ARIZONA MINERALS

3845 North Business Center Drive
Suite 115
Tucson, AZ 85705
Tel: 520-485-1300
Email: info@arizonamining.com
Web: www.arizonamining.com

June 5, 2017

Mr. Luke Peterson
Arizona Department of Environmental Quality
Groundwater Aquifer Protection Permit Unit
1110 W. Washington St.
Phoenix, AZ 85007

Re: Aquifer Protection Permit Application
Trench Camp Property (January Mine, Norton Mine and Trench Camp Mine Claims)
Arizona Minerals, Inc.

Dear Mr. Peterson:

Arizona Minerals, Inc. (AMI) is the applicant for an individual Aquifer Protection Permit (APP) for facilities to be constructed at the January Adit (Norton Mine) Project at the Trench Camp Mine property in Santa Cruz County, Arizona. . All of the work proposed in this application will be conducted on land that is 100% owned by AMI. This permit application covers the following facilities and regulated discharges:

- A lined Tailing Storage Facility (TSF) with integrated stormwater detention ponds constructed using Prescriptive BADCT. The TSF will contain tailings from historical tailings piles at the site and development rock from a decline that AMI will construct for future underground mining operations.
- An Underdrain Collection Pond, constructed with a double liner according to Prescriptive BADCT.
- Discharge from a water treatment plant (WTP) to Alum Gulch. The WTP will treat seepage from the TSF and January Mine water. The WTP has been designed so that discharges will meet applicable surface water quality standards and Aquifer Water Quality Standards.

AMI is currently working with the Arizona Department of Environmental Quality's Voluntary Remediation Program (VRP) (Site Code 505143-02) to eliminate discharges of mine impacted water to Alum Gulch from the January Adit and tailings pile seepage. A Work Plan was submitted to ADEQ-VRP on April 27, 2017. This APP application is for the APP-regulated discharges associated with the VRP Project.

AMI is a Nevada corporation registered with the Arizona Corporation commission, and is a wholly-owned subsidiary of Arizona Mining, Inc. AMI is moving forward with plans to develop the Hermosa Taylor deposit, a lead-zinc-silver resource at the site. Eventually, the TSF included in this application will receive dry stack tailings from the development of the underground mine.

AMI is providing a check for $2,000 to cover the application fees.

AMI looks forward to working with ADEQ to move this project forward in order to eliminate discharges from historic mining operations.

If you have any questions or need additional information, please do not hesitate to contact me on my cell phone at 803-235-5563.

Sincerely,

Johnny Pappas
Director of Environmental and Permitting

Enclosures (three hard copies and two disc)

ADEQ
Arizona Department of Environmental Quality

INDIVIDUAL AQUIFER PROTECTION PERMIT APPLICATION

APP

GENERAL INFORMATION

1 Applicant [A.A.C. R18-1-503(1)] – Person signing the application

(Check One) ☐ Owner ☐ Operator ☒ Owner and Operator Email dtaylor@arizonamining.com

Name Don Taylor Phone 520-485-1300

Title President Business Arizona Minerals, Inc.

Mailing Address 3845 Business Center Drive, Suite 115 City Tucson State AZ Zip 85705

2 Permittee – Person responsible for complying with the terms and conditions of the APP

(Check One) ☐ Owner ☐ Operator ☒ Owner and Operator Email jpappas@arizonamining.com

Name Johnny Pappas Phone 520-485-1300 803-235-5563 (cell)

Title Director, Environmental and Permitting Firm Name Arizona Minerals, Inc.

Mailing Address 3845 Business Center Dr. Suite 115 City Tucson State AZ Zip 85705

3 Landowner(s)

☐ Check this box if the person listed below is not the applicant, include a copy of the Lease or Contract

Name see applicant info Phone

Title Business

Mailing Address City State Zip

4 Facility Name [A.A.C. R18-1-503(2)]

Facility Name Trench Camp Property

☒ New ☐ Currently Operating

5 Authorized Agent [A.A.C. R18-1-503(3)]

☐ Check this box if the person listed below is authorized to act as an "Agent" on behalf of the applicant

Email

Name NA Phone

Title Firm Name

Mailing Address City State Zip

6 Completed Form [A.A.C. R18-1-503(5)]

☒ I have completed and signed the APP application.

7 Initial Fee [A.A.C. R18-1-503(6) and R18-14-103]

☒ Check this box if an initial fee of $2,000 is attached.

8 Facility Address and Location Information [A.A.C. R18-9-A201(B)(1)]

Address 749 Harshaw Road

City Patagonia, State AZ Zip 85624

County Santa Cruz

Township see below Range Section Qtr1 Qtr2 Qtr3

Latitude 31 ° 27 ' 59.4 "N Longitude 110 ° 43 ' 35.8 "W ☐ NAD27 ☒ NAD83

property is in T22S, 16E Sec 32 and T23S, R16E unsurveyed sections 4 and 5

9 Emergency Contact [A.A.C. R18-9-A202(A)(11)]

Name Johnny Pappas or Greg Lucero Phone 803-235-5563 (Pappas Cell) or 520-604-0618 (Lucero cell)

10 Legal Description [A.A.C. R18-9-A201(B)(1)]

Legal Description see Table 2 of main text

11 Operational Life [A.A.C. R18-9-A201(B)(1)]

The operational life of the facility is 30 years

12 Facility Description [A.R.S. § 49-243(K)(8)]

I have attached a facility description that includes the following information:

A) General description of what the facility does.
B) When operations began or are estimated to begin.
C) A general description of your process as it relates to the discharge. List all operational and closed discharging facilities, source of the wastewater, and where the wastewater is discharged.

■ Yes (include as attachment) Section 1.2

13 Existing Environmental Permits [A.A.C. R18-9-A201(B)(1)]

List any other federal or state environmental permits issued for or needed by the facility, including any individual permit, Groundwater Quality Protection Permit, or Notice of Disposal that may have previously authorized the discharge (insert additional rows if necessary).

Section 9

14 Certificate of Disclosure [A.A.C. R18-9-A201(B)(2)]

Are you required to file a certificate of disclosure according to A.R.S. § 49-109? ☐ Yes (include as attachment) ■ No

15 Compliance with Zoning [A.A.C. R18-9-A201(B)(3)]

I have attached evidence that the facility complies with applicable municipal or county zoning ordinances, codes and regulations? ■ Yes (include as attachment) Section 2.6

16 Technical Capability [A.A.C. R18-9-A202(B)]

I have attached evidence that the applicant has the ability to carry out the terms of the permit (design, construction, operation, closure).

The attached evidence includes:

A) Pertinent licenses or certifications held by the person.
B) Professional training relevant to the design, construction, or operation of the facility.
C) Work experience relevant to the design, construction, or operation of the facility.

■ Yes (include as attachment) Section 2.7

17 Cost Estimates [A.A.C. R18-9-A201(B)(5)]

Description	Cost Estimate
Construction	$ See Capital Cost Estimate and Basis of Estimate
Operation	$ See Capital Cost Estimate and Basis of Estimate
Maintenance	$ See Capital Cost Estimate and Basis of Estimate
Closure	$ 2,131,000
Post-closure	$ 618,162

I have attached documentation supporting the cost estimates listed above? ■ Yes (include as attachment)

18 Financial Demonstration [A.A.C. R18-9-A203]

A) I have attached a letter by the Chief Financial Officer stating that the applicant is financially capable of meeting the costs listed in the above item. ■ Yes (include as attachment) See Capital Cost Estimate
B) For government entities, submit a statement that indicates how the entity is capable of meeting the costs in Item 17 above.
☐ Yes (include as attachment)

C) For non-government entities, submit the information required for at least one of the financial assurance mechanisms listed below that covers the closure and post-closure costs submitted in Item 17, including:
1. The selected financial mechanism or mechanisms;
2. The amount covered by each financial mechanism;
3. The institution or company that is responsible for each financial mechanism used in the demonstration; and
4. Any other details that demonstrate how the applicant is financially capable of meeting the costs described in Item 17.

Select Financial Mechanism (Check all that apply)	
☐ Financial Test for Self-Assurance	☐ Letter of Credit
☒ Performance Surety Bond	☐ Insurance Policy
☐ Certificate of Deposit	☐ Cash Deposit
☐ Trust Fund	☐ Guarantees

Note: Please reference A.A.C. R18-9-A203 for specific financial mechanism requirements.

19 Conformance with Area-wide 208 Quality Management Plan FOR SEWAGE TREATMENT FACILITIES (STF) ONLY [A.A.C. R18-9-A201(B)(6)]

Is the STF in conformance with the 208 plan? ☐ Yes ☐ No (submit request to determine conformance) NA

20 Compliance History (A.A.C. R18-9-A202(A)(11))

Have there been compliance or enforcement actions relating to this facility within the last 5 years? Yes ☒ No ☐

Applicant has provided a history of compliance and enforcement actions relating to this facility for the last 5 years.
Yes ☒ No ☐ See Section 1.5, Site is also VRP Site 505143-02

21 Design Flow [A.A.C. R18-9-101(13)]

Please provide the design flow in gallons per day for all the discharging facilities located at the Site. Calculations for determining design flow must be attached part of this application. "Design flow" means the daily flow rate a facility is designed to accommodate on a sustained basis while satisfying all Aquifer Protection Permit discharge limitations and treatment and operational requirements. The design flow either incorporates or is used with appropriate peaking and safety factors to ensure sustained, reliable operation. The design flow will be used to calculate the Annual Registration Fee in accordance with Arizona Revised Statutes § 49-242.

Design Flow 172,800 gallons per day or 120 gpm

22 Process Flow Diagram [A.A.C. R18-9-A202(A)(11)]

Describe the activity producing the discharge. (Example – wastewater treatment, dewatering, cooling, manufacturing, etc.). Include pertinent elements of water processing or treatment that could affect the quality of the water discharged in a process flow diagram.

Process flow diagram page number Figure 4

23 List of Discharging Facilities [A.R.S. § 49-241]

Operational Discharging Facilities		
Description	**Latitude**	**Longitude**
See Table 1 in main Text		

Discharging Facilities to be Closed Under this Permit		
Description	**Latitude**	**Longitude**
See Table 1		

Please insert additional rows, if more space is needed.

24 Disposal Method (Check all that apply) [A.R.S. § 49-241]

☒ Outfall to Navigable Water	☐ Land Treatment Area
☐ Recharge	☐ Injection Well
☐ Surface Impoundment	☒ Reuse
☐ Leach Field	☐ Other

25 Technical Requirements (Check all that have been attached. See Rule Citation for Specific Requirements)

Description	Page #	Attached?
A) Maps [A.A.C. R18-9-A202(A)(1)]	In Figures Section	☒
B) Site Plan [A.A.C. R18-9-A202(A)(2)] Fig 3 and drawing A010 in Att B		☒
C) Design Documents [A.A.C. R18-9-A202(A)(3)]	Attachments B, C	☒
D) Characterization of Discharge [A.A.C. R18-9-A202(A)(4)]	Attachment C	☒
E) Description of Best Available Demonstrated Control Technology [A.A.C. R18-9-A202(A)(5)]	Attachments B, C	☒
F) Compliance with Aquifer Water Quality Standards at the Point of Compliance [A.A.C. R18-9-A202(A)(6)] Sec 5 Att C and	section 8	☒
G) Contingency Plan [A.A.C. R18-9-A202(A)(7) and R18-9-A204]	Section 11	☒
H) Hydrogeologic Study or ■ Justification that a limited study or no hydrogeologic study is required [A.A.C. R18-9-A202(A)(8)]	Section 5	☒
I) Detailed proposal indicating alert levels, discharge limitations, aquifer quality limits, monitoring requirements (discharge, groundwater and operational monitoring), and compliance schedule items. [A.A.C. R18-9-A202(A)(9)]	Section 10	☒
J) Closure and post-closure plans [A.A.C. R18-9-A202(A)(10)] Section 13 of Att.	B	☒
SEWAGE TREATMENT FACILITIES (STF) ONLY		
K) For a STF provide a map demonstrating that setbacks have been met [A.A.C. R18-9-B201(I)]	NA	☐
L) Design Report [A.A.C. R18-9-B202 and B203]	NA	☐
M) Engineering Plans [A.A.C. R18-9-B203]	NA	☐

26 Point of Compliance [A.A.C. R18-9-A202(A)(6)]

Latitude 31 ° 29 ' 1.8 " N Longitude 110 ° 44 ' 16.4 " W

Lat/Long Coordinate System: ☐ NAD27 ■ NAD83

☐ Existing Well ☐ Proposed Well ■ Proposed Point

Narrative Description of POC Location: A conceptual POC is proposed based on expected extent of discharge surface flow (see Figure 14).

27 Reclaimed Water Classification (FOR STF ONLY)

Reclaimed Water Classification: ☐ A+ ☐ A ☐ B+ ☐ B ☐ C

28 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 well as the possibility of fine and imprisonment for knowing violations.

Print Name Donald R. Taylor

[signature]

Signature

June 5, 2017

Date

Pursuant to A.R.S. § 41-1030:

(1) ADEQ shall not base a licensing decision, in whole or in part, on a requirement or condition not specifically authorized by statute or rule. General authority in a statute does not authorize a requirement or condition unless a rule is made pursuant to it that specifically authorizes the requirement or condition.

(2) Prohibited licensing decisions may be challenged in a private civil action. Relief may be awarded to the prevailing party against ADEQ, including reasonable attorney fees, damages, and all fees associated with the license application.

(3) ADEQ employees may not intentionally or knowingly violate the requirement for specific licensing authority. Violation is cause for disciplinary action or dismissal, pursuant to ADEQ's adopted personnel policy. ADEQ employees are still afforded the immunity in A.R.S. §§ 12-821.01 and 12-820.02.

Individual Aquifer Protection Permit Administrative Completeness Review Checklist

Permittee:	**Arizona Minerals Inc.**	**Inventory No.:**	
Reviewer:		**LTF:**	
Today's Date		**Checked By**	

Checklist instructions

This checklist is provided as a guideline for ADEQ staff in performing administrative completeness reviews and to the applicant on what information ADEQ will need to review Aquifer Protection Permit applications. This checklist is designed to be easy to read and follow. It is intended to address the majority of applications submitted to ADEQ, but not every possible variation or situation. Please visit the APP website to find program specific information including applications, rules, statutes, BADCT manuals, and other guidance information. This checklist does not supplant or supersede statutory or rule requirements and is not intended to be binding on the applicant or ADEQ staff.

ADEQ is actively seeking comments, suggestions, or improvement of this checklist via email to Maribeth Greenslade (mg3@azdeq.gov).

Requirements for all (WWTP, Mining, and Industrial APP New and Significant amendments)

Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply

	Two copies of all materials at a minimum, preferably three copies of the application and supporting attachments (comb or spiral bound). The submittal of three copies allows ADEQ to conduct concurrent technical reviews. Please note that the State of Arizona records management system cannot store information in three ring binders, therefore, comb or spiral bound documents are preferred.
comment	3 hard copies and 2 electronic (disc) provided
	$2,000 initial fee is included with the application
comment	Yes
	Signature by the applicant on the certification page (cannot be the engineer, consultant, or non-corporate agent unless an applicant-signed affidavit, indicating the person signing the application is authorized to act as an agent of the permittee, accompanies the application)
comment	Yes – signed by Don Taylor, AMI President
ADEQ Task	**ADEQ Project Manager** (PM) to identify or verify the application type, (i.e. Individual APP, Significant Amendment, Other Amendment, Minor Amendment or Closure APP). Please note this determination may change at a later date through further review.
comment	Individual APP
	Applicant's name and mailing address.
comment	Cover Page and Section 2.1
	If the applicant is different than the land owner, is there a lease or other agreement in place?
comment	NA
	Permittee's name and address (if different from applicant)
comment	NA
	Land owner's name and address (if different from applicant)
comment	NA

Individual Aquifer Protection Permit Administrative Completeness Review Checklist

Requirements for all (WWTP, Mining, and Industrial APP New and Significant amendments)	
	Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply
	Property Legal description included. Land descriptions can generally be one of these types (1) the "metes and bounds" system; (2) the US Public Land Survey system; and (3) the "lot and block" survey system.
comment	Table 2
	Estimated operational life of the facility. PM, please note section or location in the submitted material.
comment	30 years – Section 1.2.4
	List of existing environmental permits
comment	Section 9
	Authorized agent contact information. PM to enter authorized agent information into AZURITE, verify information is updated in Customer and the agent is entered into the LTF.
comment	Not applicable
	Facility's Emergency Contact Person's name and phone number
comment	Section 2.3
	Certificate of Disclosure, if required (A.R.S. 49-109)
comment	Not applicable
	Proof of zoning compliance: Provide evidence that the facility complies with applicable municipal or county zoning ordinances, codes and regulations, or evidence that the zoning process has been initiated. [Mining operations (A.R.S. 11-812) and facilities located on Indian reservations may be exempt from county zoning requirements.]
comment	Section 2.6
	List of all discharging facilities with accurate latitude and longitude information (center of facility)
comment	Table 1
	Process flow diagram include a schematic diagram of all inflows and outflows for all discharging facilities with the quantity
comment	Figure 4
	Treatment process description – get from pre-feasibility study
comment	Attachment C
	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. Tabulated data is preferred.
comment	Section 1.5, Section 1.7, expected solution characterization in Attachment C
Yes	Sampling point(s) with latitude and longitude (e.g. effluent, discharge, groundwater monitoring or other sampling points)
comment	WTP discharge @ 31°28'15" N, 110°43'43" W
N/A	Disposal method(s) specified including capacity for each disposal method (only applicable to sewage treatment on on-site wastewater treatment systems)
comment	Not applicable
YES	Daily design flow rate the facility is designed to accommodate. This information is required to determine the Annual Fee. Provide design flow for each individual discharging facility and a sum total for all discharging facilities.
comment	120 gpm (see also Figure 4)
YES	Latitude and longitude for all proposed and installed POC wells
comment	Conceptual POC proposed @ 31°29'1.7" N, 110°44'16.4" W – See Figure 14
Yes	Contingency Plan addressing requirements in A.A.C. R18-9-A204.
comment	Section II

Individual Aquifer Protection Permit Administrative Completeness Review Checklist

ADEQ Arizona Department of Environmental Quality

Requirements for all (WWTP, Mining, and Industrial APP New and Significant amendments)	
Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply	
Select	Compliance with aquifer water quality standards (AWQS) at the point of (POC) compliance: Include the POC wells on the site plan. A POC for purposes of the APP program is a location where a monitoring well could be located, not an end of pipe monitoring point. Proposed POC well designs shall be included. Verify details of a demonstration/analysis are submitted. This may be apart of the hydrogeologic study report; ***however, this section in the application should be identified clearly.***
comment	Figure 14 and Section 8
	Proposed alert levels, discharge limitations, aquifer quality limits, and compliance schedule items. An applicant may defer to ADEQ for these items.
comment	Section 10 for DLs, AQL, ALs. The compliance schedule is in Section 12.
	Hydrogeologic study, if required --See start of Section 5 for the justification of limited hydro study.
comment	Some elements of a hydro study are provided. However, Project uses Prescriptive BADCT.
BADCT demonstration (Mining/Industrial Design Report)	
Yes	This report shall be sealed by an Arizona registered engineer and contain engineering details for all discharging facilities[1]. Provide design information pertaining to all discharging facilities including all calculations/analysis 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, etc.
comment	Attachments, B, C, and E are sealed by a PE. The main text is sealed by an Arizona RG
WWTP Documents Required (for WWTP Applications Only)	
N/A	Engineering Plans & Specifications including manufacturer specifications and cut sheets. The documents shall be sealed by an Arizona registered engineer
comment	
N/A	Reclaimed water classification. ADEQ PM: If re-use; please assign initial classification based on the submittals.
comment	
N/A	Provide sludge treatment and disposal description
comment	
N/A	**WWTP Design Report (R18-9-A202/B202) and BADCT** Provide design information pertaining to all discharging facilities including all calculations/analysis 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, etc. Design report shall be sealed by an Arizona registered engineer. For further specifics please see the engineering review checklist.
comment	
N/A	Verify if 208 Plan Review Application has been submitted.
comment	

[1] Per A.R.S. § 32-101(B)(17), reports prepared by a person employed as an engineer by a mining company are not required to be sealed because such a person is not deemed to be practicing engineering.

Site Plan Requirements (WWTP, Mining, and Industrial APP)	
Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply	
A site plan shall be submitted for all APP applications incorporating the items identified below. The size of the site plan for large facilities should be the standard size for engineering drawings. If appropriate, include separate maps for engineering facilities and hydrologic information. The site plan shall include the following:	
	Include north arrow and scale on each page and identify the latitude and longitude at the center of the facility. (Optional[2])
comment	Lat Longs in Table 1, See Attachment B and drawing A010 in Attachment B for proposed facilities
	An outline of the 100-year flood plain boundary. A FEMA Flood Insurance Rate Map (FIRM) 100-year showing floodplain boundary preferred, if available(Optional)
comment	Figure 8
	Identify and label all stream channels, surface water bodies, watershed boundaries, open pits/dumps/leach piles, underground workings, etc. on the site plan. (Optional)
comment	Figures 5, 3
	Surface water flow direction arrow with diversions (Optional)
comment	Figure 5
	Groundwater flow direction arrow. (Optional)
comment	Figure 10
	Pollutant management area (PMA) (Optional)
comment	Figure 14
	Discharge impact area (DIA) (Optional)
comment	Figure 14
	Topographic map with sufficient resolution and legible elevations of contours for the facility.
comment	Shown on several maps. Best ones are provided in Attachment B—particularly drawing A010
	All discharging facilities with the latitude and longitude. Summarize the information in a table on the site plan (Optional)
comment	Table 1
	All known water wells within 1/2 mile of property boundary, labeled with ADWR Well Number, latitude and longitude, and use. Tabulation of this data to prevent excessive labeling on the site plan itself is preferred. Provide water level elevations in the wells, and highlight/identify the nearest downgradient well (Optional)
comment	Table 3 and Figure 9
	All known borings, labeled with latitude and longitude. Tabulation of this data to prevent excessive labeling on the site plan itself is preferred.
comment	Figure 9, Table 3
	Show the delineation of the passive containment capture zone and open pit boundary, if relying on this for BADCT (Optional)
comment	NA
	Latitude and Longitude for all proposed and installed POC locations
comment	Section 8

[2] Optional – means that the application won't be considered administratively incomplete if these items are not present. However, these items may be important for a complete understanding of the facility. Providing these items with the application is recommended in most cases.

Site Plan Requirements (WWTP, Mining, and Industrial APP)	
Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply	
	Latitude and longitude for all proposed discharge monitoring points. (Optional)
comment	Section 8
	All known property lines and known use of all adjacent properties are shown on the site plan.
comment	Figure 2
	Overlay of State and/or Federal Land property (Optional)
comment	Figure 2
	All facility structures labeled and identified
comment	Figure 3 for existing facilities. See Figure 14 in the main text and drawing A010 and others in Attachment B for planned facilities
	Identify all closed facilities (A.R.S. 49-201.7) (Optional)
comment	Table 1 and Figure 3
Site Plan components for WWTP applications only (Maybe on additional page(s) if needed)	
N/A	Effluent sampling point(s), labeled with latitude and longitude (Optional)
comment	
N/A	Effluent discharge location(s), labeled with latitude and longitude (Optional)
comment	
N/A	Influent lift station(s), if any, labeled with latitude and longitude (Optional)
comment	
N/A	Effluent pump station, if any, labeled with latitude and longitude (Optional)
comment	
N/A	Setback distance(s) are shown on the site plan. Setbacks are 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
comment	

Technical Capability, Closure, Post-closure, and Financial Demonstration Requirements (WWTP, Mining, and Industrial APP)	
Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply	
	Technical capability demonstration including licenses, certifications, professional training, work experience to design, construct, and operate the facility. WWTP facilities to include operator certifications.
comment	Section 2.7
	Closure and post-closure plans or strategies. For guidance on what needs to be included in a closure and post-closure plan or strategy, see the Individual Aquifer Protection Permit Closure and Post-Closure Plan/Strategy and Cost Estimate checklist available on the ADEQ website at: http://www.azdeq.gov/environ/water/permits/app.html.
comment	Attachment B, Section 13. Also separate document for costs.
	Closure and post-closure costs (updated if submitting a significant amendment, an "other" amendment for permit transfer, change of financial mechanism, or a revision to a closure plan or strategy that results in an increase in the estimated costs) Cost estimates for construction, operation and maintenance, closure, post-closure shall be derived by an engineer, controller, or accountant using competitive bids, construction plan take-off's, specifications, operating history for similar facilities, or other appropriate sources, equipment production rates, rental costs, standard labor costs as applicable The cost estimates are to be provided for all discharging facilities and contain details to demonstrate the estimates are sufficient to verify total costs. Details to submit data such as quantities, units, unit costs, itemized costs, and total cost. For guidance on what needs to be included in a closure and post-closure cost estimate, see the Individual Aquifer Protection Permit Closure and Post-Closure Plan/Strategy and Cost Estimate checklist available on the ADEQ website at http://www.azdeq.gov/environ/water/permits/app.html
comment	Separate document
	Closure and post-closure costs are derived by an engineer, controller or accountant. Cost estimates derived by an engineer should be sealed by an Arizona licensed engineer (unless the engineer is an employee of a mining company applicant).
comment	Yes, prepared and sealed by NewFields engineer
	Financial demonstration: Financial capability letter from the CFO.
comment	Separate document
	Financial demonstration: Financial mechanism intended to be used.
comment	Performance surety bond, Section 2.8

ADEQ Project Manager Action	
Y: yes, meets the requirement; N: no, does not meet the requirement (see comment below); NA: does not apply	
The following elements are to be determined by the PM	
Select	Verify applicant status in the Arizona Corporation Commission STARPAS database http://starpas.azcc.gov/scripts/cgiip.exe/WService=wsbroker1/main.p
comment	

General notes for submittals to ADEQ for APP review	
	When provided drawings, the following are acceptable: A. Drawings prepared by a consultant and marked “For Construction” must be sealed by a professional engineer licensed in Arizona. B. Drawings prepared by a consultant and not finalized for construction must not contain any description, such as “Preliminary”, “Conceptual”, “For Permitting Purposes Only”, “Not For Construction” etc. but shall be sealed by a professional engineer licensed in Arizona. C. Per A.R.S. § 32-101(B)(17), drawings prepared by a person employed as an engineer by a mining company are not required to be sealed because such a person is not deemed to be practicing engineering; however, the drawings prepared by such a person must not contain labels, such as “Preliminary”, “Conceptual”, “For Permitting Purposes Only”, “Not for Construction”, etc.

ASARCO January Adit (Norton Mine)
Aquifer Protection Permit Application

SANTA CRUZ COUNTY, ARIZONA

Volume 1 of 2

Prepared for:

ARIZONA MINERALS INC.
3845 North Business Center Drive
Suite 115
Tucson, AZ 85705

Prepared by:

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

NEWFIELDS MINING DESIGN AND TECHNICAL SERVICES
9400 Station Street, Suite 300
Lone Tree, CO 80124

SCHAFER LIMITED LLC
3018 Colter Avenue
Bozeman, MT 59715

WATER ENGINEERING TECHNOLOGIES, INC.
4691 Shandalyn Lane
Bozeman, MT 59718

June 5, 2017

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

Volume 1:

Attachment A: Materials Characterization by Schafer Limited LLC

Attachment B: Included in Volume 2 (see below)

Attachment C: Water Treatment Plant Design by Water Engineering Technologies, Inc.

Attachment D: Clean Water Act Section 404 Jurisdictional Determination

Attachment E: PMA Delineation Memo by Ecological Resource Consultants, Inc.

Volume 2:

Attachment B: Tailings and Potential Acid Generating Material Remediation, Placement and Storage Facilities by NewFields Mining Design and Technical Services

ACRONYMS AND ABBREVIATIONS

AAC	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AL	Alert Level
AMI	Arizona Minerals Inc.
APP	Aquifer Protection Permit
AQL	Aquifer Quality Limit
ARS	Arizona Revised Statutes
AWQS	Aquifer Water Quality Standard
AZPDES	Arizona Pollutant Discharge Elimination System
BADCT	Best Available Demonstrated Control Technology
bls	below land surface
CFR	Code of Federal Regulations
Clear Creek	Clear Creek Associates, PLC
COC	Constituent of Concern
CRD	Carbonate Replacement Deposit
CWA	Clean Water Act
DIA	Discharge Impact Area
FEMA	Federal Emergency Management Agency
ft	feet
ft/day	feet per day
gpm/ft	gallons per day per foot
gpm	gallons per minute
GWSI	Groundwater Site Inventory
m	meter
MIW	mine influenced water
mg/L	milligrams per liter
PAG	Potentially Acid Generating
POC	Point of Compliance
RPTS	Remediation Passive Treatment System
TMDL	total maximum daily load
TSF	tailing storage facility
USEPA	United States Environmental Protection Agency
USGS	United Stated Geological Survey

VRP	Voluntary Remediation Program
Wells 55	ADWR Well Registry Database
WTP	Water Treatment Plant
µg/l	microgram per liter

1 PROJECT BACKGROUND

Arizona Minerals, Inc. (AMI) is the applicant to the Arizona Department of Environmental Quality (ADEQ) for an Aquifer Protection Permit (APP) for facilities to be constructed at the January Adit (Norton Mine) Project at the Trench Camp Mine Property in Santa Cruz County, Arizona. AMI submitted a Work Plan to ADEQ's Voluntary Remediation Program (VRP) for the project to eliminate discharges of mine impacted water to Alum Gulch from the January Adit and tailings pile seepage. This application covers the VRP facilities that are regulated under APP in accordance with A.R.S §49-241 et seq.

Key elements of this application include materials characterization by Schafer Limited (Attachment A), and design of the proposed lined tailing storage facility and underdrain collection pond using Best Available Demonstrated Control Technologies (BADCT) by NewFields Mining Design and Technical Services (Attachment B). The design of the proposed water treatment plant by Water Engineering Technologies is provided in Attachment C.

1.1 Location

The Trench Camp, Norton, and January Mine claims (Property) are located approximately 5 miles south of the Town of Patagonia, Arizona. 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 (Figure 1). AMI acquired the January, Trench Camp, and Norton claims in early 2016 from ASARCO, LLC. Both 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 (Figure 2, Santa Cruz County Assessor Map Book 105, Page 50). The Trench Camp and Josephine Mine claims have been assigned parcel numbers 105-50-001A and 105-49-003. The U.S. Forest Service manages the surrounding adjacent lands, as part of the Coronado National Forest.

1.2 Project Description

In early 2016, AMI purchased the January and Norton Mine Claims and the Trench Camp Mine Claims from the ASARCO Trust. In accordance with the purchase agreement, AMI agreed to conduct remedial actions under the VRP to address mine influenced water (MIW) discharges from the January Mine Adit and seepage from historic tailing and potentially acid generating (PAG) waste rock storage piles located on Property. This will be achieved through the following actions:

- Material from historic tailing storage piles #1, #2, #3, and #4 (Figure 3) and PAG waste rock will be re-handled and placed on a lined tailing storage facility (TSF) for collection of solutions through an underdrain collection system. This will prevent future seeps from the toe of the historic tailing piles, and allow for collection of underdrain solutions.

- A double-lined underdrain collection pond will be constructed downgradient of the lined TSF to collect solutions from the re-handled historic tailings and PAG waste rock.
- An active water treatment plant (WTP) will be constructed to treat discharges from the January Mine workings and solutions captured in the underdrain collection pond from the historic tailings, PAG waste rock, and precipitation that falls within the lined facility.

Remedial design and operations will be conducted under the provisions of an Arizona Pollutant Discharge Elimination System (AZPDES) permit and an APP.

AMI is planning to start construction of the APP facilities in November of 2017 after applicable permits are acquired.

1.2.1 Discharging Facilities

Facilities at the Property are listed in Table 1. Their geographic coordinates and regulatory status under APP are also provided. If the facility is not regulated under APP, the regulatory basis for the exemption is provided.

Arizona Minerals is seeking to permit three facilities/discharges in this APP Application:

- Lined TSF, including integral Stage 1 and Stage 2 stormwater detention ponds
- Underdrain Collection Pond.
- WTP discharge to Alum Gulch

1.2.2 APP-Exempt Facilities

The WTP is not considered an APP-regulated facility, as noted on Table 1, because it consists of tanks and piping, and thus exempt according to 49-250.B.22. The discharge to Alum Gulch from the WTP is considered an APP-regulated discharge. A BADCT demonstration for the WTP discharge is provided in Attachment C.

The old tailing piles, as shown on Figure 3, are exempt because they are considered closed facilities as defined in 49-201.7.

1.2.3 Process Flows

Process flows used in the designs for the facilities are shown schematically on Figure 4. A mine water balance was prepared by Ecological Resource Associates, Inc. (Appendix K in Attachment B).

1.2.4 Operational Life of APP-regulated facilities

Discharges from the WTP are expected to continue for at least 30 years. Eventually, as flows diminish, a passive treatment plant will be constructed and will operate for an unknown period of time. For the purpose of this application, WTP discharges are expected to last for 30 years.

The TSF will be constructed in stages as described in Attachment B. This application includes Stages 1 and 2. A future amendment will be submitted for additional stages to accommodate tailings from future mining operations. Future underground mining operations are estimated to have at least a 30 year life.

1.3 Constituents of Concern

As discussed in more detail in Section 1.5, ADEQ evaluated conditions along Alum Gulch and promulgated the Total Maximum Daily Loading (TMDL) Implementation Plan for Alum Gulch, in March 2007. The plan recognizes cadmium, copper, zinc and acidity as the primary agents with undesirable levels of concentration present in the Alum Gulch drainage. These are considered the Constituents of Concern (COCs).

1.4 January Mine, Norton Mine, and Trench Camp Mine History

Mining in the Harshaw District dates from mid-18th century Spanish Colonial times, but is poorly documented before the 1870's. Initially, oxide lead-silver vein ore was mined from small operations on the Trench property. This work continued intermittently until the late 19th century. Historical information from the late 1800s and early 1900s has been well documented (Schrader, 1915; Keith, 1975). The district's historic production is poorly reported but is believed to be around 250,000 tons, yielding approximately two million ounces of silver with by-product lead, zinc, copper and manganese. Production from the Harshaw district was dominated by the Trench-area mines, small mines on the Alta claim, the Hardshell Incline and the Hermosa mine.

Ownership of the Property prior to its acquisition by American Smelting and Refining Company, precursor to ASARCO, LLC (ASARCO) is not known. ASARCO began operating the Trench Camp Mine in 1939. The Trench area mines and sulfide flotation custom mill produced primarily silver ores with minor by-product lead from small underground operations. Approximately half of the production was direct-shipping oxide ore and the balance was milling ore. The Trench mill produced both lead and zinc concentrates with copper, silver and minor gold by-product production. The 150-ton per day Trench lead-zinc flotation mill also treated district ores between 1939 and 1964 on a custom basis. ASARCO continued ownership of the Property until it was acquired by AMI in 2016.

According to public records, the January mine was worked intermittently since the early 1870s. It was patented in 1894, and it was last operated by ASARCO in the period 1925 to 1949. Originally, the January and Norton Mines were operated jointly, extracting zinc, lead, silver, gold and manganese ore. In its later years ASARCO extracted mostly copper, lead and zinc ore.

Mineral extraction and concentration activities generated mining waste material, which was deposited at four tailings storage locations within the larger Trench Camp Mine claim, and in several smaller piles within the two other smaller mining claim sites (Figure 3). As can be seen in the figure, three of the spent mineral ore tailings piles, identified as TP#1, TP#2 and TP#4 are located within areas that drain into the lowlands of Alum Gulch and eventually join other discharge along the main wash in Alum Gulch. TP#3 is within the Harshaw Creek Watershed.

1.5 Mine Influenced Water Sources

The Property falls within the Alum Gulch and Harshaw Creek watersheds. The January and Norton claims and most of the Trench claim are within the Alum Gulch watershed; the eastern portion of the Trench claim is within the Harshaw Creek watershed (Figure 5). Alum Gulch is a tributary of Sonoita Creek, joining it approximately 5.5 miles downstream from the January Mine and 2.25 miles southwest (and downstream) of the Town of Patagonia. Harshaw Creek is also a tributary of Sonoita Creek. It joins Sonoita Creek approximately 8 miles downstream and is upstream (east) of the Town of Patagonia.

In addition to past mining activities at the Property, several other historical mining ventures have extracted mineral ore from the upstream canyons that eventually drain into Alum Gulch. Historic mining activity in the watershed raised concerns about the presence of trace minerals in the natural drainage that eventually would reach Sonoita Creek.

Two sources of mine influenced water (MIW) have been identified at the Trench/January/Norton sites:

- Discharges from the January Mine Adit into Alum Gulch: Testing of these discharges by ADEQ indicated the presence of cadmium, copper, zinc and acidity at levels exceeding the provisions of the TMDL Implementation Plan for Alum Gulch. ADEQ issued a discharge violation notice to ASARCO, who at that time owned the mining claim parcels.
- Seepage from Tailing Pile #1: In 2014, seepage from the base of the covered tailings into the unnamed wash on the Trench Mine property was observed. ADEQ issued a Notice of Violation to the ASARCO Multi-State Environmental Custodial Trust, the owner at the time. The Trust committed to the development and implementation of a SWPPP and initiated the application for an AZPDES Multi-Sector General Permit from ADEQ.

Both of these discharges are within the Alum Gulch watershed.

ASARCO implemented a plan to capture MIW discharges by capturing it and delivering it to a constructed passive treatment wetlands system. This treatment system did not meet the treatment goals, resulting in exceedances of the surface water quality standards specified by ADEQ in an AZPDES permit that was issued for the constructed passive treatment wetlands. This permit was allowed to lapse by ASARCO. Because the initial constructed passive treatment wetlands system implemented by ASARCO was not effective, after AMI acquired the property in 2016, AMI proposed to implement an alternative treatment under the provisions of VRP.

1.6 Nearby Property Uses

The Property is surrounded by Coronado National Forest land which undeveloped. Parcels within one mile that are not owned by the Forest Service, as shown on Figure 2, are as follows:

- AMI also owns nearby patented mining claims to the east.
- Clifford and Linda Hirsch own a property with a house located approximately 2000 feet to the south of the Property and 4000 feet south of the proposed TSF.
- Norman and Ruth Hale own a house with associated ranch buildings approximately 4000 feet to the east of the property and 5000 feet east of the proposed TSF.

1.7 Past and Proposed Discharging Activities

With the exception of the aforementioned discharges (Section 1.5) there are no known past discharges.

Proposed discharging activities are the activities for which AMI is seeking this APP permit. This includes operation of the TSF, Underdrain Collection Pond, and discharges from the WTP.

2 PROJECT INFORMATION

2.1 Applicant and Permittee

Arizona Minerals Inc., 3845 North Business Center Drive, Suite 115, Tucson, AZ 85705.

2.2 Landowners

Arizona Minerals Inc. Same address as above

2.3 Facility's Emergency Contact Person

- Primary Contact: Johnny Pappas, Director of Environmental and Permitting, 520-485-1300 (office) and 803-235-5563 (cell).
- Secondary Contact: Greg Lucero, VP Community and Government Affairs, 520-604-0618 (cell)

2.4 Physical Address

749 Harshaw Road, Patagonia, AZ 85624

2.5 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) as shown on Figure 2. Claim numbers are provided on Table 2.

2.6 Zoning

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."

2.7 Technical Capability

2.7.1 Arizona Minerals, Inc.

- Mr. Don Taylor joined Arizona Mining in June, 2010. He has more than 25 years of mineral exploration experience with precious and base metals on five continents, taking projects from exploration to mine development. He has worked extensively for large and small cap companies, including BHP Minerals, Bear Creek Mining, American Copper and Nickel, Doe Run Resources, and Westmont Mining Company. He is a Licensed Professional Geologist in several eastern and western states and a qualified person as defined by National Instrument 43-101. Mr. Taylor has a Bachelor of Science degree in Geology from Southeast Missouri State University and a Master of Science degree from University of Missouri at Rolla.
- Mr. Johnny Pappas joined Arizona Mining in January, 2016. He has a distinguished career in the field of environmental management and permitting. Mr. Pappas recently held the position of Director of Environmental Affairs for Romarco Minerals Inc. where he was instrumental in directing the federal and state permitting of the Haile Gold Mine. He was previously the Environmental Manager of the Climax Mine and was Permit Coordinator for Barrick's Cortez Gold Mines. In addition, he has held several Senior Environmental Engineer positions with Pacificorp, Plateau Mining and Santa Fe Pacific Gold. Mr. Pappas holds a B.Sc. degree in Geology and Business Administration.

2.7.2 Clear Creek Associates, LLC

As the hydrogeological consultant on the Project, Clear Creek LLC, 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, 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 Hydrogeologist 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.
- Greg Hess, R.G. Arizona Registered Geologist No. 50994. Mr. Hess is a Senior Hydrogeologist for Clear Creek where he manages water supply, mining support and other projects. He has over 25 years of technical experience. Mr. Hess received a BS degree in Geology in 1987 and an MS in Geosciences in 1992.

2.7.3 Schaffer, Limited

- Dr. William Schafer who has managed and directed over 200 projects involving the environmental aspects of mining over more than 35 years. Projects have included prediction, prevention, and control of acid rock drainage (ARD); pit lake water quality prediction; mine closure and reclamation of waste rock, tailings, and spent ore piles; baseline studies in support of permit application; fate and transport evaluations; and vadose zone modeling. Dr. Schafer has a Ph.D. in Soil Science from Montana State University, a Master degree in Soil Science from University of California at Davis and a Bachelor of Science in Watershed Management from Colorado State University.

2.7.4 NewFields

As the engineering consultant for the Tailings Storage Facility and Underdrain Collection Pond on the Project, NewFields personnel are registered Professional Civil Engineers capable of performing civil design work. The NewFields team includes the following individual:

- Mike Smith, PE. Registered PE in Alaska (License No. AELC8785), Colorado (License No. 28114) and Nevada (License No. 16194). Principal for NewFields. Over 30 years of engineering experience. Received a BS degree in Civil Engineering in 1983.
- Nick Rocco, PE. Registered PE in California (License No. 70454). Project Manager and Senior Geotechnical Engineer for NewFields. Over 14 years of engineering experience. Received a BS degree in Civil Engineering in 2000, a MS degree in Geotechnical Engineering in 2003 and a Ph.D. in Geotechnical Engineering in 2012.
- Craig Thompson, PE. Registered PE in Arizona (License No. 63431) and Colorado (License No. 49559). Project Engineer for NewFields. Over 7 years of engineering experience. Received a BS degree in Civil Engineering in 2009.

2.7.5 Water Engineering

Water Engineering Technologies, Inc. (WET) is the water treatment process consultant for the project. WET is registered with the Arizona Board of Technical Registration number 20282-0 to perform Civil Engineering services. Mr. Scott Benowitz is the Principal Engineer and owner of WET. Mr. Benowitz is an Arizona Registered Civil Engineer (number 63837). He has over 32 years of technical expertise. He received BS degree in Civil Engineering and Engineering Mechanics in 1985.

2.8 Financial Capability

AMI intends to use a performance surety bond as a financial capability mechanism. A letter from AMI's CFO and closure and post-closure costs are provided in the Capital Cost Estimate.

3 GEOLOGY

3.1 Regional Geology

The Project Area is located in the Patagonia Mountains of southern Arizona within the Basin and Range physiographic province. The province is typified by north-northwest trending normal faults. The fault-bounded mountains, typically with large intrusive cores, are separated by deep basins filled with Tertiary and Quaternary sediments ("basin fill"). The core of the Patagonia Mountain range is a Laramide-age granodiorite pluton that has been dated at 60-65 million years (Graybeal, 2007).

3.2 Geologic Formations

The geology of the area was recently mapped by Graybeal et al (2015) (Figure 6). Much of Graybeal's work includes mapping of Simons (1974).

Rocks exposed at the surface in the Property consist primarily of:

- Cretaceous andesite (designated as *Ka* by Graybeal et al, 2015) - Gray, greenish-gray, or grayish-red, porphyritic to fine-grained, thin to very thick flows of trachyandesite or diorite; contains some rhyodacite or dacite. Maximum thickness of about 3000 feet. The Cretaceous andesite is the surface unit throughout most of the Trench Camp claim and most of the Alta Claim.
- Tertiary Volcaniclastic Rocks of middle Alum Gulch (*Tv*) - Grayish to white, well consolidated and poorly sorted lapilli tuff and tuff breccia, probable crater-fill material of the Sunnyside porphyry Cu-Mo system. Contains clasts of Mesozoic volcanic and sedimentary rocks and clear quartz xenocrysts in fine-grained, illite-alunite-kaolinite-altered matrix. Numerous silicified zones. Bedded sequences have concentric strike and inward dips. This unit can be observed at the surface on the western side of the Trench Camp Claims.
- Jurassic/Triassic volcanics (*JTrv*) - Light-colored rhyolitic, alkali rhyolitic, and quartz latitic lava, tuff, and welded tuff; locally much altered to sericite, epidote, carbonate, and chlorite, or strongly hornfelsed. Thickness uncertain but probably more than 6,000 feet. This unit is present at the surface at the eastern part of the Alta Claim, and elsewhere is underneath the Cretaceous andesite.

North- to northwest-dipping Paleozoic sedimentary rocks underlie the *JTrv*. The Paleozoic-Mesozoic contact is unconformable. The Paleozoic units, from youngest to oldest, include:

- Naco group
    - Permian Concha Limestone (*Pcn*) - Gray to light-gray, fine-grained, medium to thick-bedded limestone with lenses and nodules of chert. About 155 m (510 ft) thick.
    - Permian Scherrer Formation (Ps) - Brownish-gray to gray, massive, sandy limestone and white to light-brownish-gray, fine-grained sandstone. About 46 m (150 ft) thick.
    - Permian Epitaph Dolomite (*Pe*) - Gray fine-grained, thick-bedded limestone, silty limestone, gray dolomitic limestone, lesser sandstone and conglomerate, and sparse pods of chert and quartz. About 262 m (860 ft) thick.
    - Permian Colina Limestone (*Pc*) - Gray to dark-gray, fine-grained, and medium- to thin-bedded limestone and thin beds of dolomite. About 72–104 m (235–340 ft) thick.
    - Permian/Pennsylvanian Earp Formation (*P*e*) - Gray, light-gray, or pink thin-bedded to massive, sandy to silty limestone and dolomitic limestone, and lesser dolomite, chert and limestone conglomerate, and sandstone. About 229 m (750 ft) thick.
    - Pennsylvanian Horquilla Limestone (**h*) - Light-gray, gray, or pinkish-gray, fine- to coarse-grained, medium-bedded limestone and lesser dolomitic limestone and brown to maroon thin-bedded limestone. About 82 m (270 ft) thick. Unconformably overlies Escabrosa Limestone (unit Me).
- Mississippian Escabrosa Formation is below the Horquilla Limestone. The contact is disconformable.
- The Devonian Martin Limestone unconformably underlies the Escabrosa Formation.
- Cambrian Abrigo Limestone unconformably underlies the Martin Limestone.
- Cambrian Bolsa Quartzite underlies the Abrigo Limestone. This contact is generally conformable.
- Precambrian Quartz Monzonite is the basement rock in the area. The contact with the Bolsa Quartzite is a nonconformity.

3.3 Site Specific Geology

3.3.1 Geologic Cross Sections

A geologic cross section through the Property was included in Graybeal et al (2015). It is provided as Figure 7. This cross section depicts the Mesozoic volcanics underlain by the Paleozoic sedimentary units. A lead-zinc-silver deposit called the “Hermosa Taylor Deposit” is hosted in these sedimentary units at the Property.

A major structural feature in the Project Area is the Harshaw Creek Fault, a north-northwest trending left-lateral strike slip fault that has more than 4 miles of displacement at its southern end. It is late Cretaceous in age (Laramide). According to Graybeal et al (2015), this fault appears to run west of the project site where it is covered by Tertiary volcanics.

3.3.2 Mineralization

The core of the Patagonia Mountain range is a Laramide-age granodiorite pluton that has been dated at 60-65 million years (Graybeal, 2007). Mineralization is associated with the pluton, which crops out to the west of the Property. Following emplacement of the pluton, a quartz feldspar porphyry stock was intruded at about 60 million years (Paleocene). This porphyry generated a strong hydrothermal system that developed a zone of disseminated pyrite and resulted in additional mineralization. It is the quartz feldspar porphyry that is considered to be the source of the mineralization.

3.4 Geologic Hazards

In addition to earthquakes (discussed in Section 3.5), geologic hazards in Arizona include earth fissures, landslides and debris flows, and floods. The risk from any of these hazards at the Project Area is low.

Earth fissures and land subsidence occur in alluvial basins where there have been extensive groundwater withdrawals. The Project is not located in an alluvial basin, and therefore the area is not susceptible to subsidence and earth fissure formation.

Debris flows are recognized as a hazard in mountainous areas (Pearthree and Youberg, 2006). Although these events are infrequent, generally occurring as the result of very high precipitation events, they can alter the landscape significantly. Loss of vegetation from wildfires can increase the chances for debris flows. Operations at the project site will be sited and designed to reduce risks from debris flows.

According to the Flood Insurance Rate Map (Federal Emergency Management Agency [FEMA, 2011]), the Project is located in a Zone D (Figure 8). The Zone D designation is used for areas where there are possible but undetermined flood hazards, as no analysis of flood hazards has been conducted. These areas are often undeveloped and sparsely populated.

3.5 Seismicity

According to the Arizona Geological Survey (Fellows, 2000), the Property is located in an area of moderate to low seismic hazard. National Seismic Hazard Maps are available from the United States Geological Survey (USGS). These maps display earthquake ground motions for various probability levels across the United States. The motion is expressed as peak acceleration as a percent of gravity. In the vicinity of the Project, the Peak Horizontal Acceleration with a 10 percent probability of exceedance in 50 Years is between 3 and 4 percent of gravity. Statewide, the values range between 2 and 10 percent of gravity (Peterson et al., 2015).

NewFields conducted a seismic hazard assessment (SHA) to define the maximum probable earthquake event for the design of the lined TSF, as discussed in Appendix C in Attachment B.

The SHA was completed to determine ground motions that would be 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 are 0.11 gravity (g) and 0.10 g, respectively.

4 HYDROLOGY

4.1 Climate

The climate in the general vicinity of the Property varies from high desert in the Sonoita Valley to the steppe-like climate of the higher elevation grasslands and scrub area (ADEQ, 2003). In this semi-arid climate, average rainfall is 17 inches per year, with the majority of precipitation occurring between June and October through "monsoonal" convective thunderstorms. Daytime temperatures in the summer may reach 90°F with warm to moderately cool nights. Temperatures are usually mild with periodic overnight frosts and occasional snowfall at higher elevations during the winter months that usually melts within a few days (WRCC, 2017).

Ecological Resource Consultants, Inc. prepared a "Meteorological Analysis" memorandum summarizing historical precipitation data and evaporation data. This memorandum can be found as Appendix B in Attachment B.

4.2 Surface Water Hydrology

The Property is located within the Middle Sonoita Creek (USGS Hydrologic Unit Code [HUC] #150503010206) and Harshaw Creek (HUC# 15050301-025A) watersheds. The upper Alum Gulch subwatershed[1] (HUC# 15050301-561A) of the Middle Sonoita Creek watershed drains the western portion of the Property. Portions of Alum Gulch are designated as ephemeral reaches: from its headwaters to the January Adit, and from 800 meters downstream of the World's Fair Mine to its confluence with Sonoita Creek. From the January Adit to 800 meters downstream of World's Fair Mine, Alum Gulch is designated as an intermittent reach. Harshaw Creek drains the eastern portion of the Property. Harshaw Creek and all of its tributaries are designated as ephemeral reaches (ADEQ, 2003). Both drainages are tributaries of Sonoita Creek, which is located to the northwest between the Santa Rita and Patagonia Mountains (Figure 5). Sonoita Creek flows to the west as a tributary of the Santa Cruz River.

Both Alum Gulch and Harshaw Creek in the Project Area are considered "Not Attaining" under the Clean Water Act §303(d). Segments of Alum Gulch are Not Attaining for cadmium, copper, zinc, and acidity while segments of Harshaw Creek upstream of the Property are Not Attaining for copper and acidity. Another drainage basin to the west of Alum Gulch, the Three R Basin, is also Not-Attaining due to exceedances of cadmium, copper, zinc, and acidity. In the TMDL Implementation Plan for Alum Gulch (ADEQ, 2007), ADEQ notes that "all three waters are in

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[1] Alum Gulch subwatershed is divided into the upper watershed, HUC# 15050301-561 A, and the lower watershed, HUC# 15050301-561A.

areas of high mineralization and share similar historic mining practices". The sources of impairment for Alum Gulch "include adit drainage, waste rock and tailings piles, and sediments" and "the major portion of the loading originates from the World's Fair Mine and Humboldt Canyon areas with relatively minor contributions from Trench Camp Mine and January Adit". The TMDL document for Harshaw Creek (ADEQ, 2003) identifies the Trench mine's dump number 3 as a "minor source" of loading into Harshaw Creek. ADEQ considered mining residues from the Morning Glory Mine and the Endless Chain Mine, located upstream of the Trench Camp, to be significant sources of loading to Harshaw Creek.

4.3 Site Stormwater Analysis

The TSF, underdrain collection pond, and associated stormwater controls were designed for a 100-year/24 hour storm event, as described in Attachment B, Section 9. NewFields used the hydrological modeling system HEC-HMS (version 3.5), a precipitation-runoff simulation computer program developed by the Army Corps of Engineers, to calculate the magnitude and timing of the peak flows as well as volumes resulting from specified storm events. 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.

5 HYDROGEOLOGY

Limited hydrogeologic data are provided in this application for the following reasons:

- According to Sections 2.3.1 (Siting Criteria for Process Solution Ponds) and Section 2.5.1 (Siting Criteria for Tailing Impoundments) in the BADCT Manual (ADEQ, 2004), "the Prescriptive BADCT criteria are designed to eliminate the need for considering site hydrogeology and vadose zone characteristics, and minimize the need for consideration of other site factors."
- Discharges from the WTP will be treated to AWQSs and applicable surface water quality standards.

Based on these considerations, this application meets the requirements of A.A.C. R-18-9-A202(A)(8).

5.1 Aquifer Properties

Groundwater flows in bedrock fractures at the site. There is little to no alluvium present. Porosity of fractured bedrock aquifers is generally low, on the order of 1 to 2 percent. However mineralization can result in higher porosities.

5.2 Wells and Borings

Clear Creek used ADWR Wells 55 database and data provided by AMI to plot known water wells on and within one-half mile, as shown on Figure 9. Information regarding these wells is provided on Table 3. Exploration borings have been drilled in the area, but they have either been converted to wells (and thus included on Figure 9 and on Table 3) or they were immediately abandoned (and therefore not included on the figure or the table).

There are no known drinking water wells within ½ mile. A stockwater/wildlife (#642746) is located approximately ¼ mile north of the property. Arizona Minerals owns some water supply wells, but they are not used for drinking water. All other wells are used for monitoring water levels and/or water quality.

The location of well 642746 is a cadastral location from the ADWR database. The registered location corresponds to a square measuring ¼ mile by ¼ mile centered on the mapped location. ADWR well registry records are not always accurate, and are limited by the quality of data that was submitted when a well was registered. Other well locations are surveyed locations provided by AMI.

5.3 Depth to Groundwater and Groundwater Flow

There is no alluvial aquifer in the Project Area. As noted in Section 2.1, the bedrock outcrops at the surface. Groundwater in the area is limited to faults, fractures, and voids within the bedrock complex.

5.3.1 Depth to Groundwater

A map of the potentiometric surface, based primarily on water level measurements conducted in September 2016, is presented on Figure 10. Depths to water in wells ranged from 17.1 feet bls at MW-3 near the January Adit at the northwest portion of the Project Area, to 338 feet bls at HDS-345. In general, depths to water decrease to the north as the land surface elevation decreases.

5.3.2 Water Level Trends

Monthly monitoring of water levels in selected boreholes began in July 2013. Since 2013, groundwater elevation has been stable with very little variation (2 to 5 feet) at most locations. The greatest variation (over 10 feet) in groundwater elevation is seen at HDS-321 and HDS-249 to the east of the Property near an unnamed tributary of Harshaw Creek. At these two boreholes the groundwater elevation has increased approximately 2 feet per year over the three years of monitoring (Figure 11). The higher variability of water levels in these wells may be due to their proximity to surface drainages. AMI continues to collect water level data at several locations at the Project site to characterize hydrogeologic conditions and trends.

5.3.3 Groundwater Flow Direction and Hydraulic Gradient

As shown on Figure 10, groundwater flow is generally towards the north, with localized northeast and northwest flows, depending on the location. Based on the September 2016 groundwater levels shown on Figure 10, which are generally representative of static conditions, the horizontal hydraulic gradient ranged from 0.025 at the southern part of the site to approximately 0.013 at the northeastern part of the site.

5.3.4 Recharge

Groundwater is recharged from precipitation at higher elevation. Based on water level trends observed in wells located near washes (as noted in Section 5.2.2), recharge also appears to occur in the washes and drainages which carry surface flows to the north and northwest.

6 SITE CHARACTERIZATION

6.1 Previously Conducted Characterization

Characterization studies were conducted in support of AMI's original VRP Work Plan dated October 19, 2016 (CPE and Sovereign Consulting Inc., 2016) that was submitted to ADEQ and Public Noticed on October 21 and 28, 2016. The work plan characterized the quantity and quality of adit and tailings pile discharges. Samples of the adit and tailings piles seepages were collected by AMI personnel in 2015. After AMI took ownership of the Trench Camp Mine property in January 2016, AMI personnel conducted field measurements and sampling of both the adit and onsite seepages, in conjunction with installation of a Pilot Remediation Passive Treatment System (RPTS). CPE and Sovereign Consulting Inc. used the data to characterize flows and levels of metals (including the constituents of concern) present in the subject seepages. Portions of the CPE and Sovereign Consulting Inc. characterizations that are pertinent to the revised Work Plan are summarized below.

6.1.1 January Adit Seepage Flows and January Mine Workings Recharge Flows

CPE and Sovereign Consulting Inc. (2016) evaluated January adit seepage flow for the Work Plan as follows:

> *In order to determine the level of treatment needed for remediation of the January Mine Adit discharges, the parameters that must be identified are the volume of water contained in the adit as well as the rate of flow of the discharges observed at the adit. The initial measurements were performed in the adit drain pipe that discharges into the existing constructed wetlands immediately downstream from the adit, during the period September through November of 2015. The resulting measurements placed the flow in the range between 7-10 gallon-per-minute (GPM). Subsequent flow measurements using a flowmeter installed as part of the Pilot RPTS confirmed the prior flows and the sensitivity of flow to seasonal conditions.*
>
> *In conjunction with the pilot plant installation, one of two monitoring wells that had earlier been installed, by ASARCO, above the adit and into the January Mine workings was equipped with a submersible pump. This well is identified as Well #1 (see Figure 5, Well Equipment Diagram). The second well, identified as Well #2, was outfitted with equipment to measure water level in the adit, as shown in Figure 5.*
>
> *In May of 2016, a well recovery test was performed at the adit with a 70 GPM pump. The results from this test provided an initial estimate of 7 GPM as the recovery rate of the January Mine workings, measured at the existing January Mine wells (see Figure 6, January Mine Workings Pumping Test Results). This was taken to be representative of dry weather conditions, and correspond to the smaller flows in the 2016 adit discharge*

measurements. Similar adit discharge flows were reported by the previous owner/operator.

In order not to release adit seepage into the existing constructed wetlands during the Pilot RPTS evaluation, AMI requested authorization to use the January Mine water for its mineral exploration activities. ADEQ granted its authorization in July of 2016.

Detailed January Mine water pumping measurements were observed and recorded during August through October of 2016, during which time a 32 GPM pump was kept in nearly continuous operation, to evaluate the adit well production and recovery during dry and rainfall periods. The results from this test provided an estimate of 14 GPM for the well recovery rate of the adit during Monsoon Season without major storm events. A 39 GPM recovery rate was noted during Monsoon Season, due to a major storm event where 2.8-inches of rain fell within two-hours.

As explained earlier, a pilot remedial process treatment system evaluation was conducted for discharges originating at the January Adit, which also provided an opportunity to further investigate the January Mine well recovery rate and, from extrapolation of this data, the available storage in the January Mine workings. These parameters will be used for sizing of the final remedial passive treatment system. The pilot test system was installed at a location close to the January Mine Adit (see Figure 7, Remedial Treatment System Pilot Test Site Layout). Effluent generated by the pilot test treatment system was discharged to the existing constructed wetlands.

Well production, pumping rate and static water level were closely monitored during the pilot treatment period. The data gathered and the data analysis computations are provided in Appendix B to this report; the findings are summarized in an annotated graph, for ease of reference (see Figure 8, January Mine Workings Pumping Analysis Summary).

Accordingly, the following observations can be made:

- *The measured overflow discharge rate for the January Mine workings was 7 GPM, and this was taken to be representative of the adit recharge rate under dry weather conditions.*

- *The computed recovery rate for the January Mine workings was 14 GPM, and this was taken to be representative of mine workings recharge under continuous pumping conditions, during the monsoon season and without significant rainfall events.*
- *When a significant rainfall event was observed on site, the computed recharge rate for the January Mine workings was 39 GPM.*

- *The well static water level dropped to a depth of 7.52 feet during the active pumping period when the pilot test was conducted. The available January Mine working storage at this depth is estimated at 393,120 gallons.*

- *Using a recovery rate of 7 GPM, this storage volume is equivalent to 39 days of available storage before January Mine workings overflow and begin discharging from the adit.*

- *Using a January Mine working recovery rate of 14 GPM, this storage volume is equivalent to 19.5 days of storage before the mine workings would overflow and a discharge would occur from the adit.*

It is proposed that the pumping rate at its well be maintained at 20 GPM, in order to extract more water from the January Mine workings than its average recovery rate, thus creating storage for use in times of extreme rainfall or in case of temporary outages or stoppages for periodic maintenance. A mass balance worksheet is provided in Appendix B, in support of this recommendation.

CPE recently updated Figure 8 of their January Mine Workings Recharge Rate Analysis report for this work plan (Figure 12). Pumping at 28 gpm has continued to lower the water level in the January Mine, which will allow for additional storage volume when recharge rates increase during the monsoon season.

6.1.2 Seepage Flows from Tailings Piles

Tailings pile seepages volumes were also evaluated by CPE and Sovereign Consulting Inc. to determine the level of treatment needed for remediation. They examined pumping records for the dewatering pump installed at the TP#1 pond and concluded that seepages are generated at a rate of 3 gpm during the monsoon season. CPE and Sovereign Consulting Inc. estimated that the remediation passive treatment system should be designed based on a treatment flow rate of 23 gpm average flow, to accommodate a pumping rate of 20 gpm from the January Adit and a seepage rate of 3gpm from TP#1.

6.1.3 Pilot scale Remedial Passive Treatment System

CPE and Sovereign Consulting Inc. used water quality data from an initial water quality sample collected in 2015 from the January Adit and the TSF#1 seepage to arrive at a mixed water chemistry for the passive treatment system influent. A pilot scale RPTS (Pilot RPTS) was constructed near the January Mine Adit in February 2016. The Pilot RPTS was continuously monitored by AMI personnel for a period of 24 weeks, from March to August 2016. The monitoring included influent and effluent changes in pH, temperature, flow rate, oxidation-reduction potential (ORP), conductivity, dissolved oxygen, and ferrous iron. CPE and Sovereign Consulting Inc. concluded that the results obtained during the Pilot RPTS period indicated a successful removal of metals from the water sources treated. Based on what was learned from operating the Pilot RPTS, CPE and Sovereign Consulting Inc. recommended design modifications to be included in a full-scale treatment system.

The complete Pilot RPTS findings and conclusions are provided in Appendix C (Pilot Scale Test Report, Passive Treatment System January Mine) of the October 19, 2016 Work Plan.

6.1.4 Abandoned Passive Treatment Wetlands

Sovereign Consulting Inc. characterized soil and vegetation in the passive treatment wetlands that were constructed by ASARCO to act as a treatment system to evaluate whether contaminants of concern may have precipitated in the soil or been taken up in the vegetation. Elevated concentrations of metals (arsenic, lead) were identified that were consistent with the geology of the local bedrock. Sovereign concluded that the wetland soils could be managed or co-mingled with the historic tailings and placed in tailing facilities. The concentrations of RCRA metals in vegetation were below non-residential soil remediation levels. The original report was included in the October 19, 2016 VRP work plan that was submitted to ADEQ.

6.2 Recent Site Characterization

AMI has conducted further site characterization since the previous Work Plan. The following characterization tasks are described below and in the relevant Attachments, as noted.

- Geotechnical Investigation
- Historic Tailing and Waste Rock Characterization
- January Mine Workings Recharge and Water Quality
- Tailings Piles Seepage Flows and Water Quality
- Surface Water Quality
- Water Balance

6.2.1 Geotechnical Investigation

NewFields conducted a geotechnical investigation in January 2017 to characterize the proposed site and define relevant engineering material properties for the design of the new lined tailing/waste rock storage facility and underdrain pond. The investigation consisted of borings, test pits, and geophysical surveys, and was focused on the existing tailings piles 1 through 4. The objectives of the investigation were to:

- define the tailings and PAG waste rock volumes within each facility
- identify potentially impacted material below the piles
- determine tailings and PAG waste rock material properties.

Additional boreholes, test pits and seismic refraction lines were placed outside the limits of the existing tailings piles, in order to define engineering characteristics of the near surface soil, bedrock depth and potential construction borrow sources. Samples were collected during the field investigation for laboratory testing for engineering characterization, standard soil and rock strength, liner interface shear strength, permeability, consolidation and a battery of geochemical testing. Refer to Drawing A030 in Attachment B for the geotechnical investigation plan view. No groundwater was encountered during the geotechnical investigation.

Boreholes were placed along the geophysics lines in order to correlate known depths of the logged materials to seismic velocities. Using the depth to tailings and waste rock identified in the boreholes in combination with the velocities generated during the geophysical survey, a velocity band was identified that correlated with the bottom of the tailings and waste rock material within the historic tailings deposits. Refer to Attachment B (Drawings A050 through A053) for a plan view of the geophysics survey lines, boreholes and test pits as well as profiles showing the estimated depth of tailings and PAG waste rock.

NewFields used the tailings depth data to estimate the volume of tailings or PAG waste rock within each pile. The estimated tailings and PAG waste rock volumes to be relocated onto the lined TSF are presented in the table below:

VRP TAILINGS PILES RELOCATED VOLUMES

Stage	Material Volumes (tons)				Material Source
	Tailings	Waste Rock	Native Material	Total Material	
Tailings Pile 1 on Tailings Pile 2 and 4 (Temporary Condition)	112,800	223,600	15,500	~352,000	Tailings Pile 1
Stage 1 TSF	112,800	223,600	15,500	~1,036,000	Tailings Pile 1
	649,900	0	33,700		Tailings Piles 2 and 4
Stage 2 TSF	213,800	0	12,300	~227,000	Tailings Pile 3

Supporting documentation and volume calculations are provided in NewFields' report in Attachment B.

During NewFields' drilling program in January 2017, native materials from beneath the historic tailings were collected for geochemical testing. As documented in Attachment A, foundation (native) soil and rock samples were lower in sulfur than either tailings or waste rock but 4 of the 19 samples still had pyritic sulfur greater than 0.3%, which would likely generate acidic conditions after sufficient exposure to oxygen. These higher sulfide samples were encountered in boreholes 1 and 2 beneath tailing pile 2/4. It is possible that some of the foundation soil and rock material in this area consists of historic sulfide waste or may contain naturally occurring sulfides. However, any sulfides beneath the tailings in pile 2/4 will be covered by the liner for the new repository, which will prevent contact with infiltrating water.

6.2.2 Historic Tailing and Waste Rock Characterization

A range of geochemical tests were conducted on representative samples of historic tailings, waste rock, foundation soils (underlying the unlined tailings), and development rock from an exploration decline and shaft to characterize the material that will be placed in the lined TSF. The methodology and results are provided in Attachment A.

6.2.3 January Mine Adit and January Mine Workings Water Quality

Water quality samples have been collected from the January Adit and January Mine workings (sampling locations denoted on Figure 13 as "JAN AD" and JA-1, respectively) since April 2016. The results of these samples are compared to SWQSs (Table 4), including the dissolved-metal standards, which are the focus of the TMDL Implementation Plan for Alum Gulch. The results of the comparison are provided on Table 4. For some dissolved metals (cadmium, copper, lead, nickel, silver, and zinc), SWQSs are based on the hardness of the receiving water body (in this case, Alum Gulch) or the hardness of the water from the discharge when there is not a receiving flow of water (i.e., ephemeral).

Samples were analyzed for dissolved metals. Iron and zinc were identified to be above the SWQSs (Aquatic and Wildlife warm, chronic). Samples were also analyzed for total metals. Arsenic, cadmium, and lead were identified to be above the applicable SWQSs, as noted on Table 4. Discharges from the January Adit to the constructed passive treatment wetlands ceased in August 2016 and the January mine workings water is pumped and used for exploration drilling following approval from ADEQ.

6.2.4 Tailings Pile Seepage Water Quality

In addition to tailing seepage samples collected in 2015, seepage was collected on January 9, 2017 and the water quality data were used in the design of the active WTP. The seepage chemistry is provided on Table 3-1 in Attachment C.

6.2.5 Surface Water Quality

AMI and its consultants have conducted surface water quality monitoring in the Alum Gulch and Harshaw Creek watersheds. The monitoring locations are shown on Figure 13. Results of surface water analyses are provided on Tables 5A (Alum Gulch) and 5B (Harshaw Creek).

The SWQS for pH is 6.5 to 9.0. The pH values measured in all of the Alum Gulch samples listed on Table 4A were below 6.5. In contrast, the pH values measured in samples from Harshaw Creek met the standard.

Several dissolved metals were identified to be elevated in the Alum Gulch watershed. Dissolved zinc, lead, iron, cadmium, and nickel concentrations are above their respective SWQSs for aquatic and wildlife (warm water, chronic). Total cadmium, copper, iron, lead, and zinc concentrations were also identified to be above their SWQSs.

6.2.6 Groundwater Quality

MW-3 is located downstream of the proposed WTP (Figure 13). AMI has collected three rounds of groundwater samples from this well. The results are summarized on Table 6. Dissolved cadmium was detected at a concentration of 0.0051 mg/L, above the AWQS of 0.005 mg/L, in February 2017. In March and April 2017, dissolved cadmium was below the AWQS. The other analytes met AWQSs.

7 BEST AVAILABLE DEMONSTRATED CONTROL TECHNOLOGIES

The proposed TSF and Underdrain Collection Pond are designed and will be operated and maintained to ensure the greatest degree of discharge reduction achievable through application of prescriptive BADCT. The prescriptive criteria are conservative; using these criteria eliminates the need for considering site hydrogeology and vadose zone characteristics and minimizes the need for consideration of other site factors (ADEQ, 2004).

Solutions from the TSF and Underdrain Collection Pond, along with water from the January Mine Adit, will be routed to a WTP. The WTP is the BADCT mechanism for reducing discharges from the TSF and Underdrain Collection Pond. Discharges to Alum Gulch from the WTP will be treated to meet AWQSs and the applicable discharge surface water quality standards that will be specified in an AZPDES permit (to be issued). As such, groundwater will be compliant with AWQSs at the POC.

The BADCT demonstrations are provided in Attachments to this document, including design criteria, applicable site characteristics, and other criteria that were used in the facility designs. The BADCT demonstrations for the TSF and the Underdrain collection Pond were prepared by NewFields and are provided in Attachment B. Key BADCT elements for the TSF, and the Underdrain Collection Pond are provided in section 7.1 and 7.2 and in Attachment B. The BADCT demonstration for the WTP is discussed in Section 7.3 below and in Attachment C.

7.1 Tailing Storage Facility

The TSF is designed as a lined permanent storage area for placement of the existing historic tailings piles that are shown on Figure 3. Tailings, PAG waste rock and impacted soils beneath the historic tailings facilities will be excavated and placed in the lined Trench Camp TSF as an earthen material. PAG development rock from a planned exploration decline and shaft will also be stored in the lined TSF as a co-mingled material with the existing tailings and PAG waste rock. Additionally, development rock 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.

The TSF will be constructed in two stages. Some of the elements of BADCT include:

- The TSF is sited in the northeast portion of the Trench Camp property. Flux Canyon Road is the boundary on the western and southern reaches of the facility. The TSF includes a perimeter road which fully encompasses a synthetically lined basin area capable of storing the design tailings and waste rock as well as conveying the internal 100-yr/24-hr peak storm flows while maintaining 2 feet of freeboard.
- The TSF basin will be prepared and graded for geomembrane placement. Impacted soils from the historic tailings piles will be removed.
- The composite liner design consists of a 60 mil double sided textured high-density polyethylene (HDPE) geomembrane overlying a low permeability compacted soil layer

or GCL. To protect the geomembrane, reduce head and facilitate long-term drainage of the tailings, a granular protective layer is specified over the geomembrane liner.

- The protective layer is augmented by a dendritic, perforated corrugated polyethylene (CPe) pipe network placed in topographic lows to collect percolation through the tailings and convey the flow via gravity to an Underdrain Collection Pond located downstream of the TSF.
- Integral Stage 1 and Stage 2 detention ponds, both constructed with a single liner, to manage stormwater run-on and direct it to the Underdrain Collection Pond. Because impacted soil will be removed from the base of the old tailings piles prior to installation of the pond liner, these integral ponds will contain non-contact stormwater only. The Stage 1 detention pond will be covered by the Stage 2 TSF, and the Stage 2 detention pond will eventually be covered by the Stage 3 TSF. Refer to Attachment B for the details of the TSF design.

The closure strategy for the TSF is provided in Section 13 of Attachment B.

AMI has applied for a Dam Safety Permit from the Arizona Department of Water Resources for the construction and operation of the Underdrain Collection Pond.

7.2 Underdrain Collection Pond

The Underdrain Collection Pond is sized to contain underdrainage flow, direct precipitation runoff from the TSF and direct precipitation on the pond from the 100-yr/24-hr storm event. The pond will be double 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 serve to reduce head on the secondary liner, thereby reducing the propensity for seepage beyond the secondary liner system.

Water collected in the Underdrain Collection Pond will be pumped to the WTP and used for exploration drilling makeup or other approved operational uses, or released to Alum Gulch downgradient of the WTP.

Construction level design drawings and supporting documentation are provided in Attachment B.

The closure strategy for the Underdrain Collection Pond is provided in Section 13 of Attachment B.

7.3 Water Treatment Plant

The WTP is designed for treating underdrain seepage and storm water runoff from the TSF and water from the January Mine workings. The design accommodates variable flow rates from the TSF, using a nominal basis of design throughput of 120 gpm. The design allows for seasonal fluctuations in flow rates.

The engineering report for the WTP, prepared by Water Engineering Technologies, Inc. (WET), is in Attachment C. The engineering report contains plans and sections on: WTP background; design criteria including water chemistry and design flow rates; evaluation of process alternatives, process design including a process flow diagram, process and instrumentation diagrams, mechanical equipment list, a facility general arrangement, and major equipment data sheets. WET evaluated several process alternatives to identify the BADCT alternative selected for the WTP design.

Treated water will 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. This discharge will be authorized under an AZPDES permit.

As noted in Section 13 of Attachment B, the WTP will operate until closure of the TSF, when a passive treatment system will be constructed in the underdrain collection pond.

8 POLLUTANT MANAGEMENT AREA, DISCHARGE IMPACT AREA AND POINT OF COMPLIANCE

The Pollutant Management Area (PMA) is drawn to closely circumscribe the TSF the Underdrain Collection Pond, and the extent of surface flow of the discharge from the WTP (Figure 14).

To identify the northern end of the PMA, Ecological Resource Consultants, Inc., determined the distance that the design flow (120 gpm) from the WTP discharge point would travel. The distance was determined to be approximately 1.22 miles. A memo describing the method by which this analysis was conducted is provided in Appendix E.

The location of the WTP discharge, shown on Figure 14, is:

Latitude: **31° 28' 15" N**
Longitude: **110° 43' 43" W**

The location for a conceptual Point-of-Compliance (POC) is shown on Figure 14. The latitude and longitude are as follows:

Latitude: **31° 29' 1.7" N**
Longitude: **110° 44' 16.4" W**

The Discharge Impact area (DIA) for the TSF and Underdrain Collection Pond are the same as the PMA for these facilities. Because they are constructed according to Prescriptive BADCT, discharges are not anticipated. The DIA for the WTP discharge was calculated using Darcy's Law using conservative (higher) K values obtained at the site for the Cretaceous andesite and groundwater gradients obtained from well gaging data. The DIA, as drawn on Figure 14, was developed for 30 years.

As required by R-18-9-A-202(A)(6), the permitted discharges will not cause or contribute to an AWQS at the POC. The WTP is designed to treat to AWQSs and applicable surface water quality standards.

9 PERMITTING AND LEGAL REQUIREMENTS

9.1 Applicable Requirements

AMI currently has the following authorizations/permits:

- Mining Multi-Sector General Permit Authorization AZMSG-88923;
- Arizona State Mine Inspector State ID# 13-03295;
- ADEQ Voluntary Remediation Program Site Code #505143-02.

Permits for which AMI will apply include:

- State Air Quality Control Permit
- Arizona Department of Water Resources (ADWR) – Dam safety procedures for any artificial barrier that is not an exempt structure (application for underdrain collection pond has been submitted).
- Arizona Pollutant Discharge Elimination System (AZPDES) Permit – This permit provides authorization to discharge treated water from the WTP in compliance with applicable water quality standards.
- Arizona State Mine Inspector (ASMI) – Site reclamation plan, health and safety, and financial assurance mechanisms.
- EPA RCRA generator ID.

9.2 Other Determinations

A request for a Clean Water Section 4040 Jurisdictional Determination covering the project area was submitted to the Los Angeles District Office of the US Army Corps of Engineers. Following their jurisdictional review, they determined that jurisdictional waters of the US do not occur in where the proposed APP facilities will be constructed.

A copy of the Jurisdictional Determination Letter is included in Attachment D to this Application.

10 PROPOSED MONITORING REQUIREMENTS

10.1 Operational Monitoring

10.1.1 TSF

Regular inspections of the TSF will be conducted to ensure ongoing BADCT is being satisfied. Inspections will begin at the time of construction to ensure that construction is completed in accordance with the Design Drawings and Technical Specifications. Inspections will also be conducted after major storm or surface water events, and no less frequently than quarterly. The visual inspection will be conducted to evaluate the overall facility integrity and performance, to document liner and dry stack TSF conditions, to confirm storm water management facility integrity, and to identify unusual scour, sloughing, rock falls, or visual seepage that need to be addressed. Inspection records will be recorded in a logbook that is kept at the site office. The log book will also detail any remedial action that is required as a result of the visual inspection summary.

The TSF will have has piezometers placed within the protective layer near the geomembrane to measure hydraulic head on the liner system. If the piezometers read a phreatic surface in excess of the proposed alert level of 1.5 feet (Hydraulic gradient greater than unity), actions will be conducted according to the Contingency Plan (Section 11). Monitoring of the piezometers will be conducted weekly.

10.1.2 Underdrain Collection Pond

Operational monitoring for the Underdrain Collection Pond includes inspections for freeboard, liner integrity, and monitoring solutions in the Leak Collection and Removal System (LCRS).

Routine facility inspections of the Underdrain Collection Pond will be instituted at the time of construction and will continue quarterly with additional inspections in the event of a process upset or a major storm/surface water flow event. A visual assessment of pond integrity along with a physical appraisal of the pond capacity will be conducted. Inspection records will be maintained in a log book that will remain onsite for a period prescribed in the APP. A contingency plan (Attachment B, Section 12) has been developed and will be implemented in the event of an accidental discharge.

The Underdrain Collection Pond has a double geomembrane liner system with a LCRS located between primary and secondary liners. Alert levels have been calculated for the LCRS as noted in Attachment B, Section 5.6 and also shown in the table below. The calculations for the alert levels are provided in Appendix H-1 to Attachment B. The LCRS will be equipped with a level control to activate a pump. The outflow will be measured with a flow totalizer and a record of these measurements will be maintained on site. Totalizer readings will be collected at approximately the same time each day and recorded in the logbook. If a LCRS alert level is exceeded, AMI will take the actions identified in the Contingency Plan (Attachment B, Section 12)

Location	Alert Level 1 (AL1)	Alert Level 2 (AL2)	LCRS Design Capacity
Number of Defects	1 per acre	1 per acre	1 per acre
Area of Circular Defect	1.08E-4 ft^2 (10 mm^2)	1.08E-3 ft^2 (1 cm^2)	1.08E-3 ft^2 (1 cm^2)
Hydraulic Head Above Geomembrane	42.0 ft	42.0 ft	42.0 ft
Area of Geomembrane	68,994 ft^2	68,994 ft^2	68,944 ft^2
Leakage Rate	2.4 gpm	15.9 gpm	23.9 gpm
Note: AL2 was calculated based on a safety factor of 1.5 utilizing the same inputs as the LCRS Design Capacity			

10.2 Discharge Monitoring

Monitoring of the WTP influent and effluent and the associated reporting and record keeping requirements will be specified in the AZPDES and APP permits. The discharge location will be located in Alum Gulch at 31° 28’ 15” N 110° 43’ 43” W. Sampling locations of influent and effluent (discharge) will be within the WTP near the discharge location.

The WTP will be operated by State-licensed operators (names to be provided to ADEQ when available). The facility will utilize on-site operators as well as 24-hour remote monitoring capability of the process and alarm systems incorporated in the WTP.

WTP effluent will be regularly monitored utilizing a flow meter and sampling port that enables the plant operators to ensure the WTP is operating as intended, and ensure the effluent meets the appropriate water quality standards (the proposed AQL) as designated in the APP and AZPDES permits.

The plant operators will utilize operating protocols that include:

- Daily visual monitoring of reactions occurring in the reaction tank, clarifier, and pH adjustment tank;
- Continuous monitoring of the pH values in the reaction tank and pH adjustment tank utilizing process control instrumentation;
- Monitoring the flow rates of the mine water and UP water into the WTP and the flow rate leaving the WTP utilizing process control instrumentation;

- Monitoring the water level in the mine and UP utilizing process control instrumentation; and

- Monitoring the WTP chemical volumes retained on-site utilizing process control instrumentation and visual inspections.

The following data will be reported to ADEQ:

1—Total volume of water treated, recorded daily, reported quarterly.

2—Total volume discharged to Alum Gulch, recorded daily, reported quarterly.

3—Monthly monitoring of water discharged to Alum Gulch (if none is discharged, no sampling required) will be analyzed (dissolved fraction) for As, Ba, Be, Cd, Cr, F, Pb, Hg, Ni, Nitrate/Nitrite as N, Se, Tl. Note that additional analytes may be required under the AZPDES permit.

10.3 Groundwater Monitoring

No regular groundwater monitoring is proposed under this APP.

11 CONTINGENCY PLAN

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.

11.1 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 cell number is listed below:

Primary Contact – Emergency Response Coordinator (ERC):

Contact Name: Johnny Pappas
Job Title: Director of Environmental and Permitting
Address: 3845 North Business Center Drive, Suite 115, Tucson, AZ 85705
Office Number: 520-485-1300
Cell Number: 803-235-5563

Secondary Contact – Back up ERC:

Contact Name: Greg Lucero
Job Title: VP Community and Government Affairs
Address: 3845 North Business Center Drive, Suite 115, Tucson, AZ 85705
Office Number: 520-485-1300
Cell Number: 520-604-0618

11.2 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

11.3 Underdrain Collection Pond Freeboard

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. In the event that the Underdrain Collection Pond freeboard is not maintained, AMI will take the following actions:

- 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.
- 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.
- Within 5 days of discovery, evaluate the cause and adjust operational conditions to avoid future occurrences.
- Records documenting each freeboard incident and actions taken to correct the problem shall be included in the facility log.

11.4 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.

11.5 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.

11.6 Underdrain Collection Pond LCRS Alert Levels

The Underdrain Collection Pond has a double geomembrane liner with a Leakage Collection and Recovery System (LCRS). AL calculations are on Table 4.1 of Attachment B. 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. 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. 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.

11.7 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.

11.8 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.

11.9 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.

11.10 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.

11.10.1 <u>Hazardous Substances or Toxic Pollutants:</u>

In the event of an unauthorized discharge 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 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 AQL being exceeded; or b) could pose an endangerment to public health or the environment.

11.10.2 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 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.

11.10.3 Corrective Actions

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.

11.11 Reporting

AMI must submit a written report to the ADEQ WQCS within 30 days of completion of any corrective action. 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.

12 COMPLIANCE SCHEDULE

AMI proposes the following compliance schedule for ADEQ's consideration:

Action	Completed by:
Revisions to Contingency Plan	Within 30 days of permit issuance
Underdrain Collection Pond as-built	Within 90 days of completion

13 REFERENCES

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TABLES

Facility Name	Latitude* (NAD 83)	Longitude* (NAD 83)	Facility Use / Description	Categorical facility under 49-241.b?	Subject to General Permit Rules?	Subject to Individual APP?	Exemption Citation	Comments
Lined TSF	31° 27’ 59.4”N	110° 43’ 35.8”W	Mined Tailings Piles	Yes	No	Yes	NA	Lined tailings storage facility will receive historic tailings from tailings piles 1, 2, 3, and 4 and potentially acid-generating development rock. Facility is designed according to prescriptive BADCT criteria.
Underdrain Collection Pond	31° 27’ 59.0”N	110° 43’ 39.2”W	Surface Impoundment (Process Solution)	Yes	No	Yes	NA	Process solution impoundment with a double liner, leak collection and removal system. Constructed using prescriptive BADCT criteria.
Water Treatment Plant Discharge	31° 28' 15" N	110° 43' 43" W	treated water from tailing seepage and January adit	No	No	Yes	NA	The WTP discharge meets the definition of "discharge" as defined in 49-201.14.
Tailings Pile 1	31° 27' 59.838"N	110° 43' 41.596"W	Mine Tailings Piles	Yes	No	No	Yes, § 49-250.B.11	The historical tailings piles are exempt because they are closed facilities as defined by 49-201.7
Tailings Piles 2 and 4	31° 27' 54.918"N	110° 43' 28.381"W	Mine Tailings Piles	Yes	No	No	Yes, § 49-250.B.11	The historical tailings piles are exempt because they are closed facilities as defined by 49-201.7
Tailings Pile 3	31° 27' 47.808" N	110° 43' 39.239"W	Mine Tailings Piles	Yes	No	No	Yes, § 49-250.B.11	The historical tailings piles are exempt because they are closed facilities as defined by 49-201.7

TABLE 2
Patented Claims Owned by Arizona Mining, Inc.

Patented Claim Name	BLM Recorded Patent No.	Santa Cruz County Records Document	County Assessor Parcel No.
January	25015	Seq. 2010-03552(QCD), Seq. 2016-00445(QCD)	105-50-001B
Norton	19644	Seq. 2010-03552(QCD), Seq. 2016-00445(QCD)	105-50-001B
Trench	2837	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 2	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 3	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 4	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 5	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 6	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 7	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench No. 8	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench Ext. No. 1	1107723	Doc. 119/393, Seq. 2009-239(QCD), Seq. 2010-03552(QCD), Seq. 2016-00443(QCD), Seq. 2011-02069(Survey)	105-49-003
Trench Ext. No. 2	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench Ext. No. 3	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A
Trench Ext. No. 4	1107723	Doc. 119/393, Seq. 2009-239(QCD), Seq. 2010-03552(QCD), Seq. 2016-00443(QCD), Seq. 2011-02069(Survey)	105-49-003
Hardshell No. 7	1107723	Doc. 119/393, Seq. 2009-239(QCD), Seq. 2010-03552(QCD), Seq. 2016-00443(QCD), Seq. 2011-02069(Survey)	105-49-003
Josephine	1107723	Seq. 2009-11239(QCD), Rerecorded 2010-03552(QCD), Seq. 2016-00443(QCD(6.00)), Seq. 2016-00444(QCD), Seq. 2011-02069(Survey)	105-50-001A

TABLE 3
Wells within One Half Mile

ADWR Well Registry ID	Well ID	Use	DEPTH (feet)	Latitude (Degrees, Minutes, Seconds)	Longitude (Degrees, Minutes, Seconds)
226139	MW-2	Exempt	1005	31° 27' 50.22" N	110° 43' 48" W
226398	HDS-349	Exempt	1045	31° 27' 44.496" N	110° 43' 40.8" W
226902	JA-2	Exempt	125	31° 27' 18.552" N	110° 43' 40.8" W
227120	WW-1	Non-Exempt	TBD	31° 27' 34.34" N	110° 43' 44.4" W
620838		Non-Exempt	412	31° 27' 43.187" N	110° 42' 42.220" W
620839		Non-Exempt	750	31° 27' 57.767" N	110° 43' 39.526" W
642746	USFS	Exempt-Livestock/wildlife	0	31° 28' 35.860" N	110° 44' 7.097" W
910210	JA-1	Exempt	110	31° 28' 18.912" N	110° 43' 44.4" W
913354	HDS-130	Non-Exempt	550	31° 27' 34.056" N	110° 43' 46.8" W
913499	HDS-188	Exempt	800	31° 27' 36.9" N	110° 43' 4.8" W
913830		Monitor	560	31° 27' 24.124" N	110° 43' 12.899" W
920120	MW-3	Monitor	86	31° 27' 19.912" N	110° 43' 48" W
920266	HDS-403	Monitor	3247	31° 27' 39.888" N	110° 43' 8.4" W
920319	HDS-417	Monitor	3056	31° 27' 43.34" N	110° 43' 8.4" W
920323	HDS-356	Exempt	3576	31° 27' 41.94" N	110° 43' 4.8" W
920370	HDS-354	Monitor	5327	31° 27' 56.196" N	110° 43' 22.8" W
920371	HDS-345	Monitor	4127	31° 27' 39.816" N	110° 43' 40.8" W
920378	HDS-430	Monitor	3640	31° 27' 37.458" N	110° 43' 1.2" W
920389	HDS-364	Piezometer	4722	31° 27' 48.528" N	110° 43' 22.8" W
920390	HDS-369	Piezometer	5000	31° 27' 54.36" N	110° 43' 54.36" W
920391	HDS-371	Piezometer	3760	31° 27' 38.016" N	110° 43' 38.016" W
920392	HDS-397	Piezometer	3973	31° 27' 43.38" N	110° 43' 43.38" W
920448	MW-4	Monitor	0	31° 27' 45.40" N	110° 43' 45.40" W
920459	HT-1	Non-Exempt	3700	31° 27' 41.688" N	110° 43' 41.688" W
920461	HDS-179	Monitor	750	31° 27' 24.804" N	110° 43' 24.804" W
920498	HDS-343	Monitor	5567	31° 27' 53.68" N	110° 43' 53.68" W
920500	HDS-363	Monitor	4247	31° 27' 45.54" N	110° 43' 45.54" W

TABLE 4
January Adit and January Mine Workings

Analyte	Units	SWQS[2]	Date						
			JAN AD[1]	JA#1	JA#1	JAN AD	JA#1	JA#1	JA#1
			4/14/2016	**4/15/2016**	**6/20/2016**	**6/20/2016**	**8/15/2016**	**2/7/2017**	**3/14/2017**
Field Parameters									
Flow	**gpm**	NA	12	--	--	5	--	--	--
Conductivity	**µS/cm**	NA	3,180	3,425	3,480	3,790	3,687	3,200	3,498
pH	**SU**	6.5-9.0	**5.87**	**6.20**	6.75	**6.35**	**5.87**	**6.40**	**5.85**
ORP	**mV**	NA	--	--	--	--	--	--	--
Temperature	**°C**	NA	20.3	21.2	22.1	23.3	21.9	21.2	20.7
Dissolved Metals									
Aluminum	**mg/L**	NA	<2.0	<2.0	--	--	<10	<2.0	--
Antimony	**mg/L**	0.03	<0.0050	<0.0050	<0.00050	0.0032	0.0045	<0.0050	--
Arsenic	**mg/L**	0.15	0.089	0.066	0.024	0.072	0.13	0.085	--
Barium	**mg/L**	NA	--	--	0.0072	--	0.0047	<0.0050	--
Beryllium	**mg/L**	0.0053	<0.0025	<0.0025	<0.00025	0.00036	<0.0013	<0.0025	--
Calcium	**mg/L**	NA	--	--	470	520	--	480	--
Cadmium	**mg/L**	0.0062	0.0035	<0.0025	<0.00025	0.0022	0.00040	0.00038	--
Chromium	**mg/L**	1	<0.0050	<0.0050	0.0024	0.00093	0.0030	<0.0050	--
Copper	**mg/L**	0.0293	<0.0050	<0.0050	0.00093	0.0014	0.0014	<0.0050	--
Iron	**mg/L**	1	**36**	**31**	**23**	**38**	**42**	**36**	--
Lead	**mg/L**	0.0109	<0.025	<0.0050	<0.00050	0.0014	0.0078	<0.0050	--
Magnesium	**mg/L**	NA	--	--	260	260	--	250	--
Manganese	**mg/L**	130.667	68	66	48	62	61	53	--
Mercury	**mg/L**	0.00001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	--
Nickel	**mg/L**	0.1680	0.055	0.042	0.034	0.057	0.057	0.050	--
Selenium	**mg/L**	NA	0.0031	0.0024	0.0031	0.0039	0.0026	0.0021	--
Silver	**mg/L**	0.0349	<0.0050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	--
Thallium	**mg/L**	0.15	<0.025	<0.0050	<0.00050	<0.0010	<0.00050	<0.0050	--
Zinc	**mg/L**	0.379	**9.8**	0.27	<0.40	**8.9**	**6.0**	**4.8**	--
Total Metals									
Aluminum	**mg/L**	NA	<2.0	<2.0	--	--	<2.0	<2.0	--
Antimony	**mg/L**	0.64	<0.0050	0.011	0.0026	0.0030	0.0052	0.0063	--
Arsenic	**mg/L**	0.03	**0.097**	**0.092**	0.025	**0.077**	**0.10**	**0.11**	--
Barium	**mg/L**	98	--	--	0.020	--	0.013	0.0063	--
Beryllium	**mg/L**	0.084	<0.0025	<0.0025	<0.00025	<0.00025	<0.00025	0.00028	--
Calcium	**mg/L**	NA	470	450	460	510	450	520	--
Cadmium	**mg/L**	0.05	0.0043	0.035	0.0018	0.0020	0.0005	0.0006	--
Chromium	**mg/L**	1	<0.0050	<0.0050	0.0024	0.00069	0.0077	0.0010	--
Copper	**mg/L**	0.5	0.0053	0.010	0.0047	<0.0050	0.0044	0.0011	--
Iron	**mg/L**	NA	35	38	22	38	40	41	--
Lead	**mg/L**	0.015	0.0092	**0.32**	**0.050**	0.0091	0.0088	0.0088	--
Magnesium	**mg/L**	NA	240	250	250	270	260	270	--
Manganese	**mg/L**	130.667	61	61	45	59	64	59	--
Mercury	**mg/L**	0.010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	--
Nickel	**mg/L**	4.6	0.0029	0.054	0.026	0.053	0.053	0.040	--
Selenium	**mg/L**	0.002	<0.0050	**0.0024**	0.0014	**0.0051**	0.00045	**0.0021**	--
Silver	**mg/L**	4.667	<0.0050	<0.0050	0.00077	<0.00050	<0.00050	<0.00050	--
Thallium	**mg/L**	0.0072	<0.0010	<0.0050	<0.00050	<0.0050	<0.00050	<0.00050	--
Zinc	**mg/L**	5.106	**10**	4.9	1.4	**8.1**	**5.7**	**5.2**	--
Inorganics									
Alkalinity, Bicarbonate (as $CaCO_3$)	**mg/L**	NA	--	--	--	--	170	--	--
Alkalinity, Carbonate (as $CaCO_3$)	**mg/L**	NA	--	--	--	--	<2.0	--	--
Alkalinity, Hydroxide (as $CaCO_3$)	**mg/L**	NA	--	--	--	--	<2.0	--	--
Alkalinity, Total (as $CaCO_3$)	**mg/L**	NA	--	--	--	--	170	--	--
Hardness -[CALC] Ca (as $CaCO_3$)	**mg/L**	NA	--	--	--	--	--	--	--
Hardness -[CALC] Ca/Mg (as $CaCO_3$) (Dissolved)	**mg/L**	NA	--	2100	--	2400	--	2200	--
Hardness -[CALC] Ca/Mg (as $CaCO_3$)	**mg/L**	NA	2200	--	2200	--	2400	2400	--
TSS (residue, non-filterable)	**mg/L**	NA	12	42	71	15	22	<10	--
TDS (residue filterable)	**mg/L**	NA	--	--	3100	3700	3900	3600	--
Anions									
Cyanide	**mg/L**	0.2	--	--	<0.10	--	<0.10	<0.10	--
Fluoride	**mg/L**	NA	--	--	0.68	--	0.62	0.95	--
Nitrate + Nitrite	**mg/L**	NA	--	--	<0.10	--	<0.10	<0.10	--
Sulfate	**mg/L**	NA	--	--	--	--	--	--	2200

Notes:

Bold *indicates concentration above SWQS (Surface Water Quality Standard)*

[1] *Jan Ad = January Adit discharge; JA#1 = January Adit Well*

[2] *Designated Uses at Alum Gulch: Aquatic & wildlife warm water, full body contact, fish consumption, and Agricultural Livestock watering.*

[2] *SWQS - standards for cadmium, copper, lead, nickel, zinc based on a maximum hardness of 400 mg/L*

$CaCO_3$ *= calcium carbonate*

°C = degrees Celsius

gpm = gallons per minute

mg/L = milligrams per Liter

µS/cm = microsiemens per centimeter

SU = standard units

mV = millivolts

NA = no applicable standard

TDS = total dissolved solids

TSS = total suspended solids

-- indicates no sample

Duplicate Values separated by a '/'

Analyte	Units	Alum Gulch SWQS (mg/L)	FC-1	FC-2	HC-1	SW-AL1	SW-AL1	SW-AL1	SW-AL1	SW-AL2	SW-AL2	SW-AL2	SW-AL2	SW-AL 3	SW-AL 3	SW-AL 3	SW-AL 3	SW-AL 4	SW-AL 4	SW-AL 4	SW-AL 4	SW-AL 4	SW-AL4
			12/29/2016	12/29/2016	12/29/2016	4/14/2016	8/15/2016	11/29/2016	2/8/2017	4/14/2016	8/15/2016	11/29/2016	2/8/2017	4/14/2016	8/15/2016	11/29/2016	2/8/2017	4/14/2016	8/15/2016	8/15/16 DUP	11/29/2016	2/8/2017	2/8/17 DUP
Field Parameters																							
Conductivity	µS/cm	NA	3680	2923	939.8	3541				3334	3030			3233	3220			2573	2140	2140	375	2820	2820
pH	SU	6.5-9.0	**3.66**	**3.94**	**3.17**	**5.16**	Pooled water (No sample collected)	DRY	DRY	**5.66**	**5.80**	DRY	DRY	**5.31**	**5.38**	DRY	DRY	**4.57**	**4.43**	**4.43**	**3.12**	**4.04**	**4.04**
Temperature	°C	NA	10.6	11.5	10.5	21.4				19.8	27.9			21.8	28.7			20.4	23.5	23.5	9.1	6.5	6.5
Flow	gpm	NA	0.025	0.2	0.004	0				3-4	9			3-4	12			7-8	25	25	0.2	1.0	1.0
Dissolved Metals																							
Aluminum	mg/L	NA	--	--	--	5.4	--	--	--	<2.0	<10	--	--	4.0	<10	--	--	24	19	18	--	18.0	16.6
Antimony	mg/L	0.03	<0.00050	<0.00050	<0.00050	<0.0050	--	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	<0.00050	<0.0050	<0.0050	<0.00050
Arsenic	mg/L	0.15	<0.0400	<0.0400	<0.0400	<0.0051	--	--	--	<0.0050	0.0013	--	--	<0.0050	0.0016	--	--	<0.0050	0.0012	0.0013	<0.0050	<0.0050	0.0013
Barium	mg/L	NA	0.05	<0.050	<0.050	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	mg/L	0.0053	0.016	0.0027	0.0026	<0.0025	--	--	--	<0.0025	<0.0013	--	--	<0.0025	0.0019	--	--	0.0029	0.0024	0.0023	0.0031	0.0027	0.0019
Cadmium	mg/L	0.0062	**0.21**	**0.18**	**0.031**	**0.092**	--	--	--	**0.043**	**0.040**	--	--	**0.074**	**0.058**	--	--	**0.074**	**0.084**	**0.083**	**0.11**	**0.20**	**0.18**
Calcium	mg/L	NA	380	350	17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	430	320
Chromium	mg/L	1	0.043	<0.030	<0.030	<0.0050	--	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	--	--	<0.0050	0.00054	0.00068	<0.0050	<0.00050	<0.00050
Copper	mg/L	0.50	**2.1**	**0.51**	**3.2**	0.092	--	--	--	0.045	0.040	--	--	**0.16**	0.088	--	--	**0.42**	**0.71**	**0.76**	**0.32**	**0.72**	**0.64**
Iron	mg/L	1.0	**1.7**	0.42	**5.4**	**4.5**	--	--	--	<0.30	<1.5	--	--	<0.30	<1.5	--	--	0.33	**1.3**	**1.3**	0.60	<0.30	<0.30
Lead	mg/L	0.0109	**0.6**	**0.12**	<0.040	**0.68**	--	--	--	**0.058**	**0.027**	--	--	**0.070**	0.050	--	--	**0.18**	**0.13**	**0.12**	**0.13**	**0.11**	**0.1**
Magnesium	mg/L	NA	220	200	17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	260	200
Manganese	mg/L	130.667	**190**	59	6.5	100	--	--	--	31	39	--	--	56	55	--	--	54	38	38	72	58	57
Mercury	mg/L	0.00001	<0.0010	<0.0010	<0.0010	<0.0010	--	--	--	<0.0010	<0.0010	--	--	<0.0010	<0.0010	--	--	<0.0010	<0.0010	<0.0010	--	--	--
Nickel	mg/L	0.1680	**0.39**	**0.21**	0.073	**0.25**	--	--	--	0.080	0.096	--	--	0.14	0.13	--	--	**0.18**	0.15	0.15	**0.26**	**0.22**	**0.23**
Potassium	mg/L	NA	7.1	6.1	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	mg/L	NA	<0.040	<0.040	<0.040	0.0073	--	--	--	0.0043	0.0027	--	--	0.0063	0.0032	--	--	0.0051	0.0022	0.0025	0.0071	0.0069	0.0035
Silver	mg/L	0.0349	**0.051**	0.017	<0.010	<0.0050	--	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	<0.00050	<0.0050	<0.0050	<0.00050
Sodium	mg/L	NA	78	72	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	mg/L	0.15	<0.00050	<0.00050	0.00058	<0.025	--	--	--	<0.025	<0.00050	--	--	<0.025	<0.00050	--	--	<0.025	0.00051	<0.00050	<0.0050	<0.0050	<0.0050
Uranium	mg/L	NA	0.014	0.0013	0.0045	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	mg/L	0.379	**76**	**45**	**6.4**	**49**	--	--	--	**26**	**24**	--	--	**32**	**31**	--	--	**34**	**25**	**25**	**45**	**38**	**39**
Total Metals																							
Aluminum	mg/L	NA	--	--	--	5.2	--	--	--	<2.0	<2.0	--	--	3.9	2.6	--	--	21	19	19	--	20.6	20.6
Antimony	mg/L	0.64	--	--	--	<0.0050	--	--	--	<0.0050	0.00080	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic	mg/L	0.03	--	--	--	<0.0050	--	--	--	<0.0050	0.0016	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	<0.00050	<0.0025	<0.00050	0.00050
Barium	mg/L	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	mg/L	0.084	--	--	--	<0.0025	--	--	--	<0.0025	0.00051	--	--	0.0028	0.0017	--	--	0.0030	0.0026	0.0027	0.0029	0.0027	0.0021
Cadmium	mg/L	0.050	--	--	--	**0.11**	--	--	--	**0.052**	0.043	--	--	**0.089**	**0.062**	--	--	**0.085**	**0.089**	**0.090**	**0.110**	**0.19**	**0.18**
Calcium	mg/L	NA	--	--	--	480	--	--	--	410	420	--	--	470	460	--	--	320	230	230	320	320	340
Chromium	mg/L	1	--	--	--	<0.0050	--	--	--	<0.0050	0.0082	--	--	<0.0050	0.0078	--	--	<0.0050	0.0086	0.0083	<0.0025	0.0025	0.0026
Copper	mg/L	0.5	--	--	--	0.098	--	--	--	0.054	0.034	--	--	0.17	0.097	--	--	0.44	**0.74**	**0.73**	0.32	**0.66**	**0.66**
Iron	mg/L	NA	--	--	--	5.1	--	--	--	<0.30	0.74	--	--	<0.30	<0.30	--	--	0.33	1.3	1.4	0.67	<0.30	<0.30
Lead	mg/L	0.015	--	--	--	**0.63**	--	--	--	**0.049**	**0.059**	--	--	**0.068**	**0.046**	--	--	**0.17**	**0.12**	**0.12**	**0.11**	**0.11**	**0.10**
Magnesium	mg/L	NA	--	--	--	280	--	--	--	230	230	--	--	260	250	--	--	190	140	140	210	200	200
Manganese	mg/L	130.667	--	--	--	100	--	--	--	33	34	--	--	54	56	--	--	49	38	39	63	58	61
Mercury	mg/L	0.010	--	--	--	<0.0010	--	--	--	<0.0010	<0.0010	--	--	<0.0010	<0.0010	--	--	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel	mg/L	4.6	--	--	--	0.27	--	--	--	0.094	0.080	--	--	0.15	0.13	--	--	0.19	0.13	0.13	0.23	0.20	0.18
Potassium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	mg/L	0.002	--	--	--	**0.0082**	--	--	--	**0.0050**	0.00089	--	--	**0.0067**	**0.0020**	--	--	**0.0054**	0.00082	0.00084	**0.0037**	**0.0039**	**0.0037**
Silver	mg/L	4.667	--	--	--	<0.0050	--	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Sodium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	mg/L	0.0072	--	--	--	<0.0050	--	--	--	<0.0050	<0.00050	--	--	<0.0050	<0.00050	--	--	<0.0050	0.00052	<0.00050	<0.00050	<0.00050	<0.0050
Uranium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	mg/L	5.106	--	--	--	**50**	--	--	--	**21**	**20**	--	--	**30**	**30**	--	--	**31**	**24**	**24**	**38**	**36**	**38**
Inorganics																							
Nitrogen, Nitrate (as N)	mg/L	NA	<0.50	<0.50	<0.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.55	<0.50
Nitrogen, Nitrite (as N)	mg/L	NA	<0.10	<0.10	<0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.10	<0.10
Hardness , Ca/Mg (as $CaCO_3$)	mg/L	NA	--	--	--	2300	--	--	--	2000	2000	--	--	2200	2200	--	--	1600	1100	1200	1700	2200	1600
TSS (residue, non-filterable)	mg/L	NA	--	--	--	41	--	--	--	<10	12	--	--	<10	<10	--	--	<10	<10	<10	<10	<10	<10
TDS (residue, filterable)	mg/L	NA	4100	3100	730	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2800	2800
Anions																							
Chloride	mg/L	NA	13	15.00	8.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cyanide	mg/L	0.0097	<0.10	<0.10	<0.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	mg/L	140	1.5	0.54	<0.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate	mg/L	NA	3200	2100	620	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
***Bold** indicates concentration above SWQS (Surface Water Quality Standard)*
[1] *Dissolved metals SWQSs: Only the most stringent hardness based calculated SWQS of all applicable designated uses is shown above.*
Designated Uses at Alum Gulch: Aquatic & wildlife warm water, full body contact, fish consumption, and Agricultural Livestock watering.
Designated Uses at Humboldt Canyon (SW-HU-1): Aquatic & wildlife ephemeral, partial body contact.
Hardness based SWQSs calculated using 400 mg/L in Alum Gulch; Humboldt Canyon uses hardness value of the collected sample
$CaCO_3$ = calcium carbonate
µS/cm = microsiemens per centimeter
SU = standard units
°C = degrees Celsius
gpm = gallons per minute
mg/L = milligrams per Liter
NA = no applicable standard
TDS = total dissolved solids
TSS = total suspended solids
-- indicates no data available

CLEAR CREEK ASSOCIATES

Analyte	Units	Humboldt Canyon SWQS (mg/L)	SW-HU 1 4/14/2016	SW-HU 1 8/15/2016	SW-HU 1 11/29/2016	SW-HU 1 2/8/2017
Field Parameters						
Conductivity	µS/cm	NA	DRY	717	DRY	DRY
pH	SU	6.5-9.0		**3.72**		
Temperature	°C	NA		26.0		
Flow	gpm	NA		10		
Dissolved Metals						
Aluminum	mg/L	NA	--	27	--	--
Antimony	mg/L	NA	--	<0.00050	--	--
Arsenic	mg/L	0.44	--	0.00068	--	--
Barium	mg/L	NA	--	NA	--	--
Beryllium	mg/L	NA	--	0.0020	--	--
Cadmium	mg/L	0.072	--	0.050	--	--
Calcium	mg/L	NA	--	--	--	--
Chromium	mg/L	NA	--	0.0021	--	--
Copper	mg/L	0.1506	--	**1.8**	--	--
Iron	mg/L	0.1	--	**0.59**	--	--
Lead	mg/L	0.1512	--	0.042	--	--
Magnesium	mg/L	NA	--	--	--	--
Manganese	mg/L	NA	--	4.4	--	--
Mercury	mg/L	0.005	--	<0.0010	--	--
Nickel	mg/L	0.1512	--	0.067	--	--
Potassium	mg/L	NA	--	--	--	--
Selenium	mg/L	NA	--	0.00070	--	--
Silver	mg/L	0.0038	--	<0.00050	--	--
Sodium	mg/L	NA	--	--	--	--
Thallium	mg/L	NA	--	0.00075	--	--
Uranium	mg/L	2.8	--	--	--	--
Zinc	mg/L	3.599	--	**5.3**	--	--
Total Metals						
Aluminum	mg/L	NA	--	26	--	--
Antimony	mg/L	0.747	--	<0.00050	--	--
Arsenic	mg/L	0.03	--	<0.00050	--	--
Barium	mg/L	98	--	--	--	--
Beryllium	mg/L	1.867	--	0.0022	--	--
Cadmium	mg/L	0.07	--	0.052	--	--
Calcium	mg/L	NA	--	17	--	--
Chromium	mg/L	NA	--	0.012	--	--
Copper	mg/L	1.3	--	**1.8**	--	--
Iron	mg/L	NA	--	0.57	--	--
Lead	mg/L	0.015	--	**0.028**	--	--
Magnesium	mg/L	NA	--	16	--	--
Manganese	mg/L	130.667	--	4.1	--	--
Mercury	mg/L	0.28	--	<0.0010	--	--
Nickel	mg/L	28	--	0.065	--	--
Potassium	mg/L	NA	--	--	--	--
Selenium	mg/L	0.033	--	<0.0025	--	--
Silver	mg/L	4.667	--	<0.00050	--	--
Sodium	mg/L	NA	--	--	--	--
Thallium	mg/L	0.075	--	0.00064	--	--
Uranium	mg/L	2.8	--	--	--	--
Zinc	mg/L	280	--	5.1	--	--
Inorganics						
Nitrogen, Nitrate (as N)	mg/L	NA	--	--	--	--
Nitrogen, Nitrite (as N)	mg/L	NA	--	--	--	--
Hardness , Ca/Mg (as $CaCO_3$)	mg/L	NA	--	110	--	--
TSS (residue, non-filterable)	mg/L	NA	--	<10	--	--
TDS (residue, filterable)	mg/L	NA	--	--	--	--
Anions						
Chloride	mg/L	NA	--	--	--	--
Cyanide	mg/L	0.084	--	--	--	--
Fluoride	mg/L	140	--	--	--	--
Sulfate	mg/L	NA	--	--	--	--

Notes:
Bold *indicates concentration above SWQS (Surface Water Quality Standard)*
[1] *Dissolved metals SWQSs: Only the most stringent hardness based calculated SWQS of all applicable designated uses is shown above.*
Designated Uses at Alum Gulch: Aquatic & wildlife warm water, full body contact, fish consumption, and Agricultural Livestock watering.
Designated Uses at Humboldt Canyon (SW-HU-1): Aquatic & wildlife ephemeral, partial body contact.
Hardness based SWQSs calculated using 400 mg/L in Alum Gulch; Humboldt Canyon uses hardness value of the collected sample
$CaCO_3$ = calcium carbonate
µS/cm = microsiemens per centimeter
SU = standard units
°C = degrees Celsius
gpm = gallons per minute
mg/L = milligrams per Liter
NA = no applicable standard
TDS = total dissolved solids
TSS = total suspended solids
-- indicates no data available

Analyte	Units	SWQS[1,2] (mg/L)	SW-HA 1 4/14/2016	SW-HA 1 8/15/2016	SW-HA 1 11/29/2016	SW-HA 1 2/8/2017	SW-HA 2 4/14/2016	SW-HA 2 8/15/2016	SW-HA 2 11/29/2016	SW-HA 2 2/8/2017	SW-HA 3 4/14/2016	SW-HA 3 8/15/2016	SW-HA 3 11/29/2016	SW-HA 3 2/8/2017	SW-HA 4 4/14/2016	SW-HA 4 8/15/2016	SW-HA 4 11/29/2016	SW-HA 4 2/8/2017	SW-HA 5 4/14/2016	SW-HA 5 8/15/2016	SW-HA 5 11/29/2016	SW-HA 5 2/8/2017	SW-HA 6 8/15/2016	SW-HA 6 11/29/2016	SW-HA 6 11/29/16 DUP	SW-HA 6 2/8/2017
Field Parameters																										
Conductivity	µS/cm	NA									1802	1043	1416	1636					1435	942	1308	1519	1677	1448	1448	1633
pH	SU	6.5-9.0	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	6.95	7.20	7.47	7.42	DRY	DRY	DRY	DRY	6.87	7.71	7.33	8.04	7.25	6.88	6.88	7.29
Temperature	°C	NA									21.1	24.2	11.8	6.9					18.4	25.2	14.1	8.6	22.6	10.3	10.3	10.1
Flow	gpm	NA	0	0	0	0	0	0	0	0	15	4	25	2	0	0	0	0	4-5	40	15	0.2	5	15	15	3
Dissolved Metals																										
Aluminum	mg/L	NA	--	--	--	--	--	--	--	--	<2.0	<10	--	<0.0400	--	--	--	--	<2.0	<2.0	--	<0.0400	<10	--	--	<0.0400
Antimony	mg/L	NA	--	--	--	--	--	--	--	--	0.0010	0.0014	<0.0050	0.00054	--	--	--	--	0.0028	0.0024	<0.0050	0.0020	0.0037	<0.0050	<0.0050	0.0035
Arsenic	mg/L	0.28	--	--	--	--	--	--	--	--	0.0027	0.0035	<0.0050	0.0026	--	--	--	--	0.0038	0.0054	<0.0050	0.0031	0.0029	<0.0050	<0.0050	0.0021
Barium	mg/L	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	mg/L	1.867	--	--	--	--	--	--	--	--	<0.00025	<0.00025	<0.00025	<0.00025	--	--	--	--	<0.00025	<0.00025	<0.00025	<0.00025	<0.00050	<0.00025	<0.00025	<0.00025
Cadmium	mg/L	0.290	--	--	--	--	--	--	--	--	<0.00025	0.00025	<0.0025	<0.00025	--	--	--	--	<0.00025	<0.00025	<0.0025	<0.00025	0.00037	<0.0025	<0.0025	<0.00050
Calcium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	270	--	--	--	--	--	--	--	240	--	--	--	280
Chromium	mg/L	NA	--	--	--	--	--	--	--	--	0.0016	0.00059	<0.00050	<0.00050	--	--	--	--	0.0011	0.00096	<0.00050	<0.00050	0.0010	<0.0050	<0.0050	<0.0010
Copper	mg/L	0.08588	--	--	--	--	--	--	--	--	0.0014	0.0031	0.0014	0.00081	--	--	--	--	0.0016	0.0019	0.0016	0.00097	0.0026	0.0017	0.0019	0.0011
Iron	mg/L	NA	--	--	--	--	--	--	--	--	<0.30	<1.5	<0.30	<0.30	--	--	--	--	<0.30	<0.30	<0.30	<0.30	<1.5	<0.30	<0.30	<0.30
Lead	mg/L	0.5927	--	--	--	--	--	--	--	--	<0.00050	<0.00050	<0.0050	<0.00050	--	--	--	--	0.00068	0.0033	<0.0050	<0.00050	0.0011	<0.0050	<0.0050	<0.00050
Magnesium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	42	--	--	--	--	--	--	--	45	--	--	--	44
Manganese	mg/L	130.7	--	--	--	--	--	--	--	--	0.11	0.038	0.11	0.085	--	--	--	--	0.022	0.025	0.020	0.016	0.030	0.073	0.062	0.0056
Mercury	mg/L	0.28	--	--	--	--	--	--	--	--	<0.0010	<0.0010	--	--	--	--	--	--	<0.0010	<0.0010	--	--	<0.0010	--	--	--
Nickel	mg/L	13.436	--	--	--	--	--	--	--	--	0.011	0.014	0.017	0.0078	--	--	--	--	0.0092	0.0062	0.012	0.0070	0.015	0.0096	0.0099	0.0081
Potassium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	mg/L	4.667	--	--	--	--	--	--	--	--	0.0023	0.0013	<0.025	0.0012	--	--	--	--	0.0017	0.0013	<0.025	0.0011	0.0032	<0.025	<0.025	0.0015
Silver	mg/L	0.0349	--	--	--	--	--	--	--	--	<0.00050	<0.00050	<0.0050	<0.00050	--	--	--	--	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	<0.0050	<0.0050	<0.0010
Sodium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	mg/L	0.075	--	--	--	--	--	--	--	--	<0.0050	<0.00050	<0.0050	<0.00050	--	--	--	--	<0.00050	<0.00050	<0.0050	<0.00050	<0.00050	<0.0050	<0.0050	<0.00050
Uranium	mg/L	2.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	mg/L	3.599	--	--	--	--	--	--	--	--	<0.040	<0.20	0.048	<0.040	--	--	--	--	<0.040	<0.040	<0.040	<0.040	<0.20	0.055	0.048	0.069
Total Metals																										
Aluminum	mg/L	NA	--	--	--	--	--	--	--	--	<2.0	<2.0	--	0.282	--	--	--	--	<2.0	<2.0	--	0.0896	<2.0	--	--	0.535
Antimony	mg/L	0.747	--	--	--	--	--	--	--	--	0.0010	0.0018	0.00065	0.00068	--	--	--	--	0.0028	0.0025	0.0020	0.0019	0.0036	0.0014	0.0014	0.0037
Arsenic	mg/L	0.28	--	--	--	--	--	--	--	--	<0.0050	0.0034	<0.0025	0.0029	--	--	--	--	0.0052	0.0037	0.0037	0.0022	0.0014	<0.0025	<0.0025	0.0024
Barium	mg/L	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	mg/L	1.867	--	--	--	--	--	--	--	--	<0.0025	<0.00025	<0.00025	<0.0013	--	--	--	--	<0.00025	<0.00025	<0.00025	<0.00025	<0.00025	<0.0013	<0.0013	<0.00025
Cadmium	mg/L	0.7	--	--	--	--	--	--	--	--	<0.00025	0.00031	<0.00025	<0.00025	--	--	--	--	<0.00025	<0.00025	<0.00025	<0.00025	0.00036	<0.00025	<0.00025	<0.00025
Calcium	mg/L	NA	--	--	--	--	--	--	--	--	300	320	280	300	--	--	--	--	270	150	260	250	340	340	290	300
Chromium	mg/L	NA	--	--	--	--	--	--	--	--	0.00099	0.0077	<0.0025	0.0027	--	--	--	--	0.0012	0.0065	<0.0025	0.0026	0.0067	0.0034	<0.0025	0.0040
Copper	mg/L	1.3	--	--	--	--	--	--	--	--	<0.0050	0.0097	0.0037	0.0060	--	--	--	--	<0.0050	0.0053	0.0065	0.0015	0.0061	<0.0025	<0.0025	0.0068
Iron	mg/L	NA	--	--	--	--	--	--	--	--	<0.30	0.78	<0.30	0.76	--	--	--	--	<0.30	<0.30	0.49	<0.30	<0.30	<0.30	<0.30	0.98
Lead	mg/L	0.015	--	--	--	--	--	--	--	--	<0.0050	0.020	0.0010	0.0048	--	--	--	--	<0.0050	0.0044	0.018	0.0012	0.0050	0.0017	0.0022	0.0035
Magnesium	mg/L	NA	--	--	--	--	--	--	--	--	44	48	39	45	--	--	--	--	51	30	50	49	54	43	44	48
Manganese	mg/L	130.7	--	--	--	--	--	--	--	--	0.057	0.12	0.11	0.14	--	--	--	--	0.024	0.072	0.17	0.023	0.081	0.051	0.062	0.078
Mercury	mg/L	0.28	--	--	--	--	--	--	--	--	<0.0010	<0.0010	<0.0010	<0.0010	--	--	--	--	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Nickel	mg/L	28	--	--	--	--	--	--	--	--	0.018	0.019	0.011	0.0082	--	--	--	--	0.016	0.012	0.010	0.0078	0.019	0.011	0.011	0.010
Potassium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	mg/L	4.667	--	--	--	--	--	--	--	--	0.0017	0.0013	0.0012	0.0010	--	--	--	--	0.0014	0.00079	0.00080	0.00075	0.0021	0.0012	0.0010	0.0019
Silver	mg/L	4.667	--	--	--	--	--	--	--	--	<0.00050	<0.00050	<0.00050	<0.00050	--	--	--	--	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Sodium	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	mg/L	0.075	--	--	--	--	--	--	--	--	<0.0050	<0.00050	<0.00050	<0.00050	--	--	--	--	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Uranium	mg/L	2.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	mg/L	280	--	--	--	--	--	--	--	--	<0.040	0.049	0.048	<0.040	--	--	--	--	<0.040	<0.040	<0.040	<0.040	0.093	0.042	0.048	0.088
Inorganics																										
Nitrogen, Nitrate (as N)	mg/L	3733	--	--	--	--	--	--	--	--	--	--	--	<0.50	--	--	--	--	--	--	--	<0.50	--	--	--	0.52
Nitrogen, Nitrite (as N)	mg/L	233	--	--	--	--	--	--	--	--	--	--	--	<0.10	--	--	--	--	--	--	--	<0.10	--	--	--	<0.10
Hardness , Ca/Mg (as $CaCO_3$)	mg/L	NA	--	--	--	--	--	--	--	--	930	990	860	850	--	--	--	--	880	500	860	790	1100	1000	900	880
TSS (residue, non-filterable)	mg/L	NA	--	--	--	--	--	--	--	--	<10	18	<10	39	--	--	--	--	<10	<10	14	<10	<10	<10	<10	33
TDS (residue, filterable)	mg/L	NA	--	--	--	--	--	--	--	--	--	--	--	1400	--	--	--	--	--	--	--	1300	--	--	--	1400

Notes:

Bold *indicates concentration above SWQS (Surface Water Quality Standard)*

[1] *Dissolved metals SWQSs: Aquatic and Wildlife ephemeral (A&We) use. Hardness based standards (for dissolved cadmium copper, lead, nickel, silver, and zinc)are based on 400 mg/L hardness of the sample.*

[2] *Partial Body Contact (PBC) standard applies to total metals*

$CaCO_3$ = calcium carbonate

µS/cm = microsiemens per centimeter

SU = standard units

°C = degrees Celsius

gpm = gallons per minute

mg/L = milligrams per Liter

TDS = total dissolved solids

TSS = total suspended solids

NA = no applicable standard

-- indicates no data available

TABLE 6
MW-3 Groundwater Quality

Analyte	Units	AWQS (mg/L)	2/7/2017	3/14/2017	4/19/2017
Field Parameters					
Conductivity	µS/cm	NA	2960	3191	3287
pH	SU	NA	7.98	7.09	6.64
Temperature	°C	NA	19.8	19.7	19.6
Dissolved Metals					
Aluminum	mg/L	NA	<2.0	--	--
Antimony	mg/L	0.006	<0.00050	<0.00050	<0.00050
Arsenic	mg/L	0.05	0.0064	0.0087	0.0083
Barium	mg/L	2	0.027	0.022	0.022
Beryllium	mg/L	0.004	<0.00025	0.00043	0.00047
Cadmium	mg/L	0.005	**0.0051**	0.0044	0.0049
Calcium	mg/L	NA	570	--	--
Chromium	mg/L	0.1	0.00053	<0.0050	0.0018
Copper	mg/L	NA	0.00080	--	--
Iron	mg/L	NA	<0.30	--	--
Lead	mg/L	0.05	<0.0050	<0.00050	<0.00050
Magnesium	mg/L	NA	210	--	--
Manganese	mg/L	NA	24	--	--
Mercury	mg/L	0.002	<0.000094	<0.000094	<0.000094
Nickel	mg/L	0.1	0.070	0.071	0.065
Selenium	mg/L	0.05	0.0021	0.0065	0.0023
Silver	mg/L	NA	<0.00050	--	--
Thallium	mg/L	0.002	<0.0050	<0.00050	<0.00050
Zinc	mg/L	NA	4.7	--	--
Total Metals					
Aluminum	mg/L		<2.0	--	--
Antimony	mg/L		<0.00050	<0.00050	<0.00050
Arsenic	mg/L		0.0061	0.0068	0.0078
Barium	mg/L		0.033	0.026	0.036
Beryllium	mg/L		0.00066	0.00052	0.00048
Cadmium	mg/L		0.0065	0.0042	0.0054
Calcium	mg/L		580	520	510
Chromium	mg/L		0.0016	0.0066	<0.0050
Copper	mg/L		0.0011	--	--
Iron	mg/L		1.8	--	--
Lead	mg/L		0.00059	0.0027	0.0062
Magnesium	mg/L		220	200	230
Manganese	mg/L		24	--	--
Mercury	mg/L		<0.00094	<0.000094	<0.000094
Nickel	mg/L		0.059	0.08	0.083
Selenium	mg/L		0.0021	0.0046	0.00091
Silver	mg/L		<0.00050	--	--
Thallium	mg/L		<0.00050	<0.00050	<0.00050
Zinc	mg/L		5.8	--	--
Inorganics					
Hardness, Ca/Mg (as $CaCO_3$)	mg/L	NA	2300	--	--
Nitrogen, Nitrate (as N)	mg/L	10	<0.50	<0.50	<0.50
Nitrogen, Nitrite (as N)	mg/L	1	<0.10	<0.10	<0.10
TDS (residue, filterable)	mg/L	NA	3300	--	--
TSS (residue, non-filterable)	mg/L	NA	<10	--	--
Anions					
Cyanide	mg/L	0.2	<0.10	<0.10	<0.10
Fluoride	mg/L	4	0.80	0.85	0.78
Sulfate	mg/L	NA	--	2100	2100
Radionuclides					
Uranium-234	µg/L	NA	0.00015 ± 0.00004	--	--
Uranium-235	µg/L	NA	0.010 ± 0.001	--	--
Uranium-238	µg/L	NA	1.4 ± 0.5	--	--
Uranium Activity (U^{234}, U^{235}, U^{238})	pCi/L	NA	1.4 ± 0.5	--	--
Radium-226	pCi/L	NA	0.7 ± 0.2	<0.3	<0.5
Radium-228	pCi/L	NA	<0.6	<0.6	<0.6
Total Radium Activity	pCi/L	5	0.7 ± 0.2	<0.6	<0.6
Gross Alpha Activity	pCi/L	15	--	3.3 ± 1.2	4.8 ± 1.5

Notes:

Bold *indicates concentration above AWQS (Aquifer Water Quality Standard)*

$CaCO_3$ = calcium carbonate

°C = degrees Celsius

mg/L = milligrams per Liter

NA = no applicable standard

SU = standard units

TDS = total dissolved solids

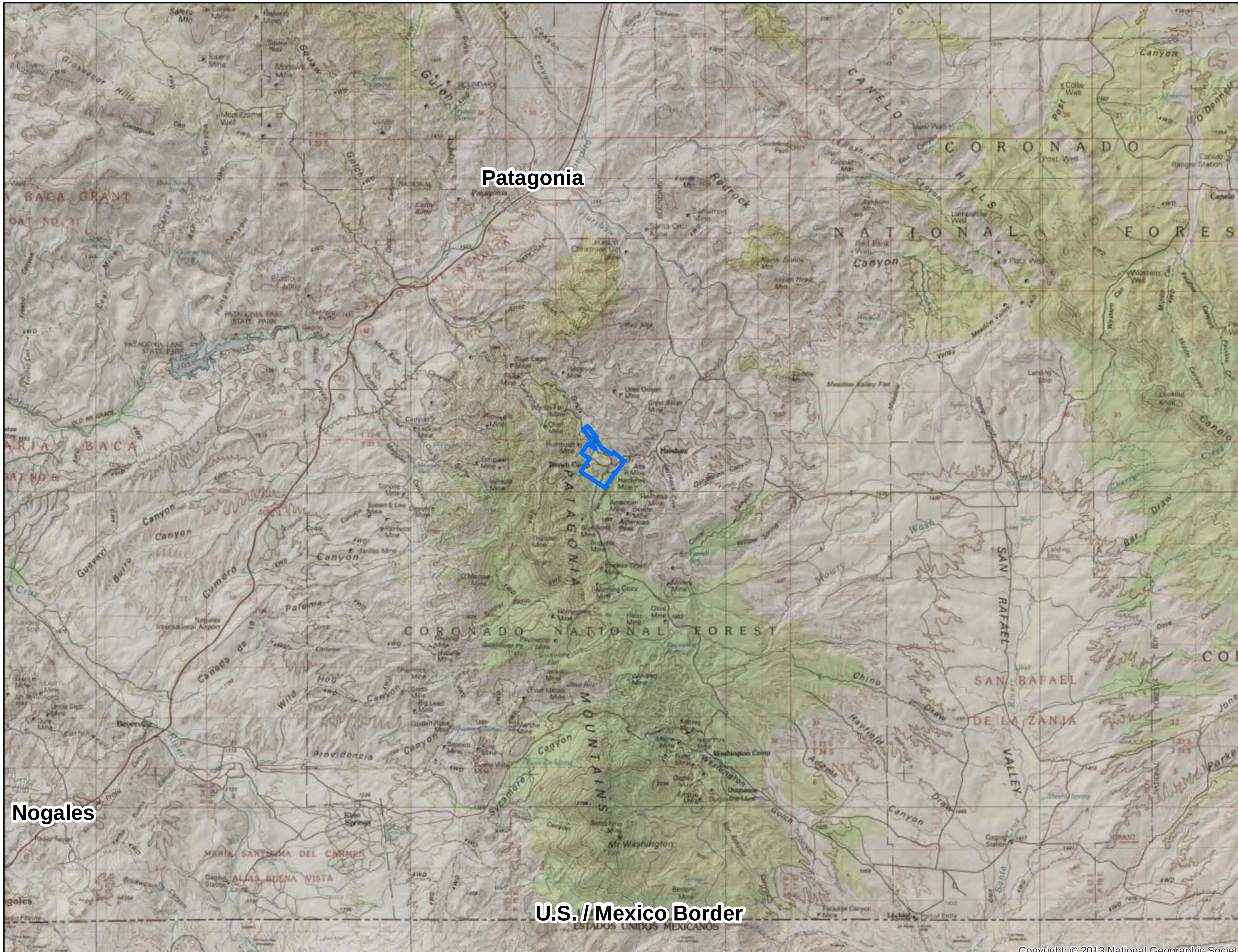
TSS = total suspended solids

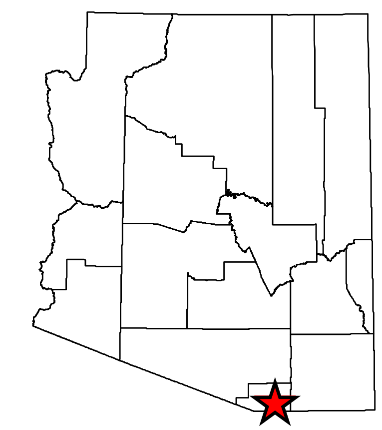
µS/cm = microsiemens per centimeter

-- indicates no data available

CLEAR CREEK ASSOCIATES

FIGURES





Legend

Project Area

0 1 2 4

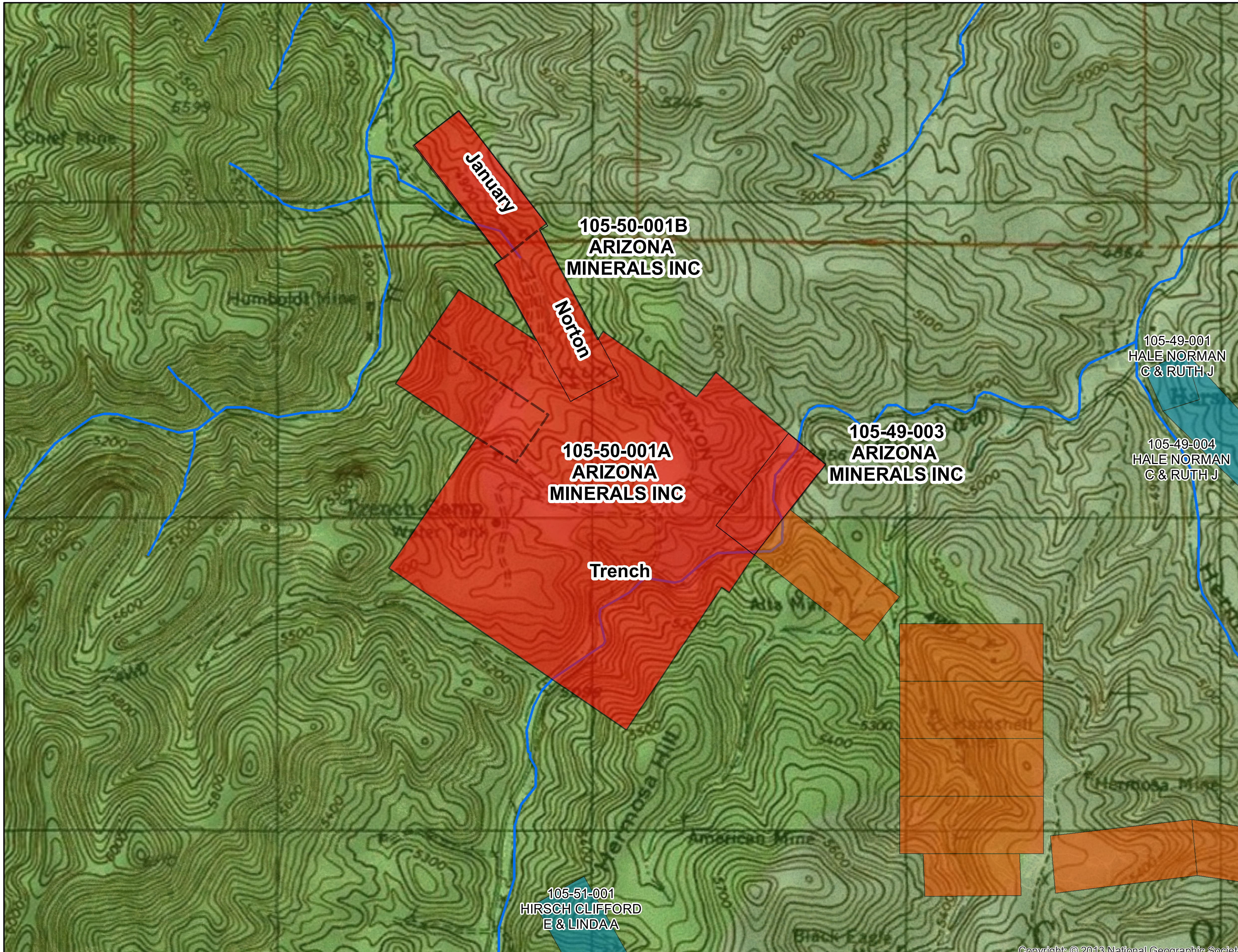
Miles

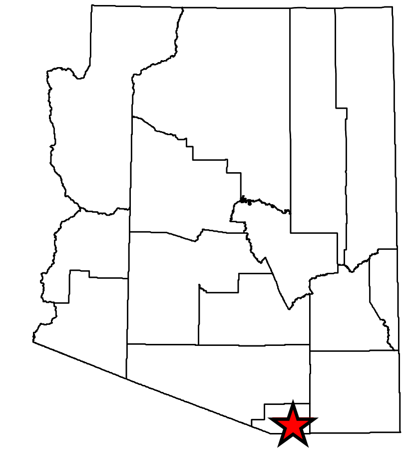
Projection: UTM Zone 12N NAD83

Date	File ID
5/10/17	AZM-019

CLEAR CREEK ASSOCIATES

FIGURE 1
Project Location





Legend

- January / Norton / Trench Claims
- Other Arizona Minerals Inc. Properties
- USFS - Coronado National Forest

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

0 500 1,000 2,000

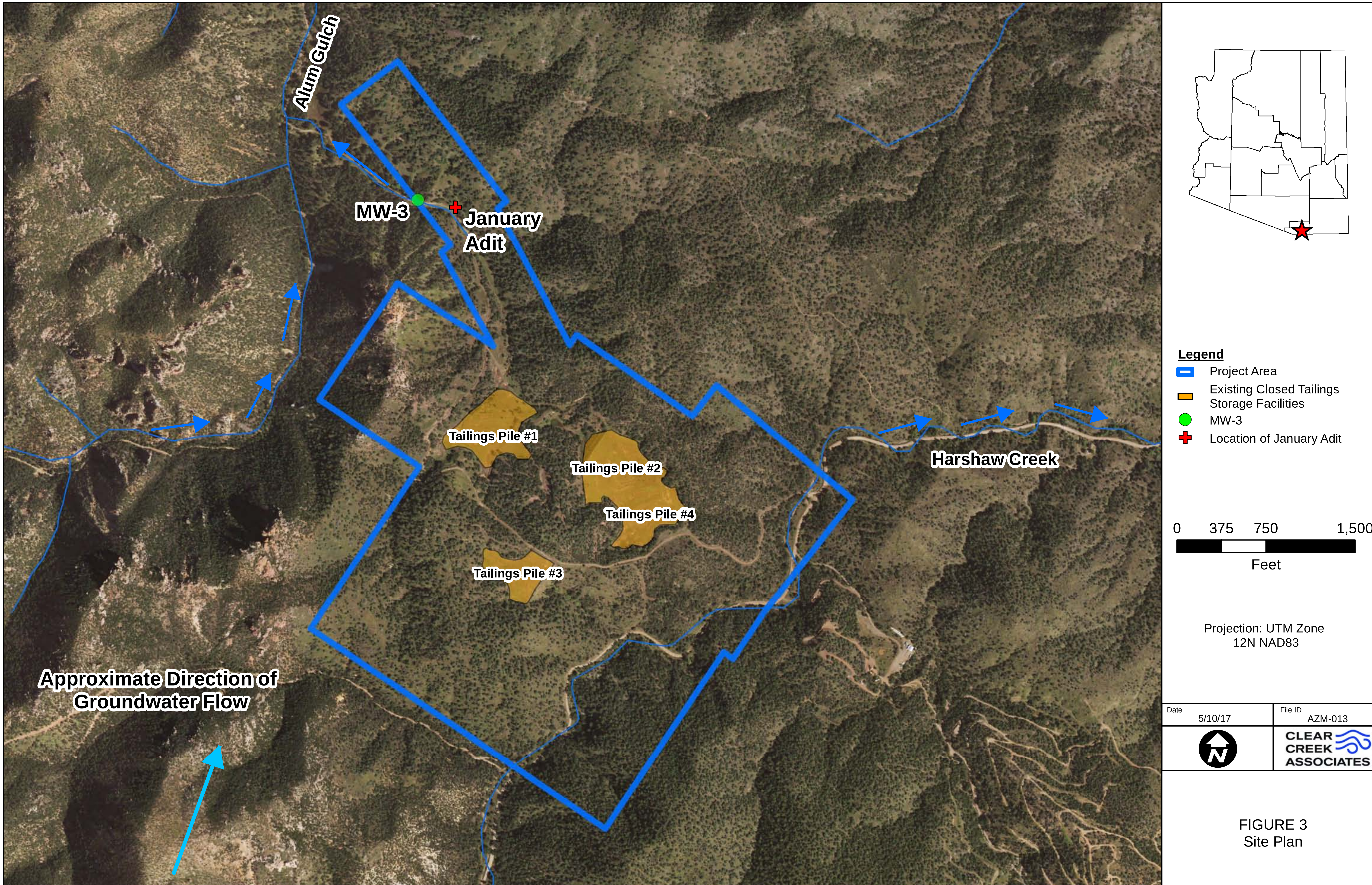
Feet

Projection: UTM Zone 12N NAD83

Date	File ID
5/30/17	AZM-014

CLEAR CREEK ASSOCIATES

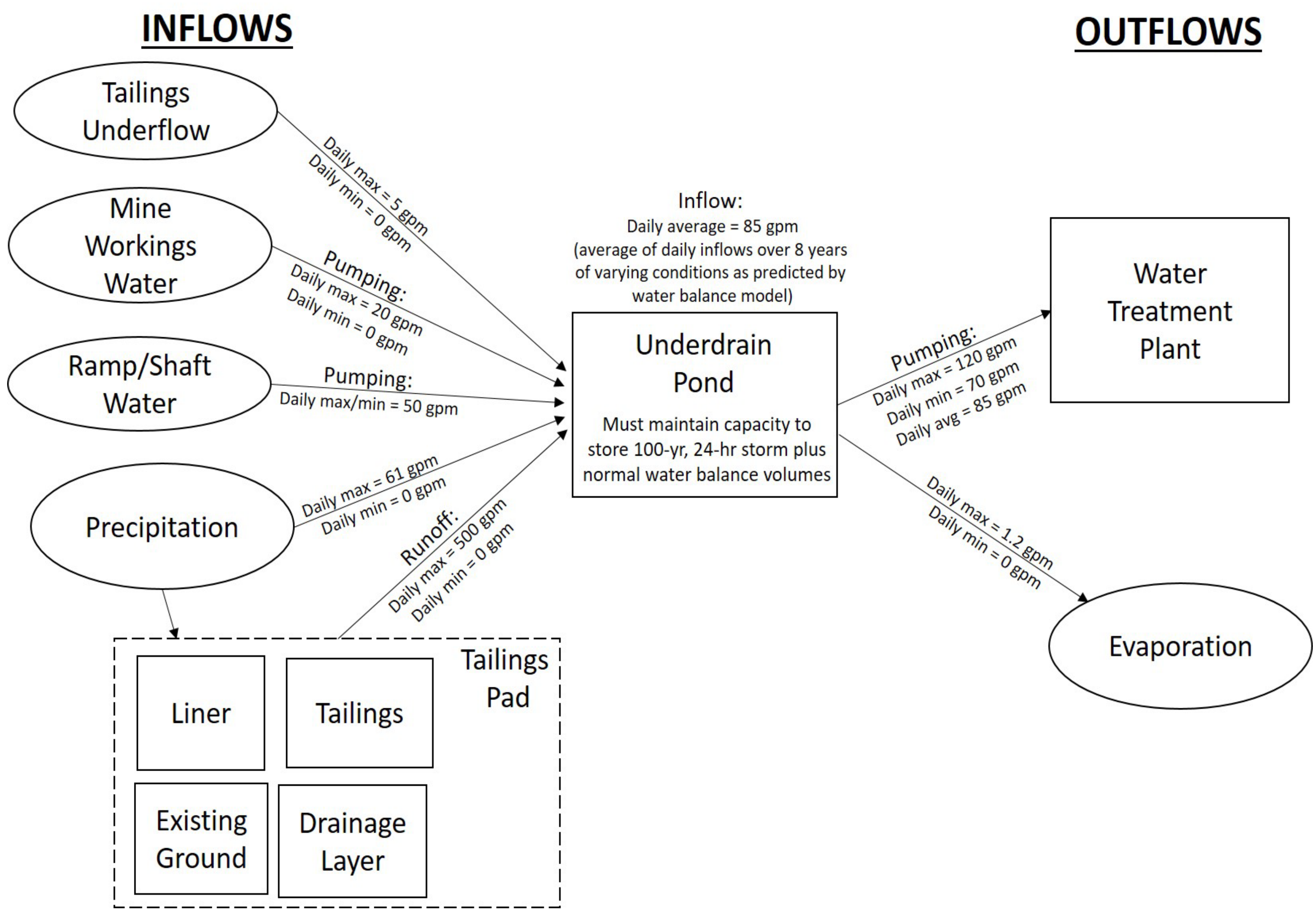
FIGURE 2
Land Ownership



Date 5/10/17
File ID AZM-013

CLEAR CREEK ASSOCIATES

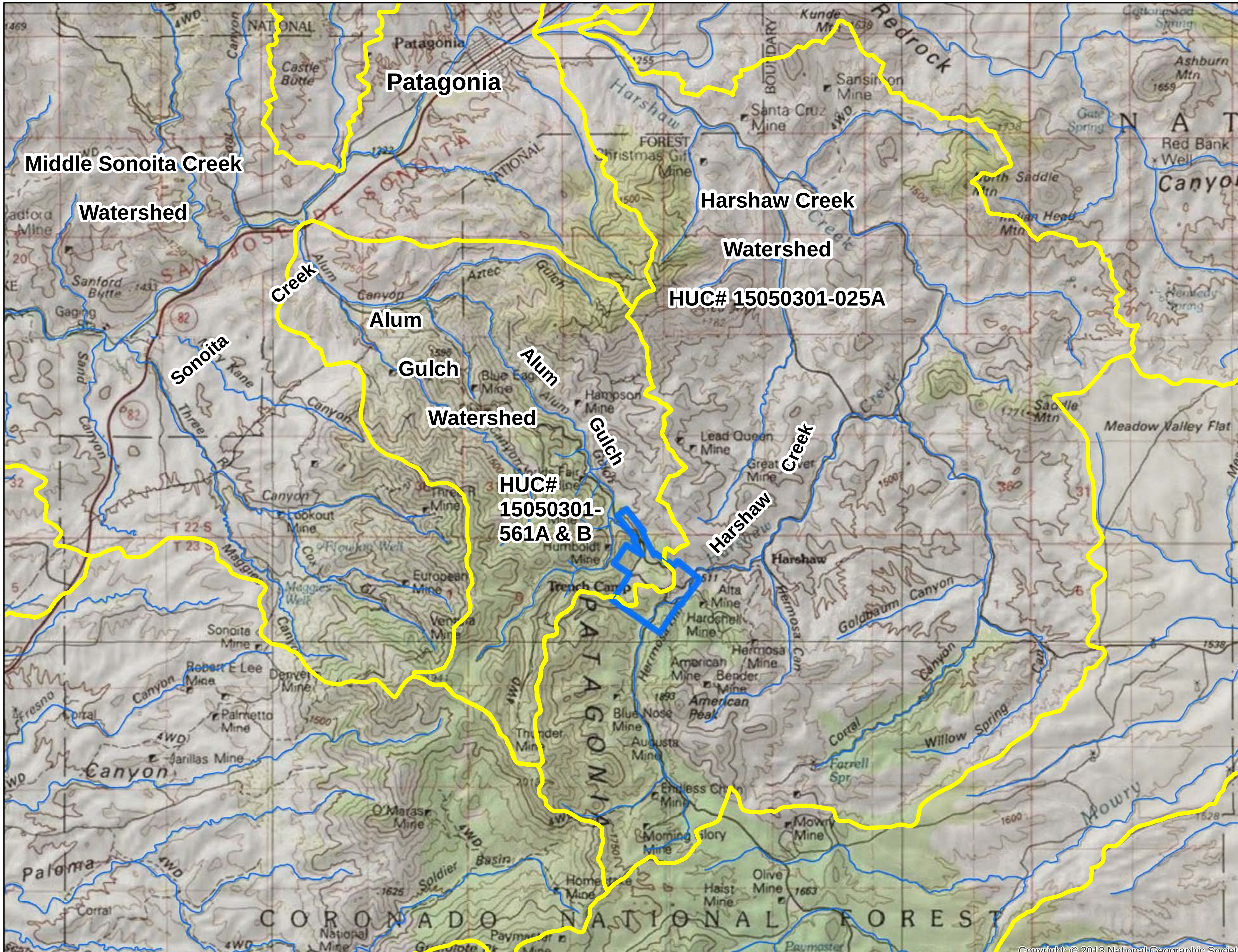
FIGURE 3
Site Plan



CLEAR CREEK ASSOCIATES

File ID	AZM-A002
Date	5/22/17

FIGURE 4
Process Flows



Legend

- Project Area
- Stream / River Channels
- Watershed Divide

Source: https://prd-tnm.s3.amazonaws.com/StagedProducts/Hydrography/NHD/HU8/HighResolution/Shape/NHD_H_15050301_Shape.zip

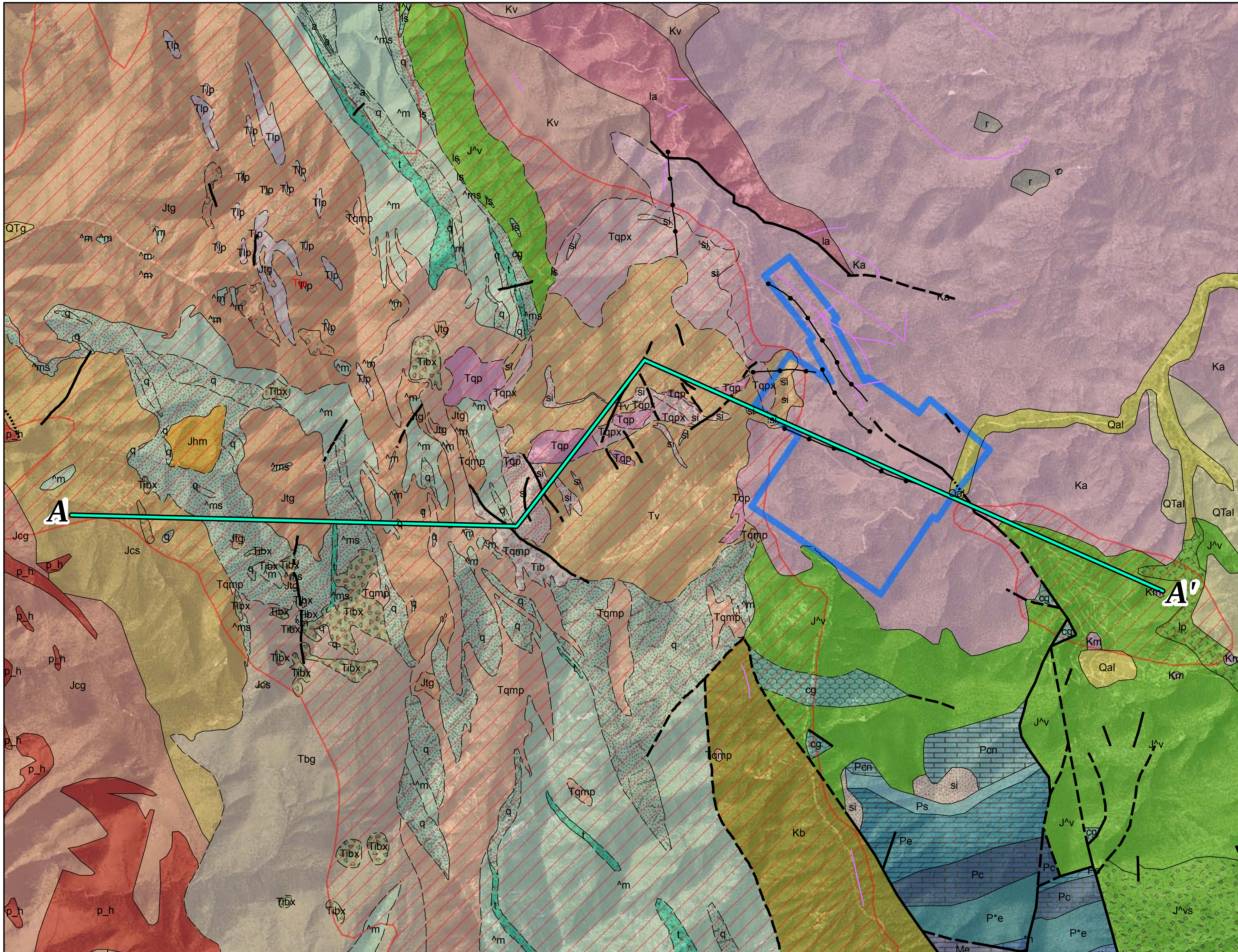
0 0.5 1 2
Miles

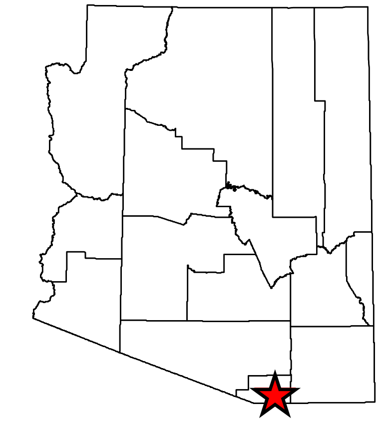
Projection: UTM Zone 12N NAD83

Date	File ID
5/22/17	AZM-012

CLEAR CREEK ASSOCIATES

FIGURE 5
Watershed Boundaries





Legend

- Project Area
- Geologic Cross Section Line

0 1,000 2,000 4,000

Feet

Projection: UTM Zone 12N NAD83

Source: 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, https://dx.doi.org/10.3133/ofr20151023. ISSN 2331-1258 (online)

Date	File ID
5/22/17	AZM-023

N

CLEAR CREEK ASSOCIATES

FIGURE 6
Geologic Map

Legend

Project Area

Contacts, faults, folds, and linear units

- linear units
- contact, certain
- contact, dashed where approximately located
- contact, dotted where concealed
- fault, certain
- fault, dashed where approximately located
- fault, dotted where concealed
- thrust fault, certain
- anticline
- vein
- Extent of mapped area

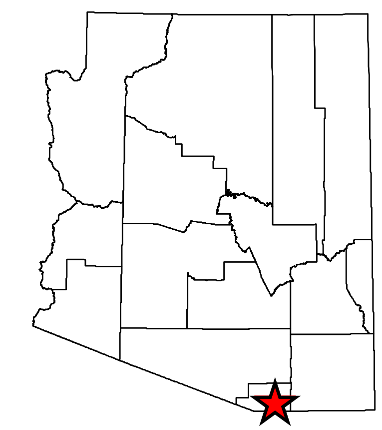
Shear zones

Pyrite zones

Map units

Symbol, Unit name

- Qal—Younger alluvium and talus
- QTal—Older alluvium
- QTg—Gravel and conglomerate
- Tl—Limestone
- Tt—Biotite rhyolite tuff
- si—Silicification
- Tv—Volcaniclastic rocks of middle Alum Gulch
- Tib—Intrusive breccia of middle Alum Gulch
- Tqp—Quartz feldspar porphyry of middle Alum Gulch
- Tqpx—Xenolithic quartz feldspar porphyry of middle Alum Gulch
- Tqmp—Quartz monzonite porphyry, in granodiorite of the Patagonia Mountains
- Tqmpb—Breccia, in quartz monzonite porphyry (unit Tqmp) of granodiorite of the Patagonia Mountains
- Tg—Granodiorite, in granodiorite of the Patagonia Mountains
- Tgb—Breccia, in granodiorite (unit Tg) of granodiorite of the Patagonia Mountains
- Tlp—Latite porphyry, in granodiorite of the Patagonia Mountains
- Tbq—Biotite quartz monzonite, in granodiorite of the Patagonia Mountains
- Tbqb—Breccia, in biotite quartz monzonite (unit Tbq) of granodiorite of the Patagonia Mountains
- Tbg—Biotite granodiorite, in granodiorite of the Patagonia Mountains
- Tibx—Intrusion breccia, in granodiorite of the Patagonia Mountains
- Tsy—Syenodiorite or mangerite, in granodiorite of the Patagonia Mountains
- Tag—Biotite augite quartz diorite, in granodiorite of the Patagonia Mountains
- Tmp—Quartz monzonite porphyry of Red Mountain
- TKr—Rhyolite of Red Mountain
- TKggt—Gringo Gulch Volcanics
- Ka—Trachyandesite
- r—Rhyolite or latite, in trachyandesite (unit Ka)
- Km—Pyroxene monzonite
- Kl—Biotite quartz latite(?)
- Kv—Silicic volcanics
- la—Biotite latite(?), in silicic volcanics (unit Kv)
- Kpg—Porphyritic biotite granodiorite
- Kb—Bisbee Formation
- Kbc—Conglomerate, in Bisbee Formation (unit Kb)
- Jtg—Granite of Three R Canyon, in granite of Cumero Canyon
- Jtgb—Breccia, in granite of Three R Canyon (unit Jtg) of granite of Cumero Canyon
- Jcm—Porphyritic granite, in granite of Cumero Canyon
- Jcs—Equigranular alkali syenite, in granite of Cumero Canyon
- Jcsb—Breccia, in equigranular alkalik syenite (unit Jcs) of granite of Cumero Canyon
- Jcg—Equigranular granite, in granite of Cumero Canyon
- Jcgb—Breccia, in equigranular granite (unit Jcg) of granite of Cumero Canyon
- Jhm—Hornblende monzonite of European Canyon
- JTRv—Volcanic rocks, in silicic volcanic rocks
- ha—Hornblende andesite dike and (or) plug, in volcanic rocks (unit JTRv)
- b—Volcanic breccia, in volcanic rocks (unit JTRv)
- s—Sedimentary rocks, in volcanic rocks (unit JTRv)
- cg—Limestone conglomerate, in volcanic rocks (unit JTRv)
- qz—Quartzite, in volcanic rocks (unit JTRv)
- ls—Exotic blocks of upper Paleozoic limestone, in volcanic rocks (unit JTRv)
- w—Rhyolitic welded(?) tuff, in volcanic rocks (unit JTRv)
- lp—Latite(?) porphyry, in volcanic rocks (JTRv)
- JTRvs—Volcanic and sedimentary rocks, in silicic volcanic rocks
- TRm—Mount Wrightson Formation
- q—Quartzite, in Mount Wrightson Formation (unit TRm)
- a—Biotite(?)-albite andesite lava(?), in Mount Wrightson Formation (unit TRm)
- t—Coarse volcaniclastic beds, in Mount Wrightson Formation (unit TRm)
- TRms—Sedimentary rocks, in the Mount Wrightson Formation (unit TRm)
- Pcn—Concha Limestone
- Ps—Scherrer Formation
- Pe—Epitaph Dolomite
- Pc—Colina Limestone
- PPe—Earp Formation
- Ph—Horquilla Limestone
- Me—Escabrosa Limestone
- Dm—Martin Limestone
- Ca—Abrigo Limestone
- Cb—Bolsa Quartzite
- pCq—Biotite or biotite-hornblende quartz monzonite
- pCh—Hornblende-rich metamorphic and igneous rocks
- pCm—Biotite quartz monzonite
- pCd—Hornblende diorite

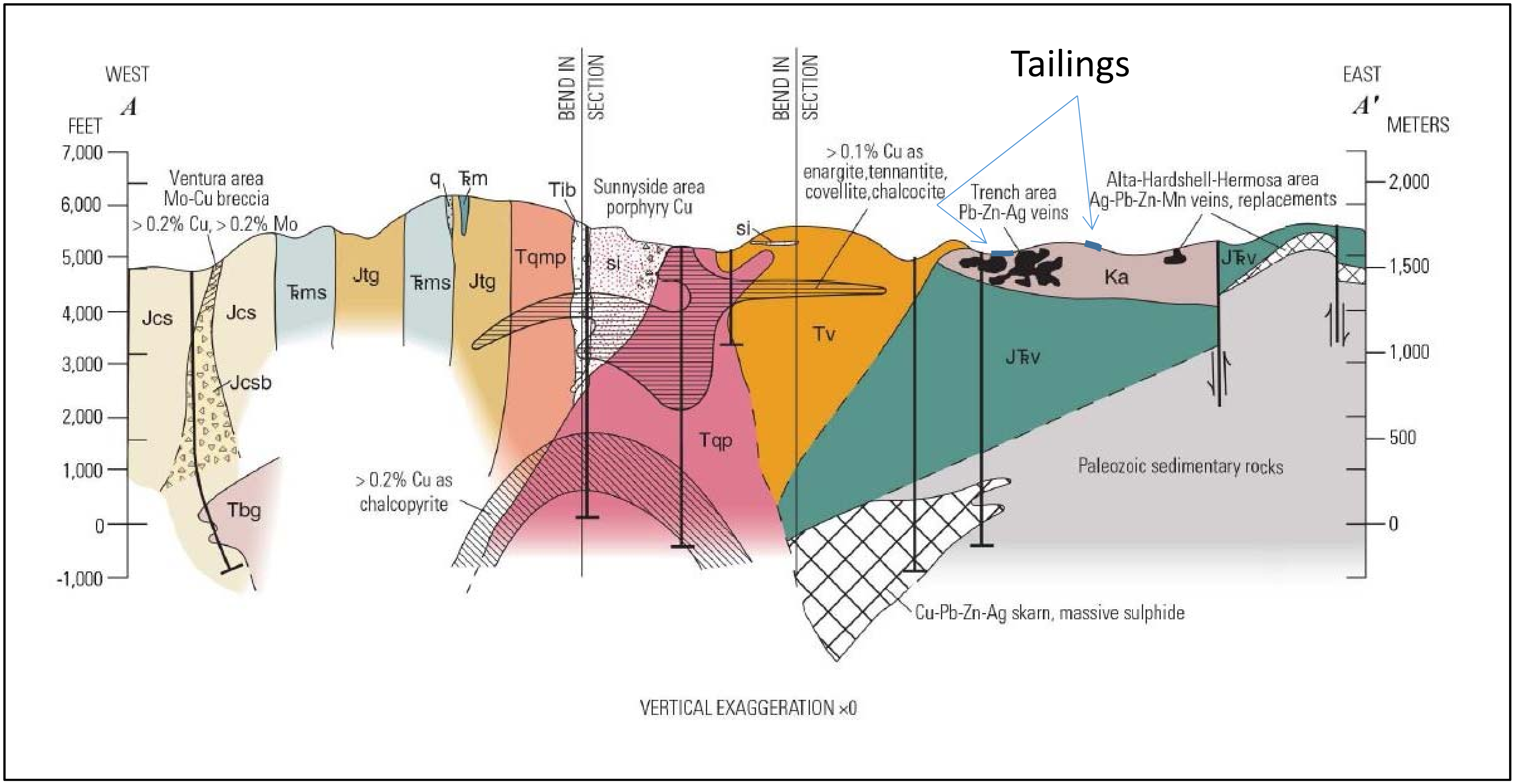


Source: Graybeal, F.T., Moyer, L.A., Vikre, P.G., Dunlap, P., and Wallis, J.C., 2015, Geologic map of the Patagonia Mountains, Santa Cruz County, Arizona: U.S. Geological Survey Open-File Report 2015–1023, 10 p., 1 sheet, scale 1:48,000, https://dx.doi.org/10.3133/ofr20151023.
ISSN 2331-1258 (online)

Date	File ID
5/22/17	AZM-023

CLEAR CREEK ASSOCIATES

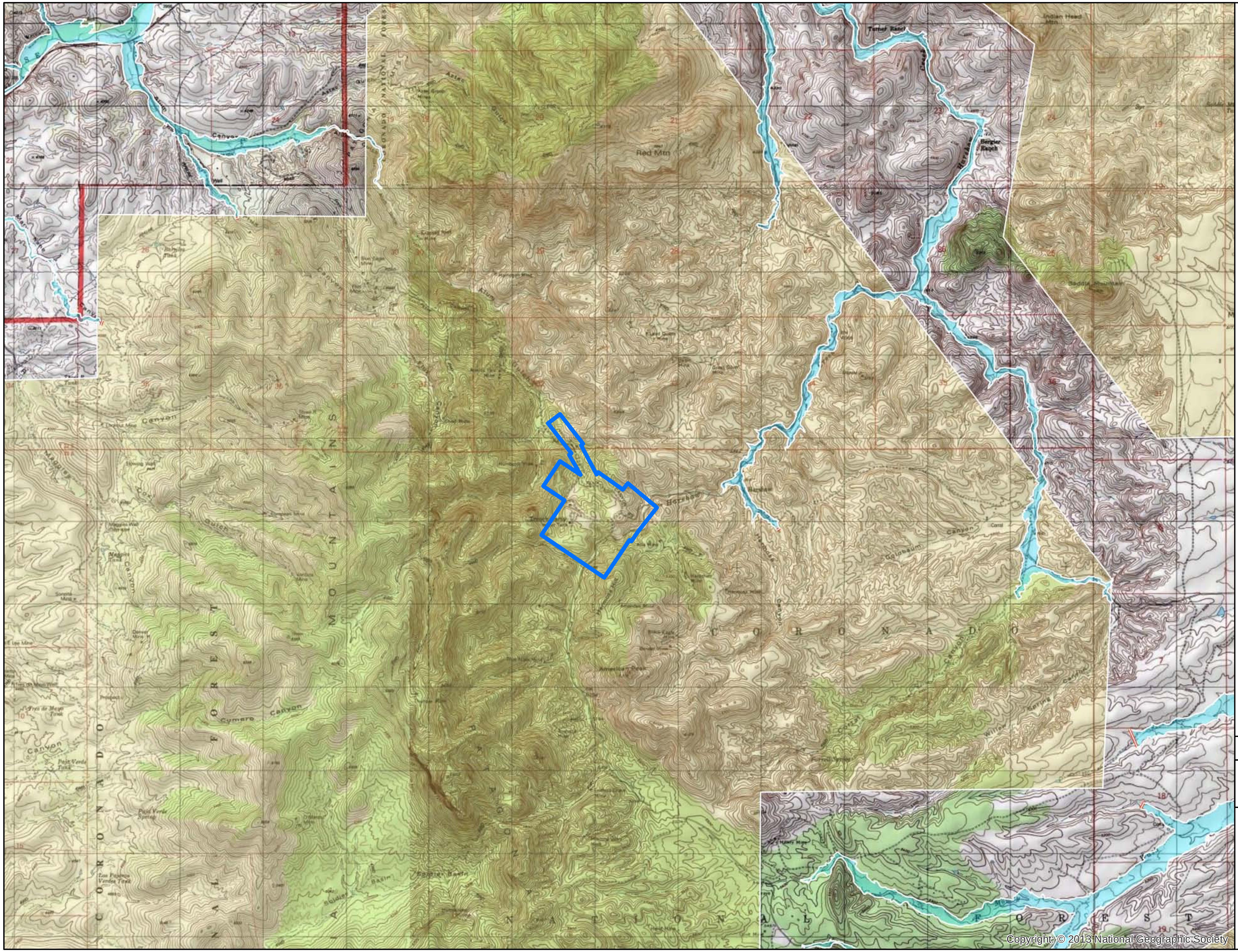
FIGURE 6
Legend

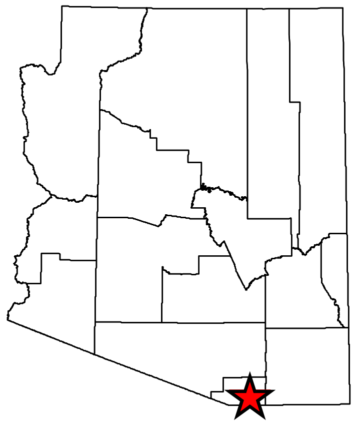


Source: Graybeal, F.T., Moyer, L.A., Vikre, P.G., Dunlap, P., and Wallis, J.C., 2015

CLEAR CREEK ASSOCIATES	
File ID	AZM-A003
Date	5/22/17

FIGURE 7
Cross Section A – A′





Legend

- Project
- 1% Annual Chance Flood Hazard
- Area Of Undetermined Flood Hazard

Source: FEMA 2011 FIRM Flood Insurance Rate Map
Map # 04023C0525C
http://hazards.fema.gov/gis/nfhl/services/public/NFHLWMS/MapServer/WMSServer

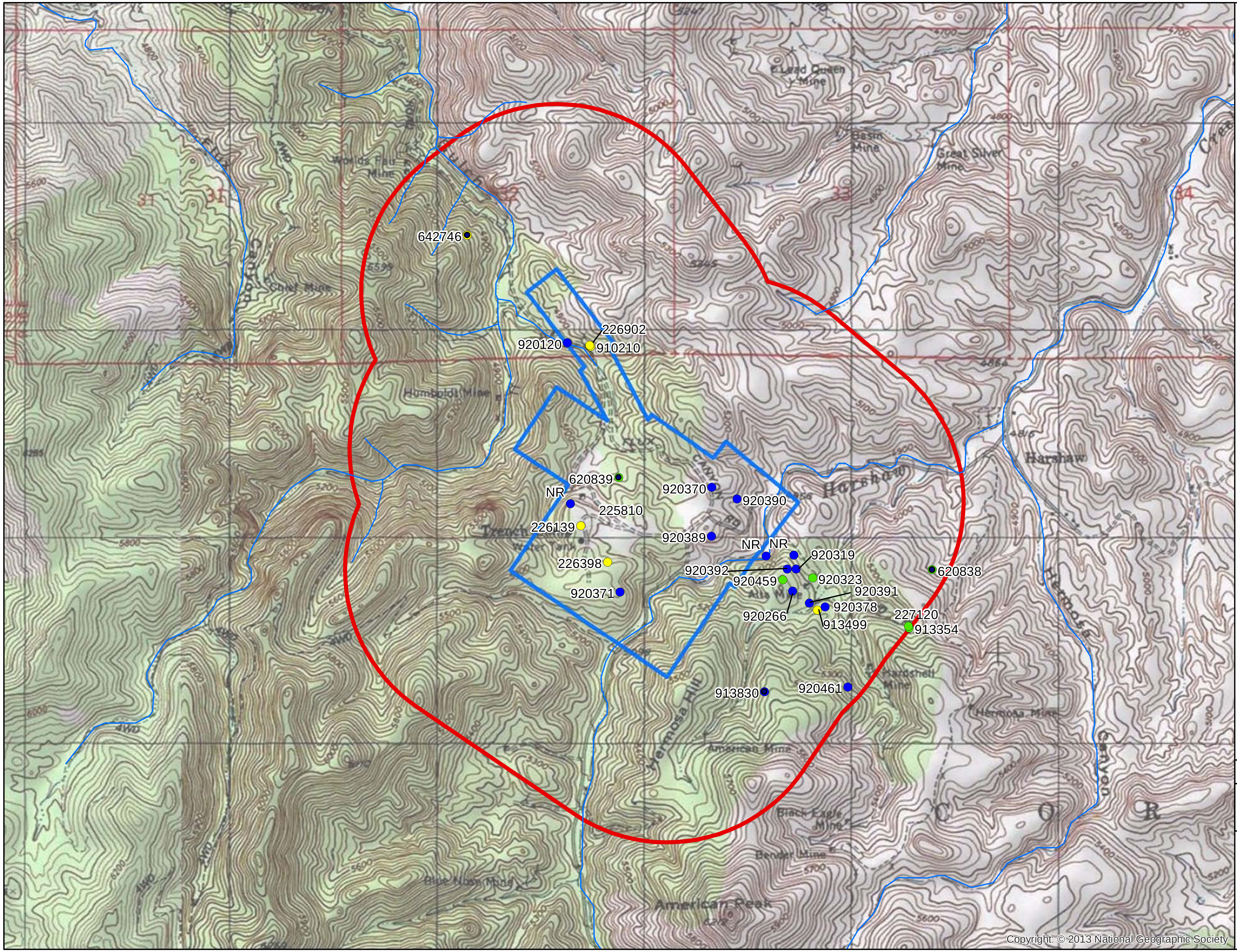
0 2,050 4,100 8,200
Feet

Projection: UTM Zone 12N NAD83

Date	File ID
5/22/17	AZM-017

CLEAR CREEK ASSOCIATES

FIGURE 8
FEMA Floodplain Map



Legend

- Project
- Half-Mile_Radius

Known Wells

- Exempt
- Non-Exempt
- Monitor

0 750 1,500 3,000

Feet

Projection: UTM Zone 12N NAD83

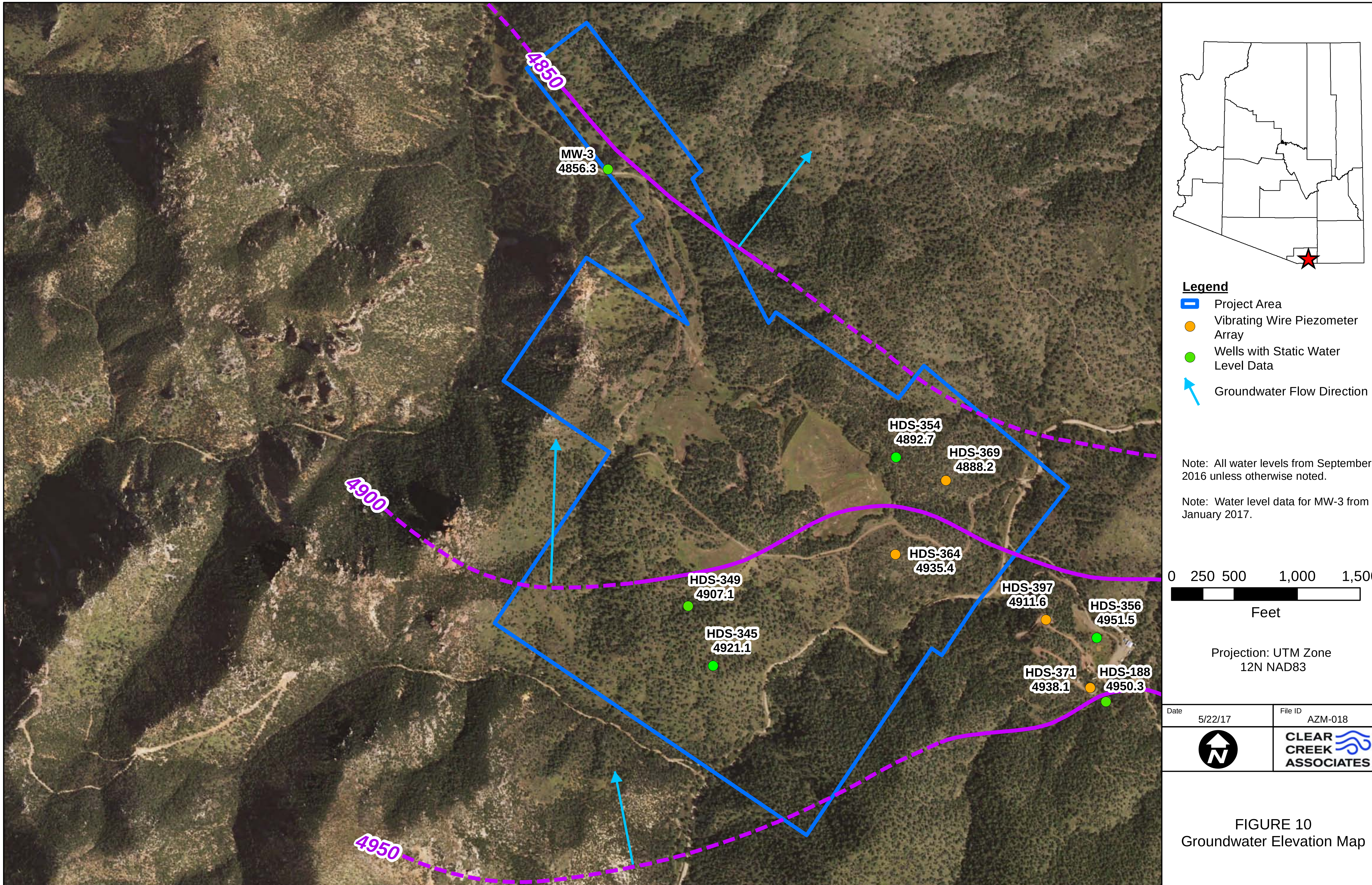
NOTES:

NR = No Registry ID

Date	File ID
5/22/17	AZM-031

CLEAR CREEK ASSOCIATES

FIGURE 9
Wells Within
1/2 Mile of Project Area



Note: All water levels from September 2016 unless otherwise noted.

