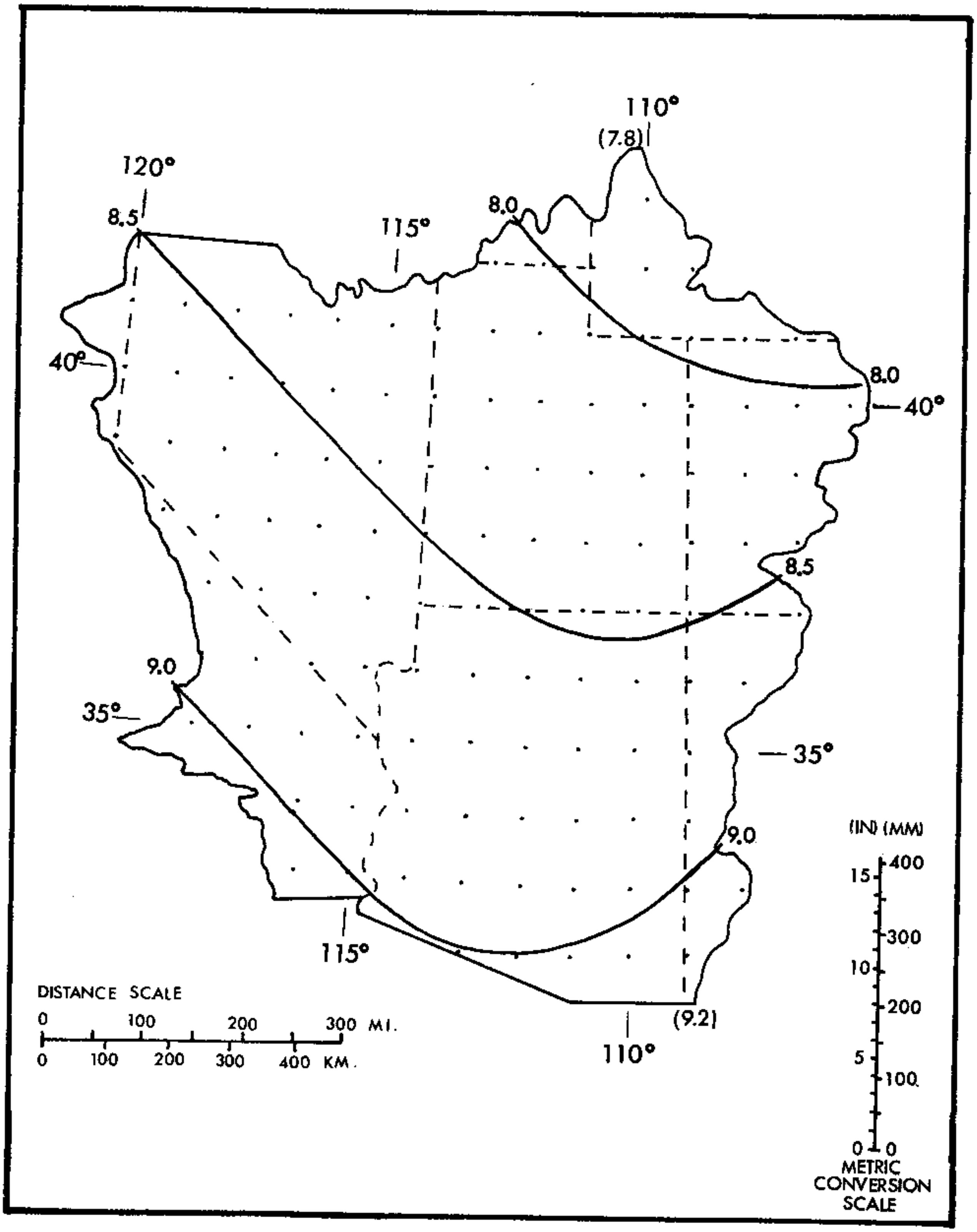


Figure 2.6.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for February. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

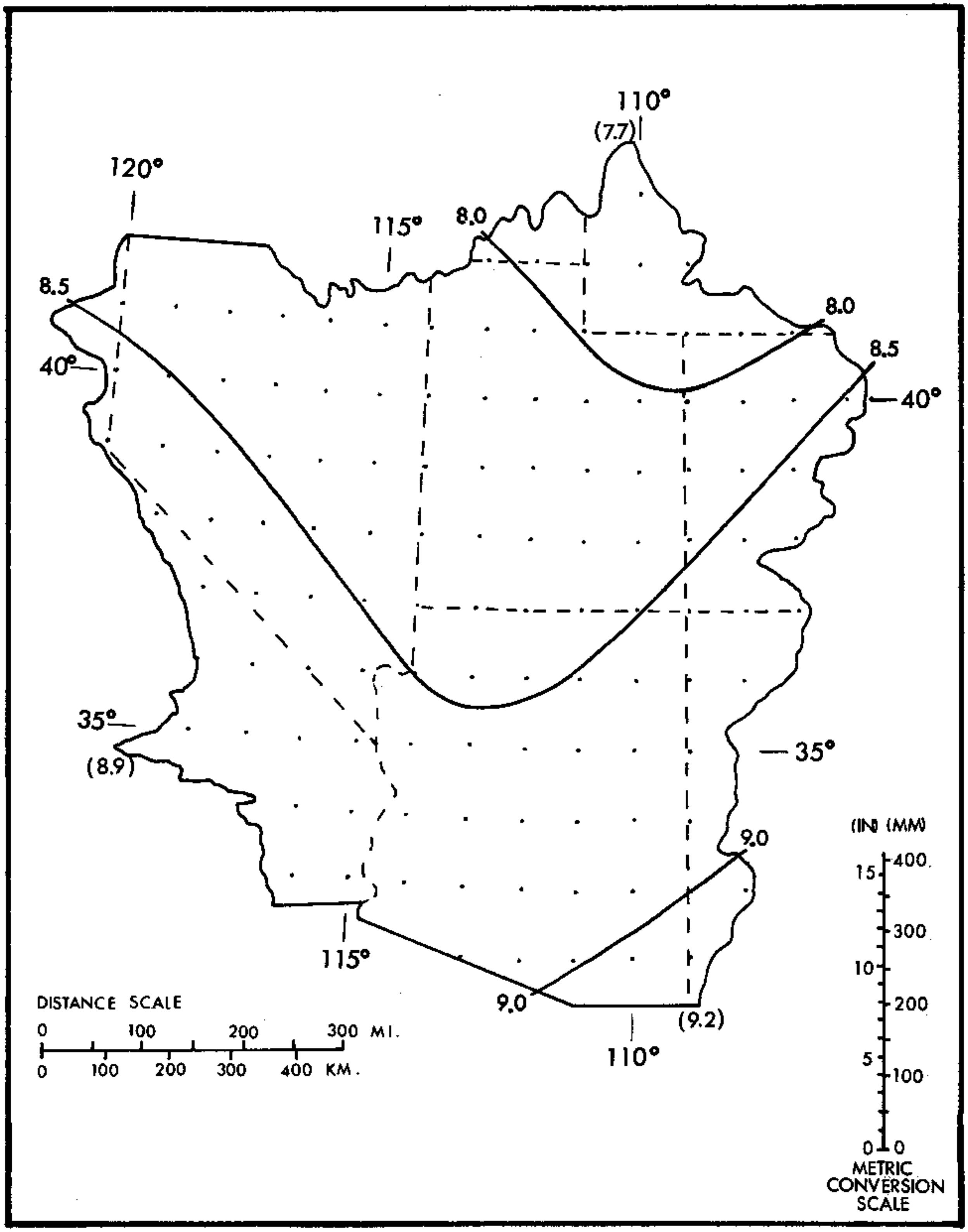


Figure 2.7.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for March. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

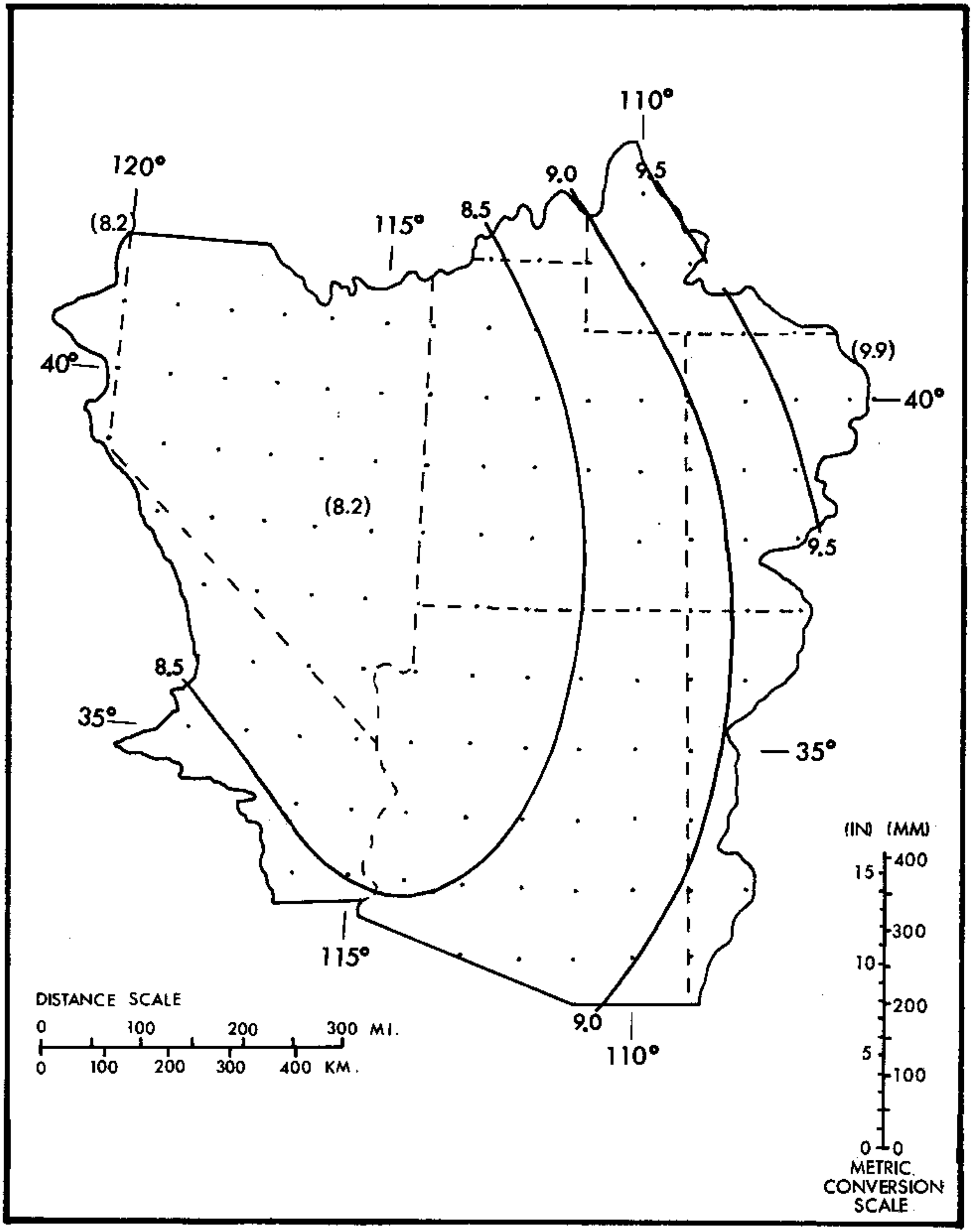


Figure 2.8.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for April. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

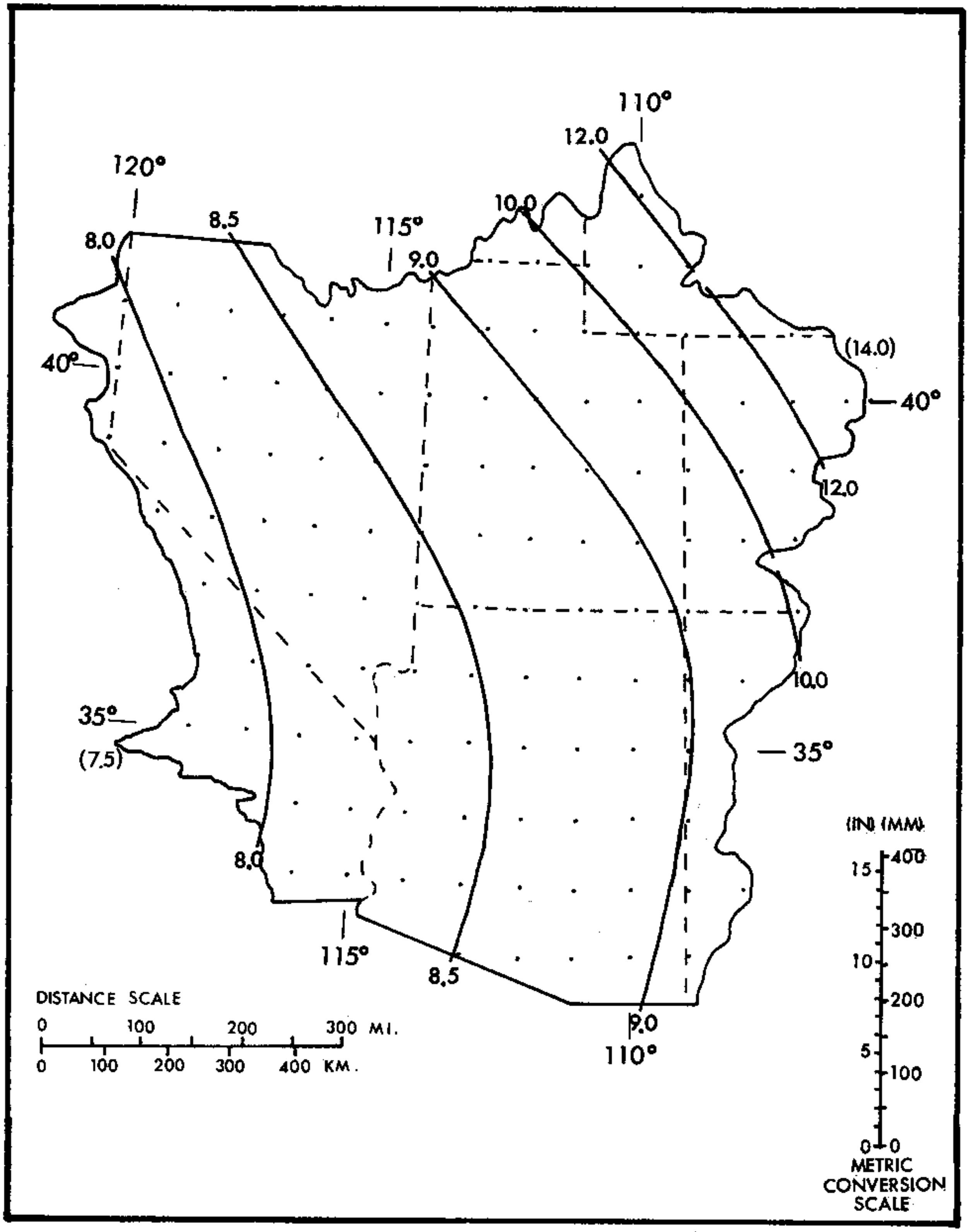


Figure 2.9.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for May. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

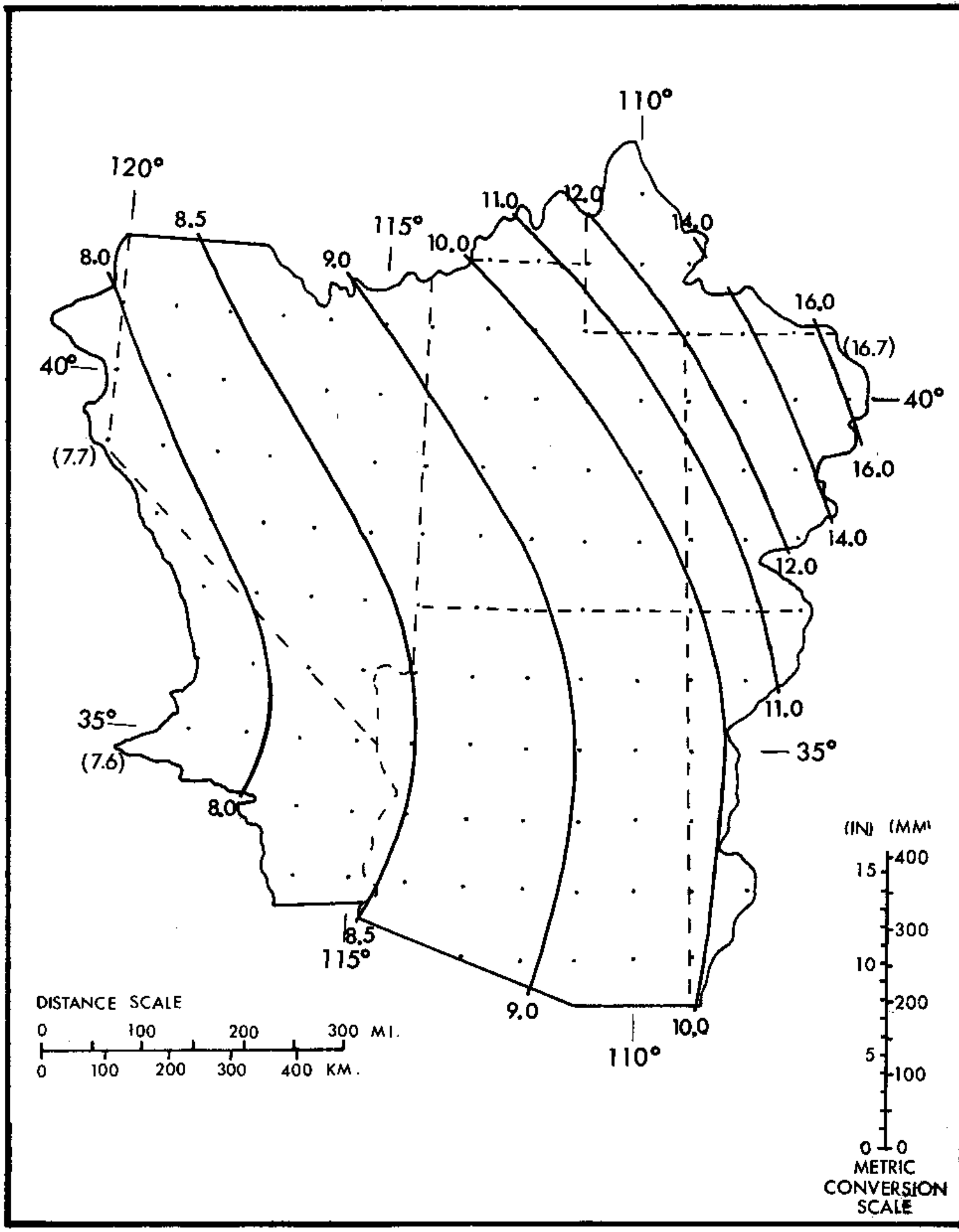


Figure 2.10.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for June. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

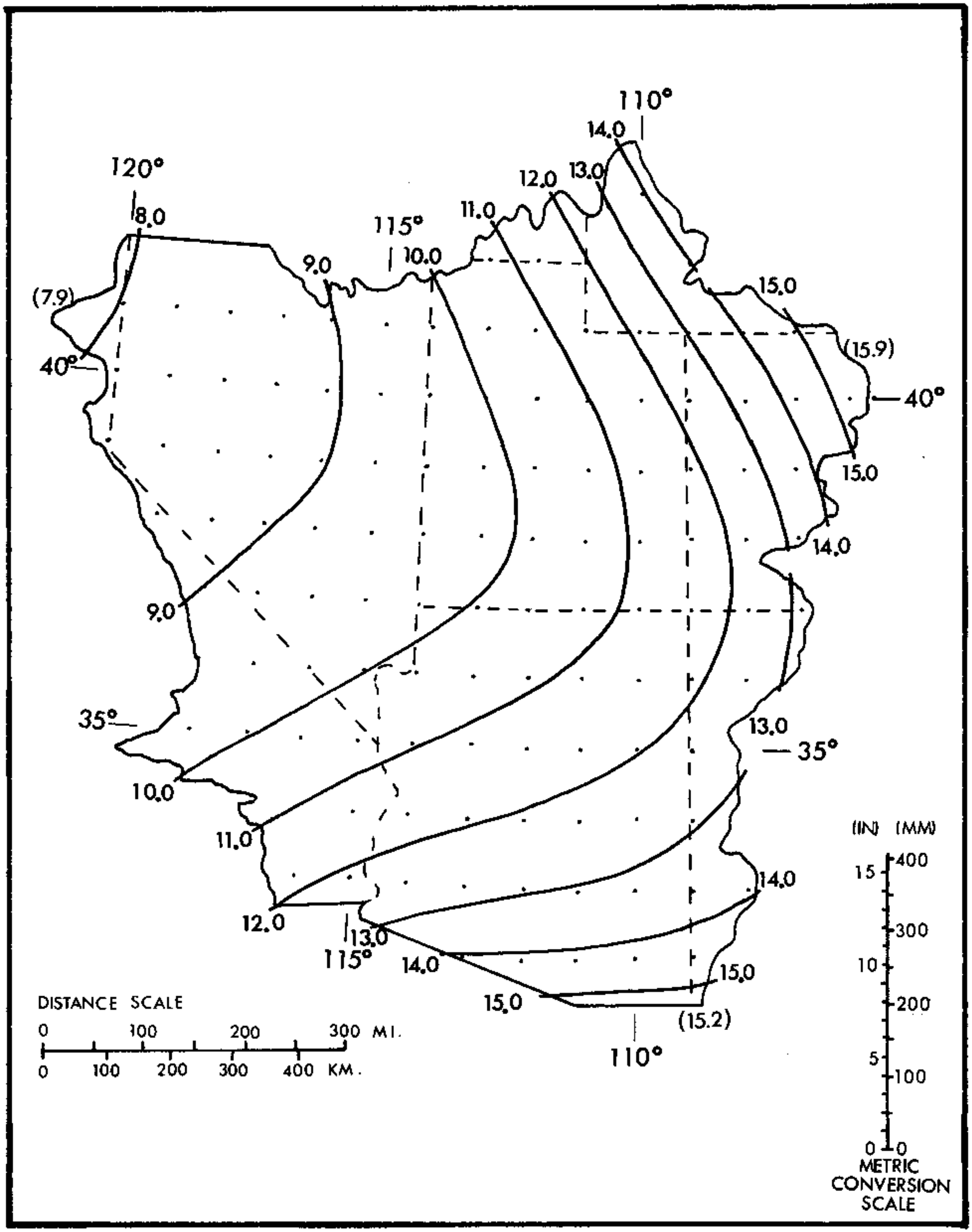


Figure 2.11.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi2 (26 km2) for July. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

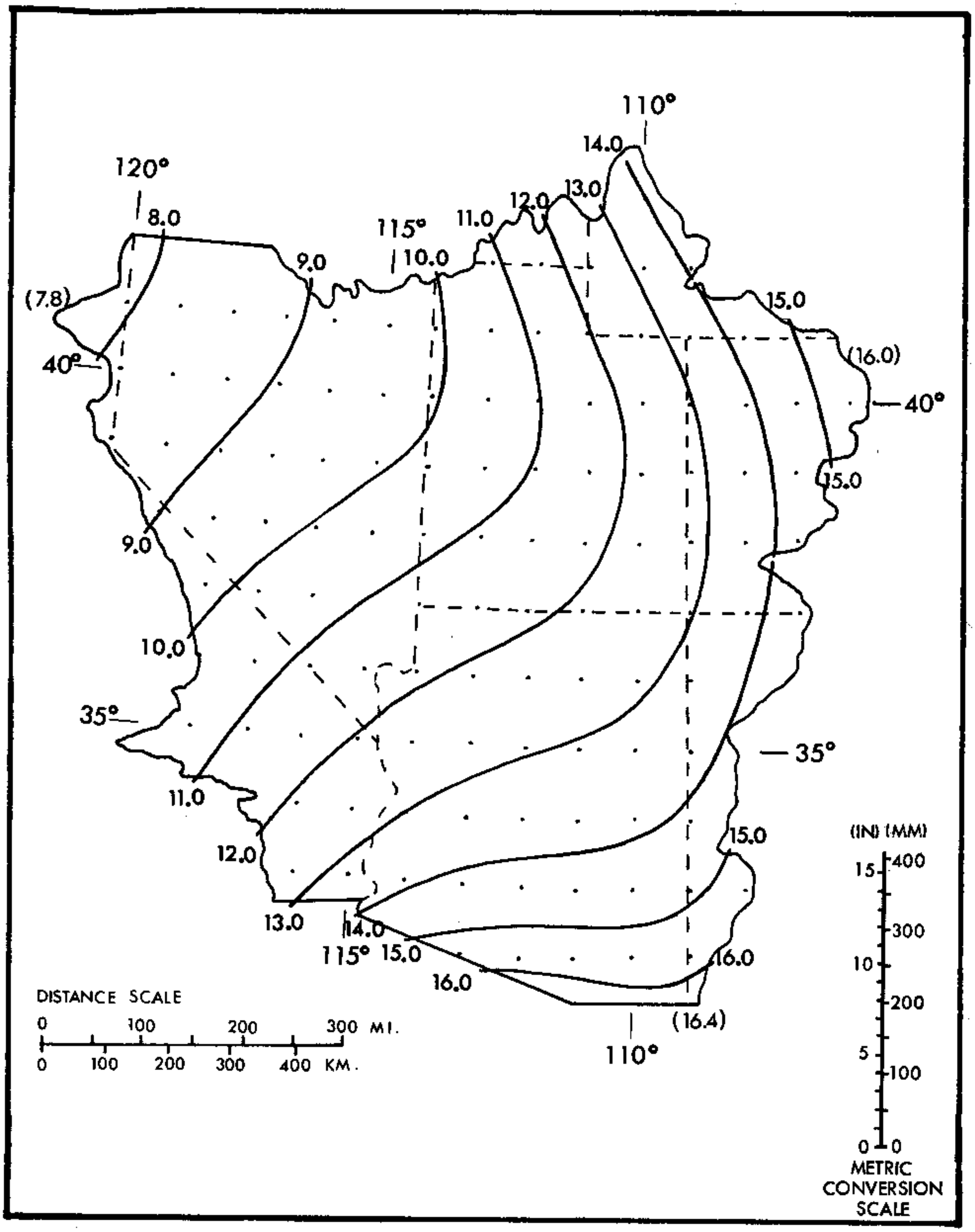


Figure 2.12.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for August. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

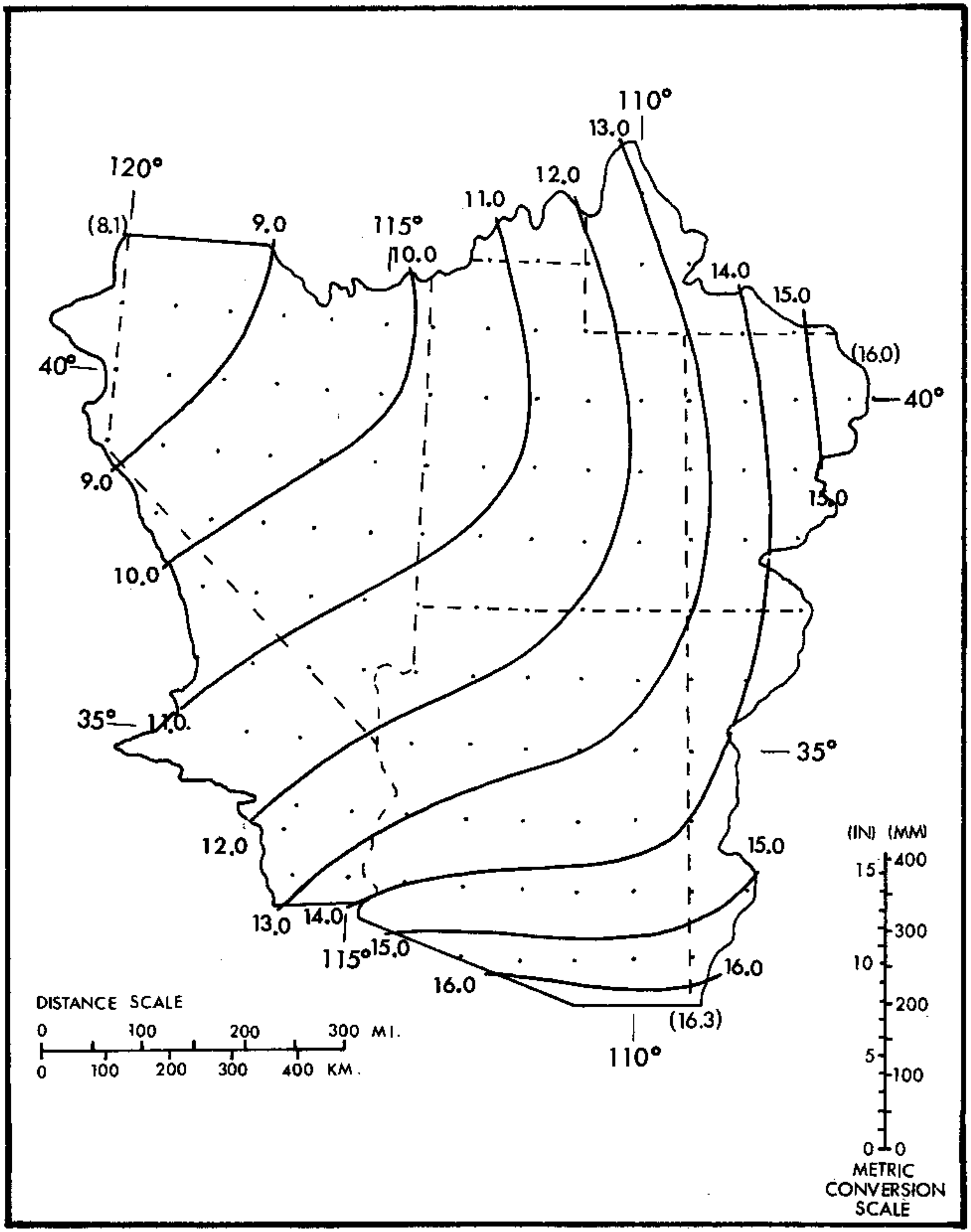


Figure 2.13.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for September. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

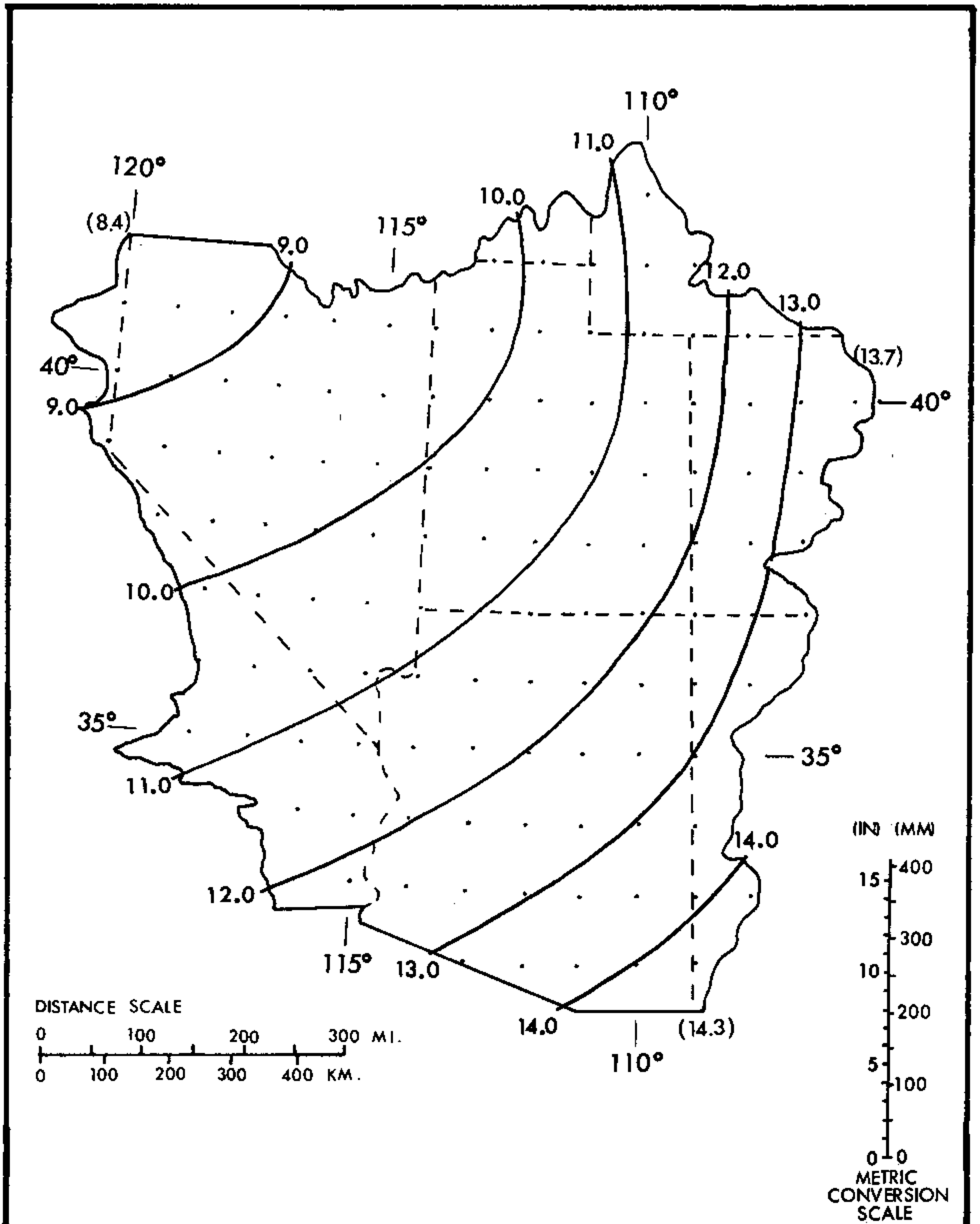


Figure 2.14.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for October. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

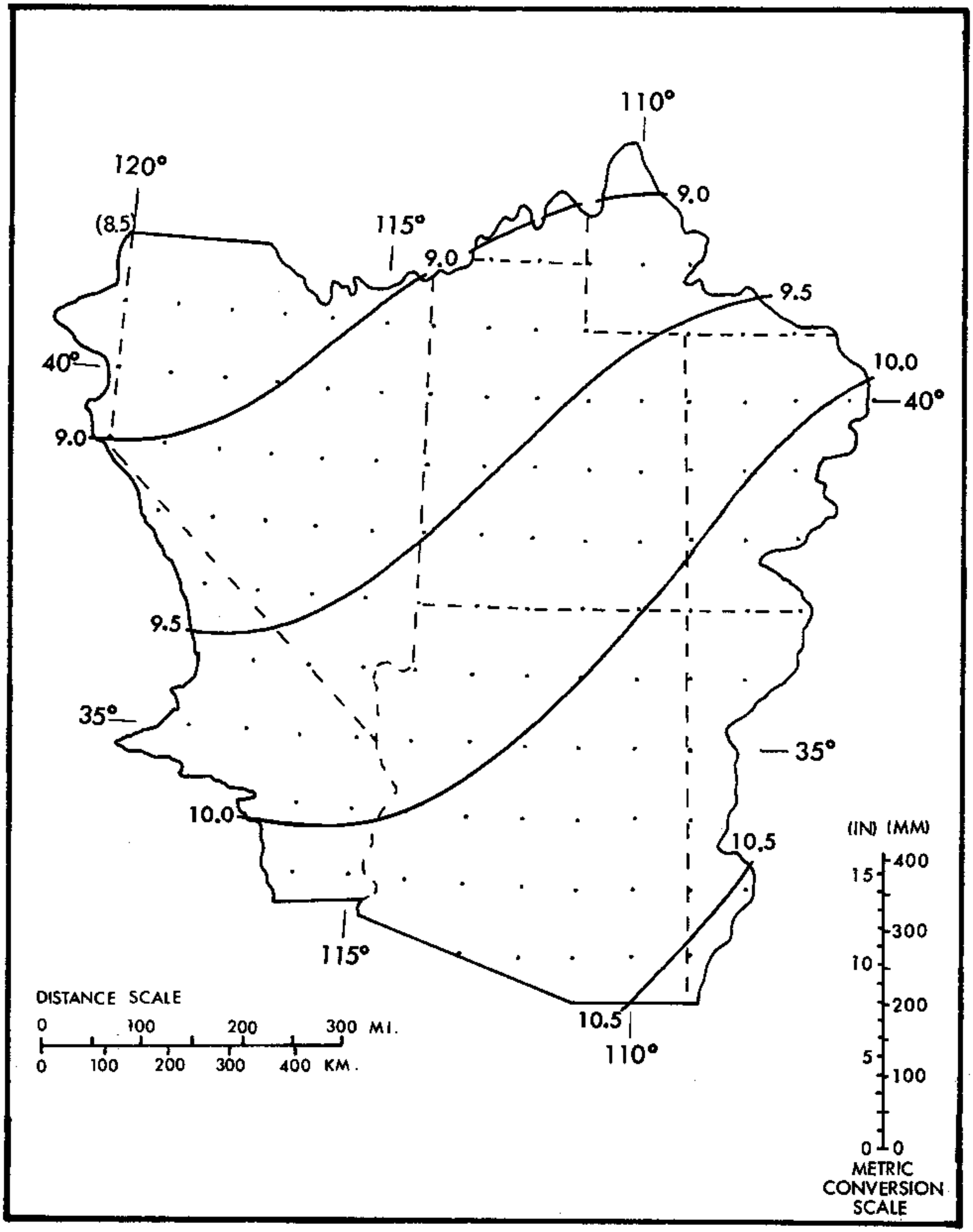


Figure 2.15.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for November. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

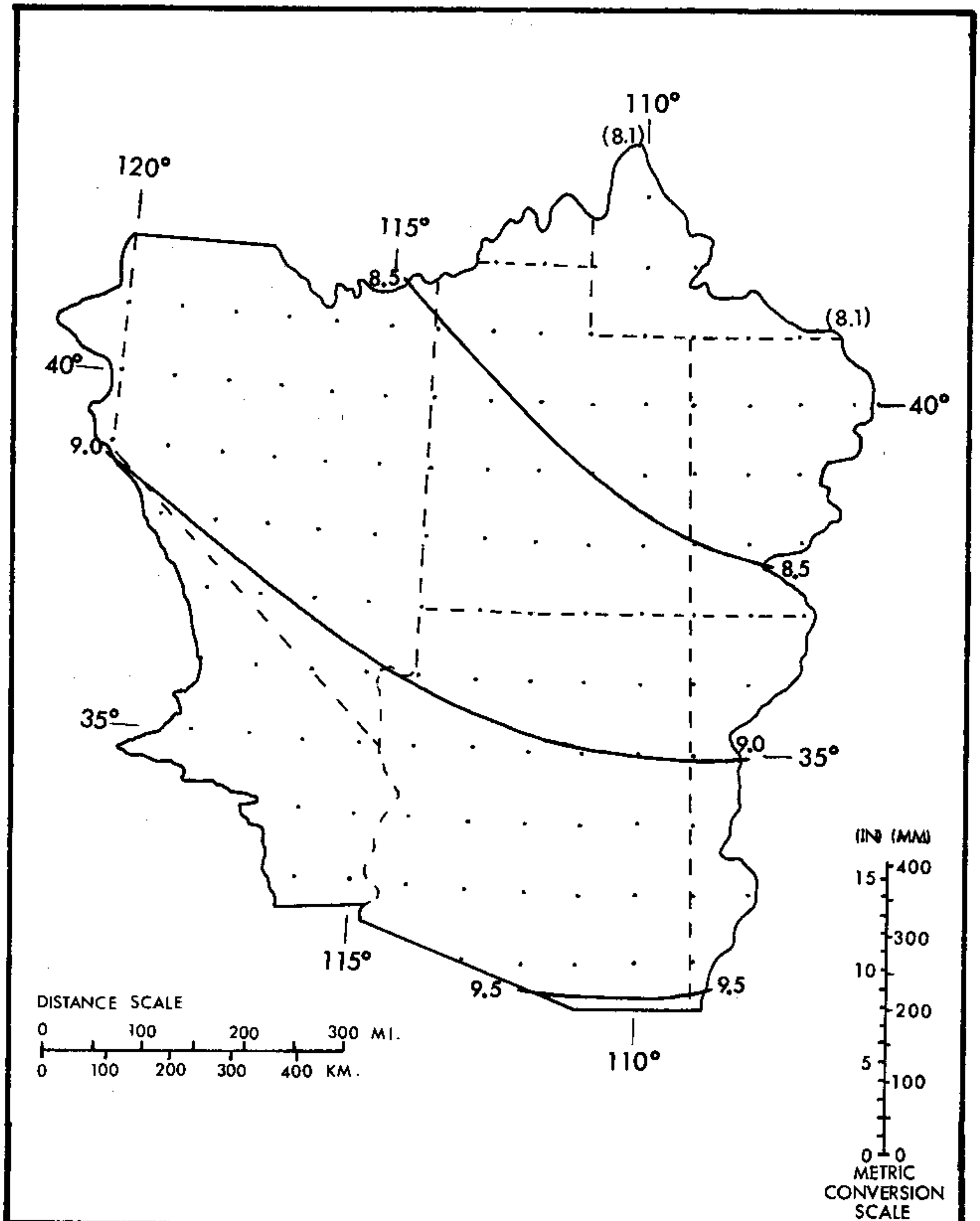


Figure 2.16.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for December. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

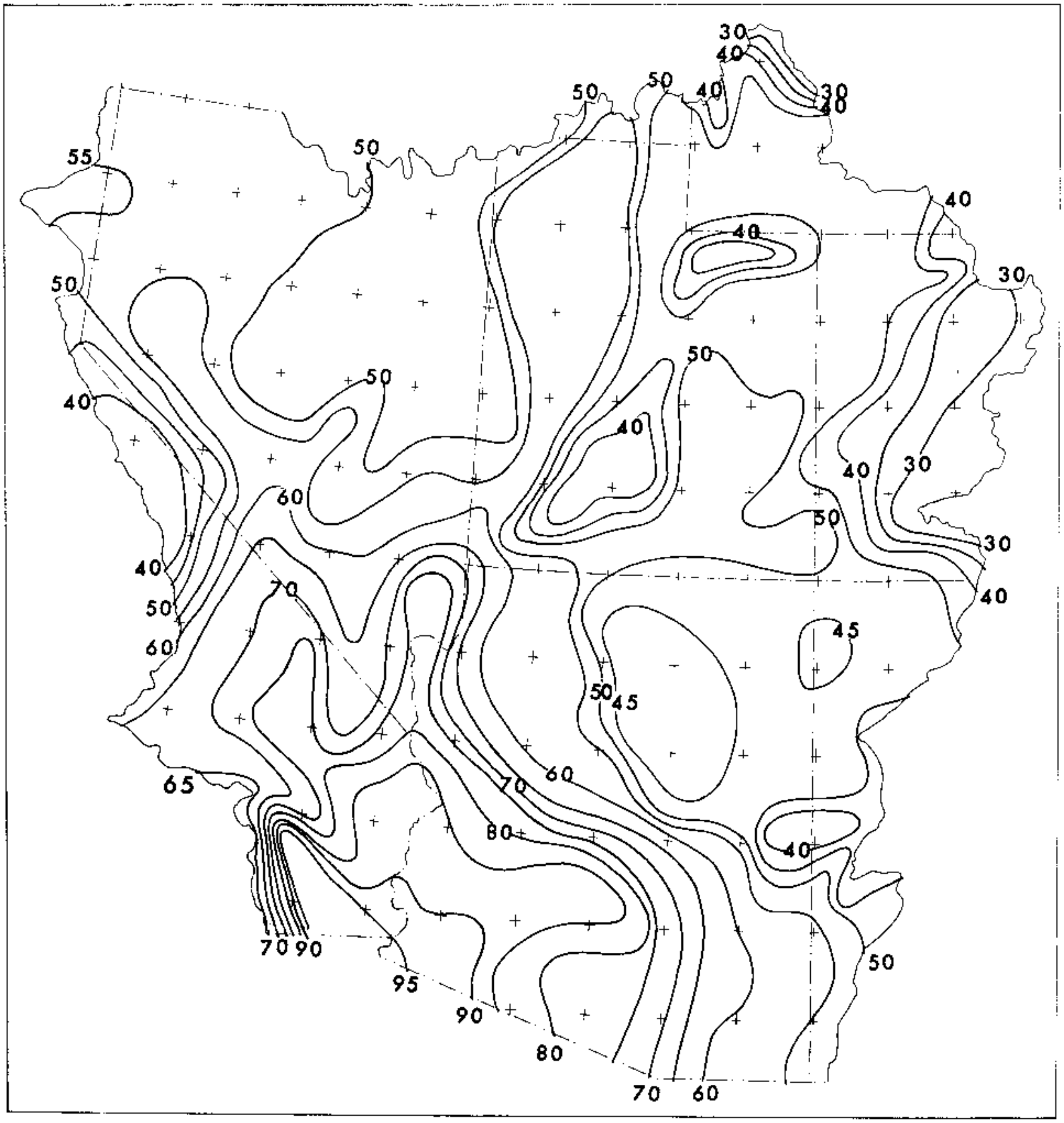


Figure 2.18.--Percent of 1000-mb (100-kPa) convergence PMP resulting from effective elevation and barrier considerations. Isolines drawn for every five percent.

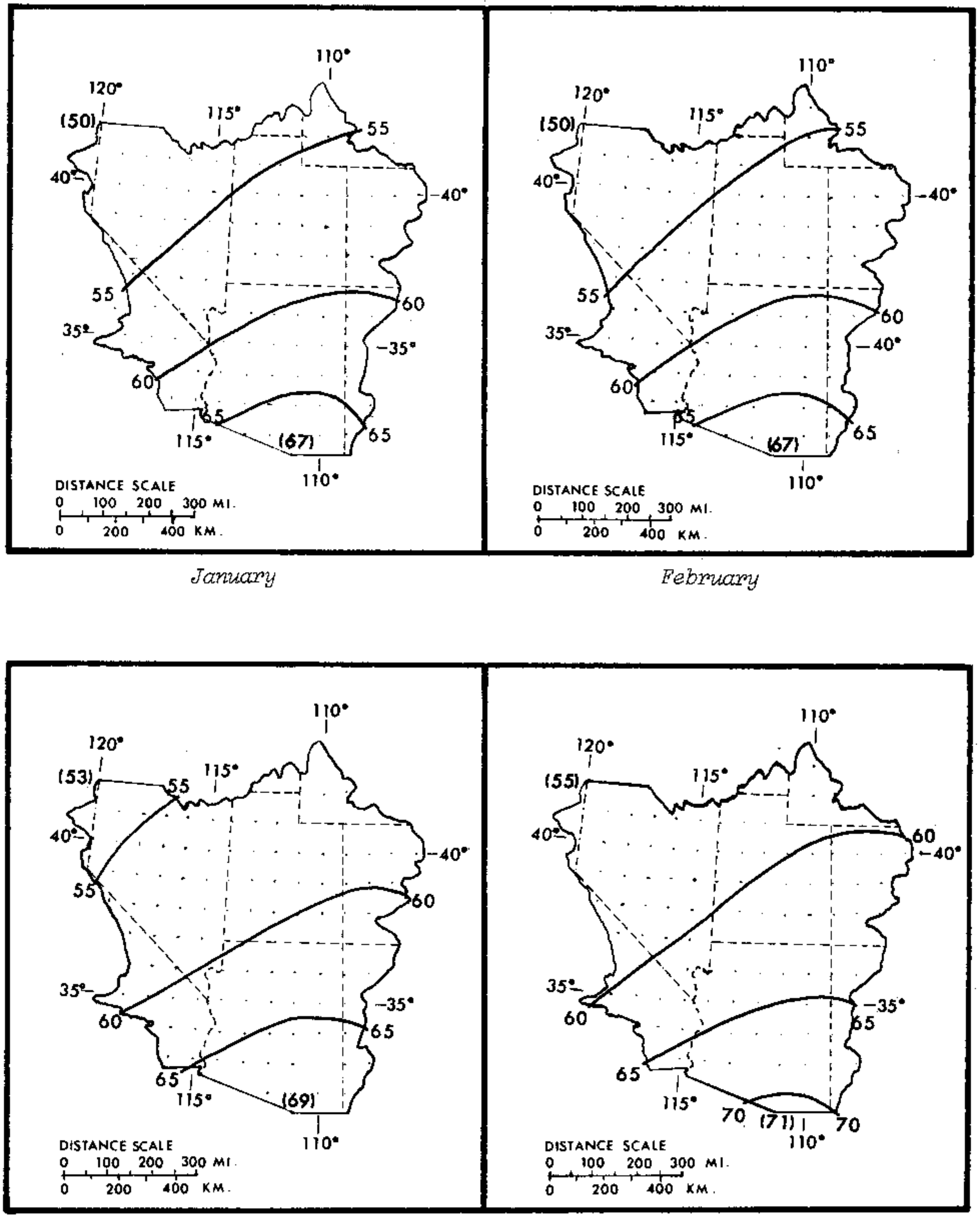
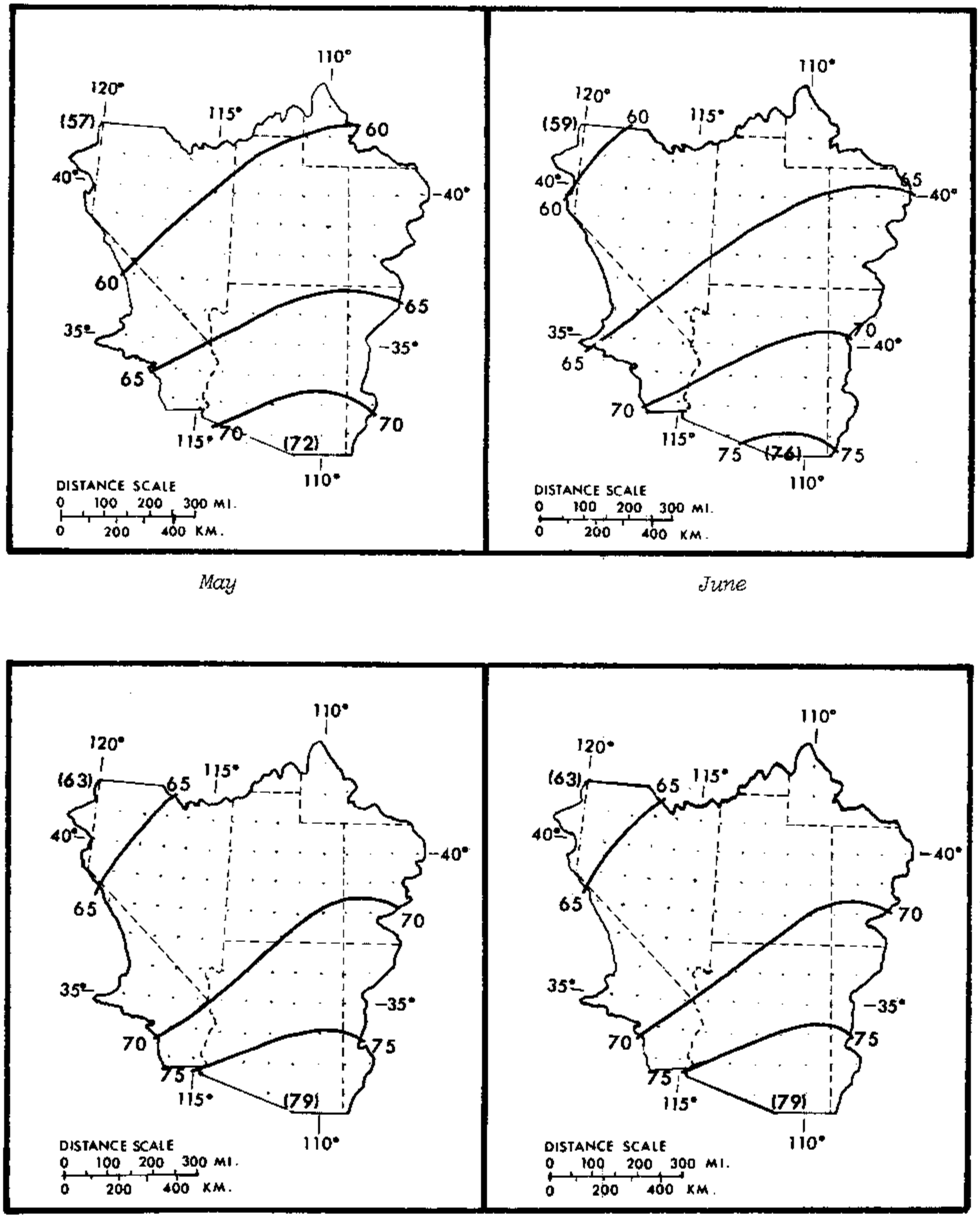


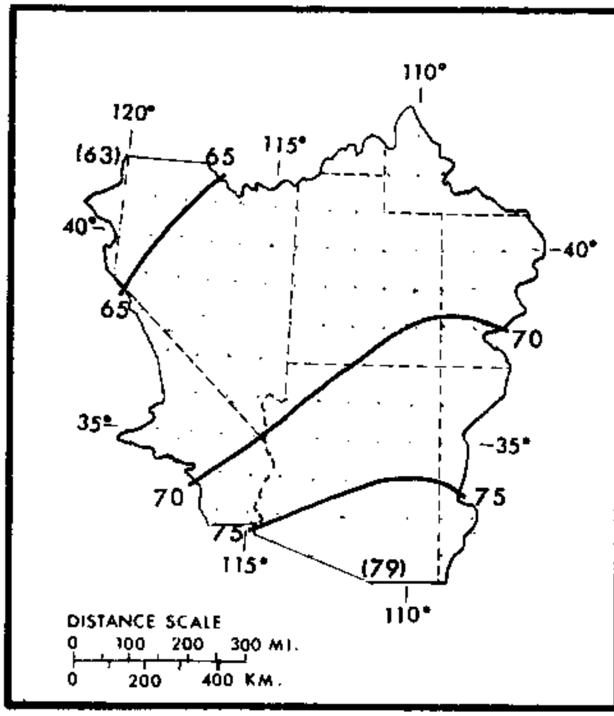
Figure 2.25.--Regional variation of 6/24-hr ratios by month (percent). Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.



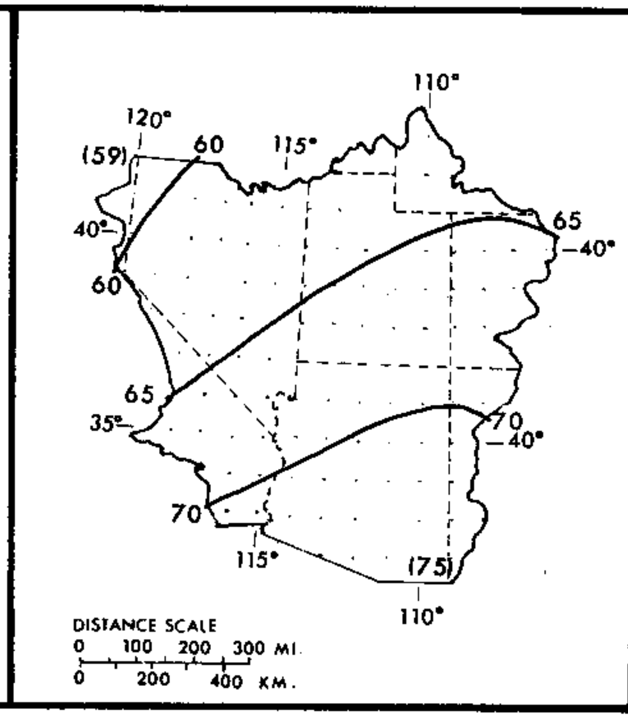
May *June*

July *August*

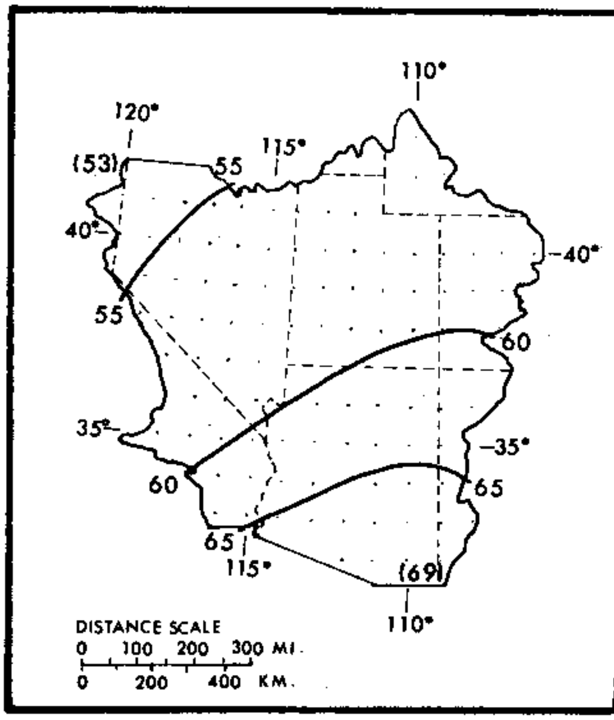
Figure 2.26.--Regional variation of 6/24-hr ratios by month (percent). Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.



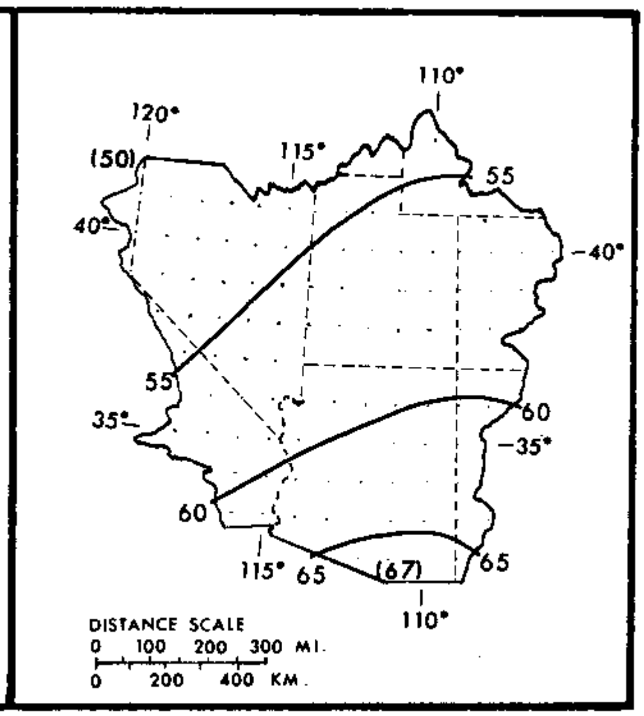
September



October



November



December

Figure 2.27.--Regional variation of 6/24-hr ratios by month (percent). Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

For the range of 6/24-hr ratios included in figures 2.25 to 2.27, depth-duration values in percent of 24-hr amounts are found in table 2.7. The regional ratio maps, and the depth-duration curves presented in figure 2.20 were used in adjusting the major storm data to 24-hr amounts listed in table 2.1.

Table 2.7.--Durational variation of convergence PMP (in percent of 24-hr amount).

Duration (Hrs)					
6	12	18	24	48	72
50	76	90	100	129	150
51	77	90	100	128	148
52	77	90	100	127	146
53	77	91	100	127	144
54	78	91	100	126	142
55	78	91	100	125	140
56	79	91	100	124	138
57	79	92	100	123	137
58	80	92	100	122	135
59	80	92	100	121	134
60	81	92	100	120	132
61	81	92	100	120	131
62	82	93	100	119	129
63	82	93	100	118	128
64	83	93	100	117	126
65	84	93	100	117	125

Duration (Hrs)					
6	12	18	24	48	72
66	84	93	100	116	124
67	85	94	100	116	123
68	85	94	100	115	122
69	86	94	100	115	121
70	87	94	100	114	120
71	87	95	100	114	119
72	88	95	100	113	118
73	88	95	100	113	118
74	89	95	100	112	117
75	89	96	100	112	116
76	90	96	100	111	115
77	90	96	100	110	114
78	91	96	100	110	114
79	92	97	100	109	113
80	92	97	100	109	113

Note: For use, enter first column (6 hr) with 6/24-hr ratio from figures 2.25 to 2.27.

2.5 Areal Reduction for Basin Size

For operational use, basin average values of convergence PMP are needed rather than 10-mi^2 (26-km^2) values. Preferably, the method for reducing 10-mi^2 (26-km^2) values to basin average rainfalls should be derived from depth-area relations of storms in the region. However, all general storms in the region include large proportions ot orographic precipitation.

Our solution was to use generalized depth-area relations developed for PMP estimates within bordering zones in the Central and Eastern United States (Riedel et al. 1956). The smoothed areal variations adopted for the Southwestern States are shown in figures 2.28 and 2.29 for each month or a combination of months where differences are insignificant.

Figures 2.28 and 2.29 give depth-area relations that reduce 10-mi^2 (26-km^2) convergence PMP for basin sizes up to 5,000 mi^2 (12,950 km^2) for each month. Areal variations are given for the 4 greatest (1st to 4th) 6-hr PMP increments. After the 4th increment no reduction for basin size is required. Application of these figures will become clear through consideration of an example of PMP computation in chapter 6.

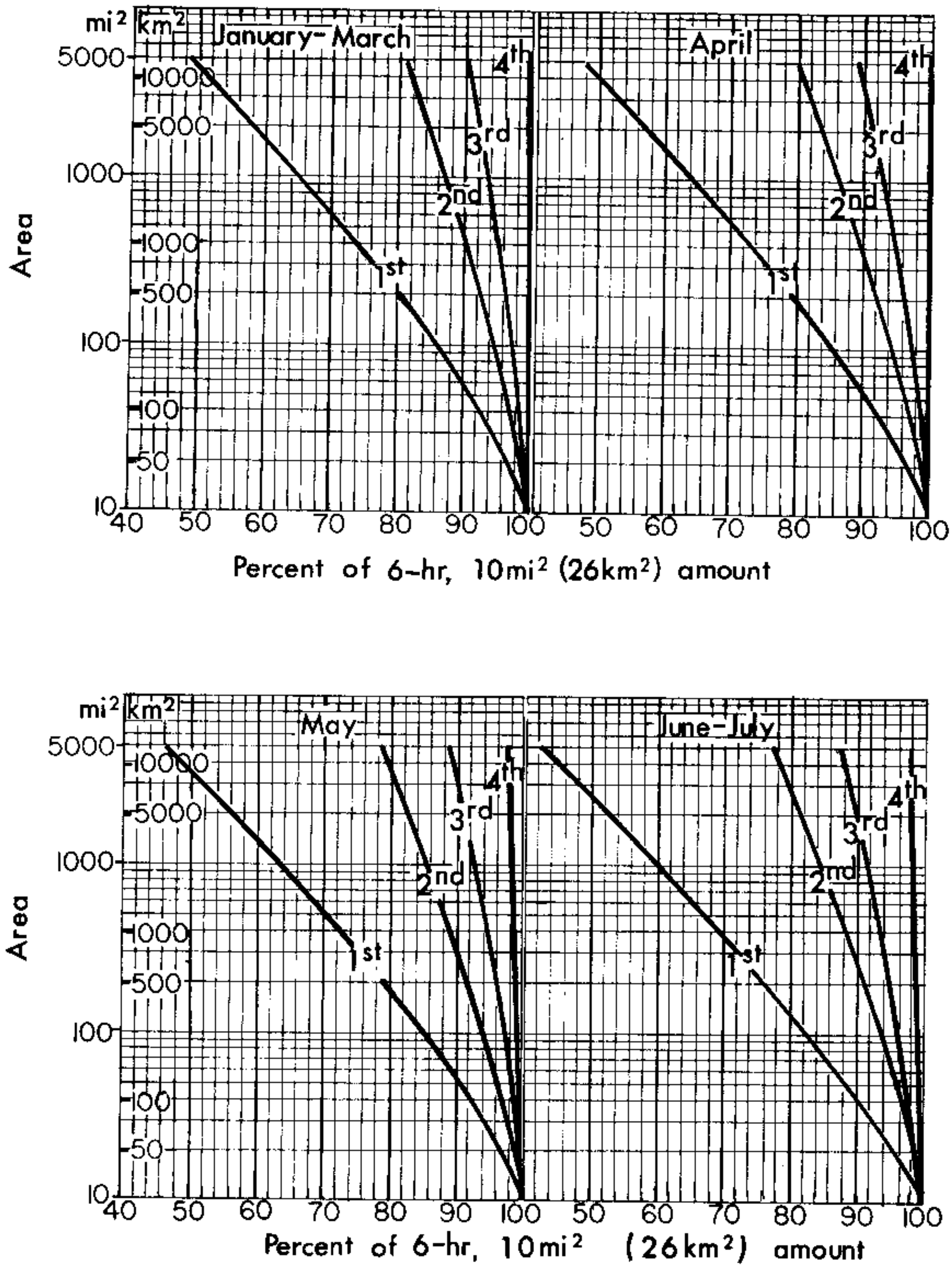


Figure 2.28.--Depth-area variation for convergence PMP for first to fourth 6-hr increments.

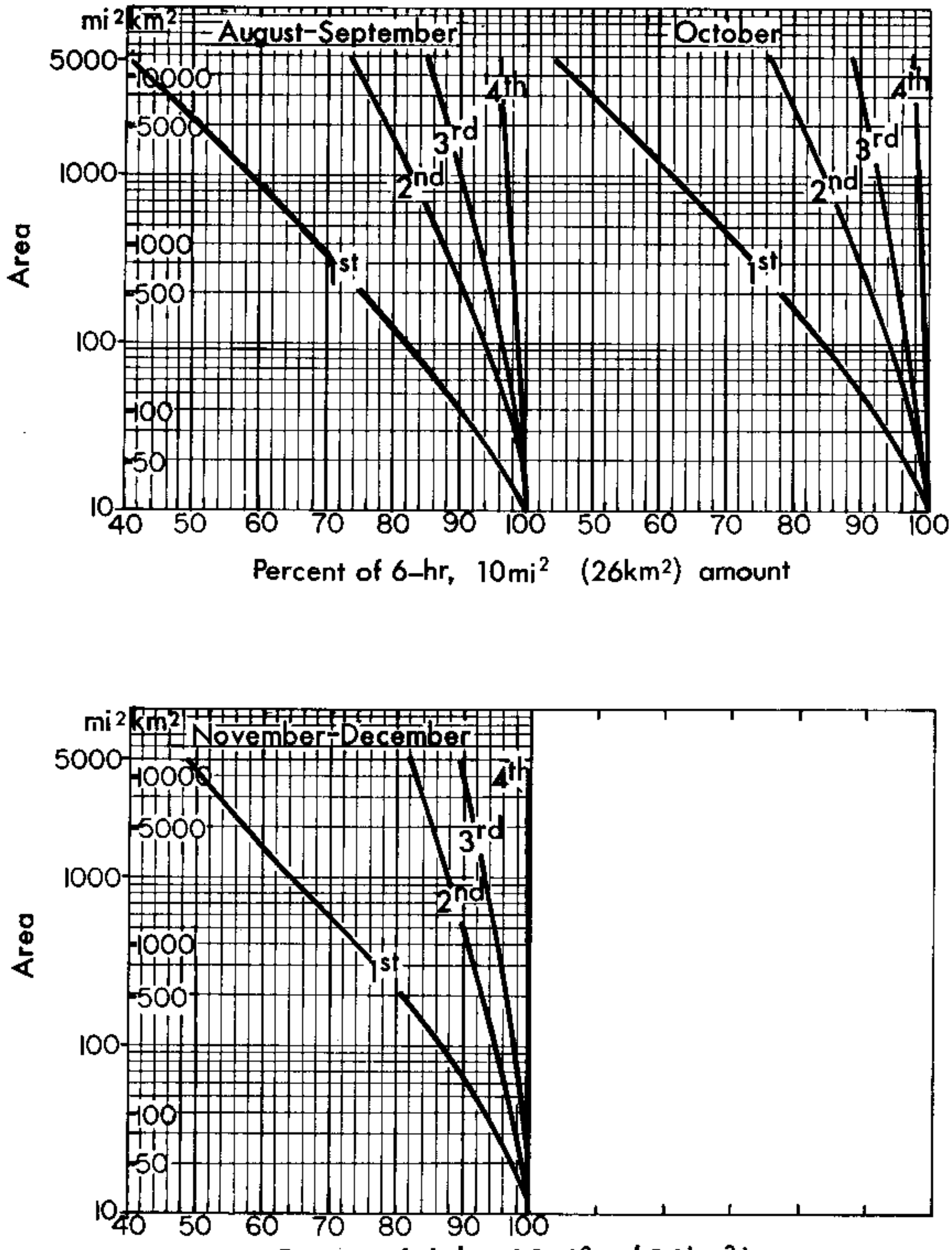


Figure 2.29.--Depth-area variation for convergence PMP for first to fourth 6-hr increments.

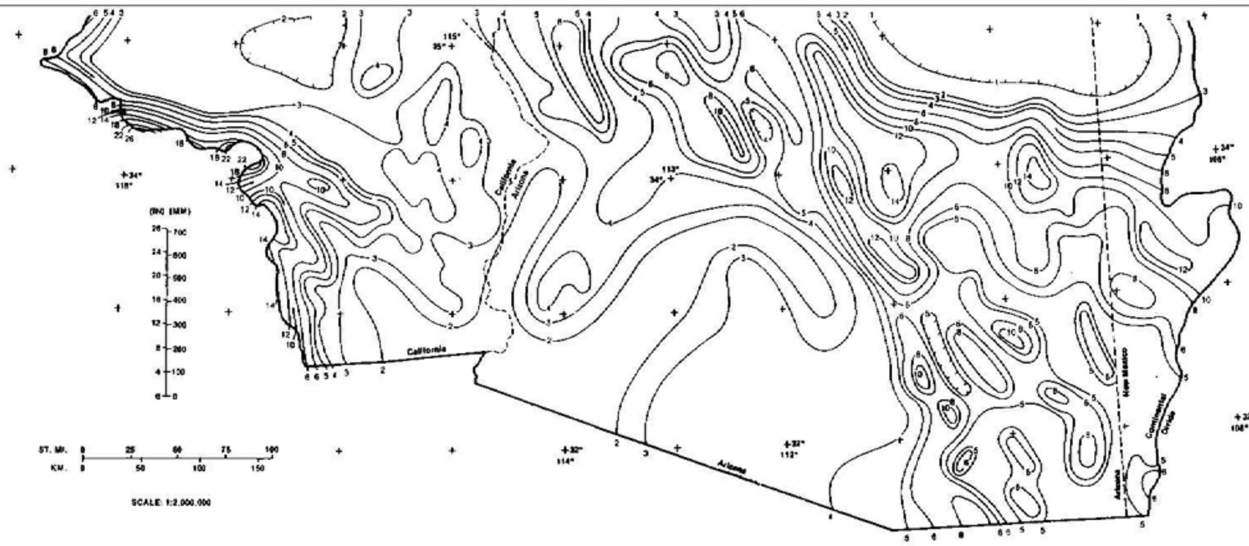
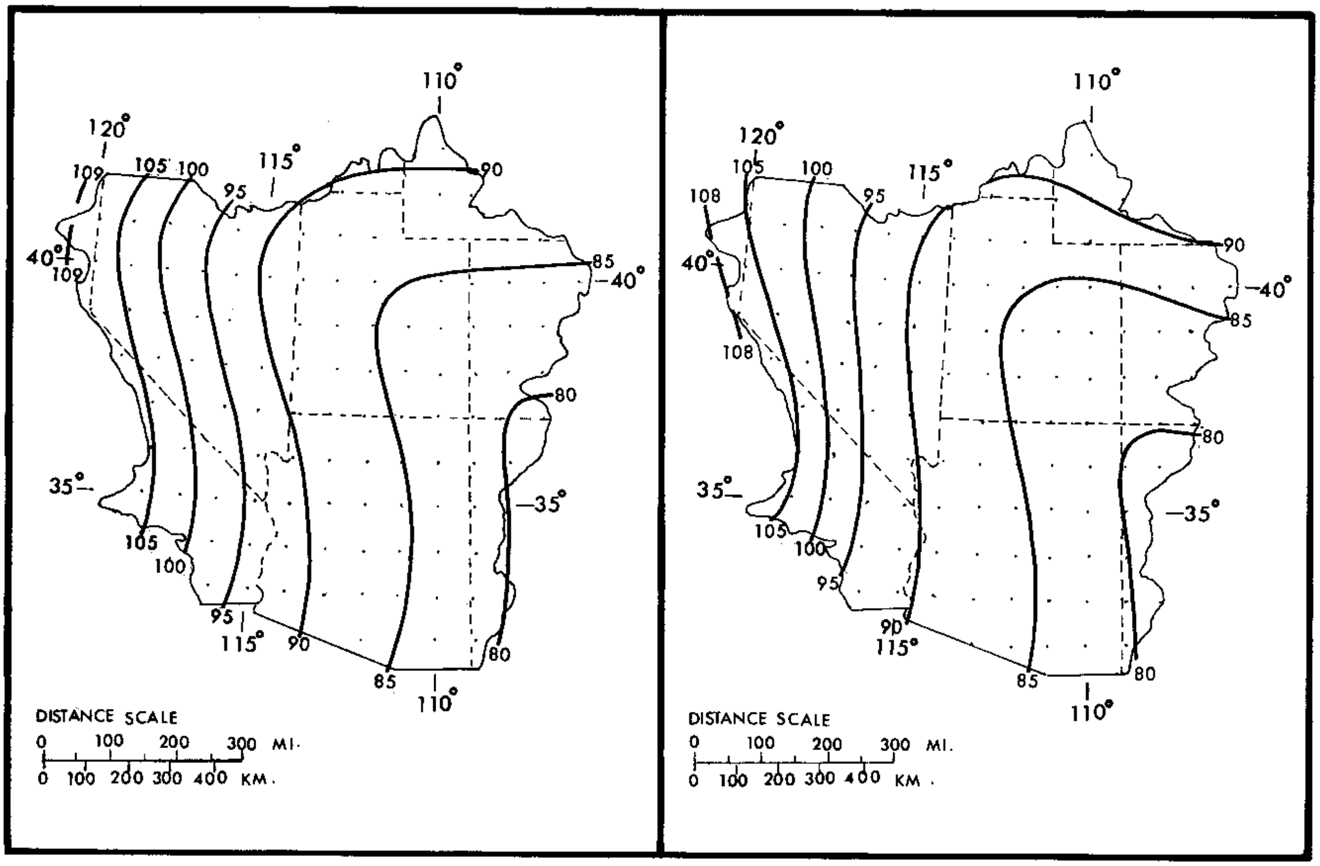
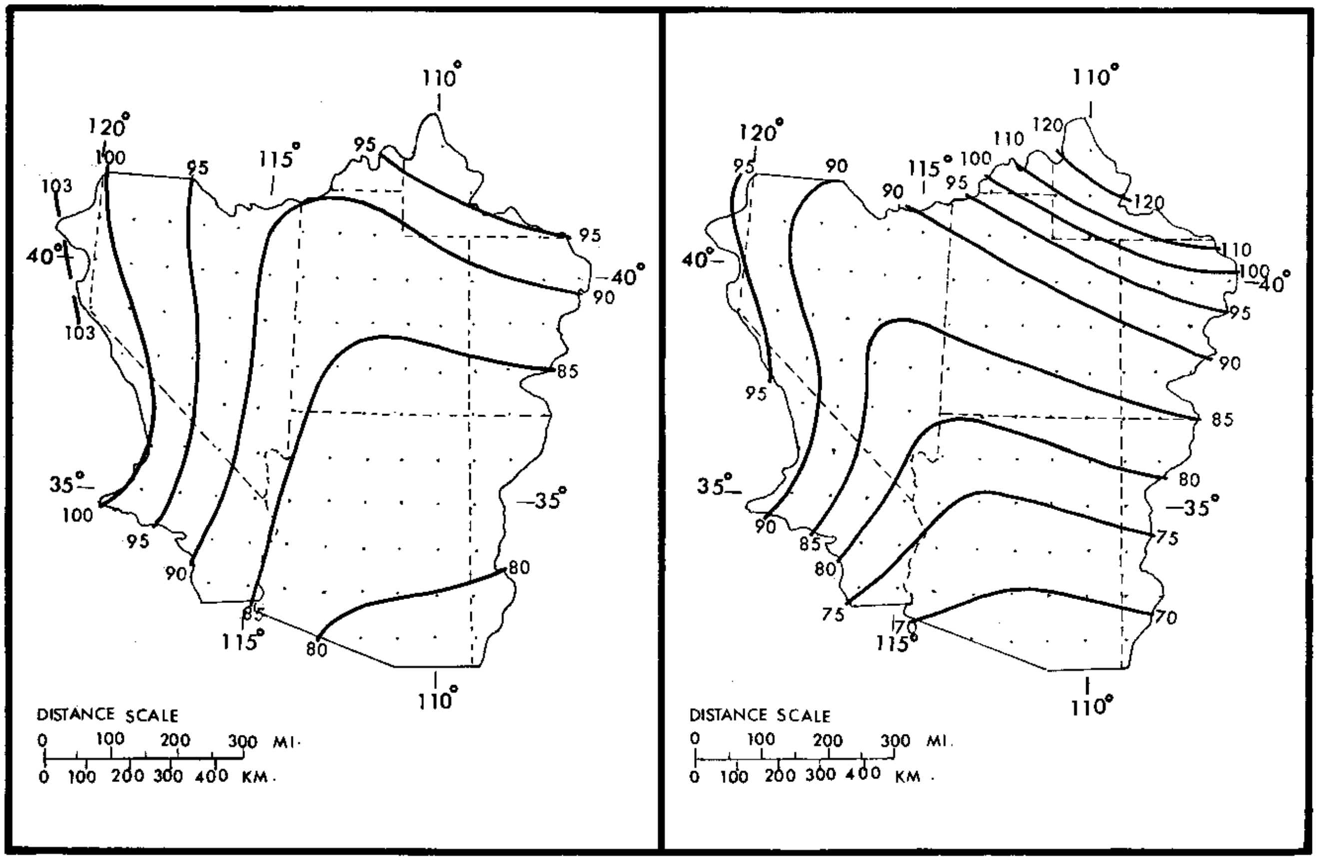


FIGURE 3.11d (Revised) — 10 mi² (26 km²) 24-hr orographic PMP index map (inches), southern section.



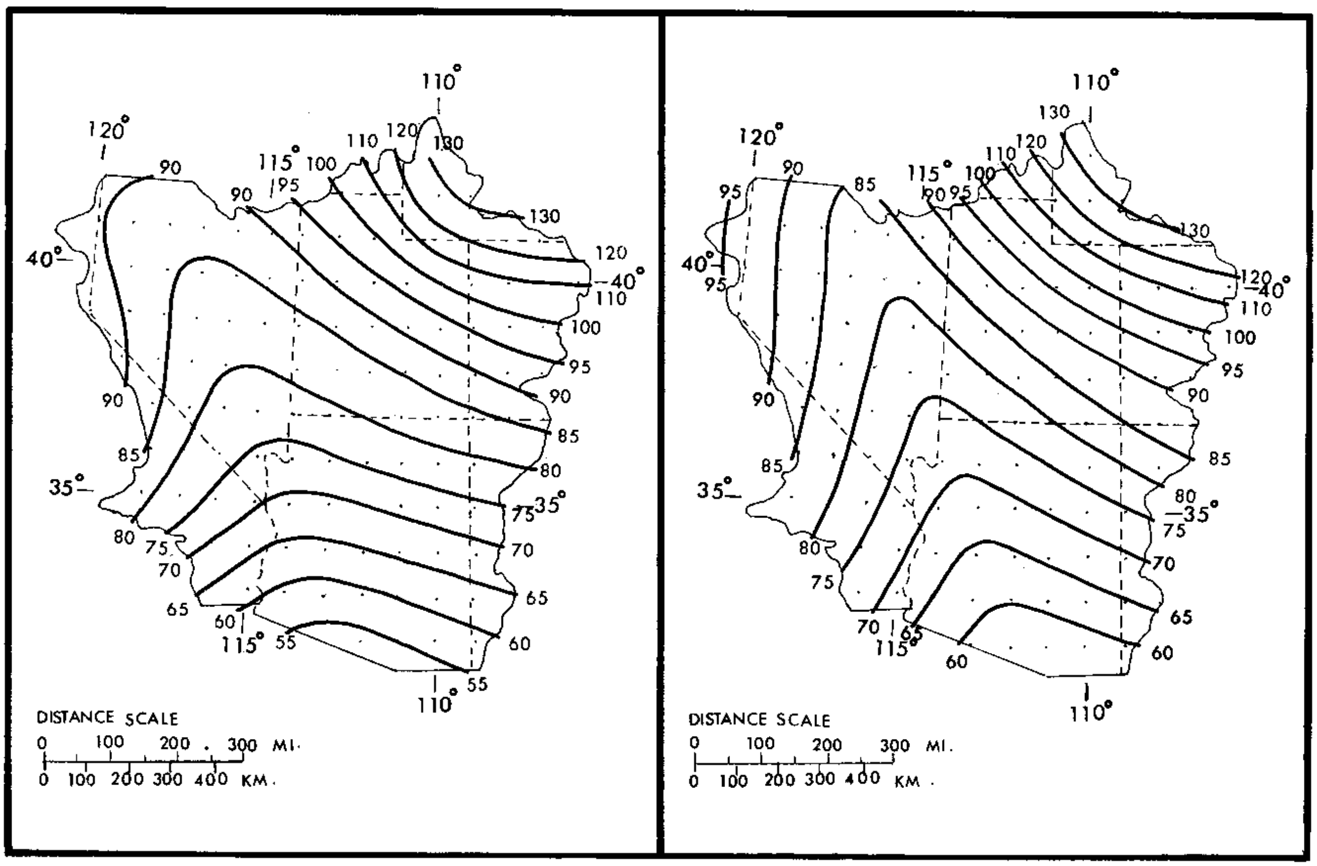
January *February*

Figure 3.12.--Seasonal variation in 10-mi² (26-km²) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



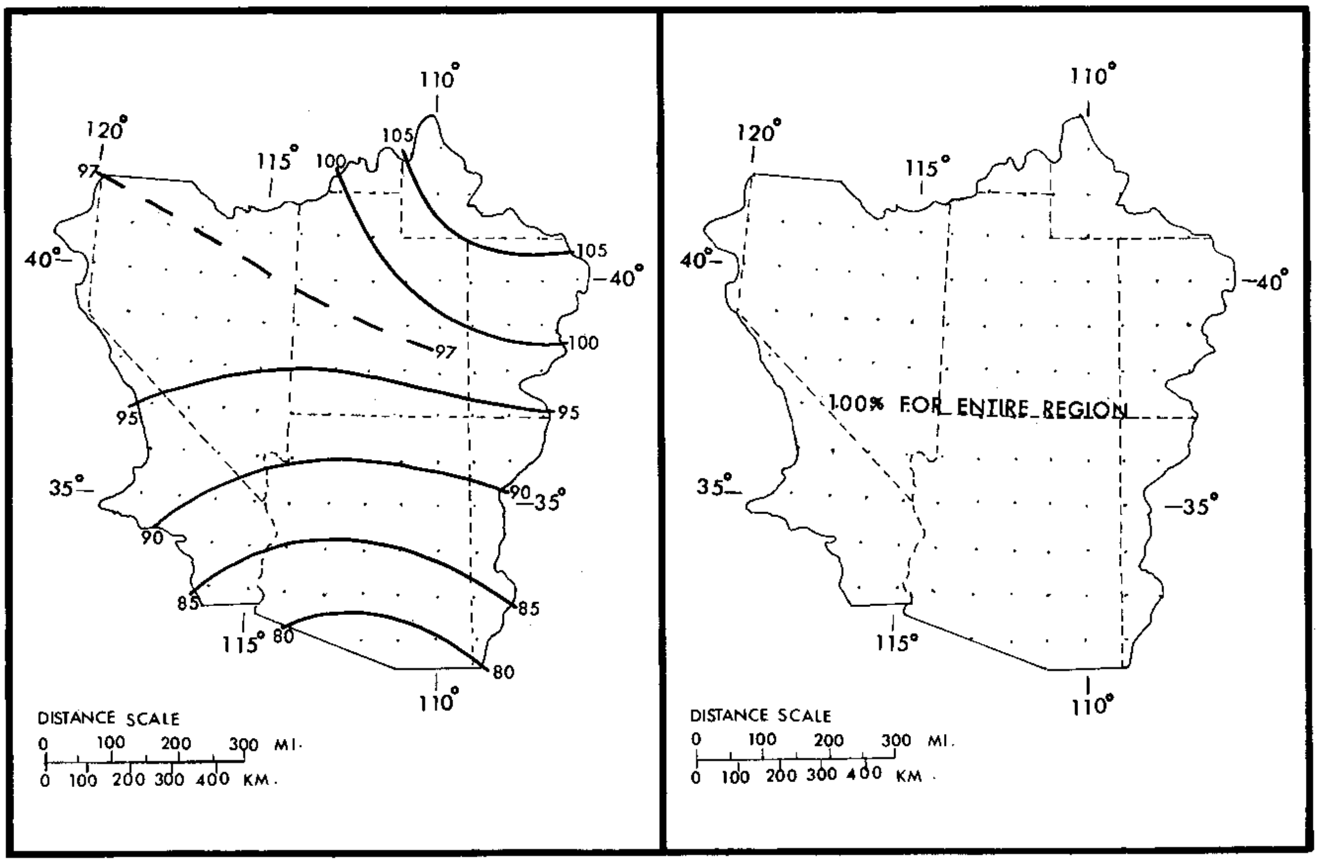
March | *April*

Figure 3.13.--Seasonal variation in 10-mi^2 (26-km^2) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



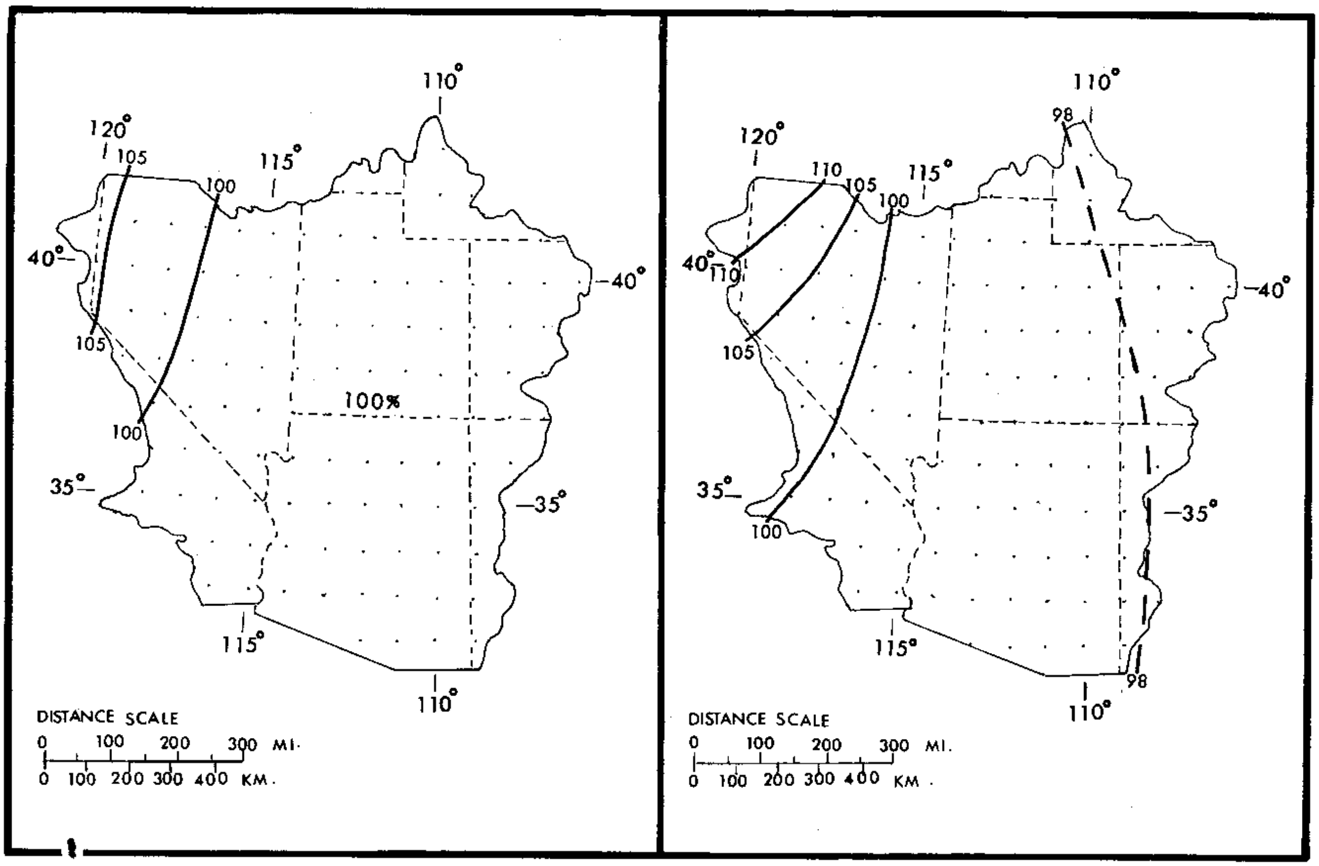
May *June*

Figure 3.14.--Seasonal variation in 10-mi² (26-km²) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



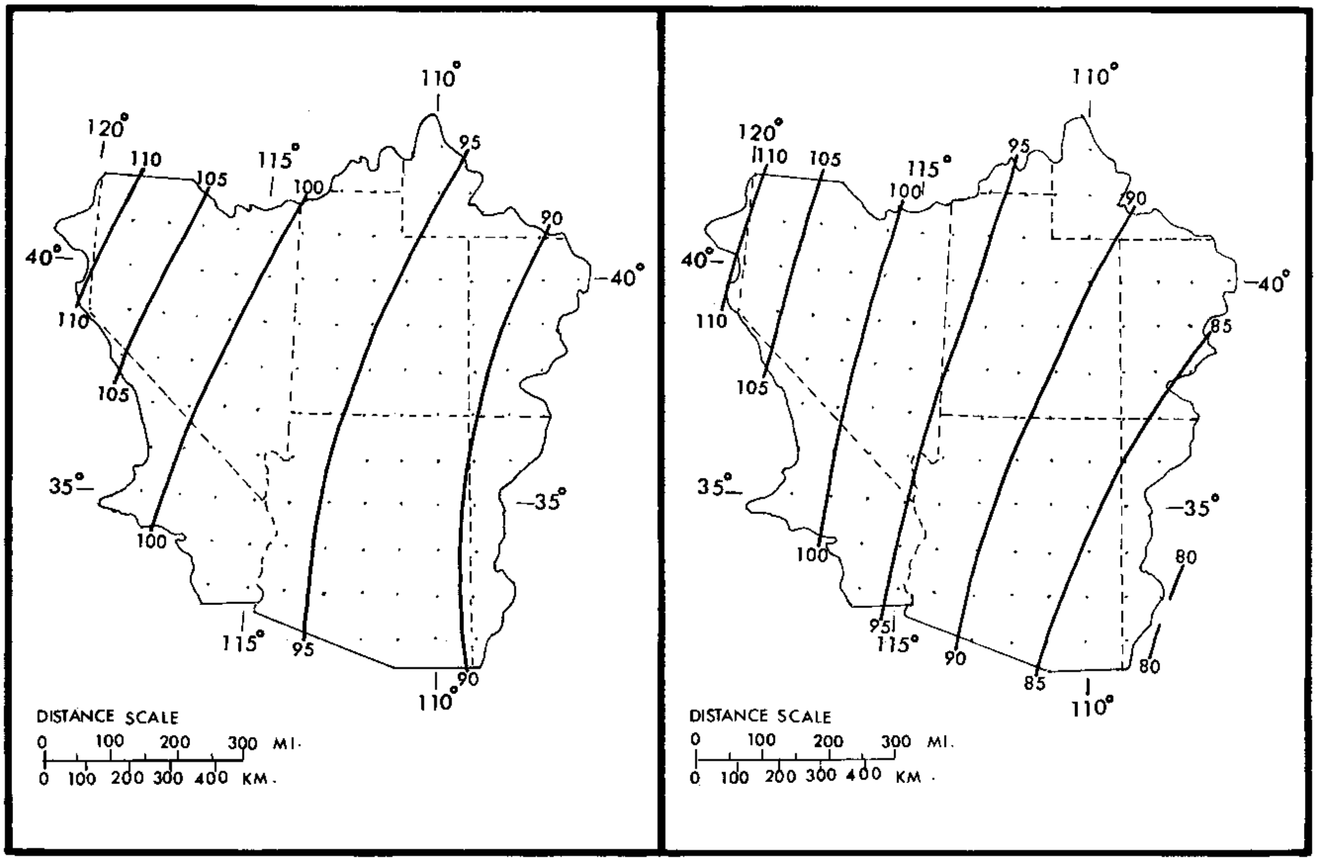
July *August*

Figure 3.15.--Seasonal variation in 10-mi^2 (26-km^2) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



September *October*

Figure 3.16.--Seasonal variation in 10-mi² (26-km²) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



November *December*

Figure 3.17.--Seasonal variation in 10-mi² (26-km²) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).

Appendix B

General Storm PMP Calculations

Convergence PMP

Step		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Drainage Average 1000-mb, 24-hr, 10-mi2 convergence (Fig. 2.5-2.16	9.2	9.2	9.2	9	8.8	9.4	15.2	16.4	16.3	14.1	10.5	9.5
2	1000-mb, 24-hr, 10-mi2 convergence PMP reduction factor (Fig 2.18)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
3	Multiply Step 1 by Step 2 for barrier-elevation reduced 24-hr converge PMP average	5.98	5.98	5.98	5.85	5.72	6.11	9.88	10.66	10.595	9.165	6.825	6.175
4	Determine 6/24 hr ratio for each month (Fig 2.25 and 2.27)												
4a	% 6-hr (Table 2.7)	0.67	0.67	0.69	0.71	0.72	0.76	0.79	0.79	0.79	0.75	0.69	0.67
	%12-hr	0.85	0.85	0.86	0.87	0.88	0.90	0.92	0.92	0.92	0.89	0.86	0.85
	% 18-hr	0.94	0.94	0.94	0.95	0.95	0.96	0.97	0.97	0.97	0.96	0.94	0.94
	% 24-hr	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	% 48-hr	1.16	1.16	1.15	1.14	1.13	1.11	1.09	1.09	1.09	1.12	1.15	1.16
	% 72-hr	1.23	1.23	1.22	1.19	1.18	1.15	1.13	1.13	1.13	1.16	1.22	1.23
5	Step 3 time percent from step 4a gives convergence PMP for 10 mi2												
	% 6-hr	4.01	4.01	4.13	4.15	4.12	4.64	7.81	8.42	8.37	6.87	4.71	4.14
	%12-hr	5.08	5.08	5.14	5.09	5.03	5.50	9.09	9.81	9.75	8.16	5.87	5.25
	% 18-hr	5.62	5.62	5.62	5.56	5.43	5.87	9.58	10.34	10.28	8.80	6.42	5.80
	% 24-hr	5.98	5.98	5.98	5.85	5.72	6.11	9.88	10.66	10.60	9.17	6.83	6.18
	% 48-hr	6.94	6.94	6.88	6.67	6.46	6.78	10.77	11.62	11.55	10.26	7.85	7.16
	% 72-hr	7.36	7.36	7.30	6.96	6.75	7.03	11.16	12.05	11.97	10.63	8.33	7.60
6	Create incremental convergence PMP												
	Incremental hrs 0 - 6	4.01	4.01	4.13	4.15	4.12	4.64	7.81	8.42	8.37	6.87	4.71	4.14
	Incremental hrs 6 - 12	1.08	1.08	1.02	0.94	0.92	0.86	1.28	1.39	1.38	1.28	1.16	1.11
	Incremental hrs 12 - 18	0.54	0.54	0.48	0.47	0.40	0.37	0.49	0.53	0.53	0.64	0.55	0.56
	Incremental hrs 18 - 24	0.36	0.36	0.36	0.29	0.29	0.24	0.30	0.32	0.32	0.37	0.41	0.37
	Incremental hrs 24 - 48	0.96	0.96	0.90	0.82	0.74	0.67	0.89	0.96	0.95	1.10	1.02	0.99
	Incremental hrs 48 - 72	0.42	0.42	0.42	0.29	0.29	0.24	0.40	0.43	0.42	0.37	0.48	0.43
7	Aerial reduction for drainage area (Fig 2.28 and 2.29)												
	1st - hours 0 to 6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	2nd - hours 7 to 12	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	3rd - hours 13 to 18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	4th - hours 19 to 24	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	Aerial reduced incremental convergence PMP (Step 6 x 7)												
	Incremental hrs 0 - 6	4.01	4.01	4.13	4.15	4.12	4.64	7.81	8.42	8.37	6.87	4.71	4.14
	Incremental hrs 6 - 12	1.08	1.08	1.02	0.94	0.92	0.86	1.28	1.39	1.38	1.28	1.16	1.11
	Incremental hrs 12 - 18	0.54	0.54	0.48	0.47	0.40	0.37	0.49	0.53	0.53	0.64	0.55	0.56
	Incremental hrs 18 - 24	0.36	0.36	0.36	0.29	0.29	0.24	0.30	0.32	0.32	0.37	0.41	0.37
	Incremental hrs 24 - 48	0.96	0.96	0.90	0.82	0.74	0.67	0.89	0.96	0.95	1.10	1.02	0.99
	Incremental hrs 48 - 72	0.42	0.42	0.42	0.29	0.29	0.24	0.40	0.43	0.42	0.37	0.48	0.43
9	Accumulation of incremental values from Step 8 - Drainage Average Convergent PMP												
	Cumulative 6 hr	4.01	4.01	4.13	4.15	4.12	4.64	7.81	8.42	8.37	6.87	4.71	4.14
	Cumulative 12 hr	5.08	5.08	5.14	5.09	5.03	5.50	9.09	9.81	9.75	8.16	5.87	5.25
	Cumulative 18 hr	5.62	5.62	5.62	5.56	5.43	5.87	9.58	10.34	10.28	8.80	6.42	5.80
	Cumulative 24 hr	5.98	5.98	5.98	5.85	5.72	6.11	9.88	10.66	10.60	9.17	6.83	6.18
	Cumulative 48 hr	6.94	6.94	6.88	6.67	6.46	6.78	10.77	11.62	11.55	10.26	7.85	7.16
	Cumulative 72 hr	7.36	7.36	7.30	6.96	6.75	7.03	11.16	12.05	11.97	10.63	8.33	7.60

Orographic PMP

Step		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Drainage Average orographic PMP, 24-hr, 10-mi2 (Fig.3.11a to d)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
2	Aerial reduction factor in % for drainage size (Fig 3.20)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	Seasonal adjustment - average % for drainage (Fig 3.12 to 3.17)	0.84	0.84	0.76	0.65	0.54	0.57	0.78	1.00	1.00	0.98	0.91	0.83
4	Aerially and seasonally adjusted 24-hr orographic PMP (Multiply 1 x 2% x 3%)	5.04	5.04	4.56	3.90	3.24	3.42	4.68	6.00	6.00	5.88	5.46	4.98
5	Durational variation of orographic PMP of the 24-hr value (Table 3.9)												
	% 6-hr	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
	%12-hr	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	% 18-hr	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	% 24-hr	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	% 48-hr	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
	% 72-hr	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46
6	Orographic PMP (Multiply 4 x 5)												
	Cumulative 6 hr	1.81	1.81	1.64	1.40	1.17	1.23	1.68	2.16	2.16	2.12	1.97	1.79
	Cumulative 12 hr	3.33	3.33	3.01	2.57	2.14	2.26	3.09	3.96	3.96	3.88	3.60	3.29
	Cumulative 18 hr	4.28	4.28	3.88	3.32	2.75	2.91	3.98	5.10	5.10	5.00	4.64	4.23
	Cumulative 24 hr	5.04	5.04	4.56	3.90	3.24	3.42	4.68	6.00	6.00	5.88	5.46	4.98
	Cumulative 48 hr	6.65	6.65	6.02	5.15	4.28	4.51	6.18	7.92	7.92	7.76	7.21	6.57
	Cumulative 72 hr	7.36	7.36	6.66	5.69	4.73	4.99	6.83	8.76	8.76	8.58	7.97	7.27

Total PMP

Step		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Combine Convergent and Orographic PMP Values from above	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cumulative 6 hr	5.82	5.82	5.77	5.56	5.28	5.87	9.49	10.58	10.53	8.99	6.67	5.93
	Cumulative 12 hr	8.41	8.41	8.15	7.66	7.17	7.76	12.18	13.77	13.71	12.04	9.47	8.54
	Cumulative 18 hr	9.91	9.91	9.50	8.87	8.19	8.77	13.56	15.44	15.38	13.80	11.06	10.04
	Cumulative 24 hr	11.02	11.02	10.54	9.75	8.96	9.53	14.56	16.66	16.60	15.05	12.29	11.16
	Cumulative 48 hr	13.59	13.59	12.90	11.82	10.74	11.30	16.95	19.54	19.47	18.03	15.06	13.74
	Cumulative 72 hr	14.71	14.71	13.95	12.66	11.48	12.02	18.00	20.81	20.73	19.22	16.30	14.87

Appendix C

Graphical and Tabular Data for Local Storm PMP

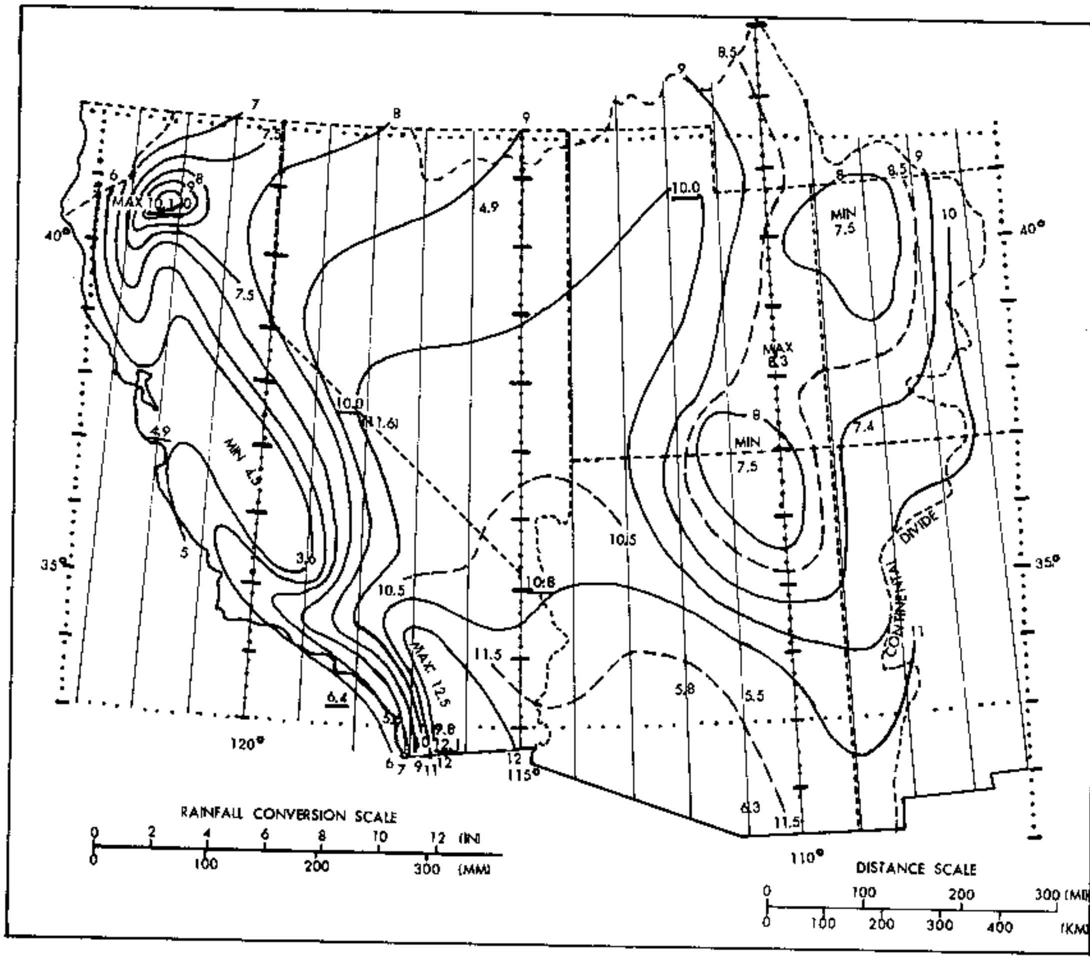


Figure 4.5--Local-storm PMP for 1 mi^2 (2.6 km^2) 1 hr. Directly applicable for locations between sea level and 5000 ft (1524 m). Elevation adjustment must be applied for locations above 5000 ft.

events. In contrast to figure 4.4, figure 4.5 maintains a maximum between these two locations. There is no known meteorological basis for a different solution. The analysis suggests that in the northern portion of the region maximum PMP occurs between the Sierra Nevada on the west and the Wasatch range on the east.

A discrete maximum (> 10 inches, 254 mm) occurs at the north end of the Sacramento Valley in northern California because the northward-flowing moist air is increasingly channeled and forced upslope. Support for this PMP center comes from the Newton, Kennett, and Red Bluff storms (fig. 4.1). Although the analysis in this region appears to be an extension of the broad maximum through the center of the Southwestern Region, it does not indicate the direction of moist inflow. The pattern has evolved primarily as a result of attempts to tie plotted maxima into a reasonable picture while considering inflow directions, terrain effects, and moisture potential.

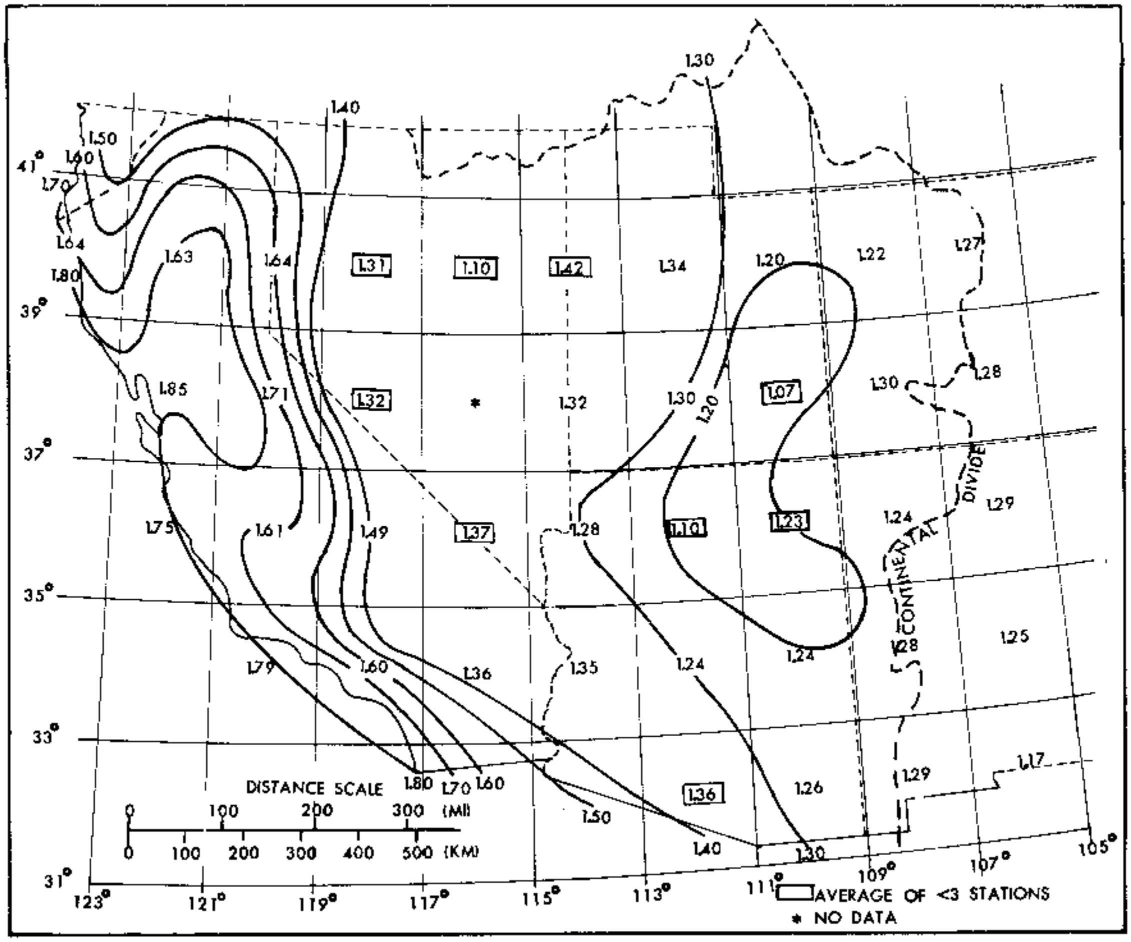


Figure 4.7.--Analysis of 6/1-hr ratios of averaged maximum station data (plotted at midpoints of a 2° latitude-longitude grid).

establish the basic depth-duration curve, then structure a variable set of depth-duration curves to cover the range of 6/1-hr ratios that are needed.

Three sets of data were considered for obtaining a base relation (see table 4.3 for depth-duration data).

a. An average of depth-duration relations from each of 17 greatest 3-hr rains from summer storms (1940-49) in Utah (U. S. Weather Bureau 1951b) and in unpublished tabulations for Nevada and Arizona (1940-63). The 3-hr amounts ranged from 1 to 3 inches (25 to 76 mm) in these events.

b. An average depth-duration relation from 14 of the most extreme short-duration storms listed in Storm Rainfall (U. S. Army, Corps of Engineers 1945-). These storms come from Eastern and Central States and have 3-hr amounts of 5 to 22 inches (127 to 559 mm).

ratios than storms with high 3/1-hr ratios. The geographical distribution of 15-min to 1-hr ratios also were inversely correlated with magnitudes of the 6/1-hr ratios of figure 4.7. For example, Los Angeles and San Diego (high 6/1-hr ratios) have low 15-min to 1-hr ratios (approximately 0.60) whereas the 15-min to 1-hr ratios in Arizona and Utah (low 6/1-hr ratios) were generally higher (approximately 0.75).

Depth-duration relations for durations less than 1 hour were then smoothed to provide a family of curves consistent with the relations determined for 1 to 6 hours, as shown in figure 4.3. Adjustment was necessary to some of the curves to provide smoother relations through the common point at 1 hour.

We believe we were justified in reducing the number of the curves shown in figure 4.3 for durations less than 1 hour, letting one curve apply to a range of 6/1-hr ratios. The corresponding curves have been indicated by letter designators, A-D, on figure 4.3. As an example, for any 6-hr amount between 115% and 135% of 1-hr, 1-mi^2 (2.6-km^2) PMP, the associated values for durations less than 1 hour are obtained from the curve designated as "B".

Table 4.4 lists durational variations in percent of 1-hr PMP for selected 6/1-hr rain ratios. These values were interpolated from figure 4.3.

To determine 6-hr PMP for a basin, use figure 4.3 (or table 4.4) and the geographical distribution of 6/1-hr ratios given in figure 4.7.

Table 4.4.--Durational variation of 1-mi^2 (2.6-km^2) local-storm PMP in percent of 1-hr PMP (see figure 4.3)

6/1-hr ratio	Duration (hr) 1/4	1/2	3/4	1	2	3	4	5	6
1.1	86	93	97	100	107	109	110	110	110
1.2	74	89	95	100	110	115	118	119	120
1.3	74	89	95	100	114	121	125	128	130
1.4	63	83	93	100	118	126	132	137	140
1.5	63	83	93	100	121	132	140	145	150
1.6	43	70	87	100	124	138	147	154	160
1.8	43	70	87	100	130	149	161	171	180
2.0	43	70	87	100	137	161	175	188	200

4.5 Depth-Area Relation

We have thus far developed local-storm PMP for an area of 1 mi^2 (2.6 km^2). To apply PMP to a basin, we need to determine how 1-mi^2 (2.6-km^2) PMP should decrease with increasing area. We have adopted depth-area relations based on rainfalls in the Southwest and from consideration of a model thunderstorm.

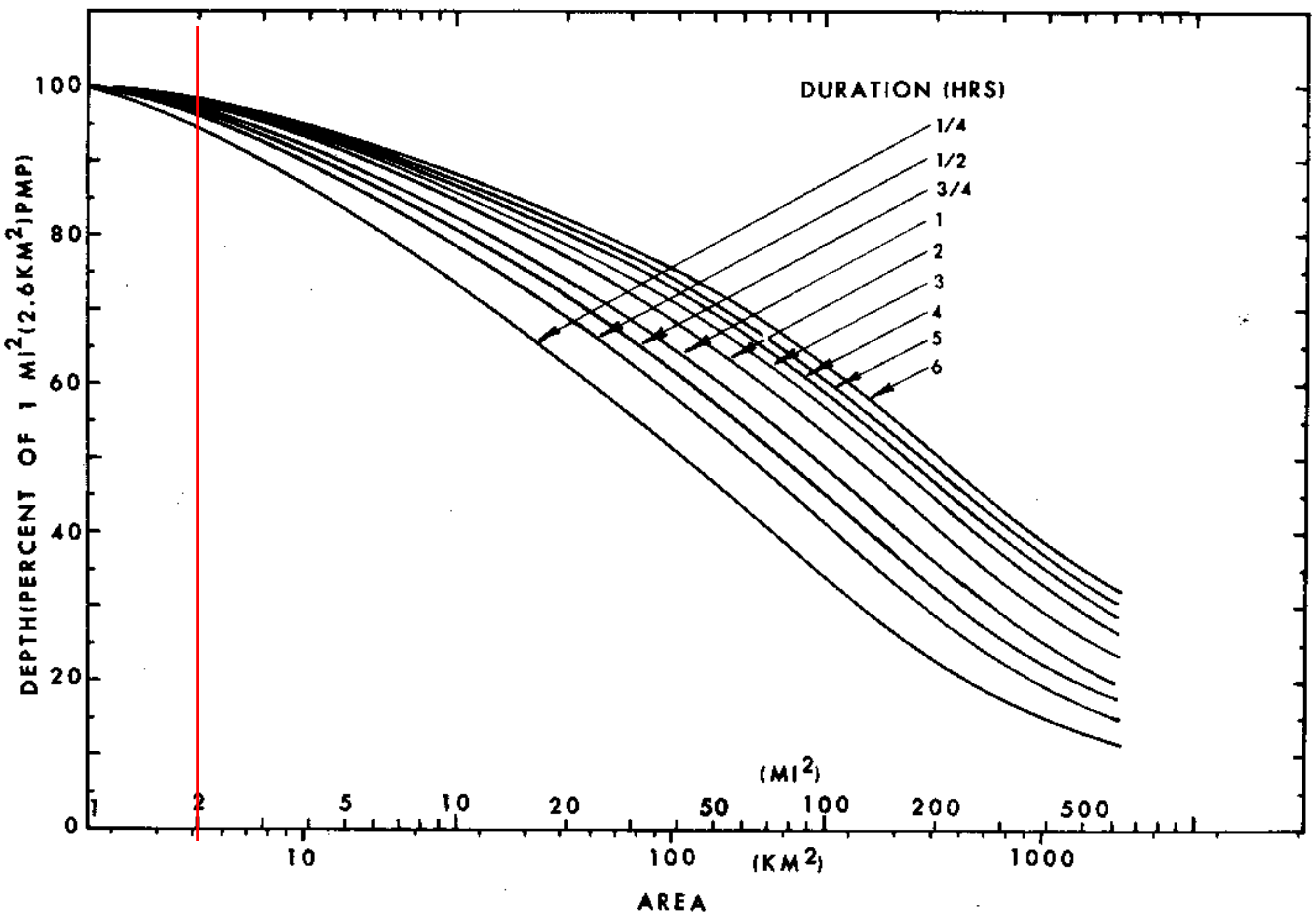


Figure 4.9.--Adopted depth-area relations for local-storm PMP.

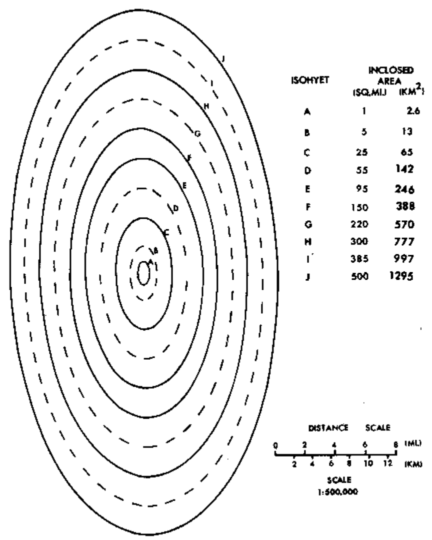


Figure 4.10.--Idealized local-storm isohyetal pattern.

storm period. The sequence of hourly incremental PMP for the Southwest 6-hr thunderstorm in accord with this study is presented in column 2 of table 4.7. A small variation from this sequence is given in Engineering Manual 1110-2-1411 (U. S. Army, Corps of Engineers 1965). The latter, listed in column 3 of table 4.7, places greater incremental amounts somewhat more toward the end of the 6-hr storm period. In application, the choice of either of these distributions is left to the user since one may prove to be more critical in a specific case than the other.

Table 4.7.--Time sequence for hourly incremental PMP in 6-hr storm

Increment	HMR No. 5[1]	EM1110-2-1411[2]
	Sequence Position	
Largest hourly amount	Third	Fourth
2nd largest	Fourth	Third
3rd largest	Second	Fifth
4th largest	Fifth	Second
5th largest	First	Last
least	Last	First

[1]U. S. Weather Bureau 1947.
[2]U. S. Corps of Engineers 1952.

Also of importance is the sequence of the four 15-min incremental PMP values. We recommend a time distribution, table 4.8, giving the greatest intensity in the first 15-min interval (U.S. Weather Bureau 1947). This is based on data from a broad geographical region. Additional support for this time distribution is found in the reports of specific storms by Keppell (1963) and Osborn and Renard (1969).

Table 4.8.--Time sequence for 15-min incremental PMP within 1 hr.

Increment	Sequence Position
Largest 15-min amount	First
2nd largest	Second
3rd largest	Third
least	Last

4.8 Seasonal Distribution

The time of the year when local-storm PMP is most likely is of interest. Guidance was obtained from analysis of the distribution of maximum 1-hr thunderstorm events through the warm season at the recording stations in Utah, Arizona, and in southern California (south of 37°N and east of the Sierra Nevada ridgeline). The period of record used was for 1940-72 with an average record length for the stations considered of 27 years. The month with the one greatest thunderstorm rainfall for the period of record at each station was noted. The totals of these events for each month, by States, are shown in table 4.9.

Table 4.9.--Seasonal distribution of thunderstorm rainfalls.

(The maximum event at each of 108 stations, period of record 1940-72.)

	Month						
	M	J	J	A	S	O	No. of Cases
Utah	1	5	9	14	5		34
Arizona		4	16	19	4		43
S. Calif.*		14	10	7			31
No. of cases/mo.	1	23	35	40	9	0	

*South of 37°N and east of Sierra Nevada ridgeline.

Appendix D

Local Storm PMP Calculations

Local PMP

Step		
1	Read interpolated Avg. PMP for 1-hr, 1 mi2 (Figure 4.5)	11.6
2a	Determine lowest elevation within drainage	5200
2b	If lowest elevation is above 5000 ft, reduce (1) by 5% for every 1000 ft.	0.12
2c	This gives elevation adjusted drainage average 1-hr, 1-mi2 PMP	11.48
3	Find 6/1 hr ratio for drainage locaiton (Figure 4.7)	1.3
4	Determine % durational variation given results of (3) and Table 4.4	
	0.25 hr	0.74
	0.5 hr	0.89
	0.75 hr	0.95
	1 hr	1.00
	2 hr	1.14
	3 hr	1.21
	4 hr	1.25
	5 hr	1.28
	6 hr	1.30
5	Obtain PMP for 1/4 to 6 hrs (Multiply step 2 by step 4)	
	0.25 hr	8.50
	0.5 hr	10.22
	0.75 hr	10.91
	1 hr	11.48
	2 hr	13.09
	3 hr	13.90
	4 hr	14.36
	5 hr	14.70
	6 hr	14.93
6	Determine aerial reduction in % given size of drainage (Figure 4.9)	
	0.25 hr	0.94
	0.5 hr	0.95
	0.75 hr	0.96
	1 hr	0.96
	2 hr	0.97
	3 hr	0.97
	4 hr	0.98
	5 hr	0.98
	6 hr	0.98
7	Determine aerial reduced PMP value (Multiply 5 by 6)	
	0.25 hr	7.99
	0.5 hr	9.71
	0.75 hr	10.47
	1 hr	11.02
	2 hr	12.70
	3 hr	13.48
	4 hr	14.07
	5 hr	14.41
	6 hr	14.63
8	Incremental PMP Values by subtraction of 7	
	0.25 hr	7.99
	0.5 hr	1.72
	0.75 hr	0.76
	1 hr	0.55
	2 hr	1.67
	3 hr	0.78
	4 hr	0.59
	5 hr	0.34
	6 hr	0.23

9	Arrange hourly incremental precip and 4 peak 15 minute intervals (Tables 4.7 and 4.8)	
	1 hr	0.34
	2 hr	0.78
	3 hr	11.02
	4 hr	1.67
	5 hr	0.59
	6 hr	0.23
10	Arrange hourly incremental precip and 4 peak 15 minute intervals (Tables 4.7 and 4.8)	
	0.00	0.00
	0.25	0.08
	0.50	0.08
	0.75	0.08
	1.00	0.08
	1.25	0.19
	1.50	0.19
	1.75	0.19
	2.00	0.19
	2.25	7.99
	2.50	1.72
	2.75	0.76
	3.00	0.55
	3.25	0.42
	3.50	0.42
	3.75	0.42
	4.00	0.42
	4.25	0.15
	4.50	0.15
	4.75	0.15
	5.00	0.15
	5.25	0.06
	5.50	0.06
	5.75	0.06
	6.00	0.06

APPENDIX C

Seismic Hazard Assessment

HERMOSA UNDERGROUND PROJECT
SEISMIC HAZARD ASSESSMENT
TRENCH CAMP PROPERTY
SANTA CRUZ COUNTY, ARIZONA

Prepared for:

ARIZONA MINERALS

Arizona Minerals, Inc.
#115 – 3845 North Business Center Drive
Tucson, Arizona 85705

Prepared by:

NewFields

NewFields Mining Design & Technical Services
9400 Station Street, Suite 300
Lone Tree, Colorado 80124

NewFields Project No. 475.0014.008
March 2017

NewFields

March 27, 2017
NewFields Project No. 475.0014.008

Arizona Minerals, Inc.
#115 – 3845 North Business Center Drive
Tucson, Arizona 85705

Attention: **Don Taylor**
Chief Operating Officer

Re: **HERMOSA UNDERGROUND PROJECT**
Seismic Hazard Assessment
Trench Camp Property
Santa Cruz County, Arizona

Dear Mr. Taylor,

We are pleased to submit the seismic hazard assessment report for the Hermosa Project. Historical seismicity and regional seismic sources are presented, and design-level ground motions were developed. This report was prepared based on the scope of work set forth in our proposal dated December 13, 2016.

We appreciate the opportunity to work with Arizona Minerals, Inc. on this project. If you have any questions or require additional information, please contact the undersigned.

Sincerely,
NewFields Mining Design & Technical Services

John W. Roberts, P.G.
Project Geologist

Nick Rocco, Ph.D., P.E.
Senior Geotechnical Engineer

JWR/NR/jh

Addressee: (via e-mail)

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1. INTRODUCTION

This report presents the seismic hazard assessment (SHA) for the Hermosa Underground Project (Project) and includes the development of design level ground motions. The Project is located in the northern end of the Patagonia Mountains, within Santa Cruz County, Arizona. The approximate latitude and longitude of the site are 31.47°N and 110.73°W, respectively. The primary objective of this SHA was to characterize the site-specific ground motion hazard for potential future earthquakes in the region. The prescriptive requirements outlined in the Arizona Best Available Demonstrated Control Technology (BADCT) Manual for the state of Arizona were followed.

Ground motions associated with the maximum credible earthquake (MCE) and various risk levels were assessed. The MCE is the largest event considered possible under the current tectonic regime. The scope of work completed follows.

- Review available literature and project specific reports related to regional geology and tectonics, particularly during the Quaternary Period (last 2.6 million years);
- Review earthquake catalogues to identify historical earthquake activity within approximately 124 miles (200 km) from the Project;
- Identify faults sources within 124 miles of the Project;
- Perform a site-specific deterministic seismic hazard analysis (DSHA) to identify the MCE;
- Utilize existing United States Geological Survey (USGS) tools to perform a probabilistic seismic hazard analysis (PSHA);
- Summarize the data and present estimates of seismic hazards in terms of peak horizontal ground acceleration and spectral accelerations for a range of return periods; and
- Identify the site classification and code-based seismic ordinates for structural design.

2. REGIONAL GEOLOGY AND TECTONIC SETTING

The Project lies within the southern Basin and Range province of the Western United States and northern Mexico. The province is an actively deforming region of crustal extension over the last 65 million years.

The Project is located northeast of the highly seismic active area of the Gulf of California, which is described as 1300 kilometers (km) of active rifting between the East Pacific Rise and the San Andreas Fault in southern California (Clayton et al., 2004), and south of the seismically active area of north-northwest Arizona near Flagstaff and the Grand Canyon. The general seismic hazard of the Project area has been categorized as moderate to low hazard (Pearthree, 1998).

2.1. Historical Seismicity

Historical seismicity in the region was reviewed. The following earthquake catalogs were queried to identify earthquake events with a moment magnitude (M_w) of 4.0 or greater within a radius of approximately 124 miles (200 km) from the Project:

- Advance National Seismic System (ANSS);
- International Seismological Centre (ISC);
- México Servicio Sismológico Nacional (SSN) – Universidad Nacional Autónoma de Mexico;
- Southern California Earthquake Data Center (SCEDC); and
- Arizona Geological Survey (AZGS).

All identified historical events were reviewed, and duplicate events, foreshocks and aftershocks were removed. Some historic events were recorded with different magnitude scales than moment magnitude, and the body wave magnitude (M_b) was adjusted to moment magnitude using the recommendations of Scordilis (2006). Local magnitudes (M_l) on the Richter scale, duration magnitudes (M_D) and unknown (not reported) magnitudes were not converted since a universal relationship with moment magnitude does not exist.

The search indicated that very few sizeable seismic events have been recorded in the vicinity of the Project. The largest historic event was the M_w 7.6 Sonora earthquake on May 3, 1887, as estimated by Suarez and Hough (2008). The historic events greater than M_w 5.0 are listed in **Table 2.1** and a complete list of the historic events with M_w 4.0 and greater is presented in **Appendix A**. The spatial relationship between the historical earthquakes with M_w greater than 4.0 and the project site is presented in **Figure 1**.

Table 2.1 - Historic Seismic Events with M_w 5.0 or Greater

Date	Name	Magnitude		Distance to Site (miles)
		Scale	Value	
5/3/1887	Sonora	M_w	7.6	98.8
6/29/2014	Unnamed	M_w	5.6	119.5
5/26/1907	Unnamed	M_w	5.2	98.8

2.2. Fault Sources

The Project is close to some regional, active faults. There are multiple interpretations of fault activity, but according to the BADCT an active fault is considered to be a fault that has exhibited movement during the last 35,000 years. Evaluation of regional faults within a 124 mile (200 km) radius from the project site was focused on structures considered capable of generating earthquakes of M_w 5.0 or greater using an empirical relationship between magnitude and rupture area (Wells and Coppersmith, 1994). Faults further than this distance are significantly attenuated and would not generate significant ground motions at the Project.

The data for each fault was based on documented fault length and widths as reported by Pederson, et al. (2008), the USGS Fault and Fold Database (2006) and the AZGS Natural Hazards Database (2013), and the Quaternary Fault Data and Map for Arizona (Pearthree, 1998). Typically, the length of rupture is a portion of the total length of the fault, but there is documentable evidence that shorter faults can rupture along their entire length. For this analysis, the length of rupture was estimated by using the following criteria:

- Half the total length for faults longer than 31 miles (50 km);
- Two-thirds of the fault length for fault lengths between 15.5 and 13 miles (25 and 50 km); and
- The total fault length for faults shorter than 15.5 miles (25 km).

Parameters for each fault are documented in **Table 2.2**, and the traces of the active faults in relation to the project site are presented in **Figure 1**.

Table 2.2 - Fault Parameters for Significant Regional Faults

Fault Name	Length[1] (mi)	Width[1] (mi)	Distance[3] (mi)	Dip/Sense of Slip[1]	Slip Rate[1] (mm/yr)	M_w[2]
Santa Rita FZ - Southern Section	18.0	12.4	16.8	70°/Normal	0.2	6.6
Santa Rita FZ - Northern Section	14.3	12.4	24.9	70°/Normal	0.2	6.7
Pitaycachi Fault	30.0	12.4	88.9	90°/Strike Slip	20.0	6.8
Gillespie Mountain Fault[4]	19.8	12.4	119.9	60°/Normal	0.2	6.7
Gray Ranch Fault - West Section[4]	9.7	12.4	111.2	60°/Normal	0.2	6.5
Gray Ranch Fault - East Section[4]	5.9	12.4	113.1	60°/Normal	0.2	6.3
Washburn Ranch FZ[4]	13.6	12.4	113.7	60°/Normal	0.2	6.7
Animas Valley Faults[4]	16.2	12.4	122.4	60°/Normal	0.2	6.6
Unnamed Faults West of Pyramid Mountain - Southern Section[4]	1.4	12.4	120.5	60°/Normal	0.2	5.7
Unnamed Faults West of Pyramid Mountain - Northern Section[4]	7.8	12.4	123.7	60°/Normal	0.2	6.4
Safford FZ - Southern Section[4]	19.0	12.4	98.2	60°/Normal	0.2	6.6
Safford FZ - Northern Section[4]	16.5	12.4	101.3	60°/Normal	0.2	6.6
Background Source	n/a	n/a	15.0	60°/Normal	n/a	6.5

Notes:
1) **From USGS Fault and Fold Database and AZGS Natural Hazards Database**
2) **Calculated using relationship of Wells & Coppersmith (1994)**
3) **Identified on Figure 1; closest distance**
4) **No dip angle reported, 60° assumed based on Anderson's Theory of Faulting**
FZ Fault zone

3. DETERMINISTIC SEISMIC HAZARD

Peak ground acceleration values were estimated for three potential seismic sources within 124 miles (200 km) of the site: historical seismic sources, fault sources, and a background source, which accounts for the possibility that an event may be generated in regions that are not associated with previously observed seismic sources. Based on recommendations by dePolo (1994), the background source for the region is a M_w 6.5 event, which for the current deterministic analysis was assumed to rupture 9 miles (15 km) from the site.

Attenuation relationships relate peak ground acceleration (PGA) or response spectral acceleration to earthquake magnitude, source-to-site distance, and local site conditions. Different attenuation models are required for different types of seismic sources. The five Next Generation (West) attenuation relationships of Abrahamson and Silva (2008), Boore and Atkinson (2008), Campbell and Bozorgnia (2008), Chiou and Youngs (2008), and Idriss (2008) were used to assess the local fault sources and the background event. The specified seismic accelerations are the average acceleration from the ground motion models. The ground motion models are based on the M_w and are generally applicable to M_w equal to 5.0 or greater. When moment magnitude was not available for historic seismic events, alternate available magnitudes were used in the models.

The ground motion models for fault sources rely on estimation of the various site-to-source distance parameters. The Boore and Atkinson attenuation relationship uses the closest horizontal distance to the surface projection of the rupture, often called the Joyner-Boore distance, which was calculated based on fault orientation and dip angle. The remaining four ground motion models use the closest direct distance to the rupture plane, and this distance was estimated following the recommendations of Kaklamanos et al. (2011). The attenuation relationships were used with a conservative shear wave velocity of 2,800 feet per second (854 meters per second) in the upper one hundred feet of the subsurface materials, based on recent geophysical data from the site. The relationships of Chiou and Youngs and Campbell and Bozorgnia were applied to estimate the depth to a shear wave velocity of 1 kilometer per second (km/sec) and 2.5 km/sec, respectively, due to the fact that data recorded during the seismic survey did not have the resolution to provide site-specific depths for the velocities required to run the models.

The Spudich et al. (1997) and Boore et al. (1993) attenuation relationships were used to estimate the PGA from historic earthquake events. The models were developed based on known earthquake events in western North America. The relationships are based on specific source criteria (i.e. depth of rupture, distance to epicenter, ground type, fault type, etc.), and they were selected based on their applicability to the Project and regional tectonics.

The PGAs calculated for the active faults are presented in **Table 3.1**, and the PGAs calculated for the historical events of M_w of 5.0 or greater (**Table 2.1**) are presented in **Table 3.2**. The complete list of calculated PGAs for all historical events are presented in **Appendix A**.

Table 3.1 - Deterministic Peak Ground Accelerations

Fault Name	Calculated PGA from the MCE (g)
Santa Rita Fault Zone - Southern Section	0.11
Background Source	0.09
Santa Rita Fault Zone - Northern Section	0.07
Pitaycachi Fault	0.02
Gillespie Mountain Fault	0.01
Gray Ranch Fault - West Section	0.01
Gray Ranch Fault - East Section	0.01
Washburn Ranch Fault Zone	0.01
Animas Valley Faults	0.01
Unnamed Faults West of Pyramid Mountain - Southern Section	0.00
Unnamed Faults West of Pyramid Mountain - Northern Section	0.01
Safford Fault Zone - Southern Section	0.01
Safford Fault Zone - Northern Section	0.01

Table 3.2 - Calculated PGA of Historic Seismic Events with Mw 5.0 or Greater

Date	Name	Magnitude		PGA[1]	PGA[2]
		Scale	Value	(g)	(g)
5/3/1887	Sonora	M_w	7.6	0.03	0.04
6/29/2014	Unnamed	M_w	5.6	0.01	0.03
5/26/1907	Unnamed	M_w	5.2	0.01	0.02

Notes: 1) Spudich et al., (1997)
2) Boore et al., (1993)

These values represent the most conservative estimate of the PGA at the site from the MCE event. It should be noted that potential accelerations at the Project significantly decrease for fault sources that are greater than 25 miles.

4. PROBABILISTIC SEISMIC HAZARD ANALYSIS

The probabilistic seismic hazard for the Project was determined using the USGS interactive deaggregation tool, which is based on published national seismic hazard maps. Due to the region the site is located, the interactive tool does not allow for the average shear wave velocity of the upper 30 meters to be input above the default value of 760 meters per second, which is approximately 150 meter per second less than the average shear wave velocity recorded during the seismic survey, completed as part of the geotechnical investigation. The reported PGA for the 50 percent chance of exceedance in 30 years corresponds to a 108 years, and a 10 percent and 2 percent chance of exceedance in 50 years. These correspond to return periods of 475 years and 2,475 years, respectively. The return period cited above along with corresponding PGA (g) values are presented in **Table 4.1**. Deaggregation plots for each return period are included in **Appendix B**.

Table 4.1 - Probabilistic Design Accelerations

Return Period	PGA(g)
100-Year	0.01
475-Year	0.04
2,475-Year	0.10

5. SITE CLASSIFICATION

Based on the results of the recent geotechnical subsurface investigation program, and in accordance with the 2012 IBC and ASCE 7-10, the site classifies as rock, Site Class B, with the upper one hundred feet dominated by andesite. The site classification is based on natural rock and overburden, and does not include any existing mine waste materials around the site.

The maximum postulated earthquake response accelerations at short and long periods, S_S and S_1, respectively, were determined using an online calculator provided by the USGS. All relevant seismic design values for structures are listed in **Table 5.1** and included in **Appendix C**.

Table 5.1 - Code Based Seismic Parameters

Site Soil Class	B
Mapped MCE_R, five (5) percent damped, spectral response acceleration parameter at short periods (Site Class B), S_S	0.230g
Mapped MCE_R, five (5) percent damped, spectral response acceleration parameter at a period of one (1) second (Site Class B), S_1	0.067g

The deterministic PGA was also evaluated according to IBC and ASCE 7-10 building codes. The PGA adjusted for site class effects is reported as 0.10g, as shown in **Appendix C**.

6. RECOMMENDED DESIGN GROUND MOTIONS

Ground motions associated with design-level earthquakes were developed for the Project using both site-specific procedures and publically available information from the USGS. Based on a site-specific deterministic assessment of historic earthquakes and fault sources, the design seismic event would be a M_W 6.6 event on the southern section of the Santa Rita Fault Zone at a distance of approximately 16.8 miles (26 km), which could produce a PGA of 0.11g at the Project from the MCE event. The risk targeted MCE peak acceleration reported by the USGS for the site is 0.10g for a Site Soil Class B. The probabilistic assessment indicated a PGA of approximately 0.01g and 0.10g for the 108-year and 2,475-year return period events, respectively.

Based on all the available information, we recommend the following:

- Earthen structures (such as the TSF) should be designed considering a PGA equal to 0.11g based on the most conservative results of the DSHA and 100-year return probabilistic event. This is in compliance with the BADCT guidelines.
- The code based seismic parameters presented should be used to for seismic design of all buildings.

7. OTHER SEISMIC HAZARDS

Potential seismic hazards for any site include ground rupture, slope instability, seismic induced settlement, and liquefaction or strain softening of subsurface deposits. Ground rupture is not expected to be a hazard for the Project or associated facilities since near-surface faulting and active faults have not been documented. Liquefaction, which can occur within loose, saturated granular deposits, is not expected to be a hazard for naturally occurring subsurface materials given the significant depth to groundwater and the near surface deposits are relatively dense. Similarly, potential seismic settlement from liquefaction of saturated, deep deposits is not expected based on our understanding of the subsurface.

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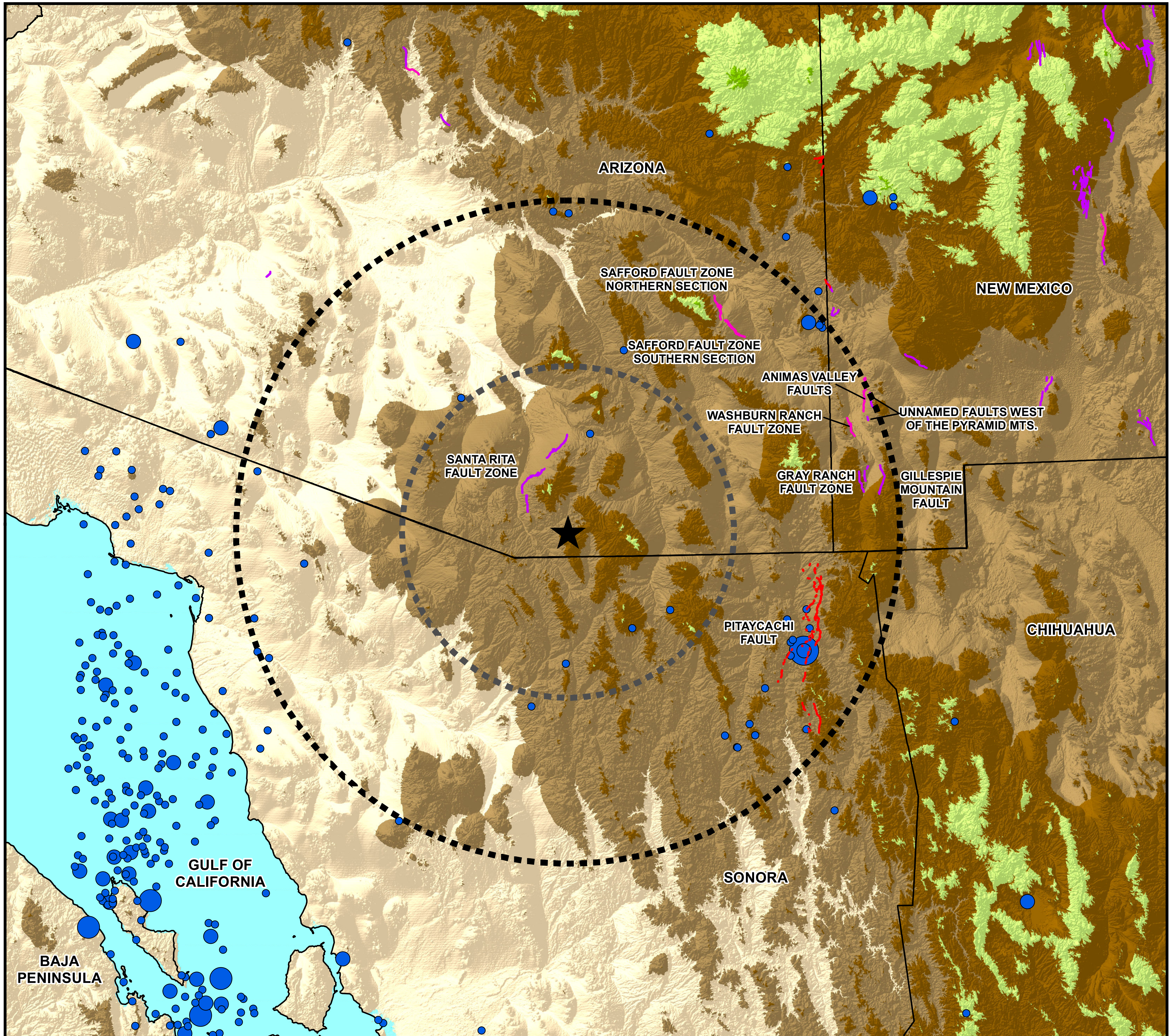
FIGURE



LEGEND

★ HERMOSA PROJECT

124 MILE (200 km) RADIUS

62 MILE (100 km) RADIUS

ACTIVE FAULTS

<130,000 YEARS

<15,000 YEARS

<150 YEARS

HISTORICAL EARTHQUAKE MAGNITUDE

4.0 - 4.9

5.0 - 5.9

6.0 - 6.9

>7

ELEVATION (feet)

SEA LEVEL

0 - 750

751 - 1,500

1,501 - 2,250

2,251 - 3,000

3,001 - 3,750

3,751 - 4,500

N

0 20 40 60

Miles

NewFields	CLIENT ARIZONA MINERALS, INC.	
PROJECT	HERMOSA UNDERGROUND PROJECT	
TITLE	HISTORIC SEISMICITY AND ACTIVE FAULTS	FILENAME GIS-0014.008.001F.mxd; FIGURE NO. 1; REV A

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APPENDIX A

COMPILATION OF HISTORIC SEISMIC EVENTS

	Latitude	Longitude
Project Site Location:	31.47	-110.73

CATALOG LIST	EVENT DATE	EVENT TIME	LATITUDE	LONGITUDE	DEPTH (km)	MAGNITUDE	MAGNITUDE SCALE	Mw[1]	Distance To Site (km)	Distance To Site (miles)	PGA[2] (g)	PGA[3] (g)
AZGS	5/3/1887	14:30:00	30.800	-109.250	10.0	7.6	Mw	7.60	159.1	98.8	0.03	0.04
AZGS	5/26/1907	3:00:00	30.800	-109.250	0.0	5.2	Mw	5.20	159.1	98.8	0.03	0.04
AZGS	4/7/1908	0:00:00	30.600	-109.500	0.0	4.8	Mw	4.80	151.7	94.2	0.01	0.01
AZGS	6/6/1938	2:42:00	32.000	-110.580	0.0	4.8	Ml	4.80	60.8	37.8	0.01	0.01
ANSS (NCEDC)	9/11/1963	11:59:41	33.200	-110.700	33.0	4.2	Mb	4.60	192.6	119.7	0.02	0.02
AZGS	3/13/1965	8:46:57	32.200	-111.400	0.0	4.4	ML	4.40	103.2	64.1	0.00	0.01
ANSS (NCEDC)	11/26/1965	13:57:03	31.800	-112.700	33.0	4.1	Mb	4.52	190.3	118.3	0.01	0.01
ANSS (NCEDC)	2/10/1969	13:27:13	30.784	-112.619	33.0	4.3	Mb	4.69	195.4	121.4	0.00	0.01
ISC	3/21/1969	4:22:29	31.300	-112.400	33.0	4.5	Mb	4.86	159.8	99.3	0.01	0.01
ISC	12/25/1969	12:49:12	33.210	-110.800	16.0	4.4	Mb	4.77	193.8	120.4	0.01	0.01
ISC	3/9/1972	18:45:01	32.451	-110.357	0.0	4.1	Unknown	4.10	114.8	71.3	0.01	0.01
ANSS (USGS)	6/8/1977	13:09:07	31.024	-109.227	5.0	4.6	Mb	4.94	151.0	93.8	0.01	0.01
ANSS (USGS)	3/18/1980	11:29:47	31.000	-112.714	6.0	4.4	Ml	4.39	195.9	121.7	0.01	0.01
ANSS (USGS)	6/11/1988	8:58:35	30.774	-109.334	5.0	4.5	Mb	4.86	153.5	95.4	0.00	0.01
ANSS (USGS)	5/25/1989	7:43:18	30.846	-109.332	5.0	4.6	Mb	4.94	149.8	93.1	0.01	0.01
ISC	9/13/1996	19:20:26	30.920	-109.210	0.0	4.5	Mb	4.86	156.7	97.4	0.01	0.01
ANSS (USGS)	10/16/1999	17:15:09	30.751	-110.749	5.0	4.5	Ml	4.50	79.8	49.6	0.01	0.01
ISC	6/11/2013	18:50:04	30.407	-109.601	1.0	4.0	Md	4.00	159.6	99.2	0.01	0.01
ISC	8/5/2013	18:58:06	30.282	-109.683	5.0	4.0	Md	4.00	165.3	102.7	0.00	0.01
ISC	10/6/2013	22:59:06	30.372	-109.246	2.5	4.2	Md	4.20	186.6	116.0	0.00	0.01
ISC	5/17/2014	20:25:38	30.347	-109.758	5.0	4.0	Md	4.00	155.2	96.5	0.00	0.01
ISC	6/29/2014	4:59:35	32.582	-109.168	6.4	5.4	Mb	5.62	192.3	119.5	0.00	0.01
ANSS (USGS)	6/29/2014	6:10:05	32.565	-109.100	5.0	4.0	Mw	4.00	196.0	121.8	0.01	0.01
ISC	7/3/2014	22:56:31	32.578	-109.087	5.0	4.2	Ml	4.20	197.9	123.0	0.00	0.00
ISC	7/9/2014	8:15:21	32.552	-109.083	5.0	4.1	Ml	4.10	196.4	122.1	0.00	0.00
ISC	7/12/2015	19:10:24	30.345	-109.568	3.0	4.2	Md	4.20	166.9	103.7	0.00	0.00
ISC	7/15/2015	21:11:40	30.519	-110.968	15.8	4.0	Md	4.00	108.0	67.1	0.00	0.01
ISC	9/11/2015	21:20:02	31.035	-110.088	3.4	4.3	Md	4.30	77.6	48.2	0.01	0.01
Mexico - SSN	11/19/2016	15:53:56	30.940	-110.330	5.0	4.0	Unknown	4.00	69.9	43.4	0.01	0.01
Mexico - SSN	11/30/2016	20:26:22	30.860	-109.320	5.0	4.1	Unknown	4.10	150.1	93.2	0.01	0.01
ISC	12/1/2016	2:26:17	30.971	-109.351	0.0	4.3	Ml	4.30	142.1	88.3	0.01	0.01

Notes:

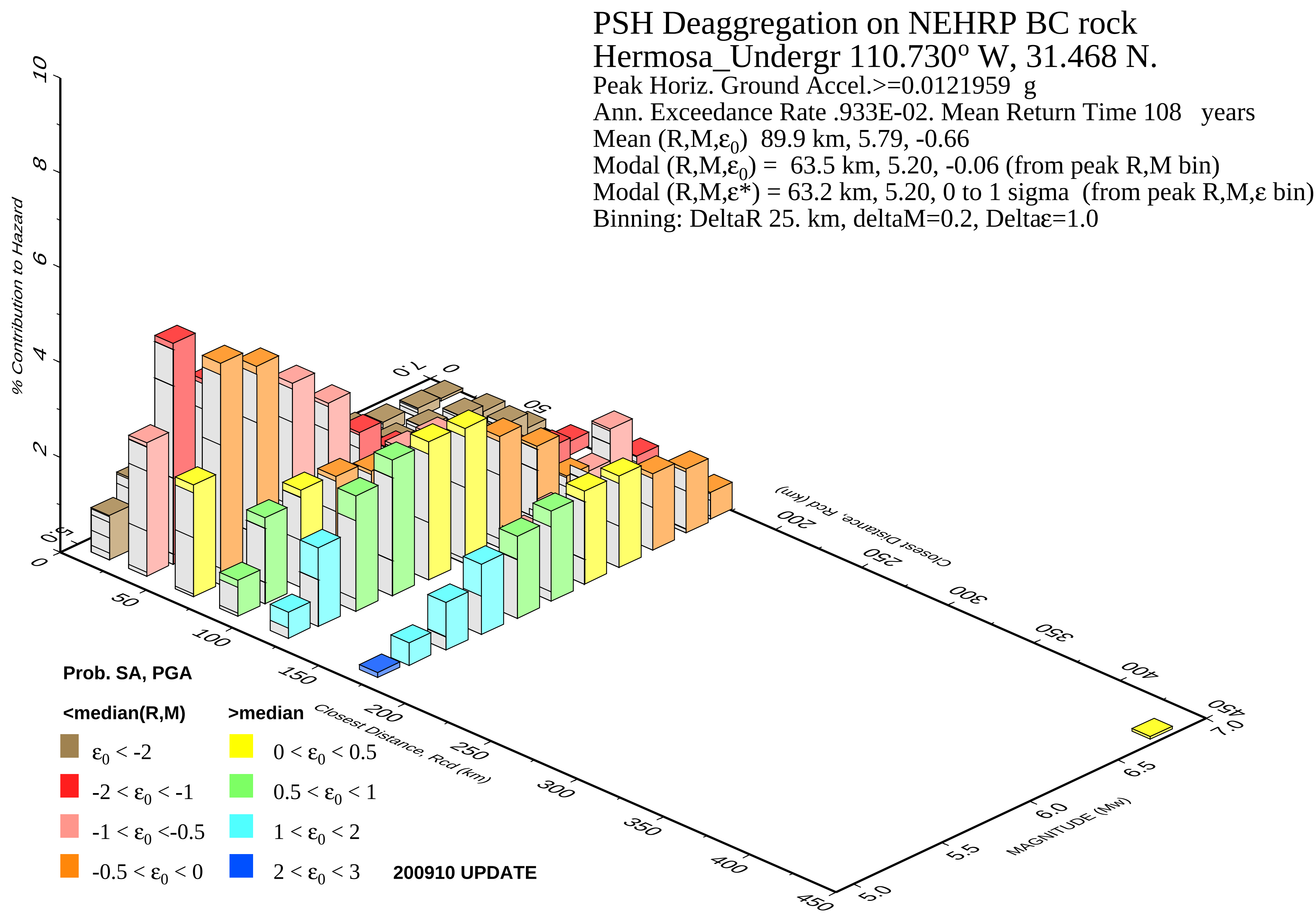
1 Body wave (Mb) magnitudes were converted to moment magnitude (Mw) using relationships presented by Scordilis (2006). Duration magnitude (Md), local magnitudes (Ml) and unknown magnitude scales were not converted.

2 Spudich et al., (1997)

3 Boore et al., (1993)

APPENDIX B

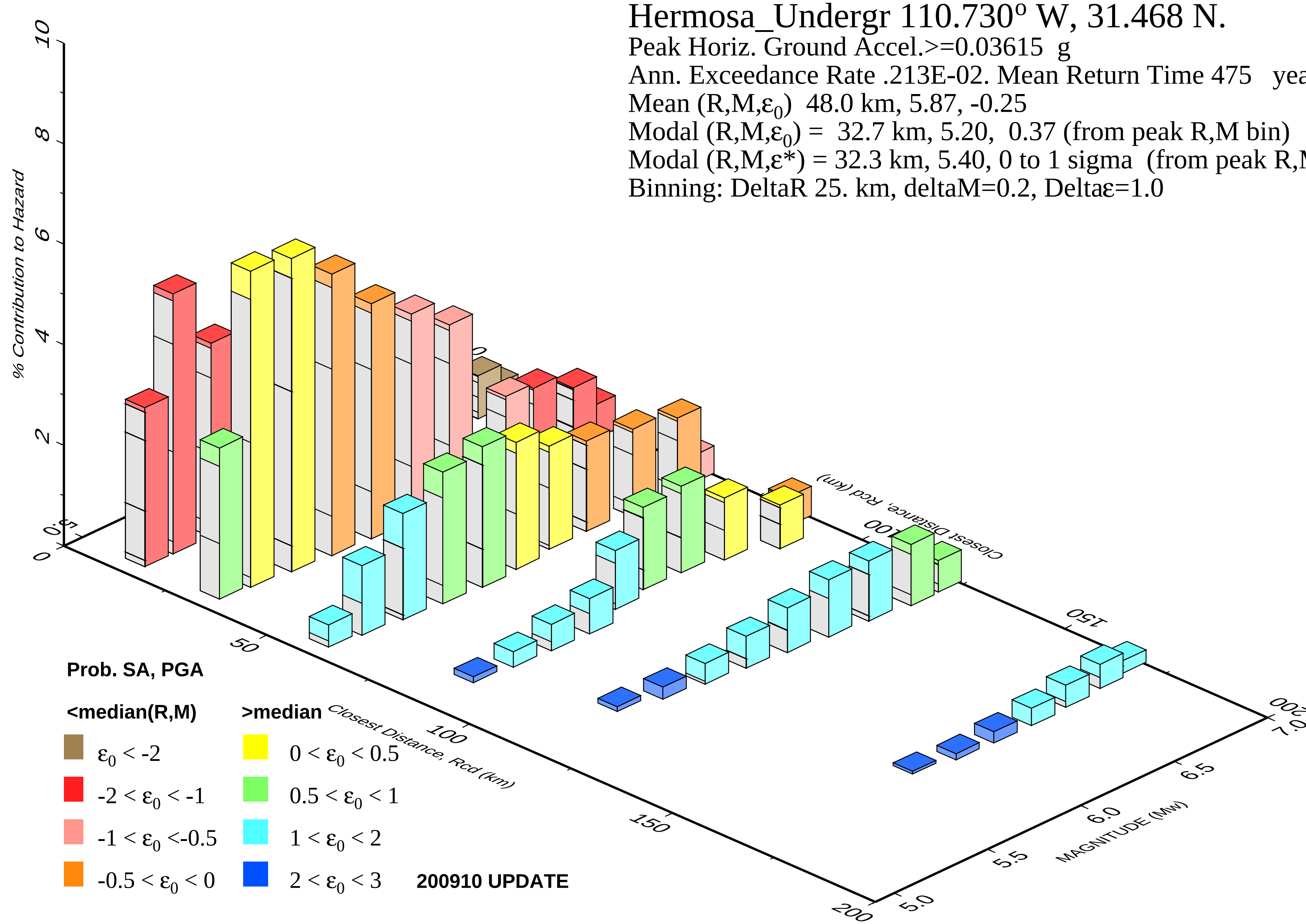
PROBABILISTIC SEISMIC HAZARD



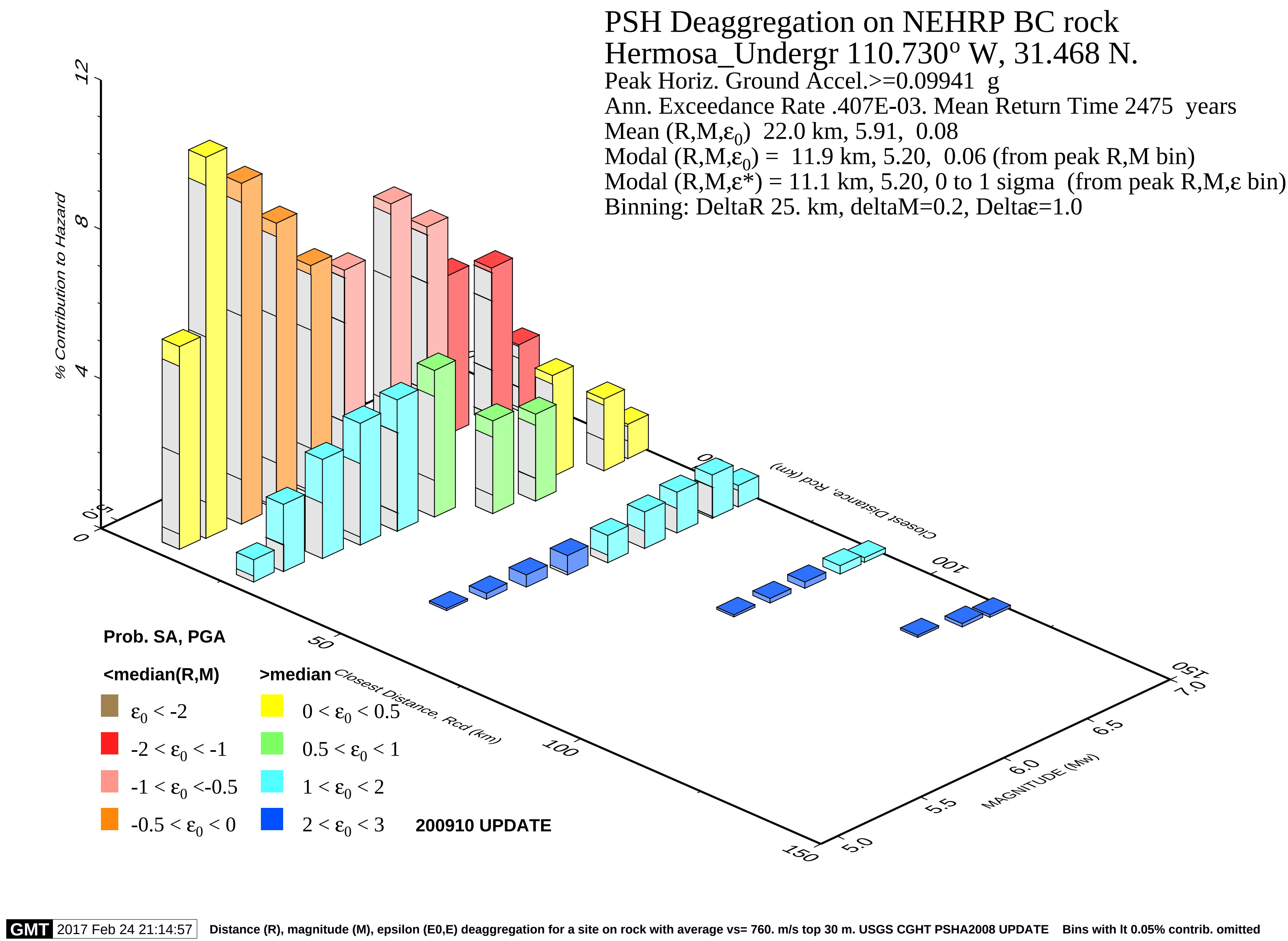
GMT 2017 Feb 27 22:46:28 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

PSH Deaggregation on NEHRP BC rock
Hermosa_Undergr 110.730° W, 31.468 N.

Peak Horiz. Ground Accel.>=0.03615 g
Ann. Exceedance Rate .213E-02. Mean Return Time 475 years
Mean (R,M,ε_0) 48.0 km, 5.87, -0.25
Modal (R,M,ε_0) = 32.7 km, 5.20, 0.37 (from peak R,M bin)
Modal (R,M,ε*) = 32.3 km, 5.40, 0 to 1 sigma (from peak R,M,ε bin)
Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0



GMT 2017 Feb 24 21:18:31 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**



PSH Deaggregation on NEHRP BC rock
Hermosa_Undergr 110.730° W, 31.468 N.
Peak Horiz. Ground Accel.>=0.09941 g
Ann. Exceedance Rate .407E-03. Mean Return Time 2475 years
Mean (R,M,ε0) 22.0 km, 5.91, 0.08
Modal (R,M,ε0) = 11.9 km, 5.20, 0.06 (from peak R,M bin)
Modal (R,M,ε*) = 11.1 km, 5.20, 0 to 1 sigma (from peak R,M,ε bin)
Binning: DeltaR 25. km, deltaM=0.2, Deltaε=1.0
% Contribution to Hazard
0
4
8
12
50
100
150
Closest Distance, Rcd (km)
5.0
5.5
6.0
6.5
7.0
MAGNITUDE (Mw)
Prob. SA, PGA
<median(R,M)
>median
ε0 < -2
-2 < ε0 < -1
-1 < ε0 <-0.5
-0.5 < ε0 < 0
0 < ε0 < 0.5
0.5 < ε0 < 1
1 < ε0 < 2
2 < ε0 < 3
200910 UPDATE
GMT 2017 Feb 24 21:14:57
Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on rock with average vs= 760. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

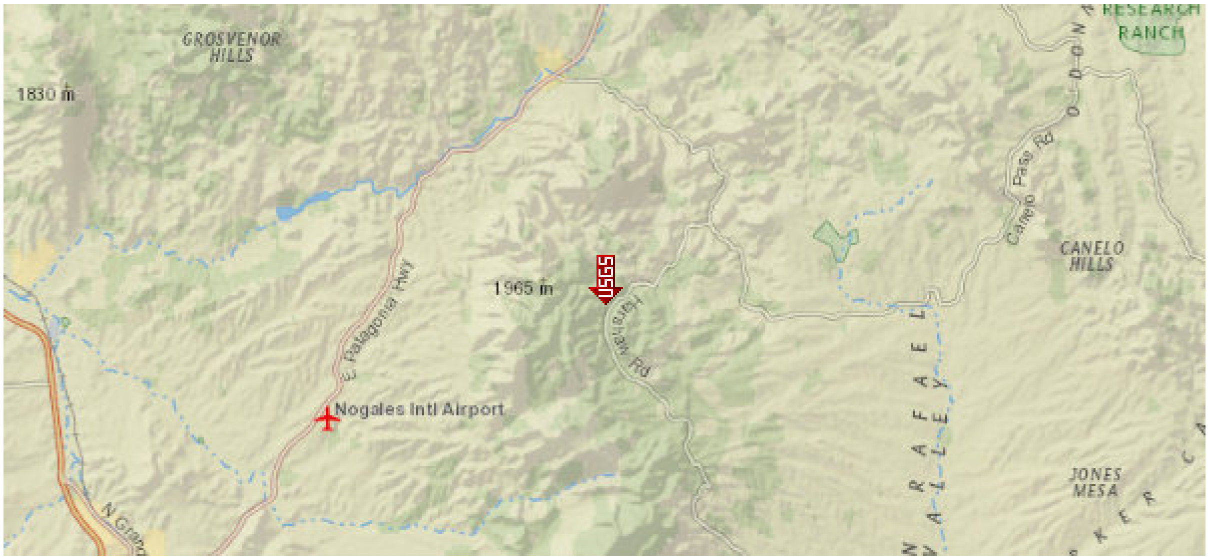
APPENDIX C

CODE BASED SEISMIC PARAMETERS

Design Maps Summary Report

User–Specified Input

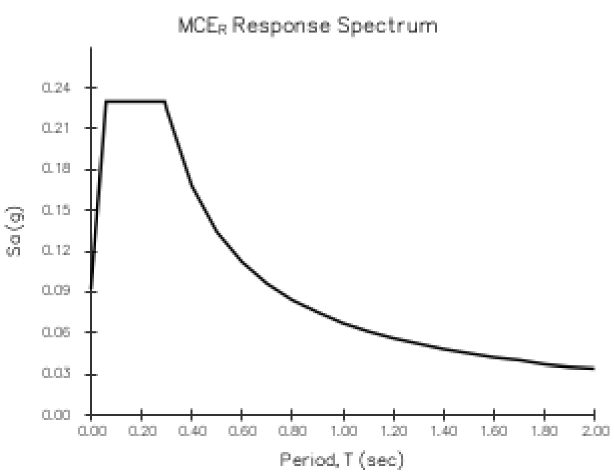
Report Title	Hermosa Underground Project Fri February 24, 2017 21:49:31 UTC
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	31.468°N, 110.73°W
Site Soil Classification	Site Class B – "Rock"
Risk Category	I/II/III

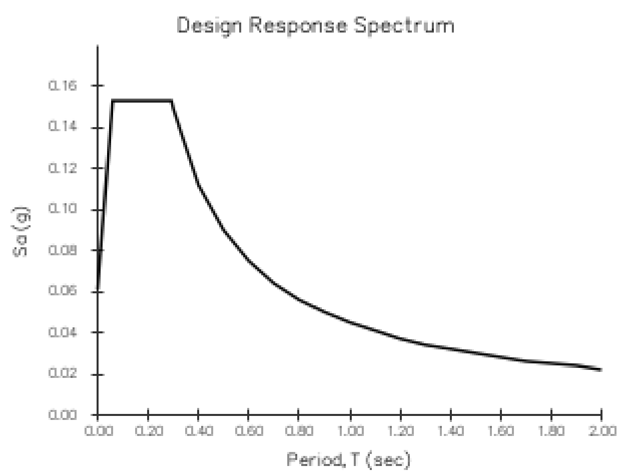


USGS–Provided Output

S_S = 0.230 g	S_{MS} = 0.230 g	S_{DS} = 0.153 g
S_1 = 0.067 g	S_{M1} = 0.067 g	S_{D1} = 0.045 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Design Maps Detailed Report

ASCE 7-10 Standard (31.468°N, 110.73°W)

Site Class B – "Rock", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

From Figure 22-1 [1]	S_S = 0.230 g
From Figure 22-2 [2]	S_1 = 0.067 g

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class B, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Table 11.4–1: Site Coefficient F_a

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = B and S_S = 0.230 g, F_a = 1.000

Table 11.4–2: Site Coefficient F_v

Site Class	Mapped MCE $_R$ Spectral Response Acceleration Parameter at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = B and S_1 = 0.067 g, F_v = 1.000

Equation (11.4–1): $S_{MS} = F_aS_S = 1.000 \times 0.230 = 0.230$ g

Equation (11.4–2): $S_{M1} = F_vS_1 = 1.000 \times 0.067 = 0.067$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

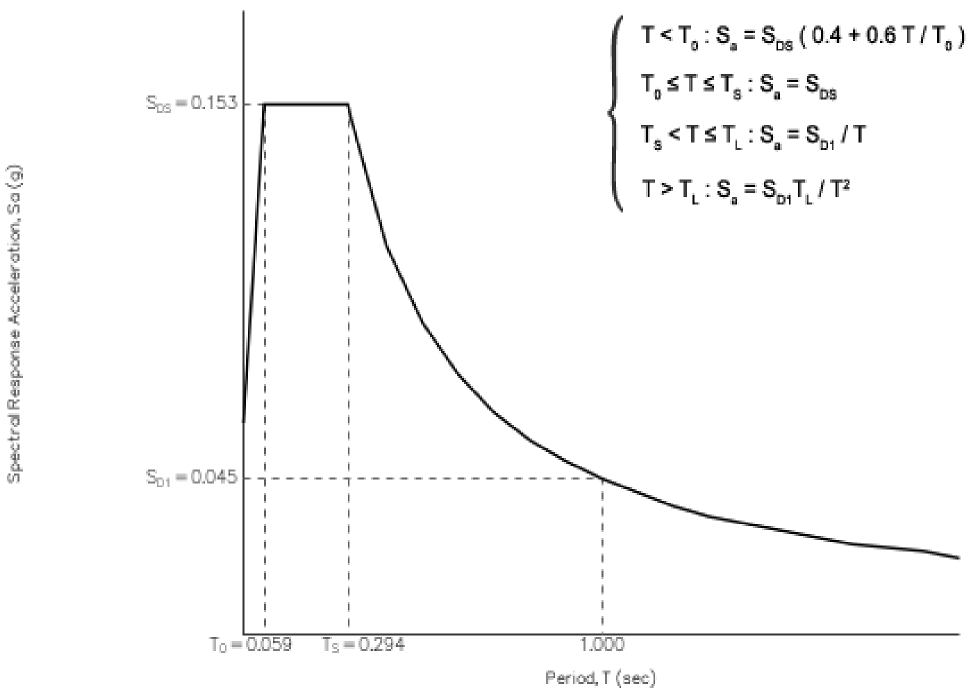
Equation (11.4–3): $S_{DS} = ⅔ S_{MS} = ⅔ \times 0.230 = 0.153$ g

Equation (11.4–4): $S_{D1} = ⅔ S_{M1} = ⅔ \times 0.067 = 0.045$ g

Section 11.4.5 — Design Response Spectrum

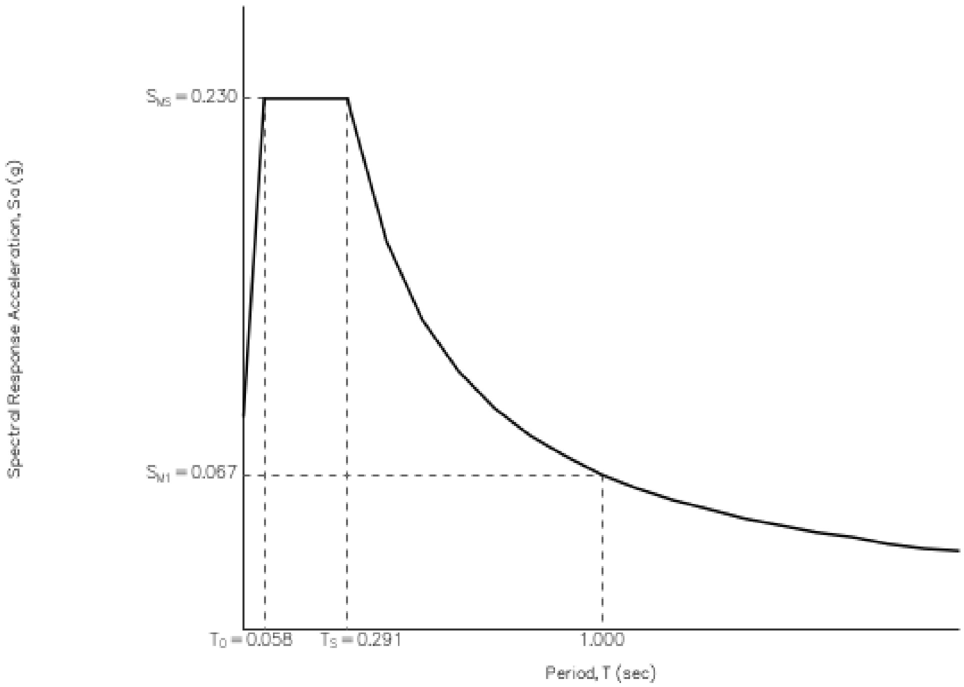
From Figure 22-12 [3] $T_L = 6$ seconds

Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake (MCE_R) Response Spectrum

The MCE_R Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4] PGA = 0.098

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.098 = 0.098$ g

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = B and PGA = 0.098 g, F_{PGA} = 1.000

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] C_{RS} = 0.888

From Figure 22-18 [6] C_{R1} = 0.914

Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.153 g, Seismic Design Category = A

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.045 g, Seismic Design Category = A

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ "the more severe design category in accordance with Table 11.6-1 or 11.6-2" = A

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

References

1. *Figure 22-1*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

APPENDIX D
APPENDIX D.1 – BOREHOLE AND TEST PIT LOGS
APPENDIX D.2 –LABORATORY TEST RESULTS
APPENDIX D.3 –VRP TSF CQA RESULTS

APPENDIX D.1

APPENDIX D.1.1 – BOREHOLE AND TEST PIT LOGS (JANUARY 2017)

APPENDIX D.1.2 –TEST PIT LOGS (JUNE 2017)

APPENDIX D.1.3 –TEST PIT LOGS (JANUARY 2017)

APPENDIX D.1.1

Borehole and Test Pit Logs (January 2017)

Note:

Appendix D.1.1 is included in this report for completeness although it is also presented as Appendix D in the NewFields' "Tailings and Potentially Acid Generating (PAG) Material, Remediation, Placement and Storage Project, Aquifer Protection Permit (APP), Best Available Demonstrated Control Technology (BADCT) Design Report" dated June 5, 2017 which is currently permitted under the Aquifer Protection Permit (APP) Program (No. P-512235) issued by the Arizona Department of Environmental Quality (ADEQ).

FIELD SOIL EXPLORATION LOG

NewFields

BOREHOLE ID: BH-01

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/5/2017
END DATE: 1/5/2017

NORTHING: 171434.89
EASTING: 1071638.05
GROUND ELEV.: 5099.00
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	6-8-11		SM		COVER MATERIAL: SAND (SM), silty, with gravel, rootlets, fine to medium grained, poorly graded, medium dense, nonplastic, reddish brown moist TAILINGS: SAND (SM), silty, orange (oxidized), moist	Cover material 0 - 1.4ft depth Tailings 1.4 - 51.5ft depth Description from auger cuttings
5 5.0	MC	8-14-8				SAND/SILT (SM/ML), silty/sandy, trace clay, fine grained, medium dense/stiff, nonplastic, olive, moist	pH = 6.5 EC = 1020uS (microseimens)
10							
15 15.0	MC	2-6-10		ML		SILT (ML), sandy, with interbedded clay, stiff, nonplastic (clays are medium plastic), olive and gray, moist	pH = 5.1 EC = 1495uS
20							
25 25.0	MC	5-9-11		SM		SILT (ML), sandy, medium dense, nonplastic, gray, moist	pH = 5.5 EC = 910uS
30							
35 35.0	MC	7-12-18		ML		SILT (ML), some clay and fine sand, hard, nonplastic, dark gray, moist	pH = 5.5 EC = 245uS

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-01

PROJECT: Hermosa Underground Project	NORTHING: 171434.89	START DATE: 1/5/2017
PROJECT No.: 475.0014.008	EASTING: 1071638.05	END DATE: 1/5/2017
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5099.00	LOGGED BY: J. Roberts
DRILLING METHOD: 4 1/4" HSA	DATUM: NAD83 AZ State Plane Central US feet	BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger	EQUIPMENT: CME 850	Page 2 of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
45.0	MC	3-5-5		CL		CLAY (CL), trace silt sand, medium stiff, medium plastic, gray, moist	pH = 5.0 EC = 125uS
46.5	ST						
52.5	MC	50/5"		GC		NATIVE GROUND: Presumed gravel with silt based on drive sample at 52.5ft depth and drilling 0.2ft of organic silt (OL) at top of recovered material GRAVEL (GC), clayey, with sand, coarse, angular, very dense, reddish brown, moist - bedrock Borehole terminated at approximately 53ft depth due to auger refusal in bedrock No free water observed in the borehole Borehole was abandoned with 20% solids bentonite grout poured from surface.	Native ground encountered at 51.5ft depth as indicated by auger drilling behavior. pH = 6.5 EC = 100uS

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-02

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/5/2017
END DATE: 1/6/2017

NORTHING: 171251.10
EASTING: 1071918.68
GROUND ELEV.: 5098.30
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	2-4-9		CL		COVER MATERIAL: CLAY (CL), sandy, with silt, trace gravel, rootlets, stiff, medium plastic, dark reddish brown, moist	Cover material 0 - 3ft depth
				ML		TAILINGS:	Tailings 3 - 36.6ft depth
5.0	MC	4-5-6				SILT (ML), sandy, with clay, stiff, nonplastic, orange (oxidized), moist	pH = 5.5 EC = 1680uS (microseimens)
15.0	MC	4-5-3				High plastic clay lenses, becomes gray and olive Becomes gray	pH = 5.5 EC = 1040uS
25.0	MC	1-1-2				Trace sand, soft, medium plastic	pH = 5.0 EC = 375uS
26.5	ST						
35.0	MC	2-3-6		CL		CLAY (CL), some silt lenses <0.1ft thick, medium stiff, low plastic, dark gray, moist - wood in shoe of sampler	pH = 5.3 EC = NA
				GC		NATIVE GROUND: Presumed gravel based on drive sample at 37.5ft depth and drilling	Native ground encountered at 36.6ft as indicated by auger drilling behavior
37.5	MC						

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-02

PROJECT: Hermosa Underground Project	NORTHING: 171251.10	START DATE: 1/5/2017
PROJECT No.: 475.0014.008	EASTING: 1071918.68	END DATE: 1/6/2017
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5098.30	LOGGED BY: J. Roberts
DRILLING METHOD: 4 1/4" HSA	DATUM: NAD83 AZ State Plane Central US feet	BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger	EQUIPMENT: CME 850	Page 2 of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
		36-50/3"				GRAVEL (GC), clayey, with sand, very dense, low plastic, mottled, red and light gray, moist	pH = 6.4 EC = 225uS
40 — 40.0	MC	50/5"				Borehole terminated at approximately 40.5ft depth in completely weathered bedrock with neutral pH and low conductivity No free water observed in borehole Borehole was abandoned with 20% solids bentonite grout poured from surface.	pH = 6.7 EC = 85uS Sample retained for environmental testing only
45							
50							
55							
60							
65							
70							
75							

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-03

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/5/2017
END DATE: 1/5/2017

NORTHING: 170993.46
EASTING: 1071848.26
GROUND ELEV.: 5115.00
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	4-7-15		SM/SC		COVER MATERIAL: SAND (SM/SC), silty/clayey, with gravel, rootlets, fine to medium grained, poorly graded, angular gravel, medium dense, low plastic, reddish brown, moist	Cover material 0 - 2ft depth
				SM		TAILINGS:	Tailings 2 - 40.6ft depth
4.0	MC	6-8-7				SAND (SM), silty, trace clay and fine gravel, medium dense, nonplastic, light brown and gray, moist	pH = 5.7 EC = 790uS (microseimens)
15.0	MC	5-8-10		ML		SILT (ML), trace fine sand, clay lenses, silty sand lens 0.3ft thick, stiff, nonplastic, gray, moist	pH = 5.5 EC = 655uS
25.0	MC	2-2-3		CH/MH		Interbedded nonplastic silts and high plastic clays up to 0.4ft thick	pH = 5.5 EC = 550uS
35.0	MC	3-3-3		CL		CLAY (CL), some silt, trace fine sand, medium stiff, low plastic, dark gray, moist	pH = 5.5 EC = 350uS

Depth scale (ft): 0, 5, 10, 15, 20, 25, 30, 35

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-03

PROJECT: Hermosa Underground Project	NORTHING: 170993.46	START DATE: 1/5/2017
PROJECT No.: 475.0014.008	EASTING: 1071848.26	END DATE: 1/5/2017
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5115.00	LOGGED BY: J. Roberts
DRILLING METHOD: 4 1/4" HSA	DATUM: NAD83 AZ State Plane Central US feet	BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger	EQUIPMENT: CME 850	Page 2 of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
40 / 40.0	ST			SM		NATIVE GROUND: Presumed silty sand based on crushed Shelby tube, drive sample at 43.0ft depth and drilling	Shelby tube sample attempted 40 - 43ft depth, crushed - driller indicated native ground at 40.6ft depth due to drilling behavior - native ground observed in bottom of discarded tube
43.0	MC	18-35-50/3"				SAND (SM), silty, trace fine gravel, very dense, nonplastic, red, moist - completely weathered bedrock	Sampler driven at base of Shelby tube
45						Borehole terminated at approximately 44.3ft depth in weathered bedrock with neutral pH and low conductivity	pH = 6.5 EC = 110uS
						No free water observed in borehole	
						Borehole abandoned with 20% solids bentonite grout poured from surface	
50							
55							
60							
65							
70							
75							

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-04

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/6/2017
END DATE: 1/7/2017

NORTHING: 171783.52
EASTING: 1070582.77
GROUND ELEV.: 5038.76
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	6-6-10		SM		COVER MATERIAL: SAND (SM), silty with gravel and clay, rootlets, medium dense, nonplastic to low plastic, reddish brown, moist	Cover material 0 - 1.1ft depth
				ML		TAILINGS: SILT (ML), some clay and sand, nonplastic, yellow and orange (oxidized), moist	Tailings 1.1 - 16.1ft depth pH = 6.5 EC = 1755uS (microseimens)
5.0	MC	5-5-6				Some fine sand, trace clay, stiff, nonplastic, gray, moist	pH = 5.5 EC = 580uS
15.0	MC	8-17-27				Clay lenses, hard, nonplastic	pH = 5.5 EC = 355uS
				CL		WASTE ROCK: CLAY (CL), silty, with sand, hard, low to medium plastic, yellow, moist	Waste rock 16.1 - 38ft depth pH = 6.5 EC = 255uS
20.0	MC	14-17-18		GM		GRAVEL (GM), silty, with sand, coarse, dense, nonplastic to low plastic, yellow and light gray, moist Boulders 16 - 20ft depth	pH = 5.5 EC = 355uS
30.0	MC	13-23-24					pH = 6.5 EC = 2.40mS (milliseimens)

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-04

PROJECT: Hermosa Underground Project	NORTHING: 171783.52	START DATE: 1/6/2017	
PROJECT No.: 475.0014.008	EASTING: 1070582.77	END DATE: 1/7/2017	
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5038.76	LOGGED BY: J. Roberts	
DRILLING METHOD: 4 1/4" HSA	DATUM: NAD83 AZ State Plane Central US feet	BACKFILLED: 20% Solids Bentonite Grout	
OPERATOR: Roger	EQUIPMENT: CME 850	Page 2	of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
				SC		NATIVE GROUND (est.):	Native ground encountered at approximately 38ft depth as indicated by drill cuttings at the surface
40 — 40.0	MC	50/3"		SC		SAND (SC), clayey, with gravel, wood, very dense, low plastic, red, moist - completely weathered bedrock Borehole terminated at approximately 40.5ft depth in weathered bedrock with neutral pH No free water observed in borehole Borehole abandoned with 20% solids bentonite grout	pH = 6.0 EC = 520uS
45							
50							
55							
60							
65							
70							
75							

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-05

Page 1 of 1

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/6/2017
END DATE: 1/6/2017

NORTHING: 171544.73
EASTING: 1070656.11
GROUND ELEV.: 5047.47
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	8-13-10		GM		COVER MATERIAL: GRAVEL (GM), silty, with sand, trace clay, medium dense, nonplastic to low plastic, reddish brown, moist	Cover material 0 - 2.4ft depth
				ML		TAILINGS:	Tailings 2.4 - 16.1ft depth
5.0	MC	4-5-6				SILT (ML), sandy, some clay, stiff, nonplastic, gray, moist	pH = 5.6 EC = 790uS (microseimens)
15.0	MC	5-11-15		SM		SAND (SM), silty, with clay, medium dense, nonplastic, gray, moist	pH = 6.6 EC = 870uS
				CL		NATIVE GROUND: CLAY (CL), silty, with gravel and sand, very stiff, medium plastic, red, moist - wood in shoe	NATIVE GROUND: pH = 6.6 EC = 105uS
17.5	MC	6-17-50/6"		SC		SAND (SC), clayey, with gravel, very dense, medium plastic, red, moist - completely weathered bedrock	pH = 6.6 EC = 120uS
20.0	MC	50/5"		GP		GRAVEL (GP), with sand and silt, very dense, red, moist Borehole terminated at approximately 20.5ft depth on bedrock with neutral pH and low conductivity No free water observed in borehole Borehole abandoned with 20% solids bentonite grout poured from surface	pH = 6.5 EC = 55uS

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

FIELD SOIL EXPLORATION LOG

NewFields

BOREHOLE ID: BH-06

Page 1 of 1

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/6/2017
END DATE: 1/6/2017

NORTHING: 171591.49
EASTING: 1070273.94
GROUND ELEV.: 5041.04
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	8-14-41		CL		COVER MATERIAL: CLAY (CL), gravelly, some sand, hard (gravel impacted SPT), medium plastic, reddish brown, moist	Cover material 0 - 6.5ft depth Still augering cover material at 5ft depth, continued to advance borehole to 10ft depth
				GC		WASTE ROCK: GRAVEL (GC), clayey - as observed in drill cuttings	Waste rock from 6.5 to TD
10.0	MC	5-5-4				GRAVEL (GC), clayey, with sand, loose, medium plastic, tan, moist	pH = 5.4 EC = 1590uS (microseimens)
20.0	MC	6-6-10				Tan and orange	pH = 5.6 EC = 2040uS
21.9	MC	25-26-26				Very dense	pH = 5.6 EC = 555uS Auger refusal at 21.9ft depth before SPT - unable to advance augers after SPT
						Borehole terminated at 23.4ft depth in waste rock due to auger refusal No free water observed in borehole Borehole abandoned with 20% solids bentonite grout poured from surface	

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-07

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/4/2017
END DATE: 1/4/2017

NORTHING: 170517.23
EASTING: 1070668.61
GROUND ELEV.: 5182.42
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0						COVER MATERIAL:	Cover material 0 - 2.6ft depth
1.0	MC	9-25-24		CL		CLAY (CL), sandy, with gravel, rootlets, gravel is angular, max. particle size 0.15ft, very stiff (gravel impacted SPT), medium plastic, dark brown, moist	
				ML		TAILINGS:	Tailings 2.6 - 31.1ft depth
5.0	MC	3-3-3				SILT (ML), sandy, with clay lenses, medium stiff, nonplastic (clays are medium plastic), light gray, moist	EC = 1140uS (microseimens) Soil pH meter not available
10.0	SS	1-1-1		CH		CLAY (CH), trace silt, very soft, high plastic, dark gray, moist	EC = 630uS
15							
20.0	MC	1-2-2		CL		Soft, medium plastic	EC = 285uS
21.5	ST						
25							
30.0	MC	4-11-15					Native ground penetrated in sampler at 31.1ft depth
				SM		NATIVE GROUND: SAND (SM), silty, with clay and gravel, fine to coarse grained, poorly graded, dense, nonplastic to low plastic, dark reddish brown, moist	EC = 85uS
32.5	MC	18-50/5"		SC		SAND (SC), clayey, trace fine gravel, dense, low plastic, red, moist - completely weathered bedrock	EC = 225uS
35.0	MC	18-36-50/4"					EC = 285uS

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-07

PROJECT: Hermosa Underground Project	NORTHING: 170517.23	START DATE: 1/4/2017
PROJECT No.: 475.0014.008	EASTING: 1070668.61	END DATE: 1/4/2017
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5182.42	LOGGED BY: J. Roberts
DRILLING METHOD: 4 1/4" HSA	DATUM: NAD83 AZ State Plane Central US feet	BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger	EQUIPMENT: CME 850	Page 2 of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
40 — 40.0	MC	50/4"				Becomes highly weathered, very hard rock fragments, olive-brown, moist Borehole terminated at 40.3ft depth due to encountering bedrock Free water weeping into borehole after TD achieved, no water level probe to measure available Borehole abandoned with 20% solids bentonite grout	EC = 295uS
45							
50							
55							
60							
65							
70							
75							

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-08

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/4/2017
END DATE: 1/5/2017

NORTHING: 170456.57
EASTING: 1070864.19
GROUND ELEV.: 5187.44
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)
	NA	NA
	NA	NA

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	MC	3-4-6		CL		COVER MATERIAL: CLAY (CL), sandy, some gravel, rootlets, medium stiff, medium plastic, dark reddish brown, moist	Cover material 0 - 2.1ft depth
				ML		TAILINGS:	Tailings 2.1 - 48ft depth
5.0	MC	6-8-8				SILT (ML), sandy, trace clay, stiff, nonplastic, tan to light gray, moist	EC = 740uS (microseimens)
15.0	MC	3-5-10				Clay lenses and trace gravel	pH = 6.5 EC = 1110uS
25.0	MC	3-4-6				With fine sand, medium stiff	pH = 5.3 EC = 860uS
35.0	MC	2-3-3				Clay lenses	pH = 5.0 EC = 475uS

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-08

PROJECT: Hermosa Underground Project	NORTHING: 170456.57	START DATE: 1/4/2017
PROJECT No.: 475.0014.008	EASTING: 1070864.19	END DATE: 1/5/2017
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5187.44	LOGGED BY: J. Roberts
DRILLING METHOD: 4 1/4" HSA	DATUM: NAD83 AZ State Plane Central US feet	BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger	EQUIPMENT: CME 850	Page 2 of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
45.0	ST MC	3-4-5				Clayey	Shelby tube pushed through SPT interval - upper 1.5ft of sample not suitable for testing pH = 6.0 EC = 70uS
				GM/ GC		NATIVE GROUND: Rock fragment in bottom of Shelby tube - native ground estimated at 48ft depth	
50.0	MC	50/5"				GRAVEL (GM/GC), silty/clayey, some sand, fine to coarse grained, poorly graded, angular, very dense, low plastic, oxidized, olive and tan, moist - completely weathered bedrock	pH = 6.7 EC = 280uS
52.5	MC	39-50/3"		GP		GRAVEL (GP), some clay and sand, very dense, nonplastic, tan and brown, moist	pH = 6.7 EC = 100uS
55.0	MC	31-48-50/3"					pH = 6.5 EC = 210uS
						Borehole terminated at 56.5ft depth in weathered bedrock with neutral pH No free water observed in borehole Borehole abandoned with 20% solids bentonite grout	

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 25.5	Borehole ID: BH-09	
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Truck Shop/Tailings Thickener	
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts	
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA	
Drill Operator: Roger	Easting: 1071812.79	Circulation Loss: NA	
Date Started: 1/16/2017	Northing: 170488.65	Datum: NAD83 State Plane Arizona Central US feet	
Date Completed: 1/17/2017	Elevation: 5125.87	Page: 1	of 1

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
0							Fill - silty sand with gravel - est. 2.5ft thick			Drilled in road Weathered andesite outcropping at road cut into hillside HWT casing advanced to 4. 2ft depth
5	1	4	33%	0%	HW	R2	Andesite, highly weathered, limonite and Mn oxide staining, intensely fractured - rubble, light gray and brown			Coring method HQ3 with drilling mud
	2	1.8	72%	0%	HW	R2	Rubble, some clays on fracture faces			Core barrel plugged off during drilling
10	3	3.2	69%	0%	HW	R2	Rubble, some clays on fracture faces, dominant measurable joint sets observed at 70, 60, 40, 10deg and subvertical			
15	4	5	96%	0%	MW	R3	Moderately weathered, intensely fractured throughout, some hematitie alteration observed at 60deg, dominant joint sets observed at 50, 40, 60 and 75deg with Mn oxide on faces			
	5	0.9	144%	0%	MW	R3	Highly fractured with dominating measurable joints at 30 and 40deg with oxide on faces			Advanced HWT casing to 12.4ft depth to mitigate core plugging off in core barrel
20	6	3.1	85%	0%	F	R4	Fresh, highly fractured, some hematite alteration 18.9 to 19.2ft depth, fractures: 19.0ft at 30deg with no infill, 19.1ft at 30 and 70deg with oxide, 19.8ft at 30 and 60deg with oxide, 20.1ft at subvertical and 30deg with no infill, 20.5ft at 40deg with oxide, and 20.7 and 20.8ft at 30deg with no infill			Core Run #6 was from 17 to 21ft depth in rubble-overdrilled material within the casing
	7	1	30%	47%	F	R4	Highly fractured with measurable joint sets at 30 and 40deg with hematite alteration on faces, trace clays at 21.6ft			
25	8	3.5	71%	0%	SW	R4	Slightly weathered, highly fractured with dominant joint sets at 70, 40, 60, 50 and 30deg, hematite alteration in upper 0.8ft and lower 0.8ft of recovered core			
							Borehole terminated at 25.5ft depth in fresh to slightly weathered, highly fractured andesite Borehole abandoned with neat cement grout			

FIELD SOIL EXPLORATION LOG

NewFields

BOREHOLE ID: BH-10

PROJECT: Hermosa Underground Project	NORTHING: 170596.56		
PROJECT No.: 475.0014.008	EASTING: 1072228.21		
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 5146.81		
LOGGED BY: J. Roberts	DATUM: NAD83 AZ State Plane Central US feet		
START DATE: 1/14/2017	EQUIPMENT: CME 850	BACKFILLED: 20% Solids Bentonite Grout	
END DATE: 1/14/2017	DRILLING METHOD: 4 1/4" HSA	OPERATOR: Roger	

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0				FILL		FILL: GRAVEL (GP), with sand, silt, and trace clay, nonplastic, brown, moist	
4.5	SS	7-41-37					
				ML		SILT (ML), sandy, with gravel, nonplastic, brown, damp	Description from auger cuttings (fill? - exploration drill pad construction)
9.5	SS	15-50/5"					Recovered a single gravel fragment
				ROCK		Bedrock encountered during augering	
						Auger refusal at 12.4ft depth - switch drill method to HQ3 core	Log continues on core log (next page)

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 40.0	Borehole ID: BH-10
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Floatation Cells
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1072228.21	Circulation Loss: NA
Date Started: 1/14/2017	Northing: 170596.56	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/16/2017	Elevation: 5146.81	Page: 1 of 1

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
							...continued from soil borehole log Weathered andesite encountered at 11ft depth with augers, refusal at 12.4ft depth			
15	1	4.6	76%	14%	MW	R2	Andesite, slightly weathered, hardness of R3, phaneritic, plagioclase, hornblende, anhedral to subhedral, fine grained, light gray and light brown At 13.7ft depth becomes moderately weathered and intensely fractured with dominant joint sets at 75, 60, 50 and 30deg with Mn oxide on faces			Coring method HQ3 with drilling mud
20	2	5	80%	0%	SW	R3	Slightly weathered, moderately fractured, intensely fractured from 18ft depth, measurable joint sets at 70, 60 and 50deg with oxide on faces, rubble zones (most likely zones of loss) 18.7 to 20.4ft and 21.4 to 21.6ft depth			
25	3	5	100%	21%	SW	R3	Slightly weathered, moderately fractured from 22.7 to 25.3ft depth, measurable joints at 60 and 40deg with oxide on fracture faces, rubble zone 25.5 to 26.3ft depth with hardness of R2			
30	4	3.2	100%	0%	SW	R3	Slightly weathered, intensely fractured with Mn oxide on faces throughout, some epidote alteration observed, rubble zones 27.5 to 28.3ft and 29.1 to 30.0ft depth			
	5	1.9	116%	0%	SW	R3	Intensely fractured with Mn oxide on faces, dominant measurable joint sets at 30, 50 and 60deg, some subvertical fractures observed			
35	6	5	100%	21%	SW	R5	Slightly weathered, hard, highly fractured throughout with oxide on faces, dominant measurable joints at 60 and 40deg, some epidote alteration observed			
40	7	2.9	97%	0%	SW	R5	Highly fractured with dominant measurable joint sets at 60, 40 and 30deg			
							Borehole termianted at 40.0ft depth in slightly weathered, hard, highly fractured andesite Borehole abandoned with neat cement grout			

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 37.8	Borehole ID: BH-11
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Floatation Cells
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1072311.63	Circulation Loss: NA
Date Started: 1/16/2017	Northing: 170715.49	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/16/2017	Elevation: 5127.26	Page: 1 of 2

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
0 5							GRAVEL (GM), sandy, with silt and clay			HWT casing advanced to 9. 0ft depth
10	1	4.7	77%	0%	MW	R3	Andesite, phaneritic, plagioclase and hornblende, moderately weathered, intensely fractured from 11.3ft, rubble above 11.3ft, fractures at 80, 60, and 40deg with Mn oxide on all faces, hematite alteration throughout.			Coring method HQ3 with drilling mud
15	2	5	74%	0%	HW	R2	Highly weathered, highly altered rubble with Mn oxide on all faces, Truncates on 60deg fractures with heavy Mn oxide on faces, hardness R0 at 16.5ft depth			
20	3	5	84%	0%	MW	R3	Moderately weathered rubble to 20.9ft depth (presume loss in this zone) From 20.9ft slightly weathered, hardness R3, highly fractured with some healed subvertical joints, fractures at 21.4ft at 40 and 50deg with Mn oxide on faces, fracture zone 21.8 to 22.3ft depth with measurable joints at 40, 50 and 60deg, intensely fractured from 22.7ft to 23.1ft detph with some oxide on faces			Loss of 30-50% circulation at 20.9ft depth
25	4	3.6	100%	0%	SW	R4	Slightly weathered, highly fractured with measurable joints at 40 and 70deg, fracture zone 23.7 to 24.0ft detpth with epidote alteration Intensely fractured from 24.8 to 27.0ft depth with Mn oxide and some epidote alteration - dominant measurable joints at 60 and 30deg			
	5	1.4	100%	0%	MW	R4	Moderately weathered, intensely fractured throughout with measurable joints at 60 and 40deg			
30	6	4.7	100%	28%	SW	R4	Slightly weatehred, intensely fractured to joint at 28.8ft depth at 70deg Moderately fractured from 28.8ft depth, fractures: 29.1ft at 40deg with epidote, fracture zone 29.6 to 29.9ft at 60 and 40deg with Mn oxide, 30.1ft at 50deg with no infill, 30.6ft at 50deg with Mn oxide, 31.0ft at 50deg with calcite, intensely fractured 31.1 to 31.5ft with oxide, 31.8ft at 50deg with no infill, 32.3ft at 50deg with epidote, 32.4ft at 50deg with no infill, 32.6ft at 50deg with Mn oxide, and 33.0ft at 70deg with no infill, intensely fracture at 33.1ft (base of run) with Mn oxide			
							Fresh, hairline thick veins throughout, intensely fractured to 34.4ft depth,			

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project | Total Depth (ft): 37.8 | Borehole ID: BH-11

Project No.: 475.0014.008 | Easting: 1072311.63 | Northing: 170715.49

Ground Water Depth (ft): NA | Elevation: 5127.26 | Page: 2 of 2

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
35	7	4.7	94%	38%	F	R4	fractures at 34.5 and 34.6ft at subvertical, 50 and 60deg with Mn oxide, 35.2ft at 50 and 60deg with qtz and Mn oxide, highly fractured from 36.4 to 37. 3ft with measurable joints at 50 and 30deg with no infill, intensely fractured 37.3 to 37.8ft depth with some calcite			
							Borehole terminated at 37.8ft depth in fresh andesite Borehole abandoned with neat cement grout.			

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 28.5	Borehole ID: BH-12
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Ore Stockpile
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1072440.26	Circulation Loss: NA
Date Started: 1/11/2017	Northing: 171414.06	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/14/2017	Elevation: 5149.59	Page: 1 of 1

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
0							GRAVEL (GP), with silt and sand, remnant from drill pad construction			Approximatley 1ft of soil at the surface removed for drill pad construction, borehole approximately 5ft below natural grade
5	1	5	54%	9%	MW	R3	Andesite, porphyritic, fine grained, plagioclase phenocrysts, subhedral, red ground mass, hematite alteration, highly to completely weathered, rubble (weathered clays and sands washed/blown away) to 3.5ft, light gray and red At 3.1ft becomes moderately weathered, hardness R3, moderately fractured, with fractures at3.3ft at 20 and 60deg with fine sand and oxide infill, 3.4ft at 30deg with fine sand and oxide, 3.9ft at 30deg with oxide, 4.0ft at 30 with oxide, 4.45 and 4.48 at 30deg with oxide			Presume loss at top of run Coring method of HQ3 with compressed air and a small amount of water injection There are 2 joint sets in the run at 30deg approximately orthogonal
	2	0.2	300%	0%	MW	R3	Recover 0.4ft of overdrilled material from Run #1, measurable joints at 20 and 30deg with oxide			
	3	4.3	102%	9%	SW	R5	Slightly weathered, highly fractured with dominant joints at 30 and 60deg, intensely fractured zone from 8.6 to 9.5ft with clayey sand infill, oxide staining on fracture faces throughout run			
10	4	3.9	100%	0%	SW	R4	Slightly weathered, intensely fractured throughout, dominant measureable joints sets at 20, 30 and 60deg with some oxide on fracture faces, subertical fracture 10.8 to 12.0ft depth			
	5	0.7	100%	50%	SW	R4	Fracture at 12.8ft at 70deg, highly weathered with clayey sand infill, intensely fractured 12.7 to 13.0ft depth with silty infill below this zone			
							Slightly weathered, moderately fractured, hairline veins at subvertical to 60deg			
15	6	0.9	78%	0%	SW	R4	Slightly weathered, moderately to intensely fractured			Change to coring method HQ3 with drilling mud
	7	2.0	100%	42%	F	R4	Fresh, moderately fractured to 16.0ft depth with fractures at 70, 10 and 20deg with no infill Hairline vein at 60deg cross cut by vein at 30deg, intensely fractured zone 16.9 to 17.3ft depth with some clay infill, fractures at 17.4ft at 30 and 60deg with oxide on faces			
20	8	5	84%	27%	F	R4	Fresh, slighly fractured Fracture at 17.9ft at 60deg with no infill, fracture zone 18.6 to 21.3ft with trace clays and hematite alteration, intensely fractured 22.0 to 22.5ft with oxide on faces			Presume zone of loss in fracture zone 18.6 to 21. 3ft depth
25	9	5	100%	90%	F	R4	Fresh, slightly fractured, hailine veins throughout, fractures at 23.3ft at 20deg with no infill, 24.1ft at 20deg with no infill, vesicle at 24.2ft partially infilled with calcite, 26.3ft at 10deg with trace clay infill, and 27. 2 at 10deg with trace clay infill			Hard wall contact on fractures at 26.3 and 27. 2ft depth
	10	1	90%	0%	F	R4	Fresh, moderately fractured, measureable joint at 40deg			Equipment locked up in hole - took some time to free
							Borehole terminated at 28.5ft depth in fresh, fractured andesite to prevent losing tooling down-hole Borehole abandoned with neat cement grout			

FIELD SOIL EXPLORATION LOG

NewFields

BOREHOLE ID: BH-13

Page 1 of 1

PROJECT: Hermosa Underground Project	NORTHING: 170798.07
PROJECT No.: 475.0014.008	EASTING: 1072078.3
LOCATION: Santa Cruz County, Arizona	GROUND ELEV.: 4973.88
LOGGED BY: J. Roberts	DATUM: NAD83 AZ State Plane Central US feet
START DATE: 1/8/2017	EQUIPMENT: CME 850
END DATE: 1/9/2017	DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)

BACKFILLED: 20% Solids Bentonite Grout

OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0				SC			
1.0	SS	3-2-3				SAND (SC), clayey, with gravel, angular gravel, loose, low plastic, reddish brown, moist	
3.5	MC	5-6-13				Medium dense	No recovery
6.0	SS	23-50/3"		SP-SM		SAND (SP-SM), with silt and gravel, very dense, medium plastic, reddish brown, moist - completely weathered bedrock	
8.5	MC	50/4"					
10						Auger refusal at 10.0ft depth - switch drill method to HQ3 core	Log continues on core log (next page)

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 42.3	Borehole ID: BH-13
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Proposed embankment
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1070692.81	Circulation Loss: NA
Date Started: 1/8/2017	Northing: 172088.43	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/10/2017	Elevation: 4973.88	Page: 1 of 1

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
							...continued from soil borehole log			
10–15	1	5	24%	0%	HW	R2	Andesite, heavy hematite alteration, highly weathered, rubble, measurable fracture at 60deg with Mn oxide			HQ3 coring with compressed air
	2	2.7	26%	0%	HW	R2	Rubble			
20	3	5	16%	0%	MW	R3	Moderately weathered, intensely fractured, dominant measureable fractures at 60deg			
25	4	5	30%	0%	CW	R0	Completely weathered, hardness of R2 for upper 0.3ft of recovered core and R0 for remaining core, friable, rubble with silt, sand and clay infill			
30	5	5	60%	0%	HW	R2	Highly weathered, hardness R2, intensely fractured 30.3 to 30.7 with measurable joint at 60deg and clay infill, rubble zone with clayey 31.6 to 32.2ft, intensely fractured "intact" rock 32.2ft to 33.0ft			Lower fracture zone turned into rubble during transfer from split barrel to the core box
35	6	4.3	16%	0%	HW	R2	Highly weathered rubble, no measurable features			
40	7	5	0%	0%	HW	R2	NO RECOVERY - presumed highly weathered			
							Borehole terminated at 42.3ft depth in highly weathered andesite Borehole abandoned with neat cement grout			

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 16.7	Borehole ID: BH-14
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Under drainage pond
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1070596.40	Circulation Loss: NA
Date Started: 1/7/2017	Northing: 172850.27	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/7/2017	Elevation: 4929.69	Page: 1 of 1

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
0							GRAVEL (GC), clayey, some silt and sand, medium plastic, fine to coarse grained gravel, angular, reddish brown, moist			Auger refusal at 1.7ft, switch to HQ3 coring methods with compressed air
5	1	5	18%	1%	MW	R3	Andesite, plagioclase, porphyritic, fine grained, moderately weathered, fracture at 60deg with Mn oxide			Core fell from inner barrel during barrel removal - only able to retrieve 0. 4ft of rubble and 0.5ft of whole core
10	2	5	36%	0%	MW	R3	Intensely fractured with hematite and limonite alteration and limonite staining on faces, dominant joint sets at 60 and 40deg Presuming loss at top of run, at 10.6ft becomes slightly weathered, hardness R4, gray, intensely fractured with limonite and hematite staining on faces			
15	3	5	38%	0%	SW	R4	Slightly weathered, rubble with 0.5ft of recognizable intensely fractured core, bottom 1.2ft of recovered core has limonite staining on fracture faces			
							Borehole terminated at 16.7ft depth in intensely fractured andesite Groundwater not observed Borehole abandoned with neat cement grout			

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 41.3	Borehole ID: BH-15
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Crusher
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1070670.55	Circulation Loss: NA
Date Started: 1/17/2017	Northing: 169790.25	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/18/2017	Elevation: 5267.44	Page: 1 of 2

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
0 5 10							Highly weathered andesite bedrock			Attemp to advance augers - experienced refusal at 3ft depth, advanced HWT casing to 14.0ft depth Proposed founding elevation was passed with the casing due to very easy drilling Coring with drilling mud
15	1	5	72%	0%	MW	R3	Andesite, plagioclase, hornblende, trace magnetite, moderately weathered, rubble, intensely fractured with dominant measurable joints at 60, 70, 30deg and subvertical in the upper 2.6ft and lower 0.3ft of recovered core,			
20	2	5	68%	8%	SW	R4	Intensely fractured with measurable joints at 30 and 60deg with Mn oxide			
25	3	4.7	87%	28%	SW	R4	Slightly weathered, moderately fractured to 24.1ft, highly fractured to 25.1ft, intensely fractured to 26.8ft Fractures at 23.7ft at 20deg with oxide, 24.2ft at 30deg with oxide, 24.3ft at 60deg with oxide, 24.4ft at 40deg with oxide, 24.6 and 24.7ft at subhorizontal with oxide and silt infill, 24.8ft at 50deg and subvertical to 25.6ft, 25.2ft at 40deg with oxide, 25.3ft at 50deg with oxide, rubble 26.1 to 26.6ft			
	4	1	70%	0%	MW	R3	Rubble with oxides on fragments			Drill return fluid during drilling was dark gray/black, which is atypical return on the project in the andesite formation
30	5	3.5	26%	7%	SW	R4	Slightly weathered, moderately fractured, rubble with clays at bottom of recovered core			Partial borheole collapse after Run #4 - Run #5 was advanced through 1.5ft of caved material from 26.3 to 31.3ft depth - % Recovery and RQD values presented reflect the length drilled which includes overdrilled material
							Highly weathered, average hardness R1, 0.4ft of rubble, 32.7 to 33.3ft fractures at 30deg with some clays and heavy limonite staining, 33.3 to 34.3ft moderately weathered and highly fractured with Mn oxide on faces, 34.3 to 35.6ft is highly weathered, hardness R2, intensely fractured and rubblized with clay infill,			

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project | Total Depth (ft): 41.3 | Borehole ID: BH-15
Project No.: 475.0014.008 | Easting: 1070670.55 | Northing: 169790.25
Ground Water Depth (ft): NA | Elevation: 5267.44 | Page: 2 of 2

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
35	6	5	78%	8%	HW	R1	fracture at 36.4ft at 40deg with oxide			
40	7	5	102%	74%	SW	R4	Slightly weathered, hardness R4, moderately fractured, occasional veins at 60, 40 and 70deg up to 0.01ft thick, fractures at 37.2ft at 40deg with oxide, 37.9ft at 60deg with oxide, 38.2ft at subhorizontal with oxide, 38.6ft at 40deg with oxide, 37.8ft at 50deg with oxide, 39.1ft at 30deg with oxide, 39.6ft at 40deg with oxide, 39.9ft at 40deg with oxide, and 40.3ft at 50deg with oxide and calcite			
							Borehole termianted at 41.3ft depth in competent andesite Borehole abandoned with neat cement grout			

FIELD SOIL EXPLORATION LOG

NewFields

BOREHOLE ID: BH-16

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/18/2017
END DATE: 1/18/2017

NORTHING: 170170.13
EASTING: 1072440.26
GROUND ELEV.: 5052.50
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850
DRILLING METHOD: 4 1/4" HSA

GROUNDWATER LEVEL		
DATE	DEPTH (ft)	ELEV. (ft)

BACKFILLED: 20% Solids Bentonite Grout
OPERATOR: Roger

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
0	SS	10-13-18		SC		SAND (SC), clayey, with gravel, dense, medium plastic, brown, moist	
3.5	MC	6-24-23				Hard	
6.0	SS	5-20-25				With gravel, low plastic	
8.0	MC	42-50/3"		GC		GRAVEL (GC), clayey, with sand, some silt very dense, low plastic, brown and gray, moist Auger refusal at 8.4ft depth - switch drill method to HQ3 core	Log continues on core log (next page)

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35

FIELD CORE LOG

NewFields

Project: Hermosa Uunderground Project	Total Depth (ft): 18.4	Borehole ID: BH-16
Project No.: 475.0014.008	Core Size: HQ3	Borehole Location: Administration
Drilling Contractor: Yellow Jacket Drilling	Azimuth: NA	Logged By: J. Roberts
Drilling Equipment: CME 850	Inclination: -90	Ground Water Depth (ft): NA
Drill Operator: Roger	Easting: 1070248.54	Circulation Loss: NA
Date Started: 1/18/2017	Northing: 170013.21	Datum: NAD83 State Plane Arizona Central US feet
Date Completed: 1/18/2017	Elevation: 5267.44	Page: 1 of 1

Depth (ft)	Run No.	Run Length (ft)	REC (%)	RQD (%)	Weathering	Hardness	Material Description	Graphic Log	Water Table	Remarks
							...continued from soil borehole log			
10	1	5	18%	NA	NA	NA	Gravel with clay and silt and sand, maximum particle size 0.25ft			Run #1 in drainage channel buried with fill for drill pad construction and/or possibly colluvium (pre existing conditions unknown)
15	2	5	18%	0%	CW	R1	Andesite, completely weathered hematite alteration, highly fractured with measurable joints at 60 and 40deg			
							Borehole terminated at 18.4ft depth in completly weathered andesite. Borehole abandoned with neat cement grout.			

NewFields

Pit ID: TP-01

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	170548.03 N 1071847.74 E	Elevation:	5114.72	Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Moderately sloping East, edge of road	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
		 		Sited on outcrop, moved up hill towards road for access and better depth
2.5	LD-1 @ 3-4ft		GRAVEL (GW), trace sand, coarse, angular, MPS=8.0in, brown, moist, weathered bedrock	
5.0				Hard digging at 5-6ft
		6.0	TD = 6.0ft, refusal on competent bedrock. Water table not encountered at time of excavation.	TD measure perpendicular to slope
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

10'

095° ← 5'

NewFields

Pit ID: TP-02

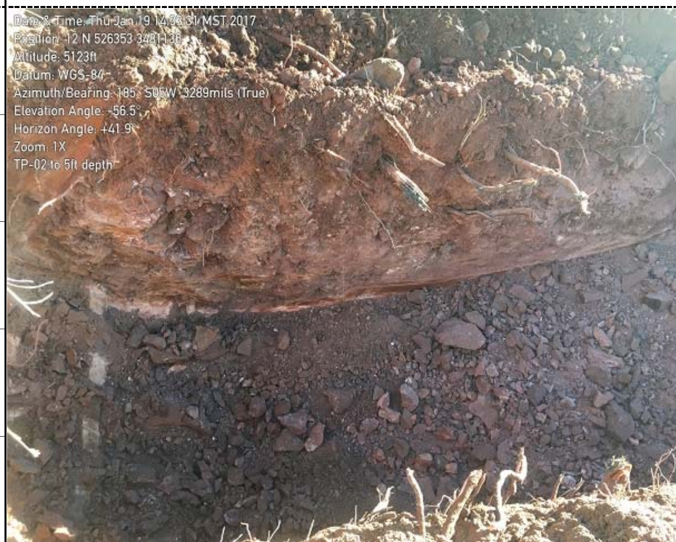
Project: Hermosa Underground
Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona
Date: 1/19/2017

Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: J. Roberts

Coordinates: 171042.32N 1072285.55E
Elevation: 5108.80
Total Pit Depth: 5.0ft

Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Gently sloping east
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD-1 @ 2-3ft		SAND (SC), with gravel and fines, medium plastic, reddish brown, moist	
4.0			GRAVEL (GP), with sand, fine to coarse, angular, hard, brown moist, Andesite bedrock	Very hard at 4.0ft
5.0			TD = 5.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- ρ In-situ density test
- ω Water content
- ▼ Water table encountered

Plan View of Pit:

070° ← [8' × 5']

NewFields

Pit ID: TP-06

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/19/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: J. Roberts

Coordinates: 170244.73N 1072068.89E

Elevation: 5094.13

Total Pit Depth: 10.5ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Edge of road

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD-1 @ 1-3ft	4.0	CLAY (CH), sandy, some silt, medium to high plastic, brown, moist Red, orange, and light gray	Test pit placed in road Clay thickens to the North Residual soil
5.0 / 7.5 / 10.0	SD-1 @ 7-8ft	10.5	GRAVEL (GP), sandy with some silt, coarse, angular, MPS=6.0in, reddish gray, moist, Andesite bedrock	Hard digging at 9.0ft
12.5 / 15.0 / 17.5 / 20.0			TD = 10.5ft, refusal on competent bedrock Water table not encountered at time of excavation.	