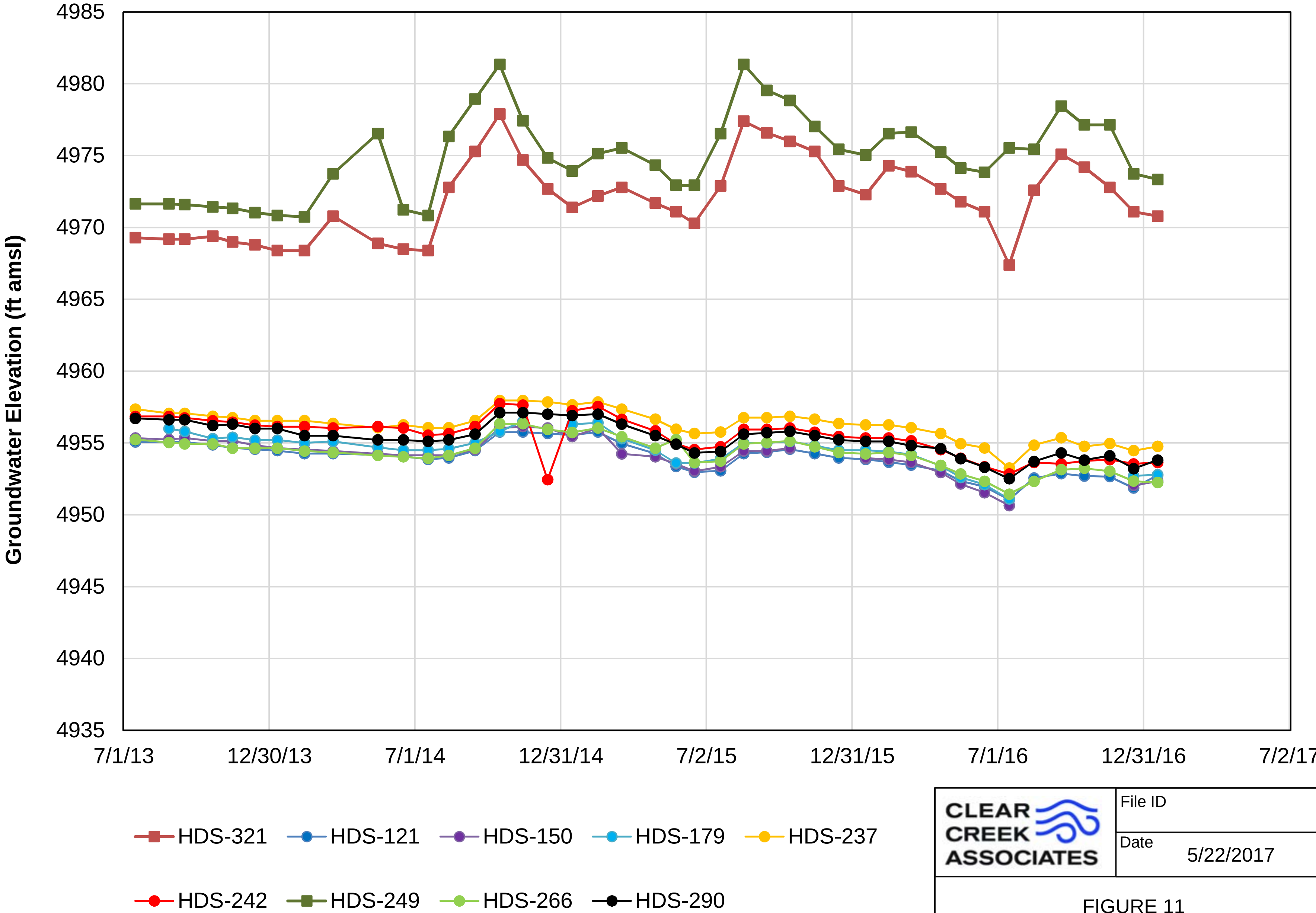
Note: Water level data for MW-3 from January 2017.

Projection: UTM Zone 12N NAD83

Date	File ID
5/22/17	AZM-018

CLEAR CREEK ASSOCIATES

FIGURE 10
Groundwater Elevation Map

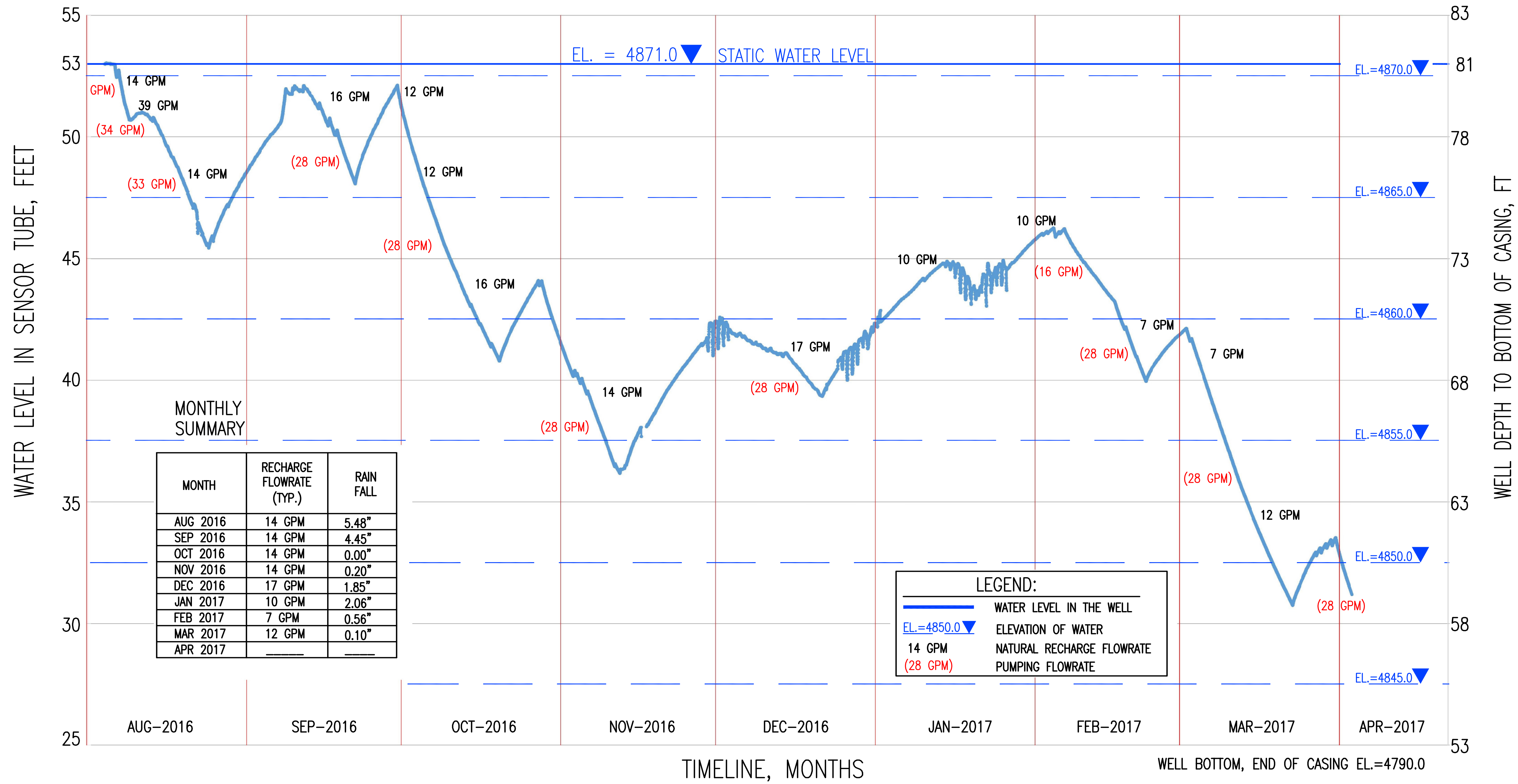


CLEAR CREEK ASSOCIATES

File ID	
Date	5/22/2017

FIGURE 11
HDS Boreholes Hydrograph

JANUARY MINE WORKINGS PUMPING AND RECHARGE SUMMARY FOR AUGUST 2016 – APRIL 2017



MONTHLY SUMMARY

MONTH	RECHARGE FLOWRATE (TYP.)	RAIN FALL
AUG 2016	14 GPM	5.48"
SEP 2016	14 GPM	4.45"
OCT 2016	14 GPM	0.00"
NOV 2016	14 GPM	0.20"
DEC 2016	17 GPM	1.85"
JAN 2017	10 GPM	2.06"
FEB 2017	7 GPM	0.56"
MAR 2017	12 GPM	0.10"
APR 2017	_____	_____

TOTAL WATER PUMPED OUT: 4,866,000 GALS (8/06/2016 to 3/31/2017)

04.21.2017

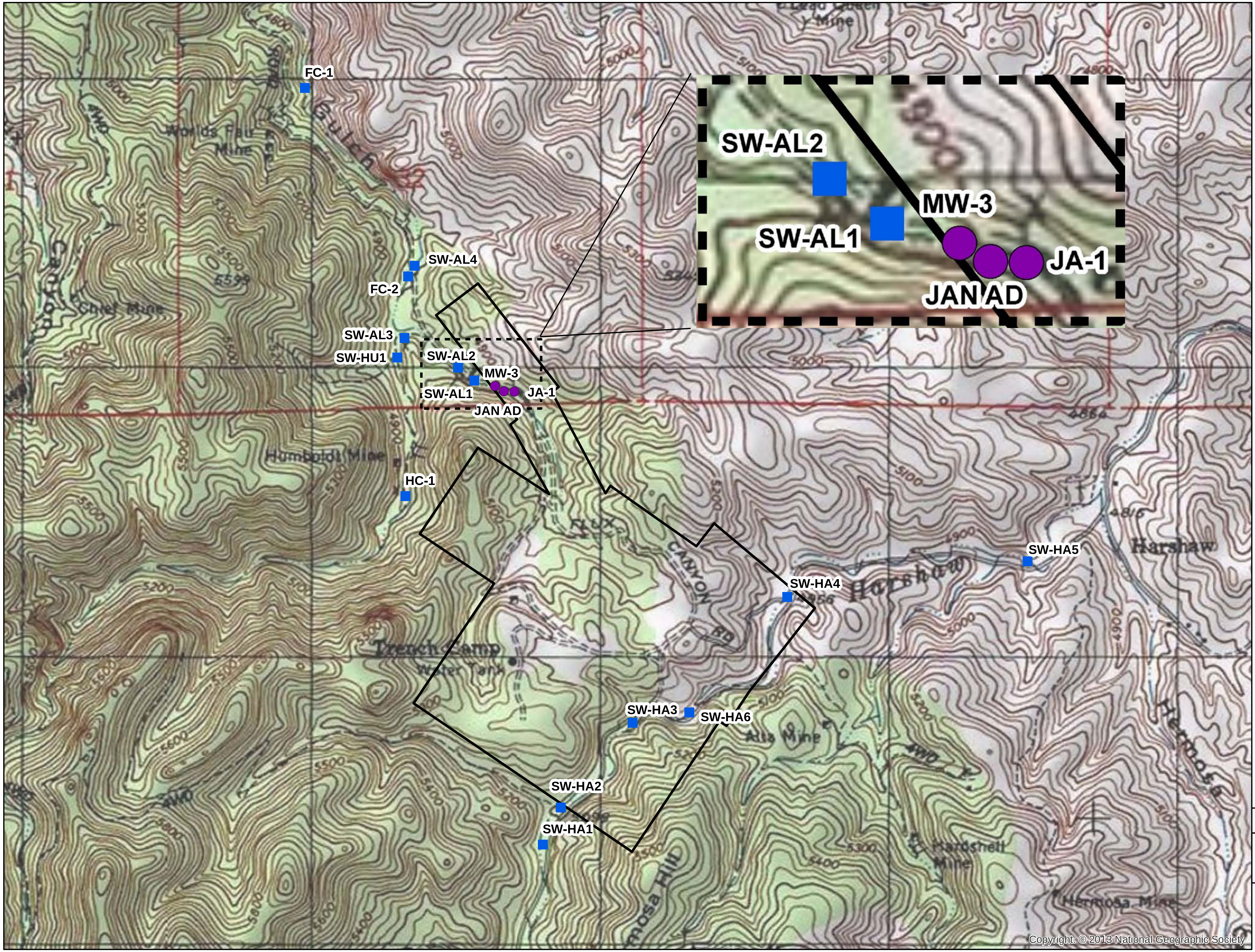
CLEAR CREEK ASSOCIATES

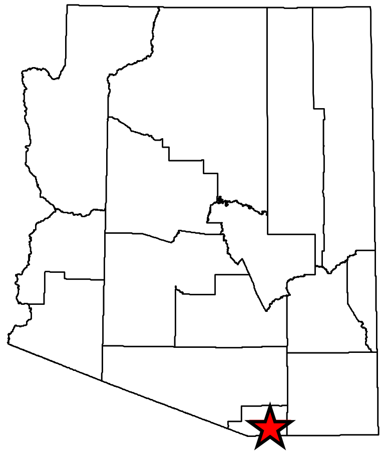
File ID AZM-A001

Date 5/22/17

FIGURE 12
January Mine Workings Pumping & Recharge Summary for August 2016 to April 2017

Drawing file: 08392550A002.dwg Jan 29, 2009 – 2:19pm



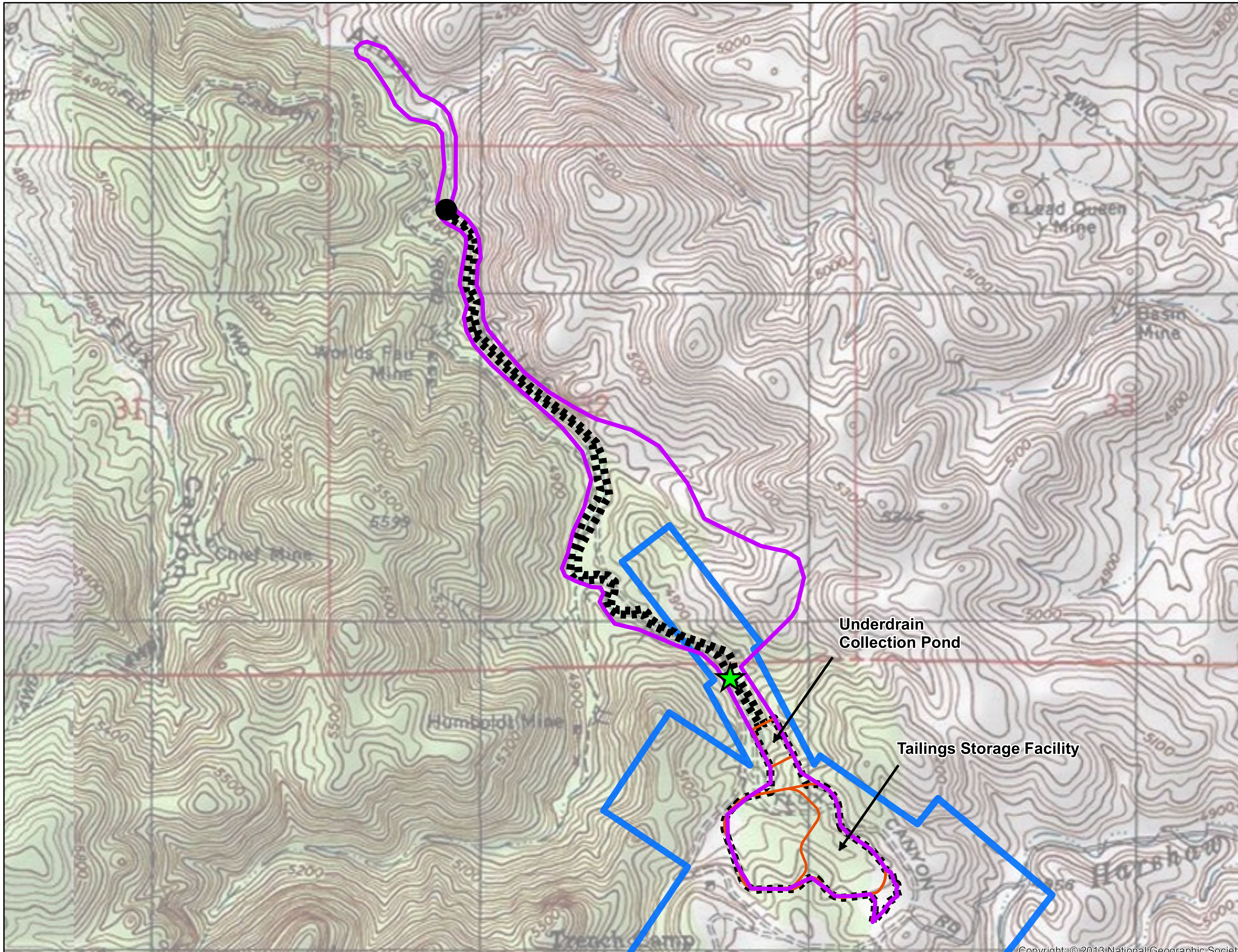


Date 5/22/17

File ID AZM-020

CLEAR CREEK ASSOCIATES

FIGURE 13
Water Monitoring Locations



Legend

- Discharge Impact Area
- Pollutant Management Area
- Point of Compliance
- WTP Discharge Point
- Mine Facility
- Property

0 750 1,500
Feet

Projection: UTM Zone 12N NAD83

Date	File ID
5/11/17	AZM-033

CLEAR CREEK ASSOCIATES

FIGURE 14
Pollution Management Area, Discharge Impact Area, and Point of Compliance (POC)

ATTACHMENT A

MATERIALS CHARACTERIZATION BY SCHAFER LIMITED LLC

Trench Camp Historic Tailings
Geochemistry and Material Characterization

Submitted to:
Arizona Minerals Inc.

Submitted by:
Schafer Limited LLC
Bozeman, MT

Schafer
limited

Date
April, 2017

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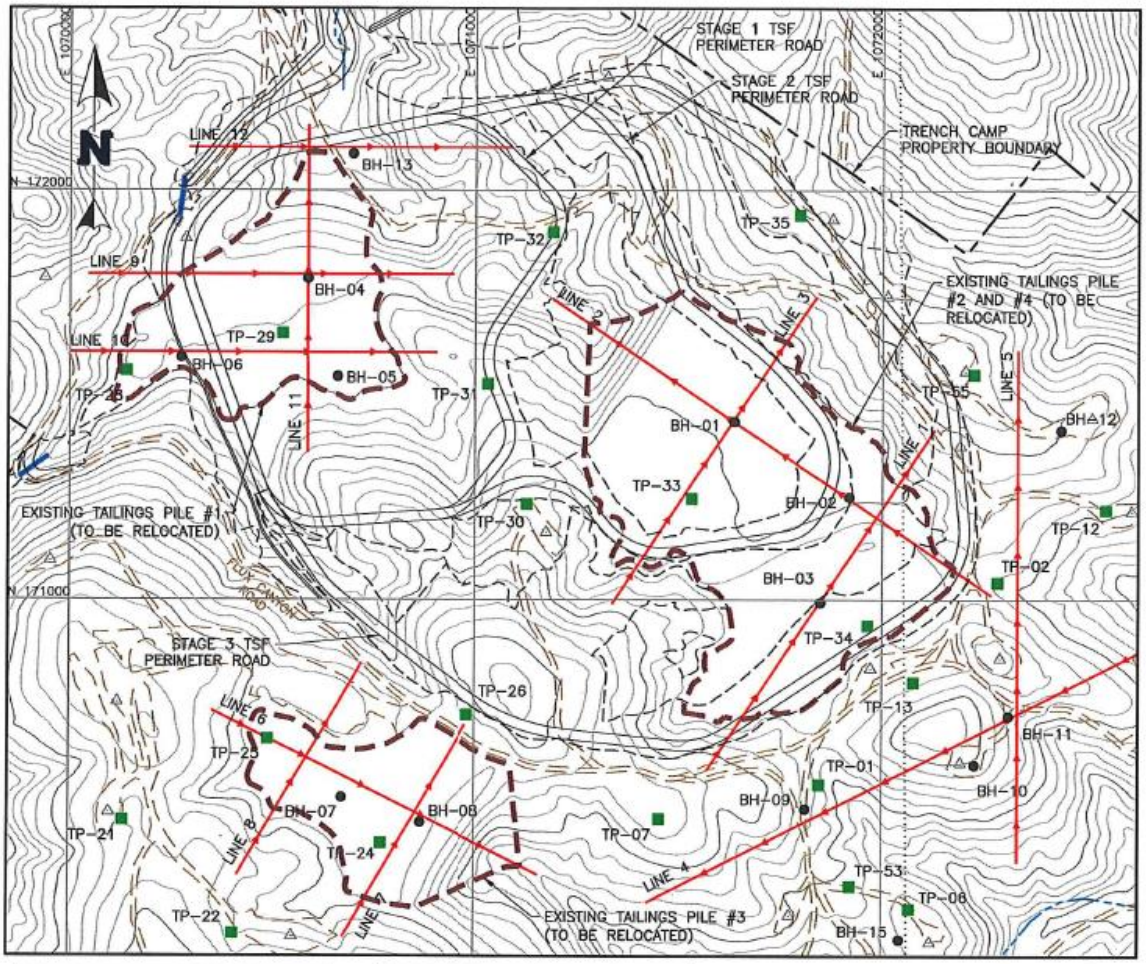
1.0 Material Characterization

1.1 Geochemical Characterization Plan

A range of geochemical tests (Table 1) was conducted on representative samples from the historic Trench Camp Tailings piles 1, 2/4 and 3 (Figure 1). Samples consisted of tailings, foundation soils underlying the unlined tailings, and waste rock material located near the base of tailings pile #1. In addition, samples of development rock that will be generated from an exploration decline and a shaft proposed as part of the Hermosa Taylor Deposit were also characterized.

Samples from the historic tailings are grouped into classes of similar materials (tailings, waste rock, and foundation soils) to facilitate test interpretation. Tests for metal solubility were conducted on composite samples. Three tailings composites included waste rock, shallow-oxidized, deeper-unoxidized and non acid-generating categories. The foundation layer soils underlying tailings were grouped by depth beneath base of the tailings (0-2 ft, 2-3 ft, 3-6 ft, and 8-20 ft). Drillhole samples were categorized into major rock units recognized in the Hermosa Taylor Deposit: Meadow Valley Volcanics, Hardshell Volcanics, Concha, Epitaph and Sherrer Formation.



TEST PIT LOCATIONS (JAN 2017)			
POINT	NORTHING	EASTING	ELEVATION
TP-01	170,548.03	1,071,846.74	5,114.72
TP-02	171,042.32	1,072,285.55	5,108.80
TP-06	170,244.73	1,072,068.89	5,094.13
TP-07	170,464.69	1,071,455.51	5,176.05
TP-12	171,219.43	1,072,550.65	5,106.08
TP-13	170,798.07	1,072,078.30	5,127.18
TP-21	170,461.94	1,070,133.19	5,230.00
TP-22	170,185.20	1,070,404.66	5,222.82
TP-24	170,405.67	1,070,766.81	5,185.94
TP-25	170,660.35	1,070,489.09	5,182.00
TP-26	170,718.48	1,070,981.20	5,188.99
TP-28	171,558.67	1,070,139.78	5,040.09
TP-29	171,650.11	1,070,522.92	5,041.43
TP-30	171,233.35	1,071,128.15	5,135.85
TP-31	171,526.23	1,071,031.00	5,085.63
TP-32	171,897.83	1,071,190.83	5,042.39
TP-33	171,247.24	1,071,534.42	5,102.44
TP-34	170,936.99	1,071,964.91	5,114.71
TP-35	171,939.49	1,071,797.34	5,166.58
TP-53	170,300.30	1,071,923.07	5,094.20
TP-55	171,549.36	1,072,226.65	5,168.14

BOREHOLE LOCATIONS (JAN 2017)			
POINT	NORTHING	EASTING	ELEVATION
BH-01	171,434.89	1,071,638.05	5,099.00
BH-02	171,251.10	1,071,918.68	5,098.30
BH-03	170,993.46	1,071,848.26	5,115.00
BH-04	171,783.52	1,070,582.77	5,038.76
BH-05	171,544.73	1,070,656.11	5,047.47
BH-06	171,591.49	1,070,273.94	5,041.04
BH-07	170,517.23	1,070,668.61	5,182.42
BH-08	170,456.57	1,070,864.19	5,187.44
BH-09	170,488.85	1,071,812.79	5,125.87
BH-10	170,596.56	1,072,228.21	5,146.81
BH-11	170,715.49	1,072,311.63	5,127.26
BH-12	171,414.06	1,072,440.26	5,149.59
BH-13	172,088.43	1,070,692.81	4,973.88
BH-15	170,170.13	1,072,044.06	5,089.30

LEGEND:

- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- BH-01 NEWFIELDS BOREHOLE (JAN 2017)
- TP-01 NEWFIELDS TEST PIT (JAN 2017)
- AMI DRILLING LOCATION
- GEOPHYSICAL SURVEY (JAN 2017)
- EXISTING TAILINGS PILE LIMITS

0 200 400 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

NewFields	CLIENT: ARIZONA MINERALS INC
PROJECT	TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE
TITLE	EXISTING TRENCH CAMP TAILINGS GEOTECHNICAL INVESTIGATION
FILENAME	14.008.019F
FIGURE NO.	1
REVISION	0

Table 1. Number and kind of tests conducted on Trench Camp historic tailings and exploration core from the Hermosa Taylor Deposit.

Sample Type	Tests	Purpose
Trench Camp Area Tailings (n=29) Waste Rock (n=6) Foundation Soil and Rock (n=19)	Sobek Acid Base Accounting	Assess acid generation and neutralization risk
	Paste pH	Assess current degree of weathering and acidification
	MWMP and EPA 1312	Performed on composites of the waste rock, tailings (shallow and deep), and foundation samples to assess metal leaching risk
	Multi element analysis	Total metals in 4-acid digest of samples
Exploration Drillhole Core (n=35,000)	Sobek Acid Base Accounting	Assess acid generation and neutralization risk
	Paste pH	Assess current degree of weathering and acidification on 307 representative samples
	Multi element analysis	Total metals in 4-acid digest of samples

2.0 Trench Camp Historic Tailings Area Geochemistry

2.1 Historic Tailings Area

Static test results (Appendix A) for historic tailings samples (Figure 2 and 3) show the potential for rock to produce or to neutralize acidity as a result of weathering. The Acid Generation Potential (AGP) is based on the quantity of pyritic sulfur contained in a sample and expresses the amount of acidity that a sample could release if all pyrite was to fully oxidize. The AGP is expressed in units of kg/t as $CaCO_3$. Acid Neutralization Potential (ANP) is the capacity of a sample to neutralize acidity and is expressed in the same units as AGP. The ANP minus AGP is the Net Neutralization Potential (NNP) and in theory a sample is potentially acid generating if the NNP is less than zero. Conversely, a sample with a NNP greater than zero would be considered non-acid generating. In practice, there is some uncertainty for samples with NNP between -20 and +20 kg/t, and test results in this range are often considered uncertain in terms of the acid generation risk.

Virtually all historic tailings and waste rock samples would be considered acid generating (Figure 2) because of the NNP values that are less than -20 kg/t as $CaCO_3$. However, most of the tailings samples have not yet become acidic in pH owing to the abundance of carbonates in the tailings material. Only five tailings samples, all located in the upper few feet of the tailings piles, have developed a pH of less than 5 (Figure 3). Two of the lower pH samples were in Pile 3 and the others were in Pile 2/4. In these samples, oxidation of the sulfides has removed most the ANP, thus allowing the pH to drop from 7 to below 5. Given a long enough period of exposure to oxygen, all tailings would eventually become acid, but this would likely require many decades of exposure given the limited oxidation evidenced after more than 50 years of exposure of the historic Trench Camp tailings to weathering. Therefore, after the historic Trench Camp tailings are removed and replaced on a liner, they are not likely to change appreciably from the conditions currently found in surface tailings. Ultimately, the re-handled tailing piles, which are placed on the liner, will be compacted, sloped, and covered in a manner that limits infiltration of meteoric water and oxygen, thus minimizing long-term oxidation and acidification risk.

Samples were analyzed using the Net Acid Generation pH (NAG pH, Figure 4) test in which hydrogen peroxide is added to a sample and allowed to react with sulfides for 24 hours before pH is recorded. NAG pH provides a reliable indication of long-term pH that would develop is a sample after years of weathering. While most tailings samples had a NAG pH less than 4.5, which indicates acid generation risk, many samples with low NNP (<-100 kg/t as CaCO3) also had NAG pH above 4.5. These samples were likely dominated by lead and zinc sulfide minerals that may have high sulfur and low NNP but do not form acidity upon oxidation. Tailings samples with NAG pH above 4.5 were grouped for the soluble metals tests under the non potentially acid generating (non-PAG) tailings category.

Waste rock samples, although much lower in total sulfur than tailings also had much lower ANP values. The relative lack of ANP allowed these samples to acidify more quickly than tailings. As a result all waste rock samples had low pH values, even though they were buried by several feet of tailings in Tailings pile #1. Given their pH, water in contact with waste rock is likely to be more strongly acidic and have higher metals and sulfate than tailings contact water. To the extent possible, waste rock will be buried by tailings in the lined repository to minimize contact with water.

Foundation soil and rock samples were much lower in sulfur than either tailings or waste rock but 4 of the 19 samples still had pyritic sulfur greater than 0.3%, which would likely generate acidic conditions after sufficient exposure to oxygen. The higher sulfide samples were all encountered in boreholes 1 and 2 beneath pile 2/4. It is possible that some of the foundation soil and rock material in this area consist of historic sulfide waste or may contain naturally occurring sulfides. However, any sulfides beneath the tailings in pile 2/4 will be covered by the liner for the new repository, which will prevent any contact with water.

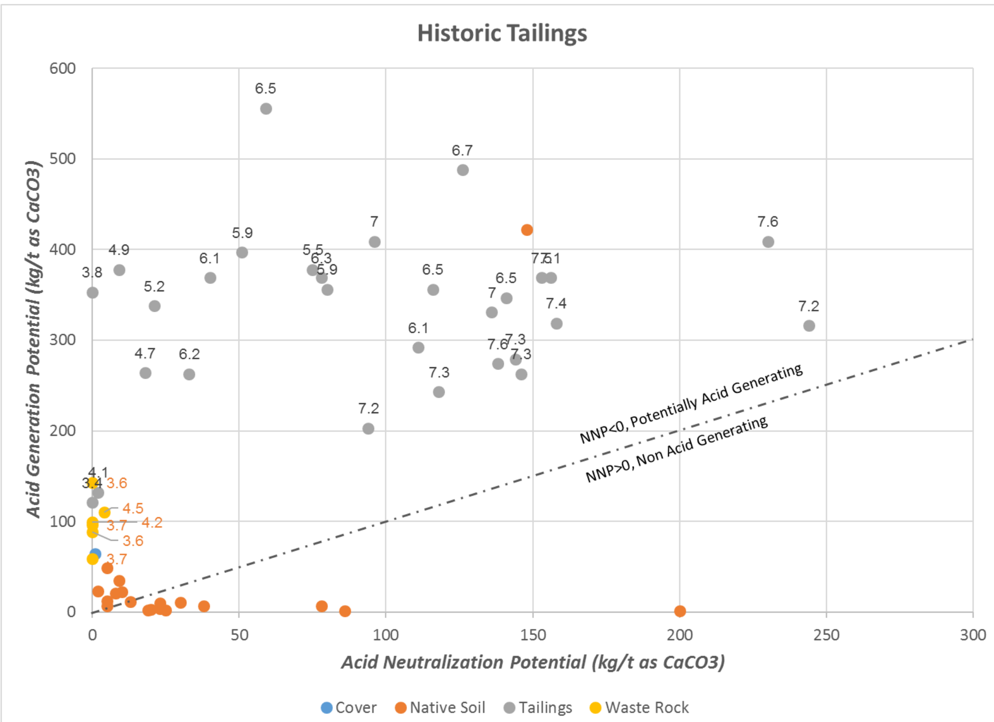


Figure 2. ANP and AGP of samples collected from the historic tailings area.

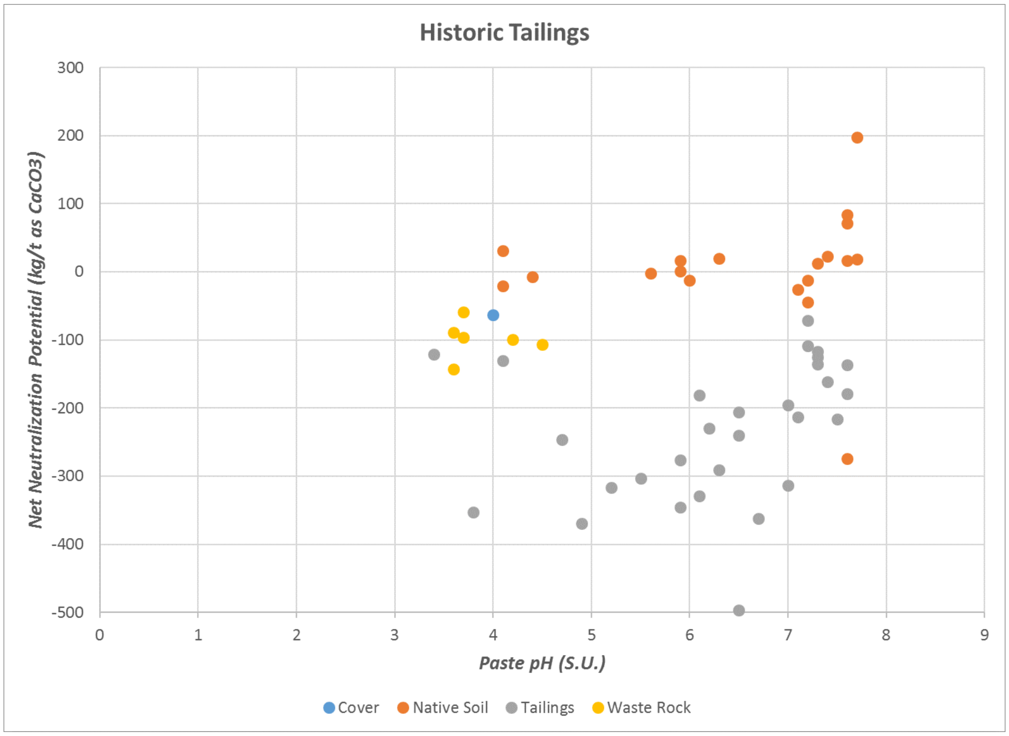


Figure 3. NNP and Paste pH of samples collected from the historic tailings area.

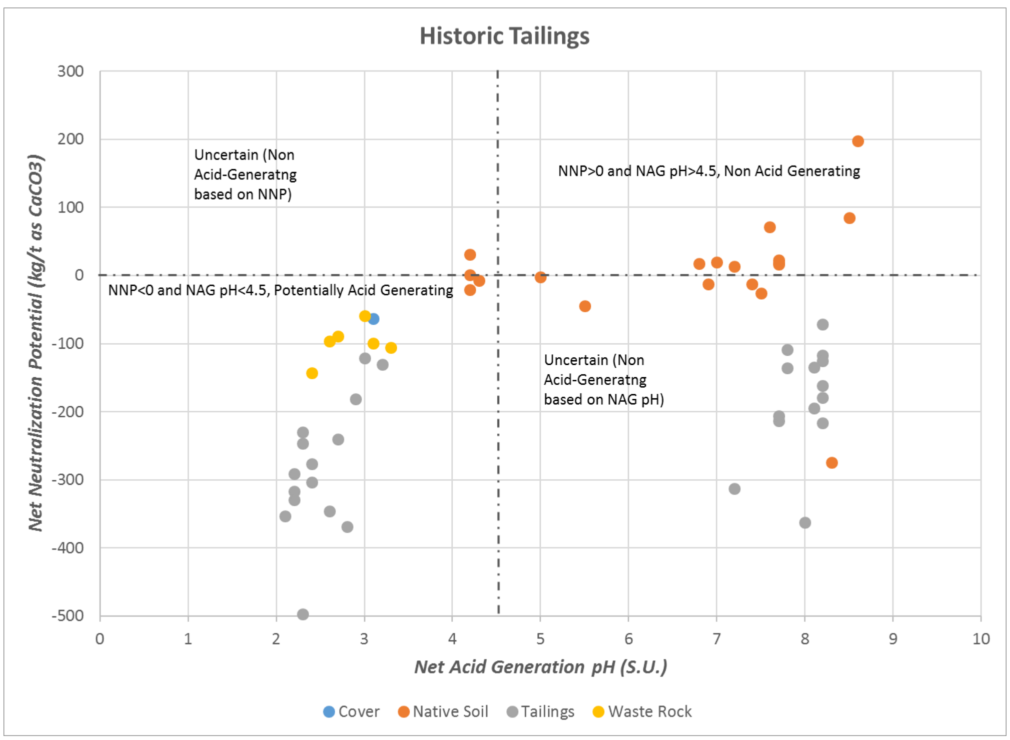


Figure 4. NNP and NAG pH of samples collected from the historic tailings area.

Soluble metals were determined using both Meteoric Water Mobility Procedure (MWMP) and Synthetic Precipitation Leaching Procedure (SPLP) tests. These methods differ primarily in the water to rock ratio. The SPLP is a more dilute extraction 20:1 than the MWMP, which is 1:1. Eight composite samples were tested including shallow oxidized and deeper unoxidized tailings, waste rock, and 4 foundation layers (Table 2 and 3). Soluble metals in SPLP extracts exceeded Arizona aquifer standards for four constituents in one or more samples: antimony, cadmium, lead, and nickel (Figures 5 to 8). Since contact water within the lined repository will be collected and treated, the elevated levels of metals will not pose an environmental risk. All other constituents met Arizona Ambient Water Quality Standards. The MWMP tests tended to have higher levels of soluble constituents than the SPLP tests due to differences in the water to rock ratio used in the tests. The MWMP tests were used to estimate contact water quality in section 2.3.

Table 2. Soluble constituents in composite samples using SPLP method.

Constituent (mg/L)	Unoxidized Tailings	Oxidized Tailings	Non PAG Tailings	Waste	Foundation (0 TO 2 ft)	Foundation (2 TO 3 ft)	Foundation (3 TO 6 ft)	Foundation (8 TO 20 ft)
Aluminum	<0.03	<0.03	0.1	13.8	<0.03	<0.03	0.09	<0.03
Antimony	<0.002	<0.002	0.0011	0.004	0.0088	0.0005	0.0016	0.0016
Arsenic	0.001	0.002	0.0008	0.005	0.0138	0.0054	0.0098	0.0011
Barium	0.01	0.014	0.014	0.011	0.023	0.004	0.018	0.016
Boron	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.02	0.01
Cadmium	0.069	0.145	0.0247	0.128	0.0019	0.0008	0.0066	0.0037
Calcium	586	582	318	267	30.3	14.1	22.1	86.5
Chloride	<0.5	6.5	23.3	<0.5	<0.5	<0.5	<0.5	16.6
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	0.05	0.13	<0.01	0.07	<0.01	<0.01	0.01	<0.01
Conductivity (uS/cm)	2350	2410	1470	1680	385	199	257	574
Copper	<0.01	<0.01	<0.01	0.12	<0.01	<0.01	0.02	<0.01
Cyanide, WAD	<0.003	0.013	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluoride	0.07	0.34	0.35	1.07	0.23	0.46	0.16	0.35
Iron	<0.02	<0.02	0.13	2	<0.02	<0.02	<0.02	<0.02
Lead	0.0467	0.599	0.118	2.6	0.0002	0.0004	0.001	0.0089
Magnesium	6.1	11.3	15.6	35	19.2	8.2	9	12.2
Manganese	47.9	68.8	9.3	37.9	3.79	3.75	4.81	5.61
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel	0.026	0.077	<0.008	0.065	<0.008	<0.008	<0.008	<0.008
Nitrate/Nitrite as N	0.03	0.04	0.04	0.04	0.04	0.03	0.04	0.04
Phosphorus	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium	0.4	0.8	1.3	2.4	4	1.6	2.2	2.3
Selenium	0.0046	0.0032	0.0019	0.0016	<0.0002	0.0002	<0.0002	0.0009
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	0.5	0.3	0.5	0.3	1.8	1.9	1.1	1.2
Strontium	0.164	0.186	0.129	0.054	0.104	0.045	0.077	0.111
Sulfate	1550	1550	809	1000	159	72.7	103	232
Thallium	<0.0005	0.0006	0.0007	<0.0005	0.0007	<0.0001	<0.0002	0.0002
Thorium	<0.005	<0.005	<0.002	<0.005	<0.002	<0.001	<0.002	<0.002
Tin	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Uranium	<0.0005	<0.0005	<0.0002	0.0005	<0.0002	<0.0001	<0.0002	<0.0002
Vanadium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc	3.36	14.4	1	30.4	0.07	0.01	0.71	0.05

Table 3. Soluble constituents in composite samples using MWMP method.

Constituent (mg/L)	Unoxidized Tailings	Oxidized Tailings	Non PAG Tailings	Waste	Foundation (0 TO 2 ft)	Foundation (2 TO 3 ft)	Foundation (3 TO 6 ft)	Foundation (8 TO 20 ft)
Aluminum	0.08	<0.06	<0.06	108	<0.06	<0.06	0.43	<0.06
Antimony	<0.002	0.002	0.004	0.013	0.0118	<0.0008	0.0022	0.0038
Arsenic	0.002	0.002	0.0016	0.012	0.0171	0.0085	0.0223	0.0019
Barium	0.024	<0.006	0.021	<0.006	0.031	0.018	0.025	0.048
Boron	0.02	0.04	0.04	0.04	0.09	0.03	0.13	0.16
Cadmium	1.96	1.05	0.182	1.43	0.0294	0.0138	0.0847	0.0429
Calcium	495	498	604	434	312	160	316	603
Chloride	0.9	94	265	5.8	2.2	0.6	1.3	159
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	1.7	1.68	0.14	0.66	<0.02	<0.02	0.08	0.04
Conductivity (uS/cm)	4390	4500	3230	5150	2750	1450	2110	3110
Copper	0.11	0.05	<0.02	0.33	<0.02	<0.02	0.05	<0.02
Cyanide, WAD	<0.003	0.097	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Fluoride	0.05	0.35	0.54	0.26	0.38	0.43	0.34	0.39
Iron	0.18	0.06	<0.04	14.3	<0.04	<0.04	<0.04	<0.04
Lead	0.88	3.2	0.586	2.65	0.0017	0.0026	0.0048	0.0828
Magnesium	106	241	188	362	250	91.2	121	147
Manganese	1110	761	75.6	428	50.8	37.4	67.5	69.5
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nickel	0.93	1.48	0.1	0.67	<0.02	<0.02	0.12	<0.02
Nitrate/Nitrite as N	0.09	<0.02	0.03	<0.2	0.06	0.02	0.04	<0.1
Phosphorus	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Potassium	1.7	9.8	14.8	26.2	20.4	8.3	13.8	18.7
Selenium	0.0324	0.03	0.0147	0.0116	0.0012	0.0018	0.0011	0.0088
Silver	<0.2	<0.1	<0.02	<0.05	<0.02	<0.02	<0.02	<0.02
Sodium	5.4	4.9	10.2	5.3	25.8	20	14.6	20.7
Strontium	0.77	0.28	0.56	0.16	1.1	0.46	0.78	1.07
Sulfate	3800	3620	2170	4440	1940	837	1400	2040
Thallium	<0.0005	0.0036	0.0031	0.0006	0.0019	0.0005	0.0005	0.0012
Thorium	<0.005	<0.005	<0.002	<0.005	<0.002	<0.002	<0.002	<0.002
Tin	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Uranium	<0.0005	<0.0005	0.0007	0.0029	<0.0002	<0.0002	<0.0002	0.0015
Vanadium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	129	158	24.9	306	0.55	0.31	5.74	1.73

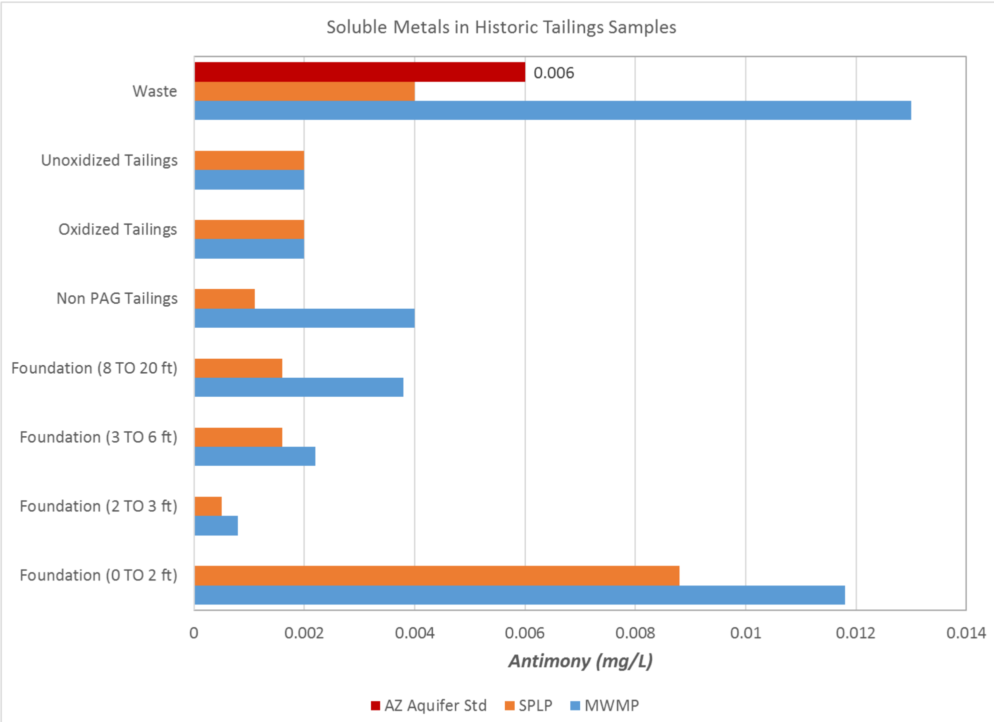


Figure 5. Soluble antimony in samples collected from the historic tailings area.

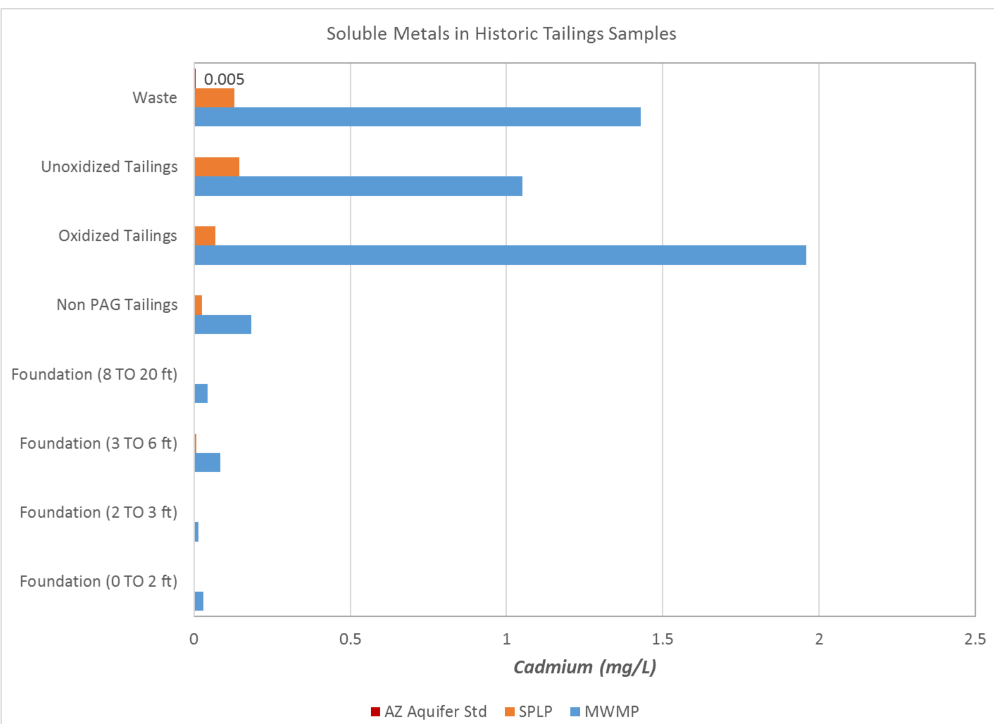


Figure 6. Soluble cadmium in samples collected from the historic tailings area.

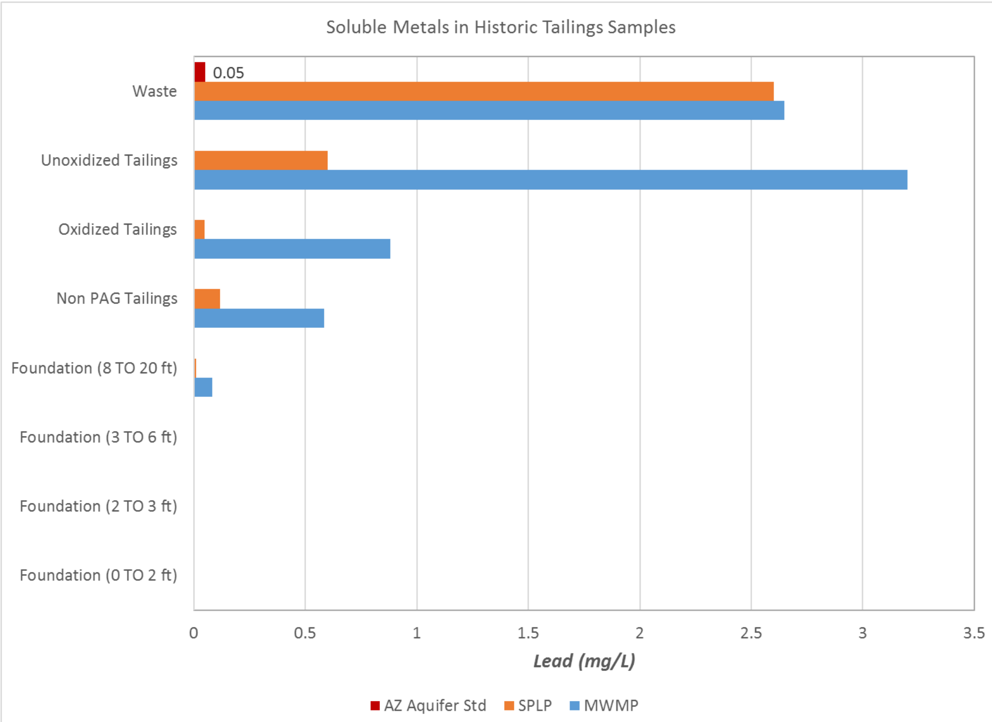


Figure 7. Soluble lead in samples collected from the historic tailings area.

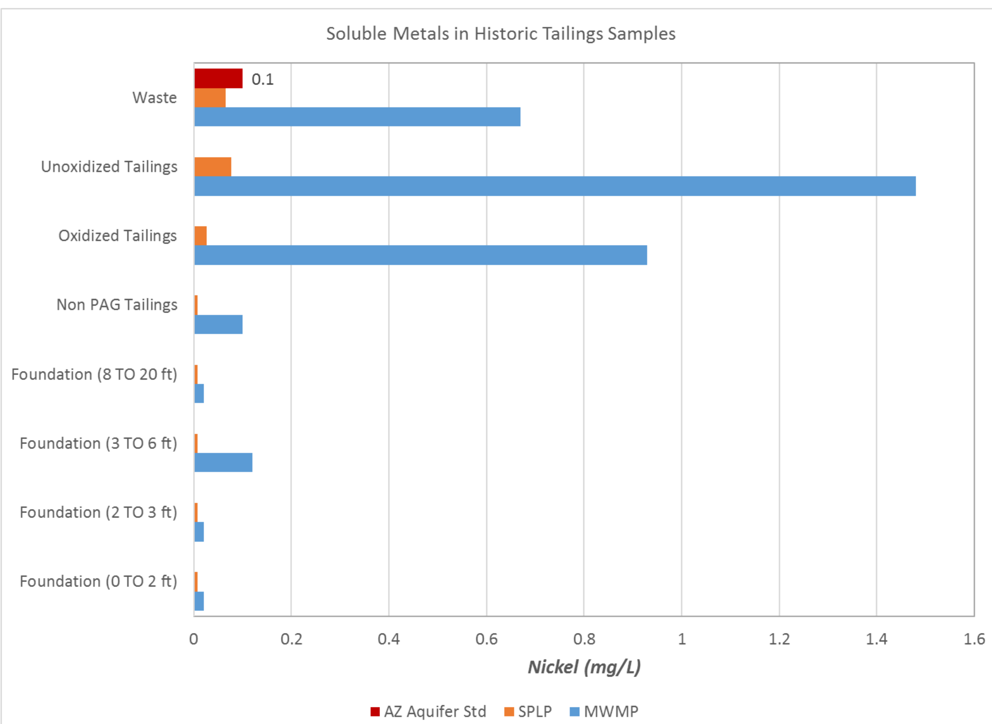


Figure 8. Soluble nickel in samples collected from the historic tailings area.

2.2 Development Rock

Potentially acid generating (PAG) development rock from the proposed Hermosa Taylor Deposit project will be placed in the same lined facility as the historic tailings and waste rock. Extensive data have been collected from rock units to be mined in the Taylor project including 307 samples from 2 representative boreholes (HDS-332 and HDS-364) that were analyzed for Sobek acid base accounting NAG pH and paste pH. In addition, total metals were measured on over 35,000 samples across all exploration holes.

The NAG pH and NNP of samples from boreholes HDS-332 and HDS-364 (Figure 9 and 10) show three distinct groups of samples (Figure 11). The vast majority of rocks encountered in the Taylor Deposit is strongly alkaline and not expected to become acidic or to leach appreciable levels of metals. Unlike the historic tailings and waste rock that was volcanic-hosted, the Taylor Deposit, the first group in Figure 11, is a deeper Carbonate Replacement Deposit, accounting for the preponderance of alkaline rock. The second group of materials is potentially acid generating (PAG), due to the pyritic sulfur content. In order to access the carbonate host rock, a decline will be developed through approximately 1,000 feet of volcanic rock. The surficial Meadow Valley Volcanics and deeper Hardshell Volcanics contain a proportion of PAG material with NNP <0 and NAG pH < 4.5. The third group of samples is zinc-lead-silver ore. Ore in the carbonate sequence had low NNP but also had high NAG pH. In these samples, the majority of sulfur is in the form of galena and sphalerite, which are not acid generating sulfides like pyrite. The Sobek test therefore overestimates acid generating risk in samples where pyrite is not the primary sulfide mineral. Ore samples will be processed to recover economic sulfides as a concentrate (that will be shipped off-site) and the resultant tailings will be non acid-generating based on preliminary tests.

The vertical distribution of ANP, AGP and lead plus zinc grade in HDS-332 and HDS-364 is shown in Figures 12 and 13, respectively. PAG Zones occur where the red bars are more pronounced than the blue bars. In the upper volcanic units, PAG material will be treated as waste and will be placed in the lined repository to prevent release of acidity or metals in contact water. Most zones that appear as PAG in the carbonate units are actually ore and will be processed to remove the economic sulfides.

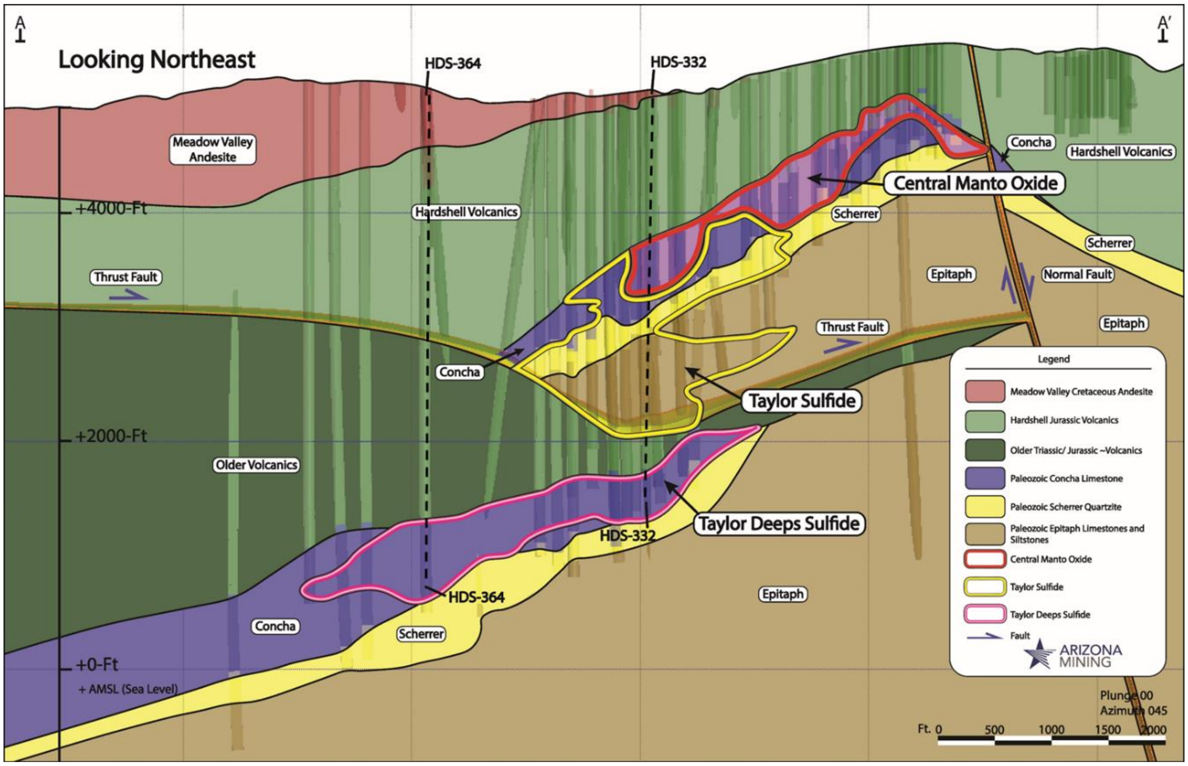


Figure 9. Cross section 1 through the Hermosa Taylor Deposit.

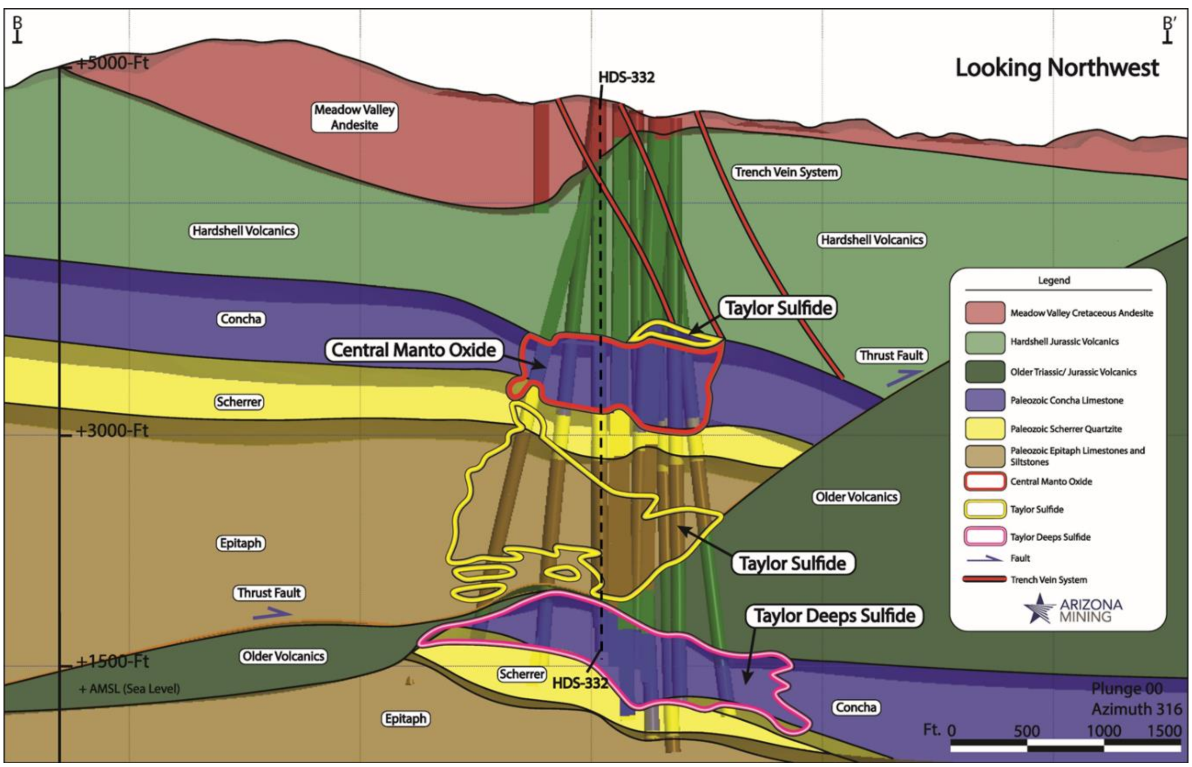


Figure 10. Cross section 2 through the Hermosa Taylor Deposit.

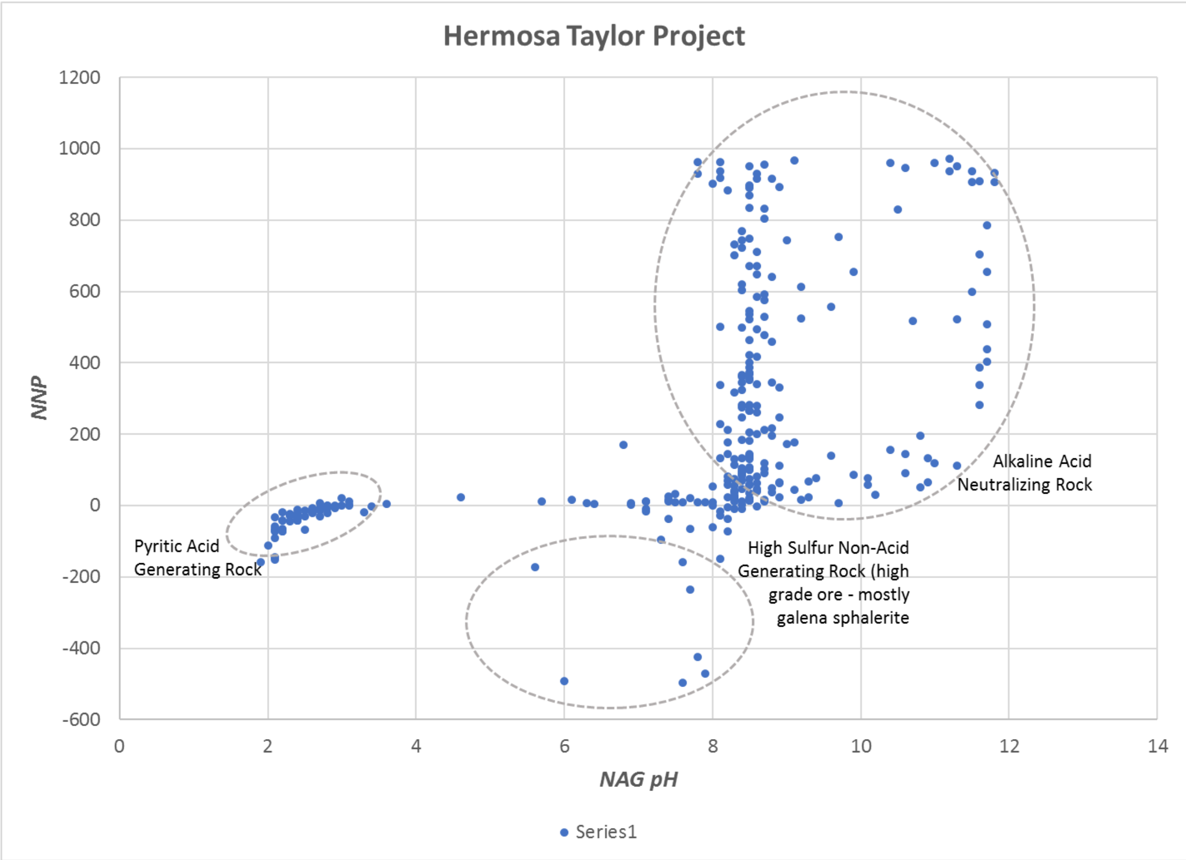


Figure 11. Distribution of NNP and NAG pH in select exploration samples.

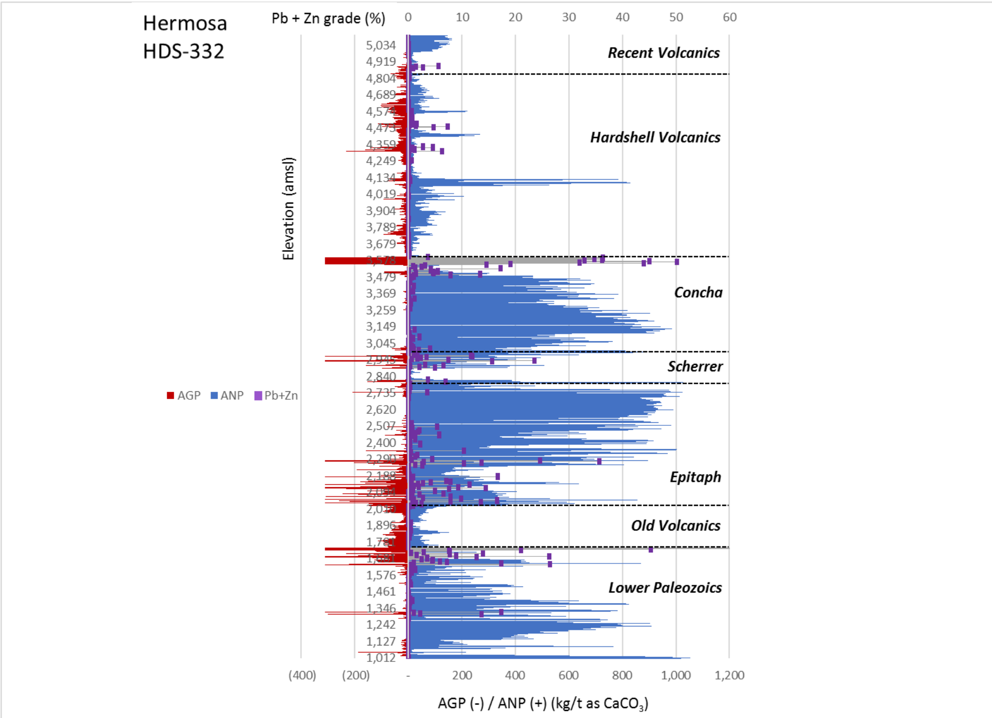


Figure 12. Distribution and ANP, AGP and Pb+Zn grade in borehole HDS-332.

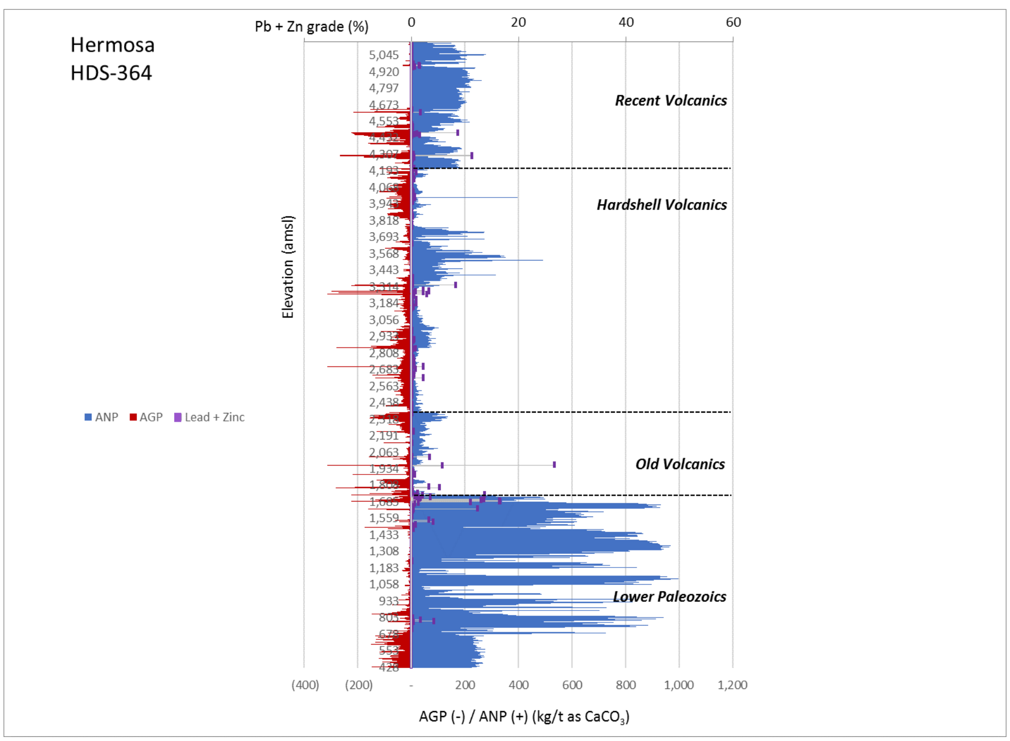


Figure 13. Distribution and ANP, AGP and Pb+Zn grade in borehole HDS-364.

2.2.1 Estimating ANP and AGP from Total Metals Data

Arizona Minerals Inc. has performed multi-element analyses on over 35,000 samples to date using a 4-acid digestion and ion determination by ICP AES and MS methods (ALS Chemex ME-MS61m). The ANP and AGP values for all 35,000 samples were estimated by assuming all calcium and magnesium are present as carbonate and all sulfur is pyrite according to equation [1]. The estimated ANP and AGP from multi element data will provide more spatially extensive information about the Hermosa Taylor deposit. However, it is important to establish whether the estimated ANP and AGP derived from equation 1 are in agreement with ANP and AGP measured using the standard Sobek method.

Estimated NNP (kg/t as CaCO3) = ANP (Total Ca % x 10 x 40.1/100 +
Total Mg % x 10 x 24.3/100) - AGP (Total S % x 31.25) [1]

Estimated ANP and AGP based on multi-element data (Figure 14 and 15) provided good correlation with the Sobek method as shown for the 307 samples tested by both methods. Estimated and measured AGP had an R^2 of 0.9888 and a slope of 1.01 while estimated and measured ANP had an R^2 of 0.9341 and a slope of 0.9865. Based on the strong correlation, the multi-element data available for all boreholes provide an accurate and precise estimate ANP and AGP.

Based on average composition (Table 4) all Paleozoic units (Concha, Epitaph and Sherrer plus older Paleozoics below the Sherrer) are strongly alkaline with ANP ranging from 320 to 610 kg/t as CaCO3. Some PAG material was found in the Paleozoic units in or near ore zones where mineralization caused increases in sulfide sulfur and significant loss of carbonates due to alteration. PAG abundance varied from 3 to 8% in the Concha, Epitaph, Scherrer and older Paleozoic rocks. Most drifts and ore development will occur in the Paleozoic units although much of the waste produced would likely be placed underground as backfill.

The volcanic units had somewhat lower alkalinity than the Paleozoic rocks with ANP averaging 161 kg/t as $CaCO_3$ in the Meadow Valley and 73 kg/t in the deeper Hardshell Volcanics. Pyritic sulfur averaged about 0.5% in the Meadow Valley (AGP = 18 kg.t) and was a little over 1% in the Hardshell (AGP = 39 kg/t). The Hardshell Volcanics had 20.5% PAG material and this PAG development rock will be placed on the lined facility. The upper volcanics in the Meadow Valley Unit had more carbonate so contain only 4% PAG material.

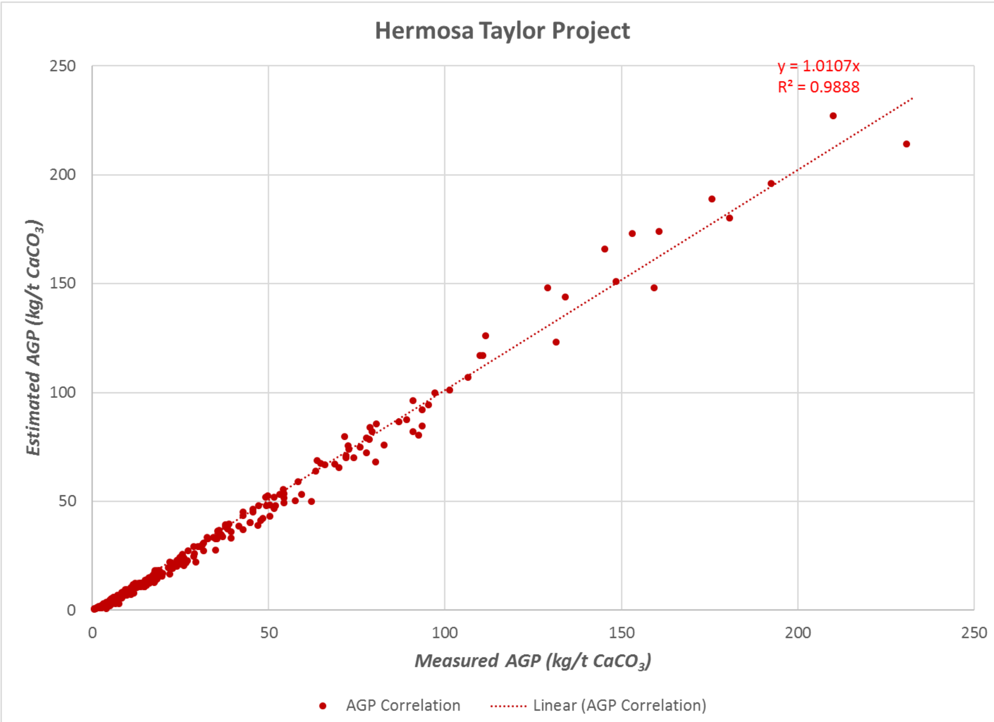


Figure 14. Correlation of measured and estimated AGP in boreholes HDS-332 and HDS-364.

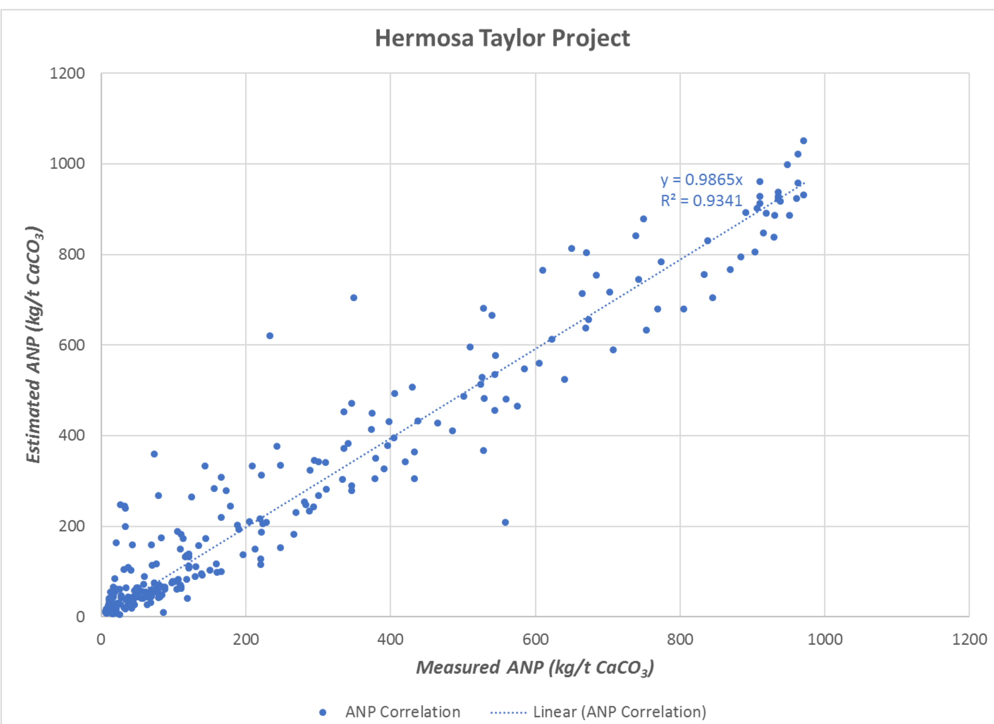


Figure 15. Correlation of measured and estimated ANP in boreholes HDS-332 and HDS-364.

Table 4. Average ANP, AGP and PAG abundance in each rock unit in the Hermosa Taylor Deposit.

Row Labels	n	Average of ANP	Average of AGP	Average of NNP	PAG (%)
Meadow Valley Volcanics	3,777	161	18	143	4.3%
Hardshell Volcanics	12,727	73	39	33	20.5%
Concha Formation	2,671	412	38	374	8.1%
Scherrer Formation	1,510	322	44	278	6.7%
Epitaph Formation	3,884	610	53	557	2.8%
Old Volcanics	4,723	57	45	12	17.5%
Lower Paleozoics	5,780	478	32	446	2.7%

2.3 Expected Water Quality of Contact Water

Water that comes into contact with materials placed on the liner will be directed to the lined underdrain pond where it will be stored for eventual treatment and re-use or discharge under an approved permit. Tests of different materials to be placed in the liner repository indicate that contact water quality may vary spatially depending on the kind of material contacted. This variability will cause some variation in water fed to the water treatment plant, although the variability will be less pronounced than the range of values in Table 5 because underdrain pond water will be an average across the facility. An overall average water quality was computed by assuming that about 40% of the contact water is represented by oxidized tailings, 25% by unoxidized tailings, 25% by non-PAG tailings and 10% by waste rock. The composite water quality was estimated by combining these three water types in a geochemical equilibrium model (PHREEQC). Reasonable low temperature solid phases were allowed to form and sorption on ferrihydrite was permitted. Contact water pH may range between 3.8 and 6.8 with a most likely pH of 4.2. Sulfate may range from 2,170 to 4,440 mg/L with a most likely concentration of around 3,300 mg/L. Most metals levels will be relatively low except for cadmium, manganese and zinc with likely concentrations of 1.1, 645 and 133 mg/L respectively.

Table 5. Likely range in quality of contact water in Trench Camp historic tailings underdrain pond.

Constituent (mg/L)	Minimum	Maximum	Expected
pH	3.8	6.8	4.17
Aluminum	<0.06	108	5.05
Antimony	<0.002	0.013	0.0036
Arsenic	0.0016	0.012	0.003
Barium	<0.006	0.024	0.003
Boron	<0.02	0.04	0.04
Cadmium	0.182	1.96	1.09
Calcium	434	604	480
Bicarbonate	<2	51.2	9.82
Chloride	0.9	265	105
Chromium	<0.02	<0.02	<0.02
Cobalt	0.14	1.7	1.20
Copper	<0.02	0.33	0.09
Fluoride	<0.05	0.54	0.31
Iron	<0.04	14.3	1.45
Lead	0.59	3.2	1.59
Magnesium	106	362	207.1
Manganese	75.6	1,110	645
Mercury	<0.0002	<0.0002	<0.0002
Molybdenum	<0.04	<0.04	<0.04
Nickel	<0.1	1.48	0.92
Nitrate/Nitrite as N	<0.02	0.2	0.06
Phosphorus	<0.2	<0.2	<0.2
Potassium	1.7	26.2	9.32
Selenium	0.0116	0.0324	0.025
Silver	<0.02	0.2	0.10
Sodium	4.9	10.2	6.42
Strontium	0.16	0.77	0.46
Sulfate	2,170	4,440	3,287
Thallium	0.0005	0.0036	0.002
Thorium	<0.002	<0.005	<0.005
Tin	<0.08	<0.08	<0.08
Uranium	0.0005	0.0029	0.001
Vanadium	<0.01	<0.01	<0.010
Zinc	24.9	306	133

Appendix A - Acid Base Accounting Data

Table A-1. Static test results for Trench Camp historic tailings area samples.

Sample	Acid Generation Potential (calc on Sulfur total)	Acid Neutralization Potential (calc)	Net Neutralization Potential (calc on Sulfur total)	Net Acid Generation Procedure	Neutralization Potential as CaCO3	pH, Saturated Paste
BH-01 / S-1	64.4	1	-63.4	3.1	0.1	4
BH-01 / S-2	356	116	-240	2.7	11.6	6.5
BH-01 / S-3	369	156	-213	7.7	15.6	7.1
BH-01 / S-4	409	230	-179	8.2	23	7.6
BH-01 / S-5	369	153	-216	8.2	15.3	7.5
BH-01 / S-6	422	148	-274	8.3	14.8	7.6
BH-01 / S-8	3.13	20	16.9	7.7	2	7.6
BH-02 / S-2	132	2	-130	3.2	0.2	4.1
BH-02 / S-3	378	9	-369	2.8	0.9	4.9
BH-02 / S-4	331	136	-195	8.1	13.6	7
BH-02 / S-6	316	244	-71.6	8.2	24.4	7.2
BH-02 / S-7	34.7	9	-25.7	7.5	0.9	7.1
BH-02 / S-8	49.1	5	-44.1	5.5	0.5	7.2
BH-03 / S-2	369	40	-329	2.2	4	6.1
BH-03 / S-3	369	78	-291	2.2	7.8	6.3
BH-03 / S-4	279	144	-135	8.1	14.4	7.3
BH-03 / S-5	263	146	-117	8.2	14.6	7.3
BH-03 / S-6	22.2	10	-12.2	7.4	1	7.2
BH-04 / S-1	121	0	-121	3		3.4
BH-04 / S-2	397	51	-346	2.6	5.1	5.9
BH-04 / S-3A	347	141	-206	7.7	14.1	6.5
BH-04 / S-3B	99.7	0	-99.7	3.1		4.2
BH-04 / S-4	88.8	0	-88.8	2.7		3.6
BH-04 / S-5	143	0	-143	2.4		3.6
BH-04 / S-6	23.1	2	-21.1	4.2	0.2	4.1
BH-05 / S-2	409	96	-313	7.2	9.6	7
BH-05 / S-3A	556	59	-497	2.3	5.9	6.5
BH-05 / S-3B	10	23	13	7.2	2.3	7.3
BH-05 / S-4	1.88	25	23.1	7.7	2.5	7.4
BH-05 / S-5	4.06	23	18.9	7.7	2.3	7.7
BH-06 / S-2	110	4	-106	3.3	0.4	4.5
BH-06 / S-3	59.1	0	-59.1	3		3.7
BH-06 / S-4	96.3	0	-96.3	2.6		3.7
BH-07 / S-2	353	0	-353	2.1		3.8
BH-07 / S-3	338	21	-317	2.2	2.1	5.2
BH-07 / S-4	263	33	-230	2.3	3.3	6.2
BH-07 / S-6A	203	94	-109	7.8	9.4	7.2
BH-07 / S-6B	11.6	13	1.4	4.2	1.3	5.9
BH-07 / S-7	12.5	5	-7.5	4.3	0.5	4.4
BH-07 / S-8	7.19	5	-2.2	5	0.5	5.6
BH-07 / S-9	1.88	19	17.1	6.8	1.9	5.9
BH-08 / S-2	378	75	-303	2.4	7.5	5.5
BH-08 / S-3	488	126	-362	8	12.6	6.7
BH-08 / S-4	319	158	-161	8.2	15.8	7.4
BH-08 / S-5	243	118	-125	8.2	11.8	7.3
BH-08 / S-6	274	138	-136	7.8	13.8	7.6
BH-08 / S-8	6.56	78	71.4	7.6	7.8	7.6
BH-08 / S-9	1.56	86	84.4	8.5	8.6	7.6
BH-08 / S-10	1.56	200	198	8.6	20	7.7
TP-24 / S-1	356	80	-276	2.4	8	5.9
TP-24 / S-2	10.6	30	19.4	7	3	6.3
TP-25 / S-1	264	18	-246	2.3	1.8	4.7
TP-25 / S-2	6.88	38	31.1	4.2	3.8	4.1
TP-34 / S-1	292	111	-181	2.9	11.1	6.1
TP-34 / S-2	20.6	8	-12.6	6.9	0.8	6

Table A-2. Static test results for Trench Camp historic tailings area samples.

Sample	Sulfur HCl Residue	Sulfur HNO3 Residue	Sulfur Organic Residual	Sulfur Pyritic Sulfide	Sulfur Sulfate	Sulfur Total	Total Sulfur minus Sulfate	Material	Depth
BH-01 / S-1	0.39	0.03	0.03	0.36	1.67	2.06	0.39	Cover	-1.5
BH-01 / S-2	7.11			7.11	4.26	11.4	7.11	Tailings	-5.75
BH-01 / S-3	7.67	0.01	0.01	7.66	4.11	11.8	7.67	Tailings	-15.75
BH-01 / S-4	10.1	0.01	0.01	10	3.01	13.1	10.1	Tailings	-25.75
BH-01 / S-5	10.9			10.9	0.95	11.8	10.9	Tailings	-35.75
BH-01 / S-6	12			12	1.51	13.5	12	Native Grounc	-45.75
BH-01 / S-8	0.05			0.05	0.05	0.1	0.05	Native Grounc	-53.25
BH-02 / S-2	0.54			0.54	3.69	4.23	0.54	Tailings	-5.75
BH-02 / S-3	7.66	0.01	0.01	7.65	4.48	12.1	7.66	Tailings	-15.75
BH-02 / S-4	9.78	0.04	0.04	9.74	0.78	10.6	9.78	Tailings	-25.75
BH-02 / S-6	9.42	0.05	0.05	9.37	0.71	10.1	9.42	Tailings	-35.75
BH-02 / S-7	1	0.69	0.69	0.31	0.11	1.11	1	Native Grounc	-38.25
BH-02 / S-8	1.56	1.17	1.17	0.39	0.01	1.57	1.56	Native Grounc	-40.75
BH-03 / S-2	7.78	0.02	0.02	7.76	3.98	11.8	7.78	Tailings	-4.75
BH-03 / S-3	8.99	0.03	0.03	8.96	2.77	11.8	8.99	Tailings	-15.75
BH-03 / S-4	7.88	0.03	0.03	7.85	1.06	8.94	7.88	Tailings	-25.75
BH-03 / S-5	5.79	0.03	0.03	5.76	2.61	8.4	5.79	Tailings	-35.8
BH-03 / S-6	0.67	0.47	0.47	0.2	0.04	0.71	0.67	Native Grounc	-43.75
BH-04 / S-1	1.48	0.02	0.02	1.46	2.38	3.86	1.48	Tailings	-1.3
BH-04 / S-2	8.52	0.02	0.02	8.5	4.13	12.7	8.52	Tailings	-5.75
BH-04 / S-3A	7.82	0.01	0.01	7.81	3.27	11.1	7.82	Tailings	-15.55
BH-04 / S-3B	1.2	0.02	0.02	1.18	1.99	3.19	1.2	Waste Rock	-16
BH-04 / S-4	0.95	0.01	0.01	0.94	1.89	2.84	0.95	Waste Rock	-20.75
BH-04 / S-5	2.2	0.03	0.03	2.17	2.38	4.58	2.2	Waste Rock	-25.75
BH-04 / S-6	0.22	0.19	0.19	0.03	0.52	0.74	0.22	Native Grounc	-40.75
BH-05 / S-2	11.3	0.02	0.02	11.3	1.87	13.1	11.3	Tailings	-5.75
BH-05 / S-3A	16.4	0.01	0.01	16.4	1.38	17.8	16.4	Tailings	-15.55
BH-05 / S-3B	0.16	0.04	0.04	0.12	0.16	0.32	0.16	Native Grounc	-16
BH-05 / S-4		0.01	0.01		0.06	0.06		Native Grounc	-18.25
BH-05 / S-5	0.06			0.06	0.07	0.13	0.06	Native Grounc	-20.75
BH-06 / S-2	0.94	0.12	0.12	0.82	2.58	3.52	0.94	Waste Rock	-10.75
BH-06 / S-3	0.73	0.01	0.01	0.72	1.16	1.89	0.73	Waste Rock	-20.75
BH-06 / S-4	1.79	0.03	0.03	1.76	1.29	3.08	1.79	Waste Rock	-22.65
BH-07 / S-2	7.94	0.01	0.01	7.93	3.31	11.3	7.94	Tailings	-5.75
BH-07 / S-3	7.47	0.01	0.01	7.46	3.35	10.8	7.47	Tailings	-10.75
BH-07 / S-4	6.14	0.03	0.03	6.11	2.27	8.41	6.14	Tailings	-20.75
BH-07 / S-6A	5.15	0.03	0.03	5.12	1.36	6.51	5.15	Tailings	-30.55
BH-07 / S-6B	0.23	0.04	0.04	0.19	0.14	0.37	0.23	Native Grounc	-31
BH-07 / S-7	0.21	0.18	0.18	0.03	0.19	0.4	0.21	Native Grounc	-33.25
BH-07 / S-8	0.16	0.15	0.15	0.01	0.07	0.23	0.16	Native Grounc	-35.75
BH-07 / S-9	0.01			0.01	0.05	0.06	0.01	Native Grounc	-40.75
BH-08 / S-2	7.12	0.11	0.11	7.01	5	12.1	7.12	Tailings	-5.75
BH-08 / S-3	14.7	0.26	0.26	14.4	0.97	15.6	14.7	Tailings	-15.75
BH-08 / S-4	9.51	0.22	0.22	9.29	0.67	10.2	9.51	Tailings	-25.75
BH-08 / S-5	6.33	0.16	0.16	6.17	1.46	7.79	6.33	Tailings	-35.75
BH-08 / S-6	7.14	0.3	0.3	6.84	1.64	8.78	7.14	Tailings	-45.75
BH-08 / S-8	0.11			0.11	0.1	0.21	0.11	Native Grounc	-50.75
BH-08 / S-9					0.05	0.05		Native Grounc	-53.25
BH-08 / S-10	0.02			0.02	0.03	0.05	0.02	Native Grounc	-55.75
TP-24 / S-1	7.98	0.13	0.13	7.85	3.4	11.4	7.98	Tailings	-7.5
TP-24 / S-2	0.06			0.06	0.28	0.34	0.06	Native Grounc	-9.5
TP-25 / S-1	5.44	0.14	0.14	5.3	3.02	8.46	5.44	Tailings	-9
TP-25 / S-2	0.02	0.01	0.01	0.01	0.2	0.22	0.02	Native Grounc	-15
TP-34 / S-1	5.56	0.08	0.08	5.48	3.78	9.34	5.56	Tailings	-6
TP-34 / S-2	0.61	0.41	0.41	0.2	0.05	0.66	0.61	Native Grounc	-9

ATTACHMENT B

TAILINGS AND POTENTIAL ACID GENERATING MATERIAL REMEDIATION, PLACEMENT AND STORAGE FACILITIES BY NEWFIELDS MINING DESIGN AND TECHNICAL SERVICES

TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE PROJECT AQUIFER PROTECTION PERMIT (APP) BEST AVAILABLE DEMONSTRATED CONTROL TECHNOLOGY (BADCT) DESIGN PATAGONIA, ARIZONA

Prepared for:
Arizona Minerals Inc
3845 North Business Center Drive, Suite 115
Tucson, AZ 85705

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
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

NewFields Job No. 475.0014.008
June 5, 2017

NewFields
Perspective. Vision. Solutions.

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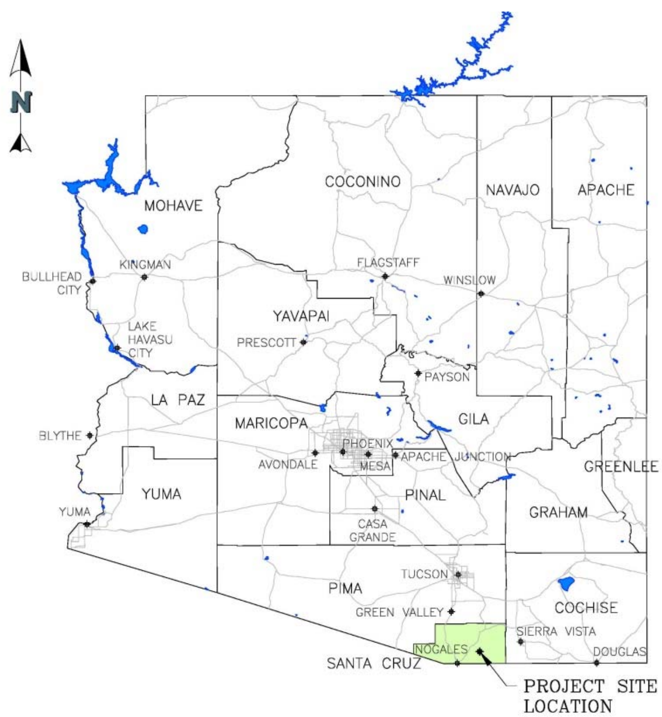
1. INTRODUCTION

NewFields Mining Design and Technical Services, LLC (NewFields) was commissioned by Arizona Minerals Inc (AMI) to complete an "Issued for Construction" (IFC) remediation design for AMI's four historic tailings piles also known as existing tailings and Tailings Piles 1 through 4. Given the age of the tailings piles, the solids content is significantly higher than traditional slurry tailings, and thus the remediation activities will be more in-line with traditional earthworks rather than traditional slurry tailings deposition. The remediation, known as the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project is presented in this report and supporting design documents. The design is being submitted under the Aquifer Protection Permit (APP) Application Program currently supported by the Arizona Department of Environmental Quality (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. border with Mexico. The site is accessed through the town of Patagonia via Harshaw Road. The proposed tailings storage facility (TSF) for the remediated tailings is located on private land owned by AMI, and commonly referred to as Trench Camp. The location of the project is identified on Drawing A000 and shown in Figure 1.1.

FIGURE 1.1 PROJECT VICINITY MAP



1.1. Scope of Work

NewFields design scope for the remediation project included the following civil elements:

- Dry Stack TSF design to avoid Flux Canyon Road to the greatest extent possible
- Establish remediation approach to existing tailings piles 1 through 4
- Underdrainage Collection Pond design
- Surface water management systems and sediment control design
- Perform a focused geotechnical investigation to characterize the existing tailings and near surface soil and rock
- Complete laboratory testing on tailings, soils and rock to establish engineering characteristics for design
- Perform a seismic hazard assessment
- Provide design and a construction sequencing for remediation of Tailings Piles 1 through 4

NewFields Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage project deliverables include the following:

- Final Design Report
- IFC drawing set
- Technical Specifications
- Material Take-Offs (MTOs)
- Construction Capital Cost Estimate
- Closure Cost Estimate

1.2. Project Description

The Trench Camp site contains four historic tailings deposits (Tailings Piles 1 through 4) within the property boundary. The deposits primarily contain tailings, but some PAG waste rock was identified intermixed with the tailings in at least one of the facilities. Placement of the tailings piles onto a lined permanent containment is part of the APP cited previously. The proposed TSF is designed as a lined permanent storage area for remediation of the existing tailings piles utilizing prescriptive Arizona Best Available Design Control Technology (BADCT) standards. Tailings, PAG waste rock and impacted soils contained within the existing tailings piles are to be excavated and placed in the lined Trench Camp dry stack TSF as an earthen material. PAG development rock from a planned exploration ramp and shaft will also be stored in the lined TSF as a co-mingled material with the existing tailings. Alternately, the development rock may be placed on the exterior face of the reclaimed tailings thereby acting as rock armor to minimize water and wind erosion. A general layout of the project can be referenced on Drawing A010.

1.3. Trench Camp Existing Tailings Piles

Tailings Piles 1 through 4, are located within the Trench Camp TSF footprint. The tailings piles are currently unlined deposits located within natural basins. Tailings Pile 1 contains both tailings and PAG waste rock while the remaining piles contain only tailings. It is important to note that Tailings Piles 2 and 4 are combined into one facility and divisional reference between the two is based on the 5,100 ft contour elevation. Tailings Pile 2 and 4 are referred to as one tailings pile.

The tailings and PAG material, including potentially impacted natural ground below the piles, will be exhumed and relocated onto the proposed fully-lined dry stack TSF. This effort will effectively mitigate the environmental issues currently associated with the Tailings Piles 1 through 4. A plan view of the tailings piles can be referenced on Drawing A050.

1.4. Exploration Ramp and Shaft

As part of the mine planning and resource evaluation, an exploration ramp will be developed to obtain bulk samples of the ore body. It is anticipated that the exploration ramp will generate PAG development rock which will be stored within the TSF. In the event it is non-PAG, the development rock will be utilized as temporary cover material on the reclaimed tailings placed in the TSF. The location of the exploration ramp can be referenced on Drawing A010.

1.5. Proposed TSF Design

1.5.1. Storage Capacity

The TSF has been designed to store the tailings and waste rock in the Tailings Piles 1 through 4 and development rock from the exploration ramp and shaft. Stage 1 of the TSF will be capable of storing existing tailings and waste rock from Tailings Piles 1, 2, and 4 and some development rock from the exploration ramp/shaft. The storage capacity is based on a compacted dry unit weight of 104 pounds per cubic foot (pcf). This unit weight translates to approximately 90% of the maximum proctor unit weight as determined by ASTM D-698. The Stage 2 TSF expansion will accommodate additional tailings from Tailings Pile 3 and exploration ramp and shaft development rock that is identified as PAG material.

1.5.2. TSF Description

The TSF is sited in the northeast portion of the Trench Camp property, and utilizes Flux Canyon Road as the boundary on the western and southern reaches of the facility. The TSF includes a perimeter road which fully encompasses a synthetically lined basin area capable of storing the design tailings and waste rock as well as conveying the internal 100-yr/24-hr peak storm flows while maintaining 2 feet of freeboard. The perimeter road will provide light vehicle access, containment of surface water runoff and passive resistance at the downstream toe of the facility.

The composite liner design consists of a 60 mil double sided textured high-density polyethylene (HDPE) geomembrane overlying a low permeability compacted soil layer or GCL (see Section 6.7.4 for additional information). To protect the geomembrane, reduce head and facilitate long-term drainage of the tailings, a granular protective layer is specified over the geomembrane liner. The protective layer is augmented by a dendritic, perforated corrugated polyethylene (CPe) pipe network placed in topographic lows to collect percolation through the tailings and convey the flow via gravity to an Underdrain Collection Pond located downstream of the TSF.

The Underdrain Collection Pond has been sized to contain underdrainage flow, direct precipitation runoff from the TSF and direct precipitation on the pond from the 100-yr/24-hr storm event. The pond will be double 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 serve to reduce head on the secondary liner, thereby reducing the propensity for seepage beyond the secondary liner system. Water collected in the Underdrain Collection Pond will be pumped to the Water Treatment Plant (WTP), used for exploration make-up water, treated and released to Alum Gulch or consumed for other operational uses.

TSF and Underdrain Collection Pond design criteria can be referenced in Appendix A.

1.5.3. Stormwater Management

The stormwater management system has been designed to prevent run-on to the TSF by conveying external flows around the TSF to the Flux Canyon drainage downstream of the facility. This system consists of stormwater diversion channels and culverts located upstream and along the periphery of the TSF. The conveyance structures are sized for peak flows resulting from the 100-yr/24-hr storm event. A plan view showing the stormwater management can be referenced on Drawing A500.

1.6. 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 piñon and mesquite trees with several different species of grasses and shrubs. Area elevations range from approximately 4,800 to 5,300 feet above mean sea level (amsl). The main drainages in the area Alum Gulch, which flows northwest and Harshaw Creek, which flows northeast and empty into Sonoita Creek. Alum Gulch and Harshaw Creek are ephemeral drainages that experience flows during the summer monsoon precipitation events. The area has 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.

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 spans over 9 years and 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.

TABLE 2.2 – ESTIMATED MONTHLY PRECIPITATION STATISTICS FOR THE TSF

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

Due to drier than normal conditions at the site within the last decade, the site specific data was correlated to historic WRCC data and increased by approximately 15 percent. In an attempt to verify the adjusted monthly precipitation values, a Parameter-elevation Regressions analysis was created on Independent Slope Model (PRISM, 2017). The PRISM data supported the increase in precipitation at the project site to account for the site specific data recorded over a drier time period. Further details regarding climatic conditions at the site can be found in Appendix B.

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.

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 Paleozic 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. Regional Hydrogeology and Hydrology

The project is located in the southern portion of the Cienega Creek Basin which has an area of 606 square miles. The basin is characterized by Arizona Division of Water Resources (ADWR) as a narrow alluvial valley surrounded by fault block mountains. A surface water divide is present southwest of Sonoita, Arizona, with the Sonoita Creek draining the basin to the southwest and the Cienega Creek draining to the northeast. Surface water runoff at the project site flows to the northwest towards Sonoita Creek which flows into the Santa Cruz River.

Hydrogeology within the basin is complex, with the basin being divided into three subareas, the upper Cienega Creek, the lower Cienega Creek and the Sonoita Creek. The upper Cienega Creek main aquifer is comprised of basin fill and encompasses most of the basin's main valley. The lower Cienega Creek subarea aquifers consist of alluvium, basin fill and the Pantano Formation. The alluvium is the main aquifer in this subarea, which exhibits artesian and leaky confined conditions resulting from interbedded clays (ADWR, 2014). The Sonoita Creek subarea, where the project site is located, consists of an alluvial aquifer. Groundwater flow direction mimics surface water flow direction for the subareas. Recharge to the basin is from stream infiltration and mountain front recharge. Recharge estimates are 8,500 to 25,500 acre-feet per year for the lower and upper Cienega Creek subareas, there are no estimates for the Sonoita Creek subarea available at this time (ADWR, 2014).

2.5. 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 probably 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 are 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

The purpose of the geotechnical site investigation was to identify and characterize the engineering properties of subsurface materials beneath the proposed TSF and surrounding area. The information obtained during the exploration and subsequent laboratory testing was used to advance the design of the TSF and relocating Tailings Piles 1 through 4 into the new facility. The data was used to develop design and construction criteria for the tailings piles, TSF foundation and necessary construction material. The scope of the field investigation included the following:

- Characterize the existing tailings and estimate the depth to the natural ground contact beneath the tailings piles
- Characterize the near surface natural soil and rock materials around the project site to a depth of approximately 40 feet below ground surface (bgs)
- Assess subsurface material and waste rock characteristics to determine their suitability for use as construction materials
- Estimate excavation requirements for site grading and the availability of required construction materials

The geotechnical investigation was completed January 3 through January 20, 2017. The field investigation included 16 boreholes, eight within Tailings Piles 1 through 4 and eight in the surrounding areas. A surface based geophysical survey was completed to measure both the compressional wave velocity (refraction) and shear wave velocity (MASW) of the materials. Additionally, 38 test pits were completed within the project limits to determine potential borrow sources for construction materials, albeit, due to limited access a comprehensive borrow investigation could not be conducted. Select samples collected from the investigation were sent to the NewFields' laboratory in Elko, Nevada for testing.

All borehole and test pit locations were surveyed by NewFields using a handheld GPS unit. The geophysical lines were staked in the field by AMI's contracted surveyor prior to the investigation. Ground surface elevations of the borings and test pits were determined by interpolation of contour maps provided by AMI. The locations of the boreholes, test pits and geophysical lines are presented in Drawing A030.

All soils were classified in the field and field logs were prepared. These logs contain visual classifications of the materials encountered, in addition to the geologist/engineer's interpretation of the subsurface conditions between samples. The final borehole logs represent the interpretation of the subsurface conditions at the exploration locations, based on data from the field logs, laboratory tests and observation of the samples.

3.1.1. Boreholes

Boreholes were drilled to depths ranging between 17 and 57 feet bgs with a track-mounted CME 850 drill rig. All borings in soil were advanced using 4¼-inch inside diameter hollow-stem auger (HSA). During auger drilling, standard penetration test (SPT) driven samples were obtained using the standard split-barrel sampler (1.38-inch ID) and a larger brass lined split-barrel modified California sampler (3-inch OD / 2.5-inch ID). A 140-pound automatic trip hammer with a drop height of 30 inches was used to drive the samplers. Generally, the SPT is performed by driving the sampler 18 inches into the subgrade with the hammer. The hammer blows are counted and recorded for each 6-inch increment of the test. The first 6-inch increment is the seating increment, and the penetration resistance, or raw N-value, is determined by the sum of the blow counts for the second and third 6-inch increments. In areas of rock, where HSA drilling could not be advanced, HQ3 rock coring was performed. A continuous rock core sample was obtained using a 5 feet core barrel. After the rock sample was visually logged, the core was placed into a core box and photographed. Borehole abandonment consisted of 20 percent solids bentonite grout in the tailings piles and cement-bentonite grout in all the other boreholes for the entire length of each penetration. All borehole logs are presented in Appendix D.

Eight of the 16 boreholes were advanced in Tailings Piles 1 through 4 (Drawing A030). Samples were retained for geotechnical and geochemical laboratory analysis; all geochemistry data review and analysis was performed by others. Samples collected from SPTs had soil pH and electrical conductivity (EC) measured in the field. Measurements were taken with a soil pH meter and by mixing a small amount of sample with distilled water and measuring the EC after some time was allowed for particulates to settle. These measurements were used to identify the transition from tailings to the natural ground beneath the deposits.

3.1.2. Test Pits

A total of 38 test pits were excavated to assess potential borrow sources for construction materials. The test pits were excavated with John Deere 180G LC and John Deere 350D excavators to a maximum depth of 20.5 feet bgs. Disturbed samples were collected of the materials encountered for laboratory testing. Test pit logs are presented in Appendix D.

3.1.3. Geophysical Survey

Geophysical surveys were completed to determine seismic wave velocities of the subsurface materials to depths of approximately 150 feet. The surveys included both seismic refraction measurements to determine P-wave velocities, and a multi-channel analysis of surface waves (MASW) to determine S-wave velocities. The data from the surveys was utilized to identify the transition from tailings to natural ground beneath the existing tailings piles, also to estimate the rippability of near surface rock, and also to determine the elastic moduli of subsurface materials. Twelve transects were selected for evaluation. The geophysics report is included in Appendix E.

3.2. Laboratory Test Work

Samples obtained during the field investigation were sent to NewFields' laboratory in Elko, Nevada where the majority of testing was completed. 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)
- In-Place Density and Moisture (ASTM D2937)
- Soil Compaction Tests
  - Standard Proctor (ASTM D698)
  - Modified Proctor (ASTM D1557)
- Hydraulic Conductivity (ASTM D5084 / USBR 5800)
- Unconfined Compressive Strength (ASTM D2166)
- Direct Shear (ASTM D3080)
- Soil Liner Interface Direct Shear Testing (ASTM D5321)

The purpose of the testing program was to characterize the materials encountered during the field investigation, confirm field interpretation of the materials, and to develop engineering parameters to aid with the design evaluations. Individual laboratory sheets for all tests performed are included in Appendix F, and a summary of the soil classification tests, natural density, and natural moisture results is included on Table F-1 for boreholes and Table F-2 for test pits, in Appendix F.

3.2.1. Index Properties

The index properties of soils were evaluated by particle size analyses and Atterberg limits testing, which 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).

Results indicate that the soil materials encountered in the boreholes and test pits were predominantly composed of sand with fine-grained silt and clay particles. Atterberg limits results for tests completed on the existing tailings indicate a PI ranging from nonplastic (NP) to 30, with an average of 8.0. In general, the fines within the existing tailings are low plastic.

Atterberg limits results for the samples completed on natural ground materials indicate a PI ranging from NP to 34, with an average of approximately 13. In general, the fines within the natural ground are low to medium plastic.

3.2.2. Compaction Tests

The relationship between unit weight (density) and moisture was established for the existing tailings and natural materials with the Proctor test. The modified Proctor test (ASTM D1557) was performed on natural materials and the standard Proctor test (ASTM D698) was performed on existing tailings samples. Two existing tailings samples from test pits TP-24 and TP-25 were tested using both methods. Results were used to guide the moisture requirements for construction materials and to assess the need to dry back the existing tailings prior to placement.

3.2.3. Los Angeles Abrasion Tests

The L.A. abrasion test (ASTM C131) is used to determine the toughness and abrasion resistance of aggregates. Aggregate toughness and abrasion resistance is a concern primarily during the production and placement of the material, as breakdown during handling can have detrimental impacts on the material properties. Three samples were tested with results indicated between 35 to 60 percent loss.

3.2.4. Hydraulic Conductivity

The hydraulic conductivity (permeability) of remolded samples from the test pit program was measured using both flexible wall and rigid wall permeameters. In general, finer-grained materials were tested in the flexible wall apparatus and coarser materials were tested in the rigid wall apparatus. Results from the tests are listed in Table 3.1.

Flexible wall samples were remolded to approximately 95 percent of the maximum dry unit weight as determined by standard or modified Proctor compactive effort at the optimum water content. Samples were back saturated, consolidated and the hydraulic conductivity was measured using falling head-increasing tailwater methods (ASTM D5084 Method C).

Rigid wall samples were screened over a No. 4 sieve and saturated prior to testing as per USBR 5600. The test was completed in three sequential stages with normal stresses from 0 to 6,000 and 12,000 psf.

TABLE 3.1 – HYDRAULIC CONDUCTIVITY TEST DATA

Location	Depth (feet bgs)	Apparatus Type	Material Type	USCS Group Symbol	Effective Stress (psi)	Hydraulic Conductivity (cm/sec)
TP-06	1 - 3	Flex-Wall	Natural	CH	5	2.3E-07
TP-08	4	Flex-Wall	Natural	SC	5	8.9E-05
TP-13	1 - 3	Rigid Wall	Natural	GP	0	1.0
					42	2.4E-01
					83	1.1E-01
TP-24	4 - 7	Flex-Wall	Tailings	SC	5	1.3E-05
					20	7.2E-06
TP-25	8 - 10	Flex-Wall	Tailings	CH	5	1.5E-08
TP-32	11.5 - 14	Flex-Wall	Natural	CL	5	2.7E-05
					20	2.6E-06
TP-47A	3 - 4	Flex-Wall	Natural	SC	5	7.3E-07
TP-48	0 - 4	Flex-Wall	Natural	SC	5	5.4E-06
TP-51	1 - 2	Flex-Wall	Natural	GC	5	4.1E-05

Hydraulic conductivity results indicate that a number of the materials tested exceed the 1×10^{-6} cm/sec requirement for low permeable materials. As an example, samples from TP-06 and TP-

47A meet the low permeability criterion with 2.3 x 10^{-7} and 7.3 x 10^{-7} cm/sec, respectively. Confining pressures were not typically increased to observe if a reduction in permeability would occur since loading conditions vary across the proposed dry stack TSF. The rigid wall test completed on coarse material experienced an order of magnitude reduction in permeability as the material was initially loaded, but further reductions under additional stress were noted.

3.2.5. Direct Shear

Consolidated drained direct shear tests (ASTM D3080) were conducted on a variety of intact and remolded materials collected during the field investigation program. The cohesiveless samples were sheared at a rate of 0.02 inches per minute and the cohesive samples at a rate of 0.001 inches per minute. Testing was continued until approximately 15 percent strain, was achieved. Normal loads applied during testing ranged from 500 to 6,800 pounds per square foot (psf) on the cohesiveless samples, and 2,000 to 16,000 psf on the cohesive samples. Mohr-Coulomb strength parameters developed from the test data are summarized in Table 3.2.

TABLE 3.2 –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
TP-38	0 - 7	Remolded	Natural	ML	32.2	0

3.2.6. Unconfined Compressive Strength

Unconfined compressive strength testing of cohesive soils (ASTM D2166) was conducted on undisturbed Shelby tube specimens using strain-controlled application of the axial load. A load was applied continuously and without shock to produce a constant rate of strain of 1.0 percent strain per minute. Continuous loading was applied until 20 percent strain was achieved. Both the axial force and the axial deformation during the test were recorded.

The unconfined compressive strength (q_u) is taken as the maximum load attained per unit area or the load per unit area at 15 percent axial strain, whichever is secured first during the test. The shear strength (s_u) is calculated to be half of the compressive stress at failure. Specimens from BH-01 exhibited strain softening behavior; the peak shear strength occurred at 10-12 percent strain. Specimens from BH-02, being in a relatively soft state, exhibited strain hardening behavior; the peak shear strength was assumed at 15 percent strain. The results of the unconfined compressive test are summarized in Table 3.3.

TABLE 3.3 – UNCONFINED COMPRESSION TEST RESULTS

Location	Depth (feet bgs)	USCS Group Symbol[1]	Specimen Location	Moisture Content (%)	Dry Unit Weight (psf)	Unconfined Compressive Strength, q_u (psi)	Peak Strain (%)	Undrained Shear Strength, s_u (psi)
BH-01	46.5 – 49	ML	Top	32.6	95.3	14.2[2]	11.3	7.1[2]
			Middle	31.0	98.3	9.9	10.8	5.4
			Bottom	32.5	95.2	13.0	11.5	7.5
BH-02	26.5 – 29	ML	Top	35.9	88.0	**[3]	**[3]	**[3]
			Middle	41.7	83.6	5.8[4]	15.0	2.9
			Bottom	40.0	87	5.8[4]	15.0	2.9

Notes:

1. Based on visual classification.
2. Sample does not meet the Height/Diameter ratio of 2 to 2.5.
3. Sample was disturbed during extrusion and not tested.
4. Value at 15% Strain

3.2.7. Interface Shear Strength

A large-scale direct shear (LSDS) test was used to evaluate the shear strength of a selected sample placed against 60 mil double sided textured HDPE geomembrane under a range of anticipated loads. The geomembrane utilized in the tests was the microspike product manufactured by AGRU America and the soil was sheared across the "dull" side.

A 12-inch diameter shear box was used for the test. A clayey sand (SC) soil sample from TP-47A was selected from one of the potential local borrow sources. The soil was placed in the upper shear box and compacted to 95% of the maximum modified Proctor dry unit weight and approximately two percent over the optimum moisture content. 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 at a rate of 0.004 inches per minute.

Interpreted peak and residual strength values are shown in Table 3.4 and the laboratory data sheets are presented in Attachment F.

TABLE 3.4 – INTERFACE SHEAR TEST RESULTS

Soil Sample	USCS		Peak Strength		Residual Strength	
			ϕ (deg)	C (psi)	$\phi_{Residual}$ (deg)	$C_{Residual}$ (psi)
TP-47A	SC		22	1540	15	1250

4. ARIZONA AQUIFER PROTECTION PERMIT (APP) PROGRAM

The Arizona APP application process is administered by the Arizona Department of Environmental Quality (ADEQ) in accordance with Arizona Revised Statute (A.R.S.) 49-241 to ensure that a regulated facility is designed, constructed and operated so that there will be no migration of pollutants directly to the aquifer or vadose zone. The design and construction for the Tailing Storage and Underdrain Collection Pond Facility utilize the Best Available Demonstrated Technology (BADCT) in accordance with A.R.S. 49-243.B.1.

The Trench Camp Property Tailings Piles 1 through 4 are currently unlined facilities containing tailings and PAG waste rock. The intent of the IFC design presented herein as part of the APP application submittal process is to relocate the tailings piles including impacted material immediately below the tailings piles onto a geomembrane lined permanent dry stack TSF. Relocation of the existing tailings, waste rock (that exists in Tailing Pile 1) and impacted soils beneath the tailings piles will effectively remove current sources for low pH seepage in the area. Relocating the tailings piles to a lined TSF that is designed to stabilize the existing tailings through drying, compaction and stacking in a engineered earthen structure and placing a closure cover on the stacked tailings will result is minimizing infiltration into the tailings, thereby reducing seepage from the tailings. The small amount to seepage predicted from the closure will be sent to a treatment system prior to release to the environment post closure. Described herein is the tailings management approach to relocate the existing tailings and PAG waste rock onto the geomembrane lined dry stack TSF.

The first action of the remediation plan involves excavation of Tailings Pile 1 and subsequent temporary placement of the excavated materials onto Tailings Piles 2 and 4. The relocation of Tailings Pile 1 allows for Stage 1 of the dry stack TSF to be constructed. A detailed sequence of construction related to this APP application submittal can be referenced in Section 10.0.

The temporary placement geometry for 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. The temporary placement plan can be referenced on Drawing A055. The relocation volume of pile 1 is presented in Table 4.1. No historic topographic data underlying the tailings piles is available; volumes of materials have been estimated based on the data gathered during the geotechnical investigation (boreholes and geophysics).

After Stage 1 TSF construction is complete, material from Tailings Piles 1, 2 and 4 will be transported to the lined TSF. The material from Tailings pile 1 will require double handling as part of this construction sequence to allow the Stage 1 TSF to be constructed where the Tailings

Pile 1 was previously located. The material will be excavated, hauled, manipulated to reduce moisture content (as needed) and mechanically compacted as a standard earthen material on Stage 1 of the lined TSF. The relocation volume of piles 1, 2 and 4 are presented in Table 4.1. These materials will be placed in horizontal lifts within the basin and compacted to a target density of approximately 104 pcf or 90% of the maximum dry density as determined by the standard proctor (ASTM D-698). The tailings stacking is designed with exterior compound slopes of 3H:1V, which are comprised of 2.5H:1V open slopes with 12.5 ft wide benches every 25 ft in vertical rise. The proposed stacking plan of the completed Stage 1 TSF can be referenced on Drawing A160.

The Stage 2 TSF construction may begin after the removal of the tailings piles located within the Stage 2 TSF basin. After completion of the Stage 2 expansion of the TSF, Tailings Pile 3 will be relocated. This material will be handled in a similar manner to the Stage 1 materials to meet handling and placement requirements as defined in the Technical Specifications.

TABLE 4.1 – TAILINGS PILES RELOCATED VOLUMES

Stage	Material Volumes (tons)				Material Source
	Tailings	Waste Rock	Native Material	Total Material	
Tailings Pile 1 on Tailings Pile 2 and 4 (Temporary Condition)	112,800	223,600	15,500	~352,000	Tailings Pile 1
Stage 1 TSF	112,800	223,600	15,500	~1,036,000	Tailings Pile 1
	649,900	0	33,700		Tailings Piles 2 and 4
Stage 2 TSF	213,800	0	12,300	~227,000	Tailings Pile 3

Note: Native material volume estimated based on 1 foot of over excavated material.

5. TSF DESIGN

The facility has been designed as a lined permanent storage area for remediation of the Tailings Piles 1 through 4 currently located on the Trench Camp property and exploration ramp and shaft PAG development rock. The dry stack TSF is sited in the northern portion of the Trench Camp property, located to the east and north of Flux Canyon Road and to the west of Harshaw Road. All the materials placed in the TSF are to be placed and compacted as an earthen material.

The facility will be split into 2 stages utilizing the Stage 1 and Stage 2 perimeter roads, which will be constructed with upstream slopes of 2.5H:1V (Horizontal:Vertical) and downstream slopes of 2.0H:1V. The basin and interior slope of the perimeter road are designed with a composite liner system consisting of low permeability soil layer (LPSL) and/or Geosynthetic Clay Liner (GCL) overlain by a HDPE geomembrane. To protect the geomembrane, reduce head/hydraulic gradient on the liner and to facilitate long-term drainage of the tailings, a granular protective layer is designed over the liner and augmented by a dendritic, CPe pipe network placed in topographic lows. A concrete encased underdrain outlet will be constructed underneath the perimeter road and underdrain flows from the facility will be directed via gravity to the Underdrain Collection Pond. Water collected in the Underdrain Collection Pond will be pumped to the WTP for treatment and used for exploration drilling makeup water, other operational uses, or released to Alum Gulch downgradient of the WTP once water quality meets ADEQ water quality standards.

5.1. TSF Sizing

The TSF was sized based on the following criteria:

- Two stage facility
- Stage 1 TSF storage capacity of approximately 1.2 Mtons
  - Capacity for Tailings Pile 1 (352,000 tons)
  - Capacity for Tailings Piles 2 and 4 (684,000 tons)
  - Capacity for development rock from exploration ramp and shaft (176,400 tons)
- Stage 2 TSF cumulative storage capacity of approximately 2.58 Mtons
  - Capacity for Tailings Piles 1, 2, 3 and 4 (1,263,000 tons)
  - Capacity for exploration ramp and shaft PAG development rock (1.0 Mtons)
  - Contingent capacity (0.3178 Mtons)
    - May be utilized for additional Tailings Piles 1, 2, 3 or 4 impacted material if actual excavation limits are larger than anticipated or if natural density/compacted densities vary from the samples tested during the geotechnical investigation

    - May be utilized for additional ramp and shaft PAG development rock

- Average in-place target material (dry) density
  - 104 pcf for tailings in Tailings Pile 1, 2, 3 and 4 based target density of 90% maximum dry density (Standard Proctor ASTM D-698)
  - 115 pcf for waste rock in Tailings Pile 1 based on typical waste rock density
  - 125 pcf for exploration ramp and shaft PAG development rock based on typical development rock 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 the Tailings Pile material to be generally configured based on an 118 ft internal offset from the interior edge of the perimeter road
  - Offset stacking to provide an area for future filtered tailings from the proposed mine operation to encapsulate the tailings piles material with more geochemically stable tailings
  - Some areas that are considered internal from Stage 1 to Stage 2 have a lesser offset because the stacking face will be covered

5.2. Primary Design Components

The design of the TSF consists of the following elements:

- Perimeter Road
  - Foundation preparation, removal of low strength and deleterious material
  - Constructed from cut/fill operations within the TSF basin, stormwater diversion channel, TSF Underdrain Collection Pond and water treatment plant
  - Composite lined interior face consisting of 60 mil HDPE geomembrane overly either a 12 inch thick LPSL or GCL
- Basin
  - Foundation preparation and grading for geomembrane placement
  - Composite lining system consisting of 60 mil HDPE geomembrane overlying 12 inches of LPSL or GCL
  - 18 inches of protective layer material over geomembrane liner
  - Underdrain system in topographic lows

  - Relocation of existing tailings piles on top of geomembrane liner
- Underdrain Outlet and Collection Pond
  - Located downstream of the proposed TSF to collect TSF basin underdrain flows via gravity as well as storm water flows from the TSF
  - Pumped solution recovery system located on the pond slope for evacuation of water to the WTP
  - LCRS with submersible pumping system to evacuate any leakage that may occur through the primary geomembrane
  - Lining system consisting of geonet sited between two 60 mil HDPE geomembrane layers all overlying 6 inches of LPSL or GCL (the upper most geomembrane is referred to as the primary geomembrane and the lower most geomembrane is referred to as the secondary geomembrane)
  - Flows from the TSF will be conveyed to the pond via a concrete encased underdrain outlet to direct flow from the TSF and under the perimeter road
    - Valves are placed at the concrete encased underdrain outlet to eliminate flow to the Underdrain Collection Pond if the pond needs to be pumped dry for repairs
    - Runoff from the TSF is directed to the Underdrain Collection Pond through internal TSF detention areas which are drained by detention outfall pipes and direct flow through the concrete encased underdrain
  - Pipe in pipe containment outside of the TSF concrete encased underdrain outlet
  - An emergency spillway has been will be constructed as part of the Underdrain Collection Pond facility
- Relocated Tailings Piles 1 through 4
  - 3.0H:1V compound slope comprised of 25 ft high 2.5H:1V slopes in combination with a 12.5 ft bench
  - Internal stormwater diversion channel to pass 100-yr/24-hr storm event with 2 ft of freeboard
  - Cover material on existing tailings piles to be temporarily stockpiled and placed on top of relocated existing tailings piles
  - Rock armored exterior (exploration ramp development material)
- Instrumentation
  - Piezometers and monitoring wells will be used to monitor the facility
- Stormwater Management

    - External stormwater diversion channels located upstream and along the periphery of the TSF to collect and transmit runoff from meteoric storm events
    - External stormwater diversion channel to pass 100-yr/24-hr storm event with 1 ft of freeboard
- Realignment of Flux Canyon Road adjacent to Underdrain Collection Pond and TSF
    - 24 ft wide road
    - 6 inches of wearing course

5.3. Pre-Closure Site Preparation

Growth media will be removed and stockpiled for future reclamation prior to construction activities as presented in Drawing A010. The growth media storage material will be placed at a 3H:1V slope and revegetated. Best management practices (BMP's) will be employed to minimize erosion and sediment transport such as control of surface runoff and installation of silt fencing around the downstream perimeter toe. After removing growth media, the basins will be graded to reduce slopes for liner system placement, generate borrow materials for perimeter road construction and promote flow to the basin low point.

5.4. Perimeter Road

The TSF is circumscribed by a perimeter road which is used to provide light vehicle access, passive slope stability resistance, as well as contact water containment. Contact water is considered any water which comes in contact with the historic tailings/waste rock. The perimeter road was designed considering the following parameters:

- 2.5H:1V upstream side slopes
- 2.0H:1V downstream side slopes
- 25 ft total width measured from internal to external edge of road
    - 16 ft driving width with 6 inches of wearing course
    - (2) 1.5 ft high safety berms
    - 3 ft horizontal distance for geomembrane anchor trench
- 15 percent maximum grade for light vehicle travel
- Elevated road to create passive resistance for the toe of the dry stack tailings

The perimeter road subgrade will be prepared prior to construction by clearing, grubbing and removal of unsuitable materials encountered, including existing tailings, existing PAG waste rock, organics, low strength materials and soils that have high propensity for consolidation. Once the foundation is stripped of vegetation, growth media and other deleterious materials the exposed soils will be scarified, moisture conditioned if necessary and compacted to form a firm and unyielding surface in preparation for fill placement. The subgrade will be compacted to a minimum depth of six inches to 95 percent maximum dry unit weight (Standard Proctor ASTM D-698) following the prescriptive BADCT 2.5.2.3 or as required by the engineer. Upon completion of the perimeter road subgrade, perimeter road fill placement will occur to the grades, elevations and geometry shown in the Design Drawings. The interior face of the perimeter road will utilize a composite liner system consisting of a 12 inch LPSL or GCL overlain by a 60 mil HDPE geomembrane (BADCT 2.5.2.4). The interior face liner will tie into a continuous liner system within the basin. The composite liner system is described in greater detail in Section 5.5.2.

Detailed requirements regarding the perimeter road subgrade preparation and fill placement are presented in the Technical Specifications (Appendix G). The plan and profile of the Stage 1 perimeter road can be referenced on Drawing A110 and A135, respectively. The plan and profile of the Stage 2 perimeter road can be referenced on Drawing A200 and A220, respectively. Typical TSF perimeter road sections can be referenced on Drawings A300 and A310.

5.5. Basin

Prior to placement of the liner system, the area will be cleared of any vegetation and stripped of any existing growth media. Growth media will be hauled to a dedicated storage area located west of the TSF for use during reclamation.

The existing topography generally slopes to provide drainage to the underdrain collection outlet point, however, some grading will be required to address localized drainage issues to ensure positive drainage within the basin. Additionally, localized slopes will be reduced to provide an acceptable slope to install liner. After the basin has been graded, a 12-inch thick layer of LPSL material or GCL will either be placed on existing ground or if it is present at rough grade within the basin, will be scarified, moisture conditioned and recompacted in place. A 60 mil HDPE geomembrane liner will be placed over the LPSL material.

The basin areas for the two stages are as follows:

- Stage 1 – 680,000 ft^2
- Stage 2 – 580,000 ft^2
- Total – 1,260,000 ft^2

Typical details of the basin composition can be referenced on Drawing A320 and more detailed descriptions of the basin components are discussed in the following subsections

5.5.1. Grading Plan and Geomembrane Surface Preparation

In general, the basin will be graded to have maximum slopes of 2.5H:1V and upon completion of the rough grading, the surface will be smoothed and compacted with a vibratory roller. This will create a usable surface for placement of the liner system, and will also bed any larger stones into the subgrade, preventing any unbedded sharp protrusions which might translate through the LPSL or GCL of the composite liner system and result in liner stress.

5.5.2. Liner System

The basin liner system will consist of a composite liner, containing both a soil liner LPSL or GCL) and geomembrane liner (60 mil double sided textured HDPE). The soil component, 12 inches of low permeability soil, will have a coefficient of permeability that is less than or equal to 1.0 x 10^{-6} cm/sec. The low permeability soil material will be placed, moisture conditioned and compacted to produce a smooth, unyielding surface prior to geomembrane liner deployment. A GCL (Cetco Bentomat DN or similar) is considered an acceptable alternative to the 12-inch LPSL, but geotechnical considerations prevent its use throughout the entire facility. See Section 6.7.4 for more information pertaining to GCL as a construction material. The geomembrane liner component will overlie the soil component and will consist of a double sided textured 60 mil HDPE geomembrane. The geomembrane will be anchored in the perimeter road at a setback of 3 ft with trenched dimensions of 3 ft deep by 2 ft wide.

Due to stability of the TSF, see Section 7.0 for additional details, GCL is not permitted as an approved alternative for LPSL material in Stage 1. However, it may be used as an alternative in Stage 2.

The composite liner system is designed to eliminate seepage through the base of the TSF. It is commonly employed in the mining industry and has been proven to be effective for environmental control of contact fluids. Based on laboratory data the seepage fluid from the existing tailings and PAG waste rock will be somewhat variable. The majority of fluid contacting historic tailings will have near neutral pH and moderate levels of total dissolved solids dominated by calcium sulfate salts. Water contacting waste rock will be slightly acidic and far below the acidity threshold that is tolerated by the geomembrane. See Appendix G.1 for information specific to polyethylene geomembrane chemical resistance. The liner limits are presented on Drawing A120 (Stage 1) and A210 (Stage 2) and the liner sections and details are presented on Drawing A320.

Leakage flow rates were calculated based on principles from Giroud et al. (1997) using a formula for the "Equations for Calculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects." Using the inputs in Table 5.1, the leakage flow rates for Stage 1 and Stage 2 were calculated. For further details, see the leakage rate calculation presented in Appendix H.1.

TABLE 5.1 – TSF LEAKAGE FLOW RATE

Location	Stage 1 (LPSL)	Stage 2 (GCL)
Number of Defects	2 per acre	2 per acre
Contact Quality Factor	0.21	0.21
Area of Circular Defect	1.08E-3 ft^2 (1 cm^2)	1.08E-3 ft^2 (1 cm^2)
Hydraulic Head Above Geomembrane	1.5 ft	1.5 ft
Area of Geomembrane	678,700 ft^2	576,800 ft^2
Permeability of Underlying Soil Layer	3.28E-8 ft/sec (1.0E-6 cm/s)	3.28E-9 ft/sec (1.0E-7 cm/s)
Leakage Rate	0.0245 gpm	0.0038 gpm

5.5.3. Protective Layer

An 18 inch protective layer composed of 1 1/2 inch minus granular material will be placed over the geomembrane. The protective layer will serve to prevent damage to the geomembrane during tailings placement. In addition the protective layer will act as a drainage layer to reducing head on the geomembrane by collecting and transmitting tailings seepage to the underdrain system. Typical TSF protective layer sections and details are presented on Drawing A320.

5.5.4. Underdrain Collection System

As the tailings will be placed as an earthen material at water contents significantly below saturation, minimal solution is expected to be generated. Disking may be necessary to promote drying and to achieve target placement moisture content. The well-compacted tailings material placed near optimum moisture content will produce hydraulic conductivities near 1×10^{-6} centimeters per second and will have an in-place moisture content very similar to the residual moisture level and therefore tailings seepage will be nominal. There is a small risk that some fluids may be generated at the base of the facility from consolidation of the tailings over time and percolation of direct precipitation from the tailing surface, but the head on the liner is expected to be quite small.

The underdrain collection system, consisting of a series of pipes located in topographic lows, will collect drainage from the base of the facility and convey any flow to the Underdrain Collection Pond via the concrete encased underdrain outlet pipe work. The underdrain pipe will be used to augment the performance of the protective/drainage layer and reduce hydraulic head over the liner. The underdrain collection pipes will be perforated CPe pipe surrounded by select gravel all wrapped in non-woven geotextile. The select gravel wrapped in non-woven geotextile will be used to encapsulate the pipes in order to resist the migration of the tailings material into the underdrain system. Approximate pipe alignments and pipe sizes for the underdrain collection system are presented on Drawing A140 (Stage 1) and A228 (Stage 2). Underdrain collection pipe sections and details are presented on Drawing A320.

The underdrain collection system was designed considering the following:

- Collect underdrainage from the tailings due to consolidation
- Decrease the overall hydraulic head on the geomembrane liner to a maximum of 18 inches, reducing the propensity for seepage through the liner system
- Allow for long-term drainage of the tailings mass through the closure period
- Although the material is placed at moisture contents well below saturation, the underdrain collection pipe spacing was based on a hydraulic gradient of unity which is conservative

The underdrain collection system is designed with 4 inch perforated CPe piping spaced at 90 ft on center and located at the perimeter berm upstream toe as well as 8 inch and 12 inch perforated CPe collection headers located in the topographic lows. The piping is designed to limit hydraulic head on the liner to no more than 18 inches. The existing tailings permeability was determined through laboratory evaluation of the existing tailings material collected from the geotechnical investigation. Refer to Appendix H for design calculations.

5.5.5. Basin Underdrain Outlet

At the underdrain outlet point (upstream toe of the perimeter road), the perforated underdrain collection pipes will transition into a solid reinforced concrete encased HDPE pipe. The geomembrane liner at the upstream embankment face will be attached to the concrete encasement by heat fusing the liner to an HDPE batten strip embedded into the concrete. The concrete encased outlet pipe will be routed under the perimeter road where it will transition to pipe in pipe containment which extends to the Underdrain Collection Pond. At the outlet point, valves will be installed to control flow to the Underdrain Collection Pond. A plan and profile of the concrete encased underdrain outlet pipe can be referenced on Drawing A150 and a section on Drawing A320.

It is important to note that the valves placed at the inlet to the Underdrain Collection Pond must remain completely open unless the Underdrain Collection Pond needs be pumped completely dry for repairs. Shutting the valves has a potential to create an elevated phreatic surface which could compromise the stability of the dry stack. If the valves need to be closed, the engineer will be notified prior to closing.

5.6. Underdrain Collection Pond Design

The Underdrain Collection Pond will be constructed downstream of the TSF and have the following design components:

- Constructed from cut/fill operations
- 25 ft wide perimeter access road around crest
- Liner system consisting of geonet sited between two 60 mil HDPE double sided textured geomembrane layers overlying 6 inches of LPSL ($k \leq 1x10^{-6}$ cm/sec) material
- 1.5H:1V daylight rock cut slope around the pond
- 2.0H:1V daylight fill slope around the pond
- 2.0H:1V internal pond slope
- Pond bottom graded at 1.0% minimum to pond sump
- Sloping decant structure housing a submersible pump for water extraction to WTP
- LCRS for recovery of any flows should the primary liner experience any punctures or defects that might transmit flows

- 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 as specified by ADWR

The Underdrain Collection Pond is sized to store the following:

- 100-yr/24-hr storm event runoff from the TSF (ADEQ requirement)
- 100-yr/24-hr direct precipitation over the pond area (ADEQ requirement)
- Drain down from the TSF
- Minimum of 5 feet of total freeboard and/or the IDF maximum water depth above the spillway invert crest plus 3 feet, whichever is greatest (ADWR requirement)
- 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
- 2,200,000 gallons of maximum operational volume

The Underdrain Collection Pond embankment subgrade will be prepared prior to construction by clearing, grubbing and removal of unsuitable materials encountered including organics, low strength materials and soils that have a high propensity for consolidation. In general, foundation areas are expected to be removed to expose bedrock or other durable subgrade as approved by the Engineer. Exposing bedrock will also satisfy the BADCT foundation standard for a firm unyielding surface to receive fill. If soils are encountered in the foundation area that are considered by the design engineer to be satisfactory for fill placement the material will be scarified 6 inches deep and compacted to a minimum of 95 percent of the maximum dry unit weight. In addition, the compacted soil surface will be proof rolled to verify that the compacted surface is firm and unyielding under equipment loads prior to any fill placement. This requirement satisfies the foundation treatment approach outlined in BADCT 2.3.2.3. Upon completion of the Underdrain Collection Pond embankment subgrade, fill placement will occur to the grades, elevations and geometry shown in the Design Drawings.

The Underdrain Collection Pond crest measures approximately 200 ft wide by 345 ft long and 42 ft deep. The pond is designed with a 25 ft wide perimeter access road around the crest which widens to 50 ft on the southern edge where the pumps are sited for pump maintenance that may be required. The underdrain pond is sized to contain 8,900,000 gallons up to the spillway elevation while maintaining a minimum of 7 feet of total freeboard. The pond slopes will be 2H:1V, and the bottom of the pond will be graded at 1% to a low point in the corner of the pond. At the low point, two parallel sloping decant structures will be constructed for housing a submersible pumps to reclaim fluids for treatment at the Water Treatment Plant (See Section 5.6.1).

The pond liner system consists of geonet sited between two 60 mil HDPE double sided textured geomembrane layers overlying 6 inches of LPSL material. The pond will have a LCRS, where a gravel filled sump will be placed in the low-point of the pond, between the geomembrane liners. Geotextile will be used to encapsulate the gravel as an added layer of protection of the liner system. In the unlikely event of seepage through the primary liner, a 4-in diameter perforated CPe collection pipe will be placed along the interior toe of the pond slopes to collect and quickly convey any lateral seepage flows to the sump. Any potential leaks will be detected through the use of water level switches and be removed from the sump using a submersible pump. A sloping decant consisting of an HDPE pipe will extend down the slope of the pond between the primary and secondary geomembrane liners and will terminate in the sump. A submersible pump will be inserted in the decant pipe to remove any solution collected between the primary and secondary liners. Sections and details of the LCRS system can be referenced on Drawings A400 and A420.

Potential primary geomembrane leakage flow rates were calculated to determine alert level 1 (AL1), alert level 2 (AL2) and LCRS flow rates. Leakage flow rates were calculated based on principles from Giroud et al. (1997). The area of geomembrane and hydraulic head above the geomembrane is based on 2 feet below the spillway invert. Using the inputs in Table 5.2, the leakage flow rates for AL1, AL2 and LCRS capacity were calculated. For further details, see the leakage rate calculation presented in Appendix H.1.

TABLE 5.2– LCRS LEAKAGE FLOW RATE

Location	Alert Level 1 (AL1)	Alert Level 2 (AL2)	LCRS Design Capacity
Number of Defects	1 per acre	1 per acre	1 per acre
Area of Circular Defect	1.08E-4 ft^2 (10 mm^2)	1.08E-3 ft^2 (1 cm^2)	1.08E-3 ft^2 (1 cm^2)
Hydraulic Head Above Geomembrane	42.0 ft	42.0 ft	42.0 ft
Area of Geomembrane	68,994 ft^2	68,994 ft^2	68,944 ft^2
Leakage Rate	2.4 gpm	15.9 gpm	23.9 gpm
Note: AL2 was calculated based on a safety factor of 1.5 utilizing the same inputs as the LCRS Design Capacity			

In order to satisfy ADWR dam permit requirements, an Underdrain Collection Pond spillway has been designed to safely pass flows resulting from the routed IDF while maintaining 3 ft of freeboard in the spillway. The spillway is located on the north side of the pond and created from rock cut. Layout and details of the pond and its design components can be referenced on Drawings A400 through A420. AMI will obtain a Dam Safety Permit from ADWR for the construction and operation of Underdrain Collection Pond. The application is currently under review.

The slopes around the Underdrain Collection Pond will be cut back at a 1.5H:1V approximately 140 feet in height removing approximately 50 feet near the base. Based on data collected during the geotechnical investigation, including rock encountered in borehole BH-14 and the site-wide geophysical survey, NewFields is of the opinion this slope is stable. However, monitoring during construction must be completed by qualified personnel to observe features within the rock mass that would cause concern to reduce the slope.

5.6.1. Underdrain Collection Pond Upstream Watersheds

The remediation project will be constructed in three stages, each of which alters the watersheds within the TSF basin upstream of the Underdrain Collection Pond. This section describes how the TSF staging impacts the watersheds which produce runoff that reports to the Underdrain Collection Pond. Listed below is a summary of TSF staging, for detailed water balance information refer to Section 8.

- Stage 1 TSF (Prior to Existing Tailings Piles 1, 2 and 4 relocated to TSF)
  - Watersheds reporting to the Underdrain Collection Pond include Stage 1 TSF (geomembrane/protective layer) and existing ground watershed upgradient of TSF (existing ground and Tailings Pile 2/4)
- Stage 1 TSF (After Existing Tailings Piles 1, 2 and 4 relocated to TSF)
  - Stage 1 external detention basin constructed to capture runoff from TSF upgradient watershed
  - Watersheds reporting to the Underdrain Collection Pond includes Stage 1 TSF (stacked with Tailings Piles 1, 2 and 4 co-mingled with development rock from the exploration decline)
- Stage 2 TSF
  - Stage 2 external detention basin constructed to capture runoff from TSF upgradient watershed

  - Watersheds reporting to the Underdrain Collection Pond includes Stage 1 and Stage 2 TSF (stacked with Tailings Piles 1 through 4 co-mingled with development rock from the exploration decline)
- Closure
  - No runoff reports to the Underdrain Collection Pond
  - Only draindown through the dry stack TSF reports to the Underdrain Collection Pond

5.6.2. Underdrain Collection Pond Pumping System to WTP (By others)

A pump back pipe, pump and support pipes will be located in the pond sump at the southern end of the Underdrain Collection Pond to extract fluid to the WTP. All flows within the Underdrain Collection Pond will gravity drain to the pump back sump. The system will utilize a submersible pump housed at the bottom of the support pipes which extend along the pond slope from the crest to the sump. The pump back pipe is sited between the submersible pump to be used for the solution reclaim and the WTP. Upon exiting the underdrain pond geomembrane containment, the solution pumping system will provide double containment within the pond and utilizing a pipe in pipe configuration once the pipe leaves the Underdrain Pond Collection containment area. The solution pumping system will have a redundant system in a dedicated reclaim pipe that resides immediately adjacent to the primary solution pumping system. The redundant pumping system has been provided for use during periods of maintenance or for a contingency should the primary pump is not operational. The submersible pump and pump back pipe are designed by others. The support pipe system is designed by Newfields.

The support pipe system consists of a 12-inch diameter carbon steel (CS) support pipe which will rest on two 6-inch CS pipes running down the pond slope. The system is anchored at the pond crest with steel support channels and a reinforced pipe support concrete foundation. Plan view, sections and details of the Underdrain Collection Pond support pipe system can be referenced on Drawing A420.

5.6.3. Arizona Department of Water Resources (ADWR) Dam Safety

The Underdrain Collection Pond is considered a jurisdictional dam and an application for approval of the plans and specifications for the construction of a dam was submitted to ADWR. The application was submitted with the design report "Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project Underdrain Collection Pond and Embankment Design" on May 24, 2017 and is currently under review.

5.7. Rock Armoring

Rock armoring will be placed on the exterior slopes of the dry stack TSF. The rock armoring materials will consist of development rock from the exploration ramp and/or from onsite borrow yet to be fully defined. Sections of the rock armor can be referenced on Drawing A300. This material will be initially placed as rock berms that are approximately 5 ft high around the perimeter of the dry stack. Every 5 ft in vertical elevation change a new rock berm will be established thereby effectively placing the armoring material on the open slopes of the dry stack while it is being filled with tailings. Rock armoring will be placed to reduce the potential for wind and water erosion of the tailings. At closure the rock armoring will act as a capillary break between the tailings and a 1 to 2 ft layer of growth media sited on the final geometry of the TSF.

5.8. Instrumentation and Facility Performance Monitoring

Instrumentation associated with the TSF and Underdrain Collection Pond is to include piezometers, settlement monuments and a monitoring well (located downstream of the facilities) to monitor performance of the remediation project. Proposed instrument locations along with details of the instrumentation specific installation can be referenced on Drawings A040.

Piezometers P1 through P4 will be located within the TSF to measure hydraulic head on the liner system. Specifically they will be placed immediately adjacent to the geomembrane surface within the protective layer next to an underdrain collection pipe. Piezometers P5 and P6, will be placed along the maximum section of the Underdrain Collection Pond embankment at the base of the fill. One piezometer will be located directly under the embankment crest and another located at the half way point between the hinge point of the downstream crest and the toe of the downstream slope. The piezometers will be used to monitor the phreatic surface within the embankment in the unlikely event the lining system fails.

Settlement monuments will be placed on the Underdrain Collection Pond embankment crest near the maximum section and approximately 50 ft to the northeast of the maximum section line. The settlement monuments will be used to monitor any settlement of the embankment crest during the operational period.

The monitoring well located downstream of the Underdrain Collection Pond, TSF-1, is sited in an area where hydrogeological data indicates groundwater approximately 50 feet bgs. The well will be screened across the known water table interval and have an approximate depth of 100 feet with the top of screen located at approximately 40 feet bgs, 10 feet above the current top of groundwater, and extend approximately 60 feet to an ultimate depth of 100 feet bgs.

6. CONSTRUCTION MATERIALS

6.1. Engineered Fill

Engineered fill materials will be generated from mass grading activities within the TSF basin, stormwater diversion channel, TSF underdrain pond and water treatment plant. The fill is anticipated to consist primarily of fractured rock and near surface overburden soil after removal of any deleterious materials. These materials are expected to be generated as a result of ripping with a dozer. Significant variability in engineered fill should be expected across the site due to varying degrees of fracturing and weathering. 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)

The LPSL material will consist of predominantly fine-grained soils with a coefficient of permeability less than or equal to 1×10^{-6} cm/sec. Areas of low permeability soil were identified and tested but the low permeability soil construction borrow areas were not quantified during the geotechnical field program due to limited access during the field investigation driven by AMI's need to stay within permitted disturbance areas. Nonetheless, the geotechnical investigation suggests low permeability soil material exists on site but may not be available in sufficient quantity. If sufficient quantity of LPSL does not exist on site, the material will be imported from off site.

In order to reduce risk to capital cost exposure during construction and once the final design and additional area of disturbance has been approved, the on-site borrow areas for low permeability soils will need to be verified through additional borrow investigation. If sufficient quantity of low permeability soils does not exist on site, the material will be imported from off site. Quantification of on-site low permeability soil material would require additional test pitting around identified borrow areas to assess material limits, depths and ultimately quantities available on the Trench Camp property. The LPSL borrow area target are identified below.

- Potential LPSL Borrow Area 1 (TP-6)
  - Red sandy fat clay from 1 ft to 3 ft of depth
  - Depth increase to North of test pit
  - Trench Camp Property
- Potential LPSL Borrow Area 2 (TP-32)

  - Red sandy lean clay from 11.5 ft to 14 ft of depth
  - Trench Camp Property
- Potential LPSL Borrow Area 3 near TP-11 (Not sampled)
  - Sandy clay based on observation
  - Alta Property
- Potential LPSL Borrow Area 4 (TP-47A)
  - Red clayey sand with gravel from 3 ft to 4 ft of depth
  - Hermosa Property
- Potential LPSL Borrow Area 5 (TP-48)
  - Light brown clayey gravel
  - Hermosa Property

The LPSL will be placed in two 6 inch lifts, moisture conditioned and compacted to produce a smooth, unyielding surface prior to geomembrane deployment. Any rocks protruding from the finished LPSL will be removed through hand picking and the voids will be filled with replacement fine grained soil and recompacted. Details of this procedure can be referenced in the Technical Specification. The LPSL and geomembrane composite liner will be utilized throughout the TSF basin as well as the upstream face of the perimeter road. The material will be placed, compacted, and tested in accordance with the requirements outlined in the Technical Specifications (Appendix G). If sufficient quantities of LPSL is unavailable in local borrow areas, a geosynthetic clay liner (GCL) may be suitable as a substitute, pending approval by the design engineer.

6.3. Protective Layer / Drainage Layer

The protective / drainage layer (PL) material will consist of 1 1/2 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. This material will be produced either from a local import source or from on-site borrow sources. Again, due to limited access during the geotechnical investigation, an adequate protective layer borrow sources was not identified on site. Prior to construction, AMI will endeavor to find a borrow source for this material on the Trench Camp site or adjacent AMI private land. This material will be placed and tested in accordance with the requirements outlined in the Technical Specifications (Appendix G). A geocomposite drainage layer (Geonet) can be substituted for the PL if an acceptable borrow source is not locally available. This substitution would also be subject to the design engineer's approval.

6.4. Drainage Aggregate

Drainage aggregate will be placed in the finger drains located in the topographic lows within the TSF basin and in the LCRS sump area in the Underdrain Collection Pond. The drainage aggregate will be processed from an acceptable on-site borrow at or near the Trench Camp Property or from an imported location. An additional borrow investigation will be conducted prior to construction to determine if an acceptable rock borrow source can be developed on the Trench Camp property. Requirements for the drainage aggregate material can be referenced in the Technical Specifications (Appendix G). Placement geometry of the drainage aggregate can be referenced on Drawings A310, A410 and A420.

6.5. Pipe Bedding

Pipe bedding will be placed to the springline around the base of culverts and densified in accordance with the requirements outlined in the Technical Specifications (Appendix G) prior to placing pipe backfill. This material can be generated from local borrow or imported C-33 concrete sand. Placement geometry of the pipe bedding can be referenced on Drawing A525.

6.6. Pipe Backfill

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 A525.

6.7. Geosynthetics

6.7.1. HDPE Geomembrane

The entire TSF basin and the interior slopes of the perimeter road will be lined with 60 mil double sided textured HDPE geomembrane as the principal environmental containment. The geomembrane, in general will be deployed directly on top of approved LPSL material. The geomembrane will be heat bonded through fusion or extrusion welding techniques. This layer is the first line of defense against potential seepage and has proven to be very effective in numerous applications throughout the world.

The geomembrane materials used during construction shall meet all of the requirements outlined in the Technical Specifications (Appendix G). Rigorous construction quality control (CQC) and construction quality assurance (CQA) testing and inspection of the liner will be undertaken to verify that the liner is placed in accordance with the design requirements and industry standards. CQC and CQA testing and inspection requirements can be referenced in the Technical Specifications (Appendix G). During procurement of HDPE for construction, conformance testing will be necessary to confirm the shear strength of the HDPE versus the LPSL.

As cited above the geomembrane will be deployed directly on the approved low permeability layer in all cases except at the Underdrain Collection Pond. In the Underdrain Collection Pond, the secondary liner will be placed on the LPSL and the primary liner will be placed on a geonet composite that resided on top of the secondary liner as a leakage collection and recovery system. Typical application of this material can be referenced on a number of Drawings including but not limited to A300 through A320, A410, A420, and A710.

6.7.2. Geonet Composite

The geonet composite material will be placed primarily in the Underdrain Collection Pond between the primary and secondary geomembranes. This material could also be deployed within the TSF basin on top of the geomembrane in certain areas, subject to the design engineer's approval. The geocomposite material consists of a HDPE geonet sandwiched between two non-woven needle punched geotextiles that have been heat bonded to form a composite product. The requirements of the geonet composite are outlined in the Technical Specifications. Typical application of this material can be referenced on Drawings A410 and A420.

6.7.3. Geotextile

Non-woven geotextile will be installed around the underdrain pipes in the TSF basin, around the LCRS sump gravel in the Underdrain Collection Pond, around the LCRS reclaim pipe, in diversion channels, a number of drainage collection pipe joints and in culvert placements. 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 applications for geotextile in this design can be referenced on Drawings A320, A410, A420, A520 and A525.

6.7.4. Geosynthetic Clay Liner

GCL consists of sodium bentonite sandwiched between two layers of geotextile (non-woven and needle punched for this application). See Appendix G.2 for Agru and Cetco GCL Technical Data Sheets. The GCL was evaluated for suitability based on the ability to achieve an equivalent permeability of 1x10-6 cm/sec or less, to provide adequate interface frictional strength when placed against geomembrane liner and subjected to a surcharge pressure equal to the expected tailings loadings and to be chemically compatible with site soil and process fluids. Published technical data for GCL products indicate the hydraulic conductivity is typically less than $5x10^{-9}$ cm/sec, which exceeds and therefore satisfies the regulatory requirements.

Stability is a concern with the use of GCL due to the low strength at both the GCL interface against the overlying HDPE geomembrane liner and internal to the bentonite core (particularly when hydrated). The interface strength is low because the bentonite can be squeezed through openings in the geotextile carrier producing a low friction surface at the interface between the GCL and the adjacent geomembrane liner. Published data is available to provide guidance in the engineering process and establish geometric conditions needed to generate a stable configuration. The available data indicated that the shear strength of a HDPE/GLC interface can be estimated with peak friction angle between 15 degrees to 25 degrees and with large displacement (residual) friction angle between 8 degrees to 12 degrees (CETCO 2009) for both the interface and internal strength. The HDPE will be textured, which laboratory testing indicates increased interface friction values between the liner and the GCL. Pure bentonite, under total stress conditions which are relevant for a material with such low hydraulic conductivity, tends to be on the lower range of the strength envelope particularly when saturated and subjected to lower confining pressures. In general, GCL can be used in areas where sufficient confining pressures to prevent swelling of the bentonite and potential decrease in strength due to fiber pullout within the GCL. The use of GCL within the TSF was evaluated through a robust limit equilibrium slope stability evaluation and is further discussed in Section 7.

7. GEOTECHNICAL EVALUATION

A geotechnical evaluation was completed to ensure the integrity of the Tailings Pile 1 temporary stacking, the TSF and Underdrain Collection Pond embankment throughout the operational life of the facilities. Static stability analyses were performed for each section and pseudostatic analyses were performed for long term structures. Tailings Pile 1 temporary stacking was not evaluated for pseudostatic due to its short duration and it low potential to experience seismic loading.

Specific to the Underdrain Collection Pond, the Underdrain Collection Pond embankment utilizes a robust lining system with LCRS. Seepage through the embankment, embankment groins, or into the surrounding formation is not expected, and thus a detailed seepage evaluation or filter design has not been included. Similarly, stability during rapid drawdown during operations was not considered. The embankment will be sited on rock or compacted, granular fill, and thus settlement of the foundation is not appreciable for the expected embankment loading.

7.1. Stability Evaluation

Stability analyses for the Tailings Pile 1 temporary stacking plan, the TSF and Underdrain Collection Pond were 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 procedure was 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 were established as 1.3 and 1.0, respectively. This acceptance criteria is consistent with the Arizona BADCT. The Stage 2 expansion of the TSF does not result in additional relocated tailings being placed against the primary downstream embankment, and thus the global stability was not influenced for this stage and the evaluation is not presented.

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. Very simply, the seismic force is the weight of the sliding mass multiplied by a horizontal pseudostatic earthquake coefficient (k_h).

The k_h is typically considered as a portion of the PGA because during an actual 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) discussed that use of one-half of the PGA for the horizontal pseudostatic earthquake coefficient will result in slope deformations that will be within tolerable limits, 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 (Section 2.5), the k_h for these analyses was selected as 0.055 g, which is one-half of the PGA.

7.2.1. Stability Model Development

The stability was evaluated on three cross sections in the following scenarios:

- Section A - Tailings Pile 1 temporarily stacked onto Tailings Piles 2 and 4;
- Section B - Stage 1 TSF configuration loaded with reclaimed tailings materials; and
- Section C - Underdrain Collection Pond downstream embankment.

The sections evaluated are presented in plan view on Figure 1 in Appendix I. These sections were selected as representative of the most critical sections within each structure. Static stability analyses were performed on all sections. Pseudostatic analyses were performed for the Stage 1 TSF configuration loaded with reclaimed tailings and the Underdrain Collection Pond. The pseudostatic evaluation was completed on long-term structures. Due to the construction schedule, it is highly unlikely the temporarily stacked Tailings Pile 1 configuration will exist long enough to experience potential seismic loading.

Tailings Piles 2 and 4 have a crest elevation of approximately 5,098 feet amsl with a relative height of 78 feet at a slope of 1.6H:1V above the valley floor. The temporary stacking plan for Tailings Pile 1 will have a setback of approximately 50 feet from the crest of Tailings Piles 2 and 4 and a slope of 5.0H:1V to approximately 5,126 feet amsl. The natural ground – existing tailings interface has been estimated from information gathered during the geotechnical investigation and surrounding natural topography.

The Stage 1 TSF embankment geometry consists of a 2.5H:1V upstream slope and a 2.0H:1V downstream slope with a crest elevation of 5,040 feet amsl. The reclaimed tailings is stacked with a 3.0H:1V slope from the approximate midpoint of the upstream TSF embankment face up to 5,110 feet amsl. The facility was modeled with a composite HDPE geomembrane-clay liner system. A pieziometric surface was applied approximately 1.5 feet above the liner to simulate minimal saturation at the base of the permanently placed reclaimed tailings.

The Underdrain Collection Pond section embankment maintains 2.0H:1V upstream and downstream slopes with a crest elevation of 5,040 feet amsl. The model is a composite configuration of the topographic low along the natural drainage and the middle of the embankment, which is done due to these most critical aspects being misaligned in the design. This synthetic slope configuration represents a worst case scenario and therefore conservative. The model was executed with the minimum design freeboard of 5 feet to simulate maximum capacity operating conditions.

The natural groundwater was not considered in the stability evaluations as levels within the subsurface are too deep to have an impact on the stability of the structures evaluated.

7.2.2. Material Properties

Material properties utilized in the stability assessment were 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.

Relocated Tailings Pile 1: Properties of the relocated Tailings Pile 1 were based on the current understanding of this material and field penetration test data. The relocated tailings strength was modeled using a phi angle of 32. This value is reasonably conservative given this material is granular in nature and has a significant fraction of waste rock intermingled with the tailings.

Existing Tailings Piles 2 & 4: Properties of the reclaimed Tailings Piles 2 and 4 was separated into two groups based on the material particle size distribution. The siltier material strength was assigned as a vertical stress ratio of 0.7 with a minimum shear strength of 1400 psf. The clayey material, near the base of the pile, was assigned an undrained shear strength with a constant cohesion value of 700 psf. The strength parameters were determined based on direct shear and unconfined compressive strength testing and field penetration data.

Reclaimed Tailings: Properties of the reclaimed tailings from Tailings Piles 1, 2, and 4 were based on laboratory testing and specifications developed for permanent placement of the material into the Stage 1 TSF. The reclaimed tailings strength was modeled with a phi angle of 28 degrees. The reclaimed tailings from Tailings Pile 3 will be placed in the Stage 2 TSF and comingled with waste rock from the underground development. This composite material will likely mobilize greater strength. An assumed piezometric surface was also applied to this material to provide a bit more conservatism to the model.

Composite Liner Interface: The composite liner system of HDPE-LPSL interface was assigned a friction angle of 15 degrees. This value is based on soil-liner interface shear testing completed on the design liner type and potential clay borrow material from the Trench Camp site.

Engineered Fill: Properties for the engineered embankment fill have been determined based on direct shear testing results and field penetration data of potential borrow sources. A friction angle of 32 has been assigned to the material. This value is conservative given it is for a silt material, and the majority of the fill will be native fractured rock.

Foundation: The material properties used for the foundation materials beneath the TSF were assumed based on a very thin veneer of soil overlying hard rock.

TABLE 7.1 - MATERIAL PROPERTIES USED IN THE STABILITY ANALYSES

Material	Moist Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)	Minimum Shear Strength (psf)
Relocated Tailings Pile 1	120	32	0	
Existing Tailings Piles 2 & 4 (silty)	120	$S_u/\sigma_v' = 0.7$		1400
Existing Tailings Piles 2 & 4 (clayey)	120		700	
Reclaimed Tailings	120	28	0	
HDPE-LPSL Interface	120	15	0	
Embankment Fill	120	32	0	
Foundation	120	38	0	

7.2.3. Stability Evaluation Results

Results indicate that the facilities will remain stable under both static and pseudostatic conditions. Results of the stability analysis are shown in Table 7.2 and stability output sheets are included in Appendix I. 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.

TABLE 7.2 - CALCULATED MINIMUM FACTORS OF SAFETY

Section	Condition	Critical Failure Mode	Minimum Factor of Safety	
			Static	Pseudostatic
A	Relocated Tailing Pile 1 onto Existing Tailings Piles 2 & 4	Block	1.3	--
B	Stage 1 TSF Loaded with Reclaimed Tailings	Block	1.4	1.2
C	Underdrain Collection Pond Downstream Embankment Maximum Capacity	Circular	1.5	1.3

Results indicate that the facility will remain stable under both static and pseudostatic conditions. Section A was only evaluated under static conditions due to the very low probability of a seismic event occurring during the temporary tailings relocation (Tailings Pile 1 on top of Tailings Piles 2 and 4).

The Stage 1 TSF requires a HDPE-LPSL system for stability. In general, GCL should not be used in this Stage without a detailed orientation-specific slope stability analysis. The Stage 2 expansion design has assumed GCL use due to a potential shortage of LPSL borrow on the AMI controlled property. The use of GCL in Stage 2 will not be problematic from the stand point of slope stability given the large buttressing effect that the Stage 1 TSF will have on the Stage 2 expansion. This expansion was not evaluated after the permanent placement of Tailings Pile 3 due to no significant changes in geometry. If additional expansion of Stage 2 is required, slope stability should be re-evaluated with the designed stacking plan to confirm stable conditions exist. Currently we do not see a problem with potential expansion beyond the current configuration.

Considering the level of materials testing involved in the geotechnical investigation in conjunction with the engineer of record's CQC and CQA program to be completed during project implementation, the minimum static factor of safety value of 1.3 was used for this stability evaluation based on BADCT guidelines.

In the case of the Underdrain Collection Pond embankment, the slope stability was evaluated for both static and pseudostatic conditions. This structure is double geomembrane lined (60 mil HDPE double textured geomembrane) with a leakage collection and recovery system sited between the primary and secondary geomembranes. The liner design will effectively keep any sort of internal hydraulic loading off of the embankment in question.

7.3. Settlement Evaluation

A settlement evaluation was performed 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 has been assumed that any compression of embankment fill materials will occur during construction and not influence the long-term performance of the facility. Results from the geotechnical investigations were used to develop a generalized subsurface stratigraphy and 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 northern embankment section. Less settlement is expected underneath the smaller embankment sections where fill volumes are reduced.

7.4. Pond Cut Slopes

The slopes around the underdrain pond will be cut back at a 1.5H:1V approximately 140 feet in height removing approximately 50 feet near the base. Based on data collected during the geotechnical investigation, including rock encountered in borehole BH-14 and the site-wide geophysical survey, NewFields determined that this slope is globally stable. Although globally stable, dislodged blocks and minor surface raveling could occur and should be evaluated. A visual evaluation immediately after construction must be completed by qualified personnel to observe features within the rock mass and provide a final assessment of stability. If slope configuration requires adjustment during construction, the geotechnical engineer should be contacted re-evaluate and to update slope cut configurations if appropriate.

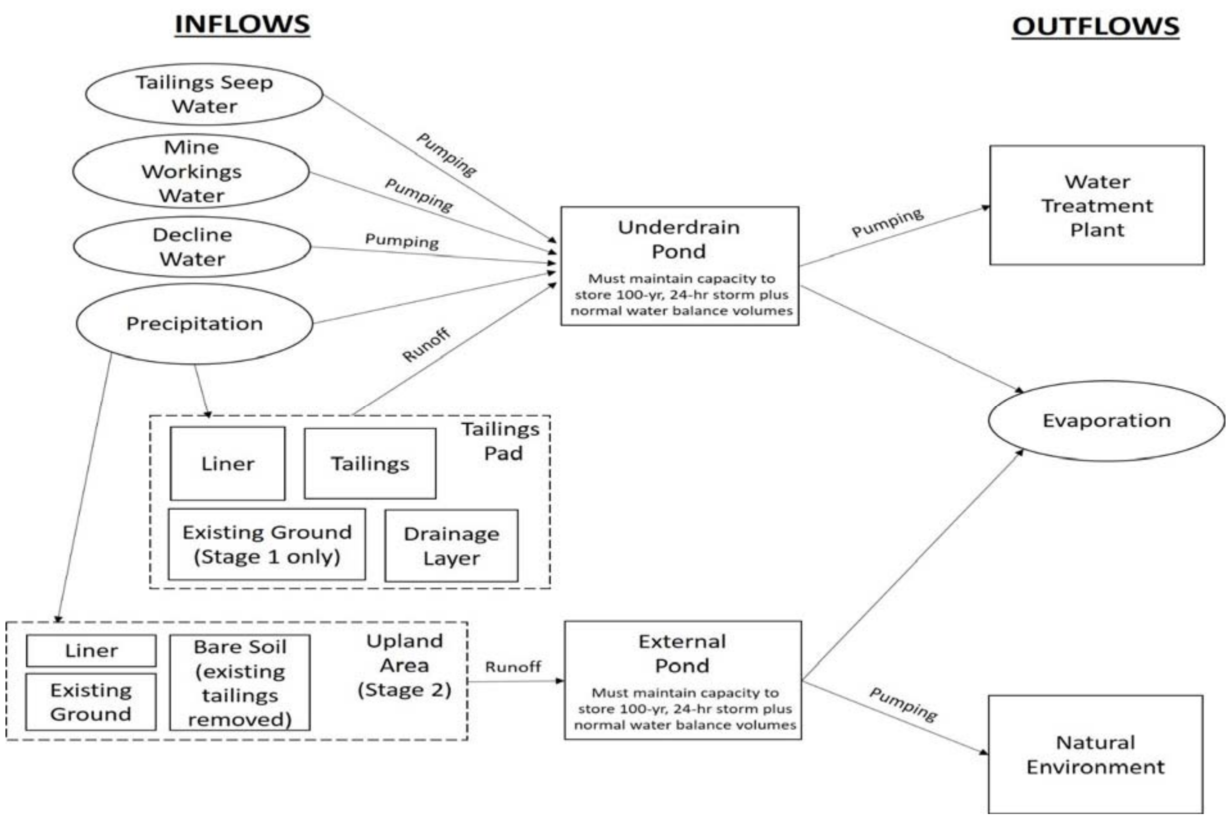
8. WATER BALANCE (ERC)

A site wide water balance was completed by Ecological Resource Consultants, Inc. (ERC) using a standard interactive spreadsheet approach to modeling the water/solution regime at the Trench Camp site. The focus of the water balance was to aid AMI in sizing the Water Treatment Plant (WTP), sizing of the Underdrain Collection Pond and external Detention Ponds. The water balance considered pre-closure and post-closure scenarios for the TSF currently seeking permitting under the APP application process in Arizona. 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 and Detention Pond sizing. In addition, the model differentiates between meteoric inflows and losses from the TSF catchment both during the remediation process (pre-closure) and post-closure, inflows from the historic underground works, inflow from the exploration ramp/shaft development and outflows to the proposed WTP.

Modeling and management of two principal categories of solution, contact and non-contact, were addressed as part of the site wide water balance. Contact solution is defined as any solution that comes in contact with the historic tailings/waste rock, low pH solution from the underground works and dewatering water from the exploration ramp/shaft development that are the subject of this remediation. Non-contact solution, pre-closure, is defined as the meteoric water that falls outside of the TSF footprint that can be safely captured in external detention ponds and diverted around the TSF facility through pumping. Post-closure non-contact solutions are defined as meteoric water falling on the water shed upstream of the TSF and direct precipitation on the closure cap that does not come in contact with the tailings. This solution category will by-pass the Underdrain Collection Pond and will be directed to the natural environment downstream of the Underdrain Collection Pond.

ERC's analysis includes a stochastic approach which allows a variable output of pond size for wet and dry years with the prescriptive Design Storm (100-yr/24-hr event) as shown in Appendix J. A flow diagram showing the inputs and outputs is presented below.

FIGURE 8.1 WATER BALANCE MODEL SCHEMATIC



8.1. Model Development

The water balance incorporates water inputs into the TSF system that vary by stage of operation. In Stage 1, inputs include direct precipitation on the Underdrain Collection Pond and TSF. During the initial operations of the Stage 1 TSF before the historic tailing piles are moved onto the Stage 1 facility, runoff from the up-gradient basin (which includes contact with existing tailings) is considered contact water and needs to be routed to the Underdrain Collection Pond. After the existing tailings piles in the areas, upstream of the Stage 1 TSF, have been relocated, runoff from the up-gradient basin will no longer be contact water. At this time an external pond is constructed to capture runoff from the upland basin. During this stage, inputs to the Underdrain Collection Pond include direct precipitation on the Underdrain Collection Pond and TSF. Runoff from the upland basin reports to the external pond as non-contact solution. Water losses from the Underdrain Collection Pond include evaporation and pumping to the WTP. Losses from the external 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 ponds. 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. Pond capacities storage requirement detailed in this section are consistent with pond capacities presented in the filling curves on Drawings A146, A230 and A400 for the Stage 1 External Detention Pond, Stage 2 External Detention Pond and the Underdrain Collection Pond, respectively. Operating decisions such as the pumping capacities to the WTP and from the external pond greatly influence the TSF water balance. Miscellaneous water such as mine underground workings water, tailings seepage and ramp/shaft development water are also included. Gains to and losses from the system are summarized in Table 8.1.

Table 8.1. TSF Water Balance Modeling Components by Stage

STAGE 1 Before Existing Tailings Piles are Relocated	
UD Pond Water Gains	**UD Pond Water Losses**
Direct Precipitation	Pumping to WTP
Miscellaneous Water	Evaporation
Runoff from TSF Pad	
Runoff from Up-gradient Basin	
STAGE 1 After Existing Tailings Piles are Relocated	
UD Pond Water Gains	**UD Pond Water Losses**
Direct Precipitation	Pumping to WTP
Miscellaneous Water	Evaporation
Runoff from TSF Pad	
External Pond Water Gains	**External Pond Water Losses**
Direct Precipitation	Pumping to Natural Environment
Runoff from Upland Basin	Evaporation

STAGE 2	
UD Pond Water Gains	**UD Pond Water Losses**
Direct Precipitation	Pumping to WTP
Miscellaneous Water	Evaporation
Runoff from TSF Pad	
External Pond Water Gains	**External Pond Water Losses**
Direct Precipitation	Pumping to Natural Environment
Runoff from Upland Basin	Evaporation

8.2. Water Demands

Water demands associated with the external Detention Ponds are relatively minor. Dust suppression and construction water are potential areas where detention pond water could be used but for all intents and purposes water demands for these uses are disregarded in the modeling, primarily due to the fact that detention ponds will be part of the remedial construction process and will not be available for a significant timeframe. As a result, the detention ponds are slightly oversized. Contact water cannot be used for either construction or dust suppression so it is not considered in the modeling as a water source. Consumptive use from the contact water will be the WTP only.

9. STORMWATER MANAGEMENT

The intent of the stormwater management plan is to prevent damage to the mine infrastructure, in particular the TSF, Underdrain Collection Pond and downstream receiving points. The plan for stormwater runoff is to construct:

- External conveyance structures (Reference Drawings A500 through A525)
  - Route/divert surface water flows around the facilities through engineered diversion channels
  - Armor sections of channels or outlet points to minimize erosion and sediment transport
- Internal conveyance structures (Reference Drawings A160, A240, A300, A700 and A710)
  - Internal diversion channels located at the perimeter of the TSF to convey surface water runoff from the dry stack facility
  - 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 (Reference Drawings A400 through A420)
- Implement Best Management Practices (BMP) in design and construction of the temporary surface water management systems during construction

The stormwater conveyance structures have been designed considering the following criteria:

- External conveyance structures
  - Pass peak flows from 100-yr/24-hr storm event
  - Maintain 1 ft of freeboard
- Internal conveyance structures
  - Pass peak flows from 100-yr/24-hr storm event
  - Maintain 2 ft of freeboard
- Underdrain Collection Pond
  - Sized to contain average pre-closure volume plus the 100-yr/24-hr storm event while maintaining 2 ft freeboard requirement below the spillway
  - Fitted with an emergency spillway to safely pass the routed 1/4 PMF while maintaining freeboard requirement specified by ADWR

9.1. Hydrologic Model

The hydrological modeling system HEC-HMS (version 3.5), 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 design the necessary hydraulic structures to control runoff, site-wide watershed maps were developed to establish inputs for a hydrologic model. Based on the 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 Stage 1, Stage 2 and TSF closure scenario layouts. See Appendix H for the site wide 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 Appendix H.

<u>Infiltration and runoff characteristics</u> 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 Pinion-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 9.1: PHOTO OF TYPICAL LANDSCAPE

- **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.

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 has been estimated using the equation below.

$$L = \frac{\ell^{0.8}\,(S+1)^{0.7}}{1900\,Y^{0.5}} \quad \text{(NRCS, 2010)}$$

L = Lag time in hours

ℓ = Hydraulic length of watershed in ft

S = (1000/CN') - 10, where CN' ~ hydrologic soil cover complex number

Y = Average watershed land slope in percent

Refer to Appendix H 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. Annual precipitation averages 21.5 inches and ranges from 12 to 35 inches per year with higher amounts of precipitation occurring at higher elevations in the range. 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, destructive winds. Design storm events have been assigned to each design element on the project. These design storm events are consistent with BADCT guidance document requirements and are presented below.

- External runoff tributary to the TSF
  - 100-yr/24-hr storm event (BADCT)
  - As required by the Arizona Pollutant Discharge Elimination System sediment basins will be designed to provide a minimum of 3,600 cubic feet of storage per acre drained or sized based on the 2-yr/24-hr storm event.
- Runoff/Sediment Detention Basin
  - As required by the Arizona Pollutant Discharge Elimination System "…sediment basins at sites with common drainage locations that serve an area with 10 or more acres disturbed at one time. The operator shall design and construct sediment basins as follows:
  - The basin shall provide storage for a calculated volume of runoff from a 2-yr, 24-hr rain event from each disturbed acre drained or

- Where no calculation is performed, a sediment basin providing 3,600 cubic feet of storage per acre drained shall be provided

- Surface water conveyance structures internal to the TSF
  - 100-yr/24-hr storm event (BADCT)
- Culvert Crossings (Impacting TSF): 100-year/24-hour storm event

9.4. Peak Flow and Volume Results

The peak discharges were estimated using HEC-HMS and are included in the table below:

TABLE 9.1: HYDROLOGIC MODEL RESULTS

Conveyance Structure	Peak Discharge 100-yr/24-hr (cfs)
Stage 1 Stormwater Diversion Channel (Station 0+00 to 13+80)	220.4 (313.8 in closure scenario)
Stage 1 Stormwater Diversion Channel / Culvert (Station 13+80 to 18+55)	181.1
Stage 1 Stormwater Diversion Channel (Station 18+55 to end)	41.0
Underdrain Collection Pond Stormwater Diversion Channel (South)	12.4
Underdrain Collection Pond Stormwater Diversion Channel (East)	62.8
Stage 2 North Storm Water Diversion Channel	28.8
Stage 2 South Stormwater Diversion Channel	18.9
North Closure Diversion Channel	124.9
South Closure Diversion Channel	12.8
TSF Closure Spillway	126.6
Flux Canyon Road Culvert	171.1
Detention Structure	**Stage 1 Volume 100-yr/24-hr (ac-ft)**
Stage 1West TSF Internal Detention Pond	2.6
Stage 1 East TSF Internal Detention Pond	1.5
Stage 2 West TSF Internal Detention Pond	10.0
Stage 2 East TSF Internal Detention Pond	0.8

9.5. Stormwater Diversion Channel Sizing

The diversion channels were sized to convey the peak discharges utilizing a trapezoidal or triangular cross section. The channel depths were determined based on the flow depths calculated using Manning's formula for open channel flow utilizing the computer program FlowMaster. Manning's roughness "n" coefficients were estimated 0.055 for a rip rap armored channels.

After the channels were created the sections were imported into the modeling system HEC-RAS (Version 5.0.3) which was developed by the US Army Corps of Engineers to model the hydraulics of water flow through designed channels and natural drainages. HEC-RAS was used to calculate the flow depth using the channel geometries in the proposed grading utilizing the total flow results from HEC-HMS. Refer to Drawing A520 for diversion channel sections and details and Appendix H for detailed design calculations. It is important to note that the stationing used in the HEC-RAS stormwater model may be different than the diversion channel based on alignment direction and evaluation of individual sections of the overall channel.

TABLE 9.2: 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)
Stage 1 Stormwater Diversion Channel (Sta 0+00 to 18+55)*	100-yr/ 24-hr	313.8	2.5	12	1.7%	4.0
Stage 1 Stormwater Diversion Channel (18+55 to End)	100-yr/ 24-hr	41.0	2.5	5	3.1%	3.0
Underdrain Collection Pond Stormwater Diversion Channel (South)	100-yr/ 24-hr	12.4	1.5	0	0.5%	3.0
Underdrain Collection Pond Stormwater Diversion Channel (East)	100-yr/ 24-hr	62.8	1.5	3	0.5%	3.5
Stage 2 TSF Stormwater Diversion Channel (North)	100-yr/ 24-hr	28.8	2.0	0	0.5%	3.5
Stage 2 TSF Stormwater Diversion Channel (South)	100-yr/ 24-hr	18.9	2.0	0	1.6%	3.5
East Closure Diversion Channel (Sta 0+00 to 5+42)	100-yr/ 24-hr	44.7	2.5	15	2.9%	3.5
East Closure Diversion Channel (Sta 5+42 to 18+75)	100-yr/ 24-hr	124.9	2.5	15	0.5%	4.5
East Closure Diversion Channel (Sta 18+75 to 21+61)	100-yr/ 24-hr	124.9	2.5	15	14.4%	3.5
East Closure Diversion Channel (Sta 21+61 to 26+81)	100-yr/ 24-hr	124.9	2.5	15	0.5%	4.5
West Closure Diversion Channel (Sta 26+81 to end)	100-yr/ 24-hr	12.8	2.5	15	0.5%	3.0

9.6. Pipe Sizing

The detention areas and pipes were sized to temporarily store and convey flow from the 100-yr/24-hr storm event while maintaining 2 ft of freeboard. The pipes were sized using the computer program CulvertMaster. Refer to Drawings A160 and A240 for detention areas as well as sections and details. Detailed design calculations can be referenced in Appendix H.

TABLE 9.3: PIPE SIZING RESULTS

Conveyance Structure	Design Storm	Peak Flow (cfs)	Slope (%)	Number of Pipes	Pipe Diameter (ft)
Stormwater Diversion Channel Culvert (Sta 13+80 to 15+20)	100-yr/ 24-hr	181.1	2	2	4
Flux Canyon Culvert	100-yr/ 24-hr	171.1	10	2	3.5
Closure Spillway Culvert	100-yr/ 24-hr	126.6	4.8	2	3.5

9.7. Riprap Revetment

The riprap revetment 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 in the Stage 1 Stormwater Diversion Channel and the Closure Stormwater Diversion Channels to minimize erosion. Plan view locations of the riprap can be reference on Drawings A500 and A715. The channel sections and details in addition to the tables showing riprap sizing can be referenced on Drawings A520 and A710.

9.8. Concrete Cutoff Wall

A concrete cutoff wall was placed at the Stage 1 TSF Stormwater Diversion Channel exit (station 0+00). The cutoff wall is constructed of reinforced concrete and is sited flush with the top of riprap and natural channel invert. The cutoff wall will protect against erosion at the end of the diversion channel where the channel transitions from riprap to natural channel. The plan and section of the concrete cutoff wall can be referenced on Drawing A510.

9.9. Stilling Basin

Stilling basins were sited within the Stage 1 Stormwater Diversion Channel and the Closure Stormwater Diversion Channels as energy dissipaters placed at the transition of steep slopes. The stilling basin locations can be referenced in plan view on Drawings A500 and A715. The stilling basin sections and details can be referenced on Drawing A522 and A718.

10. CONSTRUCTION SEQUENCING

In general terms the Dry Stack TSF will be constructed in compliance with the IFC" Design Package. The current closure approach is to place the existing tailings and waste rock from Tailings Piles 1, 2 and 4 on the Stage 1 TSF and to place Tailings Pile 3 on the Stage 2 TSF. Relocated materials will be covered with rock to create erosion protection during stack development and to act as a capillary break between the tailings and the growth media when covered with 1 to 2 feet of growth media. The growth media will be captured during the site stripping process prior to basin grading. The growth media will be seeded using the seed mix in AMI's approved reclamation plan. The final slopes on the Dry Stack TSF will be a composite open slope benched arrangement to reduce sheet flow velocities and prevent the initiation of surface erosion.

The sequence of remediation will require moving Tailings Pile 1 onto Tailings Piles 2 and 4 so that the Stage 1 TSF can be constructed. Once constructed, the Stage 1 TSF will take existing tailings and waste rock previously stacked on top of Tailings Piles 2 and 4 as well as the tailings from Tailings Piles 2 and 4. The existing piles will be exhumed, hauled and spread on the newly constructed geomembrane lined containment, dried through mechanical manipulation, where necessary, and compacted to a target density of 90 percent of the maximum proctor density as determined by ASTM D-698. This method of placement will increase stability and minimize infiltration and therefore dry stack tailings underdrainage post closure.

It should be noted that construction of the TSF will be performed by third party contractors in accordance with the IFC Design Package issued herewith to ADEQ for review. The design package includes this report, the attached IFC Drawing Set and Technical Specifications for the APP design submittal for the project. To provide more clarity on construction approach details of the construction sequence and remediation activities anticipated is provided below.

- Realign Flux Canyon Road (Drawing A601)
  - Align Flux Canyon Road to conform to the TSF layout and provide adequate width for the stormwater diversion channel
- Construct stormwater diversion channel (Drawings A500, A510 and A515)
  - Diversion channel to collect and convey upstream watershed runoff around the TSF thereby preventing it from entering the facility.
- Construct the Underdrain Collection Pond (Drawings A400 through A420)
- Temporarily relocate Tailings Pile 1 to the top of Tailings Piles 2 and 4 (Drawing A055)
  - Tailings Pile 1 and PAG waste rock must be moved to allow construction of the Stage 1 TSF perimeter road and basin

- Construct Stage 1 TSF perimeter road and basin (Drawing A100)
  - To provide storage for tailings, PAG waste rock, impacted soils from existing Tailings Piles 1, 2 and 4 and development rock from the exploration ramp/shaft (Drawing A160)
  - Stage 1 construction of an external detention basin will be established to route runoff from the east side of Stage 1 (Tailings Piles 1, 2 and 4) to the underdrain collection system (Drawings A145 and A146) via a pipe located in the basin low point
  - Stage 1 geomembrane installation (Drawing A120)
  - Stage 1 underdrain piping system placement (Drawing A140)
  - Concrete encased underdrain outlet to Underdrain Collection Pond (Drawing A150)
  - Relocate tailings and waste rock from Tailings Piles 1, 2 and 4 to lined TSF (Drawing A160).
  - Tailings and waste rock to be excavated, hauled, spread, disked (if needed) and compacted to a target density of 90% of the maximum dry density as determined by the standard proctor (ASTM D-698).
  - After Tailings Piles 1, 2 and 4 are relocated to the Stage 1 TSF, the external detention basin pipe will be capped and the geomembrane lined external detention basin will be expanded as part of the Stage 2 TSF basin construction.
  - A notch will be excavated to connect the Stage 2 TSF basin to the Stage 1 basin to convey surface flow and underdrainage flow to the Underdrain Collection Pond (See Drawing A205 and A207)

- Stage 2 TSF perimeter road and basin (Drawing A200)
  - Storage for tailings from Tailings Pile 3 and development rock from the exploration ramp and shaft (Drawing A240)
  - Stage 2 construction of a geomembrane lined external detention basin to store upstream runoff on the east side of Stage 2 (Drawing A230). The flow captured in this detention pond will be pumped around the TSF until closure is substantially complete
  - Stage 2 geomembrane installation (Drawing A210)
  - Stage 2 underdrain piping system placement (Drawing A228)
  - Relocate tailings from Tailings Pile 3 to the lined Stage 2 TSF (Drawing A240)
  - Tailings to be excavated, hauled, spread, disked (if needed) and compacted to a target density of 90% of the maximum dry density as determined by the standard proctor (ASTM D-698).

- Incrementally place Non-PAG development rock from the exploration ramp/shaft development that AMI intends to execute to collect a large exploratory mining sample, on-site rock borrow or other sources as an interim erosion control over the historic tailings once they reach design geometry
  - PAG development rock to be comingled with existing tailings pile material and placed in TSF
- Place closure cap over the entire area of the TSF
  - Initial layer of the closure cap will consist of a rock capillary break placed during tailings relocation. This capillary break is initially placed as rock armoring on the surface of the relocated tailings to minimize water and wind erosion during tailings placement but later will be used as a capillary break.
  - The capillary break/rock armoring will be covered by 1 to 2 ft of growth media and the growth media will be reseeded
- Prior to growth media placement and prior to reseeding the surface of the dry stack a stormwater management system will be constructed to safety collect and convey peak storm flows up to and including the 100-yr/24-hr event

11. FACILITY OPERATIONS

The Dry Stack TSF will be stacked in general compliance with the geometries shown on drawings A160 and A240. The current concept is to place the existing or historic tailings and waste rock from Tailings Piles 1, 2 and 4 on the Stage 1 TSF and to place Tailings Pile 3 on the Stage 2 TSF. As cited above, relocated materials will be covered with rock to create erosion protection during stack development and to act as a capillary break between the tailings and the growth media when covered with 1 to 2 feet of growth media during closure. The growth media will be captured during the site stripping process prior to basin grading. The growth media will be hydro-seeded after cap placement. The final slopes on the Dry Stack 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 of surface erosion.

The sequence of remediation will require moving Tailings Pile 1 onto Tailings Piles 2 and 4 so that the Stage 1 TSF can be constructed. Once constructed, the Stage 1 TSF will take existing tailings and waste rock previously stacked on top of Tailings Piles 2 and 4 as well as the Tailings Piles 2 and 4. The existing piles will be exhumed, hauled and spread on the newly constructed geomembrane lined containment, dried through mechanical manipulation and compacted to a target of 90 percent of the maximum proctor density as determined by ASTM D-698. This method of placement will increase stability and minimize future infiltration and therefore underdrainage post-closure.

As part of the Stage 1 construction, a detention pond (Drawing A160) will be constructed in the drainage to the south of Stage 1 and surface flow from areas south of Stage 1 will be captured and pumped around the facility. This pond is part of an interim solution to manage surface flows. The Stage 1 pond will be evacuated immediately prior to the Stage 2 construction, the TSF will be expanded into Stage 2 and Tailings Pile 3 material as well as waste rock from the exploration ramp/shaft development will be directed to the Stage 2 TSF. A Stage 2 detention pond will be constructed as part of the Stage 2 TSF expansion (Drawing A230), immediately upstream of the Stage 2 facility. The Stage 2 detention pond will be constructed again to help control surface water by capturing non-contact flows upstream of the Stage 2 facility and pumping them around the facility. Once closure operations are complete the Stage 2 TSF perimeter berm will be breached and the detention pond will be regraded to direct surface flows to the closure channel (Drawing A700) and ultimately to the natural drainage downstream of the Underdrain Collection Pond.

During construction and on a quarterly basis 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 the 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 K.

If the inspection was to identify 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 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 cell number is listed below:

Primary Contact – Emergency Response Coordinator (ERC):

Contact Name: Johnny Pappas
Job Title: Director of Environmental and Permitting
Address: 3845 North Business Center Drive, Suite 115, Tucson, AZ 85705
Office Number: 520-485-1300
Cell Number: 803-235-5563

Secondary Contact – Back up ERC:

Contact Name: Greg Lucero
Job Title: VP Community and Government Affairs
Address: 3845 North Business Center Drive, Suite 115, Tucson, AZ 85705
Office Number: 520-485-1300
Cell Number: 520-604-0618

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 construction and 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. 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. 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 Pieziometric 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 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 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 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 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

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. 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

A closure configuration is presented on Drawing A700. The closure strategy includes capping the Dry Stack TSF with 1 to 2 feet of reseeded growth media underlain by a capillary break created from the rock armoring berms placed during Tailings Piles 1 through 4 remediation or relocation to the lined TSF. The sides 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 the south to an outfall located on the southwest corner of the TSF, where flows from the top of the reclaimed TSF will be directed to the base of the TSF at the southwest corner of the facility where TSF slope heights are at a minimum. Flows reporting to the base of the TSF from this outfall and from the TSF slope areas will be collected in the closure channel (located inside of the TSF perimeter berm) and conveyed to the northwest corner of the TSF base where they will be directed, via the TSF spillway, to the permanent Stage 1 stormwater diversion channel located north and outside of the TSF. Layout of the closure channel can be referenced on Drawings A700 and A715. Details of the closure channel can be referenced on Drawing A710.

It should be noted that meteoric flow in the closure channel will be separated from the underdrain by a low permeability soil layer to minimize infiltration into the underdrain system from the surface flows. Surface water flow reporting to the closure surface will exit the TSF in the TSF spillway (See Drawings A700, A715 and A720) and will be passed under Flux Canyon Road via 2-42 inch diameter CPe culverts. The TSF Spillway will be armored with 24 inches of D_{50} 12 inch riprap. Flows entering the Stage 1 stormwater diversion channel will require energy dissipation to address erosion of channel sides so the Stage 1 revetment will be excavated and replaced with 36 inches of D_{50} 18 inch grouted riprap where the closure channel flow enters the Stage 1 stormwater diversion channel. See Drawing A720 for spillway details.

As part of surface water management system at closure, a notch will be cut into the southeast corner (See Drawings A700, A720 and A730) of the Stage 2 perimeter berm. The area upstream of the notch, previously used to impound meteoric water during the pre-closure period, will be regraded to create positive surface water flow through the notch and into the closure channel.

It is expected that the post-closure underdrain flows will be minimal. They will continue to be collected and transmitted to the water treatment system until a passive treatment system can be constructed in the Underdrain Collection Pond. This will allow the engineer to evaluate post closure underdrain water chemistry and expected flow rate ranges to effectively design a passive treatment system. If the effluent cannot be effectively treated passively, the active treatment system will continue to be operated to treat these flows.

The current approach to siting an appropriate passive treatment system 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. As cited above, until an effective passive treatment approach can be demonstrated, active treatment of underdrain flows will continue.

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 perimeter road, stormwater diversion channels and Underdrain Collection Pond areas will also be monitored, inspected and repaired, if needed.

REFERENCES

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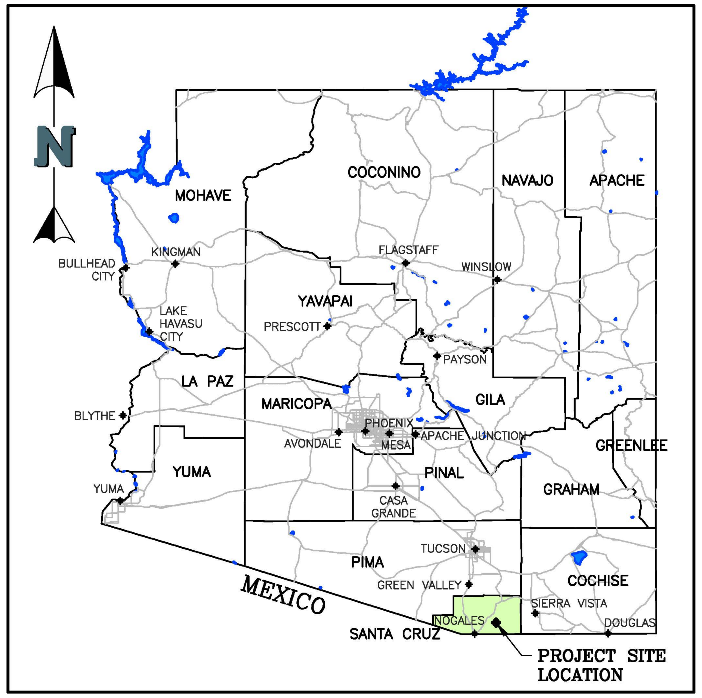
DESIGN DRAWINGS

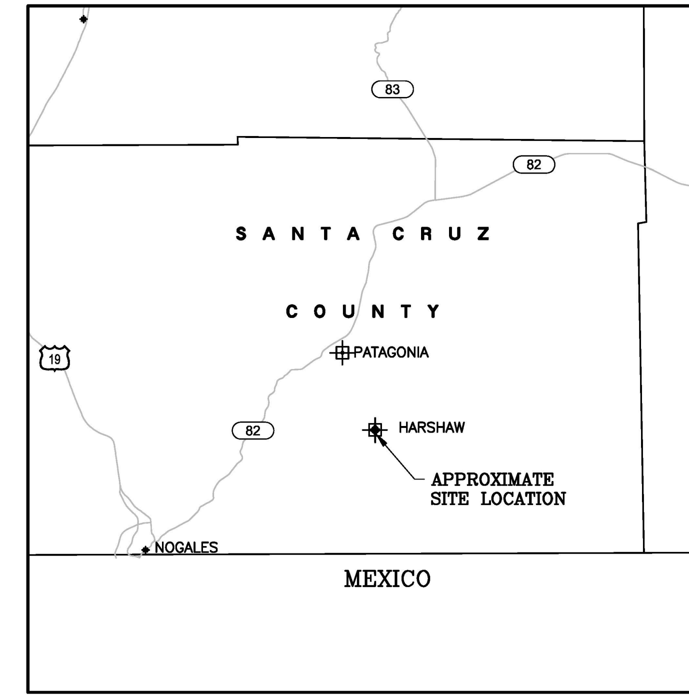


COUNTY MAP

ARIZONA MINERALS INC

TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

ISSUED FOR CONSTRUCTION
JUNE 5, 2017



VICINITY MAP

DRAWING LIST		
REV	TITLE	DWG #
0	TITLE SHEET	A000
0	TRENCH CAMP GENERAL LAYOUT	A010
0	GEOLOGIC PLAN VIEW	A020
0	GEOTECHNICAL INVESTIGATION PLAN VIEW	A030
0	INSTRUMENTATION PLAN VIEW	A040
0	TRENCH CAMP TAILINGS PILES PLAN VIEW	A050
0	TRENCH CAMP TAILINGS PILES SECTIONS (SHEET 1 OF 3)	A051
0	TRENCH CAMP TAILINGS PILES SECTIONS (SHEET 2 OF 3)	A052
0	TRENCH CAMP TAILINGS PILES SECTIONS (SHEET 3 OF 3)	A053
0	TRENCH CAMP TAILINGS PILES ISOPACH	A054
0	TRENCH CAMP TAILINGS PILE 1 EXCAVATION PLAN VIEW	A055
0	TSF PLAN VIEW STAGE 1	A100
0	STAGE 1 TSF GRADING PLAN VIEW	A110
0	STAGE 1 TSF GRADING ISOPACH	A115
0	STAGE 1 TSF GEOMEMBRANE PLAN VIEW	A120
0	STAGE 1 TSF PERIMETER ROAD CENTERLINE PROFILE	A130
0	STAGE 1 TSF PERIMETER ROAD SECTIONS	A135
0	STAGE 1 TSF PIPING PLAN VIEW	A140
0	STAGE 1 TSF EXTERNAL DETENTION BASIN (SHEET 1 OF 2)	A145
0	STAGE 1 TSF EXTERNAL DETENTION BASIN (SHEET 2 OF 2)	A146
0	TSF CONCRETE ENCASED UNDERDRAIN PLAN AND PROFILE	A150
0	STAGE 1 TSF EXISTING TAILINGS STACKING PLAN VIEW	A160
0	STAGE 2 TSF GRADING PLAN VIEW	A200
0	STAGE 2 TSF GRADING ISOPACH	A205
0	STAGE 2 NOTCH	A207
0	STAGE 2 TSF GEOMEMBRANE PLAN VIEW	A210
0	STAGE 2 TSF PERIMETER ROAD CENTERLINE PROFILE	A220
0	STAGE 2 TSF PIPING PLAN	A228
0	STAGE 2 TSF EXTERNAL DETENTION BASIN	A230
0	STAGE 2 TSF STACKING PLAN VIEW	A240

DRAWING LIST		
REV	TITLE	DWG #
0	EXISTING TAILINGS 3 AND SEDIMENT POND PLAN VIEW	A250
0	TSF TYPICAL SECTIONS AND DETAILS (SHEET 1 OF 3)	A300
0	TSF TYPICAL SECTIONS AND DETAILS (SHEET 2 OF 3)	A310
0	TSF TYPICAL SECTIONS AND DETAILS (SHEET 3 OF 3)	A320
0	TSF UNDERDRAIN COLLECTION POND PLAN VIEW	A400
0	UNDERDRAIN COLLECTION POND ISOPACH	A402
0	TSF UNDERDRAIN COLLECTION POND SUMP	A405
0	TSF UNDERDRAIN COLLECTION POND PROFILES	A407
0	UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 1 OF 3)	A410
0	UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 2 OF 3)	A420
0	UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 3 OF 3)	A430
0	PROPOSED EXPLORATION RAMP SETTLING BASIN	A450
0	SURFACE WATER MANAGEMENT PLAN VIEW STAGE 1	A500
0	STAGE 1 TSF STORMWATER DIVERSION CHANNEL PLAN AND PROFILE	A510
0	STAGE 1 TSF STORMWATER DIVERSION CHANNEL PLAN AND PROFILE	A515
0	FLUX CANYON ROAD CULVERT	A516
0	STORMWATER DIVERSION CHANNEL SECTIONS AND DETAILS (SHEET 1 OF 3)	A520
0	STORMWATER DIVERSION CHANNEL SECTIONS AND DETAILS (SHEET 2 OF 3)	A522
0	STORMWATER DIVERSION CHANNEL SECTIONS AND DETAILS (SHEET 3 OF 3)	A525
0	FLUX CANYON ROAD REALIGNMENT PLAN AND PROFILE	A601
0	FLUX CANYON ROAD REALIGNMENT SECTIONS AND DETAILS	A610
0	CONCEPTUAL CLOSURE PLAN VIEW	A700
0	CONCEPTUAL CLOSURE SECTIONS AND DETAILS	A710
0	CLOSURE STORMWATER DIVERSION CHANNEL PLAN	A715
0	CLOSURE STORMWATER DIVERSION CHANNEL PROFILE	A716
0	CLOSURE STORMWATER DIVERSION CHANNEL STILLING BASINS	A718
0	CLOSURE SPILLWAY PLAN AND PROFILE	A720
0	CLOSURE FILL AREA	A730
0	WILDLIFE FENCE DETAILS (SHEET 1 OF 2)	A800
0	WILDLIFE FENCE DETAILS (SHEET 2 OF 2)	A805

TEXT ABBREVIATIONS:

TSF – TAILINGS STORAGE FACILITY
PAG – POTENTIALLY ACID GENERATING
PCF – POUNDS PER CUBIC FOOT
HDPE – HIGH DENSITY POLYETHYLENE
DIA – DIAMETER
MIN – MINIMUM
DR – DIMENSION RATIO
LCRS – LEAK COLLECTION AND RECOVERY SYSTEM
CPeP – CORRUGATED POLYETHYLENE PIPE

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

OWNER:

ARIZONA MINERALS
3845 North Business Center Drive, Suite 115
Tucson, AZ 85705

NewFields
9400 Station Street, Suite 300, Lone Tree, CO 80124
Phone: 720.508.3300 www.newfields.com

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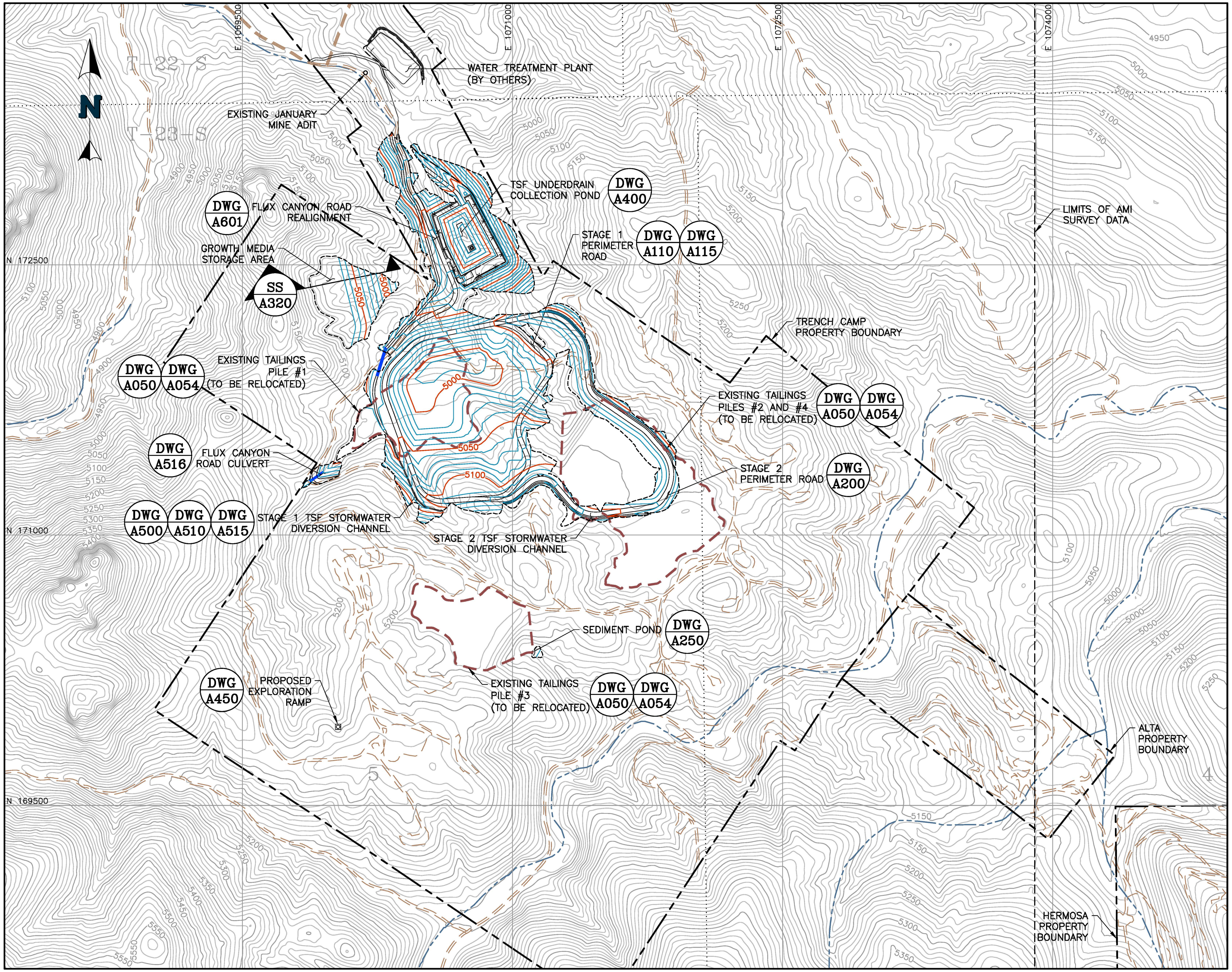

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- PROPOSED FENCE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWINGS A120 AND A210 FOR THE STAGE 1 AND STAGE 2 GEOMEMBRANE LINER LIMITS, RESPECTIVELY.

0 300 600 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TRENCH CAMP GENERAL LAYOUT

FILENAME: 14.008.024M

DRAWING NO.: A010 REVISION: 0

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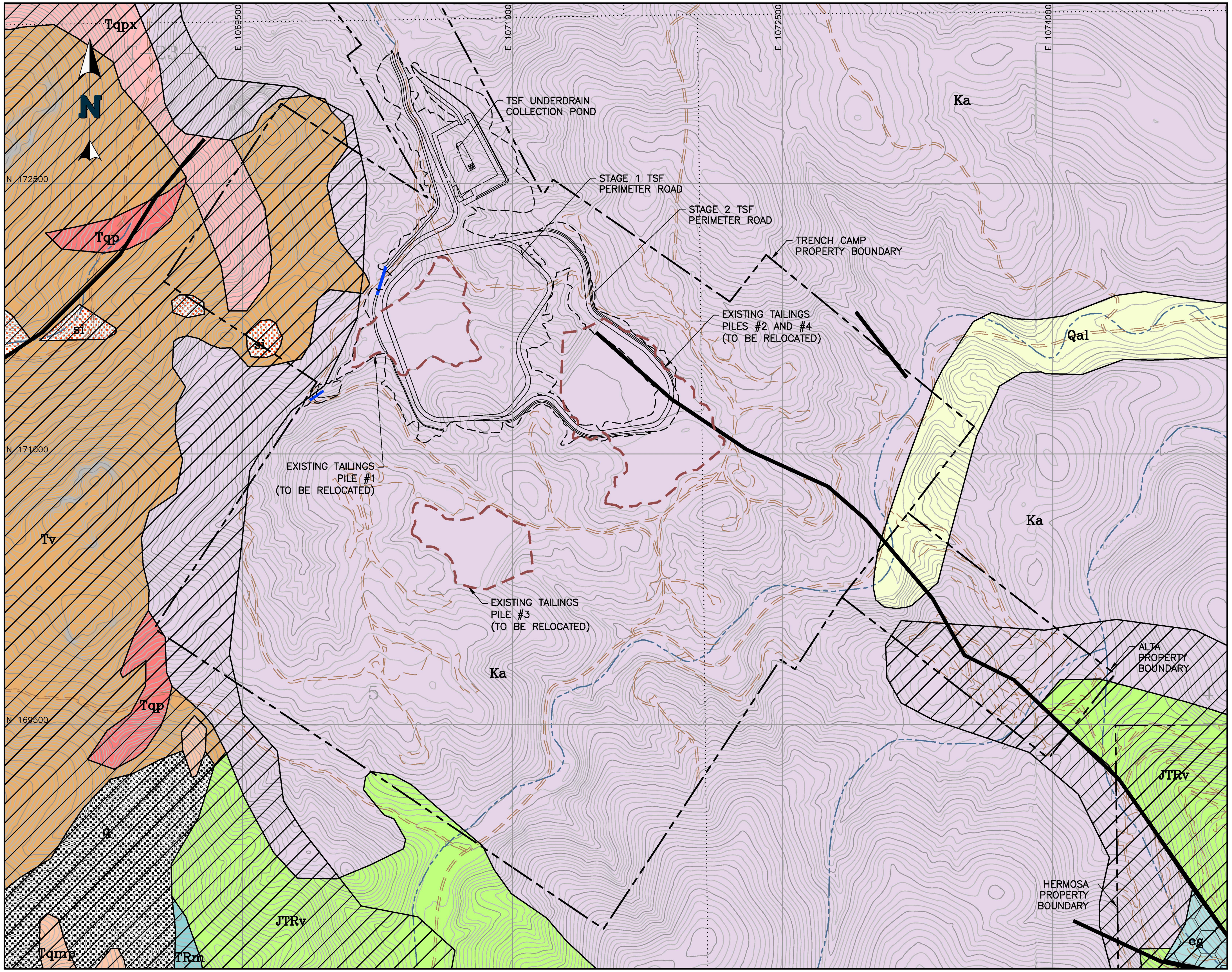

LEGEND:

- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- FAULT LINE
- EXISTING TAILINGS PILE LIMITS

UNCONSOLIDATED DEPOSITS

- Qal — YOUNGER ALLUVIUM AND TALUS (QUATERNARY)

BEDROCK

- si — SILICIFICATION (PALEOCENE)

ROCKS OF MIDDLE ALUM GULCH (PALEOCENE)

- Tv — VOLCANICLASTIC ROCKS OF MIDDLE ALUM GULCH (PALEOCENE)
- Tqp — QUARTZ FELDSPAR PORPHYRY OF MIDDLE ALUM GULCH (PALEOCENE)
- Tqpx — XENOLITHIC QUARTZ FELDSPAR PORPHYRY OF MIDDLE ALUM GULCH (PALEOCENE)

GRANODIORITE OF THE PATAGONIA MOUNTAINS (PALEOCENE)

- Tqmp — QUARTZ MONZONITE PORPHYRY

VOLCANIC AND IGNEOUS ROCKS OF RED MOUNTAIN

- Ka — TRACHYANDESITE (UPPER CRETACEOUS)

SILICIC VOLCANIC AND SEDIMENTARY ROCKS (JURASSIC OR TRIASSIC)

- JTRv — VOLCANIC ROCKS
- cg — LIMESTONE CONGLOMERATE

VOLCANIC AND SEDIMENTARY ROCKS

- TRm — MOUNT WRIGHTSON FORMATION (TRIASSIC)
- QUARTZITE

- PYRITE ZONE

NOTE:

1. GEOLOGICAL INFORMATION FROM THE USGS "GEOLOGIC MAP OF PATAGONIA MOUNTAINS, SANTA CRUZ COUNTY, ARIZONA", 2015.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

0 300 600 FEET

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0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: GEOLOGIC PLAN VIEW

FILENAME: 14.008.017M

DRAWING NO.: A020

REVISION: 0

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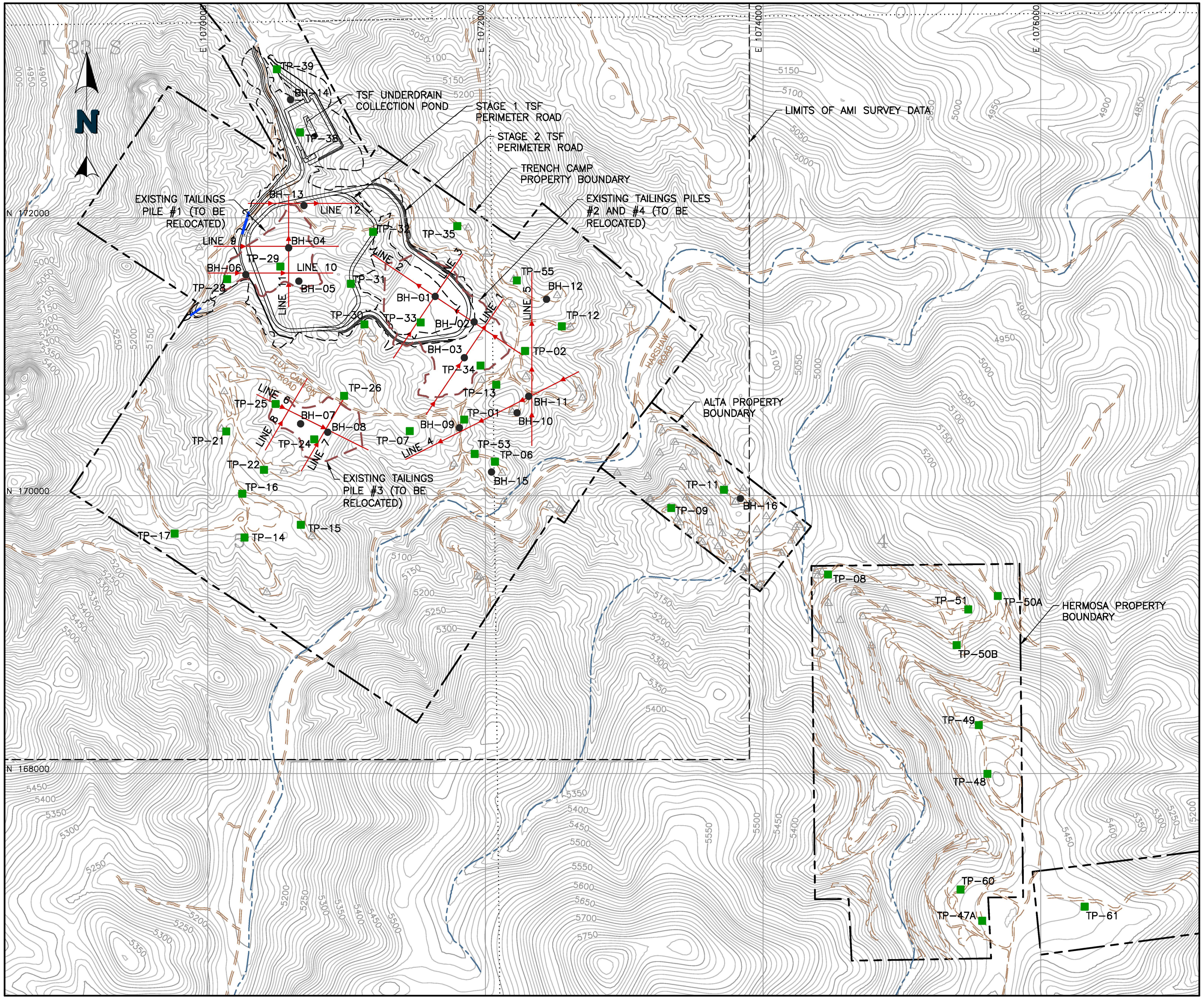

LEGEND:

- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- BH-01 NEWFIELDS BOREHOLE (JAN 2017)
- TP-01 NEWFIELDS TEST PIT (JAN 2017)
- AMI DRILLING LOCATION
- GEOPHYSICAL SURVEY (JAN 2017)
- EXISTING TAILINGS PILE LIMITS

BOREHOLE LOCATIONS (JAN 2017)

POINT	NORTHING	EASTING	ELEVATION
BH-01	171,434.89	1,071,638.05	5,099.00
BH-02	171,251.10	1,071,918.68	5,098.30
BH-03	170,993.46	1,071,848.26	5,115.00
BH-04	171,783.52	1,070,582.77	5,038.76
BH-05	171,544.73	1,070,656.11	5,047.47
BH-06	171,591.49	1,070,273.94	5,041.04
BH-07	170,517.23	1,070,668.61	5,182.42
BH-08	170,456.57	1,070,864.19	5,187.44
BH-09	170,488.85	1,071,812.79	5,125.87
BH-10	170,596.56	1,072,228.21	5,146.81
BH-11	170,715.49	1,072,311.63	5,127.26
BH-12	171,414.06	1,072,440.26	5,149.59
BH-13	172,088.43	1,070,692.81	4,973.88
BH-14	172,850.27	1,070,596.40	4,929.69
BH-15	170,170.13	1,072,044.06	5,089.30
BH-16	169,979.59	1,073,837.40	5,052.50

TEST PIT LOCATIONS (JAN 2017)

POINT	NORTHING	EASTING	ELEVATION
TP-01	170,548.03	1,071,846.74	5,114.72
TP-02	171,042.32	1,072,285.55	5,108.80
TP-06	170,244.73	1,072,068.89	5,094.13
TP-07	170,464.69	1,071,455.51	5,176.05
TP-08	169,431.35	1,074,468.04	5,120.56
TP-09	169,911.00	1,073,338.16	5,189.56
TP-11	170,042.18	1,073,717.82	5,044.47
TP-12	171,219.43	1,072,550.65	5,106.08
TP-13	170,798.07	1,072,078.30	5,127.18
TP-14	169,698.23	1,070,264.30	5,189.54
TP-15	169,790.25	1,070,670.55	5,267.44
TP-16	170,013.21	1,070,248.54	5,268.52
TP-17	169,726.86	1,069,761.85	5,263.04
TP-21	170,461.94	1,070,133.19	5,230.00
TP-22	170,185.20	1,070,404.66	5,222.82
TP-24	170,405.67	1,070,766.81	5,185.94
TP-25	170,660.35	1,070,489.09	5,182.00
TP-26	170,718.48	1,070,981.20	5,188.99
TP-28	171,558.67	1,070,139.78	5,040.09
TP-29	171,650.11	1,070,522.92	5,041.43
TP-30	171,233.35	1,071,128.15	5,135.85
TP-31	171,526.23	1,071,031.00	5,085.63
TP-32	171,897.83	1,071,190.83	5,042.39
TP-33	171,247.24	1,071,534.42	5,102.44
TP-34	170,936.99	1,071,964.91	5,114.71
TP-35	171,939.49	1,071,797.34	5,166.58

TEST PIT LOCATIONS (JAN 2017)

POINT	NORTHING	EASTING	ELEVATION
TP-38	172,614.40	1,070,664.38	4,946.49
TP-39	173,068.20	1,070,497.83	4,909.98
TP-47A	166,939.41	1,075,578.61	5,481.70
TP-48	167,996.67	1,075,615.74	5,491.93
TP-49	168,347.37	1,075,553.73	5,462.39
TP-50A	169,277.44	1,075,690.39	5,259.44
TP-50B	168,923.75	1,075,394.64	5,263.82
TP-51	169,180.47	1,075,477.84	5,213.69
TP-53	170,300.30	1,071,923.07	5,094.20
TP-55	171,549.36	1,072,226.65	5,168.14
TP-60	167,164.60	1,075,422.46	5,465.40
TP-61	167,040.76	1,076,316.31	5,477.95

0 400 800 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: GEOTECHNICAL INVESTIGATION PLAN VIEW

FILENAME: 14.008.001M
DRAWING NO.: A030
REVISION: 0

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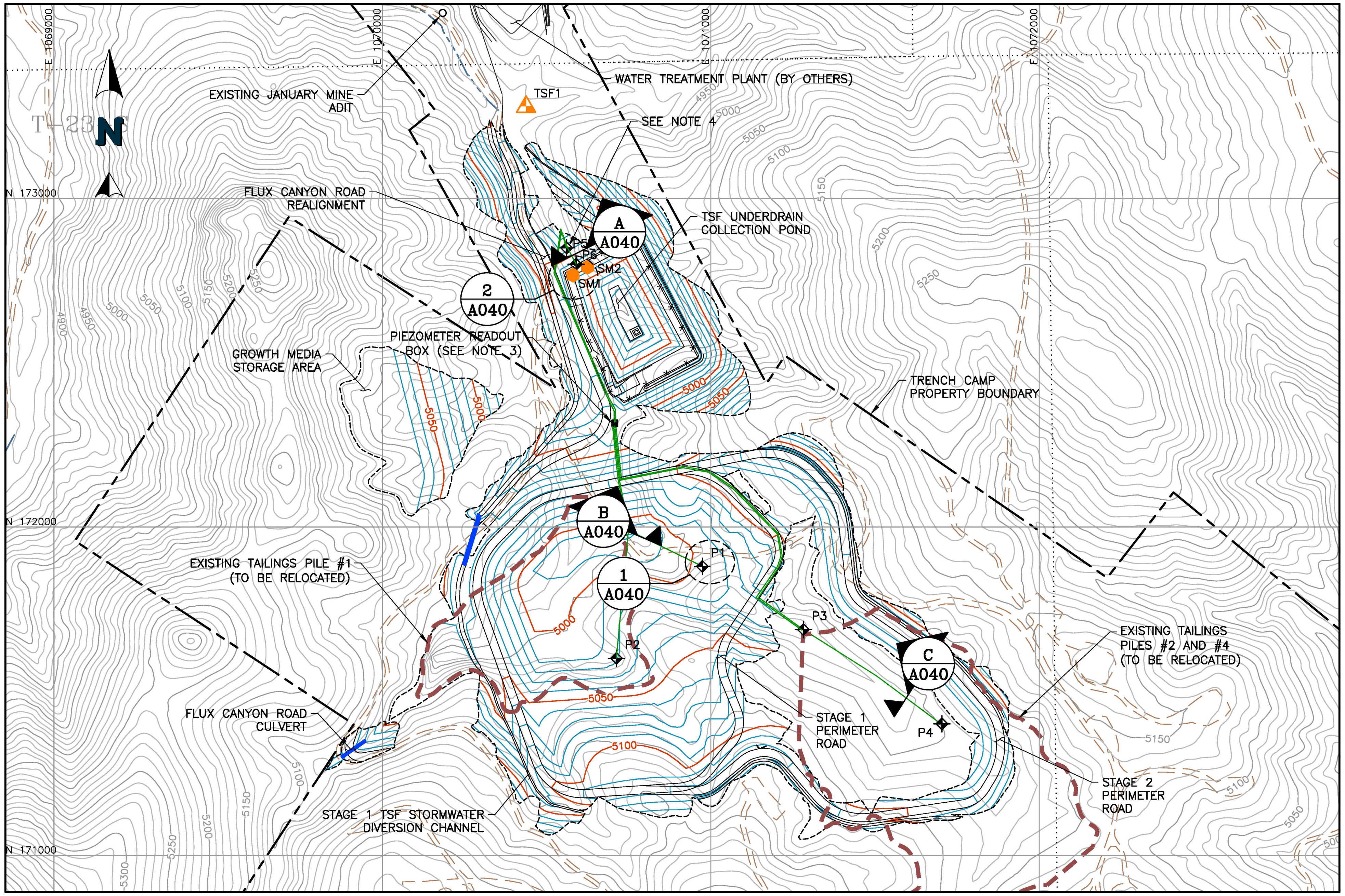


LEGEND:

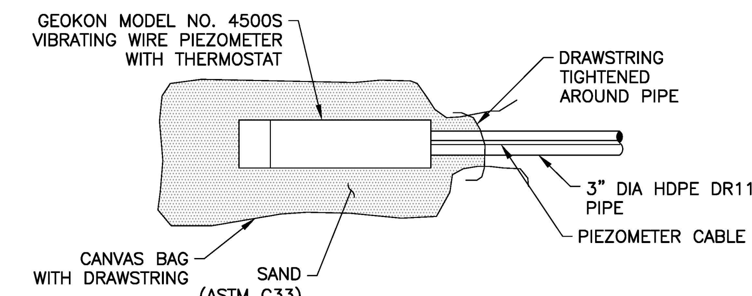
- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- PROPOSED FENCE
- PIEZOMETER CABLE
- TSF1 — MONITORING WELL
- P1 — VIBRATING WIRE PIEZOMETER
- SM1 — SETTLEMENT MONUMENT

GEOTECHNICAL INSTRUMENTS AND MONITORING WELL SETTING OUT DATA

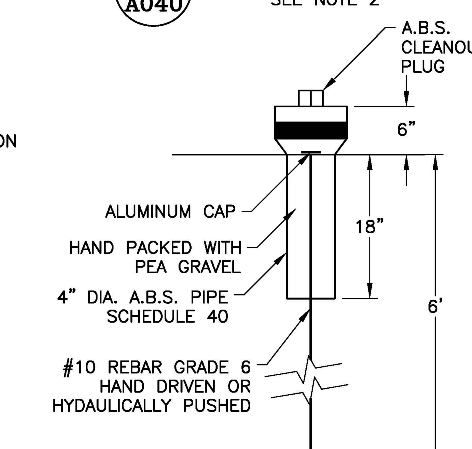
POINT	NORTHING	EASTING
P1	171,880.21	1,070,974.41
P2	171,600.22	1,070,712.78
P3	171,687.44	1,071,281.89
P4	171,400.39	1,071,703.53
P5	172,849.40	1,070,561.18
P6	172,799.57	1,070,589.66
SM1	172,766.32	1,070,580.51
SM2	172,790.32	1,070,624.37
TSF1	173,278.29	1,070,437.41

NOTES:

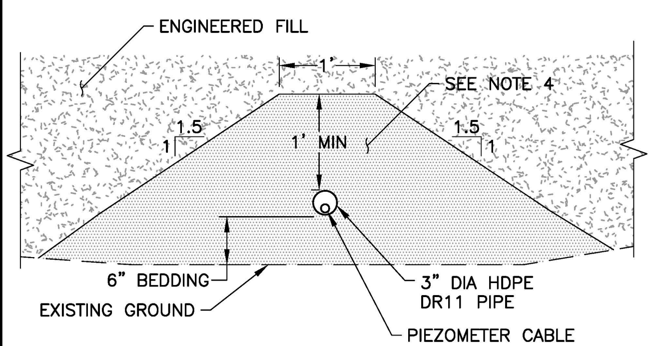
1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWINGS A120 AND A210 FOR THE STAGE 1 AND STAGE 2 GEOMEMBRANE LINER LIMITS, RESPECTIVELY.
2. IN TSF, PIEZOMETERS TO BE POSITIONED ADJACENT TO A DRAINAGE COLLECTION PIPE.
3. CONTRACTOR TO SUBMIT SHOP DRAWING OF FABRICATED STAND.
4. PROTECTIVE MATERIAL TO BE PLACED ONLY AROUND UNDERDRAIN COLLECTION POND PIEZOMETER CABLES FROM P5 AND P6. THE 3" DIA HDPE DR11 PIEZOMETER CABLE HOUSING PIPE WILL BE BEDDED ON 6" OF C33 SAND AND COVERED WITH A MINIMUM OF OF 12" OF C33 SAND ABOVE THE TOP OF THE PIPE. SAND BACKFILL WILL ALSO EXTEND A MINIMUM OF 12" ON EITHER SIDE OF THE PIPE. ALTERNATIVE PIPE BEDDING MAY BE USED UPON ENGINEERS APPROVAL. CARE TO BE TAKEN WHEN PERFORMING FILL AROUND PIEZOMETER AND 3" DIA HDPE DR11 PIPE TO AVOID DAMAGING THE INSTRUMENTATION OR CABLE.
5. PIPING OMITTED IN PLAN VIEW FOR CLARITY. SEE DWG A228 FOR PIPING LAYOUT.
6. GCL MAY BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY)



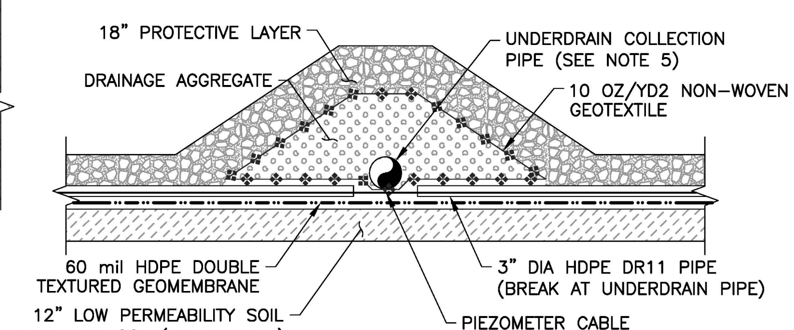
1 / A040 VIBRATING WIRE PIEZOMETER
SEE NOTE 2



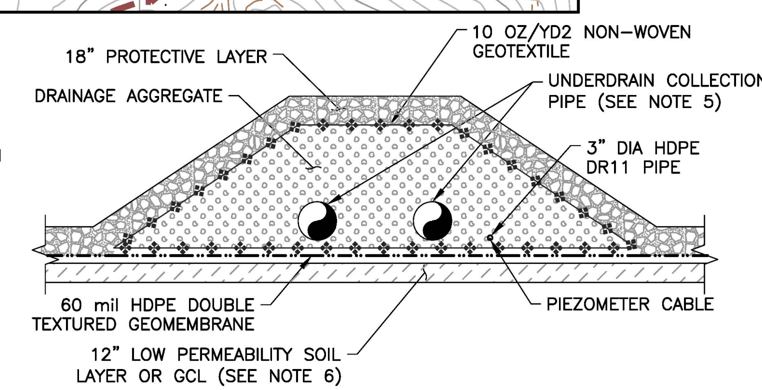
2 / A040 TYPICAL SETTLEMENT MONUMENT



A / A040 PIEZOMETER CABLE SECTION FROM UNDERDRAIN POND



B / A040 TYPICAL PIEZOMETER CABLE PIPE CROSSING



C / A040 PIEZOMETER CABLE SECTION

Registered Professional Engineer (Civil) — CERTIFICATE NO. 63431 — CRAIG M. THOMPSON — Date Signed 6/5/17 — ARIZONA, U.S.A. — EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

0 200 400 FEET

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: INSTRUMENTATION PLAN VIEW

FILENAME: 14.008.067M
DRAWING NO.: A040
REVISION: 0

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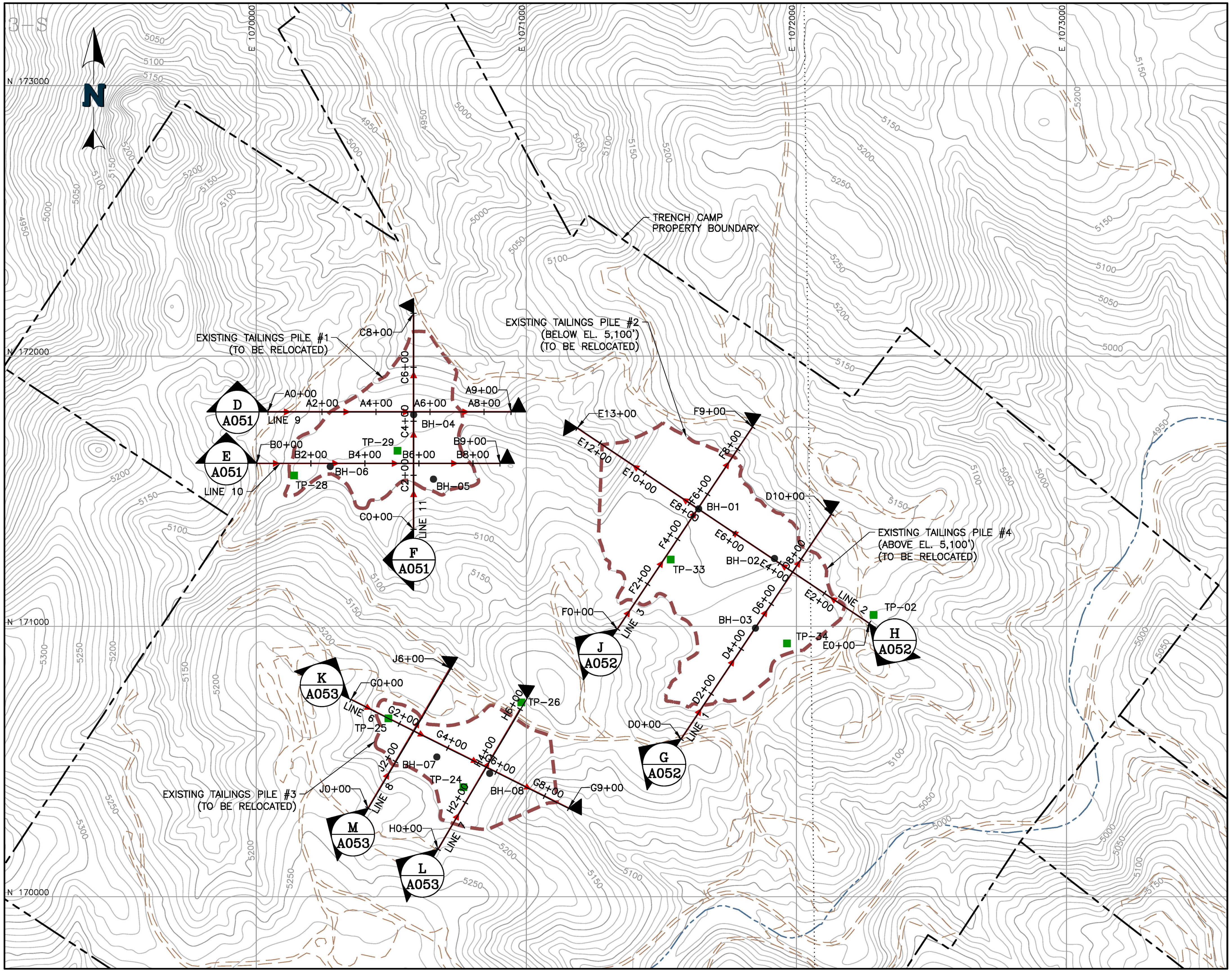

LEGEND:

- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- GEOPHYSICAL SURVEY (JAN 2017)
- BH-01 NEWFIELDS BOREHOLE (JAN 2017)
- TP-01 NEWFIELDS TEST PIT (JAN 2017)
- EXISTING TAILINGS PILE LIMIT

GEOPHYSICAL SURVEY LINES

EXISTING TAILINGS PILE	STATION RANGE	GEOPHYSICAL SURVEY LINE
1	A0+00 – A9+00	9
1	B0+00 – B9+00	10
1	C0+00 – C8+00	11
2/4	D0+00 – D10+00	1
2/4	E0+00 – E13+00	2
2/4	F0+00 – F9+00	3
3	G0+00 – G9+00	6
3	H0+00 – H6+00	7
3	J0+00 – J6+00	8

0 200 400 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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CLIENT: ARIZONA MINERALS INC

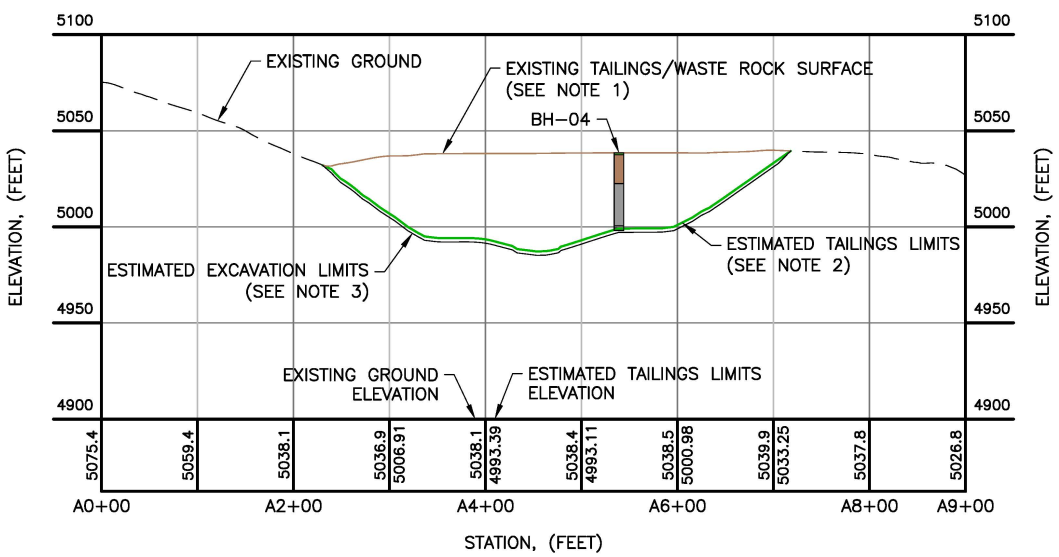
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TRENCH CAMP TAILINGS PILES PLAN VIEW

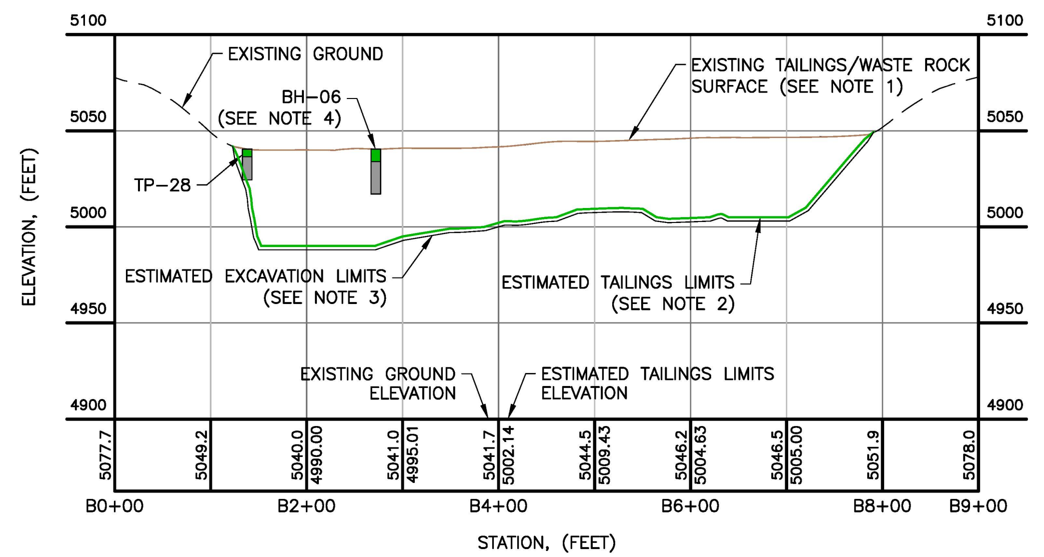
FILENAME: 14.008.004M

DRAWING NO.: A050

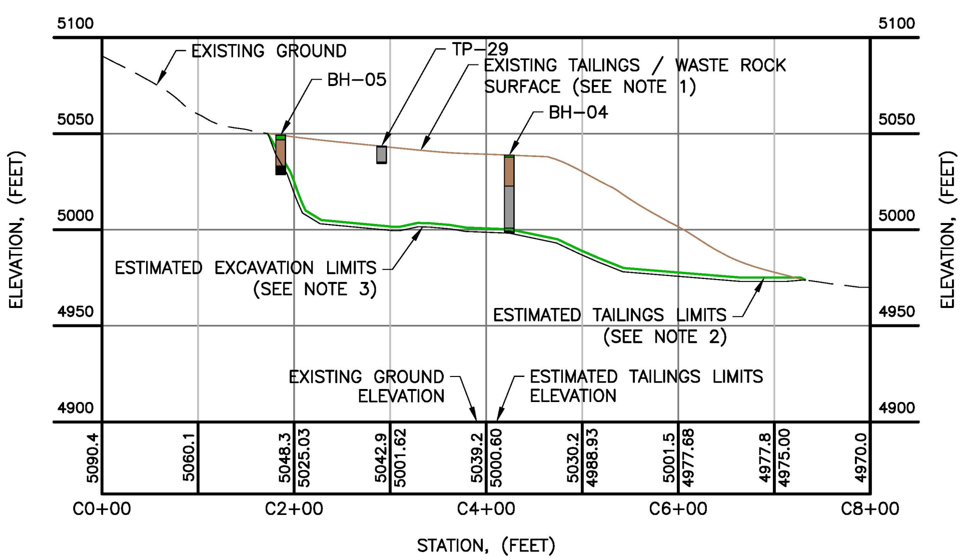
REVISION: 0



D / A050 **HISTORIC TAILINGS PILE #1 SECTION**
(GEOPHYSICS SURVEY LINE 9)

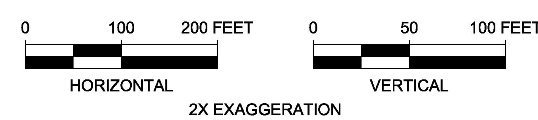


E / A050 **HISTORIC TAILINGS PILE #1 SECTION**
(GEOPHYSICS SURVEY LINE 10)



F / A050 **HISTORIC TAILINGS PILE #1 SECTION**
(GEOPHYSICS SURVEY LINE 11)

EXISTING TAILINGS PILE #1		
MATERIAL TYPE	ESTIMATED VOLUME (CY)	ESTIMATED VOLUME (TONS)
TAILINGS	87,000	112,752 (SEE NOTE 5)
WASTE ROCK	144,000	223,560 (SEE NOTE 5)
NATIVE SOIL	9,970	15,480 (SEE NOTE 5)



NOTES:

1. EXISTING TAILINGS PILE #1 CONTAINS BOTH HISTORIC TAILINGS AND WASTE ROCK.
2. ESTIMATED TAILINGS AND WASTE ROCK LIMITS SHOWN IN THE PROFILES ARE BASED ON THE CORRELATION OF SEISMIC VELOCITIES TO BOREHOLE DATA ACQUIRED ALONG OR NEAR THE GEOPHYSICS LINE.
3. ESTIMATED EXCAVATION LIMITS SHOWN IN THE PROFILE ARE APPROXIMATE. ACTUAL EXCAVATION LIMITS WILL BE ESTABLISHED WHEN THE FOLLOWING CRITERIA IS MET:
   3.1. ALL EXISTING TAILINGS AND WASTE ROCK ARE REMOVED.
   3.2. NATIVE SOIL BENEATH THE TAILINGS IS REMOVED TO A DEPTH OF 1 FT.
4. BOREHOLE TERMINATED DUE TO REFUSAL IN WASTE ROCK MATERIAL.
5. IN PLACE TAILINGS DENSITY ESTIMATED TO BE 96 PCF AND WASTE ROCK AND NATIVE SOIL DENSITY ESTIMATED TO BE 115 PCF.

LEGEND:

- COVER MATERIAL
- TAILINGS
- WASTE ROCK
- NATIVE GROUND

REV	DATE	DESCRIPTION	TECH	ENG
0	08/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TRENCH CAMP TAILINGS PILES SECTIONS (SHEET 1 OF 3)

FILENAME: 14.008.005D
DRAWING NO.: A051
REVISION: 0

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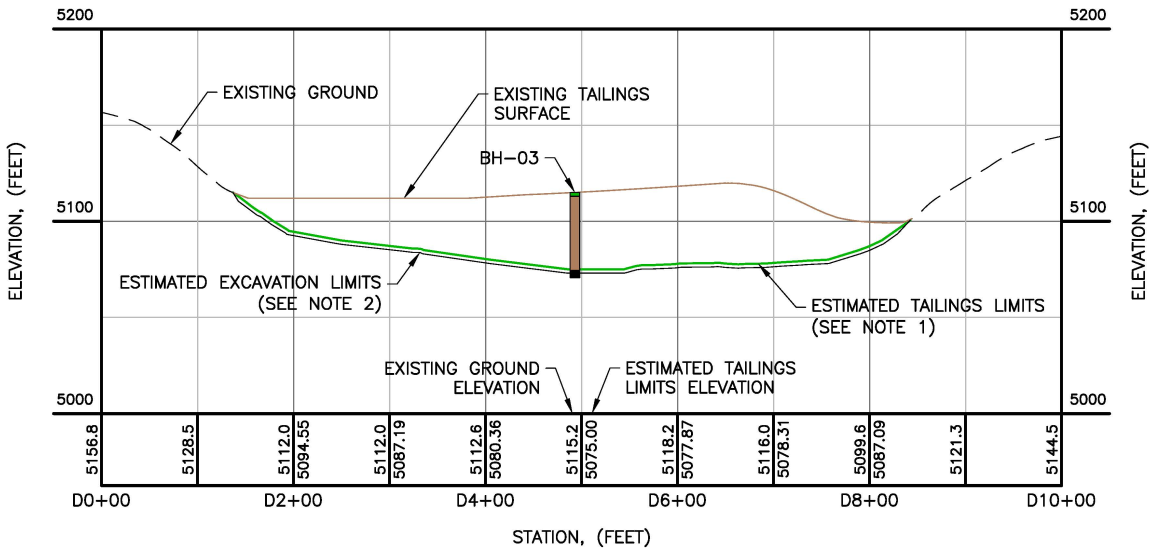
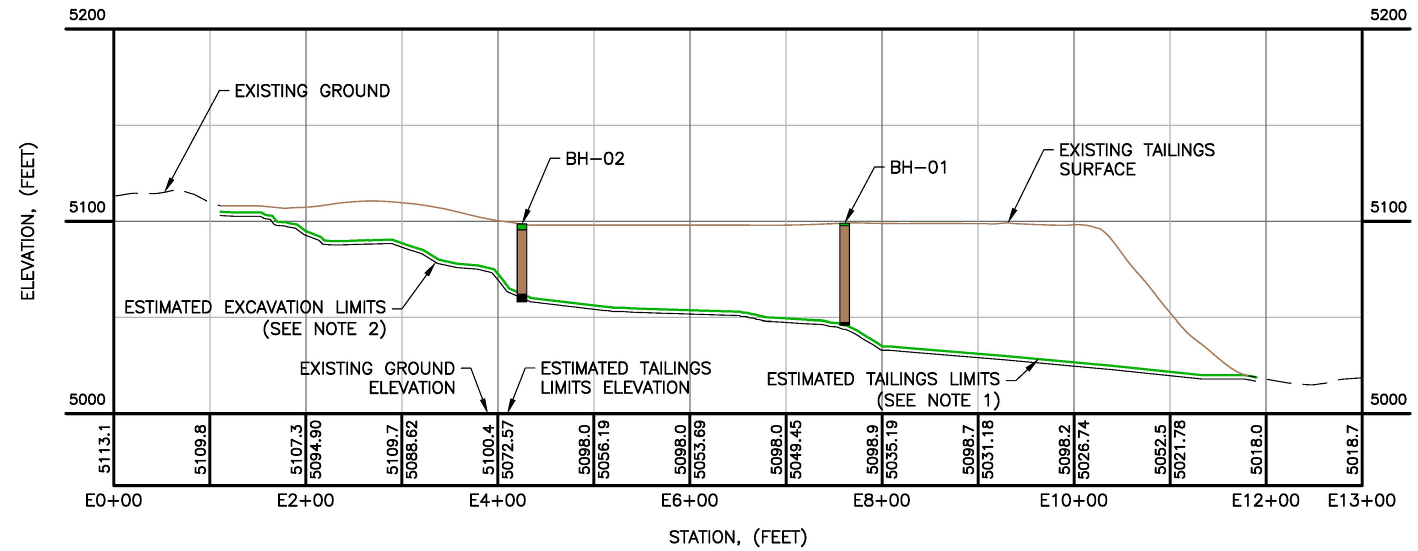
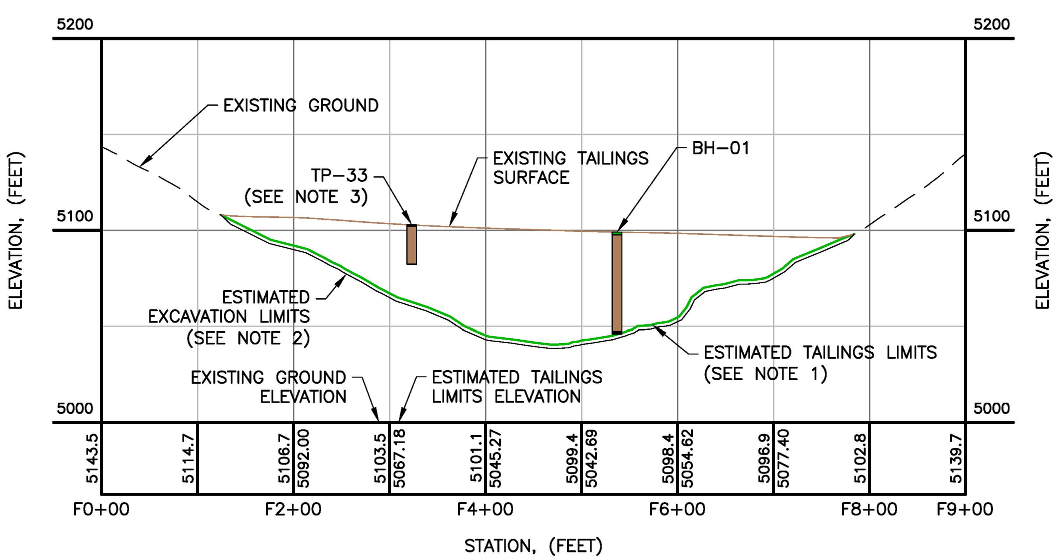


G / A050 EXISTING TAILINGS PILE #2/#4 SECTION
(GEOPHYSICS SURVEY LINE 1)

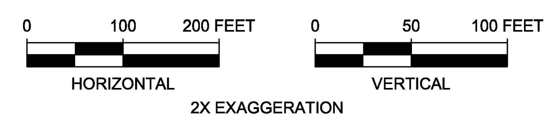


H / A050 EXISTING TAILINGS PILE #2/#4 SECTION
(GEOPHYSICS SURVEY LINE 2)



J / A050 EXISTING TAILINGS PILE #2/#4 SECTION
(GEOPHYSICS SURVEY LINE 3)

EXISTING TAILINGS PILE #2/#4		
MATERIAL TYPE	ESTIMATED VOLUME (CY)	ESTIMATED VOLUME (TONS)
TAILINGS	501,500	649,944 (SEE NOTE 4)
NATIVE SOIL	21,680	33,660 (SEE NOTE 4)



NOTES:

1. ESTIMATED TAILINGS LIMITS SHOWN IN THE PROFILES ARE BASED ON THE CORRELATION OF SEISMIC VELOCITIES TO BOREHOLE DATA ACQUIRED ALONG OR NEAR THE GEOPHYSICS LINE.
2. ESTIMATED EXCAVATION LIMITS SHOWN IN THE PROFILE ARE APPROXIMATE. ACTUAL EXCAVATION LIMITS WILL BE ESTABLISHED WHEN THE FOLLOWING CRITERIA IS MET:
   - 2.1. ALL EXISTING TAILINGS AND WASTE ROCK ARE REMOVED.
   - 2.2. NATIVE SOIL BENEATH THE TAILINGS IS REMOVED TO A DEPTH OF 1 FT.
3. TEST PIT EXCAVATED TO MACHINE DEPTH LIMITS.
4. IN PLACE TAILINGS DENSITY ESTIMATED TO BE 96 PCF AND WASTE ROCK AND NATIVE SOIL DENSITY ESTIMATED TO BE 115 PCF.

LEGEND:

- COVER MATERIAL
- TAILINGS
- NATIVE GROUND

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER
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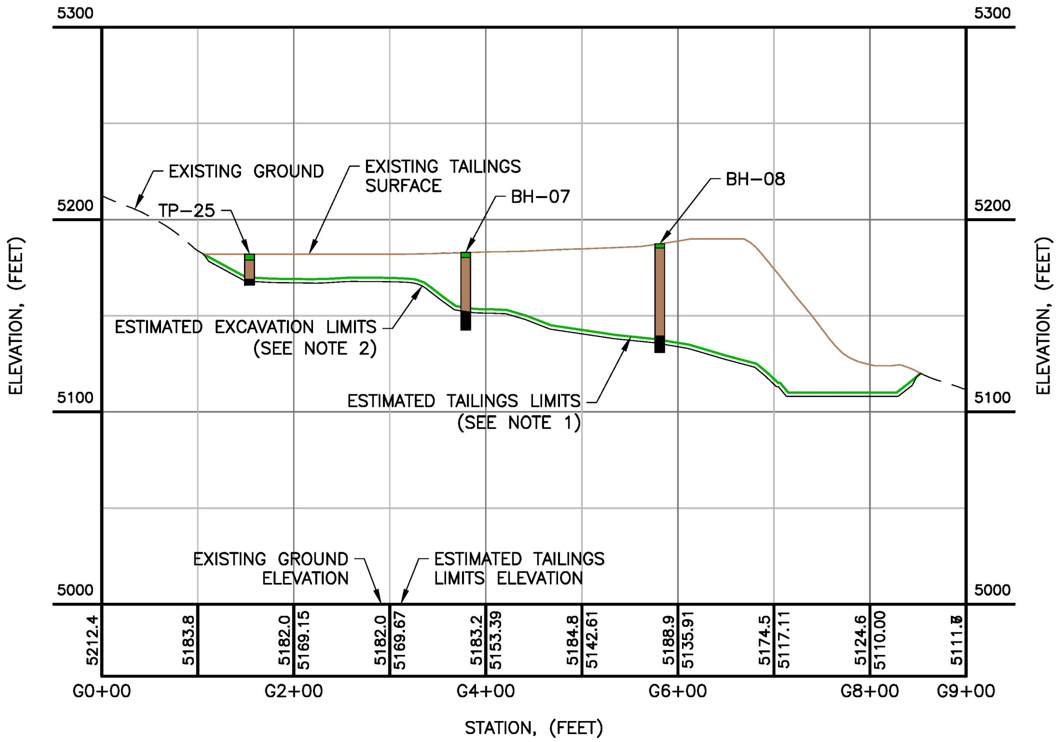
NewFields

CLIENT: ARIZONA MINERALS INC

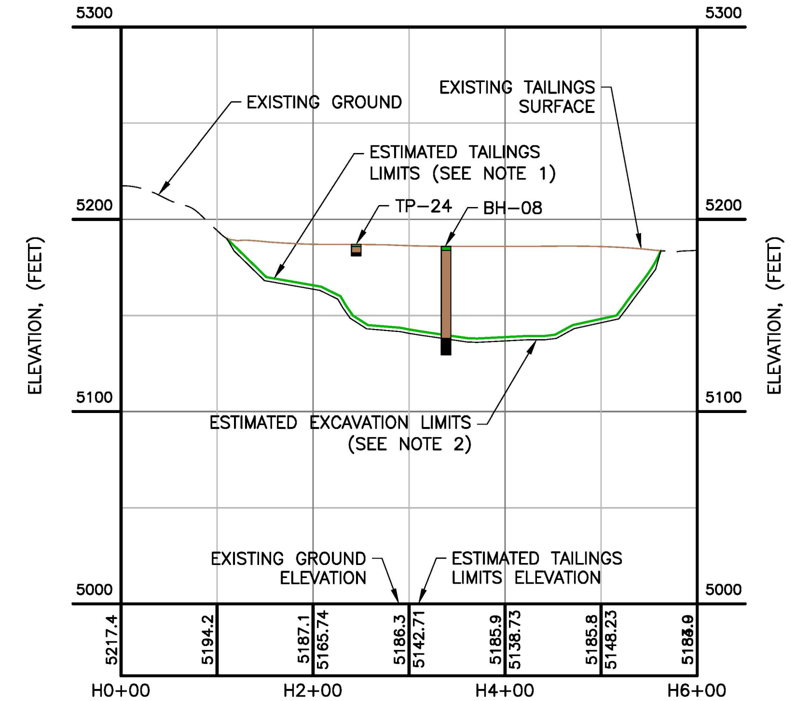
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TRENCH CAMP TAILINGS PILES SECTIONS (SHEET 2 OF 3)

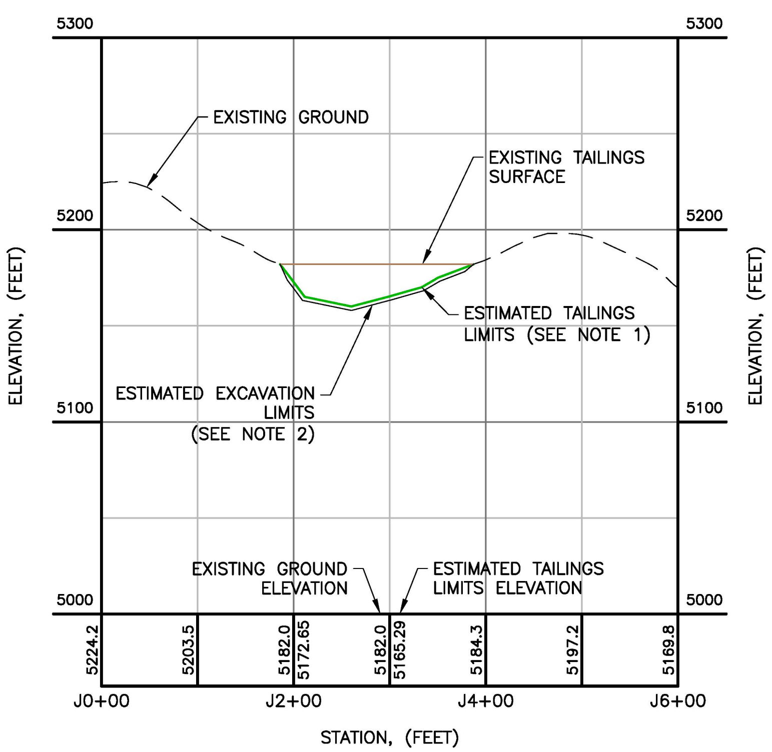
FILENAME: 14.008.051D
DRAWING NO.: A052
REVISION: 0



K A050 EXISTING TAILINGS PILE #3 SECTION
(GEOPHYSICS SURVEY LINE 6)



L A050 EXISTING TAILINGS PILE #3 SECTION
(GEOPHYSICS SURVEY LINE 7)



M A050 EXISTING TAILINGS PILE #3 SECTION
(GEOPHYSICS SURVEY LINE 8)

EXISTING TAILINGS PILE #3		
MATERIAL TYPE	ESTIMATED VOLUME (CY)	ESTIMATED VOLUME (TONS)
TAILINGS	165,000	213,840 (SEE NOTE 3)
NATIVE SOIL	7,930	12,315 (SEE NOTE 3)

0 100 200 FEET — HORIZONTAL
0 50 100 FEET — VERTICAL
2X EXAGGERATION

NOTES:

1. ESTIMATED TAILINGS LIMITS SHOWN IN THE PROFILES ARE BASED ON THE CORRELATION OF SEISMIC VELOCITIES TO BOREHOLE DATA ACQUIRED ALONG OR NEAR THE GEOPHYSICS LINE.
2. ESTIMATED EXCAVATION LIMITS SHOWN IN THE PROFILE ARE APPROXIMATE. ACTUAL EXCAVATION LIMITS WILL BE ESTABLISHED WHEN THE FOLLOWING CRITERIA IS MET:
   - 2.1. ALL EXISTING TAILINGS AND WASTE ROCK ARE REMOVED.
   - 2.2. NATIVE SOIL BENEATH THE TAILINGS IS REMOVED TO A DEPTH OF 1 FT.
3. IN PLACE TAILINGS DENSITY ESTIMATED TO BE 96 PCF AND WASTE ROCK AND NATIVE SOIL DENSITY ESTIMATED TO BE 115 PCF.

LEGEND:

- COVER MATERIAL
- TAILINGS
- NATIVE GROUND

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TRENCH CAMP TAILINGS PILES SECTIONS (SHEET 3 OF 3)

FILENAME: 14.008.052D
DRAWING NO.: A053
REVISION: 0

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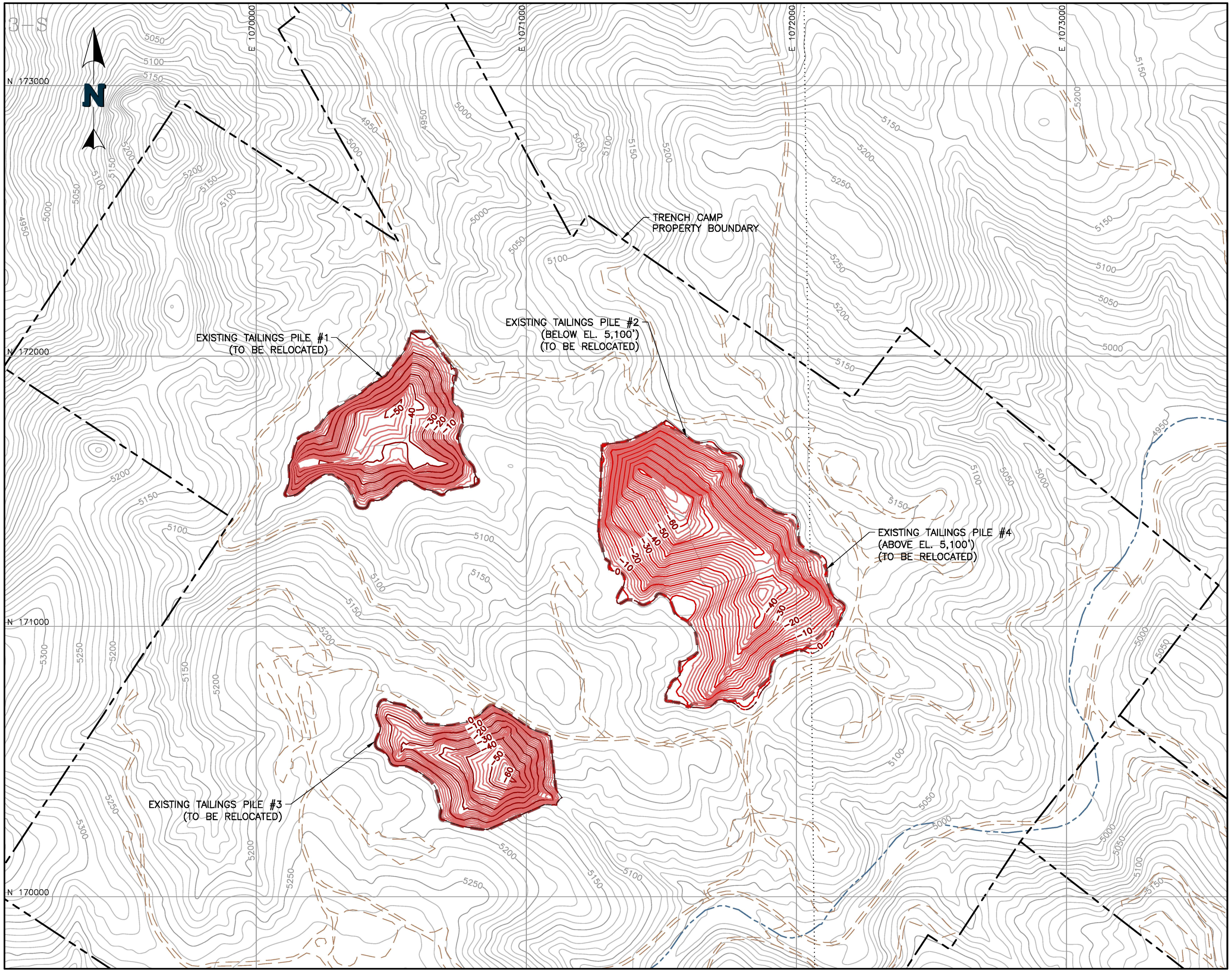

LEGEND:

- EXISTING GROUND CONTOURS
- CUT ISOPACH CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMIT

NOTES:

1. THE TAILINGS VOLUMES ARE ESTIMATED BASED ON BOREHOLE AND GEOPHYSICAL DATA COLLECTED DURING THE GEOTECHNICAL FIELD INVESTIGATION.

0 200 400 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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DESIGNED BY: CMT
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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TRENCH CAMP TAILINGS PILES ISOPACH

FILENAME: 14.008.055M

DRAWING NO.: A054

REVISION: 0

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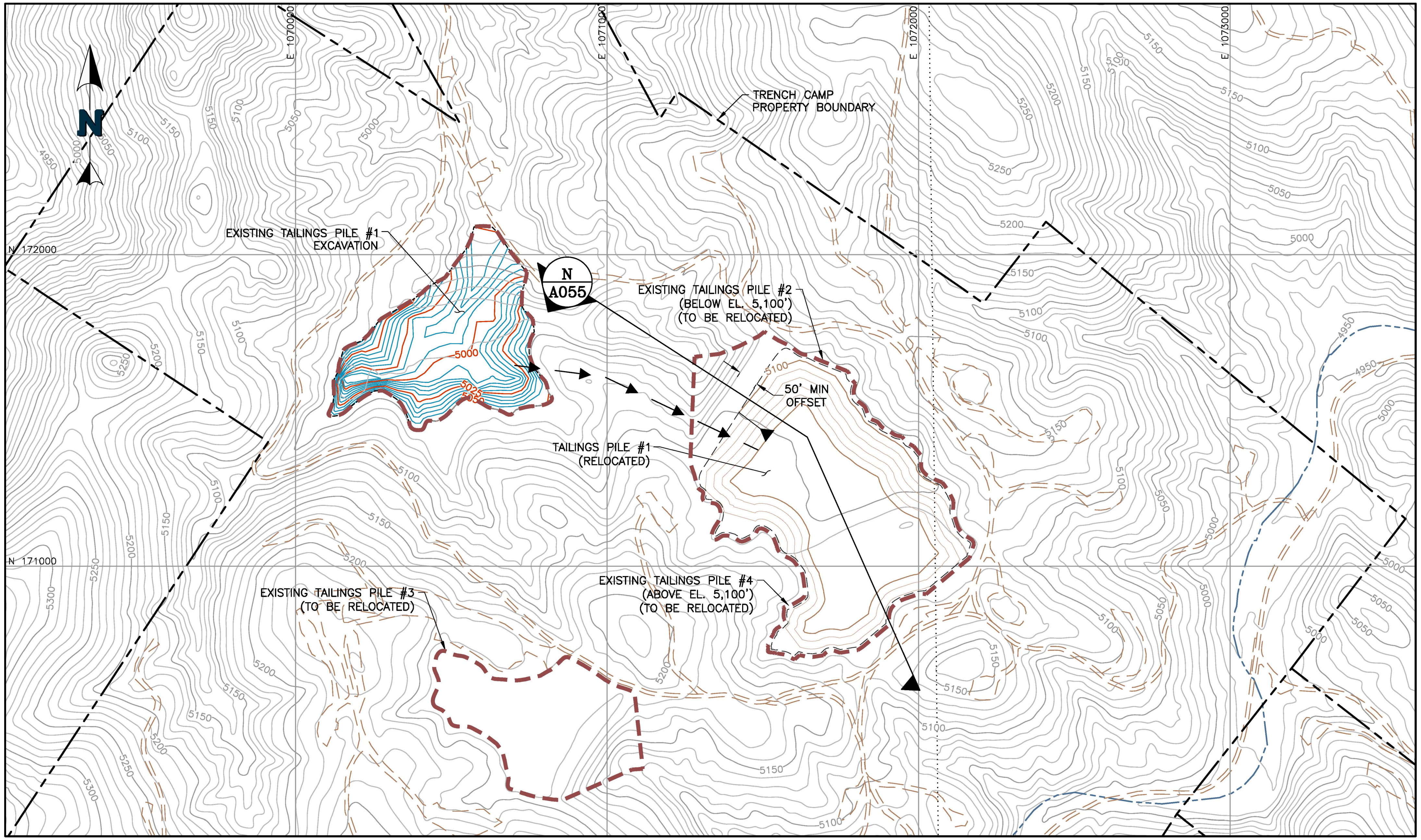


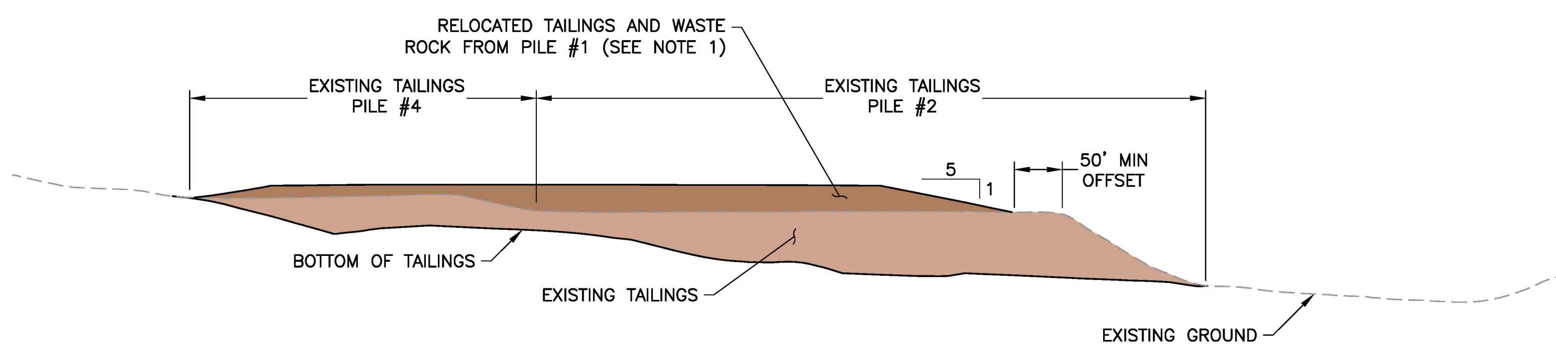
LEGEND:

- EXISTING GROUND CONTOURS
- TAILINGS BASE GRADING CONTOURS
- TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS

NOTES:

1. THE TAILINGS VOLUMES ARE CALCULATED BASED ON BOREHOLE AND GEOPHYSICAL DATA COLLECTED DURING THE GEOTECHNICAL FIELD INVESTIGATION.

0 200 400 FEET



N / A055 EXISTING TAILINGS PILE #1 TEMPORARY STORAGE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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CLIENT: ARIZONA MINERALS INC
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE
TITLE: TRENCH CAMP TAILINGS PILE 1 EXCAVATION PLAN VIEW
FILENAME: 14.008.006M
DRAWING NO.: A055
REVISION: 0

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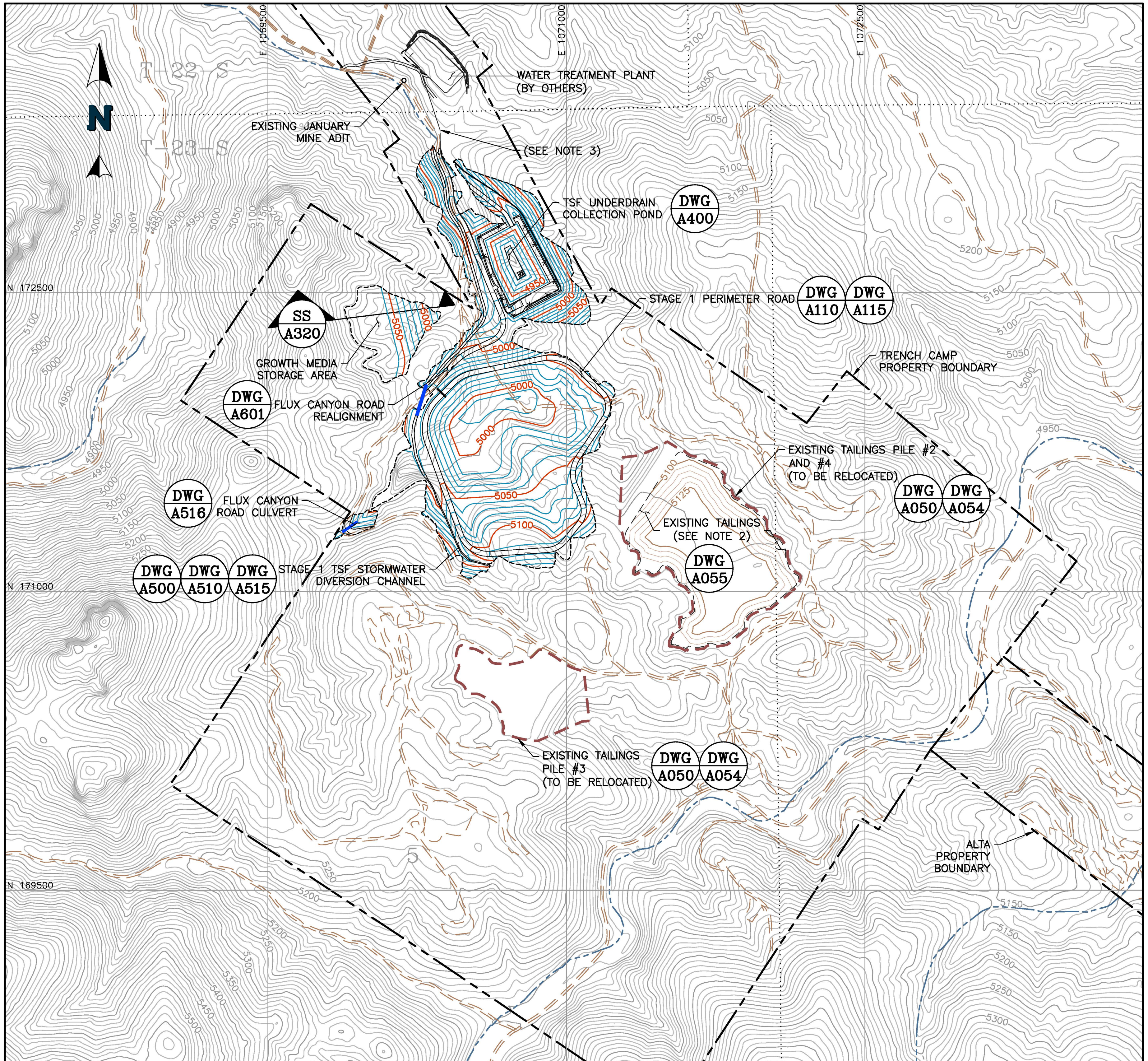

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- TAILINGS CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- PROPOSED FENCE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWING A120 FOR THE STAGE 1 GEOMEMBRANE LIMITS.
2. EXISTING TAILINGS FROM PILE #1 RELOCATED TO THE TOP OF EXISTING TAILINGS PILE #2/#4.
3. TSF UNDERDRAIN COLLECTION POND WATER TO BE PUMPED TO WATER TREATMENT PLANT. PIPE-IN-PIPE CONTAINMENT REQUIRED.

0 300 600 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
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APPROVED BY: RMS
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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF PLAN VIEW STAGE 1

FILENAME: 14.008.002M

DRAWING NO.: A100

REVISION: 0

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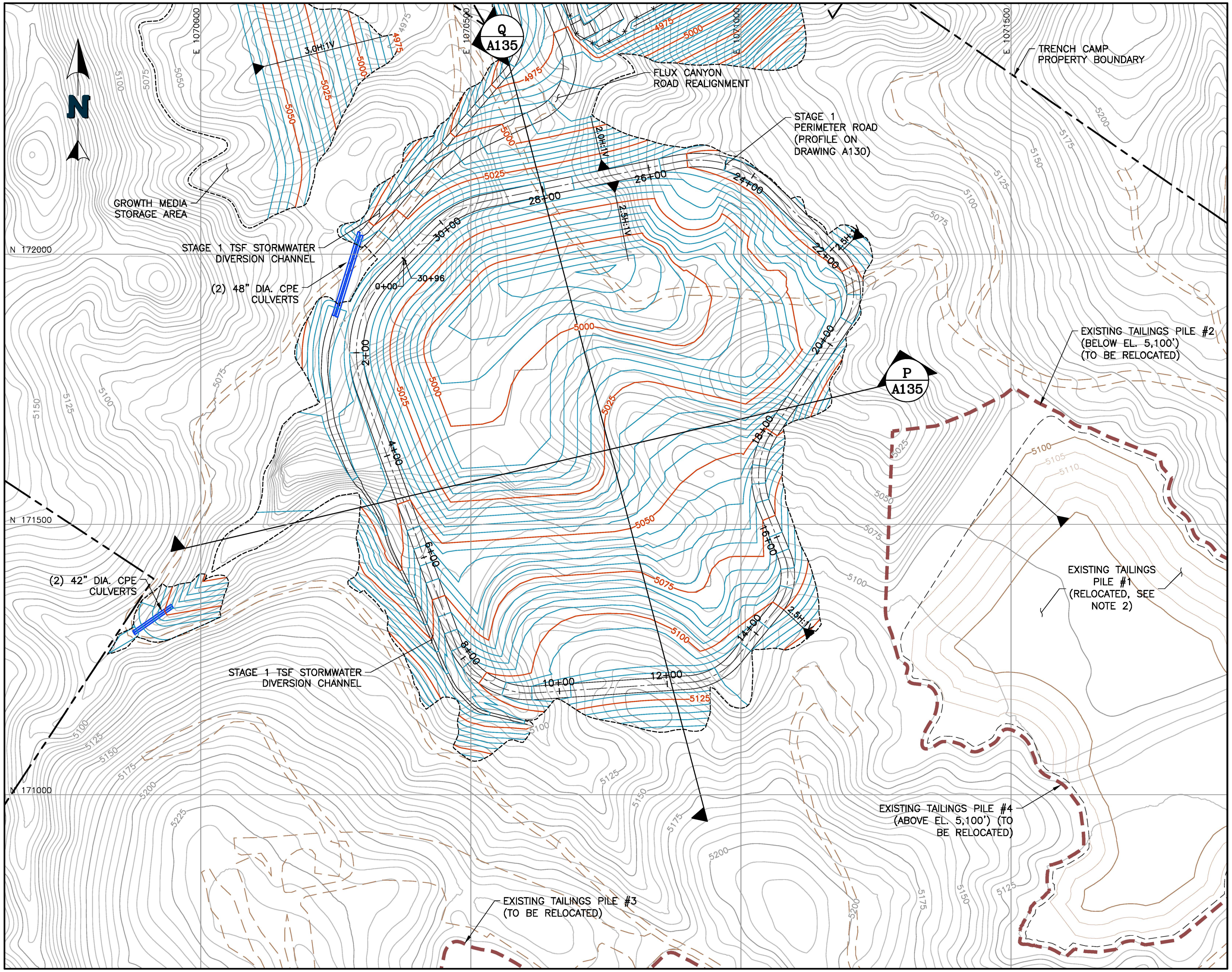

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- EXISTING TAILINGS PILE LIMITS
- PROPOSED FENCE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. TAILINGS PILE #1 TO BE RELOCATED TEMPORARILY ON TOP OF TAILINGS PILE #2/#4 TO ALLOW CONSTRUCTION OF STAGE 1 TSF.

0 100 200 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF GRADING PLAN VIEW

FILENAME: 14.008.007M
DRAWING NO.: A110
REVISION: 0

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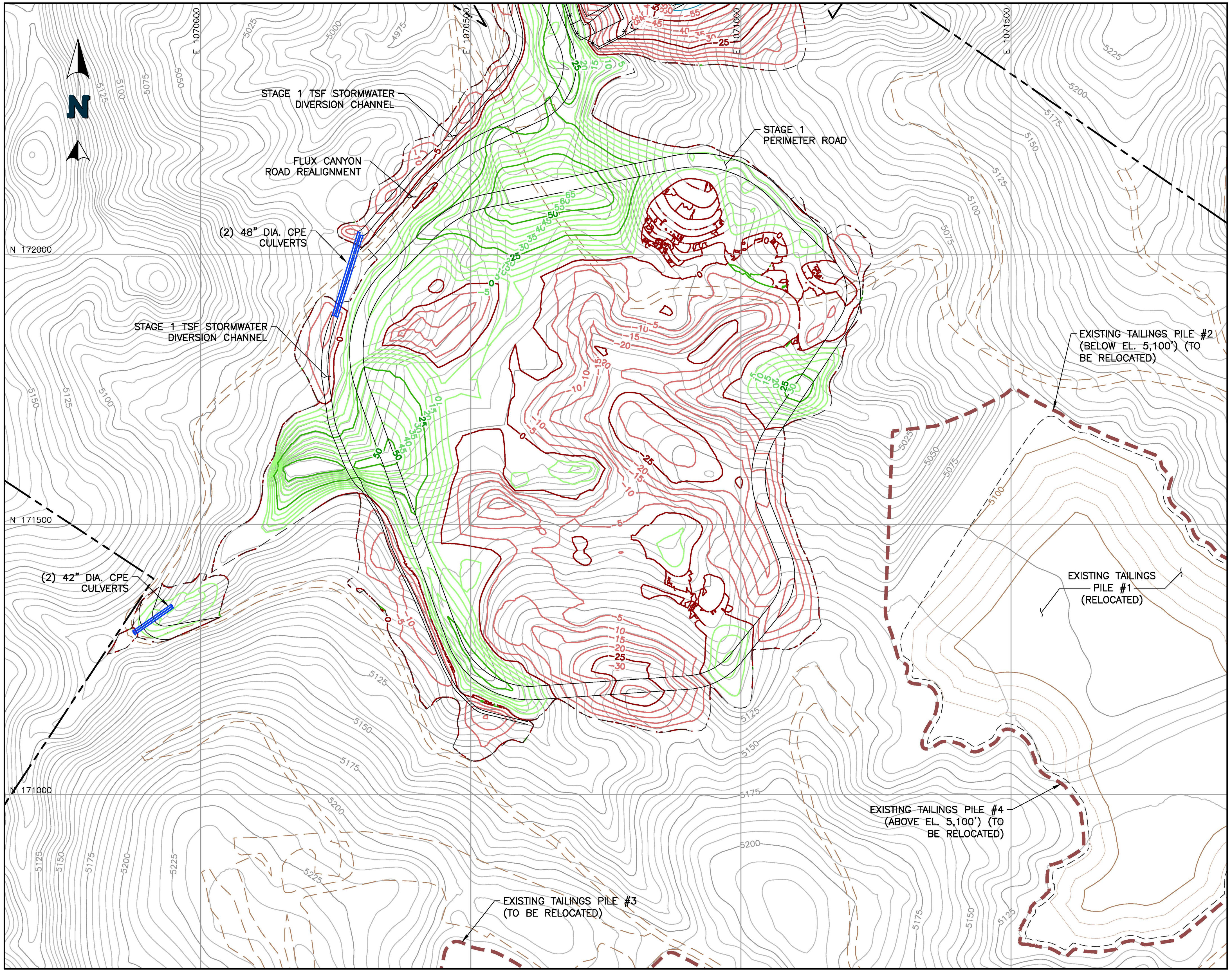

LEGEND:

- EXISTING GROUND CONTOURS
- FILL ISOPACH CONTOURS
- CUT ISOPACH CONTOURS
- TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- EXISTING TAILINGS PILE LIMITS
- PROPOSED FENCE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.

0 100 200 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF GRADING ISOPACH

FILENAME: 14.008.020M
DRAWING NO.: A115
REVISION: 0

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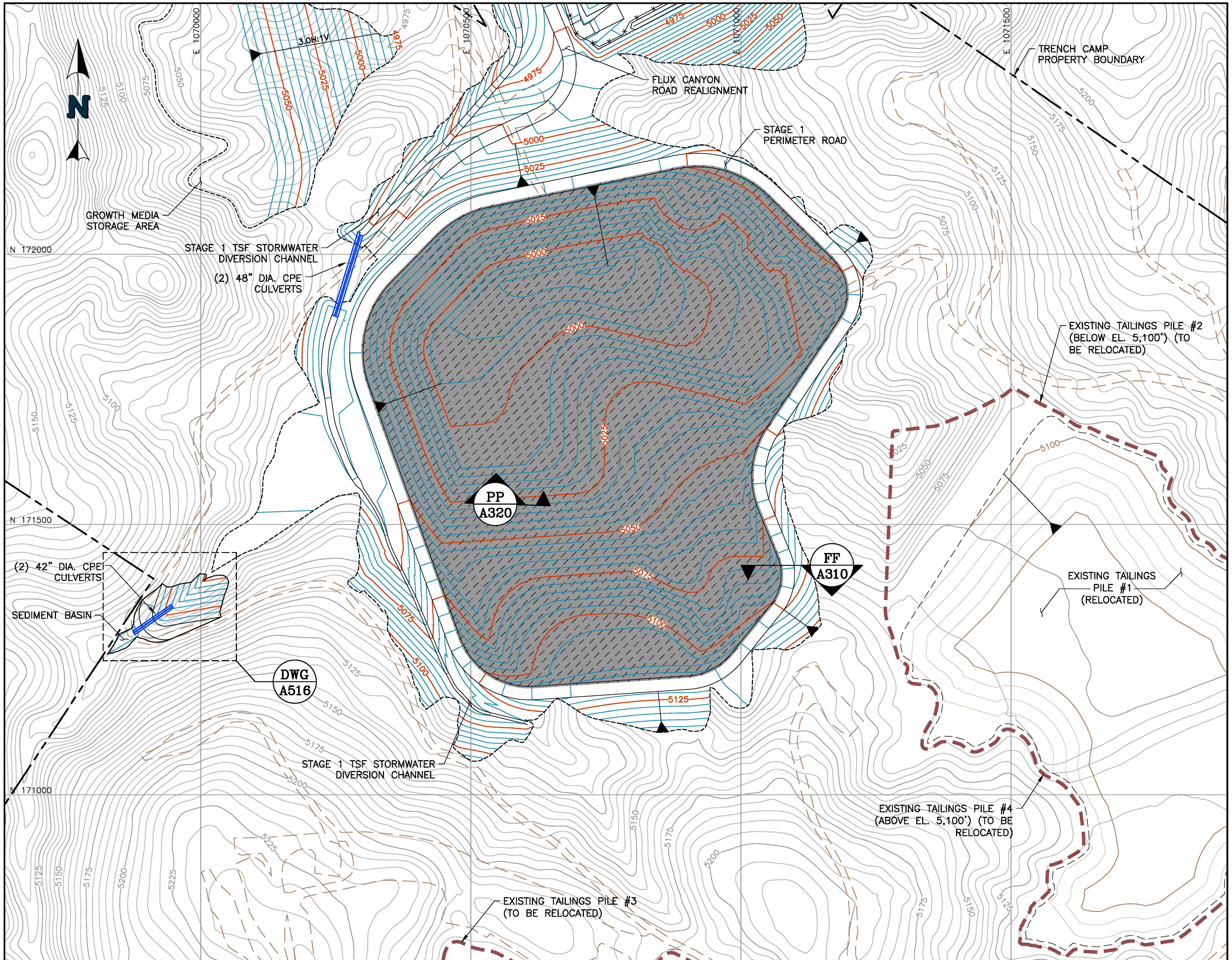

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- EXISTING TAILINGS PILE LIMITS
- GEOMEMBRANE
- PROPOSED FENCE
- LOW PERMEABILITY SOIL LAYER (SEE NOTE 2)

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. LOW PERMEABILITY SOIL LAYER REQUIRED WITHIN STAGE 1 LIMITS. GCL MUST NOT BE USED WITHIN STAGE 1.

0 100 200 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF GEOMEMBRANE PLAN VIEW

FILENAME: 14.008.021M
DRAWING NO.: A120
REVISION: 0

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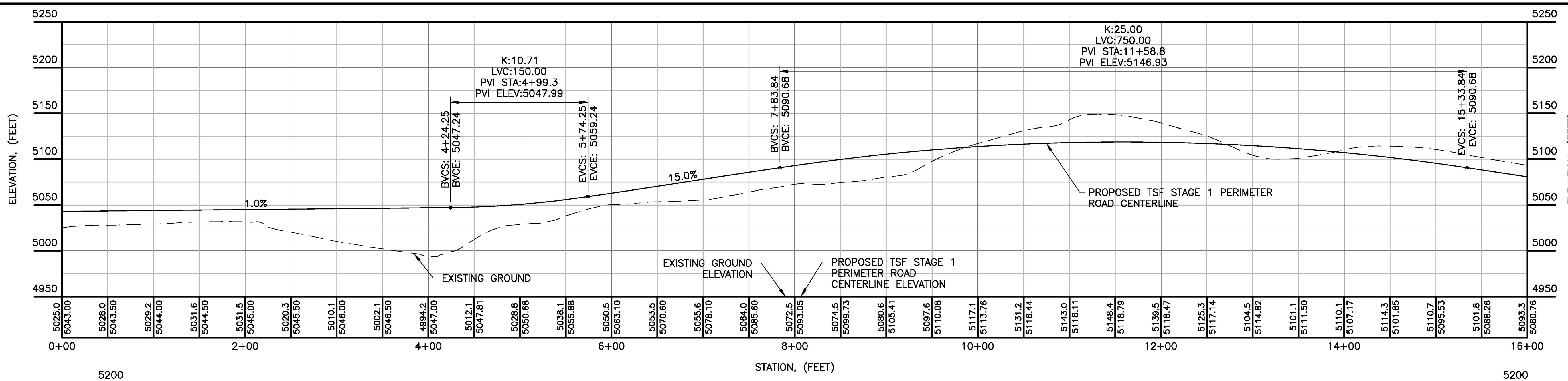

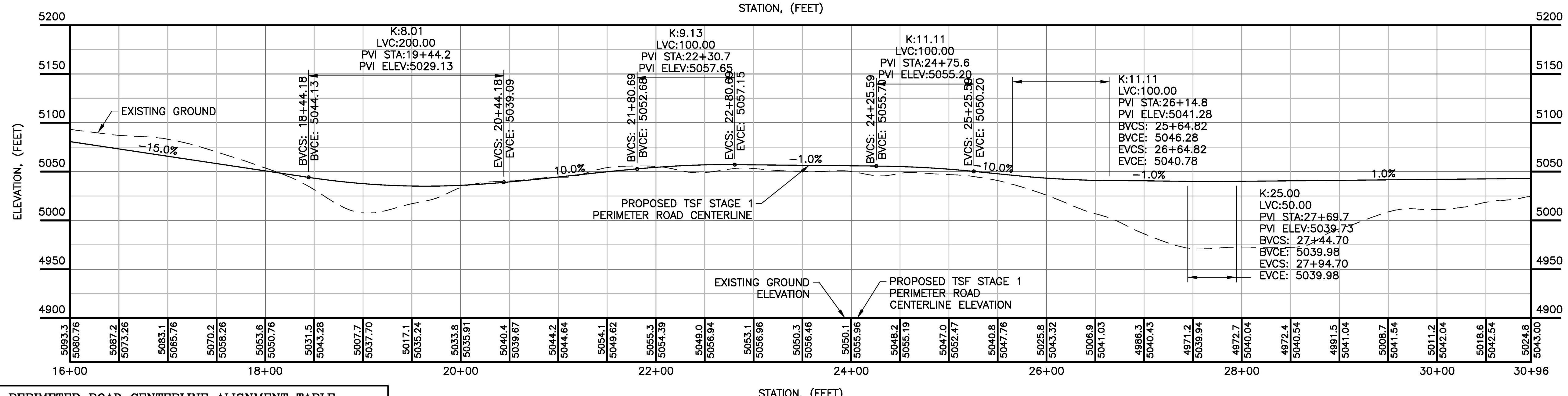

0 60 120 FEET HORIZONTAL

0 60 120 FEET VERTICAL

NO EXAGGERATION

STAGE 1 PERIMETER ROAD CENTERLINE ALIGNMENT TABLE						
	STATION	NORTHING	EASTING	DELTA (D–M–S)	LENGTH (FT)	RADIUS (FT)
BP	0+00.00	171,989.90	1,070,375.93			
PC	0+43.07	171,959.24	1,070,345.68	064–33–38	225.36	200.00
PT	2+68.43	171,750.54	1,070,300.05			
PC	7+61.95	171,286.63	1,070,468.41	073–56–24	193.57	150.00
PT	9+55.52	171,188.15	1,070,619.58			
PC	12+39.72	171,207.41	1,070,903.13	047–03–43	102.67	125.00
PT	13+42.39	171,253.37	1,070,991.73			
PC	14+58.09	171,343.22	1,071,064.62	061–11–48	106.81	100.00
PT	15+64.90	171,443.92	1,071,079.58			
PC	16+60.44	171,532.41	1,071,043.57	055–59–18	146.58	150.00
PT	18+07.02	171,672.50	1,071,057.92			
PC	20+47.48	171,872.21	1,071,191.84	079–26–52	138.66	100.00
PT	21+86.14	171,999.36	1,071,178.74			
PC	23+54.03	172,116.82	1,071,058.78	055–56–54	195.30	200.00
PT	25+49.33	172,169.86	1,070,878.80			
PC	29+04.43	172,098.74	1,070,530.89	033–49–59	118.10	200.00
PT	30+22.53	172,043.26	1,070,428.58			
EP	30+96.39	171,989.90	1,070,375.93			

NOTE:

1. SEE DRAWING A110 FOR STAGE 1 PERIMETER ROAD PLAN VIEW.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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DRAWN BY: JEA

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF PERIMETER ROAD CENTERLINE PROFILE

FILENAME: 14.008.010P

DRAWING NO.: A130

REVISION: 0

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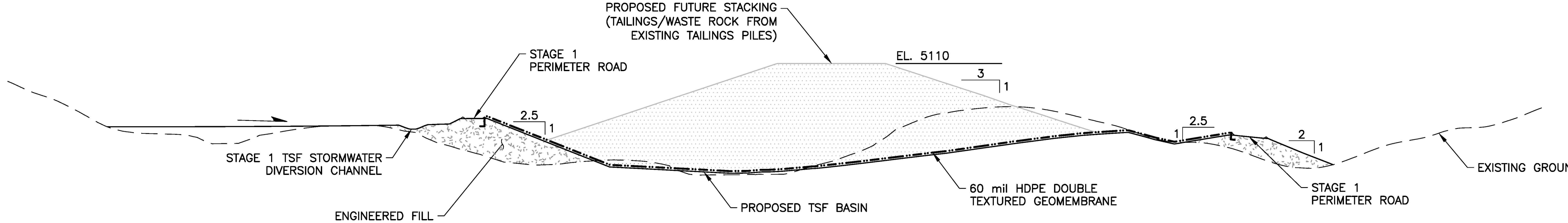
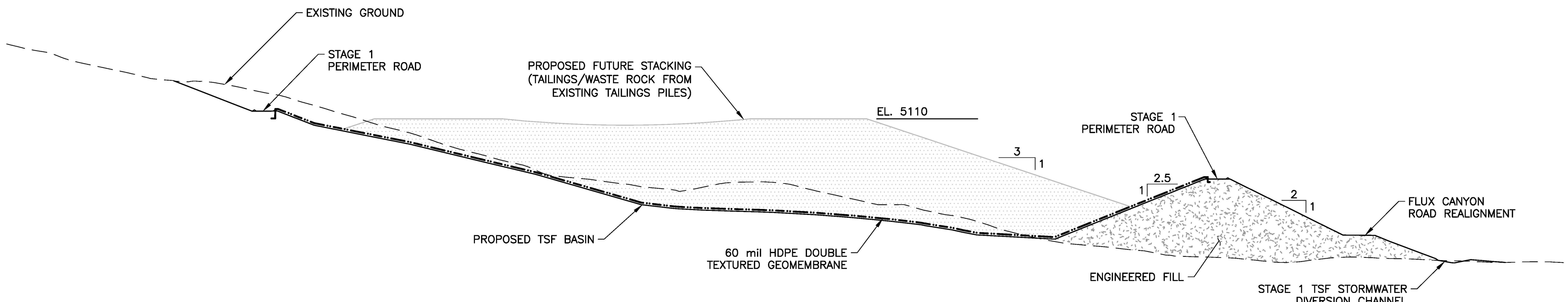


P / A110 **STAGE 1 TSF SECTION – EXISTING TAILINGS**



Q / A110 **STAGE 1 TSF SECTION – EXISTING TAILINGS**

NOTE:

1. PROTECTIVE LAYER AND UNDERDRAIN POND COLLECTION PIPES OMITTED FOR CLARITY.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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DESIGNED BY: CMT
DRAWN BY: JEA

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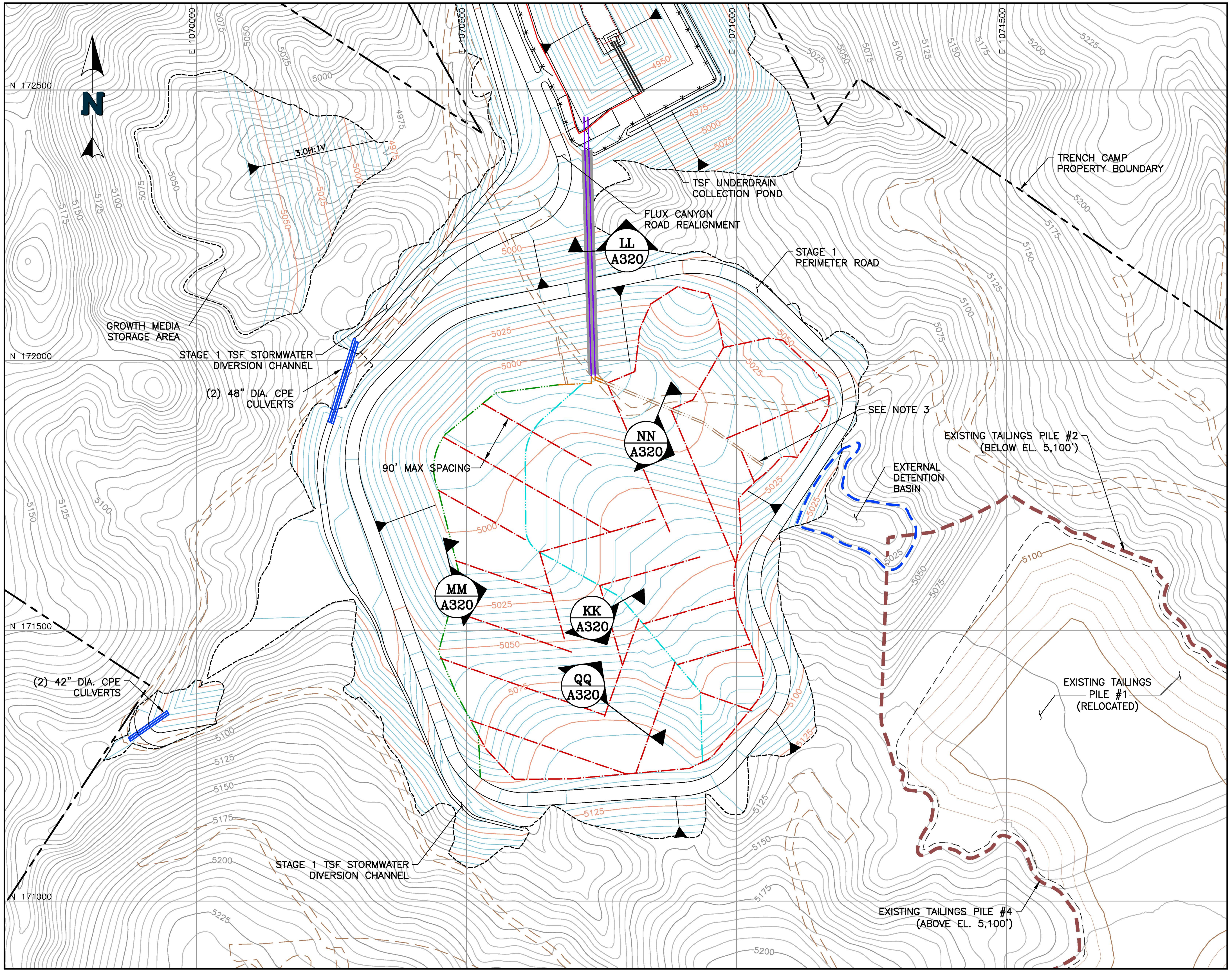
NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF PERIMETER ROAD SECTIONS

FILENAME: 14.008.019D
DRAWING NO.: A135
REVISION: 0



LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED)
- 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- 12" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- CONCRETE ENCASED UNDERDRAIN
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED)
- 36" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED)
- 36" DIA. HDPE DR11 DETENTION POND OUTFALL AND UNDERDRAIN PIPE (SOLID)
- PROPOSED FENCE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. ALL UPSTREAM OPEN ENDS OF PIPES TO BE CAPPED.
3. 24" DIA CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPES NOT TO EXTEND INTO DAYLIGHT OF STAGE 2 NOTCH (SEE DWG A207).

0 100 200 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF PIPING PLAN VIEW

FILENAME: 14.008.049M
DRAWING NO.: A140
REVISION: 0

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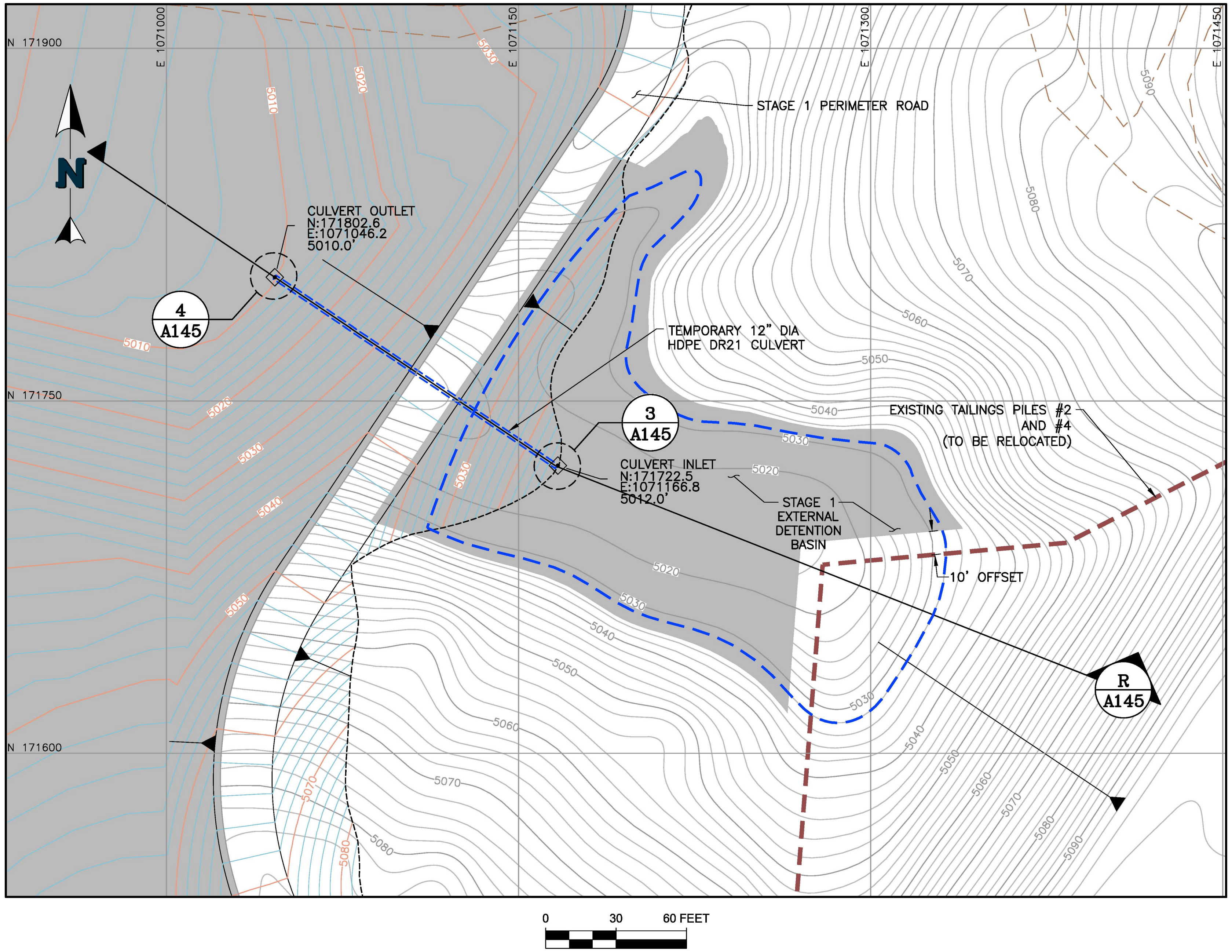
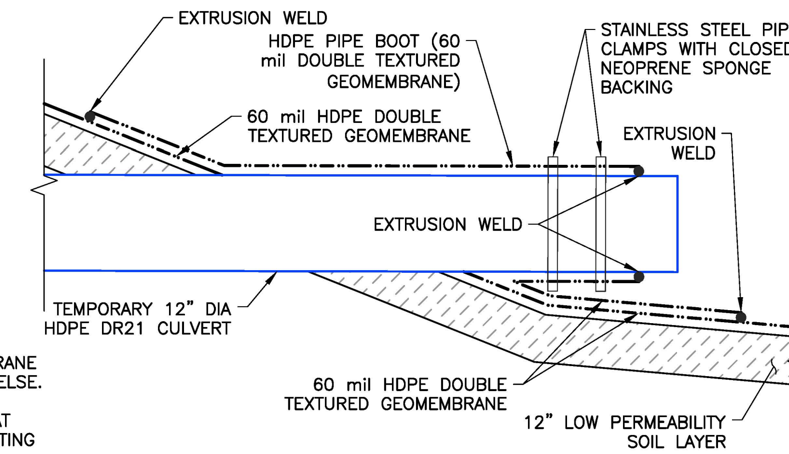


LEGEND:

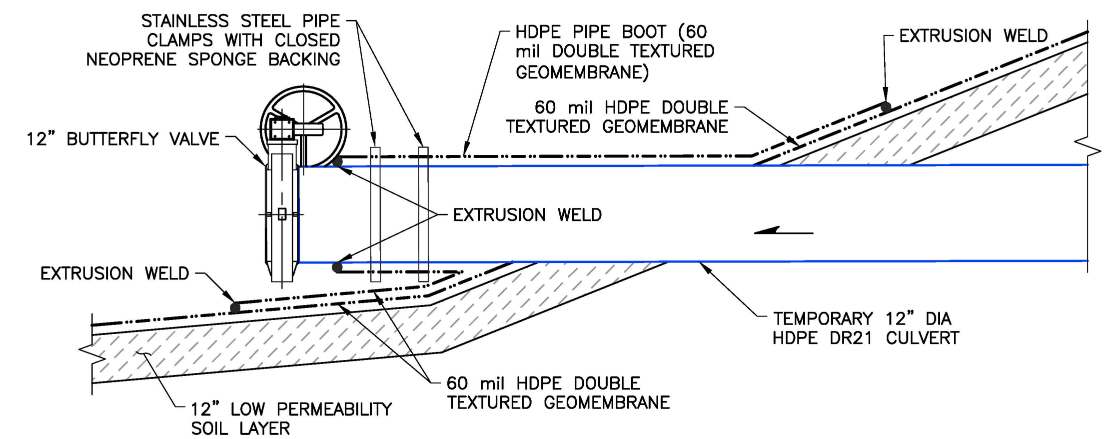
- EXISTING GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- PROPOSED TSF STAGE 1 CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- EXISTING TAILINGS PILE LIMITS
- STAGE 2 GEOMEMBRANE

NOTES:

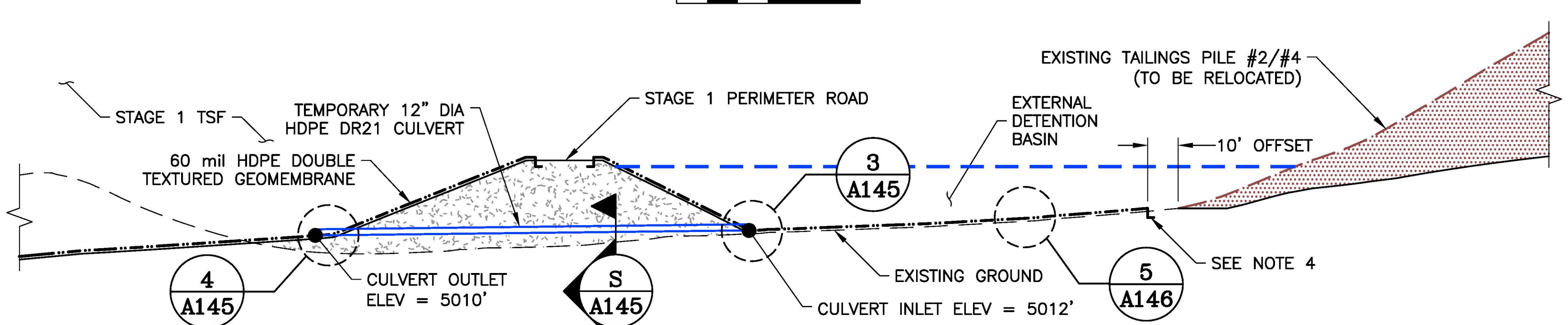
1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. CULVERT TO BE GROUTED WITH LOW SLUMP NEAT CEMENT GROUT AFTER THE RELOCATION OF EXISTING TAILINGS PILES #1, #2 AND #4.
3. EXTERNAL DETENTION BASIN TO BE TEMPORARILY LINED AFTER RELOCATION OF EXISTING TAILINGS PILE #1, #2 AND #4. SEE DRAWING A146.
4. TEMPORARY LINER ANCHORAGE PRIOR TO REMOVAL OF TAILINGS PILES #2/#4.
5. PIPE BEDDING TO SPRING LINE OF PIPE WITH A MINIMUM OF 6" BENEATH PIPE.



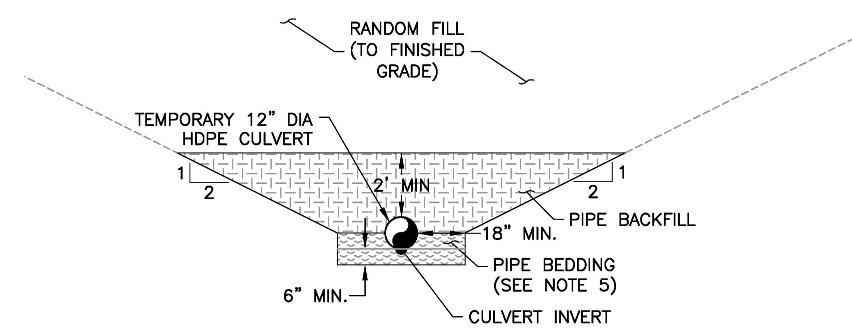
3 / A145 **EXTERIOR DETENTION BASIN CULVERT INLET**
(SEE NOTE 2)



4 / A145 **CULVERT OUTLET DETAIL**



R / A145 **EXTERNAL DETENTION BASIN SECTION – STAGE 1**



S / A145 **BURIED CULVERT SECTION**

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER
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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF EXTERNAL DETENTION BASIN (SHEET 1 OF 2)

FILENAME: 14.008.039M
DRAWING NO.: A145
REVISION: 0

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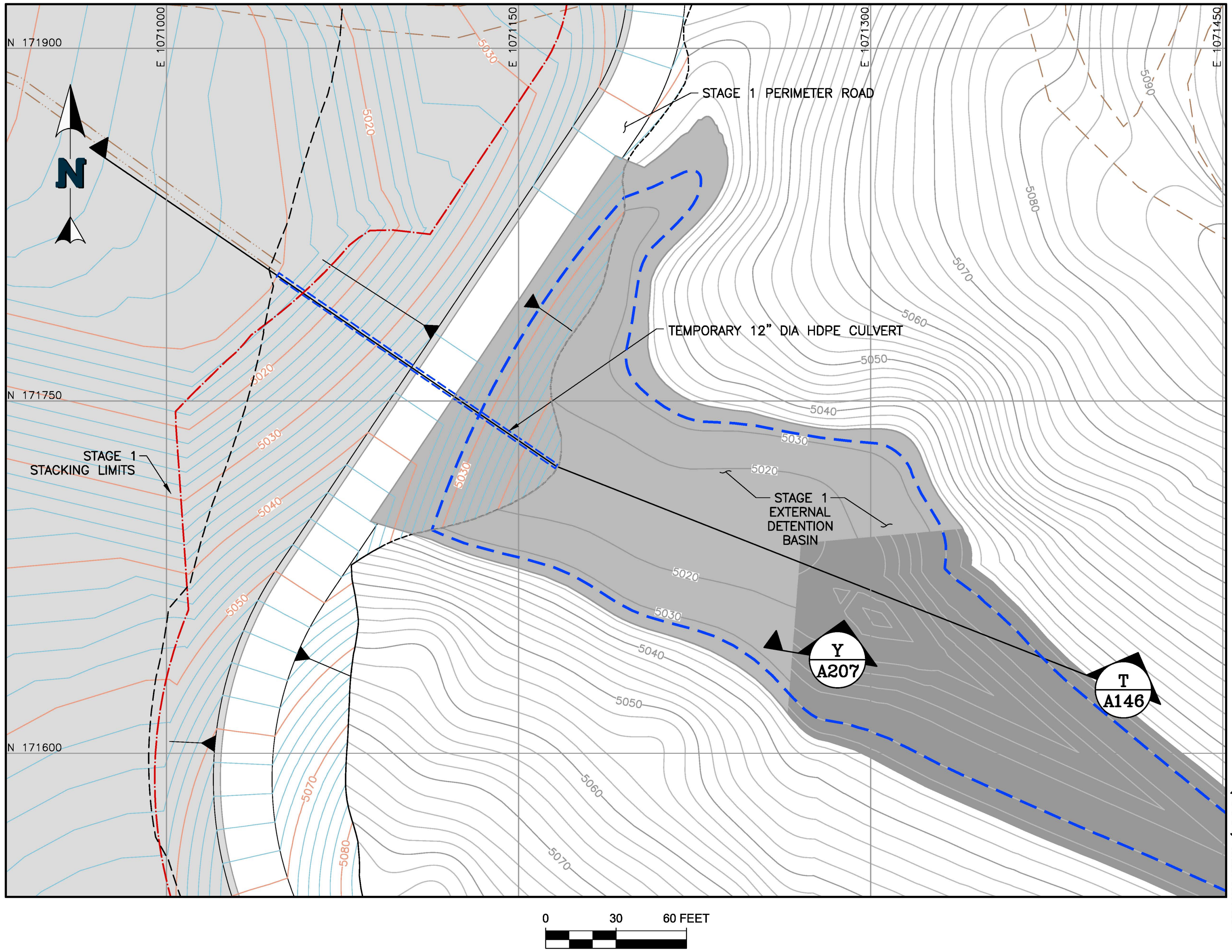
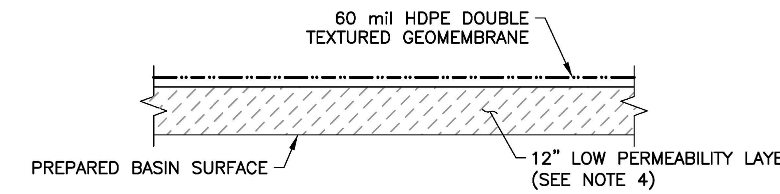


LEGEND:

- EXISTING GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- PROPOSED TSF STAGE 1 CONTOURS
- EXISTING ROADS/TRAILS
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED)
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED)
- STAGE 1 GEOMEMBRANE
- STAGE 2 GEOMEMBRANE
- STAGE 2 GEOMEMBRANE AFTER TAILINGS PILES #2/#4 REMOVED

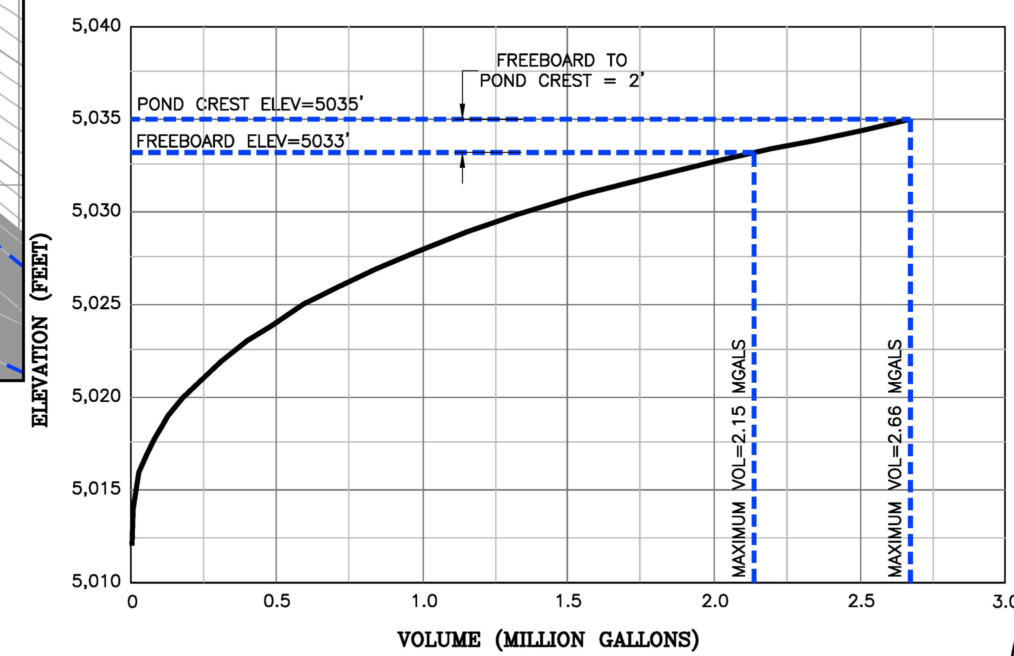
NOTES:

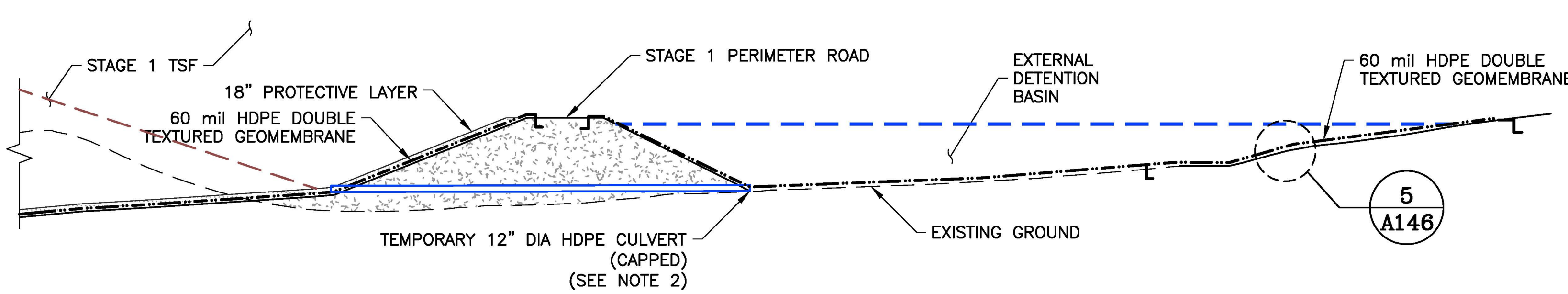
1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. TEMPORARY 12" DIA. HDPE RISER PIPE TO BE REMOVED AND CULVERT TO BE CAPPED AFTER THE RELOCATION OF EXISTING TAILINGS PILES #1, #2 AND #4.
3. EXTERNAL DETENTION BASIN TO BE LINED AFTER RELOCATION OF EXISTING TAILINGS PILE #1, #2 AND #4.
4. GCL MAY BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY).



5 A145 / 5 A146 / 5 A230 GEOMEMBRANE DETAIL—STAGE 1 EXTERNAL DETENTION POND

STAGE 1 EXTERNAL DETENTION POND FILLING CURVE





T A146 EXTERNAL DETENTION BASIN SECTION – STAGE 1

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. Expires 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER
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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF EXTERNAL DETENTION BASIN (SHEET 2 OF 2)

FILENAME: 14.008.065M
DRAWING NO.: A146
REVISION: 0

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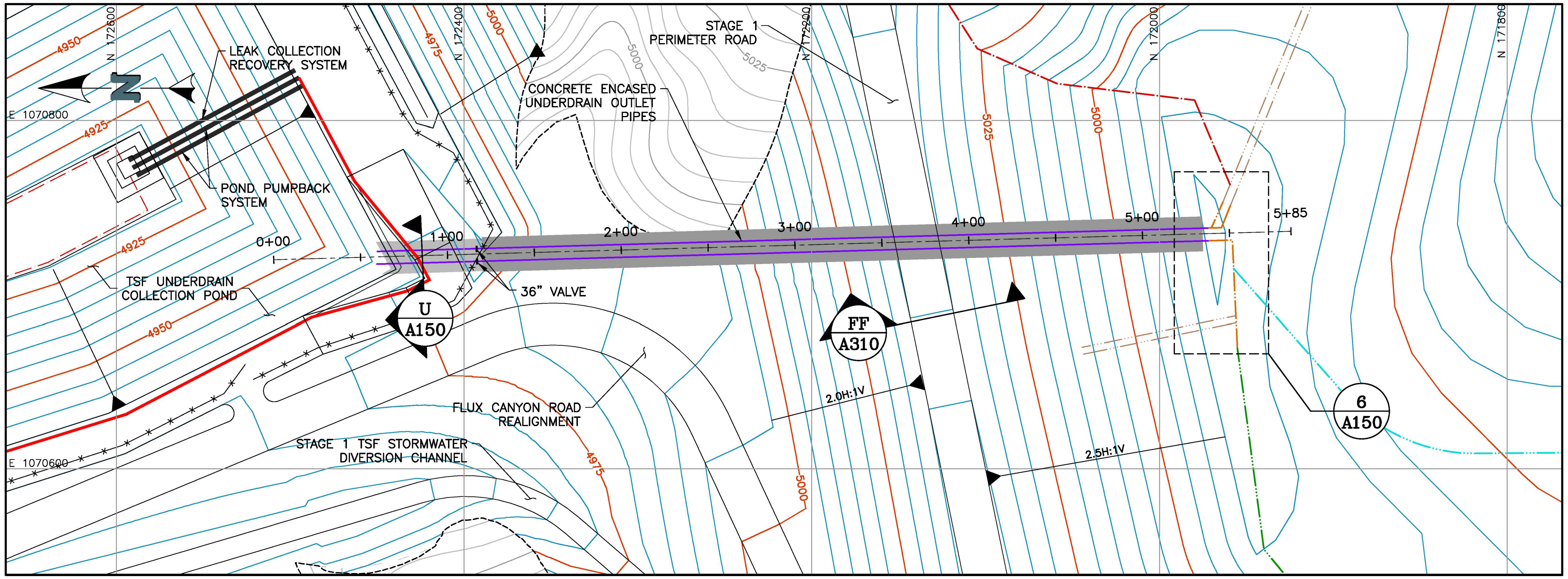


0 40 80 FEET

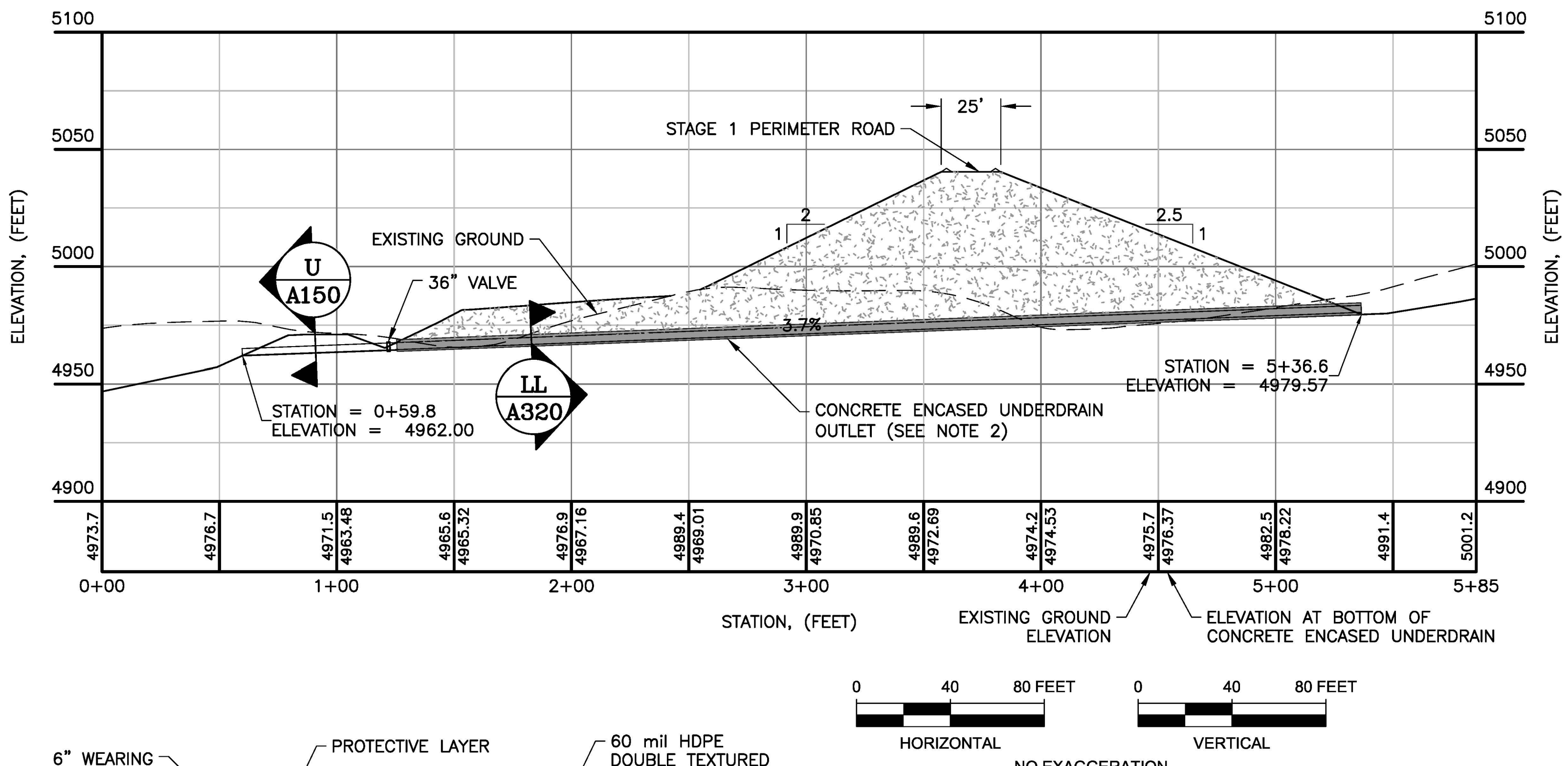
LEGEND:

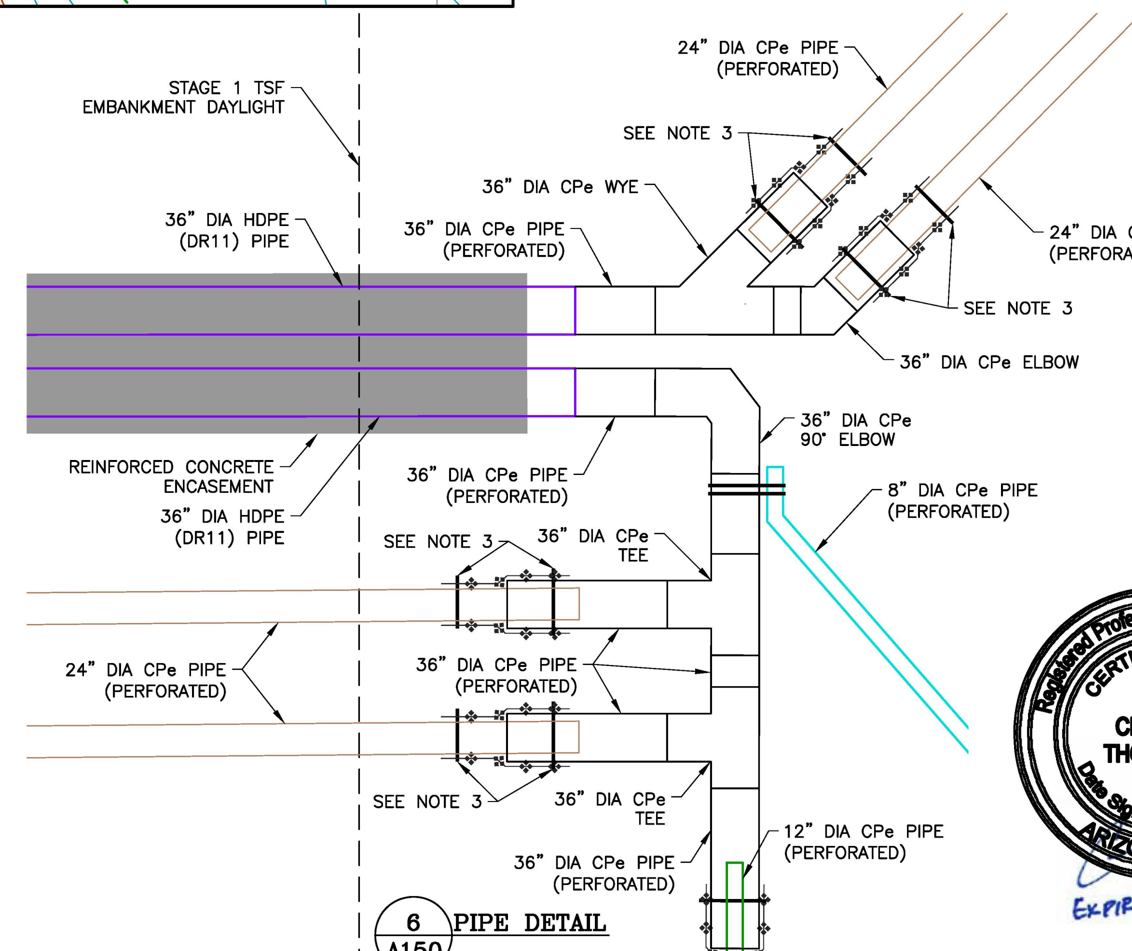
- EXISTING GROUND CONTOURS
- PROPOSED TSF CONTOURS
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED)
- 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- 12" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED)
- CONCRETE ENCASED UNDERDRAIN
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED)
- 36" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED)
- 36" DIA. HDPE DR11 DETENTION POND OUTFALL AND UNDERDRAIN PIPE (SOLID)
- PROPOSED FENCE

NOTES:

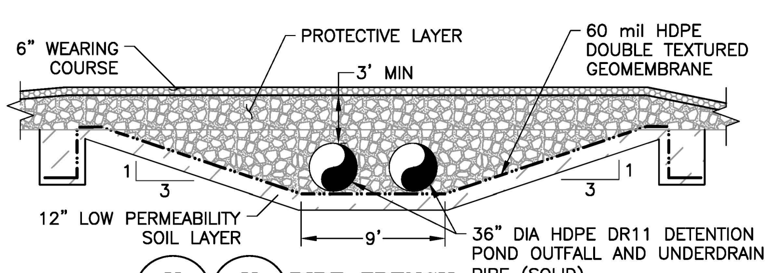
1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. THE CONCRETE ENCASED UNDERDRAIN OUTLET PIPE ENCASEMENT SHOULD BE POURED NEAT TO THE WALLS OF THE ENCASEMENT EXCAVATION.
3. PIPE SHOULD BE WRAPPED IN 10 oz/yd^2 NON-WOVEN GEOTEXTILE AND THEN CLAMPED AT A MINIMUM OF 3' ON EITHER SIDE OF THE JOINT WITH FIBER GLASS STRAPS OR SUITABLE ALTERNATIVE.

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.





6 A150 PIPE DETAIL



U A150 U A405 PIPE TRENCH

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF CONCRETE ENCASED UNDERDRAIN PLAN AND PROFILE

FILENAME: 14.008.022P

DRAWING NO.: A150 REVISION: 0

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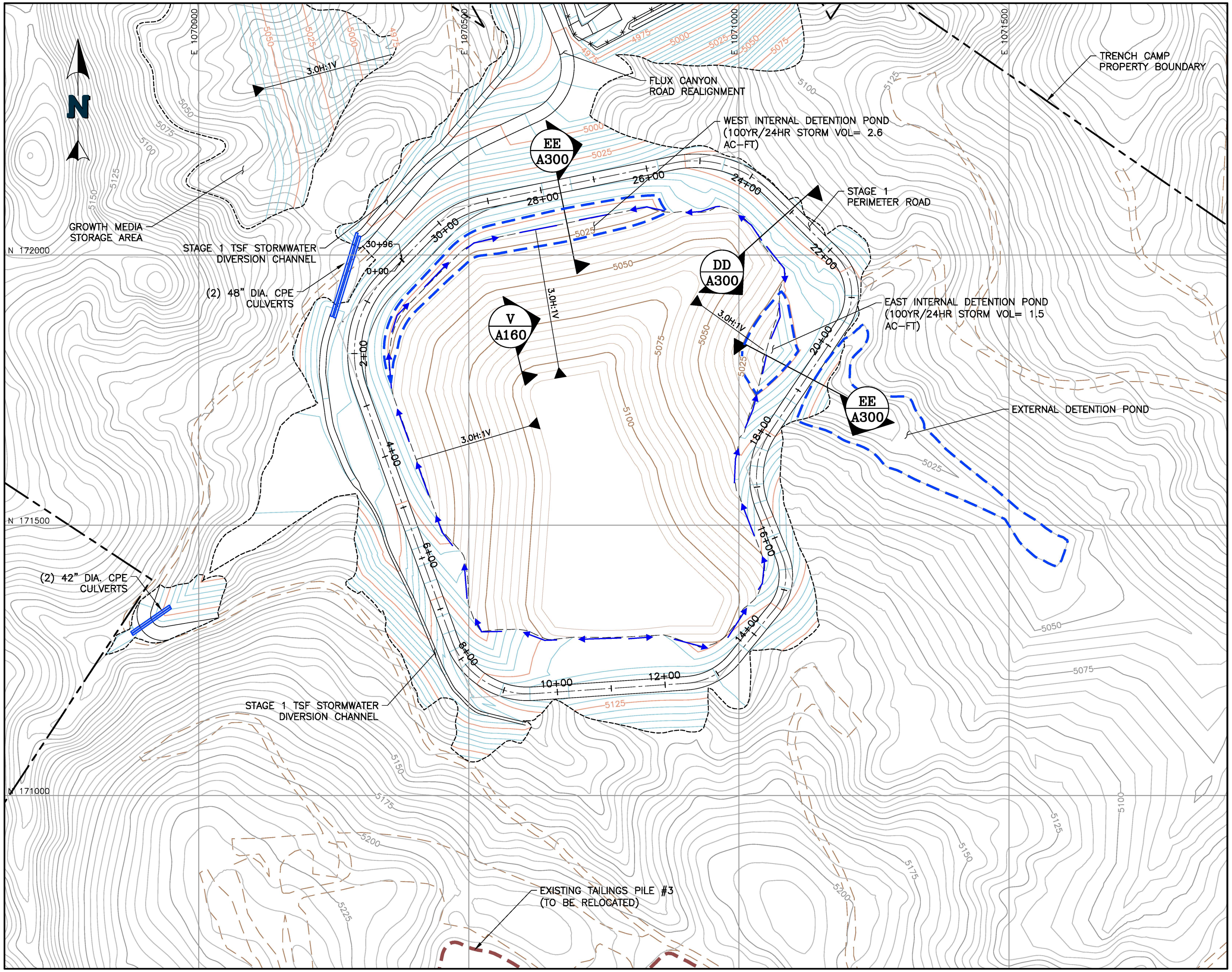


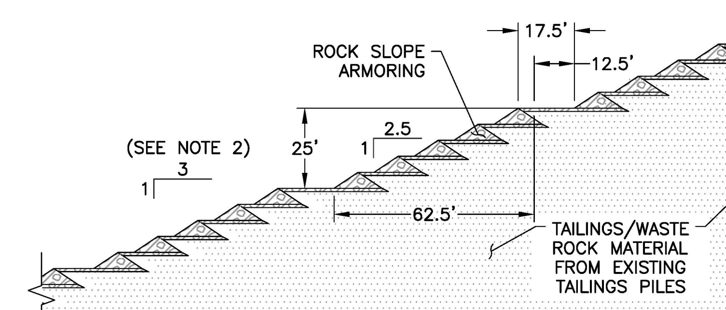
LEGEND:

- EXISTING GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- STAGE 1 CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- DETENTION POND WATER LIMITS
- INTERNAL DIVERSION CHANNEL FLOW DIRECTION
- PROPOSED FENCE

STAGE 1 STACKING OFFSET FROM CREST	
APPROXIMATE STATION	OFFSET
0+00 – 2+50	118'
2+50 – 10+25	88'
10+25 – 18+25	50'
18+25 – 21+25	155.5'
21+25 – 24+50	88'
24+50 – 29+25	125.5'
29+25 – 30+96	118'

VOLUMETRICS*		
	VOLUME (cy)	VOLUME (tons)
EXISTING TAILINGS #1	234,400	352,000
EXISTING TAILINGS #2 AND #4	484,600	684,000
EXPLORATION RAMP DEVELOPMENT ROCK	104,550	176,400
TOTAL IN STAGE 1	823,550	1,212,400

*BASED ON AN APPROXIMATE STACKING DENSITY OF 104 PCF FOR TAILINGS, 115 PCF FOR WASTE ROCK, AND 125 PCF FOR DEVELOPMENT ROCK



V A160 V A240 EXISTING TAILINGS STACKING

NOTES:

1. THE TAILINGS VOLUMES ARE CALCULATED BASED ON BOREHOLE AND GEOPHYSICAL DATA COLLECTED DURING THE GEOTECHNICAL FIELD INVESTIGATION.
2. EXISTING TAILINGS 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FOOT HIGH 2.5H:1V SLOPES IN COMBINATION WITH A 12.5 FOOT BENCH.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. Expires 3/31/17

0 100 200 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF EXISTING TAILINGS STACKING PLAN VIEW

FILENAME: 14.008.008M

DRAWING NO.: A160

REVISION: 0

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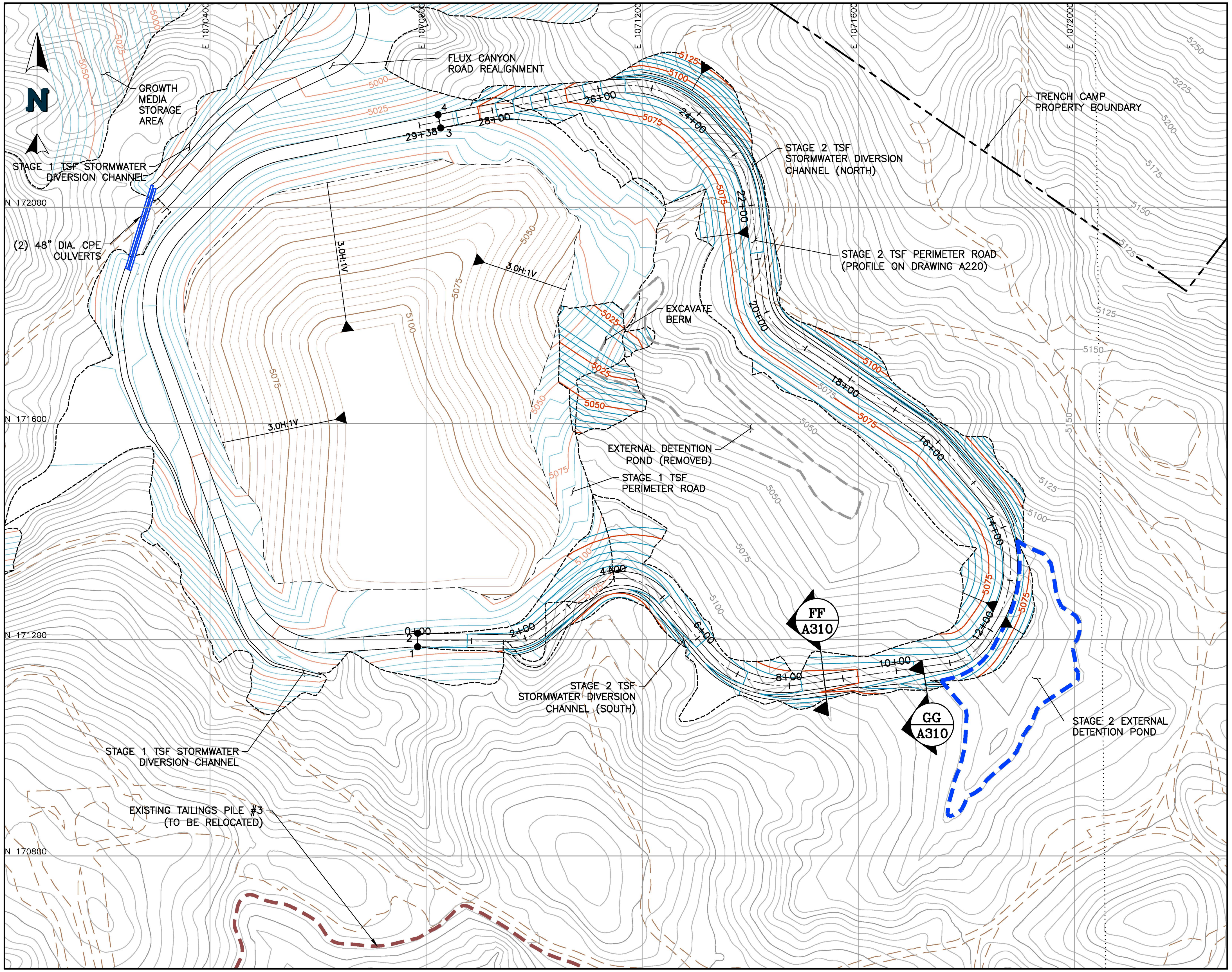

LEGEND:

- EXISTING GROUND CONTOURS
- STAGE 1 PROPOSED CONTOURS
- STAGE 2 PROPOSED CONTOURS
- STAGE 1 TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS

NOTE:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWING A210 FOR THE STAGE 1 GEOMEMBRANE LIMITS.

SETTING OUT DATA

POINT	NORTHING	EASTING	ELEVATION
1	171,186.82	1,070,784.24	5,118.50
2	171,211.85	1,070,784.67	5,118.52
3	172,146.56	1,070,827.27	5,043.02
4	172,171.06	1,070,822.26	5,043.02

0 100 200 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

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0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 TSF GRADING PLAN VIEW

FILENAME: 14.008.027M

DRAWING NO.: A200

REVISION: 0

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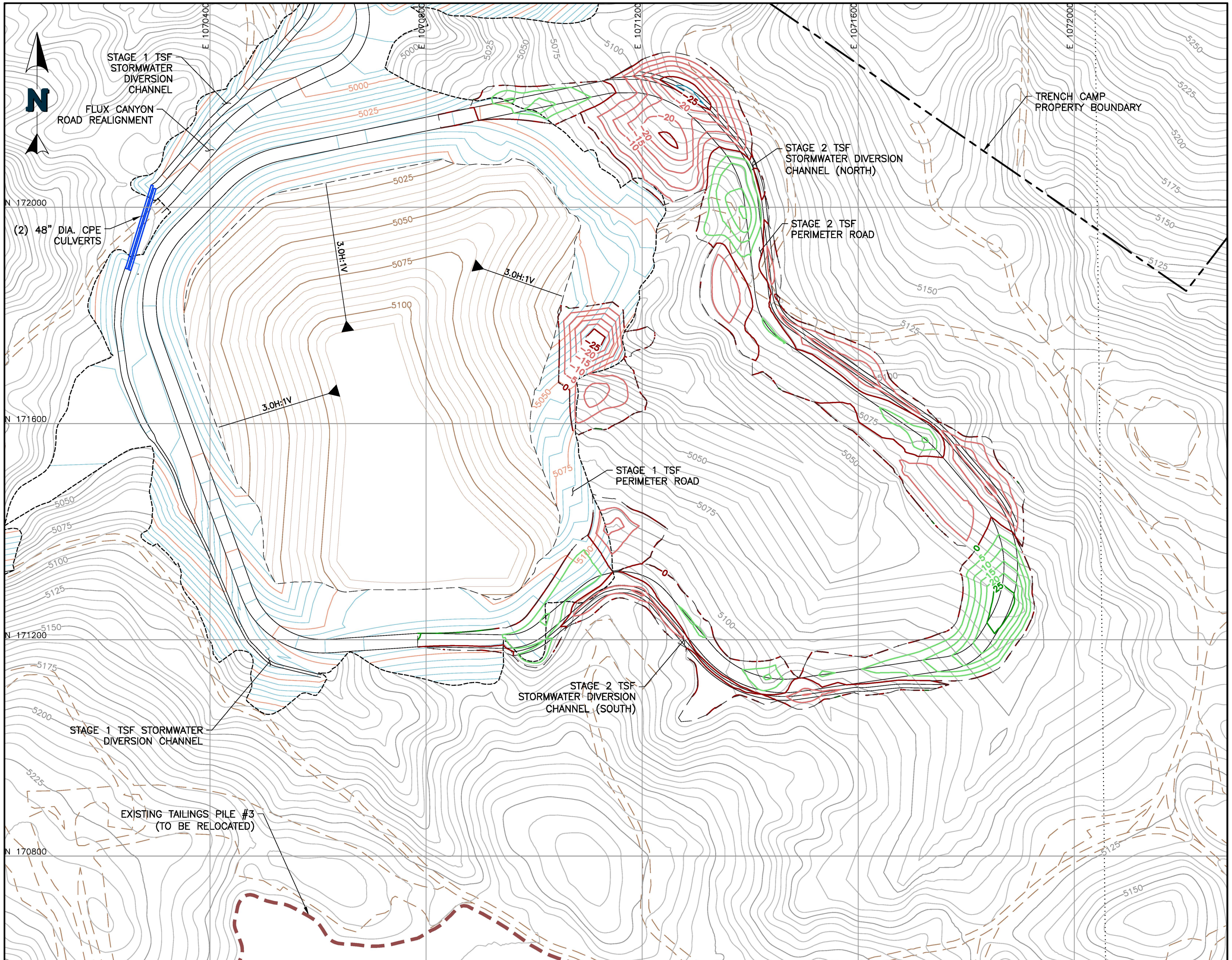

LEGEND:

- EXISTING GROUND CONTOURS
- FILL ISOPACH CONTOURS
- CUT ISOPACH CONTOURS
- STAGE 1 CONTOURS
- STAGE TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS

NOTE:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWING A210 FOR THE STAGE 1 GEOMEMBRANE LIMITS.

0 100 200 FEET

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

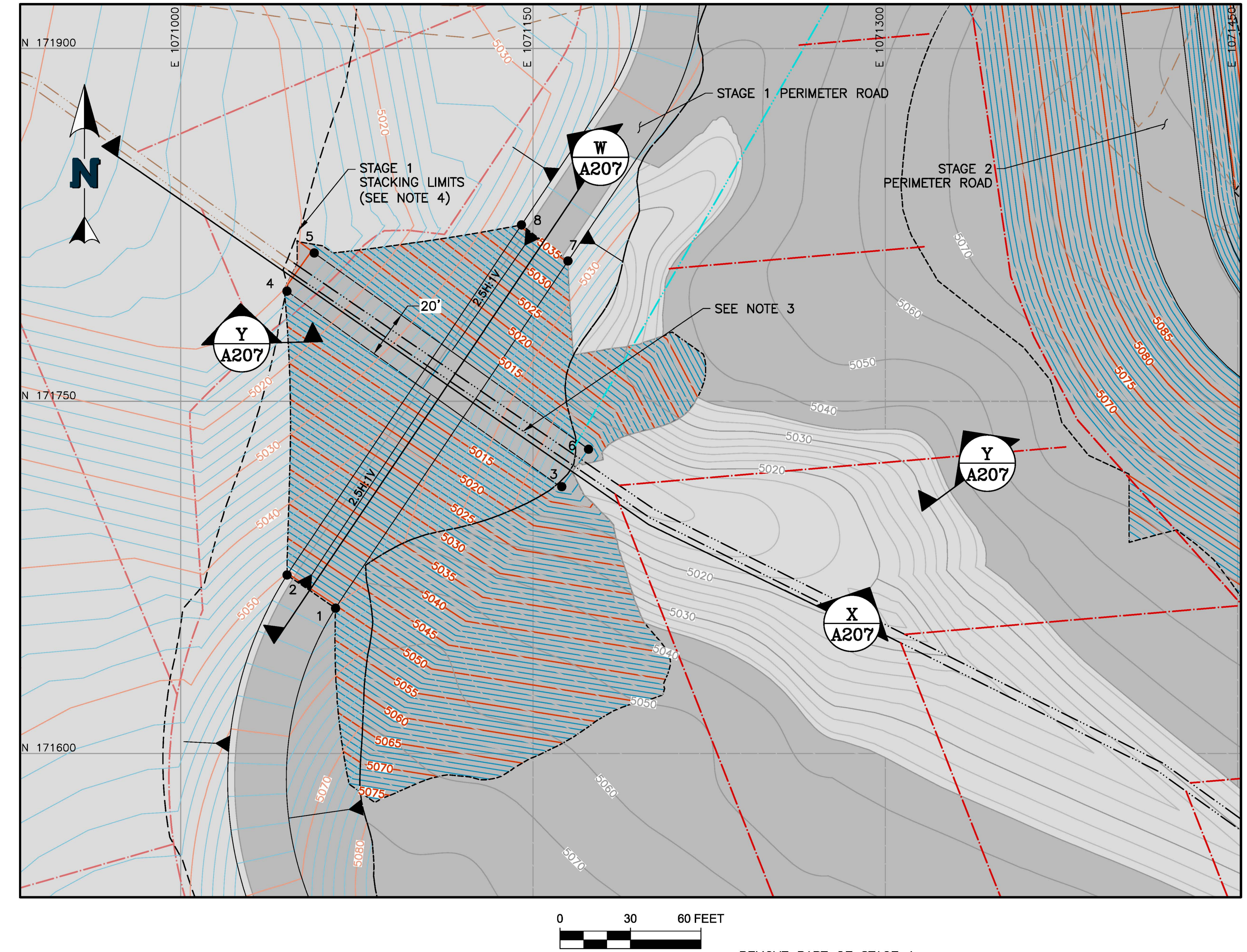
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 TSF GRADING ISOPACH

FILENAME: 14.008.028M

DRAWING NO.: A205

REVISION: 0



LEGEND:

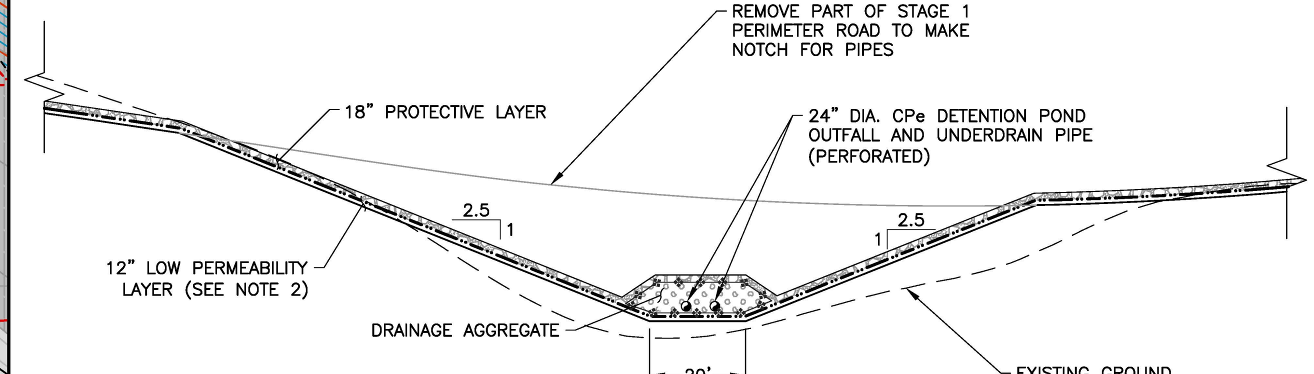
- EXISTING GROUND CONTOURS
- PROPOSED TSF STAGE 2 CONTOURS
- PROPOSED TSF STAGE 1 CONTOURS
- EXISTING ROADS/TRAILS
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED) (STAGE 1)
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED) (STAGE 2)
- 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED) (STAGE 2)
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED) (STAGE 1)
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED) (STAGE 2)
- STAGE 1 GEOMEMBRANE
- STAGE 2 GEOMEMBRANE

SETTING OUT DATA

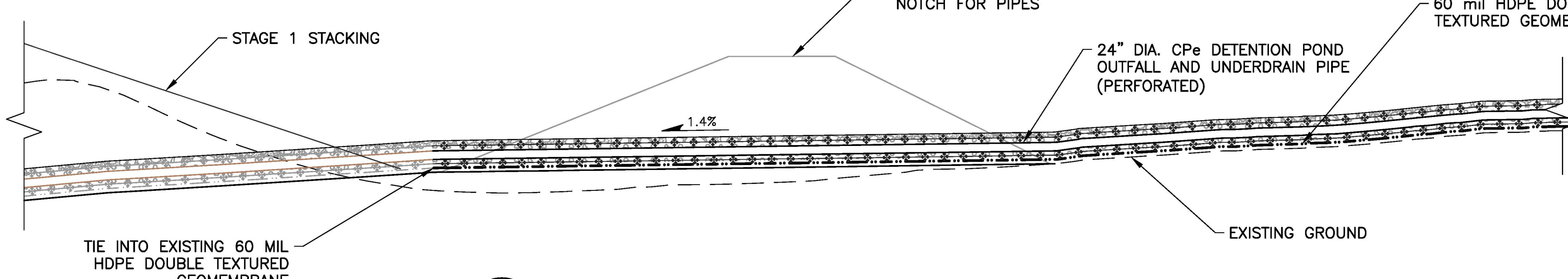
POINT	NORTHING	EASTING	ELEVATION
1	171,661.89	1,071,065.96	5,050.41
2	171,676.02	1,071,045.32	5,050.27
3	171,713.63	1,071,162.28	5,012.00
4	171,796.77	1,071,045.25	5,010.02
5	171,813.04	1,071,056.88	5,010.02
6	171,729.58	1,071,173.68	5,012.00
7	171,809.63	1,071,164.93	5,035.28
8	171,824.97	1,071,145.11	5,035.32

NOTES:

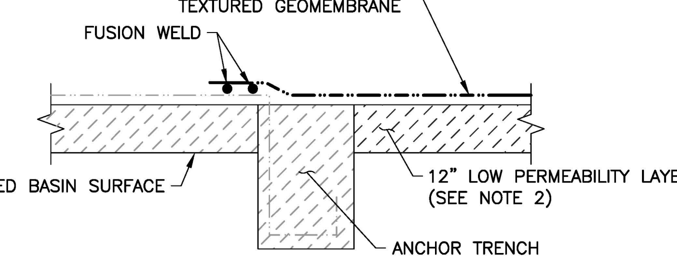
1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. GCL MAY BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY).
3. REMOVE TEMPORARY 12" DIA HDPE CULVERT AND CONTINUE UNDERDRAIN PIPING THROUGH NOTCH IN EMBANKMENT.
4. STAGE 1 STACKING LIMITS AND 24" DIA CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPES NOT TO EXTEND INTO DAYLIGHT OF STAGE 2 NOTCH.