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12'

150° ←

6'

NewFields

Pit ID: TP-07

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/19/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: J. Roberts

Coordinates: 170464.69N 1071455.51E

Elevation: 5176.05

Total Pit Depth: 15.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Gentle slope to the East, top of ridge sub rounded float on surface

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	SD-1 @ 0-1.5ft	1.5	SAND (SM), silty, some gravel, coarse, sub rounded to angular, nonplastic, brown, moist	
2.5				
5.0				
7.5	LD-1 @ 7-8ft		GRAVEL (GP), with sand, trace silt, coarse, angular, MPS= 6.0in, nonplastic, reddish gray, moist, Andesite bedrock	
10.0				
12.5				
15.0		15.0	TD = 15.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

View 020°

12'

6'

NewFields

Pit ID: TP-08

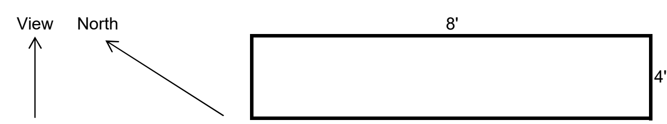
Project: Hermosa Underground		Project No.: 475.0014.008	
Project Location: Sant Cruz County, Arizona		Date: 1/19/2017	
Equipment: Deere 350D	Contractor: DM Engineering & Excavating	Logged by: N. Owens	
Coordinates: 169431.35N 1074468.04E	Elevation: 5120.56	Total Pit Depth: 4.0ft	
Datum: NAD 83 Arizona Central State Plane US feet	Surface Conditions: In road sloping to the South	Backfilled: Yes	

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
(+)11.5				Moved test pit to road, rig was drilling in proposed test pit location
(+)10			SAND (SM), silty with gravel, MPS=2.0in, brown, moist	
(+)7.5				
(+)5		(+) 5.0		
(+)2.5				Exposed Cut
0.0		0.0	SAND (SC), clayey, with gravel and fines, angular, MPS=6.0in, medium plastic, brown, moist - weathered bedrock	0.0ft - Ground Surface
	SD-1 @ 0-1ft			Test Pit
2.5	LD-1 @ 3-4ft			More competent at 3.0ft
		(-) 4.0	TD = 4.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
5.0				
7.5				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-09

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/19/2017

Equipment: Deere 350D

Contractor: DM Engineering & Excavating

Logged by: N. Owens

Coordinates: 169911.00N 1073338.16E

Elevation: 5189.56

Total Pit Depth: 8.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Top of mountain, old drill pad

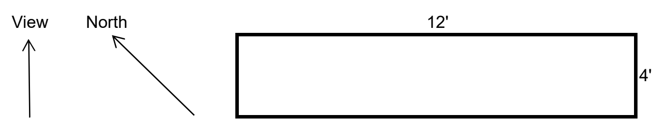
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	SD-1 @ 1-2ft		SAND (SC-SM), with gravel and fines, low plastic, red, moist	
2.5		3.0		Hard digging at 3.0ft
5.0	LD-1 @ 6-8ft		GRAVEL (GP), trace silt and sand, angular, MPS=12.0in, weathered bedrock	More competent at 7.0ft
7.5		8.0	TD = 8.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-11

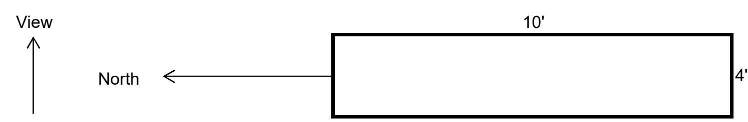
Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Sant Cruz County, Arizona
Date: 1/19/2017
Equipment: Deere 350D
Contractor: DM Engineering & Excavating
Logged by: N. Owens
Coordinates: 170042.18N 1073717.82E
Elevation: 5044.47
Total Pit Depth: 13.0ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Lay down yard by cut bank, 20ft tall cut measured from the bottom
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	SD-1 @ 3-4ft		SAND (SP), with gravel and fines, fine to medium grained, angular, MPS=12.0in, nonplastic, dark brown, moist	Easy digging
5.0		6.0		
7.5	LD-1 @ 8-9ft		GRAVEL (GP-GM), with silt and sand, fine grained sand, angular, MPS=6.0in, dark brown, moist, very weathered friable bedrock	
10.0	SD-2 @ 10-11ft	10.0	SAND (SC), clayey with gravel, fine to medium grained, angular, MPS= 3.0in, low to medium plastic, brown, moist	
12.5		13.0	TD = 13.0ft due to excavator limits Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-12

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171219.43N 1072550.65E	Elevation:	5106.08	Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat, existing drill pad	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			GRAVEL (GP), with sand, coarse, angular, MPS=6.0in, medium hard, brown, moist, weathered bedrock	
5.0				Increase hardness MPS=8.0in at 5.0ft
		6.0	TD = 6.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

12'

090° ← 6'

NewFields

Pit ID: TP-13

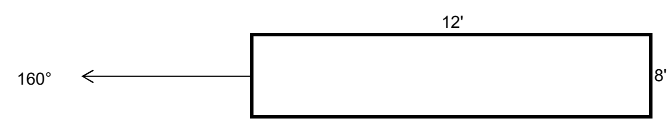
Project: Hermosa Underground		Project No.: 475.0014.008	
Project Location: Sant Cruz County, Arizona		Date: 1/19/2017	
Equipment: Deere 180G LC	Contractor: DM Engineering & Excavating	Logged by: J. Roberts	
Coordinates: 170798.07N 1072078.30E	Elevation: 5127.18	Total Pit Depth: 8.0ft	
Datum: NAD 83 Arizona Central State Plane US feet	Surface Conditions: Moderately sloped North	Backfilled: Yes	

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 1-3ft			Moved down slope for safety Pit sidewalls collapsing
2.5				
5.0			GRAVEL (GP), with sand, trace fines, coarse, angular, MPS=4.0in, nonplastic, brown, moist	Highly weathered bedrock at 5.0ft
7.5		8.0		
			TD = 8.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-14

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/20/2017

Equipment: Deere 350D

Contractor: DM Engineering & Excavating

Logged by: N. Owens

Coordinates: 169698.23N 1070264.30E

Elevation: 5189.54

Total Pit Depth: 8.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Side of road, top of mountain

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			1.5 GRAVEL (GM), silty with sand, fine to medium grained sand, angular, MPS=3.0in, dark brown, moist	Coring rig was blocking access to test pit location. Moved test pit up the road from core rig.
2.5	LD-1 @ 3-4ft			
5.0			GRAVEL (GP-GC), with sand and some fines, fine to coarse grained sand, angular, MPS=12.0in, brown, moist, friable bedrock	More competent at 6.5ft
7.5			8.0	
			TD = 8.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

View

North ←

12'

4'

NewFields

Pit ID: TP-15

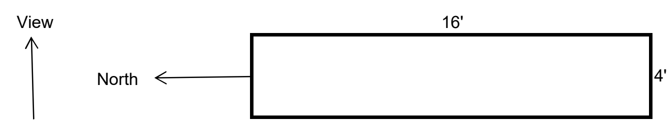
Project: Hermosa Underground | Project No.: 475.0014.008
Project Location: Sant Cruz County, Arizona | Date: 1/20/2017
Equipment: Deere 350D | Contractor: DM Engineering & Excavating | Logged by: N. Owens
Coordinates: 169790.25N 1070670.55E | Elevation: 5267.44 | Total Pit Depth: 11.0ft
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Uphill side of drill pad | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
				Rootlets in the upper 0.5ft
2.5		3.0	GRAVEL (GM), silty with sand, fine to coarse grained sand, angular, MPS=6.0in, reddish brown to brown, moist, weathered bedrock	
5.0	LD-1 @ 5-6ft			
7.5			GRAVEL (GP), sandy, with fines, fine to coarse grained sand, angular, MPS=12.0in, white, red, light brown, moist, bedrock	
10.0		11.0		More competent at 10.0ft
			TD = 11.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- ρ In-situ density test
- ω Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-16

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	170013.21N 1070248.54E	Elevation:	5268.52	Total Pit Depth:	8.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Uphill side of road, native ground, grass	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
		1.0	GRAVEL (GM), silty with sand, fine to medium grained sand, angular, MPS=1.5in, dark brown, moist	Rootlets in upper 1.0ft
2.5				
5.0	LD-1 @ 5-6ft		GRAVEL (GP), with some sand, fine to coarse grained sand, angular, MPS=8.0in, grayish brown, moist, bedrock	More competent at 6.0ft
7.5		8.0		
			TD = 8.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

View North

8'

4'

NewFields

Pit ID: TP-17

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	169726.86N 1069761.85E	Elevation:	5263.04	Total Pit Depth:	7.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	On bend in access road	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–1.0			GRAVEL (GM), silty with sand, fine to medium grained sand, angular, MPS=3.0in, dark brown, moist	Rootlets in upper 1.0ft
1.0–7.0	LD-1 @ 5-6ft		GRAVEL (GP-GM), sandy with fines, fine to coarse grained sand, angular, MPS=12.0in, light brown to red, moist	Hard digging at 5.0ft More competent at 6.5ft
7.0			TD = 7.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

View ↑ North ↖ — 11' × 4'

NewFields

Pit ID: TP-21

Project:	Hermosa Underground
Project Location:	Sant Cruz County, Arizona
Project No.:	475.0014.008
Date:	1/20/2017
Equipment:	Deere 350D
Contractor:	DM Engineering & Excavating
Logged by:	N. Owens
Coordinates:	170461.94N 1070133.19E
Elevation:	5230.00
Total Pit Depth:	9.0ft
Datum:	NAD 83 Arizona Central State Plane US feet
Surface Conditions:	Edge of lay down yard
Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.5			SILT (ML), with gravel and sand, rootlets, red, moist	Moved test pit to outer edge of lay down yard
2.5	LD-1 @ 4-5ft		GRAVEL (GM), with silt and sand, fine to medium grained sand, angular, MPS=5.0in, reddish brown, moist, weathered bedrock	
5.0			GRAVEL (GP), with some sand, fine to coarse graded sand, angular, MPS=8.0in, brown, moist, bedrock	More competent at 8.0ft
7.5				
9.0			TD = 9.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

View

North

10'

4'

NewFields

Pit ID: TP-22

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	170185.20N 1070404.66E	Elevation:	5222.82	Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Edge of road, sloping to the North, grass	Backfilled:	Yes

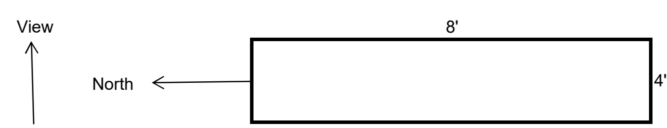
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.0	LD-1 @ 2-3ft		GRAVEL (GM), silty with clay, fine to medium grained sand, angular, MPS=6.0in, reddish brown, moist, weathered bedrock	Rootlets in upper 0.5ft
3.0–6.0			GRAVEL (GP), with some sand, fine to coarse grained sand, angular, MPS=12.0in, reddish gray, moist, bedrock	More competent at 5.0ft
6.0			TD = 6.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-24

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	170405.67N 1070766.81E	Elevation:	5185.94	Total Pit Depth:	12.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	flat - reclaimed	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5		2.3	**COVER MATERIAL:** SAND (SM), silty with gravel and clay, low plastic, moist, reddish brown	
5.0	LD-1 @ 4-7ft		**TAILINGS:**	
7.5		9.0	SILT (ML), sandy, nonplastic, gray, moist	7.0ft pH = 4.5 Conductivity = 955µs
10.0		12.0	**NATURAL GROUND:** GRAVEL (GP), sandy with silt, reddish brown, moist	10.0ft pH = 6.5 Conductivity = 320µs
12.5			TD = 12.0ft, terminated test pit in natural ground with neutral pH and lower conductivity Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12'

010° ←

5'

NewFields

Pit ID: TP-25

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	170660.35N 1070489.09E	Elevation:	5182.00	Total Pit Depth:	16.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat - reclaimed	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5		 	**COVER MATERIAL:** SAND (SC), clayey with gravel, reddish brown, moist	
		3.0	**TAILINGS:**	
5.0				
7.5	LD-1 @ 8-10ft		CLAY (CH), fat clay with silt lenses, gray, moist	9.0ft pH = 5.5 Conductivity = 3.35ms
10.0				
12.5		13.0	**NATURAL GROUND:** GRAVEL (GP), sandy with silt, reddish brown, moist	
15.0		16.0	TD = 16.0ft, terminated test pit in natural ground with neutral pH and lower conductivity Water table not encountered at time of excavation.	15.0ft pH = 6.3 Conductivity = 300µs
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12'

100° ← 5'

NewFields

Pit ID: TP-26

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/20/2017

Equipment: Deere 350D

Contractor: DM Engineering & Excavating

Logged by: N. Owens

Coordinates: 170718.48N 1070981.20E

Elevation: 5188.99

Total Pit Depth: 14.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Uphill side of road, sloping to the South

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
1.0			GRAVEL (GM), silty with sand, fine to medium grained sand, angular, MPS=6.0in, brown, moist	Rootlets in upper 1.0ft
2.5				
5.0				
7.5			GRAVEL (GP-GM), with sand and silt, fine to coarse grained sand, angular, MPS=12.0in, reddish brown, moist, friable bedrock	
10.0	LD-1 @ 10-12ft			
12.5				
14.0			TD = 14.0ft due to machine limits Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

View North

14'

5'

NewFields

Pit ID: TP-28

Project:	Hermosa Underground	Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona	Date:	1/20/2017

Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171558.67N 1070139.78E	Elevation:	5040.09	Total Pit Depth:	20.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat - reclaimed	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5		2.0	**COVER MATERIAL:** GRAVEL (GC), clayey with sand and silt, medium plastic, brown, moist	Buried wood with strong decaying odor
5.0	LD-1 @ 5-8ft	4.0	SAND (SC), clayey with gravel, low plastic, reddish brown, moist	Sidewalls collapsing
7.5 – 20.0		20.0	**WASTE ROCK:** GRAVEL (GC), clayey with silt and sand TD = 20.0ft due to machine limits Water table not encountered at time of excavation	

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12'

030° ← 8'

NewFields

Pit ID: TP-29

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/20/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: J. Roberts

Coordinates: 171650.11N 1070522.92E

Elevation: 5041.43

Total Pit Depth: 18.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Flat

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
				

Depth (ft)	Description	Additional Notes
0 – 1.0	**COVER MATERIAL:** SAND (SC), clayey with gravel, low plastic, reddish brown, moist	No pH or Conductivity measurements or environmental samples collected 2.9 - 3.6ft depth gray silty sand tailings stringers observed
1.0 – 10.0	**WASTE ROCK:** GRAVEL (GC), clayey, coarse, medium plastic, orange, tan, and light gray, moist	
10.0 – 16.5	GRAVEL (GP), sandy with silt, reddish brown, moist	
16.5 – 18.0	**NATURAL GROUND:** SAND (SC), clayey with gravel, medium plastic, reddish brown, moist	
18.0	TD = 18.0ft, terminated test pit in natural ground Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12' × 5'; 090°

NewFields

Pit ID: TP-30

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171233.35N 1071128.15E	Elevation:	5135.85	Total Pit Depth:	10.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0 – 1.0		1.0	GRAVEL (GM), silty with sand, non plastic, brown	Residual soil
1.0 – 10.0	LD-1 @ 3-5ft	10.0	GRAVEL (GP), trace silt and sand, coarse, angular, brown, weathered bedrock	Increase competency at 6.0ft
10.0			TD = 10.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12'

320° ← 5'

NewFields

Pit ID: TP-31

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171526.23N 1071031.00E	Elevation:	5085.63	Total Pit Depth:	10.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	On ridge sloping to the Northwest	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 0-1.5ft		GRAVEL (GM), silty with sand and clay, low to non plastic, brown, moist	
	LD-2 @ 2-4ft	1.5		
2.5				
5.0			SAND (SP), gravelly, trace fines, coarse, planar, angular, MPS=5.0in, light grayish brown, moist	
7.5				
10.0		10.0	TD = 10.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

12'

000° ←

5'

NewFields

Pit ID: TP-32

Project: Hermosa Underground
Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona
Date: 1/20/2017

Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: J. Roberts

Coordinates: 171897.83N 1071190.83E
Elevation: 5042.39
Total Pit Depth: 18.0ft

Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Gently sloping Southwest
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 1-3ft		SAND (SC), clayey with silt and gravel, low plastic, brown, moist	Becomes damp at 1.0ft
2.5		3.0		
5.0			CLAY (CL), sandy, with gravel, gravel is coarse and angular, MPS=10.0in, medium to high plastic, brown, damp, highly weathered bedrock	Hard to dig at 3.0ft
7.5				
10.0				
12.5	LD-2 @ 11.5-14ft			11.5 to 17.0ft clayey red hematite alteration in fracture zones
15.0				
17.5		18.0	TD = 18.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

340° ← [8' × 5']

NewFields

Pit ID: TP-33

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171247.24N 1071534.42E	Elevation:	5102.44	Total Pit Depth:	20.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 1-7ft		**COVER MATERIAL:**	Photo is mislabeled as TP-20, actually TP-33 Oxidized to 3.0ft Upper unoxidized tails hard to dig
0.7			SAND (SC), clayey with gravel and silt, low plastic, reddish brown, moist	
			TAILINGS:	
2.5			CLAY (CL), silty, with sand, fine grained sand interbedded	
5.0				
7.5				
10.0				
12.5			SAND (SM), silty, nonplastic, gray, damp	
15.0	LD-2 @ 15-20.5ft			
17.5				
20.0 / 20.5			TD = 20.5ft due to machine limits Water table not encountered at time of excavation.	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

12' × 5'; 030°

NewFields

Pit ID: TP-34

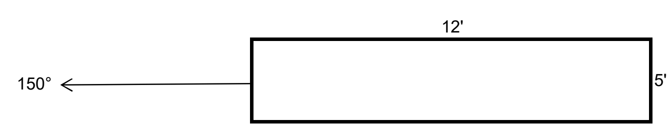
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	170936.99N 1071964.91E	Elevation:	5114.71	Total Pit Depth:	9.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat, tailings area	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			**COVER MATERIAL:** SAND (SC), clayey with gravel, low to medium plastic, reddish brown, moist (to 2.5)	
5.0	LD-1 @ 4-7ft		**TAILINGS:** SILT and FAT CLAY (ML/CH), interbedded (to 7.0)	Oxidized to 5.0ft Easy excavation
7.5				6.0ft pH = 5.6 Conductivity = 1280μs
10.0			**NATURAL GROUND:** GRAVEL (GP), with sand and clay, reddish brown, moist (to 9.5)	9.0ft pH = 6.5 Conductivity = 110μs
12.5			TD = 9.5ft, terminated test pit in natural ground Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-35

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171939.49N 1071797.34E	Elevation:	5166.58	Total Pit Depth:	5.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Sloping West	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
		1.0	GRAVEL (GP-GM), with silt and sand, brown, moist	
2.5			GRAVEL (GP), course, angular, brown, moist, bedrock	
5.0	SD-1 @ 5-5.5ft	5.5		
			TD = 5.5ft, refusal on competent bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

12'

250° ←

5'

NewFields

Pit ID: TP-38

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Sant Cruz County, Arizona
Date: 1/20/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: J. Roberts
Coordinates: 172614.40N 1070664.38E
Elevation: 4946.49
Total Pit Depth: 8.0ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Gently sloped North
Backfilled: Yes

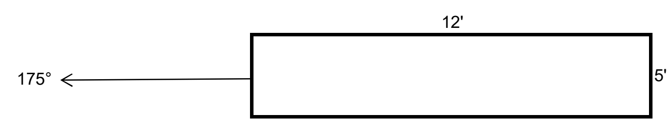
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 0-7ft		**FILL:**	Fill placed in drainage
			SAND (SM), silty with gravel and clay, nonplastic, brown, damp	Portion of incised channel at 4.0ft
				Capillary fringe at 6.5ft
		7.0	**NATURAL GROUND:**	Stream channel at 7.5ft
		8.0	GRAVEL (GP-GM), with silt and sand, nonplastic, brown, moist	
			TD = 8.0ft, refusal on competent bedrock Increased moisture content due to capillary fringe at 6.5ft during time of excavation	

Depth scale (ft): 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-39

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	173068.20N 1070497.83E	Elevation:	4909.98	Total Pit Depth:	9.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Bottom of drainage	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.6			**COVER MATERIAL:** GRAVEL (GC), clayey	
			FILL - POSSIBLE HISTORIC TAILINGS/WASTE ROCK:	
			SAND (SP-SM), with silt and gravel, nonplastic, brown, damp	White walled tire
6.0			Gravelly at base	
			NATURAL GROUND:	
8.0			SAND (SP), some silt and gravel, brown, moist	
9.0			GRAVEL (GP), light gray, highly oxidized, weathered, limonite staining, argillaceous, bedrock	
			TD = 9.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

12'

150° ← 5'

NewFields

Pit ID: TP-47A

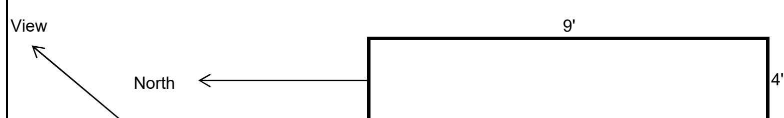
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	166939.41N 1075578.61E	Elevation:	5481.70	Total Pit Depth:	9.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Bottom of cut, old drill pad	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD-1 @ 3-4ft		SAND (SC), clayey, gravelly, fine to medium grained, angular, MPS=3.0in, low to medium plastic, brownish red, moist	
5.0	SD-1 @ 6-7ft	5.0	GRAVEL (GP), with sand, angular, MPS=12.0in, brown, moist, bedrock	Hard digging at 5.0ft
7.5				More competent at 8.0ft
10.0		9.0	TD = 9.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-48

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	167996.67N 1075615.74E	Elevation:	5491.93	Total Pit Depth:	2.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Side of road, on steep slope	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 0-1ft		GRAVEL (GP-GC), clayey with some sand, fine to medium grained sand, angular, MPS=6.0in, low to medium plastic, reddish brown, moist	Very hard digging at 1.0ft
1.0			GRAVEL (GP), with some sand, fine to coarse grained sand, angular, MPS=14.0in, reddish brown, moist, bedrock	
2.0			TD = 2.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

View ↑ North ↖

10' × 4'

NewFields

Pit ID: TP-49

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/19/2017

Equipment: Deere 350D

Contractor: DM Engineering & Excavating

Logged by: N. Owens

Coordinates: 168347.37N 1075553.73E

Elevation: 5462.39

Total Pit Depth: 2.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Gently sloping to the East, top of mountain

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	SD-1 @ 0-1ft		1.0	GRAVEL (GM), silty clayey with sand, fine to medium grained sand, angular, brown, moist	Very hard digging at 1.0ft
			2.0	GRAVEL (GP), with sand, fine to coarse grained sand, angular, MPS=12.0in, brown, moist, competent bedrock	
2.5				TD = 2.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
5.0					
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

View ↑ North ↑

8' × 4'

NewFields

Pit ID: TP-50A

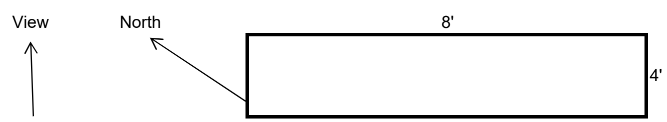
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	169277.44N 1075690.39E	Elevation:	5259.44	Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Flat area on ridge	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Depth	Description	Additional Notes
			1.0	GRAVEL (GP-GM), silty with sand, fine to medium grained sand, angular, MPS=4.0in, brown, moist	
2.5	SD-1 @ 2-3ft				Hard digging at 2.0ft
5.0	LD-1 @ 5-6ft		6.0	GRAVEL (GP-GM), with silt, some sand, angular, MPS=18.0in, nonplastic, light brown, moist, bedrock	
7.5				TD = 6.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-50B

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Sant Cruz County, Arizona
Date: 1/19/2017
Equipment: Deere 350D
Contractor: DM Engineering & Excavating
Logged by: N. Owens
Coordinates: 168923.75N 1075394.64E
Elevation: 5263.82
Total Pit Depth: 4.0ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Center of steep drainage
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	SD-1 @ 0-1ft LD-1 @ 1-2ft		2.0	GRAVEL (GC), clayey, with sand, angular, MPS=6.0in, low to medium plastic, brown, moist	Very hard at 2.0ft
2.5			4.0	GRAVEL (GP), angular, MPS=18.0in, very hard, white, tan, pink, moist, bedrock	
5.0				TD = 4.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- ρ In-situ density test
- ω Water content
- ▼ Water table encountered

Plan View of Pit:

View North 8' 4'

NewFields

Pit ID: TP-51

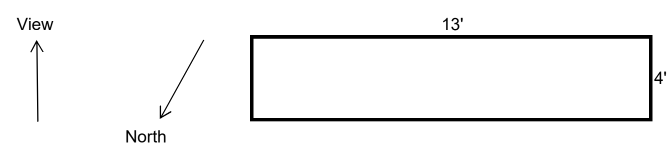
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/19/2017
Equipment:	Deere 350G	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	169180.47N 1075477.84E	Elevation:	5213.69	Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	At base of drainage	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	SD-1 @ 1-2ft		GRAVEL (GC), clayey, with sand, fine to medium grained sand, angular, MPS=3.0in, medium plastic, red moist	
5.0	LD-1 @ 5ft		GRAVEL (GM), silty with some sand, angular, MPS=18.0in, light brown to red, moist, bedrock (2.5–6.0)	Very hard at 4.0ft
7.5			TD = 6.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- ρ In-situ density test
- ω Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-53

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Sant Cruz County, Arizona

Date: 1/18/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: J. Roberts

Coordinates: 170300.30N 1071923.07E

Elevation: 5094.20

Total Pit Depth: 4.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Top of hill

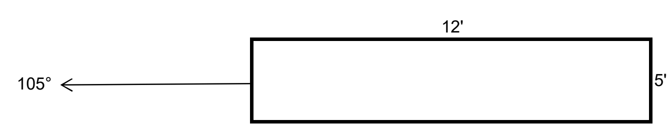
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD-1 @ 1-3ft	1.5	CLAY (CL), gravelly, some sand, medium plastic, reddish brown, moist	Moved test pit to road to save trees
2.5		4.0	GRAVEL (GP), with sand, silt, and clay, coarse, angular, MPS=6.0in, bedrock	Bedrock at 2.5ft
			TD = 4.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-55

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171549.36N 1072226.65E	Elevation:	5168.14	Total Pit Depth:	10.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Sloping Northeast	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD-1 @ 3-4ft		GRAVEL (GC), clayey with sand, low plastic, brown, moist	
		1.5		
5.0			GRAVEL (GP), some sand, coarse grained, angular, hard, brown and gray, moist, weathered bedrock	Hard digging at 4.0ft
7.5				
10.0		10.0	TD = 10.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert / horz.)
BL	Block sample
ρ	In-situ density test
ω	Water content
▼	Water table encountered

Plan View of Pit:

12'

030° ← 5'

NewFields

Pit ID: TP-60

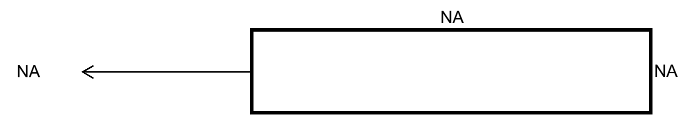
Project: Hermosa Underground | Project No.: 475.0014.008
Project Location: Sant Cruz County, Arizona | Date: 1/20/2017
Equipment: Deere 350D | Contractor: DM Engineering & Excavating | Logged by: N. Owens
Coordinates: 167164.60N 1075422.46E | Elevation: 5465.40 | Total Pit Depth: 5.0ft
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Drill pad, gently sloping near mountain top | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	SD-1 @ 0-1ft		1.0	GRAVEL (GM), silty, sandy, fine to medium grained sand, angular, MPS=3.0in, nonplastic, reddish brown, moist	
			2.0	GRAVEL (GP-GM), with silt and sand, fine to medium grained sand, angular, MPS=12.0in, gray, moist	
2.5	LD-1 @ 3-4ft		5.0	GRAVEL (GM), silty, sandy, fine to coarse grained sand, angular, MPS=12.0in, gray, red, moist	Very hard digging at 4.0ft
5.0				TD = 5.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:



NewFields

Pit ID: TP-61

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	167040.76N 1076316.31E	Elevation:	5477.95	Total Pit Depth:	2.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Top of mountain, flat area, drill pad access	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	SD-1 @ 0-1ft		SAND (SP-SM), gravelly, with silt, fine to medium grained sand, angular, MPS=6.0in, reddish brown, moist, bedrock	Very hard digging at 1.0ft
2.0			TD = 2.0ft, refusal on competent bedrock Water table not encountered at time of excavation.	
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω** Water content
- ▼ Water table encountered

Plan View of Pit:

NA

NA ← [ ] NA

APPENDIX D.1.2

Test Pit Logs (June 2017)

NewFields

Pit ID: TP-62

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/22/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070941 N 173049.9

Elevation:

Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Base of valley

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	Surface LD-2 buckets		Bedrock- Andesite, slightly weathered, strong, moderate to highly fractured, fracture spacing 4-20in., minor oxidation along fractures, light gray	LA Abrasion - 13% Loss
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP-62A

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/22/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070515 N 172871.8

Elevation:

Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Base of valley

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–2.5	Surface LD-2 buckets		Bedrock- Andesite, slightly weathered, strong, moderate to highly fractured, fracture spacing 4-25in, minor oxidation along fractures, light gray	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP-63

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 06/22//2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070406 N 171990.2

Elevation:

Total Pit Depth: 8.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Grass and trees

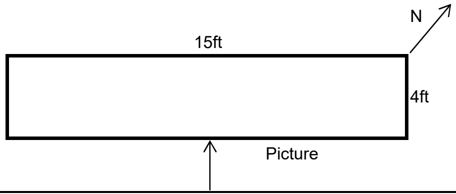
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			clayey SAND (SC) with gravel and cobbles, fine to coarse grained, Maximum Particle Size (MPS)=6in., subrounded to subangular, slight to low plasticity, reddish brown. (Colluvium)	Roots to 24in. %G=21, %S=63, %F=16 PL=14, LL=24, PI=10
2.5	LD 2-3ft		@ 2ft. - Cobble content increases, MPS=13in.	Cobble sized material not included in soil sample.
5.0				
7.5		7.5		
		8.0	Bedrock- Andesite, strong, slightly weathered.	
			TD = 8.0 ft - refusal on bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-64

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/22/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070394 N 172263

Elevation:

Total Pit Depth: 7.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Grass with sparse trees

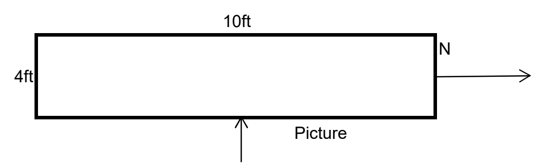
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 0.5-1.5ft		clayey GRAVEL, fine to coarse grained, subangular, high gravel content, medium plastic fines, dry, reddish brown.	Roots to 16in.
2.5		1.5	Bedrock- Andesite, medium strong, moderately weathered, highly fractured, MPS=6in., maroon with feldspar leached out.	
5.0				
7.5		7.0	TD = 7.0ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-65

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/22/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1071521 N 172093.3

Elevation:

Total Pit Depth: 6.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Grasses with sparse trees

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
2.5	LD- 1-2ft		2.0	clayey SAND (SC) with gravel, fine to coarse grained, subangular, MPS=5in., medium plastic fines, dry, light brown.	Roots to 12in. %G=19, %S=62, %F=19 PL=19, LL=30, PI=11 ω%=6.4
5.0			6.0	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=12in., slight plasticity, light brown.	
7.5				TD = 6.0ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

12ft

4ft

Picture

NewFields

Pit ID: TP-66

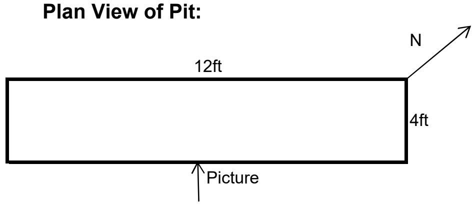
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/22/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1071538 N 172013.4	Elevation:		Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grass with sparse trees and bushes	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1.5-2.5ft		clayey SAND (SC), with gravel, fine to coarse grained, angular, MPS=3in., high plastic fines, dry, reddish brown	Roots to 16in. %G=18, %S=49, %F=33 PL=19, LL=44, PI=25 ω%=7.5
2.5		3.0	clayey GRAVEL (GC), with sand, trace cobbles, MPS=8in., angular, medium plastic fines, dry, reddish brown	
		4.0	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=7in., light gray	
5.0		6.0	TD = 6.0ft, refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-67

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/23/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1071564 N 171922.8

Elevation:

Total Pit Depth: 7.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Grass, bushes, and sparse trees

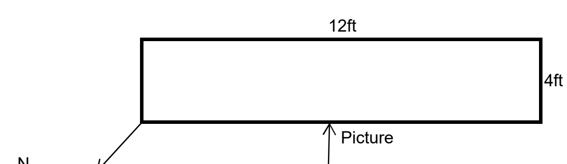
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
			1.5	clayey SAND (SC), with gravel, fine to coarse grained, subangular, MPS=4in., low to medium plastic fines, dry, reddish brown	Roots to 24in.
2.5					
			7.0	Bedrock- Andesite, moderately weathered, weak, highly fractured, MPS=10in., oxidized along joints, light gray. @ 3ft - hardness increases to medium strong	
5.0					
7.5				TD = 7.0ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-68

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/23/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1071492 N 172205.7
Elevation:
Total Pit Depth: 6.5ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Grass with sparse trees and shrubs
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	LD 1-2ft		2.0	clayey SAND (SC), some gravel, fine to coarse grained, subangular, MPS=3in., low to medium plastic fines, dry, reddish brown	Roots to 18in.
2.5					
5.0			6.5	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=6in., reddish brown	
7.5				TD = 6.5ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

Picture

12ft

4ft

N

NewFields

Pit ID: TP-69

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/23/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069905 N 171904.8	Elevation:		Total Pit Depth:	NA
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Top of bedrock knob	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	Surface LD 2 buckets		Bedrock- Silicified Volcani-clastic, slightly weathered, strong, slightly fractured, one joint set with approximate spacing 8-14in., light gray with purple	LA Abrasion - 33% Loss
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

Picture

N

NewFields

Pit ID: TP-70

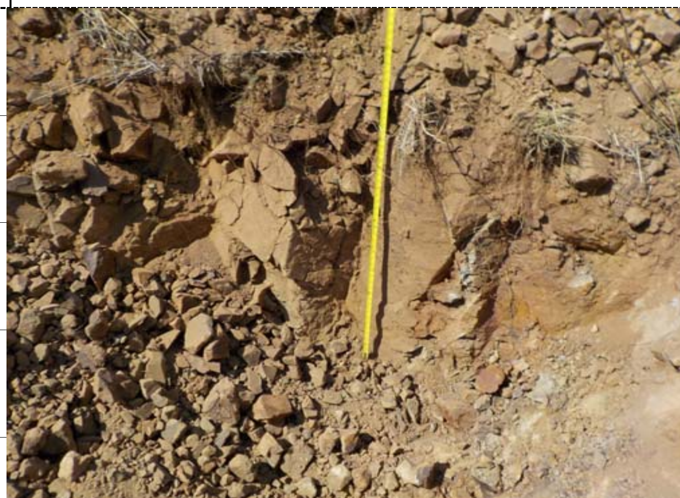
Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/22/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1069947 N 171745.2 | Elevation: | Total Pit Depth: 3.5ft

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Grasses | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.5			Bedrock- Andesite, slightly weathered, strong, highly fractured, MPS=10in., oxidation along joints, greenish gray	
3.5			TD = 3.5ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

9ft

4ft

Picture

NewFields

Pit ID: TP- 71

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070504 N 171271	Elevation:		Total Pit Depth:	NA
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	Surface LD 2 buckets		Bedrock- Andesite, slightly weathered, highly fractured, fracture spacing 2-12in., medium strong to strong, maroon to gray	Roots to 12in. LA Abrasion - 26% Loss
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP-72

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/20/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069976 N 171090.6

Elevation:

Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Existing drill pad

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			Bedrock- Andesite, highly weathered, weak, highly fractured, fracture spacing 3-8in., oxidized throughout, plagioclase decomposed, light gray matrix	
5.0	LD 5-6ft 2 buckets	6'		
7.5			Base of drill pad at 6ft.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP- 73

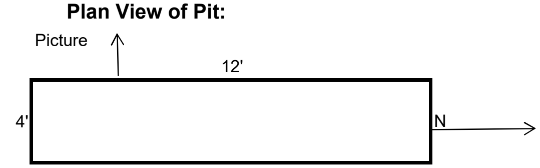
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/26/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069576 N 170576.9	Elevation:		Total Pit Depth:	6.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grass with sparse trees	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1.5-2.5ft		clayey GRAVEL (GC) some cobbles, fine to coarse, subangular and subrounded, angular, low plasticity fines, MPS=6in.	Roots to 12in.
		1.2	Bedrock- Andesite, highly weathered, weak to medium strong, highly fractured, MPS=9in., feldspar leached out, light gray	
		6.5	TD = 6.5ft, No useable borrow material Water table not encountered at time of excavation.	
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-74

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069481 N 170193.9	Elevation:		Total Pit Depth:	12.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Existing drill pad	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			Bedrock- Andesite, weak, high plasticity, highly fractured, MPS=8in., oxidized throughout, reddish brown	
5.0	LD 5-6ft 3 buckets			LA Abrasion - 29% Loss
7.5			Occasional seams of completely weathered, extremely weak material up to 8in. thick, light gray	
10.0				
		12.0	TD = Base of drill pad at 12.0ft.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP- 75

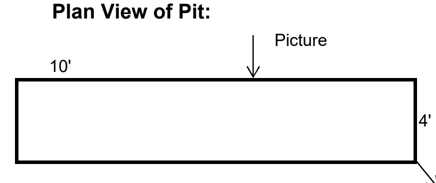
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/27/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069543 N 169899.9	Elevation:		Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Located on top of ridge	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
				Competent rock runs along ridge to the NW
2.5			Bedrock- Andesite, slightly weathered, medium strong to strong, moderately fractured, MPS=24in., oxidized, greenish gray	
5.0	LD 5-6ft 3 buckets			LA Abrasion - 13% Loss
		6.0	TD = 6.0ft, refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-76

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/23/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1071991 N 170173.8 | Elevation: | Total Pit Depth: 5.2ft

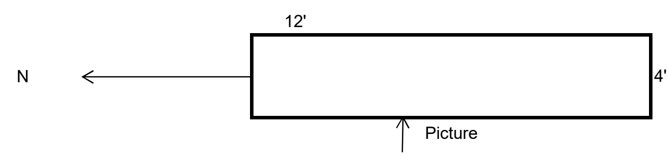
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Edge of existing roadway. | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1-2ft		clayey SAND (SC) with gravel, fine to coarse grained, angular MPS= 4in., medium plastic fines, dry, brown	Roots to 16in.
2.0				
2.5			Bedrock-Andesite, slightly weathered, highly fractured, MPS=8in., oxidized along joints, greenish gray	
5.0				
5.2			TD = 5.2ft, refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

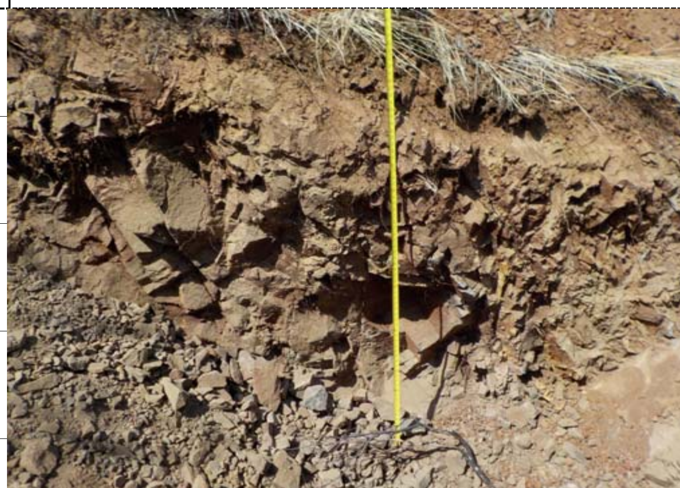
Plan View of Pit:



NewFields

Pit ID: TP- 77

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/23/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1072163 N 170146.6	Elevation:		Total Pit Depth:	5.5 ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grasses, sparse trees and shrubs	Backfilled:	Yes

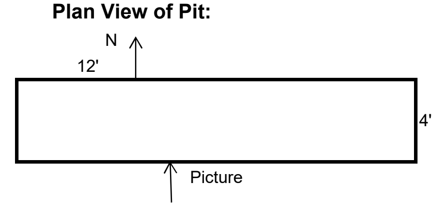
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.5			silty SAND (SM) with gravel and organics (topsoil)	Roots to 14in.
5.5			Bedrock- Andesite, slightly weathered, strong, highly fractured, becomes less fractured with depth, MPS=10in., green and maroon	
			TD =5.5ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 78

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/23/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1071993 N 170319.4

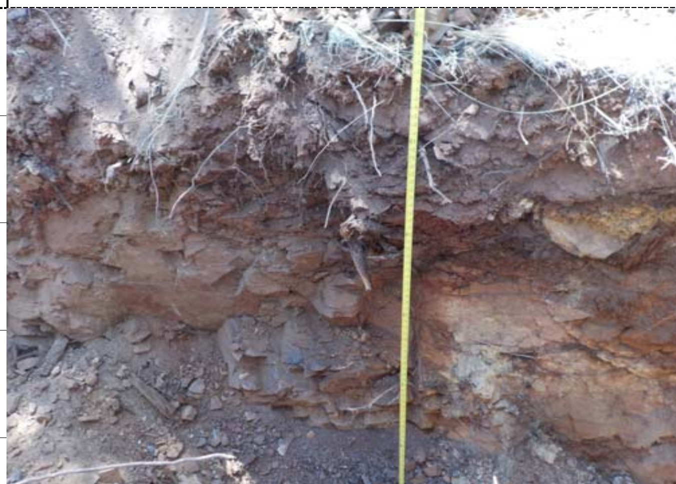
Elevation:

Total Pit Depth: 6.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

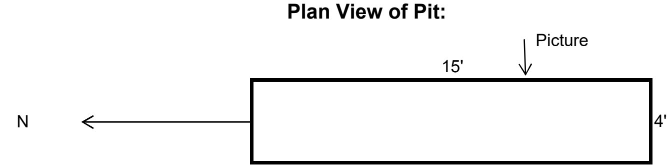
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1-2ft		clayey SAND (SC) with gravel, fine to coarse grained, angular, medium plastic fines, MPS=4in., brown, dry	Roots to 36in. Layer varies in thickness 1.5-3ft. thick
2.5		2.5	Bedrock- Andesite, slightly weathered, strong, highly fractured, MPS=6in., oxidation along fractures, maroon	
5.0		6.0	TD =6.0ft, Refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-79

Project:	Hermosa Underground	Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona	Date:	6/22/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating
Logged by:	R. Bartingale	Coordinates:	E 1072217 N 170645.6
Elevation:		Total Pit Depth:	NA
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Existing drill pad
Backfilled:	Yes		

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0				
7.5			Bedrock- Andesite, slightly weathered, strong, moderate to highly fractured, fracture spacing 3-8in., reddish gray matrix	
10.0				
12.5				
15.0	LD 14-16ft 2 buckets	16.0	Base of drill pad at 16.0ft	LA Abrasion - 12% Loss
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP-80

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/22/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1072643 N 170770.3 | Elevation: | Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Existing drill pad | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0				
7.5			Bedrock- Andesite, moderately weathered, medium strong, highly fractured, fracture spacing 3-10in., gray	
10.0				
12.5				
15.0				LA Abrasion - 15% Loss
16.0	LD 14-16ft 2 buckets	16.0	Base of drill pad at 16.0ft	
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N →

↑ Picture

NewFields

Pit ID: TP-81

Project:	Hermosa Underground
Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona
Date:	6/22/2017
Equipment:	Deere 180G LC
Contractor:	DM Engineering & Excavating
Logged by:	R. Bartingale
Coordinates:	E 1069918 N 171290.1
Elevation:	
Total Pit Depth:	NA
Datum:	NAD 83 Arizona Central State Plane US feet
Surface Conditions:	Existing road cut
Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			Bedrock- Andesite, slightly weathered, medium strong, oxidized along fractures, highly to moderately fractured, fracture spacing 6-20in., light gray matrix	
	LD 2-4ft	4.0	TD= Base of roadcut at 4.0ft	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP-82

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/22/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1072563 N 171224.2 | Elevation: | Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Existing drill pad | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0			Bedrock- Andesite, highly weathered, weak, highly fractured, fracture spacing 3-8in., feldspar completely weathered, reddish brown	
7.5	LD 6-8ft			LA Abrasion - 41% Loss
		8.0	TD= Base of drill pad at 8.0ft	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

Picture

NewFields

Pit ID: TP-83

Project: Hermosa Underground

Project Location: Santa Cruz County, Arizona

Equipment: Deere 180G LC

Coordinates: E 1073638 N 170144.5

Datum: NAD 83 Arizona Central State Plane US feet

Contractor: DM Engineering & Excavating

Elevation:

Surface Conditions: Existing pad hole sitting below 17' high cut slope

Project No.: 475.0014.008

Date: 6/23/2017

Logged by: R. Bartingale

Total Pit Depth: 17.0ft

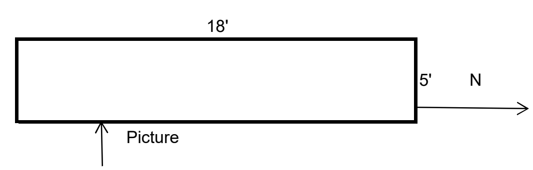
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 5-6ft			%G=7, %S=56, %F=37 PL=18, LL=27, PI=9 ω%=15.0
7.5			clayey SAND (SC), some gravel, trace cobbles MPS=14in., rounded to subrounded, well graded, slight plasticity, fine to coarse sand, fine to medium grained gravel, moist, brown	
10.0				
12.5	LD 12-13ft			%G=30, %S=50, %F=20 PL=16, LL=29, PI=13
15.0		16.0		
		17.0	Bedrock- Andesite, slightly weathered, strong, highly fractured, greenish gray	
17.5			TD = 17 ft, excavator reach limit Water table not encountered at time of excavation.	
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 84

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/24/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1073612 N 169947.7	Elevation:		Total Pit Depth:	8.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Existing roadway	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
			2.0	Fill (roadway) silty clayey GRAVEL, (GC-GM) some cobbles, MPS=12in., angular, dry, reddish brown	Roots 6ft. on downward slope side of pit
2.5	LD 2.5-3.5ftt		4.0	silty clayey GRAVEL, (GC-GM) some cobbles, MPS=5in., angular, fine to coarse grained, dry, reddish brown, (Residual bedrock)	
5.0			8.5	Bedrock- Andesite, moderately weathered, medium strong, highly fractured, MPS=10in., oxidized throughout, feldspar leached out	
7.5				TD = 8.5ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:

NewFields

Pit ID: TP- 85

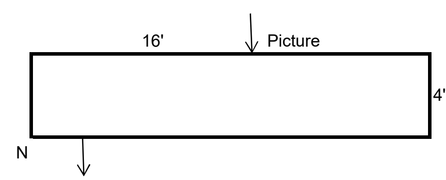
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/24/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1073743 N 169974.6	Elevation:		Total Pit Depth:	16.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Edge of cleared working area	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD 2-3ft		0–7.5: clayey SAND (SC) some gravel, primarily fine sand, fine to medium gravel, subangular, low plasticity, slightly moist, brown	%G=8, %S=60, %F=32 PL=17, LL=29, PI=12 ω%=7.8
5.0				
7.5	LD 8-9ft		7.5–11.0: clayey SAND (SC) with gravel, some cobbles MPS=8in., subrounded, fine to coarse grained, medium plastic fines, moist, brown	
10.0				
12.5			11.0–16.0: Bedrock- Andesite highly weathered to decomposed, weak, heavy oxide staining, extremely fractured, dark reddish brown	
15.0				
17.5			16.0: TD = 16ft, refusal on bedrock Water table not encountered at time of excavation.	
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 86

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/23/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1073792 N 169786

Elevation:

Total Pit Depth: 17.5ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Disturbed area adjacent to Drillers pond

Backfilled: Yes

Pit Wall Profile

Depth (ft)	Sample (depth & type)	Description	Additional Notes
0.0–4.0	LD 2-3ft	clayey SAND predominately fine sand, occasional fine gravel, low plastic fines, subangular, moist, dark brown	%G=4, %S=48, %F=48 PL=13, LL=30, PI=17
4.0–17.5	LD 16-17ft	clayey SAND with gravel, trace cobbles, fine to coarse sand and gravel, MPS=14in., subrounded, moist, dark brown	%G=18, %S=58, %F=24 PL=15, LL=30, PI=15
17.5		TD = 17.5ft, Excavator reach limit Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:

N

14'

4'

Picture

NewFields

Pit ID: TP- 87

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/24/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1073819 N 169578.9 | Elevation: | Total Pit Depth: 10.5ft

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Undisturbed area between roadway and pumphous | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–2.5			clayey GRAVEL (GC) some cobbles MPS=8in., fine to coarse sand and gravel, angular, low plasticity, dry, fines light brown (colluvium)	Roots to 24in.
2.5–5.0	LD 4-5ft		@ 3ft. - cobble content increases, MPS increases to 14in., clay content increases slightly	Cobbles not included in bucket sample
7.5				
10.0		10.5	TD= 10.5ft, machine reach limit, excavator on elevated road Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

Picture ↑

14'

4'

N ↓

NewFields

Pit ID: TP- 88

Project: Hermosa Underground | Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona | Date: 6/24/2017
Equipment: Deere 350D LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale
Coordinates: E 1074191 N 169797.6 | Elevation: | Total Pit Depth: 11.0ft
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Old drill pad area | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 5-7ft		well-graded GRAVEL with clay and sand, some cobbles, MPS=9in., fine to coarse sand and gravel, angular to subrounded, durable casts, medium plastic fines, moist (colluvium)	%G=54, %S=36, %F=10 PL=15, LL=37, PI=22
7.5		8.0		
10.0		11.0	Bedrock- Andesite, medium strong, slightly to moderately weathered, extremely fractured, dark gray	
12.5			TD = 11.0ft, refusal on bedrock Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

Picture ↑

10'

4'

N

NewFields

Pit ID: TP- 89

Project:	Hermosa Underground	Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona	Date:	6/24/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating
Logged by:	R. Bartingale	Coordinates:	E 1074056 N 169577.8
Elevation:		Total Pit Depth:	15.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Upslope edge of existing road
Backfilled:	Yes		

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–13.0	LD 6-8ft		clayey SAND (SC) with gravel and cobbles, trace boulders, MPS= 12in., durable clasts, angular, medium plastic fines, brown (colluvium) - @ 11ft. boulder content increases, MPS=26in.	%G=48, %S=40, %F=12 PL=22, LL=33, PI=11 ω%=9.2
13.0–15.0			Bedrock- Andesite, slightly weathered, strong, moderately fractured, greenish gray	
15.0			TD = 15ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

14'

4'

Picture

NewFields

Pit ID: TP-90

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/22/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1074451 N 169069.2	Elevation:		Total Pit Depth:	NA
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Drill pad access roadcut	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD 2-3ft		Bedrock- Volcanic Rock, Silica-rich Rhyolite, slightly weathered, strong, fine grained, pinkish-gray matrix	LA Abrasion - 20% Loss
		3.0	TD= Base of roadcut at 3.0ft.	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

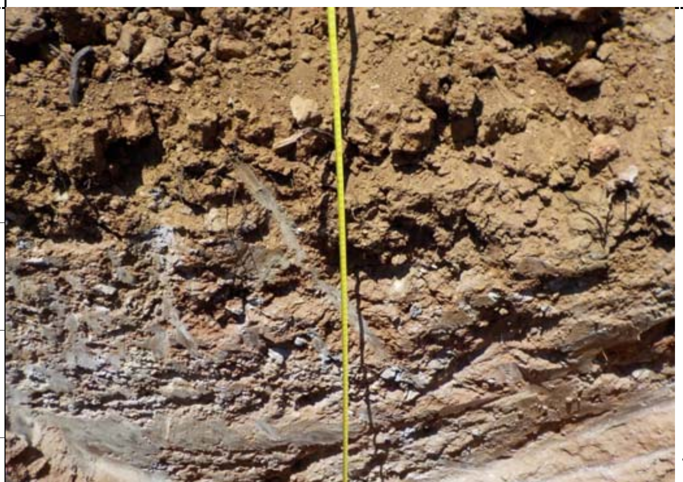
N

Picture

NewFields

Pit ID: TP- 91

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/28/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1076060 N 166834.8
Elevation:
Total Pit Depth: 10.0ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Grass with sparse bushes
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 2-3ft		clayey SAND (SC) with gravel, some cobbles, MPS=7in., fine to coarse grained, high plastic fines, angular to subrounded, slightly moist, brown @ 4ft. - gravel content increases, medium plastic fines	%G=38, %S=41, %F=21 PL=20, LL=56, PI=36
2.5				
5.0				
7.5				
10.0		10.0	TD = 10.0ft Refusal on bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

10'

4'

Picture

NewFields

Pit ID: TP- 91A

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/28/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1076270 N 166749.8
Elevation:
Total Pit Depth: 3.0ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Grasses with sparse bushes
Backfilled: Yes

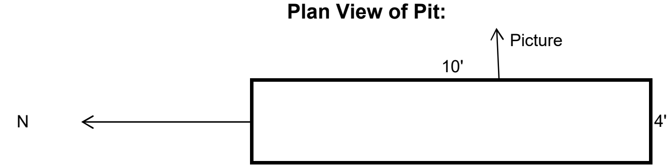
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	SD 1-2ft		clayey SAND, (SC), some cobbles and gravel, fine to coarse grained, MPS=6in., medium plastic fines, slightly moist, brown	Roots to 1.5ft.
3.0			TD = 3.0ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 91B

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/28/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1076086 N 166729.6

Elevation:

Total Pit Depth: 10.5ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Grasses with sparse trees

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	SD 2-3ft	3.0	clayey SAND (SC) some gravel and cobbles, fine to coarse grained, MPS=8in., subangular to subrounded, high plasticity fines, high dry strength, dry, brown	%G=15, %S=43, %F=42 PL=18, LL=41, PI=23
5.0	LD 5-6ft			%G=48, %S=36, %F=16 PL=14, LL=42, PI=28
7.5		10.5	clayey GRAVEL (GC) with sand, some cobbles, occasional boulders, MPS=22in., subrounded to subangular, medium plastic fines, slightly moist, reddish brown	
10.0			TD = 10.5ft, Refusal on bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

NewFields

Pit ID: TP- 92

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/28/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1076036 N 167005.5

Elevation:

Total Pit Depth: 3.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Grasses, trees, and shrubs

Backfilled: Yes

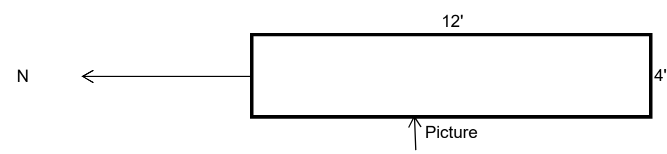
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	SD 2-3ft		clayey SAND (SC) some gravel, MPS=5in., medium plasticity, dry, brown	roots to 5in.
1.0			clayey SAND (SC) with gravel, MPS=5in., angular, slighty plastic, light brown to light gray (Residual bedrock)	
3.0			TD = 3.0ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 93

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/28/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1076032 N 167096.4	Elevation:		Total Pit Depth:	3.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Edge of Roadway	Backfilled:	Yes

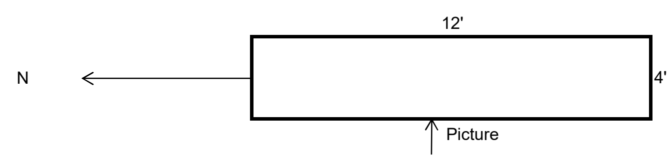
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.0			clayey SAND (SC) with gravel, MPS=4in., fine to coarse grained, medium to highly plastic fines, subrounded to subangular (Residual bedrock)	Roots to 10in.
3.0			TD = 3.0ft, Refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 94

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/28/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1075820 N 167141.4 | Elevation: | Total Pit Depth: 15.0ft

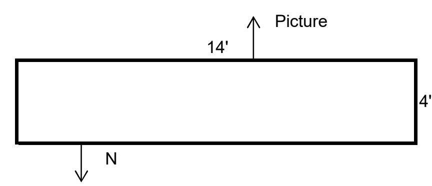
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Excavated within old drill pad | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD 2-3ft		sandy CLAY (CL), medium plasticity, fine to coarse sand, high dry strength, dry, reddish brown	%G=2, %S=33, %F=65 PL=15, LL=39, PI=24 ω%=10.8
		3.0	clayey GRAVEL (GC) with sand, some cobbles and boulders, MPS=20in., fine to coarse grained, angular to subrounded, medium plasticity fines, reddish brown	Difficult digging at 4ft.
5.0				
7.5				
10.0	LD 11-12ft		@ 13-15ft. - boulder content increases MPS=20in.	%G=41, %S=37, %F=22 PL=17, LL=39, PI=22 ω%=6.8
12.5				
15.0		15.0	TD = 15.0ft, Refusal on bedrock Water table not encountered at time of excavation.	
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 95

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/24/2017

Equipment: Deere 350D | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1075574 N 167051.4 | Elevation: | Total Pit Depth: 18.0ft

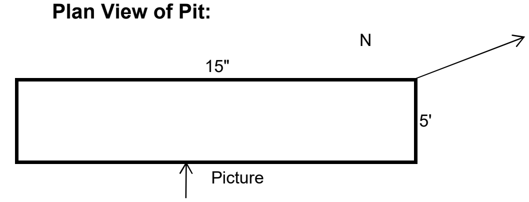
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Excavated into existing cut slope | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0			@ 4ft. - Layer of clayey GRAVEL	
7.5	LD 7-8ft		clayey SAND (SC) with gravel, MPS=4in., fine to coarse grained, medium plastic fines, moderate dry strength, subangular, slightly moist, brown	%G=16, %S=54, %F=30 PL=14, LL=33, PI=19 ω%=7.4
10.0		11.0		-@ 11ft. difficult digging
12.5	LD 13-15ft		clayey GRAVEL (GC) with sand and cobbles, MPS=13", fine to coarse grained, medium plastic fines, subrounded, slightly moist, brown	Large cobbles not included in sample %G=52, %S=35, %F=13 PL=17, LL=43, PI=26 ω%=5.3
15.0			@16ft. - 24in. diameter boulder encountered	
17.5		18.0	TD = 18ft, refusal on bedrock Water table not encountered at time of excavation.	
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 96

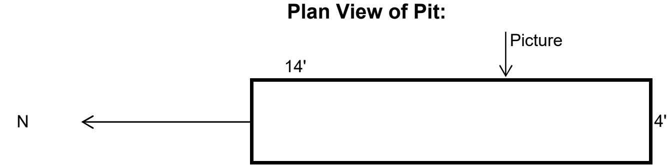
Project:	Hermosa Underground	Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona	Date:	6/28/2017
Equipment:	Deere 180G LC	Contractor: DM Engineering & Excavating	Logged by: R. Bartingale
Coordinates:	E 1075592 N 167175.3	Elevation:	Total Pit Depth: 9.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD 3-4ft		clayey GRAVEL (GC) with sand, some cobbles, trace boulders, MPS=16in., subangular to subrounded, medium plasticity fines, dry, light brown	%G=43, %S=39, %F=18 PL=16, LL=40, PI=24
5.0		5.0		
7.5	LD 7-8ft		clayey GRAVEL (GC) with sand, some cobbles and boulders, MPS=10in., angular to subanglular, low to medium plastic fines, dry, light gray	Higher gravel content than overlying unit
10.0		9.5	TD = 9.5ft, Refusal on bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 97

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/20/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1075465 N 167028.4
Elevation:
Total Pit Depth: 3.5ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions:
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.5	LD 2-3ft		clayey GRAVEL (GC) with sand, trace cobbles, MPS=6in., fine to coarse grained, durable clasts, subrounded, medium plastic fines, dry, reddish brown	Roots to 12in. %G=40, %S=40, %F=20 PL=16, LL=43, PI=27
3.5			TD = 3.5ft, Refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

12'
4'
N
Picture

NewFields

Pit ID: TP- 98

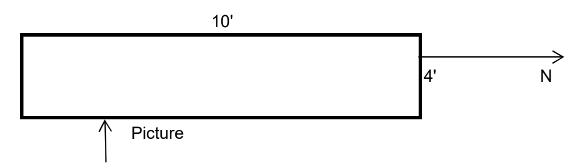
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1075573 N 166898.6	Elevation:		Total Pit Depth:	5.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Roadway cut area	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD 2-3ft		clayey SAND (SC) with gravel, some cobbles MPS=8in., highly plastic fines, subangular to subrounded, slightly moist, reddish brown @ 3.5ft. - cobbles and boulders present, MPS=12in., angular	This area has been cut 2-3ft. %G=35, %S=36, %F=29 PL=18, LL=47, PI=29
5.0		5.0	TD = 5.0ft, Refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP-99

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/22/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1074997 N 168751.4 | Elevation: | Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	Surface LD 2 buckets		Bedrock- Silia-rich brecciated Rhyolite, slightly weathered, strong, high to moderately fractured, fracture spacing 4-20in., gray	LA Abrasion - 16% Loss
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

9ft

4ft

Picture

NewFields

Pit ID: TP- 100

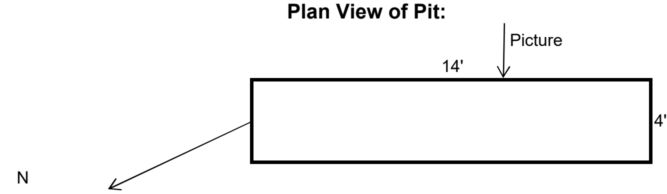
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/28/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1078505 N 166887.2	Elevation:		Total Pit Depth:	8.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Old drill pad area	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 4-6ft		silty SAND (SM) with gravel, some cobbles, trace boulders MPS=18in., no plasticity, subrounded grains, light gray (volcanic tuff, unweathered)	%G=27, %S=57, %F=14 PL=NP, LL=NP, PI=NP ω%=12.2
7.5		8.0	TD = 8.0ft,stopped due to consistent material Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 101

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/28/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1078595 N 167161.1

Elevation:

Total Pit Depth: 11.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Old drill pad area

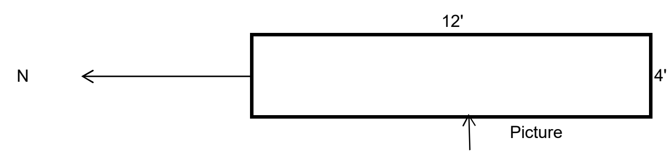
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0			clayey SAND (SC) with gravel, some cobbles and boulders, MPS=26in., low plastic fines, subangular to angular, moist, brown (weathered volcanic ash)	
7.5				
10.0	LD 5-8ft	11.0		
12.5			TD = 11.0ft, Excavador reach limit Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 102

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/28/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1078587 N 167062.8 | Elevation: | Total Pit Depth: 9.0ft

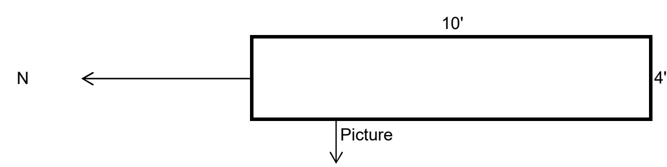
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 4-6ft		clayey SAND (SC) some gravel, fine to coarse grained, MPS=6in., low plasticity, subrounded to subangluar, light gray (slightly weathered volcanic ash)	
7.5				
10.0		9.0	TD = 9.0ft, Stopped due to consistent material Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 103

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/28/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1078483 N 167138 | Elevation: | Total Pit Depth: 17.0ft

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 4-10ft			%G=44, %S=44, %F=12 PL=18, LL=37, PI=19 ω%=7.3
7.5			clayey GRAVEL (GC) with sand, some cobbles, trace boulders, MPS=30in., subangular to angular, low plasticity, slightly moist, (moderately weathered volcanic ash)	
10.0				
12.5				
15.0		17.0	TD = 17.0ft, Excavator reach limit Water table not encountered at time of excavation.	
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

12'

N ← 4'

↑ Picture

NewFields

Pit ID: TP- 104

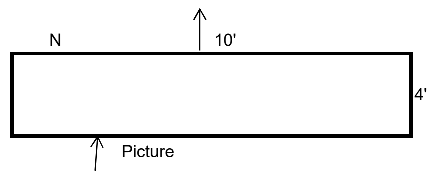
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070499 N 173475.6	Elevation:		Total Pit Depth:	4.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Excavated on the point	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			6" silty SAND with organics (topsoil)	Roots to 12in.
2.5			Bedrock- Andesite, slightly weathered, strong, highly fractured, oxidized fracture surfaces, MPS=10in., maroon	
			4.5 TD = 4.5ft, refusal on bedrock Water table not encountered at time of excavation.	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 105

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/21/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1069540 N 174516.7 | Elevation: | Total Pit Depth: 5.2ft

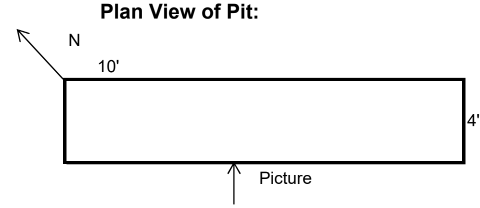
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Grasses, Sparse trees | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 0.5-1.0ft		1.1 clayey SAND (SC) some gravel, low plastic fines, dry, reddish brown	Roots to 1.3ft. %G=11, %S=54, %F=35 PL=26, LL=41, PI=15 ω%=7.5
2.5	LD 2-4ft		4.7 clayey SAND (SC) with gravel, low plastic fines, MPS=3in., subangular, reddish brown (Residual bedrock)	%G=20, %S=56, %F=24 PL=23, LL=35, PI=12
5.0			5.2 Bedrock- Andesite, highly weathered, highly fractured, weak, reddish brown.	
			TD = 5.2 Refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 106

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/21/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069559 N 174182.2

Elevation:

Total Pit Depth: 7.5ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	LD 0.5-1.2ft		1.5	sandy CLAY (CL) trace fine gravel, medium plasticity, moderate dry strength, dry, brown	Roots to 0.5ft
2.5					
5.0			7.5	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=7in., light maroon	
7.5				TD = 7.5ft, Stopped due to no useable borrow material Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:

Picture

12'

N ←

4'

NewFields

Pit ID: TP- 107

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/21/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069861 N 173938

Elevation:

Total Pit Depth: 5.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

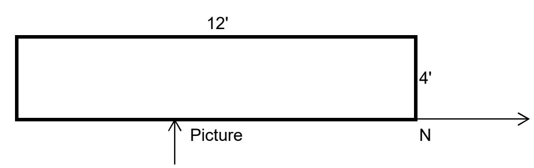
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	LD 0.8-1.2ft		1.5	clayey SAND (SC), some gravel, low plasticity, angular, MPS=4in., dry, brown	Roots to 12in.
2.5			5.0	Bedrock- Andesite, highly weathered, medium strong, highly fractured, MPS= 10in., reddish brown	
5.0				TD = 5.0ft, refusal on bedrock Water table not encountered at time of excavation.	
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 108

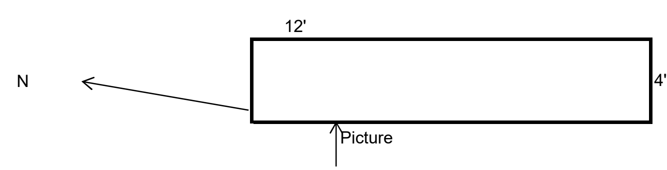
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069861 N 174214.5	Elevation:		Total Pit Depth:	10.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Excavated on existing roadway	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			clayey SAND (SC) some gravel, MPS=5in., medium to high plasticity, occasional blocks of highly to completely weathered andesite bedrock, moist, reddish brown	Roots to 12in.
2.5				
5.0	LD 5-6ft		@ 4.5ft. - occasional blocks of completely weathered Andesite	%G=8, %S=50, %F=42 PL=19, LL=49, PI=30 ω%=11.7
7.5		8.0	Bedrock - Andesite, highly weathered, highly fractured, weak, slight plasticity, reddish brown	
10.0		10.0	TD = 10.0ft, refusal on bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 109

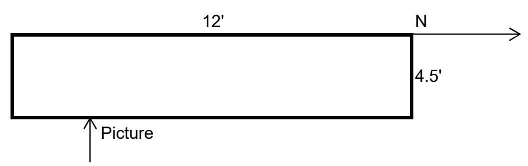
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069756 N 174391.7	Elevation:		Total Pit Depth:	5.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1-2ft			
2.0			silty SAND (SM), with gravel, slight plasticity, friable gravel clasts, moist, dry, reddish brown	Roots to 12in.
2.5				
4.5			Bedrock - Andesite, highly weathered, friable, weak, grayish brown	
5.0			Bedrock - Andesite, moderate to high weathered, weak, gray	
			TD = 5.0ft, Stopped due to no useable borrow material Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 110

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069983 N 174204.9	Elevation:		Total Pit Depth:	5.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grasses, sparse trees and bushes	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.5			silty SAND (SM) with gravel and organics, (topsoil)	Roots to 12in.
5.0			Bedrock- Andesite, moderately weathered, medium strong, highly fractured, MPS=10in., gray	
			TD = 5.0ft Stopped due to no useable borrow material Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

10'

4'

Picture

NewFields

Pit ID: TP- 111

Project:	Hermosa Underground	Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona	Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating
Logged by:	R. Bartingale	Coordinates:	E 1069353 N 174481.9
Elevation:		Total Pit Depth:	15.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	
Backfilled:	Yes		

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.5	LD 1-2ft		clayey SAND (SC) with gravel, occasional cobbles, MPS=4in., high to medium plasticity, high dry strength, moist, reddish brown (Residual bedrock)	%G=20, %S=46, %F=34 PL=19, LL=45, PI=26
3.5–15.5	LD 7-8ft 2 buckets		clayey SAND (SC) some gravel, medium plasticity, subangular, MPS=4in., moist, light brown (Residual bedrock)	%G=8, %S=70, %F=22 PL=12, LL=38, PI=26 ω%=11.9
15.5			TD = 15.5ft, Excavator reach limit Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

15'

N

4'

Picture

NewFields

Pit ID: TP- 112

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/21/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1069455 N 174293.8 | Elevation: | Total Pit Depth: 7.5ft

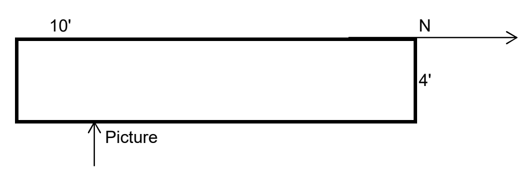
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Grass trees and shrubs | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
			0.5	silty SAND (SM) with gravel and organics, (topsoil)	Roots to 12in.
2.5					
5.0				Bedrock- Andesite, highly weathered, weak to medium strong, highly fractured, MPS=9in., gray	
7.5			7.5	TD = 7.5ft Stopped due to no useable borrow material Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 113

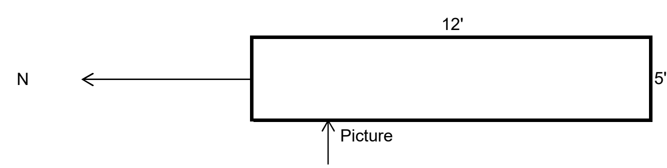
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070783 N 172580.1	Elevation:		Total Pit Depth:	8.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				Roots to 12in. Dense- difficult digging %G=28, %S=47, %F=25 PL=15, LL=37, PI=22 ω%=6.1
5.0	LD 3-4ft 2 Buckets		clayey SAND (SC) with gravel, medium plasticity, blocky, high dry strength, subrounded to angular, dry to slightly moist, reddish brown	
7.5		8.0		
10.0			TD = 8.0ft, Refusal on dense material, presumed weathered bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 114

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/21/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070940 N 172454.4	Elevation:		Total Pit Depth:	5.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.0	LD 1.5-2.5ft		clayey GRAVEL (GC) with sand, low plasticity, MPS=3in., slightly moist, reddish brown (Residual bedrock)	Roots to 18in.
3.0–5.0			Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=3in., gray	
5.0			TD = 5.0ft, Stopped due to no usable borrow material Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N ↑ 12' × 4'; Picture ↓

NewFields

Pit ID: TP- 115

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/22/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1070747 N 172481.4 | Elevation: | Total Pit Depth: 3.5ft

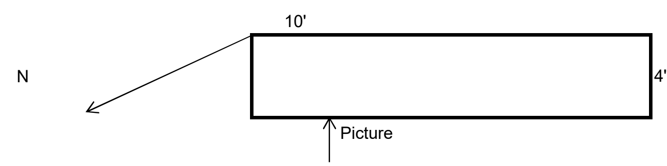
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Sparse trees and grasses | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
			0.5	silty SAND (SM) with gravel and organics (topsoil)	
2.5				Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=6in., Light to medium gray	
			3.5	TD = 3.5ft Stopped due to no usable borrow material Water table not encountered at time of excavation.	
5.0					
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 116

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/22/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070849 N 172540.8

Elevation:

Total Pit Depth: 5.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

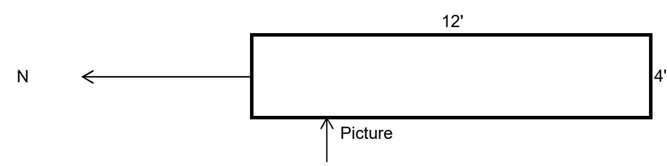
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
	LD 1-2ft		2.0	silty SAND (SM) with gravel, angular, MPS=6in., slight plasticity, dry, brown	Roots to 16in.
2.5			5.0	Bedrock- Andesite, moderately weathered, weak, highly fractured, MPS=8in., maroon with leached fedspar	
5.0				TD = 5.0ft, Stopped due to no useable borrow material Water table not encountered at time of excavation.	
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 117

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/22/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1069657 N 174401.5 | Elevation: | Total Pit Depth: 6.0ft

Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Existing drill pad, cleared of vegetation | Backfilled: Yes

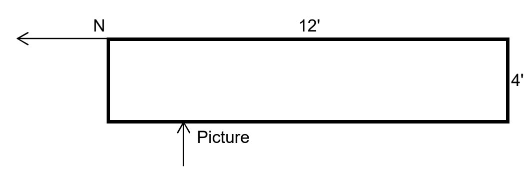
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			silty SAND (SM) with gravel, subangular, MPS=4in., no plasticity, dry, brown	
1.2			Bedrock- Andesite, moderately weathered, medium strong, highly fractured, MPS=10in., maroon	
6.0			TD = 6.0ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 118

Project: Hermosa Underground	Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona	Date: 6/22/2017
Equipment: Deere 180G LC	Contractor: DM Engineering & Excavating	Logged by: R. Bartingale
Coordinates: E 1069770 N 174268.1	Elevation:	Total Pit Depth: 8.0ft
Datum: NAD 83 Arizona Central State Plane US feet	Surface Conditions: Grasses, trees	Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
				Mine adit located 50 yds downslope with exposed bedrock
2.5	LD 2-3ft		sandy CLAY (CH), some fine sand, trace gravels, MPS=2in., high plasticity, high dry strength, moist, reddish brown	%G=2, %S=47, %F=51 PL=21, LL=50, PI=29
5.0		6.0		
7.5		8.0	Bedrock- Andesite, highly weathered, weak, MPS=6", highly fractured, maroon	
			TD = 8.0ft, Refusal on bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

14'

N

4'

Picture

NewFields

Pit ID: TP- 119

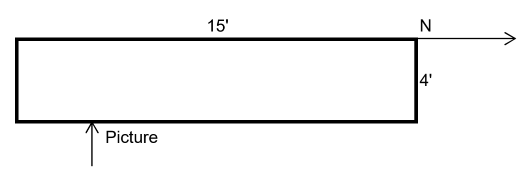
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/22/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069863 N 174268.1	Elevation:		Total Pit Depth:	8.3ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grasses, sparse trees and shrubs	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	LD 3-4ft		clayey SAND (SC) some gravel, MPS=5in., medium plasticity, dry, reddish brown	Roots at 12in. %G=9, %S=48, %F=43 PL=21, LL=45, PI=24
5.0		6.0	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=6in., maroon	
7.5		8.3	TD = 8.3ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 120

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/22/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070212 N 171795.3

Elevation:

Total Pit Depth: 13.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Native ground between tailings embankment and roadway

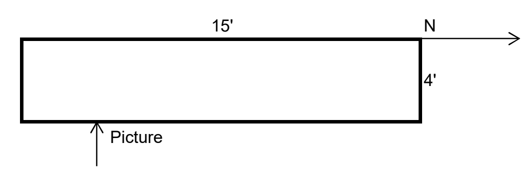
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
				Roots to 24in.
2.5				
5.0	LD 5-6ft		clayey SAND (SC) with gravel, MPS=1in., fine to coarse sand, subangular to subrounded, low plastic fines, brown	%G=20, %S=66, %F=14 PL=11, LL=21, PI=10
7.5				
10.0				
12.5		13.0	TD = 13.0ft, Excavator reach limit Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 121

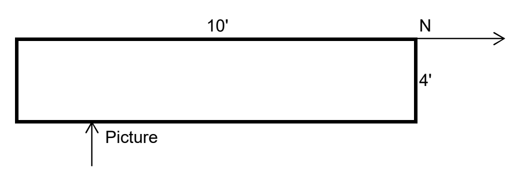
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/24/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1074078 N 169807.3	Elevation:		Total Pit Depth:	3.8ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD .5-1.5ft		clayey SAND (SC) some gravel, fine to coarse grained, subangular to subrounded, occasional cobbles, MPS=6in., medium plastic fines, dry, brown	Roots to 12in.
		2.0	Bedrock - Andesite, highly weathered, high to extremely fractured, MPS=10in., reddish brown to pink	
		3.8	TD = 3.8ft, refusal on bedrock Water table not encountered at time of excavation.	
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 122

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/26/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069623 N 170333.7

Elevation:

Total Pit Depth: 16.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Existing drill pad, cleared of vegetation

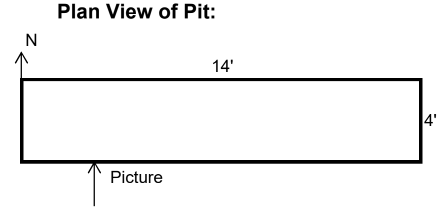
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				Roots to 24in.
5.0	LD 3-4ft		sandy CLAY (CL) trace gravel, medium plasicity, MPS=4in., subangular, slightly moist, reddish brown	%G=2, %S=47, %F=51 PL=21, LL=49, PI=28 ω%=13.4
7.5		9.0		
10.0 / 12.5			sandy CLAY (CH) some gravel and cobbles, MPS=6in., subrounded, high plasticity, moist, reddish brown @ 13ft - Gradual increase in grain size with MPS occuring just above bedrock	
15.0		15.0	Bedrock- Andesite, highly weathered, very weak, highly fractured, moist, reddish brown	
17.5 / 20.0		16.0	TD = 16.0ft, Excavator reach limit, Water table not encountered at time of excavation.	

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

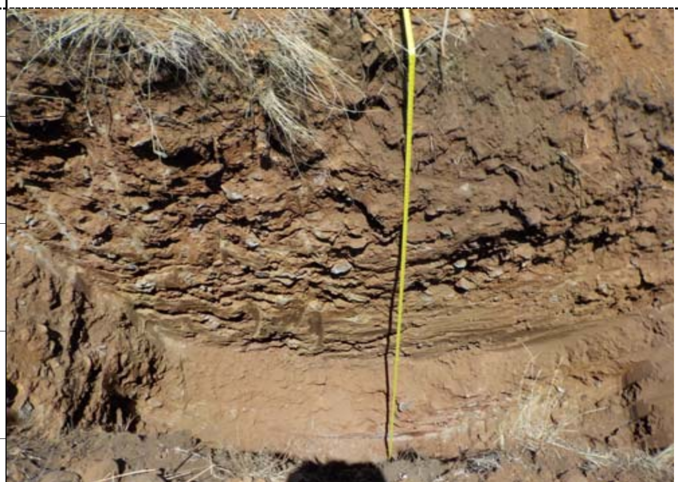
Plan View of Pit:



NewFields

Pit ID: TP- 122A

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/26/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069637 N 170410.3	Elevation:		Total Pit Depth:	13.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Existing drill pad, cleared of vegetation	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0			clayey GRAVEL (GC) with sand, trace cobbles, MPS=7in., medium plastic fines, friable gravel clasts, slightly moist, reddish brown	
7.5	LD 7-8ft		From 8-11' no cobbles observed	%G=34, %S=31, %F=35 PL=17, LL=41, PI=24
10.0				
12.5		13.0	Bedrock- Andesite, highly weathered, very weak, highly fractured, moist, reddish brown	
		13.5	TD = 13.5ft, Stopped due to out of borrow material Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

14'

4'

Picture

NewFields

Pit ID: TP- 122B

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/26/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069735 N 170345.8

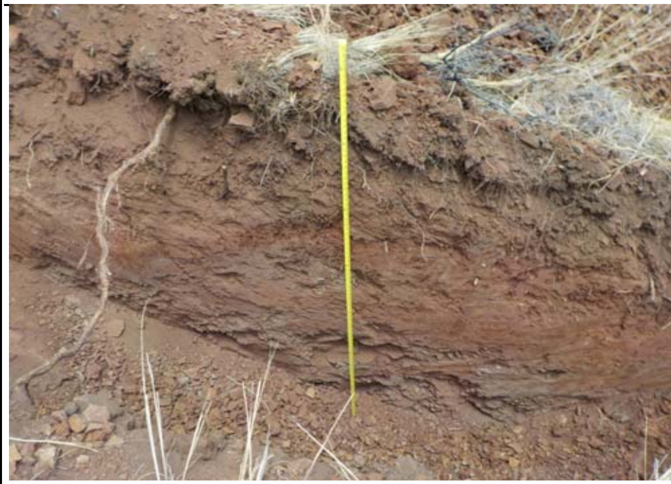
Elevation:

Total Pit Depth: 6.5ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

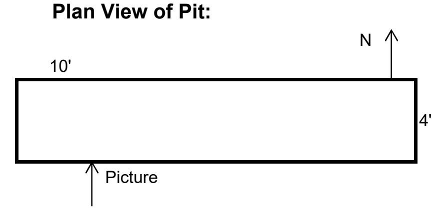
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
2.5	LD 2.5-3.5ft		4.5	clayey SAND (SC) with gravel, low plasticity fines, MPS=4in., friable clasts, slightly moist, reddish brown (Residual bedrock)	Roots to 24in. %G=24, %S=58, %F=18 PL=17, LL=37, PI=20
5.0			6.5	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=4in., reddish brown	
7.5				TD = 6.5ft Stopped due to out of borrow material Water table not encountered at time of excavation.	
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 122C

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/26/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069715 N 170480.2

Elevation:

Total Pit Depth: 10.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 4-5ft		clayey GRAVEL (GC) with sand, occasional cobbles MPS=7in., low to medium plastic fines, weak friable clasts, slightly moist (Residual bedrock)	%G=46, %S=39, %F=15 PL=14, LL=39, PI=25
7.5		6.5	Bedrock Andesite, highly weathered, weak, highly fractured, friable clasts, MPS=10in.	
10.0		10.0	TD = 10.0ft, Refusal on bedrock Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

10'

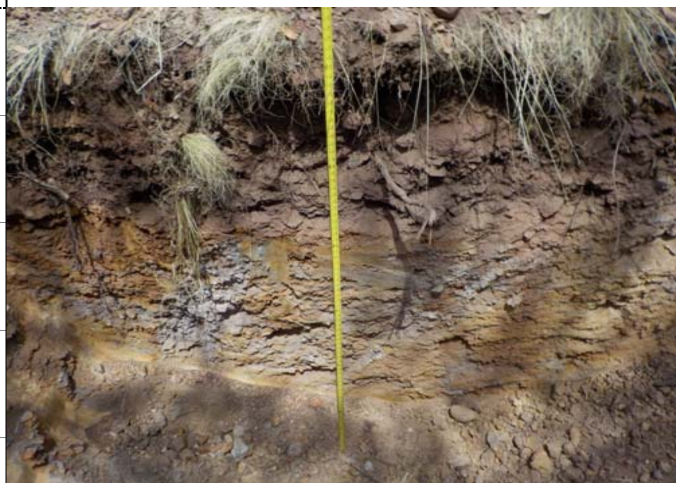
4'

Picture

NewFields

Pit ID: TP- 122D

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/26/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1069798 N 17524.8
Elevation:
Total Pit Depth: 6.0ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Grass and trees, located at base of valley
Backfilled: Yes

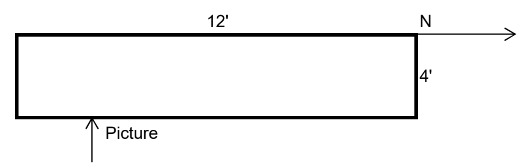
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–2.0			silty SAND (SM) some gravel, angular, MPS=7in., dry, non-plastic fines, brown	Roots to 18in.
2.0–6.0			Bedrock - Andesite, highly weathered, weak, highly fractured, MPS=10in., bleached appearance, most feldspar weathered to clay, light brown to chalk white	
6.0			TD = 6.0ft,Stopped due to lack of borrow material Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 122E

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/26/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069514 N 170285.2	Elevation:		Total Pit Depth:	6.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grass with sparse tress and shrubs	Backfilled:	Yes

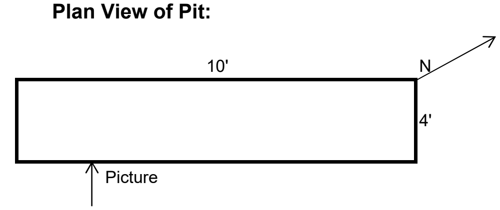
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			clayey GRAVEL (GC) some cobbles, MPS=7in., subangular, low plasticity fines, slightly moist, brown	Roots to 12in.
2.0			Bedrock- Andesite, highly weathered, medium strong, highly fractured, MPS=10in., maroon	
6.5			TD = 6.5ft, Refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 122F

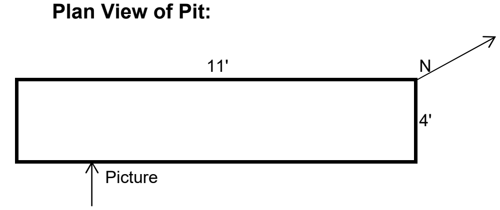
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/26/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069485 N 170390.4	Elevation:		Total Pit Depth:	6.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Existing drill pad, cleared of vegetation	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1.5-2.5ft	3.0	sandy CLAY (CL) medium plasticity, occasional gravel, MPS=3in., slightly moist, reddish brown	Roots to 16in.
2.5				
5.0		6.0	Bedrock- Andesite, highly weathered, medium strong, highly fractured, MPS=6in., reddish brown	
7.5			TD = 6.0ft Stopped due to out of borrow material Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 122G

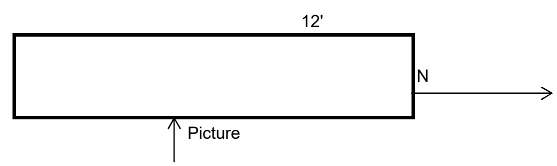
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/26/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069526 N 170339.9	Elevation:		Total Pit Depth:	11.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5				
5.0	LD 4-5ft		clayey SAND (SC) with gravel, MPS=4in., friable clasts, low plasticity, slightly moist, reddish brown	%G=18, %S=67, %F=15 PL=19, LL=33, PI=14 ω%=9.8
7.5		7.0	Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=4in.	
10.0		11.0	TD =11.0ft Excavator reach limit Water table not encountered at time of excavation.	
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 123

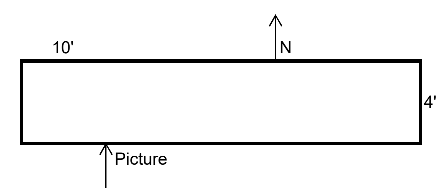
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/26/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1069653 N 170090.3	Elevation:		Total Pit Depth:	6.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Grass with sparse trees	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5	SD 2.5-3.5ft		silty SAND (SM) with gravel, MPS=2in., no plasticity, angular, dry, reddish brown (Residual bedrock)	
4.0			Bedrock - Andesite, highly weathered, weak, highly fractured, MPS=4in., reddish brown	
6.5			TD = 6.5ft, Stopped due to lack of borrow material Water table not encountered at time of excavation.	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 124

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/27/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070053 N 169763.5	Elevation:		Total Pit Depth:	7.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Side of roadway	Backfilled:	Yes

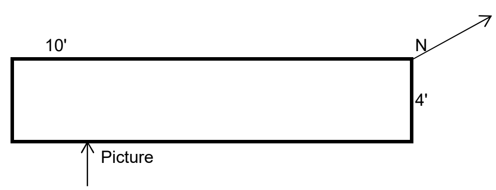
Pit Wall Profile

Depth (ft)	Sample (depth & type)	Depth	Description	Additional Notes
		0.5	clayey SAND and organics (topsoil)	Roots to 16in.
2.5	SD 2-3ft	3.0	sandy CLAY (CL), fine grained sand, low to medium plasticity, moderate dry strength, dry (Residual bedrock)	
	LD 3-4ft	6.0	clayey SAND (SC) some gravel, MPS=3in., slightly plastic, dry, light brown (Residual bedrock)	
5.0		7.0	Bedrock, highly weathered, weak, nonplastic, breaks down to silty gravel	
7.5			TD = 7.0ft Stopped due to out of borrow material Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 124A

Project: Hermosa Underground			Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona			Date: 6/27/2017
Equipment: Deere 180G LC	Contractor: DM Engineering & Excavating		Logged by: R. Bartingale
Coordinates: E 1069954 N 169969.8	Elevation:		Total Pit Depth: 5.0ft
Datum: NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			0.5 clayey SAND and organics (topsoil)	
2.5			Bedrock- Andesite, highly weathered, weak, highly fractured, MPS=4in., reddish brown	
5.0			5.0 TD = 5.0ft Stopped due to no useable borrow material Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

10'

4ft N

Picture

NewFields

Pit ID: TP- 125

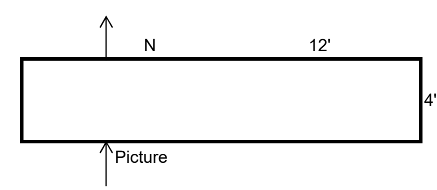
Project: Hermosa Underground		Project No.: 475.0014.008	
Project Location: Santa Cruz County, Arizona		Date: 6/27/2017	
Equipment: Deere 180G LC	Contractor: DM Engineering & Excavating	Logged by: R. Bartingale	
Coordinates: E 1070655 N 170039.3	Elevation:	Total Pit Depth: 3.5ft	
Datum: NAD 83 Arizona Central State Plane US feet	Surface Conditions: Grasses with sparse trees	Backfilled: Yes	

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
1.0			clayey SAND and organics (topsoil)	Roots to 18in.
2.5	LD 2-3ft		clayey SAND (SC) with gravel, fine to coarse sand, medium plasticity, moderate dry strength, MPS=2in.,dry, reddish brown	%G=29, %S=57, %F=14 PL=23 , LL=44 , PI=21
3.5			TD = 3.5ft Stopped due to out of borrow material Water table not encountered at time of excavation.	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 125A

Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/27/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070515 N 170005	Elevation:		Total Pit Depth:	9.0ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:		Backfilled:	Yes

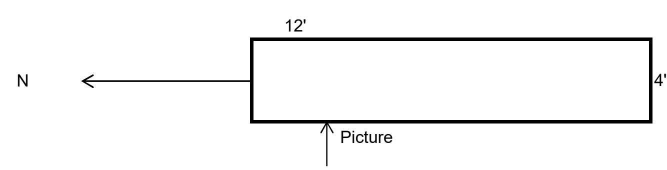
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.5			clayey SAND and organics (topsoil)	Roots to 1.5ft.
8.0	LD 3-4ft		sandy CLAY (CH) some gravel, high plasticity, fine to coarse grained, MPS=2in., angular, slightly moist, brown	%G=6, %S=41, %F=53 PL=22, LL=53, PI=31
9.0			Bedrock- Andesite, high weathered, weak, highly fractured, MPS=5in.	
			TD = 9.0ft, refusal on bedrock Water table not encountered at time of excavation.	

Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 125B

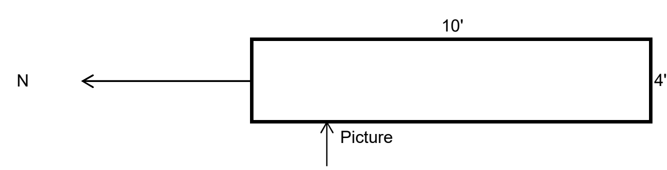
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/27/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070541 N 169892.5	Elevation:		Total Pit Depth:	3.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Roadway Area	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	LD 1-2ft		silty SAND (SM) with gravel, MPS=4in., slight plasticity, fine to coarse grained, subangular and subrounded, friable grains, dry, light reddish brown	%G=27, %S=56, %F=17 PL=NP, LL=NP, PI=NP
2.5		2.5	Bedrock - Andesite, highly weathered, weak, highly fractured, MPS=8in., light reddish brown	
		3.5	TD = 3.5ft, refusal on bedrock Water table not encountered at time of excavation.	
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	**%G**	Percent Gravel
LD	Large disturbed sample	**%S**	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	**%F**	Percent Fines
BL	Block sample	**PL**	Plastic Limit
ρ	In-situ density test	**LL**	Liquid Limit
ω	Water content	**PI**	Plasticity Index
▼	Water table encountered	**NP**	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 126

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/27/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1070016 N 170312.5

Elevation:

Total Pit Depth: 9.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

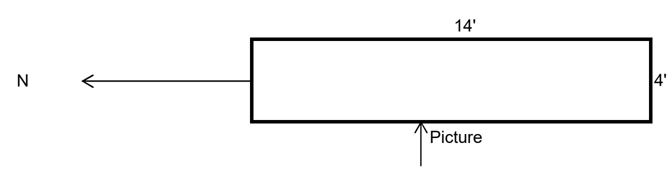
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Depth	Description	Additional Notes
			0.5	clayey GRAVEL with organics (topsoil)	
2.5	LD 2-3ft		3.0	sandy CLAY (CH) trace gravel, high plasticity, subrounded gravel, MPS=4in., dry, reddish brown (Residual bedrock)	%G=11, %S=38, %F=51 PL=19, LL=59, PI=40
5.0	LD 4-5ft		8.0	clayey SAND (SC) with gravel, subrounded, MPS=8in., medium plastic fines, dry, light brown (Residual bedrock)	%G=22, %S=43, %F=35 PL=27, LL=47, PI=20
7.5			9.0	Bedrock- Andesite, completely weathered, weak, low plasticity when pulverized	
10.0				TD = 9.0ft, Stopped due to out of borrow material Water table not encountered at time of excavation.	
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 126A

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/27/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1069992 N 170454.1 | Elevation: | Total Pit Depth: 3.0ft

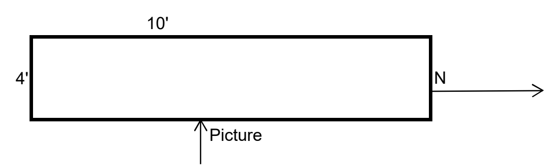
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			0.5 silty SAND with organics (topsoil)	
2.5			3.0 Bedrock- Andesite, moderately weathered, medium strong, highly fractured, heavy oxidation along fractures, greenish gray	
5.0			TD = 3.0ft, Stopped due to no useable borrow material Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 126B

Project: Hermosa Underground | Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona | Date: 6/27/2017

Equipment: Deere 180G LC | Contractor: DM Engineering & Excavating | Logged by: R. Bartingale

Coordinates: E 1070134 N 170372 | Elevation: | Total Pit Depth: 4.0ft

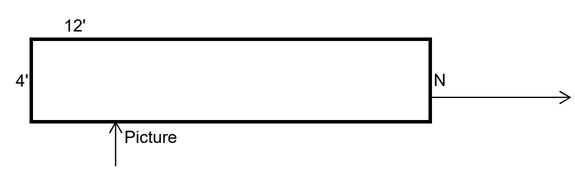
Datum: NAD 83 Arizona Central State Plane US feet | Surface Conditions: Grass sparse trees | Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile		Description	Additional Notes
			0.5	silty SAND with gravel and organics (topsoil)	
2.5				Bedrock- Andesite, moderately weathered, medium strong, highly fractured, oxidized along fractures, greenish gray	
			4.0	TD = 4.0ft, refusal on bedrock Water table not encountered at time of excavation.	
5.0					
7.5					
10.0					
12.5					
15.0					
17.5					
20.0					

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 126C

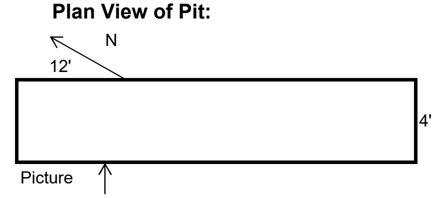
Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/27/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1070023 N 170203.4
Elevation:
Total Pit Depth: 10.5ft
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions:
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
1.0			silty SAND with organics (topsoil)	Roots to 16in.
2.5	LD 2-3ft			%G=54, %S=26, %F=20 PL=22, LL=35, PI=13
5.0			clayey GRAVEL (GC) with sand and cobbles, MPS=4in., low plasticity, dry, reddish brown	
7.5	LD 6-7ft			%G=26, %S=43, %F=31 PL=24, LL=44, PI=20
10.5			clayey SAND (SC) with gravel, MPS=4in., medium plastic fines, subangular, slighty moist, light reddish brown (Residual bedrock)	
12.5			TD = 10.5ft, Refusal on bedrock Water table not encountered at time of excavation.	
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 126D

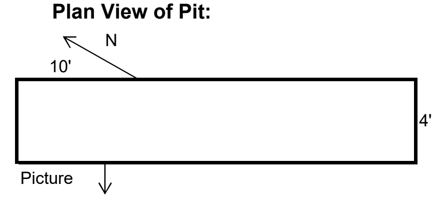
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Santa Cruz County, Arizona			Date:	6/27/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	R. Bartingale
Coordinates:	E 1070013 N 170028.7	Elevation:		Total Pit Depth:	6.5ft
Datum:	NAD 83 Arizona Central State Plane US feet	Surface Conditions:	Base of drainage valley	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
			0.5 silty SAND with gravel (topsoil)	Roots to 12in.
2.5	SD 2-3ft		clayey SAND (SC) some gravel, MPS=3in., low plastic fines, slighty moist, brown (Residual bedrock)	%G=10, %S=71, %F=19 PL=19, LL=35, PI=16 ω%=5.6
5.0				
7.5			6.5 TD = 6.5ft, refusal on bedrock Water table not encountered at time of excavation.	
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 126E

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/28/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1069945 N 1700260.8

Elevation:

Total Pit Depth: 7.0ft

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions:

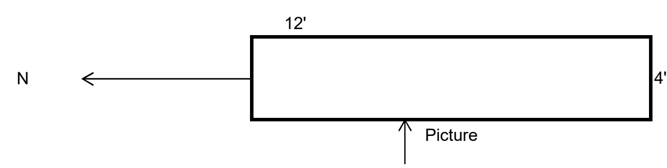
Backfilled: Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.5			silty SAND and organics (topsoil)	Roots to 12in.
2.5	LD 3-4ft		clayey GRAVEL (GC) with sand, MPS=6in., medium plastic fines, angular, slightly moist, light brown	
5.0				
7.0			TD = 7.0ft, Refusal on bedrock Water table not encountered at time of excavation.	
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:



NewFields

Pit ID: TP- 127

Project: Hermosa Underground

Project No.: 475.0014.008

Project Location: Santa Cruz County, Arizona

Date: 6/28/2017

Equipment: Deere 180G LC

Contractor: DM Engineering & Excavating

Logged by: R. Bartingale

Coordinates: E 1075359 N 167627.5

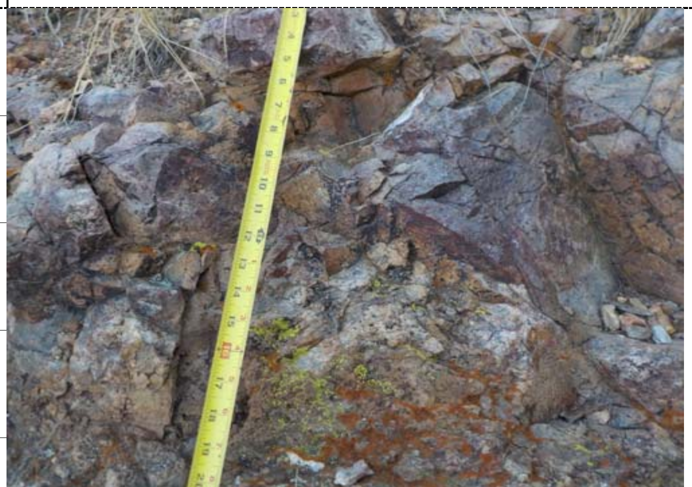
Elevation:

Total Pit Depth: NA

Datum: NAD 83 Arizona Central State Plane US feet

Surface Conditions: Exposed rock face along roadway

Backfilled:

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
	Surface 2 buckets		Bedrock- Quartzite, very strong, slightly weathered, moderately fractured, light gray	LA Abrasion - 20% Loss
2.5				
5.0				
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N ←

Pictue ↑

NewFields

Pit ID: TP-128

Project: Hermosa Underground
Project No.: 475.0014.008
Project Location: Santa Cruz County, Arizona
Date: 6/22/2017
Equipment: Deere 180G LC
Contractor: DM Engineering & Excavating
Logged by: R. Bartingale
Coordinates: E 1071125 N 170946.6
Elevation:
Total Pit Depth: NA
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Rock outcrop along roadway
Backfilled:

Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
2.5			Bedrock- Andesite, moderately weathered, slight plasticity, medium strong, highly fractured, fractures at 4-8in. spacing, reddish gray color	
5.0	LD 3-5ft 2 buckets	5.0		LA Abrasion - 43% loss
7.5				
10.0				
12.5				
15.0				
17.5				
20.0				

Legend:

SD	Small disturbed sample	%G	Percent Gravel
LD	Large disturbed sample	%S	Percent Sand
ST	Thin-walled tube sample (vert / horz.)	%F	Percent Fines
BL	Block sample	PL	Plastic Limit
ρ	In-situ density test	LL	Liquid Limit
ω	Water content	PI	Plasticity Index
▼	Water table encountered	NP	Non-plastic

Plan View of Pit:

N

Picture

APPENDIX D.1.3

Test Pit Logs (January 2018)

NewFields
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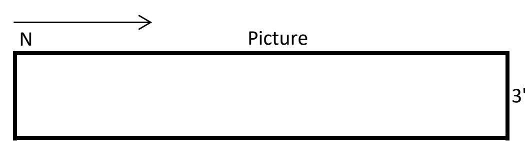
				Pit ID:	TP-01
Project:	Arizona Minerals Inc.; Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,719; E:1,069,691	Elevation:	5121'	Total Pit Depth:	31"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile Profile of face (refer to plan view of pit below): Profile Width = 3'		Description	Additional Notes
1.0			0 – 14"	Growth Media	
2.0	LD 14-31in.		14" – 31"	Poorly graded GRAVEL with silt and sand (GP-GM), angular, NP, fine to coarse grained, brown, dry	PL = NP PI = NP
3.0			31"	Water table not encountered at time of excavation. TD = 31". Refusal due to Bedrock.	

Legend:

SD	Small disturb Small disturbed sample
LD	Large disturb Large disturbed sample
ST	Thin-walled t Thin-walled tube sample (vert. / horz.)
BL	Block sample Block sample
ρ	In-situ densit In-situ density test
ω̃	Water contei Water content
BL	Water table ‹ Water table encountered

Plan View of Pit: (include width, length and North direction)



NewFields
Perspective. Vision. Solutions.

				Pit ID:	TP-02
Project:	Arizona Minerals Inc.; Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,596; E:1,069,733	Elevation:	5130'	Total Pit Depth:	44"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile Profile of face (refer to plan view of pit below): Profile Width = 3'	Description	Additional Notes
0 – 1.0		0 – 18"	Growth Media	
2.0 – 3.0	LD @ 18-44in.	18" – 44"	Well graded GRAVEL with silt and sand (GW-GM), fine to coarse grained, angular, medium plastic, brown, dry	PL = 29 PI = 14
4.0		44"	Water table not encountered at time of excavation. TD = 44". Refusal due to Bedrock.	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert. / horz.)
BL	Block sample Block sample
ρ	In-situ densit In-situ density test
ω̃	Water content
BL	Water table encountered

Plan View of Pit: (include width, length and North direction)

N

Picture

3'

12'

NewFields
Perspective. Vision. Solutions.

				Pit ID:	**TP-03**
Project:	Arizona Minerals Inc.; Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,457; E:1,069,805	Elevation:	5141'	Total Pit Depth:	120"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile Profile of face (refer to plan view of pit below): Profile Width = 6'		Description	Additional Notes
2.0			0 – 22"	Growth Media	
4.0 6.0	LD @ 22-69 in.		69"	Clayey SAND(SC) subangular to angular, medium plasticity, tan, dry	PL = 22 PI = 16
8.0 10.0	SD @ 69-120 in.		120"	Clayey SAND with gravel (SC) subangular to angular, medium plasticity, yellowish-white, moist	PL = 22 PI = 15
				Water table not encountered at time of excavation. TD = 120". Limits of Excavator.	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert. / horz.)
BL	Block sample
ρ	In-situ density test
ϖ̃	Water content
BL	Water table encountered

Plan View of Pit: (include width, length and North direction)

N
Picture
6'
12'

NewFields
Perspective. Vision. Solutions.

Pit ID: **TP-04**

Project:	Arizona Minerals Inc.; Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,330; E:1,069,843	Elevation:	5150'	Total Pit Depth:	47"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Pit Wall Profile
Profile of face (refer to plan view of pit below):
Profile Width = 4'

Depth (ft)	Sample (depth & type)	Pit Wall Profile depth	Description	Additional Notes
0 – 1.0		0 – 16"	Growth Media	
2.0	SD @ 16-24 in.		Clayey SAND (SC), subangular to angular, medium plasticity, reddish-brown, moist	PL = 20 PI = 13
3.0	LD @ 16-47 in.		Poorly graded GRAVEL with clay and sand (GP-GC), subangular to angular, high plasticity, brown, moist	PL = 25 PI = 20
	SD @ 40-47 in.	47"	Silty SAND (SM), subrounded to subangular, medium plasticity, white, moist	PL = 28 PI = 17
4.0 – 5.0			Water table not encountered at time of excavation. TD = 47". Refusal due to Bedrock.	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert. / horz.)
BL	Block sample
ρ	In-situ density test
ῶ	Water content
BL	Water table encountered

Plan View of Pit: (include width, length and North direction)

N →
Picture
4'
12'

NewFields Perspective. Vision. Solutions.

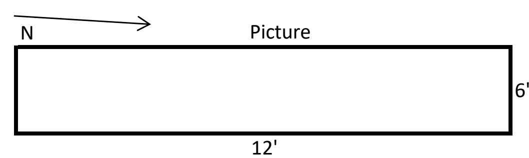
				Pit ID:	**TP-05**
Project:	Arizona Minerals Inc.; Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,265; E:1,069,758	Elevation:	5168'	Total Pit Depth:	49"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile Profile of face (refer to plan view of pit below): Profile Width = 6'	Description	Additional Notes
1.0		0 – 18"	Growth Media	
2.0 – 3.0	LD @ 18-36 in.	18" – 36"	Clayey GRAVEL with sand (GC), angular, high plasticity, brown, dry	PL = 23 PI = 23 Max. Dry Density = 128.0 pcf Optimum Moisture = 8.6% per ASTM D 1557 Method C
4.0	LD @ 36-49 in.	36" – 49"	Poorly graded GRAVEL with clay and sand (GP-GC), angular, high plasticity, brown, dry	PL = 22 PI = 19
5.0		49"	Water table not encountered at time of excavation. TD = 49". Refusal due to Bedrock.	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert. / horz.)
BL	Block sample
ρ	In-situ density test
ω̄	Water content
BL	Water table encountered

Plan View of Pit: (include width, length and North direction)



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				Pit ID:	**TP-06**
Project:	Arizona Minerals Inc., Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,181; E:1,069,845	Elevation:	5165'	Total Pit Depth:	46"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile Profile of face (refer to plan view of pit below): Profile Width = 6'	Description	Additional Notes
1.0		0 – 15"	Growth Media	
2.0, 3.0	LD @ 15-46 in.	15" – 46"	Clayey GRAVEL with sand (GC), subrounded-subangular, medium plasticity, brown, dry	PL = 23 PI = 15
4.0, 5.0		46"	Water table not encountered at time of excavation. TD = 46". Refusal due to Bedrock.	

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert. / horz.)
- **BL** Block sample
- **ρ** In-situ density test
- **ω̃** Water content
- **BL** Water table encountered

Plan View of Pit: (include width, length and North direction)

N

Picture

6'

12'

NewFields
Perspective. Vision. Solutions.

Pit ID: **TP-07**

Project:	Arizona Minerals Inc., Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,563; E:1,069,908	Elevation:	5167'	Total Pit Depth:	30"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	Sample (depth & type)	Pit Wall Profile Profile of face (refer to plan view of pit below): Profile Width = 6'	Description	Additional Notes
1.0		0 – 16"	Growth Media	
2.0		16" – 30"	Poorly graded GRAVEL with silt and sand (GP-GM), angular, NP, fine to coarse grained, brown, dry	
3.0 4.0 5.0			Water table not encountered at time of excavation. TD = 30". Refusal due to Bedrock.	

Legend:

SD	Small disturbed sample
LD	Large disturbed sample
ST	Thin-walled tube sample (vert. / horz.)
BL	Block sample
ρ	In-situ density test
ϖ	Water content
BL	Water table encountered

Plan View of Pit: (include width, length and North direction)

N → Picture

6'

12'

NewFields
Perspective. Vision. Solutions.

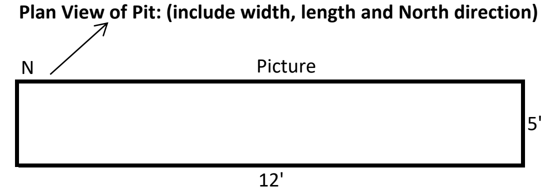
				Pit ID:	**TP-08**
Project:	Arizona Minerals Inc.; Tailings and Potentially Acid Generating (PAG) Material Remediation, Placment and Storage; Infrastructure Pad			Project #:	475.0014.011
Project Location:	Santa Cruz, AZ			Date:	1/29/2018
Equipment:	CAT 180G LC Excavator	Contractor:	DM Engineering & Excavating	Logged by:	JRK
Lat/Long (N/E):	N:170,505; E:1,069,649	Elevation:	5161'	Total Pit Depth:	49"
Shoring (if used):		Surface Conditions:	Existing Ground	Backfilled:	Yes

Depth (ft)	**Sample** (depth & type)	**Pit Wall Profile** Profile of face (refer to plan view of pit below): Profile Width = 5'	**Description**	**Additional Notes**
0–1.0		0 – 16"	Growth Media	
2.0, 3.0, 4.0	LD @ 16-49 in.	16" – 49"	Clayey GRAVEL with sand (GC), subrounded to subangular, medium plasticity, brown, dry	PL = 24 PI = 17
5.0		49"	Water table not encountered at time of excavation. TD = 49". Refusal due to Bedrock.	

Legend:

- **SD** Small disturbed sample
- **LD** Large disturbed sample
- **ST** Thin-walled tube sample (vert. / horz.)
- **BL** Block sample Block sample
- **ρ** In-situ density test
- **ῶ** Water content
- **BL** Water table encountered

Plan View of Pit: (include width, length and North direction)



APPENDIX D.2

APPENDIX D.2.1 – LABORATORY TEST RESULTS (JANUARY 2017)

APPENDIX D.2.2 – LABORATORY TEST RESULTS (JUNE 2017)

APPENDIX D.2.3 – LABORATORY TEST RESULTS (JANUARY 2018)

APPENDIX D.2.1

Laboratory Test Results (January 2017)

Note:

Appendix D.2.1 is included in this report for completeness although it is also presented as Appendix F in the NewFields' "Tailings and Potentially Acid Generating (PAG) Material, Remediation, Placement and Storage Project, Aquifer Protection Permit (APP), Best Available Demonstrated Control Technology (BADCT) Design Report" dated June 5, 2017 which is currently permitted under the Aquifer Protection Permit (APP) Program (No. P-512235) issued by the Arizona Department of Environmental Quality (ADEQ).

TABLE F-1 - BOREHOLE LAB TESTING SUMMARY

SAMPLE LOCATION				UNIFIED SOILS CLASSIFICATION (USCS)	USCS	NATURAL DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	GRADATION (%)					ATTERBERG LIMITS			SPECIFIC GRAVITY
Borehole ID	Sample ID	Depth (ft)						Gravel >#4	Sand	Fines <#200	Hydrometer		Plastic Limit	Liquid Limit	Plasticity Index	
		From	To	*Italics indicates field classification*							Silt	Clay				
BH-01	17-018-01	0	1.5	*silty SAND*	*SM*		10.9									
BH-01	17-018-02	5	6.5	*silty SAND / sandy SILT*	*SM/ML*		15.7									
BH-01	17-018-03	15	16.5	*sandy SILT*	*ML*		18.1									
BH-01	17-018-04	25.8	26.3	sandy SILT	ML	121.6	14.7	0.0	45.7	54.3			NP	NP	NP	
BH-01	17-018-05	35.9	36.4	*SILT*	*ML*	122.5	11.3									
BH-01	17-018-06	45.8	46.3	*lean CLAY*	*CL*	127.0	24.3									
BH-01	17-018-07	46.5	49.0	lean CLAY	CL		33.5	0.0	1.9	98.1	68.7	29.4	38	22	16	2.984
BH-01	17-018-08	52.5	54.0	clayey GRAVEL with sand	GC		11.5	63.8	22.8	13.4			34	22	12	
BH-02	17-018-09	0	1.5	*sandy CLAY*	*CL*		18.9									
BH-02	17-018-10	5	6.5	sandy SILT	ML		37.2	0.6	31.8	67.6			NP	NP	NP	
BH-02	17-018-11	15	16.5	*sandy SILT*	*ML*		31.0									
BH-02	17-018-12	25	26.5	*SILT*	*ML*		32.0									
BH-02	17-018-13	26.5	29.0	SILT	ML		43.2	0.0	0.4	99.6	66.0	33.6	42	29	13	3.033
BH-02	17-018-14	35	36.5	lean CLAY	CL		37.1	0.0	2.0	98.0	71.6	26.4	34	24	10	3.057
BH-02	17-018-15	37.5	39.0	*clayey GRAVEL with sand*	*GC*		11.4	39.4	36.7	23.9						
BH-03	17-018-16	0	1.5	*silty clayey SAND*	*SM/SC*		16.6									
BH-03	17-018-17	4	5.5	*silty SAND*	*SM*		12.5	0.3	56.4	43.3						
BH-03	17-018-18	15	16.5	*SILT*	*ML*		26.4									
BH-03	17-018-19	25	26.5	*SILT/CLAY*	*ML/CL*		32.1									2.971
BH-03	17-018-20	35	36.5	lean CLAY	CL		35.4	0.0	0.9	99.1			33	21	12	
BH-03	17-018-21	43.8	44.3	*lean CLAY*	*CL*		14.6	2.8	66.7	30.5						
BH-04	17-018-22	0	1.5	*silty SAND*	*SM*		9.8									
BH-04	17-018-23	5	6.5	*SILT*	*ML*		19.5									
BH-04	17-018-24	15	16.5	SILT with sand	ML		20.0	0.0	24.8	75.2			NP	NP	NP	
BH-04	17-018-25	20	21.5	silty GRAVEL with sand	GM		12.0	50.6	28.0	21.4			36	34	2	
BH-04	17-018-26	30	31.5	*silty GRAVEL with sand*	*GM*		12.9									
BH-04	17-018-27	40	41.5	clayey SAND with gravel	SC		26.8	17.8	54.2	28.0			32	21	11	
BH-05	17-018-28	0	1.5	*silty GRAVEL with sand*	*GM*		11.5									
BH-05	17-018-29	5	6.5	sandy SILT	ML		17.3	0.0	40.5	59.5			NP	NP	NP	
BH-05	17-018-30	15	16.5	silty SAND	SM		17.5	0.0	52.2	47.8	35.6	12.2	NP	NP	NP	
BH-05	17-018-31	17.5	19.0	clayey SAND	SC		19.3	10.2	50.5	39.3			38	20	18	

TABLE F-1 - BOREHOLE LAB TESTING SUMMARY

SAMPLE LOCATION				UNIFIED SOILS CLASSIFICATION (USCS)	USCS	NATURAL DENSITY (pcf)	NATURAL MOISTURE CONTENT (%)	GRADATION (%)					ATTERBERG LIMITS			SPECIFIC GRAVITY
Borehole ID	Sample ID	Depth (ft)						Gravel >#4	Sand	Fines <#200	Hydrometer		Plastic Limit	Liquid Limit	Plasticity Index	
		From	To	*Italics indicates field classification*							Silt	Clay				
BH-06	17-018-32	0	1.5	*gravelly CLAY*	*CL*		20.8									
BH-06	17-018-33	10	11.5	clayey GRAVEL with sand	GC		13.7	61.3	24.6	14.1			38	23	15	2.918
BH-06	17-018-34	20	21.5	*clayey GRAVEL with sand*	*GC*		16.7									
BH-06	17-018-35	21.9	23.4	*clayey GRAVEL with sand*	*GC*		12.3									
BH-07	17-018-36	1	2.5	*sandy CLAY with gravel*	*CL*		14.0									
BH-07	17-018-37	5	6.5	sandy SILT	ML		30.7	0.0	42.9	57.1			NP	NP	NP	3.004
BH-07	17-018-38	10	11.5	*fat CLAY*	*CH*		40.3									
BH-07	17-018-39	20	21.5	*lean CLAY*	*CL*		45.5									
BH-07	17-018-40	21.5	24.5	lean CLAY	CL		40.3	0.0	2.0	98.0			40	22	18	2.982
BH-07	17-018-41	30	31.1	*lean CLAY*	*CL*		29.7									
BH-07	17-018-42	31.1	31.5	*silty SAND*	*SM*		24.7	5.5	57.1	37.4						
BH-07	17-018-43	32.5	34.0	clayey sand	SC		17.6	0.7	51.1	48.2			34	19	15	
BH-07	17-018-44	35.9	36.4	*clayey sand*	*SC*		12.8	5.2	58.8	36.0						3.027
BH-07	17-018-45	35.4	35.9	*clayey sand*	*SC*		12.0									
BH-08	17-018-46	0	1.5	*sandy CLAY*	*CL*		15.6									
BH-08	17-018-47	5	6.5	*sandy SILT*	*ML*		21.8	0.0	38.2	61.8						
BH-08	17-018-48	15	16.5	*sandy SILT*	*ML*		19.2									
BH-08	17-018-49	25	26.5	SILT with sand	ML		21.3	0.0	28.5	71.5			NP	NP	NP	
BH-08	17-018-50	35	36.5	*SILT with sand*	*ML*		33.6									
BH-08	17-018-51	45	46.5	*SILT*	*ML*		23.2									
BH-08	17-018-52	45	48.0	*SILT*	*ML*		25.1									
BH-08	17-018-53	50	51.5	*silty clayey GRAVEL*	*GM/GC*		11.5									
BH-08	17-018-54	52.5	54.0	*poorly graded GRAVEL*	*GP*		8.0	55.8	35.2	9.0						
BH-13	17-018-55	1	2.5	clayey SAND	SC		11.7	9.7	57.4	32.9			33	20	13	
BH-13	17-018-56	6	7.5	poorly graded SAND with silt and gravel	SP-SM		8.4	30.1	58.4	11.5			NP	NP	NP	
BH-13	17-018-57	8.5	10.0	*poorly graded SAND with silt and gravel*	*SP-SM*		6.0	37.2	50.4	12.4						
BH-16	17-018-58	1	2.5	clayey SAND	SC		12.7	6.8	45.2	48.0			34	19	15	
BH-16	17-018-59	3.5	5.0	*clayey SAND*	*SC*		14.5						34	20	14	
BH-16	17-018-60	6	7.5	clayey SAND with gravel	SC		10.1	24.6	40.5	34.9			30	17	13	
BH-16	17-018-61	8.5	9.0	*clayey GRAVEL*	*GC*		5.8	60.7	20.9	18.4						

Notes:

NP - nonplastic

TABLE F-2 - TEST PIT LAB TESTING SUMMARY

SAMPLE LOCATION				UNIFIED SOILS CLASSIFICATION (USCS)	USCS	NATURAL MOISTURE CONTENT (%)	GRADATION (%)					ATTERBERG LIMITS			SPECIFIC GRAVITY	MODIFIED PROCTOR		STANDARD PROCTOR	
Test Pit ID	Sample ID	Depth (ft)					Gravel >#4	Sand	Fines <#200	Hydrometer		Plastic Limit	Liquid Limit	Plasticity Index		Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
		From	To	*Italics indicates field classification*						Silt	Clay								
TP-01	17-019-01	3.0	4.0	*well graded GRAVEL*	*GW*	5.3	93.4	5.2	1.4										
TP-02	17-019-02	2.0	3.0	clayey SAND with gravel	SC	13.0	21.8	51.8	26.4			20	37	17	2.832	129.4	10.1		
TP-06	17-019-03	1.0	3.0	sandy fat CLAY	CH	26.9	1.4	37.0	61.6			21	55	34	2.793	109.9	17.4		
TP-07	17-019-04	0.0	1.5	silty SAND	SM	10.6	9.5	60.6	29.9			NP	NP	NP					
TP-07	17-019-05	7.0	8.0	*poorly graded GRAVEL*	*GP*	2.7	77.6	19.0	3.4						2.784				
TP-08	17-019-06	1.0		*clayey SAND*	*SC*	5.3	61.3	34.4	4.3										
TP-08	17-019-07	4.0		clayey SAND with gravel	SC	5.6	23.5	61.5	15.0			18	26	8		132.1	8.4		
TP-09	17-019-08	1.0	2.0	silty SAND with gravel	SC	13.9	26.1	50.7	23.2			23	31	8					
TP-11	17-019-09	3.0	4.0	*poorly graded SAND*	*SP*	12.8	12.4	59.3	28.3										
TP-11	17-019-10	10.0	11.0	clayey SAND with gravel	SC	11.0	26.6	49.5	23.9			17	32	15					
TP-13	17-019-11	1.0	3.0	*poorly graded GRAVEL*	*GP*	6.9	74.2	21.6	4.2										
TP-14	17-019-12	3.0	4.0	poorly graded GRAVEL with clay and sand	GP-GC	4.9	69.3	21.5	6.0			20	30	10		143.4	6.8		
TP-15	17-019-13	5.0	6.0	*poorly graded GRAVEL*	*GP*	6.6	42.5	39.2	18.3						2.805				
TP-17	17-019-14	5.0	6.0	*poorly graded GRAVEL with silt*	*GP-GM*	6.9	64.3	27.5	8.2						2.804				
TP-24	17-019-15	4.0	7.0	sandy SILT	ML	16.6	1.6	43.8	54.6	44.7	9.9	NP	NP	NP		132.3	12.6	119.2	16.5
TP-25	17-019-16	8.0	10.0	fat CLAY	CH	43.5	0.1	6.0	93.9	78.5	15.4	27	57	30		115.6	17.1	101.5	23.1
TP-26	17-019-17	10.0	12.0	*poorly graded GRAVEL with silt*	*GP-GM*	8.0	10.5	54.5	35.0										
TP-28	17-019-18	5.0	8.0	clayey SAND with gravel	SC	23.9	22.1	44.6	33.3			20	33	13				115.4	17.0
TP-30	17-019-19	3.0	5.0	SILT	ML	9.7	0.1	0.8	99.1			NP	NP	NP		121.5	13.2		
TP-31	17-019-20	2.0	4.0	*poorly graded SAND*	*SP*	10.5	42.3	51.5	6.2							133.6	10.0		
TP-32	17-019-21	1.0	3.0	*clayey SAND with silt and gravel*	*SC*														
TP-32	17-019-22	11.5	14.0	sandy lean CLAY	CL	13.9	5.5	39.7	54.8			19	46	27					
TP-33	17-019-23	1.0 15.0	7.0 20.5	silty SAND	SM	11.5	10.5	56.5	33.0	24.4	8.6	NP	NP	NP				125.6	12.2
TP-38	17-019-24	0.0	7.0	*silty SAND*	*SM*														
TP-47A	17-019-25	3.0	4.0	clayey SAND with gravel	SC	13.7	29.2	31.0	37.4			18	42	24		128.4	11.3		
TP-48	17-019-26	0.0	4.0	clayey GRAVEL with sand	GP-GC	7.9	56.3	28.8	10.4			18	30	12		134.7	8.7		
TP-51	17-019-27	1.0	2.0	clayey GRAVEL	GC	11.5	60.5	25.2	14.3			18	35	17		139.0	8.6		
TP-51	17-019-28	5.0	6.0	*silty GRAVEL*	*GM*	7.8	58.0	27.8	14.2						2.696				
TP-50A	17-019-29	2.0	3.0	silty GRAVEL with sand	GP-GM	4.2	70.7	22.3	7.0			NP	NP	NP					
TP-50B	17-019-30	0.0	1.0	clayey GRAVEL	GC	10.4	47.5	33.5	19.0			19	31	12					
TP-55	17-019-31	3.0	4.0	poorly graded GRAVEL	GP	3.2	76.8	9.0	1.6										
TP-60	17-019-32	0.0	1.0	*silty sandy GRAVEL*	*GM*	9.4	36.9	35.1	28.0										
TP-60	17-019-33	3.0	4.0	*silty sandy GRAVEL*	*GM*	8.0	42.1	36.1	21.8										
TP-61	17-019-34	0.0	1.0	*SAND with silt*	*SP-SM*	5.0	33.5	56.0	10.5										

Notes:
TP-33 samples combined for testing
NP - nonplastic

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Project	**Elevation:**	See below per sample
Project Number:	475.0014.008	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-018	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-018-01	17-018-02	17-018-03	17-018-07	17-018-08
Location		BH-01	BH-01	BH-03	BH-01	BH-01
Depth		0-1.5	5-6.5	15-16.5	46.5-49	52.5-54
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	554.5	747	809.5	787.3	482.4
Tare + Dry Soil	**B**	515.2	666.3	715	645.6	448.5
Tare	**C**	155.7	153.9	193.5	223.1	154.5
Wt. of Water	**D= A-B**	39.3	80.7	94.5	141.7	33.9
Dry Soil, Ws	**E= B-C**	359.5	512.4	521.5	422.5	294
Moisture Content, (%)	**(D/E) x100**	10.9	15.7	18.1	33.5	11.5

Sample No.		17-018-09	17-018-10	17-018-11	17-018-12	17-018-13
Location		BH-02	BH-02	BH-02	BH-02	BH-02
Depth		0-1.5	5-6.5	15-16.5	25-26.5	26.5-29
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	685.9	398.4	567.2	361.8	627.7
Tare + Dry Soil	**B**	601.2	331.7	470.2	277.6	494.7
Tare	**C**	152	152.4	157.8	14.1	186.6
Wt. of Water	**D= A-B**	84.7	66.7	97	84.2	133
Dry Soil, Ws	**E= B-C**	449.2	179.3	312.4	263.5	308.1
Moisture Content, (%)	**(D/E) x100**	18.9	37.2	31.0	32.0	43.2

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Project	**Elevation:**	See below per sample
Project Number:	475.0048.008	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson	**Tested By:**	
Field Sample ID:	17-018	**Checked By:**	

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-018-14	17-018-15	17-018-16	17-018-17	17-018-18
Location		BH-02	BH-02	BH-03	BH-003	BH-03
Depth		35-36.5	37.5-39	0-1.5	4-5.5	15-16.5
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	422.5	401.2	682.4	333.8	498
Tare + Dry Soil	**B**	311.9	379.2	627.9	317.4	433.6
Tare	**C**	14	186.9	299.8	186.1	189.2
Wt. of Water	**D= A-B**	110.6	22	54.5	16.4	64.4
Dry Soil, Ws	**E= B-C**	297.9	192.3	328.1	131.3	244.4
Moisture Content, (%)	**(D/E) x100**	37.1	11.4	16.6	12.5	26.4

Sample No.		17-018-19	17-018-20	17-018-21	17-018-22	17-018-23
Location		BH-03	BH-03	BH-03	BH-04	BH-04
Depth		25-26.5	35-36.5	43.8-44.3	0-1.5	5-6.5
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	575.2	554.7	247.1	628.2	395.3
Tare + Dry Soil	**B**	481.3	441.8	231.6	589	349.1
Tare	**C**	189	122.7	125.6	188.6	111.8
Wt. of Water	**D= A-B**	93.9	112.9	15.5	39.2	46.2
Dry Soil, Ws	**E= B-C**	292.3	319.1	106	400.4	237.3
Moisture Content, (%)	**(D/E) x100**	32.1	35.4	14.6	9.8	19.5

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Prject	**Elevation:**	See below per sample
Project Number:	475.0048.008	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson.	**Tested By:**	OS
Field Sample ID:	17-018	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-018-24	17-018-25	17-018-26	17-018-27	17-018-28
Location		BH-04	BH-04	BH-04	BH-04	BH-05
Depth		15-16.5	20-21.5	30-31.5	40-41.5	0-1.5
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	381	651	686.2	330.5	553.9
Tare + Dry Soil	**B**	334.3	611.8	621.6	286.3	516.2
Tare	**C**	100.7	285.5	120.1	121.2	188.3
Wt. of Water	**D= A-B**	46.7	39.2	64.6	44.2	37.7
Dry Soil, Ws	**E= B-C**	233.6	326.3	501.5	165.1	327.9
Moisture Content, (%)	**(D/E) x100**	20.0	12.0	12.9	26.8	11.5

Sample No.		17-018-29	17-018-30	17-018-31	17-018-32	17-018-33
Location		BH-05	BH-05	BH-05	BH-06	BH-06
Depth		5-6.5	15-16.5	17.5-19	0-1.5	10-11.5
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	525	212.7	261.6	504	485.6
Tare + Dry Soil	**B**	487.1	183	222.1	419.7	450
Tare	**C**	267.7	13.5	17.3	14.4	190.2
Wt. of Water	**D= A-B**	37.9	29.7	39.5	84.3	35.6
Dry Soil, Ws	**E= B-C**	219.4	169.5	204.8	405.3	259.8
Moisture Content, (%)	**(D/E) x100**	17.3	17.5	19.3	20.8	13.7

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Prject	**Elevation:**	See below per sample
Project Number:	475.0048.008	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson.	**Tested By:**	OS
Field Sample ID:	17-018	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C   Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-018-34	17-018-35	17-018-36	17-018-37	17-018-38
Location		BH-06	BH-06	BH-07	BH-07	BH-07
Depth		20-21.5	21.9-23.4	1-2.5	5-6.5	10-11.5
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	679	837	714.6	481.4	569.5
Tare + Dry Soil	**B**	605.1	761.9	645.4	416	450.5
Tare	**C**	161.3	150	152.3	203	155.4
Wt. of Water	**D= A-B**	73.9	75.1	69.2	65.4	119
Dry Soil, Ws	**E= B-C**	443.8	611.9	493.1	213	295.1
Moisture Content, (%)	**(D/E) x100**	16.7	12.3	14.0	30.7	40.3

Sample No.		17-018-39	17-018-40	17-018-41	17-018-42	17-018-43
Location		Bh-07	BH-07	Bh-07	BH-07	BH-07
Depth		20-21.5	21.5-24.5	30-31.1	31.1-31.5	32.5-34
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	695	730.9	514.4	347.5	538.7
Tare + Dry Soil	**B**	526.5	590.4	431.8	310.2	480.8
Tare	**C**	156.2	241.8	153.9	158.9	151
Wt. of Water	**D= A-B**	168.5	140.5	82.6	37.3	57.9
Dry Soil, Ws	**E= B-C**	370.3	348.6	277.9	151.3	329.8
Moisture Content, (%)	**(D/E) x100**	45.5	40.3	29.7	24.7	17.6

Remarks:

NewFields

NF Form #15

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Prject	**Elevation:**	See below per sample
Project Number:	475.0048.008	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson.	**Tested By:**	OS
Field Sample ID:	17-018	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-018-44	17-018-45	17-018-46	17-018-47	17-018-48
Location		BH-07	BH-07	BH-08	BH-08	BH-08
Depth		35.9-36.4	35.4-35.9	0-1.5	5-6.5	15-16.5
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	366.5	524.4	655.5	560.3	883.4
Tare + Dry Soil	**B**	338.7	484.8	587.1	498.8	765.8
Tare	**C**	122.1	154.2	147.7	216.6	153.2
Wt. of Water	**D= A-B**	27.8	39.6	68.4	61.5	117.6
Dry Soil, Ws	**E= B-C**	216.6	330.6	439.4	282.2	612.6
Moisture Content, (%)	**(D/E) x100**	12.8	12.0	15.6	21.8	19.2

Sample No.		17-018-49	17-018-50	17-018-51	17-018-52	17-018-53
Location		BH-08	BH-08	BH-08	BH-08	BH-08
Depth		25-26.5	35-36.5	45-46.5	45-48	50-51.5
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	518	714.4	749.8	1113.5	738
Tare + Dry Soil	**B**	453.7	574.1	637.7	941	677.5
Tare	**C**	152.4	156.7	154.5	255	150.9
Wt. of Water	**D= A-B**	64.3	140.3	112.1	172.5	60.5
Dry Soil, Ws	**E= B-C**	301.3	417.4	483.2	686	526.6
Moisture Content, (%)	**(D/E) x100**	21.3	33.6	23.2	25.1	11.5

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Prject	**Elevation:**	See below per sample
Project Number:	475.0048.008	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson.	**Tested By:**	OS
Field Sample ID:	17-018	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-018-54	17-018-55	17-018-56	17-018-57	17-018-58
Location		BH-08	BH-13	BH-13	BH-13	BH-16
Depth		52.554	1-2.5	6-7.5	8.5-10	1-2.5
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	495.3	404.5	385.8	357.5	427
Tare + Dry Soil	**B**	469.8	378.3	367.7	346	396
Tare	**C**	150.8	153.8	152.2	154.7	152.7
Wt. of Water	**D= A-B**	25.5	26.2	18.1	11.5	31
Dry Soil, Ws	**E= B-C**	319	224.5	215.5	191.3	243.3
Moisture Content, (%)	**(D/E) x100**	8.0	11.7	8.4	6.0	12.7

Sample No.		17-018-59	17-018-60	17-018-61		
Location		BH-16	BH-16	BH-16		
Depth		3.5-5	6-7.5	8.5-10		
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	892.9	379.5	296.2		
Tare + Dry Soil	**B**	799.7	362.6	288.6		
Tare	**C**	155	194.8	158.1		
Wt. of Water	**D= A-B**	93.2	16.9	7.6		
Dry Soil, Ws	**E= B-C**	644.7	167.8	130.5		
Moisture Content, (%)	**(D/E) x100**	14.5	10.1	5.8		

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Test Pits
Project Title:	Hermosa Underground Project	**Depth:**	See below per sample
Project Number:	475.0014.008 / 1	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-019	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-019-01	17-019-02	17-019-03	17-019-04	17-019-05
Location		TP-01	TP-02	TP-06	TP-07	TP-07
Depth		3-4'	2-3'	1-3'	0-2.5'	7-8'
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	1868.1	1310.7	702.5	569	1715.9
Tare + Dry Soil	**B**	1787.6	1173.8	594.2	526.4	1676
Tare	**C**	265.7	121.4	191.7	125.6	193.6
Wt. of Water	**D= A-B**	80.5	136.9	108.3	42.6	39.9
Dry Soil, Ws	**E= B-C**	1521.9	1052.4	402.5	400.8	1482.4
Moisture Content, (%)	**(D/E) x100**	5.3	13.0	26.9	10.6	2.7

Sample No.		17-019-06	17-019-07	17-019-08	17-019-09	17-019-10
Location		TP-08	TP-08	TP-09	TP-11	TP-11
Depth		1'	4'	1-2'	3-4'	10-11'
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	504	1023	527.9	568.8	353.5
Tare + Dry Soil	**B**	488.1	980.5	478.3	525.9	330.8
Tare	**C**	188.6	223.1	121.1	189.6	123.8
Wt. of Water	**D= A-B**	15.9	42.5	49.6	42.9	22.7
Dry Soil, Ws	**E= B-C**	299.5	757.4	357.2	336.3	207
Moisture Content, (%)	**(D/E) x100**	5.3	5.6	13.9	12.8	11.0

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Test Pits
Project Title:	Hermosa Underground Project	**Depth:**	See below per sample
Project Number:	475.0014.008 / 1	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-019	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-019-11	17-019-12	17-019-13	17-019-14	17-019-15
Location		TP-13	TP-14	TP-15	TP-17	TP-24
Depth		1-3'	3-4'	5'-6'	5-6'	4-7'
Soil Description						TAILINGS
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	1121.1	766.1	1028	1407.3	607.5
Tare + Dry Soil	**B**	1060.7	736.8	972	1328.4	547.9
Tare	**C**	189.8	141.2	122	183.6	188.8
Wt. of Water	**D= A-B**	60.4	29.3	56	78.9	59.6
Dry Soil, Ws	**E= B-C**	870.9	595.6	850	1144.8	359.1
Moisture Content, (%)	**(D/E) x100**	6.9	4.9	6.6	6.9	16.6

Sample No.		17-019-16	17-019-17	17-019-18	17-019-19	17-019-20
Location		TP-25	TP-26	TP-28	TP-30	TP-31
Depth		1-3'	10-12'	5-8'	3-5'	2-4'
Soil Description		TAILINGS				
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	650.7	1016.3	665	644.8	771.4
Tare + Dry Soil	**B**	511.1	955.1	570	604.5	721.8
Tare	**C**	190.3	193.8	173.2	188.4	247.9
Wt. of Water	**D= A-B**	139.6	61.2	95	40.3	49.6
Dry Soil, Ws	**E= B-C**	320.8	761.3	396.8	416.1	473.9
Moisture Content, (%)	**(D/E) x100**	43.5	8.0	23.9	9.7	10.5

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Test Pits
Project Title:	Hermosa Underground Project	**Depth:**	See below per sample
Project Number:	475.0014.008 / 1	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-019	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C   Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-019-22	17-019-23	17-019-25	17-019-26	17-019-27
Location		TP-32	TP-33	TP-47A	TP-48	TP-51
Depth		11.5-14'	1-7',15-20.5'	3-4'	0-4'	1-2'
Soil Description			COMP			
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	696	659	609.8	473.3	691.5
Tare + Dry Soil	**B**	626.3	610.6	559.2	447.5	640.2
Tare	**C**	123.8	191.2	191.1	122.2	192.4
Wt. of Water	**D= A-B**	69.7	48.4	50.6	25.8	51.3
Dry Soil, Ws	**E= B-C**	502.5	419.4	368.1	325.3	447.8
Moisture Content, (%)	**(D/E) x100**	13.9	11.5	13.7	7.9	11.5

Sample No.		17-019-28	17-019-29	17-019-30	17-019-31	17-019-32
Location		TP-51	TP-50A	TP-50B	TP-55	TP-60
Depth		5-6'	2-3'	0-1'	3-4'	0-1'
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	597.5	779.1	674.9	595.4	573.2
Tare + Dry Soil	**B**	568.1	758.4	626.4	580.8	537.5
Tare	**C**	190.1	261.3	158.8	121.1	158.2
Wt. of Water	**D= A-B**	29.4	20.7	48.5	14.6	35.7
Dry Soil, Ws	**E= B-C**	378	497.1	467.6	459.7	379.3
Moisture Content, (%)	**(D/E) x100**	7.8	4.2	10.4	3.2	9.4

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Test Pits
Project Title:	Hermosa Underground Project	**Depth:**	See below per sample
Project Number:	475.0014.008 / 1	**Test Start Date:**	02/08/2017
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-019	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C   Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-019-33	17-019-34			
Location		TP-61	TP-61			
Depth		0'-1'	0-1'			
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	676.6	662.6			
Tare + Dry Soil	**B**	637.7	640			
Tare	**C**	154	183.7			
Wt. of Water	**D= A-B**	38.9	22.6			
Dry Soil, Ws	**E= B-C**	483.7	456.3			
Moisture Content, (%)	**(D/E) x100**	8.0	5.0			

Sample No.						
Location						
Depth						
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**					
Tare + Dry Soil	**B**					
Tare	**C**					
Wt. of Water	**D= A-B**					
Dry Soil, Ws	**E= B-C**					
Moisture Content, (%)	**(D/E) x100**					

Remarks:

NewFields

NATURAL DENSITY (ASTM 2937)

LABORATORY WORKSHEET

NF Form #16

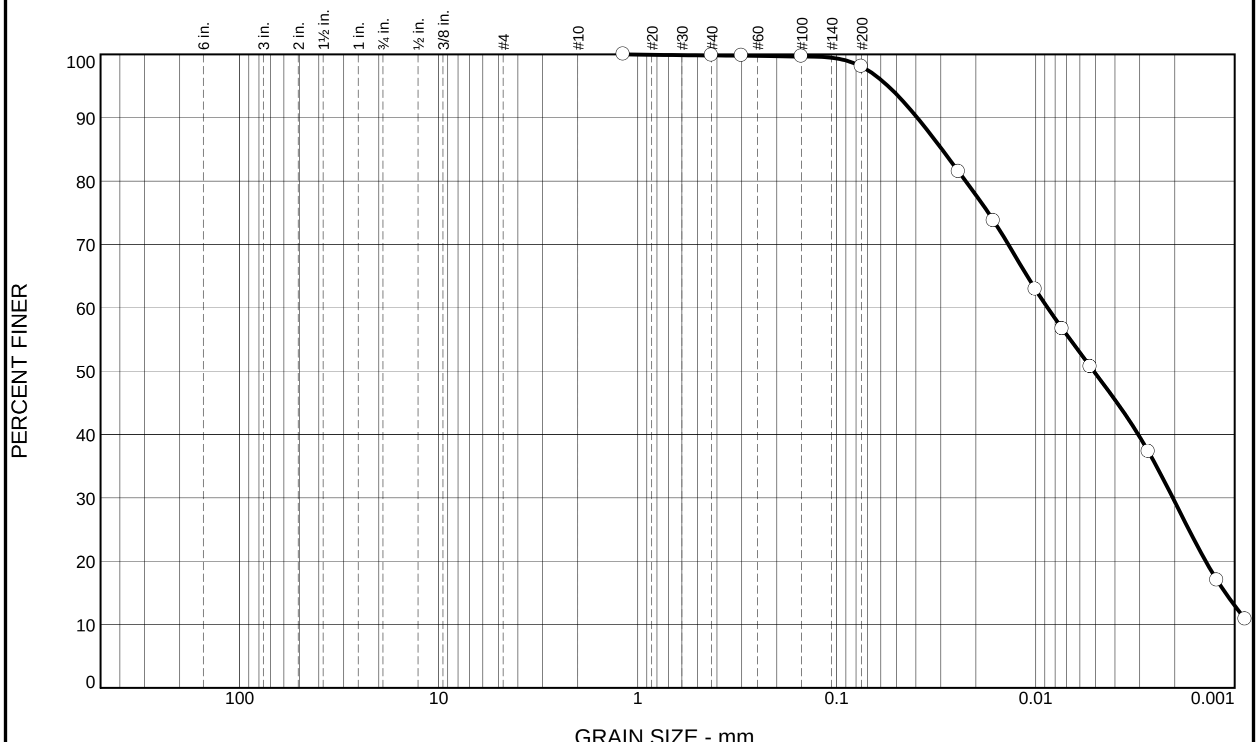
Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Project	**Elevation:**	See below per sample
Project Number:	475.0014.0008 / 1	**Test Start Date:**	
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	BH-01	**Checked By:**	RF/KE
Laboratory Sample ID:	17-020		

Drying Conditions: 60 deg C / **110 deg C** Method: **Oven (O)** / Microwave (M)

Trail No.		1	2	3	4
Sample No.		17-020-01	17-020-02	17-020-03	
Location		BH-01	BH-01	BH-01	
Depth		25.8-26.3'	35.9-36.4'	45.8-46.3'	
Soil Description					
(USCS)					
Soil + Liner Wt., g.	**A**	2191.7	2209.7	2270.5	
Liner Wt., g.	**B**	401.8	428.3	403.9	
Soil Wt., g.	**C= A-B**	1789.9	1781.4	1866.6	
Liner Length, in.	**D**	11.960	11.856	11.972	
Liner Diameter, in.	**E**	2.443	2.439	2.440	
Liner Area, in^2	**F= $(E^2/4)$*pi**	4.69	4.67	4.68	
Liner Volume, in^3	**G= D*F**	56.06	55.39	55.98	
Sample Wet Density, pcf	**H= (C/G)*3.81**	121.6	122.5	127.0	
Sample Dry Density, pcf	**H/(1+(N/100))**	106.0	110.1	102.2	
Tare No.					
Tare + Wet Soil	**I**	839.1	443.8	665.2	
Tare + Dry Soil	**J**	733.2	400.1	537.8	
Tare	**K**	13.8	13.8	13.9	
Wt. of Water	**L= I-J**	105.9	43.70	127.40	
Dry Soil, Ws	**M=-J-K**	719.4	386.30	523.90	
Moisture Content, (%)	**N= (L/M) x100**	14.7%	11.3%	24.3%	

Remarks:

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	1.7	68.7	29.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.8		
#50	99.8		
#100	99.7		
#200	98.1		

* (no specification provided)

Material Description

Gray lean clay

Atterberg Limits

PL= 22 LL= 38 PI= 16

Coefficients

D_{90}= 0.0394 D_{85}= 0.0296 D_{60}= 0.0087
D_{50}= 0.0051 D_{30}= 0.0020 D_{15}= 0.0011
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(17)

Remarks

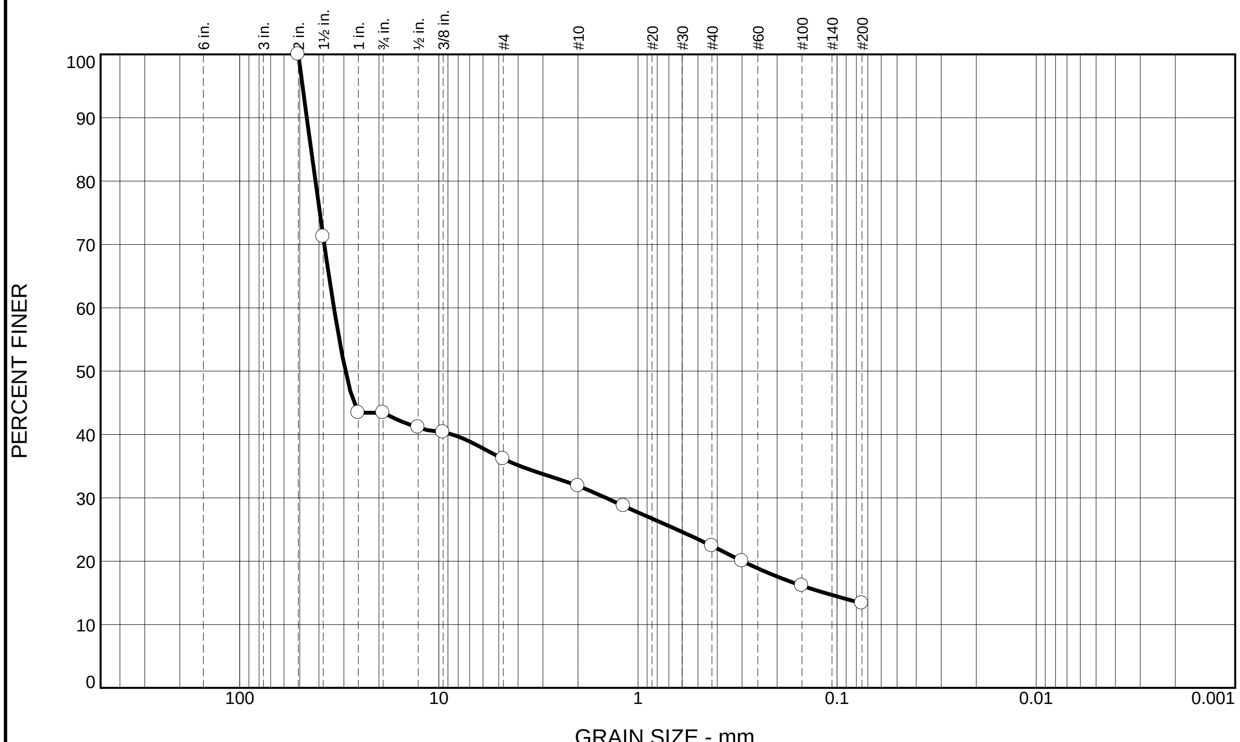
Location: BH-01
Sample Number: 17-018-07 **Depth:** 46.5-49' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-07

Tested By: TW **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	56.6	7.2	4.3	9.5	9.0	13.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	71.2		
1	43.4		
.75	43.4		
.5	41.1		
.375	40.4		
#4	36.2		
#10	31.9		
#16	28.7		
#40	22.4		
#50	20.0		
#100	16.1		
#200	13.4		

* (no specification provided)

Material Description

Black clayey gravel with sand

Atterberg Limits

PL= 22 LL= 34 PI= 12

Coefficients

D_{90}= 46.0549 D_{85}= 43.8301 D_{60}= 33.6712
D_{50}= 29.4411 D_{30}= 1.4489 D_{15}= 0.1155
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

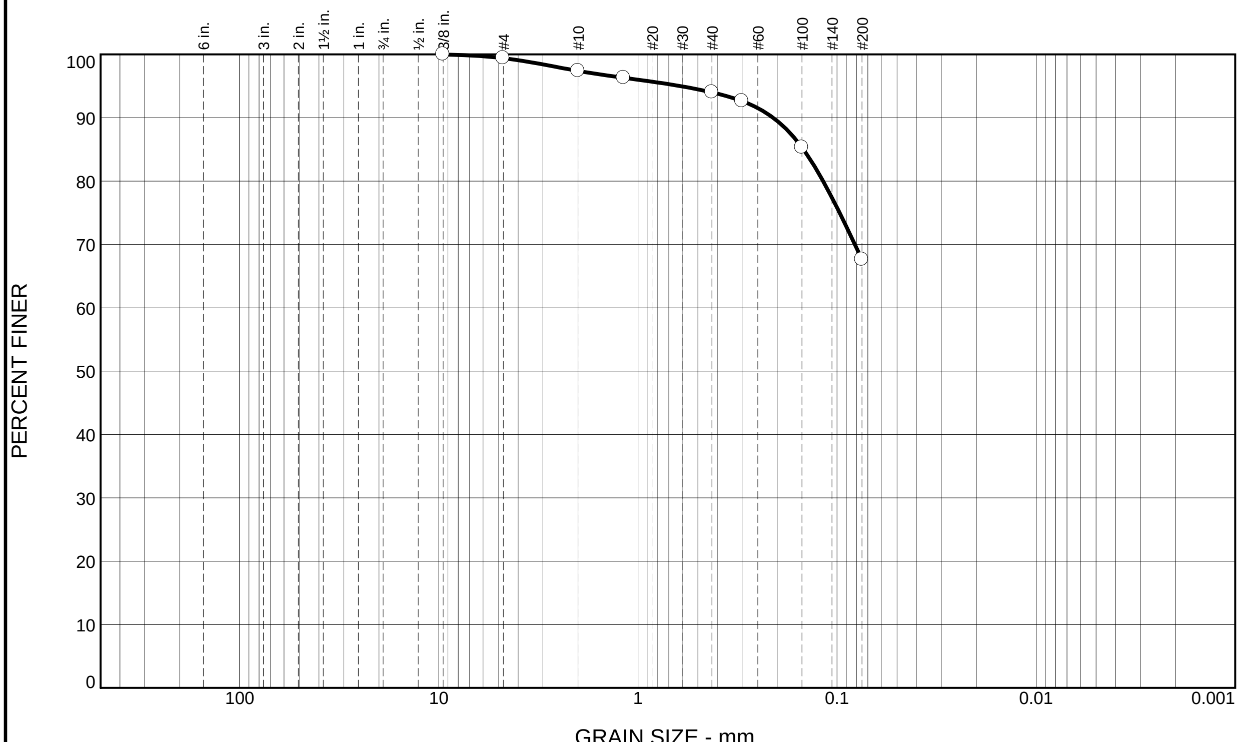
Location: BH-01
Sample Number: 17-018-08 **Depth:** 52.5-54' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-08

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	2.0	3.4	26.4	67.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	99.4		
#10	97.4		
#16	96.3		
#40	94.0		
#50	92.6		
#100	85.3		
#200	67.6		

* (no specification provided)

Material Description

Brown sandy silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.2093 D_{85}= 0.1475 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

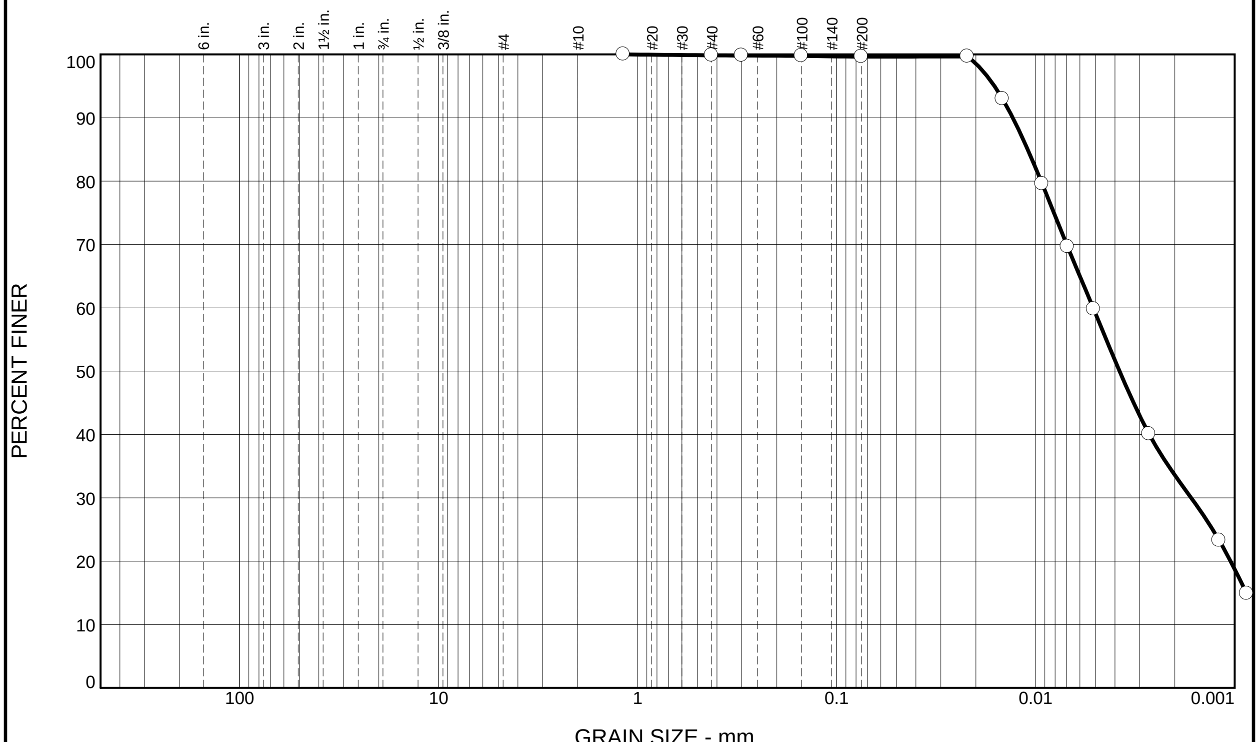
Location: BH-02
Sample Number: 17-018-10 **Depth:** 5-6.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-10

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	0.2	66.0	33.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#16	100.0		
#40	99.8		
#50	99.8		
#100	99.8		
#200	99.6		

* (no specification provided)

Material Description

Gray silt

Atterberg Limits

PL= 29 LL= 42 PI= 13

Coefficients

D_{90}= 0.0130 D_{85}= 0.0110 D_{60}= 0.0051
D_{50}= 0.0038 D_{30}= 0.0017 D_{15}= 0.0009
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-7-6(16)

Remarks

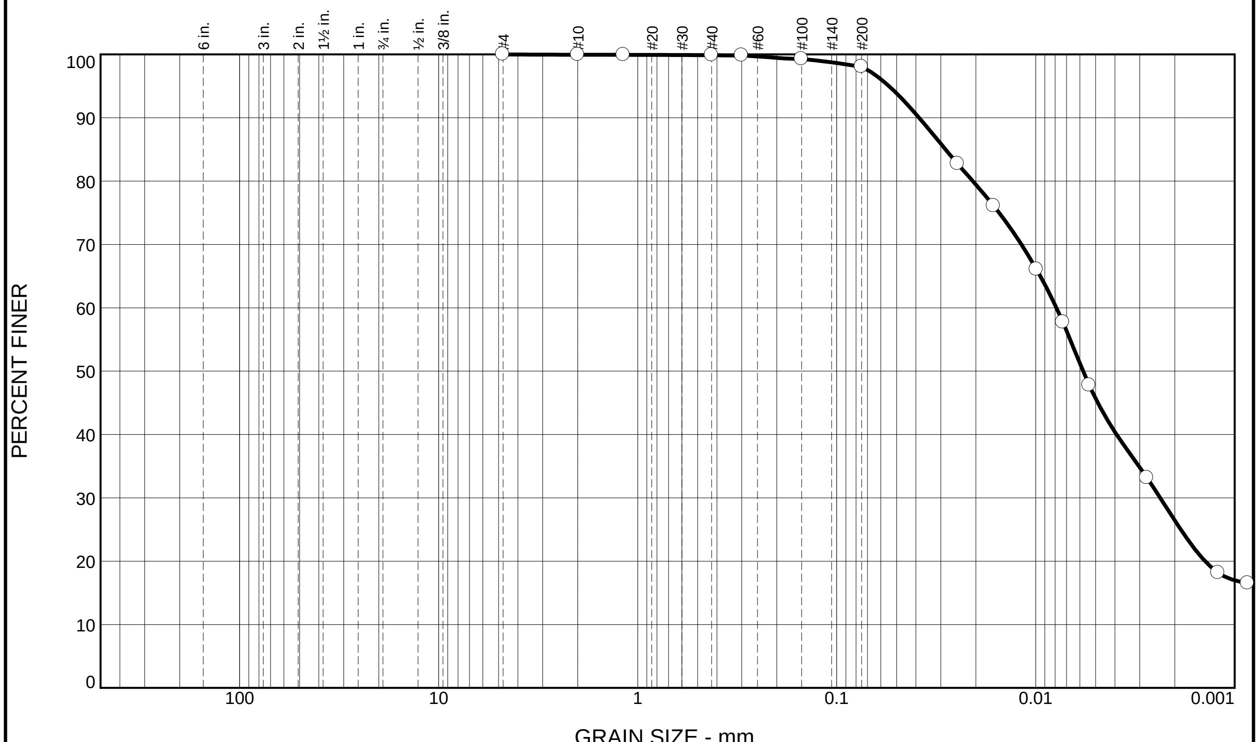
Location: BH-02
Sample Number: 17-018-13 **Depth:** 26.5-29' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-13

Tested By: TW **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	0.0	1.9	71.6	26.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#16	99.9		
#40	99.9		
#50	99.8		
#100	99.3		
#200	98.0		

* (no specification provided)

Material Description

Gray lean clay

Atterberg Limits

PL= 24 LL= 34 PI= 10

Coefficients

D_{90}= 0.0386 D_{85}= 0.0284 D_{60}= 0.0079
D_{50}= 0.0058 D_{30}= 0.0024 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-4(11)

Remarks

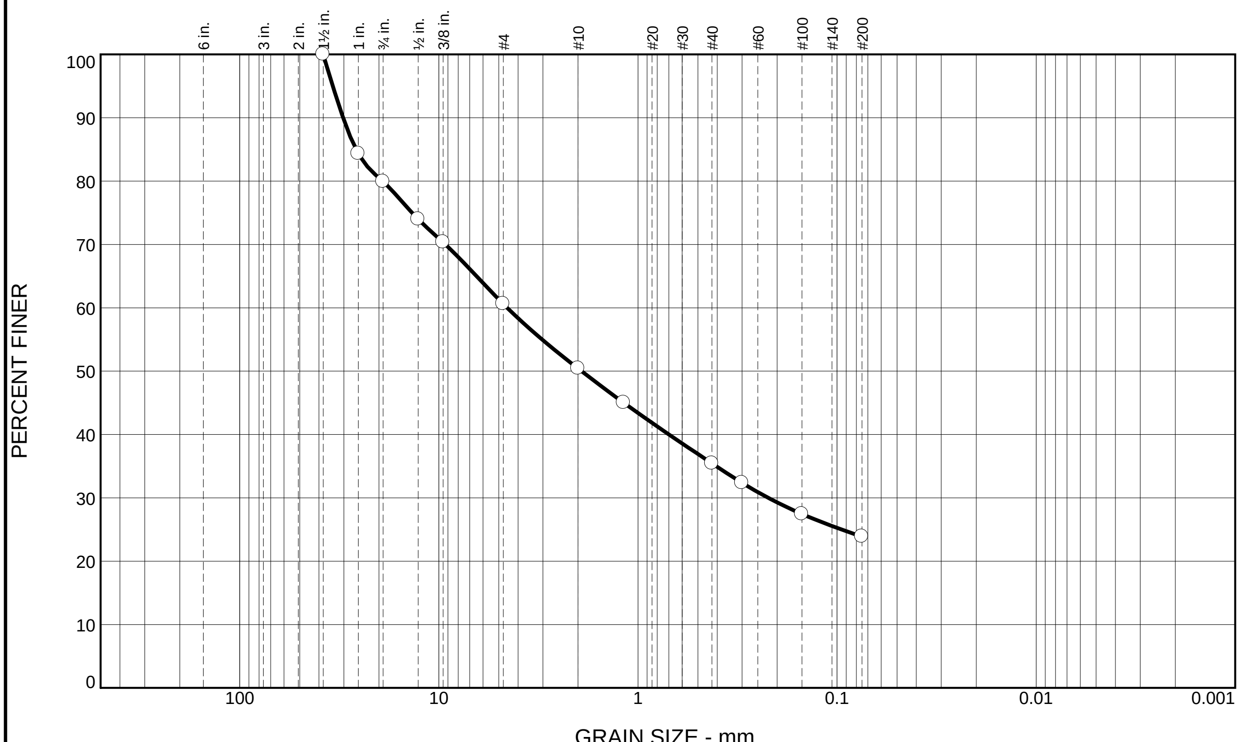
Location: BH-02
Sample Number: 17-018-14 **Depth:** 35-36.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-14

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	20.1	19.3	10.2	15.0	11.5	23.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	84.4		
.75	79.9		
.5	74.0		
.375	70.3		
#4	60.6		
#10	50.4		
#16	45.0		
#40	35.4		
#50	32.4		
#100	27.4		
#200	23.9		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 30.2594 D_{85}= 26.0462 D_{60}= 4.5385
D_{50}= 1.9203 D_{30}= 0.2214 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

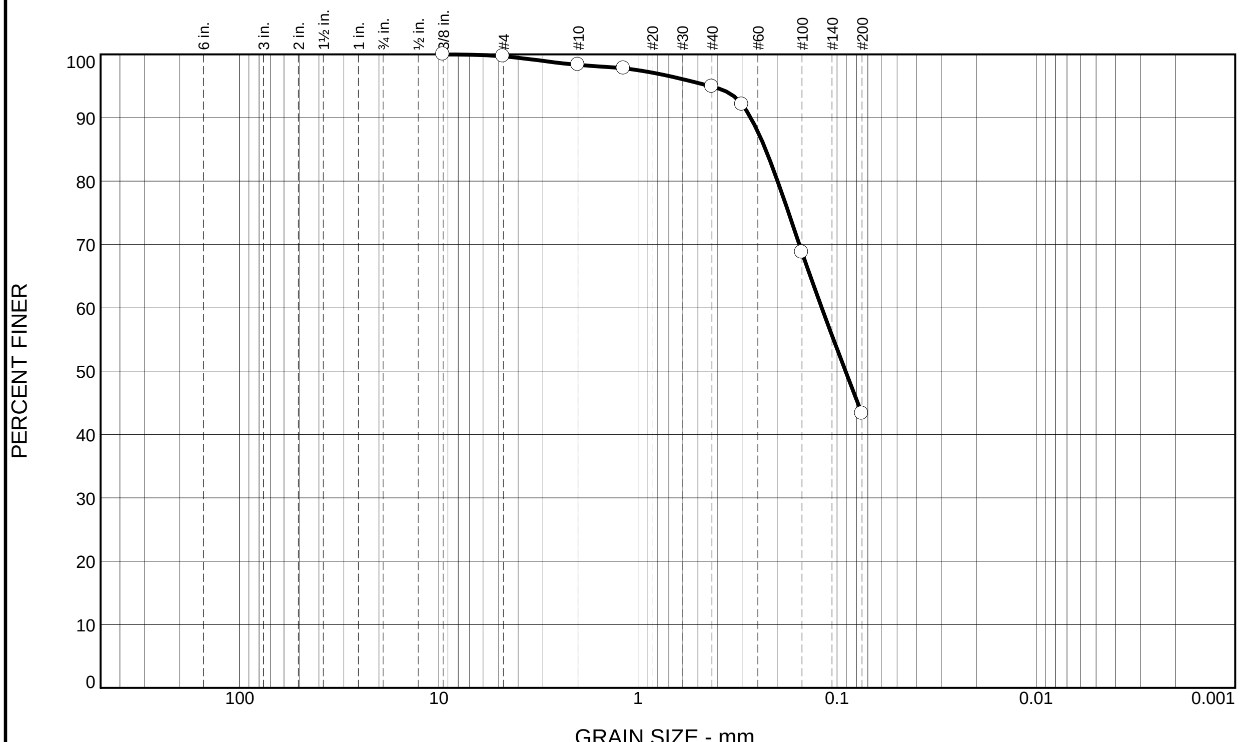
Location: BH-02
Sample Number: 17-018-15 **Depth:** 37.5-39' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-15

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	1.4	3.4	51.6	43.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	99.7		
#10	98.3		
#16	97.8		
#40	94.9		
#50	92.1		
#100	68.8		
#200	43.3		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.2712 D_{85}= 0.2286 D_{60}= 0.1194
D_{50}= 0.0906 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

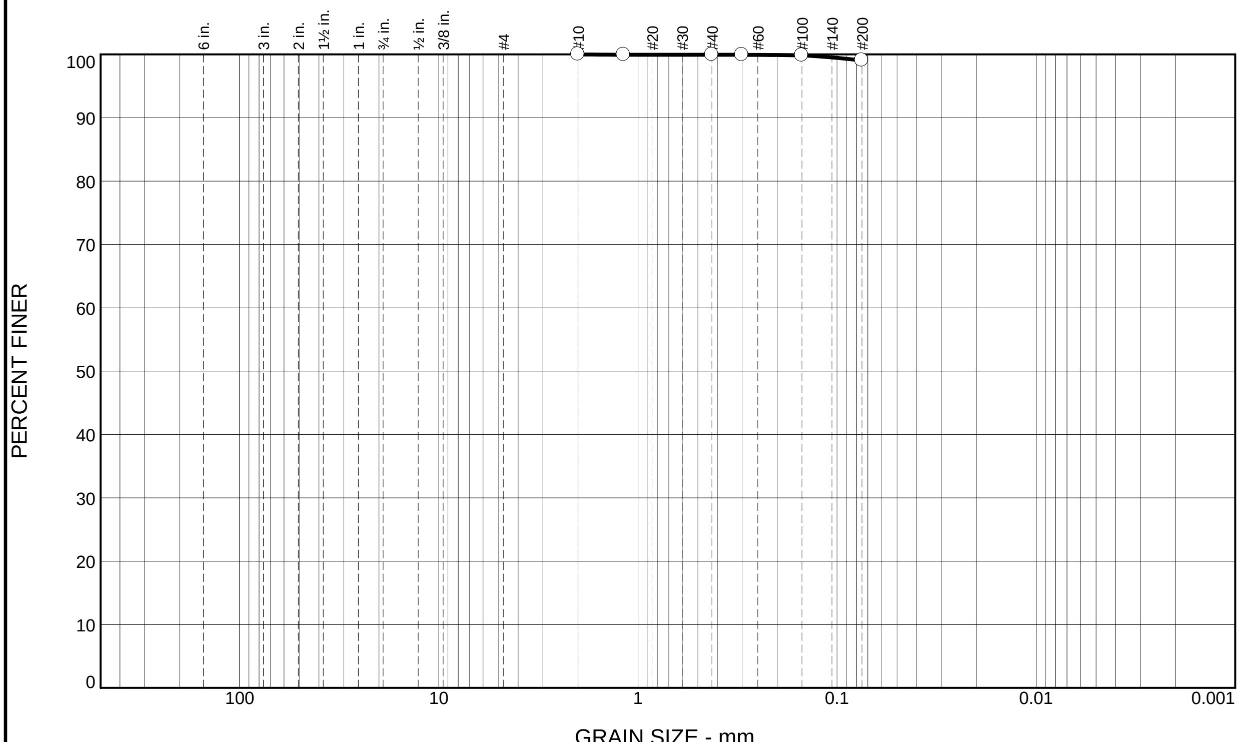
Location: BH-03
Sample Number: 17-018-17 **Depth:** 4-5.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-17

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	0.8	99.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#16	99.9		
#40	99.9		
#50	99.9		
#100	99.8		
#200	99.1		

* (no specification provided)

Material Description

Gray lean clay

Atterberg Limits

PL= 21 LL= 33 PI= 12

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(12)

Remarks

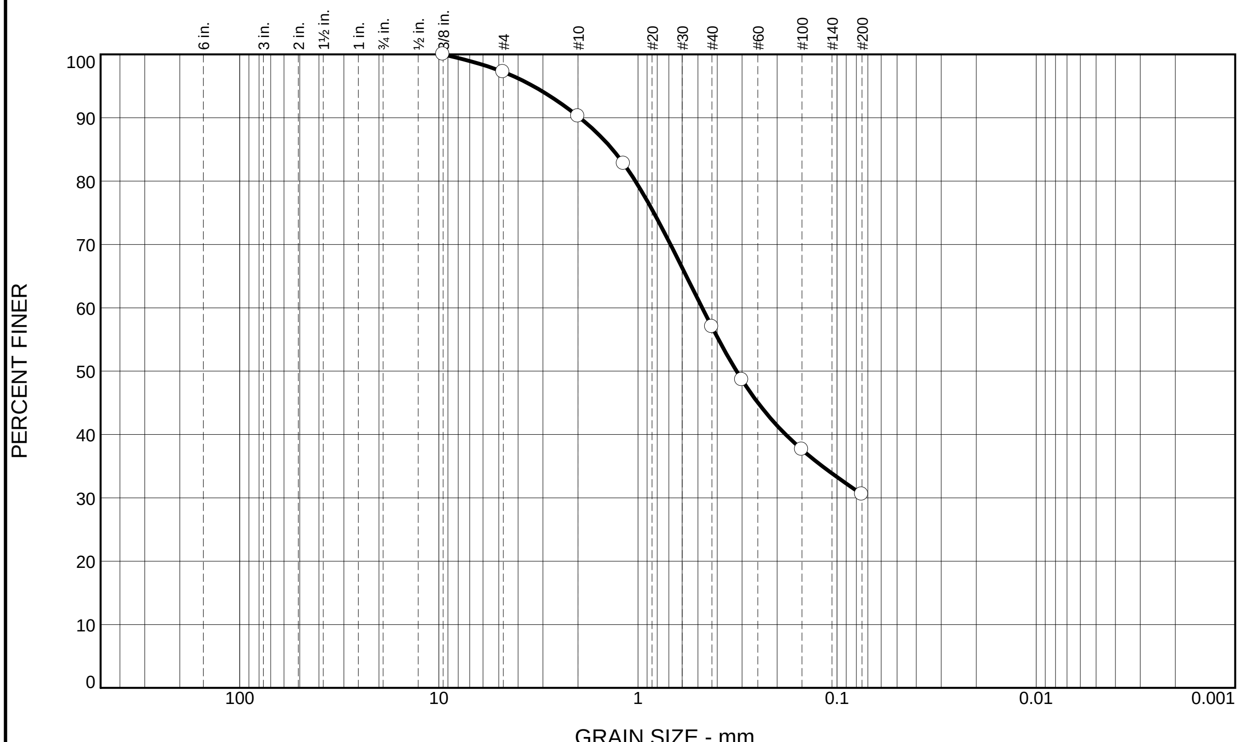
Location: BH-03
Sample Number: 17-018-20 **Depth:** 35-36.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-20

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.8	7.0	33.2	26.5	30.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	97.2		
#10	90.2		
#16	82.8		
#40	57.0		
#50	48.6		
#100	37.6		
#200	30.5		

* (no specification provided)

Material Description

Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 1.9598 D_{85}= 1.3421 D_{60}= 0.4759
D_{50}= 0.3198 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

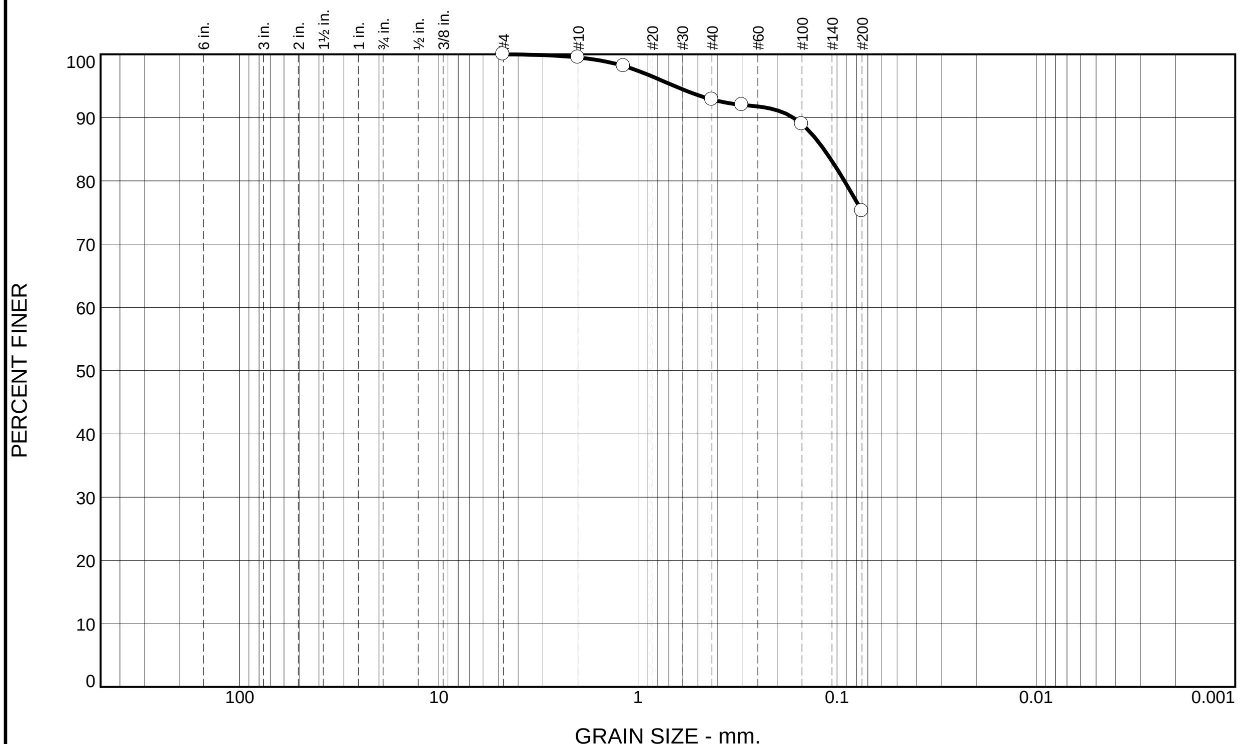
Location: BH-03
Sample Number: 17-018-21 **Depth:** 43.8-44.3' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-21

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.5	6.6	17.7	75.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.5		
#16	98.2		
#40	92.9		
#50	92.0		
#100	89.0		
#200	75.2		

* (no specification provided)

Material Description

Gray silt with sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.1661 D_{85}= 0.1165 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

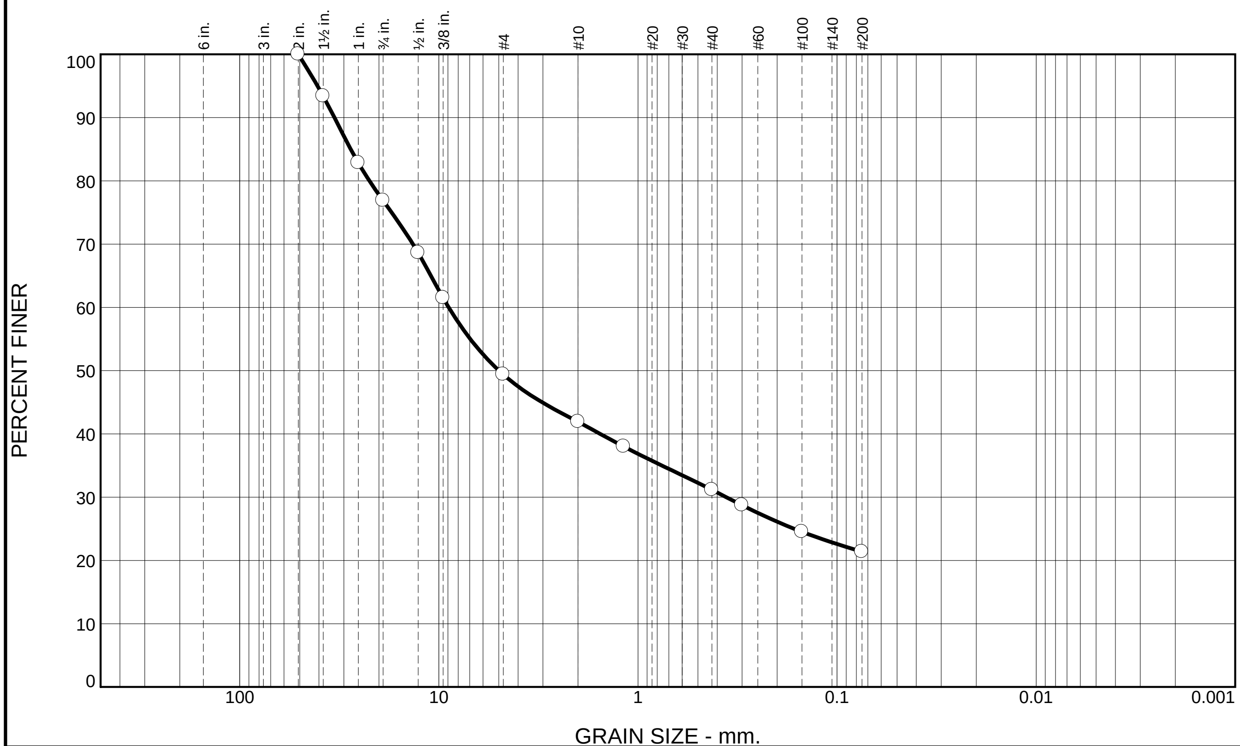
Location: BH-04
Sample Number: 17-018-24 **Depth:** 15-16.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-24

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	23.1	27.5	7.5	10.7	9.8	21.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	93.4		
1	82.8		
.75	76.9		
.5	68.6		
.375	61.5		
#4	49.4		
#10	41.9		
#16	38.0		
#40	31.2		
#50	28.7		
#100	24.5		
#200	21.4		

* (no specification provided)

Material Description

Yellow silty gravel with sand

Atterberg Limits

PL= 34 LL= 36 PI= 2

Coefficients

D_{90}= 33.4576 D_{85}= 27.7192 D_{60}= 8.9296
D_{50}= 4.9885 D_{30}= 0.3600 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GM AASHTO= A-1-b

Remarks

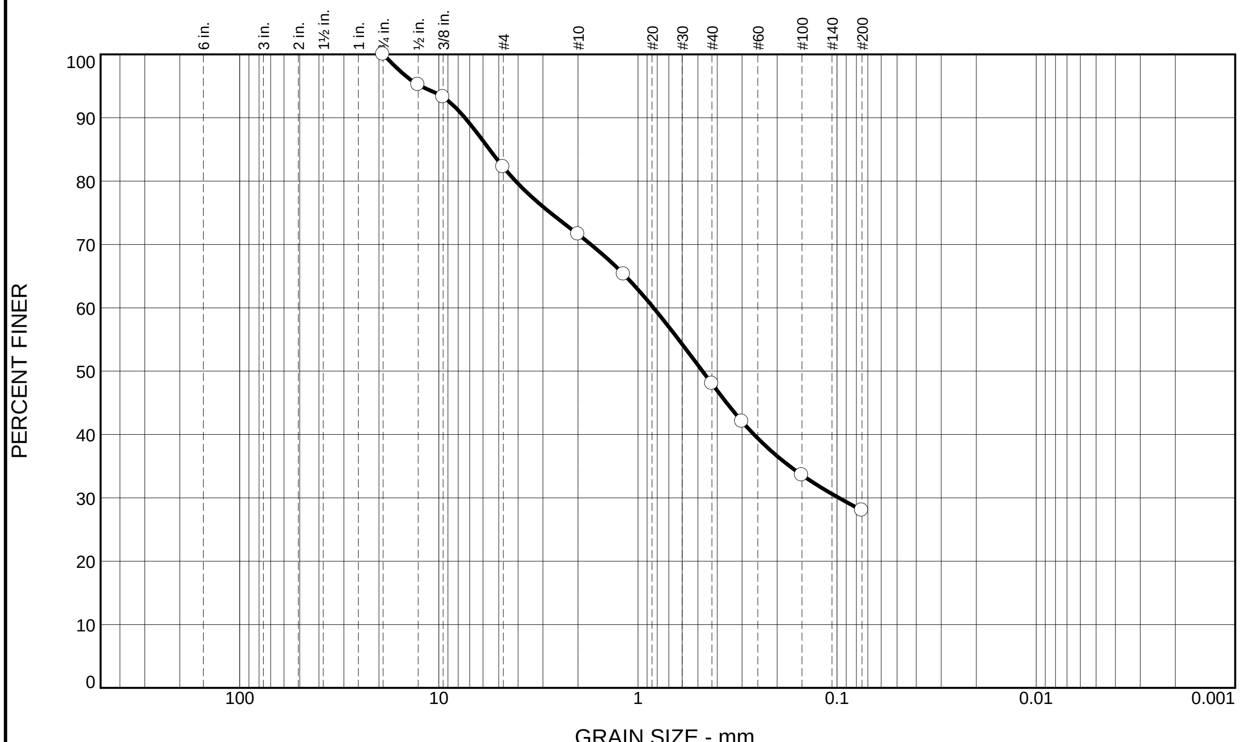
Location: BH-04
Sample Number: 17-018-25 **Depth:** 20-21.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-25

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	17.8	10.6	23.6	20.0	28.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	95.2		
.375	93.3		
#4	82.2		
#10	71.6		
#16	65.3		
#40	48.0		
#50	42.0		
#100	33.6		
#200	28.0		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 21 LL= 32 PI= 11

Coefficients

D_{90}= 7.3968 D_{85}= 5.5690 D_{60}= 0.8351
D_{50}= 0.4743 D_{30}= 0.0979 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

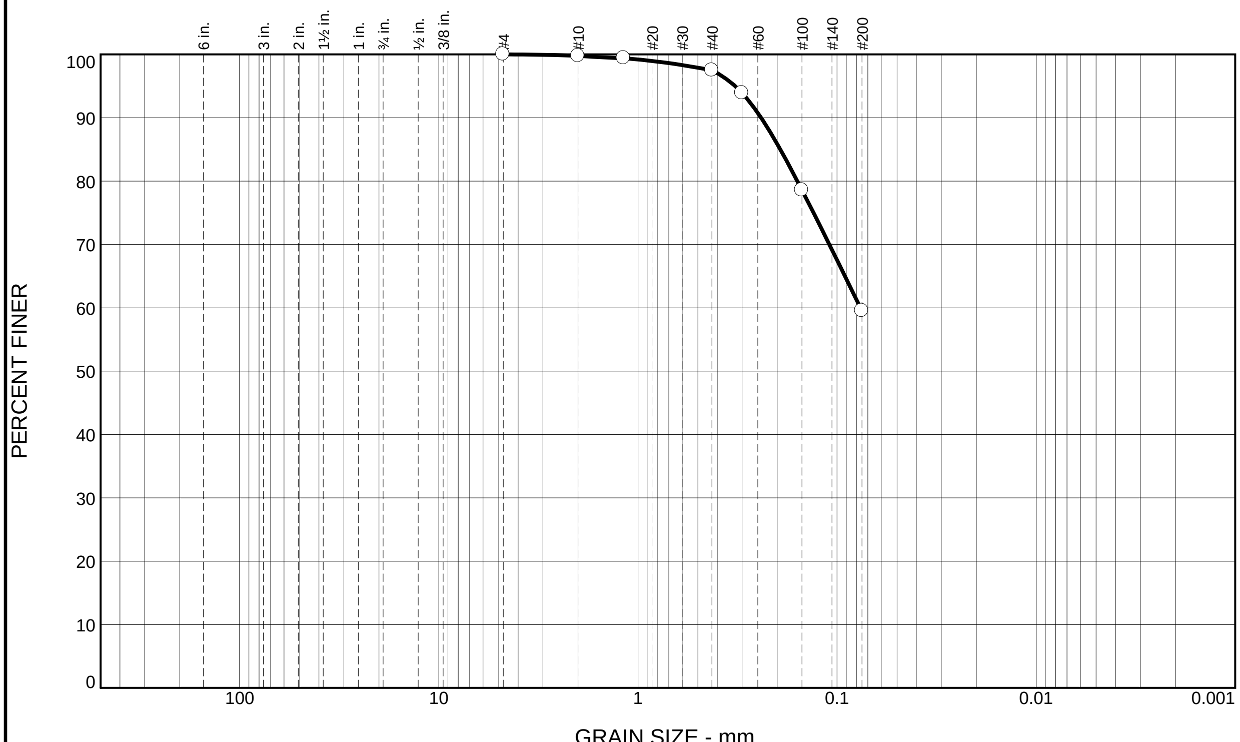
Location: BH-04
Sample Number: 17-018-27 **Depth:** 40-41.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-27

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	2.3	38.0	59.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#16	99.4		
#40	97.5		
#50	93.9		
#100	78.6		
#200	59.5		

* (no specification provided)

Material Description

Gray sandy silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.2406 D_{85}= 0.1928 D_{60}= 0.0763
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

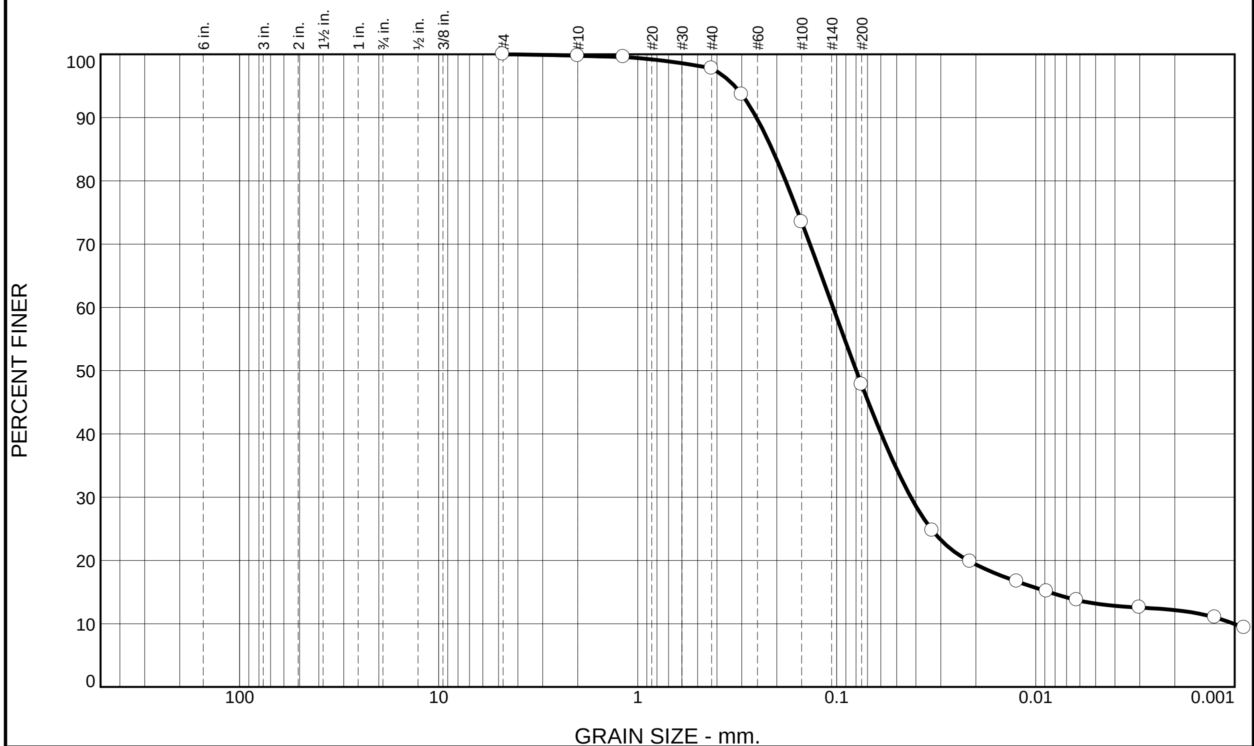
Location: BH-05
Sample Number: 17-018-29 **Depth:** 5-5.6' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-29

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	2.0	50.0	35.6	12.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#16	99.6		
#40	97.8		
#50	93.7		
#100	73.5		
#200	47.8		

* (no specification provided)

Material Description

Gray silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.2530 D_{85}= 0.2111 D_{60}= 0.1044
D_{50}= 0.0797 D_{30}= 0.0424 D_{15}= 0.0086
D_{10}= 0.0010 C_u= 103.03 C_c= 17.02

Classification

USCS= SM AASHTO= A-4(0)

Remarks

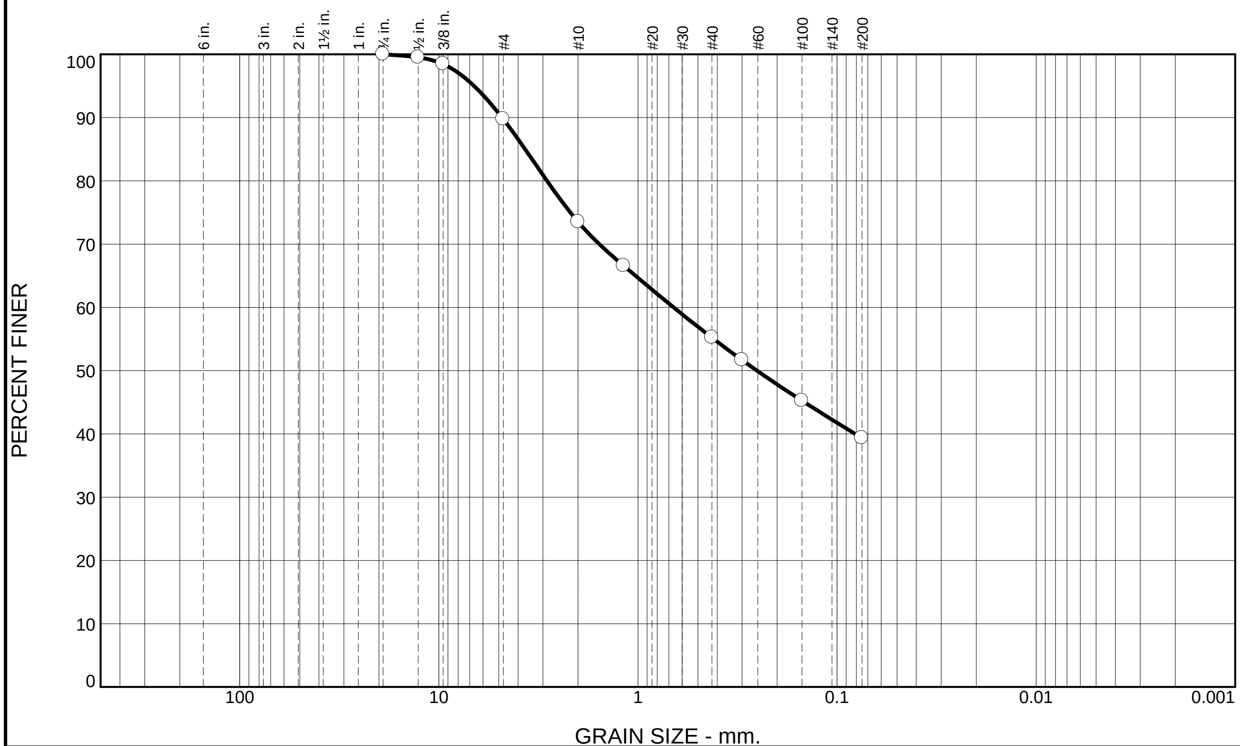
Location: BH-05
Sample Number: 17-018-30 **Depth:** 15-16.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-30

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.2	16.3	18.3	15.9	39.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	99.5		
.375	98.5		
#4	89.8		
#10	73.5		
#16	66.6		
#40	55.2		
#50	51.7		
#100	45.2		
#200	39.3		

* (no specification provided)

Material Description

Red clayey sand

Atterberg Limits

PL= 20 LL= 38 PI= 18

Coefficients

D_{90}= 4.8145 D_{85}= 3.6890 D_{60}= 0.6621
D_{50}= 0.2524 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-6(3)

Remarks

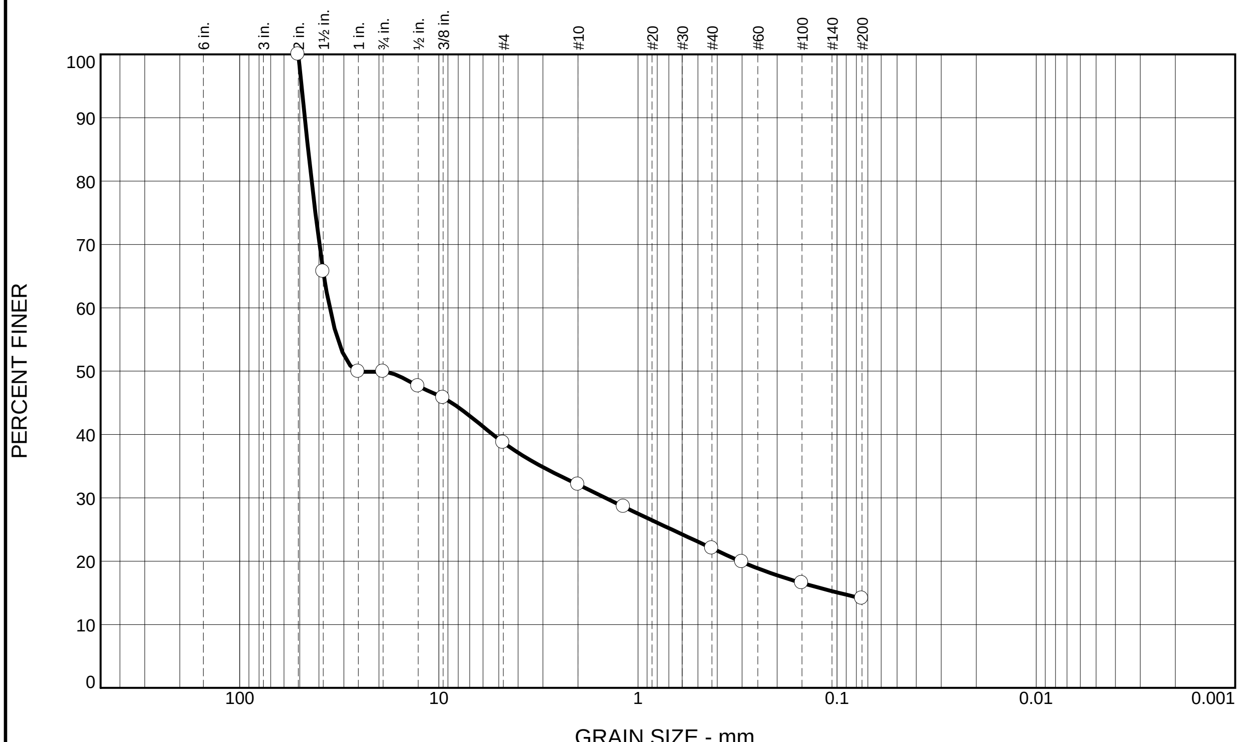
Location: BH-05
Sample Number: 17-018-31 **Depth:** 17.5-19' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-31

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	50.1	11.2	6.6	10.1	7.9	14.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	65.7		
1	49.9		
.75	49.9		
.5	47.6		
.375	45.8		
#4	38.7		
#10	32.1		
#16	28.6		
#40	22.0		
#50	19.9		
#100	16.6		
#200	14.1		

* (no specification provided)

Material Description

Yellow clayey gravel with sand

Atterberg Limits

PL= 23 LL= 38 PI= 15

Coefficients

D_{90}= 47.1338 D_{85}= 45.3488 D_{60}= 35.3573
D_{50}= 25.7532 D_{30}= 1.4593 D_{15}= 0.0978
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

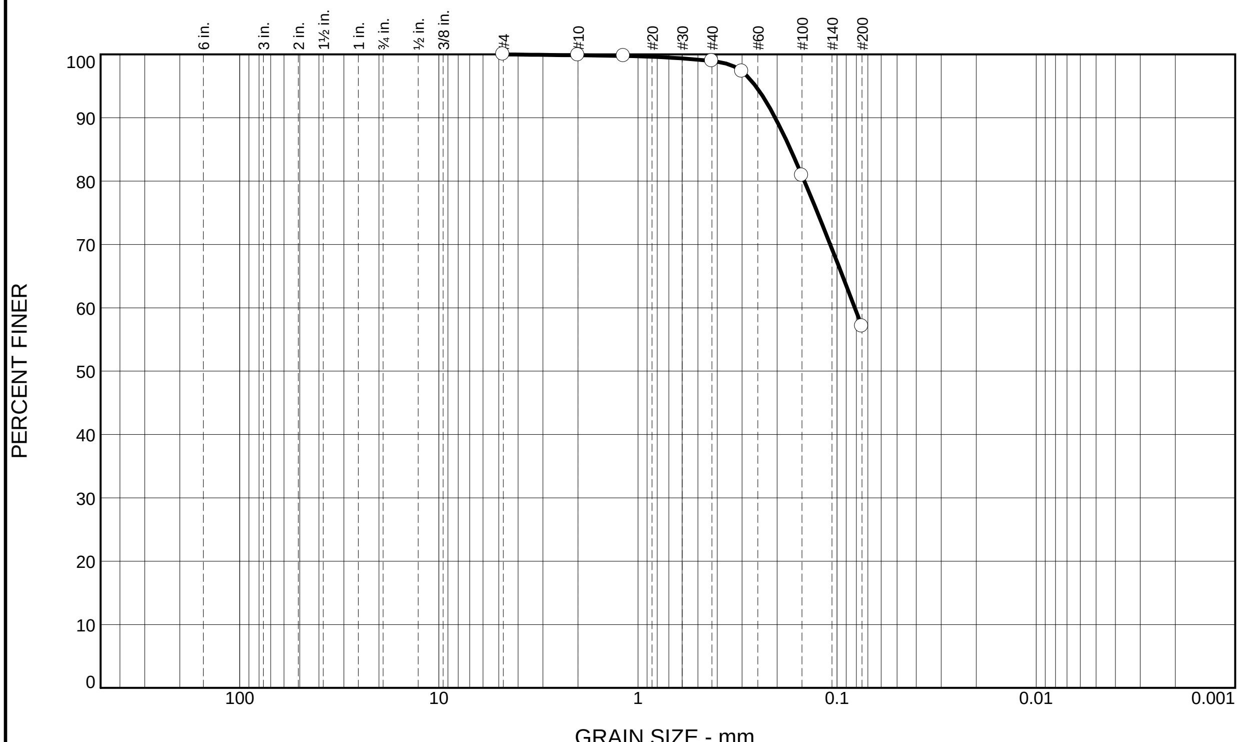
Location: BH-06
Sample Number: 17-018-33 **Depth:** 10-11.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-33

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.0	41.8	57.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#16	99.8		
#40	98.9		
#50	97.3		
#100	80.9		
#200	57.1		

* (no specification provided)

Material Description

Gray sandy silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.2045 D_{85}= 0.1712 D_{60}= 0.0814
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

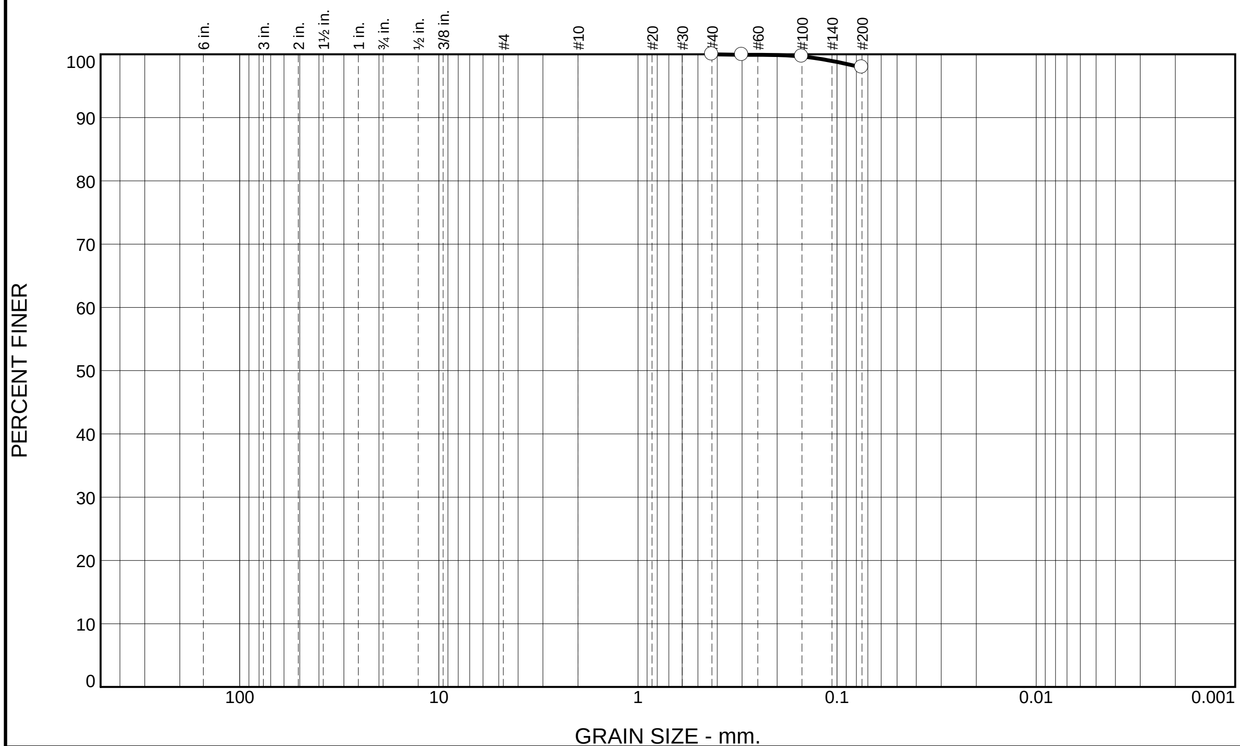
Location: BH-07
Sample Number: 17-018-37 **Depth:** 5-6.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-37

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	2.0	98.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#50	99.9		
#100	99.7		
#200	98.0		

* (no specification provided)

Material Description

Gray lean clay

Atterberg Limits

PL= 22 LL= 40 PI= 18

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(19)

Remarks

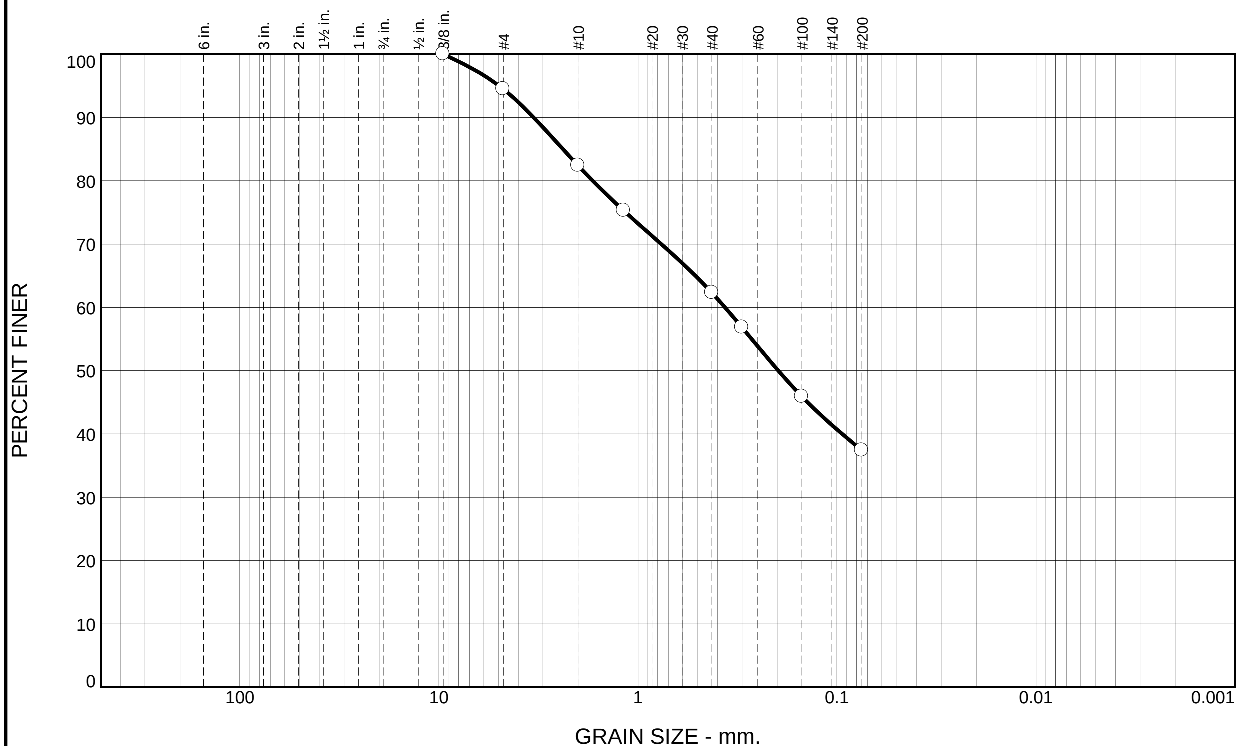
Location: BH-07
Sample Number: 17-018-40 **Depth:** 21.5-24.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-40

Tested By: TW **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.5	12.1	20.1	24.9	37.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	94.5		
#10	82.4		
#16	75.3		
#40	62.3		
#50	56.8		
#100	45.9		
#200	37.4		

* (no specification provided)

Material Description

Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 3.3445 D_{85}= 2.3849 D_{60}= 0.3655
D_{50}= 0.1970 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

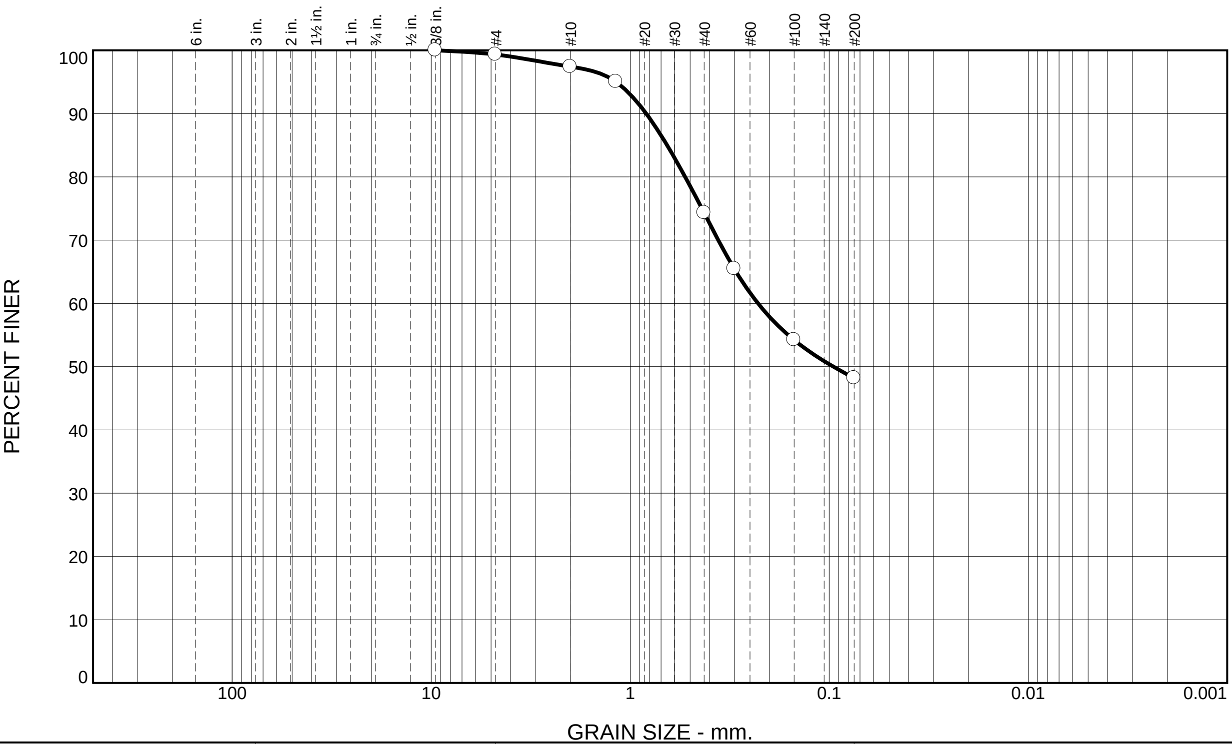
Location: BH-07
Sample Number: 17-018-42 **Depth:** 31.1-31.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-42

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	1.9	23.1	26.1	48.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	99.3		
#10	97.4		
#16	95.0		
#40	74.3		
#50	65.5		
#100	54.2		
#200	48.2		

* (no specification provided)

Material Description

Red clayey sand

Atterberg Limits

PL= 19 LL= 34 PI= 15

Coefficients

D_{90}= 0.8309 D_{85}= 0.6526 D_{60}= 0.2280
D_{50}= 0.0952 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-6(4)

Remarks

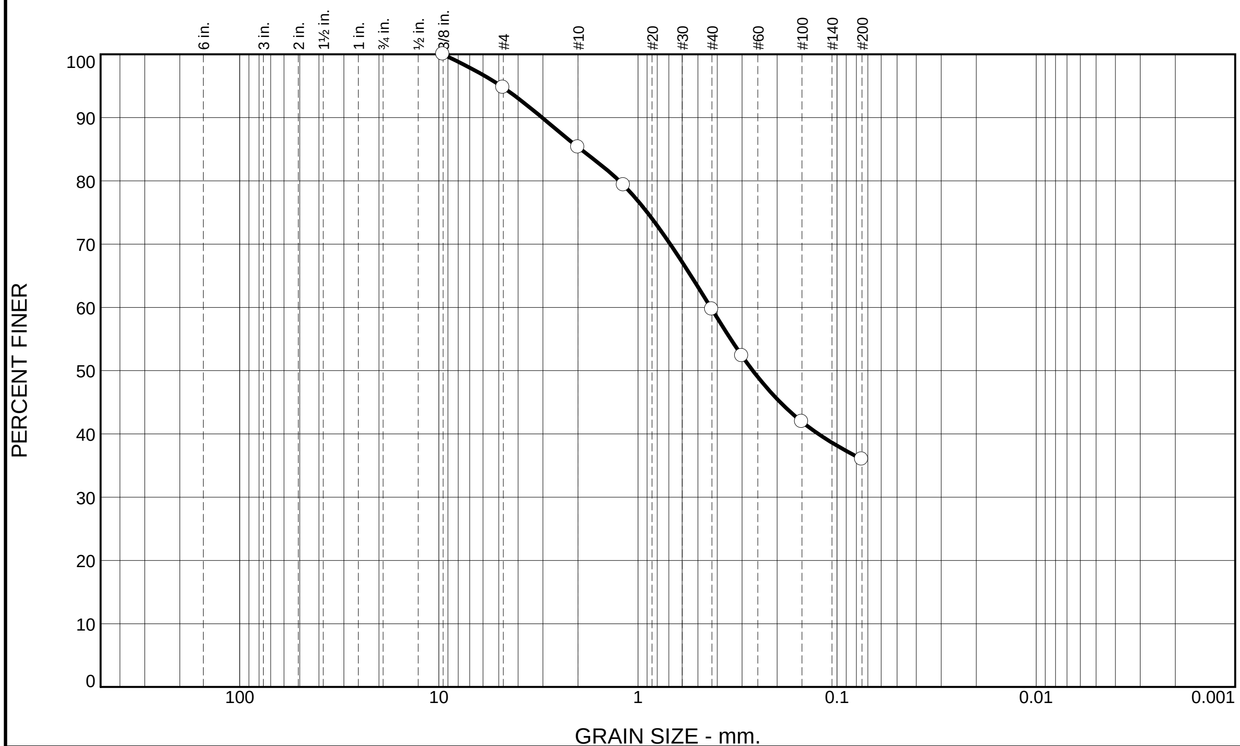
Location: BH-07
Sample Number: 17-018-43 **Depth:** 32.5-34' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-43

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	5.2	9.5	25.6	23.7	36.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	94.8		
#10	85.3		
#16	79.3		
#40	59.7		
#50	52.3		
#100	41.9		
#200	36.0		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 3.0301 D_{85}= 1.9405 D_{60}= 0.4309
D_{50}= 0.2649 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

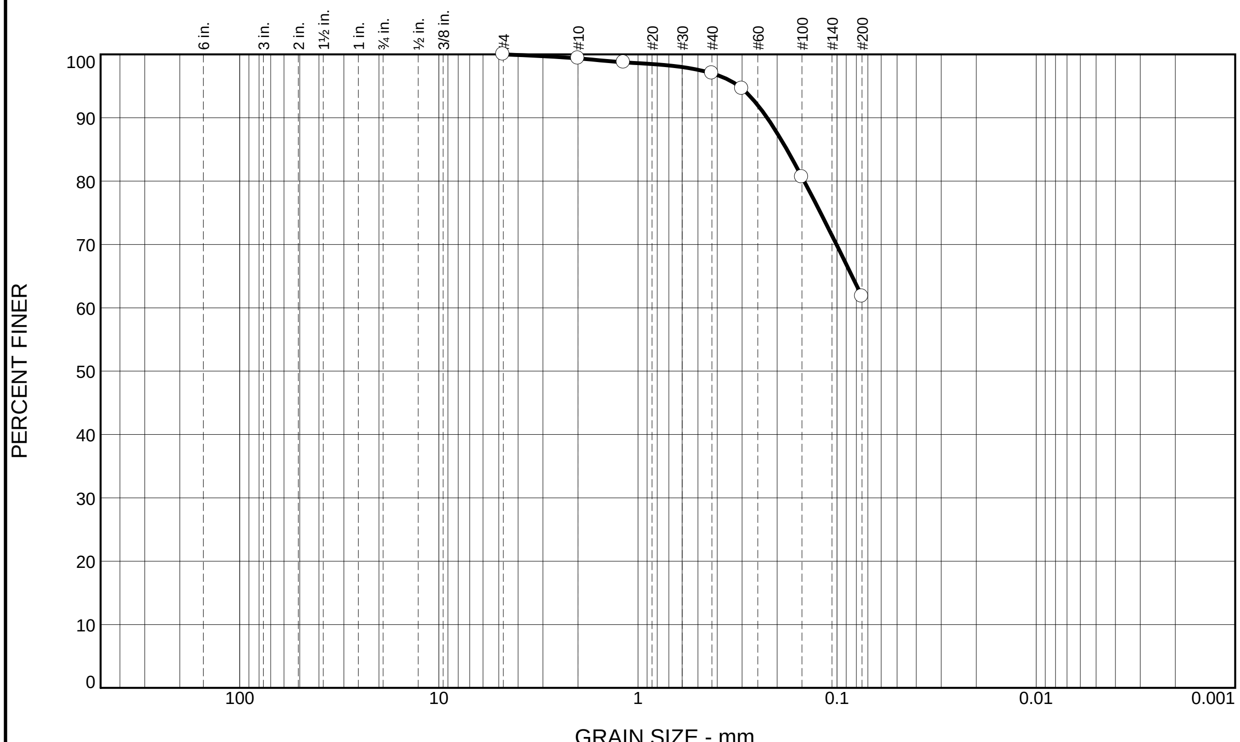
Location: BH-07
Sample Number: 17-018-44 **Depth:** 35.9-36.4' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-44

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	2.4	35.2	61.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.4		
#16	98.8		
#40	97.0		
#50	94.6		
#100	80.6		
#200	61.8		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 0.2245 D_{85}= 0.1788 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

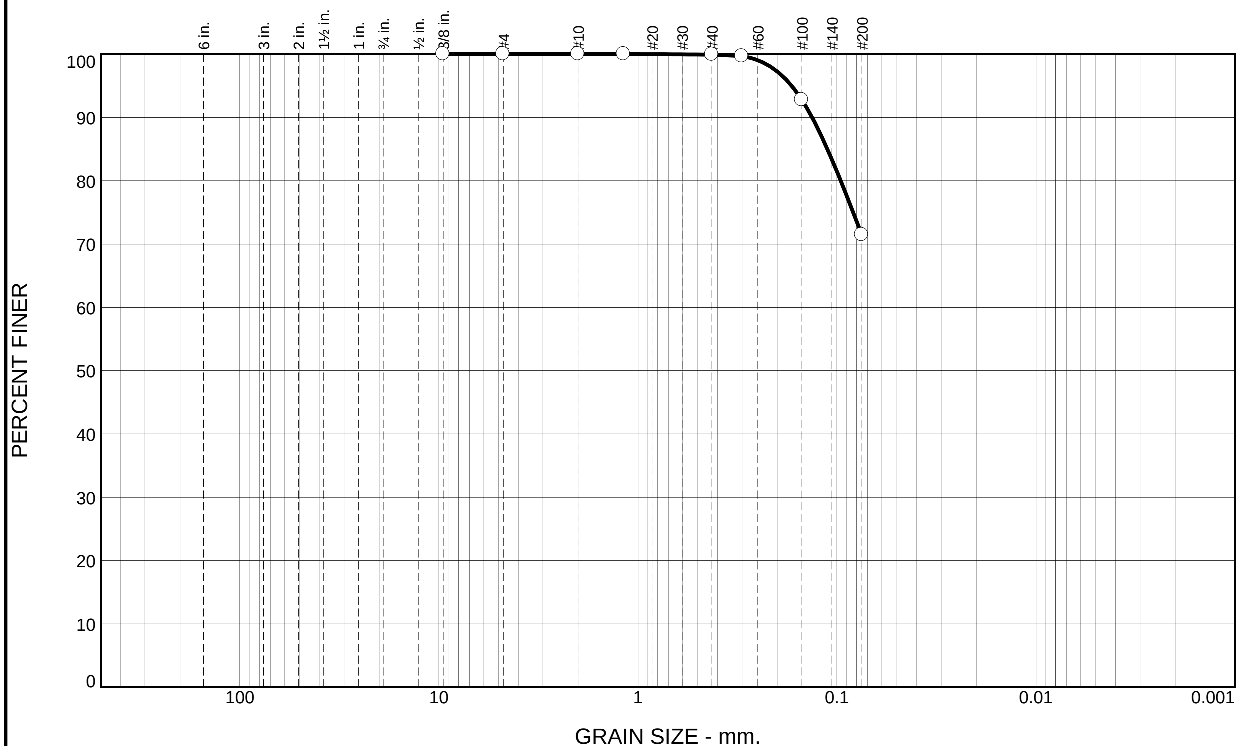
Location: BH-08
Sample Number: 17-018-47 **Depth:** 5-6.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-47

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	28.4	71.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	100.0		
#10	100.0		
#16	100.0		
#40	99.9		
#50	99.7		
#100	92.8		
#200	71.5		

* (no specification provided)

Material Description

Gray silt with sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.1333 D_{85}= 0.1118 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Location: BH-08
Sample Number: 17-018-49 **Depth:** 25-26.5' **Date:** 02/17/17

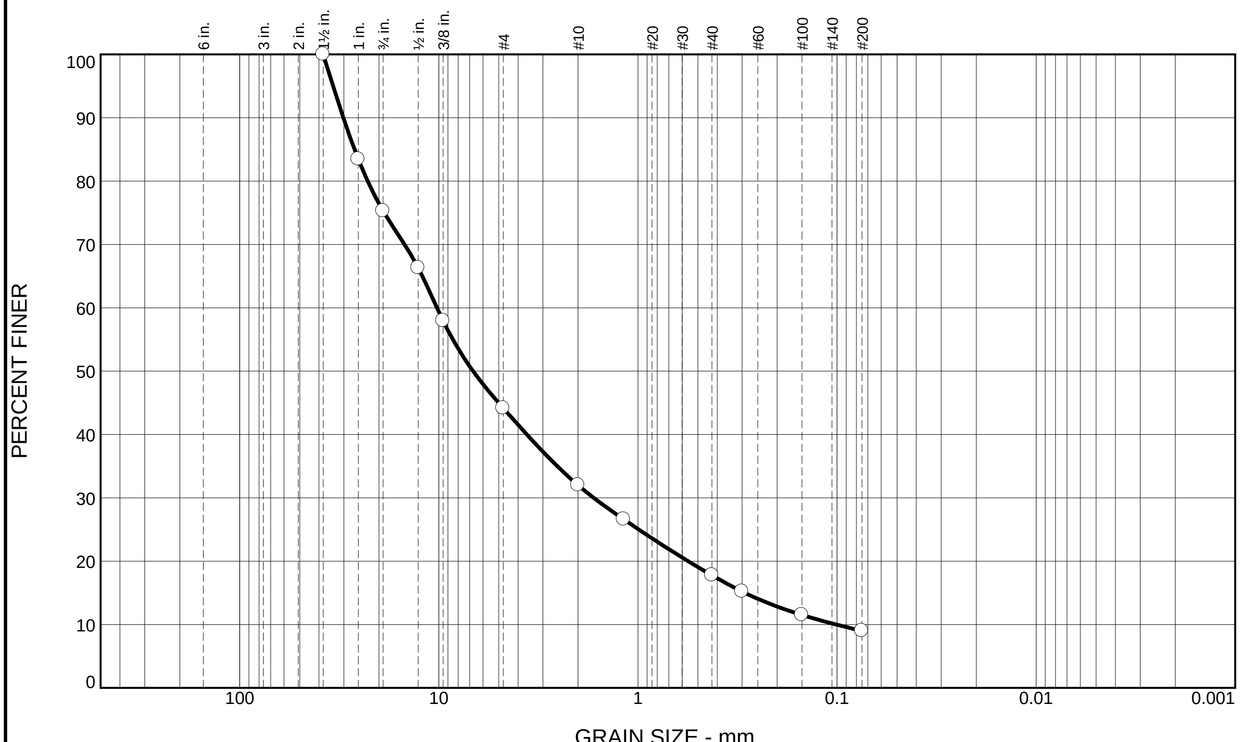
NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project

Project No: 475.0014.008 **Figure** 17-018-49

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	24.7	31.1	12.2	14.2	8.8	9.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	83.5		
.75	75.3		
.5	66.3		
.375	57.9		
#4	44.2		
#10	32.0		
#16	26.6		
#40	17.8		
#50	15.2		
#100	11.5		
#200	9.0		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 30.1749 D_{85}= 26.5212 D_{60}= 10.2251
D_{50}= 6.7349 D_{30}= 1.6689 D_{15}= 0.2906
D_{10}= 0.1009 C_u= 101.38 C_c= 2.70

Classification

USCS= AASHTO=

Remarks

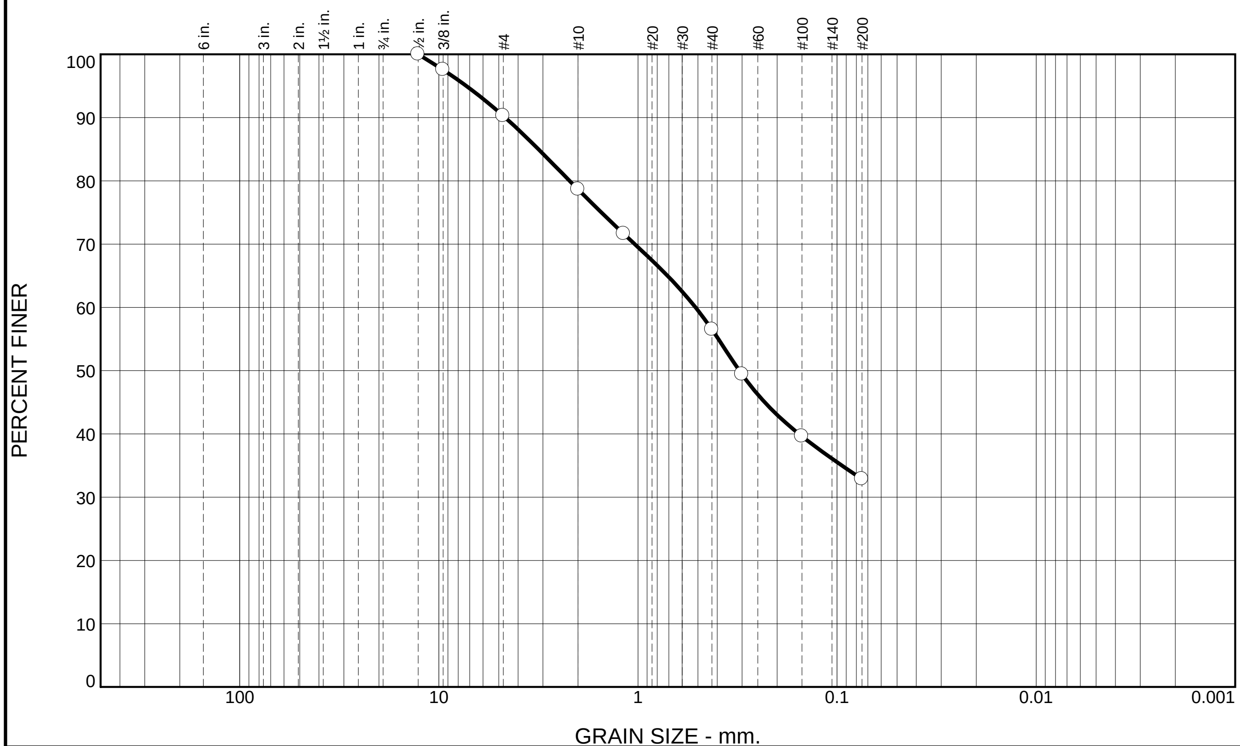
Location: BH-08
Sample Number: 17-018-54 **Depth:** 52.5-54' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-54

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.7	11.6	22.2	23.6	32.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	97.5		
#4	90.3		
#10	78.7		
#16	71.6		
#40	56.5		
#50	49.4		
#100	39.6		
#200	32.9		

* (no specification provided)

Material Description

Brown clayey sand

Atterberg Limits

PL= 20 LL= 33 PI= 13

Coefficients

D_{90}= 4.6433 D_{85}= 3.1643 D_{60}= 0.5140
D_{50}= 0.3094 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

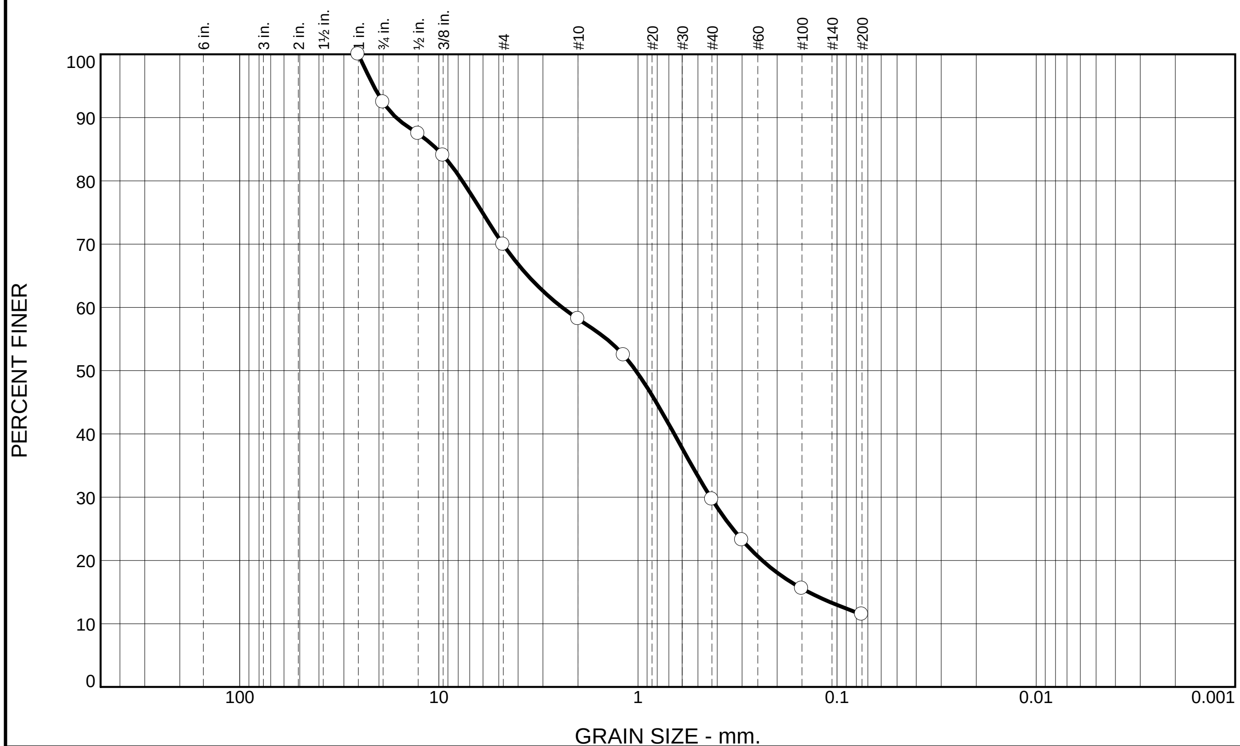
Location: BH-13
Sample Number: 17-018-55 **Depth:** 1-2.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-55

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.6	22.5	11.7	28.5	18.2	11.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100.0		
.75	92.4		
.5	87.4		
.375	84.0		
#4	69.9		
#10	58.2		
#16	52.4		
#40	29.7		
#50	23.2		
#100	15.6		
#200	11.5		

* (no specification provided)

Material Description

Red poorly graded sand with silt and gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 16.3771 D_{85}= 10.1968 D_{60}= 2.4035
D_{50}= 1.0248 D_{30}= 0.4317 D_{15}= 0.1390
D_{10}= C_u= C_c=

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

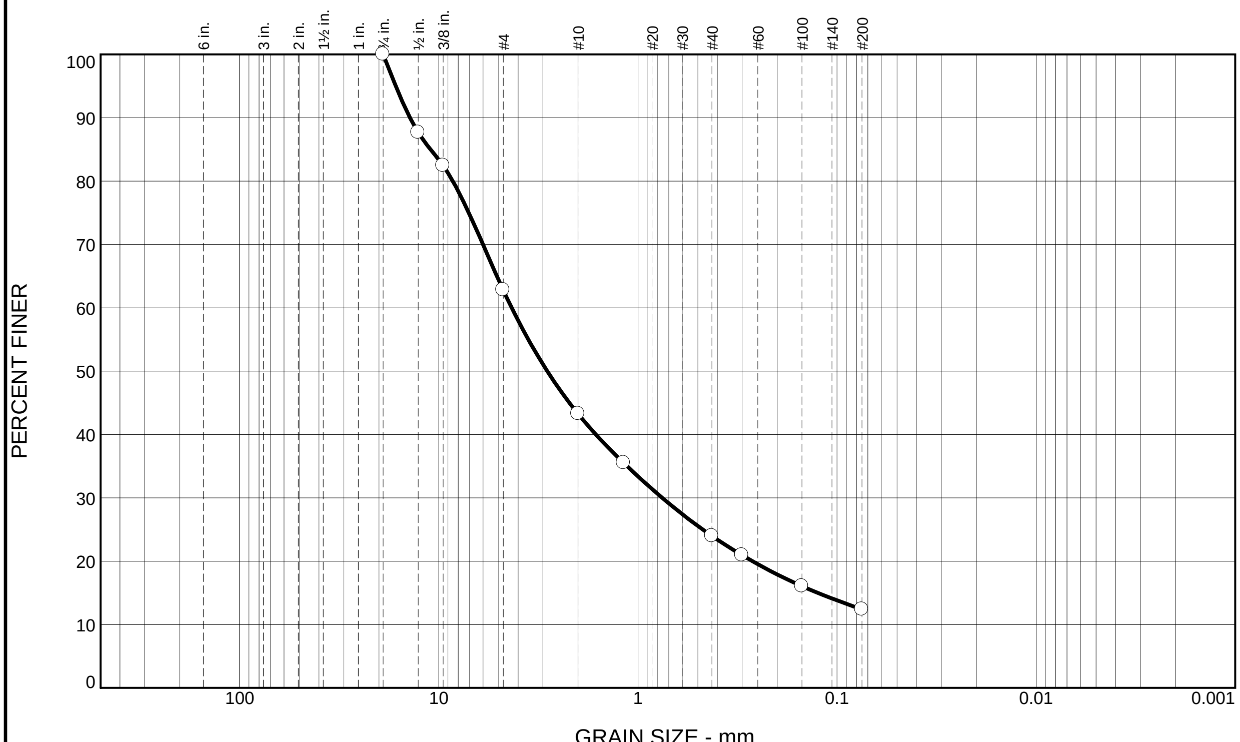
Location: BH-13
Sample Number: 17-018-56 **Depth:** 6-7.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-56

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	37.2	19.5	19.3	11.6	12.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75	100.0		
.5	87.7		
.375	82.5		
#4	62.8		
#10	43.3		
#16	35.5		
#40	24.0		
#50	21.0		
#100	16.1		
#200	12.4		

* (no specification provided)

Material Description

Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 13.9684 D_{85}= 11.0183 D_{60}= 4.3070
D_{50}= 2.8550 D_{30}= 0.7548 D_{15}= 0.1249
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

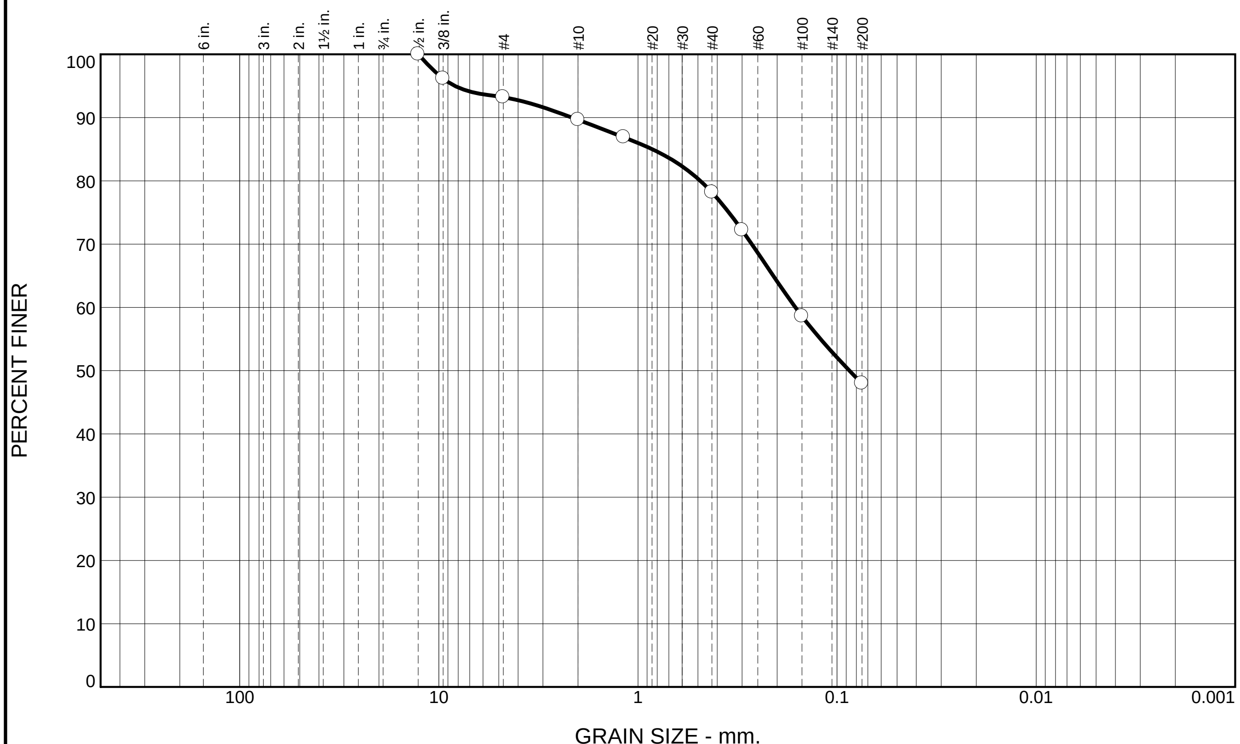
Location: BH-13
Sample Number: 17-018-57 **Depth:** 8.5-10' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-57

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.8	3.6	11.4	30.2	48.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	96.2		
#4	93.2		
#10	89.6		
#16	86.9		
#40	78.2		
#50	72.2		
#100	58.6		
#200	48.0		

* (no specification provided)

Material Description

Brown clayey sand

Atterberg Limits

PL= 19 LL= 34 PI= 15

Coefficients

D_{90}= 2.1429 D_{85}= 0.8474 D_{60}= 0.1619
D_{50}= 0.0866 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-6(4)

Remarks

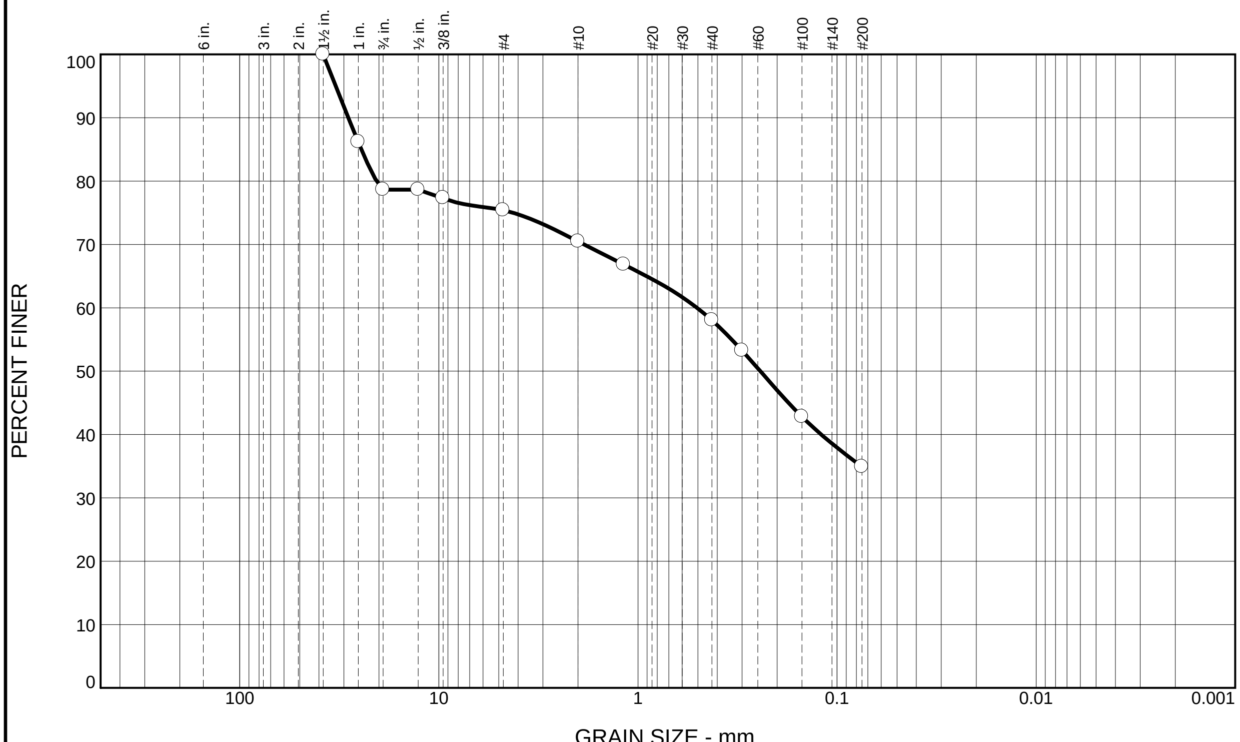
Location: BH-16
Sample Number: 17-018-58 **Depth:** 1-2.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-58

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	21.4	3.2	4.9	12.5	23.1	34.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	86.2		
.75	78.6		
.5	78.6		
.375	77.3		
#4	75.4		
#10	70.5		
#16	66.8		
#40	58.0		
#50	53.2		
#100	42.8		
#200	34.9		

* (no specification provided)

Material Description

Dark brown clayey sand with gravel

Atterberg Limits

PL= 17 LL= 30 PI= 13

Coefficients

D_{90}= 28.4750 D_{85}= 24.5084 D_{60}= 0.5053
D_{50}= 0.2429 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

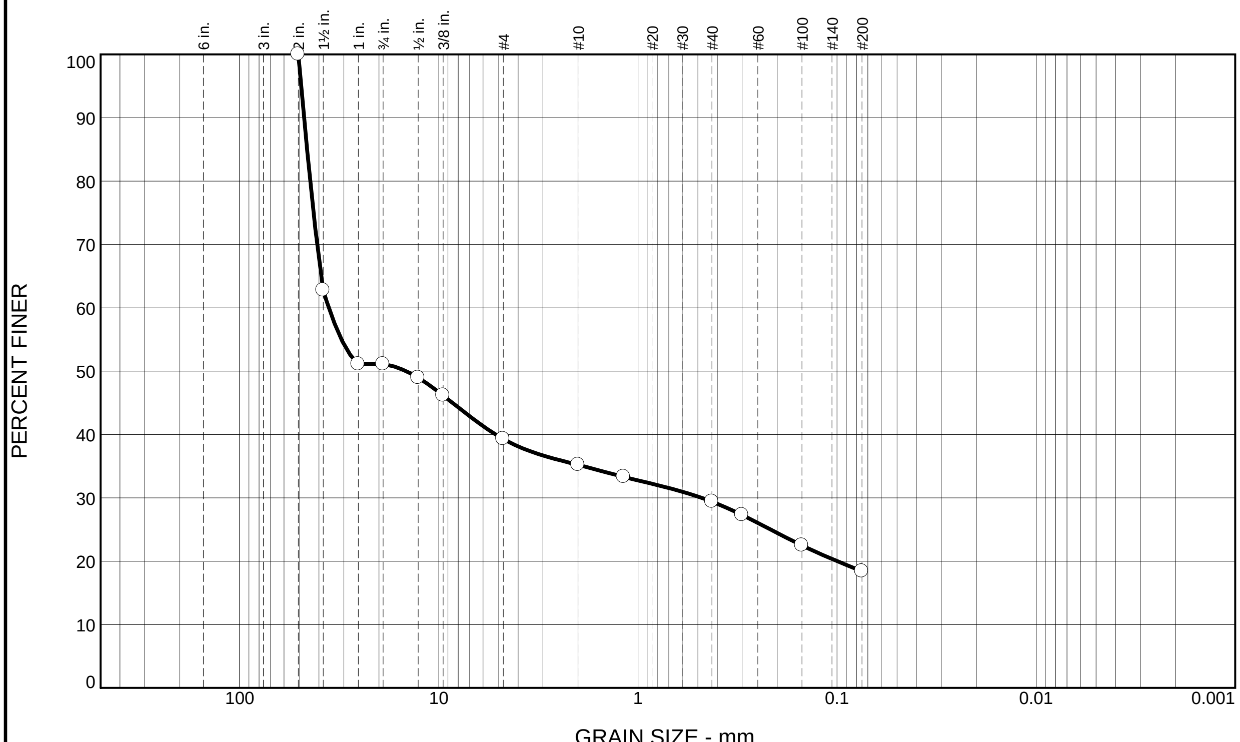
Location: BH-16
Sample Number: 17-018-60 **Depth:** 6-7.5' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-60

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	48.9	11.8	4.1	5.8	11.0	18.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	62.8		
1	51.1		
.75	51.1		
.5	49.0		
.375	46.2		
#4	39.3		
#10	35.2		
#16	33.3		
#40	29.4		
#50	27.3		
#100	22.5		
#200	18.4		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 47.5043 D_{85}= 45.8915 D_{60}= 35.7079
D_{50}= 14.6100 D_{30}= 0.4793 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

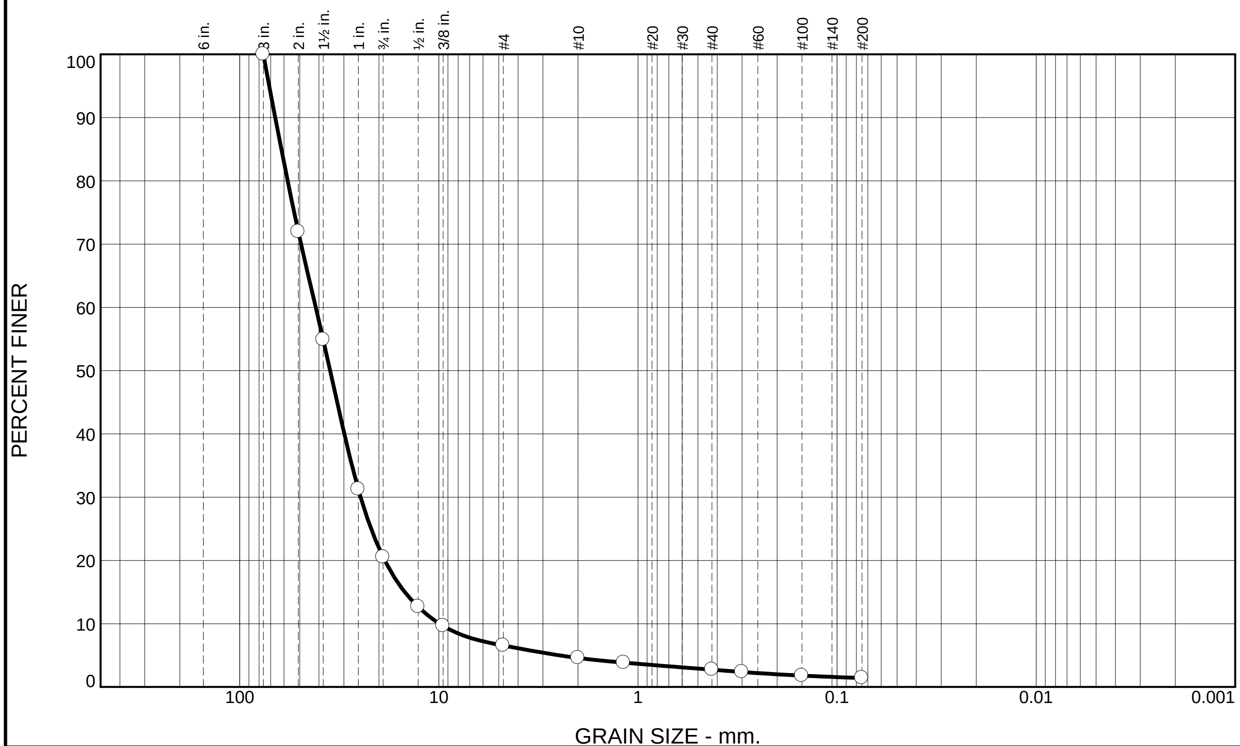
Location: BH-16
Sample Number: 17-018-61 **Depth:** 8.5-10' **Date:** 02/17/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-018-61

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	79.5	13.9	2.0	1.9	1.3	1.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	71.9		
1.5	54.9		
1	31.3		
.75	20.5		
.5	12.7		
.375	9.6		
#4	6.6		
#10	4.6		
#16	3.9		
#40	2.7		
#50	2.4		
#100	1.8		
#200	1.4		

* (no specification provided)

Material Description

Brown well-graded gravel

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 66.3389 D_{85}= 61.8077 D_{60}= 41.5500
D_{50}= 35.1614 D_{30}= 24.7334 D_{15}= 14.8365
D_{10}= 9.9326 C_u= 4.18 C_c= 1.48

Classification

USCS= GW AASHTO=

Remarks

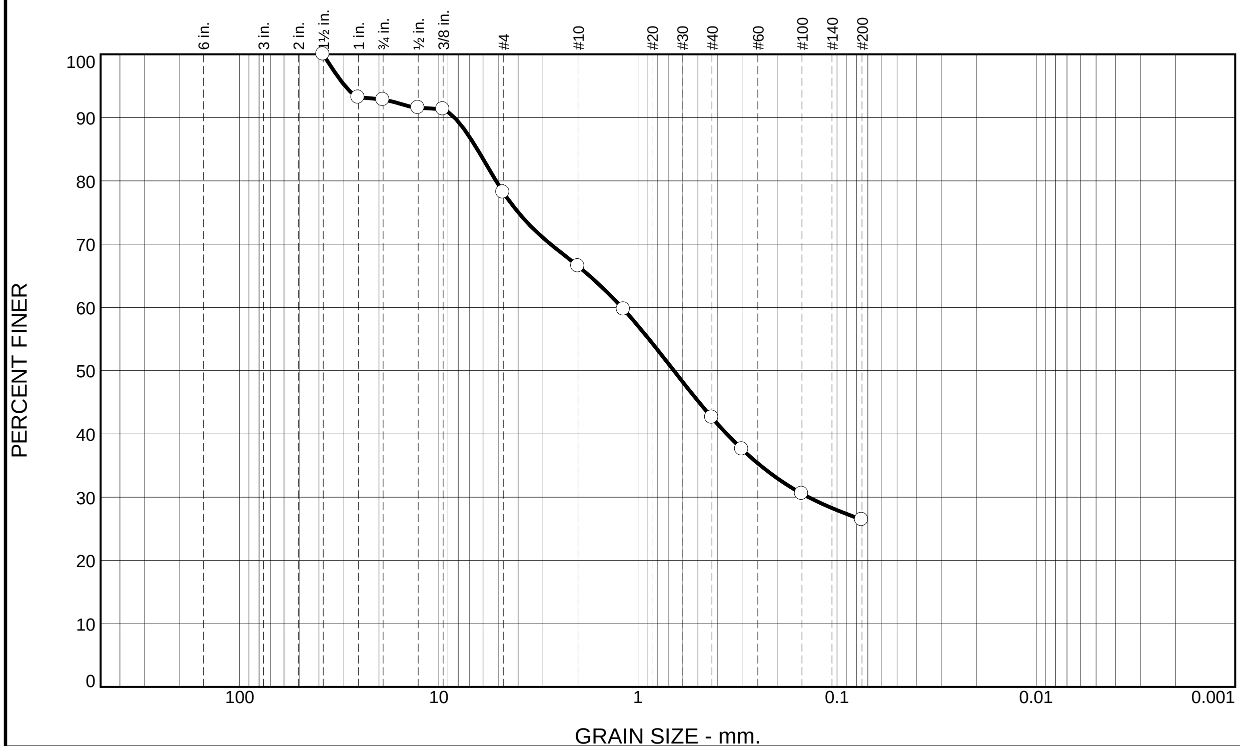
Location: TP-01
Sample Number: 17-019-01 **Depth:** 3'-4' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-01

Tested By: AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.2	14.6	11.7	23.9	16.2	26.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	93.2		
.75	92.8		
.5	91.6		
.375	91.3		
#4	78.2		
#10	66.5		
#16	59.7		
#40	42.6		
#50	37.6		
#100	30.6		
#200	26.4		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 20 LL= 37 PI= 17

Coefficients

D_{90}= 8.3485 D_{85}= 6.4166 D_{60}= 1.2057
D_{50}= 0.6602 D_{30}= 0.1391 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

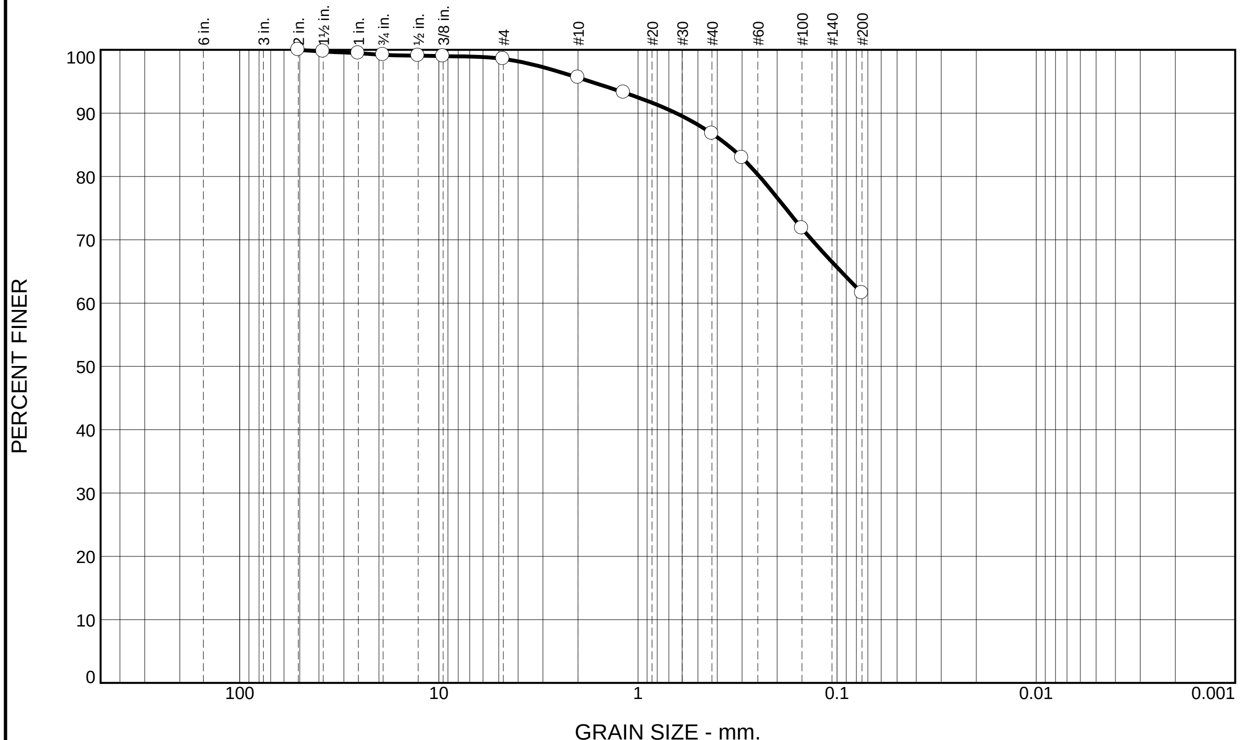
Location: TP-02
Sample Number: 17-019-02 **Depth:** 2'-3' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-02

Tested By: OS/AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.8	0.6	3.0	8.8	25.2	61.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	99.7		
1	99.5		
.75	99.2		
.5	99.1		
.375	99.0		
#4	98.6		
#10	95.6		
#16	93.3		
#40	86.8		
#50	82.9		
#100	71.8		
#200	61.6		

* (no specification provided)

Material Description

Red sandy fat clay

Atterberg Limits

PL= 21 LL= 55 PI= 34

Coefficients

D_{90}= 0.6430 D_{85}= 0.3558 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(19)

Remarks

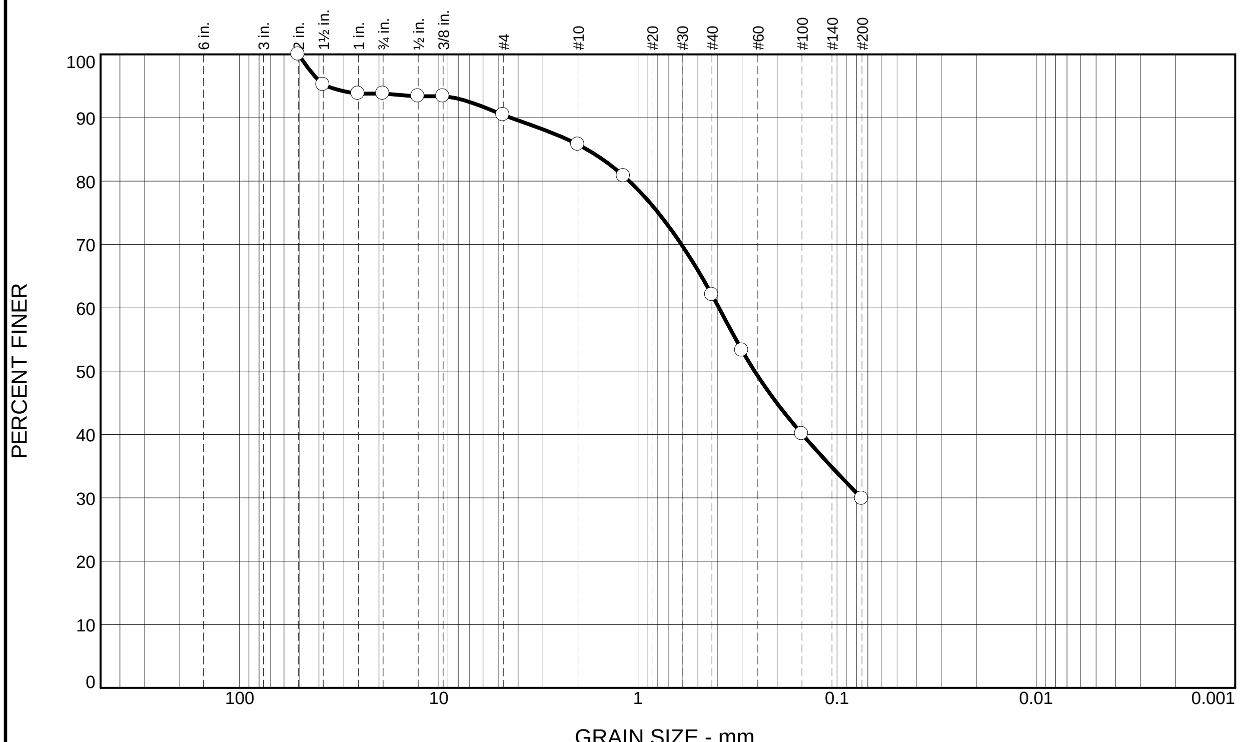
Location: TP-06
Sample Number: 17-019-03 **Depth:** 1'-3' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-03

Tested By: JG **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.2	3.3	4.7	23.7	32.2	29.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	95.2		
1	93.8		
.75	93.8		
.5	93.4		
.375	93.4		
#4	90.5		
#10	85.8		
#16	80.8		
#40	62.1		
#50	53.3		
#100	40.1		
#200	29.9		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 4.3488 D_{85}= 1.8066 D_{60}= 0.3918
D_{50}= 0.2595 D_{30}= 0.0757 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Location: TP-07
Sample Number: 17-019-04 **Depth:** 0'-1.5' **Date:** 02/08/17

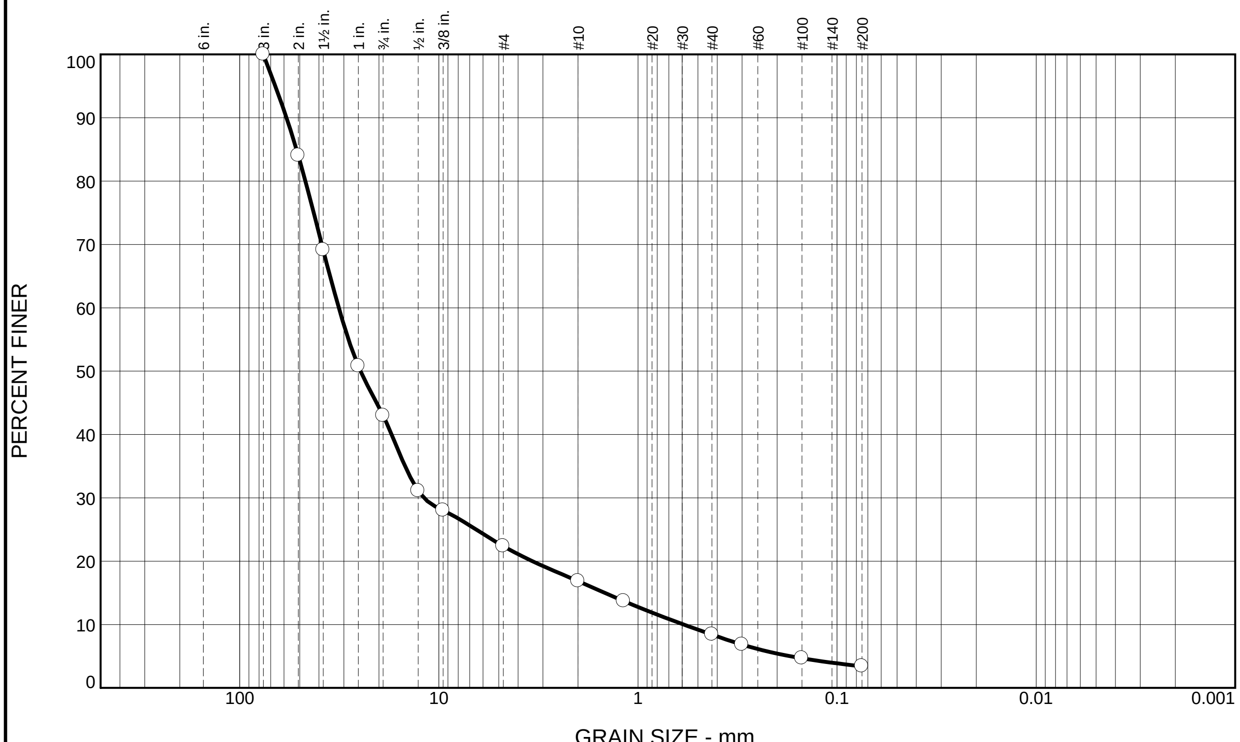
NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project

Project No: 475.0014.008 **Figure** 17-019-04

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	57.0	20.6	5.5	8.5	5.0	3.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	84.0		
1.5	69.1		
1	50.8		
.75	43.0		
.5	31.1		
.375	28.0		
#4	22.4		
#10	16.9		
#16	13.7		
#40	8.4		
#50	6.8		
#100	4.7		
#200	3.4		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 58.2416 D_{85}= 51.8652 D_{60}= 31.8257
D_{50}= 24.7581 D_{30}= 11.9056 D_{15}= 1.4671
D_{10}= 0.5889 C_u= 54.05 C_c= 7.56

Classification

USCS= GP AASHTO=

Remarks

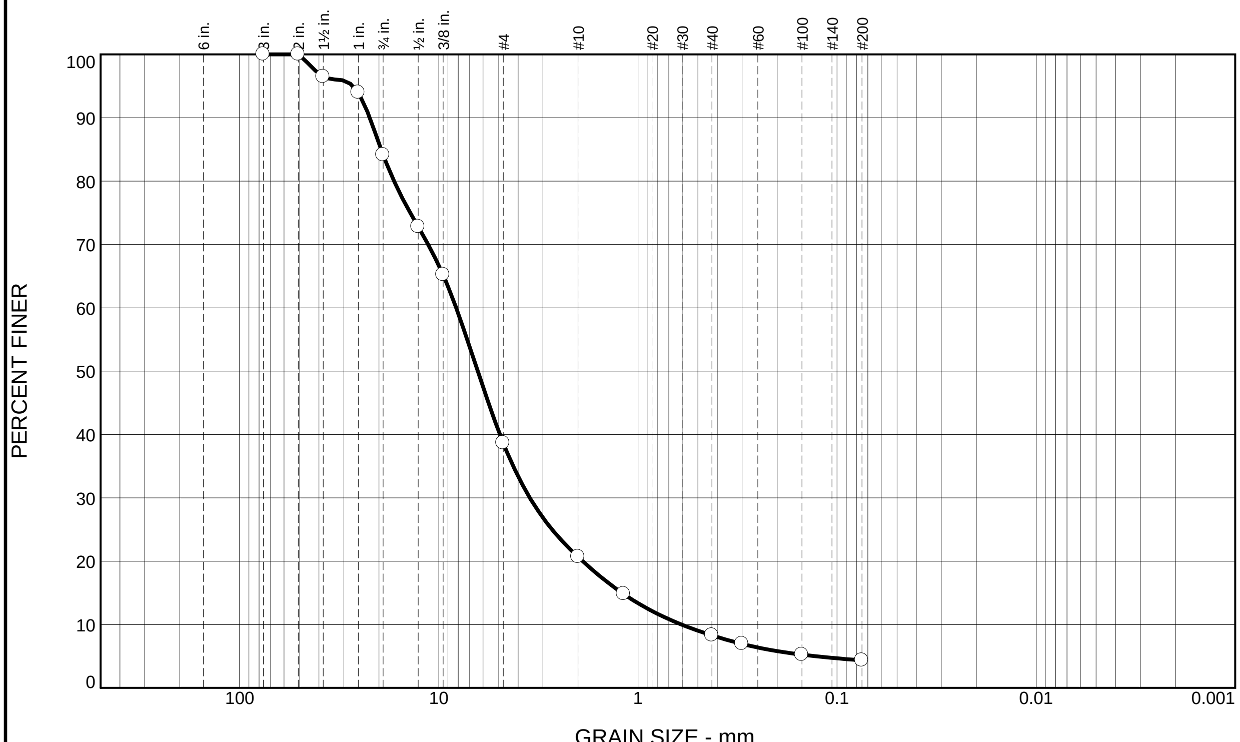
Location: TP-07
Sample Number: 17-019-05 **Depth:** 7'-8' **Date:** 02/09/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-05

Tested By: AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	15.9	45.4	18.0	12.4	4.0	4.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	100.0		
1.5	96.5		
1	94.0		
.75	84.1		
.5	72.8		
.375	65.2		
#4	38.7		
#10	20.7		
#16	14.8		
#40	8.3		
#50	6.9		
#100	5.2		
#200	4.3		

* (no specification provided)

Material Description

Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 22.2582 D_{85}= 19.5043 D_{60}= 8.1931
D_{50}= 6.3772 D_{30}= 3.4921 D_{15}= 1.2034
D_{10}= 0.6042 C_u= 13.56 C_c= 2.46

Classification

USCS= GW AASHTO=

Remarks

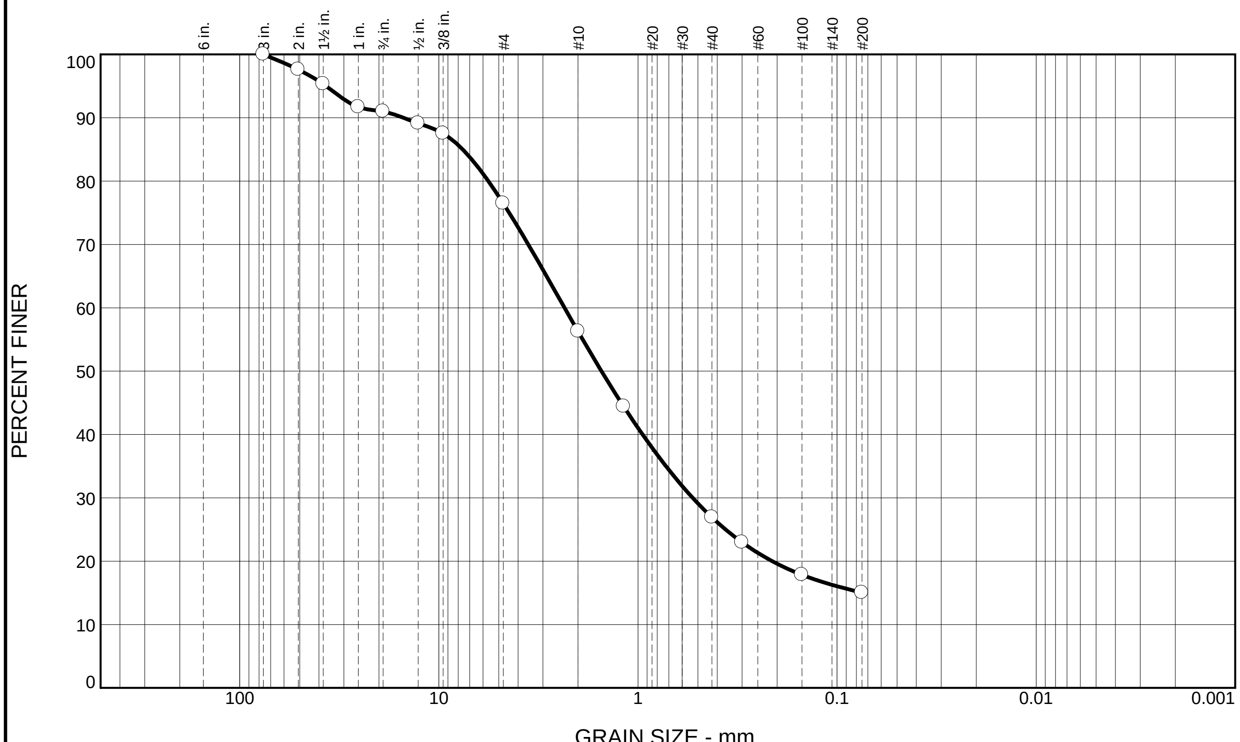
Location: TP-08
Sample Number: 17-019-06 **Depth:** 1' **Date:** 02/09/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-06

Tested By: JG **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.0	14.5	20.2	29.4	11.9	15.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
2	97.6		
1.5	95.3		
1	91.7		
.75	91.0		
.5	89.1		
.375	87.5		
#4	76.5		
#10	56.3		
#16	44.4		
#40	26.9		
#50	23.0		
#100	17.8		
#200	15.0		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 18 LL= 26 PI= 8

Coefficients

D_{90}= 15.0599 D_{85}= 7.5917 D_{60}= 2.3383
D_{50}= 1.5244 D_{30}= 0.5312 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-4(0)

Remarks

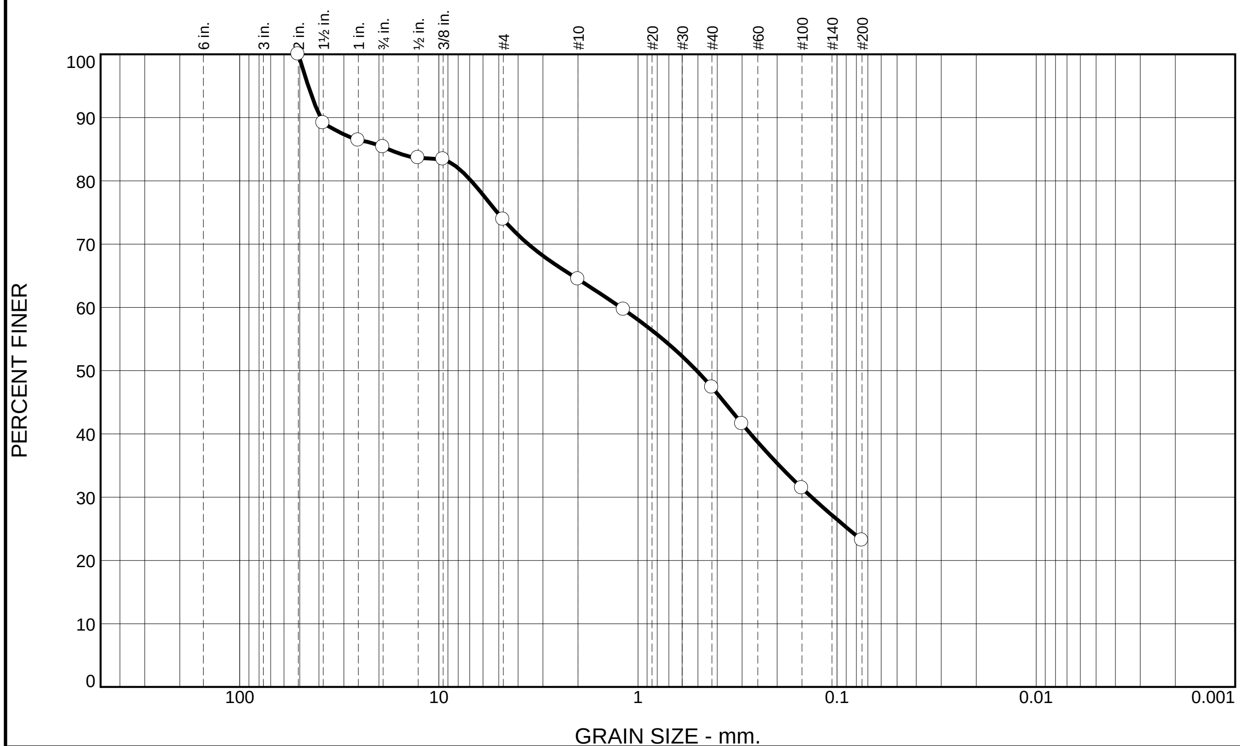
Location: TP-08
Sample Number: 17-019-07 **Depth:** 4' **Date:** 02/09/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-07

Tested By: OS/AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	14.7	11.4	9.4	17.1	24.2	23.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	89.1		
1	86.4		
.75	85.3		
.5	83.6		
.375	83.4		
#4	73.9		
#10	64.5		
#16	59.7		
#40	47.4		
#50	41.6		
#100	31.4		
#200	23.2		

* (no specification provided)

Material Description

Red silty sand with gravel

Atterberg Limits

PL= 23 LL= 31 PI= 8

Coefficients

D_{90}= 39.3635 D_{85}= 17.9264 D_{60}= 1.2216
D_{50}= 0.5069 D_{30}= 0.1341 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

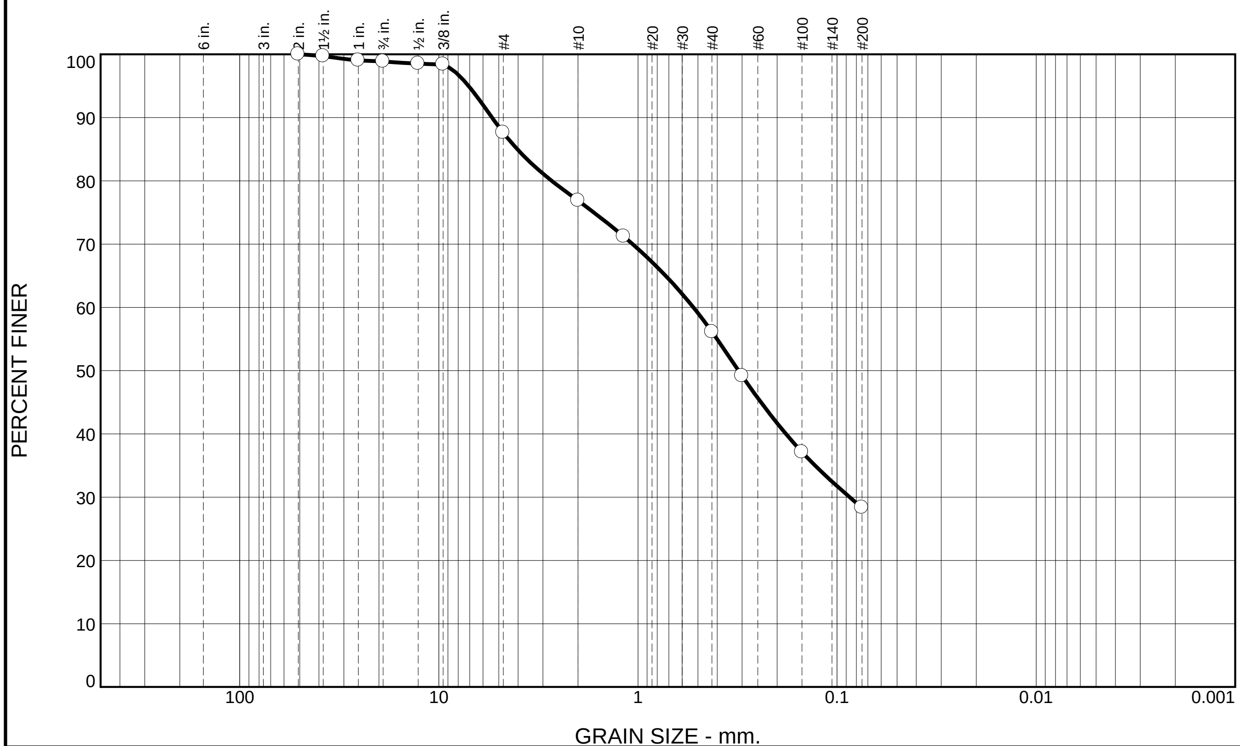
Location: TP-09
Sample Number: 17-019-08 **Depth:** 1'-2' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-08

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.1	11.3	10.7	20.8	27.8	28.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	99.7		
1	99.0		
.75	98.9		
.5	98.5		
.375	98.4		
#4	87.6		
#10	76.9		
#16	71.2		
#40	56.1		
#50	49.2		
#100	37.1		
#200	28.3		

* (no specification provided)

Material Description

Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 5.4050 D_{85}= 4.0393 D_{60}= 0.5270
D_{50}= 0.3126 D_{30}= 0.0864 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

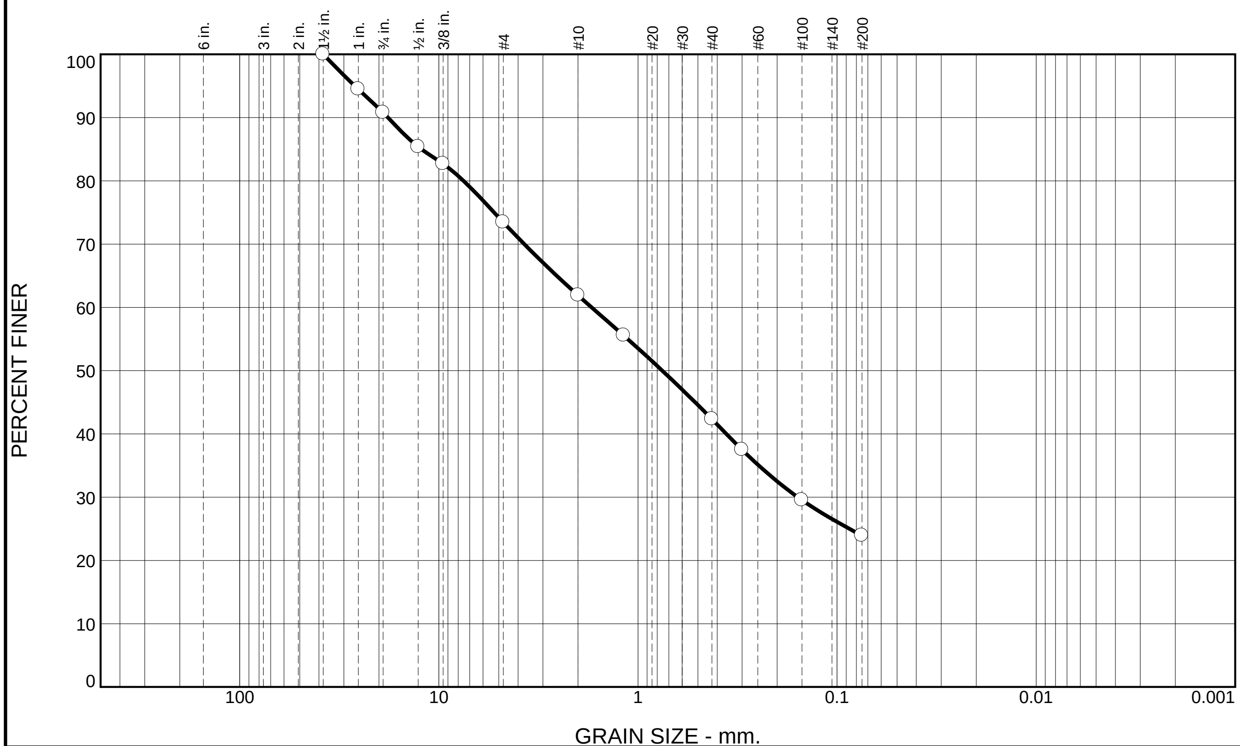
Location: TP-11
Sample Number: 17-019-09 **Depth:** 3'-4' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-09

Tested By: JG **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.2	17.4	11.5	19.6	18.4	23.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	94.5		
.75	90.8		
.5	85.4		
.375	82.7		
#4	73.4		
#10	61.9		
#16	55.6		
#40	42.3		
#50	37.5		
#100	29.5		
#200	23.9		

* (no specification provided)

Material Description

Dark brown clayey sand with gravel

Atterberg Limits

PL= 17 LL= 32 PI= 15

Coefficients

D_{90}= 18.0171 D_{85}= 12.2546 D_{60}= 1.7094
D_{50}= 0.7551 D_{30}= 0.1575 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

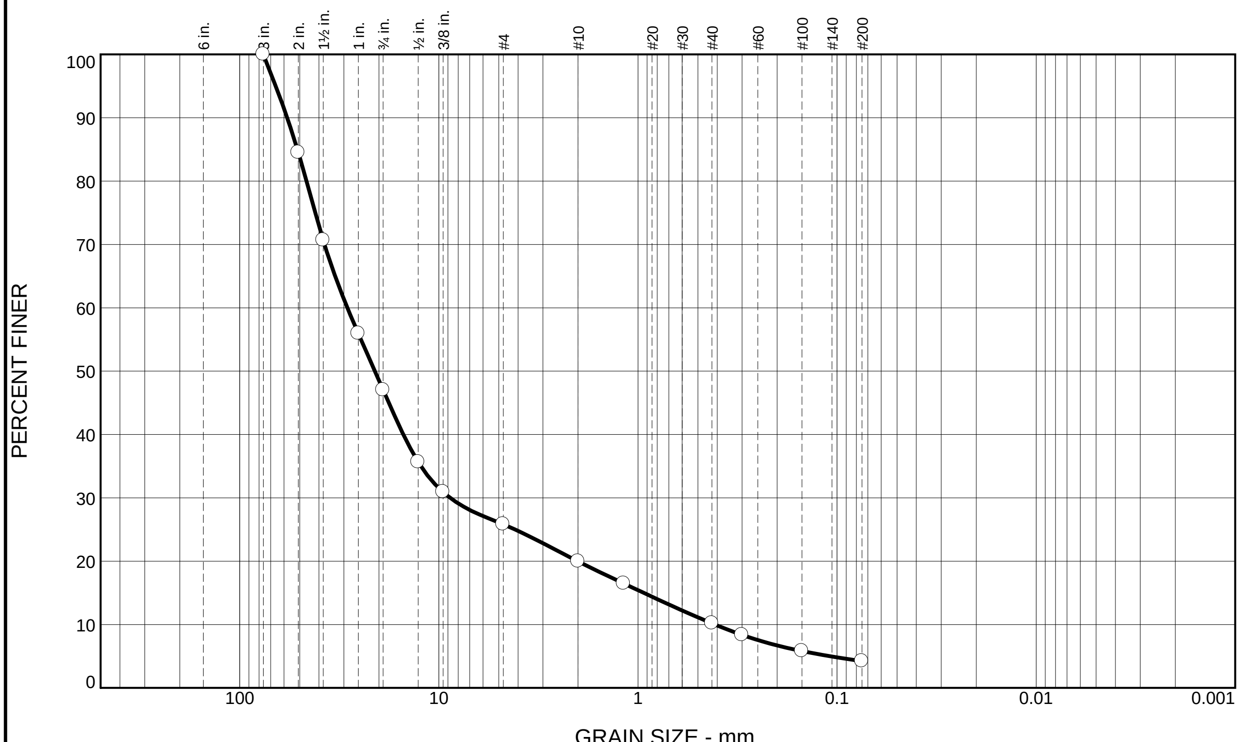
Location: TP-11
Sample Number: 17-019-10 **Depth:** 10'-11' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-10