W/A207 NOTCH SECTION 2



X/A207 NOTCH SECTION 2



Y/A146 Y/A207 TIE INTO EXISTING GEOMEMBRANE DETAIL

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 NOTCH

FILENAME: 14.008.066M

DRAWING NO.: A207 REVISION: 0

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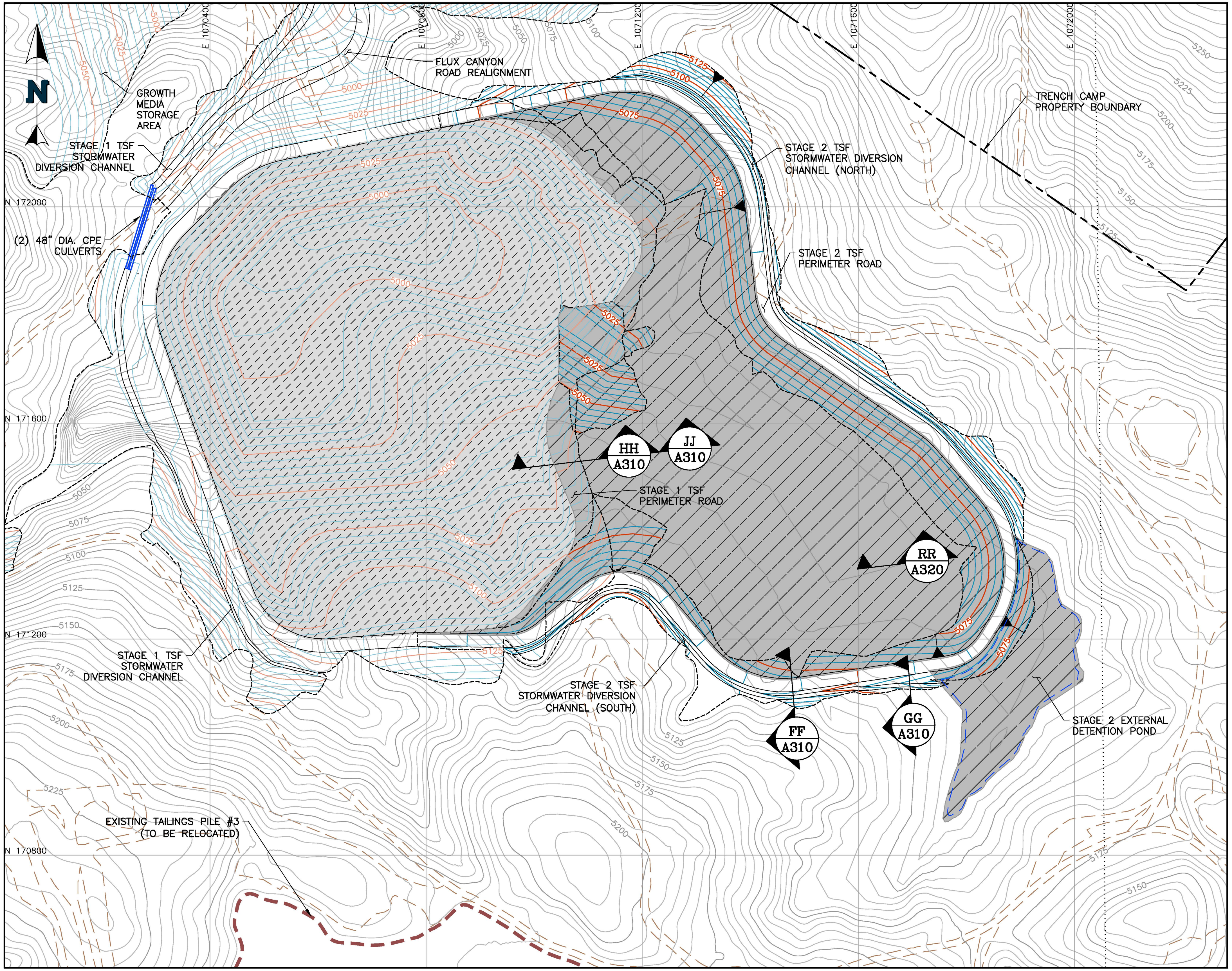

LEGEND:

- EXISTING GROUND CONTOURS
- STAGE 2 PROPOSED CONTOURS
- STAGE 1 PROPOSED CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- STAGE 1 GEOMEMBRANE
- STAGE 2 GEOMEMBRANE
- LOW PERMEABILITY SOIL LAYER
- LOW PERMEABILITY SOIL LAYER OR GCL

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.

0 100 200 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY:	RMS
CHECKED BY:	RMS
DESIGNED BY:	CMT
DRAWN BY:	JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 TSF GEOMEMBRANE PLAN VIEW

FILENAME: 14.008.029M

DRAWING NO.: A210

REVISION: 0

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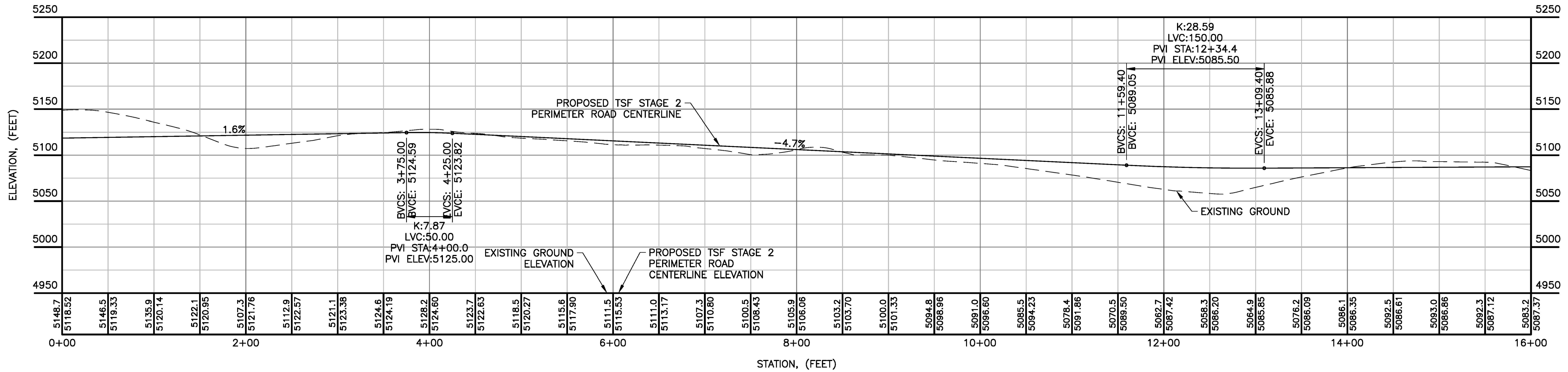

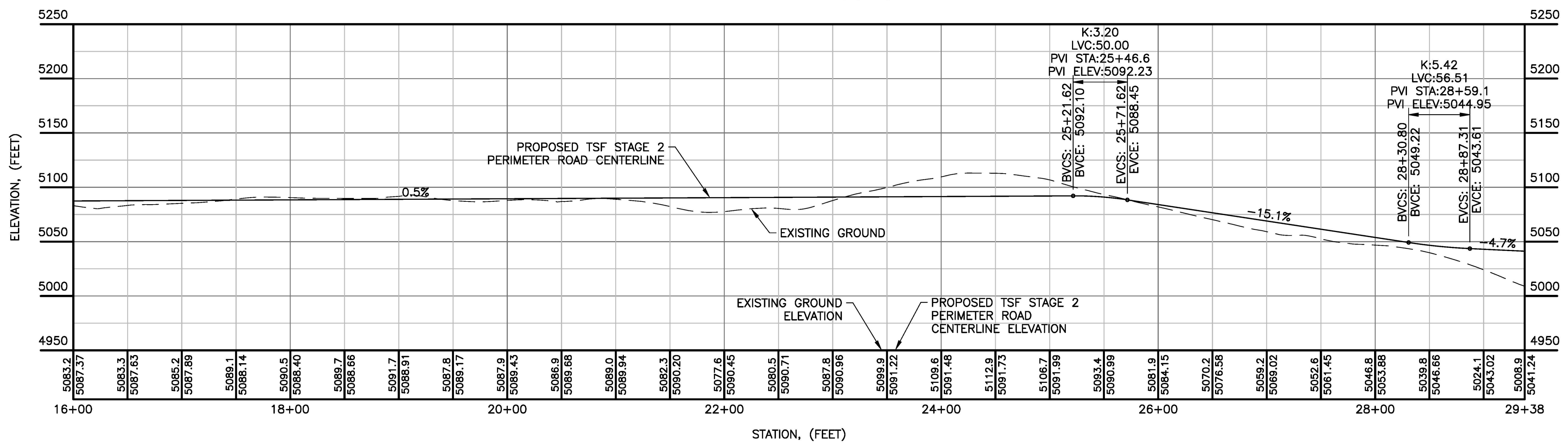

STAGE 2 PERIMETER ROAD CENTELINE ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D–M–S)	LENGTH (FT)	RADIUS (FT)
BP	0+00.00	171,199.35	1,070,784.45			
PC	1+62.97	171,196.56	1,070,947.39	040–57–42	71.49	100.00
PT	2+34.46	171,219.92	1,071,013.36			
PC	3+43.80	171,290.17	1,071,097.14	089–30–48	156.23	100.00
PT	5+00.03	171,278.45	1,071,237.47			
PC	6+30.22	171,179.40	1,071,321.97	057–45–44	186.71	185.21
PT	8+16.94	171,116.30	1,071,489.38			
PC	10+94.69	171,156.06	1,071,764.27	050–17–50	88.14	100.40
PT	11+82.82	171,203.01	1,071,835.53			
PC	12+16.17	171,231.45	1,071,852.94	072–07–38	251.77	200.00

STAGE 2 PERIMETER ROAD CENTELINE ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D–M–S)	LENGTH (FT)	RADIUS (FT)
PT	14+67.94	171,466.16	1,071,834.09			
PC	15+86.78	171,556.33	1,071,756.67	014–47–05	51.61	200.00
PT	16+38.39	171,590.73	1,071,718.39			
PC	19+46.18	171,765.34	1,071,464.92	048–44–56	85.08	100.00
PT	20+31.26	171,836.04	1,071,422.33			
PC	22+07.12	172,010.70	1,071,401.85	034–46–23	121.38	200.00
PT	23+28.50	172,119.83	1,071,353.09			
PC	23+78.95	172,157.63	1,071,319.68	060–05–25	209.75	200.00
PT	25+88.71	172,221.16	1,071,129.75			
EP	29+37.76	172,150.41	1,070,776.62			

NOTE:

1. SEE DRAWING A200 FOR STAGE 2 PERIMETER ROAD PLAN VIEW.

0 60 120 FEET
HORIZONTAL

0 60 120 FEET
VERTICAL

NO EXAGGERATION

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 TSF PERIMETER ROAD CENTERLINE PROFILE

FILENAME: 14.008.030P
DRAWING NO.: A220
REVISION: 0

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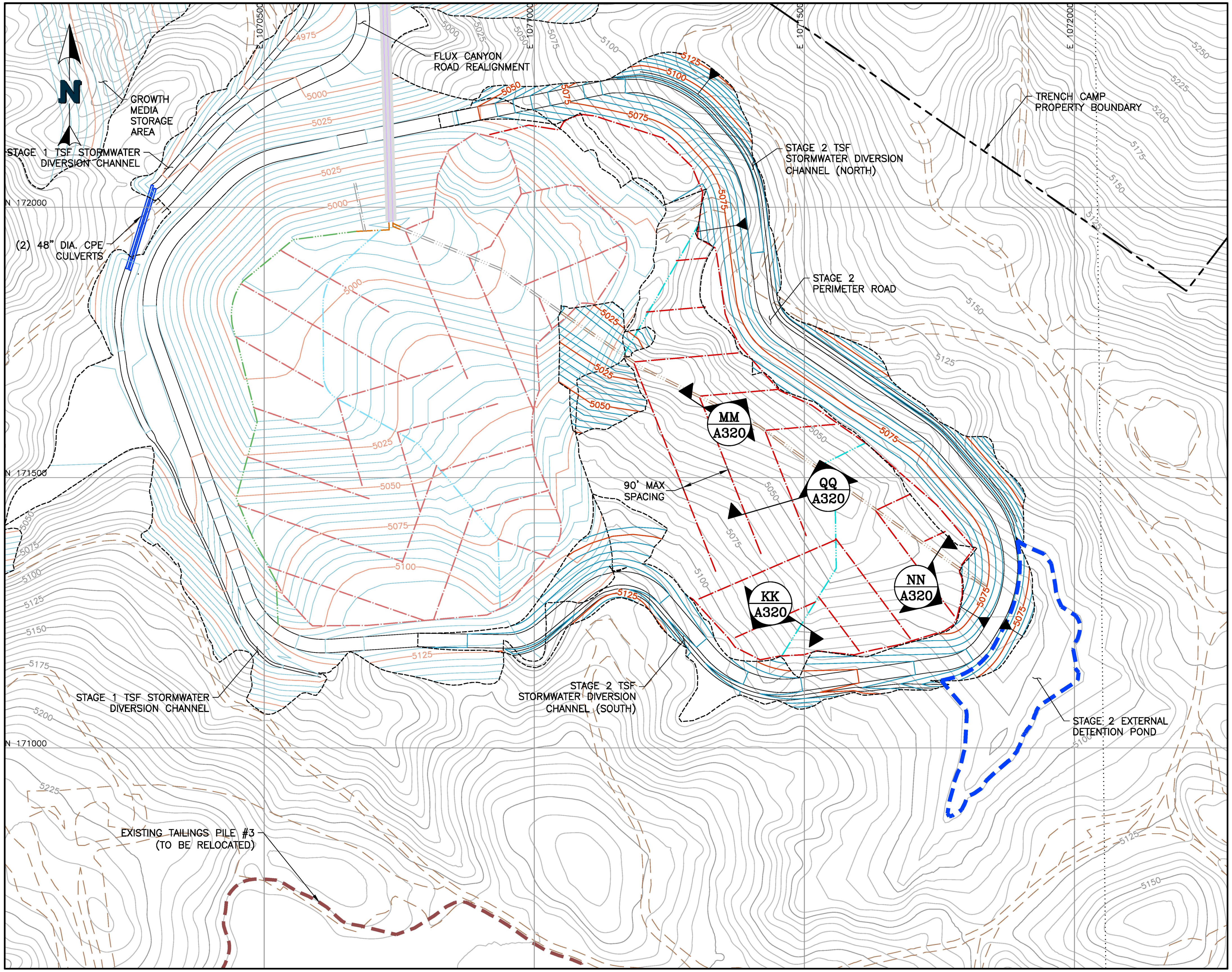

LEGEND:

- EXISTING GROUND CONTOURS
- STAGE 1 TSF CONTOURS
- STAGE 2 TSF CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED) STAGE 1
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED) STAGE 2
- 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED) STAGE 1
- 8" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED) STAGE 2
- 12" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED) STAGE 1
- 12" DIA. CPe UNDERDRAIN COLLECTION HEADER (PERFORATED) STAGE 2
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED) STAGE 1
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED) STAGE 2
- 36" DIA. HDPE DR11 DETENTION POND OUTFALL AND UNDERDRAIN PIPE (SOLID) STAGE 1
- CONCRETE ENCASED UNDERDRAIN STAGE 1

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. UNDERDRAIN PIPING SYSTEM TO BE DESIGNED TO LIMIT HYDRAULIC HEAD TO NO MORE THAN 1.5 FOOT AVERAGE AND NO MORE THAN A MAXIMUM OF 5 FEET.
3. ALL UPSTREAM OPEN ENDS OF PIPES TO BE CAPPED.

0 100 200 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 TSF PIPING PLAN

FILENAME: 14.008.050M
DRAWING NO.: A228
REVISION: 0

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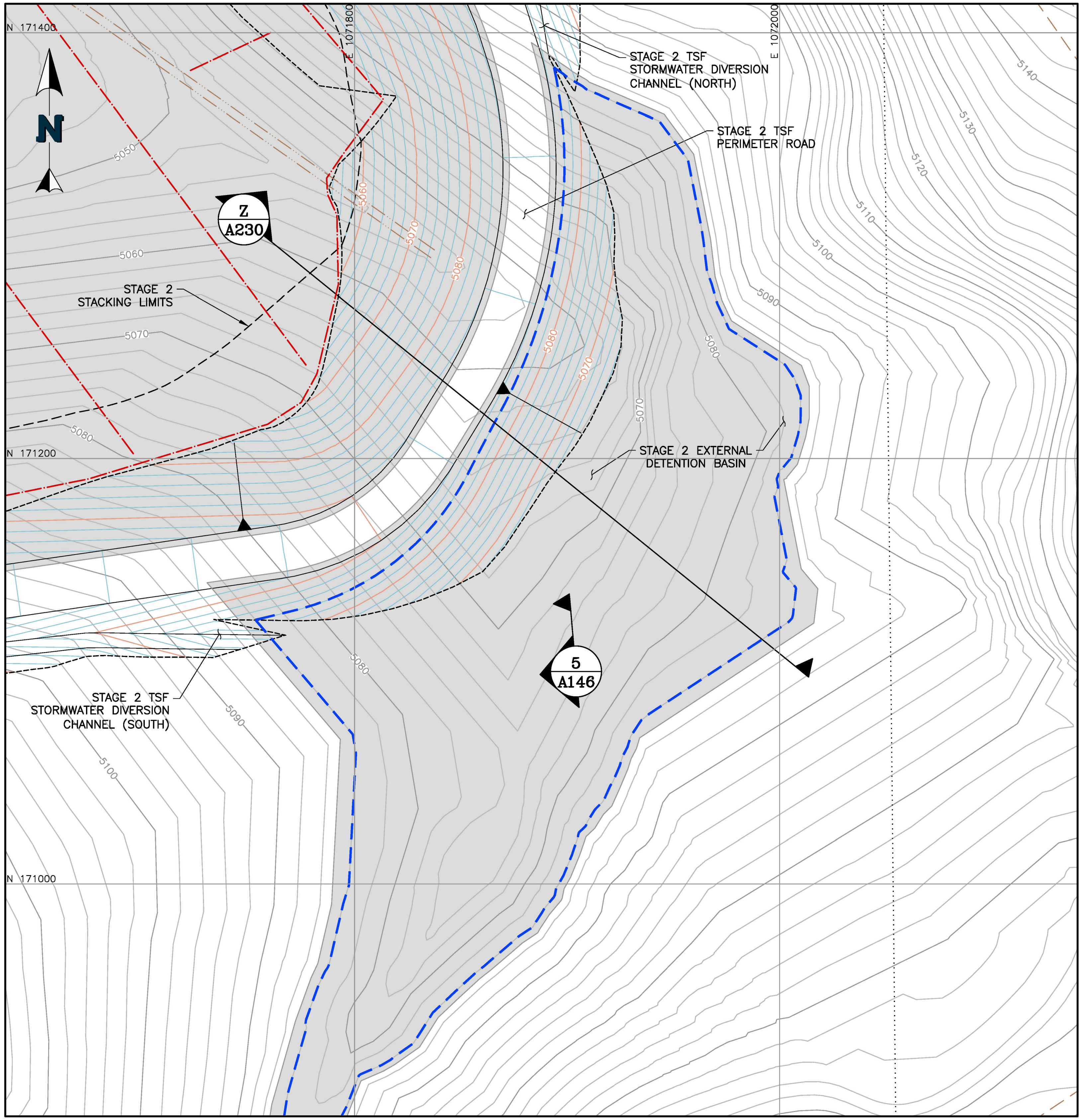


0 30 60 FEET

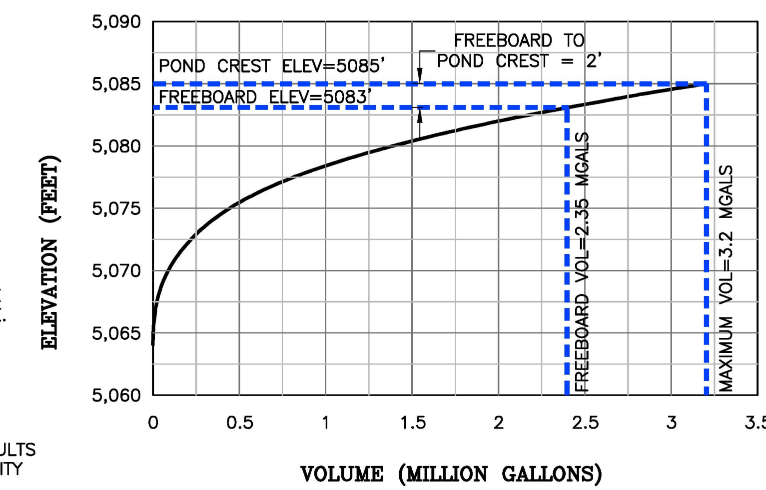
LEGEND:

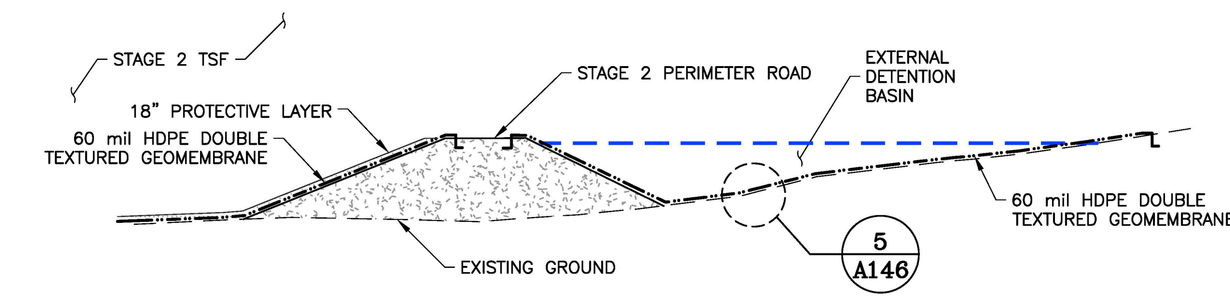
- EXISTING GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- PROPOSED STAGE 2 CONTOURS
- SECTION LINES
- 4" DIA. CPe UNDERDRAIN COLLECTION PIPE (PERFORATED)
- 24" DIA. CPe DETENTION POND OUTFALL AND UNDERDRAIN PIPE (PERFORATED)
- STAGE 2 GEOMEMBRANE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. EXTERNAL DETENTION BASIN TO BE LINED BEFORE PLACEMENT OF TEMPORARY EXPLORATION DECLINE DEVELOPMENT ROCK STOCKPILE.
3. GCL MAY BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY).

STAGE 2 EXTERNAL DETENTION POND FILLING CURVE





Z / A230 EXTERNAL DETENTION BASIN SECTION – STAGE 2

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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NewFields

CLIENT: ARIZONA MINERALS INC

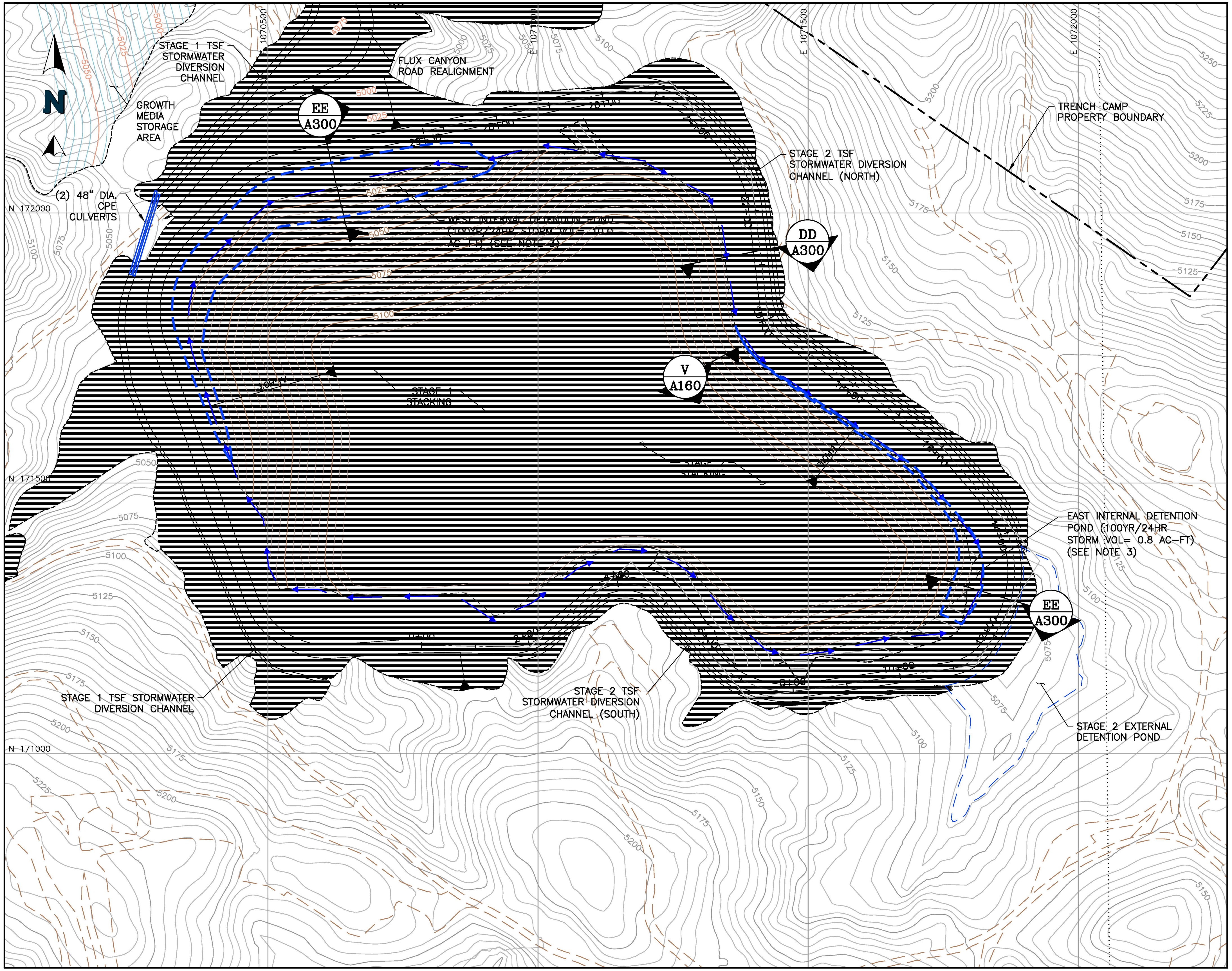
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 2 TSF EXTERNAL DETENTION BASIN

FILENAME: 14.008.068M

DRAWING NO.: A230

REVISION: 0



LEGEND:

- EXISTING GROUND CONTOURS
- TAILINGS STACKING CONTOURS
- STAGE 1 AND 2 CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- SECTION LINES
- INTERNAL SURFACE WATER DIVERSION

STAGE 2 STACKING OFFSET FROM CREST	
APPROXIMATE STATION	OFFSET
0+00 – 11+00	118'
11+00 – 14+50	155.5'
14+50 – 21+50	118'
21+50 – 29+38	VARIES

VOLUMETRICS*		
	VOLUME (cy)	VOLUME (tons)
EXISTING TAILINGS #1	234,400	352,000
EXISTING TAILINGS #2 AND #4	484,600	684,000
EXISTING TAILINGS #3	160,200	227,000
EXPLORATION RAMP DEVELOPMENT ROCK	590,000	1,000,000
CONTINGENCY STORAGE	226,350	317,800
TOTAL STAGE 1 AND 2	1,695,550	2,580,800

*BASED ON AN APPROXIMATE STACKING DENSITY OF 104 PCF FOR TAILINGS, 115 PCF FOR WASTE ROCK, AND 125 PCF FOR DEVELOPMENT ROCK

NOTES:

1. THE TAILINGS VOLUMES ARE CALCULATED BASED ON BOREHOLE AND GEOPHYSICAL DATA COLLECTED DURING THE GEOTECHNICAL FIELD INVESTIGATION.
2. PAG DEVELOPMENT ROCK FROM A PLANNED EXPLORATION DECLINE OR SHAFT WILL ALSO BE STORED IN THE LINED TSF AS A CO-MINGLED MATERIAL WITH THE EXISTING TAILINGS AND PAG WASTE ROCK.
3. DURING THE 100YR/24HR STORM EVENT, WATER FROM THE EAST INTERNAL DETENTION POND WILL OVERFLOW INTO THE WEST INTERNAL DETENTION POND.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A.
EXPIRES 3/31/17

0 100 200 FEET

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APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
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CLIENT: ARIZONA MINERALS INC
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE
TITLE: STAGE 2 TSF STACKING PLAN VIEW
FILENAME: 14.008.033M
DRAWING NO.: A240
REVISION: 0

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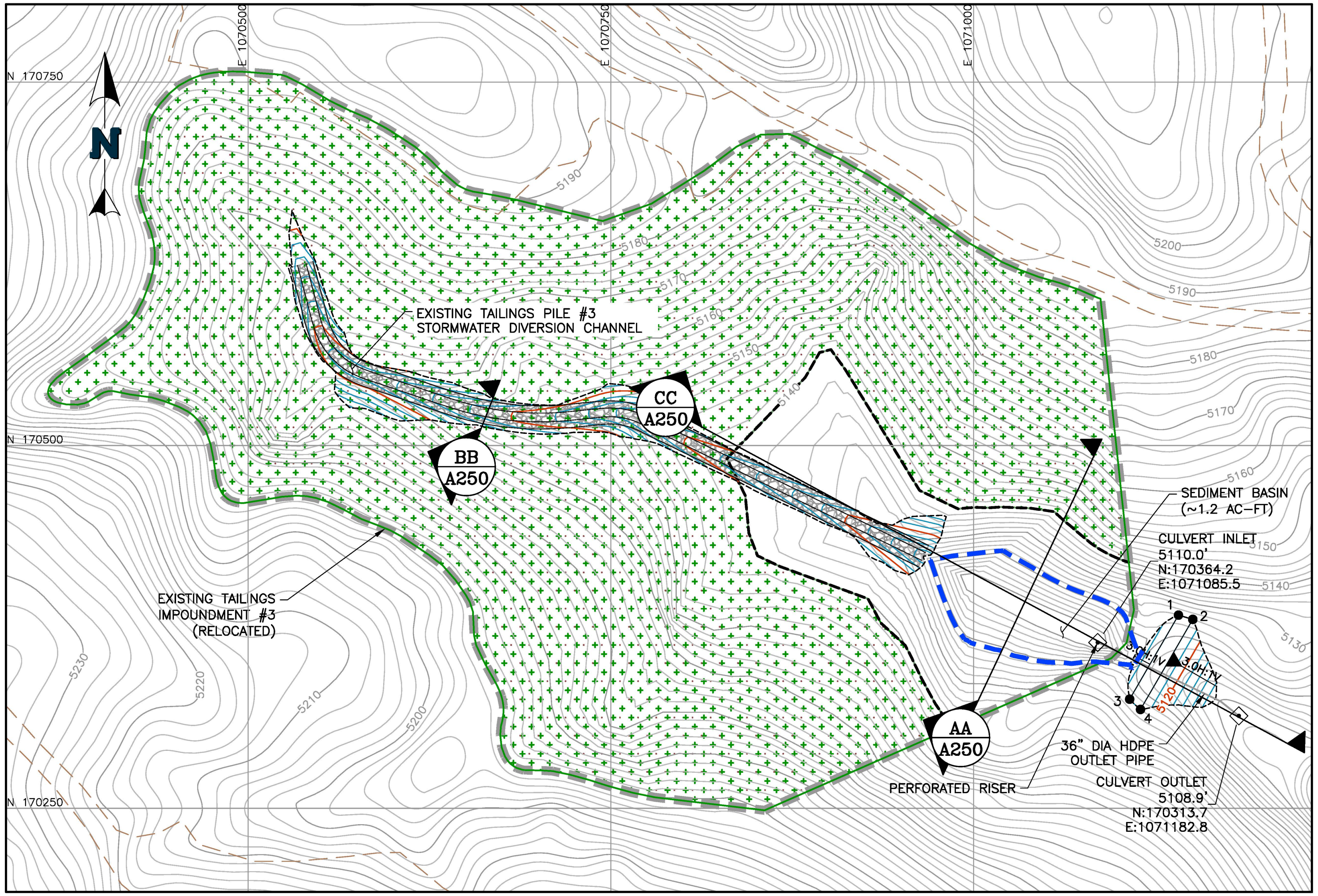

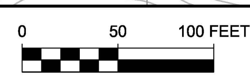

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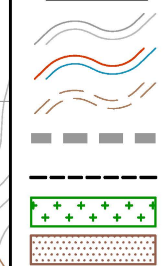
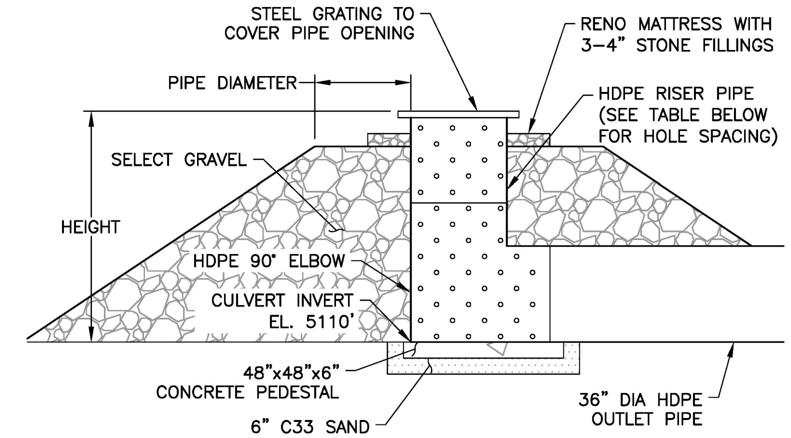
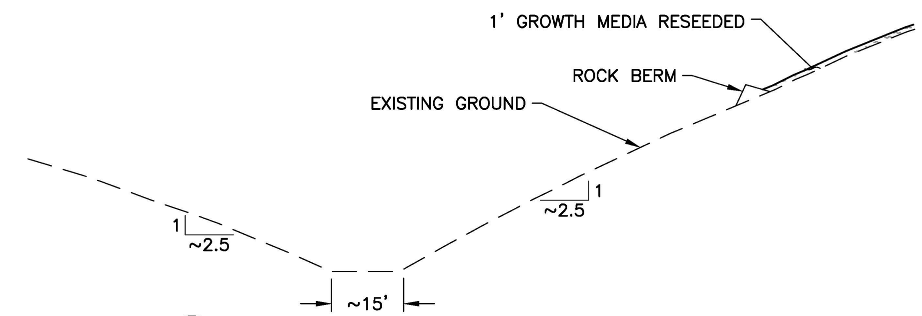


NOTES:

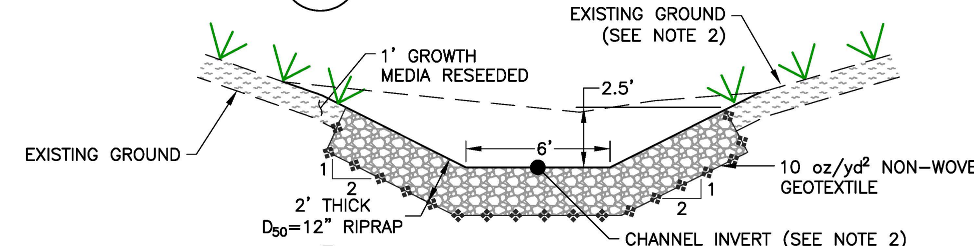
1. RIPRAP CLOSURE CHANNEL SIZED FOR THE 50YR/24HR STORM EVENT AND TO TERMINATE AT THE TOP OF THE SEDIMENT BASIN.
2. CHANNEL TO FOLLOW LOW POINT OF TAILINGS EXCAVATION AND CHANNEL INVERT TO BE 2.5' BELOW LOW POINT.



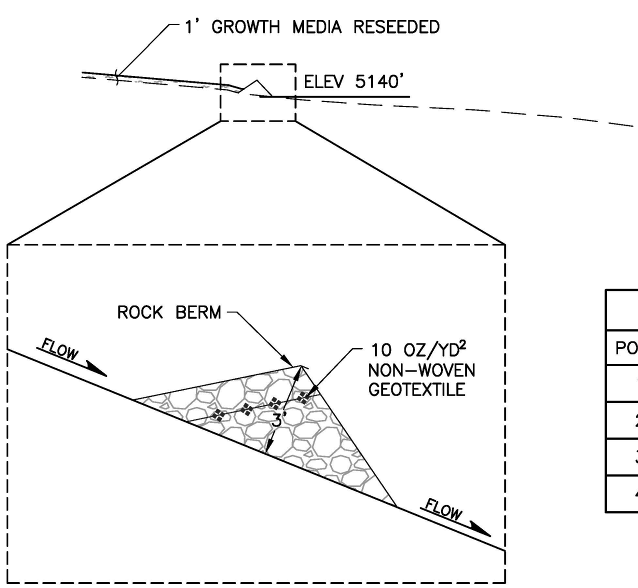
7 A250 SEDIMENT POND RISER PIPE

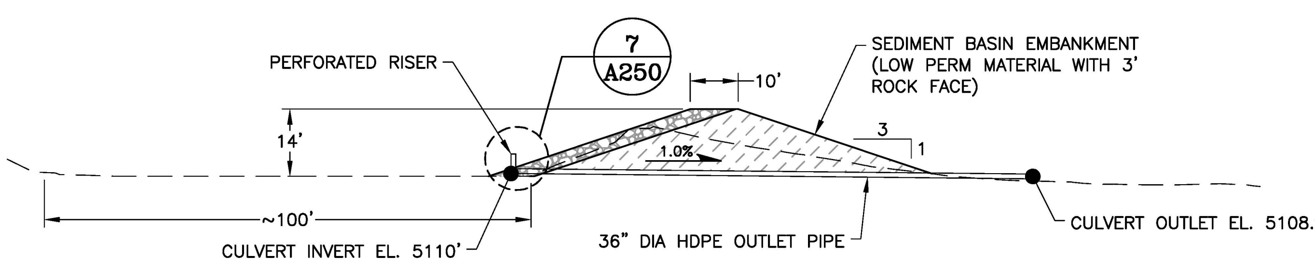


AA A250 SEDIMENT POND SECTION



BB A250 RIPRAP CLOSURE CHANNEL
SEE NOTE 2





CC A250 SEDIMENT POND SECTION

SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
1	170,383.07	1,071,141.20	5,124.00
2	170,380.13	1,071,151.05	5,124.00
3	170,325.17	1,071,107.55	5,124.00
4	170,318.11	1,071,115.01	5,124.00

RISER PIPE DETAILS				
HEIGHT	PIPE DIAMETER	HOLE DIAMETER	NUMBER OF HOLES PER ROW	ROW SPACING
6'	3'	1"	4	6"

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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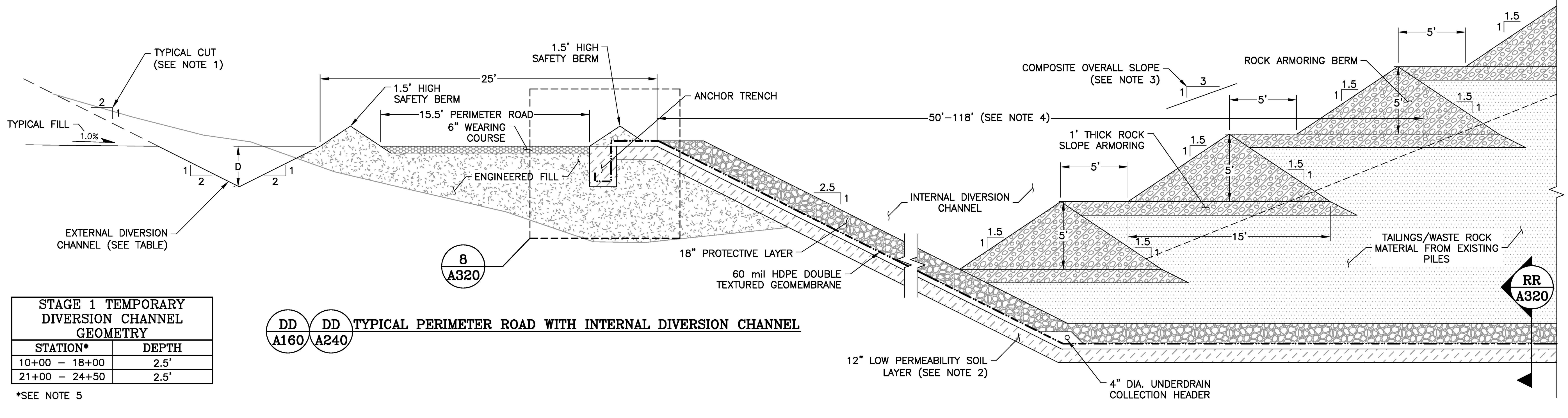
CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: EXISTING TAILINGS 3 AND SEDIMENT POND PLAN VIEW

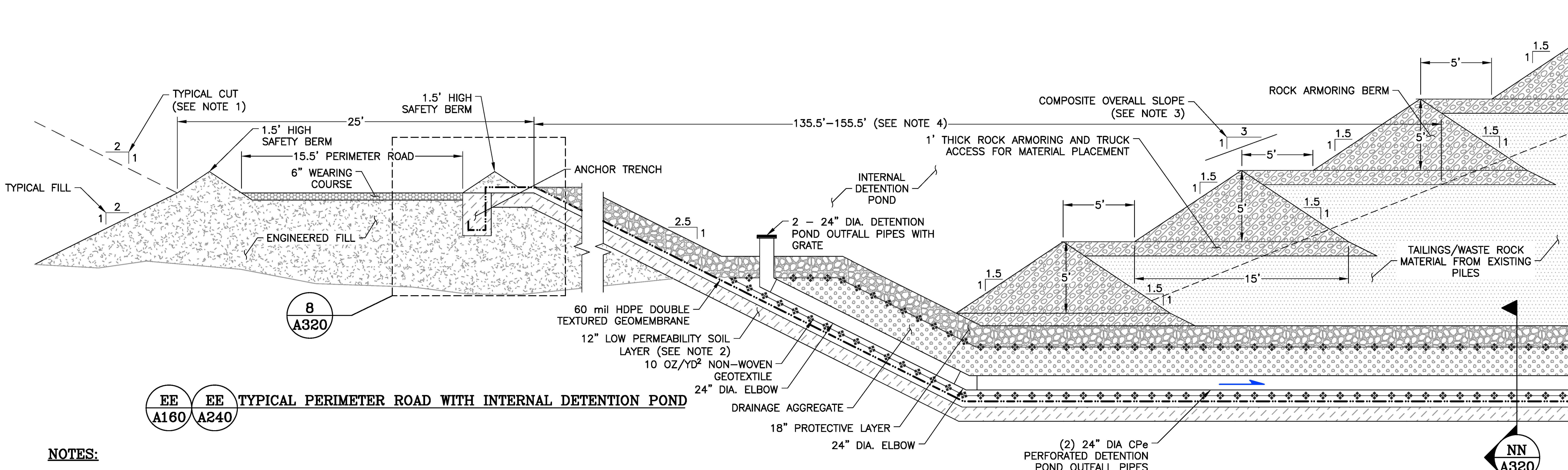
FILENAME: 14.008.034M
DRAWING NO.: A250
REVISION: 0



DD A160 DD A240 TYPICAL PERIMETER ROAD WITH INTERNAL DIVERSION CHANNEL

STAGE 1 TEMPORARY DIVERSION CHANNEL GEOMETRY	
STATION*	DEPTH
10+00 – 18+00	2.5'
21+00 – 24+50	2.5'

*SEE NOTE 5



EE A160 EE A240 TYPICAL PERIMETER ROAD WITH INTERNAL DETENTION POND

NOTES:

1. CUT SLOPES MAY BE SUBJECT TO ENGINEERS APPROVAL BASED ON ACTUAL FIELD CONDITIONS (ROCK CUT SLOPES MAY BE INCREASED TO 1.5H:1V).
2. GCL TO BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY).
3. 3H:1V COMPOUND SLOPE IS COMPRISED OF 25 FT HIGH 2.5H:1V SLOPES IN COMBINATION WITH A 12.5 FT BENCH (SEE DWG A160).
4. STACKING SHOWN ON DRAWINGS A160 AND A240 IS BASED ON TAILINGS AND WASTE ROCK MATERIAL SURFACE WITH SPECIFIED OFFSETS. SPECIFIED OFFSETS CAN BE SEEN IN THE TABLES ON DRAWINGS A160 AND A240.
5. STAGE 1 TEMPORARY DIVERSION CHANNEL STATIONING CAN BE REFERENCED ON DWG A110 AS PERIMETER ROAD STATIONING.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF TYPICAL SECTIONS AND DETAILS (SHEET 1 OF 3)

FILENAME: 14.008.014D

DRAWING NO.: A300

REVISION: 0

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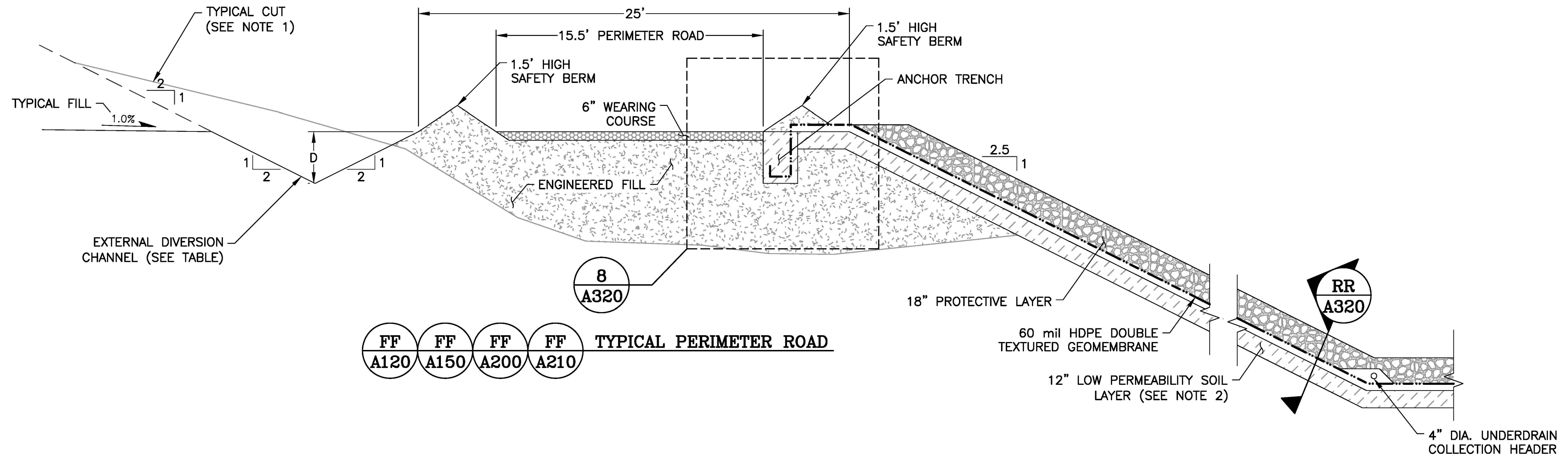
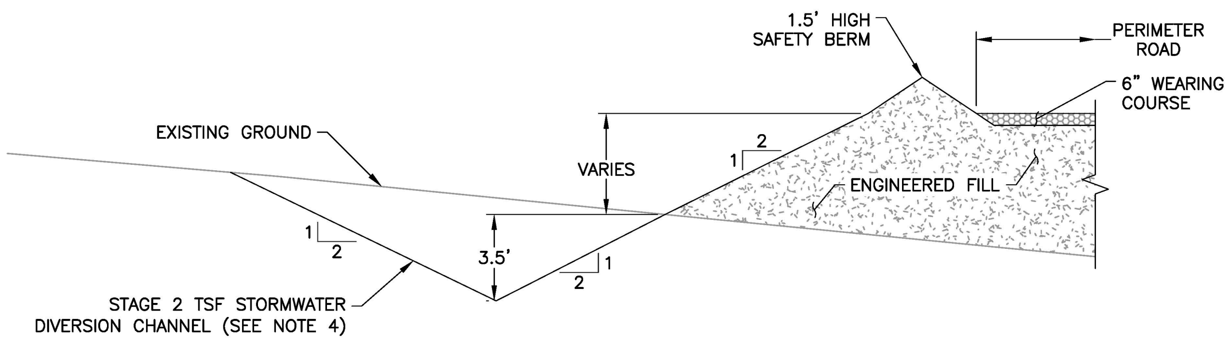
STAGE 2 TSF STORMWATER DIVERSION CHANNEL GEOMETRY	
STATION*	DEPTH (D)
0+00 – 9+00	3.5'
14+00 – 25+50	3.5'

*SEE NOTE 3

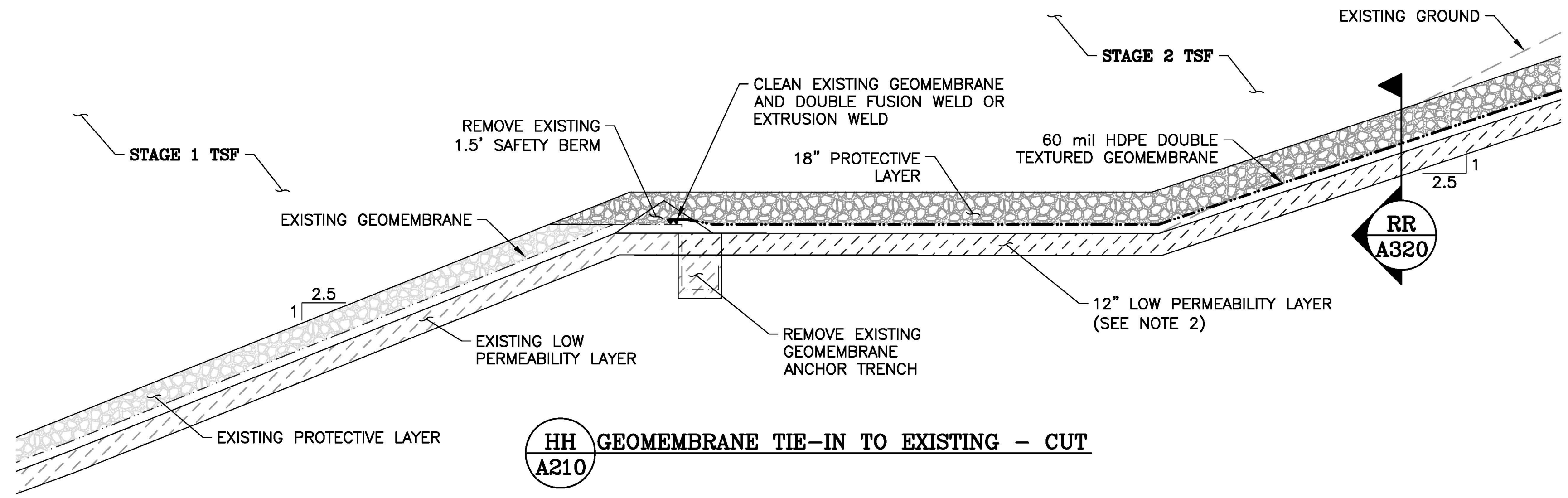


FF A120 FF A150 FF A200 FF A210 TYPICAL PERIMETER ROAD

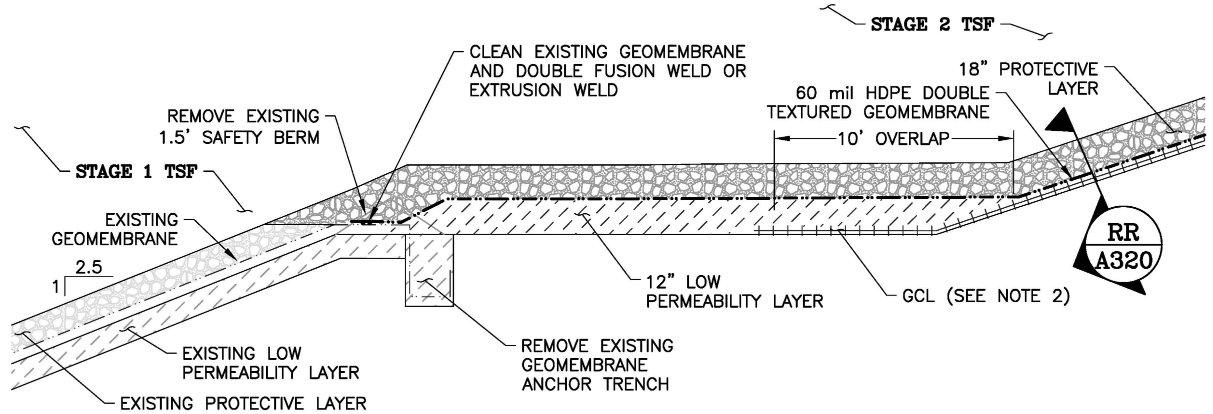


GG A200 GG A210 STAGE 2 TSF STORMWATER DIVERSION CHANNEL SECTION

STA 9+00 – 10+90 AND STA 13+60 – 14+00



HH A210 GEOMEMBRANE TIE-IN TO EXISTING – CUT



JJ A210 GCL TIE-IN TO EXISTING LOW PERMEABILITY LAYER

NOTES:

1. CUT SLOPES MAY BE SUBJECT TO ENGINEERS APPROVAL BASED ON ACTUAL FIELD CONDITIONS (ROCK CUT SLOPES MAY BE INCREASED TO 1.5H:1V).
2. GCL MAY BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY).
3. STAGE 2 TSF STORMWATER DIVERSION CHANNEL STATIONING CAN BE REFERENCED ON DWG A200 AS PERIMETER ROAD STATIONING.
4. STAGE 2 TSF STORMWATER DIVERSION CHANNEL SHALL CONTINUE ALONG THE TOE OF THE EMBANKMENT STARTING AT APPROXIMATELY STATION 9+50 WHEN THE EMBANKMENT FILL SECTION BEGINS UNTIL IT REACHES THE GEOMEMBRANE LIMITS OF THE STAGE 2 EXTERNAL DETENTION POND.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

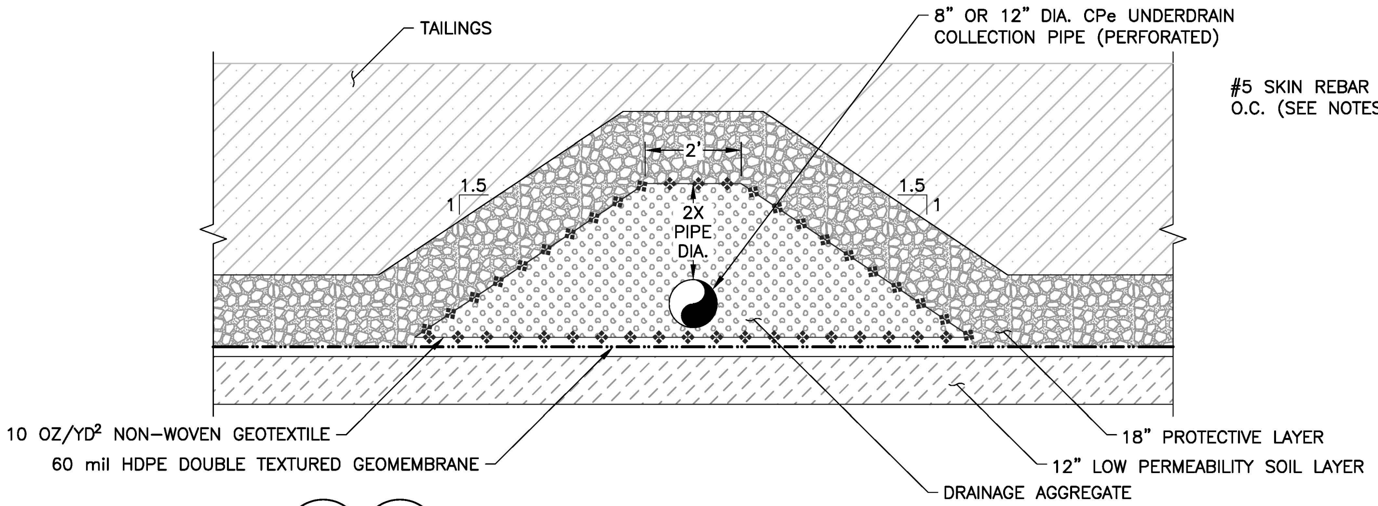
TITLE: TSF TYPICAL SECTIONS AND DETAILS (SHEET 2 OF 3)

FILENAME: 14.008.023D

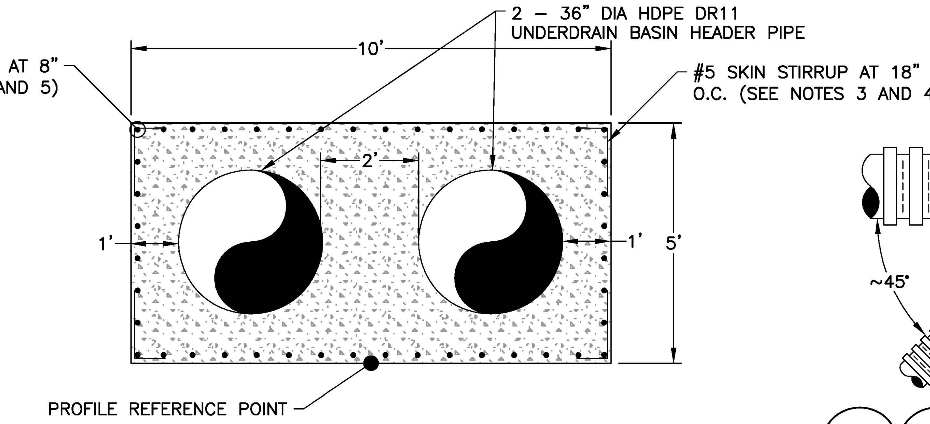
DRAWING NO.: A310

REVISION: 0

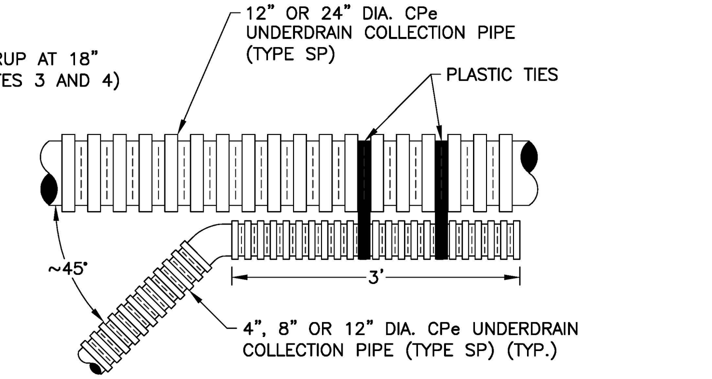
P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\DWGS\14.008.023D.dwg-5/31/2017 9:18 AM



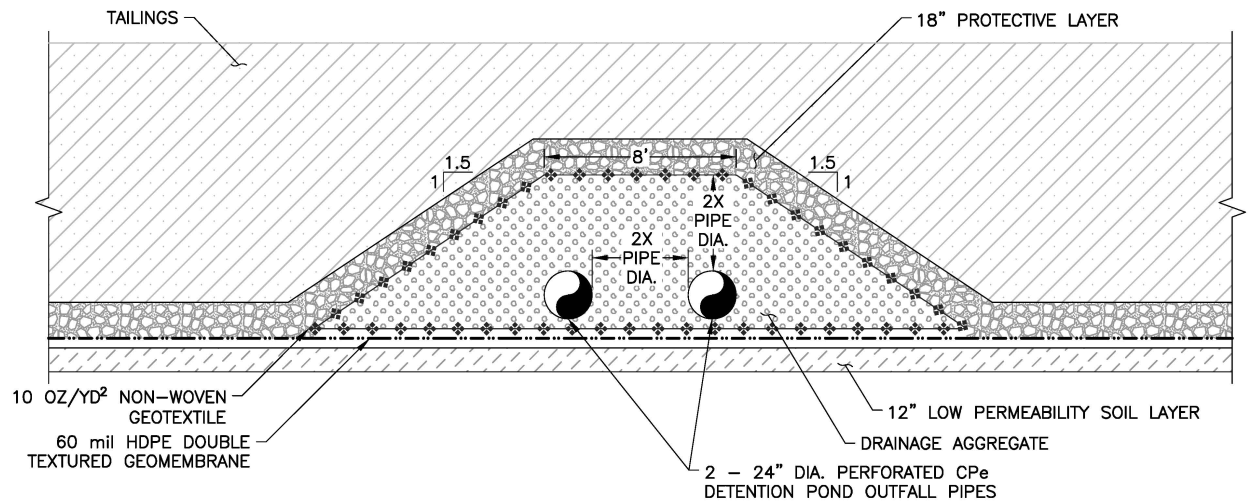
KK A140 | KK A228 UNDERDRAIN BASIN HEADER– 12" OR 8" PIPE



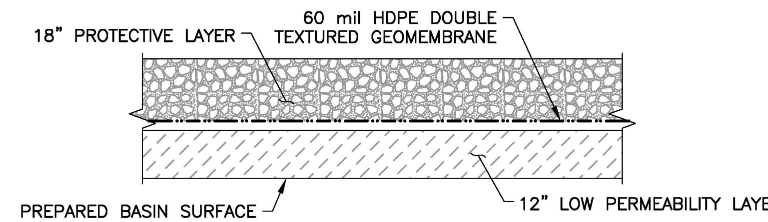
LL A140 | LL A150 REINFORCED CONCRETE PIPE ENCASEMENT



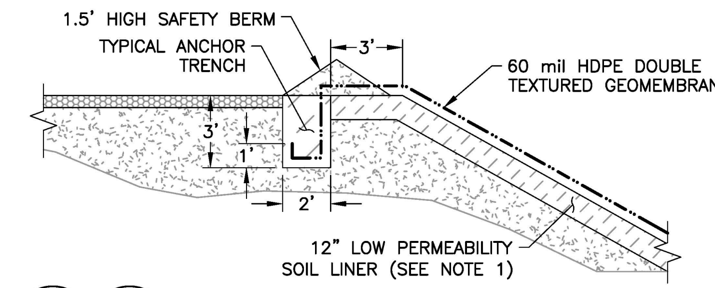
MM A140 | MM A228 UNDERDRAIN COLLECTION PIPE INTERSECTION



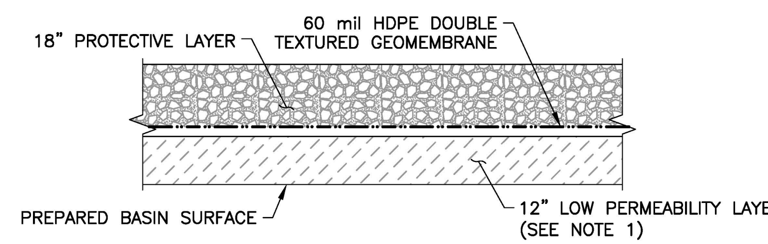
NN A140 | NN A228 | NN A300 UNDERDRAIN BASIN HEADER– (2) 24" PIPES



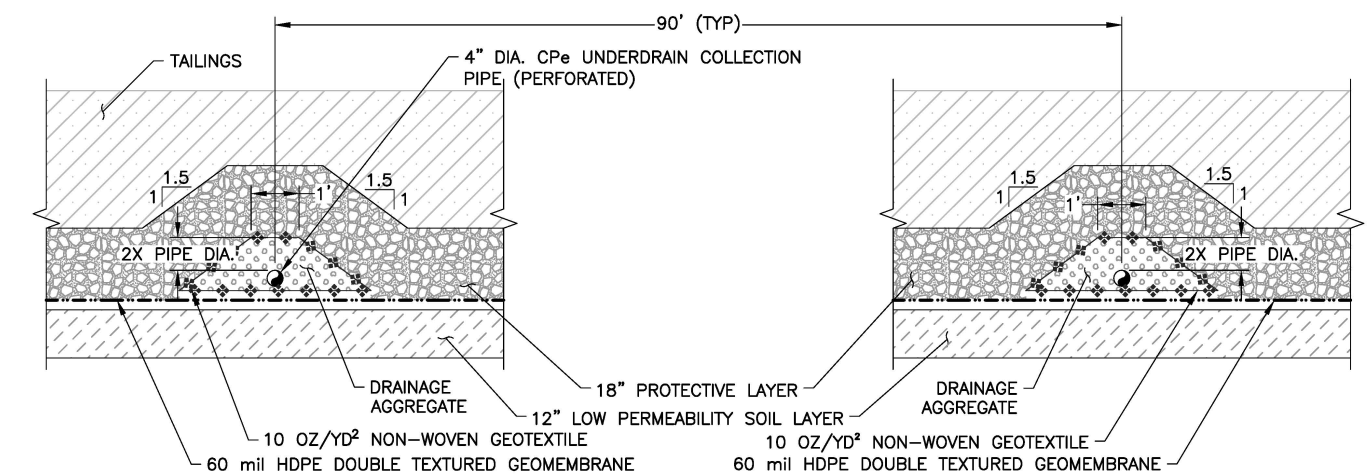
PP A120 TYPICAL BASIN SECTION (LOW PERMEABILITY LAYER)



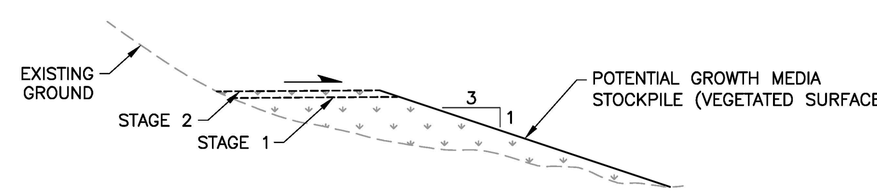
8 A300 | 8 A310 TYPICAL ANCHOR TRENCH ON PERIMETER ROAD BERM



RR A210 | RR A300 | RR A310 TYPICAL BASIN SECTION (LOW PERMEABILITY LAYER OR GCL)



QQ A140 | QQ A228 UNDERDRAIN BASIN HEADER– 4" PIPE



SS A010 | SS A100 GROWTH MEDIA STOCKPILE

NOTES:

1. GCL MAY BE USED AS AN APPROVED EQUIVALENT IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY ON THE TRENCH CAMP SITE (STAGE 2 ONLY). IF GCL IS USED, GCL WILL BE ANCHORED IN LINER ANCHOR TRENCH.
2. CONCRETE ENCASEMENT SHOULD BE INCISED INTO THE COMPACTED SOIL AND POURED NEAT TO THE EXCAVATION TO PROVIDE FOR AN INTIMATE SOIL AND CONCRETE INTERFACE.
3. ALL REBAR REINFORCING SHALL BE GRADE 60.
4. HEAT MAY NOT BE USED IN THE BENDING OF REBAR STIRRUPS.
5. BAR LAP SPLICES MUST BE STAGGERED ALONG THE CONCRETE ENCASEMENT.
6. ALL UPSTREAM OPEN ENDS OF PIPES TO BE CAPPED.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF TYPICAL SECTIONS AND DETAILS (SHEET 3 OF 3)

FILENAME: 14.008.044D
DRAWING NO.: A320
REVISION: 0

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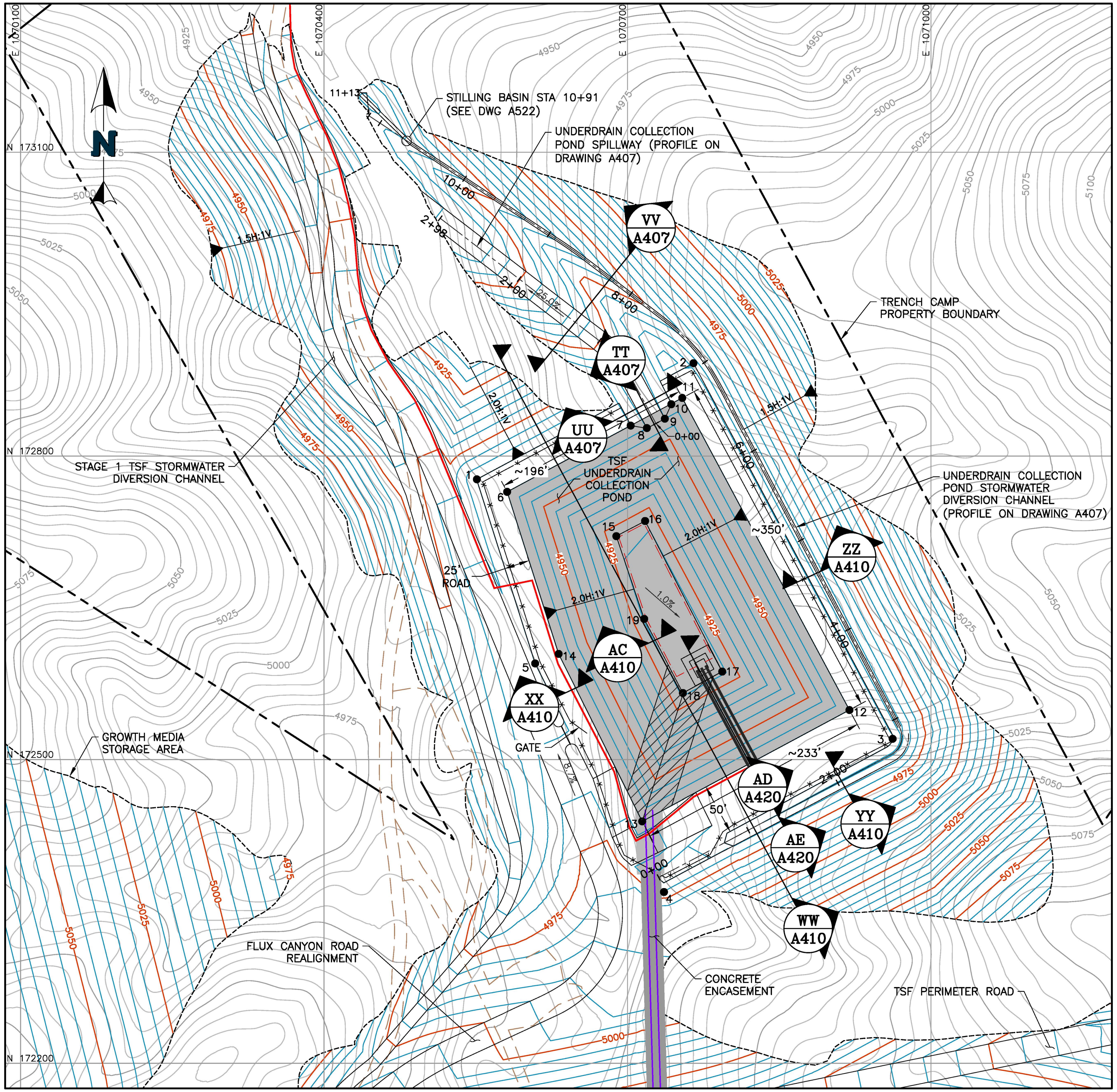


0 60 120 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

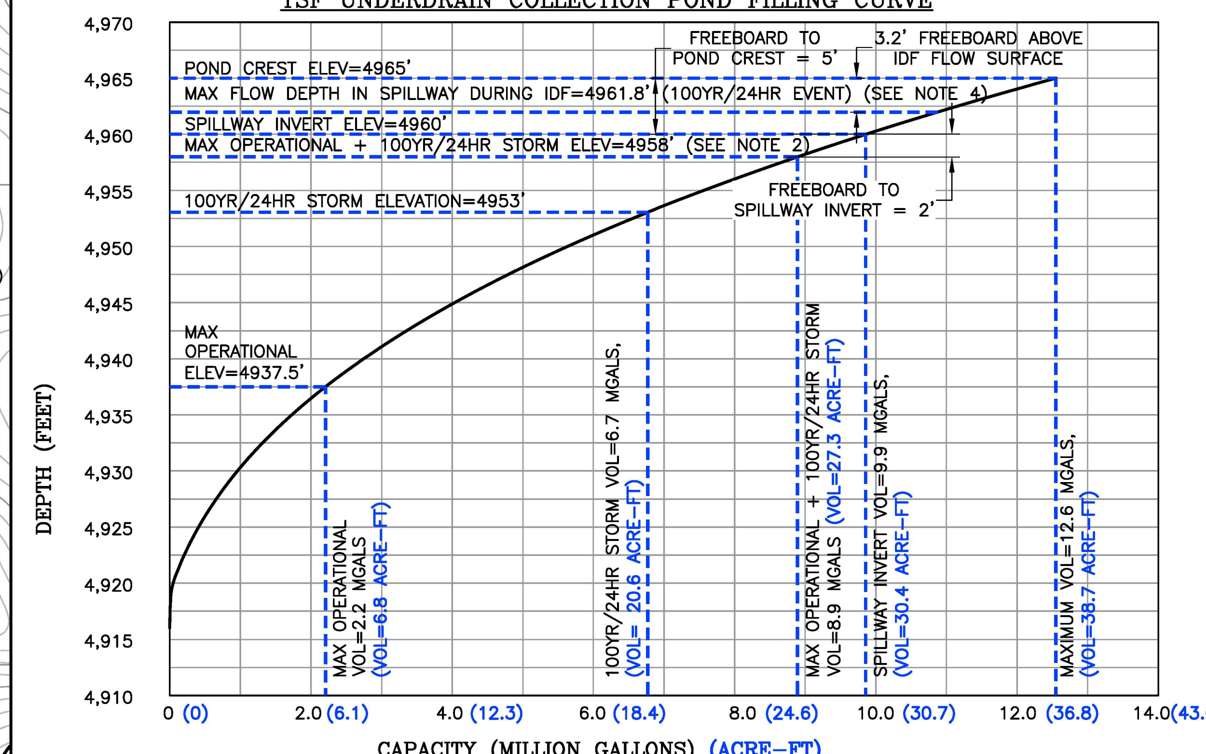
LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- 4" DIA. CPE UNDERDRAIN COLLECTION PIPE (PERFORATED)
- CONCRETE ENCASED UNDERDRAIN
- 36" DIA. HDPE DR11 DETENTION POND OUTFALL PIPE (SOLID)
- UNDERDRAIN COLLECTION POND RECLAIM PIPE TO WATER TREATMENT PLANT (SOLID) (BY OTHERS)
- GEOMEMBRANE
- PROPOSED FENCE
- GEOMEMBRANE WEAR SHEET

NOTES:

1. WATER COLLECTED IN THE UNDERDRAIN COLLECTION POND TO BE PUMPED TO WATER TREATMENT PLANT.
2. TRENCH CAMP UNDERDRAIN POND DESIGNED TO CONTAIN VERY LOW SEEPAGE FLOWS EXPECTED FROM THE DRY STACK TSF WET YEAR OPERATIONAL VOLUME FROM THE TSF AS WELL AS THE 100 YR/24 HOUR STORMWATER RUNOFF FROM THE DRY STACK TSF AND STORM PRECIPITATION DIRECTLY OVER THE POND DURING THE 100 YR/ 24 HOUR STORM EVENT.
3. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
4. IDF WATER SURFACE ELEVATION (WSEL) WAS IDENTIFIED USING ADWR PRESCRIPTIVE APPROACH. THE IDF WAS ROUTED THROUGH POND WITH POND FULL TO THE INVERT ELEVATION OF SPILLWAY.
5. UNDERDRAIN COLLECTION POND CONSTRUCTED FROM CUT AND FILL OPERATIONS.

TSF UNDERDRAIN COLLECTION POND FILLING CURVE



SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
1	172,776.99	1,070,551.11	4,965.00
2	172,891.74	1,070,765.22	4,962.39
3	172,520.52	1,070,962.13	4,965.00
4	172,369.33	1,070,736.08	4,971.00
5	172,594.98	1,070,608.70	4,965.00
6	172,764.62	1,070,580.99	4,965.00
7	172,830.09	1,070,703.12	4,964.97
8	172,827.65	1,070,719.14	4,960.00
9	172,836.85	1,070,736.94	4,959.95
10	172,851.21	1,070,743.33	4,964.80

SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
11	172,857.43	1,070,754.12	4,965.01
12	172,548.95	1,070,919.44	4,965.01
13	172,439.12	1,070,714.52	4,965.00
14	172,604.44	1,070,631.93	4,965.00
15	172,720.83	1,070,688.92	4,920.21
16	172,735.83	1,070,717.39	4,920.09
17	172,586.96	1,070,793.65	4,918.54
18	172,565.76	1,070,754.77	4,918.70
19	172,639.04	1,070,716.49	4,919.47

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A.

EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF UNDERDRAIN COLLECTION POND PLAN VIEW

FILENAME: 14.008.011M

DRAWING NO.: A400

REVISION: 0

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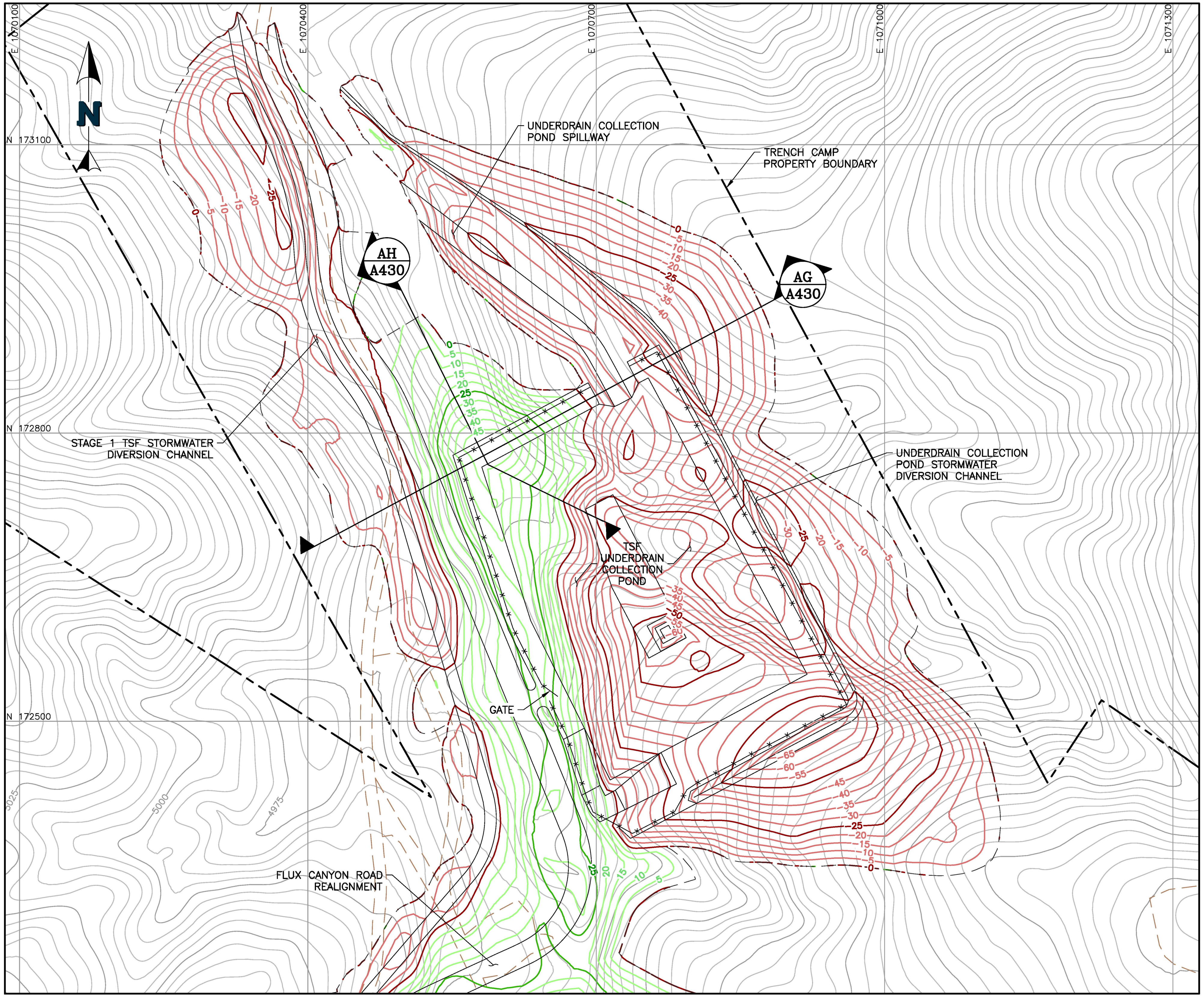

LEGEND:

- EXISTING GROUND CONTOURS
- FILL ISOPACH CONTOURS
- CUT ISOPACH CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY
- PROPOSED FENCE

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.

0 60 120 FEET

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: UNDERDRAIN COLLECTION POND ISOPACH

FILENAME: 14.008.078M
DRAWING NO.: A402
REVISION: 0

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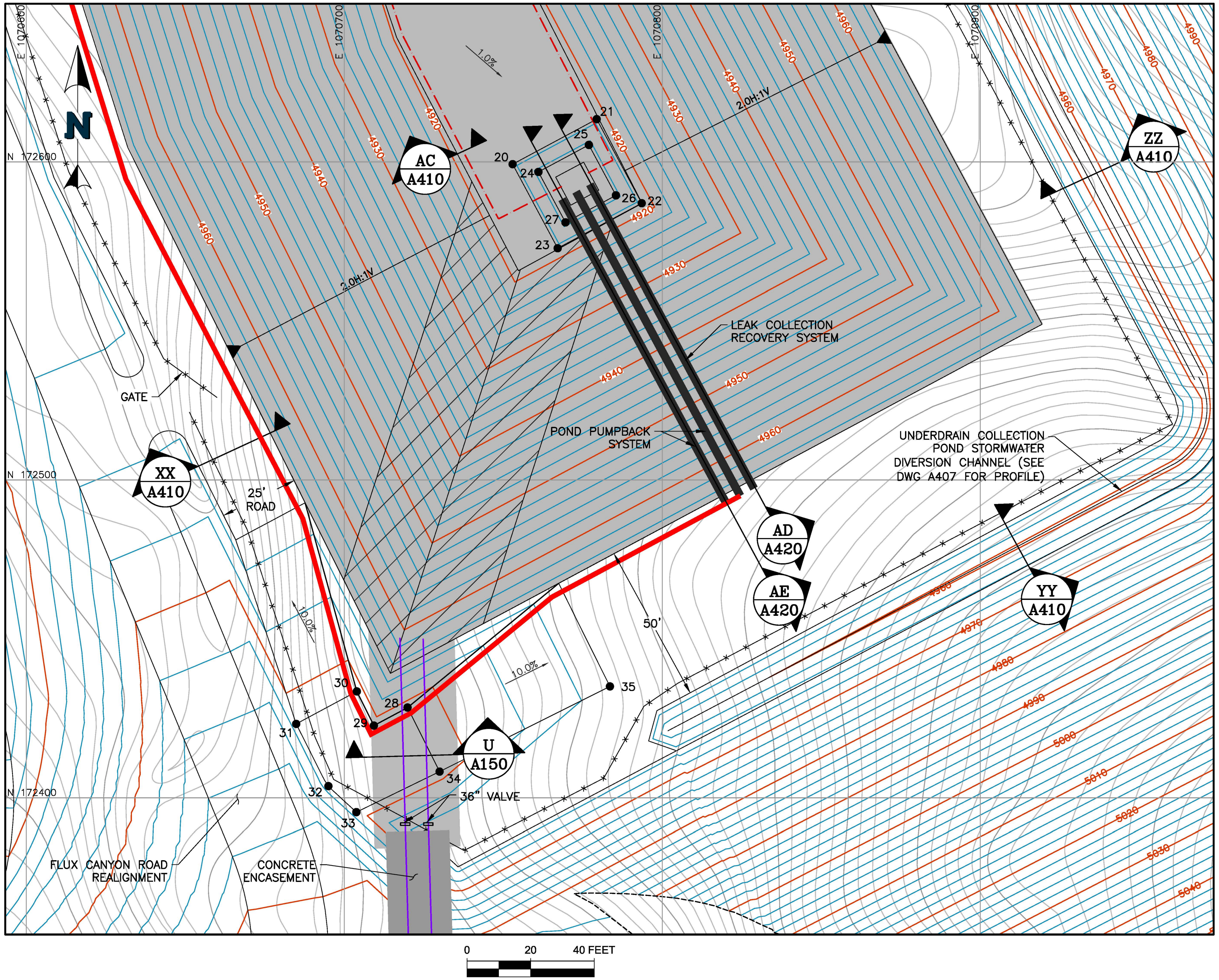

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED CONTOURS
- 4" DIA. CPE UNDERDRAIN COLLECTION PIPE (PERFORATED)
- CONCRETE ENCASED UNDERDRAIN
- 36" DIA. HDPE DR11 DETENTION POND OUTFALL PIPE (SOLID)
- UNDERDRAIN COLLECTION POND RECLAIM PIPE TO WATER TREATMENT PLANT (SOLID) (BY OTHERS)
- GEOMEMBRANE
- PROPOSED FENCE
- GEOMEMBRANE WEAR SHEET

NOTES:

1. WATER COLLECTED IN THE UNDERDRAIN COLLECTION POND TO BE PUMPED TO WATER TREATMENT PLANT.
2. TRENCH CAMP UNDERDRAIN POND DESIGNED TO CONTAIN VERY LOW SEEPAGE FLOWS EXPECTED FROM THE DRY STACK TSF WET YEAR OPERATIONAL VOLUME FROM THE TSF AS WELL AS THE 100 YR/24 HOUR STORMWATER RUNOFF FROM THE DRY STACK TSF AND PRECIPITATION DIRECTLY OVER THE POND DURING THE 100 YR/ 24 HOUR STORM EVENT.
3. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE.
4. IDF WATER SURFACE ELEVATION (WSEL) WAS IDENTIFIED USING ADWR PRESCRIPTIVE APPROACH. THE IDF WAS ROUTED THROUGH POND WITH POND FULL TO THE INVERT ELEVATION OF THE SPILLWAY.

SETTING OUT DATA

POINT	NORTHING	EASTING	ELEVATION
20	172,599.26	1,070,752.93	4,918.50
21	172,613.43	1,070,779.38	4,918.50
22	172,586.99	1,070,793.55	4,918.50
23	172,572.82	1,070,767.10	4,918.50
24	172,596.81	1,070,761.06	4,915.50
25	172,605.31	1,070,776.92	4,915.50
26	172,589.44	1,070,785.42	4,915.50
27	172,580.94	1,070,769.56	4,915.50
28	172,428.39	1,070,719.89	4,971.00
29	172,422.71	1,070,709.31	4,971.00
30	172,433.45	1,070,703.94	4,971.00
31	172,423.24	1,070,684.89	4,971.00
32	172,403.66	1,070,695.00	4,971.00
33	172,395.48	1,070,703.79	4,971.00
34	172,408.23	1,070,729.98	4,971.00
35	172,435.03	1,070,783.55	4,965.00

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF UNDERDRAIN COLLECTION POND SUMP

FILENAME: 14.008.075M

DRAWING NO.: A405

REVISION: 0

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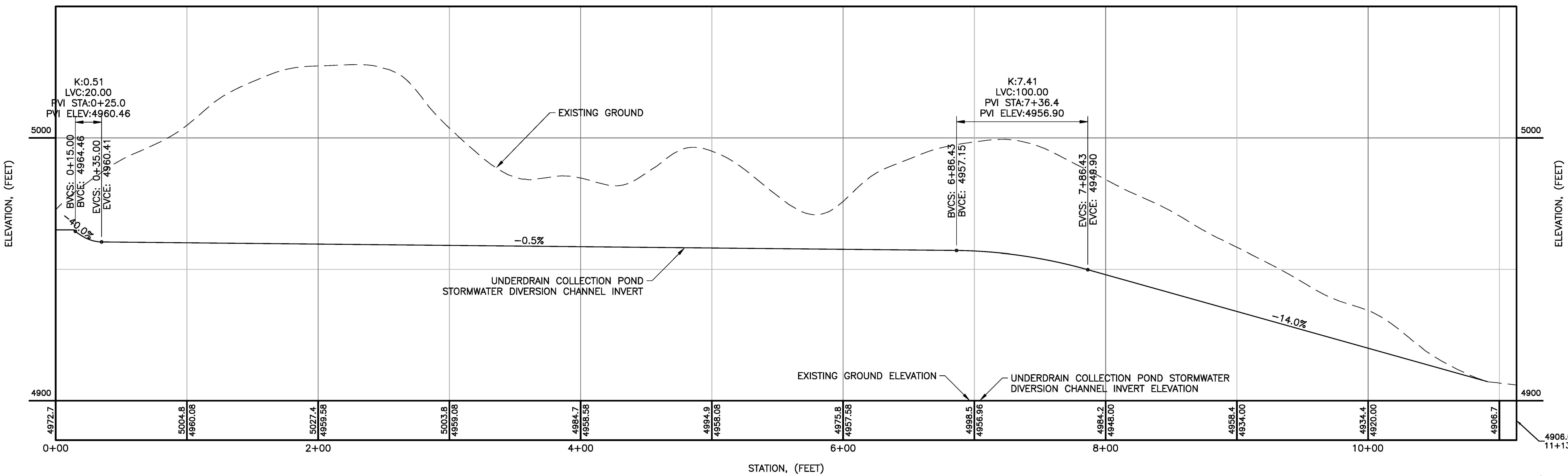
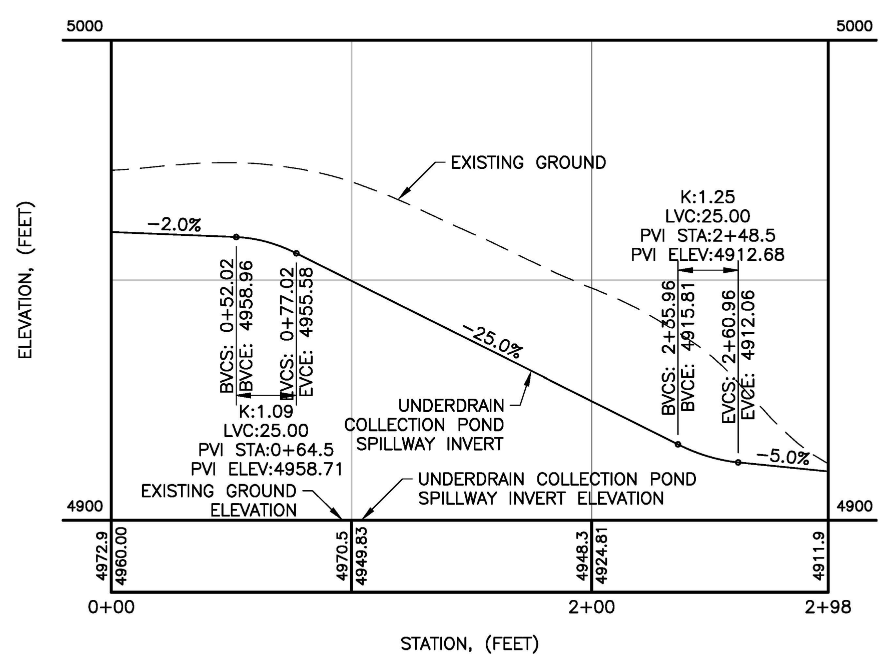


UNDERDRAIN COLLECTION POND STORMWATER DIVERSION CHANNEL

0 40 80 FEET HORIZONTAL; 0 20 40 FEET VERTICAL

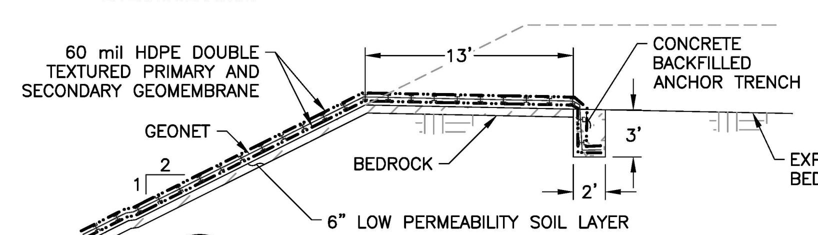
2X EXAGGERATION



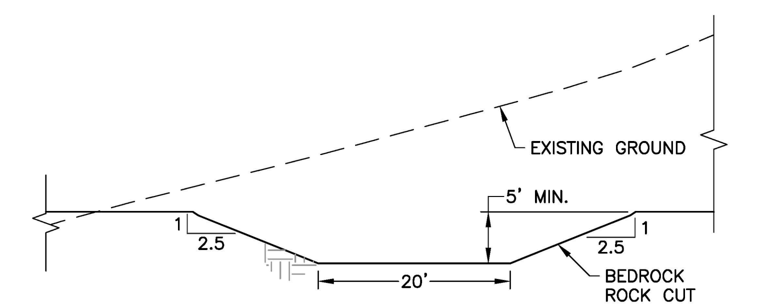
UNDERDRAIN COLLECTION POND SPILLWAY

0 40 80 FEET HORIZONTAL; 0 20 40 FEET VERTICAL

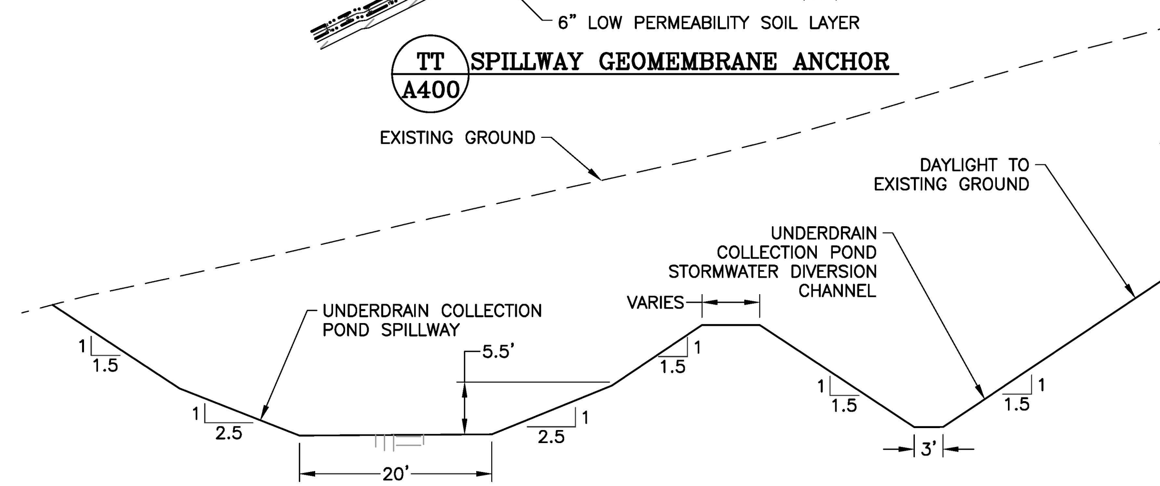
2X EXAGGERATION



TT / A400 SPILLWAY GEOMEMBRANE ANCHOR



UU / A400 UNDERDRAIN COLLECTION POND SPILLWAY SECTION



VV / A400 UNDERDRAIN COLLECTION POND SPILLWAY SECTION

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: TSF UNDERDRAIN COLLECTION POND PROFILES

FILENAME: 14.008.076P

DRAWING NO.: A407

REVISION: 0

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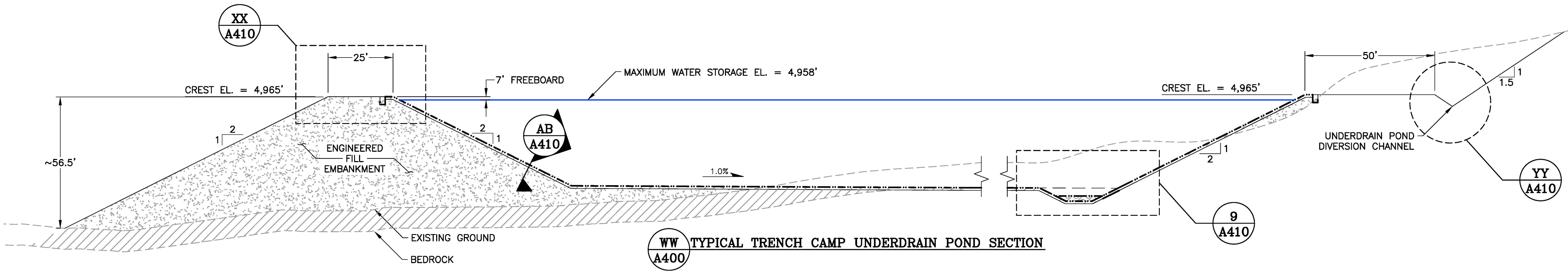
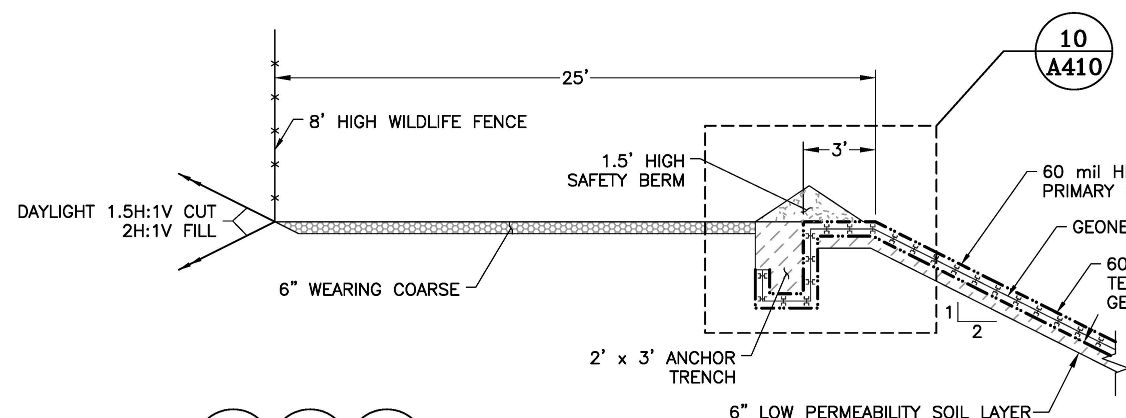
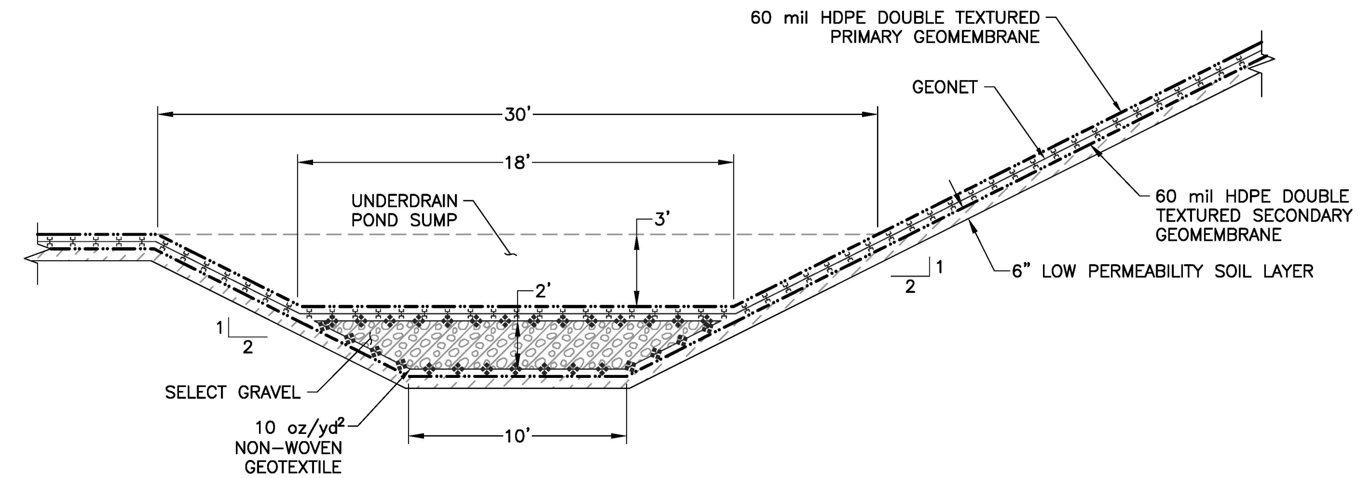


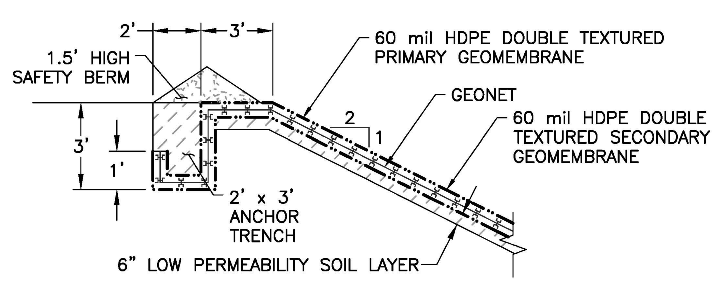
WW
A400
TYPICAL TRENCH CAMP UNDERDRAIN POND SECTION



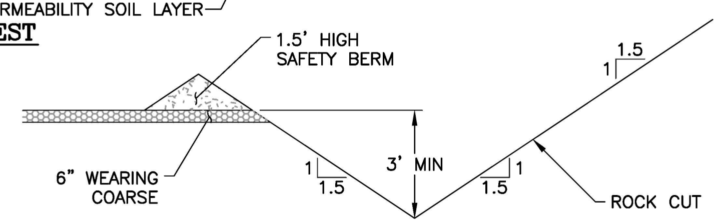
XX
A400
XX
A405
XX
A410
TYPICAL UNDERDRAIN POND CREST



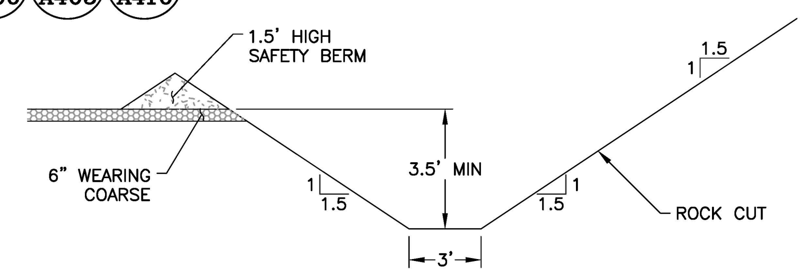
9
A410
UNDERDRAIN POND SUMP



10
A410
TYPICAL UNDERDRAIN POND ANCHOR TRENCH DETAIL



YY
A400
YY
A405
YY
A410
UNDERDRAIN POND DIVERSION CHANNEL – SOUTH



ZZ
A400
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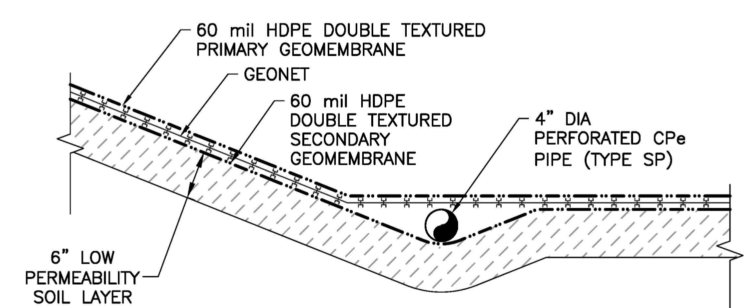
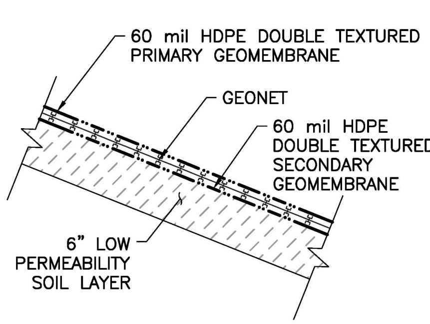
A405
UNDERDRAIN POND DIVERSION CHANNEL – EAST



AC
A400
AC
A405
TOE DRAIN TO LCRS SUMP



AB
A410
AB
A430
TYPICAL UNDERDRAIN POND GEOMEMBRANE DETAIL

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 1 OF 3)

FILENAME: 14.008.012D
DRAWING NO.: A410
REVISION: 0

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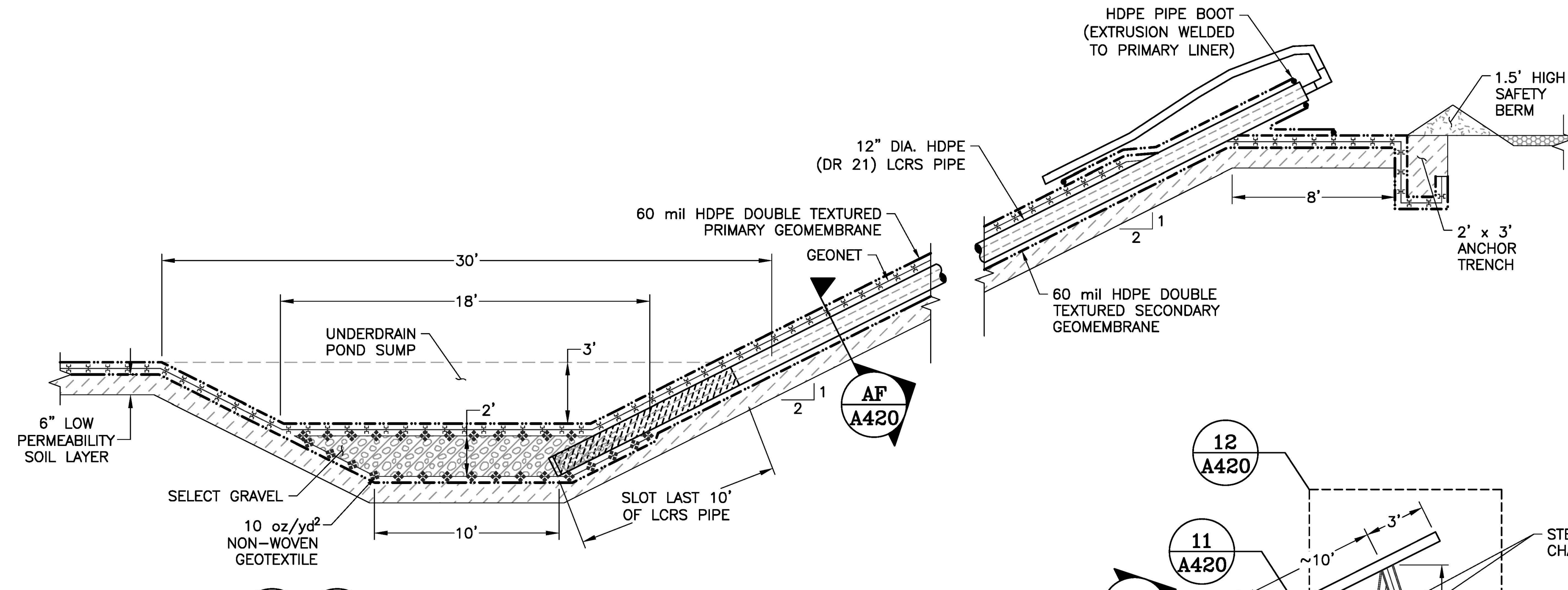
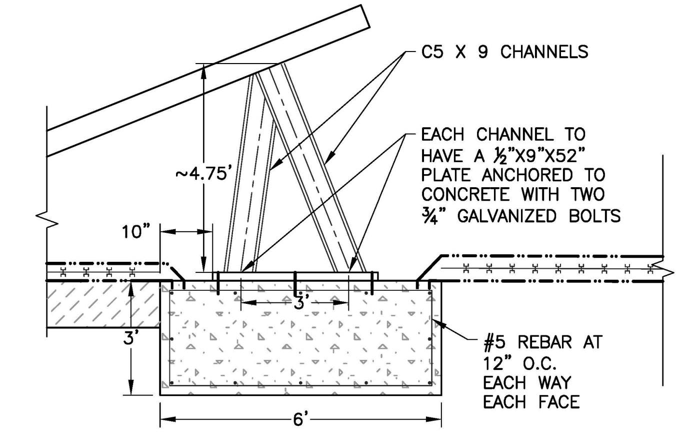
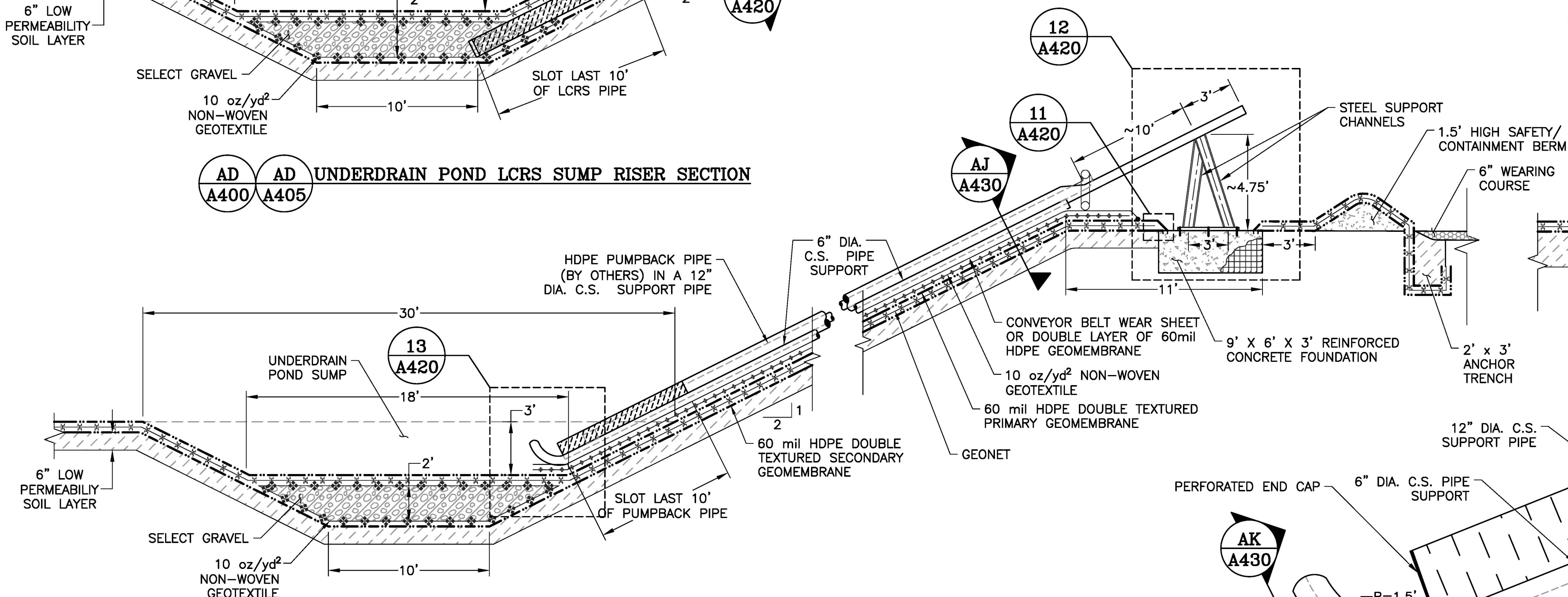


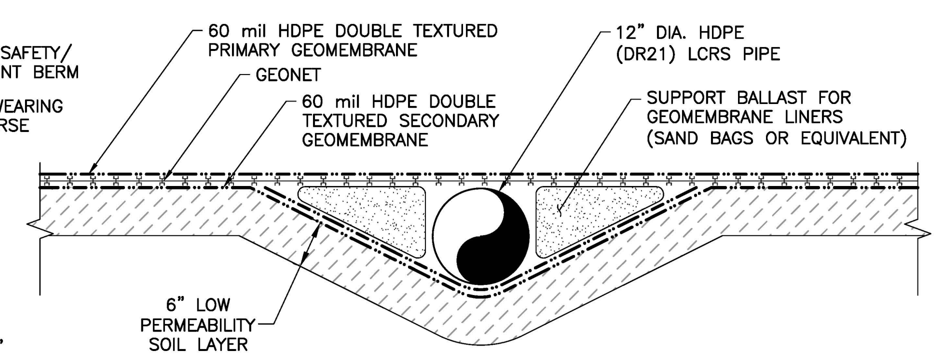
AD/A400 AD/A405 UNDERDRAIN POND LCRS SUMP RISER SECTION



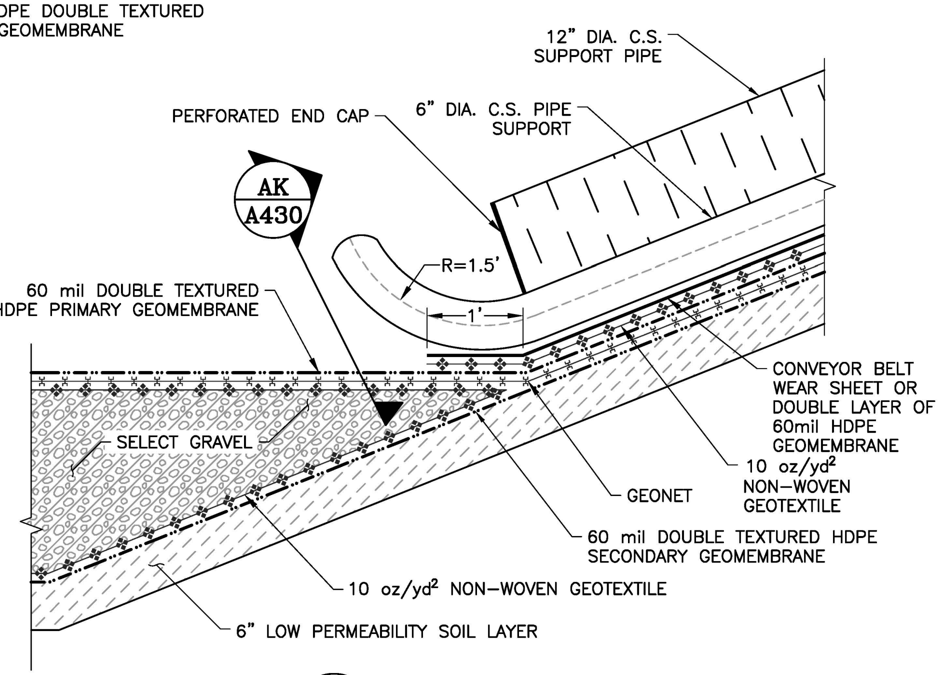
12/A420 PUMPBACK SYSTEM CONCRETE ANCHOR DETAIL



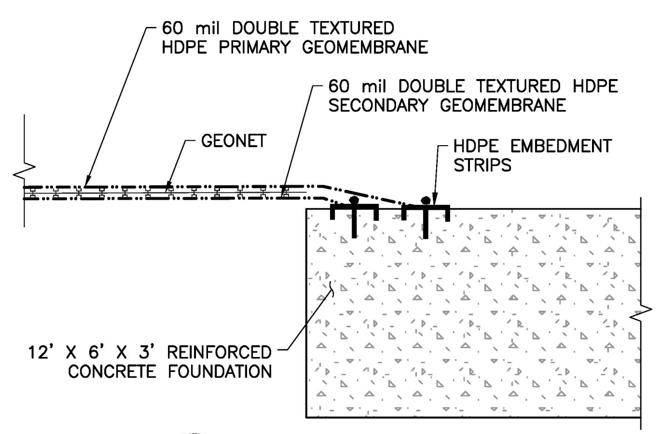
AE/A400 AE/A405 UNDERDRAIN POND PUMPBACK SYSTEM



AF/A420 LCRS PIPE SECTION



13/A420 SLOPING PUMPBACK SYSTEM



11/A420 HDPE EMBEDMENT STRIPS

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 2 OF 3)

FILENAME: 14.008.013D
DRAWING NO.: A420
REVISION: 0

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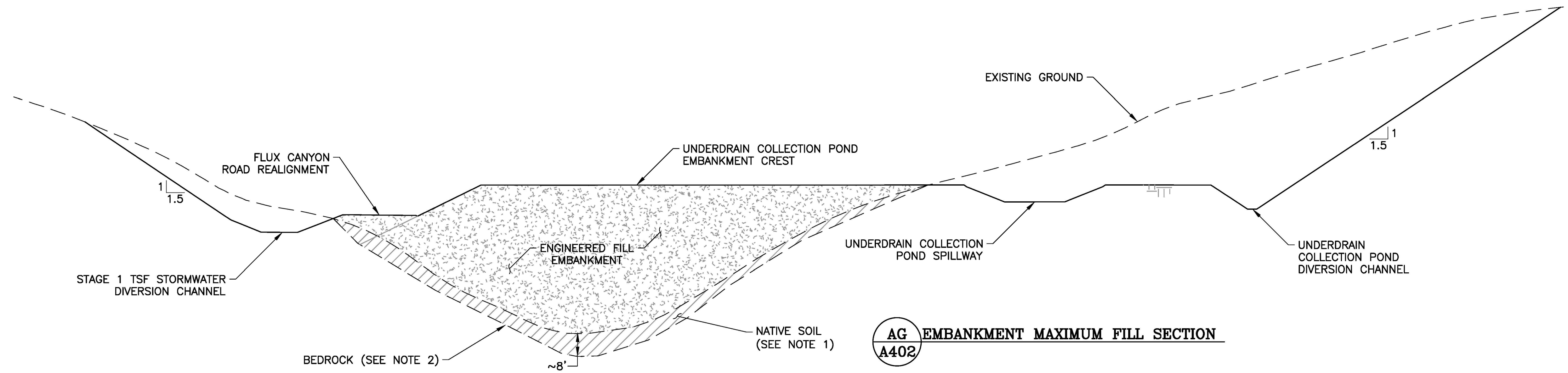
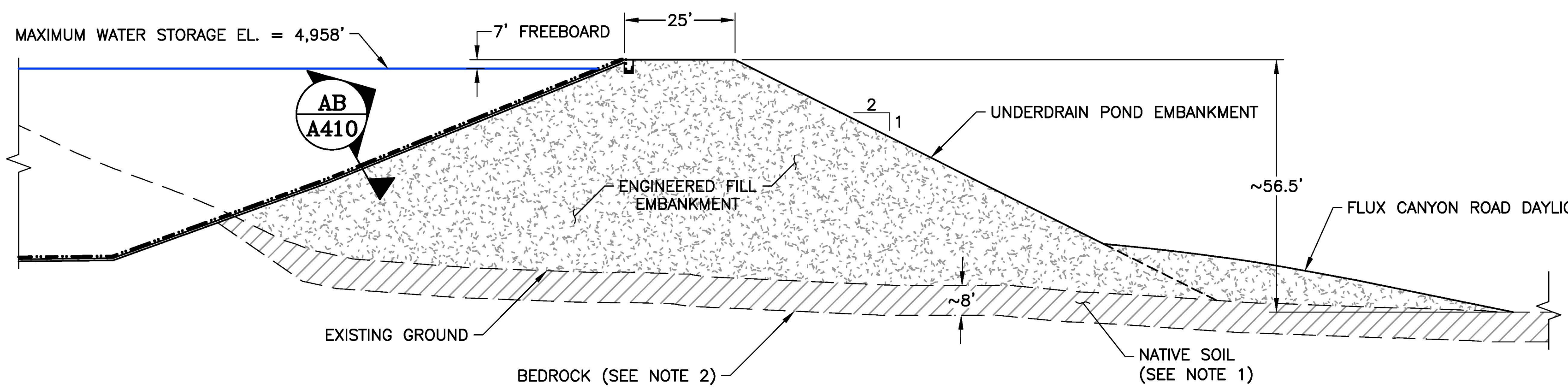


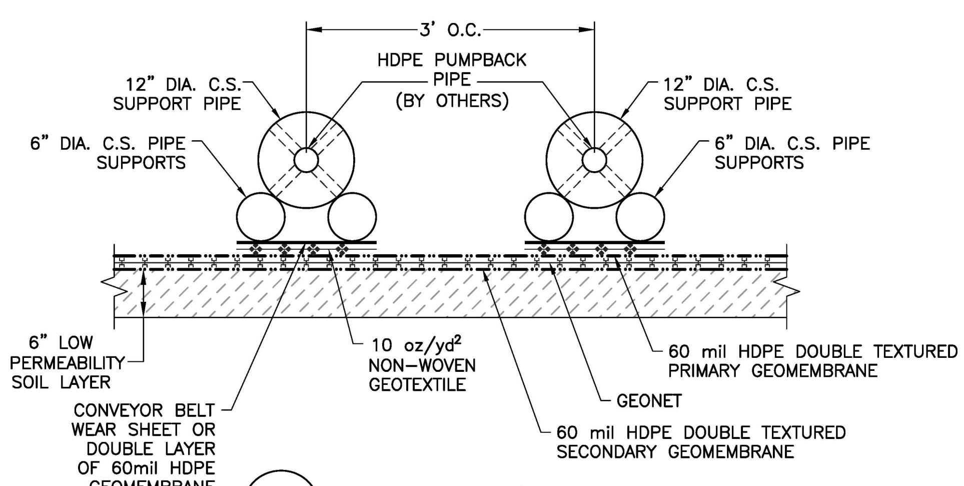
AG
A402
EMBANKMENT MAXIMUM FILL SECTION



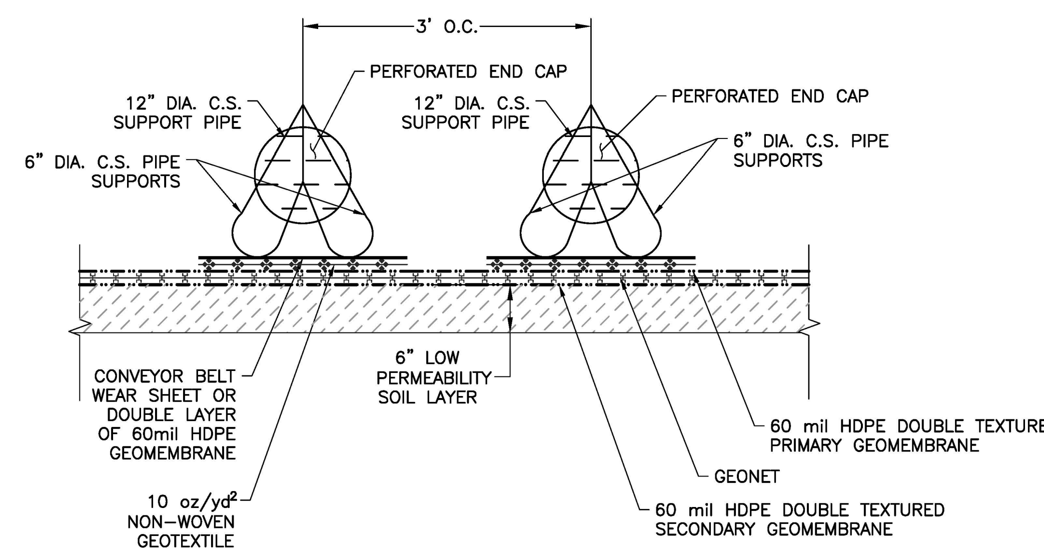
AH
A402
EMBANKMENT MAXIMUM FILL SECTION

NOTES:

1. DAM EXCAVATION TO CONTINUE TO BEDROCK IF NATIVE SOIL IS NOT SUITABLE FOR EMBANKMENT CONSTRUCTION.
2. BEDROCK DEPTH TO BE CONFIRMED IN FIELD.



AJ
A420
PUMP TUBE SECTION



AK
A420
PUMP TUBE SECTION

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

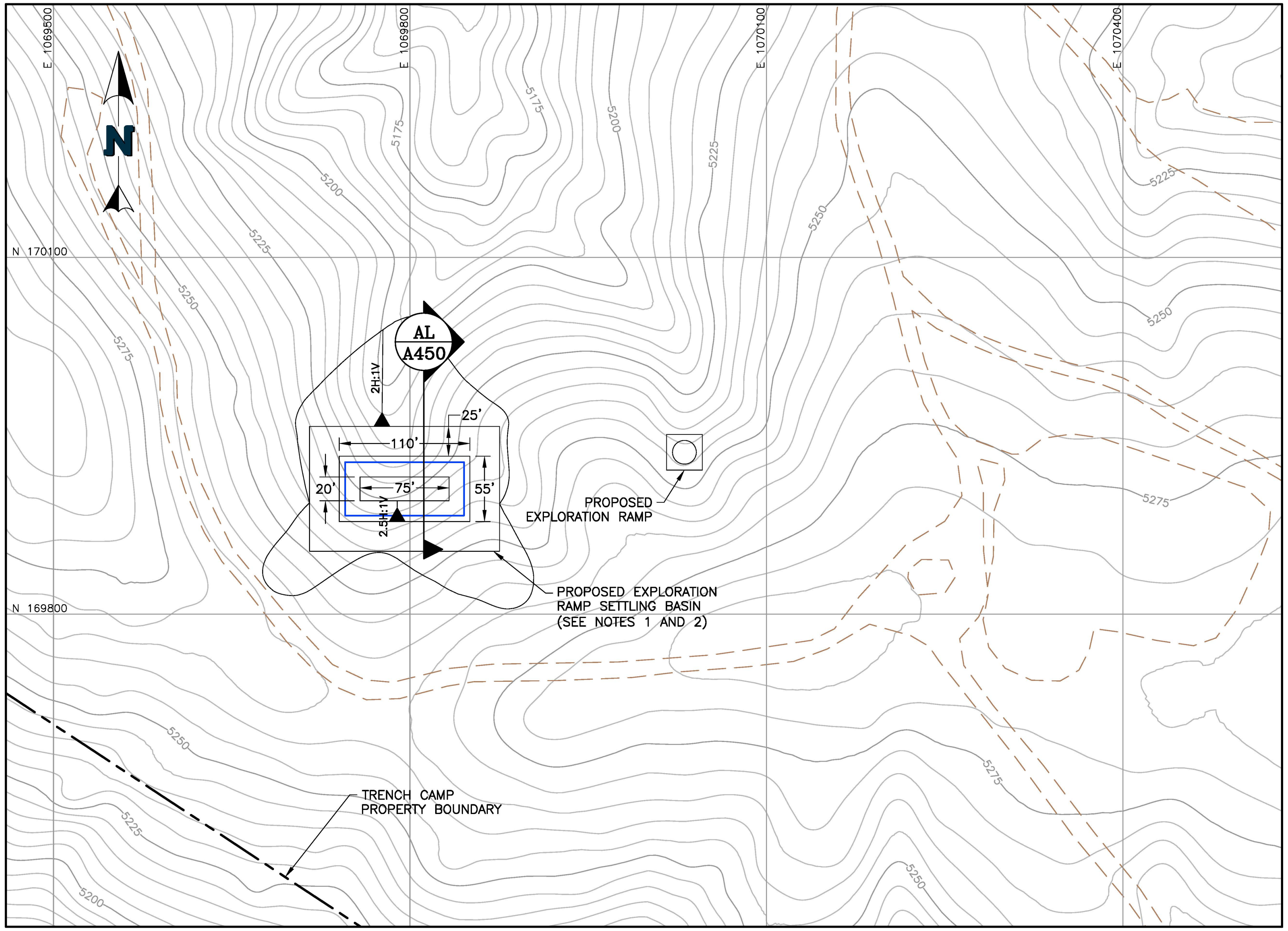
CLIENT: ARIZONA MINERALS INC

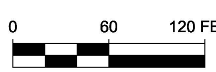
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 3 OF 3)

FILENAME: 14.008.077D
DRAWING NO.: A430
REVISION: 0

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\DWGS\14.008.077D.dwg-5/31/2017 9:48 AM



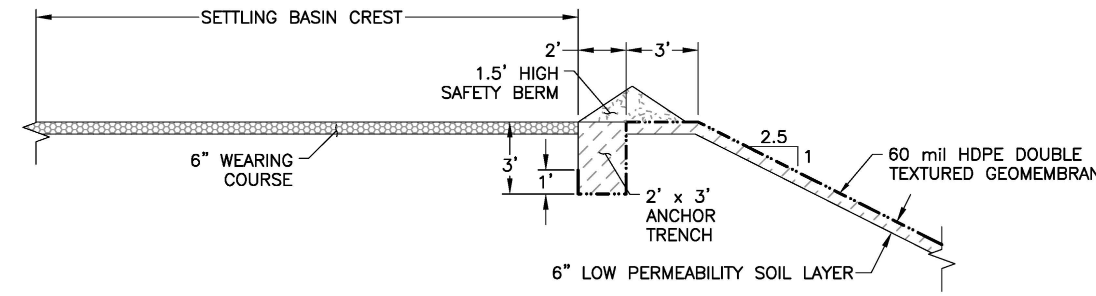


LEGEND:

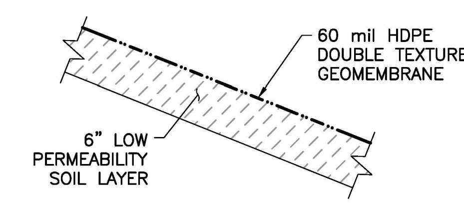
- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROPERTY BOUNDARY

NOTES:

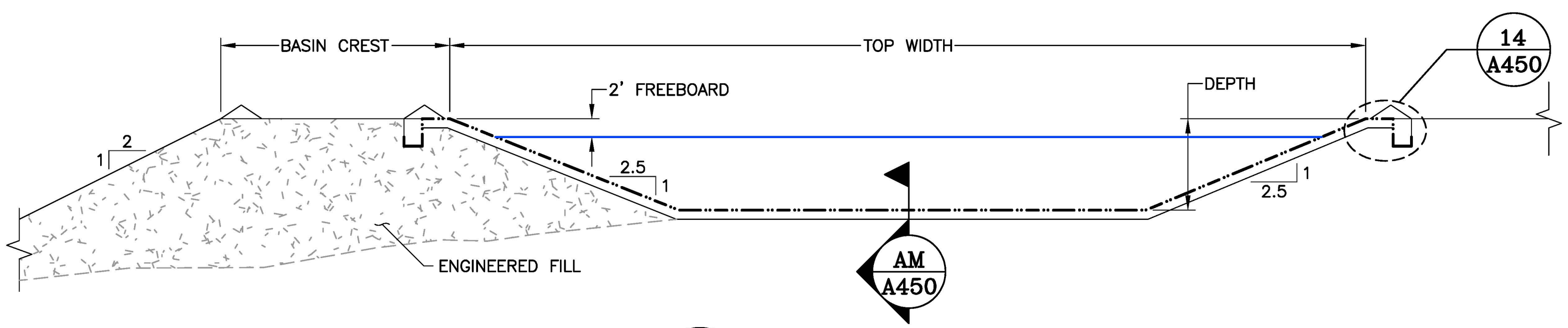
1. EXPLORATION RAMP SETTLING BASIN TO BE SIZED BASED ON EXPLORATION DECLINE DEVELOPMENT AND TO BE DESIGNED BASED ON BADCT NON–STORM WATER PONDS REQUIREMENTS.
2. EXPLORATION RAMP SETTLING BASIN WATER TO BE PUMPED TO THE UNDERDRAIN COLLECTION POND.



14 / A450 **TYPICAL CREST DETAIL**



AM / A450 **TYPICAL LINER DETAIL**



AL / A450 **EXPLORATION RAMP SETTLING BASIN**

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: PROPOSED EXPLORATION RAMP SETTLING BASIN

FILENAME: 14.008.074M

DRAWING NO.: A450

REVISION: 0

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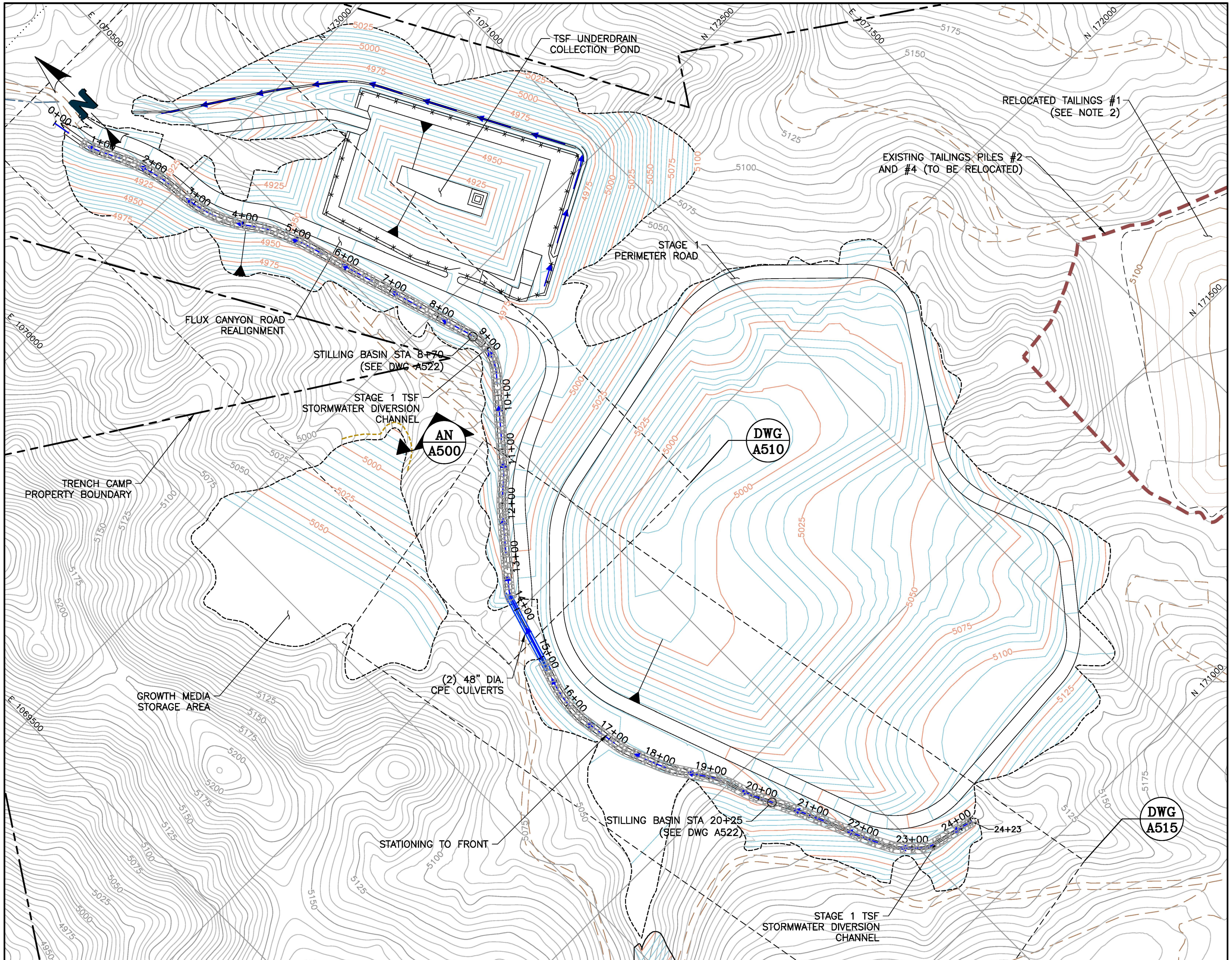
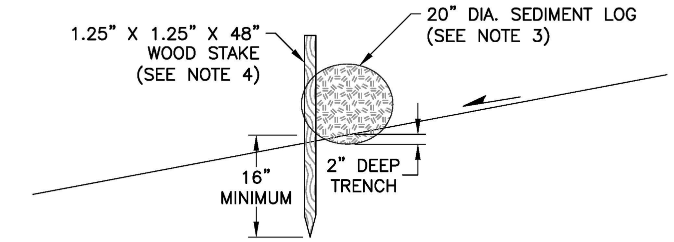


LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED CONTOURS
- TAILINGS STACKING CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- EXISTING TAILINGS PILE LIMITS
- DIVERSION CHANNEL FLOW DIRECTION
- PROPOSED FENCE
- SEDIMENT LOG

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWING A120 FOR THE STAGE 1 GEOMEMBRANE LIMITS.
2. EXISTING TAILINGS FROM PILE #1 RELOCATED TO THE TOP OF EXISTING TAILINGS PILE #2/#4.
3. SEDIMENT LOGS SHALL BE AMERICAN EXCELSIOR CURLEX SEDIMENT LOG TYPE I, OR APPROVED EQUAL.
4. THE SEDIMENT LOGS SHALL BE SECURED TO THE SUBGRADE BY WOOD STAKES EVERY TWO LINEAL FEET ACROSS THE LENGTH OF THE SEDIMENT LOG. THE STAKES SHALL BE INTERTWINED WITH THE OUTER MESH OF THE SEDIMENT LOG ONLY AND DRIVEN INTO THE GROUND A MINIMUM OF 16 INCHES ON THE DOWNSTREAM SIDE OF THE SEDIMENT LOG.



AN A500 SEDIMENT LOG DETAIL

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

0 100 200 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER

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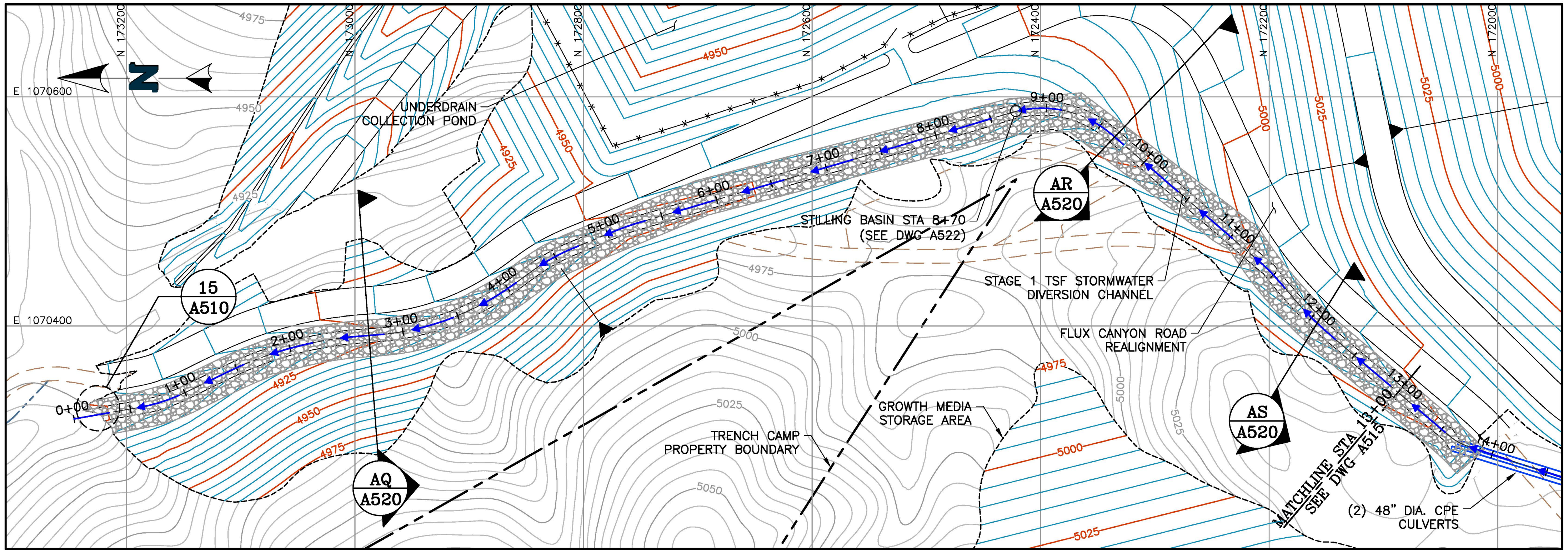
CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: SURFACE WATER MANAGEMENT PLAN VIEW STAGE 1

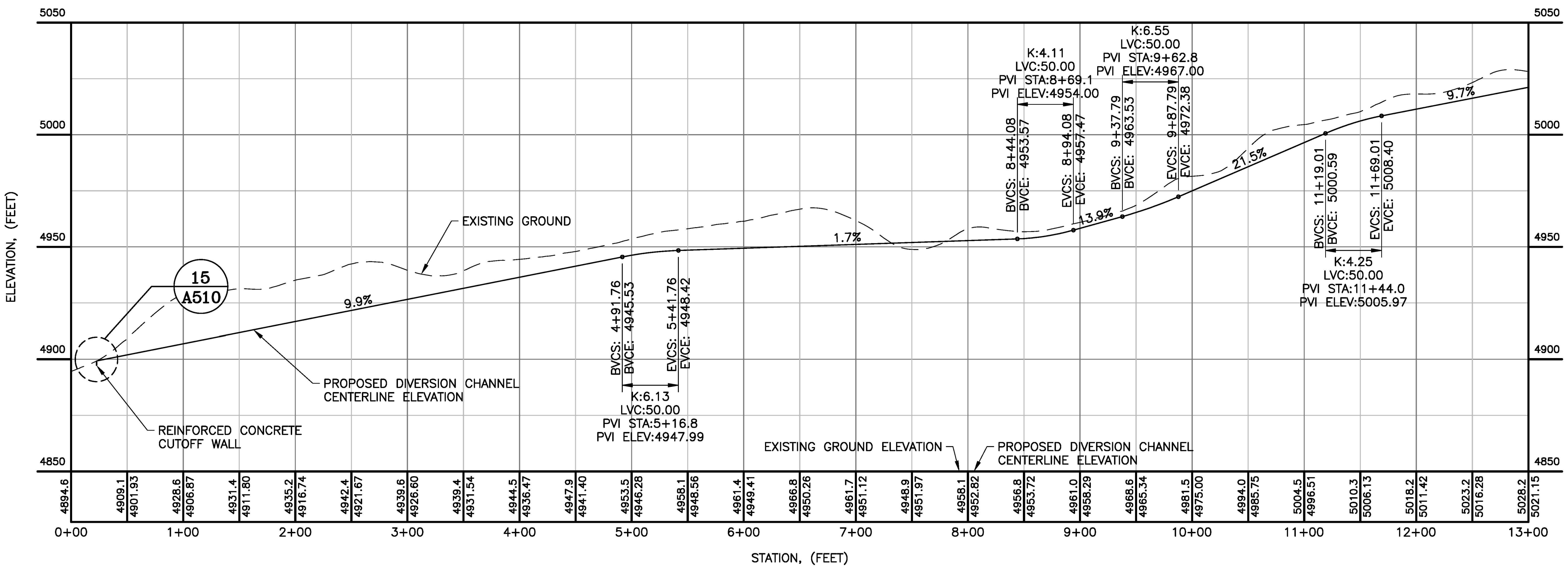
FILENAME: 14.008.036M
DRAWING NO.: A500
REVISION: 0

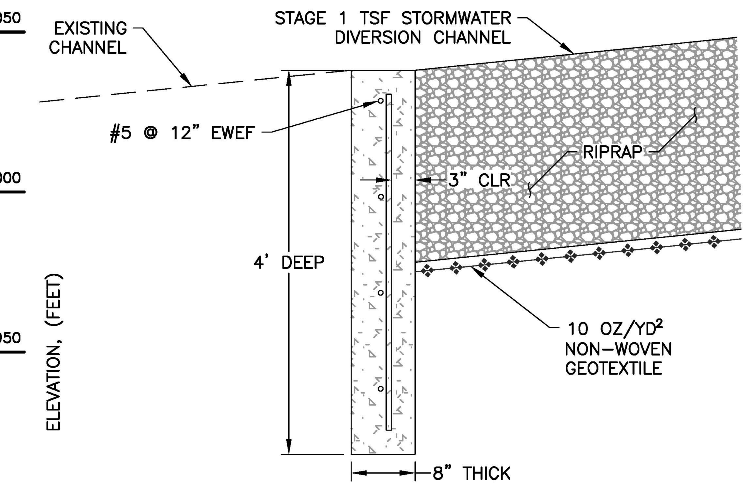
P:\Projects\0014.008 hermosa underground trench camp tsf\A-CAD\DWGS\14.008.036M.dwg-6/1/2017 9:44 AM



STAGE 1 TSF STORMWATER DIVERSION CHANNEL ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D-M-S)	LENGTH (FT)	RADIUS (FT)
PT	0+00.00	173,245.76	1,070,318.71			
PC	0+58.67	173,187.99	1,070,328.98	015-47-30	41.34	150.00
PT	1+00.01	173,148.79	1,070,341.69			
PC	1+42.79	173,110.30	1,070,360.35	021-34-32	118.81	315.50
PT	2+61.60	172,996.26	1,070,391.07			
PC	2+76.76	172,981.14	1,070,392.21	031-56-07	130.70	234.50
PT	4+07.46	172,860.10	1,070,436.88			
PC	4+25.19	172,845.80	1,070,447.35	013-46-49	40.77	169.50
PT	4+65.95	172,810.35	1,070,467.27			
PC	5+08.09	172,771.40	1,070,483.36	006-01-25	17.82	169.50
PT	5+25.91	172,754.60	1,070,489.29			
PC	8+68.90	172,425.61	1,070,586.24	057-09-16	93.77	94.00
PT	9+62.67	172,337.69	1,070,567.31			
PC	11+35.43	172,206.78	1,070,454.57	008-35-34	20.01	133.44
PT	11+55.44	172,192.65	1,070,440.43			
PC	11+75.42	172,179.63	1,070,425.28	009-06-25	50.15	315.50
PT	12+25.56	172,144.07	1,070,390.00			





15 A510 REINFORCED CONCRETE CUTOFF WALL

0 60 120 FEET HORIZONTAL
0 30 60 FEET VERTICAL
2X EXAGGERATION

LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED TSF CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- DIVERSION CHANNEL FLOW DIRECTION
- RIPRAP
- PROPOSED FENCE

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

NOTES:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWING A120 FOR THE STAGE 1 GEOMEMBRANE LIMITS.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER
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NewFields

CLIENT: ARIZONA MINERALS INC
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE
TITLE: STAGE 1 TSF STORMWATER DIVERSION CHANNEL PLAN AND PROFILE (SHEET 1 OF 2)
FILENAME: 14.008.038P
DRAWING NO.: A510
REVISION: 0

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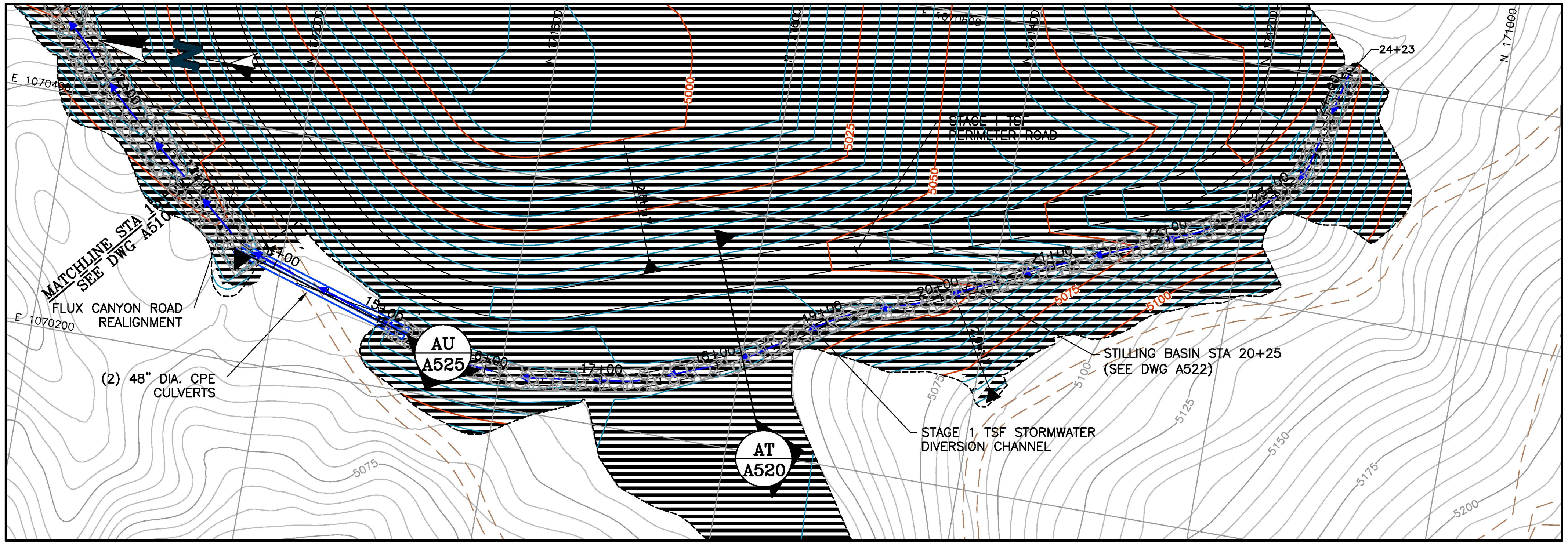
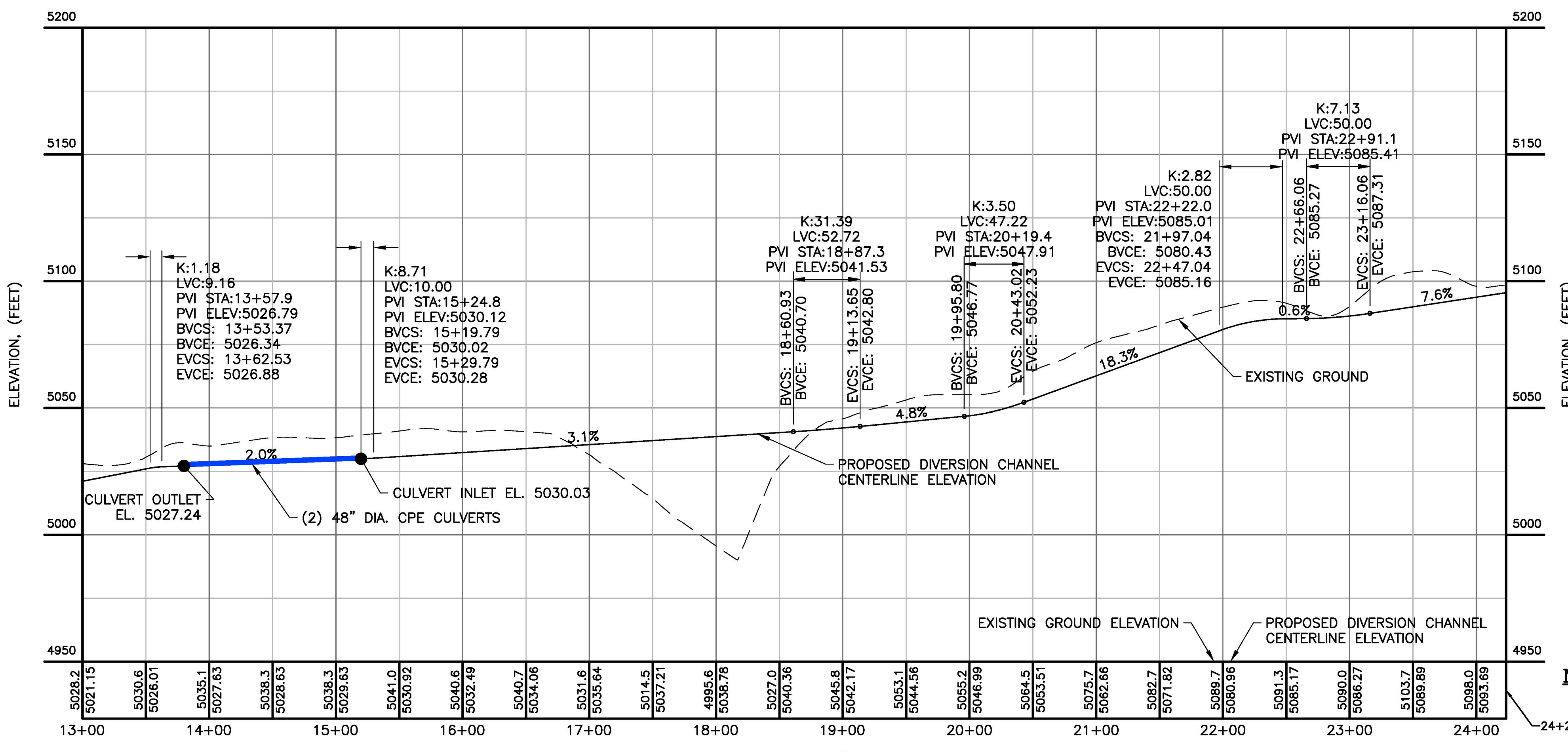


LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED TSF CONTOURS
- EXISTING ROADS/TRAILS
- DIVERSION CHANNEL FLOW DIRECTION
- RIPRAP

STAGE 1 TSF STORMWATER DIVERSION CHANNEL ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D-M-S)	LENGTH (FT)	RADIUS (FT)
PC	13+58.92	172,042.25	1,070,303.89	021-56-30	19.15	50.00
PT	13+78.07	172,025.64	1,070,294.59			
PC	15+52.22	171,860.27	1,070,239.97	015-37-00	54.51	200.00
PT	16+06.73	171,806.83	1,070,230.09			
PC	16+27.90	171,785.69	1,070,229.11	010-47-46	9.42	50.00
PT	16+37.32	171,776.29	1,070,229.56			
PC	17+17.64	171,696.79	1,070,240.93	013-30-00	27.23	115.57
PT	17+44.87	171,670.53	1,070,247.90			
PC	18+00.92	171,618.42	1,070,268.57	012-19-34	40.92	190.22
PT	18+41.85	171,582.29	1,070,287.62			
PC	18+92.35	171,540.40	1,070,315.83	018-19-23	63.96	200.00
PT	19+56.31	171,482.59	1,070,342.54			
PC	19+62.05	171,477.06	1,070,344.09	010-49-19	37.78	200.00
PT	19+99.82	171,441.86	1,070,357.64			
PC	20+82.63	171,367.73	1,070,394.53	003-34-39	3.12	50.00
PT	20+85.75	171,364.89	1,070,395.84			
PC	22+21.06	171,240.23	1,070,448.45	005-04-46	8.45	95.32
PT	22+29.51	171,232.60	1,070,452.08			
PC	22+62.53	171,203.43	1,070,467.56	016-22-07	14.28	50.00
PT	22+76.82	171,191.94	1,070,475.96			
PC	23+13.45	171,165.73	1,070,501.55	031-58-57	27.91	50.00
PT	23+41.36	171,152.09	1,070,525.49			
EP	24+23.44	171,132.67	1,070,605.24			



NOTE:

1. PROPOSED CONTOURS REPRESENT TOP OF LOW PERMEABILITY SOIL LAYER WITHIN THE GEOMEMBRANE LINED AREA AND FINISHED GRADE EVERYWHERE ELSE. SEE DRAWING A120 FOR THE STAGE 1 GEOMEMBRANE LIMITS.

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DRAWN BY: JEA

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NewFields

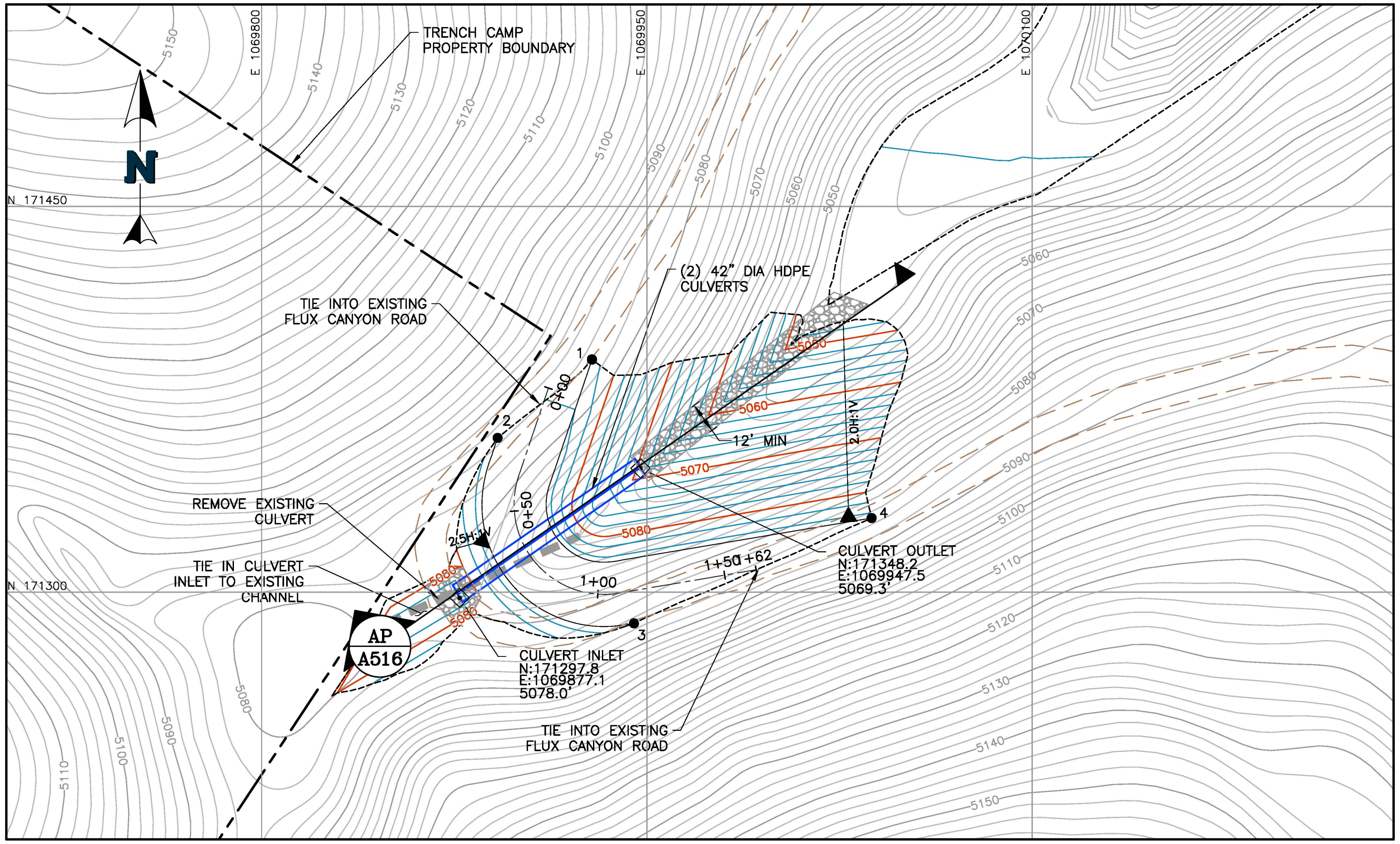
CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 TSF STORMWATER DIVERSION CHANNEL PLAN AND PROFILE (SHEET 2 OF 2)

FILENAME: 14.008.053P
DRAWING NO.: A515
REVISION: 0

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\DWGS\14.008.053P.dwg-5/31/2017 9:55 AM



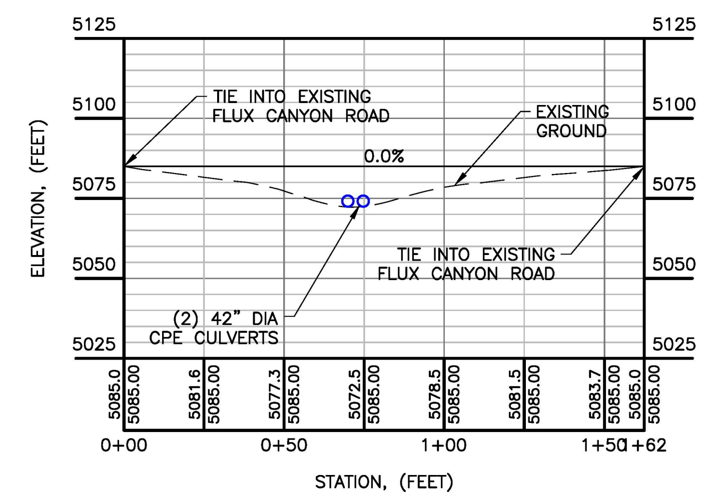
0 30 60 FEET

LEGEND:

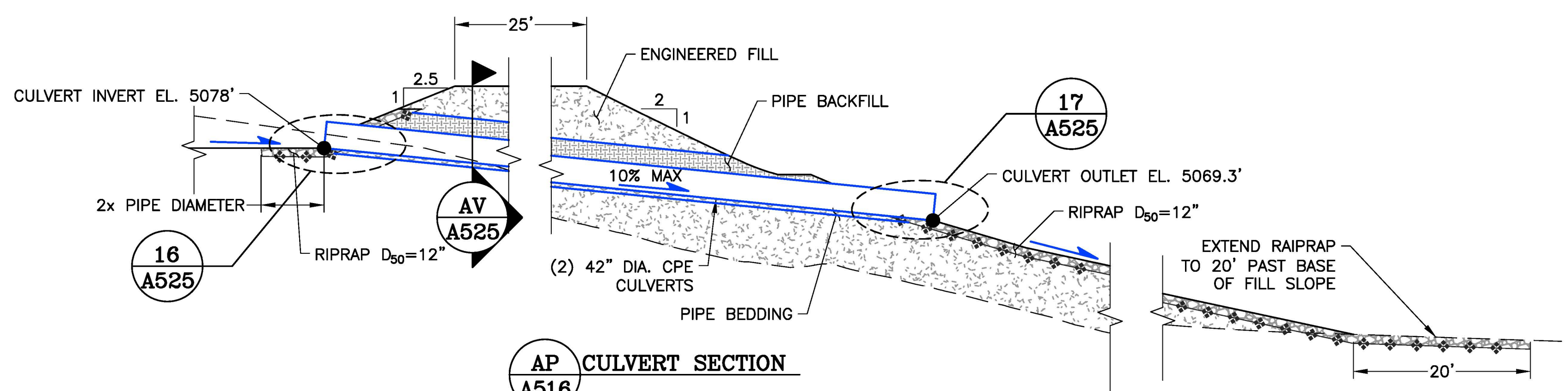
- EXISTING GROUND CONTOURS
- PROPOSED GROUND CONTOURS
- EXISTING ROADS/TRAILS
- PROJECT BOUNDARY
- RIPRAP

SETTING OUT DATA

POINT	NORTHING	EASTING	ELEVATION
1	171,390.49	1,069,928.60	5,083.18
2	171,360.03	1,069,891.89	5,084.81
3	171,287.85	1,069,944.97	5,084.96
4	171,328.85	1,070,037.49	5,085.00



0 30 60 FEET HORIZONTAL
0 30 60 FEET VERTICAL
NO EXAGGERATION



AP A516 CULVERT SECTION

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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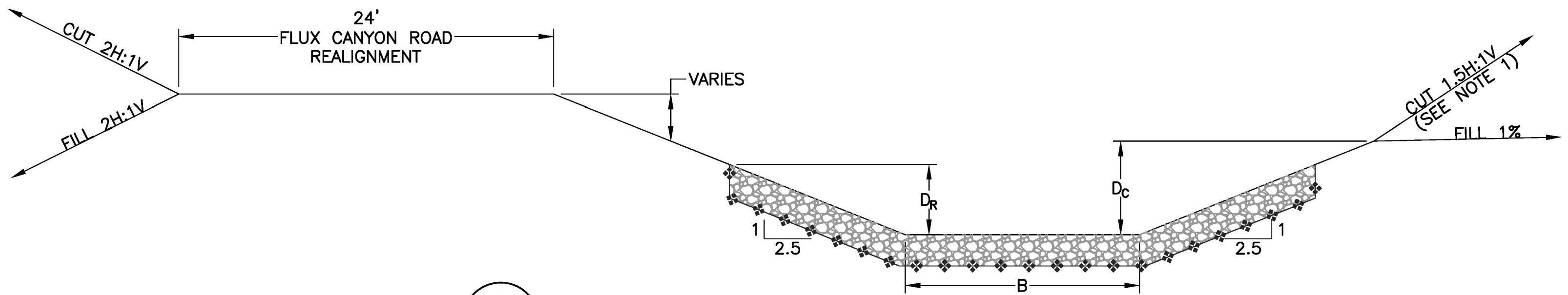
CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

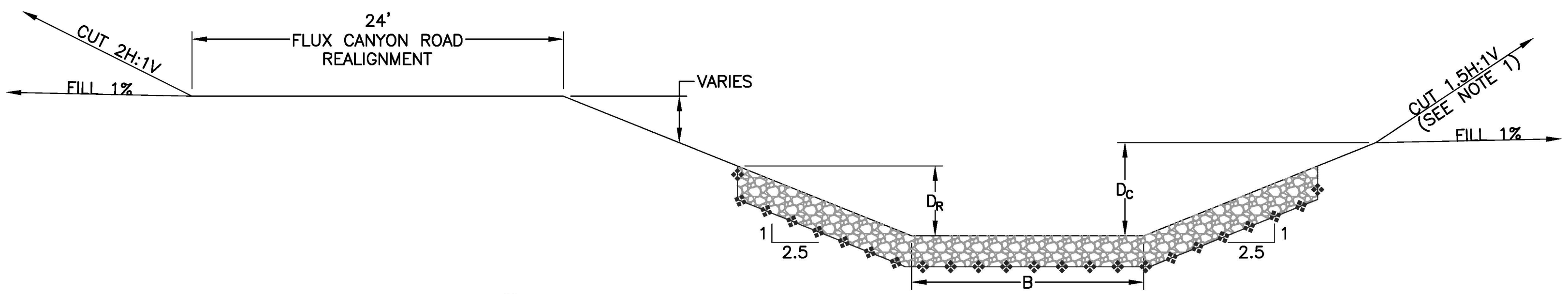
TITLE: FLUX CANYON ROAD CULVERT

FILENAME: 14.008.056M
DRAWING NO.: A516
REVISION: 0

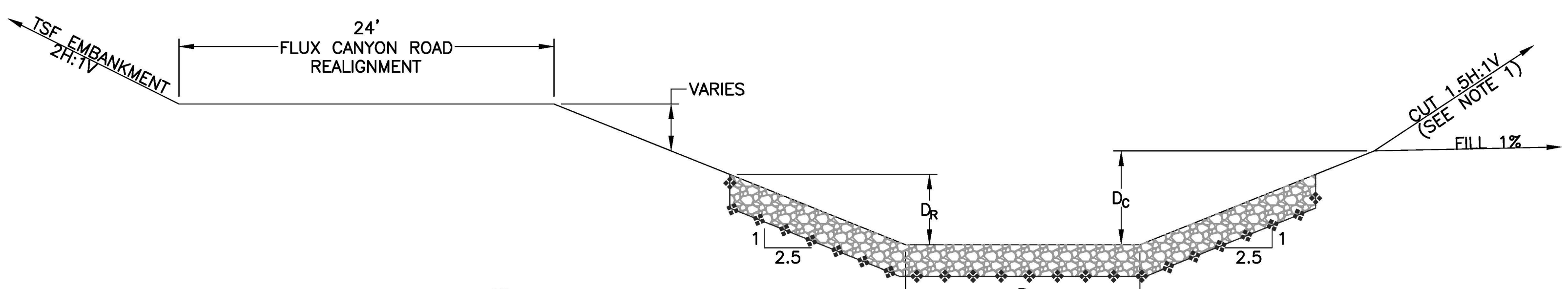
P:\Projects\0014.008 hermosa underground trench camp tsf\A-CAD\DWGS\14.008.056M.dwg-6/1/2017 9:43 AM



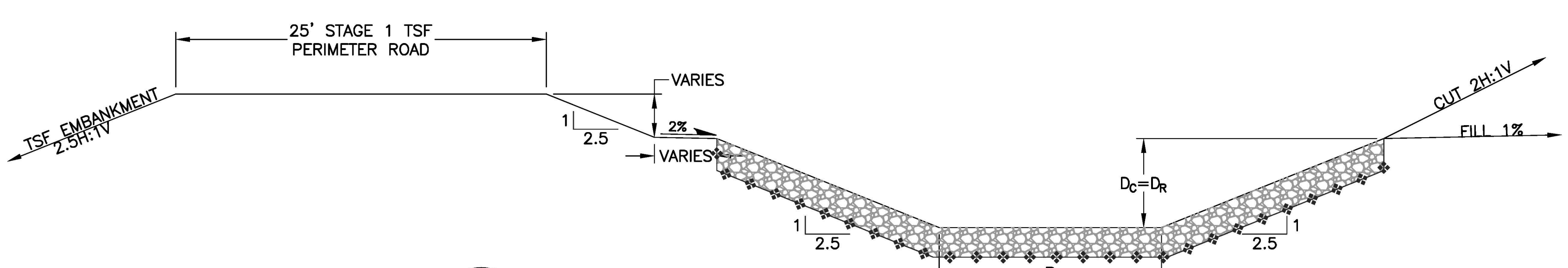
AQ / A510 TYPICAL DIVERSION CHANNEL SECTION
STATION 0+00 – 9+00



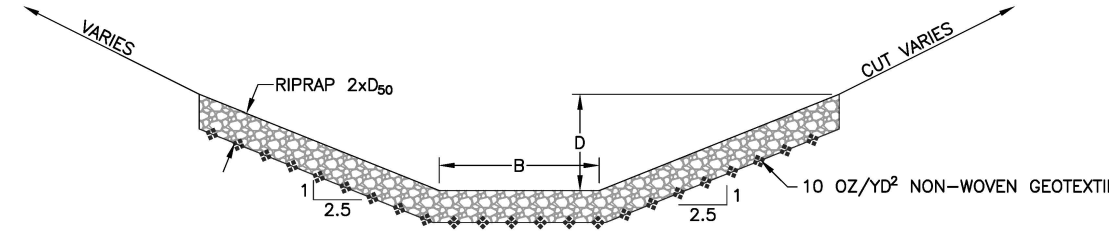
AR / A510 TYPICAL DIVERSION CHANNEL SECTION
STATION 9+00 – 9+75



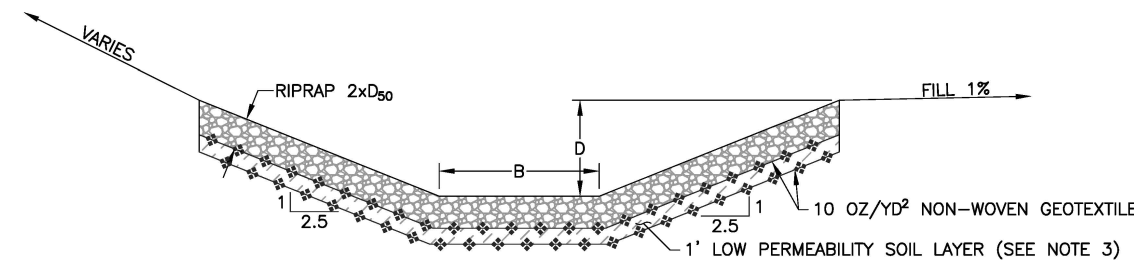
AS / A510 TYPICAL DIVERSION CHANNEL SECTION
STATION 9+75 – 13+80



AT / A515 TYPICAL DIVERSION CHANNEL SECTION
STATION 15+20 – 24+23



TYPICAL DIVERSION CHANNEL RIPRAP SECTION – CUT



TYPICAL DIVERSION CHANNEL RIPRAP SECTION – FILL

STAGE 1 TSF STORMWATER DIVERSION CHANNEL

STATION	B (ft)	D_R (RIPRAP DEPTH,ft)	D_C (CHANNEL DEPTH,ft)	EROSION PROTECTION*	RIPRAP SIZE (in,D_{50})
0+00 – 5+17	12	4	5	RIPRAP	24.00
5+17 – 8+69	12	4.25	5	RIPRAP	9.00
8+69 – 9+62	12	4	5	GROUTED RIPRAP (SEE NOTE 4)	18.00
9+62 – 11+44	12	4	5	GROUTED RIPRAP (SEE NOTE 4)	18.00
11+44 – 13+80	12	4	5	RIPRAP	24.00
13+80 – 15+20	(2) 48" DIA. CPe CULVERTS				
15+20 – 18+55	12	4	4	RIPRAP	9.00
18+55 – 20+19	5	3	3	RIPRAP	12.00
20+19 – 22+22	5	3	3	RIPRAP	24.00
22+22 – END	5	3	3	RIPRAP	12.00

* IF DIVERSION CHANNEL IS EXCAVATED IN COMPETENT BEDROCK, NO SLOPE PROTECTION IS NEEDED. IF COMPETENT BEDROCK IS NOT ENCOUNTERED, RIPRAP AND GEOTEXTILE ARE REQUIRED WITH THE SIZES AS NOTED.

NOTES:

1. CUT SLOPES MAY VARY SUBJECT TO ENGINEERS APPROVAL BASED ON ACTUAL FIELD CONDITIONS.
2. DIVERSION CHANNELS SIZED TO CONVEY FLOWS FROM THE 100 YR / 24 HR EVENT AND MAINTAIN 1 FT OF FREEBOARD.
3. GCL MAY BE USED AS AN APPROVED EQUIVALENT IN THE DIVERSION CHANNEL IF THE SUBSEQUENT GEOTECHNICAL INVESTIGATION RESULTS REVEAL INSUFFICIENT LOW PERMEABILITY SOIL QUANTITY LOCATED ON THE TRENCH CAMP SITE.
4. RIPRAP TO BE GROUTED TO 2/3 OF THE RIPRAP THICKNESS.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

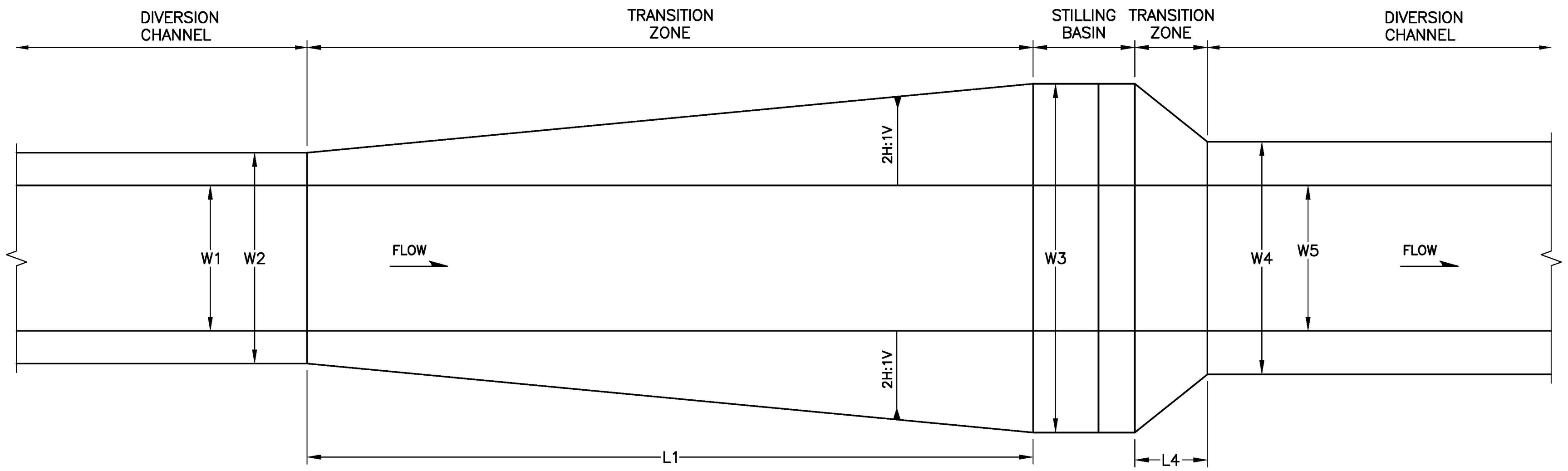
NewFields

CLIENT: ARIZONA MINERALS INC

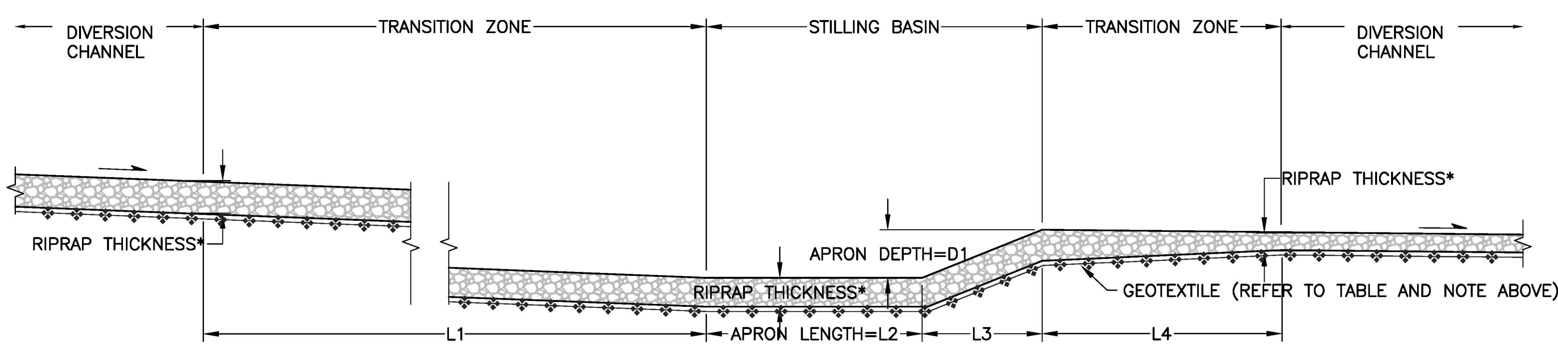
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STORMWATER DIVERSION CHANNEL SECTIONS AND DETAILS (SHEET 1 OF 3)

FILENAME: 14.008.040D
DRAWING NO.: A520
REVISION: 0



STILLING BASIN PLAN VIEW



STILLING BASIN PROFILE VIEW

STAGE 1 TSF STORMWATER DIVERSION CHANNEL STILLING BASIN DIMENSIONS

STATION (FT)	20+25	8+70
BASIN SIDE SLOPES (xH:1V)	2.5	2.5
SLOPE OUT OF BASIN (xH:1V)	2.5	2.5
RIPRAP D_{50} (IN)*	12	18
RIPRAP THICKNESS (IN)*	24	36
D1 (FT)	1	1
W1 (FT)	5	12
W2 (FT)	10	22
W3 (FT)	20	42
W4 (FT)	5	12
W5 (FT)	10	30
L1 (FT)	24	46
L2 (FT)	12	21
L3 (FT)	2.5	2.5
L4 (FT)	5	5

* STILLING BASIN IS ASSUMED TO BE EXCAVATED IN COMPETENT BEDROCK. IF COMPETENT BEDROCK IS NOT ENCOUNTERED, RIPRAP AND GEOTEXTILE ARE REQUIRED WITH THE SIZES AS NOTED. GEOTEXTILE SHALL BE 10 OZ/YD^2 NON-WOVEN.

NOTE:

1. RIPRAP AND GEOTEXTILE MAY TERMINATE EITHER SIDE OF STILLING BASIN IF CHANNEL EXCAVATION INTERCEPTS COMPETENT BEDROCK.

UNDERDRAIN COLLECTION POND STORMWATER DIVERSION CHANNEL STILLING BASIN DIMENSIONS

STATION (FT)	10+91
BASIN SIDE SLOPES (xH:1V)	2.5
SLOPE OUT OF BASIN (xH:1V)	2.5
RIPRAP D_{50} (IN)*	15
RIPRAP THICKNESS (IN)*	30
D1 (FT)	2
W1 (FT)	3
W2 (FT)	16
W3 (FT)	30
W4 (FT)	–
W5 (FT)	–
L1 (FT)	36
L2 (FT)	16
L3 (FT)	5.0
L4 (FT)	–

* STILLING BASIN IS ASSUMED TO BE EXCAVATED IN COMPETENT BEDROCK. IF COMPETENT BEDROCK IS NOT ENCOUNTERED, RIPRAP AND GEOTEXTILE ARE REQUIRED WITH THE SIZES AS NOTED. GEOTEXTILE SHALL BE 10 OZ/YD^2 NON-WOVEN.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STORMWATER DIVERSION CHANNEL SECTIONS AND DETAILS (SHEET 2 OF 3)

FILENAME: 14.008.079D
DRAWING NO.: A522
REVISION: 0

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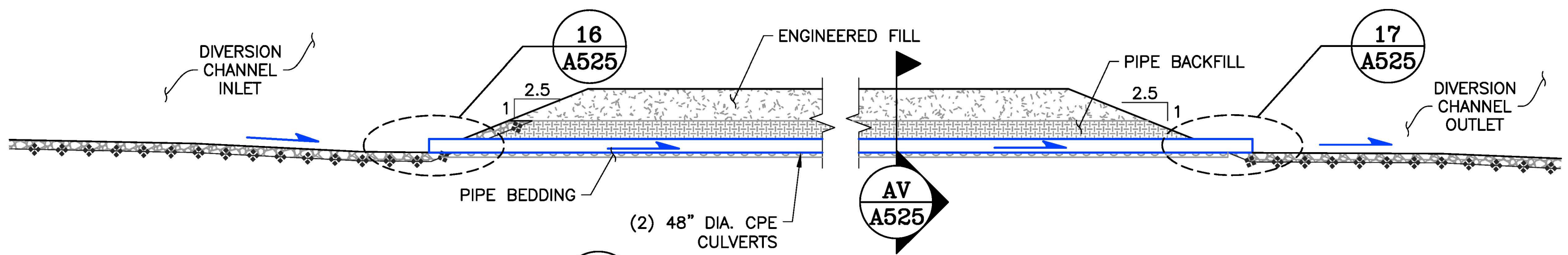
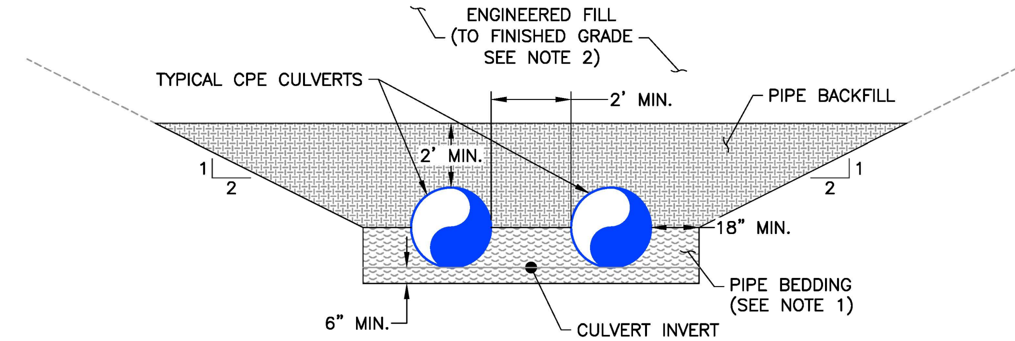
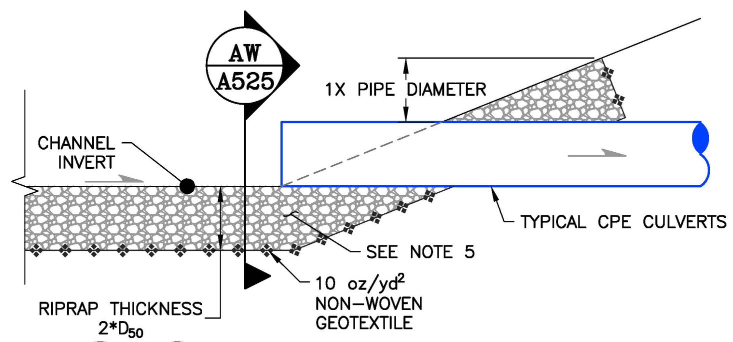


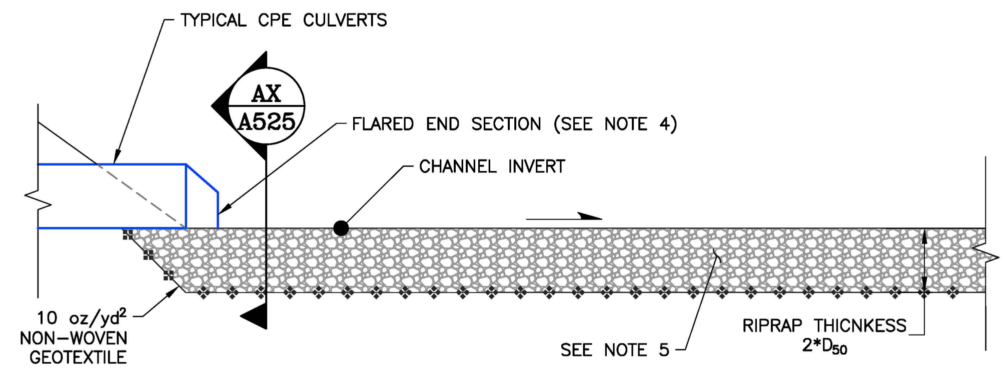
AU A515 TYPICAL CULVERT INLET AND OUTLET SECTION



AV A516 AV A525 AV A720 TYPICAL SECTION OF BURIED CULVERT



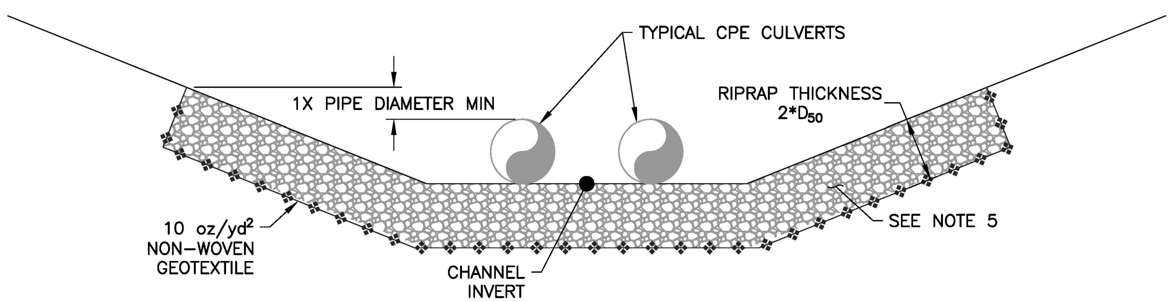
16 A516 16 A525 TYPICAL SECTION AT CULVERT INLET



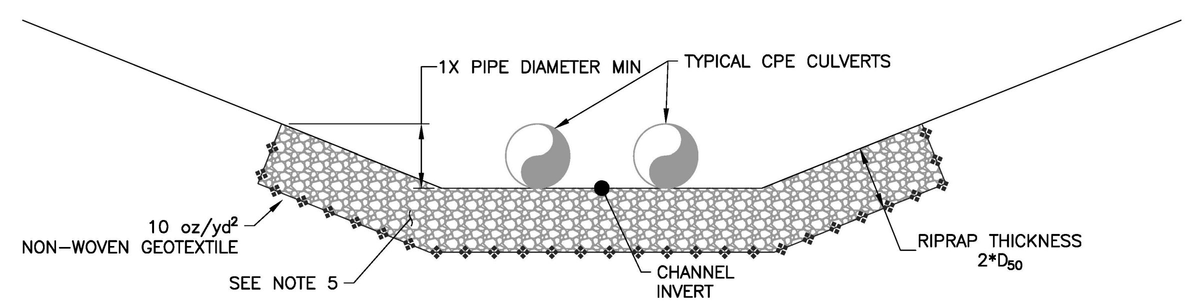
17 A516 17 A525 TYPICAL SECTION AT CULVERT OUTLET

NOTES:

1. BED PIPE BEDDING TO SPRING LINE OF PIPE WITH A MINIMUM OF 6" BENEATH PIPE.
2. MINIMUM COVER FOR CULVERTS, INCLUDING PIPE BACKFILL, IS 3' FOR ACCESS ROADS.
3. CULVERT CROSSINGS SIZED TO CONVEY FLOWS FROM THE 100 YR / 24 HR STORM EVENT.
4. PROVIDE JOINT FASTENERS FOR FLARED END SECTIONS.
5. SEE DRAWING A516 FOR D_{50} RIPRAP SIZES FOR FLUX CANYON ROAD CULVERT AND DRAWING A520 FOR STAGE 1 STORMWATER DIVERSION CHANNEL D_{50} RIPRAP SIZES.



AW A525 TYPICAL CULVERT INLET CHANNEL SECTION



AX A525 TYPICAL CULVERT OUTLET CHANNEL SECTION

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REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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DESIGNED BY: CMT
DRAWN BY: JEA

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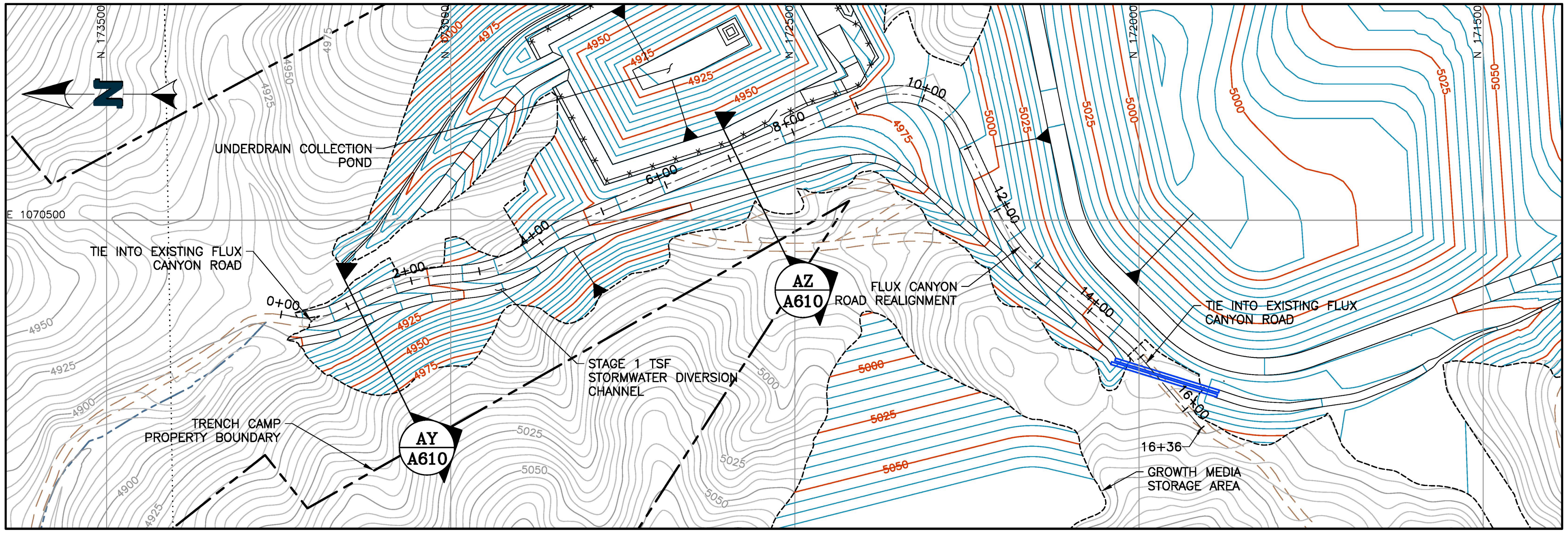
CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

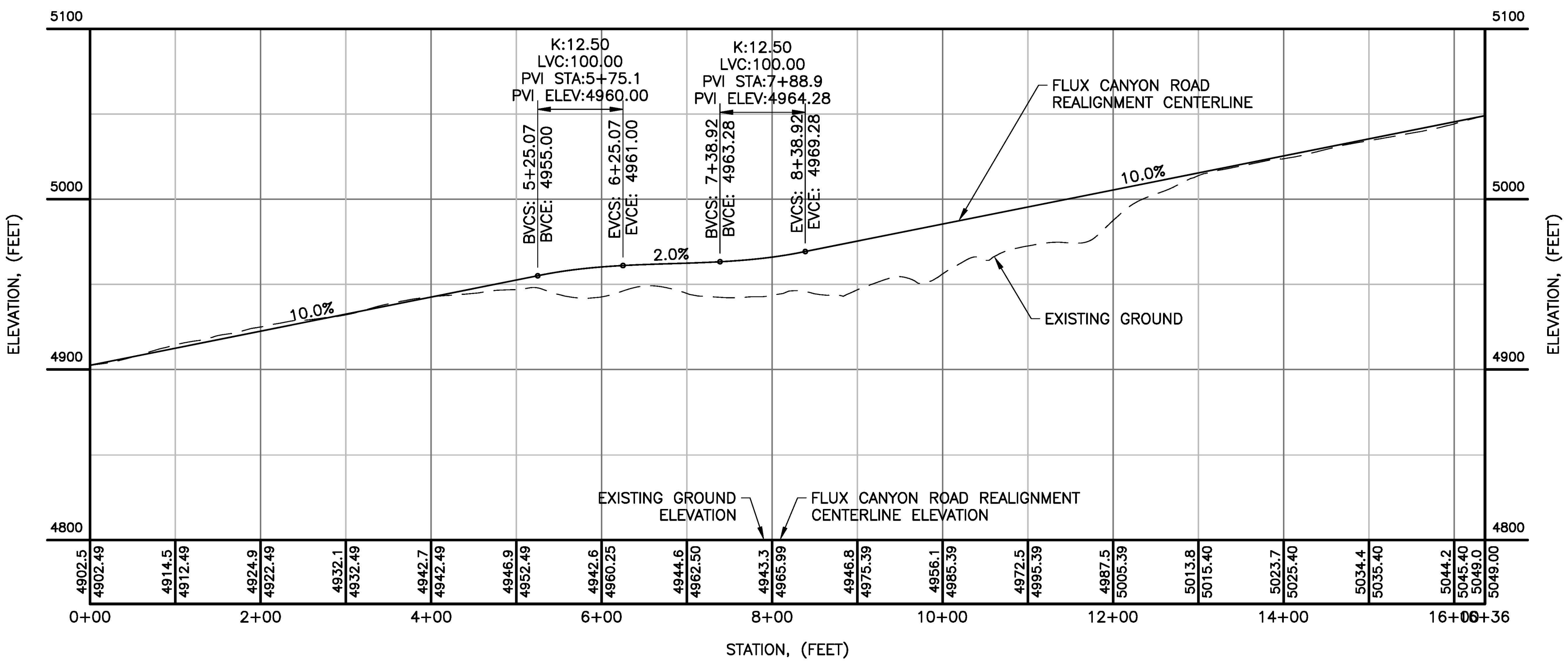
TITLE: STORMWATER DIVERSION CHANNEL SECTIONS AND DETAILS (SHEET 3 OF 3)

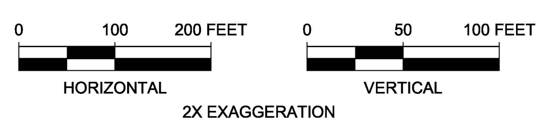
FILENAME: 14.008.041D
DRAWING NO.: A525
REVISION: 0



LEGEND:

- EXISTING GROUND CONTOURS
- PROPOSED TSF GROUND CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- PROPOSED FENCE





FLUX CANYON ROAD ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D–M–S)	LENGTH (FT)	RADIUS (FT)
PT	0+00.00	173,246.30	1,070,363.33			
PC	0+20.57	173,226.06	1,070,359.63	036–14–38	63.26	100.00
PT	0+83.83	173,164.42	1,070,368.01			
PC	1+28.43	173,124.29	1,070,387.46	021–34–32	131.80	350.00
PT	2+60.23	172,997.78	1,070,421.54			
PC	2+75.77	172,982.28	1,070,422.71	031–56–07	111.47	200.00
PT	3+87.25	172,879.04	1,070,460.80			
PC	4+06.19	172,863.76	1,070,472.00	013–43–54	47.93	200.00
PT	4+54.12	172,822.09	1,070,495.44			
PC	9+24.76	172,387.25	1,070,675.49	087–31–45	152.77	100.00
PT	10+77.53	172,258.33	1,070,625.30			
PC	11+80.16	172,215.02	1,070,532.27	024–49–01	151.60	350.00
PT	13+31.75	172,123.72	1,070,412.73			
PC	14+58.64	172,026.84	1,070,330.80	009–17–09	40.52	250.00
PT	14+99.15	171,998.15	1,070,302.25			
EP	16+35.93	171,909.33	1,070,198.24			

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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DESIGNED BY: CMT
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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: FLUX CANYON ROAD REALIGNMENT PLAN AND PROFILE

FILENAME: 14.008.042P

DRAWING NO.: A601

REVISION: 0

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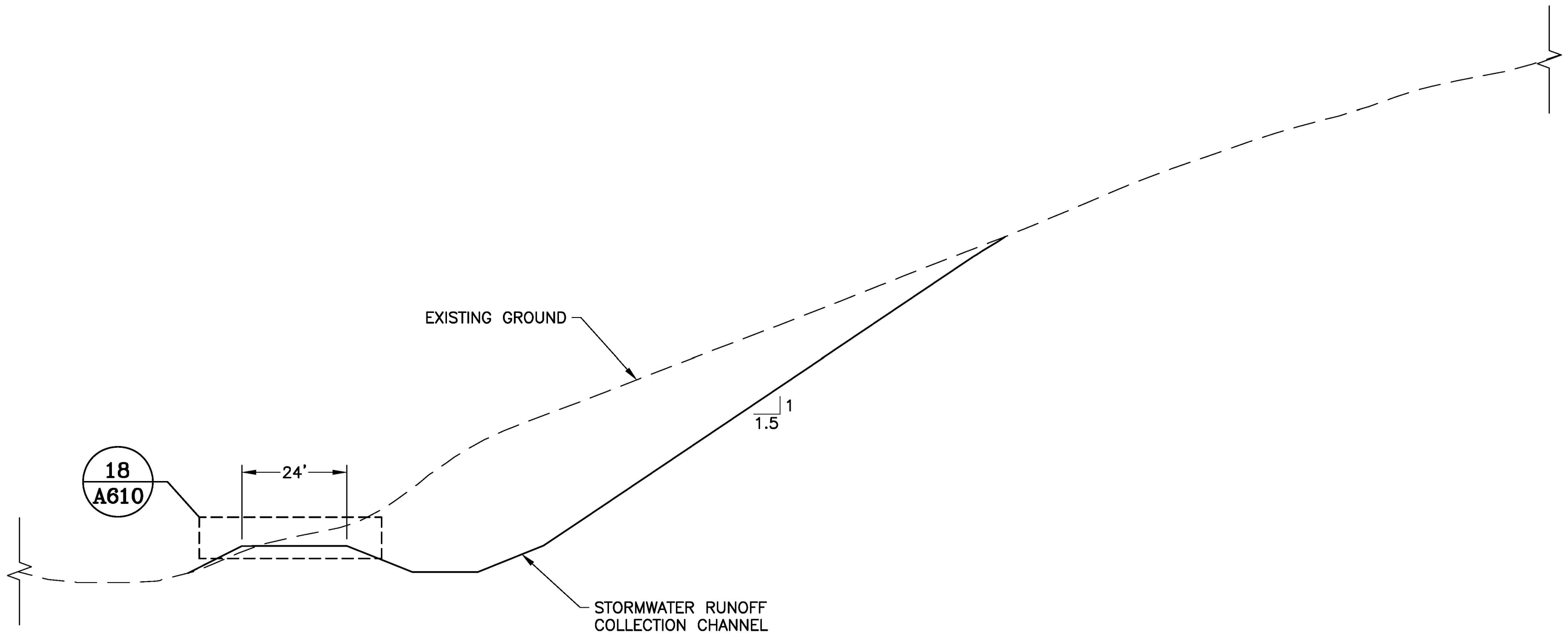
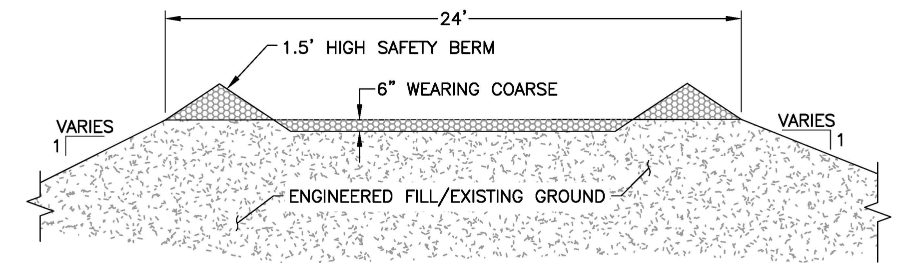


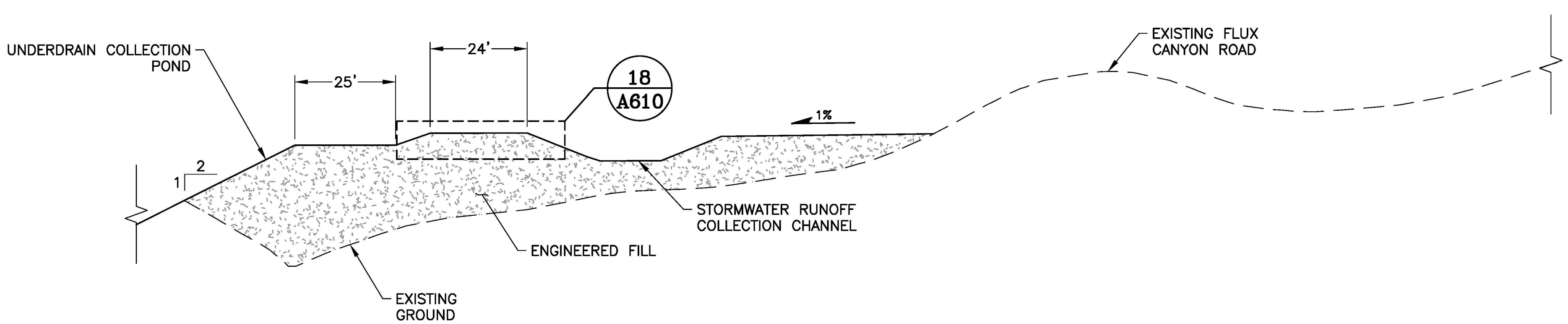
AY / A601 FLUX CANYON ROAD REALIGNMENT – CUT



18 / A610 FLUX CANYON ROAD TYPICAL SECTION

NOTE:

1. CUT SLOPES MAY VARY SUBJECT TO ENGINEERS APPROVAL BASED ON ACTUAL FIELD CONDITIONS.



AZ / A601 FLUX CANYON ROAD REALIGNMENT – FILL

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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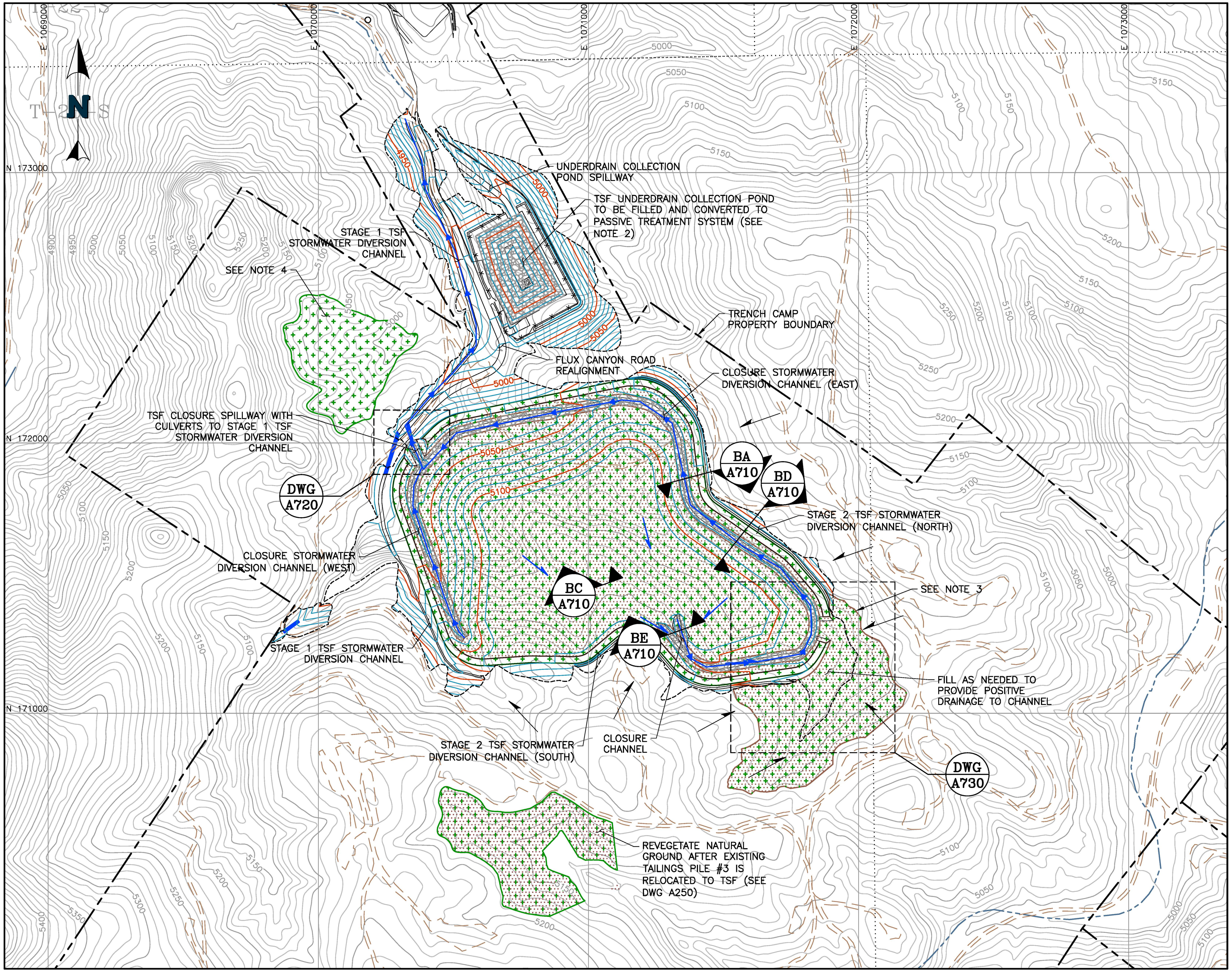
CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: FLUX CANYON ROAD REALIGNMENT SECTIONS AND DETAILS

FILENAME: 14.008.043D
DRAWING NO.: A610
REVISION: 0



LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- 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. GROWTH MEDIA AND REVEGETATION SHALL BE PLACED TO LIMITS OF RELOCATED EXISTING TAILINGS PILE #2/#4.
4. GROWTH MEDIA STORAGE AREA TO BE REVEGETATED AFTER GROWTH MEDIA IS MOVED TO TAILINGS STORAGE FACILITY.

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

0 200 400 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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DESIGNED BY: CMT
DRAWN BY: JEA

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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CONCEPTUAL CLOSURE PLAN VIEW

FILENAME: 14.008.045M

DRAWING NO.: A700 REVISION: 0

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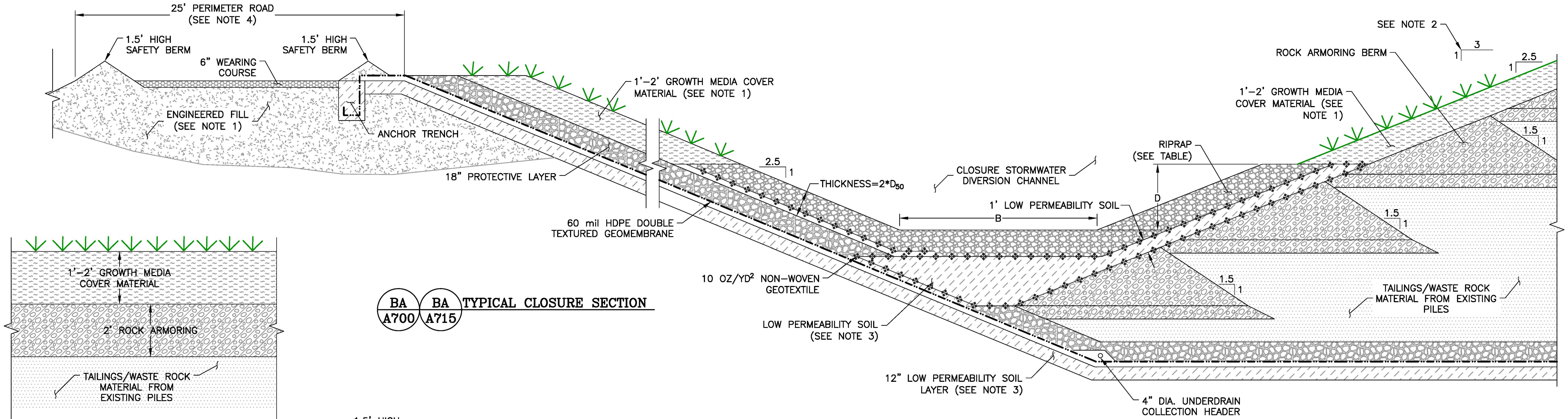
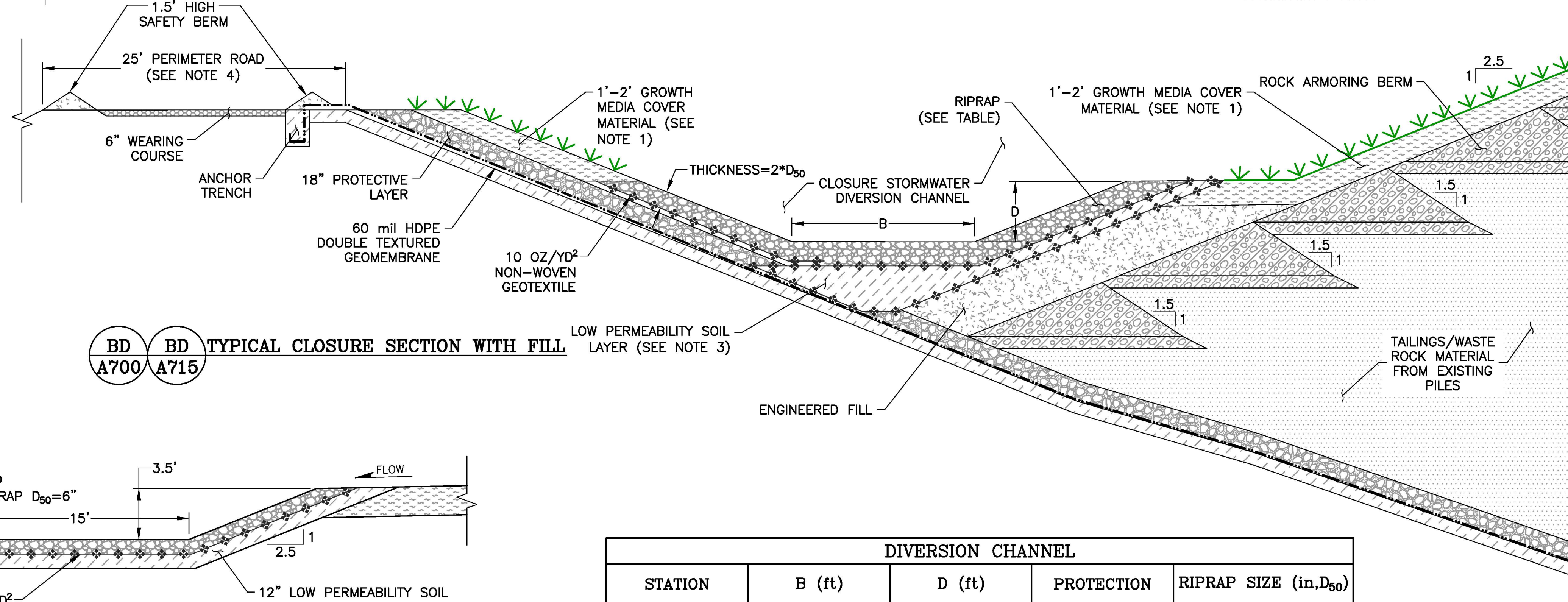
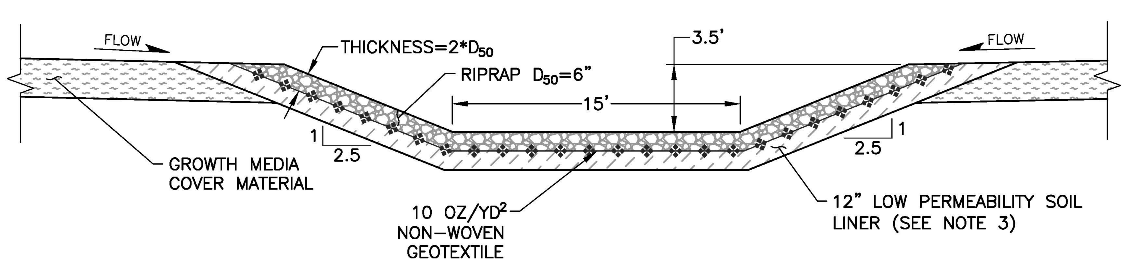


BA / A700 BA / A715 TYPICAL CLOSURE SECTION

BC / A700 BC / A715 CLOSURE SECTION



BD / A700 BD / A715 TYPICAL CLOSURE SECTION WITH FILL



BE / A700 BE / A715 CLOSURE CHANNEL

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 OR GCL 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.

DIVERSION CHANNEL

STATION	B (ft)	D (ft)	PROTECTION	RIPRAP SIZE (in,D_{50})
0+00 – 5+42	15	3.50	RIPRAP	12.00
5+42 – 18+74	15	4.50	RIPRAP	3.00
18+74 – 21+61	15	3.50	RIPRAP	18.00
21+61 – 26+81	15	4.50	RIPRAP	3.00
26+81 – 30+94	15	3.00	RIPRAP	6.00
30+94 – 33+07	15	3.00	RIPRAP	18.00
33+07 – END	15	3.00	RIPRAP	6.00

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CONCEPTUAL CLOSURE SECTIONS AND DETAILS

FILENAME: 14.008.046D

DRAWING NO.: A710

REVISION: 0

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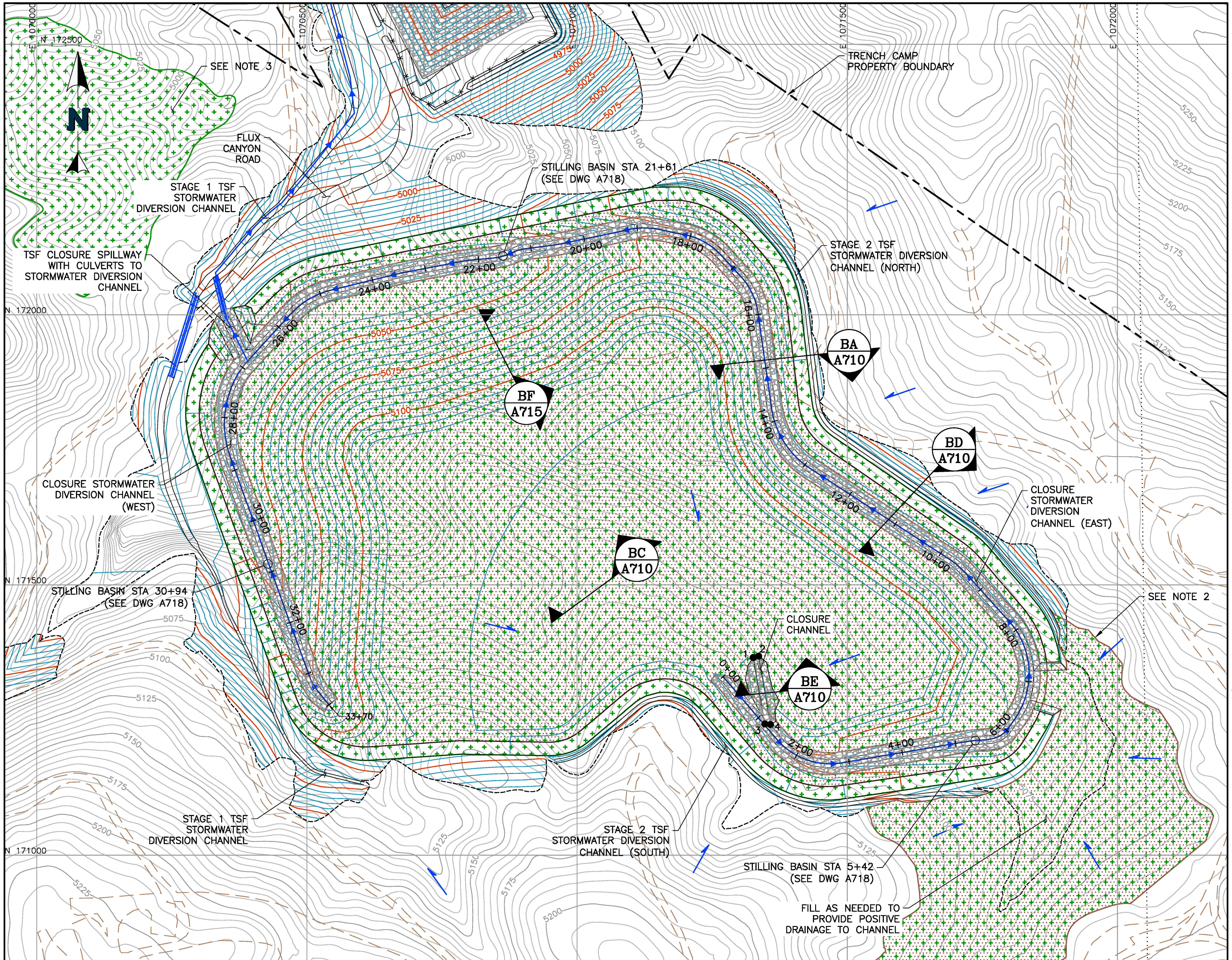


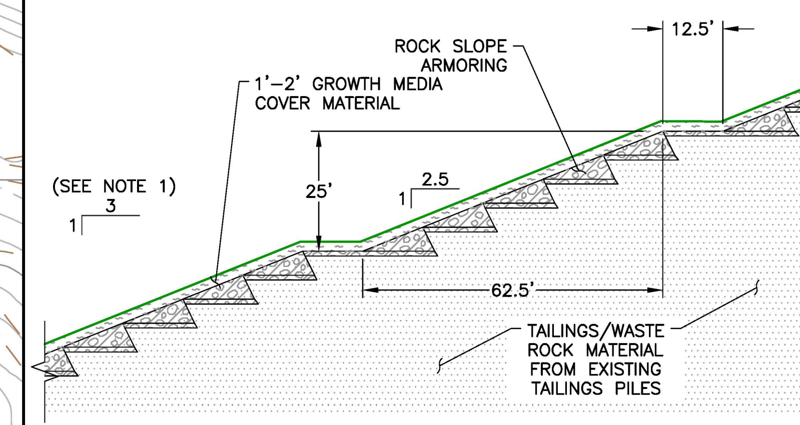
LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION

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. GROWTH MEDIA AND REVEGETATION SHALL BE PLACED TO LIMITS OF RELOCATED EXISTING TAILINGS PILE #2/#4.
3. GROWTH MEDIA STORAGE AREA TO BE REVEGETATED AFTER GROWTH MEDIA IS MOVED TO TAILINGS STORAGE FACILITY.

CLOSURE CHANNEL SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
1	171,365.47	1,071,325.99	5,110.00
2	171,367.94	1,071,335.84	5,110.00
3	171,242.81	1,071,347.44	5,103.75
4	171,241.81	1,071,357.76	5,103.73



BF A715 CLOSURE STACKING

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

0 100 200 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CLOSURE STORMWATER DIVERSION CHANNEL PLAN

FILENAME: 14.008.071P
DRAWING NO.: A715
REVISION: 0

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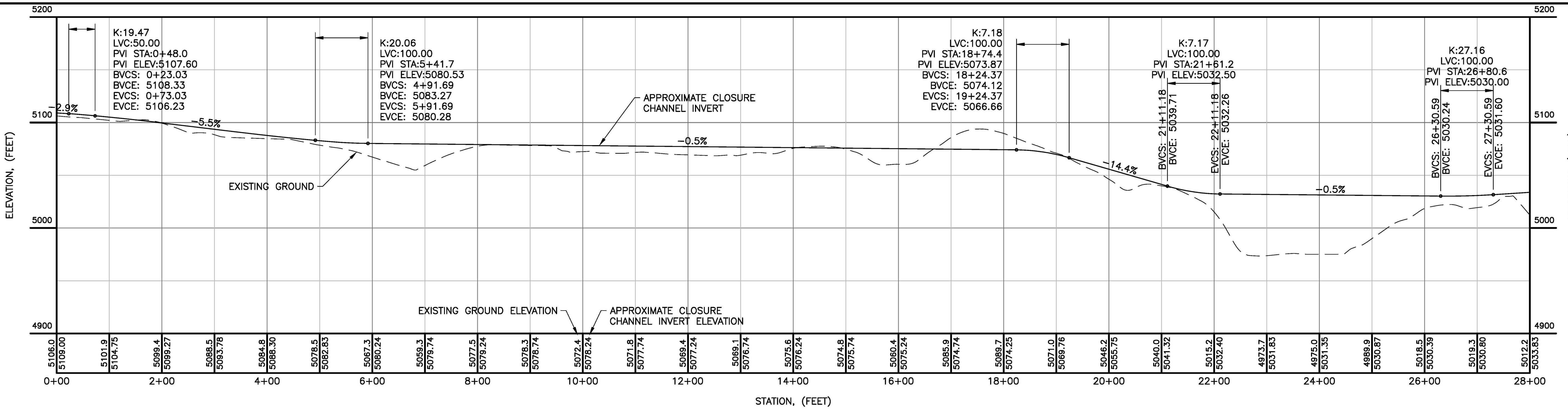
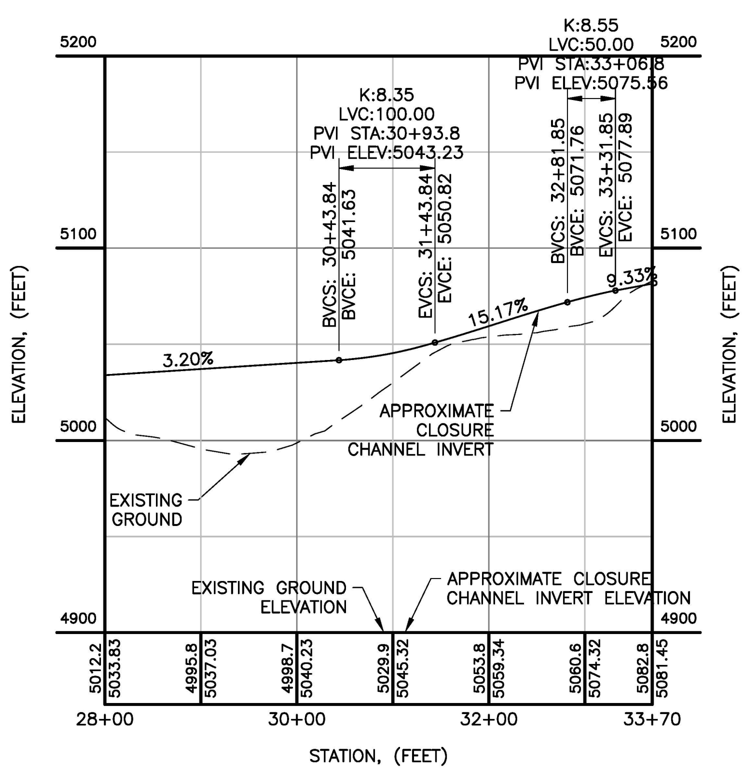


EAST CLOSURE STORMWATER DIVERSION CHANNEL PROFILE (STA 0+00 TO STA 26+80.6)

HORIZONTAL: 0 100 200 FEET — VERTICAL: 0 50 100 FEET

2X EXAGGERATION



WEST CLOSURE STORMWATER DIVERSION CHANNEL PROFILE (STA 26+80.6 TO STA 33+70)

HORIZONTAL: 0 100 200 FEET — VERTICAL: 0 50 100 FEET

2X EXAGGERATION

CLOSURE STORMWATER DIVERSION CHANNEL ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D-M-S)	LENGTH (FT)	RADIUS (FT)
PT	0+00.00	171,330.09	1,071,270.00			
PC	1+52.90	171,214.19	1,071,369.73	058-57-57	133.79	130.00
PT	2+86.69	171,170.83	1,071,490.13			
PC	5+21.26	171,210.27	1,071,721.36	004-16-34	7.46	100.00
PT	5+28.73	171,211.25	1,071,728.76			
PC	5+62.37	171,214.41	1,071,762.26	049-50-50	43.50	50.00
PT	6+05.87	171,235.69	1,071,798.64			
PC	6+26.91	171,252.98	1,071,810.63	076-51-18	194.50	145.00
PT	8+21.41	171,432.85	1,071,799.07			
PC	9+42.05	171,522.35	1,071,718.18	014-47-05	38.71	150.00
PT	9+80.75	171,547.42	1,071,688.83			
PC	12+88.70	171,715.64	1,071,430.89	048-44-56	136.13	160.00
PT	14+24.83	171,827.00	1,071,359.91			
PC	16+03.62	172,003.99	1,071,334.59	034-46-23	75.86	125.00
PT	16+79.48	172,071.40	1,071,302.40			
PC	17+32.44	172,110.18	1,071,266.34	035-33-47	77.59	125.00
PT	18+10.02	172,147.55	1,071,199.77			
PC	18+61.76	172,157.89	1,071,149.07	023-20-55	50.94	125.00
PT	19+12.70	172,157.75	1,071,098.48			
PC	20+46.23	172,130.39	1,070,967.79	004-35-55	12.04	150.00
PT	20+58.27	172,128.40	1,070,955.92			
PC	21+13.63	172,121.44	1,070,901.00	015-10-45	13.25	50.00

CLOSURE STORMWATER DIVERSION CHANNEL ALIGNMENT TABLE

	STATION	NORTHING	EASTING	DELTA (D-M-S)	LENGTH (FT)	RADIUS (FT)
PT	21+26.88	172,118.06	1,070,888.23			
PC	21+41.72	172,112.40	1,070,874.51	016-39-42	29.08	100.00
PT	21+70.80	172,105.36	1,070,846.40			
PC	22+19.43	172,100.49	1,070,798.01	005-07-56	8.96	100.00
PT	22+28.39	172,099.19	1,070,789.15			
PC	23+45.21	172,077.15	1,070,674.43	002-50-00	4.95	100.00
PT	23+50.15	172,076.10	1,070,669.60			
PC	24+78.53	172,045.67	1,070,544.87	033-48-30	88.51	150.00
PT	25+67.04	172,001.25	1,070,469.80			
PC	26+78.82	171,918.82	1,070,394.31	062-22-48	195.97	180.00
PT	28+74.79	171,736.00	1,070,357.81			
PC	33+04.87	171,331.59	1,070,504.18	018-20-31	32.01	100.00
PT	33+36.88	171,303.73	1,070,519.66			
EP	33+70.05	171,277.68	1,070,540.19			

Registered Professional Engineer (Civil) — CERTIFICATE NO. 63431 — CRAIG M. THOMPSON — Date Signed 6/5/17 — ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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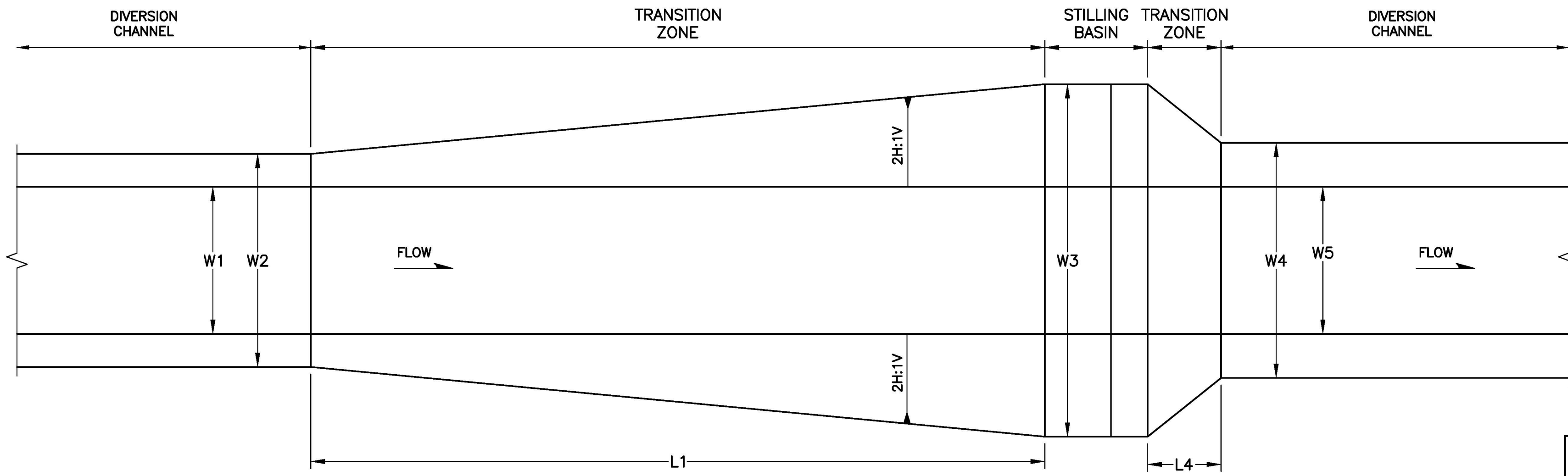
CLIENT: ARIZONA MINERALS INC

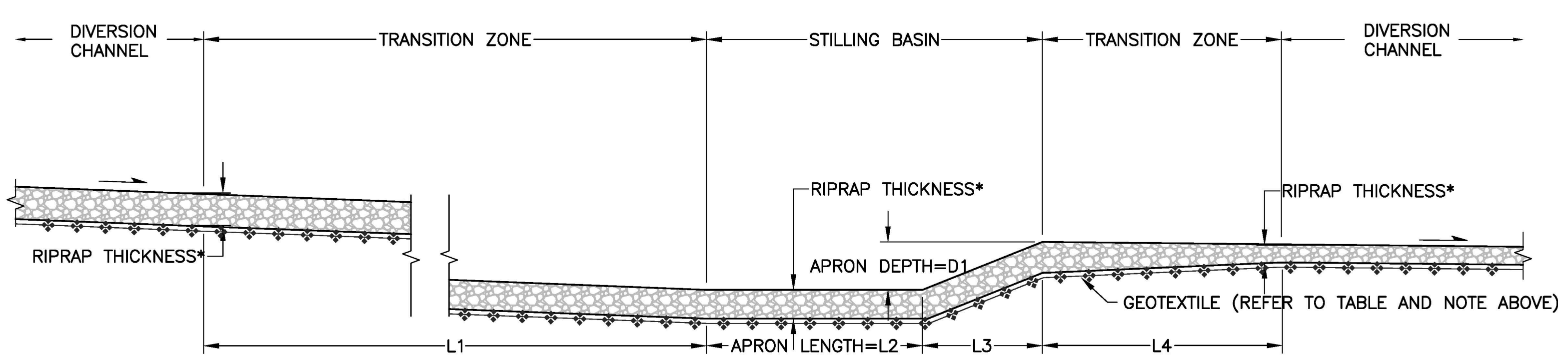
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CLOSURE STORMWATER DIVERSION CHANNEL PROFILE

FILENAME: 14.008.072P
DRAWING NO.: A716
REVISION: 0



STILLING BASIN PLAN VIEW



STILLING BASIN PROFILE VIEW

NOTE:

1. RIPRAP AND GEOTEXTILE MAY TERMINATE EITHER SIDE OF STILLING BASIN IF CHANNEL EXCAVATION INTERCEPTS COMPETENT BEDROCK.

CLOSURE STORMWATER DIVERSION CHANNEL STILLING BASIN DIMENSIONS

STATION (FT)	5+42	21+61	30+94
BASIN SIDE SLOPES (xH:1V)	2.5	2.5	2.5
SLOPE OUT OF BASIN (xH:1V)	2.5	2.5	2.5
RIPRAP D_{50} (IN)*	6	12	6
RIPRAP THICKNESS (IN)*	12	24	12
D1 (FT)	0.5	1	0.5
W1 (FT)	15	15	15
W2 (FT)	20	20	20
W3 (FT)	30	40	27.5
W4 (FT)	15	15	15
W5 (FT)	20	30	20
L1 (FT)	58	34	18
L2 (FT)	7	13	4
L3 (FT)	1.25	2.5	1.25
L4 (FT)	2.5	5	2.5

* STILLING BASIN IS ASSUMED TO BE EXCAVATED IN COMPETENT BEDROCK. IF COMPETENT BEDROCK IS NOT ENCOUNTERED, RIPRAP AND GEOTEXTILE ARE REQUIRED WITH THE SIZES AS NOTED. GEOTEXTILE SHALL BE 10 OZ/YD^2 NON-WOVEN.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A.
EXPIRES 3/31/17

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

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PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE
TITLE: CLOSURE STORMWATER DIVERSION CHANNEL STILLING BASINS
FILENAME: 14.008.080D
DRAWING NO.: A718
REVISION: 0

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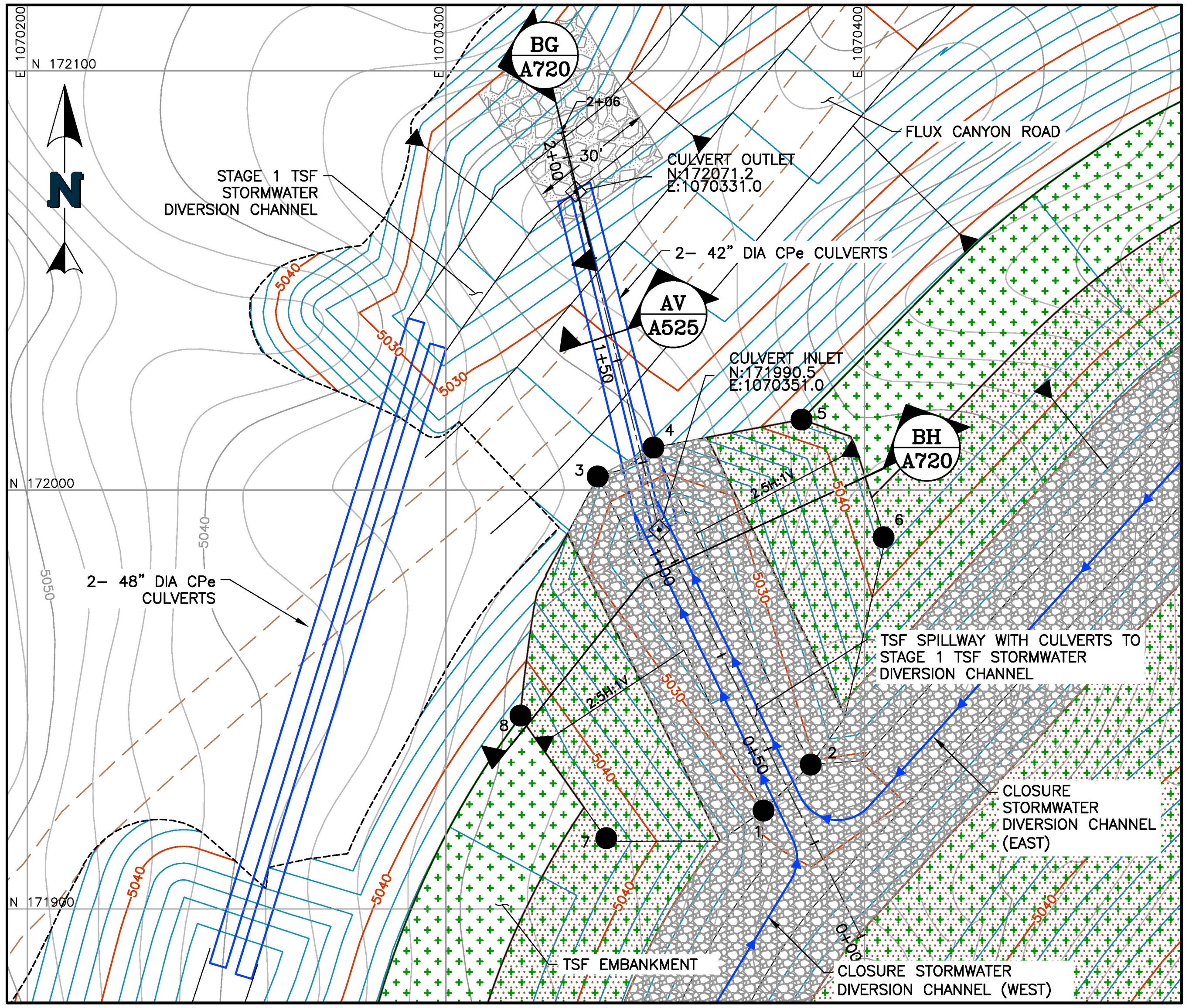
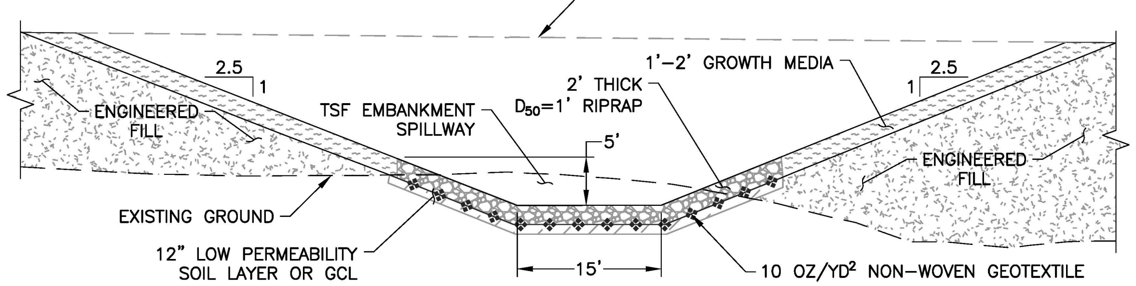


0 20 40 FEET



BH A720 CLOSURE TSF SPILLWAY SECTION

LEGEND:

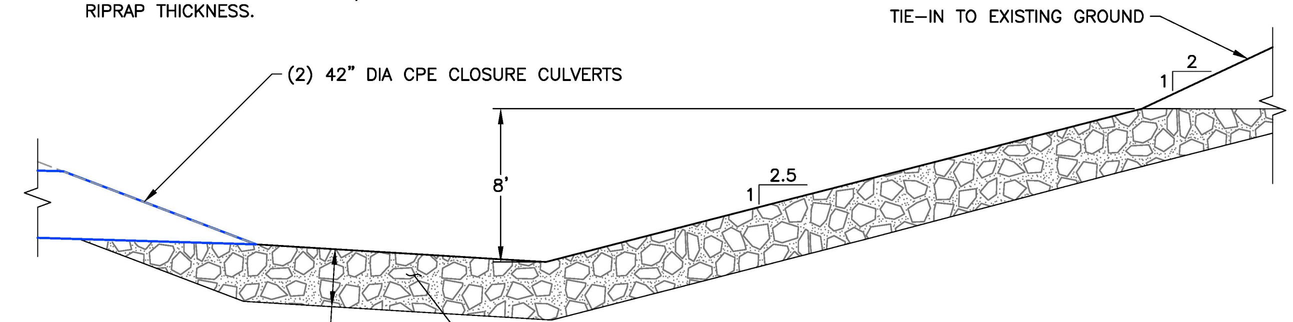
- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS (SEE NOTE 1)
- EXISTING ROADS/TRAILS
- LIMITS OF RIPRAP ARMORING
- LIMITS OF GROWTH MEDIA
- LIMITS OF GROUTED RIPRAP
- LIMITS OF REVEGETATION

NOTES:

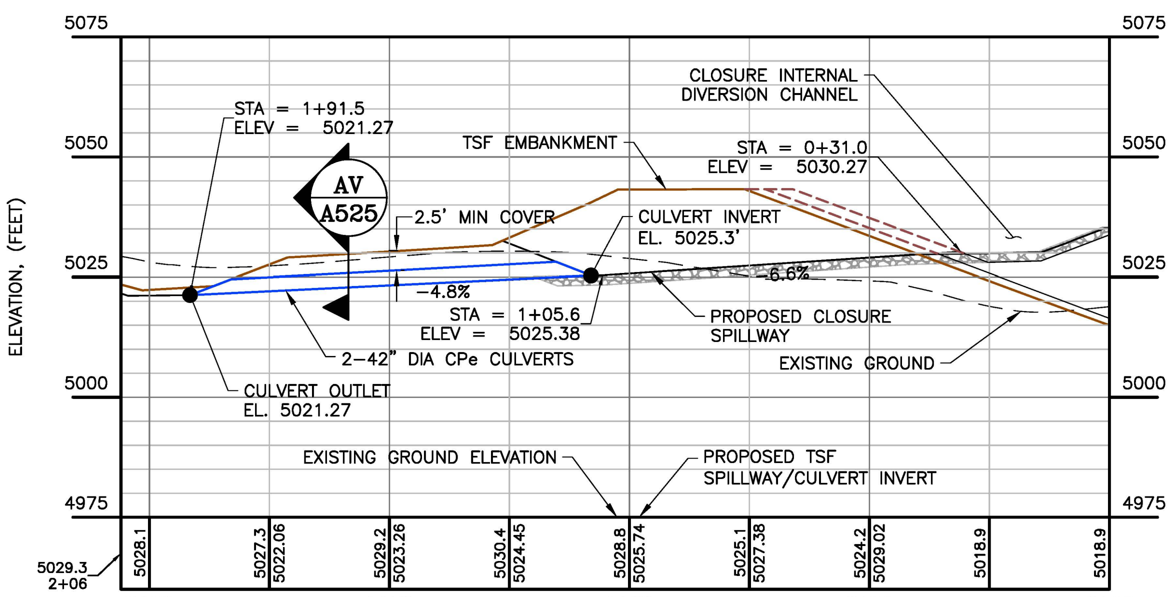
1. PROPOSED CONTOURS REPRESENT TOP OF GROWTH MEDIA WITHIN THE GROWTH MEDIA AREA AND FINISHED GRADE EVERYWHERE ELSE.
2. RIPRAP TO BE GROUTED TO 2/3 OF THE RIPRAP THICKNESS.

SETTING OUT DATA

POINT	NORTHING	EASTING	ELEVATION
1	171,923.50	1,070,375.88	5,029.87
2	171,934.50	1,070,387.17	5,029.55
3	172,003.28	1,070,336.27	5,032.68
4	172,010.18	1,070,349.59	5,032.79
5	172,016.87	1,070,384.98	5,042.76
6	171,988.76	1,070,404.57	5,042.75
7	171,916.92	1,070,338.32	5,043.54
8	171,946.18	1,070,317.81	5,043.63



BG A720 GROUTED RIPRAP AT TSF SPILLWAY CULVERT OUTLET



0 20 40 FEET — HORIZONTAL

0 20 40 FEET — VERTICAL

NO EXAGGERATION

Registered Professional Engineer (Civil)
CERTIFICATE NO. 63431
CRAIG M. THOMPSON
Date Signed 6/5/17
ARIZONA, U.S.A.
EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CLOSURE SPILLWAY PLAN AND PROFILE

FILENAME: 14.008.070P

DRAWING NO.: A720

REVISION: 0

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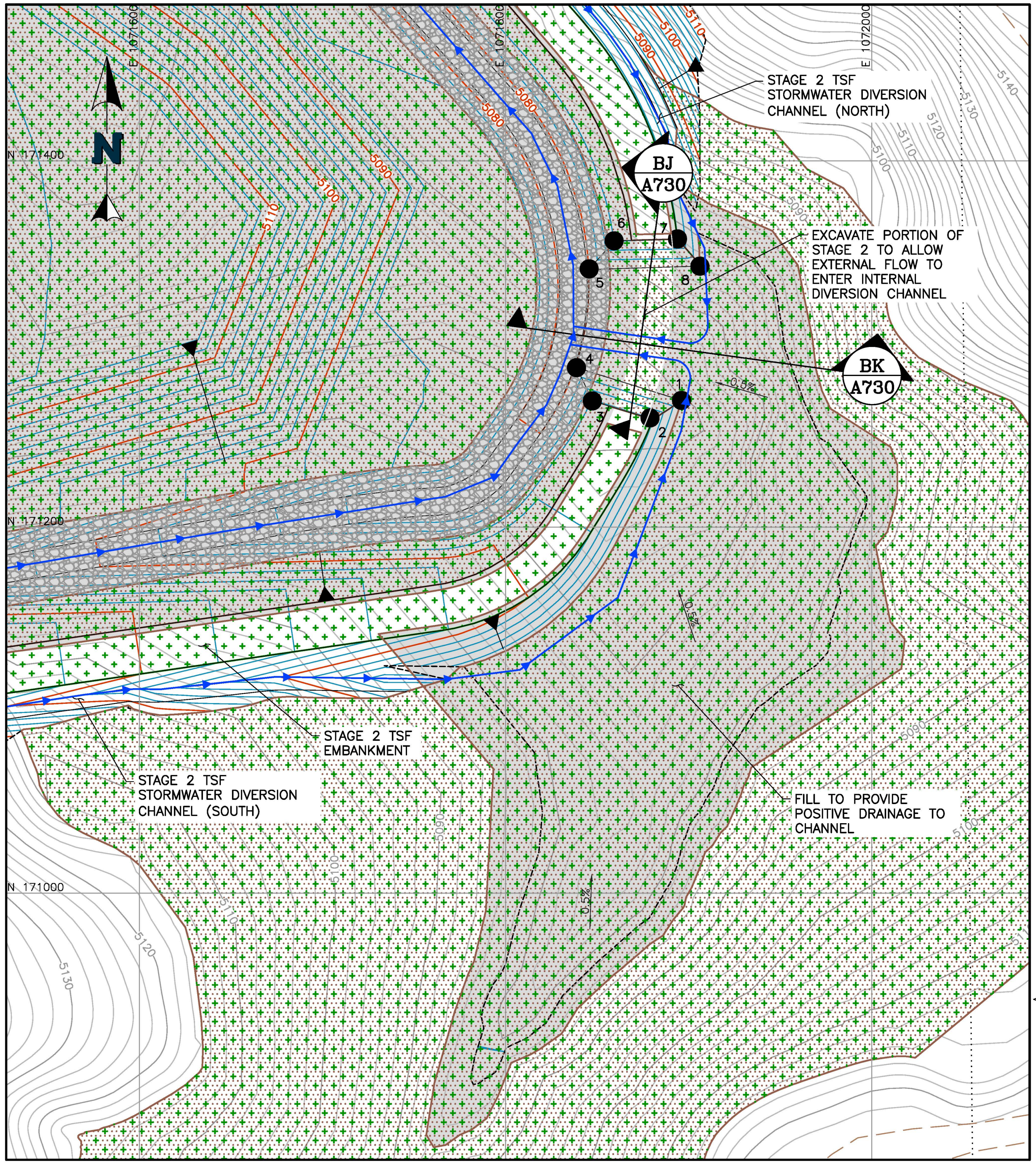
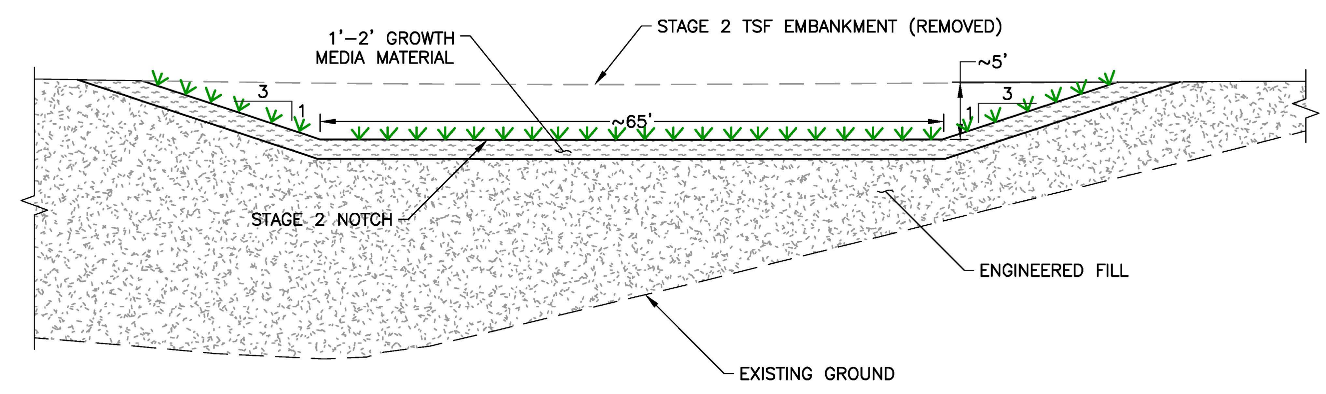


0 40 80 FEET

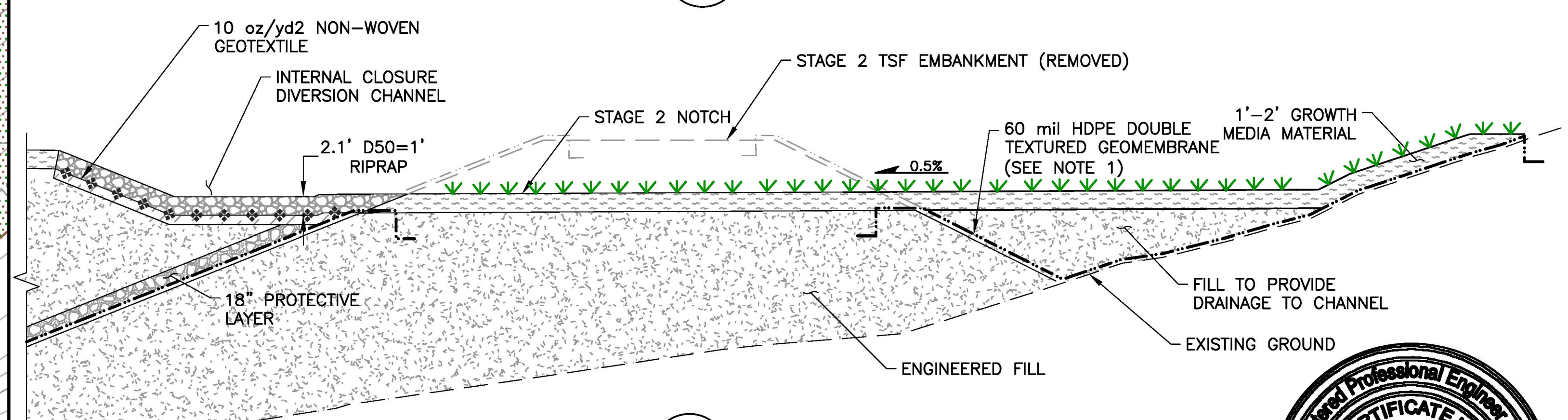
SETTING OUT DATA			
POINT	NORTHING	EASTING	ELEVATION
1	171,269.23	1,071,896.05	5,080.30
2	171,259.66	1,071,878.89	5,086.00
3	171,268.93	1,071,847.36	5,086.22
4	171,287.11	1,071,838.71	5,080.30
5	171,340.97	1,071,845.63	5,080.13
6	171,356.28	1,071,859.25	5,086.09
7	171,357.34	1,071,893.88	5,086.00
8	171,342.44	1,071,906.11	5,080.30

LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- SECTION LINES
- LIMITS OF GROWTH MEDIA
- LIMITS OF REVEGETATION
- LIMITS OF GEOMEMBRANE



BJ A730 CLOSURE SECTION



BK A730 CLOSURE SECTION

NOTE:

1. DETENTION POND LINER TO BE PERFORATED PRIOR TO CLOSURE FILL AND CLOSURE CAP PLACEMENT.

Registered Professional Engineer (Civil) CERTIFICATE NO. 63431 CRAIG M. THOMPSON Date Signed 6/5/17 ARIZONA, U.S.A. EXPIRES 3/31/17

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

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REV	DATE	DESCRIPTION	TECH	ENG
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APPROVED BY: RMS
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CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CLOSURE FILL AREA

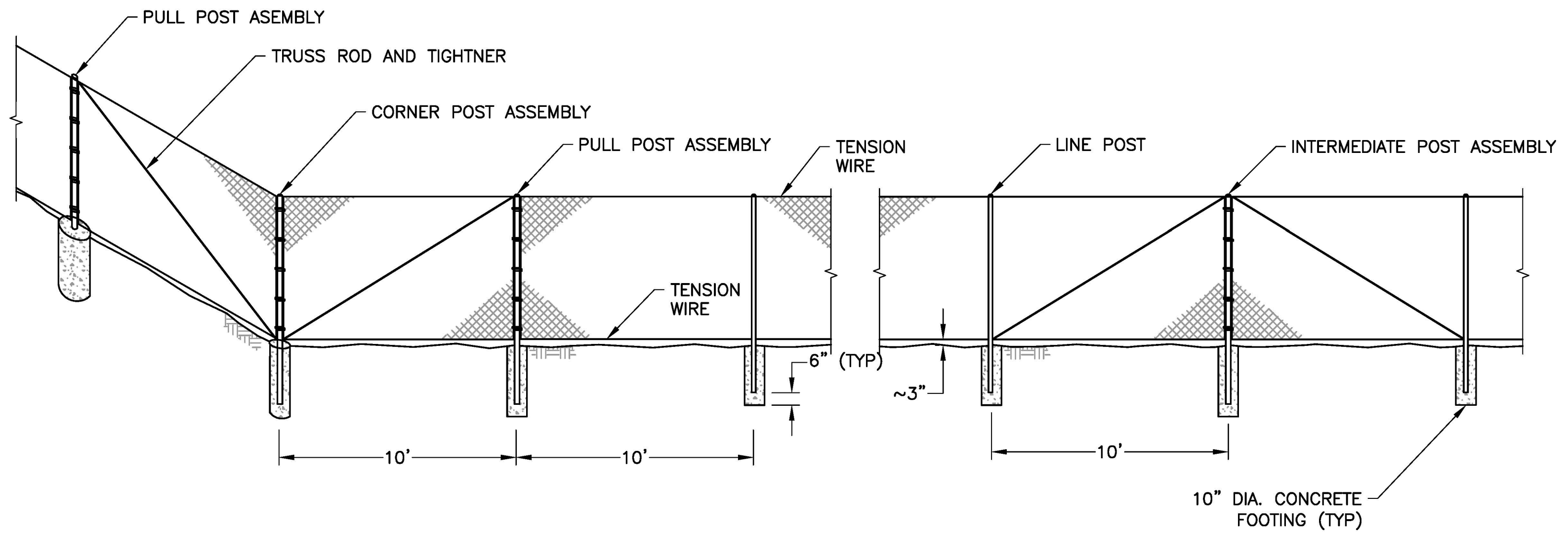
FILENAME: 14.008.073M

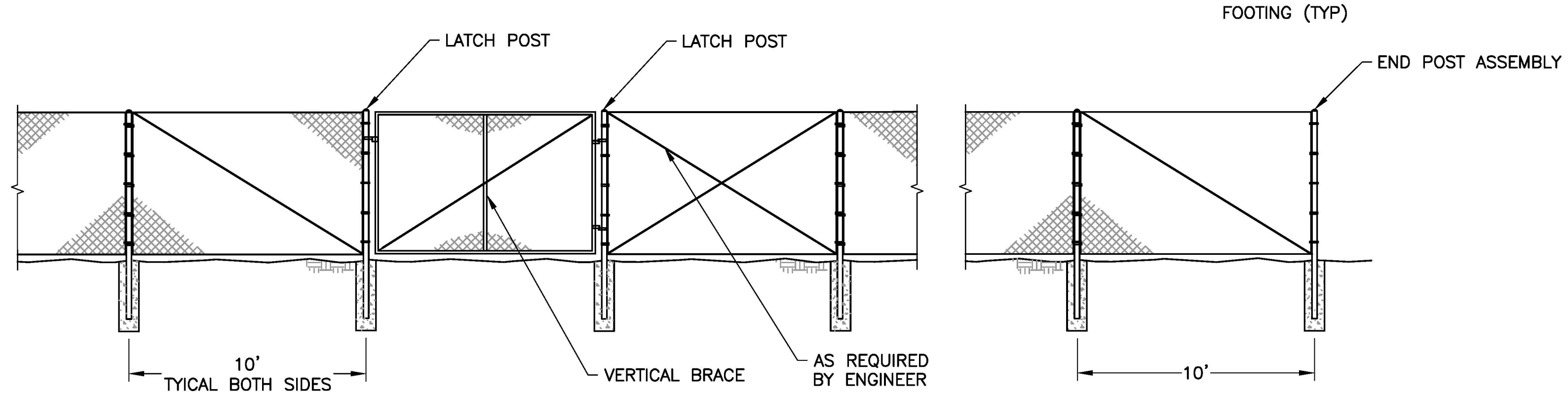
DRAWING NO.: A730

REVISION: 0

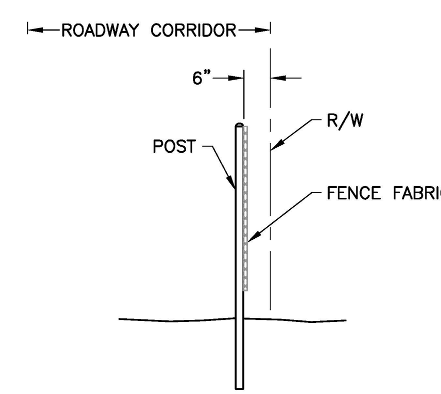
GENERAL NOTES

1. POSTS SHALL BE ROUND, H-SECTION, OR ROLL-FORMED AND SHALL CONFORM TO THE NOMINAL DIMENSIONAL REQUIREMENTS SHOWN ON THE PLANS. DIMENSIONAL TOLERANCES FOR ALL SHAPES SHALL BE ACCORDING TO ASTM A500. IN ADDITION, THE MATERIAL OF WHICH POSTS ARE FABRICATED SHALL HAVE A NOMINAL THICKNESS, BEFORE GALVANIZING, OF NOT LESS THAN 0.111" FOR LINE POSTS AND 0.130 FOR TERMINAL POSTS.
2. CHAIN LINK FABRIC SHALL BE ATTACHED ON THE SIDE OF THE LINE POSTS AWAY FROM THE MAIN ROADWAY.
3. CHAIN LINK FABRIC SHALL BE EITHER ZINC-COATED OR ALUMINUM-COATED STEEL WIRE FENCE FABRIC. ZINC-COATED STEEL FABRIC SHALL CONFORM TO THE REQUIREMENTS OF ASTM A491, WITH A MINIMUM WEIGHT OF COATING OF 0.40 OUNCE PER SQUARE FOOT OF WIRE SURFACE AREA. FABRIC SHALL BE 11 GAUGE FOR ALL FENCE FABRIC 60" OR LESS IN HEIGHT AND SHALL BE 9 GAUGE FOR FABRICS GREATER THAN 60" IN HEIGHT.
4. TENSION WIRES SHALL BE 7 GAUGE (0.177" DIAMETER) COIL SPRING STEEL WIRE WITH A MINIMUM TENSILE STRENGTH OF 75,000 PSI AND SHALL BE ZINC-COATED OR ALUMINUM-COATED.
5. TRUSS RODS SHALL BE 3/8" DIAMETER ADJUSTABLE RODS. TRUSS TIGHTENERS SHALL HAVE A STRAP THICKNESS OF NOT LESS THAN 1/4".
6. STRETCHER BARS SHALL BE 3/36" x 3/4" STEEL FLAT BARS. STRETCHER BAR BANDS SHALL BE 1/8" x 1" PREFORMED STEEL BANDS.
7. BOTTOM TENSION WIRE SHALL BE 3" FROM TOP OF CROSN ON CONCRETE FOOTINGS.
8. INTERMEDIATE POST ASSEMBLIES SHALL BE SPACED AT 500' INTERVALS OR MIDWAY BETWEEN PULL POSTS WHEN THE DISTANCE BETWEEN SUCH POSTS IS LESS THAN 1,000' AND MORE THAN 500'.





TYPICAL CHAIN LINK FENCE INSTALLATION – TYPE 1 SHOWN



TYPICAL FENCE LOCATION

TYPICAL POST DIMENSIONS

FABRIC HEIGHT (IN)	CORNER, END, INTERMEDIATE, GATE, LATCH AND PULL POSTS				LINE POSTS			
	LENGTH (FT-IN)	ROUND	ROLL FORMED		LENGTH (FT-IN)	ROUND		ROLL FORMED
		(OD) (IN)	(IN)	□ (IN)		(OD) (IN)	H-SECTION (IN)	□ (IN)
36	6-0	2.375	3.50 X 3.50	2.25 X 1.70	5-6	1.900	1.875 X 1.625	1.875 X 1.625
48	7-0	2.375	3.50 X 3.50	2.25 X 1.70	6-6	1.900	1.875 X 1.625	1.875 X 1.625
60	8-0	2.375	3.50 X 3.50	2.25 X 1.70	7-6	1.900	1.875 X 1.625	1.875 X 1.625
72	9-0	2.375	3.50 X 3.50	2.25 X 1.70	8-6	1.900	1.875 X 1.625	1.875 X 1.625
OVER 72	HEIGHT +3-0	2.875	3.50 X 3.50	2.50 X 2.50	HEIGHT +2-6	2.375	2.250 X 2.000	1.875 X 1.625

NOTES:

1. DETAILS SHOWN ARE PROVIDED BY THE ARIZONA DEPARTMENT OF TRANSPORTATION IN THE ROADWAY ENGINEERING CONSTRUCTION STANDARD DRAWINGS MAY 2012 DOCUMENT.
2. THE CHAIN LINK FENCE SHALL BE INSTALLED IN THE LOCATIONS SHOWN ON DRAWING A400.
3. GATE DETAILS ARE PROVIDED ON DRAWING A805.
4. CHAIN LINK FENCE AND GATE SHALL BE 8'-0" HIGH MINIMUM.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

NewFields

CLIENT: ARIZONA MINERALS INC

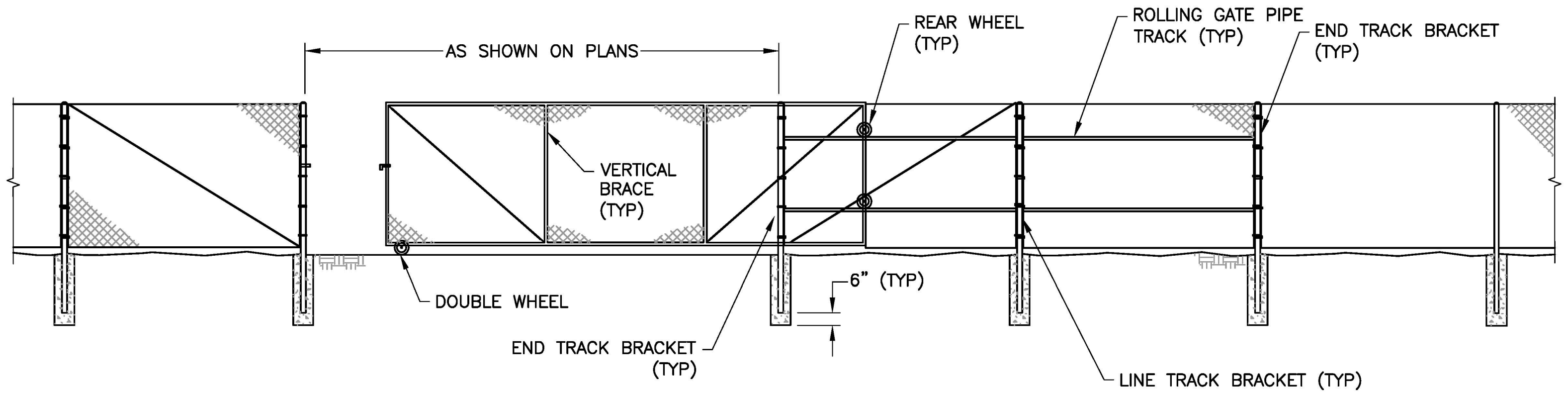
PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: WILDLIFE FENCE DETAILS (SHEET 1 OF 2)

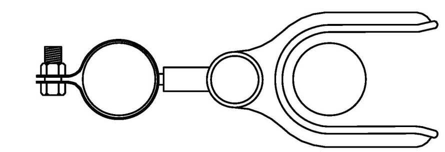
FILENAME: 14.008.047D

DRAWING NO.: A800 REVISION: 0

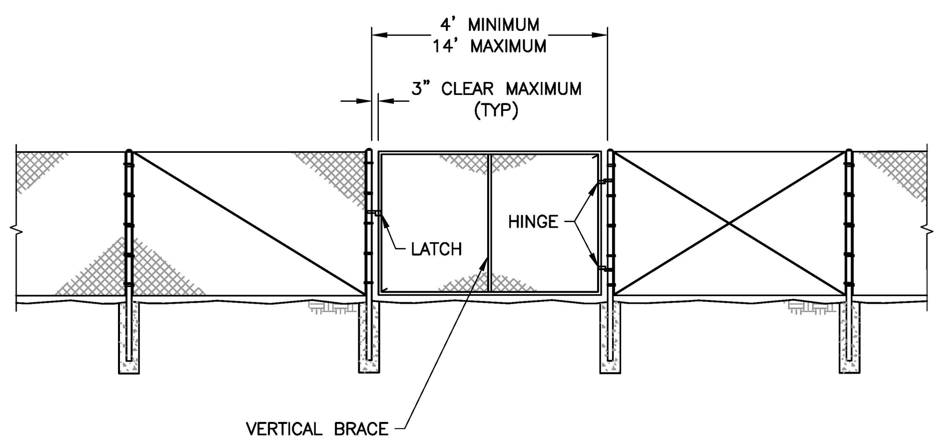
P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\DWGS\14.008.047D.dwg-5/31/2017 10:19 AM



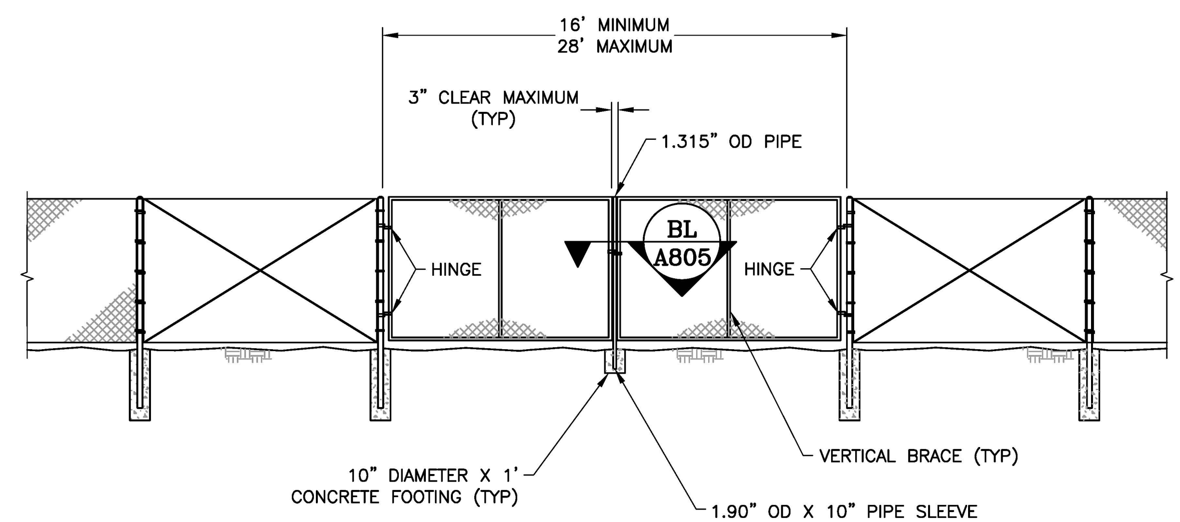
ROLLING GATE



BL A805 DOUBLE GATE LATCH ASSEMBLY



SINGLE GATE



DOUBLE GATE

TYPICAL GATE DIMENSIONS

SINGLE AND DOUBLE SWING GATES						ROLLING GATES			
GATE WIDTH (FT)	VERTICAL BRACES	GATE POST SIZE	GATE WIDTH SIZE	VERTICAL BRACES	GATE POST SIZE	GATE WIDTH (FT)	NUMBER OF EQUALLY SPACED VERTICAL BRACES	TENSION RODS PER BRACED PANEL	GATE POST SIZE
6' HT OR LESS		OD (IN)	OVER 6' HT		OD (IN)				OD (IN)
3 TO 8	0	2.875	3 TO 8	0	2.875	6 TO 13	1	0	2.875
8 TO 16	1	4.000	8 TO 16	1	4.000	13 TO 16	1	1	2.875
16 TO 18	2	4.000				16 TO 21	2	1	2.875
						21 TO 27	2	1	2.875
						28 AND LARGER	3	1	2.875

GATES FOR CHAIN LINK FENCE – TYPE 1 SHOWN
(TYPE 2, WITH BARBED WIRE TYPICAL)

NOTES:

1. DETAILS SHOWN ARE PROVIDED BY THE ARIZONA DEPARTMENT OF TRANSPORTATION IN THE ROADWAY ENGINEERING CONSTRUCTION STANDARD DRAWINGS MAY 2012 DOCUMENT.
2. THE CHAIN LINK FENCE SHALL BE INSTALLED IN THE LOCATIONS SHOWN ON DRAWING A400.
3. CHAIN LINK FENCE DETAILS ARE PROVIDED ON DRAWING A800.
4. CHAIN LINK FENCE AND GATE SHALL BE 8'-0" HIGH MINIMUM.

REV	DATE	DESCRIPTION	TECH	ENG
0	06/05/17	ISSUED FOR CONSTRUCTION	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

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: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: WILDLIFE FENCE DETAILS (SHEET 2 OF 2)

FILENAME: 14.008.048D
DRAWING NO.: A805
REVISION: 0

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APPENDIX A
Design Criteria

Arizona Minerals Inc
Tailings and Potentially Acid Generating (PAG)
Material Remediation, Placement and Storage
Design Criteria

NewFields

General Information

DESCRIPTION	VALUE	COMMENT
	BASE MAPPING	
Projection System	NAD 83, Arizona State Plane Central	
Units	English	
Topographic Files	CAD files	Received from Arizona Minerals Inc on 06/17/16 (Trench Camp)

Arizona Minerals Inc
Tailings and Potentially Acid Generating (PAG)
Material Remediation, Placement and Storage
Design Criteria

Meteorological/Climatological Data

DESCRIPTION	VALUE	COMMENT
CLIMATOLOGICAL FACTORS		
Average annual precipitation	21.5 in	ERC
Average annual evaporation	91.6 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

Arizona Minerals Inc
Tailings and Potentially Acid Generating (PAG)
Material Remediation, Placement and Storage
Design Criteria

NewFields

Tailings Storage Facility - Trench Camp

TAILINGS PROPERTIES - DRY STACK		
Solids content of paste	~93%	Weight of dry solids/total weight
Tailings specific gravity	2.75	Estimated by NewFields
Dry density of tailings for determining geometry of phases	104 lbs/ft³	Estimated by NewFields
Tailings slope	3.0H:1V Compound Slope	Estimated by NewFields
COARSE ROCK PROPERTIES		
Dry density of coarse rock	130 lbs/ft³	Estimated by NewFields
FACILITY FEATURES		
Embankment type	Rockfill/earthfill	
Embankment construction method	Downstream construction	Mine and/or Contractor placed
Embankment fill dry density	130 pcf	
Intermediate phase embankment crest width	25 ft	
Bench width between embankment phases	15 ft	Needed for access and construction of geomembrane and pipework
Final embankment crest width	25 feet	minimum
Downstream embankment slope	2.0H:1V	
Upstream embankment slope	2.5H:1V	
Embankment Upstream Face Lining	Composite Liner (60 mil HDPE Geomembrane placed over 12" low permeability soil material)	Prescriptive BADCT
Basin Containment Lining Requirement	Composite Liner (60 mil HDPE Geomembrane placed over 12" low permeability soil material)	Prescriptive BADCT
Maximum basin slope	2.5H:1V	
Minimum basin slope	1%	
Basin Underdrain System	Drainage layer with a minimum thickness of 18 inches. Finger drains consisting of perforated drain pipe encapsulated in a drainage aggregate and placed within topographic lows (drainages)	Individual BADCT

Underdrain Collection Pond

FACILITY FEATURES		
Sizing Approach	Deterministic	
Sizing Storm Event	100-yr / 24-hr	
Operational Volume	Minimum as possible	Pond should remain as dry as possible
Spillway Sizing Approach	0.25 PMF	
Spillway Freeboard	5 ft	Minimum freeboard from pond crest to spillway invert
Freeboard	2 ft	Minimum freeboard from spillway invert to maximum operation volume plus 100-yr / 24-hr storm event
Embankment type	Rockfill/earthfill	
Embankment fill dry density	130 pcf	
Final embankment crest width	25 feet	
Downstream embankment slope	2.0H:1V	
Upstream embankment slope	2.0H:1V	
Lining System	Double 60 mil HDPE geomembrane with geonet (Lower liner is a composite liner system with 60 mil HDPE gomembrane placed over 6" of low permeability soil material)	Prescriptive BADCT
Piping	4" Dia CPe Pipe (perforated)	Augments geonet layer by transmiting flows at toe of internal pond slope

Arizona Minerals Inc
Tailings and Potentially Acid Generating (PAG)
Material Remediation, Placement and Storage
Design Criteria

NewFields

Borrow Sources

DESCRIPTION	VALUE	COMMENT
Materials		
	Source	
Random Fill	Local soils and rock	As Required
Random Fill	Mine Development Rock	

Arizona Minerals Inc
Tailings and Potentially Acid Generating (PAG)
Material Remediation, Placement and Storage
Design Criteria

Roads

DESCRIPTION	VALUE	COMMENT
HAUL/CONSTRUCTION ROAD		
Maximum road grade	10%	
Road width	50 ft	clear distance between berms
Minimum radius	200 ft	measured from centerline
Safety berm height	3 ft	MSHA - Equal to the axle height of the largest piece of equipment on the road
Design vehicle	777 Haul Truck	200 ton payload
Traffic pattern	Right Hand Traffic	
LIGHT VEHICLES		
Maximum road grade	15%	
Road width	25 ft	
Safety berm height	1.5 ft	MSHA - Equal to the axle height of the largest piece of equipment on the road

Arizona Minerals Inc
Tailings and Potentially Acid Generating (PAG)
Material Remediation, Placement and Storage
Design Criteria

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 or bedrock
Temporary 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	CMP or CPEP	
Maximum headwater	1.5:1 HW/D	
Runoff Collection Ponds		
Impacted Construction Runoff	Per AZDEQ (Arizona Pollutant Discharge Elimination System)	Employ Best Management Practices in accordance with BADCT
Sediment Basin Sizing	2 year, 24 hour rain event from each disturbed acre drained	

APPENDIX B

Climate Memorandum

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)

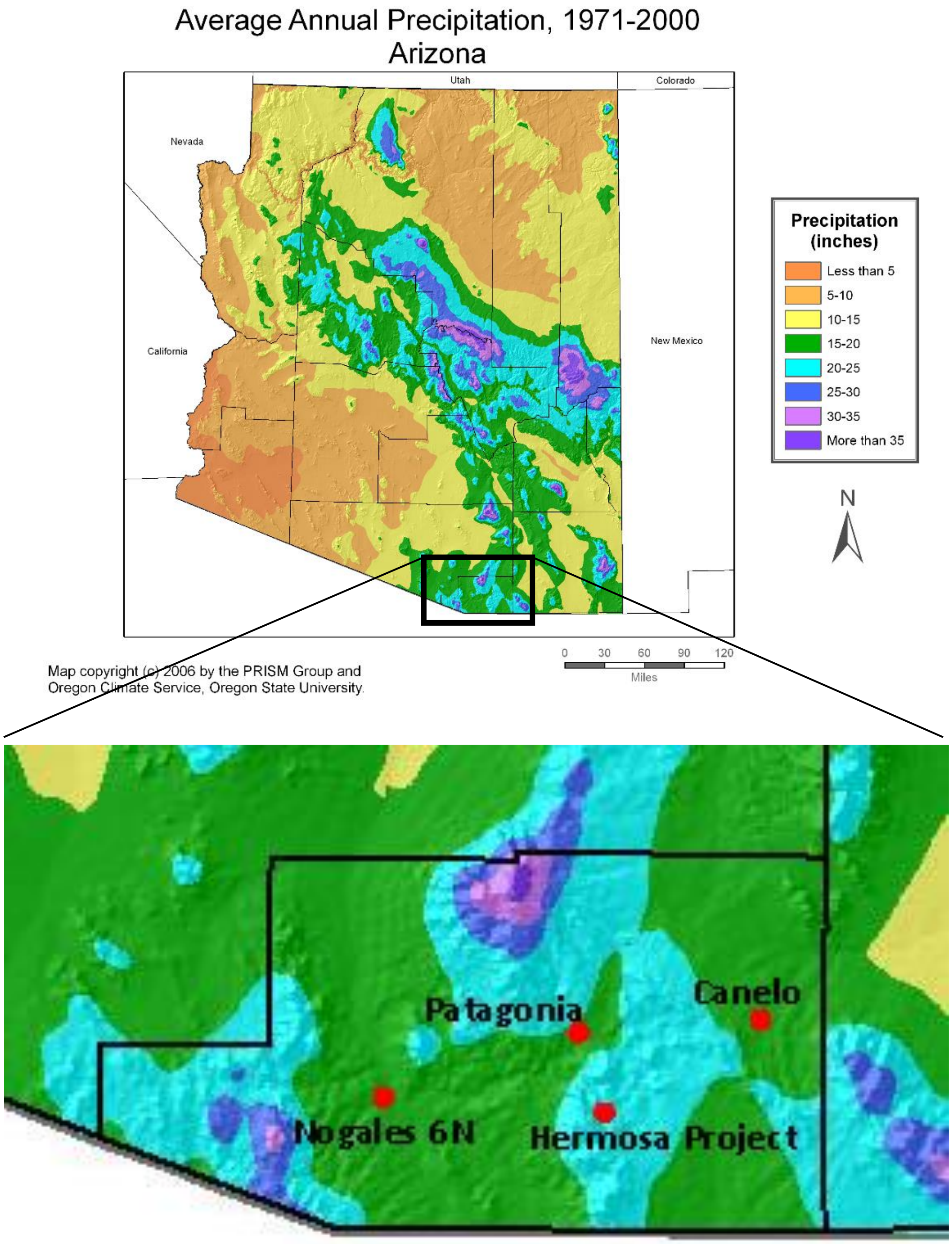
Period	Site Data	Nogales 6N	Patagonia
October 2007 – December 2016	21.90	13.98 (64% of site)	16.05 (73% of site)
1953 - 2016	NA	16.88 (21% greater than 2008 - 2014)	17.92 (12% greater than 2008 - 2014)
1923 - 2016	NA	NA	17.84 (11% greater than 2008 - 2014)

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.

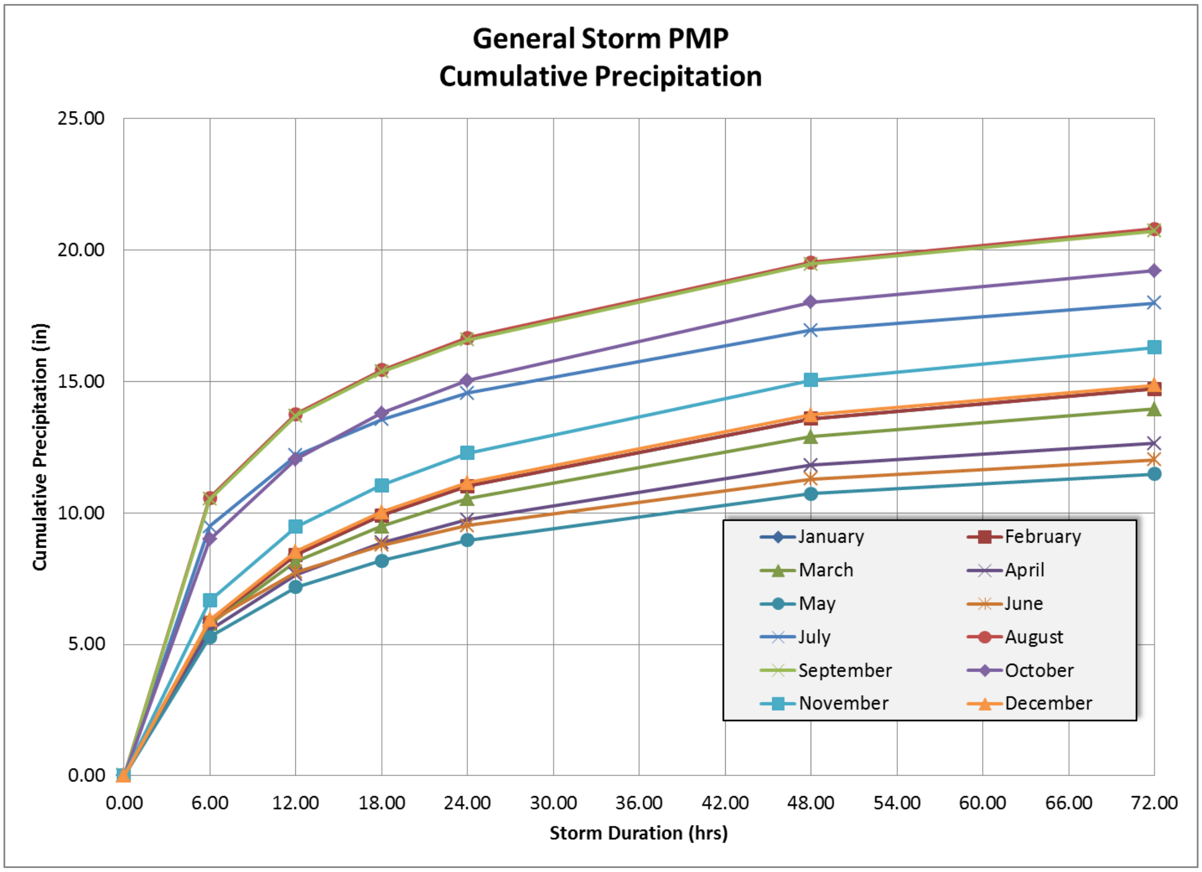
Graphical and tabular data from HMR 49 used in the calculation of the General Storm are presented in **Appendix A**. Calculations are given in **Appendix B**.

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

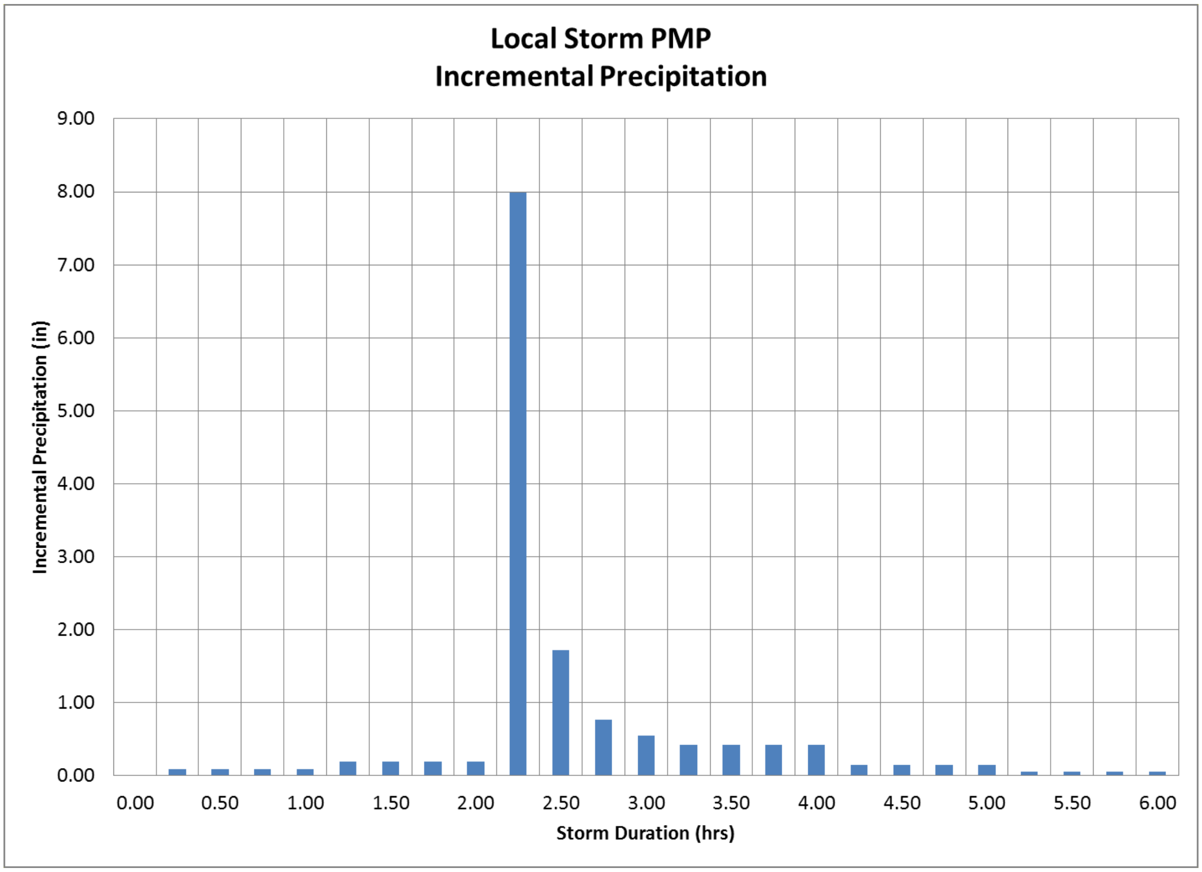


5.4 *Local Storm Calculations*

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

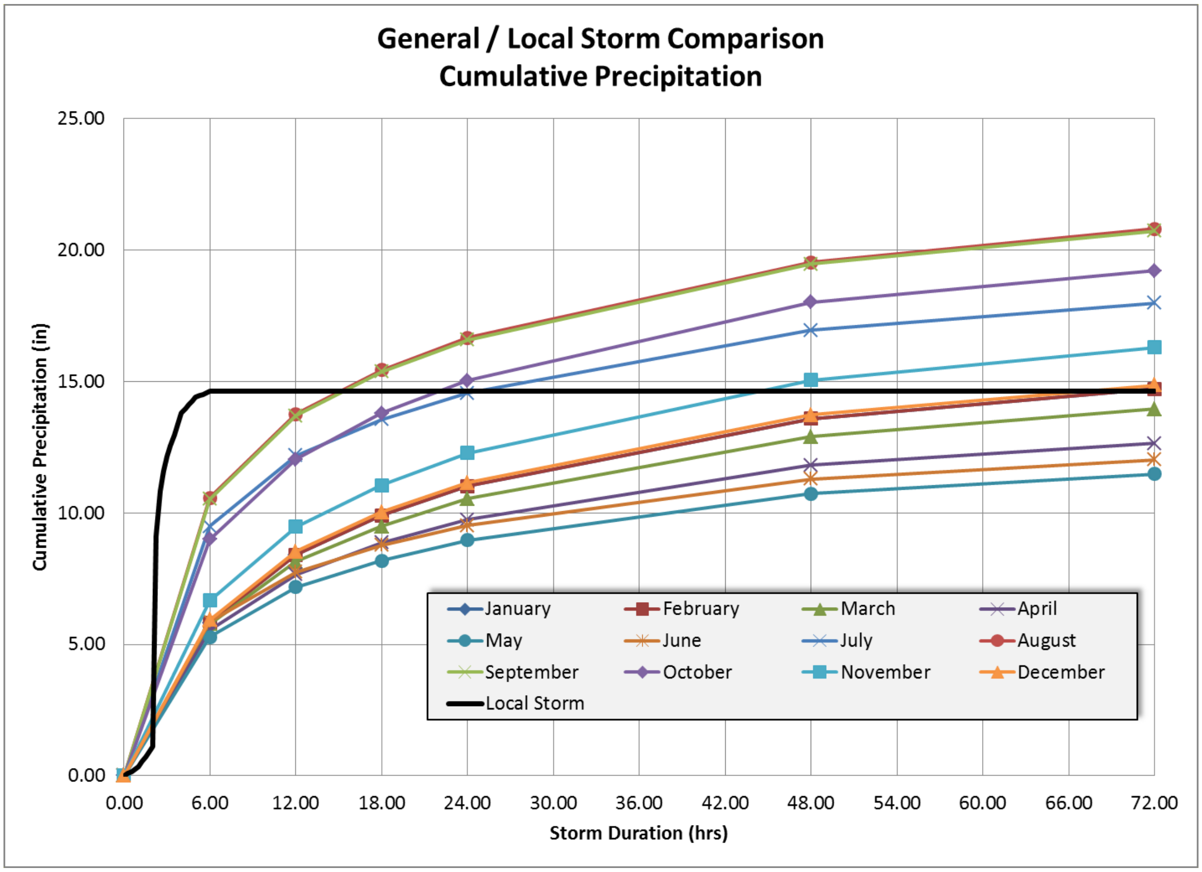


5.5 Comparison of General and Local Storm PMPs

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.

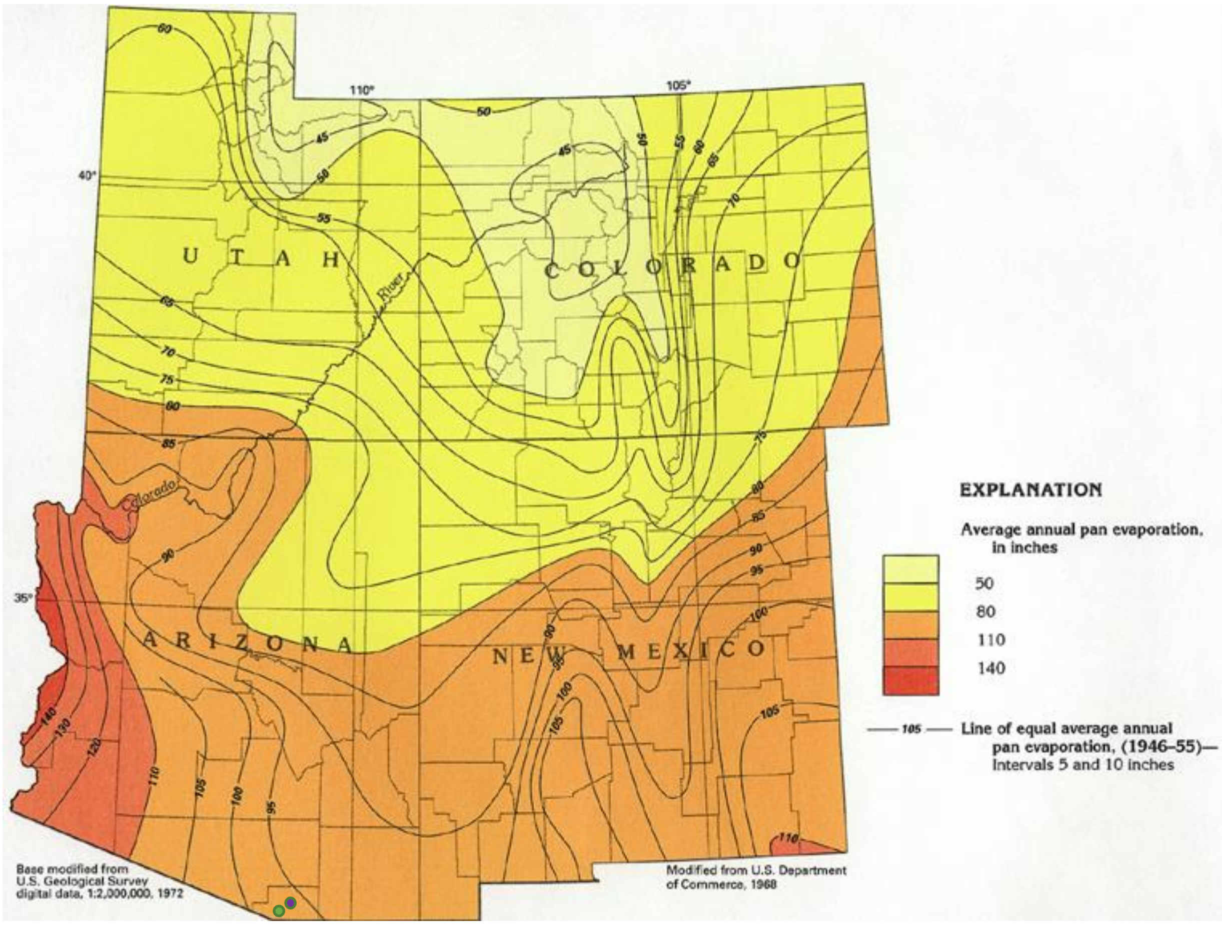
In an attempt to verify site data, ERC considered available regional pan evaporation data. From a regional basis, evaporation data is not available from the Canelo or Patagonia stations. The nearest meteorological station with available evaporation data is the Nogales 6N Station located in Nogales, AZ, 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

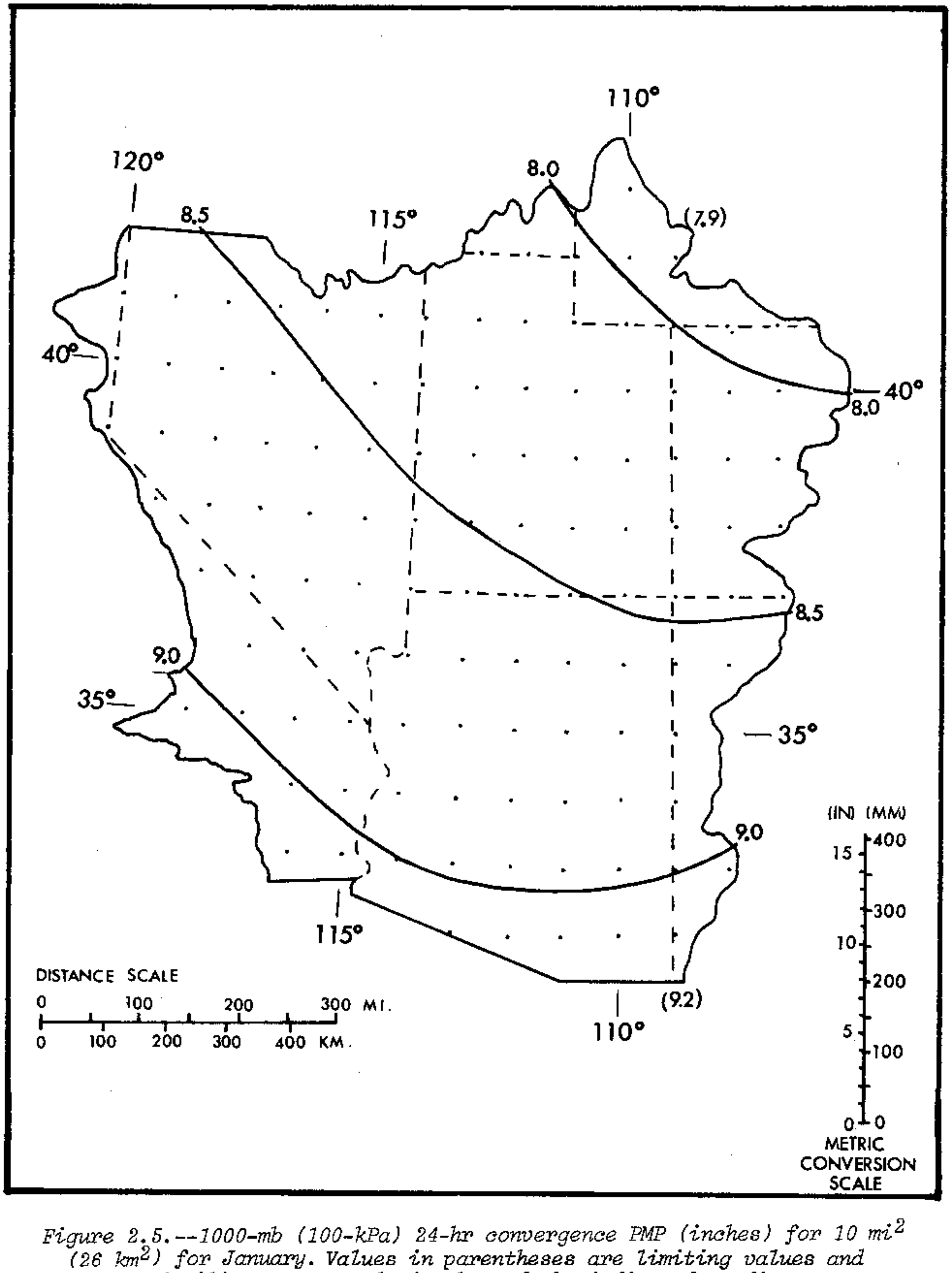


Figure 2.5.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for January. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

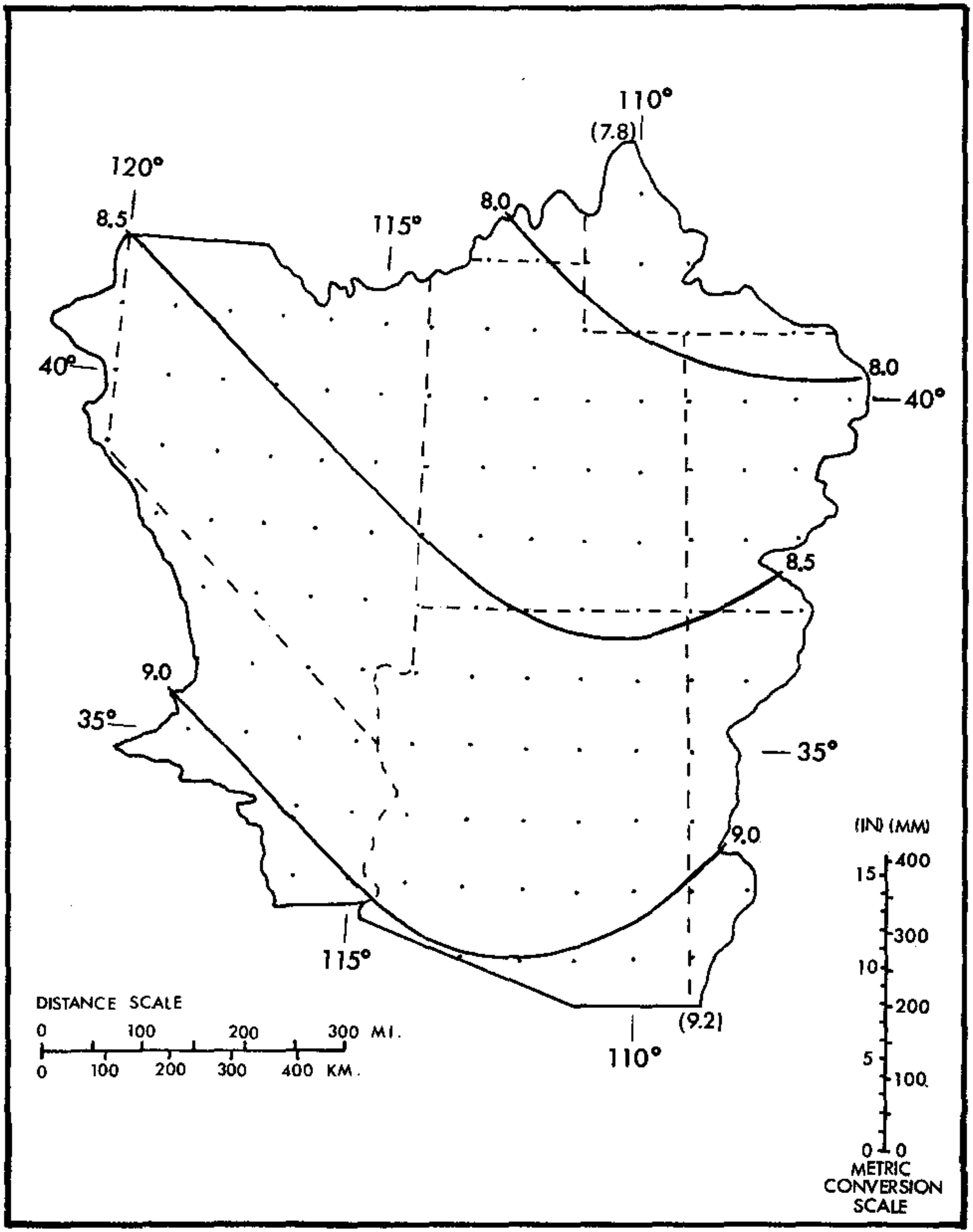


Figure 2.6.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for February. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

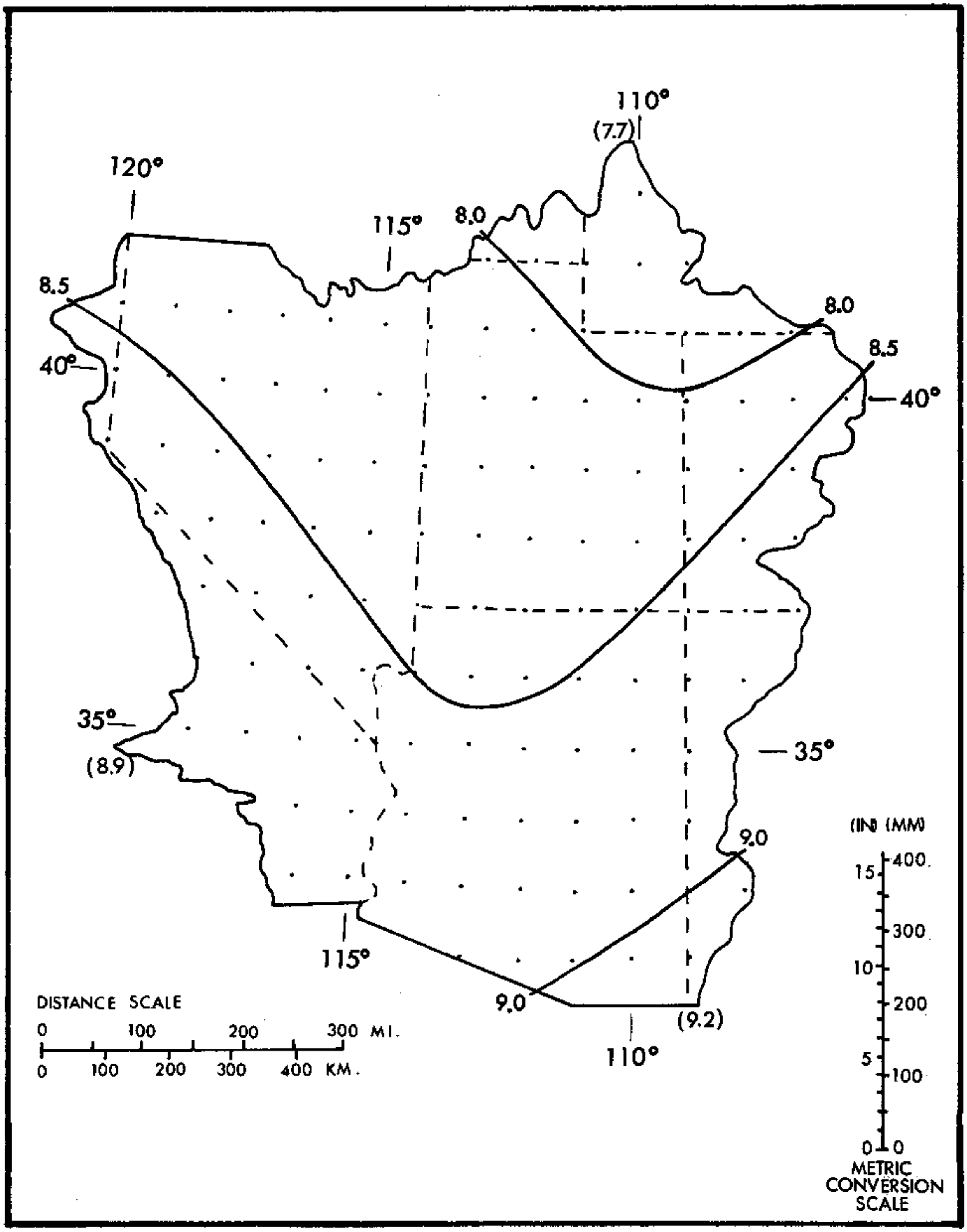


Figure 2.7.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for March. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

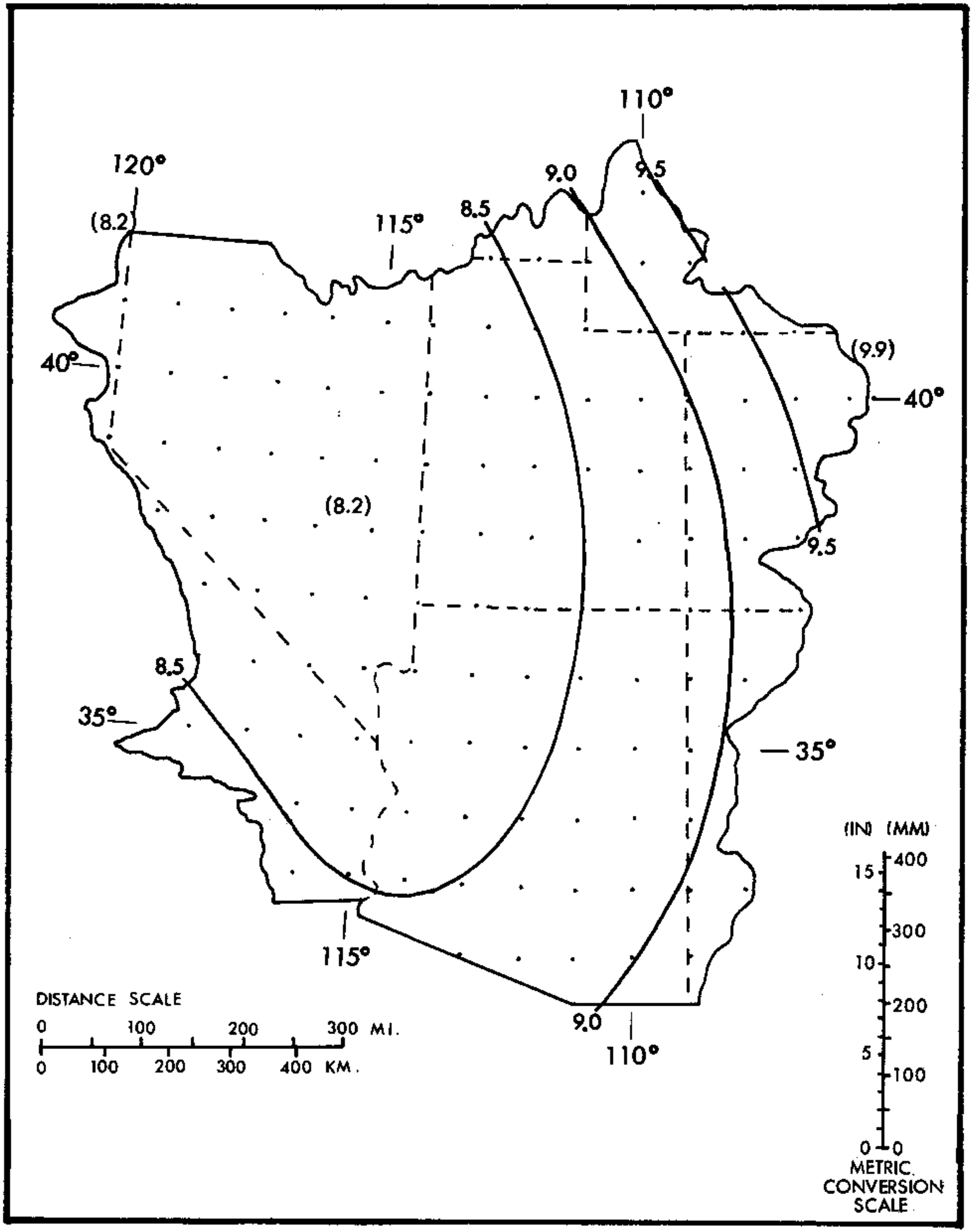


Figure 2.8.---1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for April. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

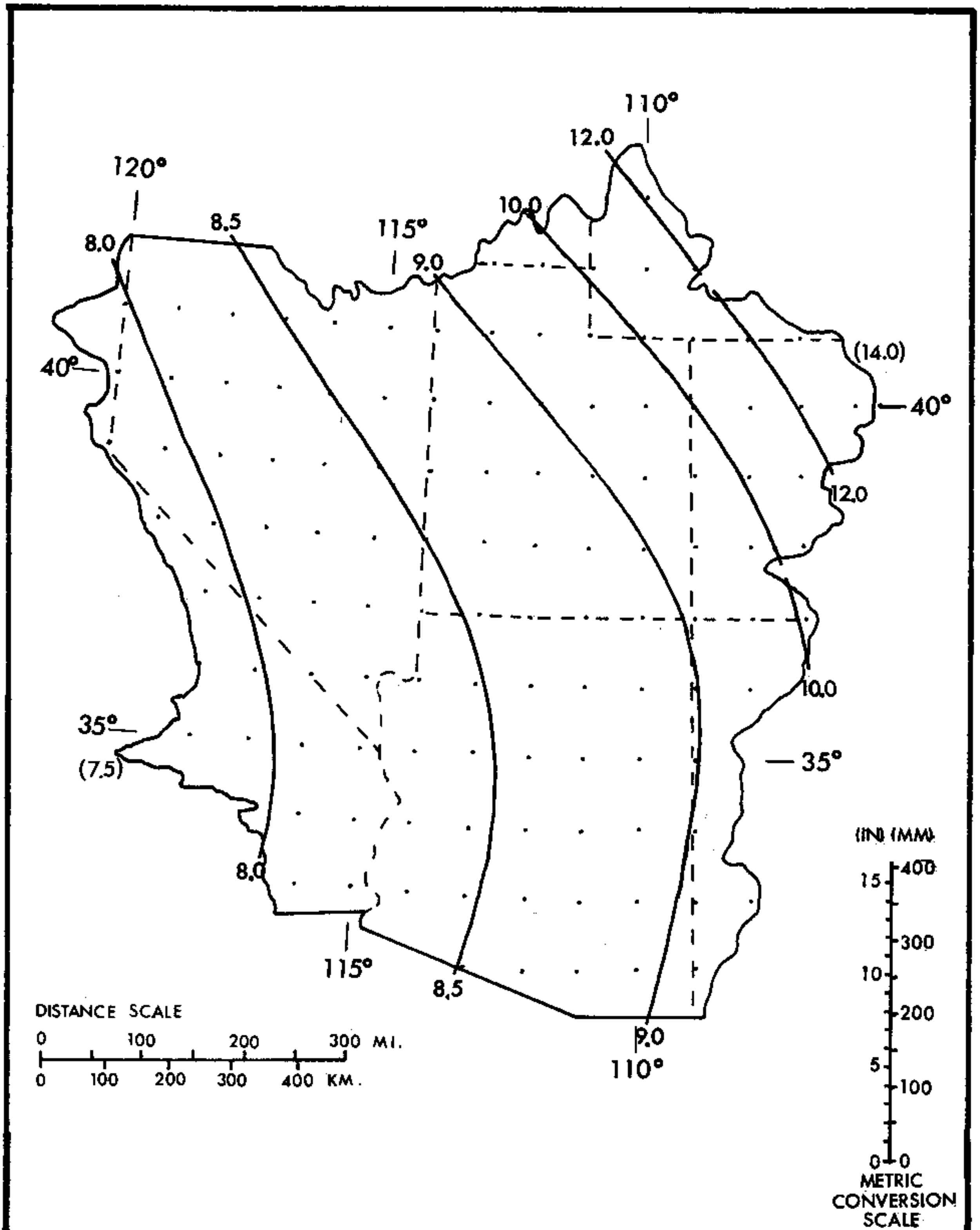


Figure 2.9.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for May. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

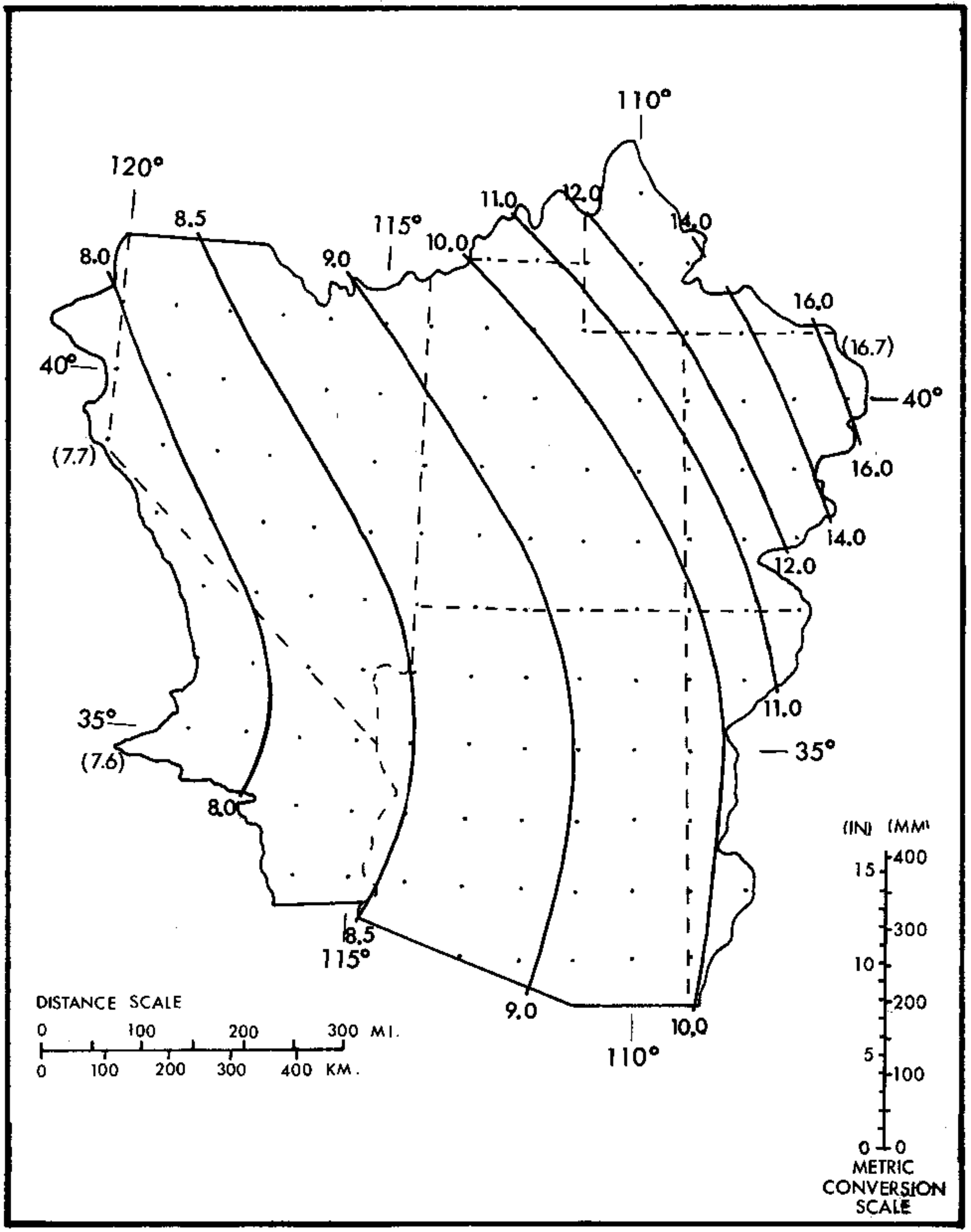


Figure 2.10.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for June. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

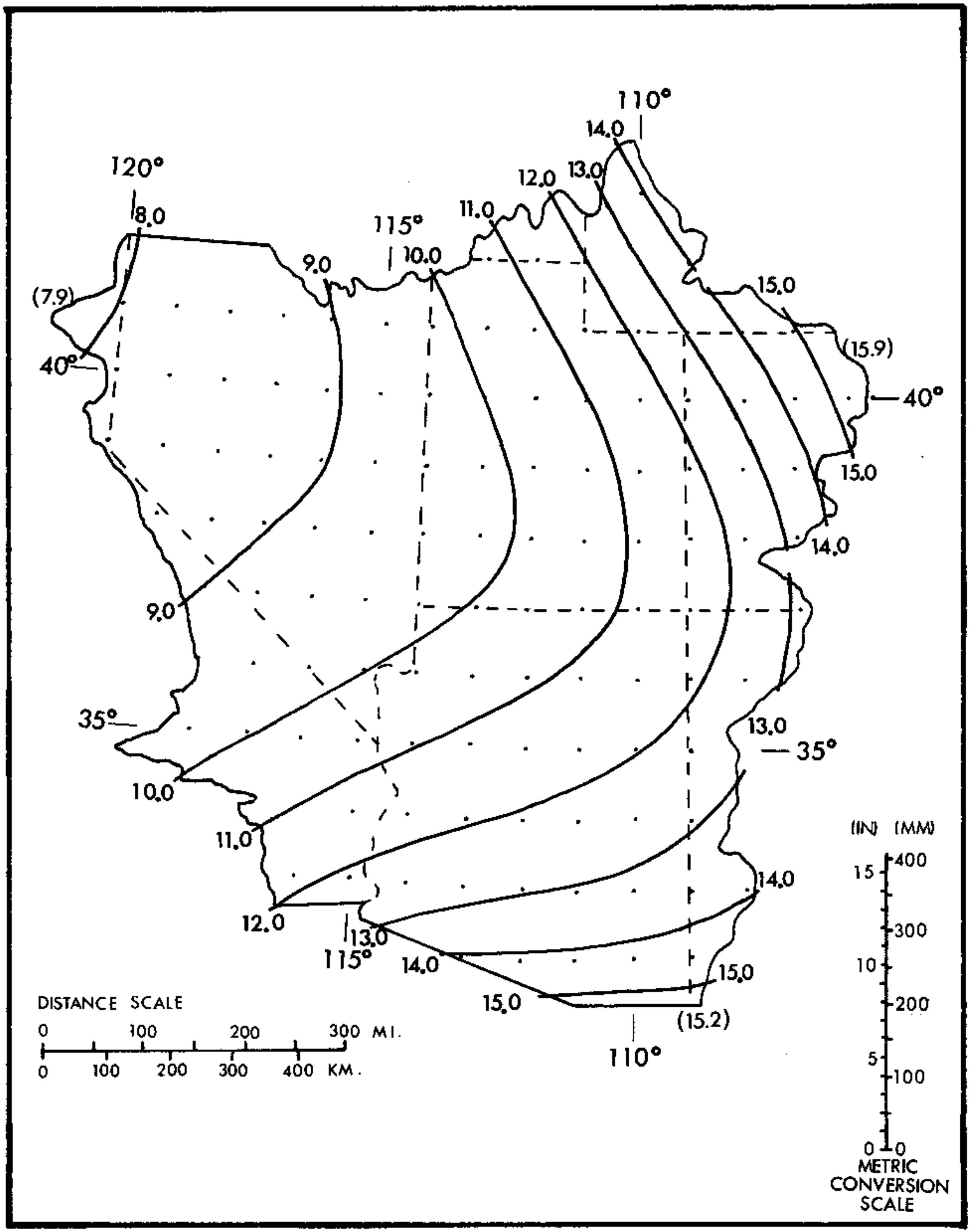


Figure 2.11.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi2 (26 km2) for July. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

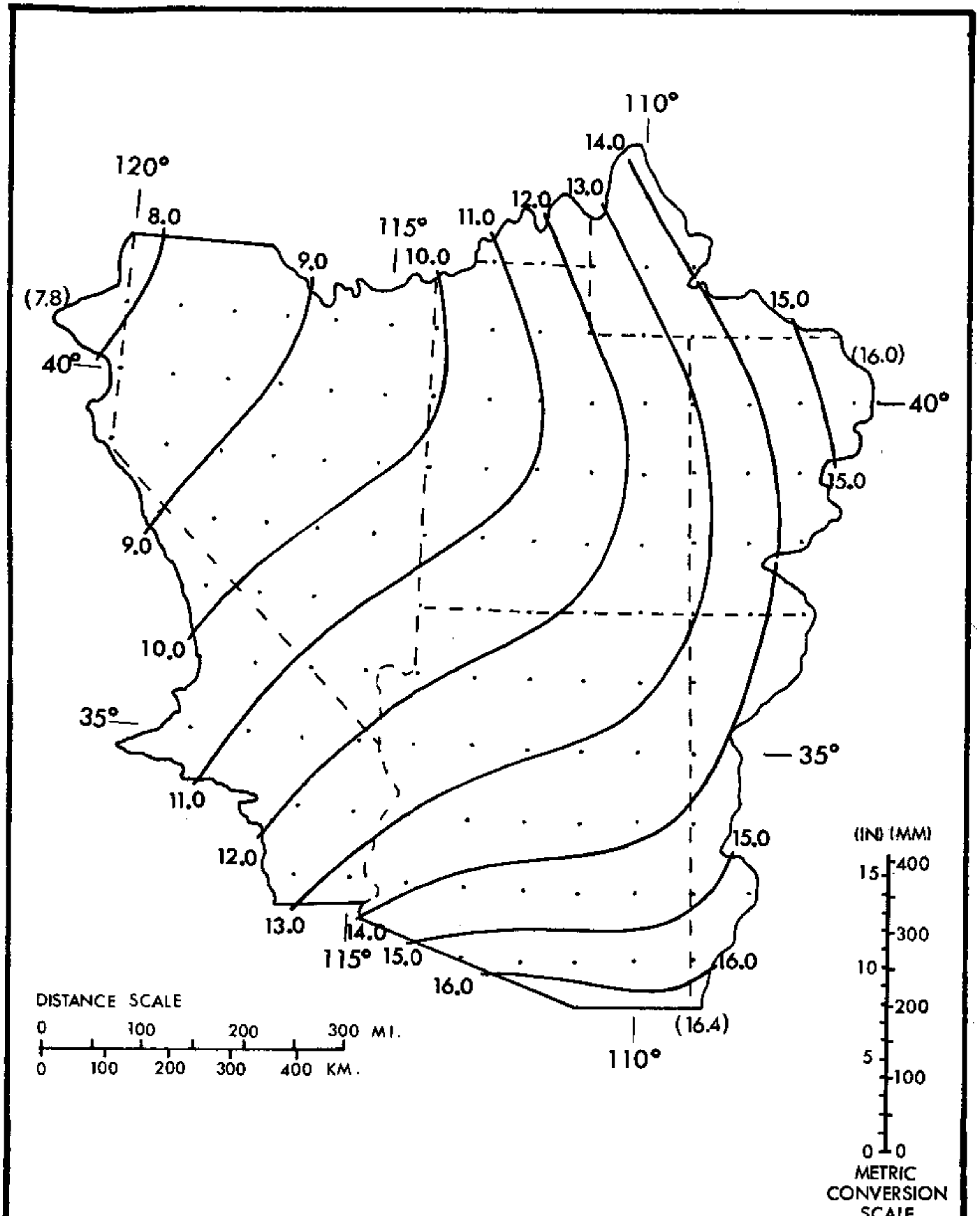


Figure 2.12.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for August. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

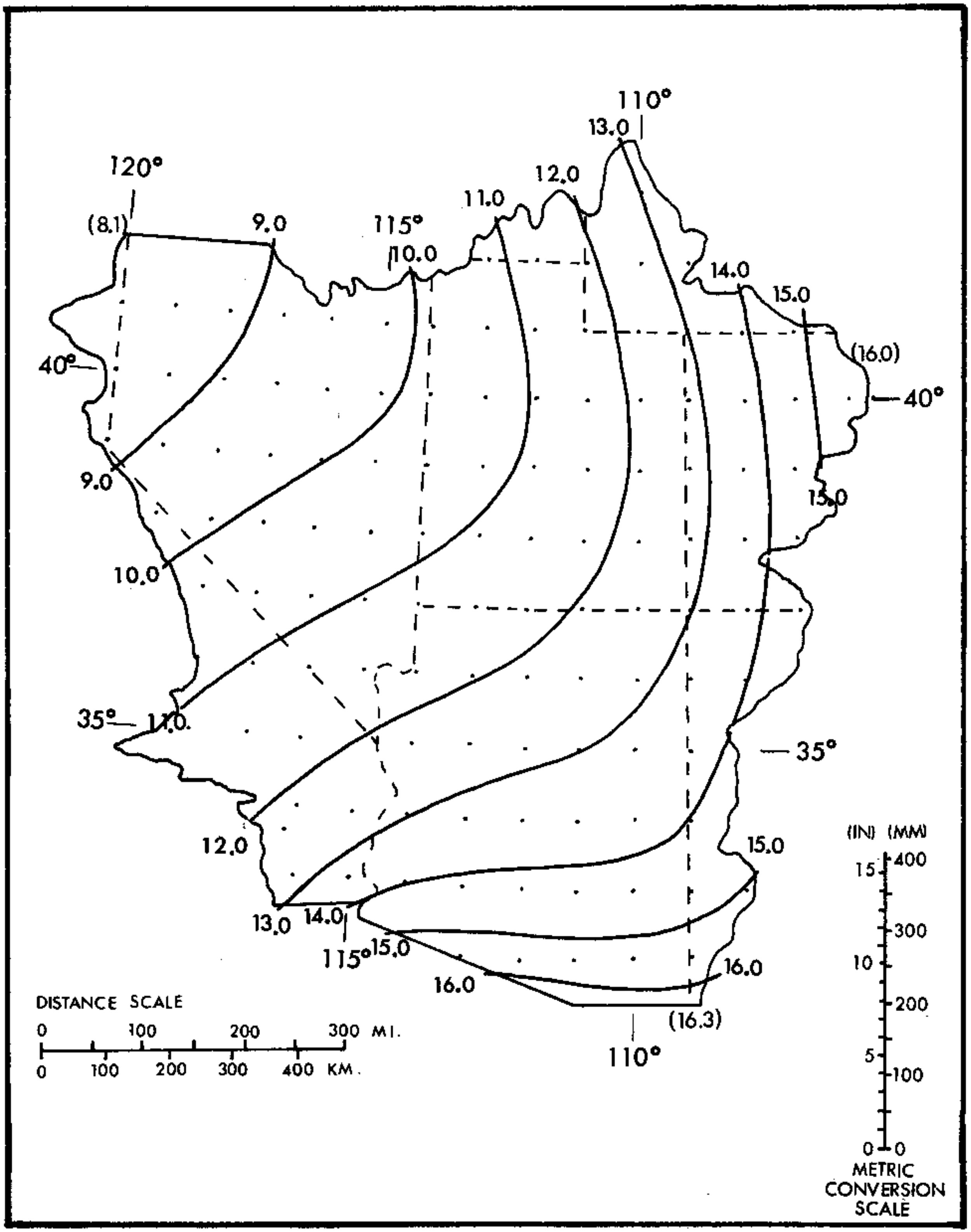


Figure 2.13.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi^2 (26 km^2) for September. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

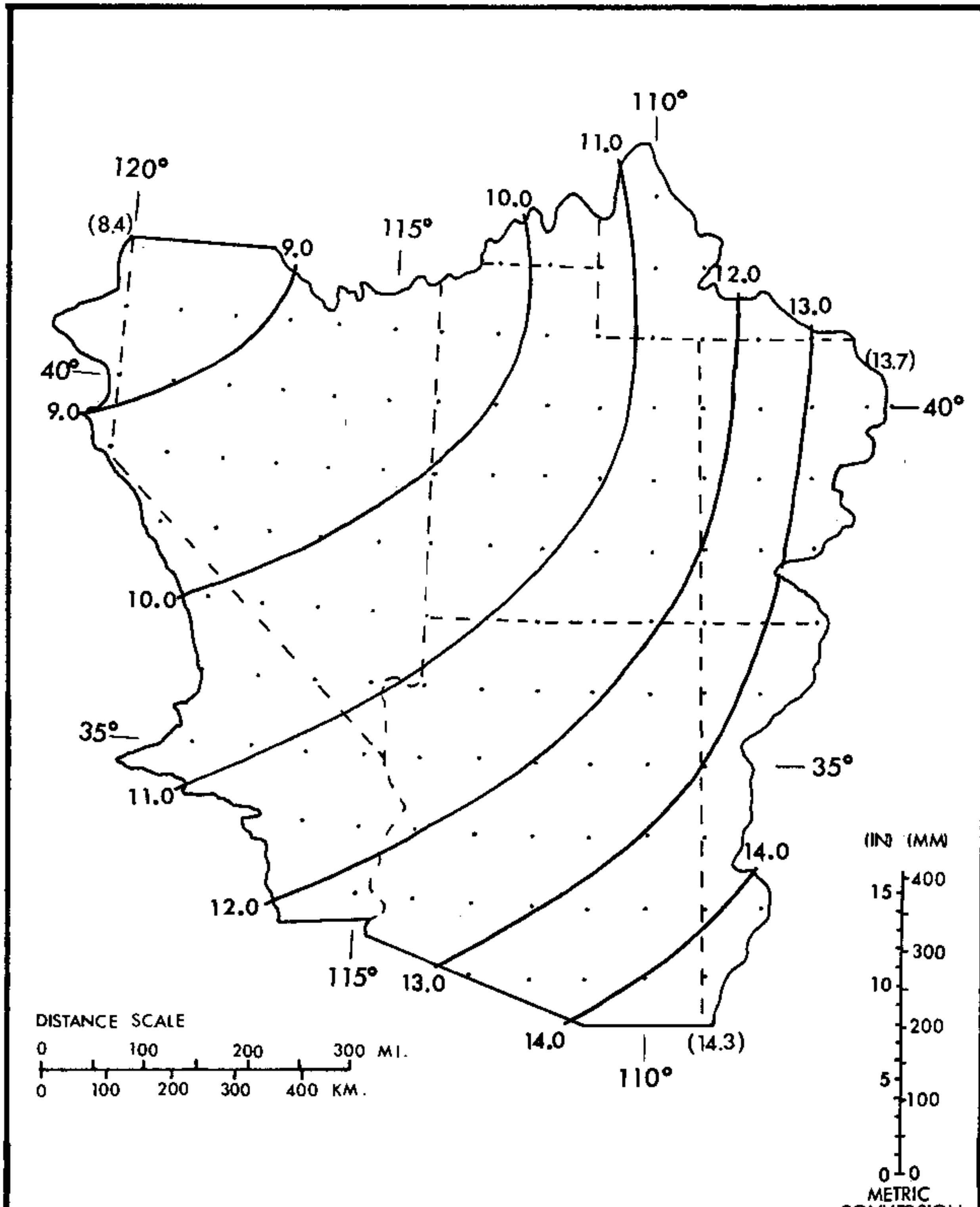


Figure 2.14.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for October. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

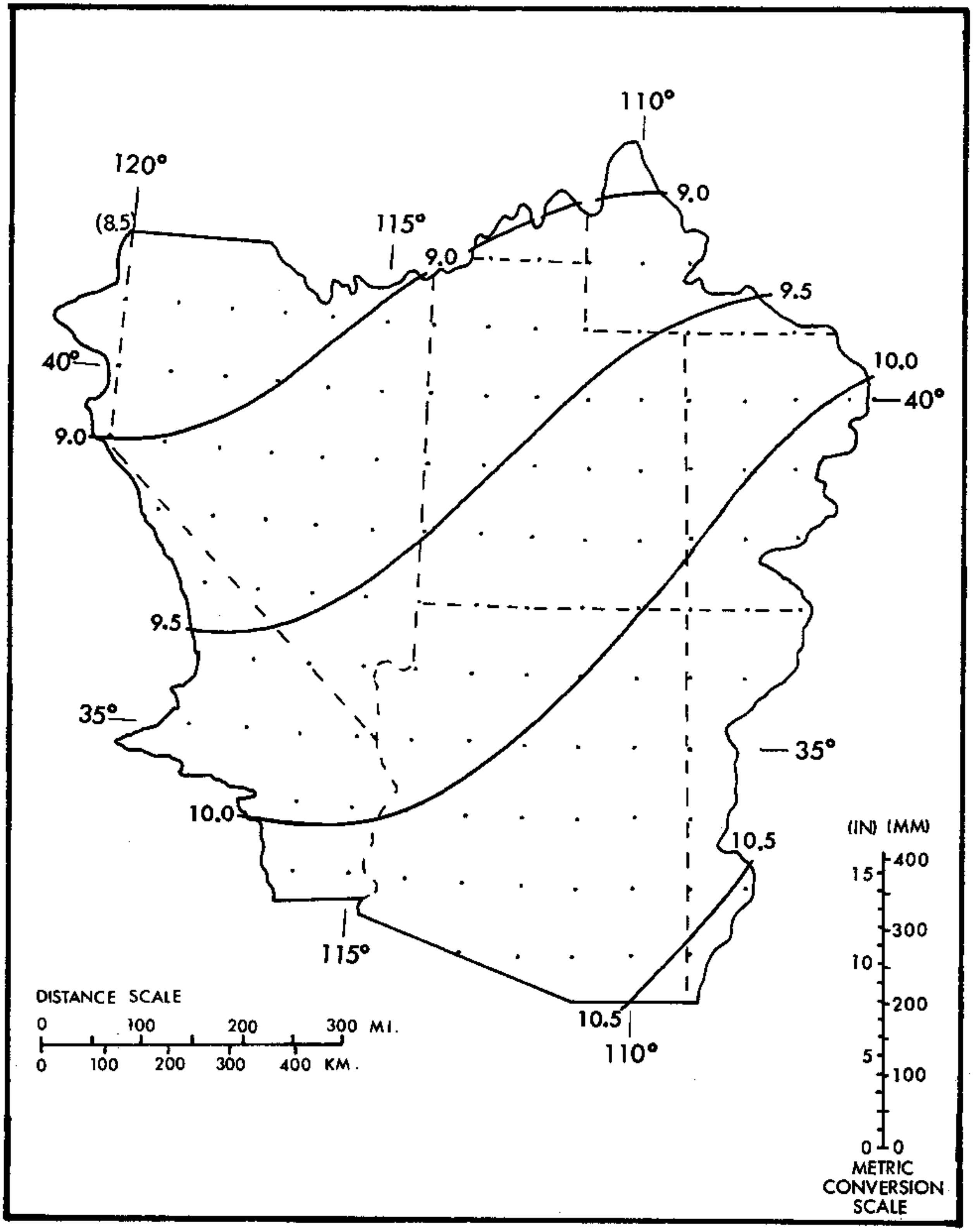


Figure 2.15.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for November. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

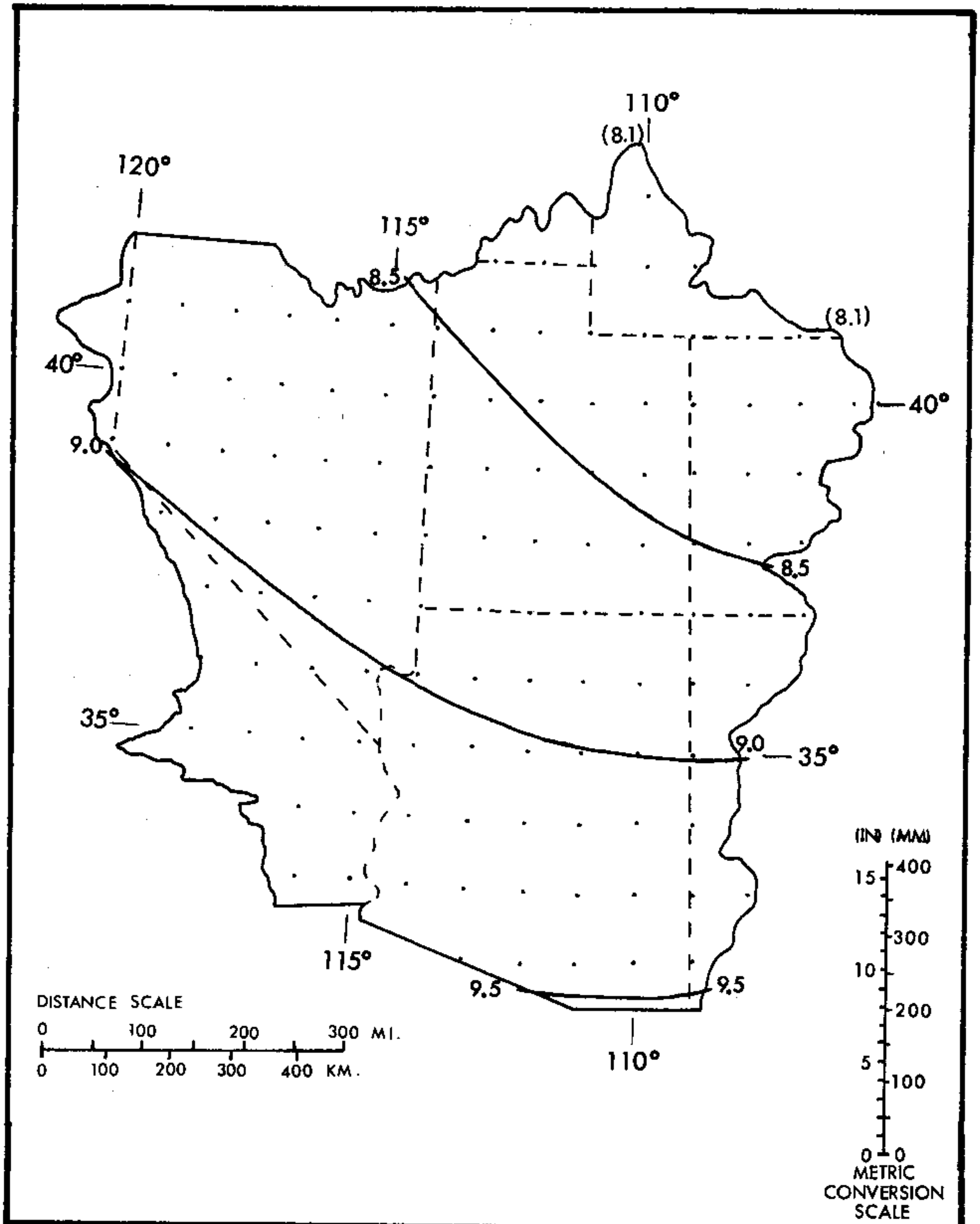


Figure 2.16.--1000-mb (100-kPa) 24-hr convergence PMP (inches) for 10 mi² (26 km²) for December. Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

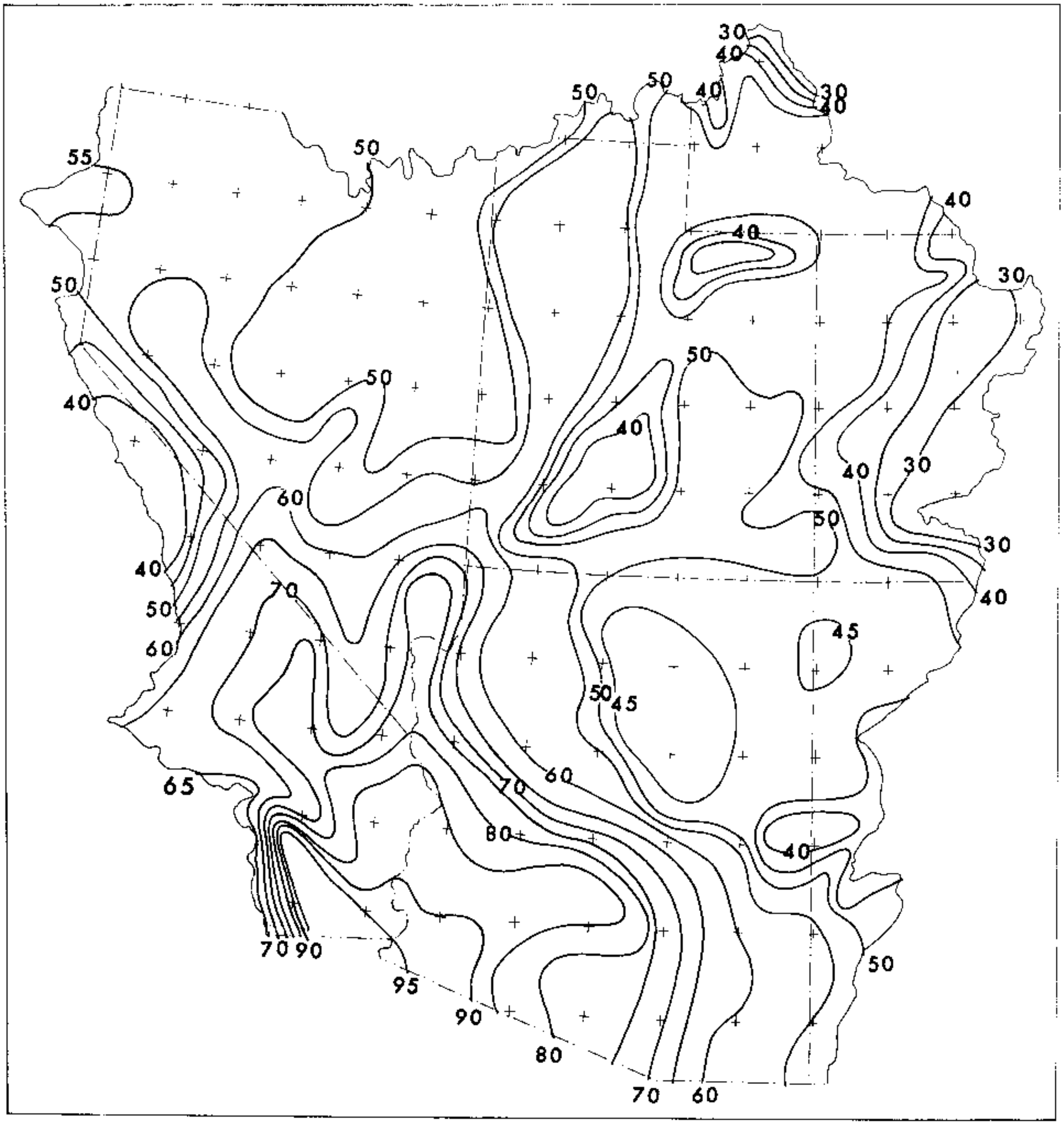
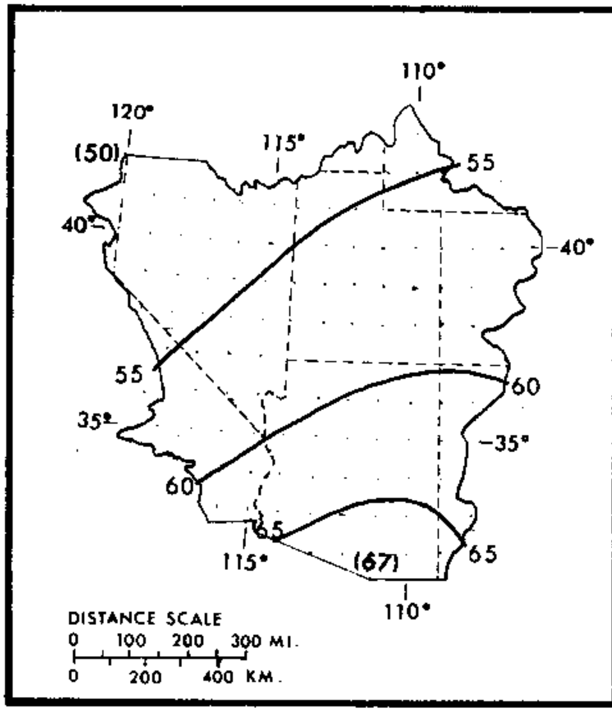
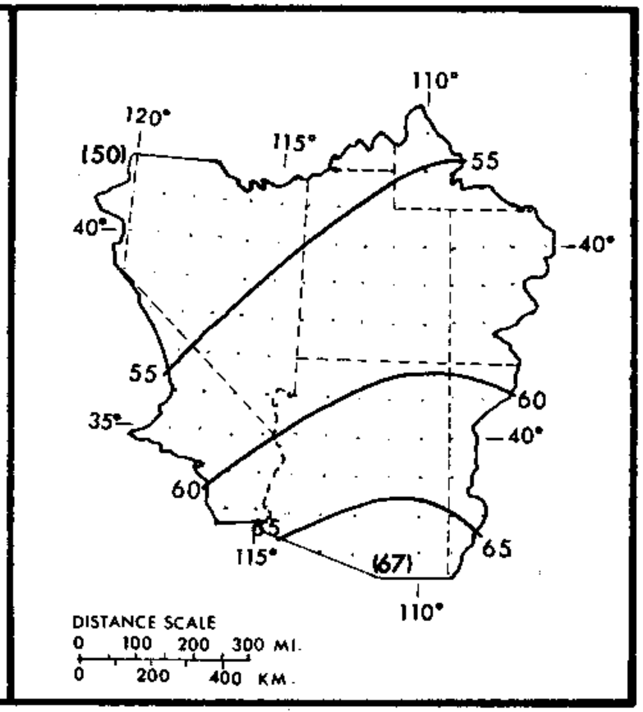


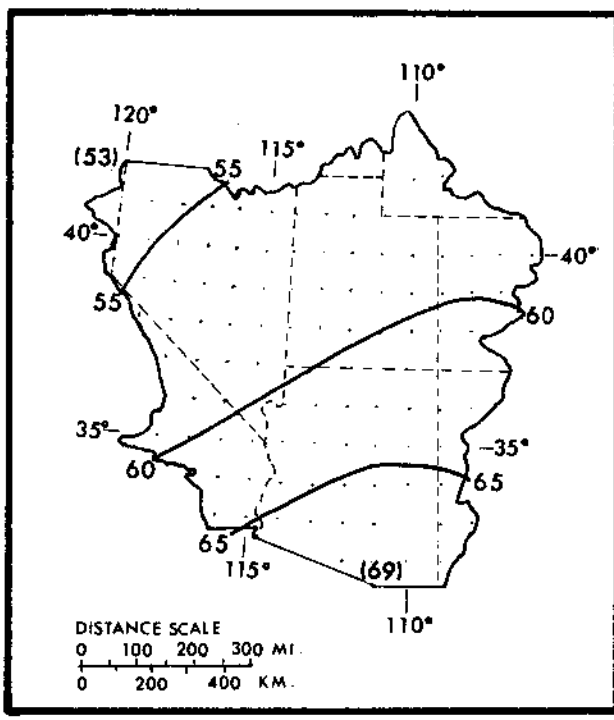
Figure 2.18.--Percent of 1000-mb (100-kPa) convergence PMP resulting from effective elevation and barrier considerations. Isolines drawn for every five percent.



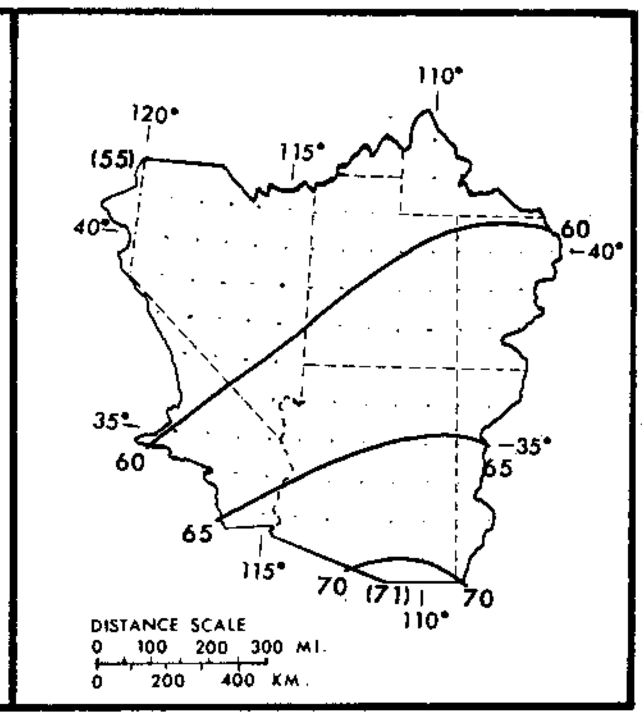
January



February

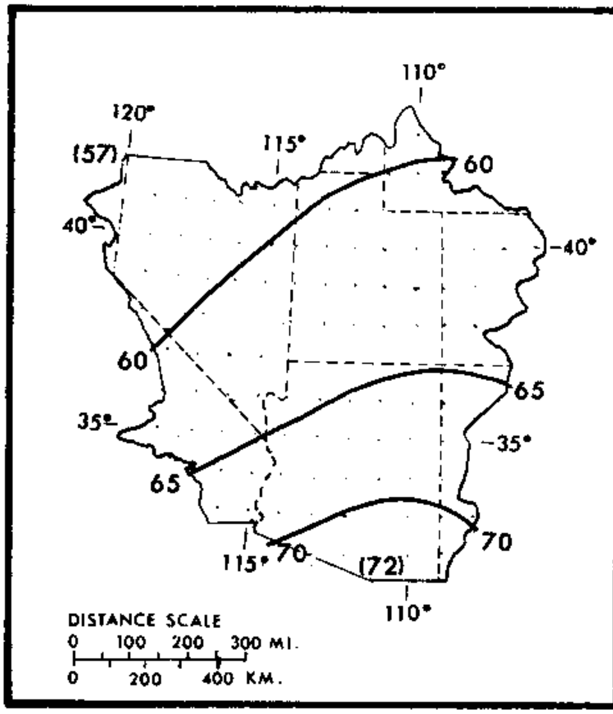


March

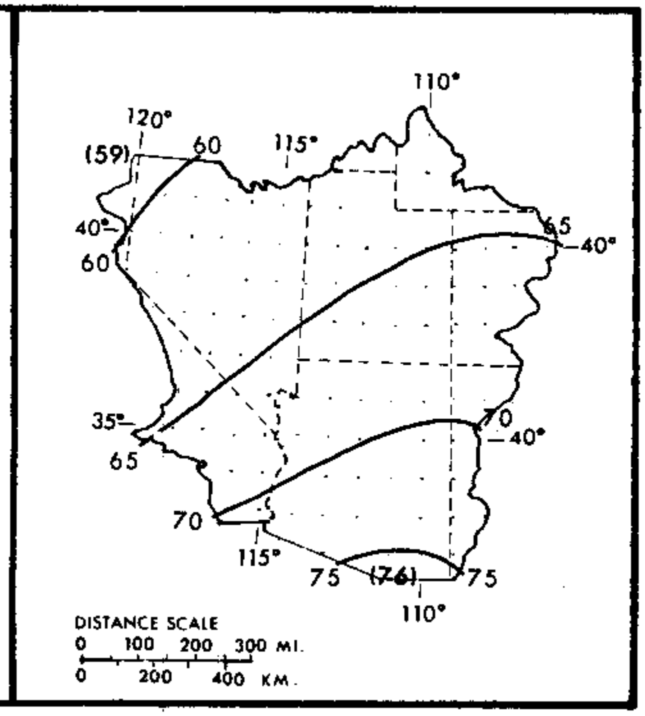


April

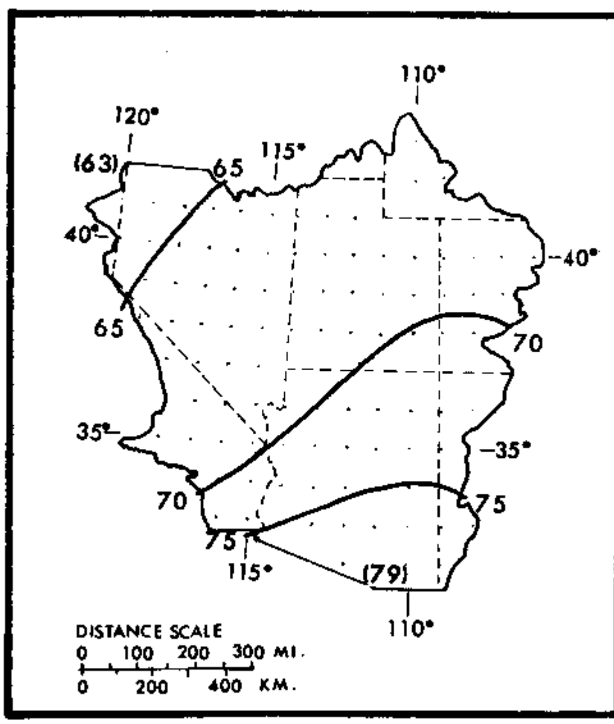
Figure 2.25.--Regional variation of 6/24-hr ratios by month (percent). Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.



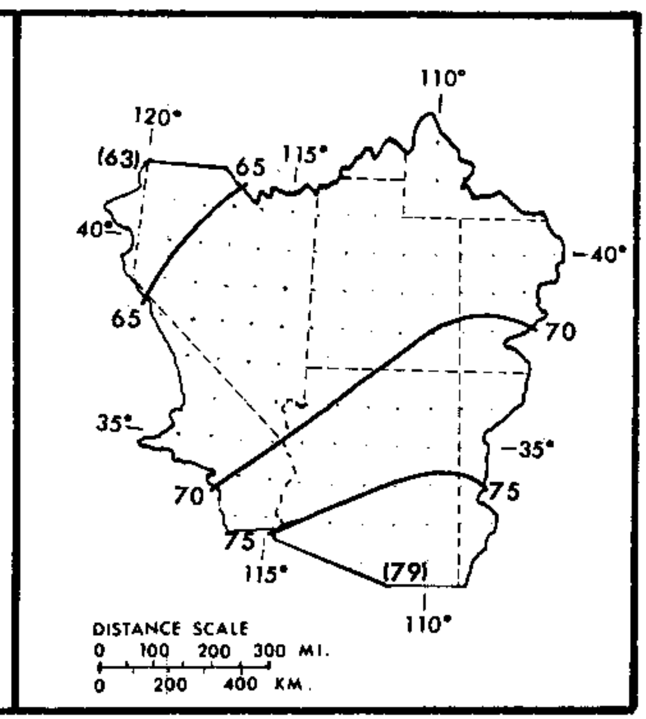
May



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.