Tested By: AR **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	53.0	21.2	5.8	9.8	6.0	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	84.5		
1.5	70.7		
1	56.0		
.75	47.0		
.5	35.6		
.375	30.9		
#4	25.8		
#10	20.0		
#16	16.5		
#40	10.2		
#50	8.4		
#100	5.8		
#200	4.2		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 57.7845 D_{85}= 51.3354 D_{60}= 28.8057
D_{50}= 20.9700 D_{30}= 8.7751 D_{15}= 0.9354
D_{10}= 0.4104 C_u= 70.18 C_c= 6.51

Classification

USCS= GP AASHTO=

Remarks

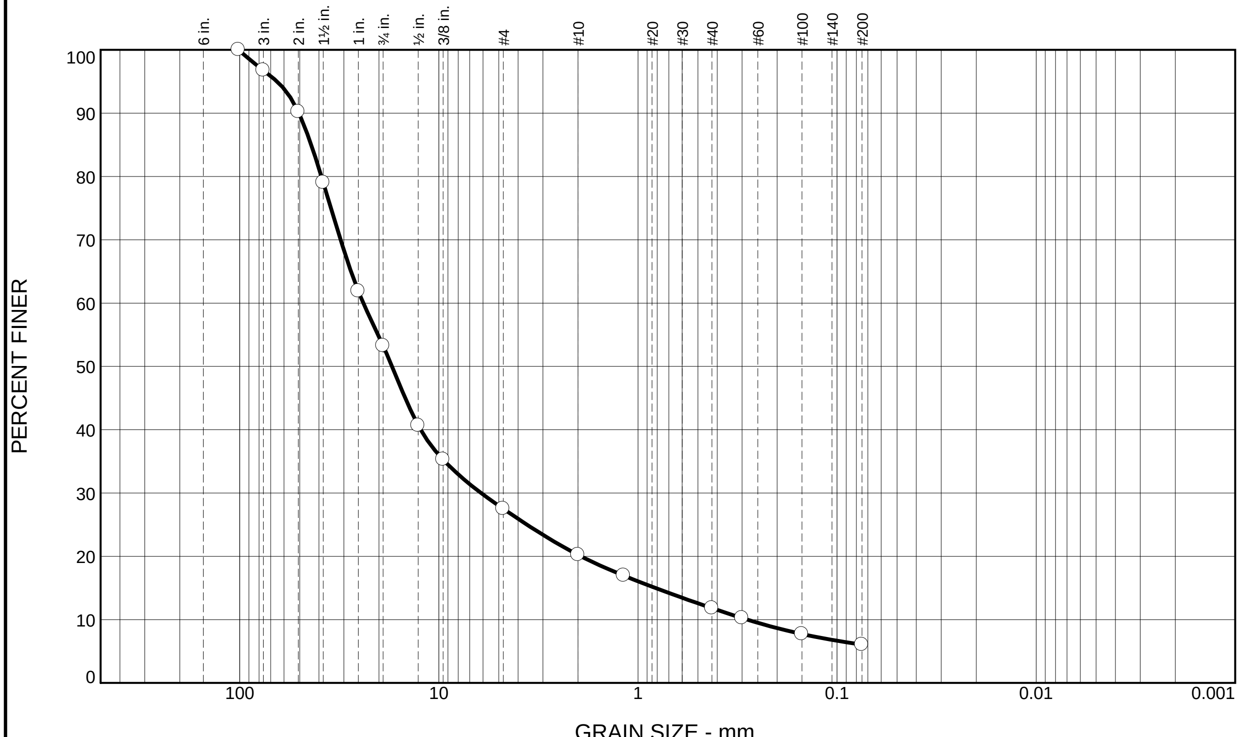
Location: TP-13
Sample Number: 17-019-11 **Depth:** 1'-3' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-11

Tested By: AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
3.2	43.5	25.8	7.3	8.4	5.8	6.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.0	100.0		
3.0	96.8		
2.0	90.2		
1.5	79.0		
1	61.9		
.75	53.3		
.5	40.7		
.375	35.3		
#4	27.5		
#10	20.2		
#16	17.0		
#40	11.8		
#50	10.3		
#100	7.7		
#200	6.0		

* (no specification provided)

Material Description

Dark brown poorly graded gravel with clay and sand

Atterberg Limits

PL= 20 LL= 30 PI= 10

Coefficients

D_{90}= 50.4270 D_{85}= 43.7685 D_{60}= 23.9751
D_{50}= 17.1964 D_{30}= 6.1435 D_{15}= 0.8175
D_{10}= 0.2827 C_u= 84.80 C_c= 5.57

Classification

USCS= GP-GC AASHTO= A-2-4(0)

Remarks

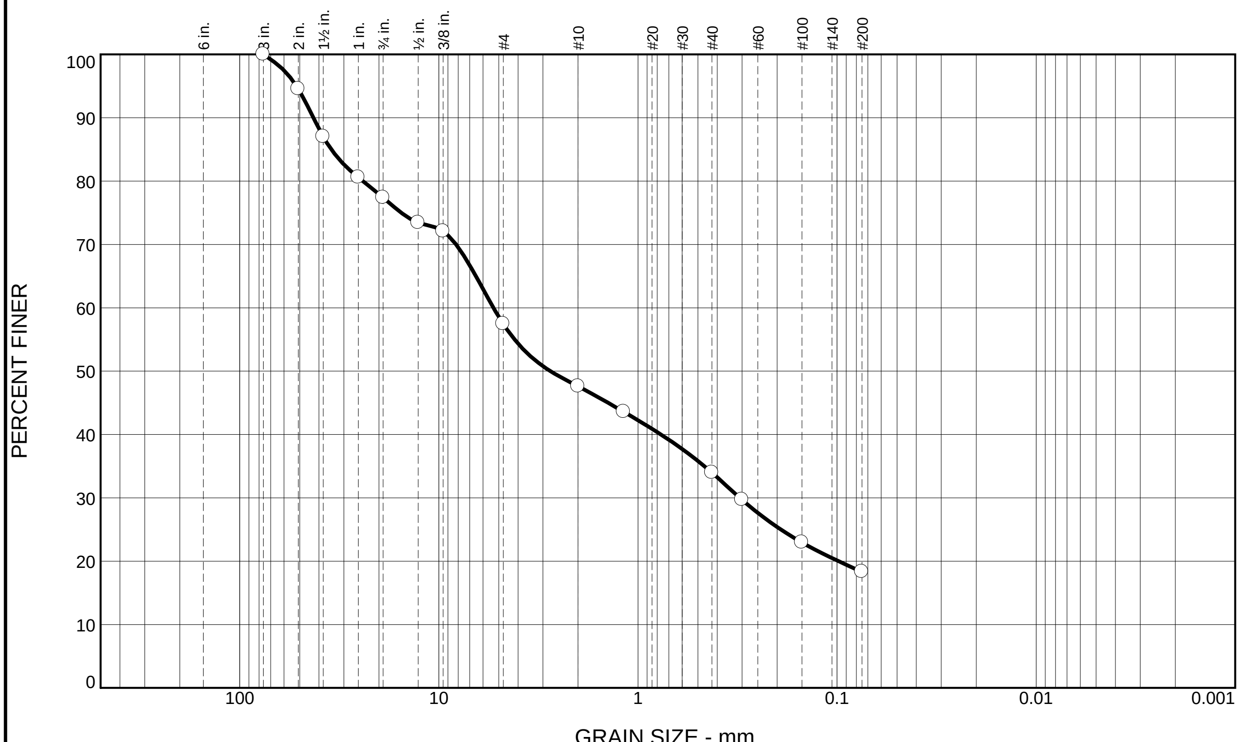
Location: TP-14
Sample Number: 17-019-12 **Depth:** 3'-4' **Date:** 02/09/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-12

Tested By: JG **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	22.6	19.9	9.9	13.6	15.7	18.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	94.6		
1.5	87.0		
1	80.6		
.75	77.4		
.5	73.4		
.375	72.1		
#4	57.5		
#10	47.6		
#16	43.6		
#40	34.0		
#50	29.7		
#100	22.9		
#200	18.3		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 42.6926 D_{85}= 34.6866 D_{60}= 5.3185
D_{50}= 2.7518 D_{30}= 0.3079 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

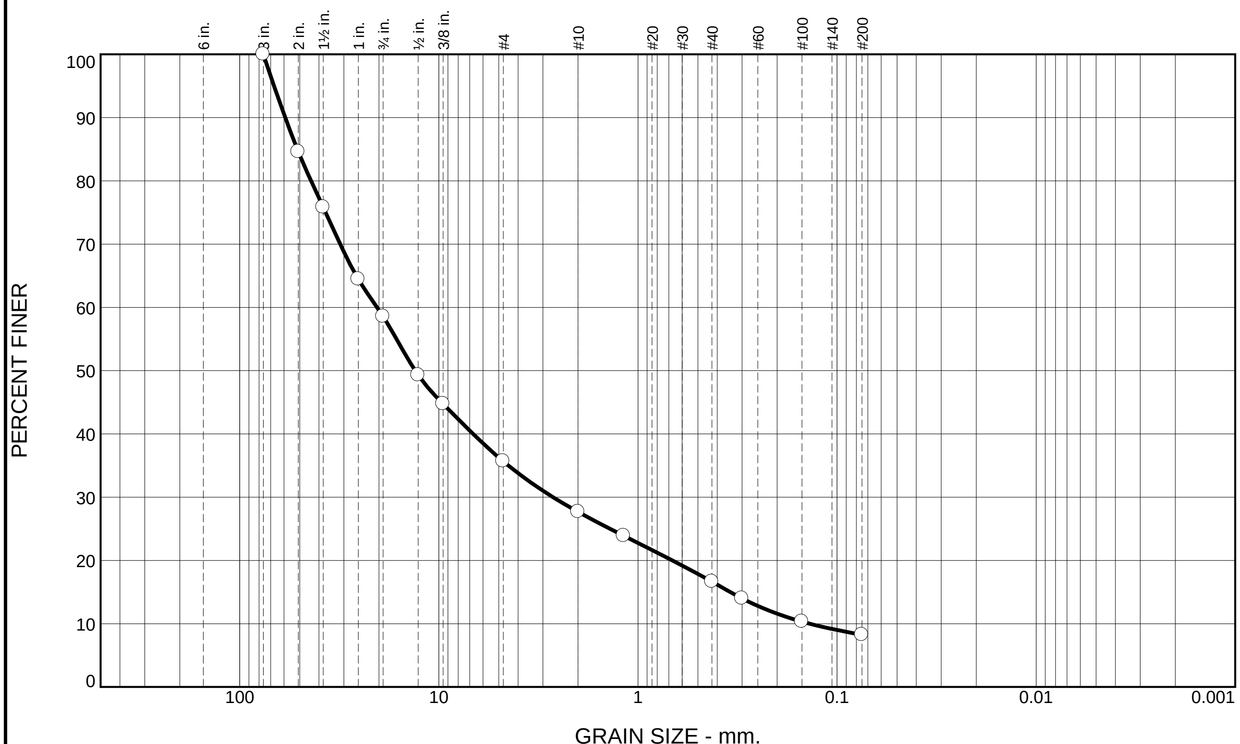
Location: TP-15
Sample Number: 17-019-13 **Depth:** 5'-6' **Date:** 02/14/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-13

Tested By: AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	41.4	22.9	8.0	11.1	8.4	8.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	84.6		
1.5	75.8		
1	64.5		
.75	58.6		
.5	49.3		
.375	44.8		
#4	35.7		
#10	27.7		
#16	23.9		
#40	16.6		
#50	14.0		
#100	10.3		
#200	8.2		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 59.1097 D_{85}= 51.3987 D_{60}= 20.4368
D_{50}= 13.1467 D_{30}= 2.6706 D_{15}= 0.3439
D_{10}= 0.1372 C_u= 148.92 C_c= 2.54

Classification

USCS= AASHTO=

Remarks

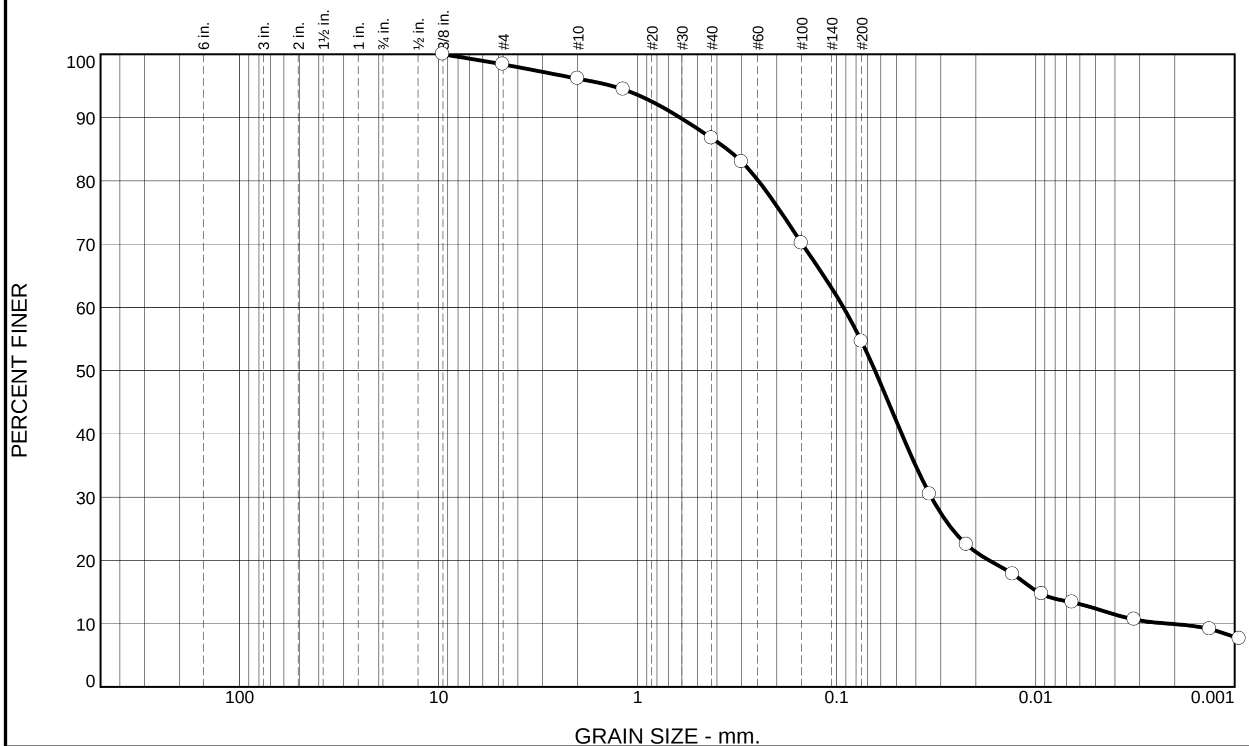
Location: TP-17
Sample Number: 17-019-14 **Depth:** 5'-6' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-14

Tested By: AH **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.6	2.2	9.5	32.1	44.7	9.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	98.4		
#10	96.2		
#16	94.5		
#40	86.7		
#50	83.0		
#100	70.2		
#200	54.6		

* (no specification provided)

Material Description

Gray sandy silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.6121 D_{85}= 0.3550 D_{60}= 0.0925
D_{50}= 0.0642 D_{30}= 0.0335 D_{15}= 0.0097
D_{10}= 0.0021 C_u= 43.62 C_c= 5.71

Classification

USCS= ML AASHTO= A-4(0)

Remarks

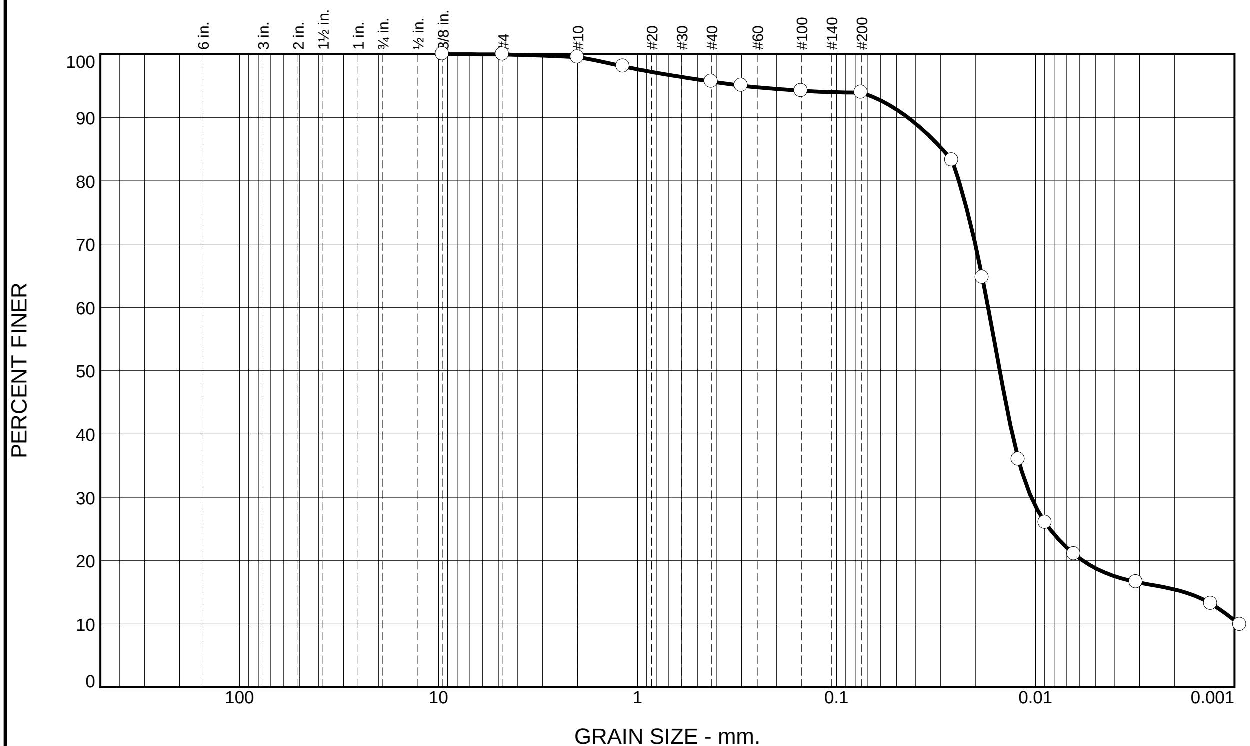
Location: TP-24
Sample Number: 17-019-15 **Depth:** 4'-7' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-15

Tested By: JG **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.4	3.8	1.8	78.5	15.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	99.9		
#10	99.5		
#16	98.1		
#40	95.7		
#50	95.0		
#100	94.2		
#200	93.9		

* (no specification provided)

Material Description

Gray fat clay

Atterberg Limits

PL= 27 LL= 57 PI= 30

Coefficients

D_{90}= 0.0438 D_{85}= 0.0294 D_{60}= 0.0173
D_{50}= 0.0151 D_{30}= 0.0105 D_{15}= 0.0018
D_{10}= 0.0010 C_u= 18.20 C_c= 6.71

Classification

USCS= CH AASHTO= A-7-6(33)

Remarks

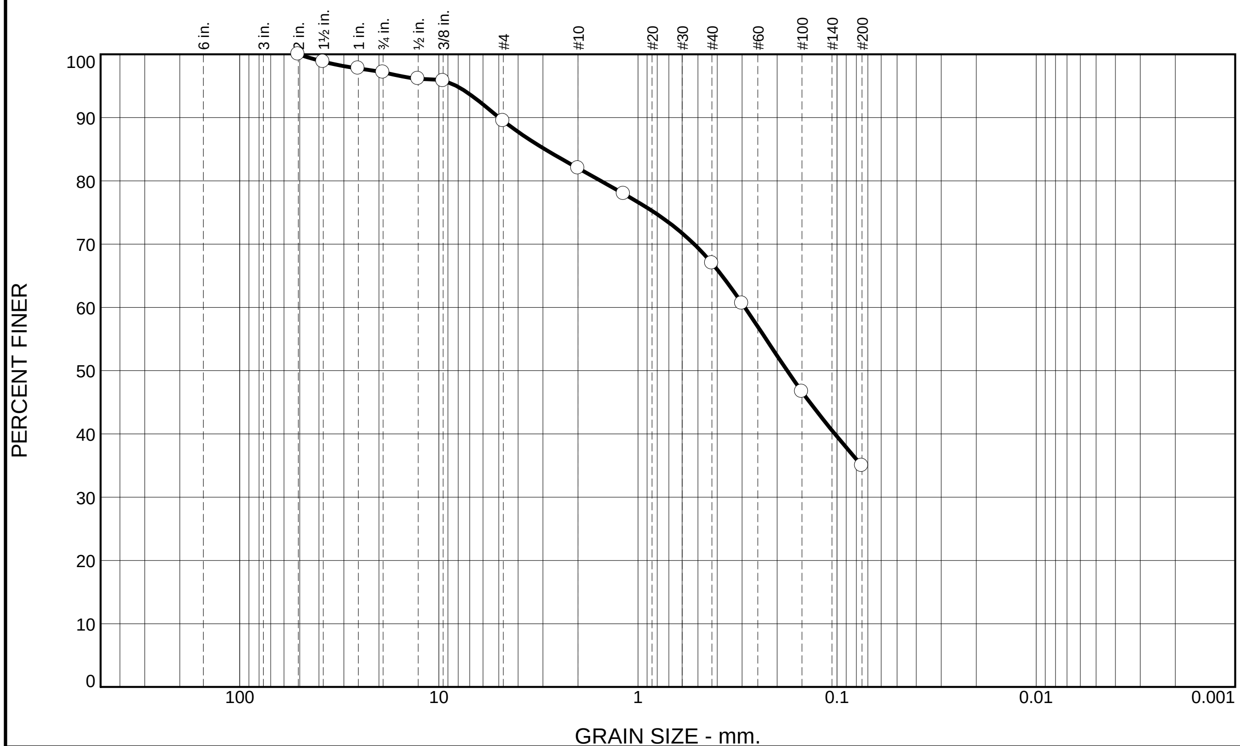
Location: TP-25
Sample Number: 17-019-16 **Depth:** 8'-10' **Date:** 02/08/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-16

Tested By: JG **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.8	7.7	7.5	15.0	32.0	35.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	98.8		
1	97.8		
.75	97.2		
.5	96.1		
.375	95.8		
#4	89.5		
#10	82.0		
#16	78.0		
#40	67.0		
#50	60.6		
#100	46.7		
#200	35.0		

* (no specification provided)

Material Description

Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 4.9780 D_{85}= 2.9356 D_{60}= 0.2906
D_{50}= 0.1780 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

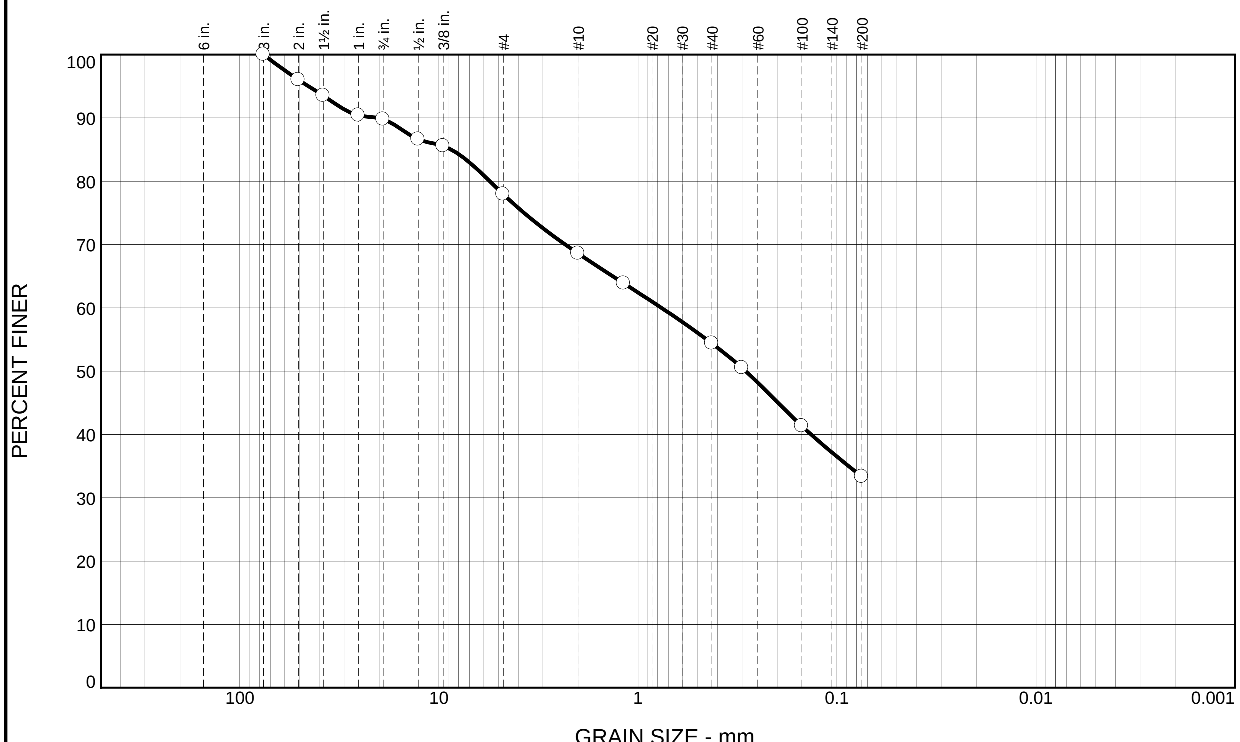
Location: TP-26
Sample Number: 17-019-17 **Depth:** 10'-12' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-17

Tested By: AH **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.2	11.9	9.3	14.2	21.1	33.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	96.0		
1.5	93.5		
1	90.4		
.75	89.8		
.5	86.6		
.375	85.6		
#4	77.9		
#10	68.6		
#16	63.9		
#40	54.4		
#50	50.5		
#100	41.3		
#200	33.3		

* (no specification provided)

Material Description

Light brown clayey sand with gravel

Atterberg Limits

PL= 20 LL= 33 PI= 13

Coefficients

D_{90}= 20.2664 D_{85}= 8.6734 D_{60}= 0.7622
D_{50}= 0.2877 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

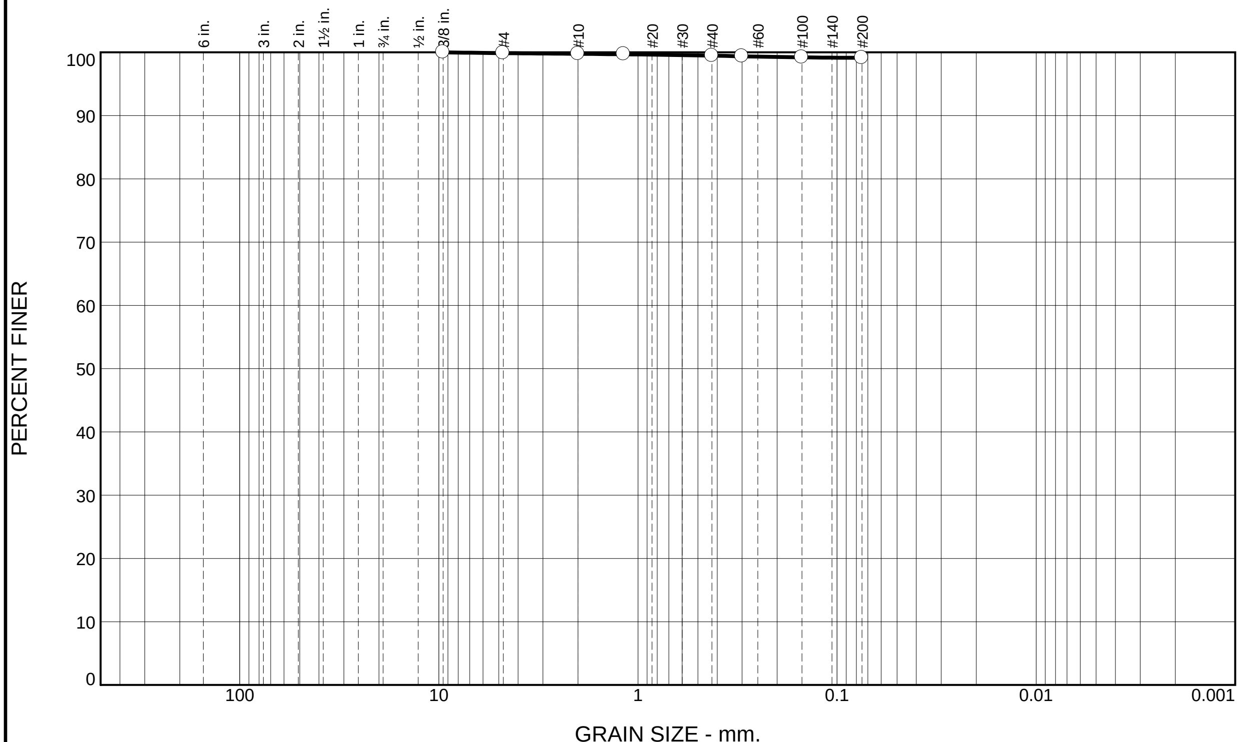
Location: TP-28
Sample Number: 17-019-18 **Depth:** 5'-8' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-18

Tested By: JG **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.1	0.3	0.4	99.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375"	100.0		
#4	99.9		
#10	99.8		
#16	99.7		
#40	99.5		
#50	99.4		
#100	99.2		
#200	99.1		

* (no specification provided)

Material Description

Brown silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

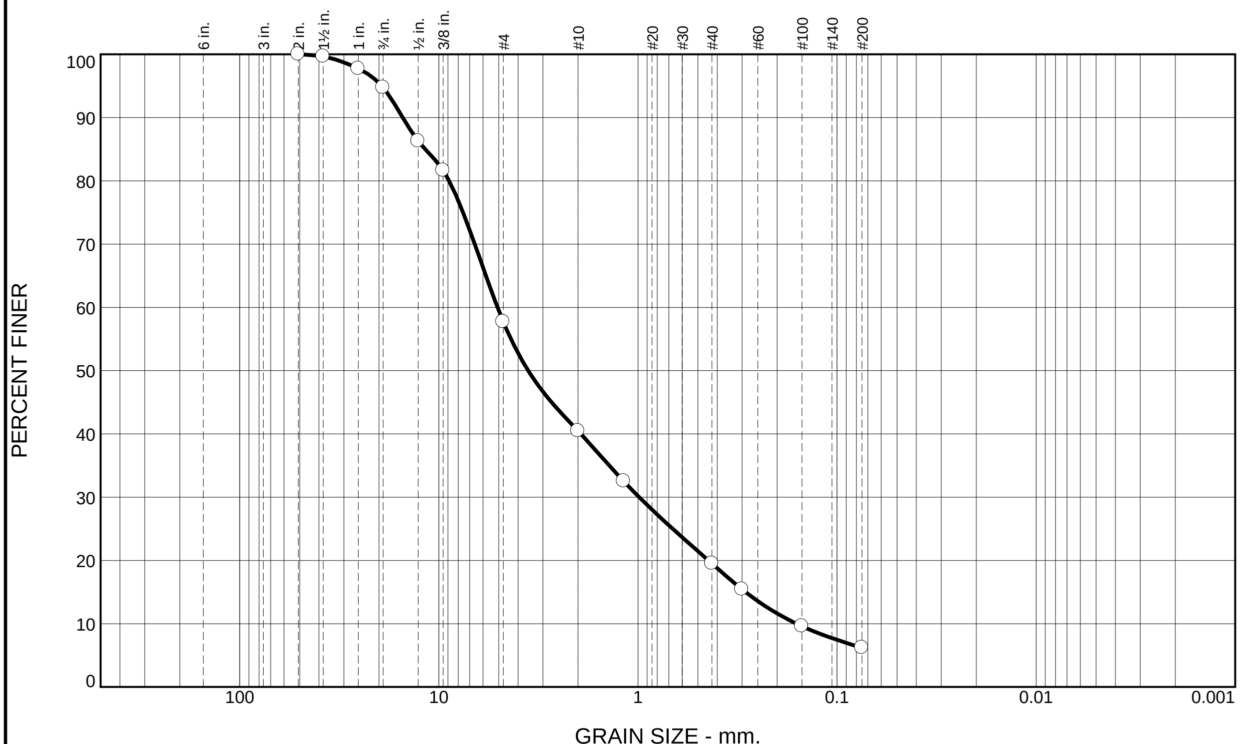
Location: TP-30
Sample Number: 17-019-19 **Depth:** 3'5' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-19

Tested By: AH **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.3	37.0	17.2	21.0	13.3	6.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	99.7		
1	97.7		
.75	94.7		
.5	86.3		
.375	81.6		
#4	57.7		
#10	40.5		
#16	32.5		
#40	19.5		
#50	15.4		
#100	9.6		
#200	6.2		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 15.1795 D_{85}= 11.7130 D_{60}= 5.0754
D_{50}= 3.5611 D_{30}= 0.9861 D_{15}= 0.2883
D_{10}= 0.1599 C_u= 31.74 C_c= 1.20

Classification

USCS= AASHTO=

Remarks

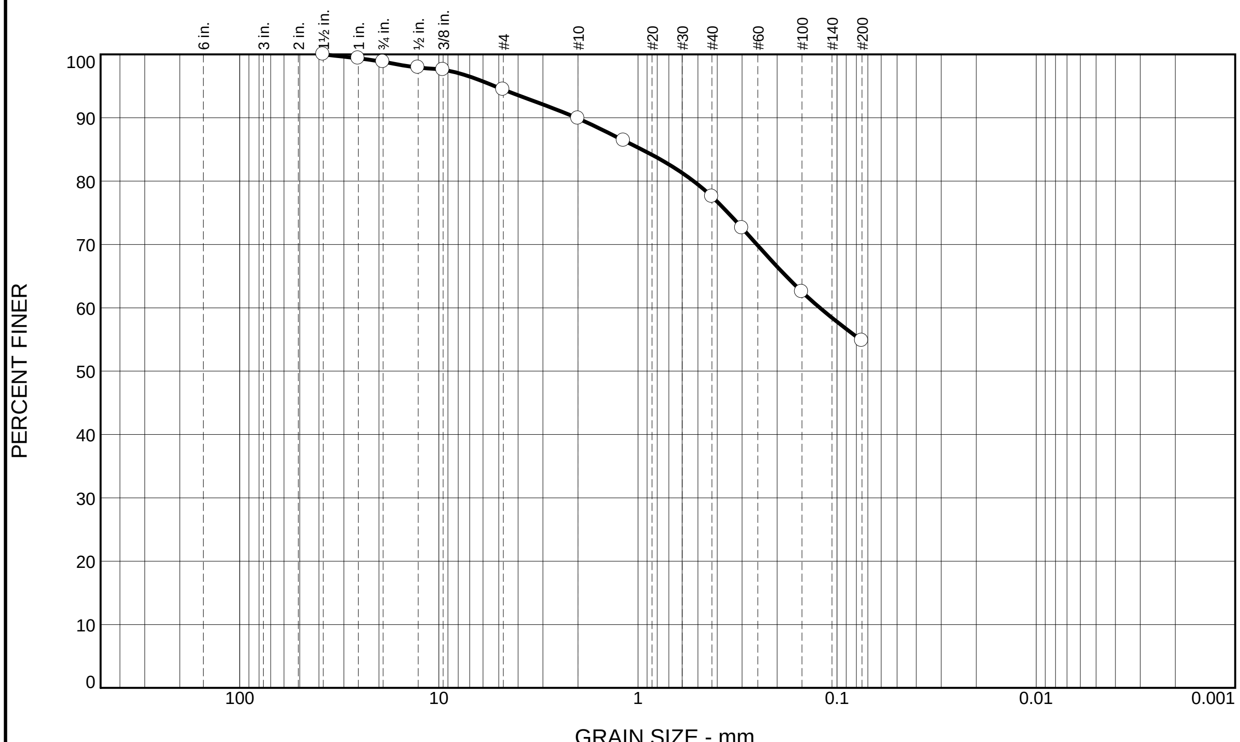
Location: TP-31
Sample Number: 17-019-20 **Depth:** 2-4' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-20

Tested By: JG **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.2	4.3	4.6	12.3	22.8	54.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	99.4		
.75	98.8		
.5	97.9		
.375	97.6		
#4	94.5		
#10	89.9		
#16	86.4		
#40	77.6		
#50	72.6		
#100	62.5		
#200	54.8		

* (no specification provided)

Material Description

Red sandy lean clay

Atterberg Limits

PL= 19 LL= 46 PI= 27

Coefficients

D_{90}= 2.0385 D_{85}= 0.9585 D_{60}= 0.1220
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(11)

Remarks

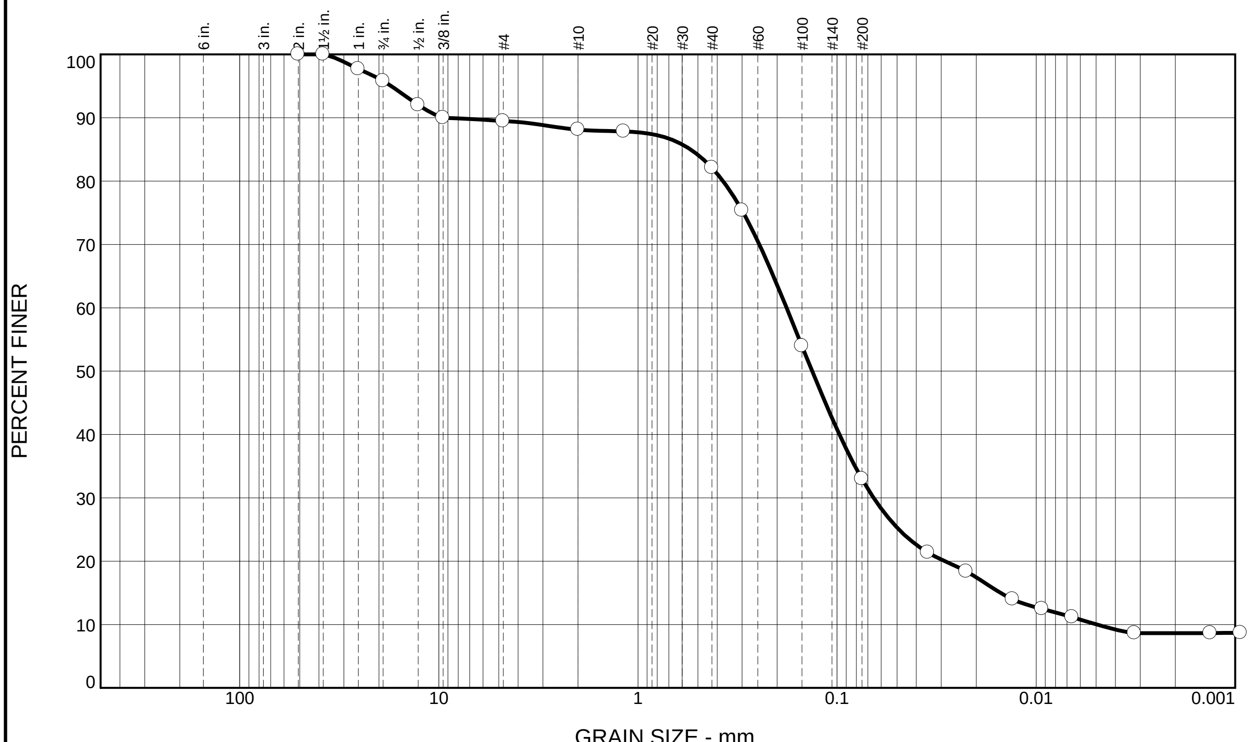
Location: TP-32
Sample Number: 17-019-22 **Depth:** 11.5'-14' **Date:** 02/20/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-22

Tested By: JG **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.2	6.3	1.4	6.0	49.1	24.4	8.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	100.0		
1	97.7		
.75	95.8		
.5	92.0		
.375	90.0		
#4	89.5		
#10	88.1		
#16	87.8		
#40	82.1		
#50	75.4		
#100	54.0		
#200	33.0		

* (no specification provided)

Material Description

Grey silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 9.5675 D_{85}= 0.5447 D_{60}= 0.1793
D_{50}= 0.1333 D_{30}= 0.0655 D_{15}= 0.0151
D_{10}= 0.0049 C_u= 36.23 C_c= 4.84

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

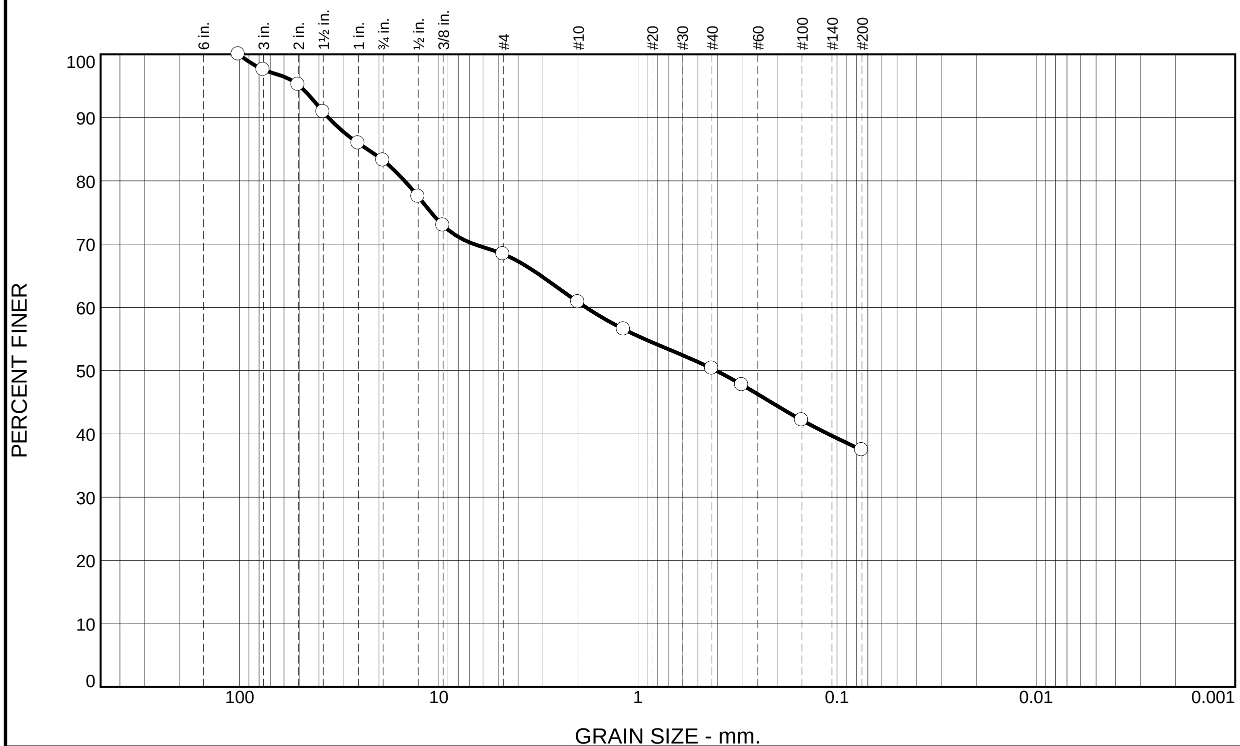
Location: TP-33
Sample Number: 17-019-23 **Depth:** 1'-7' 15'-20.5' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-23

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2.4	14.4	14.8	7.6	10.5	12.9	37.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4"	100.0		
3	97.6		
2	95.2		
1.5	90.9		
1	85.9		
.75	83.2		
.5	77.5		
.375	72.9		
#4	68.4		
#10	60.8		
#16	56.6		
#40	50.3		
#50	47.8		
#100	42.2		
#200	37.4		

* (no specification provided)

Material Description

Red clayey sand with gravel

Atterberg Limits

PL= 18 LL= 42 PI= 24

Coefficients

D_{90}= 35.9104 D_{85}= 22.8972 D_{60}= 1.8250
D_{50}= 0.4053 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(4)

Remarks

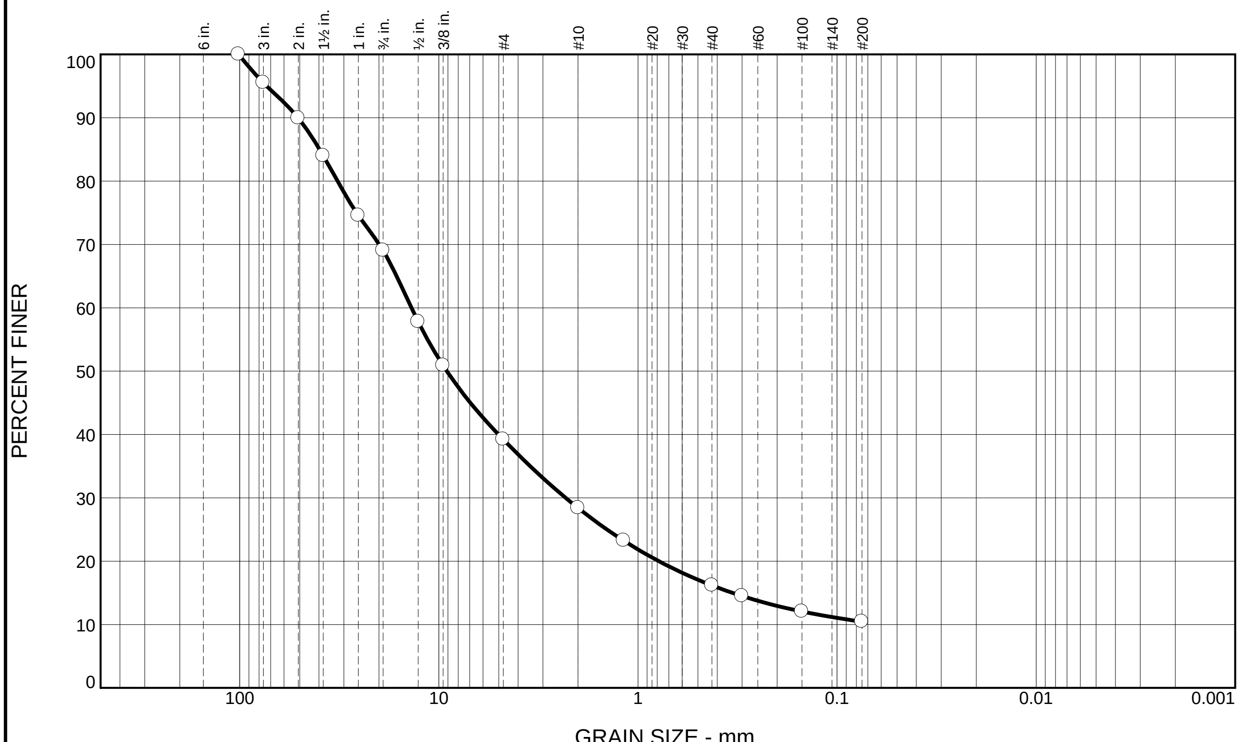
Location: TP-47A
Sample Number: 17-019-25 **Depth:** 3'-4' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-25

Tested By: JG **Checked By:** TW

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4.5	26.5	29.8	10.8	12.2	5.8	10.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4	100.0		
3	95.5		
2	90.0		
1.5	84.0		
1	74.6		
.75	69.0		
.5	57.8		
.375	50.9		
#4	39.2		
#10	28.4		
#16	23.2		
#40	16.2		
#50	14.5		
#100	12.1		
#200	10.4		

* (no specification provided)

Material Description

Light brown clayey gravel

Atterberg Limits

PL= 18 LL= 30 PI= 12

Coefficients

D_{90}= 50.9435 D_{85}= 39.7592 D_{60}= 13.7304
D_{50}= 9.1156 D_{30}= 2.3090 D_{15}= 0.3349
D_{10}= C_u= C_c=

Classification

USCS= GP-GC AASHTO= A-2-6(0)

Remarks

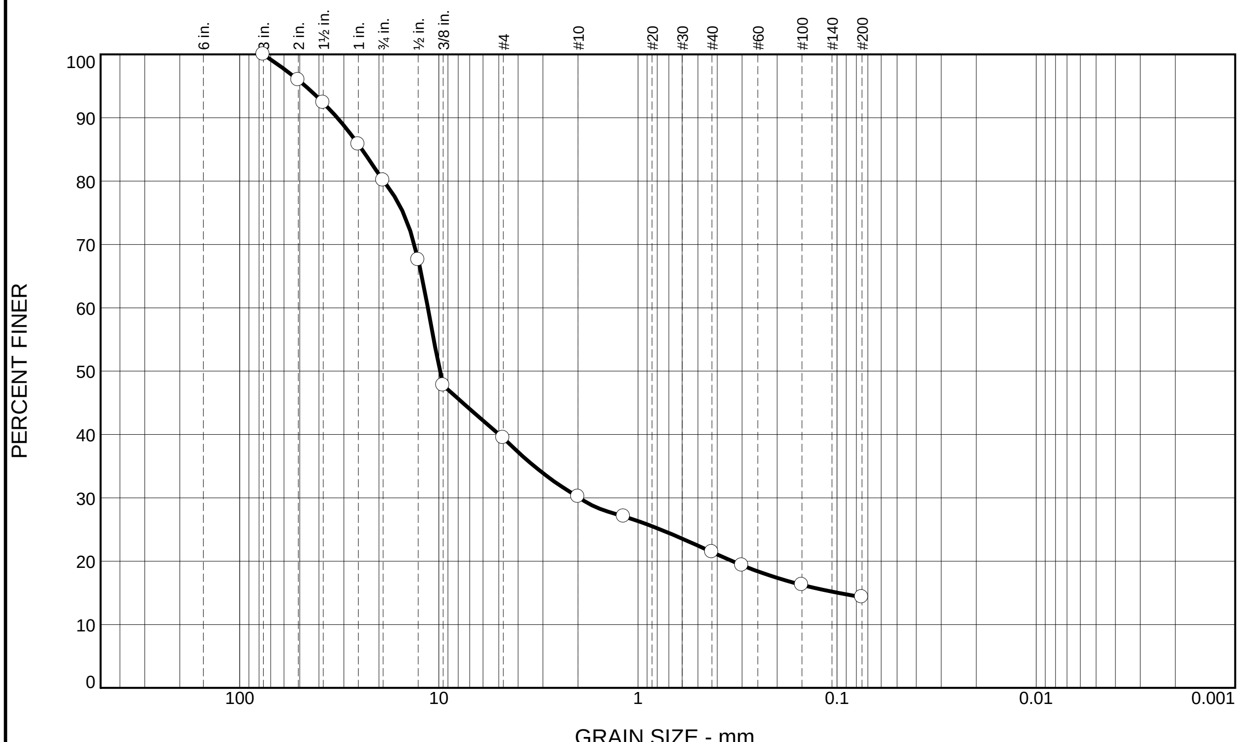
Location: TP-48
Sample Number: 17-019-26 **Depth:** 0'-4' **Date:** 02/13/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-26

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.9	40.6	9.3	8.8	7.1	14.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
2	96.0		
1.5	92.4		
1	85.8		
.75	80.1		
.5	67.6		
.375	47.8		
#4	39.5		
#10	30.2		
#16	27.1		
#40	21.4		
#50	19.4		
#100	16.3		
#200	14.3		

* (no specification provided)

Material Description

Orange clayey gravel with sand

Atterberg Limits

PL= 18 LL= 35 PI= 17

Coefficients

D_{90}= 32.3877 D_{85}= 24.3358 D_{60}= 11.3574
D_{50}= 9.8746 D_{30}= 1.9636 D_{15}= 0.0983
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

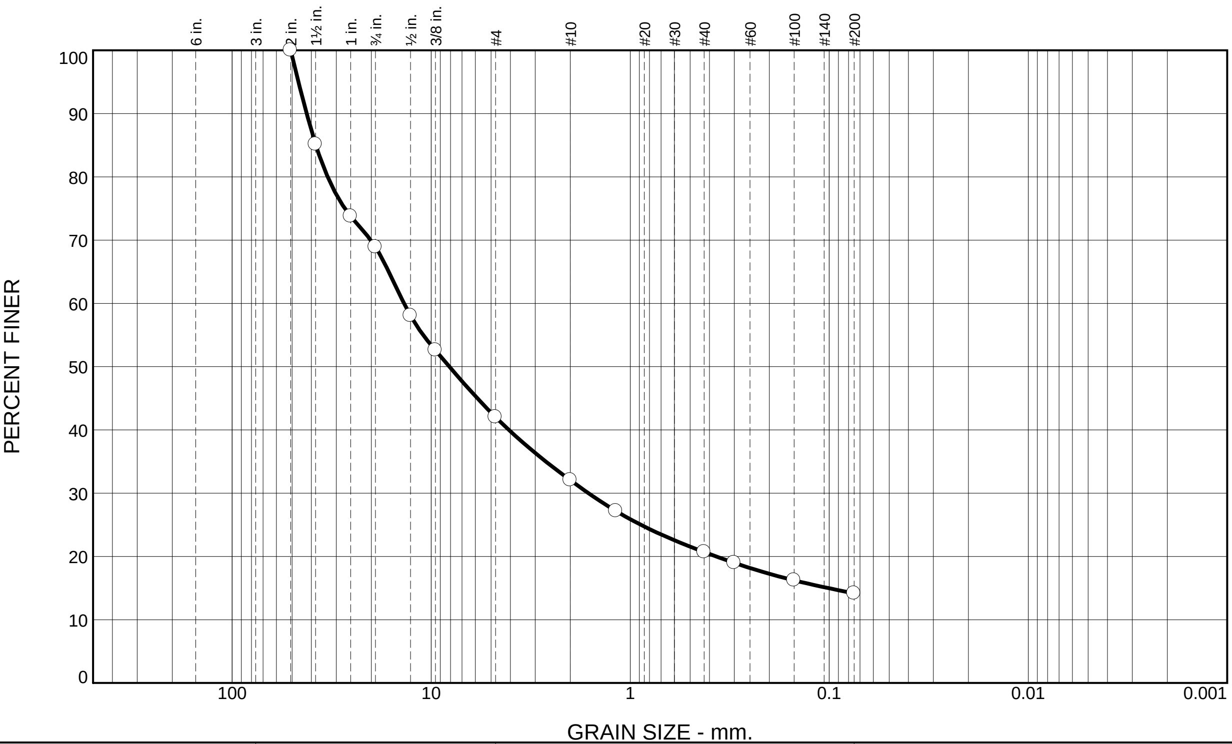
Location: TP-51
Sample Number: 17-019-27 **Depth:** 1'-2' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-27

Tested By: AH/JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	31.1	26.9	9.9	11.4	6.5	14.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	85.2		
1	73.8		
.75	68.9		
.5	58.0		
.375	52.6		
#4	42.0		
#10	32.1		
#16	27.2		
#40	20.7		
#50	19.0		
#100	16.2		
#200	14.2		

* (no specification provided)

Material Description

Brown Red

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 42.2418 D_{85}= 37.9655 D_{60}= 13.7016
D_{50}= 8.1068 D_{30}= 1.6204 D_{15}= 0.1010
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

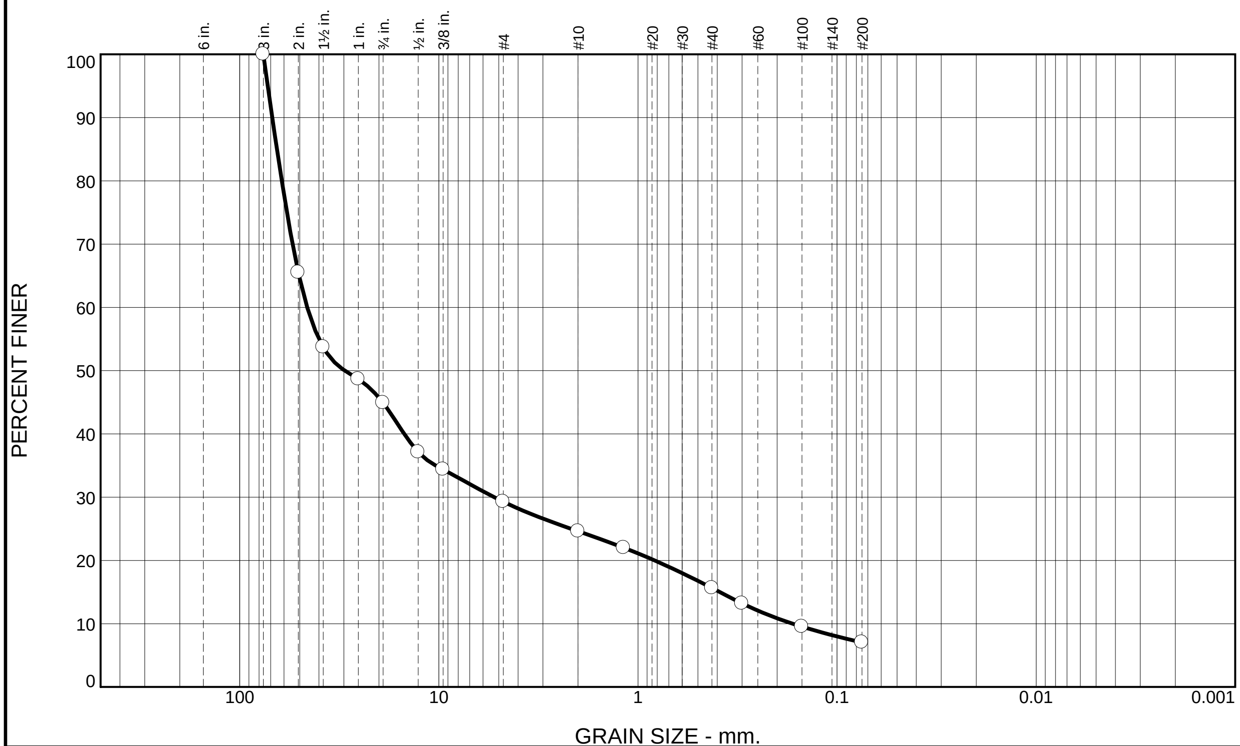
Location: TP-51
Sample Number: 17-019-28 **Depth:** 5'-6' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-28

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	55.1	15.6	4.7	8.9	8.7	7.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
2	65.5		
1.5	53.7		
1	48.7		
.75	44.9		
.5	37.1		
.375	34.4		
#4	29.3		
#10	24.6		
#16	22.0		
#40	15.7		
#50	13.2		
#100	9.5		
#200	7.0		

* (no specification provided)

Material Description

Light brown poorly graded gravel with silt and sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 68.6466 D_{85}= 65.0490 D_{60}= 45.8367
D_{50}= 29.6951 D_{30}= 5.2724 D_{15}= 0.3880
D_{10}= 0.1670 C_u= 274.44 C_c= 3.63

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

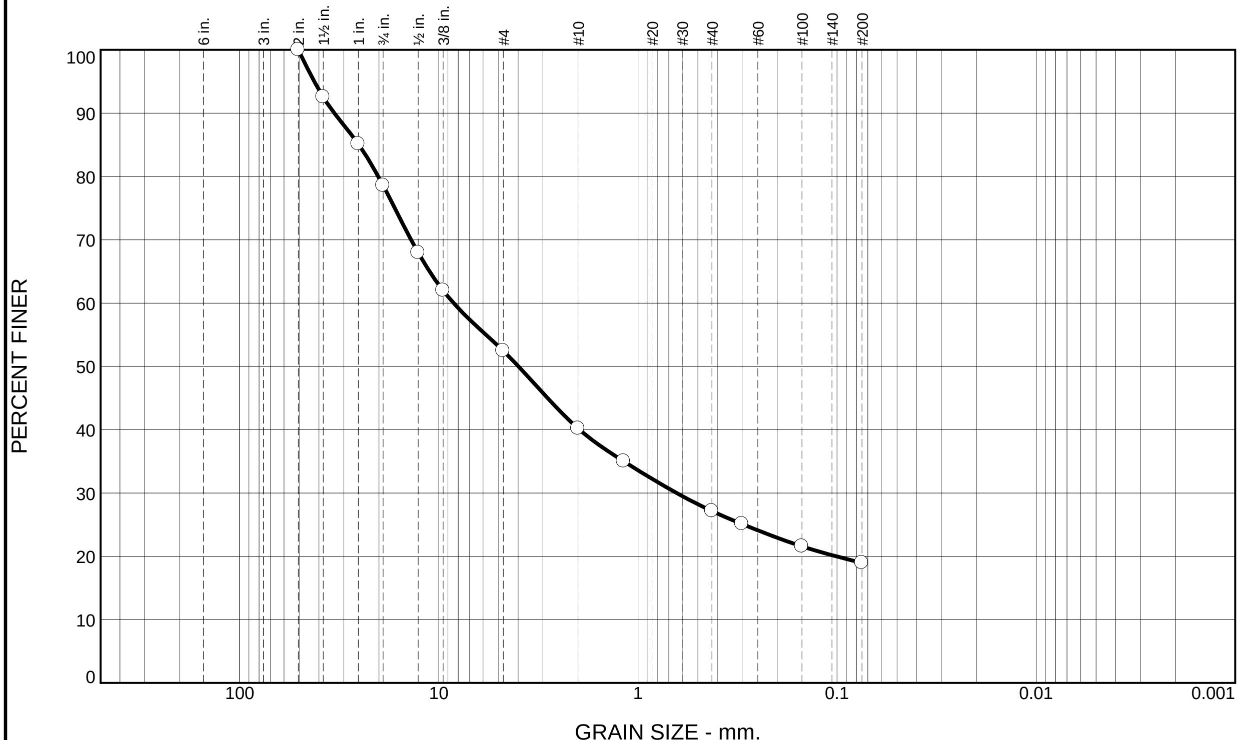
Location: TP-50A
Sample Number: 17-019-29 **Depth:** 2'-3' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-29

Tested By: AR **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	21.4	26.1	12.3	13.0	8.2	19.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0	100.0		
1.5	92.5		
1	85.1		
.75	78.6		
.5	67.9		
.375	62.0		
#4	52.5		
#10	40.2		
#16	35.0		
#40	27.2		
#50	25.1		
#100	21.6		
#200	19.0		

* (no specification provided)

Material Description

Dark brown clayey gravel with sand

Atterberg Limits

PL= 19 LL= 31 PI= 12

Coefficients

D_{90}= 33.4895 D_{85}= 25.2132 D_{60}= 8.4347
D_{50}= 3.9831 D_{30}= 0.6388 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

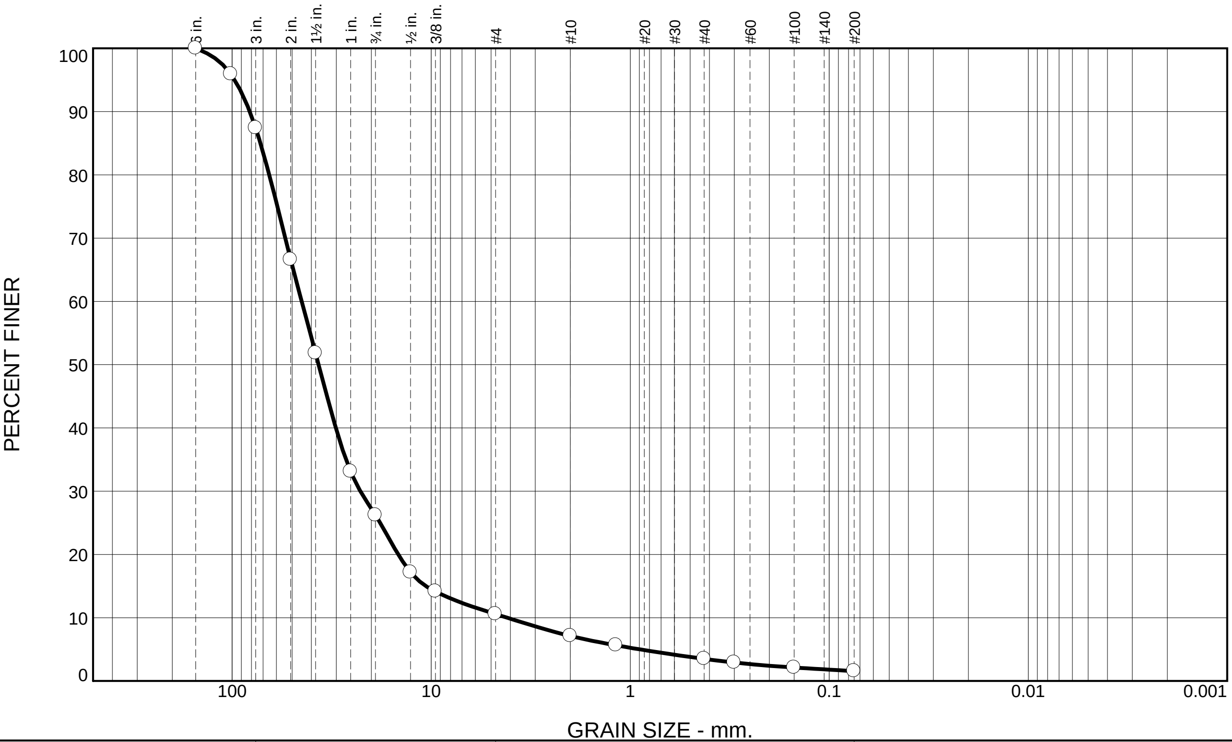
Location: TP-50B
Sample Number: 17-019-30 **Depth:** 0'-1' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-30

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
12.6	61.2	15.6	3.5	3.6	1.9	1.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6	100.0		
4	95.9		
3	87.4		
2	66.6		
1.5	51.8		
1	33.1		
.75	26.2		
.5	17.2		
.375	14.2		
#4	10.6		
#10	7.1		
#16	5.6		
#40	3.5		
#50	2.9		
#100	2.1		
#200	1.6		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 81.5496 D_{85}= 72.1088 D_{60}= 44.7451
D_{50}= 36.7854 D_{30}= 22.7115 D_{15}= 10.6293
D_{10}= 4.1541 C_u= 10.77 C_c= 2.78

Classification

USCS= GW AASHTO=

Remarks

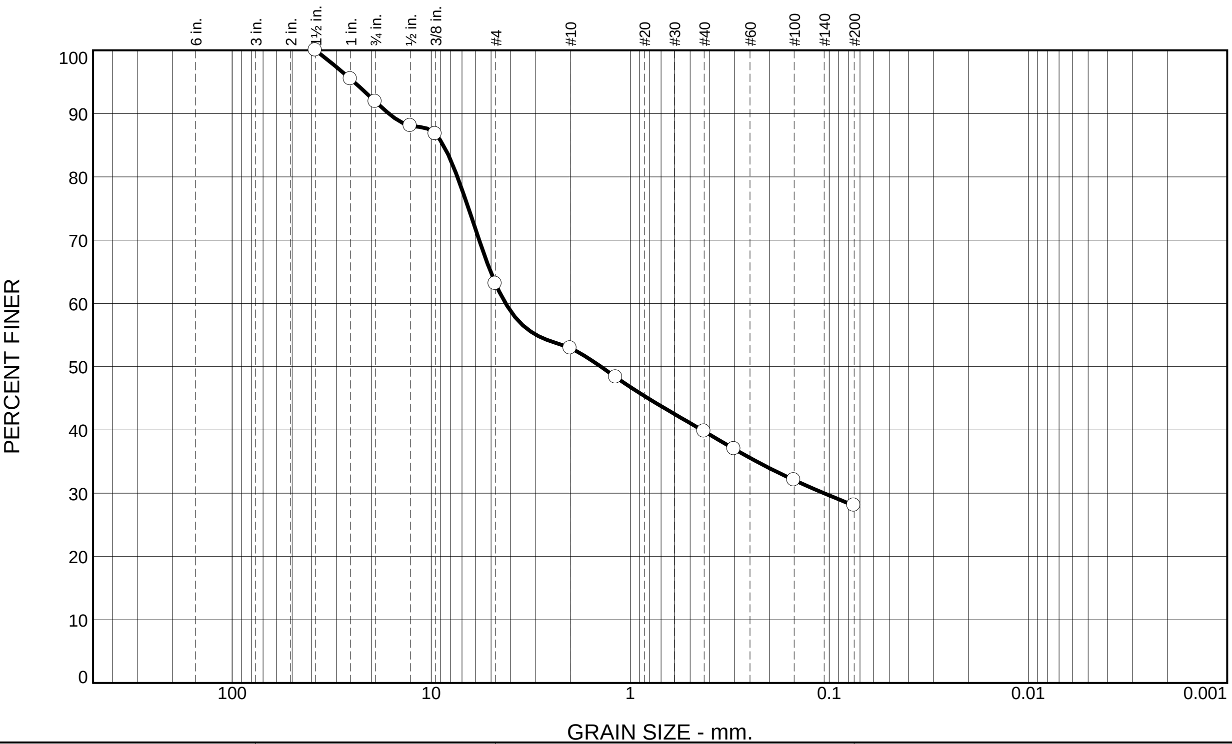
Location: TP-55
Sample Number: 17-019-31 **Depth:** 3'-4' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-31

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.1	28.8	10.2	13.1	11.8	28.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	95.5		
.75	91.9		
.5	88.1		
.375	86.8		
#4	63.1		
#10	52.9		
#16	48.3		
#40	39.8		
#50	37.0		
#100	32.1		
#200	28.0		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 16.3216 D_{85}= 8.6832 D_{60}= 4.2275
D_{50}= 1.4046 D_{30}= 0.1063 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

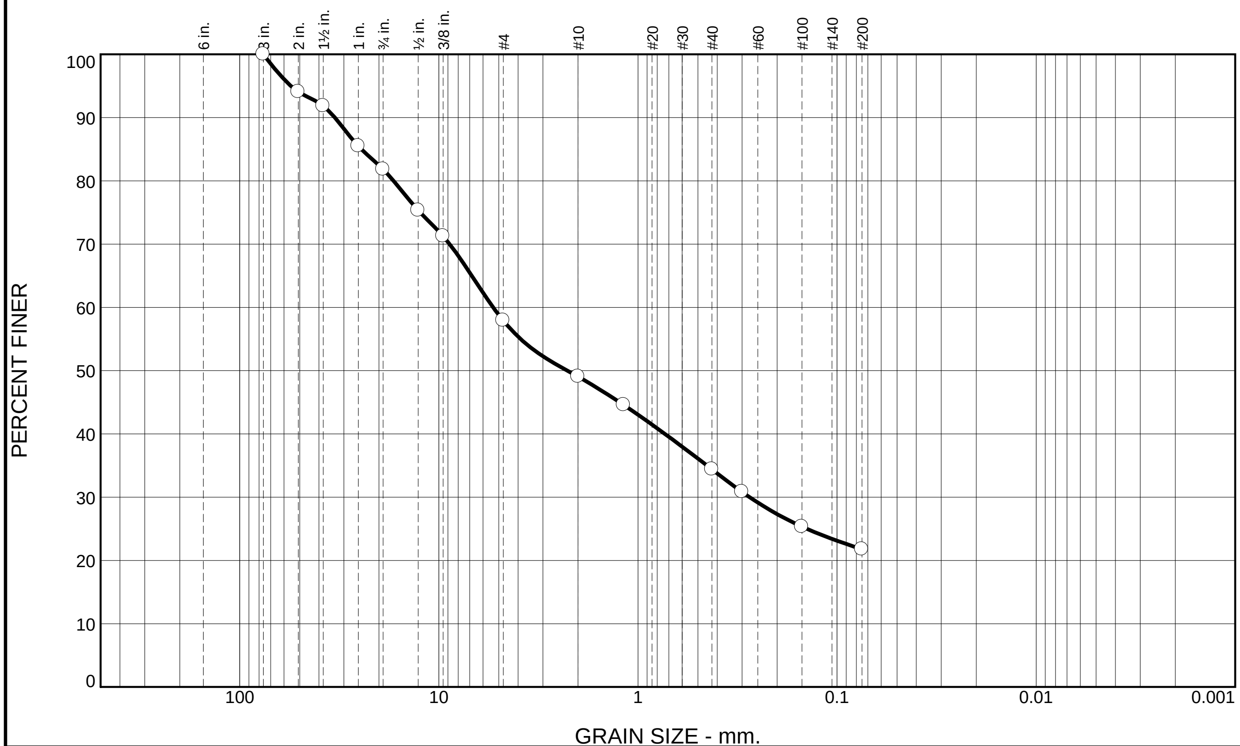
Location: TP-60
Sample Number: 17-019-32 **Depth:** 0'-1' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-32

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	18.2	23.9	8.8	14.7	12.6	21.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3	100.0		
2	94.1		
1.5	91.9		
1	85.5		
.75	81.8		
.5	75.3		
.375	71.3		
#4	57.9		
#10	49.1		
#16	44.6		
#40	34.4		
#50	30.8		
#100	25.3		
#200	21.8		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 33.2893 D_{85}= 24.5245 D_{60}= 5.3359
D_{50}= 2.2642 D_{30}= 0.2750 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

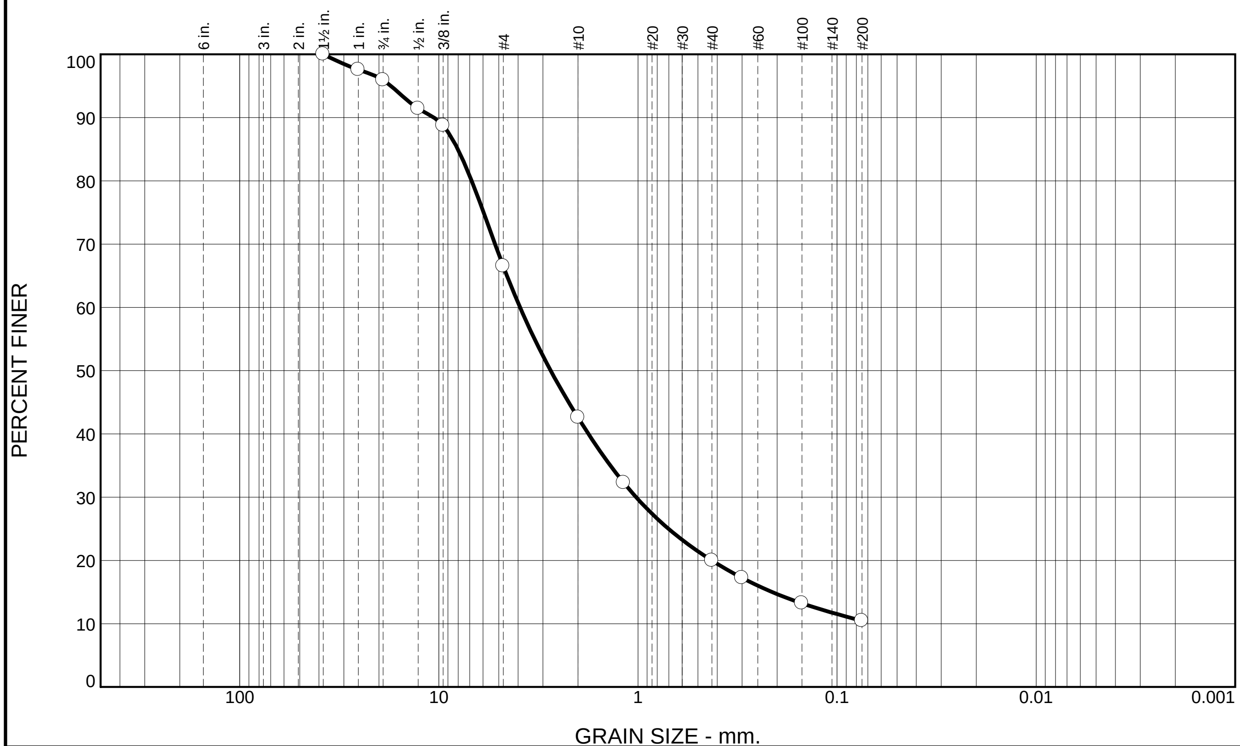
Location: TP-60
Sample Number: 17-019-33 **Depth:** 3'-4' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-33

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.1	29.4	23.9	22.6	9.5	10.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	97.6		
.75	95.9		
.5	91.4		
.375	88.7		
#4	66.5		
#10	42.6		
#16	32.3		
#40	20.0		
#50	17.2		
#100	13.2		
#200	10.5		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= NR LL= NR PI= NR

Coefficients

D_{90}= 10.5838 D_{85}= 8.0293 D_{60}= 3.9117
D_{50}= 2.7441 D_{30}= 1.0220 D_{15}= 0.2116
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

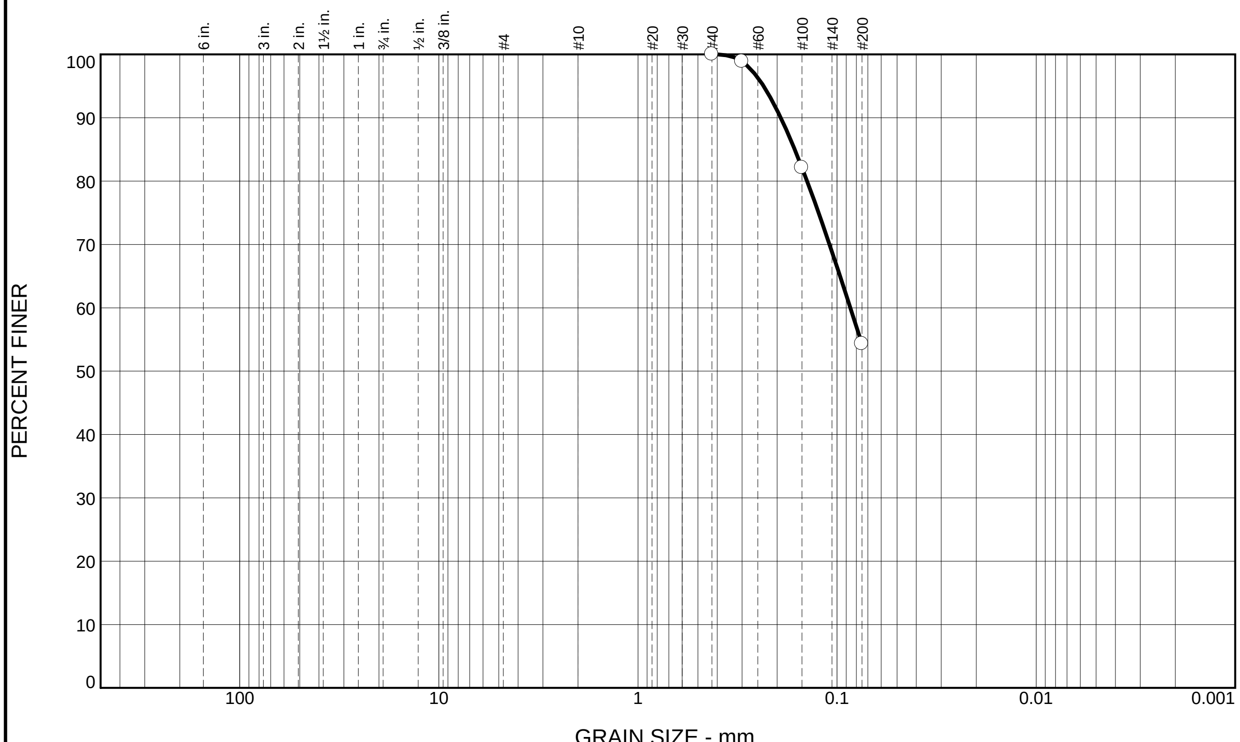
Location: TP-61
Sample Number: 17-019-34 **Depth:** 0'-1' **Date:** 02/16/17

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-019-34

Tested By: JG **Checked By:** AR

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	45.7	54.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#40	100.0		
#50	98.9		
#100	82.1		
#200	54.3		

* (no specification provided)

Material Description

Gray sandy silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 0.1917 D_{85}= 0.1632 D_{60}= 0.0858
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

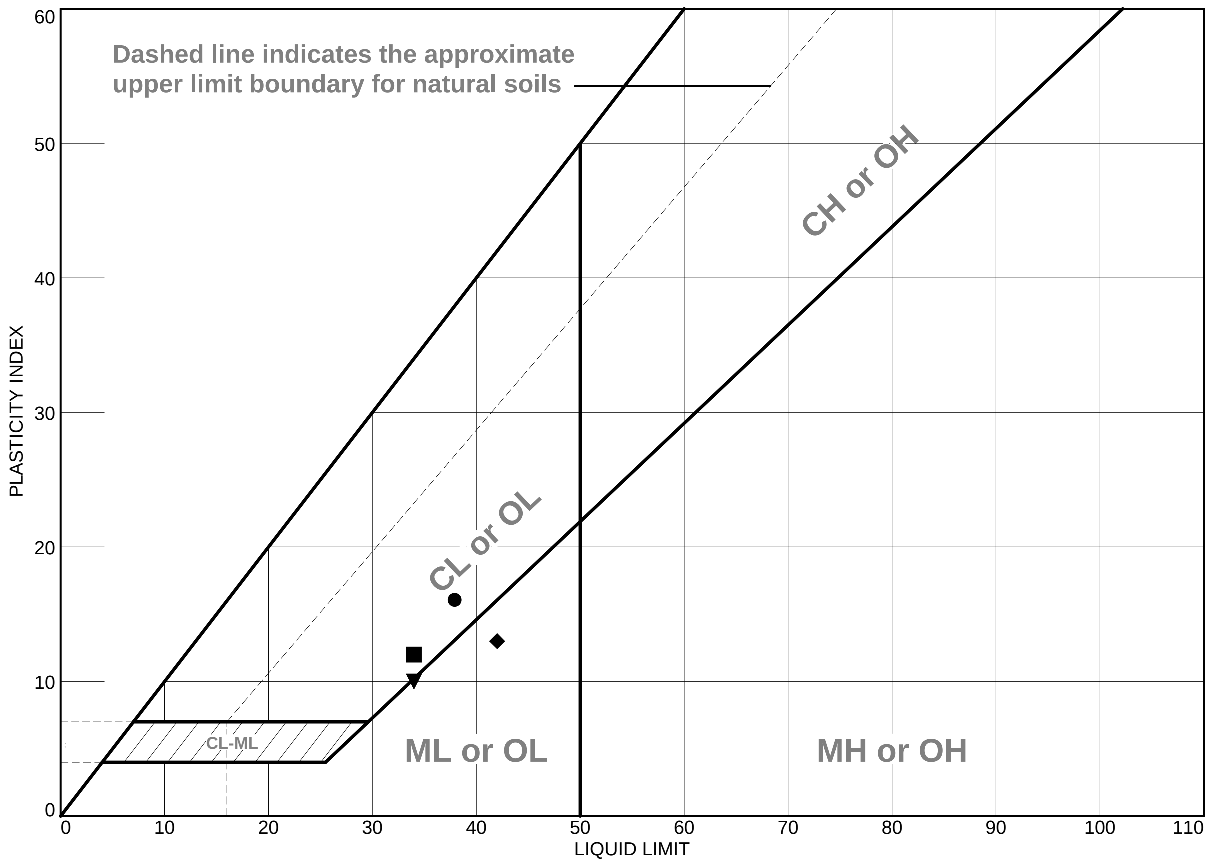
Location: BH-01
Sample Number: 17-020-01 **Depth:** 25.8'-26.3' **Date:** 02/20/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-020-01

Tested By: OS/AR **Checked By:** TW

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	38	22	16	99.8	98.1	CL
■	Black clayey gravel with sand	34	22	12	22.4	13.4	GC
▲	Brown sandy silt	NP	NP	NP	94.0	67.6	ML
◆	Gray silt	42	29	13	99.8	99.6	ML
▼	Gray lean clay	34	24	10	99.9	98.0	CL

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** BH-01 **Depth:** 46.5-49' **Sample Number:** 17-018-07
■**Location:** BH-01 **Depth:** 52.5-54' **Sample Number:** 17-018-08
▲**Location:** BH-02 **Depth:** 5-6.5' **Sample Number:** 17-018-10
◆**Location:** BH-02 **Depth:** 26.5-29' **Sample Number:** 17-018-13
▼**Location:** BH-02 **Depth:** 35-36.5' **Sample Number:** 17-018-14

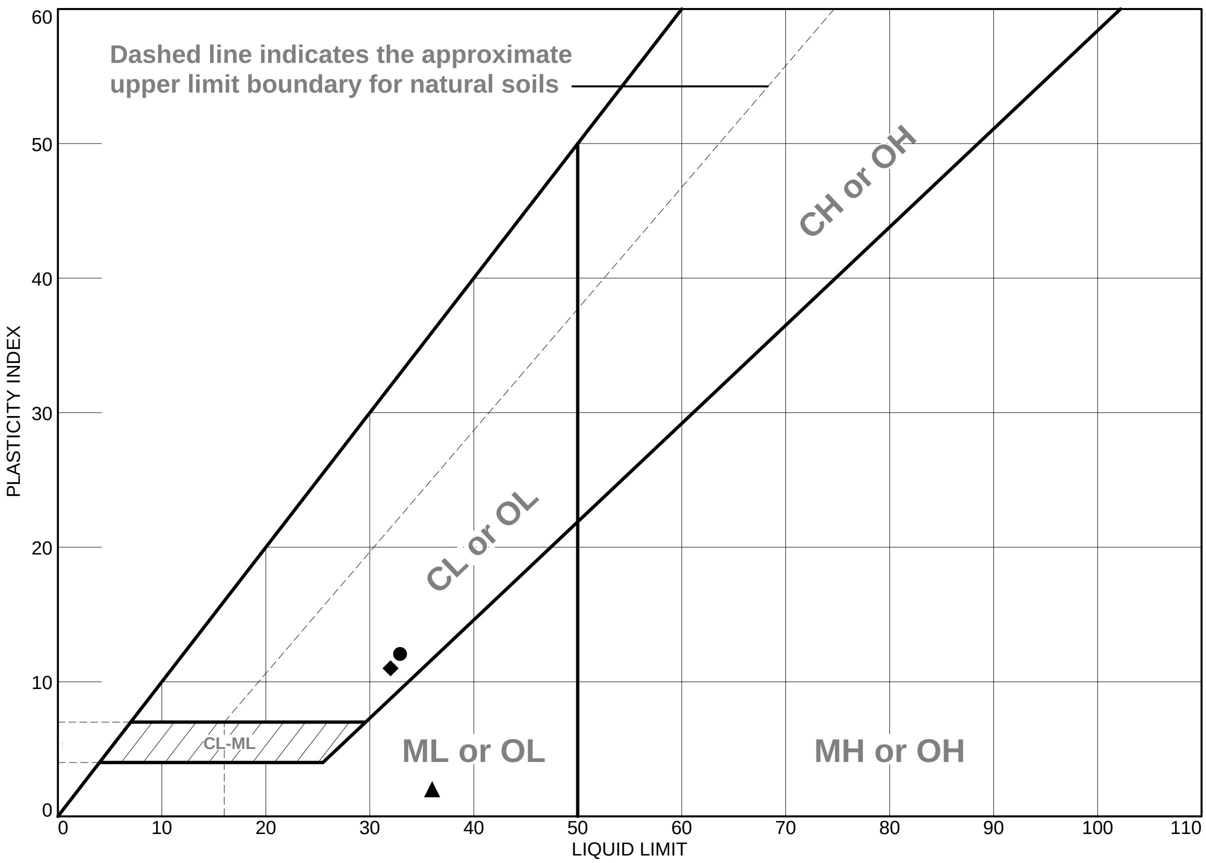
NewFields

Remarks:

Figure 17-018

Tested By: ○ JG □ JG △ AH ◇ OS ▽ AH **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray lean clay	33	21	12	99.9	99.1	CL
■	Gray silt with sand	NP	NP	NP	92.9	75.2	ML
▲	Yellow silty gravel with sand	36	34	2	31.2	21.4	GM
◆	Brown clayey sand with gravel	32	21	11	48.0	28.0	SC
▼	Gray sandy silt	NP	NP	NP	97.5	59.5	ML

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

● **Location:** BH-03 **Depth:** 35-36.5' **Sample Number:** 17-018-20
■ **Location:** BH-04 **Depth:** 15-16.5' **Sample Number:** 17-018-24
▲ **Location:** BH-04 **Depth:** 20-21.5' **Sample Number:** 17-018-25
◆ **Location:** BH-04 **Depth:** 40-41.5' **Sample Number:** 17-018-27
▼ **Location:** BH-05 **Depth:** 5-5.6' **Sample Number:** 17-018-29

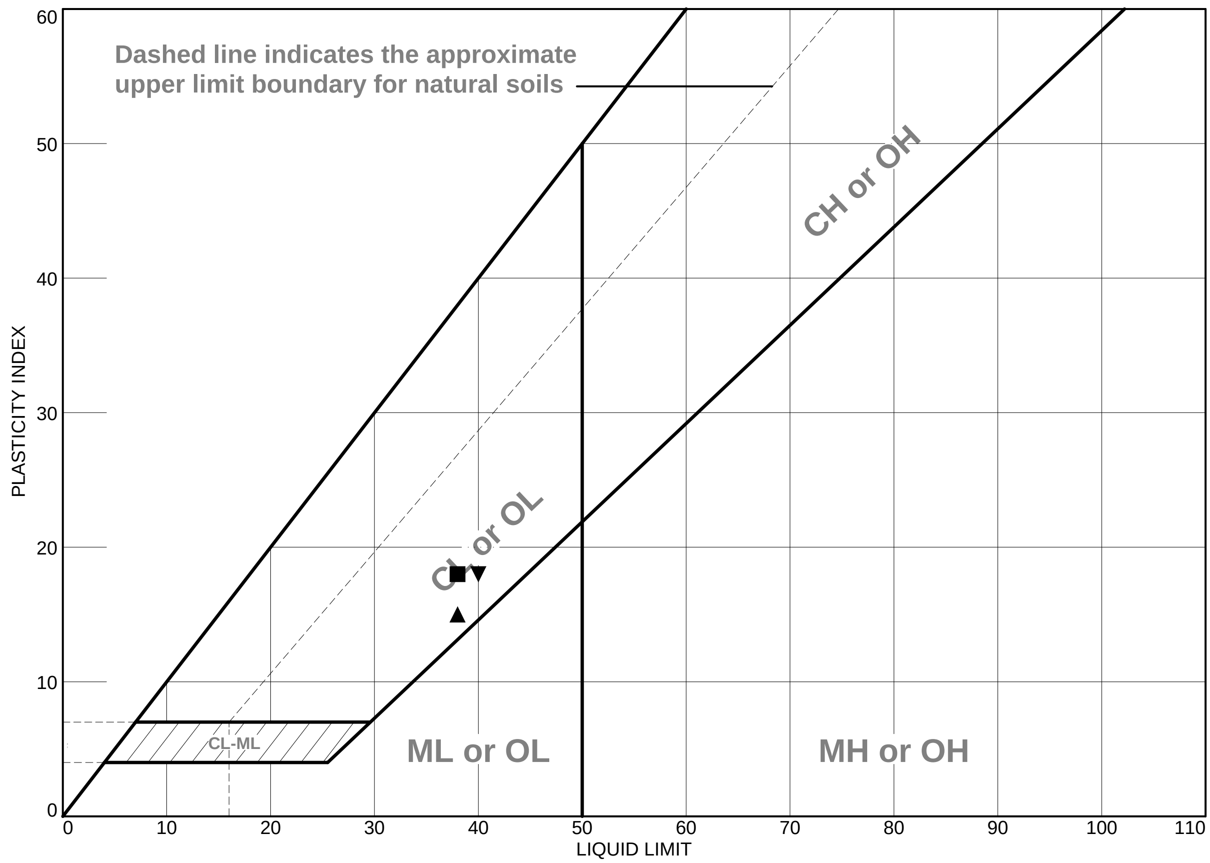
NewFields

Remarks:

Figure 17-018

Tested By: ○ AH □ AH △ JG ◇ JG ▽ JG **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray silty sand	NP	NP	NP	97.8	47.8	SM
■	Red clayey sand	38	20	18	55.2	39.3	SC
▲	Yellow clayey gravel with sand	38	23	15	22.0	14.1	GC
◆	Gray sandy silt	NP	NP	NP	98.9	57.1	ML
▼	Gray lean clay	40	22	18	100.0	98.0	CL

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** BH-05 **Depth:** 15-16.5' **Sample Number:** 17-018-30
■**Location:** BH-05 **Depth:** 17.5-19' **Sample Number:** 17-018-31
▲**Location:** BH-06 **Depth:** 10-11.5' **Sample Number:** 17-018-33
◆**Location:** BH-07 **Depth:** 5-6.5' **Sample Number:** 17-018-37
▼**Location:** BH-07 **Depth:** 21.5-24.5' **Sample Number:** 17-018-40

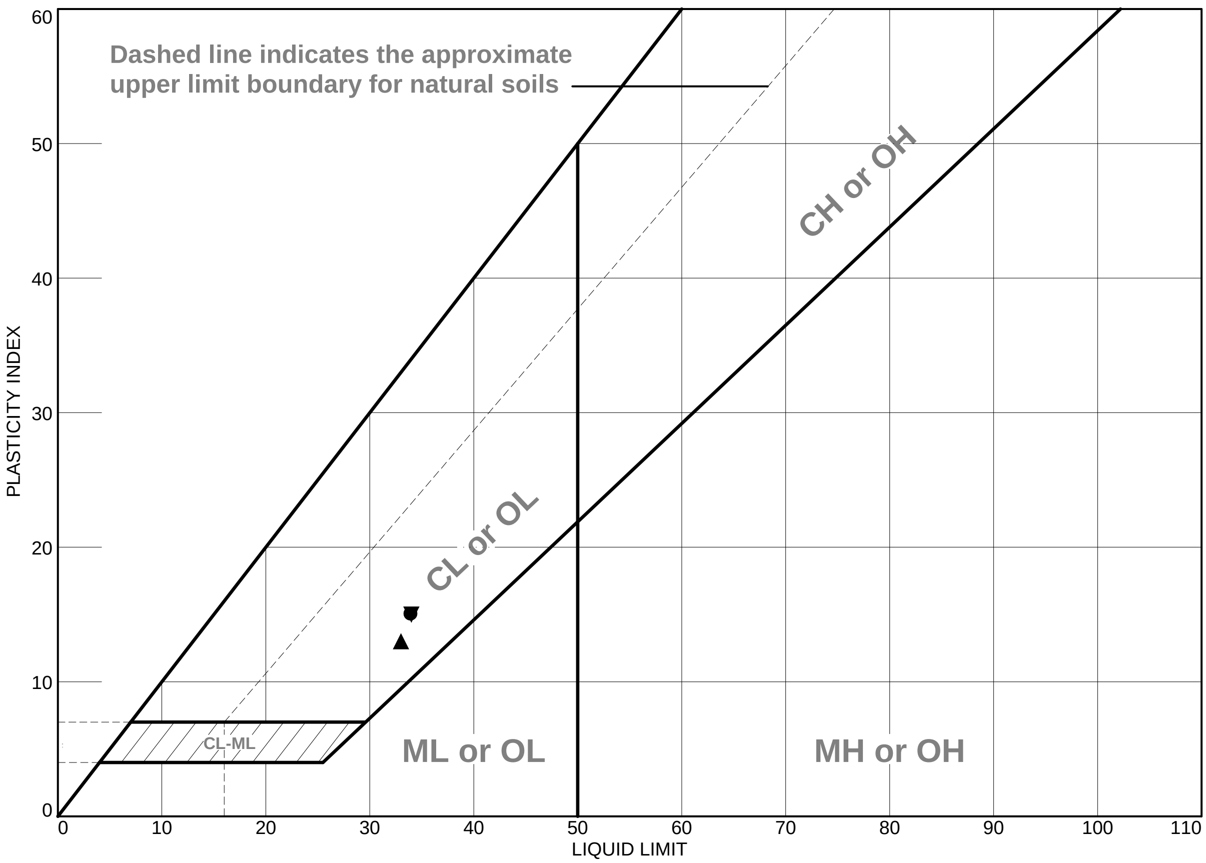
NewFields

Remarks:

Figure 17-018

Tested By: ○ JG □ AH △ JG ◇ AH ▽ JG **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Red clayey sand	34	19	15	74.3	48.2	SC
■	Gray silt with sand	NP	NP	NP	99.9	71.5	ML
▲	Brown clayey sand	33	20	13	56.5	32.9	SC
◆	Red poorly graded sand with silt and gravel	NP	NP	NP	29.7	11.5	SP-SM
▼	Brown clayey sand	34	19	15	78.2	48.0	SC

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** BH-07 **Depth:** 32.5-34' **Sample Number:** 17-018-43
■**Location:** BH-08 **Depth:** 25-26.5' **Sample Number:** 17-018-49
▲**Location:** BH-13 **Depth:** 1-2.5' **Sample Number:** 17-018-55
◆**Location:** BH-13 **Depth:** 6-7.5' **Sample Number:** 17-018-56
▼**Location:** BH-16 **Depth:** 1-2.5' **Sample Number:** 17-018-58

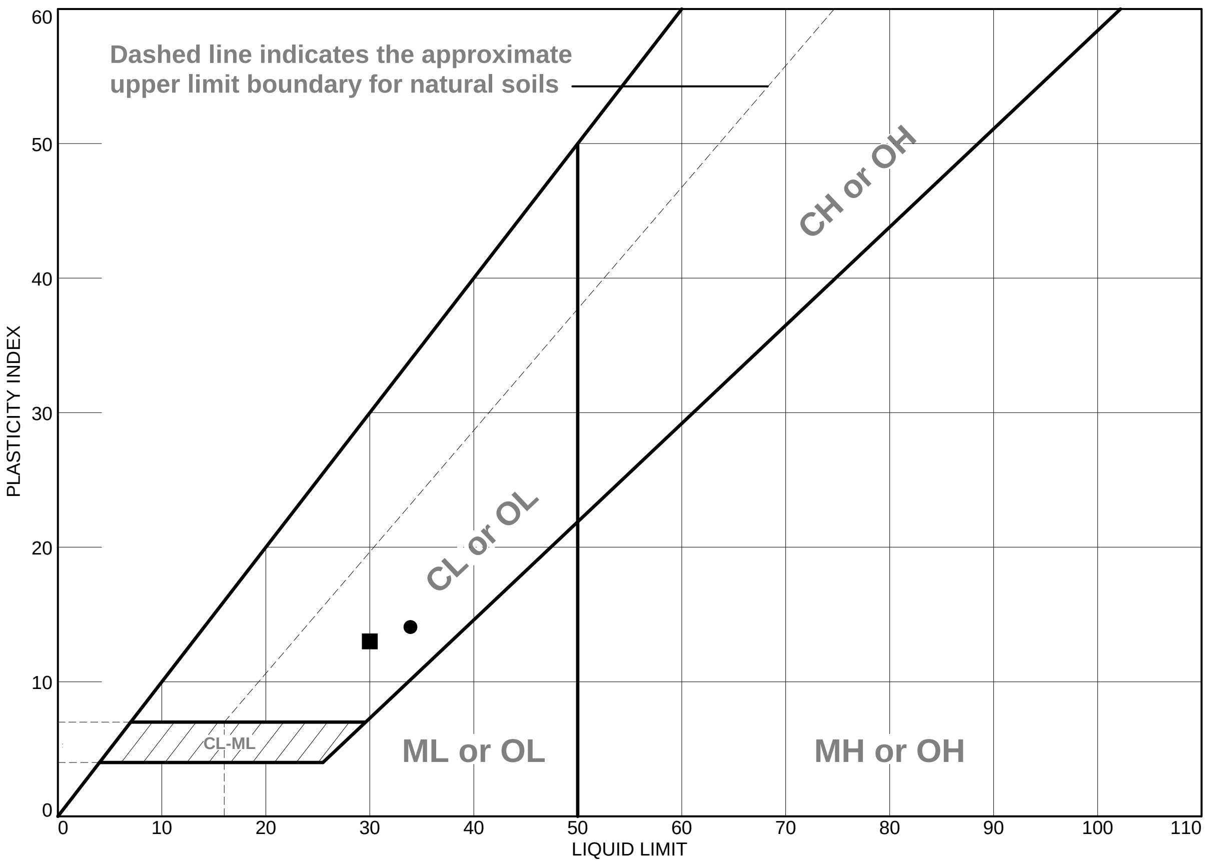
NewFields

Remarks:

Figure 17-018

Tested By: ○ JG □ AH △ JG ◇ OS ▽ AH **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown	34	20	14	NR	NR	N/A
■	Dark brown clayey sand with gravel	30	17	13	58.0	34.9	SC

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** BH-16 **Depth:** 3.5-5' **Sample Number:** 17-018-59

■**Location:** BH-16 **Depth:** 6-7.5' **Sample Number:** 17-018-60

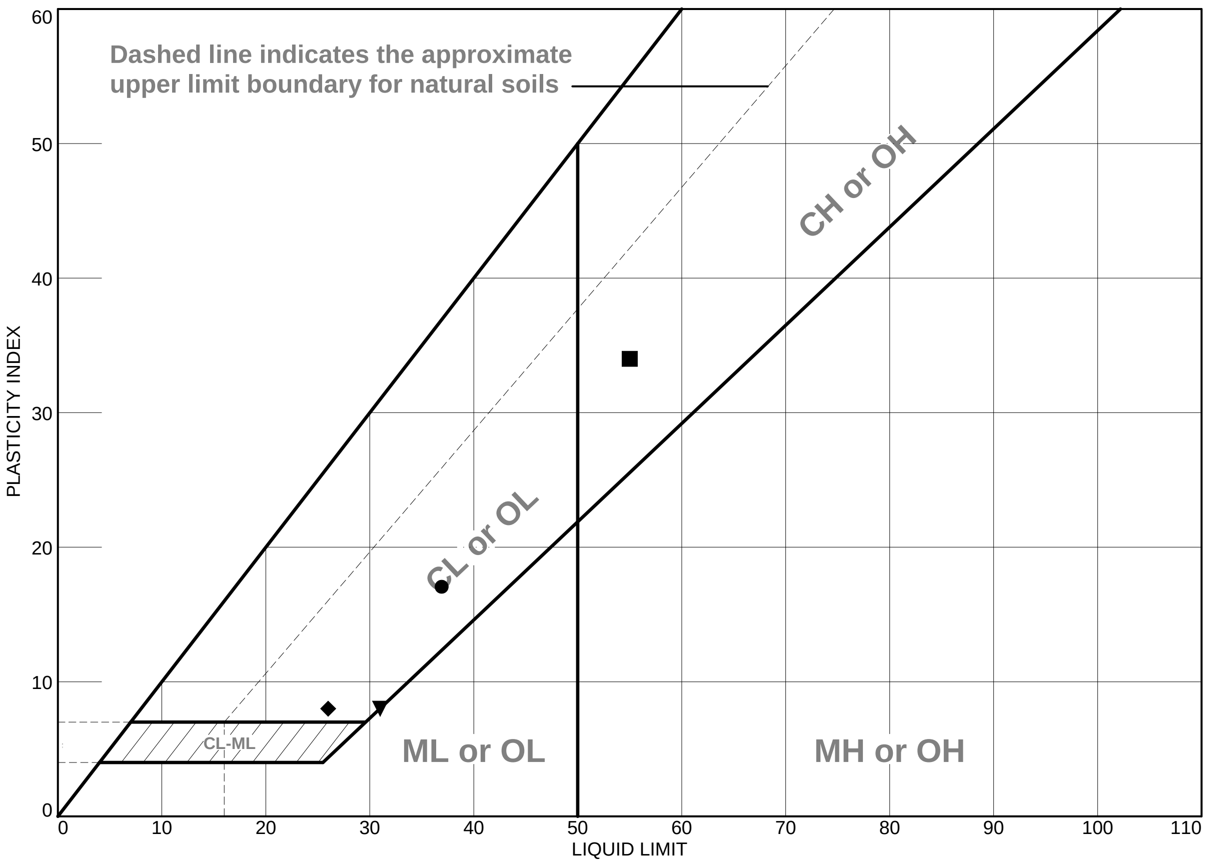
NewFields

Remarks:

Figure 17-018

Tested By: ○ AH □ JG **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown clayey sand with gravel	37	20	17	42.6	26.4	SC
■	Red sandy fat clay	55	21	34	86.8	61.6	CH
▲	Brown silty sand	NP	NP	NP	62.1	29.9	SM
◆	Brown clayey sand with gravel	26	18	8	26.9	15.0	SC
▼	Red silty sand with gravel	31	23	8	47.4	23.2	SC

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** TP-02 **Depth:** 2'-3' **Sample Number:** 17-019-02
■**Location:** TP-06 **Depth:** 1'-3' **Sample Number:** 17-019-03
▲**Location:** TP-07 **Depth:** 0'-1.5' **Sample Number:** 17-019-04
◆**Location:** TP-08 **Depth:** 4' **Sample Number:** 17-019-07
▼**Location:** TP-09 **Depth:** 1'-2' **Sample Number:** 17-019-08

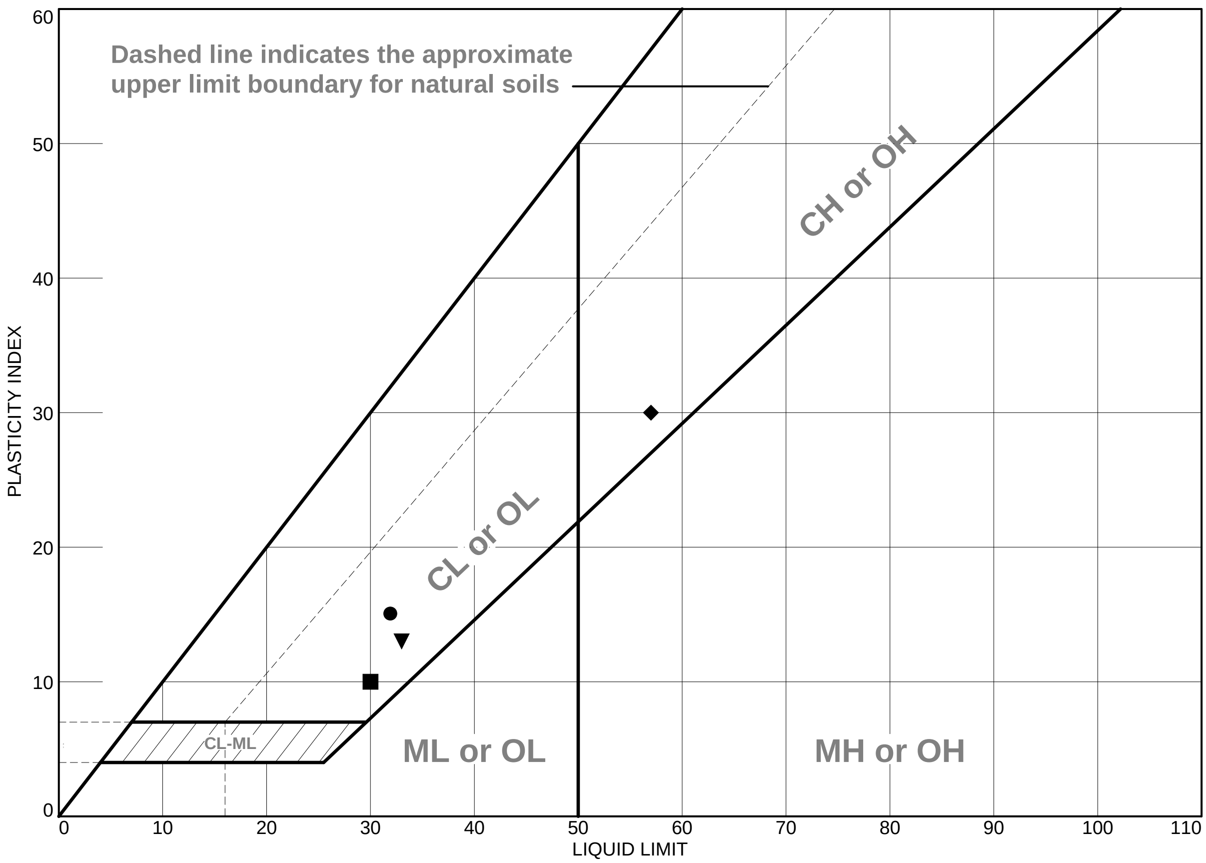
NewFields

Remarks:

Figure 17-019

Tested By: ○ OS □ AH △ JG ◇ RF ▽ JG **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown clayey sand with gravel	32	17	15	42.3	23.9	SC
■	Dark brown poorly graded gravel with clay and sand	30	20	10	11.8	6.0	GP-GC
▲	Gray sandy silt	NP	NP	NP	86.7	54.6	ML
◆	Gray fat clay	57	27	30	95.7	93.9	CH
▼	Light brown clayey sand with gravel	33	20	13	54.4	33.3	SC

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** TP-11 **Depth:** 10'-11' **Sample Number:** 17-019-10
■**Location:** TP-14 **Depth:** 3'-4' **Sample Number:** 17-019-12
▲**Location:** TP-24 **Depth:** 4'-7' **Sample Number:** 17-019-15
◆**Location:** TP-25 **Depth:** 8'-10' **Sample Number:** 17-019-16
▼**Location:** TP-28 **Depth:** 5'-8' **Sample Number:** 17-019-18

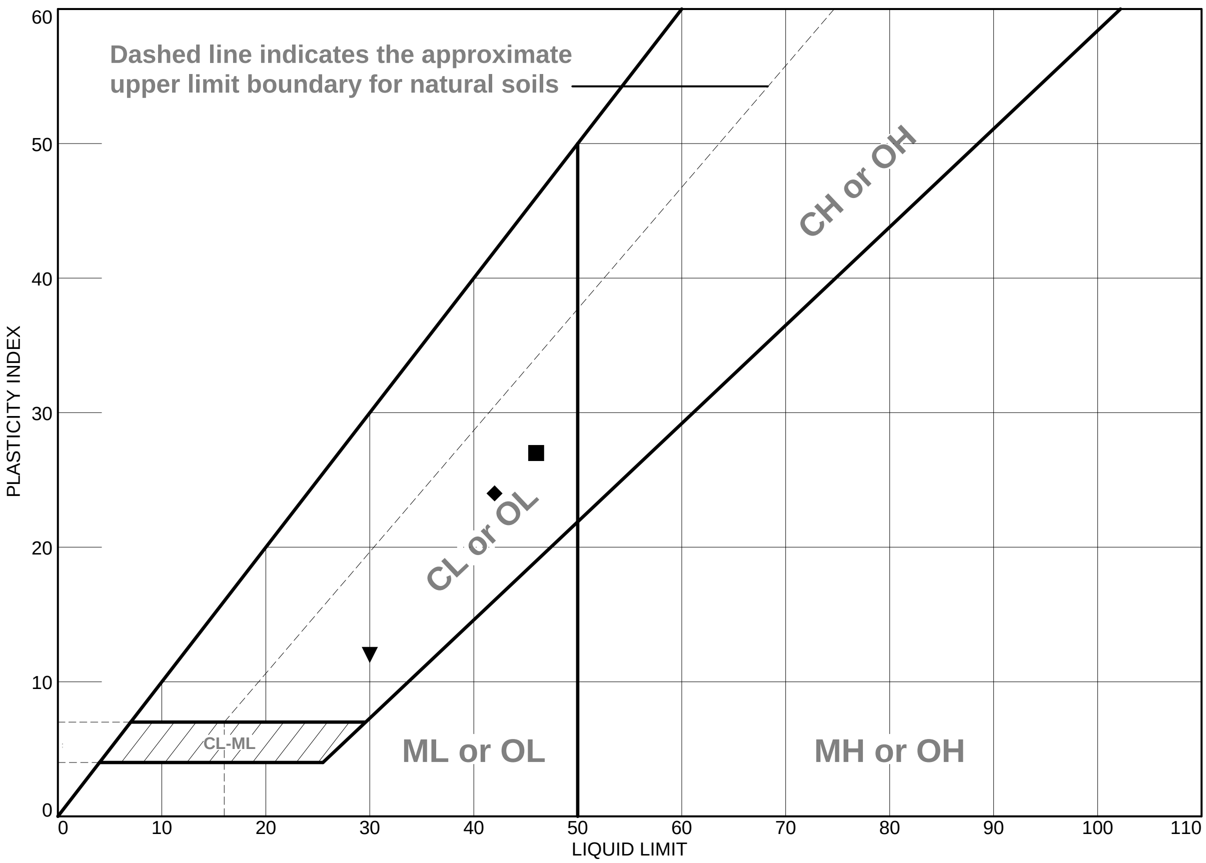
NewFields

Remarks:

Figure 17-019

Tested By: ○ JG □ TW △ JG ◇ JG ▽ JG **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown silt	NP	NP	NP	99.5	99.1	ML
■	Red sandy lean clay	46	19	27	77.6	54.8	CL
▲	Grey silty sand	NP	NP	NP	82.1	33.0	SM
◆	Red clayey sand with gravel	42	18	24	50.3	37.4	SC
▼	Light brown clayey gravel	30	18	12	16.2	10.4	GP-GC

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** TP-30 **Depth:** 3'5' **Sample Number:** 17-019-19
■**Location:** TP-32 **Depth:** 11.5'-14' **Sample Number:** 17-019-22
▲**Location:** TP-33 **Depth:** 1'-7' 15'-20.5' **Sample Number:** 17-019-23
◆**Location:** TP-47A **Depth:** 3'-4' **Sample Number:** 17-019-25
▼**Location:** TP-48 **Depth:** 0'-4' **Sample Number:** 17-019-26

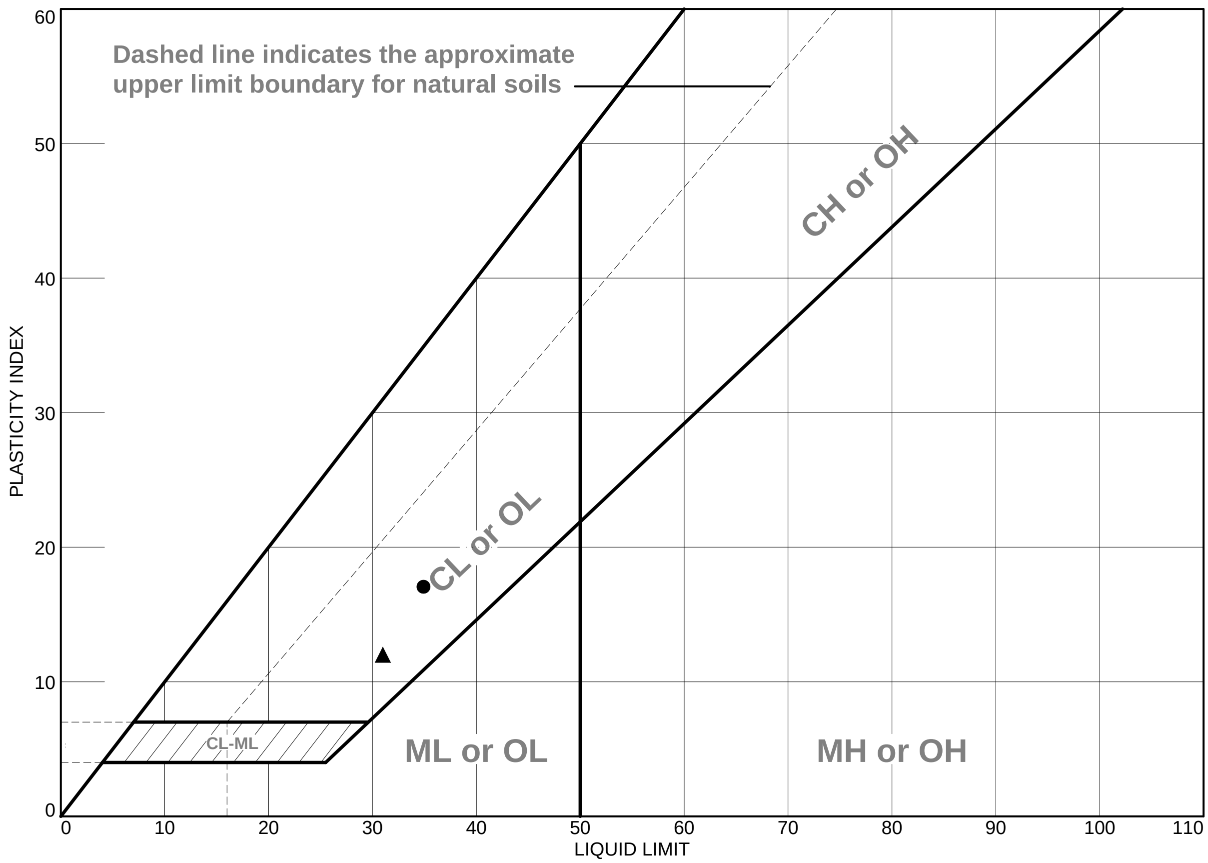
NewFields

Remarks:

Figure 17-019

Tested By: ○ AH □ JG △ JG ◇ JG ▽ JG **Checked By:** RF

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Orange clayey gravel with sand	35	18	17	21.4	14.3	GC
■	Light brown poorly graded gravel with silt and sand	NP	NP	NP	15.7	7.0	GP-GM
▲	Dark brown clayey gravel with sand	31	19	12	27.2	19.0	GC

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

●**Location:** TP-51 **Depth:** 1'-2' **Sample Number:** 17-019-27
■**Location:** TP-50A **Depth:** 2'-3' **Sample Number:** 17-019-29
▲**Location:** TP-50B **Depth:** 0'-1' **Sample Number:** 17-019-30

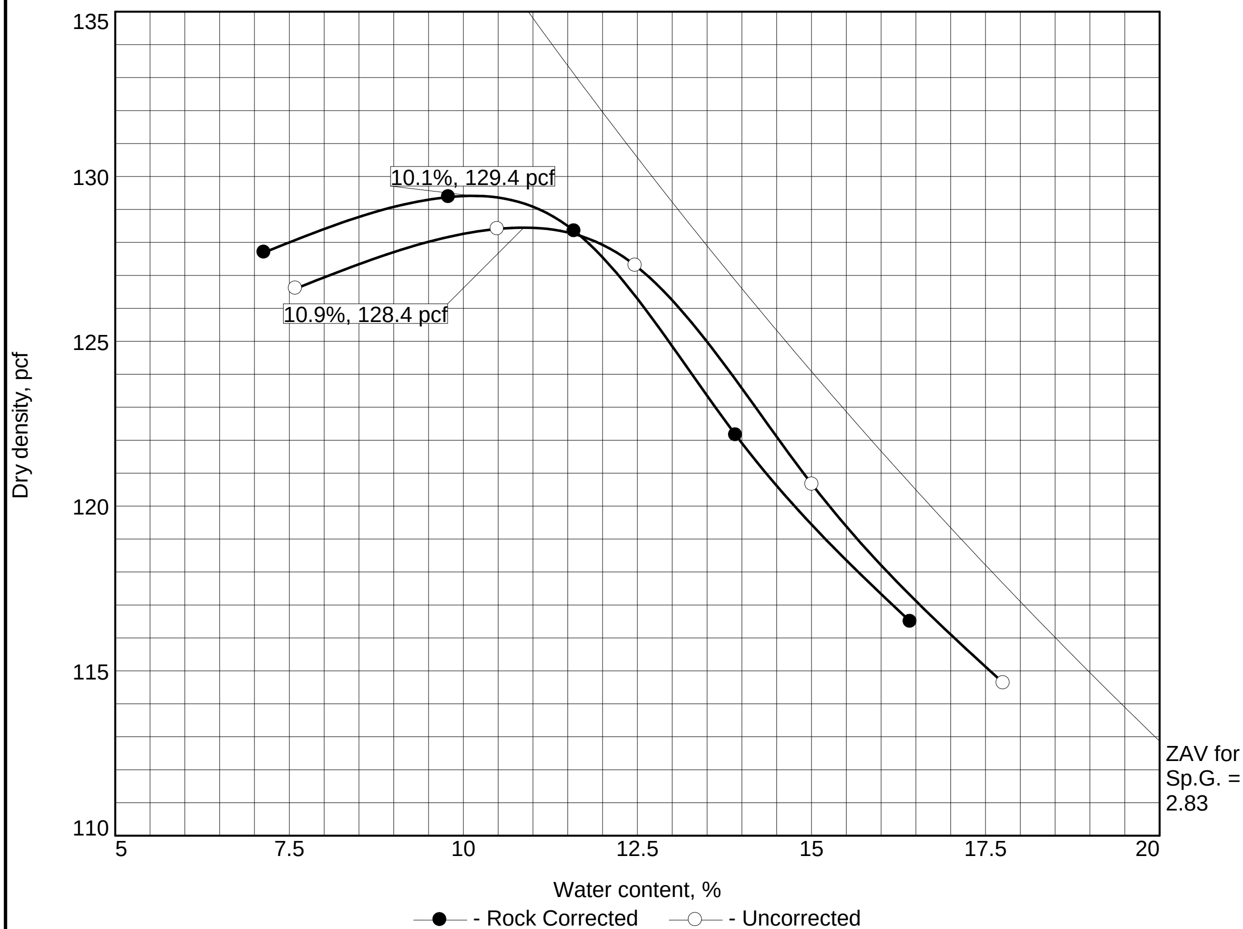
NewFields

Remarks:

Figure 17-019

Tested By: JG **Checked By:** RF

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
2'-3'	SC	A-2-6(1)		2.832	37	17	8.7	26.4

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 129.4 pcf	128.4 pcf
Optimum moisture = 10.1 %	10.9 %

MATERIAL DESCRIPTION

Brown clayey sand with gravel

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-02 **Sample Number:** 17-019-02

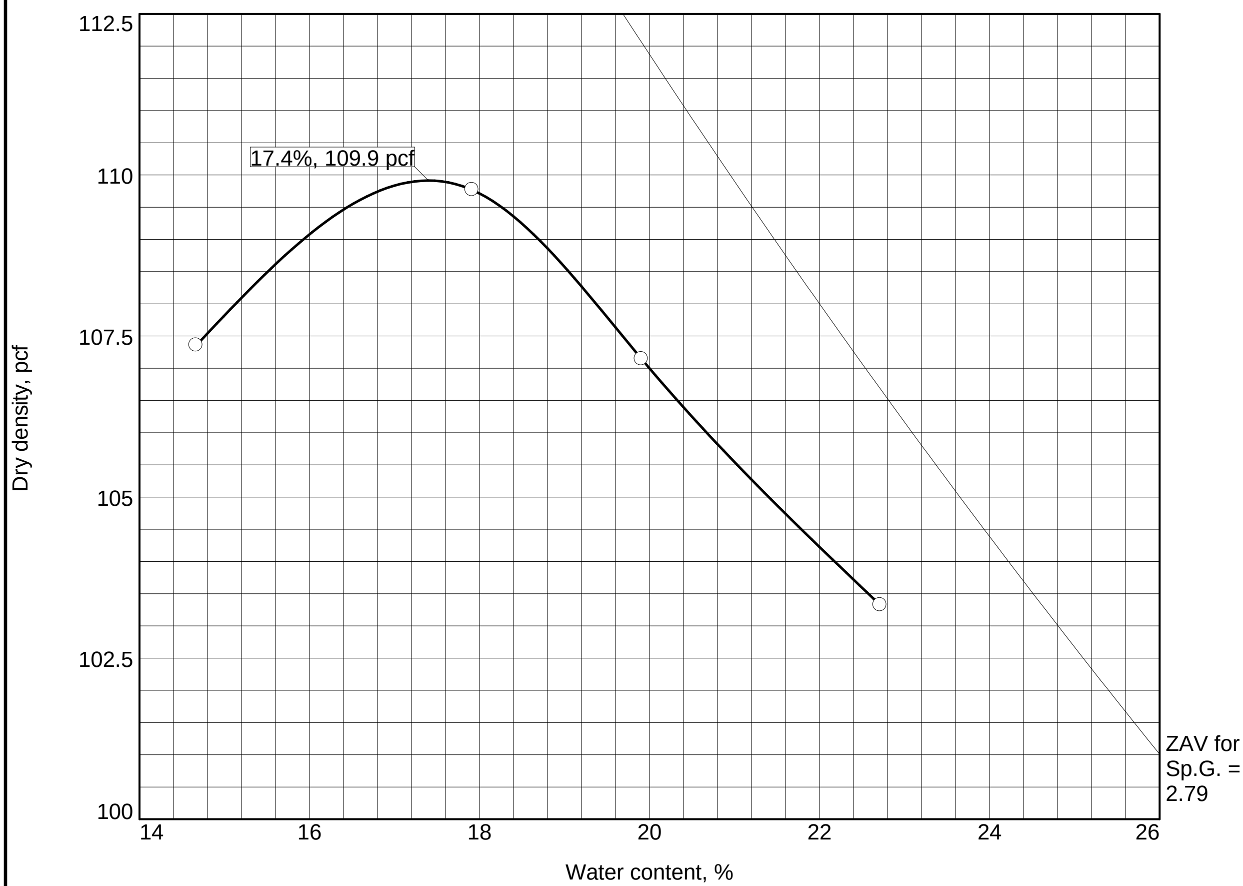
NewFields

Remarks:

Figure 17-019-02

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
1'-3'	CH	A-7-6(19)		2.793	55	34	1.0	61.6

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 109.9 pcf	109.9 pcf	Red sandy fat clay
Optimum moisture = 17.4 %	17.4 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-06 **Sample Number:** 17-019-03

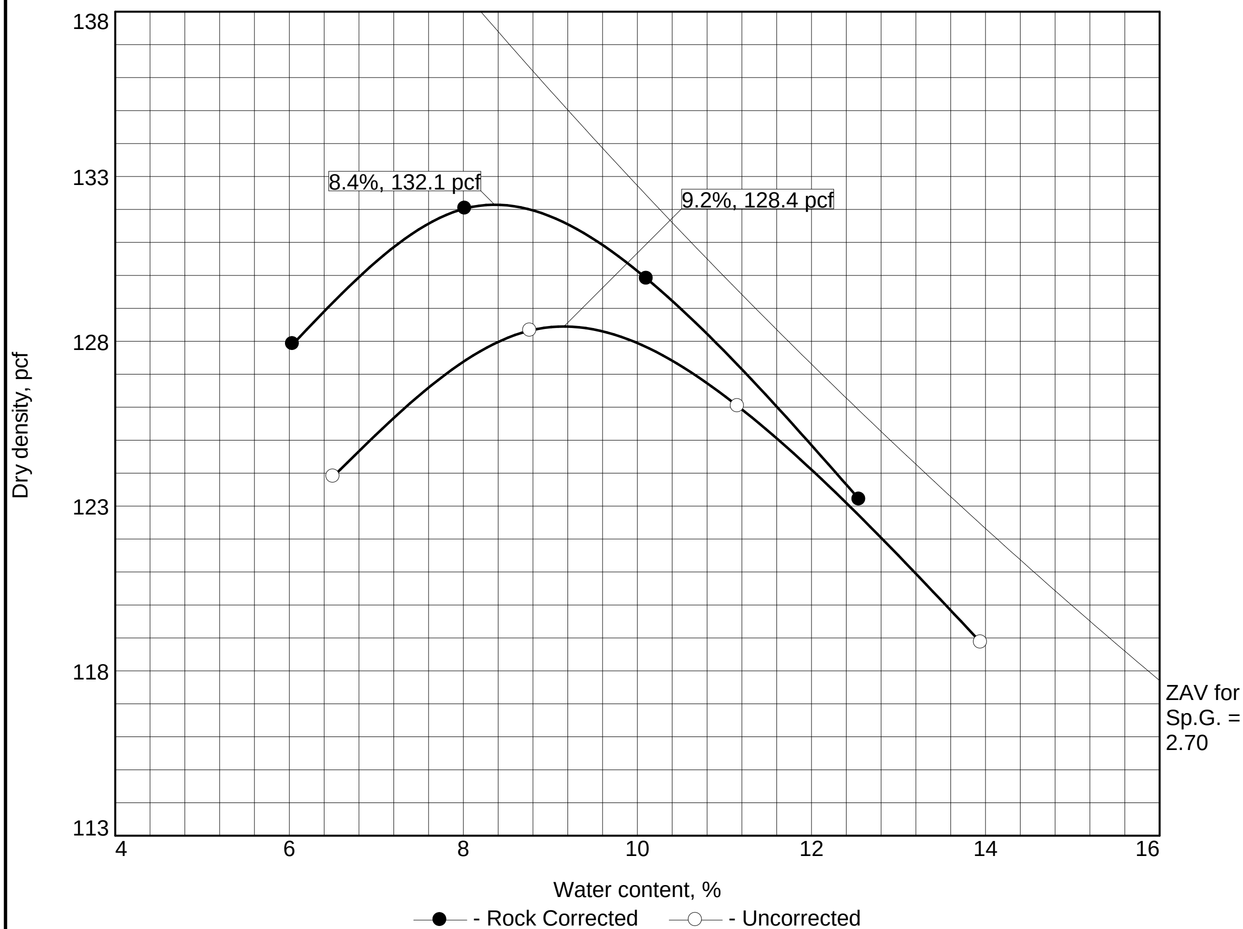
NewFields

Remarks:

Figure 17-019-03

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
4'	SC	A-2-4(0)		2.70	26	8	12.5	15.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 132.1 pcf	128.4 pcf	Brown clayey sand with gravel
Optimum moisture = 8.4 %	9.2 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-08 **Sample Number:** 17-019-07

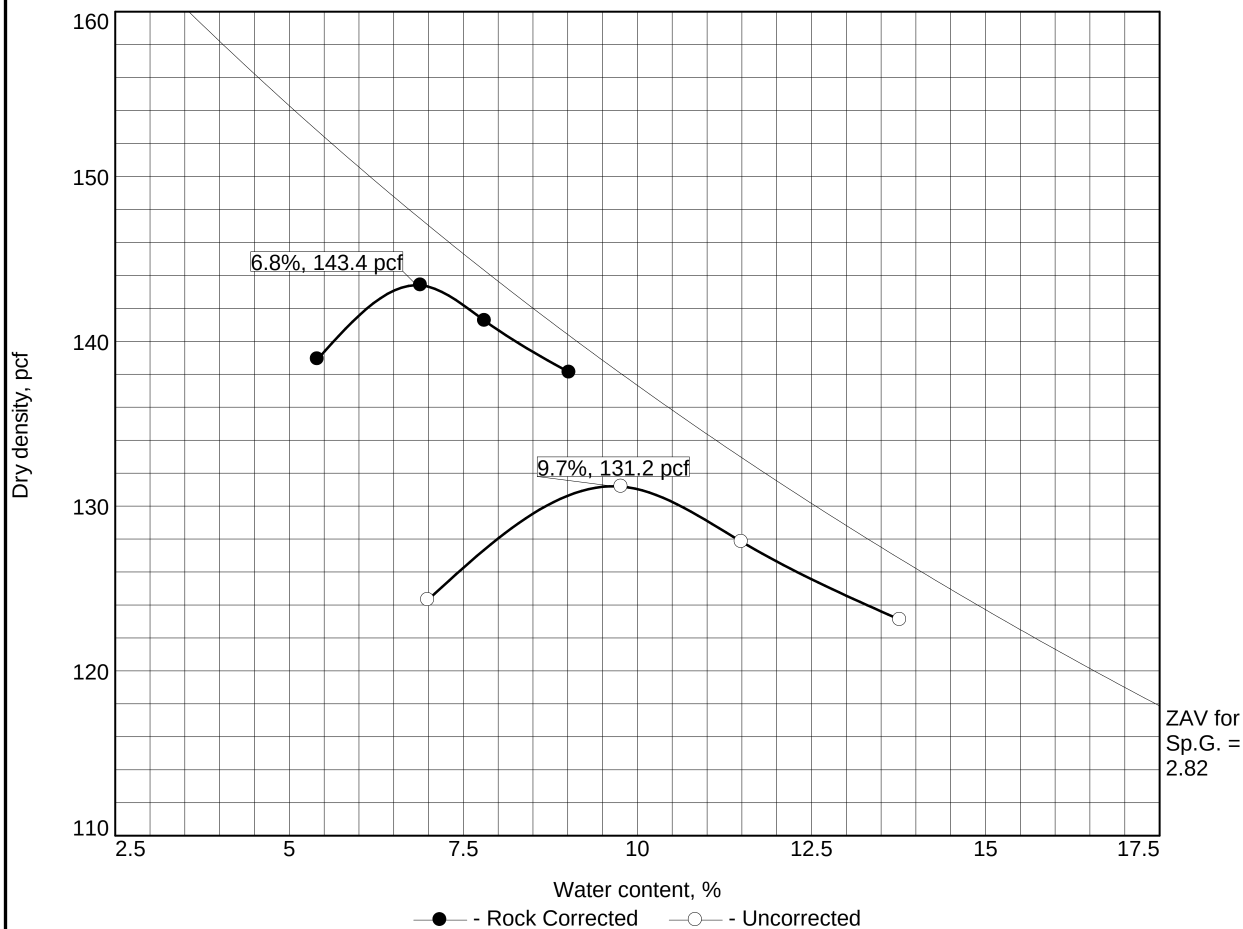
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-07

Tested By: KE **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
3'-4'	GP-GC	A-2-4(0)		2.82	30	10	46.7	6.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 143.4 pcf	131.2 pcf	Dark brown poorly graded gravel with clay and sand
Optimum moisture = 6.8 %	9.7 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-14 **Sample Number:** 17-019-12

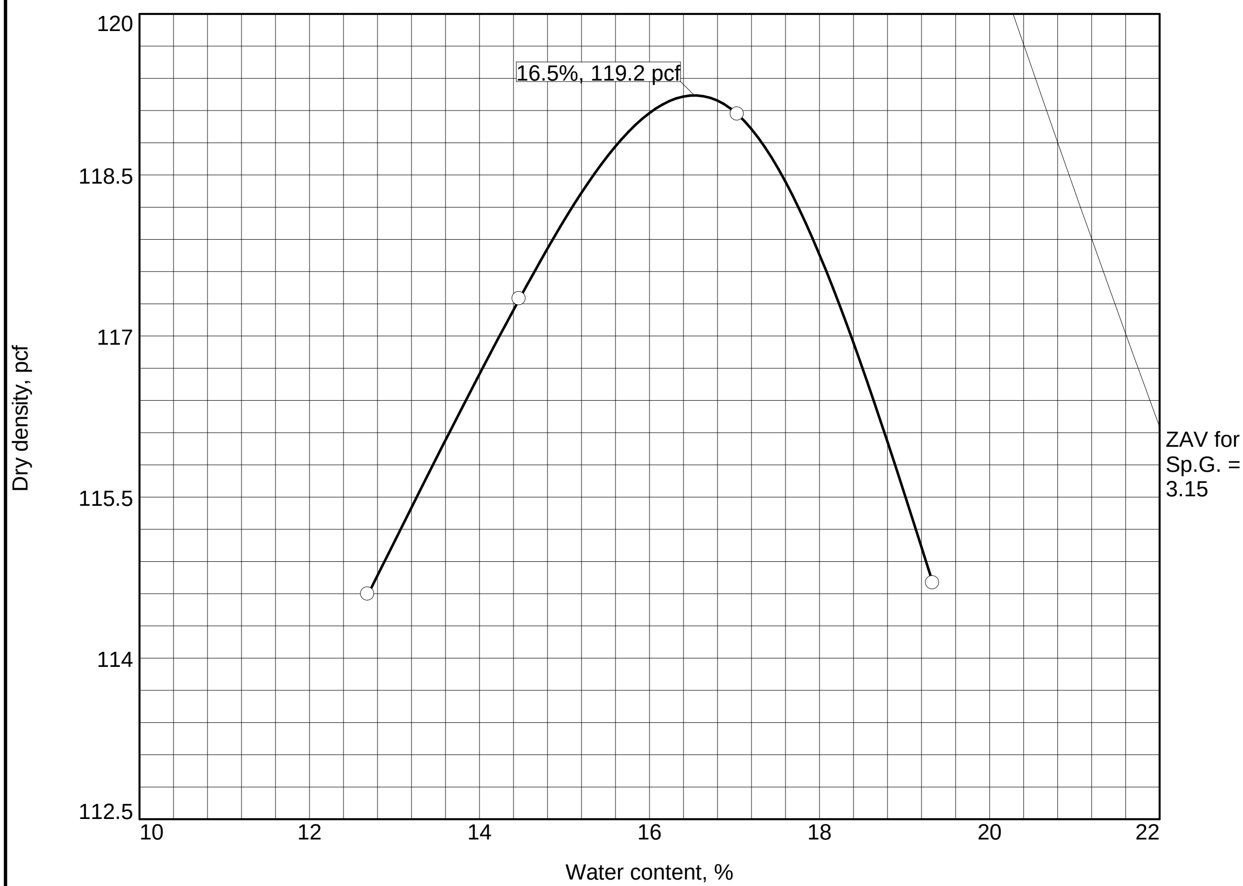
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-12

Tested By: OS **Checked By:** RF

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
4'-7'	ML	A-4(0)		3.15	NP	NP	0.0	54.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 119.2 pcf Optimum moisture = 16.5 %	Gray sandy silt

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

○ **Location:** TP-24 **Sample Number:** 17-019-15

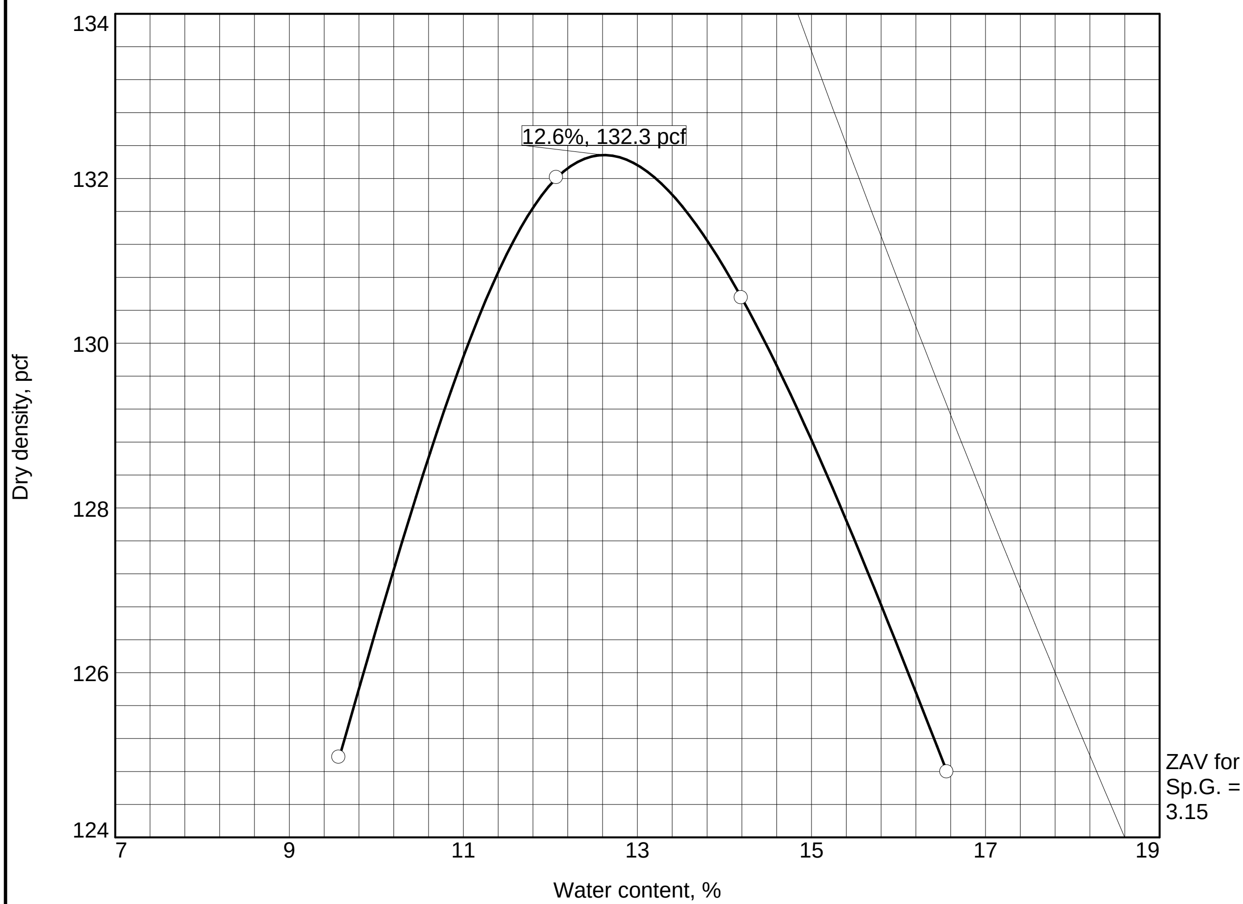
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-15

Tested By: OS **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
4'-7'	ML	A-4(0)		3.15	NP	NP	0.0	54.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 132.3 pcf Optimum moisture = 12.6 %	Gray sandy silt

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-24 **Sample Number:** 17-019-15M

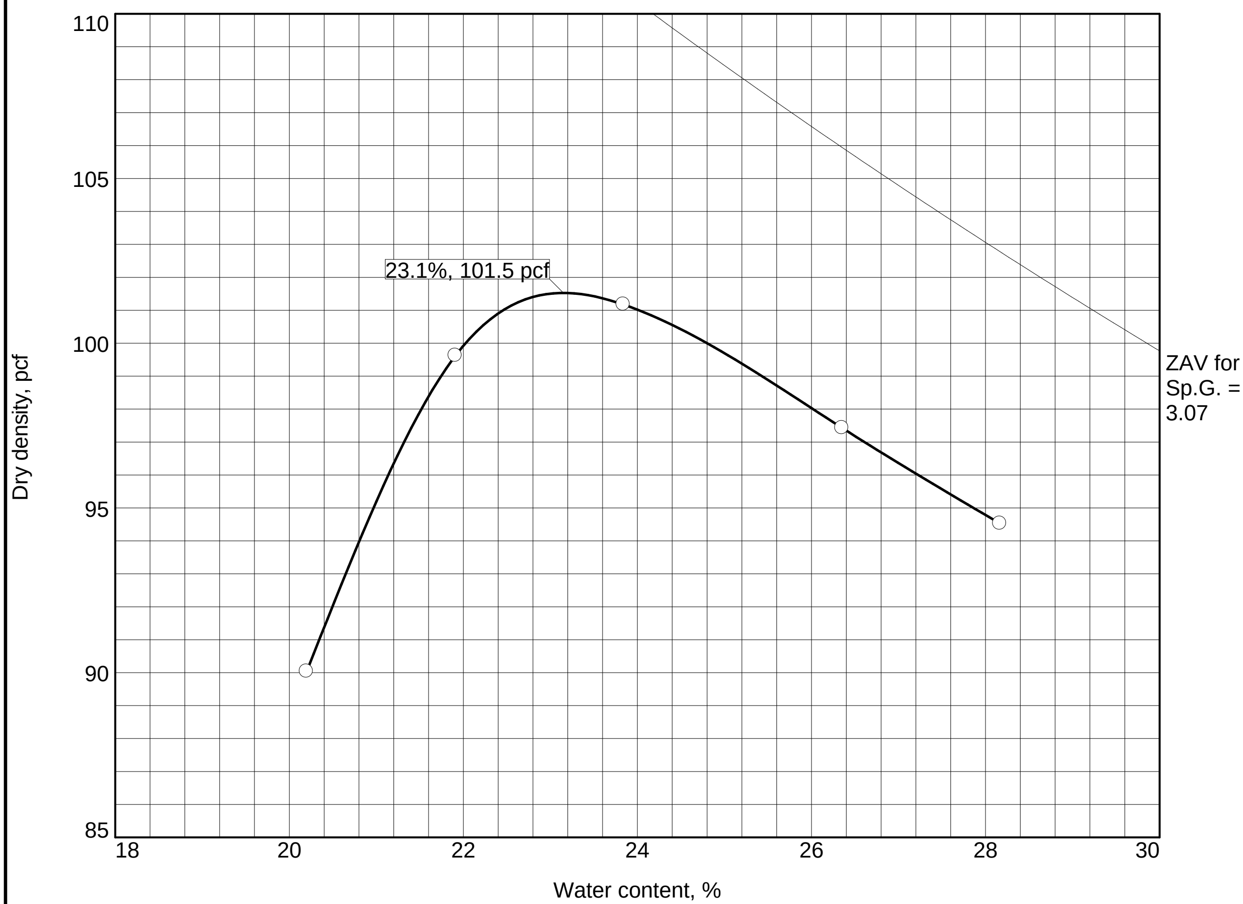
NewFields

Remarks:
Assumed Specific Gravity
Figure 15M = Modified proctor

Figure 17-019-15M

Tested By: OS **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method B Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
8'-10'	CH	A-7-6(33)		3.07	57	30	0.0	93.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 101.5 pcf Optimum moisture = 23.1 %	Gray fat clay

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-25 **Sample Number:** 17-019-16

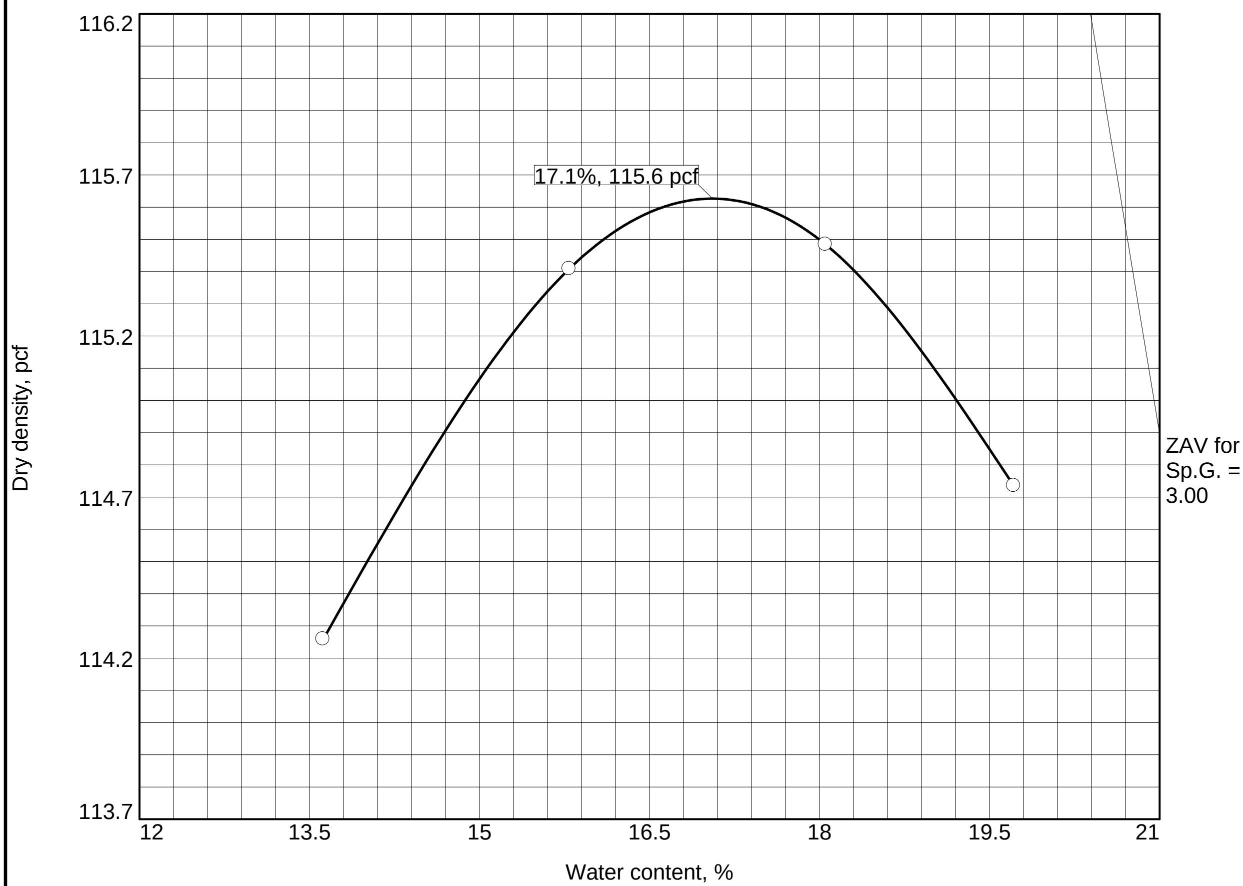
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-16

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
8'-10'	CH	A-7-6(33)		3.0	57	30	0.0	93.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 115.6 pcf Optimum moisture = 17.1 %	Gray fat clay

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

○**Location:** TP-25 **Sample Number:** 17-019-16M

NewFields

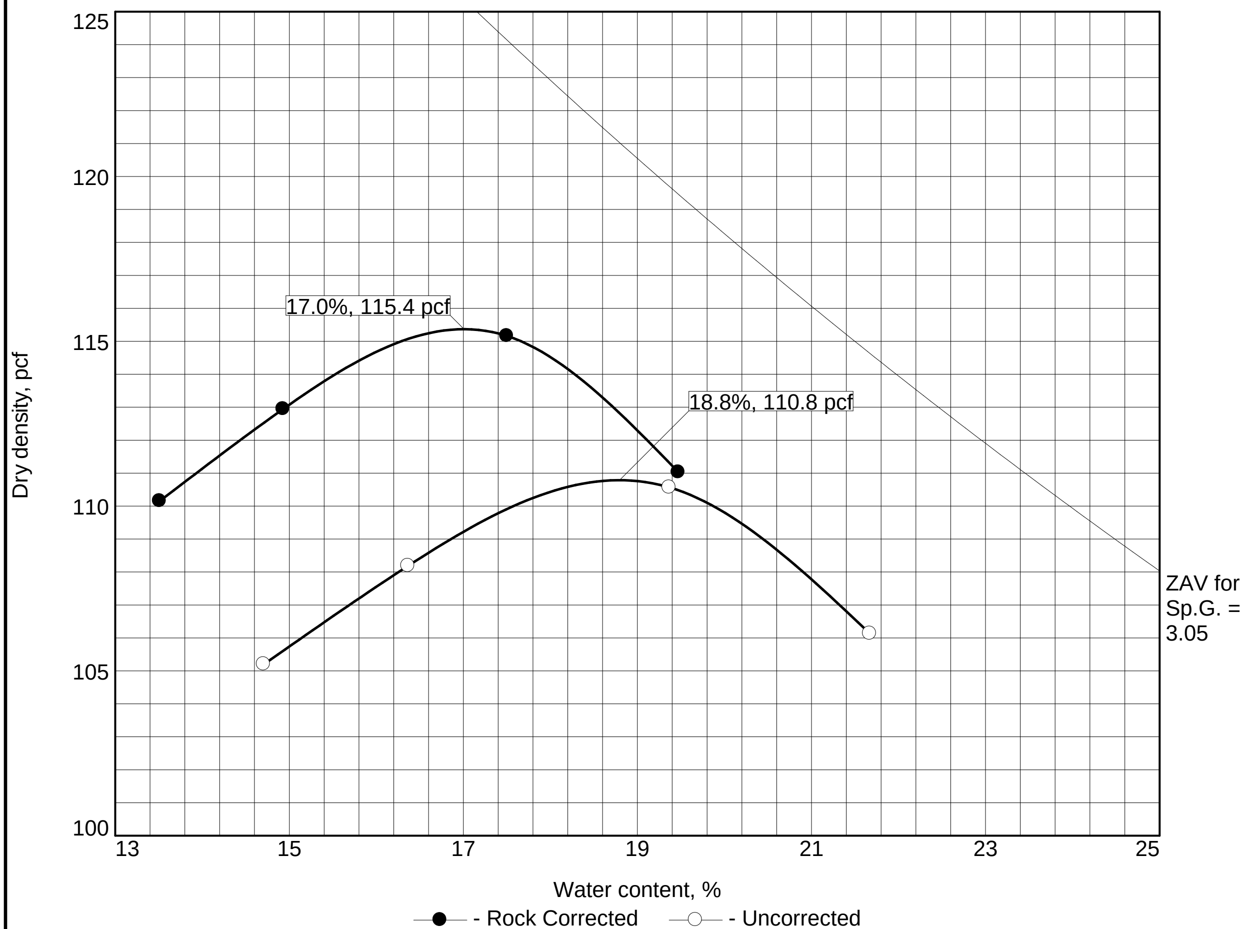
Remarks:

Assumed Specific Gravity
Figure 16M = Modified proctor

Figure 17-019-16M

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method B Standard
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
5'-8'	SC	A-2-6(1)		3.05	33	13	14.4	33.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 115.4 pcf	110.8 pcf
Optimum moisture = 17.0 %	18.8 %

MATERIAL DESCRIPTION

Light brown clayey sand with gravel

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

○**Location:** TP-28 **Sample Number:** 17-019-18

NewFields

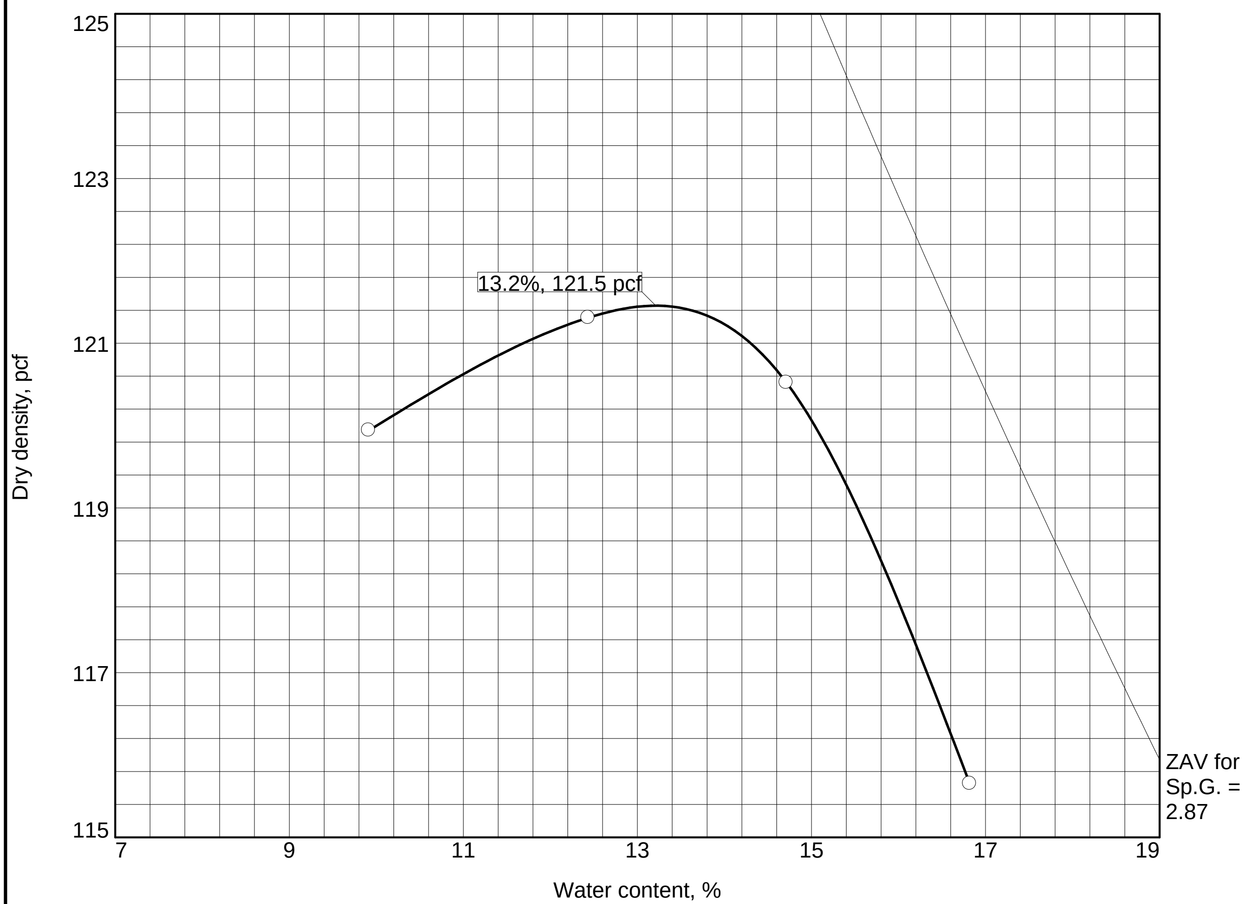
Remarks:

Assumed Specific Gravity

Figure 17-019-18

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
3'5'	ML	A-4(0)		2.87	NP	NP	0.0	99.1

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 121.5 pcf Optimum moisture = 13.2 %	Brown silt

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

○**Location:** TP-30 **Sample Number:** 17-019-19

NewFields

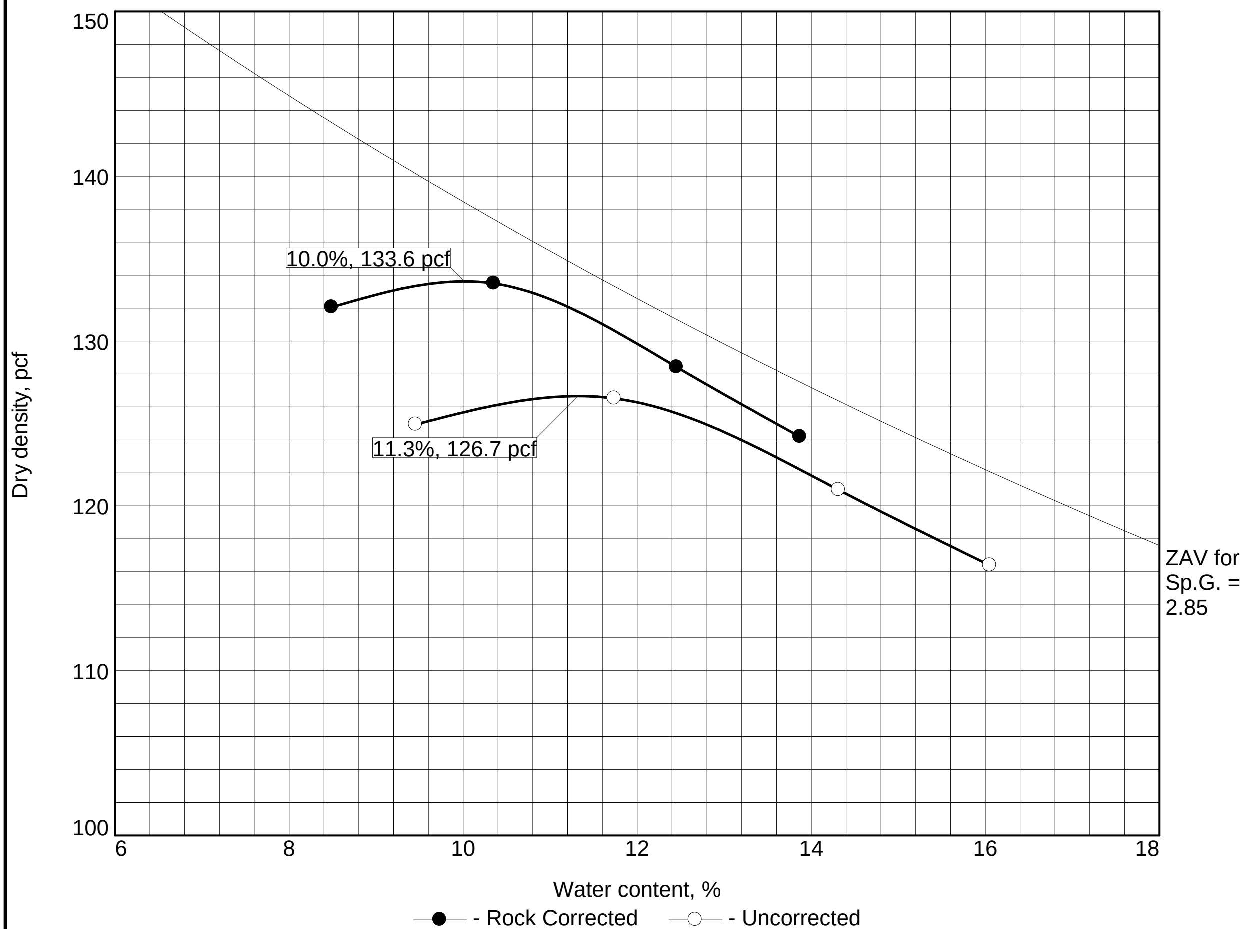
Remarks:

Assumed Specific Gravity

Figure 17-019-19

Tested By: JG **Checked By:** RF

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
2-4'				2.85	NR	NR	18.4	6.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 133.6 pcf	126.7 pcf	Brown
Optimum moisture = 10.0 %	11.3 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

Location: TP-31 **Sample Number:** 17-019-20

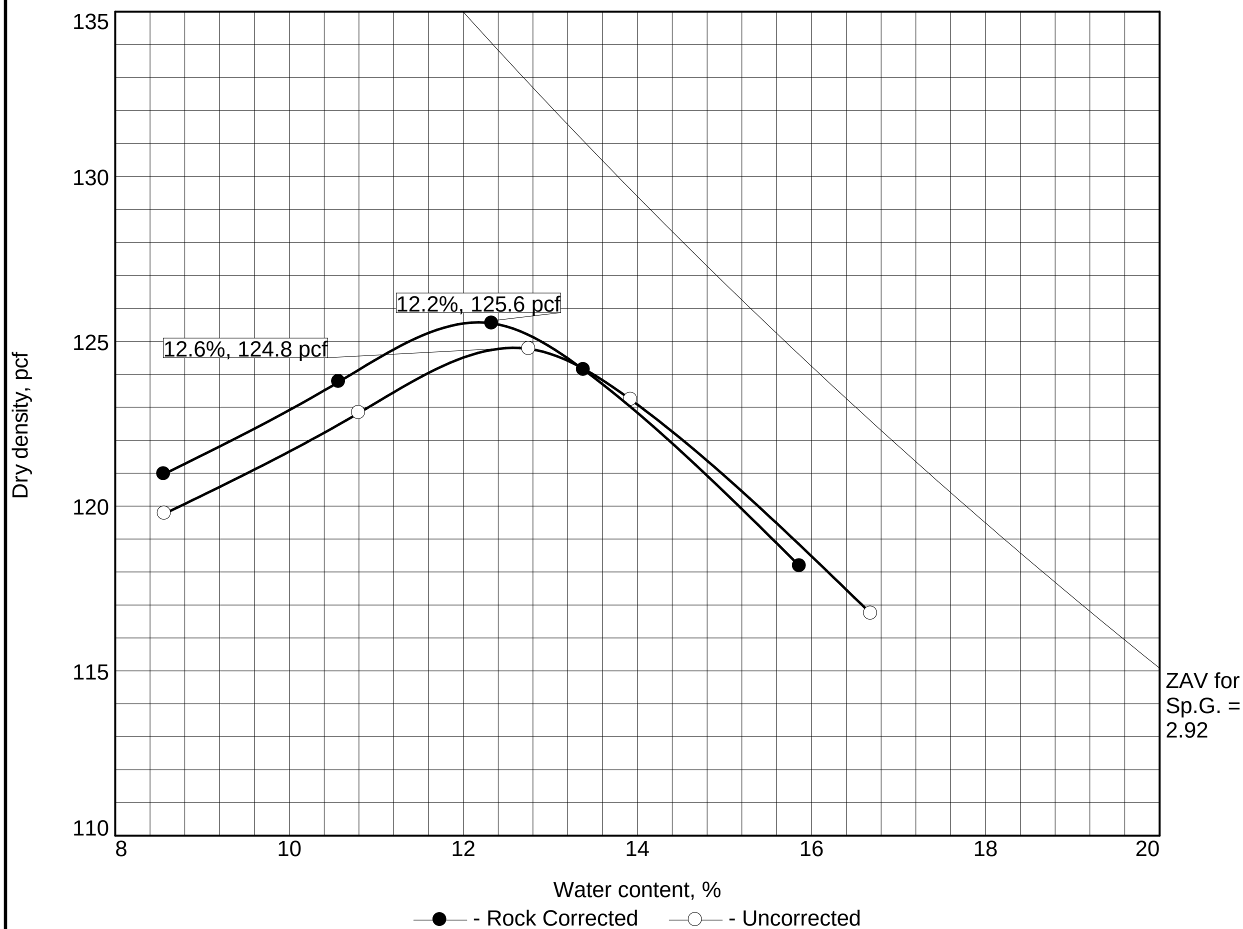
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-20

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method B Standard
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
1'-7' 15'-20.5'	SM	A-2-4(0)		2.92	NP	NP	10.0	33.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 125.6 pcf	124.8 pcf	Grey silty sand
Optimum moisture = 12.2 %	12.6 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-33 **Sample Number:** 17-019-23

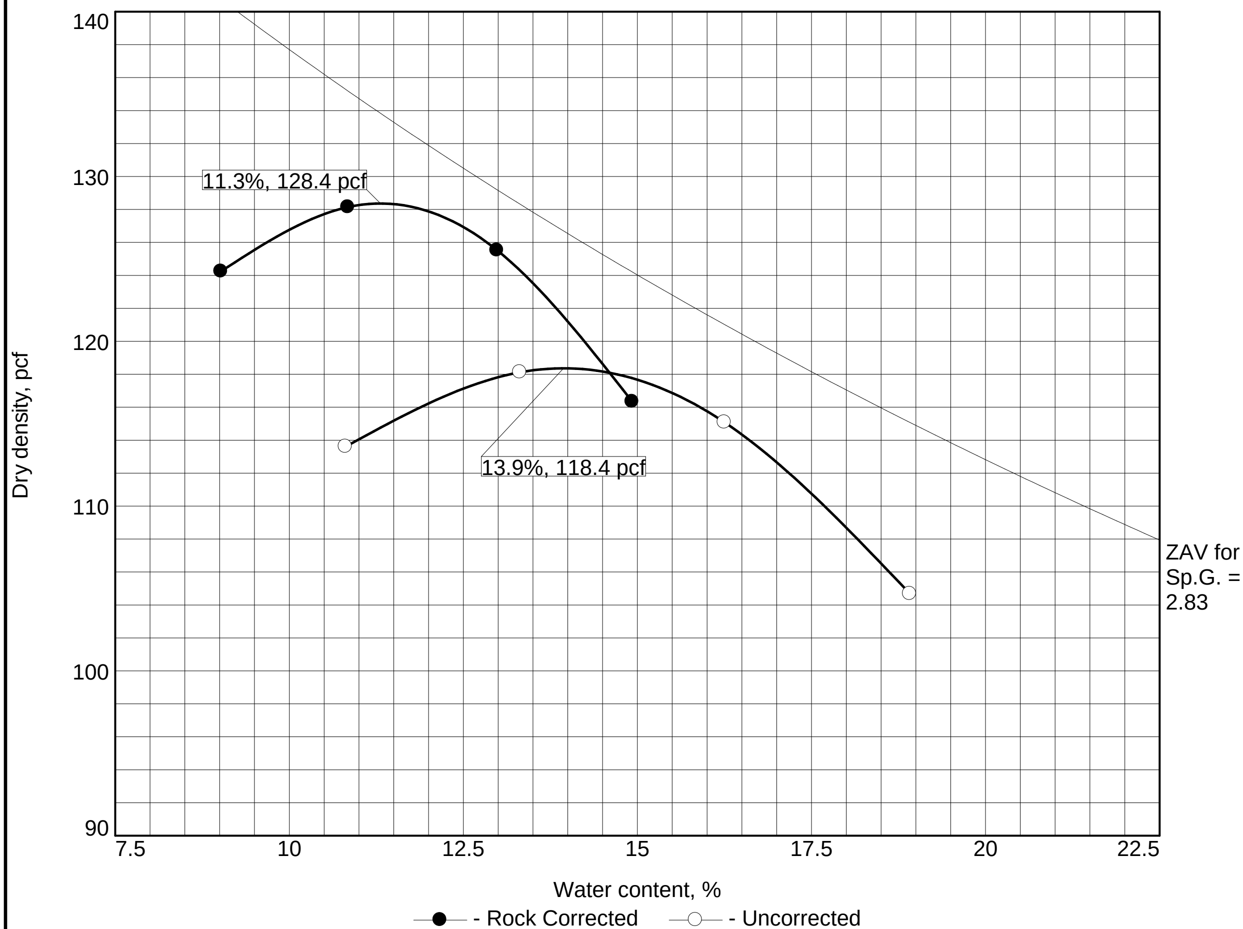
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-23

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
3'-4'	SC	A-7-6(4)		2.83	42	24	27.1	37.4

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 128.4 pcf	118.4 pcf
Optimum moisture = 11.3 %	13.9 %

MATERIAL DESCRIPTION

Red clayey sand with gravel

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-47A **Sample Number:** 17-019-25

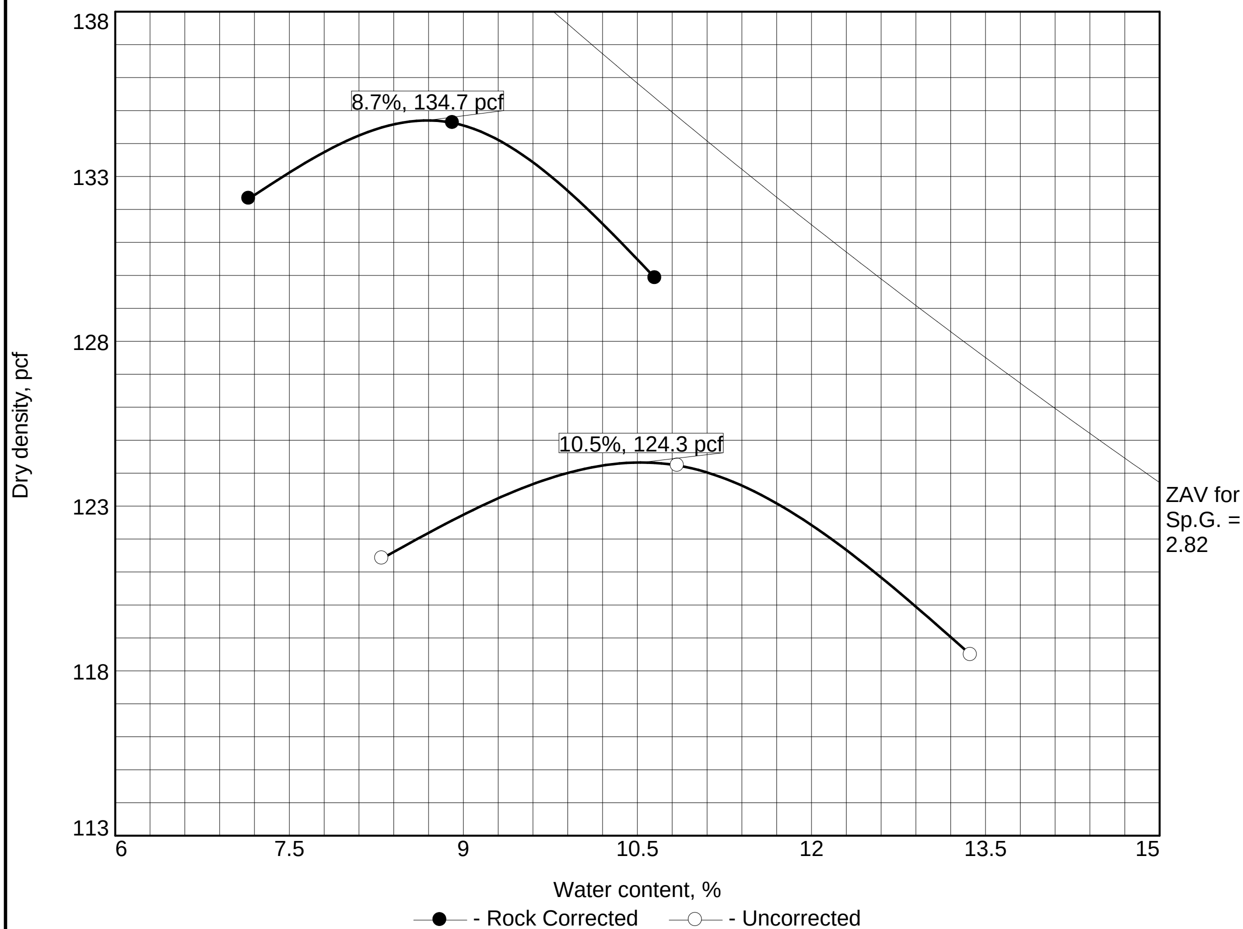
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-25

Tested By: JG **Checked By:** RF

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
0'-4'	GP-GC	A-2-6(0)		2.82	30	12	31.0	10.4

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 134.7 pcf	124.3 pcf	Light brown clayey gravel
Optimum moisture = 8.7 %	10.5 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-48 **Sample Number:** 17-019-26

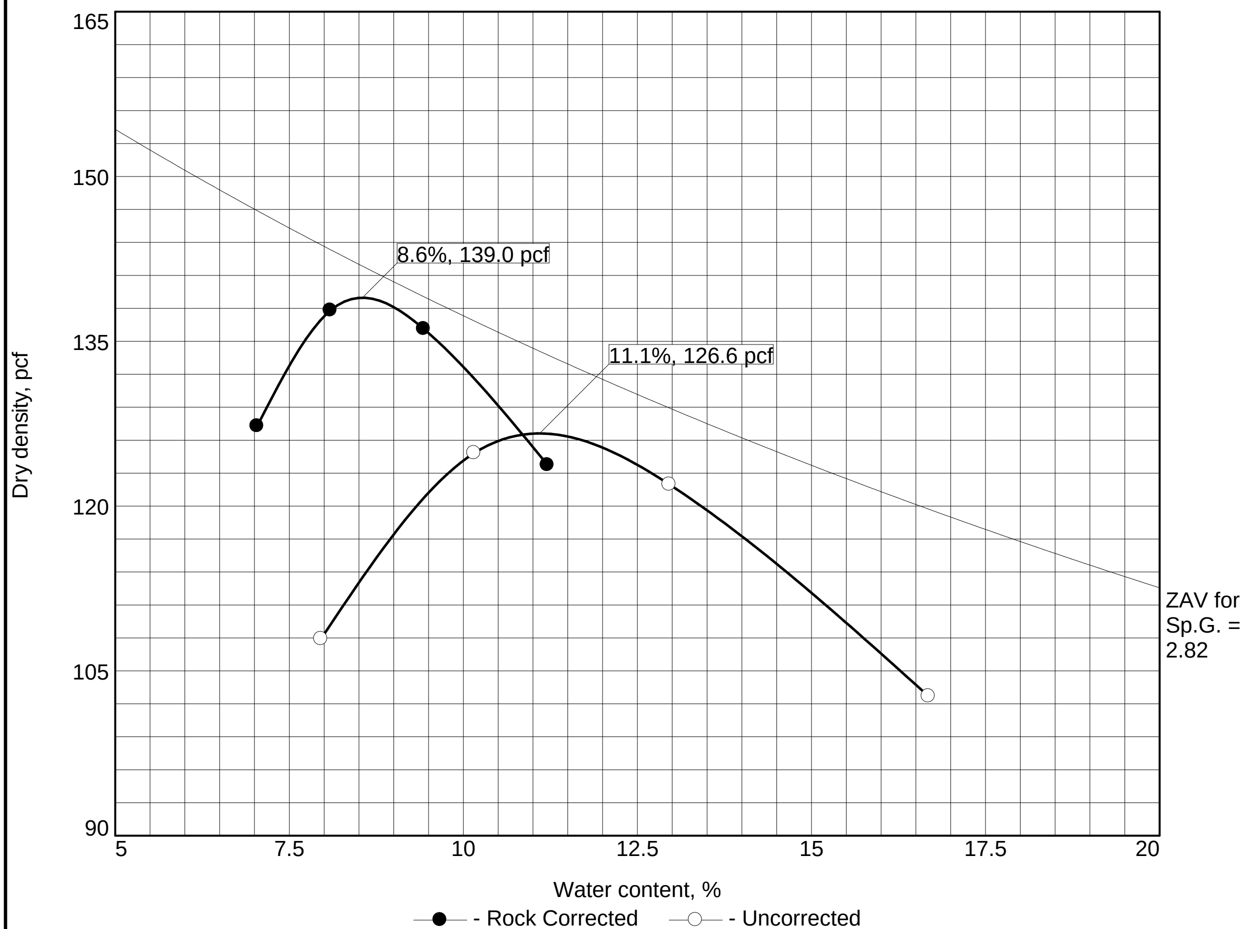
NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-26

Tested By: JG **Checked By:** TW

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
1'-2'	GC	A-2-6(0)		2.82	35	17	52.2	14.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 139.0 pcf	126.6 pcf
Optimum moisture = 8.6 %	11.1 %

MATERIAL DESCRIPTION

Orange clayey gravel with sand

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

Location: TP-51 **Sample Number:** 17-019-27

NewFields

Remarks:
Assumed Specific Gravity

Figure 17-019-27

Tested By: JG **Checked By:** TW

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-03
Project:	Hermosa Underground Project	Field Sample No.:	TP-06
Project No.:	475.0014.008	Location:	TP-06
Phase:	1	Elevation/Depth:	1'-3'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	2/19/2017	Checked By:	TW
Test Finished:	2/22/2017	Sample Description:	Red sandy fat clay

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	599.73	867.23
Dry Soil + Tare (g)	511.28	701.40
Tare (g)	0.0	190.37
Wt. of Water (g)	88.45	165.83
Dry Soil (g)	511.28	511.28
Moisture Content (%)	17.3	32.5
Volume (ft^3)	0.0107	0.0107
Dry Density (pcf)	104.9	104.9
Wet Density (pcf)	123.0	128.5
Saturation (%)	77.0	100.0

Initial Height (in)	3.039
Initial Diameter (in)	2.790
Initial Area (in^2)	6.112
Consolidated Height (in)	3.039
Area After Consolidation (in^2)	6.112
Diameter During Perm (in)	2.790
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	22.5%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	110.3	
Remolded Density (pcf):	104.9	
Percent Compaction:	95%	
Void Ratio:	0.607	
Optimum Moisture Content(%):	17.3	
Initial Water Content (%):	17.3	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**2.3E-07**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-07
Project:	Hermosa Underground Project	Field Sample No.:	TP-08
Project No.:	475.0014.008	Location:	TP-08
Phase:	1	Elevation/Depth:	4'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	2/19/2017	Checked By:	TW
Test Finished:	2/23/2017	Sample Description:	Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	663.02	885.05
Dry Soil + Tare (g)	611.64	801.81
Tare (g)	0.0	190.76
Wt. of Water (g)	51.38	83.24
Dry Soil (g)	611.64	611.64
Moisture Content (%)	8.4	13.6
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	124.7	124.7
Wet Density (pcf)	135.2	141.0
Saturation (%)	64.7	100.0

Initial Height (in)	3.042
Initial Diameter (in)	2.796
Initial Area (in^2)	6.141
Consolidated Height (in)	3.042
Area After Consolidation (in^2)	6.141
Diameter During Perm (in)	2.796
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	13.0%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	132	
Remolded Density (pcf):	124.7	
Percent Compaction:	94%	
Void Ratio:	0.351	
Optimum Moisture Content(%):	8.4	
Initial Water Content (%):	8.4	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**8.9E-05**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-15
Project:	Hermosa Underground Project	Field Sample No.:	TP-24
Project No.:	475.0014.008	Location:	TP-24
Phase:	1	Elevation/Depth:	4-7'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	2/19/2017	Checked By:	TW
Test Finished:	2/23/2017	Sample Description:	Tailings

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	697.6	849.18
Dry Soil + Tare (g)	611.39	726.96
Tare (g)	0.0	120.6
Wt. of Water (g)	86.21	122.22
Dry Soil (g)	611.39	611.39
Moisture Content (%)	14.1	20.2
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	125.0	125.0
Wet Density (pcf)	142.6	141.1
Saturation (%)	109.5	100.0

Initial Height (in)	3.038
Initial Diameter (in)	2.794
Initial Area (in^2)	6.133
Consolidated Height (in)	3.038
Area After Consolidation (in^2)	6.133
Diameter During Perm (in)	2.794
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	12.9%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	132	
Remolded Density (pcf):	125.0	
Percent Compaction:	95%	
Void Ratio:	0.348	
Optimum Moisture Content(%):	12.1	
Initial Water Content (%):	14.1	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**1.3E-05**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-15
Project:	Hermosa Underground Project	Field Sample No.:	TP-24
Project No.:	475.0014.008	Location:	TP-24
Phase:	1	Elevation/Depth:	4'-7'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	2/19/2017	Checked By:	TW
Test Finished:	2/24/2017	Sample Description:	Tailings

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	697.6	849.18
Dry Soil + Tare (g)	611.39	726.96
Tare (g)	0.0	120.6
Wt. of Water (g)	86.21	122.22
Dry Soil (g)	611.39	611.39
Moisture Content (%)	14.1	20.2
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	125.0	125.0
Wet Density (pcf)	142.6	141.1
Saturation (%)	109.5	100.0

Initial Height (in)	3.038
Initial Diameter (in)	2.794
Initial Area (in^2)	6.133
Consolidated Height (in)	3.038
Area After Consolidation (in^2)	6.133
Diameter During Perm (in)	2.794
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	12.9%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	132	
Remolded Density (pcf):	125.0	
Percent Compaction:	95%	
Void Ratio:	0.348	
Optimum Moisture Content(%):	12.1	
Initial Water Content (%):	14.1	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**7.2E-06**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-16
Project:	Hermosa Underground Project	Field Sample No.:	TP-25
Project No.:	475.0014.008	Location:	TP-25
Phase:	1	Elevation/Depth:	8-10'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	2/19/2017	Checked By:	TW
Test Finished:	3/1/2017	Sample Description:	Tailings

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	588.52	911.88
Dry Soil + Tare (g)	470.44	748.20
Tare (g)	0.0	225.46
Wt. of Water (g)	118.08	163.68
Dry Soil (g)	470.44	470.44
Moisture Content (%)	25.1	31.3
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	96.2	96.2
Wet Density (pcf)	120.3	123.0
Saturation (%)	90.2	100.0

Initial Height (in)	3.043
Initial Diameter (in)	2.792
Initial Area (in^2)	6.124
Consolidated Height (in)	3.043
Area After Consolidation (in^2)	6.124
Diameter During Perm (in)	2.792
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	27.9%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D698

Maximum Dry Density (pcf):	101.5	
Remolded Density (pcf):	96.2	
Percent Compaction:	95%	
Void Ratio:	0.752	
Optimum Moisture Content(%):	23.1	
Initial Water Content (%):	25.1	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**1.5E-08**	
Gradient Range (h/L):	1.4	2.6

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-22
Project:	Hermosa Underground Project	Field Sample No.:	TP-32
Project No.:	475.0014.008	Location:	TP-32
Phase:	1	Elevation/Depth:	11.5'-14'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	4/3/2017	Checked By:	TW
Test Finished:	4/9/2017	Sample Description:	Red sandy lean clay

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	50
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	593.17	751.49
Dry Soil + Tare (g)	510.91	629.00
Tare (g)	0.0	120.07
Wt. of Water (g)	82.26	122.49
Dry Soil (g)	667.13	667.13
Moisture Content (%)	16.1	24.1
Volume (ft^3)	0.0108	0.0107
Dry Density (pcf)	104.8	104.9
Wet Density (pcf)	121.6	128.6
Saturation (%)	71.5	100.0

Initial Height (in)	3.036
Initial Diameter (in)	2.791
Initial Area (in^2)	6.119
Consolidated Height (in)	3.033
Area After Consolidation (in^2)	6.107
Diameter During Perm (in)	2.789
Change in Height (in)	0.003
Moisture Content after Consolidation (%)	22.4%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	110.2	
Remolded Density (pcf):	104.8	
Percent Compaction:	95%	
Void Ratio:	0.604	
Optimum Moisture Content(%):	16.1	
Initial Water Content (%):	16.1	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**2.7E-05**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-22
Project:	Hermosa Underground Project	Field Sample No.:	TP-32
Project No.:	475.0014.008	Location:	TP-32
Phase:	1	Elevation/Depth:	11.5-14'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	4/3/2017	Checked By:	TW
Test Finished:	4/12/2017	Sample Description:	Red sandy lean clay

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	50
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	593.17	751.49
Dry Soil + Tare (g)	510.91	629.00
Tare (g)	0.0	120.07
Wt. of Water (g)	82.26	122.49
Dry Soil (g)	508.93	508.93
Moisture Content (%)	16.1	24.1
Volume (ft^3)	0.0108	0.0107
Dry Density (pcf)	104.8	104.9
Wet Density (pcf)	121.6	128.6
Saturation (%)	71.5	100.0

Initial Height (in)	3.036
Initial Diameter (in)	2.791
Initial Area (in^2)	6.119
Consolidated Height (in)	2.992
Area After Consolidation (in^2)	5.939
Diameter During Perm (in)	2.750
Change in Height (in)	0.044
Moisture Content after Consolidation (%)	19.9%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D698

Maximum Dry Density (pcf):	110.2	
Remolded Density (pcf):	104.8	
Percent Compaction:	95%	
Void Ratio:	0.539	
Optimum Moisture Content(%):	16.1	
Initial Water Content (%):	16.1	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**2.6E-07**	
Gradient Range (h/L):	1.5	2.0

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-25
Project:	Hermosa Underground Project	Field Sample No.:	TP-47A
Project No.:	475.0014.008	Location:	TP-47A
Phase:	1	Elevation/Depth:	3'-4'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	3/3/2017	Checked By:	TW
Test Finished:	3/6/2017	Sample Description:	Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	659.65	886.77
Dry Soil + Tare (g)	594.82	784.38
Tare (g)	0.0	190.75
Wt. of Water (g)	64.83	102.39
Dry Soil (g)	594.82	594.82
Moisture Content (%)	10.9	17.2
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	121.8	121.8
Wet Density (pcf)	135.1	139.1
Saturation (%)	76.8	100.0

Initial Height (in)	3.038
Initial Diameter (in)	2.793
Initial Area (in^2)	6.125
Consolidated Height (in)	3.038
Area After Consolidation (in^2)	6.125
Diameter During Perm (in)	2.793
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	14.2%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	128.3	
Remolded Density (pcf):	121.8	
Percent Compaction:	95%	
Void Ratio:	0.384	
Optimum Moisture Content(%):	10.9	
Initial Water Content (%):	10.9	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**7.3E-07**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-26
Project:	Hermosa Underground Project	Field Sample No.:	TP-48
Project No.:	475.0014.008	Location:	TP-48
Phase:	1	Elevation/Depth:	0'-4'
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	3/3/2017	Checked By:	TW
Test Finished:	3/6/2017	Sample Description:	Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	678.95	876.36
Dry Soil + Tare (g)	624.61	803.78
Tare (g)	0.0	190.31
Wt. of Water (g)	54.34	72.58
Dry Soil (g)	624.61	624.61
Moisture Content (%)	8.7	11.8
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	127.6	127.6
Wet Density (pcf)	138.7	142.8
Saturation (%)	73.4	100.0

Initial Height (in)	3.056
Initial Diameter (in)	2.787
Initial Area (in^2)	6.100
Consolidated Height (in)	3.056
Area After Consolidation (in^2)	6.100
Diameter During Perm (in)	2.787
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	11.9%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	134.7	
Remolded Density (pcf):	127.6	
Percent Compaction:	95%	
Void Ratio:	0.321	
Optimum Moisture Content(%):	8.7	
Initial Water Content (%):	8.7	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**5.4E-06**	
Gradient Range (h/L):	4.7	4.7

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-019-27
Project:	Hermosa Underground Project	Field Sample No.:	TP-51
Project No.:	475.0014.008	Location:	TP-51
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	TW
Test Started:	3/3/2017	Checked By:	TW
Test Finished:	3/6/2017	Sample Description:	Orange clayey gravel with sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	5
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	724.5	888.72
Dry Soil + Tare (g)	667.13	813.28
Tare (g)	0.0	190.57
Wt. of Water (g)	57.37	75.44
Dry Soil (g)	667.13	667.13
Moisture Content (%)	8.6	12.1
Volume (ft^3)	0.0108	0.0108
Dry Density (pcf)	136.6	136.6
Wet Density (pcf)	148.4	148.4
Saturation (%)	99.5	100.0

Initial Height (in)	3.035
Initial Diameter (in)	2.794
Initial Area (in^2)	6.130
Consolidated Height (in)	3.035
Area After Consolidation (in^2)	6.130
Diameter During Perm (in)	2.794
Change in Height (in)	0.000
Moisture Content after Consolidation (%)	8.7%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	144.4	
Remolded Density (pcf):	136.6	
Percent Compaction:	95%	
Void Ratio:	0.234	
Optimum Moisture Content(%):	8.6	
Initial Water Content (%):	8.6	
Confining Pressure (psi):	5.0	
Permeability (k cm/s):	**4.1E-05**	
Gradient Range (h/L):	4.7	4.7

Rigid Wall Constant Head Permeability
USBR 5600

Client	Arizona Minerals Inc.	Lab Sample No.	17-019-11
Project	Hermosa Underground Project	Field Sample No.	TP-13
Project No.	475.0014.008	Location	TP-13 1'-3'
Phase	1	Tested By	KE
Test Date	3/28/17	Checked By	KE
		Sample Description	Brown

Test Boundary Conditions

Type of Permeant	Tap water	
Saturated (Y/N)	Yes	
Stage 1: Normal Stress (psf)	0	
Equivalent Load Height (ft)	0	(Normal Stress/Density)

Test Specimen Data

Normal Load (lbs):	0	Normal Stress (psf):	0.0
Specimen Wt. (Dry) (lbs):	47.605	Change in Specimen Length (in):	0.000
Initial Specimen Length, L_0:	10.375	Final Specimen Length, L_f:	10.375
Initial Sample Volume (in^3):	978.8	Final Sample Volume (in^3):	978.8
Initial Sample Volume (ft^3):	0.566	Final Sample Volume (ft^3):	0.566
Initial Bulk Density (pcf):	84.0	Final Bulk Density (pcf):	84.0
Initial Void Ratio:	0.97	Final Void Ratio:	0.97
Initial Porosity:	49.2%	Final Porosity:	49.2%

Hydraulic Conductivity Data

Trial #	Gradient, i	Volume of Water (ml)	ΔTime (sec)	Velocity, v (cm/sec)	Hydraulic Conductivity, k (cm/sec)
1	0.034	250	10	0.0411	1.2E+00
2	0.034	250	12	0.0342	9.9E-01
3	0.034	250	12	0.0342	9.9E-01
4	0.034	250	12	0.0342	9.9E-01
				Average Hydraulic Conductivity, k (cm/s)	**1.0E+00**

NewFields

Rigid Wall Constant Head Permeability
USBR 5600

Client	Arizona Minerals Inc.	Lab Sample No.	17-019-11
Project	Hermosa Underground Project	Field Sample No.	TP-13
Project No.	475.0014.008	Location	TP-13 1'-3'
Phase	1	Tested By	KE
Test Date	3/28/17	Checked By	KE
		Sample Description	Brown

Test Boundary Conditions

Type of Permeant	Tap water	
Saturated (Y/N)	Yes	
Stage 1: Normal Stress (psf)	6,000	
Equivalent Load Height (ft)	50	(Normal Stress/Density)

Test Specimen Data

Normal Load (lbs):	471	Normal Stress (psf):	2400
Specimen Wt. (Dry) (lbs):	47.605	Change in Specimen Length (in):	2.031
Initial Specimen Length, L_0:	10.375	Final Specimen Length, L_f:	8.344
Initial Sample Volume (in^3):	978.8	Final Sample Volume (in^3):	787.2
Initial Sample Volume (ft^3):	0.566	Final Sample Volume (ft^3):	0.456
Initial Bulk Density (pcf):	84.0	Final Bulk Density (pcf):	104.5
Initial Void Ratio:	0.97	Final Void Ratio:	0.58
Initial Porosity:	49.2%	Final Porosity:	36.8%

Hydraulic Conductivity Data

Trial #	Gradient, i	Volume of Water (ml)	ΔTime (sec)	Velocity, v (cm/sec)	Hydraulic Conductivity, k (cm/sec)
1	0.109	250	14	0.0293	2.7E-01
2	0.109	250	16	0.0257	2.3E-01
3	0.109	250	16	0.0257	2.3E-01
4	0.109	250	16	0.0257	2.3E-01
				Average Hydraulic Conductivity, k (cm/s)	**2.4E-01**

NewFields

Rigid Wall Constant Head Permeability
USBR 5600

Client	Arizona Minerals Inc.	Lab Sample No.	17-019-11
Project	Hermosa Underground Project	Field Sample No.	TP-13
Project No.	475.0014.008	Location	TP-13 1'-3'
Phase	1	Tested By	KE
Test Date	3/28/17	Checked By	KE
		Sample Description	Brown

Test Boundary Conditions

Type of Permeant	Tap water	
Saturated (Y/N)	Yes	
Stage 1: Normal Stress (psf)	12,000	
Equivalent Load Height (ft)	100	(Normal Stress/Density)

Test Specimen Data

Normal Load (lbs):	7862	Normal Stress (psf):	12000
Specimen Wt. (Dry) (lbs):	47.605	Change in Specimen Length (in):	2.563
Initial Specimen Length, L_0:	8.344	Final Specimen Length, L_f:	5.781
Initial Sample Volume (in^3):	787.2	Final Sample Volume (in^3):	545.4
Initial Sample Volume (ft^3):	0.456	Final Sample Volume (ft^3):	0.316
Initial Bulk Density (pcf):	104.5	Final Bulk Density (pcf):	150.8
Initial Void Ratio:	0.58	Final Void Ratio:	0.10
Initial Porosity:	36.8%	Final Porosity:	8.8%

Hydraulic Conductivity Data

Trial #	Gradient, i	Volume of Water (ml)	ΔTime (sec)	Velocity, v (cm/sec)	Hydraulic Conductivity, k (cm/sec)
1	0.191	250	20	0.0205	1.1E-01
2	0.191	250	19	0.0216	1.1E-01
3	0.191	250	20	0.0205	1.1E-01
4	0.191	250	19	0.0216	1.1E-01
				Average Hydraulic Conductivity, k (cm/s)	**1.1E-01**

NewFields

SPECIFIC GRAVITY SOILS (ASTM D854)

LABORATORY WORKSHEET

NF Form #11

Client:	Arizona Minerals Inc.	**Field Sample ID:**	Bore Holes	**Test Start Date:**	03/05/17
Project Title:	Hermosa Underground Project	**Laboratory Sample ID:**	17-018	**Tested By:**	KE
Project Number:	475.0014.008	**Location:**	Bore Holes	**Checked By:**	TW
Project Engineer:	Craig Thompson	**Elevation:**	See Below		

Sample Number	17-018-07		17-018-13		17-018-14		17-018-19	
Sample Location	BH-01; 46.5'-49'		BH-02; 26.5'-29'		BH-02; 35'-36.5'		BH-03; 25'-26.5'	
Prep Dish								
Flask No.	6	9	10	15	3	11	13	14
1) Wt. of Flask + Soil	109.13	108.71	103.72	108.31	112.15	110.87	110.30	111.01
2) Wt. of Flask	84.70	84.94	84.61	86.68	86.05	85.13	83.79	85.51
3) Wt. of Soil = 1-2	24.43	23.77	19.11	21.63	26.10	25.74	26.51	25.50
4) Calibrated Wt. of Flask + Water	334.20	334.33	334.04	336.11	335.34	334.56	333.28	334.92
5) (3+4)	358.63	358.10	353.15	357.74	361.44	360.30	359.79	360.42
6) Wt. of Flask + Water +Soil	350.47	350.26	346.95	350.70	353.02	351.86	350.86	351.94
7) Volume of Soil = (5-6)	8.16	7.84	6.20	7.04	8.42	8.44	8.93	8.48
8) Test Temperature, deg.C (Ta)	18.9	18.8	18.5	18.6	19.2	19.3	19.3	19.2
9) Temperature Correction, k	1.00022	1.00024	1.00030	1.00028	1.00016	1.00014	1.00014	1.00016
10) Specific Gravity	2.967	3.001	3.033	3.032	3.080	3.033	2.953	2.988
11) Average Specific Gravity, Gs	2.984		3.033		3.057		2.971	

General Notes:

NewFields

SPECIFIC GRAVITY SOILS (ASTM D854)

LABORATORY WORKSHEET

NF Form #11

Client:	Arizona Minerals Inc.	**Field Sample ID:**	Bore Holes	**Test Start Date:**	03/05/17
Project Title:	Hermosa Underground Project	**Laboratory Sample ID:**	17-018	**Tested By:**	KE
Project Number:	475.0014.008	**Location:**	Bore Holes	**Checked By:**	TW
Project Engineer:	Craig Thompson	**Elevation:**	See Below		

Sample Number	17-018-33		17-018-37		17-018-40		17-018-44	
Sample Location	BH-06; 10'-11.5'		BH-07; 5'-6.5'		BH-07; 21.5'-24.5'		BH-07; 35.9'-36.4'	
Prep Dish								
Flask No.	7	2	4	1	6	2	11	9
1) Wt. of Flask + Soil	116.50	114.16	114.09	119.14	113.46	114.78	115.95	119.34
2) Wt. of Flask	83.31	85.10	85.77	86.22	84.63	85.11	85.09	84.93
3) Wt. of Soil = 1-2	33.19	29.06	28.32	32.92	28.83	29.67	30.86	34.41
4) Calibrated Wt. of Flask + Water	332.84	334.62	335.06	335.60	334.20	334.62	333.28	334.92
5) (3+4)	366.03	363.68	363.38	368.52	363.03	364.29	364.14	369.33
6) Wt. of Flask + Water +Soil	354.66	353.84	354.05	357.56	353.46	354.35	354.02	357.99
7) Volume of Soil = (5-6)	11.37	9.84	9.33	10.96	9.57	9.94	10.12	11.34
8) Test Temperature, deg.C (Ta)	19.0	19.0	19.2	19.2	19.2	19.2	19.2	19.2
9) Temperature Correction, k	1.00020	1.00020	1.00016	1.00016	1.00016	1.00016	1.00016	1.00016
10) Specific Gravity	2.902	2.933	3.018	2.989	2.996	2.969	3.033	3.020
11) Average Specific Gravity, Gs	2.918		3.004		2.982		3.027	

General Notes:

NewFields

SPECIFIC GRAVITY SOILS (ASTM D854)

LABORATORY WORKSHEET

NF Form #11

Client:	Arizona Minerals Inc.	**Field Sample ID:**	Test Pits	**Test Start Date:**	03/10/17
Project Title:	Hermosa Underground Project	**Laboratory Sample ID:**	17-019	**Tested By:**	KE
Project Number:	475.0014.008	**Location:**	Test Pits	**Checked By:**	TW
Project Engineer:	Craig Thompson	**Elevation:**	See Below		

Sample Number	17-019-02		17-019-03		17-019-05		17-019-13	
Sample Location	TP-02; 2'-3'		TP-06; 1'-3'		TP-07; 7-8'		TP-15; 5-6'	
Prep Dish								
Flask No.	4	14	3	1	10	7	3	14
1) Wt. of Flask + Soil	115.12	114.81	115.00	120.69	122.03	116.08	122.05	121.27
2) Wt. of Flask	85.77	85.50	86.05	86.21	84.61	83.29	86.05	85.48
3) Wt. of Soil = 1-2	29.35	29.31	28.95	34.48	37.42	32.79	36.00	35.79
4) Calibrated Wt. of Flask + Water	335.06	334.92	335.34	335.60	334.04	332.84	335.34	334.92
5) (3+4)	364.41	364.23	364.29	370.08	371.46	365.63	371.34	370.71
6) Wt. of Flask + Water +Soil	354.11	354.00	354.08	357.72	358.07	353.91	358.53	358.05
7) Volume of Soil = (5-6)	10.30	10.23	10.21	12.36	13.39	11.72	12.81	12.66
8) Test Temperature, deg.C (Ta)	18.7	18.6	18.9	18.8	19.1	19.2	19.2	19.0
9) Temperature Correction, k	1.00026	1.00028	1.00022	1.00024	1.00018	1.00016	1.00016	1.00020
10) Specific Gravity	2.826	2.839	2.815	2.772	2.782	2.785	2.799	2.812
11) Average Specific Gravity, Gs	2.832		2.793		2.784		2.805	

General Notes:

NewFields

SPECIFIC GRAVITY SOILS (ASTM D854)

LABORATORY WORKSHEET

NF Form #11

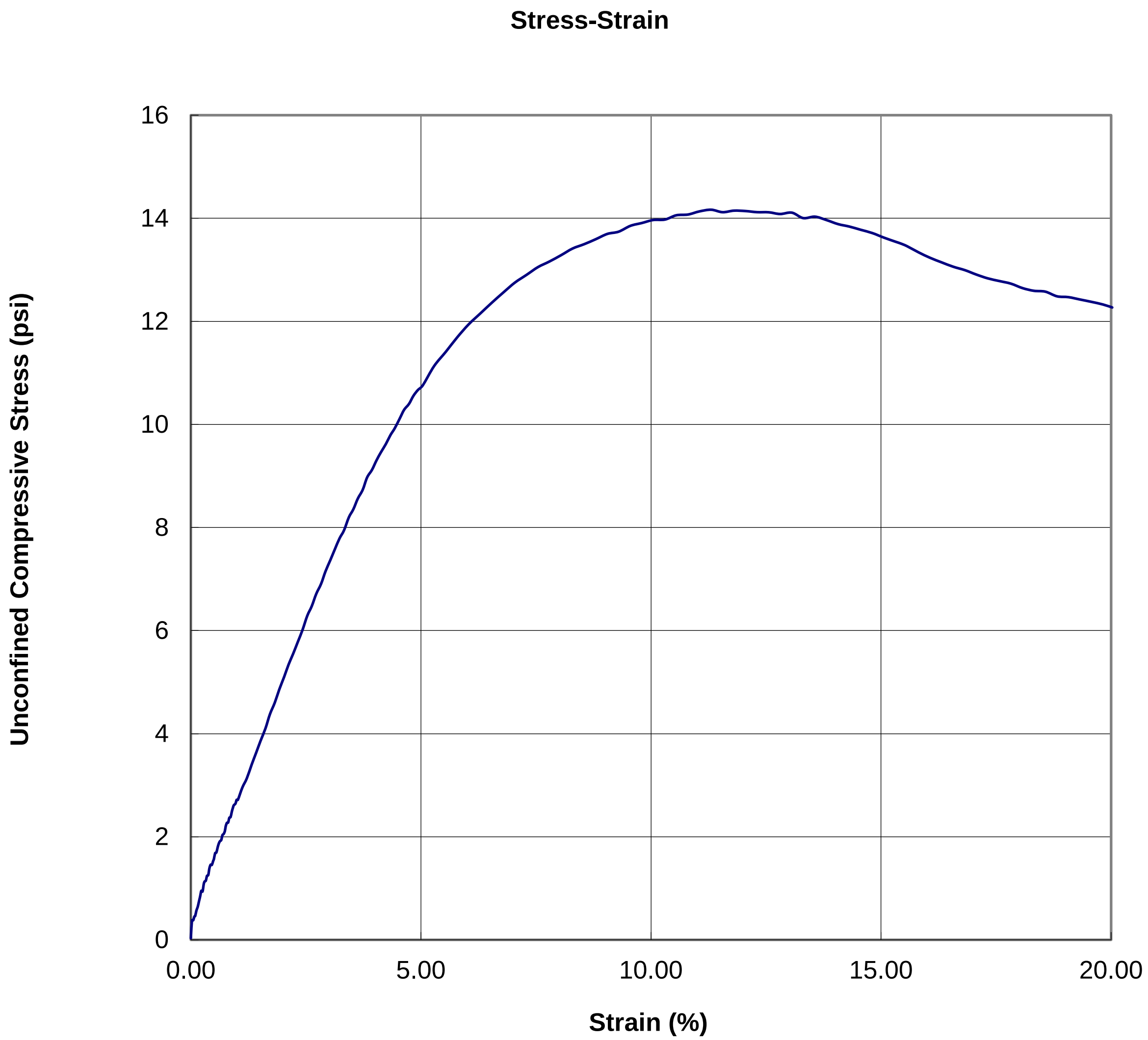
Client:	Arizona Minerals Inc.	**Field Sample ID:**	Test Pits	**Test Start Date:**	03/05/17
Project Title:	Hermosa Underground Project	**Laboratory Sample ID:**	17-019	**Tested By:**	KE
Project Number:	475.0014.008	**Location:**	Test Pits	**Checked By:**	TW
Project Engineer:	Craig Thompson	**Elevation:**	See Below		

Sample Number	17-019-14		17-019-28					
Sample Location	TP-17; 5'-6'		TP-51; 5'-6'					
Prep Dish								
Flask No.	4	1	15	13				
1) Wt. of Flask + Soil	122.40	127.85	122.99	118.93				
2) Wt. of Flask	85.79	86.22	86.69	83.82				
3) Wt. of Soil = 1-2	36.61	41.63	36.30	35.11				
4) Calibrated Wt. of Flask + Water	335.06	335.60	336.11	333.28				
5) (3+4)	371.67	377.23	372.41	368.39				
6) Wt. of Flask + Water +Soil	358.71	362.42	359.09	355.35				
7) Volume of Soil = (5-6)	12.96	14.81	13.32	13.04				
8) Test Temperature, deg.C (Ta)	18.9	19.0	19.1	19.0				
9) Temperature Correction, k	1.00022	1.00020	1.00018	1.00020				
10) Specific Gravity	2.809	2.798	2.713	2.679				
11) Average Specific Gravity, Gs	2.804		2.696					

General Notes:

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

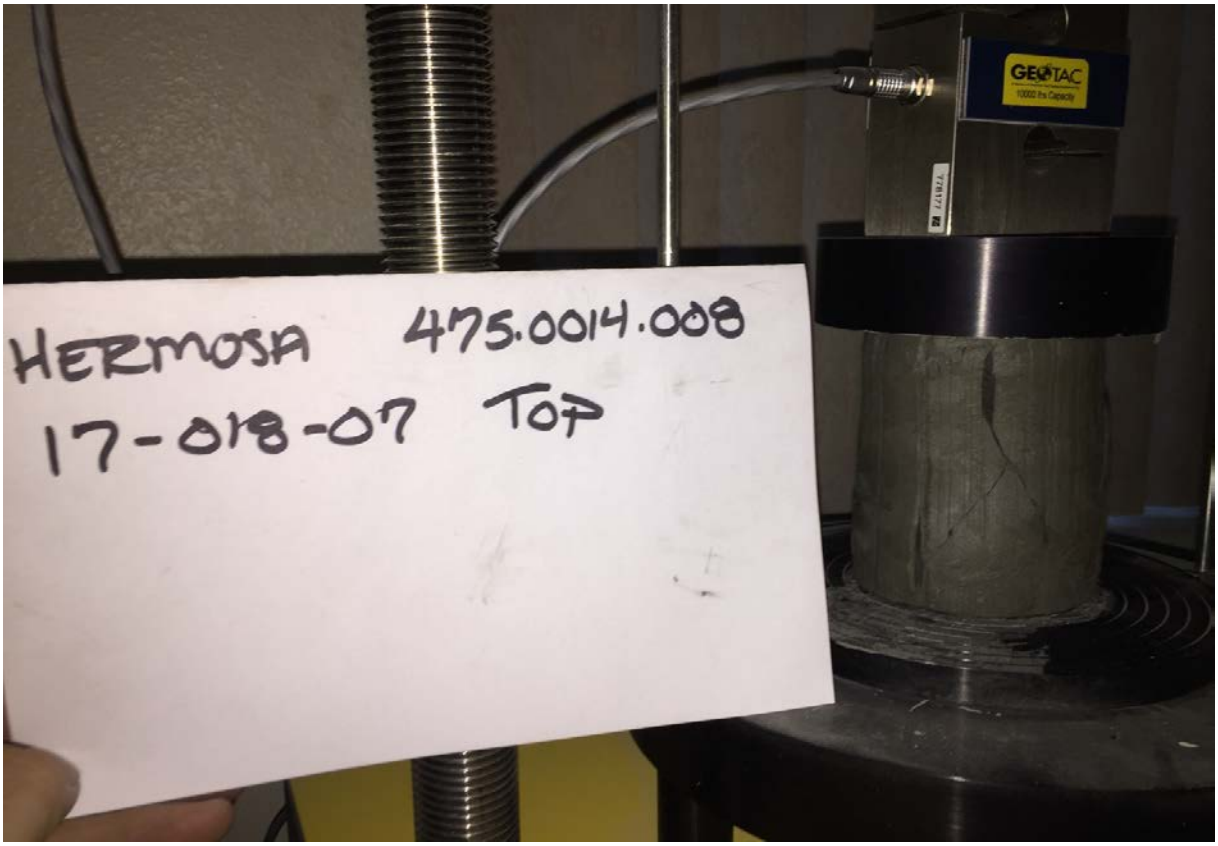
(ASTM D2166-06)



	Strain (%)	Stress (psi)
Peak Point	**11.3**	**14.2**

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	5:08:49 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 TOP	Depth (ft):	46.5
Diameter (inch):	2.845	Height (inch):	4.95
H/D Ratio:	1.7	Note: H/D Ratio Out of Spec	

Water Content in % Dry Wt.		
at 105^{o} C (215^{o} F)	32.6	%
Unit Weight Wet	126.4	PCF
Unit Weight Dry	95.3	PCF



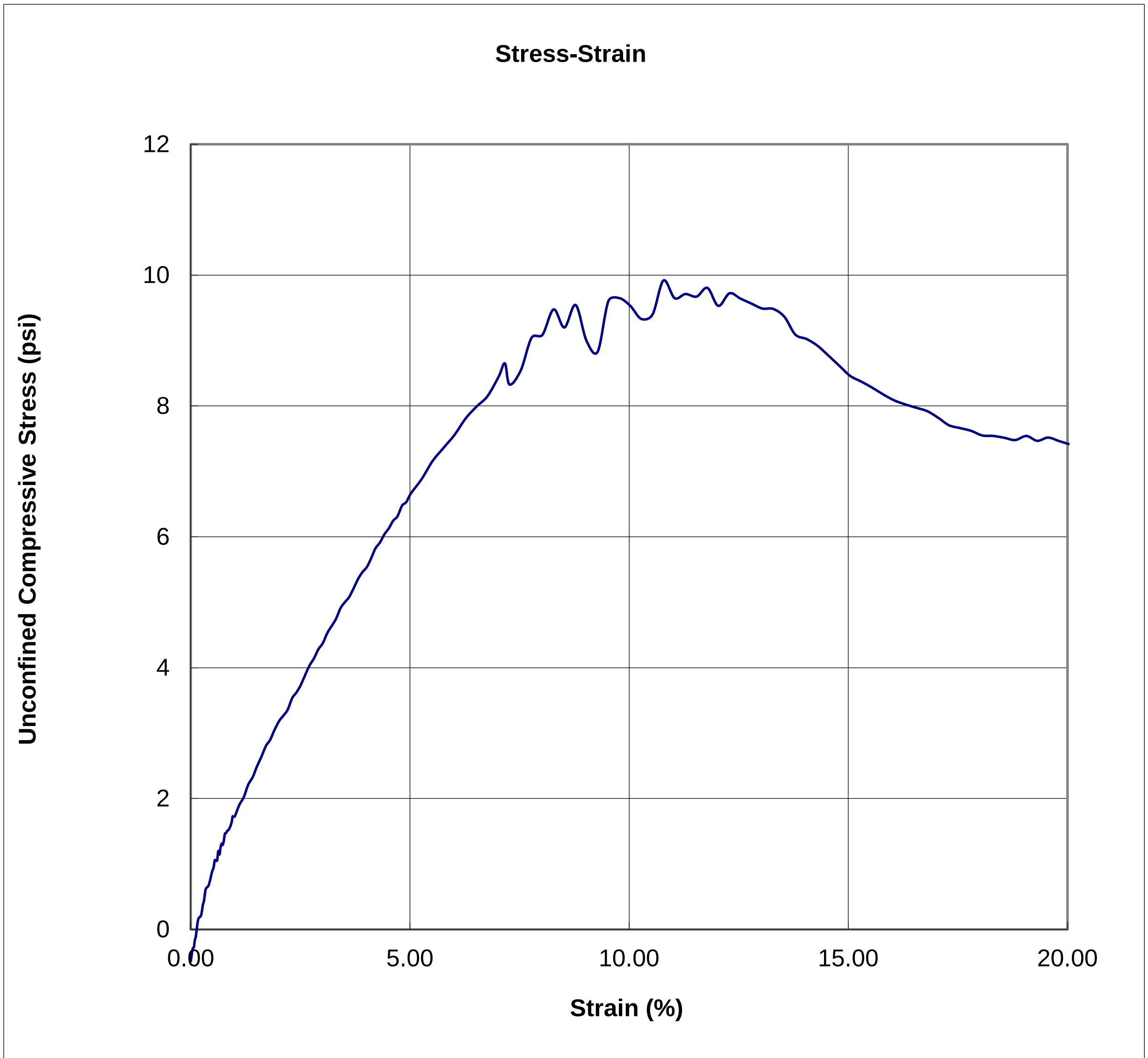
Post Failure Photo

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	5:08:49 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 TOP	Depth (ft):	46.5
Diameter (inch):	2.845	Height (inch):	4.946

Water Content in % Dry Wt.	
at 105° C (215° F)	32.6 %
Unit Weight Wet	126.4 PCF
Unit Weight Dry	95.3 PCF

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

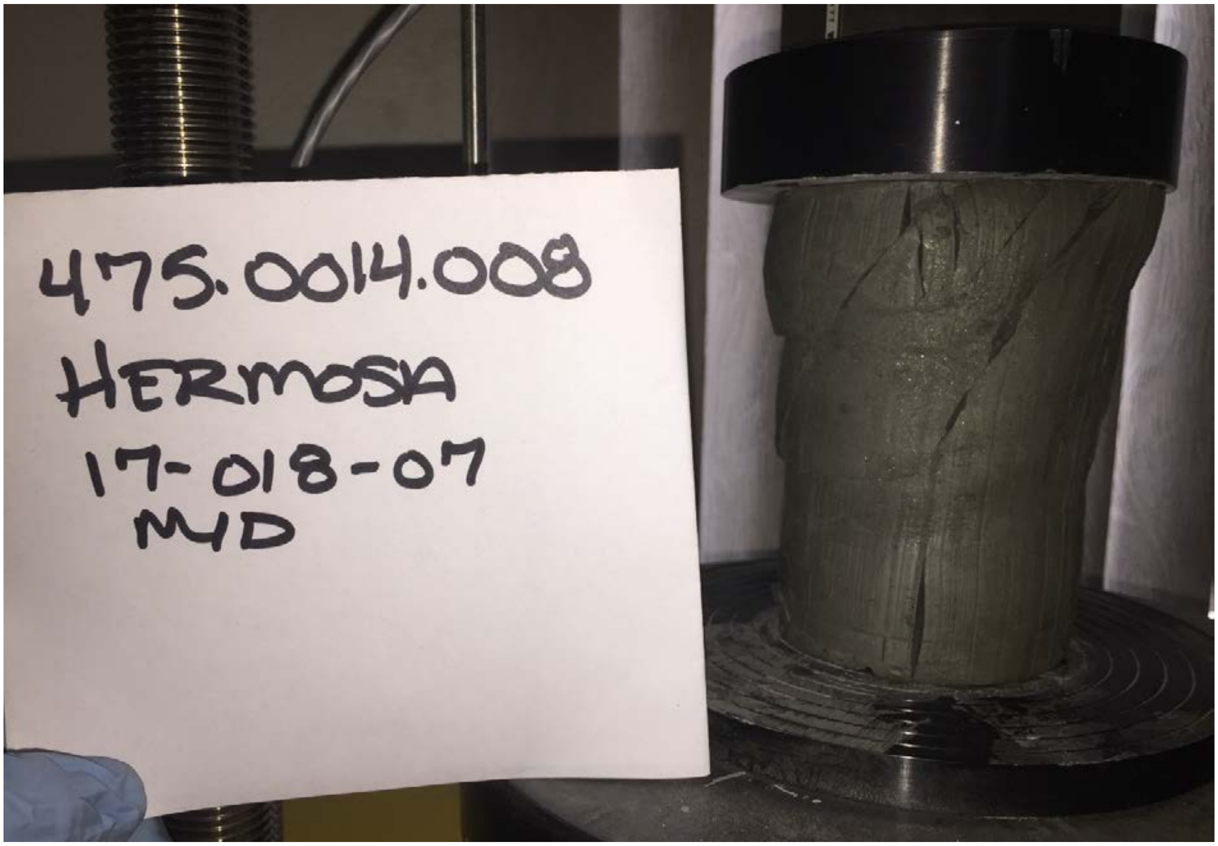
(ASTM D2166-06)



	Strain (%)	Stress (psi)
Peak Point	**10.8**	**9.9**

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/4/2017	Time:	12:46:38 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 MID	Depth (ft):	46.5
Diameter (inch):	2.864	Height (inch):	6.47
H/D Ratio:	2.3		

Water Content in % Dry Wt.		
at 105° C (215° F)	31.0	%
Unit Weight Wet	128.7	PCF
Unit Weight Dry	98.3	PCF



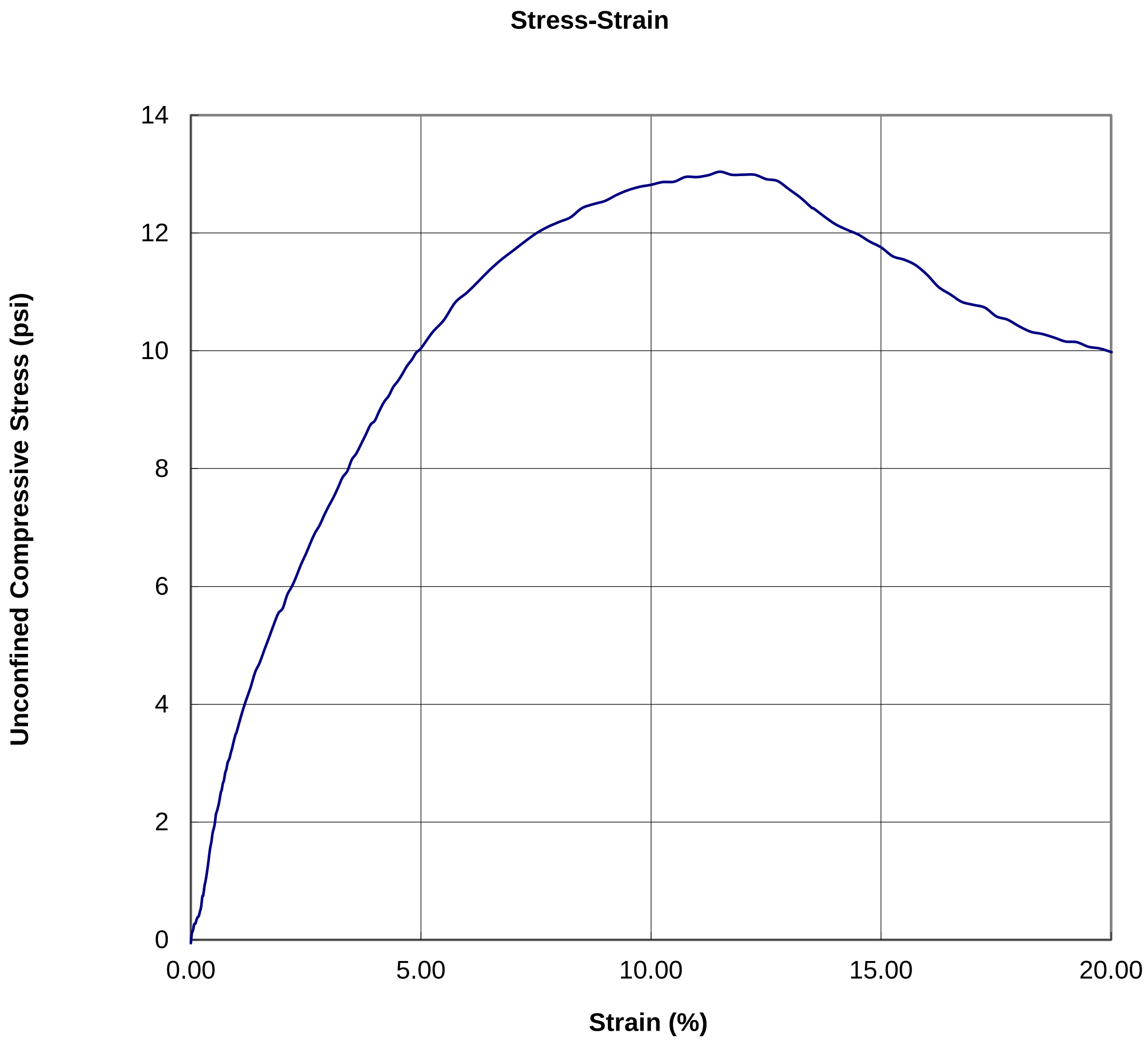
Post Failure Photo

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/4/2017	Time:	12:46:38 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 MID	Depth (ft):	46.5
Diameter (inch):	2.864	Height (inch):	6.465

Water Content in % Dry Wt.		
at 105° C (215° F)	31.0	%
Unit Weight Wet	128.7	PCF
Unit Weight Dry	98.3	PCF

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

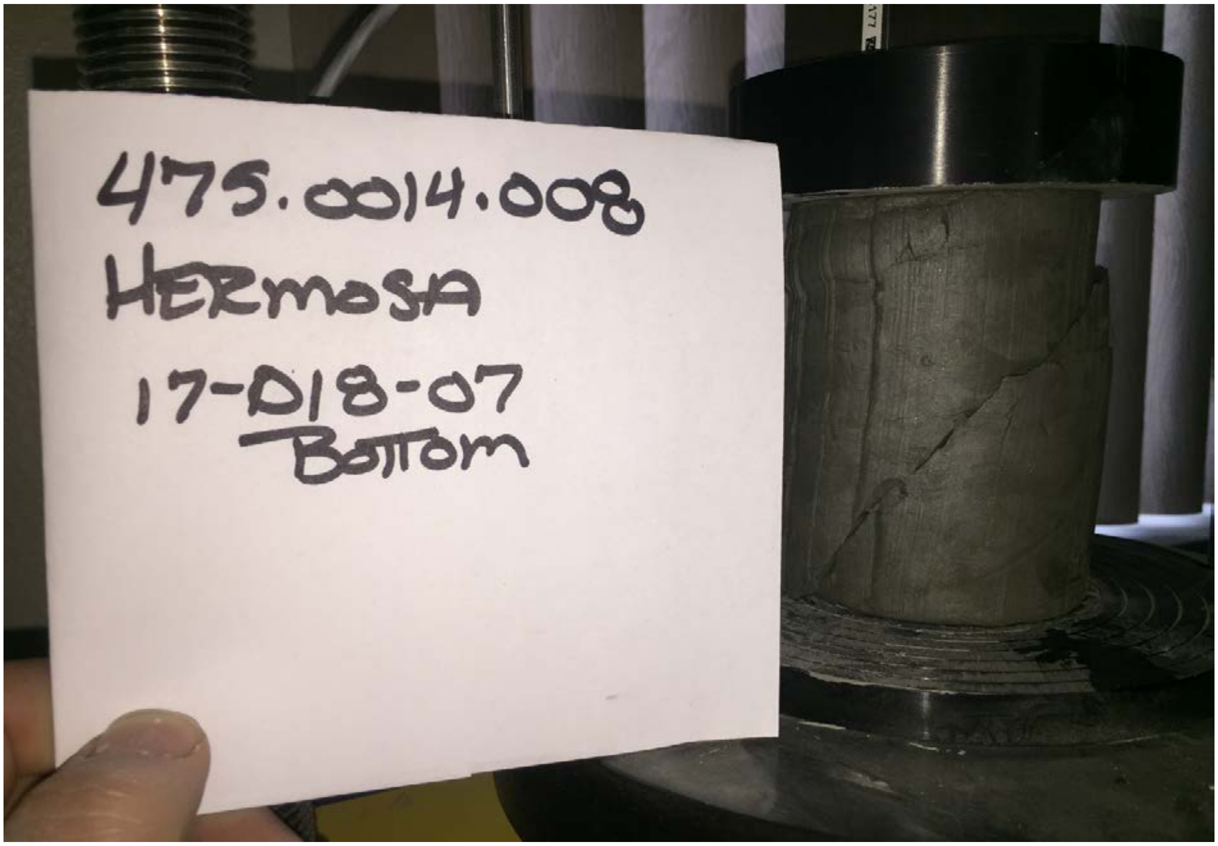
(ASTM D2166-06)



	Strain (%)	Stress (psi)
Peak Point	**11.5**	**13.0**

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/4/2017	Time:	1:25:41 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 BOT	Depth (ft):	46.5
Diameter (inch):	2.866	Height (inch):	5.62
H/D Ratio:	2.0		

Water Content in % Dry Wt.		
at 105° C (215° F)	32.5	%
Unit Weight Wet	126.1	PCF
Unit Weight Dry	95.2	PCF



Post Failure Photo

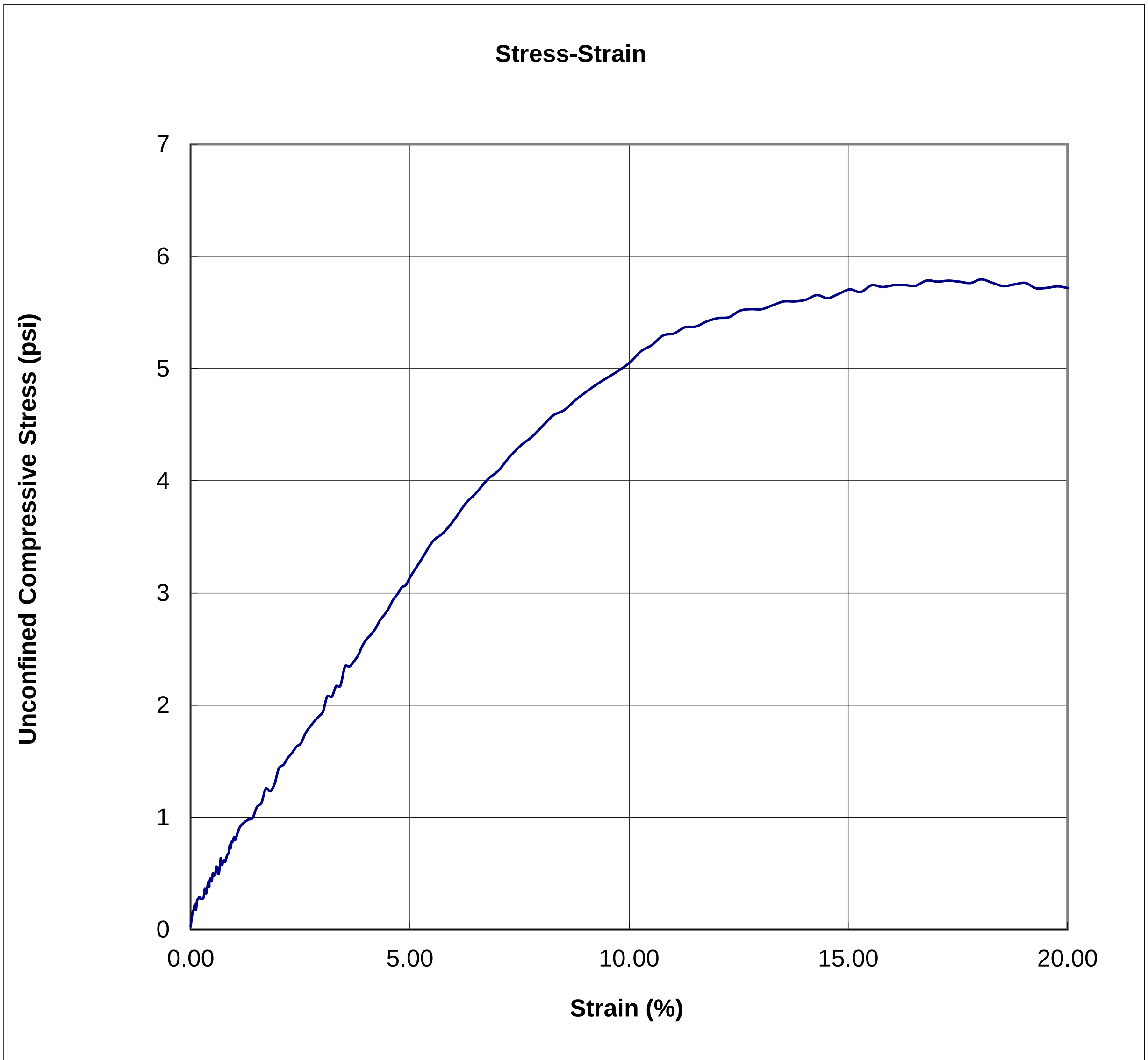
Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/4/2017	Time:	1:25:41 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 BOT	Depth (ft):	46.5
Diameter (inch):	2.866	Height (inch):	5.618

Water Content in % Dry Wt.		
at 105° C (215° F)	32.5	%
Unit Weight Wet	126.1	PCF
Unit Weight Dry	95.2	PCF

NewFields

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

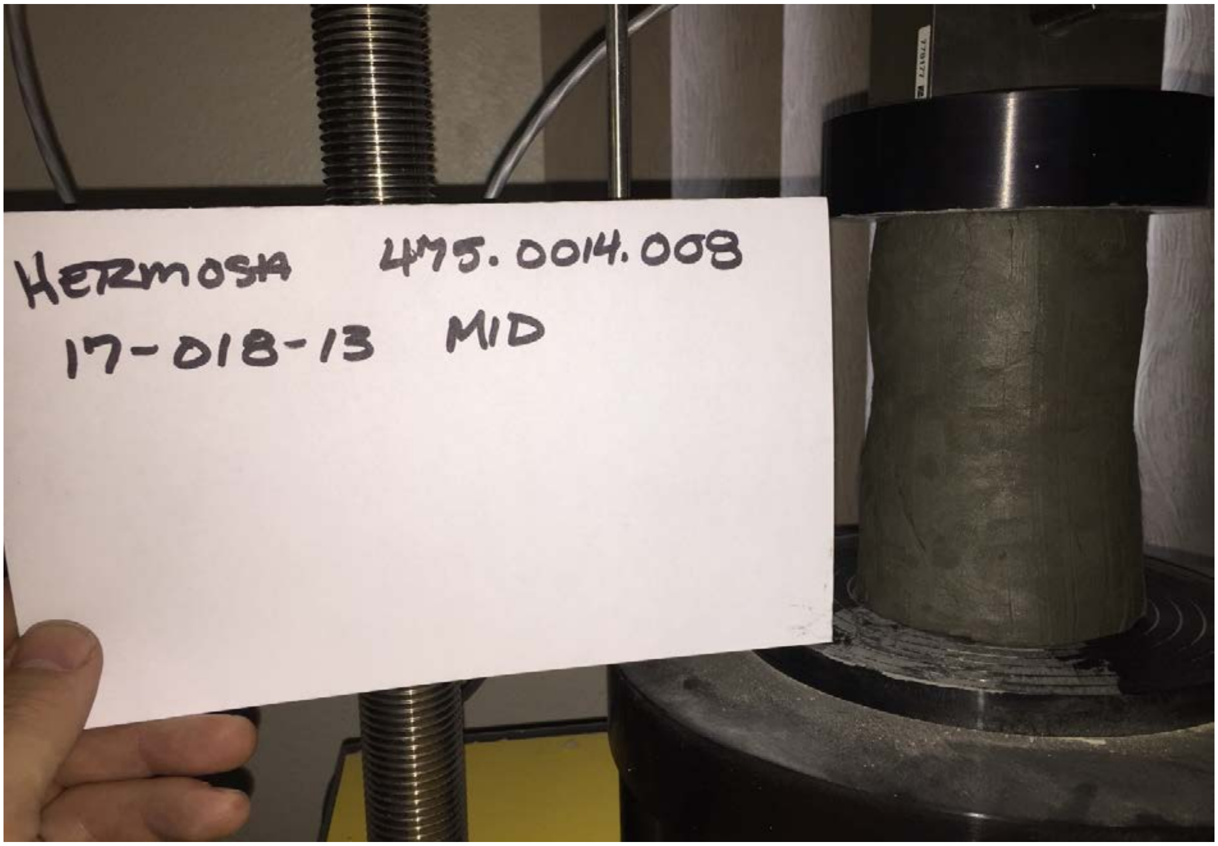
(ASTM D2166-06)



	Strain (%)	Stress (psi)
Peak Point	**18.0**	**5.8**

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	3:37:14 PM
Boring:	BH-02	Sample:	SH-05
Specimen:	17-018-13 MID	Depth (ft):	26.5
Diameter (inch):	2.868	Height (inch):	6.59
H/D Ratio:	2.3		

Water Content in % Dry Wt.		
at 105° C (215° F)	41.7	%
Unit Weight Wet	118.4	PCF
Unit Weight Dry	83.6	PCF



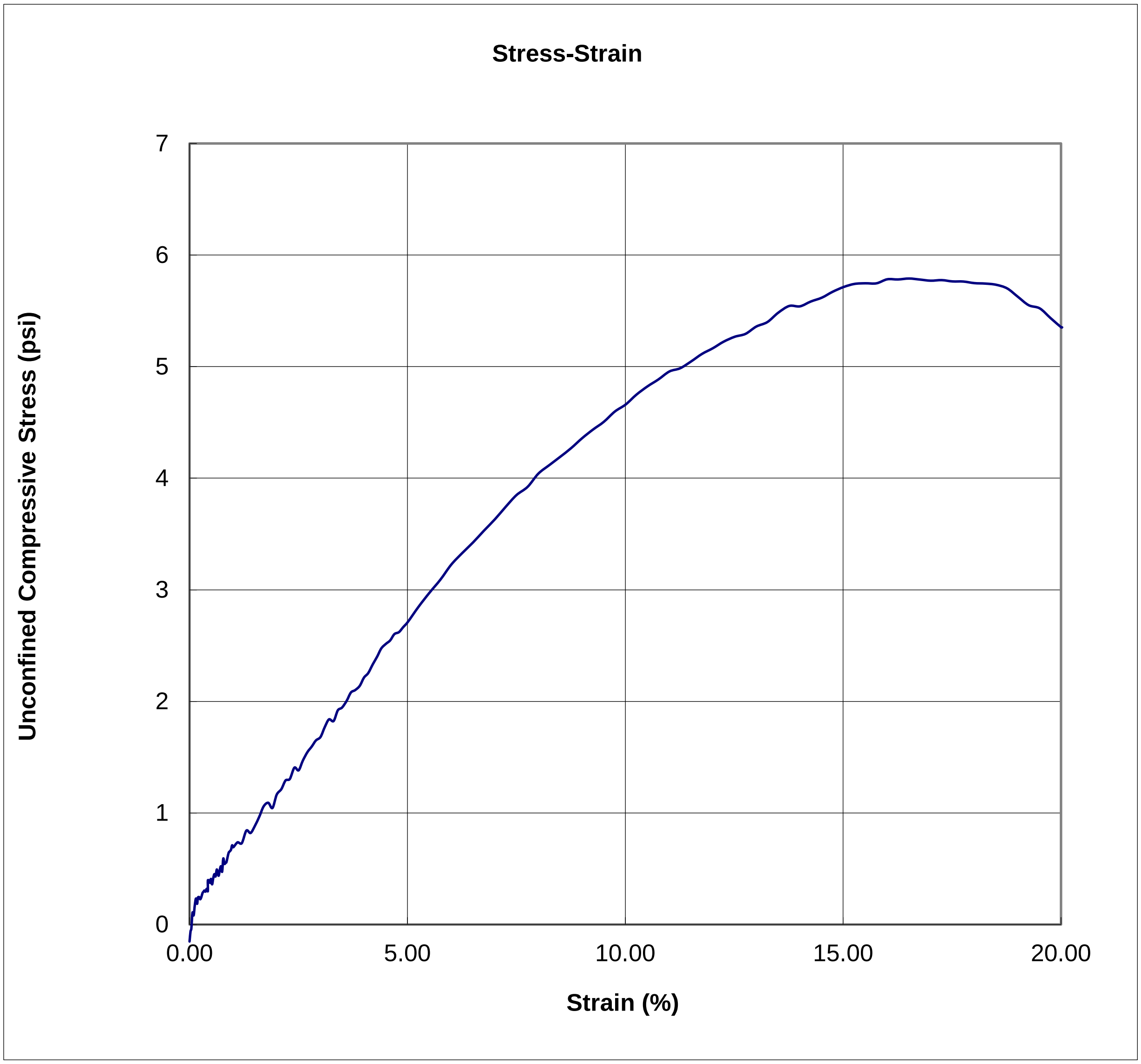
Post Failure Photo

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	3:37:14 PM
Boring:	BH-02	Sample:	SH-05
Specimen:	17-018-13 MID	Depth (ft):	26.5
Diameter (inch):	2.868	Height (inch):	6.592

Water Content in % Dry Wt.		
at 105° C (215° F)	41.7	%
Unit Weight Wet	118.4	PCF
Unit Weight Dry	83.6	PCF

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

(ASTM D2166-06)

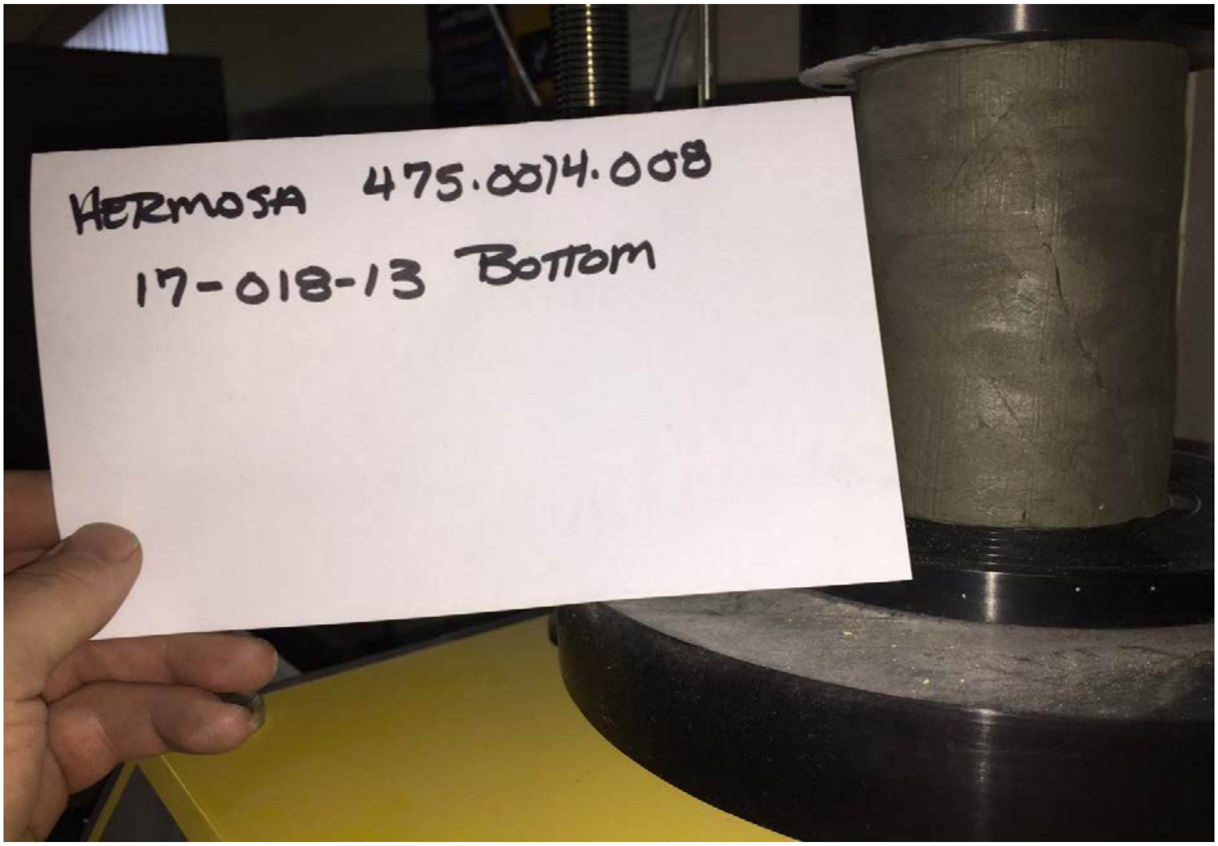


	Strain (%)	Stress (psi)
Peak Point	**16.5**	**5.8**

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	4:17:47 PM
Boring:	BH-02	Sample:	SH-05
Specimen:	17-018-13 BOT	Depth (ft):	10.0
Diameter (inch):	2.835	Height (inch):	6.06
H/D Ratio:	2.1		

Water Content in % Dry Wt.		
at 105° C (215° F)	40.0	%
Unit Weight Wet	121.7	PCF
Unit Weight Dry	87.0	PCF

NewFields

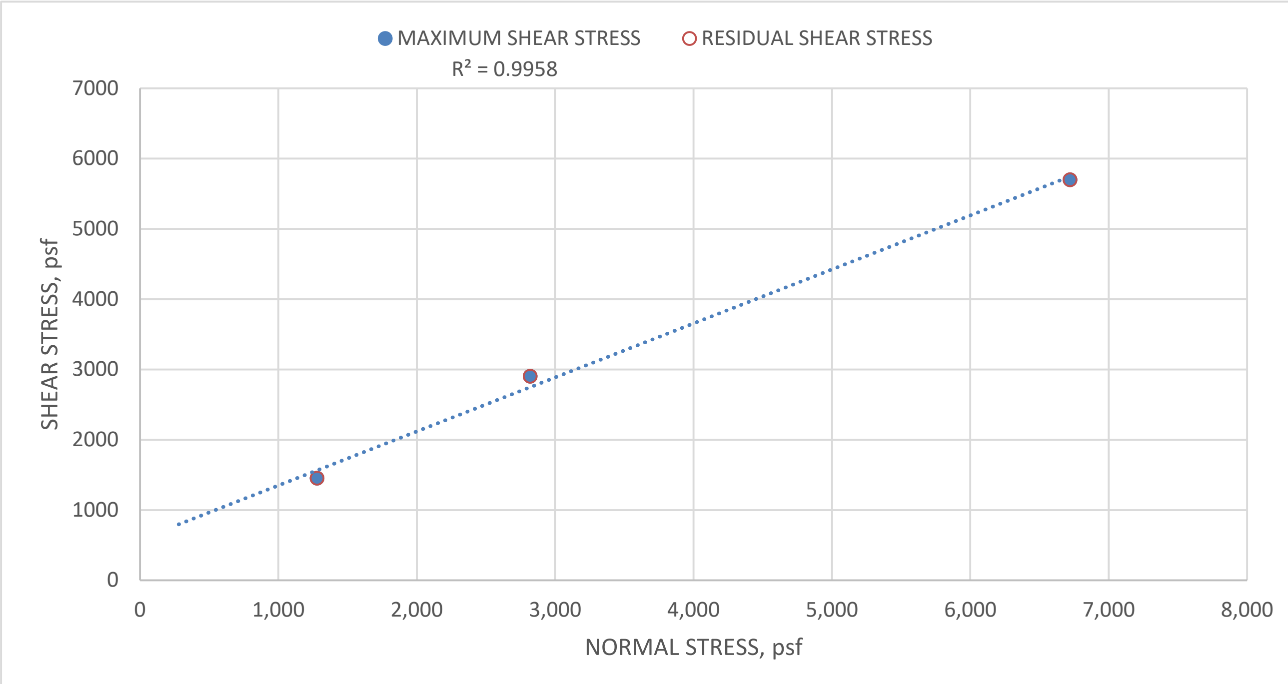


Post Failure Photo

Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	4:17:47 PM
Boring:	BH-02	Sample:	SH-05
Specimen:	17-018-13 BOT	Depth (ft):	10.0
Diameter (inch):	2.835	Height (inch):	6.062

Water Content in % Dry Wt.	
at 105° C (215° F)	40.0 %
Unit Weight Wet	121.7 PCF
Unit Weight Dry	87.0 PCF

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080/3080M-11



	FRICTION ANGLE		COHESION		SHEAR 1	SHEAR 2	SHEAR 3
AT MAXIMUM SHEAR STRESS	31.8	deg	0	psf	NORMAL STRESS, psf	NORMAL STRESS, psf	NORMAL STRESS, psf
AT RESIDUAL SHEAR STRESS[3]	31.8	deg	0	psf	1280	2820	6720

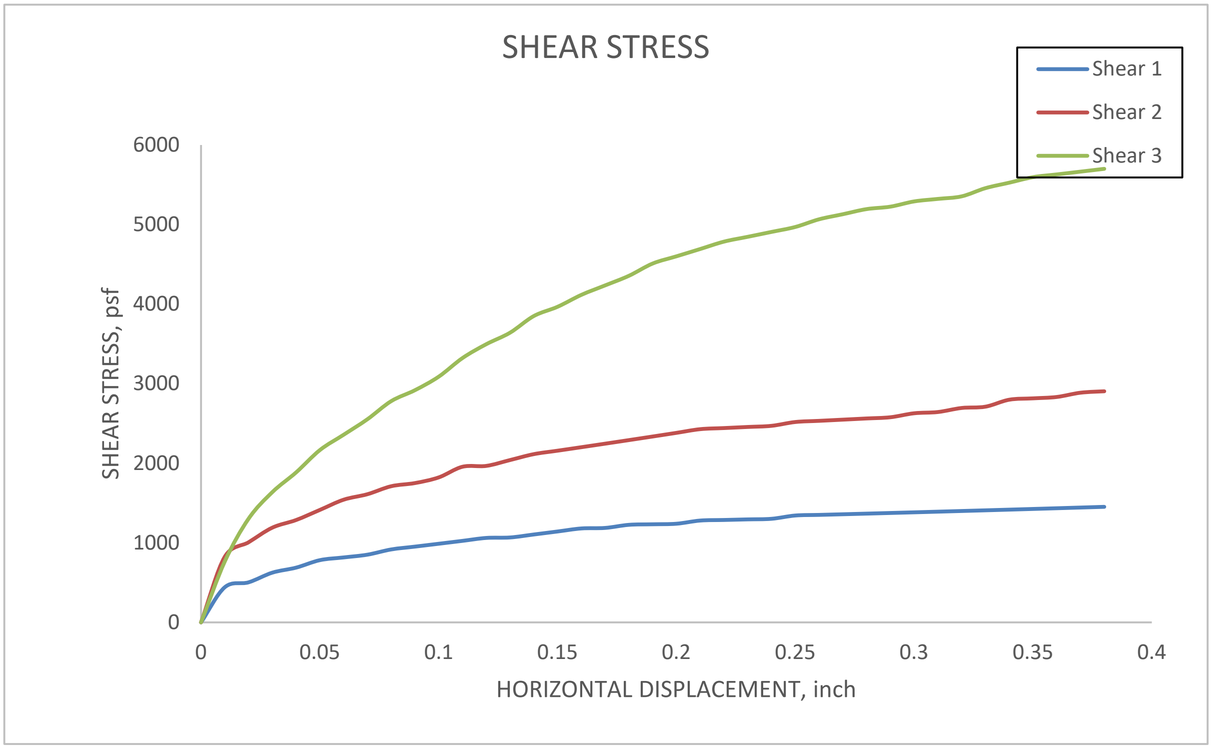
INITIAL AREA, sq.in.	4.91
SG ASSUMED	2.65
SG TESTED[1]	N/R
LIQUID LIMIT	NP
PLASTIC LIMIT	NP
PLASTICITY INDEX	NP
SAMPLE TYPE	Bulk

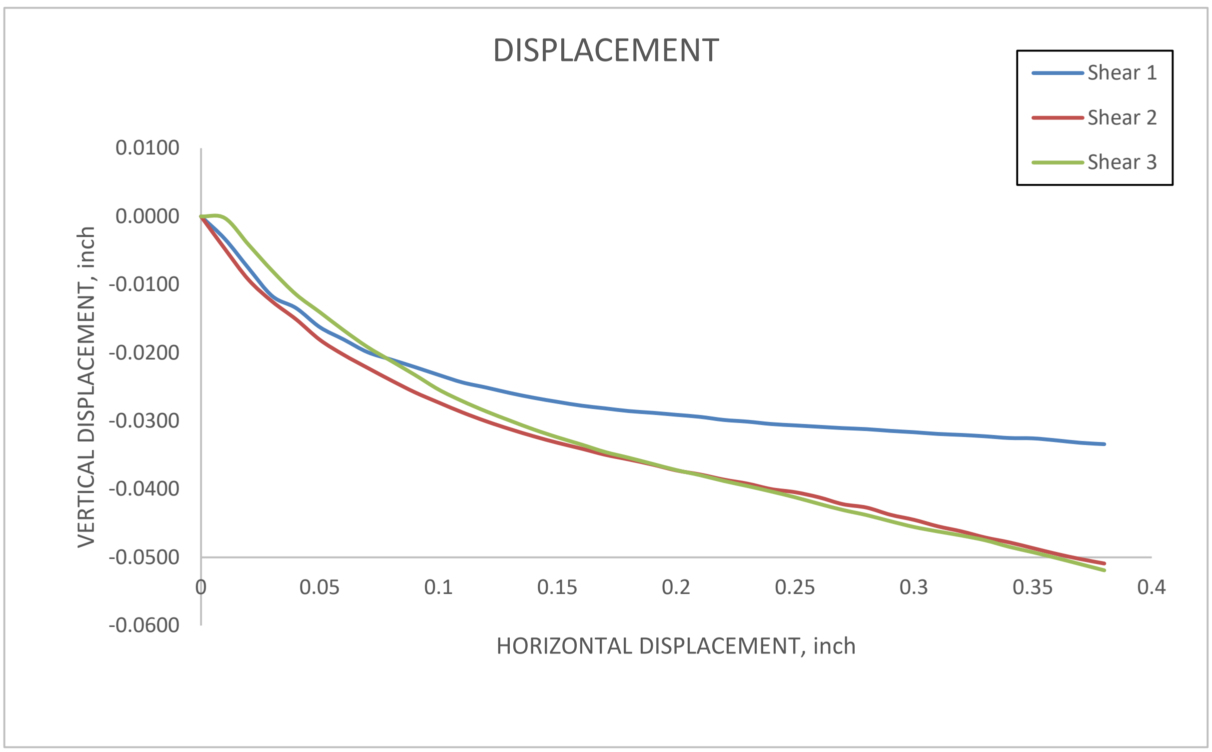
	SHEAR 1	SHEAR 2	SHEAR 3
REMOLDED MOISTURE, %	7%	7%	7%
REMOLDED DRY DENSITY, pcf	93.5	98.3	99.1
REMOLDED SATURATION, %	27%	30%	31%
REMOLDED VOID RATIO[2]	0.659	0.577	0.566
FINAL MOISTURE, %	28%	28%	27%
FINAL SATURATION, %	100%	100%	100%
FINAL VOIL RATIO	0.618	0.514	0.501
MAXIMUM SHEAR STRESS, psf	1452	2905	5701
RESIDUALSHEAR STRESS[3],psf	1452	2905	5701
RATE OF LOADING, in/min	0.02	0.02	0.02

DESCRIPTION: Sand(SP) silty/clayey trace gravel, light grey[4,5]

Note:
[1]N/R = Not reported
[2]Remolded sample inundated and consolidated at 100psf
[3]Residual shear stress obtained at 15% horizontal strain
[4] Direct shear testing performed on material passing #4 sieve only
[5] Visual Classification only. ASTM 2488

PROJECT NAME: Hermosa Underground Project
LOCATION: N/R
JOB NO.: 475.0014.008
DATE: 2/20/2017
BORING NO.: TP-33
SAMPLE NO.: 17-019-23
DEPTH, feet: 1'-20.5'

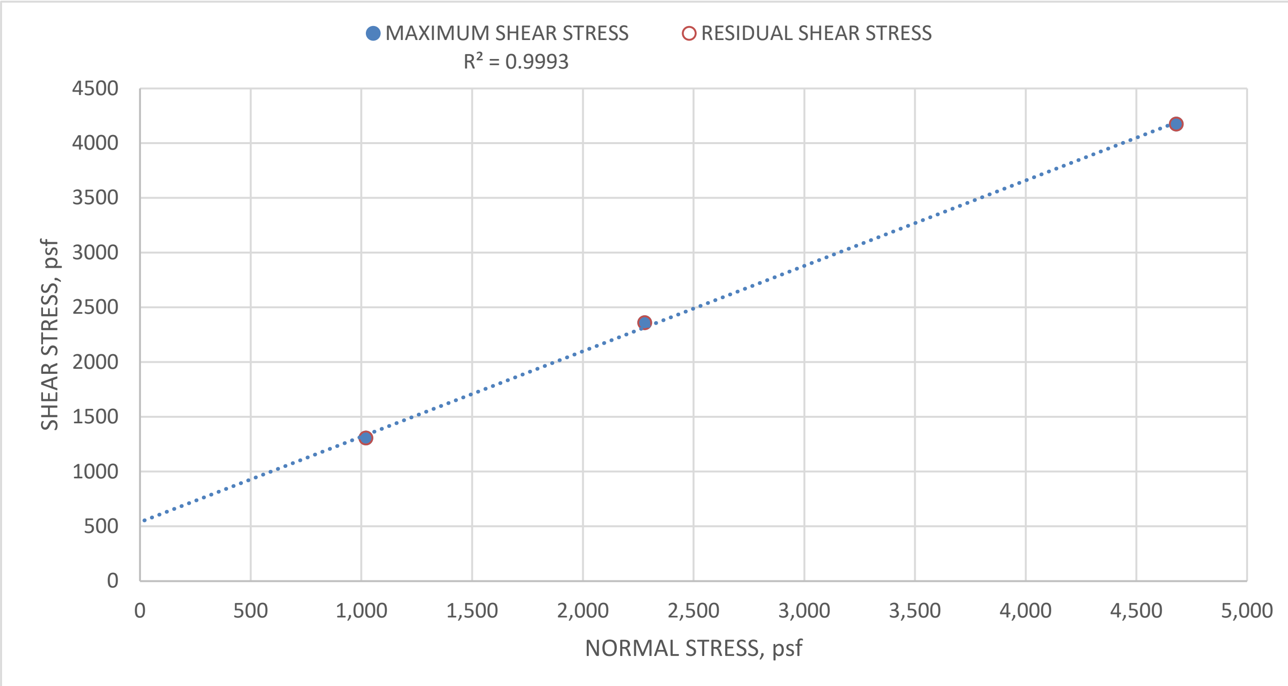




PROJECT NAME:	Hermosa Underground Project	BORING NO.:	TP-33
LOCATION:	N/R	SAMPLE NO.:	17-019-23
JOB NO.:	475.0014.008	DEPTH, feet:	1'-20.5'
DATE:	2/20/2017		

NewFields

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080/3080M-11



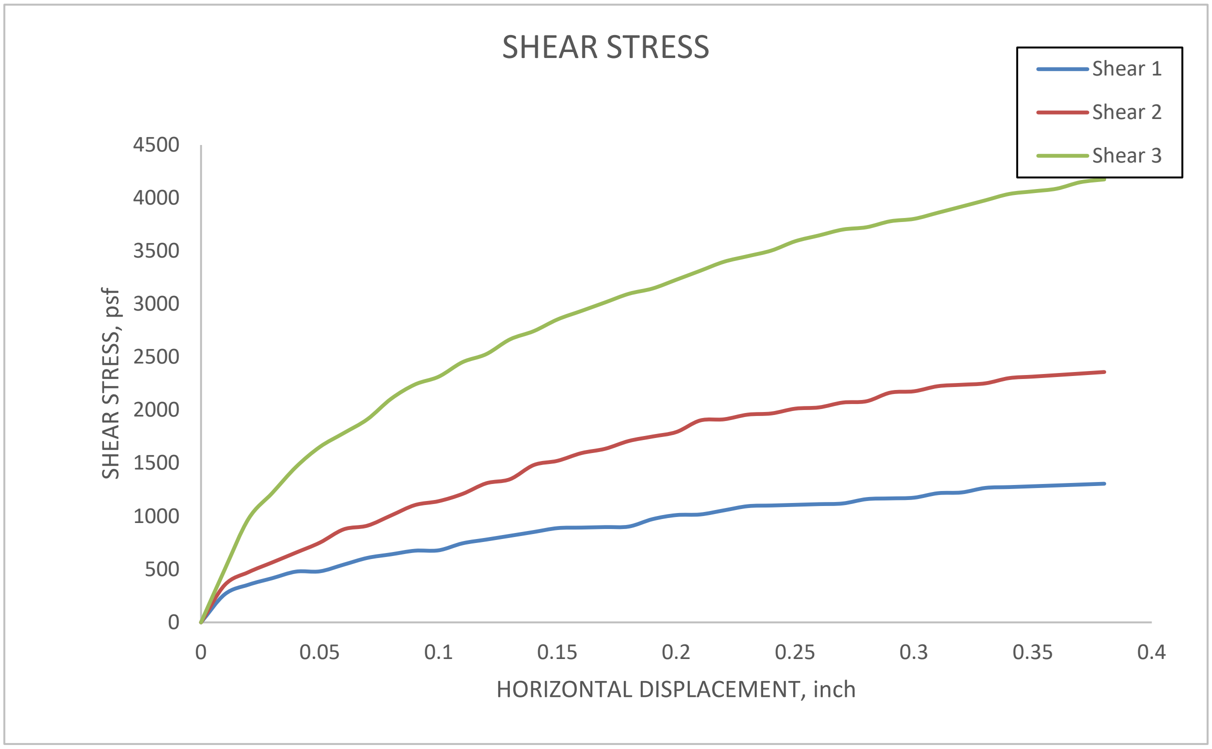
	FRICTION ANGLE		COHESION		SHEAR 1	SHEAR 2	SHEAR 3
AT MAXIMUM SHEAR STRESS	32.2	deg	0	psf	NORMAL STRESS, psf	NORMAL STRESS, psf	NORMAL STRESS, psf
AT RESIDUAL SHEAR STRESS[3]	32.2	deg	0	psf	1020	2280	4680

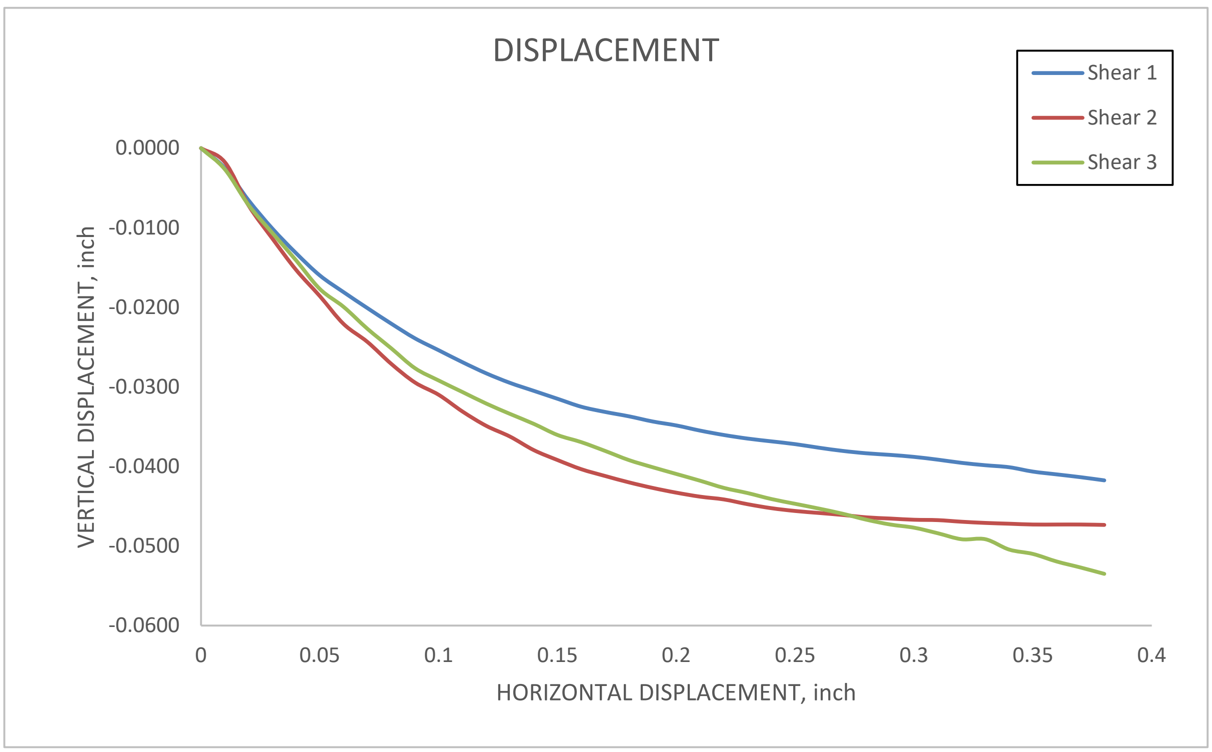
			SHEAR 1	SHEAR 2	SHEAR 3
INITIAL AREA, sq.in.	4.91	REMOLDED MOISTURE, %	8%	8%	8%
SG ASSUMED	2.65	REMOLDED DRY DENSITY, pcf	94.3	95.4	97.9
SG TESTED[1]	N/R	REMOLDED SATURATION, %	36%	37%	40%
LIQUID LIMIT	N/R	REMOLDED VOID RATIO[2]	0.618	0.599	0.558
PLASTIC LIMIT	N/R	FINAL MOISTURE, %	25%	25%	20%
PLASTICITY INDEX	N/R	FINAL SATURATION, %	100%	100%	100%
SAMPLE TYPE	Bulk	FINAL VOIL RATIO	0.563	0.541	0.491
		MAXIMUM SHEAR STRESS, psf	1307	2360	4176
		RESIDUALSHEAR STRESS[3],psf	1307	2360	4176
		RATE OF LOADING, in/min	0.02	0.02	0.02

DESCRIPTION: Silt (ML) sandy with gravel, dark brown[4,5]

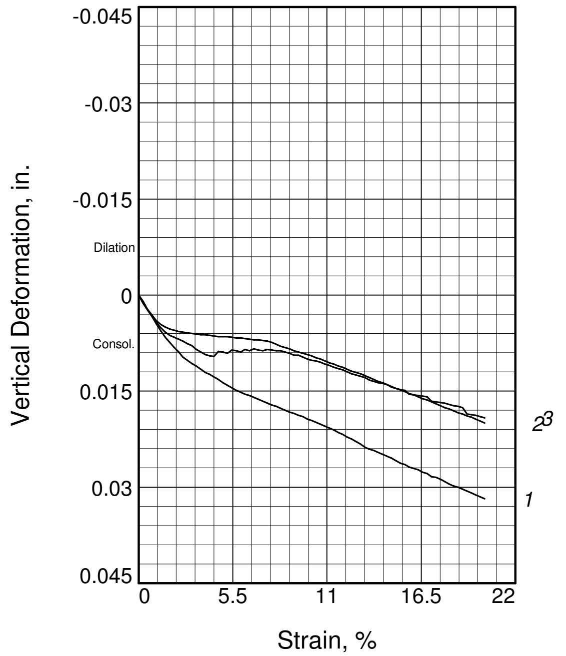
Note:
[1]N/R = Not reported
[2]Remolded sample inundated and consolidated at 100psf
[3]Residual shear stress obtained at 15% horizontal strain
[4] Direct shear testing performed on material passing #4 sieve only
[5] Visual Classification only. ASTM 2488

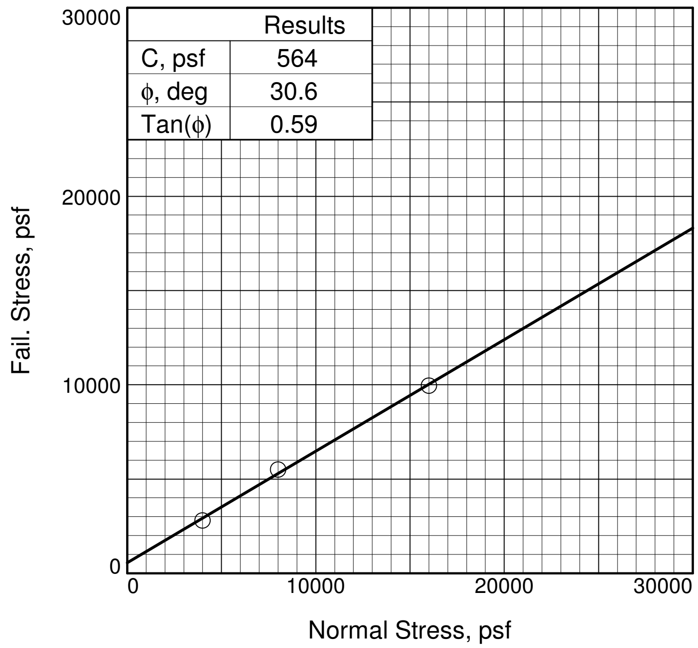
PROJECT NAME:	Hermosa Underground Project	BORING NO.:	TP-38
LOCATION:	N/R	SAMPLE NO.:	17-019-24
JOB NO.:	475.0014.008	DEPTH, feet:	0-7'
DATE:	2/21/2017		

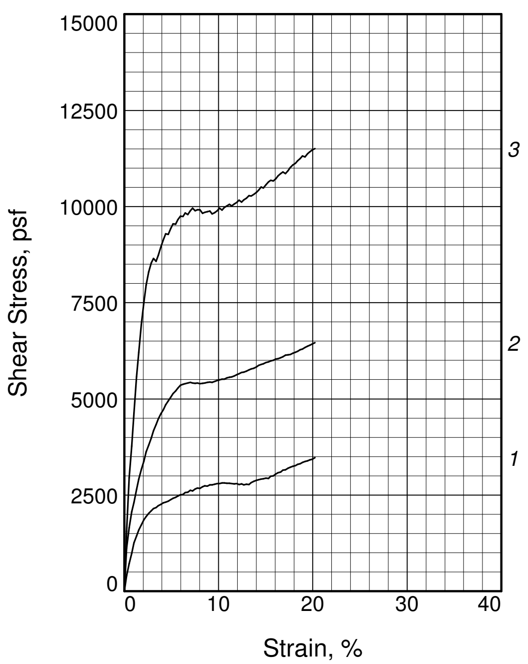




PROJECT NAME:	Hermosa Underground Project	BORING NO.:	TP-38
LOCATION:	N/R	SAMPLE NO.:	17-019-24
JOB NO.:	475.0014.008	DEPTH, feet:	0-7'
DATE:	2/21/2017		







Specimen No.		1	2	3
Initial	Water Content, %	18.5	18.5	18.5
	Dry Density, pcf	109.3	109.3	109.8
	Saturation, %	92.3	92.4	93.5
	Void Ratio	0.5424	0.5418	0.5354
	Diameter, in.	1.93	1.93	1.93
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	17.1	16.8	14.6
	Dry Density, pcf	115.3	115.9	120.8
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4624	0.4542	0.3949
	Diameter, in.	1.93	1.93	1.93
	Height, in.	0.95	0.94	0.91
Normal Stress, psf		4000	8000	16000
Fail. Stress, psf		2794	5498	9958
Strain, %		10.1	10.1	10.1
Ult. Stress, psf				
Strain, %				
Strain rate, %/min.		0.05	0.05	0.05

Sample Type: Remolded 92%MDD @ OMC+2%.

Description: sandy silt

Assumed Specific Gravity= 2.7

Remarks: Failure chosen at 10% strain. Test was inundated. Area correction applied per client.

Figure ________

Client: NewFields

Project: Hermosa Underground
475.0014.008

Location: TP-24

Depth: 4-7'

Proj. No.: DV108-00305/06 **Date Sampled:** 3/29/17

Knight Piésold
CONSULTING

Tested By: EAG **Checked By:** JDB

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.

DIRECT SHEAR TEST

Date: 3/29/17
Client: NewFields
Project: Hermosa Underground
475.0014.008
Project No.: DV108-00305/06
Location: TP-24
Depth: 4-7'
Description: sandy silt
Remarks: Failure chosen at 10% strain. Test was inundated. Area correction applied per client.
Type of Sample: Remolded 92%MDD @ OMC+2%.
Assumed Specific Gravity=2.7 **LL=** **PL=** **PI=**

Parameters for Specimen No. 1

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	512.900		215.930
Moisture content: Dry soil+tare, gms.	461.860		201.610
Moisture content: Tare, gms.	186.700		117.980
Moisture, %	18.5	17.1	17.1
Moist specimen weight, gms.	99.5		
Diameter, in.	1.93	1.93	
Area, in.^{2}	2.93	2.93	
Height, in.	1.00	0.95	
Net decrease in height, in.		0.05	
Wet density, pcf	129.6	135.0	
Dry density, pcf	109.3	115.3	
Void ratio	0.5424	0.4624	
Saturation, %	92.3	100.0	

Test Readings for Specimen No. 1

Load ring constant = 49.2 lbs. per input unit
Normal stress = 4000 psf
Strain rate, %/min. = 0.05
Strength calculations use strain adjusted areas
Fail. Stress = 2794 psf **at reading no.** 39

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	-0.0001
1	0.0050	0.1646	8.1	0.3	400	-0.0011
2	0.0100	0.2926	14.4	0.5	713	-0.0023
3	0.0150	0.4023	19.8	0.8	984	-0.0034
4	0.0200	0.5140	25.3	1.0	1261	-0.0046
5	0.0250	0.5810	28.6	1.3	1431	-0.0057
6	0.0300	0.6440	31.7	1.6	1591	-0.0067
7	0.0350	0.6968	34.3	1.8	1727	-0.0075
8	0.0400	0.7456	36.7	2.1	1855	-0.0083
9	0.0450	0.7781	38.3	2.3	1942	-0.0090
10	0.0500	0.8066	39.7	2.6	2020	-0.0098
11	0.0550	0.8309	40.9	2.8	2088	-0.0103

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
12	0.0600	0.8512	41.9	3.1	2146	-0.0108
13	0.0650	0.8594	42.3	3.4	2174	-0.0112
14	0.0700	0.8756	43.1	3.6	2223	-0.0117
15	0.0750	0.8858	43.6	3.9	2257	-0.0122
16	0.0800	0.9000	44.3	4.1	2301	-0.0125
17	0.0850	0.9041	44.5	4.4	2319	-0.0129
18	0.0900	0.9081	44.7	4.7	2338	-0.0133
19	0.0950	0.9224	45.4	4.9	2383	-0.0138
20	0.1000	0.9305	45.8	5.2	2412	-0.0142
21	0.1050	0.9366	46.1	5.4	2437	-0.0146
22	0.1100	0.9488	46.7	5.7	2477	-0.0150
23	0.1150	0.9569	47.1	6.0	2507	-0.0153
24	0.1200	0.9569	47.1	6.2	2516	-0.0156
25	0.1250	0.9731	47.9	6.5	2568	-0.0158
26	0.1300	0.9711	47.8	6.7	2572	-0.0161
27	0.1350	0.9853	48.5	7.0	2619	-0.0164
28	0.1400	0.9772	48.1	7.3	2607	-0.0167
29	0.1450	0.9914	48.8	7.5	2655	-0.0170
30	0.1500	0.9975	49.1	7.8	2681	-0.0173
31	0.1550	0.9914	48.8	8.0	2674	-0.0175
32	0.1600	1.0016	49.3	8.3	2711	-0.0178
33	0.1650	1.0077	49.6	8.5	2738	-0.0181
34	0.1700	1.0016	49.3	8.8	2732	-0.0184
35	0.1750	1.0097	49.7	9.1	2764	-0.0186
36	0.1800	1.0057	49.5	9.3	2763	-0.0189
37	0.1850	1.0097	49.7	9.6	2785	-0.0191
38	0.1900	1.0097	49.7	9.8	2795	-0.0195
39	0.1950	1.0057	49.5	10.1	2794	-0.0197
40	0.2000	1.0097	49.7	10.4	2816	-0.0200
41	0.2050	1.0057	49.5	10.6	2815	-0.0203
42	0.2100	0.9996	49.2	10.9	2809	-0.0206
43	0.2150	0.9935	48.9	11.1	2803	-0.0209
44	0.2200	0.9894	48.7	11.4	2802	-0.0212
45	0.2250	0.9813	48.3	11.7	2789	-0.0216
46	0.2300	0.9792	48.2	11.9	2794	-0.0219
47	0.2350	0.9671	47.6	12.2	2770	-0.0223
48	0.2400	0.9691	47.7	12.4	2787	-0.0226
49	0.2450	0.9589	47.2	12.7	2769	-0.0230
50	0.2500	0.9610	47.3	13.0	2785	-0.0234
51	0.2550	0.9528	46.9	13.2	2773	-0.0239
52	0.2600	0.9650	47.5	13.5	2819	-0.0242
53	0.2650	0.9731	47.9	13.7	2854	-0.0244
54	0.2700	0.9772	48.1	14.0	2877	-0.0247
55	0.2750	0.9792	48.2	14.2	2895	-0.0250
56	0.2800	0.9813	48.3	14.5	2912	-0.0253
57	0.2850	0.9813	48.3	14.8	2924	-0.0256
58	0.2900	0.9813	48.3	15.0	2936	-0.0260

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
59	0.2950	0.9772	48.1	15.3	2936	-0.0264
60	0.3000	0.9914	48.8	15.5	2990	-0.0266
61	0.3050	0.9894	48.7	15.8	2996	-0.0270
62	0.3100	1.0036	49.4	16.1	3052	-0.0272
63	0.3150	1.0097	49.7	16.3	3083	-0.0274
64	0.3200	1.0117	49.8	16.6	3102	-0.0278
65	0.3250	1.0219	50.3	16.8	3146	-0.0280
66	0.3300	1.0199	50.2	17.1	3153	-0.0285
67	0.3350	1.0300	50.7	17.4	3198	-0.0286
68	0.3400	1.0341	50.9	17.6	3224	-0.0289
69	0.3450	1.0382	51.1	17.9	3250	-0.0292
70	0.3500	1.0382	51.1	18.1	3264	-0.0296
71	0.3550	1.0443	51.4	18.4	3297	-0.0299
72	0.3600	1.0463	51.5	18.7	3317	-0.0301
73	0.3650	1.0503	51.7	18.9	3344	-0.0304
74	0.3700	1.0544	51.9	19.2	3371	-0.0307
75	0.3750	1.0564	52.0	19.4	3392	-0.0310
76	0.3800	1.0585	52.1	19.7	3413	-0.0313
77	0.3850	1.0585	52.1	19.9	3428	-0.0316
78	0.3900	1.0666	52.5	20.2	3470	-0.0319

Parameters for Specimen No. 2

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	512.900		501.100
Moisture content: Dry soil+tare, gms.	461.860		486.960
Moisture content: Tare, gms.	186.700		402.910
Moisture, %	18.5	16.8	16.8
Moist specimen weight, gms.	99.5		
Diameter, in.	1.93	1.93	
Area, in.²	2.93	2.93	
Height, in.	1.00	0.94	
Net decrease in height, in.		0.06	
Wet density, pcf	129.6	135.4	
Dry density, pcf	109.3	115.9	
Void ratio	0.5418	0.4542	
Saturation, %	92.4	100.0	

Test Readings for Specimen No. 2

Load ring constant = 49.2 lbs. per input unit
Normal stress = 8000 psf
Strain rate, %/min. = 0.05
Strength calculations use strain adjusted areas
Fail. Stress = 5498 psf **at reading no.** 39

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	-0.0002
1	0.0050	0.4612	22.7	0.3	1121	-0.0015
2	0.0100	0.6765	33.3	0.5	1649	-0.0024
3	0.0150	0.8431	41.5	0.8	2062	-0.0033
4	0.0200	0.9406	46.3	1.0	2308	-0.0042
5	0.0250	1.0707	52.7	1.3	2636	-0.0048
6	0.0300	1.1783	58.0	1.6	2911	-0.0052
7	0.0350	1.2779	62.9	1.8	3168	-0.0055
8	0.0400	1.3592	66.9	2.1	3381	-0.0057
9	0.0450	1.4506	71.4	2.3	3620	-0.0059
10	0.0500	1.5176	74.7	2.6	3801	-0.0060
11	0.0550	1.5826	77.9	2.8	3977	-0.0061
12	0.0600	1.6558	81.5	3.1	4175	-0.0062
13	0.0650	1.7127	84.3	3.4	4333	-0.0063
14	0.0700	1.7655	86.9	3.6	4482	-0.0064
15	0.0750	1.8102	89.1	3.9	4612	-0.0064
16	0.0800	1.8467	90.9	4.1	4721	-0.0065
17	0.0850	1.8874	92.9	4.4	4842	-0.0066
18	0.0900	1.9199	94.5	4.7	4943	-0.0067
19	0.0950	1.9524	96.1	4.9	5044	-0.0067
20	0.1000	1.9808	97.5	5.2	5136	-0.0067
21	0.1050	2.0011	98.5	5.4	5207	-0.0068
22	0.1100	2.0215	99.5	5.7	5278	-0.0069
23	0.1150	2.0418	100.5	6.0	5350	-0.0069
24	0.1200	2.0458	100.7	6.2	5380	-0.0070
25	0.1250	2.0458	100.7	6.5	5399	-0.0071
26	0.1300	2.0438	100.6	6.7	5413	-0.0072

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
27	0.1350	2.0418	100.5	7.0	5428	-0.0072
28	0.1400	2.0296	99.9	7.3	5415	-0.0073
29	0.1450	2.0194	99.4	7.5	5407	-0.0074
30	0.1500	2.0133	99.1	7.8	5411	-0.0076
31	0.1550	2.0011	98.5	8.0	5398	-0.0079
32	0.1600	1.9971	98.3	8.3	5406	-0.0082
33	0.1650	1.9930	98.1	8.5	5415	-0.0084
34	0.1700	1.9910	98.0	8.8	5430	-0.0086
35	0.1750	1.9849	97.7	9.1	5433	-0.0089
36	0.1800	1.9768	97.3	9.3	5431	-0.0091
37	0.1850	1.9768	97.3	9.6	5451	-0.0093
38	0.1900	1.9788	97.4	9.8	5478	-0.0095
39	0.1950	1.9788	97.4	10.1	5498	-0.0097
40	0.2000	1.9768	97.3	10.4	5513	-0.0100
41	0.2050	1.9686	96.9	10.6	5511	-0.0102
42	0.2100	1.9727	97.1	10.9	5544	-0.0105
43	0.2150	1.9707	97.0	11.1	5559	-0.0108
44	0.2200	1.9666	96.8	11.4	5569	-0.0110
45	0.2250	1.9686	96.9	11.7	5596	-0.0113
46	0.2300	1.9727	97.1	11.9	5629	-0.0115
47	0.2350	1.9727	97.1	12.2	5651	-0.0118
48	0.2400	1.9768	97.3	12.4	5685	-0.0121
49	0.2450	1.9727	97.1	12.7	5695	-0.0123
50	0.2500	1.9727	97.1	13.0	5718	-0.0125
51	0.2550	1.9768	97.3	13.2	5752	-0.0128
52	0.2600	1.9768	97.3	13.5	5775	-0.0131
53	0.2650	1.9768	97.3	13.7	5798	-0.0134
54	0.2700	1.9808	97.5	14.0	5832	-0.0137
55	0.2750	1.9849	97.7	14.2	5868	-0.0139
56	0.2800	1.9849	97.7	14.5	5891	-0.0142
57	0.2850	1.9829	97.6	14.8	5909	-0.0145
58	0.2900	1.9869	97.8	15.0	5945	-0.0148
59	0.2950	1.9849	97.7	15.3	5963	-0.0150
60	0.3000	1.9849	97.7	15.5	5987	-0.0153
61	0.3050	1.9829	97.6	15.8	6005	-0.0156
62	0.3100	1.9849	97.7	16.1	6036	-0.0158
63	0.3150	1.9808	97.5	16.3	6048	-0.0161
64	0.3200	1.9808	97.5	16.6	6073	-0.0164
65	0.3250	1.9788	97.4	16.8	6092	-0.0166
66	0.3300	1.9849	97.7	17.1	6136	-0.0169
67	0.3350	1.9788	97.4	17.4	6143	-0.0172
68	0.3400	1.9747	97.2	17.6	6156	-0.0175
69	0.3450	1.9768	97.3	17.9	6188	-0.0178
70	0.3500	1.9768	97.3	18.1	6214	-0.0180
71	0.3550	1.9768	97.3	18.4	6240	-0.0183
72	0.3600	1.9808	97.5	18.7	6280	-0.0186
73	0.3650	1.9768	97.3	18.9	6294	-0.0188

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
74	0.3700	1.9808	97.5	19.2	6333	-0.0191
75	0.3750	1.9849	97.7	19.4	6374	-0.0193
76	0.3800	1.9829	97.6	19.7	6395	-0.0196
77	0.3850	1.9849	97.7	19.9	6429	-0.0199
78	0.3900	1.9869	97.8	20.2	6463	-0.0202

Parameters for Specimen No. 3

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	512.900		214.010
Moisture content: Dry soil+tare, gms.	461.860		201.730
Moisture content: Tare, gms.	186.700		117.770
Moisture, %	18.5	14.6	14.6
Moist specimen weight, gms.	99.9		
Diameter, in.	1.93	1.93	
Area, in.^{2}	2.93	2.93	
Height, in.	1.00	0.91	
Net decrease in height, in.		0.09	
Wet density, pcf	130.1	138.5	
Dry density, pcf	109.8	120.8	
Void ratio	0.5354	0.3949	
Saturation, %	93.5	100.0	

Test Readings for Specimen No. 3

Load ring constant = 49.2 lbs. per input unit
Normal stress = 16000 psf
Strain rate, %/min. = 0.05
Strength calculations use strain adjusted areas
Fail. Stress = 9958 psf **at reading no.** 39

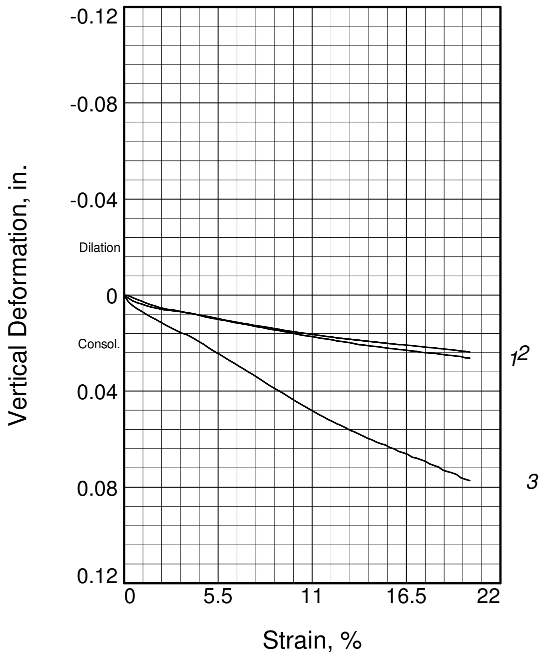
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	-0.0004
1	0.0050	0.6400	31.5	0.3	1555	-0.0017
2	0.0100	1.2088	59.5	0.5	2947	-0.0027
3	0.0150	1.5420	75.9	0.8	3772	-0.0037
4	0.0200	1.8874	92.9	1.0	4632	-0.0047
5	0.0250	2.2612	111.3	1.3	5568	-0.0055
6	0.0300	2.5131	123.6	1.6	6209	-0.0062
7	0.0350	2.7975	137.6	1.8	6935	-0.0067
8	0.0400	3.0210	148.6	2.1	7514	-0.0070
9	0.0450	3.1896	156.9	2.3	7961	-0.0073
10	0.0500	3.3136	163.0	2.6	8298	-0.0076
11	0.0550	3.3969	167.1	2.8	8536	-0.0080
12	0.0600	3.4314	168.8	3.1	8652	-0.0083
13	0.0650	3.3908	166.8	3.4	8579	-0.0089
14	0.0700	3.4416	169.3	3.6	8738	-0.0093
15	0.0750	3.5127	172.8	3.9	8949	-0.0097
16	0.0800	3.5756	175.9	4.1	9142	-0.0099
17	0.0850	3.6224	178.2	4.4	9293	-0.0100

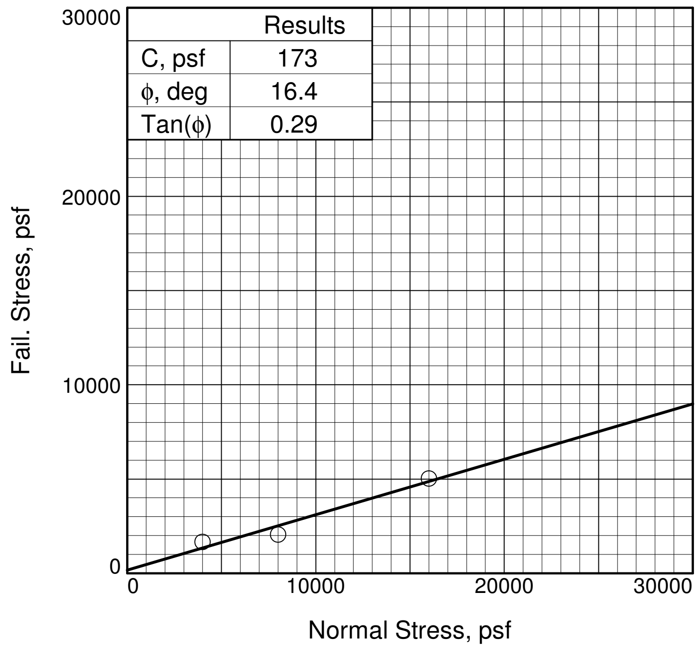
Test Readings for Specimen No. 3

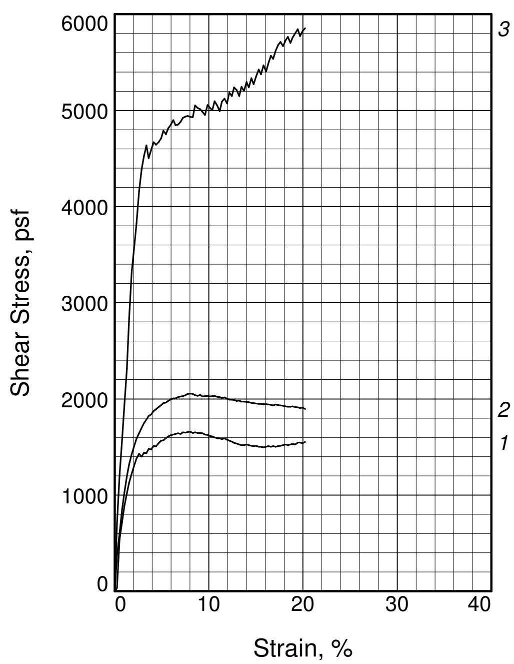
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
18	0.0900	3.6021	177.2	4.7	9274	-0.0092
19	0.0950	3.6508	179.6	4.9	9432	-0.0093
20	0.1000	3.6833	181.2	5.2	9550	-0.0095
21	0.1050	3.6671	180.4	5.4	9541	-0.0090
22	0.1100	3.6996	182.0	5.7	9660	-0.0091
23	0.1150	3.7199	183.0	6.0	9748	-0.0093
24	0.1200	3.7036	182.2	6.2	9740	-0.0089
25	0.1250	3.7260	183.3	6.5	9834	-0.0091
26	0.1300	3.6955	181.8	6.7	9788	-0.0088
27	0.1350	3.7219	183.1	7.0	9894	-0.0090
28	0.1400	3.7321	183.6	7.3	9957	-0.0091
29	0.1450	3.6955	181.8	7.5	9895	-0.0089
30	0.1500	3.6914	181.6	7.8	9920	-0.0090
31	0.1550	3.6752	180.8	8.0	9913	-0.0091
32	0.1600	3.6305	178.6	8.3	9828	-0.0091
33	0.1650	3.6264	178.4	8.5	9853	-0.0093
34	0.1700	3.6183	178.0	8.8	9868	-0.0095
35	0.1750	3.6102	177.6	9.1	9882	-0.0098
36	0.1800	3.5696	175.6	9.3	9807	-0.0098
37	0.1850	3.5696	175.6	9.6	9844	-0.0101
38	0.1900	3.5736	175.8	9.8	9892	-0.0104
39	0.1950	3.5838	176.3	10.1	9958	-0.0106
40	0.2000	3.5513	174.7	10.4	9905	-0.0107
41	0.2050	3.5614	175.2	10.6	9971	-0.0109
42	0.2100	3.5655	175.4	10.9	10020	-0.0112
43	0.2150	3.5655	175.4	11.1	10058	-0.0114
44	0.2200	3.5370	174.0	11.4	10016	-0.0117
45	0.2250	3.5411	174.2	11.7	10066	-0.0119
46	0.2300	3.5411	174.2	11.9	10105	-0.0121
47	0.2350	3.5492	174.6	12.2	10168	-0.0124
48	0.2400	3.5167	173.0	12.4	10114	-0.0127
49	0.2450	3.5249	173.4	12.7	10177	-0.0129
50	0.2500	3.5249	173.4	13.0	10216	-0.0131
51	0.2550	3.5330	173.8	13.2	10280	-0.0133
52	0.2600	3.5167	173.0	13.5	10273	-0.0137
53	0.2650	3.5167	173.0	13.7	10314	-0.0139
54	0.2700	3.5208	173.2	14.0	10367	-0.0141
55	0.2750	3.5269	173.5	14.2	10426	-0.0142
56	0.2800	3.5391	174.1	14.5	10504	-0.0144
57	0.2850	3.5167	173.0	14.8	10480	-0.0148
58	0.2900	3.5310	173.7	15.0	10564	-0.0150
59	0.2950	3.5431	174.3	15.3	10644	-0.0152
60	0.3000	3.5411	174.2	15.5	10681	-0.0153
61	0.3050	3.5228	173.3	15.8	10669	-0.0159
62	0.3100	3.5269	173.5	16.1	10725	-0.0160
63	0.3150	3.5370	174.0	16.3	10800	-0.0161
64	0.3200	3.5411	174.2	16.6	10857	-0.0162

Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
65	0.3250	3.5411	174.2	16.8	10902	-0.0163
66	0.3300	3.5127	172.8	17.1	10859	-0.0170
67	0.3350	3.5208	173.2	17.4	10930	-0.0171
68	0.3400	3.5330	173.8	17.6	11013	-0.0172
69	0.3450	3.5411	174.2	17.9	11085	-0.0173
70	0.3500	3.5391	174.1	18.1	11125	-0.0175
71	0.3550	3.5452	174.4	18.4	11192	-0.0177
72	0.3600	3.5492	174.6	18.7	11252	-0.0178
73	0.3650	3.5533	174.8	18.9	11313	-0.0180
74	0.3700	3.5310	173.7	19.2	11290	-0.0190
75	0.3750	3.5411	174.2	19.4	11371	-0.0191
76	0.3800	3.5431	174.3	19.7	11426	-0.0192
77	0.3850	3.5411	174.2	19.9	11469	-0.0194
78	0.3900	3.5370	174.0	20.2	11506	-0.0196







	Specimen No.	1	2	3
Initial	Water Content, %	26.5	26.5	25.0
	Dry Density, pcf	93.4	92.8	93.8
	Saturation, %	89.1	87.6	84.7
	Void Ratio	0.8038	0.8172	0.7968
	Diameter, in.	1.93	1.93	1.93
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	24.2	25.4	19.5
	Dry Density, pcf	101.9	100.0	110.4
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.6544	0.6858	0.5273
	Diameter, in.	1.93	1.93	1.93
	Height, in.	0.92	0.93	0.85
	Normal Stress, psf	4000	8000	16000
	Fail. Stress, psf	1660	2055	5030
	Strain, %	8.0	8.0	10.1
	Ult. Stress, psf			
	Strain, %			
	Strain rate, %/min.	0.05	0.05	0.0010

Sample Type: Remolded
Description: fat clay

Assumed Specific Gravity= 2.7
Remarks: Failure chosen at peak shear stress and 10% strain for third point. Test was inundated. Area correction applied per client.

Figure ________

Client: NewFields

Project: Hermosa Underground
475.0014.008
Location: TP-25
Depth: 8-10'
Proj. No.: DV108-00305/06 **Date Sampled:** 04/01/17

Knight Piésold CONSULTING

Tested By: EAG **Checked By:** JDB

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.

DIRECT SHEAR TEST

Date: 04/01/17
Client: NewFields
Project: Hermosa Underground
475.0014.008
Project No.: DV108-00305/06
Location: TP-25
Depth: 8-10'
Description: fat clay
Remarks: Failure chosen at peak shear stress and 10% strain for third point. Test was inundated. Area correction applied per client.
Type of Sample: Remolded
Assumed Specific Gravity=2.7 **LL=** **PL=** **PI=**

Parameters for Specimen No. 1

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	468.700		491.700
Moisture content: Dry soil+tare, gms.	409.320		474.190
Moisture content: Tare, gms.	185.400		401.950
Moisture, %	26.5	24.2	24.2
Moist specimen weight, gms.	90.8		
Diameter, in.	1.93	1.93	
Area, in.²	2.93	2.93	
Height, in.	1.00	0.92	
Net decrease in height, in.		0.08	
Wet density, pcf	118.2	126.6	
Dry density, pcf	93.4	101.9	
Void ratio	0.8038	0.6544	
Saturation, %	89.1	100.0	

Test Readings for Specimen No. 1

Load ring constant = 49.2 lbs. per input unit
Normal stress = 4000 psf
Strain rate, %/min. = 0.05
Strength calculations use strain adjusted areas
Fail. Stress = 1660 psf **at reading no.** 31

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	0.0001
1	0.0050	0.0142	0.7	0.3	35	-0.0002
2	0.0100	0.2194	10.8	0.5	535	-0.0010
3	0.0150	0.2946	14.5	0.8	721	-0.0018
4	0.0200	0.3596	17.7	1.0	882	-0.0025
5	0.0250	0.4145	20.4	1.3	1021	-0.0033
6	0.0300	0.4571	22.5	1.6	1129	-0.0039
7	0.0350	0.4937	24.3	1.8	1224	-0.0045
8	0.0400	0.5262	25.9	2.1	1309	-0.0051
9	0.0450	0.5526	27.2	2.3	1379	-0.0055
10	0.0500	0.5709	28.1	2.6	1430	-0.0059

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
11	0.0550	0.5567	27.4	2.8	1399	-0.0061
12	0.0600	0.5709	28.1	3.1	1439	-0.0065
13	0.0650	0.5668	27.9	3.4	1434	-0.0068
14	0.0700	0.5831	28.7	3.6	1480	-0.0072
15	0.0750	0.5790	28.5	3.9	1475	-0.0075
16	0.0800	0.5912	29.1	4.1	1511	-0.0079
17	0.0850	0.5871	28.9	4.4	1506	-0.0083
18	0.0900	0.5973	29.4	4.7	1538	-0.0088
19	0.0950	0.6054	29.8	4.9	1564	-0.0092
20	0.1000	0.6054	29.8	5.2	1570	-0.0096
21	0.1050	0.6115	30.1	5.4	1591	-0.0099
22	0.1100	0.6156	30.3	5.7	1607	-0.0103
23	0.1150	0.6196	30.5	6.0	1624	-0.0106
24	0.1200	0.6196	30.5	6.2	1630	-0.0109
25	0.1250	0.6196	30.5	6.5	1635	-0.0113
26	0.1300	0.6196	30.5	6.7	1641	-0.0116
27	0.1350	0.6156	30.3	7.0	1636	-0.0120
28	0.1400	0.6196	30.5	7.3	1653	-0.0123
29	0.1450	0.6156	30.3	7.5	1648	-0.0127
30	0.1500	0.6156	30.3	7.8	1654	-0.0131
31	0.1550	0.6156	30.3	8.0	1660	-0.0134
32	0.1600	0.6075	29.9	8.3	1644	-0.0138
33	0.1650	0.6075	29.9	8.5	1651	-0.0141
34	0.1700	0.6034	29.7	8.8	1646	-0.0144
35	0.1750	0.6014	29.6	9.1	1646	-0.0147
36	0.1800	0.5973	29.4	9.3	1641	-0.0151
37	0.1850	0.5912	29.1	9.6	1630	-0.0154
38	0.1900	0.5871	28.9	9.8	1625	-0.0158
39	0.1950	0.5810	28.6	10.1	1614	-0.0161
40	0.2000	0.5770	28.4	10.4	1609	-0.0165
41	0.2050	0.5709	28.1	10.6	1598	-0.0168
42	0.2100	0.5668	27.9	10.9	1593	-0.0171
43	0.2150	0.5628	27.7	11.1	1588	-0.0174
44	0.2200	0.5587	27.5	11.4	1582	-0.0177
45	0.2250	0.5587	27.5	11.7	1588	-0.0180
46	0.2300	0.5526	27.2	11.9	1577	-0.0183
47	0.2350	0.5465	26.9	12.2	1566	-0.0186
48	0.2400	0.5404	26.6	12.4	1554	-0.0189
49	0.2450	0.5343	26.3	12.7	1543	-0.0192
50	0.2500	0.5303	26.1	13.0	1537	-0.0195
51	0.2550	0.5242	25.8	13.2	1525	-0.0198
52	0.2600	0.5201	25.6	13.5	1519	-0.0201
53	0.2650	0.5181	25.5	13.7	1519	-0.0205
54	0.2700	0.5181	25.5	14.0	1525	-0.0207
55	0.2750	0.5140	25.3	14.2	1519	-0.0210
56	0.2800	0.5099	25.1	14.5	1514	-0.0212
57	0.2850	0.5059	24.9	14.8	1507	-0.0214

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
58	0.2900	0.5059	24.9	15.0	1514	-0.0216
59	0.2950	0.4998	24.6	15.3	1501	-0.0219
60	0.3000	0.4977	24.5	15.5	1501	-0.0221
61	0.3050	0.4937	24.3	15.8	1495	-0.0223
62	0.3100	0.4937	24.3	16.1	1501	-0.0225
63	0.3150	0.4937	24.3	16.3	1507	-0.0227
64	0.3200	0.4896	24.1	16.6	1501	-0.0230
65	0.3250	0.4896	24.1	16.8	1507	-0.0232
66	0.3300	0.4856	23.9	17.1	1501	-0.0233
67	0.3350	0.4856	23.9	17.4	1507	-0.0237
68	0.3400	0.4856	23.9	17.6	1514	-0.0239
69	0.3450	0.4856	23.9	17.9	1520	-0.0240
70	0.3500	0.4856	23.9	18.1	1526	-0.0242
71	0.3550	0.4815	23.7	18.4	1520	-0.0244
72	0.3600	0.4815	23.7	18.7	1526	-0.0247
73	0.3650	0.4815	23.7	18.9	1533	-0.0249
74	0.3700	0.4774	23.5	19.2	1527	-0.0251
75	0.3750	0.4815	23.7	19.4	1546	-0.0253
76	0.3800	0.4795	23.6	19.7	1546	-0.0255
77	0.3850	0.4754	23.4	19.9	1540	-0.0260
78	0.3900	0.4774	23.5	20.2	1553	-0.0262

Parameters for Specimen No. 2

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	468.700		484.630
Moisture content: Dry soil+tare, gms.	409.320		466.160
Moisture content: Tare, gms.	185.400		393.410
Moisture, %	26.5	25.4	25.4
Moist specimen weight, gms.	90.1		
Diameter, in.	1.93	1.93	
Area, in.²	2.93	2.93	
Height, in.	1.00	0.93	
Net decrease in height, in.		0.07	
Wet density, pcf	117.4	125.4	
Dry density, pcf	92.8	100.0	
Void ratio	0.8172	0.6858	
Saturation, %	87.6	100.0	

Test Readings for Specimen No. 2

Load ring constant = 49.2 lbs. per input unit
Normal stress = 8000 psf
Strain rate, %/min. = 0.05
Strength calculations use strain adjusted areas
Fail. Stress = 2055 psf **at reading no.** 31

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	-0.0001
1	0.0050	0.1524	7.5	0.3	370	-0.0015
2	0.0100	0.2458	12.1	0.5	599	-0.0025
3	0.0150	0.3474	17.1	0.8	850	-0.0033
4	0.0200	0.4165	20.5	1.0	1022	-0.0039
5	0.0250	0.4856	23.9	1.3	1196	-0.0045
6	0.0300	0.5343	26.3	1.6	1320	-0.0050
7	0.0350	0.5749	28.3	1.8	1425	-0.0054
8	0.0400	0.6075	29.9	2.1	1511	-0.0058
9	0.0450	0.6359	31.3	2.3	1587	-0.0062
10	0.0500	0.6562	32.3	2.6	1643	-0.0064
11	0.0550	0.6765	33.3	2.8	1700	-0.0066
12	0.0600	0.6928	34.1	3.1	1747	-0.0069
13	0.0650	0.7050	34.7	3.4	1784	-0.0071
14	0.0700	0.7172	35.3	3.6	1821	-0.0074
15	0.0750	0.7212	35.5	3.9	1837	-0.0077
16	0.0800	0.7334	36.1	4.1	1875	-0.0081
17	0.0850	0.7375	36.3	4.4	1892	-0.0084
18	0.0900	0.7436	36.6	4.7	1914	-0.0088
19	0.0950	0.7497	36.9	4.9	1937	-0.0091
20	0.1000	0.7537	37.1	5.2	1954	-0.0095
21	0.1050	0.7537	37.1	5.4	1961	-0.0098
22	0.1100	0.7578	37.3	5.7	1979	-0.0102
23	0.1150	0.7619	37.5	6.0	1996	-0.0106
24	0.1200	0.7619	37.5	6.2	2004	-0.0109
25	0.1250	0.7598	37.4	6.5	2005	-0.0113
26	0.1300	0.7619	37.5	6.7	2018	-0.0116

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
27	0.1350	0.7619	37.5	7.0	2025	-0.0119
28	0.1400	0.7598	37.4	7.3	2027	-0.0122
29	0.1450	0.7619	37.5	7.5	2040	-0.0126
30	0.1500	0.7639	37.6	7.8	2053	-0.0129
31	0.1550	0.7619	37.5	8.0	2055	-0.0131
32	0.1600	0.7578	37.3	8.3	2051	-0.0134
33	0.1650	0.7497	36.9	8.5	2037	-0.0137
34	0.1700	0.7456	36.7	8.8	2033	-0.0141
35	0.1750	0.7456	36.7	9.1	2041	-0.0144
36	0.1800	0.7375	36.3	9.3	2026	-0.0147
37	0.1850	0.7354	36.2	9.6	2028	-0.0150
38	0.1900	0.7334	36.1	9.8	2030	-0.0153
39	0.1950	0.7294	35.9	10.1	2027	-0.0155
40	0.2000	0.7273	35.8	10.4	2029	-0.0158
41	0.2050	0.7253	35.7	10.6	2031	-0.0161
42	0.2100	0.7192	35.4	10.9	2021	-0.0163
43	0.2150	0.7151	35.2	11.1	2017	-0.0166
44	0.2200	0.7090	34.9	11.4	2008	-0.0169
45	0.2250	0.7090	34.9	11.7	2016	-0.0171
46	0.2300	0.7009	34.5	11.9	2000	-0.0174
47	0.2350	0.6948	34.2	12.2	1990	-0.0176
48	0.2400	0.6928	34.1	12.4	1992	-0.0179
49	0.2450	0.6887	33.9	12.7	1988	-0.0181
50	0.2500	0.6826	33.6	13.0	1979	-0.0183
51	0.2550	0.6806	33.5	13.2	1980	-0.0185
52	0.2600	0.6745	33.2	13.5	1970	-0.0187
53	0.2650	0.6725	33.1	13.7	1972	-0.0189
54	0.2700	0.6684	32.9	14.0	1968	-0.0191
55	0.2750	0.6643	32.7	14.2	1964	-0.0193
56	0.2800	0.6603	32.5	14.5	1960	-0.0195
57	0.2850	0.6562	32.3	14.8	1955	-0.0197
58	0.2900	0.6521	32.1	15.0	1951	-0.0199
59	0.2950	0.6481	31.9	15.3	1947	-0.0201
60	0.3000	0.6461	31.8	15.5	1949	-0.0203
61	0.3050	0.6420	31.6	15.8	1944	-0.0205
62	0.3100	0.6400	31.5	16.1	1946	-0.0207
63	0.3150	0.6359	31.3	16.3	1942	-0.0208
64	0.3200	0.6318	31.1	16.6	1937	-0.0210
65	0.3250	0.6278	30.9	16.8	1933	-0.0212
66	0.3300	0.6278	30.9	17.1	1941	-0.0214
67	0.3350	0.6237	30.7	17.4	1936	-0.0216
68	0.3400	0.6196	30.5	17.6	1932	-0.0218
69	0.3450	0.6156	30.3	17.9	1927	-0.0220
70	0.3500	0.6115	30.1	18.1	1922	-0.0221
71	0.3550	0.6075	29.9	18.4	1918	-0.0223
72	0.3600	0.6054	29.8	18.7	1919	-0.0225
73	0.3650	0.6034	29.7	18.9	1921	-0.0227

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
74	0.3700	0.5993	29.5	19.2	1916	-0.0229
75	0.3750	0.5953	29.3	19.4	1911	-0.0232
76	0.3800	0.5912	29.1	19.7	1907	-0.0234
77	0.3850	0.5892	29.0	19.9	1908	-0.0236
78	0.3900	0.5831	28.7	20.2	1897	-0.0238

Parameters for Specimen No. 3

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	452.900		457.040
Moisture content: Dry soil+tare, gms.	399.100		443.150
Moisture content: Tare, gms.	183.900		372.030
Moisture, %	25.0	19.5	19.5
Moist specimen weight, gms.	90.0		
Diameter, in.	1.93	1.93	
Area, in.²	2.93	2.93	
Height, in.	1.00	0.85	
Net decrease in height, in.		0.15	
Wet density, pcf	117.3	131.9	
Dry density, pcf	93.8	110.4	
Void ratio	0.7968	0.5273	
Saturation, %	84.7	100.0	

Test Readings for Specimen No. 3

Load ring constant = 49.2 lbs. per input unit
Normal stress = 16000 psf
Strain rate, %/min. = 0.0010
Strength calculations use strain adjusted areas
Fail. Stress = 5030 psf **at reading no.** 39

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
0	0.0000	0.0000	0.0	0.0	0	-0.0005
1	0.0050	0.2905	14.3	0.3	706	-0.0035
2	0.0100	0.4937	24.3	0.5	1203	-0.0049
3	0.0150	0.6440	31.7	0.8	1575	-0.0062
4	0.0200	0.7862	38.7	1.0	1929	-0.0073
5	0.0250	0.9406	46.3	1.3	2316	-0.0085
6	0.0300	1.1499	56.6	1.6	2841	-0.0096
7	0.0350	1.3388	65.9	1.8	3319	-0.0105
8	0.0400	1.4404	70.9	2.1	3583	-0.0116
9	0.0450	1.5318	75.4	2.3	3823	-0.0126
10	0.0500	1.6598	81.7	2.6	4157	-0.0135
11	0.0550	1.7452	85.9	2.8	4385	-0.0145
12	0.0600	1.7919	88.2	3.1	4518	-0.0154
13	0.0650	1.8325	90.2	3.4	4637	-0.0164
14	0.0700	1.7736	87.3	3.6	4503	-0.0169
15	0.0750	1.8020	88.7	3.9	4591	-0.0178
16	0.0800	1.8264	89.9	4.1	4669	-0.0189
17	0.0850	1.8102	89.1	4.4	4644	-0.0200

Test Readings for Specimen No. 3

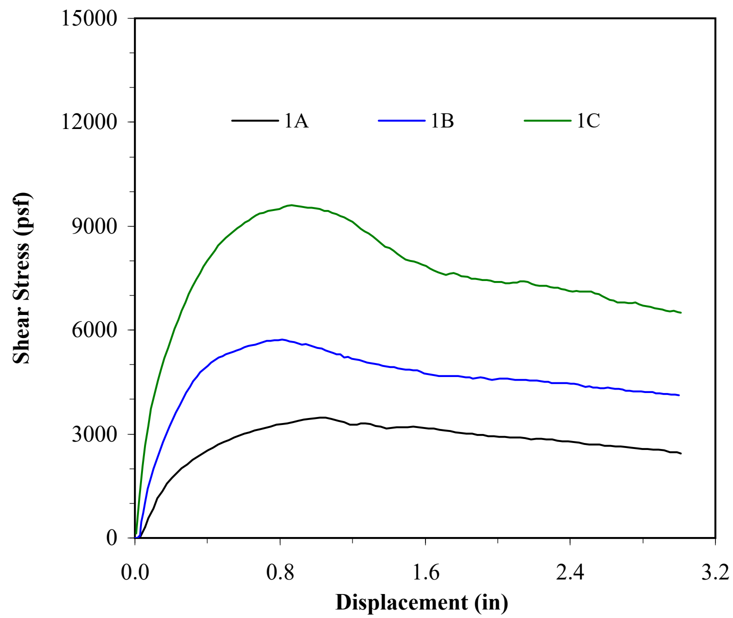
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
18	0.0900	1.8142	89.3	4.7	4671	-0.0210
19	0.0950	1.8224	89.7	4.9	4708	-0.0223
20	0.1000	1.8467	90.9	5.2	4788	-0.0235
21	0.1050	1.8264	89.9	5.4	4752	-0.0246
22	0.1100	1.8427	90.7	5.7	4811	-0.0257
23	0.1150	1.8508	91.1	6.0	4850	-0.0269
24	0.1200	1.8630	91.7	6.2	4899	-0.0280
25	0.1250	1.8366	90.4	6.5	4847	-0.0290
26	0.1300	1.8325	90.2	6.7	4854	-0.0302
27	0.1350	1.8366	90.4	7.0	4882	-0.0313
28	0.1400	1.8447	90.8	7.3	4922	-0.0325
29	0.1450	1.8427	90.7	7.5	4934	-0.0336
30	0.1500	1.8386	90.5	7.8	4941	-0.0348
31	0.1550	1.8285	90.0	8.0	4932	-0.0360
32	0.1600	1.8203	89.6	8.3	4928	-0.0371
33	0.1650	1.8589	91.5	8.5	5051	-0.0384
34	0.1700	1.8427	90.7	8.8	5025	-0.0394
35	0.1750	1.8305	90.1	9.1	5011	-0.0405
36	0.1800	1.8142	89.3	9.3	4985	-0.0416
37	0.1850	1.7960	88.4	9.6	4953	-0.0428
38	0.1900	1.8264	89.9	9.8	5056	-0.0439
39	0.1950	1.8102	89.1	10.1	5030	-0.0450
40	0.2000	1.7939	88.3	10.4	5003	-0.0461
41	0.2050	1.8203	89.6	10.6	5096	-0.0471
42	0.2100	1.7980	88.5	10.9	5053	-0.0482
43	0.2150	1.7695	87.1	11.1	4992	-0.0493
44	0.2200	1.7980	88.5	11.4	5092	-0.0503
45	0.2250	1.8020	88.7	11.7	5123	-0.0513
46	0.2300	1.7777	87.5	11.9	5073	-0.0523
47	0.2350	1.8102	89.1	12.2	5186	-0.0531
48	0.2400	1.7899	88.1	12.4	5147	-0.0540
49	0.2450	1.8142	89.3	12.7	5238	-0.0548
50	0.2500	1.7980	88.5	13.0	5211	-0.0558
51	0.2550	1.7695	87.1	13.2	5149	-0.0569
52	0.2600	1.7960	88.4	13.5	5246	-0.0575
53	0.2650	1.7736	87.3	13.7	5202	-0.0585
54	0.2700	1.7980	88.5	14.0	5294	-0.0592
55	0.2750	1.7716	87.2	14.2	5237	-0.0602
56	0.2800	1.7980	88.5	14.5	5336	-0.0608
57	0.2850	1.7695	87.1	14.8	5273	-0.0618
58	0.2900	1.7899	88.1	15.0	5355	-0.0624
59	0.2950	1.8061	88.9	15.3	5426	-0.0630
60	0.3000	1.7817	87.7	15.5	5374	-0.0640
61	0.3050	1.8061	88.9	15.8	5470	-0.0646
62	0.3100	1.7777	87.5	16.1	5406	-0.0657
63	0.3150	1.7980	88.5	16.3	5490	-0.0662
64	0.3200	1.8163	89.4	16.6	5569	-0.0669

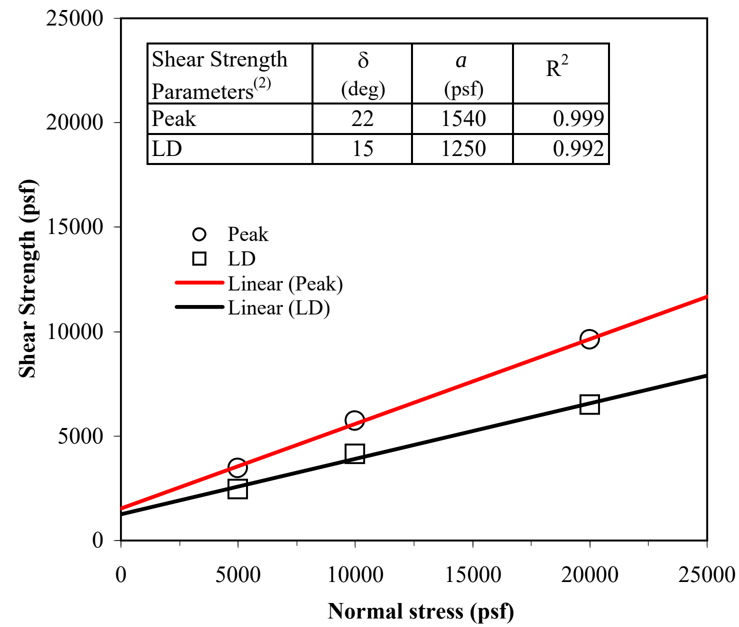
Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
65	0.3250	1.7980	88.5	16.8	5535	-0.0680
66	0.3300	1.8183	89.5	17.1	5621	-0.0685
67	0.3350	1.8305	90.1	17.4	5682	-0.0691
68	0.3400	1.8325	90.2	17.6	5713	-0.0698
69	0.3450	1.8102	89.1	17.9	5667	-0.0709
70	0.3500	1.8224	89.7	18.1	5729	-0.0715
71	0.3550	1.8264	89.9	18.4	5766	-0.0722
72	0.3600	1.7980	88.5	18.7	5700	-0.0735
73	0.3650	1.8081	89.0	18.9	5757	-0.0740
74	0.3700	1.8142	89.3	19.2	5801	-0.0746
75	0.3750	1.8203	89.6	19.4	5845	-0.0753
76	0.3800	1.7899	88.1	19.7	5772	-0.0766
77	0.3850	1.7980	88.5	19.9	5823	-0.0772
78	0.3900	1.8000	88.6	20.2	5855	-0.0778

NEWFIELDS COMPANIES, LLC - HERMOSA UNDERGROUND PROJECT
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

Upper Shear Box: Clayey sand with gravel # TP-47A compacted to approximately 95% of max modified Proctor dry unit weight at OMC + 2% (γ_{dmax} = 128.4 pcf, OMC = 11.3%) against Agru 60-mil Microspike HDPE geomembrane #475.0014.008.Task.2 with dull side up
Lower Shear Box: Concrete sand





Shear Strength Parameters[(2)]	δ (deg)	a (psf)	R^2
Peak	22	1540	0.999
LD	15	1250	0.992

Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	Soaking Stress (psf)	Soaking Time (hour)	Consolidation Stress (psf)	Consolidation Time (hour)	Upper Soil γ_d (pcf)	Upper Soil ω_i (%)	Upper Soil ω_f (%)	Lower Soil γ_d (pcf)	Lower Soil ω_i (%)	Lower Soil ω_f (%)	GCL ω_i (%)	GCL ω_f (%)	Shear Strength τ_P (psf)	Shear Strength τ_{LD} (psf)	Failure Mode
1A	12 x 12	5000	0.004	5000	24			121.7	13.6	-	-	-	-	-	-	3477	2440	(1)
1B	12 x 12	10000	0.004	10000	24			122.1	13.2	-	-	-	-	-	-	5728	4122	(1)
1C	12 x 12	20000	0.004	20000	24			121.4	13.8	-	-	-	-	-	-	9605	6498	(1)

NOTES:
(1)) Sliding (shear failure) occurred at the interface between the soil and dull side of 60-mil Microspike HDPE geomembrane.
(2) The reported total-stress parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

SGI TESTING SERVICES, LLC

DATE OF REPORT:	4/9/2017
FIGURE NO.	1
PROJECT NO.	SGI14024
DOCUMENT NO.	
FILE NO.	

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	TP-07	**Test Start Date:**	2/21/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-05	**Tested By:**	OS
Project Number:	475.0014.008	**Location:**	TP-07	**Checked By:**	KE
Project Engineer:	Kerry Manger	**Depth:**	7'-8'	**Sample Description:**	Brown

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	SPG12
Initial Wt. + Tare	5027.30
Post Wt. + Tare	1988.9
Percent Loss	**60%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-019-20	**Test Start Date:**	2/21/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-19-20	**Tested By:**	OS
Project Number:	475.0014.008	**Location:**	TP-31	**Checked By:**	KE
Project Engineer:	Kerry Manger	**Depth:**	2'-4'	**Sample Description:**	Brown

Test Type	
ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	Total Wt. (g)
Tare ID	SPG12
Initial Wt. + Tare	5006.90
Post Wt. + Tare	2017.9
Percent Loss	**60%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-019-27	**Test Start Date:**	3/27/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	KE
Project Number:	475.0014.008	**Location:**	TP-51	**Checked By:**	TW
Project Engineer:	Craig Thompson	**Depth:**	1'-2'	**Sample Description:**	Orange clayey gravel

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	SPG12
Initial Wt. + Tare	11002.0
Post Wt. + Tare	7116.0
Percent Loss	**35%**

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 03/15/2017
Date Submitted 03/08/2017

To: John Roberts
Newfields
9400 Station St. Ste 300
Denver, CO 80124

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : BH-16 Site ID : S-4@8-9.5FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 73757-153810.

EVALUATION FOR SOIL CORROSION

Soil pH	7.51		
Minimum Resistivity	1.13	ohm-cm (x1000)	
Chloride	509.5 ppm	00.05095	%
Sulfate	231.5 ppm	00.02315	%
Redox Potential	(+) 298	mv	
Sulfides	Presence - NEGATIVE		

METHODS
pH AASTO T289, Min.Resistivity AASTO T288 Mod.(Sm.Cell)
Sulfate AASHTO T290, Chloride AASHTO T291
Redox Potential ASTM G-200, Sulfides AWWA C105/A25.5

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 03/15/2017
Date Submitted 03/08/2017

To: John Roberts
Newfields
9400 Station St. Ste 300
Denver, CO 80124

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : TP-13 Site ID : LD-1@1-3FT.
Thank you for your business.

* For future reference to this analysis please use SUN # 73758-153811.

EVALUATION FOR SOIL CORROSION

Soil pH	7.72	
Minimum Resistivity	4.56 ohm-cm (x1000)	
Chloride	2.1 ppm	00.00021 %
Sulfate	34.7 ppm	00.00347 %
Redox Potential	(+) 210 mv	
Sulfides	Presence - NEGATIVE	

METHODS
pH AASTO T289, Min.Resistivity AASTO T288 Mod.(Sm.Cell)
Sulfate AASHTO T290, Chloride AASHTO T291
Redox Potential ASTM G-200, Sulfides AWWA C105/A25.5

APPENDIX D.2.2

Laboratory Test Results (June 2017)

Table 1

Hermosa Underground Mine, Santa Cruz County, AZ

Geotechnical Test Pit Sample Soil Testing Summary

Test Pit	Depth (ft)	Material Description	USCS	Grain Size Analysis - Percent Passing														Gradation (%)			Atterberg Limits			Natural Moisture (%)	Flexible Wall Perm (cm/sec)		Flexible Wall Perm (+2% Bentonite) (cm/sec)	
				Mechanical Sieve																								
				3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#16	#40	#50	#100	#200	Gravels	Sands	Fines	Plastic Limit	Liquid Limit	Plasticity Index		10 psi	20psi	10 psi	20psi
TP-63	3-4	clayey SAND with gravel	SC	100.0	99.3	98.0	95.7	92.7	88.3	85.3	78.7	68.7	62.0	43.5	35.4	23.5	15.8	21.3	62.9	15.8	14	24	10	-				
TP-65	1-2	clayey SAND with gravel	SC	100.0	97.3	93.6	89.8	88.4	87.1	86.5	80.9	73.5	67.7	50.8	42.2	28.0	19.3	19.1	61.6	19.3	19	60	11	6.4				
TP-66	1.5-2.5	clayey SAND with gravel	SC	100.0	99.0	98.0	95.6	94.0	91.1	88.8	81.8	74.4	70.0	55.8	49.6	39.2	32.7	18.2	49.1	32.7	19	44	25	7.5	5.4E-07			
TP-83	5-6	clayey SAND	SC	100.0	100.0	100.0	99.0	98.1	96.8	95.7	93.5	88.2	84.3	73.1	65.6	50.6	37.0	6.5	56.5	37.0	18	27	9	15.0				
TP-83	12-13	clayey SAND with gravel	SC	100.0	94.1	90.1	87.5	84.0	79.4	76.3	70.3	60.6	55.0	43.2	37.5	27.5	19.7	29.7	50.6	19.7	16	29	13	-				
TP-85	2-3	clayey SAND	SC	100.0	100.0	99.4	98.8	98.5	97.8	97.3	91.9	85.3	81.3	71.9	65.0	47.6	32.1	8.1	59.8	32.1	17	29	12	7.8	4.7E-06	3.3E-06	1.8E-06	1.3E-06
TP-86	2-3	clayey SAND	SC	100.0	100.0	100.0	99.7	99.3	98.7	97.9	95.6	90.7	87.3	80.1	75.4	62.1	48.1	4.4	47.5	48.1	13	30	17	-	1.9E-06	1.7E-07		
TP-86	16-17	clayey SAND with gravel	SC	100.0	97.7	96.5	94.3	92.7	89.6	87.2	81.8	72.6	66.9	54.8	48.4	34.8	24.3	18.2	57.5	24.3	15	30	15	-				
TP-88	5-7	well-graded GRAVEL with clay and sand	GP-GC	100.0	91.1	85.4	75.7	69.6	61.7	57.3	46.4	35.8	30.6	20.6	17.2	12.7	10.1	53.6	36.3	10.1	15	37	22	-				
TP-89	6-8	poorly-graded GRAVEL with clay and sand	GP-GC	100.0	86.1	80.4	72.6	68.8	63.3	59.6	51.8	40.7	34.8	24.1	20.3	15.1	11.8	48.2	40.0	11.8	22	33	11	9.2				
TP-91	2-3	clayey SAND with gravel	SC	100.0	84.2	81.2	76.9	74.9	72.0	69.7	62.0	53.0	47.9	39.2	34.3	26.0	21.4	38.0	40.6	21.4	20	56	36	-				
TP-91B	2-3	clayey SAND	SC	100.0	95.5	93.4	92.9	92.1	92.1	89.9	85.2	80.7	78.1	71.1	65.5	51.7	42.0	14.8	43.2	42.0	18	41	32	-				
TP-91B	5-6	clayey GRAVEL with sand	GC	100.0	95.3	92.2	82.3	74.4	65.8	60.9	51.5	42.0	36.8	28.4	24.9	19.3	15.8	48.5	35.7	15.8	14	42	28	-				
TP-94	2-3	sandy lean CLAY	CL	100.0	100.0	100.0	99.7	99.1	98.8	98.7	98.0	96.2	94.0	87.4	82.9	72.6	64.9	2.0	33.1	64.9	15	39	24	10.8				
TP-94	11-12	clayey GRAVEL with sand	GC	100.0	96.7	92.2	86.2	80.4	73.1	68.2	59.0	51.1	46.4	37.5	33.6	27.1	22.5	41.0	36.5	22.5	17	39	22	6.8				
TP-95	7-8	clayey SAND with gravel	SC	100.0	93.9	92.6	91.9	90.6	88.9	87.7	84.4	78.0	73.4	62.1	55.6	42.0	30.5	15.6	53.9	30.5	14	33	19	7.4				
TP-95	7-8	clayey GRAVEL with sand	GC	100.0	98.6	87.1	79.7	74.1	66.5	61.7	48.1	36.3	31.4	24.0	21.3	16.7	12.9	51.9	35.2	12.9	17	43	26	5.3				
TP-96	3-4	clayey GRAVEL with sand	GC	100.0	88.4	83.2	75.7	71.8	65.7	62.5	56.7	48.6	43.8	35.1	30.7	22.6	17.8	43.3	38.9	17.8	16	40	24	-				
TP-97	2-3	clayey GRAVEL with sand	GC	100.0	99.0	95.7	87.9	82.9	76.2	69.9	59.6	50.5	45.1	35.1	31.4	24.6	20.0	40.4	39.6	20.0	16	43	27	-	2.4E-07			
TP-98	2-3	clayey SAND with gravel	SC	100.0	92.8	90.3	85.9	83.1	76.9	72.4	65.0	55.1	49.6	41.8	39.1	33.6	28.7	35.0	36.3	28.7	18	47	29	-				
TP-100	4-6	silty SAND with gravel	SM	100.0	100.0	99.5	95.6	91.5	85.0	80.0	71.4	59.8	52.1	37.6	32.1	22.5	14.4	28.6	57.0	14.4	NP	NP	NP	12.2				
TP-103	4-10	clayey GRAVEL with sand	GC	100.0	93.1	85.6	77.3	74.5	69.2	65.2	55.9	43.4	36.9	25.5	21.9	16.1	12.1	44.1	43.8	12.1	18	37	19	7.3				
TP-105	.5-1	clayey SAND	SC	100.0	100.0	99.4	97.5	96.2	94.8	94.3	89.5	82.3	77.4	65.1	57.9	44.0	35.0	10.5	54.5	35.0	26	41	15	7.5				
TP-105	2-4	clayey SAND with gravel	SC	100.0	100.0	98.0	94.8	91.7	87.6	85.3	80.2	73.2	67.7	53.7	46.0	32.9	24.2	19.8	56.0	24.2	23	35	12	-				
TP-108	5-6	clayey SAND	SC	100.0	100.0	98.4	97.5	96.6	95.8	95.1	91.9	94.9	77.5	61.9	56.6	48.3	42.0	8.1	49.9	42.0	19	49	30	11.7				
TP-111	1-2	clayey SAND with gravel	SC	100.0	100.0	95.2	90.5	88.9	86.4	84.6	80.2	75.7	73.3	66.6	59.8	43.6	34.4	19.8	45.8	34.4	19	45	26	-				
TP-111	7-8	clayey SAND	SC	100.0	100.0	100.0	100.0	99.9	99.4	98.5	91.6	80.8	73.9	53.8	43.7	29.5	21.9	8.4	69.7	21.9	12	38	26	11.9	5.2E-05	3.7E-05		
TP-113	3-4	clayey SAND with gravel	SC	100.0	98.4	97.7	95.6	93.1	87.8	82.9	72.2	61.5	55.1	41.5	36.5	29.4	24.9	27.8	47.3	24.9	15	37	22	6.1				
TP-118	2-3	sandy fat CLAY	CH	100.0	100.0	100.0	100.0	99.8	99.3	99.0	98.0	95.4	92.8	83.6	75.9	60.5	51.1	2.0	46.9	51.1	21	50	29	-				
TP-119	3-4	clayey SAND	SC	100.0	98.5	97.7	96.8	96.4	95.7	95.5	91.2	88.0	85.9	77.5	70.9	55.2	43.3	8.8	47.9	43.3	21	45	24	-	2.4E-06	7.2E-07	5.4E-07	
TP-120	5-6	clayey SAND with gravel	SC	100.0	100.0	99.5	97.3	95.2	91.2	88.0	80.2	63.7	53.5	32.5	26.1	18.4	13.6	19.8	66.6	13.6	11	21	10	-				
TP-122	3-4	sandy lean CLAY	CL	100.0	100.0	100.0	99.9	99.7	99.6	99.5	97.7	95.6	93.7	82.7	73.9	59.2	51.0	2.3	46.7	51.0	21	49	28	13.4				
TP-122A	7-8	clayey GRAVEL with sand	GC	100.0	82.8	79.0	73.6	72.0	70.4	69.6	66.4	61.9	59.6	51.8	47.2	40.2	35.2	33.6	31.2	35.2	17	41	24	-	6.1E-07	1.7E-07		
TP-122B	2.5-3.5	clayey SAND with gravel	SC	100.0	100.0	99.2	95.7	93.1	89.1	85.9	76.4	67.6	62.2	45.1	36.7	25.0	18.3	23.6	58.1	18.3	17	37	20	-	7.0E-06	4.5E-06		
TP-122C	4-5	clayey GRAVEL with sand	GC	100.0	95.0	94.1	88.7	82.4	71.6	65.4	53.7	43.5	38.1	27.5	23.5	17.9	14.8	46.3	38.9	14.8	14	39	25	-				
TP-122G	4-5	clayey SAND with gravel	SC	100.0	99.3	98.9	98.9	98.9	98.9	98.9	82.5	70.4	62.4	42.9	33.7	21.4	15.4	17.5	67.1	15.4	19	33	14	9.8				
TP-125	2-3	clayey SAND with gravel	SC	100.0	100.0	100.0	99.0	98.2	96.3	95.1	71.3	52.3	45.2	30.2	24.1	17.4	14.3	28.7	57.0	14.3	23	44	21	-				
TP-125A	3-4	sandy fat CLAY	CH	100.0	100.0	97.4	96.2	96.0	95.8	95.8	94.2	92.3	90.8	84.9	78.6	62.3	53.2	5.8	41.0	53.2	22	53	31	-				
TP-125B	1-2	silty SAND with gravel	SM	100.0	95.2	92.7	87.2	85.6	84.3	83.4	73.4	63.6	58.1	43.6	36.2	24.6	17.3	26.6	56.1	17.3	NP	NP	NP	-				
TP-126	2-3	sandy fat CLAY	CH	100.0	97.2	96.9	96.3	96.3	95.9	95.4	94.9	88.5	83.4	80.9	74.8	56.7	50.8	5.1	44.1	50.8	19	59	40					
TP-126	4-5	clayey SAND with gravel	SC	100.0	100.0	100.0	98.3	96.3	90.8	86.6	78.4	69.9	65.3	55.1	49.8	41.2	35.4	21.6	43.0	35.4	27	47	20	-	9.6E-07	6.2E-07		
TP-126C	2-3	clayey GRAVEL with sand	GC	100.0	86.8	72.8	62.9	59.2	55.3	53.2	45.5	39.0	36.2	30.4	27.8	23.1	19.5	54.5	26.0	19.5	22	35	13	-				
TP-126C	6-7	clayey SAND with gravel	SC	100.0	100.0	98.9	96.9	96.0	91.0	86.6	73.7	61.6	56.2	47.0	43.1	35.9	30.8	26.3	42.9	30.8	24	44	20	-				
TP-126D	2-3	clayey SAND	SC	100.0	100.0	100.0	100.0	100.0	99.1	98.8	90.1	76.9	67.9	45.8	37.2	26.0	19.1	9.9	71.0	19.1	19	35	16	5.6				

Notes:
NP - Non-Plastic
NV - Non-Viscus

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Project	**Elevation:**	See below per sample
Project Number:	475.0014.008	**Test Start Date:**	07/14/17
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-177	**Checked By:**	RF

Drying Conditions: 60 deg C / 110 deg C   Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-177-03/	17-177-04/	17-177-12/	17-177-14/	17-177-18/
Location		TP-65	TP-66	TP-83	TP-85	TP-89
Depth		1-2'	1.5-2.5'	5-6'	2-3'	6-8'
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	773.1	873.9	778.9	872	917
Tare + Dry Soil	**B**	733.7	826.1	693	817.8	855.8
Tare	**C**	121.5	190.5	120.1	124.8	192.3
Wt. of Water	**D= A-B**	39.4	47.8	85.9	54.2	61.2
Dry Soil, Ws	**E= B-C**	612.2	635.6	572.9	693	663.5
Moisture Content, (%)	**(D/E) x100**	6.4	7.5	15.0	7.8	9.2

Sample No.		17-177-23/	17-177-24/	17-177-25/	17-177-26/	17-177-31/
Location		TP-94	TP-94	TP-95	TP-95	TP-100
Depth		2-3'	11-12'	7-8'	7-8'	4-6'
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	998.4	1202.4	801.5	1386	930.2
Tare + Dry Soil	**B**	927.3	1138.5	761.7	1322.8	842.2
Tare	**C**	270.9	193.4	223.2	121.1	123.8
Wt. of Water	**D= A-B**	71.1	63.9	39.8	63.2	88
Dry Soil, Ws	**E= B-C**	656.4	945.1	538.5	1201.7	718.4
Moisture Content, (%)	**(D/E) x100**	10.8	6.8	7.4	5.3	12.2

Remarks:

NewFields

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NF Form #15

Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Project	**Elevation:**	See below per sample
Project Number:	475.0014.008	**Test Start Date:**	07/14/17
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	17-177	**Checked By:**	RF

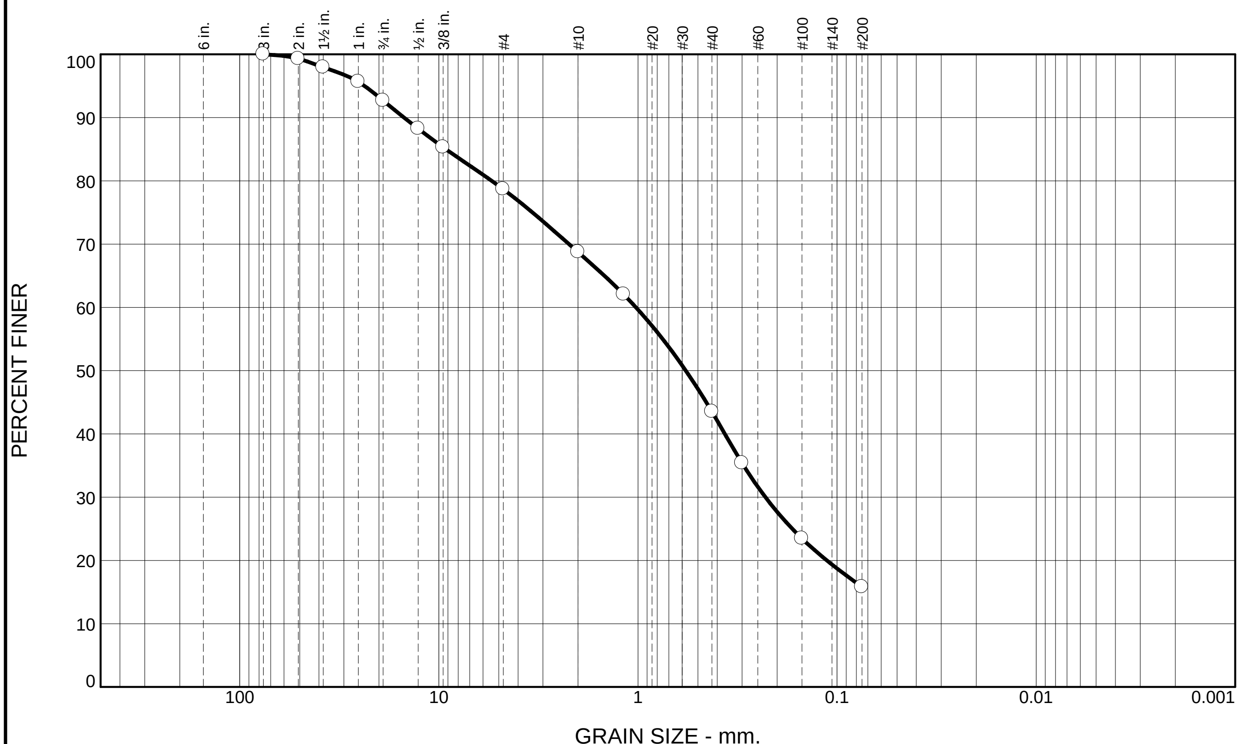
Drying Conditions: 60 deg C / 110 deg C   Method: Oven (O) / Microwave (M) / Hot Plate (H)

Sample No.		17-177-33/	17-177-34/	17-177-36/	17-177-38/	17-177-39/
Location		TP-103	TP-105	TP-108	TP-111	TP-113
Depth		4-10'	.5-1'	5-6'	7-8'	3-4'
Soil Description						
(USCS)						
Trial No.		**1**	**2**	**3**	**4**	**5**
Tare No.						
Tare + Wet Soil	**A**	912.5	1015.5	872.8	1067.5	848.9
Tare + Dry Soil	**B**	859	963.5	809.5	974.2	810.9
Tare	**C**	122.2	268.9	267.2	189.3	189.2
Wt. of Water	**D= A-B**	53.5	52	63.3	93.3	38
Dry Soil, Ws	**E= B-C**	736.8	694.6	542.3	784.9	621.7
Moisture Content, (%)	**(D/E) x100**	7.3	7.5	11.7	11.9	6.1

Sample No.		17-177-43/	17-177-47/	17-177-52/	17-177-55/	
Location		TP-122	TP-122G	TP-126	TP-126D	
Depth		3-4'	4-5'	4-5'	2-3'	
Soil Description						
(USCS)						
Trial No.		**6**	**7**	**8**	**9**	**10**
Tare No.						
Tare + Wet Soil	**A**	1171.7	1045.4	832.5	802.4	
Tare + Dry Soil	**B**	1064.6	975.5	748.6	766.5	
Tare	**C**	268.3	264.5	140.9	129.4	
Wt. of Water	**D= A-B**	107.1	69.9	83.9	35.9	
Dry Soil, Ws	**E= B-C**	796.3	711	607.7	637.1	
Moisture Content, (%)	**(D/E) x100**	13.4	9.8	13.8	5.6	

Remarks:

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.3	14.0	10.0	25.2	27.7	15.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	99.3		
1.5"	98.0		
1"	95.7		
0.75"	92.7		
0.5"	88.3		
0.375"	85.3		
#4	78.7		
#10	68.7		
#16	62.0		
#40	43.5		
#50	35.4		
#100	23.5		
#200	15.8		

* (no specification provided)

Material Description

Dark Brown clayey sand with gravel

Atterberg Limits

PL= 14 LL= 24 PI= 10

Coefficients

D_{90}= 14.9488 D_{85}= 9.2156 D_{60}= 1.0238
D_{50}= 0.5751 D_{30}= 0.2290 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-4(0)

Remarks

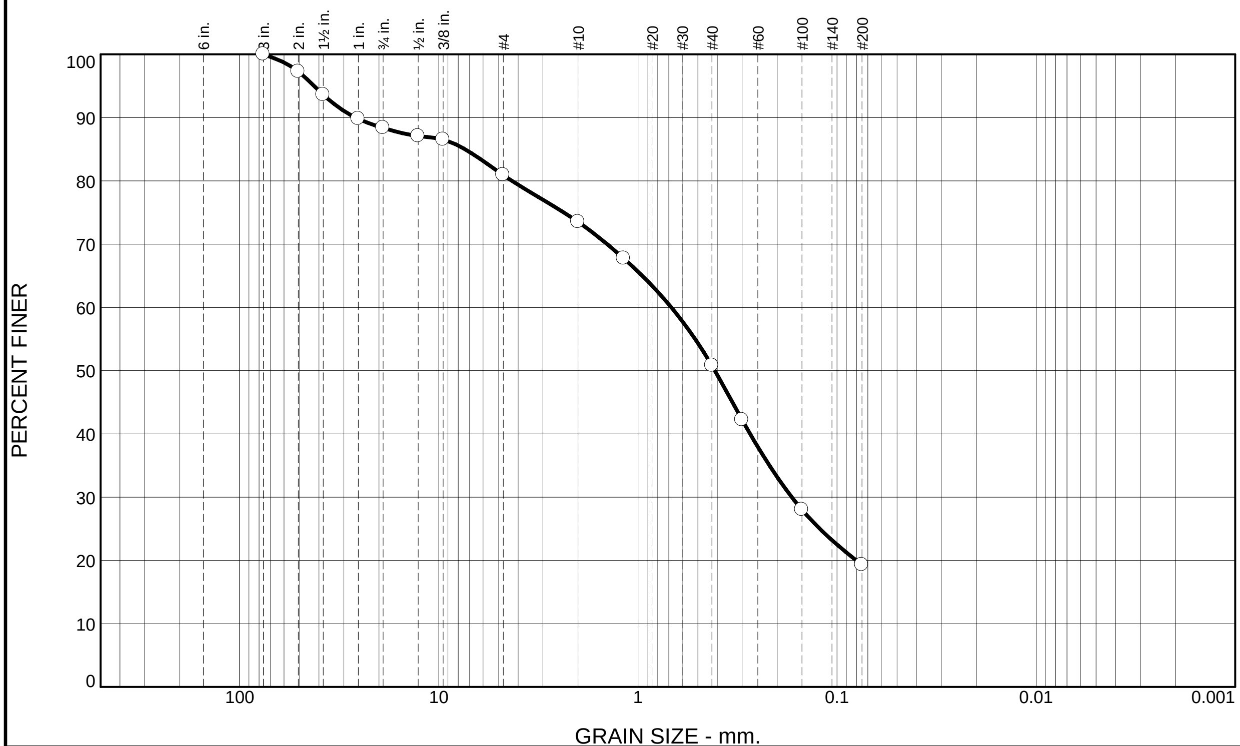
Location: TP-63
Sample Number: 17-177-02 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-02

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.6	7.5	7.4	22.7	31.5	19.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	97.3		
1.5"	93.6		
1"	89.8		
.75"	88.4		
0.5"	87.1		
0.375"	86.5		
#4	80.9		
#10	73.5		
#16	67.7		
#40	50.8		
#50	42.2		
#100	28.0		
#200	19.3		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 19 LL= 30 PI= 11

Coefficients

D_{90}= 26.1682 D_{85}= 7.3924 D_{60}= 0.6798
D_{50}= 0.4108 D_{30}= 0.1687 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

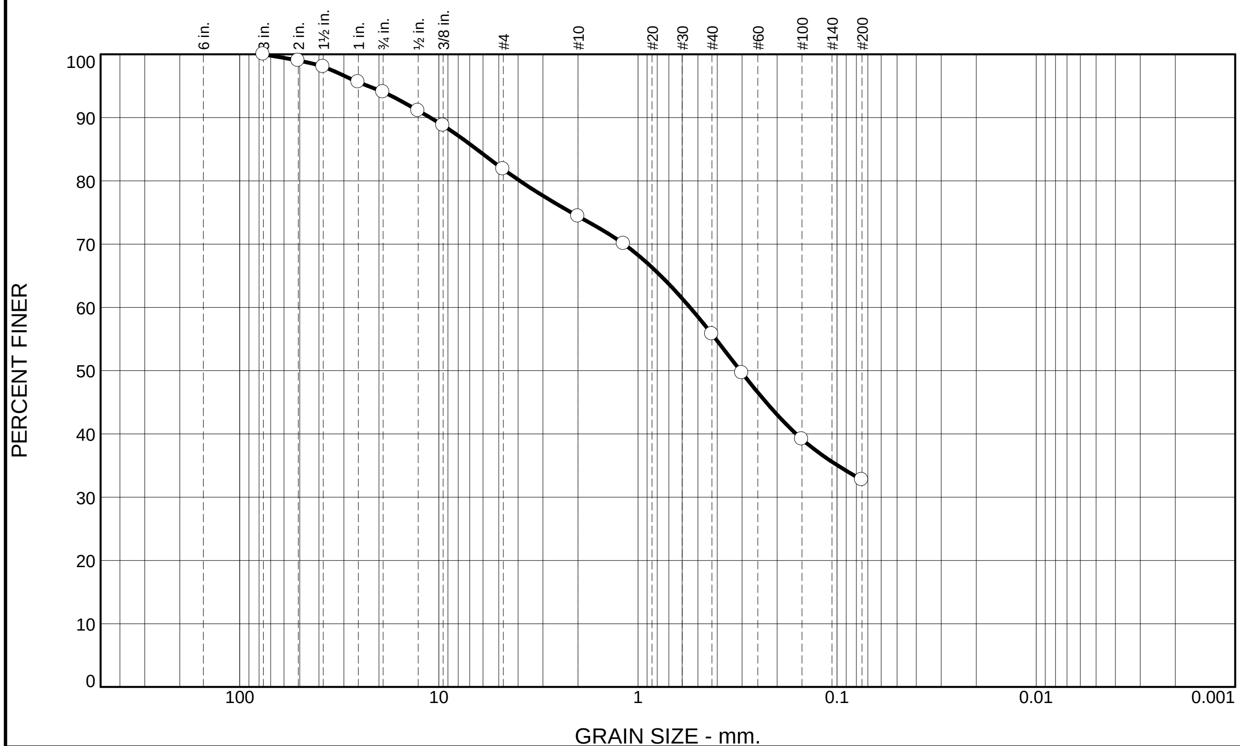
Location: TP-65
Sample Number: 17-177-03 **Depth:** 1-2' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-03

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.0	12.2	7.4	18.6	23.1	32.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	99.0		
1.5"	98.0		
1"	95.6		
0.75"	94.0		
0.5"	91.1		
0.375"	88.8		
#4	81.8		
#10	74.4		
#16	70.0		
#40	55.8		
#50	49.6		
#100	39.2		
#200	32.7		

* (no specification provided)

Material Description

Red Brown clayey sand with gravel

Atterberg Limits

PL= 19 LL= 44 PI= 25

Coefficients

D_{90}= 11.0498 D_{85}= 6.4666 D_{60}= 0.5478
D_{50}= 0.3061 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(3)

Remarks

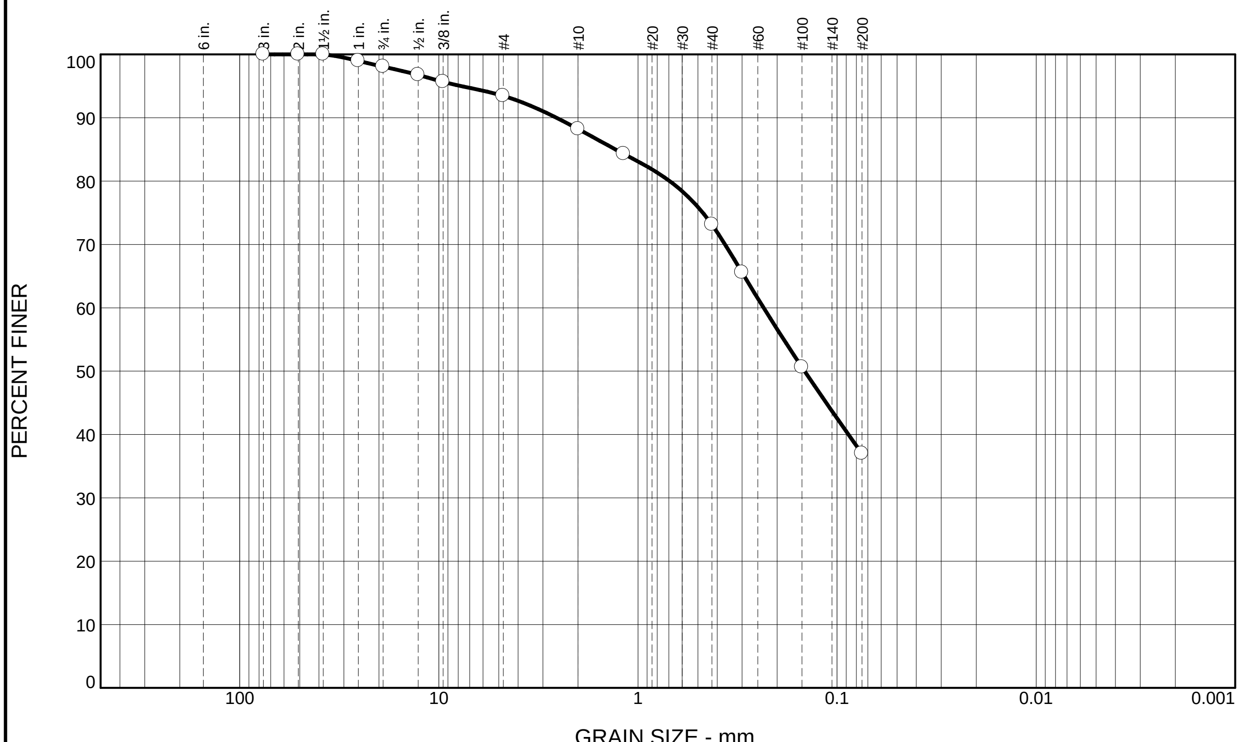
Location: TP-66
Sample Number: 17-177-04 **Depth:** 1.5-2.5' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-04

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.9	4.6	5.3	15.1	36.1	37.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	99.0		
0.75"	98.1		
0.5"	96.8		
0.375"	95.7		
#4	93.5		
#10	88.2		
#16	84.3		
#40	73.1		
#50	65.6		
#100	50.6		
#200	37.0		

* (no specification provided)

Material Description

Dark Brown clayey sand

Atterberg Limits

PL= 18 LL= 27 PI= 9

Coefficients

D_{90}= 2.5683 D_{85}= 1.2976 D_{60}= 0.2337
D_{50}= 0.1455 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-4(0)

Remarks

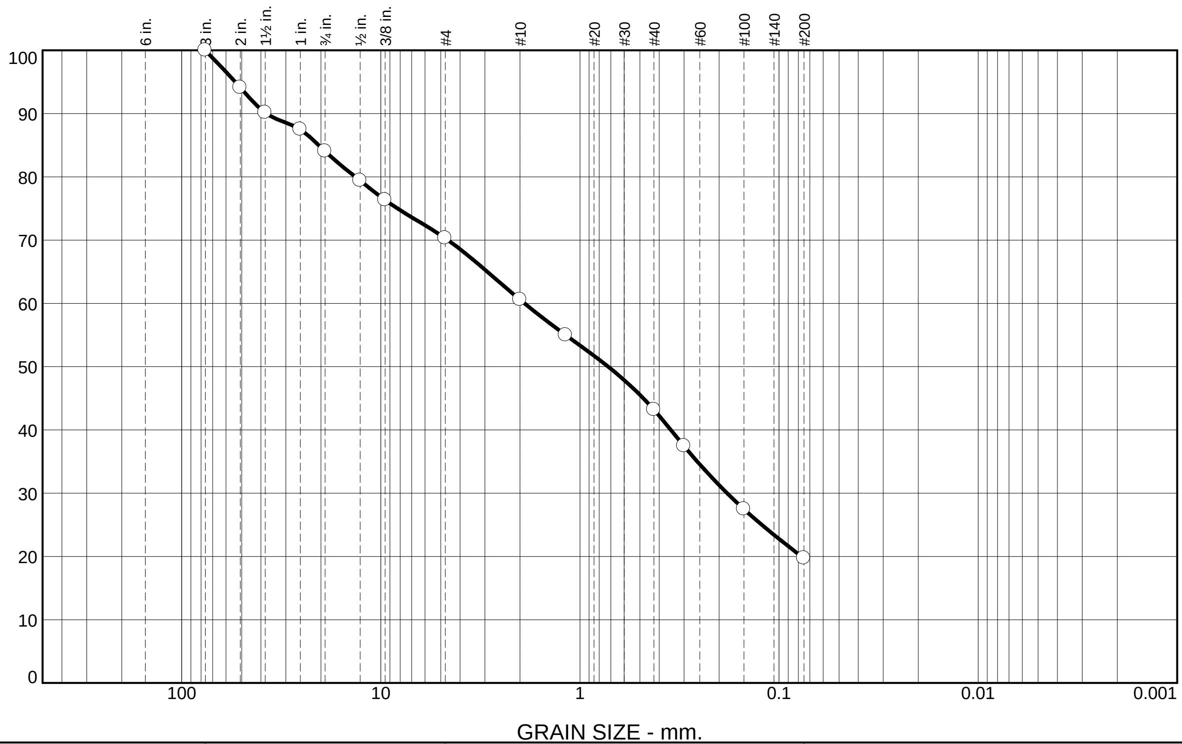
Location: TP-83
Sample Number: 17-177-12 **Depth:** 5-6' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-12

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.0	13.7	9.7	17.4	23.5	19.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	94.1		
1.5"	90.1		
1"	87.5		
0.75"	84.0		
0.5"	79.4		
0.375"	76.3		
#4	70.3		
#10	60.6		
#16	55.0		
#40	43.2		
#50	37.5		
#100	27.5		
#200	19.7		

* (no specification provided)

Material Description

Red Brown clayey sand with gravel

Atterberg Limits

PL= 16 LL= 29 PI= 13

Coefficients

D_{90}= 37.5617 D_{85}= 20.5189 D_{60}= 1.9003
D_{50}= 0.7219 D_{30}= 0.1823 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

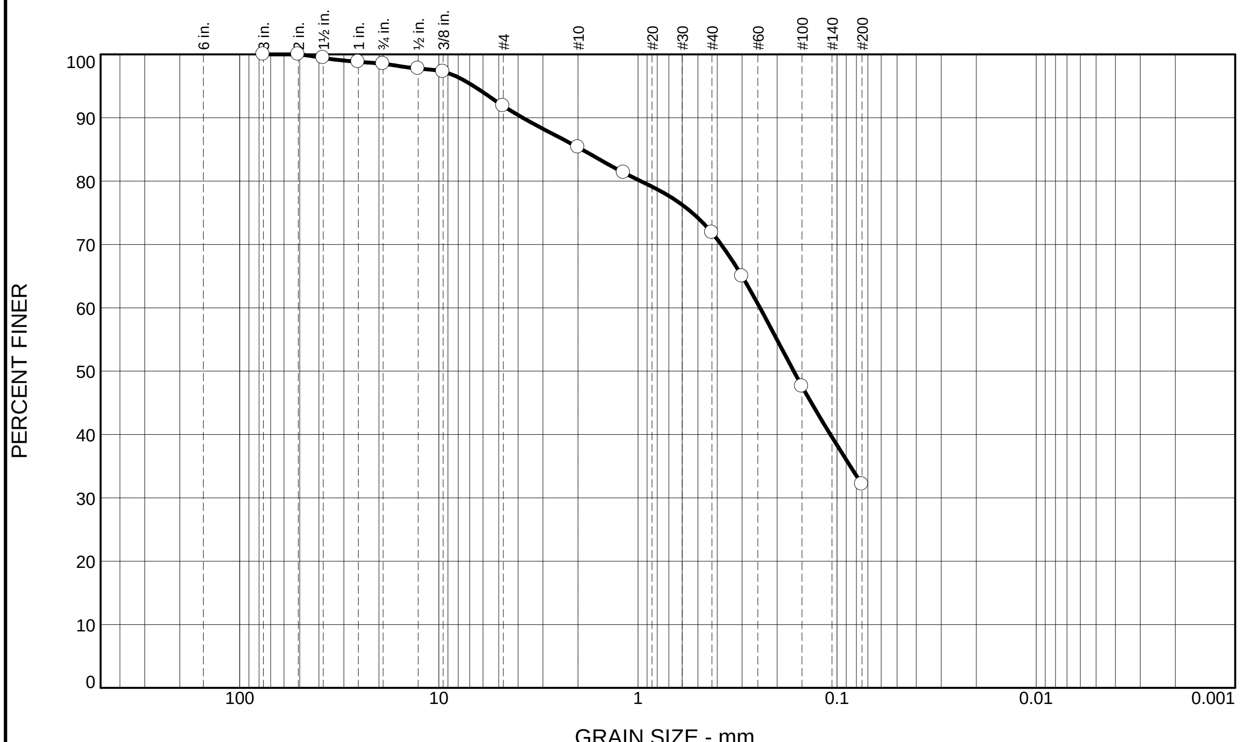
Location: TP-83
Sample Number: 17-177-13 **Depth:** 12-13' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-13

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.5	6.6	6.6	13.4	39.8	32.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	99.4		
1"	98.8		
0.75"	98.5		
0.5"	97.8		
0.375"	97.3		
#4	91.9		
#10	85.3		
#16	81.3		
#40	71.9		
#50	65.0		
#100	47.6		
#200	32.1		

* (no specification provided)

Material Description

Brown clayey sand

Atterberg Limits

PL= 17 LL= 29 PI= 12

Coefficients

D_{90}= 3.7963 D_{85}= 1.9132 D_{60}= 0.2439
D_{50}= 0.1651 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

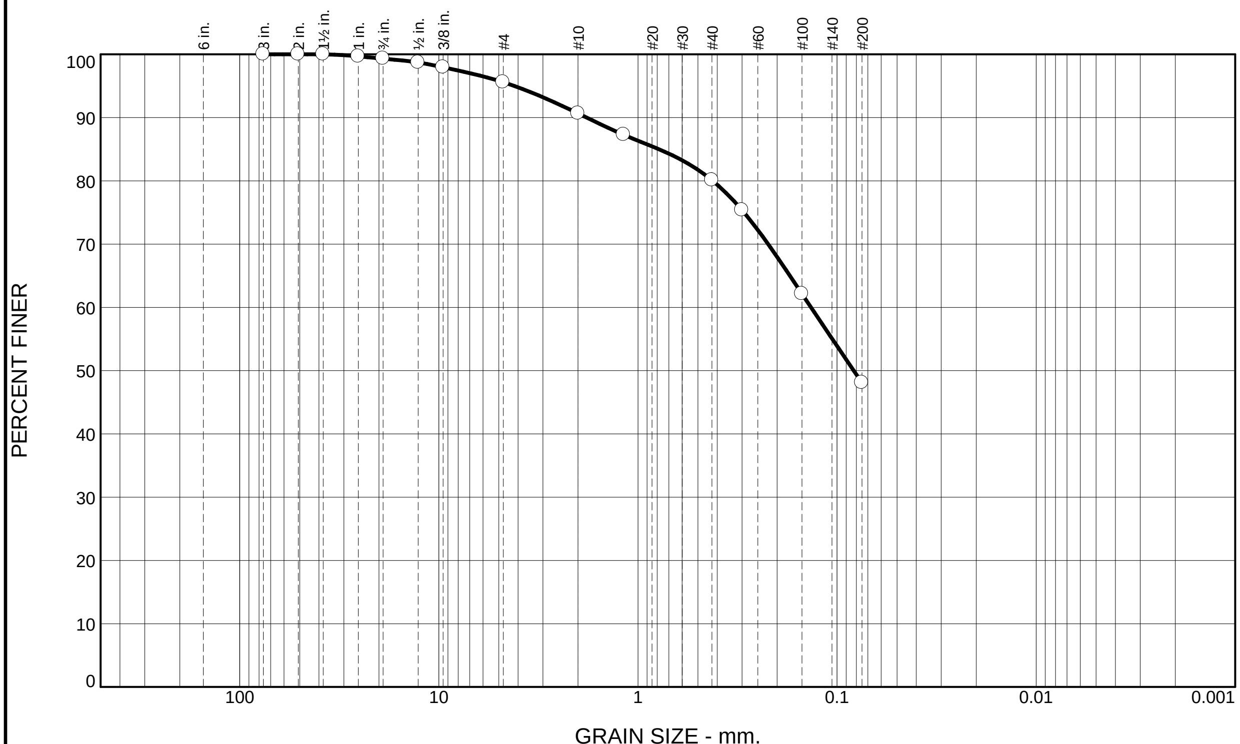
Location: TP-85
Sample Number: 17-177-14 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-14

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.7	3.7	4.9	10.6	32.0	48.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	99.7		
0.75"	99.3		
0.5"	98.7		
0.375"	97.9		
#4	95.6		
#10	90.7		
#16	87.3		
#40	80.1		
#50	75.4		
#100	62.1		
#200	48.1		

* (no specification provided)

Material Description

Dark Brown clayey sand

Atterberg Limits

PL= 13 LL= 30 PI= 17

Coefficients

D_{90}= 1.8091 D_{85}= 0.7855 D_{60}= 0.1351
D_{50}= 0.0825 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-6(4)

Remarks

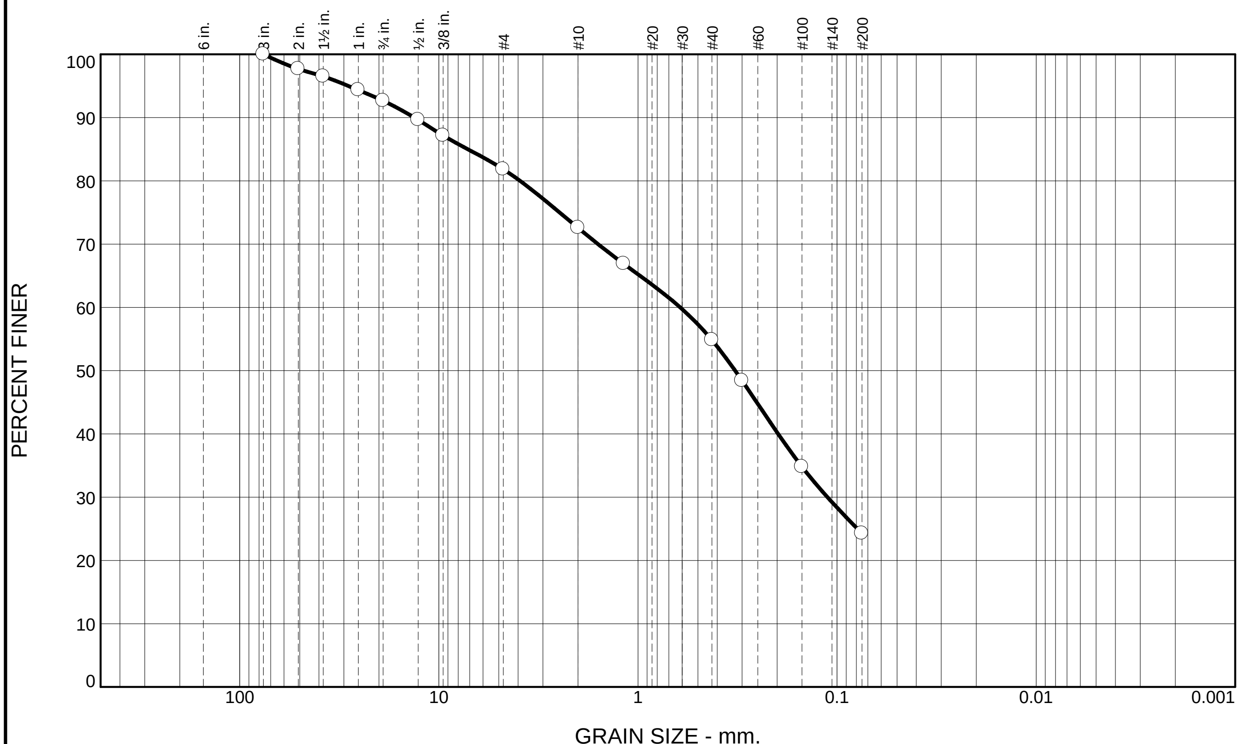
Location: TP-86
Sample Number: 17-177-15 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-15

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.3	10.9	9.2	17.8	30.5	24.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	97.7		
1.5"	96.5		
1"	94.3		
0.75"	92.7		
0.5"	89.6		
0.375"	87.2		
#4	81.8		
#10	72.6		
#16	66.9		
#40	54.8		
#50	48.4		
#100	34.8		
#200	24.3		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 15 LL= 30 PI= 15

Coefficients

D_{90}= 13.2764 D_{85}= 7.1559 D_{60}= 0.6135
D_{50}= 0.3252 D_{30}= 0.1118 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

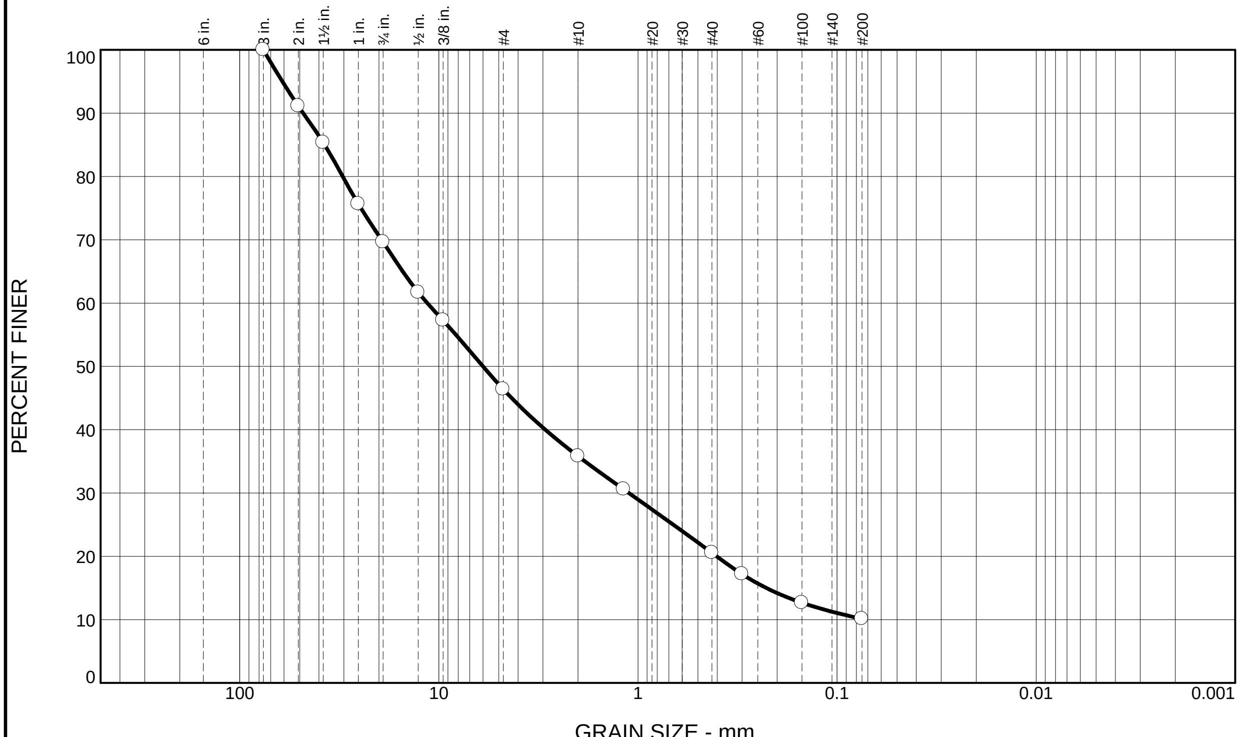
Location: TP-86
Sample Number: 17-177-16 **Depth:** 16-17' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-16

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	30.4	23.2	10.6	15.2	10.5	10.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	91.1		
1.5"	85.4		
1"	75.7		
0.75"	69.6		
0.5"	61.7		
0.375"	57.3		
#4	46.4		
#10	35.8		
#16	30.6		
#40	20.6		
#50	17.2		
#100	12.7		
#200	10.1		

* (no specification provided)

Material Description

Light brown well-graded gravel with clay and sand

Atterberg Limits

PL= 15 LL= 37 PI= 22

Coefficients

D_{90}= 48.0215 D_{85}= 37.4831 D_{60}= 11.4380
D_{50}= 6.0033 D_{30}= 1.1112 D_{15}= 0.2268
D_{10}= C_u= C_c=

Classification

USCS= GP-GC AASHTO= A-2-6(0)

Remarks

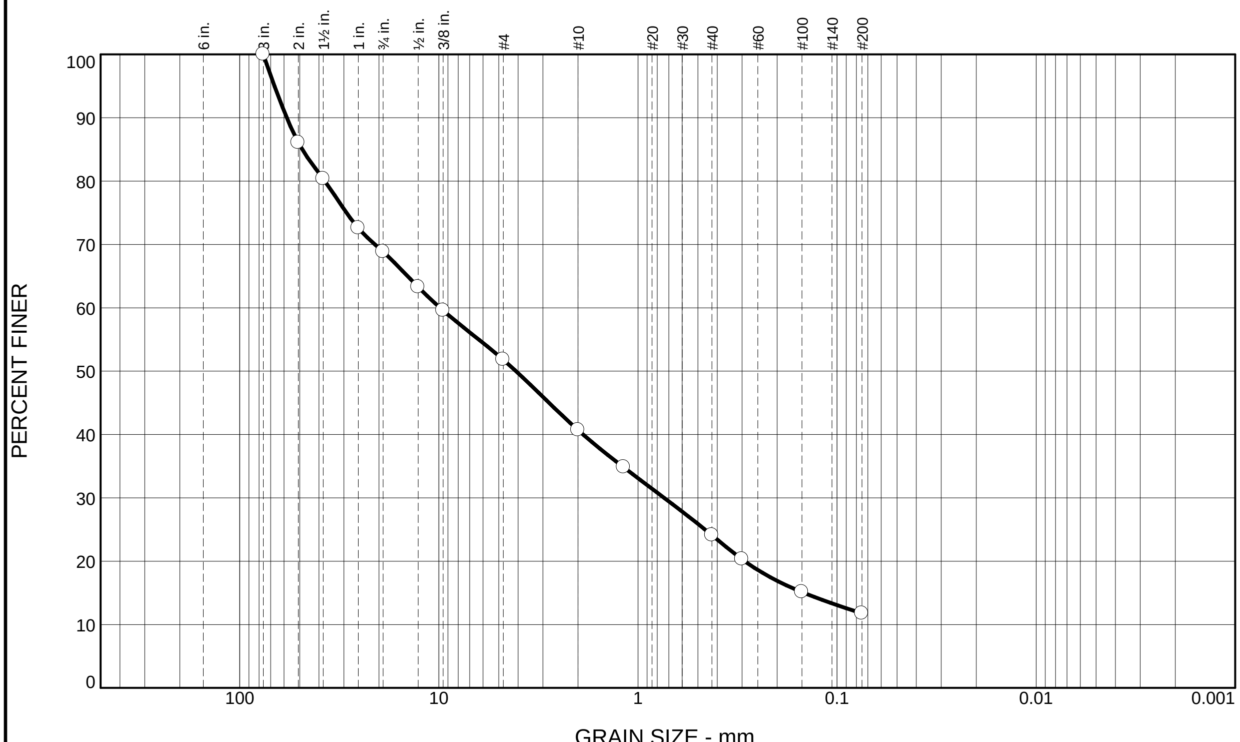
Location: TP-88
Sample Number: 17-177-17 **Depth:** 5-7' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-17

Tested By: DR **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	31.2	17.0	11.1	16.6	12.3	11.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	86.1		
1.5"	80.4		
1"	72.6		
0.75"	68.8		
0.5"	63.3		
0.375"	59.6		
#4	51.8		
#10	40.7		
#16	34.8		
#40	24.1		
#50	20.3		
#100	15.1		
#200	11.8		

* (no specification provided)

Material Description

Brown poorly graded gravel with clay and sand

Atterberg Limits

PL= 22 LL= 33 PI= 11

Coefficients

D_{90}= 58.0861 D_{85}= 48.5638 D_{60}= 9.8595
D_{50}= 4.0990 D_{30}= 0.7392 D_{15}= 0.1469
D_{10}= C_u= C_c=

Classification

USCS= GP-GC AASHTO= A-2-6(0)

Remarks

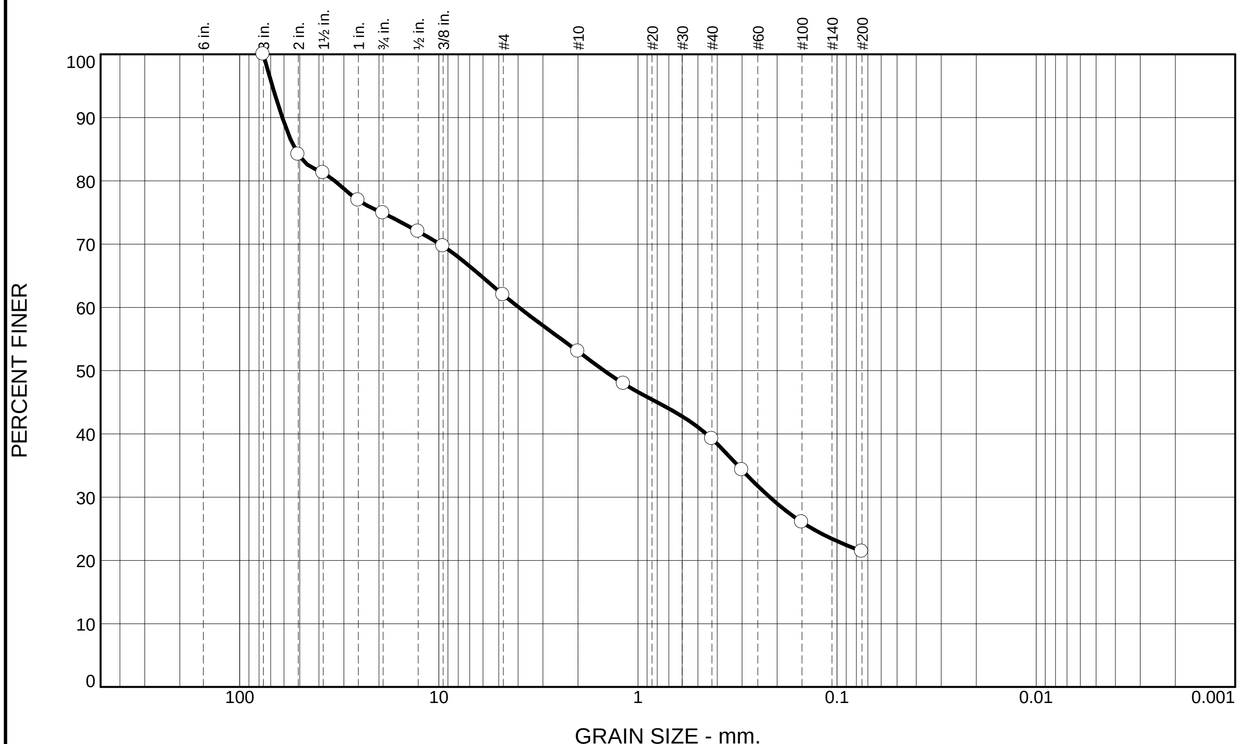
Location: TP-89
Sample Number: 17-177-18 **Depth:** 6-8' **Date:** 07/114/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-18

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	25.1	12.9	9.0	13.8	17.8	21.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	84.2		
1.5"	81.2		
1"	76.9		
0.75"	74.9		
0.5"	72.0		
0.375"	69.7		
#4	62.0		
#10	53.0		
#16	47.9		
#40	39.2		
#50	34.3		
#100	26.0		
#200	21.4		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 20 LL= 56 PI= 36

Coefficients

D_{90}= 61.1348 D_{85}= 52.6512 D_{60}= 3.9649
D_{50}= 1.4783 D_{30}= 0.2176 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(2)

Remarks

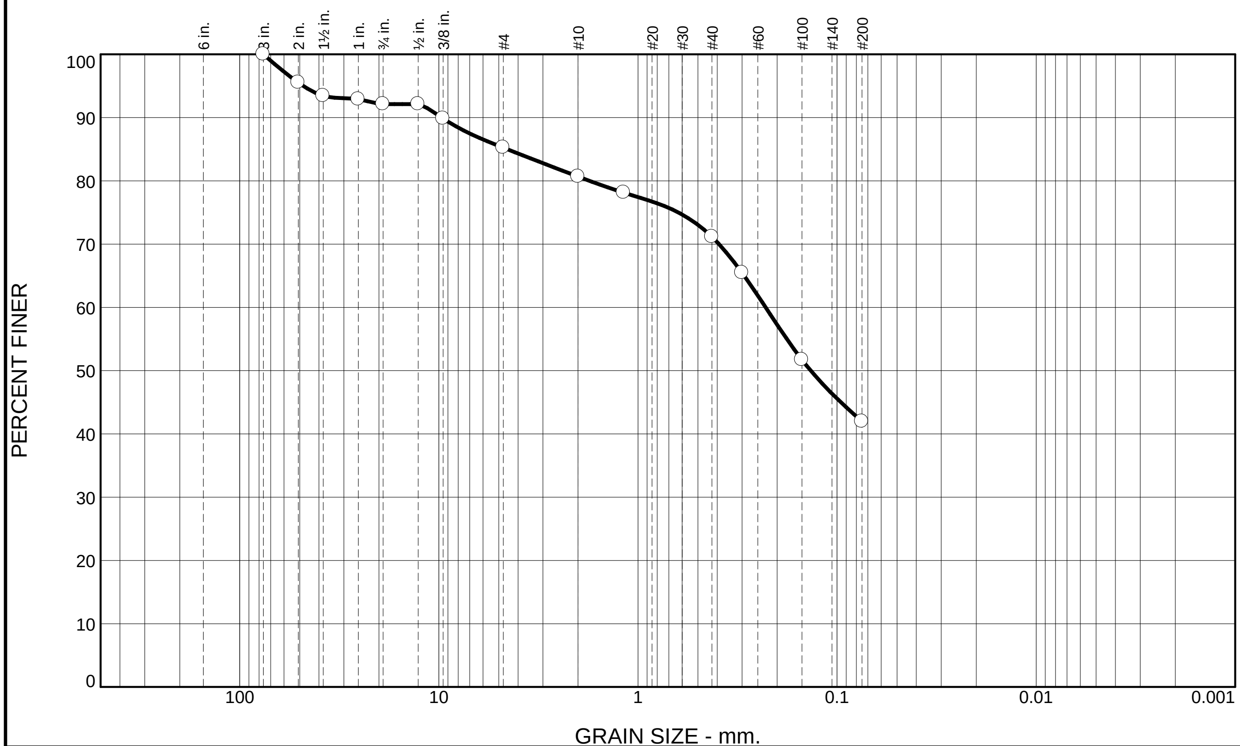
Location: TP-91
Sample Number: 17-177-20 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-20

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.9	6.9	4.5	9.6	29.1	42.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	95.5		
1.5"	93.4		
1"	92.9		
0.75"	92.1		
0.5"	92.1		
0.375"	89.9		
#4	85.2		
#10	80.7		
#16	78.1		
#40	71.1		
#50	65.5		
#100	51.7		
#200	42.0		

* (no specification provided)

Material Description

Red Brown clayey sand

Atterberg Limits

PL= 18 LL= 41 PI= 23

Coefficients

D_{90}= 9.6731 D_{85}= 4.5378 D_{60}= 0.2284
D_{50}= 0.1355 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(5)

Remarks

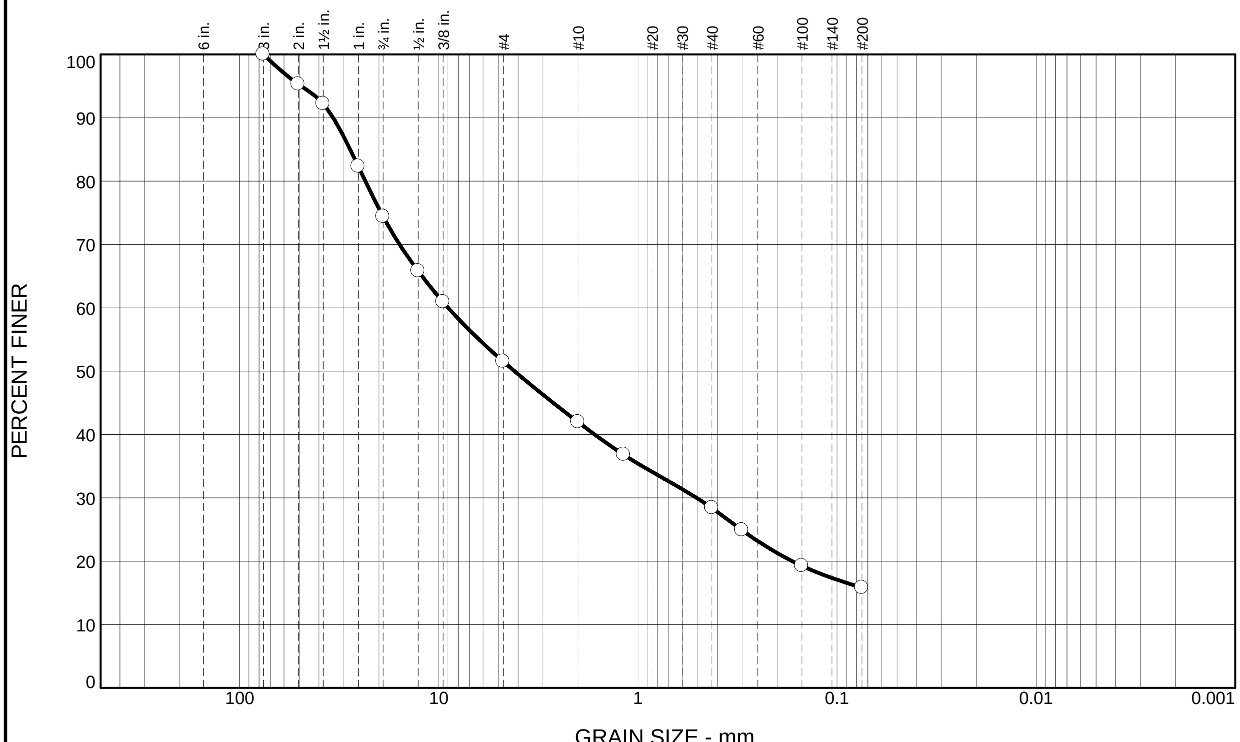
Location: TP-91B
Sample Number: 17-177-21 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-21

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	25.6	22.9	9.5	13.6	12.6	15.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	95.3		
1.5"	92.2		
1"	82.3		
0.75"	74.4		
0.5"	65.8		
0.375	60.9		
#4	51.5		
#10	42.0		
#16	36.8		
#40	28.4		
#50	24.9		
#100	19.3		
#200	15.8		

* (no specification provided)

Material Description

Red brown clayey gravel with sand

Atterberg Limits

PL= 14 LL= 42 PI= 28

Coefficients

D_{90}= 33.9650 D_{85}= 27.9054 D_{60}= 8.9805
D_{50}= 4.1741 D_{30}= 0.5082 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(0)

Remarks

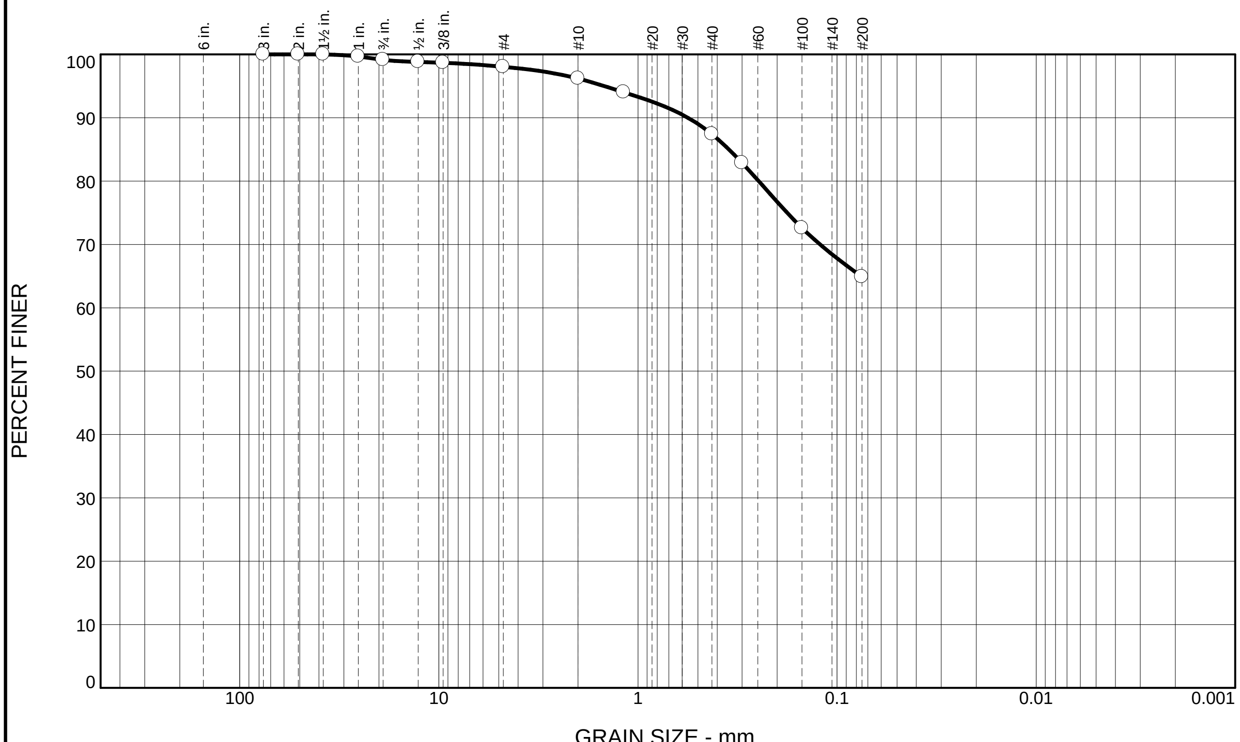
Location: TP-91B
Sample Number: 17-177-22 **Depth:** 5-6' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-22

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.9	1.1	1.8	8.8	22.5	64.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	99.7		
0.75"	99.1		
0.5"	98.8		
0.375"	98.7		
#4	98.0		
#10	96.2		
#16	94.0		
#40	87.4		
#50	82.9		
#100	72.6		
#200	64.9		

* (no specification provided)

Material Description

Brown sandy lean clay

Atterberg Limits

PL= 15 LL= 39 PI= 24

Coefficients

D_{90}= 0.5614 D_{85}= 0.3493 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(13)

Remarks

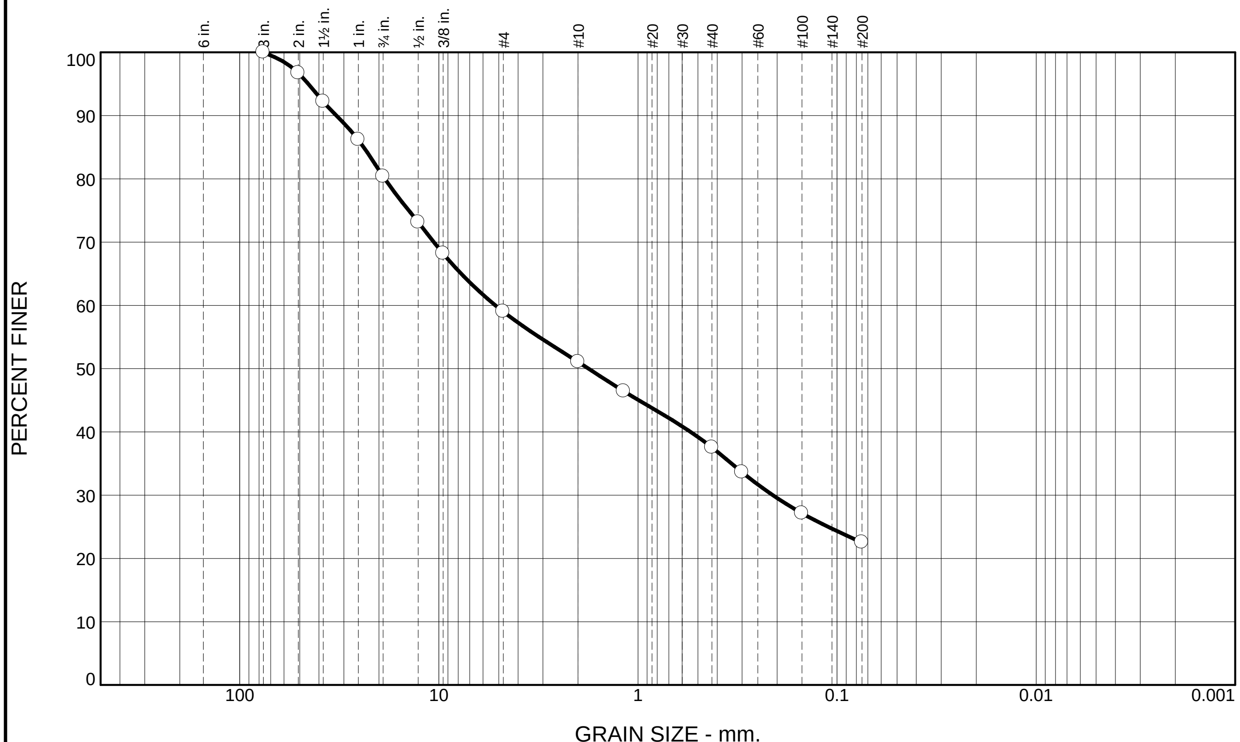
Location: TP-94
Sample Number: 17-177-23 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-23

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.6	21.4	7.9	13.6	15.0	22.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	96.7		
1.5"	92.2		
1"	86.2		
0.75"	80.4		
0.5"	73.1		
0.375"	68.2		
#4	59.0		
#10	51.1		
#16	46.4		
#40	37.5		
#50	33.6		
#100	27.1		
#200	22.5		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 17 LL= 39 PI= 22

Coefficients

D_{90}= 32.7061 D_{85}= 23.8494 D_{60}= 5.1978
D_{50}= 1.7722 D_{30}= 0.2103 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(1)

Remarks

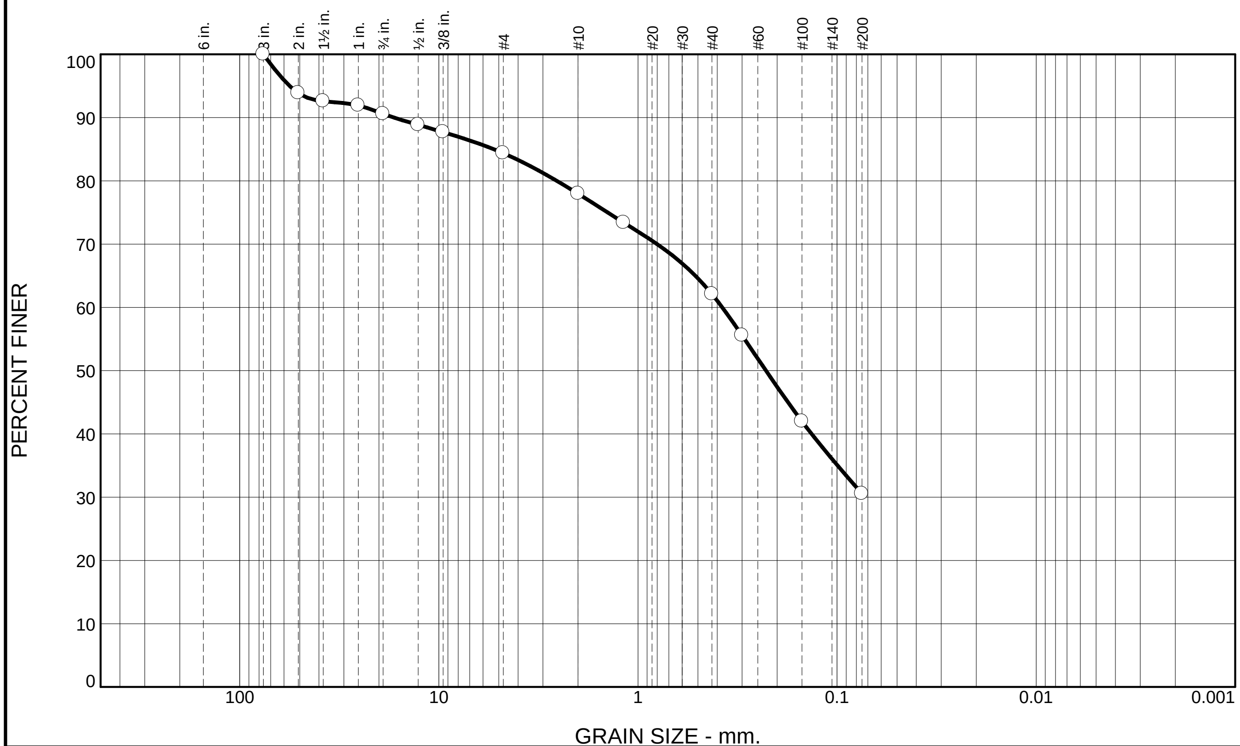
Location: TP-94
Sample Number: 17-177-24 **Depth:** 11-12' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-24

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	9.4	6.2	6.4	15.9	31.5	30.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	93.9		
1.5"	92.6		
1"	91.9		
0.75"	90.6		
0.5"	88.9		
0.375"	87.7		
#4	84.4		
#10	78.0		
#16	73.4		
#40	62.1		
#50	55.6		
#100	42.0		
#200	30.6		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 14 LL= 33 PI= 19

Coefficients

D_{90}= 16.7945 D_{85}= 5.3035 D_{60}= 0.3773
D_{50}= 0.2275 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

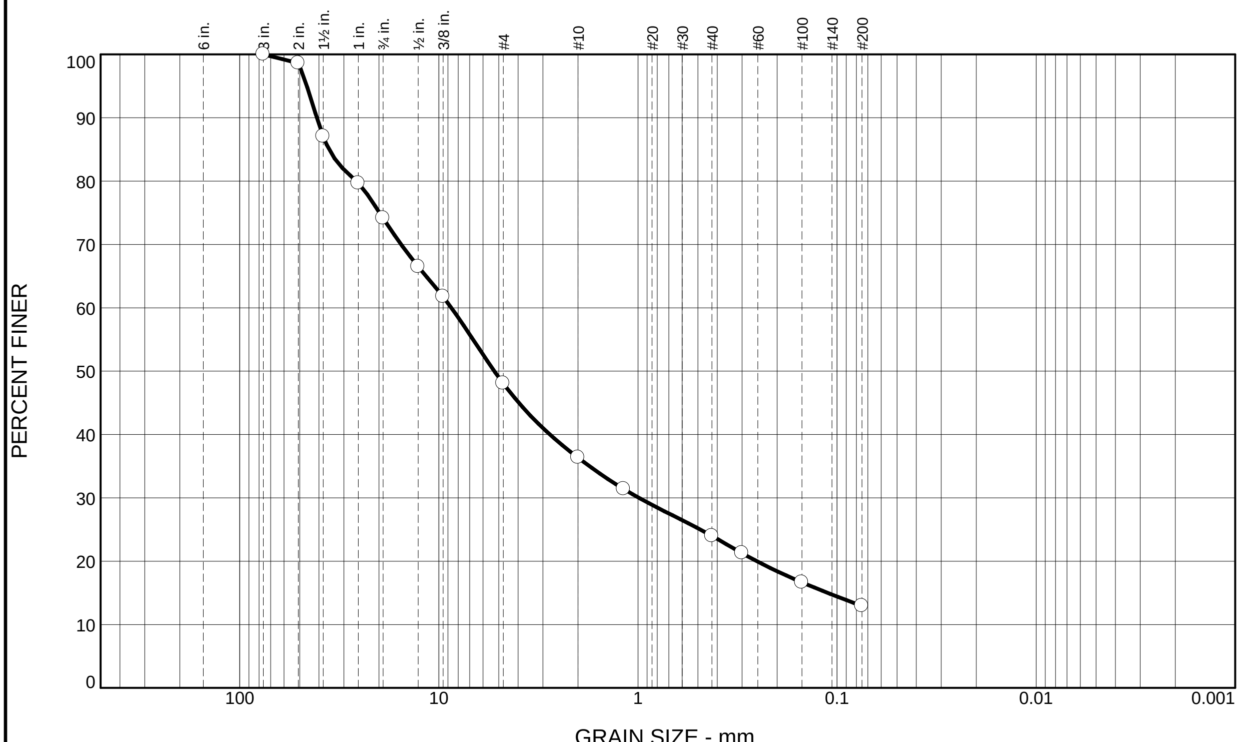
Location: TP-95
Sample Number: 17-177-25 **Depth:** 7-8' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-25

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	25.9	26.0	11.8	12.3	11.1	12.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	98.6		
1.5"	87.1		
1"	79.7		
0.75"	74.1		
0.5"	66.5		
0.375"	61.7		
#4	48.1		
#10	36.3		
#16	31.4		
#40	24.0		
#50	21.3		
#100	16.7		
#200	12.9		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 17 LL= 43 PI= 26

Coefficients

D_{90}= 41.0527 D_{85}= 35.6064 D_{60}= 8.6580
D_{50}= 5.2645 D_{30}= 0.9889 D_{15}= 0.1114
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(0)

Remarks

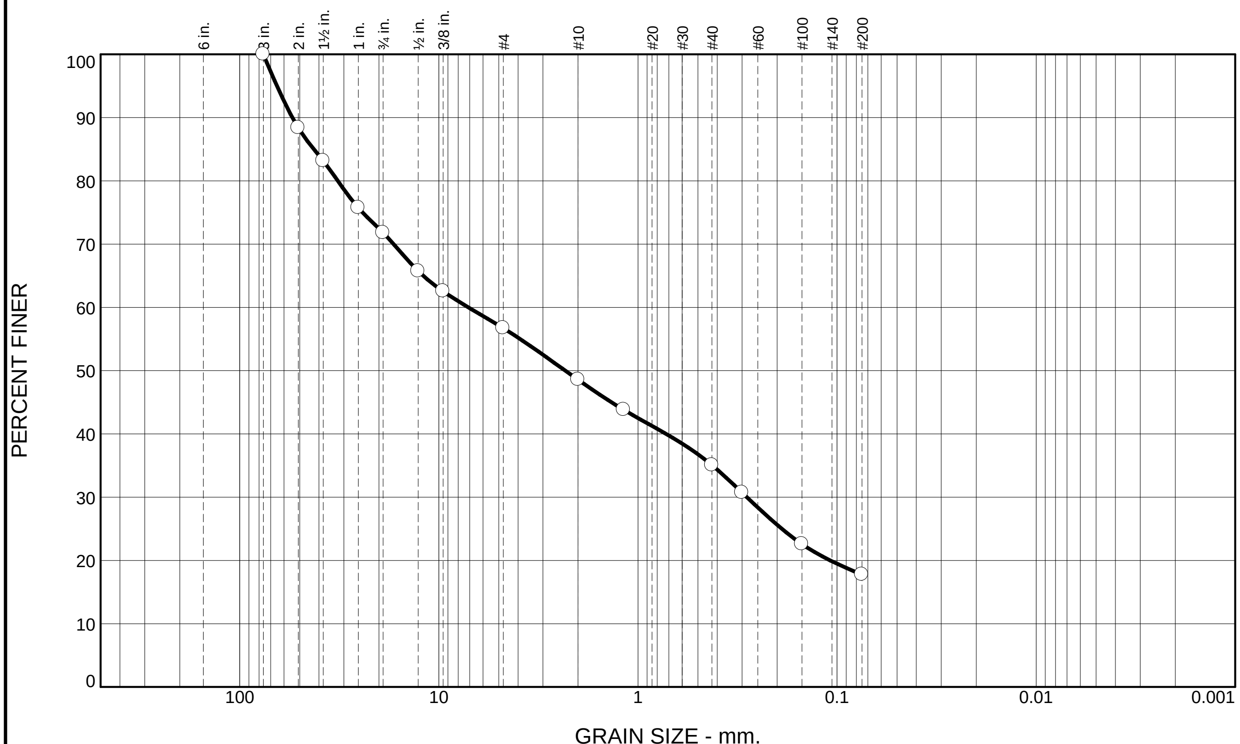
Location: TP-95
Sample Number: 17-177-26 **Depth:** 7-8' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-26

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	28.2	15.1	8.1	13.5	17.3	17.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	88.4		
1.5"	83.2		
1"	75.7		
0.75"	71.8		
0.5"	65.7		
0.375"	62.5		
#4	56.7		
#10	48.6		
#16	43.8		
#40	35.1		
#50	30.7		
#100	22.6		
#200	17.8		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 16 LL= 40 PI= 24

Coefficients

D_{90}= 54.4411 D_{85}= 42.4519 D_{60}= 7.1100
D_{50}= 2.3182 D_{30}= 0.2838 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

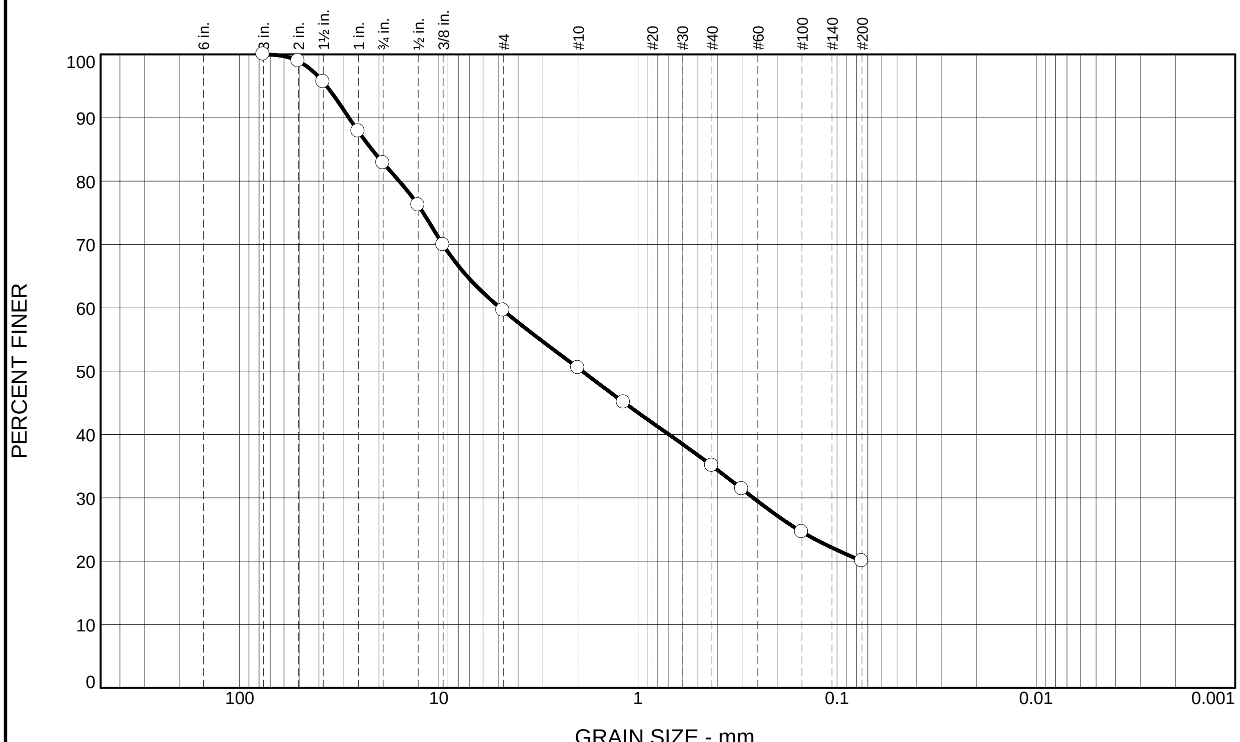
Location: TP-96
Sample Number: 17-177-27 **Depth:** 3-4' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-27

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	17.1	23.3	9.1	15.4	15.1	20.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	99.0		
1.5"	95.7		
1"	87.9		
0.75"	82.9		
0.5"	76.2		
0.375"	69.9		
#4	59.6		
#10	50.5		
#16	45.1		
#40	35.1		
#50	31.4		
#100	24.6		
#200	20.0		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 16 LL= 43 PI= 27

Coefficients

D_{90}= 28.2847 D_{85}= 21.6992 D_{60}= 4.9242
D_{50}= 1.9050 D_{30}= 0.2636 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(1)

Remarks

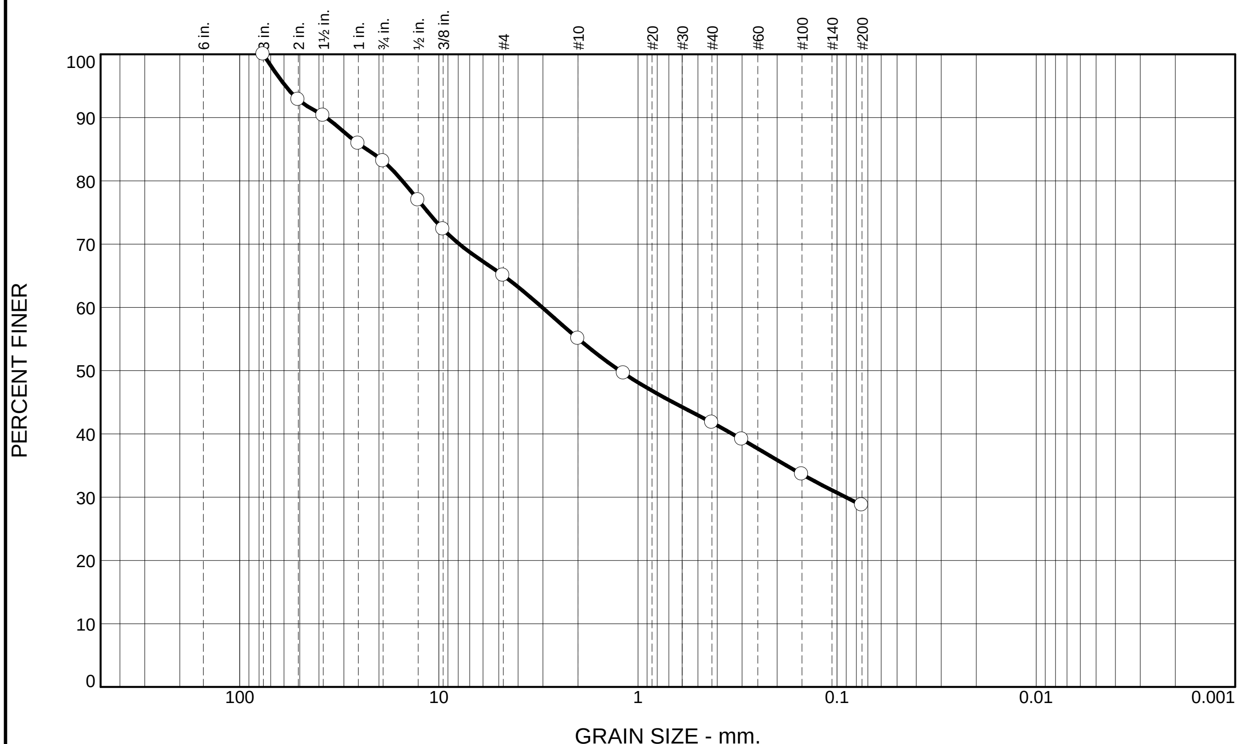
Location: TP-97
Sample Number: 17-177-28 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-28

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.9	18.1	9.9	13.3	13.1	28.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	92.8		
1.5"	90.3		
1"	85.9		
0.75"	83.1		
0.5"	76.9		
0.375"	72.4		
#4	65.0		
#10	55.1		
#16	49.6		
#40	41.8		
#50	39.1		
#100	33.6		
#200	28.7		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 18 LL= 47 PI= 29

Coefficients

D_{90}= 36.7929 D_{85}= 23.0623 D_{60}= 3.0283
D_{50}= 1.2347 D_{30}= 0.0904 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(3)

Remarks

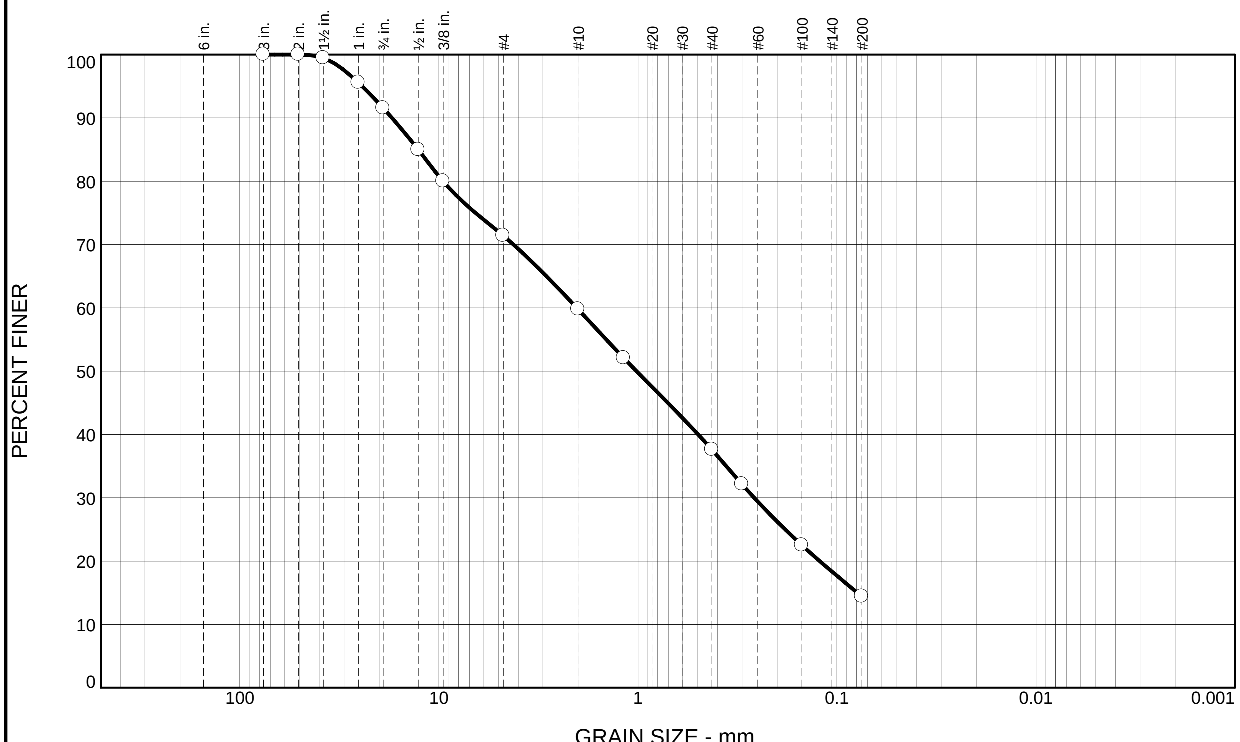
Location: TP-98
Sample Number: 17-177-29 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-29

Tested By: DR **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.5	20.1	11.6	22.2	23.2	14.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	99.5		
1"	95.6		
0.75"	91.5		
0.5"	85.0		
0.375"	80.0		
#4	71.4		
#10	59.8		
#16	52.1		
#40	37.6		
#50	32.1		
#100	22.5		
#200	14.4		

* (no specification provided)

Material Description

Brown silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 17.2246 D_{85}= 12.7155 D_{60}= 2.0307
D_{50}= 1.0171 D_{30}= 0.2605 D_{15}= 0.0790
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

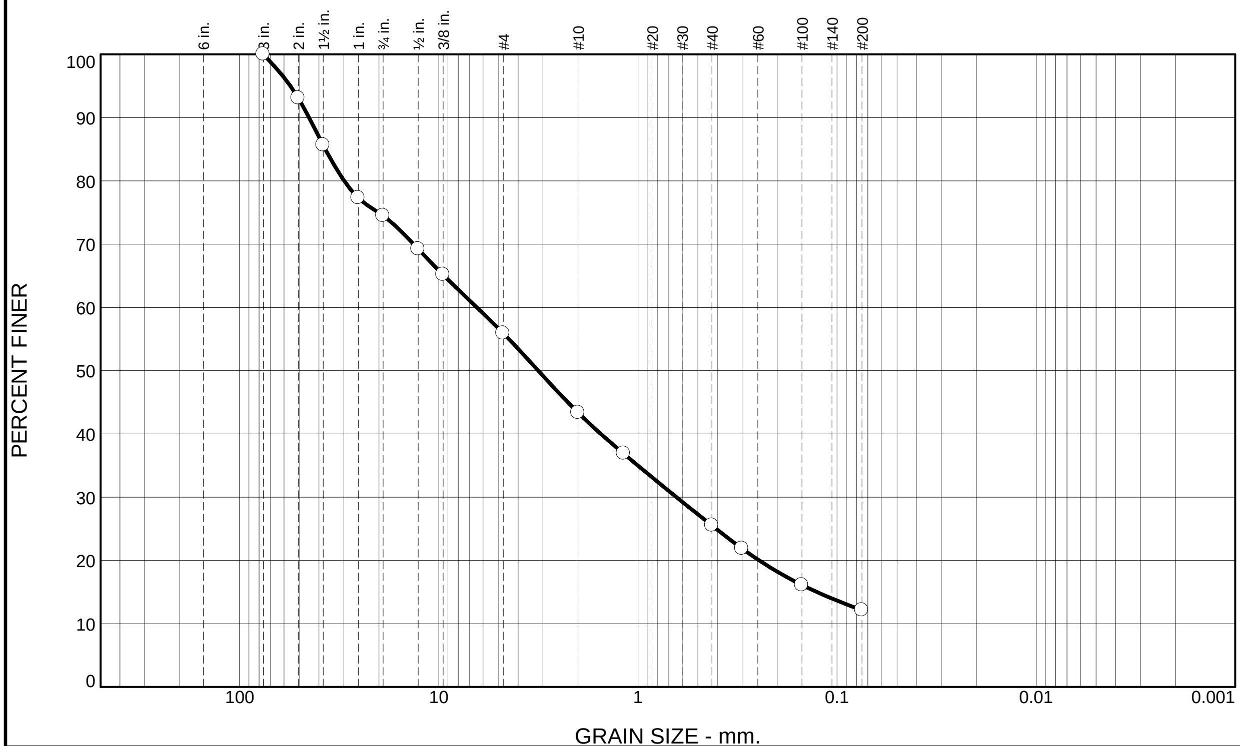
Location: TP-100
Sample Number: 17-177-31 **Depth:** 4-6' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-32

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	25.5	18.6	12.5	17.9	13.4	12.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	93.1		
1.5"	85.6		
1"	77.3		
0.75"	74.5		
0.5"	69.2		
0.375"	65.2		
#4	55.9		
#10	43.4		
#16	36.9		
#40	25.5		
#50	21.9		
#100	16.1		
#200	12.1		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 18 LL= 37 PI= 19

Coefficients

D_{90}= 44.8755 D_{85}= 37.1846 D_{60}= 6.4464
D_{50}= 3.1686 D_{30}= 0.6406 D_{15}= 0.1261
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

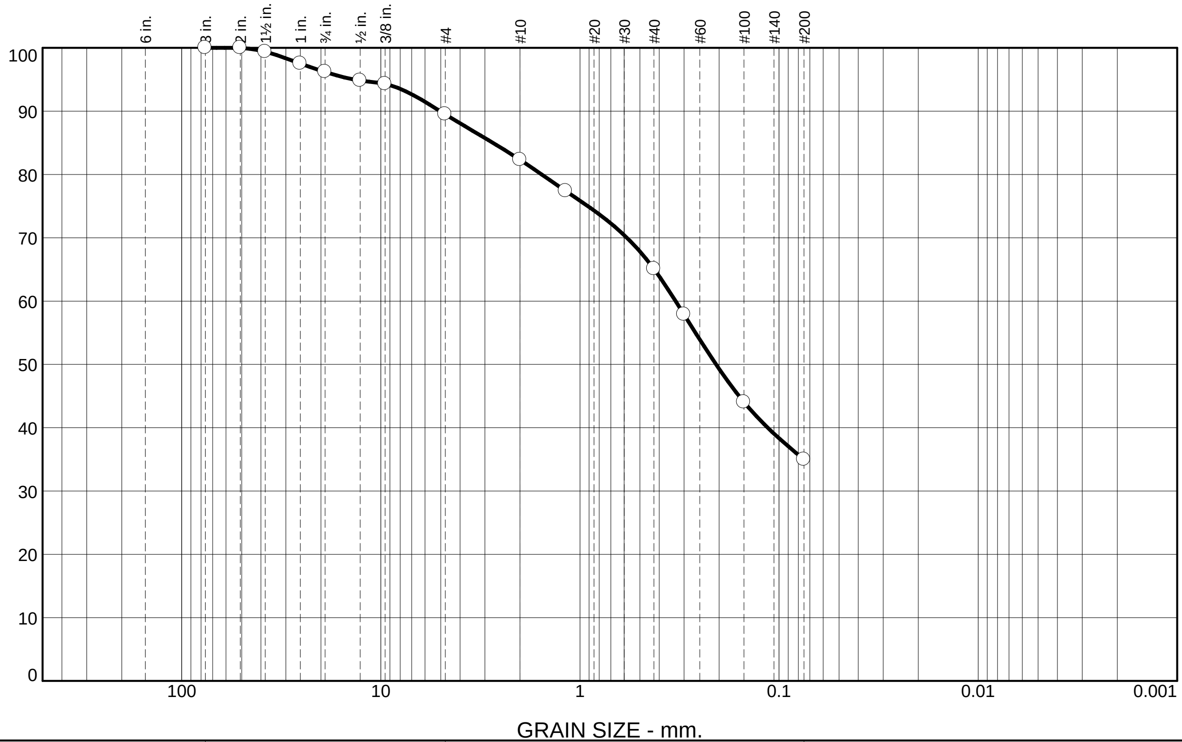
Location: TP-103
Sample Number: 17-177-33 **Depth:** 4-10' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-33

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.8	6.7	7.2	17.2	30.1	35.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	99.4		
1"	97.5		
0.75"	96.2		
0.5"	94.8		
0.375"	94.3		
#4	89.5		
#10	82.3		
#16	77.4		
#40	65.1		
#50	57.9		
#100	44.0		
#200	35.0		

* (no specification provided)

Material Description

Brown clayey sand

Atterberg Limits

PL= 26 LL= 41 PI= 15

Coefficients

D_{90}= 5.0332 D_{85}= 2.7380 D_{60}= 0.3309
D_{50}= 0.2071 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-2-7(1)

Remarks

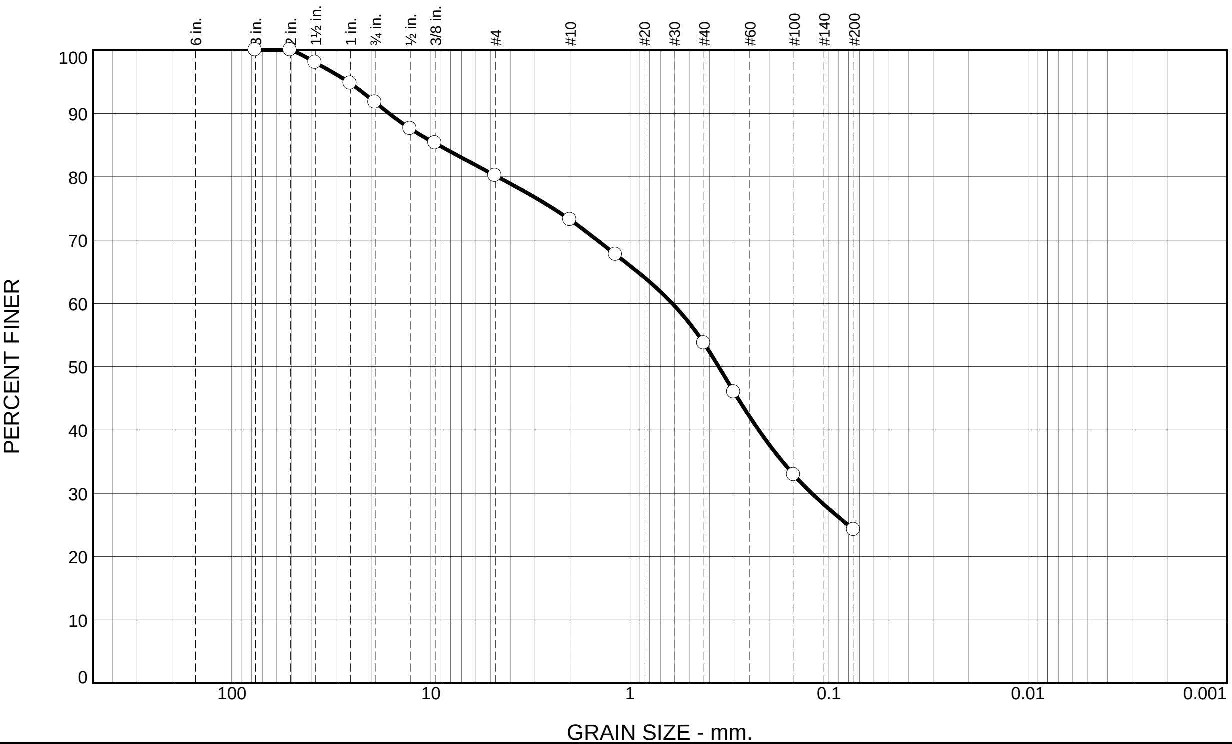
Location: TP-105
Sample Number: 17-177-34 **Depth:** .5-1 **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-34

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.3	11.5	7.0	19.5	29.5	24.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	98.0		
1"	94.8		
0.75"	91.7		
0.5"	87.6		
0.375"	85.3		
#4	80.2		
#10	73.2		
#16	67.7		
#40	53.7		
#50	46.0		
#100	32.9		
#200	24.2		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 23 LL= 35 PI= 12

Coefficients

D_{90}= 16.2211 D_{85}= 9.1632 D_{60}= 0.6133
D_{50}= 0.3583 D_{30}= 0.1220 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

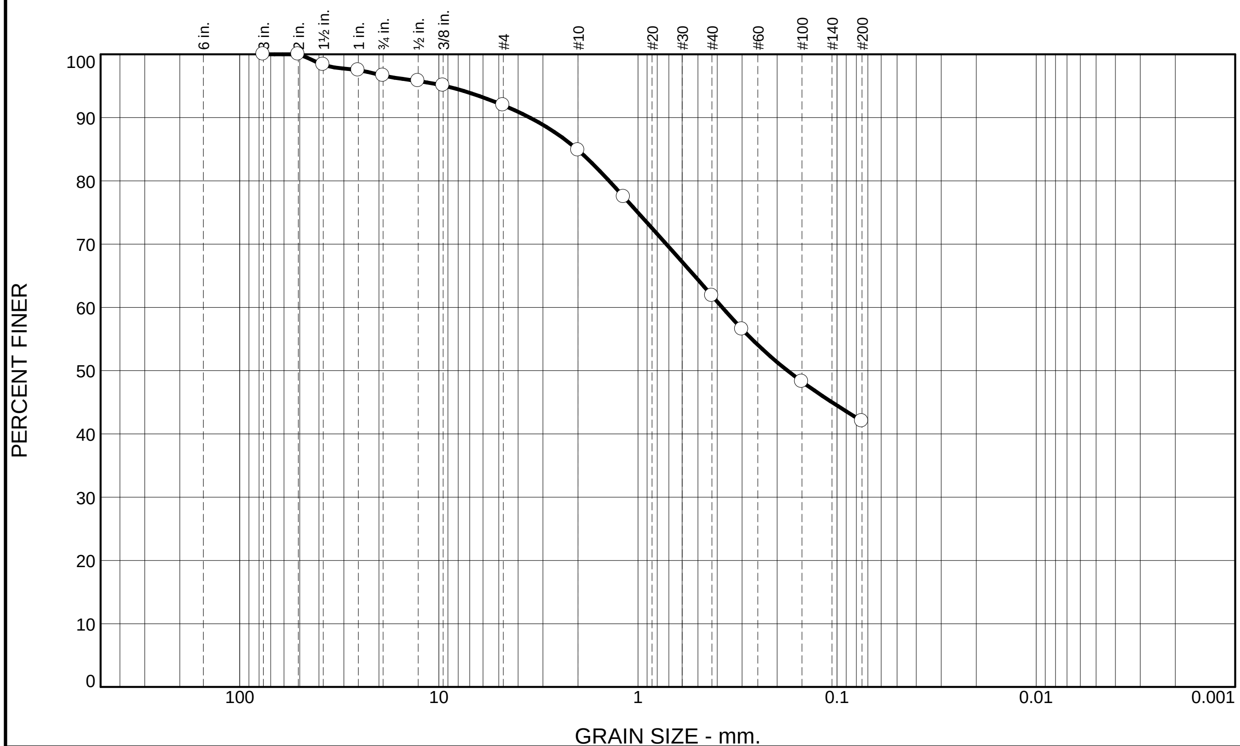
Location: TP-105
Sample Number: 17-177-35 **Depth:** 2-4' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-35

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.4	4.7	7.0	23.0	19.9	42.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	98.4		
1"	97.5		
0.75"	96.6		
0.5"	95.8		
0.375"	95.1		
#4	91.9		
#10	84.9		
#16	77.5		
#40	61.9		
#50	56.6		
#100	48.3		
#200	42.0		

* (no specification provided)

Material Description

Brown clayey sand

Atterberg Limits

PL= 19 LL= 49 PI= 30

Coefficients

D_{90}= 3.4888 D_{85}= 2.0244 D_{60}= 0.3773
D_{50}= 0.1773 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(7)

Remarks

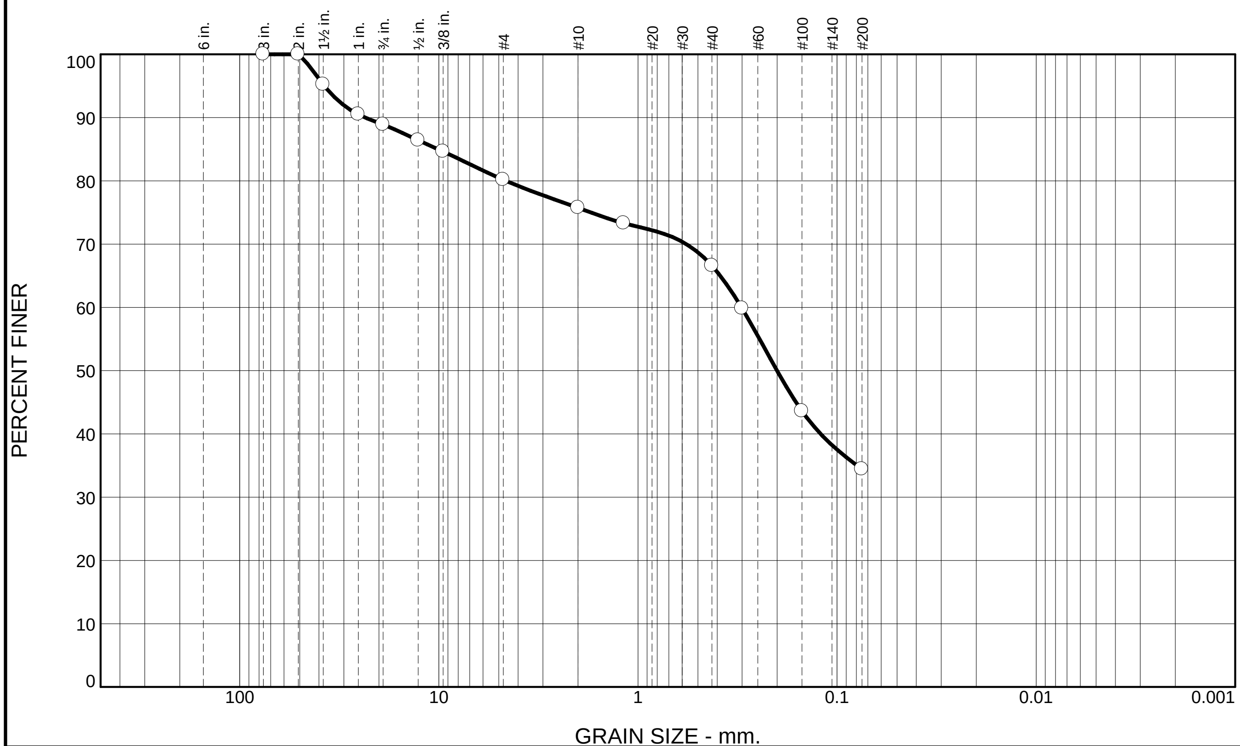
Location: TP-108
Sample Number: 17-177-36 **Depth:** 5-6' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-36

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.1	8.7	4.5	9.1	32.2	34.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	95.2		
1"	90.5		
0.75"	88.9		
0.5"	86.4		
0.375"	84.6		
#4	80.2		
#10	75.7		
#16	73.3		
#40	66.6		
#50	59.8		
#100	43.6		
#200	34.4		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 19 LL= 45 PI= 26

Coefficients

D_{90}= 23.4600 D_{85}= 10.0967 D_{60}= 0.3021
D_{50}= 0.2002 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(3)

Remarks

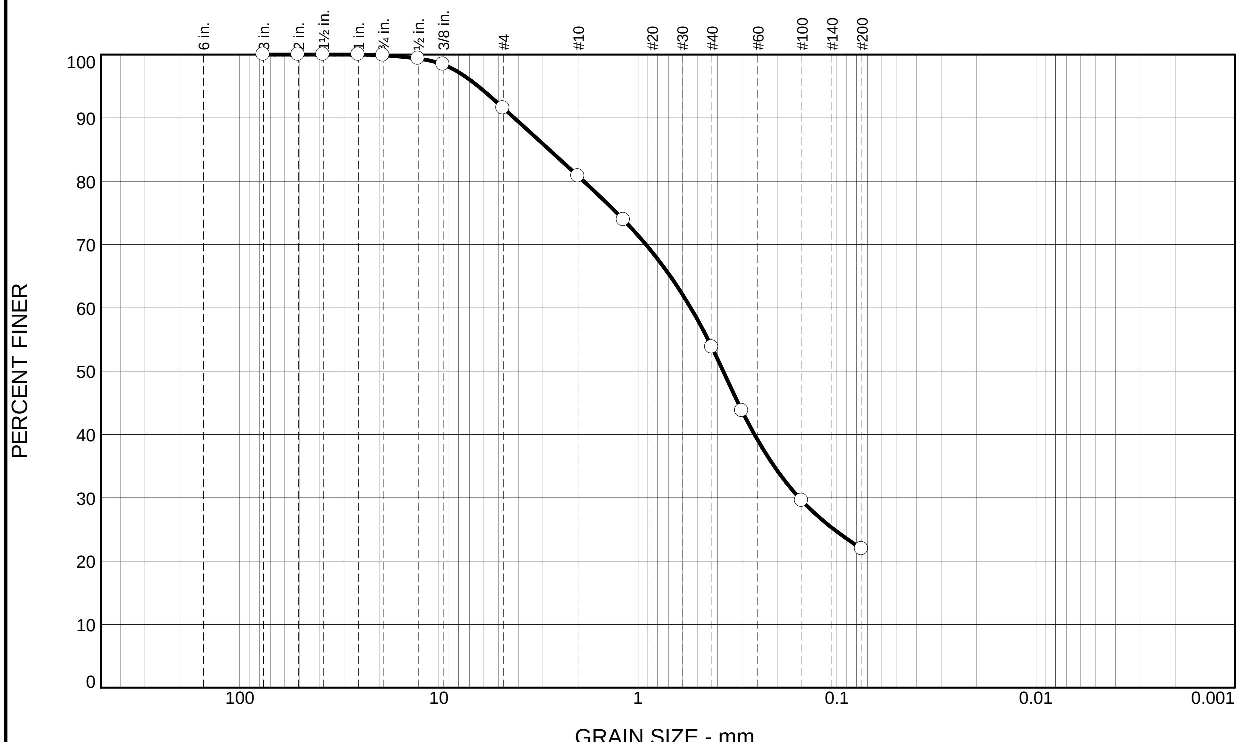
Location: TP-111
Sample Number: 17-177-37 **Depth:** 1-2' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-37

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.1	8.3	10.8	27.0	31.9	21.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"0	100.0		
1.5"	100.0		
1"	100.0		
0.75"	99.9		
0.5"	99.4		
0.375"	98.5		
#4	91.6		
#10	80.8		
#16	73.9		
#40	53.8		
#50	43.7		
#100	29.5		
#200	21.9		

* (no specification provided)

Material Description

Light Brown clayey sand

Atterberg Limits

PL= 12 LL= 38 PI= 26

Coefficients

D_{90}= 4.1862 D_{85}= 2.7959 D_{60}= 0.5432
D_{50}= 0.3728 D_{30}= 0.1549 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

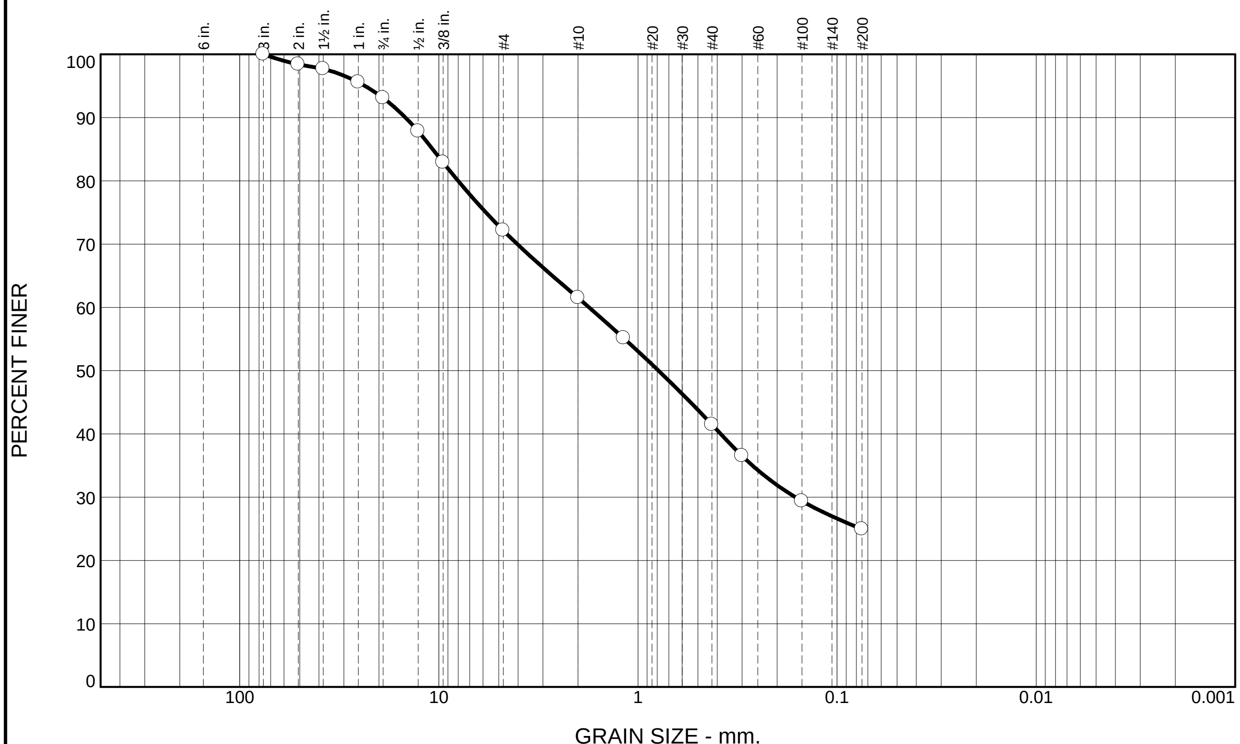
Location: TP-111
Sample Number: 17-177-38 **Depth:** 7-8' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-38

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.9	20.9	10.7	20.0	16.6	24.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	98.4		
1.5"	97.7		
1"	95.6		
0.75"	93.1		
0.5"	87.8		
0.375"	82.9		
#4	72.2		
#10	61.5		
#16	55.1		
#40	41.5		
#50	36.5		
#100	29.4		
#200	24.9		

* (no specification provided)

Material Description

Red Brown clayey sand with gravel

Atterberg Limits

PL= 15 LL= 37 PI= 22

Coefficients

D_{90}= 14.7097 D_{85}= 10.7344 D_{60}= 1.7615
D_{50}= 0.7888 D_{30}= 0.1619 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

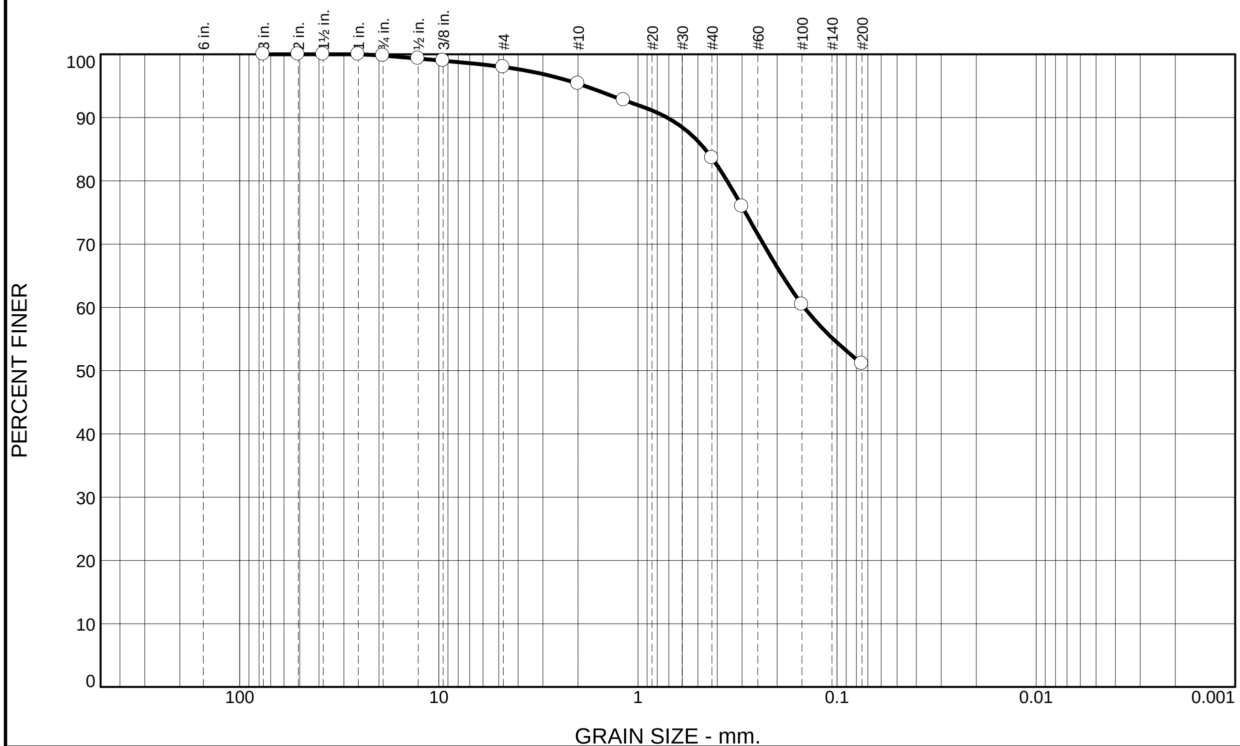
Location: TP-113
Sample Number: 17-177-39 **Depth:** 3-4' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-39

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.2	1.8	2.6	11.8	32.5	51.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	99.8		
0.5"	99.3		
0.375"	99.0		
#4	98.0		
#10	95.4		
#16	92.8		
#40	83.6		
#50	75.9		
#100	60.5		
#200	51.1		

* (no specification provided)

Material Description

Brown sandy fat clay

Atterberg Limits

PL= 21 LL= 50 PI= 29

Coefficients

D_{90}= 0.7130 D_{85}= 0.4598 D_{60}= 0.1461
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(11)

Remarks

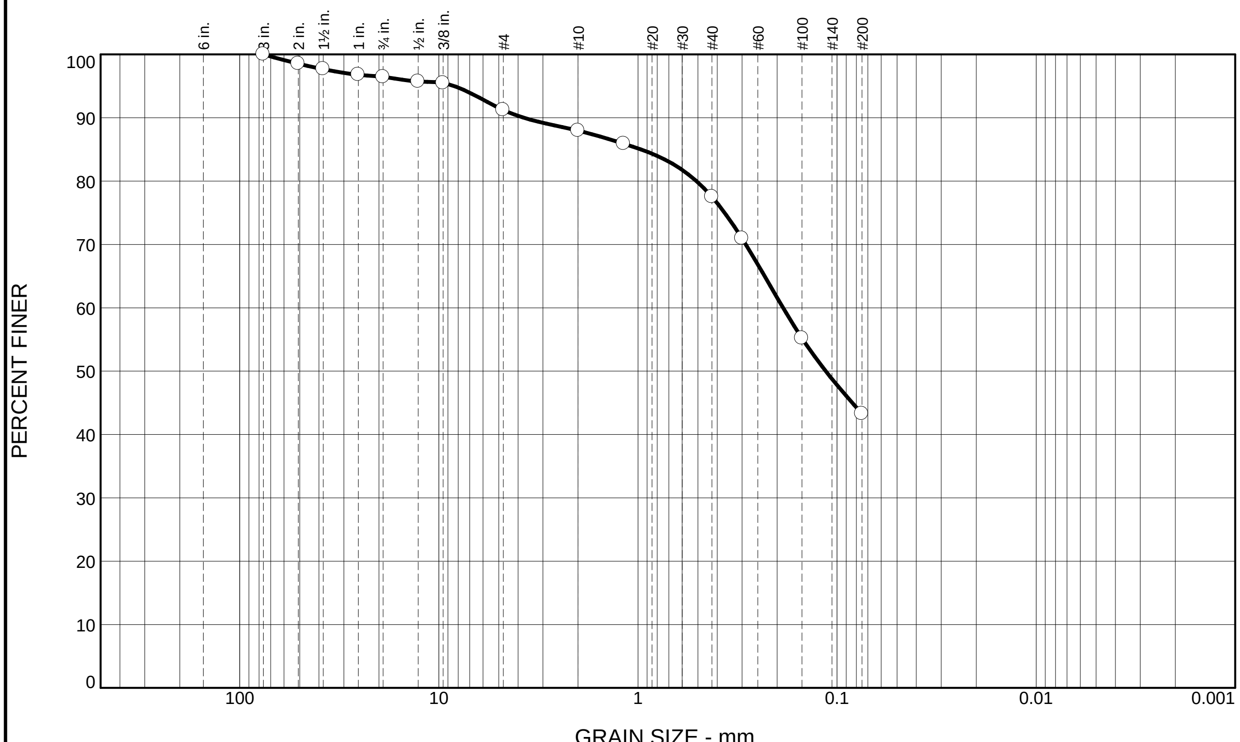
Location: TP-118
Sample Number: 17-177-40 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-40

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.6	5.2	3.2	10.5	34.2	43.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	98.5		
1.5"	97.7		
1"	96.8		
0.75"	96.4		
0.5"	95.7		
0.375"	95.5		
#4	91.2		
#10	88.0		
#16	85.9		
#40	77.5		
#50	70.9		
#100	55.2		
#200	43.3		

* (no specification provided)

Material Description

Brown clayey sand

Atterberg Limits

PL= 21 LL= 45 PI= 24

Coefficients

D_{90}= 3.7399 D_{85}= 0.9680 D_{60}= 0.1866
D_{50}= 0.1139 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(6)

Remarks

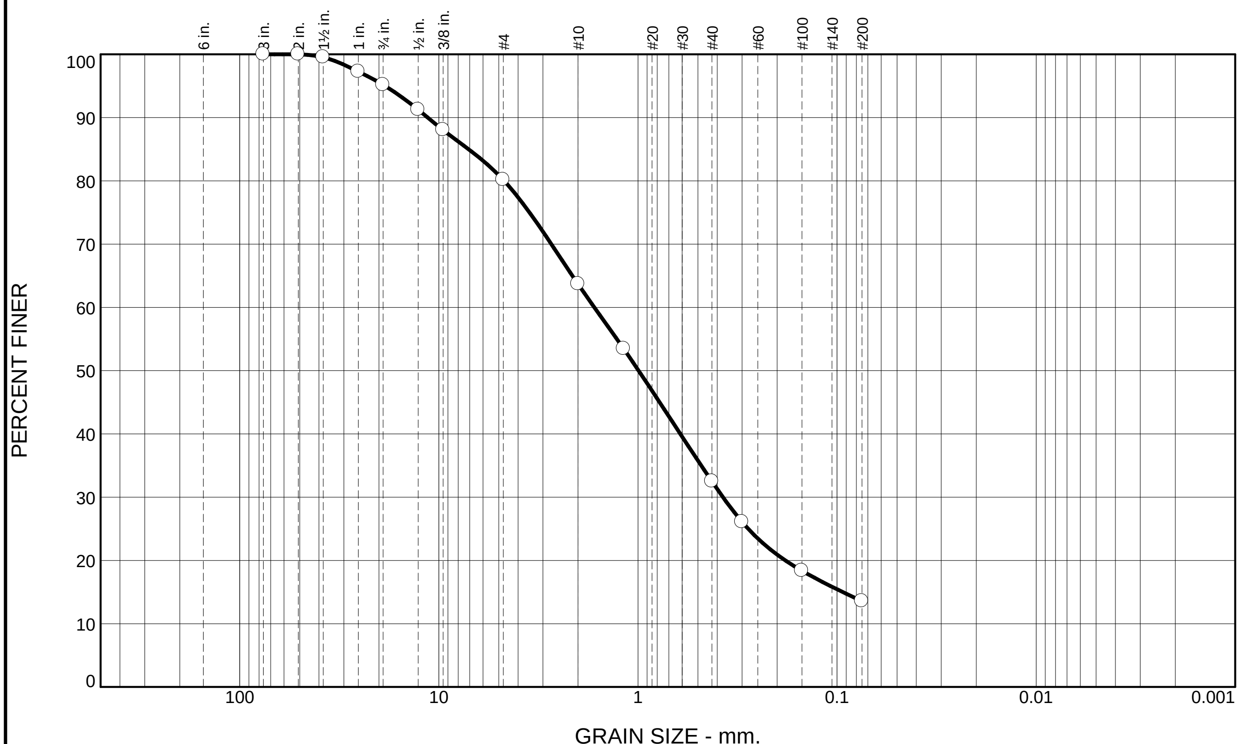
Location: TP-119
Sample Number: 17-177-41 **Depth:** 3-4' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-41

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.8	15.0	16.5	31.2	18.9	13.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	99.5		
1"	97.3		
0.75"	95.2		
0.5"	91.2		
0.375"	88.0		
#4	80.2		
#10	63.7		
#16	53.5		
#40	32.5		
#50	26.1		
#100	18.4		
#200	13.6		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 11 LL= 21 PI= 10

Coefficients

D_{90}= 11.3679 D_{85}= 7.0988 D_{60}= 1.6566
D_{50}= 0.9925 D_{30}= 0.3740 D_{15}= 0.0935
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-4(0)

Remarks

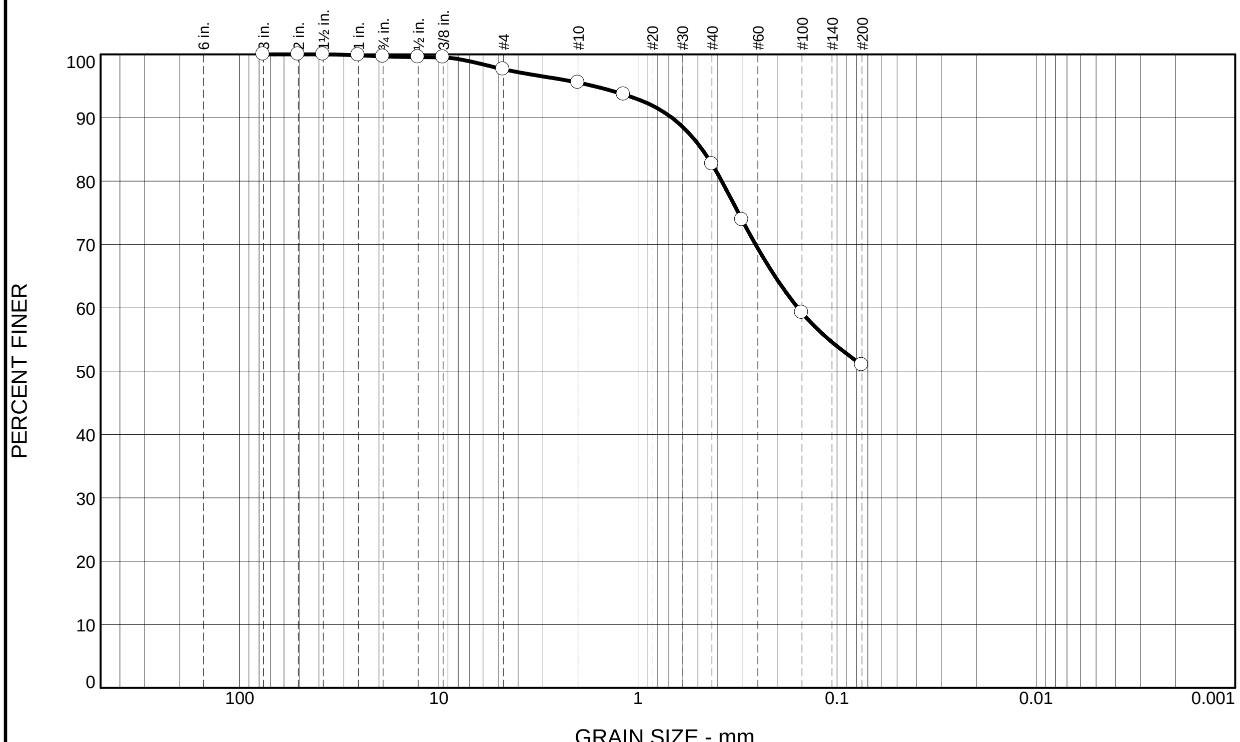
Location: TP-120
Sample Number: 17-177-42 **Depth:** 5-6' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-42

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.3	2.0	2.1	12.9	31.7	51.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	99.9		
0.75"	99.7		
0.5"	99.6		
0.375"	99.5		
#4	97.7		
#10	95.6		
#16	93.7		
#40	82.7		
#50	73.9		
#100	59.2		
#200	51.0		

* (no specification provided)

Material Description

Brown sandy lean clay

Atterberg Limits

PL= 21 LL= 49 PI= 28

Coefficients

D_{90}= 0.6749 D_{85}= 0.4757 D_{60}= 0.1574
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(10)

Remarks

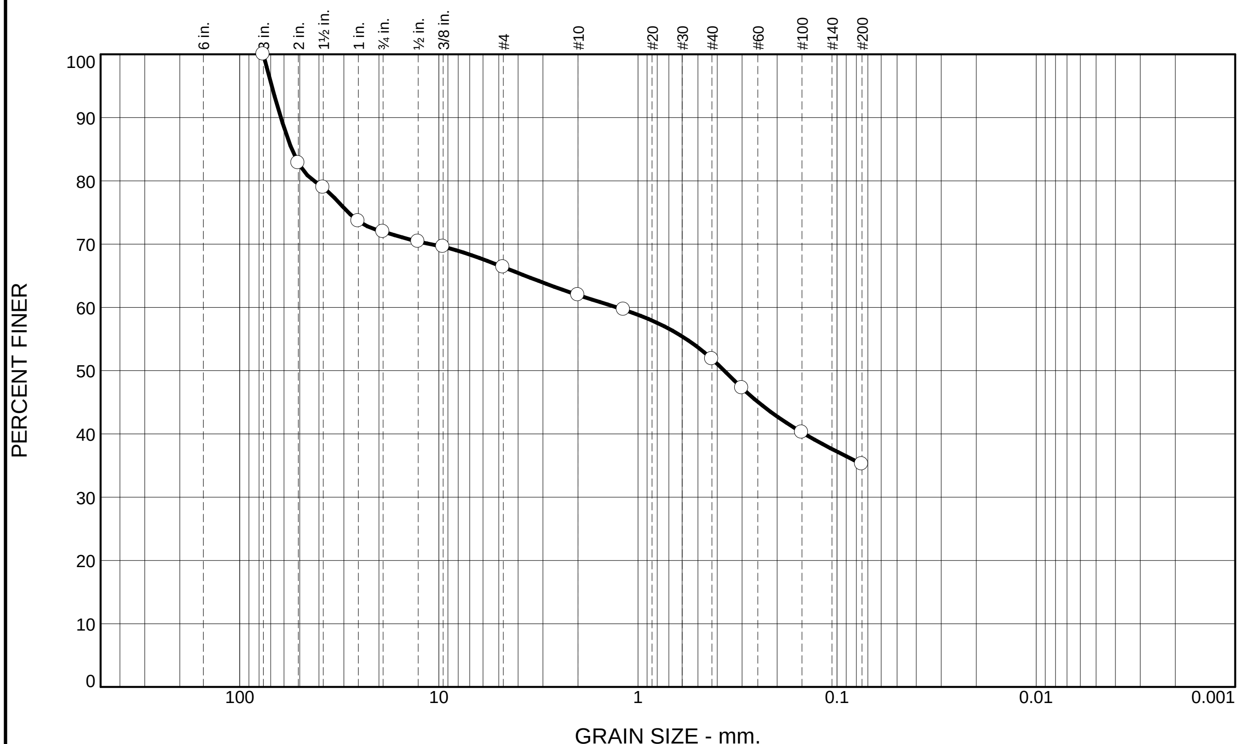
Location: TP-122
Sample Number: 17-177-43 **Depth:** 3-4' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-43

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	28.0	5.6	4.5	10.1	16.6	35.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	82.8		
1.5"	79.0		
1"	73.6		
0.75"	72.0		
0.5"	70.4		
0.375"	69.6		
#4	66.4		
#10	61.9		
#16	59.6		
#40	51.8		
#50	47.2		
#100	40.2		
#200	35.2		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 17 LL= 41 PI= 24

Coefficients

D_{90}= 62.1768 D_{85}= 54.7820 D_{60}= 1.2772
D_{50}= 0.3688 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(3)

Remarks

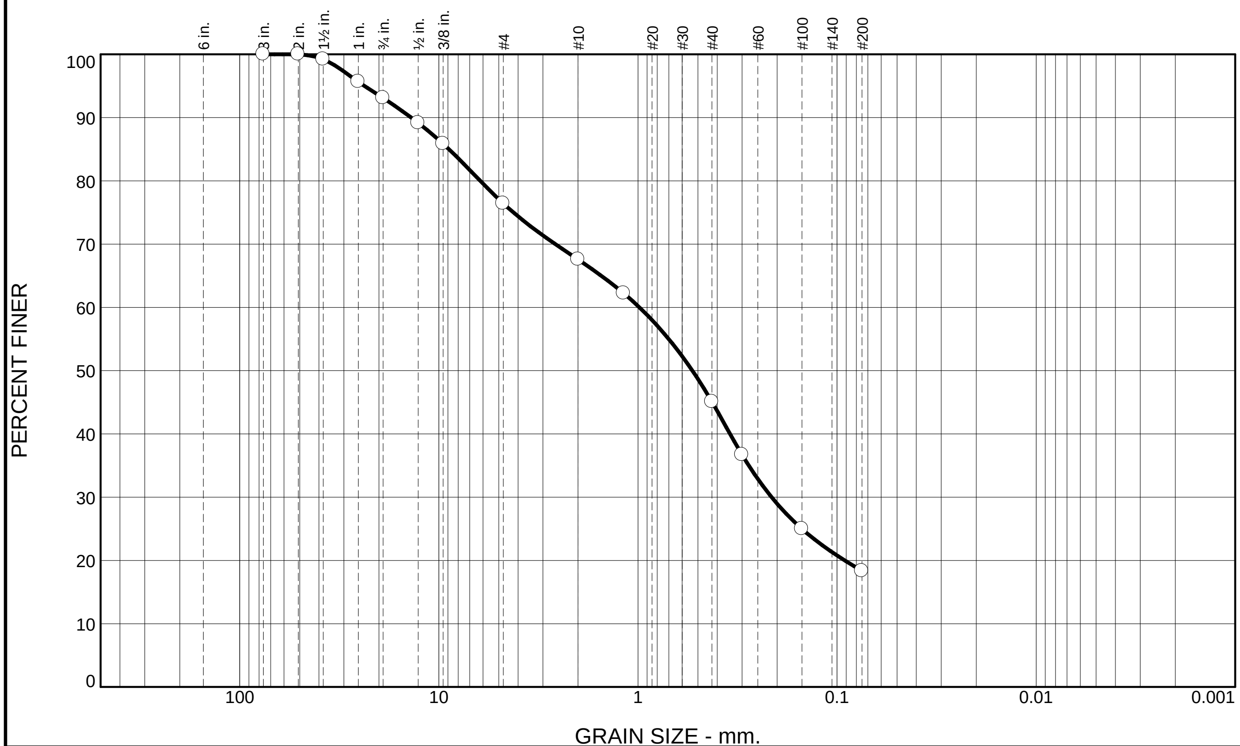
Location: TP-122A
Sample Number: 17-177-44 **Depth:** 7-8' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-44

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.9	16.7	8.8	22.5	26.8	18.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	99.2		
1"	95.7		
0.75"	93.1		
0.5"	89.1		
0.375"	85.9		
#4	76.4		
#10	67.6		
#16	62.2		
#40	45.1		
#50	36.7		
#100	25.0		
#200	18.3		

* (no specification provided)

Material Description

Red Brown clayey sand with gravel

Atterberg Limits

PL= 17 LL= 37 PI= 20

Coefficients

D_{90}= 13.7820 D_{85}= 8.9016 D_{60}= 0.9833
D_{50}= 0.5330 D_{30}= 0.2131 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

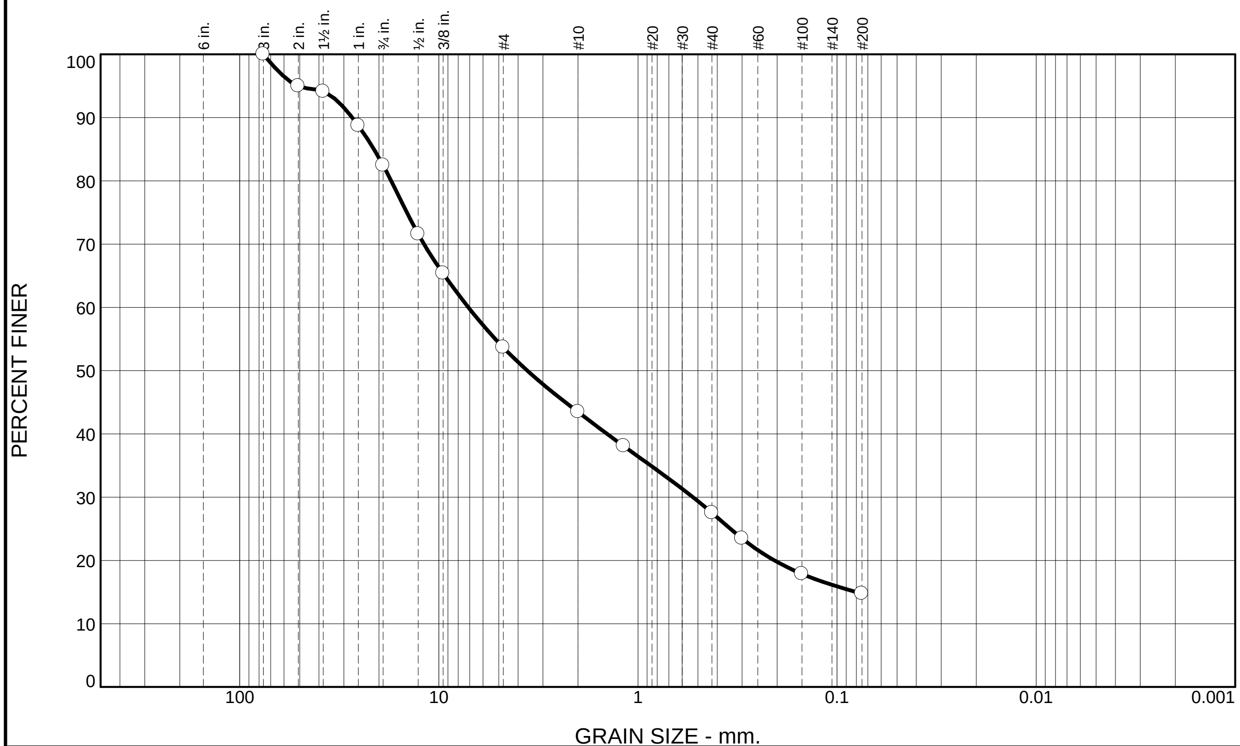
Location: TP-122B
Sample Number: 17-177-45 **Depth:** 2.5-3.5 **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-45

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	17.6	28.7	10.2	16.0	12.7	14.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	95.0		
1.5"	94.1		
1"	88.7		
0.75"	82.4		
0.5"	71.6		
0.375"	65.4		
#4	53.7		
#10	43.5		
#16	38.1		
#40	27.5		
#50	23.5		
#100	17.9		
#200	14.8		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 14 LL= 39 PI= 25

Coefficients

D_{90}= 27.2180 D_{85}= 21.2063 D_{60}= 7.1089
D_{50}= 3.5969 D_{30}= 0.5296 D_{15}= 0.0798
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

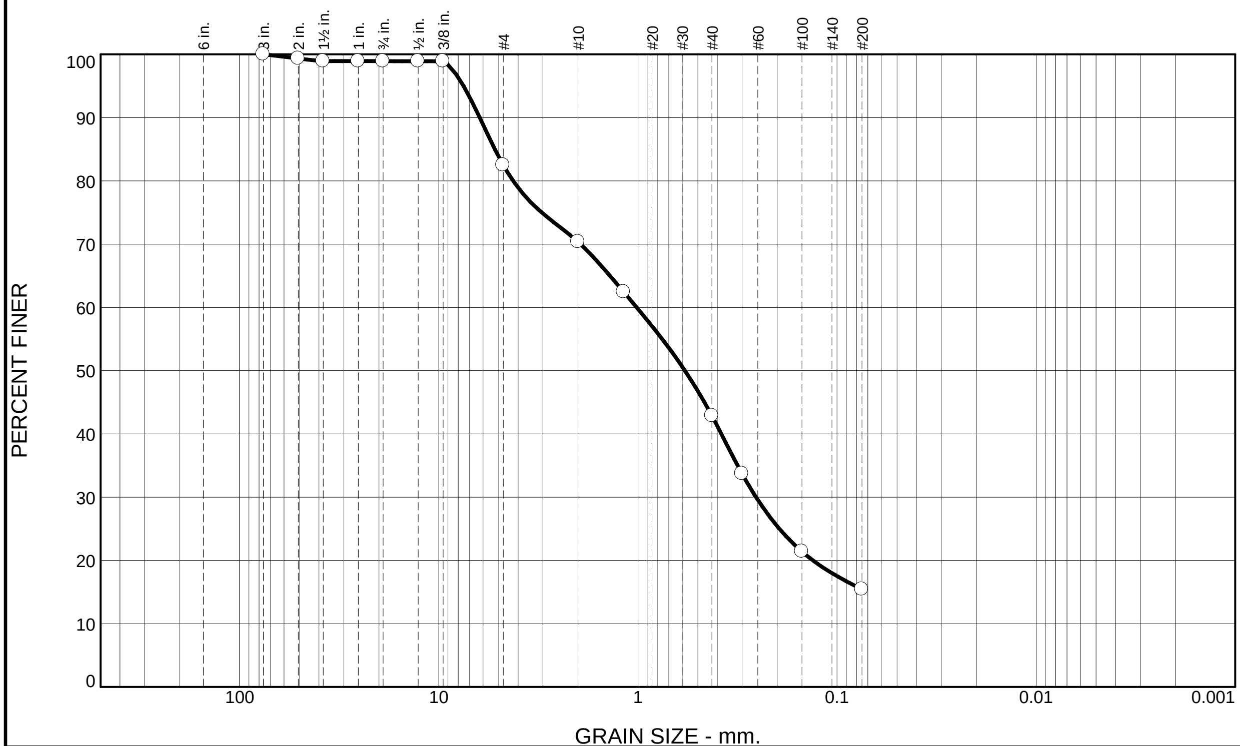
Location: TP-122C
Sample Number: 17-177-46 **Depth:** 4-5' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-46

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.1	16.4	12.1	27.5	27.5	15.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	99.3		
1.5"	98.9		
1"	98.9		
0.75"	98.9		
0.5"	98.9		
0.375"	98.9		
#4	82.5		
#10	70.4		
#16	62.4		
#40	42.9		
#50	33.7		
#100	21.4		
#200	15.4		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 19 LL= 33 PI= 14

Coefficients

D_{90}= 6.2354 D_{85}= 5.2326 D_{60}= 1.0159
D_{50}= 0.5810 D_{30}= 0.2552 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

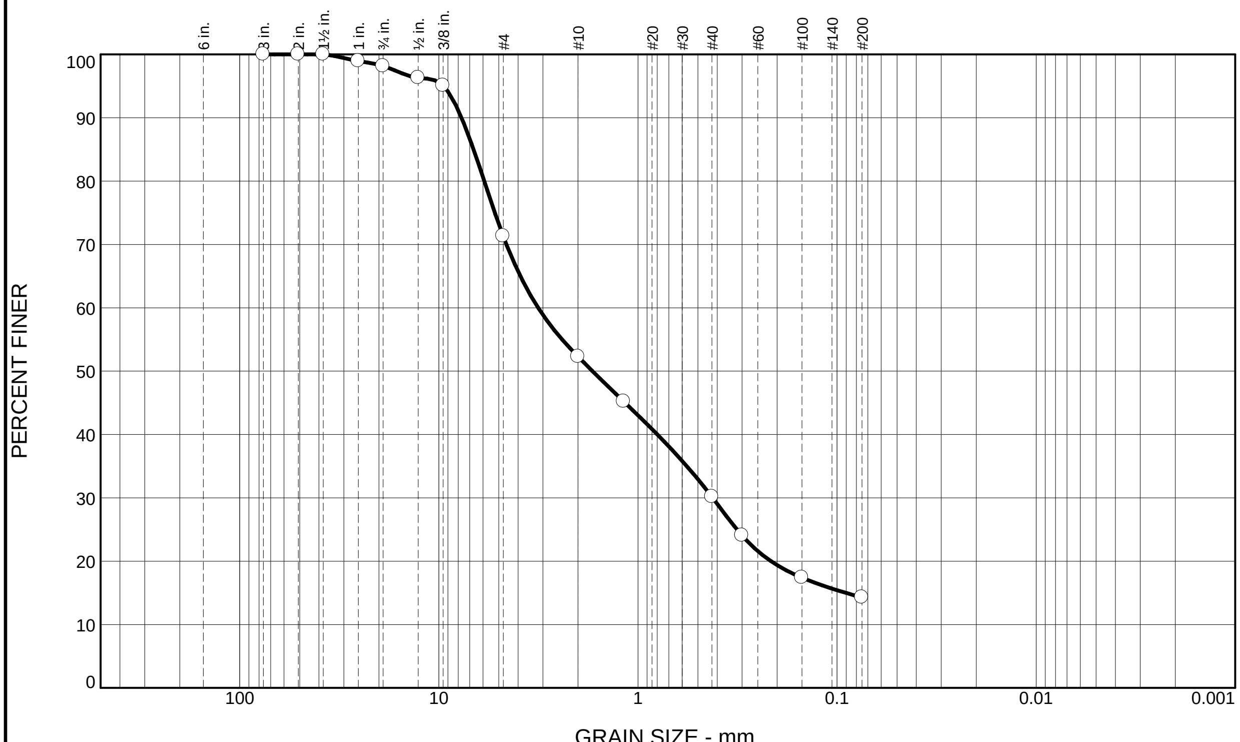
Location: TP-122G
Sample Number: 17-177-47 **Depth:** 4-5' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-47

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.8	26.9	19.0	22.1	15.9	14.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	99.0		
0.75"	98.2		
0.5"	96.3		
0.375"	95.1		
#4	71.3		
#10	52.3		
#16	45.2		
#40	30.2		
#50	24.1		
#100	17.4		
#200	14.3		

* (no specification provided)

Material Description

Brown

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 7.6943 D_{85}= 6.6973 D_{60}= 3.1721
D_{50}= 1.6924 D_{30}= 0.4213 D_{15}= 0.0901
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

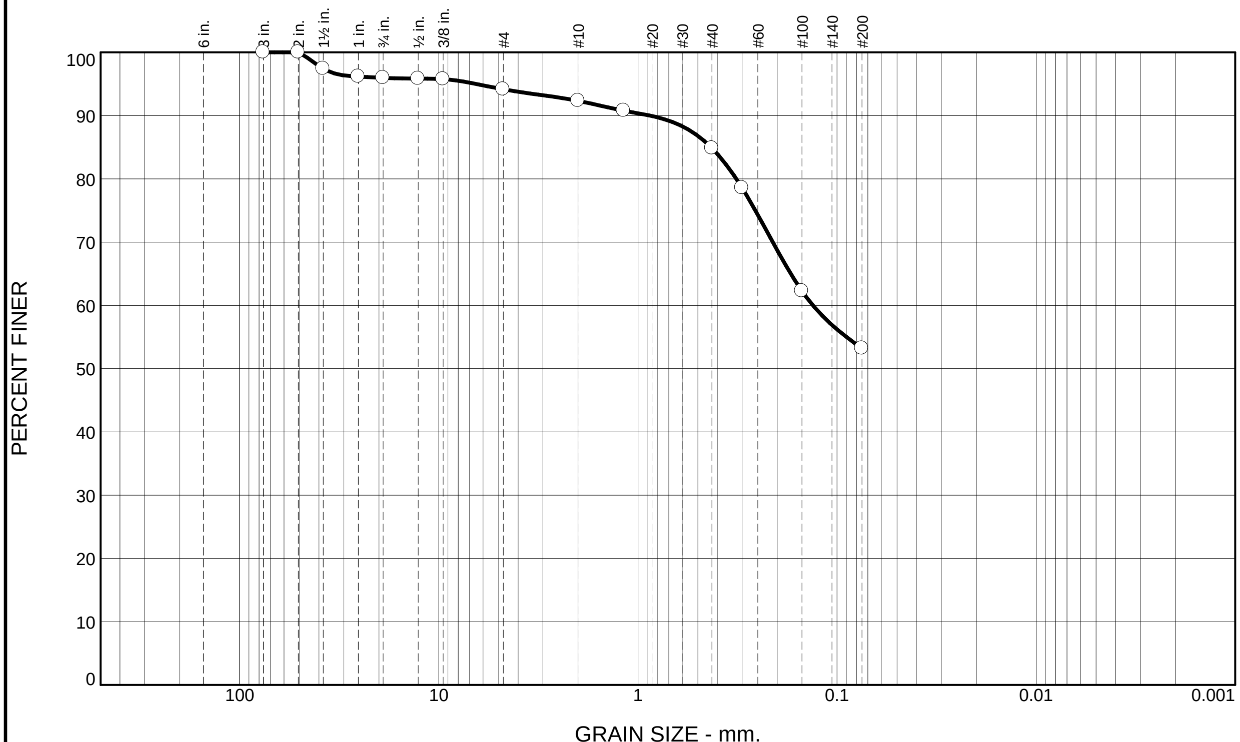
Location: TP-125
Sample Number: 17-177-48 **Depth:** 2-3' **Date:**

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-48

Tested By: ______________ **Checked By:** ______________

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.0	1.8	1.9	7.4	31.7	53.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	97.4		
1"	96.2		
0.75"	96.0		
0.5"	95.8		
0.375"	95.8		
#4	94.2		
#10	92.3		
#16	90.8		
#40	84.9		
#50	78.6		
#100	62.3		
#200	53.2		

* (no specification provided)

Material Description

Brown sandy fat clay

Atterberg Limits

PL= 22 LL= 53 PI= 31

Coefficients

D_{90}= 0.8707 D_{85}= 0.4294 D_{60}= 0.1321
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(13)

Remarks

Location: TP-125A
Sample Number: 17-177-49 **Depth:** 3-4' **Date:** 07/14/2017

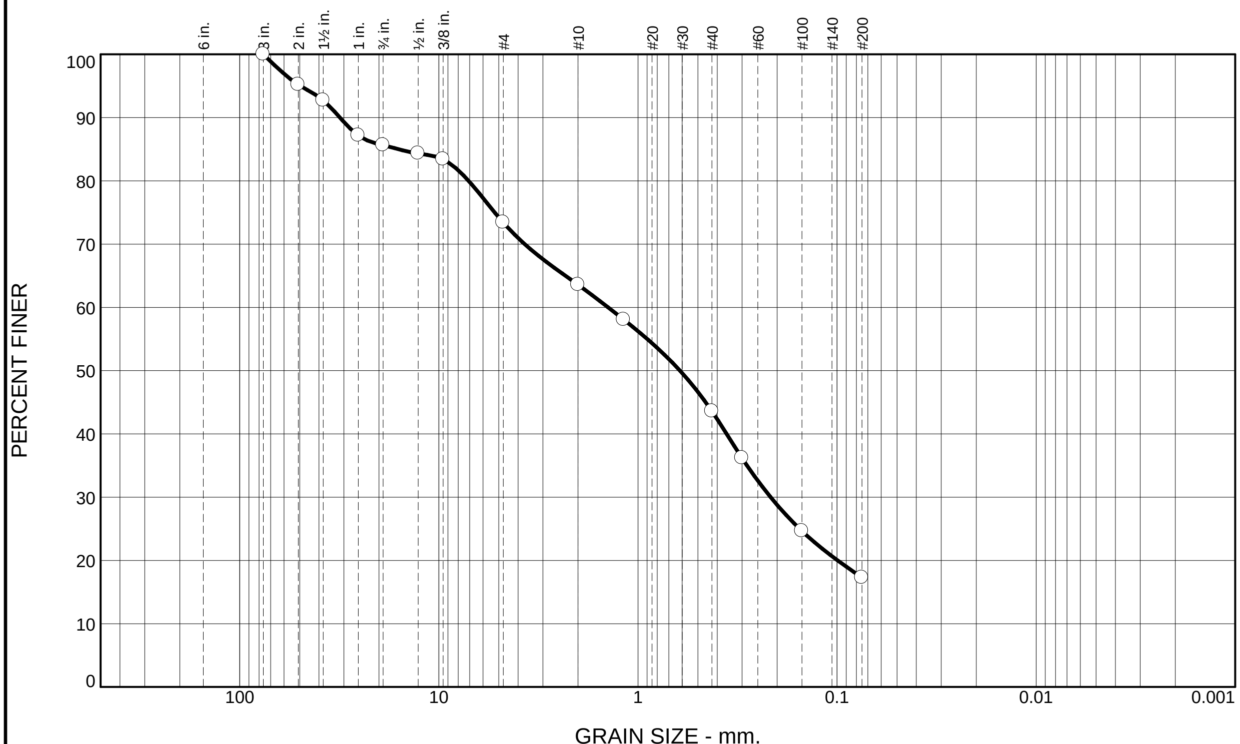
NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project

Project No: 475.0014.008 **Figure** 17-177-49

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	14.4	12.2	9.8	20.0	26.3	17.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	95.2		
1.5"	92.7		
1"	87.2		
0.75"	85.6		
0.5"	84.3		
0.375"	83.4		
#4	73.4		
#10	63.6		
#16	58.1		
#40	43.6		
#50	36.2		
#100	24.6		
#200	17.3		

* (no specification provided)

Material Description

Brown silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{90}= 31.3823 D_{85}= 15.9372 D_{60}= 1.4115
D_{50}= 0.6153 D_{30}= 0.2157 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

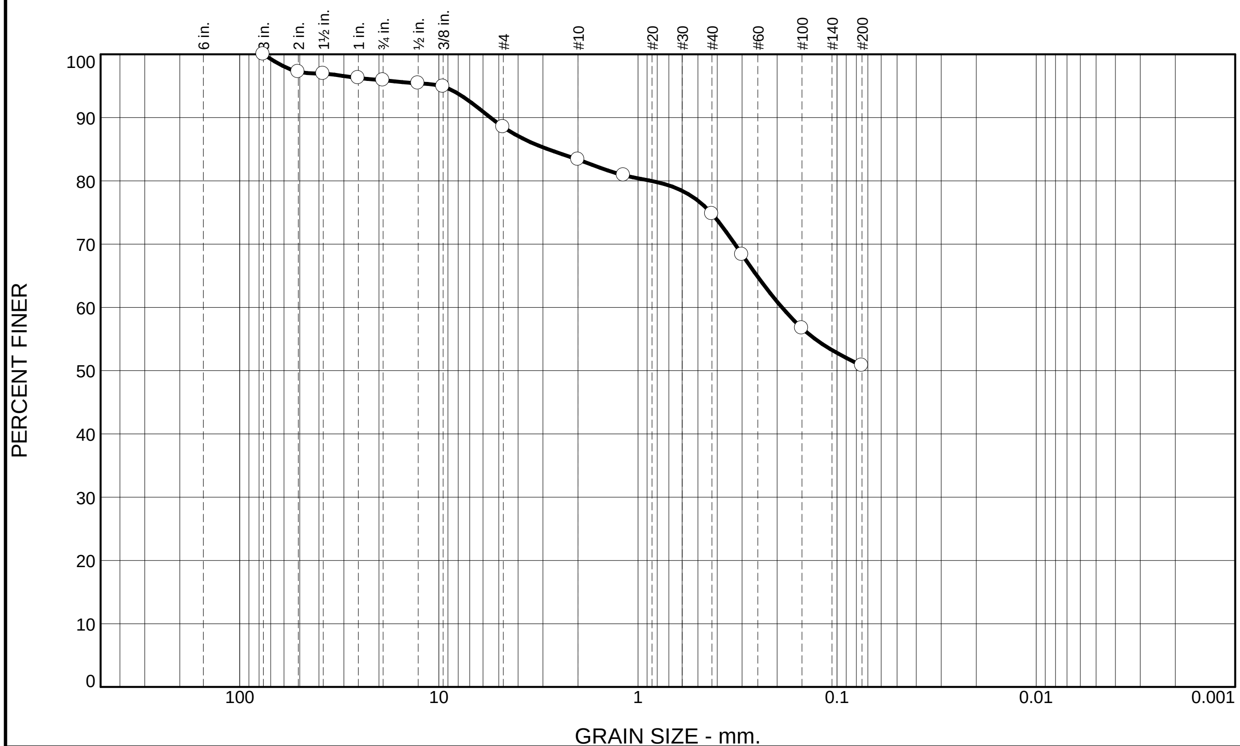
Location: TP-125B
Sample Number: 17-177-50 **Depth:** 1-2' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-50

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.1	7.4	5.1	8.6	24.0	50.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	97.2		
1.5"	96.9		
1"	96.3		
0.75"	95.9		
0.5"	95.4		
0.375"	94.9		
#4	88.5		
#10	83.4		
#16	80.9		
#40	74.8		
#50	68.3		
#100	56.7		
#200	50.8		

* (no specification provided)

Material Description

Brown sandy fat clay

Atterberg Limits

PL= 19 LL= 59 PI= 40

Coefficients

D_{90}= 5.5023 D_{85}= 2.8280 D_{60}= 0.1892
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(16)

Remarks

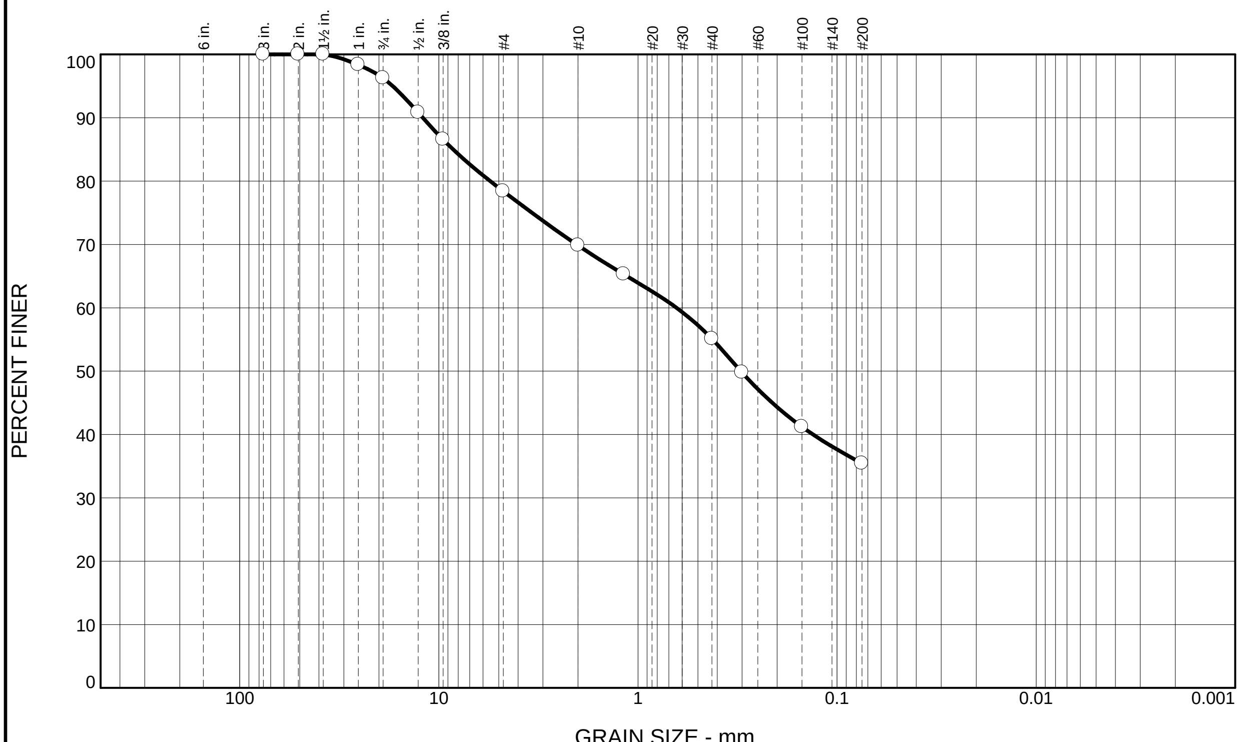
Location: TP-126
Sample Number: 17-177-51 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-51

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.7	17.9	8.5	14.8	19.7	35.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	98.3		
0.75"	96.3		
0.5"	90.8		
0.375"	86.6		
#4	78.4		
#10	69.9		
#16	65.3		
#40	55.1		
#50	49.8		
#100	41.2		
#200	35.4		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 27 LL= 47 PI= 20

Coefficients

D_{90}= 12.0400 D_{85}= 8.4825 D_{60}= 0.6406
D_{50}= 0.3044 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(2)

Remarks

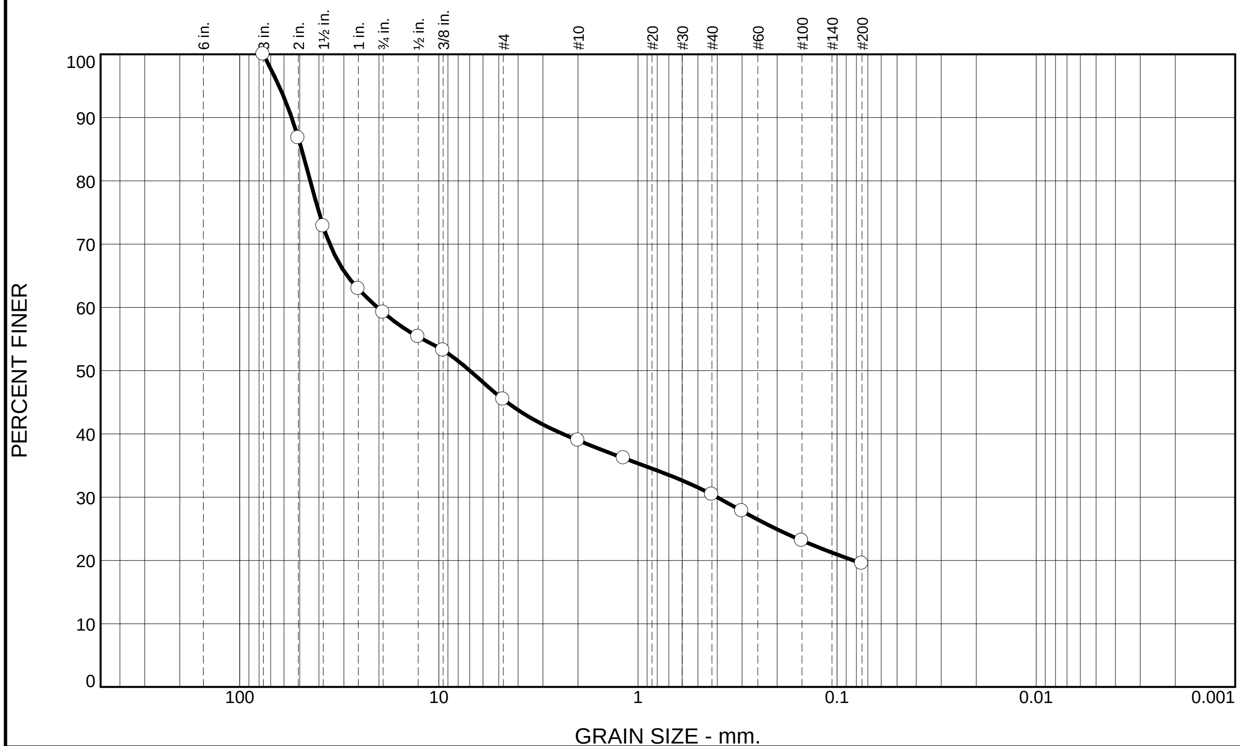
Location: TP-126
Sample Number: 17-177-52 **Depth:** 4-5' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-52

Tested By: AL **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	40.8	13.7	6.5	8.6	10.9	19.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	86.8		
1.5"	72.8		
1"	62.9		
0.75"	59.2		
0.5"	55.3		
0.375"	53.2		
#4	45.5		
#10	39.0		
#16	36.2		
#40	30.4		
#50	27.8		
#100	23.1		
#200	19.5		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 22 LL= 35 PI= 13

Coefficients

D_{90}= 54.8339 D_{85}= 48.8924 D_{60}= 20.3700
D_{50}= 6.9945 D_{30}= 0.4002 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-6(0)

Remarks

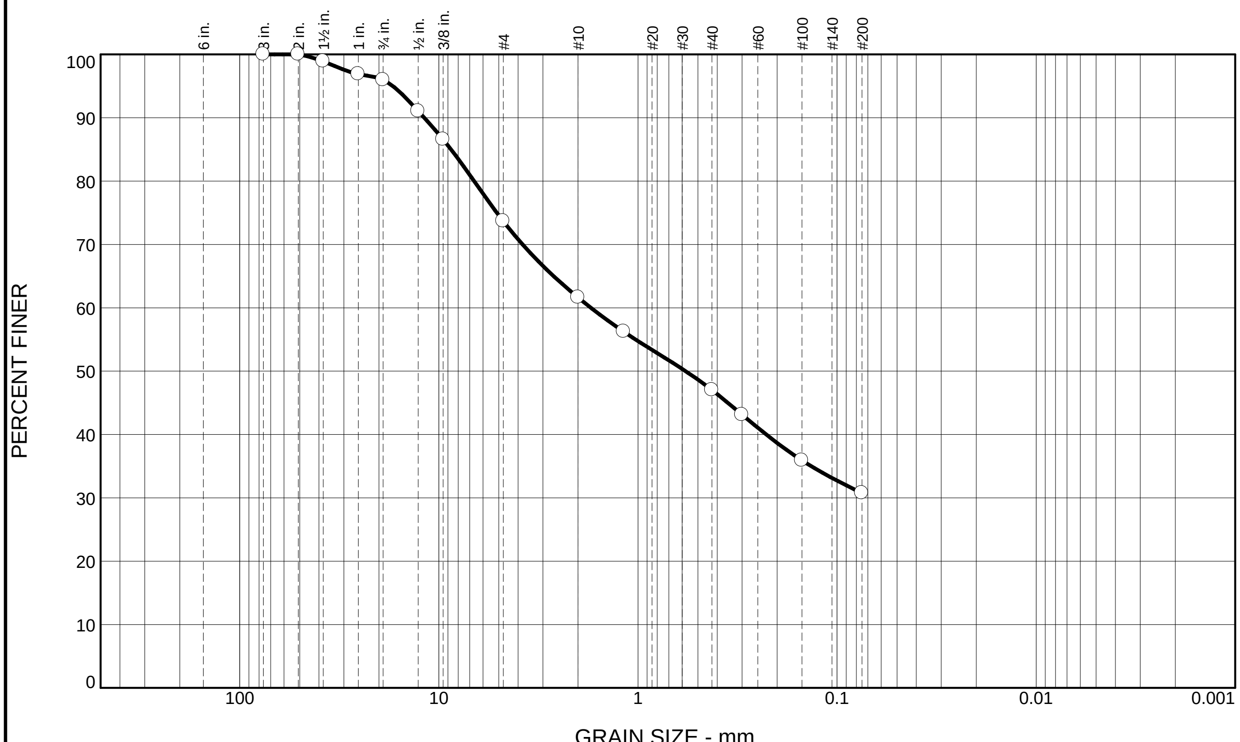
Location: TP-126C
Sample Number: 17-177-53 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-53

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.0	22.3	12.1	14.6	16.2	30.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	98.9		
1"	96.9		
0.75"	96.0		
0.5"	91.0		
0.375"	86.6		
#4	73.7		
#10	61.6		
#16	56.2		
#40	47.0		
#50	43.1		
#100	35.9		
#200	30.8		

* (no specification provided)

Material Description

Brown clayey sand with gravel

Atterberg Limits

PL= 24 LL= 44 PI= 20

Coefficients

D_{90}= 11.8526 D_{85}= 8.6902 D_{60}= 1.7224
D_{50}= 0.5768 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-7(2)

Remarks

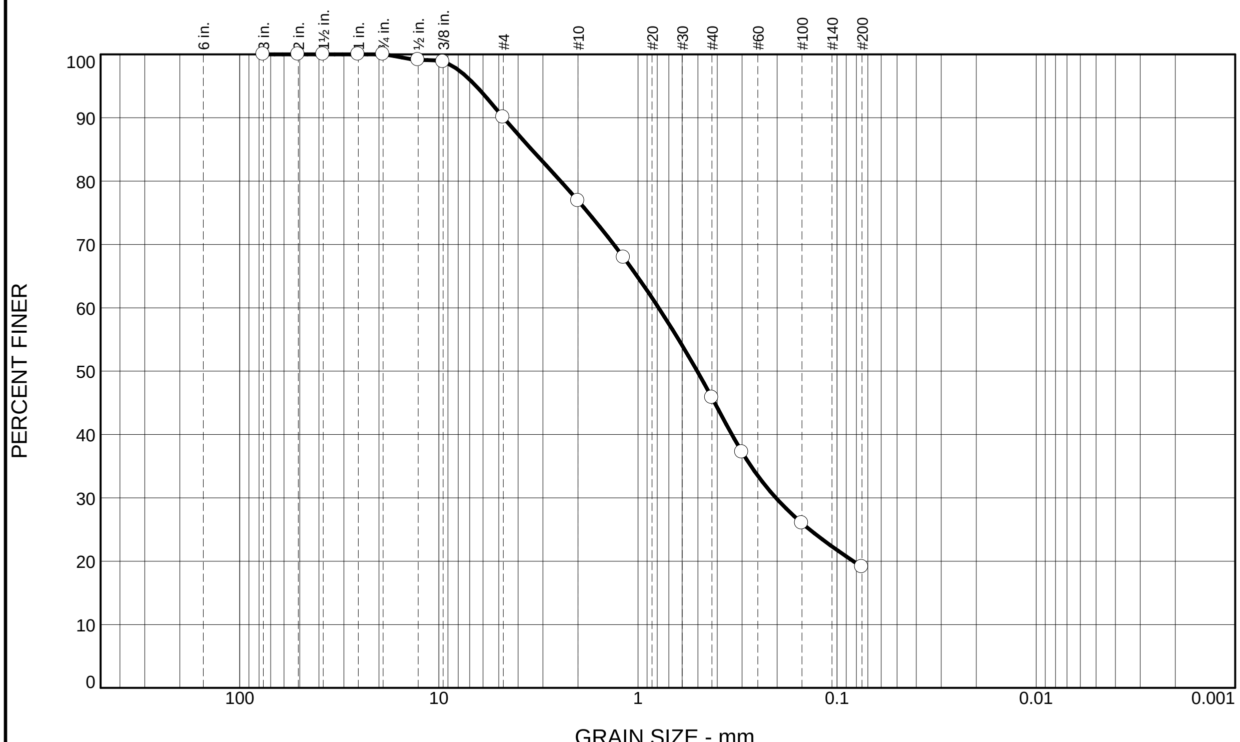
Location: TP-126C
Sample Number: 17-177-54 **Depth:** 6-7' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-54

Tested By: BB **Checked By:** RF

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.9	13.2	31.1	26.7	19.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1.5"	100.0		
1"	100.0		
0.75"	100.0		
0.5"	99.1		
0.375"	98.8		
#4	90.1		
#10	76.9		
#16	67.9		
#40	45.8		
#50	37.2		
#100	26.0		
#200	19.1		

* (no specification provided)

Material Description

Red Brown clayey sand

Atterberg Limits

PL= 19 LL= 35 PI= 16

Coefficients

D_{90}= 4.7324 D_{85}= 3.4206 D_{60}= 0.7878
D_{50}= 0.5040 D_{30}= 0.2029 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

Location: TP-126D
Sample Number: 17-177-55 **Depth:** 2-3' **Date:** 07/14/2017

NewFields

Client: Arizona Minerals Inc.
Project: Hermosa Underground Project
Project No: 475.0014.008 **Figure** 17-177-55

Tested By: BB **Checked By:** AL

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-01/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-62	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	Surface	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	B-2
Initial Wt. + Tare	10878.0
Post Wt. + Tare	9417.8
Percent Loss	**13%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-05/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-69	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	Surface	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	B9
Initial Wt. + Tare	10738.6
Post Wt. + Tare	7216.3
Percent Loss	**33%**

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-06/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-71	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	Surface	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	Total Wt. (g)
Tare ID	B-6
Initial Wt. + Tare	10718.5
Post Wt. + Tare	7931.8
Percent Loss	**26%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-07/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-74	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	5-6'	**Sample Description:**	

Test Type	
ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	Total Wt. (g)
Tare ID	Cow
Initial Wt. + Tare	10687.2
Post Wt. + Tare	7631.4
Percent Loss	**29%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-08/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-75	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	5-6'	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	Total Wt. (g)
Tare ID	A1
Initial Wt. + Tare	10247.2
Post Wt. + Tare	8943.9
Percent Loss	**13%**

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-09/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-79	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	14-16'	**Sample Description:**	

Test Type	
ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	SPG 12
Initial Wt. + Tare	10436.3
Post Wt. + Tare	9222.9
Percent Loss	**12%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-10/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-80	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	14-16'	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	Pan
Initial Wt. + Tare	10341.2
Post Wt. + Tare	8830.9
Percent Loss	**15%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-11/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-82	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	6-8'	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	SPG 2
Initial Wt. + Tare	10291.6
Post Wt. + Tare	6023.1
Percent Loss	**41%**

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-19/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-90	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	2-3'	**Sample Description:**	

Test Type	
ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	A
Initial Wt. + Tare	10630.7
Post Wt. + Tare	8456.5
Percent Loss	**20%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-30/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-99	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	Surface	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	Alpha
Initial Wt. + Tare	10199.0
Post Wt. + Tare	8580.7
Percent Loss	**16%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-56/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-127	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	Surface	**Sample Description:**	

Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	**Total Wt. (g)**
Tare ID	X5
Initial Wt. + Tare	10510.8
Post Wt. + Tare	8396.4
Percent Loss	**20%**

NewFields

LOS ANGELES ABRASION (ASTM C131/ASTM C535)

LABORATORY WORKSHEET

NF Form #48

Client:	Arizona Minerals Inc	**Field Sample ID:**	17-177-57/	**Test Start Date:**	7/14/2017
Project Title:	Hermosa Underground TSF PEA	**Laboratory Sample ID:**	17-019-27	**Tested By:**	AL
Project Number:	475.0014.008	**Location:**	TP-128	**Checked By:**	RF
Project Engineer:	Craig Thompson	**Depth:**	3-5'	**Sample Description:**	

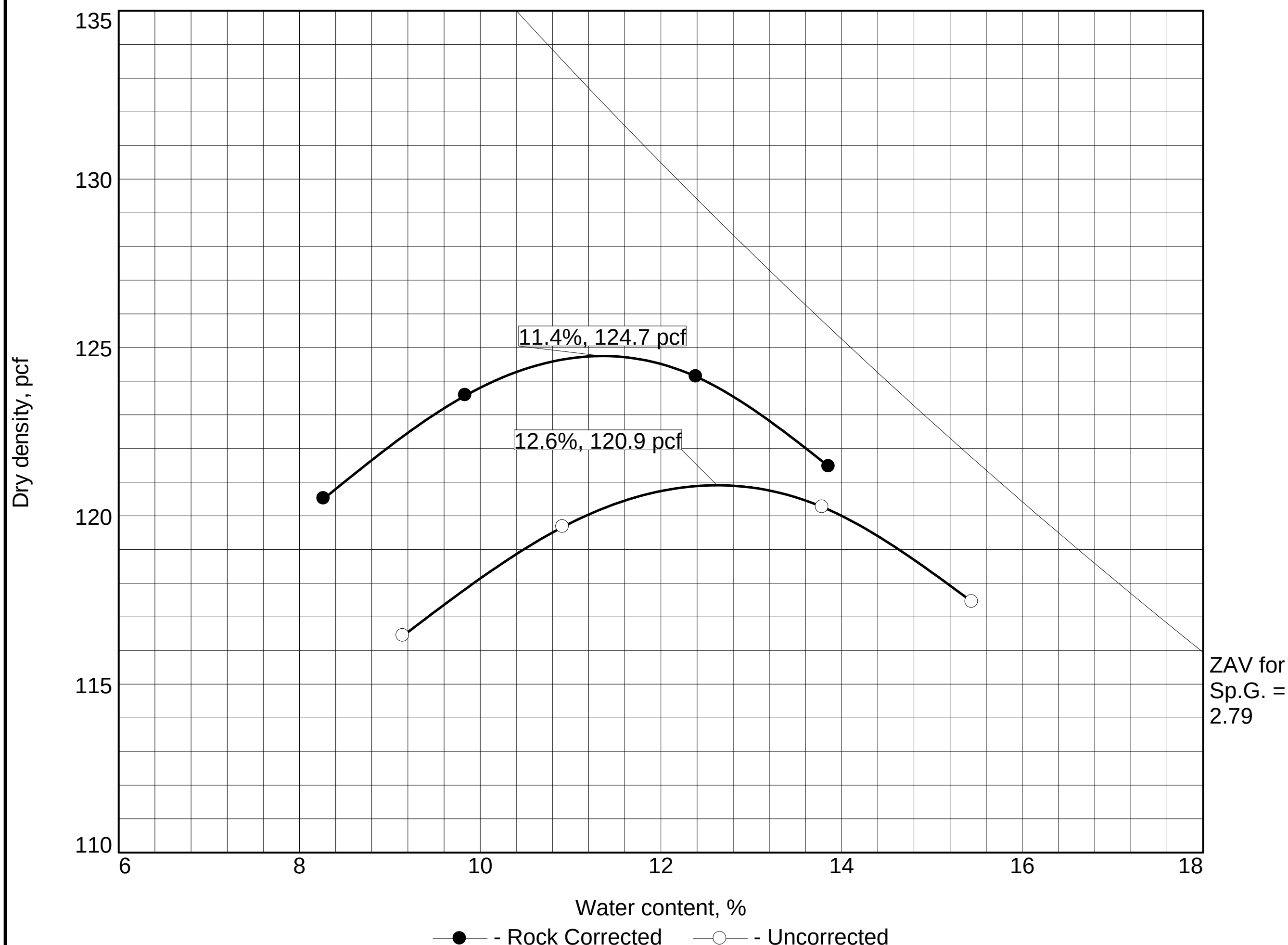
Test Type

ASTM C131	ASTM C535
A	1
B	2
C	3
D	

Remarks:

Sample	Total Wt. (g)
Tare ID	B-1
Initial Wt. + Tare	9957.5
Post Wt. + Tare	5647.8
Percent Loss	**43%**

COMPACTION TEST REPORT



Test specification: ASTM D 1557-00 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
1.5-2.5'	SC	A-2-7(3)		2.79	44	25	11.2	32.7

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 124.7 pcf	120.9 pcf
Optimum moisture = 11.4 %	12.6 %

MATERIAL DESCRIPTION

Red Brown clayey sand with gravel

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-66 **Sample Number:** 17-177-04

NewFields

Remarks:
Assumed specific gravity.