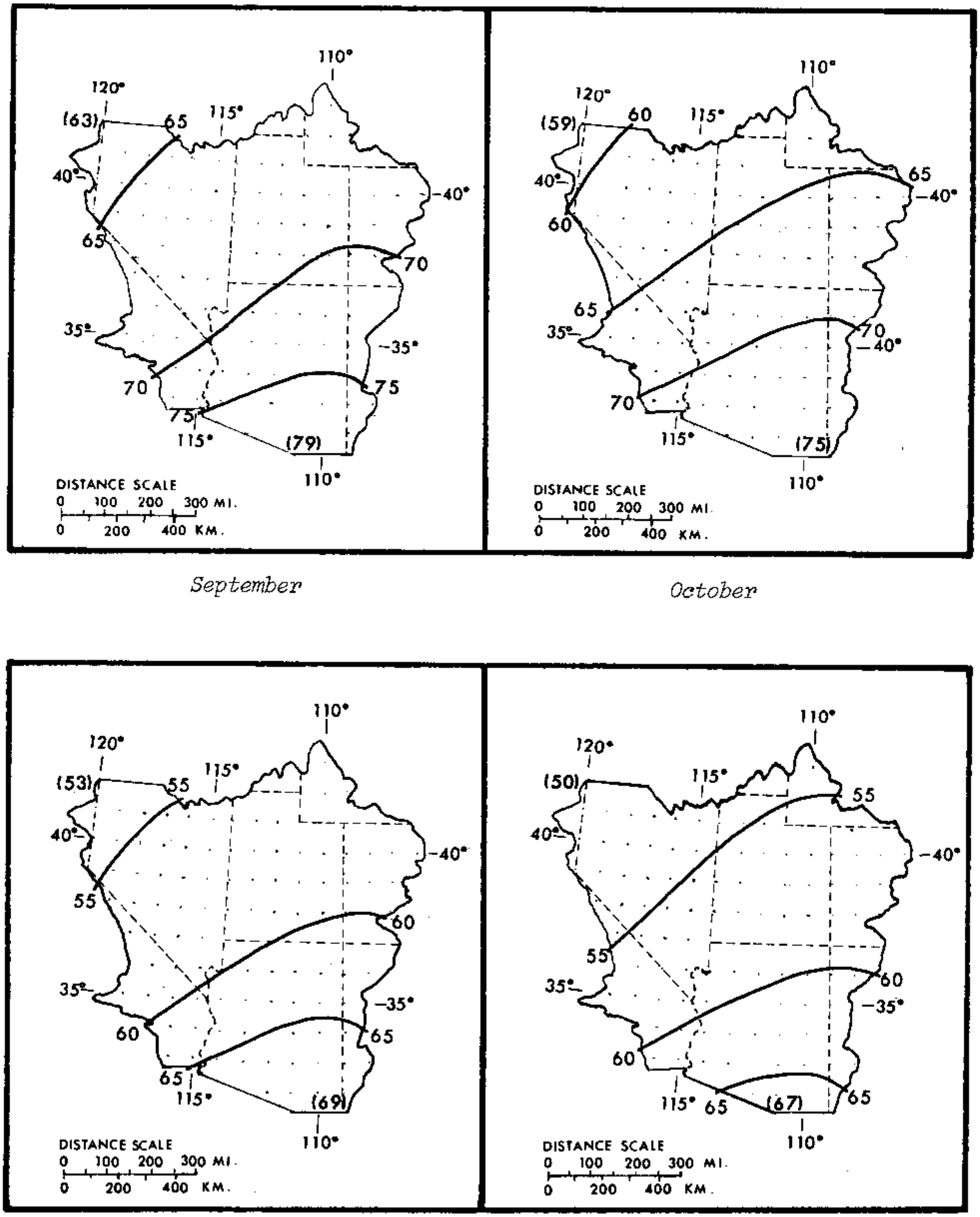


Figure 2.27.--Regional variation of 6/24-hr ratios by month (percent). Values in parentheses are limiting values and are to facilitate extrapolation beyond the indicated gradient.

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)						Duration (Hrs)					
6	12	18	24	48	72	6	12	18	24	48	72
50	76	90	100	129	150	66	84	93	100	116	124
51	77	90	100	128	148	67	85	94	100	116	123
52	77	90	100	127	146	68	85	94	100	115	122
53	77	91	100	127	144	69	86	94	100	115	121
54	78	91	100	126	142						
55	78	91	100	125	140	70	87	94	100	114	120
56	79	91	100	124	138	71	87	95	100	114	119
57	79	92	100	123	137	72	88	95	100	113	118
58	80	92	100	122	135	73	88	95	100	113	118
59	80	92	100	121	134	74	89	95	100	112	117
						75	89	96	100	112	116
60	81	92	100	120	132	76	90	96	100	111	115
61	81	92	100	120	131	77	90	96	100	110	114
62	82	93	100	119	129	78	91	96	100	110	114
63	82	93	100	118	128	79	92	97	100	109	113
64	83	93	100	117	126						
65	84	93	100	117	125	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.

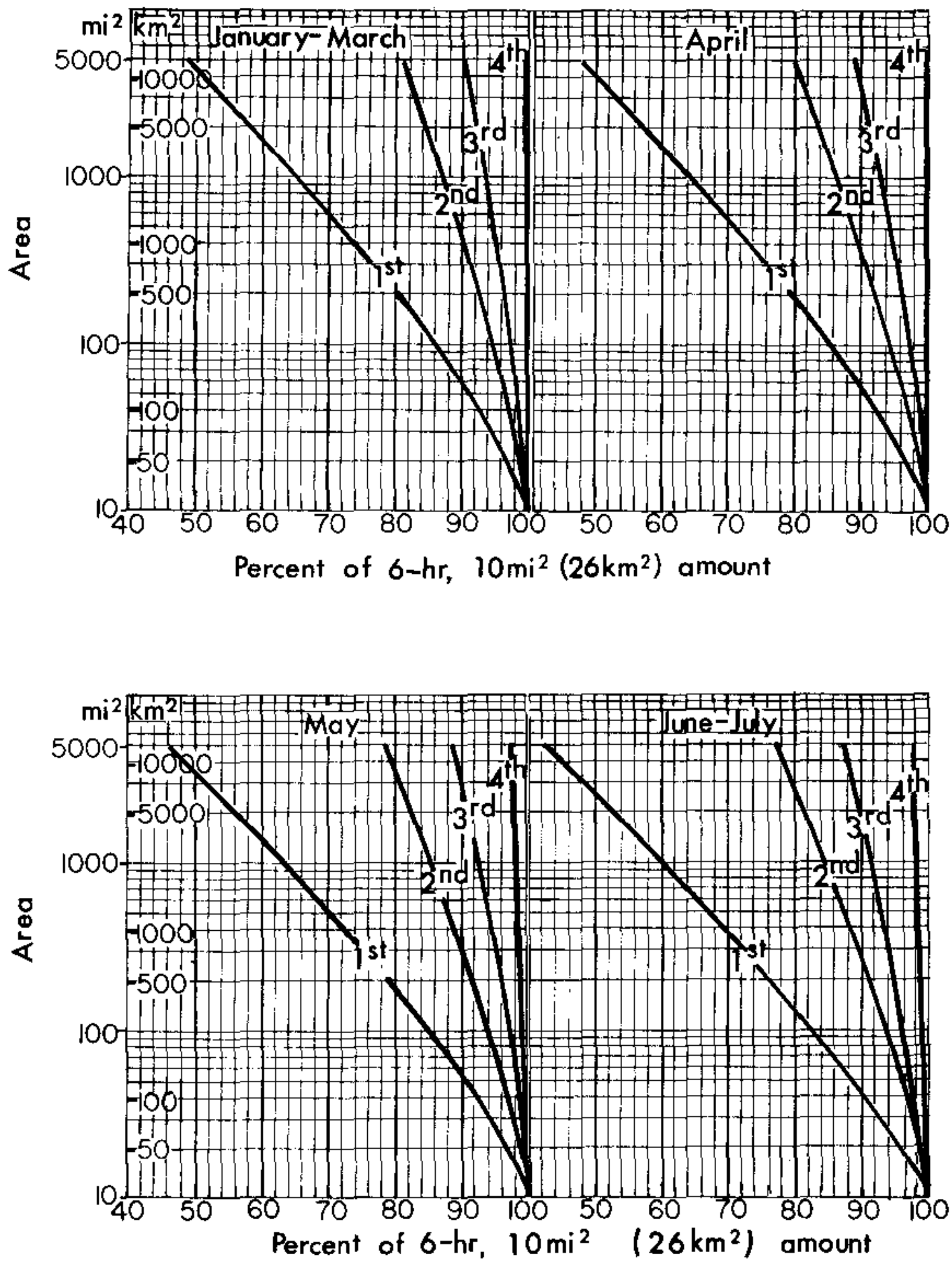


Figure 2.28.--Depth-area variation for convergence PMP for first to fourth 6-hr increments.

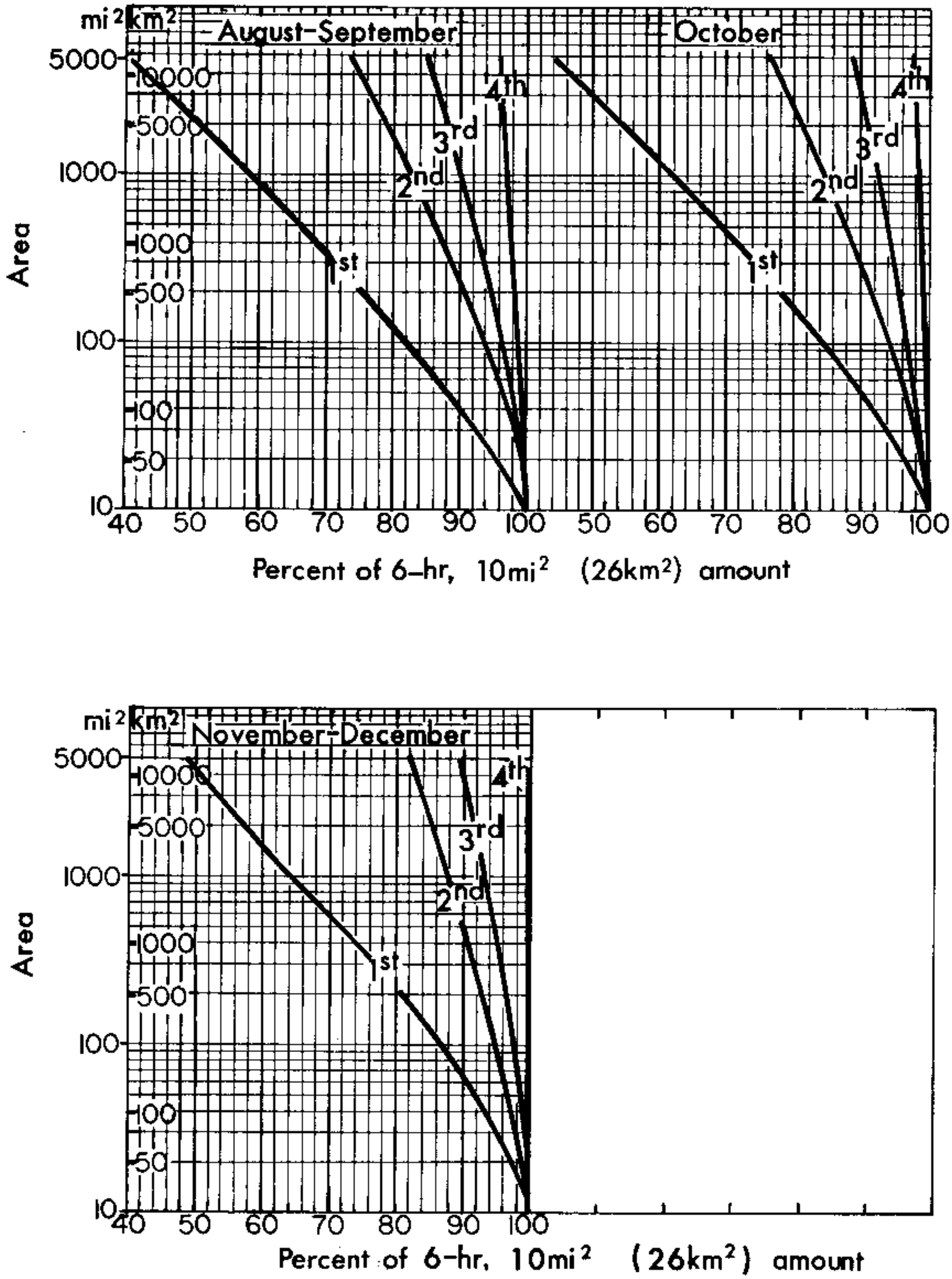


Figure 2.29.--Depth-area variation for convergence PMP for first to fourth 6-hr increments.

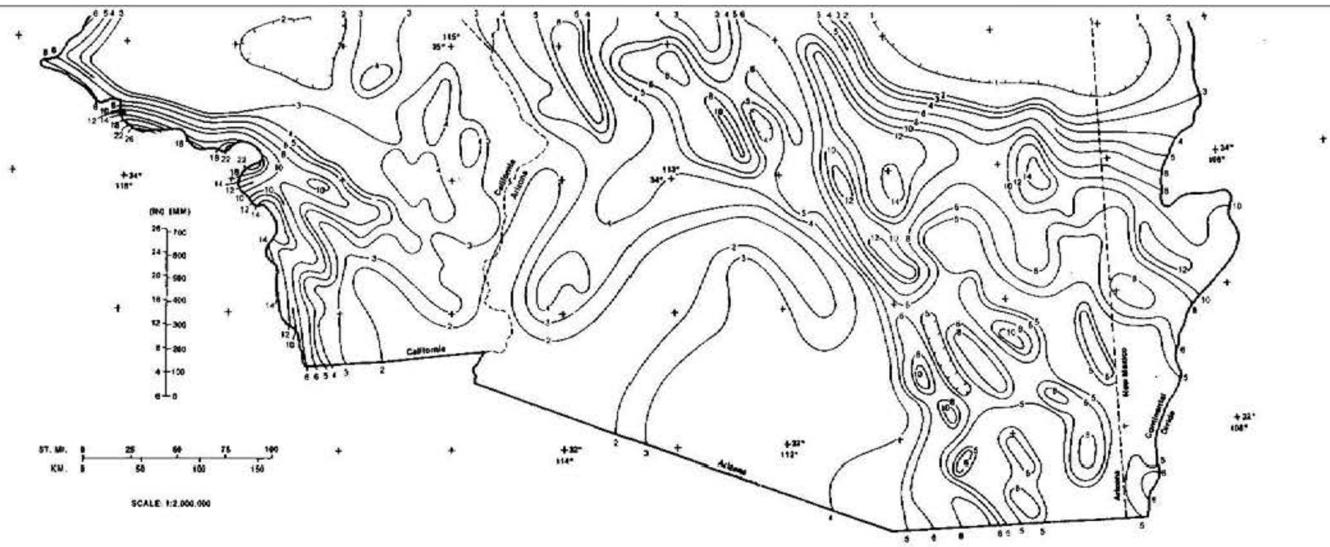
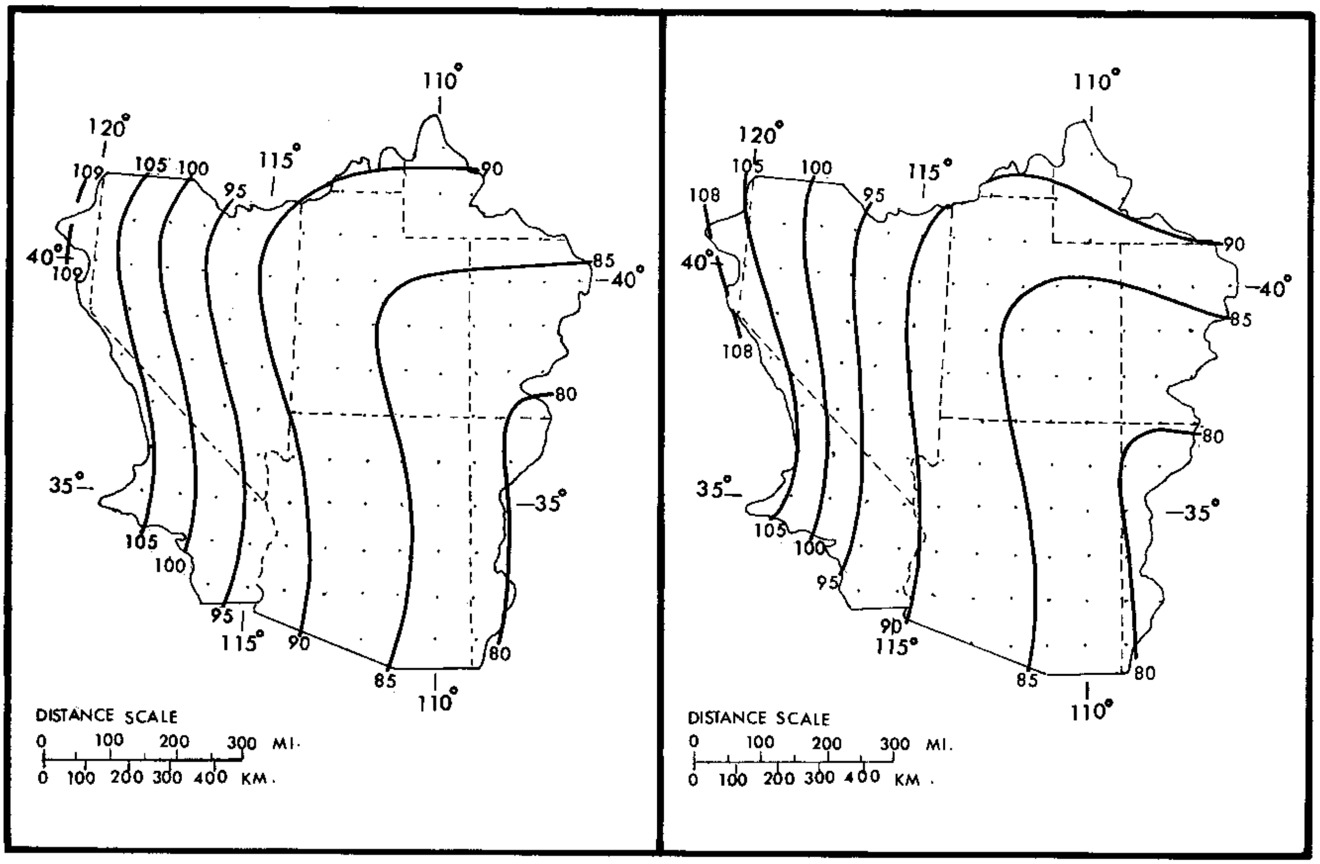
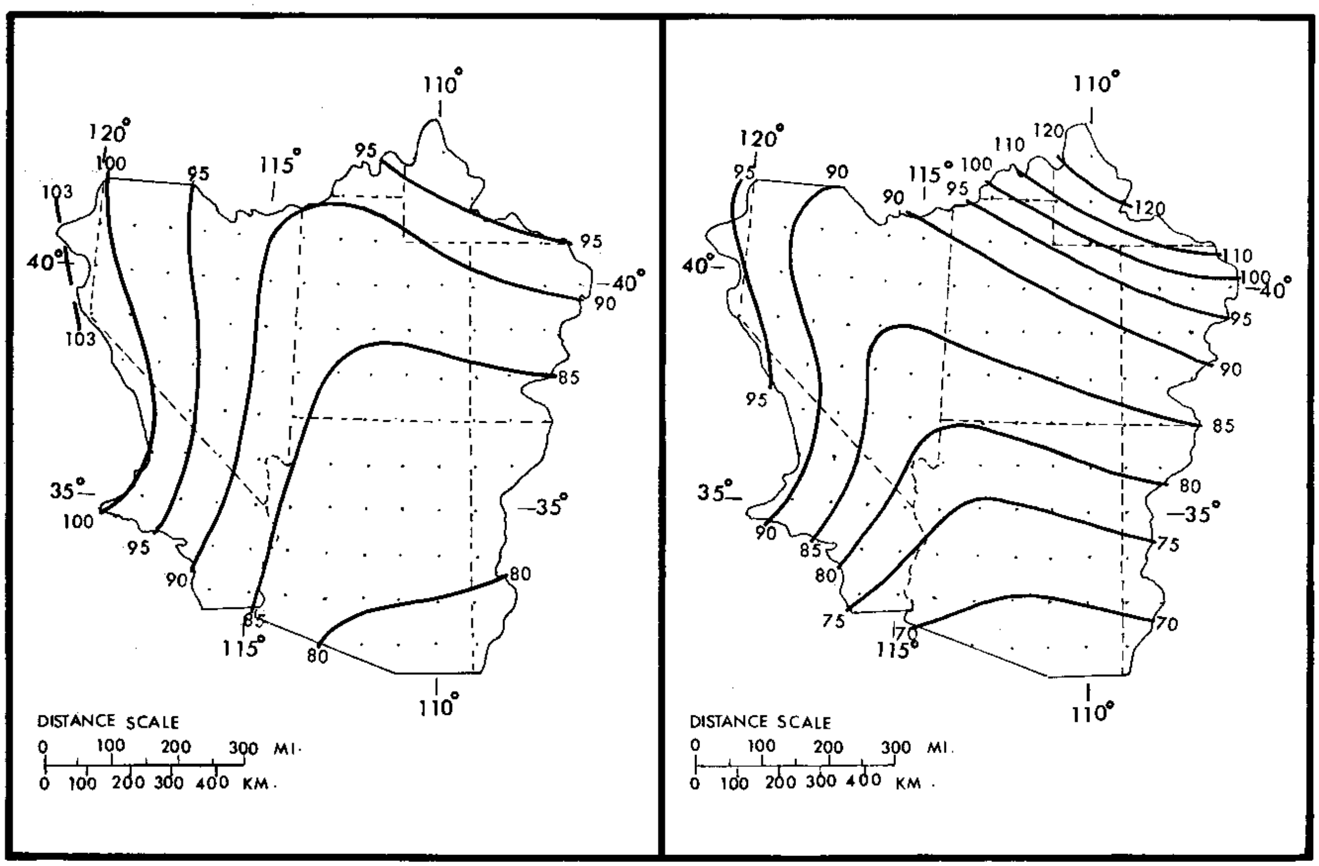


FIGURE 3.11d (Revised) — 10 mi² (26 km²) 24 hr orographic PMP index map (inches), southern section.



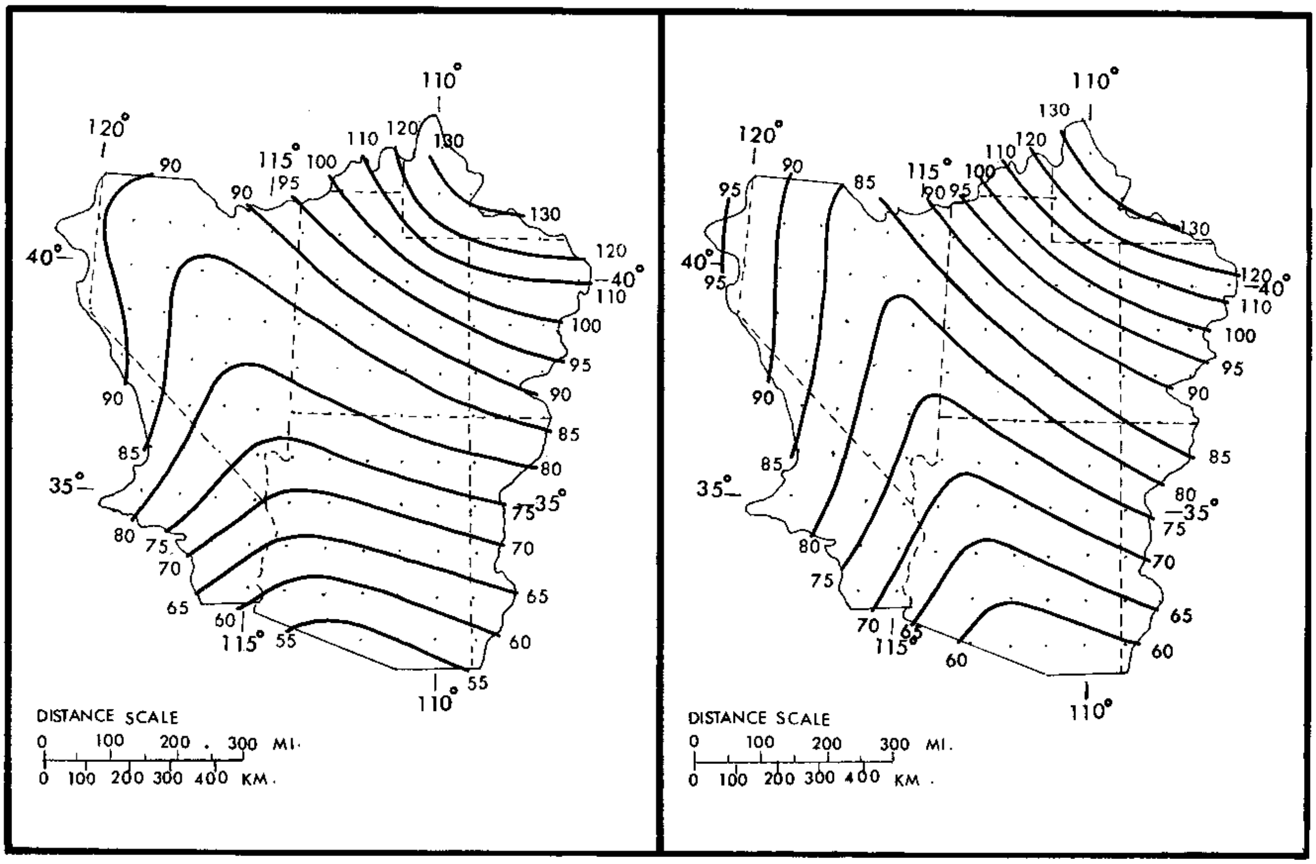
January *February*

Figure 3.12.--Seasonal variation in 10-mi^2 (26-km^2) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



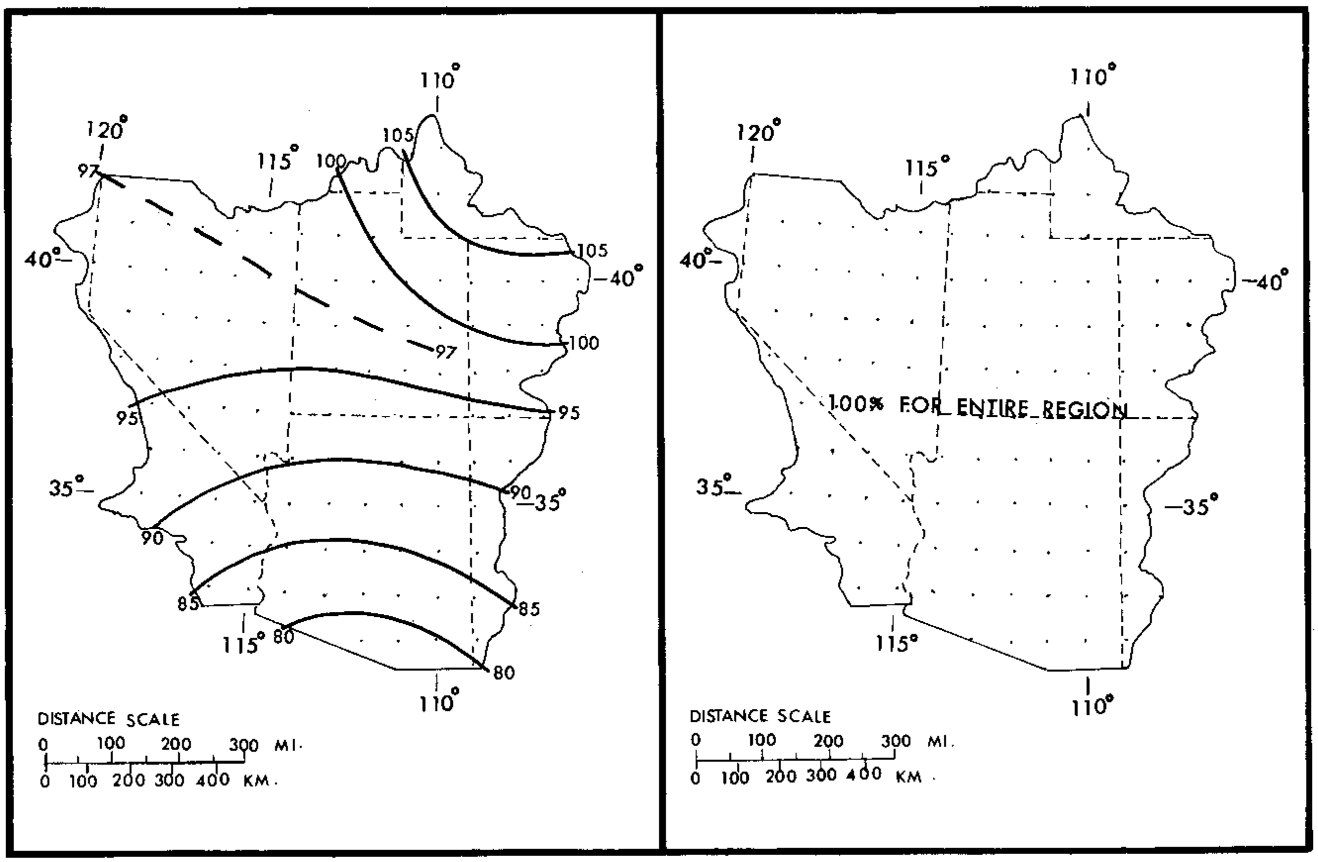
March *April*

Figure 3.13.--Seasonal variation in 10-mi² (26-km²) 24-hr orographic PMP for the study region (in percent of values in figure 3.11).



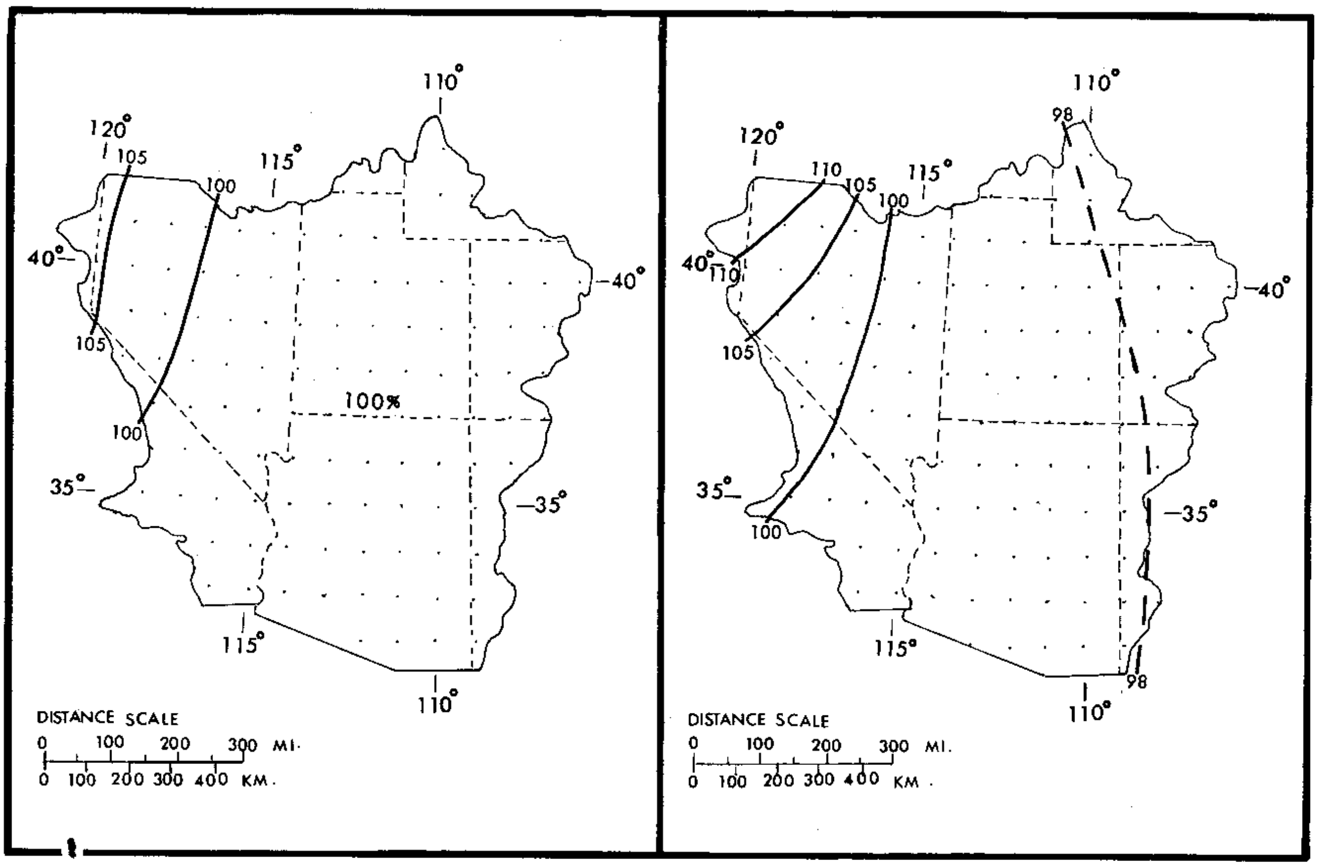
May *June*

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).



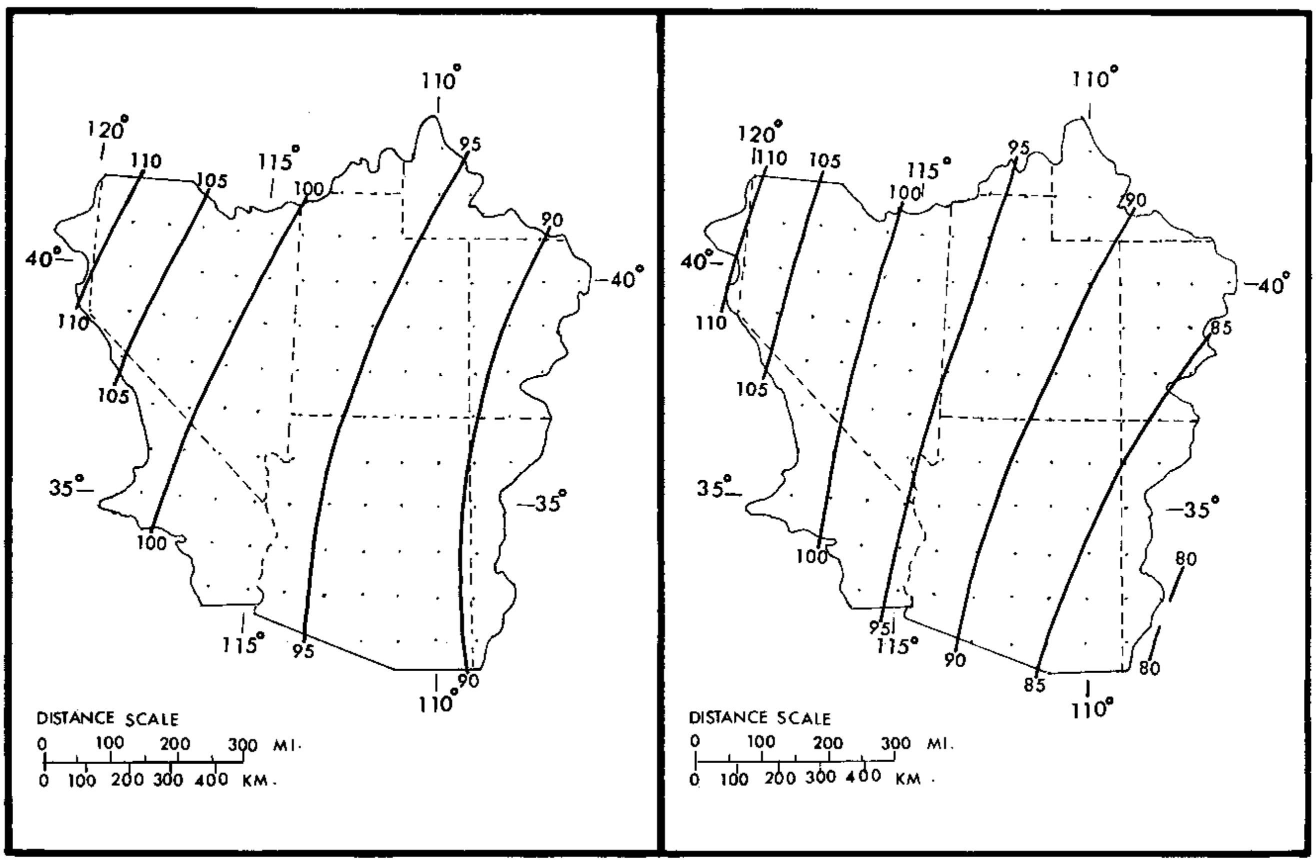
July *August*

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-mi^2 (26-km^2) 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	Description	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

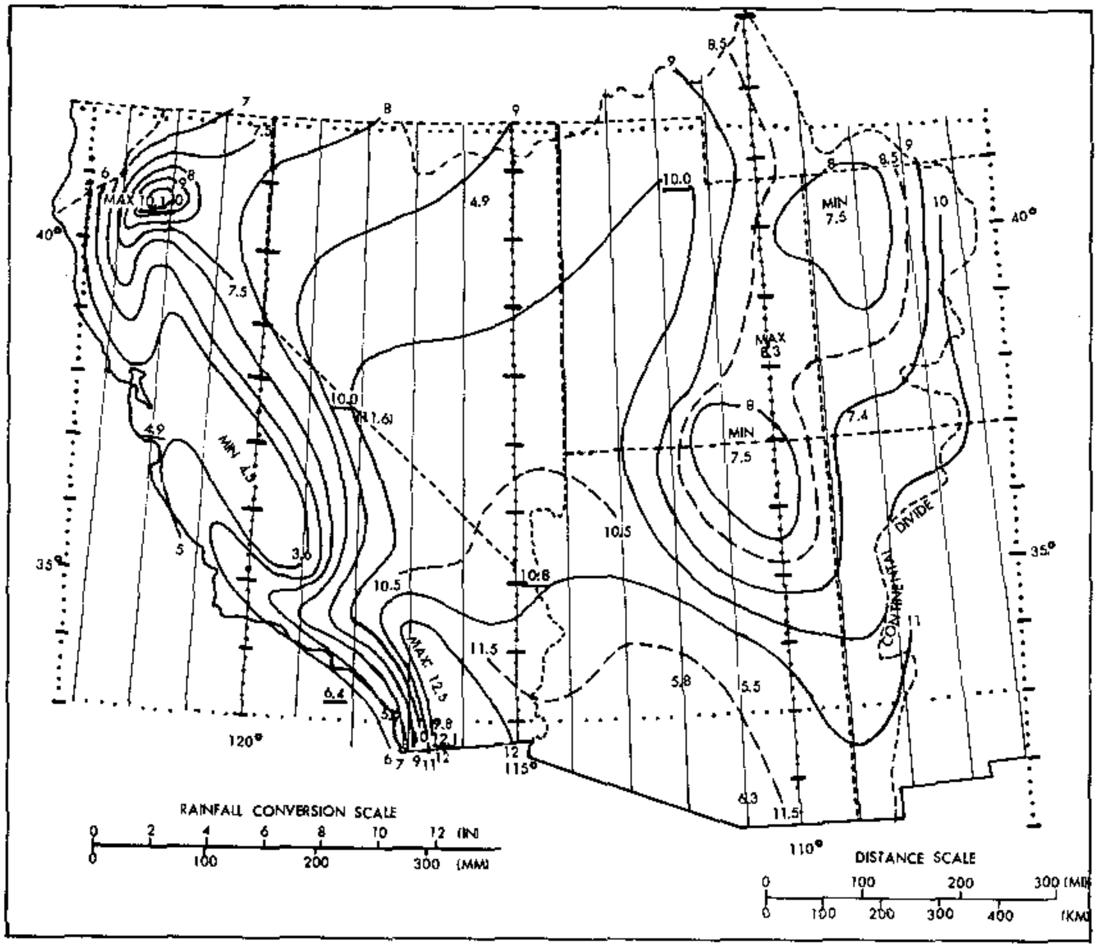


Figure 4.5--Local-storm PMP for 1 mi^2 (2.6 km^2) 1 hr. Directly applicable for locations between sea level and 5000 ft (1524 m). Elevation adjustment must be applied for locations above 5000 ft.

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.

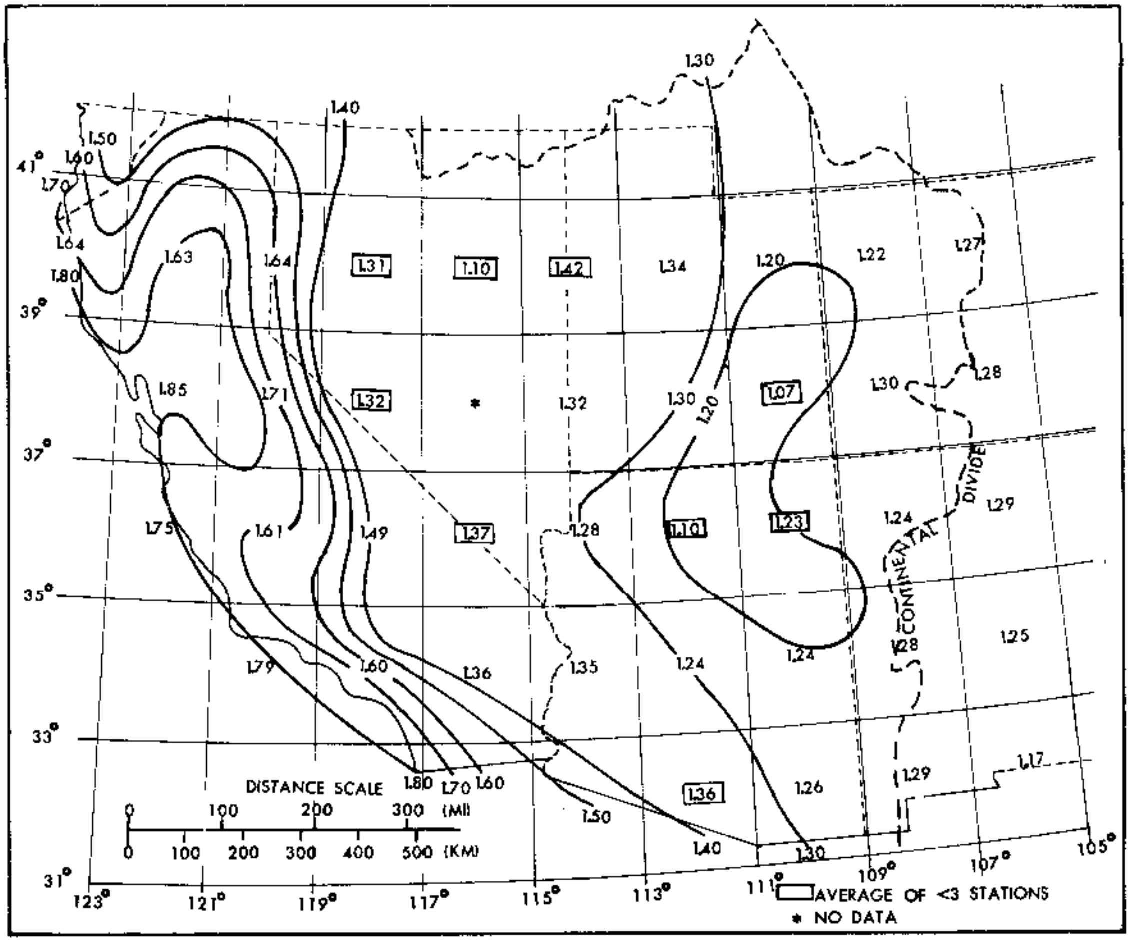


Figure 4.7.--Analysis of 6/1-hr ratios of averaged maximum station data (plotted at midpoints of a 2° latitude-longitude grid).

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.

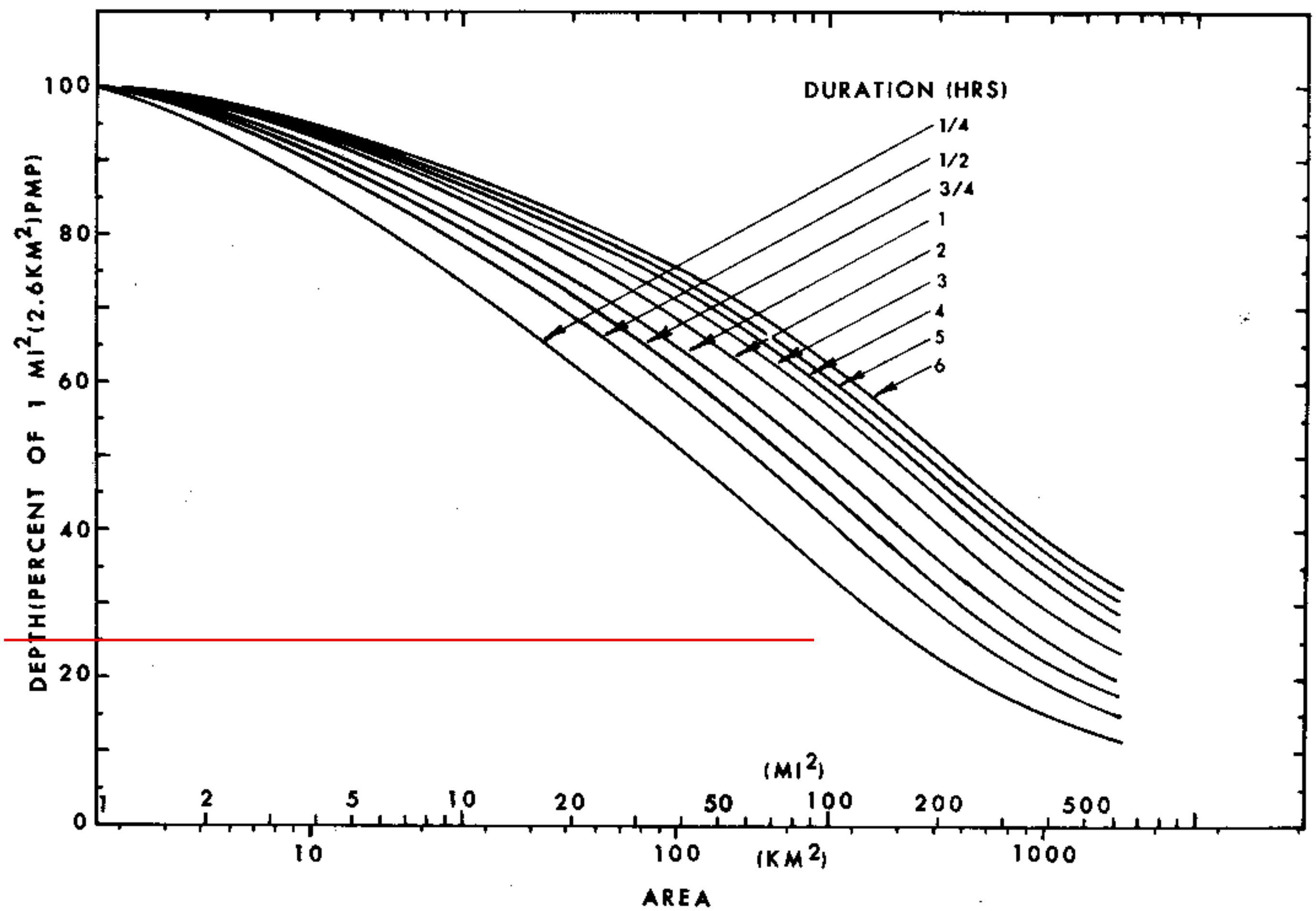


Figure 4.9.--Adopted depth-area relations for local-storm PMP.

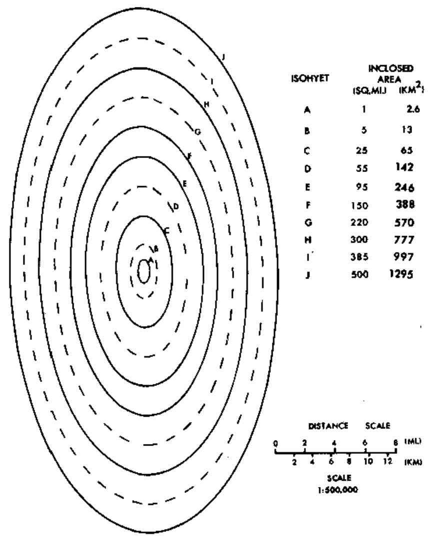


Figure 4.10.--Idealized local-storm isohyetal pattern.

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

	HMR No. 5[1]	EM1110-2-1411[2]
Increment	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

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)

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\J-REPORTS\Seismic Hazard\Hermosa Seismic Hazard Report.docx

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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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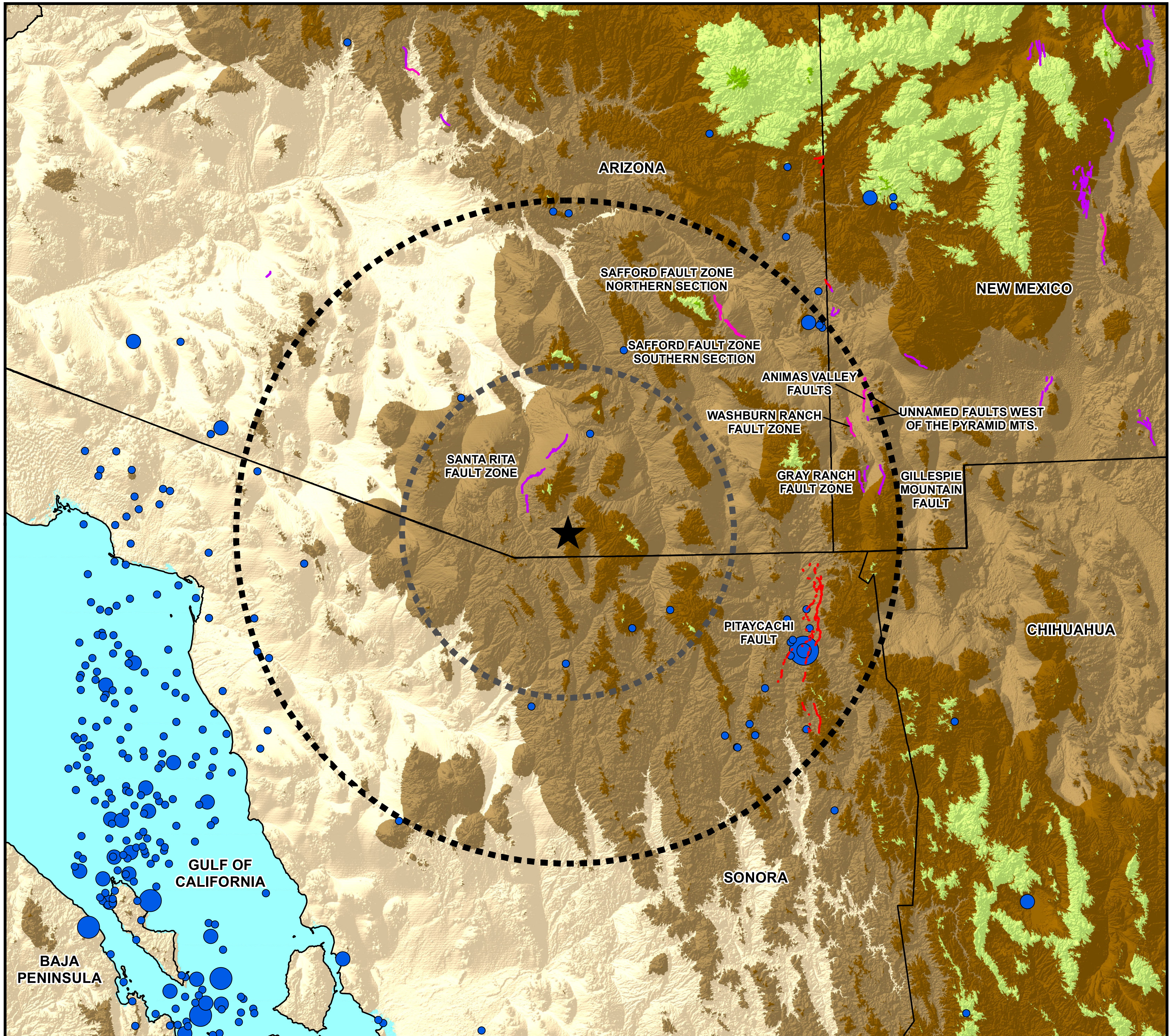
FIGURE



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

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

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\X-GIS\MAPS\GIS-0014.008.001F.mxd

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)	(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:

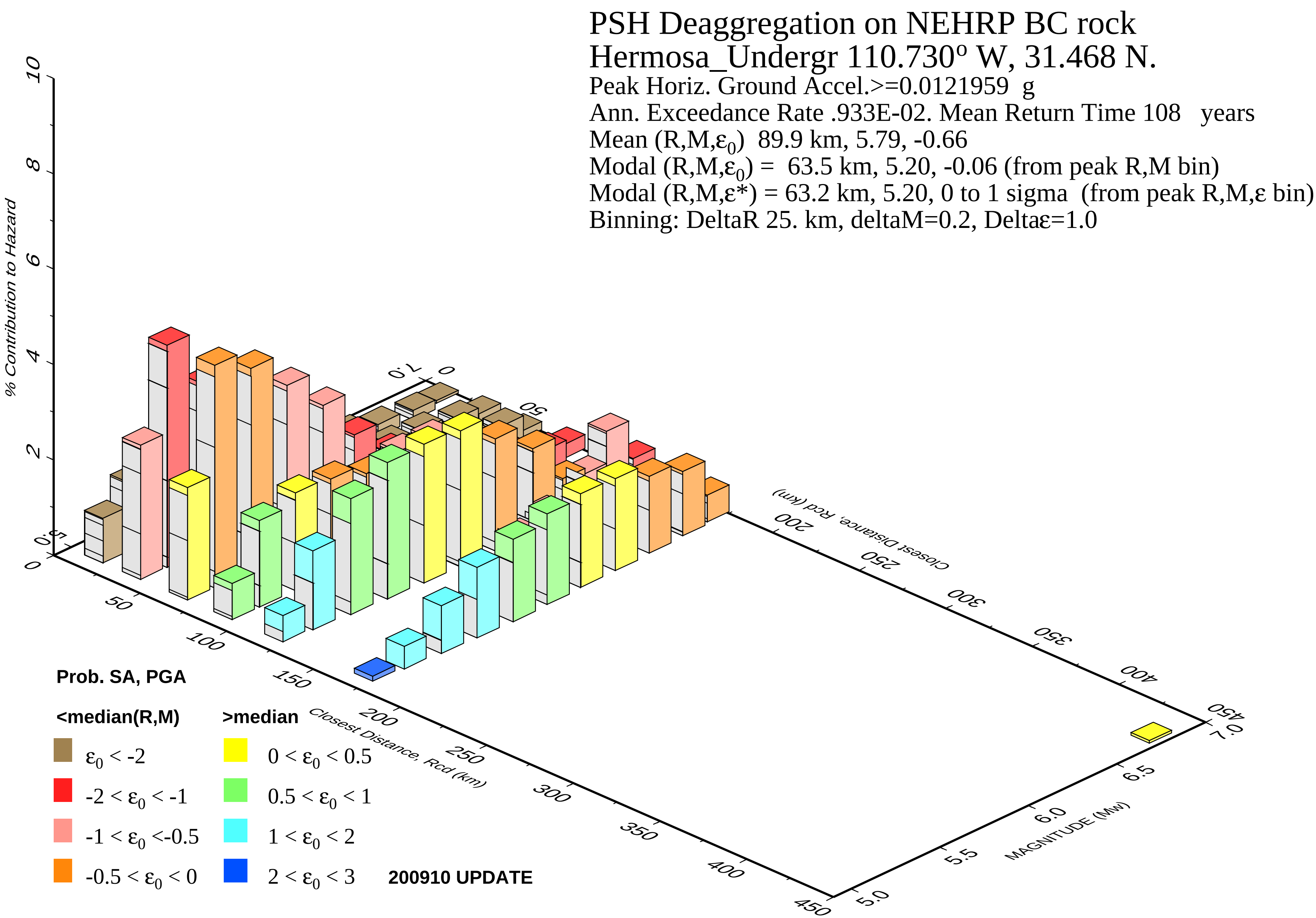
1 Body wave (Mb) magnitudes were converted to moment magnitude (Mw) using relationships presented by Scordilis (2006). Duration magnitude (Md), local magnitudes (Ml) and unknown magnitude scales were not converted.

2 Spudich et al., (1997)

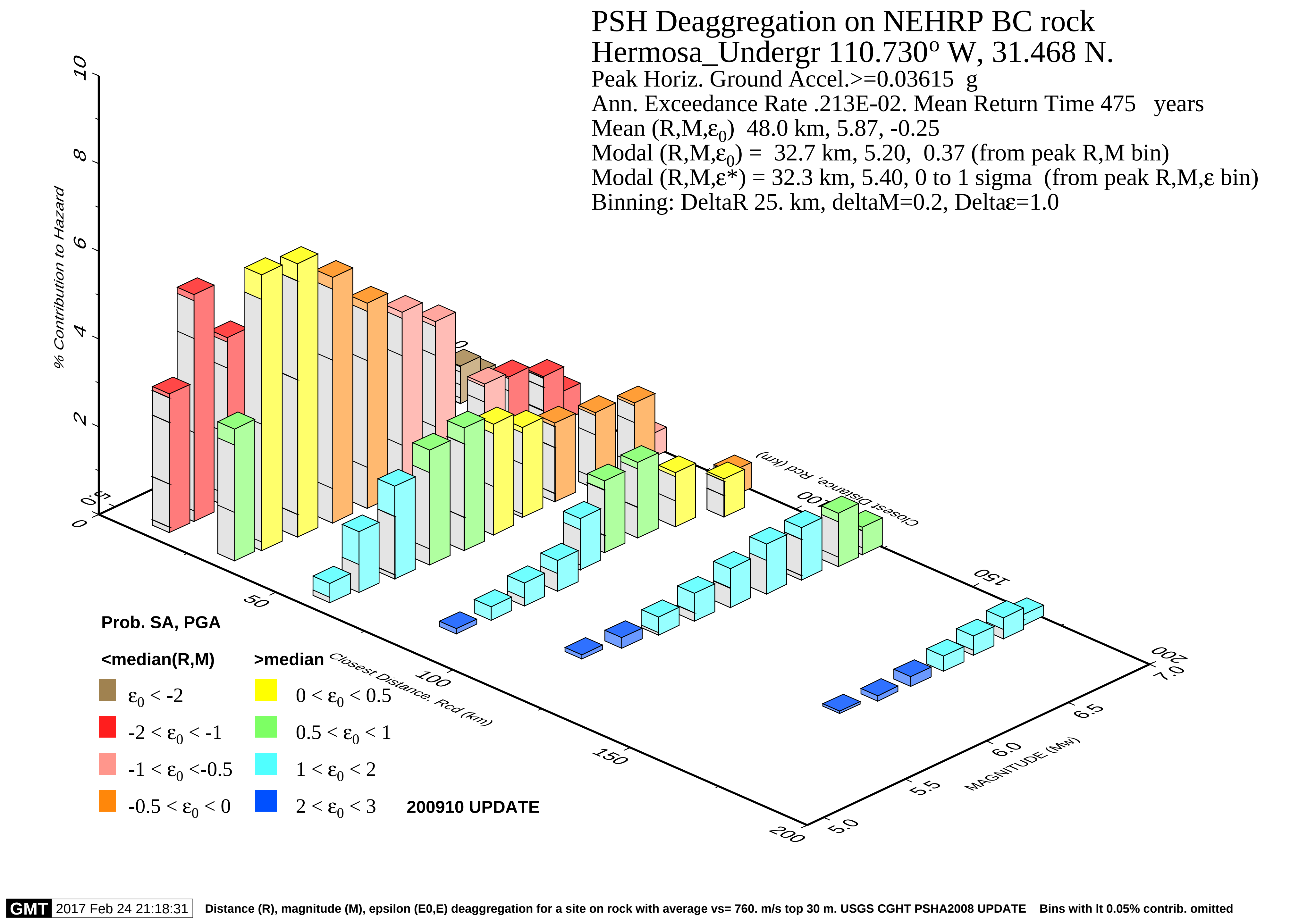
3 Boore et al., (1993)

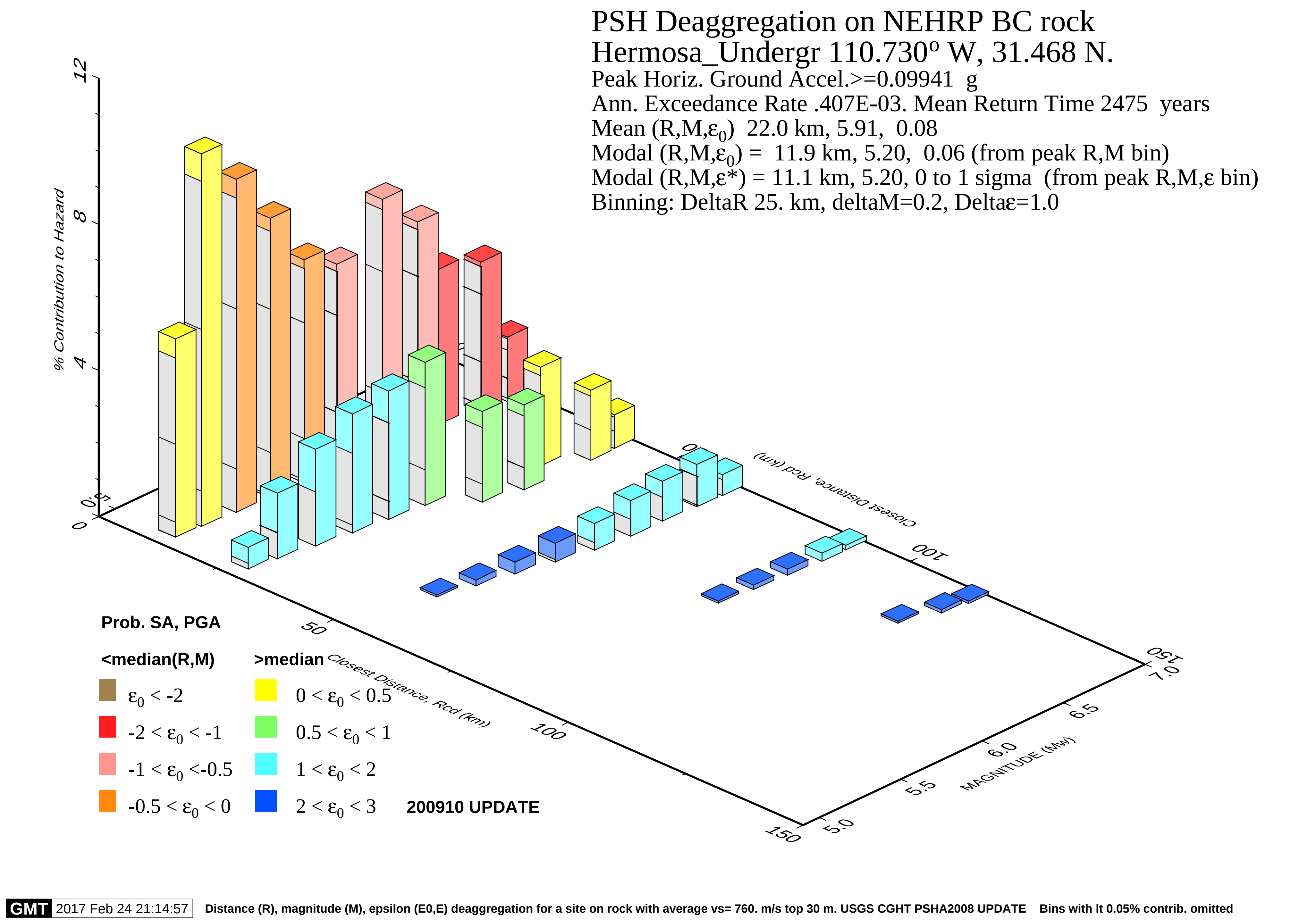
APPENDIX B

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,ε0) 48.0 km, 5.87, -0.25
Modal (R,M,ε0) = 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
% Contribution to Hazard
0
2
4
6
8
10
50
100
150
200
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 21:18:31
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
12
8
4
0
Closest Distance, Rcd (km)
50
100
150
MAGNITUDE (Mw)
5.0
5.5
6.0
6.5
7.0
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

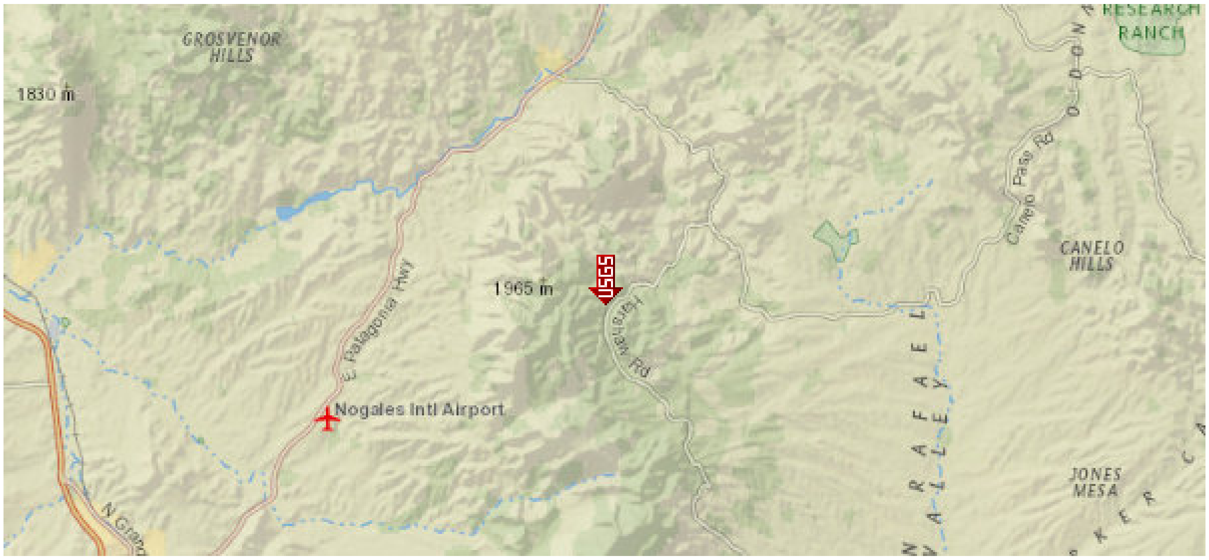
APPENDIX C

CODE BASED SEISMIC PARAMETERS

Design Maps Summary Report

User–Specified Input

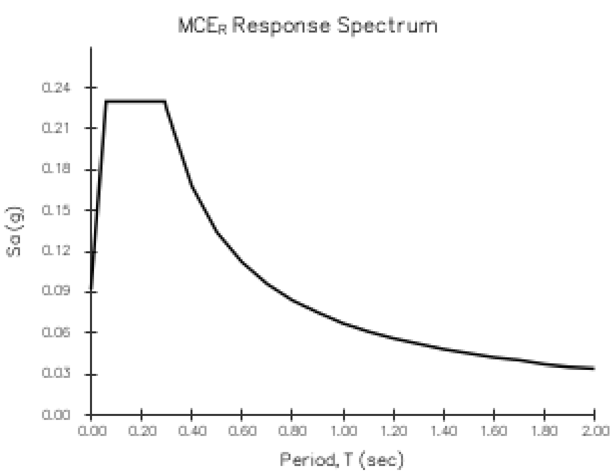
Report Title	Hermosa Underground Project Fri February 24, 2017 21:49:31 UTC
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	31.468°N, 110.73°W
Site Soil Classification	Site Class B – "Rock"
Risk Category	I/II/III

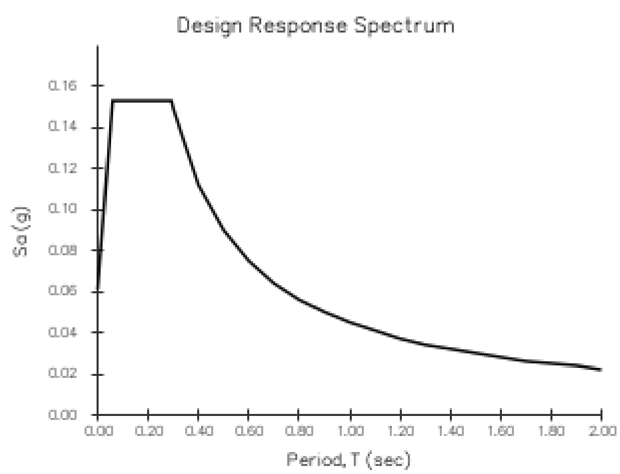


USGS–Provided Output

$S_S =$ 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.

USGS 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				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
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				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
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

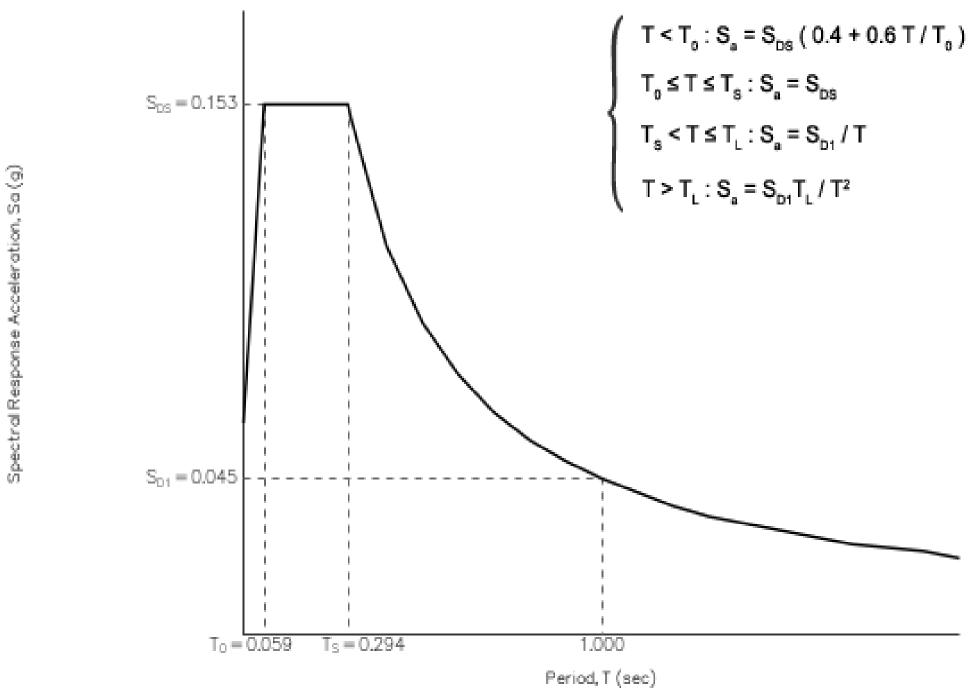
Equation (11.4–3): $S_{DS} = ⅔\ S_{MS} = ⅔ \times 0.230 = 0.153$ g

Equation (11.4–4): $S_{D1} = ⅔\ S_{M1} = ⅔ \times 0.067 = 0.045$ g

Section 11.4.5 — Design Response Spectrum

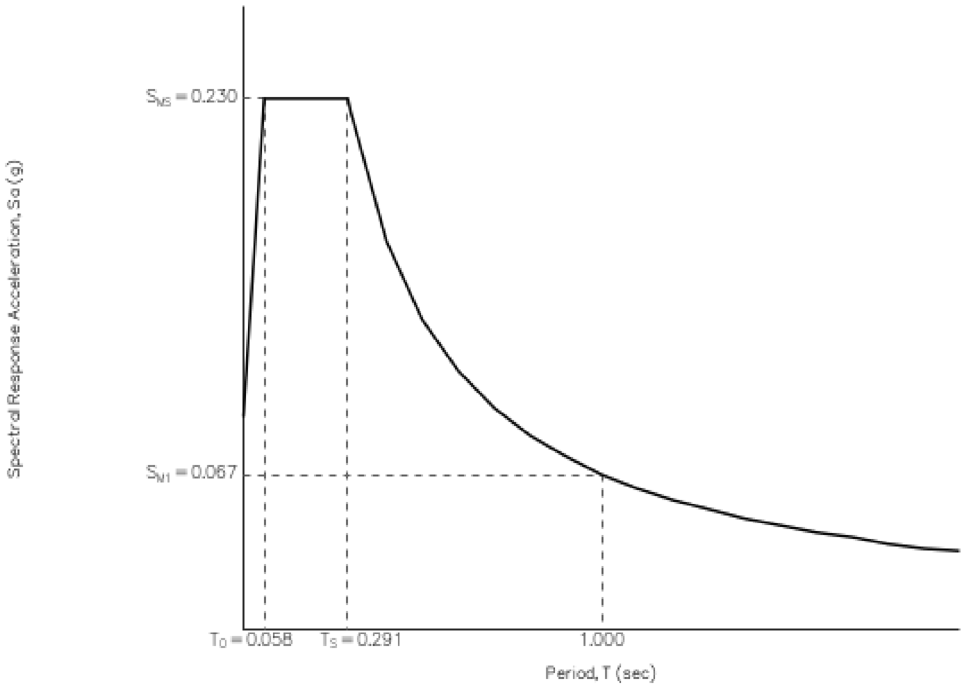
From Figure 22-12 [3] T_L = 6 seconds

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 x 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
Borehole and Test Pit Logs

NewFields

FIELD SOIL EXPLORATION LOG

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
5.0	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)
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
25.0	MC	5-9-11		SM		SILT (ML), sandy, medium dense, nonplastic, gray, moist	pH = 5.5 EC = 910uS
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
40							
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						
50							
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
55							
60							
65							
70							
75							

FIELD SOIL EXPLORATION LOG

NewFields

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						

FIELD SOIL EXPLORATION LOG

NewFields

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
40.0	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

Depth scale: 40, 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: 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
40.0	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
						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	

Depth scale: 40, 45, 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
10							
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
25							
30.0	MC	13-23-24					pH = 6.5 EC = 2.40mS (milliseimens)
35							

FIELD SOIL EXPLORATION LOG

NewFields

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

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

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-06

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 (ft): 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	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
20.0	MC	1-2-2	CL		Soft, medium plastic	EC = 285uS
21.5	ST					
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
40.0	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

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75

FIELD SOIL EXPLORATION LOG

NewFields

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 — 5.0	MC	6-8-8				SILT (ML), sandy, trace clay, stiff, nonplastic, tan to light gray, moist	EC = 740uS (microseimens)
10							
15 — 15.0	MC	3-5-10				Clay lenses and trace gravel	pH = 6.5 EC = 1110uS
20							
25 — 25.0	MC	3-4-6				With fine sand, medium stiff	pH = 5.3 EC = 860uS
30							
35 — 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
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
DRILLING METHOD: 4 1/4" HSA
OPERATOR: Roger

NORTHING: 170456.57
EASTING: 1070864.19
GROUND ELEV.: 5187.44
DATUM: NAD83 AZ State Plane Central US feet
EQUIPMENT: CME 850

START DATE: 1/4/2017
END DATE: 1/5/2017
LOGGED BY: J. Roberts
BACKFILLED: 20% Solids Bentonite Grout
Page 2 of 2

Depth (ft)	Sample Type	SPT 6 Inch Increments	Graphic Log	USCS	Water Table	Material Description	Remarks
40							
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	
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	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
END DATE:	1/14/2017	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				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 (ft): 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			
10	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			
	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			

NewFields

FIELD SOIL EXPLORATION LOG

BOREHOLE ID: BH-13

PROJECT: Hermosa Underground Project
PROJECT No.: 475.0014.008
LOCATION: Santa Cruz County, Arizona
LOGGED BY: J. Roberts
START DATE: 1/8/2017
END DATE: 1/9/2017

NORTHING: 170798.07
EASTING: 1072078.3
GROUND ELEV.: 4973.88
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				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)

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
10							...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
15	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 – 12							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 (ft): 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
0–2.5				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' × 5'; 095°

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	
4.0–5.0			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° ← [pit rectangle 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

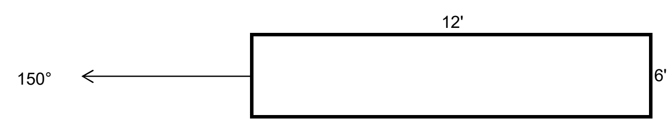
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–4.0	LD-1 @ 1-3ft		CLAY (CH), sandy, some silt, medium to high plastic, brown, moist Red, orange, and light gray	Test pit placed in road Clay thickens to the North Residual soil
4.0–10.5	SD-1 @ 7-8ft		GRAVEL (GP), sandy with some silt, coarse, angular, MPS=6.0in, reddish gray, moist, Andesite bedrock	Hard digging at 9.0ft
10.5			TD = 10.5ft, 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-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

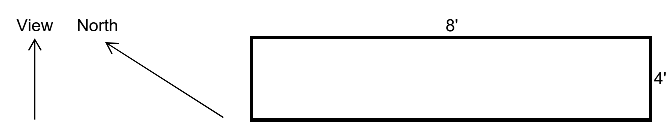
Backfilled: Yes

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				
(+)7.5			SAND (SM), silty with gravel, MPS=2.0in, brown, moist	
(+)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

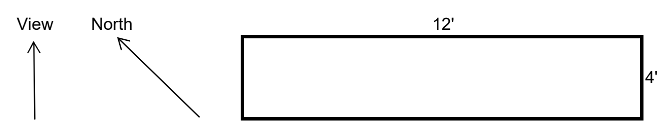
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.0	SD-1 @ 1-2ft		SAND (SC-SM), with gravel and fines, low plastic, red, moist	Hard digging at 3.0ft
3.0–8.0	LD-1 @ 6-8ft		GRAVEL (GP), trace silt and sand, angular, MPS=12.0in, weathered bedrock	More competent at 7.0ft
8.0			TD = 8.0ft, 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-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

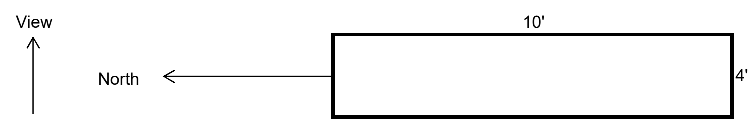
Datum: NAD 83 Arizona Central State Plane US feet
Surface Conditions: Lay down yard by cut bank, 20ft tall cut measured from the bottom
Backfilled: Yes

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
0.0–6.0			GRAVEL (GP), with sand, coarse, angular, MPS=6.0in, medium hard, brown, moist, weathered bedrock	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.	

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' × 6'; 090° ←

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		GRAVEL (GP), with sand, trace fines, coarse, angular, MPS=4.0in, nonplastic, brown, moist	Moved down slope for safety Pit sidewalls collapsing
2.5				
5.0				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:

12' × 8'; 160°

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		8.0	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			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

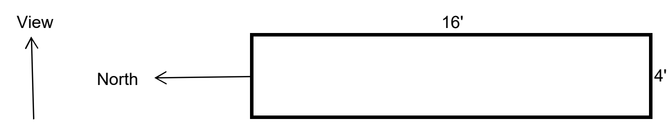
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	169790.25N 1070670.55E	Elevation:	5267.44	Total Pit Depth:	11.0ft
Datum:	NAD 83 Arizona 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			GRAVEL (GM), silty with sand, fine to coarse grained sand, angular, MPS=6.0in, reddish brown to brown, moist, weathered bedrock	
		3.0		
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				More competent at 10.0ft
		11.0	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

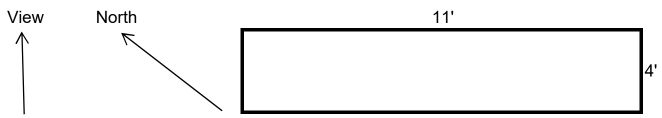
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 350D	Contractor:	DM Engineering & Excavating	Logged by:	N. Owens
Coordinates:	169726.86N 1069761.85E	Elevation:	5263.04	Total Pit Depth:	7.0ft
Datum:	NAD 83 Arizona 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
		1.0	GRAVEL (GM), silty with sand, fine to medium grained sand, angular, MPS=3.0in, dark brown, moist	Rootlets in upper 1.0ft
2.5				
5.0	LD-1 @ 5-6ft	7.0	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
7.5			TD = 7.0ft, 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-21

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: 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
0.5–5.0	LD-1 @ 4-5ft		GRAVEL (GM), with silt and sand, fine to medium grained sand, angular, MPS=5.0in, reddish brown, moist, weathered bedrock	
5.0–9.0			GRAVEL (GP), with some sand, fine to coarse graded sand, angular, MPS=8.0in, brown, moist, bedrock	More competent at 8.0ft
9.0			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:

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

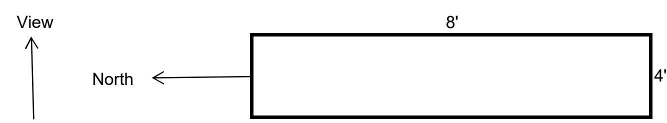
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.0	LD-1 @ 2-3ft		GRAVEL (GM), silty with clay, fine to medium grained sand, angular, MPS=6.0in, reddish brown, moist, weathered bedrock	Rootlets in upper 0.5ft
3.0–6.0			GRAVEL (GP), with some sand, fine to coarse grained 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

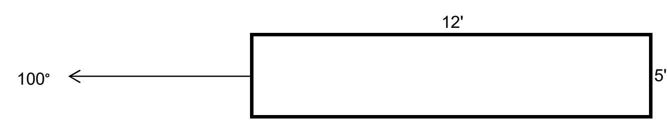
Backfilled: Yes

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:**	
15.0			GRAVEL (GP), sandy with silt, reddish brown, moist	15.0ft pH = 6.3 Conductivity = 300µs
		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.	
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-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

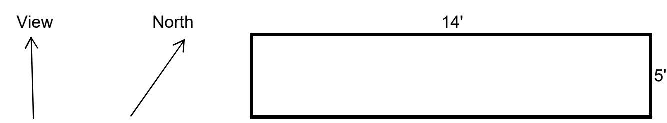
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–1.0			GRAVEL (GM), silty with sand, fine to medium grained sand, angular, MPS=6.0in, brown, moist	Rootlets in upper 1.0ft
1.0–14.0	LD-1 @ 10-12ft		GRAVEL (GP-GM), with sand and silt, fine to coarse grained sand, angular, MPS=12.0in, reddish brown, moist, friable bedrock	
14.0			TD = 14.0ft due to machine limits 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-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
			COVER MATERIAL:	
		2.0	GRAVEL (GC), clayey with sand and silt, medium plastic, brown, moist	Buried wood with strong decaying odor
2.5		4.0	SAND (SC), clayey with gravel, low plastic, reddish brown, moist	
			WASTE ROCK:	
5.0	LD-1 @ 5-8ft			Sidewalls collapsing
7.5				
10.0				
12.5			GRAVEL (GC), clayey with silt and sand	
15.0				
17.5				
20.0		20.0	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
				
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
10.0			**WASTE ROCK:** GRAVEL (GC), clayey, coarse, medium plastic, orange, tan, and light gray, moist	
16.5			GRAVEL (GP), sandy with silt, reddish brown, moist	
18.0			**NATURAL GROUND:** SAND (SC), clayey with gravel, medium plastic, reddish brown, moist	
			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:

090° ← 12' × 5'

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)	Description	Additional Notes
0–1.0		GRAVEL (GM), silty with sand, non plastic, brown	Residual soil
1.0–10.0	LD-1 @ 3-5ft	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.	

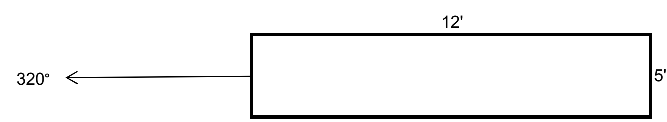
Depth scale: 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Pit Wall Profile

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-31

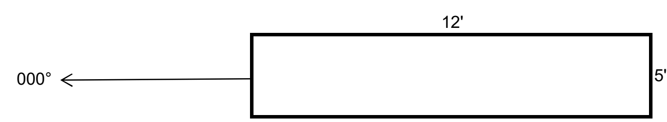
Project:	Hermosa Underground			Project No.:	475.0014.008
Project Location:	Sant Cruz County, Arizona			Date:	1/20/2017
Equipment:	Deere 180G LC	Contractor:	DM Engineering & Excavating	Logged by:	J. Roberts
Coordinates:	171526.23N 1071031.00E	Elevation:	5085.63	Total Pit Depth:	10.0ft
Datum:	NAD 83 Arizona 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	
		1.5		
2.5	LD-2 @ 2-4ft			
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:



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

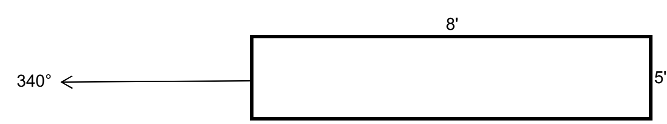
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–3.0	LD-1 @ 1-3ft		SAND (SC), clayey with silt and gravel, low plastic, brown, moist	Becomes damp at 1.0ft
3.0–18.0	LD-2 @ 11.5-14ft		CLAY (CL), sandy, with gravel, gravel is coarse and angular, MPS=10.0in, medium to high plastic, brown, damp, highly weathered bedrock	Hard to dig at 3.0ft 11.5 to 17.0ft clayey red hematite alteration in fracture zones
18.0			TD = 18.0ft, 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-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
		0.7	SAND (SC), clayey with gravel and silt, low plastic, reddish brown, moist	Oxidized to 3.0ft
2.5			**TAILINGS:**	Upper unoxidized tails hard to dig
			CLAY (CL), silty, with sand, fine grained sand interbedded	
5.0		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'

030° ←

5'

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)	Description	Additional Notes
0–2.5		**COVER MATERIAL:** SAND (SC), clayey with gravel, low to medium plastic, reddish brown, moist	Oxidized to 5.0ft Easy excavation
2.5–7.0	LD-1 @ 4-7ft	**TAILINGS:** SILT and FAT CLAY (ML/CH), interbedded	6.0ft pH = 5.6 Conductivity = 1280μs
7.0–9.5		**NATURAL GROUND:** GRAVEL (GP), with sand and clay, reddish brown, moist	9.0ft pH = 6.5 Conductivity = 110μs
9.5		TD = 9.5ft, terminated test pit in natural ground Water table not encountered at time of excavation.	

Depth scale (ft): 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0

Pit Wall Profile

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'

150° ←

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
2.5			1.0	GRAVEL (GP-GM), with silt and sand, brown, moist	
5.0	SD-1 @ 5-5.5ft		5.5	GRAVEL (GP), course, angular, brown, moist, bedrock	
7.5				TD = 5.5ft, 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:

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
2.5				
			SAND (SM), silty with gravel and clay, nonplastic, brown, damp	Portion of incised channel at 4.0ft
5.0				
				Capillary fringe at 6.5ft
		7.0	**NATURAL GROUND:**	
7.5				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	
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'; 175° ←

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

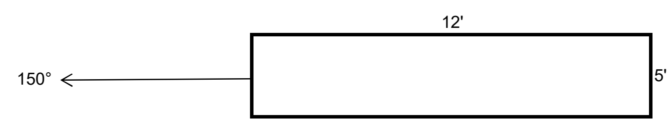
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.6			**COVER MATERIAL:** GRAVEL (GC), clayey	
			FILL - POSSIBLE HISTORIC TAILINGS/WASTE ROCK:	
			SAND (SP-SM), with silt and gravel, nonplastic, brown, damp	White walled tire
6.0			Gravelly at base	
			NATURAL GROUND:	
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:



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
		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 ←

9'

4'

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
1.0	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
2.0			GRAVEL (GP), with some sand, fine to coarse grained sand, angular, MPS=14.0in, reddish brown, moist, bedrock	
			TD = 2.0ft, 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 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
2.5			2.0	GRAVEL (GP), with sand, fine to coarse grained sand, angular, MPS=12.0in, brown, moist, competent bedrock	
5.0				TD = 2.0ft, 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-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	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		GRAVEL (GP-GM), with silt, some sand, angular, MPS=18.0in, nonplastic, light brown, moist, bedrock	
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:

View ↑ North ↖ 8' × 4'

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

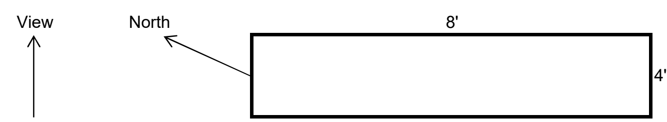
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0–2.0	SD-1 @ 0-1ft LD-1 @ 1-2ft		GRAVEL (GC), clayey, with sand, angular, MPS=6.0in, low to medium plastic, brown, moist	Very hard at 2.0ft
2.0–4.0			GRAVEL (GP), angular, MPS=18.0in, very hard, white, tan, pink, moist, bedrock	
4.0			TD = 4.0ft, 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-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 (to 2.5)	
5.0	LD-1 @ 5ft		GRAVEL (GM), silty with some sand, angular, MPS=18.0in, light brown to red, moist, bedrock (to 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:

View

North

13'

4'

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
0–1.5	LD-1 @ 1-3ft		CLAY (CL), gravelly, some sand, medium plastic, reddish brown, moist	Moved test pit to road to save trees
1.5–4.0			GRAVEL (GP), with sand, silt, and clay, coarse, angular, MPS=6.0in, bedrock	Bedrock at 2.5ft
4.0			TD = 4.0ft, 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' × 5'; 105° ←

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

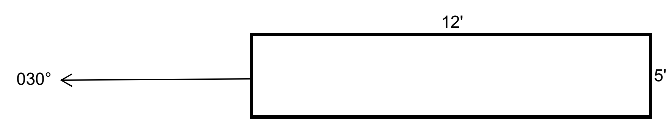
Depth (ft)	Sample (depth & type)	Pit Wall Profile	Description	Additional Notes
0.0–1.5			GRAVEL (GC), clayey with sand, low plastic, brown, moist	
1.5–10.0	LD-1 @ 3-4ft		GRAVEL (GP), some sand, coarse grained, angular, hard, brown and gray, moist, weathered bedrock	Hard digging at 4.0ft
10.0			TD = 10.0ft, 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:



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	Depth	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	
2.5			2.0	GRAVEL (GP-GM), with silt and sand, fine to medium grained sand, angular, MPS=12.0in, gray, moist	
	LD-1 @ 3-4ft			GRAVEL (GM), silty, sandy, fine to coarse grained sand, angular, MPS=12.0in, gray, red, moist	Very hard digging at 4.0ft
5.0			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:

NA

NA ← [ ] NA

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 ← [pit] NA

APPENDIX E

Geophysical Survey

SAGE EARTH SCIENCE
GEOPHYSICAL SURVEYS

January 30, 2017

RE: SEISMIC VELOCITY SURVEY - HERMOSA UNDERGROUND PROJECT

Based on the project objective and site conditions, Sage Earth Science conducted a series of seismic P-wave (V_P) refraction and shear wave velocity (V_s) profiles at the Southern Arizona site. The objective of the surveys is to determine the compression wave and shear wave velocity profile of the shallow subsurface (0-100 ft.) for the purpose of determining depth to rock and seismic velocity of the rock and overlying materials.

P-wave survey (refraction)

Given a physical setting of increasing density with depth, and by measuring the travel time of a compression wave (*p-wave*) between known points, the seismic refraction method can be used to determine the depth to a refracting horizon(s), the seismic velocity of the refracting horizon(s), as well as thickness and velocities of the overlying materials.

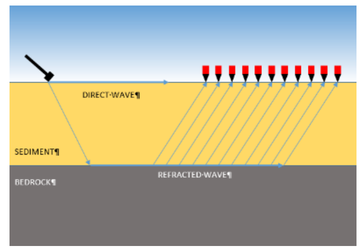


Figure 1 refraction schematic

Approximately 11,000 feet profile was acquired. The profiles were located at the site as directed by the customer. Site elevation data were provided by the customer. Data acquisition was performed in accordance with ASTM standard, **ASTM D 5777-00** *Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation.* Results were reduced using PlotRefra™ seismic refraction tomographic inversion software produced by Geometrics Inc.

Shear wave velocity survey (MASW)

Using the same records obtained for the compression wave refraction survey, shear wave velocity profiles were also developed.

Seismic Surface Waves methods such as MASW (Multichannel Analysis of Surface Waves) and Refraction Micro Tremor (ReMi™) use the dispersive characteristics of surface waves to determine the variation of the seismic shear wave velocity with depth. Velocity data are acquired by analyzing seismic surface waves generated by random sources or by a controlled impulsive source and received by a linear array of geophones.

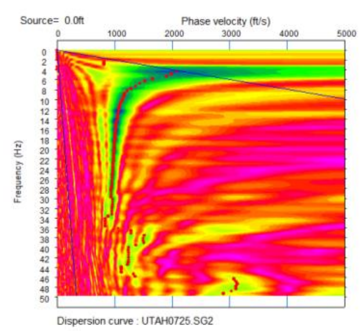


Figure 2 frequency vs velocity plot

A dispersion curve is calculated from the data that shows the phase velocity of the surface wave as a function of frequency or wavelength. A shear wave velocity profile is then modeled from the dispersion curve and the shear wave velocity of the near surface is calculated.

2184 Channing Way, Suite 110, Idaho Falls, ID 83404
telephone: (208)522-5049, Fax: (208)528-6200, email: sageearthscience@yahoo.com
http://www.sageearthscience.com

Table 1. Survey recording parameters

recording instrument	Bison 9024 s/n 6-93913
geophone	Mark products – 4.5 Hz. vertical
Geophone/station spacing	5 meter (16.4 ft.)
number of channels	24
Overall spread length	377 ft.
sample rate	0.5 millisecond
number of samples	2,000
record length	1 seconds
low pass filter	120 Hz.
low cut filter	4 Hz.
seismic source	16 pound sledge hammer
source locations	Channel 1,5,10,15,20 and 24
Refraction Processing software	PlotRefra™ Tomographic inversion software, Geometrics, Inc.
Surface Wave Velocity Processing software	SurfSeis™ Geometrics, Inc.

Discussion

The following figures in Appendix A show the compression wave and shear wave velocity profiles at the locations shown in figure 6.

The seismic velocities mapped across the sites are characterized by a contrast between two general velocity zones. The first zone consists of low density materials exhibiting a velocity V_P of less than 4,000-5,000 feet per second. This material is likely composed of sediment, tailings, or in potentially heavily weathered rock. The second zone is high velocity zone range of velocity averaging V_P greater than 7,000 feet per second and should be considered dense rock.

As a general guide, quoting from the ASTM standard, **ASTM D 5777-00** *Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation*

> *The seismic refraction method provides the velocity of compressional P-waves in subsurface materials. Although the P-wave velocity can be a good indicator of the type of soil or rock, it is not a unique indicator. Table 2 shows that each type of sediment or rock has a wide range of seismic velocities, and many of these ranges significantly overlap. While the seismic refraction technique measures the seismic velocity of seismic waves in earth materials, it is the interpreter who based on knowledge of the local conditions or other data, or both, must interpret the seismic refraction data and arrive at a geologically reasonable solution*

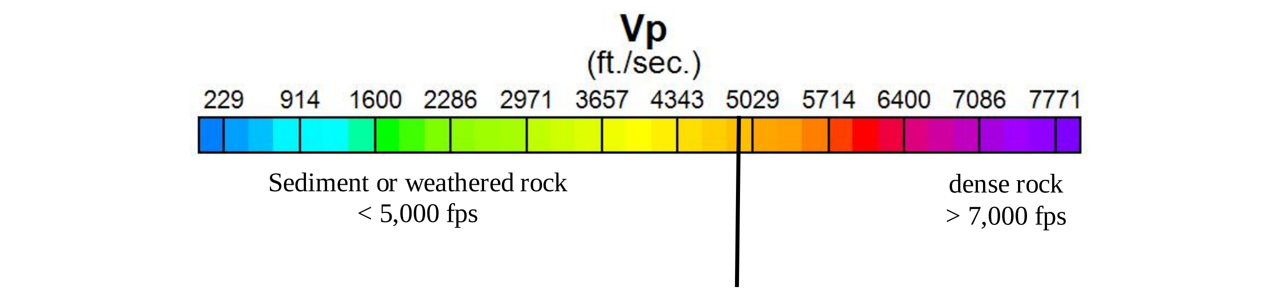


Figure 3. General compression wave velocity range of materials

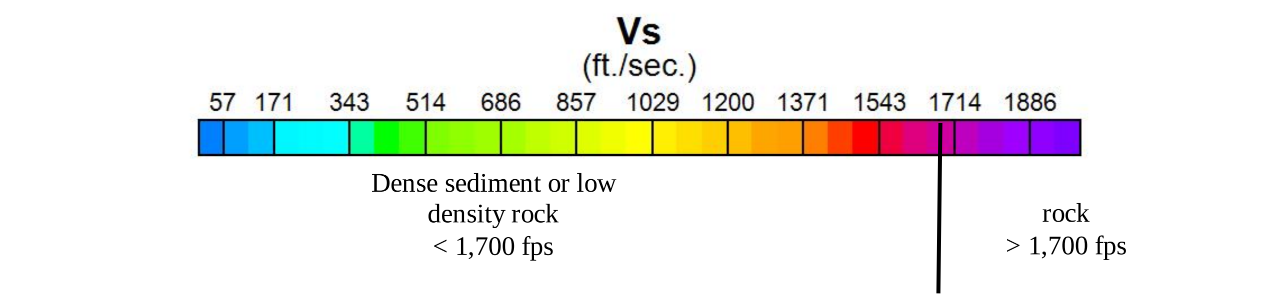


Figure 4. General shear wave velocity range of materials

The velocity ranges, both V_P and V_S are interpreted from a range of criteria including typical values for sediment and rock and inflection points in the individual vertical velocity profiles observed in these data sets. The numbers chosen are intended to reflect the materials found at this site and are applied across profiles in common areas or that intersect one another. The depth of horizons should generally correlate between V_P and V_S profiles but are independent calculations and will show variability.

These velocity ranges and descriptions should be correlated with other site information including test pits, bore holes, and other available supporting information to better characterize the velocity ranges and materials encountered.

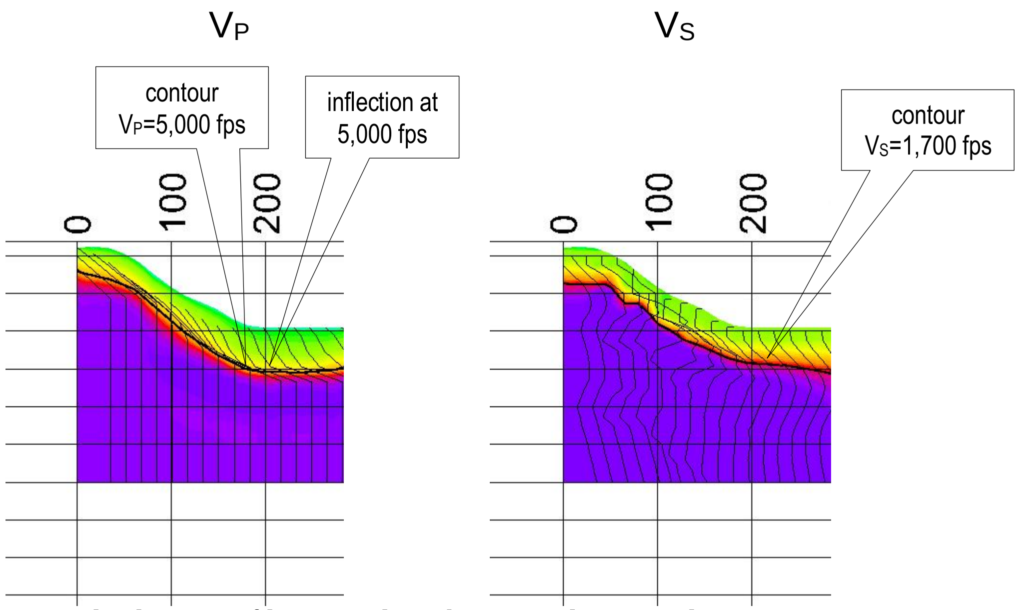


Figure 5a and 5b. Vertical velocity profiles V_P and V_S showing velocity gradients

By the nature of the methods, the compression wave velocity profile will typically provide significantly better resolution of the sediment – rock interface both vertically and laterally.

Each profile has a constant V_P velocity contour intended to represent the sediment – rock interface. This contour line V_P is also superimposed on the V_S profile as a guide and comparison between methods.

Color scales survey areas because the materials vary somewhat between survey. However, profiles in common areas or that intersect one another will have the same color scale applied. Scale differences were chosen to emphasis the sediment-rock interface

The typical velocity reported for each zone is an estimate based on the velocity histogram of each profile.

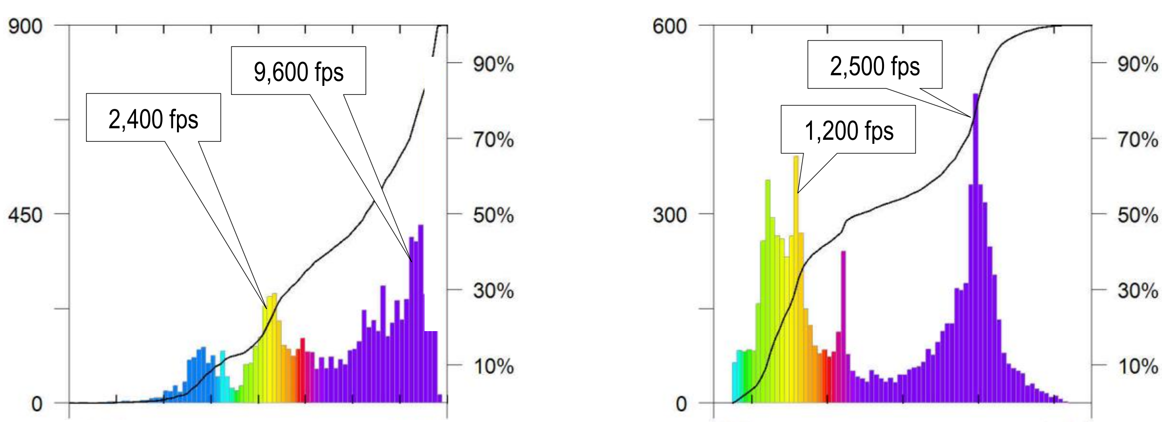


Figure 6a and 6b. Velocity histogram - V_P and V_S

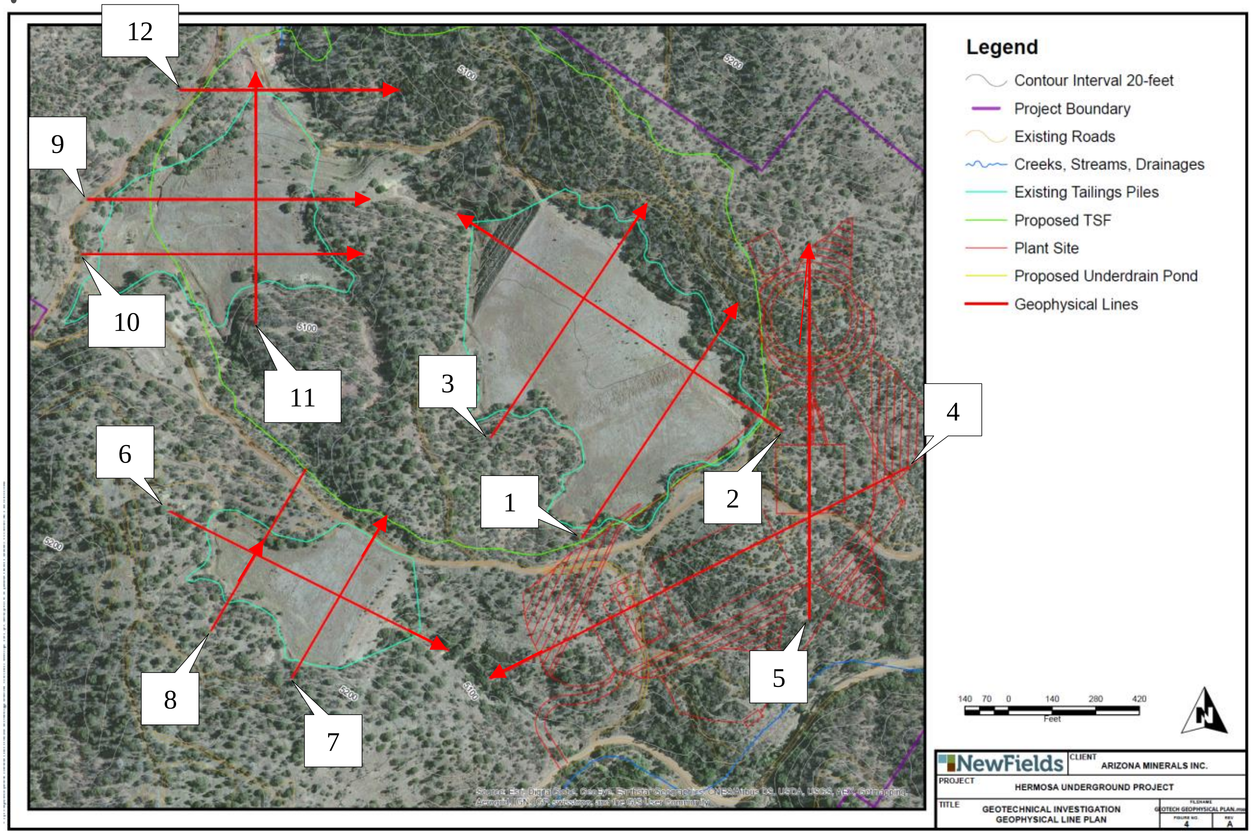


Figure 6a. Profile location map (photo)

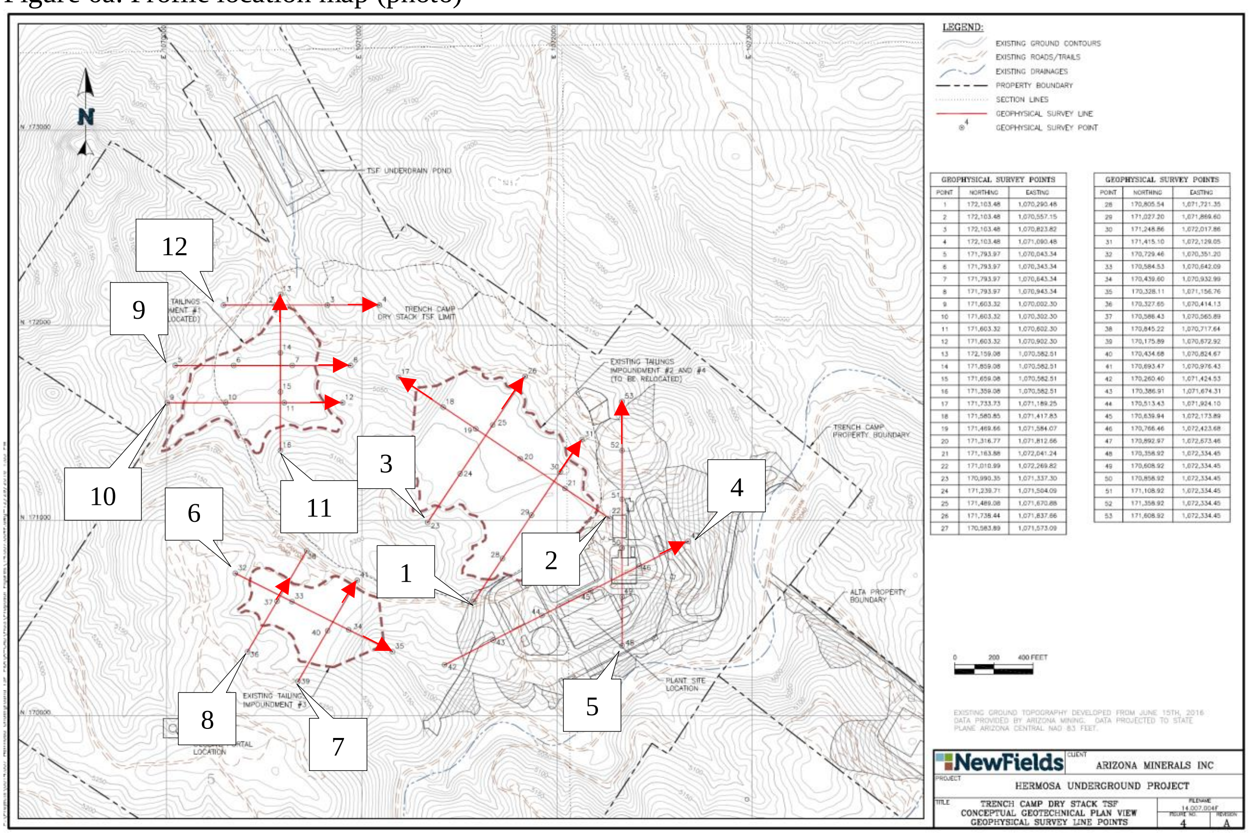


Figure 6b. Profile location map

Glen Carpenter / principal

APPENDIX A

Velocity Profiles

Top profile – refracted compression wave velocity

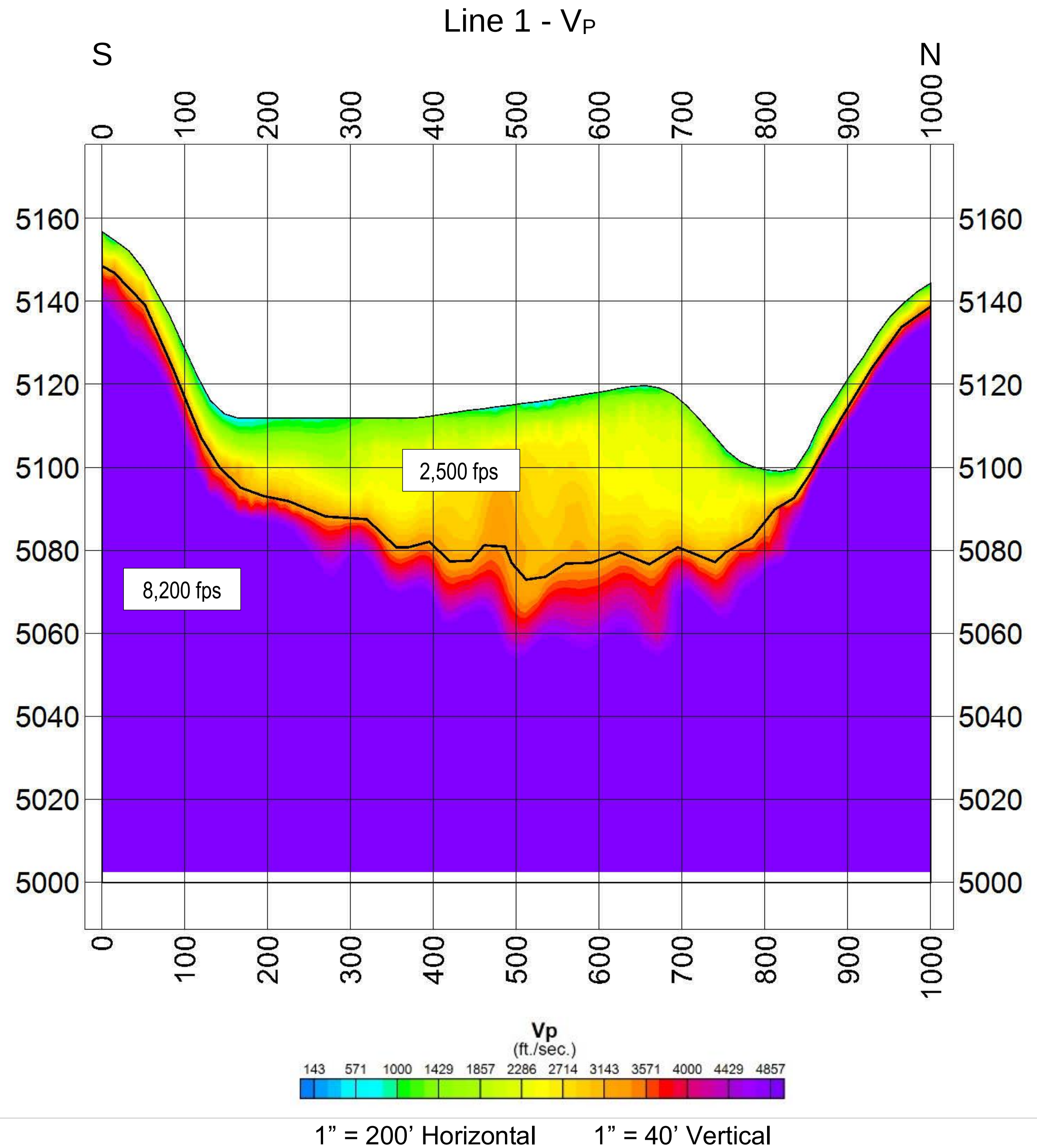
Lower profile – shear wave velocity

(Distance scales are consistent between all charts. All distances are measured in feet. Velocity is reported in feet per second.)

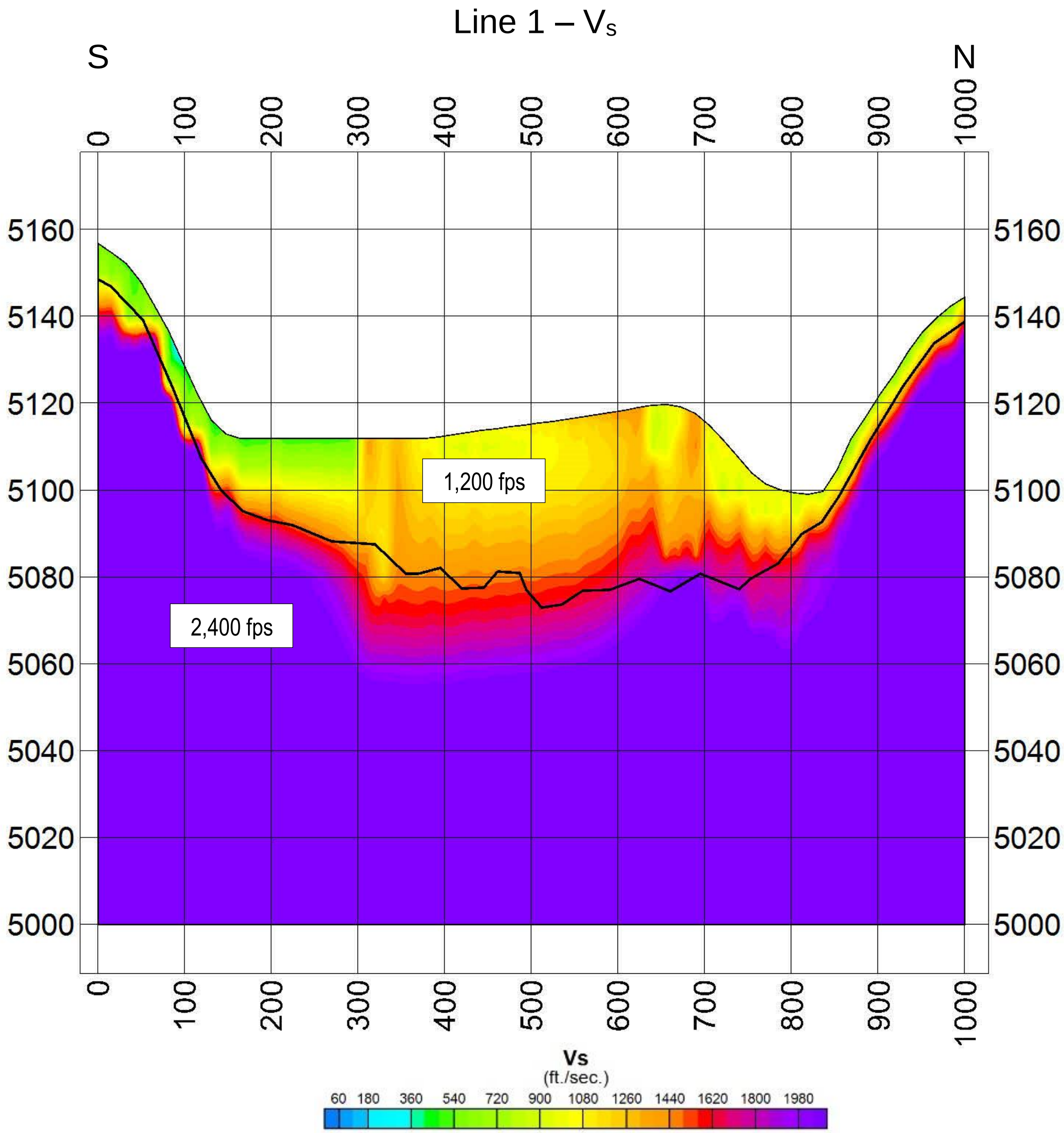
Comment: by the nature of the methods, the compression wave velocity profile will typically provide significantly better resolution of the sediment – rock interface both vertically and laterally.

Each profile has a constant V_P velocity contour intended to represent the sediment – rock interface. This contour line V_P is also superimposed on the V_S profile as a guide and comparison between methods.

Color scales may vary between survey areas. Scale differences are intended to emphasis the sediment-rock interface.

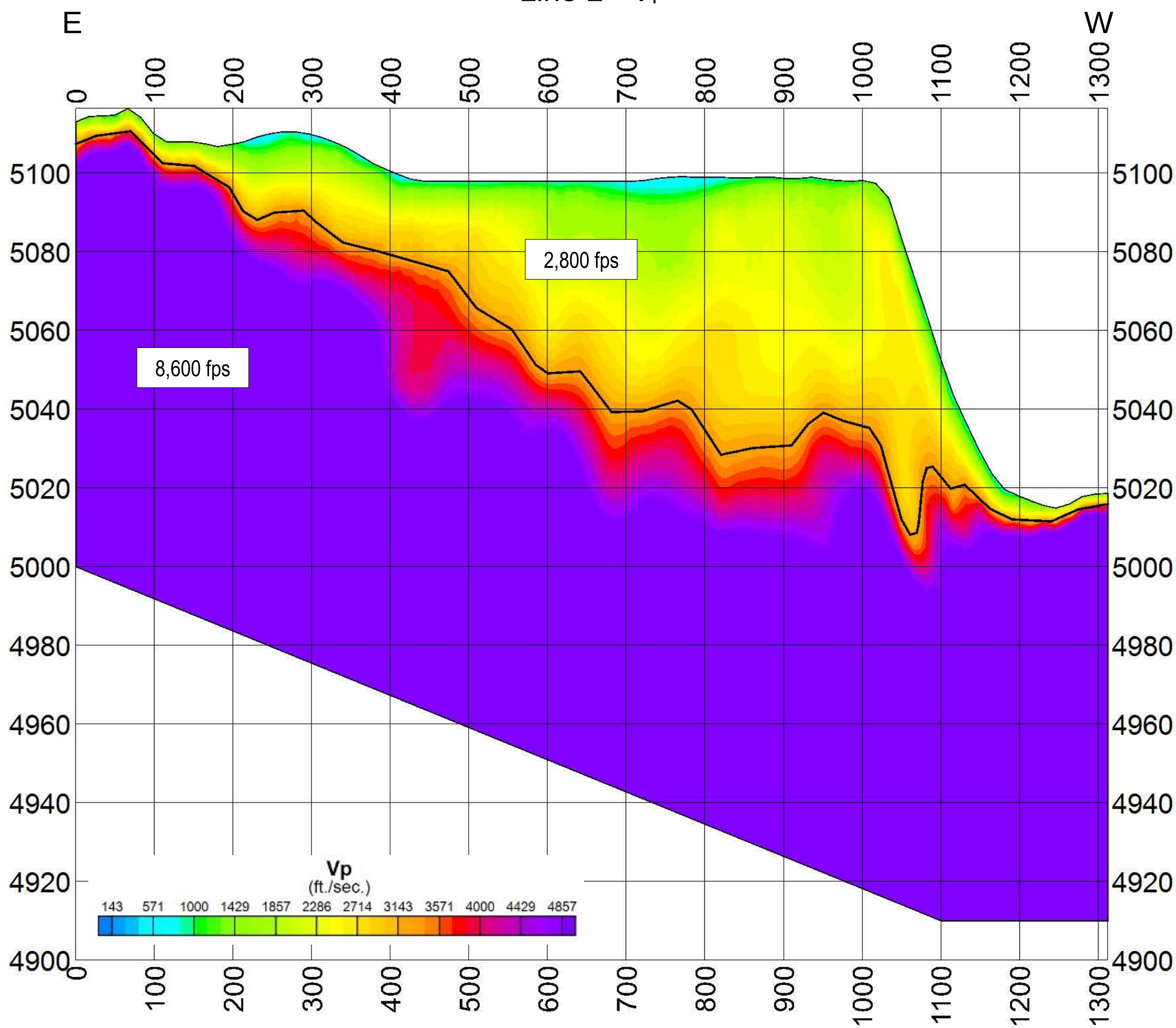


Line 1 - VP
S
N
0
100
200
300
400
500
600
700
800
900
1000
5160
5140
5120
5100
5080
5060
5040
5020
5000
2,500 fps
8,200 fps
Vp
(ft./sec.)
143 571 1000 1429 1857 2286 2714 3143 3571 4000 4429 4857
1" = 200' Horizontal
1" = 40' Vertical



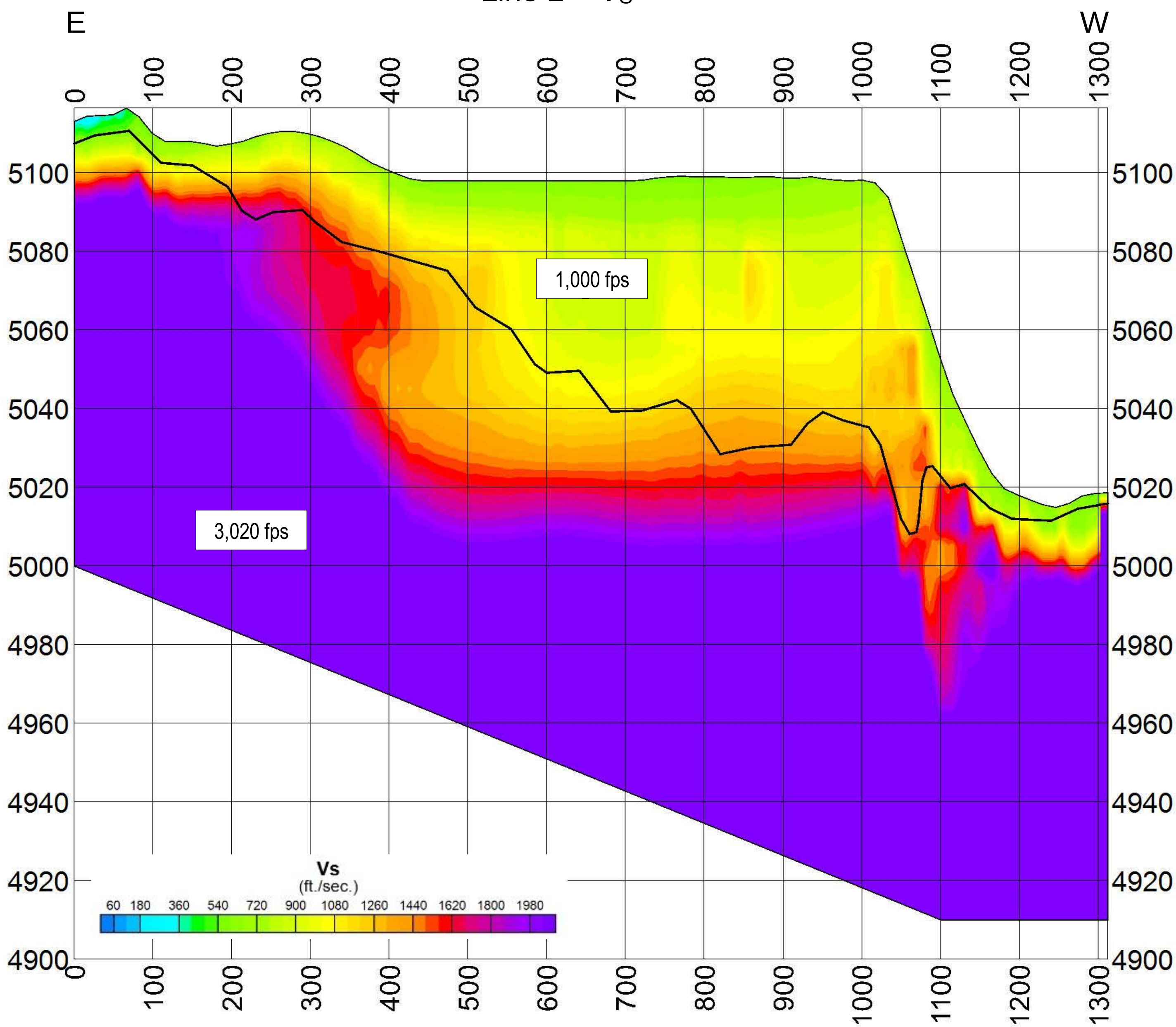
1" = 200' Horizontal   1" = 40' Vertical

Line 2 - VP



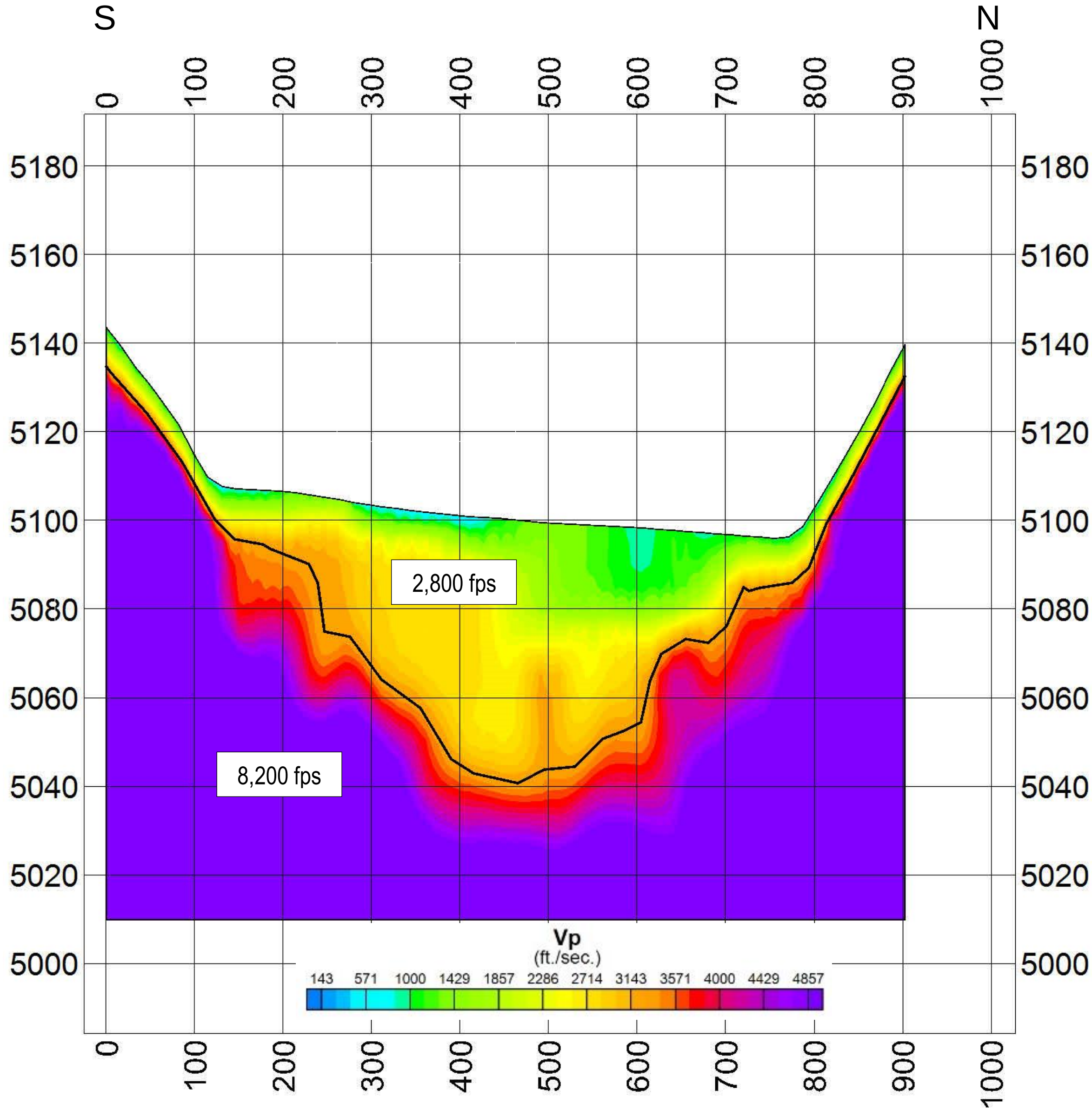
1” = 200’ Horizontal 1” = 40’ Vertical

Line 2 – V_S



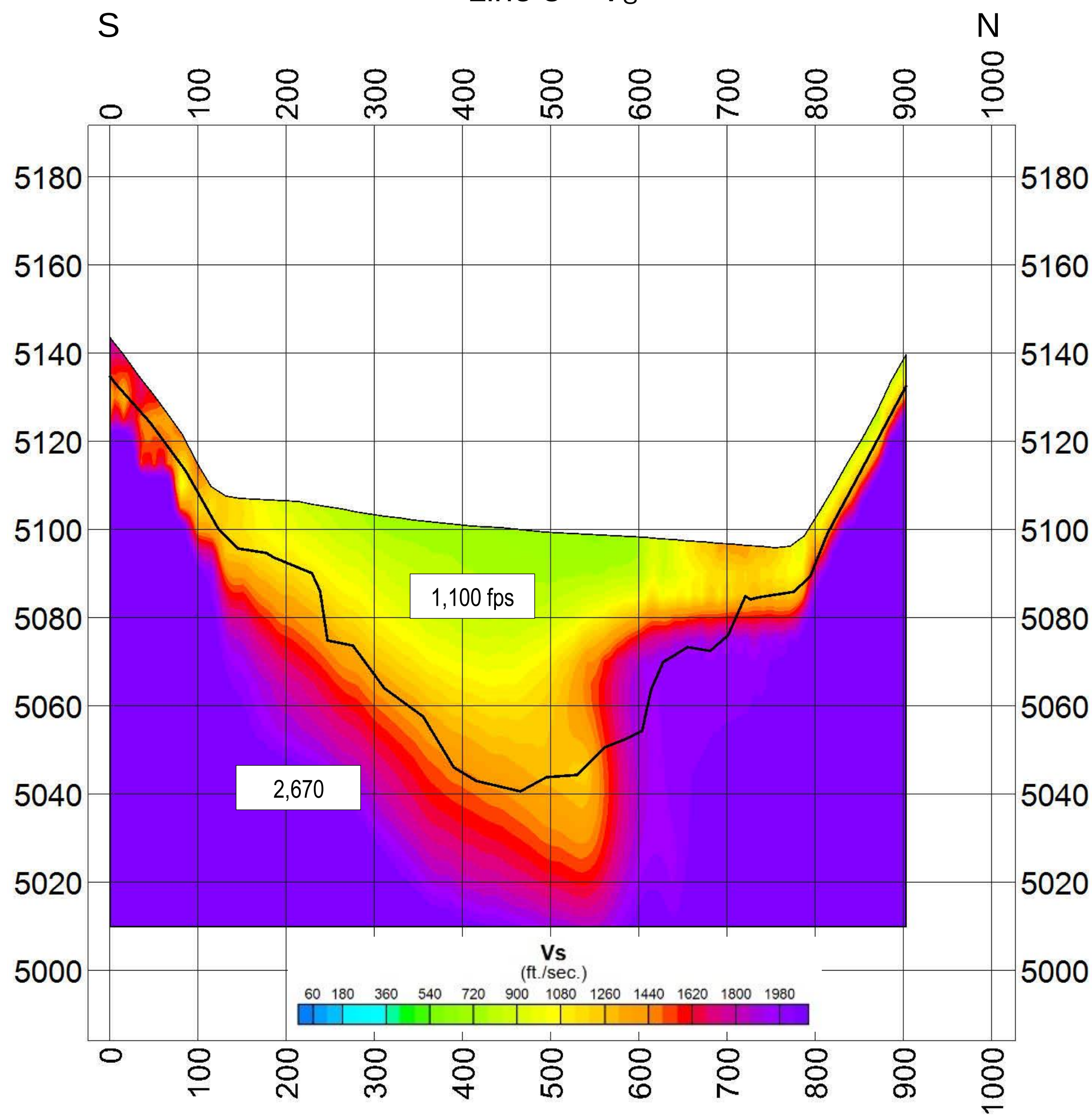
1" = 200' Horizontal 1" = 40' Vertical

Line 3 - V_P



1" = 200' Horizontal 1" = 40' Vertical

Line 3 – V_S



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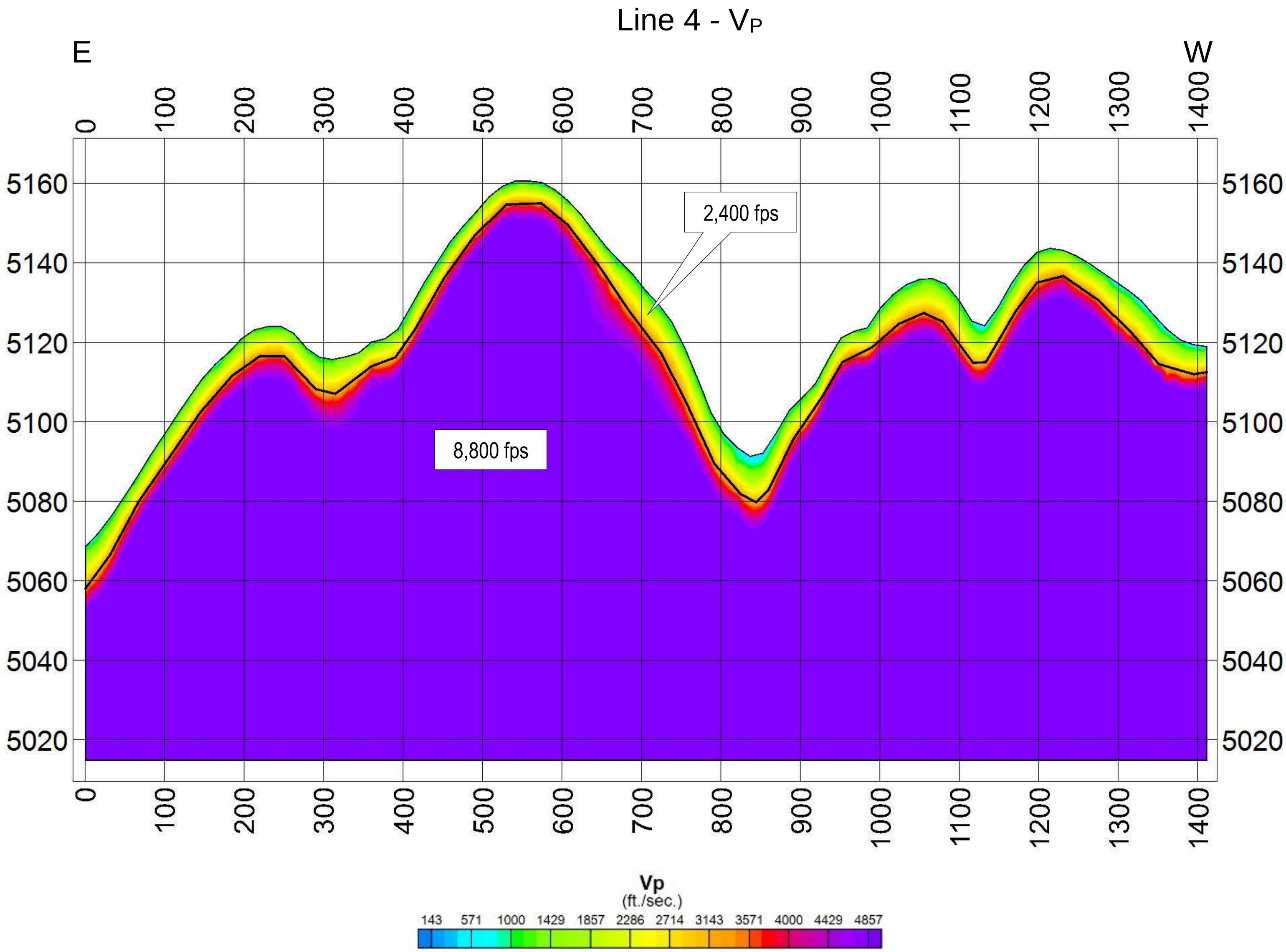
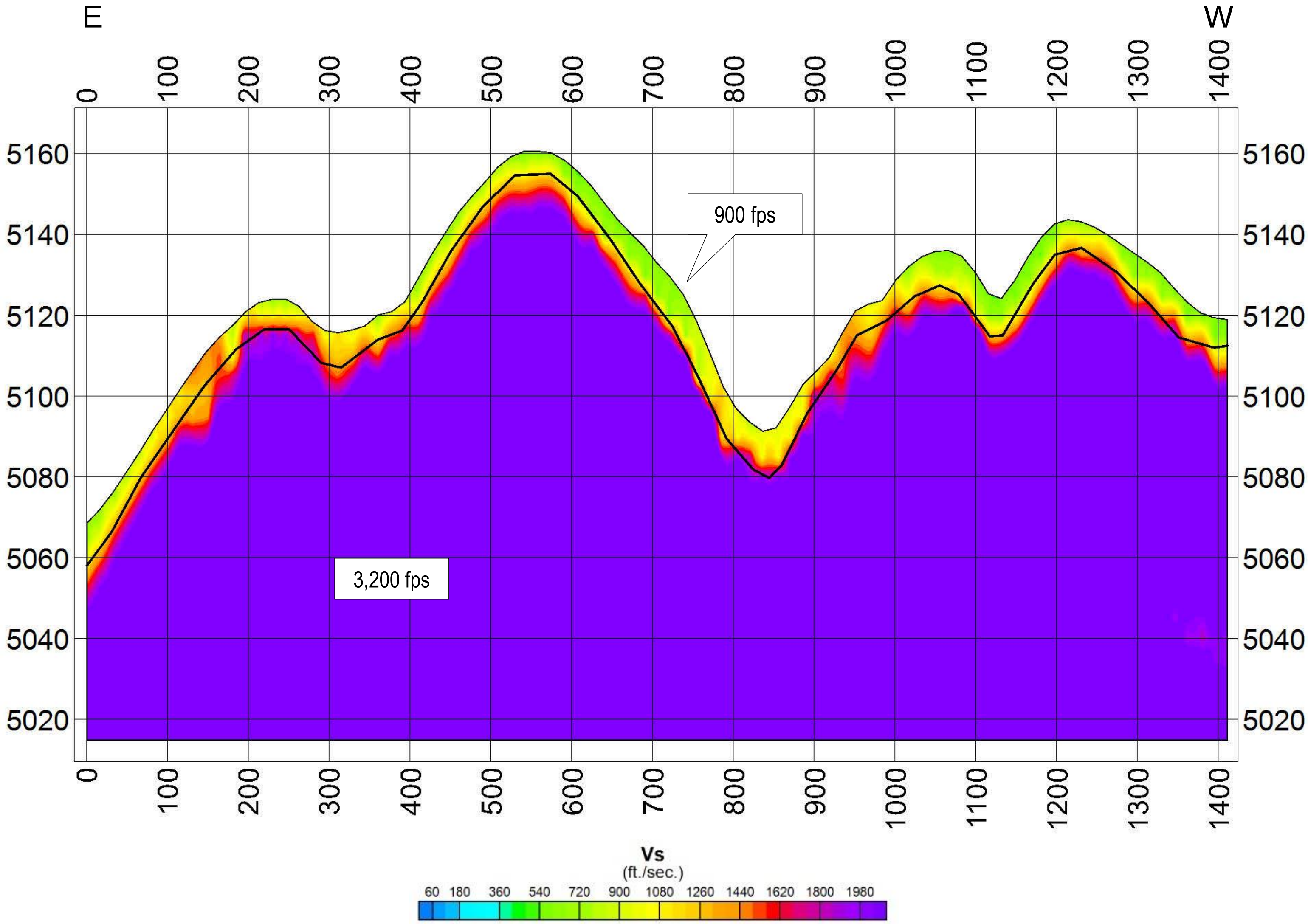
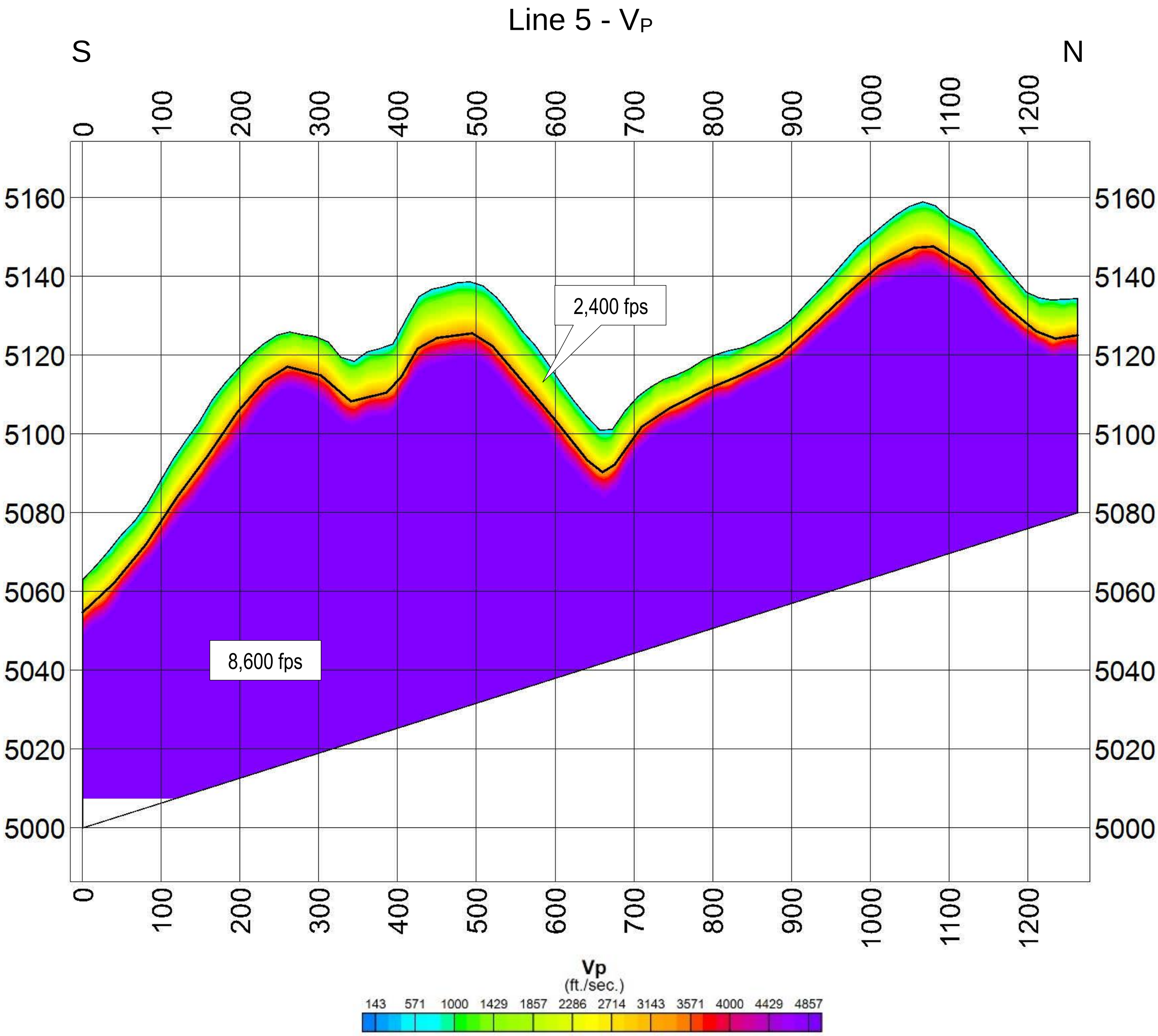


1" = 200' Horizontal 1" = 40' Vertical

Line 4 – V_S



1" = 200' Horizontal 1" = 40' Vertical



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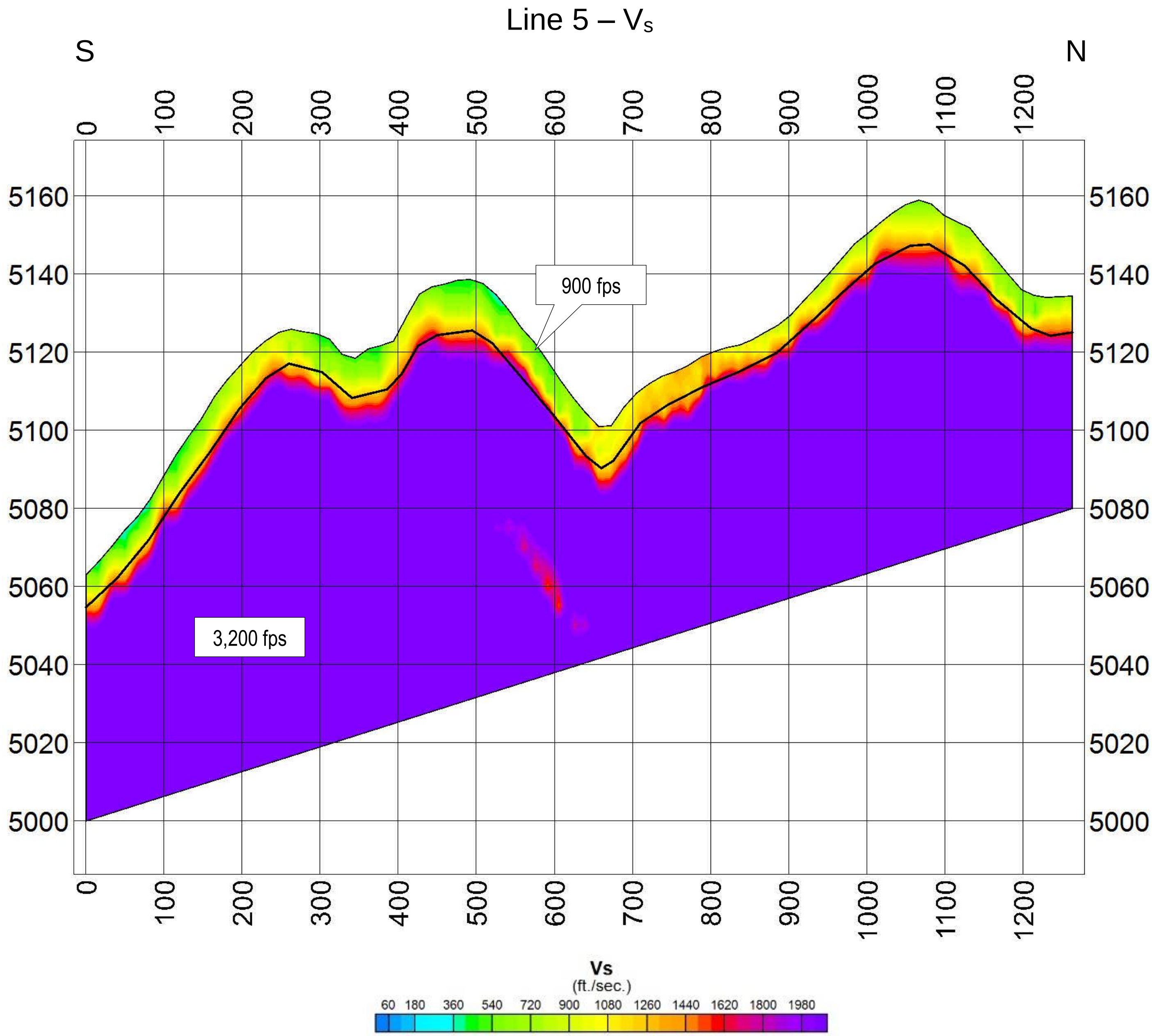

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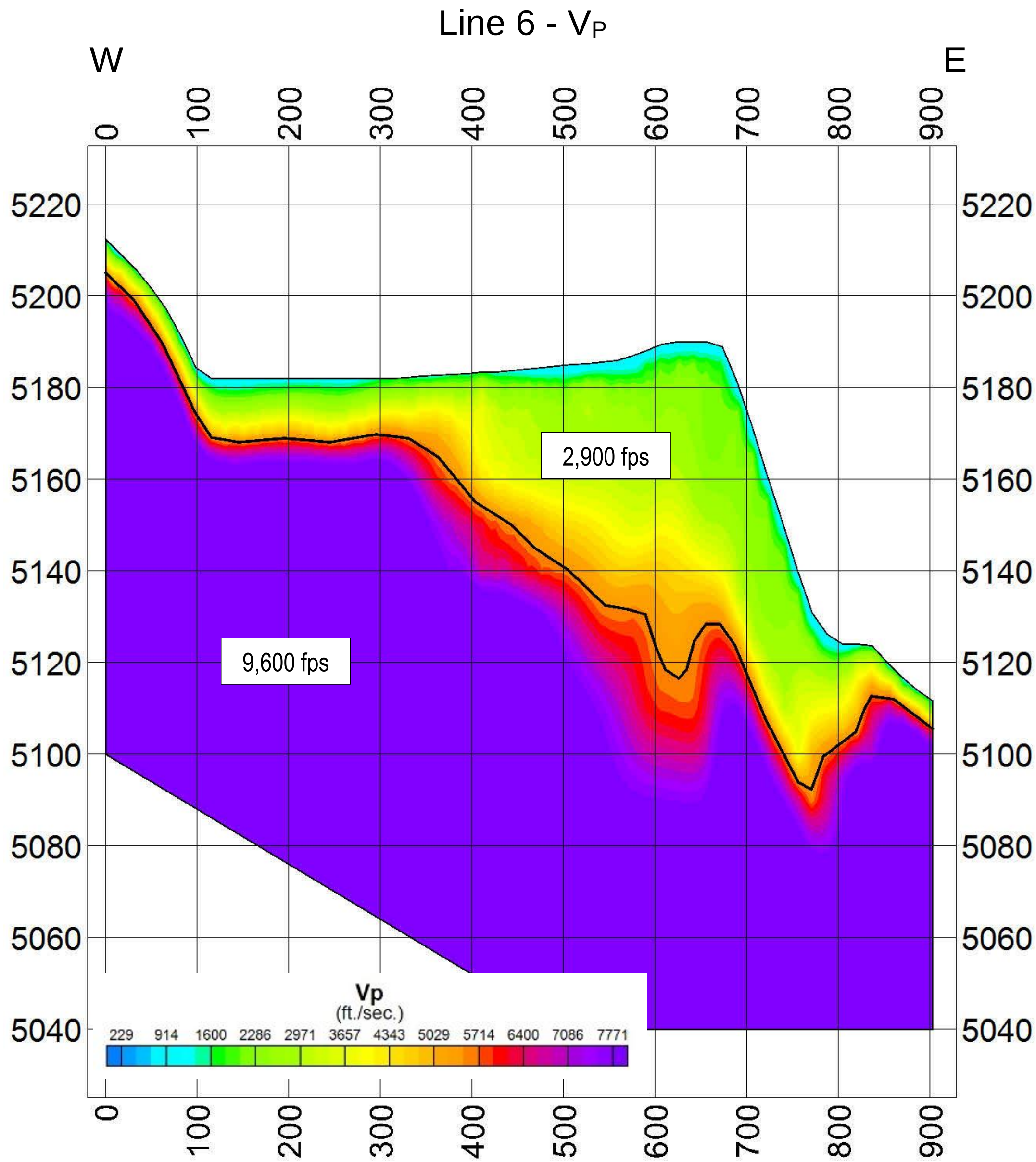
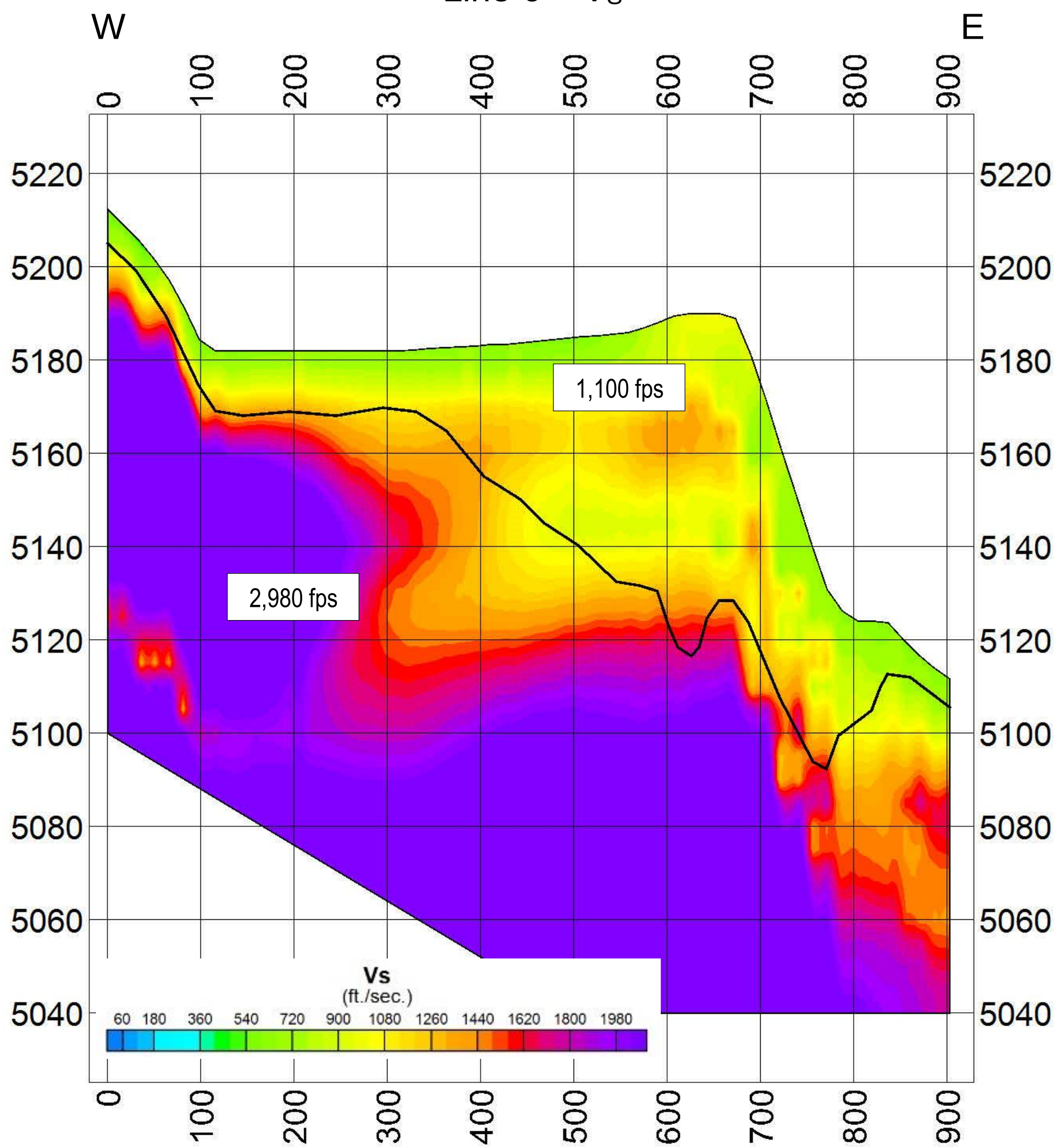
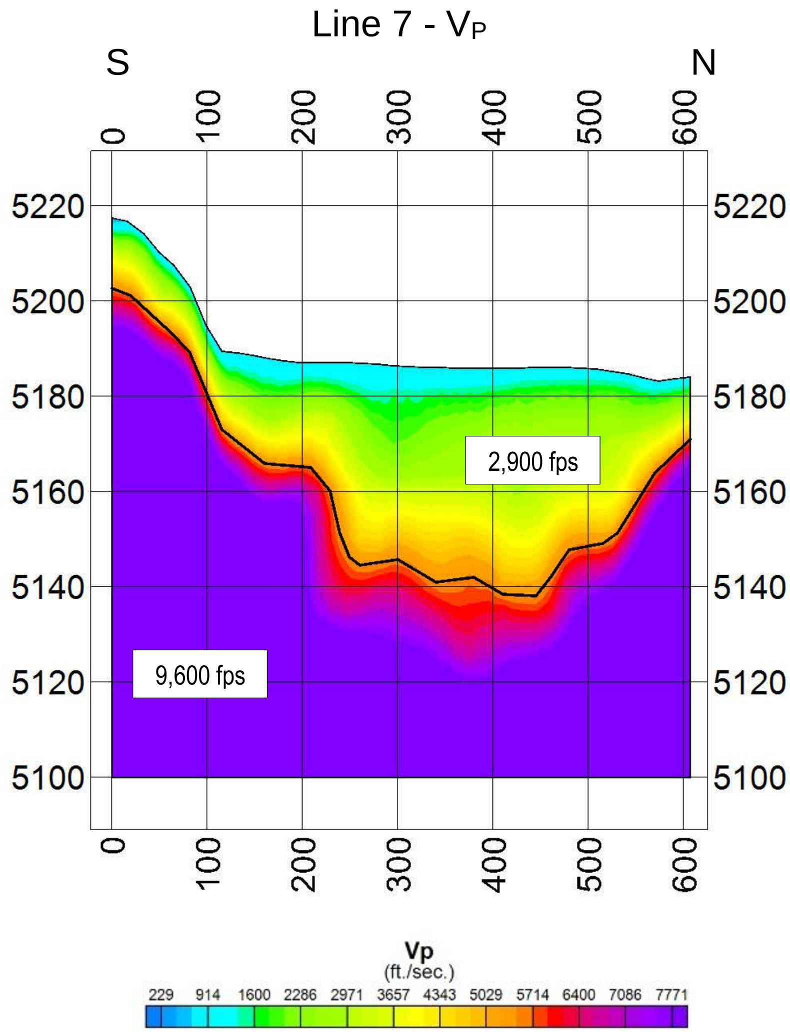


1” = 200’ Horizontal 1” = 40’ Vertical

Line 6 – Vs

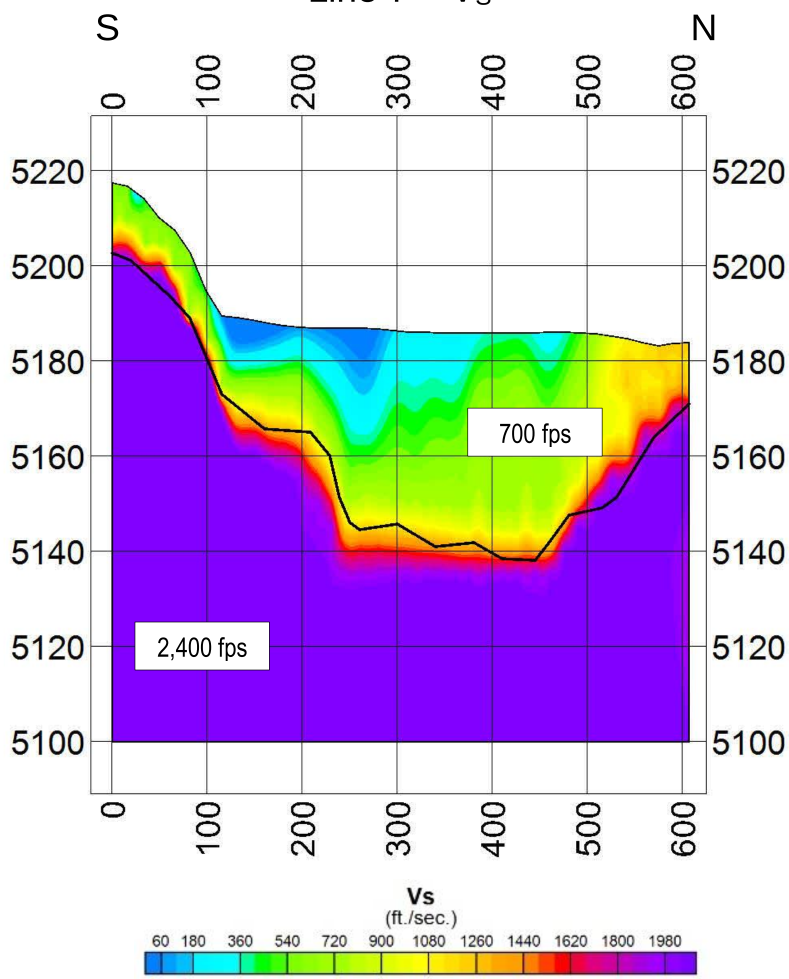


1" = 200' Horizontal 1" = 40' Vertical

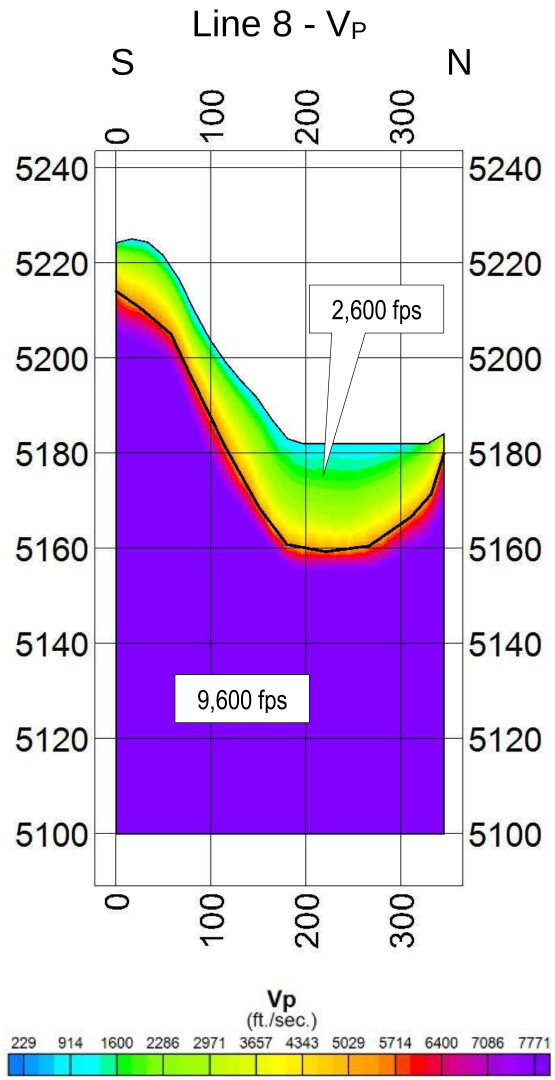


1” = 200’ Horizontal 1” = 40’ Vertical

Line 7 – Vs

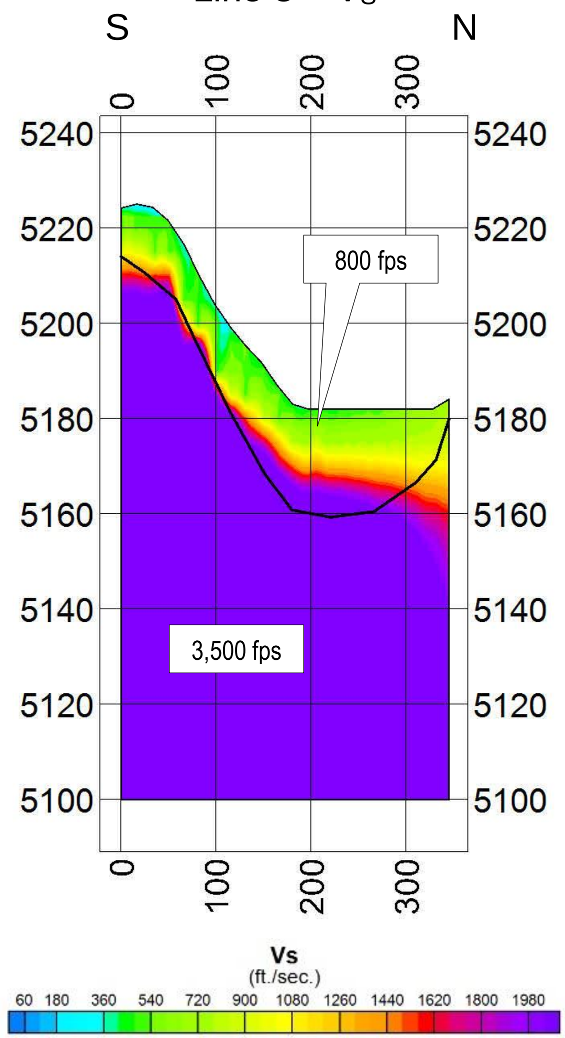


1" = 200' Horizontal 1" = 40' Vertical

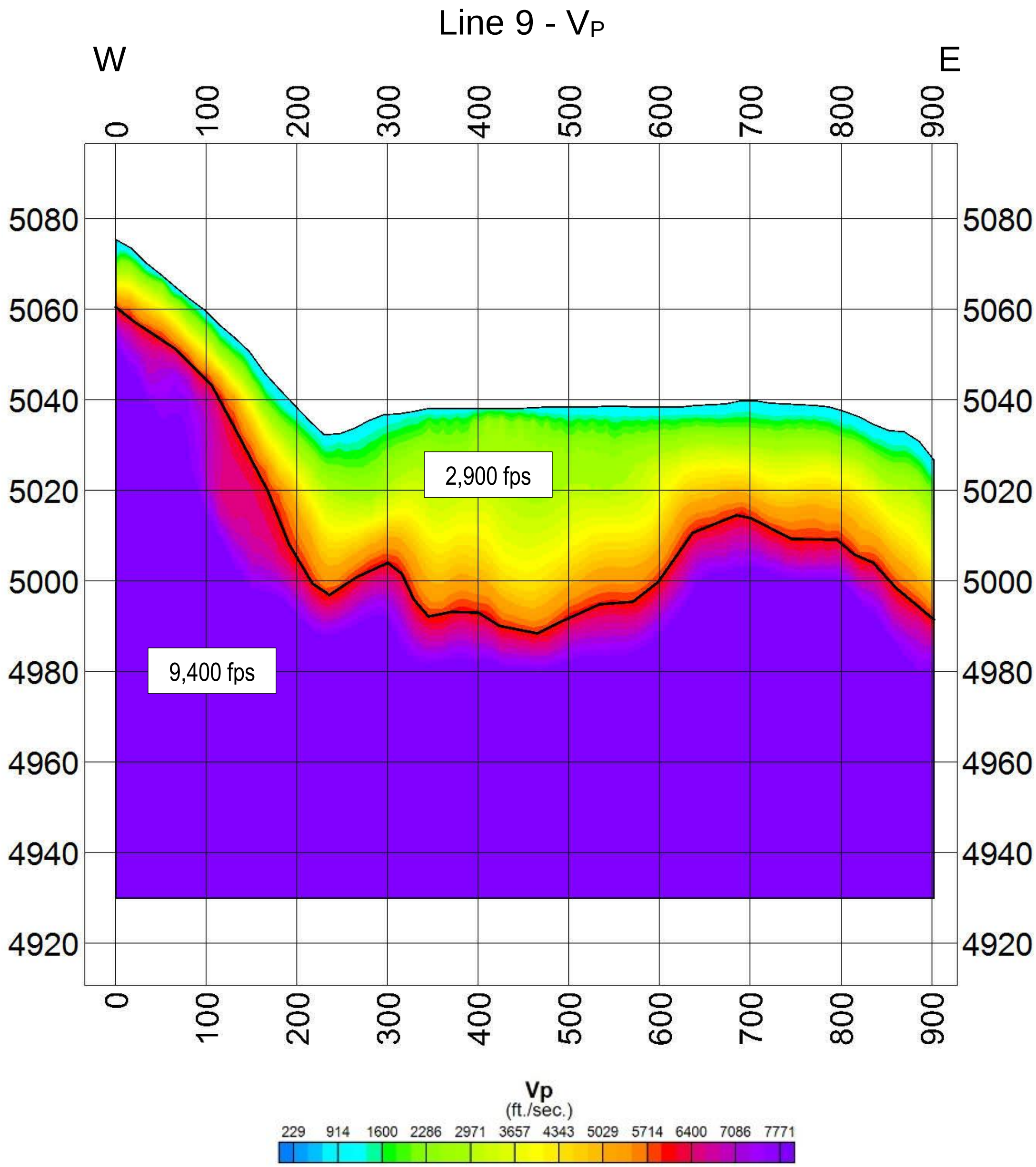


1” = 200’ Horizontal 1” = 40’ Vertical

Line 8 – V_S

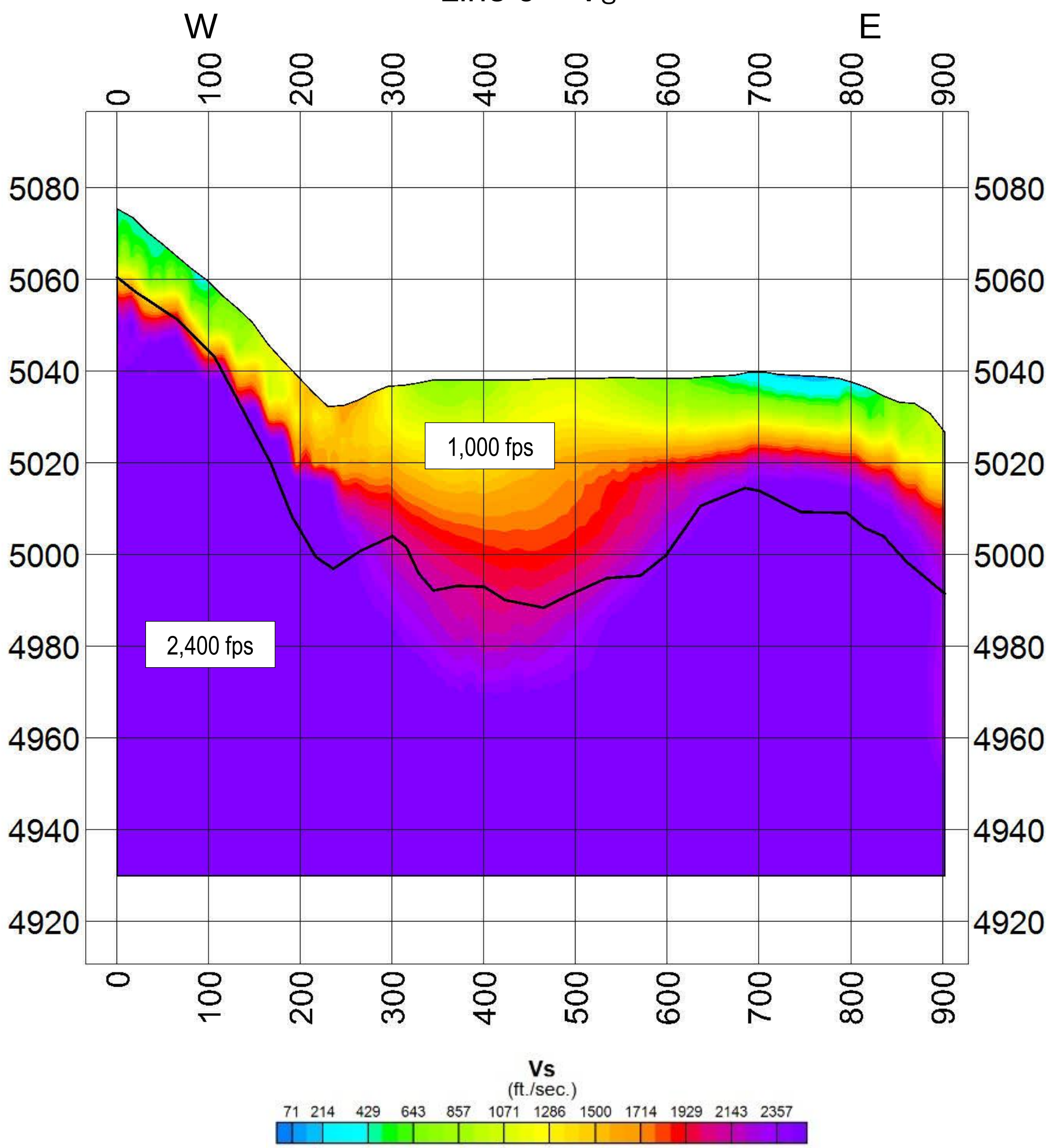


1" = 200' Horizontal 1" = 40' Vertical

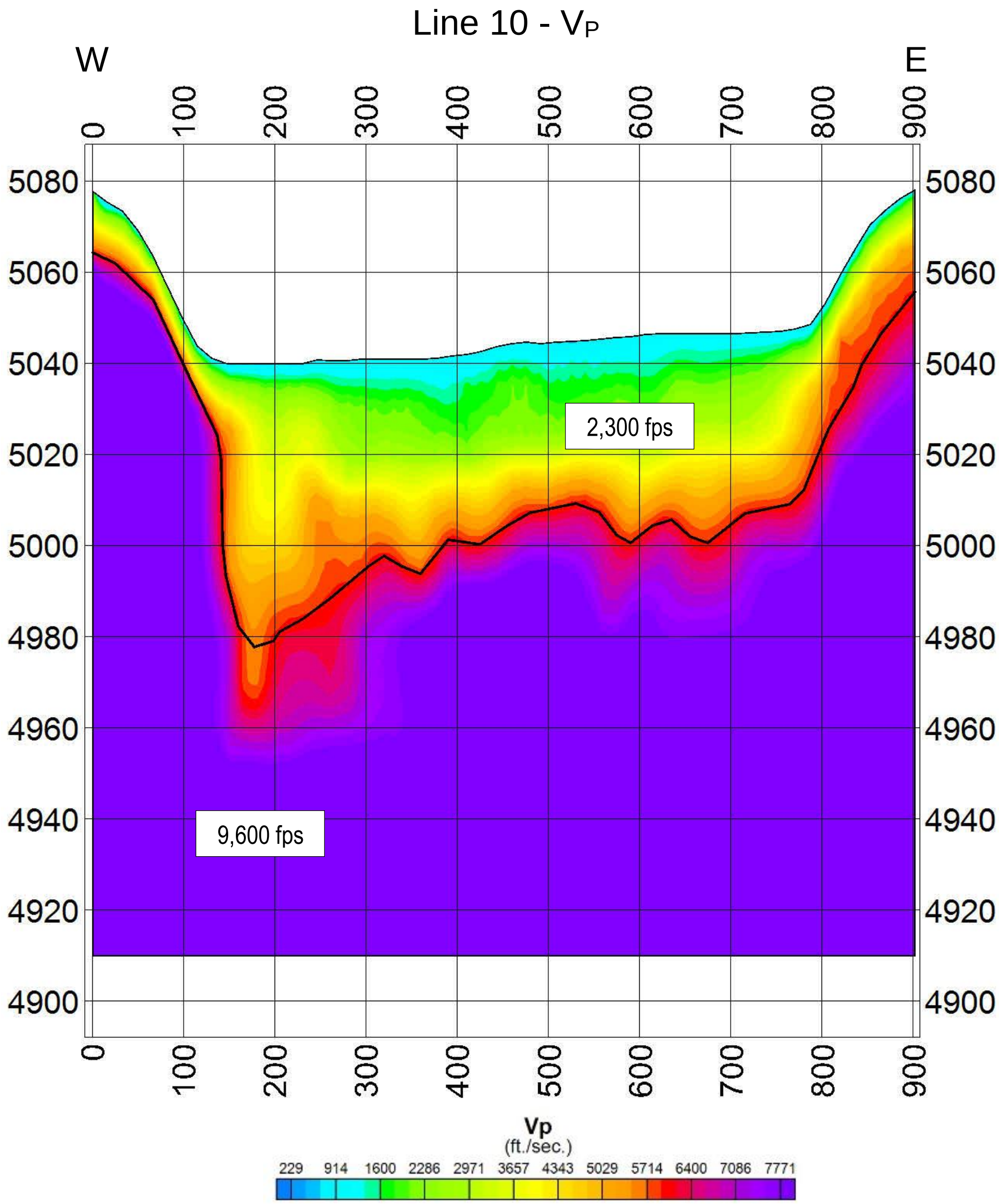


1” = 200’ Horizontal 1” = 40’ Vertical

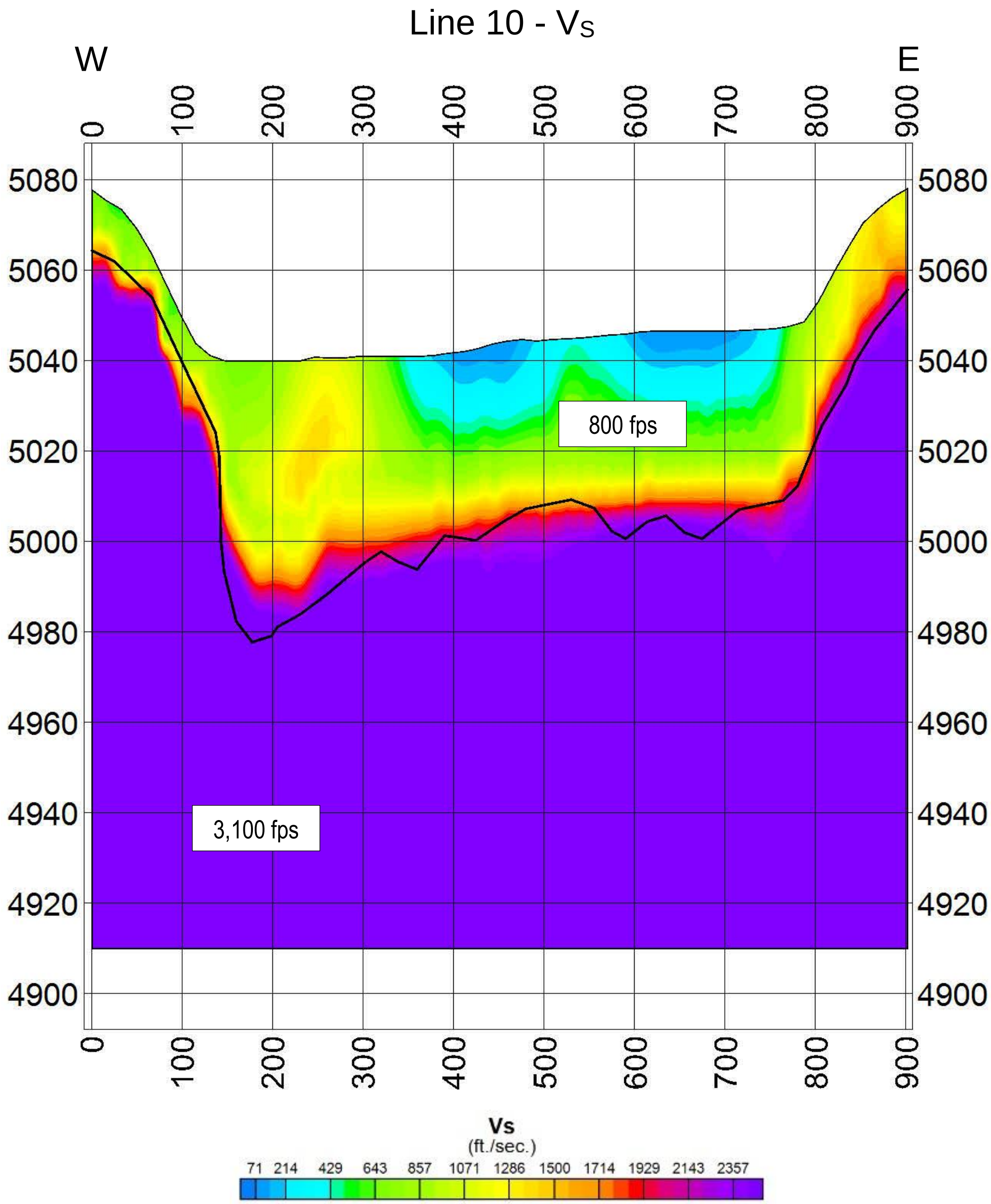
Line 9 – Vs



1" = 200' Horizontal 1" = 40' Vertical

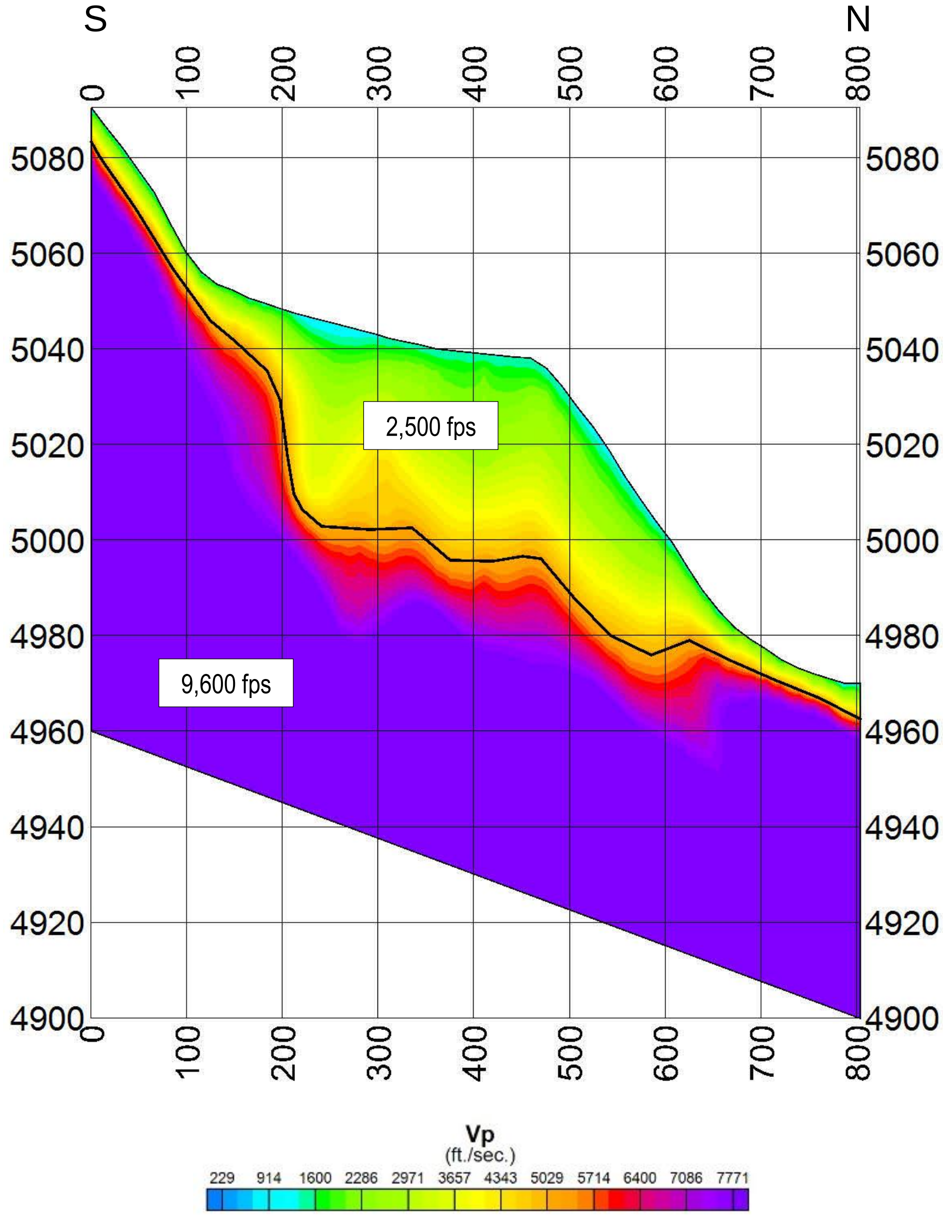


1” = 200’ Horizontal 1” = 40’ Vertical



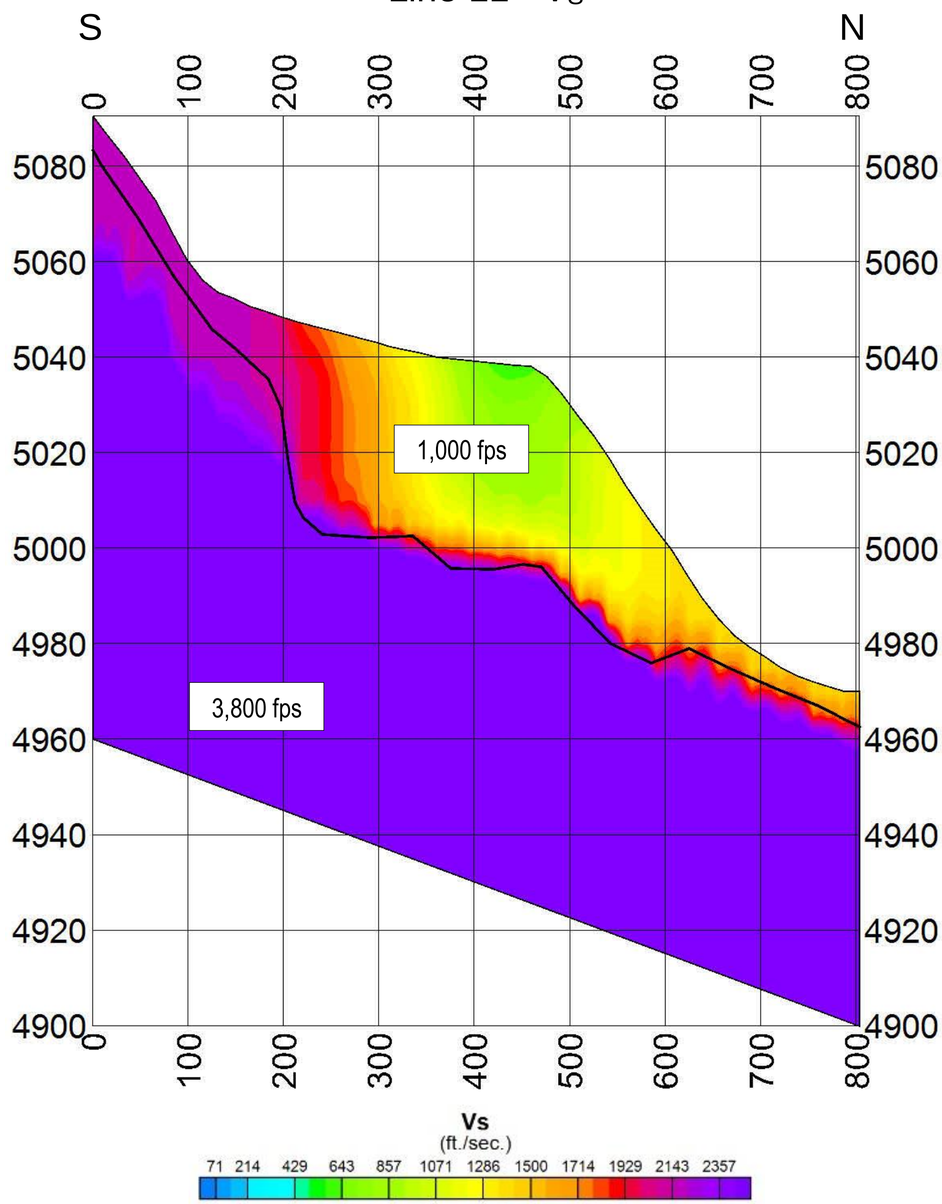
1” = 200’ Horizontal 1” = 40’ Vertical

Line 11 - VP

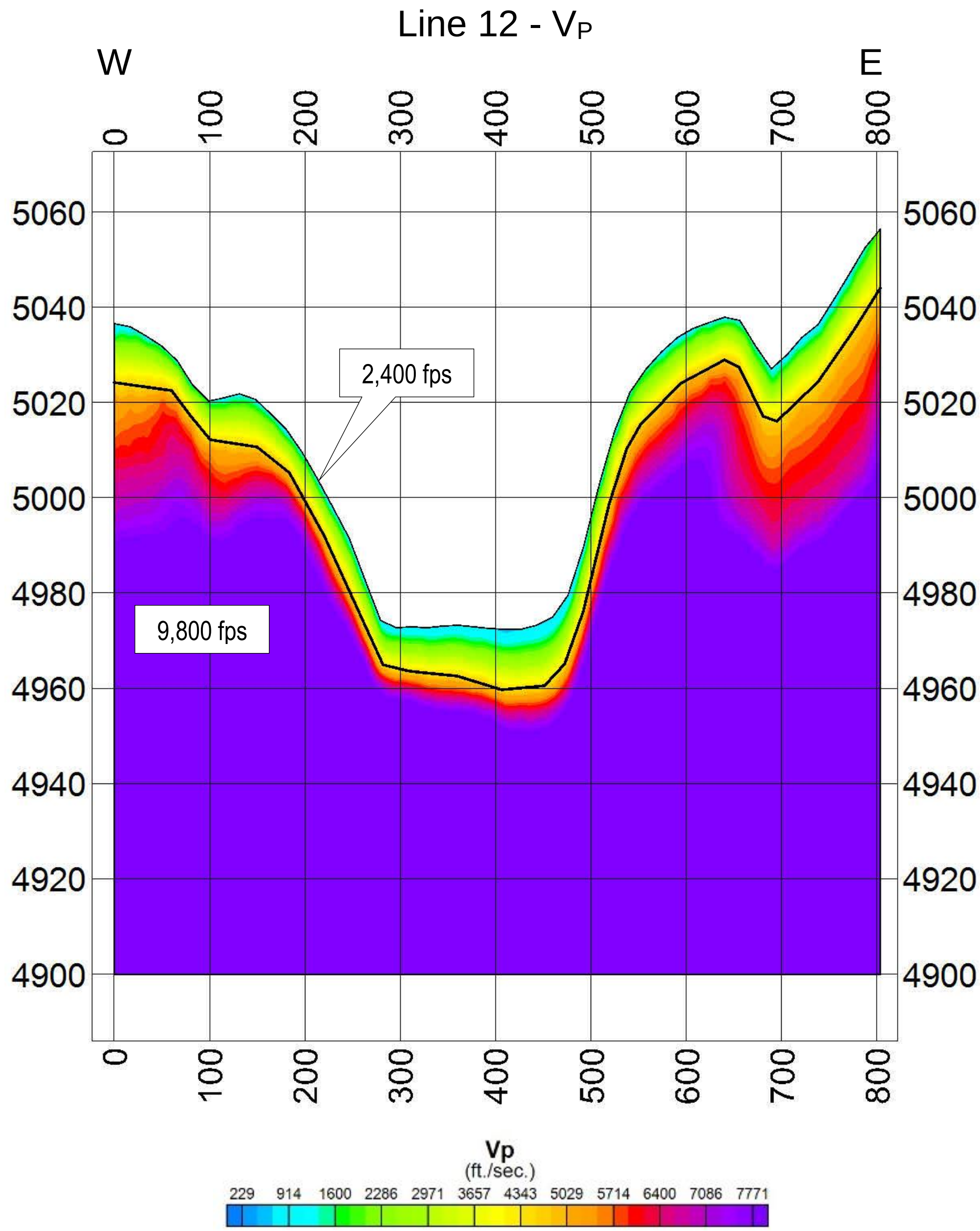


1” = 200’ Horizontal 1” = 40’ Vertical

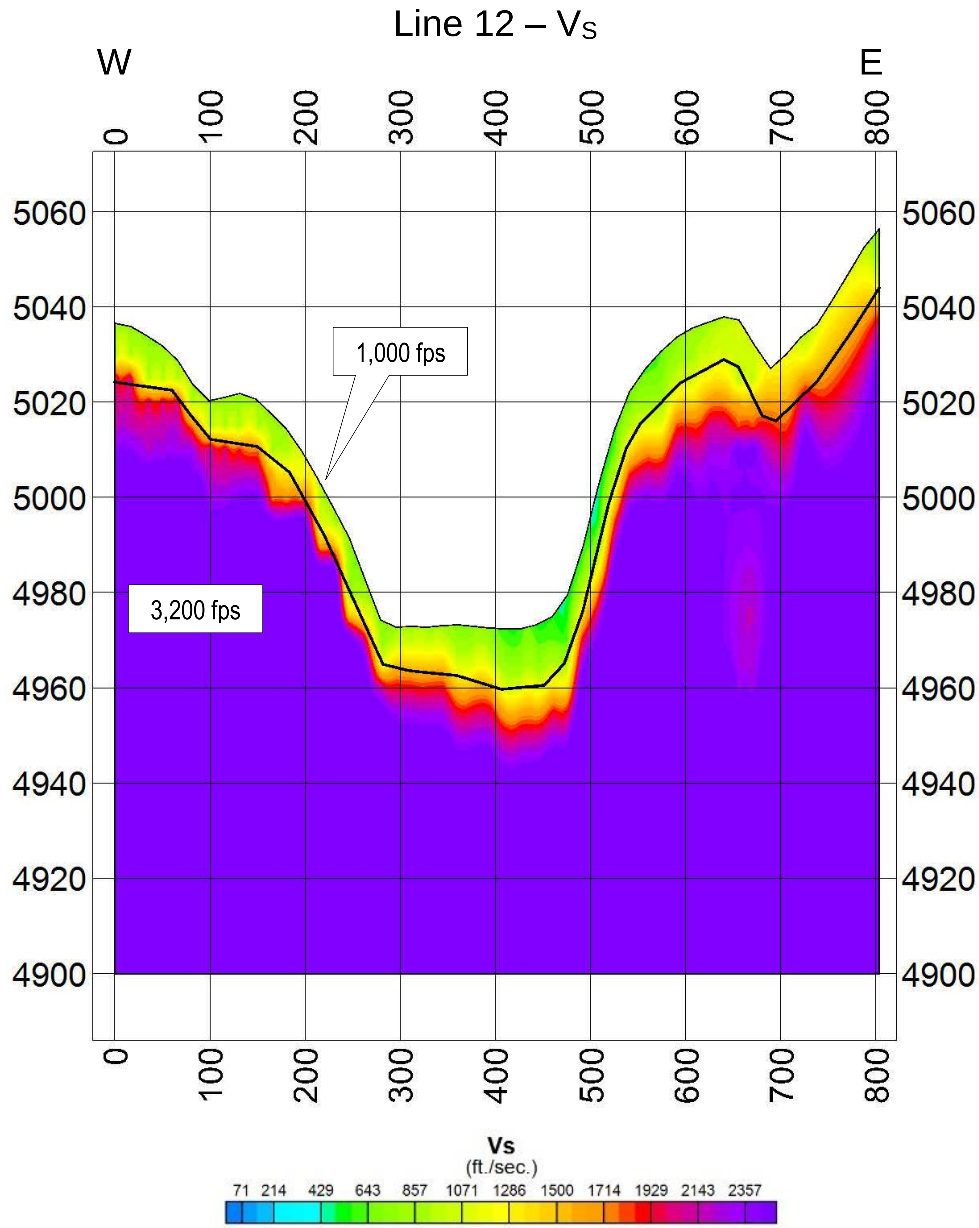
Line 11 - Vs



1" = 200' Horizontal   1" = 40' Vertical



1” = 200’ Horizontal 1” = 40’ Vertical



1” = 200’ Horizontal 1” = 40’ Vertical

APPENDIX F

Laboratory Test Results

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	

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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