Figure 17-233-01

Tested By: OS **Checked By:** RF

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-233-01
Project:	Hermosa Underground Project	Field Sample No.:	TP-66
Project No.:	475.0014.008	Location:	TP-66
Phase:	1	Elevation/Depth:	4-5'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	9/16/2017	Checked By:	KE
Test Finished:	9/22/2017	Sample Description:	Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	643.72	961.60
Dry Soil + Tare (g)	577.85	849.41
Tare (g)	0.0	271.43
Wt. of Water (g)	65.87	112.19
Dry Soil (g)	667.13	667.13
Moisture Content (%)	11.4	19.4
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	118.5	119.5
Wet Density (pcf)	132.0	138.2
Saturation (%)	72.9	100.0

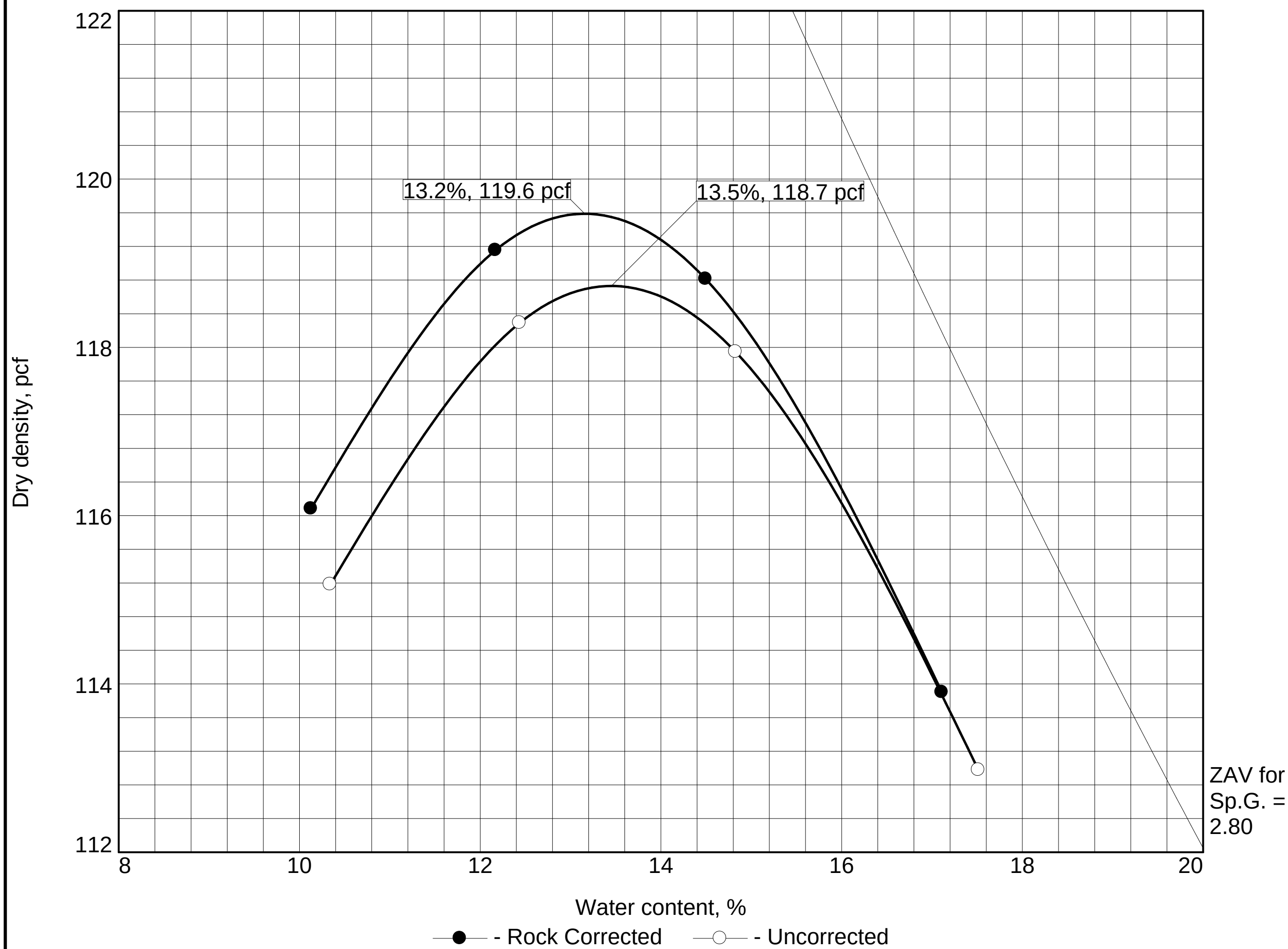
Initial Height (in)	3.033
Initial Diameter (in)	2.793
Initial Area (in^2)	6.127
Consolidated Height (in)	3.017
Area After Consolidation (in^2)	6.062
Diameter During Perm (in)	2.778
Change in Height (in)	0.016
Moisture Content after Consolidation (%)	14.8%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	124.7	
Remolded Density (pcf):	118.5	
Percent Compaction:	95%	
Void Ratio:	0.400	
Optimum Moisture Content(%):	11.4	
Initial Water Content (%):	11.4	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**5.4E-07**	
Gradient Range (h/L):	3.3	6.7

COMPACTION TEST REPORT



Test specification: ASTM D 1557-02 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
2-3'	SC	A-2-6(0)		2.80	29	12	2.7	32.1

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 119.6 pcf	118.7 pcf
Optimum moisture = 13.2 %	13.5 %

MATERIAL DESCRIPTION

Brown clayey sand

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-85 **Sample Number:** 17-177-14

NewFields

Remarks:

Figure 17-177-14

Tested By: AL **Checked By:** KE

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-14
Project:	Hermosa Underground Project	Field Sample No.:	TP-85
Project No.:	475.0014.008	Location:	TP-85
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/9/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	627.35	790.41
Dry Soil + Tare (g)	554.20	676.10
Tare (g)	0.0	122.45
Wt. of Water (g)	73.15	114.31
Dry Soil (g)	667.13	667.13
Moisture Content (%)	13.2	20.6
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	113.3	114.0
Wet Density (pcf)	128.2	134.6
Saturation (%)	73.1	100.0

Initial Height (in)	3.032
Initial Diameter (in)	2.798
Initial Area (in^2)	6.149
Consolidated Height (in)	3.019
Area After Consolidation (in^2)	6.098
Diameter During Perm (in)	2.786
Change in Height (in)	0.013
Moisture Content after Consolidation (%)	17.4%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	119.6	
Remolded Density (pcf):	113.3	
Percent Compaction:	95%	
Void Ratio:	0.470	
Optimum Moisture Content(%):	13.2	
Initial Water Content (%):	13.2	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**4.7E-06**	
Gradient Range (h/L):	7.5	7.5

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-14
Project:	Hermosa Underground Project	Field Sample No.:	TP-85
Project No.:	475.0014.008	Location:	TP-85
Phase:	1	Elevation/Depth:	2'-3'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/10/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	627.35	790.41
Dry Soil + Tare (g)	554.20	676.10
Tare (g)	0.0	122.45
Wt. of Water (g)	73.15	114.31
Dry Soil (g)	553.65	553.65
Moisture Content (%)	13.2	20.6
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	113.3	114.0
Wet Density (pcf)	128.2	134.6
Saturation (%)	73.1	100.0

Initial Height (in)	3.032
Initial Diameter (in)	2.798
Initial Area (in^2)	6.149
Consolidated Height (in)	3.012
Area After Consolidation (in^2)	6.068
Diameter During Perm (in)	2.780
Change in Height (in)	0.020
Moisture Content after Consolidation (%)	17.0%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	119.6	
Remolded Density (pcf):	113.3	
Percent Compaction:	95%	
Void Ratio:	0.459	
Optimum Moisture Content(%):	13.2	
Initial Water Content (%):	13.2	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**3.3E-06**	
Gradient Range (h/L):	7.9	8.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-14/17-365-01
Project:	Hermosa Underground Project	Field Sample No.:	2% benonite amended TP-85
Project No.:	475.0014.008	Location:	TP-85
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	11/6/2017	Checked By:	KE
Test Finished:	11/13/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test		After Test
Wet Soil + Tare (g)	638.4		856.53
Dry Soil + Tare (g)	554.17		749.09
Tare (g)	0.0		192.02
Wt. of Water (g)	84.23		107.44
Dry Soil (g)	554.17		554.17
Moisture Content (%)	15.2		19.3
Volume (ft^3)	0.0107		0.0107
Dry Density (pcf)	113.9		114.2
Wet Density (pcf)	131.2		134.5
Saturation (%)	85.7		100.0
Initial Height (in)		3.032	
Initial Diameter (in)		2.790	
Initial Area (in^2)		6.112	
Consolidated Height (in)		3.027	
Area After Consolidation (in^2)		6.092	
Diameter During Perm (in)		2.785	
Change in Height (in)		0.005	
Moisture Content after Consolidation (%)		17.5%	
Specific Gravity*		2.70	

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	119.6	
Remolded Density (pcf):	113.9	
Percent Compaction:	95%	
Void Ratio:	0.472	
Optimum Moisture Content(%):	13.2	
Initial Water Content (%):	15.2	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**1.8E-06**	
Gradient Range (h/L):	5.6	6.4

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-14/17-365-01
Project:	Hermosa Underground Project	Field Sample No.:	2% benonite amended TP-85
Project No.:	475.0014.008	Location:	TP-85
Phase:	1	Elevation/Depth:	2'-3'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	11/6/2017	Checked By:	KE
Test Finished:	11/14/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	638.4	856.53
Dry Soil + Tare (g)	554.17	749.09
Tare (g)	0.0	192.02
Wt. of Water (g)	84.23	107.44
Dry Soil (g)	554.17	554.17
Moisture Content (%)	15.2	19.3
Volume (ft^3)	0.0107	0.0107
Dry Density (pcf)	113.9	114.2
Wet Density (pcf)	131.2	134.5
Saturation (%)	85.7	100.0

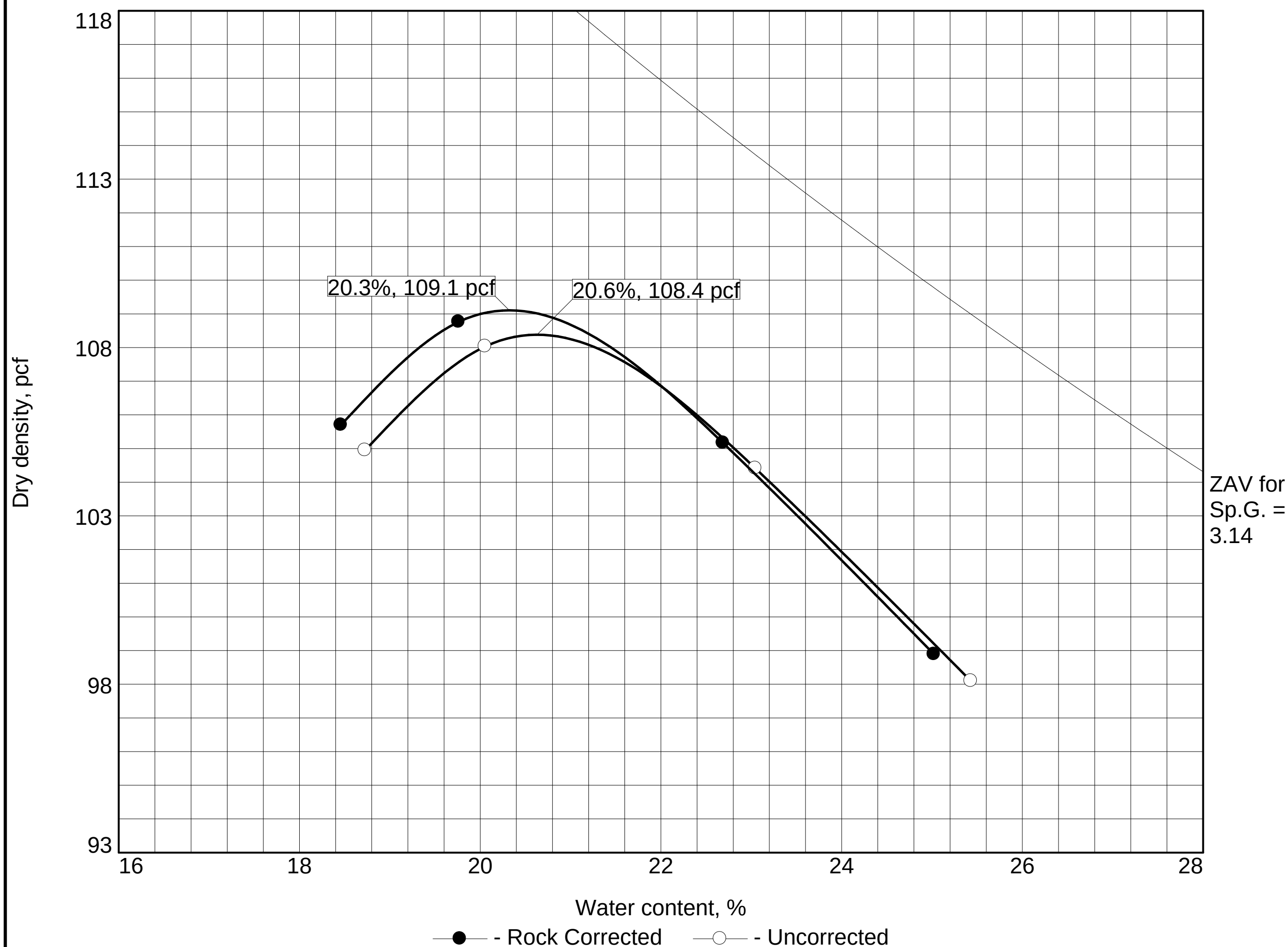
Initial Height (in)	3.032
Initial Diameter (in)	2.790
Initial Area (in^2)	6.112
Consolidated Height (in)	3.018
Area After Consolidation (in^2)	6.056
Diameter During Perm (in)	2.777
Change in Height (in)	0.014
Moisture Content after Consolidation (%)	17.0%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	119.6	
Remolded Density (pcf):	113.9	
Percent Compaction:	95%	
Void Ratio:	0.459	
Optimum Moisture Content(%):	13.2	
Initial Water Content (%):	15.2	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**1.3E-06**	
Gradient Range (h/L):	5.6	7.8

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
2-3'	SC	A-6(4)		3.14	30	17	2.1	48.1

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 109.1 pcf	108.4 pcf	Dark Brown clayey sand
Optimum moisture = 20.3 %	20.6 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

Location: TP-86 **Sample Number:** 17-177-15

NewFields

Remarks:

Figure 17-177-15

Tested By: BB/JM **Checked By:** KE

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-15/17-205-01
Project:	Hermosa Underground Project	Field Sample No.:	TP-86
Project No.:	475.0014.008	Location:	TP-86
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/20/2017	Checked By:	KE
Test Finished:	8/22/2017	Sample Description:	Dark Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	606.73	741.13
Dry Soil + Tare (g)	503.09	627.41
Tare (g)	0.0	121.17
Wt. of Water (g)	103.64	113.72
Dry Soil (g)	667.13	667.13
Moisture Content (%)	20.6	22.5
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	103.0	103.5
Wet Density (pcf)	124.2	127.9
Saturation (%)	87.5	100.0

Initial Height (in)	3.036
Initial Diameter (in)	2.793
Initial Area (in^2)	6.128
Consolidated Height (in)	3.026
Area After Consolidation (in^2)	6.088
Diameter During Perm (in)	2.784
Change in Height (in)	0.010
Moisture Content after Consolidation (%)	23.0%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	108.4	
Remolded Density (pcf):	103.0	
Percent Compaction:	95%	
Void Ratio:	0.620	
Optimum Moisture Content(%):	20.6	
Initial Water Content (%):	20.6	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**1.9E-06**	
Gradient Range (h/L):	5.5	6.3

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-15/17-205-01
Project:	Hermosa Underground Project	Field Sample No.:	TP-86
Project No.:	475.0014.008	Location:	TP-86
Phase:	1	Elevation/Depth:	2'-3'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/20/2017	Checked By:	KE
Test Finished:	8/24/2017	Sample Description:	Dark Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	606.73	741.13
Dry Soil + Tare (g)	503.09	627.41
Tare (g)	0.0	121.17
Wt. of Water (g)	103.64	113.72
Dry Soil (g)	506.24	506.24
Moisture Content (%)	20.6	22.5
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	103.0	103.5
Wet Density (pcf)	124.2	127.9
Saturation (%)	87.5	100.0

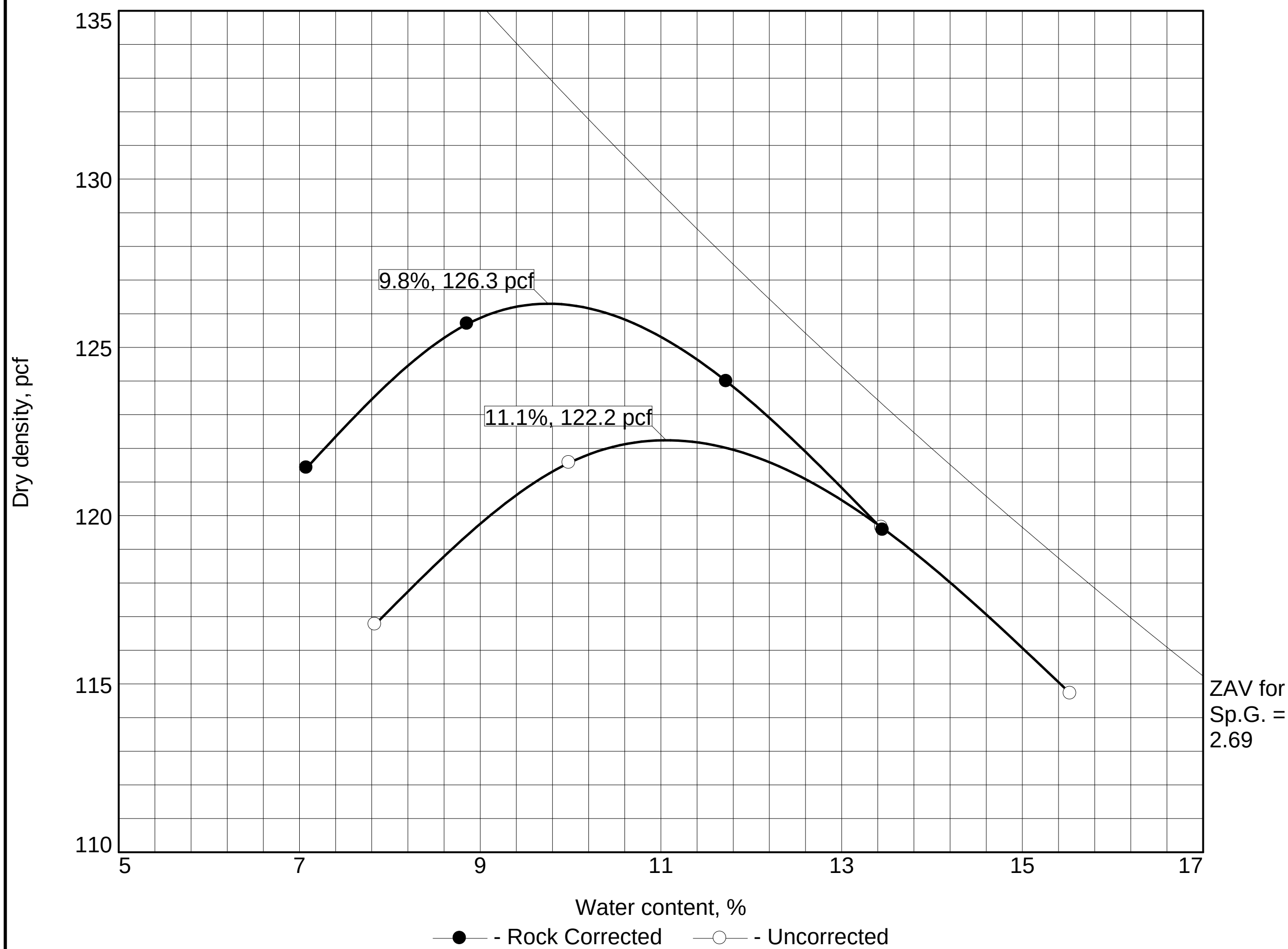
Initial Height (in)	3.036
Initial Diameter (in)	2.793
Initial Area (in^2)	6.128
Consolidated Height (in)	3.019
Area After Consolidation (in^2)	6.058
Diameter During Perm (in)	2.777
Change in Height (in)	0.017
Moisture Content after Consolidation (%)	22.5%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	108.4	
Remolded Density (pcf):	103.0	
Percent Compaction:	95%	
Void Ratio:	0.609	
Optimum Moisture Content(%):	20.6	
Initial Water Content (%):	20.6	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**1.7E-07**	
Gradient Range (h/L):	2.4	3.7

COMPACTION TEST REPORT



Test specification: ASTM D 1557-02 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
2-3'	GC	A-2-7(1)		2.69	43	27	17.1	20.0

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 126.3 pcf	122.2 pcf	Brown clayey gravel with sand
Optimum moisture = 9.8 %	11.1 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

Location: TP-97 **Sample Number:** 17-177-28

NewFields

Remarks:

Figure 17-177-28

Tested By: AL **Checked By:** KE

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-28
Project:	Hermosa Underground Project	Field Sample No.:	TP-97
Project No.:	475.0014.008	Location:	TP-97
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/9/2017	Sample Description:	Brown clayey gravel with sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	55
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	643.03	878.80
Dry Soil + Tare (g)	585.64	774.00
Tare (g)	0.0	189.95
Wt. of Water (g)	57.39	104.80
Dry Soil (g)	667.13	667.13
Moisture Content (%)	9.8	17.9
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	119.5	120.6
Wet Density (pcf)	131.2	138.9
Saturation (%)	64.6	100.0

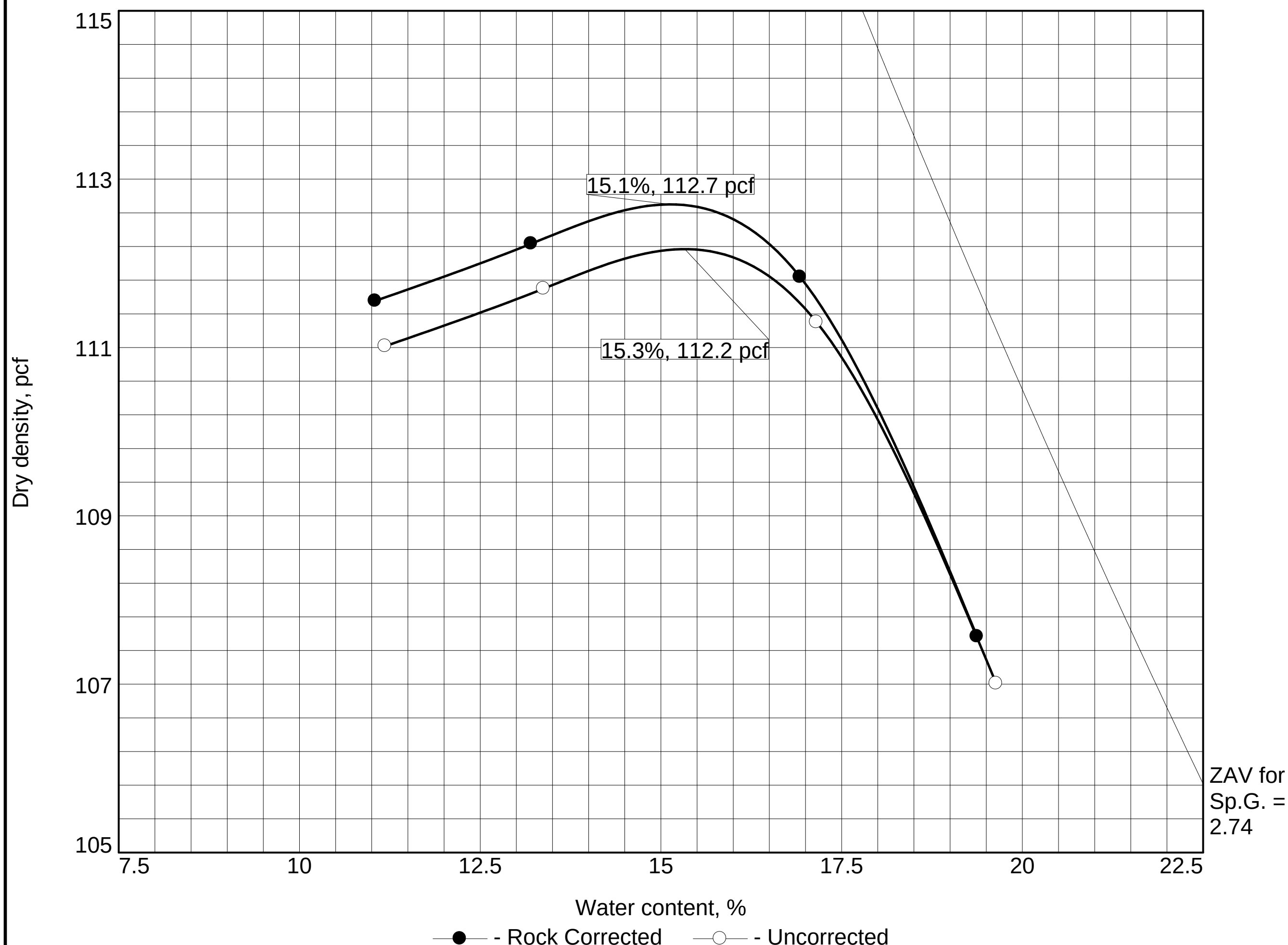
Initial Height (in)	3.035
Initial Diameter (in)	2.799
Initial Area (in^2)	6.152
Consolidated Height (in)	3.019
Area After Consolidation (in^2)	6.086
Diameter During Perm (in)	2.784
Change in Height (in)	0.016
Moisture Content after Consolidation (%)	14.4%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	126.3
Remolded Density (pcf):	119.5
Percent Compaction:	95%
Void Ratio:	0.388
Optimum Moisture Content(%):	9.8
Initial Water Content (%):	9.8
Confining Pressure (psi):	10.0
Permeability (k cm/s):	**2.4E-07**
Gradient Range (h/L):	5.7 7.4

COMPACTION TEST REPORT



Test specification: ASTM D 1557-00 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
7-8'	SC	A-2-6(1)		2.74	38	26	1.5	21.9

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 112.7 pcf	112.2 pcf	Light Brown clayey sand
Optimum moisture = 15.1 %	15.3 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-111 **Sample Number:** 17-177-38

NewFields

Remarks:
Assumed specific gravity.

Figure 17-233-02

Tested By: OS **Checked By:** RF

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-233-02
Project:	Hermosa Underground Project	Field Sample No.:	TP-111
Project No.:	475.0014.008	Location:	TP-111
Phase:	1	Elevation/Depth:	4-5'
Requested By:	Craig Thompson	Tested By:	OS
Test Started:	9/15/2017	Checked By:	KE
Test Finished:	9/22/2017	Sample Description:	Light Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	588.43	836.08
Dry Soil + Tare (g)	522.12	707.37
Tare (g)	0.0	189.53
Wt. of Water (g)	66.31	128.71
Dry Soil (g)	667.13	667.13
Moisture Content (%)	12.7	24.9
Volume (ft^3)	0.0107	0.0106
Dry Density (pcf)	107.1	107.6
Wet Density (pcf)	120.7	130.5
Saturation (%)	59.9	100.0

Initial Height (in)	3.033
Initial Diameter (in)	2.792
Initial Area (in^2)	6.121
Consolidated Height (in)	3.024
Area After Consolidation (in^2)	6.085
Diameter During Perm (in)	2.783
Change in Height (in)	0.009
Moisture Content after Consolidation (%)	20.7%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	112.7	
Remolded Density (pcf):	107.1	
Percent Compaction:	95%	
Void Ratio:	0.559	
Optimum Moisture Content(%):	15.2	
Initial Water Content (%):	12.7	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**5.2E-05**	
Gradient Range (h/L):	4.7	4.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-233-02
Project:	Hermosa Underground Project	Field Sample No.:	TP-111
Project No.:	475.0014.008	Location:	TP-111
Phase:	1	Elevation/Depth:	7-8'
Requested By:	Craig Thompson	Tested By:	OS
Test Started:	9/15/2017	Checked By:	KE
Test Finished:	8/11/2017	Sample Description:	Light Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	588.43	836.08
Dry Soil + Tare (g)	522.12	707.37
Tare (g)	0.0	189.53
Wt. of Water (g)	66.31	128.71
Dry Soil (g)	517.84	517.84
Moisture Content (%)	12.7	24.9
Volume (ft^3)	0.0107	0.0106
Dry Density (pcf)	107.1	107.6
Wet Density (pcf)	120.7	130.5
Saturation (%)	59.9	100.0

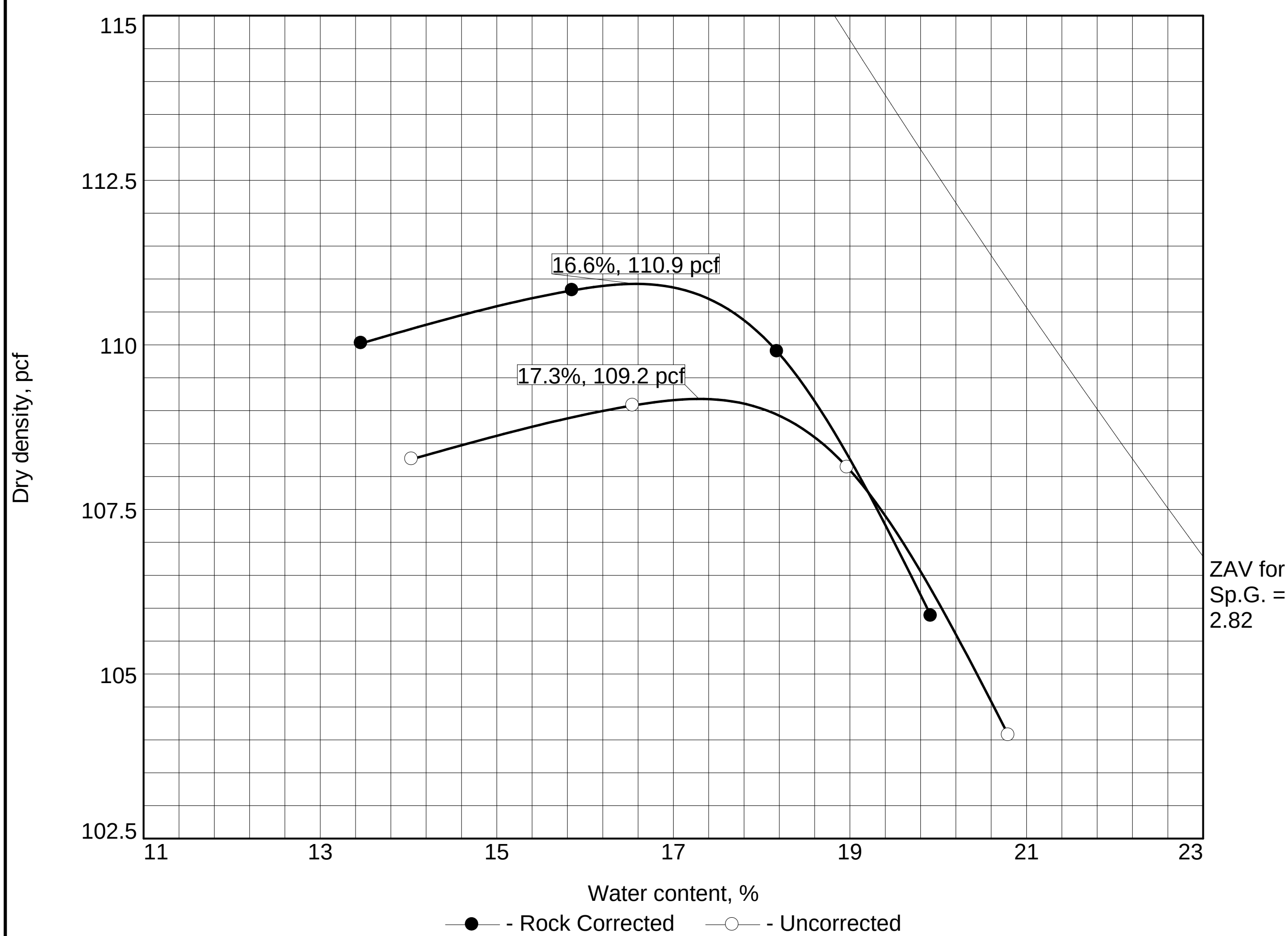
Initial Height (in)	3.033
Initial Diameter (in)	2.792
Initial Area (in^2)	6.121
Consolidated Height (in)	3.011
Area After Consolidation (in^2)	6.031
Diameter During Perm (in)	2.771
Change in Height (in)	0.022
Moisture Content after Consolidation (%)	20.0%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	112.7	
Remolded Density (pcf):	107.1	
Percent Compaction:	95%	
Void Ratio:	0.539	
Optimum Moisture Content(%):	15.2	
Initial Water Content (%):	12.7	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**3.7E-05**	
Gradient Range (h/L):	14.1	14.2

COMPACTION TEST REPORT



Test specification: ASTM D 1557-00 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
3-4'	SC	A-7-6(6)		2.82	45	24	4.5	43.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 110.9 pcf	109.2 pcf
Optimum moisture = 16.6 %	17.3 %

MATERIAL DESCRIPTION

Brown clayey sand

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-119 **Sample Number:** 17-177-41

NewFields

Remarks:
Assumed specific gravity.

Figure 17-233-03

Tested By: OS **Checked By:** RF

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-233-03
Project:	Hermosa Underground Project	Field Sample No.:	TP-119
Project No.:	475.0014.008	Location:	TP-119
Phase:	1	Elevation/Depth:	4-5'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	9/15/2017	Checked By:	KE
Test Finished:	9/22/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	599.34	904.60
Dry Soil + Tare (g)	514.01	776.96
Tare (g)	0.0	268.99
Wt. of Water (g)	85.33	127.64
Dry Soil (g)	667.13	667.13
Moisture Content (%)	16.6	25.1
Volume (ft^3)	0.0107	0.0105
Dry Density (pcf)	105.5	106.7
Wet Density (pcf)	123.0	130.3
Saturation (%)	75.1	100.0

Initial Height (in)	3.035
Initial Diameter (in)	2.791
Initial Area (in^2)	6.117
Consolidated Height (in)	3.013
Area After Consolidation (in^2)	6.029
Diameter During Perm (in)	2.771
Change in Height (in)	0.022
Moisture Content after Consolidation (%)	20.9%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	110.9	
Remolded Density (pcf):	105.5	
Percent Compaction:	95%	
Void Ratio:	0.564	
Optimum Moisture Content(%):	16.6	
Initial Water Content (%):	16.6	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**2.4E-06**	
Gradient Range (h/L):	15.5	16.9

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-233-03
Project:	Hermosa Underground Project	Field Sample No.:	TP-119
Project No.:	475.0014.008	Location:	TP-119
Phase:	1	Elevation/Depth:	3-4'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	9/15/2017	Checked By:	KE
Test Finished:	8/11/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	599.34	904.60
Dry Soil + Tare (g)	514.01	776.96
Tare (g)	0.0	268.99
Wt. of Water (g)	85.33	127.64
Dry Soil (g)	507.97	507.97
Moisture Content (%)	16.6	25.1
Volume (ft^3)	0.0107	0.0105
Dry Density (pcf)	105.5	106.7
Wet Density (pcf)	123.0	130.3
Saturation (%)	75.1	100.0

Initial Height (in)	3.035
Initial Diameter (in)	2.791
Initial Area (in^2)	6.117
Consolidated Height (in)	3.009
Area After Consolidation (in^2)	6.013
Diameter During Perm (in)	2.767
Change in Height (in)	0.026
Moisture Content after Consolidation (%)	20.6%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	110.9	
Remolded Density (pcf):	105.5	
Percent Compaction:	95%	
Void Ratio:	0.557	
Optimum Moisture Content(%):	16.6	
Initial Water Content (%):	16.6	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**7.2E-07**	
Gradient Range (h/L):	4.8	7.7

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-41/17-365-02
Project:	Hermosa Underground Project	Field Sample No.:	2% benonite amended TP-119
Project No.:	475.0014.008	Location:	TP-119
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	11/6/2017	Checked By:	KE
Test Finished:	11/22/2017	Sample Description:	Brown clayey sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	609.65	867.57
Dry Soil + Tare (g)	514.04	739.97
Tare (g)	0.0	222.12
Wt. of Water (g)	95.61	127.60
Dry Soil (g)	514.04	514.04
Moisture Content (%)	18.6	24.6
Volume (ft^3)	0.0107	0.0106
Dry Density (pcf)	106.0	106.7
Wet Density (pcf)	125.7	130.0
Saturation (%)	85.2	100.0

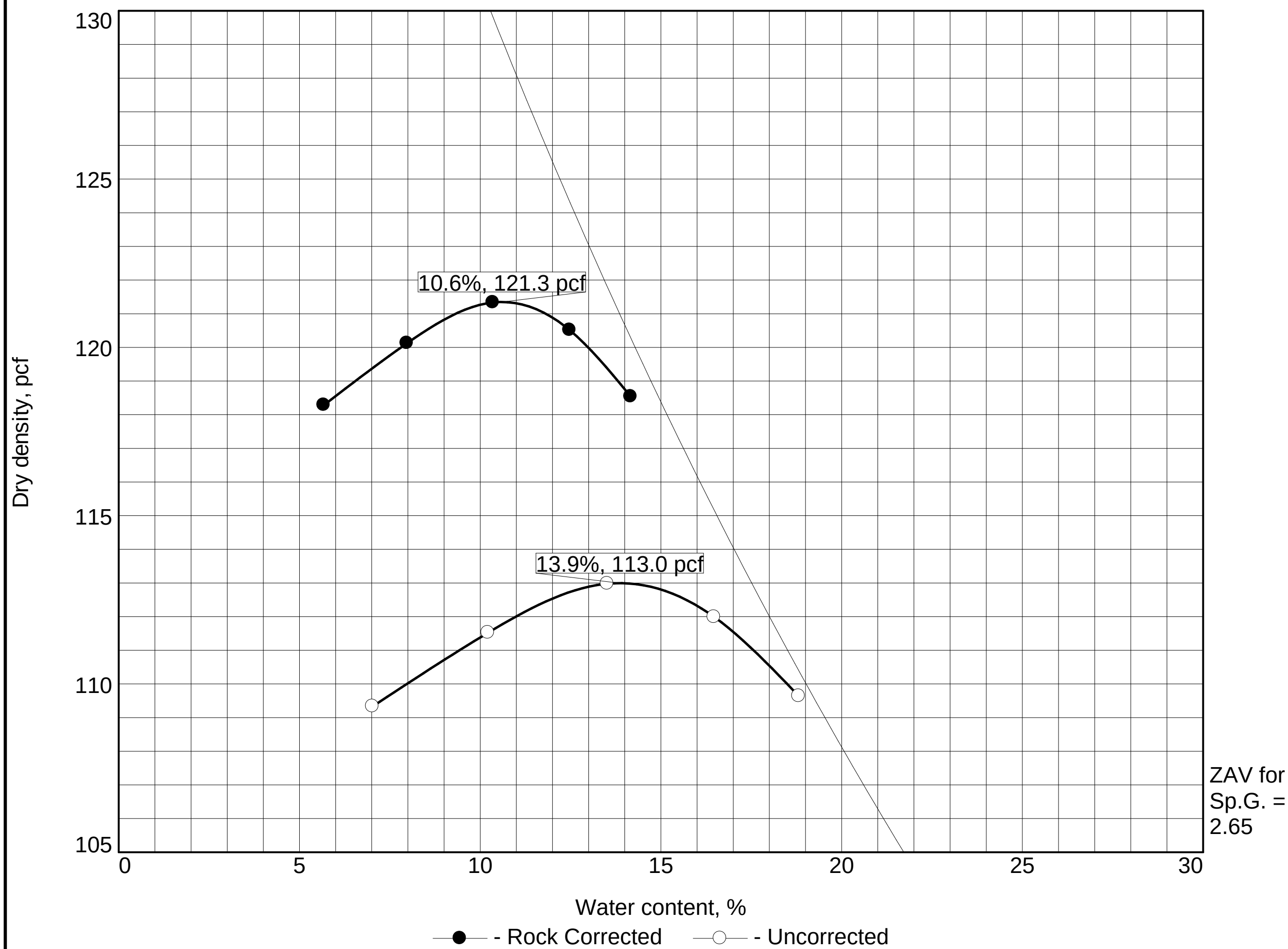
Initial Height (in)	3.031
Initial Diameter (in)	2.785
Initial Area (in^2)	6.093
Consolidated Height (in)	3.020
Area After Consolidation (in^2)	6.046
Diameter During Perm (in)	2.775
Change in Height (in)	0.012
Moisture Content after Consolidation (%)	21.2%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	110.9	
Remolded Density (pcf):	106.0	
Percent Compaction:	96%	
Void Ratio:	0.571	
Optimum Moisture Content(%):	16.6	
Initial Water Content (%):	18.6	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**5.4E-07**	
Gradient Range (h/L):	5.8	8.2

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
7-8'	GC	A-2-7(3)		2.65	41	24	28.0	35.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 121.3 pcf	113.0 pcf	Brown clayey gravel with sand
Optimum moisture = 10.6 %	13.9 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-122A **Sample Number:** 17-177-44

NewFields

Remarks:

Figure 17-177-44

Tested By: BB/JM **Checked By:** KE

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-44/17-205-02
Project:	Hermosa Underground Project	Field Sample No.:	TP-122A
Project No.:	475.0014.008	Location:	TP-122A
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/20/2017	Checked By:	KE
Test Finished:	8/22/2017	Sample Description:	Brown clayey grevel with sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	622.09	814.52
Dry Soil + Tare (g)	562.47	688.71
Tare (g)	0.0	125.72
Wt. of Water (g)	59.62	125.81
Dry Soil (g)	667.13	667.13
Moisture Content (%)	10.6	22.3
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	114.8	115.9
Wet Density (pcf)	126.9	136.1
Saturation (%)	61.1	100.0

Initial Height (in)	3.039
Initial Diameter (in)	2.797
Initial Area (in^2)	6.144
Consolidated Height (in)	3.020
Area After Consolidation (in^2)	6.066
Diameter During Perm (in)	2.779
Change in Height (in)	0.019
Moisture Content after Consolidation (%)	16.3%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	121.3	
Remolded Density (pcf):	114.8	
Percent Compaction:	95%	
Void Ratio:	0.441	
Optimum Moisture Content(%):	10.6	
Initial Water Content (%):	10.6	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**6.1E-07**	
Gradient Range (h/L):	6.5	7.2

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-44/17-205-02
Project:	Hermosa Underground Project	Field Sample No.:	TP-122A
Project No.:	475.0014.008	Location:	TP-122A
Phase:	1	Elevation/Depth:	7'-8'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/20/2017	Checked By:	KE
Test Finished:	8/24/2017	Sample Description:	Brown clayey grevel with sand

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	40
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

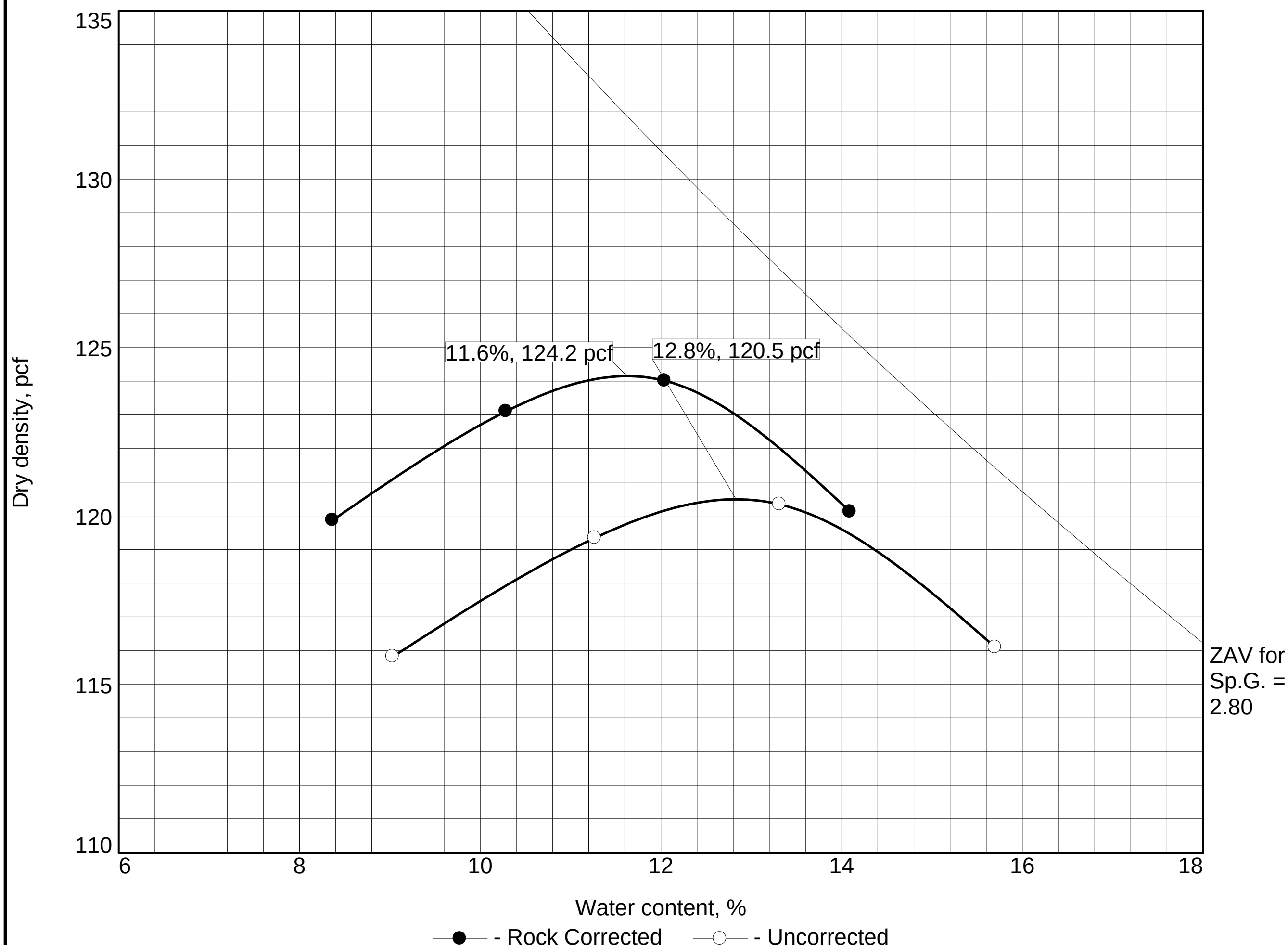
Test Specimen Data	Before Test		After Test
Wet Soil + Tare (g)	622.09		814.52
Dry Soil + Tare (g)	562.47		688.71
Tare (g)	0.0		125.72
Wt. of Water (g)	59.62		125.81
Dry Soil (g)	562.99		562.99
Moisture Content (%)	10.6		22.3
Volume (ft^3)	0.0108		0.0106
Dry Density (pcf)	114.8		115.9
Wet Density (pcf)	126.9		136.1
Saturation (%)	61.1		100.0
Initial Height (in)		3.039	
Initial Diameter (in)		2.797	
Initial Area (in^2)		6.144	
Consolidated Height (in)		3.012	
Area After Consolidation (in^2)		6.036	
Diameter During Perm (in)		2.772	
Change in Height (in)		0.027	
Moisture Content after Consolidation (%)		15.9%	
Specific Gravity*		2.70	

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	121.3	
Remolded Density (pcf):	114.8	
Percent Compaction:	95%	
Void Ratio:	0.430	
Optimum Moisture Content(%):	10.6	
Initial Water Content (%):	10.6	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**1.7E-07**	
Gradient Range (h/L):	2.4	3.7

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
2.5-3.5	SC	A-2-6(0)		2.80	37	20	14.1	18.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED
Maximum dry density = 124.2 pcf	120.5 pcf
Optimum moisture = 11.6 %	12.8 %

MATERIAL DESCRIPTION

Red Brown clayey sand with gravel

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-122B **Sample Number:** 17-177-45

NewFields

Remarks:

Figure 17-177-45

Tested By: AL **Checked By:** KE

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-45
Project:	Hermosa Underground Project	Field Sample No.:	TP-122B
Project No.:	475.0014.008	Location:	TP-122B
Phase:	1	Elevation/Depth:	Stockpile
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/9/2017	Sample Description:	Red/Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	642.41	869.59
Dry Soil + Tare (g)	575.64	762.30
Tare (g)	0.0	189.09
Wt. of Water (g)	66.77	107.29
Dry Soil (g)	667.13	667.13
Moisture Content (%)	11.6	18.7
Volume (ft^3)	0.0108	0.0107
Dry Density (pcf)	117.7	118.4
Wet Density (pcf)	131.4	137.3
Saturation (%)	72.7	100.0

Initial Height (in)	3.038
Initial Diameter (in)	2.794
Initial Area (in^2)	6.131
Consolidated Height (in)	3.027
Area After Consolidation (in^2)	6.088
Diameter During Perm (in)	2.784
Change in Height (in)	0.011
Moisture Content after Consolidation (%)	15.4%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf)	124.2	
Remolded Density (pcf)	117.7	
Percent Compaction	95%	
Void Ratio	0.417	
Optimum Moisture Content(%	11.6	
Initial Water Content (%	11.6	
Confining Pressure (psi)	10.0	
Permeability (k cm/s)	**7.0E-06**	
Gradient Range (h/L)	7.8	7.8

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-45
Project:	Hermosa Underground Project	Field Sample No.:	TP-122B
Project No.:	475.0014.008	Location:	TP-122B
Phase:	1	Elevation/Depth:	2.5'-3.5'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/11/2017	Sample Description:	Red/Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	642.41	869.59
Dry Soil + Tare (g)	575.64	762.30
Tare (g)	0.0	189.09
Wt. of Water (g)	66.77	107.29
Dry Soil (g)	573.21	573.21
Moisture Content (%)	11.6	18.7
Volume (ft^3)	0.0108	0.0107
Dry Density (pcf)	117.7	118.4
Wet Density (pcf)	131.4	137.3
Saturation (%)	72.7	100.0

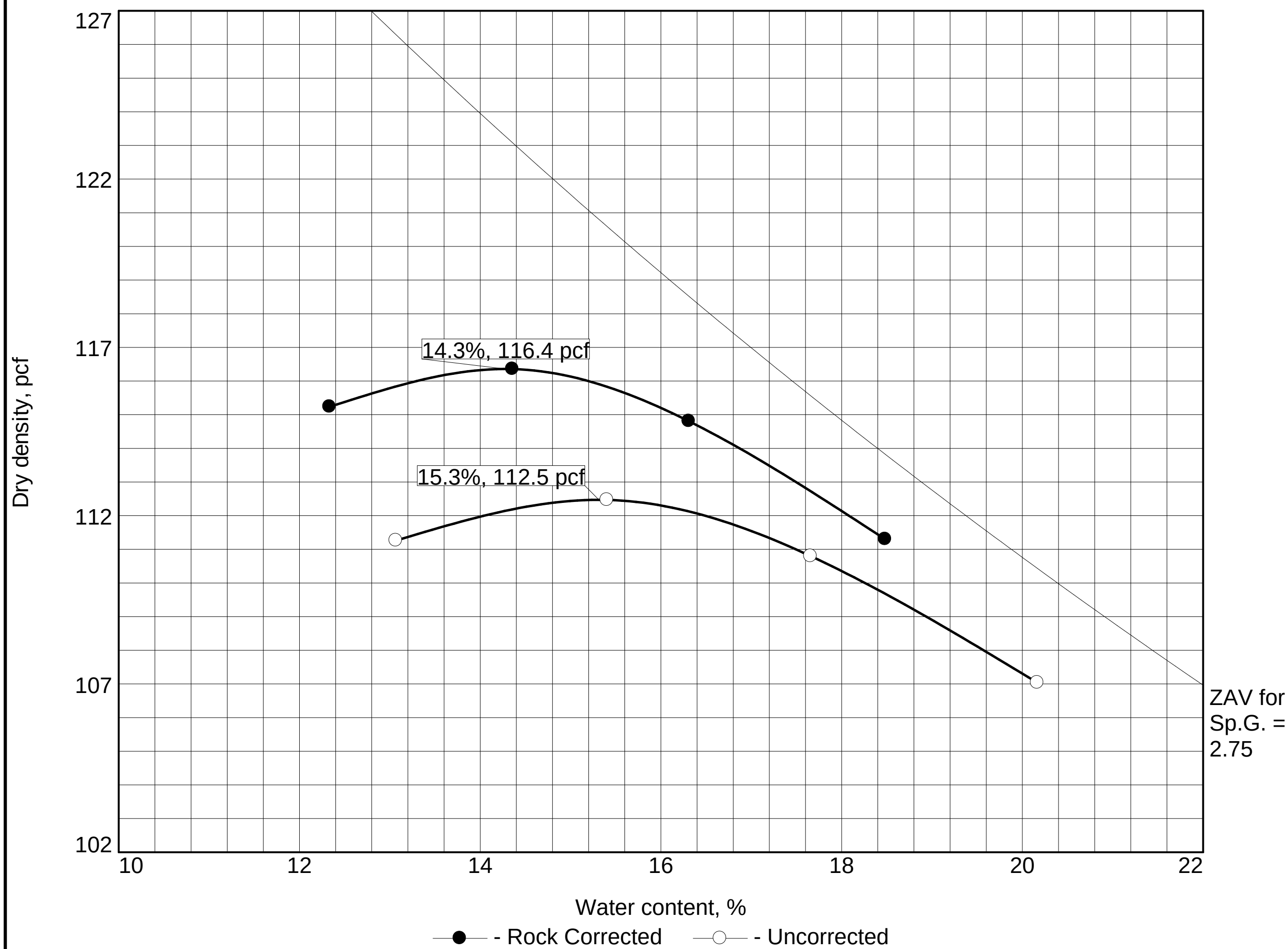
Initial Height (in)	3.038
Initial Diameter (in)	2.794
Initial Area (in^2)	6.131
Consolidated Height (in)	3.019
Area After Consolidation (in^2)	6.056
Diameter During Perm (in)	2.777
Change in Height (in)	0.019
Moisture Content after Consolidation (%)	15.0%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	124.2	
Remolded Density (pcf):	117.7	
Percent Compaction:	95%	
Void Ratio:	0.405	
Optimum Moisture Content(%):	11.6	
Initial Water Content (%):	11.6	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**4.5E-06**	
Gradient Range (h/L):	4.7	5.5

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method B Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/8 in.	% < No.200
	USCS	AASHTO						
4-5'	SC	A-2-7(2)		2.75	47	20	13.4	35.4

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 116.4 pcf	112.5 pcf	Brown clayey sand with gravel
Optimum moisture = 14.3 %	15.3 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○**Location:** TP-126 **Sample Number:** 17-177-52

NewFields

Remarks:

Figure 17-177-52

Tested By: AL **Checked By:** KE

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-52
Project:	Hermosa Underground Project	Field Sample No.:	TP-126
Project No.:	475.0014.008	Location:	TP-126
Phase:	1	Elevation/Depth:	4-5'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/8/2017	Sample Description:	Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 1: Effective Stress (psi)	10
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	616.72	786.00
Dry Soil + Tare (g)	539.56	659.50
Tare (g)	0.0	122.2
Wt. of Water (g)	77.16	126.50
Dry Soil (g)	667.13	667.13
Moisture Content (%)	14.3	23.5
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	110.6	111.6
Wet Density (pcf)	126.4	133.3
Saturation (%)	73.8	100.0

Initial Height (in)	3.032
Initial Diameter (in)	2.793
Initial Area (in^2)	6.128
Consolidated Height (in)	3.015
Area After Consolidation (in^2)	6.059
Diameter During Perm (in)	2.778
Change in Height (in)	0.017
Moisture Content after Consolidation (%)	18.5%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM D1557

Maximum Dry Density (pcf):	116.4	
Remolded Density (pcf):	110.6	
Percent Compaction:	95%	
Void Ratio:	0.498	
Optimum Moisture Content(%):	14.3	
Initial Water Content (%):	14.3	
Confining Pressure (psi):	10.0	
Permeability (k cm/s):	**9.6E-07**	
Gradient Range (h/L):	7.1	7.8

NewFields

Flexible Wall Permeability
ASTM D5084

Client:	Arizona Minerals Inc.	Lab Sample No.:	17-177-52
Project:	Hermosa Underground Project	Field Sample No.:	TP-126
Project No.:	475.0014.008	Location:	TP-126
Phase:	1	Elevation/Depth:	4'-5'
Requested By:	Craig Thompson	Tested By:	RF
Test Started:	8/4/2017	Checked By:	KE
Test Finished:	8/11/2017	Sample Description:	Brown clayey sand with gravel

Test Boundary Conditions	
Type of Permeant	De-aired Bottled
Magnitude of Back pressure (psi)	45
Saturated (Y/N):	Yes
Stage 2: Effective Stress (psi)	20
Sample Type	Remolded
Burrete Area (cm^2)	0.877

Test Specimen Data	Before Test	After Test
Wet Soil + Tare (g)	616.72	786.00
Dry Soil + Tare (g)	539.56	659.50
Tare (g)	0.0	122.2
Wt. of Water (g)	77.16	126.50
Dry Soil (g)	537.30	537.30
Moisture Content (%)	14.3	23.5
Volume (ft^3)	0.0108	0.0106
Dry Density (pcf)	110.6	111.6
Wet Density (pcf)	126.4	133.3
Saturation (%)	73.8	100.0

Initial Height (in)	3.032
Initial Diameter (in)	2.793
Initial Area (in^2)	6.128
Consolidated Height (in)	3.001
Area After Consolidation (in^2)	6.001
Diameter During Perm (in)	2.764
Change in Height (in)	0.031
Moisture Content after Consolidation (%)	17.7%
Specific Gravity*	2.70

*Specific gravity is assumed

Maximum Dry Density: ASTM 1557-12

Maximum Dry Density (pcf):	116.4	
Remolded Density (pcf):	110.6	
Percent Compaction:	95%	
Void Ratio:	0.477	
Optimum Moisture Content(%):	14.3	
Initial Water Content (%):	14.3	
Confining Pressure (psi):	20.0	
Permeability (k cm/s):	**6.2E-07**	
Gradient Range (h/L):	5.7	6.2

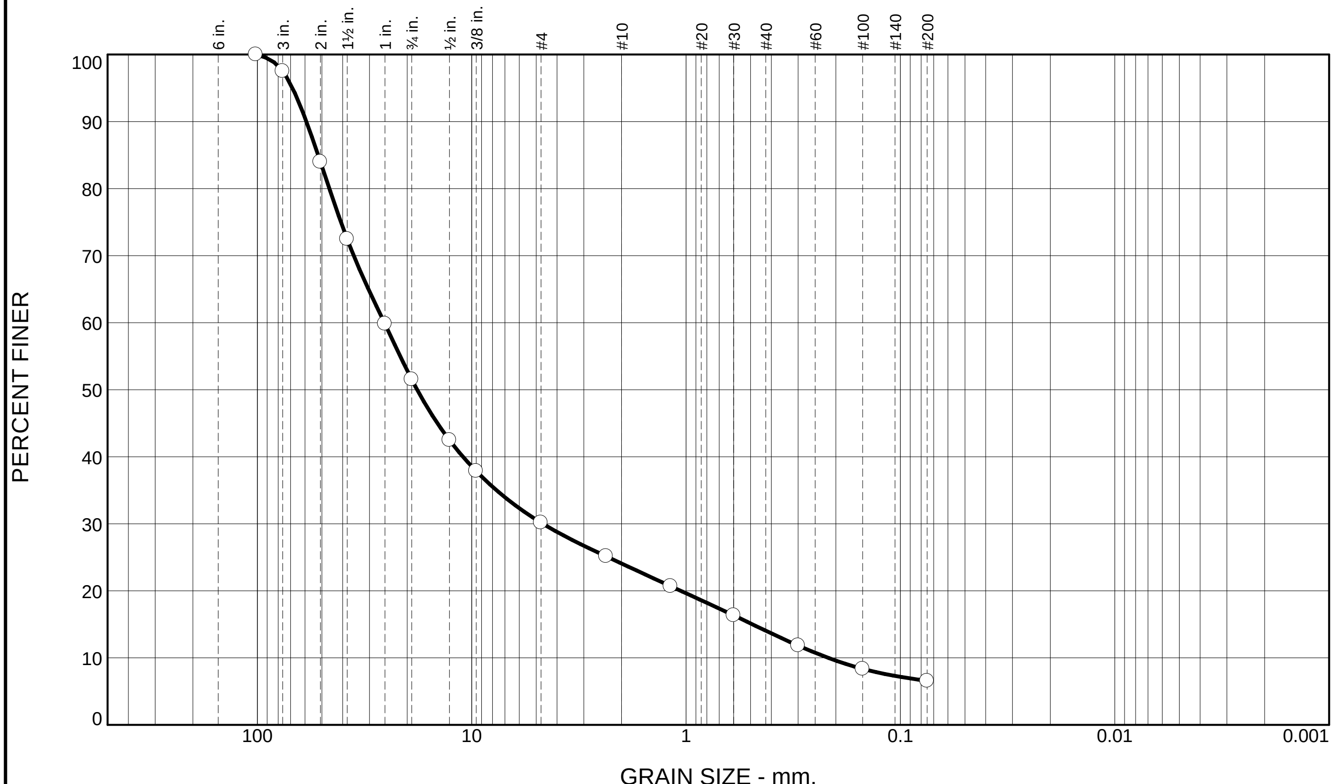
APPENDIX D.2.3

Laboratory Test Results (January 2018)

INFRASTRUCTURE PAD TEST PIT SUMMARY TABLE

NEWFIELDS SAMPLE NUMBER	SAMPLE TYPE	LOCATION		GRAIN SIZE DISTRIBUTION - PERCENT PASSING																USCS	ATTERBERG LIMITS		
				GRAVEL									SAND						CLAY/ SILT		PLASTIC LIMIT	LIQUID LIMIT	PLASTIC INDEX
				6.0"	4.0"	3.0"	2.0"	1.5"	1.0"	0.75"	0.5"	0.375"	#4	#8	#16	#30	#50	#100	#200				
				SPECIFICATION																	SPECIFICATION		
		Northing	Easting																				
TP-01 (14-31")	BUCKET	170,719	1,069,691	100.0	100.0	97.5	84.0	72.5	59.8	51.5	42.5	37.9	30.2	25.1	20.7	16.3	11.8	8.3	6.5	GP-GM	NP	NV	NP
TP-02 (18-44")	BUCKET	170,596	1,069,733	100.0	100.0	95.4	85.1	80.1	73.0	66.1	56.1	49.8	37.9	30.9	25.8	21.2	15.7	11.1	8.5	GW-GM	29	43	14
TP-03 (22-69")	BUCKET	170,457	1,069,805	100.0	100.0	100.0	100.0	100.0	100.0	99.8	99.2	98.4	88.1	77.5	67.4	56.9	44.6	34.1	27.8	SC	22	38	16
TP-03 (69-120")	BAGGY	170,457	1,069,805	100.0	100.0	100.0	100.0	100.0	100.0	98.9	95.3	92.0	80.1	67.9	56.8	47.8	40.8	34.8	30.2	SC	22	37	15
TP-04 (12-36")	BAGGY	170,330	1,069,843	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	89.8	80.3	72.0	63.5	54.9	46.7	41.1	SC	20	33	13
TP-04 (36-47")	BAGGY	170,330	1,069,843	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90.7	78.0	67.0	58.4	51.3	43.8	37.8	SM	28	45	17
TP-04 (16-47")	BUCKET	170,330	1,069,843	100.0	100.0	95.9	84.8	76.2	65.9	56.9	45.0	38.3	28.7	22.7	18.1	14.2	10.6	7.5	5.8	GP-GC	25	45	20
TP-05 (18-36")	BUCKET	170,265	1,069,758	100.0	100.0	100.0	94.2	89.0	83.3	78.0	69.1	65.5	54.7	46.6	38.8	30.8	23.4	17.6	14.5	GC	23	46	23
TP-05 (36-49")	BUCKET	170,265	1,069,758	100.0	100.0	100.0	89.5	84.1	71.9	59.8	45.3	37.6	26.5	21.3	17.1	13.2	9.7	7.0	5.3	GP-GC	22	41	19
TP-06 (15-46")	BUCKET	170,181	1,069,845	100.0	94.5	85.2	75.2	64.5	51.7	43.0	33.3	28.7	24.9	22.1	18.7	14.8	10.5	6.7	4.7	GP-GC	23	38	15
TP-08 (16-49")	BUCKET	170,505	1,069,649	100.0	100.0	97.1	86.3	77.2	67.4	58.4	49.2	43.4	39.6	35.8	31.5	26.9	22.1	17.5	14.4	GC	24	41	17

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2.5	46.0	21.3	6.1	10.0	7.6	6.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.0	100.0		
3.0	97.5		
2.0	84.0		
1.5	72.5		
1.0	59.8		
0.75	51.5		
0.5	42.5		
0.375	37.9		
#4	30.2		
#8	25.1		
#16	20.7		
#30	16.3		
#50	11.8		
#100	8.3		
#200	6.5		

* (no specification provided)

Material Description

Brown poorly graded gravel with silt and sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 59.0515 D_{85}= 52.0688 D_{60}= 25.5611
D_{50}= 17.9660 D_{30}= 4.6574 D_{15}= 0.4903
D_{10}= 0.2172 C_u= 117.69 C_c= 3.91

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Location: N:170,719; E:1,069,691
Sample Number: TP-01 (14-31")

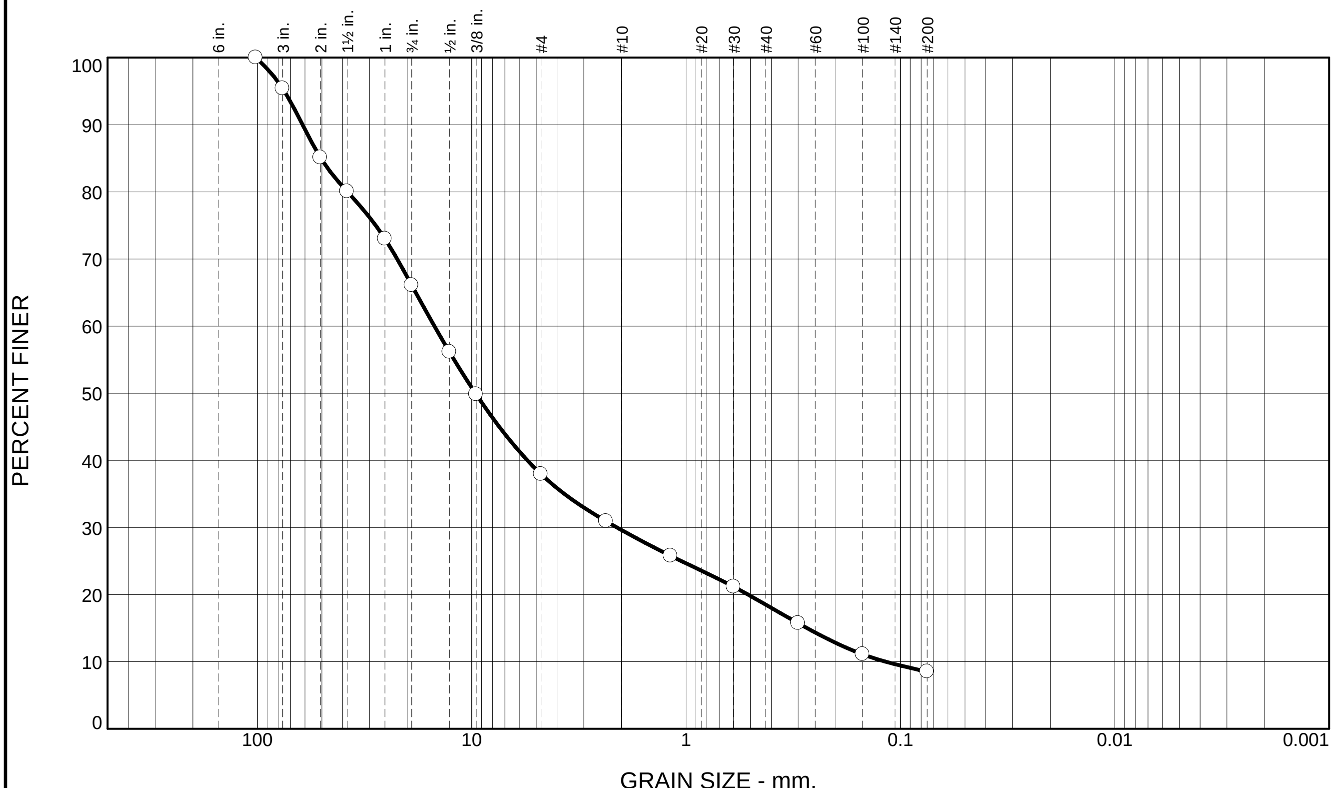
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-01

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4.6	29.3	28.2	8.3	11.1	10.0	8.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.0	100.0		
3.0	95.4		
2.0	85.1		
1.5	80.1		
1.0	73.0		
0.75	66.1		
0.5	56.1		
0.375	49.8		
#4	37.9		
#8	30.9		
#16	25.8		
#30	21.2		
#50	15.7		
#100	11.1		
#200	8.5		

* (no specification provided)

Material Description

Brown well-graded gravel with silt and sand

Atterberg Limits

PL= 29 LL= 43 PI= 14

Coefficients

D_{90}= 61.5203 D_{85}= 50.5588 D_{60}= 14.9246
D_{50}= 9.6083 D_{30}= 2.1024 D_{15}= 0.2728
D_{10}= 0.1172 C_u= 127.29 C_c= 2.53

Classification

USCS= GW-GM AASHTO= A-2-7(0)

Remarks

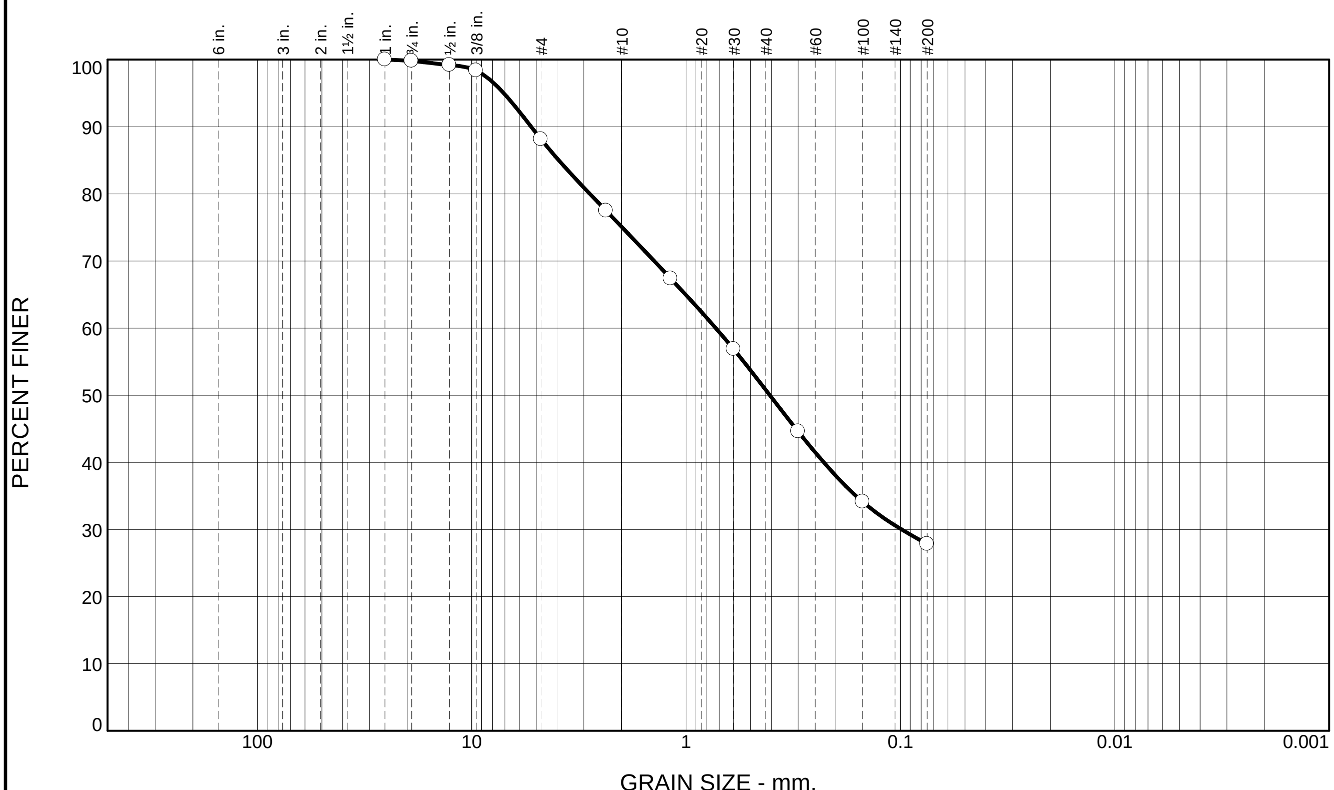
Location: N:170,596; E:1,069,733
Sample Number: TP-02 (18-44") **Date:** 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-02

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.2	11.7	13.0	24.3	23.0	27.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0	100.0		
0.75	99.8		
0.5	99.2		
0.375	98.4		
#4	88.1		
#8	77.5		
#16	67.4		
#30	56.9		
#50	44.6		
#100	34.1		
#200	27.8		

* (no specification provided)

Material Description

Reddish tan clayey sand

Atterberg Limits

PL= 22 LL= 38 PI= 16

Coefficients

D_{90}= 5.2786 D_{85}= 3.9253 D_{60}= 0.7268
D_{50}= 0.4066 D_{30}= 0.0989 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

Location: N:170,457; E:1,069,805
Sample Number: TP-03 (22-69")

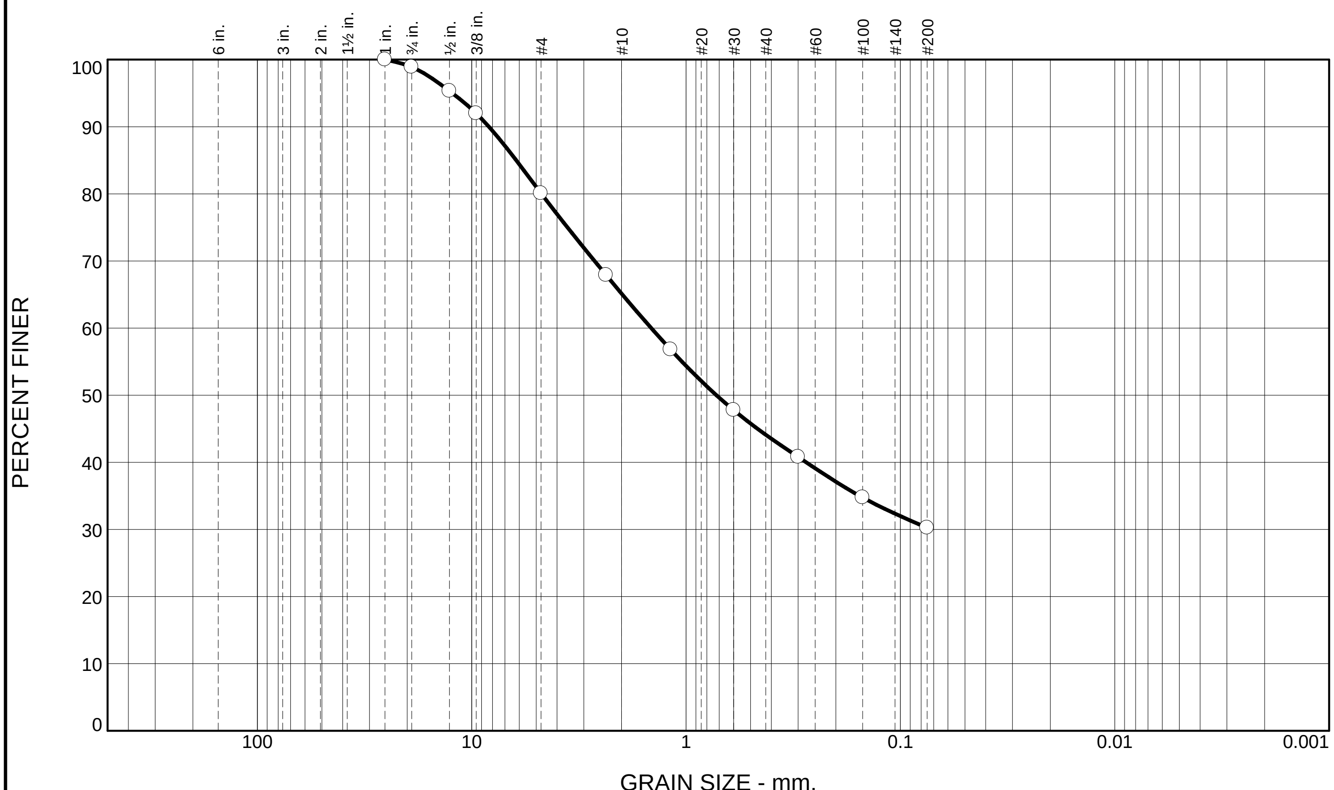
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-03

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.1	18.8	15.0	21.0	13.9	30.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0	100.0		
0.75	98.9		
0.5	95.3		
0.375	92.0		
#4	80.1		
#8	67.9		
#16	56.8		
#30	47.8		
#50	40.8		
#100	34.8		
#200	30.2		

* (no specification provided)

Material Description

Yellowish-White clayey sand with gravel

Atterberg Limits

PL= 22 LL= 37 PI= 15

Coefficients

D_{90}= 8.3076 D_{85}= 6.1993 D_{60}= 1.4541
D_{50}= 0.7216 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(1)

Remarks

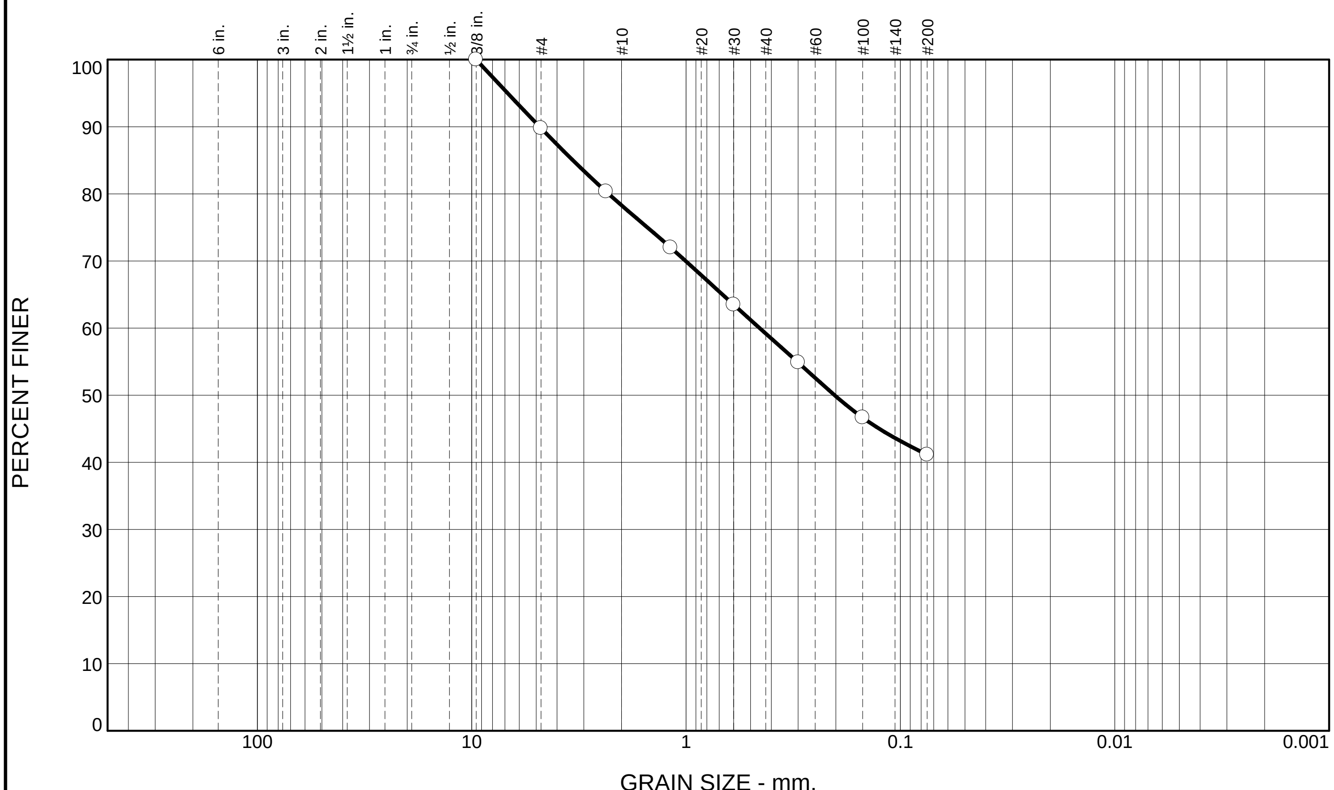
Location: N:170,457; E:1,069,805
Sample Number: TP-03 (69-120") **Date:** 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-03

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	10.2	11.5	19.1	18.1	41.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	89.8		
#8	80.3		
#16	72.0		
#30	63.5		
#50	54.9		
#100	46.7		
#200	41.1		

* (no specification provided)

Material Description

Reddish-Brown clayey sand

Atterberg Limits

PL= 20 LL= 33 PI= 13

Coefficients

D_{90}= 4.8216 D_{85}= 3.3723 D_{60}= 0.4534
D_{50}= 0.2028 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-6(2)

Remarks

Location: N:170,330; E:1,069,843
Sample Number: TP-04 (12-36")

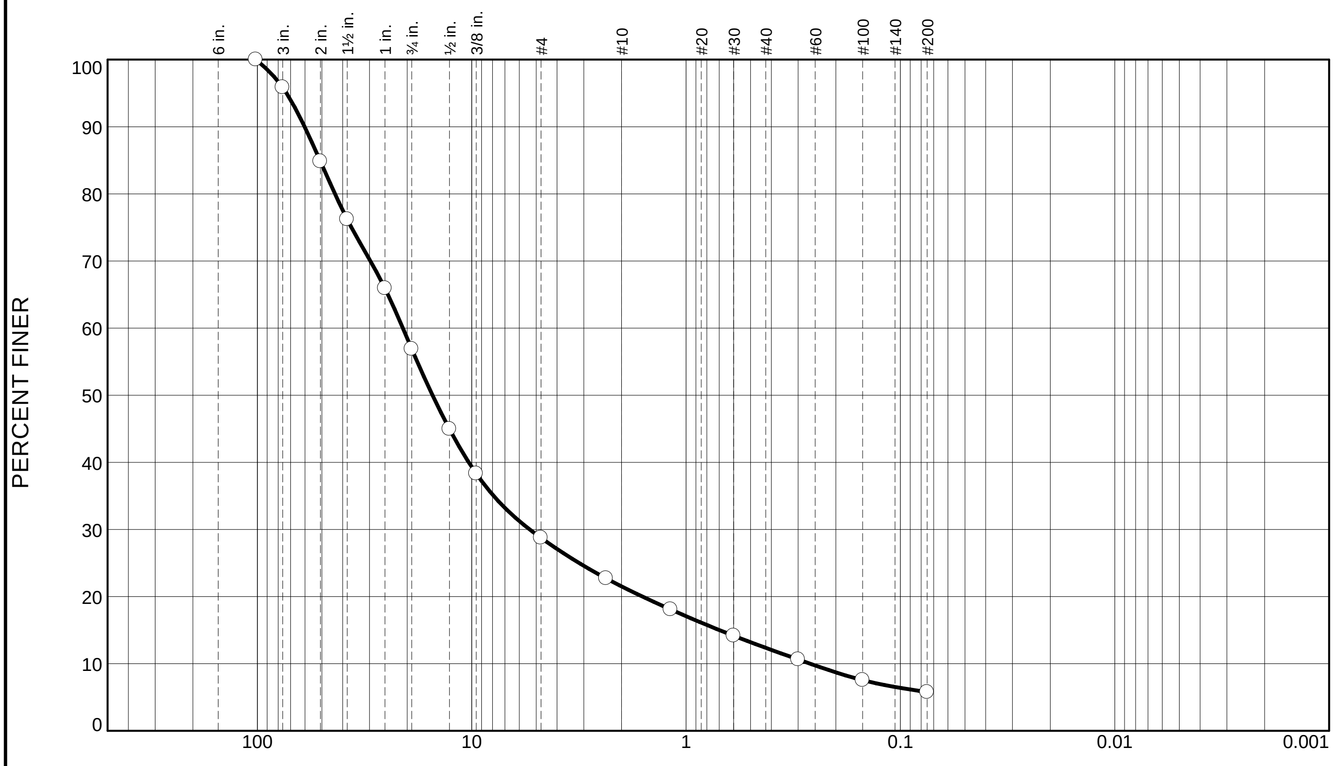
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-04

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
4.1	39.0	28.2	7.2	9.1	6.6	5.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.0	100.0		
3.0	95.9		
2.0	84.8		
1.5	76.2		
1.0	65.9		
0.75	56.9		
0.5	45.0		
0.375	38.3		
#4	28.7		
#8	22.7		
#16	18.1		
#30	14.2		
#50	10.6		
#100	7.5		
#200	5.8		

* (no specification provided)

Material Description

Brown poorly graded gravel with clay and sand

Atterberg Limits

PL= 25 LL= 45 PI= 20

Coefficients

D_{90}= 60.1987 D_{85}= 51.0663 D_{60}= 20.9634
D_{50}= 15.2323 D_{30}= 5.3645 D_{15}= 0.6989
D_{10}= 0.2638 C_u= 79.46 C_c= 5.20

Classification

USCS= GP-GC AASHTO= A-2-7(0)

Remarks

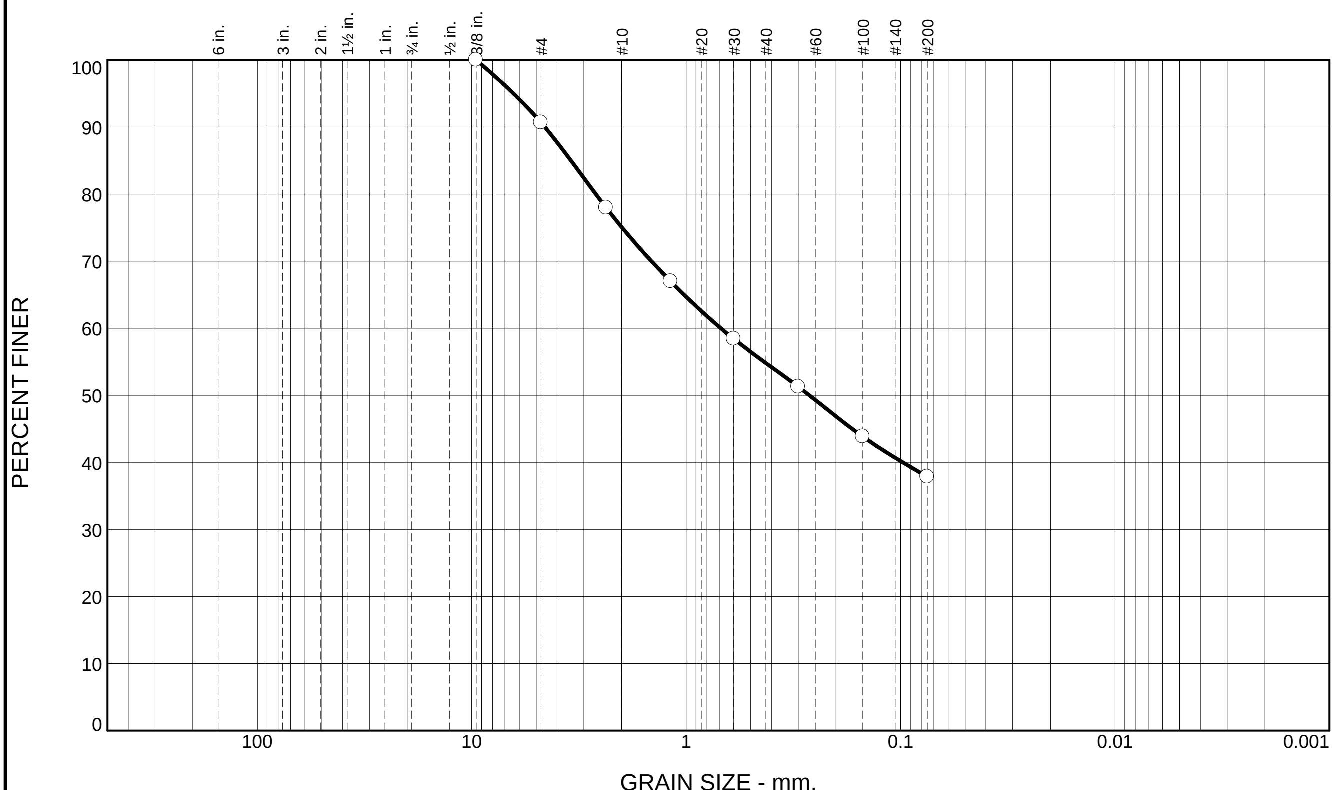
Location: N:170,330; E:1,069,843
Sample Number: TP-04 (16-47")
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-04

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.3	15.6	20.3	17.0	37.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375	100.0		
#4	90.7		
#8	78.0		
#16	67.0		
#30	58.4		
#50	51.3		
#100	43.8		
#200	37.8		

* (no specification provided)

Material Description

White silty sand

Atterberg Limits

PL= 28 LL= 45 PI= 17

Coefficients

D_{90}= 4.5647 D_{85}= 3.4477 D_{60}= 0.6896
D_{50}= 0.2666 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-7-6(2)

Remarks

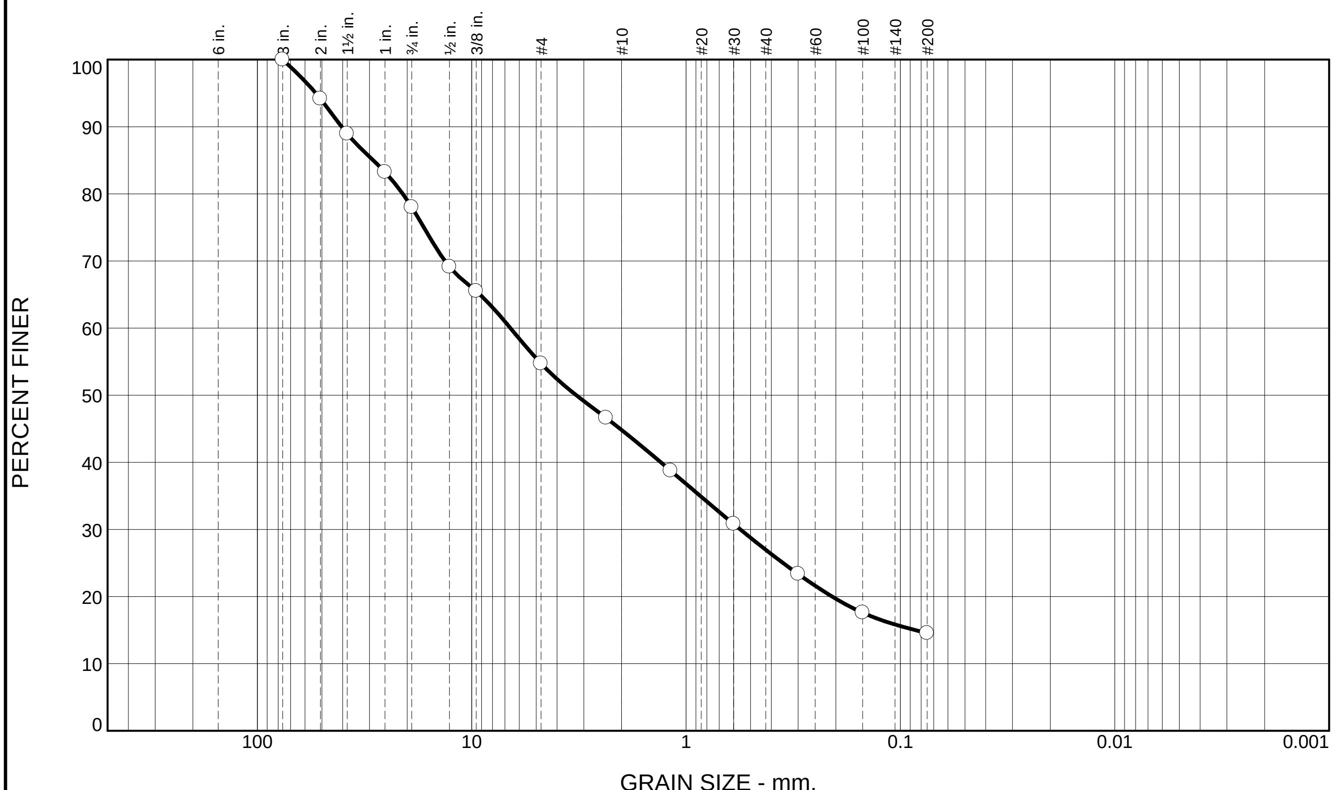
Location: N:170,330; E:1,069,843
Sample Number: TP-04 (36-47") **Date:** 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-04

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	22.0	23.3	9.9	17.8	12.5	14.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	94.2		
1.5	89.0		
1.0	83.3		
0.75	78.0		
0.5	69.1		
0.375	65.5		
#4	54.7		
#8	46.6		
#16	38.8		
#30	30.8		
#50	23.4		
#100	17.6		
#200	14.5		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 23 LL= 46 PI= 23

Coefficients

D_{90}= 40.4857 D_{85}= 28.7875 D_{60}= 6.5958
D_{50}= 3.2540 D_{30}= 0.5584 D_{15}= 0.0853
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(0)

Remarks

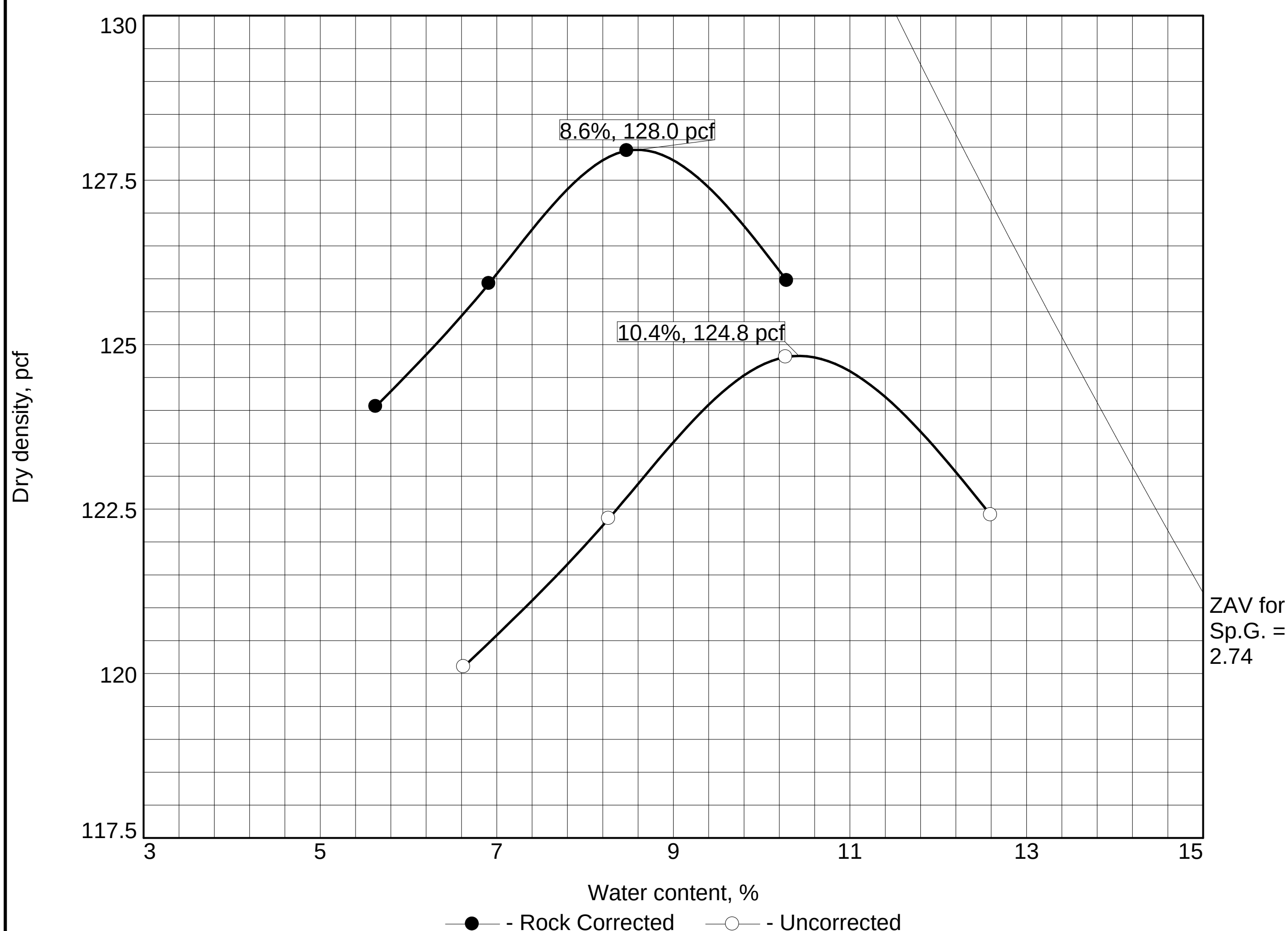
Location: N:170,265; E:1,069,758
Sample Number: TP-05 (18-36")
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-05

Tested By: RQ **Checked By:** JRK

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	GC	A-2-7(0)		2.74	46	23	22.0	14.5

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 128.0 pcf	124.8 pcf	Brown clayey gravel with sand
Optimum moisture = 8.6 %	10.4 %	

Project No. 475.0014.011 **Client:** Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Location: N:170,265; E:1,069,758 **Sample Number:** TP-05 (18-36")

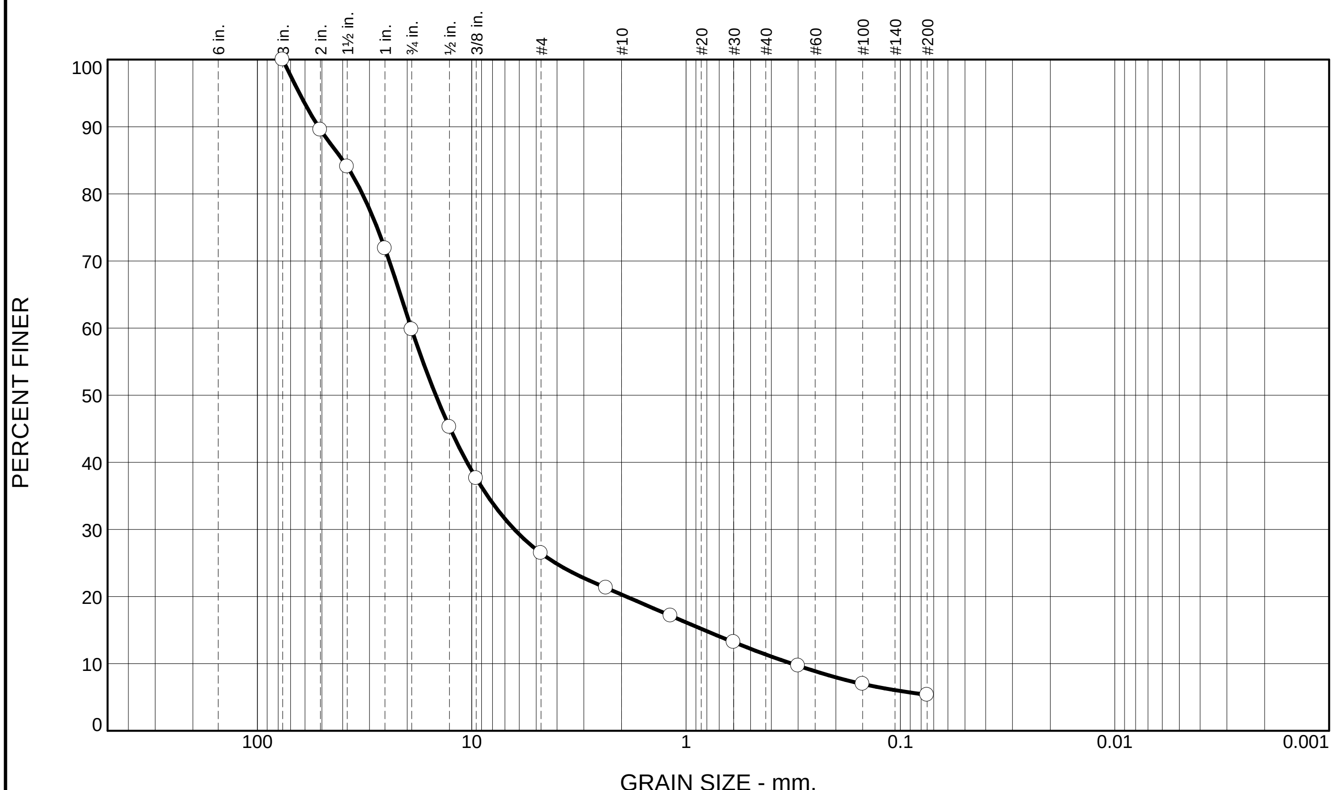
NewFields

Remarks:

Figure TP-05

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	40.2	33.3	6.2	8.9	6.1	5.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3.0	100.0		
2.0	89.5		
1.5	84.1		
1.0	71.9		
0.75	59.8		
0.5	45.3		
0.375	37.6		
#4	26.5		
#8	21.3		
#16	17.1		
#30	13.2		
#50	9.7		
#100	7.0		
#200	5.3		

* (no specification provided)

Material Description

Brown poorly graded gravel with clay and sand

Atterberg Limits

PL= 22 LL= 41 PI= 19

Coefficients

D_{90}= 51.9070 D_{85}= 39.9060 D_{60}= 19.1409
D_{50}= 14.7102 D_{30}= 6.3190 D_{15}= 0.8227
D_{10}= 0.3214 C_u= 59.56 C_c= 6.49

Classification

USCS= GP-GC AASHTO= A-2-7(0)

Remarks

Location: N:170,265; E:1,069,758
Sample Number: TP-05 (36-49")

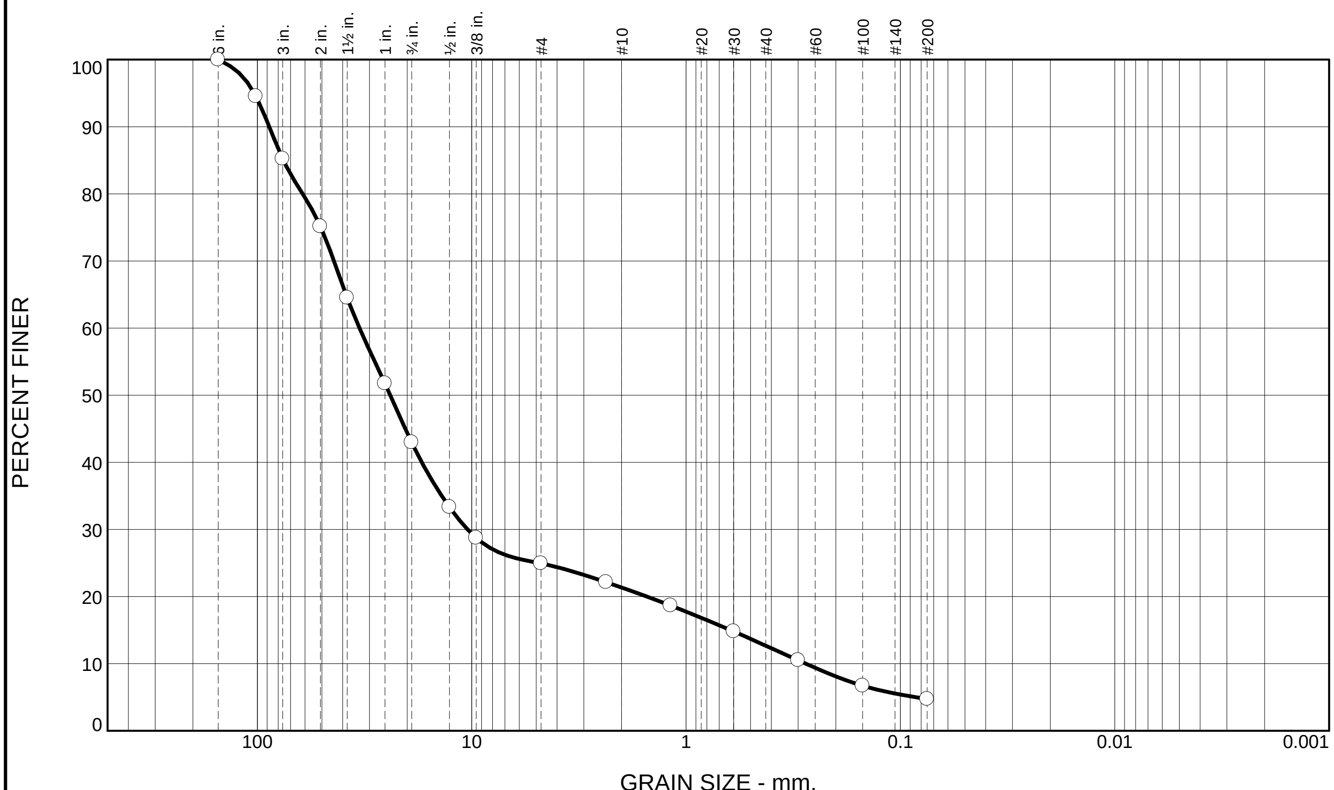
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-05

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
14.8	42.2	18.1	3.6	8.6	8.0	4.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
6.0	100.0		
4.0	94.5		
3.0	85.2		
2.0	75.2		
1.5	64.5		
1.0	51.7		
0.75	43.0		
0.5	33.3		
0.375	28.7		
#4	24.9		
#8	22.1		
#16	18.7		
#30	14.8		
#50	10.5		
#100	6.7		
#200	4.7		

* (no specification provided)

Material Description

Brown poorly graded gravel with clay and sand

Atterberg Limits

PL= 23 LL= 38 PI= 15

Coefficients

D_{90}= 88.0353 D_{85}= 75.6337 D_{60}= 33.3724
D_{50}= 23.9970 D_{30}= 10.4605 D_{15}= 0.6200
D_{10}= 0.2767 C_u= 120.60 C_c= 11.85

Classification

USCS= GP-GC AASHTO= A-2-6(0)

Remarks

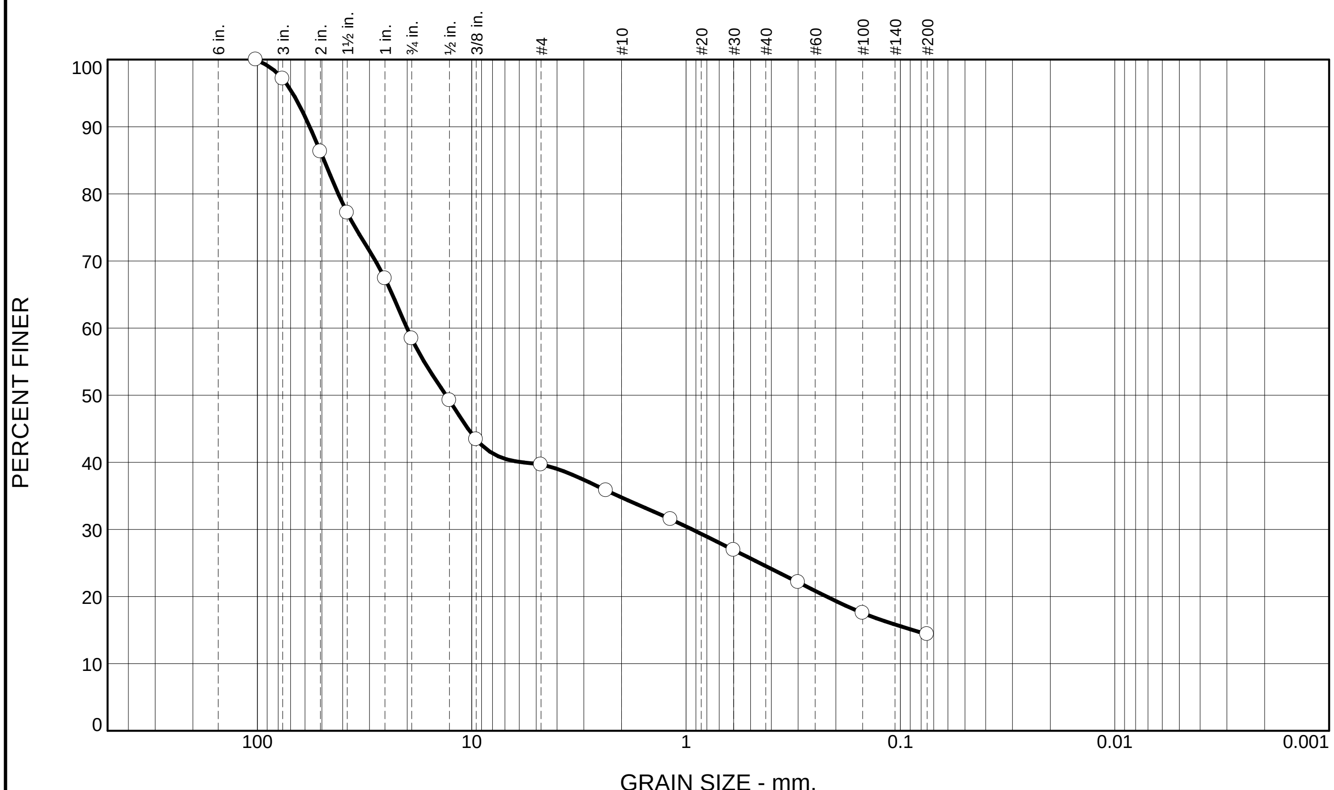
Location: N:170,181; E:1,069,845
Sample Number: TP-06 (15-46") **Date:** 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-06

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
2.9	38.7	18.8	4.8	10.3	10.1	14.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.0	100.0		
3.0	97.1		
2.0	86.3		
1.5	77.2		
1.0	67.4		
0.75	58.4		
0.5	49.2		
0.375	43.4		
#4	39.6		
#8	35.8		
#16	31.5		
#30	26.9		
#50	22.1		
#100	17.5		
#200	14.4		

* (no specification provided)

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 24 LL= 41 PI= 17

Coefficients

D_{90}= 57.0129 D_{85}= 48.8515 D_{60}= 20.0608
D_{50}= 13.1768 D_{30}= 0.9363 D_{15}= 0.0872
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-7(0)

Remarks

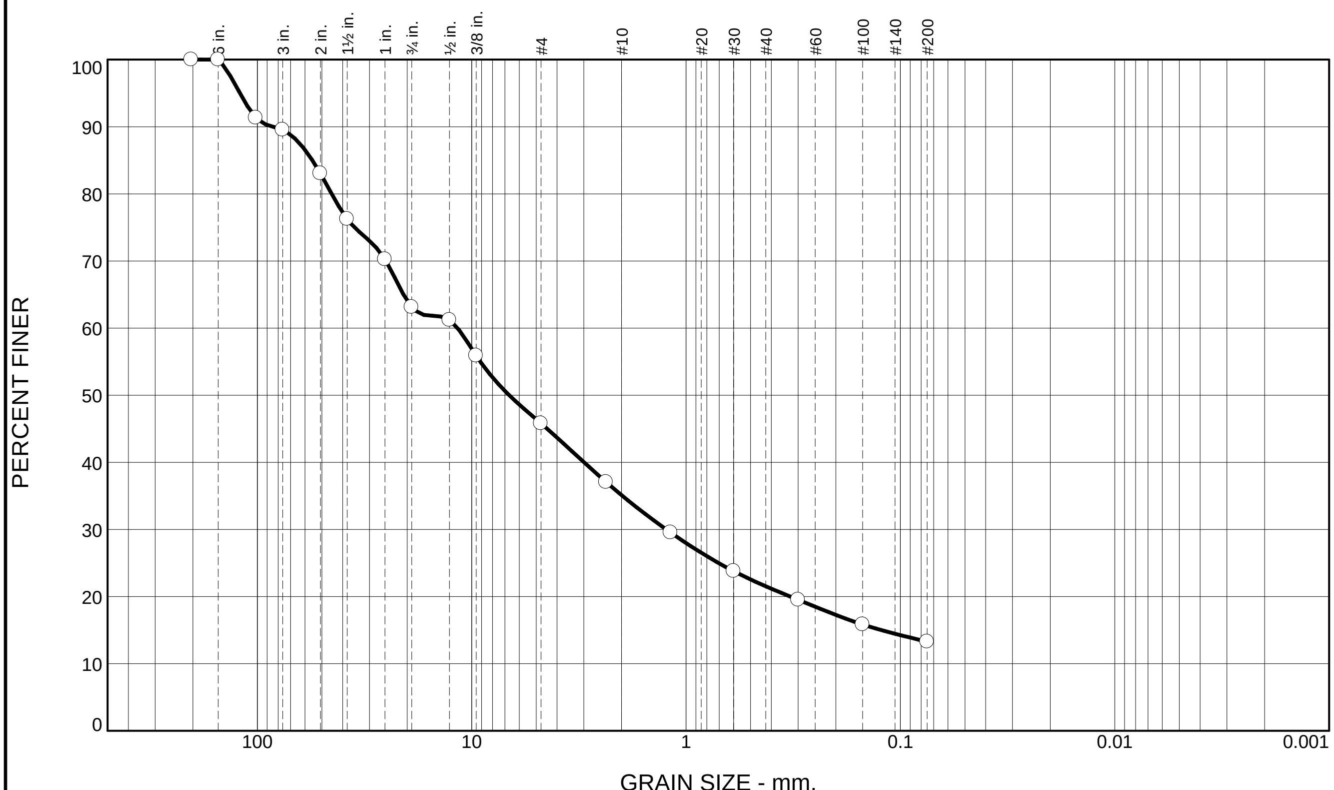
Location: N:170,505; E:1,069,649
Sample Number: TP-08 (16-49")
Date: 01/29/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** TP-08

Tested By: RQ **Checked By:** JRK

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
10.5	26.4	17.3	10.7	13.6	8.2	13.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
8.0	100.0	100.0	
6.0	100.0		
4.0	91.3		
3.0	89.5		
2.0	83.0		
1.5	76.2		
1.0	70.2		
0.75	63.1		
0.5	61.2		
0.375	55.9		
#4	45.8		
#8	37.1		
#16	29.5		
#30	23.8		
#50	19.5		
#100	15.8		
#200	13.3	0.0 - 15.0	

* AMI - Engineered Fill

Material Description

Brown clayey gravel with sand

Atterberg Limits

PL= 23 LL= 33 PI= 10

Coefficients

D_{90}= 84.5406 D_{85}= 55.4066 D_{60}= 11.6371
D_{50}= 6.6833 D_{30}= 1.2373 D_{15}= 0.1228
D_{10}= C_u= C_c=

Classification

USCS= GC AASHTO= A-2-4(0)

Remarks

Specification: PI-10 Max.

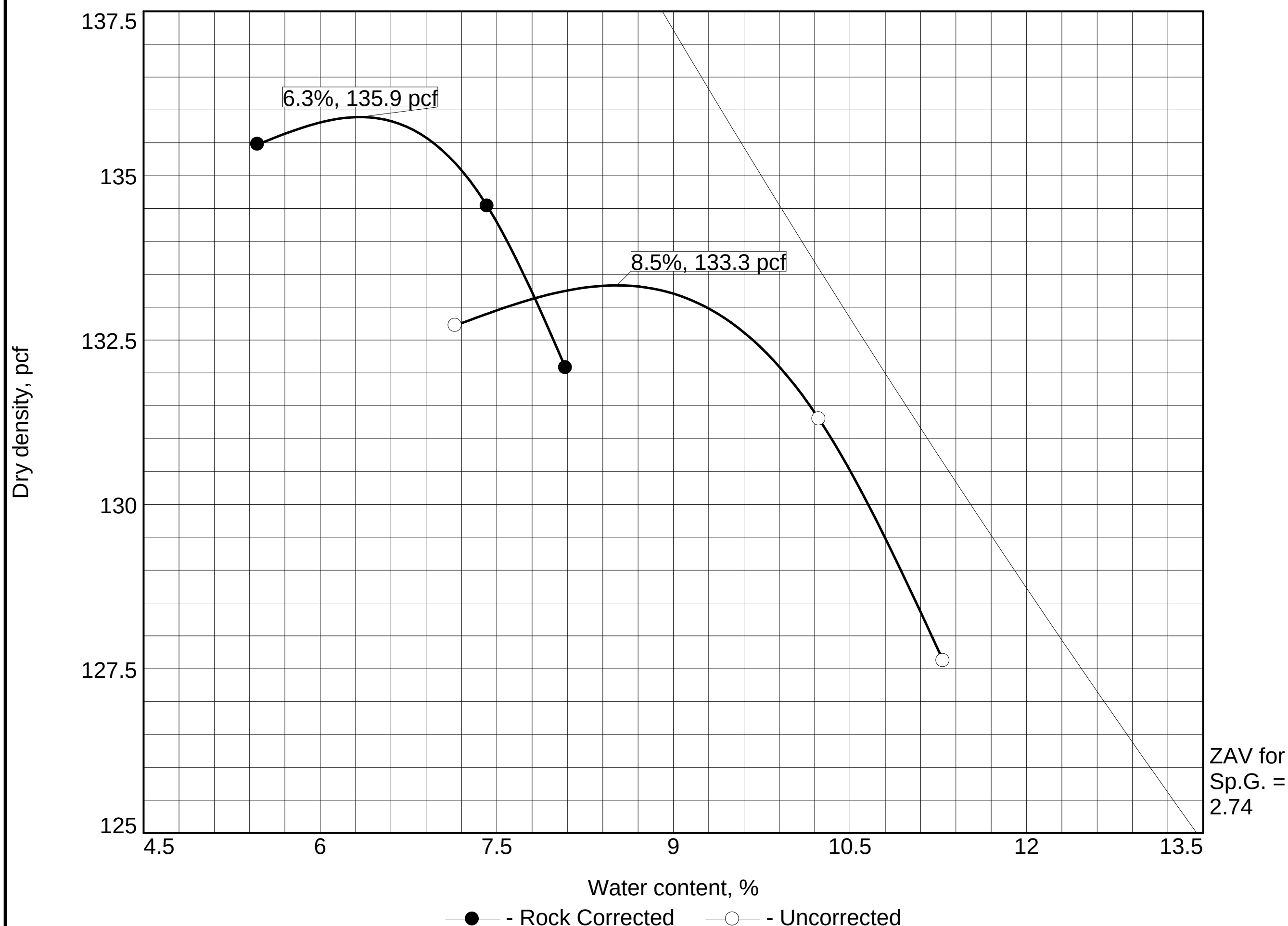
Location: N:172,786; E:1,070,622
Sample Number: EF-017-R **Depth:** LIFT 26 **Date:** 01/17/18

NewFields

Client: Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Project No: 475.0014.011 **Figure** EF-017-R

Tested By: JRK **Checked By:** JRK

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
LIFT 26	GC	A-2-4(0)		2.74	33	10	36.9	13.3

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 135.9 pcf	133.3 pcf	Brown clayey gravel with sand
Optimum moisture = 6.3 %	8.5 %	

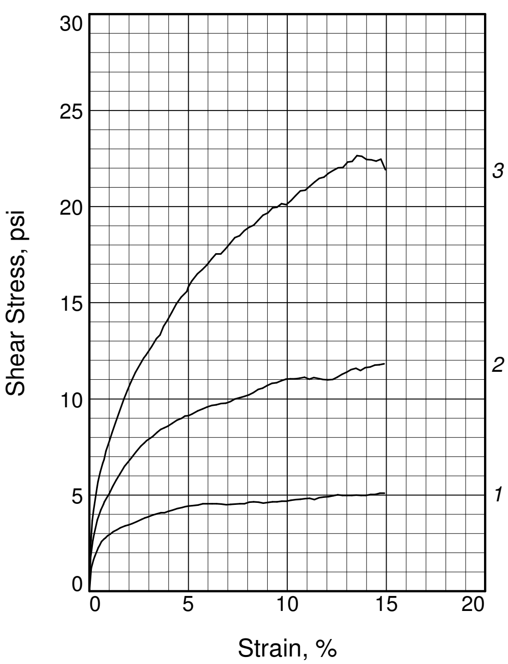
Project No. 475.0014.011 **Client:** Arizona Minerals Inc
Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage
Location: N:172,786; E:1,070,622 **Sample Number:** EF-017-R

NewFields

Remarks:

Figure EF-017-R

Tested By: JRK **Checked By:** JRK



Specimen No.		1	2	3
Initial	Water Content, %	8.2	8.2	8.2
	Dry Density, pcf	104.2	103.7	103.7
	Saturation, %	35.8	35.4	35.3
	Void Ratio	0.6181	0.6256	0.6256
	Side Length, in.	8.00	8.00	8.00
	Height, in.	4.00	4.00	4.00
At Test	Water Content, %	20.3	19.0	17.9
	Dry Density, pcf	108.9	111.3	113.6
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.5479	0.5139	0.4837
	Side Length, in.	8.00	8.00	8.00
	Height, in.	3.83	3.73	3.65
Normal Stress, psi		10.00	20.00	40.00
Fail. Stress, psi		4.69	11.03	20.09
Strain, %		10.0	9.9	10.0
Ult. Stress, psi				
Strain, %				
Strain rate, %/min.		0.25	0.25	0.25

Sample Type: Reconstituted @ 81%MDD
Description:

Assumed Specific Gravity= 2.7
Remarks: Failure chosen at 10% strain. Test was inundated. Gap=0.4". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.
Figure ________

Client: NewFields

Project: Arizona Minerals PAG Remediation
NF#475.0014.011
Location: TP-05
Sample Number: IPF-01 (81%) **Depth:** 18-36"
Proj. No.: DV108-00305/07 **Date Sampled:** 3/9/18

Knight Piésold
CONSULTING

Tested By: LEB **Checked By:** JDB

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.

DIRECT SHEAR TEST

4/3/2018

Date: 3/9/18
Client: NewFields
Project: Arizona Minerals PAG Remediation
NF#475.0014.011
Project No.: DV108-00305/07
Location: TP-05
Depth: 18-36"   **Sample Number:** IPF-01 (81%)
Description:
Remarks: Failure chosen at 10% strain. Test was inundated. Gap=0.4". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.
Type of Sample: Reconstituted @ 81%MDD
Assumed Specific Gravity=2.7   **LL=**   **PL=**   **PI=**

Parameters for Specimen No. 1

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	7574.000		8420.000
Moisture content: Dry soil+tare, gms.	7000.000		7000.000
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	8.2	20.3	20.3
Moist specimen weight, gms.	7574.0		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.83	
Net decrease in height, in.		0.17	
Wet density, pcf	112.7	131.0	
Dry density, pcf	104.2	108.9	
Void ratio	0.6181	0.5479	
Saturation, %	35.8	100.0	

Test Readings for Specimen No. 1

Normal stress = 10 psi
Strain rate, %/min. = 0.25
Fail. Stress = 4.69 psi **at reading no.** 51

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	0.0000	-17.000	0.0	0.0	0.00
1	0.0075	60.000	77.0	0.1	1.20
2	0.0169	88.000	105.0	0.2	1.64
3	0.0216	99.000	116.0	0.3	1.81
4	0.0362	128.000	145.0	0.5	2.27
5	0.0411	135.000	152.0	0.5	2.38
6	0.0497	148.000	165.0	0.6	2.58
7	0.0598	157.000	174.0	0.7	2.72
8	0.0647	160.000	177.0	0.8	2.77
9	0.0740	167.000	184.0	0.9	2.88
10	0.0837	173.000	190.0	1.0	2.97
11	0.0975	181.000	198.0	1.2	3.09
12	0.1119	188.000	205.0	1.4	3.20

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
13	0.1258	194.000	211.0	1.6	3.30
14	0.1449	201.000	218.0	1.8	3.41
15	0.1592	204.000	221.0	2.0	3.45
16	0.1735	208.000	225.0	2.2	3.52
17	0.1918	214.000	231.0	2.4	3.61
18	0.2108	222.000	239.0	2.6	3.73
19	0.2243	227.000	244.0	2.8	3.81
20	0.2334	229.000	246.0	2.9	3.84
21	0.2569	237.000	254.0	3.2	3.97
22	0.2758	241.000	258.0	3.4	4.03
23	0.2895	244.000	261.0	3.6	4.08
24	0.3041	244.000	261.0	3.8	4.08
25	0.3178	249.000	266.0	4.0	4.16
26	0.3365	253.000	270.0	4.2	4.22
27	0.3551	258.000	275.0	4.4	4.30
28	0.3740	261.000	278.0	4.7	4.34
29	0.3881	264.000	281.0	4.9	4.39
30	0.4024	267.000	284.0	5.0	4.44
31	0.4159	268.000	285.0	5.2	4.45
32	0.4397	270.000	287.0	5.5	4.48
33	0.4583	274.000	291.0	5.7	4.55
34	0.4772	274.000	291.0	6.0	4.55
35	0.4958	274.000	291.0	6.2	4.55
36	0.5145	274.000	291.0	6.4	4.55
37	0.5335	273.000	290.0	6.7	4.53
38	0.5524	271.000	288.0	6.9	4.50
39	0.5707	272.000	289.0	7.1	4.52
40	0.5894	273.000	290.0	7.4	4.53
41	0.6088	274.000	291.0	7.6	4.55
42	0.6272	274.000	291.0	7.8	4.55
43	0.6462	279.000	296.0	8.1	4.63
44	0.6647	280.000	297.0	8.3	4.64
45	0.6834	279.000	296.0	8.5	4.63
46	0.7029	276.000	293.0	8.8	4.58
47	0.7215	278.000	295.0	9.0	4.61
48	0.7400	280.000	297.0	9.3	4.64
49	0.7590	280.000	297.0	9.5	4.64
50	0.7776	283.000	300.0	9.7	4.69
51	0.7964	283.000	300.0	10.0	4.69
52	0.8152	286.000	303.0	10.2	4.73
53	0.8343	288.000	305.0	10.4	4.77
54	0.8533	289.000	306.0	10.7	4.78
55	0.8715	291.000	308.0	10.9	4.81
56	0.8905	292.000	309.0	11.1	4.83
57	0.9094	288.000	305.0	11.4	4.77
58	0.9285	294.000	311.0	11.6	4.86
59	0.9466	296.000	313.0	11.8	4.89

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
60	0.9658	298.000	315.0	12.1	4.92
61	0.9852	301.000	318.0	12.3	4.97
62	1.0043	304.000	321.0	12.6	5.02
63	1.0229	302.000	319.0	12.8	4.98
64	1.0414	302.000	319.0	13.0	4.98
65	1.0602	302.000	319.0	13.3	4.98
66	1.0792	303.000	320.0	13.5	5.00
67	1.0984	302.000	319.0	13.7	4.98
68	1.1175	302.000	319.0	14.0	4.98
69	1.1366	305.000	322.0	14.2	5.03
70	1.1551	305.000	322.0	14.4	5.03
71	1.1740	309.000	326.0	14.7	5.09
72	1.1929	309.000	326.0	14.9	5.09

Parameters for Specimen No. 2

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	7539.700		8294.000
Moisture content: Dry soil+tare, gms.	6967.800		6967.800
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	8.2	19.0	19.0
Moist specimen weight, gms.	7539.7		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.73	
Net decrease in height, in.		0.27	
Wet density, pcf	112.2	132.5	
Dry density, pcf	103.7	111.3	
Void ratio	0.6256	0.5139	
Saturation, %	35.4	100.0	

Test Readings for Specimen No. 2

Normal stress = 20 psi

Strain rate, %/min. = 0.25

Fail. Stress = 11.03 psi **at reading no.** 51

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	-0.0033	12.000	0.0	0.0	0.00
1	0.0022	125.000	113.0	0.1	1.77
2	0.0113	182.000	170.0	0.2	2.66
3	0.0158	203.000	191.0	0.2	2.98
4	0.0297	250.000	238.0	0.4	3.72
5	0.0345	262.000	250.0	0.5	3.91
6	0.0435	283.000	271.0	0.6	4.23
7	0.0533	301.000	289.0	0.7	4.52
8	0.0573	309.000	297.0	0.8	4.64
9	0.0669	322.000	310.0	0.9	4.84
10	0.0767	336.000	324.0	1.0	5.06
11	0.0910	361.000	349.0	1.2	5.45

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
12	0.1054	382.000	370.0	1.4	5.78
13	0.1194	401.000	389.0	1.5	6.08
14	0.1386	428.000	416.0	1.8	6.50
15	0.1523	440.000	428.0	1.9	6.69
16	0.1672	457.000	445.0	2.1	6.95
17	0.1859	476.000	464.0	2.4	7.25
18	0.2048	495.000	483.0	2.6	7.55
19	0.2185	506.000	494.0	2.8	7.72
20	0.2284	513.000	501.0	2.9	7.83
21	0.2522	527.000	515.0	3.2	8.05
22	0.2705	541.000	529.0	3.4	8.27
23	0.2845	550.000	538.0	3.6	8.41
24	0.2987	556.000	544.0	3.8	8.50
25	0.3129	561.000	549.0	4.0	8.58
26	0.3319	571.000	559.0	4.2	8.73
27	0.3509	581.000	569.0	4.4	8.89
28	0.3698	588.000	576.0	4.7	9.00
29	0.3837	595.000	583.0	4.8	9.11
30	0.3973	596.000	584.0	5.0	9.13
31	0.4116	601.000	589.0	5.2	9.20
32	0.4350	612.000	600.0	5.5	9.38
33	0.4540	618.000	606.0	5.7	9.47
34	0.4722	625.000	613.0	5.9	9.58
35	0.4918	630.000	618.0	6.2	9.66
36	0.5101	632.000	620.0	6.4	9.69
37	0.5285	637.000	625.0	6.6	9.77
38	0.5479	638.000	626.0	6.9	9.78
39	0.5661	643.000	631.0	7.1	9.86
40	0.5851	651.000	639.0	7.4	9.98
41	0.6035	656.000	644.0	7.6	10.06
42	0.6221	660.000	648.0	7.8	10.13
43	0.6411	665.000	653.0	8.1	10.20
44	0.6596	673.000	661.0	8.3	10.33
45	0.6785	684.000	672.0	8.5	10.50
46	0.6972	688.000	676.0	8.8	10.56
47	0.7154	696.000	684.0	9.0	10.69
48	0.7346	704.000	692.0	9.2	10.81
49	0.7537	706.000	694.0	9.5	10.84
50	0.7724	712.000	700.0	9.7	10.94
51	0.7911	718.000	706.0	9.9	11.03
52	0.8093	719.000	707.0	10.2	11.05
53	0.8280	719.000	707.0	10.4	11.05
54	0.8474	721.000	709.0	10.6	11.08
55	0.8659	724.000	712.0	10.9	11.13
56	0.8851	718.000	706.0	11.1	11.03
57	0.9037	723.000	711.0	11.3	11.11
58	0.9226	720.000	708.0	11.6	11.06

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
59	0.9417	716.000	704.0	11.8	11.00
60	0.9605	715.000	703.0	12.0	10.98
61	0.9795	717.000	705.0	12.3	11.02
62	0.9983	724.000	712.0	12.5	11.13
63	1.0170	734.000	722.0	12.8	11.28
64	1.0364	741.000	729.0	13.0	11.39
65	1.0552	750.000	738.0	13.2	11.53
66	1.0745	754.000	742.0	13.5	11.59
67	1.0925	746.000	734.0	13.7	11.47
68	1.1117	756.000	744.0	13.9	11.63
69	1.1310	758.000	746.0	14.2	11.66
70	1.1501	764.000	752.0	14.4	11.75
71	1.1690	766.000	754.0	14.7	11.78
72	1.1878	769.000	757.0	14.9	11.83

Parameters for Specimen No. 3

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	7537.700		8216.000
Moisture content: Dry soil+tare, gms.	6967.800		6967.800
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	8.2	17.9	17.9
Moist specimen weight, gms.	7537.7		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.65	
Net decrease in height, in.		0.35	
Wet density, pcf	112.2	134.0	
Dry density, pcf	103.7	113.6	
Void ratio	0.6256	0.4837	
Saturation, %	35.3	100.0	

Test Readings for Specimen No. 3

Normal stress = 40 psi

Strain rate, %/min. = 0.25

Fail. Stress = 20.09 psi **at reading no.** 51

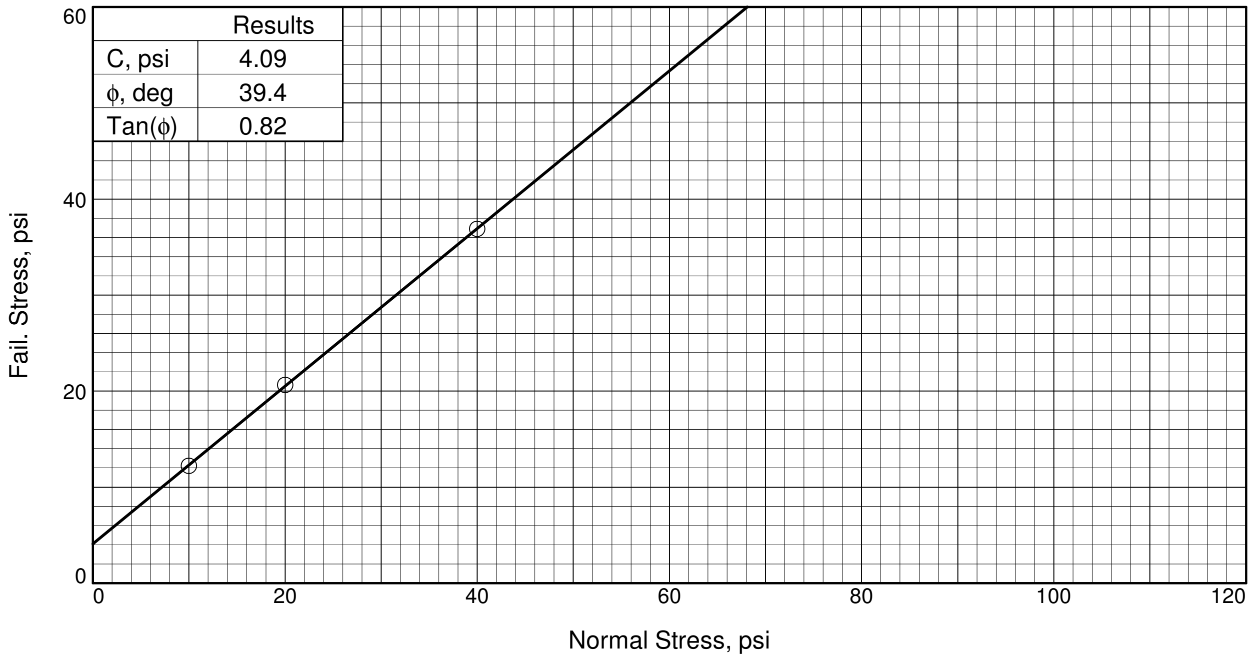
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	0.0015	1.000	0.0	0.0	0.00
1	0.0059	131.000	130.0	0.1	2.03
2	0.0136	236.000	235.0	0.2	3.67
3	0.0181	270.000	269.0	0.2	4.20
4	0.0324	346.000	345.0	0.4	5.39
5	0.0365	366.000	365.0	0.4	5.70
6	0.0461	398.000	397.0	0.6	6.20
7	0.0556	427.000	426.0	0.7	6.66
8	0.0605	439.000	438.0	0.7	6.84
9	0.0692	468.000	467.0	0.8	7.30
10	0.0793	492.000	491.0	1.0	7.67

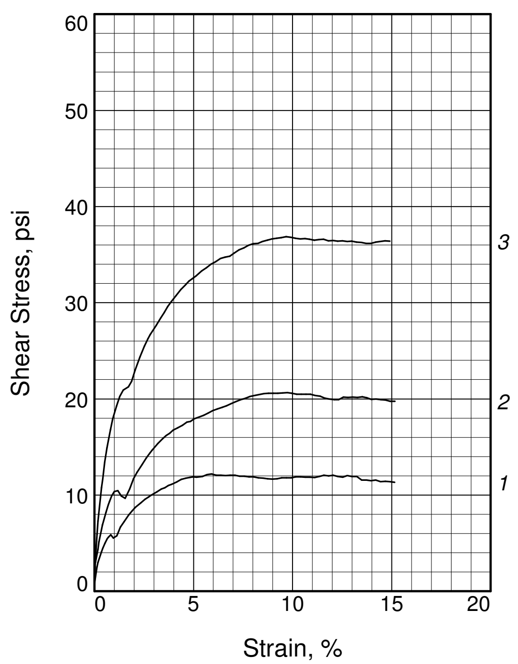
Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
11	0.0937	529.000	528.0	1.2	8.25
12	0.1080	563.000	562.0	1.3	8.78
13	0.1218	596.000	595.0	1.5	9.30
14	0.1411	641.000	640.0	1.7	10.00
15	0.1552	669.000	668.0	1.9	10.44
16	0.1692	697.000	696.0	2.1	10.88
17	0.1878	729.000	728.0	2.3	11.38
18	0.2070	757.000	756.0	2.6	11.81
19	0.2215	777.000	776.0	2.8	12.13
20	0.2306	786.000	785.0	2.9	12.27
21	0.2540	815.000	814.0	3.2	12.72
22	0.2725	842.000	841.0	3.4	13.14
23	0.2875	854.000	853.0	3.6	13.33
24	0.3015	882.000	881.0	3.8	13.77
25	0.3152	901.000	900.0	3.9	14.06
26	0.3343	929.000	928.0	4.2	14.50
27	0.3535	957.000	956.0	4.4	14.94
28	0.3725	979.000	978.0	4.6	15.28
29	0.3961	999.000	998.0	4.9	15.59
30	0.4008	1012.000	1011.0	5.0	15.80
31	0.4148	1033.000	1032.0	5.2	16.13
32	0.4382	1057.000	1056.0	5.5	16.50
33	0.4571	1071.000	1070.0	5.7	16.72
34	0.4761	1086.000	1085.0	5.9	16.95
35	0.4951	1106.000	1105.0	6.2	17.27
36	0.5138	1123.000	1122.0	6.4	17.53
37	0.5329	1123.000	1122.0	6.6	17.53
38	0.5518	1140.000	1139.0	6.9	17.80
39	0.5707	1159.000	1158.0	7.1	18.09
40	0.5893	1178.000	1177.0	7.3	18.39
41	0.6082	1184.000	1183.0	7.6	18.48
42	0.6276	1201.000	1200.0	7.8	18.75
43	0.6462	1212.000	1211.0	8.1	18.92
44	0.6655	1219.000	1218.0	8.3	19.03
45	0.6838	1235.000	1234.0	8.5	19.28
46	0.7030	1252.000	1251.0	8.8	19.55
47	0.7223	1260.000	1259.0	9.0	19.67
48	0.7413	1277.000	1276.0	9.2	19.94
49	0.7600	1279.000	1278.0	9.5	19.97
50	0.7784	1291.000	1290.0	9.7	20.16
51	0.7978	1287.000	1286.0	10.0	20.09
52	0.8167	1301.000	1300.0	10.2	20.31
53	0.8353	1317.000	1316.0	10.4	20.56
54	0.8545	1333.000	1332.0	10.7	20.81
55	0.8734	1335.000	1334.0	10.9	20.84
56	0.8924	1349.000	1348.0	11.1	21.06
57	0.9117	1363.000	1362.0	11.4	21.28

Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
58	0.9309	1375.000	1374.0	11.6	21.47
59	0.9495	1379.000	1378.0	11.8	21.53
60	0.9684	1392.000	1391.0	12.1	21.73
61	0.9877	1401.000	1400.0	12.3	21.88
62	1.0067	1410.000	1409.0	12.6	22.02
63	1.0257	1411.000	1410.0	12.8	22.03
64	1.0450	1429.000	1428.0	13.0	22.31
65	1.0639	1431.000	1430.0	13.3	22.34
66	1.0832	1450.000	1449.0	13.5	22.64
67	1.1023	1448.000	1447.0	13.8	22.61
68	1.1216	1438.000	1437.0	14.0	22.45
69	1.1408	1437.000	1436.0	14.2	22.44
70	1.1599	1432.000	1431.0	14.5	22.36
71	1.1792	1439.000	1438.0	14.7	22.47
72	1.1976	1403.000	1402.0	15.0	21.91





	Specimen No.	1	2	3
Initial	Water Content, %	8.6	8.6	8.6
	Dry Density, pcf	121.6	121.6	121.6
	Saturation, %	60.0	60.0	60.0
	Void Ratio	0.3865	0.3867	0.3867
	Side Length, in.	8.00	8.00	8.00
	Height, in.	4.00	4.00	4.00
At Test	Water Content, %	12.4	12.4	12.3
	Dry Density, pcf	126.2	126.1	126.6
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.3357	0.3362	0.3314
	Side Length, in.	8.00	8.00	8.00
	Height, in.	3.85	3.85	3.84
	Normal Stress, psi	10.00	20.00	40.00
	Fail. Stress, psi	12.20	20.66	36.88
	Strain, %	5.9	9.7	9.7
	Ult. Stress, psi			
	Strain, %			
	Strain rate, %/min.	0.25	0.25	0.25

Sample Type: Reconstituted @ 95%MDD
Description:

Assumed Specific Gravity= 2.7
Remarks: Faikure chosen at peak shear stress. Test was inundated. Gap= 0.04". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.
Figure ________

Client: NewFields

Project: Arizona Minerals PAG Remediation
NF#475.0014.011
Location: TP-05
Sample Number: IPF-01 (95%) **Depth:** 18-36"
Proj. No.: DV108-00305/07 **Date Sampled:** 3/10/18

Knight Piésold CONSULTING

Tested By: LEB **Checked By:** JDB

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.

DIRECT SHEAR TEST

4/3/2018

Date: 3/10/18
Client: NewFields
Project: Arizona Minerals PAG Remediation
NF#475.0014.011
Project No.: DV108-00305/07
Location: TP-05
Depth: 18-36" **Sample Number:** IPF-01 (95%)
Description:
Remarks: Faikure chosen at peak shear stress. Test was inundated. Gap= 0.04". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.
Type of Sample: Reconstituted @ 95%MDD
Assumed Specific Gravity=2.7 **LL=** **PL=** **PI=**

Parameters for Specimen No. 1

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	8870.600		9184.000
Moisture content: Dry soil+tare, gms.	8169.100		8168.100
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	8.6	12.4	12.4
Moist specimen weight, gms.	8870.6		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.85	
Net decrease in height, in.		0.15	
Wet density, pcf	132.0	141.9	
Dry density, pcf	121.6	126.2	
Void ratio	0.3865	0.3357	
Saturation, %	60.0	100.0	

Test Readings for Specimen No. 1

Normal stress = 10 psi
Strain rate, %/min. = 0.25
Fail. Stress = 12.20 psi **at reading no.** 34

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	-0.0001	6.000	0.0	0.0	0.00
1	0.0017	71.000	65.0	0.0	1.02
2	0.0099	168.000	162.0	0.1	2.53
3	0.0146	199.000	193.0	0.2	3.02
4	0.0288	269.000	263.0	0.4	4.11
5	0.0332	291.000	285.0	0.4	4.45
6	0.0423	326.000	320.0	0.5	5.00
7	0.0521	355.000	349.0	0.7	5.45
8	0.0569	366.000	360.0	0.7	5.63
9	0.0659	381.000	375.0	0.8	5.86
10	0.0761	359.000	353.0	1.0	5.52
11	0.0900	375.000	369.0	1.1	5.77
12	0.1041	432.000	426.0	1.3	6.66

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
13	0.1186	467.000	461.0	1.5	7.20
14	0.1376	513.000	507.0	1.7	7.92
15	0.1520	542.000	536.0	1.9	8.38
16	0.1658	565.000	559.0	2.1	8.73
17	0.1855	593.000	587.0	2.3	9.17
18	0.2040	617.000	611.0	2.6	9.55
19	0.2182	632.000	626.0	2.7	9.78
20	0.2279	644.000	638.0	2.8	9.97
21	0.2517	668.000	662.0	3.1	10.34
22	0.2706	686.000	680.0	3.4	10.63
23	0.2844	695.000	689.0	3.6	10.77
24	0.2984	709.000	703.0	3.7	10.98
25	0.3126	718.000	712.0	3.9	11.13
26	0.3315	733.000	727.0	4.1	11.36
27	0.3504	749.000	743.0	4.4	11.61
28	0.3689	758.000	752.0	4.6	11.75
29	0.3833	762.000	756.0	4.8	11.81
30	0.3973	767.000	761.0	5.0	11.89
31	0.4118	764.000	758.0	5.1	11.84
32	0.4351	769.000	763.0	5.4	11.92
33	0.4542	782.000	776.0	5.7	12.13
34	0.4729	787.000	781.0	5.9	12.20
35	0.4917	778.000	772.0	6.1	12.06
36	0.5105	777.000	771.0	6.4	12.05
37	0.5292	775.000	769.0	6.6	12.02
38	0.5483	777.000	771.0	6.9	12.05
39	0.5670	778.000	772.0	7.1	12.06
40	0.5859	772.000	766.0	7.3	11.97
41	0.6049	772.000	766.0	7.6	11.97
42	0.6240	768.000	762.0	7.8	11.91
43	0.6426	768.000	762.0	8.0	11.91
44	0.6615	761.000	755.0	8.3	11.80
45	0.6806	759.000	753.0	8.5	11.77
46	0.6991	755.000	749.0	8.7	11.70
47	0.7183	753.000	747.0	9.0	11.67
48	0.7370	755.000	749.0	9.2	11.70
49	0.7557	761.000	755.0	9.4	11.80
50	0.7752	760.000	754.0	9.7	11.78
51	0.7940	761.000	755.0	9.9	11.80
52	0.8128	767.000	761.0	10.2	11.89
53	0.8316	767.000	761.0	10.4	11.89
54	0.8507	765.000	759.0	10.6	11.86
55	0.8698	764.000	758.0	10.9	11.84
56	0.8884	762.000	756.0	11.1	11.81
57	0.9075	769.000	763.0	11.3	11.92
58	0.9265	777.000	771.0	11.6	12.05
59	0.9452	773.000	767.0	11.8	11.98

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
60	0.9642	778.000	772.0	12.1	12.06
61	0.9832	769.000	763.0	12.3	11.92
62	1.0023	765.000	759.0	12.5	11.86
63	1.0210	775.000	769.0	12.8	12.02
64	1.0398	769.000	763.0	13.0	11.92
65	1.0592	769.000	763.0	13.2	11.92
66	1.0782	746.000	740.0	13.5	11.56
67	1.0976	746.000	740.0	13.7	11.56
68	1.1158	741.000	735.0	13.9	11.48
69	1.1354	745.000	739.0	14.2	11.55
70	1.1546	735.000	729.0	14.4	11.39
71	1.1738	738.000	732.0	14.7	11.44
72	1.1924	735.000	729.0	14.9	11.39
73	1.2114	730.000	724.0	15.1	11.31

Parameters for Specimen No. 2

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	8870.600		9185.000
Moisture content: Dry soil+tare, gms.	8168.100		8168.140
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	8.6	12.4	12.4
Moist specimen weight, gms.	8870.6		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.85	
Net decrease in height, in.		0.15	
Wet density, pcf	132.0	141.9	
Dry density, pcf	121.6	126.1	
Void ratio	0.3867	0.3362	
Saturation, %	60.0	100.0	

Test Readings for Specimen No. 2

Normal stress = 20 psi

Strain rate, %/min. = 0.25

Fail. Stress = 20.66 psi **at reading no.** 50

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	-0.0086	12.000	0.0	0.0	0.00
1	-0.0065	192.000	180.0	0.0	2.81
2	0.0054	292.000	280.0	0.2	4.38
3	0.0102	340.000	328.0	0.2	5.13
4	0.0237	453.000	441.0	0.4	6.89
5	0.0286	484.000	472.0	0.5	7.38
6	0.0378	536.000	524.0	0.6	8.19
7	0.0474	585.000	573.0	0.7	8.95
8	0.0522	608.000	596.0	0.8	9.31
9	0.0615	647.000	635.0	0.9	9.92
10	0.0713	676.000	664.0	1.0	10.38

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
11	0.0858	681.000	669.0	1.2	10.45
12	0.1005	645.000	633.0	1.4	9.89
13	0.1151	630.000	618.0	1.5	9.66
14	0.1338	693.000	681.0	1.8	10.64
15	0.1489	760.000	748.0	2.0	11.69
16	0.1627	804.000	792.0	2.1	12.38
17	0.1822	853.000	841.0	2.4	13.14
18	0.2005	899.000	887.0	2.6	13.86
19	0.2153	930.000	918.0	2.8	14.34
20	0.2246	949.000	937.0	2.9	14.64
21	0.2476	995.000	983.0	3.2	15.36
22	0.2665	1026.000	1014.0	3.4	15.84
23	0.2807	1049.000	1037.0	3.6	16.20
24	0.2946	1064.000	1052.0	3.8	16.44
25	0.3089	1085.000	1073.0	4.0	16.77
26	0.3273	1100.000	1088.0	4.2	17.00
27	0.3468	1116.000	1104.0	4.4	17.25
28	0.3654	1137.000	1125.0	4.7	17.58
29	0.3790	1141.000	1129.0	4.8	17.64
30	0.3934	1158.000	1146.0	5.0	17.91
31	0.4077	1168.000	1156.0	5.2	18.06
32	0.4314	1183.000	1171.0	5.5	18.30
33	0.4499	1197.000	1185.0	5.7	18.52
34	0.4689	1214.000	1202.0	6.0	18.78
35	0.4881	1225.000	1213.0	6.2	18.95
36	0.5066	1235.000	1223.0	6.4	19.11
37	0.5252	1246.000	1234.0	6.7	19.28
38	0.5442	1261.000	1249.0	6.9	19.52
39	0.5628	1273.000	1261.0	7.1	19.70
40	0.5814	1286.000	1274.0	7.4	19.91
41	0.6005	1296.000	1284.0	7.6	20.06
42	0.6194	1308.000	1296.0	7.8	20.25
43	0.6378	1315.000	1303.0	8.1	20.36
44	0.6567	1321.000	1309.0	8.3	20.45
45	0.6760	1328.000	1316.0	8.6	20.56
46	0.6949	1329.000	1317.0	8.8	20.58
47	0.7137	1330.000	1318.0	9.0	20.59
48	0.7320	1329.000	1317.0	9.3	20.58
49	0.7512	1332.000	1320.0	9.5	20.63
50	0.7701	1334.000	1322.0	9.7	20.66
51	0.7888	1330.000	1318.0	10.0	20.59
52	0.8076	1324.000	1312.0	10.2	20.50
53	0.8261	1323.000	1311.0	10.4	20.48
54	0.8451	1324.000	1312.0	10.7	20.50
55	0.8639	1323.000	1311.0	10.9	20.48
56	0.8826	1315.000	1303.0	11.1	20.36
57	0.9017	1310.000	1298.0	11.4	20.28

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
58	0.9208	1298.000	1286.0	11.6	20.09
59	0.9394	1290.000	1278.0	11.9	19.97
60	0.9585	1287.000	1275.0	12.1	19.92
61	0.9775	1287.000	1275.0	12.3	19.92
62	0.9966	1303.000	1291.0	12.6	20.17
63	1.0149	1302.000	1290.0	12.8	20.16
64	1.0337	1303.000	1291.0	13.0	20.17
65	1.0534	1301.000	1289.0	13.3	20.14
66	1.0723	1306.000	1294.0	13.5	20.22
67	1.0912	1299.000	1287.0	13.7	20.11
68	1.1091	1289.000	1277.0	14.0	19.95
69	1.1285	1291.000	1279.0	14.2	19.98
70	1.1477	1287.000	1275.0	14.5	19.92
71	1.1660	1284.000	1272.0	14.7	19.88
72	1.1857	1277.000	1265.0	14.9	19.77
73	1.2047	1277.000	1265.0	15.2	19.77

Parameters for Specimen No. 3

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	8870.600		9171.000
Moisture content: Dry soil+tare, gms.	8168.100		8168.140
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	8.6	12.3	12.3
Moist specimen weight, gms.	8870.6		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.84	
Net decrease in height, in.		0.16	
Wet density, pcf	132.0	142.1	
Dry density, pcf	121.6	126.6	
Void ratio	0.3867	0.3314	
Saturation, %	60.0	100.0	

Test Readings for Specimen No. 3

Normal stress = 40 psi

Strain rate, %/min. = 0.25

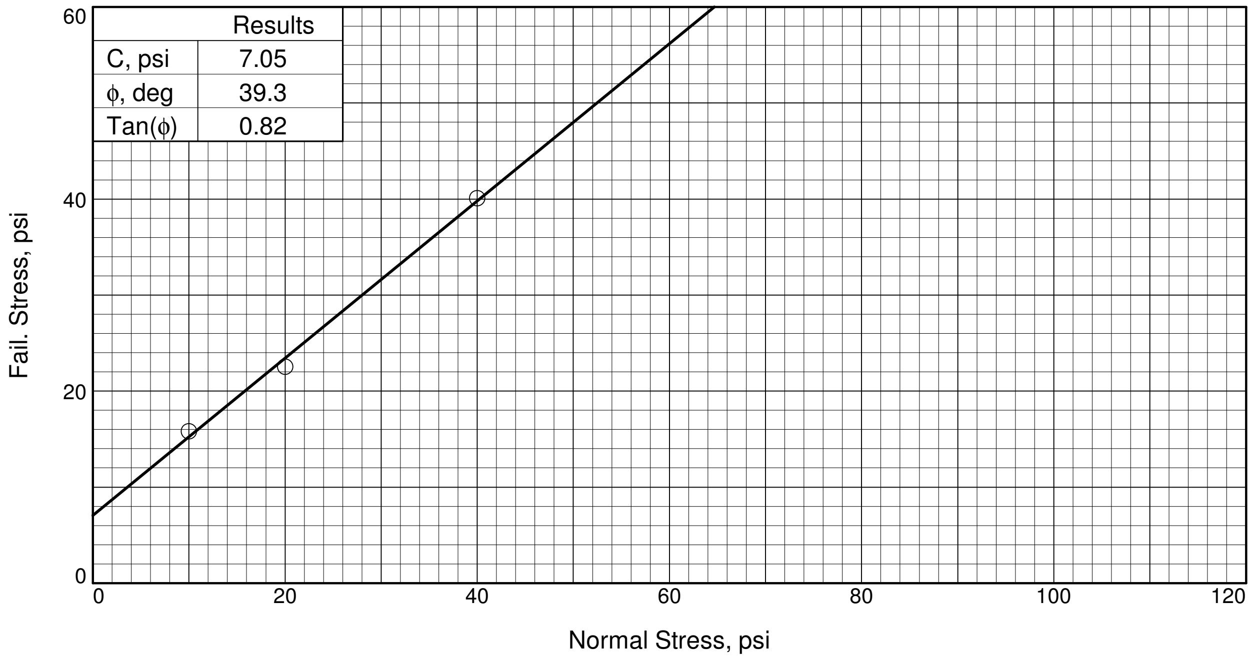
Fail. Stress = 36.88 psi **at reading no.** 50

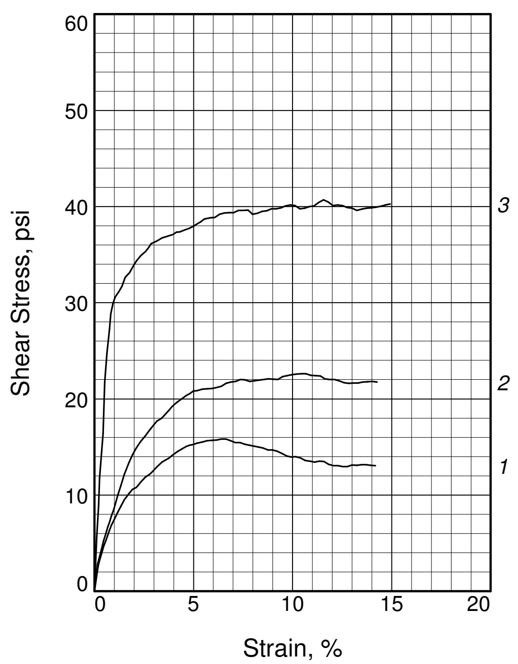
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	0.0064	0.000	0.0	0.0	0.00
1	0.0090	174.000	174.0	0.0	2.72
2	0.0172	377.000	377.0	0.1	5.89
3	0.0212	468.000	468.0	0.2	7.31
4	0.0349	688.000	688.0	0.4	10.75
5	0.0395	748.000	748.0	0.4	11.69
6	0.0482	860.000	860.0	0.5	13.44
7	0.0573	952.000	952.0	0.6	14.88
8	0.0625	998.000	998.0	0.7	15.59
9	0.0711	1074.000	1074.0	0.8	16.78
10	0.0806	1146.000	1146.0	0.9	17.91
11	0.0950	1232.000	1232.0	1.1	19.25
12	0.1090	1296.000	1296.0	1.3	20.25
13	0.1233	1339.000	1339.0	1.5	20.92
14	0.1429	1359.000	1359.0	1.7	21.23
15	0.1567	1397.000	1397.0	1.9	21.83
16	0.1712	1471.000	1471.0	2.1	22.98
17	0.1896	1558.000	1558.0	2.3	24.34
18	0.2086	1630.000	1630.0	2.5	25.47
19	0.2228	1679.000	1679.0	2.7	26.23
20	0.2319	1708.000	1708.0	2.8	26.69
21	0.2555	1770.000	1770.0	3.1	27.66
22	0.2745	1818.000	1818.0	3.4	28.41
23	0.2886	1855.000	1855.0	3.5	28.98
24	0.3025	1894.000	1894.0	3.7	29.59
25	0.3170	1927.000	1927.0	3.9	30.11
26	0.3358	1967.000	1967.0	4.1	30.73
27	0.3548	2007.000	2007.0	4.4	31.36
28	0.3734	2037.000	2037.0	4.6	31.83

Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
29	0.3873	2063.000	2063.0	4.8	32.23
30	0.4015	2080.000	2080.0	4.9	32.50
31	0.4160	2098.000	2098.0	5.1	32.78
32	0.4392	2131.000	2131.0	5.4	33.30
33	0.4584	2153.000	2153.0	5.6	33.64
34	0.4771	2176.000	2176.0	5.9	34.00
35	0.4965	2194.000	2194.0	6.1	34.28
36	0.5152	2214.000	2214.0	6.4	34.59
37	0.5339	2223.000	2223.0	6.6	34.73
38	0.5531	2229.000	2229.0	6.8	34.83
39	0.5712	2250.000	2250.0	7.1	35.16
40	0.5903	2272.000	2272.0	7.3	35.50
41	0.6095	2286.000	2286.0	7.5	35.72
42	0.6281	2303.000	2303.0	7.8	35.98
43	0.6473	2312.000	2312.0	8.0	36.13
44	0.6662	2315.000	2315.0	8.2	36.17
45	0.6851	2327.000	2327.0	8.5	36.36
46	0.7043	2336.000	2336.0	8.7	36.50
47	0.7230	2344.000	2344.0	9.0	36.63
48	0.7414	2349.000	2349.0	9.2	36.70
49	0.7612	2353.000	2353.0	9.4	36.77
50	0.7803	2360.000	2360.0	9.7	36.88
51	0.7994	2356.000	2356.0	9.9	36.81
52	0.8179	2348.000	2348.0	10.1	36.69
53	0.8369	2345.000	2345.0	10.4	36.64
54	0.8561	2346.000	2346.0	10.6	36.66
55	0.8748	2343.000	2343.0	10.9	36.61
56	0.8943	2336.000	2336.0	11.1	36.50
57	0.9128	2341.000	2341.0	11.3	36.58
58	0.9320	2342.000	2342.0	11.6	36.59
59	0.9510	2332.000	2332.0	11.8	36.44
60	0.9701	2334.000	2334.0	12.0	36.47
61	0.9886	2330.000	2330.0	12.3	36.41
62	1.0077	2332.000	2332.0	12.5	36.44
63	1.0270	2328.000	2328.0	12.8	36.38
64	1.0457	2330.000	2330.0	13.0	36.41
65	1.0648	2323.000	2323.0	13.2	36.30
66	1.0836	2322.000	2322.0	13.5	36.28
67	1.1032	2315.000	2315.0	13.7	36.17
68	1.1222	2315.000	2315.0	13.9	36.17
69	1.1414	2324.000	2324.0	14.2	36.31
70	1.1602	2328.000	2328.0	14.4	36.38
71	1.1794	2331.000	2331.0	14.7	36.42
72	1.1986	2329.000	2329.0	14.9	36.39

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.





Specimen No.		1	2	3
Initial	Water Content, %	6.3	6.3	6.3
	Dry Density, pcf	129.0	129.0	129.0
	Saturation, %	55.4	55.4	55.4
	Void Ratio	0.3069	0.3069	0.3069
	Side Length, in.	8.00	8.00	8.00
	Height, in.	4.00	4.00	4.00
At Test	Water Content, %	10.6	9.3	9.8
	Dry Density, pcf	131.2	134.6	133.2
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.2850	0.2518	0.2657
	Side Length, in.	8.00	8.00	8.00
	Height, in.	3.93	3.83	3.87
Normal Stress, psi		10.00	20.00	40.00
Fail. Stress, psi		15.83	22.53	40.09
Strain, %		6.6	10.0	10.1
Ult. Stress, psi				
Strain, %				
Strain rate, %/min.		0.25	0.25	0.25

Sample Type: Reconstitued @ 95% MDD
Description:

Assumed Specific Gravity= 2.7
Remarks: Failure chosen at peak shear stress and 10% strain. Test was inundated. Gap =0.4". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.
Figure ________

Client: NewFields

Project: Arizona Minerals PAG Remediation
NF#475.0014.011
Location: EF-017-R
Sample Number: IPF-02 **Depth:** Lift 26
Proj. No.: DV108-00305/07 **Date Sampled:** 3/12/18

Knight Piésold
CONSULTING

Tested By: LEB **Checked By:** JDB

DIRECT SHEAR TEST

4/3/2018

Date: 3/12/18
Client: NewFields
Project: Arizona Minerals PAG Remediation
NF#475.0014.011
Project No.: DV108-00305/07
Location: EF-017-R
Depth: Lift 26 **Sample Number:** IPF-02
Description:
Remarks: Failure chosen at peak shear stress and 10% strain. Test was inundated. Gap =0.4". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.
Type of Sample: Reconstitued @ 95% MDD
Assumed Specific Gravity=2.7 **LL=** **PL=** **PI=**

Parameters for Specimen No. 1

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	9213.100		9582.000
Moisture content: Dry soil+tare, gms.	8667.100		8667.100
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	6.3	10.6	10.6
Moist specimen weight, gms.	9213.1		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.93	
Net decrease in height, in.		0.07	
Wet density, pcf	137.1	145.0	
Dry density, pcf	129.0	131.2	
Void ratio	0.3069	0.2850	
Saturation, %	55.4	100.0	

Test Readings for Specimen No. 1

Normal stress = 10 psi
Strain rate, %/min. = 0.25
Fail. Stress = 15.83 psi **at reading no.** 36

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	-0.0060	76.000	0.0	0.0	0.00
1	0.0082	237.000	161.0	0.2	2.52
2	0.0122	267.000	191.0	0.2	2.98
3	0.0259	347.000	271.0	0.4	4.23
4	0.0305	371.000	295.0	0.5	4.61
5	0.0400	416.000	340.0	0.6	5.31
6	0.0492	457.000	381.0	0.7	5.95
7	0.0539	476.000	400.0	0.7	6.25
8	0.0629	515.000	439.0	0.9	6.86
9	0.0725	549.000	473.0	1.0	7.39
10	0.0866	598.000	522.0	1.2	8.16
11	0.1010	644.000	568.0	1.3	8.88
12	0.1145	683.000	607.0	1.5	9.48

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
13	0.1339	726.000	650.0	1.7	10.16
14	0.1476	755.000	679.0	1.9	10.61
15	0.1628	766.000	690.0	2.1	10.78
16	0.1811	804.000	728.0	2.3	11.38
17	0.2001	834.000	758.0	2.6	11.84
18	0.2148	852.000	776.0	2.8	12.13
19	0.2235	864.000	788.0	2.9	12.31
20	0.2473	905.000	829.0	3.2	12.95
21	0.2664	935.000	859.0	3.4	13.42
22	0.2799	947.000	871.0	3.6	13.61
23	0.2942	960.000	884.0	3.8	13.81
24	0.3082	979.000	903.0	3.9	14.11
25	0.3276	1003.000	927.0	4.2	14.48
26	0.3462	1022.000	946.0	4.4	14.78
27	0.3648	1040.000	964.0	4.6	15.06
28	0.3790	1049.000	973.0	4.8	15.20
29	0.3936	1053.000	977.0	5.0	15.27
30	0.4071	1061.000	985.0	5.2	15.39
31	0.4308	1069.000	993.0	5.5	15.52
32	0.4500	1077.000	1001.0	5.7	15.64
33	0.4689	1081.000	1005.0	5.9	15.70
34	0.4875	1082.000	1006.0	6.2	15.72
35	0.5062	1088.000	1012.0	6.4	15.81
36	0.5250	1089.000	1013.0	6.6	15.83
37	0.5437	1079.000	1003.0	6.9	15.67
38	0.5622	1065.000	989.0	7.1	15.45
39	0.5814	1065.000	989.0	7.3	15.45
40	0.6002	1054.000	978.0	7.6	15.28
41	0.6185	1048.000	972.0	7.8	15.19
42	0.6374	1041.000	965.0	8.0	15.08
43	0.6566	1036.000	960.0	8.3	15.00
44	0.6754	1028.000	952.0	8.5	14.88
45	0.6944	1017.000	941.0	8.8	14.70
46	0.7126	1016.000	940.0	9.0	14.69
47	0.7318	1008.000	932.0	9.2	14.56
48	0.7509	993.000	917.0	9.5	14.33
49	0.7700	976.000	900.0	9.7	14.06
50	0.7887	970.000	894.0	9.9	13.97
51	0.8070	972.000	896.0	10.2	14.00
52	0.8262	962.000	886.0	10.4	13.84
53	0.8450	945.000	869.0	10.6	13.58
54	0.8637	941.000	865.0	10.9	13.52
55	0.8829	935.000	859.0	11.1	13.42
56	0.9016	941.000	865.0	11.3	13.52
57	0.9205	939.000	863.0	11.6	13.48
58	0.9397	920.000	844.0	11.8	13.19
59	0.9587	911.000	835.0	12.1	13.05

Test Readings for Specimen No. 1

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
60	0.9775	911.000	835.0	12.3	13.05
61	0.9962	906.000	830.0	12.5	12.97
62	1.0149	906.000	830.0	12.8	12.97
63	1.0342	915.000	839.0	13.0	13.11
64	1.0531	914.000	838.0	13.2	13.09
65	1.0722	918.000	842.0	13.5	13.16
66	1.0902	918.000	842.0	13.7	13.16
67	1.1094	913.000	837.0	13.9	13.08
68	1.1288	911.000	835.0	14.2	13.05

Parameters for Specimen No. 2

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	9213.100		9475.800
Moisture content: Dry soil+tare, gms.	8667.100		8667.100
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	6.3	9.3	9.3
Moist specimen weight, gms.	9213.1		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.83	
Net decrease in height, in.		0.17	
Wet density, pcf	137.1	147.2	
Dry density, pcf	129.0	134.6	
Void ratio	0.3069	0.2518	
Saturation, %	55.4	100.0	

Test Readings for Specimen No. 2

Normal stress = 20 psi

Strain rate, %/min. = 0.25

Fail. Stress = 22.53 psi **at reading no.** 51

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	-0.0121	276.000	0.0	0.0	0.00
1	-0.0074	372.000	96.0	0.1	1.50
2	0.0013	459.000	183.0	0.2	2.86
3	0.0062	489.000	213.0	0.2	3.33
4	0.0197	581.000	305.0	0.4	4.77
5	0.0243	609.000	333.0	0.5	5.20
6	0.0341	661.000	385.0	0.6	6.02
7	0.0429	707.000	431.0	0.7	6.73
8	0.0477	728.000	452.0	0.7	7.06
9	0.0569	777.000	501.0	0.9	7.83
10	0.0662	823.000	547.0	1.0	8.55
11	0.0804	909.000	633.0	1.2	9.89
12	0.0947	982.000	706.0	1.3	11.03
13	0.1087	1052.000	776.0	1.5	12.13
14	0.1276	1133.000	857.0	1.7	13.39
15	0.1412	1184.000	908.0	1.9	14.19

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
16	0.1556	1227.000	951.0	2.1	14.86
17	0.1743	1272.000	996.0	2.3	15.56
18	0.1936	1310.000	1034.0	2.6	16.16
19	0.2078	1342.000	1066.0	2.7	16.66
20	0.2171	1362.000	1086.0	2.9	16.97
21	0.2405	1407.000	1131.0	3.2	17.67
22	0.2598	1427.000	1151.0	3.4	17.98
23	0.2734	1453.000	1177.0	3.6	18.39
24	0.2878	1478.000	1202.0	3.7	18.78
25	0.3017	1505.000	1229.0	3.9	19.20
26	0.3209	1534.000	1258.0	4.2	19.66
27	0.3394	1554.000	1278.0	4.4	19.97
28	0.3586	1578.000	1302.0	4.6	20.34
29	0.3728	1592.000	1316.0	4.8	20.56
30	0.3867	1608.000	1332.0	5.0	20.81
31	0.4011	1610.000	1334.0	5.2	20.84
32	0.4246	1622.000	1346.0	5.5	21.03
33	0.4436	1624.000	1348.0	5.7	21.06
34	0.4633	1626.000	1350.0	5.9	21.09
35	0.4818	1631.000	1355.0	6.2	21.17
36	0.5008	1640.000	1364.0	6.4	21.31
37	0.5193	1659.000	1383.0	6.6	21.61
38	0.5382	1667.000	1391.0	6.9	21.73
39	0.5578	1672.000	1396.0	7.1	21.81
40	0.5767	1684.000	1408.0	7.4	22.00
41	0.5954	1682.000	1406.0	7.6	21.97
42	0.6146	1673.000	1397.0	7.8	21.83
43	0.6333	1676.000	1400.0	8.1	21.88
44	0.6524	1681.000	1405.0	8.3	21.95
45	0.6708	1684.000	1408.0	8.5	22.00
46	0.6900	1690.000	1414.0	8.8	22.09
47	0.7096	1688.000	1412.0	9.0	22.06
48	0.7279	1686.000	1410.0	9.3	22.03
49	0.7476	1704.000	1428.0	9.5	22.31
50	0.7660	1711.000	1435.0	9.7	22.42
51	0.7851	1718.000	1442.0	10.0	22.53
52	0.8041	1721.000	1445.0	10.2	22.58
53	0.8236	1724.000	1448.0	10.4	22.63
54	0.8419	1723.000	1447.0	10.7	22.61
55	0.8613	1713.000	1437.0	10.9	22.45
56	0.8803	1711.000	1435.0	11.2	22.42
57	0.8996	1708.000	1432.0	11.4	22.38
58	0.9186	1689.000	1413.0	11.6	22.08
59	0.9375	1684.000	1408.0	11.9	22.00
60	0.9568	1686.000	1410.0	12.1	22.03
61	0.9755	1676.000	1400.0	12.3	21.88
62	0.9950	1664.000	1388.0	12.6	21.69

Test Readings for Specimen No. 2

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
63	1.0139	1660.000	1384.0	12.8	21.63
64	1.0330	1662.000	1386.0	13.1	21.66
65	1.0522	1662.000	1386.0	13.3	21.66
66	1.0705	1667.000	1391.0	13.5	21.73
67	1.0900	1670.000	1394.0	13.8	21.78
68	1.1089	1672.000	1396.0	14.0	21.81
69	1.1284	1667.000	1391.0	14.3	21.73

Parameters for Specimen No. 3

Specimen Parameter	Initial	Consolidated	Final
Moisture content: Moist soil+tare, gms.	9213.100		9520.000
Moisture content: Dry soil+tare, gms.	8667.100		8667.100
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	6.3	9.8	9.8
Moist specimen weight, gms.	9213.1		
Side Length, in.	8.00	8.00	
Area, in.²	64.00	64.00	
Height, in.	4.00	3.87	
Net decrease in height, in.		0.13	
Wet density, pcf	137.1	146.3	
Dry density, pcf	129.0	133.2	
Void ratio	0.3069	0.2657	
Saturation, %	55.4	100.0	

Test Readings for Specimen No. 3

Normal stress = 40 psi

Strain rate, %/min. = 0.25

Fail. Stress = 40.09 psi **at reading no.** 50

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
0	-0.0364	43.000	0.0	0.0	0.00
1	-0.0276	402.000	359.0	0.1	5.61
2	-0.0198	615.000	572.0	0.2	8.94
3	-0.0159	797.000	754.0	0.3	11.78
4	-0.0013	1095.000	1052.0	0.4	16.44
5	0.0045	1433.000	1390.0	0.5	21.72
6	0.0145	1627.000	1584.0	0.6	24.75
7	0.0246	1787.000	1744.0	0.8	27.25
8	0.0296	1889.000	1846.0	0.8	28.84
9	0.0388	1959.000	1916.0	0.9	29.94
10	0.0478	2002.000	1959.0	1.1	30.61
11	0.0616	2035.000	1992.0	1.2	31.13
12	0.0746	2072.000	2029.0	1.4	31.70
13	0.0880	2131.000	2088.0	1.6	32.63
14	0.1054	2163.000	2120.0	1.8	33.13
15	0.1188	2202.000	2159.0	1.9	33.73
16	0.1323	2241.000	2198.0	2.1	34.34
17	0.1507	2277.000	2234.0	2.3	34.91

Test Readings for Specimen No. 3

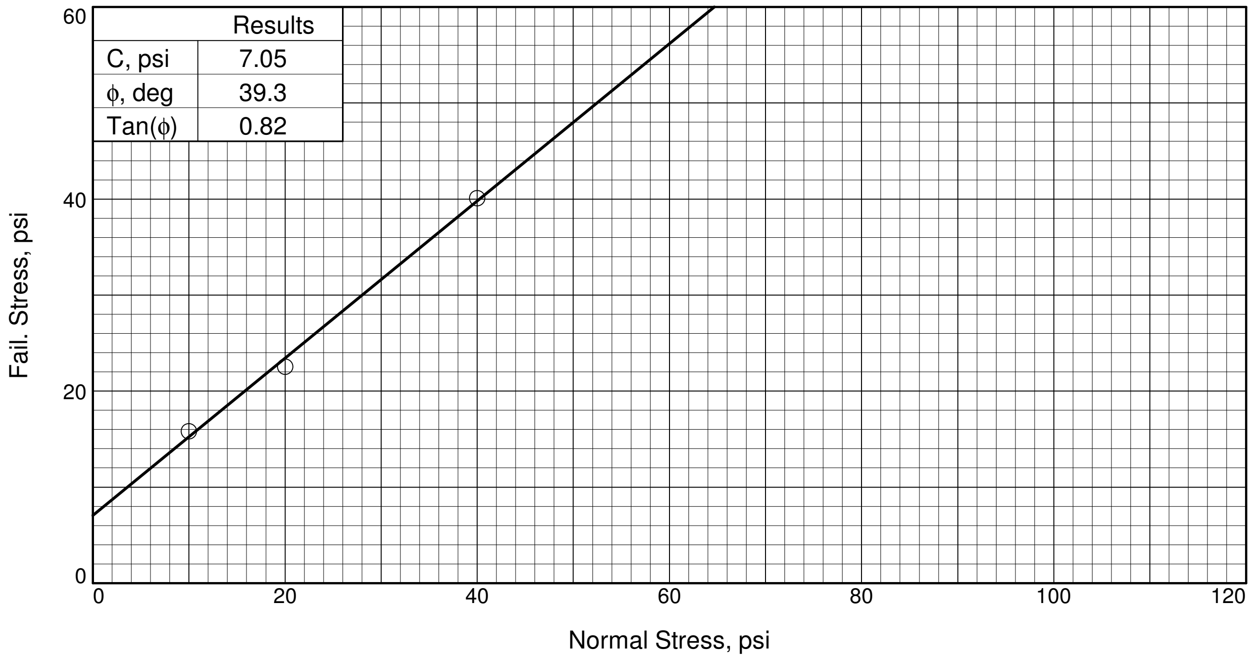
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
18	0.1698	2305.000	2262.0	2.6	35.34
19	0.1835	2332.000	2289.0	2.7	35.77
20	0.1928	2356.000	2313.0	2.9	36.14
21	0.2163	2375.000	2332.0	3.2	36.44
22	0.2359	2394.000	2351.0	3.4	36.73
23	0.2811	2417.000	2374.0	4.0	37.09
24	0.2945	2432.000	2389.0	4.1	37.33
25	0.3080	2434.000	2391.0	4.3	37.36
26	0.3275	2448.000	2405.0	4.5	37.58
27	0.3459	2457.000	2414.0	4.8	37.72
28	0.3646	2472.000	2429.0	5.0	37.95
29	0.3789	2488.000	2445.0	5.2	38.20
30	0.3936	2503.000	2460.0	5.4	38.44
31	0.4071	2519.000	2476.0	5.5	38.69
32	0.4309	2528.000	2485.0	5.8	38.83
33	0.4499	2531.000	2488.0	6.1	38.88
34	0.4692	2551.000	2508.0	6.3	39.19
35	0.4880	2561.000	2518.0	6.6	39.34
36	0.5071	2562.000	2519.0	6.8	39.36
37	0.5260	2563.000	2520.0	7.0	39.38
38	0.5454	2578.000	2535.0	7.3	39.61
39	0.5635	2577.000	2534.0	7.5	39.59
40	0.5834	2579.000	2536.0	7.7	39.63
41	0.6020	2552.000	2509.0	8.0	39.20
42	0.6210	2559.000	2516.0	8.2	39.31
43	0.6402	2570.000	2527.0	8.5	39.48
44	0.6595	2575.000	2532.0	8.7	39.56
45	0.6784	2588.000	2545.0	8.9	39.77
46	0.6973	2589.000	2546.0	9.2	39.78
47	0.7167	2594.000	2551.0	9.4	39.86
48	0.7354	2608.000	2565.0	9.6	40.08
49	0.7549	2614.000	2571.0	9.9	40.17
50	0.7737	2609.000	2566.0	10.1	40.09
51	0.7929	2588.000	2545.0	10.4	39.77
52	0.8123	2592.000	2549.0	10.6	39.83
53	0.8314	2602.000	2559.0	10.8	39.98
54	0.8501	2607.000	2564.0	11.1	40.06
55	0.8690	2630.000	2587.0	11.3	40.42
56	0.8888	2648.000	2605.0	11.6	40.70
57	0.9076	2632.000	2589.0	11.8	40.45
58	0.9266	2610.000	2567.0	12.0	40.11
59	0.9458	2614.000	2571.0	12.3	40.17
60	0.9653	2610.000	2567.0	12.5	40.11
61	0.9843	2597.000	2554.0	12.8	39.91
62	1.0031	2593.000	2550.0	13.0	39.84
63	1.0225	2578.000	2535.0	13.2	39.61
64	1.0421	2585.000	2542.0	13.5	39.72

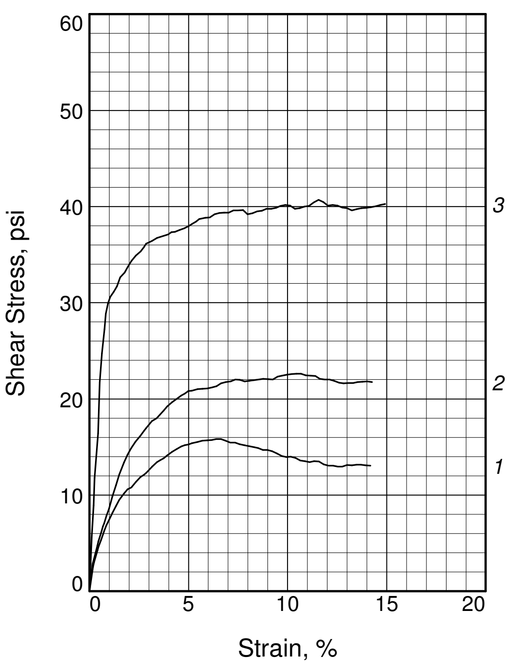
Test Readings for Specimen No. 3

No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psi
65	1.0613	2592.000	2549.0	13.7	39.83
66	1.0807	2595.000	2552.0	14.0	39.88
67	1.0995	2598.000	2555.0	14.2	39.92
68	1.1193	2606.000	2563.0	14.4	40.05
69	1.1386	2614.000	2571.0	14.7	40.17
70	1.1572	2620.000	2577.0	14.9	40.27

APPENDIX D.3

VRP TSF Construction Quality Assurance Results





Specimen No.		1	2	3
Initial	Water Content, %	6.3	6.3	6.3
	Dry Density, pcf	129.0	129.0	129.0
	Saturation, %	55.4	55.4	55.4
	Void Ratio	0.3069	0.3069	0.3069
	Side Length, in.	8.00	8.00	8.00
	Height, in.	4.00	4.00	4.00
At Test	Water Content, %	10.6	9.3	9.8
	Dry Density, pcf	131.2	134.6	133.2
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.2850	0.2518	0.2657
	Side Length, in.	8.00	8.00	8.00
	Height, in.	3.93	3.83	3.87
Normal Stress, psi		10.00	20.00	40.00
Fail. Stress, psi		15.83	22.53	40.09
Strain, %		6.6	10.0	10.1
Ult. Stress, psi				
Strain, %				
Strain rate, %/min.		0.25	0.25	0.25

Sample Type: Reconstitued @ 95% MDD

Description:

Assumed Specific Gravity= 2.7

Remarks: Failure chosen at peak shear stress and 10% strain. Test was inundated. Gap =0.4". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.

Figure ________

Client: NewFields

Project: Arizona Minerals PAG Remediation
NF#475.0014.011

Location: EF-017-R

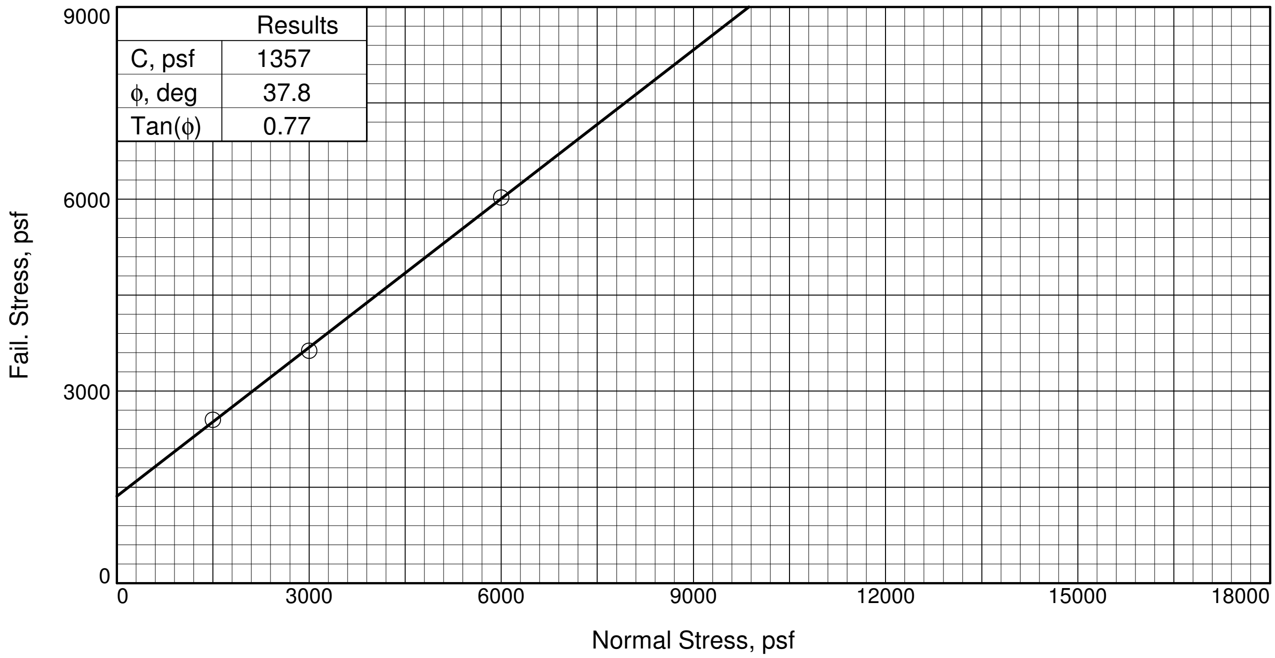
Sample Number: IPF-02 **Depth:** Lift 26

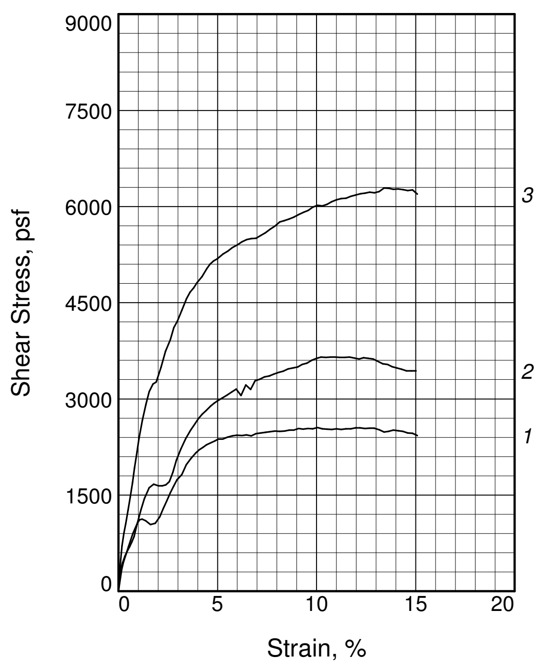
Proj. No.: DV108-00305/07 **Date Sampled:** 3/12/18

Knight Piésold CONSULTING

Tested By: LEB **Checked By:** JDB

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.





	Specimen No.	1	2	3
Initial	Water Content, %	5.2	5.2	5.2
	Dry Density, pcf	133.3	130.1	130.1
	Saturation, %	53.0	47.5	47.5
	Void Ratio	0.2647	0.2956	0.2956
	Side Length, in.	8.00	8.00	8.00
	Height, in.	4.10	4.20	4.20
At Test	Water Content, %	9.3	10.2	10.1
	Dry Density, pcf	134.7	132.1	132.5
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.2513	0.2760	0.2725
	Side Length, in.	8.00	8.00	8.00
	Height, in.	4.06	4.14	4.13
	Normal Stress, psf	1500	3000	6000
	Fail. Stress, psf	2552	3632	6021
	Strain, %	10.0	10.0	10.0
	Ult. Stress, psf			
	Strain, %			
	Strain rate, %/min.	0.25	0.25	0.25

Sample Type: Reconstituted

Description:

Assumed Specific Gravity= 2.7

Remarks: Failure chosen at 10% strain. Test was inundated. Gap=0.4". Particles larger than 3/4" were removed and replaced with finer gravel prior to test.

Figure ________

Client: NewFields

Project: Arizona Minerals PAG Remediation
NF#475.0014.011

Location: EF-39-R

Sample Number: EF-39-R

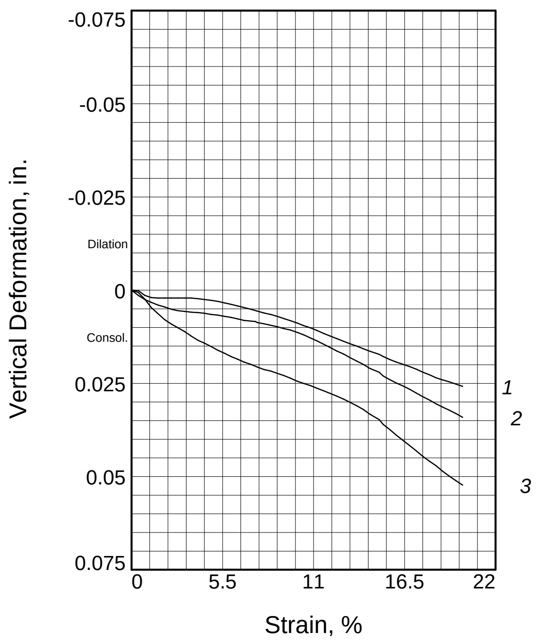
Proj. No.: DV108-00305/07 **Date Sampled:** 6/18/18

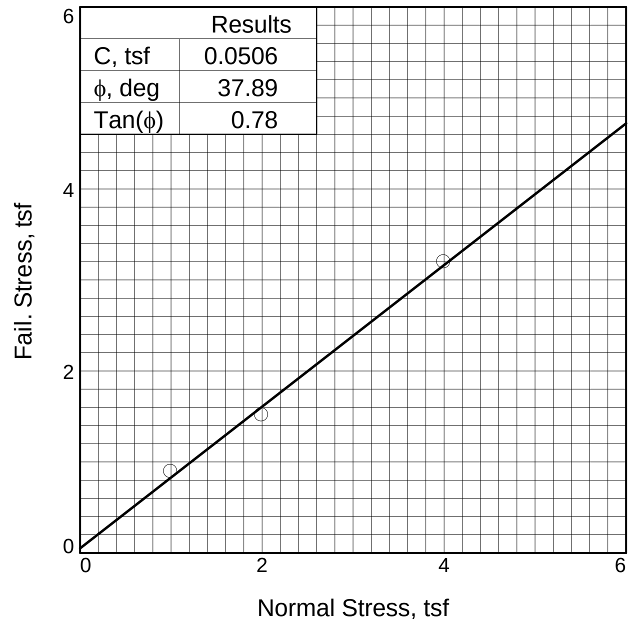
Knight Piésold CONSULTING

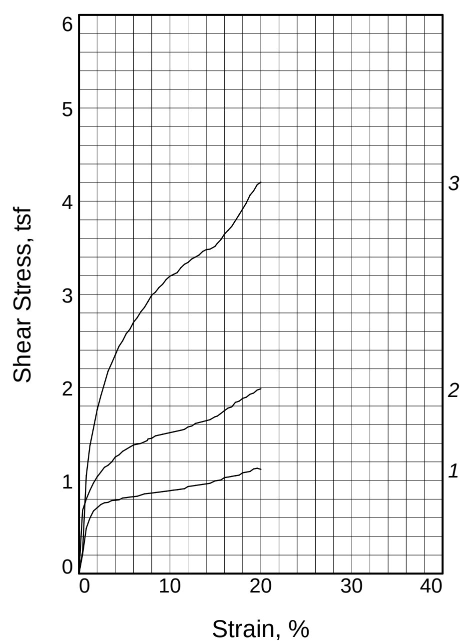
Tested By: LEB **Checked By:** JDB

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.

Test results included in this report relate only to the items inspected or tested. This report shall not be reproduced, in full, without prior written approval of NewFields.







	Sample No.	1	2	3
Initial	Water Content, %	4.7	4.7	4.7
	Dry Density, pcf	124.1	121.9	119.1
	Saturation, %	26.6	25.3	23.7
	Void Ratio	0.5345	0.5615	0.5988
	Diameter, in.	2.499	2.499	2.499
	Height, in.	1.144	1.167	1.194
At Test	Water Content, %	17.5	18.4	19.2
	Dry Density, pcf	124.1	121.9	120.0
	Saturation, %	99.8	99.7	99.7
	Void Ratio	0.5345	0.5615	0.5868
	Diameter, in.	2.499	2.499	2.499
	Height, in.	1.144	1.167	1.185
	Normal Stress, tsf	1.0000	2.0000	4.0000
	Fail. Stress, tsf	0.8912	1.5136	3.1949
	Strain, %	10.0	10.0	10.0
	Ult. Stress, tsf			
	Strain, %			
	Strain rate, in./min.	0.020	0.020	0.020

Sample Type: Remolded - Inundated
Description: Gray silty sand

LL= NP **PI=** NP
Assumed Specific Gravity= 3.05
Remarks: Failure assumed at 10% strain

Figure 19-070-05

Client: Arizona Minerals Inc.

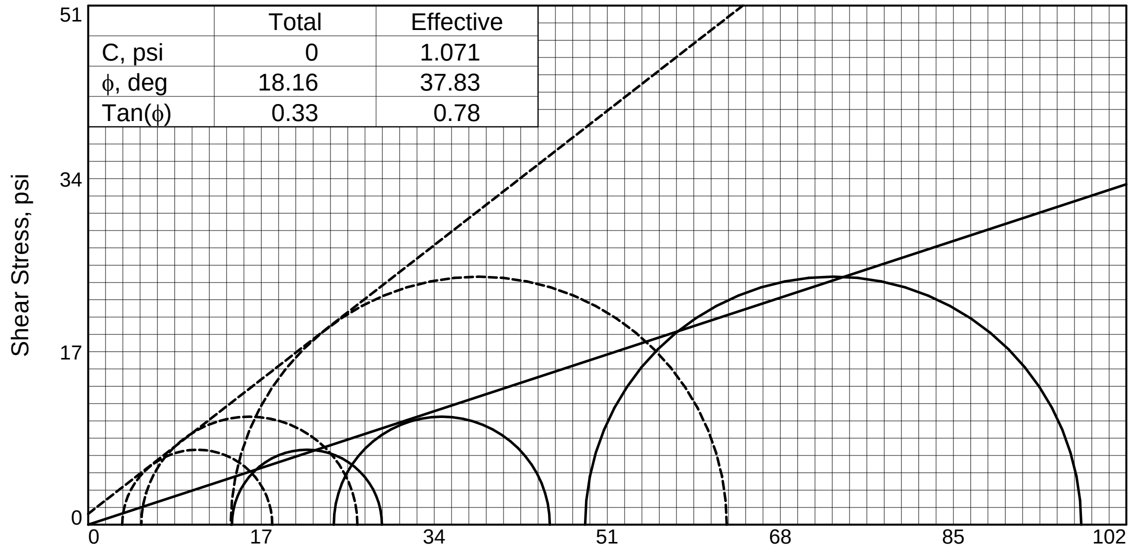
Project: Hermosa TSF CQA

Location: TF-28-R
Sample Number: 19-070-05
Proj. No.: 475.0014.011 **Date Sampled:** 4/9/19

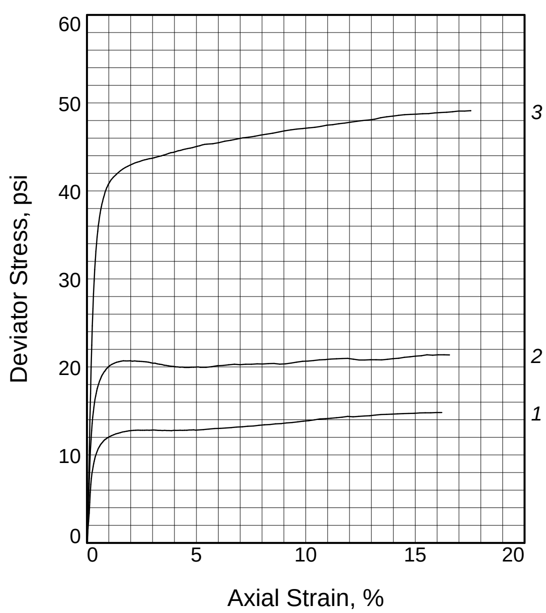
NewFields

Tested By: AR **Checked By:** KM

Test results included in this report relate only to the items inspected or tested. This report shall not be reproduced, in full, without prior written approval of NewFields.



	Total	Effective
C, psi	0	1.071
ϕ, deg	18.16	37.83
Tan(ϕ)	0.33	0.78



Sample No.		1	2	3
Initial	Water Content, %	26.8	26.8	26.8
	Dry Density, pcf	88.4	88.3	88.6
	Saturation, %	79.9	79.6	80.3
	Void Ratio	0.9062	0.9093	0.9014
	Diameter, in.	2.790	2.798	2.795
	Height, in.	5.640	5.630	5.620
At Test	Water Content, %	30.8	26.6	16.0
	Dry Density, pcf	92.0	98.1	117.6
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.8328	0.7174	0.4330
	Diameter, in.	2.754	2.700	2.540
	Height, in.	5.567	5.437	5.130
Strain rate, in./min.		0.001	0.001	0.001
Eff. Cell Pressure, psi		14.12	24.13	48.83
Fail. Stress, psi		14.74	21.23	48.74
Total Pore Pr., psi		82.52	90.34	109.16
Strain, %		15.0	15.0	15.1
Ult. Stress, psi				
Total Pore Pr., psi				
Strain, %				
$\bar{\sigma}_1$ Failure, psi		18.08	26.45	62.74
$\bar{\sigma}_3$ Failure, psi		3.34	5.22	14.00

Type of Test:
CU with Pore Pressures

Sample Type: Remolded

Description: T/FC#1

LL= NP **PI=** NP

Assumed Specific Gravity= 2.70

Remarks: Failure Selected at 15% Strain

Figure ________

Client: Arizona Minerals Inc.

Project: Hermosa TSF CQA

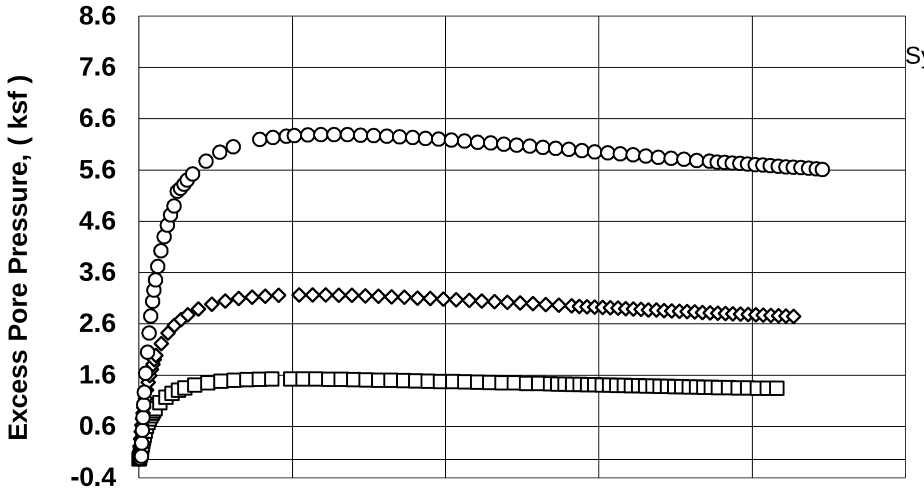
Source of Sample: TF

Sample Number: 20-014

Proj. No.: 475.0014.011 **Date Sampled:** 1/30/20

NewFields

Tested By: K.Magner **Checked By:** K.Magner



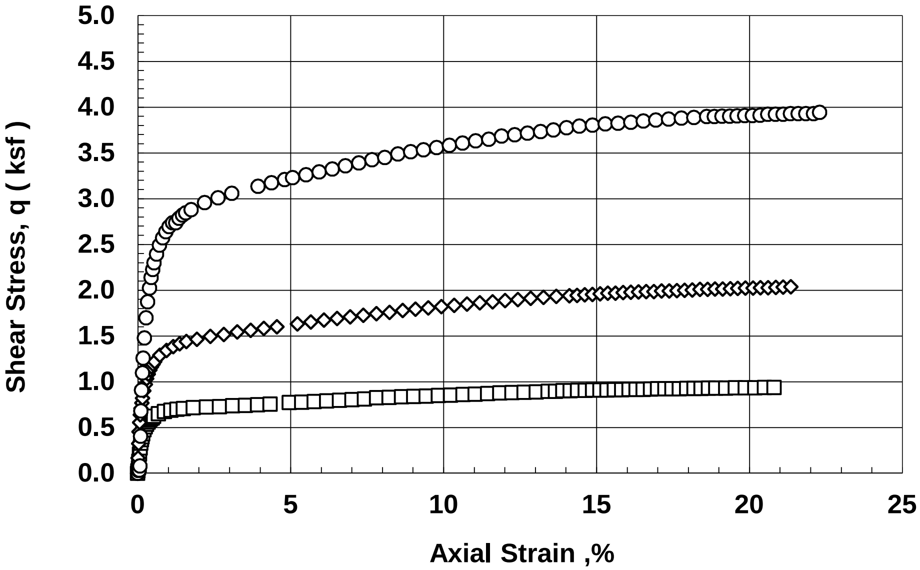
LEGEND AND SUMMARY INFORMATION

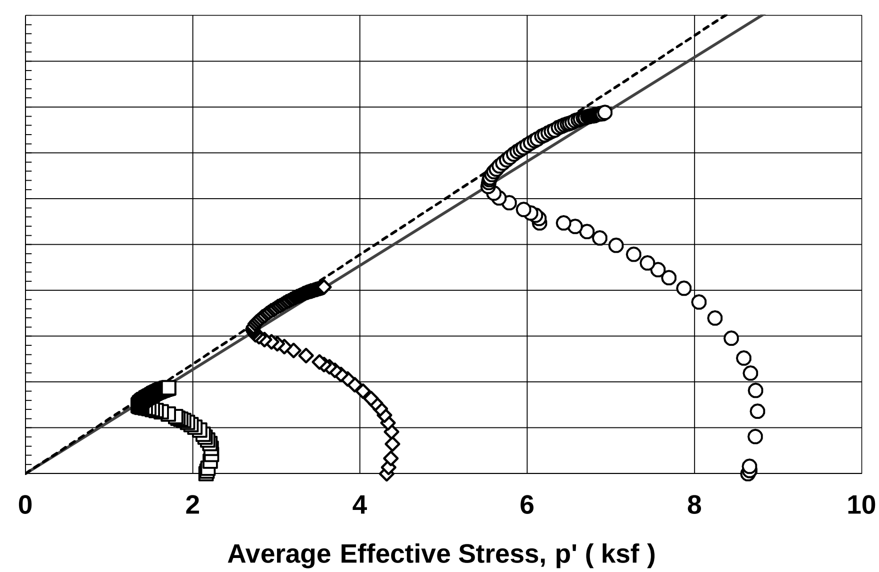
Symbol	Test	Boring	Sample	Depth (ft)	w_o (%)	γ_{to} (pcf)	σ'_c (ksf)
□	T4404	Reduced Composite*			18.2	126.6	2.16
◊	T4405	Reduced Composite*			18.1	127.0	4.32
○	T4406	Reduced Composite*			21.7	130.4	8.64

* Composite from TF-002R, TF-003R, TF-004R
(*-#16 sieve size as tested)

SERIES SUMMARY

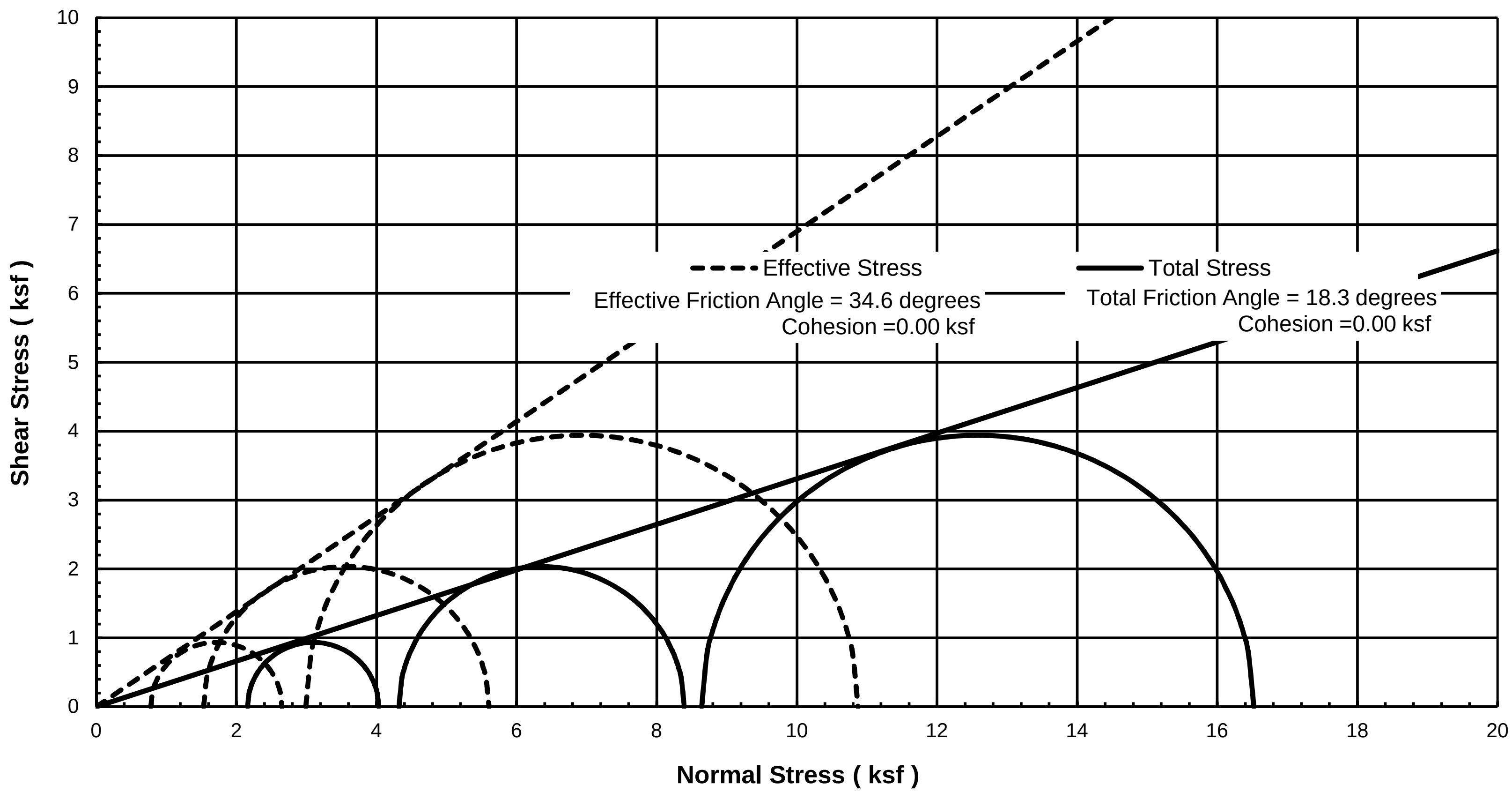
Notation	Failure Criteria	c' (ksf)	Φ' (degrees)
(solid line)	Peak Deviator Stress	0.00	34.6
(dotted line)	Peak Obliquity	0.00	36.7





New Fields	**Project No. 475.0014.011**	**Hermosa**	**CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION**
TerraSense, LLC	**Project No. 8194-18001**		**with Pore Pressure Measurements Reduced Composite***

Prepared by: CMJ
Checked by: G. Thomas

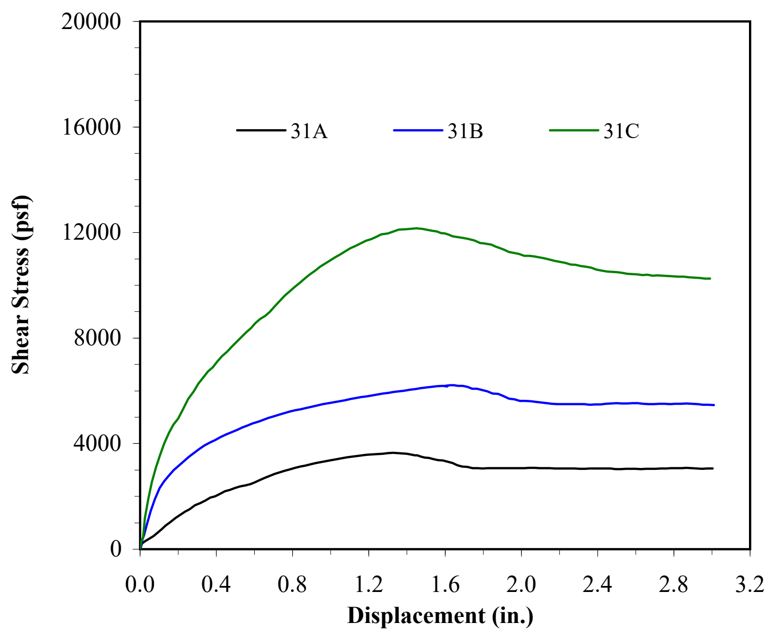


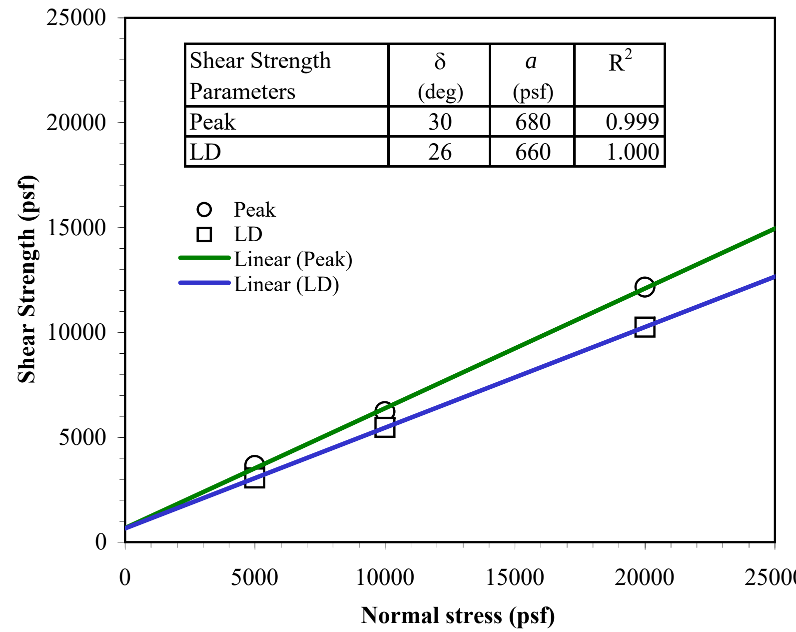
New Fields	**Project No.** 475.0014.011	**Hermosa**	**Mohr Circles of Total and Effective Stresses at Peak**
TerraSense, LLC	**Project No.** 8194-18001		**CIU' Triaxial Test Reduced Composite***

Analysis File: Cu'sum3v4.xls Ciusum1.xlsx 10/25/2018

NEWFIELDS COMPANIES, LLC - HERMOAS PROJECT
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

Upper Shear Box: LPSL-002-C soil compacted to approximately 95% of max dry density at OMC (γ_{dmax} = 128.3 pcf, OMC = 10.3%) against
1/8" to 1/4" thick friction layer FL-002-C against
Agru 60-mil Microspike HDPE geomembrane with dull side up
Lower Shear Box: Concrete sand





Shear Strength Parameters	δ (deg)	a (psf)	R^2
Peak	30	680	0.999
LD	26	660	1.000

Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	Soaking Stress (psf)	Soaking Time (hour)	Consolidation by Step Loading (psf, hours) 1	2	3	4	5	6	7	8	9	GCL ω_f (%)	Shear Strength τ_P (psf)	Shear Strength τ_{LD} (psf)	Failure Mode
31A	12 x 12	5000	0.01	5000	24											3650	3055	(1)
31B	12 x 12	10000	0.01	10000	24											6211	5465	(1)
31C	12 x 12	20000	0.01	20000	24											12155	10255	(1)

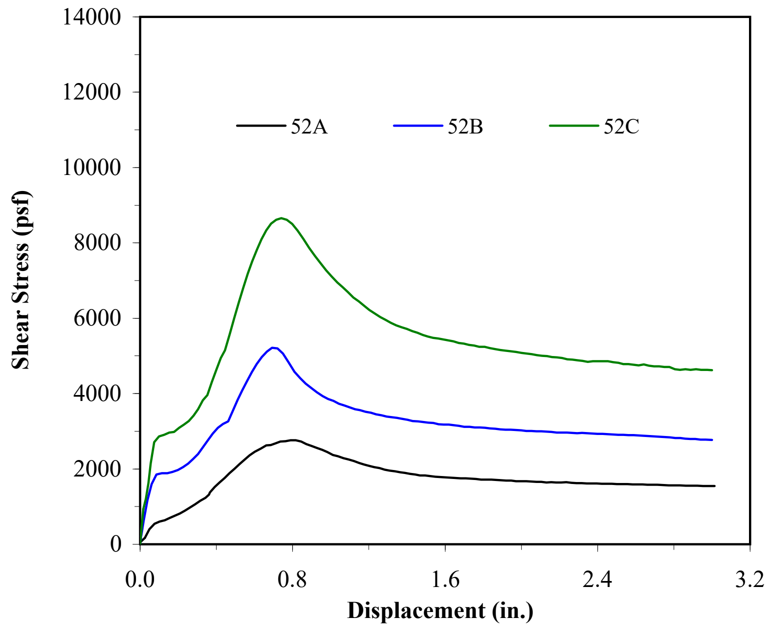
NOTES:
(1) Shear failure at the interface between the thick friction layer soil FL-002-C and dull side of Agru 60-mil Microspike HDPE geomembrane.
(2) The reported total-stress parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

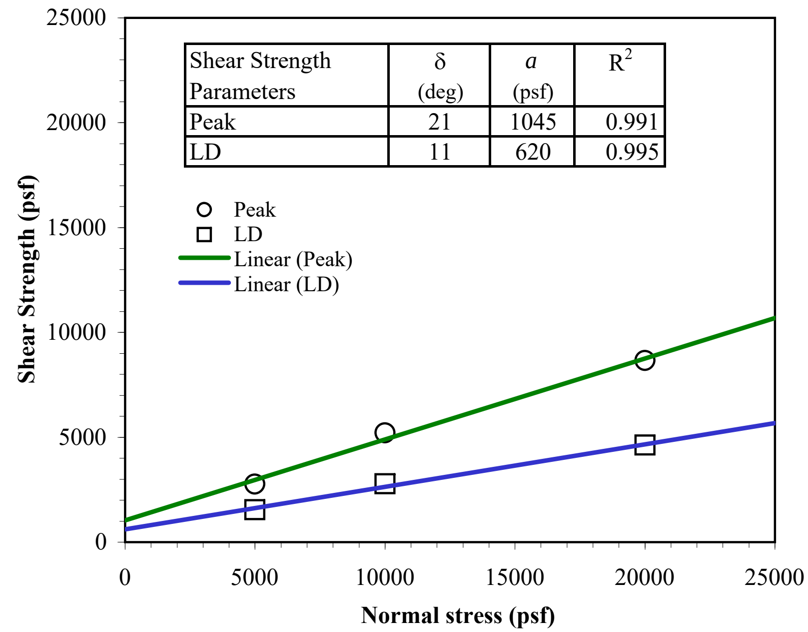
SGI TESTING SERVICES, LLC

DATE OF REPORT:	6/14/2018
FIGURE NO.	1
PROJECT NO.	SGI18024
DOCUMENT NO.	
FILE NO.	

NEWFIELDS COMPANIES, LLC - HERMOAS PROJECT
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

Upper Shear Box: Steel grip
Hydrated Bentomat DN GCL with white nonwoven geotextile side down against
Agru 60-mil Microspike HDPE geomembrane with dull side up
Lower Shear Box: Concrete sand





Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	Soaking Stress (psf)	Soaking Time (hour)	Consolidation by Step Loading (psf, hours) 1	2	3	4	5	6	7	8	9	GCL ω_f (%)	Shear Strength τ_P (psf)	τ_{LD} (psf)	Failure Mode
52A	12 x 12	5000	0.01	5000	24	5000, 24	400, 2	800, 2	1600, 2	3200, 2	5000, 24				88.9	2765	1545	(1)
52B	12 x 12	10000	0.01	10000	24	10000, 24	400, 2	800, 2	1600, 2	3200, 2	6400, 2	10000, 24			66.4	5213	2772	(1)
52C	12 x 12	20000	0.01	20000	24	20000, 24	400, 2	800, 2	1600, 2	3200, 2	6400, 2	12800, 2	20000, 24		62.0	8655	4625	(1)

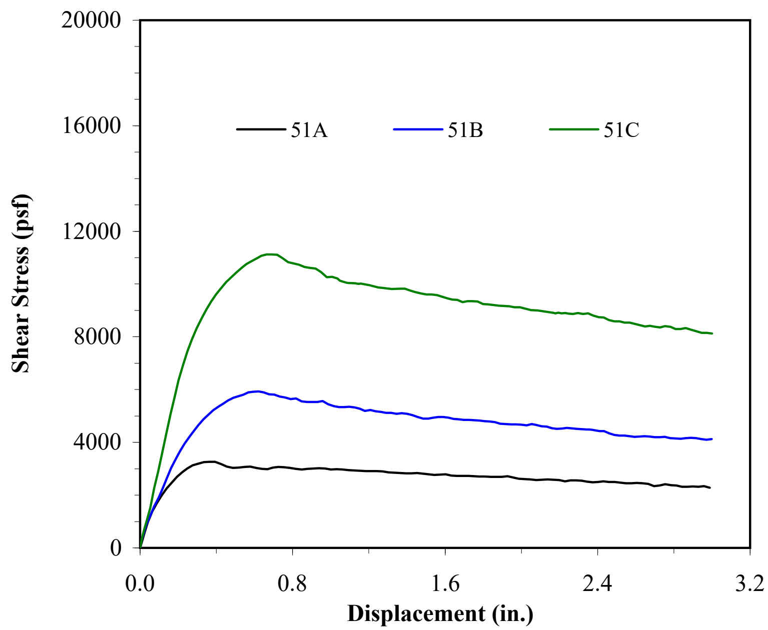
NOTES:
(1) Shear failure at the interface between the white nonwoven geotextile side of the hydrated bentomat GCL and the dull side of Microspike geomembrane.
(2) The reported total-stress parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

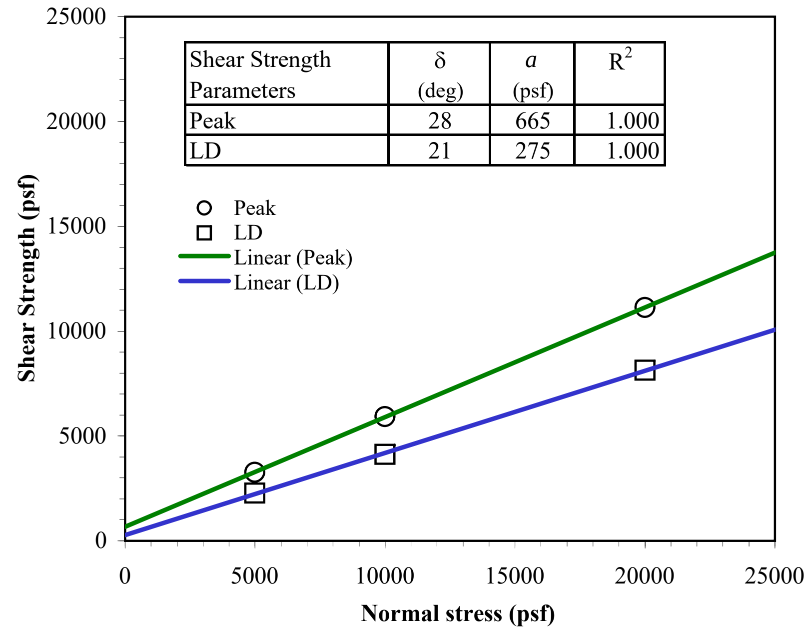
SGI TESTING SERVICES, LLC

DATE OF REPORT:	8/5/2018
FIGURE NO.	2
PROJECT NO.	SGI18024
DOCUMENT NO.	
FILE NO.	

NEWFIELDS COMPANIES, LLC - HERMOAS PROJECT
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

Upper Shear Box: Subgrade soil compacted to 95% of max modified Proctor dry unit weight at OMC (γ_{dmax} = 127.8, OMC = 10.4%)/
1/8" to 1/4" thick friction layer (gravel)/
Agru 60-mil Microspike HDPE geomembrane with dull side up /
Lower Shear Box: Concrete sand





Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	Soaking Stress (psf)	Soaking Time (hour)	Consolidation by Step Loading (psf, hours) 1	2	3	4	5	6	7	8	9	GCL ω_f (%)	Shear Strength τ_P (psf)	Shear Strength τ_{LD} (psf)	Failure Mode
51A	12 x 12	5000	0.01	5000	24	5000, 24										3265	2279	(1)
51B	12 x 12	10000	0.01	10000	24	10000, 24										5925	4123	(1)
51C	12 x 12	20000	0.01	20000	24	20000, 24										11121	8130	(1)

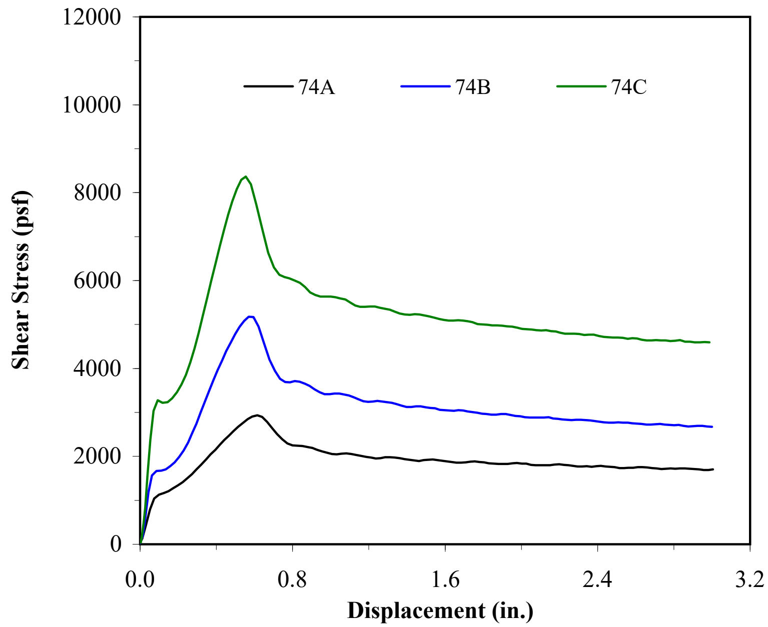
NOTES:
(1) Shear failure at the interface between the thick friction layer soil (gravel) and dull side of Agru 60-mil Microspike HDPE geomembrane.
(2) The reported total-stress parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

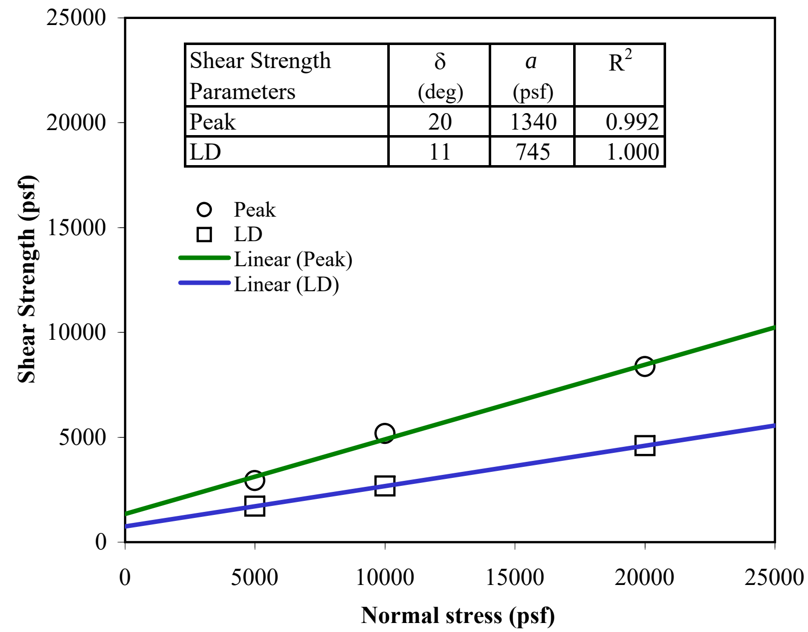
DATE OF REPORT:	8/5/2018
FIGURE NO.	1
PROJECT NO.	SGI18024
DOCUMENT NO.	
FILE NO.	

SGI TESTING SERVICES, LLC

NEWFIELDS COMPANIES, LLC - HERMOAS COMPLEX PROJECT
INTERFACE DIRECT SHEAR TESTING (ASTM D 5321)

Upper Shear Box: Steel grip
Hydrated Bentomat DN9 GCL (No Roll # given) with white NWGT side down against
Agru 60-mil Microspike HDPE geomembrane (Roll #) with shiny side (shiny side asperity: 39 mils) up
Lower Shear Box: Concrete sand





Shear Strength Parameters	δ (deg)	*a* (psf)	R^2
Peak	20	1340	0.992
LD	11	745	1.000

Test No.	Shear Box Size (in. x in.)	Normal Stress (psf)	Shear Rate (in./min)	GCL Soaking Stress (psf)	GCL Soaking Time (hour)	Consolidation by Step Loading (psf, hours) 1	2	3	4	5	6	7	8	9	GCL ω_f (%)	Shear Strength τ_P (psf)	Shear Strength τ_{LD} (psf)	Failure Mode
74A	12 x 12	5000	0.04	200	24	400, 2	800, 2	1600, 2	3200, 2	5000, 24					84.0	2935	1707	(1)
74B	12 x 12	10000	0.04	200	24	400, 2	800, 2	1600, 2	3200, 2	6400, 2	10000, 24				65.0	5177	2669	(1)
74C	12 x 12	20000	0.04	200	24	400, 2	800, 2	1600, 2	3200, 2	6400, 2	12800, 2	20000, 24			58.9	8366	4598	(1)

NOTES:
(1) Shear failure at the interface between the white side NWGT of GCL and the shiny side of Agru 60-mil Microspike HDPE geomembrane.
(2) The reported total-stress parameters of friction angle and adhesion were determined from a best-fit line drawn through the test data. Caution should be exercised in using these strength parameters for applications involving normal stresses outside the range of the stresses covered by the test series. The large-displacement (LD) shear strength was calculated using the shear force measured at the end of the test.

SGI TESTING SERVICES, LLC

DATE OF REPORT:	10/7/2018
FIGURE NO.	4B
PROJECT NO.	SGI18024
DOCUMENT NO.	
FILE NO.	

LINER INTEGRITY TEST

Project:	Hermosa TSF CQA	Client:	South 3.2 (AMI)
Project No.	475.0014.011	Date:	12/2/2019
Sample ID:	Subgrade	Tested By:	KE
Lab No.	19-413-01	Reviewed By:	KM

Test Parameters

Geosynthetic:	60 Mil Textured Liner
Substrate:	GCL Subgrade
Superstrate:	PL
Normal Load (psf):	16,500

Test Data

	Coupon
Start Date:	12/2/2019
Start Time:	2:00pm
End Date:	12/3/2019
End Time:	2:00pm
Duration (hrs):	24 hrs
No. of Dimples:	7
No. of Punctures:	0
No. of Tears:	0
(Pass/Fail)	**PASS**

General Test Notes: Small visible defects occurred during testing.
Loaded at 110' equivalent height for 24 hours.
Assuming 150 pcf

LINER INTEGRITY TEST

Project:	Hermosa TSF CQA	Client:	South32 (AMI)
Project No.	475.0014.011	Date:	12/2/2019
Sample ID:	LPSL	Tested By:	KE
Lab No.	19-413-02	Reviewed By:	KM

Test Parameters

Geosynthetic:	60 Mil Textured Liner
Substrate:	LPSL
Superstrate:	PL
Normal Load (psf):	16,500

Test Data

	Coupon
Start Date:	12/2/2019
Start Time:	2:00pm
End Date:	12/3/2019
End Time:	2:00pm
Duration (hrs):	24 hrs
No. of Dimples:	3
No. of Punctures:	0
No. of Tears:	0
(Pass/Fail)	**PASS**

General Test Notes: Small visible defects occurred during testing.
Loaded at 110' equivalent height for 24 hours.
Assuming 150 pcf

APPENDIX E

APPENDIX E.1 – LINER LEAKAGE CALCULATION

APPENDIX E.2 – HYDROLOGY AND HYDRAULICS (STAGE 2 EXPANSION)

APPENDIX E.3 – HYDROLOGY AND HYDRAULICS (CLOSURE)

APPENDIX E.1

Liner Leakage Calculation

Geomembrane Leakage Rate Underlain by Relatively Low Permeability Soil	
Project:	Hermosa Lined TSF Design Amendment
Client:	Arizona Minerals Inc
Facility:	Tailings Storage Facility
Engineer:	Craig Thompson
Date	9-Jun-20

NewFields

Inputs
Outputs

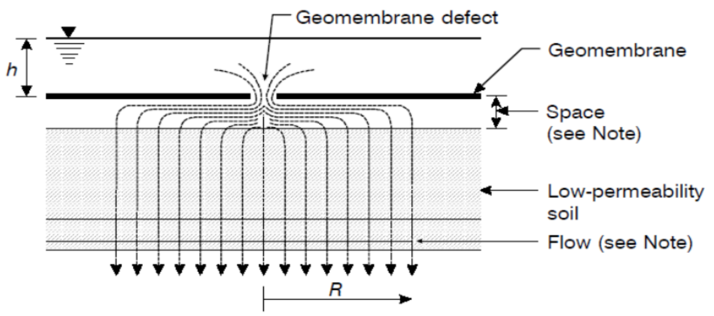


Figure 1. Liquid migration through a composite liner.

$$Q = C_{qo}\, a^{0.1}\, h^{0.9}\, k_s^{0.74}\, n$$ (Giroud, 1997)

Where: $n = \left(A / 43{,}560\ ft^2 \right) \times DefectsPer\ \ Acre$

$$a = \pi \left(d^2 / 4 \right)$$

Typical Installation Damage

Installation Quality	Defects per Acre
Excellent	Up to 1
Good	1 to 4
Fair	4 to 10
Poor	10 to 20

Assume **2** Defects Per Acre

Contact Quality Factor, C_{qo}

Liner/Soil Contact	Factor (Circ. Defect)
Good	0.21
Poor	1.15

Assume **0.21** for Contact Quality

Inputs Defined:

Q = Leakage Rate
n = Number of Defects in Geomembrane
a = Area of Circular Defect
g = Acceleration of Gravity (32.2 ft/s^2 or 9.81 m/s^2)
h = Hydraulic Head Above Geomembrane
d = Diameter of Circular Defect
A = Area of Geomembrane Lined Facility
C_{qo} = Contact Quality Factor
k_s = Permeability of Underlying Soil Layer

Variable Inputs

English Units		Metric Units	
d (in)	0.444	d (m)	0.0113
A (ft^2)	1,238,580	A (m^2)	115,068
h (ft)	1.5000	h (m)	0.4572
k_s (ft/sec)	3.3E-08	k_s (m/s)	1.0E-08

Calculated Values

English Units		Metric Units	
n	57	n	57
a (ft^2)	1.08E-03	a (m^2)	1.00E-04
Q (ft^3/s)	9.98E-05	Q (m^3/s)	2.83E-06

Conversion

$$2.83\text{E-}06\ \frac{m^3}{\sec} \times \frac{60 \sec}{\min} \times \frac{264.1 gal}{m^3} = 0.0448\ \frac{gal}{\min}$$

Assumptions

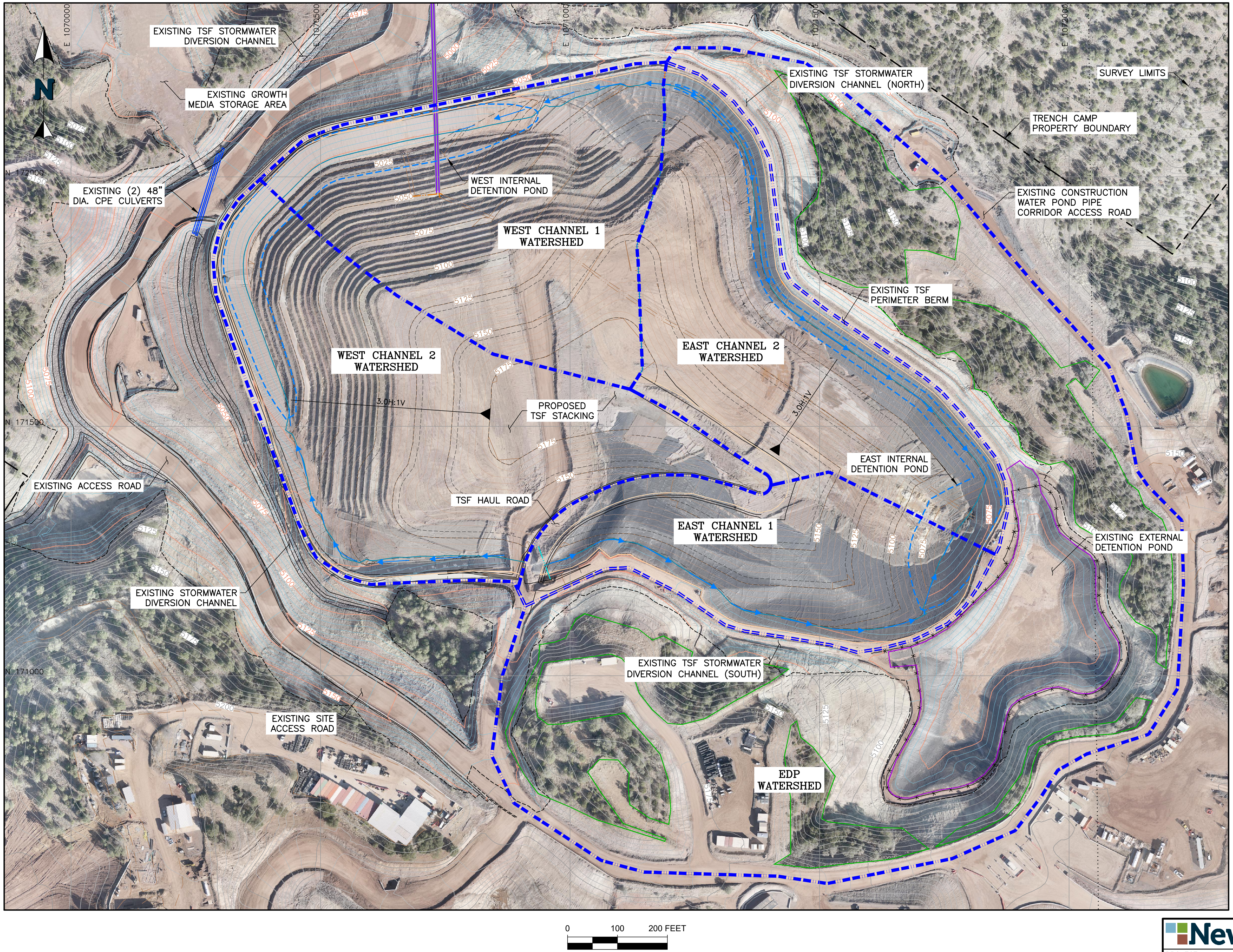
1. Above equations are for a circular defect with a diameter less than 25 mm.
2. The hydraulic head above the liner should be equal to or less than 3 m
3. The typical installation damage assumes a circular defect diameter of approxiately 3.5 mm given good to excellent quality control.

References

1. Giroud, J.P. 1997. "Equations for Calculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects". Geosynthetics International. Vol 4, Nos. 3-4, pp. 335-348.

APPENDIX E.2

Hydrology and Hydraulics (Stage 2 TSF Expansion)



LEGEND:

- EXISTING/CURRENT GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE
- WATERSHED BOUNDARY
- NATURAL GROUND WITHIN WATERSHED
- GEOMEMBRANE LINER WITHIN WATERSHED
- ROCK ARMOR WITHIN WATERSHED
- TAILINGS FILL WITHIN WATERSHED
- PROTECTIVE LAYER WITHIN WATERSHED
- ROAD/DISTURBED AREA WITHIN WATERSHED
- STORMWATER FLOW DIRECTION

WATERSHED INFORMATION

WATERSHED	AREA (AC)
EDP WATERSHED	23.0
EAST CHANNEL 1 WATERSHED	5.02
EAST CHANNEL 2 WATERSHED	7.16
WEST CHANNEL 1 WATERSHED	7.57
WEST CHANNEL 2 WATERSHED	9.28

NewFields

CLIENT: ARIZONA MINERAL INC.

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TSF WATERSHED BOUNDARIES

FILENAME: 14.022.025F

FIGURE NO. 1

REVISION A

P:\Projects\0014.022 Hermosa VRP TSF Expansion\A-CAD\FIGS\14.022.025F.dwg–7/2/2020 1:38 PM

NewFields	CALCULATION COVER SHEET		
Client	Arizona Minerals Inc.	Preparer:	S. Breidt	05/22/20
Project	Hermosa Lined TSF Design Amendment	Checked:		
Title	TSF Hydrology	Revision		

CALCULATION OBJECTIVE

1. Model the TSF hydrology after TSF crest elevation increase and closure
2. Determine water elevation at TSF West Internal Detention Pond during extreme storm events.

ASSUMPTIONS

1. Pond filling curves were extracted from AutoCAD Civil 3D
2. Composite SCS Curve numbers are calculated based on ground type.

METHODOLOGY

1. Area and length measurements were determined using AutoCAD Civil 3D.
2. Storm event data was calculated by Ecological Resource Consultants.