NF Form #15

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

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:

MOISTURE CONTENT
(ASTM D 2216 / ASTM D 4643)
LABORATORY WORKSHEET

NewFields

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

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.		17-018-44	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:

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

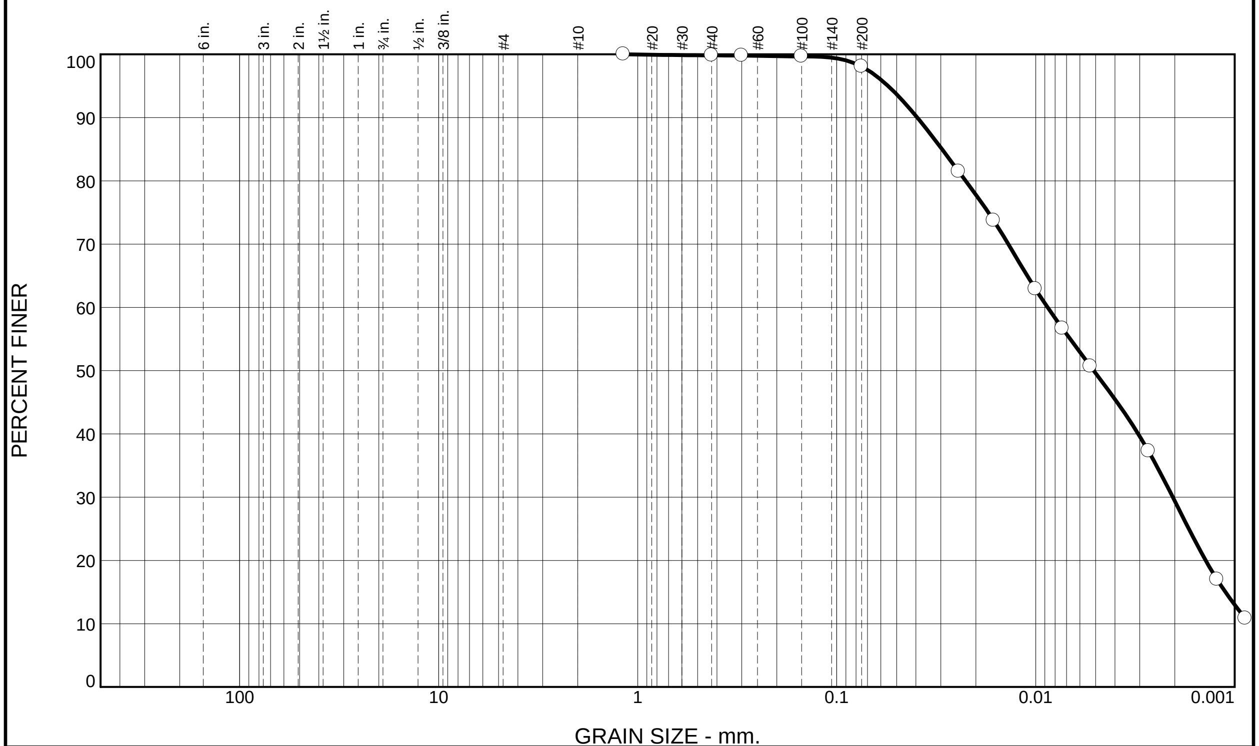
Client:	Arizona Minerals Inc.	**Location:**	Bore Holes
Project Title:	Hermosa Underground Project	**Elevation:**	See below per sample
Project Number:	475.0014.0008 / 1	**Test Start Date:**	
Project Engineer:	Craig Thompson	**Tested By:**	OS
Field Sample ID:	BH-01	**Checked By:**	RF/KE
Laboratory Sample 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

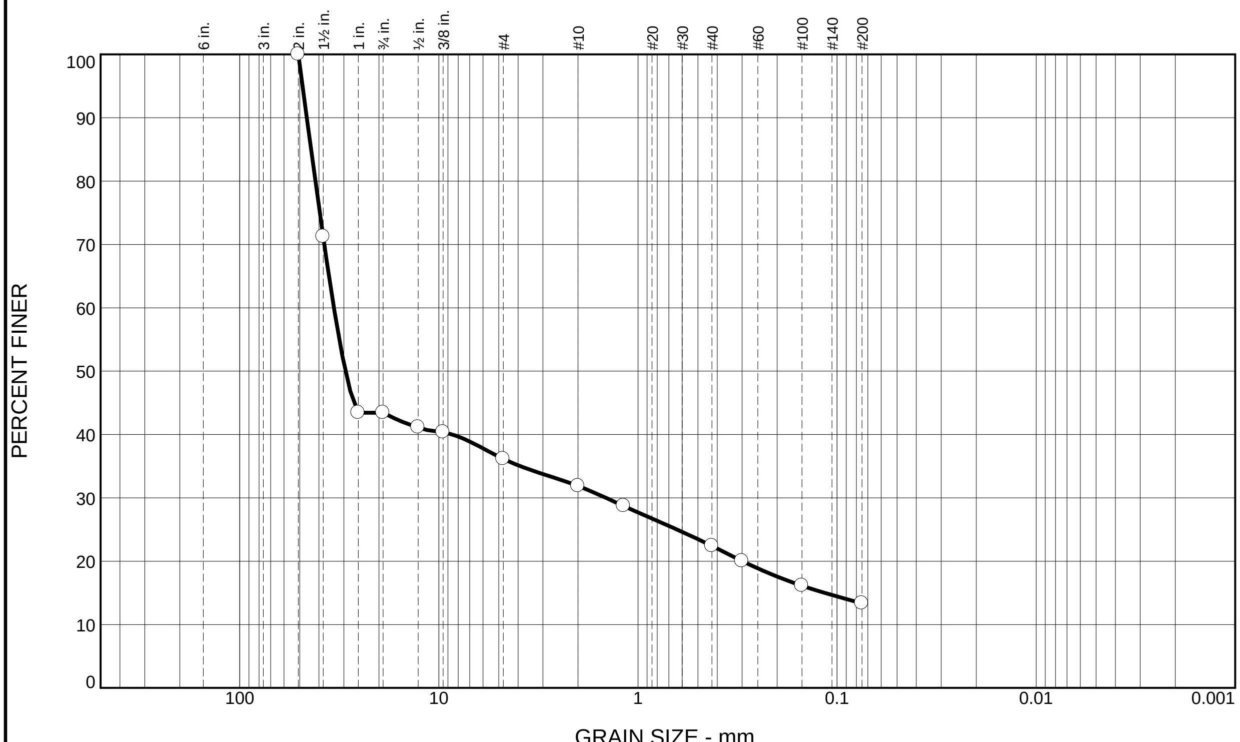
Location: BH-01
Sample Number: 17-018-07 **Depth:** 46.5-49' **Date:** 02/17/17

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

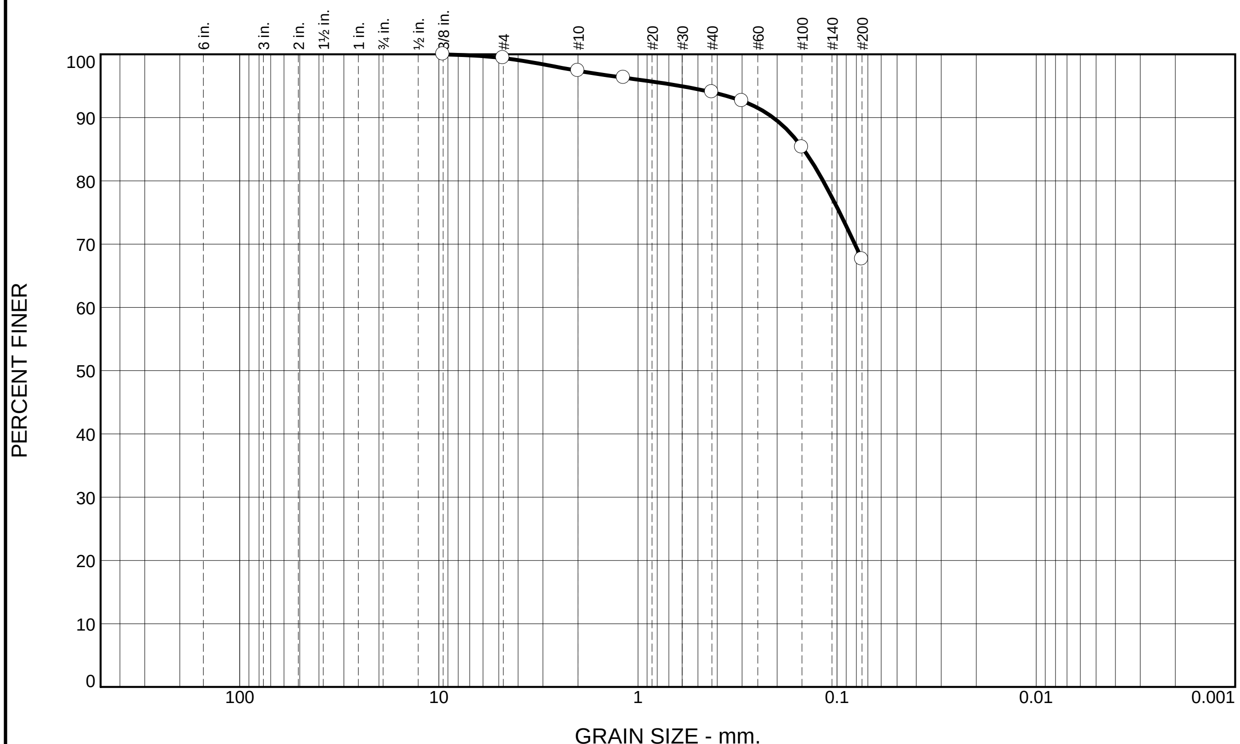
Location: BH-01
Sample Number: 17-018-08 **Depth:** 52.5-54' **Date:** 02/17/17

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

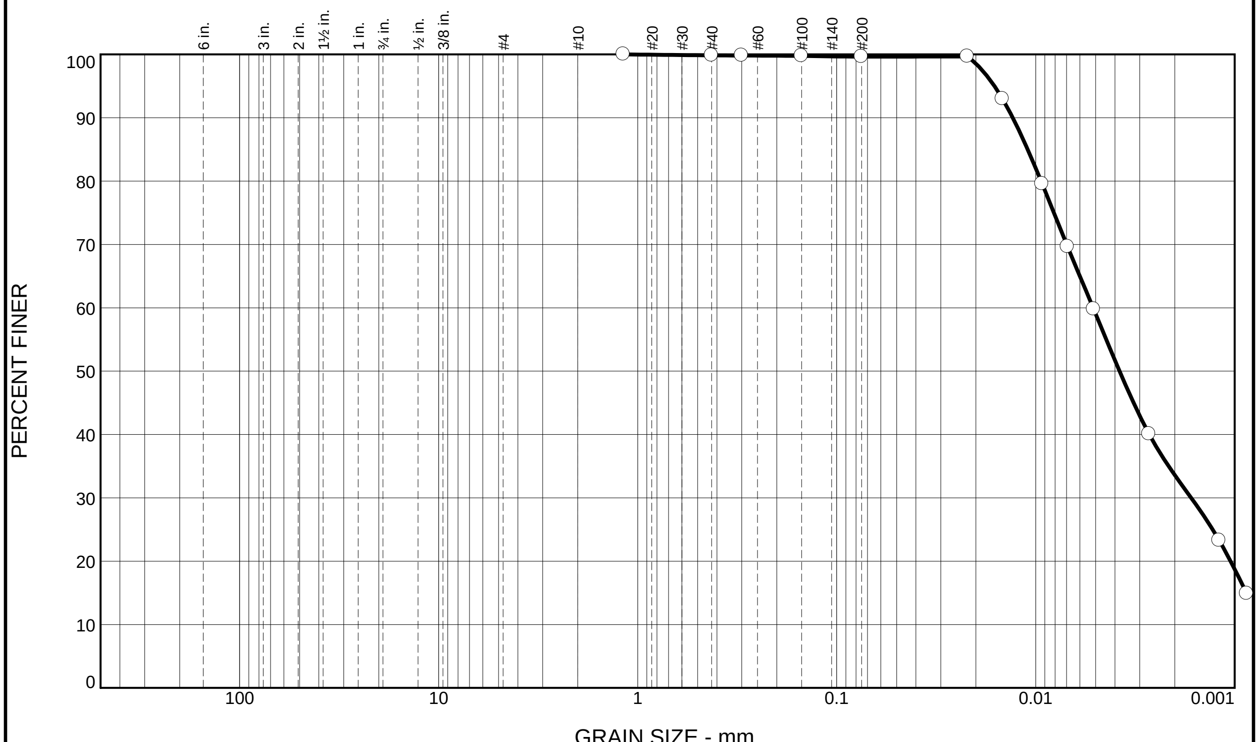
Location: BH-02
Sample Number: 17-018-10 **Depth:** 5-6.5' **Date:** 02/17/17

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

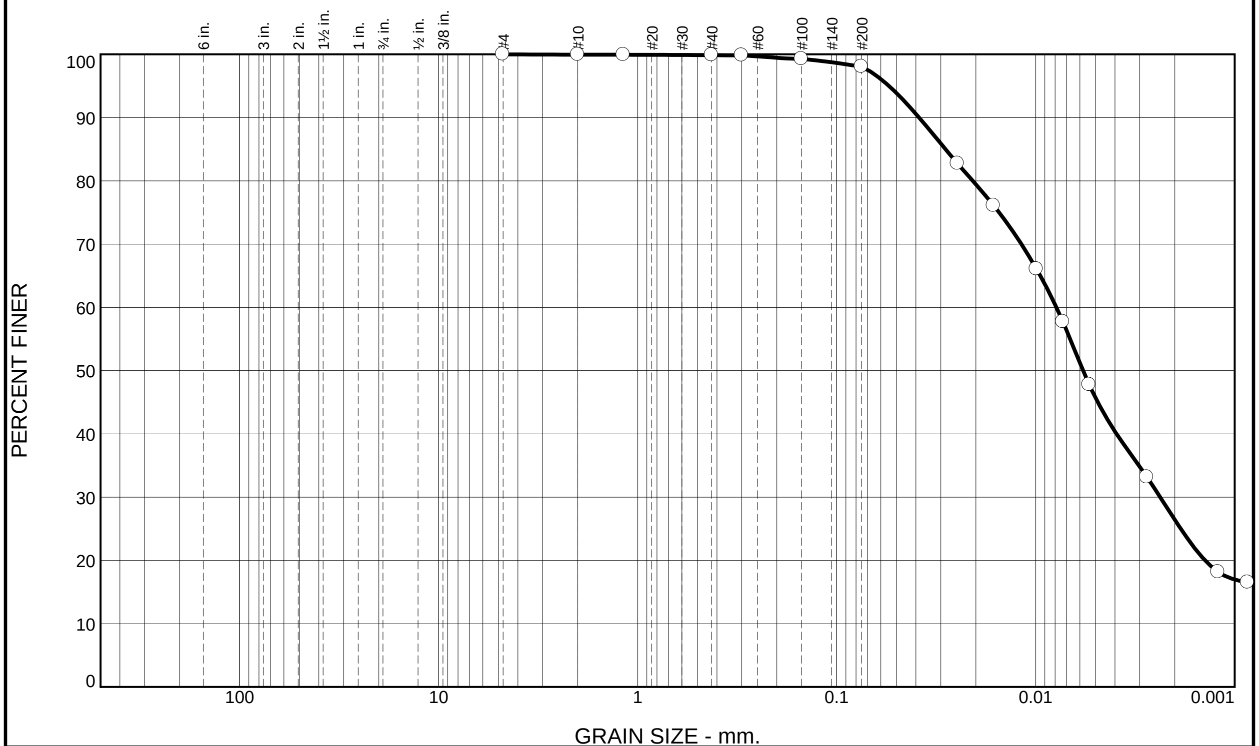
Location: BH-02
Sample Number: 17-018-13 **Depth:** 26.5-29' **Date:** 02/17/17

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

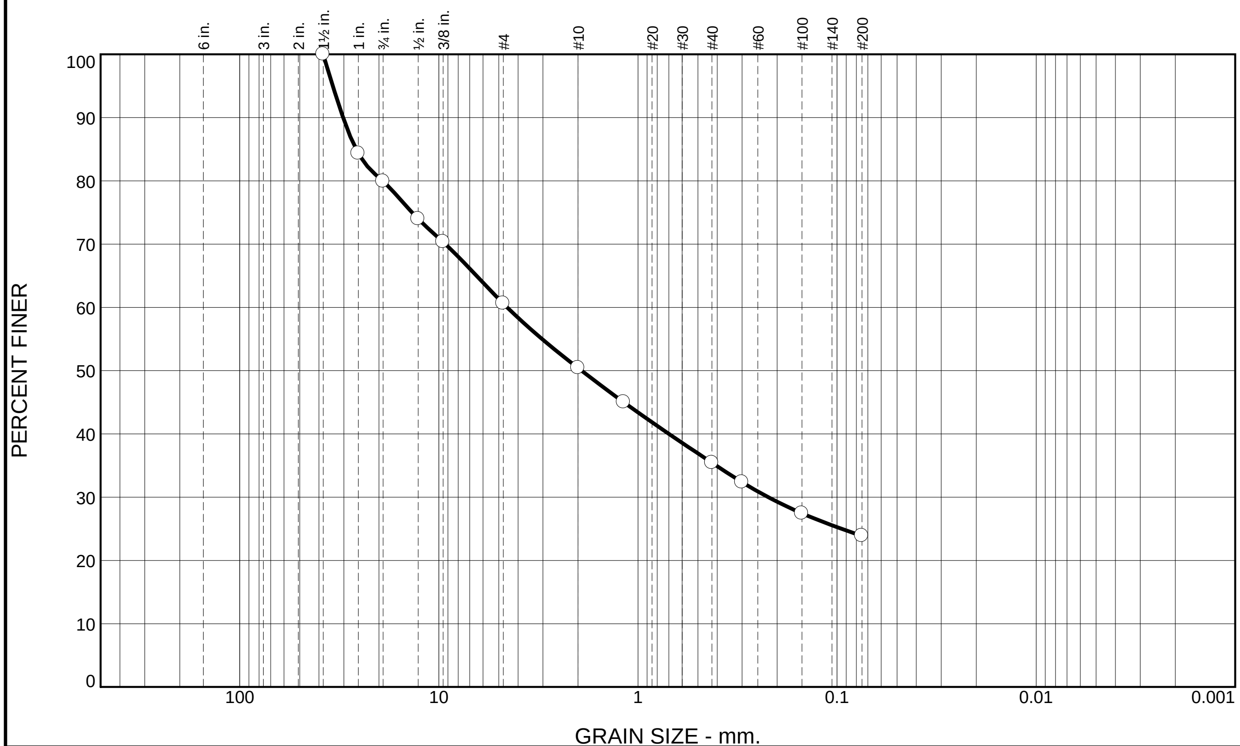
Location: BH-02
Sample Number: 17-018-14 **Depth:** 35-36.5' **Date:** 02/17/17

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

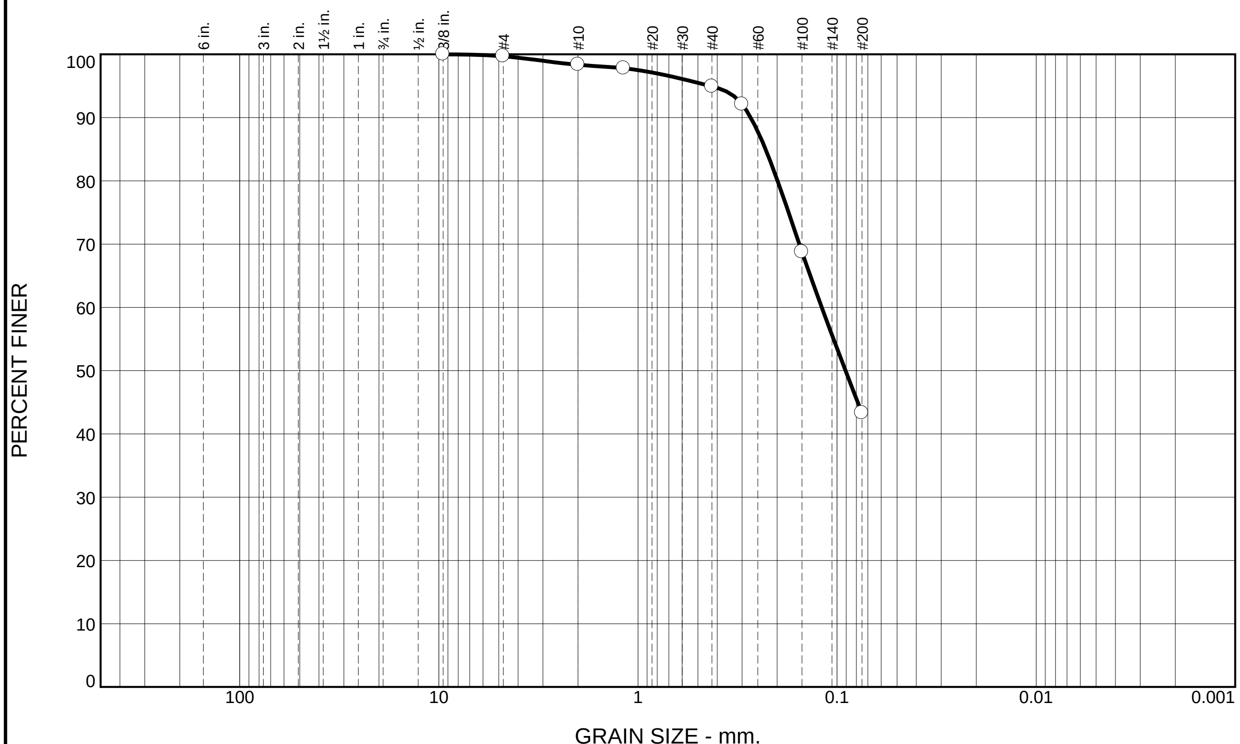
Location: BH-02
Sample Number: 17-018-15 **Depth:** 37.5-39' **Date:** 02/17/17

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

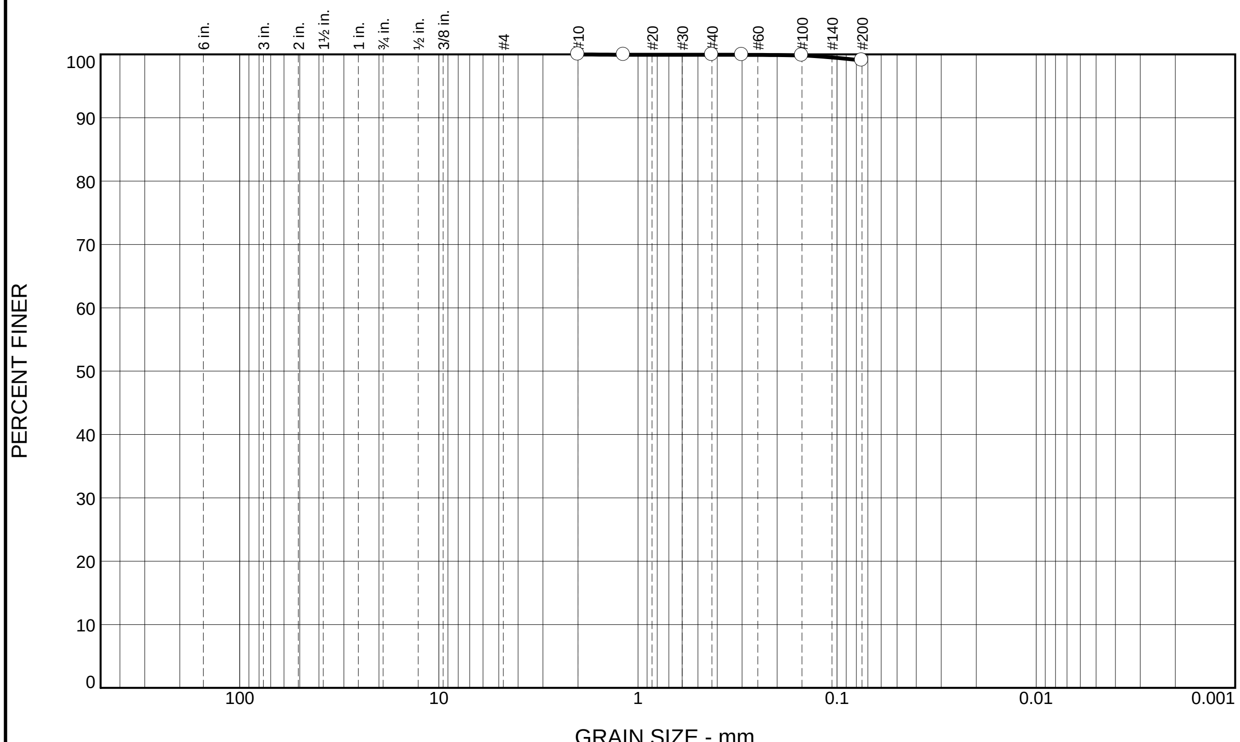
Location: BH-03
Sample Number: 17-018-17 **Depth:** 4-5.5' **Date:** 02/17/17

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

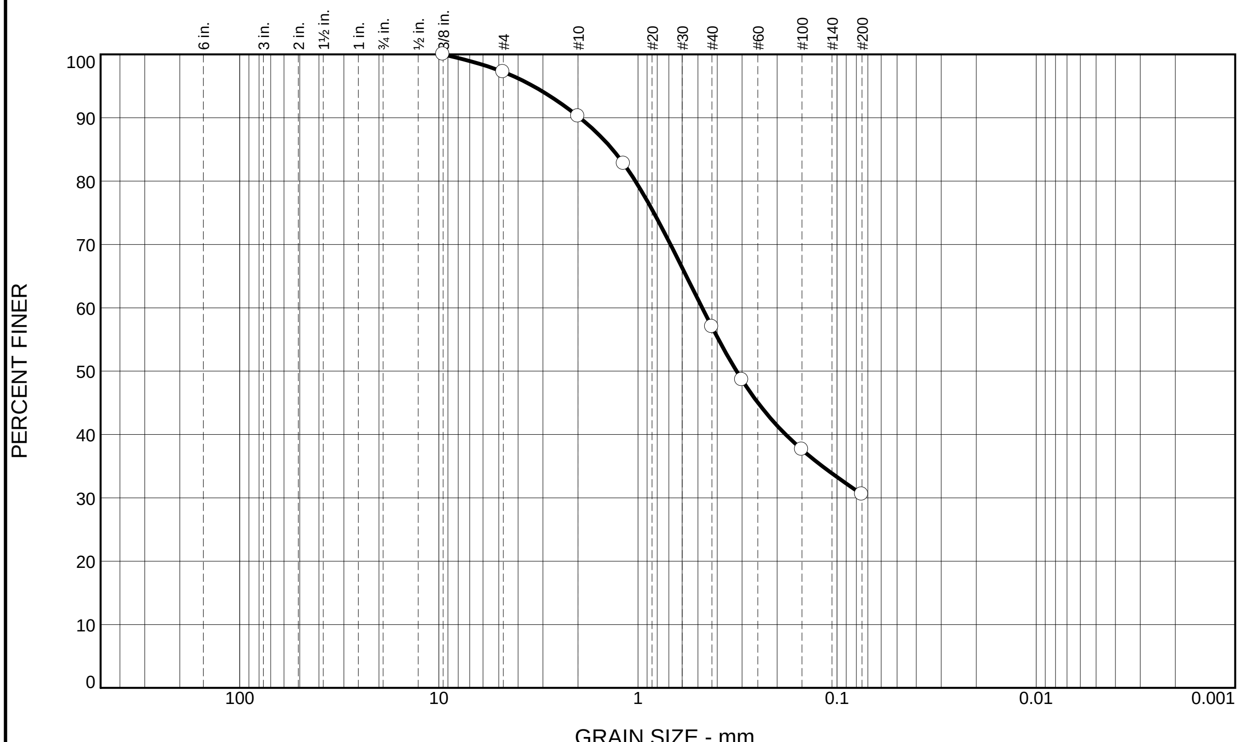
Location: BH-03
Sample Number: 17-018-20 **Depth:** 35-36.5' **Date:** 02/17/17

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

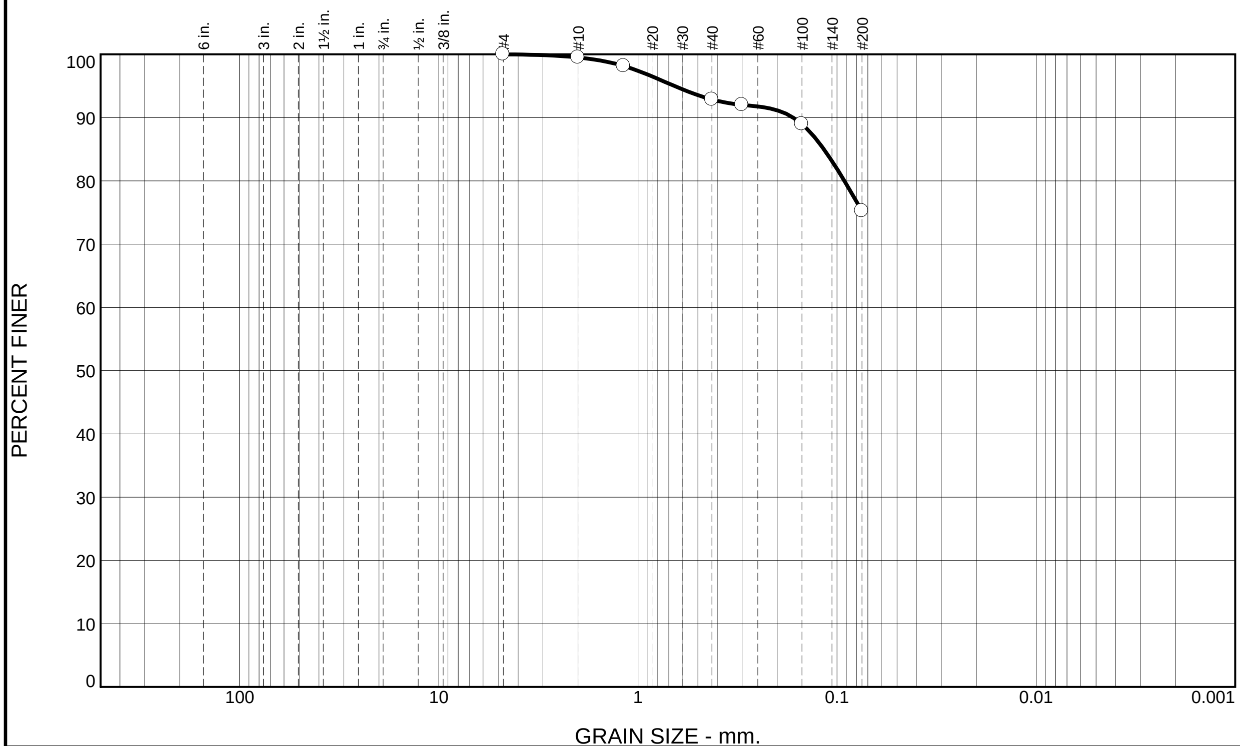
Location: BH-03
Sample Number: 17-018-21 **Depth:** 43.8-44.3' **Date:** 02/17/17

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

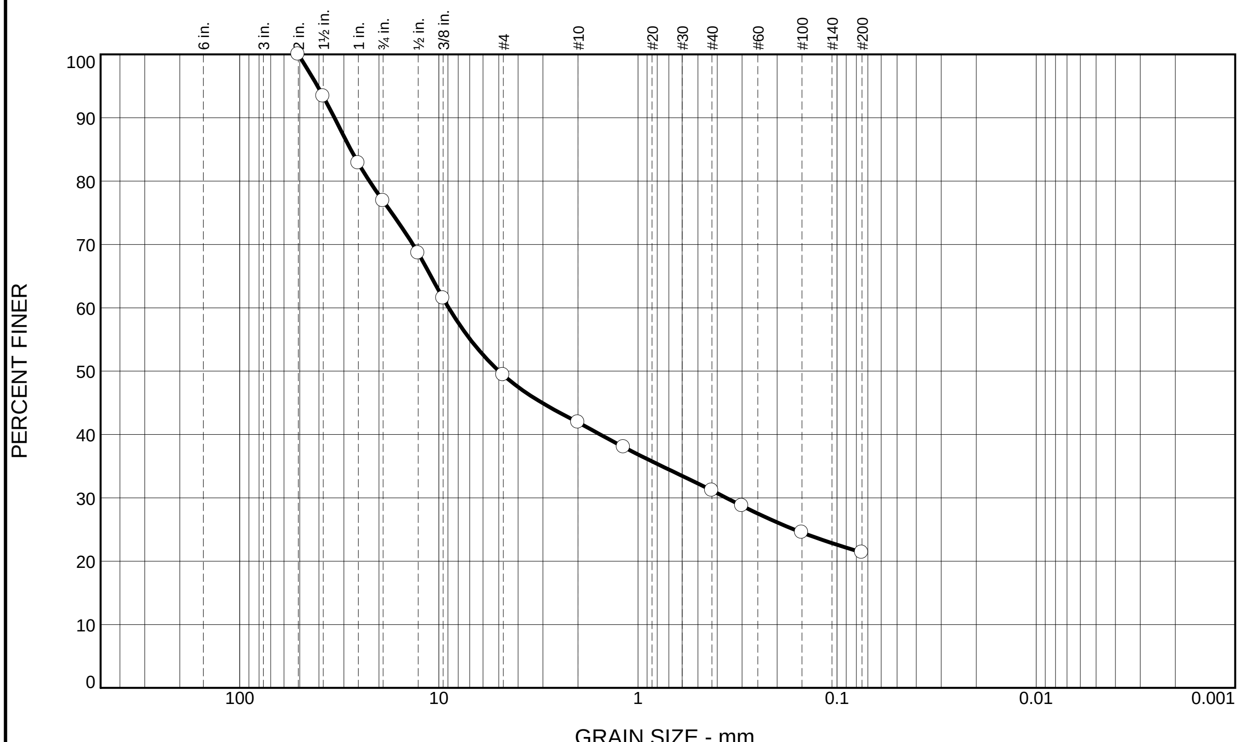
Location: BH-04
Sample Number: 17-018-24 **Depth:** 15-16.5' **Date:** 02/17/17

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

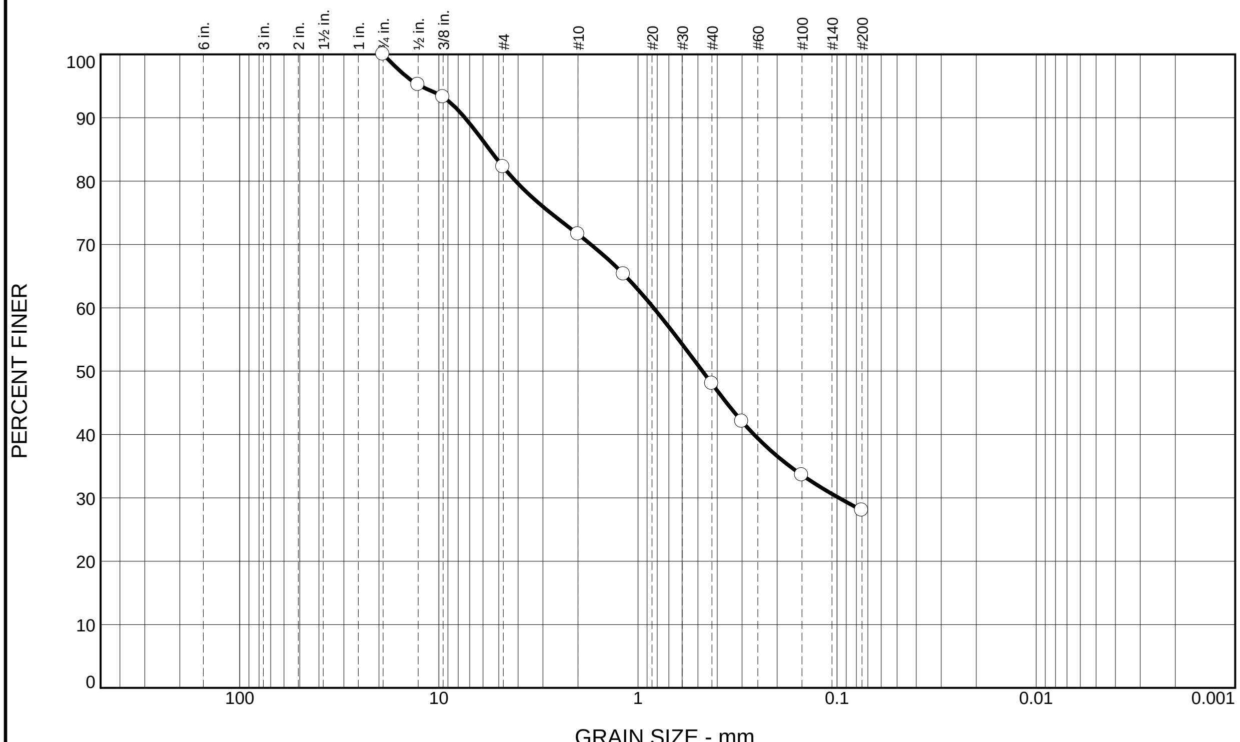
Location: BH-04
Sample Number: 17-018-25 **Depth:** 20-21.5' **Date:** 02/17/17

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

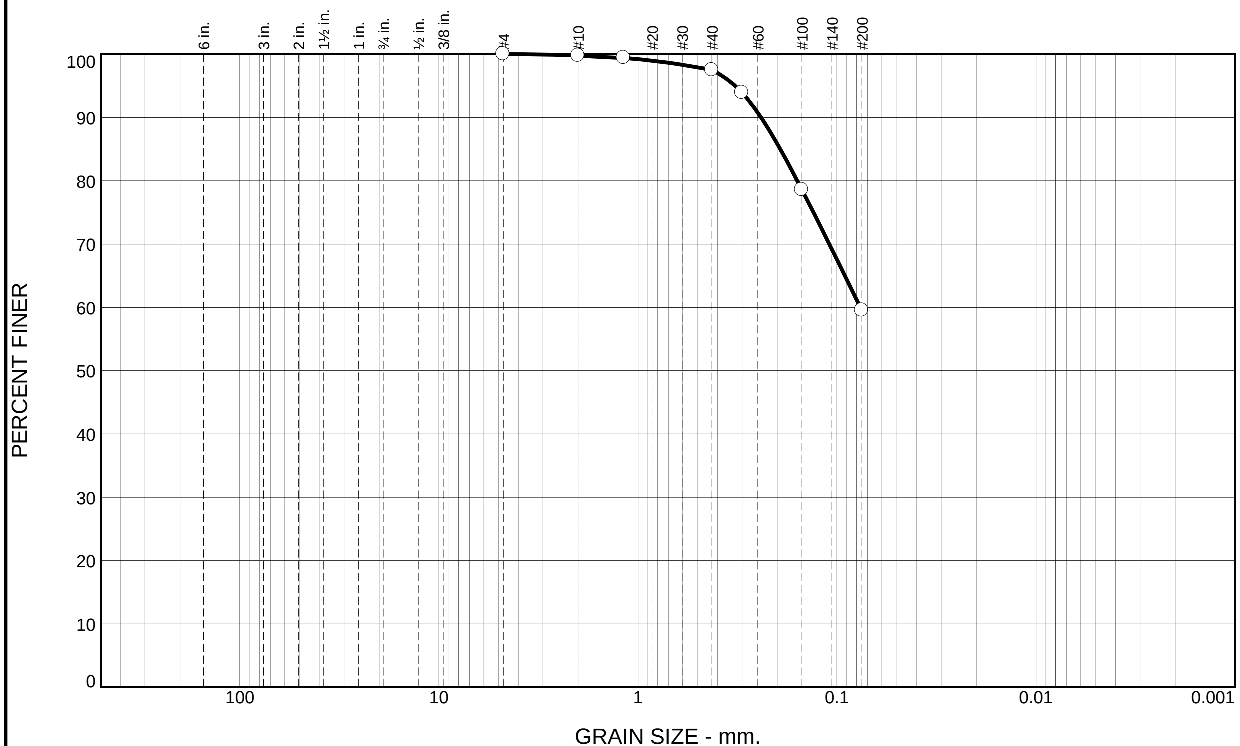
Location: BH-04
Sample Number: 17-018-27 **Depth:** 40-41.5' **Date:** 02/17/17

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

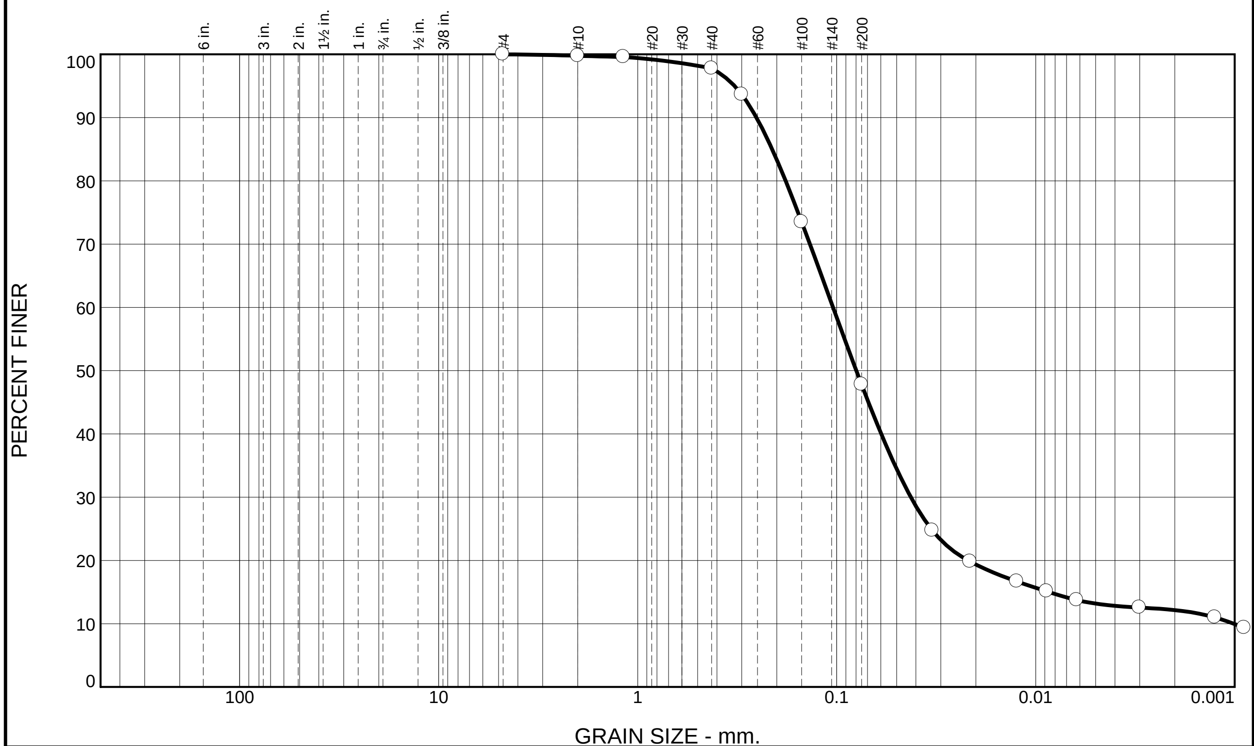
Location: BH-05
Sample Number: 17-018-29 **Depth:** 5-5.6' **Date:** 02/17/17

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

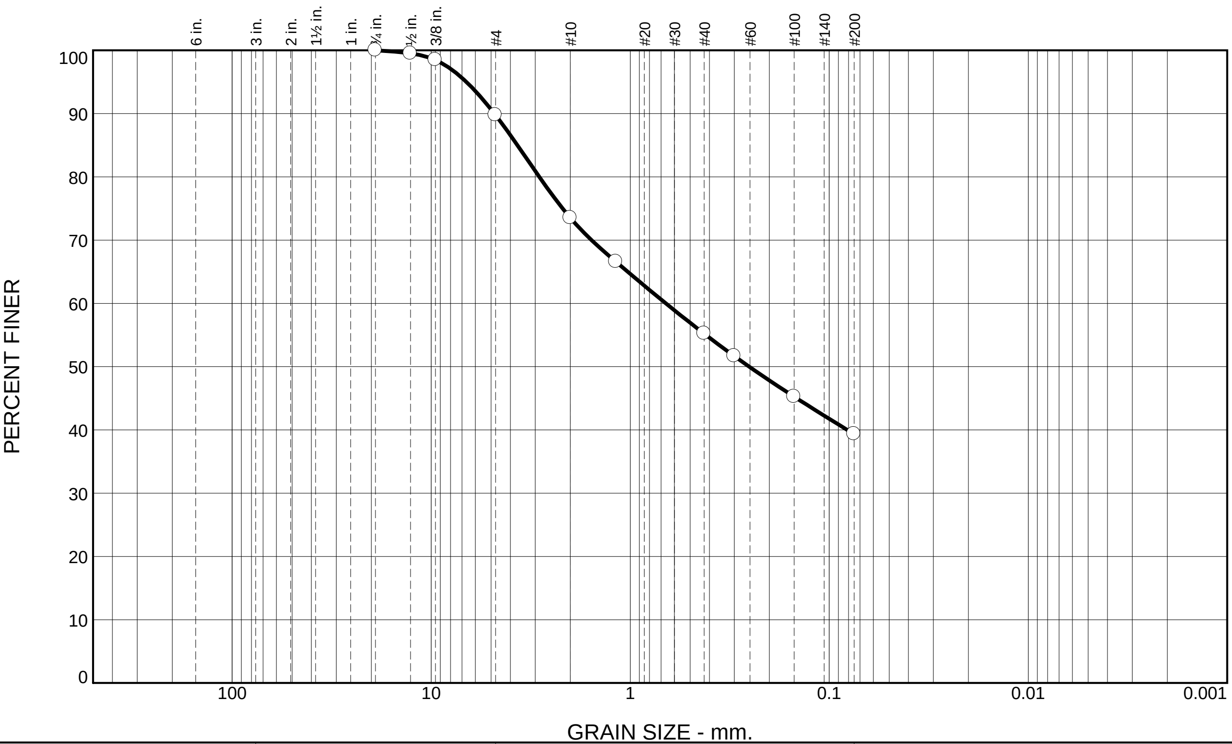
Location: BH-05
Sample Number: 17-018-30 **Depth:** 15-16.5' **Date:** 02/17/17

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

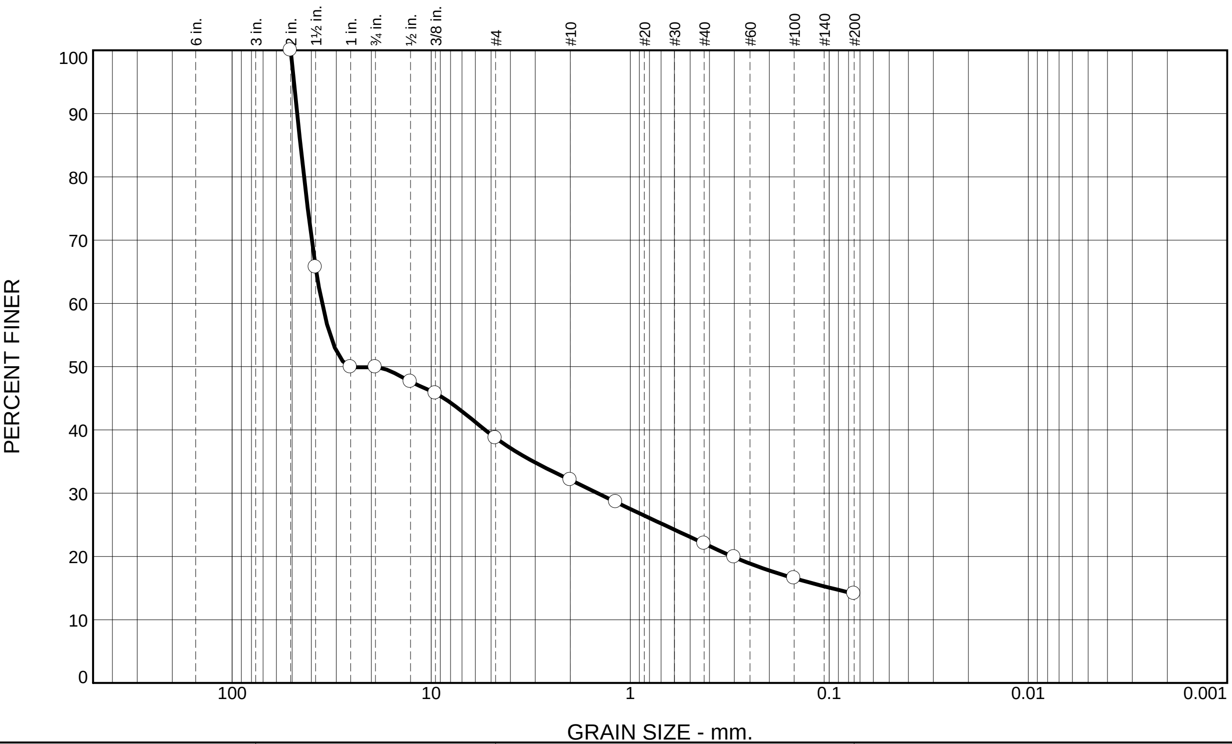
Location: BH-05
Sample Number: 17-018-31 **Depth:** 17.5-19' **Date:** 02/17/17

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

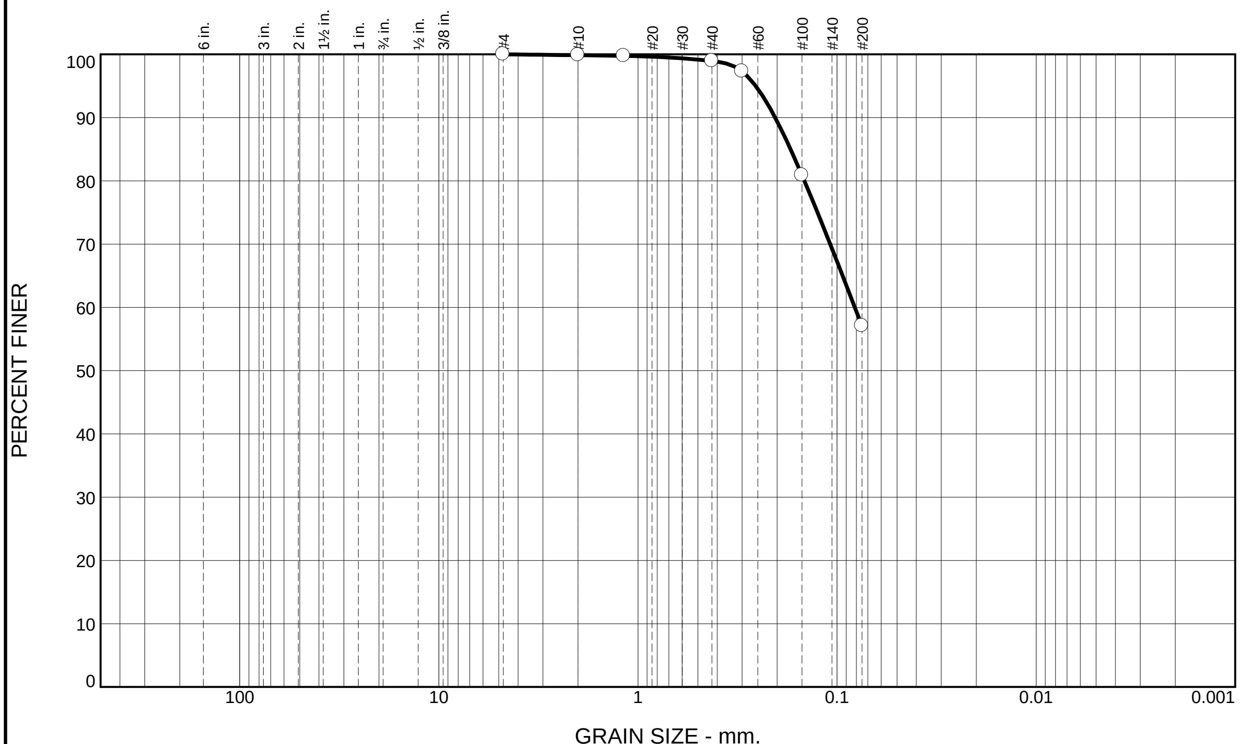
Location: BH-06
Sample Number: 17-018-33 **Depth:** 10-11.5' **Date:** 02/17/17

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

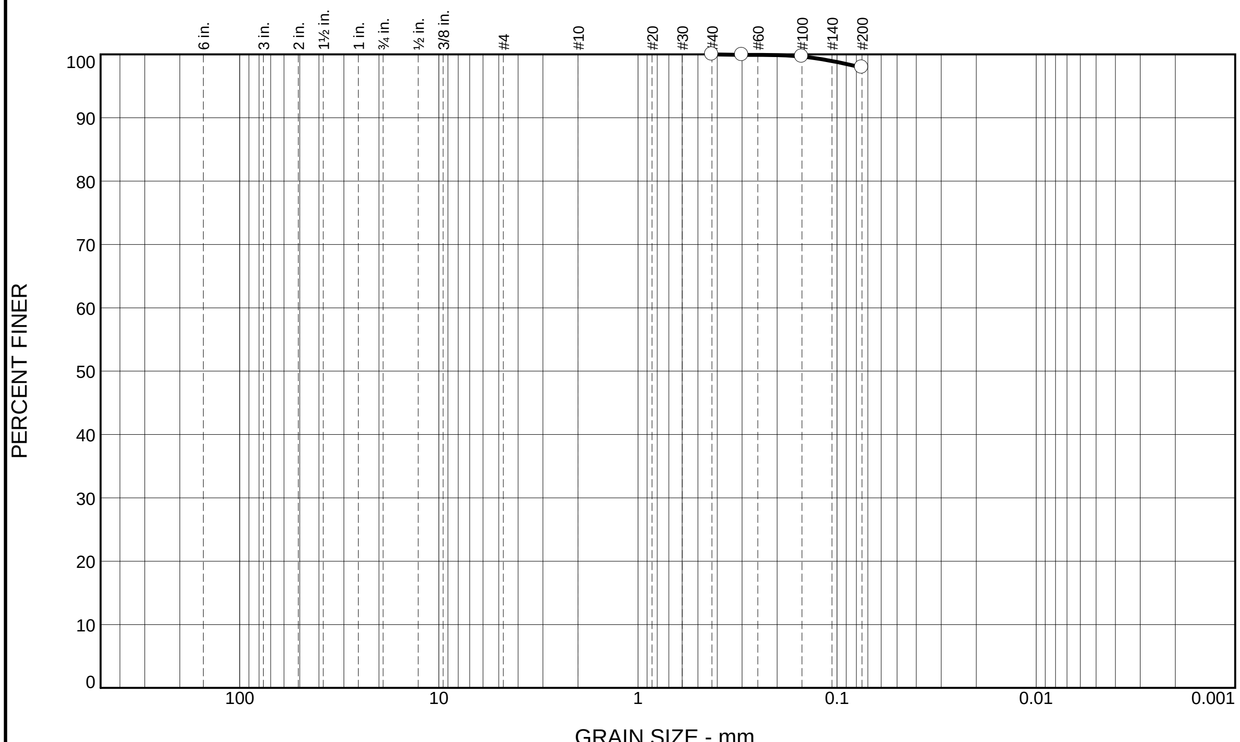
Location: BH-07
Sample Number: 17-018-37 **Depth:** 5-6.5' **Date:** 02/17/17

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

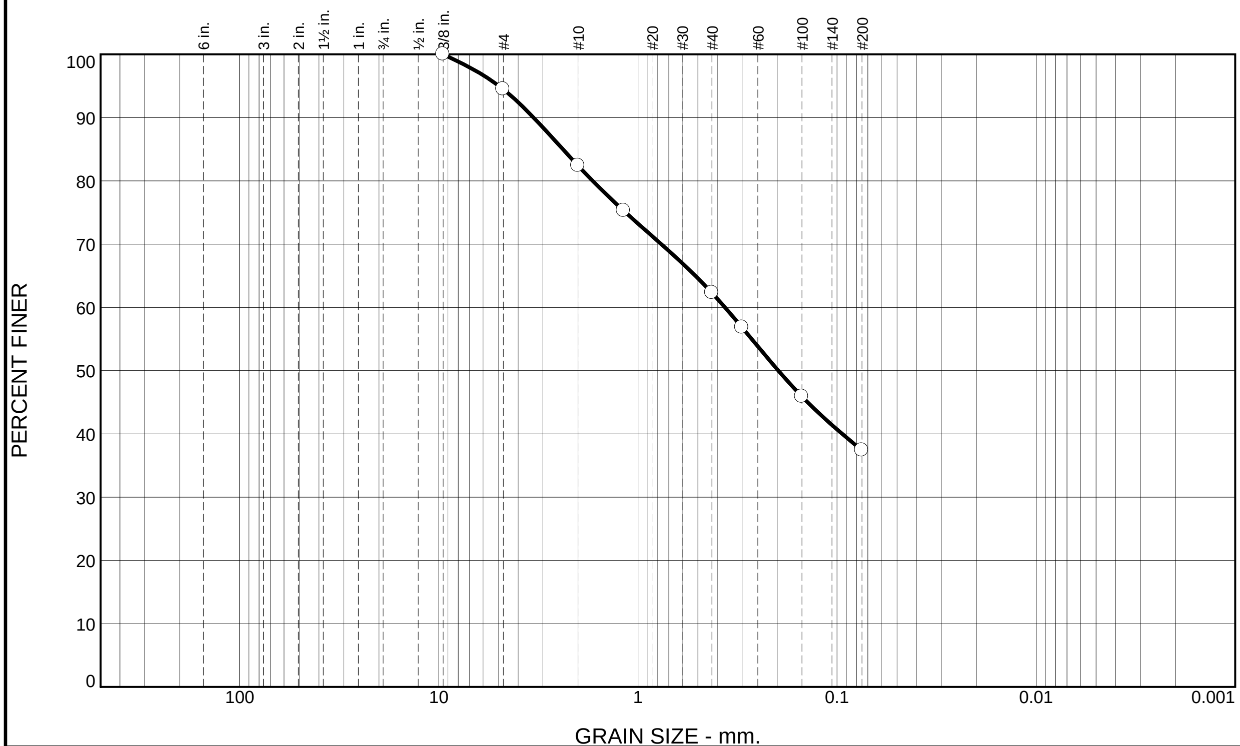
NewFields

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

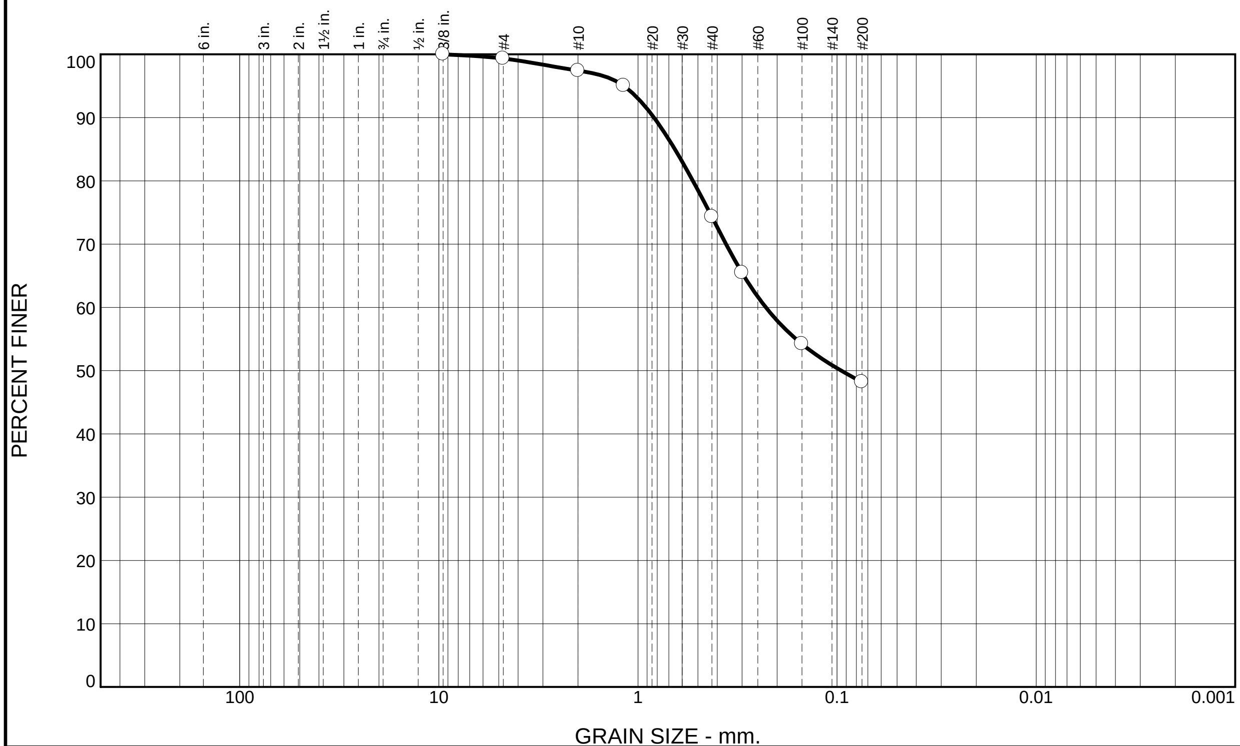
Location: BH-07
Sample Number: 17-018-42 **Depth:** 31.1-31.5' **Date:** 02/17/17

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

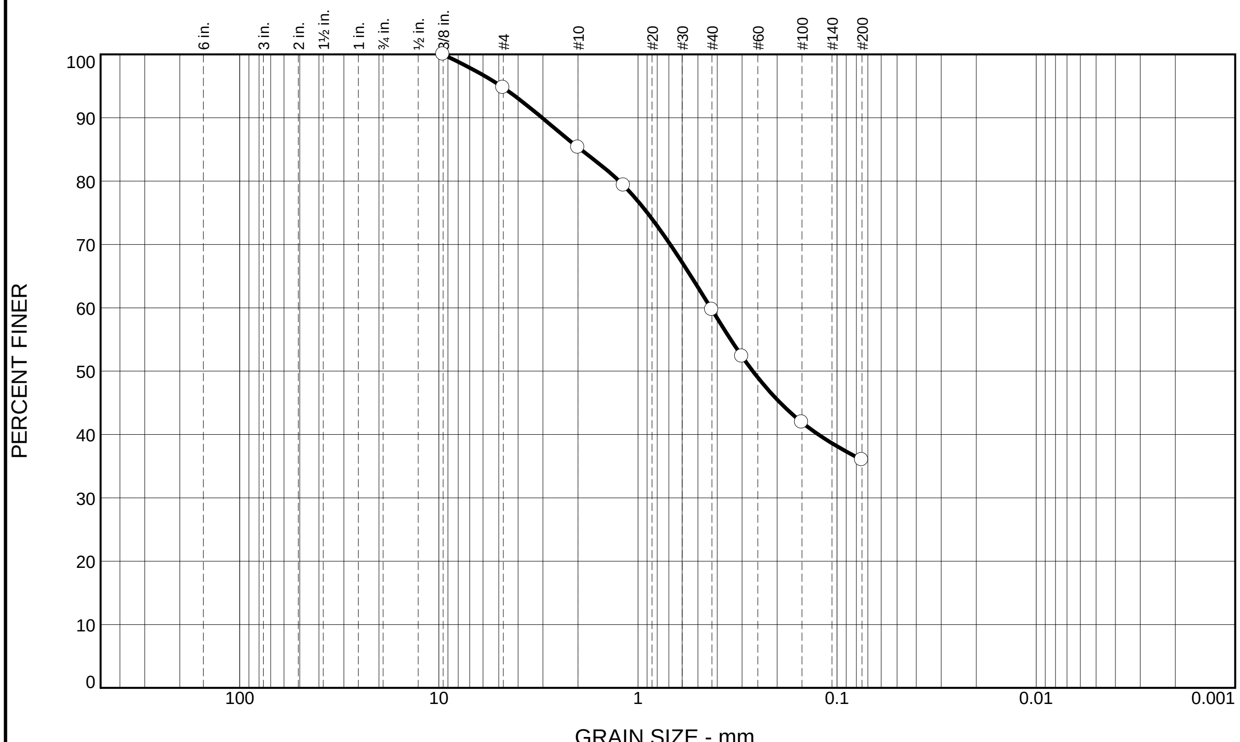
NewFields

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

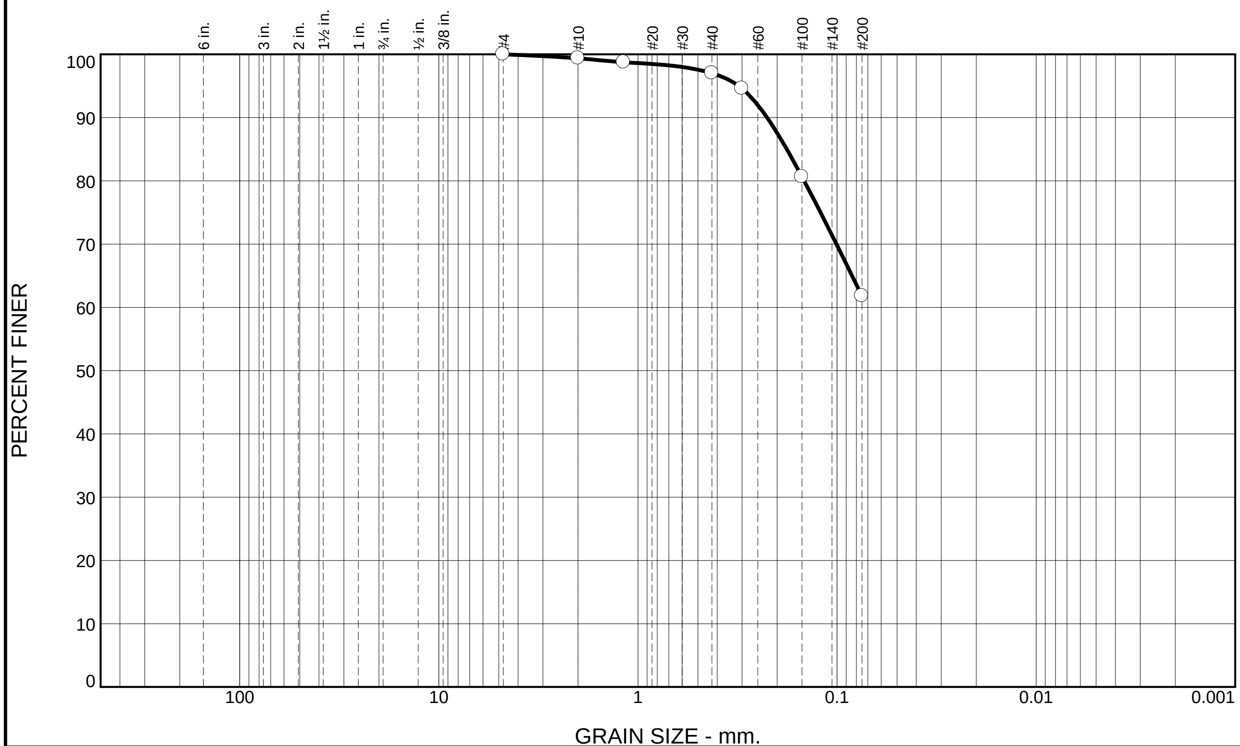
Location: BH-07
Sample Number: 17-018-44 **Depth:** 35.9-36.4' **Date:** 02/17/17

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

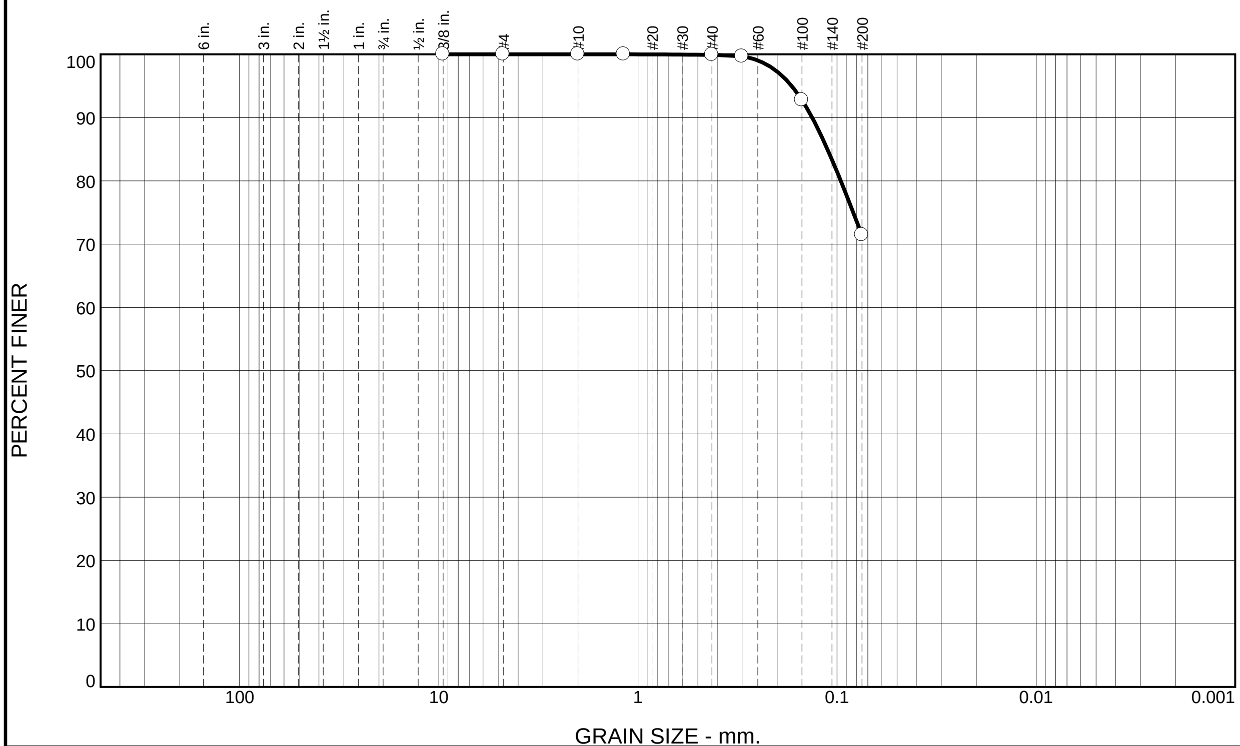
Location: BH-08
Sample Number: 17-018-47 **Depth:** 5-6.5' **Date:** 02/17/17

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

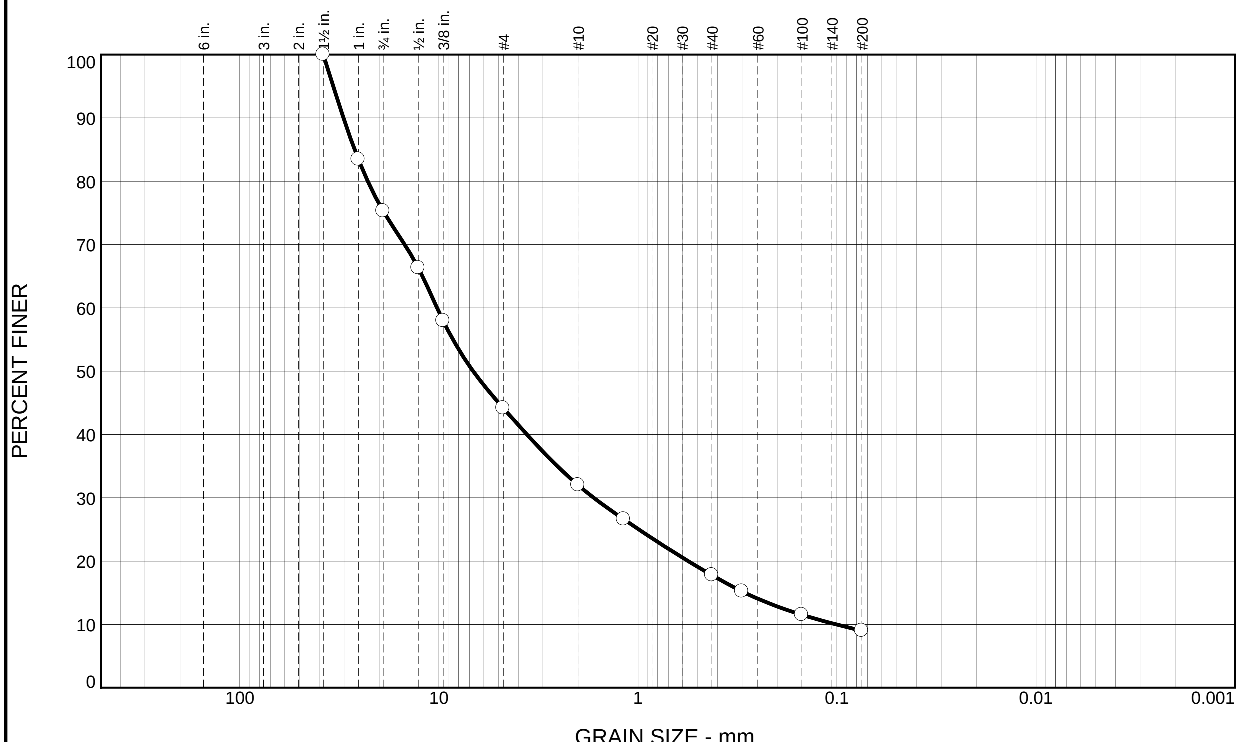
Location: BH-08
Sample Number: 17-018-49 **Depth:** 25-26.5' **Date:** 02/17/17

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

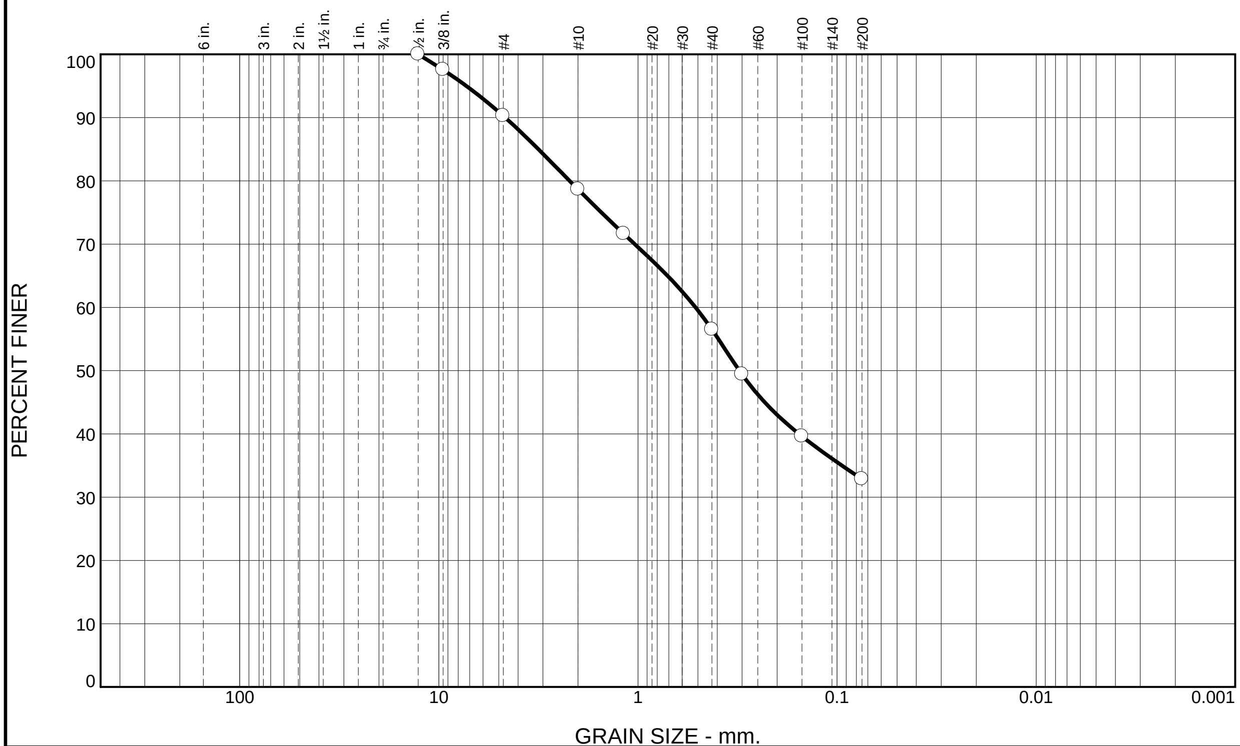
Location: BH-08
Sample Number: 17-018-54 **Depth:** 52.5-54' **Date:** 02/17/17

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

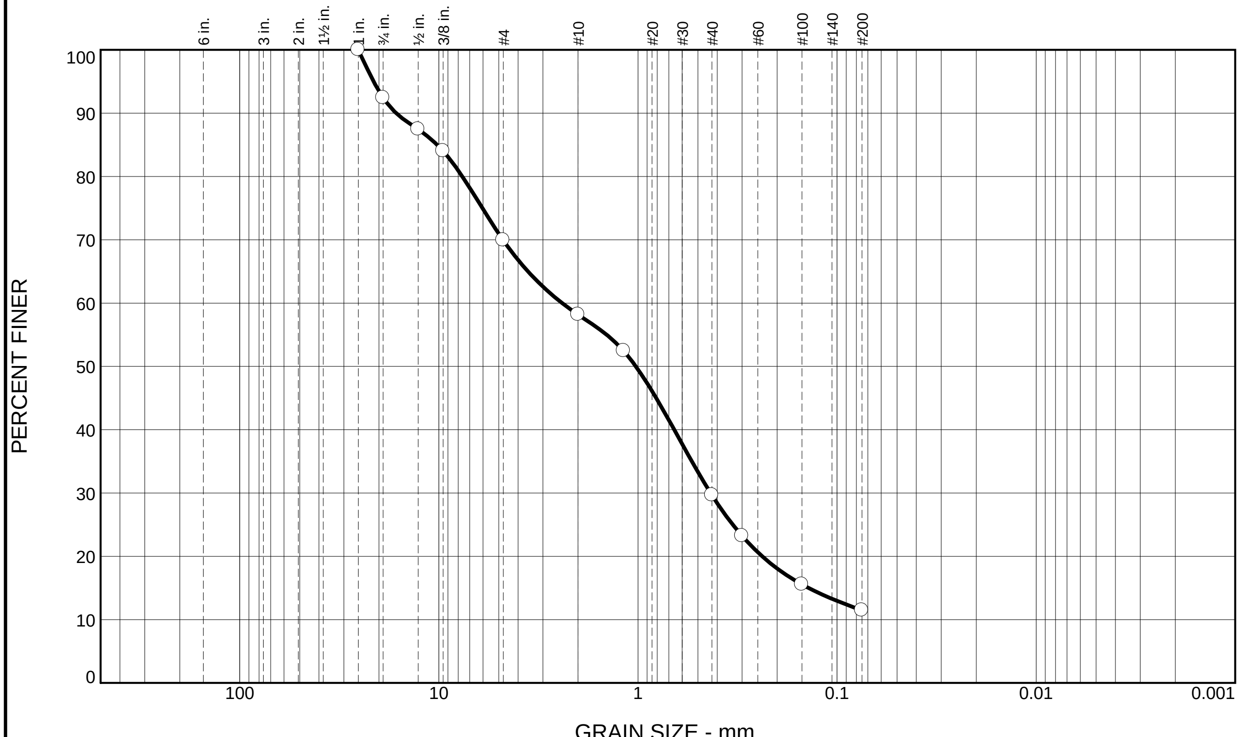
Location: BH-13
Sample Number: 17-018-55 **Depth:** 1-2.5' **Date:** 02/17/17

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

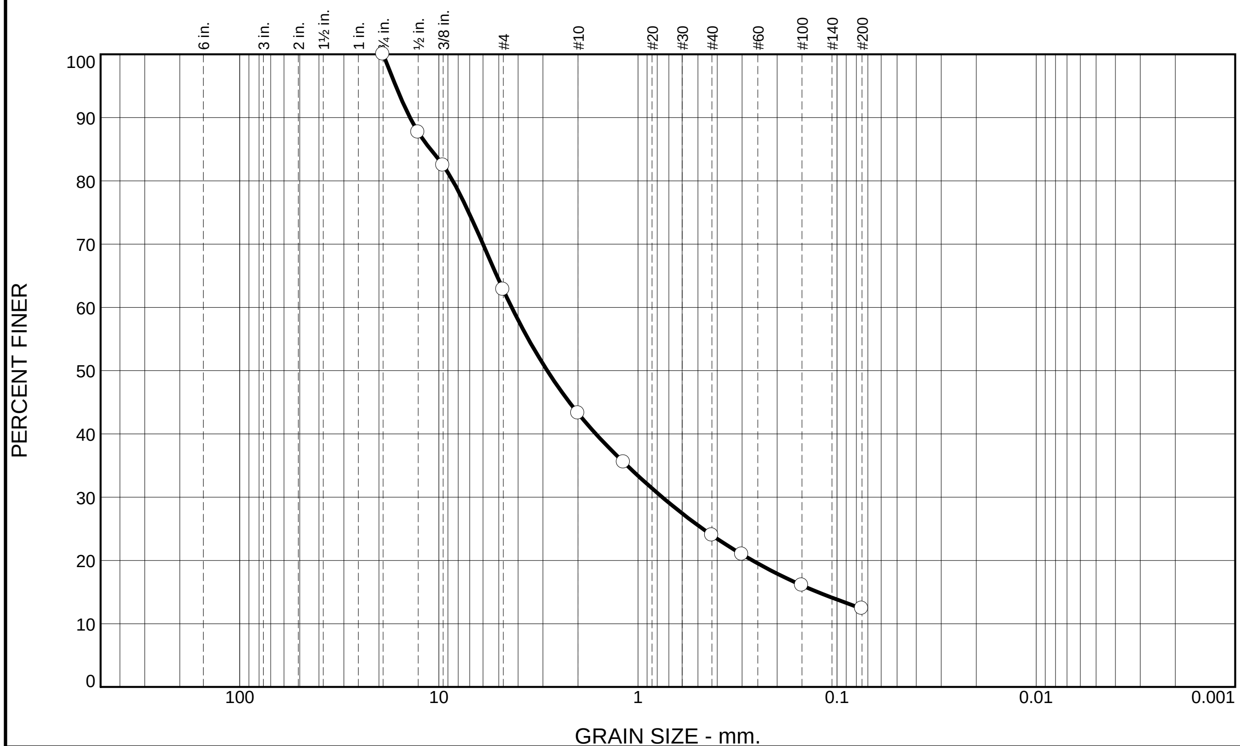
Location: BH-13
Sample Number: 17-018-56 **Depth:** 6-7.5' **Date:** 02/17/17

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

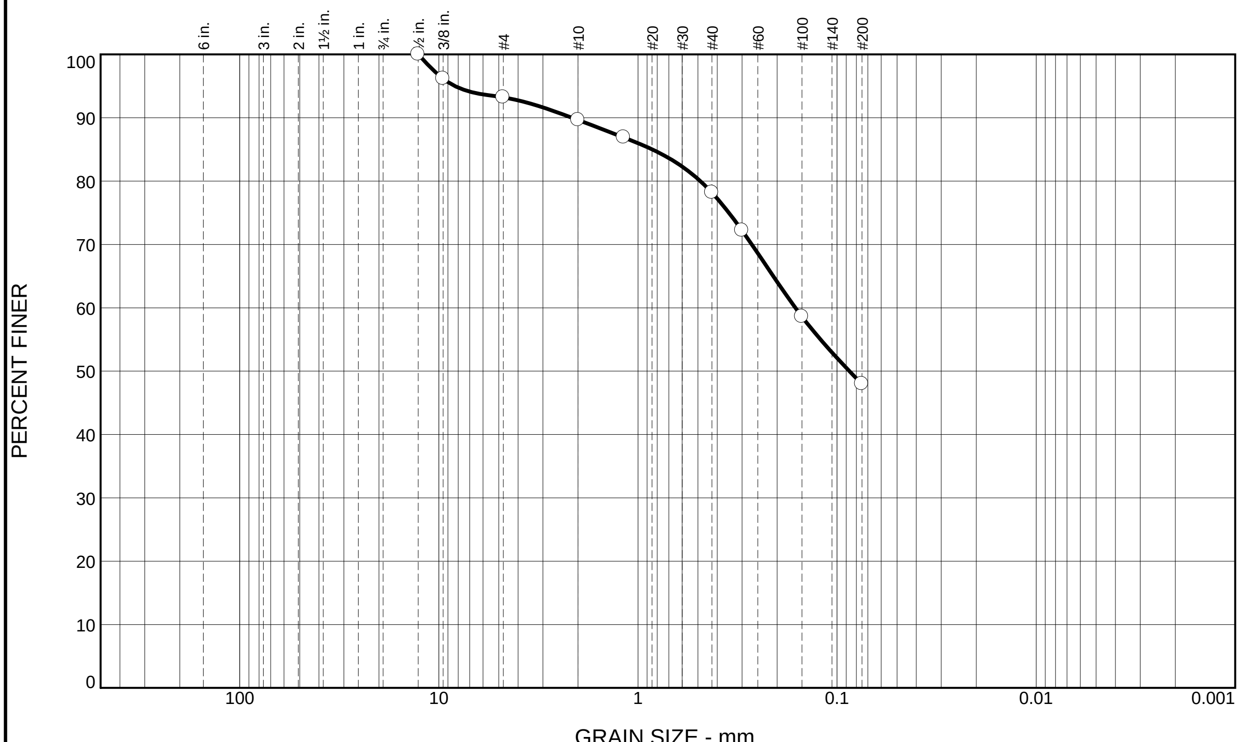
Location: BH-13
Sample Number: 17-018-57 **Depth:** 8.5-10' **Date:** 02/17/17

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

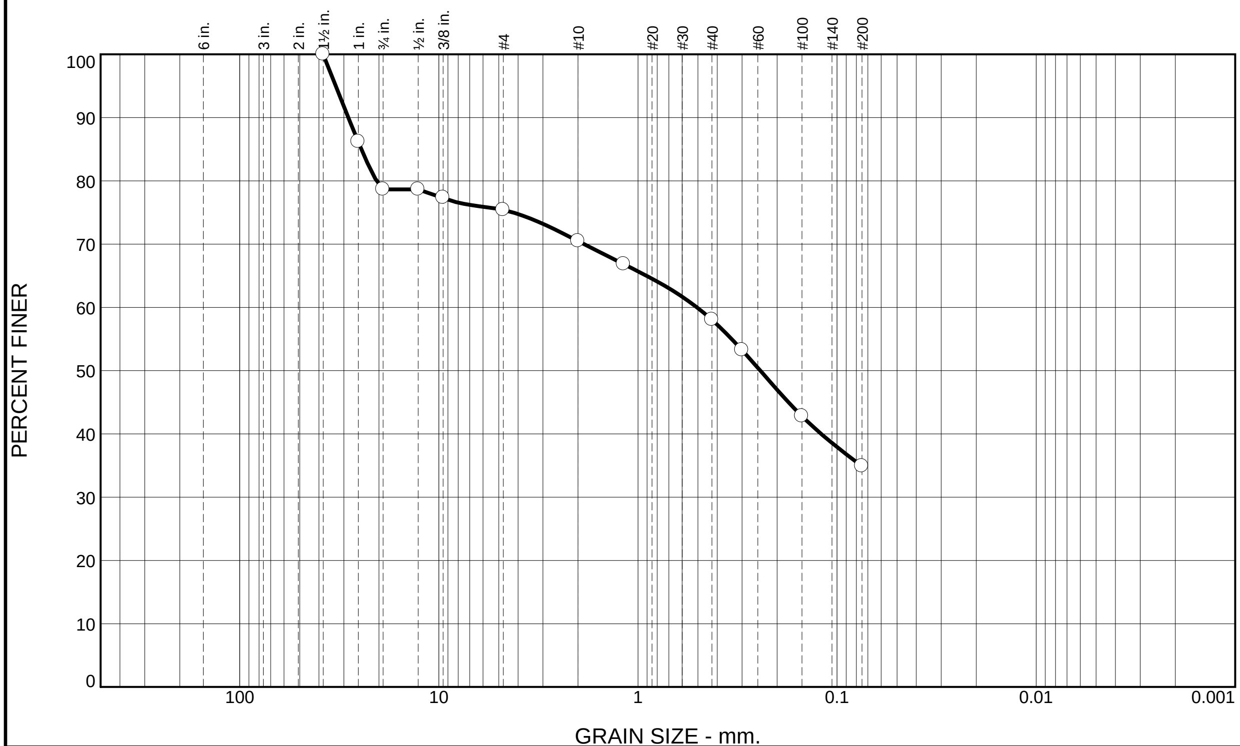
Location: BH-16
Sample Number: 17-018-58 **Depth:** 1-2.5' **Date:** 02/17/17

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

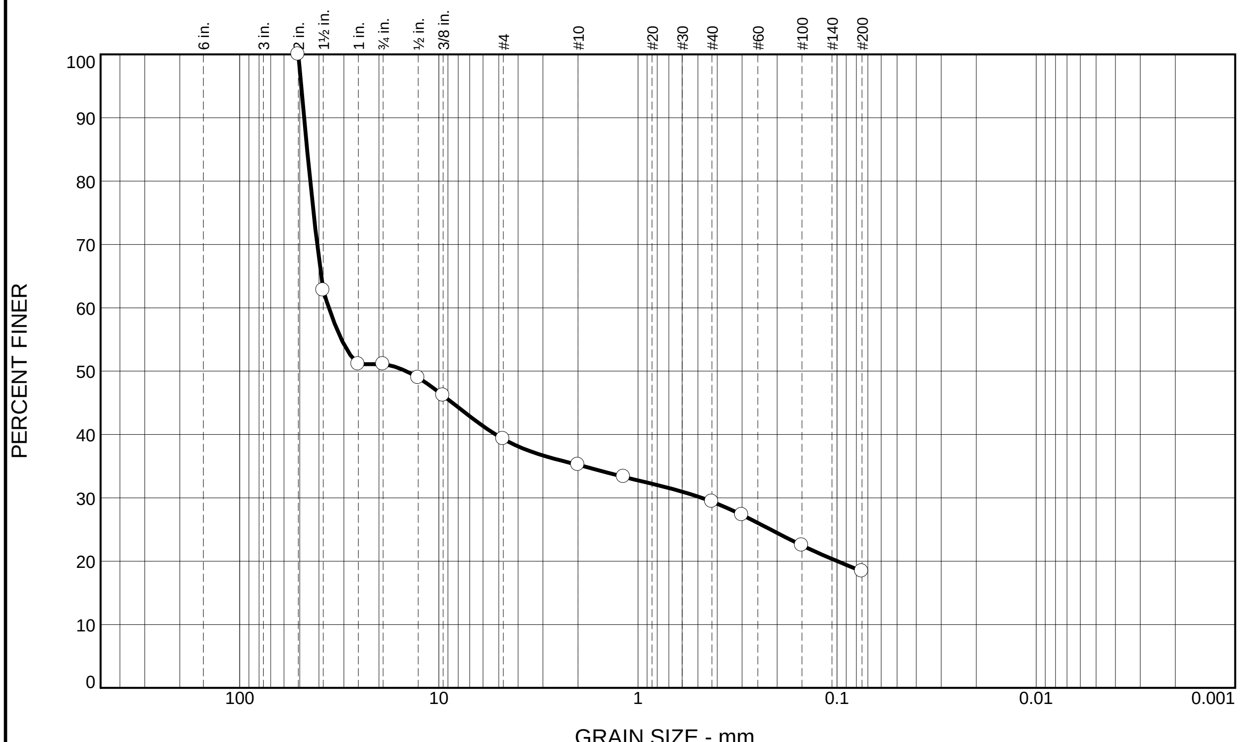
Location: BH-16
Sample Number: 17-018-60 **Depth:** 6-7.5' **Date:** 02/17/17

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

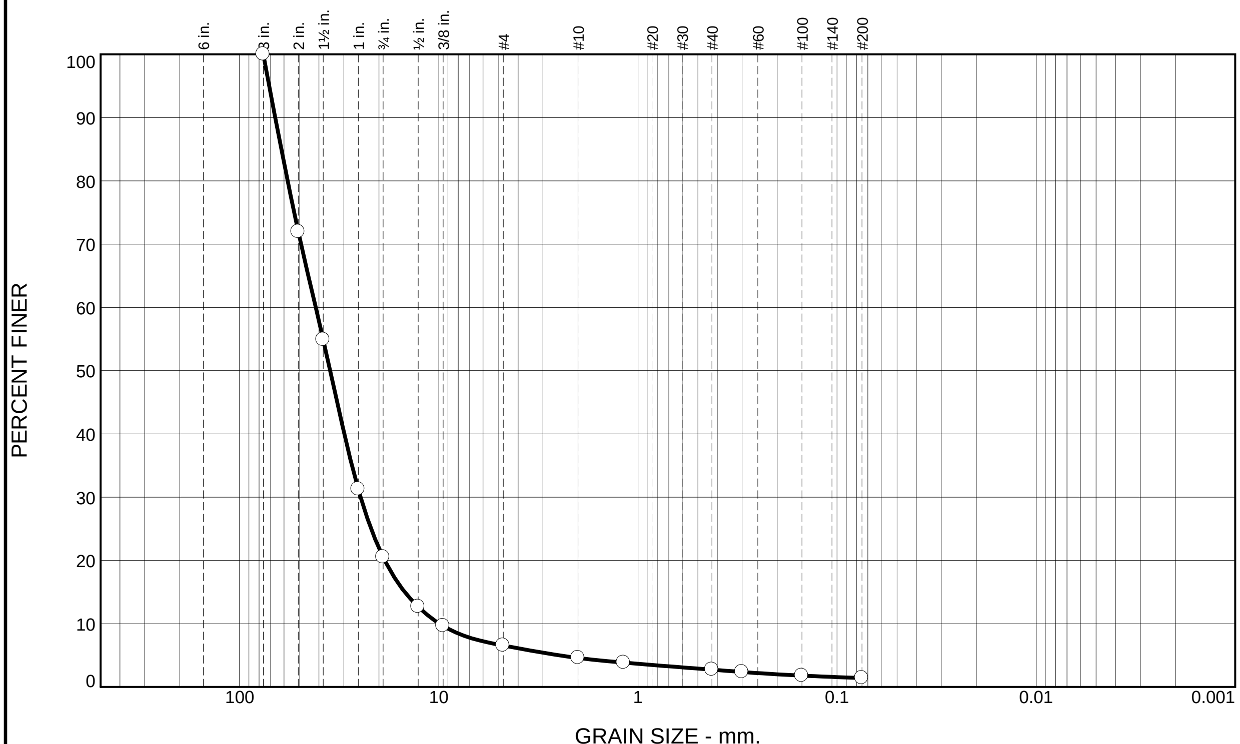
Location: BH-16
Sample Number: 17-018-61 **Depth:** 8.5-10' **Date:** 02/17/17

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

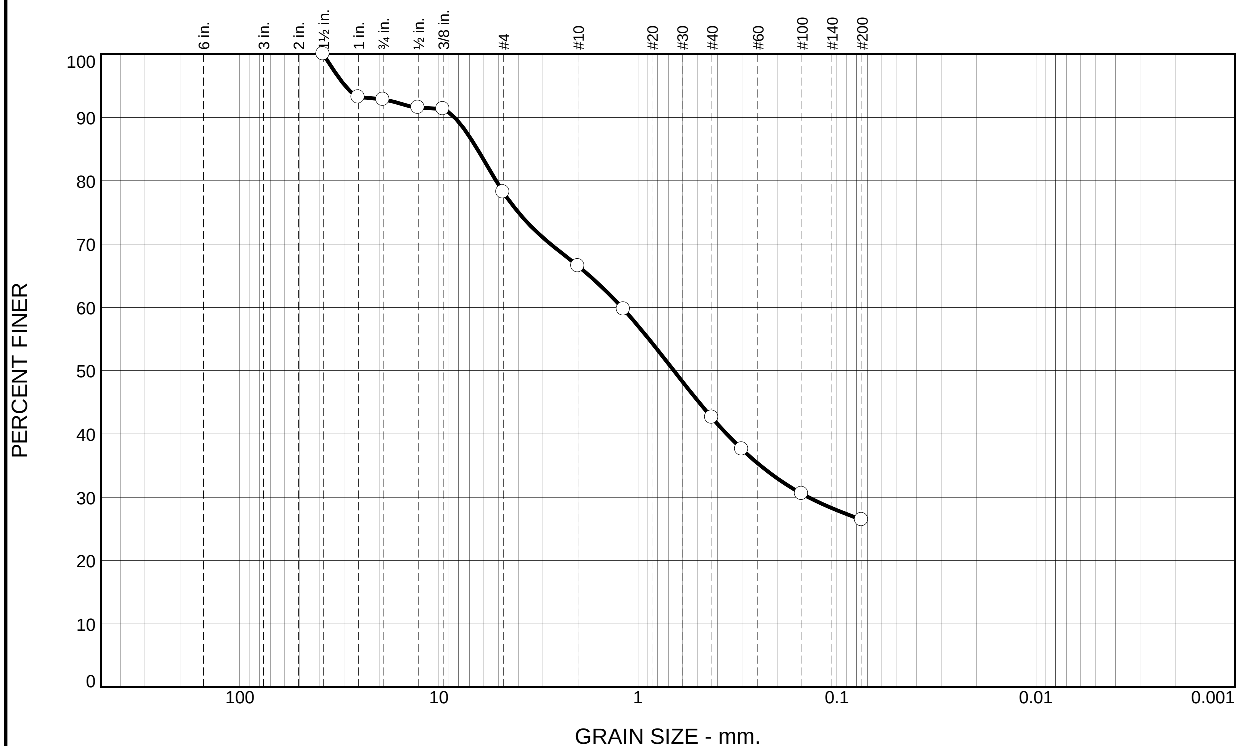
Location: TP-01
Sample Number: 17-019-01 **Depth:** 3'-4' **Date:** 02/08/17

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

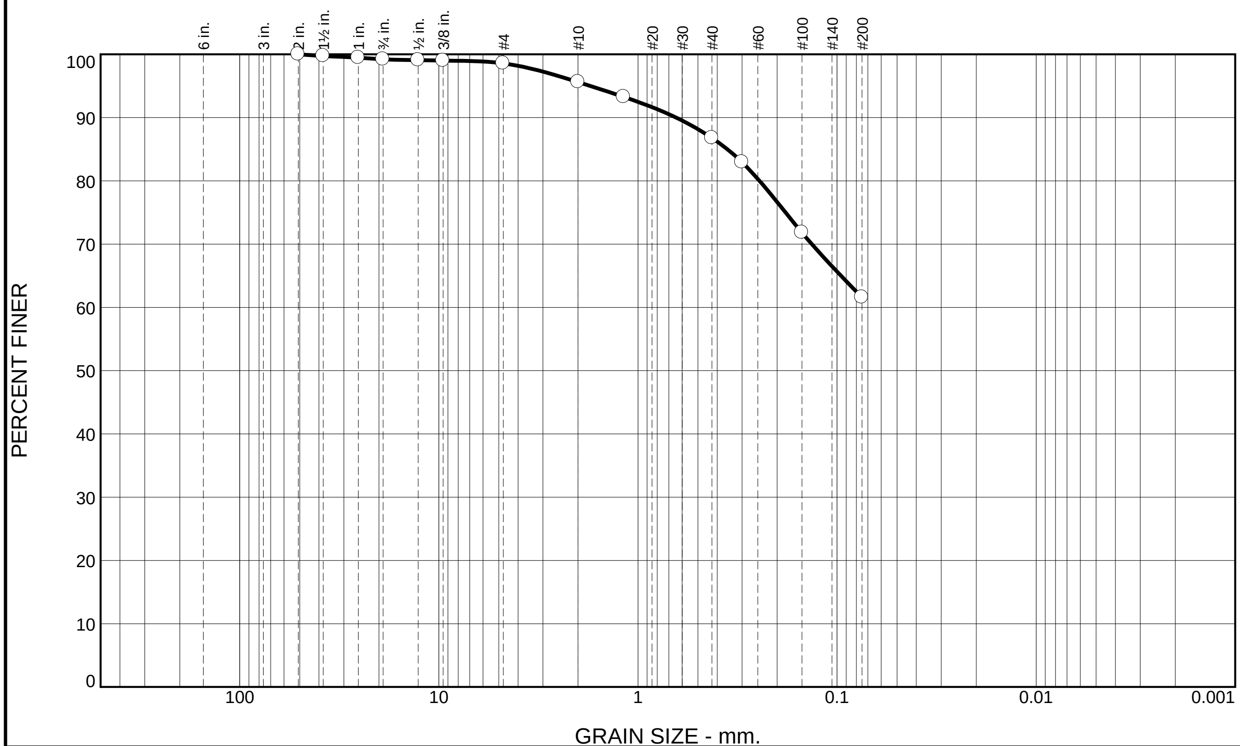
Location: TP-02
Sample Number: 17-019-02 **Depth:** 2'-3' **Date:** 02/08/17

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

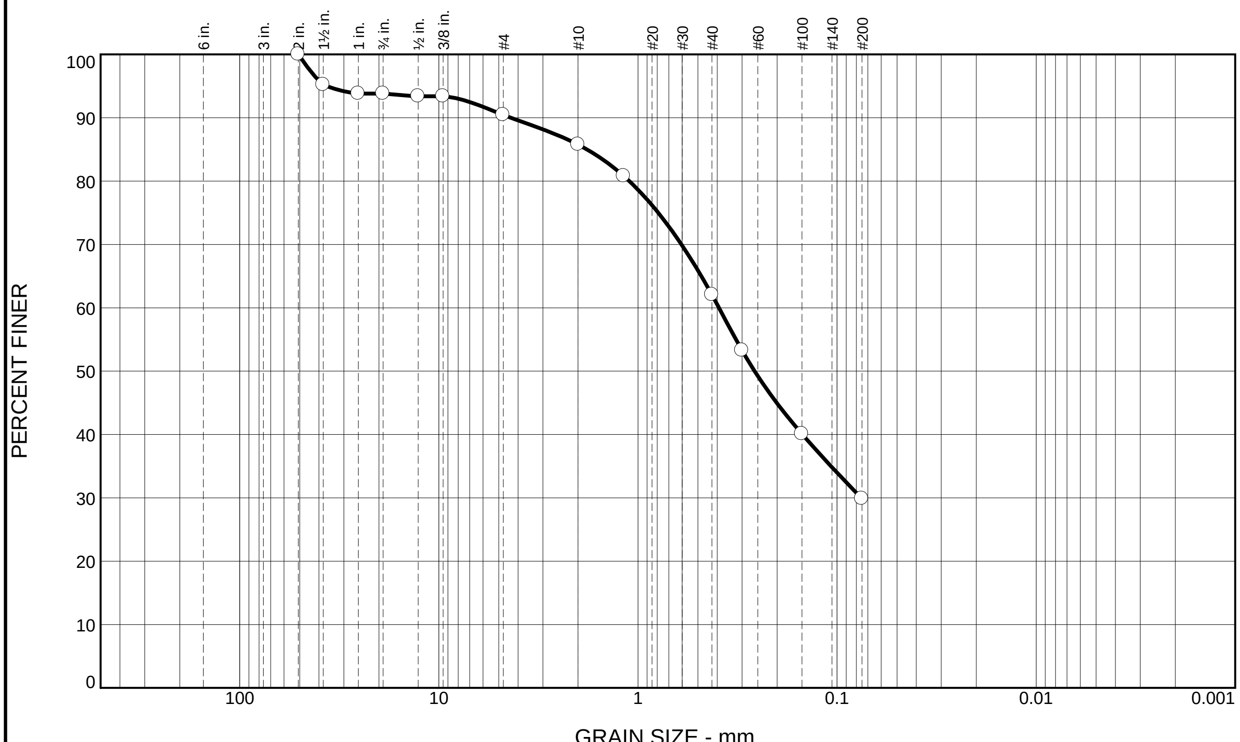
Location: TP-06
Sample Number: 17-019-03 **Depth:** 1'-3' **Date:** 02/08/17

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

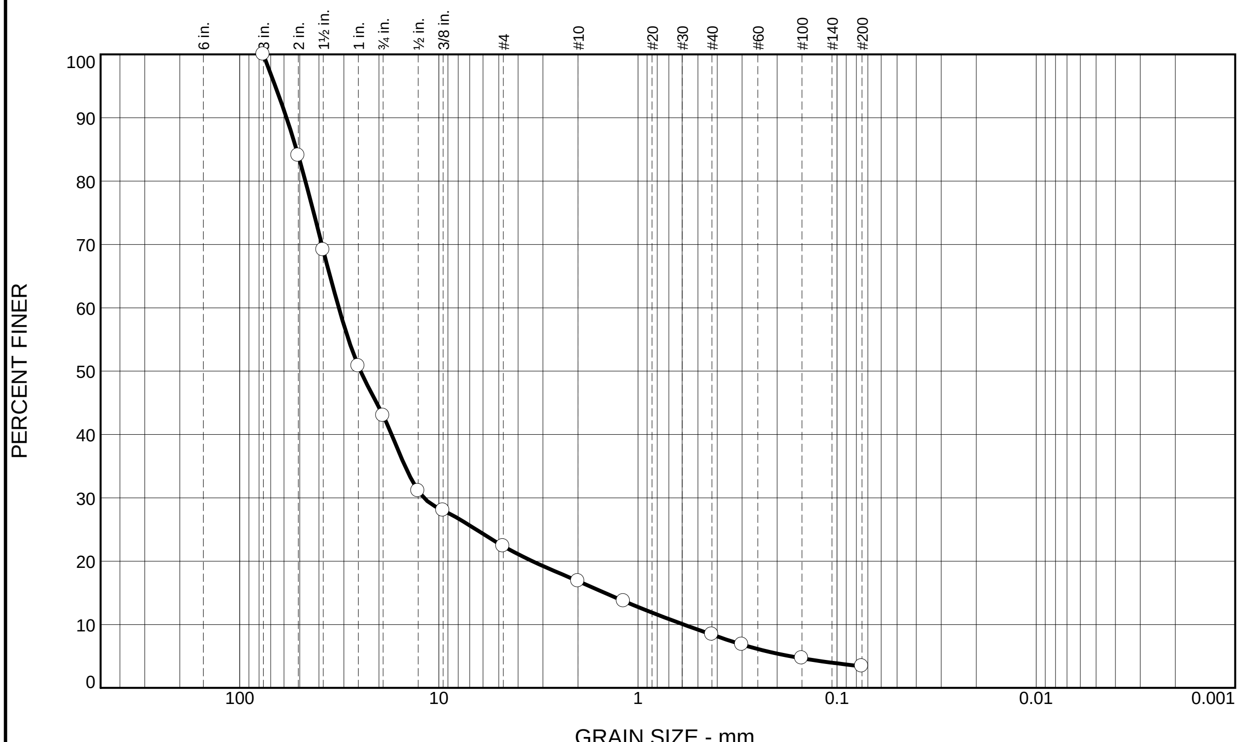
Location: TP-07
Sample Number: 17-019-04 **Depth:** 0'-1.5' **Date:** 02/08/17

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

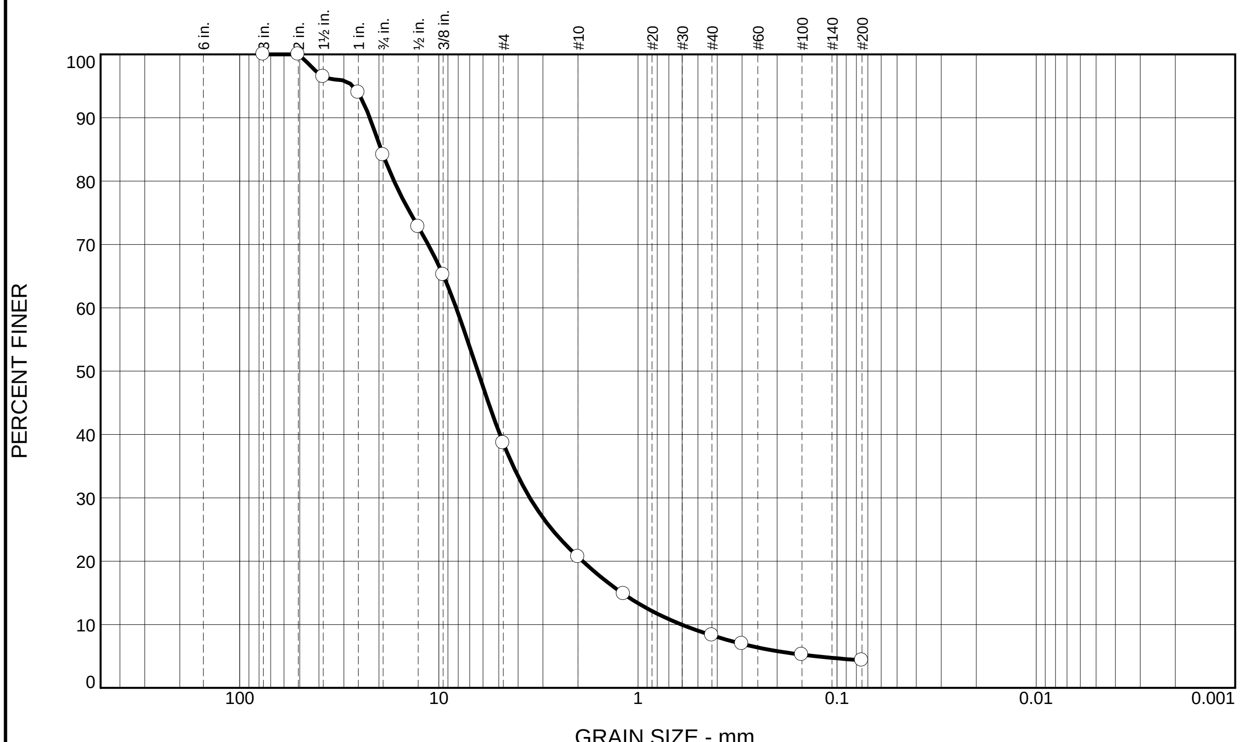
Location: TP-07
Sample Number: 17-019-05 **Depth:** 7'-8' **Date:** 02/09/17

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

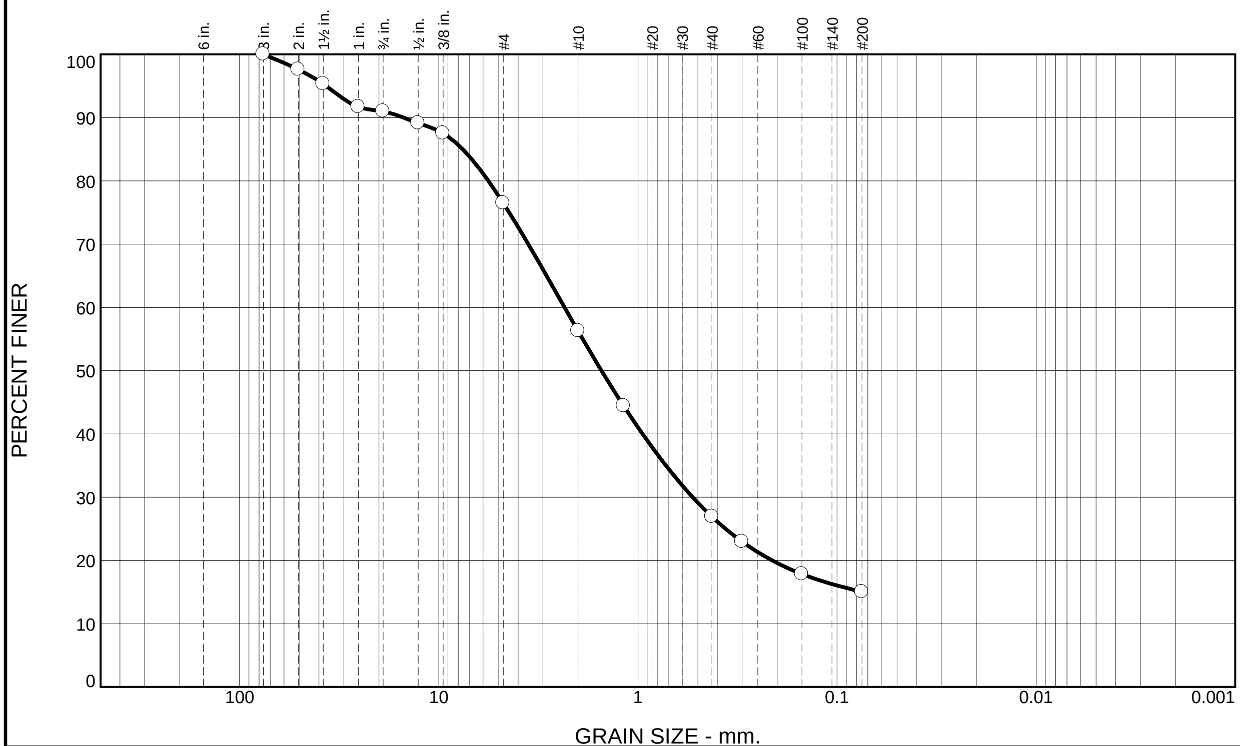
Location: TP-08
Sample Number: 17-019-06 **Depth:** 1' **Date:** 02/09/17

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

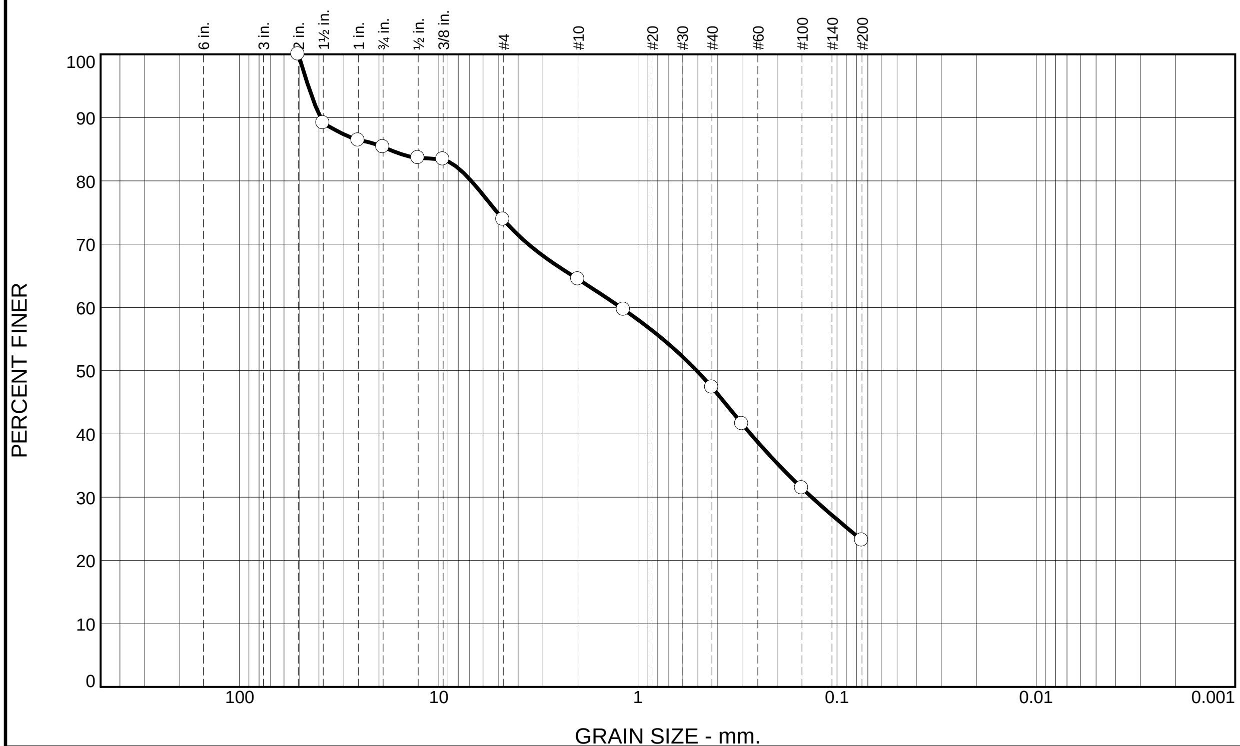
NewFields

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

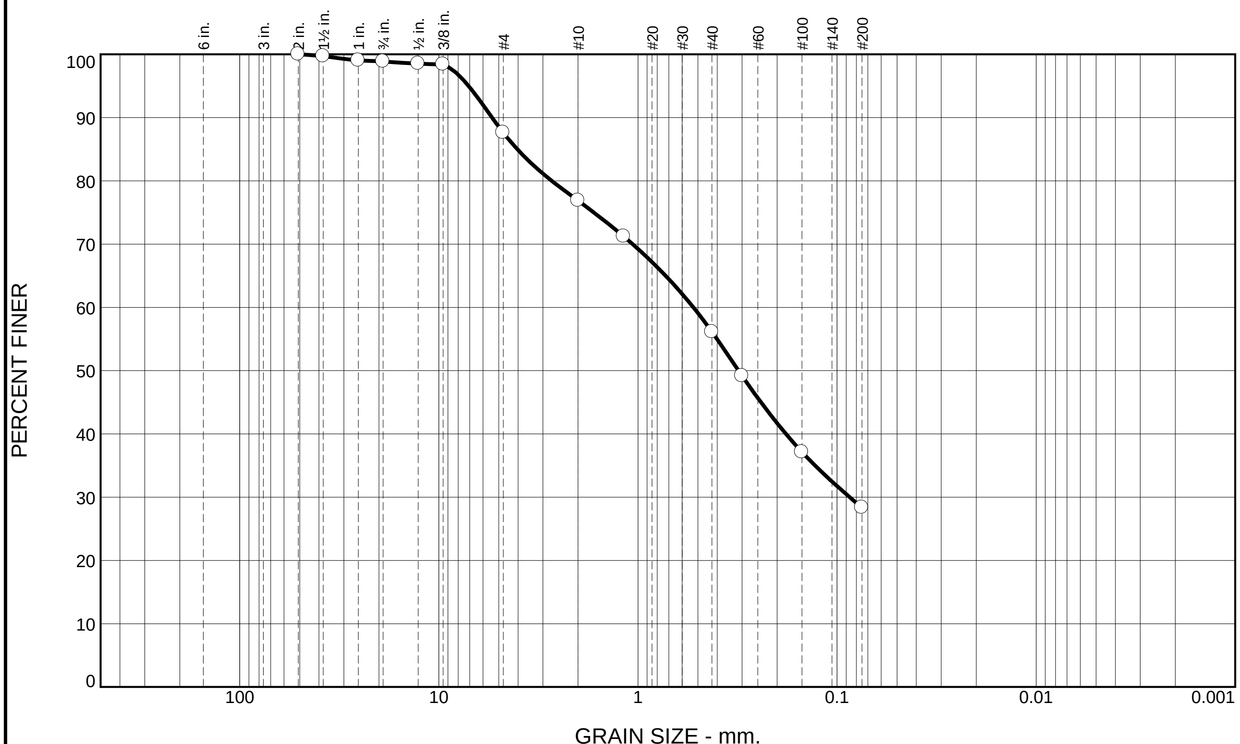
Location: TP-09
Sample Number: 17-019-08 **Depth:** 1'-2' **Date:** 02/08/17

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

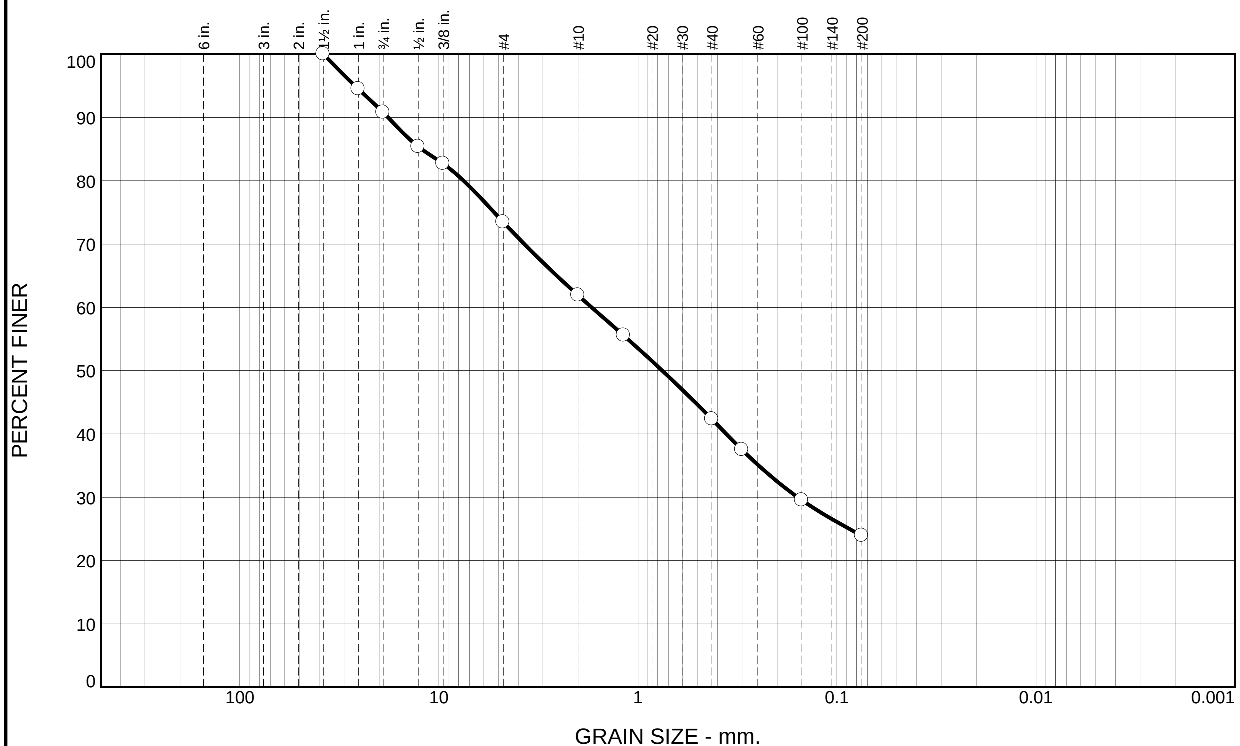
Location: TP-11
Sample Number: 17-019-09 **Depth:** 3'-4' **Date:** 02/08/17

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

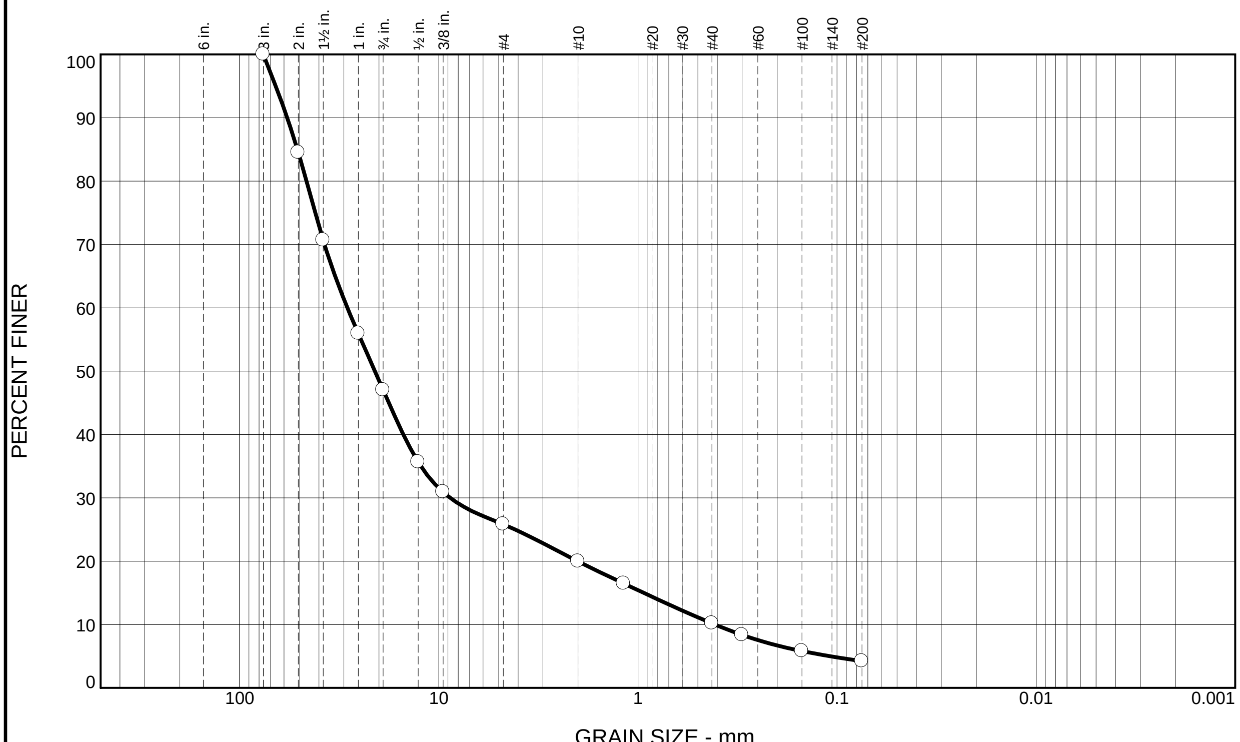
Location: TP-11
Sample Number: 17-019-10 **Depth:** 10'-11' **Date:** 02/16/17

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

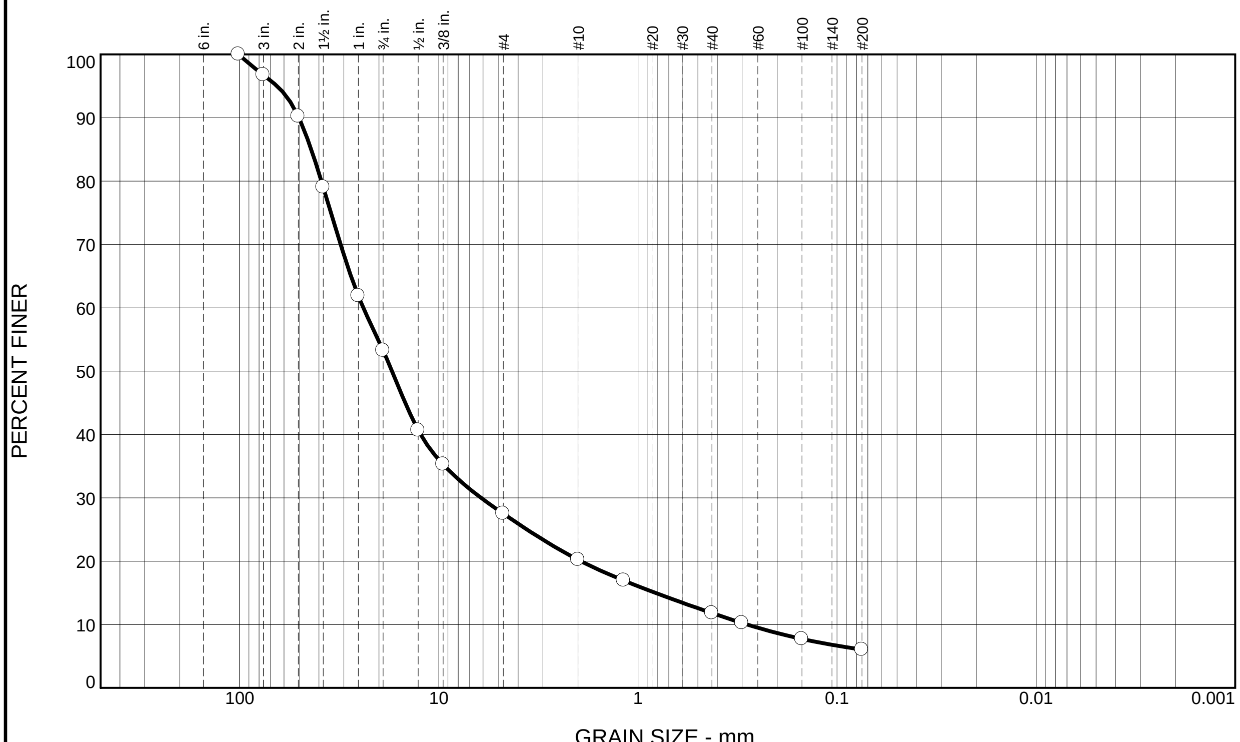
Location: TP-13
Sample Number: 17-019-11 **Depth:** 1'-3' **Date:** 02/16/17

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

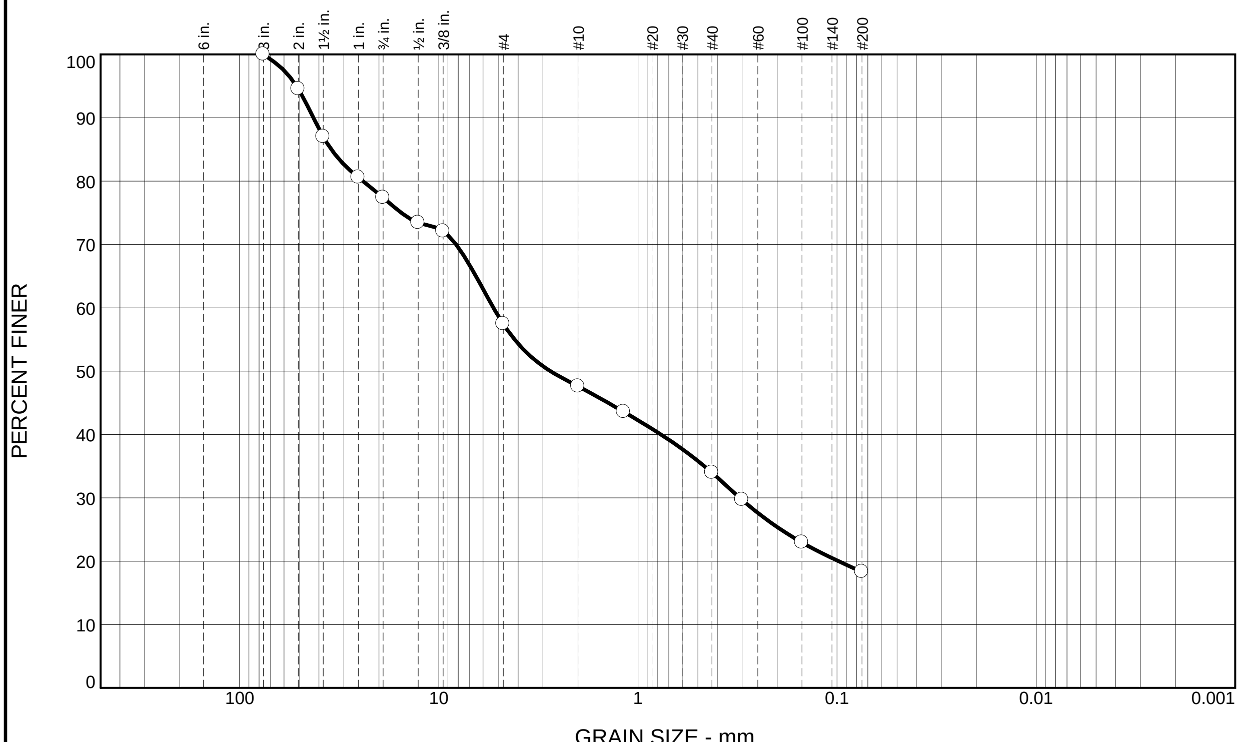
Location: TP-14
Sample Number: 17-019-12 **Depth:** 3'-4' **Date:** 02/09/17

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

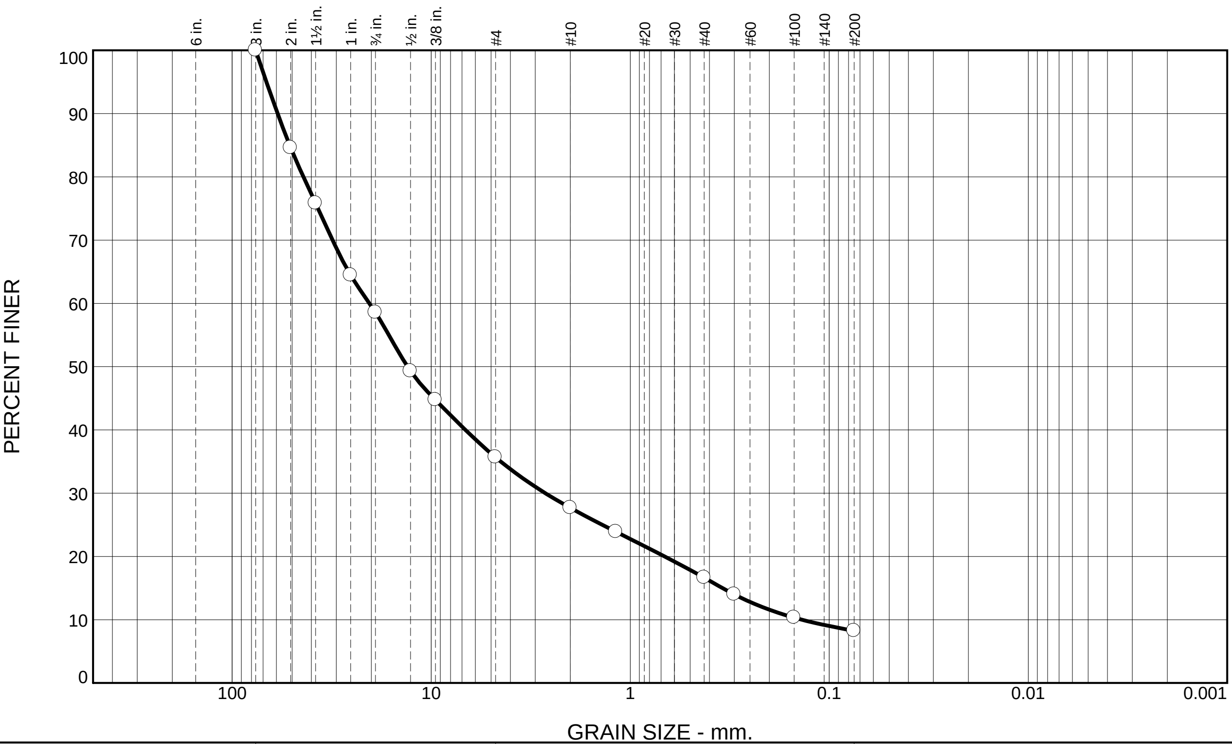
Location: TP-15
Sample Number: 17-019-13 **Depth:** 5'-6' **Date:** 02/14/17

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

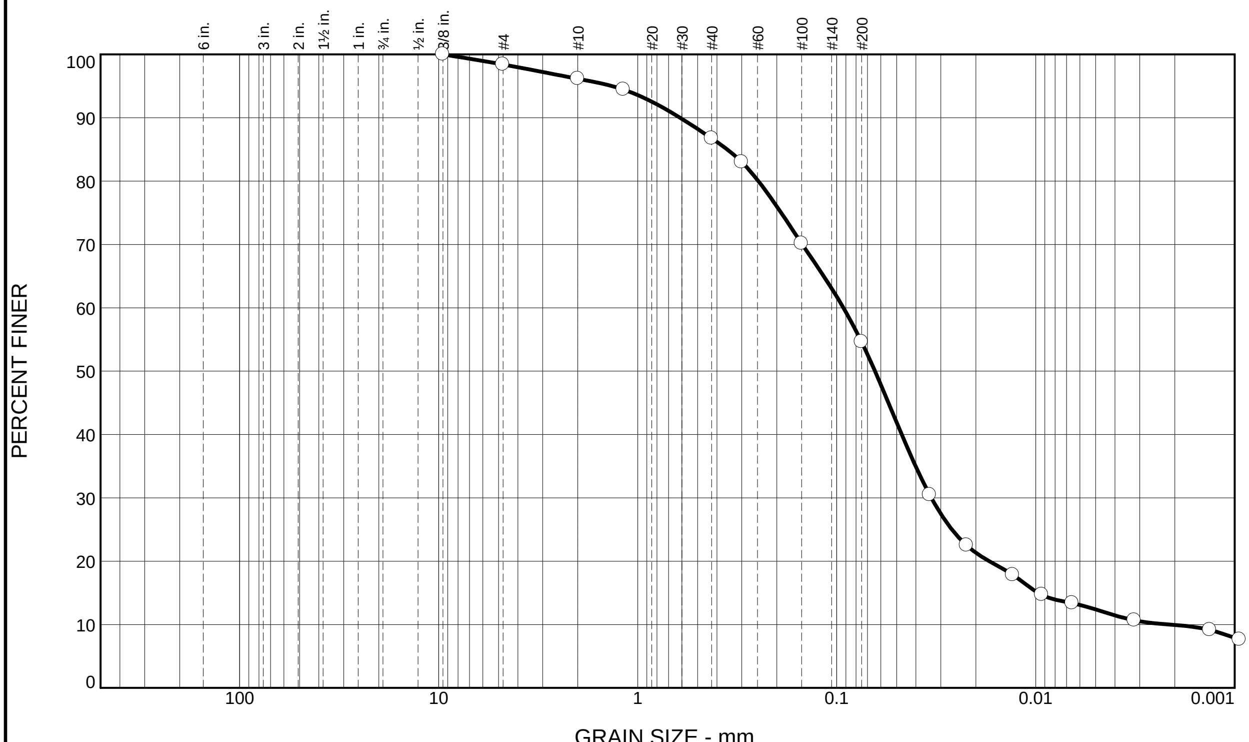
Location: TP-17
Sample Number: 17-019-14 **Depth:** 5'-6' **Date:** 02/16/17

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

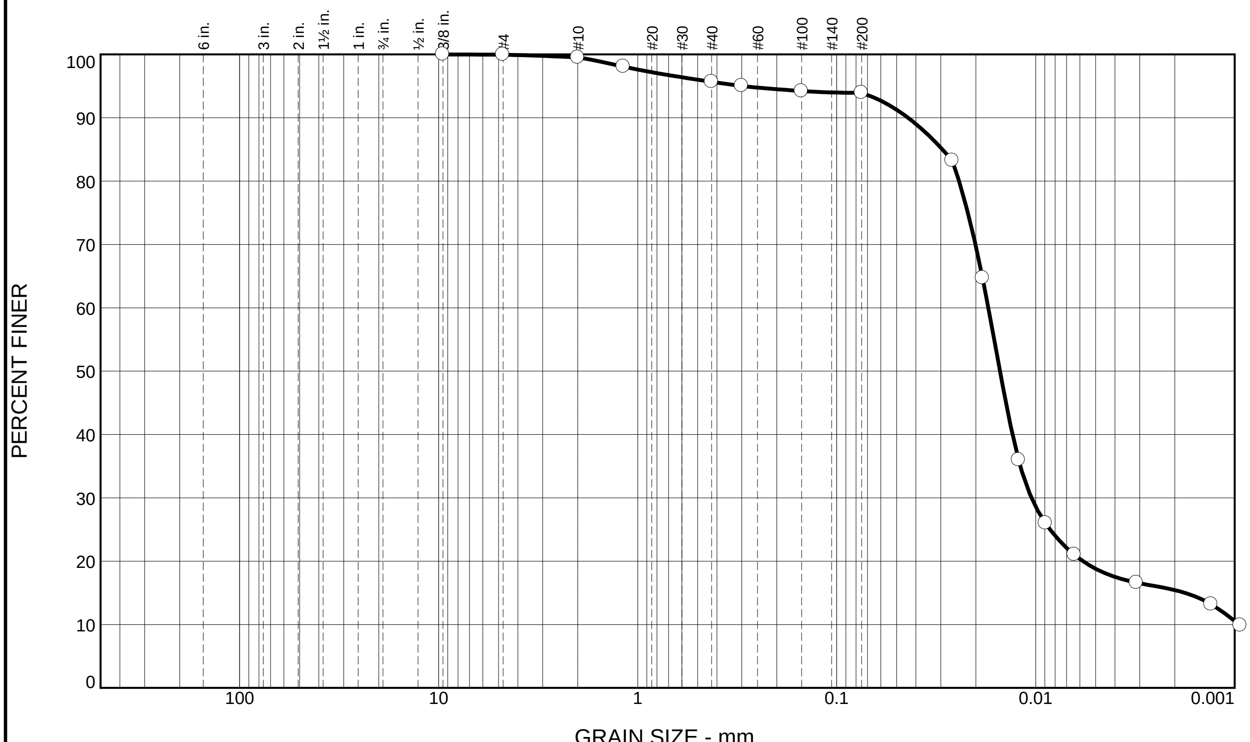
Location: TP-24
Sample Number: 17-019-15 **Depth:** 4'-7' **Date:** 02/08/17

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

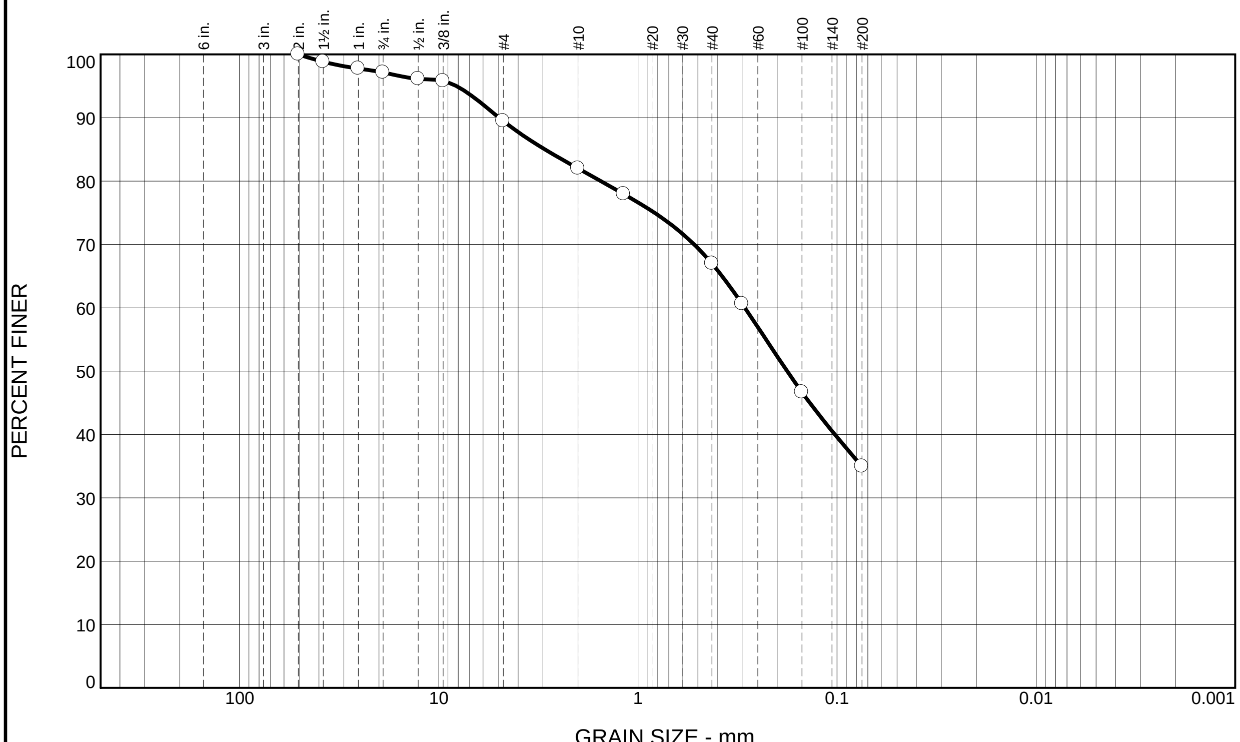
Location: TP-25
Sample Number: 17-019-16 **Depth:** 8'-10' **Date:** 02/08/17

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

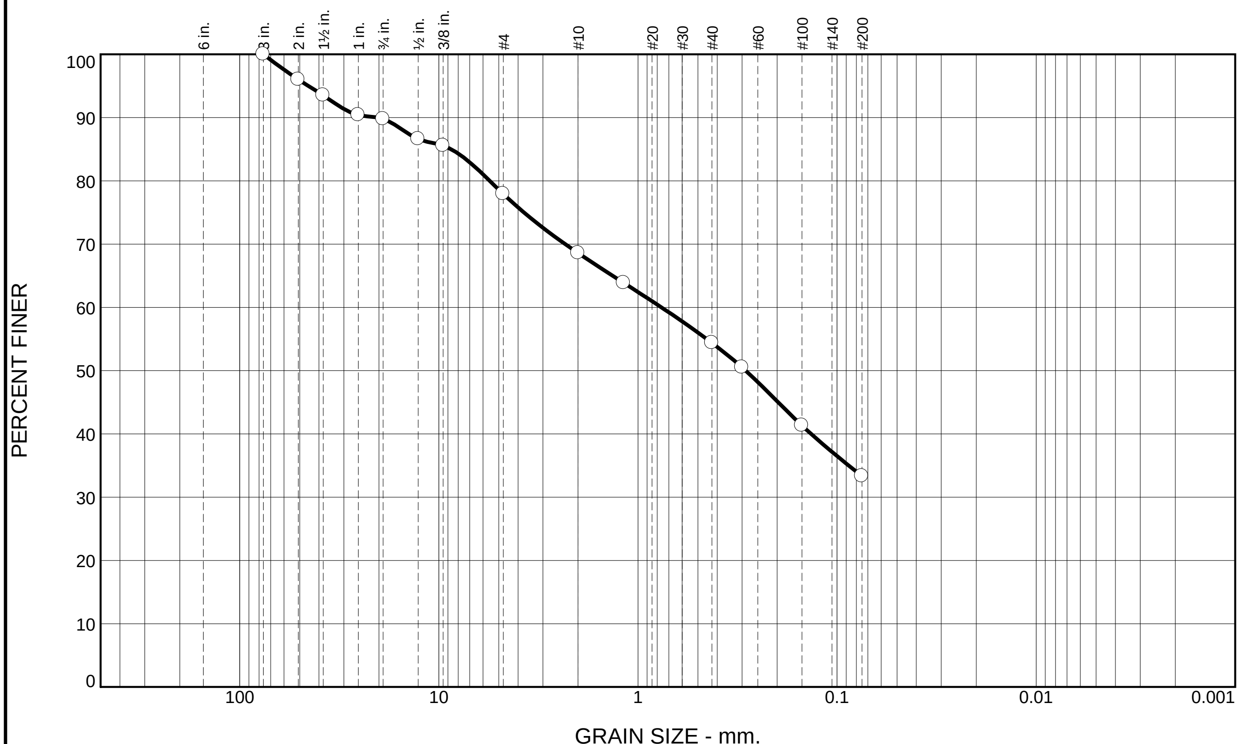
Location: TP-26
Sample Number: 17-019-17 **Depth:** 10'-12' **Date:** 02/16/17

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

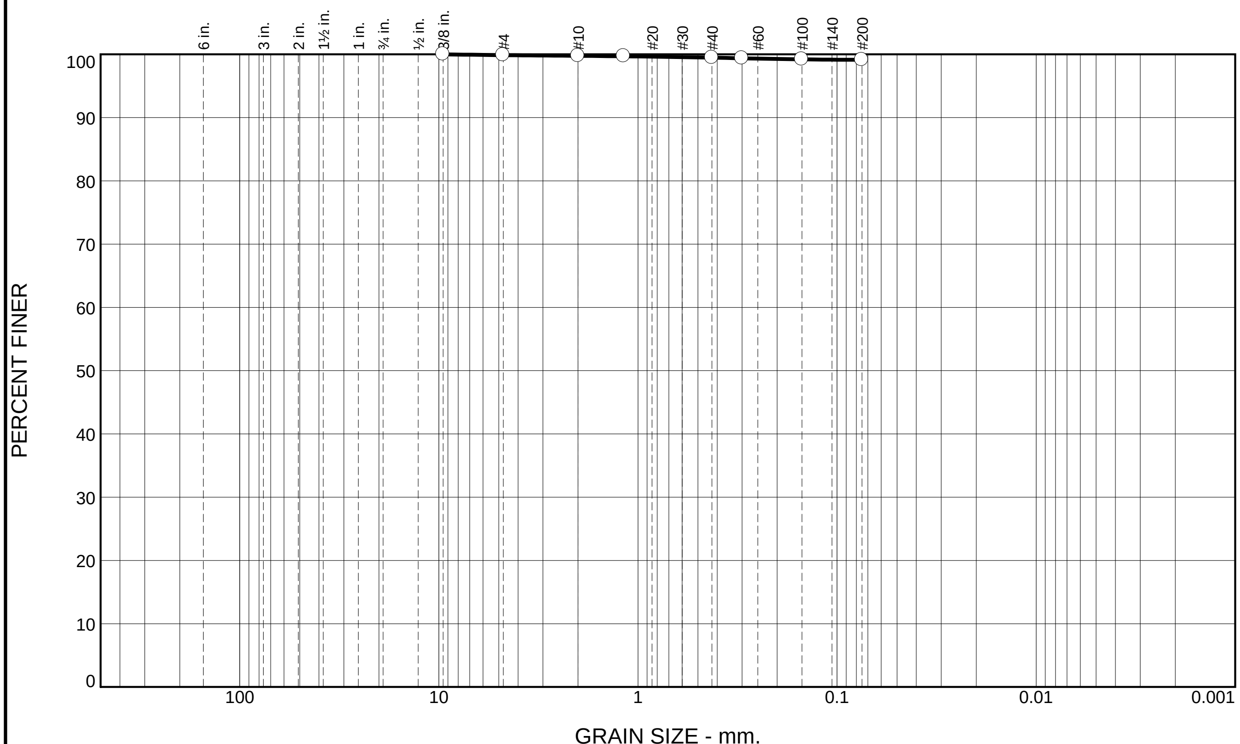
Location: TP-28
Sample Number: 17-019-18 **Depth:** 5'-8' **Date:** 02/16/17

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

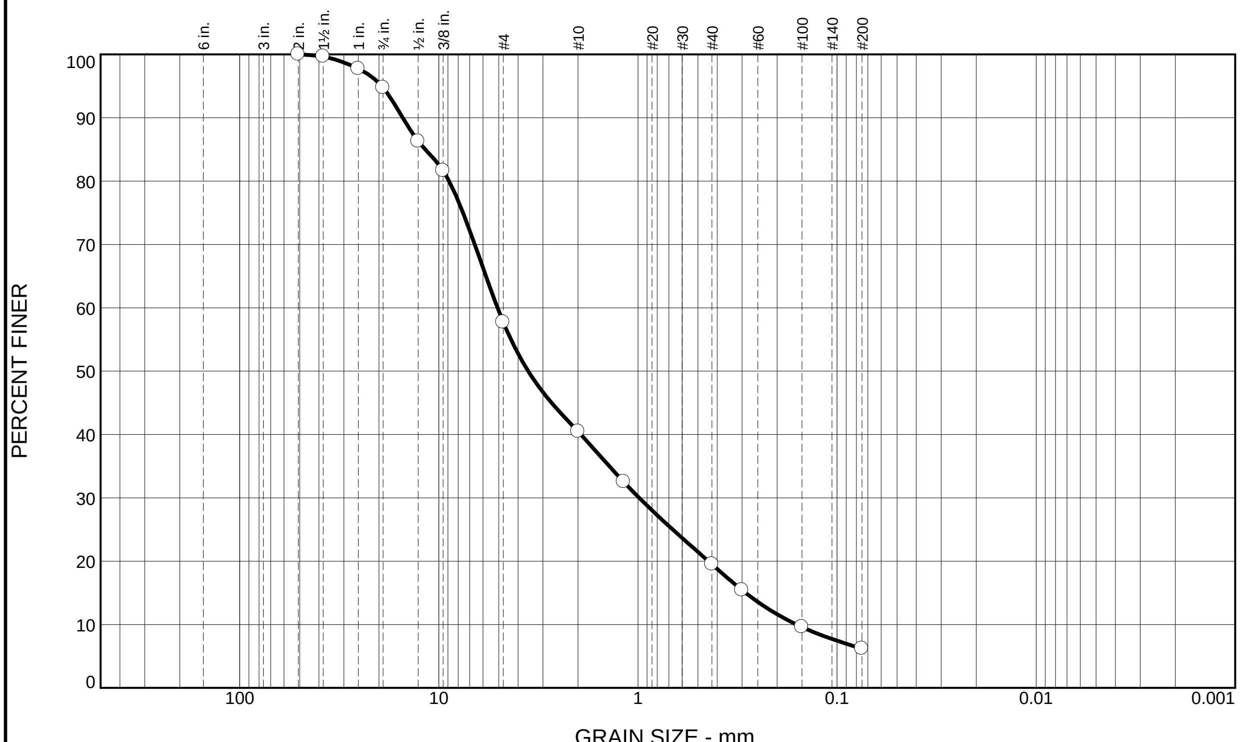
NewFields

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

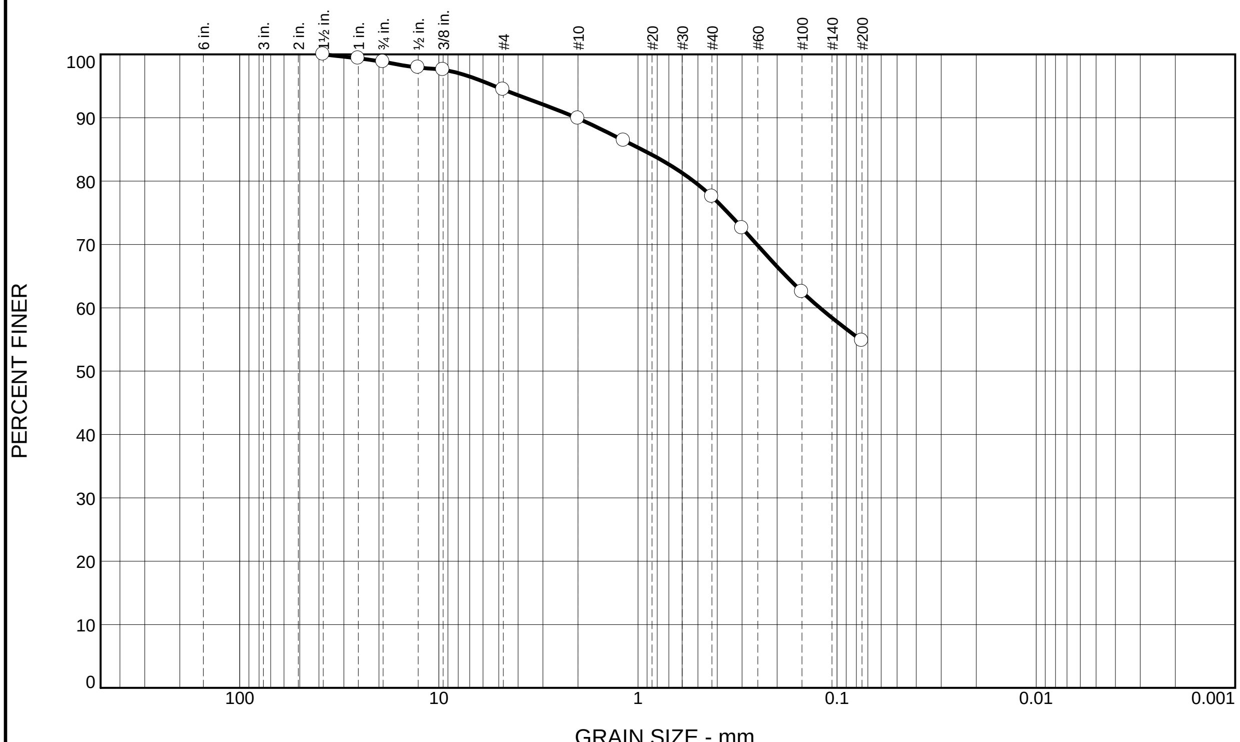
Location: TP-31
Sample Number: 17-019-20 **Depth:** 2-4' **Date:** 02/16/17

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

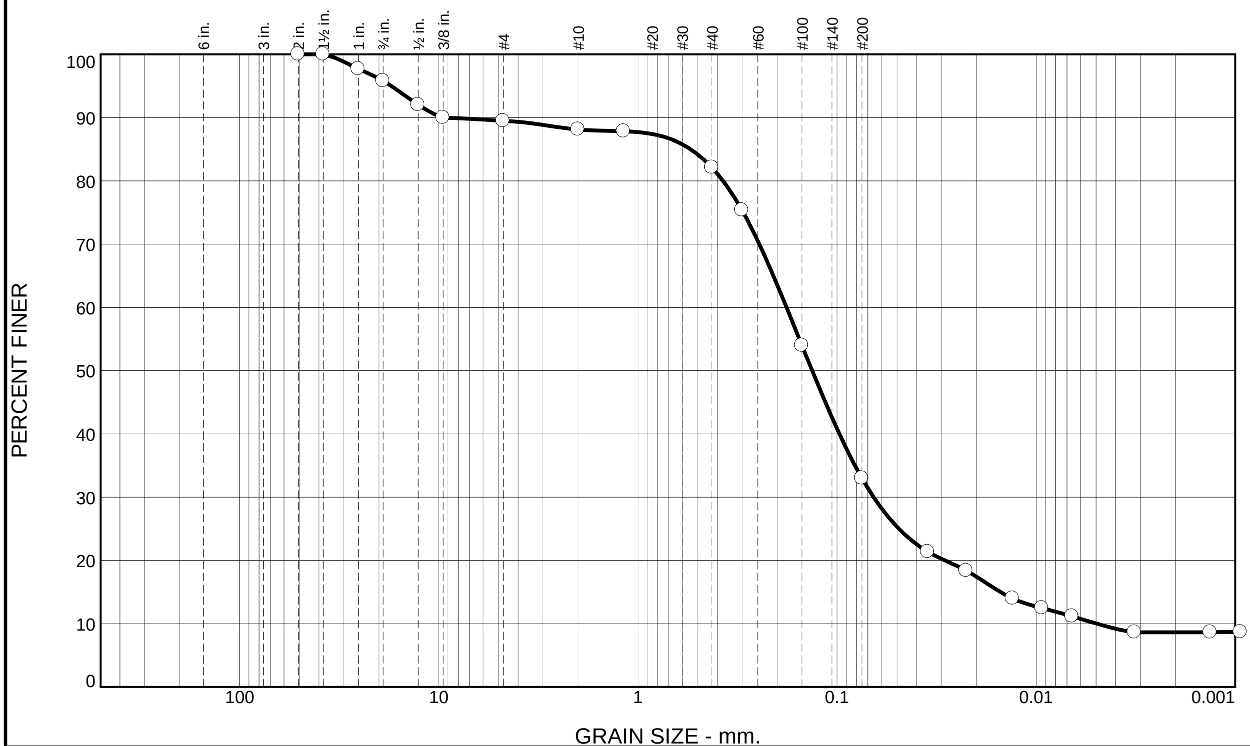
Location: TP-32
Sample Number: 17-019-22 **Depth:** 11.5'-14' **Date:** 02/20/17