REFERENCES

1. AutoCAD Civil 3D version 2018.
2. United States Department of Agriculture Natural Resources Conservation Service (NRCS). (1986). “Urban Hydrology for Small Watersheds, Technical Release 55 Second Edition,” June
3. U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). “Part 630 Hydrology National Engineering Handbook.” 210-vi, NEH, May 2010.
4. United Stated Department of Commerce, National Oceanic and Atmospheric Administration. (reprinted 1984). “Hydrometeorological Report No. 49, Probably Maximum Precipitation Estimates, Colorado River and Great Basin Drainages,” (HRM 49)
5. United States Army Corps of Engineers. Hydrologic Modeling System (HEC-HMS) Version 4.4, Computer Program (May 2020)

CONCLUSIONS

1. See attached pages for inputs and results.

NewFields

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
TSF Hydrology
Lag Time Calculation

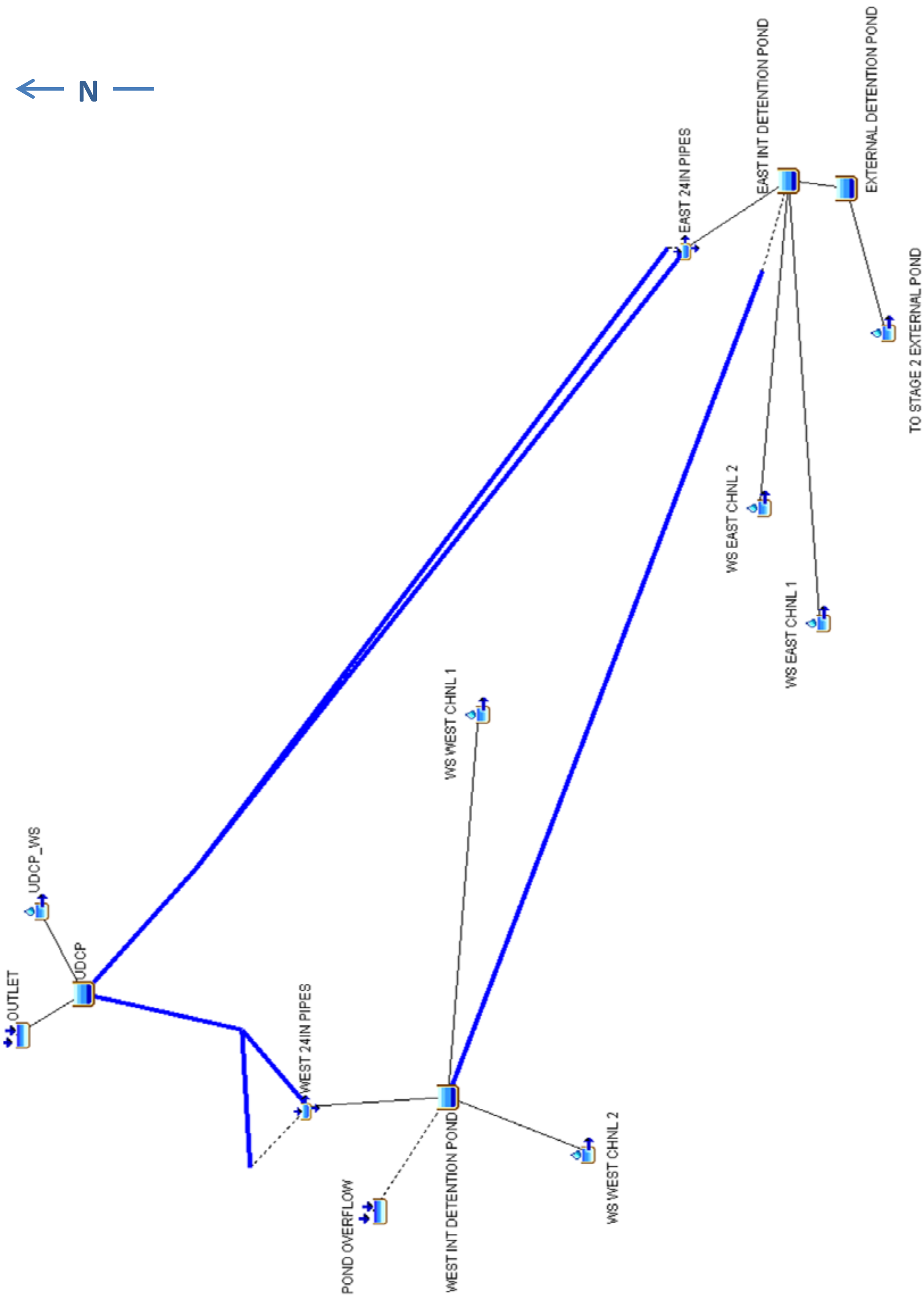
$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Ia	Initial Abstraction (0.2*S)
Input Values	

Lag Time and Watershed Characteristics								
Watershed	**Area (mi^2)**	**l (ft)**	**CN**	**y**	**S**	**t_p (hr)**	**t_p (min)**	**Ia**
EDP WATERSHED	0.0359	1,459	88	34.7%	1.31	0.05	3.3	0.26
UDCP GEOMEMBRANE	0.0029	100	100	50.0%	0.00	0.00	0.2	0.00
EAST CHNL 1 WATERSHED	0.0078	1,535	85	32.0%	1.75	0.07	4.0	0.35
EAST CHNL 2 WATERSHED	0.0112	729	84	33.2%	1.84	0.04	2.2	0.37
WEST CHNL 1 WATERSHED	0.0118	1,223	84	32.4%	1.89	0.06	3.4	0.38
WEST CHNL 2 WATERSHED	0.0145	604	84	29.5%	1.92	0.03	2.1	0.38

Reach Data						
Reach	**Length (ft)**	**Slope (ft/ft)**	**n**	**Type**	**S. Slope (ft/ft)**	**Dia. (ft)**
24" DIA OUTFALL PIPE 1 -EAST	1287	0.052	0.012	Cirular Pipe	n/a	2
24" DIA OUTFALL PIPE 2 -EAST	1287	0.052	0.012	Cirular Pipe	n/a	2
36" DIA OUTFALL PIPE (EAST)	482	0.038	0.012	Cirular Pipe	n/a	3
EAST SPILLWAY CHANNEL	285	0.146	0.069	Triangular Channel	2.5	n/a
24" DIA OUTFALL PIPE 1 -WEST	43	0.394	0.012	Cirular Pipe	n/a	2
24" DIA OUTFALL PIPE 2 -WEST	43	0.394	0.012	Cirular Pipe	n/a	2
36" DIA OUTFALL PIPE (WEST)	482	0.038	0.012	Cirular Pipe	n/a	3

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
Hec-HMS Overall View



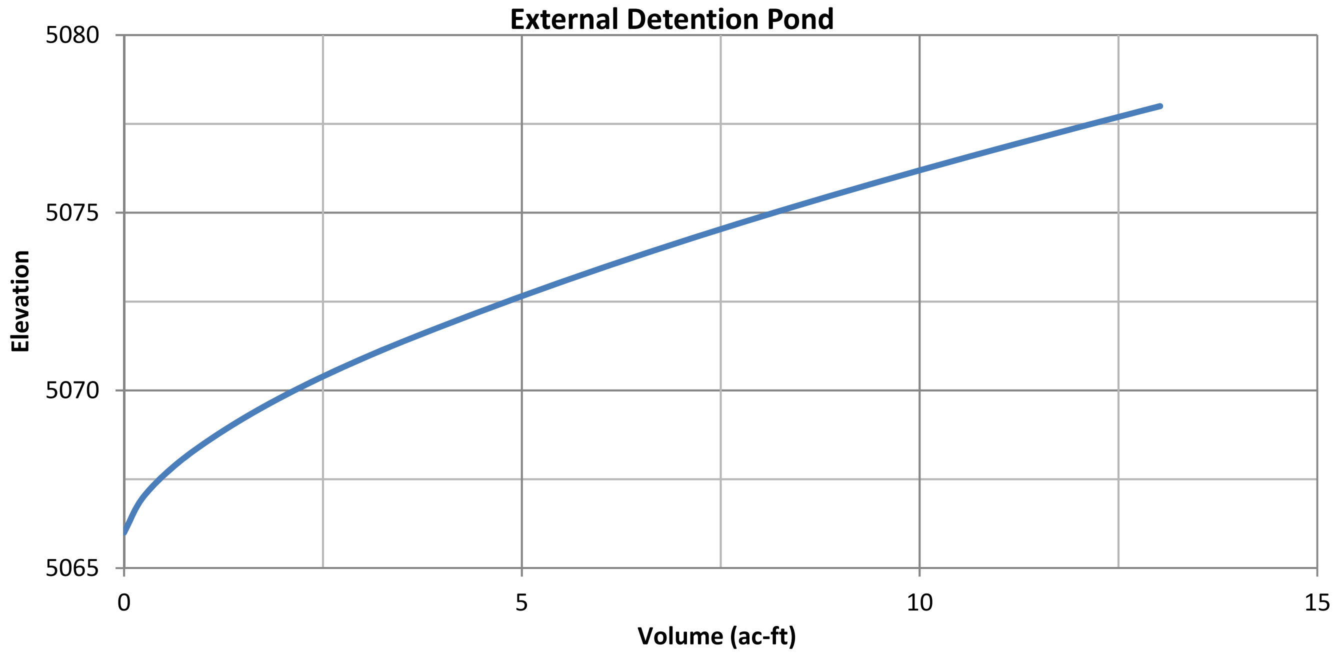
Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
TSF Hydrology

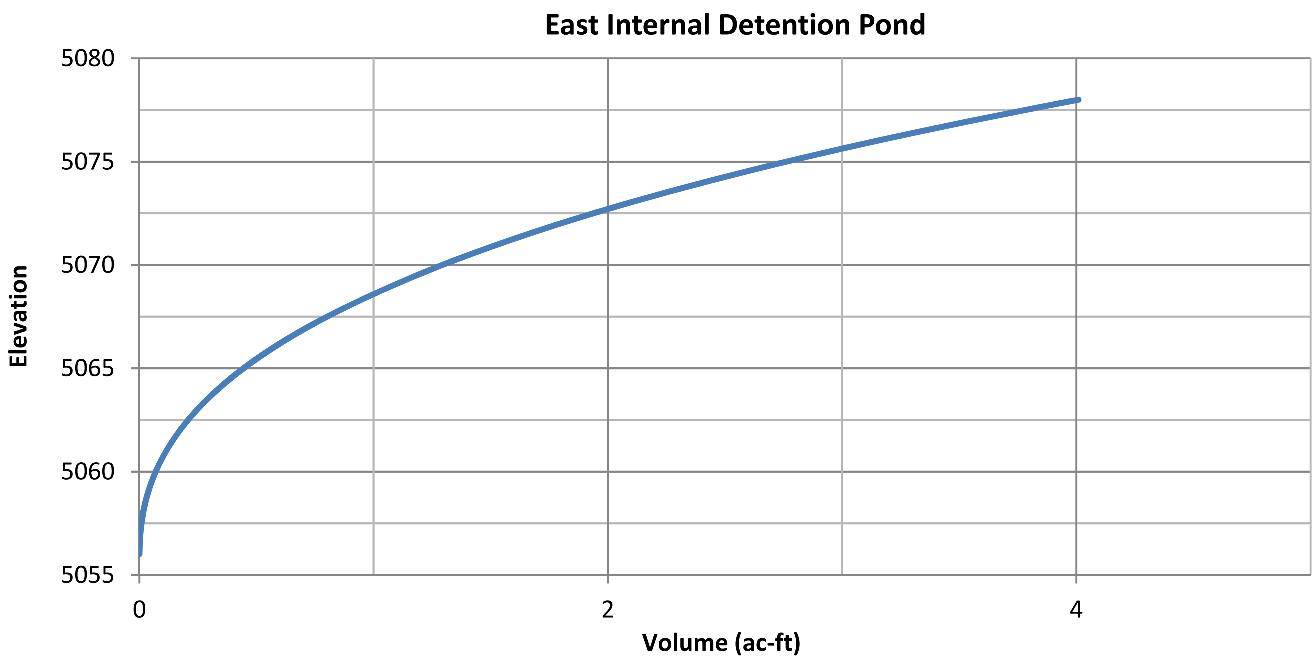
100 Year-24 Hour Hec-HMS Results

Hydraulic Element	Drainage Area (Mi^2)	Peak Discharge (ft^3/s)	Discharged Volume (acre-ft)	Peak Storage Elev (ft)	Vol (ac-ft)	Vol (mgal)
EDP WATERSHED	0.0359	116.7	6.8			
EXTERNAL DETENTION POND	0.0359	0	0.0	5074.10	6.8	2.22
EAST CHNL 2 WATERSHED	0.0112	34.9	1.9			
EAST INT DETENTION POND	0.0549	49.2	3.2	5062.60	0.2	0.07
WEST CHNL 2 WATERSHED	0.0145	45.1	2.4			
WEST CHNL 1 WATERSHED	0.0118	34.3	2.0			
EAST INT SPILLWAY CHANNEL	**0.0000**	**0**	**0.0**			
WEST INT DETENTION POND	0.0263	53.5	4.3	5025.10	0.5	0.16
WEST INT POND OUTFALL JCTN	0.0263	26.8	2.2			
24" DIA OUTFALL PIPE 1 -WEST	0.0263	26.7	2.2			
24" DIA OUTFALL PIPE 2 -WEST	0.0000	26.7	2.2			
24" DIA OUTFALL PIPE 1 -EAST	0.0549	24	1.6			
EAST INT POND OUTFALL JCTN	0.0549	24.6	1.6			
24" DIA OUTFALL PIPE 2 -EAST	0.0000	24	1.6			
36" DIA OUTFALL PIPE (EAST)	0.0549	47.4	3.2			
36" DIA OUTFALL PIPE (WEST)	0.0263	53.1	4.3			
UDCP GEOMEMBRANE	0.0029	11.7	0.7			
UDCP	0.0841	84.2	8.2	*4961.00*	32.0	10.43
UDCP OUTLET	0.0841	84.2	8.2			
WEST INT POND OVERFLOW	**0.0000**	**0**	**0.0**			
EAST CHNL 1 WATERSHED	0.0078	22.1	1.4			

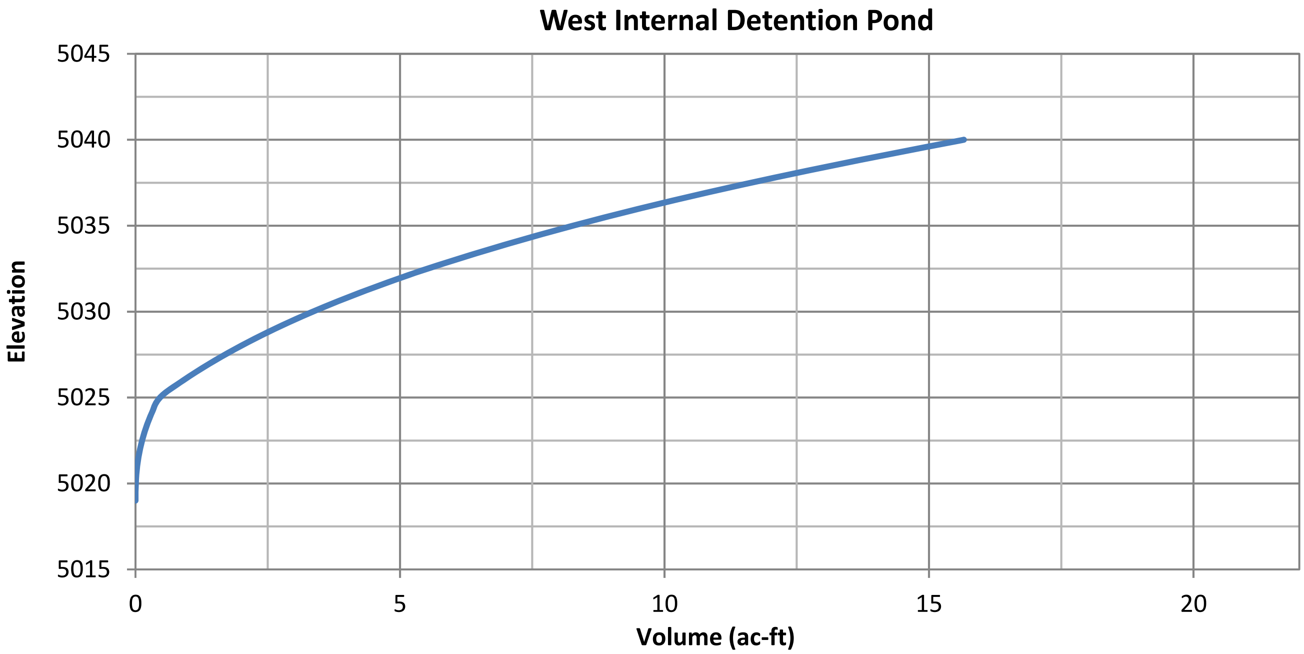
Note: Underdrain Collection Pond is assumed to be full, ponding to spillway, prior to storm event. Peak storage and discharge rate shown are through the UDCP spillway.

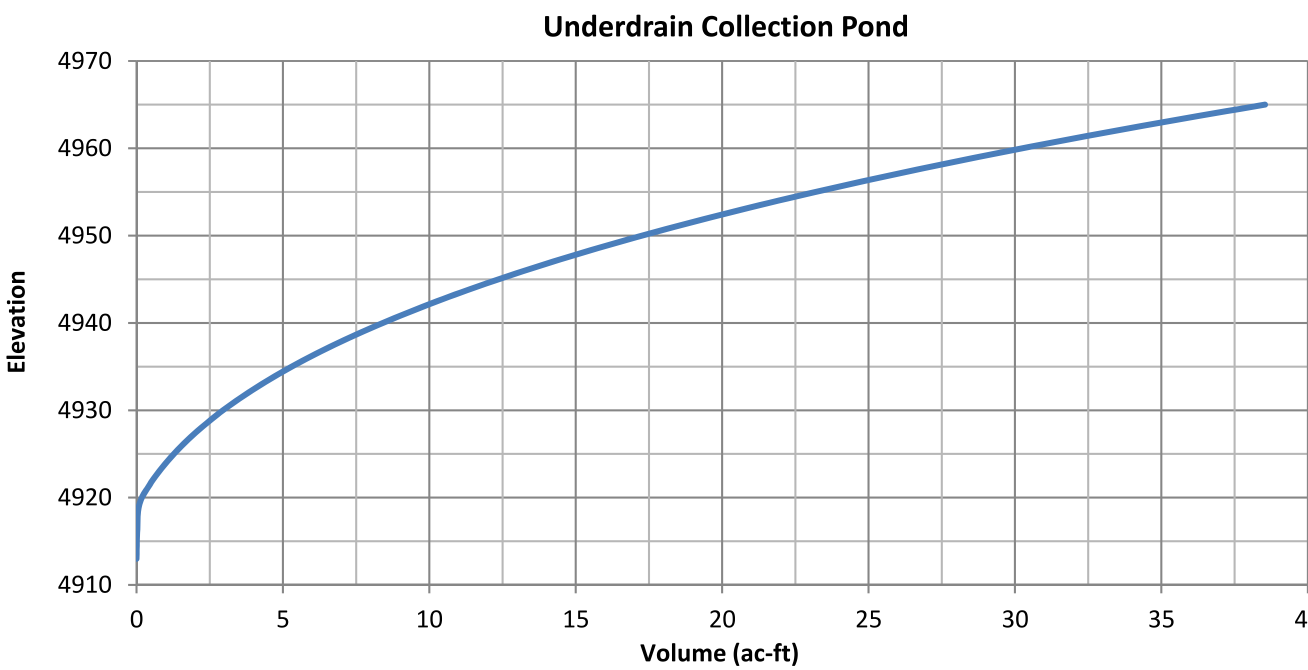
Arizona Mineral Inc.
Hermosa Lined TSF Design Amendment
Pond Filling Curves





Arizona Mineral Inc.
Hermosa Lined TSF Design Amendment
Pond Filling Curves





West Int TSF Channel (Haul Road Sta 0+00-9+50)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.071	
Channel Slope	0.13200	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	0.10	ft
Discharge	34.30	ft^3/s

Results

Normal Depth	1.49	ft
Flow Area	5.71	ft^2
Wetted Perimeter	8.13	ft
Hydraulic Radius	0.70	ft
Top Width	7.56	ft
Critical Depth	1.62	ft
Critical Slope	0.08662	ft/ft
Velocity	6.01	ft/s
Velocity Head	0.56	ft
Specific Energy	2.05	ft
Froude Number	1.22	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.49	ft
Critical Depth	1.62	ft
Channel Slope	0.13200	ft/ft
Critical Slope	0.08662	ft/ft

East Int TSF Channel (Haul Road Sta 9+50-21+50)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.047	
Channel Slope	0.00500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	0.10	ft
Discharge	34.90	ft³/s

Results

Normal Depth	2.39	ft
Flow Area	14.49	ft²
Wetted Perimeter	12.96	ft
Hydraulic Radius	1.12	ft
Top Width	12.04	ft
Critical Depth	1.63	ft
Critical Slope	0.03787	ft/ft
Velocity	2.41	ft/s
Velocity Head	0.09	ft
Specific Energy	2.48	ft
Froude Number	0.39	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.39	ft
Critical Depth	1.63	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.03787	ft/ft

East Int TSF Channel (Haul Road Sta 21+50-32+00)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.072	
Channel Slope	0.00500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	0.10	ft
Discharge	22.10	ft³/s

Results

Normal Depth	2.36	ft
Flow Area	14.17	ft²
Wetted Perimeter	12.81	ft
Hydraulic Radius	1.11	ft
Top Width	11.90	ft
Critical Depth	1.35	ft
Critical Slope	0.09444	ft/ft
Velocity	1.56	ft/s
Velocity Head	0.04	ft
Specific Energy	2.40	ft
Froude Number	0.25	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.36	ft
Critical Depth	1.35	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.09444	ft/ft

West Int TSF Channel (Haul Road Sta 32+00-44+00)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.064	
Channel Slope	0.01600	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	0.10	ft
Discharge	45.10	ft³/s

Results

Normal Depth	2.37	ft
Flow Area	14.32	ft²
Wetted Perimeter	12.88	ft
Hydraulic Radius	1.11	ft
Top Width	11.96	ft
Critical Depth	1.80	ft
Critical Slope	0.06787	ft/ft
Velocity	3.15	ft/s
Velocity Head	0.15	ft
Specific Energy	2.53	ft
Froude Number	0.51	
Flow Type	Subcritical	

GVF Input Data

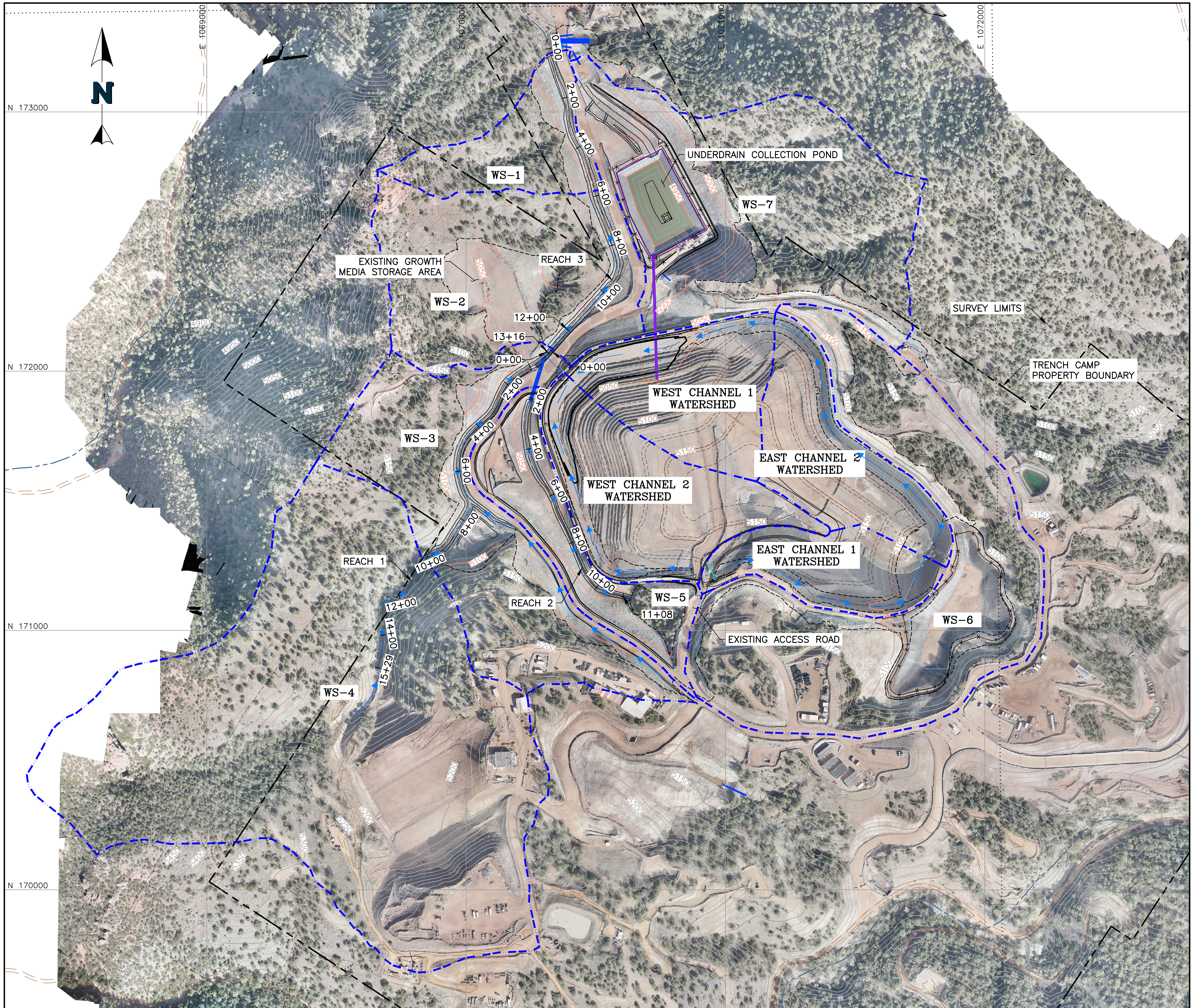
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.37	ft
Critical Depth	1.80	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.06787	ft/ft

APPENDIX E.3

Hydrology and Hydraulics (Closure)



LEGEND:

- EXISTING/CURRENT GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE
- WATERSHED BOUNDARY
- STORMWATER FLOW DIRECTION

0 200 400 FEET

WATERSHED INFORMATION	
WATERSHED	AREA (AC)
EAST CHANNEL 1 WS	5.0
EAST CHANNEL 2 WS	7.2
WEST CHANNEL 1 WS	7.6
WEST CHANNEL 2 WS	9.3
WS-1	5.0
WS-2	14.3
WS-3	16.1
WS-4	47.7
WS-5	6.5
WS-6	23.0
WS-7	21.5

NewFields

CLIENT: ARIZONA MINERALS INC.

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: TSF CLOSURE WATERSHED BOUNDARIES

FILENAME: 14.022.026F

FIGURE NO.: 2

REVISION: A

P:\Projects\0014.022 Hermosa VRP TSF Expansion\A-CAD\FIGS\14.022.026F.dwg-7/2/2020 2:32 PM

NewFields	CALCULATION COVER SHEET		
Client	Arizona Minerals Inc.	Preparer:	S. Breidt	05/22/20
Project	Hermosa Lined TSF Design Amendment	Checked:		
Title	TSF Hydrology	Revision		

CALCULATION OBJECTIVE

1. Model the TSF hydrology after TSF crest elevation increase and closure
2. Determine water elevation at TSF West Internal Detention Pond during extreme storm events.

ASSUMPTIONS

1. Pond filling curves were extracted from AutoCAD Civil 3D
2. Composite SCS Curve numbers are calculated based on ground type.

METHODOLOGY

1. Area and length measurements were determined using AutoCAD Civil 3D.
2. Storm event data was calculated by Ecological Resource Consultants.

REFERENCES

1. AutoCAD Civil 3D version 2018.
2. United States Department of Agriculture Natural Resources Conservation Service (NRCS). (1986). “Urban Hydrology for Small Watersheds, Technical Release 55 Second Edition,” June
3. U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). “Part 630 Hydrology National Engineering Handbook.” 210-vi, NEH, May 2010.
4. United Stated Department of Commerce, National Oceanic and Atmospheric Administration. (reprinted 1984). “Hydrometeorological Report No. 49, Probably Maximum Precipitation Estimates, Colorado River and Great Basin Drainages,” (HRM 49)
5. United States Army Corps of Engineers. Hydrologic Modeling System (HEC-HMS) Version 4.4, Computer Program (May 2020)

CONCLUSIONS

1. See attached pages for inputs and results.

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
Closure Hydrology
Lag Time Calculation

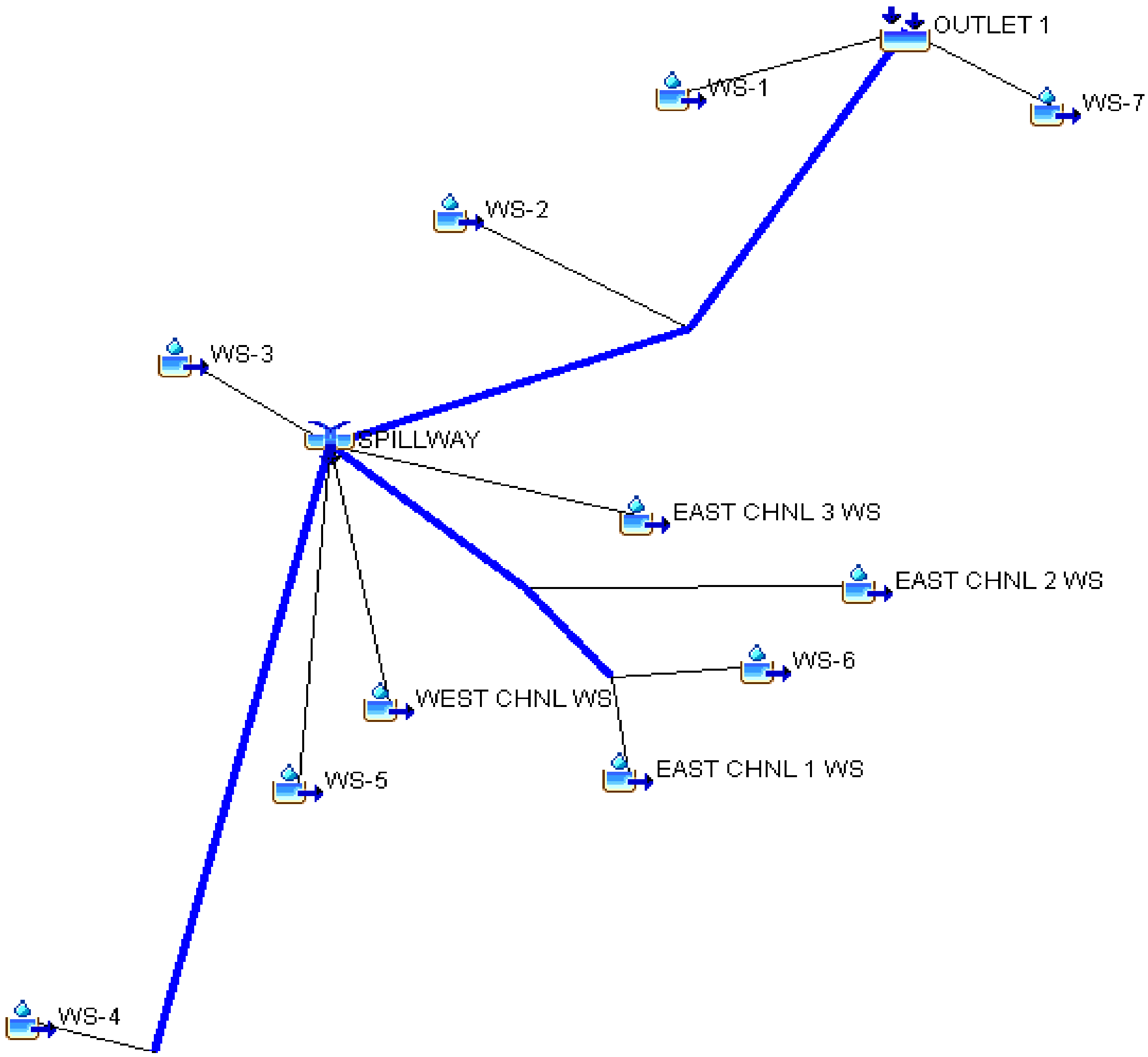
$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Ia	Initial Abstraction (0.2*S)
Input Values	

Lag Time and Watershed Characteristics								
Watershed	**Area (mi^2)**	**l (ft)**	**CN**	**y**	**S**	**t_p (hr)**	**t_p (min)**	**Ia**
EAST CHN 1 WS	0.0078	1,535	72	32.0%	3.89	0.10	6.0	0.78
EAST CHNL 2 WS	0.0112	1,906	72	33.2%	3.89	0.12	7.0	0.78
WEST CHNL 1 WS	0.0118	1,223	72	32.4%	3.89	0.08	5.0	0.78
WEST CHNL 2 WS	0.0145	604	72	29.5%	3.89	0.05	3.0	0.78
WS-1	0.0079	1,131	72	51.8%	3.89	0.06	3.7	0.78
WS-2	0.0223	1,343	72	48.1%	3.89	0.07	4.4	0.78
WS-3	0.0251	2,030	72	38.8%	3.89	0.11	6.8	0.78
WS-4	0.0745	2,072	72	36.3%	3.89	0.12	7.2	0.78
WS-5	0.0101	1,410	72	56.0%	3.89	0.07	4.2	0.78
WS-6	0.0360	1,459	72	34.7%	3.89	0.09	5.5	0.78
WS-7	0.0336	1,879	72	49.5%	3.89	0.09	5.7	0.78

Reach Data					
Reach	**Length**	**Slope**	**n**	**Type**	BW
RS -1	1,019	0.055	0.035	Trapezoidal	12.5
RS -2	714	0.102	0.035	Trapezoidal	12.5
RS - 3	559	0.09127	0.035	Trapezoidal	12.5

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
Closure Hydrology



NewFields

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
Closure Hydrology

100 Year-24 Hour Hec-HMS Results

Hydraulic Element	Drainage Area (Mi^2)	Peak Discharge (ft^3/s)	Discharged Volume (acre-ft)	Peak Storage Elev (ft)
WS-4	0.0745	125.1	8.4	
WS-6	0.0360	65.5	4.0	
EAST CHNL 1 WS	0.0078	13.9	0.9	
TSF CLOSURE CHNL 1	0.0438	76.7	4.9	
EAST CHNL 2 WS	0.0112	19	1.3	
TSF CLOSURE CHNL 2	0.0550	85.5	6.1	
WEST CHNL 2 WS	0.0145	28.8	1.6	
WEST CHNL 1 WS	0.0118	21.7	1.3	
CLOSURE SPILLWAY	**0.0813**	**108.6**	**9.1**	
RS-1	0.0745	115.6	8.4	
WS-3	0.0251	43.1	2.8	
WS-5	0.0101	18.7	1.1	
RS-2	0.1910	271.5	21.4	
WS-2	0.0223	41.4	2.5	
RS-3	0.2133	298.1	24.0	
WS-7	0.0336	60.7	3.8	
WS-1	0.0079	14.6	0.9	
OUTLET 1	0.2548	370.5	28.6	
SPILLWAY PONDING	0.0000	0	0.0	

Culvert Calculator Report
Hermosa Lined TSF Design Amendment Closure Culverts

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	5,029.63	ft	Headwater Depth/Height	1.21	
Computed Headwater Eleva	5,027.56	ft	Discharge	108.60	cfs
Inlet Control HW Elev.	5,026.76	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,027.56	ft	Control Type	Entrance Control	

Grades

Upstream Invert	5,023.33	ft	Downstream Invert	5,021.65	ft
Length	78.93	ft	Constructed Slope	0.021285	ft/ft

Hydraulic Profile

Profile	S2		Depth, Downstream	1.57	ft
Slope Type	Steep		Normal Depth	1.41	ft
Flow Regime	Supercritical		Critical Depth	2.31	ft
Velocity Downstream	12.93	ft/s	Critical Slope	0.004172	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties

Outlet Control HW Elev.	5,027.56	ft	Upstream Velocity Head	1.01	ft
Ke	0.90		Entrance Loss	0.91	ft

Inlet Control Properties

Inlet Control HW Elev.	5,026.76	ft	Flow Control	N/A	
Inlet Type	Groove end projecting		Area Full	19.2	ft²
K	0.00450		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	3	
C	0.03170		Equation Form	1	
Y	0.69000				

Hermosa Lined TSF Design Amend. Closure East Channel 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.049	
Channel Slope	0.01400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	13.90	ft^3/s

Results

Normal Depth	0.44	ft
Flow Area	7.06	ft^2
Wetted Perimeter	17.36	ft
Hydraulic Radius	0.41	ft
Top Width	17.19	ft
Critical Depth	0.29	ft
Critical Slope	0.05393	ft/ft
Velocity	1.97	ft/s
Velocity Head	0.06	ft
Specific Energy	0.50	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.44	ft
Critical Depth	0.29	ft
Channel Slope	0.01400	ft/ft
Critical Slope	0.05393	ft/ft

Hermosa Lined TSF Design Amend. Closure East Channel 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.067	
Channel Slope	0.08100	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	13.90	ft^3/s

Results

Normal Depth	0.31	ft
Flow Area	4.95	ft^2
Wetted Perimeter	16.69	ft
Hydraulic Radius	0.30	ft
Top Width	16.57	ft
Critical Depth	0.29	ft
Critical Slope	0.10083	ft/ft
Velocity	2.81	ft/s
Velocity Head	0.12	ft
Specific Energy	0.44	ft
Froude Number	0.91	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.31	ft
Critical Depth	0.29	ft
Channel Slope	0.08100	ft/ft
Critical Slope	0.10083	ft/ft

Hermosa Lined TSF Design Amend. Closure East Channel 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.039	
Channel Slope	0.00500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	76.70	ft³/s

Results

Normal Depth	1.40	ft
Flow Area	25.93	ft²
Wetted Perimeter	22.55	ft
Hydraulic Radius	1.15	ft
Top Width	22.01	ft
Critical Depth	0.89	ft
Critical Slope	0.02459	ft/ft
Velocity	2.96	ft/s
Velocity Head	0.14	ft
Specific Energy	1.54	ft
Froude Number	0.48	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.40	ft
Critical Depth	0.89	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02459	ft/ft

Hermosa Lined TSF Design Amend. Closure West Channel 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.048	
Channel Slope	0.15000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	85.50	ft³/s

Results

Normal Depth	0.63	ft
Flow Area	10.42	ft²
Wetted Perimeter	18.39	ft
Hydraulic Radius	0.57	ft
Top Width	18.14	ft
Critical Depth	0.95	ft
Critical Slope	0.03653	ft/ft
Velocity	8.21	ft/s
Velocity Head	1.05	ft
Specific Energy	1.68	ft
Froude Number	1.91	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.63	ft
Critical Depth	0.95	ft
Channel Slope	0.15000	ft/ft
Critical Slope	0.03653	ft/ft

Hermosa Lined TSF Design Amend. Closure West Channel 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.048	
Channel Slope	0.01500	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	85.50	ft³/s

Results

Normal Depth	1.23	ft
Flow Area	22.17	ft²
Wetted Perimeter	21.61	ft
Hydraulic Radius	1.03	ft
Top Width	21.14	ft
Critical Depth	0.95	ft
Critical Slope	0.03653	ft/ft
Velocity	3.86	ft/s
Velocity Head	0.23	ft
Specific Energy	1.46	ft
Froude Number	0.66	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.23	ft
Critical Depth	0.95	ft
Channel Slope	0.01500	ft/ft
Critical Slope	0.03653	ft/ft

Hermosa Lined TSF Design Amend. Closure West Channel 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.058	
Channel Slope	0.02400	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	28.80	ft³/s

Results

Normal Depth	0.64	ft
Flow Area	10.54	ft²
Wetted Perimeter	18.42	ft
Hydraulic Radius	0.57	ft
Top Width	18.18	ft
Critical Depth	0.47	ft
Critical Slope	0.06532	ft/ft
Velocity	2.73	ft/s
Velocity Head	0.12	ft
Specific Energy	0.75	ft
Froude Number	0.63	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.64	ft
Critical Depth	0.47	ft
Channel Slope	0.02400	ft/ft
Critical Slope	0.06532	ft/ft

Hermosa Lined TSF Design Amend. Closure West Channel 100yr-24hr

Project Description

Friction Method	Manning Formula	
Solve For	Normal Depth	

Input Data

Roughness Coefficient	0.065	
Channel Slope	0.19000	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	28.80	ft³/s

Results

Normal Depth	0.37	ft
Flow Area	5.87	ft²
Wetted Perimeter	16.99	ft
Hydraulic Radius	0.35	ft
Top Width	16.84	ft
Critical Depth	0.47	ft
Critical Slope	0.08204	ft/ft
Velocity	4.91	ft/s
Velocity Head	0.37	ft
Specific Energy	0.74	ft
Froude Number	1.47	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.37	ft
Critical Depth	0.47	ft
Channel Slope	0.19000	ft/ft
Critical Slope	0.08204	ft/ft

Hermosa Lined TSF Design Amend. Closure Spillway 100yr-24hr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.070	
Channel Slope	0.07300	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	15.00	ft
Discharge	108.60	ft^3/s

Results

Normal Depth	1.11	ft
Flow Area	19.73	ft^2
Wetted Perimeter	20.98	ft
Hydraulic Radius	0.94	ft
Top Width	20.55	ft
Critical Depth	1.10	ft
Critical Slope	0.07452	ft/ft
Velocity	5.51	ft/s
Velocity Head	0.47	ft
Specific Energy	1.58	ft
Froude Number	0.99	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.11	ft
Critical Depth	1.10	ft
Channel Slope	0.07300	ft/ft
Critical Slope	0.07452	ft/ft

HEC-15 RIPRAP DESIGN

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel East (1.4%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.014	ft/ft
Flow	Q	13.9	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.15**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	3.00	inch
	D_{75}	2.25	inch
	D_{50}	1.80	inch
	D_{30}	1.20	inch
	D_{15}	0.90	inch
	D_{10}	0.60	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**0.45**	ft
Area of Channel	A	7.26	ft^2
Wetted Perimeter	P	17.42	ft
Hydraulic Radius	R	0.42	ft
Wetted Top Width	T	17.25	ft
Calculated Average Flow Depth	D_a	0.42	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		2.804	
For $1.5 < D_a/D_{50} < 185$	n	0.049	
Q from mannings	Qi	14.45	ft^3/s
% Difference from Design Discharge		3.93%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.057	
function(Froude number)	f(Fr)	0.747	
Froude number	Fr	0.520	
Velocity of flow	V	**1.916**	
effective roughness concrentration	b	0.308	
Roughness element geometry	f(REG)	16.723	
Channel geometry	f(CG)	0.319	
Q from mannings	Qi	12.52	ft^3/s
% Difference from Design Discharge		-9.95%	

Step 5:		
If % difference is > 5%, estimate a new depth in Step 3	FALSE	Proceed to Step 6
For $0.3 < D_a/D_{50} < 1.5$	TRUE	
If false, proceed to step 6		

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	0.450		
Reynolds number	R_e	5.55E+03		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.047		
From Table 6.1	SF	1.000		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.08	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.025	0.892	(Linear Interpolation)
$\geq 2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	54.35%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42	°		
For 1.5 < Z < 5	K1	0.835			
	Θ	21.80	°		
	K2	0.83			
Stable D_{50}	$D_{50,s}$	0.08			
Difference to Chosen Riprap		54.56%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel East (8.1%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.081	ft/ft
Flow	Q	13.9	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.5**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	10.00	inch
	D_{75}	7.50	inch
	D_{50}	6.00	inch
	D_{30}	4.00	inch
	D_{15}	3.00	inch
	D_{10}	2.00	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**0.31**	ft
Area of Channel	A	4.89	ft^2
Wetted Perimeter	P	16.67	ft
Hydraulic Radius	R	0.29	ft
Wetted Top Width	T	16.55	ft
Calculated Average Flow Depth	D_a	0.30	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.591	
For $1.5 < D_a/D_{50} < 185$	n	0.203	
Q from mannings	Qi	4.52	ft^3/s
% Difference from Design Discharge		-67.49%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.067	
function(Froude number)	f(Fr)	1.443	
Froude number	Fr	0.921	
Velocity of flow	V	**2.842**	
effective roughness concrentration	b	0.152	
Roughness element geometry	f(REG)	4.070	
Channel geometry	f(CG)	0.542	
Q from mannings	Qi	13.60	ft^3/s
% Difference from Design Discharge		-2.16%	

Step 5:		
If % difference is > 5%, estimate a new depth in Step 3	TRUE	
For 0.3 < D_a/D_{50} < 1.5	FALSE	Proceed to Step 6
If false, proceed to step 6		

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	0.899		
Reynolds number	R_e	3.69E+04		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.047		
From Table 6.1	SF	1.000		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.32	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.045	0.990	(Linear Interpolation)
$\geq 2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	64.99%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42	°		
For 1.5 < Z < 5	K1	0.835			
	Θ	21.80	°		
	K2	0.83			
Stable D_{50}	$D_{50,s}$	0.33			
Difference to Chosen Riprap		65.23%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel East (0.5%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.005	ft/ft
Flow	Q	76.7	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.15**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	3.00	inch
	D_{75}	2.25	inch
	D_{50}	1.80	inch
	D_{30}	1.20	inch
	D_{15}	0.90	inch
	D_{10}	0.60	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**1.4**	ft
Area of Channel	A	25.90	ft^2
Wetted Perimeter	P	22.54	ft
Hydraulic Radius	R	1.15	ft
Wetted Top Width	T	22.00	ft
Calculated Average Flow Depth	D_a	1.18	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		7.848	
For $1.5 < D_a/D_{50} < 185$	n	0.039	
Q from mannings	Qi	77.06	ft^3/s
% Difference from Design Discharge		0.47%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.029	
function(Froude number)	f(Fr)	0.891	
Froude number	Fr	0.481	
Velocity of flow	V	**2.961**	
effective roughness concrentration	b	0.637	
Roughness element geometry	f(REG)	67.915	
Channel geometry	f(CG)	0.155	
Q from mannings	Qi	104.14	ft^3/s
% Difference from Design Discharge		35.77%	

Step 5:			
If % difference is > 5%, estimate a new depth in Step 3		FALSE	Proceed to Step 6
For 0.3 < D_a/D_{50} < 1.5		TRUE	
If false, proceed to step 6			

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	0.475		
Reynolds number	R_e	5.85E+03		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.047		
From Table 6.1	SF	1.000		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.09	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
≤ $4x10^4$	0.047	1	
$4x10^4$<Re<$2x10^5$	0.025	0.893	(Linear Interpolation)
≥ $2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	60.39%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42	°		
For 1.5 < Z < 5	K1	0.835			
	Θ	21.80	°		
	K2	0.83			
Stable D_{50}	$D_{50,s}$	0.09			
Difference to Chosen Riprap		60.62%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel West (15%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.15	ft/ft
Flow	Q	85.5	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**1**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	20.00	inch
	D_{75}	15.00	inch
	D_{50}	12.00	inch
	D_{30}	8.00	inch
	D_{15}	6.00	inch
	D_{10}	4.00	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**0.61**	ft
Area of Channel	A	10.08	ft^2
Wetted Perimeter	P	18.28	ft
Hydraulic Radius	R	0.55	ft
Wetted Top Width	T	18.05	ft
Calculated Average Flow Depth	D_a	0.56	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.558	
For $1.5 < D_a/D_{50} < 185$	n	0.257	
Q from mannings	Qi	15.25	ft^3/s
% Difference from Design Discharge		-82.17%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.048	
function(Froude number)	f(Fr)	1.897	
Froude number	Fr	2.000	
Velocity of flow	V	**8.482**	
effective roughness concrentration	b	0.191	
Roughness element geometry	f(REG)	5.136	
Channel geometry	f(CG)	0.514	
Q from mannings	Qi	82.25	ft^3/s
% Difference from Design Discharge		-3.80%	

Step 5:			
If % difference is > 5%, estimate a new depth in Step 3		TRUE	
For 0.3 < D_a/D_{50} < 1.5		FALSE	Proceed to Step 6
If false, proceed to step 6			

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	1.716		
Reynolds number	R_e	1.41E+05		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.112		
From Table 6.1	SF	1.316		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.65	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
≤ $4x10^4$	0.047	1	
$4x10^4$<Re<$2x10^5$	0.112	1.316	(Linear Interpolation)
≥ $2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	65.35%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42	°			
For 1.5 < Z < 5	K1	0.835				
	Θ	21.80	°			
	K2	0.83				
Stable D_{50}	$D_{50,s}$	0.66				
Difference to Chosen Riprap		65.60%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	8.53	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	24.83	°			
Shear Stress	τ	4.77	lb/ft^2			
Stability Number	η	0.41				
	Δ	1.48				
For S > 10%	D_{50}	0.97				
Difference to Chosen Riprap		97.00%		<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel West (1.5%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.015	ft/ft
Flow	Q	85.5	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.25**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	5.00	inch
	D_{75}	3.75	inch
	D_{50}	3.00	inch
	D_{30}	2.00	inch
	D_{15}	1.50	inch
	D_{10}	1.00	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**1.2**	ft
Area of Channel	A	21.60	ft^2
Wetted Perimeter	P	21.46	ft
Hydraulic Radius	R	1.01	ft
Wetted Top Width	T	21.00	ft
Calculated Average Flow Depth	D_a	1.03	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		4.114	
For $1.5 < D_a/D_{50} < 185$	n	0.048	
Q from mannings	Qi	82.15	ft^3/s
% Difference from Design Discharge		-3.92%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.040	
function(Froude number)	f(Fr)	0.837	
Froude number	Fr	0.688	
Velocity of flow	V	**3.958**	
effective roughness concrentration	b	0.484	
Roughness element geometry	f(REG)	33.942	
Channel geometry	f(CG)	0.232	
Q from mannings	Qi	98.89	ft^3/s
% Difference from Design Discharge		15.67%	

Step 5:		
If % difference is > 5%, estimate a new depth in Step 3	FALSE	Proceed to Step 6
For 0.3 < D_a/D_{50} < 1.5	TRUE	
If false, proceed to step 6		

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	0.761		
Reynolds number	R_e	1.56E+04		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.047		
From Table 6.1	SF	1.000		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.23	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.031	0.924	(Linear Interpolation)
$\geq 2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	93.17%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42	°		
For 1.5 < Z < 5	K1	0.835			
	Θ	21.80	°		
	K2	0.83			
Stable D_{50}	$D_{50,s}$	0.23			
Difference to Chosen Riprap		93.52%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel West (2.4%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.024	ft/ft
Flow	Q	28.8	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.25**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	5.00	inch
	D_{75}	3.75	inch
	D_{50}	3.00	inch
	D_{30}	2.00	inch
	D_{15}	1.50	inch
	D_{10}	1.00	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**0.62**	ft
Area of Channel	A	10.26	ft^2
Wetted Perimeter	P	18.34	ft
Hydraulic Radius	R	0.56	ft
Wetted Top Width	T	18.10	ft
Calculated Average Flow Depth	D_a	0.57	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		2.268	
For $1.5 < D_a/D_{50} < 185$	n	0.058	
Q from mannings	Qi	27.73	ft^3/s
% Difference from Design Discharge		-3.72%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.056	
function(Froude number)	f(Fr)	0.814	
Froude number	Fr	0.657	
Velocity of flow	V	**2.807**	
effective roughness concrentration	b	0.319	
Roughness element geometry	f(REG)	15.861	
Channel geometry	f(CG)	0.331	
Q from mannings	Qi	28.78	ft^3/s
% Difference from Design Discharge		-0.07%	

Step 5:			
If % difference is > 5%, estimate a new depth in Step 3		FALSE	Proceed to Step 6
For $0.3 < D_a/D_{50} < 1.5$		FALSE	
If false, proceed to step 6			

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	0.692		
Reynolds number	R_e	1.42E+04		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.047		
From Table 6.1	SF	1.000		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.19	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.030	0.919	(Linear Interpolation)
$\geq 2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	77.02%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42	°		
For 1.5 < Z < 5	K1	0.835			
	ϴ	21.80	°		
	K2	0.83			
Stable D_{50}	$D_{50,s}$	0.19			
Difference to Chosen Riprap		77.31%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Channel West (19%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.19	ft/ft
Flow*	Q	85.5	ft^3/s

**Note: the highest west channel peak flow was used for this section*

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**1**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	20.00	inch
	D_{75}	15.00	inch
	D_{50}	12.00	inch
	D_{30}	8.00	inch
	D_{15}	6.00	inch
	D_{10}	4.00	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**0.32**	ft
Area of Channel	A	5.06	ft^2
Wetted Perimeter	P	16.72	ft
Hydraulic Radius	R	0.30	ft
Wetted Top Width	T	16.60	ft
Calculated Average Flow Depth	D_a	0.30	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.305	
For $1.5 < D_a/D_{50} < 185$	n	-0.477	
Q from mannings	Qi	-3.10	ft^3/s
% Difference from Design Discharge		-103.62%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.018	
function(Froude number)	f(Fr)	7.412	
Froude number	Fr	5.400	
Velocity of flow	V	**16.911**	
effective roughness concrentration	b	0.121	
Roughness element geometry	f(REG)	2.633	
Channel geometry	f(CG)	0.616	
Q from mannings	Qi	82.52	ft^3/s
% Difference from Design Discharge		-3.49%	

Step 5:		
If % difference is > 5%, estimate a new depth in Step 3	TRUE	
For 0.3 < D_a/D_{50} < 1.5	FALSE	Proceed to Step 6
If false, proceed to step 6		

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	1.399		
Reynolds number	R_e	1.15E+05		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.095		
From Table 6.1	SF	1.234		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.48	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
≤ $4x10^4$	0.047	1	
$4x10^4$<Re<$2x10^5$	0.095	1.234	(Linear Interpolation)
≥ $2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	47.91%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42	°		
For 1.5 < Z < 5	K1	0.835			
	Θ	21.80	°		
	K2	0.83			
Stable D_{50}	$D_{50,s}$	0.48			
Difference to Chosen Riprap		48.09%	<	100%	TRUE

Step 9. Steep Grade Assessment					
Angle of Channel Bottom	α	10.76	°		
Angle b/t weight vector and the resultant in the plane of the side slope	β	19.78	°		
Shear Stress	τ	3.17	lb/ft^2		
Stability Number	η	0.32			
	Δ	1.40			
For S > 10%	D_{50}	0.67			
Difference to Chosen Riprap		67.12%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

Arizona Minerals Inc. **Hermosa Lined TSF Design Amendment** **Closure Spillway (7.3%) 100yr, 24hr storm**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	15	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.073	ft/ft
Flow*	Q	108.6	ft^3/s

**Note: the highest west channel peak flow was used for this section*

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**1**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	20.00	inch
	D_{75}	15.00	inch
	D_{50}	12.00	inch
	D_{30}	8.00	inch
	D_{15}	6.00	inch
	D_{10}	4.00	inch

Step 3: Estimate Flow Depth			
Initial Flow Depth Estimate	D_i	**1.1**	ft
Area of Channel	A	19.53	ft^2
Wetted Perimeter	P	20.92	ft
Hydraulic Radius	R	0.93	ft
Wetted Top Width	T	20.50	ft
Calculated Average Flow Depth	D_a	0.95	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.952	
For $1.5 < D_a/D_{50} < 185$	n	0.121	
Q from mannings	Qi	61.79	ft^3/s
% Difference from Design Discharge		-43.10%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.067	
function(Froude number)	f(Fr)	1.004	
Froude number	Fr	1.004	
Velocity of flow	V	**5.562**	
effective roughness concrentration	b	0.279	
Roughness element geometry	f(REG)	9.158	
Channel geometry	f(CG)	0.425	
Q from mannings	Qi	112.53	ft^3/s
% Difference from Design Discharge		3.62%	

Step 5:			
If % difference is > 5%, estimate a new depth in Step 3		TRUE	
For $0.3 < D_a/D_{50} < 1.5$		FALSE	Proceed to Step 6
If false, proceed to step 6			

Step 6: Calculate Reynolds and Determine Appropriate Shields Parameter & Safety Factor				
Shear Velocity	V_*	1.608		
Reynolds number	R_e	1.32E+05		
Gravity	g	32.2	ft/s^2	
Kinematic Viscosity	v	1.22E-05	ft^2/s	(1.217e-5 for 60 °F)
From Table 6.1	F_*	0.106		
From Table 6.1	SF	1.288		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.59	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.106	1.288	(Linear Interpolation)
$\geq 2x10^5$	0.15	1.5	

Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	59.17%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42	°			
For 1.5 < Z < 5	K1	0.835				
	ϴ	21.80	°			
	K2	0.83				
Stable D_{50}	$D_{50,s}$	0.59				
Difference to Chosen Riprap		59.39%		<	100%	TRUE

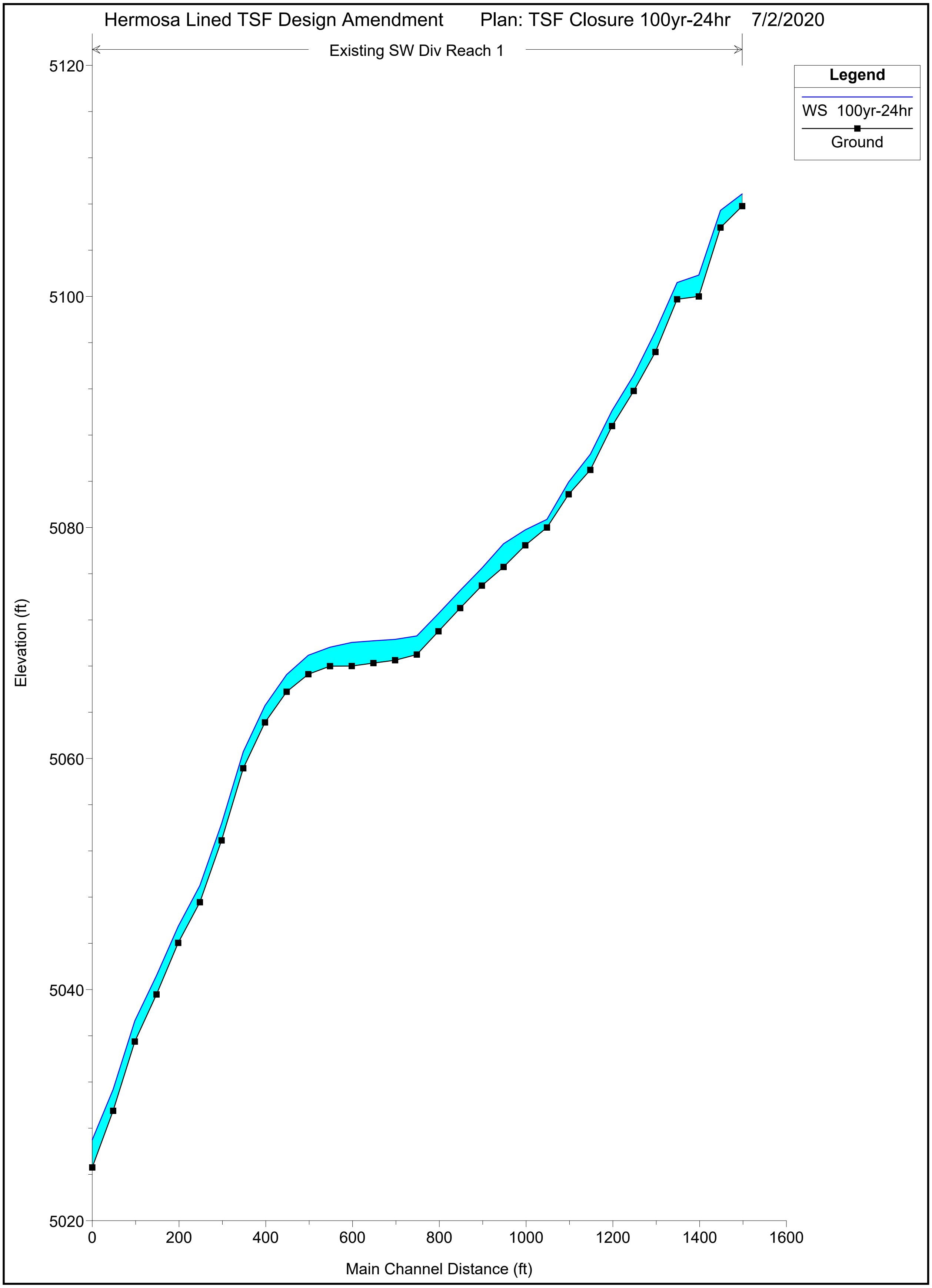
Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
100YR-24HR Closure HEC RAS Steady Flow Inputs

Channel	Station	Watershed	HEC-HMS	HEC HMS Flow Rate, cfs 100yr-24hr
Reach 1	15+00			93.825
Reach 1	10+50	WS-4	WS-4	125.1
Reach 1	1+00	WS-3	WS4+WS3	168.2
Reach 2	9+62	.5WS-5	WS-5	9.35
Reach 2	5+35	WS-5	WS-5	18.7
Reach 3	12+87	WS-3, WS -5, TSF	RS-2	271.5
Reach 3	5+95	WS-2	RS-3	298.1
Reach 3	0+24	WS-1	RS3+WS-1	312.7
Reach 3	0+00	Outlet	Outlet 1	370.5

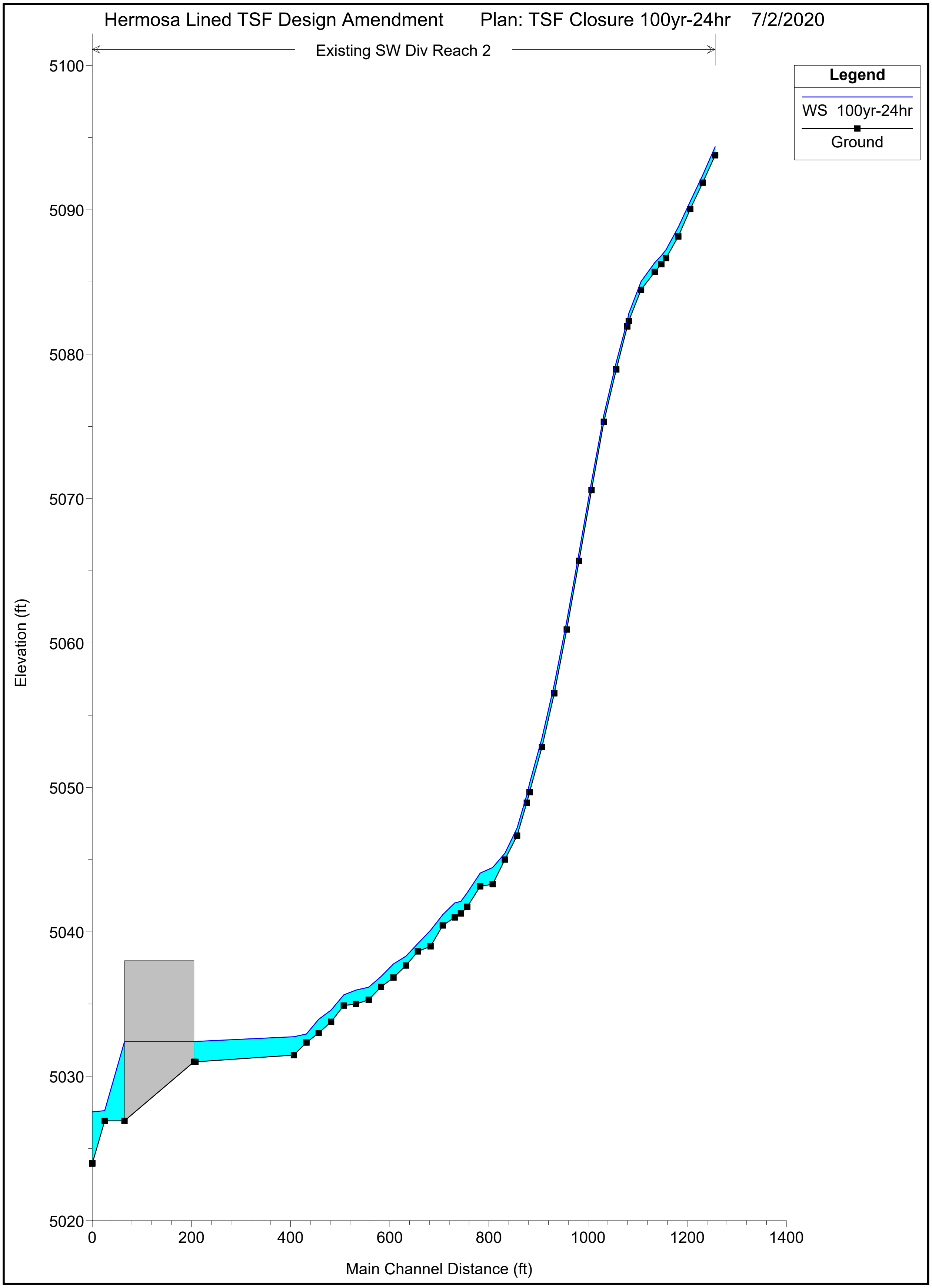
Reach Boundary Conditions

	R1	R2	R3
Upstream	0.038	0.063	0.15
Downstream	0.096	0.063	0.066

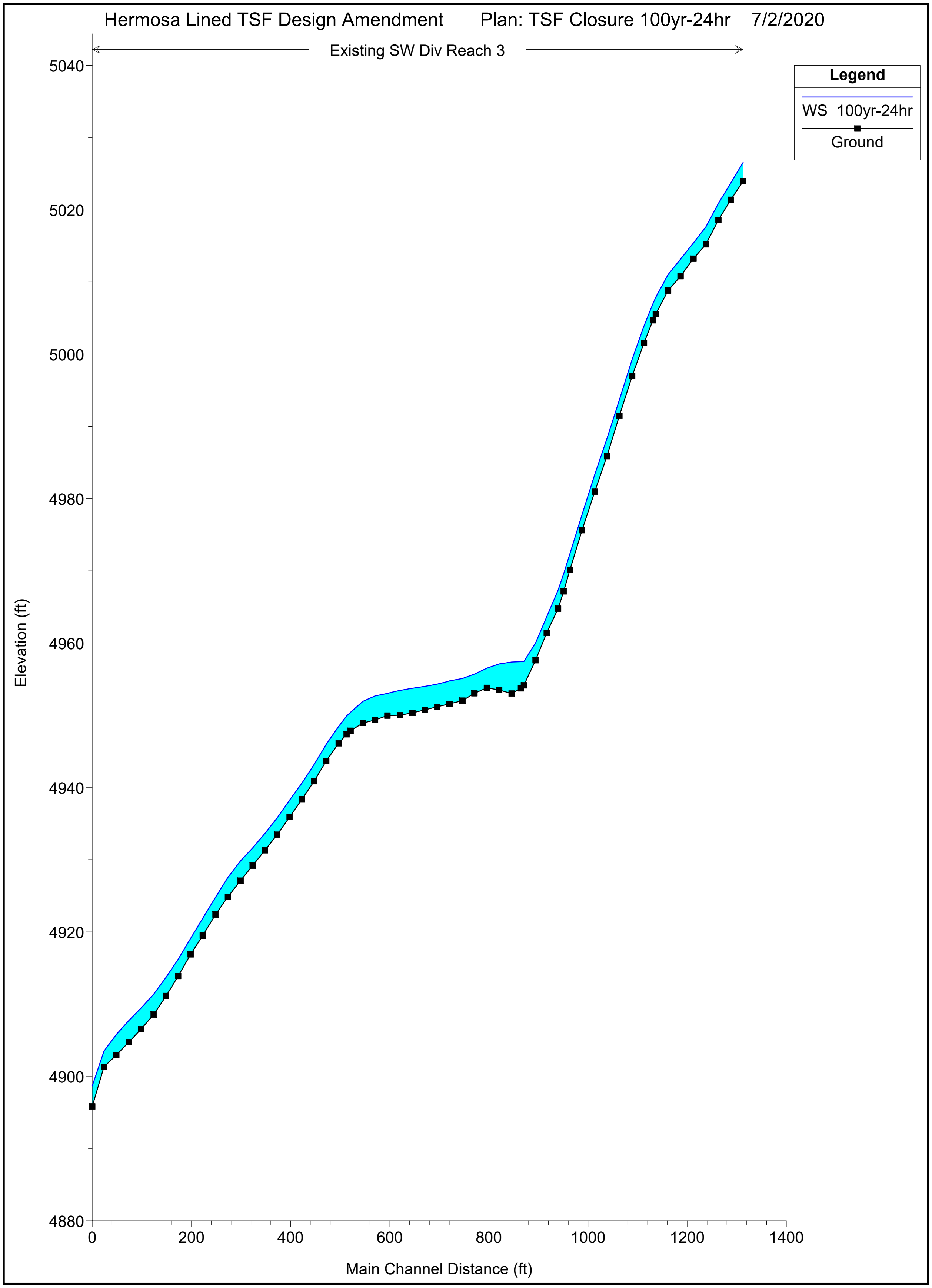
Junction at upstream DS reach is boundary condition



Hermosa Lined TSF Design Amendment
Plan: TSF Closure 100yr-24hr
7/2/2020
Existing SW Div Reach 1
Legend
WS 100yr-24hr
Ground
Elevation (ft)
5120
5100
5080
5060
5040
5020
0
200
400
600
800
1000
1200
1400
1600
Main Channel Distance (ft)



Hermosa Lined TSF Design Amendment Plan: TSF Closure 100yr-24hr 7/2/2020
Existing SW Div Reach 2
Legend
WS 100yr-24hr
Ground
Elevation (ft)
5100
5090
5080
5070
5060
5050
5040
5030
5020
0
200
400
600
800
1000
1200
1400
Main Channel Distance (ft)



Hermosa Lined TSF Design Amendment Plan: TSF Closure 100yr-24hr 7/2/2020
Existing SW Div Reach 3
Legend
WS 100yr-24hr
Ground
Elevation (ft)
5040
5020
5000
4980
4960
4940
4920
4900
4880
0
200
400
600
800
1000
1200
1400
Main Channel Distance (ft)

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
100YR-24HR Closure HEC RAS Results

River	Reach	River Sta	Profile	Q Total	Invert Slope	Min Ch El	W.S. Elev	Depth	E.G. Slope	Mann	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude #
				cfs	*ft/ft*	*ft*	*ft*	*ft*	*ft/ft*	n	*ft/s*	*sf*	*ft*	*ft*	
Existing SW Div Chnl	Reach 2	1084.77	100yr 24hr	9.35	0.0756	5093.77	5094.36	0.59	0.06	0.07	2.80	3.34	8.03	8.23	0.77
Existing SW Div Chnl	Reach 2	1059.77	100yr 24hr	9.35	0.0731	5091.88	5092.40	0.52	0.11	0.07	3.32	2.82	8.27	8.42	1.00
Existing SW Div Chnl	Reach 2	1034.73	100yr 24hr	9.35	0.0782	5090.05	5090.57	0.52	0.05	0.07	2.62	3.57	9.04	9.22	0.74
Existing SW Div Chnl	Reach 2	1010.45	100yr 24hr	9.35	0.0607	5088.15	5088.81	0.66	0.09	0.07	3.28	2.85	7.76	7.91	0.95
Existing SW Div Chnl	Reach 2	985.9	100yr 24hr	9.35	0.045	5086.66	5087.21	0.55	0.05	0.07	2.59	3.61	8.86	9	0.72
Existing SW Div Chnl	Reach 2	976.33	100yr 24hr	9.35	0.0397	5086.23	5087.00	0.77	0.02	0.07	1.74	5.37	9.76	10.03	0.41
Existing SW Div Chnl	Reach 2	962.97	100yr 24hr	18.7	0.045	5085.70	5086.61	0.91	0.03	0.07	2.75	6.81	10.17	10.47	0.59
Existing SW Div Chnl	Reach 2	935.41	100yr 24hr	18.7	0.087	5084.46	5085.23	0.77	0.08	0.07	3.79	4.93	9.51	9.75	0.93
Existing SW Div Chnl	Reach 2	910.58	100yr 24hr	18.7	0.1279	5082.30	5083.01	0.71	0.10	0.07	4.10	4.56	9.08	9.39	1.02
Existing SW Div Chnl	Reach 2	907.61	100yr 24hr	18.7	0.1344	5081.92	5082.52	0.60	0.10	0.07	4.15	4.51	8.66	8.96	1.01
Existing SW Div Chnl	Reach 2	885.44	100yr 24hr	18.7	0.1448	5078.94	5079.68	0.74	0.10	0.07	4.19	4.46	8.36	8.7	1.01
Existing SW Div Chnl	Reach 2	860.44	100yr 24hr	18.7	0.1896	5075.32	5076.02	0.70	0.09	0.07	4.28	4.37	7.78	8.14	1.01
Existing SW Div Chnl	Reach 2	835.44	100yr 24hr	18.7	0.1956	5070.58	5071.42	0.84	0.09	0.07	4.43	4.23	7.09	7.51	1.01
Existing SW Div Chnl	Reach 2	810.44	100yr 24hr	18.7	0.1904	5065.69	5066.53	0.84	0.09	0.07	4.44	4.21	6.95	7.4	1.01
Existing SW Div Chnl	Reach 2	785.44	100yr 24hr	18.7	0.1764	5060.93	5061.78	0.85	0.09	0.07	4.47	4.18	6.87	7.34	1.01
Existing SW Div Chnl	Reach 2	760.44	100yr 24hr	18.7	0.1493	5056.52	5057.40	0.88	0.09	0.07	4.47	4.19	6.9	7.35	1.01
Existing SW Div Chnl	Reach 2	735.45	100yr 24hr	18.7	0.1248	5052.79	5053.68	0.89	0.09	0.07	4.36	4.28	7.46	7.84	1.02
Existing SW Div Chnl	Reach 2	710.45	100yr 24hr	18.7	0.1304	5049.67	5050.49	0.82	0.09	0.07	4.18	4.47	8.48	8.75	1.01
Existing SW Div Chnl	Reach 2	704.85	100yr 24hr	18.7	0.1175	5048.94	5049.70	0.76	0.09	0.07	4.11	4.55	8.6	8.91	1.00
Existing SW Div Chnl	Reach 2	685.45	100yr 24hr	18.7	0.0672	5046.66	5047.40	0.74	0.05	0.07	3.26	5.74	9.8	10.06	0.75
Existing SW Div Chnl	Reach 2	660.76	100yr 24hr	18.7	0.0689	5045.00	5045.66	0.66	0.09	0.07	4.11	4.55	8.69	8.98	1.00
Existing SW Div Chnl	Reach 2	636.09	100yr 24hr	18.7	0.006	5043.30	5044.88	1.58	0.00	0.07	1.33	14.04	12.04	12.8	0.22
Existing SW Div Chnl	Reach 2	611.01	100yr 24hr	18.7	0.0539	5043.15	5044.34	1.19	0.07	0.07	4.47	4.36	6.87	5.54	0.89
Existing SW Div Chnl	Reach 2	584.84	100yr 24hr	18.7	0.0366	5041.74	5042.97	1.23	0.05	0.07	3.33	5.62	8.91	9.25	0.74
Existing SW Div Chnl	Reach 2	571.99	100yr 24hr	18.7	0.022	5041.27	5042.35	1.08	0.05	0.07	3.26	5.73	9.52	10.02	0.74
Existing SW Div Chnl	Reach 2	559.69	100yr 24hr	18.7	0.023	5041.00	5042.10	1.10	0.02	0.07	2.18	8.59	11.7	11.48	0.44
Existing SW Div Chnl	Reach 2	535.38	100yr 24hr	18.7	0.0588	5040.44	5041.19	0.75	0.10	0.07	3.66	5.1	12.29	12.45	1.00
Existing SW Div Chnl	Reach 2	510.89	100yr 24hr	18.7	0.014	5039.00	5040.11	1.11	0.02	0.07	1.96	9.53	15.6	15.95	0.44
Existing SW Div Chnl	Reach 2	485.25	100yr 24hr	18.7	0.0406	5038.64	5039.20	0.56	0.08	0.07	3.18	5.89	14.61	14.72	0.88
Existing SW Div Chnl	Reach 2	461.33	100yr 24hr	18.7	0.0331	5037.67	5038.32	0.65	0.02	0.07	2.15	8.72	16.4	16.62	0.52
Existing SW Div Chnl	Reach 2	435.95	100yr 24hr	18.7	0.026	5036.83	5037.77	0.94	0.02	0.07	2.01	9.29	16.43	16.64	0.47
Existing SW Div Chnl	Reach 2	410.91	100yr 24hr	18.7	0.0353	5036.18	5036.91	0.73	0.06	0.07	2.87	6.52	16.14	16.25	0.80
Existing SW Div Chnl	Reach 2	385.98	100yr 24hr	18.7	0.0118	5035.30	5036.17	0.87	0.02	0.07	1.98	9.43	16.51	16.7	0.46
Existing SW Div Chnl	Reach 2	360.64	100yr 24hr	18.7	0.0044	5035.00	5035.97	0.97	0.01	0.07	1.29	14.5	18.32	18.59	0.26
Existing SW Div Chnl	Reach 2	335.74	100yr 24hr	18.7	0.0439	5034.89	5035.63	0.74	0.03	0.07	2.45	7.63	15.26	15.43	0.61
Existing SW Div Chnl	Reach 2	310.24	100yr 24hr	18.7	0.0312	5033.77	5034.58	0.81	0.05	0.07	2.78	6.73	14.38	14.54	0.72
Existing SW Div Chnl	Reach 2	285.22	100yr 24hr	18.7	0.0267	5032.99	5033.94	0.95	0.02	0.07	1.92	9.73	17.23	17.44	0.45
Existing SW Div Chnl	Reach 2	260.47	100yr 24hr	18.7	0.0343	5032.33	5032.92	0.59	0.10	0.07	3.42	5.47	15.09	15.16	1.00
Existing SW Div Chnl	Reach 2	235.1	100yr 24hr	18.7	0.0023	5031.46	5032.73	1.27	0.00	0.07	1.00	18.76	18.99	19.48	0.18
Existing SW Div Chnl	Reach 2	210.11	100yr 24hr	18.7	0	5031.00	5032.41	1.41	0.00	0.07	0.83	22.61	19.18	19.79	0.13
Existing SW Div Chnl	Reach 2	209.85	100yr 24hr	18.7	0.0225	5031.00	5032.40	1.40	0.00	0.07	0.99	18.88	19.26	13.54	0.15
Existing SW Div Chnl	Reach 2	205	100yr 24hr	Inl Struct				0.00							

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River	Reach	River Sta	Profile	Q Total	Invert Slope	Min Ch El	W.S. Elev	Depth	E.G. Slope	Mann	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude #
				cfs	*ft/ft*	*ft*	*ft*	*ft*	*ft/ft*	n	*ft/s*	*sf*	*ft*	*ft*	
Existing SW Div Chnl	Reach 2	35	100yr 24hr	18.7	0.1176	5026.91	5027.62	0.71	0.02	0.03	3.43	5.45	15.43	15.61	1.02
Existing SW Div Chnl	Reach 2	9.85	100yr 24hr	18.7	0.143	5023.97	5027.53	3.56	0.00	0.03	0.33	57.53	23.79	25.45	0.04
Existing SW Div Chnl	Reach 2	9.71	100yr 24hr	18.7	0	5023.95	5027.53	3.58	0.00	0.03	0.32	57.93	23.85	25.53	0.04
Existing SW Div Chnl	Reach 3	1312.84	100yr 24hr	271.5	0.1028	5023.95	5026.55	2.60	0.01	0.03	7.57	35.85	20.22	21.37	1.00
Existing SW Div Chnl	Reach 3	1287.94	100yr 24hr	271.5	0.1136	5021.39	5023.71	2.32	0.01	0.03	7.60	35.71	20.09	21.25	1.01
Existing SW Div Chnl	Reach 3	1263.02	100yr 24hr	271.5	0.1326	5018.56	5020.88	2.32	0.01	0.03	7.58	35.83	20.3	21.36	1.01
Existing SW Div Chnl	Reach 3	1237.76	100yr 24hr	271.5	0.0794	5015.21	5017.65	2.44	0.01	0.03	7.41	36.66	21.75	22.71	1.01
Existing SW Div Chnl	Reach 3	1212.82	100yr 24hr	271.5	0.0923	5013.23	5015.41	2.18	0.01	0.03	7.39	36.73	21.87	22.83	1.01
Existing SW Div Chnl	Reach 3	1186.6	100yr 24hr	271.5	0.08	5010.81	5013.17	2.36	0.01	0.03	7.38	36.78	22.06	22.96	1.01
Existing SW Div Chnl	Reach 3	1161.61	100yr 24hr	271.5	0.1303	5008.81	5011.03	2.22	0.01	0.03	7.34	36.98	22.31	23.17	1.01
Existing SW Div Chnl	Reach 3	1136.74	100yr 24hr	271.5	0.1552	5005.57	5007.89	2.32	0.01	0.03	7.34	36.98	22.17	23.05	1.00
Existing SW Div Chnl	Reach 3	1131.07	100yr 24hr	271.5	0.1732	5004.69	5006.99	2.30	0.01	0.03	7.37	36.84	22.19	23.05	1.01
Existing SW Div Chnl	Reach 3	1113	100yr 24hr	271.5	0.1912	5001.56	5003.93	2.37	0.01	0.03	7.30	37.18	22.7	23.53	1.01
Existing SW Div Chnl	Reach 3	1089.05	100yr 24hr	271.5	0.2149	4996.98	4999.32	2.34	0.01	0.03	7.28	37.31	23.18	23.97	1.01
Existing SW Div Chnl	Reach 3	1063.41	100yr 24hr	271.5	0.2222	4991.47	4993.68	2.21	0.01	0.03	7.28	37.3	22.82	23.64	1.00
Existing SW Div Chnl	Reach 3	1038.25	100yr 24hr	271.5	0.1994	4985.88	4988.30	2.42	0.01	0.03	7.37	36.86	22.15	23.03	1.01
Existing SW Div Chnl	Reach 3	1013.53	100yr 24hr	271.5	0.2091	4980.95	4983.33	2.38	0.01	0.03	7.25	37.47	23.18	23.95	1.00
Existing SW Div Chnl	Reach 3	987.99	100yr 24hr	271.5	0.2233	4975.61	4977.78	2.17	0.01	0.03	7.20	37.7	23.65	24.38	1.01
Existing SW Div Chnl	Reach 3	963.49	100yr 24hr	271.5	0.24	4970.14	4972.39	2.25	0.01	0.03	7.25	37.45	23.37	24.14	1.01
Existing SW Div Chnl	Reach 3	951.03	100yr 24hr	271.5	0.2124	4967.15	4969.59	2.44	0.01	0.03	7.44	36.5	21.63	22.53	1.01
Existing SW Div Chnl	Reach 3	939.73	100yr 24hr	271.5	0.1453	4964.75	4967.34	2.59	0.06	0.07	7.49	36.24	20.93	21.91	1.00
Existing SW Div Chnl	Reach 3	916.68	100yr 24hr	271.5	0.1684	4961.40	4963.64	2.24	0.06	0.07	7.49	36.24	21.23	22.22	1.01
Existing SW Div Chnl	Reach 3	894.18	100yr 24hr	271.5	0.1473	4957.61	4960.01	2.40	0.06	0.07	7.43	36.55	21.68	22.64	1.01
Existing SW Div Chnl	Reach 3	870.63	100yr 24hr	271.5	0.0696	4954.14	4957.43	3.29	0.03	0.07	5.71	47.82	23.59	22.89	0.68
Existing SW Div Chnl	Reach 3	864.74	100yr 24hr	271.5	0.0389	4953.73	4957.41	3.68	0.01	0.07	4.87	57.66	25.03	21.28	0.52
Existing SW Div Chnl	Reach 3	845.97	100yr 24hr	271.5	-0.0196	4953.00	4957.36	4.36	0.01	0.07	3.69	80.88	28.81	19.32	0.34
Existing SW Div Chnl	Reach 3	820.99	100yr 24hr	271.5	-0.0119	4953.49	4957.10	3.61	0.01	0.07	4.32	68.96	28.12	18.69	0.43
Existing SW Div Chnl	Reach 3	795.9	100yr 24hr	271.5	0.0301	4953.79	4956.51	2.72	0.02	0.07	5.80	50.65	26.09	18.3	0.65
Existing SW Div Chnl	Reach 3	771	100yr 24hr	271.5	0.042	4953.04	4955.69	2.65	0.04	0.07	6.02	45.09	26.62	27.41	0.82
Existing SW Div Chnl	Reach 3	746.73	100yr 24hr	271.5	0.017	4952.02	4955.08	3.06	0.02	0.07	5.38	52.48	26.07	21.34	0.61
Existing SW Div Chnl	Reach 3	720.82	100yr 24hr	271.5	0.0168	4951.58	4954.75	3.17	0.01	0.07	4.43	62.43	28.71	25.46	0.50
Existing SW Div Chnl	Reach 3	695.88	100yr 24hr	271.5	0.0168	4951.16	4954.32	3.16	0.02	0.07	4.62	58.79	28.17	29.2	0.56
Existing SW Div Chnl	Reach 3	670.86	100yr 24hr	271.5	0.0165	4950.74	4953.99	3.25	0.01	0.07	4.31	64.73	28.57	24.44	0.47
Existing SW Div Chnl	Reach 3	646	100yr 24hr	271.5	0.013	4950.33	4953.71	3.38	0.01	0.07	4.15	66.1	28.95	26.8	0.46
Existing SW Div Chnl	Reach 3	620.69	100yr 24hr	271.5	0.0024	4950.00	4953.45	3.45	0.01	0.07	4.03	68.8	27.83	24.6	0.42
Existing SW Div Chnl	Reach 3	595.52	100yr 24hr	298.1	0.0242	4949.94	4953.02	3.08	0.02	0.07	4.89	62.71	27.81	23.74	0.53
Existing SW Div Chnl	Reach 3	570.68	100yr 24hr	298.1	0.017	4949.34	4952.68	3.34	0.01	0.07	4.64	65.09	28.47	26.1	0.51
Existing SW Div Chnl	Reach 3	545.97	100yr 24hr	298.1	0.0434	4948.92	4951.92	3.00	0.04	0.07	5.89	50.61	27.51	28.34	0.77
Existing SW Div Chnl	Reach 3	521.09	100yr 24hr	298.1	0.0601	4947.84	4950.40	2.56	0.06	0.07	7.44	40.06	23.78	24.61	1.01
Existing SW Div Chnl	Reach 3	513.1	100yr 24hr	298.1	0.0793	4947.36	4949.90	2.54	0.01	0.03	7.47	39.93	23.39	24.28	1.01
Existing SW Div Chnl	Reach 3	497.21	100yr 24hr	298.1	0.0967	4946.10	4948.46	2.36	0.01	0.03	7.54	39.56	22.85	23.81	1.01
Existing SW Div Chnl	Reach 3	472.07	100yr 24hr	298.1	0.1157	4943.67	4945.98	2.31	0.01	0.03	7.41	40.25	23.74	24.56	1.00

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River	Reach	River Sta	Profile	Q Total *cfs*	Invert Slope *ft/ft*	Min Ch El *ft*	W.S. Elev *ft*	Depth *ft*	E.G. Slope *ft/ft*	Mann n	Vel Chnl *ft/s*	Flow Area *sf*	Top Width *ft*	W.P. Channel *ft*	Froude #
Existing SW Div Chnl	Reach 3	447.7	100yr 24hr	298.1	0.101	4940.85	4943.19	2.34	0.01	0.03	7.45	40	23.65	24.47	1.01
Existing SW Div Chnl	Reach 3	423.24	100yr 24hr	298.1	0.0989	4938.38	4940.63	2.25	0.01	0.03	7.50	39.75	23.16	24.06	1.01
Existing SW Div Chnl	Reach 3	398.16	100yr 24hr	298.1	0.0981	4935.90	4938.25	2.35	0.01	0.03	7.39	40.33	23.13	24.04	0.99
Existing SW Div Chnl	Reach 3	373.19	100yr 24hr	298.1	0.0873	4933.45	4935.79	2.34	0.01	0.03	7.52	39.66	22.73	23.66	1
Existing SW Div Chnl	Reach 3	348.45	100yr 24hr	298.1	0.0855	4931.29	4933.64	2.35	0.01	0.03	7.40	40.26	23.3	24.21	0.99
Existing SW Div Chnl	Reach 3	323.65	100yr 24hr	298.1	0.0849	4929.17	4931.61	2.44	0.01	0.03	7.64	39.01	21.76	22.88	1.01
Existing SW Div Chnl	Reach 3	299.15	100yr 24hr	298.1	0.088	4927.09	4929.83	2.74	0.01	0.03	7.59	39.27	21.23	22.35	0.98
Existing SW Div Chnl	Reach 3	273.59	100yr 24hr	298.1	0.0981	4924.84	4927.52	2.68	0.01	0.03	7.48	39.85	22.22	23.19	0.98
Existing SW Div Chnl	Reach 3	248.72	100yr 24hr	298.1	0.114	4922.40	4924.78	2.38	0.01	0.03	7.52	39.66	21.83	22.88	0.98
Existing SW Div Chnl	Reach 3	223.02	100yr 24hr	298.1	0.1064	4919.47	4921.89	2.42	0.01	0.03	7.33	40.66	23.56	24.45	0.98
Existing SW Div Chnl	Reach 3	198.58	100yr 24hr	298.1	0.1188	4916.87	4919.10	2.23	0.01	0.03	7.25	41.14	24.55	25.43	0.99
Existing SW Div Chnl	Reach 3	173.4	100yr 24hr	298.1	0.1139	4913.88	4916.21	2.33	0.01	0.03	7.30	40.82	25.13	25.94	1.01
Existing SW Div Chnl	Reach 3	149.16	100yr 24hr	298.1	0.1021	4911.12	4913.71	2.59	0.06	0.07	7.42	40.19	23.82	24.7	1.01
Existing SW Div Chnl	Reach 3	123.9	100yr 24hr	298.1	0.0798	4908.54	4911.36	2.82	0.07	0.07	7.81	38.15	22	22.96	1.05
Existing SW Div Chnl	Reach 3	98.34	100yr 24hr	298.1	0.0732	4906.50	4909.43	2.93	0.07	0.07	7.94	37.54	20.62	21.73	1.04
Existing SW Div Chnl	Reach 3	73.89	100yr 24hr	298.1	0.0711	4904.71	4907.70	2.99	0.06	0.07	7.74	38.51	20.46	21.63	0.99
Existing SW Div Chnl	Reach 3	48.72	100yr 24hr	298.1	0.0649	4902.92	4905.79	2.87	0.06	0.07	7.80	38.2	19.77	21.02	0.99
Existing SW Div Chnl	Reach 3	23.92	100yr 24hr	312.7	0.231	4901.31	4903.48	2.17	0.06	0.07	7.14	44.4	30.03	27.01	0.99
Existing SW Div Chnl	Reach 3	0.15	100yr 24hr	370.5		4895.82	4898.66	2.84	0.06	0.07	7.66	48.37	26.55	27.37	1
Existing SW Div Chnl	Reach 1	1500	100yr 24hr	93.83	0.037	5107.81	5108.87	1.06	0.01	0.03	5.09	18.43	23.06	23.28	1
Existing SW Div Chnl	Reach 1	1450	100yr 24hr	93.83	0.1192	5105.96	5107.45	1.49	0.01	0.03	5.33	17.59	20.61	20.86	1.02
Existing SW Div Chnl	Reach 1	1400	100yr 24hr	93.83	0.005	5100.00	5101.85	1.85	0.01	0.03	5.20	18.03	15.77	16.3	0.86
Existing SW Div Chnl	Reach 1	1350	100yr 24hr	93.83	0.0912	5099.75	5101.19	1.44	0.01	0.03	5.62	16.68	17.37	17.7	1.01
Existing SW Div Chnl	Reach 1	1300	100yr 24hr	93.83	0.0676	5095.19	5096.96	1.77	0.01	0.03	5.82	16.13	15.52	15.98	1.01
Existing SW Div Chnl	Reach 1	1250	100yr 24hr	93.83	0.0606	5091.81	5093.18	1.37	0.01	0.03	5.31	17.65	20.48	20.71	1.01
Existing SW Div Chnl	Reach 1	1200	100yr 24hr	93.83	0.076	5088.78	5090.11	1.33	0.01	0.03	5.20	18.05	21.66	21.87	1
Existing SW Div Chnl	Reach 1	1150	100yr 24hr	93.83	0.0422	5084.98	5086.34	1.36	0.01	0.03	5.69	16.5	16.52	16.91	1
Existing SW Div Chnl	Reach 1	1100	100yr 24hr	93.83	0.0574	5082.87	5083.93	1.06	0.01	0.03	4.90	19.14	25.71	25.86	1
Existing SW Div Chnl	Reach 1	1050	100yr 24hr	125.1	0.0308	5080.00	5080.71	0.71	0.02	0.03	4.44	28.18	46.97	47.04	1.01
Existing SW Div Chnl	Reach 1	1000	100yr 24hr	125.1	0.0376	5078.46	5079.79	1.33	0.02	0.03	4.79	26.12	37.76	37.98	1.02
Existing SW Div Chnl	Reach 1	950	100yr 24hr	125.1	0.0322	5076.58	5078.60	2.02	0.01	0.03	6.18	20.25	17.39	17.9	1.01
Existing SW Div Chnl	Reach 1	900	100yr 24hr	125.1	0.039	5074.97	5076.48	1.51	0.01	0.03	5.92	21.13	19.52	20.01	1
Existing SW Div Chnl	Reach 1	850	100yr 24hr	125.1	0.0402	5073.02	5074.55	1.53	0.01	0.03	5.94	21.07	19.4	19.95	1
Existing SW Div Chnl	Reach 1	800	100yr 24hr	125.1	0.0402	5071.01	5072.55	1.54	0.01	0.03	5.97	20.96	19.31	19.86	1.01
Existing SW Div Chnl	Reach 1	750	100yr 24hr	125.1	0.0098	5069.00	5070.61	1.61	0.01	0.03	5.70	21.95	18.71	19.25	0.93
Existing SW Div Chnl	Reach 1	700	100yr 24hr	125.1	0.005	5068.51	5070.31	1.80	0.01	0.03	4.71	26.56	19.93	20.56	0.72
Existing SW Div Chnl	Reach 1	650	100yr 24hr	125.1	0.0052	5068.26	5070.19	1.93	0.00	0.03	3.66	34.23	21.86	22.72	0.52
Existing SW Div Chnl	Reach 1	600	100yr 24hr	125.1	0.0002	5068.00	5070.05	2.05	0.00	0.03	3.57	35.02	21.01	22.02	0.49
Existing SW Div Chnl	Reach 1	550	100yr 24hr	125.1	0.0138	5067.99	5069.64	1.65	0.01	0.03	4.93	25.37	18.64	19.44	0.75
Existing SW Div Chnl	Reach 1	500	100yr 24hr	125.1	0.0304	5067.30	5068.94	1.64	0.01	0.03	6.18	20.24	17.32	17.86	1.01
Existing SW Div Chnl	Reach 1	450	100yr 24hr	125.1	0.0532	5065.78	5067.26	1.48	0.01	0.03	6.03	20.73	18.6	19.12	1.01
Existing SW Div Chnl	Reach 1	400	100yr 24hr	125.1	0.0794	5063.12	5064.58	1.46	0.01	0.03	6.05	20.66	18.26	18.88	1

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
100YR-24HR Closure HEC RAS Results

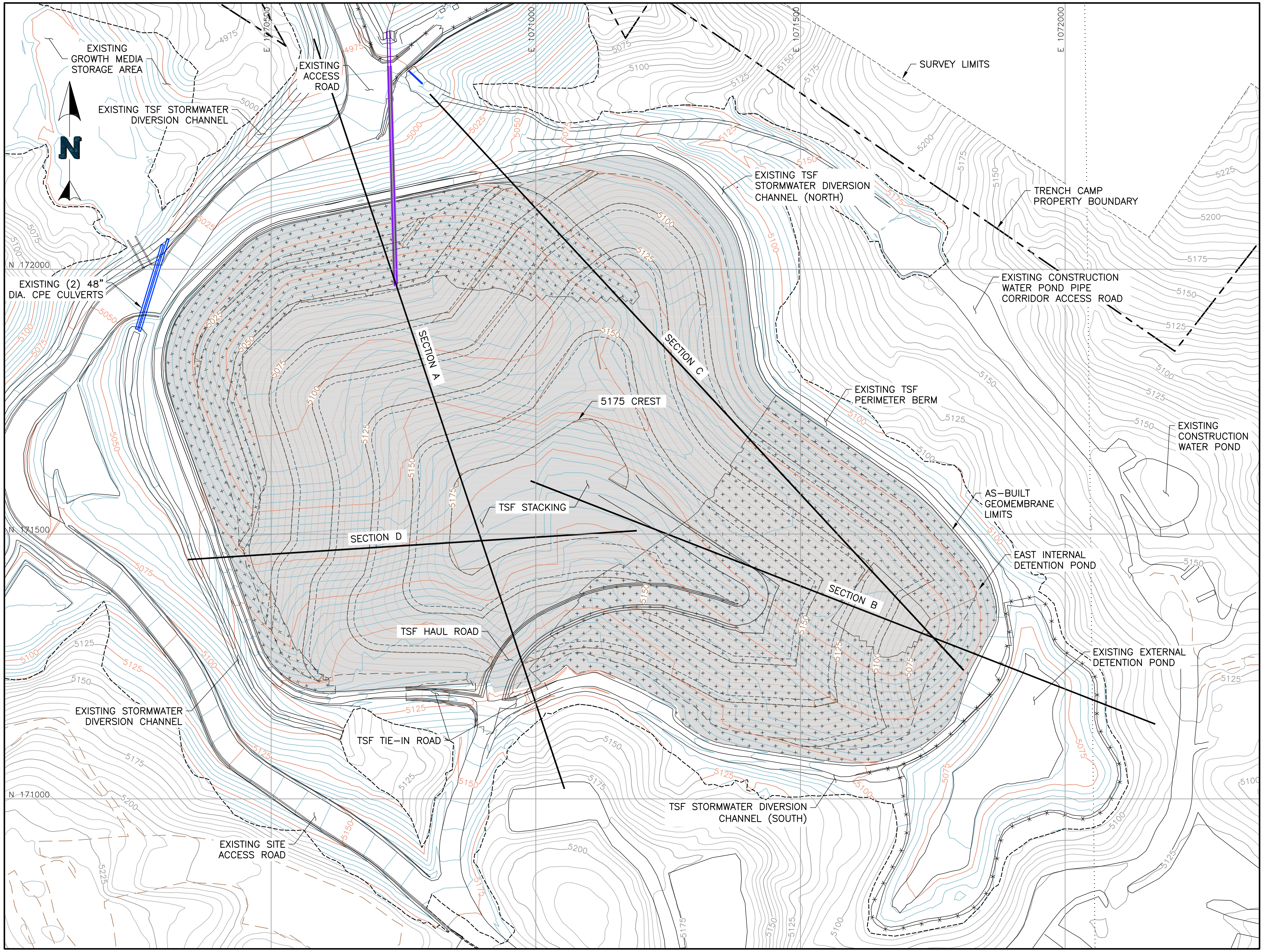
River	Reach	River Sta	Profile	Q Total *cfs*	Invert Slope *ft/ft*	Min Ch El *ft*	W.S. Elev *ft*	Depth *ft*	E.G. Slope *ft/ft*	Mann **n**	Vel Chnl *ft/s*	Flow Area *sf*	Top Width *ft*	W.P. Channel *ft*	Froude #
Existing SW Div Chnl	Reach 1	350	100yr 24hr	125.1	0.1246	5059.15	5060.59	1.44	0.01	0.03	6.10	20.52	17.79	18.43	1
Existing SW Div Chnl	Reach 1	300	100yr 24hr	125.1	0.1072	5052.92	5054.37	1.45	0.01	0.03	6.14	20.38	17.56	18.18	1
Existing SW Div Chnl	Reach 1	250	100yr 24hr	125.1	0.0704	5047.56	5049.01	1.45	0.01	0.03	6.15	20.35	17.57	18.23	1.01
Existing SW Div Chnl	Reach 1	200	100yr 24hr	125.1	0.0892	5044.04	5045.47	1.43	0.01	0.03	5.95	21.04	19.17	19.75	1
Existing SW Div Chnl	Reach 1	150	100yr 24hr	125.1	0.0816	5039.58	5041.21	1.63	0.01	0.03	6.09	20.54	18.18	18.71	1.01
Existing SW Div Chnl	Reach 1	100	100yr 24hr	168.2	0.1198	5035.50	5037.30	1.80	0.01	0.03	6.59	25.54	19.25	19.93	1.01
Existing SW Div Chnl	Reach 1	50	100yr 24hr	168.2	0.1021	5029.51	5031.35	1.84	0.01	0.03	6.64	25.33	18.63	19.35	1
Existing SW Div Chnl	Reach 1	2	100yr 24hr	168.2	0	5024.61	5027.00	2.39	0.01	0.03	5.59	30.06	19.21	20.2	0.79

Arizona Minerals Inc.
Hermosa Lined TSF Design Amendment
TSF Closure Channel Summary

Watershed	Approximate Station	Channel Slope		Riprap D50 (in)	Manning's n	100YR 24HR	
		Scenario	%			Q, *cfs*	D, *ft*
East 1 Chnl WS	0+00 - 12+00	min slope	1.40%	2	0.049	13.9	0.44
East 1 Chnl WS	0+00 - 12+00	max slope	8.10%	6	0.067	13.9	0.31
East 2 Chnl WS	12+00 - 19+00	min slope	0.50%	2	0.039	76.7	1.40
East 2 Chnl WS	12+00 - 19+00	max slope	0.50%	2	0.039	76.7	1.40
West 1 Chnl WS	19+00 - 28+00	min slope	1.50%	3	0.048	85.5	1.23
West 1 Chnl WS	19+00 - 28+00	max slope	15%	12	0.048	85.5	0.63
West 2 Chnl WS	28+00 - 36+99	min slope	2.40%	3	0.058	28.8	0.64
West 2 Chnl WS*	28+00 - 36+99	max slope	19%	12	0.065	28.8	0.37

*Note: Manning's n for West 2 Channel (19% slope) is estimated from Flowmaster typical riprap roughness values. All other n values were obtained from HEC-15

APPENDIX F
Stability Graphics



LEGEND:

- EXISTING GROUND CONTOURS
- AS-BUILT GROUND CONTOURS
- STACKING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- AS-BUILT FENCE
- STABILITY SECTION LINE
- 60mil HDPE DOUBLE TEXTURED GEOMEMBRANE LIMITS
- GEOSYNTHETIC CLAY LINER LIMITS

NOTES:

1. AS-BUILT CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. AREAS OUTSIDE OF GEOSYNTHETIC CLAY LINER LIMTS CONSIST OF LOW PERMEABILITY SOIL LAYER PLACED UNDER GEOMEMBRANE.

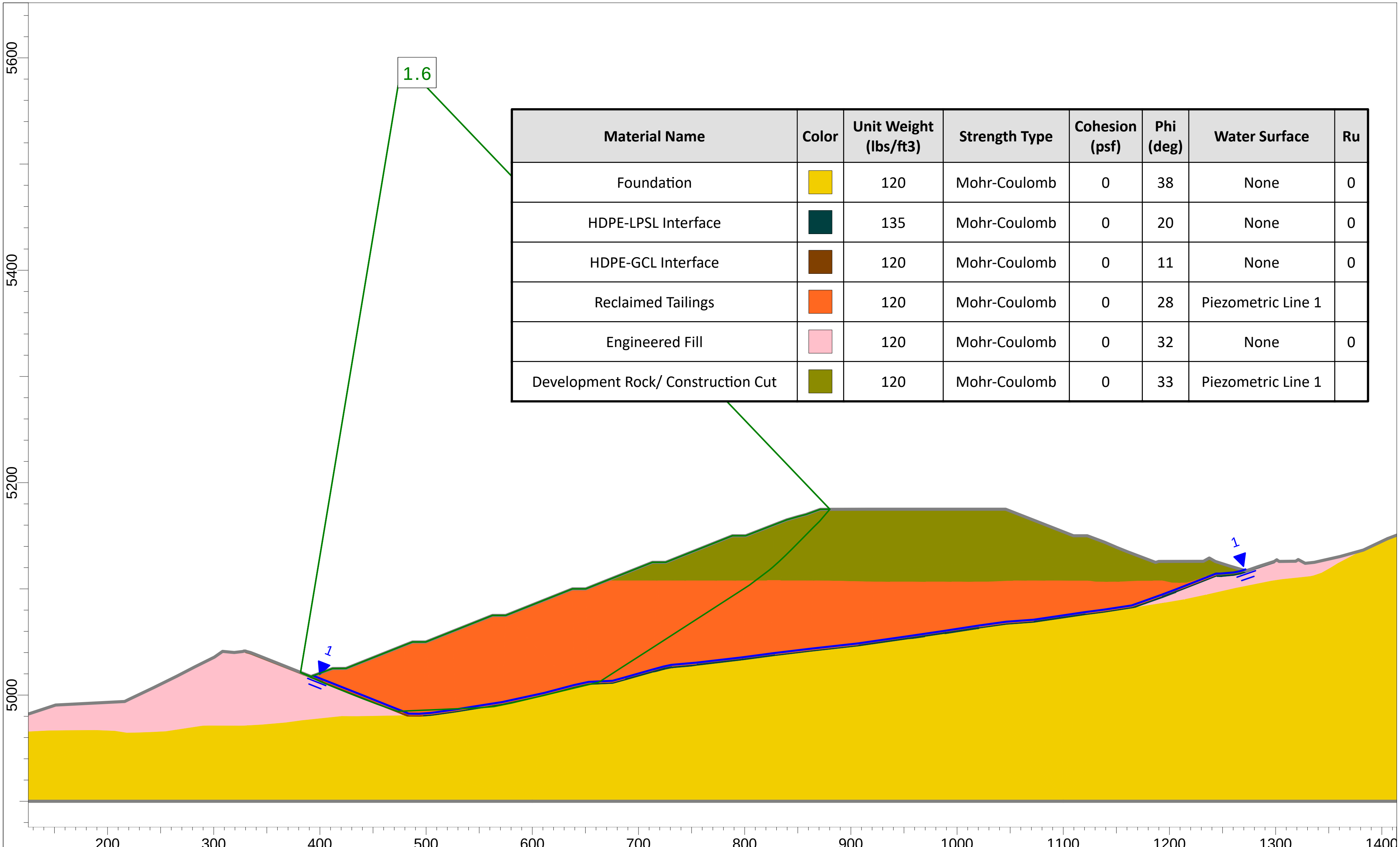
0 100 200 FEET

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

P:\Projects\0014.022 Hermosa VRP TSF Expansion\A-CAD\FIGS\14.022.024F.dwg-6/3/2020 4:39 PM

NewFields	CLIENT: SOUTH32 (AMI)
PROJECT	HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: STABILITY SECTIONS PLAN VIEW	FILENAME: 14.022.024F; FIGURE NO.: 1; REVISION: A



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38	None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20	None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11	None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32	None	0
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33	Piezometric Line 1	

NewFields

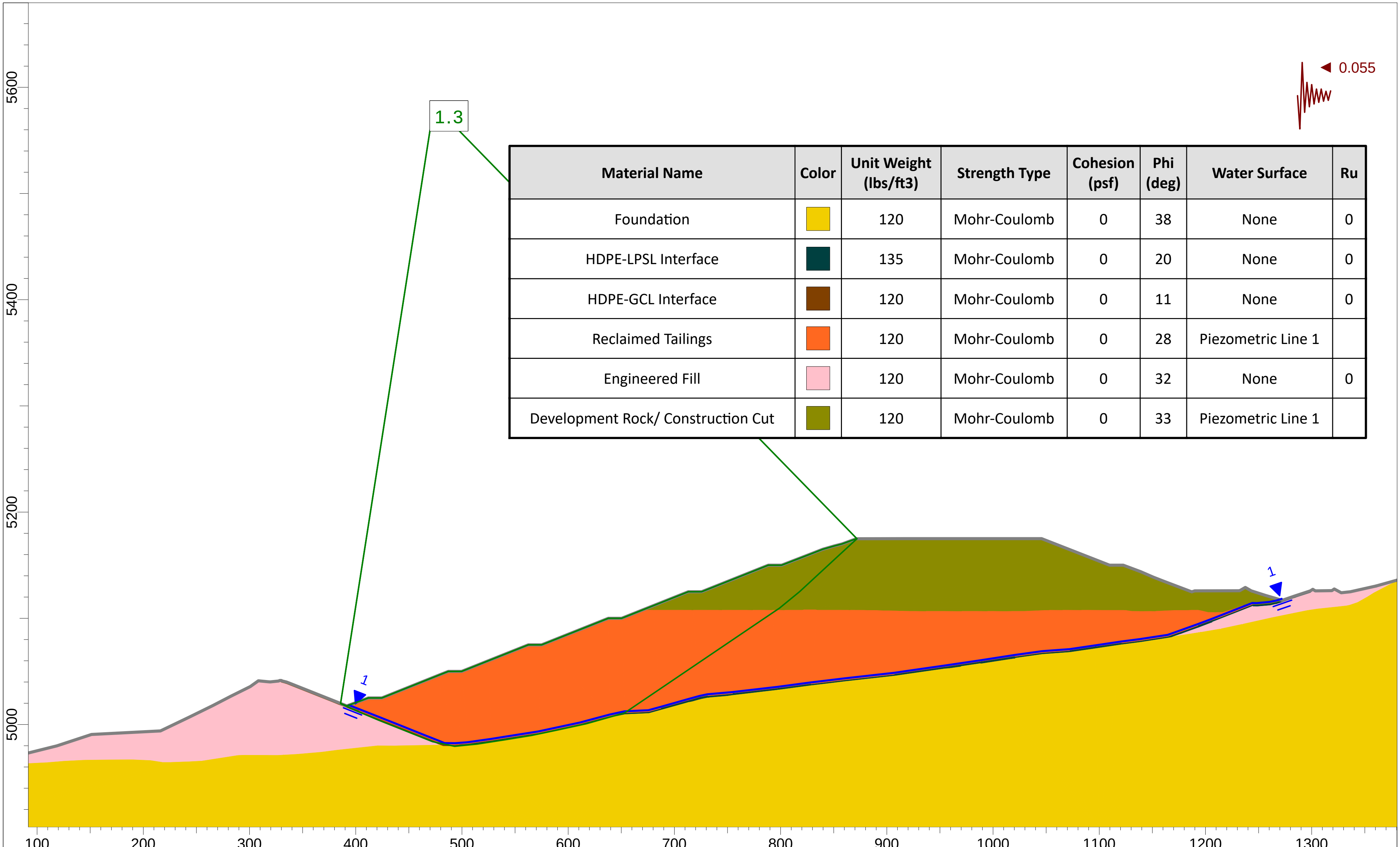
Trench Camp Tailings Storage Facility

Analysis Description Hermosa Lined TSF Design Amendment - Section A - Static Condition

Drawn By JTC | *Scale* 1:1500 | *Company* Arizona Minerals Inc.

Date Printed 7/23/2020 | *File Name* SECTION A STATIC.slmd

SLIDEINTERPRET 8.022



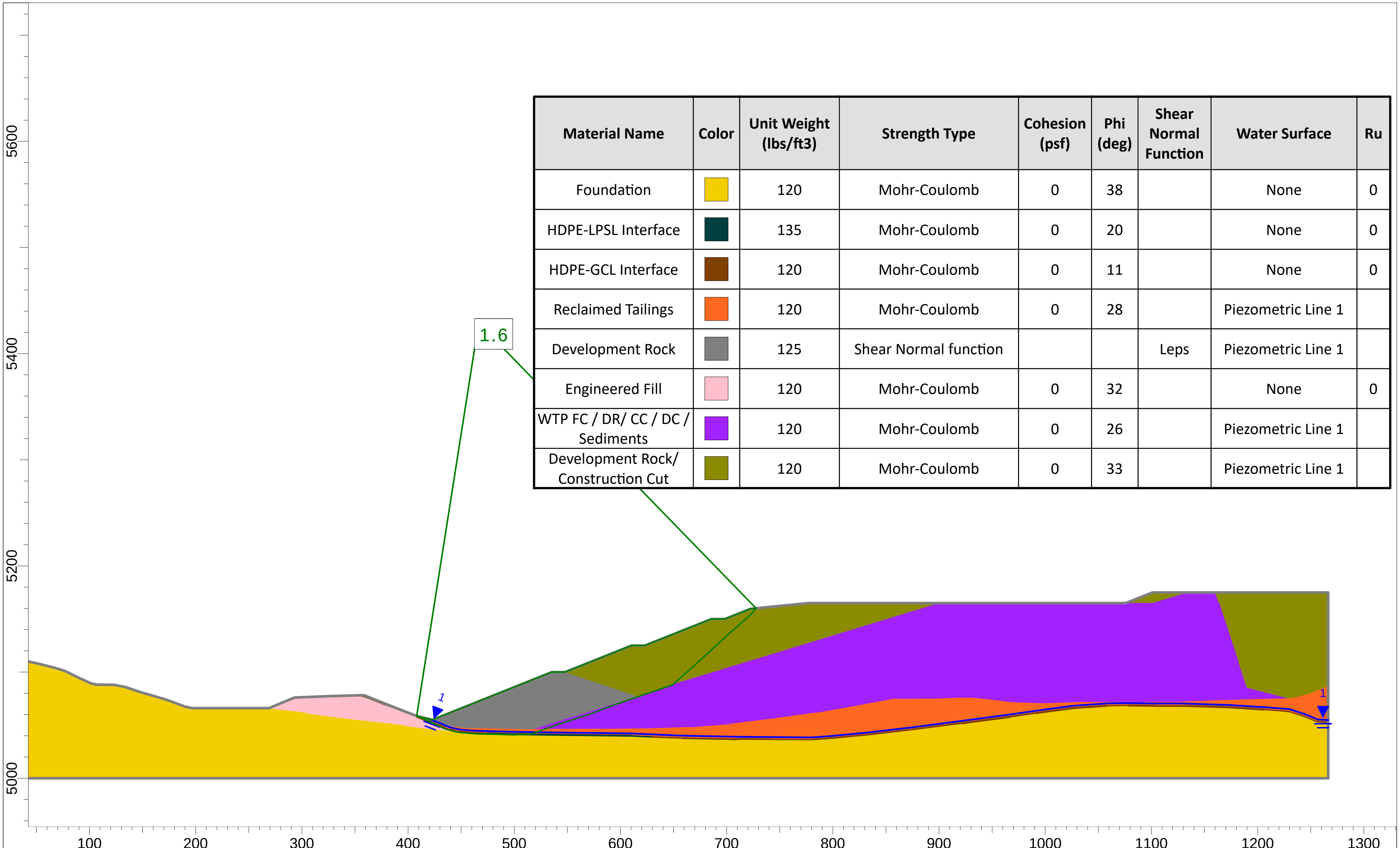
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38	None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20	None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11	None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32	None	0
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33	Piezometric Line 1	

NewFields

SLIDEINTERPRET 8.022

Trench Camp Tailings Storage Facility

Analysis Description	Hermosa Lined TSF Design Amendment - Section A - Pseudostatic Condition		
Drawn By JTC	*Scale* 1:1500	*Company*	Arizona Minerals Inc.
Date Printed	7/23/2020	*File Name*	SECTION A PSEUDOSTATIC.slmd



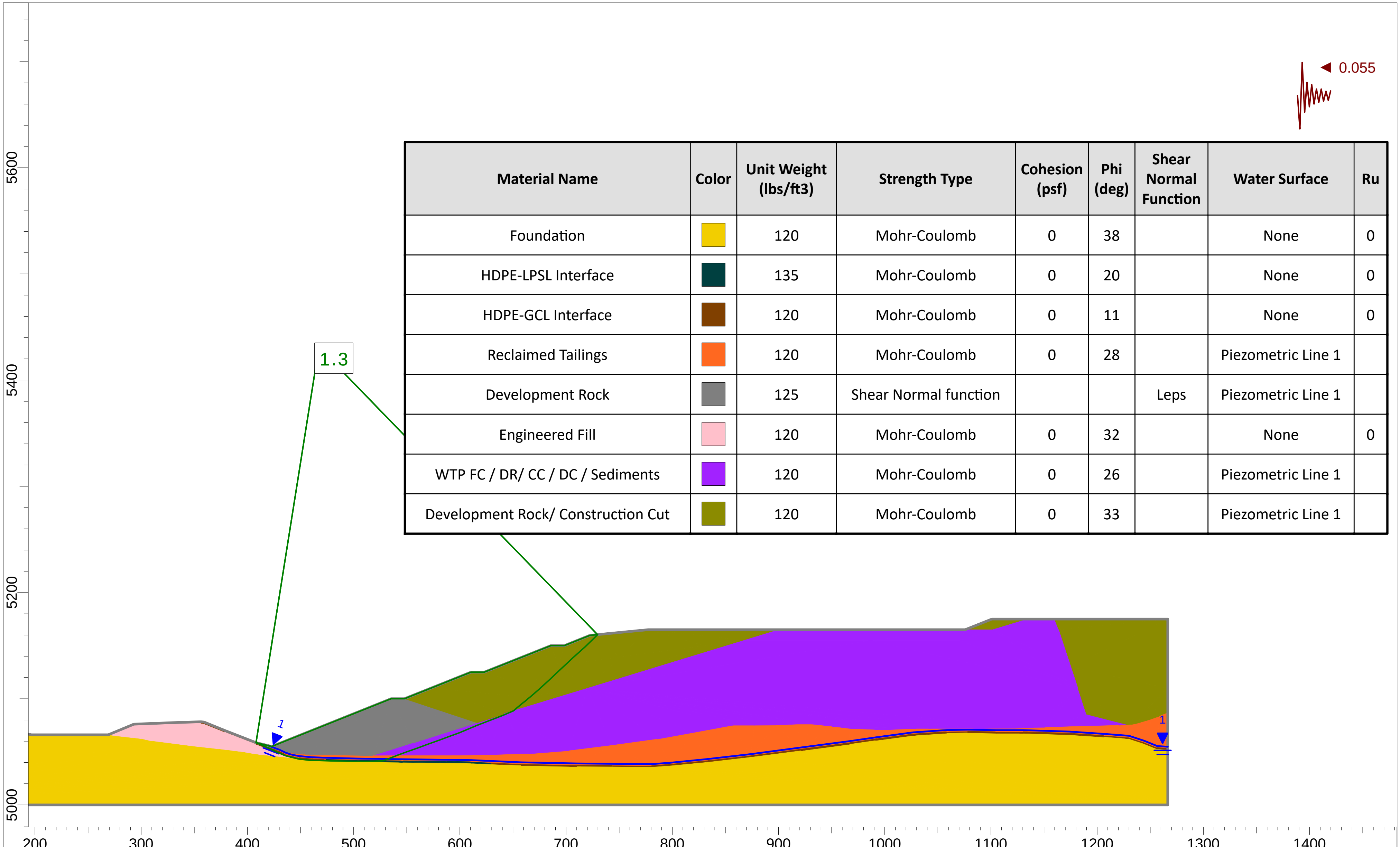
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shear Normal Function	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38		None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20		None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11		None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28		Piezometric Line 1	
Development Rock		125	Shear Normal function			Leps	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32		None	0
WTP FC / DR/ CC / DC / Sediments		120	Mohr-Coulomb	0	26		Piezometric Line 1	
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33		Piezometric Line 1	

NewFields

Trench Camp Tailings Storage Facility

Analysis Description	Hermosa Lined TSF Design Amendment - Section B - Static Condition		
Drawn By JTC	*Scale* 1:1500	*Company* Arizona Minerals Inc	
Date Printed 7/23/2020		*File Name* SECTION B STATIC.slmd	

SLIDEINTERPRET 8.022



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shear Normal Function	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38		None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20		None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11		None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28		Piezometric Line 1	
Development Rock		125	Shear Normal function			Leps	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32		None	0
WTP FC / DR/ CC / DC / Sediments		120	Mohr-Coulomb	0	26		Piezometric Line 1	
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33		Piezometric Line 1	

NewFields

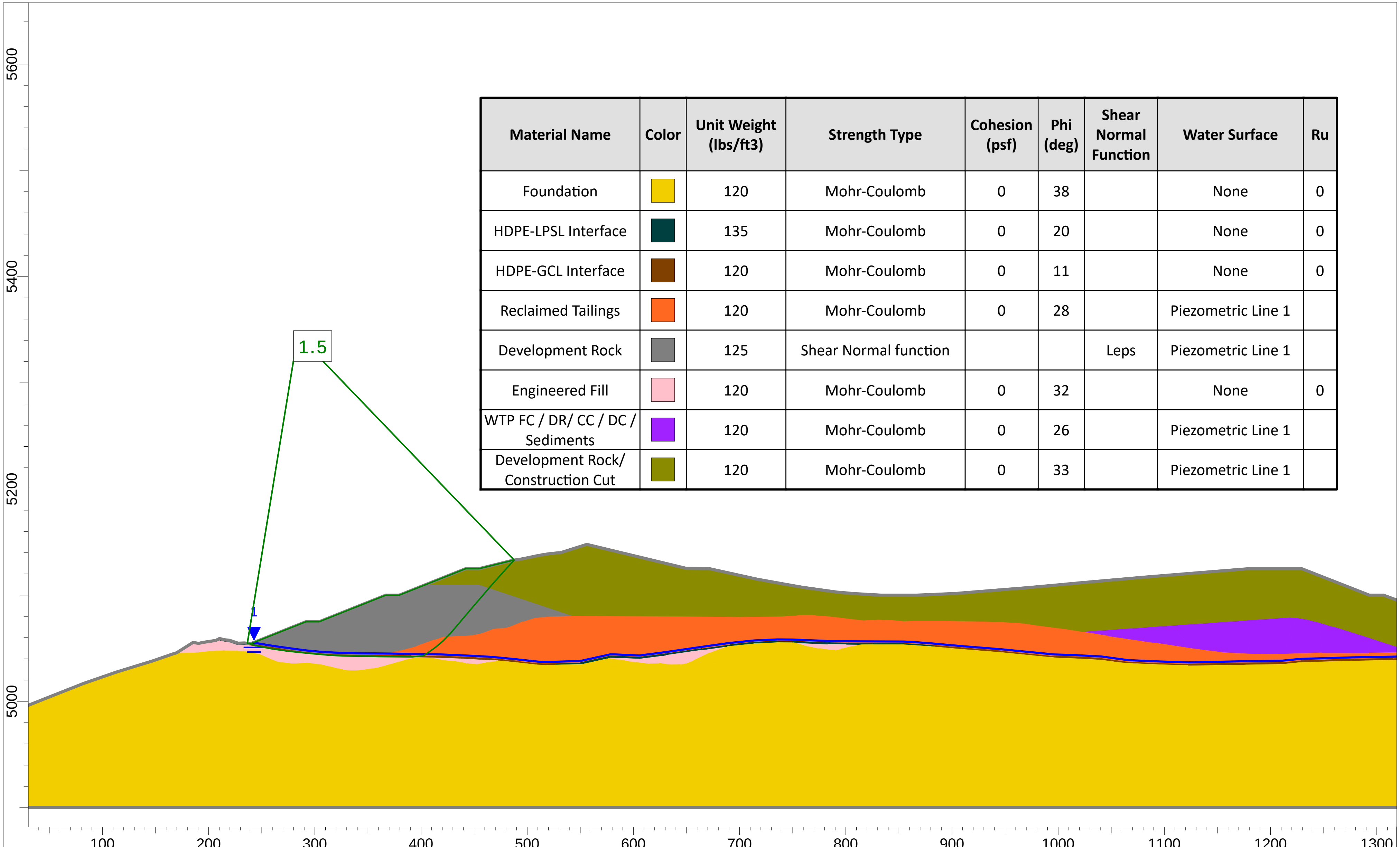
SLIDEINTERPRET 8.022

Trench Camp Tailings Storage Facility

Analysis Description Hermosa Lined TSF Design Amendment - Section B - Pseudostatic Condition

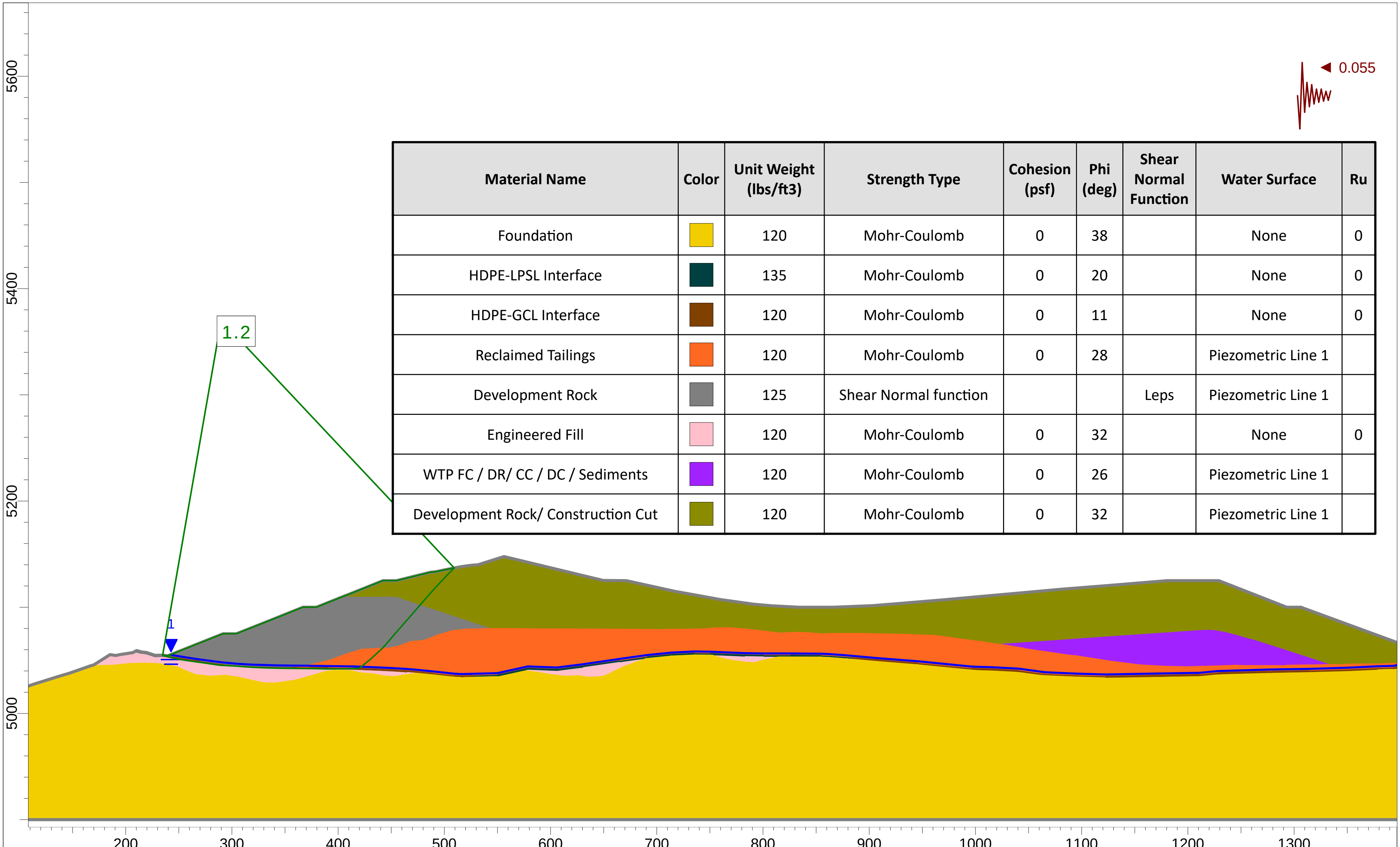
Drawn By JTC | *Scale* 1:1500 | *Company* Arizona Minerals Inc

Date Printed 7/23/2020 | *File Name* SECTION B PSEUDOSTATIC.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shear Normal Function	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38		None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20		None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11		None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28		Piezometric Line 1	
Development Rock		125	Shear Normal function			Leps	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32		None	0
WTP FC / DR/ CC / DC / Sediments		120	Mohr-Coulomb	0	26		Piezometric Line 1	
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33		Piezometric Line 1	

NewFields	Trench Camp Tailings Storage Facility		
	Analysis Description Hermosa Lined TSF Design Amendment - Section C - Static Condition		
	Drawn By JTC	*Scale* 1:1500	*Company* Arizona Minerals Inc
SLIDEINTERPRET 8.022	*Date Printed* 7/23/2020		*File Name* SECTION C STATIC.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shear Normal Function	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38		None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20		None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11		None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28		Piezometric Line 1	
Development Rock		125	Shear Normal function			Leps	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32		None	0
WTP FC / DR/ CC / DC / Sediments		120	Mohr-Coulomb	0	26		Piezometric Line 1	
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	32		Piezometric Line 1	

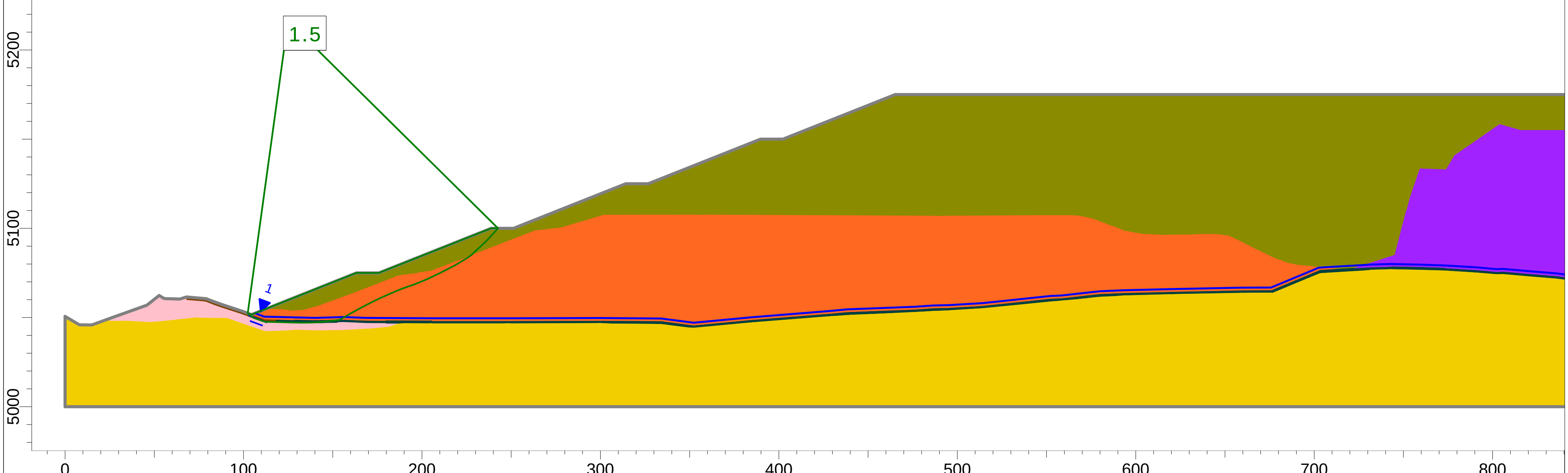
NewFields

Trench Camp Tailings Storage Facility

Analysis Description	Hermosa Lined TSF Design Amendment - Section C - Pseudostatic Condition		
Drawn By JTC	*Scale* 1:1500	*Company*	Arizona Minerals Inc
Date Printed	7/23/2020	*File Name*	SECTION C PSEUDOSTATIC.slmd

SLIDEINTERPRET 8.022

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38	None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20	None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11	None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32	None	0
WTP FC / DR/ CC / DC / Sediments		120	Mohr-Coulomb	0	26	Piezometric Line 1	
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33	Piezometric Line 1	

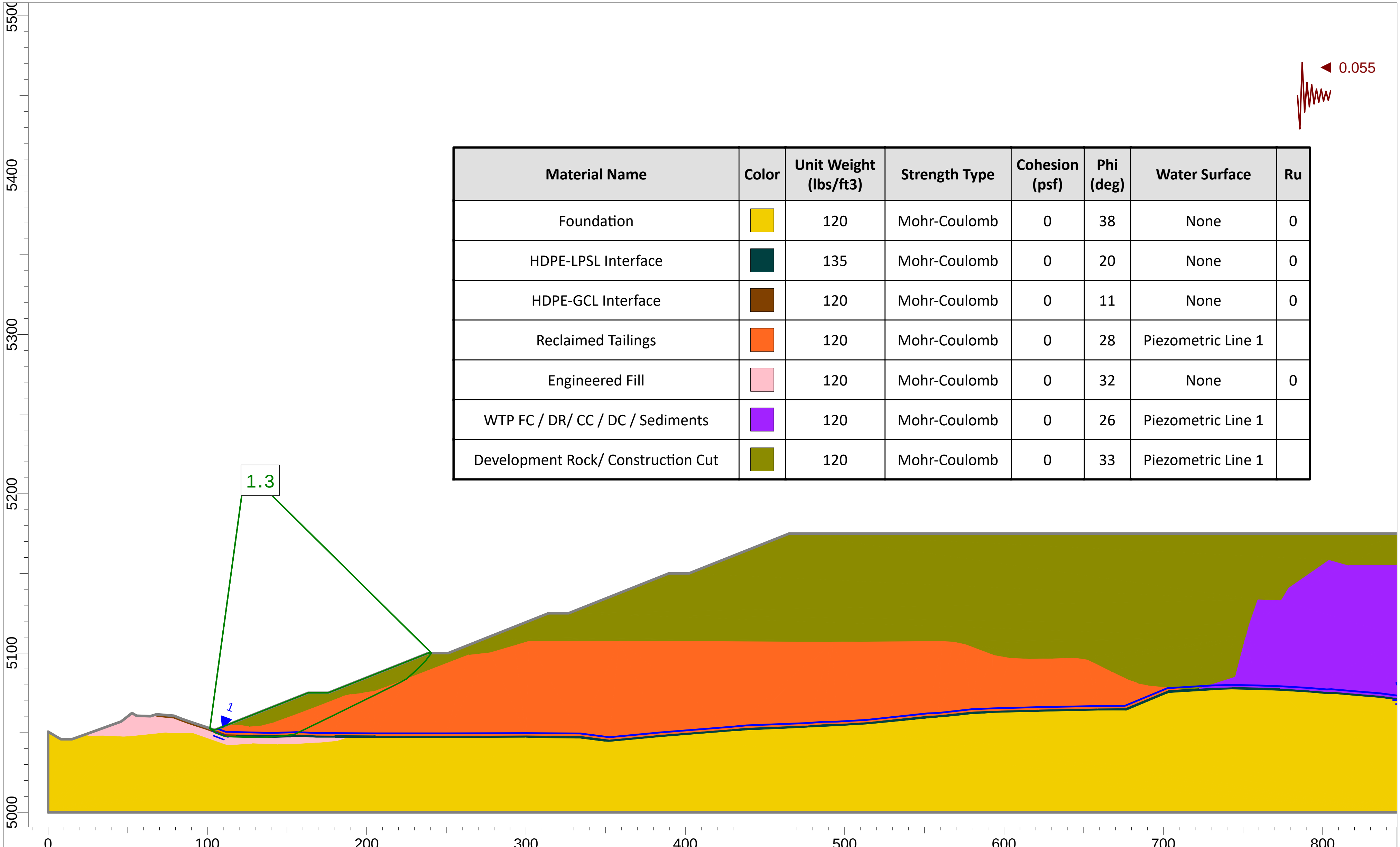


NewFields

Trench Camp Tailings Storage Facility

Analysis Description	Hermosa Lined TSF Design Amendment - Section D - Static Condition		
Drawn By	JTC	Scale	1:1000
Company	Arizona Minerals Inc		
Date Printed	7/23/2020	File Name	SECTION D STATIC.slmd

SLIDEINTERPRET 8.022



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Foundation		120	Mohr-Coulomb	0	38	None	0
HDPE-LPSL Interface		135	Mohr-Coulomb	0	20	None	0
HDPE-GCL Interface		120	Mohr-Coulomb	0	11	None	0
Reclaimed Tailings		120	Mohr-Coulomb	0	28	Piezometric Line 1	
Engineered Fill		120	Mohr-Coulomb	0	32	None	0
WTP FC / DR/ CC / DC / Sediments		120	Mohr-Coulomb	0	26	Piezometric Line 1	
Development Rock/ Construction Cut		120	Mohr-Coulomb	0	33	Piezometric Line 1	

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SLIDEINTERPRET 8.022

Trench Camp Tailings Storage Facility

Analysis Description	Hermosa Lined TSF Design Amendment - Section D - Pseudostatic Condition		
Drawn By	JTC	*Scale*	1:1000
Company	Arizona Minerals Inc		
Date Printed	7/23/2020	*File Name*	SECTION D PSEUDOSTATIC.slmd

APPENDIX G

Technical Specifications

HERMOSA LINED TSF DESIGN AMENDMENT
AQUIFER PROTECTION PERMIT (APP)
BEST AVAILABLE DEMONSTRATED CONTROL TECHNOLOGY (BADCT) DESIGN

TECHNICAL SPECIFICATIONS

Prepared for:

Arizona Minerals Inc
2210 East Fort Lowell Road
Tucson, AZ 85719

Prepared by:

NewFields

NewFields Mining Design & Technical Services
9400 Station Street, Suite 300
Lone Tree, CO 80124

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
Date Signed 8/13/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

NewFields Job No. 475.0014.022
July 2020

NewFields

LIST OF TECHNICAL SPECIFICATIONS FOR THE HERMOSA LINED TSF DESIGN AMENDMENT

Specification No.	Rev	Title
0014-SPT-CPeP	0	Technical Specifications for Corrugated Polyethylene Pipe Materials and Construction
0014-SPT-EW	0	Technical Specifications for Earthworks Materials and Construction
0014-SPT-GT	0	Technical Specifications for Geotextile Materials and Construction

CORRUGATED POLYETHYLENE PIPE

Technical Specifications

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ARIZONA MINERALS INC (AMI)</td><td>PROJECT NO
475.0014.022</td></tr>
<tr><td colspan="7">PROJECT HERMOSA LINED TAILINGS STORAGE FACILITY (TSF) DESIGN AMENDMENT</td></tr>
<tr><td colspan="6">TITLE TECHNICAL SPECIFICATIONS FOR CORRUGATED POLYETHYLENE PIPE MATERIALS AND CONSTRUCTION</td><td>SPECIFICATION NO.
0014-SPT-CPeP</td></tr>
<tr><td rowspan="2">REV</td><td rowspan="2">DATE</td><td rowspan="2">PAGES</td><td colspan="3">APPROVALS</td><td rowspan="2">REMARKS</td></tr>
<tr><td>AUTHOR</td><td>REVIEW</td><td>CLIENT</td></tr>
<tr><td>0</td><td>07/17/20</td><td>5</td><td>CMT</td><td>RMS</td><td></td><td>Issued for Tender</td></tr>
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TABLE OF CONTENTS

1. GENERAL

This specification defines the requirements for Corrugated Polyethylene Pipe (CPeP) materials, installation, and quality control associated with the Arizona Minerals Inc (AMI) (**Owner**) Hermosa Lined TSF Design Amendment project.

Any alternatives or exceptions to this specification shall be submitted in writing to the **Owner** or its designated representatives and shall be approved by the **Engineer**.

The owner's engineer shall control the quality of construction and shall verify that all construction elements have been completed in accordance with Design Drawings and Technical Specifications.

1.1. Definition of Terms

- "**Owner**" is defined as AMI or any of its authorized representative(s) / agent(s).
- "**Engineer**" is defined as the **Consultant** or **Engineering Company** (NewFields) responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- "**Construction Manager**" is defined as the **Consultant** or **Engineering Company** (to be determined) responsible for the overall project completion.
- "**Construction Quality Assurance (CQA)**" is defined as the **Consultant** or **Engineering Company** (to be determined) hired by the **Owner** to provide independent inspection and testing services for the overall project.
- "**Contractor**" is defined as the party(s) that has executed the contract agreement for the specified Work with the **Owner** or its authorized representative(s)/agent(s).
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the **Owner**, the **Engineer**, or others that apply to the Work.
- "Drawings" are defined as the "Issued for Tender" Drawings for Hermosa Lined TSF Design Amendment project furnished by the **Owner**, **Engineer**, or others that apply to the Work.
- "Site" is defined as the area being developed by the **Owner** and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the **Owner** or its authorized representative(s)/agent(s) with the **Contractor** to complete specified portions of the Work.
- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.
- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by **Owner** and **Engineer** in writing, after the Specifications and Drawings have

been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.

- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.
- "Units" – In general, these Specifications and the Drawings will utilize Imperial units, however metric units will be used when appropriate.

1.2. Codes and Standards

All pipe work shall be of the best quality available complying with the latest standards for the following:

- ANSI American National Standard Institute
- ASTM American Society of Testing and Materials
- AWWA American Water Works Association
- AASHTO American Association of State Highway Officials
- SPI Society of the Plastics Industry, Inc.
- PPI Plastics Pipe Institute

1.3. Material Properties

1.3.1. Corrugated Polyethylene Pipe (CPeP) with Smooth Interior

Pipe and fittings shall be made of virgin polyethylene compounds that conform with the applicable current edition of the AASHTO Material Specifications for cell classification as defined and described in ASTM D3350. Resins that have higher cell classifications in one or more properties, with the exception of density, are acceptable provided the product requirements are met.

For slow crack growth resistance, acceptance of resins shall be determined by using the notched constant tensile load (NCTL) test in accordance with ASTM F2136 except that the applied stress for the NCTL test shall be 600 psi (Note: The notched depth of 20 percent of the nominal thickness of the specimen is critical to this procedure). The average failure time of the five test specimens must exceed 24 hours with no single test specimen's failure time less than 17 hours.

Pipe and fittings shall be manufactured and comply with the current edition of AASHTO Standard Specifications M252 and M294. All sizes shall conform to the AASHTO classification "Type S" for smooth wall interior solid pipe and "Type SP" for smooth wall interior perforated pipe.

CPeP and couplings for watertight application shall be Advanced Drainage System ADS N12 WT IB or equivalent. Prefabricated fittings for the watertight application shall have bell ends suitable for connecting to the pipe or alternatively shall have plain ends suitable for using bell-to-bell push-on gasketed couplings.

The pipe shall have a minimum pipe stiffness of 5-percent deflection when tested in accordance with ASTM D2412, as follows:

Nominal Diameter (inches)	Pipe Stiffness (psi)
4	70
6	65
8	60
10-12	50
15	42
18	40
24	34
30	28
36	22
42	20
48	18
60	14

The diameters refer to the inside pipe diameter.

Where perforations are specified, they shall conform to the requirements as follows:

- AASHTO M252 “Class 2” for 4-inch to 10-inch diameter CPeP
- AASHTO M294 “Class 2” for 12-inch to 36-inch diameter CPeP

Couplings (non-watertight) shall be corrugated to match the pipe corrugations and shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Couplings, unless watertight connections are specified, shall be split collar and shall engage at least two full corrugations on each pipe section. Where pipe is joined to other materials or fittings, or joined by other methods, the manufacturer’s recommendations shall be strictly enforced.

CPeP-to-HDPE pipe connections, if specified, shall be made using CPeP-to-HDPE adapters supplied by the CPeP manufacturer. The HDPE pipe end of the adapter shall match the dimensional ratio (DR) of the pipe being connected.

Pipe sizes and types shall be as specified on the Drawings, or as required by the **Engineer**.

1.4. Submittals

The CPeP material supplier shall submit to the **Engineer** a manufacturer's certification that all pipe and fittings they intend to supply comply with the applicable portions of the specifications.

1.5. Pipe Delivery, Handling, and Storage

Pipe, fittings, valves, and other appurtenances shall be loaded and unloaded by lifting with hoists in such a manner as to avoid damage or hazard. Under no circumstances shall pipe or pipe fittings be dropped to the ground or into trenches. Pipe handled on skid ways shall not be skidded or rolled against pipe already on the ground. The interior of all pipe and pipe fittings shall be kept free from dirt and foreign material at all times.

The **Contractor** shall be responsible for any material furnished to him by the **Owner** and shall replace or repair, in a manner approved by the **Engineer** at the **Contractor's** expense, all such material damaged in handling after delivery. This shall include the furnishing of all materials and labor required for the replacement of installed material damaged prior to the final acceptance of the Work.

1.6. Pipe Installation

CPeP shall be installed to the sizes, lines, and grades shown on the Drawings. When using plain end pipe and couplers, pipe sections shall be joined with manufacturer-supplied spilt couplers with the open seam of the coupler turned to the side of the pipe, near the spring line (to avoid opening under load) and shall be fastened with plastic zip ties or equivalent until covered. End caps shall be installed on the upstream ends of the pipe. Pipes shall be closely monitored during backfilling activities to ensure no damage is done to the pipe.

The pipe shall be installed to the lines and grades and generally in the manner shown on the Drawings. Where specific lines and grades are not indicated on the Drawings, the lines and grades will be determined by the **Engineer** in the field to suit the existing ground conditions. The **Contractor** shall use equipment and methods acceptable to the **Engineer** and in accordance with the pipe manufacturer's recommendations for handling and placement of the pipe and fittings.

The **Contractor** shall provide and install all piping required to complete the piping installation in accordance with good piping practices, regardless of whether such piping is specifically detailed on the Drawings. The general layout as shown on the Drawings shall be maintained. Where interference is encountered during installation or relocation of pipelines is deemed necessary, the **Engineer** shall be consulted before any changes are made.

All pipelines shall be erected to preserve accurate alignment. Care shall be taken in the installation of pipeline runs where drainage is required to ensure that the pipeline has a continuous slope to the point of drainage.

Prior to installation, each segment of pipe and all fittings shall be inspected for defects or damage. All pipe, fittings, and other appurtenances shall be carefully lowered into position, piece by piece. Under no circumstances shall such materials be dropped into position. Extreme care shall be taken to prevent foreign material from entering the pipe while it is being installed. Temporary end caps or other approved means shall cover open ends of the pipe when installation is not in progress.

Pipe bends to form curves either in the horizontal or vertical plane shall not exceed that recommended by the manufacturer or approved by the **Engineer**. The cutting of pipe for inserting fittings or closure pieces shall be done in a neat manner and with good workmanship without damage to the pipe and leaving a smooth end at right angles to the axis of the pipe.

Wherever obstructions not shown on the Drawings are encountered during construction, and where such obstructions interfere with the work to an extent that an alteration in the lines or grades of the pipe is required, the **Engineer** shall approve any deviation or arrange for removal, relocation, or reconstruction of the obstructions.

EARTHWORKS

Technical Specifications

NewFields	CLIENT ARIZONA MINERALS INC (AMI)					PROJECT NO 475.0014.022
PROJECT HERMOSA LINED TAILINGS STORAGE FACILITY (TSF) DESIGN AMENDMENT						
TITLE TECHNICAL SPECIFICATIONS FOR EARTHWORKS MATERIALS AND CONSTRUCTION						**SPECIFICATION NO.** 0014-SPT-EW
			APPROVALS			
REV	**DATE**	**PAGES**	**AUTHOR**	**REVIEW**	**CLIENT**	**REMARKS**
0	07/17/20	39	CMT	RMS		Issued for Tender

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1. GENERAL

This specification defines the requirements for the earthwork construction activities associated with the Arizona Minerals Inc (AMI) (**Owner**) Hermosa Lined Tailings Storage Facility (TSF) Design Amendment project. The specifications set forth in this document cover the quality of materials and workmanship for earthworks construction.

Any alternatives or exceptions to this Specification shall be submitted in writing to the **Owner** or its designated representatives and shall be approved by the **Engineer**.

The owner's engineer shall control the quality of construction and shall verify that all construction elements have been completed in accordance with Design Drawings and Technical Specifications.

1.1. Definition of Terms

- "**Owner**" is defined as AMI or any of its authorized representative(s) / agent(s).
- "**Engineer**" is defined as the **Consultant** or **Engineering Company** (NewFields) responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- "**Construction Manager**" is defined as the **Consultant** or **Engineering Company** (to be determined) responsible for the overall project completion.
- "**Construction Quality Assurance (CQA)**" is defined as the **Consultant** or **Engineering Company** (to be determined) hired by the **Owner** to provide independent inspection and testing services for the overall project.
- "**Contractor**" is defined as the party(s) that has executed the contract agreement for the specified Work with the **Owner** or its authorized representative(s)/agent(s).
- "Geomembrane Installer" is defined as the party (s) contracted by the **Contractor** or **Owner** to install, inspect, and test the geomembrane portions of the project.
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the **Owner**, the **Engineer**, or others that apply to the Work.
- "Drawings" are defined as the "Issued for Tender" Drawings for the Hermosa Lined TSF Design Amendment project furnished by the **Owner**, **Engineer**, or others that apply to the Work.
- "Site" is defined as the area being developed by the **Owner** and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the **Owner** or its authorized representative(s)/agent(s) with the **Contractor** to complete specified portions of the Work.

- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Technical Specifications and Contract Documents.
- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by **Owner** and **Engineer** in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.
- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.
- "Units" These Specifications and the Drawings will utilize Imperial units; however metric units will be used when appropriate.

1.2. Codes and Standards

All tests shall be performed in accordance with the current edition of the testing standards as indicated below.

1.2.1. American Association of State Highway and Transportation Officials (AASHTO):

- AASHTO T103-08: Soundness of Aggregates by Freezing and Thawing (Procedure A Total Immersion in Water
- AASHTO T104-99: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

1.2.2. American Society for Testing and Materials (ASTM):

- ASTM C88/C88M-18: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C117-17: Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
- ASTM C131-14: Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM C136-20: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
- ASTM C535-16: Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- ASTM D698-12e2: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
- ASTM D1556-15e1: Standard Test Methods for Density and Unit Weight of Soil in Place by Sand-Cone Method

- ASTM D1557-12e1: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D2434-19: Standard Test Method for Permeability of Granular Soils (Constant Head)
- ASTM D4318-17e1: Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D4644-16: Standard Test Method for Slake Durability of Shales and Other Similar Weak Rocks
- ASTM D5030 -13a: Standard Test Method for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit
- ASTM D5084-16a: Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- ASTM D5126-16e1: Standard Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in Vadose Zone
- ASTM D6913 -17: Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- ASTM D6938-17a: Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- ASTM D7928-17: Standard Test Methods for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

1.2.3. United States Environmental Protection Agency (USEPA)

- EPA M600/2-78-054 3.2.3: Field and Laboratory Methods Applicable to Overburdens and Minesoils

1.2.4. United States Army Corps of Engineers (USACE):

- USACE, EM 1110-2-2301 Part 2: Engineering Manual, Engineering and Design, Test Fills

1.2.5. United States Bureau of Reclamation (USBR):

- USBR 5600: Determining Permeability and Settlement of Soils, Fixed Wall Saturated Hydraulic Conductivity
- USBR 5605: Determining Permeability and Settlement of Soils Containing Gravel, Fixed Wall Saturated Hydraulic Conductivity

1.2.6. United States Department of Transportation- Federal Highway Administration (USDOT-FHWA):

- USDOT FLH T 521: Standard Method of Determining Riprap Gradation by Wolman Count

2. LANDSCAPE PRESERVATION

2.1. General

The **Contractor** shall exercise care at all times to preserve the natural landscape and shall conduct operations to prevent unnecessary damage, scarring or defacing of the natural surroundings in the vicinity of the work. Movement of personnel and equipment within the site disturbance area, site access roads, and easements provided for access to the work shall be performed in a manner to prevent damage to the property and the environment.

3. EARTHWORKS

This section presents the technical requirements for the earthworks construction for the Hermosa Lined TSF Design Amendment project.

All equipment used by the **Contractor** shall meet satisfactory conditions and comply with the Specifications with the approval of the **Engineer**. The **Engineer** reserves the right to request in writing a change in the required equipment or procedure of any work and the **Contractor** shall comply.

During all earthwork operations the **Contractor** will be responsible for dust control. Care shall be taken to minimize and control the generation of dust by means approved by the **Owner** or **Construction Manager**.

3.1. Control of Surface Water and Stormwater Runoff

The **Contractor** shall review the available surface runoff and subsoils data for the project site and evaluate the surface and subsurface conditions at the project site with respect to required diversion and dewatering requirements as conceptually shown on the Drawings. During the construction period, the **Contractor** will be responsible for constructing and maintaining any temporary ditches, channels, and or sediment control ponds required to protect the works and control surface water flows as well as limit sediment transport outside the limits of the work as directed by the **Owner**.

The **Contractor** shall prepare a stormwater management plan in accordance with "Best Management Practices (BMP's). The plan shall detail the materials, equipment pumps, piping, cofferdams, channels, and other components necessary to complete the construction and erosion and sediment control.

The temporary surface water runoff control including temporary and permanent berms, canals and any other control measures, shall be built according to the line and grade indicated on a plan submitted by the **Contractor** and approved by the **Owner** and **Construction Manager** and maintained throughout the work.

The **Contractor** shall build berms, embankments, and other erosion control measures required to prevent significant transport of sediments from the stockpiles, fill areas, and other areas of the work that may be subject to the effects of stormwater.

The **Contractor** shall provide equipment and perform all necessary work to maintain the areas of surface and groundwater collection to remove sediments from the water before it leaves the site. The **Contractor** shall provide the temporary erosion control measures and make improvements immediately to these control measures as required by the **Owner** or **Engineer**.

The **Contractor** shall prevent all damage to the work areas due to drying, water runoff, and sediment control.

The **Contractor** shall remove all temporary installations of erosion control measures when they are no longer necessary and restore the areas affected by these measures.

The **Contractor** shall be responsible for the damage that results from rainfall runoff and for failed erosion control measures.

3.2. Earthwork Specifications

3.2.1. Clearing, Stripping and Topsoil Removal

The natural ground surface is to be cleared and stripped of all topsoil, organic, and objectionable materials to the limits shown on the Drawings or as required by the **Engineer** to facilitate construction. The limits of stripping shall generally extend approximately 10 feet outside of the Work activity areas as shown on the Drawings. Any clearing and stripping beyond the limits shown on the Drawings, or as required by the **Engineer**, shall be subject to the approval of the **Owner**. The estimated average depth of material to be removed is 24 inches.

Clearing and Grubbing will be carried out using whatever method is deemed necessary, providing it is consistent with producing an acceptable end result as determined by the **Owner** and the **Engineer**. Care is to be taken to minimize erosion and excessive sediment buildup.

The stripped material shall be hauled to topsoil stockpiles as shown on the Drawings or as directed by the **Owner**. Topsoil stockpiles shall be leveled, trimmed, and shaped to prevent the occurrence of ponding or concentrations of surface runoff and to provide a neat appearance. Finished slopes of the stockpiles shall be graded to 2.5H:1V for interim reclamation. All surface water runoff shall be directed to available natural drainage courses and shall utilize proper sediment control measures approved by the **Owner**.

After clearing, grubbing and topsoil removal is complete, the surface shall be prepared as specified on the Drawings or in the Technical Specifications. A survey shall be taken of the area if necessary, to determine quantities or for verification of lift or layer thickness after stripping is complete.

3.2.2. Grading and Prepared Surfaces

Once the work area has been cleared and stripped to the satisfaction of the **Engineer**, the surface shall be prepared and approved by the **CQA** before any overlying materials are placed. All work areas shall be graded according to the limits shown on the Drawings. Areas of both cut and fill shall be required to bring the grading of the work area to the elevations specified in the Drawings.

Areas that are to be filled and finished subgrade elevation for cut surfaces shall have the exposed surface scarified to a depth of approximately 8–inches, moisture conditioned, and compacted to 95 percent of the maximum dry density, within 3 percent of optimum moisture content as determined by the Modified Proctor Density Test, ASTM D1557. The **Engineer** may waive this requirement if the exposed surface soils without manipulating will provide a firm, non-yielding surface for fill placement, in which case the surface shall be moistened, lightly scarified and the first layer of fill placed.

Cut surfaces on which there is no overlying construction such as a road and channel slopes, in general, do not require scarification, moisture conditioning or compaction.

All boulders and cobbles that are located at the surface or partially exposed in a finish cut or fill area that could be detrimental to the overlying construction shall be removed as directed by the **Engineer**.

Areas of unsuitable material as determined by the **Engineer** or areas of pre-existing fill not compacted to the Technical Specifications shall be excavated to the limits designated by the **Engineer** and replaced with compacted Engineered Fill.

The **Contractor** is responsible for maintaining the surface in a satisfactory condition after approval of the **Engineer**. The **Contractor** shall protect the prepared surface from weather, construction equipment, and other factors.

3.2.3. Excavations and Borrow Areas

Excavation methods, techniques, and procedures shall be developed with consideration to the nature of the materials to be excavated and shall include all precautions that are necessary to preserve, in an undisturbed condition, all areas outside the lines and grades shown on the Drawings or as required by the **Engineer**. Excavation, shaping, etc., shall be carried out by whatever method is considered most suitable, providing it is consistent with producing an acceptable result as determined by the **Engineer**. Excavations shall be graded to provide drainage and prevent ponding. For excavations that cannot be graded to drain, the **Contractor** shall make provisions for the equipment and labor necessary to keep the excavations free of standing water.

No excavation beyond the lines and grades shown on the Drawings or as required by the **Engineer** shall be completed without the prior approval of the **Engineer** and **Owner**. If such additional excavation is done without prior approval and, in the opinion of the **Engineer**, requires backfilling to complete the Work, such backfilling shall be approved by the **Engineer** and shall be completed at the **Contractor's** cost. The **Contractor** shall protect and maintain all excavations until the adjacent placement or overlying placement of material has been completed.

The **Contractor** shall coordinate borrow activities with the **Engineer** and **CQA** to allow the sampling and testing of materials prior to their excavation. The **Contractor** shall allow the **Engineer** and **CQA** adequate time to evaluate potential borrow materials. Materials from excavations within the works or borrow areas that meet the specified requirements for other construction materials shall be stockpiled or placed in fill areas as directed by the **Engineer** and **Owner**. Unsuitable or excess materials shall be hauled to waste or stockpile areas.

The materials obtained from borrow pits or **Owner**-stockpiled material shall be selected to ensure that the gradation requirements for the various construction materials are achieved and that the materials are as homogeneous as possible. Care shall be taken to avoid cross-contaminating different types of materials.

On-site borrow areas shall be developed within the limits shown on the Drawings or as required by the **Owner**. Should the **Contractor** wish to develop additional borrow sources, the **Contractor** shall receive written approval from the **Owner** prior to proceeding. Approval by the **Owner** may require that subsurface investigations be carried out to obtain samples as are required by the **Engineer** to make an appropriate assessment of the suitability of the borrow materials in the area for the intended use at the **Contractor's** cost.

Borrow pit operations shall be subject to the approval of the **Owner** and **Engineer** and shall avoid waste of any suitable construction material therein. Clearing and stripping of any borrow area is to be completed with all salvageable growth media stockpiled in areas designated on the Drawings or as directed by the **Owner**. Each borrow area shall be developed with due consideration for drainage and runoff from the excavated surfaces to minimize erosion and ensure sediment control prior to release of any surface water or stormwater. Each borrow area shall be excavated in near horizontal layers and in such a manner that water will not collect and pond except as approved by the **Owner**. Before being abandoned, the sides of any borrow areas outside the Work area shall be brought to stable slopes (not steeper than 2.5H:1V) with slope intersections rounded and contoured to provide a natural, neatly graded appearance.

3.2.4. Fill Materials

Earthfill will not be placed until clearing and stripping and required foundation preparation have been completed, the foundation has been inspected and approved by the **Engineer**, and any required surveys completed.

All material used for fill shall be loaded and hauled to the placement site, dumped, spread, and leveled to the specified layer thickness. Fill shall be moisture conditioned and compacted to form a dense integral fill in accordance with these Technical Specifications and as approved by the **Engineer**. Care shall be taken at all times to avoid segregation of the material being placed and, if required by the **Engineer**, all pockets of segregated or undesirable material shall be removed and replaced with material that matches the surrounding material. All oversize material will be removed from the fill material either prior to it being placed or after it is dumped and spread but prior to compaction. No additional payment will be made to remove oversized materials unless the Work is specifically identified as a payment item on the Schedule of Quantities.

For most construction conditions, the fill is to be constructed in near horizontal layers with each layer being completed over the full length and breadth of the zone before placement of subsequent layers. Each zone shall be constructed with materials meeting the specified requirements and shall be free from lenses, pockets, and layers of materials that are substantially different in gradation from the surrounding material in the same zone, as determined by the **Engineer**.

Except in areas approved by the **Engineer**, where space is limited or as otherwise specified, fill shall be placed by routing the hauling and spreading units approximately parallel to the axis of the fill. The hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their travel routes evenly over the surface of the fill to aid in compaction.

Moisture conditioning is the operation required to increase or decrease the moisture content of material to within the specified limits. If moisture conditioning is necessary, it may be carried out by whatever method the **Contractor** deems is suitable, provided it produces the moisture content specified in these Technical Specifications or designated by the **Engineer**. The **Contractor** shall take the necessary measures to ensure that moisture is being distributed uniformly throughout each layer of material being placed immediately prior to compaction. Measures shall be adopted as are necessary to ensure that the designated moisture content is preserved after compaction until the overlying layer is placed.

All particles having dimensions that interfere with compaction in the fill as determined by the **Engineer** or **CQA** shall be removed from the zone in which they were placed either prior to or during compaction.

The rolling pattern for compaction of all zone boundaries or construction joints shall be such that the full number of roller passes required in one of the adjacent zones, or on one side of the construction joint, extends completely across the boundary or joint.

Minor deviations from the material properties and gradation limitations specified in the Sections below may be acceptable, subject to the review and approval of the **Engineer**. Refer to subsequent Sections 3.2.5 through Sections 3.2.17 for material properties and placement method requirements specific to each fill material type.

3.2.5. Engineered Fill

Material Properties - The Engineered fill will have a wide range of Unified Soil Classifications (USCS) and may contain significant variations in gradation and compaction properties. Engineered fill shall be placed in areas where the material is not required to be of uniform character and engineering properties. Engineered fill shall be free of roots, grass and other organic material and consist of inorganic soil and rock materials from required excavations, overburden materials or borrow material from other sources, as approved by the **Engineer**.

Materials containing rock or cobbles, gravel and clean gap graded sand (minimal fines) from required excavations may be used subject to the **Engineer**'s approval and provided the rock be reasonably graded such that large void spaces do not result and the clean sand is not placed within 10 feet of a permanently exposed slope. Further, the maximum size rock shall be no larger than two-thirds (2/3) of the compacted lift thickness.

Placement Methods - Engineered fill shall be moisture conditioned to within 2 percent below and 3 percent above of the optimum moisture content, placed in 12-inch maximum loose lifts, and compacted to 95 percent of the maximum dry density (ASTM D1557). Slight variations from the specified moisture range may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The Engineered fill material shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift layer.

If the Engineered fill placement and compaction utilizes 90-ton or larger haul trucks, the lift thickness can be increased subject to the approval of the **Engineer** based on the acceptable test fill performance.

Engineered fill containing more than 30-percent rock (materials above ¾-inch size) shall be spread, placed, and compacted using procedures based on the results of a test fill. The type of compaction equipment, number of passes, maximum rock size and loose lift thickness will be approved by the **Engineer** in writing based on the acceptable test fill performance. The **Contractor** shall outline his proposed procedures for moisture conditioning and fill placement and submit them to the **Engineer** for review and approval. The **Contractor** shall construct a test fill to verify the adequacy of the compaction equipment for achieving the required density. The test fill may be located so that it is incorporated into the fill area. The test fill shall be constructed and monitored in accordance with the U. S. Army Corps of Engineers' (USACE) guidelines for test fill construction (USACE, EM 1110-2-2301 Part 2).

The data to be collected during construction of the test fill shall include the following:

- Lift thickness of 1, 2, and 4-feet (three test fills to determine optimum lift thickness).
    - Note, maximum particle size may not allow for some test fill lift thicknesses.
- Amount of settlement after every two passes of the compactor to a maximum of 25 passes.
- Gradation and moisture content of in-place material.
- In-place fill density at completion of the test by nuclear gauge or other methods approved by the **Engineer**. For some rock fill the water replacement method may be required to assess compaction.

A curve showing change in settlement versus number of passes shall be produced from the data. This curve will be used to determine the required minimum number of passes for acceptable compaction. In general, the minimum number of passes will be that number to achieve 80 percent of the total settlement obtained after ten complete passes of the compaction equipment. Final determination by the **Engineer** of the lift thickness and minimum required passes will be based on review of the test data.

Maximum rock size for all fills shall be two–thirds (2/3) of the compacted lift thickness, unless otherwise approved by the **Engineer**. Oversize materials shall be removed from the fill.

The placement of fill shall be temporarily suspended by the **Contractor** due to weather concerns if the materials and installation cannot comply with the Technical Specifications, with no cost to the **Owner**.

3.2.6. Low Permeability Soil Layer

Material Properties – Low permeability soil layer shall consist of an inorganic fine-grained silt and clay or sandy and gravelly silt and clay material obtained from on-site excavations, near-site borrow areas, or generated and stockpiled by the **Owner**.

The material gradation as determined by ASTM D6913 shall be as follows:

Sieve Size (square openings)	Percent Passing (by dry weight)
4 -inch	100
No. 4	55-100
No. 200	25 Min

The low permeability soil layer material shall have a minimum plasticity index of 15 as determined by ASTM D4318.

Laboratory testing (see Table 4) shall be completed on all low permeability soil layer sources prior to placement by the **CQA**. The material shall be classified and compared to the material properties used in the design and approved by the **Engineer** prior to placement.

Removal of the oversize materials may be necessary to meet the requirements of the material gradation and to meet the Technical Specifications for the requirement of the finished surface discussed in Section 3.3.

Placement Methods – Low permeability soil layer materials shall be placed in two successive lifts not to exceed 6 inches in compacted lift thickness. This material shall be compacted to 95 percent of the maximum dry density as determined by ASTM D1557. The moisture content of the material will be maintained at 1 percent below optimum to 4 percent above optimum moisture content. Slight variations from the specified material gradation, moisture range, and compaction requirements may be acceptable subject to the acceptance of the **Engineer**. The low permeability soil layer shall be compacted using a tamping or sheep’s foot compactor or approved alternate. Smooth-drum finishing rollers shall be used to smooth the surface to remove the tracks from the tamping or sheep's foot rollers and to embed small stones and rocks into the soil matrix in preparation for geosynthetic placement.

The **Contractor** shall protect the finished surface of the low permeability soil layer from desiccation cracking and weather damage between placement activity and coverage by the Geomembrane Installer. Areas that exhibit desiccation cracks in excess of ¾ inch in depth or are damaged due to weather shall be reworked prior to geosynthetics placement without additional costs to the **Owner**.

The **Contractor** shall remove all rocks larger than 4 inches and construction stakes from the low permeability materials and any holes shall be filled to the approval of the **Engineer**.

If any area of the low permeability soil layer does not comply with the requirements of the Technical Specifications and is not approved by the **Engineer** it shall be considered in nonconformance and the **Contractor** shall be required to rework the area until acceptable at no cost to the **Owner**.

3.2.7. Protective Layer (Underdrain)

Material Properties - The protective layer material lies directly above the HDPE geomembrane liner. The purpose of this layer is to provide a protective cover above the HDPE geomembrane and to facilitate drainage of any solutions reporting through the tailings to the geomembrane liner. The protective layer shall consist of acceptable natural silty sands, sandy silts, gravel, silty/sandy gravel or similar. The protective layer material shall be free of large gravel particles (greater 1½ inches in diameter), debris or any other material that has the potential to damage the underlying geomembrane.

The Protective Layer material gradation as determined by ASTM D6913 shall be as follows:

Sieve Size (square openings)	Percent Passing (by dry weight)
1 1/2 inch (38 mm)	100
#200 (0.074mm)	0-10

The protective layer shall have a maximum plasticity index of 10 as determined by ASTM D4318. The coefficient of permeability (k) for the protective layer shall be greater than or equal to $1x10^{-4}$ cm/sec.

Placement Methods - Before placing the protective layer, the **Contractor** shall verify by a visual inspection that all geomembrane material installed in the area are free from perforations, wrinkles, scratches, and other damage. The **Engineer** shall inspect the geomembrane material to verify that it is ready to receive the protective layer.

Protective layer material shall be placed directly on the geomembrane with extreme care to prevent damage of the geomembrane. This is generally done by hauling and placing the material on the geomembrane in a single lift with haulage units that exert less than 80 pounds per square inch (psi) of ground pressure. The material shall be spread with a low ground pressure crawler-type tractor or equivalent that exerts less than 10 psi of ground pressure. The material shall be placed at a minimum loose thickness such that the final lift thickness is not less than the design thickness shown on the drawings (**Contractor** to determine allowance for settlement). At no time shall equipment operate directly on the surface of the geomembrane.

Special attention shall be taken when protective layer is being placed over the geomembrane. All oversized material that may damage the underlying geomembrane shall be removed by whatever means necessary to ensure there is no damage. Because of the thickness of the protective layer and the potential for damage to the geomembrane, vehicle traffic on the protective layer shall be kept to a minimum and shall be restricted to roadways and other main access ways. Protective layer thickness within roadways shall be maintained at least 4-feet above the geomembrane surface or whatever thickness is deemed necessary by the **Engineer.**

Proposed methods and equipment to be utilized in protective layer construction, shall be submitted to the **Engineer** for review prior to commencement of the Work.

The **Contractor** shall not place fill materials at such times that, in the opinion of the **Engineer**, conditions for such operations are unsatisfactory due to precipitation, low temperatures, or any other reason. As the ambient air temperature increases, wrinkles in the geomembrane will develop due to thermal expansion of the geomembrane. Placement of the protective layer will cease if the wrinkles become large enough to fold over or it causes a crease to form when covered with protective layer material. Protective layer material shall be placed during the cooler times of the day or during the evening when the geomembrane lays relatively flat. To minimize the effect of wrinkles, the protective layer shall be placed in an uphill direction and perpendicular to the contours. At no time, shall conditions result in the movement or slippage of the protective layer materials that could potentially cause liner or pipe damage. Except as necessary for construction and the safety of the Works, geomembrane anchor trenches shall not be filled until several cycles of expansion and contraction have occurred.

The thickness of the protective layer shall be verified by the **CQA** and areas with deficient amounts of material shall be reworked to comply with the Technical Specifications. Any damage done to the geomembrane material during installation shall be exposed by the **Contractor** and repaired by the Geomembrane Installer at no cost to the **Owner**.

Protective layer placement shall be suspended if in the opinion of the **Engineer** the operation creates unsafe conditions due to moisture or ice build-up on the geomembrane, visibility becomes problematic or the quality of work is being compromised. The **Contractor** shall make sure material is not rutting or pumping under the haul traffic due to the excessive moisture.

The **Contractor** shall supply a full-time laborer to visually inspect 100% of the protective layer placement and direct the equipment. The **CQA** will also observe all protective layer placement and will have the authority to require any areas to be removed and inspected if damage to the geomembrane is suspected.

3.2.8. Drainage Aggregate (Select Gravel)

Material Properties - The drainage aggregate material shall consist of clean gravel. The materials shall be composed of hard, durable stone particles reasonably free from thin, flat, and elongated pieces. The material shall consist of native non-plastic materials generated through an off-site crushing and screening operation. The material shall meet the following gradation limits as determined by ASTM D6913 or C136:

Sieve Size (square openings)	Percent Passing (by dry weight)
1 ½ –inch	100
¾ -inch (19mm)	70-100
No. 4 (19mm)	5-50
No. 40 (mm)	0-35
No. 200 (0.075mm)	0-5

Material used for drainage aggregate may be approved by the **Engineer** by visual inspection if the rock is determined to be sound and durable. However, if in the **Engineer**’s opinion, the material is questionable or unacceptable, the **Engineer** may require one or more of the following laboratory tests on representative drainage material samples in order to assess the quality of the material.

Drainage Aggregate Material Laboratory Tests

Test Description	Test Method	Specification Requirement
Los Angeles Abrasion	ASTM C 535	50% Loss Maximum (after 500 revolutions)
Sodium Sulfate or Magnesium Sulfate Soundness	AASHTO T 104 or ASTM C88	10% Maximum Loss (after 5 cycles)
Soundness by Freezing and Thawing	AASHTO T 103	10% Maximum Loss (after 12 cycles)
Slake Durability	ASTM 4644	Classification as Type 1

Placement Methods – The drainage aggregate material shall be borrowed, processed if necessary, hauled and placed in a manner that does not contaminate or segregate the material.

3.2.9. Pipe Bedding and Pipe Backfill

Material Properties - Pipe bedding and backfill material for foundations, culverts and pipes shall consist of materials with the following typical characteristics:

Sieve Size (square openings)	Percent Passing (by dry weight)	
	Pipe Backfill	Pipe Bedding
4 –inch (100 mm)	100	
3 –inch (75 mm)	90-100	
1-½ -inch (37.5 mm)	--	100
¾ -inch (19 mm)	--	90-100
No. 4 (4.75 mm)	--	30-70
No. 40 (0.425 mm)	--	--
No. 200 (0.075 mm)	8-20	8-20
Plasticity Index	10 max	10 max

Pipe bedding and pipe backfill shall be free of organic material.

Placement Methods - Backfilling shall be done as soon as possible after pipe or culvert installation. Suitable backfill and embankment material, free from large lumps, clods, or rocks shall be placed alongside the structure in loose layers not exceeding 8–inches in thickness to provide a berm of compacted earth on each side of the pipe or structure. The fill materials shall be a minimum of 5-feet wide or the width of the pipe diameter or structure but no less than required to operate the appropriate compaction equipment. Each 8-inch layer shall be moisture conditioned, as required to facilitate compaction and compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM D1557 or as directed by the **Engineer**.

If it is necessary to construct a road over the pipe alignment, the **Engineer** shall be consulted prior to the initiation of pipe trench construction for specification modification, as required, to achieve structure sufficient for such traffic loading. Backfill shall be placed symmetrically on each side of the pipe/structure to prevent undue lateral pressure on buried pipe during the backfill process. The backfill differential on either side of the pipe shall not exceed 8-inches, or one quarter of the diameter of the structure, whichever is less.

Prior to adding each new layer of loose backfill material until a minimum 12-inches of cover is obtained, an inspection shall be made by the **CQA** of the inside of the pipe/structure for local or unequal deformation caused by the backfilling operation. Only hand-operated tamping or vibratory compaction equipment shall be allowed within 3-feet of the sides of any buried pipe or structure. Modification to this Technical Specification as recommended by the culvert or structure manufacturer or designer can be submitted for approval by the **Engineer**. No heavy earthmoving equipment shall be permitted over the structure until a minimum of 150 percent of the largest buried pipe diameter of compacted fill has been placed over the top of the structure, or the minimum cover recommended by the culvert manufacturer or designer. In no case shall the minimum compacted structural cover be less than 24-inches for permanent installations.

Backfill material shall not be placed against any concrete foundation, concrete pipe encasement, concrete abutment, wing wall, or concrete integral culvert installation until the concrete has been in place at least seven days or the compressive strength of the concrete is 75 percent of the required 28-day strength. On structures that are not permanently supported laterally and that cannot tolerate horizontal movement, internal bracing or support should be placed during backfill operations.

3.2.10. Riprap

Material Properties - Riprap shall be hard, durable, angular in shape, reasonably well graded and free of organic and deleterious material and foreign debris. It shall have a specific gravity greater than 2.5. Rounded gravel, cobble and boulders shall not be allowed unless otherwise approved by the **Engineer**. Riprap shall generally conform to the following gradation.

D_{50} = 3 in. (75 mm)

Sieve Size	% Passing	Typical Stone Mass
6 in. (150 mm)	100	
3 in. (75 mm)	35-55	1.3 lbs. (0.6 kg)
1.5 in. (37.5 mm)	0-20	

D_{50} = 6 in. (150 mm)

Sieve Size	% Passing	Typical Stone Mass
12 in. (300 mm)	100	
9 in. (225 mm)	50-70	35 lbs. (16 kg)
6 in. (150 mm)	35-55	10 lbs. (4.5 kg)
2 in. (50 mm)	2-10	0.5 lbs. (0.2 kg)

D_{50} = 9 in. (225 mm)

Sieve Size	% Passing	Typical Stone Mass
18 in. (450 mm)	100	
15 in. (375 mm)	70-100	165 lbs. (75 kg)
9 in. (225 mm)	50-70	35 lbs. (16 kg)
6 in. (150 mm)	35-55	10 lbs. (4.5 kg)
3 in. (75 mm)	2-10	1.3 lbs. (0.6 kg)

D_{50} = 12 in. (300 mm)

Sieve Size	% Passing	Typical Stone Mass
24 in. (600 mm)	100	
21 in. (525 mm)	70-100	440 lbs. (200 kg)
18 in. (450 mm)	50-70	275 lbs. (125 kg)
12 in. (300 mm)	35-55	88 lbs. (40 kg)
4 in. (100 mm)	2-10	3 lbs. (1.4 kg)

D_{50} = 15 in. (375 mm)

Sieve Size	% Passing	Typical Stone Mass
30 in. (750 mm)	100	
24 in. (600 mm)	70-100	650 lbs. (295 kg)
18 in. (450 mm)	50-70	275 lbs. (125 kg)
15 in. (375 mm)	35-55	165 lbs. (75 kg)
6 in. (150 mm)	2-10	10 lbs. (4.5 kg)

D_{50} = 18 in. (450 mm)

Sieve Size	% Passing	Typical Stone Mass
36 in. (900 mm)	100	
30 in. (750 mm)	70-100	1280 lbs. (580 kg)
24 in. (600 mm)	50-70	650 lbs. (295 kg)
18 in. (450 mm)	35-55	275 lbs. (125 kg)
6 in. (150 mm)	2-10	10 lbs. (4.5 kg)

D_{50} = 24 in. (600 mm)

Sieve Size	% Passing	Typical Stone Mass
48 in. (1200 mm)	100	
36 in. (900 mm)	70-100	2200 lbs. (1000 kg)
30 in. (750 mm)	50-70	1280 lbs. (580 kg)
24 in. (600 mm)	35-55	650 lbs. (295 kg)
8 in. (200 mm)	2-10	10 lbs. (4.5 kg)

Minor deviations to the above gradations may be allowed if approved by the **Engineer**.

The stone size for grouted boulder riprap shall be as follows:

Rock Size[a]	Typical Stone Mass	Percent Passing			
		9 in. (225mm)	12in. (300mm)	15in. (375mm)	18in. (450mm)
6 in. (150mm)	10lbs. (4.5kg)	0-5	0-5		
9 in. (225mm)	35lbs. (16kg)	0-50	-		
12 in. (300mm)	88lbs. (40kg)	70-100	0-50	0-5	0-5
15 in. (375 mm)	165lbs. (75kg)	100	70-100	0-50	-
18 in. (450 mm)	275lbs. (125kg)		100	70-100	0-50
21 in. (525 mm)	440lbs. (200kg)			100	70-100
24 in. (600 mm)	650lbs. (295kg)				100
27 in. (675 mm)	925lbs. (420kg)				
30 in. (750 mm)	1280lbs. (580kg)				
Minimum Grout Thickness[b]		6 in. (150mm)	8in. (200mm)	10 in. (250 mm)	12 in. (300mm)

[a] The median rock size in the grouted riprap blanket should not exceed 0.67 times the blanket thickness. The largest rock used should not exceed the blanket thickness.

[b] The finished grout should not leave face stones exposed more than one-third their depth.

The concrete mortar for the grouted riprap shall consist of concrete with a minimum strength of 2,000 psi after 28 days of curing. The maximum aggregate size should be 0.5 inches and have a slump of between 5 to 8 inches. Sand mixes may be used if sufficient cement is included in the mix to give the mortar good strength and workability. The **Engineer** shall approve all mortar mix designs before beginning work.

Weep holes should be installed through the full thickness of the grout or mortar blanket to release any hydrostatic pressure that may build up beneath the blanket. The weep holes shall be constructed by installing 2-inch diameter PVC pipes at a spacing of 6-feet. The end of the pipe that is buried shall be covered with a wire screen or nonwoven geotextile. If there is no filter layer designed beneath the grout blanket, then the bottom end of the weep hole shall be extended at least 6 inches below the grout blanket and encapsulated in a clean drain gravel material that is wrapped with geotextile. The clean gravel shall consist of 1-inch gravel.

Material used for riprap may be approved by the **Engineer** by visual inspection if the rock is determined to be sound and durable. However, if in the **Engineer**'s opinion, the material is questionable, the **Engineer** may require one or more of the following laboratory tests on representative riprap samples in order to evaluate the quality of the material.

Riprap Laboratory Tests

Test Description	Test Method	Specification Requirement
Los Angeles Abrasion	ASTM C 535	50% Loss Maximum (after 500 revolutions)
Sodium Sulfate or Magnesium Sulfate Soundness	AASHTO T 104 or ASTM C88	10% Maximum Loss (after 5 cycles)
Soundness by Freezing and Thawing	AASHTO T 103	10% Maximum Loss (after 12 cycles)
Slake Durability	ASTM 4644	Classification as Type 1

Placement Methods - Surfaces and piping to be protected by riprap shall be dressed to a smooth surface. All soft or objectionable material shall be removed as directed by the **Engineer** and replaced with an approved material. Materials underlying the riprap shall be placed in accordance with each material's specific placement specifications.

The riprap shall be placed as shown on the Drawings or as required by the **Engineer** in a manner that will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids and good stone interlocking and contact. The entire mass of stone shall be placed in reasonable conformance with the lines, grades, and thicknesses shown on the Drawings. Riprap shall be placed to its full thickness during a single operation and in such a manner as to avoid damaging or displacing the underlying bedding material or geotextile.

The larger stones shall be well distributed and the materials shall be placed and distributed so that there will be no large accumulations of either the larger or the smaller size stones. Hand placing or rearranging of individual stones by mechanical equipment may be required to achieve the results specified.

For grouted riprap, stones shall be placed with due care to prevent soil, sand, or spall from filling the voids. The rock shall be wet immediately prior to commencing the grouting operation. Joints shall be filled with grout from bottom to top and the surfaces swept with a stiff broom. Full depth penetration of the concrete mortar (grout) into the riprap shall be required. To achieve this spading and rodding or a small diameter vibrator (pencil vibrator) will be required.

Grouting shall not be done in freezing weather. In hot, dry weather, the work shall be protected and kept moist for at least three days after grouting, or clear membrane curing compound may be used.

No loads will be allowed on the finished grouted riprap until 70 percent of the specified concrete mortar strength has been achieved or as approved by the **Engineer**.

3.2.11. Road Wearing Course

Material Properties - The road wearing course shall generally conform to the following gradation requirements as determined by ASTM D6913 or as approved by the **Engineer**.

Sieve Size (square openings)	Percent Passing (by dry weight)
4 –inch (100 mm)	100
3/4 –inch (19 mm)	50-80
No. 4 (4.75 mm)	35-50
No. 16 (1.18 mm)	15-40
No. 200 (0.075mm)	2-10

The plasticity index for road wearing course materials shall be no greater than 15 as determined by ASTM D4318.

Placement Methods – Road wearing course shall be placed as shown on the Drawings and compacted to 90% of the maximum dry density as determined by ASTM D1557. The moisture content shall be sufficient to obtain adequate density.

3.2.12. Rock Armoring

The rock armoring is intended to decrease the potential for wind and water erosion of the sloped tailings surface.

Material Properties - The rock armoring material shall consist of approved materials and shall meet the following grading requirements or as approved by the Engineer.

Sieve Size (square openings)	Percent Passing (by dry weight)
8-inch	100
No. 200	0-15

Placement Methods – The rock armoring shall be placed at the exterior of the dry stack surface in 5 ft high rock berms as shown on the Drawings. Every 5 ft in vertical elevation change a new rock berm shall be established prior to additional material placement thereby protecting the open slopes of the dry stack.

3.2.13. Development Rock

The Development Rock from the Exploration Decline shall be placed in the TSF for permanent storage on lined containment.

Material Properties - Due to the unknown gradation of the Development Rock and the potential variation of the gradation that is likely to occur throughout the construction of the Exploration Decline, the placement procedures address a wide range of material. If the Development Rock gradation has a maximum particle size of less than 8-inches and contains less than 30-percent rock (materials above ¾-inch size) follow the specification shown in Section 3.2.13.1. If the Development Rock has a maximum particle size greater than 8-inches or contains more than 30-percent rock (materials above ¾-inch size) follow the specification for a test fill (U. S. Army Corps of Engineers') described in Section 3.2.13.2.

3.2.13.1. Development Rock Placement (Maximum particle size is less than or equal to 8-inches and material is less than 30-percent rock)

Development rock shall be placed free of organic and other deleterious material in 12-inch loose lifts. This material shall be moisture conditioned to within 3 percent of the optimum moisture content and compacted to 90 percent of the maximum dry density as determined by ASTM D698. Slight variations from the specified moisture range may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The Development Rock shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift layer. Maximum rock size shall be equal to two–thirds (2/3) of the compacted lift thickness, unless otherwise approved by the **Engineer**.

3.2.13.2. Development Rock Placement (Maximum particle size is greater than 8-inches and/or material is more than 30-percent rock)

If materials greater than 8-inches are encountered during Development Rock placement, the lift thickness can be increased subject to the approval of the **Engineer** based on the acceptable test fill performance. Also, Development Rock containing more than 30-percent rock (materials above ¾-inch size) shall be spread, placed, and compacted using procedures based on the results of a test fill. The type of compaction equipment, number of passes, maximum rock size and loose lift thickness will be approved by the **Engineer** in writing based on the acceptable test fill performance. The **Contractor** shall outline his proposed procedures for moisture conditioning and fill placement and submit them to the **Engineer** for review and approval. The

Contractor shall construct a test fill to verify the adequacy of the compaction equipment for achieving the required density. The test fill may be located so that it is incorporated into the fill area. The test fill shall be constructed and monitored in accordance with the USACE guidelines for test fill construction (USACE, EM 1110-2-2301).

The data to be collected during construction of the test fill shall include the following:

- Lift thickness of 1, 2, and 4-feet (three test fills to determine optimum lift thickness).
  - Note, maximum particle size may not allow for some test fill lift thicknesses.
- Amount of settlement after every two passes of the compactor to a maximum of 25 passes.
- Gradation and moisture content of in-place material.
- In-place fill density at completion of the test by nuclear gauge or other methods approved by the **Engineer**. For some rock fill the water replacement method may be required to assess compaction.

A curve showing change in settlement versus number of passes shall be produced from the data. This curve will be used to determine the required minimum number of passes for acceptable compaction. In general, the minimum number of passes will be that number to achieve 80 percent of the total settlement obtained after ten complete passes of the compaction equipment. Final determination by the **Engineer** of the lift thickness and minimum required passes will be based on review of the test data.

3.2.13.3. Development Rock Placement (Maximum particle size is greater than 32-inches)

For placement of Development Rock containing oversize particles (particles in excess of 32-inches), care shall be taken to prevent nesting of the oversize particles during placement. Development Rock placement in close proximity to the oversize particle shall be compacted in accordance with Sections 3.2.13.1 and 3.2.13.2. Particles exceeding 32-inches shall not constitute more than 5% of the fill volume unless otherwise approved by the **Engineer**.

3.2.13.4. Development Rock Additional Placement Criteria

The **Contractor** shall make sure that the material placed is not rutting, pumping, or exhibiting excessive deflection during compaction under haul traffic loading. If the surface exhibits excessive deflection, the material in the area of question will require stabilization using a combination of moisture reduction through active drying and recompaction, selective placement of cleaner rock material and recompaction or other means of stabilization such as geogrid placement in these areas.

Development Rock is to be placed in near horizontal layers with each layer being completed over the full length and breadth of the zone before placement of subsequent layers. Except in areas approved by the **Engineer**, where space is limited or as otherwise specified, Development Rock shall be placed by routing the hauling and spreading units approximately parallel to the axis of fill. The hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their travel routes evenly over the surface of the Development Rock to aid in compaction.

The **Contractor** will also be responsible for protecting the work from weather related degradation. Given the risk of weather related degradation is quite high during the Monsoon season, the **Contractor** should plan his work carefully to make sure that the Development Rock is well compacted prior to rain events and that the Development Rock is graded to allow positive drainage away from both active and completed work areas. Any degradation of the work due to weather will be remediated at the **Contractor's** expense. Placement of Development Rock shall be temporarily suspended by the **Contractor** due to weather concerns if the materials and installation cannot comply with the guidance parameters stated above, with no cost to the **Owner**.

3.2.14. Construction Cut

The Construction Cut from various onsite projects that is considered potentially acid generating (PAG) shall be placed in the TSF for permanent storage on lined containment.

Material Properties - The construction cut will have a wide range of Unified Soil Classifications and may contain significant variations in gradation and compaction properties. Due to the unknown gradation of the Construction Cut and the potential variation of the gradation that is likely to occur throughout the construction, the placement procedures address a wide range of material. If the Construction Cut gradation has a maximum particle size of less than 8-inches and contains less than 30-percent rock (materials above ¾-inch size) follow the specification shown in Section 3.2.14.1. If the Construction Cut has a maximum particle size greater than 8-inches or contains more than 30-percent rock (materials above ¾-inch size) follow the specification for a test fill (U. S. Army Corps of Engineers') described in Section 3.2.14.2.

3.2.14.1. Construction Cut Placement (Maximum particle size is less than or equal to 8-inches and material is less than 30-percent rock)

Construction Cut shall be placed free of organic and other deleterious material in 12-inch loose lifts. This material shall be moisture conditioned to within 3 percent of the optimum moisture content and compacted to 90 percent of the maximum dry density as determined by ASTM D698. Slight variations from the specified moisture range may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The Construction Cut shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift layer. Maximum rock size shall be equal to two–thirds (2/3) of the compacted lift thickness, unless otherwise approved by the **Engineer**.

3.2.14.2. Construction Cut Placement (Maximum particle size is greater than 8-inches and/or material is more than 30-percent rock)

If materials greater than 8-inches are encountered during Construction Cut placement, the lift thickness can be increased subject to the approval of the **Engineer** based on the acceptable test fill performance. Also, Construction Cut containing more than 30-percent rock (materials above ¾-inch size) shall be spread, placed, and compacted using procedures based on the results of a test fill. The type of compaction equipment, number of passes, maximum rock size and loose lift thickness will be approved by the **Engineer** in writing based on the acceptable test fill performance. The **Contractor** shall outline his proposed procedures for moisture conditioning and fill placement and submit them to the **Engineer** for review and approval. The **Contractor** shall construct a test fill to verify the adequacy of the compaction equipment for achieving the required density. The test fill may be located so that it is incorporated into the fill area. The test fill shall be constructed and monitored in accordance with the USACE guidelines for test fill construction (USACE, EM 1110-2-2301).

The data to be collected during construction of the test fill shall include the following:

- Lift thickness of 1, 2, and 4-feet (three test fills to determine optimum lift thickness).
  - Note, maximum particle size may not allow for some test fill lift thicknesses.
- Amount of settlement after every two passes of the compactor to a maximum of 25 passes.
- Gradation and moisture content of in-place material.
- In-place fill density at completion of the test by nuclear gauge or other methods approved by the **Engineer**. For some rock fill the water replacement method may be required to assess compaction.

A curve showing change in settlement versus number of passes shall be produced from the data. This curve will be used to determine the required minimum number of passes for acceptable compaction. In general, the minimum number of passes will be that number to achieve 80 percent of the total settlement obtained after ten complete passes of the compaction equipment. Final determination by the **Engineer** of the lift thickness and minimum required passes will be based on review of the test data.

3.2.14.3. Construction Cut Placement (Maximum particle size is greater than 32-inches)

For placement of Construction Cut containing oversize particles (particles in excess of 32-inches), care shall be taken to prevent nesting of the oversize particles during placement. D Construction Cut placement in close proximity to the oversize particle shall be compacted in accordance with Sections 3.2.15.1 and 3.2.15.2. Particles exceeding 32-inches shall not constitute more than 5% of the fill volume unless otherwise approved by the **Engineer**.

3.2.14.4. Construction Cut Additional Placement Criteria

The **Contractor** shall make sure that the material placed is not rutting, pumping, or exhibiting excessive deflection during compaction under haul traffic loading. If the surface exhibits excessive deflection, the material in the area of question will require stabilization using a combination of moisture reduction through active drying and recompaction, selective placement of cleaner rock material and recompaction or other means of stabilization such as geogrid placement in these areas.

Construction Cut is to be placed in near horizontal layers with each layer being completed over the full length and breadth of the zone before placement of subsequent layers. Except in areas approved by the **Engineer**, where space is limited or as otherwise specified, Construction Cut shall be placed by routing the hauling and spreading units approximately parallel to the axis of fill. The hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their travel routes evenly over the surface of the Construction Cut to aid in compaction.

The **Contractor** will also be responsible for protecting the work from weather related degradation. Given the risk of weather related degradation is quite high during the Monsoon season, the **Contractor** should plan his work carefully to make sure that the Construction Cut is well compacted prior to rain events and that the Construction Cut is graded to allow positive drainage away from both active and completed work areas. Any degradation of the work due to weather will be remediated at the **Contractor's** expense. Placement of Construction Cut shall be temporarily suspended by the **Contractor** due to weather concerns if the materials and installation cannot comply with the guidance parameters stated above, with no cost to the **Owner**.

3.2.15. Water Treatment Plant (WTP) Filter Cake

The Water Treatment Plant (WTP) filter cake is anticipated to be hauled and placed in the TSF at a rate of approximately 8,176 cubic yards per year. It will be hauled to the TSF in approximately 20 cubic yard increments. The WTP filter cake quantity is estimated from the following:

- WTP1 Filter Cake at 3,650 cubic yards per year
- WTP2 Filter Cake (primary filter) 4,380 at cubic yards per year
- WTP2 Filter Cake (secondary filter) 146 at cubic yards per year

Material Properties - The anticipated material properties are as follows (the material properties are based on a WTP1 control sample obtained on November 20th, 2019):

- 100 percent passing (by dry weight) the no. 200 sieve.
- Non-plastic soil.
- Moisture content will be ~360% (based on dry weight of solids) upon arrival to the TSF.

Placement Methods – Upon placement in the TSF, the WTP filter cake shall be spread and dried to reduce the material moisture content. The filter cake shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (filter cake). After mixing, the material shall be moisture conditioned to within 2 percent below and 3 percent above the optimum moisture content. The material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. Slight variations from the specified moisture range above may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The WTP filter cake material shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift.

Care shall be taken to ensure that the mixed material is not rutting, pumping, or exhibiting excessive deflection during compaction under haul traffic loading. If the surface exhibits excessive deflection, the material in the area of question will require stabilization using a combination of moisture reduction through active drying and recompaction, selective placement of rock material and recompaction or other means of stabilization such as geogrid placement in these areas.

WTP filter cake material placement shall occur only in the area shown on the Drawings. To the greatest extent possible, filter cake material placement shall not be in one continuous area or layer. Placement of each load of filter cake material shall be spread out so that distance between each placement area is maximized. Placement of filter cake material shall be temporarily suspended due to weather concerns if the materials and installation cannot comply with the Technical Specifications.

The specified requirements listed above are based on index testing results from a WTP1 filter cake sample obtained on November 20th, 2019. If the filter cake material properties change or the estimated quantity of filter cake placed in the TSF increases, the **Engineer** shall be notified.

3.2.16. Core Cutting

The core cutting material will be generated from trimming core recovered from the exploration drilling process. The core cutting material is anticipated to be hauled and placed in the TSF utilizing 55 gallon drums at a rate of approximately 12 cubic yards per year.

Material Properties - The anticipated material properties are as follows (based on a control sample obtained January 2nd, 2019):

- Particle Size Distribution (by dry weight)
  - 100 percent passing the 1-inch sieve
  - 76.1 percent passing the no. 4 sieve
  - 72.3 percent passing the no. 10 sieve
  - 68.8 percent passing the no. 40 sieve
  - 64.4 percent passing the no. 200 sieve
- Material will be saturated upon arrival to the TSF.

Placement Methods – The core cutting material shall be spread and dried to reduce the material moisture content. The core cutting material shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (core cutting material). After mixing, the material shall be moisture conditioned to within 2 percent below and 3 percent above the optimum moisture content. The material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. Slight variations from the specified moisture range above may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The core cutting material shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift.

Care shall be taken to ensure that the mixed material is not rutting, pumping, or exhibiting excessive deflection during compaction under haul traffic loading. If the surface exhibits excessive deflection, the material in the area of question will require stabilization using a combination of moisture reduction through active drying and recompaction, selective placement of rock material and recompaction or other means of stabilization such as geogrid placement in these areas.

Core cutting material placement shall occur only in the area shown on the Drawings (filter cake zone). To the greatest extent possible, core cutting material placement shall not be in one continuous area or layer. Placement of each load of core cutting material shall be spread out so that distance between each placement area is maximized. Placement of core cutting material shall be temporarily suspended due to weather concerns if the materials and installation cannot comply with the Technical Specifications.

The specified requirements listed above are based on index testing results from a composite core cutting sample obtained on January 2nd, 2019. If the core cutting material properties change or the estimated quantity of core cutting placed in the TSF increases, the **Engineer** shall be notified.

Independent core cutting material quality assurance tests are not required due to the nominal quantity of core cutting material to be placed in the TSF.

3.2.17. Drill Cutting Material

The drill cutting material will be generated from exploration drilling activities. The drill cutting material is anticipated to be hauled and placed in the TSF at a rate of less than 1 cubic yards per year.

Placement Methods – The drill cutting material shall be spread and dried to reduce the material moisture content. The drill cutting material shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (drill cutting material). After mixing, the material shall be moisture conditioned to within 2 percent below and 3 percent above the optimum moisture content. The material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. Slight variations from the specified moisture range above may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The drill cutting material shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift.

Care shall be taken to ensure that the mixed material is not rutting, pumping, or exhibiting excessive deflection during compaction under haul traffic loading. If the surface exhibits excessive deflection, the material in the area of question will require stabilization using a combination of moisture reduction through active drying and recompaction, selective placement of rock material and recompaction or other means of stabilization such as geogrid placement in these areas.

Drill cutting material placement shall occur only in the filter cake zone shown on the Drawings. Placement of drill cutting material shall be temporarily suspended due to weather concerns if the materials and installation cannot comply with the Technical Specifications. If the estimated drill cutting material quantity increases, the **Engineer** shall be notified.

Independent drill cutting material quality assurance tests are not required due to the nominal quantity of drill cutting material to be placed in the TSF.

3.2.18. Sediments from Stormwater BMPs

The sediments generated from site stormwater BMPs is anticipated to be hauled and placed in the TSF at a rate of approximately 1,800 cubic yards per year. The material is assumed to be a CL or ML.

Placement Methods – The sediment material shall be spread and dried to reduce the material moisture content. The sediment material shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (sediment material). After mixing, the material shall be moisture conditioned to within 2 percent below and 3 percent above the optimum moisture content. The material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698. Slight variations from the specified moisture range above may be acceptable subject to acceptance by the **Engineer** and provided the required compacted densities are achieved. The sediment material shall be compacted with appropriate compaction equipment capable of achieving compaction through the full thickness of the lift.

Care shall be taken to ensure that the mixed material is not rutting, pumping, or exhibiting excessive deflection during compaction under haul traffic loading. If the surface exhibits excessive deflection, the material in the area of question will require stabilization using a combination of moisture reduction through active drying and recompaction, selective placement of rock material and recompaction or other means of stabilization such as geogrid placement in these areas.

Sediment material placement shall occur only in the area shown on the Drawings (filter cake zone). To the greatest extent possible, sediment material placement shall not be in one continuous area or layer. Placement of each load of sediment material shall be spread out so that distance between each placement area is maximized. Placement of sediment material shall be temporarily suspended due to weather concerns if the materials and installation cannot comply with the Technical Specifications. If the estimated sediment material quantity increases, the **Engineer** shall be notified.

3.2.19. Growth Media

Growth media will consist of organic soils placed during closure to provide a medium for plant growth. Growth media sources shall be designated by the **Owner** and approved by the **Engineer** prior to placement.

Placement Methods – Growth media shall be hauled and spread to the lines, grades, and in areas shown on the Drawings. Materials shall be placed in a 24 inch non-compacted lift. The finished surface of the growth media material shall be scarified or harrowed to allow for proper seed placement and plant growth.

3.3. Finished Surface Preparation of Areas to Receive Geosynthetics

Areas to receive geosynthetics shall be approved subgrade free of angular particles over 3/4-inch diameter and hard objects that may damage the geosynthetic. Where excessive coarse material is exposed at the surface, rock removal by appropriate methods or other surface finishing as directed by the **Engineer** will be required. Rough areas with depressions or loose material shall be covered with a cushion of fine-grained materials or for large depressions, with screened, low permeability soil layer material (passed over ½--inch mesh screen) or equivalent.

Once the **Contractor** believes that the surface preparation is complete, an inspection will be completed by the Geomembrane Installer, **Engineer**, and **Owner** with the **Contractor** present. Any areas requiring repairs shall be fixed by the **Contractor** at no cost to the **Owner**.

3.4. Compaction Equipment

Sufficient compaction equipment of the types and sizes required to complete the work shall be provided for compaction of the various fill materials. The use of alternative equipment will be dependent upon completion of suitable test fills to the satisfaction of the **Engineer** to confirm that the alternative equipment will compact the fill materials to the specified density.

Compaction equipment shall be maintained in good working condition at all times to ensure that the amount of compaction obtained is a maximum for the equipment. The **Contractor** shall provide the **Owner** and **Engineer** a list of proposed compaction equipment to be used before commencing Work.

3.4.1. Smooth Drum Vibratory Roller

Smooth drum vibratory rollers shall be equipped with a suitable cleaning device to prevent the accumulation of material on the drum during rolling. Each roller shall have a total static weight of not less than 20,000 pounds at the drum when the roller is standing on level ground. The drum shall be not less than 60-inches in diameter and 78-inches in width. The vibration frequency of the roller drum during operation shall be between 1,100 and 1,500 vibrations per minute, and the centrifugal force developed by the roller, at 1,250 vibrations per minute, shall not be less than 38,000 pounds.

For compaction by the vibratory roller, a single coverage shall be defined as one pass of the roller. A minimum overlap of 12-inches shall be maintained between the surfaces traversed by adjacent passes of the roller drum. During compaction, the roller shall be propelled at 2 miles per hour (mph) or lesser speed as approved by the **Engineer**. The power of the motor driving the vibrator shall be sufficient to maintain the specified frequency and centrifugal force under the most adverse conditions that may be encountered during the compaction of the fill. Propulsion equipment for the roller shall be adequate to propel the roller at speeds up to 4 mph.

3.4.2. Tamping-Foot or Sheep's-foot Roller

The majority of the fill may be compacted with a tamping-foot or sheepsfoot roller. The tamping foot roller shall be self-propelled and fully ballasted with a standard tamping-foot design developing 5,000 pounds in force per linear foot of width at rest on level ground or equivalent as approved by the **Engineer**.

3.4.3. Special Compactors

Special compactors shall be used to compact materials that, in the opinion of the **Engineer**, cannot be compacted properly by the specified larger vibratory roller because of location or accessibility.

Special compaction measures shall be adopted such as hand-held or small walk behind compactors or other methods approved by the **Engineer** to compact fill in trenches, around structures, and in other confined areas that are not accessible to the larger vibratory roller or tamping-foot roller. Such compaction shall be to the specified density for the particular material.

4. CONSTRUCTION TOLERANCES

The **Contractor** shall construct the various aspects of the project to the lines and grades shown on the Drawings, or as required by the **Engineer**, within the following tolerances:

- Finish grades and slopes for the TSF shall be in general conformance with the Drawings. Deviations from finished grades and slopes are subject to approval by the **Engineer** and shall not result in low spots, pockets, non-uniform slopes or result in slopes, which deviate by more than 4 inches from the design. The overall slope needs to be the same as shown on the Drawings.

- Finish grades and slopes for diversion channels shall be in general conformance with the Drawings. Deviations from finished grades and slopes are subject to approval by the **Engineer** and shall not result in flat or low spots, pockets, non-uniform slopes, or channel grades, which deviate by more than 2 inches from the design. The overall slope needs to be the same as shown on the Drawings.
- The maximum permissible combined horizontal and vertical deviation of the perimeter boundaries of the TSF and channels from the lines and grades shown on the Drawings or as required by the **Engineer** shall be 12-inches.
- The finished surface of the TSF shall not deviate vertically by more than 4-inches from the lines and grades shown on the drawings.
- All pipes shall be constructed to the following tolerances: alignment and grade shall not deviate from manufacturer recommendations and more than 5 percent of the nominal diameter of the pipe from a straight line between control points.

5. QUALITY ASSURANCE

The **CQA** will take samples of fill materials and perform gradation, moisture content, Atterberg limits and Proctor moisture density tests on the materials to establish engineering parameters for each material type. During material placement, field density tests on the compacted fill and any other tests that the **Engineer** considers necessary to ensure that the fill being placed meets the specified requirements. The results of the tests carried out by the **CQA** will be final and conclusive in determining compliance with the Technical Specifications. Test Methods are listed in Table 1 of Section 6.

Each lift of fill will be approved by the **CQA** prior to placement of additional fill materials. Sufficient time shall be allowed by the **Contractor** for the **CQA** to carry out the required test work and interpret the test results in order to determine the acceptability of each lift. Cooperation shall be given by the **Contractor**, to the **Owner** and the **Engineer** and the **CQA**, for taking samples or making tests, and such assistance shall be rendered as is necessary to enable sampling and testing to be carried out expeditiously.

Tests carried out by the **CQA** will be performed in accordance with the latest test methods prescribed by ASTM and other such recognized industry standards. The tests shall include Control (borrow source samples and samples taken on the fill prior to compaction) and Record Tests (samples taken on the fill after compaction).

5.1. Control Tests

Tests for gradation, moisture content, moisture density relationship (Proctor compaction test) and other tests where applicable will be made by the **CQA** on samples of fill materials taken from borrow areas and on the fill material after spreading but prior to compaction. Samples will be tested at the minimum frequencies listed in Section 6 in order to ensure that the fill material is in full compliance with the Technical Specifications. Materials not meeting specified material properties shall be reworked or rejected until passing results are achieved.

5.2. Record Tests

The **CQA** will conduct field density, moisture content, and other tests on the compacted in-place fill and will obtain samples of the compacted fill for related laboratory testing at such frequency as the **Engineer** considers necessary to determine that the compacted fill is in full compliance with the Technical Specifications. Areas with failing field tests shall be reworked until passing tests are achieved. Holes created from field-testing of low permeability soil layer material shall be backfilled with a mixture of soil and bentonite at a 5:1 ratio, respectively or alternatively by bentonite powder.

6. TESTING FREQUENCIES

The **CQA** will carry out frequent quality control and quality assurance tests to determine compliance of the Work with the Technical Specifications.

The latest edition of standard procedures shall be used for all activities, and in general, these will be adopted from recognized organizations such as ASTM. The following tables outline the test methods and the minimum testing requirements for the project:

Table 1: Test Methods

Test	Type of Test	Test Method (ASTM)
C1, R1	Atterberg Limits	D4318
C2, R2	Moisture Content	D6938
C3, R3	Particle Size Distribution	D6913 [a]
C4, R4	Laboratory Compaction-Mod. Proctor	D1557
R5a	Nuclear Density	D6938
R5b	Sand Cone	D1556
R5c	Water Replacement	D5030
C6, R6a	Laboratory Permeability	D5084/ USBR 5600/ USBR 5605
R6b	Air Entry Permeameter	D5126
C7	Acid Generating Potential	EPA M600/2-78-054 3.2.3
C8, R8	Rigid Wall Falling Permeability	USBR 5600 /USBR 5605
R9	Wolman Count	USDOT FLH T521
R10	Consolidated Undrained Triaxial Compression	D4767

Notes: C = Control Tests; R = Record Tests

[a] Hydrometer tests down to the 2-micron size will be carried out in accordance with ASTM D7928 as directed by the QA Engineer but will generally not be required; all samples to be washed over a No.200 sieve.

Table 2: Test Frequency – Prepared Surfaces

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	Soil Type/ 500,000 ft^2
C2, R2	Moisture Content	100,000 ft^2
C3, R3	Particle Size Distribution	Soil Type / 500,000 ft^2
C4, R4	Laboratory Compaction	Soil type
R5a	Nuclear Density	100,000 ft^2
R5b/R5c	Sand Cone or Water Replacement Density	1/30 Nuclear Density Tests

Note: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests.

Table 3: Test Frequency – Engineered Fill

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	15,000 yd^3
C2, R2	Moisture Content	5,000 yd^3
C3, R3	Particle Size Distribution	15,000 yd^3
C4, R4	Laboratory Compaction	Soil type or every 100,000 yd^3
R5a	Nuclear Density	5,000 yd^3
R5b/R5c	Sand Cone or Water Replacement Density	50,000 yd^3
Note: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests. If material is too coarse for testing per ASTM, then use test fill method per USACE EM 1110-2-2301.		

Table 4: Test Frequency – Low Permeability Soil Layer

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	Lesser of Soil type or every 10,000 yd^3
C2, R2	Moisture Content	2,000 yd^3
C3, R3	Particle Size Distribution	10,000 yd^3
C4, R4	Laboratory Compaction	Lesser of Soil type or every 100,000 yd^3
R5a	Nuclear Density	2,000 yd^3
R5b	Sand Cone Density	20,000 yd^3
R6	Laboratory Permeability	200,000 yd^3
Note: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests.		

Table 5: Test Frequency – Protective Layer

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	7,500 yd^3
C3, R3	Particle Size Distribution	7,500 yd^3
C8, R8	Rigid Wall Falling Permeability	20,000 yd^3
Note: Sample sizes to be sampled in accordance with ASTM standards.		

Table 6: Test Frequency – Drainage Aggregate

Test	Type of Test	Minimum Frequency (one per)
C3, R3	Particle Size Distribution	7,500 yd^3
C6, R6	Laboratory Permeability	37,500 yd^3
C9	Acid Generating Potential	1 per source or as requested by **Engineer**
Note: Sample sizes to be sampled in accordance with ASTM standards.		

Table 7: Test Frequency – Road Wearing Course

Test	Type of Test	Minimum Frequency (one per)
R1	Atterberg Limits	2,000 yd^3
R3	Particle Size Distribution	2,000 yd^3
R5a	Nuclear Density	1 per 500 ft of roadway

Table 8: Test Frequency – Pipe Backfill and Pipe Bedding

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	Soil type/5,000 yd^3 or 1 per structure
C2, R2	Moisture Content	per nuclear density requirements
C3, R3	Particle Size Distribution	5,000 yd^3 or 1 per structure
C4, R4	Laboratory Compaction	Soil type/25,000 yd^3
R5a	Nuclear Density	Greater of 2 per major foundation / 500 yd^3 *
R5b	Sand Cone Density	every 20 nuclear density tests
***Frequency of testing for backfill for minor foundations shall be determined by the Project Field Engineer**		

Table 9: Test Frequency – Riprap

Test	Type of Test	Frequency (one per)
Visual Inspection and Documentation		Continuous during placement
R9	Wolman Count	One per size and every 5,000 yd^3
Note: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests.		

Table 10: Test Frequency – Rock Armor

Test	Type of Test	Minimum Frequency (one per)
C3, R3	Particle Size Distribution	5,000 yd^3

Table 11: Test Frequency – Development Rock

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	15,000 yd^3
C2, R2	Moisture Content	5,000 yd^3
C3, R3	Particle Size Distribution	15,000 yd^3
C4, R4	Laboratory Compaction	Soil type or every 100,000 yd^3
R5a	Nuclear Density	5,000 yd^3
R5b/R5c	Sand Cone or Water Replacement Density	50,000 yd^3
Notes: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests. If material is too coarse for testing per ASTM, then use test fill method per USACE EM 1110-2-2301.		

Table 12: Test Frequency – Construction Cut

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	15,000 yd^3
C2, R2	Moisture Content	5,000 yd^3
C3, R3	Particle Size Distribution	15,000 yd^3
C4, R4	Laboratory Compaction	Soil type or every 100,000 yd^3
R5a	Nuclear Density	5,000 yd^3
R5b/R5c	Sand Cone or Water Replacement Density	50,000 yd^3
Notes: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests. If material is too coarse for testing per ASTM, then use test fill method per USACE EM 1110-2-2301.		

Table 13: Test Frequency – WTP Filter Cake (WTP1 and WTP2)

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	2,000 yd^3
C2, R2	Moisture Content	1,000 yd^3
C3, R3	Particle Size Distribution	2,000 yd^3
C4, R4	Laboratory Compaction	Soil type or every 15,000 yd^3
R5a	Nuclear Density	1,000 yd^3
R5b/R5c	Sand Cone or Water Replacement Density	15,000 yd^3
R10	CU Triaxial Compression	Annually or 3,500 yd^3
Notes: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests. If material is too coarse for testing per ASTM, then use test fill method per USACE EM 1110-2-2301.Testing frequencies shall only apply when WTP filter cake material is placed as a mixture with tailings and/or on site native borrow material that is less than 30% rock by weight (materials above ¾-inch size). When WTP filter cake is mixed with exploration decline development rock or any material containing more than 30% rock, the placement method shall adhere to the technical specifications developed for placement of exploration decline development rock in the TSF.		

Table 14: Test Frequency – Sediment from Stormwater BMPs

Test	Type of Test	Minimum Frequency (one per)
C1, R1	Atterberg Limits	2,000 yd^3
C2, R2	Moisture Content	1,000 yd^3
C3, R3	Particle Size Distribution	2,000 yd^3
C4, R4	Laboratory Compaction	Soil type or every 15,000 yd^3
R5a	Nuclear Density	1,000 yd^3
R5b/R5c	Sand Cone or Water Replacement Density	15,000 yd^3
R10	CU Triaxial Compression	Annually or 2,000 yd^3
Notes: Required number of tests shall be determined by whichever method of determining the frequency requires the most tests. If material is too coarse for testing per ASTM, then use test fill method per USACE EM 1110-2-2301.Testing frequencies shall only apply when sediment material is placed as a mixture with tailings and/or on site native borrow material that is less than 30% rock by weight (materials above ¾-inch size). When sediment material is mixed with exploration decline development rock or any material containing more than 30% rock, the placement method shall adhere to the technical specifications developed for placement of exploration decline development rock in the TSF.		

GEOTEXTILE
Technical Specifications

NewFields	CLIENT ARIZONA MINERALS INC (AMI)					PROJECT NO 475.0014.022
PROJECT	HERMOSA LINED TAILINGS STORAGE FACILITY (TSF) DESIGN AMENDMENT					
TITLE	TECHNICAL SPECIFICATIONS FOR GEOTEXTILE MATERIALS AND CONSTRUCTION					**SPECIFICATION NO.** 0014-SPT-GT
			APPROVALS			
REV	**DATE**	**PAGES**	**AUTHOR**	**REVIEW**	**CLIENT**	**REMARKS**
0	07/17/20	9	CMT	RMS		Issued for Tender

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1. GENERAL

1.1. Scope

This specification defines the requirements for geotextile materials, installation, and quality control for use as a protection (cushioning) material and as a separation material associated with the Arizona Minerals Inc (AMI) (**Owner**) Hermosa Lined Tailings Storage Facility (TSF) Design Amendment project.

Any alternatives or exceptions to this specification shall be submitted in writing to the **Owner** or its designated representatives and shall be approved by the **Engineer**.

The owner's engineer shall control the quality of construction and shall verify that all construction elements have been completed in accordance with Design Drawings and Technical Specifications.

1.2. Definition of Terms

- "**Owner**" is defined as AMI or any of its authorized representative(s) / agent(s).
- "**Engineer**" is defined as the **Consultant** or **Engineering Company** (NewFields) responsible for the detailed design or any of its authorized representative(s)/ agent(s).
- **"Construction Manager"** is defined as the **Consultant** or **Engineering Company** (to be determined) responsible for the overall project completion.
- "**Construction Quality Assurance (CQA)**" is defined as the **Consultant** or **Engineering Company** (to be determined) hired by the **Owner** to provide independent inspection and testing services for the overall project.
- "**Contractor**" is defined as the party(s) that has executed the contract agreement for the specified Work with the **Owner** or its authorized representative(s)/agent(s).
- "Specifications" are defined as this document, all supplemental addenda, and any modifications furnished by the **Owner**, the **Engineer**, or others that apply to the Work.
- "Drawings" are defined as the "Issued for Tender" Drawings for the Hermosa Lined TSF Design Amendment project furnished by the **Owner**, **Engineer**, or others that apply to the Work.
- "Site" is defined as the area being developed by the **Owner** and where the Work is to be completed as described in these Technical Specifications and detailed on the Drawings.
- "Contract" is defined as the document executed by the **Owner** or its authorized representative(s)/agent(s) with the **Contractor** to complete specified portions of the Work.
- "Work" is defined as the entire completed construction or the various separately identifiable parts thereof required to be furnished as shown on the Drawings and as described in the Specifications and Contract Documents.

- "Modifications" are defined as changes made to the Specifications or the Drawings that are approved by **Owner** and **Engineer** in writing, after the Specifications and Drawings have been issued for construction. These also refer to changes to design elements in the field to account for unforeseen conditions.
- "Plant" is defined as all equipment, supplies, accommodations, temporary offices, etc., required to complete the Work.
- "Units" – In general, these Specifications and the Drawings will utilize Imperial units, however Metric units will be used when appropriate.

1.3. References

1.3.1. American Society for Testing and Materials (ASTM):

- ASTM D4354-12 (2020): Practice for Sampling of Geosynthetics for Testing
- ASTM D4491-17: Standard Test Method for Water Permeability of Geotextiles by Permittivity
- ASTM D4533-15: Test Method for Trapezoidal Tearing Strength of Geotextiles
- ASTM D4632-15a: Test Method for Grab Breaking Load and Elongation of Geotextiles
- ASTM D4751-20: Standard Test Method for Determining Apparent Opening Size of a Geotextile
- ASTM D4759-11 (2018): Practice for Determining the Specification Conformance of Geosynthetics
- ASTM D4873-17: Guide for Identification, Storage and Handling of Geotextiles
- ASTM D5261-10 (2018): Test Method for Measuring Mass per Unit Area of Geotextiles
- ASTM D5494-93 (2018): Test Method for the Determination of Pyramid Puncture Resistance of Unprotected and Protected Geomembranes
- ASTM D6241-14: Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Product Using a 50-mm Probe
- ASTM D7238-06 (2017): Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Apparatus

1.3.2. American Association of State Highway and Transportation Officials (AASHTO):

- M288-17: Geotextile Specification for Highway Applications

1.3.3. Geosynthetic Research Institute (GRI):

- GRI GT12(a) Revision 2 dated March 3, 2016: Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials

- GRI GT13(a) Revision 4 dated June 20, 2017: Test Methods and Properties for Geotextiles Used as Separation between Subgrade Soil and Aggregate

1.4. Submittals Post-Award

- Prior to material delivery to the project site, the **Contractor** shall provide the **Engineer** with a written certification or manufacturers quality control data which displays that the geotextile meets or exceeds the values specified herein.
- The **Contractor** shall submit, if required by the **Engineer**, manufacturer's quality control manual for the geotextile to be delivered to the site.

1.5. Submittals during Manufacturing

- Manufacturer quality control certificates stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile.
- The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the Specification. Documentation describing the quality control program shall be made available upon request.
- The manufacturer's certificate shall state that the finished geotextile meets the minimum average roll value (MARV) requirements of the Specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.
- Mislabeling or misrepresentation of materials shall be reason to reject those geotextile products.

1.6. Shipment, Storage and Handling

- Geotextile labelling, shipment and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
- Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight, and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.
- During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C), and any other environmental condition that may damage the property values of the geotextile.

2. PRODUCT

2.1. Geotextile

- The nonwoven needle punched geotextile specified herein shall be made from staple fiber.
- The geotextile shall be of new prime quality virgin polymer of 100-percent polyethylene (97-percent polypropylene and 3-percent carbon black with antioxidants and heat stabilizers), or polyester/polypropylene blend designed and manufactured specifically for the purpose of separation, tensile reinforcement, planar flow, filtration and protection and shall be used as designated on the Drawings.
- The geotextile shall be able to withstand direct exposure to ultraviolet radiation from the Sun for up to 15 days without any noticeable effect on index or performance properties.
- Rolls shall be free of holes, contamination, and foreign debris.
- Geotextile shall meet or exceed all material properties listed herein based on the specific purpose and expected conditions.

Table 1 – Required Properties, Test Methods and Values for Geotextiles Used as Geomembrane Protection (or Cushioning) Materials

Property[1]	Test Method ASTM	Unit	Mass/Unit Area (oz/yd^2)					
Mass per unit area	D5261	oz/yd^2	10	12	16	24	32	60
Puncture (pyramid) strength	D5494	lb	300	320	410	440	510	760
Puncture (CBR) strength	D6241	lb	700	800	900	1100	1700	2400
Puncture (CBR) elongation	D6241	in	1.5	1.5	1.5	1.5	1.5	1.5

Notes: 1) All values are MARV except UV resistance which is a minimum value. For geosynthetics, MARV is a manufacturing quality control tool used to establish published values such that the purchaser will have a 97.7% confidence that the property in question will meet published values. For normally distributed data, "MARV" is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.
2) Evaluation to be on 2.0-inch strip tensile specimens after 500 lt. hour's exposure.

- For the purposes of separation, the geotextile shall meet the minimum required values as defined in the Tables 2, 3 and 4 below with the exception of AOS which is maximum average roll value (MaxARV) and UV stability which is a minimum average value:

Table 2– Geotextile Properties Class 1 (High Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D4632	lb	315	203
Trapezoid Tear Strength	D4533	lb	112	79
CBR Puncture Strength	D6241	lb	630	440
Permittivity	D4491	sec^{-1}	0.02	0.02
Apparent Opening Size	D4751	in	0.024	0.024
UV Stability[2]	D7238	% Str. Ret. @ 500 lt. hours	80	80

Notes: 1) All values are MARV except UV resistance which is a minimum value. For geosynthetics, MARV is a manufacturing quality control tool used to establish published values such that the purchaser will have a 97.7% confidence that the property in question will meet published values. For normally distributed data, "MARV" is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.
2) Evaluation to be on 2.0-inch strip tensile specimens after 500 lt. hour's exposure.

Table 3 – Geotextile Properties Class 2 (Moderate Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D4632	lb	248	158
Trapezoid Tear Strength	D4533	lb	90	56
CBR Puncture Strength	D6241	lb	500	320
Permittivity	D4491	sec^{-1}	0.02	0.02
Apparent Opening Size	D4751	in	0.024	0.024
UV Stability[2]	D7238	% Str. Ret. @ 500 lt. hours	70	70

Notes: 1) All values are MARV except UV resistance which is a minimum value. For geosynthetics, MARV is a manufacturing quality control tool used to establish published values such that the purchaser will have a 97.7% confidence that the property in question will meet published values. For normally distributed data, "MARV" is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.
2) Evaluation to be on 2.0-inch strip tensile specimens after 500 lt. hour's exposure.

Table 4– Geotextile Properties Class 3 (Low Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation ≥ 50%
Grab Tensile Strength	D4632	lb	180	113
Trapezoid Tear Strength	D4533	lb	68	41
CBR Puncture Strength	D6241	lb	380	230
Permittivity	D4491	sec^{-1}	0.02	0.02
Apparent Opening Size	D4751	in	0.024	0.024
UV Stability[2]	D7238	% Str. Ret. @ 500 lt. hours	60	60

Notes:
1) **All values are MARV except UV resistance which is a minimum value. For geosynthetics, MARV is a manufacturing quality control tool used to establish published values such that the purchaser will have a 97.7% confidence that the property in question will meet published values. For normally distributed data, "MARV" is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.**
2) **Evaluation to be on 2.0-inch strip tensile specimens after 500 lt. hour's exposure.**

Table 5 – Required Degree of Survivability as a Function of Subgrade Conditions, Construction Equipment and Lift Thickness (Class 1, 2 and 3 Properties are Given in Table 3, 4 and 5; Class 1+ Properties are Higher than Class 1 but Not Defined at this Time)

	Low ground-pressure equipment ≤ 25 kPa (3.6 psi)	**Medium ground-pressure equipment > 25 to ≤ 50 kPa (> 3.6 to ≤ 7.3 psi)**	**High ground-pressure equipment > 50 kPa (> 7.3psi)**
Subgrade has been cleared of all obstacles except grass, weeds, leaves and fine wood debris. Surface is smooth and level so that any shallow depressions and humps do not exceed 450 mm (18 in.) in depth or height. All larger depressions are filled. Alternatively, a smooth working table may be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 450mm (18 in.) in depth or height. Larger depressions should be filled.	Moderate (Class 2)	High (Class 1)	Very High (Class 1+)
Minimal site preparation is required. Trees may be felled, delimbed, and left in place. Stumps should be cut to project not more than ± 150mm (6 in.) above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High (Class 1)	Very High (Class 1+)	Not Recommended

***Recommendations are for 150 to 300 mm (6 to 12 in.) initial lift thickness. For other initial lift thicknesses:**
300 to 450mm (12 to 18 in.): reduce survivability requirement one level.
450 to 600mm (18 to 24 in.): reduce survivability requirement two levels.
>600mm (24 in.): reduce survivability requirement three levels.
Note 1: While separation occurs in every geotextile application, this pavement-related specification focuses on subgrade soils being "firm" as indicated by CBR values higher then 3.0 (soaked) or 8.0 (un-soaked).
Source: Modified after Christopher, Holtz, and DiMaggio

3. EXECUTION

3.1. Quality Assurance

- The **Engineer** or **CQA** shall examine the geotextile rolls upon delivery to the site and report any deviations from project Specifications to the **Contractor**.
- The **Engineer** may decide to arrange conformance testing of the rolls delivered to the job site. For this purpose, the **Engineer** shall take a sample three feet (along roll length) by roll width according to ASTM D4354. The sample shall be properly marked, wrapped, and sent to an independent laboratory for conformance testing.
- The pass or fail of the conformance test results shall be determined according to ASTM D4759.

3.2. Installation

- The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Should the **Contractor** damage the geotextile to the extent that it is no longer usable as determined by these Specifications or by the **Engineer** or **CQA**, the **Contractor** shall replace the geotextile at his own cost.
- The geotextile shall be installed to the lines and grades as shown on the contract drawings and as described herein.
- The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self-weight. The geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.
- In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.
- The **Contractor** shall take necessary precautions to prevent damage to adjacent or underlying materials during placement of the geotextile. Should damage to such material occur due to the fault of the **Contractor**, the **Contractor** shall repair the damaged materials at his own cost and to the satisfaction of the **Engineer**.
- During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the **Engineer** or **CQA**.
- The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sun light for more than 15 days after installation.
- The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the **Engineer**. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat seaming, fusion welding techniques recommended by the manufacturer shall be used.
- The **Contractor** shall not use heavy equipment to traffic above the geotextile without approved protection.
- The geotextile shall be covered as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.
- Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.
- Holes in the geotextile material shall be repaired using a patch of identical material extending a minimum 6 inches on all sides of the hole and heat bonded. If heat bonding is not possible, the patch shall extend a minimum of 18 inches on all sides of the hole.

- In areas where the non-woven geotextile is used as separation or filtration, care shall be taken to install the layer without producing holes or gaps where the migration of fines could occur. This is accomplished by ensuring sufficient overlap of seams of 18-inches minimum and properly wrapping the edges of the geotextile under the gravel areas being protected or by over running the edges of the geotextile beyond the area requiring separation or filtration.

4. CERTIFICATION

At the completion of the geotextile installation, the **Contractor** shall provide the **Owner** with a certification stating that the geotextile was installed and tested in accordance with the Specifications together with a report of the test results. The certification shall be provided to the **Owner** prior to the demobilization of the installation personnel from the site unless agreed otherwise by the **Owner**. The report of the test results shall be provided in hard copy and digital format to the **Owner** and the **Engineer** no later than 30 days after the installation work has been completed.

APPENDIX H

Water Balance

Ecological Resource Consultants, Inc.
225 Union Blvd, Suite 325 ~ Lakewood, CO ~ 80228 ~ (303) 679-4820

Technical Memorandum

Date: August 13, 2020

To: Craig Thompson, NewFields Mining & Design Services

From: Troy Thompson and James Koehler

Re: TSF Water Balance Assessment

1.0 Introduction

Ecological Resource Consultants, Inc. (ERC) was retained by NewFields Mining & Design Services (NewFields) to conduct a water balance analysis of the TSF Amended Design and related facilities at the Arizona Minerals, Inc. (AMI) property located near Patagonia, AZ. Models were set up to evaluate adequacy of the water systems given two different conditions. One evaluates Interim Conditions (current) in the TSF while the second is based on the future TSF Amended Design geometry. Models include two water storage facilities: the existing Underdrain Collection Pond (UDCP) and the existing External Detention Pond (EDP). Inflows to the facilities include runoff from different land types, inflows from mine workings and inflow from the Exploration Decline. Water release occurs via pumping to the existing water treatment plant. The purpose of this water balance analysis is to evaluate the fluctuation of water volumes in the UDCP and EDP to illustrate that their capacities, combined with anticipated inflows and water treatment rates, are suitable for containment for both current and future conditions. Results obtained from the water balance modeling efforts are presented below.

2.0 Objectives

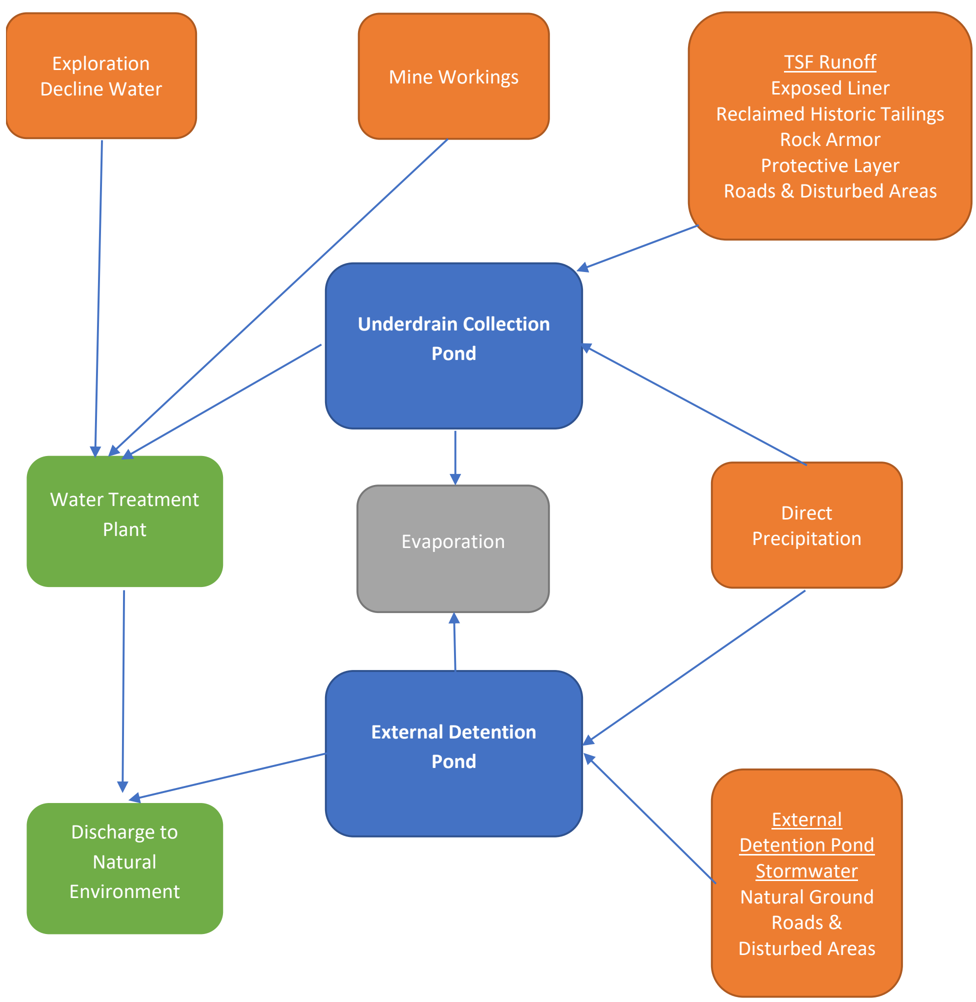
The water balance is an important planning and operational consideration of this project. Environmental regulations prohibit the release of contact water (water that comes into contact with tailings or other potentially contaminated workings) to the natural environment. To meet this requirement, the systems must be sized correctly. An understanding of water volume fluctuations in the ponds given different potential meteorological conditions from year-to-year and at different times of the year is critical to managing the water within the system.

Water volumes in the UDCP are dependent on the configuration of the TSF pad, the runoff characteristics of exposed areas (i.e. geomembrane, reclaimed historic tailings, protective layer, etc.) and daily precipitation and evaporation rates. Other factors that impact the water balance include: 1) the use of the EDP to capture runoff from upland areas tributary to the UDCP and 2) inflows to the UDCP from mine workings and the Exploration Decline. The water balance model was developed as a tool to aid in water management and assist with future water management decisions.

3.0 Water Balance Components

The water balance model was configured based on a daily time-step and tracks inflows to and losses from the system. The model calculates the daily storage in the UDCP and EDP and daily water treatment requirements. **Figure 3.1** shows a schematic of the overall water balance as it is configured in the model.

Figure 3.1. Water Balance Model Schematic



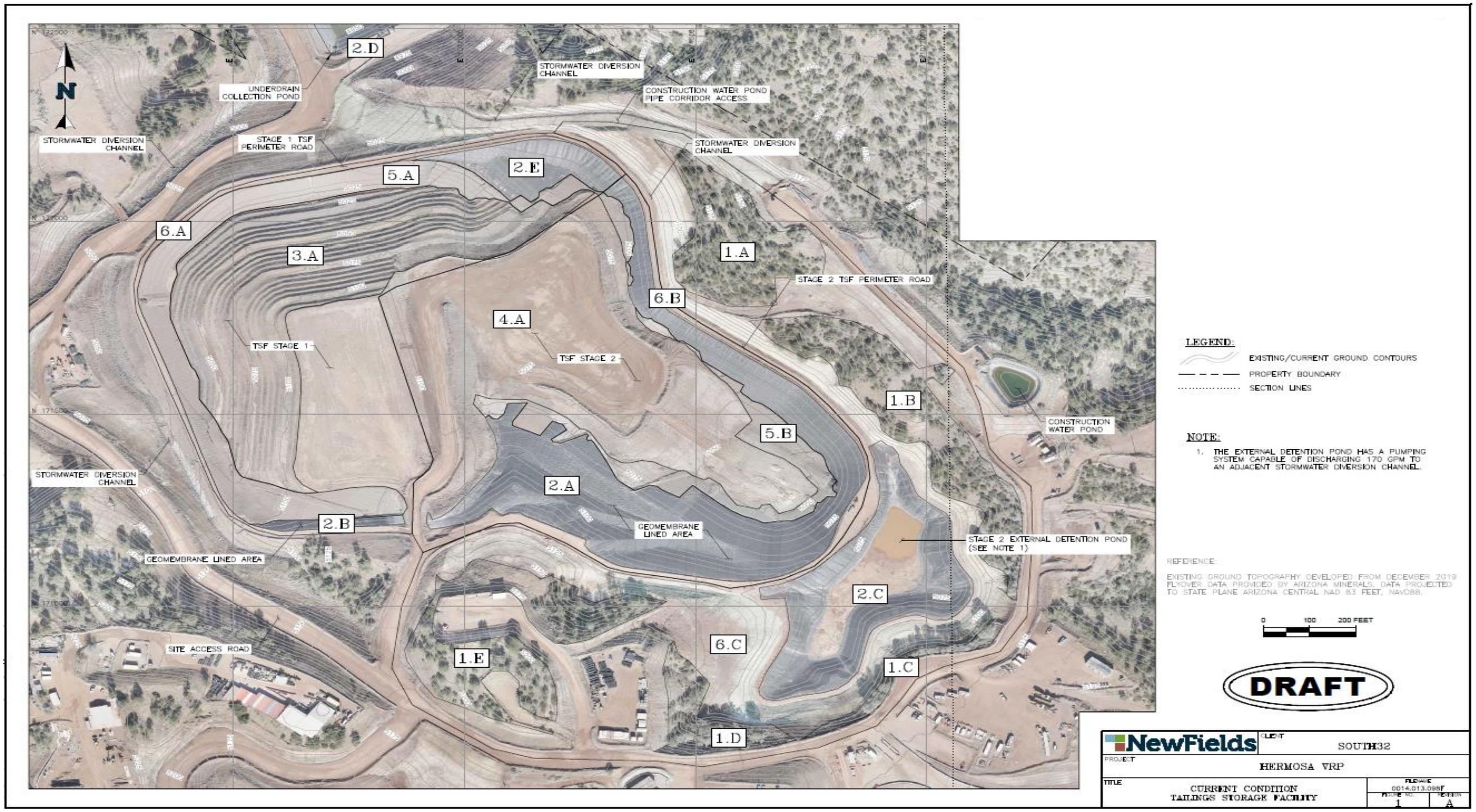
3.1 Water Balance Components

The water balance incorporates water inputs into the system based on the two different conditions: the Interim VRP TSF and the final TSF Amended Design. Inputs that contribute water to the UDCP include direct rainfall on the pond and runoff from the TSF. Runoff from the TSF is subdivided into runoff based on the various up-gradient land types and include the exposed geomembrane, reclaimed historic tailings surface, a rock armor layer, a protective layer placed over geomembrane liner and disturbed lands and roads. The area of each of these parameters differs from the Interim VRP TSF to the TSF Amended Design conditions. All water that enters the TSF/UDCP is considered contract water which requires treatment before it can be released. The existing water treatment plant has a treatment capacity is 120 gallons per minute (gpm) which was used in the model. In addition to treatment, water from the UDCP is eliminated from the system through evaporation.

The EDP, which is located upgradient of the TSF, helps to reduce the total volume of water entering the TSF/UDCP. It captures water that is considered non-contact water. Inputs to EDP include direct precipitation on the pond, runoff from natural ground surfaces and runoff from disturbed lands and roads. Evaporation from the pond surface reduces the total stored water volume. Also, as water reporting to the EDP is non-contact, it is pumped from the pond and released to the environment. A pumping capacity of 170 gpm from EDP was modeled.

The model tracks normal daily inflows and runoff to the UDCP and EDP. Pond storage volumes are tracked against capacities and water treatment rates are calculated. A site map prepared by NewFields showing the different elements and their locations is provided as **Figure 3.2**.

Figure 3.2. Site Map



4.0 Model Assumptions / Inputs

4.1 Facility Areas

The areas contributing runoff and direct precipitation to the UDCP and EDP for the current interim condition and the future TSF Amended Design were input to the water balance model. The various tributary land types, areas and Natural Resources Conservation Service (NRCS) Curve Number (CN) used to model runoff characteristics are provided in **Table 4.1**. Any minor difference in total area between the Interim VRP TSF and TSF Amended Design conditions are due to rounding.

Table 4.1. Tributary Areas and Associated Curve Numbers

Contributes Flow To	Land Type	Interim VRP TSF Condition Areas (ft^2)	TSF Amended Design Areas (ft^2)	Curve Number
UDCP	Underdrain Collection Pond	80,760	80,760	100
	TSF Exposed Geomembrane	267,040	0	100
	TSF Reclaimed Historic Tailings	482,560	0	95
	TSF Rock Armor	262,400	1,014,450	85
	TSF Protective Layer	184,920	146,410	72
	Roads & Disturbed Areas in TSF	67,400	103,500	94
	Total Area Reporting to UDCP	**1,345,080**	**1,345,120**	NA
EDP	EDP	134,700	134,700	100
	Natural Ground to EDP	314,760	314,760	72
	Roads & Disturbed Areas to EDP	552,810	552,810	94
	Total Area Reporting to EDP	**1,002,270**	**1,002,270**	NA

4.2 Climatologic and Hydrologic Inputs

4.2.1 Precipitation

The goal of the water balance model is to evaluate fluctuations in the water systems on a day-to-day basis. For this reason, the best way to accomplish this was to utilize actual daily site precipitation. Daily precipitation values for the site from 2008-2019 were provided by AMI. The water balance model was therefore set up to evaluate conditions over a twelve-year period where precipitation mimics actual values from 2008 – 2019. **Table 4.2** presents precipitation totals for each month and year in the period of record.

It is worth noting that 2017 contained an extreme wet period that included several extreme precipitation events in July of that year's monsoon. A peak daily precipitation amount of 4.56 inches was recorded on July 22nd. In the seven days from July 16 – July 22, a total of 12.39 inches of rainfall was recorded including

3.47 inches on July 16th. For comparison, the 24-hour duration storm depths at the site for the 25-year, 50-year and 100-year storm events are 3.93 inches, 4.40 inches and 4.88 inches, respectively (ERC 2017). The 30-day stretch between July 12th and August 10th produced 18.1 inches of rainfall.

To evaluate the likelihood that the site might see an event like the 2017 monsoon in the future, ERC consulted NOAA's online Atlas 14 Volume 1. This website publishes precipitation estimates for any location in the semi-arid southwestern United States. The estimates include annual maximum precipitation for 5-minute through 60-day durations at average recurrence intervals of 1-year through 1,000-year (NOAA). **Appendix A** contains a table with these results for the mine location. According to the table, the average precipitation depth for a 7-day, 1,000-year storm at the site is 10.8 inches. In other words, the maximum 7-day total in 2017 exceeded the 7-day, 1,000-year storm. This means there is less than a 0.1% chance in any given year that the site will experience a 7-day precipitation total exceeding the 12.39 inches seen in July 2017. Furthermore, the average precipitation depth for a 30-day, 1,000-year storm at the site is 17.2 inches. Therefore, the maximum 30-day total in 2017 exceeded the 30-day, 1,000-year storm. This means there is less than a 0.1% chance in any given year that the site will experience a 30-day precipitation total exceeding the 18.1 inches seen in July-August 2017.

Capturing this extreme monsoon in the model provides valuable information on how the system would respond in an extreme wet condition. For the table below, site precipitation was missing for January 1 – February 6, 2018 (except for February 2nd). Data from 2017 was used to fill in the missing days.

Table 4.2. Monthly Precipitation Totals (2008-2019) in inches

Month	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Avg
Jan	0.87	0.25	4.78	0.27	1.54	1.54	0.01	2.79	2.30	1.79	1.79	1.91	1.65
Feb	0.90	0.71	2.82	0.40	0.72	0.72	0.12	0.17	1.00	0.46	4.45	2.62	1.26
Mar	3.44	2.42	3.44	2.01	0.35	0.35	4.02	0.94	0.00	0.00	0.91	1.48	1.61
Apr	0.00	0.18	0.63	0.48	0.00	0.00	0.03	0.63	0.00	0.09	0.01	0.44	0.21
May	0.89	0.45	0.00	0.00	1.00	1.00	0.00	0.19	0.00	0.38	0.22	0.79	0.41
June	0.49	0.90	0.00	0.00	0.35	0.35	0.01	3.44	1.05	0.27	1.29	0.86	0.75
July	7.19	2.53	6.51	6.34	4.10	4.10	5.74	4.44	2.85	17.63	5.07	3.66	5.85
Aug	4.66	3.26	5.47	4.09	2.70	2.70	5.82	4.95	5.65	3.59	4.30	5.06	4.35
Sep	2.63	3.92	3.60	5.00	2.95	2.95	6.96	2.97	4.30	0.04	1.97	3.94	3.44
Oct	0.33	0.85	0.72	0.09	0.00	0.00	1.90	1.62	0.00	0.11	4.48	0.30	0.87
Nov	0.60	0.04	0.05	1.37	1.09	1.09	0.00	0.77	0.20	0.12	0.24	6.40	1.00
Dec	1.03	1.00	1.08	2.96	0.65	0.65	1.17	0.84	1.62	0.49	1.94	1.74	1.27
Total	**23.03**	**16.51**	**29.10**	**23.01**	**15.45**	**15.45**	**25.78**	**23.75**	**19.00**	**24.97**	**26.67**	**29.20**	**22.66**

4.2.2 *Curve Numbers*

Curve Numbers were used to model the daily runoff to the UDCP and EDP systems from daily precipitation. Curve numbers predict runoff from effective precipitation or the amount of precipitation available for runoff. Effective precipitation is the direct precipitation that is not intercepted, infiltrated or evaporated. Effective rainfall, E, using the NRCS CN method, is defined by **Equation 1** (NRCS):

$$E = \frac{(P-I)^2}{(P-I+S)} \tag{1}$$

Where:

P = daily precipitation, in inches
I = initial abstraction (or amount of rain absorbed before runoff is produced), in inches
S = moisture retention of the soil and vegetative cover, in inches

Assuming the initial abstraction is 5% of retention, as determined by Woodward *et al*, moisture retention is related to the NRCS curve number by **Equation 2** (Woodward):

$$S = 1.33\left[\left(\frac{1000}{CN}\right) - 10\right]^{1.15} \tag{2}$$

To account for the variability in curve numbers from rainfall intensity, soil moisture conditions and other factors, NRCS uses an Antecedent Runoff Condition (NRCS). Antecedent Runoff Condition (or ARC II) assumes normal conditions while ARC III assumes wetter conditions (NRCS). The idea is that the more precipitation that has recently occurred, the wetter the soil. Since wet soil cannot absorb as much moisture, more runoff is expected. In the model, curve numbers were increased to ARC III when precipitation over the preceding five (5) days exceeded the initial abstraction for the given ground type. **Table 4.3** presents relevant curve number values for the different land use types modeled.

Table 4.3. Curve Numbers Information for Modeled Land Types

Tributary Area	ARC II Curve Number	ARC II Initial Abstraction (in)	ARC II Soil Retention (in)	ARC III Curve Number[1]	ARC III Initial Abstraction (in)	ARC III Soil Retention (in)
UDCP and EDP2 Ponds	100	0.0	0.0	100	0.0	0.0
Exposed Liner	100	0.0	0.0	100	0.0	0.0
Tailings Fill	95	0.032	0.636	98	0.011	0.214
Rock Armor	85	0.128	2.556	93	0.048	0.959
Protective Layer	72	0.317	6.341	86	0.116	2.329
Natural Ground	72	0.317	6.341	86	0.116	2.329
Roads & Disturbed Areas	94	0.04	0.794	97	0.017	0.345

1. NCRS, Table 10-1.

4.2.3 Evaporation Losses

Daily evaporation losses were modeled for the UDCP and EDP surfaces using monthly pond evaporation rates (ERC 2017). Monthly pond evaporation data was converted to daily values by dividing by the number of days in each month. The values of daily pond evaporation used for the free water surface in the UDCP and EDP are included in **Table 4.4**.

Table 4.4. Mean Monthly Evaporation

Month	Monthly Pond Evaporation (in)	Days per Month	Daily Evaporation (in)
January	2.26	31	0.07
February	2.71	28	0.10
March	3.94	31	0.13
April	4.48	30	0.15
May	6.44	31	0.21
June	7.50	30	0.25
July	3.72	31	0.12
August	3.40	31	0.11
September	3.33	30	0.11
October	4.27	31	0.14
November	3.13	30	0.10
December	2.14	31	0.07

4.3 Pond Geometries

Specific filling curve geometry for the UDCP and EDP were provided by NewFields and are presented in **Tables 4.7** and **4.8**, respectively. In the tables, purple denotes the pond crest elevation, blue denotes the freeboard elevation and green denotes the spillway invert elevation (UDCP only). A dead pool volume representing the lowest level that each pond can be pumped to was set at 971 ft^3 for the UDCP (1.5 feet of water depth) and 684 ft^3 for EDP (one foot of depth in the pond).

Table 4.7. UDCP Filling Curve Data

ELEV	VOLUME (CY)	VOLUME (cu ft)	VOLUME (gal)	VOLUME (Mgal)	VOLUME (ac-ft)
4,915.0	0	0	0	0.00	0.00
4,916.0	27	734	5,488	0.01	0.02
4,917.0	46	1,252	9,363	0.01	0.03
4,918.0	73	1,961	14,672	0.01	0.05
4,919.0	122	3,289	24,601	0.02	0.08
4,920.0	298	8,033	60,090	0.06	0.18
4,921.0	580	15,661	117,142	0.12	0.36
4,922.0	899	24,280	181,616	0.18	0.56
4,923.0	1,253	33,833	253,069	0.25	0.78
4,924.0	1,643	44,348	331,722	0.33	1.02
4,925.0	2,069	55,859	417,825	0.42	1.28
4,926.0	2,533	68,394	511,589	0.51	1.57
4,927.0	3,036	81,976	613,184	0.61	1.88
4,928.0	3,579	96,631	722,802	0.72	2.22
4,929.0	4,162	112,387	840,653	0.84	2.58
4,930.0	4,788	129,273	966,960	0.97	2.97
4,931.0	5,456	147,321	1,101,961	1.10	3.38
4,932.0	6,169	166,564	1,245,899	1.25	3.82
4,933.0	6,927	187,034	1,399,017	1.40	4.29
4,934.0	7,732	208,765	1,561,561	1.56	4.79
4,935.0	8,585	231,788	1,733,774	1.73	5.32
4,936.0	9,487	256,136	1,915,899	1.92	5.88
4,937.0	10,439	281,842	2,108,179	2.11	6.47
4,938.0	11,442	308,938	2,310,857	2.31	7.09
4,939.0	12,498	337,454	2,524,156	2.52	7.75
4,940.0	13,608	367,417	2,748,279	2.75	8.43
4,941.0	14,773	398,858	2,983,455	2.98	9.16
4,942.0	15,993	431,807	3,229,917	3.23	9.91

Table 4.7 (continued). UDCP Filling Curve Data

ELEV	VOLUME (CY)	VOLUME (cu ft)	VOLUME (gal)	VOLUME (Mgal)	VOLUME (ac-ft)
4,943.0	17,270	466,297	3,487,900	3.49	10.70
4,944.0	18,606	502,358	3,757,641	3.76	11.53
4,945.0	20,001	540,024	4,039,381	4.04	12.40
4,946.0	21,457	579,326	4,333,357	4.33	13.30
4,947.0	22,974	620,296	4,639,811	4.64	14.24
4,948.0	24,554	662,966	4,958,982	4.96	15.22
4,949.0	26,199	707,368	5,291,110	5.29	16.24
4,950.0	27,909	753,535	5,636,439	5.64	17.30
4,951.0	29,685	801,499	5,995,214	6.00	18.40
4,952.0	31,529	851,293	6,367,673	6.37	19.54
4,953.0	33,443	902,948	6,754,048	6.75	20.73
4,954.0	35,426	956,493	7,154,567	7.15	21.96
4,955.0	37,480	1,011,960	7,569,458	7.57	23.23
4,956.0	39,607	1,069,378	7,998,950	8.00	24.55
4,957.0	41,807	1,128,779	8,443,270	8.44	25.91
4,958.0	44,081	1,190,193	8,902,646	8.90	27.32
4,959.0	46,431	1,253,650	9,377,305	9.38	28.78
4,960.0	48,859	1,319,182	9,867,479	9.87	30.28
4,961.0	51,364	1,386,829	10,373,484	10.37	31.84
4,962.0	53,951	1,456,670	10,895,889	10.90	33.44
4,963.0	56,621	1,528,772	11,435,218	11.44	35.10
4,964.0	59,375	1,603,126	11,991,384	11.99	36.80
4,965.0	62,214	1,679,786	12,564,800	12.56	38.56

Table 4.8. EDP Filling Curve Data

ELEV	VOLUME (CY)	VOLUME (cu ft)	VOLUME (gal)	VOLUME (Mgal)	VOLUME (ac-ft)
5,065.0	0	0	0	0.00	0.00
5,065.5	25	684	5,118	0.01	0.02
5,066.0	125	3,377	25,261	0.03	0.08
5,066.5	287	7,760	58,043	0.06	0.18
5,067.0	532	14,364	107,443	0.11	0.33
5,067.5	874	23,587	176,432	0.18	0.54
5,068.0	1,296	35,000	261,803	0.26	0.80
5,068.5	1,799	48,573	363,326	0.36	1.12
5,069.0	2,354	63,562	475,440	0.48	1.46
5,069.5	2,976	80,358	601,075	0.60	1.84
5,070.0	3,664	98,929	739,992	0.74	2.27
5,070.5	4,411	119,101	890,878	0.89	2.73
5,071.0	5,229	141,189	1,056,095	1.06	3.24
5,071.5	6,110	164,971	1,233,986	1.23	3.79
5,072.0	7,032	189,851	1,420,084	1.42	4.36
5,072.5	7,991	215,753	1,613,832	1.61	4.95
5,073.0	8,992	242,771	1,815,923	1.82	5.57
5,073.5	10,036	270,984	2,026,959	2.03	6.22
5,074.0	11,124	300,349	2,246,611	2.25	6.90
5,074.5	12,253	330,842	2,474,697	2.47	7.60
5,075.0	13,426	362,493	2,711,448	2.71	8.32
5,075.5	14,636	395,181	2,955,951	2.96	9.07
5,076.0	15,884	428,877	3,208,001	3.21	9.85
5,076.5	17,172	463,635	3,467,992	3.47	10.64

4.4 Miscellaneous Inflows

Additional water that reports to the Water Treatment Plant includes water from mine working and the Exploration Decline. In the water balance model, ERC assumed that inflows from mine workings are a constant 23 gpm to the system while the Exploration Decline adds 47 gpm. These two inputs sum to a constant inflow rate of 70 gpm.

4.5 Pumping

Pumping is used to draw down water levels in the UDCP and EDP. From the UDCP, water is pumped to the WTP at 120 gpm which was set as the maximum rate that water would be removed. From the EDP water is pumped and discharged to the environment at a rate of 170 gpm. Water in the EDP is not considered contact water and can be released without additional treatment.

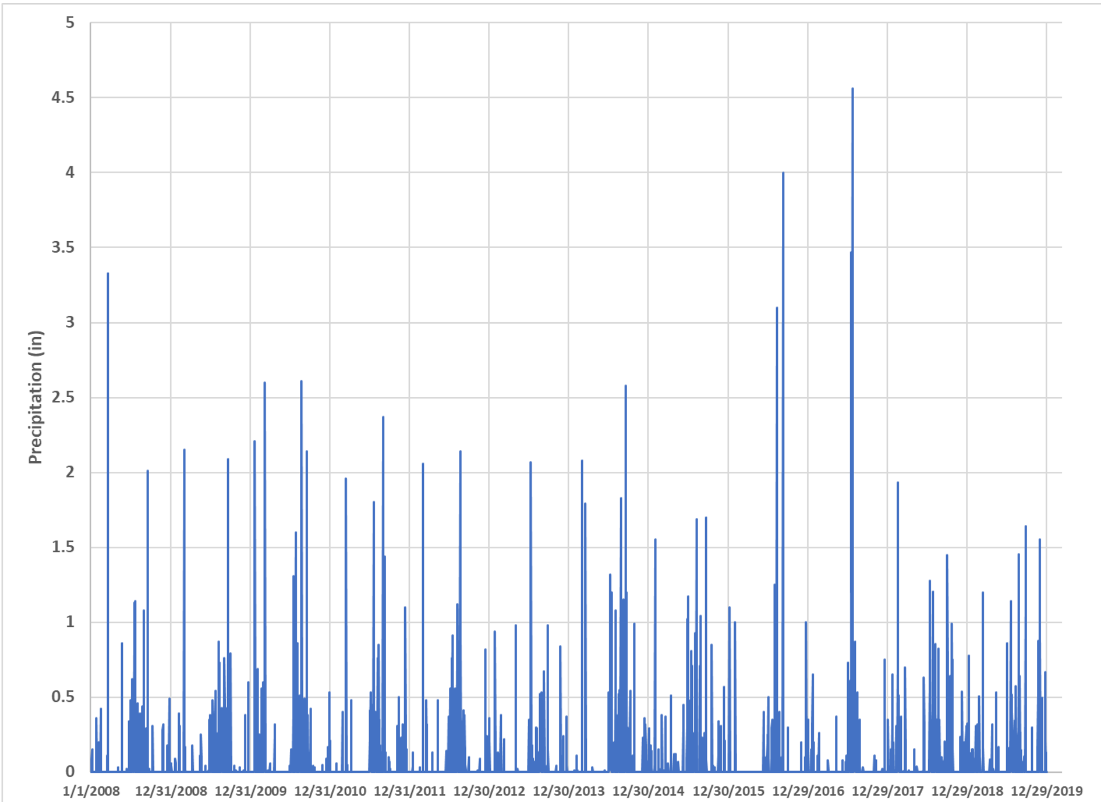
5.0 Model Runs and Results

The water balance model was developed using an analytical spreadsheet model developed in Microsoft Excel. The water balance calculated the daily storage volume in the UDCP and EDP as the difference between inflows and outflows (as shown in **Figure 3.1** above). Different models were generated to evaluate the current interim VRP TSF and TSF Amended Design phases. Twelve separate years of precipitation data were modeled to capture annual variability within each model. The peak pumping rate from the UDCP to the WTP was set at 120 gpm while the peak pumping rate from the EDP was set at 170 gpm. Results obtained from the model runs are presented below.

5.1 Precipitation

Monthly precipitation values from the twelve years of site recorded data are presented in **Figure 5.1.** Note that the variability in precipitation presented in this figure provides the basis for the range of predicted results for other water balance elements. Increases in runoff occur during the months of July, August and September during the monsoon.

Figure 5.1. Modeled Precipitation



5.2 UDCP Results

Figure 5.2 presents the normal daily volume of contact water that is expected to be stored in the UDCP for the current interim VRP TSF condition for the 12 years of modeled precipitation. **Figure 5.3** provides the same information assuming the TSF Amended Design is complete. Both figures also show the pond freeboard, spillway and crest elevations. **Table 5.1** summarizes results from the two modeled conditions. Results show that if precipitation similar to the extreme conditions that occurred in July of 2017 (exceeded the 7-day / 30-day 1,000-year storm event) were to occur during the current Interim VRP TSF condition, storage would exceed pond freeboard limits. However, water would not spill from the pond. For the TSF Amended Design condition, the UDCP is predicted to remain below the freeboard limit for all modeled precipitation scenarios.

Figure 5.2. UDCP Predicted Water Levels – Current Interim VRP TSF Condition

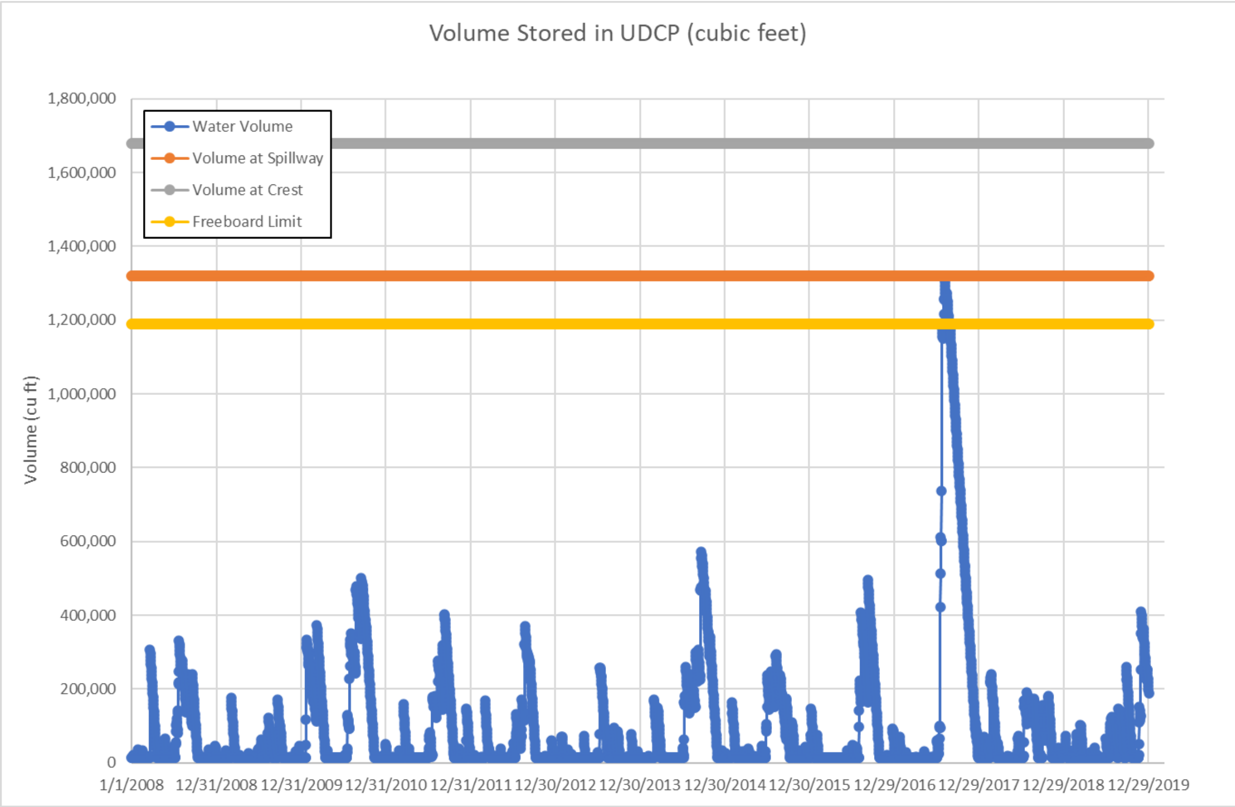


Figure 5.3. UDCP Predicted Water Levels – TSF Amended Design Condition

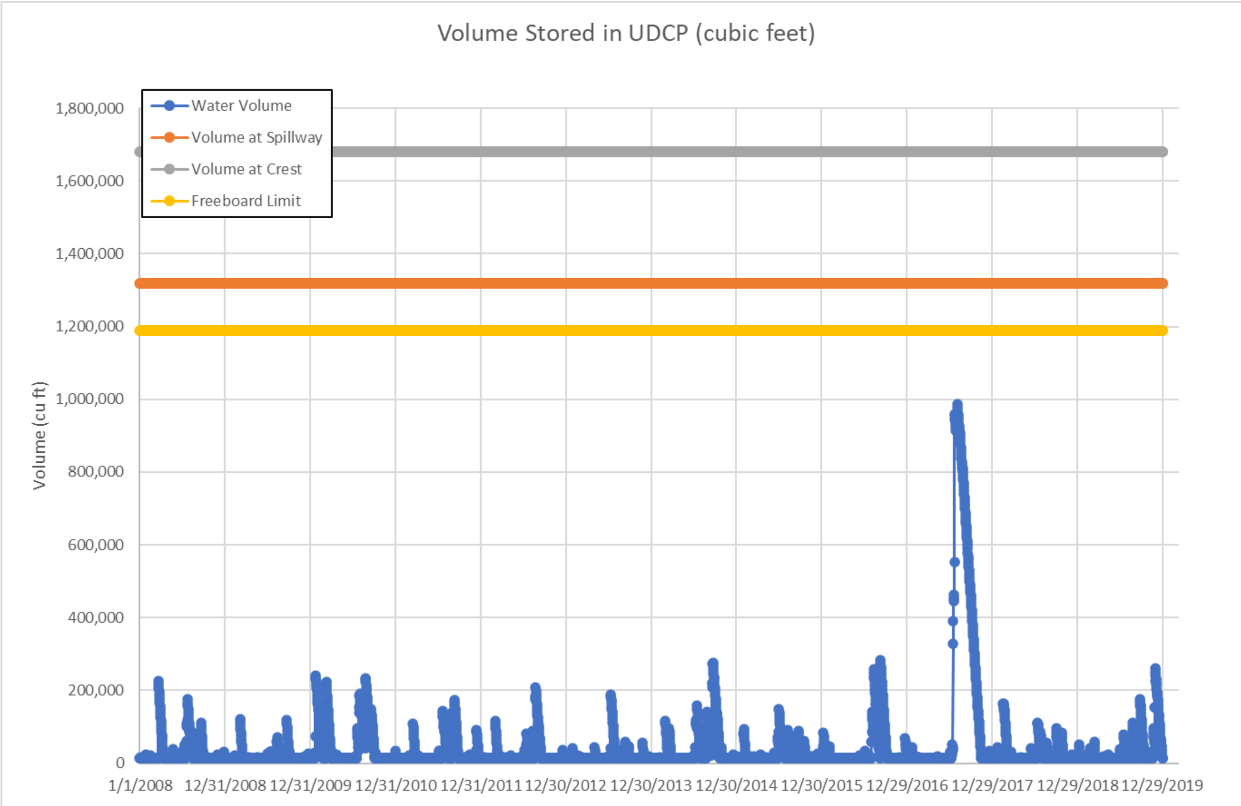


Table 5.1. UDCP Results

Condition	Parameter	Value
Current Interim VRP TSF Condition	Peak Storage Volume (ft^3)	1,313,000
	Peak Storage Volume Excluding 2017 Results (ft^3)	572,000
	Freeboard Limits Violated?	Yes
	Spillway Flows Predicted?	No
TSF Amended Design Condition	Peak Storage Volume (ft^3)	987,000
	Peak Storage Volume Excluding 2017 Results (ft^3)	283,000
	Freeboard Limits Violated?	No
	Spillway Flows Predicted?	No

5.3 Water Treatment Results

Figure 5.4 presents predicted water treatment rates for the Interim VRP TSF condition while **Figure 5.5** provides the same information for the TSF Amended Design. Results show that for both conditions, during the monsoon and after larger rainfall events, treatment rates reach the water treatment plant capacity of 120 gpm for a finite period of time. During drier times of the year, predicted water treatment rates drop to 70 gpm (mine workings and exploration decline water). **Table 5.2** presents the calculated mean annual water treatment requirements for both scenarios in each of the 12 modeled years. The models predict a minimum daily water treatment rate of 70 gpm in both scenarios for every year. This equates to the assumed constant inflow from mine working and the exploration decline. The maximum average annual water treatment is predicted to occur as a result of 2017 type precipitation and ranges from 96 gpm for the Interim VRP TSF condition to 89 gpm for the future TSF Amended Design condition. Years with precipitation similar to 2009 and 2013 are predicted to require the least water treatment with average annual values of 89 gpm and 81 gpm for the Interim VRP TSF and TSF Amended Design conditions, respectively.

Figure 5.4. Contact Water Treatment – Current Interim VRP TSF Condition

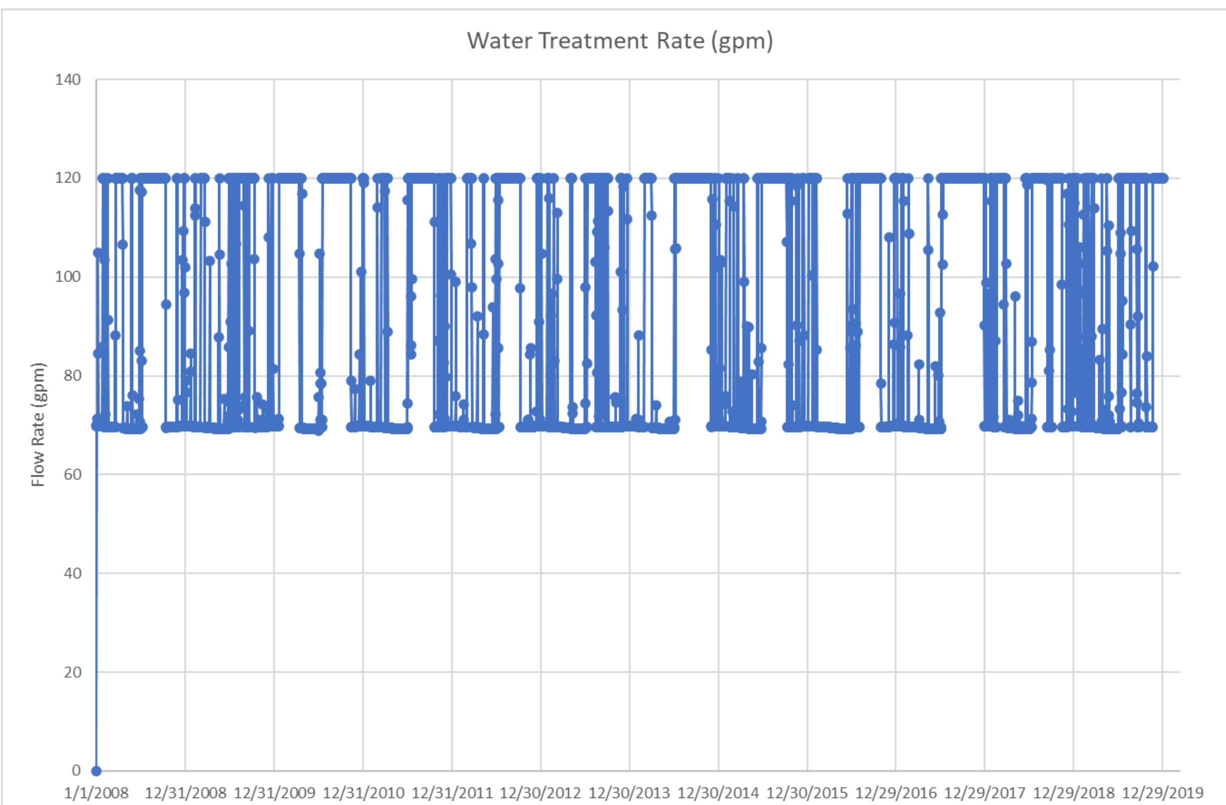


Figure 5.5. Contact Water Treatment – Future TSF Amended Design Condition

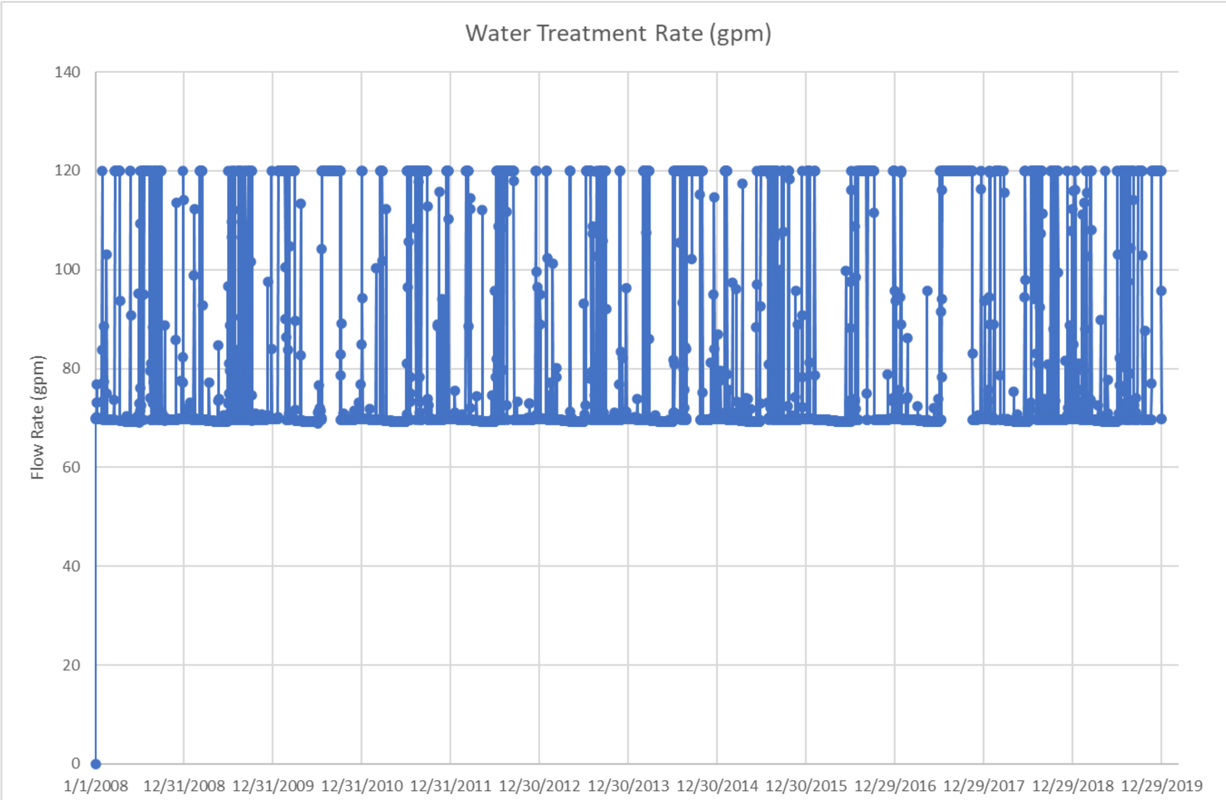


Table 5.2. Predicted Water Treatment Requirements

Condition	Modeled Year	Average Annual Water Treatment (gpm)
Interim Conditions	2008	91
	2009	84
	2010	99
	2011	87
	2012	91
	2013	83
	2014	89
	2015	91
	2016	90
	2017	96
	2018	93
	2019	94
TSF Amended Design Condition	2008	82
	2009	77
	2010	89
	2011	80
	2012	82
	2013	77
	2014	81
	2015	81
	2016	82
	2017	89
	2018	83
	2019	85

5.4 External Detention Pond Results

Given that runoff to the EDP is not influenced by land use changes in the TSF basin, the model results for the EDP are the same for the Interim VRP TSF and TSF Amended Design conditions. Therefore, a single graph is presented to represent both conditions. **Figure 5.6** presents the predicted water volume in the EDP assuming pumping to release flows is 170 gpm. Results show that if precipitation similar to the extreme conditions that occurred in July of 2017 were to occur (exceeding the 7-day/ 30-day 1,000-year storm event), inflows would exceed the pond capacity and water would be predicted to spill from the External Detention Pond into the TSF east internal detention pond which would be collected and conveyed to the Underdrain Collection Pond by the detention outfall pipes. The total volume of water spilled from the pond would be approximately 133,000 cubic feet. During all other modeled climatological conditions, the EDP would have sufficient capacity to store all inflows below its freeboard limits.

Figure 5.6. EDP Predicted Water Levels

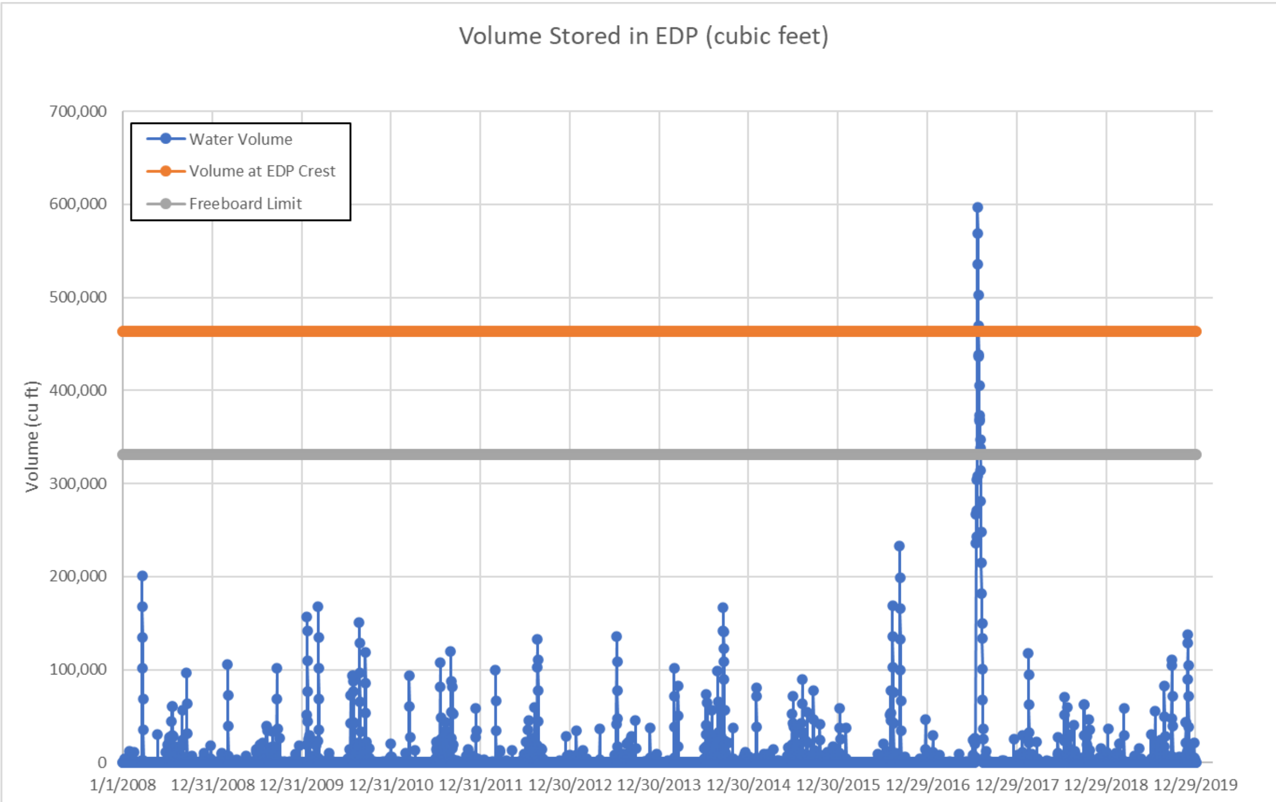
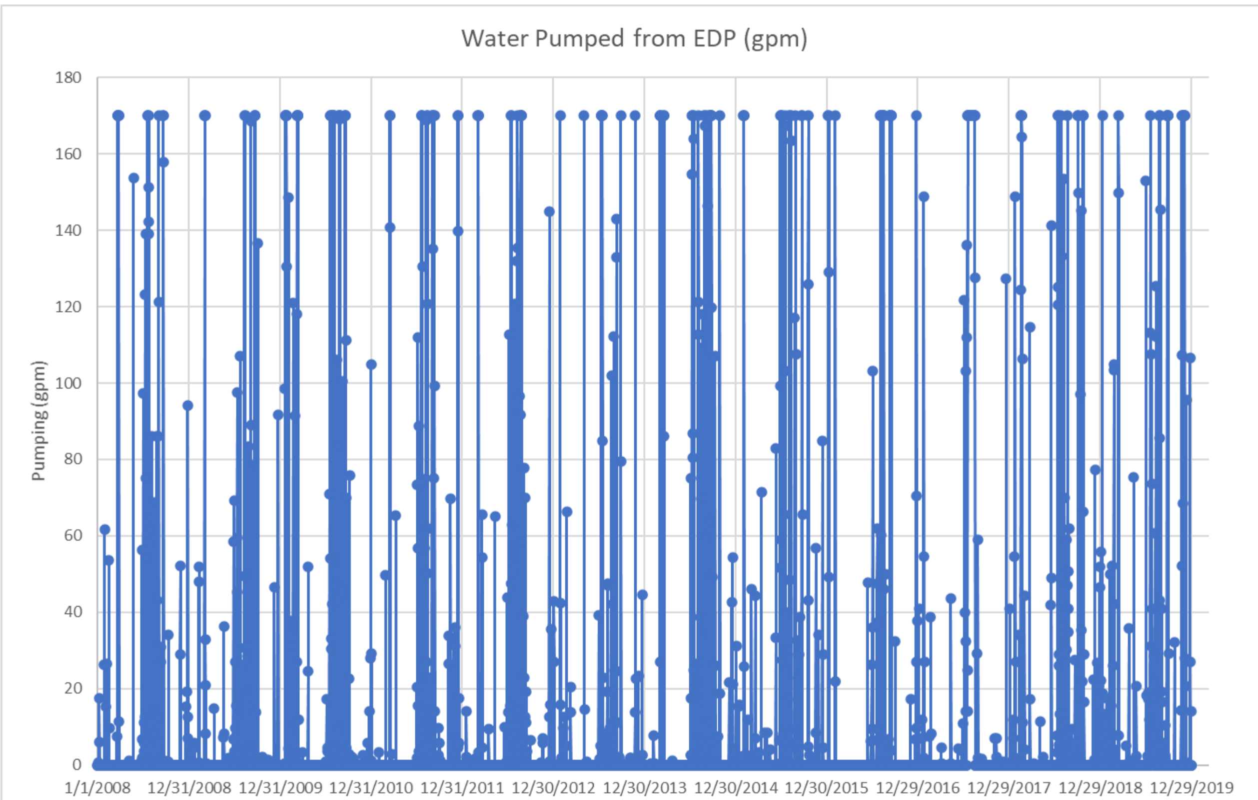


Figure 5.7 illustrates predicted pumping from EDP to the environment. The Water Balance results show that during the monsoons, pumping of 170 gpm from EDP would occur and during drier times, no pumping would be expected. Over the 12-year simulation, the predicted average pumping rate from the EDP is 13 gpm in both the Interim VRP TSF and TSF Amended Design conditions.

Figure 5.7. Predicted Pumping from EDP



6.0 100-year, 24-hour Runoff Capacity Analysis

In addition to the storage requirements for daily operations, ERC evaluated the potential for the ponds to store runoff from the 100-year, 24-hour storm. The NOAA Atlas 14 point precipitation estimate of the 100-year, 24-hour storm event at the site is 4.88 inches. This is shown on the table in **Appendix A**. Runoff from this event was calculated using that value, **Equations 1** and **2**, and ARC III curve numbers shown in **Table 4.3**. Using ARC III provides a conservative estimate of runoff since it assumes the 100-year, 24-hour storm occurs after 5-days of rain when the ground is unable to retain as much moisture. The calculated runoff was applied across the land use areas identified in **Table 4.1**. The results of this analysis are presented in **Table 6.1**.

Table 6.1. Predicted 100-Year, 24-Hour Storm Runoff Volumes

Land Use	P100[1] (in)	Q100[2] (in)	Current Interim VRP TSF Condition Runoff Volume[3] (ft^3)		TSF Amended Design Runoff Volume[3] (ft^3)	
			UDCP	EDP	UDCP	EDP
Natural Ground and Protective Layer	4.88	3.20	49,300	83,920	39,030	83,920
Rock Armor	4.88	4.03	88,160	0	340,820	0
Road/Disturbed Areas	4.88	4.54	25,520	209,180	39,160	209,180
Tailings	4.88	4.66	187,570	0	0	0
Membrane Areas/Ponds	4.88	4.88	141,440	54,780	32,840	54,780
TOTAL			**491,990**	**347,880**	**451,850**	**347,880**

1. Source: NOAA Atlas 14 (see **Appendix A**)
2. Calculated using **Equation 1**, **Equation 2** and ARC III curve numbers in **Table 4.3**
3. Calculated using Q100 and Land Use Areas in **Table 4.1**

The results in **Table 6.1** show that approximately 492,000 ft^3 of runoff will report to the UDCP during a 100-year, 24-hour storm in the current Interim VRP TSF Condition. According to **Table 5.1**, the UDCP requires a peak storage capacity of 572,000 ft^3 to handle daily operations during the modeled period of record (excluding the extremely wet conditions of 2017). Adding the 100-year, 24-hour runoff volume to the peak daily volume requires 1,064,000 ft^3 of storage capacity in the pond. This is approximately 126,000 ft^3 less than the freeboard capacity.

In the TSF Amended Design condition, approximately 452,000 ft^3 of runoff will report to the UDCP during a 100-year, 24-hour storm. According to **Table 5.1**, the UDCP requires a peak storage capacity of approximately 283,000 ft^3 to handle daily operations during the modeled period of record (excluding the extremely wet conditions of 2017). Adding the 100-year, 24-hour runoff volume to the peak daily volume requires 735,000 ft^3 of storage capacity in the pond. This is approximately 455,000 ft^3 less than the freeboard capacity.

During both phases of TSF construction, approximately 348,000 ft^3 of runoff will report to the EDP during a 100-year, 24-hour storm. If the pond is empty, this runoff volume will exceed the freeboard limit by about 17,000 ft^3. However, it is approximately 116,000 ft^3 less than the crest level capacity. According to **Figure 5.6**, the EDP requires a peak storage of approximately 233,000 ft^3 to handle daily operations during the modeled period of record (excluding the extremely wet conditions of 2017). Adding the 100-year, 24-hour runoff volume to the peak daily volume requires 581,000 ft^3 of storage capacity. This is approximately 250,000 ft^3 more than the freeboard capacity and approximately 117,000 ft^3 more than the full (crest level) capacity of the pond. Freeboard is exceeded because the analysis assumed wet (ARC III) conditions. Under average (ARC II) conditions, the EDP can store runoff from the 100-year, 24-hour storm below the freeboard level. As mentioned above, the UDCP has at least 126,000 ft^3 of capacity below the freeboard limit when storing the peak daily inflow and the 100-year, 24-hour storm. Therefore, the UDCP has capacity to store the potential 117,000 ft^3 spillover from the EDP resulting from the 100-year, 24-hour storm runoff without exceeding freeboard limit.

7.0 Summary

ERC completed a water balance analysis of the TSF, UDCP and EDP considering both the current Interim VRP TSF and TSF Amended Design conditions. The evaluation predicted water levels in the UDCP and EDP using historic site precipitation data on a daily time step. A model was run using areas with specified ground cover for both scenarios and 12 years of daily site precipitation data recorded from 2008 through 2019. The model period includes the extremely wet monsoon season of 2017 during which the mine recorded 4.56 inches of precipitation in a single day and 12.39 inches of rainfall in a one-week period. For comparison the 24-hour duration 25-year, 50-year and 100-year storm events for the site are 3.93 inches, 4.40 inches and 4.88 inches, respectively (ERC 2017). The probability of these single day (4.56 inches) and one-week (12.39 inches) measurements being exceeded in any given year are less than 2% and 0.1%, respectively. Over the 30-day stretch of July 12th through August 10th the mine recorded 18.1 inches of rainfall which has an exceedance probability in any given year of less than 0.1%. The monsoon of 2017 was an extremely wet period resulting in single week and 30-day rainfall totals exceeding the 1,000-year storm event. Including 2017 historical data and considering the day, week or month probabilities noted above, the water balance model shows how the system would operate in future extreme monsoon seasons.

The models assume a constant inflow to the UDCP of 23 gpm from mine workings and 47 gpm from the Exploration Decline. The water treatment capacity was set at 120 gpm in the model while discharge from EDP was 170 gpm.

Model results indicate there is sufficient storage in the UCDP to contain all flows for the current interim VRP TSF condition. This is true even in the event of an extreme monsoon such as 2017 (exceeding the 7-day/ 30-day 1,000-year storm event), although freeboard limits would be exceeded in that specific historic year. In the TSF Amended Design condition, model results indicate sufficient storage in the UCDP to contain all flows below the freeboard elevation, even in the event of an extreme monsoon such as 2017.

Furthermore, in both phases of TSF construction, the UDCP has sufficient capacity to simultaneously contain runoff from a 100-year, 24-hour storm in addition to the peak daily flow expected during the modeled period of record (excluding the extremely wet conditions of 2017).

For the EDP, model results show the EDP has sufficient capacity to store all inflows for either the current Interim VRP TSF or the TSF Amended Design conditions, except during the extreme conditions that occurred in July of 2017. The peak predicted stored water volume is approximately 100,000 ft^3 below the freeboard limits for all years except 2017. During the modeled period of record, when considering a 100-year, 24-hour storm in addition to the peak daily flow, the EDP would spill a portion of the water volume into the TSF east internal detention pond which reports to the Underdrain Collection Pond. In the worst-case scenario in the modeled period of record (excluding the extremely we conditions of 2017), the EDP spillover would be contained in the UDCP without exceeding the UDCP freeboard limit.

8.0 References

Ecological Resources Consultants, Inc. (ERC). 2017. Arizona Mining Mine Site Climate Analysis. March 13.

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National Resources Conservation Service (NRCS), National Engineering Handbook, Chapter 10: Estimation of Direct Runoff from Storm Rainfall, July 2004.

Woodward, et al. (2003). Runoff Curve Number Method: Examination of the Initial Abstraction Ratio. World Water and Environmental Resources Congress. 1-10. 10.1061/40685(2003)308.

APPENDIX A:

NOAA ATLAS 14 POINT PRECIPITATION VALUES FOR THE MINE SITE

NOAA Atlas 14, Volume 1, Version 5
Location name: Patagonia, Arizona, USA*
Latitude: 31.4556°, Longitude: -110.713°
Elevation: 5319.75 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

AMS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Annual exceedance probability (1/years)								
	1/2	1/5	1/10	1/25	1/50	1/100	1/200	1/500	1/1000
5-min	**0.380** (0.333-0.433)	**0.534** (0.466-0.606)	**0.634** (0.552-0.718)	**0.760** (0.657-0.860)	**0.851** (0.730-0.965)	**0.943** (0.802-1.07)	**1.03** (0.870-1.18)	**1.15** (0.949-1.33)	**1.24** (1.01-1.45)
10-min	**0.579** (0.507-0.659)	**0.813** (0.709-0.922)	**0.965** (0.840-1.09)	**1.16** (1.00-1.31)	**1.30** (1.11-1.47)	**1.44** (1.22-1.64)	**1.57** (1.32-1.80)	**1.75** (1.44-2.02)	**1.88** (1.53-2.20)
15-min	**0.718** (0.628-0.817)	**1.01** (0.880-1.14)	**1.20** (1.04-1.36)	**1.43** (1.24-1.62)	**1.61** (1.38-1.82)	**1.78** (1.51-2.03)	**1.95** (1.64-2.23)	**2.17** (1.79-2.50)	**2.34** (1.90-2.73)
30-min	**0.967** (0.846-1.10)	**1.36** (1.19-1.54)	**1.61** (1.40-1.82)	**1.93** (1.67-2.18)	**2.16** (1.85-2.45)	**2.40** (2.04-2.73)	**2.63** (2.21-3.00)	**2.92** (2.41-3.37)	**3.14** (2.56-3.67)
60-min	**1.20** (1.05-1.36)	**1.68** (1.47-1.91)	**1.99** (1.74-2.26)	**2.39** (2.07-2.70)	**2.68** (2.30-3.04)	**2.97** (2.52-3.38)	**3.25** (2.74-3.71)	**3.61** (2.98-4.17)	**3.89** (3.17-4.54)
2-hr	**1.36** (1.20-1.53)	**1.88** (1.66-2.12)	**2.24** (1.96-2.51)	**2.70** (2.36-3.04)	**3.06** (2.64-3.44)	**3.42** (2.93-3.88)	**3.78** (3.19-4.30)	**4.27** (3.53-4.89)	**4.65** (3.79-5.38)
3-hr	**1.40** (1.25-1.57)	**1.92** (1.71-2.15)	**2.28** (2.02-2.55)	**2.76** (2.43-3.09)	**3.13** (2.72-3.51)	**3.52** (3.03-3.96)	**3.91** (3.32-4.43)	**4.45** (3.68-5.09)	**4.87** (3.96-5.65)
6-hr	**1.60** (1.42-1.81)	**2.17** (1.92-2.45)	**2.57** (2.27-2.91)	**3.12** (2.72-3.52)	**3.55** (3.06-4.01)	**4.01** (3.41-4.56)	**4.47** (3.75-5.11)	**5.11** (4.17-5.90)	**5.62** (4.51-6.56)
12-hr	**1.86** (1.66-2.09)	**2.51** (2.22-2.81)	**2.96** (2.61-3.31)	**3.56** (3.12-3.99)	**4.03** (3.50-4.53)	**4.54** (3.88-5.12)	**5.04** (4.25-5.72)	**5.73** (4.73-6.59)	**6.27** (5.09-7.29)
24-hr	**2.08** (1.89-2.29)	**2.79** (2.53-3.08)	**3.28** (2.96-3.61)	**3.90** (3.51-4.30)	**4.38** (3.92-4.82)	**4.88** (4.34-5.37)	**5.36** (4.75-5.92)	**6.02** (5.28-6.66)	**6.53** (5.68-7.36)
2-day	**2.31** (2.11-2.55)	**3.10** (2.82-3.41)	**3.65** (3.31-4.02)	**4.38** (3.95-4.82)	**4.95** (4.43-5.44)	**5.55** (4.95-6.12)	**6.16** (5.45-6.82)	**7.01** (6.13-7.79)	**7.67** (6.64-8.57)
3-day	**2.52** (2.30-2.78)	**3.38** (3.08-3.73)	**3.99** (3.62-4.39)	**4.80** (4.33-5.28)	**5.43** (4.87-5.98)	**6.11** (5.45-6.74)	**6.80** (6.01-7.52)	**7.75** (6.77-8.62)	**8.51** (7.35-9.50)
4-day	**2.73** (2.49-3.01)	**3.67** (3.34-4.04)	**4.33** (3.93-4.77)	**5.22** (4.72-5.74)	**5.92** (5.31-6.51)	**6.67** (5.95-7.36)	**7.44** (6.57-8.22)	**8.50** (7.41-9.44)	**9.34** (8.06-10.4)
7-day	**3.28** (3.00-3.61)	**4.42** (4.04-4.86)	**5.21** (4.74-5.73)	**6.24** (5.65-6.86)	**7.03** (6.34-7.74)	**7.88** (7.06-8.68)	**8.71** (7.75-9.63)	**9.86** (8.66-10.9)	**10.8** (9.37-12.0)
10-day	**3.83** (3.52-4.19)	**5.13** (4.71-5.60)	**6.00** (5.50-6.55)	**7.11** (6.49-7.76)	**7.94** (7.21-8.68)	**8.82** (7.96-9.65)	**9.66** (8.67-10.6)	**10.8** (9.58-11.9)	**11.7** (10.3-12.9)
20-day	**5.37** (4.96-5.83)	**7.13** (6.57-7.74)	**8.25** (7.59-8.95)	**9.62** (8.83-10.4)	**10.6** (9.71-11.5)	**11.6** (10.6-12.6)	**12.5** (11.4-13.7)	**13.7** (12.4-15.1)	**14.6** (13.1-16.1)
30-day	**6.77** (6.26-7.33)	**8.92** (8.22-9.64)	**10.2** (9.44-11.1)	**11.8** (10.9-12.8)	**12.9** (11.9-14.0)	**14.0** (12.8-15.2)	**15.0** (13.7-16.3)	**16.3** (14.7-17.8)	**17.2** (15.5-18.8)
45-day	**8.41** (7.77-9.09)	**11.0** (10.1-11.8)	**12.5** (11.5-13.5)	**14.3** (13.1-15.4)	**15.5** (14.2-16.8)	**16.7** (15.3-18.1)	**17.8** (16.2-19.3)	**19.1** (17.3-20.8)	**20.0** (18.1-21.9)
60-day	**9.82** (9.09-10.6)	**12.8** (11.8-13.8)	**14.5** (13.4-15.7)	**16.5** (15.2-17.8)	**17.8** (16.4-19.3)	**19.1** (17.6-20.8)	**20.3** (18.6-22.1)	**21.7** (19.7-23.7)	**22.7** (20.6-24.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of annual maxima series (AMS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and annual exceedance probability) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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APPENDIX I
Operations and Maintenance

TECHNICAL MEMORANDUM

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T: 720.508.3300
F: 720.508.3339

To: Arizona Minerals Inc

From: Craig Thompson, P.E. – Senior Engineer

R. Michael Smith, P.E. – Project Principal

Project: Hermosa Lined Tailings Storage Facility (TSF) Design Amendment

Project No: 475.0014.022

Subject: Operation and Maintenance Plan

Date: July 2020

The purpose of this Technical Memorandum is to provide a guide detailing the Operations and Maintenance activities in association with the Hermosa Lined Tailings Storage Facility (TSF) Design Amendment. All inspection frequencies listed should be considered minimum frequencies.

Please note, the information presented in this memo is the same as presented in the approved Aquifer Protection Permit (APP) No. 512235 with the following revisions:

- Underdrain Collection Pond, Item: Instrumentation, Area to focus: Monitoring Well: This item was removed because this monitoring well was not constructed.
- Underdrain Collection Pond, Item: Pond, Area to focus: Water Level Readings: The water level measurement method of using a cloth tape was removed because the water level readings are taken via instrumentation installed on the Underdrain Collection Pond pumpback system pumps.

Tailings Storage Facility and Ancillary Facilities

Item	Area to focus	Inspection Type and Frequency
TSF Embankment	Settlement	Visual inspection quarterly by operations staff.
	Slides, depressions, misalignment, cracking, burrowing by animals, seepage	Visual inspection quarterly by operations staff.
Tailings Slope	Settlement	Visual inspection quarterly by operations staff.
	Slides, depressions, misalignment, cracking, burrowing by animals, seepage	Visual inspection quarterly by operations staff.

Tailings Storage Facility (continued)

Item	Area to focus	Inspection Type and Frequency
Stormwater Diversion Channels	Channels	Operations staff to inspect the channels monthly for any evidence of back cutting or erosion impacting the operational effectiveness of the channels or flow carrying capacity. Any potential impacts to channel operation will be remediated immediately.
Instrumentation	Piezometers	Vibrating wire piezometers for the dry stack tailings will be monitored weekly by operations staff to determine if any phreatic surface development has occurred that could impact performance of the TSF. A histogram of piezometer readings will be developed updated and maintained on site after each new reading.
Photographic Log	Embankment, perimeter road, stormwater diversion channels, tailings stacking and culvert	Operations staff will keep a quarterly photographic log of the upstream and downstream embankment slopes, perimeter road, stormwater diversion channels, tailings stacking and culverts. Whenever possible the photos will be taken from the same vantage points to allow relevant comparison of photos taken at different times in operational history.
Basin	Geomembrane	Operations staff to check geomembrane in the TSF basin quarterly for damage or possible leakage areas. If geomembrane liner damage is noticed, repairs to the liner will be completed immediately with oversight and approval by a qualified quality assurance inspector.
Culverts	Flow Blockage	Visual inspection monthly of any potential blockage in culverts. If any blockage is found, it is to be immediately removed with oversight and approval by a qualified quality assurance inspector.
Sediment Control Structures	Sediment control ponds, sediment control logs, silt fencing and general slope controls	Visual inspection daily of sediment control elements on the project shall occur. The sediment control infrastructure will be inspected for functionality. When functionality is compromised, repairs to and/or replacement of the sediment control elements will be completed as part of routine maintenance during operations. Maintenance may also include cleaning the structures out periodically.

Underdrain Collection Pond

Item	Area to focus	Inspection Type and Frequency
Pond Embankment	Settlement	Visual inspection quarterly by operations staff.
	Slides, depressions, misalignment, cracking, burrowing by animals, seepage	Visual inspection quarterly with a formal dam safety inspection every 5 years.
Spillway	Approach Channel and chute	Visual inspection monthly by operations staff and every 5 years a formal dam safety inspection to report condition of the spillway.
Downstream Channel Areas	Spillway outfall	Operations staff to inspect Spillway outfall monthly to check for any evidence of back cutting or other types of erosion that might impact the operational effectiveness of the spillway or that might impair outfall channel flow carrying capacity.
Pond perimeter	Rim area	Operations staff to check pond perimeter monthly for evidence of movement which could compromise the storage capacity or operational integrity of the pond. As required, rock fall from the surrounding cut slopes will be removed each week to maintain flow carrying capacity in the diversion ditch around the pond. In addition, if rock fall results in geomembrane liner damage, repairs to the liner will be completed immediately with oversight and approval by a qualified quality assurance inspector.
Site Security	Fencing	Fencing around the Underdrain Collection Pond will be checked monthly to ensure that breaches in the fence perimeter have not occurred.

Underdrain Collection Pond (continued)

Item	Area to focus	Inspection Type and Frequency
Instrumentation	Piezometers	Vibrating wire piezometers for the pond embankment will be monitored weekly by operations staff for any phreatic surface that may develop in the embankment structure. A histogram of piezometer readings will be developed, updated and maintained on site after each new reading. The histogram will be included in the formal dam safety inspection report completed every 5 years by the design engineer or by a representative of ADWR, Dam Safety.
	Settlement Monuments	Settlement monuments will be surveyed biannually or at any point when evidence of potential settlement is compelling. Formal survey history for the settlement monuments will be presented to ADWR, Dam Safety Division, as part of the dam safety inspection report to be completed every 5 years for the pond embankment.
Photographic Log	Embankment, spillway, pond perimeter and cut slopes around the pond	Operations staff will keep a quarterly photographic log of the upstream and downstream embankment slopes, embankment crest, pond perimeter, spillway, entrance, chute and outfall as well as the cut slopes around the Underdrain Collection Pond. Whenever possible the photos will be taken from the same vantage points to allow relevant comparison of photos taken at different times in operational history.

Underdrain Collection Pond (continued)

Item	Area to focus	Inspection Type and Frequency
Pond	Water Level Readings	Water level readings will be taken in the pond monthly or otherwise when volume in the pond appears to be high, to monitor historic storage levels. This measurement will be recorded and compared against the “as-built” filling curve for the pond to report both resident volume in the pond and available storage above the current pond surface to the spillway sill elevation. These readings will be sent to the Design Engineer monthly and included as a hydrograph in the dam safety report to be completed every 5 years that will be issued to ADWR.
Pond	Geomembrane	Operations staff to annually carry out detailed visual inspection of exposed liner. Inspection should be scheduled when the Underdrain Collection Pond level is low. Pay particular attention to all seams, liner penetrations, and connections to structures and to anchor trenches. If geomembrane liner damage is noticed, repairs to the liner will be completed immediately with oversight and approval by a qualified quality assurance inspector.
	Debris	Remove floating debris whenever observed.
Pumps	LCRS	Operations staff to inspect pumps daily and note leakages or any similar problems such as rapid increase or decrease in pond volumes. LCRS flow totalizer readings to be collected daily and compared to Alert Levels. If Alert Levels are exceeded refer to the actions specified in the Contingency Plan. Quarterly, staff should perform necessary maintenance on the pumps and pipes per manufacturer’s recommendations.

Operations staff will document changes in any conditions and will contact the design engineer regarding the changes immediately. If corrective action is required, due to changes observed, the design engineer will submit the corrective action deemed necessary to the Arizona Department of Environmental Quality for its timely review and approval. Any corrective action will be accompanied by photos of the area of concern, design calculations supporting the corrective action (if appropriate) and a time frame to execute the action. A log book will be maintained as part of the TSF and Underdrain Collection Pond record and document all inspections and maintenance work. Each entry will show the date, description of activity performed and a signature by the person responsible for the data collection. Entries to include inspections, volumetric observations, maintenance and instrument readings.

If you have questions or require additional information, please contact the undersigned.

Sincerely,

NewFields Mining Design & Technical Services

Craig M. Thompson
Senior Engineer

Reviewed by:

R. Michael Smith, P.E.
Principal

ATTACHMENT D

Memorandum

Re: Standardized Reclamation Cost Estimator (SRCE)

by

NewFields

NewFields
Perspective. Vision. Solutions.

August 12, 2020

Arizona Minerals Inc.
2210 East Fort Lowell Road
Tucson, Arizona 85719

Attention: Mr. Brent Musslewhite

Re: Standardized Reclamation Cost Estimator for the Hermosa Lined TSF Design Amendment

NewFields has prepared this letter in response to a request from Arizona Minerals Inc. (AMI) to develop a Standardized Reclamation Cost Estimator (SRCE) model to estimate closure costs associated with the Hermosa Lined TSF Design Amendment. The Hermosa Lined TSF Design Amendment is being submitted to the Arizona Department of Environmental Quality (ADEQ) Aquifer Protection Permit (APP) program as a proposed significant APP amendment. The attached NewFields' technical memorandum titled "Standardized Reclamation Cost Estimator (SRCE)" dated August 12th, 2020 includes a description of the SRCE model development as well as the SRCE model results. The description is presented in Sections 1 through 7 (pages 1 through 23), the SRCE model outputs are presented in Appendix A, and a set of Figures are presented after Appendix A to illustrate the inputs utilized for the model.

The engineer of record, Craig M Thompson, has directed the work of the development of the SRCE model described herein. Please reference the attached NewFields' technical memorandum for SRCE model details and results.

Sincerely,

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
Date Signed 8/12/20
ARIZONA, U.S.A.
EXPIRES 3/31/23

Craig Thompson, P.E.
Project Engineer

Reviewed by:

R. Michael Smith, P.E.
Principal

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TECHNICAL MEMORANDUM

To: Arizona Minerals Inc. (AMI)

From: R. Michael Smith, P.E. – Project Principal and
Craig M. Thompson, P.E. – Project Manager

Project: Hermosa Lined TSF Design Amendment

Subject: Standardized Reclamation Cost Estimator (SRCE)

Date: August 12, 2020

1. INTRODUCTION

NewFields has prepared a Standardized Reclamation Cost Estimator (SRCE) model to estimate closure costs associated with the "Issued for Tender" Hermosa Lined TSF Design Amendment. The TSF design amendment is being submitted to the Arizona Department of Environmental Quality (ADEQ) Aquifer Protection Permit (APP) program as part of a proposed significant APP amendment. The SRCE model, used for this estimate, is software that was developed as a collaborative effort between the Nevada Division of Environmental Protection (NDEP) Bureau of Mining Regulation and Reclamation (BMRR), the US Department of Interior Bureau of Land Management (BLM) and the Nevada Mining Association (NvMA). The SRCE model was developed by these agencies to provide a template for the calculation of mine site reclamation costs in an effort to provide consistent, complete and accurate estimates. ADEQ recommends (but does not require) that applicants use the SRCE model to estimate closure costs as can be seen on the "Individual Aquifer Protection Permit Closure and Post-Closure Plan/Strategy and Cost Estimate Checklist" (p. 1) (available at https://static.azdeq.gov/forms/app_cost_est_checklist_mining_indust.pdf).

The SRCE model does not include a specific reclamation section for dry stack tailings storage facilities. The historic tailings relocated onto the current lined TSF are functionally equivalent to dry stack tailings because of their low moisture content and placement method following engineering specifications and controls. In addition, the TSF will be used to contain a significant quantity of rock generated from advancement of the exploration decline and construction activities, which is similar to waste rock. Therefore, to estimate reclamation cost for the Hermosa dry stack TSF, the "Waste Rock Dumps" section of the SRCE model was used because reclamation elements in the SRCE model for a waste dump are identical to those that are required for a dry stack TSF.

NewFields prepared the SRCE model for the elements identified as APP discharging facilities in the current permit amendment. The following facilities were included in the model:

- Existing Water Treatment Plant 1 (WTP1)
- Existing Underdrain Collection Pond

- Existing Tailings Storage Facility (TSF) based on the TSF amended design stacking geometry
- Existing External Detention Pond
- Proposed Water Treatment Plant 2 (WTP2)

Model inputs were developed based on existing aerial topography (collected February 2020), as-built data from the Voluntary Remediation Program (VRP) Tailings Storage Facility (TSF) construction, and the proposed Hermosa Lined TSF Design Amendment. A general site arrangement can be referenced on Figure 1 and details of the various facilities can be referenced on Figure 2 through Figure 6. Conceptual closure drawings for the TSF amended design, created to show the closure strategy, can be referenced in the Drawings section attached to Newfields' design report titled, "Hermosa Lined TSF Design Amendment, Aquifer Protection Permit (APP), Best Available Demonstrated Control Technology (BADCT) Design, Patagonia, Arizona (July 2020)". The conceptual closure drawings are A500 through A550.

The reclamation costs were calculated using SRCE version 1.4.1, which was downloaded from the NDEP-BMRR website and approved for use by the State of Nevada as of August 1, 2012. The SRCE model outputs are provided as Appendix A, and the assumptions used to develop the SRCE model are summarized in the following sections.

2. CLOSURE STRATEGY

An applicant for an APP or a permit amendment must identify a closure strategy. A.R.S. 49-243(A)(8) & 49-243(N)(2). The closure strategy for the APP facilities described above is presented below, with estimated costs following the description of the strategy.

The closure strategy includes capping the dry stack TSF with 1 to 2 feet of reseeded growth media underlain by a capillary break created by the rock armor berms placed during construction. The side slopes of the final TSF will have a 3H:1V compound slope with 2.5H:1V open slopes broken every 25 ft in vertical elevation rise by a 12.5 ft wide bench. The compound slope configuration will aid in reducing meteoric water runoff velocities, thereby reducing the propensity for erosion of the closure cap on the sides of the TSF. The top of the TSF will be graded to form a swale that flows to an outfall along the haul road, where flows from the top of the reclaimed TSF will be directed to the base of the TSF. Flows reporting to the base of the TSF from this outfall and from the TSF slope areas will be collected in a closure channel (located inside of the TSF perimeter berm) and conveyed around the TSF base where they will be directed, via the TSF spillway, to a permanent stormwater diversion channel.

It should be noted that meteoric flow collected in the closure channel will be separated from the underdrain by a low permeability soil layer to minimize infiltration of the surface flows into the underdrain system. Surface water flow reporting to the closure surface will exit the TSF via the TSF spillway and will be passed under the existing access road via (2) 42-inch diameter corrugated polyethylene (CPe) culverts. The TSF Spillway will be armored with 24 inches of D_{50} 12-inch riprap and will direct flows to the existing stormwater diversion channel. The existing stormwater diversion channel was constructed with grouted riprap at the culvert outlet and therefore will not require additional revetment to address erosion.

The External Detention Pond will be backfilled with engineered fill and capped with growth media and reseeded. The External Detention Pond area will be graded to provide positive drainage to the closure stormwater diversion channel to encourage stormwater runoff flows to exit the facility. In addition, the External Detention Pond liner will be perforated prior to backfill placement, the existing wildlife fence around the pond will be removed and the existing 3-inch diameter pipeline that is currently located on grade on the north side of the TSF from the External Detention Pond to the downstream side of the Underdrain Collection Pond will also be removed.

It is expected that the post-closure underdrain flows from the TSF will be minimal because the closure cap will minimize infiltration and little water is expected to be entrained within the TSF at closure. The flows will continue to be collected and transmitted to WTP1 until a passive treatment system can be constructed in the Underdrain Collection Pond area. This will allow the engineer to evaluate post closure underdrain water chemistry and expected flow rate ranges to effectively design a passive treatment system.

The closure strategy for siting a passive treatment system remains unchanged from the approved closure strategy for the VRP project. The approach is to reduce the Underdrain Collection Pond size post closure by reducing the north embankment height, fill the remaining pond storage area with a passive treatment substrate that effectively addresses the remaining underflow water chemistry, site an effluent delivery system that feeds the bottom of the substrate, and design an appropriate outfall to the natural drainage downstream of the pond/passive treatment system. The specific mix of substrate will be developed through observation of pilot scale passive treatment cells during the post-closure period for a duration of 1 year. Results of the pilot scale testing, post closure effluent chemistry variability, and flow rate variability will form the design basis for the permanent passive treatment system to be sited. Until an effective passive treatment approach can be demonstrated, active treatment of underdrain flows will continue. It is currently anticipated that active treatment will continue for up to 5 years, at which time the passive treatment system will be constructed. An additional 2 years of active treatment will be continued while the passive treatment system is established.

Post closure will require maintenance of the closure cap until a vegetated surface can be established. The closure surface will be monitored, inspected and repaired, if needed, to address water and wind erosion. In addition to the closure cap, the access roads, stormwater diversion channels and Underdrain Collection Pond areas will also be monitored, inspected and repaired, if needed.

If January Adit ground water is not pumped down in post-closure, the water level will rise over time in the January Norton Workings. Once the water level returns to the January Adit surface elevation, it would begin to discharge on the surface. As part of the closure strategy, a concrete bulkhead will be constructed in the January Adit and an injection grouting program will be performed in competent rock around the adit. It is assumed injection grouting would be performed in concentric circles with radii of 10 ft, 20 ft and 30 ft. The injection grouting holes are assumed to be drilled at 10 ft intervals around the circumference of each circle. The concrete bulkhead in conjunction with the injection grouting is the conceptual closure strategy to prevent a discharge from the January Adit after the water levels return during closure. If the January Adit plug does not prevent discharging at closure, flow from the January Adit mine workings would be treated at the passive treatment system established in the repurposed Underdrain Collection Pond as a backup contingency.

For more detailed descriptions regarding the various components of the closure strategy as well as assumptions, calculations, quantities and/or unit rate development, refer to Section 6 of this Technical Memorandum.

3. WATER TREATMENT PLANT 1 (WTP1)

Cost associated with the closure of WTP1 are calculated based on the following data and assumptions:

- Treatment of contact water reporting to the Underdrain Collection Pond
  - Treatment duration: Estimated to be a total of 7 years based on 5 years of active treatment at which time a passive treatment system will be constructed. An additional 2 years of active treatment will be continued while the passive treatment system is established.
  - Treatment cost: Estimated by AMI based on current treatment costs experienced to date and costs associated with the planned WTP1 upgrade.
  - Treatment quantity: Contact water reporting to the Underdrain Collection Pond is estimated based on assumed drain down flowrates through the TSF stacking as well as estimated infiltration through the closure cap. All other meteoric precipitation is assumed to be directed from the facility as non-contact runoff or lost through evaporation.
- There is no cost associated with turning the WTP1 off as part of the APP closure strategy. Costs, such as building demolition, associated with closure of the WTP1 are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

Additional details regarding WTP1 closure costs can be referenced in the “Other User” and “User 9” printouts from the SRCE model (Appendix A) and Section 6.33 of this technical memo.

4. UNDERDRAIN COLLECTION POND, TSF AND EXTERNAL DETENTION POND

Closure of the Underdrain Collection Pond, TSF and External Detention Pond are estimated by the SRCE model and described in Section 2 (Closure Strategy) as well as in detail in the remaining sections of this report. Additionally, figures showing the various closure tasks can be referenced in the attached Figures 1 through 6.

5. WATER TREATMENT PLANT 2 (WTP2)

There is no cost associated with closure of the WTP2 because the facility will only be turned off as part of the APP closure strategy. Unlike WTP1, WTP2 will not be needed for TSF draindown after closure, and the activities that create water that is treated by WTP2 will cease. Costs, such as decommissioning and building demolition, associated with closure of the WTP2 are not part of this APP SRCE model. Financial assurance for these elements of reclamation are under the jurisdiction of the Arizona State Mine Inspector.

6. SRCE MODEL SECTIONS

The following sections summarize the inputs and outputs for the SRCE model. Detailed information for each section can be referenced in the SRCE model printouts in Appendix A.

6.1 Cost Summary

The Cost Summary compiles labor, equipment, material and total cost for the following:

- A. Earthwork/Recontouring
- B. Revegetation/Stabilization
- C. Detoxification/Water Treatment/Disposal of Wastes
- D. Structure, Equipment and Facility Removal, and Misc
- E. Monitoring
- F. Construction Management and Support
- Indirect Costs

Please note, the cost associated with the Underdrain Collection Pond conversion to a passive treatment system is included under the “Earthworks/Recontouring” section of the Cost Summary and supporting documentation can be referenced on the “User 11” and “Other User” printouts in Appendix A. In addition, mobilization and demobilization costs are included under the “Earthworks/Recontouring” section of the Cost Summary and the supporting documentation can be referenced on the “User 1” printout in Appendix A. WTP1 treatment costs are included under the “Detoxification/Water Treatment/Disposal of Wastes” section of the Cost Summary and supporting documentation can be referenced on the “User 9” and “Other User” printouts in Appendix A.

All indirect costs (i.e. engineering, design and construction plan, contingency, etc.) utilize the default values provided in the SRCE model. The indirect cost percentages can be referenced in the administrative cost rates table shown in the cost summary printout. In general, these percentages are determined from a variable rate scale based on the total reclamation cost.

6.2 Other User

The other user section is utilized to define the following costs and quantities:

- Riprap (D_{50}=3in, D_{50}=6in and D_{50}=12in)
    - Additional information regarding the creation of the riprap unit cost including labor, equipment and material costs can be referenced on the “User 5” printout in the SRCE model (Appendix A) and Section 6.29 of this memo.
    - The riprap quantities are based on closure stormwater diversion channel lengths measured in AutoCAD multiplied by the riprap cross sectional area. The closure stormwater diversion channel stationing and typical cross section can be referenced on Figure 2 and Figure 6, respectively.
- Dual 42 inch diameter CPe culverts
    - Additional information regarding the creation of the culvert unit cost including labor, equipment and material costs can be referenced on the “User 6” printout in the SRCE model (Appendix A) and Section 6.30 of this memo.
    - The quantities are based on culvert length measured in AutoCAD multiplied by the cross-sectional areas for the various materials. The culvert location and typical cross section can be referenced on Figure 2 and Figure 6, respectively.
- 10 oz/yd^2 non-woven geotextile
    - Additional information regarding the creation of the geotextile unit cost including labor, equipment and material costs can be referenced on the “User 7” printout in the SRCE model (Appendix A) and Section 6.31 of this memo.
    - The geotextile quantity is based on closure stormwater diversion channel lengths measured in AutoCAD multiplied by the geotextile cross sectional length. The closure stormwater diversion channel stationing and typical cross section can be referenced on Figure 2 and Figure 6, respectively.
- Bentonite Amendment
    - Additional information regarding the unit cost of amending the low permeability soil layer material with bentonite including labor, equipment and material cost can be referenced on the “User 8” printout in the SRCE model (Appendix A) and Section 6.32

of this memo. The quantity of bentonite was determined using 2% of the low permeability soil layer weight.

- Water Treatment Plant 1
  - Additional information regarding the creation of the costs associated with the operation of WTP1 can be referenced on the "User 9" printout in the SRCE model (Appendix A) and Section 6.33 of this memo.
- The January Adit Plug
  - Additional information regarding the cost of the January Adit Plug can be referenced on the "User 10" printout in the SRCE model (Appendix A) and Section 6.34 of this memo.
- Passive Treatment System
  - Additional information regarding the creation of the costs associated with the conversion of the Underdrain Collection Pond to a passive treatment system can be referenced on the "User 11" printout in the SRCE model (Appendix A) and Section 6.35 of this memo.

6.3 Exploration

Exploration is not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.4 Exploration Roads and Pads

Exploration roads and pads are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.5 Waste Rock Dumps

The SRCE waste rock dump section is utilized to model the reclamation costs for the dry stack TSF due to the TSF stacking geometry and placement method of the contained materials (historic tailings with low moisture content, exploration decline development rock, etc.) being most representative of a waste rock dump. During operations, the materials within the dry stack TSF are placed as a mechanically compacted earthen material designed with a composite open slope benched arrangement to break up continuous slope lengths and thereby reduce sheet flow velocities with the intent to minimize the initiation and/or propagation of surface erosion.

The stacked material geometry is an overall 3H:1V slope comprised of 25 vertical foot 2.5H:1V slopes with 12.5 foot wide benches every 25 vertical feet. Within the 25 vertical foot 2.5H:1V slope are five 1.5H:1V open slopes each 5 vertical feet high with a 5 foot wide bench. During closure, the 1.5H:1V slopes with corresponding benches will be re-graded to create one continuous 25 vertical foot open slope. Slopes requiring re-grading and a cross section of the closure stacking configuration can be referenced on Figure 2.

The flat areas will be ripped, and the slopes and top will be covered with 1 to 2 feet of growth media material and revegetated. During VRP TSF construction, growth media material was stockpiled in the Growth Media Storage Area and Infrastructure Pad. The Growth Media Storage Area and Infrastructure Pad locations can be referenced on Figure 1.

It is important to note, the TSF embankment downstream slope was hydroseeded during construction and the TSF embankment upstream slope is geomembrane lined. The TSF embankment crest reclamation costs are included under Section 6.8, "Roads".

All waste rock dump inputs, such as bench lengths, footprint area and haul distance/slope are calculated using AutoCAD Civil 3d.

6.6 Heap Leach Pads

No heap leach pads are planned as part of this project.

6.7 Tailings

The tailings section in SRCE is configured for conventional slurry tailings facilities. The dry stack TSF geometry and placement method is representative of a waste rock dump. Refer to Section 6.5, Waste Rock Dumps, for reclamation cost of the dry stack TSF.

6.8 Roads

The TSF Perimeter Road and TSF Haul Road are included in the road section of the SRCE model. The TSF Perimeter Road will have the safety berms removed (both sides), and the road will be ripped and revegetated. The TSF Haul Road will have the safety berm removed, ripped, covered with 1 to 2 feet of growth media, fertilized and revegetated. The TSF Perimeter Road and TSF Haul Road locations can be referenced on Figure 2 and the road dimensions and lengths can be referenced in the SRCE printouts. All other site roads are not included in this APP SRCE model as they are not associated with APP regulated facilities. Financial assurance for these roads and any future site roads not associated with APP facilities are under the jurisdiction of the Arizona State Mine Inspector.

All road inputs, such as length, width and haul distance/slope are calculated using AutoCAD Civil 3d. Please note, the growth media and revegetation reclamation costs for the roads are included as part of the "Waste Rock Dumps" growth media and revegetation costs.

6.9 Pits

No pits are planned as part of this project.

6.10 Quarries and Borrow Pits

No quarries and borrow pits are planned as part of this project.

6.11 Underground Openings

Underground openings are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.12 Material Hauling

Engineered fill is planned to be loaded at the Infrastructure Pad, hauled to the TSF for use in the closure stormwater diversion channel and compacted to create positive drainage for stormwater runoff. Similarly, low permeability soil layer material is planned to be screened at the Infrastructure Pad, loaded and then hauled to the closure stormwater diversion channel and compacted. Meteoric flow collecting in the closure stormwater diversion channel will be separated from the underdrain by a low permeability soil layer to minimize infiltration of the surface flows into the underdrain system.

The closure stormwater diversion channel and Infrastructure Pad locations can be referenced on Figure 1. The engineered fill and low permeability soil layer material volume, haul distance and haul slope can be referenced in the SRCE printouts. All material haulage inputs, such as road lengths and slopes are calculated using AutoCAD Civil 3d.

6.13 Building and Foundation Demolition

Building and foundation demolition are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.14 Other Demolition and Equipment Removal

Other demolition and equipment removal are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.15 Sediment and Drainage Control

Closure stormwater diversion channels will be constructed at the base of the TSF to collect and convey stormwater runoff within the TSF footprint to the permanent stormwater diversion channel via the TSF spillway. The closure stormwater diversion channel, including the TSF spillway, can be referenced in plan view on Figure 2. The reclamation costs associated with the closure stormwater diversion channel and TSF spillway are included as follows:

Closure Stormwater Diversion Channel – See Figures 2 (plan view) and 6 (typical section):

- Riprap revetment: Included in "other users" section. Riprap was included in the other users because SRCE does not have built in riprap sizes that are specific to this project (i.e. D_{50}=3in, D_{50}=6in and D_{50}=12in).
- Geotextile: Included in "other users" section. Geotextile was included in the other users because SRCE does not have a built in geotextile cost.
- Engineered fill and Low Permeability Soil Layer: Included in "Material Hauling" section.

Closure TSF Spillway – See Drawing A550:

- Riprap revetment: Included in "other users" section. Riprap was included in the other users because SRCE does not have built in riprap sizes that are specific to this project (i.e. D_{50}=12in).
- Geotextile: Included in "other users" section. Geotextile was included in the other users because SRCE does not have a built in geotextile cost.
- Dual 42 inch diameter CPe culverts installation: Included in "other users" section.
- Low Permeability Soil Layer: Included in "Material Hauling" section.
- Spillway excavation: Included in "Sediment & Drainage Control" section.

The diversion channel length, depth, bottom width, and slope can be referenced in the SRCE printouts. All sediment and drainage control inputs are calculated using AutoCAD Civil 3d.

Removal of existing sediment ponds/basins are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.16 Ponds

During closure, the Underdrain Collection Pond is planned to be converted to a passive treatment system. A plan view of the Underdrain Collection Pond can be referenced in Figure 3 and description can be referenced in Section 2 titled Closure Strategy. The costs to convert the Underdrain Collection Pond to a passive treatment system were estimated by CPE Consultants. Detailed closure costs associated with the passive treatment system can be referenced on the "User 11" printout in the SRCE model and Section 6.35 of this memo.

The External Detention Pond will be backfilled with compacted engineered fill material during closure to provide positive drainage to the closure stormwater diversion channel located at the base of the TSF stacking. The backfill will be capped with 1 to 2 feet of growth media and hydroseeded. Prior to placement of backfill material the geomembrane liner will be perforated and left in place. A plan view of the External Detention Pond can be referenced in Figure 4. All pond inputs, such as pond length, width and depth as well as material haul distance/slope are calculated using AutoCAD Civil 3d. Please note, the reclamation costs associated with removal of the existing wildlife fence and the existing 3-inch diameter pipeline (from the External Detention Pond to the downstream side of the Underdrain Collection Pond) is captured under Section 6.21 titled Miscellaneous Costs.

6.17 Landfills

No on-site landfills are currently planned as part of this project.

6.18 Yards

Yards are not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.19 Waste Disposal

Waste disposal accounts for a 30 cubic yard dumpster to handle solid waste generated during closure construction. The quantity of solid waste is an assumed value. The dumpster rental is assumed to be required during the months of active reclamation construction.

6.20 Well Abandonment

Well abandonment cost accounts for the Point of Compliance (POC) monitoring well abandonment (referred to as MW-3). The well location can be referenced on Figure 1. All well abandonment inputs are provided by Clear Creek Associates based on the MW-3 as-built condition.

6.21 Misc Costs

The miscellaneous costs include the following:

- Removal of the 8 foot high wildlife fence around the External Detention Pond. The wildlife fence locations can be referenced on Figure 1.
- Removal of the 3 inch diameter HDPE pipe placed on existing ground from the External Detention Pond to the downstream side of the Underdrain Collection Pond. The 3 inch diameter HDPE pipe alignment can be referenced on Figure 1.

All miscellaneous cost inputs, such as fence and pipe length are calculated using AutoCAD Civil 3d. Removal of other miscellaneous site culverts and buried pipes is not part of this APP SRCE model. Financial assurance for this element of reclamation is under the jurisdiction of the Arizona State Mine Inspector.

6.22 Reclamation Monitoring and Maintenance

Reclamation monitoring and maintenance cost assumes that 25 percent of the area will require revegetation maintenance (reseeding) and 10 percent of the volume will require erosion maintenance. It also assumes that reclamation monitoring will be performed by a field geologist/engineer using the following inputs:

- 5 hours/day of field work, 2 hours/day of reporting, and 3 hours/day of driving
- 12 days per year of reclamation monitoring (once per month)
- 30 years of reclamation monitoring
- Assumes local firm performs reclamation monitoring work (no flights included)

Water and rock sample analysis assumes one sample will be collected from the POC on a semi-annual basis for thirty years and tested per the parameters shown in the “User 4” printout (see quote received from Turner Laboratories Inc for actual cost of the POC monitoring tests). The reclamation monitoring cost also includes 8 hours for collection and 2 hours for reporting for a field geologist/engineer per sample obtained. The POC location can be referenced on Figure 1 as MW-3.

6.23 Construction Management and Road Maintenance

Based on hours and the specified equipment fleet produced from the SRCE model, it is anticipated that active reclamation construction will require approximately six months of construction management. A construction manager as well as equipment for road maintenance are included for active reclamation construction utilizing the following assumptions:

- 6 month duration (covers anticipated construction schedule)
- 160 hours per month
- 1 temporary office rental
- 2 toilet rentals
- A medium size water truck for the duration of anticipated construction (road maintenance) assumed to work 160 hours per month
- A medium size grader for the duration of anticipated construction (road maintenance) assumed to work 160 hours per month

After active reclamation construction is complete, monitoring and maintenance is assumed utilizing the following assumptions:

- A medium size water truck and grader (road maintenance) is assumed to be required semiannually for a duration of 7 years (totaling 14 "durations").
- Each "duration" would require 16 hours to perform maintenance activities.
- A mobilization/demobilization is included for all 14 occurrences for both the water truck and grader.

6.24 Labor Rates, Equipment Costs, Material Costs and Misc. Unit Costs

Historical contractor time and material costs were provided by AMI for the creation of site-specific contractor labor and equipment rates. Although AMI has a comprehensive list of site-specific contractor labor and equipment rates, it does not address every labor category and piece of equipment in the SRCE model. In order to fill in any missing site-specific contractor labor or equipment rates, the following methods were utilized:

- Where site specific data was available for similar equipment, the standard SRCE model rates (Southern Nevada region) were used to linear scale the site-specific rates. For example, site specific data for a CAT D6 dozer exist but there is not site-specific data for a CAT D7 dozer. In this case, the standard SRCE model rates (Southern Nevada region) was utilized to scale the site-specific CAT D6 dozer rate at the same ratio as the standard SRCE model rate increase from a CAT D6 dozer to a CAT D7 dozer.
- Where site-specific data was unavailable for similar equipment, the standard SRCE model rate for the Southern Nevada region was utilized. The Southern Nevada region was selected as the most representative due to the geographic proximity to the project.

When comparing the site-specific cost to the standard SRCE cost for the Southern Nevada region, the site-specific costs were similar but resulted in a slightly lower reclamation cost. To be conservative, the higher standard SRCE Southern Nevada labor and equipment rates were used to populate the reclamation cost. The standard SRCE Southern Nevada rates are provided by NDEP in the file "SRCE Standard Cost Data File 2019 – Nevada, USA – NEVADA STANDARDIZED DATA" last updated August 1, 2019.

Generally, standard SRCE model rates for Southern Nevada were used for material and miscellaneous unit costs. However, site material rates for seed mix and water quality analysis were utilized to represent actual site costs. In both instances, the site rates are higher than the standard SRCE rates.

6.25 User 1

The mobilization/demobilization cost estimate for the equipment fleet anticipated to perform the active closure construction is included under "User 1." The costs were manually input into the "Cost Summary" sheet under the "Earthwork/Recontouring" section. The required equipment was obtained from the SRCE model which can also be referenced in the "User 2" printout.

6.26 User 2

The active closure construction equipment fleet and corresponding projected hours for the various work items were obtained from the SRCE model and collated in the "User 2" printout. Based on the summation of hours for each equipment fleet, an assumed construction timeline was determined. The construction management and road maintenance durations were set based on this assumed construction timeline. In addition, the equipment fleets shown in this spreadsheet were utilized as an input into the mobilization/demobilization cost estimate that is provided in the "User 1" printout (Appendix A).

6.27 User 3

A quote for the proposed seed mix was provided by Arizona Revegetation & Monitoring Co. on February 27, 2020 and can be referenced in the "User 3" printout (Appendix A). The seed mix is specified as "User Mix 1" is the SRCE model.

6.28 User 4

A quote for the water sample analysis under the monitoring section was provided by Turner Laboratories Inc on July 7, 2020 and can be referenced in the "User 4" printout (Appendix A).

6.29 User 5

A cost was developed by NewFields to estimate production and placement cost for the following riprap sizes:

- Riprap D_{50} = 3 inch
- Riprap D_{50} = 6 inch
- Riprap D_{50} = 12 inch

The following information was utilized to develop the unit rate:

- Construction performed by a third-party contractor
- Labor and equipment rates utilized from SRCE model
- Overbuild and wastage of 15%

The supply cost of riprap was estimated assuming the riprap would be produced from the existing material stockpile located at the Infrastructure Pad by passing the material over a set of bar screens. It was assumed that a percentage of the material passed over the screen would be usable product and the remainder was waste. The estimated usable vs waste product varied for each riprap D_{50} size. The installation cost was estimated assuming the material would be loaded with a hydraulic loader, hauled with an articulated truck fleet, end dumped in the bottom of the channel and spread with a large excavator at a rate of 70 to 80 cy/hr. The installation rate was dependent on riprap size with the largest riprap having the slowest installation rate.

The riprap quantity was calculated by multiplying AutoCAD riprap lengths and the riprap cross sectional area. The detailed development of the unit rates including material, labor and equipment/operating cost can be referenced in the “User 5” printout.

6.30 User 6

A cost was developed by NewFields to estimate a cost per linear foot for the dual 42 inch diameter culverts at the closure TSF spillway inclusive of the culvert supply and installation cost. The installation cost also includes the excavation of the trench, supply and installation of pipe bedding and pipe backfill as a cost per liner foot of culvert. The following information was utilized to develop the unit rate:

- Construction performed by a third-party contractor
- Labor and equipment rates utilized from SRCE model
- 42-inch diameter CPe pipe
  - Supply cost: $57.68/ft including, freight and tax (based on quote provided by Southwest Irrigation July 27, 2020)
- Pipe bedding
  - Supply cost: $24.00/ton (based on historic information provided by AMI from the VRP project construction)
- Pipe backfill
  - Supply cost: Material was assumed to be the material that was excavated from the trench and screened over a bar screen.

The culvert quantity was calculated using an AutoCAD length measurement. The detailed development of the unit rate including material, labor and equipment/operating cost can be referenced in the “User 6” printout (Appendix A).

6.31 User 7

A cost was developed by NewFields to estimate the supply and installation cost of 10 oz/yd^2 non-woven geotextile. The following information was utilized to develop the unit rate:

- Construction performed by a third-party contractor
- Labor and equipment rates utilized from SRCE model
- Supply cost was developed using quote from Agru America ($0.115/sf) provided July 21, 2020.
- The cost includes an allowance for sales tax of 6.6% and for freight from the supplier's facility to the site.
- The installation cost was developed based on historic information and input from Agru at an assumed average placement rate of approximately 2,000 square feet per hour.

Detailed development of the unit rate including material supply and delivery costs as well as labor and equipment rates can be referenced in the "User 7" printout (Appendix A).

6.32 User 8

A cost was developed by NewFields to estimate the supply and use of bentonite as an amendment to the low permeability soil layer. The total unit cost includes material supply and transportation to the project site as well as processing the bentonite into the low permeability soil. The following information was utilized to develop the unit rate:

- Construction performed by a third-party contractor.
- Labor and equipment rates utilized from SRCE model.
- Costs for supply and delivery of CETCO bentonite ($284.40/ton) was based on 2019 VRP TSF construction costs.
- Installation costs based on historical site data provided by Arizona Minerals Inc for equipment and labor rates (Wirtgen spreader and tractor with disc).
- Placement rate assumed to be approximately 24 tons/hour.

Detailed development of the unit rate including material supply and delivery costs as well as labor and equipment rates for processing can be referenced in the "User 8" printout (Appendix A).

6.33 User 9

A cost was developed by NewFields to estimate the operational cost of WTP1 upon closure. The operating cost includes labor and material costs based on current WTP1 operating costs to date. The following information was used to develop the labor and material costs:

- Current labor and operational costs provided by AMI based on an approximate 120 gallon per minute treatment rate.
    - Current labor cost includes a man hour load for 8 personnel working in shifts at the WTP1 covering 24 hours per day and 7 days per week.
    - Closure labor cost is calculated as a factor of the current labor cost based on projected man-hours.
        - Years 1 and 2 of closure remains at 100% of current labor costs. Labor costs are reduced when TSF and January Adit Plug closure construction has been completed. Closure construction is assumed to take 2 years from design to completion of construction.
        - In Years 3 through 7 of closure, the closure labor cost accounts for 2 staff working 8 hours per day and 5 days per week which equates to 23.7% of the current hours.
    - Current material costs (i.e. utilities, spares, chemicals, etc) were summed and utilized to develop a dollar per gallon basis.
    - Closure material costs utilized the current material dollar per gallon cost.
- The operating duration of the WTP1 once closure activities commence is 7 years.
    - The first two years provides time to finalize design and construct the TSF and January Adit closure system.
    - At year five the Underdrain Collection Pond will be converted to a passive treatment system.
    - Active treatment will continue until year seven providing time for the passive treatment system to be established.
- Water reporting to WTP1 was assumed to be from the following:
    - January Adit will be pumped and treated for the first two years of closure until the January Adit plug can be installed.
        - January Adit is assumed to be pumped at 23 gallons per minute based on current treatment rates provided by AMI.
    - Precipitation over the TSF is assumed to be collected and conveyed to the Underdrain Collection Pond for the first two years of closure until the TSF and External Detention Pond closure can be final designed and constructed. From the Underdrain Collection Pond, the water will be pumped to WTP1 for treatment.

        - It is conservatively assumed that 100% of the annual precipitation over the TSF is collected and conveyed to the Underdrain Collection Pond and then pumped to WTP1 (no evaporation).
    - Precipitation over the Underdrain Collection Pond is assumed to be collected for the first five years of closure until the Underdrain Collection Pond can be converted to a passive treatment system. From the Underdrain Collection Pond, the water will be pumped to WTP1 for treatment.
        - It is conservatively assumed that 100% of the annual precipitation is collected and pumped to WTP1 (no evaporation).
    - Draindown from the TSF to the Underdrain Collection Pond at a rate of approximately 1.3 gallons per minute after closure.
        - The draindown was calculated based on maximum stacking volume (~2.7 million cubic yards), average in place density of material placed to date (121.81 pounds per cubic foot), average in place moisture content of material placed to date (13.94%), assumed residual moisture content (12%) of the stacked material and draindown duration (30 years).
    - Infiltration through the TSF closure cover is assumed to be a value of 2% of the average annual rainfall at site. All infiltration will report to the Underdrain Collection Pond.
    - Laboratory sample analysis costs have been included for quarterly ($910/quarter) and annual ($5,672/year) sample analysis for a duration of 7 years which is the same duration that the WTP1 will be operating). This laboratory sample analysis cost is for monitoring of discharge from WTP1 only and not part of the POC monitoring.

Detailed development of the WTP1 operational treatment cost can be referenced in the “User 9” printout (Appendix A).

6.34 User 10

A high level cost estimate was developed by NewFields to estimate the reclamation cost of a January Adit Plug. As currently envisioned, the construction of the January Adit plug would involve the following:

- Excavate area around the January Adit/Shaft to create access and required space for construction of the adit plug. Excavation area is assumed to be approximately 80ft by 80ft of flat area at the rough current ground elevation. This working platform will be the flat surface where excavation to the competent bedrock will occur. Excavation cut slopes are assumed to be 1.5H:1V daylights (horizontal:vertical).
- Once competent bedrock is exposed, historic backfill, placed in the January Adit/Shaft, will be removed to a depth of approximately 30ft to allow placement of a concrete bulkhead in the adit/shaft.
- Construct a concrete bulkhead in the January Adit/Shaft.

- Assume concrete bulkhead to be 15ft by 15ft by 30ft (depth).
- Backfill bulkhead excavation in preparation for injection grouting.
- Perform an injection grouting campaign using the following assumptions:
  - An inner injection grouting ring with a 10 ft radius and holes at 10 ft spacing.
  - An intermediate injection grouting ring with a 20 ft radius and holes at 10 ft spacing.
  - An outer injection grouting ring with a 30 ft radius and holes at 10 ft spacing.
  - Assume one confirmatory hole is drilled for each injection grouting hole to check degree of injection grouting translation laterally.
  - Assume half of the confirmatory holes require injection grouting.
  - Assume competent bedrock is at 30 ft below ground surface.
  - Assume injection grouting is performed for 20 vertical ft in the competent bedrock.
- Based on historical site data, drilling mobilization and demobilization is approximately $10,000 and drilling cost would be approximately $125 per foot. Assumed 50 ft of drill depth per injection grouting hole.
- Injection grouting cost is assumed at $280 per hour with each hole needing active grouting time of 15 hours. Grouting time/cost includes grout plant elements, injection grout nipple installation and packer testing of the grout holes prior to grouting.
- An additional 10% contingency was applied to cover uncertainties and unknowns.

6.35 User 11

The reclamation cost estimate associated with the conversion of the existing Underdrain Collection Pond to a passive treatment system was generated by CPE Consultants. It is currently anticipated that active treatment will continue for approximately 5 years at which time the passive treatment system will be implemented. An additional 2 years of active treatment will be continued while the passive treatment system is established. The passive treatment system costs considered the following:

- Construction Capital Costs
  - Site improvement work including mobilization/demobilization, grading, equipment and piping
- Biochemical Reactor (BCR) Cells
- Aerobic Polishing Wetland
- Manganese Removal Bed (MRB)

Details of the reclamation costs can be referenced on the “User 11” printout (Appendix A).

7. CONCLUSIONS

NewFields has completed a SRCE model, version 1.4.1, to estimate reclamation/closure costs associated with the Hermosa Lined TSF Design Amendment which is being submitted to ADEQ as part of a proposed significant APP amendment. Assumptions used to complete the SRCE model are summarized in the above sections. Model inputs were derived from existing aerial topography, as-built data from the VRP TSF construction, and the TSF amended design work. Facilities used to complete the model include:

- Existing WTP1
- Existing Underdrain Collection Pond
- Existing Tailings Storage Facility based on the Hermosa Lined TSF Design Amendment stacking geometry
- Existing External Detention Pond
- Proposed WTP2

All SRCE model outputs can be referenced in Appendix A. The final reclamation cost estimate was calculated by SRCE to be $13,920,872. Please note, the SRCE model is being utilized to update the 2018 VRP permitted reclamation costs based on the design amendment. The SRCE model was not utilized to develop the current reclamation cost estimate submitted and approved by ADEQ as part of the January 8, 2018 permit approval. The approved 2018 VRP reclamation costs were determined using a compilation of engineering estimates performed by multiple consultants. Although the SRCE model was not utilized for the 2018 VRP reclamation estimate, it is being implemented as part of this application per ADEQ's request to employ an industry recognized tool which can be easily updated as time progresses.

Differences between the approved 2018 VRP and SRCE reclamation estimates are shown by cost category in Table 8.1.

TABLE 8.1 – 2018 VRP AND SRCE RECLAMATION COST ESTIMATE COMPARISON

Facility	2018 VRP Reclamation Estimate ($)	SRCE Reclamation Estimate ($)	Difference ($)
Tailings Storage Facility / External Detention Pond	$2,130,908	$2,312,686	+$181,778
TSF Post Closure	$618,162	$977,956	+$359,794
Underdrain Collection Pond / Water Treatment Plant 1	$5,190,310	$8,621,930	+$3,431,620
January Adit Plug	$0	$2,008,300	+$2,008,300
Water Treatment Plant 2	$0	$0	$0
Total	$7,939,380	$13,920,872	+$5,981,492

Cost variations shown in Table 8.1 are presented from a holistic standpoint for each category rather than focusing on specific line items within each facility. Due to the protection built into the SRCE model, the user is not able to view the SRCE calculations used to create the various unit rates. As a result, a review and comparison of each specific line item unit rate would be difficult on a line by line basis. The major differences between the estimates are shown in Tables 8.2 through 8.5.

TABLE 8.2 – 2018 VRP AND SRCE RECLAMATION COST ESTIMATE – TSF/EXTERNAL DETENTION POND

2018 VRP Reclamation Estimate	SRCE Reclamation Estimate
Quantities based on VRP TSF design stacking.	Quantities based on TSF Design Amendment stacking. Due to changes in the overall stacking plan, additional earthworks are required to construct the closure geometry and create positive drainage around the facilities.

TABLE 8.3 – 2018 VRP AND SRCE RECLAMATION COST ESTIMATE – POST CLOSURE

2018 VRP Reclamation Estimate	SRCE Reclamation Estimate
Post closure cover maintenance based on 10% (year 1) and 5% (year 2) of the total TSF reclamation cost estimate.	Post closure cover maintenance based on 25% of revegetation area requiring reseeding and 10% of growth media volume requiring replacement.
Reclamation monitoring based on: ➢ Field Tech ➢ 10 hours/week for 10 years to perform closure monitoring (including field work, reporting and travel)	Reclamation monitoring based on: ➢ Field Geologist/Engineer ➢ 5 hours/day, 12 days/year and 30 years for field work ➢ 2 hours/day, 12 days/year and 30 years for reporting ➢ 3 hours/day, 12 days/year and 30 years for travel
Post Closure Sampling and Analysis: ➢ $3,000 per quarter for 10 years for laboratory testing.	Post Closure Sampling and Analysis (POC): ➢ Semiannually for 30 years performed by a field Geologist/Engineer ➢ 8 hours/day for field work and 2 hours/day for reporting ➢ Water sample analysis is based on recent quote of $631.90/sample
Does not include pump replacement.	Includes replacement of the ground/surface water monitoring pump.

TABLE 8.4 – 2018 VRP AND SRCE RECLAMATION COST ESTIMATE – UNDERDRAIN COLLECTION POND / WTP1

2018 VRP Reclamation Estimate	SRCE Reclamation Estimate
Closure strategy for the Underdrain Collection Pond was to convert to a passive treatment system in year 10 of closure.	Closure strategy for the Underdrain Collection Pond is to convert to a passive treatment system in year 5 of closure.
Passive treatment system designed by CPE Consultants to have an equalization basin (EB), biochemical reactor (BCR), aerobic polishing wetland (APW) and manganese removal bed (MRB).	Passive treatment system designed by CPE Consultants to have an EB, BCR, APW and MRB (same design as 2018 VRP reclamation estimate).
WTP1 labor cost based on assumed hours work. ➢ 24 hours/day for 10 days/month for 8 months/year for 10 years ➢ 24 hours/day for 30 days/month for 4 months/year (wet season) for 10 years	WTP1 labor cost based on factored cost of actual operation. ➢ Assume 100% of actual labor cost for 2 years (pre TSF closure cap) ➢ Assume 23.7% of actual labor cost in years 3 – 7 (post TSF closure cap)
WTP1 operational cost (i.e. chemicals, power, etc) based on projected operating cost.	WTP1 operational cost (i.e. chemicals, power, etc) based on actual operating cost.
WTP1 treatment quantity based full operation (120 gpm) of WTP1 during working hours.	WTP1 treatment quantity based on assumed January Adit dewatering, TSF runoff/draindown/closure cap infiltration, direct precipitation over the Underdrain Collection Pond, and construction timelines for the January Adit plug, TSF closure cap, and passive treatment system in the Underdrain Collection Pond.
Monthly monitoring at one location assuming $1,500/month.	Laboratory sample analysis (WTP1 only) based on quarterly and annual testing with costs informed by recent quotes.

TABLE 8.5 – 2018 VRP AND SRCE RECLAMATION COST ESTIMATE – MISCELLANEOUS

ITEM	2018 VRP Reclamation Estimate	SRCE Reclamation Estimate
Contingency	In general, 15% contingency was applied to most of the 2018 VRP reclamation estimates.	8% contingency (based on sliding scale provided in SRCE).
WTP2	A WTP2 was not contemplated during the VRP project.	There is no cost associated with closure of the WTP2 because the facility will simply be turned off as part of the APP closure strategy. Costs, such as building demolition, associated with closure of the WTP2 are not part of this APP SRCE model. Financial assurance for these elements of reclamation are under the jurisdiction of the Arizona State Mine Inspector.
January Adit Plug	No January Adit Plug contemplated.	Construct a concrete bulkhead and perform injection grouting in the January Adit during closure.

APPENDIX A

Enter Data Below in Green and Blue Spaces

STANDARDIZED RECLAMATION COST ESTIMATOR

Version 1.4.1
Build 017b (Revised 16 May 2019)

Approved for use in Nevada, August 1, 2012

COST DATA FILE INFORMATION

File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm

Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm

Cost Data Date: July 6, 2020

Cost Data Basis: User Data   Data Cost Units: Imperial

Author/Source: NewFields

PROJECT INFORMATION

Property/Mine Name: Hermosa   Property Code:

Project Name: Hermosa Lined TSF Design Amendment

Date of Submittal: August 7, 2020   Average Altitude: 5000 ft.

Select One: ☐ Notice or Sm Exploration Plan ☒ Lg Exploration Plan ☐ Mine Operation

Select One: ☒ Private Land ☐ Public or Public/Private

Cost Estimate Type: Surety

Cost Basis Category: Southern Nevada

Clark, Esmeralda, Lincoln and Nye Counties

Cost Basis Description:

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Closure Cost Estimate
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ct Name: Hermosa Lined TSF Design Amendment
Project Date: August 7, 2020
SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Plan of Operations

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Closure Cost Estimate
Cost Summary

Project Name: Hermosa Lined TSF Design Amendment
Project Date: August 7, 2020
Model Version: Version 1.4.1
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm

A. Earthwork/Recontouring		Labor (1)	Equipment (2)	Materials	Total
Exploration		$0	$0	$0	$0
Exploration Roads & Drill Pads		$0	$0	$0	$0
Roads		$255	$674	$0	$929
Well Abandonment		$650	$1,219	$3	$1,872
Pits		$0	$0	N/A	$0
Quarries & Borrow Areas		$0	$0	$0	$0
Underground Openings		$0	$0	$0	$0
Process Ponds		$46,397	$103,678	$0	$150,075
Heaps		$0	$0	$0	$0
Waste Rock Dumps		$62,981	$145,396	$0	$208,377
Landfills		$0	$0	$0	$0
Tailings		$0	$0	$0	$0
Foundation & Buildings Areas		$0	$0	$0	$0
Yards, Etc.		$0	$0	$0	$0
Drainage & Sediment Control		$426	$655	$0	$1,081
Generic Material Hauling		$84,084	$144,722	$0	$228,805
Other User Costs (from Other User sheet)		$150,259	$125,088	$4,462,119	$4,737,465
Other**					$0
Subtotal		**$345,051**	**$521,432**	**$4,462,122**	**$5,328,604**
Mob/Demob if included in Other User sheet		$0	$0	$0	$0
Mob/Demob	**See "User 1" for equipment list and calc sheet**		$50,986		$50,986
Subtotal "A"		**$345,051**	**$572,418**	**$4,462,122**	**$5,379,590**

B. Revegetation/Stabilization		Labor (1)	Equipment (2)	Materials	Total
Exploration		$0	$0	$0	$0
Exploration Roads & Drill Pads		$0	$0	$0	$0
Roads		$0	$0	$0	$0
Well Abandonment					N/A
Pits		$0	$0	$0	$0
Quarries & Borrow Areas		$0	$0	$0	$0
Underground Openings					N/A
Process Ponds		$380	$144	$6,731	$7,255
Heaps		$0	$0	$0	$0
Waste Rock Dumps		$7,013	$3,506	$49,687	$60,206
Landfills		$0	$0	$0	$0
Tailings		$0	$0	$0	$0
Foundation & Buildings Areas		$0	$0	$0	$0
Yards, Etc.		$0	$0	$0	$0
Drainage & Sediment Control		$0	$0	$0	$0
Generic Material Hauling		$0	$0	$0	$0
Other User Costs (from Other User sheet)		$0	$0	$0	$0
Other**					$0
Subtotal "B"		**$7,393**	**$3,650**	**$56,418**	**$67,461**

C. Detoxification/Water Treatment/Disposal of Wastes**		Labor (1)	Equipment (2)	Materials	Total
Process Ponds/Sludge					$0
Heaps					$0
Dumps (Waste & Landfill)					$0
Tailings					$0
Surplus Water Disposal					$0
Monitoring					$0
Miscellaneous					$0
Solid Waste - On Site		$0	$0	N/A	$0
Solid Waste - Off Site					$7,125
Hazardous Materials					$0
Hydrocarbon Contaminated Soils		$0	$0	$0	$0
Other User Costs (from Other User sheet)		$1,185,229	$0	$2,492,042	$3,677,271
Other**					$0
Subtotal "C"		**$1,185,229**	**$0**	**$2,492,042**	**$3,684,396**

D. Structure, Equipment and Facility Removal, and Misc.		Labor (1)	Equipment (2)	Materials	Total
Foundation & Buildings Areas		$0	$0	$0	$0
Other Demolition		$0	$0	$0	$0
Equipment Removal		$0	$0	$0	$0
Fence Removal		$6,807	$1,752		$8,559
Fence Installation		$0	$0	$0	$0
Culvert Removal		$0	$0	N/A	$0
Pipe Removal		$8,335	$992	N/A	$9,327
Powerline Removal		$0			$0
Transformer Removal		$0			$0
Rip-rap, rock lining, gabions		$0	$0	$0	$0
Other Misc. Costs		$0	$0	$0	$0
Other User Costs (from Other User sheet)		$0	$0	$0	$0
Other**					$0
Subtotal "D"		**$15,142**	**$2,744**	**$0**	**$17,886**

E. Monitoring		Labor (1)	Equipment (2)	Materials	Total
Reclamation Monitoring and Maintenance		$494,855	$51,027	$15,267	$561,149
Ground and Surface Water Monitoring		$101,239	$17,116	$38,285	$156,640
Other User Costs (from Other User sheet)		$0	$0	$0	$0
Subtotal "E"		**$596,094**	**$68,143**	**$53,552**	**$717,789**

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Closure Cost Estimate
Cost Summary

Project Name: Hermosa Lined TSF Design Amendment
Project Date: August 7, 2020
Model Version: Version 1.4.1
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm

F. Construction Management & Support		Labor	Equipment (2)	Materials	Total
Construction Management		$135,965	$18,326	N/A	$154,291
Construction Support		$0	$11,932	$0	$11,932
Road Maintenance		$175,991	$229,731	$0	$405,722
Other User Costs (from Other User sheet)		$0	$0	$0	$0
Other**					$0
Subtotal "F"		**$311,956**	**$259,989**	**$0**	**$571,945**
Subtotal Operational & Maintenance Costs		**Labor (1)**	**Equipment (2)**	**Materials (3)**	**Total**
Subtotal A through F		**$2,460,866**	**$906,943**	**$7,064,134**	**$10,439,067**

** Other Operator supplied costs - additional documentation required.

Indirect Costs			Include?	Total
1. Engineering, Design and Construction (ED&C) Plan (7)				$626,344
2. Contingency (8)				$626,344
3. Insurance (9)	$36,913			$36,913
4. Performance Bond (10)				$313,172
5. Contractor Profit (11)				$1,043,907
6. Contract Administration (12)				$835,125
7. Government Indirect Cost (13)				N/A
Subtotal Add-On Costs				**$3,481,805**
Total Indirect Costs as % of Direct Cost				33%
GRAND TOTAL				**$13,920,872**

Administrative Cost Rates (%)					
	Cost Ranges for Indirect Cost Percentages				
	<=	<=	<=	>	
1. Engineering, Design and Construction (ED&C) Plan (7)	$1,000,000	$25,000,000		$25,000,000	Small Plan
Variable Rate	8%	6%		4%	0%
	<=	<=	<=	>	
2. Contingency (8)	$500,000	$5,000,000	$50,000,000	$50,000,000	Small Plan
Variable Rate	10%	8%	6%	4%	0%
3. Insurance (9)	1.5%	of labor costs			
4. Bond (10)	3.0%	of the O&M costs if O&M costs are >$100,000			
5. Contractor Profit (11)	10%	of the O&M costs			
	<=	<=	<=	>	
6. Contract Administration (12)	$1,000,000	$25,000,000		$25,000,000	
Variable Rate	10%	8%		6%	
0	21%	of contract administration			

RECLAMATION COST ESTIMATION SUMMARY SHEET FOOTNOTES

1. Federal construction contracts require Davis-Bacon wage rates for contracts over $2,000. Wage rate estimates may include base pay, payroll loading, overhead
2. The reclamation cost estimate must include the estimated plugging cost of at least one drill hole for each active drill rig in the project area. Where the submitted
3. Miscellaneous items should be itemized on accompanying worksheets.
4. Fluid management should be calculated only when mineral processing activities are involved. Fluid management represents the costs of maintaining proper
5. Handling of hazardous materials includes the cost of decontaminating, neutralizing, disposing, treating and/or isolating all hazardous materials used, produced,
6. Any mitigation measures required in the Plan of Operations must be included in the reclamation cost estimate. Mitigation may include measures to avoid,
7. Engineering, design and construction (ED&C) plans are often necessary to provide details on the reclamation needed to contract for the required work. To
8. A contingency cost is included in the reclamation cost estimation to cover unforeseen cost elements. Calculate the contingency cost as a percentage of the
9. Insurance premiums are calculated at 1.5% of the total labor costs. Enter the premium amount if liability insurance is not included in the itemized unit costs.
10. Federal construction contracts exceeding $100,000 require both a performance and a payment bond (Miller Act, 40 USC 270et seq.). Each bond premium is
11. For Federal construction contracts, use 10% of estimated O&M cost for the contractor's profit.
12. To estimate the contract administration cost, use 6 to 10% of the operational and maintenance (O&M) cost. Calculate the contract administration cost as a
13. Government indirect cost rate is 21% of the contract administration costs.

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Closure Cost Estimate
Other User

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Other Cost Items Calculated Elsewhere

	Description (required)	ID Code	Facility Type	Quantity	Units	Total Capital Cost $	Material Unit Cost $	Labor Unit Cost $	Equipment/ Operating Unit Cost $	Cost Type (select)	Total Cost $	Comments
1	Riprap (D50=3in)		RipRap	2,200	cy	$30	$0.00	$13.44	$16.29	A. Earthwork	$65,419	
2	Riprap (D50=6in)		RipRap	940	cy	$34	$0.00	$15.50	$18.95	A. Earthwork	$32,417	
3	Riprap (D50=12in)		RipRap	2,390	cy	$43	$0.00	$19.11	$23.69	A. Earthwork	$102,321	
4	Dual 42" Dia. Cpe Culvert		Culverts	90	ft	$229	$146.10	$41.48	$41.05	A. Earthwork	$20,806	
5	10 oz/yd2 non-woven geotextile		Surface Channels	405,000	sf	$0.29	$0.14	$0.14	$0.02	A. Earthwork	$117,956	Non-woven geotextile is placed under riprap in closure stormwater diversion channel.
6	Bentonite (for Low Permeability Soil Layer amendment)		Surface Channels	192	tons	$311	$284.40	$8.11	$18.10	A. Earthwork	$60,090	Bentonite is amended into Low Permeability Soil Layer.
7	Water Treatment Plant 1		Water Treatment - Contac	1	ls		$2,492,041.99	$1,185,229.19	$0.00	C. Water Management	$3,677,271	
8	January Adit Plug		UG Mine - Openings Horiz	1	ls	$1,510,000				A. Earthwork	$1,510,000	
9	Passive Treatment System		H2O Treat Sys Constr - Pa	1	ls	$2,828,457				A. Earthwork	$2,828,457	
						$4,339,104	$2,615,057	$1,335,488	$125,088		$8,414,736	

Notes: Capital cost is lump sum (i.e. not multiplied by the quantity).
Material, Labor and Equipment/Operating costs are unit costs (i.e. multiplied by the quantity).

1. For riprap cost information refer to "User 5"
2. For Dual 42" Dia CPE Culvert cost information refer to "User 6"
3. For 10 oz/yd2 non-woven geotextile cost information refer to "User 7"
4. For Bentonite cost information refer to "User 8"
5. For Water Treatment Plant 1 cost information refer to "User 9"
6. For January Adit Plug cost information refer to "User 10" and Passive Treatment System cost information refer to "User 11"

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Closure Cost Estimate
Reclamation Quantities

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Data Cost File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Reclamation Quantity Summary

												Unit Costs					
	Description	Total Regrade or Haul Volume cy	Total Regrade or Haul Cost $	Total Cover Volume cy	Cover Placement Cost $	Total Growth Media Volume cy	Growth Media Placement Cost $	Total Surface Area acres	Total Scarify Cost $	Total Revetation Cost $	TOTALS $	Regrade Unit Cost $/CY	Material Haul or Backfill Unit Cost $/CY	Cover Unit Cost $/CY	Growth Media Unit Cost $/CY	Scarify Unit Cost $/CY	Area Unit Cost $/acre
1	Waste Rock Dumps	6,720	$ 929		$ -	90,508	$ 204,972	28.05	$ 2,476	$ 60,206	$ 268,583	$0.14	N/A		$2.26	$88.27	$9,575.15
2	Tailings Impoundments		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
3	Heap Leach Pads		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
5	Open Pits		$ -							$ -	$ -		N/A				
4	Quarries & Borrow Pits		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
6	Roads	1,623	$ 929				$ -	2.43	$ -	$ -	$ 929	$0.57	N/A			$0.00	$382.30
7	Landfills		$ -		$ -		$ -		$ -	$ -	$ -		N/A				
8	Buildings				$ -		$ -		$ -	$ -	$ -		N/A				
9	Yards		$ -		$ -		$ -	2.74	$ 619	$ 5,232	$ 5,851		N/A			$225.91	$2,135.40
10	Ponds	61,824	$ 122,745			12,358	$ 25,026	5.6		$ 7,255	$ 155,026	N/A	$1.99		$2.03		$27,683.21
11	Exploration Roads		$ -				$ -		$ -	$ -	$ -		N/A				
12	Exploration Trenches		$ -							$ -	$ -		N/A				
13	Diversion Ditches		$ 1,081					0.1		$ -	$ 1,081		N/A				$10,810.00
14	Sediment Ponds		$ -				$ -		$ -	$ -	$ -						
15	Generic Haulage/Backfill	61,310	$ 228,805		$ -		$ -	0.3	$ -	$ -	$ 228,805	N/A	$3.73			$0.00	#########
16	Adit/Decline Backfilling1		$ -								$ -	N/A					
17	Shaft Backfilling		$ -								$ -	N/A					
	TOTALS	131,477	$ 354,489	-	$ -	102,866	$ 229,998	39.22	$ 3,095	$ 72,693	$ 660,275						
	Average Costs	per CY	$2.70	per CY		per CY	$2.24	per acre	$78.91	$23.49	$16,835	per acre					

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Closure Cost Estimate
Exploration

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Drillhole Abandonment - User Input

	Facility Description		Hole Plugging							
	Description (required)	ID Code	Hole Type (select)	Diameter in	Total Number of Holes	Max Holes Open at One Time	Casing to Remove ft	Average Depth of Hole[1] ft bgs	Depth to Water ft bgs	Hole Plug Method (select)

Notes:
1. If core holes are pre-drilled, use length of hole below pre-drilled length
2. If Top Plug is selected, assumes maximum 1/2hr laborer time to place plug and backfill with cuttings/soil (including move-to/set up time).

Exploration Trenches - User Input

	Facility Description		Trench Parameters					Backfill			Revegetation		
	Description (required)	ID Code	Trench Length ft	Trench Depth ft	Trench Bottom Width ft	Trench Sideslope Angle degrees	Additional Hrs for Walk-in [1] hr	Backfill Material (select)	Cut Material Type (select)	Backfilling Fleet (select)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Notes:
1. Include one-way hours necessary to walk equipment in from drop-off point to work area
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Exploration Drillhole Abandonment

	Description (required)	Vol/foot of depth ft3	Hole Plugging Material [1]	Total Grout Volume [2] cy	Total Cuttings Volume cy	Total Top Seal Volume [3,4] cy	Total Drillhole Abandon. Hours [6,7] hrs	Casing Removal Labor Cost [5] $	Casing Removal Equipment Cost $	Plugging Labor Cost $	Plugging Equipment Cost $	Plugging Material Cost $	Top Seal Material Cost [2,3] $	Total Cost [6,7] $
								$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Notes:

1. Assumes grout backfill from bottom of hole to 50' (15.24m) above static water level, up to 10' (3m) from top of hole
2. Assumes 25% loss to formation for grout backfill
3. If "Top Plug" hole plug method is used, assumes physical plug installed without backfill, grout or cement. Not available option for Nevada projects
4. Assumes top 20' (6 m) of hole is plugged with cement if "Grout Only", "Backfill + Grout", or "Cement Plug" hole plug method are chosen.
5. Assumes that a) casing is not cemented entire length, b) does not include temporary surface casing
6. Assumes minimum 1 hr per hole for abandonment (excluding move-to and casing removal)
7. Assumes fixed hours per hole for setup & tear-down and moving between holes (see Productivty Sheet) per drill hole (includes rig time if grouting required, labor crew only if cuttings backfill only)

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Closure Cost Estimate
Exploration

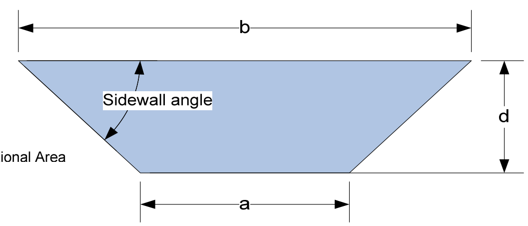
Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Exploration - Cost Summary	Labor	Equipment	Materials	Totals
Hole Abandonment Costs	$0	$0	$0	$0
Trench Backfilling Costs	$0	$0		$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Trench Revegetation Costs	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Trenches - Calculations

Exploration Trench Volume Calculation

Trench Volume = Trench Length x Cross Sectional Area



Dozing & Ripping/Scarifying Calculations

Dozing: Dozing distance = 1/2 trench length or 400 ft (max push) whichever is less
Assumes flat push (grade correction factor = 1)

Revegetation: 10 ft added to trench width to account for revegetation under spoil pile

Exploration Trenches - Backfill/Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83)

Description (required)	Trench Backfill Volume	Dozer Push Distance	Equipment Productivity	Dozing Material	Density Correction	Backfilling Fleet	Corrected Hourly Productivity	Total Dozer Hours	Trench Backfill Labor Cost	Trench Backfill Equipment Cost	Total Trench Backfill Cost
	LCY (BCY+30%)	ft	yd3/hr				yd3/hr	hr	$	$	$
									$0	**$0**	**$0**

Exploration Trenches - Revegetation Costs

Description (required)	Surface Area	Revegetation Labor Cost	Revegetation Equipment Cost	Revgetation Material Cost	Total Revegetation Cost
	acres	$	$	$	$
		$0	**$0**	**$0**	**$0**

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Exploration Roads & Pads - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Exploration Roads & Pads - User Input

You must fill in ALL green cells and relevant blue cells in this section for each road

Facility Description			Physical (1) - MANDATORY										User Overrides		Growth Media		
	Description (required)	ID Code	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Cut Slope degrees	Road + Drill Pad Length ft	Road Width ft	Number of Drill Pads	Individual Sump Volume cy	Drill Pad Width ft	Drill Pad Length ft	Slope Replacement Percent %	Regrade Volume (if calculated elsewhere) cy	Disturbed Area (if calculated elsewhere) acres	Growth Media Thickness in	Distance to Growth Media Stockpile ft	Slope from Road to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. Slope replacement refers to the percentage of cut volumn replaced during regrading.
3. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
4. Sump volume will be applied to all roads on slopes <20%. On slopes >20% pad width (i.e. cut volume) should be adequate to account for sump volume.

Exploration Roads & Pads - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each road

		Grading				Growth Media				Revegetation				
	Description (required)	Regrade Material Condition (select)	Cut Material Type (select)	Recontouring Equipment Fleet (select)	Additional Hrs for Walk-in (1)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Additional Hrs for Walk-in (1)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarifying/ Ripping? (select)	Ripping Fleet (select)

Notes:
1. Include one-way hours necessary to walk equipment in from drop-off point to work area
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Exploration Roads & Pads - Calculations

Regrading Volume and Footprint Volume

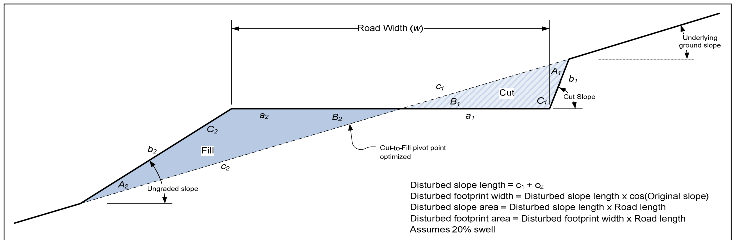

Figure 1 - Regrading Volume Calculation

Will not allow dozer for slopes greater than 30%
For dozer regrading push distance = road width
Assumes dozer push is uphill
Assumes minimum push distance of 100 ft

Swell Factor: 1.2

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per area
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Road length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
For dozer regrading assumes push distance = 3 x road width

Revegetation Calculations

Minimum of 1 acre crew time per area

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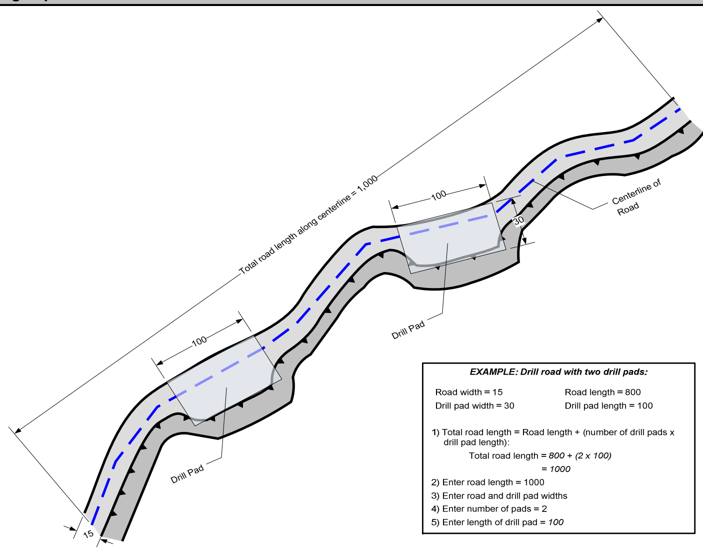
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Exploration Roads & Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Inputting Exploration Roads and Drill Pads



Exploration Roads & Pads - Regrading Costs

	Description (required)	Total Road Length ft	Total Drill Pad Length ft	Regrading Volume cy	Recontouring Fleet	Equipment Productivity cy/hr	Total Equipment Hours (1) hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
								$0	$0	$0

(1) Includes walk-in time based on distance and travel speed (see Productivity sheet for speeds)

Exploration Roads & Pads - Growth Media Costs

	Description (required)	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
							$0	$0	$0

Exploration Roads & Pads - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Ripping/ Scarifying Fleet	Ripping Hours hrs	Ripping Labor Costs $	Ripping Equipment Cost $	Total Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
					$0	$0	$0	$0	$0	$0	$0

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Model Version: Version 1.4.1
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Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$255	$674	N/A	$929
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$62,047	$142,925	N/A	$204,972
Ripping/Scarifying Cost	$679	$1,797	N/A	$2,476
Subtotal Earthworks	**$62,981**	**$145,396**	**$0**	**$208,377**
Revegetation Cost	$7,013	$3,506	$49,687	$60,206
TOTALS	**$69,994**	**$148,902**	**$49,687**	**$268,583**

Waste Rock Dumps - User Input

You must fill in ALL green cells in this section for each dump, lift or dump category

	Facility Description			Physical - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % Grade	Lift (dump) Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Dump Footprint acres	Regrade Volume (1) (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Dump to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Dump to Stockpile % grade
1	**TSF Crest Elevation Increase**	**N/A**	**Waste Rock Dump**	**0.0**	**1.5**	**2.5**	**0.0**	**5**	**60,481**	**350**	**26.19**						**24.0**	**24.0**	**3,600**	**-3.5**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

3. The mid-bench length, ripping distance and final dump footprint was calculated using AutoCAD.
4. The Haul Distance from Growth Media Stockpile was calculated using AutoCAD.

Waste Rock Dumps - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each dump, lift or dump category

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)
1	**TSF Crest Elevation Increase**	**1**	**Clay - Dry**	**Med**	**No**	**Topsoil**	**Med Truck**	**Topsoil**	**Med Truck**	**User Mix 1**	**User Mix 1**	**None**	**None**	**Chemical**	**Chemical**	**No**	**Yes**	**Med Dozer**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Waste Rock Dumps - Calculations

Regrading Volume Calculation

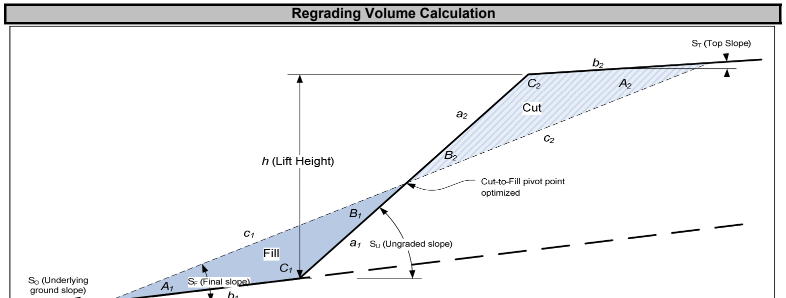

Figure 1 - Regrace Volume Calculation

Final Slope Area and Footprint Area Calculations

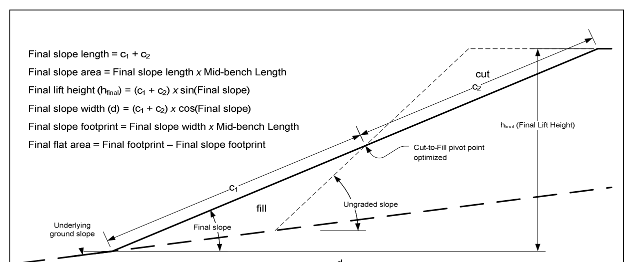

Figure 3 - Final Slope Area and Footprint Area Calculation

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Closure Cost Estimate
Waste Rock Dumps

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$255	$674	N/A	$929
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$62,047	$142,925	N/A	$204,972
Ripping/Scarifying Cost	$679	$1,797	N/A	$2,476
Subtotal Earthworks	**$62,981**	**$145,396**	**$0**	**$208,377**
Revegetation Cost	$7,013	$3,506	$49,687	$60,206
TOTALS	**$69,994**	**$148,902**	**$49,687**	**$268,583**

Regrading Push Distance Calculation

dozing distance: based on 2/3 final cut slope + 2/3 final fill slope (minimum = 50 ft)

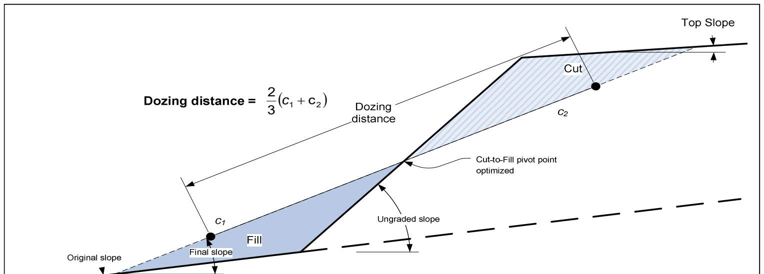

Figure 2 - Dozing Distance Calculation

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per dump

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

Waste Rock Dumps - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**TSF Crest Elevation Increase**	6,720	50	D9R	2,251	1.6	1.0	0.92	1.0	2,063	3	$255	$674	$929
		6,720									3	**$255**	**$674**	**$929**

Waste Rock Dumps - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**TSF Crest Elevation Increase**						$0	$0	$0	90,508	740/988G/D8R	525	3	172	$62,047	$142,925	$204,972
							$0	**$0**	**$0**	90,508				172	**$62,047**	**$142,925**	**$204,972**

Waste Rock Dumps - Scarifying/Revegetation Costs

	Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**TSF Crest Elevation Increase**	18.05	10.00	28.05	13	350	D9R		8	$679	$1,797	$2,476	$7,013	$3,506	$49,687	$60,206
		18.05	10.00	28.05					8	**$679**	**$1,797**	**$2,476**	**$7,013**	**$3,506**	**$49,687**	**$60,206**

Notes: 1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)

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Closure Cost Estimate
Heap Leach

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Heap Leach Pads - Cost Summary	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pads - User Input

You must fill in ALL green cells and relevant blue cells in this section for each heap, lift or heap category

	Facility Description			Physical (1) - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % grade	Lift (heap) Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Heap Footprint acres	Regrade Volume (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Heap to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Material Stockpile ft	Slope from Heap to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Heap Leach Pads - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each heap, lift or heap category

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Slot/ Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Heap Leach Pads - User Input (cont.)

		Solution Collection Ditch Fill							Piping			
	Description (required)	Collection Ditch Length ft	Collection Ditch Top Width ft	Collection Ditch Depth ft	Volume (if calculated elsewhere) cy	Distance from Borrow ft	Slope to Borrow % grade	Drain Rock Equipment Fleet (select)	Solid Pipe Length ft	Solid Pipe Type (select)	Drainage Pipe Length ft	Drainage Pipe Type (select)

Notes:

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Heap Leach Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pads - Calculations

Regrading Volume Calculation

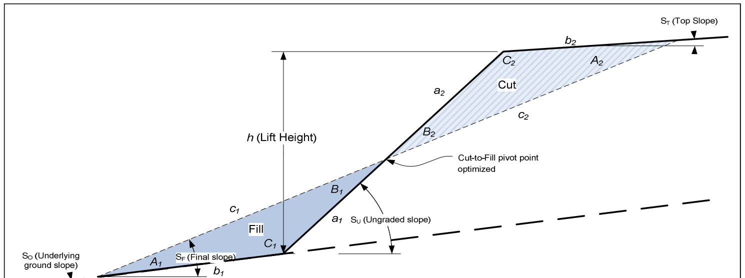

Figure 1 - Regrading Volume Calculation

Regrading Push Distance Calculation

dozing distance: based on 2/3 final cut slope + 2/3 final fill slope (minimum = 50 ft)

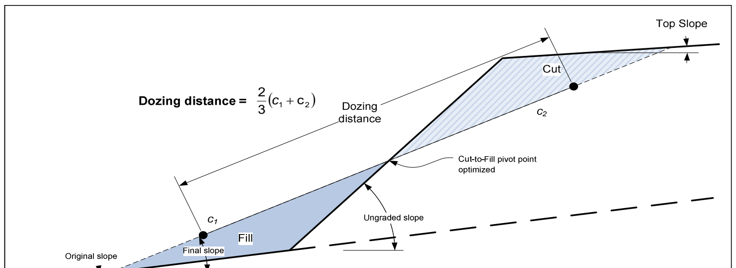

Figure 2 - Dozing Distance Calculation

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying per area

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

Final Slope Area and Footprint Area Calculations

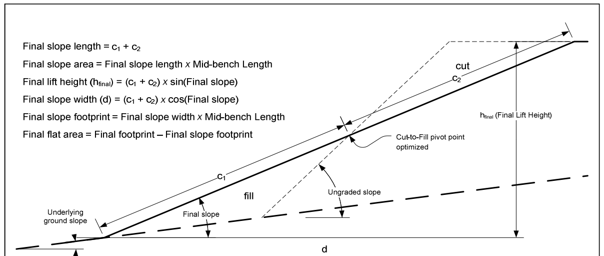

Figure 3 - Final Slope Area and Footprint Area Calculation

Solution Collection Ditch Calculations

Use when existing heap material is not suitable drain rock
Assume to be constructed in existing solution channels
Assume 2H:1V ditch sideslopes
Drain rock assumed to be Gravel - Dry at 2,550 lb/cy (1,510 kg/m3) from CAT Handbook 35th Ed.

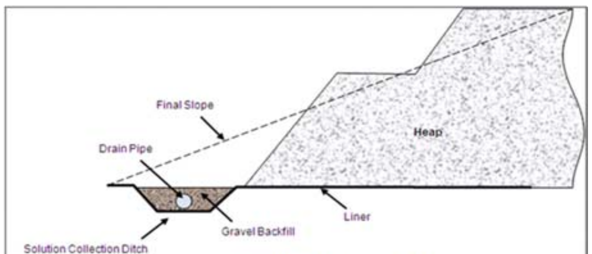

Figure 4 – Drainage Ditch Construction

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Heap Leach Pads - Cost Summary

	Labor	Equipment	Materials	Totals
Drain Installation	$0	$0	$0	$0
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Heap Leach Pad - Drainage Channel Fill & Drainage Pipe Installation

		Drain Rock Placement								Drainpipe Installation				
	Description (required)	Drain Rock Volume cy	Drain Rock Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours hrs	Drainage Labor Cost $	Drainage Equipment Cost $	Total Drainage Cost $	Piping Crew Hours hrs	Piping Labor Cost $	Piping Equipment Cost $	Piping Material Cost $	Total Pipe Installation Cost $
						0	$0	$0	$0		$0	$0	$0	$0

Heap Leach Pad - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
												$0	$0	$0

Heap Leach Pad - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
							$0	$0	$0						$0	$0	$0

Heap Leach Pad - Scarifying/Revegetation Costs

	Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
										$0	$0	$0	$0	$0	$0	$0

1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - User Input — You must fill in ALL green cells and relevant blue cells in this section for each tailings impoundment

	Facility Description		Physical - MANDATORY								Cover				Growth Media			
	Description (required)	ID Code	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final (Regraded) Embankment Slope _H:1V	Final Embankment Height ft	Final Tailings Surface Area acres	Mid-Embankment or Ripping Length ft	Embankment Regrade Volume (if calculated elsewhere) cy	Surface Regrade Volume (calculated elsewhere) cy	Embankment Cover Thickness in	Tailings Surface Cover Thickness in	Distance from Cover Borrow ft	Slope from Tailings to Borrow % grade	Embankment Growth Media Thickness in	Tailings Surface Growth Media Thickness in	Distance from Growth Material Stockpile ft	Slope from Tailings to Stockpile % grade
1																		

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Tailings - User Input (cont.) — You must fill in ALL green cells and relevant blue cells in this section for each tailings impoundment

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Regrading Material Condition (select)	Embankment Material Type (select)	Regrading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Embankment Slope (select)	Seed Mix Tailings Surface (select)	Mulch Embankment Slopes (select)	Mulch Tailings Surface (select)	Fertilizer Embankment Slopes (select)	Fertilizer Tailing Surface (select)	Embankment Slope Scarify/ Rip? (select)	Tailings Surface Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)
1																		

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Bond Calculation
Tailings

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Calculations

Surface Area Calculations

Top Surface Area provided by user

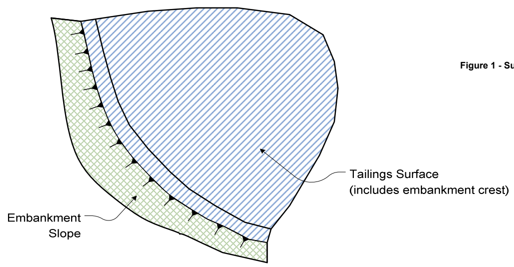

Figure 1 - Surface Areas

Final Slope Area and Footprint Area Calculations

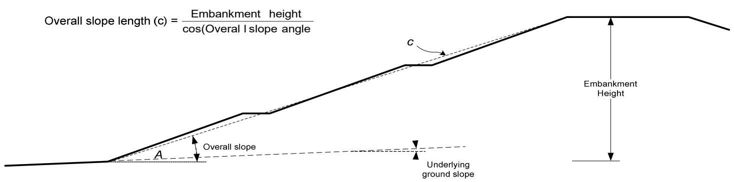

Figure 2 - Final Slope Area and Footprint Area Calculation

Grading Calculations

Grading assumed on impoundment surface only, not embankment
Average push distance assumed to be 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Material assumed to be loose stockile (1.2 productivity factor)
Dozing density correction based on dry sand = 2300/2400 = 0.96
Slope assumed to be 0 to 5% (1.0 productivity factor)

Ripping/Scarifying/Revegetation Calculation

Minimum 1 hr ripping/scarifying per area
Minimum 1 acre revegetation crew time per area

Regrading Volume Calculation

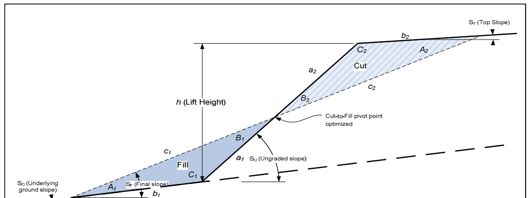

Figure 1 - Regrading Volume Calculation

Regrading Push Distance Calculation

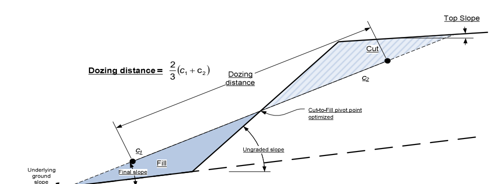

Figure 2 - Dozing Distance Calculation

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Tailings - Cost Summary

	Labor	Equipment	Materials	Totals
Embankment Regrading Cost	$0	$0	N/A	$0
Tailings Surface Grading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Tailings - Embankment Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material Condition	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1												$0	$0	$0
												$0	**$0**	**$0**

Tailings - Surface Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Density Correction	Dozing Material	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1												$0	$0	$0
												$0	**$0**	**$0**

Tailings - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Placement Fleet	Cover Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $	Growth Media Volume cy	Growth Media Placement Fleet	Growth Media Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1							$0	$0	$0						$0	$0	$0
							$0	**$0**	**$0**						**$0**	**$0**	**$0**

Tailings - Scarifying/Revegetation Costs

	Description (required)	Embankment Slope Area acres	Tailings Surface Area acres	Total Surface Area acres	Final Slope Length ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Cost $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Cost $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1									$0	$0	$0	$0	$0	$0	$0
									$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Roads

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$255	$674	N/A	$929
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$255**	**$674**		**$929**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$255**	**$674**	**$0**	**$929**

Roads - User Input

You must fill in ALL green cells and relevant blue cells in this section for each road

	Facility Description			Physical (1) - MANDATORY						User Overrides		Growth Media		
	Description (required)	ID Code	Type	Underlying Ground Slope % grade	Ungraded Slope _H:1V	Cut Slope degrees	Road Width ft	Road Length ft	Slope Replacement Percent %	Regrade Volume (if calculated elsewhere) cy	Disturbed Area (if calculated elsewhere) acres	Growth Media Thickness in	Haul Distance from Growth Media Stockpile ft	Slope from Road to Stockpile % grade
1	**TSF Perimeter Road**		**Access Road**				**15.5**	**4,490**				**0.0**	**3,700**	**-1%**
2	**TSF Haul Road**		**Haul Road**				**36.0**	**1,000**				**0.0**	**2,850**	**-4%**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Because the work required for building roads with a dozer is similar to that required to regrade a road with a dozer, this sheet could be used to provide a rough estimate of road construction costs if a dozer is selected as the grading fleet.
4. The TSF Perimeter Road and TSF Haul Road lengths were calculated using AutoCAD.
5. The Haul Distance from Growth Media Stockpile was calculated using AutoCAD.
6. TSF Perimeter Road growth media and revegetation is incorporated as part of the "Waste Rock Dumps" section.
7. TSF Haul Road growth media and revegetation is incorporated as part of the "Waste Rock Dumps" section.

Roads - User Input (cont.)

		Haul Road Safety Berms				
	Description (required)	Berm Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Number of Berms (2) (1 or 2 sides)
1	**TSF Perimeter Road**	**4,490.0**	**1.5**	**4.5**	**1.5**	**2**
2	**TSF Haul Road**	**1,000.0**	**3.0**	**9.0**	**1.5**	**1**

(2) Enter 1 if berm on only one side of road, 2 if both sides of road are bermed.

Roads - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each road

		Grading				Growth Media			Revegetation				
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	No. of Excavators if grade >30% (select)	Growth Media Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarifying/ Ripping? (select)	Ripping Fleet (select)
1	**TSF Perimeter Road**	**1**	**Clay - Dry**	**Med Dozer**		**Topsoil**	**Med Truck**		**None**	**None**	**None**	**No**	**Med Dozer**
2	**TSF Haul Road**	**1**	**Clay - Dry**	**Med Dozer**		**Topsoil**	**Med Truck**		**None**	**None**	**None**	**No**	**Med Dozer**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table
2. If original slope >30% only excavators are allowed.

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$255	$674	N/A	$929
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$255**	**$674**		**$929**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$255**	**$674**	**$0**	**$929**

Roads - Calculations

Regrading Volume and Footprint Volume

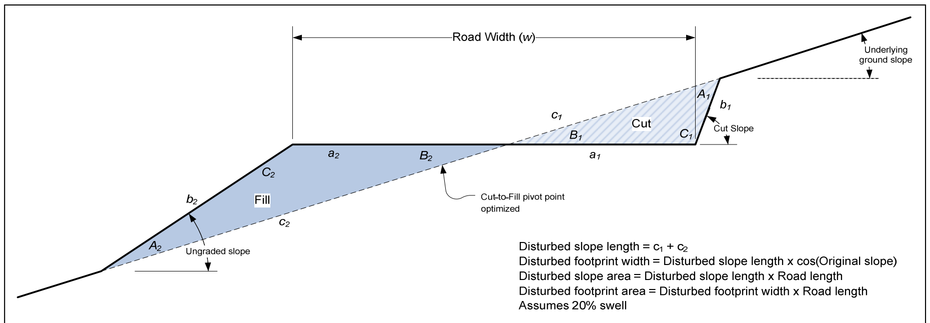
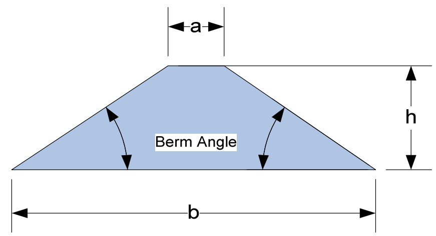


Figure 1 - Regrading Volume Calculation

Will not allow dozer for slopes greater than 30%
For dozer regrading push distance = road width
Assumes dozer push is uphill
Assumes minimum push distance of 100 ft

Safety Berm Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times h$
Berm Volume = Berm Length x Cross Sectional Area x No. Sides



Total berm volume doubled if both sides of road are bermed.
If length of berm on each side of road is different, input total length of both berms and input 1 for number of sides

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per area
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Road length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
For dozer regrading assumes push distance = 3 x road width

Revegetation Calculations

Minimum of 1 acre crew time per area

Roads - Regrading Costs

	Description (required)	Regrading Volume cy	Recontouring Fleet	Fleet Productivity cy/hr	Total Fleet Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
1	**TSF Perimeter Road**	1,123	D9R	672	2	$170	$449	$619
2	**TSF Haul Road**	500	D9R	672	1	$85	$225	$310
		1,623			3	**$255**	**$674**	**$929**

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Closure Cost Estimate
Roads

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Roads - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$255	$674	N/A	$929
Cover Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$255**	**$674**		**$929**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$255**	**$674**	**$0**	**$929**

Roads - Growth Media Costs

	Description (required)	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**TSF Perimeter Road**						$0	$0	$0
2	**TSF Haul Road**						$0	$0	$0
							$0	**$0**	**$0**

Roads - Scarifying/Revegetation Costs

	Description (required)	Total Surface Area acres	Final Slope Length ft	Ripping/ Scarifying Fleet	Ripping Hours hrs	Ripping Labor Costs $	Ripping Equipment Cost $	Total Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**TSF Perimeter Road**	1.60	16.0	D9R		$0	$0	$0	$0	$0	$0	$0
2	**TSF Haul Road**	0.83	36.0	D9R		$0	$0	$0	$0	$0	$0	$0
		2.43				**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Pits - Cost Summary

	Labor	Equipment	Materials	Totals
Safety Berm Construction Cost	$0	$0	N/A	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Pits - User Input

Facility Description				Pit Berms					Berm Construction		Excavate or Doze	Hauling (if selected method)				Revegetation		
	Description (required)	ID Code	Type	Berm (or Highwall) Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Volume (if calculated elsewhere) cy	Construction Method (select)	Berm Material Type (select)	Berm Construction Equipment Fleet (select)	Berm Hauling Fleet (select)	Distance to Borrow Source ft	Slope to Borrow Source % grade	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

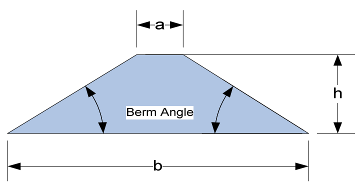
Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Pits - Calculations

Safety Berm Volume Calculation

$$\text{Cross Sectional Area} = \frac{(a+b)}{2} \times h$$

Berm Volume = Berm Length x Cross Sectional Area



Dozer productivity assumes push distance of: 100 feet

Dozer:
Length x (Berm Base Width + Dozer Push Distance) - accounts for disturbance created in borrow area

Excavator:
Length x (Berm Base Width + (2 x Excavator Track Width) - accounts for disturbance created in borrow area

Haul & Place:
Length x Berm Base Width - if necessary use Yards sheet to account for disturbance created in borrow area

Revegetation Calculations

Minimum 1 acre revegetation crew time per area

Pits - Safety Berm Construction Costs

		Safety Berm							
	Description (required)	Safety Berm Volume cy	Selected Fleet	Number of Trucks/ Scrapers	Corrected Fleet Productivity cy/hr	Total Hours	Safety Berm Labor Cost $	Safety Berm Equipment Cost $	Total Safety Berm Cost $
							$0	$0	$0

Pits - Safety Berms - Revegetation Costs

	Description (required)	Flat Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
			$0	$0	$0	$0

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Closure Cost Estimate
Quarries & Borrow Pits

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Waste Rock Dumps - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - User Input

You must fill in ALL green cells in this section for each dump, lift or dump category

Facility Description				Physical - MANDATORY									Cover				Growth Media			
	Description (required)	ID Code	Type	Underlying Ground Slope % Grade	Ungraded Slope _H:1V	Final Slope _H:1V	Final Top Slope % Grade	Bench or Highwall Height ft	Mid-Bench Length ft	Average Flat Area Long Dimension (ripping distance) ft	Final (Regraded) Footprint acres	Regrade Volume (1) (if calculated elsewhere) cy	Cover Thickness Slopes in	Cover Thickness Flat Areas in	Distance from Cover Borrow ft	Slope from Dump to Cover Borrow % grade	Slope Growth Media Thickness in	Flat Area Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Dump to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Quarries & Borrow Pits - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each dump, lift or dump category

		Grading				Cover		Growth Media		Revegetation								
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Slot/Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Seed Mix Slopes (select)	Seed Mix Flat Areas (select)	Mulch Slopes (select)	Mulch Flat Areas (select)	Fertilizer Slopes (select)	Fertilizer Flat Areas (select)	Slope Scarify/ Rip? (select)	Flat Area Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Quarries & Borrow Pits - User Input (cont.)

Facility Description		Highwall Berms					Berm Construction		Excavate or Doze	Hauling (if selected method)				Revegetation		
	Description (required)	Berm (or Highwall) Length ft	Berm Height ft	Berm Base Width ft	Berm Sideslope Angle _H:1V	Volume (if calculated elsewhere) cy	Construction Method (select)	Berm Material Type (select)	Berm Construction Equipment Fleet (select)	Berm Hauling Fleet (select)	Distance to Borrow Source ft	Slope to Borrow Source % grade	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Waste Rock Dumps - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	**$0**	**$0**	**$0**
TOTALS	**$0**	**$0**	**$0**	**$0**

Quarries & Borrow Pits - Calculations

Regrading Volume Calculation

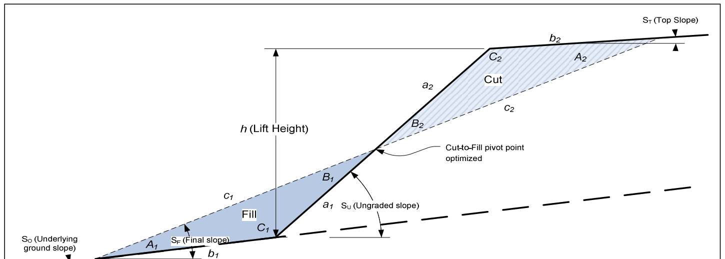


Figure 1 - Regrade Volume Calculation

Regrading Push Distance Calculation

dozing distance: based on 2/3 final cut slope + 2/3 final fill slope (minimum = 50 ft)

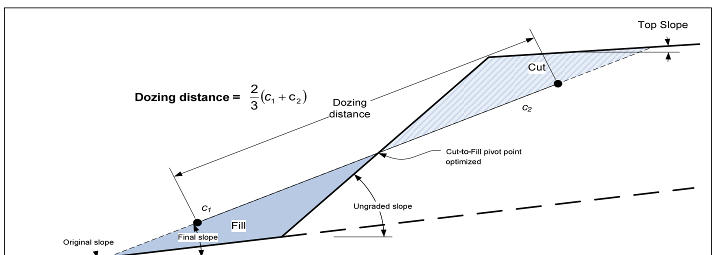
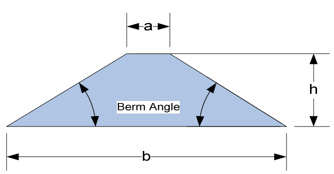


Figure 2 - Dozing Distance Calculation

Safety Berm Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times h$

Berm Volume = Berm Length x Cross Sectional Area



Dozer productivity assumes push distance of: **100** feet

Dozer:
Length x (Berm Base Width + Dozer Push Distance) - accounts for disturbance created in borrow area

Excavator:
Length x (Berm Base Width + (2 x Excavator Track Width) - accounts for disturbance created in borrow area

Haul & Place:
Length x Berm Base Width - if necessary use Yards sheet to account for disturbance created in borrow area

Final Slope Area and Footprint Area Calculations

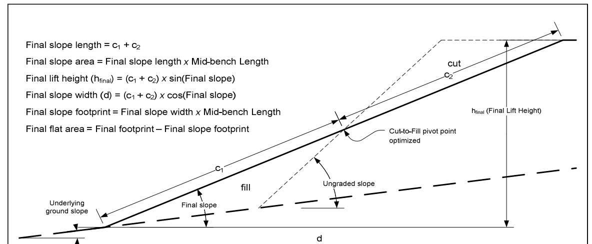


Figure 3 - Final Slope Area and Footprint Area Calculation

Ripping/Scarifying Calculations

Minimum 1 hr ripping/scarifying time per dump

Slopes:
Number of passes = Final slope length ÷ Grader width
Travel distance = Number of passes x Mid-bench length
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr

Flat Areas:
Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation: Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Quarries & Borrow Pits

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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Waste Rock Dumps - Cost Summary	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost		$0	N/A	$0
Safety Berm Construction Cost	$0	$0	N/A	$0
Subtotal Earthwork	$0	$0	$0	$0
Revegetation Cost	$0	$0	$0	$0
Safety Berm Revegetation Cost	$0	$0	$0	$0
	$0	$0	$0	$0
TOTALS	$0	$0	$0	$0

Quarries & Borrow Pits - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side) x (Altitude Deration)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
												$0	$0	$0

Quarries & Borrow Pits - Cover and Growth Media Costs

		Cover (lower layer)								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Replacement Fleet	Fleet Productivity BCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
							$0	$0	$0						$0	$0	$0

Quarries & Borrow Pits - Scarifying/Revegetation Costs

	Description (required)	Slope Area acres	Flat Area acres	Total Surface Area acres	Final Slope Length ft	Flat Area Long Dimension ft	Ripping/ Scarifying Fleet	Slope Scarifying/ Ripping Hours hrs	Flat Area Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
											$0	$0	$0	$0	$0	$0

Notes: 1) Minimum total ripping hours = 1 (i.e. If total ripping hrs (slope + flat) < 1, then one hour of fleet time is assumed, regardless of acres shown in in scarifying table.)
2) Assumes 50min/hr equipment availability

Quarries & Borrow Pits - Safety Berm Construction Costs

		Safety Berm							
	Description (required)	Safety Berm Volume cy	Selected Fleet	Number of Trucks/ Scrapers	Corrected Fleet Productivity cy/hr	Total Hours	Safety Berm Labor Cost $	Safety Berm Equipment Cost $	Total Safety Berm Cost $
							$0	$0	$0

Quarries & Borrow Pits - Safety Berms - Revegetation Costs

	Description (required)	Flat Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
			$0	$0	$0	$0

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Model Version: Version 1.4.1
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Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Underground Openings Cost Summary

	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$0	$0	$0	$0
Shaft Backfill/Cover	$0	$0	N/A	$0
Shaft Capping	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Adits, Portals & Declines - User Input

	Facility Description		Physical Characteristics				Backfill Material			
	Description (required)	ID Code	Height ft	Width ft	Backfill/ Plug Type	Distance to Bulkhead ft	Backfill Material Condition (select)	Backfill Material Type (select)	Distance to Backfill Borrow ft	Slope from Adit to Borrow Area % grade
1										

Notes: 1) Foam (adit) option is for smaller openings that can be plugged with simple forms and a 5 ft thick plug.
2) Foam (production) option is for larger production openings (declines, etc.) and requires larger form construction and minimum 10 ft thick plug.
3) All foam plugs include minimum 15ft of backfill from opening to plug.
4) Bat gate option is for small openings and the material cost is the same for any size opening.
5) Backfilling assumes that small dozer will push material from nearby stockpile or dump
6) Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Shaft Openings - User Input

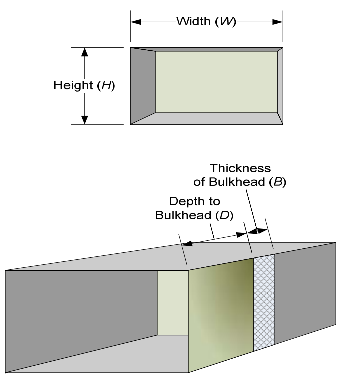
You must fill in ALL green cells and relevant blue cells in this section for each shaft

	Facility Description		Physical Characteristics			Backfill or Foundation Cover					
	Description (required)	ID Code	Diameter ft	Shaft Depth (for backfill method) ft	Backfill/ Plug Type (select)	Backfill Material Type (select)	Cover/ Backfill Fleet (select)	Thickness (if not complete backfill) ft	Distance to Backfill Borrow ft	Slope from Shaft to Borrow Area % grade	Maximum Fleet Size (user override)

Notes:
1. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
2. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Underground Openings - Calculations

Adits, Declines and Portals - Volume Calculations



Cross-Sectional Area (A) = *W* x *H*
Volume of Concrete Bulkhead = *A* x *B*
Volume of Backfill = *A* x *D*

Concrete Cover/Bulkhead Volume Calculation

Using Means Heavy Construction Cost Data (2004)
Estimage cover/bulkhead thickness
Assumes that all concrete works are reinforced
Productivity for crew from Means Heavy Construction Cost Data (2004) adjusted for supervision (addressed in Misc. Costs) and Davis-Bacon Wage Rates
Assumes 18 in thick slab

Backfill Calculations

Uses 1 large and 1 small dozer for adit backfill
Assumes max 400 foot push
Assumes average operator and 50 min/hr availability

Uses truck & loader load, haul place fleets for shafts
Concrete cap will be 1.5 feet thick, reinforced, structually supported.
If concrete cap is used, assume 10 feet of rock backfill on top of cap.
Assumes that all concrete works are reinforced
If backfill is used, assume overfill by 5 feet
Carpenter rate incl Fringe: 1 per hour

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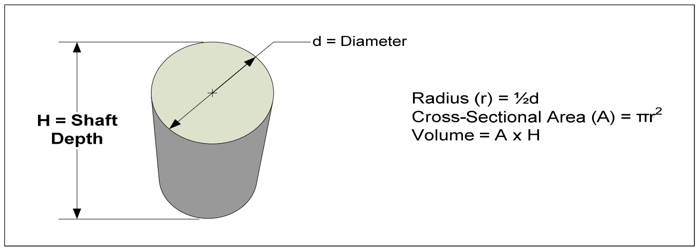
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Underground Openings Cost Summary	Labor	Equipment	Materials	Totals
Adits, Portals & Declines Plugging	$0	$0	$0	$0
Shaft Backfill/Cover	$0	$0	N/A	$0
Shaft Capping	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Shaft Volume Calculations



Adits, Portals & Declines Plugging

Uses RS Means Heavy Construction Cost Data for bulkhead production rate, material costs and crews

							Bulkhead Construction				Backfill or Foam (1)				Bat Gate or Culvert (2,3,4)				Total Costs			
	Description (required)	Bulkhead Volume cy	Backfill (rock) Volume cy	Backfill Equipment Fleet	Backfill Productivity LCY/hr	Backfill Hours	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Bulkhead Cost $	Total Labor Cost $	Total Equipment Cost $	Material (Foam) Cost $	Total Backfill Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Bat Gate Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Plugging Costs $
1							$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
							$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Notes:
1) Foam costs include 1 hour move to and setup + 1 hr. minimum crew time
2) Assumes 1 hr walk-in/walk-out time for equipment
3) Batgate assumes 8 hr install time each
4) Bat culvert backfill costs based on one 8-hr day (i.e. backfilling hours = 8 hrs).

Shaft Plugging

		Cover/Cap										Backfill/Cover		
	Description (required)	Cover Area ft2	Backfill or Cover Volume cy	Backfill Equipment Fleet	Number of Trucks	Backfill Productivity LCY/hr	Backfill Hours	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Shaft Cap Cost $	Total Labor Cost $	Total Equipment Cost $	Total Backfill Cost $
								$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Generic Material Hauling - Cost Summary

	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$84,084	$144,722	N/A	$228,805
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$84,084**	**$144,722**	**$0**	**$228,805**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$84,084**	**$144,722**	**$0**	**$228,805**

Generic Material Hauling - User Input

Facility Description				Physical		Hauled Material			Crushing & Screening					Cover			Growth Media		
	Description (required)	ID Code	Type	Final Surface Area acres	Average Ripping Distance ft	Material Volume Required cy	Distance from Borrow Source (1) ft	Slope to Borrow Source % grade	Crush Material	Screen Material	Loss to Crushing/ Screening %	Distance to Placement Location (2) ft	Slope to Placement % grade	Cover Thickness in	Distance to Cover Borrow ft	Slope to Borrow % grade	Growth Media Thickness in	Distance to Growth Material Stockpile ft	Slope to Stockpile % grade
1	**Engineered Fill (Closure Stormwater Diversion Channel)**		**Surface Channels**			**55,370**	**3,700**	**5.5**	**No**	**No**									
2	**Low Permeability Soil Layer (Closure Stormwater Diversion Channel)**		**Surface Channels**			**5,800**	**0**	**0.0**	**No**	**Yes**	**75%**	**3,700**	**5.5**						
3	**Low Permeability Soil Layer (Spillway)**		**Surface Channels**			**140**	**0**	**0.0**	**No**	**Yes**	**75%**	**3,800**	**7.0**						

Notes:
1. Input distance to crusher if material to be crushed
2. Input distance from crusher to placement if material to be crushed
3. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
4. The Engineered Fill and Low Permeability Soil Layer distances from borrow source (Infrastructure Pad) were calculated using AutoCAD.

Generic Material Hauling - User Input (cont.)

		Hauling Material				Cover			Growth Media			Revegetation				
	Description (required)	Haul Material Type (select)	Material Hauling Fleet (select)	Each Fleet Size (from/to crusher) (user override)	Compact After Placement?	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch Type (select)	Fertilizer Type (select)	Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)
1	**Engineered Fill (Closure Stormwater Diversion Channel)**	**Clay - Dry**	**Med Truck**		**Yes**	**Topsoil**	**Med Truck**		**Topsoil**	**Med Truck**		**None**	**None**	**None**	**No**	**Med Dozer**
2	**Low Permeability Soil Layer (Closure Stormwater Diversion**	**Clay - Dry**	**Med Truck**		**Yes**	**Topsoil**	**Med Truck**		**Topsoil**	**Med Truck**		**None**	**None**	**None**	**No**	**Med Dozer**
3	**Low Permeability Soil Layer (Spillway)**	**Clay - Dry**	**Med Truck**		**Yes**	**Topsoil**	**Med Truck**		**Topsoil**	**Med Truck**		**None**	**None**	**None**	**No**	**Med Dozer**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Generic Material Hauling - Cost Summary

	Labor	Equipment	Materials	Totals
Hauling/Crush/Screen/Compact	$84,084	$144,722	N/A	$228,805
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$84,084**	**$144,722**	**$0**	**$228,805**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$84,084**	**$144,722**	**$0**	**$228,805**

Generic Material Hauling - Load, Haul, Place and Grade

		Material Haulage								Crush and/or Compact			
	Description (required)	Material Volume to Crusher cy	Final Material Volume cy	Material Haulage Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Hauling Labor Cost $	Hauling Equipment Cost $	Total Crush/ Screen Cost $	Compact Labor Cost $	Compact Equipment Cost $	Total Load/Haul/ Place Cost $
1	**Engineered Fill (Closure Stormwater Diversion Channel)**	55,370	55,370	740/988G/D8R	558	3	99	$35,713	$82,265	$0	$24,917	$10,520	$153,415
2	**Low Permeability Soil Layer (Closure Stormwater Diversion**	23,200	5,800	740/988G/D8R	333	4	70	$19,953	$45,932	$2,900	$2,610	$1,102	$72,497
3	**Low Permeability Soil Layer (Spillway)**	560	140	740/988G/D8R	333	4	2	$828	$1,906	$70	$63	$27	$2,894
		79,130	61,310				171	**$56,494**	**$130,103**	**$2,970**	**$27,590**	**$11,649**	**$228,805**

Notes: Final Material Volume includes allowance for additional material hauled to crushing/screening plant based on Loss to Crushing/Screening input above.

Generic Material Hauling - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement							
	Description (required)	Cover Volume cy	Cover Placement Fleet	Cover Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $	Growth Media Volume cy	Growth Media Placement Fleet	Growth Media Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Engineered Fill (Closure Stormwater Diversion Channel)**						$0	$0	$0	0					$0	$0	$0
2	**Low Permeability Soil Layer (Closure Stormwater Diversion**						$0	$0	$0	0					$0	$0	$0
3	**Low Permeability Soil Layer (Spillway)**						$0	$0	$0	0					$0	$0	$0
							$0	**$0**	**$0**						**$0**	**$0**	**$0**

Generic Material Hauling - Scarifying/Revegetation Costs

	Description (required)	Total Surface Area acres	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Cost $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Cost $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Engineered Fill (Closure Stormwater Diversion Channel)**	0.10	D9R		$0	$0	$0	$0	$0	$0	$0
2	**Low Permeability Soil Layer (Closure Stormwater Diversion**	0.10	D9R		$0	$0	$0	$0	$0	$0	$0
3	**Low Permeability Soil Layer (Spillway)**	0.10	D9R		$0	$0	$0	$0	$0	$0	$0
		0.30			**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Foundations & Buildings

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Model Version: Version 1.4.1
Cost Data: User Data
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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$0	$0	N/A	$0
Wall Demolition Cost	$0	$0	N/A	$0
Slab Demolition	$0	$0	N/A	$0
Subtotal Demolition	**$0**	**$0**	**$0**	**$0**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Buildings & Foundation - User Input

You must fill in ALL green cells and relevant blue cells in this section for each building or facility

	Facility Description			Physical - MANDATORY								Foundation Cover (1)			Growth Media (1) (entire footprint)		
	Description (required)	ID Code	Type	Length ft	Width ft	Eve Height ft	Slab Thickness in	Foundation Wall Thickness in	Foundation Wall Height ft	Average Flat Area Long Dimension (ripping distance) ft	Building Area Footprint (including surrounding facilities) acres	Foundation Cover Thickness in	Distance from Foundation Cover Borrow Area ft	Slope from Facility to Borrow Area % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade

Notes:
1. Foundation cover only calculated to cover slab. Growth media estimated over entire footprint area
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Buildings & Foundation - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each building or facility

		Construction Materials		Slab Demolition		Foundation Cover			Growth Media			Revegetation				
	Description (required)	Building Type (select)	Foundation Wall Type (select)	Slab Demo Method (select)	Slab Breaking Equipment Fleet (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Buildings & Foundation - Calculations

Building Volume Calculations

Using Means Heavy Construction Cost Data (2004) calculates cubic feet from building dimensions
- Estimage slab thickness and wall thickness if not known
- Assumes that all concrete slabs are reinforced
- Productivity for crew from Means Heavy Construction Cost Data (2004) adjusted for supervision (addressed in Misc. Costs) and Davis-Bacon Wage Rates
- Demolition costs do not include hauling or disposing if debris - Use Waste Disposal module

Slab Demolition Calculations

Minimum 1 hr excavator time for slab demolition

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Buildings & Foundation Demolition Cost Summary

	Labor	Equipment	Materials	Totals
Building Demolition Cost	$0	$0	N/A	$0
Wall Demolition Cost	$0	$0	N/A	$0
Slab Demolition	$0	$0	N/A	$0
Subtotal Demolition	**$0**	**$0**	**$0**	**$0**
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Cover Volume Calculation

Foundation area x cover thickness
If "Bury in Place" is selected as slab demolition method, cover thickness is adjusted such that
total cover (cover + growth media) equals value entered in "Minimum thickness of cover over unbroken slab" cell above

Ripping/Scarifying Calculations

Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)

Revegetation

Minimum 1 acre revegetation crew time per area

Building & Foundation Demolition Costs

Uses RS Means Heavy Construction Cost Data for building and wall demolition cost calculations. Uses CAT Handbook for slab breaking production.

								Building Demolition			Wall Demolition			Slab Demolition			Total Costs		
	Description (required)	Building Footprint (slab area) sqft	Building Volume cu ft	Wall Length ft	Wall Area sq ft	Slab Demolition Fleet	Slab Volume cy	Total Labor Cost $	Total Equipment Cost $	Total Building Demolition Cost $	Total Labor Cost $	Total Equipment Cost $	Total Wall Demolition Cost $	Total Labor Cost $	Total Equipment Cost $	Total Slab Breaking Cost $	Total Labor Cost $	Total Equipment Cost $	Total Demolition Costs $
								$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Building & Foundation - Foundation Cover and Growth Media Costs

		Foundation Cover								Growth Media								Total Cover & Growth Media Costs		
	Description (required)	Cover Volume cy	Cover Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $	Total Labor Cost $	Total Equipment Cost $	Total Costs $
							$0	**$0**	**$0**						**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Building & Foundation - Scarifying/Revegetation Costs

					Scarifying/Ripping			Revegetation				Total Scarify & Revegation Costs			
	Description (required)	Flat Area acres	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Costs $
					$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Other Demo & Equip Removal

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Model Version: Version 1.4.1
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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Other Demoltion and Equipment Removal - Cost Summary	Labor	Equipment	Materials	Totals
Other Demolition	$0	$0	$0	$0
Equipment Removal	$0	$0	$0	$0
TOTALS	$0	$0	$0	$0

Other Demolition

	Description (required)	ID Code	Type	Quantity	Units	Labor Unit Cost $	Equipment Unit Cost $	Material Unit Cost $	Total Cost $
						$0	$0	$0	

Notes:

Equipment & Material Removal

	Description (required)	ID Code	Type	Quantity	Units	Labor Unit Cost ($)	Equipment Unit Cost ($)	Material Unit Cost ($)	Total Cost ($)
						$0	$0	$0	

Notes:

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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$426	$655	N/A	$1,081
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$426**	**$655**	**$0**	**$1,081**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$426**	**$655**	**$0**	**$1,081**

Diversion Ditches - User Input

			Diversions Ditches								Revegetation			Liner and Rip-Rap Installation			
	Description (required)	ID Code	Diversion Length ft	Diversion Depth ft	Ditch Bottom Width ft	Ditch Sideslope Angle _H:1V	Excavate Volume (if calculated elsewhere) cy	Excavating Material Condition (select)	Excavating Equipment Fleet (select)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Liner Area S.Y.	Liner Type (select)	Rip-Rap Area S.Y.	Rip-Rap Type (select type)
1	**Closure Stormwater Diversion Channel (Spillway)**		**100**	**5.0**	**15.0**	**2.5**	**2,200**	**1**	**Medium**	**None**	**None**	**None**	**0**		**0**	**Rip-Rap 18 in (450**

Notes:
1. The Closure Stormwater Diversion Channel (Spillway) excavated volume was calculated using AutoCAD Civil 3d as-built and design surfaces.
2. See the "Other User" tab for spillway riprap revetment cost (Riprap (D50=12in)).
3. See the "Haul Material" tab for Low Permeability Soil Layer cost.

Sediment/Evaporation Pond Construction/Removal - User Input

			Sediment Ponds								Growth Media		
	Description (required)	ID Code	Pond Width ft	Pond/Berm Length ft	Berm Height ft	Crest Width ft	Sideslope Angle _H:1V	Final Area (if calculated elsewhere) acres	Regrade Volume (if calculated elsewhere) cy	Cover Volume (if calculated elsewhere) cy	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Pond to Borrow % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)
3. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Sediment/Evaporation Pond Construction/Removal - User Input (cont.)

		Sediment Ponds				Growth Media			Revegetation			Ripping/Scarifying	
	Description (required)	Excavating Material Condition (select)	Material Type (select)	Excavating Equipment Fleet (select)	Liner Type (select)	Growth Media Material Type (select)	Growth Media Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Scarify/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

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Closure Cost Estimate
Sediment & Drainage Control

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
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Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$426	$655	N/A	$1,081
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$426**	**$655**	**$0**	**$1,081**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$426**	**$655**	**$0**	**$1,081**

Drainage Control - Calculations

Diversion Ditch Volume Calculation

Cross Sectional Area = $\frac{(a+b)}{2} \times d$

Ditch Volume = Ditch Length x Cross Sectional Area

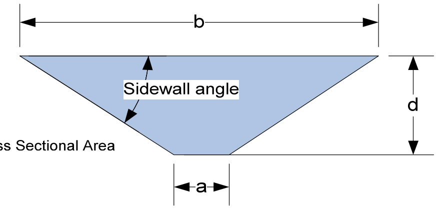
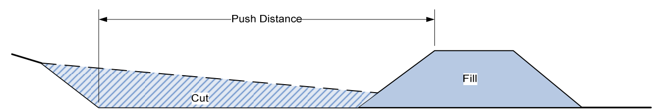


Figure 1 - Ditch Volume Calculation

1) Assume 20% swell for excavations
2) Assumes heavy duty trenching bucket is used

Sediment/Evaporation Pond Construction Calculation



Cut = Fill
Push distance = pond width up to 2/3 max push distance (400 ft)

Figure 2 - Sediment Ponds

1) Assume balanced cut-to-fill for berm construction
2) Include cost for liner, if required.
3) Include line items for removal, if necessary.
4) Assume 20% swell for excavations
5) Minimum 1 hr ripping/scarifying per area
6) Minimum 1 acre revegetation crew time per area

Diversion Ditches - Excavation Costs

									Liner Installation				Rip-Rap Installation			
	Description (required)	Diversion Ditch Volume LCY	Diversion Ditch Equipment	Corrected Excavator Productivity LCY/hr	Total Hours	Diversion Ditch Labor Cost $	Diversion Ditch Equipment Cost $	Total Diversion Ditch Cost $	Total Labor Cost $	Total Equipment Cost $	Total Material Cost $	Total Liner Cost $	Labor Cost $	Equipment Cost $	Material Cost $	Total Cost $
1	**Closure Stormwater Diversion Channel (Spillway)**	2,640	345B	480	5	$426	$655	$1,081	$0	$0	$0	$0	$0	$0	$0	$0
		2,640			5	**$426**	**$655**	**$1,081**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Notes: LCM assumes 20% swell from ditch volume

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Drainage Control - Cost Summary

	Labor	Equipment	Materials	Totals
Diversion Ditch Construction	$426	$655	N/A	$1,081
Diversion Ditch Liner	$0	$0	$0	$0
Diversion Ditch Rip-Rap	$0	$0	$0	$0
Sed Pond Construct/Regrade	$0	$0	N/A	$0
Liner Installation	$0	$0	$0	$0
Sed Pond Cover	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$426**	**$655**	**$0**	**$1,081**
Diversion Ditch Revegetation	$0	$0	$0	$0
Sediment Pond Revegetation	$0	$0	$0	$0
Subtotal Revegetation	**$0**	**$0**	**$0**	**$0**
TOTALS	**$426**	**$655**	**$0**	**$1,081**

Diversion Ditches - Revegetation Costs

	Description (required)	Surface Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Closure Stormwater Diversion Channel (Spillway)**	0.10	$0	$0	$0	$0
		0.10	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Ponds - Construction/Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83)

	Description (required)	Regrading Volume cy	Sed/Evap Pond Equipment	Dozing Distance (see above) ft	Uncorrected Dozer Productivity LCY/hr	Grade Correction	Density Correction	Excavating Material	Corrected Productivity LCY/hr	Total Dozer Hours hr	Earthwork: Total Labor Cost $	Earthwork: Total Equipment Cost $	Earthwork: Total Constr/ Regrading Cost $	Liner: Total Labor Cost $	Liner: Total Equipment Cost $	Liner: Total Material Cost $	Liner: Total Liner Cost $
											$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Sediment/Evaporation Ponds - Growth Media Costs

	Description (required)	Growth Media: Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Placement Cost $
							$0	**$0**	**$0**

Sediment/Evaporation Ponds - Revegetation Costs

	Description (required)	Surface Area acres	Long Ripping Distance ft	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
					0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Process Ponds

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$37,156	$85,589	N/A	$122,745
Growth Media Placement Costs	$7,576	$17,450	N/A	$25,026
Liner Cutting & Folding Costs	$1,665	$639	N/A	$2,304
Subtotal Earthworks	**$46,397**	**$103,678**	**$0**	**$150,075**
Revegetation Costs	$380	$144	$6,731	$7,255
TOTALS	**$46,777**	**$103,822**	**$6,731**	**$157,330**

Process Ponds - User Input

You must fill in ALL green cells and relevant blue cells in this section for each pond

	Facility Description		Pond Dimensions (1)					Backfill - (If trucks are used) (1)				Growth Media		
	Description (required)	**ID Code**	**Pond Length** ft	**Pond Width** ft	**Pond Depth** ft	**Pond Sideslope Angle** _H:1V	**Disturbed Area (if calculated elsewhere)** acres	**Percent Backfill** (100% if blank)	**Distance from Backfill Borrow** ft	**Slope from Facility to Borrow Area** % grade	**Pond Volume (if calculated elsewhere)** cy	**Growth Media Thickness** in	**Distance from Growth Media Stockpile** ft	**Slope from Facility to Stockpile** % grade
1	**Underdrain Collection Pond**		**352**	**229**	**50.5**	**2.0**	**1.80**	**115%**	**4,550**	**7%**	**0**	**0**		
2	**External Detention Pond**		**614**	**215**	**11.5**	**2.5**	**3.83**	**115%**	**3,600**	**6%**	**53,760**	**24**	**3,500**	**-1%**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

3. The Underdrain Collection Pond and External Detention Pond distances from backfill borrow (Infrastructure Pad) and pond volumes were calculated using AutoCAD Civil 3d.
4. The Haul Distance from Growth Media Stockpile was calculated using AutoCAD.
5. The Underdrain Collection Pond will be converted to a passive treatment system. See "User 11" for details.

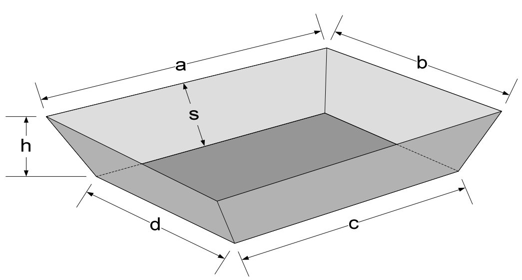
Process Ponds - User Input (cont.)

		Liner	Backfill			Growth Media			Revegetation		
	Description (required)	**Crew Cut & Fold Time** (2) hrs	**Backfill Material Type** (select)	**Backfill Equipment Fleet** (select)	**Maximum Fleet Size** (user override)	**Growth Media Material Type** (select)	**Growth Media Placement Equipment Fleet** (select)	**Maximum Fleet Size** (user override)	**Seed Mix** (select)	**Mulch** (select)	**Fertilizer** (select)
1	**Underdrain Collection Pond**	**0.0**	**Clay - Dry**	**Med Truck**		**Topsoil**	**Med Truck**		**None**	**None**	**None**
2	**External Detention Pond**	**8.0**	**Clay - Dry**	**Med Truck**		**Topsoil**	**Med Truck**		**User Mix 1**	**None**	**Chemical**

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table
(2) Pond liner removal crew (2Clab + excavator) = 2 General Laborers + 325C Excavator

Process Ponds - Calculations

Pond Volume Calculation



Area and Volume of the Frustrum of a Pyramid

$$\text{Surface Area} = ab + cd + (a+b+c+d) \times \frac{s}{2}$$

$$\text{Volume} = \frac{h\,(ab + cd + \sqrt{abcd}\,)}{3}$$

Revegetation Calculations

Minimum 1 acre revegetation crew time per area

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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Model Version: Version 1.4.1
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Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Process Ponds - Cost Summary

	Labor	Equipment	Materials	Totals
Backfilling Costs	$37,156	$85,589	N/A	$122,745
Growth Media Placement Costs	$7,576	$17,450	N/A	$25,026
Liner Cutting & Folding Costs	$1,665	$639	N/A	$2,304
Subtotal Earthworks	**$46,397**	**$103,678**	**$0**	**$150,075**
Revegetation Costs	$380	$144	$6,731	$7,255
TOTALS	**$46,777**	**$103,822**	**$6,731**	**$157,330**

Process Ponds - Liner Cutting and Folding

	Description (required)	Crew Hours hrs	Total Labor Cost $	Total Equipment Cost $	Total Liner Removal Cost $
1	**Underdrain Collection Pond**	0	$0	$0	$0
2	**External Detention Pond**	8	$1,665	$639	$2,304
		8	**$1,665**	**$639**	**$2,304**

Process Ponds - Backfill and Growth Media Costs

		Pond Backfill								Growth Media							
	Description (required)	Backfill Volume cy	Backfill Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours hrs	Total Labor Cost $	Total Equipment Cost $	Total Backfill Cost $	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
1	**Underdrain Collection Pond**	0					$0	$0	$0						$0	$0	$0
2	**External Detention Pond**	61,824	740/988G/D8R	600	3	103	$37,156	$85,589	$122,745	12,358	740/988G/D8R	598	3	21	$7,576	$17,450	$25,026
		61,824				103	**$37,156**	**$85,589**	**$122,745**	12,358				21	**$7,576**	**$17,450**	**$25,026**

Process Ponds - Revegetation Costs

	Description (required)	Surface Area acres	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
1	**Underdrain Collection Pond**	1.80	$0	$0	$0	$0
2	**External Detention Pond**	3.80	$380	$144	$6,731	$7,255
		5.60	**$380**	**$144**	**$6,731**	**$7,255**

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Date of Submittal: July 27, 2020
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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Landfills - Cost Summary

	Labor	Equipment	Materials	Totals
Grading Costs	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Topsoil Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**	**$0**	**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Landfills - User Input

You must fill in ALL green cells and relevant blue cells in this section for each landfill

	Facility Description		Physical (1)			Cover			Growth Media		
	Description (required)	ID Code	Final Landfill Footprint acres	Average Long Dimension (ripping distance) ft	Regrade Volume (calculated elsewhere) cy	Cover Thickness in	Distance from Cover Borrow ft	Slope from Landfill to Cover Borrow % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Landfill to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Landfills - User Input (cont.)

You must fill in ALL green cells and relevant blue cells in this section for each landfill

		Grading				Cover			Growth Media			Revegetation				
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Slot/ Side-by-Side (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch Type (select)	Fertilizer (select)	Scarify/ Rip? (select)	Scarifying/ Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Landfills - Calculations

Dozing, Ripping/Scarifying & Revegetation Calculations

Dozing: Dozing distance = 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Assumes flat push (grade correction factor = 1)
Minimum 1 hr per area

Ripping: Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr per area

Revegetation: Minimum 1 acre revegetation crew time per area

Landfills - Regrading Costs

Productivity = Dozer Productivity x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Dozing Material	Density Correction	Side-by-Side or Slot Dozing	Total Hourly Productivity LCY/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
											$0	$0	$0

Landfills - Cover and Growth Media Costs

		Cover Placement								Growth Media Placement							
	Description (required)	Cover Volume ft	Cover Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Cover Labor Cost $	Cover Equipment Cost $	Total Cover Cost $	Growth Media Volume ft	Growth Media Replacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
							$0	$0	$0						$0	$0	$0

Landfills - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Long Dimension ft	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
						$0	$0	$0	$0	$0	$0	$0

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Yards, Etc. - Cost Summary

	Labor	Equipment	Materials	Totals
Regrading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Yards, Etc. - User Input — **You must fill in ALL green cells and relevant blue cells in this section for each building or facility**

Facility Description				Physical			Cover			Growth Media		
	Description (required)	ID Code	Type	Area acres	Average Flat Area Long Dimension (ripping distance) ft	Regrade Volume (calculated elsewhere) cy	Cover Thickness in	Distance from Cover Borrow Area ft	Slope from Facility to Borrow Area % grade	Growth Media Thickness in	Distance from Growth Media Stockpile ft	Slope from Facility to Stockpile % grade

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

Yards, Etc. - User Input (cont.) — **You must fill in ALL green cells and relevant blue cells in this section for each building or facility**

		Grading			Cover			Growth Media			Revegetation				
	Description (required)	Regrading Material Condition (select)	Regrading Material Type (select)	Regrading Equipment Fleet (select)	Cover Material Type (select)	Cover Placement Equipment Fleet (select)	Maximum Fleet Size (user override)	Growth Media Material Type (select)	Growth Media Equipment Fleet (select)	Maximum Fleet Size (user override)	Seed Mix (select)	Mulch (select)	Fertilizer (select)	Scarify/ Rip? (select)	Ripping Fleet (select)

Notes:
1. Material Types are used for density correction based on material densities in Caterpillar Performance Handbook material density table

Yards, Etc. - Calculations

Grading Calculations

Average push distance assumed to be 2/3 of the 600 feet maximum from Catepillar Handbook or 400 feet
Material assumed to be loose stockile (1.2 productivity factor)
Slope assumed to be 0 to 5% (1.0 productivity factor)

Cover Volume Calculation

Yard area x cover thickness

Ripping/Scarifying Calculations

Flat area width = Final flat area ÷ Average long dimensions
Number of passes = Flat area width ÷ Grader width
Travel distance = Number of passes x Average long dimensions
Total hours = (Travel distance ÷ Grader productivity) + (Number of passes x Grader maneuver time)
Minimum 1 hr ripping/scarifying per area

Revegetation

Minimum 1 acre revegetation crew time per area

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Closure Cost Estimate
Yards, Etc.

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Yards, Etc. - Cost Summary

	Labor	Equipment	Materials	Totals
Regrading Cost	$0	$0	N/A	$0
Cover Placement Cost	$0	$0	N/A	$0
Growth Media Placement Cost	$0	$0	N/A	$0
Ripping/Scarifying Cost	$0	$0	N/A	$0
Subtotal Earthworks	**$0**	**$0**		**$0**
Revegetation Cost	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$0**

Yards, Etc. - Regrading Costs

Productivity = Dozer Productivity x Grade Correction x Density Correction x Operator (0.75) x Material x Visibility x Job Efficiency (0.83) x (Slot/Side-by-Side)

	Description (required)	Regrading Volume cy	Dozing Distance (see above) ft	Regrading Fleet	Uncorrected Dozer Productivity cy/hr	Grade Correction	Dozing Material	Density Correction	Total Hourly Productivity cy/hr	Total Dozer Hours hr	Total Labor Cost $	Total Equipment Cost $	Total Regrading Cost $
											$0	$0	$0

Yards, Etc. - Cover and Growth Media Costs

		Cover								Growth Media							
	Description (required)	Cover Volume cy	Topsoil Repacement Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Cover Cost $	Growth Media Volume cy	Growth Media Fleet	Fleet Productivity LCY/hr	Number of Trucks/ Scrapers	Total Fleet Hours	Total Labor Cost $	Total Equipment Cost $	Total Growth Media Cost $
							$0	$0	$0						$0	$0	$0

Yards, Etc. - Scarifying/Revegetation Costs

	Description (required)	Surface Area acres	Area Long Dimension ft	Ripping/ Scarifying Fleet	Scarifying/ Ripping Hours hrs	Scarifying/ Ripping Labor Costs $	Scarifying/ Ripping Equipment Cost $	Total Scarifying/ Ripping Costs $	Revegetation Labor Cost $	Revegetation Equipment Cost $	Revgetation Material Cost $	Total Revegetation Cost $
						$0	$0	$0	$0	$0	$0	$0

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Closure Cost Estimate
Waste Disposal

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$7,125
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$7,125**

Waste Disposal - User Input - Solid Waste

						Landfill (Bulk) Disposal			Dumpster
	Description (required)	**ID Code**	**Waste Type** (select)	**Disposal Method** (select)	**Quantity** cy	**Distance to Landfill** ft	**Slope to Landfill** % grade	**Number of Trucks** (user override)	**Months Dumpster Rental** months
1	**Dumpster for Waste during Reclamation**		**Waste Mgmt & Disposal**	**Dumpster**	**180**				**6**

Notes:
1. All Physical parameters must be input even if manual overrides for volume or area are used.
2. If Slope from facility to borrow source is >20, downhill travel time may be underestimated due to limitation of uphill travel time curves and downhill speed tables from CAT Handbook (see Productivty Sheet)

3. A 30 cubic yard dumpster was assumed to be utilized for the duration of active reclamation construction.

Waste Disposal - User Input - Hazardous Materials

	Description (required)	**ID Code**	**Waste Type** (select)	**Container Type** (select)	**Vacuum Truck Size** (select)	**Liquid Quantity** gallons	**Soild Quantity** cy	**One Way Travel Distance to Disposal Site** mi	**One Way Travel Time to Disposal Site** hr

Notes:
1. Use Other Demo & Equip Removal Sheet for tank removal

Waste Disposal - User Input - Hydrocarbon Contaminated Soils

	Description (required)	**ID Code**	**Waste Type** (select)	**Disposal Method** (select)	**Quantity** cy	**Travel Distance to Offsite Disposal** mi

Notes:
1. Use Yards or Landfills Sheets for bioremediation facility reclamation

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Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$7,125
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$7,125**

Waste Disposal - Assumptions & Calculations

Solid Waste Disposal

Off site disposal assumes use of average rolloff dumpster [30 cy (m3), 10 ton (tonne)]
On site disposal assumes use of small loader/truck fleet for haulage
Average density for on site disposal = 2,600 lb/cy (1,540 kg/m3)
For on site disposal only 1 truck is required unless total truck hours > 8, only 2 trucks unless total truck hours are > 16

Hazardous Materials Disposal

Assumes all hazardous materials are known
Enter EITHER solid or liquid quantity each line.
If container type = 55 gallon (200 liter) drum then solid waste hauling costs apply
Average density for solids assumed to be 2,600 lb/cy (1,540 kg/m3)
Vacuum truck sizes: small = 2,200 gal (~8,300 litres), large = 5,000 gal (~19,000 litres)
Vacuum truck on site for 4 hours for each load

Hydrocarbon Contaminated Soils Disposal

Assumes all hazardous materials are known
On site disposal assumes biopad treatment
Exavation productivity =45 cy./hr (35 m3/hr) (Means Heavy Construction, 2006: 02315-424-0360)

Waste Disposal - Solid Waste Disposal

	Description (required)	Waste Volume cy	Number of Off Site Dumpster Loads	Landfill Fleet Equipment	Landfill Fleet Productivity LCY/hr	Number of Trucks	Total Fleet Hours	Total Dumpster Cost $	Total Labor Cost $	Total Equipment Cost $	Total Waste Disposal Cost $
1	**Dumpster for Waste during Reclamation**	180	6					$7,125	$0	$0	$0
		180						**$7,125**	**$0**	**$0**	**$0**

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Closure Cost Estimate
Waste Disposal

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Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Waste Disposal - Cost Summary

	Labor	Equipment	Fees	Totals
Solid Waste - On Site	$0	$0	N/A	$0
Solid Waste - Off Site				$7,125
Hazardous Materials				$0
Hydrocarbon Contaminated Soils	$0	$0	$0	$0
TOTALS	**$0**	**$0**	**$0**	**$7,125**

Waste Disposal - Hazardous Materials Disposal

	Description (required)	Liquid Waste Volume gallons	Solid Waste Volume cy	Number of Truck Loads	Tons of Waste Tons	Pick-up Fees $	Transport Fees $	Disposal Fees $	Total Hazardous Material Cost $
						$0	**$0**	**$0**	**$0**

Waste Disposal - Hydrocarbon Contaminated Soils

	Description (required)	Quantity cy	Disposal Equipment Fleet	Total Fleet Hours	Treatment Cost $	Transport Fees $	Disposal Fees $	Total Labor Cost $	Total Equipment Cost $	Total Waste Disposal Cost $
					$0	**$0**	**$0**	**$0**	**$0**	**$0**

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Model Version: Version 1.4.1
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Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Well Abandonment	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$0	$0	$0	$0
Monitoring Wells	$650	$1,219	$3	$1,872
TOTALS	**$650**	**$1,219**	**$3**	**$1,872**

Production, Dewatering and Infiltration Well Closure

Description (required)	ID Code	Number of Holes	Casing Diam in	Average Depth(1) ft bgs	Depth to First Water ft bgs	Original Static Water Level ft bgs	Top of Slotted Casing(2) ft bgs	Blank Casing Below Top of Screen(2) ft	Type of Pump (if any) (select)	Depth to Pump ft bgs	Hole Plug Method (select)	Casing Volume per ft cf	Perforation Length (3,4) ft	Grout Volume per Hole(4,5) cy	Cement Volume per Hole(6) cy	Inert Media Volume per Hole(7) cy	Pump Removal Labor Cost $	Pump Removal Equip Cost $	Perf Labor Cost $	Perf Equip Cost (8) $	Grout + Cement Labor Cost(9) $	Grout + Cement Equip Cost(9) $	Grout + Cement Material Cost $	Inert Media Labor Cost(10) $	Inert Media Equip Cost(9) $	Total Cost $
																	$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

(1) For previously abandoned holes enter "0" for depth
(2) Wells abandoned per Nevada Administrative Code (NAC 534.420). Hole grouted and perforated from bottom to 50 feet (15.24m) above the top of the screen, or first water encountered or original static water level, depending on vertical hydraulic gradient and well construction parameters. Inert media (cuttings or alluvium) used from top of grout to top seal.
(3) Perforation length = amount of blank casing below first water (for confined aquifers) or predicted recovered water table (unconfined aquifers) + 50 feet (15.24m) of blank casing above water table
(4) Assumes 50' (15.24m) sanitary seal at top of hole. Therefore, perforation and grouting only required to bottom of sanitary seal.
(5) Assumes 100% loss to formation for grout (abandonite) for screened and perforated sections.
(6) Assumes 20' (6m) top seal of cement in casing only. See note 4.
(7) Inert material is cuttings or alluvium sourced locally.
(8) Includes perforation tool wear cost/ft of perforation (see Productivty Sheet).
(9) See Productivity Sheet for hourly production. Minimum 1 hr per hole + fixed hours per hole for move and setup. If no perforation required, use standard drill rig.
(10) See Productivity Sheet for hourly production. Minimum 1 hr per hole.

Notes:

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Well Abandonment

	Labor	Equipment	Materials	Totals
Production, Dewatering, Infiltration Wells	$0	$0	$0	$0
Monitoring Wells	$650	$1,219	$3	$1,872
TOTALS	**$650**	**$1,219**	**$3**	**$1,872**

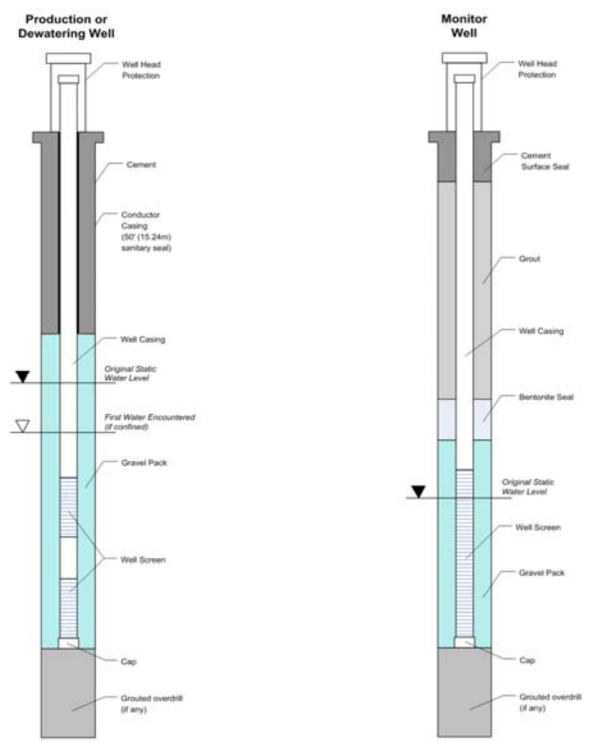
Monitoring Well Closure

	Description (required)	ID Code	Number of Holes	Casing Diam in	Average Depth ft bgs	Top of Screen(1) ft bgs	Hole Plug Method (select)	Casing Volume per ft ft3	Grout Volume/ Well(2,3) cy	Cement Volume per Hole(4) cy	Inert Backfill Volume per Hole(5) cy	Total Grouting Hours/ Hole hr	Total Inert Media Hours/ Hole hr	Grout + Cement Labor Cost(6) $	Grout + Cement Equip Cost(6) $	Grout + Cement Material Cost $	Inert Material Labor Cost(7) $	Inert Material Equip Cost(7) $	Total Cost $
1	**POC Well**		**1**	**2.0**	**86**	**18**	**Grout Only**	0.020	0.06	0.02		3.2		$650	$1,219	$3	$0	$0	$1,872
														$650	**$1,219**	**$3**	**$0**	**$0**	**$1,872**

Wells abandoned per NAC 534.420 with bentonite grout placed to 50 feet above the top of the screen (see note 1).
(1) Assumes top of screen is at or above the static water level (in unconfined aquifers) or the depth of first water encountered (in confined aquifers).
(2) Assumes 25% loss to formation for grouting
(3) Grouting only required to 50' (15.24m) above the top of screen because monitor wells are constructed with a seal in the annular space.
(4) Assumes top 20' (6m) plugged with cement.
(5) Assumes hole plugged with inert material (cuttings or alluvium) above grout up to cement surface plug.
(6) See Productivity Sheet for hourly production. Minimum 1 hr per hole + fixed hours per hole for move and setup (see Productivty Sheet).
(7) See Productivity Sheet for hourly production. Minimum 1 hr per hole.

Notes:

Well Construction



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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$6,807	$1,752	N/A	$8,559
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$8,335	$992	N/A	$9,327
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$0	N/A	N/A	$0
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$15,142**	**$2,744**	**$0**	**$17,886**

Fence Removal

You must fill in ALL green and blue cells

	Description (required)	ID Code	Length ft	Type (select type)	Labor Cost $	Equipment Cost $	Total Cost $
1	**External Detention Pond**		**1825**	**Chain link 8-10 ft**	$6,807	$1,752	$8,559
					$6,807	**$1,752**	**$8,559**

Notes: **The fence distances to be removed were calculated using AutoCAD.**

Fence Installation

You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Material Cost ($)	Costs: Total Cost $
					$0	**$0**	**$0**	**$0**

Notes:

Culvert & Buried Pipe Removal

You must fill in ALL green and blue cells

	Description (required)	ID Code	Input: Length ft	Input: Type (select type)	Input: Location (select)	Costs: Labor Cost $	Costs: Equipment Cost $	Costs: Total Cost $
						$0	**$0**	**$0**

Notes:

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Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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Model Version: Version 1.4.1
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Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Miscellaneous Cost Summary

	Labor	Equipment	Materials	Totals
Fence Removal	$6,807	$1,752	N/A	$8,559
Fence Installation	$0	$0	$0	$0
Culvert & Buried Pipe Removal	$0	$0	N/A	$0
Surface Pipe Removal	$8,335	$992	N/A	$9,327
Power Lines	$0	N/A	N/A	$0
Substations/Transformers	$0	N/A	N/A	$0
Rip-rap, rock lining, gabions	$0	$0	$0	$0
Other Costs	$0	$0	$0	$0
TOTALS	**$15,142**	**$2,744**	**$0**	**$17,886**

Surface Pipe Removal

You must fill in ALL green and blue cells

			Input			Costs		
	Description (required)	ID Code	Length ft	Type (select type)	Location (select)	Labor Cost $	Equipment Cost $	Total Cost $
1	**External Detention Pond Pipe**		**2835**	**0.75 in (20mm) - 4**	**On site**	$8,335	$992	$9,327
						$8,335	**$992**	**$9,327**

Notes: **The surface pipe removal distances were calculated using AutoCAD.**

Power Line and Substation Removal

You must fill in ALL green and blue cells

			Input				Costs			Cost Breakdown	
	Description (required)	ID Code	Power Line Length miles	Power Line Type (select)	Number of Substations #	Location (select)	Power Line Removal $	Substation Removal $	Total Cost $	Labor Cost $	Equipment Cost $
							$0	**$0**	**$0**	**$0**	**$0**

Notes: If substation owned by operator, use Other Demo & Equipment Removal sheet
User may need to add line items in Foundations & Buildings for substation slab demolition and fence removal
Labor/Equipment costs assume approximately 80% of cost are equipment and 20% are labor related costs

Rip-Rap & Rock Lining

You must fill in ALL green and blue cells

			Input		Costs			
	Description (required)	ID Code	Area S.Y.	Type (select type)	Labor Cost $	Equipment Cost $	Material Cost $	Total Cost $
					$0	**$0**	**$0**	**$0**

Notes:

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Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Reclamation Monitoring & Maintenance - Cost Summary

	Labor	Equipment	Lab & Materials	Totals
Revegetation Maintenance	$2,280	$1,140	$15,267	$18,687
Erosion Maintenance	$5,761	$17,282	N/A	$23,043
Reclamation Monitoring	$486,814	$32,605	N/A	$519,419
Subtotal Reclamation Monitoring	**$494,855**	**$51,027**	**$15,267**	**$561,149**
Water Quality Monitoring	$101,239	$17,116	$38,285	$156,640
TOTAL MONITORING	**$596,094**	**$68,143**	**$53,552**	**$717,789**

Reclamation Maintenance

Description	Total Revegetation Surface Area (1,2) acres	% Area Requiring Reseeding	Seed Mix (select)	Area Requiring Reseeding acres	Seed $/acres	Labor $/acres	Equipment $/acres	Totals $
Revegetation Maintenance	36	25%	User Mix 1	9.1	$1,674.00	$250.00	$125.00	
Labor								$2,280
Equipment								$1,140
Materials								$15,267
Cost/Acre								$2,049
							Subtotal	**$18,687**

Notes: 1) Surface area is NOT the same as footprint disturbance area typically used for permitting purposes.

	Total Volume Growth Media cy	% Volume Requiring Maintenance	Average Growth Media Placement Cost $/CY	Volume Requiring Replacement cy		Labor (assume: 25%) $/acres	Equipment (assume: 75%) $/acres	Total $
Erosion Maintenance	102,866	10%	$2.24	10,287		$5,761.00	$17,282.00	$23,043

Notes:

Reclamation Monitoring

Description	Hrs/Day	Days/Year	Number of Years	Rate $/hr	
Field Work					
Field Geologist/Engineer	5	12	30	$193.18	$347,724
Range Scientist				$178.47	$0
Reporting					
Field Geologist/Engineer	2	12	30	$193.18	$139,090
Range Scientist				$178.47	$0
				Subtotal	**$486,814**
Travel					
	Hrs/Trip hr	Trips/Year	Years	Truck Cost $/hr	
Travel	3	12	30	$30.19	$32,605
				Subtotal	**$32,605**
				Total Reclamation Monitoring	**$519,419**

Notes: **Reclamation monitoring assumes local firm performs the work.**

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Reclamation Monitoring & Maintenance - Cost Summary

	Labor	Equipment	Lab & Materials	Totals
Revegetation Maintenance	$2,280	$1,140	$15,267	$18,687
Erosion Maintenance	$5,761	$17,282	N/A	$23,043
Reclamation Monitoring	$486,814	$32,605	N/A	$519,419
Subtotal Reclamation Monitoring	**$494,855**	**$51,027**	**$15,267**	**$561,149**
Water Quality Monitoring	$101,239	$17,116	$38,285	$156,640
TOTAL MONITORING	**$596,094**	**$68,143**	**$53,552**	**$717,789**

Water and Rock Sample Analysis

Description	Samples #	Events/Year	No. Years	First Sample Year closure year (1-100)	No. of Samplers	Days/Event	Hrs/Day	Analysis Cost $/sample	Supplies $/sample	Lab Cost $	Material Cost $	Equipment Cost $	Labor Cost $	Cost $	Comments
Arizona Minerals Inc	**1**	**2**	**30**	**1**	**1**	**1**	**8**	$631.90	$6.19	$37,914	$371	$9,163	$78,058	$125,506	**Quote received for cost of required testing is shown in User 4**
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
														$0	
									$37,914.00	$371.00	$9,163.20	$78,057.60		
												Subtotal Sampling Costs		**$125,506**	

Notes: Sampling labor cost = No. Samplers x Years x Events/year x Days/event x Hour/Day x Labor Rate
Sampling equipment costs include 1 pickup truck for every two samplers

Ground & Surface Water Monitoring

Pump Costs

Description	No. of units		Years		Cost $
Pump (purchased)	**1**	Replacement period (yrs):	**10**	2650.8	$7,952
				Subtotal Field Work	**$7,952**

Notes: Replacement period = frequency of pump replacement

Reporting

Description	Hrs/Event	Rate $/hr	Cost $
Field Geologist/Engineer	**2**	$193.18	$23,182
		Subtotal Reporting	**$23,182**

Notes:

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Closure Cost Estimate
Constr. Mgmt

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
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Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Construction Management & Road Maintenance - Cost Summary

	Labor	Equipment	Materials	Totals
Construction Management	$135,965	$18,326	N/A	$154,291
Construction Support		$11,932		$11,932
Road Maintenance	$175,991	$229,731	$0	$405,722
TOTAL CONSTRUCTION MANAGEMENT	**$311,956**	**$259,989**	**$0**	**$571,945**

Construction Management

Construction Management Staff

Description	Duration mo.	Hours/ Month hr.	Number of Supervisors	Supervisor Rate $/hr	Labor Cost $	Equipment Cost[1] $	Totals $
Active Reclamation	6	160	1	$141.63	$135,965	$18,326	$154,291
Monitoring & Maintenance					$0	$0	$0
				Total Staff	**$135,965**	**$18,326**	**$154,291**

Construction Management Support

Description	Duration mo.	Number of Units		Rental Rate $/mo	Generator Cost $/mo	Equipment Cost[1] $	Totals $
Temporary Office Rental	6	1		$213	$1,344	$9,342	$9,342
Temporary Toilets	6	2		$216		$2,590	$2,590
					Total Support	**$11,932**	**$11,932**

Notes: Office rental assumes only 1 generator required for every 4 trailers

Total Construction Management **$166,223**

Road Maintenance

Description	Fleet Size (select)	Number	Duration mo.	Hours/ Month hr.	Labor Cost $	Equipment Cost $	Totals $
Active Reclamation							
Water Truck	Medium	1	6	160	$61,066	$61,910	$122,976
Grader	Medium	1	6	160	$81,629	$124,358	$205,987
Monitoring & Maintenance							
Water Truck	Medium	1	14	16	$14,249	$14,446	$28,695
Grader	Medium	1	14	16	$19,047	$29,017	$48,064
Description	**Gallons/ Day**	**Days/ Month**	**Duration** mo.	**Cost/ Gallon** $			**Totals** $
Water Fees							
Water Fees							$0
				Total Project Maintenance	**$175,991**	**$229,731**	**$405,722**

Notes: 1) Supervisor equipment = pickup truck
Monitoring and maintenance assumes the following: Water truck and grader required semi-annually for a duration of 7 years (14 "durations"). Each "duration" would require 16 hours to perform maintenance work.

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Closure Cost Estimate
Labor Rates

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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Color Code Key	
User Input - Direct Input	Direct Input
User Input - Pull Down List	Pull Down Selection
Program Constant (can override)	Alternate Input
Program Calculated Value	Locked Cell - Formula or Reference

ZONE ADJUSTMENTS		
Cost Basis/Project Region	Southern Nevada	Clark, Esmeralda, Lincoln and Nye Counties
Power Equipment Operators	>60 miles	$0.00
Truck Drivers	>70 miles	$0.00
Laborers	>50 miles	$0.00
INDIRECT COSTS		
Unemployment (%)	6.00%	
Retirement/SS/Medicare (%)	7.65%	
Workman's Compensation (%)	8.90%	
Other Indirects		
State Payroll Tax (13),(15),(17),(1	2.70%	
Total Other Indirects	2.70%	

HOURLY LABOR RATE TABLE

EQUIPMENT TYPE (1) OR JOB DESCRIPTION	Labor Group	Base Rate ($/hr)	Zone Adjustment ($/hr)	Hourly Wage ($/hr)	Fringe ($/hr)	Retirement/ Medicare ($/hr)	Unemployment Insurance ($/hr)	Workman's Compensation ($/hr)	Other Indirect Costs ($/hr)	Total ($/hr)
Equipment Operators ($/hr) (2)										
Bulldozers										
D6R	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
D6R w/ Winch		$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
D7R	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
D8R	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
D9R	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
D10R	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
D11R	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
Wheeled Dozers										
824G					$24.70					
834G					$24.70					
844					$24.70					
854G					$24.70					
Motor Graders										
120H	Group 10	$48.17	$0.00	$48.17	$24.70	$2.89	$3.69	$4.29	$1.30	$85.03
14G/H	Group 10	$48.17	$0.00	$48.17	$24.70	$2.89	$3.69	$4.29	$1.30	$85.03
16G/H	Group 10	$48.17	$0.00	$48.17	$24.70	$2.89	$3.69	$4.29	$1.30	$85.03
24M					$24.70					
Track Excavators										
312C	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
320C	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
325C	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
330C	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
345B	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
365BL					$24.70					
385BL	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
Scrapers										
631G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
637G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
Wheeled Loaders										
924G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
928G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
950G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
966G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
972G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
980G	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
988G	Group 10	$48.17	$0.00	$48.17	$24.70	$2.89	$3.69	$4.29	$1.30	$85.03
990					$24.70					
992G	Group 10	$48.17	$0.00	$48.17	$24.70	$2.89	$3.69	$4.29	$1.30	$85.03
994D					$24.70					
L2350					$24.70					
Shovels										
PC2000					$24.70					
PC3000					$24.70					
PC4000					$24.70					
PC5500					$24.70					
PC8000					$24.70					
Hydraulic Hammers										
H-120 (fits 325)										
H-160 (fits 345)										
H-180 (fits 365/385)										
Demolition Shears										
S340 (fits 322/325/330)										
S365 (fits 330/345)										
S390 (fits 365/385)										
Demolition Grapples										
G315 (fits 322/325)										
G320 (fits 325/330)										
G330 (fits 345/365)										

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Closure Cost Estimate
Labor Rates

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Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Color Code Key	
User Input - Direct Input	Direct Input
User Input - Pull Down List	Pull Down Selection
Program Constant (can override)	Alternate Input
Program Calculated Value	Locked Cell - Formula or Reference

ZONE ADJUSTMENTS		
Cost Basis/Project Region	Southern Nevada	Clark, Esmeralda, Lincoln and Nye Counties
Power Equipment Operators	>60 miles	$0.00
Truck Drivers	>70 miles	$0.00
Laborers	>50 miles	$0.00
INDIRECT COSTS		
Unemployment (%)	6.00%	
Retirement/SS/Medicare (%)	7.65%	
Workman's Compensation (%)	8.90%	
Other Indirects		
State Payroll Tax (13),(15),(17),(1	2.70%	
Total Other Indirects	**2.70%**	

HOURLY LABOR RATE TABLE

Other Equipment										
420D 4WD Backhoe	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
428D 4WD Backhoe	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
CS533E Vibratory Roller	Group 12A	$48.34	$0.00	$48.34	$24.70	$2.90	$3.70	$4.30	$1.31	$85.25
CS633E Vibratory Roller					$24.70					
CP533E Sheepsfoot Compactor					$24.70					
CP633E Sheepsfoot Compactor					$24.70					
Light Truck - 1.5 Ton					$24.70					
Supervisor's Truck					$24.70					
Flatbed Truck					$24.70					
Air Compressor + tools	Group 1	$44.99	$0.00	$44.99	$24.70	$2.70	$3.44	$4.00	$1.21	$79.84
Welding Equipment	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$83.59
Heavy Duty Drill Rig	Group 1	$44.99	$0.00	$44.99	$24.70	$2.70	$3.44	$4.00	$1.21	$79.84
Pump (plugging) Drill Rig	Group 1	$44.99	$0.00	$44.99	$24.70	$2.70	$3.44	$4.00	$1.21	$79.84
Concrete Pump					$24.70					
Gas Engine Vibrator	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
Generator 5KW					$24.70					
HDEP Welder (pipe or liner)					$24.70					
5 Ton Crane	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
20 Ton Crane	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
50 Ton Crane	Group 8A	$48.05	$0.00	$48.05	$24.70	$2.88	$3.68	$4.28	$1.30	$84.88
120 Ton Crane					$24.70					

NOTES:

(1) Equipment Type:	Catepillar model or equivalent, LeTourneau
(2) Equipment Operator Source:	D-B NV20190012 7/5/2019
(3) Zone Basis:	Mine Site Costs

Truck Drivers ($/hr) (4)										
725		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
730		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
735		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
740		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
769D		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
773E					$26.72					
777D		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
785C					$26.72					
793C					$26.72					
797B					$26.72					
613E (5,000 gal) Water Wagon		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
621E (8,000 gal) Water Wagon		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61
777D Water Truck					$26.72					
785C Water Truck					$26.72					
Dump Truck (10-12 yd3)		$29.45	$0.00	$29.45	$26.72	$1.77	$2.25	$2.62	$0.80	$63.61

NOTES:

(4) Truck Driver Source:	D-B NV20190012 7/5/2019
(5) Zone Basis:	Mine Site Costs

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Closure Cost Estimate
Labor Rates

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Color Code Key	
User Input - Direct Input	Direct Input
User Input - Pull Down List	Pull Down Selection
Program Constant (can override)	Alternate Input
Program Calculated Value	Locked Cell - Formula or Reference

ZONE ADJUSTMENTS

Cost Basis/Project Region	Southern Nevada	Clark, Esmeralda, Lincoln and Nye Counties
Power Equipment Operators	>60 miles	$0.00
Truck Drivers	>70 miles	$0.00
Laborers	>50 miles	$0.00

INDIRECT COSTS

Unemployment (%)	6.00%
Retirement/SS/Medicare (%)	7.65%
Workman's Compensation (%)	8.90%
Other Indirects	
State Payroll Tax (13),(15),(17),(1	2.70%
Total Other Indirects	**2.70%**

HOURLY LABOR RATE TABLE

Laborers ($/hr) (6,7)

General Laborer	Group 1	$27.65	$0.00	$27.65	$26.79	$1.66	$2.12	$2.46	$0.75	$61.42
Skilled Laborer	Group 2	$27.86	$0.00	$27.86	$26.79	$1.67	$2.13	$2.48	$0.75	$61.68
Driller's Helper	Group 2	$27.86	$0.00	$27.86	$26.79	$1.67	$2.13	$2.48	$0.75	$61.68
Rodmen (reinforcing concrete)	Group 2	$27.86	$0.00	$27.86	$26.79	$1.67	$2.13	$2.48	$0.75	$61.68
Cement finisher	Group 2	$27.86	$0.00	$27.86	$26.79	$1.67	$2.13	$2.48	$0.75	$61.68
Carpenter		$46.15	$0.00	$46.15	$16.81	$2.77	$3.53	$4.11	$1.25	$74.61

NOTES:

(6) Laborer Source:	D-B SUNV2011-001 10/1/2010
(7) Carpenter Source:	D-B CARP1977-003 7/1/2018
(8) Zone Basis:	Mine Site Costs

Project Management and Technical Labor ($/hr) (9)

Project Manager		$91.69		$91.69	$26.79	$5.50	$7.01	$8.16	$2.48	$141.63
Foreman		$85.50		$85.50	$26.79	$5.13	$6.54	$7.61	$2.31	$133.88
Field Geologist/Engineer		$132.85		$132.85	$26.79	$7.97	$10.16	$11.82	$3.59	$193.18
Field Tech/Sampler		$108.45		$108.45	$26.79	$6.51	$8.30	$9.65	$2.93	$162.62
Range Scientist		$121.10		$121.10	$26.79	$7.27	$9.26	$10.78	$3.27	$178.47
Senior Planning Engineer					$26.79					
Project Engineer					$26.79					
Mechanic/Fitter					$26.79					
					$26.79					
					$26.79					
					$26.79					
					$26.79					

NOTES:

(9) Project Manager:	R.S. Means 2019 Q2 (01 31
(9) Foreman Source:	R.S. Means 2019 Q2 (01 31
(9) Techical Labor Source:	SRK Consulting 2019
Other Labor Source:	
Other Labor Source:	
†Additional User Markups	
(These are added by the user to the	
base rate to account for site-specific	
conditions or corporate requirements)	

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Closure Cost Estimate
Equipment Costs

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Monthly Rental Basis: 160 hrs month

EQUIPMENT RENTAL RATE TABLE

EQUIPMENT TYPE (1)	Monthly Owner/Rental Rate	Equipment Hourly Rate	Fuel/Lube/ Wear	Total Rate
Bulldozers				
D6R	$10,400.00	$65.00	$28.89	$93.89
D6R w/ Winch			$16.44	$16.44
D7R	$11,350.00	$70.94	$32.18	$103.11
D8R	$21,600.00	$135.00	$43.19	$178.19
D9R	$26,100.00	$163.13	$61.52	$224.64
D10R	$40,000.00	$250.00	$79.01	$329.01
D11R	$64,000.00	$400.00	$115.46	$515.46
Wheeled Dozers				
824G			$28.27	$28.27
834G			$33.14	$33.14
844			$39.45	$39.45
854G			$49.97	$49.97
Motor Graders				
120H	$9,600.00	$60.00	$30.82	$90.82
14G/H	$13,500.00	$84.38	$45.17	$129.54
16G/H	$21,000.00	$131.25	$56.44	$187.69
24M			$40.77	$40.77
Track Excavators				
312C	$5,275.00	$32.97	$13.10	$46.07
320C	$5,955.00	$37.22	$21.94	$59.16
325C	$8,350.00	$52.19	$27.66	$79.85
330C	$10,800.00	$67.50	$33.47	$100.97
345B	$14,280.00	$89.25	$41.80	$131.05
365BL			$34.72	$34.72
385BL	$22,500.00	$140.63	$65.46	$206.08
Scrapers				
631G	$24,800.00	$155.00	$68.42	$223.42
637G	$35,000.00	$218.75	$98.53	$317.28
Wheeled Loaders				
924G	$4,500.00	$28.13	$18.40	$46.52
928G	$5,200.00	$32.50	$20.80	$53.30
950G	$7,600.00	$47.50	$28.58	$76.08
966G	$10,900.00	$68.13	$37.72	$105.85
972G	$13,800.00	$86.25	$42.51	$128.76
980G	$13,800.00	$86.25	$48.09	$134.34
988G	$23,000.00	$143.75	$68.77	$212.52
990			$44.71	$44.71
992G	$60,000.00	$375.00	$129.34	$504.34
994D			$94.68	$94.68
L2350			$173.58	$173.58
Shovels				
PC2000			$97.31	$97.31
PC3000			$131.50	$131.50
PC4000			$184.10	$184.10
PC5500			$312.97	$312.97
PC8000			$391.87	$391.87
Hydraulic Hammers				
H-120 (fits 325)	$5,700.00	$35.63	$5.57	$41.20
H-160 (fits 345)	$12,000.00	$75.00	$10.86	$85.86
H-180 (fits 365/385)	$16,200.00	$101.25	$12.87	$114.12
Demolition Shears				
S340 (fits 322/325/330)				$0.00
S365 (fits 330/345)				$0.00
S390 (fits 365/385)				$0.00
Demolition Grapples				
G315 (fits 322/325)				$0.00
G320 (fits 325/330)				$0.00
G330 (fits 345/365)				$0.00
Other Equipment				
420D 4WD Backhoe	$2,650.00	$16.56	$16.32	$32.88
428D 4WD Backhoe	$3,400.00	$21.25	$16.21	$37.46
CS533E Vibratory Roller	$8,140.00	$50.88	$9.86	$60.74
CS633E Vibratory Roller			$12.49	$12.49
CP533E Sheepsfoot Compactor			$9.86	$9.86
CP633E Sheepsfoot Compactor			$12.49	$12.49
Light Truck - 1.5 Ton	$4,158.00	$25.99	$4.21	$30.19
Supervisor's Truck	$2,592.00	$16.20	$2.89	$19.09
Flatbed Truck	$4,158.00	$25.99	$13.80	$39.79
Air Compressor + tools	$4,301.00	$26.88	$2.63	$29.51
Welding Equipment	$2,039.00	$12.74	$5.26	$18.00
Heavy Duty Drill Rig	$56,760.00	$354.75	$31.56	$386.31
Pump (plugging) Drill Rig	$56,760.00	$354.75	$26.30	$381.05
Concrete Pump	$17,974.00	$112.34	$26.30	$138.64
Gas Engine Vibrator	$565.00	$3.53	$2.63	$6.16
Generator 5KW	$712.00	$4.45	$3.95	$8.40
HDEP Welder (pipe or liner)	$8,628.00	$53.93	$5.26	$59.19
5 Ton Crane	$535.00	$3.34	$7.89	$11.23
20 Ton Crane	$12,408.00	$77.55	$10.52	$88.07
50 Ton Crane	$12,408.00	$77.55	$12.36	$89.91
120 Ton Crane			$13.68	$13.68
Trucks				
725	$15,000.00	$93.75	$36.71	$130.46
730	$15,000.00	$93.75	$38.03	$131.78
735	$15,000.00	$93.75	$51.85	$145.60
740	$15,000.00	$93.75	$53.00	$146.75
769D	$21,000.00	$131.25	$41.02	$172.27
773E	$33,000.00	$206.25	$53.99	$260.24
777D	$54,000.00	$337.50	$77.02	$414.52
785C			$63.78	$63.78
793C			$109.80	$109.80
797B			$154.51	$154.51
613E (5,000 gal) Water Wagon	$6,500.00	$40.63	$23.87	$64.49
621E (8,000 gal) Water Wagon	$11,000.00	$68.75	$42.58	$111.33
777D Water Truck			$44.05	$44.05
785C Water Truck			$63.78	$63.78
Dump Truck (10-12 yd^3)	$12,078.00	$75.49	$14.66	$90.15

NOTES:

(1) Power Equipment Source:	
(2) Power Equipment Type:	Catepillar model or equivalent, LeTourneau loader, Komatsu shovels
(3) Drilling Equipment Source:	
(4) Other Equipment Source:	
(5) Drill rig includes support (pipe) truck	

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Closure Cost Estimate
Equipment Costs

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm

FUEL, LUBE AND WEAR CALCULATIONS

EQUIPMENT TYPE	PM Cost Per Hour(1)	Under carriage or Tires (2)	G.E.T Consumption (3)	Fuel Use Rate gal/hr (4)	Cost@ 2.63/gal	Total Hourly Equipment Cost
Bulldozers						
D6R	$7.41		$5.04	6.25	$16.44	$28.89
D6R w/ Winch				6.25	$16.44	$16.44
D7R	$7.41		$5.04	7.50	$19.73	$32.18
D8R	$7.82		$9.73	9.75	$25.64	$43.19
D9R	$8.91		$15.13	14.25	$37.48	$61.52
D10R	$10.49		$21.18	18.00	$47.34	$79.01
D11R	$14.29		$31.47	26.50	$69.70	$115.46
Wheeled Dozers						
824G		$0.00		10.75	$28.27	$28.27
834G		$0.00		12.60	$33.14	$33.14
844		$0.00		15.00	$39.45	$39.45
854G		$0.00		19.00	$49.97	$49.97
Motor Graders						
120H	$4.50	$5.36	$10.44	4.00	$10.52	$30.82
14G/H	$5.61	$8.03	$15.09	6.25	$16.44	$45.17
16G/H	$5.86	$10.24	$20.61	7.50	$19.73	$56.44
24M				15.50	$40.77	$40.77
Track Excavators						
312C	$4.23		$3.93	1.88	$4.94	$13.10
320C	$4.51		$4.54	4.90	$12.89	$21.94
325C	$4.57		$5.73	6.60	$17.36	$27.66
330C	$5.60		$6.30	8.20	$21.57	$33.47
345B	$7.47		$6.45	10.60	$27.88	$41.80
365BL				13.20	$34.72	$34.72
385BL	$6.23		$13.20	17.50	$46.03	$65.46
Scrapers						
631G	$7.52	$13.20	$8.25	15.00	$39.45	$68.42
637G	$12.49	$13.20	$10.37	23.75	$62.46	$98.53
Wheeled Loaders						
924G	$3.74	$3.09	$4.34	2.75	$7.23	$18.40
928G	$4.02	$3.09	$4.49	3.50	$9.21	$20.80
950G	$5.00	$4.71	$8.35	4.00	$10.52	$28.58
966G	$5.21	$6.91	$10.48	5.75	$15.12	$37.72
972G	$5.89	$6.91	$13.27	6.25	$16.44	$42.51
980G	$5.89	$9.20	$13.27	7.50	$19.73	$48.09
988G	$11.04	$11.69	$14.22	12.10	$31.82	$68.77
990				17.00	$44.71	$44.71
992G	$12.23	$23.97	$32.65	23.00	$60.49	$129.34
994D				36.00	$94.68	$94.68
L2350				66.00	$173.58	$173.58
Shovels						
PC2000				37.00	$97.31	$97.31
PC3000				50.00	$131.50	$131.50
PC4000				70.00	$184.10	$184.10
PC5500				119.00	$312.97	$312.97
PC8000				149.00	$391.87	$391.87
Hydraulic Hammers						
H-120 (fits 325)	N/A		$5.57			$5.57
H-160 (fits 345)	N/A		$10.86			$10.86
H-180 (fits 365/385)	N/A		$12.87			$12.87
Demolition Shears						
S340 (fits 322/325/330)	N/A					$0.00
S365 (fits 330/345)	N/A					$0.00
S390 (fits 365/385)	N/A					$0.00
Demolition Grapples						
G315 (fits 322/325)	N/A					$0.00
G320 (fits 325/330)	N/A					$0.00
G330 (fits 345/365)	N/A					$0.00
Other Equipment						
420D 4WD Backhoe	$4.16	$0.78	$3.49	3.00	$7.89	$16.32
428D 4WD Backhoe	$3.94	$0.78	$3.60	3.00	$7.89	$16.21
CS533E Vibratory Roller			N/A	3.75	$9.86	$9.86
CS633E Vibratory Roller			N/A	4.75	$12.49	$12.49
CP533E Sheepsfoot Compactor			N/A	3.75	$9.86	$9.86
CP633E Sheepsfoot Compactor			N/A	4.75	$12.49	$12.49
Light Truck - 1.5 Ton		$0.26	N/A	1.50	$3.95	$4.21
Supervisor's Truck		$0.26	N/A	1.00	$2.63	$2.89
Flatbed Truck		$1.44	N/A	4.70	$12.36	$13.80
Air Compressor + tools			N/A	1.00	$2.63	$2.63
Welding Equipment			N/A	2.00	$5.26	$5.26
Heavy Duty Drill Rig			N/A	12.00	$31.56	$31.56
Pump (plugging) Drill Rig			N/A	10.00	$26.30	$26.30
Concrete Pump			N/A	10.00	$26.30	$26.30
Gas Engine Vibrator			N/A	1.00	$2.63	$2.63
Generator 5KW			N/A	1.50	$3.95	$3.95
HDEP Welder (pipe or liner)			N/A	2.00	$5.26	$5.26
5 Ton Crane			N/A	3.00	$7.89	$7.89
20 Ton Crane			N/A	4.00	$10.52	$10.52
50 Ton Crane			N/A	4.70	$12.36	$12.36
120 Ton Crane			N/A	5.20	$13.68	$13.68
Trucks						
725	$7.44	$13.78	$3.13	4.70	$12.36	$36.71
730	$7.44	$13.78	$3.13	5.20	$13.68	$38.03
735	$7.44	$21.95	$3.13	7.35	$19.33	$51.85
740	$7.44	$23.10	$3.13	7.35	$19.33	$53.00
769D	$6.14	$7.05	$3.50	9.25	$24.33	$41.02
773E	$7.59	$11.56	$3.93	11.75	$30.90	$53.99
777D	$10.87	$17.71	$4.39	16.75	$44.05	$77.02
785C				24.25	$63.78	$63.78
793C				41.75	$109.80	$109.80
797B				58.75	$154.51	$154.51
613E (5,000 gal) Water Wagon	$4.45	$3.64		6.00	$15.78	$23.87
621E (8,000 gal) Water Wagon	$6.29	$8.02		10.75	$28.27	$42.58
777D Water Truck				16.75	$44.05	$44.05
785C Water Truck				24.25	$63.78	$63.78
Dump Truck (10-12 yd3) (5)	N/A	$0.98	N/A	5.20	$13.68	$14.66

Notes:

(1) PM Source:	Cashman Equipment Company (July 2019) unless noted
(2) Undercarriage Source:	Purecell Tire Quote: June 2019
(3) G.E.T. Source:	CAT Historical Data
(4) Fuel Use Source:	Caterpillar Handbook, Edition 35, Ch. 20; or estimated average for smaller vehicles
(5) Dump Truck Oper. Cost Source:	Means Heavy Construction (2008)

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Closure Cost Estimate
Equipment Costs

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
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Model Version: Version 1.4.1
Cost Data: User Data
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TIRE COST TABLES

Equipment	Tire Size	# of Tires Per Piece of Equipment	Cost Per Tire	Tire Cost (1)(2)	Life Expectancy Hours (Low/Zone A) (3)	Tire Cost per Hour
Bulldozers						
D6R			N/A			
D6R w/ Winch			N/A			
D7R			N/A			
D8R			N/A			
D9R			N/A			
D10R			N/A			
D11R			N/A			
Wheeled Dozers						
824G	29.5R25	4		$0.00	3,500	$0.00
834G	35/65-R33	4		$0.00	3,500	$0.00
844	45/65-R39	4		$0.00	3,500	$0.00
854G	45/65-R45	4		$0.00	3,500	$0.00
Motor Graders						
120H	13PR24	6	$3,126.20	$18,757.20	3,500	$5.36
14G/H	20.5R25	6	$4,685.30	$28,111.80	3,500	$8.03
16G/H	23.5R25	6	$5,974.20	$35,845.20	3,500	$10.24
24M	23.5R25	6		$0.00	3,500	
Track Excavators						
312C			N/A			
320C			N/A			
325C			N/A			
330C			N/A			
345B			N/A			
365BL			N/A			
385BL			N/A			
Scrapers						
631G	37.25R35	4	$13,202.70	$52,810.80	4,000	$13.20
637G	37.25R35	4	$13,202.70	$52,810.80	4,000	$13.20
Wheeled Loaders						
924G	17.5R25	4	$3,471.10	$13,884.40	4,500	$3.09
928G	17.5R25	4	$3,471.10	$13,884.40	4,500	$3.09
950G	26.5R25	4	$5,300.40	$21,201.60	4,500	$4.71
966G	26.5R25	4	$7,771.60	$31,086.40	4,500	$6.91
972G	26.5R25	4	$7,771.60	$31,086.40	4,500	$6.91
980G	29.5R25	4	$10,355.60	$41,422.40	4,500	$9.20
988G	35/65-33	4	$13,151.10	$52,604.40	4,500	$11.69
990	41.25/70-39	4		$0.00	4,500	
992G	45/65R45	4	$26,967.62	$107,870.48	4,500	$23.97
994D	55/85R57	4		$0.00	4,500	
L2350	55/85R57	4		$0.00	4,500	
Shovels						
PC2000			N/A			
PC3000			N/A			
PC4000			N/A			
PC5500			N/A			
PC8000			N/A			
Hydraulic Hammers						
H-120 (fits 325)			N/A			
H-160 (fits 345)			N/A			
H-180 (fits 365/385)			N/A			
Demolition Shears						
S340 (fits 322/325/330)			N/A			
S365 (fits 330/345)			N/A			
S390 (fits 365/385)			N/A			
Demolition Grapples						
G315 (fits 322/325)			N/A			
G320 (fits 325/330)			N/A			
G330 (fits 345/365)			N/A			
Other Equipment						
420D 4WD Backhoe	340/80R18-19.5LR24	2	$1,162.96	$2,325.92	3,000	$0.78
428D 4WD Backhoe	340/80R18-16.9R28	2	$1,162.96	$2,325.92	3,000	$0.78
CS533E Vibratory Roller			N/A			
CS633E Vibratory Roller			N/A			
CP533E Sheepsfoot Compactor			N/A			
CP633E Sheepsfoot Compactor			N/A			
Light Truck - 1.5 Ton		4	196.4	$785.60	3,000	$0.26
Supervisor's Truck		4	196.4	$785.60	3,000	$0.26
Flatbed Truck		22	196.4	$4,320.80	3,000	$1.44
Air Compressor + tools			N/A			
Welding Equipment			N/A			
Heavy Duty Drill Rig		4		$0.00	3,000	
Pump (plugging) Drill Rig		4		$0.00	3,000	
Concrete Pump			N/A			
Gas Engine Vibrator			N/A			
Generator 5KW			N/A			
HDEP Welder (pipe or liner)			N/A			
5 Ton Crane		4		$0.00	3,000	
20 Ton Crane		4		$0.00	3,000	
50 Ton Crane		6		$0.00	3,000	
120 Ton Crane		6		$0.00	3,000	
Trucks						
725	23.5R25	6	$4,594.57	$27,567.42	2,000	$13.78
730	23.5R25	6	$4,594.57	$27,567.42	2,000	$13.78
735	26.5R25	6	$7,315.27	$43,891.62	2,000	$21.95
740	29.5R25	6	$7,701.12	$46,206.72	2,000	$23.10
769D	18.00R33	6	$7,054.80	$42,328.80	6,000	$7.05
773E	24.00R35	6	$9,637.30	$57,823.80	5,000	$11.56
777D	27.00R49	6	$14,756.90	$88,541.40	5,000	$17.71
785C	33.00R51	6		$0.00	4,000	
793C	40.00R57	6		$0.00	4,000	
797B	40.00R57	6		$0.00	4,000	
613E (5,000 gal) Water Wagon	23.5R25	6	$3,636.27	$21,817.62	6,000	$3.64
621E (8,000 gal) Water Wagon	33.25R29	6	$10,688.90	$64,133.40	8,000	$8.02
777D Water Truck	27.00R49	6		$0.00	5,000	
785C Water Truck	33.00R51	6		$0.00	4,000	
Dump Truck (10-12 yd3)		10	$590.40	$5,904.00	6,000	$0.98

Notes:

(1) Unit Cost Basis:	Cost per set
(2) Cost Basis:	Total cost for all required tires.
(3) Tire Cost Source:	Purecell Tire Quote: June 2019
(4) Tire Wear Source:	Caterpillar Handbook, Ewdition 35; Ch 20

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Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Revegetation Materials

Seed Mixes

Seed Mix	Description		Cost/Acre
None			
Mix 1	Basins		$302.50
Mix 2	Low Hills		$332.75
Mix 3	Uplands		$363.00
Mix 4	Riparian or Custom		$393.25
User Mix 1	**Hermosa Project**		**$1,674.00**
User Mix 2			
User Mix 3			
User Mix 4			
	Cost/lb	**lbs/Acre**	**Cost/Acre**
User Mix 5 (from Seed Mix sheet)	$0.00	$25.97	$0.00

Notes: **User Mix 1: Seed mix price ($/acre) provided by Arizona Minerals Inc. based on historical price paid on site for seed mix.**

Mulch

Item	Cost/lb	lbs/Acre	Cost/Acre
None			
Straw Mulch	$0.17		
Hydro Mulch	$0.25		
Timber Mulch			

Notes: Granite Seed $500 per Ton in 50 lb. bag Wood (Hydro) Mulch (June 2019)

Amendments

Item	Cost/lb	lbs/Acre	Cost/Acre
None			
Organic Matter	$0.70		$0.00
Treated Sludge			
Chemical	$0.59	**165**	$97.35

Notes: Western Nevada Supply $29.34 per 50 lb. bag 15-15-15 (June 2018)

Assumed 165 lbs per acre for chemical amendments.

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Well Abandonment Materials

Description	Cost/50lb bag	Units	Cost/unit*
Cement	$7.57	cy	$36.05
Grout (Low Grade Bentonite)	$8.65	cy	$41.19
Inert Material/Cuttings		cy	
		cy	
		cy	

(1) Jentech Drilling Supply quote (June 2019) Type I,II Cement at $14.24 per 94 lb. bag
(2) Jentech Drillig Supply (June 2019) 3/8 in. Chunk Bentonite Hole Plug at $8.65 per 50lb. Bag (5.75 cf/bag at 43
* Assumes 1 bag mixes with water to make 0.21 y3 or 0.16 m3 of grout/cement slurry.

Monitoring Costs

Description	Units	Cost/unit
Monitor Well Pump	ea.	$2,650.80
Sampling Supplies	ea.	$6.19
Water Analysis (Profile I) (1)	ea.	$411.00
Leach Test (MWMP) w/ analysis	ea.	$483.40
ABA + S speciation	ea.	$150.00
WAD Cyanide in water	ea.	$56.00
Water Analysis (Profile II) (1)	ea.	$461.00
Arizona Minerals Inc	ea.	$631.90
	ea.	
	ea.	
	ea.	
	ea.	
	ea.	
	ea.	
	ea.	
	ea.	
	ea.	

(1) WET Lab, Reno, Nevada (June 2019)
Well pump and sample supply costs adjusted to 2019.

Fuel, Etc.

Description	Units	Cost/unit
Off-road Diesel - delivered (1)	$/gal	$2.630
Pickup Truck Mileage	$/mi	$0.580
Electical Power	$/kWh	$0.080

(1) Source: Oil Price information service, average annual cost including freight to Nevada (July 2019)
Source: Federal Government Vehichle Allowance Rate 2019
Source: NV Engergy (July 2019) $0.07918

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Revegetation Method				
Slopes				
Disturbance Type	**Seed Application Method**	**Labor** Cost/Acre	**Equipment** Cost/Acre	**Total** Cost/Acre
Waste Rock Dumps	**Hydroseeding**	$250.00	$125.00	$375.00
Heap Leach	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Tailings	**Hand Broadcast**	$140.00	$50.00	$190.00
Quarries & Borrow Pits	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Flat Areas and Undifferentiated				
Disturbance Type	**Seed Application Method**	**Labor** Cost/Acre	**Equipment** Cost/Acre	**Total** Cost/Acre
Exploration Trenches	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Exploration Roads	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Waste Rock Dumps	**Hydroseeding**	$250.00	$125.00	$375.00
Heap Leach	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Tailings	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Quarries & Borrow Pits	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Roads	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Pits	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Haul Material	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Foundations & Buildings	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Sediment & Drainge Control	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Process Ponds	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Landfills	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Yards, Etc.	**Mechanical Broadcast**	$100.00	$38.00	$138.00
Revegetation Maintenance	**Hydroseeding**	$250.00	$125.00	$375.00

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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Revegetation

	Means Number	Unit	Crew	Daily Output	Daily Output User	Materials	Labor	Equipment	Total	Notes
Seeding - Broadcast Hand (1)		acres					$140.00	$50.00	$190.00	
Seeding - Broadcast Mechanical (1)		acres					$100.00	$38.00	$138.00	
Seeding - Drill (1)		acres		365			$140.00	$100.00	$240.00	
Seeding - Hydroseeding (1)				365			$250.00	$125.00	$375.00	
Shrub Planting - bare root 6-10 in (150- 250mm) (2)	02910-400-0561	ea.	1 Clab	365					$0.00	
Tree Planting - bare root 11-16 in (270- 400mm) (3)	02910-400-0562	ea.	1 Clab	260					$0.00	
Cactus Planting (4)		ea.	1 Clab						$0.00	
NOTES:										
(1) Seeding Source:	Source: Kelley Erosion control (July 2019)									
(2) Shrub Source:										
(3) Tree Source:										
(4) Cactus Source:										

Building and Wall Demolition

Hourly productivity rates and crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data .
All equipment, labor and material unit costs are from Labor Costs, Equipment Costs and Material Costs spreadsheets

	Means Number	Unit	Crew	Daily Output	Daily Output User	Labor	Equipment	Premium	Total	Notes
Building Demolition										
Lg. steel	02220-110-0012	C.F.	B-8	21500		$0.21	$0.12		$0.33	
Lg. concrete	02220-110-0050	C.F.	B-8	15300		$0.29	$0.17		$0.46	
Lg. masonry	02220-110-0080	C.F.	B-8	20100		$0.22	$0.13		$0.35	
Lg. mixed	02220-110-0100	C.F.	B-8	20100		$0.22	$0.13		$0.35	
Sm. steel	02220-110-0500	C.F.	B-3	14800		$0.25	$0.13		$0.38	
Sm. concrete	02220-110-0600	C.F.	B-3	11300		$0.33	$0.17		$0.50	
Sm. masonry	02220-110-0650	C.F.	B-3	14800		$0.25	$0.13		$0.38	
Sm. wood	02220-110-0700	C.F.	B-3	14800		$0.25	$0.13		$0.38	
Wall Demolition										
Block 4 in (100 mm) thick	02220-130-2000	S.F.	1 Clab	180		$2.73	$0.00	20%	$3.28	
Block 6 in (150 mm) thick	02220-130-2040	S.F.	1 Clab	170		$2.89	$0.00	20%	$3.47	
Block 8 in (200 mm) thick	02220-130-2080	S.F.	1 Clab	150		$3.28	$0.00	20%	$3.94	
Block 12 in (300 mm) thick	02220-130-2100	S.F.	1 Clab	150		$3.28	$0.00	20%	$3.94	
Conc 6 in (150 mm) thick	02220-130-2400	S.F.	B-9	160		$22.97	$1.48	10%	$26.90	
Conc 8 in (200 mm) thick	02220-130-2420	S.F.	B-9	140		$26.25	$1.69	10%	$30.73	
Conc 10 in (250 mm) thick	02220-130-2440	S.F.	B-9	120		$30.63	$1.97	10%	$35.86	
Conc 12 in (300 mm) thick	02220-130-2500	S.F.	B-9	100		$36.75	$2.36	10%	$43.02	

Waste Disposal

Unit rates from Means Heavy Construction 2006 Edition by permission of R.S.Means/Reed Construction Data .

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment		Total	Notes
Rubbish Handling										
Dumpster delivery (average for all sizes)	02220-350-0910	ea.			$53.50				$53.50	
Haul (average for all sizes)	02220-350-0920	ea.			$167.00				$167.00	
Rent per month (average for all sizes)	02220-350-0940	ea.			$57.00				$57.00	
Disposal fee per ton (tonne) (average for all sizes)	02220-350-0950	ton			$62.50				$62.50	
NOTES:										
Dumpster Cost Source	R.S> Means Heavy Construction (2019 Q2)									
Dumpster Disposal Fee Source:	R.S> Means Heavy Construction (2019 Q2)									
Hazardous Material Handling - Solids (+ Liquids in drums)										
Pickup fees 55 gal (200 L). drums	02110-300-1100	ea.			$260.00				$260.00	
Bulk material (average)	02110-300-1220/1230	ton			$425.50				$425.50	
Transport - truck load (80 drums, 25 cy (m3), 18 tons)	02110-300-1260/1270	mile			$6.11				$6.11	
Dump site solid disposal fee	02110-300-6000/6020	ton			$298.50				$298.50	
NOTES:										
Solid Handling Cost Source	R.S> Means Heavy Construction (2019 Q2)									
Solid Disposal Fee Source:	2019 Q2 R.S. means Heavy Const. ave. 02 81									
Hazardous Material Handling - Liquids										
Vacuum Truck Pickup (2200 gal/8300 L)	02110-300-3110	hr.			$152.00				$152.00	
Vacuum Truck Pickup (5000 gal/19000 L)	02110-300-3120	hr.			$221.00				$221.00	
Dump site liquid disposal fee	02110-300-6000/6020	ton			$298.50				$298.50	
NOTES:										
Liquid Handling Cost Source	R.S> Means Heavy Construction (2019 Q2)									
Liquid Disposal Fee Source:	2019 Q2 R.S. means Heavy Const. ave. 02 81									
Hydrocarbon Contaminated Soils (HCS)										
Insitu Biotreatment	02115-200-2020/2021	C.Y.			$19.63				$19.63	
HCS disposal fee	02115-200-2050/2055	C.Y.			$288.50				$288.50	
NOTES:										
Insitu Treatement Cost Source	2019 Q2 R.S. means Heavy Const. ave. 02 65									
HCS Disposal Fee Source:	2019 Q2 R.S. means Heavy Const. ave. 02 65									

Concrete Structure Installation

Weekly dumpster rental rates from Means Heavy Construction 2005 Edition with permission by R.S.Means/Reed Construction Data .
Weekly dumpster rental rates include haul to off-site disposal site and disposal fees

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Reinforced Concrete Bulkheads and Shaft Covers										
Grade walls - 15 in (400mm) thick, 8 ft (2.5m) high	03310-240-4300	C.Y.	C-14D	80.02	$150.00	$186.92	$16.38		$353.30	includes reinforcing
Grade walls - 15 in (400mm) thick, 12 ft (3.7m) high	03310-240-4350	C.Y.	C-14D	26.2	$150.00	$570.88	$50.04		$770.92	includes reinforcing
Elevated conc, 1-way beam & slab - 15ft (4.6m) span	03310-240-2700	C.Y.	C-14B	20.59	$263.00	$740.34	$63.68		$1,067.02	includes reinforcing
Elevated conc, 1-way beam & slab - 25ft (7.5m) span	03310-240-2750	C.Y.	C-14B	28.36	$250.00	$537.50	$46.23		$833.73	includes reinforcing
Bat Gate/Foam Plug Installation										
Bat Gate (5)		ea.			$3,201.41					materials $/ea. Installed
Culvert Gate (5)		ea.			$6,402.82					materials $/ea. Installed
Adit Foam Plug (6)		ea./C.Y.			$320.14					materials $/cy placed
Production Opening Foam Plug (6)		ea./C.Y.			$320.14					materials $/cy placed
NOTES:										
(5) Bat Gate Source:	NV BLM, 2/2006: 8 hr + 1 hr mob/demob + 1 hr setup per gate (adjusted to 2019)									
(6) Foam Plug Source:	NV BLM, 2/2006: 8 hr + 1 hr mob/demob + 1 hr setup per afit; 16hrs per production opening (adjusted to 2019)									

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Closure Cost Estimate
Misc. Unit Costs

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Cost Estimate Type: Surety Cost Basis: Southern Nevada

Misc. Linear Projects

Hourly productivity rates and crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data .
All equipment, labor and material unit costs are from Labor Costs, Equipment Costs and Material Costs spreadsheets

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Fencing Installation										
Barbed 3-strand	02820-170-1650	L.F.	B-80A	760	$0.51	$1.94	$0.32		$2.77	
Barbed 4-strand	extrapolated	L.F.	B-80A	570	$0.68	$2.59	$0.42		$3.69	
Barbed 5-strand	02820-130-0920	L.F.	B-80A	456	$0.85	$3.23	$0.53		$4.61	
Chain link 8-10ft (2.5-3m) Install	02820-130-0920	L.F.	B-80C	180	$41.50	$8.19	$1.34		$51.03	
Wood stockade fence 6 ft (2 m) high - Install	02820-510-1240	L.F.	B-80C	150	$17.15	$9.83	$1.61		$28.59	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
Fencing Removal										
Barbed 3-strand Removal	02220-220-1600	L.F.	2 Clab	430		$2.29	$0.56		$2.85	
Barbed 4-strand Removal	extrapolated	L.F.	2 Clab	355		$2.77	$0.68		$3.45	
Barbed 5-strand Removal	02220-220-1650	L.F.	2 Clab	280		$3.51	$0.86		$4.37	
Chain link 8-10 ft (2.5-3 m) Removal	02220-220-1700	L.F.	B-6	445		$3.73	$0.96		$4.69	
Wood, all types 4-6 ft ("1.5-2 m) high - Removal	02220-220-1775	L.F.	2 Clab	430		$2.29	$0.56		$2.85	
	user	L.F.								
	user	L.F.							$0.00	
	user	L.F.							$0.00	
	user	L.F.							$0.00	
Culvert Removal										
12 in (300 mm) Diameter	02220-220-2900	L.F.	B-6	175		$9.50	$2.44		$11.94	
18 in (450 mm) Diameter	02220-220-2930	L.F.	B-6	150		$11.08	$2.84		$13.92	
24 in (600 mm) Diameter	02220-220-2960	L.F.	B-6	120		$13.85	$3.55		$17.40	
36 in (1m) Diameter	02220-220-3000	L.F.	B-6	90		$18.46	$4.74		$23.20	
Pipeline Removal										
0.75 in (20mm) - 4 in (100 mm) diameter	02220-381-1600	L.F.	B-20	700		$2.94	$0.35		$3.29	
6 in (150 mm) - 8 in (200 mm)	02220-381-1700	L.F.	B-20	500		$4.11	$0.48		$4.59	
10 in (250 mm) - 18 in (450 mm)	02220-381-1800	L.F.	B-20	300		$6.85	$0.81		$7.66	
20 in (500 mm) - 36 in (1 m)	02220-381-1900	L.F.	B-20	200		$10.28	$1.21		$11.49	
Pipe and Drainpipe Installation										
Water 4in (100mm) 40ft (12m) length, welded HDPE	02510-760-0100	L.F.	B-22A	400	$2.40	$7.09	$4.68		$14.17	
Water 6in (150mm) 40ft (12m) length, welded HDPE	02510-760-0200	L.F.	B-22A	380	$5.40	$7.47	$4.92		$17.79	
Water 12in (300mm) 40ft (12m) length, welded HDPE	02510-760-0500	L.F.	B-22A	260		$10.91	$7.19		$18.10	
Drain 4in (100mm) perforated PVC	02620-630-2100	L.F.	B-14	315	$1.57	$11.80	$1.60		$14.97	
Drain 6in (150mm) perforated PVC	02620-630-2110	L.F.	B-14	300	$3.46	$12.39	$1.68		$17.53	
Drain 4in (100mm) corrugated, perf or plain	02620-660-0040	L.F.	2 Clab	1200	$0.71	$0.82	$0.20		$1.73	
Drain 6in (150mm) corrugated., perf or plain	02620-660-0060	L.F.	2 Clab	900	$1.80	$1.09	$0.27		$3.16	
Drain Rock Preparation										
Crushing		C.Y.							$0.50	
Screening		C.Y.							$0.50	
TOTAL									$1.00	
Misc.										
Backhoe work	02210-700-0120	C.Y.	B-11M	28		$24.36	$9.39		$33.75	
Powerline and Transformer Removal										
Single Pole		mile							$44,494.00	
Double Pole		mile							$50,850.00	
Transformer (9)		ea.							$56,086.00	

NOTES:
(7) Single Pole Source: NV Energy estimate (2009) Adjusted to 2019
(8) Double Pole Source: NV Energy estimate (2009) Adjusted to 2020
(9) Transformer Source: NV Energy estimate (2009) Adjusted to 2021

Erosion and Sedimentation Control

Hourly productivity rates and crew composition from Means Heavy Construction 2005 Edition by permission of R.S.Means/Reed Construction Data .
All equipment, labor and material unit costs are from Labor Costs, Equipment Costs and Material Costs spreadsheets

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Rip-Rap & Rock Lining										
Rip-Rap 3/8 to 1/4 CY (m3) pieces, grouted	02370-450-0110	S.Y.	B-13	80	$25.50	$46.44	$8.81		$80.75	assumes on-site source of rip-rap
Rip-Rap 18 in (450 mm) min thick, no grout	02370-450-0200	S.Y.	B-13	53	$7.85	$70.10	$13.29		$91.24	assumes on-site source of rip-rap
Gabions, 6 in (150 mm) deep	02370-450-0400	S.Y.	B-13	200	$7.25	$18.58	$3.52		$29.35	assumes on-site source rock fill for gabions
Gabions, 9 in (250 mm) deep	02370-450-0500	S.Y.	B-13	163	$9.40	$22.79	$4.32		$36.51	assumes on-site source rock fill for gabions
Gabions, 12 in (300 mm) deep	02370-450-0200	S.Y.	B-13	153	$13.60	$24.28	$4.60		$42.48	assumes on-site source rock fill for gabions
Gabions, 18 in (450 mm) deep	02370-450-0200	S.Y.	B-13	102	$19.00	$36.43	$6.91		$62.34	assumes on-site source rock fill for gabions
Gabions, 36 in (1m) deep	02370-450-0200	S.Y.	B-13	60	$30.00	$61.93	$11.74		$103.67	assumes on-site source rock fill for gabions
HDEP Liner Installation										
Finish grading large area	2310-100-0100	S.F.	B-11L	18000		$0.07	$0.06		$0.13	
Compaction-riding, vibrating roller - 12in (300mm) lifts	2315-310-5100	C.Y.	B-10Y	2600		$0.45	$0.19		$0.64	
60 mil HDPE	2660-610-0010	S.F.	3 Skwk	1600	$0.53	$1.35	$0.46		$2.34	
80 mil HDPE	user	S.F.	3 Skwk	149		$14.51	$4.94		$19.45	
40 mil VLDPE	user	S.F.	3 Skwk	150		$14.42	$4.91		$19.33	
	user	S.F.	3 Skwk	149		$14.51	$4.94		$19.45	
	user	S.F.	3 Skwk	149		$14.51	$4.94		$19.45	

Construction Management Support

	Means Number	Unit	Crew	Daily Output	Materials	Labor	Equipment	Premium	Total	Notes
Office Trailer, Furnished, no hook-ups	0150-500-0250	mo.			$213.00				$213.00	
Toilet Portable, chemical	1590-400-6410	mo.			$215.80				$215.80	
TOTAL					$428.80				$428.80	

Pump and Casing Removal

Pump Type	Measurement	Unit				Labor	Equipment		Total	Notes
Pump Removal										
Submersible	ft to pump	L.F.				$6.56	$17.66		$24.22	
Line Shaft	ft to pump	L.F.				$6.56	$17.66		$24.22	

NOTES:
(10) Pump Removal Source: Boart Longyear Quote: June 2019

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Closure Cost Estimate
Seed Mixture

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Seed Mixture

Common Name	Scientific Name	Species Number of Seeds / lb	Species % in Mix	PLS/acre	Cost/Lb	Cost/Acre
Grasses						
Ephraim Crested Wheatgrass	*Agropyron Cristatum var. Ephraim*					
Thickspike Wheatgrass	*Agropyron dasystrachyum*	154,000	4.40	1.24		
Bluebunch Wheatgrass	*Agropyron spicatum*	117,000	23.42	8.65		
Great Basin Wildrye	*Elymus cinereus*	95,000	8.15	6.18		
Big Bluegrass	*Poa ampla*	917,000	13.11	0.62		
Indian Ricegrass	*Oryzopsis hymenoides*	188,000	5.38	1.24		
Sandberg Bluegrass	*Poa secunda*	925,000	13.23	0.62		
Forbs						
Blue Flax				0.62		
Small Burnet	*Sanguisorba minor*	55,000	1.57	1.24		
Forage Kochia	*Kochia prostrata var. Immigrant*	407,700	2.33	0.25		
Palmer Penstemon	*Penstemon palmeri*	610,000	3.49	0.25		
Shrubs						
Fourwing Saltbush	*Atriplex canescens*	52,000	5.95	1.85		
Antelope Bitterbrush	*Purshia tridentate*	15,000	0.43	2.47		
Winterfat	*Eurotia lanata*	111,000	1.59	0.62		
Wyoming Big Sagebrush	*Artemesia tridentata wyomingensis*	2,500,000	7.15	0.12		
Total				$25.97		$0.00

Source:

Notes:

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Closure Cost Estimate
User 1

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

2019 MOB/DEMOB using R.S. MEANS and SRCE equipment and DAVIS-BACON wages

Miles from Washoe County Courthouse to project, one way	
Miles from equipment rental yard to project, one way (9)	75
Hours travel time @ 55 MPH	**1.36**

Hermosa Lined TSF Design Amendment

Equipment	Mobilization $/hour (1)	$ Flat Rate load & unload (2)	$/hour Deadhead (empty return cost (3)	Disassembly and assembly (4)	Permit cost $ (5)	Pilot car costs	# of units	One Way Mob Cost	Total Mob and Demob Cost
Bulldozers									
D6R	$ 97	$ 97	$ 97	$ -	$ -	$ -		$ -	$ -
D7R	$ 126	$ 126	$ 126	$ -	$ 25	$ 128		$ -	$ -
D8R	$ 148	$ 148	$ 148	$ -	$ 25	$ 257	1	$ 834	$ 1,669
D9R	$ 148	$ 148	$ 148	$ -	$ 25	$ 257	1	$ 834	$ 1,669
D10R	$ 148	$ 148	$ 148	$ 63,720	$ 25	$ 385		$ -	$ -
D11R (two transports) (7)	$ 148	$ 148	$ 148	$ 135,720	$ 25	$ 257		$ -	$ -
Motor Graders									
14G/H	$ 97	$ 97	$ 97	$ -	$ -	$ -	14	$ 362	$ 10,144
16G/H	$ 126	$ 126	$ 126	$ -	$ 25	$ 128		$ -	$ -
Track Excavators									
320C	$ 126	$ 126	$ 126	$ -	$ -	$ -		$ -	$ -
325C	$ 126	$ 126	$ 126	$ -	$ -	$ -		$ -	$ -
345B	$ 148	$ 148	$ 148	$ -	$ 25	$ 257	1	$ 834	$ 1,669
385BL	$ 148	$ 148	$ 148	$ 44,880	$ 25	$ 257		$ -	$ -
Scrapers									
631G	$ 148	$ 148	$ 148	$ -	$ 25	$ 257		$ -	$ -
637G PP	$ 148	$ 148	$ 148	$ -	$ 25	$ 257		$ -	$ -
Wheeled Loaders									
928G	$ 97	$ 97	$ 97	$ -	$ -	$ -		$ -	$ -
966G	$ 97	$ 97	$ 97	$ -	$ -	$ -	1	$ 362	$ 725
972G	$ 126	$ 126	$ 126	$ -	$ -	$ -		$ -	$ -
988G	$ 126	$ 126	$ 126	$ -	$ 25	$ 128	2	$ 1,249	$ 2,498
992G (two transports) (7)	$ 148	$ 148	$ 148	$ 74,160	$ 25	$ 257		$ -	$ -
Hydraulic Hammers									
H-120 (fits 325) no charge, mobilize with machine	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -
H-160 (fits 345) no charge, mobilize with machine	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -
H-180 (fits 365/385) no charge, mobilize with machine	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -
Other Equipment									
420D 4WD Backhoe	$ 97	$ 97	$ 97	$ -	$ -	$ -		$ -	$ -
CS563E Vibratory Roller	$ 97	$ 97	$ 97	$ -	$ -	$ -	1	$ 362	$ 725
Light Truck - 1.5 Ton	$ 67	$ 67	$ -	$ -	$ -	$ -		$ -	$ -
Supervisor's Truck	$ 58	$ 58	$ -	$ -	$ -	$ -	1	$ 137	$ 273
Air Compressor + tools	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
Welding Equipment	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
Heavy Duty Drill Rig	$ 397	$ 397	$ -	$ -	$ -	$ -	1	$ 938	$ 1,877
Pump (plugging) Drill Rig	$ 397	$ 397	$ -	$ -	$ -	$ -		$ -	$ -
Concrete Pump	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
Gas Engine Vibrator	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
Generator 5KW	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
HDEP Welder (pipe or liner)	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
5 Ton Crane Truck	$ 107	$ 107	$ -	$ -	$ -	$ -		$ -	$ -
25 Ton Crane	$ 146	$ 146	$ -	$ -	$ -	$ -	2	$ 690	$ 1,381
Trucks									
725	$ 97	$ 97	$ 97	$ -	$ -	$ -		$ -	$ -
740	$ 126	$ 126	$ 126	$ -	$ 25	$ 128	4	$ 2,498	$ 4,996
769D	$ 126	$ 126	$ 126	$ -	$ 25	$ 257		$ -	$ -
777D (two transports) (8)	$ 148	$ 148	$ 148	$ 71,280	$ 25	$ 385		$ -	$ -
613E (5,000 gal) Water Wagon	$ 148	$ 148	$ 148	$ -	$ -	$ -		$ -	$ -
621E (8,000 gal) Water Wagon	$ 148	$ 148	$ 148	$ -	$ 25	$ 257	14	$ 834	$ 23,362
Dump Truck (10-12 yd3)	$ 111	$ 111	$ 111	$ -	$ -	$ -		$ -	$ -
Miscellaneous									
Equipment for dry hole abandonment (420D 4WD Backhoe)	$ 97	$ 97	$ 97	$ -	$ -	$ -		$ -	$ -
Pilot car (Light Truck)	$ 58	$ 58	$ 58	$ -	$ -	$ -		$ -	$ -
Truck Tractor + Lowbed Trailer 75 ton	$ 148	$ 148	$ 148	$ -	$ -	$ -		$ -	$ -
Truck Tractor + Flatbed Trailer 40 ton	$ 126	$ 126	$ 126	$ -	$ -	$ -		$ -	$ -
Light Truck + Flatbed Trailer 25 ton	$ 74	$ 74	$ 74	$ -	$ -	$ -		$ -	$ -
							43		**$ 50,986**

Footnotes and explanations of assumptions
(1) The sum of the cost of equipment from either the SRCE or RSM equipment tab plus Davis-Bacon labor tab
(2) Assumes minimum of 30 minutes load and secure and 30 minutes unsecure and unload machine.
(3) No "Deadhead" (empty) charge for Mob up to 50 miles. More than 50 miles the cost of deadhead same rate as loaded miles.
(4) Only large equipment requires disassembly for transport. Includes cost of mechanic + mechanic's truck + crane operator + crane.
(5) Nevada Dept. of Transportation overdimensional permits are $25 per trip or $60 per year.
(6) Sum of mobilization plus all ancillary costs for one way loaded and return empty.
(7) Two transports are required but the second transport does not need pilot cars or permits or a heavy duty trailer.
(8) Two transports required with both requiring full complement of pilot cars and permits.
(9) For large mining operations, mobilization may be required from more than one location. For example, the Elko yard may not have four 631 scrapers.
Additional equipment may need to mobilize from Reno, Las Vegas, or Salt Lake City. Input the further distance here.
(10) Pilot Car costs based on SRCE light truck costs and Davis-Bacon wages
(11) SRCE costs based on July 2019 vendor quotes.
(12) RS Means costs based on R.S. Means Heavy Construction Cost Data, 2019, Q2
(13) Davis Bacon wages based on 2019 determination.

Closure Cost Estimate
User 2

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

SRCE Tab	Dozers		Track Excavators	Trucks	Loaders		Water Wagons	Motor Graders	Largest No. of trucks
	D8R	D9R	345B	740	966G	988G	621E	14G	
Exploration									
Expl. Roads & Pads									
Waste Rock Dumps	172	11		516		172			3
Heap Leach									
Tailings									
Roads		3							
Pits									
Quarries & Borrow Pits									
Underdground Openings									
Haul Material[2]	171			585		171			4
Foundations & Buildings									
Other Demo & Equip Removal									
Sediment & Drainage Control			5						
Process Ponds	124			372		124			3
E-Cell Cost Estimator									
Landfills									
Yards, Etc.		2							
Waste Disposal									
Well Abandonment[3]									
Misc. Cost									
Monitoring									
Constr. Mgmt[1]							960	960	
User 5			74	223	88	250			3
Hours	467	16	79	1,696	88	717	960	960	
Number of units	1	1	1	4	1	2	1	1	
Weeks for specified fleets	12	1	2	11	3	9	24	24	
Months for specified fleets	3	0	0	3	1	2	6	6	

1. Large Water Truck (621E 8,000gal) and 14G/H required for road maintenance during construction
2. Vibratory Roller (CS563E) included for Haul Material reclamation construction
3. Heavy duty drill rig included for Well Abandonment
4. Tabs that are shaded gray do not have equipment fleet costs associated with them.

Closure Cost Estimate
User 3

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Quote from Arizona Revegetation & Monitoring Co. (2/27/2020)

Tackifier	28	bags	$47.00	$/bag	$1,316.00	
Arizona Minerals Inc Seed Mix	240	lbs	$17.50	$/lb	$4,200.00	
				Subtotal	$5,516.00	
Seed Mix/Acre*	68.3 lb/acre			Tax	364.06	
				Total	$5,880.06	
				Coverage Area*	3.5	acre
				Cost/Acre*	$1,674	$/acre

*Cost/acre" was provided by AMI "seed mix/acre" and "coverage area" are calculated values

Arizona Revegetation & Monitoring Co.
217 Lyle Canyon Rd, Elgin Az. 85611
520-455-5780
jim@azreveg.com

PO#1305

Proposal – Arizona Minerals – Hydroseeding Supplies - 2/27/20

28 Bags Tackifier	@ $47.00	=	1,316.00
240 lbs. Az Mineral Seed Mix	@ $17.50	=	4,200.00
			5,516.00
Tax			364.06
Total			$ 5,880.06

Total $5,880.06

Thank You

Jim Koweek

2/27/20

Proposal good for 15 days

Closure Cost Estimate
User 4

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

TURNER LABORATORIES INC.

07/02/2020

QUOTATION for ANALYTICAL SERVICES

Company: Clear Creek Associates
Contact: Alison Jones
Address: 221 N. Court Ave., Suite 101
Company: Tucson, AZ, 85701
Phone: (520) 622-3222 Fax: (520) 622-4040
Quote ID:
Project: POC Monitoring

Submitted By: Elizabeth Kasik

Expires: 07/02/2021

Test ID	Test	Remarks	# Sample	Unit Price	Test Total
Non-Potable Water					
Alkalinity	SM2320B		1	$17.00	$17.00
As by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Ba by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Be by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Cd by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Conductivity	SM2510 B		1	$12.75	$12.75
Cr by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Cu by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Cyanide	SM4500-CN B		1	$29.75	$29.75
Fe by ICP, Total	E200.7 (4.4)		1	$6.80	$6.80
Fluoride by Ion Chromatography	E300.0 (2.1)		1	$12.75	$12.75
IC Prep	Prep		1	$6.80	$6.80
Mercury Prep	Prep		1	$9.35	$9.35
Mercury, Total	E245.1		1	$25.50	$25.50
Metals Prep ICP	Prep		1	$9.35	$9.35
Metals Prep ICP/MS	Prep		1	$9.35	$9.35
Mn by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Ni by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Nitrate by Ion Chromatography	E300.0 (2.1)		1	$12.75	$12.75
Nitrite by Ion Chromatography	E300.0 (2.1)		1	$12.75	$12.75
Pb by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
pH	SM4500-H+ B		1	$12.75	$12.75
Radiochemistry, Gross Alpha	ERAD		1	$85.00	$85.00
Radiochemistry, Radium 226/228	ERAD		1	$195.00	$195.00
Sb by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Se by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Sulfate by Ion Chromatography	E300.0 (2.1)		1	$12.75	$12.75
Tl by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05
Total Dissolved Solids	SM2540 C		1	$17.85	$17.85
Zn by ICP/MS	E200.8 (5.4)		1	$11.05	$11.05

Total: **$631.90**

Comments:

Approved by: ______________________ Date: _____________
Alison Jones

TURNER LABORATORIES INC.

07/02/2020

QUOTATION for ANALYTICAL SERVICES

Analysis Details

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	BlankSpike/LCS %R	BlankSpike/LCS RPD
Radiochemistry in Non-Potable Water (ERAD)								
Gross alpha in Non-Potable Water (ERAD)								
Metals Prep ICP/MS in Non-Potable Water (Prep)								
Metals Prep ICP in Non-Potable Water (Prep)								
Mercury Prep in Non-Potable Water (Prep)								
IC Prep in Non-Potable Water (Prep)								
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Zinc	0.0023	0.040 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Thallium	0.000023	0.00050 mg/L			70 - 130	20	85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Selenium	0.00025	0.0025 mg/L			70 - 130	20	85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Antimony	0.000039	0.00050 mg/L			70 - 130	20	85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Lead	0.000057	0.00050 mg/L			70 - 130	20	85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Nickel	0.000015	0.00050 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Manganese	0.000038	0.00025 mg/L			70 - 130		85 - 115	20
CVAA Total Mercury in Non-Potable Water (E245.1)								
Mercury	0.000041	0.0010 mg/L			70 - 130	20	85 - 115	20
ICP Total Metals in Non-Potable Water (E200.7 (4.4))								
Iron	0.0031	0.30 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Copper	0.00015	0.00050 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Chromium	0.000023	0.00050 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Cadmium	0.000050	0.00025 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Beryllium	0.000013	0.00025 mg/L			70 - 130		85 - 115	20

Approved by: ____________________ Date: ____________
Alison Jones

Closure Cost Estimate
User 4

TURNER LABORATORIES INC.

07/02/2020

QUOTATION for ANALYTICAL SERVICES

Analysis Details

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	BlankSpike/LCS %R	BlankSpike/LCS RPD
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Barium	0.000029	0.00050 mg/L			70 - 130		85 - 115	20
ICP/MS Total Metals in Non-Potable Water (E200.8 (5.4))								
Arsenic	0.00010	0.00050 mg/L			70 - 130	20	85 - 115	20
Total Dissolved Solids (Residue, Filterable) in Non-Potable Water (SM25								
Total Dissolved Solids (Residue, Filterab	20	20 mg/L		5				
pH in Non-Potable Water (SM4500-H+ B)								
pH (pH Units)		-						
Temperature (°C)		-						
Cyanide in Non-Potable Water (SM4500-CN BE)								
Cyanide	0.036	0.10 mg/L			80 - 120	15	85 - 115	15
Specific Conductance in Non-Potable Water (SM2510 B)								
Conductivity		0.10 µmhos/cm		10				
Alkalinity in Non-Potable Water (SM2320B)								
Alkalinity, Bicarbonate (As CaCO3)	2.0	2.0 mg/L				10		10
Alkalinity, Carbonate (As CaCO3)	2.0	2.0 mg/L						
Alkalinity, Hydroxide (As CaCO3)	2.0	2.0 mg/L						
Alkalinity, Total (As CaCO3)	2.0	2.0 mg/L			70 - 130	10	90 - 110	10
Alkalinity, Phenolphthalein (As CaCO3)	2.0	2.0 mg/L						
Anions by Ion Chromatography in Non-Potable Water (E300.0 (2.1))								
Sulfate	1.5	5.0 mg/L			80 - 120	10	90 - 110	10
Anions by Ion Chromatography in Non-Potable Water (E300.0 (2.1))								
Nitrogen, Nitrite (As N)	0.018	0.10 mg/L			80 - 120	10	90 - 110	10
Anions by Ion Chromatography in Non-Potable Water (E300.0 (2.1))								
Nitrogen, Nitrate (As N)	0.21	0.50 mg/L			80 - 120	10	90 - 110	10
Anions by Ion Chromatography in Non-Potable Water (E300.0 (2.1))								
Fluoride	0.17	0.50 mg/L			80 - 120	10	90 - 110	10

Approved by: ____________________ Date: ____________
Alison Jones

Closure Cost Estimate
User 5

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Riprap - Process and Place Cost Summary

Riprap - Supply
Raw material produced from existing stockpiles

Quantity	1	cy
Allowance for wastage	15%	
Unit quantity with allowance	1.15	cy
Quarried Cost per cy	$ -	Raw material produced from existing stockpiles

Riprap- Process

Bucket Size	6.5	cy
Cycle time	1	min
Hourly Production	390	cy/hr
Machine availability	1.000	
Job efficiency	0.833	
Operator skill	0.850	
Wastage allowance	0.850	
Corrected Hourly Production	234.8	cy/hr

Riprap Size	Usable Percentage	Assumed Production (cy/hr)	Quantity Produced (cy)	Production Fleet Hours (hr)
D_{50} = 3"	40%	93.93	2200.00	23.42
D_{50} = 6"	30%	70.44	940.00	13.34
D_{50} = 12"	20%	46.96	2390.00	50.89
			Total	87.66

Equipment	Equipment Rate	Quantity	Usage	Total Cost/hr
988G	$ 212.52	2	100%	$ 425.04
Bar Screen	$ 25.00	2	100%	$ 50.00
966G	$ 76.08	1	100%	$ 76.08
Supervisors Truck	$ 19.09	1	25%	$ 4.77
			Total Hourly Cost	$ 555.89
			Unit Production Cost D_{50} = 3"	$ 5.92
			Unit Production Cost D_{50} = 6"	$ 7.89
			Unit Production Cost D_{50} = 12"	$ 11.84

Labor	Labor Rate	Quantity	Usage	Total Cost/hr
988G Operator	$ 85.03	2	100%	$ 170.06
966G Operator	$ 84.88	1	100%	$ 84.88
General Laborer	$ 61.42	2	100%	$ 122.84
Foreman	$ 133.88	1	25%	$ 33.47
			Total Hourly Cost	$ 411.25
			Unit Production Cost D_{50} = 3"	$ 4.38
			Unit Production Cost D_{50} = 6"	$ 5.84
			Unit Production Cost D_{50} = 12"	$ 8.76

Riprap - Placement

Riprap Size	Assumed Placement (cy/hr)	Quantity Placed (cy)	Placment Fleet Hours (hr)
D_{50} = 3"	80.00	2200.00	27.50
D_{50} = 6"	75.00	940.00	12.53
D_{50} = 12"	70.00	2390.00	34.14
		Total	74.18

Equipment	Equipment Rate	Quantity	Usage	Total Cost/hr
988G	$ 212.52	1	100%	$ 212.52
345B	$ 131.05	1	100%	$ 131.05
740	$ 146.75	3	100%	$ 440.25
14G	$ 129.54	1	15%	$ 19.43
621E Water Wagon	$ 111.33	1	15%	$ 16.70
Supervisors Truck	$ 19.09	1	50%	$ 9.55
			Total Hourly Cost	$ 829.50
			Unit Placement Cost D_{50} = 3"	$ 10.37
			Unit Placement Cost D_{50} = 6"	$ 11.06
			Unit Placement Cost D_{50} = 12"	$ 11.85

Labor	Labor Rate	Quantity	Usage	Total Cost/hr
988G Operator	$ 85.03	1	100%	$ 85.03
345B Operator	$ 85.25	1	100%	$ 85.25
740 Driver	$ 63.61	3	100%	$ 190.83
14G Operator	$ 85.03	1	15%	$ 12.75
621E Water Wagon Driver	$ 63.61	1	15%	$ 9.54
Laborer	$ 61.42	4	100%	$ 245.68
Foreman	$ 133.88	1	50%	$ 66.94
Survey Crew	$ 190.00	1	15%	$ 28.50
			Total Hourly Cost	$ 724.53
			Unit Placement Cost D_{50} = 3"	$ 9.06
			Unit Placement Cost D_{50} = 6"	$ 9.66
			Unit Placement Cost D_{50} = 12"	$ 10.35

Process and Placement Cost	Labor Cost - Process	Labor Cost - Placement	Equipment Cost - Process	Equipment Cost - Placement	Total Labor Cost	Total Equipment Cost
Unit Cost D_{50} = 3"	$ 4.38	$ 9.06	$ 5.92	$ 10.37	$ 13.44	$ 16.29
Unit Cost D_{50} = 6"	$ 5.84	$ 9.66	$ 7.89	$ 11.06	$ 15.50	$ 18.95
Unit Cost D_{50} = 12"	$ 8.76	$ 10.35	$ 11.84	$ 11.85	$ 19.11	$ 23.69

	Labor Cost	Equipment Cost	Material Cost	Total Cost per cy
Total Cost D_{50} = 3"	$ 13.44	$ 16.29	$ -	$ 29.72
Total Cost D_{50} = 6"	$ 15.50	$ 18.95	$ -	$ 34.45
Total Cost D_{50} = 12"	$ 19.11	$ 23.69	$ -	$ 42.79

Notes
(1) Assume raw material produced from existing stockpiles

Closure Cost Estimate
User 6

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety **Cost Basis: Southern Nevada**

Culvert Length	90	ft
Number of culverts	2	
42" diameter Cpe culvert	180	ft
Pipe Bedding Volume		
Cross section area	20.8	sf
Pipe bedding per linear foot of culvert	0.77	cy/lf
Pipe Backfill Volume		
Cross section area	69.1	sf
Pipe backfill per linear foot of culvert	2.56	cy/lf
Random Fill Volume		
Cross section area	44.7	sf
Random fill per linear foot of culvert	1.66	cy/lf
Excavation Volume		
Cross section area	153.8	sf
Excavated volume per linear foot of culvert	5.70	cy/lf

	Quantity	Material Cost	Equip Cost	Labor Cost	Total Cost
	Unit/ft	$/ft	$/ft	$/ft	$/ft
42 inch CPe Culvert	2.00	$ 115.36	$ 20.36	$ 24.44	$ 160.16
Pipe Bedding	0.77	$ 30.74	$ 1.54	$ 1.54	$ 33.82
Pipe Backfill	2.56	$ -	$ 10.41	$ 9.02	$ 19.42
Random Fill	1.66	$ -	$ 5.91	$ 4.17	$ 10.08
Excavation	5.70	$ -	$ 2.85	$ 2.32	$ 5.16
Total		**$ 146.10**	**$ 41.05**	**$ 41.48**	**$ 228.64**

Unit Rate - 42 inch CPe Culvert

42 inch CPe - Supply

Item	Unit	Price/Unit	Freight/Unit	Tax/Unit	Total Price / Unit
42 inch CPE culvert	ft	54.11	FOB	3.57	57.68

42 inch CPe - Install

Installation Rate **60.00 ft/hr**
Installation Fleet Hours **3.00 hr**

Equipment	Equip Rate	Operator	Quantity	Usage	Equip Cost/Hr	Labor Cost/Hr	Total Cost/Hr
20 Ton Crane	$ 88.07	$ 84.88	2.0	100%	$ 176.14	$ 169.76	$ 345.90
988G	$ 212.52	$ 84.88	2.0	100%	$ 425.04	$ 169.76	$ 594.80
General Laborer		$ 61.42	3.0	100%	$ -	$ 184.26	$ 184.26
Skilled Laborer		$ 61.68	2.0	100%	$ -	$ 123.36	$ 123.36
Foreman		$ 133.88	1.0	50%	$ -	$ 66.94	$ 66.94
Supervisor's Truck	$ 19.09		1.0	50%	$ 9.55	$ -	$ 9.55
Survey Crew		$ 190.00	1.0	10%	$ -	$ 19.00	$ 19.00
						Material Unit Cost ($/ft)	**$ 57.68**
						Labor Unit Cost ($/ft)	**$ 12.22**
						Equipment/Operating Unit Cost ($/ft)	**$ 10.18**
						Total Capital Cost ($/ft)	**$ 80.08**

Unit Rate - Pipe Bedding

Import and Place

Supply

Pipe Bedding Material	24.00 $/ton	Cost Info received from AMI 6/9/20
Contractor OH&P	0.00 $/ton	Accounted for in "cost summary"
	24.00 $/ton	
Allowance for overbuild and wastage of finish product	10%	
Conversion ton to cubic yard	1.50 t/cy	
Subtotal Supply	40.00 $/cy	
Escalation	0.00 $/cy	
Total Supply	**40.00 $/cy**	

Placement

345 Excavator Bucket Capacity	3.0	cy
Cycle Time (23 sec)	156.5	cycles/hour
Uncorrected Productivity	469.6	cy/hr
Machine Availability	0.90	
Job Efficiency	0.83	
Operator Experience Avg	0.85	
Slope	1.00	
Material Weight	0.80	
Corrected Productivity (cy/hr)	**239.5**	**cy/hr**
Total Fleet Hours	**0.29**	**hr**

Equipment	Equip Rate	Operator	Quantity	Usage	Equip Cost/Hr	Labor Cost/Hr	Total Cost/Hr
345B	$ 131.05	$ 85.25	1.0	100%	$ 131.05	$ 85.25	$ 216.30
345B Excavator w/ Plate Compactor Attachment	$ 166.05	$ 85.25	1.0	100%	$ 166.05	$ 85.25	$ 251.30
621 E Water Wagon	$ 111.33	$ 63.61	1.0	100%	$ 111.33	$ 63.61	$ 174.94
Skid steer (Operated By Laborer)	$ 30.25		2.0	100%	$ 60.50	$ -	$ 60.50
General Laborer		$ 61.42	2.0	100%	$ -	$ 122.84	$ 122.84
Foreman		$ 133.88	1.0	50%	$ -	$ 66.94	$ 66.94
Supervisor's Truck	$ 19.09		1.0	50%	$ 9.55	$ -	$ 9.55
Survey Crew		$ 190.00	1.0	30%	$ -	$ 57.00	$ 57.00
						Material Unit Cost ($/cy)	**$ 40.00**
						Labor Unit Cost ($/cy)	**$ 2.01**
						Equipment/Operating Unit Cost ($/cy)	**$ 2.00**
						Total Capital Cost ($/cy)	**$ 44.01**

Closure Cost Estimate
User 6

Unit Rate - Pipe Backfill

Process and Place

Process

Material removed from trench stockpiled near excavation for pipe backfill placement

Placement

Bucket Size	4.5	cy
Cycle time	55	sec
Loader Productivity	291.3	cy/hr
Machine Availability	0.90	
Job Efficiency	0.83	
Operator Experience	0.85	
Material Weight	0.80	
Corrected Productivity	148.5	cy/hr
Total Fleet Hours	**1.55**	**hr**

Equipment	Equip Rate	Operator	Quantity	Usage	Equip Cost/Hr	Labor Cost/Hr	Total Cost/Hr
988G	$ 212.52	$ 85.03	2	100%	$ 425.04	$ 170.06	$ 595.10
Bar Screen	$ 20.00		1	100%	$ 20.00	$ -	$ 20.00
621E (8,000 gal) Water Wagon	$ 111.33	$ 63.61	1	100%	$ 111.33	$ 63.61	$ 174.94
Walk Behind Plate Compactor	$ 15.00		1	50%	$ 7.50	$ -	$ 7.50
CS533E Vibratory Roller	$ 60.74	$ 85.25	1	50%	$ 30.37	$ 42.63	$ 73.00
Supervisor's Truck	$ 19.09		1	50%	$ 9.55	$ -	$ 9.55
General Laborer		$ 61.42	2	100%	$ -	$ 122.84	$ 122.84
Foreman		$ 133.88	1	50%	$ -	$ 66.94	$ 66.94
Survey Crew		$ 190.00	1	30%	$ -	$ 57.00	$ 57.00
						Material Unit Cost ($/cy)	$ -
						Labor Unit Cost ($/cy)	$ 3.52
						Equipment Unit Cost ($/cy)	$ 4.06
						Total Captial Cost ($/cy)	$ 7.59

Unit Rate - Random Fill

Load, Haul, Stockpile, and Place

Average one way haul distance	4000	ft
Haul speed limit	25	mph

Load

Bucket Capacity	6	cy
Bucket fill factor	0.9	
Corrected bucket payload	5.4	cy
Cycle time	0.72	min
First Dump	0.1	min
Truck Manuever Time	0.45	min
Truck capacity	32.7	cy
Dumps per truck	6	
Truck payload	32.4	cy
Time to load truck	4.15	min
Loader Uncorrected Production	468.43	cy/hr
Job Efficiency	0.83	
Operator Skill	0.85	
Machine Availability	0.9	
Loader Corrected Production	298.63	cy/hr
Trucks Loaded/hour	9.22	

Haul

Truck Waiting Time	1	min
Truck travel time loaded	1.14	min
Dump time	1	min
Total Truck Cycle Time	8.42	min
Trips/Hour	5.94	min
Number of Trucks	2	
Total Fleet Hours	**0.50**	**hr**

Equipment	Equip Rate	Operator	Quantity	Usage	Equip Cost/hr	Labor Cost/hr	Total Cost/hr
D8R	$ 178.19	$ 84.88	1	100%	$ 178.19	$ 84.88	$ 263.07
345B	$ 131.05	$ 85.25	1	100%	$ 131.05	$ 85.25	$ 216.30
740	$ 146.75	$ 63.61	3	100%	$ 440.25	$ 190.83	$ 631.08
621E (8,000 gal) Water Wagon	$ 111.33	$ 63.61	1	100%	$ 111.33	$ 63.61	$ 174.94
14G/H	$ 129.54	$ 85.03	1	100%	$ 129.54	$ 85.03	$ 214.57
CS533E Vibratory Roller	$ 60.74	$ 85.25	1	100%	$ 60.74	$ 85.25	$ 145.99
Supervisor's Truck	$ 19.09		1	75%	$ 14.32	$ -	$ 14.32
Foreman		$ 133.88	1	75%	$ -	$ 100.41	$ 100.41
Survey Crew		$ 190.00	1	30%	$ -	$ 57.00	$ 57.00
						Material Unit Cost ($/cy)	$ -
						Labor Unit Cost ($/cy)	$ 2.52
						Equipment Unit Cost ($/cy)	$ 3.57
						Total Captial Cost ($/cy)	$ 6.09

Closure Cost Estimate
User 6

Unit Rate - Excavation

Excavate and Stockpile

Excavation

Bucket size	3	cy
Cycle time	23	sec
Uncorrected Productivity	469.57	cy/hr
Job Efficiency	0.83	
Operator Experience	0.85	
Material Weight	0.80	
Corrected Productivity	266.09	cy/hr
Total Fleet Hours	**1.93**	**hr**

Equipment	Equip Rate	Operator	Quantity	Usage	Equip Cost/hr	Labor Cost/hr	Total Cost/hr
345B	$ 131.05	$ 85.25	1	100%	$ 131.05	$ 85.25	$ 216.30
Supervisor's Truck	$ 19.09	$ -	1	10%	$ 1.91	$ -	$ 1.91
Foreman	$ -	$ 133.88	1	10%	$ -	$ 13.39	$ 13.39
Survey Crew	$ -	$ 190.00	1	5%	$ -	$ 9.50	$ 9.50
						Material Unit Cost ($/cy)	$ -
						Labor Unit Cost ($/cy)	$ 0.41
						Equipment Unit Cost ($/cy)	$ 0.50
						Total Captial Cost ($/cy)	$ 0.91

SWI

SOUTHWEST IRRIGATION, LLC
401 East Maley
Willcox, AZ 85643

Estimate

Date	Estimate #
7/27/2020	7284

Name / Address
NEWFIELDS MINING DESIGN AND CONSTRUCTION

Project

Item	Description	Qty	U/M	Rate	Total
426250020IBHA	42" WT PIPE LEAD TIME: PIPE IS CURRENTLY IN STOCK - THREE DAYS TO LOAD AND DELIVER	194		54.11	10,497.34T
	FREIGHT INCLUDED				

Subtotal	$10,497.34
Sales Tax (0.0%)	$0.00
Total	$10,497.34

Closure Cost Estimate
User 7

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Geotextile-Supply and Install Cost Summary

Geotextile - Supply	Supply ($/sf)	Freight ($/sf)	Tax	Total Delivered Cost ($/sf)
10 oz/yd non-woven geotextile	$ 0.115	$ 0.013	6.6%	**$ 0.14**

Geotextile - Install

Description	Roll Width (ft)	Roll Length (ft)	Roll Area (sf)	Effective Roll Area[1] (sf)	Ballasting per sf	Ballast Cost[2] per sf	Geotextile Placement (sf/hr)
10 oz/yd[2] Non Woven Geotextile	15	525	7875	7080	0.0014	$ 0.01	2000

Equipment Rates	Equipment Rate per hr	Quanity	Usage	Cost/hr
Flat Bed Truck	$ 39.79	1	25%	$ 9.95
Forklift with Spreader Bar	$ 35.00	1	25%	$ 8.75
Van	$ 19.09	1	100%	$ 19.09
			Total Equipment Cost/hr	$ 37.79
			Total Equipment Cost/sf	$ 0.02

Labor Rates	Labor Rate per hr	Quantity	Usage	Cost/hr
General Laborer	$ 61.42	4	100%	$ 245.68
Foreman	$ 133.88	1	20%	$ 26.78
			Total Labor Cost/hr	$ 272.46
			Total Labor Cost/sf	$ 0.14

Total Cost	Labor Cost	Equipment Cost	Material Cost	Total Cost
Geotextile	$ 0.14	$ 0.02	$ 0.14	$ 0.29

Notes
(1) 14.5' width with overlap and 7% allowance for another trench, end overlap and wastage
(2) $5.00 per sandbag and 10 sandbags per roll, ballast cost included in Total Labor Cost/sf

agru america

Quote:	QT000014490
Date:	7/21/2020
Exp Date:	8/20/2020
Shipping Method:	DELIVERY
Payment Terms:	NET 60
Incoterms:	PPA

Customer:
Arizona Minerals Inc.
2210 E. Fort Lowell Road
Tucson
AZ, 85719
United States
(520) 848-1338

Project:

Location:	AZ
Application:	Mining
Bid Date:	7/21/2020
Sales Person:	Nick Rauh
Phone:	(775) 232-4128

Bill To:
Arizona Minerals Inc.
2210 E. Fort Lowell Road
Tucson
AZ, 85719
United States
(520) 848-1338

Ship To:
NewFields Budget
Hermosa Mine
749 Harshaw Road (Minesite)
24 HR Precall & PPE Required
Harshaw, AZ 85724

Whse	Product	Dimensions	Roll Qty	Qty	UofM	Warranty	ShipVia	Rolls Per Truck	Unit Price	Ext Price
FN	FT-GT15-10.0-BK-PP-180-U Agrutex 101,180"	15x525	52	409500.00	SF	Agru Std.	FB	45.0/1.2	$0.11500	$47,092.50
FN	S-FREIGHTTEXFB Freight Textile Flatbed		0	2.00	EA			0.0/0.0	$2,600.0000 0	$5,200.00

Subtotal	$47,092.50
Freight	$5,200.00
Total	$52,292.50

Sales Tax is not included

Exceptions/Clarifications and Special Requirements:
Comments:
Unless otherwise specified, Agru America standard material specification values and testing will apply for all purposes to this quotation and Customer agrees that Agru America standard values will be acceptable according to this quotation.
Material prices are valid for 30 days unless otherwise specified in upper section of quote (Exp. date). Agru America's "Standard Product Warranty" shall apply to this quotation. Unless otherwise noted with the quote.
Agru America's General Terms and Conditions shall apply to this quotation.
If the Product quantity changes from the square footage / square meter set forth in this quotation, a revised quotation must be issued.
This is a fixed price quotation, unless otherwise stated. Invoicing will be on a per truckload basis.
Shipping dates are estimates only and Agru America will not be held liable for any delays due to shipping.
Any costs associated with third party testing will be the responsibility of Customer.
If there is an increase in raw materials or transportation costs prior to completion of the order, the additional cost will be borne by Customer and reflected in a Revised Order Acknowledgement, a copy of which shall be forwarded to Customer.
Any invoice not paid when due will incur a charge of 18% per annum or, if lower, the maximum applicable lawful interest rate. Customer is responsible for collection costs and attorneys' fees.
Taxes are not included in quotes.
Freight prices are estimates only. Customer will be charged for actual freight costs at the time of shipment.

Executive Offices : 500 Garrison Road, Georgetown, SC 29440 (843) 546-0600 / (800) 373-AGRU(2478) / Fax (843) 546-0516

Closure Cost Estimate
User 8

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Bentonite Supply Cost (Material):

Value	Units	Comment
$108	$/ton	Cost received from Rummel for supply of bentonite to site for the VRP project during Q1 of 2019. Supplier was CETCO.
$4,410	$/load	Cost received from Rummel for supply of bentonite to site for the VRP project during Q1 of 2019. Supplier was CETCO.
25	ton/load	Assumed truck size
$284	$/ton	Cost of bentonite delivered to site
$284.40	**$/ton delivered**	

Bentonite Processing

Processing Speed	1.2	mph	
Processor Width	8	ft	
Operator Skill	0.95		
Job Efficiency	0.83		
Equipment Availability	0.95		
Bentonite Application	1.25	lbs/sf	(6 inch lifts)
Processing	23.7	tons/hour	
Total Equipment Hours	8.1	hr	

Equipment	Equip Rate	Operator	Quantity	Usage	Total Cost/Hr
Wirtgen Spreader	$ 287.50	$ 63.61	1.0	100%	$ 351.11
Tractor with Disc	$ 105.00	$ 63.61	1.0	100%	$ 168.61
621 E Water Wagon	$ 64.49	$ 63.61	1.0	50%	$ 64.05
Foreman		$ 133.88	1.0	25%	$ 33.47
Pickup	$ 19.09		1.0	25%	$ 4.77
				Material Unit Cost ($/ton)	**$284.40**
				Labor Unit Cost ($/ton)	**$ 8.11**
				Equipment Unit Cost ($/ton)	**$ 18.10**
				Total ($/ton)	**$310.61**

Closure Cost Estimate
User 9

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

Current Water Treatment Plant 1 Costs[1]	Value	Comment
Labor Cost ($ per year at 120 gpm)	**$351,421**	Labor cost provided by AMI. Cost includes 8 staff working in shifts 24 hours/day and 7 days/week
Operational Costs ($/year at 120 gpm)		Utilities, spares, chemicals, filter cake and small works costs are (see next line)
WTP1 Utilities	$666,696	provided by AMI based on historical/projected WTP1 cost data at ~120 gpm.
Spares	$324,000	
WTP1 Chemicals (Original Plant)	$68,000	
WTP1 Chemicals (NF Filtration Area)	$188,700	
WTP1 Chemicals (Se Removal Circuit)	$601,200	
WTP1 Filter Cake TSF Blending	$60,000	
WTP1 Small Works	$120,000	
Total ($ per year at 120 gpm)	$2,028,596	
Water Treatment Rate (gallons per year)	60,826,000	
Material Costs ($ per gallon) - Does not include labor	**$0.033**	WTP1 cost excluding labor.

Projected Closure Water Treatment Rate		
January Adit (gallons per minute)	23.0	Value provided by AMI based on current treatment rate
January Adit (gallons per minute)	12,088,800	
Duration until plug installation is complete (years)	2.0	Assume a design through construction duration of 21 - 24 months
Treated January Adit water volume (gallons)	**24,177,600**	
Precipitation over TSF (inches per year)	25.18	Annual precipitation at site
Assumed runoff reporting to UDCP (%)	100%	Conservatively assume 100%
TSF geomembrane area (sf)	1,194,904	As-built TSF geomembrane area
Total Precipitation over TSF reporting to UDCP (gallons per year)	18,754,657	Assume all precipitation reports to the UDCP as runoff
Duration until cover construction is complete (years)	2.0	Assume a design through construction duration of 21 - 24 months
Treated TSF water volume pre-cover (gallons)	**37,509,315**	
Precipitation over Underdrain Collection Pond (inches per year)	25.18	Annual precipitation at site
Underdrain Collection Pond geomembrane area (sf)	80,860	As-built UDCP geomembrane area
Total Precipitation on Underdrain Collection Pond (gallons per year)	1,269,135	Assume no evaporation
Duration until passive treatment system is constructed (years)	5	Assume UDCP is converted to passive treatment system in Year 5 and no longer collects
Treated UDCP water volume pre-ET cell (gallons)	**6,345,677**	precipitation over the pond.
Draindown rate (gallons per minute)[2]	1.3	See notes below for additional information
Total draindown (gallons per year)	687,720	
Active treatment duration (years)	7	Assume all TSF draindown is treated by WTP1 until passive treatment is established (7 years)
Treated TSF draindown water volume (gallons)	**4,814,039**	
Precipitation over TSF closure cover (inches per year)	25.18	Annual precipitation at site
Infiltration through cover (%)	2%	Assume 2% of annual rainfall infiltrated through cover
Infiltration through cover (inches)	0.50	
TSF geomembrane area (sf)	1,194,904	
Total infiltration through cover (gallons per year)	375,093	
Active treatment duration (years)	5	Assume all TSF cover infiltration is treated by WTP1 until passive treatment is established (5 years)
Treated TSF cover infiltration water volume (gallons)	**1,875,466**	
Total water treatment (gallons) - Years 1 and 7	**74,722,096**	Assume active treatment is stopped after 7 years and passive treatment system in the Underdrain Collection Pond has been established.

Closure Cost Estimate
User 9

Projected Closure Water Treatment Cost

Current Labor Cost ($ per year)	**$351,421**	
Water treatment duration (years)	2	WTP1 labor cost does not change until Jan Adit is plugged and TSF closure cap is complete
Labor Cost (Year 1 through 2)	**$702,842**	
Labor Cost (Year 3 through 7)		WTP1 labor cost reduces after Jan Adit is plugged and TSF closure cap is complete
Number of WTP operators	2	
Hours of WTP operation per week	40	
Labor cost factor for reduced throughput (%)[3]	23.7%	See notes below for additional information
Water treatment duration (years)	5	
Labor Cost (Year 3 through 7)	**$417,212**	
Labor Cost (Year 1 through 7)	**$1,120,054**	
Water treatment cost ($ per gallon)	$0.033	
Water treatment quantity (gallons)	74,722,096	
Total Operational cost ($)	**$2,492,042**	
Total WTP Cost ($) - Labor and Operational	**$3,612,096**	

Laboratory Sample Analysis

Quarterly Testing	
Testing Frequency (samples per year)	4
Cost per sample	$910
Annual Laboratory Sample Testing Cost ($ per year)	$3,639
Laboratory Sample Testing Duration (years)	7
Total Laboratory Sample Testing Cost	**$25,471**

Annual Testing	
Testing Frequency (samples per year)	1
Cost per sample	$5,672
Annual Laboratory Sample Testing Cost ($ per year)	$5,672
Laboratory Sample Testing Duration (years)	7
Total Laboratory Sample Testing Cost	**$39,704**

Closure Cost Estimate
User 9

Yearly Water Treatment Plant Cost Summary Table

Cost Description	Year 1	2	3	4	5	6	7	Total
Labor Cost ($)	$351,421	$351,421	$83,442	$83,442	$83,442	$83,442	$83,442	$1,120,054
January Adit (gallons)	12,088,800	12,088,800	0	0	0	0	0	24,177,600
Precipitation over TSF (gallons)	18,754,657	18,754,657	0	0	0	0	0	37,509,315
Precipitation over Underdrain Collection Pond (gallons)	1,269,135	1,269,135	1,269,135	1,269,135	1,269,135	0	0	6,345,677
Draindown rate (gallons)	687,720	687,720	687,720	687,720	687,720	687,720	687,720	4,814,039
Precipitation over TSF closure cover (gallons)	0	0	375,093	375,093	375,093	375,093	375,093	1,875,466
Water treatment volume (gallons)	32,800,313	32,800,313	2,331,948	2,331,948	2,331,948	1,062,813	1,062,813	74,722,096
Average water treatment cost ($ per gallon)	$0.033	$0.033	$0.033	$0.033	$0.033	$0.033	$0.033	
Water Treatment Plant Cost ($) - Operational Cost Only	$1,093,917	$1,093,917	$77,772	$77,772	$77,772	$35,446	$35,446	$2,492,042
Laboratory Sample Analysis	$9,311	$9,311	$9,311	$9,311	$9,311	$9,311	$9,311	$65,175
Water Treatment Plant Cost ($) - Labor, Operational and Laboratory Cost	**$1,454,649**	**$1,454,649**	**$170,526**	**$170,526**	**$170,526**	**$128,199**	**$128,199**	**$3,677,271**

Notes:

[1]Water Treatment Plant 1 cost information provided by Arizona Minerals Inc

[2]TSF stacking draindown rate (gallons per minute)

Total TSF stacking volume	2,700,000	cy
Average in place dry density (CQA data) to date	121.81	pcf
Average in place moisture content (CQA data) to date	13.94	%
Residual moisture content (assumed)	12.00	%
Total water (percolation through stacking)	20,631,597	gallons
Duration	30	years
Flow rate (requiring treatment)	1.31	gpm

[3]Based on factoring of current man-hour load. Current WTP1 staffed by 2 person crew (8 staff total), 7 days per week and 24 hours per day. Closure WTP1 staffed by 2 person crew, 5 days per week and 8 hours per day.

Closure Cost Estimate
User 9

Consulting Engineers and Scientists

GEI Consultants

December 19, 2019

Sheena Leon
Environmental Specialist, South 32
749 Harshaw Road
Patagonia, AZ 85624

Dear Ms. Leon,

We have prepared a price quote for acute whole effluent toxicity (WET) testing for AZPDES Permit No. AZ0026387. All testing would follow requirements in the most recent permit and guidance in the U.S. Environmental Protection Agency methods (EPA-821-R-02-012). Acute 96-hour testing using *Ceriodaphnia dubia* and *Pimephales promelas* would be conducted on effluent following a pass/fail testing requirements (i.e. control and 100% effluent). Moderately hard reconstituted water will be used as the control water.

Per-test pricing is included in Table 1. These prices include up to three hours consulting per test to assist with any issues that may arise beyond standard WET data interpretation. Any additional consulting will be subject to GEI's Life Sciences Fee Schedule on an hourly basis. An estimate of expected fees would be provided prior to commencing work.

Sample containers, coolers, chain-of-custody forms, and sampling/shipping instructions are provided and will arrive at the facility at least one week prior to collection of the first sample. Our bill would include shipping costs from our facility to the site. **Additional shipping charges to ship the samples to our lab will be paid by the shipper.**

Table 1: Per-test charges for acute testing for 2020.

Test	Cost per Test
Estimate of shipping charges	$130
Acute *C. dubia* test	$830
Acute *P. promelas* test	$830
Total Cost for Single Round of Tests	**$1,790**

Please feel free to contact us should you require any additional information regarding this quote.

Sincerely,
GEI CONSULTANTS, INC.

Natalie Love, Laboratory Director

Ashley Romero, Laboratory Manager

www.geiconsultants.com
GEI Consultants, Inc./Ecological Division
4601 DTC Boulevard, Suite 900, Denver CO 80237
303.662.0100 fax: 303.662.8757

Consulting Engineers and Scientists

GEI Consultants

April 6, 2020

Sheena Leon
Environmental Specialist, South 32
749 Harshaw Road
Patagonia, AZ 85624

Dear Ms. Leon,

We have prepared a price quote for chronic whole effluent toxicity (WET) testing for AZPDES Permit No. AZ0026387. All testing would follow requirements in the permit and guidance in the U.S. Environmental Protection Agency methods (EPA-821-R-02-013). Chronic testing using *Ceriodaphnia dubia, Pimephales promelas,* and *Pseudokirchneriella subcapitata* would be conducted on effluent following the dilution series of 0, 12.5, 25, 50, 75, and 100% effluent as specified in the permit. Moderately hard reconstituted water will be used as the dilution water.

Per-test pricing is included in Table 1. These prices include up to three hours consulting per test to assist with any issues that may arise beyond standard WET data interpretation. Any additional consulting will be subject to GEI's Life Sciences Fee Schedule on an hourly basis. An estimate of expected fees would be provided prior to commencing work.

Sample containers, coolers, chain-of-custody forms, and sampling/shipping instructions are provided and will arrive at the facility at least one week prior to collection of the first sample. Our bill would include shipping costs from our facility to the site. **Additional shipping charges to ship the samples to our lab will be paid by the shipper.**

Table 1: Per-test charges for chronic testing for 2020.

Test	Cost per Test
Estimate of shipping charges	$130
Chronic *C. dubia* test	$1,287
Chronic *P. promelas* test	$1,425
Chronic *P. subcapitata* test	$1,040
Total Cost for Single Round of Tests	**$3,882**

Please feel free to contact us should you require any additional information regarding this quote.

Sincerely,
GEI CONSULTANTS, INC.

Natalie Love, Laboratory Director

Ashley Romero, Laboratory Manager

www.geiconsultants.com
GEI Consultants, Inc./Ecological Division
4601 DTC Boulevard, Suite 900, Denver CO 80237
303.662.0100 fax: 303.662.8757

Closure Cost Estimate
User 9

TURNER LABORATORIES INC.

03/30/2020

QUOTATION for ANALYTICAL SERVICES

Company: Arizona Minerals Inc.
Contact: Sarah Richman
Address: 2210 E. Fort Lowell Rd
Company: Tucson, AZ, 85719
Phone: (802) 235-5563 Fax:
Quote ID:
Project: Waste Treatment Plant APP

Submitted By: Kevin Brim

Expires: 03/30/2021

Test ID	Test	# Sample	Unit Price	Test Total
Non-Potable Water				
Alkalinity	SM2320B	1	$17.00	$17.00
As by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Ba by ICP/MS Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Be by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Cd by ICP/MS Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Cr by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Cu by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Cyanide	SM4500-CN BE	1	$29.75	$29.75
Fe by ICP, Dissolved	E 200.7 (4.4)	1	$6.80	$6.80
Fluoride by Ion Chromatography	E300.0 (2.1)	1	$12.75	$12.75
Hardness, Ca Dissolved	varies	1	$6.80	$6.80
IC Prep	Prep	1	$6.80	$6.80
Mercury Prep	Prep	1	$9.35	$9.35
Mercury, Dissolved	E 245.1	1	$25.50	$25.50
Metals Prep ICP	Prep	1	$9.35	$9.35
Metals Prep ICP/MS	Prep	1	$9.35	$9.35
Mn by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Ni by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Nitrate and Nitrite Sum	Calculation	1	$0.00	$0.00
Nitrate by Ion Chromatography	E300.0 (2.1)	1	$12.75	$12.75
Nitrite by Ion Chromatography	E300.0 (2.1)	1	$12.75	$12.75
Pb by ICP/MS, Dissolved	E 200.8 (5.4)	1	$13.00	$13.00
Radiochemistry, Gross Alpha	ERAD	1	$85.00	$85.00
Radiochemistry, Radium 226/228	ERAD	1	$195.00	$195.00
Sb by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Se by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Sulfate by Ion Chromatography	E300.0 (2.1)	1	$12.75	$12.75
Tl by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05
Total Dissolved Solids	SM2540 C	1	$17.85	$17.85
Zn by ICP/MS, Dissolved	E 200.8 (5.4)	1	$11.05	$11.05

Hardness, Ca Dissolved consists of:
Ca by ICP, Dissolved

Total: $615.15

Comments:

Approved by: ____________________ Date: ____________
Sarah Richman

Page 1 of 1

TURNER LABORATORIES INC.

03/30/2020

QUOTATION for ANALYTICAL SERVICES

Company: Arizona Minerals Inc.
Contact: Sarah Richman
Address: 2210 E. Fort Lowell Rd
Company: Tucson, AZ, 85719
Phone: (802) 235-5563 Fax:
Quote ID:
Project: Water Treatment Plant AZPDES

Submitted By: Kevin Brim

Expires: 03/30/2021

Test ID	Test	# Sample	Unit Price	Test Total
Non-Potable Water				
Ag by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
As by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
B by ICP, Total	E200.7 (4.4)	1	$6.80	$6.80
Ba by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Be by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Cd by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Cr by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Cu by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Cyanide	SM4500-CN BE	1	$29.75	$29.75
Fe by ICP, Total	E200.7 (4.4)	1	$6.80	$6.80
Hardness, Ca	varies	1	$6.80	$6.80
IC Prep	Prep	1	$6.80	$6.80
Mercury Prep	Prep	1	$9.35	$9.35
Mercury, Total	E245.1	1	$25.50	$25.50
Metals Prep ICP	Prep	1	$9.35	$9.35
Metals Prep ICP/MS	Prep	1	$9.35	$9.35
Ni by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Nitrate and Nitrite Sum	Calculation	1	$0.00	$0.00
Nitrate by Ion Chromatography	E300.0 (2.1)	1	$12.75	$12.75
Nitrite by Ion Chromatography	E300.0 (2.1)	1	$12.75	$12.75
Pb by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Sb by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Se by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Tl by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05
Total Suspended Solids	SM2540 D	1	$14.88	$14.88
Zn by ICP/MS	E200.8 (5.4)	1	$11.05	$11.05

Hardness, Ca consists of:
Ca by ICP, Total

Total: $294.53

Comments:

Approved by: ____________________ Date: ____________
Sarah Richman

Page 1 of 1

Closure Cost Estimate
User 10

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: July 27, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety Cost Basis: Southern Nevada

January Adit Bulkhead Dimensions		
Concrete Bulkhead Dimension 1 (ft)	15	Jan Adit dimensions are estimated.
Concrete Bulkhead Dimension 2 (ft)	15	Jan Adit dimensions are estimated.
Concrete Bulkhead Depth (ft)	30	Assumed bulkhead depth.
Concrete Volume (cy)	250	
Concrete Cost ($ per cubic yard)	$1,200	
Total Concrete Bulkhead Cost ($)	**$300,000**	
Earthworks for bulkhead placement (cy)	15,000	Earthworks to create usable space in vicinity of January Adit.
Excavation and re-palcement of bulkhead earthworks ($ per cy)	$15	
Total Earthworks ($)	**$225,000**	
Injection Grouting		
Outer Grouting Ring Radius (ft)	30	Assume three concentric rings with 10ft hole spacing - Outer 30ft ring radius
Intermediate Grouting Ring Radius (ft)	20	Assume three concentric rings with 10ft hole spacing - Intermediate 20ft ring radius
Inner Grouting Ring Radius (ft)	10	Assume three concentric rings with 10ft hole spacing - Inner 10ft ring radius
Number of Holes	38	Based on 10ft hole spacing around each grouting ring
Confirmation Holes	38	Assume a confirmatory hole is drilled between each of the 10 ft spaced holes to check degree of injection grouting translation laterally
Grouting Confirmatory Holes	19	Assume half of the confirmatory holes require grouting
Hole Depth (ft)	50	Assume competent bedrock is at 30 ft bgs.
Grouting Depth (ft)	20	Injection grout 20 ft of competent bedrock.
Total Drilling Depth (ft)	4,750	
Total Grouting Depth (ft)	1,140	
Drilling Mob/Demob	$10,000	Based on historical site data provided by AMI.
Drilling Cost ($ per foot)	$125	Based on historical site data provided by AMI.
Grouting Cost ($ per hour)	$280	Assumes $280 per hour and each hole take 15 hours.
Active grouting time per hole (hours)	15	Grouting time/cost includes grout plant elements, injection grout nipple installation and packer testing of the grout holes prior to grouting
Total Cost ($) - Injection Grouting	$843,150	
Total Cost ($) - Bulkhead and Injection Grouting	$1,368,150	
Contingency	10%	Additional contingency to cover unknowns beyond the contingency applied by the SRCE model.
Total Cost with Contingency ($)	**$1,510,000**	

Closure Cost Estimate
User 11

Project Name: Hermosa Lined TSF Design Amendment - Plan of Operations
Date of Submittal: August 7, 2020
File Name: SRCE_Version_1_4_1_017_NVb-Hermosa.xlsm
Model Version: Version 1.4.1
Cost Data: User Data
Cost Data File: SRCE_Cost_data-USR_1_12_AZ.xlsm
Cost Estimate Type: Surety   Cost Basis: Southern Nevada

Future Passive Treatment System
Engineer's Cost Estimate provided by CPE Consultants

Construction Capital Cost Estimate	Value	Comments
Construction Capital Cost	**$1,017,831**	See sheets below from CPE Consultants. Includes additional contingency of 30% beyond the contingency applied from the SRCE model. A portion of the 30% additional contingency should also be considered to cover escalation from Q3 2017 to now which equates to approximately 11.5% using the R.S. Means Historical Cost data.
Duration of Closure Cost Estimate	30	years
Passive Treatment System Operating Years	25	years

Sustaining Capital Expenditures	**Value**	**Comments**
BCR Replacement Substrate	$100,000	
Number of Replacements	2	Replace at year 22 and 26
Total BCR Replacement Substrate	**$200,000**	
Permit Revisions	$10,000	
Number of Permit Revisions	6	Permit revisions occur every 5 years
Total Permit Revisions Cost	**$60,000**	
Open Limestone Channel	$5,000	
Number of Limestone Replacements	2	Limestone replacement occurs every 10 years
Total Limestone Replacement Cost	**$10,000**	
Annual Passive Treatment System Misc Cost	$63,101	Cost for first 3 years
Years of Operating	3	
Annual Passive Treatment System Misc Cost	$55,101	Cost for last 23 years
Years Operating	23	
Total Annual Passive Treatment System Cost	**$1,456,626**	
Pump and Blower Replacement	$22,000	
Number of Pump and Blower Replacements	2	Replacement at year 15 and 25
Total Pump and Blower Replacement Cost	**$44,000**	
Seep Pond Sludge Disposal	$20,000	
Number of Seep Pond Sludge Disposals	2	Seep Pond Sludge Disposal every 10 years
Total Seep Pond Sludge Disposal Cost	**$40,000**	
Total Cost Future Passive Treatment System	**$2,828,457**	

Closure Cost Estimate
User 11

ARIZONA MINERALS
JANUARY ADIT (NORTON MINE) VRP SITE
SANTA CRUZ COUNTY, ARIZONA
FUTURE PASSIVE TREATMENT SYSTEM
ENGINEER'S COST ESTIMATE

Item	Unit	Quantity	Unit Cost	Total
1. SITE IMPROVEMENT WORK				
1.1. MOBILIZATION				
MOBILIZATION	LS	1	$ 11,000.00	$ 11,000
CLEARING AND GRUBBING	LS	1	$ 6,900.00	$ 6,900
SWPPP	LS	1	$ 10,000.00	$ 10,000
Subtotal Mobilization				**$ 27,900**
1.2. GRADING				
EXCAVATION & BACKFILL	CY	20,000	$ 5.00	$ 100,000
FINE GRADING	SY	9,000	$ 1.00	$ 9,000
RIPRAP PROTECTION, GROUTED, D50 = 8",T=16"	CY	30	$ 100.00	$ 3,000
Subtotal Grading				**$ 112,000**
1.3. EQUIPMENT & PIPING				
REPLACE ONE JANUARY ADIT WELL PUMP TO 20 GPM	LS	1	$ 30,000.00	$ 30,000
MODIFY EXIST. PIPING TO ALLOW WATER DELIVERY TO PTS	LS	1	$ 20,000.00	$ 20,000
Subtotal Equipment & Piping				**$ 50,000**
SUBTOTAL SITE IMPROVEMENT WORK (1.1 - 1.3)				**$ 189,900**
2. PASSIVE TREATMENT SYSTEM - PTS (SOVEREIGN CONSULTING ESTIMATE)				
2.1. BIOCHEMICAL REACTOR (BCR) CELLS				
PIPING (INLET, OUTLET, FLOW CONTROL, OVERFLOW, ETC.)	LS	1	$ 20,000.00	$ 20,000
BCR MEDIA (WOODCHIPS, LIMESTONE, STRAW, MANURE)	CY	3,150	$ 55.00	$ 173,250
LINER & ANCHOR TRENCH (60 MIL HDPE LINER W/10 OZ GEOTEXTILE ABOVE & BELOW)	SF	35,000	$ 3.00	$ 105,000
DRAINAGE LAYER	LS	1	$ 40,000.00	$ 40,000
BALLAST TO PREVENT FLOATING (GRAVEL)	LS	1	$ 15,000.00	$ 15,000
Subtotal Biochemical Reactor Cells				**$ 353,250**
2.2. AEROBIC POLISHING WETLAND				
LINER & ANCHOR TRENCH (60 MIL HDPE LINER W/10 OZ GEOTEXTILE ABOVE & BELOW)	SF	3,200	$ 3.00	$ 9,600
TOPSOIL FILL (T=6")	CY	65	$ 48.50	$ 3,153
PLANTS	EA	1,600	$ 3.00	$ 4,800
Aerobic Polishing Wetland				**$ 17,553**
2.3. MANGANESE REMOVAL BED (MRB)				
LINER & ANCHOR TRENCH	SF	15,500	$ 3.00	$ 46,500
WATER COLLECTION PIPING	FT	900	$ 14.50	$ 13,050

Registered Professional Engineer (Civil)
CERTIFICATE NO. 15606
Raul Francisco G. Piña
DATE SIGNED 8.12.2020
ARIZONA U.S.A.

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Closure Cost Estimate
User 11

ARIZONA MINERALS
JANUARY ADIT (NORTON MINE) VRP SITE
SANTA CRUZ COUNTY, ARIZONA
FUTURE PASSIVE TREATMENT SYSTEM
ENGINEER'S COST ESTIMATE

Item	Unit	Quantity	Unit Cost	Total
LIMESTONE/GRAVEL MIX (D50=3/8")	CY	650	$ 48.00	$ 31,200
MRB CONDITIONING CHEMICAL (2.5% POTASSIUM PERMANGANATE SOLUTION BATCH)	LB	1,900	$ 15.00	$ 28,500
CONDITIONING CHEMICAL RECYCLE SYSTEM (PUMP & ASSOCIATED PIPING TO RECYCLE $KMnO_4$ SOLUTION)	LS	1	$ 2,000.00	$ 2,000
INLET, OUTLET, & FLOW CONTROL WAT. LEVEL CONTROL, VAULT, PIPING, & LINER BOOTS)	LS	1	$ 20,000.00	$ 20,000
Subtotal Manganese Removal Bed				**$ 141,250**
SUBTOTAL PASSIVE TREATMENT SYSTEM (2.1 - 2.3)				**$ 512,053**
PROJECT SUBTOTAL (1 - 2)				**$ 701,953**
Contingecies - 30%				$ 210,586
Construction Administration, Inspection, and Quality Control - 10%				$ 70,195
Permit Fee - 5%				$ 35,098
PROJECT TOTAL				**$ 1,017,831**
Estimated in Prices of 2017				

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Closure Cost Estimate
User 11

SUMMARY OF JANUARY ADIT PASSIVE TREATMENT OMM COSTS
Revised June 9, 2015
Updated July 28, 2020

Registered Professional Engineer (Civil) — Certificate No. 15606 — Raul Francisco G. Piña — Date signed 8.12.2020 — Arizona U.S.A.

ASSUMPTIONS:

OMM Calendar revised to start in Year 5
Pumps and Blowers require replacement every 10 years (both pumps).
Sludge removal from Seep Detention Pond is required every 10 years.
Electricity is $0.09 per kilowatt hour.
Permit revisions are every 5 years.
Liner has 50 year design life, no replacement.
Reduce OMM Cost by $8,000 @ 3rd year (Year 8) due to reduced monitoring.

Item	Unit	Unit Cost	Quantity	Total	Description
OPERATION AND MAINTENANCE COSTS					
Routine Operation, Maintenance, and Monitoring (OMM)					
Contract Project Management	yr	$ 185	12	$ 2,220.00	PM, 1 hour per month
Field Inspection	yr.	$ 100	96	$ 9,600.00	Inspection 8 hrs. per month
Equipment & Maintenance	yr	$ 1,100	12	$ 13,200.00	2 pieces of equipment with labor, 12 days per year
Permit Agency and compliance/documentation	yr	$ 4,000	4	$ 16,000.00	Testing will be reduced to biannually @ 3rd year (Year 8)
Subtotal Monthly Routine OMM				**$ 41,020.00**	
Laboratory Fees					
Metals and Inorganic	ea	$ 800	4	$ 3,200.00	Testing at discharge location.
Subtotal Laboratory				**$ 3,200.00**	
Utilities					
Electricity Pumps & Blowers	yr	$ 8,250	1	$ 8,250.00	Assume Adit Pumps - 7.5hp @ 100%; Seep Pond - 1 hp @ 50%; Air Blowers - 5 hp @100%
Telephone/Data Line	yr	$ 2,400	1	$ 2,400.00	
Subtotal Utilities				**$ 10,650.00**	
Contingency					
15% of annual cost	ls		0.15	**$ 8,230.50**	
ANNUAL OMM COST				**$ 63,100.50**	
Life Cycle Replacement Items					
Upper liner replacement		$ -	0	$ -	Liner has 50 year design life. Therefore, no replacement.
Permit revisions	ls	$ 10,000	1	$ 10,000.00	Assume every 5 years.
Pump & Blower replacement	ls	$ 22,000	1	$ 22,000.00	Replacement of all pump & blower equipment in year 15, 25, and 35.
BCR Replacement Substrate	ls	$ 200,000	1	$ 200,000.00	Replace one BCR Substrate in year 22 and 2nd BCR Substrate in year 26, exhume & replace organic substrate & dispose of depleted substrate. Assume hazardous waste disposal.
Open Limestone Channel	ls	$ 5,000	1	$ 5,000.00	Replace consumed limestone @ 10% of media every 10 years.
Seep Pond Sludge Disposal	ls	$ 20,000	1	$ 20,000.00	Every 10 years, collection & disposal of sludge.
Subtotal Life Cycle Replacement Items				**$ 257,000.00**	

Closure Cost Estimate
User 11

JANUARY ADIT
Summary of Construction Cost
and Yearly Operation & Maintenance

	Year	Cashflow	Description
	0	-	
	1	-	
	2	-	
	3	-	
	4	-	
	5	1,090,932	Estimated Total Project Const Cost; Add permit revisions
	6	63,101	
	7	63,101	
	8	55,101	Required monitoring reduced to biannual.
	9	55,101	
	10	65,101	Add permit revisions.
	11	55,101	
	12	55,101	
	13	55,101	
	14	55,101	
	15	112,101	Add permit revisions, replace pump & blower equipment, replace limestone liner, remove sludge.
	16	55,101	
	17	55,101	
	18	55,101	
	19	55,101	
	20	65,101	Add permit revisions
	21	55,101	
	22	155,101	Replace BCR substrate
	23	55,101	
	24	55,101	
	25	112,101	Add permit revisions, replace pump & blower equipment, replace limestone liner, remove sludge.
	26	155,101	Replace BCR substrate
	27	55,101	
	28	55,101	
	29	55,101	
	30	65,101	Add permit revisions
OMM Cash Flow		2,828,457	
TOTAL CASH FLOW		2,828,457	

AZ2000 January Adit Summary Construction Cost & Yearly OMM FINAL 150609 updated 200728.xls
Updated July 28, 2020

Closure Cost Estimate
User 11

JANUARY ADIT PASSIVE TREATMENT SYSTEM															
ANNUAL OMM COST PROJECTIONS FOR 30 YEARS															
Revised June 9, 2015 (Upated July 28. 2020)															
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Annual O&M Costs		-		-	63,101	63,101	63,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101
Do not include in calculation of Total	-	-						(8,000)							
Life Cycle Replacement Items															
Permit Revisions					10,000					10,000					10,000
$10,000 each, every 5 years															
Pump & Blower Replacement															22,000
$22,000 at Year 15 and 25															
BCR Replacement Substrate															
$100,000 each at Year 22 and 26															
Open Limestone Channel															5,000
$5,000 each every 10 years															
Seep Pond Sludge Disposal															20,000
$20,000 each, every 10 years															
Construction - Engineer's Cost Estimate					1,017,831										
TOTAL	-	-	-	-	1,090,932	63,101	63,101	55,101	55,101	65,101	55,101	55,101	55,101	55,101	112,101
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

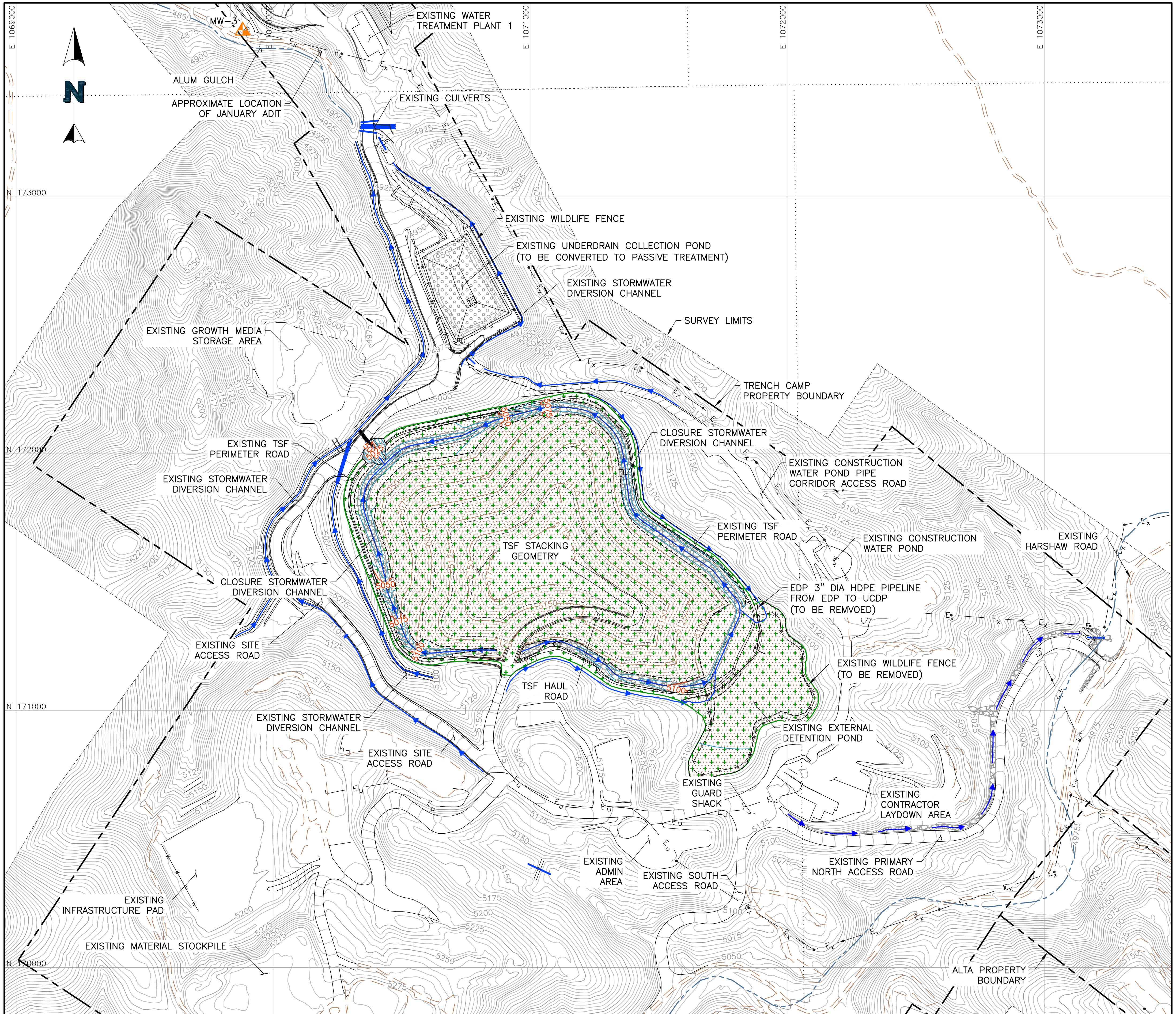
AZ2000 January Adit Summary Construction Cost & Yearly OMM FINAL 150609 updated 200728.xls
OMM Costs-30 Yrs
Revised June 9, 2015
Updated July 28, 2020

Closure Cost Estimate
User 11

JANUARY ADIT PASSIVE TREATMENT SYSTEM															
ANNUAL OMM COST PROJECTIONS FOR 30 YEARS															
Revised June 9, 2015 (Upated July 28. 2020)															
YEAR	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Annual O&M Costs	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101	55,101
Do not include in calculation of Total															
Life Cycle Replacement Items															
Permit Revisions					10,000					10,000					10,000
$10,000 each, every 5 years															
Pump & Blower Replacement										22,000					
$22,000 at Year 15 and 25															
BCR Replacement Substrate							100,000				100,000				
$100,000 each at Year 22 and 26															
Open Limestone Channel										5,000					
$5,000 each every 10 years															
Seep Pond Sludge Disposal										20,000					
$20,000 each, every 10 years															
Construction - Engineer's Cost Estimate															
TOTAL	55,101	55,101	55,101	55,101	65,101	55,101	155,101	55,101	55,101	112,101	155,101	55,101	55,101	55,101	65,101
YEAR	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
															2,828,457

AZ2000 January Adit Summary Construction Cost & Yearly OMM FINAL 150609 updated 200728.xls
OMM Costs-30 Yrs
Revised June 9, 2015
Updated July 28, 2020

FIGURES



LEGEND:

- EXISTING GROUND CONTOURS
- STACKING CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING DRAINAGE
- EXISTING WILDLIFE FENCE
- E_x EXISTING OVERHEAD ELECTRIC POWER LINE
- EXISTING OVERHEAD ELECTRIC POWER POLE
- E_u EXISTING UNDERGROUND ELECTRIC POWER LINE
- STORMWATER DIVERSION CHANNEL
- PASSIVE TREATMENT SYSTEM AREA
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION
- MW-3 MONITORING WELL (TO BE ABANDONED)

NOTES:

1. COVER MATERIAL TO BE HYDROSEEDED.
2. THE PASSIVE TREATMENT SYSTEM IS TO BE DESIGNED BASED ON POST CLOSURE WATER CHEMISTRY AND EXPECTED FLOW RATES. ACTIVE TREATMENT OF UNDERDRAIN FLOW WILL BE CONTINUED UNTIL AN APPROPRIATE PASSIVE SYSTEM CAN BE ESTABLISHED. AFTER ~2 YEARS OF SUCCESSFUL PASSIVE TREATMENT HAS BEEN COMPLETED, THE ACTIVE TREATMENT SYSTEM WILL BE DISCONTINUED.
3. ALL CUT AND FILL SLOPES LOCATED ALONG THE EXTERIOR OF THE TSF PERIMETER ROAD AND EXTERNAL DETENTION POND WERE HYDROSEEDED AS PART OF THE VRP TSF CONSTRUCTION.

REFERENCE:

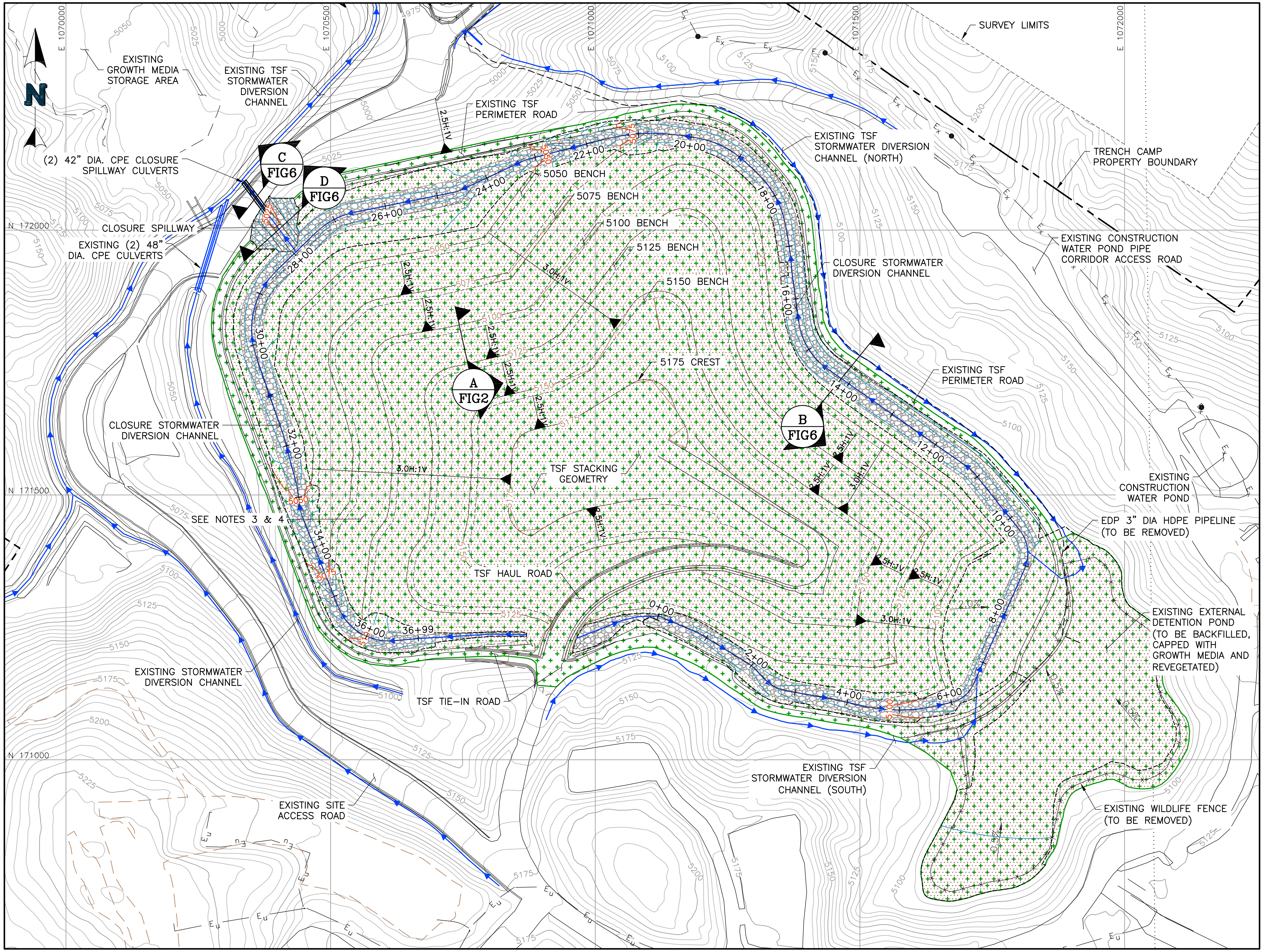
EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

0 200 400 FEET

NewFields

CLIENT	ARIZONA MINERALS INC
PROJECT	HERMOSA LINED TSF DESIGN AMENDMENT
TITLE	GENERAL ARRANGEMENT
FILENAME	14.022.001F
FIGURE NO.	FIG1
REVISION	A

P:\Projects\0014.022 hermosa vrp tsf expansion\A-CAD\FIGS\srce model\14.022.001F.dwg-8/12/2020 2:42 PM

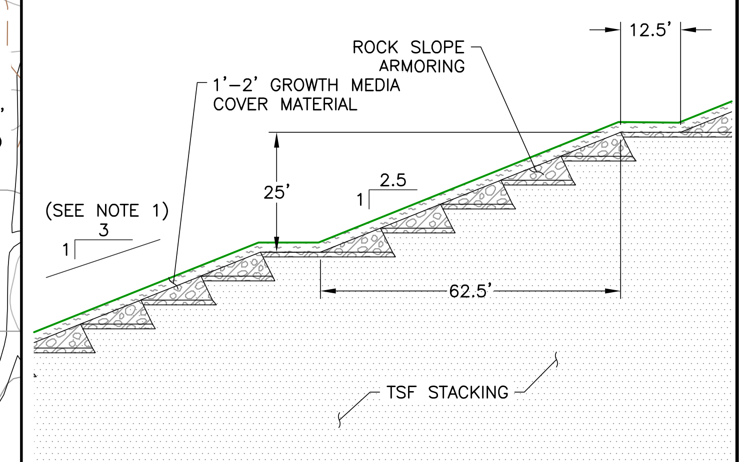


LEGEND:

- EXISTING GROUND CONTOURS
- STACKING CONTOURS (SEE NOTE 4)
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING DRAINAGE
- EXISTING WILDLIFE FENCE
- EXISTING OVERHEAD ELECTRIC POWER LINE
- EXISTING OVERHEAD ELECTRIC POWER POLE
- EXISTING UNDERGROUND ELECTRIC POWER LINE
- STORMWATER DIVERSION CHANNEL
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION

NOTES:

1. COVER MATERIAL TO BE HYDROSEEDED.
2. ALL CUT AND FILL SLOPES LOCATED ALONG THE EXTERIOR OF THE TSF PERIMETER ROAD AND EXTERNAL DETENTION POND WERE HYDROSEEDED AS PART OF THE VRP TSF CONSTRUCTION.
3. TSF ROCK ARMOR BERMS TO BE RE-GRADED TO 2.5H:1V OPEN SLOPES PRIOR TO GROWTH MEDIA PLACEMENT. COMPOSITE STACKING SLOPE WILL REMAIN AT 3H:1V WITH 12.5 FEET BENCHES REMAINING IN PLACE EVERY 25 VERTICAL FEET.
4. STACKING CONTOURS SHOWN REPRESENT MID BENCH LENGTHS WHICH ARE USED AS INPUT INTO THE SRCE MODEL TO ESTIMATE REGRADING COSTS.



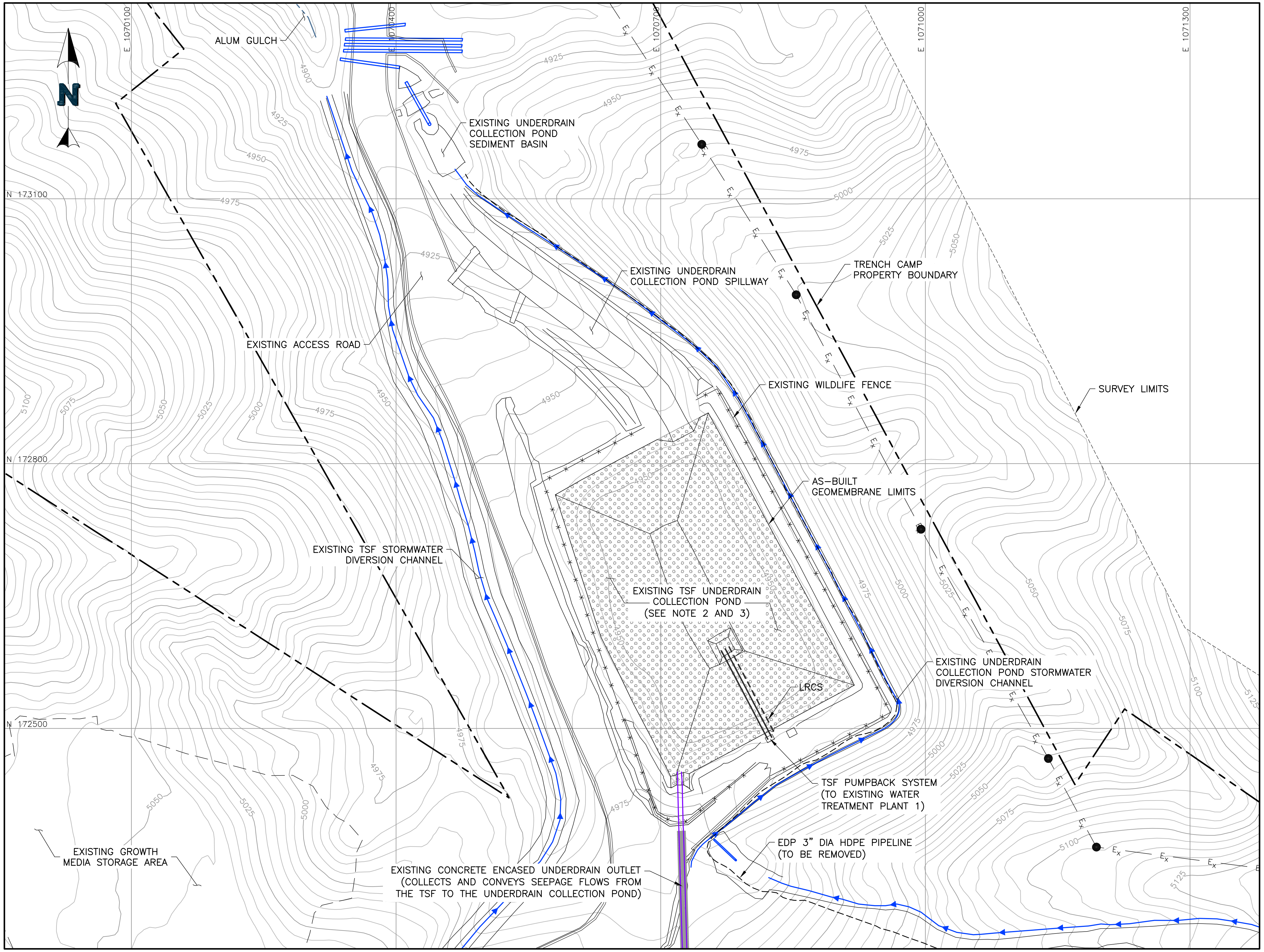
A FIG2 CLOSURE STACKING

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

P:\Projects\0014.022 hermosa vrp tsf expansion\A-CAD\FIGS\srce model\14.022.002F.dwg-8/12/2020 2:24 PM

NewFields	CLIENT: ARIZONA MINERALS INC
PROJECT	HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: TAILINGS STORAGE FACILITY	FILENAME: 14.022.002F; FIGURE NO.: FIG2; REVISION: A



0 60 120 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- PROPERTY BOUNDARY
- EXISTING DRAINAGE
- EXISTING WILFDLIFE FENCE
- EXISTING OVERHEAD ELECTRIC POWER LINE
- EXISTING OVERHEAD ELECTRIC POWER POLE
- STORMWATER DIVERSION CHANNEL
- REPURPOSED AREA FOR PASSIVE TREATMENT SYSTEM
- LIMITS OF RIPRAP ARMORING
- LIMITS OF REVEGETATION

NOTES:

1. COVER MATERIAL TO BE HYDROSEEDED.
2. THE PASSIVE TREATMENT SYSTEM IS TO BE DESIGNED BASED ON POST CLOSURE WATER CHEMISTRY AND EXPECTED FLOW RATES. ACTIVE TREATMENT OF UNDERDRAIN FLOW WILL BE CONTINUED UNTIL AN APPROPRIATE PASSIVE SYSTEM CAN BE ESTABLISHED. AFTER ~2 YEARS OF SUCCESSFUL PASSIVE TREATMENT HAS BEEN COMPLETED, THE ACTIVE TREATMENT SYSTEM WILL BE DISCONTINUED.
3. THE EXISTING UNDERDRAIN COLLECTION POND WAS CONSTRUCTED WITH A LINER SYSTEM CONSISTING OF A GEONET SITED BETWEEN TWO 60mil HDPE DOUBLE TEXTURED GEOMEMBRANE LAYERS, ALL OVERLYING A GEOSYNTHETIC CLAY LINER (GCL). A LEAK COLLECTION RECOVERY SYSTEM (LRCS) WAS CONSTRUCTED BETWEEN THE PRIMARY AND SECONDARY GEOMEMBRANE LAYERS FOR RECOVERY OF SEEPAGE FLOW IN THE EVENT OF PRIMARY GEOMEMBRANE LEAKAGE.

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

NewFields	CLIENT: ARIZONA MINERALS INC
PROJECT	HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: TSF UNDERDRAIN COLLECTION POND	FILENAME: 14.022.003F; FIGURE NO.: FIG3; REVISION: A

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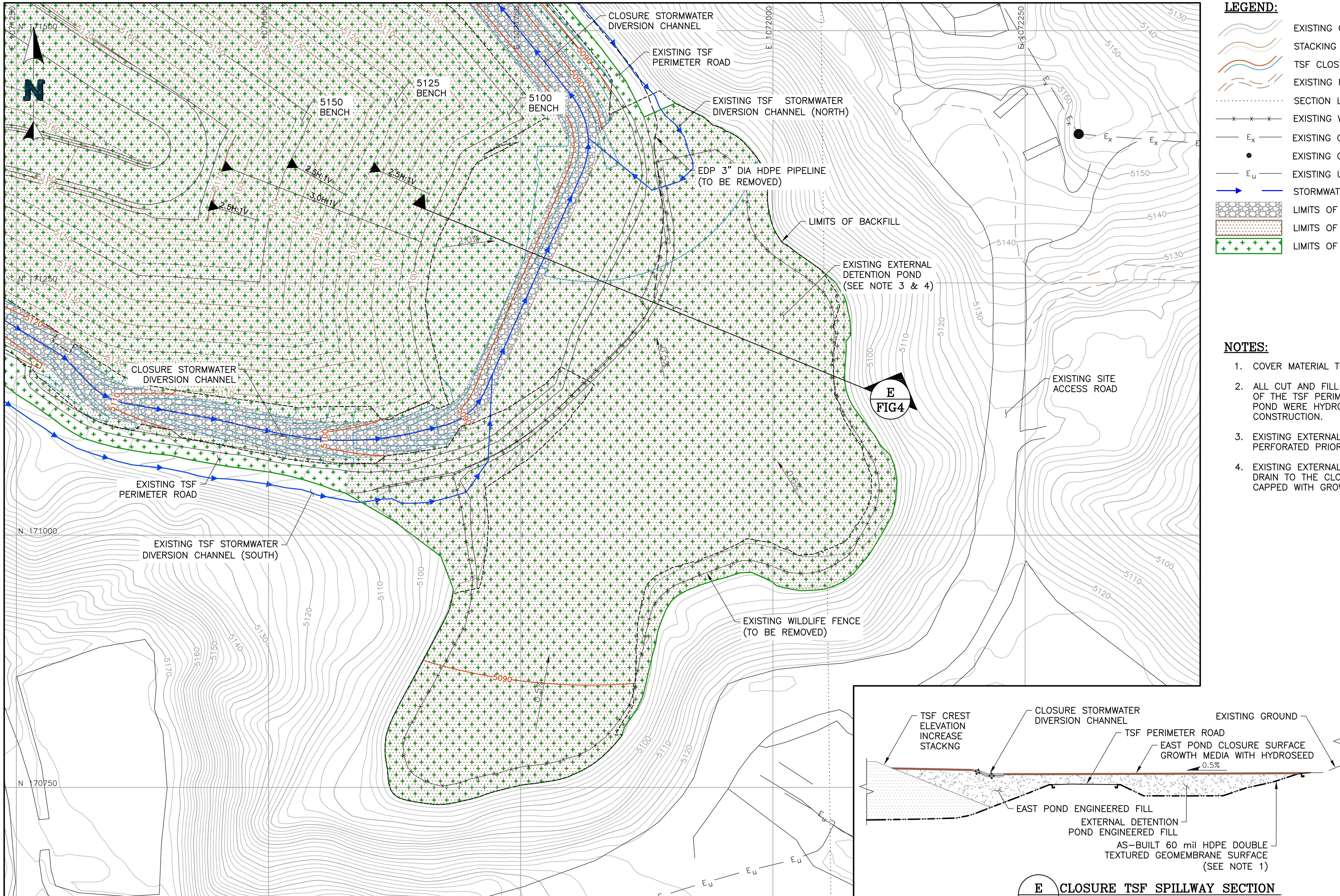


E / FIG4 CLOSURE TSF SPILLWAY SECTION

0 50 100 FEET

LEGEND:

- EXISTING GROUND CONTOURS
- STACKING CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- SECTION LINES
- EXISTING WILDLIFE FENCE (TO BE REMOVED)
- EXISTING OVERHEAD ELECTRIC POWER LINE
- EXISTING OVERHEAD ELECTRIC POWER POLE
- EXISTING UNDERGROUND ELECTRIC POWER LINE
- STORMWATER DIVERSION CHANNEL
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION

NOTES:

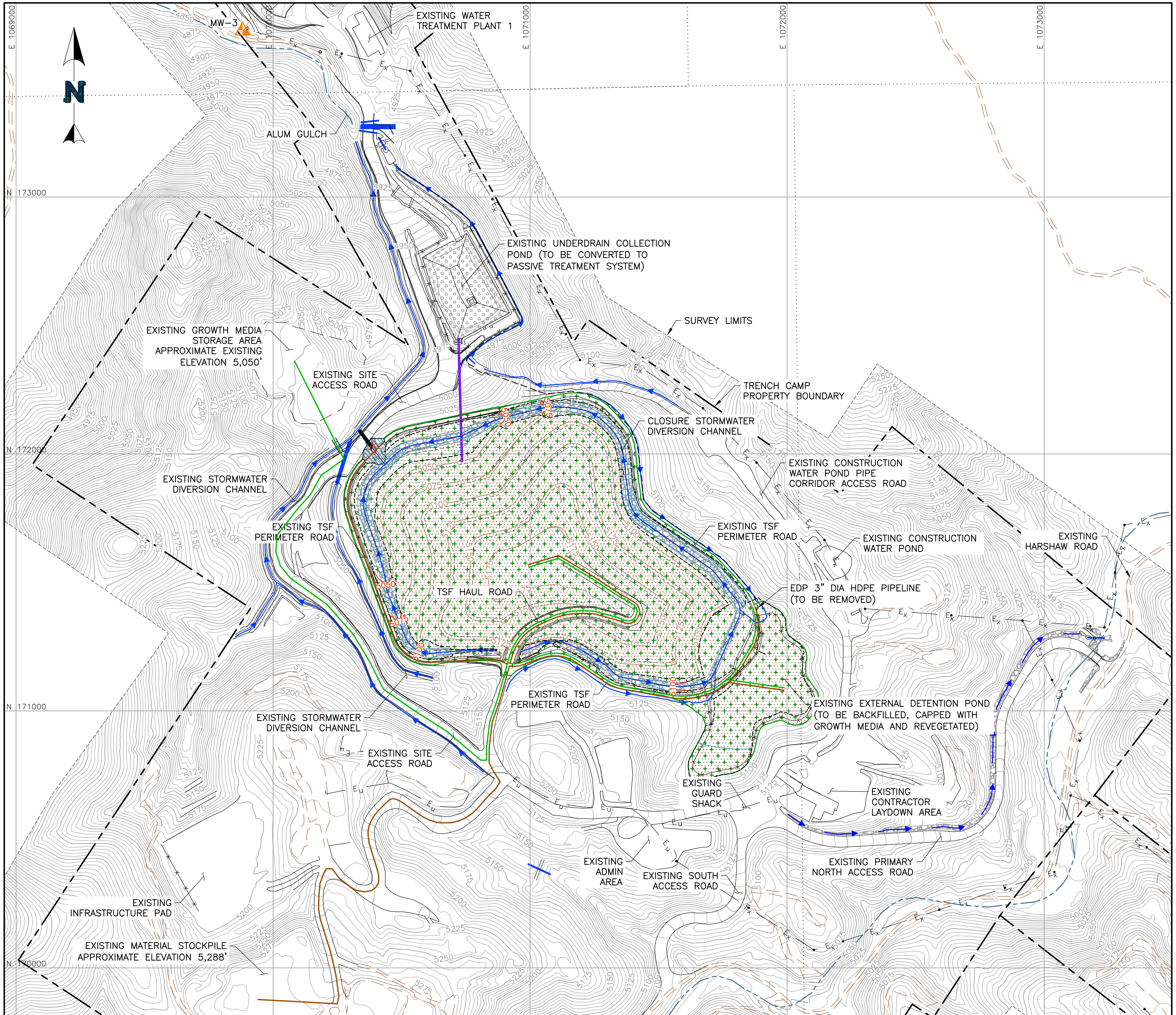
1. COVER MATERIAL TO BE HYDROSEEDED.
2. ALL CUT AND FILL SLOPES LOCATED ALONG THE EXTERIOR OF THE TSF PERIMETER ROAD AND EXTERNAL DETENTION POND WERE HYDROSEEDED AS PART OF THE VRP TSF CONSTRUCTION.
3. EXISTING EXTERNAL DETENTION POND GEOMEMBRANE TO BE PERFORATED PRIOR TO CLOSURE CAP MATERIAL PLACEMENT.
4. EXISTING EXTERNAL DETENTION POND TO BE BACKFILLED TO DRAIN TO THE CLOSURE STORMWATER DIVERSION CHANNEL, CAPPED WITH GROWTH MEDIA AND REVEGETATED.

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

P:\Projects\0014.022 hermosa vrp tsf expansion\A-CAD\FIGS\srce model\14.022.004F.dwg-7/28/2020 1:55 PM

NewFields	CLIENT: ARIZONA MINERALS INC
PROJECT	HERMOSA LINED TSF DESIGN AMENDMENT
TITLE	EXTERNAL DETENTION POND
FILENAME	14.022.004F
FIGURE NO.	FIG4
REVISION	A



LEGEND:

- EXISTING GROUND CONTOURS
- STACKING CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING DRAINAGE
- EXISTING WILDLIFE FENCE
- EXISTING OVERHEAD ELECTRIC POWER LINE
- EXISTING OVERHEAD ELECTRIC POWER POLE
- STORMWATER DIVERSION CHANNEL
- PASSIVE TREATMENT SYSTEM AREA
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION
- CLOSURE TSF HAUL ROUTE FROM GROWTH MEDIA STOCKPILE
- CLOSURE TSF HAUL ROUTE FROM INFRASTRUCTURE PAD
- MW-3 MONITORING WELL – (TO BE ABANDONED)

NOTES:

1. COVER MATERIAL TO BE HYDROSEEDED.
2. THE PASSIVE TREATMENT SYSTEM IS TO BE DESIGNED BASED ON POST CLOSURE WATER CHEMISTRY AND EXPECTED FLOW RATES. ACTIVE TREATMENT OF UNDERDRAIN FLOW WILL BE CONTINUED UNTIL AN APPROPRIATE PASSIVE SYSTEM CAN BE ESTABLISHED. AFTER ~2 YEARS OF SUCCESSFUL PASSIVE TREATMENT HAS BEEN COMPLETED, THE ACTIVE TREATMENT SYSTEM WILL BE DISCONTINUED.
3. ALL CUT AND FILL SLOPES LOCATED ALONG THE EXTERIOR OF THE TSF PERIMETER ROAD AND EXTERNAL DETENTION POND WERE HYDROSEEDED AS PART OF THE VRP TSF CONSTRUCTION.

REFERENCE:

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM FEBRUARY 2020 FLYOVER DATA PROVIDED BY SOUTH32 (AMI). DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET, NAVD88.

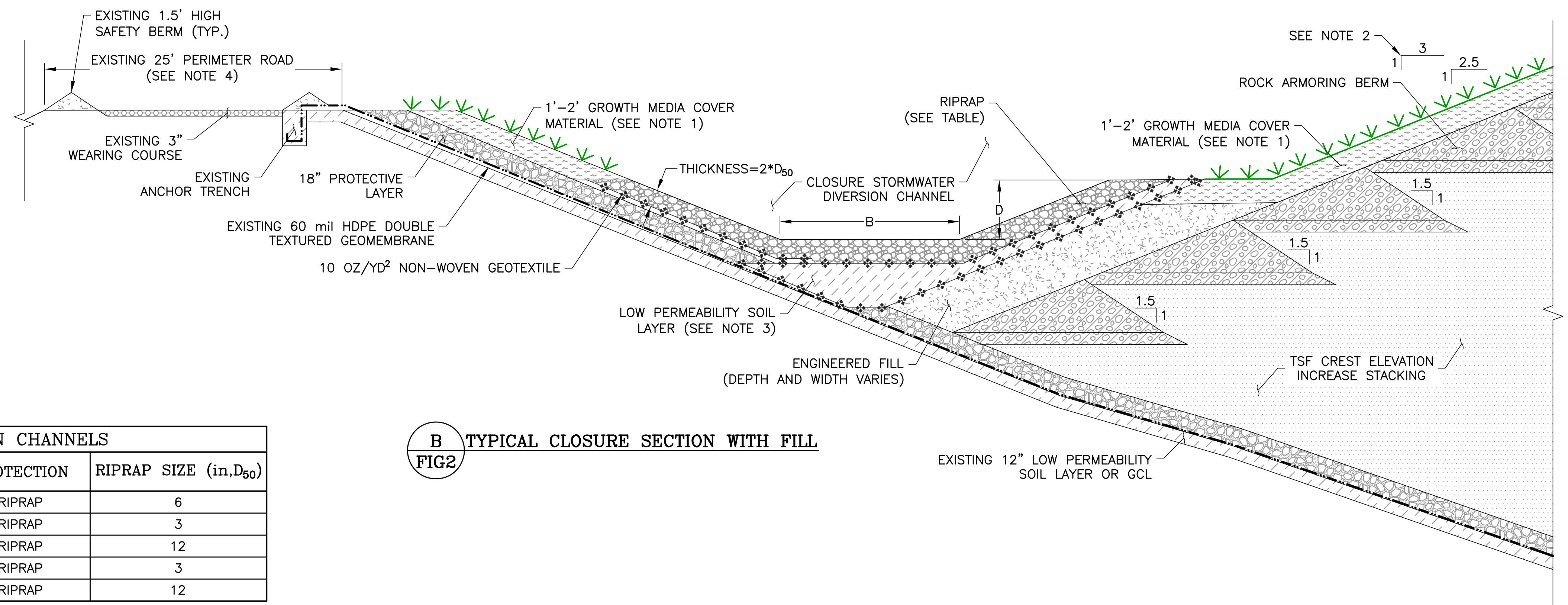
0 200 400 FEET

NewFields	CLIENT: ARIZONA MINERALS INC
PROJECT	HERMOSA LINED TSF DESIGN AMENDMENT
TITLE: HAUL ROADS	FILENAME: 14.022.005F; FIGURE NO.: FIG5; REVISION: A

P:\Projects\0014.022 hermosa vrp tsf expansion\A-CAD\FIGS\srce model\14.022.005F.dwg-8/12/2020 2:08 PM

NOTES:

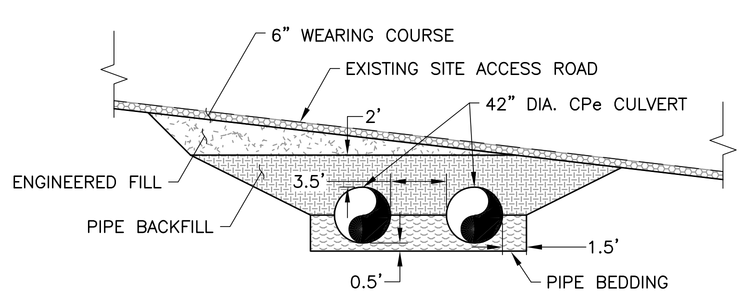
1. GROWTH MEDIA COVER MATERIAL TO BE HYDROSEEDED.
2. 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FT HIGH 2.5H:1V SLOPE IN COMBINATION WITH A 12.5 FT BENCH.
3. LOW PERMEABILITY SOIL TO BE PLACED AT CHANNEL BOTTOM DURING CLOSURE TO PREVENT POTENTIAL RECHARGE OF THE UNDERDRAIN SYSTEM.
4. PERIMETER ROAD TO BE RIPPED UP AT CLOSURE.



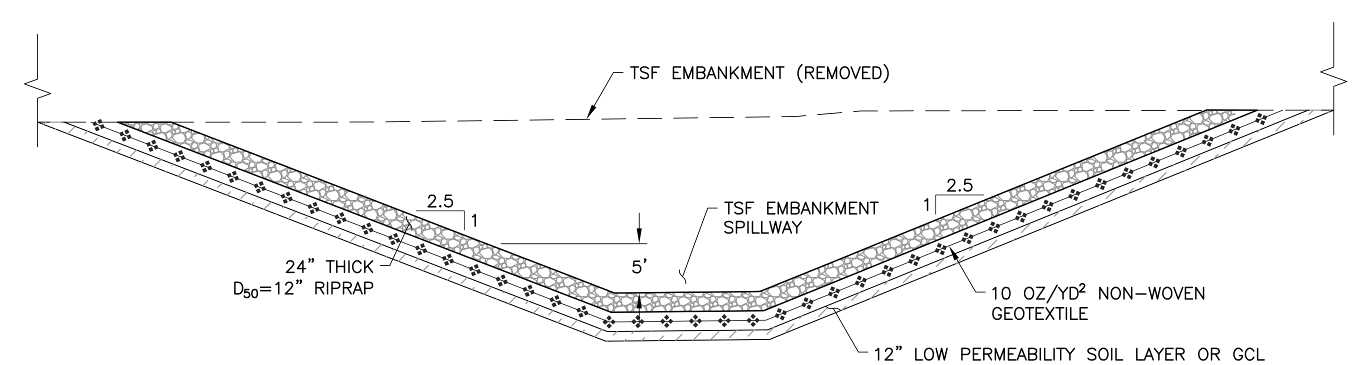
B / FIG2 TYPICAL CLOSURE SECTION WITH FILL

CLOSURE STORMWATER DIVERSION CHANNELS				
STATION	B (ft)	D (ft)	PROTECTION	RIPRAP SIZE (in,D_{50})
0+00 – 6+40	15	4.00	RIPRAP	6
6+40 – 20+67	15	6.00	RIPRAP	3
20+67 – 23+79	15	5.00	RIPRAP	12
23+79 – 32+51	15	6.00	RIPRAP	3
32+51 – 37+00	15	4.00	RIPRAP	12

REFERENCE DRAWING FIG2 FOR ALIGNMENT STATIONING IN PLAN VIEW.



C / FIG2 CLOSURE TSF CULVERT INLET



D / FIG2 CLOSURE TSF SPILLWAY SECTION

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: HERMOSA LINED TSF DESIGN AMENDMENT

TITLE: SECTIONS AND DETAILS

FILENAME: 14.022.006F

FIGURE NO.: FIG6

REVISION: A

P:\Projects\0014.022 hermosa vrp tsf expansion\A-CAD\FIGS\srce model\14.022.006F.dwg-7/28/2020 2:02 PM

ATTACHMENT E

Technical Memorandum

Water Treatment Plant 2 Discharge – Pollutant Management Area Evaluation

by

Ecological Resource Consultants, Inc.

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Technical Memorandum

Date: August 17, 2020

To: Sarah Richman, South32

From: Troy Thompson and Alan Tipton, ERC

Re: Water Treatment Plant 2 Discharge – Pollutant Management Area Evaluation

1 Introduction

Ecological Resource Consultants, Inc. (ERC) was retained to complete an estimate of the extent of the Pollutant Management Area (PMA) associated with discharges from a proposed new water treatment plant (WTP), referred to as WTP2, at the Arizona Minerals, Inc. (AMI) Hermosa Project near Patagonia, Arizona. The PMA represents the maximum anticipated extent that discharge of treated water will travel as surface flow from the discharge point associated with WTP2, based on the plant's maximum 4,500 gallon per minute (gpm) capacity. Although AMI anticipates average discharge rates substantially lower than 4,500 gpm, which would result in a smaller PMA, this maximum rate has been used in order to be conservative. ERC completed a field visit in October 2018 to assess the existing conditions of the area, estimate the infiltration capacity of the receiving streambed, and determine the geometry/hydraulics of the receiving ephemeral stream (Harshaw Creek). This memo summarizes site conditions, assumptions used for the assessment, calculations methods, and results of the evaluation.

2 Water Treatment and Discharge

WTP2 will treat water for reuse on site and for discharge to Harshaw Creek. The design capacity of the plant is 4,500 gpm. Given that Harshaw Creek is generally dry (i.e., ephemeral) with high infiltration rates, water discharge from the WTP is expected to infiltrate. To define the extent of the PMA, this evaluation used 4,500 gpm as an upper bound for potential discharge, field observation, published literature and testing to obtain conservative estimates of downstream areas wetted by WTP2 discharge.

Two seeps exist upstream of the planned discharge location as discussed in Section 3.4. Harshaw Creek dries up shortly downstream of each of these seeps and is dry at the proposed discharge point. Downstream of the discharge point, the channel bed is once again considered an ephemeral stream that is typically dry except after runoff events.

3 ERC Site Visit

ERC visited the Hermosa site on October 29-31, 2018. The intent of the visit was to evaluate the characteristics of Harshaw Creek that would affect infiltration and thus influence the extent of the PMA. As part of this assessment, ERC performed infiltration testing, analyzed existing seeps and infiltration of seepage into the groundwater system, surveyed stream sections, and evaluated sediment sizing at various locations throughout Harshaw Creek downstream of the proposed discharge location. These items were completed to aid in the development of a site-specific infiltration rate that would be considered when estimating infiltration and the extent of the PMA from WTP2 discharges.

3.1 Site Selection

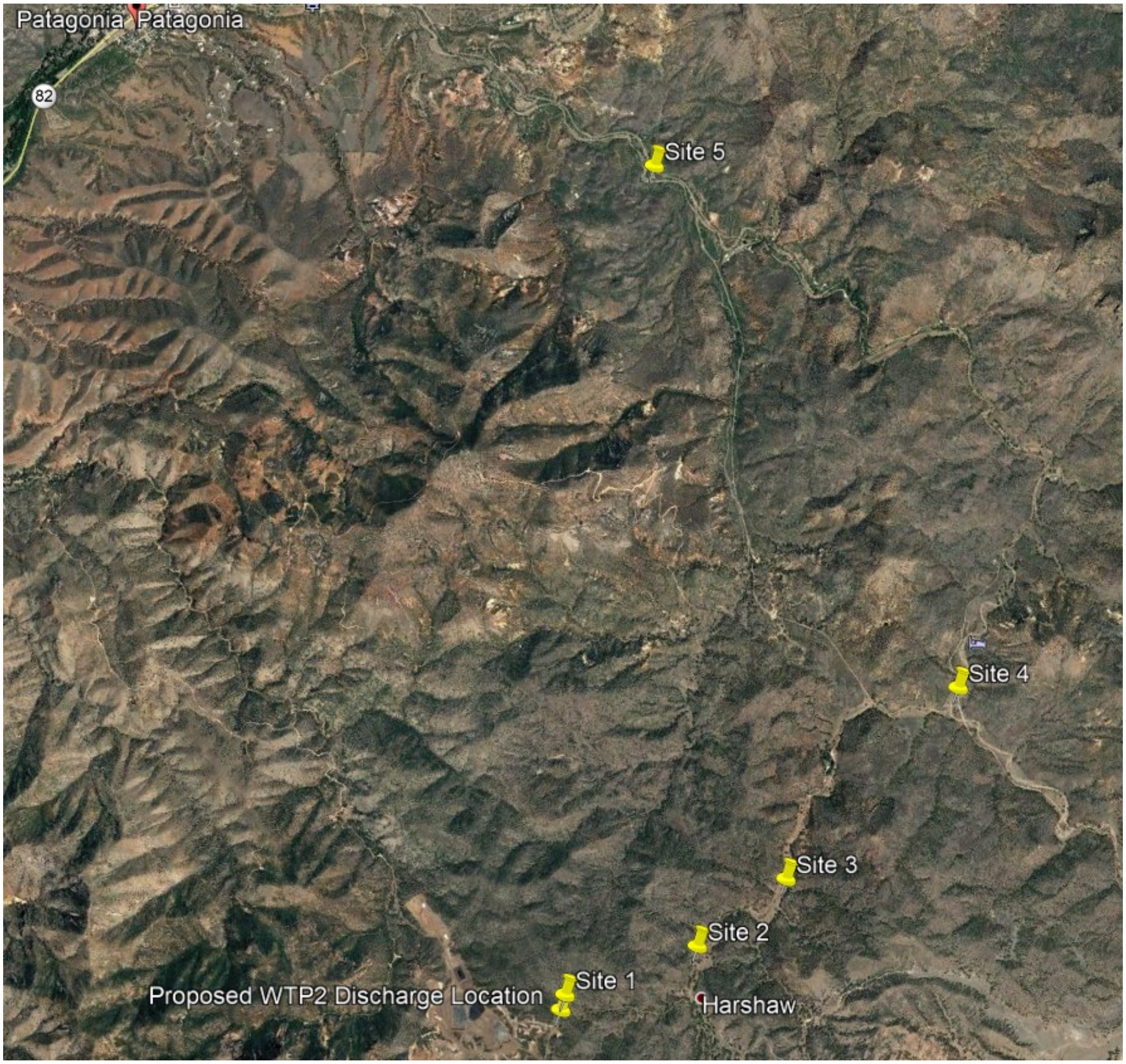
ERC conducted infiltration testing and surveyed cross-sections at five locations along Harshaw Creek. Sites were selected along a nearly 9-mile reach of Harshaw Creek so that information would be available to evaluate spatial variability downstream of the discharge point. Locations of the five sites are provided in **Table 1**, while **Figure 1** depicts an aerial view of the five sites along Harshaw Creek and in relation to the proposed WTP2 discharge location.

Table 1 – Infiltration Test Site Locations

Site	Distance Downstream from Discharge Site (mi)
1	0.2
2	1.1
3	1.8
4	3.6
5	8.7

At each of the five sites, ERC found the channel bed of Harshaw Creek to consist primarily of coarse sand and gravel with occasional cobble-sized material present. No vegetation was observed growing within the channel itself, while the floodplain outside of the main channel contained grasses, shrubs, cactus, and trees. ERC's cross-sectional surveys at each site measured channel bank height ranging from about 1-4 feet and channel bed width ranging from approximately 4 feet at Site 1 to about 35 feet at Site 3. The average channel bed width determined from the 5 sites was approximately 19 feet.

Figure 1 – Infiltration Test Site Locations along a segment of Harshaw Creek



3.2 Sediment Sizing

As described previously, visual observations of the surface material showed the Harshaw Creek bed to consist primarily of sand and gravel with some cobble size fragments. Little to no clay or silt material was observed at any of the sites. To quantify the size of the typical bed material, ERC completed a sediment gradation analysis at each site using the Federal Highway Administration's Hydraulic Toolbox application (FHWA 2018). This application determines the gradation of surface material using photographs of the sediment taken with a known dimension supplied in each photo. The program uses filters to separate the voids from the solid surfaces of individual particles to determine the size and distribution of particles. **Figure 2** presents a sample input photograph used by the application, while all photos used in the analysis are provided in **Appendix A**. ERC obtained between 4 and 6 photos at each infiltration site and used them to quantify a cumulative gradation. **Table 2** and **Figure 3** show the calculated gradations in tabular and graphical form, respectively.

Figure 2 – Sample Input Photograph to Determine Sediment Gradation using FHWA's Hydraulic Toolbox (Site 2 pictured)

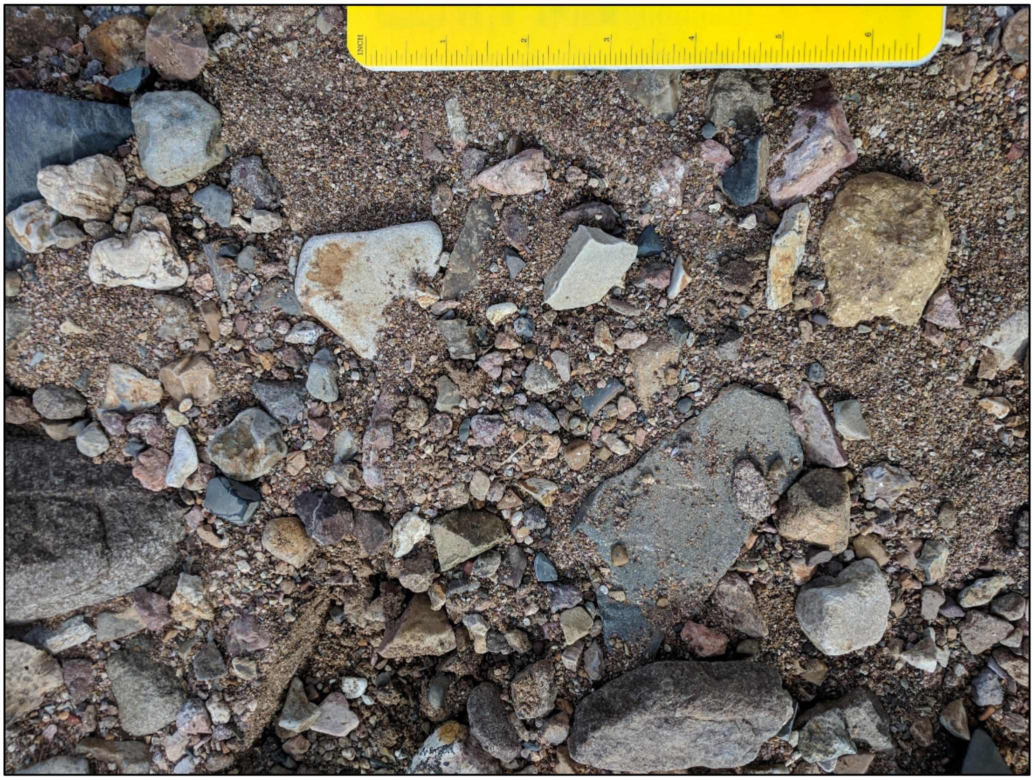
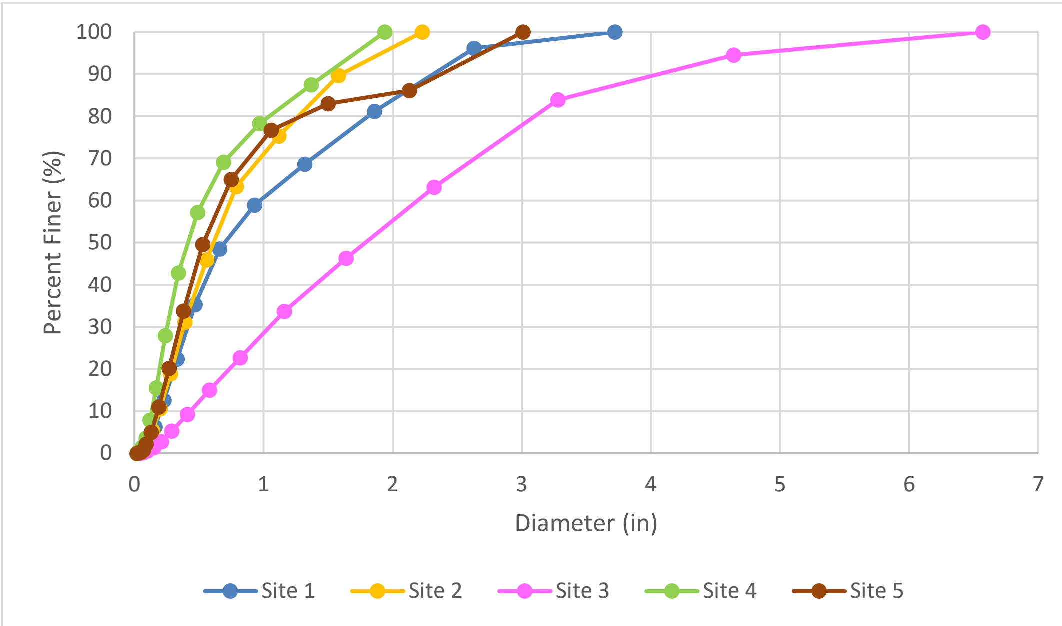


Table 2 – Bed Material Gradations from Hydraulic Toolbox

% Finer	Site 1 Substrate Sizes (in)	Site 2 Substrate Sizes (in)	Site 3 Substrate Sizes (in)	Site 4 Substrate Sizes (in)	Site 5 Substrate Sizes (in)
5	0.15	0.13	0.28	0.10	0.13
15	0.26	0.24	0.58	0.17	0.22
50	0.70	0.61	1.79	0.41	0.54
85	2.06	1.43	3.42	1.26	1.91
100	3.72	2.23	6.57	1.94	3.01

Figure 3 – Bed Material Gradations from Hydraulic Toolbox



The median bed material (D_{50}) value of the five site gradations ranged from 0.41 inches at Site 4 to 1.79 inches at Site 3. At all sites, these median particle sizes classify as gravel using ASTM and AASHTO classification systems (Holtz and Kovacs, 1981). The D_5 of the bed material (representing the particle size greater than 5% of the total material) varied between 0.10 inches at Site 4 to 0.28 inches at Site 3, suggesting very few fine particles were present in the samples. Depending on the sediment grade scale being considered, these sizes classify as either a coarser sand or a finer gravel. The surface gradations produced by the Hydraulic Toolbox application support ERC's field observations of coarser material throughout all five sites with the main Harshaw Creek channel.

Figure 4 shows that the gradation for Site 3 appears to be an outlier in that its bed gradation is coarser than that from the other four sites. This site is located at the downstream end of a small braided section of Harshaw Creek, with samples collected from the east branch, the west branch, and immediately downstream of the junction of the two branches. On the east branch of the braid, ERC observed much less sandy material than the other sites visited throughout the creek noting mostly large gravel and cobble material along with patches of dried-out mud. **Figure 4** depicts a sample photograph of the bed material along the east branch just before the braided creek returns to one channel. This was the only site visited by ERC where this material distribution was observed, and ERC does not believe it representative of the Harshaw Creek main channel (refer to **Appendix A** for photos from all sites). If this location was excluded from the Hydraulic Toolbox analysis and only the sample sites on the west branch of the stream and downstream of the junction of the two braids considered, the application produces a D_{50} of the Site 3 bed material of 0.64 inches, which is consistent with the median particle sizes of the other sites listed above in **Table 2**.

Figure 4 – Sample Bed Material at East Branch of Site 3

3.3 Infiltration Testing

ERC performed infiltration testing at each of the five sites using methodology provided by the U.S. Environmental Protection Agency (EPA 1980). ERC typically completed three separate infiltration tests at each of the five sites. At four of the areas the three tests were completed at upstream, middle, and downstream locations. Site 3, which as described above was selected at the downstream end of a small braided section in the stream, was the exception with tests done in the east branch of the creek, the west branch, and at the junction of the two branches. ERC's field results from the infiltration testing are provided in **Table 3**. Discussion of these results in relation to the overall analysis is provided in a subsequent section of this memorandum. The full raw data from the infiltration tests at each site is available in **Appendix B**.

Table 3 – Infiltration Rate Results

Location	Sample Site	Infiltration Rate (in/hr)	Infiltration Rate (ft/d)
Site 1	Upstream	150	300
	Middle	210	420
	Downstream	900	1,800
Site 2	Upstream	80	160
	Middle	150	300
	Downstream	45	90
Site 3	East Branch	210	420
	West Branch	278	555
	Junction	75	150
Site 4	Upstream	23	45
	Middle	55	110
	Downstream	60	120
Site 5	Upstream	105	210
	Middle	195	390
	Downstream	315	630

3.4 Existing Surface Flows Assessment

ERC investigated two locations along Harshaw Creek where surface water was present at the time of the October 2018 site visit. The first location (Seep 1) is approximately 0.6 miles upstream of the WTP2 discharge location at the outfall of an old masonry dam, and the second location (Seep 2) is approximately 0.4 miles upstream of the discharge location. These locations are shown in **Figure 5**. ERC estimated the infiltration rates of Harshaw Creek downstream of the seeps by measuring the current flow rate at the upstream end of each seep and then dividing the flow rate by the approximate surface area of the wetted area at each location.

The channel through which Seep 1 was flowing at the time of the site visit consisted primarily of exposed bedrock with shallow patches of sand and finer material present in pools between the bedrock. **Figure 6** displays a typical pool within the wetted area of the seep. Flow was passing through a small pipe in the masonry dam at the upstream end of the seep during the site visit (**Figure 7**). ERC measured the flow rate out of the pipe by placing a bucket under the pipe outlet and measuring the volume of water filling the bucket over a 30-second period. This was conducted three times and flow rates of 0.011, 0.010, and 0.012 cfs were calculated, for an average rate of 0.011 cfs. ERC measured from the upstream to downstream end of the seep to get a wetted channel bed length of approximately 285 feet and measured the width at roughly 20-foot intervals to obtain an average wetted width of about 2.9 feet, resulting in a total wetted area of approximately 827 ft^2. Dividing the average measured flow rate by this wetted area produces an average infiltration rate of 0.57 inches per hour (in/hr), or 1.14 feet per day (ft/d).

Figure 5 – Seep 1 and 2 Locations

Figure 6 – Typical Seep 1 Bedform, Looking Upstream

Figure 7 – Mason Dam at the Upstream End of Seep 1

Seep 2 consisted of significant quantities of exposed bedrock with gravel, sand, and finer material dispersed throughout, although ERC observed less bedrock in the channel surface downstream of Seep 2 than was noted below Seep 1 (**Figure 8)**. ERC measured from the upstream end to the downstream end of the wetted area in Seep 2 to get a length of approximately 400 feet and measured the average width to be 2.0 feet, for a total wetted area of approximately 811 ft^2. Because there was no single point source from Seep 2, ERC estimated the flow rate by using field methods to approximate velocity at multiple locations and then multiplying each velocity by the width and depth of the flow at those locations. ERC calculated an average flow rate in this seep of 0.041 cfs. This results in a calculated infiltration rate of 2.21

in/hr, or 4.42 ft/d. Flow parameters and the calculated infiltration rates for Seeps 1 and 2 are provided in **Table 4**.

Table 4 – Flow Estimates and Calculated Infiltration Rates from Seeps 1 and 2

Location	Estimated Flow (cfs)	Approximate Length (ft)	Average Width (ft)	Infiltration Rate (in/hr)	Infiltration Rate (ft/d)
Seep 1	0.011	285	2.9	0.57	1.14
Seep 2	0.041	400	2.0	2.21	4.42

Figure 8 – Typical Seep 2 Bedform, Looking Upstream

3.5 Typical Infiltration Rates

Typical infiltration rates based on soil types have been evaluated. The Army Corps of Engineers (Army Corps) rainfall- runoff model HEC-HMS provides estimates of constant infiltration rates for saturated soil conditions. This would be representative of conditions after sustained discharges. **Table 5**, reproduced from the HEC-HMS Technical Reference Manual, provides range of infiltration rates for Natural Resource Conservation Service (NRCS) Soil Hydrologic Groups.

Table 5 – Typical Water Infiltration Rates by Soil Group, from Army Corps of Engineers

Soil Hydrologic Group	Description	Range of Loss Rates (in/hr)
A	Deep sand, deep loess, aggregated silts	0.30 – 0.45
B	Shallow loess, sandy loam	0.15 – 0.30
C	Clay loam, shallow sandy loam, soils low in organic content and soils usually high in clay	0.05 – 0.15
D	Soils that swell significantly when wet, heavy plastic clays and certain saline soils	0.00 – 0.05

As described in Section 4, soils encountered in the channel were generally gravels with 95% of the material sand or coarser. This suggests that infiltration is expected to be at the high end of NRCS Soil Hydrologic Group A for infiltration. Saturated infiltration rates of approximately 0.45 in/hr are therefore predicted based on Army Corps published data. For sandy soils such as those observed in Harshaw Creek, the NRCS states that steady infiltration rates can be greater than 0.8 in/hr (1.6 ft/d) (NRCS 2018), while other sources suggest rates for these types of material can be greater than 8 in/hr (16 ft/d) but recommend that testing is conducted at any individual sites in question (MPCA 2018).

4 Infiltration Rate Discussion and Selection

ERC estimated the overall infiltration rate along a study area of Harshaw Creek using three different methods: field infiltration testing at five sites along the creek, flow and wetted perimeter calculations at seeps with surface water present at the time of ERC's October 2018 site visit, and typical published values as discussed in **Section 3.3 – 3.5**. Infiltration results from the three methodologies are shown in **Table 6**. As seen in this table, there is considerable variation in the infiltration rates depending on the method used.

Table 6 – Measured and Published Infiltration Rates

Method	Infiltration Rate (in/hr)	Infiltration Rate (ft/d)
Channel Bed Infiltration Testing	23 – 900	45 – 1,800
Seep Analysis	0.57 – 2.21	1.14 – 4.42
Army Corps HEC-HMS Published Data	0.45	0.9
NRCS Published Data	Can be > 0.8	Can be > 1.6
MPCA Published Data	Can be > 8	Can be > 16

The high infiltration rates measured by ERC during field testing at all five sites reflect the coarse sediment material observed to be ubiquitous throughout Harshaw Creek. Although these rates appeared to approach steady state conditions during the tests, rates are likely still much higher than would be expected during long-term wetted conditions. The surface layer of the soil appears to have become adequately saturated based on the testing results, but it is likely that significant lateral flows occurred, influencing infiltration. The final steady state infiltration rate of the soil is difficult to ascertain in a field test without being able to observe the soil being wetted for at least a couple of days to confirm that the entire subsurface is completely saturated. ERC believes the infiltration rate results obtained during the October 2018 site visit were accurate for the near surface material during a relatively short test but would decrease over time as continuous discharge from WTP2 saturates the subsurface. We therefore do not believe they represent long-term infiltration values that could be expected in Harshaw Creek and have not used these values for the PMA calculations.

The infiltration rate at the two upstream seeps is expected to be less than the overall average infiltration rate of the creek due to the significant exposed bedrock present at both seep locations. Areas in Harshaw Creek downstream of the proposed discharge have little to no exposed bedrock. Calculated infiltration rates below Seep 1 were less than below Seep 2 likely due to greater prevalence of bedrock (**Table 4**). Infiltration rates increase in areas without bedrock control, as observed below Seep 2 where the seep water infiltrated almost immediately at the transition from exposed bedrock to coarse grained channel bed materials (**Figure 9**).

Despite the amount of bedrock present downstream of Seep 1 and the low calculated infiltration rate in this area, we believe that the infiltration rate estimated below Seep 1 is an appropriate value to use to conservatively define the extent of the PMA. The calculated infiltration rate of 0.57 in/hr below Seep 1 is comparable to the lower end of the range of published values (0.45 in/hr to >8 in/hr) for similar material types. Consequently, ERC selected 0.57 in/hr or 1.14 ft/d to estimate the downstream extent of the proposed maximum WTP2 discharge.

Figure 9 – Downstream End of Seep 2

5 Extent of WTP2 Discharge

ERC developed a model to estimate the downstream distance in Harshaw Creek where discharge from WTP2 would remain on the surface before infiltration. The model divides Harshaw Creek into five reaches separated by the locations of ERC's surveyed cross-sections. ERC created rating curves for the geometry of each reach using the Army Corps of Engineer's river analysis system HEC-RAS (version 5.0.5) to obtain wetted perimeter values of the cross-sections for various discharge rates. The channel geometry was determined using ERC's survey data taken from the five sites during the October 2018 investigation (see **Appendix C**). The geometry of each reach was input to HEC-RAS by interpolating the average of the upstream and downstream cross-sections. The average cross-sectional geometry was then used throughout the reach. For example, for the reach of the creek between Sites 1 and 2, an average cross-section geometry and slope from the two sites was developed and applied throughout the entire reach length. For the reach located between WTP2 discharge point and the first cross-section, the geometry and slope obtained from Site 1 was used. Similarly, any modeling downstream of Site 5 assumed the geometry and slope was identical to that of Site 5.

After the relationship between flow and wetted perimeter was developed for each reach, ERC estimated flow reduction from the proposed discharge location. As water travels through the channel, flow is expected to be lost to infiltration, resulting in a smaller wetted area, which results in less infiltration per linear foot of stream. ERC conducted this analysis using a step-wise process, where an initial flow was applied at the discharge point, a wetted perimeter value obtained from the reach's rating curve, and a final flow rate (Q) calculated using **Equation 1** at a location 100 feet downstream of the previously calculated upstream point, where Q_0 equals the initial flow rate at the upstream end of a given reach, F equals the infiltration rate of the stream bed, L equals the length of the channel, and WP equals the wetted perimeter of the channel. The calculated flow rate at the end of each segment of the creek was set as the initial flow rate for the next segment, and the process was repeated at 100-foot intervals progressing downstream until the flow rate was zero. Infiltration losses in each segment was taken by multiplying the wetted perimeter by the infiltration rate of 0.57 in/hr.

Equation 1 – Calculated Downstream Flow Rates Following Infiltration

$$Q = Q_0 - F * L * WP$$

Using this method and assumptions, including a Manning's n value of 0.04, ERC estimated changes in flow due to infiltration within Harshaw Creek downstream of the WTP2 discharge point. Results indicate that a discharge of 4,500 gpm would travel approximately 49,400 feet, or about 9.4 miles downstream before fully infiltrating. ERC observed a segment of standing water approximately 2,800 feet long located 4.5 miles from the proposed discharge location during the October 2018 site visit. The analysis assumed no infiltration will occur in this 2,800-foot section. Calculated flow rates at distances downstream from the discharge point are provided in **Table 7** and **Figure 10**, and the calculated maximum flow distance is depicted on **Figure 11**.

It should be noted that the infiltration calculations and resultant area predicted to be inundated are based on the maximum predicted WTP2 discharge rate and they exclude any losses due to evapotranspiration (ET). At times when WTP2 is operating below its capacity and when ET is occurring, the extent of inundation is expected to be less than presented in this analysis. The discharge and stream flow are assumed to be constant and at steady state; this analysis does not assess transient events or changes in streambed or aquifer storage over time.

Table 7 – Predicted Flows in Harshaw Creek from Maximum WTP2 Discharge of 4,500 gpm

Distance from WTP2 Discharge (ft)	Distance from Discharge (mi)	Flow (gpm)
0	0.00	4,500
5,000	0.95	4,243
10,000	1.89	3,807
15,000	2.84	3,293
20,000	3.79	2,829
27,800	5.27	2,489
32,800	6.21	2,064
37,800	7.16	1.567
42,800	8.11	899
47,800	9.05	132
49,400	9.36	0

Figure 10 – Flows in Harshaw Creek with an Infiltration Rate of 0.57 in/hr (1.14 ft/d)

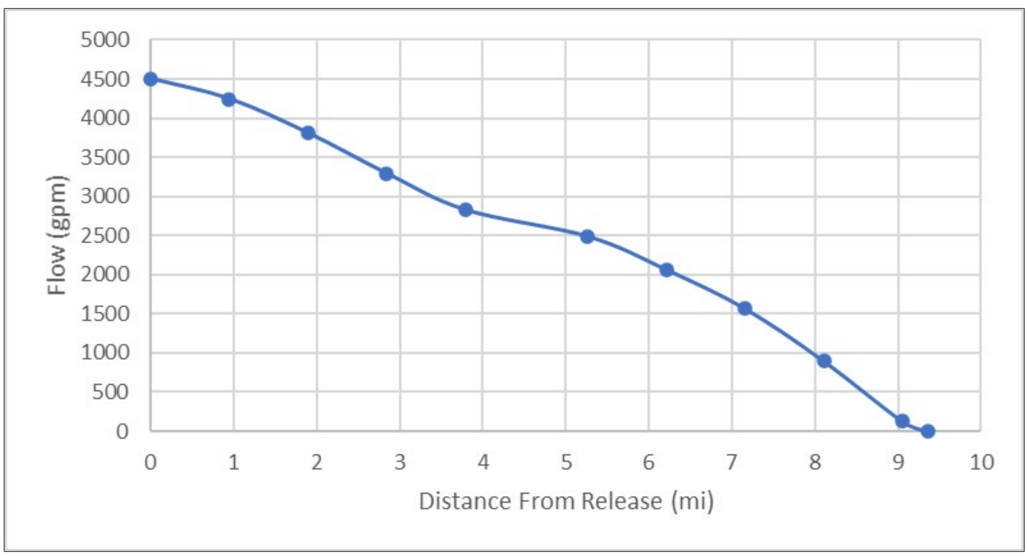
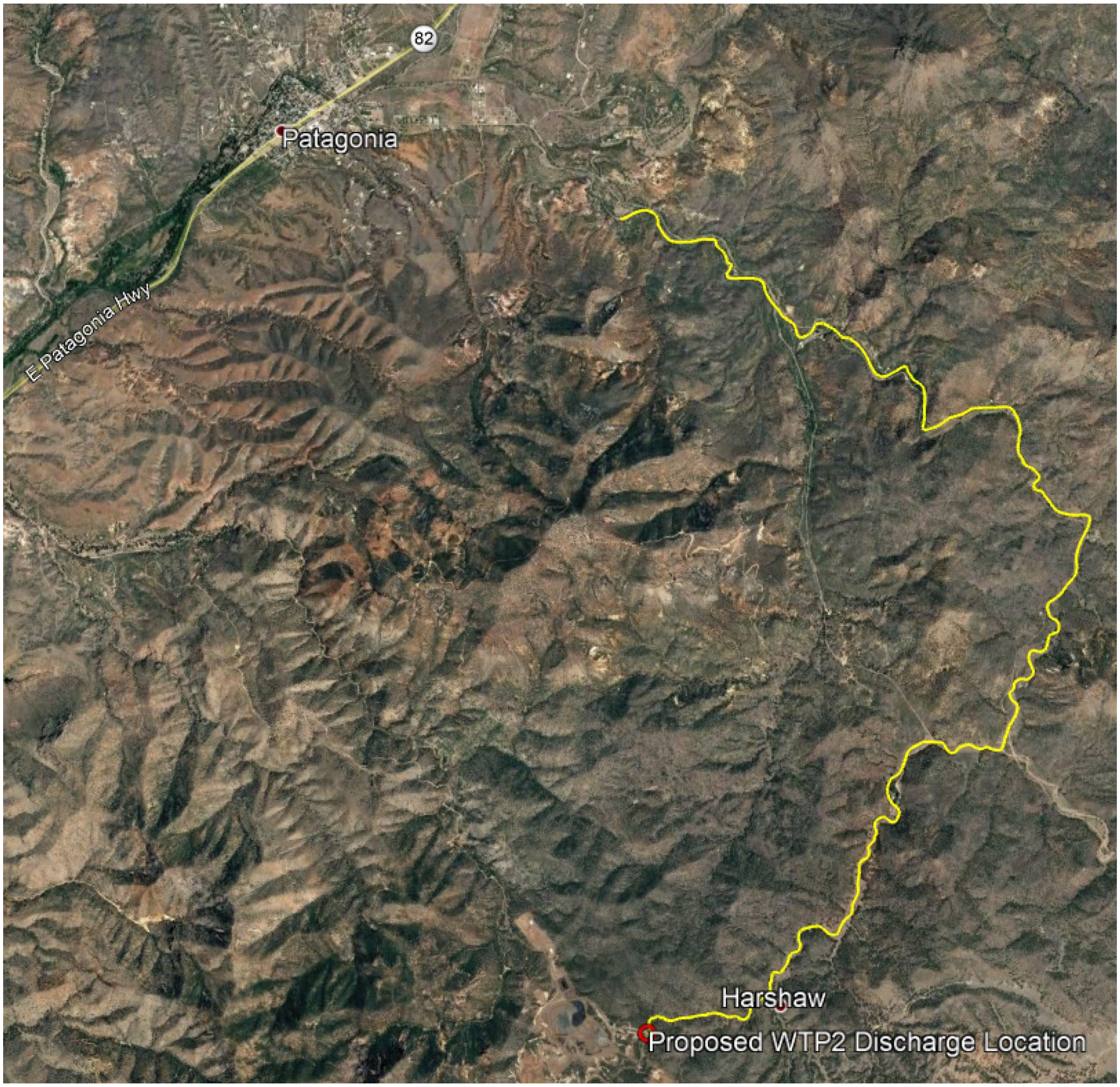


Figure 11 – Extent of Calculated PMA in Harshaw Creek (yellow) Resulting from Maximum 4,500 gpm Discharge from WTP2



6 Conclusions

The purpose of this evaluation was to estimate the extent of the PMA (i.e., extent of surface flow) in Harshaw Creek that would result from the maximum WTP2 discharge. The evaluation conservatively assumed that WTP2 would discharge at 4,500 gpm, which is equal to the planned WTP2 capacity and greater than anticipated average plant discharge. ERC's field visit found the Harshaw Creek streambed downstream of the WTP2 discharge location to primarily consist of gravel-sized material. Based on field infiltration testing, an assessment of two seeps observed upstream of the proposed discharge location at the time of the site visit, and review of published data of typical infiltration rates by material type, ERC conservatively estimated a steady-state infiltration rate of 0.57 in/hr (1.14 ft/d). Using this infiltration rate, ERC predicts the PMA will extend 9.36 miles along Harshaw Creek from the WTP2 discharge point.

7 References

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8 Appendices

Appendix A – Channel Bed Surface Material Photographs

Appendix B – Infiltration Rate Testing Raw Data

Appendix C – Surveyed and Interpolated Cross-Sectional Data

Appendix A

Channel Bed Surface Material Photographs

Figure A1 – Site 1 Channel Bed Surface Material

Figure A2 – Site 1 Channel Bed Surface Material

Figure A3 – Site 1 Channel Bed Surface Material

Figure A4 – Site 1 Channel Bed Surface Material

Figure A5 – Site 1 Channel Bed Surface Material

Figure A6 – Site 1 Channel Bed Surface Material

Figure A7 – Site 2 Channel Bed Surface Material

Figure A8 – Site 2 Channel Bed Surface Material

Figure A9 – Site 2 Channel Bed Surface Material

Figure A10 – Site 2 Channel Bed Surface Material

Figure A11 – Site 2 Channel Bed Surface Material

Figure A12 – Site 2 Channel Bed Surface Material

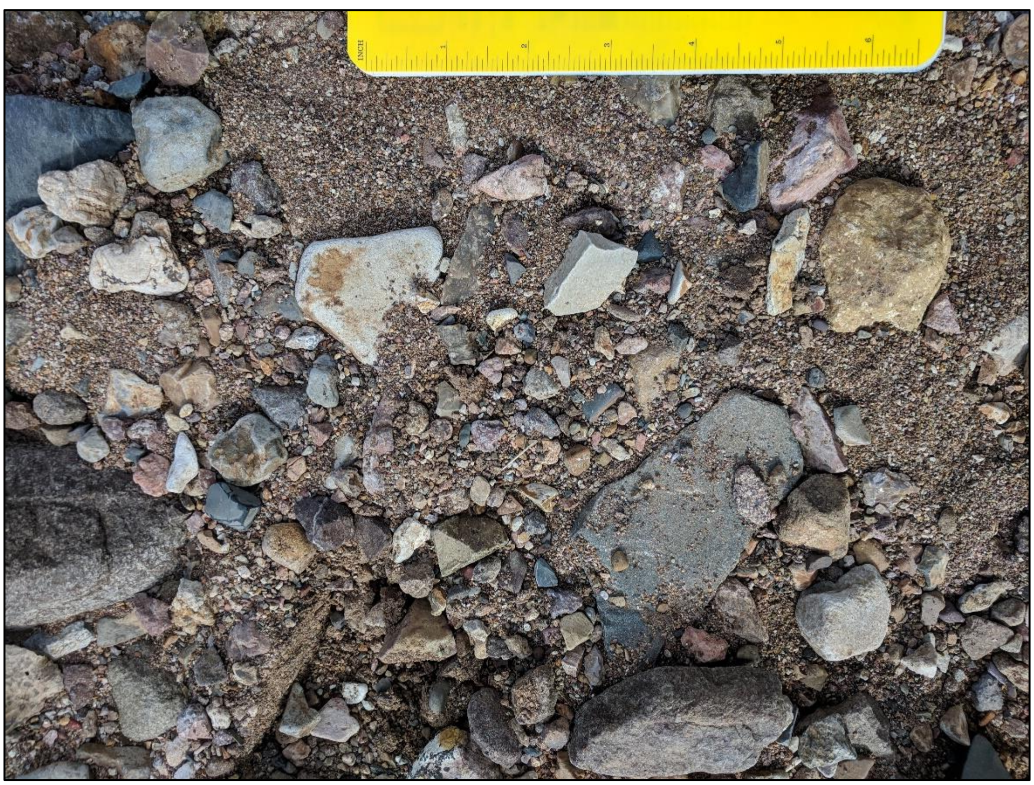


Figure A13 – Site 3 Channel Bed Surface Material (East Branch)

Figure A14 – Site 3 Channel Bed Surface Material (East Branch)

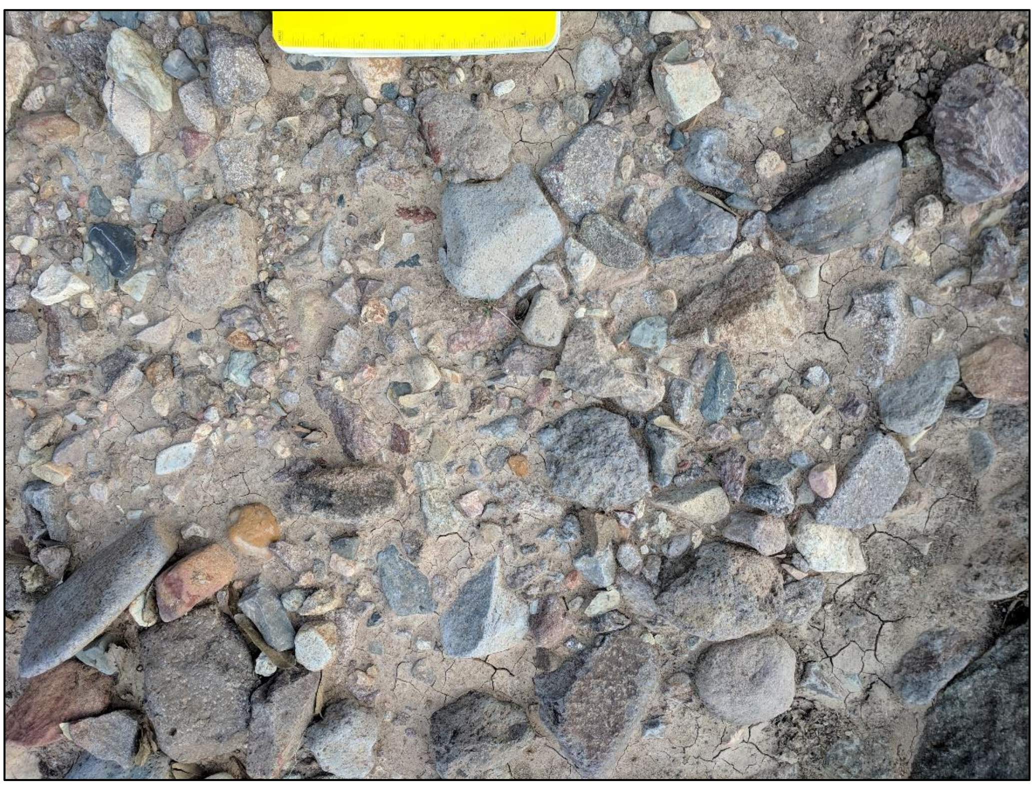


Figure A15 – Site 3 Channel Bed Surface Material (West Branch)

Figure A16 – Site 3 Channel Bed Surface Material (West Branch)

Figure A17 – Site 3 Channel Bed Surface Material (Downstream of Junction)

Figure A18 – Site 3 Channel Bed Surface Material (Downstream of Junction)

Figure A19 – Site 4 Channel Bed Surface Material

Figure A20 – Site 4 Channel Bed Surface Material

Figure A21 – Site 4 Channel Bed Surface Material

Figure A22 – Site 4 Channel Bed Surface Material

Figure A23 – Site 4 Channel Bed Surface Material

Figure A24 – Site 4 Channel Bed Surface Material

Figure A25 – Site 5 Channel Bed Surface Material

Figure A26 – Site 5 Channel Bed Surface Material

Figure A27 – Site 5 Channel Bed Surface Material

Figure A28 – Site 5 Channel Bed Surface Material

Appendix B

Infiltration Rate Testing Raw Data

Table B1 – Site 1 Infiltration Testing Data

Location	Run	Time (sec)	Start Depth (in)	End Depth (in)	Delta (in)	Rate (in/s)	Rate (in/hr)	Rate (ft/d)
Upstream	1	50	5.25	0	5.25	0.105	378	756
Upstream	2	47	4.875	0	4.875	0.104	373	747
Upstream	3	60	5.375	1.75	3.625	0.060	218	435
Upstream	4	60	5.25	2.375	2.875	0.048	173	345
Upstream	5	60	4.125	1.625	2.5	0.042	150	300
Middle	1	60	6	2.125	3.875	0.065	233	465
Middle	2	60	5.875	2	3.875	0.065	233	465
Middle	3	60	5.875	2.375	3.5	0.058	210	420
Downstream	1	15	5.25	0	5.25	0.350	1,260	2,520
Downstream	2	21	5.125	0	5.125	0.244	879	1,757
Downstream	3	19	5.5	0	5.5	0.289	1,042	2,084
Downstream	4	22	5.5	0	5.5	0.250	900	1,800

Table B2 – Site 2 Infiltration Testing Data

Location	Run	Time (sec)	Start Depth (in)	End Depth (in)	Delta (in)	Rate (in/s)	Rate (in/hr)	Rate (ft/d)
Upstream	1	90	6.5	3.625	2.875	0.032	115	230
Upstream	2	90	6.125	3.875	2.25	0.025	90	180
Upstream	3	90	6	4	2	0.022	80	160
Middle	1	60	6	2.5	3.5	0.058	210	420
Middle	2	60	6.125	3.625	2.5	0.042	150	300
Middle	3	60	5.875	3.375	2.5	0.042	150	300
Downstream	1	90	6.75	3.875	2.875	0.032	115	230
Downstream	2	90	6.25	4.625	1.625	0.018	65	130
Downstream	3	90	5.25	4.25	1	0.011	40	80
Downstream	4	90	6	4.5	1.5	0.017	60	120
Downstream	5	90	6.125	5	1.125	0.013	45	90

Table B3 – Site 3 Infiltration Testing Data

Location	Run	Time (sec)	Start Depth (in)	End Depth (in)	Delta (in)	Rate (in/s)	Rate (in/hr)	Rate (ft/d)
East Branch	1	60	4.875	0.625	4.25	0.071	255	510
East Branch	2	60	5.625	1.5	4.125	0.069	248	495
East Branch	3	60	5.375	1.75	3.625	0.060	218	435
East Branch	4	60	5.375	1.875	3.5	0.058	210	420
West Branch	1	39	6.25	0	6.25	0.160	577	1,154
West Branch	2	42	5.5	0	5.5	0.131	471	943
West Branch	3	60	6	0.5	5.5	0.092	330	660
West Branch	4	60	6.75	1.75	5	0.083	300	600
West Branch	5	60	6.125	1.375	4.75	0.079	285	570
West Branch	6	60	6.5	1.875	4.625	0.077	278	555
Junction	1	60	6.375	3.875	2.5	0.042	150	300
Junction	2	60	6.25	4.5	1.75	0.029	105	210
Junction	3	60	5.875	4.5	1.375	0.023	83	165
Junction	4	60	6	4.75	1.25	0.021	75	150

Table B4 – Site 4 Infiltration Testing Data

Location	Run	Time (sec)	Start Depth (in)	End Depth (in)	Delta (in)	Rate (in/s)	Rate (in/hr)	Rate (ft/d)
Upstream	1	60	5.625	4.75	0.875	0.015	53	105
Upstream	2	60	5.875	5.25	0.625	0.010	38	75
Upstream	3	60	6.125	5.625	0.5	0.008	30	60
Upstream	4	60	6.375	6	0.375	0.006	23	45
Middle	1	90	5.625	3.25	2.375	0.026	95	190
Middle	2	90	6.125	4.25	1.875	0.021	75	150
Middle	3	90	6	4.5	1.5	0.017	60	120
Middle	4	90	6.25	4.875	1.375	0.015	55	110
Downstream	1	90	5.5	3.375	2.125	0.024	85	170
Downstream	2	90	5.875	4.125	1.75	0.019	70	140
Downstream	3	90	5.375	3.75	1.625	0.018	65	130
Downstream	4	90	5.75	4.25	1.5	0.017	60	120

Table B5 – Site 5 Infiltration Testing Data

Location	Run	Time (sec)	Start Depth (in)	End Depth (in)	Delta (in)	Rate (in/s)	Rate (in/hr)	Rate (ft/d)
Upstream	1	60	5.125	1.875	3.25	0.054	195	390
Upstream	2	60	6.5	4.25	2.25	0.038	135	270
Upstream	3	60	6	3.875	2.125	0.035	128	255
Upstream	4	60	6.125	4.25	1.875	0.031	113	225
Upstream	5	60	6.125	4.375	1.75	0.029	105	210
Middle	1	60	5.5	1.5	4	0.067	240	480
Middle	2	60	5.5	2	3.5	0.058	210	420
Middle	3	60	5.75	2.5	3.25	0.054	195	390
Middle	4	60	6.375	3.125	3.25	0.054	195	390
Downstream	1	43	3.875	0	3.875	0.090	324	649
Downstream	2	58	5.125	0	5.125	0.088	318	636
Downstream	3	60	5.625	0.125	5.5	0.092	330	660
Downstream	4	60	5.75	0.5	5.25	0.088	315	630
Downstream	5	60	5.25	0	5.25	0.088	315	630

Appendix C

Surveyed Geometry Data

Table C1 – Site 1 Channel Geometry (Relative Elevations)

Station (ft)	Elevation (ft)
0.0	100.00
3.0	99.36
5.0	98.06
7.5	98.05
9.0	98.26
11.0	99.12
14.0	99.94

Figure C1 – Site 1 Channel Geometry (Relative Elevations)

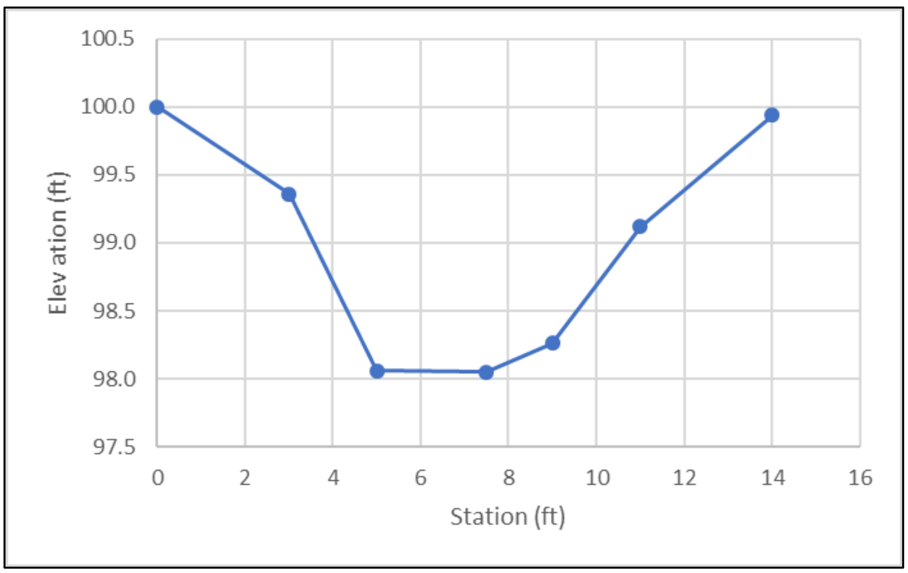


Table C2 – Average Channel Geometry Between Sites 1 and 2 (Relative Elevations)

Station (ft)	Elevation (ft)
0.0	100.00
2.8	97.95
4.1	97.70
6.3	96.94
6.8	96.77
10.3	96.46
13.4	96.72
13.5	96.74
16.1	97.31
17.7	97.66
20.1	98.12

Figure C2 – Average Channel Geometry Between Sites 1 and 2 (Relative Elevations)

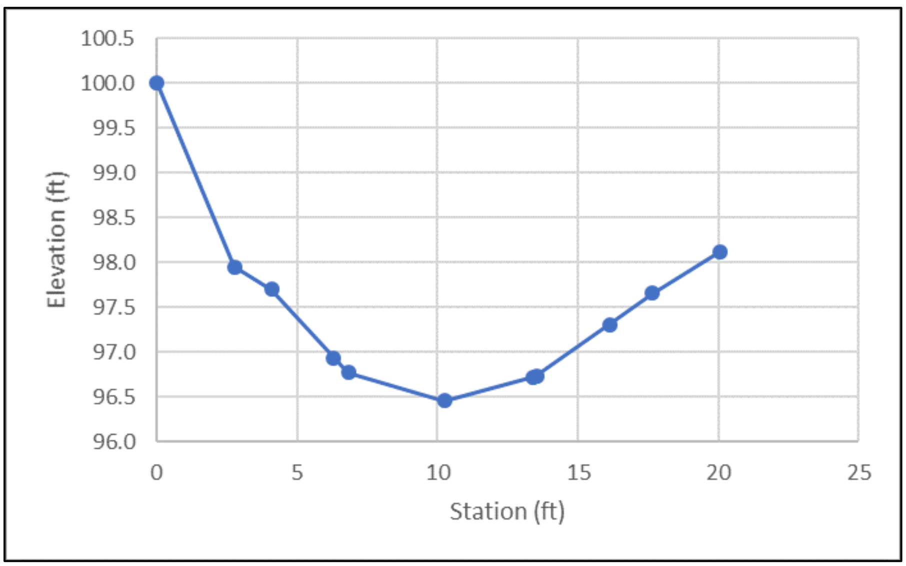


Table C3 –Site 2 Channel Geometry (Relative Elevations)

Station (ft)	Elevation (ft)
0.0	100.00
3.5	96.33
8.0	95.57
13.0	94.87
18.0	95.20
22.0	95.81
28.0	96.81
34.0	98.85

Figure C3 – Site 2 Channel Geometry (Relative Elevations)

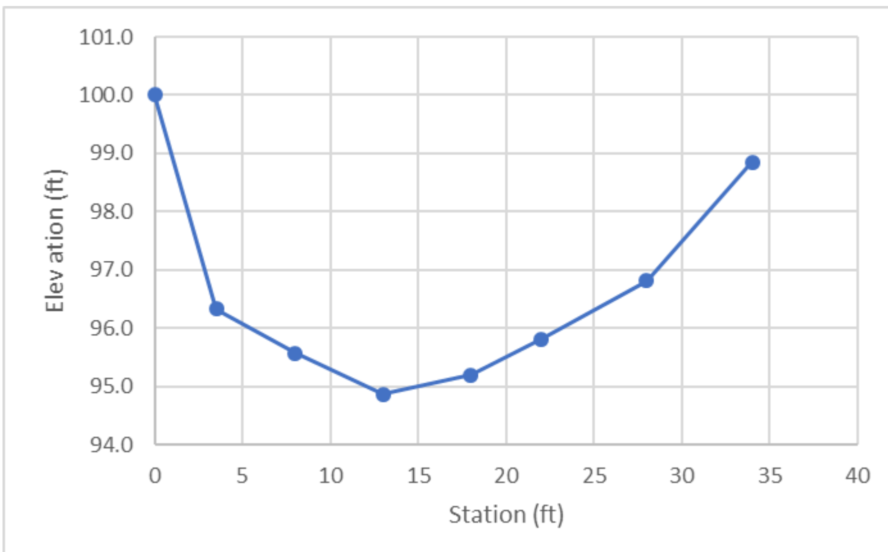


Table C4 – Average Channel Geometry Between Sites 2 and 3 (Relative Elevations)

Station (ft)	Elevation (ft)
0.0	100.00
2.1	98.90
6.4	97.47
13.8	96.80
14.6	96.78
19.3	96.66
23.8	96.19
27.1	96.44
29.9	96.81
30.4	96.89
33.9	98.22
38.0	100.26

Figure C4 – Average Channel Geometry Between Sites 2 and 3 (Relative Elevations)

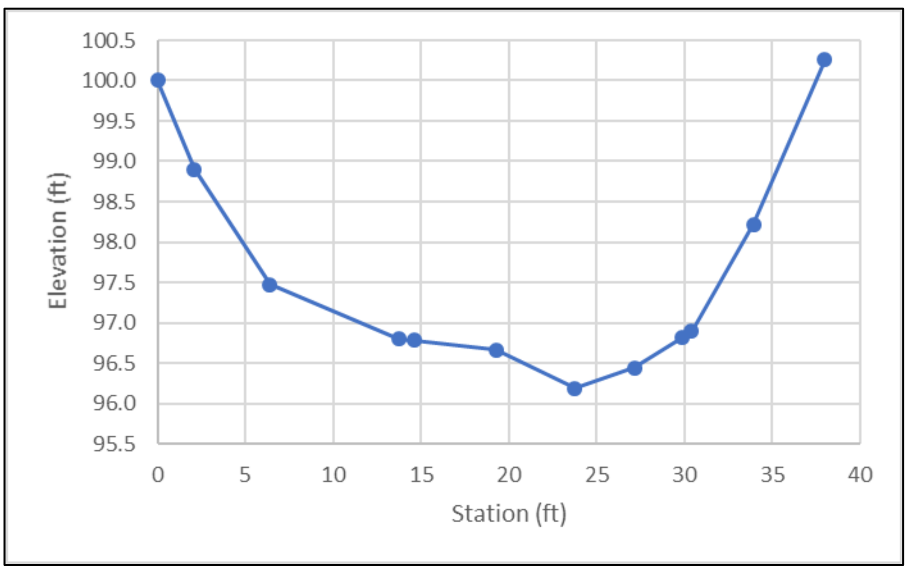


Table C5 –Site 3 Channel Geometry (Relative Elevations)

Station (ft)	Elevation (ft)
0.0	100
3.0	98.98
20.0	97.96
28.0	98.11
34.5	97.52
38.0	97.84
42.0	101.68

Figure C5 – Site 3 Channel Geometry (Relative Elevations)

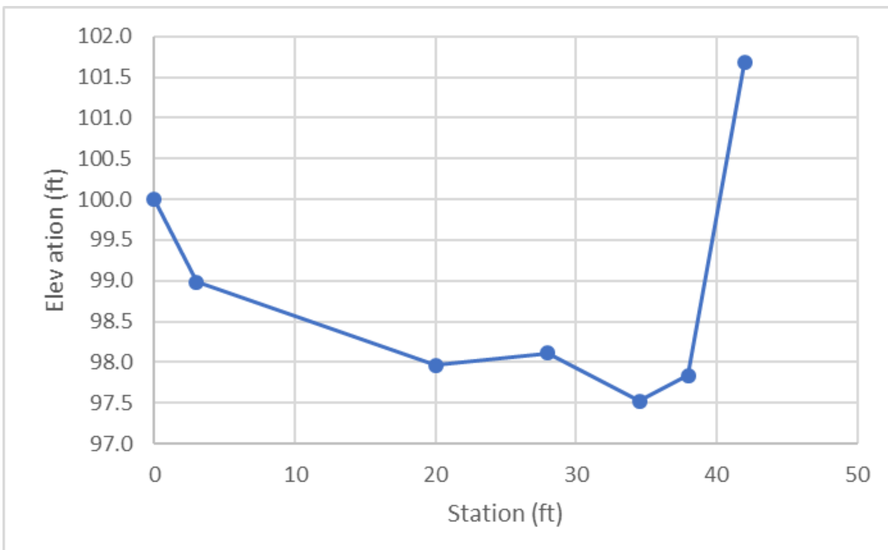


Table C5 – Average Channel Geometry Between Sites 3 and 4 (Relative Elevations)

Station (ft)	Elevation (ft)
0.5	100.00
2.6	99.32
5.7	98.93
7.4	98.48
14.6	98.00
20.2	97.94
24.8	97.53
30.5	97.79
32.7	98.48
35.2	100.11
37.0	100.79

Figure C5 – Average Channel Geometry Between Sites 3 and 4 (Relative Elevations)

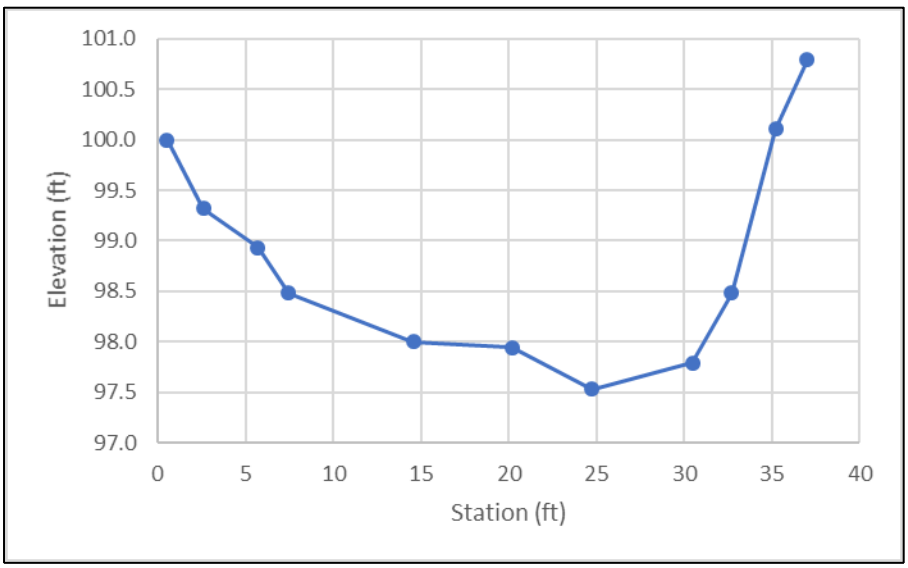


Table C6 –Site 4 Channel Geometry (Relative Elevations)

Station (ft)	Elevation (ft)
1.0	100
4.0	99.14
5.0	98.4
15.0	97.54
26.0	97.83
29.5	99.6
32.0	99.9

Figure C6 –Site 4 Channel Geometry (Relative Elevations)

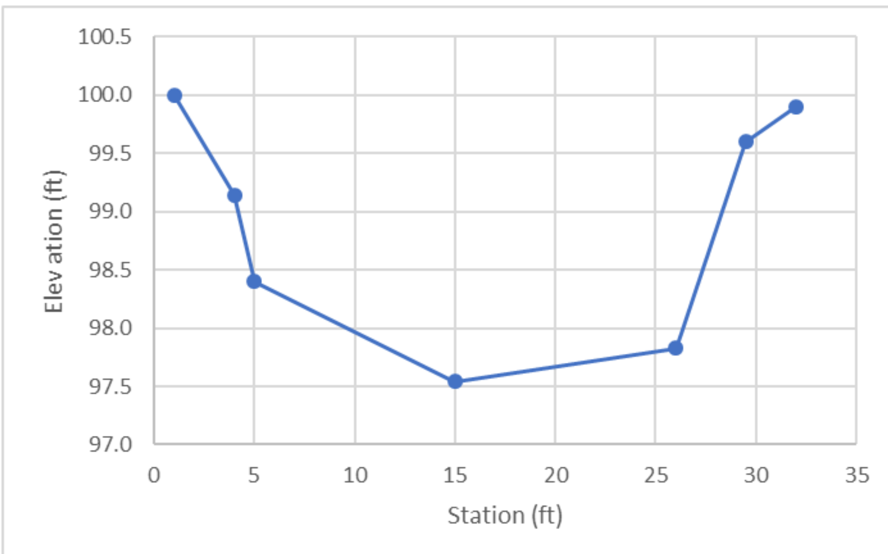


Table C7 – Average Channel Geometry Between Sites 4 and 5 (Relative Elevations)

Station (ft)	Elevation (ft)
1.0	100.00
1.5	98.14
3.8	97.54
4.7	97.06
5.3	96.97
14.0	96.53
22.9	96.63
26.6	97.13
29.1	97.98
30.6	98.35
33.5	98.56

Figure C7 – Average Channel Geometry Between Sites 4 and 5 (Relative Elevations)

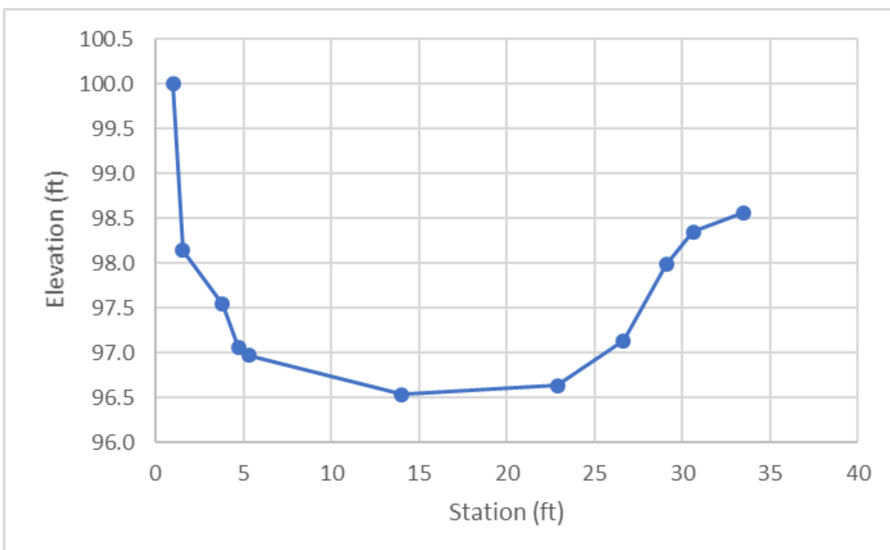
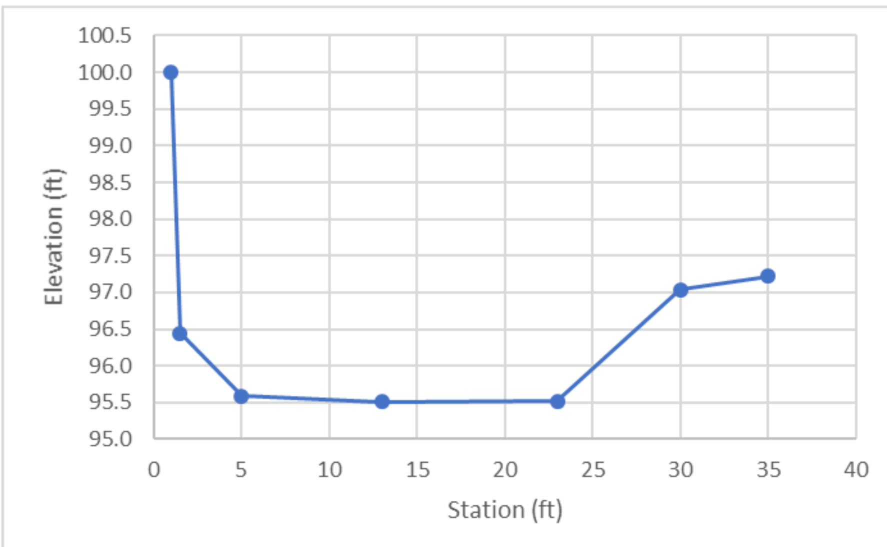


Table C8 –Site 5 Channel Geometry (Relative Elevations)

Station (ft)	Elevation (ft)
1.0	100
1.5	96.44
5.0	95.59
13.0	95.51
23.0	95.52
30.0	97.04
35.0	97.22

Figure C8 –Site 5 Channel Geometry (Relative Elevations)



ATTACHMENT F

Proposed APP Permit Revisions

STATE OF ARIZONA
AQUIFER PROTECTION PERMIT NO. P-512235
OTHER AMENDMENT
PLACE ID 150279, LTF ~~75937~~83040

1.0 AUTHORIZATION

In compliance with the provisions of Arizona Revised Statutes (A.R.S.) Title 49, Chapter 2, Articles 1, 2 and 3, Arizona Administrative Code (A.A.C.) Title 18, Chapter 9, Articles 1 and 2, A. A. C. Title 18, Chapter 11, Article 4 and amendments thereto, and the conditions set forth in this permit, the Arizona Department of Environmental Quality (ADEQ) hereby authorizes Arizona Minerals Inc. to operate the Hermosa Project Trench Camp Property located approximately 5 miles south of the Town of Patagonia, Arizona, over groundwater of the Santa Cruz groundwater basin, in Section 32 in Township 22S, Range 16E and in Township 23S, Range 16E ; and un-surveyed Sections 3 and 4, of the Gila and Salt River Baseline and Meridian.

This permit becomes effective on the date of the Water Quality Division Director's signature and shall be valid for the life of the facility (operational, closure, and post-closure periods) unless suspended or revoked pursuant to A.A.C. R18-9-A213. The permittee shall construct, operate and maintain the permitted facilities:

1. Following all the conditions of this permit including the design and operational information documented or referenced below, and
2. Such that Aquifer Water Quality Standards (AWQS) are not violated at the applicable point(s) of compliance (POC) set forth below or if an AWQS for a pollutant has been exceeded in an aquifer at the time of permit issuance, that no additional degradation of the aquifer relative to that pollutant and as determined at the applicable POC occurs as a result of the discharge from the facility.

1.1 PERMITTEE INFORMATION

Facility Name: Hermosa Project Trench Camp Property - Tailings Storage Facility (TSF)
Facility Address: 749 Harshaw Road
Patagonia, Arizona 85624

County: Santa Cruz County

Permittee: Arizona Minerals Inc.
Permittee Address: 2210 East Fort Lowell Road
Tucson, Arizona 85719

Permitted Flow Rate: ~~172,000~~6,652,000 gallons per day (gpd)

Facility Contact: Brent Musslewhite
Emergency Phone No.: (520) 485-1300

Latitude/Longitude: 31° 27' 59.4" N/110° 43' 35.8" W
Legal Description: Section 32 in Township 22S, Range 16E and in Township 23S, Range 16E; and un-surveyed Sections 3 and 4, of the Gila and Salt River Baseline and Meridian.

1.2 AUTHORIZING SIGNATURE

____
Trevor Baggiore, Director, Water Quality Division
Arizona Department of Environmental Quality
Signed this _______ day of _________________, 2020

THIS AMENDED PERMIT SUPERCEDES ALL PREVIOUS PERMITS

2.0 SPECIFIC CONDITIONS [A.R.S. §§ 49-203(4), 49-241(A)]

2.1 Facility / Site Description [A.R.S. § 49-243(K)(8)]

Arizona Minerals Inc. (AMI) shall construct and operate the Hermosa Project Trench Camp Property - Tailings Storage Facility (TSF) located approximately 5 miles south of the Town of Patagonia, Arizona. AMI purchased the historic, January and Norton Mine Claims and the Trench Camp Mine claims and associated Tailings Pile/waste rock from the ASARCO Trust in early 2016. The historic Mine Claims are closed and not considered APP regulated facilities and thus exempt according to the Arizona Revised Statue (A.R.S.) § 49 -201.7 and A.R.S. § 49-250.B.11. The APP application has been submitted for APP-regulated discharges associated with ADEQ's Voluntary Remediation Program (VRP) project related to eliminating discharges of mine impacted water from January Adit mine workings and tailing piles (which includes potentially acid generating (PAG) waste rock) seepage to Alum Gulch.

The Trench Camp historic tailings piles (1 through 4) were located within an unlined natural basin in a three pile configuration. Tailings Pile #1 contained tailings and potential acid generating (PAG) waste rock. Stockpile #2 and #4 contained only tailings and have been combined into one pile referred to as Tailings Pile #2 and are generally divided by the 5,100 foot contour elevation. In addition Tailings Pile # 3 contained only tailings.

The Trench Camp TSF is designed as a lined permanent storage area for the remediation of the existing tailings piles, sited above. Placement of the existing tailings piles on the lined permanent containment is part of the VRP program in Arizona under the site code 505143-2. Tailings, PAG waste rock and impacted soils beneath the existing tailings piles are to be excavated and placed in the lined Trench Camp TSF as an earthen material. PAG development rock from site surface construction and from a planned exploration decline or shaft, solids from the water treatment plant (WTP), and core cuttings solids will also be stored in the lined TSF as a co-mingled material with the existing tailings and PAG waste rock. Additionally, it may be placed on the exterior face of the existing tailings and PAG waste rock thereby acting as rock armor, to prevent water and wind erosion prior to closure.

The Trench Camp TSF shall be constructed in three stages; construction began in 2018. The TSF consists of a lined tailings storage facility, two stormwater detention ponds and an underdrain collection pond. The process solutions in the Trench Camp TSF will be collected through an underground collection system and gravity fed to the double lined underdrain collection pond (UCP). The UCP will be constructed downgradient of the Trench Camp TSF. The captured process solutions, precipitation that falls within the UCP and water from the January Adit (the January and Norton Mine Claims) will be piped to an active WTP for processing and discharge to Alum Gulch under AZPDES permit No AZ0026387.

Interim Stage:
The material from Tailings Pile #1 which included approximately 225,000 cubic yards of tailings, waste rock and native materials were excavated, hauled and temporarily placed on Tailings Piles #2 and #4 in order to provide space for the Stage 1 TSF construction. The temporary placement of Tailings Pile #1 on Tailings Piles #2 and #4 consisted of approximately 5H:1V slopes, a 50 ft setback from the brow of the existing slope on Tailings Pile #2, and an approximate maximum height of 30 ft.

Stage 1
Stage 1 of the Trench Camp TSF was constructed and utilizes approximately 650,000 square feet (ft2) of lined containment. Approximately 950,000 cubic yards of tailings, waste rock and native material were excavated, hauled, placed and compacted within the lined Stage 1 Trench Camp TSF from temporary Tailings Pile #1 and Tailings Piles #2 and #4.

Stage 2
Stage 2 of the Trench Camp TSF was constructed after Stage 1 and utilizes approximately 596,000 ft2 of additional lined containment. Approximately 280,000 cubic yards of additional tailings, waste rock and native material were excavated, hauled, placed and compacted within the lined Stage 2 Trench Camp TSF from Tailings Piles #2 and #4 and Tailings Pile #3. All historic tailings, waste rock and native materials from Tailings Piles #1, #2, #3 and #4 have been relocated within the constructed Stage 1 and 2 TSF lined containment as a compacted earthen fill totaling approximately 1,230,000 cubic yards. To complete the design stacking geometry, approximately 1.4 million cubic yards of material will be placed in the Trench Camp TSF including approximately

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932,092 cubic yards of exploration decline development rock, approximately 3,650 cubic yards per year of filter cake from the upgraded WTP1 (i.e. filter cake generated from the added nanofiltration), 12 cubic yards per year of solids from cutting of exploration core, approximately 385,051 cubic yards of construction PAG rock cut, approximately 4,526 cubic yards per year of filter cake from WTP2, approximately 1 cubic yard per year of drill cutting from exploration drilling, and approximately 1,800 cubic yards per year of sediments from stormwater BMPs. The total material quantity to be placed on the Trench Camp TSF (excluding the historic tailings which have already been placed) will be approximately 1.4 million cubic yards. All materials will be placed within the existing lined Stage 1 and Stage 2 TSF footprint.

Interim Stage
The existing material from Tailings Pile #1 which includes 112,800 tons of tailings, 223,600 tons of waste rock and 15,500 tons of native material for a total of approximately 352,000 tons of material will be excavated, hauled and temporality placed on Tailings pile #2 and #4 to prepare to for the construction of the Stage 1 TSF footprint. The temporary placement of Tailing Pile 1 on Tailings Piles 2 and 4 will consist of 5H:1V slopes, a 50 foot setback from the brow of the existing slope on Tailings Pile 2, and an approximate maximum height of approximately 30 ft.

Stage 1
Stage 1 of the Trench Camp TSF will cover approximately 680,000 square feet (ft^2). 1,212,000 tons of material will be relocated to the newly constructed Trench Camp TSF. This material includes the 762,700 tons of tailings (112,800 tons from Tailings Pile #1 plus 649,900 tons of tailings from Tailings Pile 2 and 4), 223,600 tons of waste rock from Tailings Pile #1, 49,200 tons of native material (15,500 tons from Tailings Pile #1 and 33,700 tons from Tailings Pile #2 and 4), and 176,400 tons of development rock from the exploration decline.

Stage 2
Stage 2 of the Trench Camp TSF will cover approximately 580,000 ft^2. Approximately 1,050,000 tons of material including 213,800 tons of material from Tailings Pile #3, 12,300 tons of native material, and 823,600 tons of development rock will be relocated to the Trench Camp TSF. Approximately 3,650 cubic yards per year of filter cake from the upgraded WTP (i.e. filter cake generated from the added nanofiltration), and 12 cubic yards per year of solids from cutting of exploration core will be deposited on the TSF.

The total materials to be placed on the Trench Camp TSF will be 2,580,000 tons which includes 317,800 tons of contingency storage on a total area of approximately 1,260,000 square feet.

The site includes the following permitted discharging facilities:

Facility Name	Latitude	Longitude
Lined Tailings Storage Facility (TSF)	31° 27' 59.4"North	110° 43' 35.8" West
Underdrain Collection Pond (UCP)	31° 27' 59" North	110° 43' 39.2" West
AZPDES Outfall 001	31° 28' 15" North	110° 43' 43" West
AZPDES Outfall 2	31° 27' 56.62" North	110° 43' 11.51" West

Annual Registration Fee [A.R.S. § 49-242 and A.A.C. R18-14-104]
The annual registration fee for this permit is payable to ADEQ each year. The permitted flow for fee calculation is 1726,652,000 gallons per day (gpd). If the facility is not yet constructed or is incapable of discharge at this time, the permittee may be eligible for reduced fees under the rule. Send all correspondence requesting reduced fees to the Water Quality Division of ADEQ. Please reference the permit number, LTF number and why reduced fees are requested under the rule.

Financial Capability [A.R.S. § 49-243(N) and A.A.C. R18-9-A203]
The Permittee shall be required to demonstrate financial capability under A.R.S. § 49-243(N) and A.A.C. R18-9-A203. The Permittee shall be required to maintain financial capability throughout the life of the facility. The closure costs are $4,320,986, and post-closure costs are $9,599,866, for a total of $13,920,872. The financial assurance mechanism shall be demonstrated through A.A.C. R18-9-A203(C)(2). Updated closure costs, post-closure costs and the associated financial assurance mechanism shall be provided per the Compliance Schedule, Section 3.3 and 3.4.

2.2 Best Available Demonstrated Control Technology (BADCT) [A.R.S. § 49-243(B) and A.A.C. R18-9-A202(A)(5)]

2.2.1 Engineering Design

The Trench Camp TSF and the UCP employ prescriptive BADCT components (in accordance with the Arizona Mining BADCT Guidance Manual (AMBGM)). BADCT has been determined in accordance with the AMBGM. The design of the UCP incorporates enhanced discharge control measures (such as double liner and leak collection and recovery systems) that go beyond the prescriptive components identified in the AMBGM for non-stormwater impoundments.

2.2.1.1 Tailings Impoundment (Stage 1 and 2 TSF)

The TSF will be constructed in two Stages (in addition to the temporary "interim" stage as described in Section 2.0). BADCT for each Stage is provided below:

Stage 1

Prior to placement of the tailings material, the basin area shall be cleared of any vegetation and stripped of any growth media and graded to have maximum slopes of 2.5H (horizontal):1V (vertical). A composite liner system consisting of a 12 inch thick low permeability soil layer (LPSL) having a coefficient of permeability that is less than or equal to 1.0 x 10-6 centimeters/second (cm/sec) overlain by a double-sided textured 60 mil high density polyethylene (HDPE) liner shall be placed over the graded area. The geomembrane shall be anchored in the perimeter road at a setback of 3 feet (ft.) with trenched dimensions of 3 ft. deep by 2 ft. wide. An 18 inch (in.) protective layer composed of 1 1/2 in. minus granular material shall be placed over the geomembrane. An underdrain collection system, consisting of a series of pipes shall be placed in topographic lows to collect drainage from the base of the facility and convey them to the UCP via the concrete encased underdrain outlet pipe works. At the outlet point of the underdrain pipes, valves shall be installed to control flow to the Underdrain Collection Pond. The maximum elevation of the Stage 1 TSF shall not exceed 5,~~110~~ 175 ft.

External and internal stormwater channels shall be constructed to appropriately capture and convey stormwater from a 100-year/24-hour storm event. A geomembrane lined external stormwater detention basin having the capacity of 2.66 million gallons (8.16 ac. ft.) shall be constructed to route runoff from the east side (upstream) of Stage 1 to the underdrain collection system via a pipe located in the basin low point. After Tailings Piles 1, 2 and 4 are relocated to the Stage 1 TSF, the external stormwater detention basin pipe shall be capped and the detention basin shall be expanded as part of the Stage 2 TSF basin construction. Two internal detention basins designed to contain contact stormwater, one having a capacity of 847,214 gallons (2.6 acre feet (ac. ft.)) shall be constructed in the northwestern portion of Stage 1 TSF, and another having a capacity of 488,777 gallons (1.5 ac. ft.) shall be constructed near the northeastern portion of Stage 1 TSF.

Stage 2

The Stage 2 TSF shall be constructed in a manner similar to that of Stage 1 TSF. The permittee may use geosynthetic clay liner (GCL) in lieu of the LPSL if field conditions allow its use and it is approved by the design engineer. The maximum elevation of the Stage 2 TSF shall match up with the Stage 1 TSF elevation and shall not exceed 5,~~110~~ 175 ft. During the Stage 2 construction, the 2.6 ac. ft. internal detention basin located at the northwestern portion will be expanded to contain a volume of 3,258,514 gallons (10 ac. ft.) of contact stormwater, and another 260,681 gallons (0.8 ac. ft.) internal detention basin will be constructed in the eastern portion of the Stage 2 TSF. The 1.5 ac. ft. internal detention basin located at the northeastern portion of the Stage I TSF will be covered by materials deposited in this stage.

A geomembrane lined external stormwater detention basin having the capacity of 3.2 million gallons (9.82 ac. ft.) to detain upstream unimpacted runoff on the east side of Stage 2 shall be constructed. The unimpacted runoff captured in this detention pond shall be pumped around the TSF until closure is substantially complete.

A minimum of four (4) piezometers shall be placed immediately adjacent to the geomembrane surface within the protective layer next to an underdrain collection pipe within the TSF to measure hydraulic head on the liner system, at the locations and as per the design submitted in the application. The

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phreatic surface in these piezometers shall be maintained below 1.5 feet.

The permittee is allowed to place additional materials including solids from the WTP1 and WTP2 and core cutting. The placement of the solids shall be in accordance with the recommendations and following all quality control and quality assurance procedures (QA/QC) made in the Attachment B C of the application dated May 29August 14, 2020.

Solids from WTP1 and WTP2
Filter cake from the existing WTP1 is currently stored on the TSF. The proposed Recently-permitted upgrades to the WTP1 will result in additional filter cake solids at approximately 3,650 cubic yards per year. The solids shall be hauled to the TSF in approximately 20 cubic yard increments.

WTP2 filter cake is anticipated to be hauled and placed in the TSF at a rate of approximately 4,380 cubic yards per year from the stage one filter press and approximately 146 cubic yards per year from the stage two filter press for an aggregate total of approximately 4,526 cubic yards per year. It will be hauled to the TSF in approximately 20 cubic yard increments. WTP2 filter cake material properties are assumed to be similar in nature to WTP1 filter cake and therefore the placement criteria are the same for both filter cake products.

The anticipated material properties are as follows based on a control sample obtained November 20th, 2019:

- 100 percent passing (by dry weight) the no. 200 sieve.
- Non-plastic soil.
- Moisture content will be 363% (based on dry weight of solids) upon arrival to the TSF.

Upon placement on the TSF, the WTP1 and WTP2 filter cake shall be spread and dried to reduce the material moisture content. The filter cake shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3:1 (tailings/on site native borrow/development rock to filter cake). After mixing, the material shall be moisture conditioned to within 2 percent below and 3 percent above the optimum moisture content. The material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698.

Core-cutting solids
Approximately 12 cubic yards per year of core cutting solids will be placed on the TSF. This material simply consists of rock fragments generated from cutting of core. Upon placement in the TSF, the core cutting material shall be spread and dried to reduce the material moisture content. The core cutting material shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3:1 (tailings/on site native borrow/development rock to core cutting material). After mixing, the material shall be moisture conditioned to within 2 percent below and 3 percent above the optimum moisture content. The material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698.

Drilling Solids
The drill cutting material that is generated from exploration activities is anticipated to be hauled and placed in the TSF at a rate of less than 1 cubic yard per year. Upon placement in the TSF, the drill cutting material shall be spread and dried to reduce the material moisture content. The drill cutting material shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (drill cutting material). After mixing, the material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698.

Solids from Stormwater BMPs
The sediments generated from site stormwater BMPs is anticipated to be hauled and placed in the TSF

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at a rate of approximately 1,800 cubic yards per year. The material is assumed to be a CL or ML. Upon placement in the TSF, the sediments shall be spread and dried to reduce the material moisture content. The sediments shall then be mixed with tailings, on site native borrow material and/or development rock at a minimum ratio of 3 (tailings/on site native borrow/development rock) to 1 (sediment). After mixing, the material shall be placed in 12-inch maximum loose lifts and compacted to 90 percent of the maximum dry density as determined by ASTM D698.

2.2.1.2 Underdrain Collection Pond (UCP)

The UCP shall be located downstream of Stage 1 TSF. Valves placed at the inlet end to the UCP from the Stage I TSF, shall remain completely open unless it needs be pumped completely dry for repairs. The UCP crest shall be approximately 200 ft. wide by 345 ft. long and 42 ft. deep. The pond shall be designed with a 25 ft. wide perimeter access road around the crest, which widens to 50 ft. on the southern edge where the pumps shall be sited for pump maintenance that may be required. The UCP shall be constructed to maintain a minimum of 2 feet of freeboard from the spillway invert to contain flows from the 100-yr/24-hr storm event, and the maximum operational volume of 2,200,000 gallons. The UCP shall be sized to contain 8,900,000 gallons up to the spillway elevation while maintaining a minimum of seven (7) feet of total freeboard. The pond slopes shall be 2H:1V, and the bottom of the pond shall be graded at 1% to a low point in the corner of the pond. At the low point, two parallel sloping decant structures shall be constructed for housing submersible pumps to reclaim fluids for treatment at the Water Treatment Plant (WTP).

The liner system for the UCP consists of geonet placed between two 60 mil HDPE double sided textured geomembrane layers overlying 6-inches of low permeability soil layer. The HDPE liner shall be secured in an engineered anchor trench around the impoundment perimeter. A leak collection and removal system (LCRS) shall be installed between the two HDPE liners. The LCRS shall be equipped with a level control to activate a pump, and the outflow shall be measured with a flow totalizer. A record of these measurements shall be maintained in a log book maintained at the site.

A minimum of two (2) piezometers shall be placed along the maximum section of the UCP, at the locations and as per the design submitted in the application. ~~The phreatic surface in these piezometers shall be maintained below 1.5 feet.~~

2.2.1.3 Water Treatment Plant 1 (WTP1)

~~The~~ WTP1 is designed for treating underdrain seepage and storm water runoff from the TSF and water from the January Adit mine workings. The flow rate from the UCP and the January Adit mine workings are anticipated to fluctuate up to a maximum of 120 gallons per minute (gpm) from each source, with a maximum combined flow from both sources not to exceed 120 gpm.

The WTP1 process consists of pH adjustment to 10.5 followed by liquid/solids separation. This process includes various elements including: an equalization tank, a multiflo tank (consisting of reaction, flocculation, and clarifier compartments), an ultrafiltration unit, a pH adjustment tank, a Moving Bed Biofilm Reactor (for treatment of residual ammonia), an electro-reduction circuit (for selenite removal), a thickening tank, a filtrate tank, and a filter press.

Treated water may be used for on-going mine exploration, construction soil conditioning, and future milling and mining operations. Periodic, short-term discharge of treated water or a portion of treated water to Alum Gulch may be necessary during periods of exploration or mine development. Releases from ~~the~~ WTP1 are authorized under an AZPDES permit.

2.2.1.4 Water Treatment Plant 2 (WTP2)

WTP2 is designed for treating groundwater pumped from a wellfield to depressurize and dewater the fractured rock aquifer, groundwater and operational water pumped from underground workings, tailing seepage and January Adit water, treated water from WTP1, drilling water and core cutting water, and water from stormwater BMPs. The design flow is 4500 gpm.

WTP2 consists of two treatment circuits. The first circuit will remove suspended solids (TSS) and metals. The second circuit will remove will remove selenate (a species of selenium not removed in the first circuit) and consists of an IX ion exchange column circuit and an Electro Reduction Circuit.

Treated water may be used for on-going mine exploration, construction soil conditioning, and future milling and mining operations. Releases from WTP2 to Harshaw Creek are authorized under an AZPDES permit.

2.2.2 Site-specific Characteristics

Not applicable

2.2.3 Pre-operational Requirements

The permittee shall submit as-built design drawings signed, dated, and sealed by an Arizona-registered Professional Engineer for the construction of the TSF and UCP. The reports shall include the results of compaction testing and shall verify that the TSF and UCP are constructed in accordance with the design drawings and QA/QC procedures submitting in the application and that seams and welds have passed required testing. The as-built reports shall be submitted as per Compliance Schedule Section 3.0; Items 3.1 and 3.2.

2.2.4 Operational Requirements

At a minimum, permitted facilities shall be inspected for performance levels listed in Section 4.2, Table 4.2.1. Results of these inspections shall be documented and maintained on location for at least 10 years from the date of each inspection, as required by Section 2.7.2 of this permit. If damage is identified during an inspection that could cause or contribute to a discharge, proper repairs shall be promptly performed and documented as described in Section 2.5.2 and Section 2.7.2.

2.3 Discharge Limitations [A.R.S. §§ 49-201(14), 49-243 and A.A.C. R18-9-A205(B)]

The permittee shall operate and maintain all permitted facilities to prevent unauthorized discharges pursuant to A.R.S. § 49-201(12) resulting from failure or bypassing of BADCT pollutant control technologies.

2.3.1 Tailings Storage Facility (TSF)

The total deposition of tailings and development rock under this permit shall not cause the ultimate dam crest elevation to exceed an elevation of 5,~~110~~ 175 feet amsl as per Section 4.2.1. If the permittee wishes to deposit a greater quantity of material, or modify the ultimate height of the dam, then the permittee shall apply for a permit amendment pursuant to Section 6.9 and Section 3.7 in the Compliance Schedule.

2.3.2 Underdrain Collection Pond (UCP)

Discharge to the UCP shall be limited to tailings seepage water, mine workings water, exploration decline water, and precipitation falling on the TSF (including the embankment, perimeter road and construction areas).

2.4 Point of Compliance (POC) [A.R.S. § 49-244]

Well Number	POC Locations	Latitude (North)	Longitude (West)	ADWR Number
POC-1	Conceptual location downgradient of the TSF	31° 28' 15.21"	110° 43' 42.45"	TBD
POC-2	200 feet downgradient of the AZPDES Outfall-001 (MW3)	31° 28' 18.91"	110° 43' 48.83"	55-920120
POC-3	Conceptual location approximately one mile to the north-northwest and downgradient of the WTP1 outfall	31° 29' 1.7"	110° 44' 16.4"	TBD
POC-4	Conceptual location approximately nine miles to the north and downgradient of the WTP2 outfall	31° 32' 2.4"	110° 43' 29.3"	TBD

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Groundwater monitoring is required under this permit at POC-2. Groundwater monitoring is not required at POC-1, ~~and~~ 3, and 4 unless as contingency monitoring. The Director may amend this permit to designate an additional point or points of compliance if information on groundwater gradient or groundwater usage indicates the need.

2.5 Monitoring Requirements [A.R.S. § 49-243(K)(1), A.A.C. R18-9-A206(A)]

Unless otherwise specified in this permit, all monitoring required in this permit shall continue for the duration of the permit, regardless of the status of the facility. Unless otherwise provided, monitoring shall commence the first full monitoring period following permit issuance. All sampling, preservation and holding times shall be in accordance with currently accepted standards of professional practice. Trip blanks, equipment blanks and duplicate samples shall also be obtained, and Chain-of-Custody procedures shall be followed, in accordance with currently accepted standards of professional practice. Copies of laboratory analyses and Chain-of-Custody forms shall be maintained at the permitted facility. Upon request, these documents shall be made immediately available for review by ADEQ personnel.

2.5.1 Pre-Operational Monitoring

Not applicable

2.5.2 Facility / Operational Monitoring

Operational monitoring inspections shall be conducted according to Section 4.2, Table 4.2.1.

If any damage of the pollution control structures is identified during inspection that could cause or contribute to a discharge, proper repair procedures shall be performed. All repair procedures and materials used shall be documented in the facility log book as per Section 2.7.2.

2.5.3 Groundwater Monitoring and Sampling Protocols

Groundwater monitoring is required under the terms of this permit at POC-2 per Section 4.2.3.

Static water levels shall be measured and recorded prior to sampling. Wells shall be purged of at least three borehole volumes (as calculated using the static water level) or until field parameters (pH, temperature, and conductivity) are stable, whichever represents the greater volume. If evacuation results in the well going dry, the well shall be allowed to recover to 80 percent of the original borehole volume, or for 24 hours, whichever is shorter, prior to sampling. If after 24 hours there is not sufficient water for sampling, the well shall be recorded as "dry" for the monitoring event. An explanation for reduced pumping volumes, a record of the volume pumped, and modified sampling procedures shall be reported and submitted with the SMRF.

The permittee may conduct the sampling using the low-flow purging method as described in the Arizona Water Resources Research Center, March 1995 *Field Manual for Water Quality Sampling*. The well must be purged until indicator parameters stabilize. Indicator parameters shall include dissolved oxygen, turbidity, pH, temperature, and conductivity.

2.5.3.1 POC Well Replacement

In the event that one or more of the designated POC wells should become unusable or inaccessible due to damage or any other event, a replacement POC well shall be constructed and installed upon approval by ADEQ. If the replacement well is 50 feet or less from the original well, the ALs and/or aquifer quality limits (AQLs) calculated for the designated POC well shall apply to the replacement well.

2.5.4 Surface Water Monitoring and Sampling Protocols

Routine surface water monitoring is not required under the terms of this permit.

2.5.5 Analytical Methodology

All samples collected for compliance monitoring shall be analyzed using Arizona state-approved methods. If no state-approved method exists, then any appropriate EPA-approved method shall be used. Regardless of the method used, the detection limits must be sufficient to determine compliance with the regulatory limits

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of the parameters specified in this permit. If all methods have detection limits higher than the applicable limit, the permittee shall follow the contingency requirements of Section 2.6 and may propose "other actions" including amending the permit to set higher limits. Analyses shall be performed by a laboratory licensed by the Arizona Department of Health Services, Office of Laboratory Licensure and Certification unless exempted under A.R.S. § 36-495.02. For results to be considered valid, all analytical work shall meet quality control standards specified in the approved methods. A list of Arizona state-certified laboratories can be obtained at the address below:

Arizona Department of Health Services
Office of Laboratory Licensure and Certification
250 North 17th Avenue
Phoenix, Arizona 85007
Phone: (602) 364-0720

2.5.6 Installation and Maintenance of Monitoring Equipment
Monitoring equipment required by this permit shall be installed and maintained so that representative samples required by the permit can be collected. If new groundwater wells are determined to be necessary, the construction details shall be submitted to the Groundwater Protection Value Stream for approval prior to installation and the permit shall be amended to include any new monitoring points.

2.6 Contingency Plan Requirements
[A.R.S. § 49-243(K)(3), (K)(7) and A.A.C. R18-9-A204 and R18-9-A205]

2.6.1 General Contingency Plan Requirements
At least one copy of this permit and ~~the approved~~an updated contingency and emergency response plan ~~submitted in the application on June 5, 2017~~(to be submitted according to Table 3.0) shall be maintained at the location where day-to-day decisions regarding the operation of the facility are made. The permittee shall be aware of and follow the contingency and emergency plans.

Any AL exceedance, or violation of an AQL, DL, or other permit condition shall be reported to ADEQ following the reporting requirements in Section 2.7.3, unless more specific reporting requirements are set forth in Sections 2.6.2 through 2.6.5.

Some contingency actions involve verification sampling. Verification sampling shall consist of the first follow-up sample collected from a location that previously indicated a violation or the exceedance of an AL. Collection and analysis of the verification sample shall use the same protocols and test methods to analyze for the pollutant or pollutants that exceeded an AL or violated an AQL or DL. Where verification sampling is specified in this permit, it is the option of the permittee to perform such sampling. If verification sampling is not conducted within the timeframe allotted, ADEQ and the permittee shall presume the initial sampling result to be confirmed as if verification sampling had been conducted.

The permittee is responsible for compliance with contingency plans relating to the exceedance of an AL or violation of a DL, AQL or any other permit condition. The permittee is subject to enforcement action for the failure to comply with any contingency actions in this permit.

2.6.2 Exceeding of Alert Levels and Performance Levels

2.6.2.1 Exceeding of Performance Levels Set for Freeboard
In the event that freeboard performance levels in the Underdrain Collection Pond listed in Section 4.2, Table 4.2.1 are not maintained, the permittee shall:

1. As soon as practicable, cease or reduce discharging to the impoundment to prevent overtopping. Remove and properly dispose or recycle to other operations the excess fluid in the reservoir until the water level is restored at or below the permitted freeboard limit.
   Within 5 days of discovery, evaluate the cause of the incident and adjust operational conditions or identify design improvements to the affected system as necessary to avoid future occurrences.
   Within 30 days of discovery, initiate repairs to the affected system, structure, or other component

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as necessary to return the system to compliance with this permit, or remove the affected system(s) from service as specified in Section 2.8 (Temporary Cessation) and Section 2.9 (Closure) of this permit. Record any repair procedures, methods, and materials used to restore the facility to operating condition in the facility log/recordkeeping file.

2. If design improvements are necessary, submit an amendment application within 90 days of discovery.
3. The facility is no longer on alert status once the operational indicator no longer indicates that the freeboard performance level is being exceeded. The permittee shall, however, complete all tasks necessary to return the facility to its pre-alert operating condition.

2.6.2.2 Exceeding of Performance Levels Set for Conditions Other Than Freeboard

1. If an operational performance level (PL) listed in Section 4.2, Table 4.2.1 has been observed or noted during required inspection and operational monitoring, such that the result could cause or contribute to an unauthorized discharge, the permittee shall immediately investigate to determine the cause of the condition. The investigation shall include the following:
   a. Inspection, testing, and assessment of the current condition of all treatment or pollutant discharge control systems that may have contributed to the operational performance condition.
   b. Review of recent process logs, reports, and other operational control information to identify any unusual occurrences.
2. The PL exceedance, results of the investigation, and any corrective action taken shall be reported to the Groundwater Protection Value Stream, within 30 days of the discovery of the condition. Upon review of the submitted report, the Department may amend the permit to require additional monitoring, increased frequency of monitoring, or other actions.
3. The permittee shall initiate actions identified in the approved contingency plan referenced in Section 5 and any necessary contingency measures to resolve problems identified by the investigation which may have led to a PL being exceeded. To implement any other corrective action the permittee may choose to obtain prior approval from ADEQ according to Section 2.6.6.

2.6.2.3 Exceeding of Alert Level 1 for Normal Liner Leakage

If the impoundment Alert Level 1 (AL1) has been exceeded, as defined in Section 4.2, Table 4.2.4, the permittee shall take the following actions:

1. Within 5 days of AL #1 exceedance, notify Groundwater Protection Value Stream in accordance with Section 2.7.6 Permit Violation and Alert Level Status Reporting. Continue monitoring to determine if the leakage rate is increasing.
2. If the leakage rate continues to exceed AL#1 for 15 days following notification of initial AL #1 exceedance, perform a visual inspection of the liner above the solution level, to determine the location of the leaks in the primary liner.
3. Within 45 days of AL #1 exceedance, if liner damage is evident, the permittee shall complete liner repairs.
4. Within 45 days of AL #1 exceedance, if the visual inspection does not identify the location of leaks, formulate a corrective action plan to determine their location and repair them.
5. Within 90 days of AL #1 exceedance and following formulation of a corrective action plan, the permittee shall complete liner repairs.
6. Within 75 days of AL #1 exceedance (if repairs were completed in Step 3), or 120 days of AL #1 exceedance (if corrective action plan was implemented per Steps 4 and 5), if no alert level exceedance is observed for 30 consecutive days, notify Groundwater Protection Value Stream and document assessment and/or repairs in the log book.
7. Within 120 days of AL #1 exceedance (if repairs were completed in Step 3), or 165 days of AL #1 exceedance (if corrective action plan was implemented per Steps 4 and 5), if 30 consecutive days without an AL #1 exceedance is not achieved, notify Groundwater Protection Value Stream and reassess the entire liner system and complete any necessary repairs as described in Steps 2 and 3 (and if necessary Steps 4 and 5 also). Repeat the assessment and liner repair cycle until requirements of Step No. 6 are attained.

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8. A liner leakage assessment and repair report shall be included in the next annual report described in Section 2.7.1 (Annual Reporting) of this permit. The permittee may also submit the liner leakage assessment report to the ADEQ prior to the annual report due date. This liner leakage assessment and repair report shall be submitted to the Groundwater Protection Value Stream. Upon review of the report, ADEQ may require that the permittee take additional corrective actions to address the problems identified from the assessment of the liner and perform other applicable repair procedures.

2.6.2.4 Exceeding of Alert Level 2 for Liner Failure or Rip

If the impoundment Alert Level 2 (AL2) has been exceeded, as defined in Section 4.2, Table 4.2.4, the Permittee shall take the following actions:

1. As soon as practicable, cease all discharge to the impoundment, implement control measures to prevent new solution buildup that may subsequently report to the impoundment, and immediately notify Groundwater Protection Value Stream of the AL #2 exceedance.
2. Within 15 days of initial AL #2 exceedance, perform a visual inspection of the liner above the solution level to identify the location of the leak(s). The permittee shall complete liner repairs and discharge to the impoundment shall not be re-initiated until the leak(s) have been identified and repaired.
3. Within 60 days of initial AL #2 exceedance if leaks were found and fixed and if no AL #2 exceedance is observed for 30 consecutive days, submit a liner leakage assessment and repair report to ADEQ. The report shall include the results of the initial liner evaluation, methods used to locate the leak(s), repair procedures and quality assurance/quality control implemented to restore the liner to optimal operational status, and other information necessary to ensure the future occurrence of the incidence will be minimized.
4. Within 30 days of initial AL #2 exceedance if the visual inspection does not identify the location of leaks and AL #2 exceedance continues, formulate a corrective action plan to determine their location and repair them. The corrective action plan will take into account the schedule for a 3rd party contractor to perform electronic leak detection or other methods if required.
5. Within 75 days of initial AL #2 exceedance and following formulation of a corrective action plan, the permittee shall complete liner repairs
6. Within 105 days of AL #2 exceedance and implementation of the corrective action plan per Steps 4 and 5, if no AL #2 exceedance is observed for 30 consecutive days, notify Groundwater Protection Value Stream and document assessment and/or repairs in the log book.
7. Within 105 days of initial AL #2 exceedance, (if repairs were completed in Step 3), or 150 days of AL #2 exceedance (if corrective action plan was implemented per Steps 4, 5, and 6) if 30 consecutive days without an AL #2 exceedance is not achieved, repeat Steps 1 through 7 until AL #2 is not exceeded for 30 consecutive days. When the Steps 1 through 7 are repeated, the notification date is reset. Discharge to the impoundment shall not be re-initiated until the leak(s) have been identified and repaired.
8. Liner leakage assessment and repair reports required by Section 2.6.2.2, shall be referenced in the next annual report described in Section 2.7.1 (Annual Reporting) of this permit.

2.6.2.5 Exceeding of Alert Levels (ALs) Set for Discharge Monitoring

1. If a discharge monitoring AL set in Section 4.2, Table 4.2.2 has been exceeded, the permittee shall immediately investigate to determine the cause of the AL exceedance. The investigation shall include the following:

a. Inspection, testing, and assessment of the current condition of all treatment or pollutant discharge control systems that may have contributed to the violation;
b. Review of recent process logs, reports, and other operational control information to identify any unusual occurrences;
c. Sampling of individual waste streams composing the wastewater for the parameters being exceeded.

2. The permittee shall initiate actions identified in the approved contingency plan referenced in Section 5.0 and specific contingency measures identified in Section 2.6 to resolve any problems identified by the investigation, which may have led to an AL exceedance. To implement any other corrective action the permittee shall obtain prior approval from ADEQ according to Section 2.6.6.
3. Within 30 days of an AL exceedance, the permittee shall submit the laboratory results to the Groundwater Protection Value Stream, along with a summary of the findings of the investigation, the cause of the AL exceedance, and actions taken to resolve the problem.
4. Upon review of the submitted report, the Department may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions or other actions.

2.6.2.6 TSF Slope Conditions

The permittee shall monitor the TSF perimeter road and dry stack TSF for general slope conditions as per Section 4.2, Table 4.2.1 to identify unusual scour or degradation of materials, sloughing, rolling rocks or visible seepage. If the TSF exhibits any signs that require maintenance, AMI shall take the following actions:

1. After discovery prevent vehicle and/or foot traffic in the area.
2. Notify the design engineer.
3. If necessary, perform remedial actions approved by the engineer.
4. Monitor the area for signs of decreasing slope stability.

2.6.2.7 TSF ~~and UCP~~ Piezometric Head

The permittee shall monitor the piezometric head per Section 4.2, Table 4.2.1. If the piezometers read a phreatic surface in excess of 1.5 ft AMI shall take the following actions:

1. Notify the design engineer.
2. Monitor the phreatic surface within the TSF.
3. Initiate an evaluation to determine the cause of the incident. Identify the circumstances that resulted in the elevated phreatic surface. Implement corrective actions including pumping, if necessary, to resolve the problems identified in the evaluation.
4. If necessary, perform a slope stability analysis on the dry stack TSF with the elevated phreatic surface to determine if any reduction in safe operation of the facility has occurred.
5. Record in the facility log book, the piezometer number, reading and location. Hydrographs of this and all other piezometers will be recorded on at least a monthly basis to allow quick inspection and evaluation of historic facility operations.

2.6.2.8 Exceeding of Alert Levels in Groundwater Monitoring

2.6.2.8.1 Alert Levels for Indicator Parameters

None required by this permit.

2.6.2.8.2 Alert Levels for Pollutants with Numeric Aquifer Water Quality Standards

1. If an AL for a pollutant set in Section 4.2, Table 4.2.3 has been exceeded, the Permittee shall request that the laboratory verify the sample results within five (5) days of becoming aware of an AL exceedance. The permittee may use the results of another sample taken between the date of the last sampling event and the date of receiving the result as verification.
2. If verification sampling confirms the AL exceedance or if the Permittee opts not to perform verification sampling, then the permittee shall increase the frequency of monitoring for that parameter to Quarterly from Semi-Annually. In addition, the permittee shall immediately initiate an investigation of the cause of the AL exceedance, including inspection of all discharging units and all related pollution control devices, review of any operational and maintenance practices that might have resulted in an unexpected discharge, and hydrologic review of groundwater conditions including upgradient water quality.
3. The Permittee shall initiate actions identified in the approved contingency plan referenced in Section 5.0 and specific contingency measures identified in Section 2.6 to resolve any problems identified by the investigation which may have led to an AL

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exceedance. To implement any other corrective action the permittee shall obtain prior approval from ADEQ according to Section 2.6.6. Alternatively, the permittee may submit a technical demonstration, subject to written approval by the Groundwater Protection Value Stream, that although an AL is exceeded, pollutants are not reasonably expected to cause a violation of an AQL. The demonstration may propose a revised AL or monitoring frequency for approval in writing by the Groundwater Protection Value Stream.

4. Within 30 days after confirmation of an AL exceedance, the permittee shall submit the laboratory results to the Groundwater Protection Value Stream along with a summary of the findings of the investigation, the cause of the AL exceedance, and actions taken to resolve the problem.
5. Upon review of the submitted report, the Department may amend the permit to require additional monitoring, increased frequency of monitoring, or other actions.
6. The increased monitoring required as a result of ALs being exceeded may be reduced to the regularly scheduled frequency, if the results of three (3) consecutive monthly sampling events demonstrate that no parameters exceed the AL.
7. If the increased monitoring required as a result of an AL exceedance continues for more than six (6) sequential sampling events, the Permittee shall submit a second (2nd) report documenting an investigation of the continued AL exceedance within 30 days of the receipt of laboratory results of the sixth (6th) sampling event.

2.6.2.8.3 Alert Levels to Protect Downgradient Users from Pollutants Without Numeric Aquifer Water Quality Standards

Not applicable

2.6.2.8.4 Alert Level for Groundwater Level

Not applicable

2.6.3 Discharge Limit Violation

2.6.3.1 Surface Impoundments: Liner Failure, Containment Structure Failure, or Unexpected Loss of Fluid for a Reason other than Overtopping

In the event of liner failure, containment structure failure, or unexpected loss of fluid as described in Section 2.3, the permittee shall take the following actions:

1. As soon as practicable, cease all discharges as necessary to prevent any further releases to the environment, including removal of any fluid remaining in the impoundment as necessary, and capture and containment of all escaped fluids.
2. Within 24-hours of discovery, notify the Groundwater Protection Value Stream.
3. Within 24 hours of discovery of a failure estimate the quantity released, collect representative samples of the fluid remaining in affected impoundments and drainage structures, analyze sample(s) according to Section 4.3, Table 4.3.1 and report in accordance with Section 2.7.3 (Permit Violation and AL Status Reporting). In the 30-day report required under Section 2.7.3, include a copy of the analytical results and forward the report to Groundwater Protection Value Stream.
4. Within 15 days of discovery, initiate an evaluation to determine the cause for the incident. Identify the circumstances that resulted in the failure and assess the condition of the discharging facility and liner system. Implement corrective actions as necessary to resolve the problems identified in the evaluation. Initiate repairs to any failed liner, system, structure, or other component as needed to restore proper functioning of the discharging facility. The permittee shall not resume discharge to the facility until repairs of any failed liner or structure are performed.

   Repair procedures, methods, and materials used to restore the system(s) to proper operating condition shall be described in the facility log/recordkeeping file and available for ADEQ review. Record in the facility log/recordkeeping file the amount of fluid released, a description of any removal method and volume of any fluid removed from the impoundment and/or captured from the release area. The facility log/recordkeeping file shall be maintained according to Section 2.7.2 (Operation Inspection / Log/Recordkeeping File).

5. As soon as practicable, remove fluid remaining in the surface impoundment as necessary to prevent further releases to the subsurface and/or to perform repairs. Record in the facility log/recordkeeping file the amount of fluid removed a description of the removal method, and other disposal arrangements. The facility log/recordkeeping file shall be maintained according to Section 2.7.2 (Operation Inspection / Log/Recordkeeping File).
6. Within 30 days of discovery of the incident, submit a report to Groundwater Protection Value Stream as specified in Section 2.7.3. Include a description of the actions performed in Subsections 1 through 5 listed above. Upon review of the report, ADEQ may request additional monitoring or remedial actions.
7. Within 60 days of discovery, conduct an assessment of the impacts to soil and/or groundwater resulting from the incident. If soil or groundwater is impacted such that it could or did cause or contribute to an exceedance of an AQL at the applicable point of compliance, submit to ADEQ, for approval, a corrective action plan to address such impacts, including identification of remedial actions and a schedule for completion of activities. At the approval of ADEQ, the permittee shall implement the approved plan.
8. Within 30 days of completion of corrective actions, submit to Groundwater Protection Value Stream, a written report as specified in Section 2.6.6 (Corrective Actions).
9. Upon review of the report, ADEQ may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions, or other actions.

2.6.3.2 Overtopping of a Surface Impoundment

If overtopping of fluid from a permitted surface impoundment occurs, and results in a discharge pursuant to A.R.S. § 49-201(12), the Permittee shall:

1. As soon as practicable, cease all discharges to the surface impoundment to prevent any further releases to the environment.
2. Within 24 hours of discovery, notify Groundwater Protection Value Stream.
3. Within 24 hours, collect representative samples of the fluid contained in the surface impoundment. Samples shall be analyzed for the parameters specified in Section 4.3, Table 4.3.1. Within 30 days of the incident, submit a copy of the analytical results to Groundwater Protection Value Stream.
4. As soon as practicable, remove and properly dispose of excess water in the impoundment until the water level is restored at or below the appropriate freeboard as described in Section 4.2, Table 4.2.1. Record in the facility log/recordkeeping file the amount of fluid released, a description of the removal method and volume of any fluid removed from the impoundment and/or captured from the release area. The facility log/recordkeeping file shall be maintained according to Section 2.7.2 (Operation Inspection/LogBook/Recordkeeping File).
5. Within 30 days of discovery, evaluate the cause of the overtopping and identify the circumstances that resulted in the incident. Implement corrective actions and adjust operational conditions as necessary to resolve the problems identified in the evaluation. Repair any systems as necessary to prevent future occurrences of overtopping.
6. Within 30 days of discovery of overtopping, submit a report to ADEQ as specified in Section 2.7.3(2) (Permit Violation and Alert Level Status Reporting). Include a description of the actions performed in Subsections 1 through 5 listed above. Upon review of the report, ADEQ may request additional monitoring or remedial actions.
7. Within 60 days of discovery, and based on sampling in Item No. 3 above, conduct an assessment of the impacts to the subsoil and/or groundwater resulting from the incident.
8. If soil or groundwater is impacted such that it could cause or contribute to an exceedance of an AQL at the applicable point of compliance, submit to ADEQ for approval, a corrective action plan to address such impacts, including identification of remedial actions and/or monitoring, and a schedule for completion of activities. At the direction of ADEQ, the permittee shall implement the approved plan.
9. Within 30 days of completion of corrective actions, submit to ADEQ, a written report as specified in Section 2.6.6 (Corrective Actions). Upon review of the report, ADEQ may amend the permit to require additional monitoring, increased frequency of monitoring,

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amendments to permit conditions, or other actions.

2.6.3.3 Inflows of Unexpected Materials to a Surface Impoundment

The types of materials that are expected to be placed in the permitted surface impoundments are specified in Section 2.3 (Discharge Limitations). If any unexpected materials flow to a permitted surface impoundment, the Permittee shall:

1. As soon as practicable, cease all unexpected inflows to the surface impoundment(s).
2. Within 24-hours of discovery, notify the Groundwater Protection Value Stream.
3. Within five (5) days of the incident, identify the source of the material and determine the cause for the inflow. Characterize the unexpected material and contents of the affected impoundment, and evaluate the volume and concentration of the material to determine if it is compatible with the surface impoundment liner. Based on the evaluation of the incident, repair any systems or equipment and/or adjust operations, as necessary to prevent future occurrences of inflows of unexpected materials.
4. Within 30 days of an inflow of unexpected materials, submit a report to ADEQ as specified in Section 2.7.3(2) (Permit Violation and Alert Level Status Reporting). Include a description of the actions performed in Subsections 1 through 3 listed above.
5. Upon review of the report, ADEQ may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions, mitigation, or other actions.

2.6.3.4 Exceeding of Discharge Limitation for Tailings Deposition Height

1. If the DL for tailings deposition height set in Section 4.2, Table 4.2.1 has been exceeded, the permittee shall immediately investigate to determine the cause of the DL being exceeded. The investigation shall include a review of recent process logs, reports, and other operational control information to identify the cause of the exceedance.
2. The Permittee shall initiate actions to return to compliance with the DL as soon as practicable.
3. Within 30 days of a DL being exceeded, the Permittee shall submit to the ADEQ Groundwater Protection Value Stream, a summary of the findings of the investigation, the cause of the DL being exceeded, and actions taken to resolve the problem.
4. Upon review of the submitted report, the Department may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions or other actions.

2.6.3.5 Slope and Berm Failures

If the slope for the TSF or the UCP becomes unstable to the point of failure and results in a discharge, AMI will take the following actions:

1. Immediately after discovery, prevent vehicle and/or foot traffic in the area.
2. Notify the ADEQ WQCS within 24 hours.
3. Notify the design engineer immediately.
4. Within 15 days of discovery, initiate an evaluation to determine the cause of the incident. Identify the circumstances that resulted in the failure and assess the condition of the facility and liner system. Implement corrective actions as necessary to resolve the problems identified in the evaluation. Initiate repairs to the slope and/or any failed liner. Repair procedures, methods, and materials used to restore the system(s) to proper operating condition shall be described in the facility log/recordkeeping file and available for ADEQ review.
5. Within 30 days of discovery of the incident, submit a report to ADEQ. Include a description of the actions performed in the steps listed above. Upon review of the report, ADEQ may request additional monitoring or remedial actions.
6. Within 60 days of discovery, conduct an assessment of the impacts to the subsoil and/or groundwater resulting from the incident. If soil or groundwater is impacted such that it could cause or contribute to an exceedance of an AQL at an applicable monitoring well or a POC (if installed), submit to ADEQ, for approval, a corrective action plan to address problems identified in the assessment, including identification of releases to the environment, remedial actions and/or monitoring, and a schedule for completion of activities. At the direction of ADEQ, implement the approved plan.

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7. Within 30 days of completion of corrective actions, submit a written report to ADEQ. Upon review of the report, ADEQ may amend the permit to require additional monitoring, increased frequency of monitoring, amendments to permit conditions, or other actions.

2.6.4 Aquifer Quality Limit Violation

1. If an AQL set in Section 4.2 Table 4.2.3 has been exceeded, the permittee may conduct verification sampling within 5 days of becoming aware of an AQL exceedance. The permittee may use the results of another sample taken between the date of the last sampling event and the date of receiving the result as verification.
2. If verification sampling confirms that the AQL is violated for any parameter or if the permittee opts not to perform verification sampling, then the permittee shall increase the frequency of monitoring to Quarterl*y* from Semi-Annually. In addition, the permittee shall immediately initiate an evaluation for the cause of the violation, including inspection of all discharging units and all related pollution control devices, and review of any operational and maintenance practices that might have resulted in unexpected discharge.

   The permittee also shall submit a report according to Section 2.7.3(2), which includes a summary of the findings of the investigation, the cause of the violation, and actions taken to resolve the problem. A verified exceedance of an AQL will be considered a violation unless the permittee demonstrates within 90 days or a longer time period if agreed to by ADEQ that the exceedance was not caused or contributed to by pollutants discharged from the facility. Unless the permittee has demonstrated that the exceedance was not caused or contributed to by pollutants discharged from the facility, the permittee shall consider and ADEQ may require corrective action that may include control of the source of discharge, cleanup of affected soil, surface water or groundwater, and mitigation of the impact of pollutants on existing uses of the aquifer. Corrective actions shall either be specifically identified in this permit, included in an ADEQ approved contingency plan, or separately approved according to Section 2.6.6.
3. Upon review of the submitted report, the Department may amend the permit to require additional monitoring, increased frequency of monitoring, or other actions.
4. The permittee shall notify any downstream or downgradient users who may be directly affected by the discharge.

2.6.5 Emergency Response and Contingency Requirements for Unauthorized Discharges pursuant to A.R.S. § 49-201(12) and pursuant to A.R.S. § 49-241 That Are Not Addressed Elsewhere in Section 2.6

2.6.5.1 Duty to Respond

The permittee shall act immediately to correct any condition resulting from a discharge pursuant to A.R.S. § 49-201(12) if that condition could pose an imminent and substantial endangerment to public health or the environment.

2.6.5.2 Discharge of Hazardous Substances or Toxic Pollutants

In the event of any unauthorized discharge pursuant to A.R.S. **§** 49-201(12) of suspected hazardous substances (A.R.S. **§** 49-201(19)) or toxic pollutants (A.R.S. **§** 49-243(I)) on the facility site, the permittee shall promptly isolate the area and attempt to identify the discharged material. The permittee shall record information, including name, nature of exposure and follow-up medical treatment, if necessary, on persons who may have been exposed during the incident. The permittee shall notify the Groundwater Protection Value Stream and the Southern Regional Office within 24 hours upon discovering the discharge of hazardous material which (a) has the potential to cause an AWQS or AQL to be exceeded, or (b) could pose an endangerment to public health or the environment.

2.6.5.3 Discharge of Non-hazardous Materials

In the event of any unauthorized discharge pursuant to A.R.S. **§** 49-201(12) of non-hazardous materials from the facility, the permittee shall promptly attempt to cease the discharge and isolate the discharged material. Discharged material shall be removed and the site cleaned up as soon as possible. The permittee shall notify the Groundwater Protection Value Stream and the Southern Regional Office

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within 24 hours of discovering the discharge of non-hazardous material which has the potential to cause an AQL exceedance, or could pose an endangerment to public health or the environment.

2.6.5.4 Reporting Requirements

The permittee shall submit a written report for any unauthorized discharges required to be reported under Sections 2.6.5.2 and 2.6.5.3 to the Groundwater Protection Value Stream and the Southern Regional Office within 30 days of the discharge or as required by subsequent ADEQ action. The report shall summarize the event, including any human exposure, and facility response activities and include all information specified in Section 2.7.3. If a notice is issued by ADEQ subsequent to the discharge notification, any additional information requested in the notice shall also be submitted within the time frame specified in the notice. Upon review of the submitted report, ADEQ may require additional monitoring or corrective actions.

2.6.6 Corrective Actions

Specific contingency measures identified in Section 2.6 have already been approved by ADEQ and do not require written approval to implement.

With the exception of emergency response actions taken under Section 2.6.5, the permittee shall obtain written approval from the Groundwater Protection Value Stream prior to implementing a corrective action to accomplish any of the following goals in response to exceedance of an AL or violation of an AQL, DL, or other permit condition:

1. Control of the source of an unauthorized discharge;
2. Soil cleanup;
3. Cleanup of affected surface waters;
4. Cleanup of affected parts of the aquifer;
5. Mitigation to limit the impact of pollutants on existing uses of the aquifer.

Within 30 days of completion of any corrective action, the operator shall submit to the Groundwater Protection Value Stream, a written report describing the causes, impacts, and actions taken to resolve the problem.

2.7 Reporting and Recordkeeping Requirements [A.R.S. § 49-243(K)(2) and A.A.C. R18-9-A206(B) and R18-9-A207]

2.7.1 Self-Monitoring Report Form

1. The permittee shall complete the Self-Monitoring Reporting Forms (SMRFs) provided by ADEQ, and submit the completed report through the myDEQ online reporting system.
2. The permittee shall complete the SMRF to the extent that the information reported may be entered on the form. If no information is required during a reporting period, the permittee shall enter "not required" on the form, include an explanation.
3. The tables contained in Section 4.2 list the monitoring parameters and the frequencies for reporting results on the SMRF:
    - Table 4.2.2 Compliance Discharge Monitoring
    - Table 4.2.3 Groundwater Compliance Monitoring

    The parameters listed in the above-identified tables from Section 4.0 are the only parameters for which SMRF reporting is required.
4. In addition to the SMRF, the information contained in A.A.C. R18-9-A206(B)(1) shall be included for exceeding an alert level (AL) or violation of an Aquifer Quality Limit (AQL), discharge limit (DL), or any other permit condition being reported in the current reporting period.

2.7.2 Operation Inspection / Log Book Recordkeeping

A signed copy of this permit shall be maintained at all times at the location where day-to-day decisions regarding the operation of the facility are made. A log book (paper copies, forms, or electronic data) of the inspections and measurements required by this permit shall be maintained at the location where day-to-day decisions are made regarding the operation of the facility. The log book shall be retained for ten years from the date of each inspection, and upon request, the permit and the log book shall be made immediately available for review by ADEQ personnel. The information in the log book shall include, but not be limited to, the following information as applicable:

1. Name of inspector;
2. Date and time inspection was conducted;
3. Condition of applicable facility components;
4. Any damage or malfunction, and the date and time any repairs were performed;
5. Documentation of sampling date and time; and
6. Any other information required by this permit to be entered in the log book.

Monitoring records for each measurement shall comply with A.A.C. R18-9-A206(B)(2).

2.7.3 Permit Violation and Alert Level Status Reporting

1. The permittee shall notify the Groundwater Protection Value Stream in writing within five (5) days (except as provided in Section 2.6.5) of becoming aware of a violation of any permit condition, discharge limitation or of an AL exceedance for which notification requirements are not specified in Sections 2.6.2 through 2.6.5.

2. The permittee shall submit a written report to the Groundwater Protection Value Stream within 30 days of becoming aware of the violation of any permit condition or discharge limitation. The report shall document all of the following:
   a. Identification and description of the permit condition for which there has been a violation and a description of the cause;
   b. The period of violation including exact date(s) and time(s), if known, and the anticipated time period during which the violation is expected to continue;
   c. Any corrective action taken or planned to mitigate the effects of the violation, or to eliminate or prevent a recurrence of the violation;
   d. Any monitoring activity or other information which indicates that any pollutants would be reasonably expected to cause a violation of an AWQS;
   e. Proposed changes to the monitoring which include changes in constituents or increased frequency of monitoring; and
   f. Description of any malfunction or failure of pollution control devices or other equipment or processes.

2.7.4 Operational, Other or Miscellaneous Reporting

2.7.4.1 Annual Report

If an Alert Level #1 or Alert Level #2 has been exceeded as discussed in Sections 2.6.2.3 and 2.6.2.4, the permittee shall submit an annual report that summarizes the results of the liner assessment. The Liner Leakage Assessment Report shall also include information including but not limited to the following: number and location of holes identified; a table summarizing the exceedances including the frequency and quantity of fluid removed, and corrective actions taken.

When required the annual report is to be submitted by January 30 of each year to cover activities from January 1 through December 31st of the previous year, consistent with Section 2.7.6.

2.7.5 Reporting Location

All Self-Monitoring Report Forms (SMRFs) shall be submitted through the myDEQ portal accessible on the ADEQ website at: http://www.azdeq.gov/welcome-mydeq

All other documents required by this permit to be submitted to the Groundwater Protection Value Stream shall be directed to:

Arizona Department of Environmental Quality
Groundwater Protection Value Stream
Mail Code 5415B-3
1110 West Washington Street
Phoenix, Arizona 85007
Phone (602) 771-4449

2.7.6 Reporting Deadline

The following table lists the due dates:

Monitoring conducted during quarter:	Quarterly Report due by:
January-March	April 30
April-June	July 30
July-September	October 30
October-December	January 30

The following table lists the due date for the Annual report per Section 2.7.4.1 and the semi-annual groundwater compliance monitoring required by Section 4.2, Table 4.2.3:

Monitoring conducted:	Report due by:
Annual: January-December	January 30
Semi-Annual: January-June	July 30
Semi-Annual: July-December	January 30

2.7.7 Changes to Facility Information in Section 1.0

The Groundwater Protection Value Stream shall be notified within ten days of any change of facility information including Facility Name, Permittee Name, Mailing or Street Address, Facility Contact Person, or Emergency Telephone Number.

2.8 Temporary Cessation [A.R.S. § 49-243(K)(8) and A.A.C. R18-9-A209(A)]

The permittee shall give written notice to the Groundwater Protection Value Stream and the Southern Regional Office before ceasing operation of the facility for a period of 60 days or greater. The permittee shall take the following measures upon temporary cessation:

- Submittal of Self-Monitoring Report Forms (SMRFs) is still required; report "temporary cessation" in the comment section.

At the time of notification the permittee shall submit for ADEQ approval a plan for maintenance of discharge control systems and for monitoring during the period of temporary cessation. Immediately following ADEQ approval, the permittee shall implement the approved plan. If necessary, ADEQ shall amend permit conditions to incorporate conditions to address temporary cessation. During the period of temporary cessation, the permittee shall provide written notice to the Groundwater Protection Value Stream and the Southern Regional Office of the operational status of the facility every three years. If the permittee intends to permanently cease operation of any facility, the permittee shall submit closure notification, as set forth in Section 2.9 below.

2.9 Closure [A.R.S. §§ 49-243(K)(6), 49-252 and A.A.C. R18-9-A209(B)]

For a facility addressed under this permit, the permittee shall give written notice of closure to the Groundwater Protection Value Stream of the intent to cease operation without resuming activity for which the facility was designed or operated. Submittal of SMRFs is still required; report "closure in process" in the comment section.

2.9.1 Closure Plan

Within 90 days following notification of closure, the permittee shall submit for approval to the Groundwater Protection Value Stream, a closure plan which meets the requirements of A.R.S. § 49-252 and A.A.C. R18-9-A209(B)(3).

If the closure plan achieves clean-closure immediately, ADEQ shall issue a letter of approval to the permittee. If the closure plan contains a schedule for bringing the facility to a clean-closure configuration at a future date, ADEQ may incorporate any part of the schedule as an amendment to this permit.

2.9.2 Closure Completion

Upon completion of closure activities, the permittee shall give written notice to the Groundwater Protection Value Stream indicating that the approved closure plan has been implemented fully and providing supporting documentation to demonstrate that clean-closure has been achieved (soil sample results, verification

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sampling results, groundwater data, as applicable). If clean-closure has been achieved, ADEQ shall issue a letter of approval to the permittee at that time. If any of the following conditions apply, the permittee shall follow the terms of post-closure stated in this permit:

1. Clean-closure cannot be achieved at the time of closure notification or within one year thereafter under a diligent schedule of closure actions;
2. Further action is necessary to keep the facility in compliance with the AWQS at the applicable POC or, for any pollutant for which the AWQS was exceeded at the time this permit was issued, further action is necessary to prevent the facility from further degrading the aquifer at the applicable POC with respect to that pollutant;
3. Activities are necessary to verify that actions or controls specified as closure requirements in an approved closure plan or strategy are routinely inspected or maintained;
4. Remedial, mitigative or corrective actions or controls are necessary to comply with A.R.S. § 49-201(30) and Title 49, Chapter 2, Article 3; and
5. Further action is necessary to meet property use restrictions.

2.10 Post-closure [A.R.S. §§ 49-243(K)(6), 49-252 and A.A.C. R18-9 A209(C)]

Post-closure requirements shall be established based on a review of facility closure actions and will be subject to review and approval by the Groundwater Protection Value Stream.

In the event clean-closure cannot be achieved pursuant to A.R.S. § 49-252, the permittee shall submit for approval to the Groundwater Protection Value Stream a post-closure plan that addresses post-closure maintenance and monitoring actions at the facility. The post-closure plan shall meet all requirements of A.R.S. §§ 49-201(30) and 49-252 and A.A.C. R18-9-A209(C). Upon approval of the post-closure plan, this permit shall be amended or a new permit shall be issued to incorporate all post-closure controls and monitoring activities of the post-closure plan.

2.10.1 Post-Closure Plan

A specific post-closure plan may be required upon the review of the closure plan.

2.10.2 Post-Closure Completion

Not required at the time of permit issuance.

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3.0 COMPLIANCE SCHEDULE [A.R.S. § 49-243(K)(5) and A.A.C. R18-9-A208]

Unless otherwise indicated, for each compliance schedule item listed below, the permittee shall submit the required information to the Groundwater Protection Value Stream.

No.	Description	Due by:	Permit Amendment Required?
1	The financial assurance mechanism listed in Section 2.1, Financial Capability, is being maintained as per A.R.S. 49-243.N.4 and A.A.C. R18-9-A203(H) for all estimated closure and post-closure costs including updated costs submitted under Section 3.0, No. 4 below. The demonstration shall include a statement that the closure and post-closure strategy has not changed, the discharging facilities listed in the permit have not been altered in a manner that would affect the closure and post-closure costs, and discharging facilities have not been added. The demonstration shall also include information in support of a performance surety bond as required in A.A.C. R18-9-A203(C)(2).	January 8, 2024, and every 6 years thereafter, for the duration of the permit.	No
2	The permittee shall submit updated cost estimates for facility closure and post-closure, as per A.A.C. R18-9-A201(B)(5) and A.R.S. 49-243.N.2.a, and an updated financial assurance demonstration for the updated cost estimate as per A.A.C. R18-9-A203(C)(2).	January 8, 2024, and every 6 years thereafter, for the duration of the permit.	Yes
3	If the permittee wishes to deposit a greater quantity of material, or to increase the crest elevation above 5,~~110~~ 175 feet amsl, then the permittee shall apply for a permit amendment.	Within six months of determination to increase tailings crest elevation	Yes
4	The permittee shall submit as-built design drawings for ~~the~~ WTP1 following upgrades. The design documents shall be sealed by an Arizona licensed professional engineer.	Within 90 days after completion of construction.	No
5	The permittee shall submit as-built design report of the TSF documenting placement of development rock from surface and exploration declines, filter cake from ~~the~~ WTP1, and core cuttings when the TSF reaches the maximum permitted elevation of the 5,~~110~~ 175 ft. The design documents shall be sealed by an Arizona licensed professional engineer.	Within 90 days after completion of construction.	No
6	The permittee shall submit as-built design drawings for WTP2 following construction. The design documents shall be sealed by an Arizona licensed professional engineer.	Within 90 days after completion of construction.	No
7	An updated Contingency and Emergency Response plan will be submitted to ADEQ and kept at the site.	Within 30 days of amended permit issuance	No

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TABLES OF MONITORING REQUIREMENTS

4.1 PRE-OPERATIONAL MONITORING (or CONSTRUCTION REQUIREMENTS)

Not Required

4.2 COMPLIANCE AND OPERATIONAL MONITORING

Table 4.2.1 Facility Inspection Monitoring (Log Book)
Table 4.2.2 Compliance Discharge Monitoring
Table 4.2.3 Groundwater Compliance Monitoring for POC-2
Table 4.2.4 Leak Collection and Removal System Monitoring (Log Book)

4.3 Contingency Monitoring

Table 4.3.1 Compliance Discharge Characterization for BADCT Failures

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4.0 TABLES OF MONITORING REQUIREMENTS and BADCT DEMONSTRATIONS

4.2 PRE-OPERATIONAL MONITORING (or CONSTRUCTION REQUIREMENTS)

Not applicable.

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4.2 COMPLIANCE (or OPERATIONAL) MONITORING

TABLE 4.2.1
FACILITY INSPECTION (OPERATIONAL MONITORING) - LOG BOOK[1]

TAILINGS STORAGE FACILITY - Log Book

Parameter	Performance Standard	Monitoring Frequency
Facility Height	Does not exceed 5,~~110~~ 175 ft amsl	Annually
Structural Integrity	No visible structural weakness, seepage erosion, sloughing, rolling rocks, or other hazardous conditions	Monthly
Piezometric Head	The phreatic surface in the piezometers shall be less than 1.5 feet[2]	Weekly

PIEZOMETER LOCATION

Piezometer ID	Association	Latitude	Longitude
P1	TSF	31° 28' 01.3135" N	110° 43' 36.4235" W
P2	TSF	31° 27' 58.5711" N	110° 43' 39.4789" W
P3	TSF	31° 27' 59.3730" N	110° 43' 32.8978" W
P4	TSF	31° 27' 56.4873" N	110° 43' 28.0662" W
~~P5~~	~~UCP~~	~~31° 28' 10.9482" N~~	~~110° 43' 41.0728" W~~
~~P6~~	~~UCP~~	~~31° 28' 10.4521" N~~	~~110° 43' 40.7503" W~~

NOTE: If replacement of a piezometer is necessary due to malfunction, the permittee may install a replacement piezometer in the same general location, and no permit amendment is necessary. The locational information may be updated in the permit, during any future amendment.

UNDERDRAIN COLLECTION POND - Log Book

Parameter	Performance Standard	Monitoring Frequency
Freeboard	Minimum of seven (7) feet	Weekly or after a significant rainstorm or other natural disaster
Anchor trench integrity	No impairment	Monthly
Embankment integrity	No visible structural weakness, seepage erosion, or other hazardous conditions	Monthly
Liner Integrity	No visible cracks, punctures, or deteriorations of liner	Monthly
Integrity of Pumping System	Good working condition	Monthly
Sediments/sludge	Remove sediments/sludge as needed to maintain at least 90 percent of designed capacity	Monthly

[1] The permittee shall record the inspection performance levels in a log book as per Section 2.7.2. In the case of an exceedance, identify which structure exceeds the performance level in the log book.
[2] If the phreatic surface is in excess of 1.5 feet, the permittee shall follow the contingency action per Section 2.6.2.7.

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4.2 COMPLIANCE (or OPERATIONAL) MONITORING

TABLE 4.2.2
COMPLIANCE DISCHARGE MONITORING

Sampling Point Numbers		**Sampling Point Identification**			**Latitude**	**Longitude**
1 and 3		AZPDES Outfall 001 and AZPDES Outfall 002			31° 28' 15" N 31° 27' 56.62" N	110° 43' 43" W 110° 43' 11.51" W
Parameter	**AL both outfalls**[3]	**DL outfall 001**[4]	**DL Outfall 002**	**Units**	**Monitoring Frequency**	**Reporting Frequency**
Flow	N/A	0.172	6.652	mgd[5]	Daily[6]	Quarterly
Temperature	Monitor[7]	Monitor	Monitor	Degrees	Quarterly	Quarterly
pH (field)	Monitor	Monitor	Monitor	S.U.	Quarterly	Quarterly
Specific Conductance (field)	Monitor	Monitor	Monitor	µmhos/cm	Quarterly	Quarterly
Nitrate (as N)	8.0	10.0	10.0	mg/L	Quarterly	Quarterly
Nitrite (as N)	0.8	1.0	1.0	mg/L	Quarterly	Quarterly
Nitrate-Nitrite as N	8.0	10.0	10.0	mg/L	Quarterly	Quarterly
Total Dissolved Solids	Monitor	Monitor	Monitor	mg/L	Quarterly	Quarterly
Total Alkalinity	Monitor	Monitor	Monitor	mg/L	Quarterly	Quarterly
Sulfate	Monitor	Monitor	Monitor	mg/L	Quarterly	Quarterly

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[3] AL = Alert Levels
[4] DL = Discharge Limits
[5] Mgd=Million gallons per day
[6] "Daily" means the days that effluent from the Water Treatment Plant is discharged to the AZPDES Outfall 001. On the days effluent from the Water Treatment Plant is NOT being discharged to the AZPDES Outfall 001, indicate "No Flow" on the SMRF reporting form.
[7] Monitor = Analysis is required but limits are not established.

4.2.2 COMPLIANCE (or OPERATIONAL) MONITORING

TABLE 4.2.2
COMPLIANCE DISCHARGE MONITORING – continued

Parameter[8]	AL[9]	DL Outfall 001[10]	DL Outfall 002	Units	Monitoring Frequency	Reporting Frequency
Antimony	0.0048	0.006	0.006	mg/L	Quarterly	Quarterly
Arsenic	0.04	0.05	0.05	mg/L	Quarterly	Quarterly
Beryllium	0.0032	0.004	0.004	mg/L	Quarterly	Quarterly
Barium	1.60	2.00	2.00	mg/L	Quarterly	Quarterly
Cadmium	0.008	0.010	0.010	mg/L	Quarterly	Quarterly
Chromium	0.08	0.1	0.1	mg/L	Quarterly	Quarterly
Cyanide (free)	0.16	0.2	0.2	mg/L	Quarterly	Quarterly
Fluoride	3.2	4.0	4.0	mg/L	Quarterly	Quarterly
Lead	0.04	0.05	0.05	mg/L	Quarterly	Quarterly
Mercury	0.0016	0.002	0.002	mg/L	Quarterly	Quarterly
Nickel	0.08	0.1	0.1	mg/L	Quarterly	Quarterly
Selenium	0.04	0.05	0.05	mg/L	Quarterly	Quarterly
Thallium	0.0016	0.002	0.002	mg/L	Quarterly	Quarterly
Iron	Monitor[11]	Monitor	Monitor	mg/L	Quarterly	Quarterly
Copper	Monitor	Monitor	Monitor	mg/L	Quarterly	Quarterly
Manganese	Monitor	Monitor	Monitor	mg/L	Quarterly	Quarterly
Zinc	Monitor	Monitor	Monitor	mg/L	Quarterly	Quarterly
Gross Alpha (including Radium 226)[12,13]	Monitor	Monitor	Monitor	pCi/L	Quarterly	Quarterly
Radium 226 + Radium 228	Monitor	Monitor	Monitor	pCi/L	Quarterly	Quarterly

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8 Metals shall be analyzed as dissolved metals.
9 AL = Alert Levels
10 DL = Discharge Limit
11 Monitoring is required, but no limit is established.
12 If the gross alpha particle activity is greater than 15 pCi/L, then calculate adjusted gross alpha particle activity
13 The adjusted gross alpha particle activity is the gross alpha particle activity, including radium 226, and any other alpha emitters, if present in the water sample, minus radon and total uranium (the sum of uranium 238, uranium 235 and uranium 234 isotopes). The gross alpha analytical procedure (evaporation technique: EPA Method 900.0) drives off radon gas in the water samples. Therefore, the Adjusted Gross Alpha should be calculated using the following formula: (Laboratory Reported Gross Alpha MINUS Sum of the Uranium Isotopes).

4.2 COMPLIANCE (or OPERATIONAL) MONITORING

TABLE 4.2.3
COMPLIANCE GROUNDWATER MONITORING (POC-2)

Sampling Point Number	**Sampling Point Identification**			**Latitude**	**Longitude**
2	300 feet downgradient of the AZPDES Outfall-001 (MW3)			31° 28' 18.91"	110° 43' 48.83"
Parameter[14]	**AL**[15]	**AQL**[16]	**Units**	**Monitoring Frequency**	**Reporting Frequency**
Depth to Water Level	Monitor[17]	Monitor	Feet	Semi-Annually[18]	Semi-Annually
Water Level Elevation	Monitor	Monitor	Feet amsl[19]	Semi-Annually	Semi-Annually
Temperature	Monitor	Monitor	Degrees	Semi-Annually	Semi-Annually
pH	Monitor	Monitor	S.U.	Semi-Annually	Semi-Annually
Specific Conductance	Monitor	Monitor	µmhos/cm	Semi-Annually	Semi-Annually
Nitrate (as N)	8	10	mg/L	Semi-Annually	Semi-Annually
Nitrite (as N)	0.8	1	mg/L	Semi-Annually	Semi-Annually
Nitrate-Nitrite as N	8	10	mg/L	Semi-Annually	Semi-Annually
Total Dissolved Solids	Monitor	Monitor	mg/L	Semi-Annually	Semi-Annually
Total Alkalinity	Monitor	Monitor	mg/L	Semi-Annually	Semi-Annually
Sulfate	Monitor	Monitor	mg/L	Semi-Annually	Semi-Annually

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[14] Metals shall be analyzed as dissolved metals.
[15] AL = Alert Levels
[16] AQL = Aquifer Quality Limits
[17] Monitor = Analysis is required but an AQL and/or AL is not established in the permit
[18] Semi-Annual monitoring shall be conducted as follows: During each semi-annual period described in Sections 2.6.2.8.2, 2.6.4, and 2.7.6 sampling shall occur within seven days of a discharge from the WTP outfall, but not exceeding one sampling event per semi-annual period. If no discharge should occur during a semi-annual period, no sample is required for that period. Should sampling frequency increase to Quarterly monitoring, sampling shall be conducted in the same manner as described above, except the period for sampling will be quarterly as described in Sections, 2.6.2.8.2, 2.6.4, and 2.7.6.
[19] amsl = above mean sea level

4.2 COMPLIANCE (or OPERATIONAL) MONITORING

TABLE 4.2.3
COMPLIANCE GROUNDWATER MONITORING (continued)

Parameter	AL[20]	AQL[21]	Units	Monitoring Frequency	Reporting Frequency
Antimony	0.0048	0.006	mg/L	Semi-Annually	Semi-Annually
Arsenic	0.04	0.05	mg/L	Semi-Annually	Semi-Annually
Beryllium	0.0032	0.004	mg/L	Semi-Annually	Semi-Annually
Barium	1.6	2	mg/L	Semi-Annually	Semi-Annually
Cadmium	Not Established[22]	0.011	mg/L	Semi-Annually	Semi-Annually
Chromium	0.08	0.1	mg/L	Semi-Annually	Semi-Annually
Cyanide (free)	0.16	0.2	mg/L	Semi-Annually	Semi-Annually
Fluoride	3.2	4.0	mg/L	Semi-Annually	Semi-Annually
Lead	0.04	0.05	mg/L	Semi-Annually	Semi-Annually
Mercury	0.0016	0.002	mg/L	Semi-Annually	Semi-Annually
Nickel	0.08	0.1	mg/L	Semi-Annually	Semi-Annually
Selenium	0.04	0.05	mg/L	Semi-Annually	Semi-Annually
Thallium	0.0016	0.002	mg/L	Semi-Annually	Semi-Annually
Iron	Monitor[23]	Monitor	mg/L	Semi-Annually	Semi-Annually
Copper	Monitor	Monitor	mg/L	Semi-Annually	Semi-Annually
Manganese	Monitor	Monitor	mg/L	Semi-Annually	Semi-Annually
Zinc	Monitor	Monitor	mg/L	Semi-Annually	Semi-Annually
Gross Alpha (including Radium 226)[24,25]	12	15	pCi/L	Semi-Annually	Semi-Annually
Radium 226 + Radium 228	4	5	pCi/L	Semi-Annually	Semi-Annually

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[20] AL = Alert Levels
[21] AQL = Aquifer Quality Limits
[22] Not Established means monitoring is required but no limits are specified.
[23] Monitoring is required, but no limit is established.
[24] If the gross alpha particle activity is greater than 15 pCi/L, then calculate adjusted gross alpha particle activity
[25] The adjusted gross alpha particle activity is the gross alpha particle activity, including radium 226, and any other alpha emitters, if present in the water sample, minus radon and total uranium (the sum of uranium 238, uranium 235 and uranium 234 isotopes). The gross alpha analytical procedure (evaporation technique: EPA Method 900.0) drives off radon gas in the water samples. Therefore, the Adjusted Gross Alpha should be calculated using the following formula: (Laboratory Reported Gross Alpha MINUS Sum of the Uranium Isotopes).

4.2 COMPLIANCE (or OPERATIONAL) MONITORING

TABLE 4.2.4
LEAK COLLECTION AND REMOVAL SYSTEM MONITORING (Log Book)

LCRS Sump	Alert Level 1 (gpd)	Alert Level 2 (gpd)	Monitoring Method	Monitoring Frequency
Underdrain Collection Pond (UCP) Sump	3,456	22,896	Automated	Daily

Note: The volume of liquid pumped from the LCRS shall be monitored on a continuous basis using a totalizer and entered in a facility log book on a daily basis. The Alert Level 1 (AL1) or Alert Level 2 (AL2) shall be exceeded when the amount of leakage pumped from the sump for the UCP is greater than the applicable quantity above. Contingency requirements of Sections 2.6.2.3 and 2.6.2.4 shall be followed for AL1 and AL2 exceedances, respectively. An exceedance of AL 1 or AL2 is not a violation of the permit unless the permittee fails to perform actions as required under the Sections referenced above.

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4.3 CONTINGENCY MONITORING

TABLE 4.3.1
CONTINGENCY DISCHARGE CHARACTERIZATION FOR BADCT FAILURES AND OVERTOPPING[26]

Parameter	Units	Monitoring Frequency[27]
pH (field)	Standard Units	One sample
Total Dissolved Solids (TDS)	mg/L	One sample
Specific Conductance (lab)	umhos/cm	One sample
Hardness [28]	Standard Units	One sample
Nitrate (as N)	mg/L	One sample
Nitrite (as N)	mg/L	One sample
Nitrate-Nitrite as N	mg/L	One sample
Total Alkalinity	mg/L	One sample
Sulfate	mg/L	One sample
Antimony	mg/L	One sample
Arsenic	mg/L	One sample
Beryllium	mg/L	One sample
Barium	mg/L	One sample
Cadmium	mg/L	One sample
Chromium	mg/L	One sample
Cyanide (free)	mg/L	One sample
Fluoride	mg/L	One sample
Lead	mg/L	One sample
Mercury	mg/L	One sample
Nickel	mg/L	One sample
Selenium	mg/L	One sample
Thallium	mg/L	One sample
Iron	mg/L	One sample
Copper	mg/L	One sample
Manganese	mg/L	One sample
Zinc	mg/L	One sample

[26] Monitor under this table per Section 2.6.3.1, Surface Impoundments, Liner Failure, Containment Structure Failure, Unexpected Loss of Fluid, or Section 2.6.3.2, Overtopping of an Impoundment.
[27] One sample shall be taken within 24 hours of discovery of an event.
[28] Hardness may be expressed as the sum of calcium plus magnesium as calcium carbonate (CaCO3)
mg/L = milligrams per liter umhos/cm = micromhos per centimeter

5.0 REFERENCES AND PERTINENT INFORMATION

The terms and conditions set forth in this permit have been developed based upon the information contained in the following, which are on file with the Department:

1.	APP Application received:	05/29/2020
2.	Contingency Plan, dated:	June 5, 2017
3.	Public Hearing, dated:	NA
4.	Public Hearing, dated:	NA

Document Reviewed

- Hermosa Project, Aquifer Protection Permit OTHER Amendment Application P-512235, prepared by Clear Creek Associates, LLC, dated May 29, 2020.

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6.0 NOTIFICATION PROVISIONS

6.1 Annual Registration Fees

The permittee is notified of the obligation to pay an Annual Registration Fee to ADEQ. The Annual Registration Fee is based on the amount of daily influent or discharge of pollutants in gallons per day (gpd) as established by A.R.S. § 49-242.

6.2 Duty to Comply [A.R.S. §§ 49-221 through 263]

The permittee is notified of the obligation to comply with all conditions of this permit and all applicable provisions of Title 49, Chapter 2, Articles 1, 2 and 3 of the Arizona Revised Statutes, Title 18, Chapter 9, Articles 1 through 4, and Title 18, Chapter 11, Article 4 of the Arizona Administrative Code. Any permit non-compliance constitutes a violation and is grounds for an enforcement action pursuant to Title 49, Chapter 2, Article 4 or permit amendment, suspension, or revocation.

6.3 Duty to Provide Information [A.R.S. §§ 49-243(K)(2) and 49-243(K)(8)]

The permittee shall furnish to the Director, or an authorized representative, within a time specified, any information which the Director may request to determine whether cause exists for amending or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

6.4 Compliance with Aquifer Water Quality Standards [A.R.S. §§ 49-243(B)(2) and 49-243(B)(3)]

The permittee shall not cause or contribute to a violation of an Aquifer Water Quality Standard (AWQS) at the applicable point of compliance (POC) for the facility. Where, at the time of issuance of the permit, an aquifer already exceeds an AWQS for a pollutant, the permittee shall not discharge that pollutant so as to further degrade, at the applicable point of compliance for the facility, the water quality of any aquifer for that pollutant.

6.5 Technical and Financial Capability [A.R.S. §§ 49-243(K)(8) and 49-243(N) and A.A.C. R18-9-A202(B) and R18-9-A203(E) and (F)]

The permittee shall have and maintain the technical and financial capability necessary to fully carry out the terms and conditions of this permit. Any bond, insurance policy, trust fund, or other financial assurance mechanism provided as a demonstration of financial capability in the permit application, pursuant to A.A.C. R18-9-A203(C), shall be in effect prior to any discharge authorized by this permit and shall remain in effect for the duration of the permit.

6.6 Reporting of Bankruptcy or Environmental Enforcement [A.A.C. R18-9-A207(C)]

The permittee shall notify the Director within five days after the occurrence of any one of the following:

1. the filing of bankruptcy by the permittee; or
2. the entry of any order or judgment not issued by the Director against the permittee for the enforcement of any environmental protection statute or rule.

6.7 Monitoring and Records [A.R.S. § 49-243(K)(8) and A.A.C. R18-9-A206]

The permittee shall conduct any monitoring stipulated in the permit necessary to assure compliance with this permit, with the applicable water quality standards established pursuant to A.R.S. §§ 49-221 and 49-223 and §§ 49-241 through 49-252.

6.8 Inspection and Entry [A.R.S. §§ 49-1009, 49-203(B), and 49-243(K)(8)]

In accordance with A.R.S. §§ 41-1009 and 49-203(B), the permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to enter and inspect the facility as reasonably necessary to ensure compliance with Title 49, Chapter 2, Article 3 of the Arizona Revised Statutes, and Title 18, Chapter 9, Articles 1 through 4 of the Arizona Administrative Code and the terms and conditions of this permit.

6.9 Duty to Modify [A.R.S. § 49-243(K)(8) and A.A.C. R18-9-A211]

The permittee shall apply for and receive a written amendment before deviating from any of the designs or operational practices authorized by this permit.

6.10 Permit Action: Amendment, Transfer, Suspension, and Revocation [A.R.S. §§ 49-201, 49-241 through 251, A.A.C. R18-9-A211, R18-9-A212 and R18-9-A213]

This permit may be amended, transferred, suspended, or revoked for cause, under the rules of the Department. The permittee shall notify the Groundwater Protection Value Stream in writing within 15 days after any change in the owner or operator of the facility. The notification shall state the permit number, the name of the facility, the date of property transfer, and the name, address, and phone number where the new owner or operator can be reached. The operator shall advise the new owner or operators of the terms of this permit and the need for permit transfer in accordance with the rules.

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7.0 ADDITIONAL PERMIT CONDITIONS

7.1 Other Information [A.R.S. § 49-243(K)(8)]

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, the permittee shall promptly submit the correct facts or information.

7.2 Severability [A.R.S. §§ 49-201, 49-241 through 251, A.A.C. R18-9-A211, R18-9-A212 and R18-9-A213]

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby. The filing of a request by the permittee for a permit action does not stay or suspend the effectiveness of any existing permit condition.

7.3 Permit Transfer

This permit may not be transferred to any other person except after notice to and approval of the transfer by the Department. No transfer shall be approved until the applicant complies with all transfer requirements as specified in A.A.C. R18-9-A212(B) and (C).

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