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

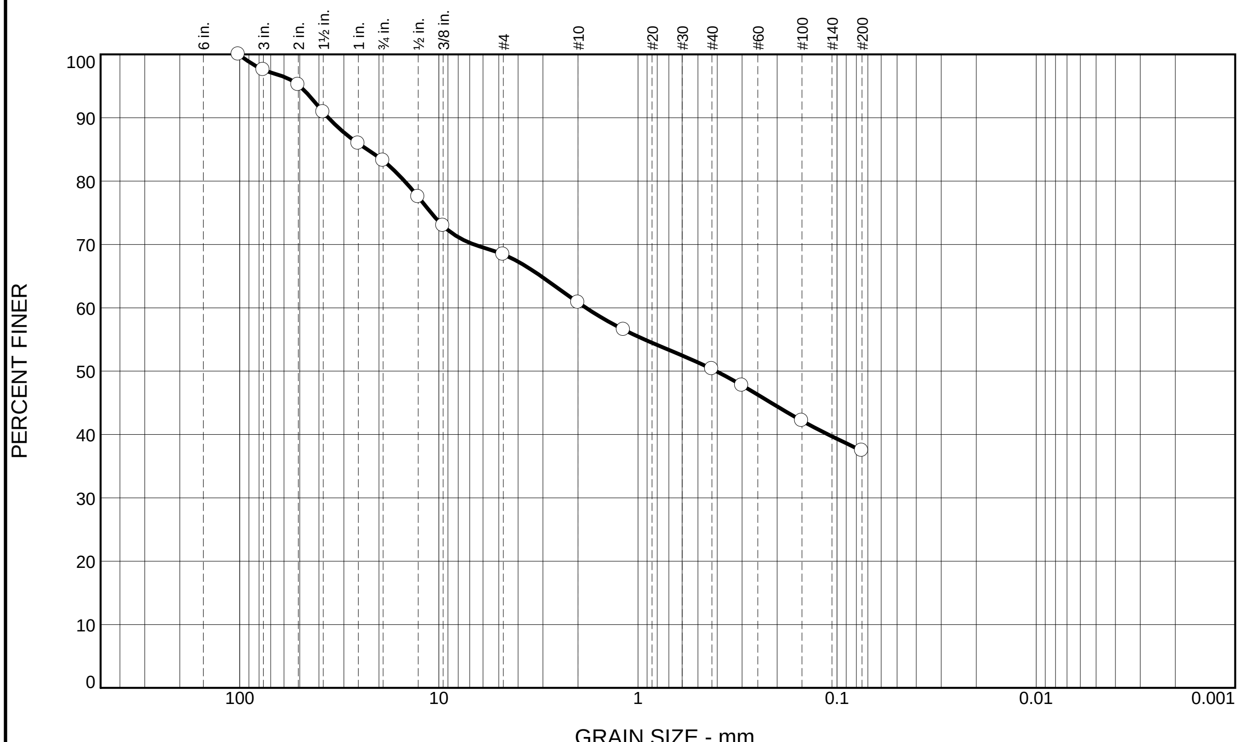
Location: TP-33
Sample Number: 17-019-23 **Depth:** 1'-7' 15'-20.5' **Date:** 02/16/17

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

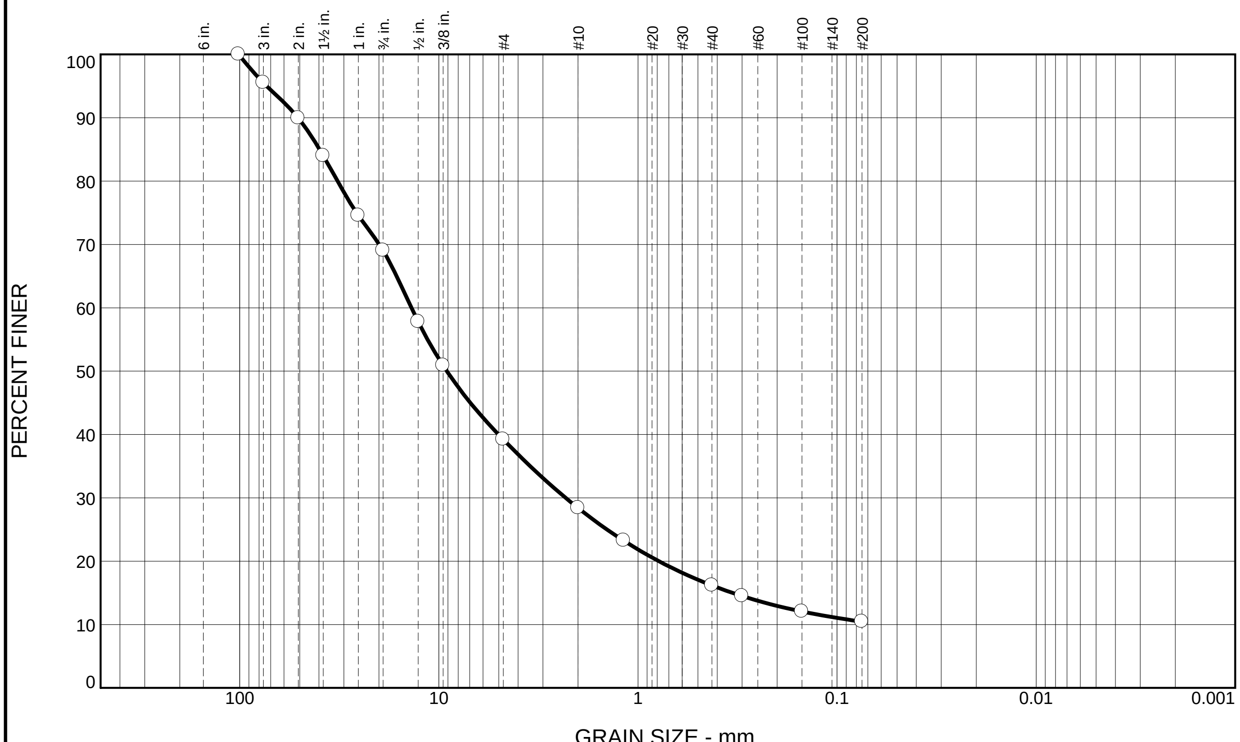
NewFields

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

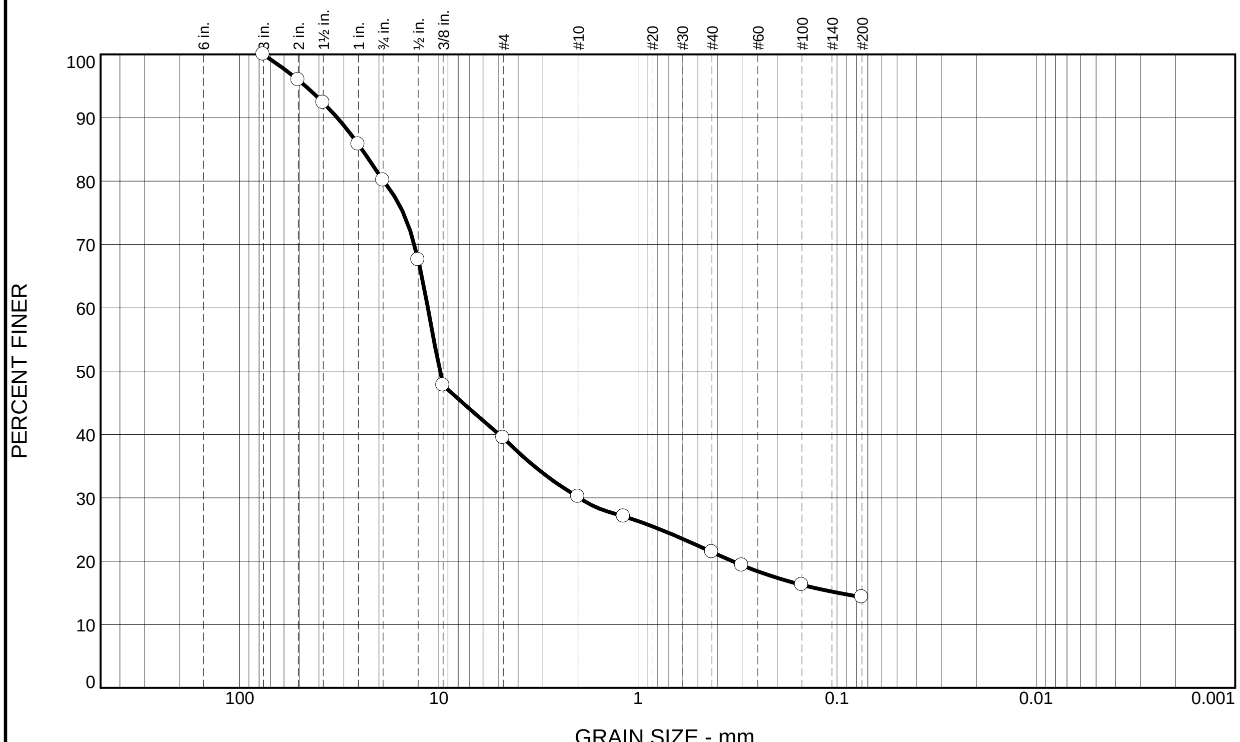
Location: TP-48
Sample Number: 17-019-26 **Depth:** 0'-4' **Date:** 02/13/17

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

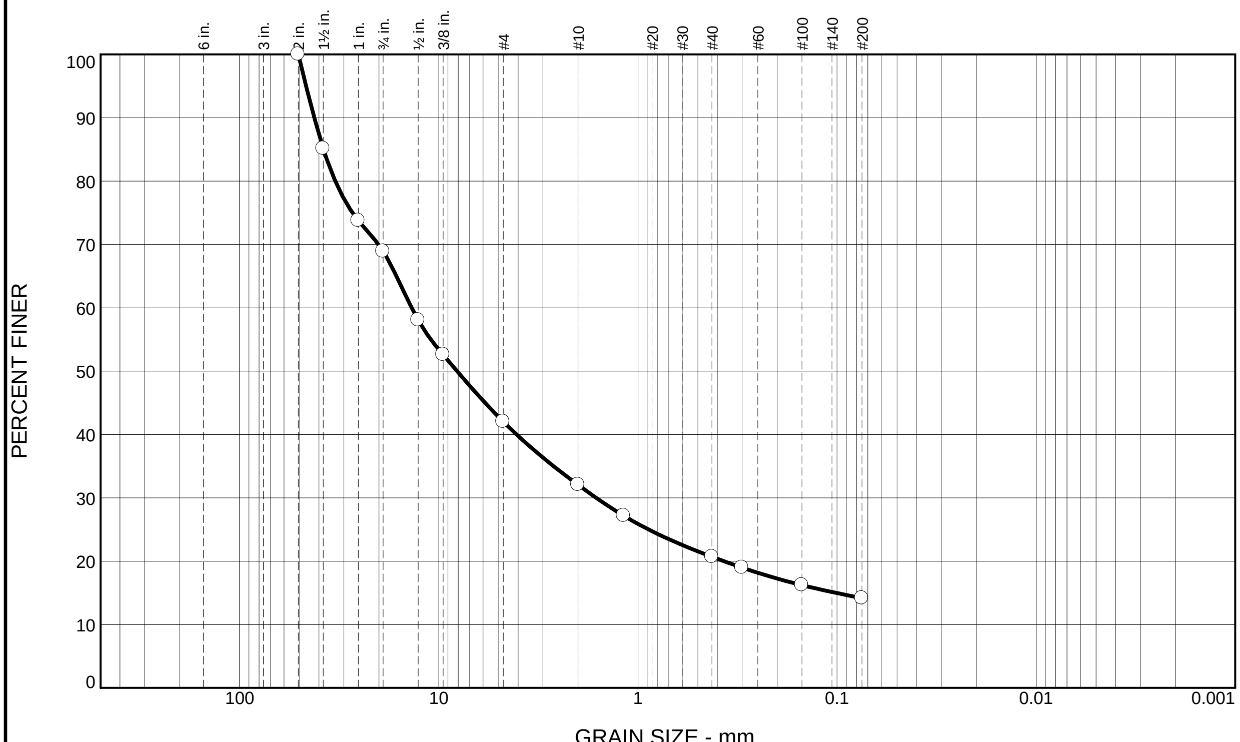
Location: TP-51
Sample Number: 17-019-27 **Depth:** 1'-2' **Date:** 02/16/17

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

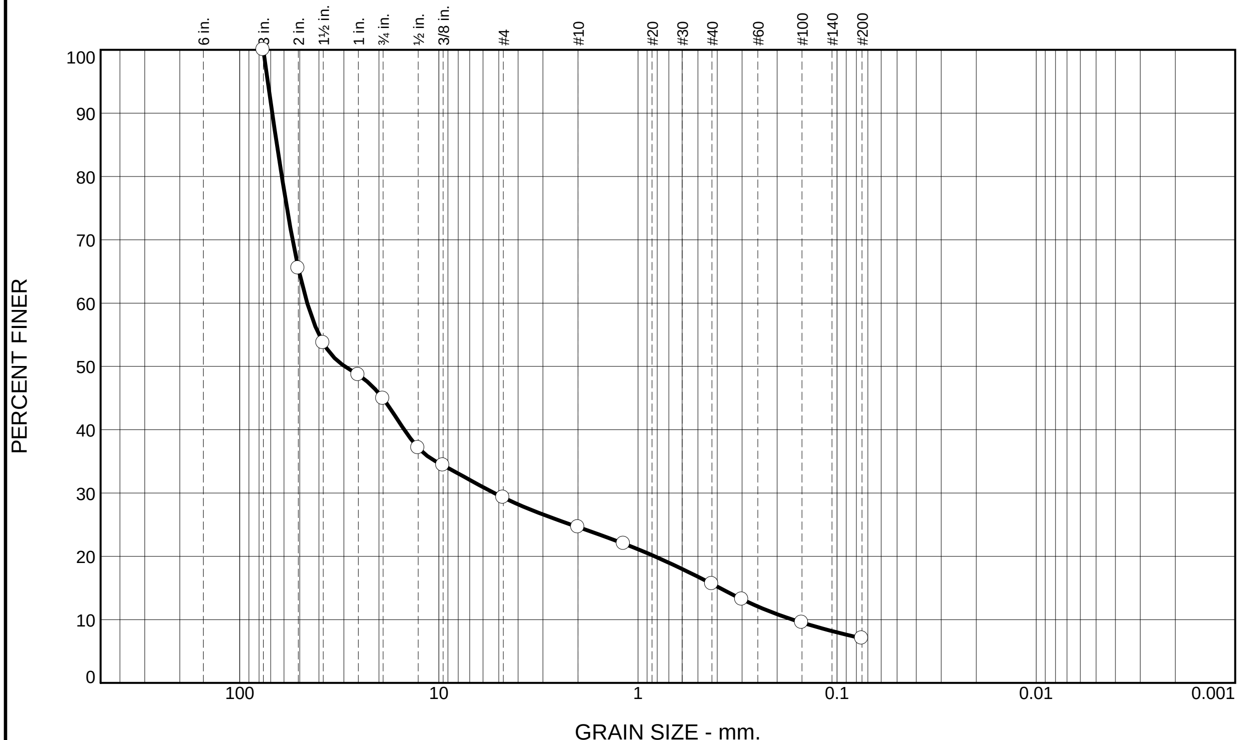
Location: TP-51
Sample Number: 17-019-28 **Depth:** 5'-6' **Date:** 02/16/17

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

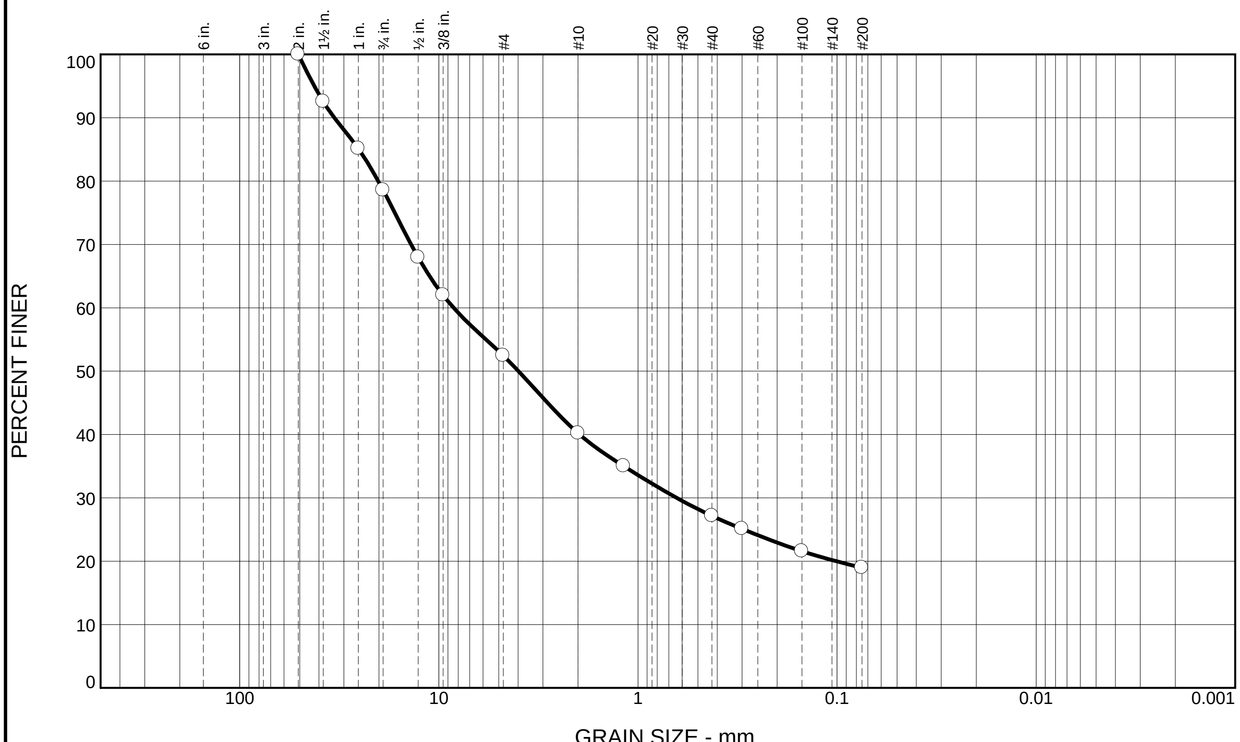
Location: TP-50A
Sample Number: 17-019-29 **Depth:** 2'-3' **Date:** 02/16/17

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

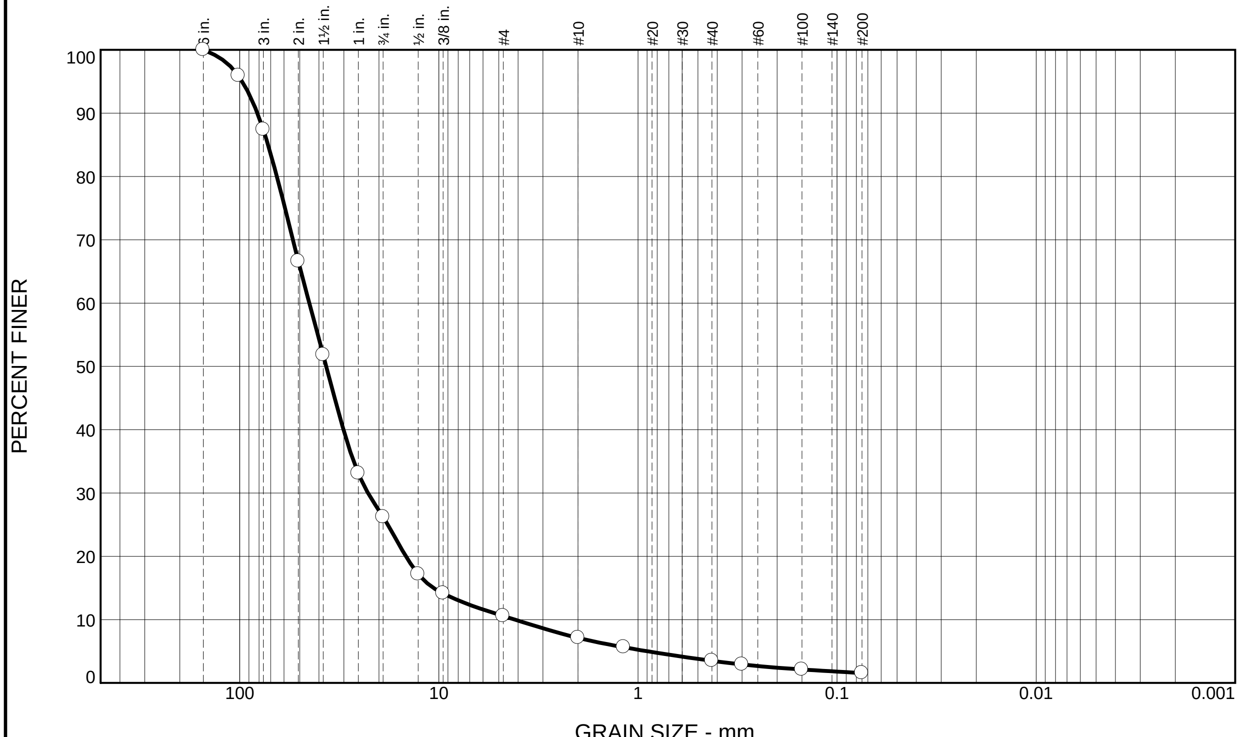
Location: TP-50B
Sample Number: 17-019-30 **Depth:** 0'-1' **Date:** 02/16/17

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

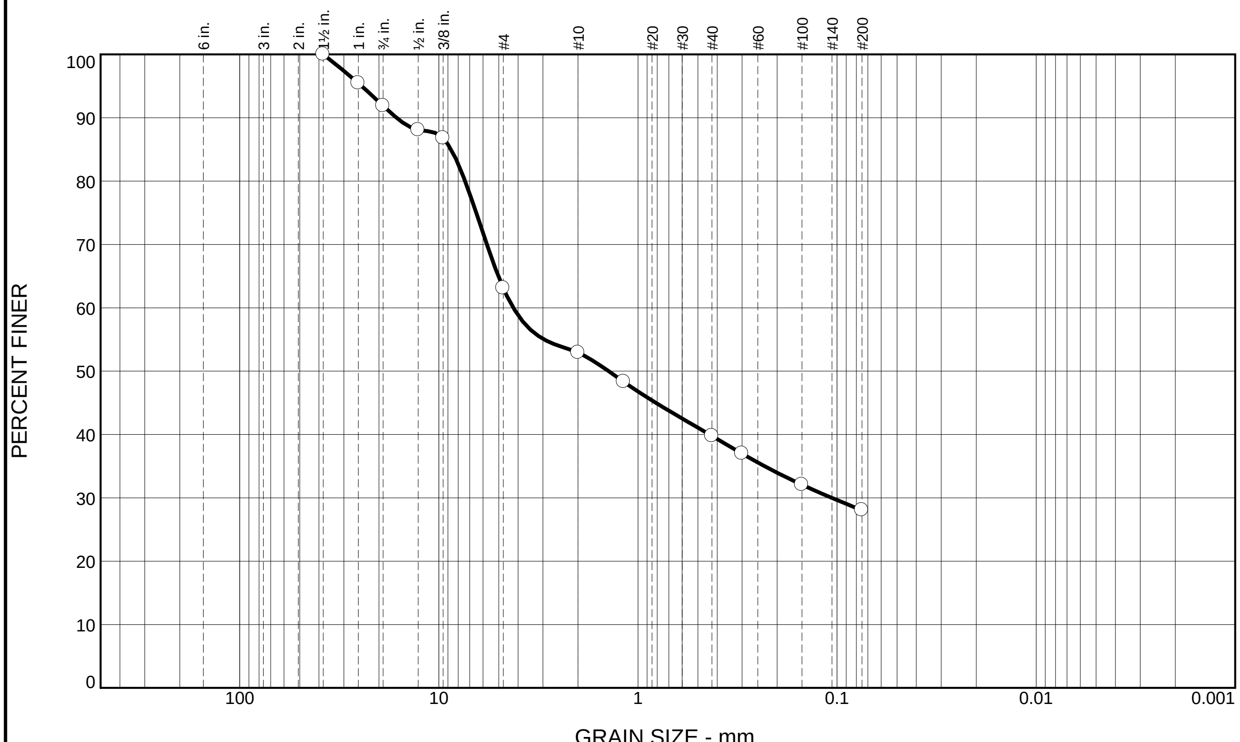
Location: TP-55
Sample Number: 17-019-31 **Depth:** 3'-4' **Date:** 02/16/17

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

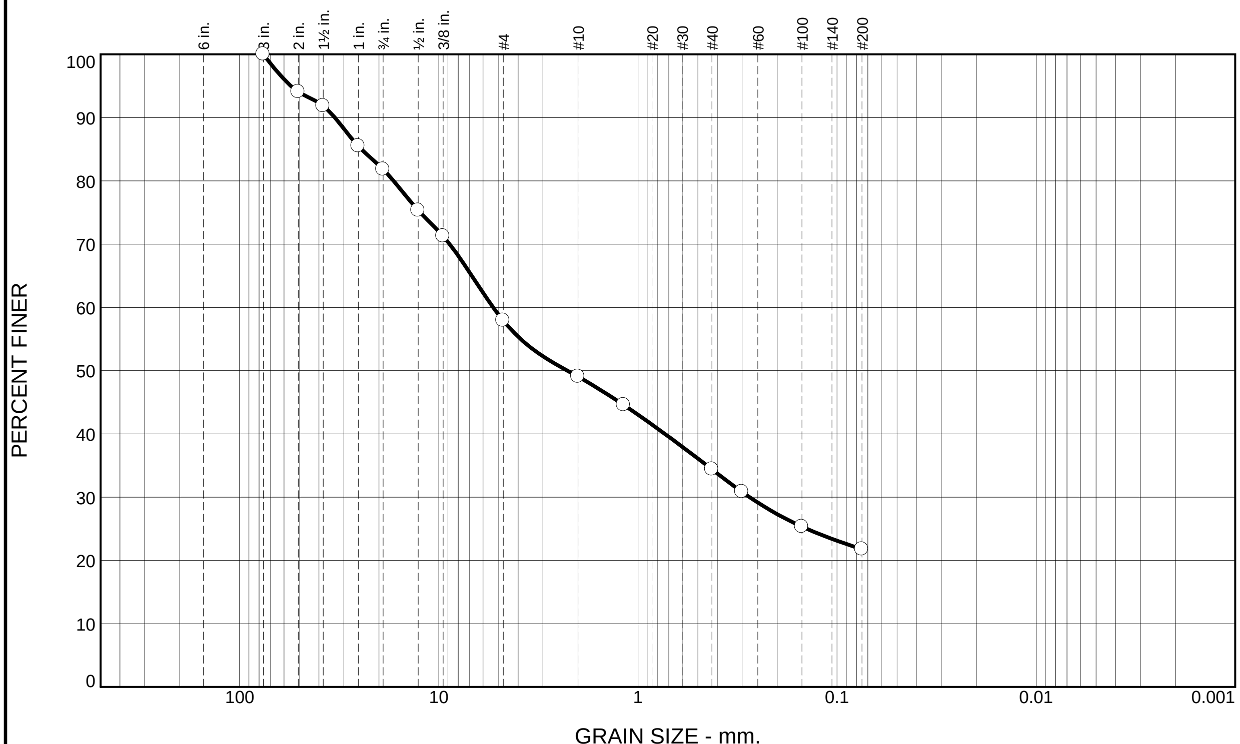
Location: TP-60
Sample Number: 17-019-32 **Depth:** 0'-1' **Date:** 02/16/17

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

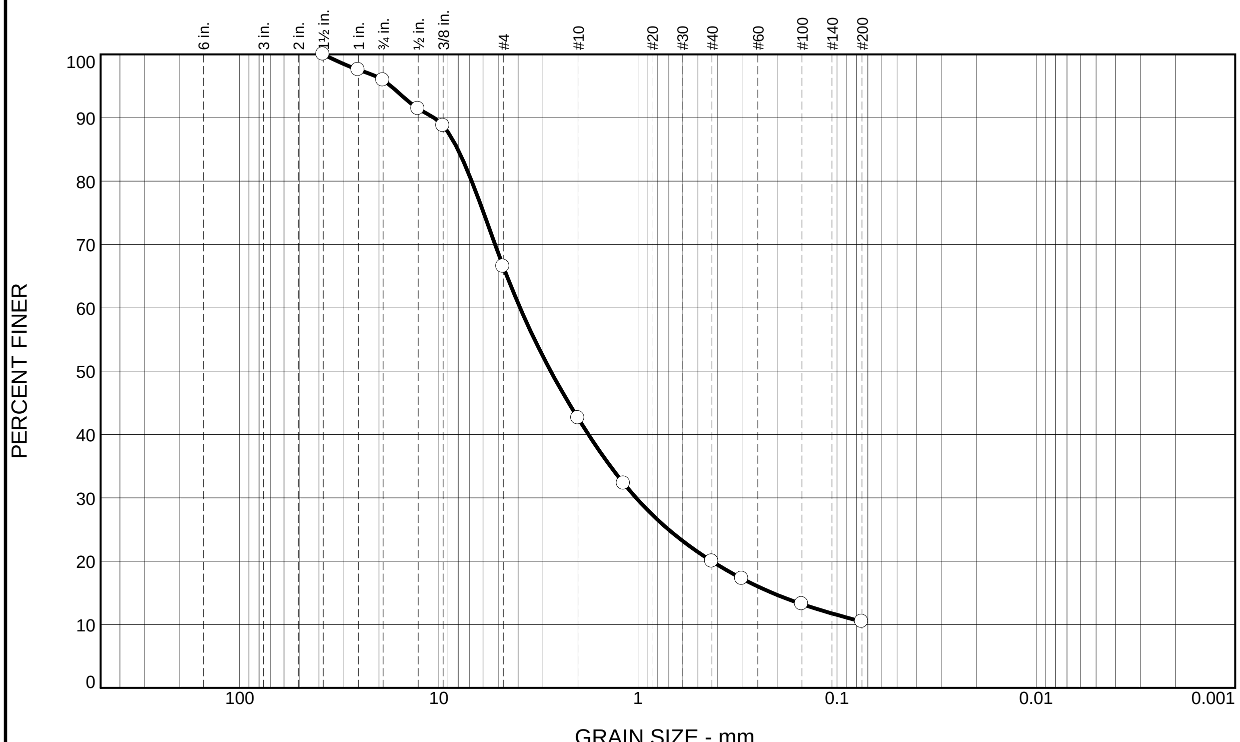
Location: TP-60
Sample Number: 17-019-33 **Depth:** 3'-4' **Date:** 02/16/17

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

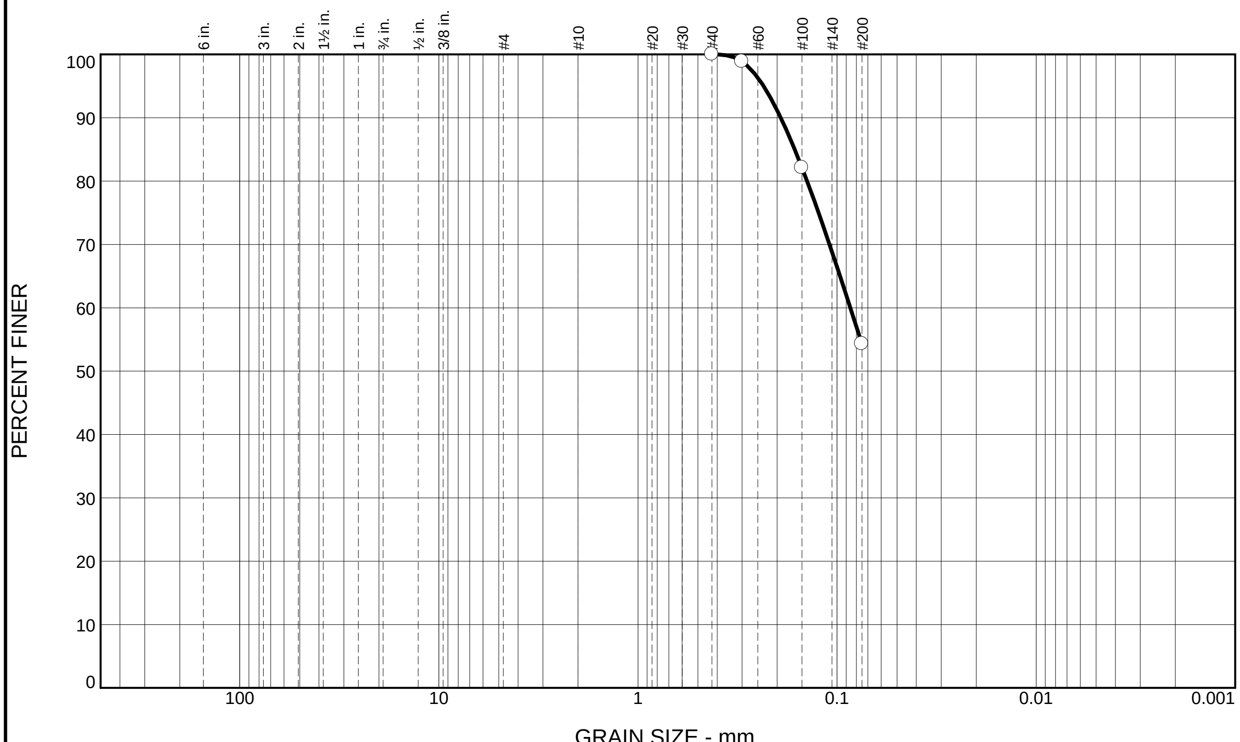
Location: TP-61
Sample Number: 17-019-34 **Depth:** 0'-1' **Date:** 02/16/17

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

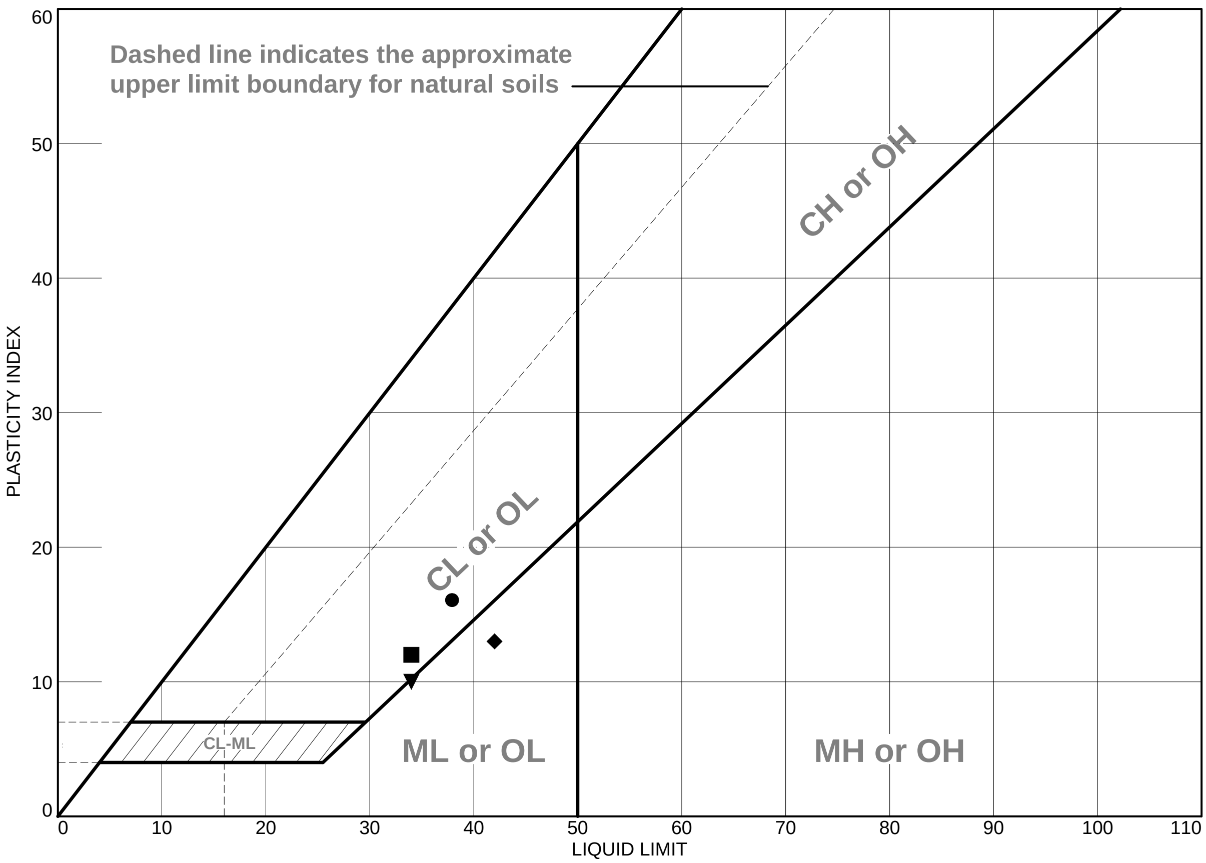
Location: BH-01
Sample Number: 17-020-01 **Depth:** 25.8'-26.3' **Date:** 02/20/2017

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

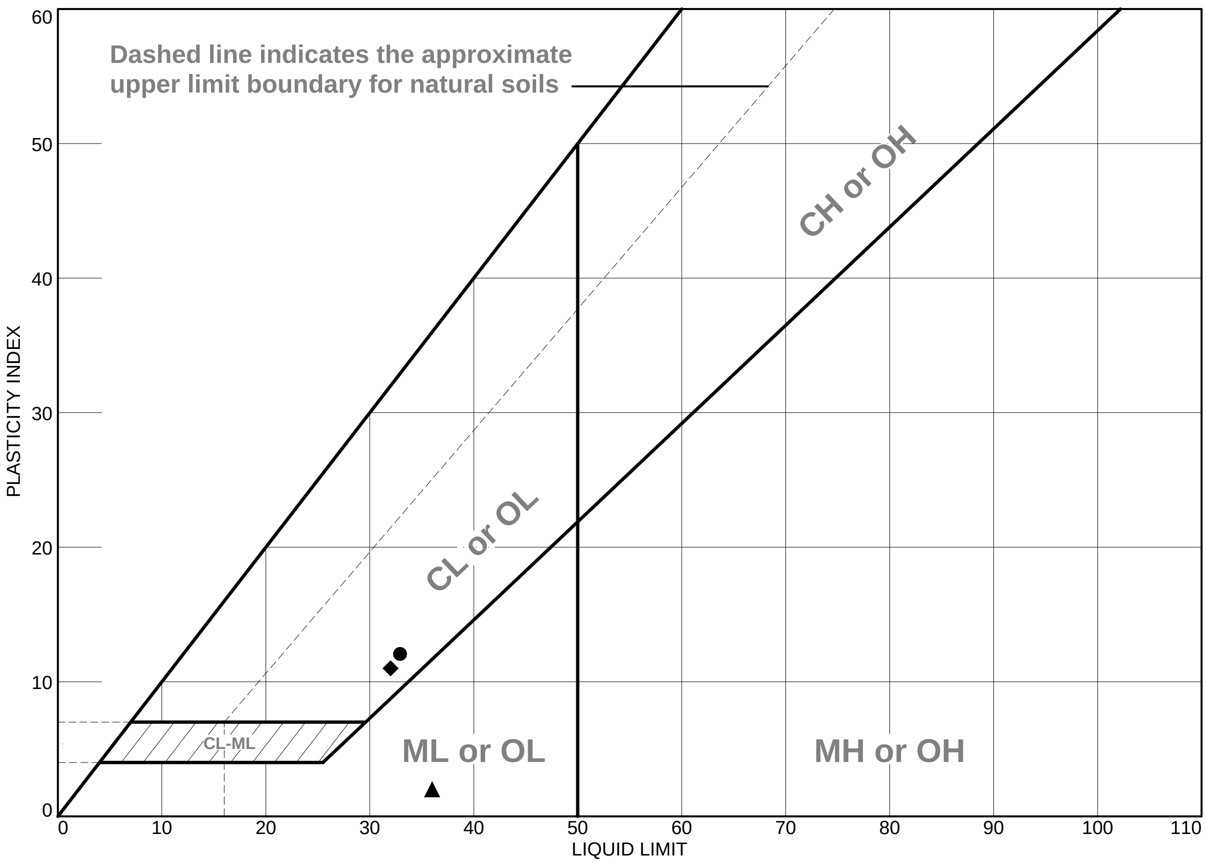
NewFields

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

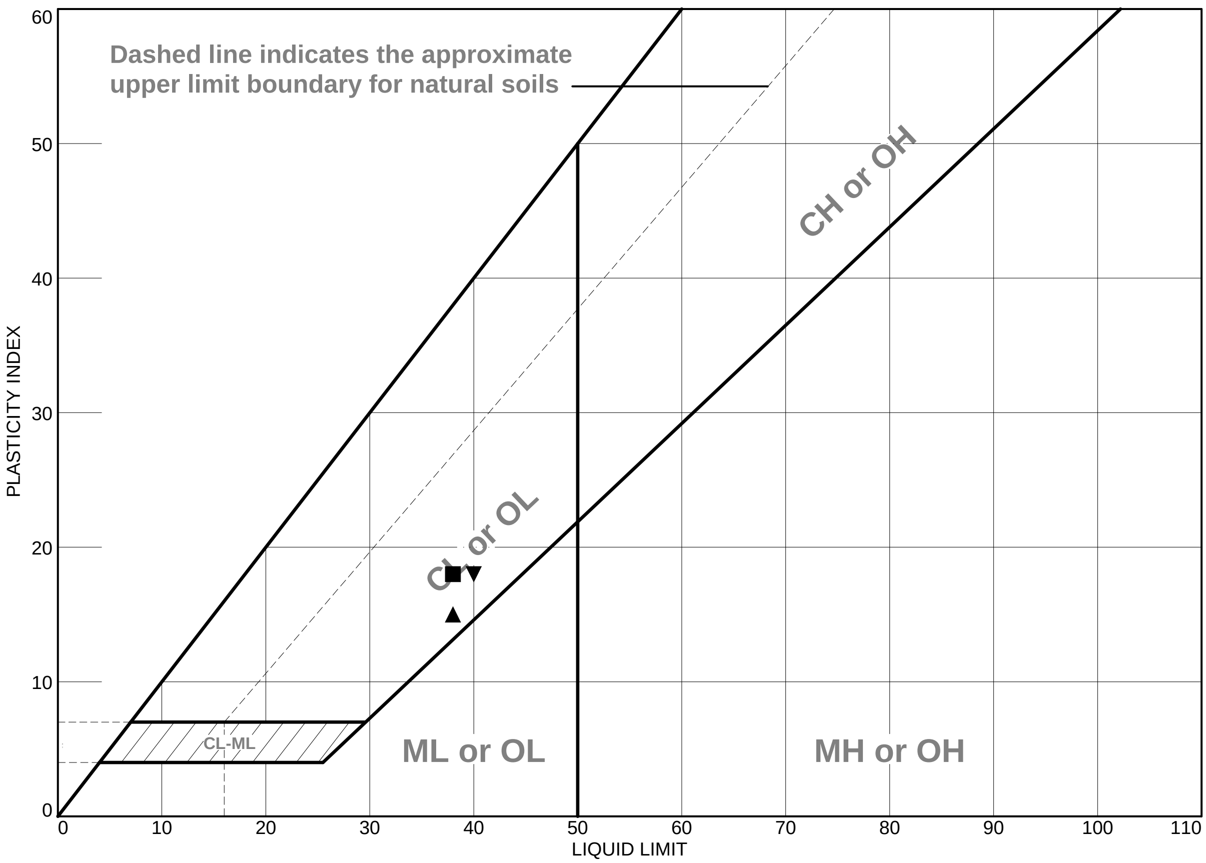
NewFields

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

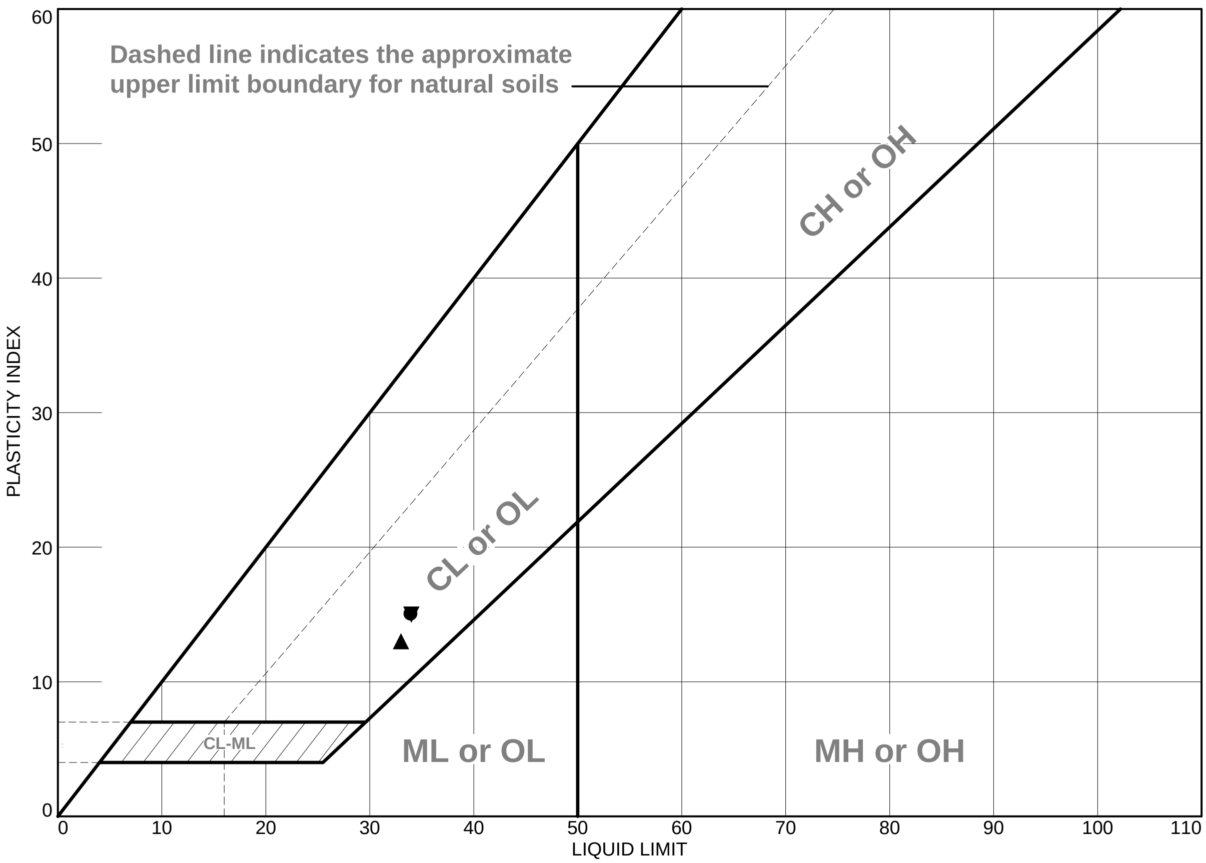
NewFields

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

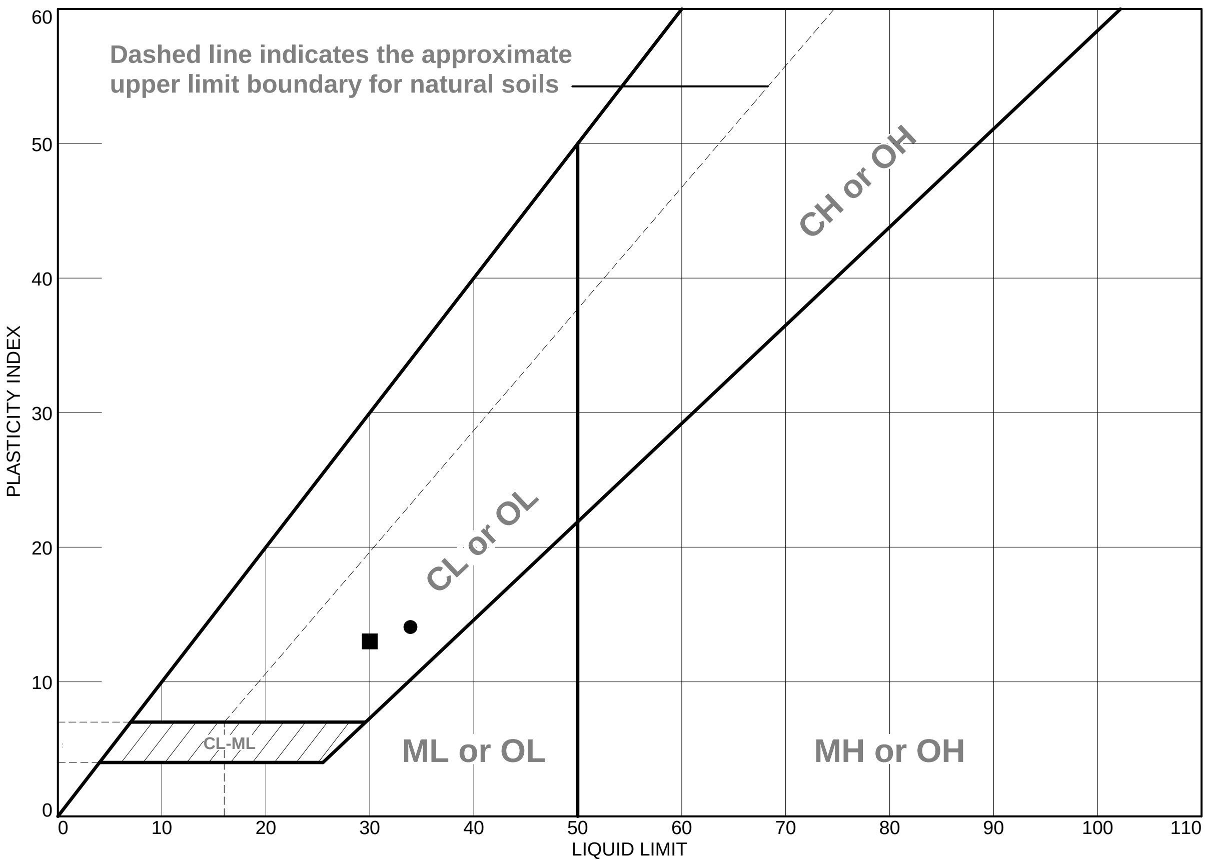
NewFields

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

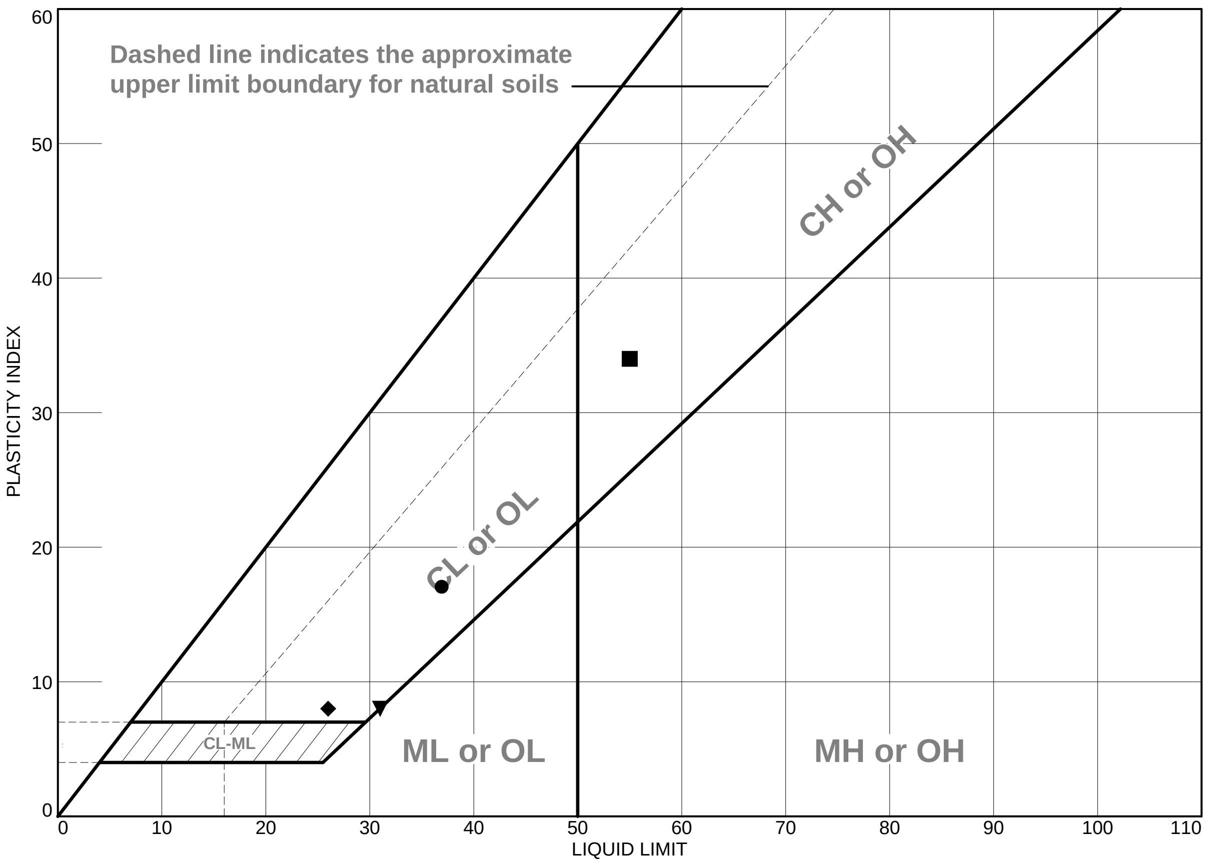
NewFields

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

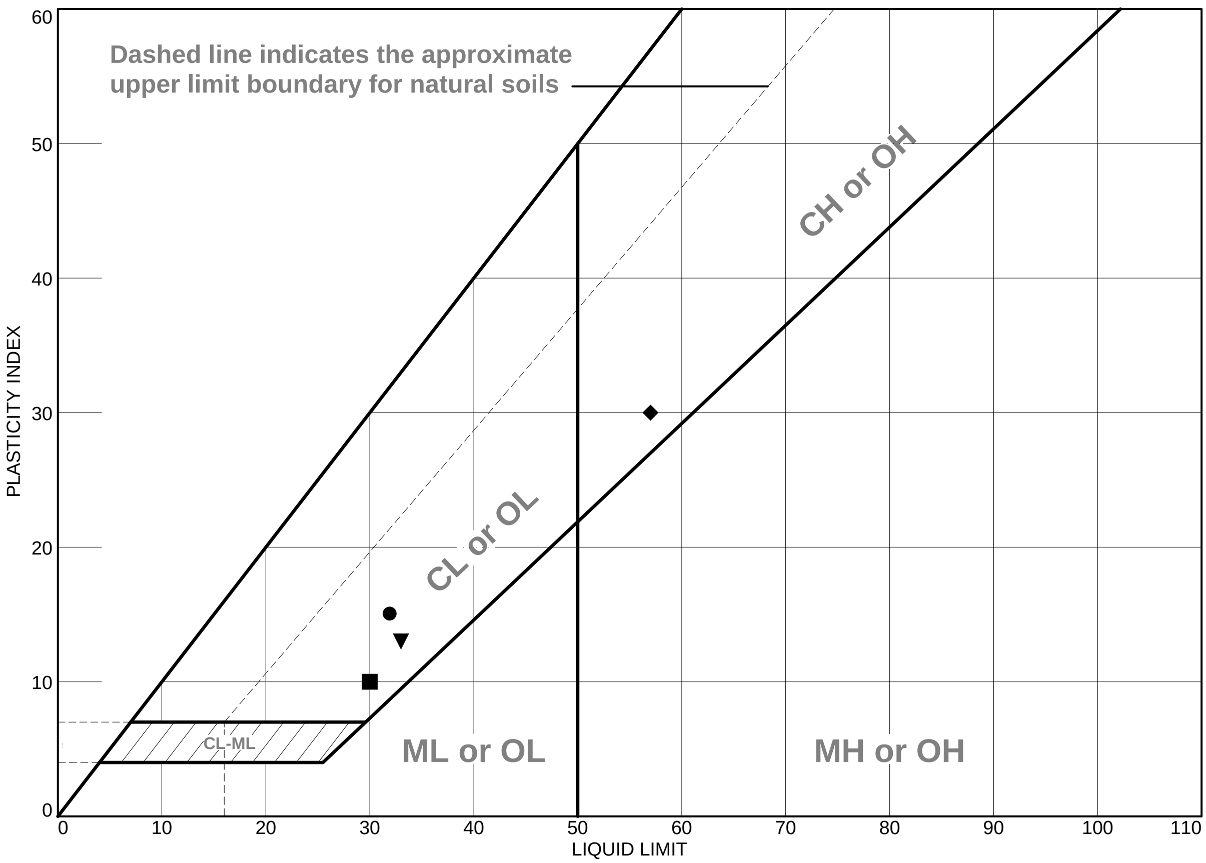
NewFields

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

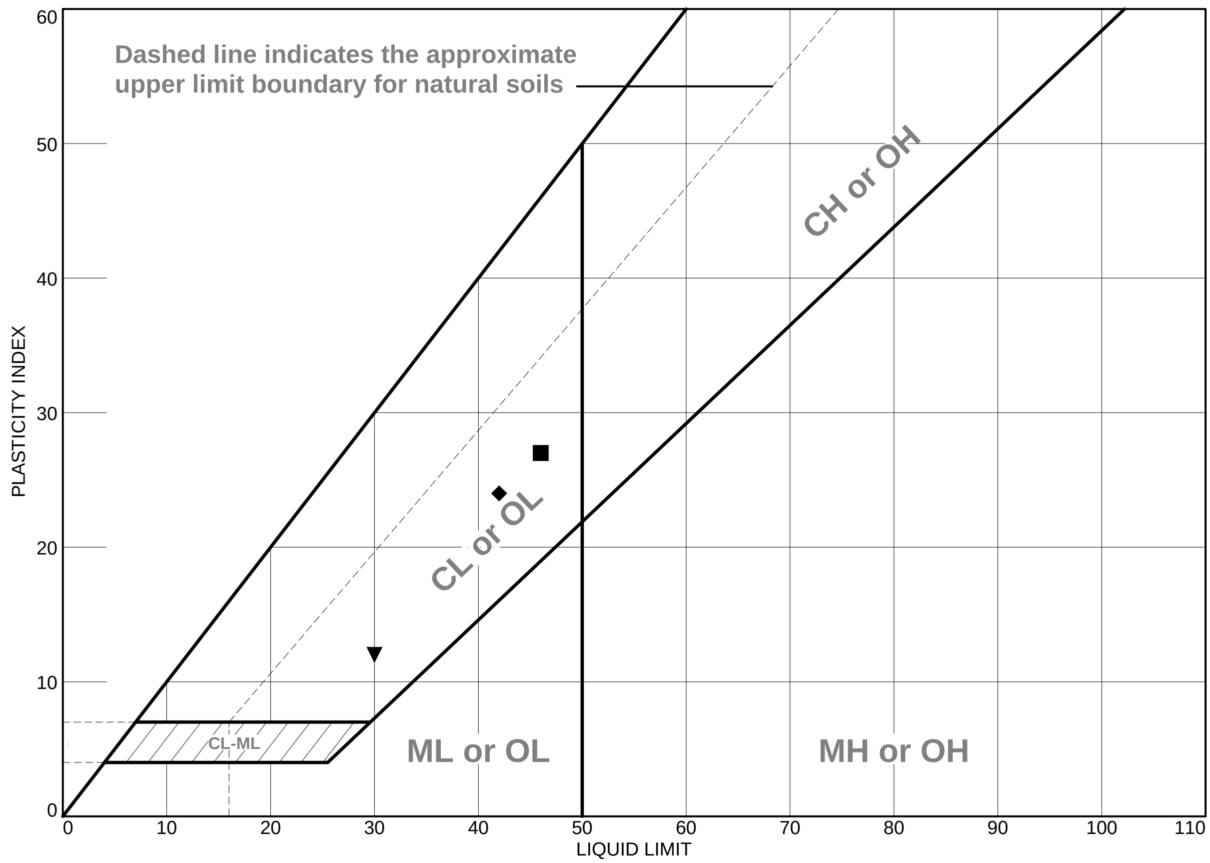
NewFields

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

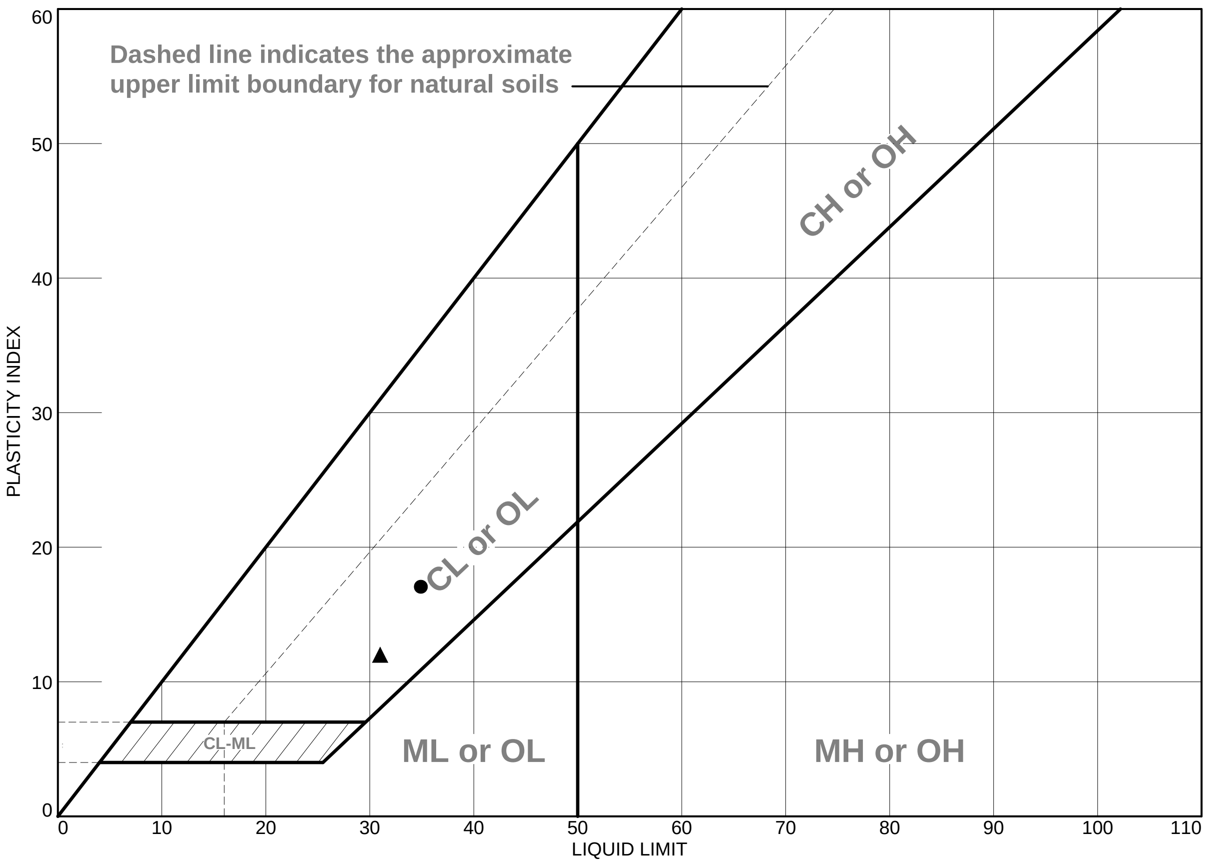
NewFields

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

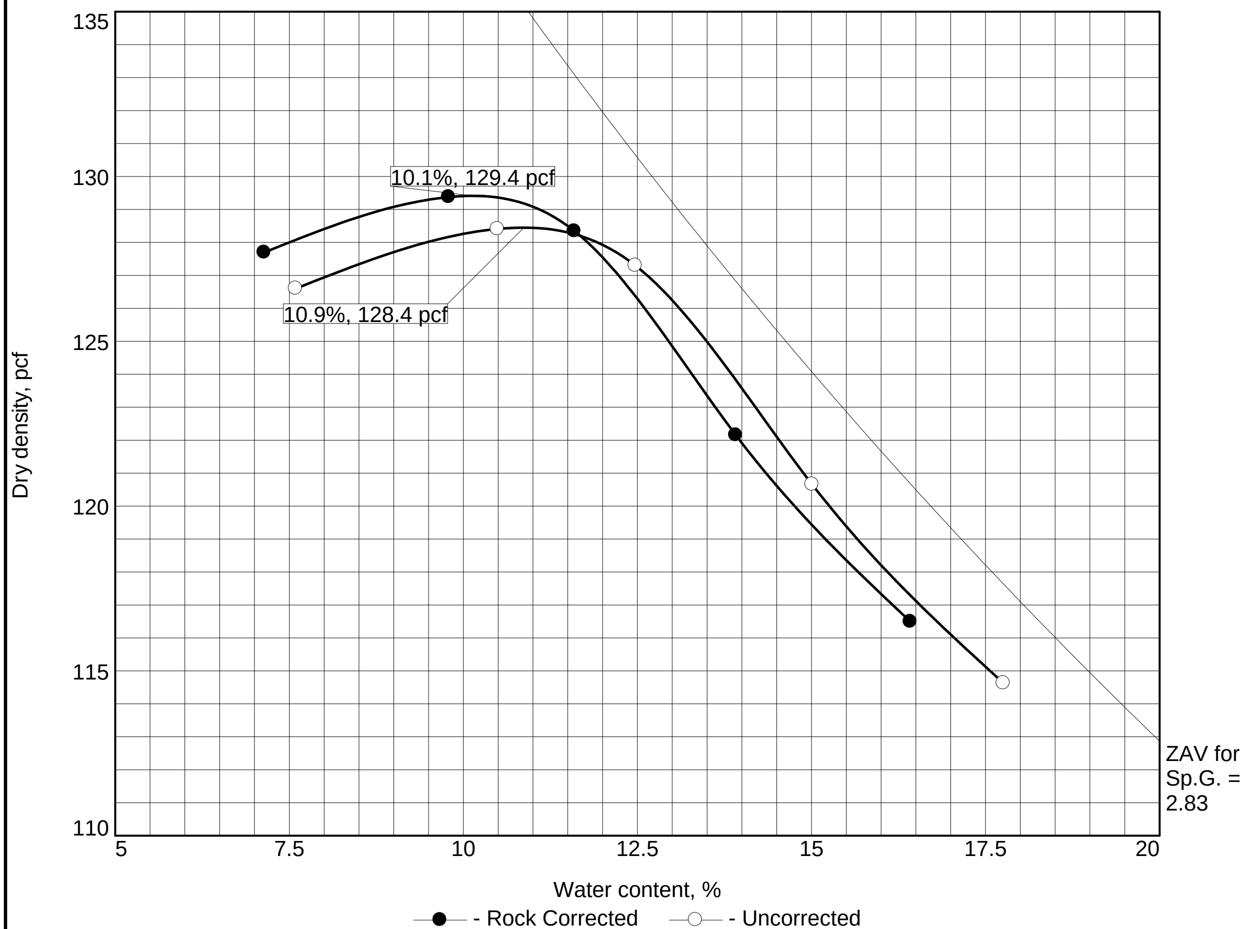
NewFields

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

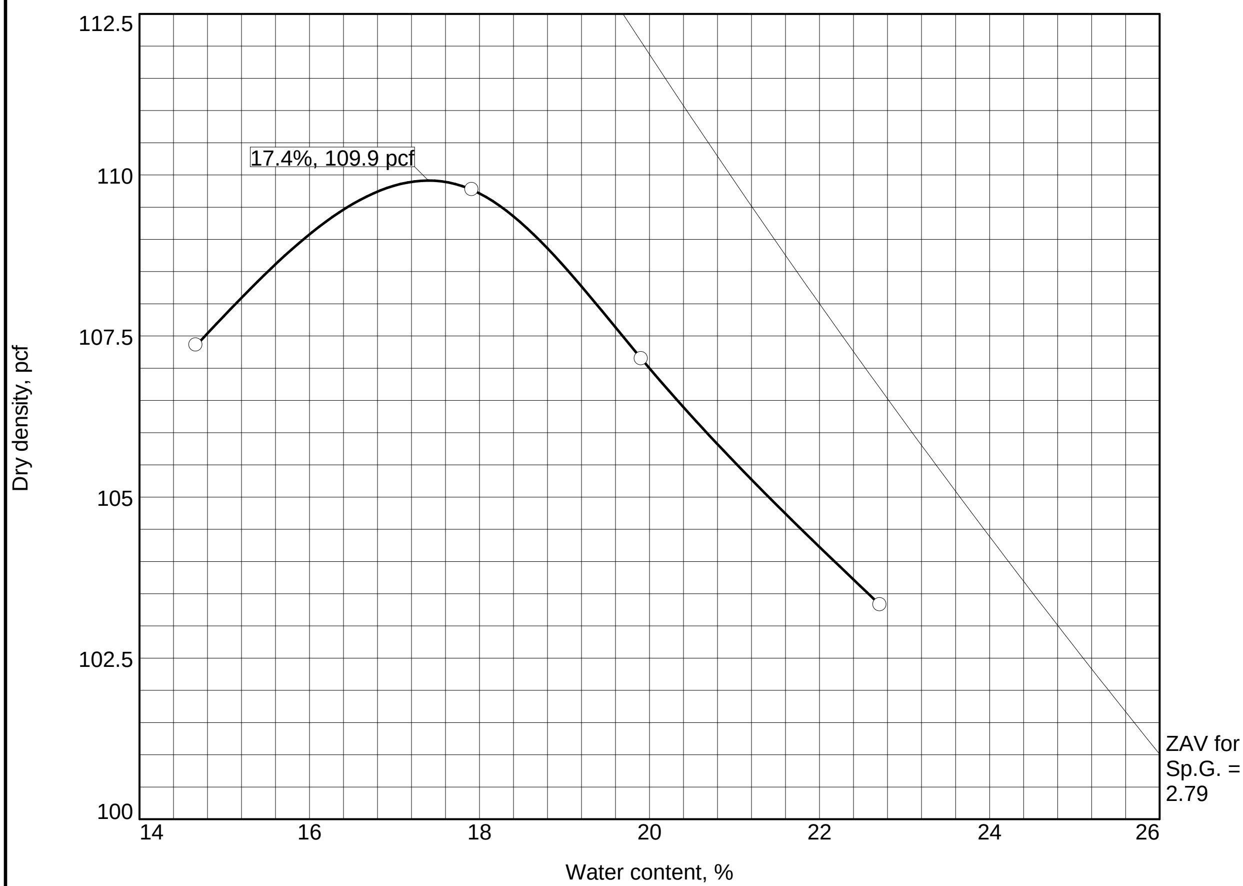
NewFields

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

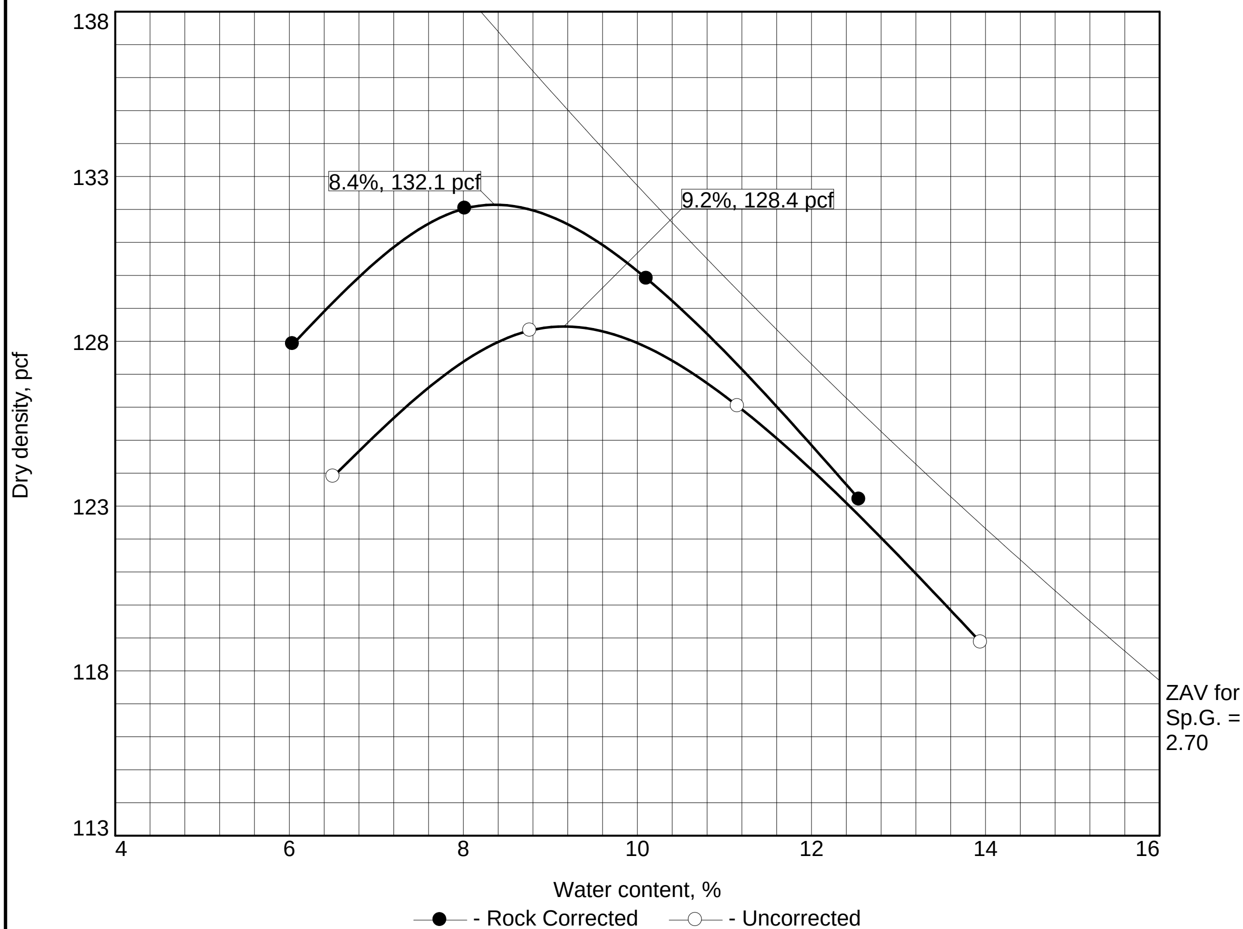
NewFields

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

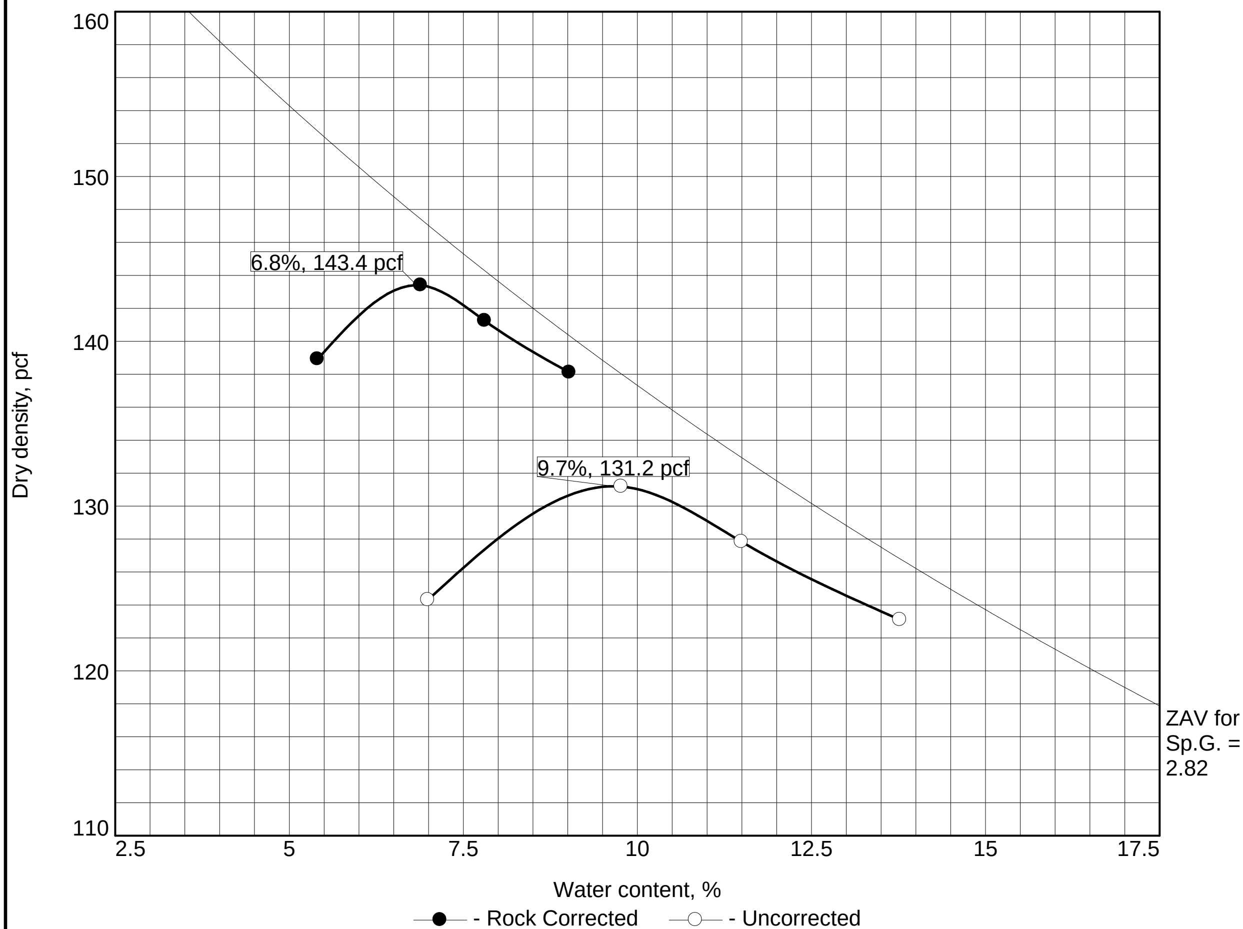
NewFields

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
Maximum dry density = 143.4 pcf	131.2 pcf
Optimum moisture = 6.8 %	9.7 %

MATERIAL DESCRIPTION

Dark brown poorly graded gravel with clay and sand

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

○ **Location:** TP-14 **Sample Number:** 17-019-12

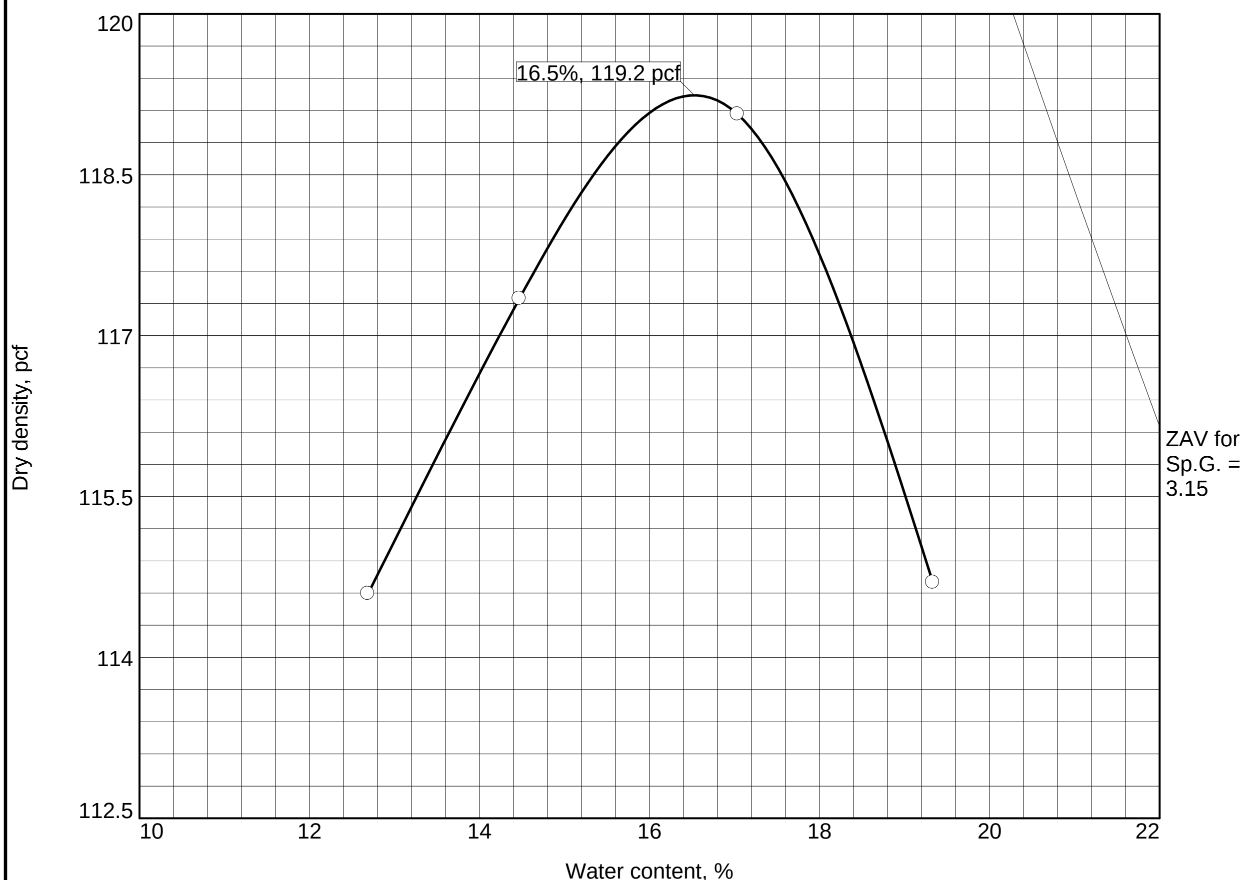
NewFields

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

Maximum dry density = 119.2 pcf

Optimum moisture = 16.5 %

MATERIAL DESCRIPTION

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

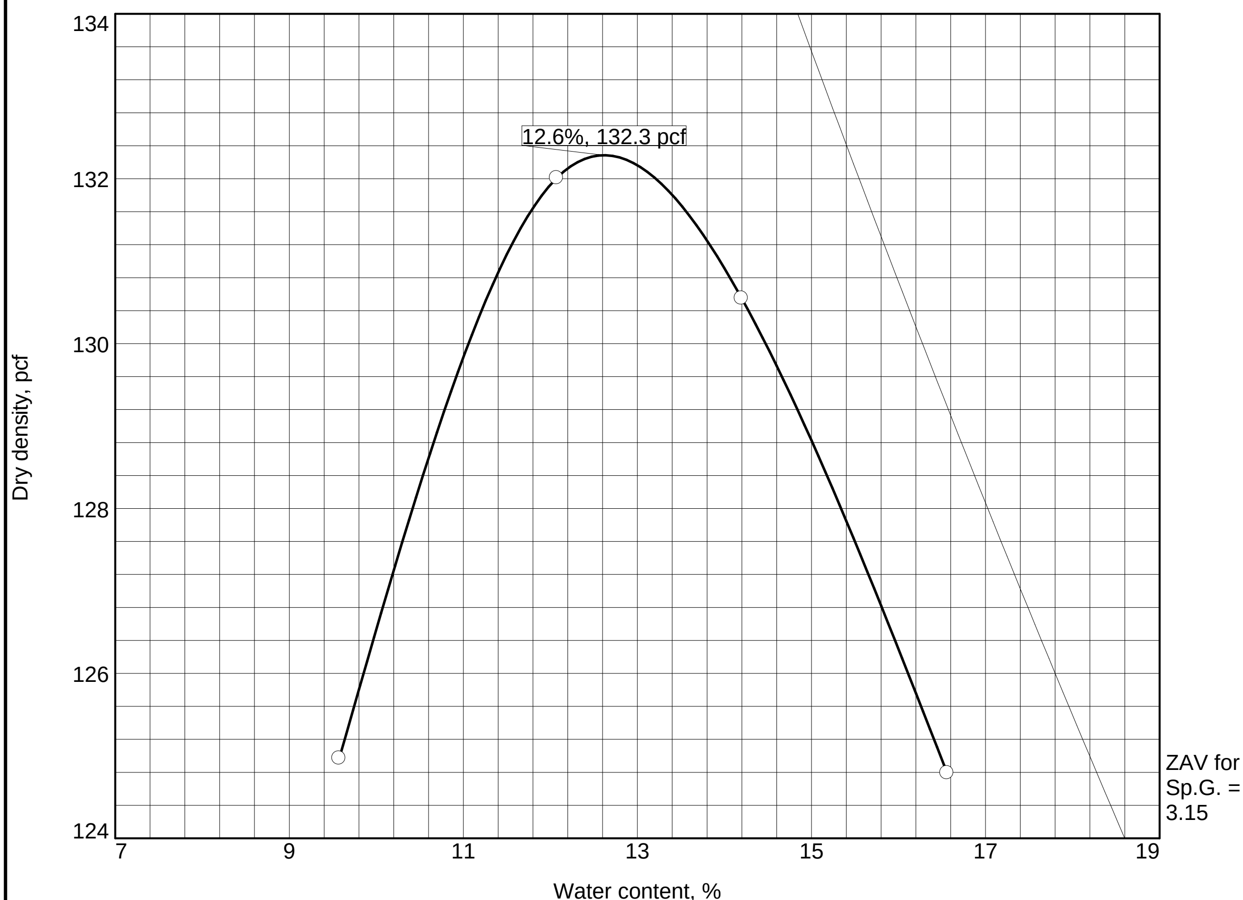
Remarks:

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

Maximum dry density = 132.3 pcf

Optimum moisture = 12.6 %

MATERIAL DESCRIPTION

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

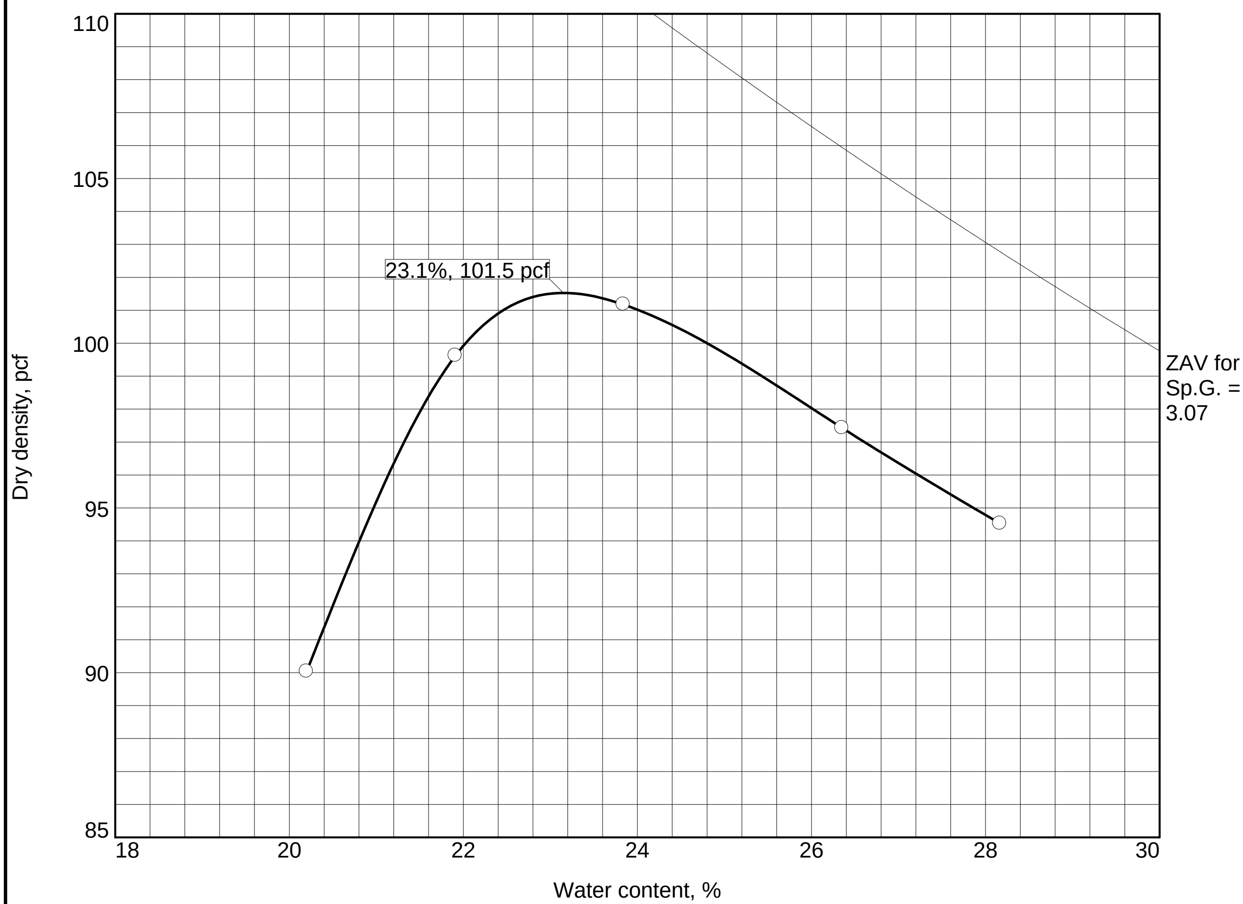
Remarks:

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

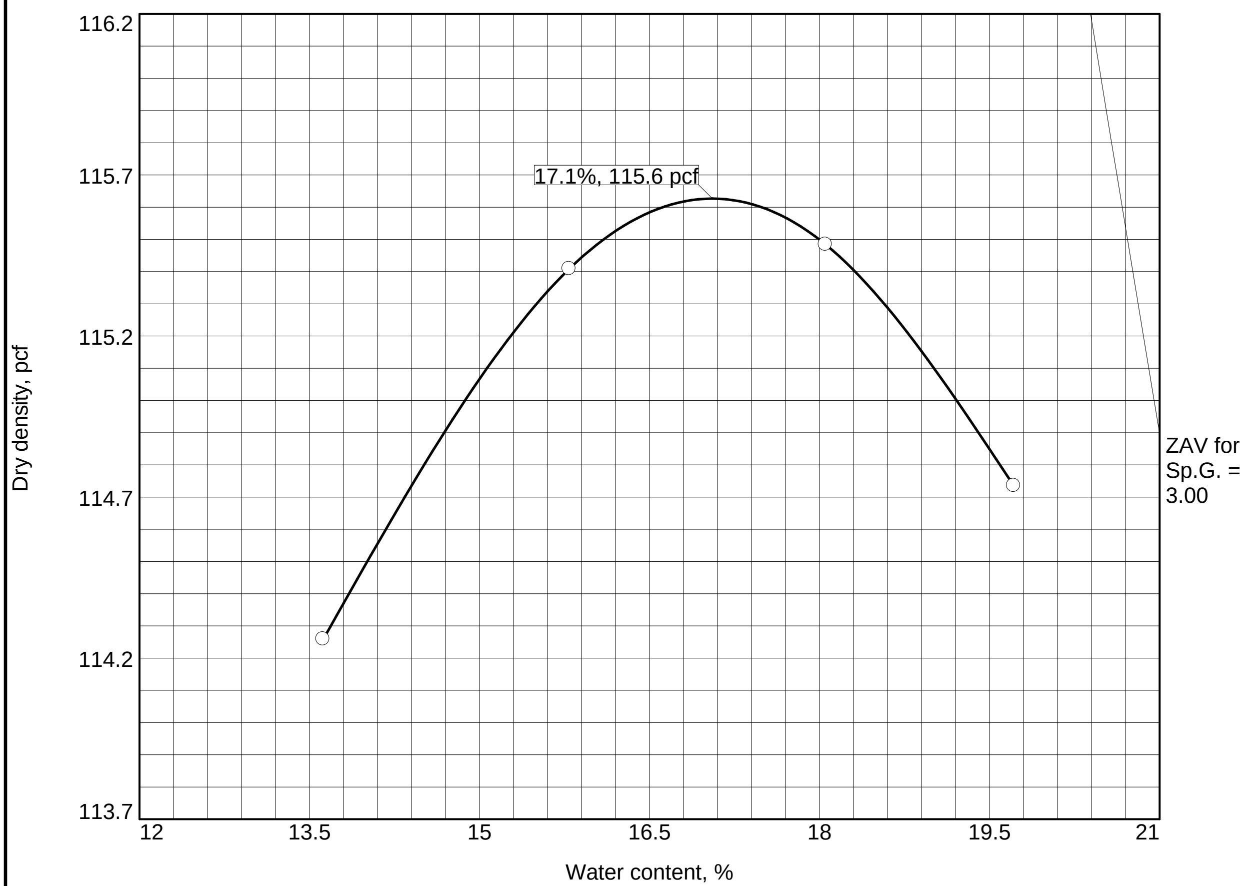
NewFields

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

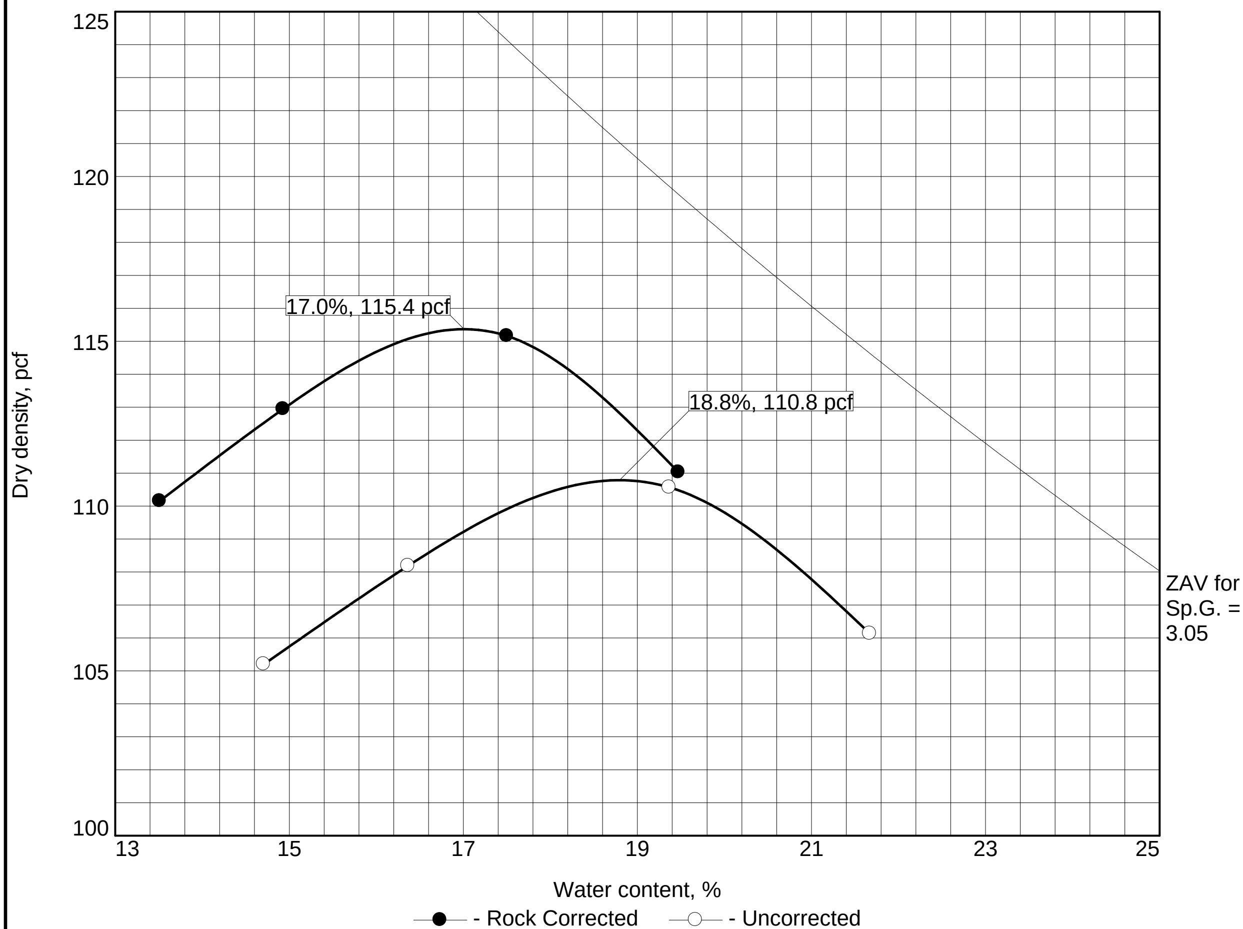
Remarks:

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

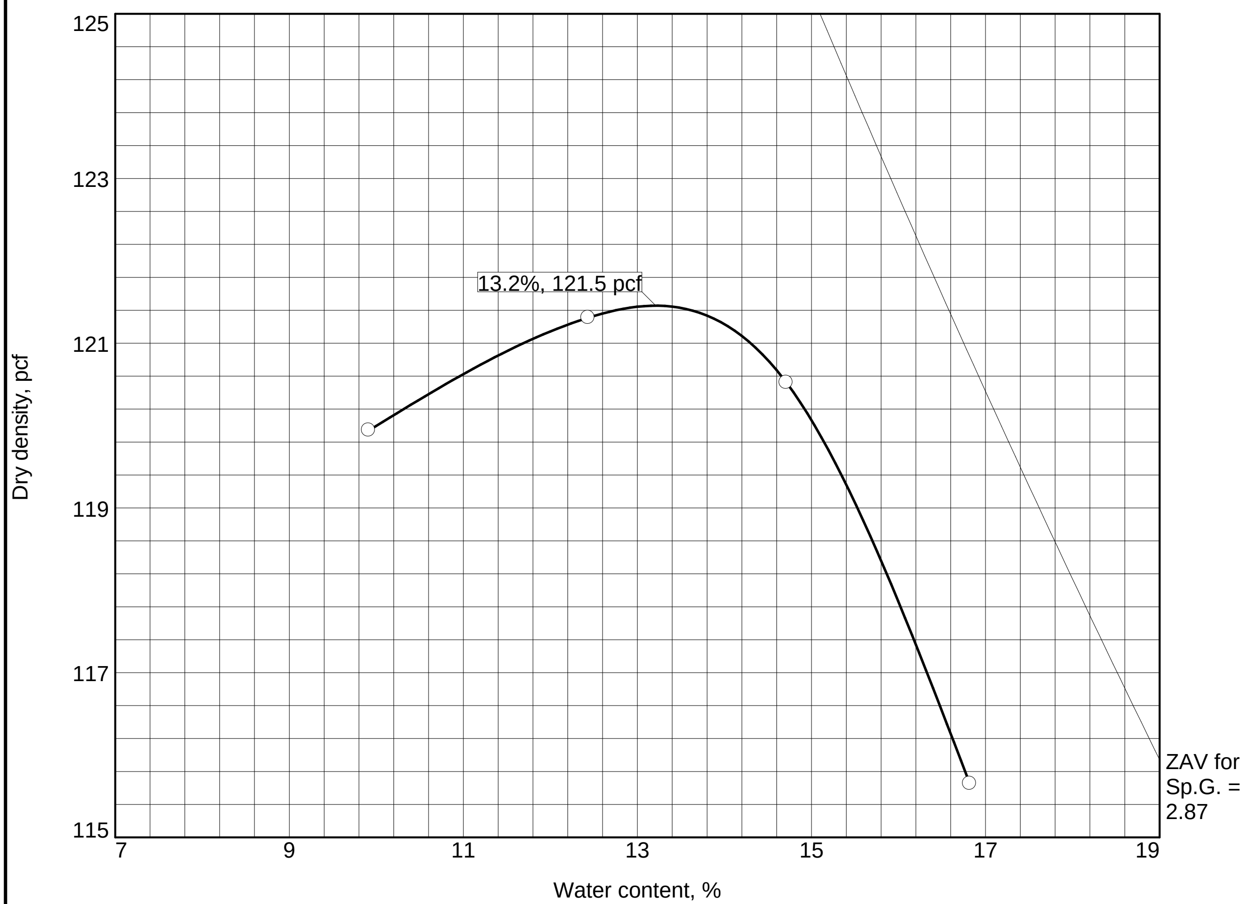
Remarks:

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

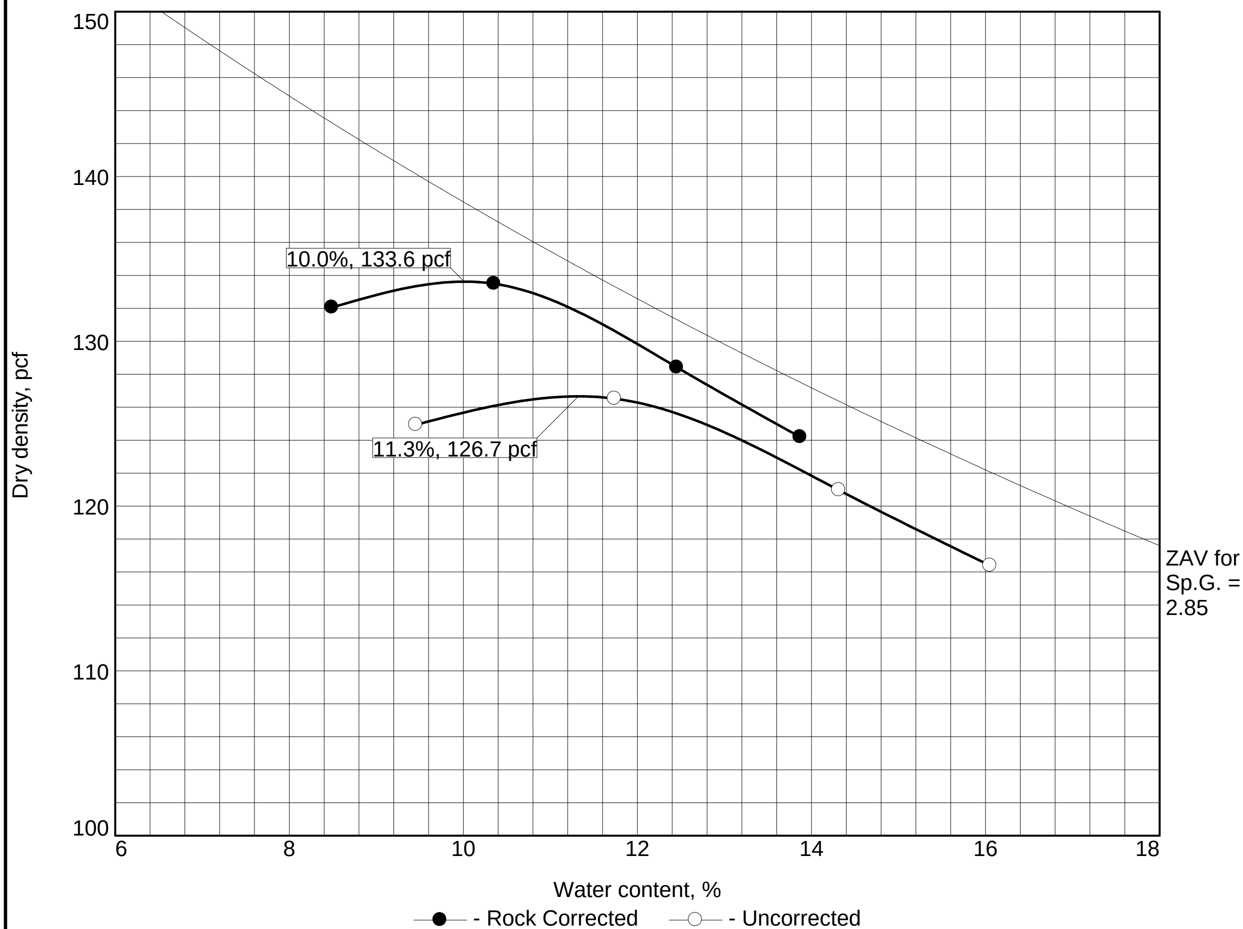
NewFields

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
Maximum dry density = 133.6 pcf	126.7 pcf
Optimum moisture = 10.0 %	11.3 %

MATERIAL DESCRIPTION

Brown

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

○ **Location:** TP-31 **Sample Number:** 17-019-20

NewFields

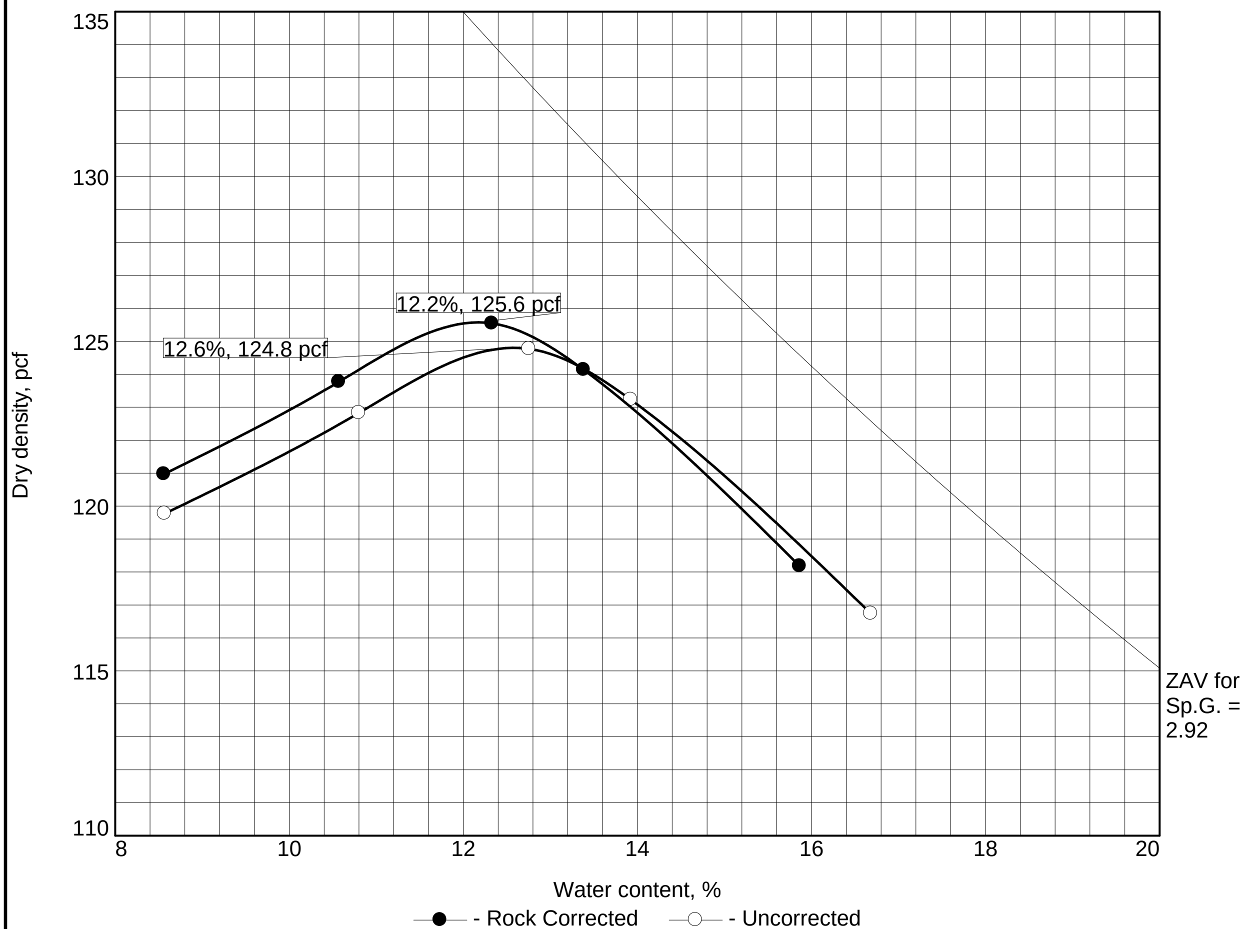
Remarks:

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
Maximum dry density = 125.6 pcf	124.8 pcf
Optimum moisture = 12.2 %	12.6 %

MATERIAL DESCRIPTION

Grey silty sand

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

Location: TP-33 **Sample Number:** 17-019-23

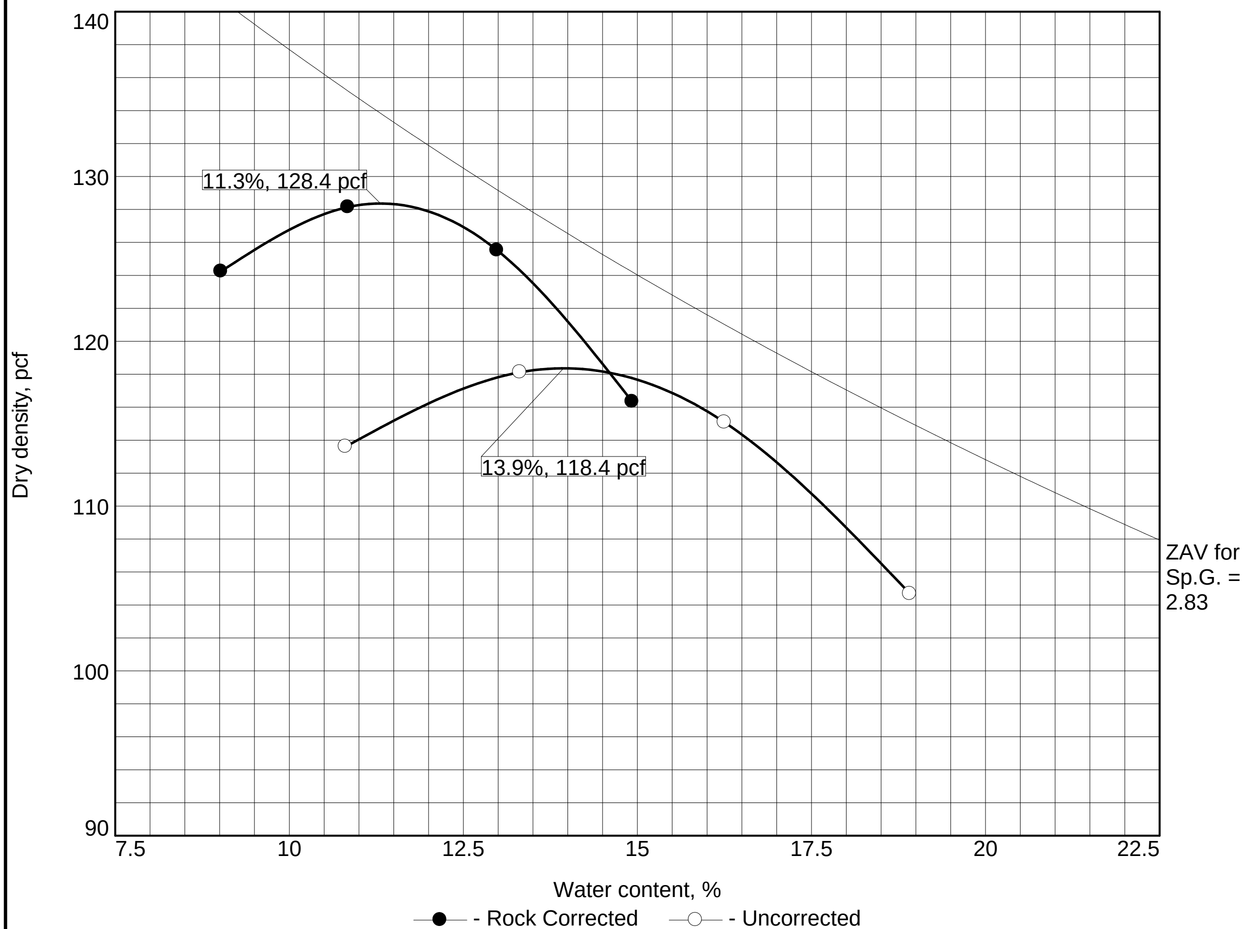
NewFields

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	MATERIAL DESCRIPTION
Maximum dry density = 128.4 pcf	118.4 pcf	Red clayey sand with gravel
Optimum moisture = 11.3 %	13.9 %	

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.
Project: Hermosa Underground Project

Location: TP-47A **Sample Number:** 17-019-25

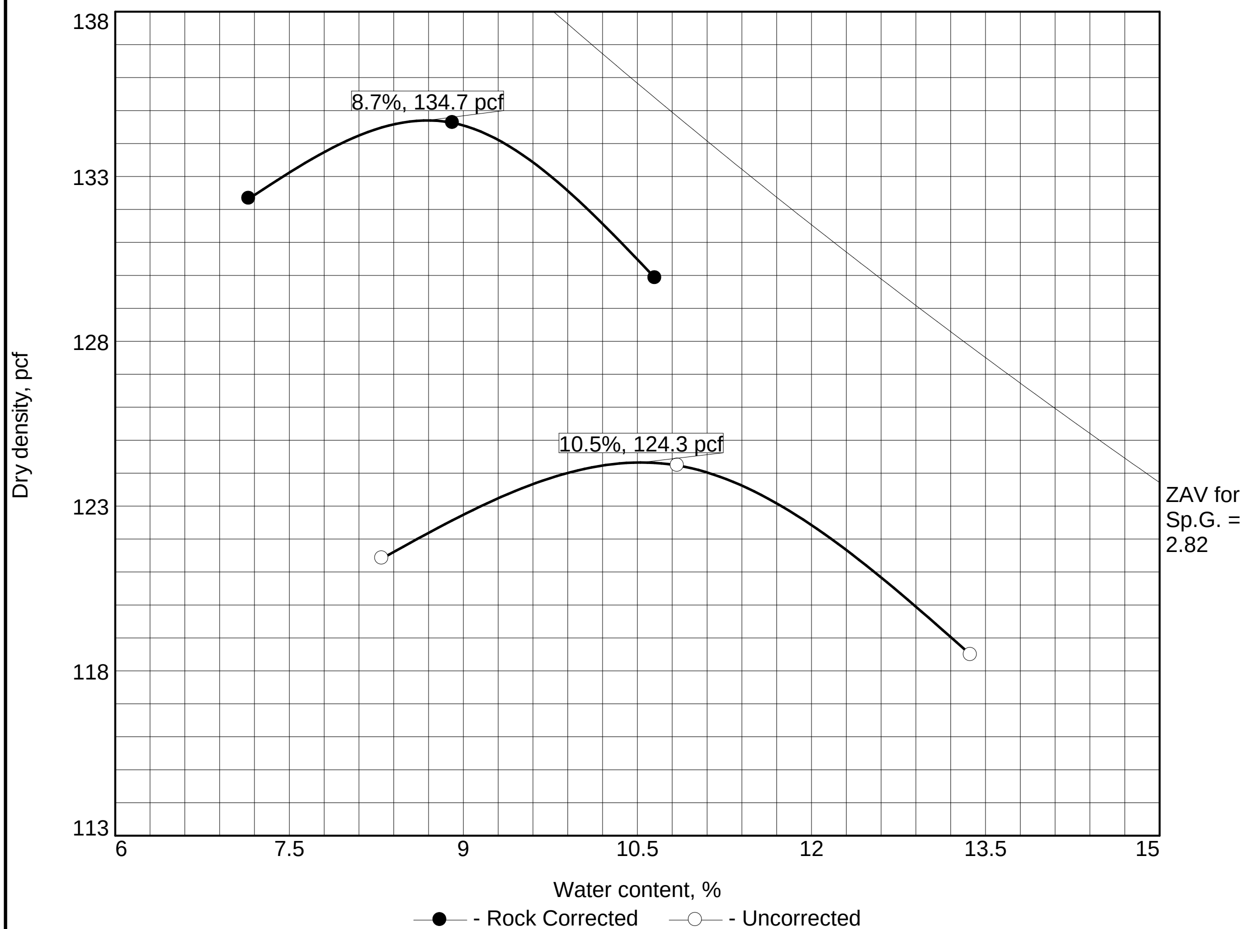
NewFields

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
Maximum dry density = 134.7 pcf	124.3 pcf
Optimum moisture = 8.7 %	10.5 %

MATERIAL DESCRIPTION

Light brown clayey gravel

Project No. 475.0014.008 **Client:** Arizona Minerals Inc.

Project: Hermosa Underground Project

○**Location:** TP-48 **Sample Number:** 17-019-26

NewFields

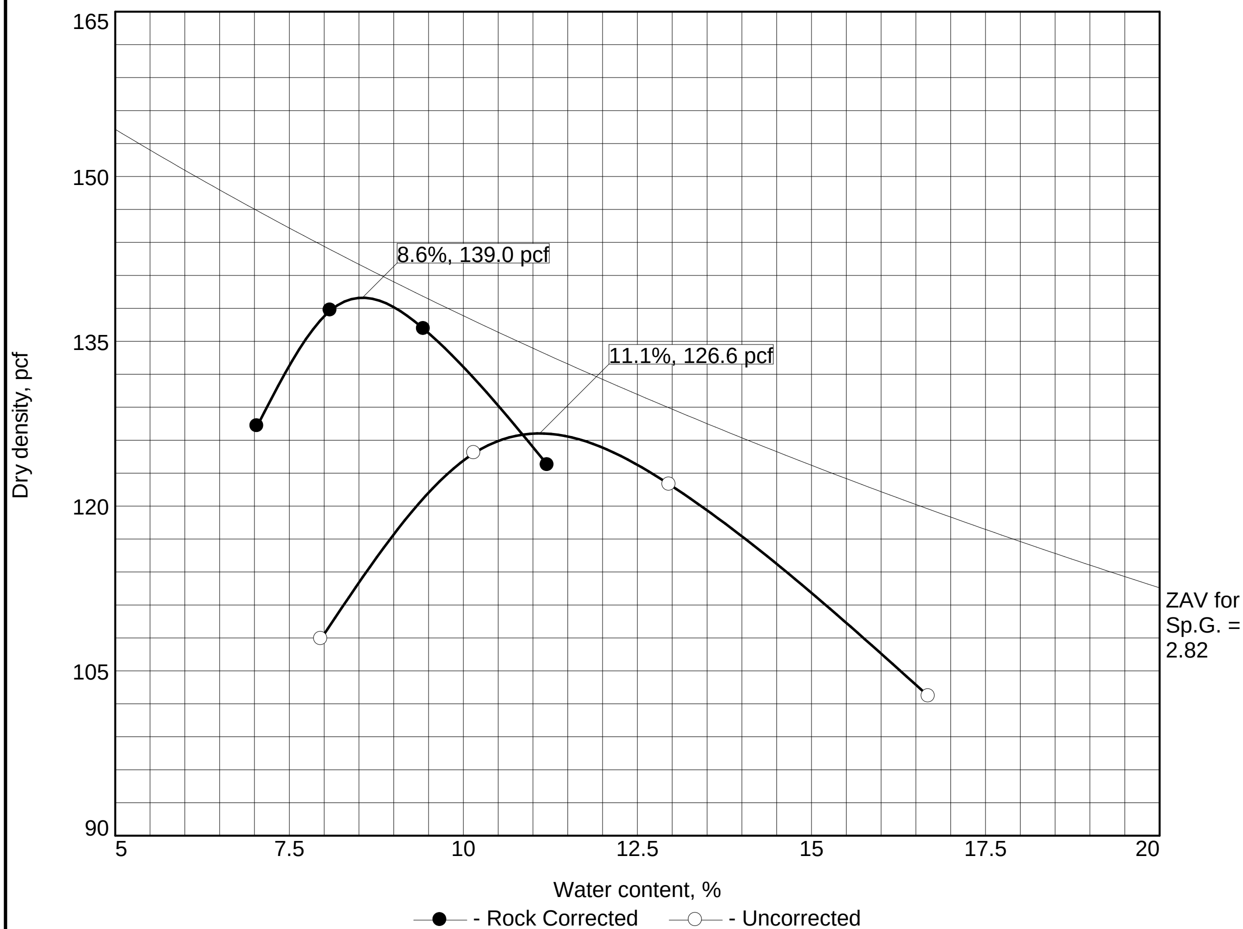
Remarks:

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	MATERIAL DESCRIPTION
Maximum dry density = 139.0 pcf	126.6 pcf	Orange clayey gravel with sand
Optimum moisture = 8.6 %	11.1 %	

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

NewFields

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

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)	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**

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		

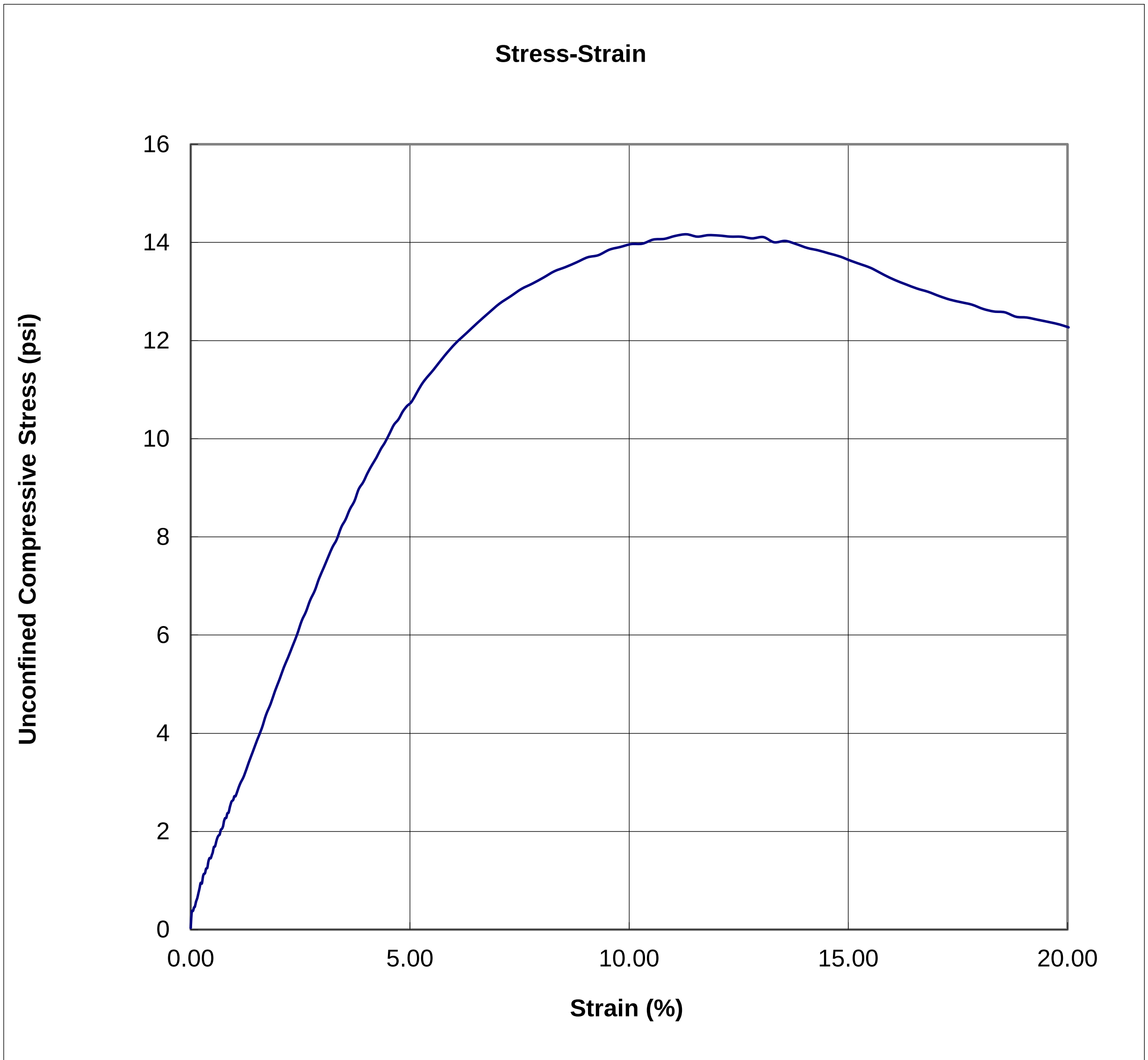
Sample Number	17-019-14		17-019-28					
Sample Location	TP-17; 5'-6'		TP-51; 5'-6'					
Prep Dish								
Flask No.	4	1	15	13				
1) Wt. of Flask + Soil	122.40	127.85	122.99	118.93				
2) Wt. of Flask	85.79	86.22	86.69	83.82				
3) Wt. of Soil = 1-2	36.61	41.63	36.30	35.11				
4) Calibrated Wt. of Flask + 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:

NewFields

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

(ASTM D2166-06)

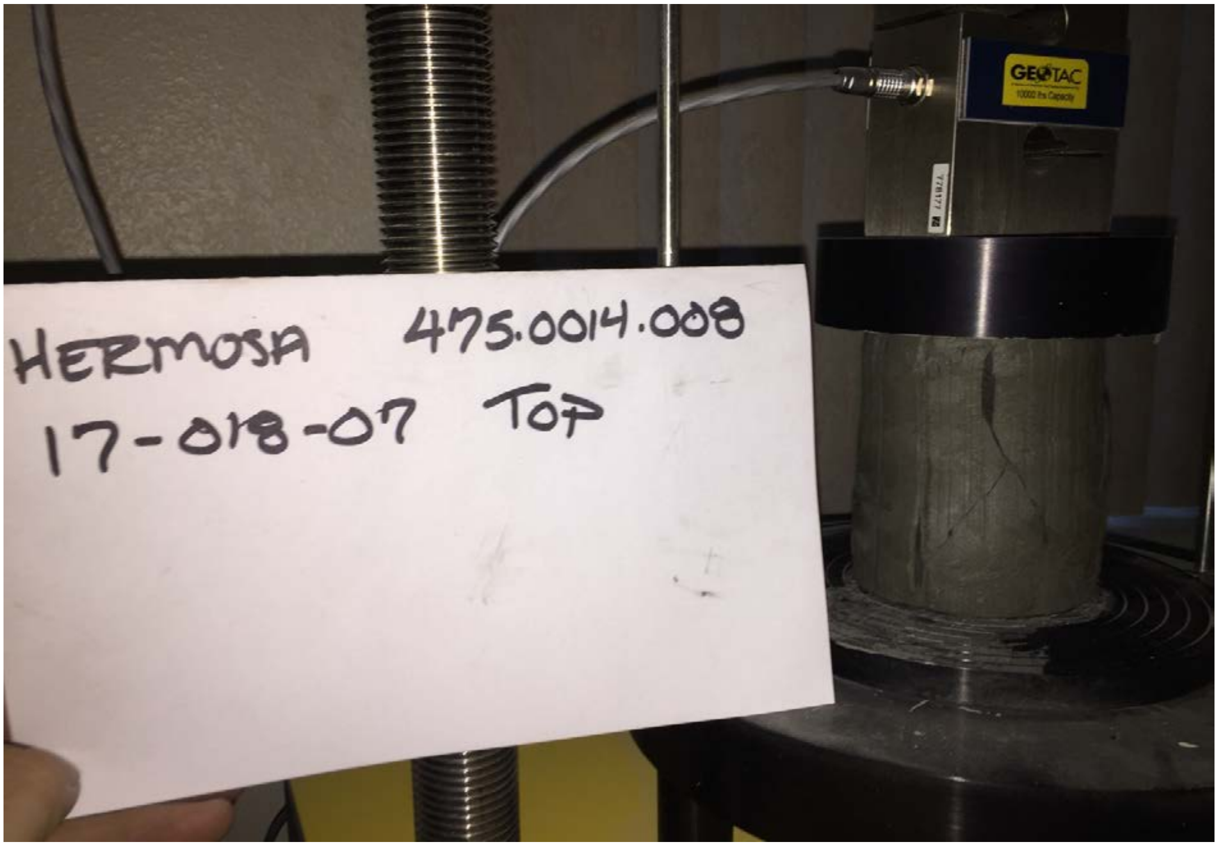


	Strain (%)	Stress (psi)
Peak Point	**11.3**	**14.2**

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

NewFields



Post Failure Photo

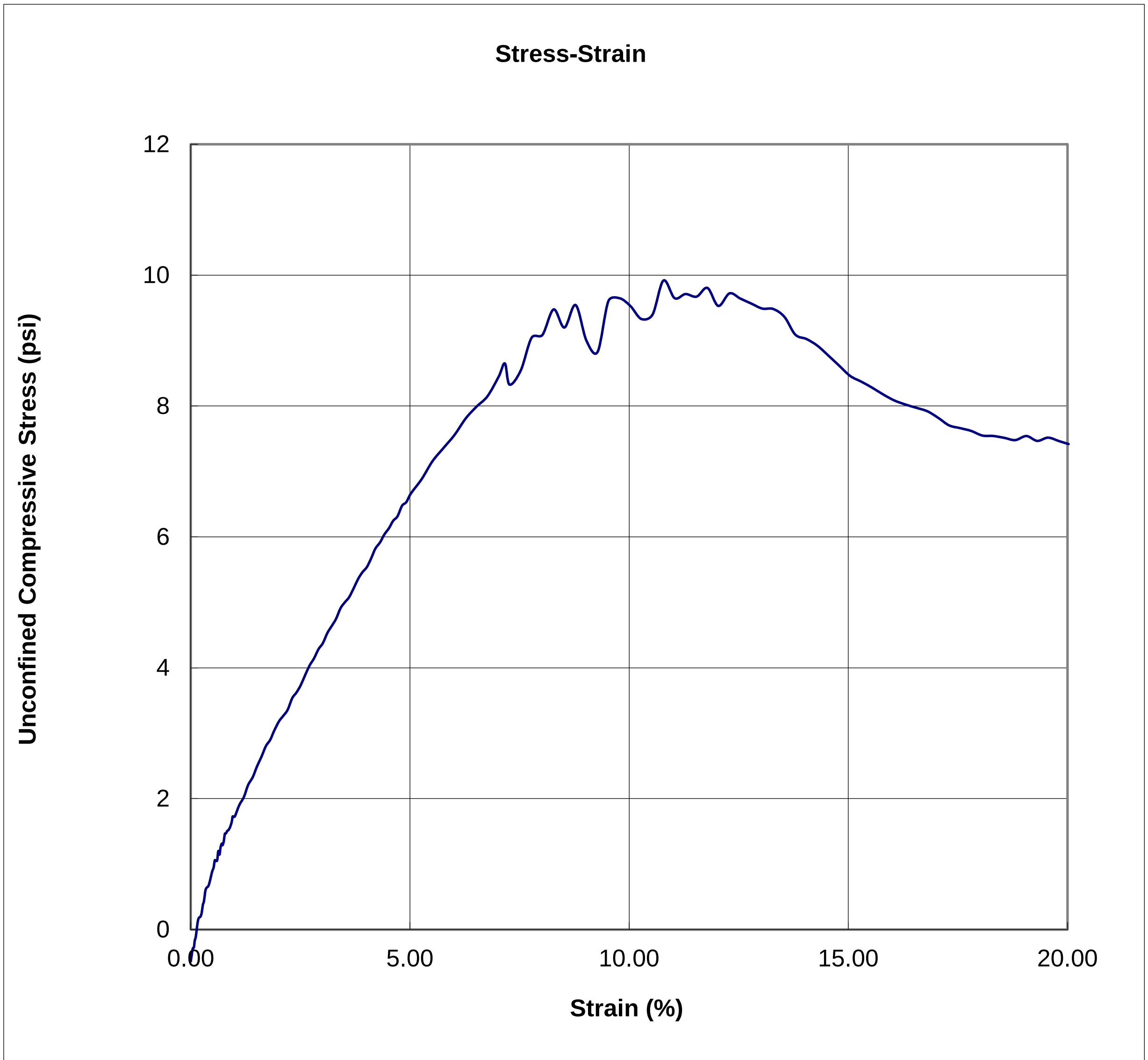
Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	5:08:49 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 TOP	Depth (ft):	46.5
Diameter (inch):	2.845	Height (inch):	4.946

Water Content in % Dry Wt.		
at 105° C (215° F)	32.6	%
Unit Weight Wet	126.4	PCF
Unit Weight Dry	95.3	PCF

NewFields

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

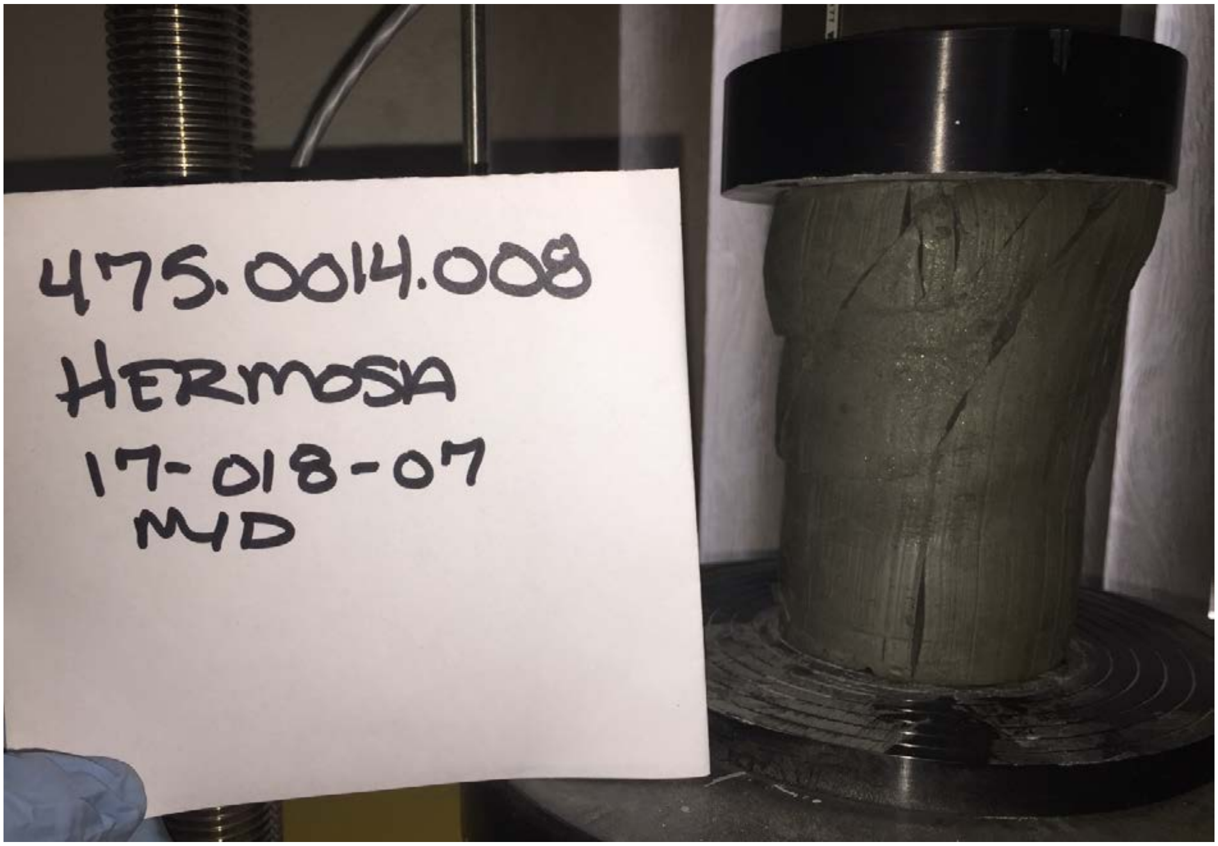
(ASTM D2166-06)



	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



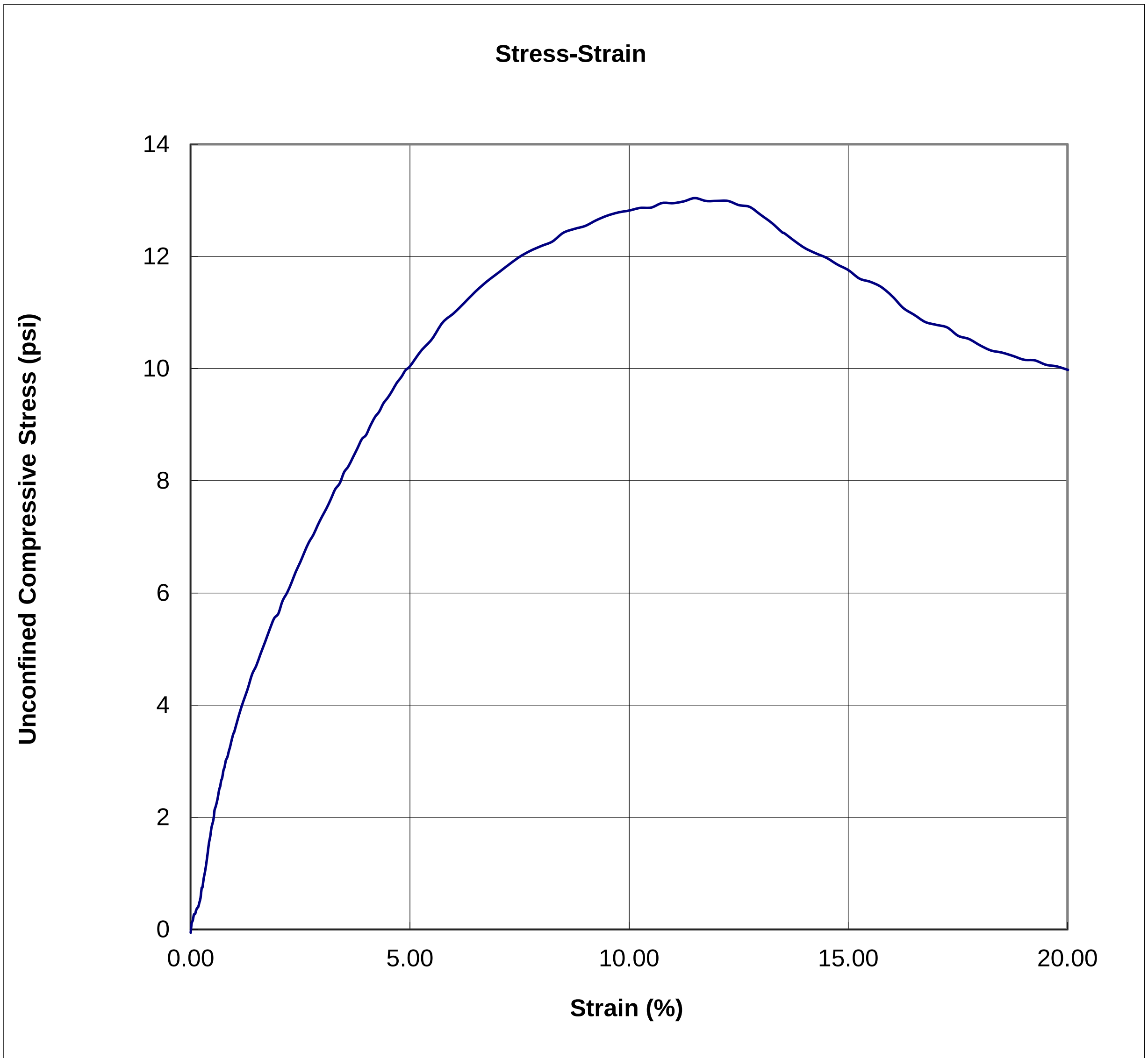
Post Failure Photo

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

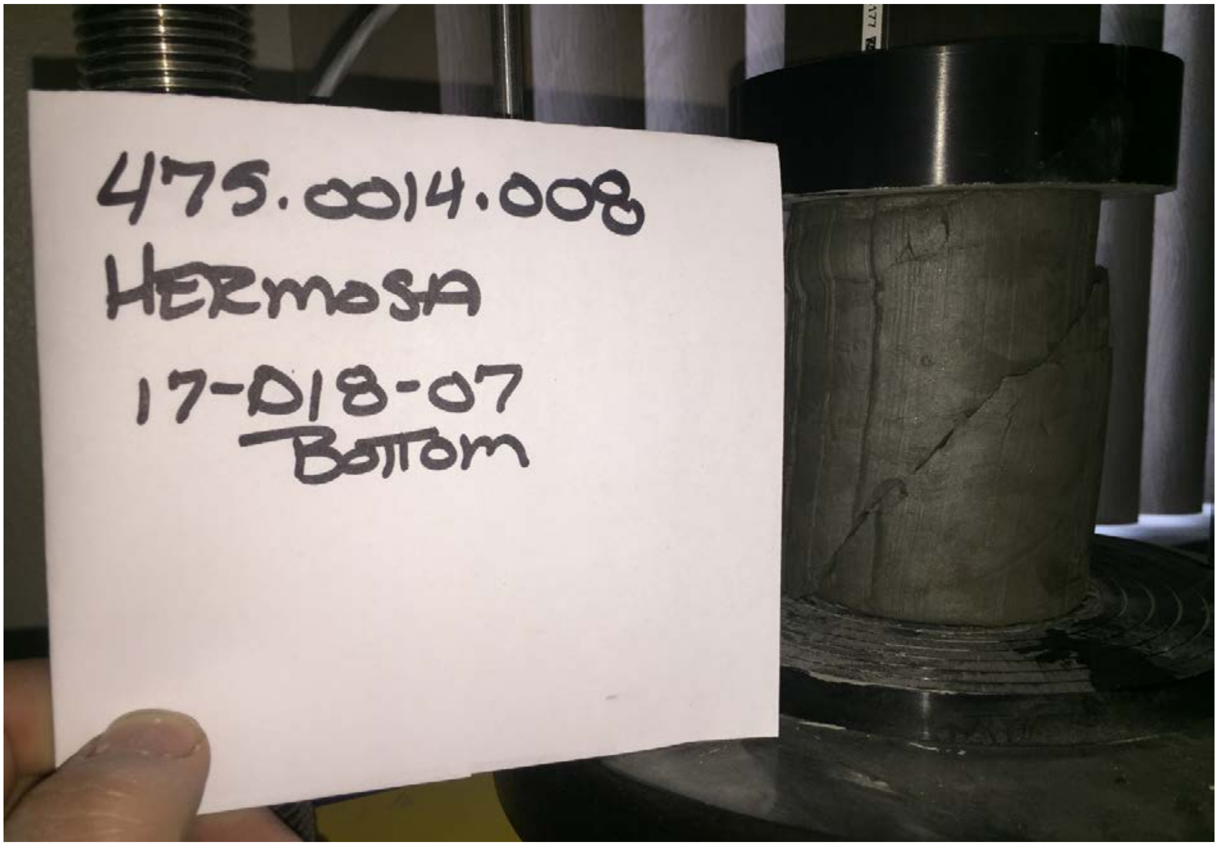
(ASTM D2166-06)



	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^{o} C (215^{o} F)	32.5	%
Unit Weight Wet	126.1	PCF
Unit Weight Dry	95.2	PCF



Post Failure Photo

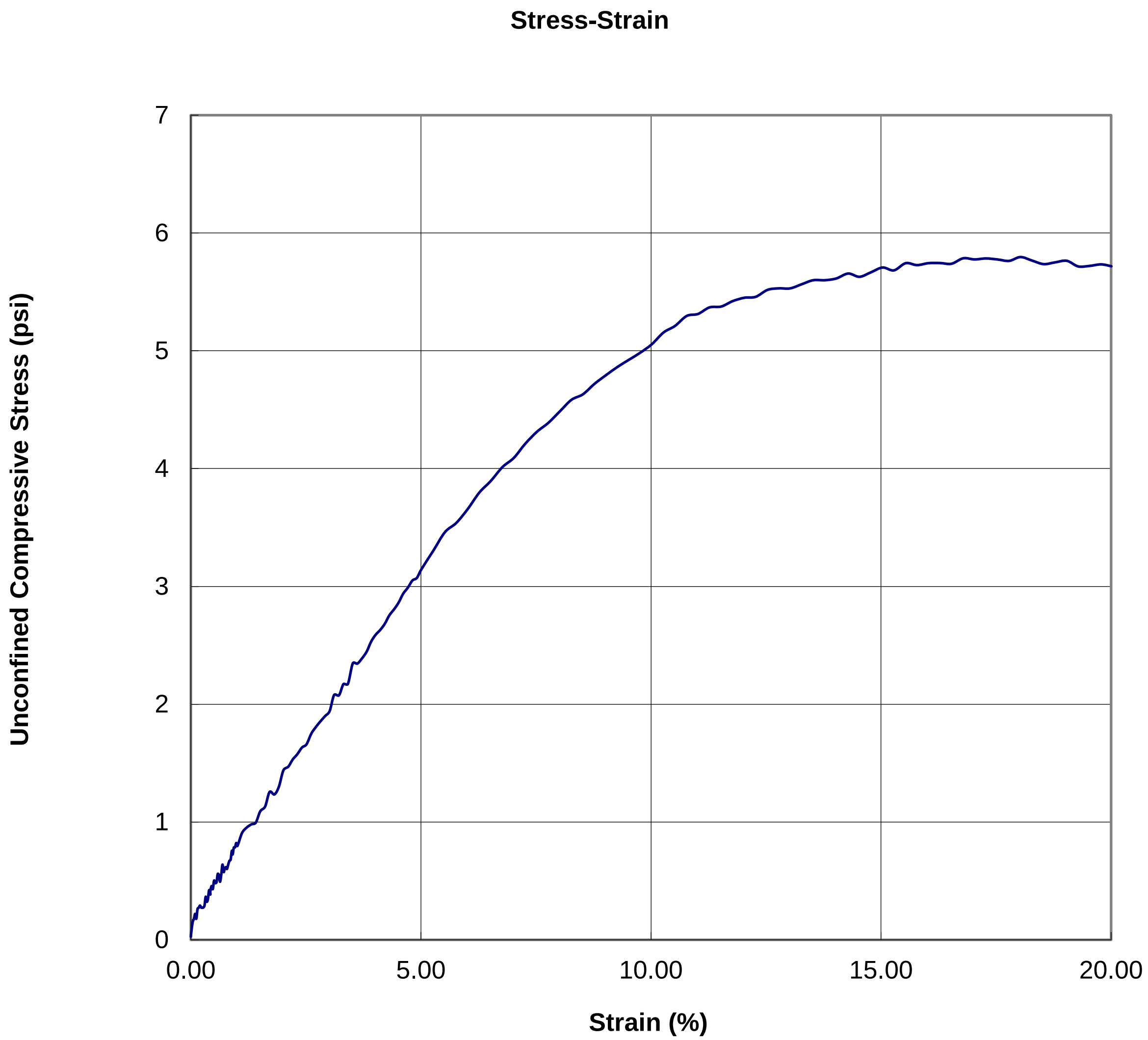
Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/4/2017	Time:	1:25:41 PM
Boring:	BH-01	Sample:	SH-07
Specimen:	17-018-07 BOT	Depth (ft):	46.5
Diameter (inch):	2.866	Height (inch):	5.618

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)

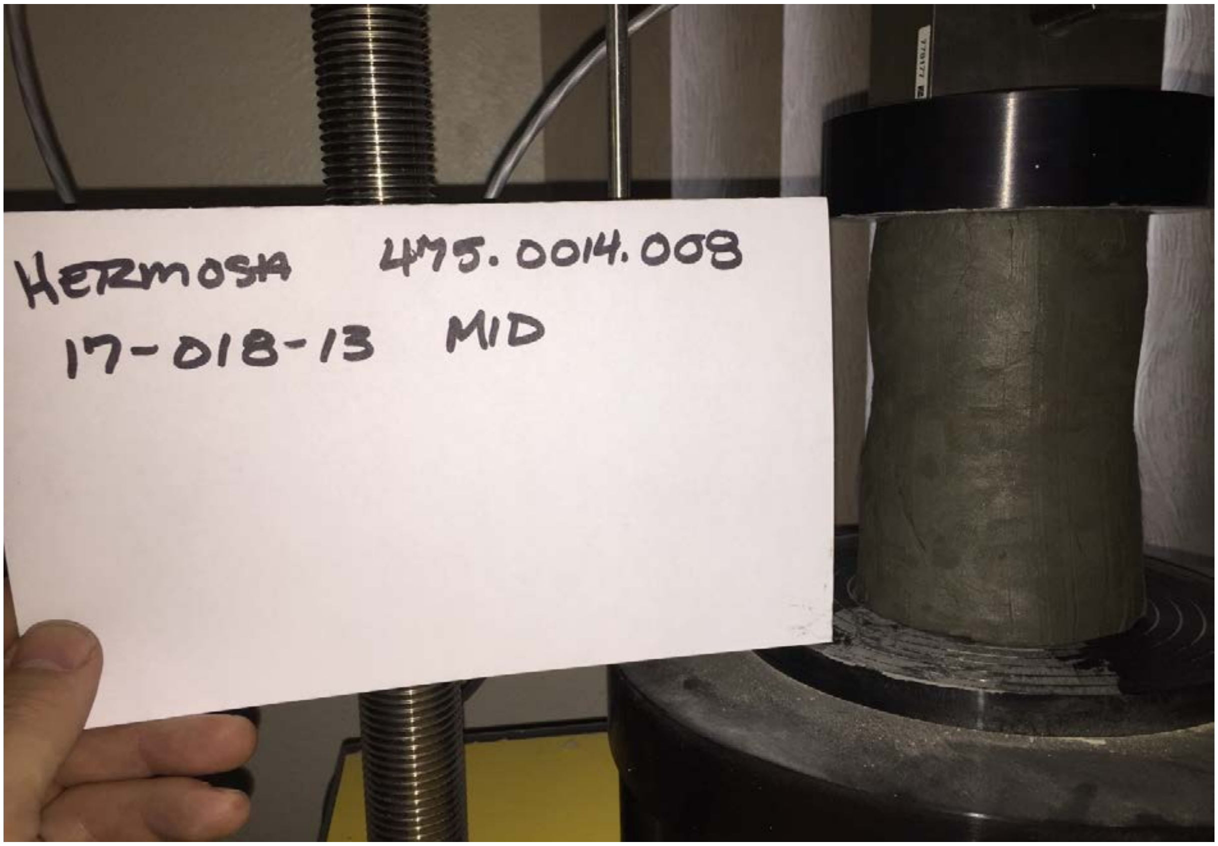


	Strain (%)	Stress (psi)
Peak Point	**18.0**	**5.8**

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

NewFields



Post Failure Photo

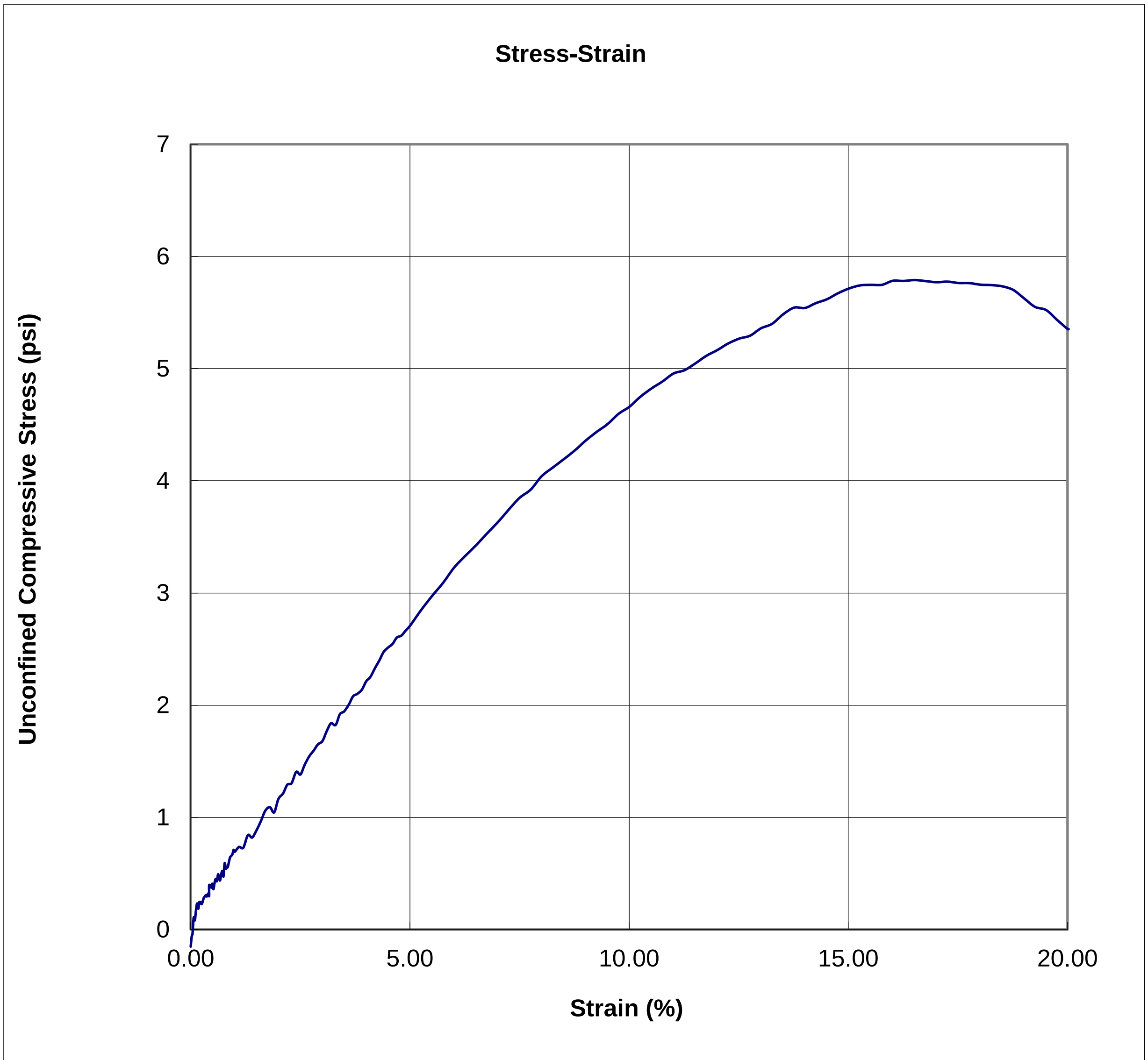
Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	3:37:14 PM
Boring:	BH-02	Sample:	SH-05
Specimen:	17-018-13 MID	Depth (ft):	26.5
Diameter (inch):	2.868	Height (inch):	6.592

Water Content in % Dry Wt.		
at 105^o C (215^o F)	41.7	%
Unit Weight Wet	118.4	PCF
Unit Weight Dry	83.6	PCF

 3/6/2017

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

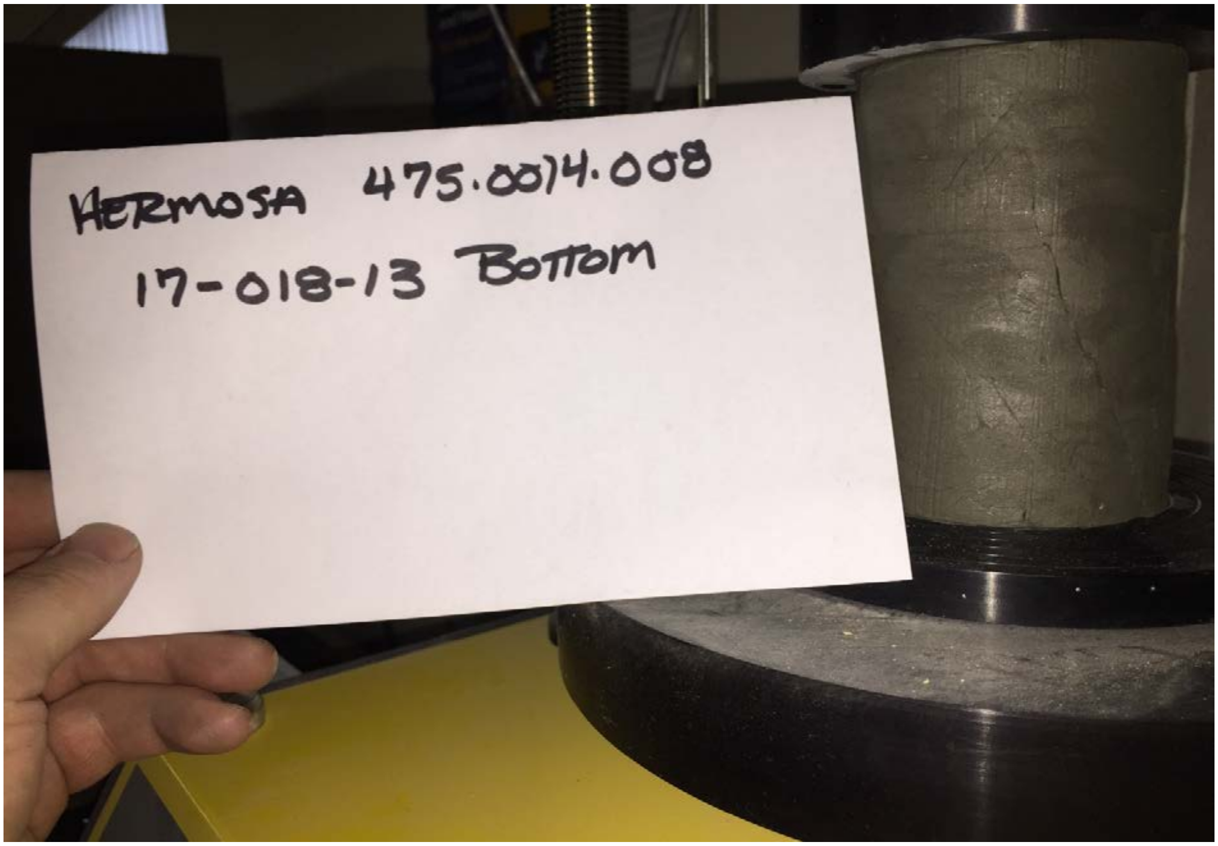
(ASTM D2166-06)



	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



Post Failure Photo

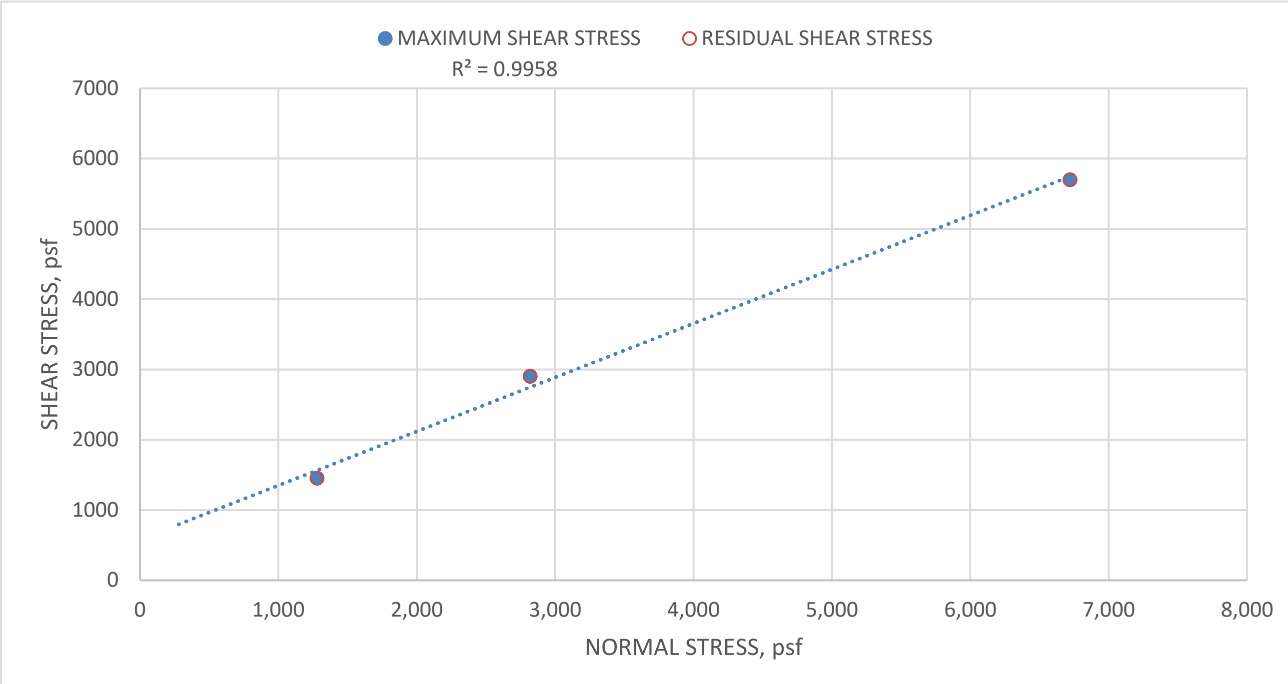
Client:	Arizona Minerals Inc		
Project:	Hermosa		
Project No.:	475.0014.008		
Date:	3/3/2017	Time:	4:17:47 PM
Boring:	BH-02	Sample:	SH-05
Specimen:	17-018-13 BOT	Depth (ft):	10.0
Diameter (inch):	2.835	Height (inch):	6.062

Water Content in % Dry Wt.	
at 105° C (215° F)	40.0 %
Unit Weight Wet	121.7 PCF
Unit Weight Dry	87.0 PCF

 3/6/2017

NewFields

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080/3080M-11



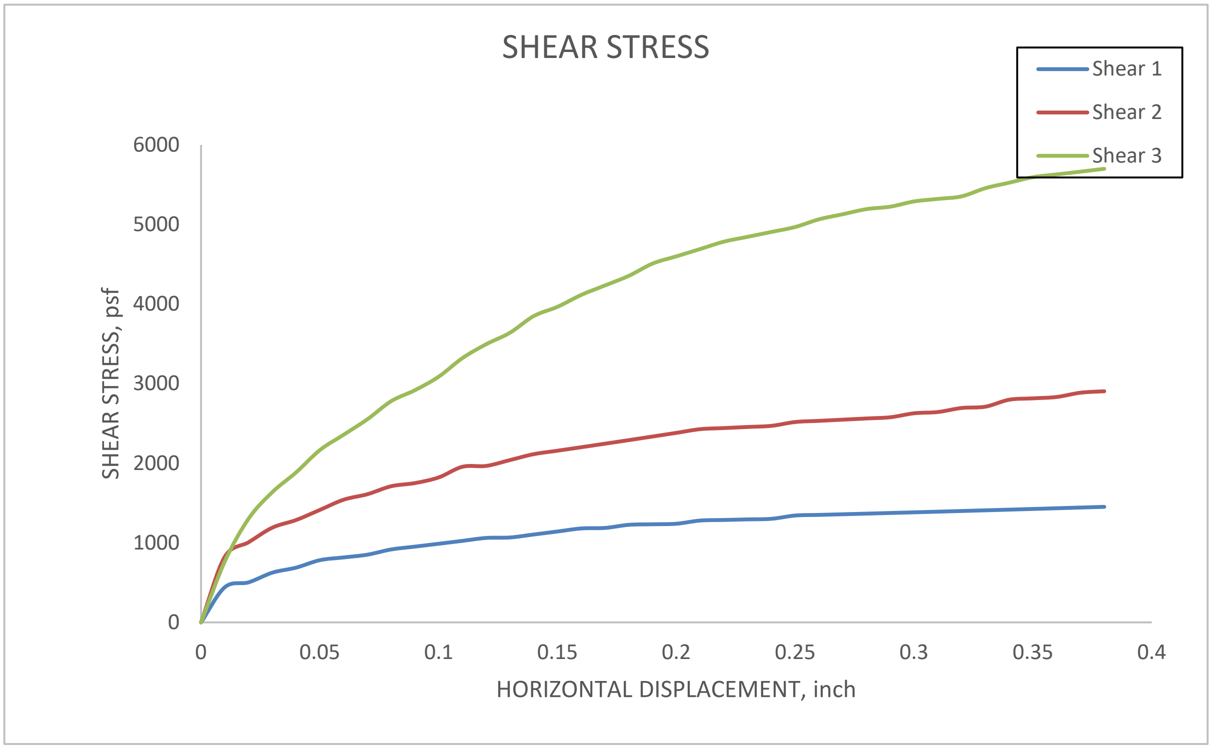
	FRICTION ANGLE		COHESION		SHEAR 1	SHEAR 2	SHEAR 3
					NORMAL STRESS, psf	NORMAL STRESS, psf	NORMAL STRESS, psf
AT MAXIMUM SHEAR STRESS	31.8	deg	0	psf			
AT RESIDUAL SHEAR STRESS[3]	31.8	deg	0	psf	1280	2820	6720

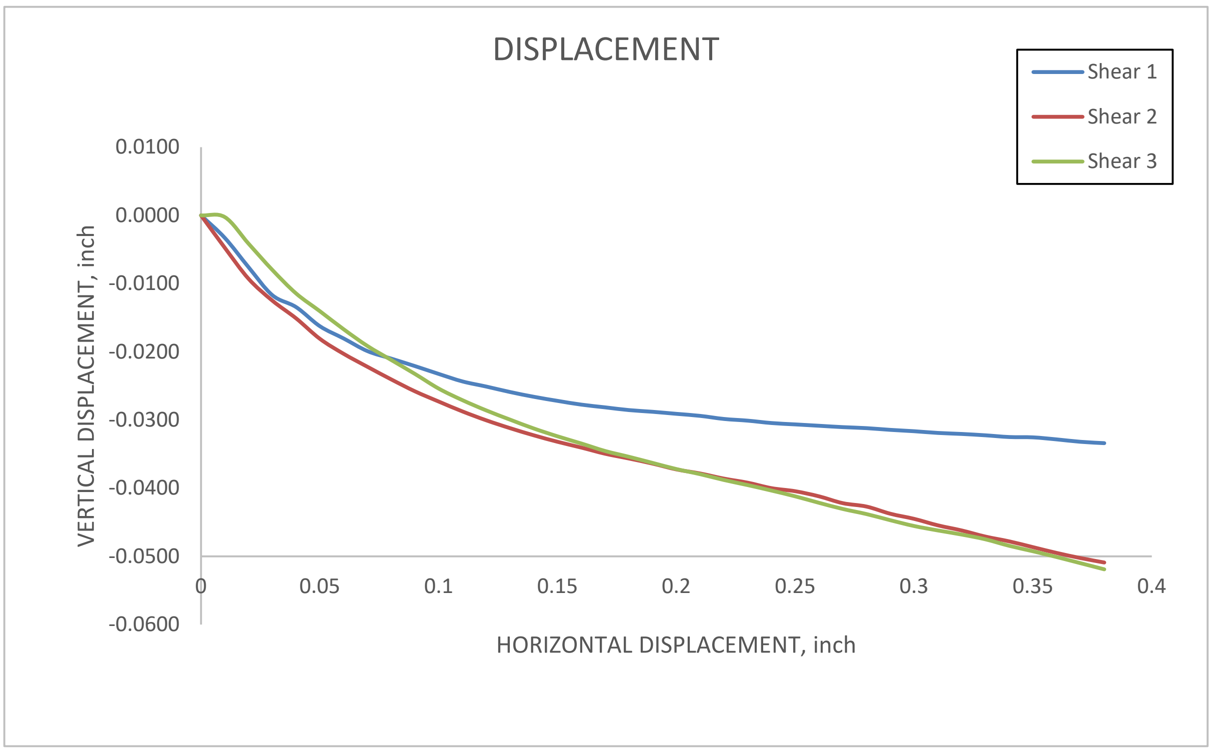
			SHEAR 1	SHEAR 2	SHEAR 3
INITIAL AREA, sq.in.	4.91	REMOLDED MOISTURE, %	7%	7%	7%
SG ASSUMED	2.65	REMOLDED DRY DENSITY, pcf	93.5	98.3	99.1
SG TESTED[1]	N/R	REMOLDED SATURATION, %	27%	30%	31%
LIQUID LIMIT	NP	REMOLDED VOID RATIO[2]	0.659	0.577	0.566
PLASTIC LIMIT	NP	FINAL MOISTURE, %	28%	28%	27%
PLASTICITY INDEX	NP	FINAL SATURATION, %	100%	100%	100%
SAMPLE TYPE	Bulk	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	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		

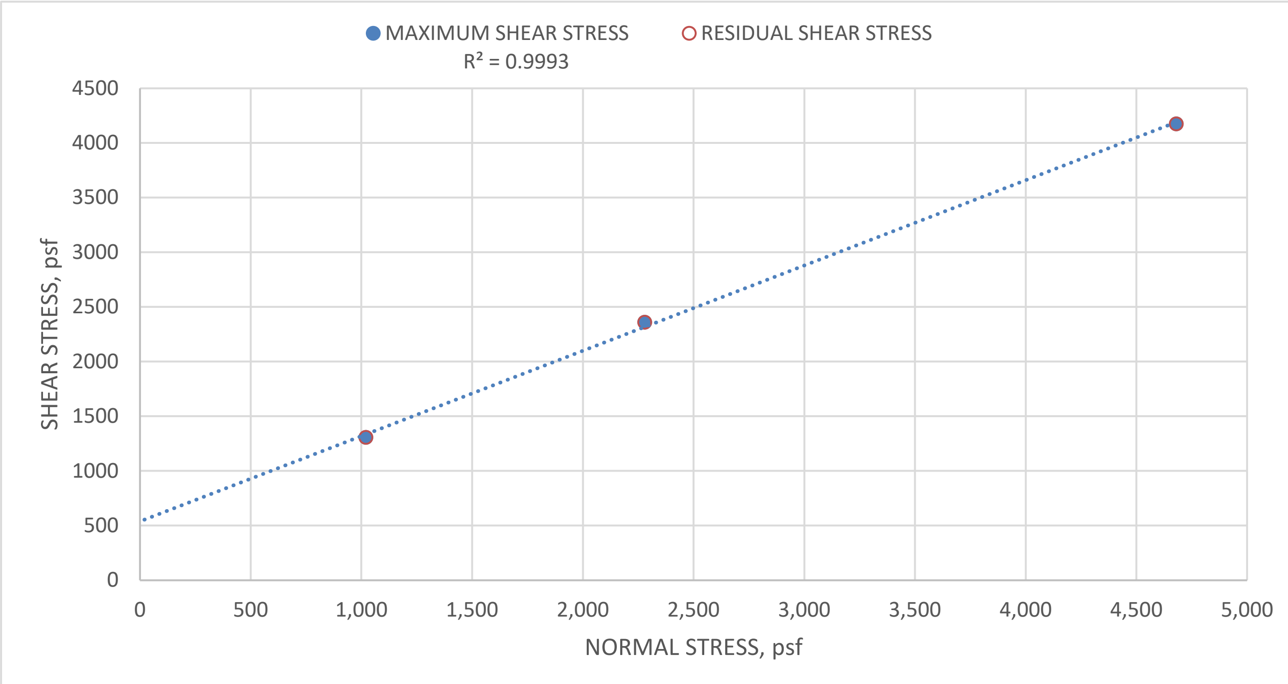




PROJECT NAME:	Hermosa Underground Project	BORING NO.:	TP-33
LOCATION:	N/R	SAMPLE NO.:	17-019-23
JOB NO.:	475.0014.008	DEPTH, feet:	1'-20.5'
DATE:	2/20/2017		

NewFields

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS
ASTM D3080/3080M-11



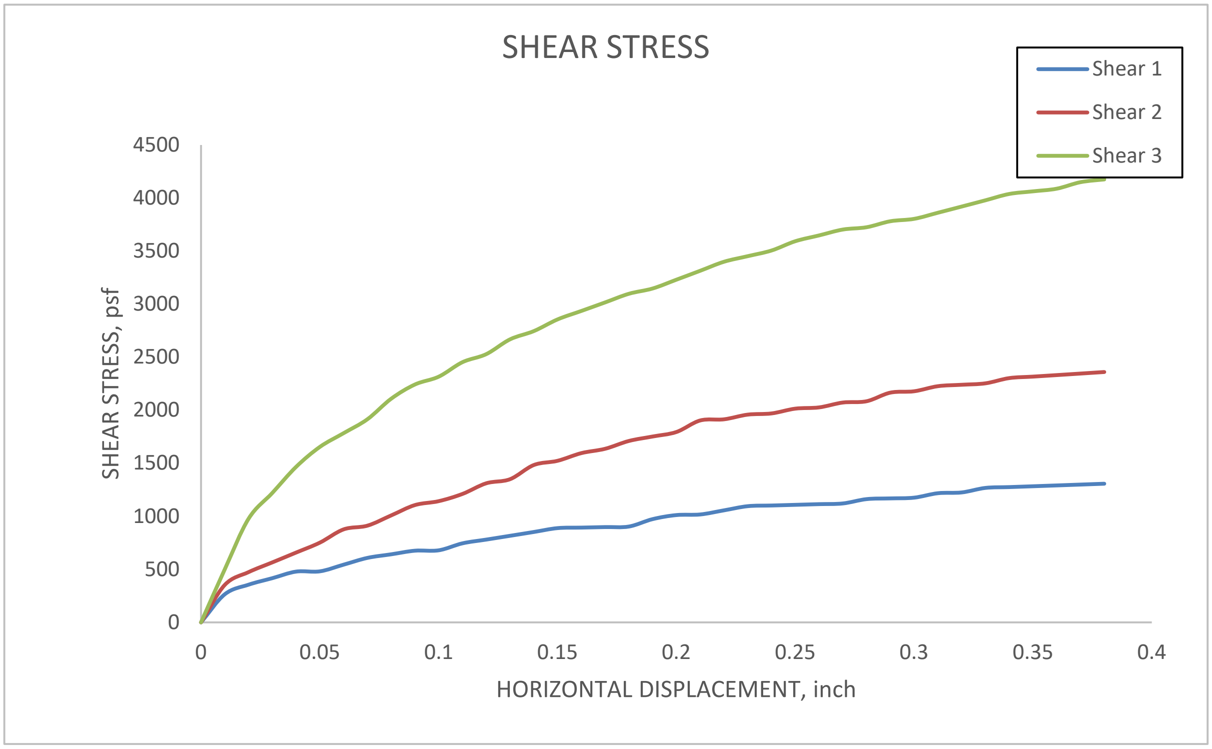
	FRICTION ANGLE		COHESION		SHEAR 1	SHEAR 2	SHEAR 3
AT MAXIMUM SHEAR STRESS	32.2	deg	0	psf	NORMAL STRESS, psf	NORMAL STRESS, psf	NORMAL STRESS, psf
AT RESIDUAL SHEAR STRESS[3]	32.2	deg	0	psf	1020	2280	4680

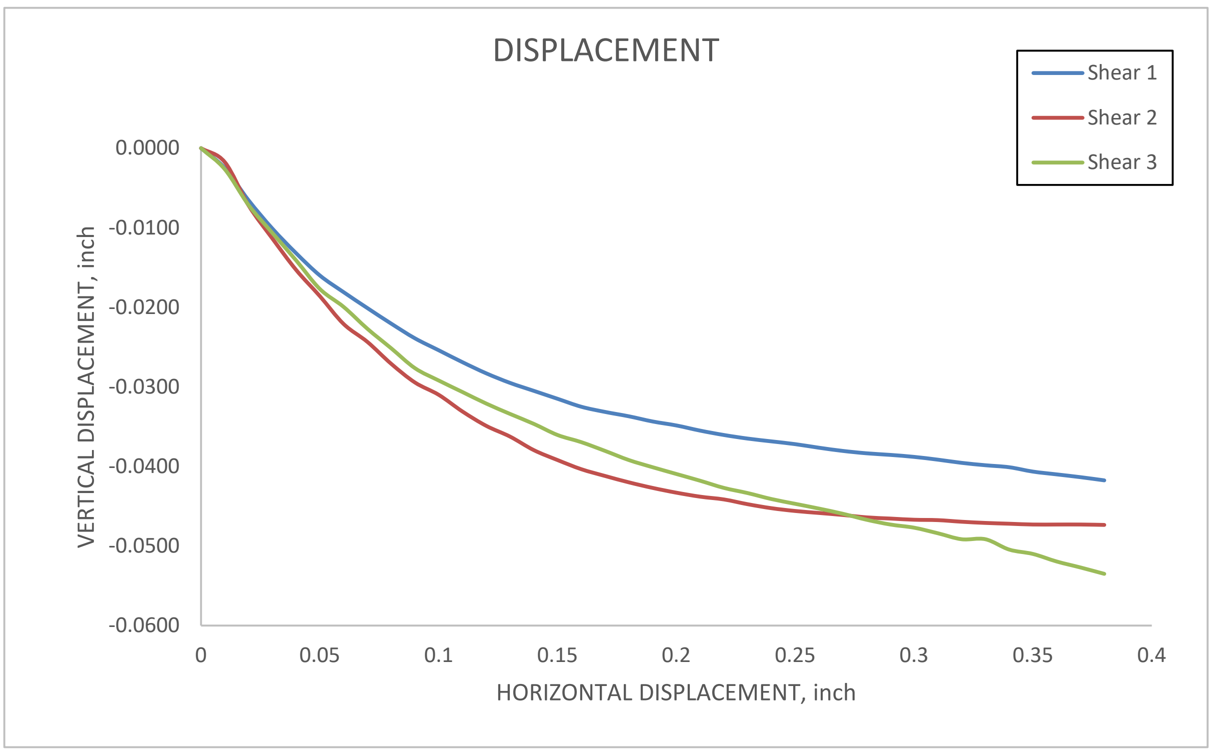
			SHEAR 1	SHEAR 2	SHEAR 3
INITIAL AREA, sq.in.	4.91	REMOLDED MOISTURE, %	8%	8%	8%
SG ASSUMED	2.65	REMOLDED DRY DENSITY, pcf	94.3	95.4	97.9
SG TESTED[1]	N/R	REMOLDED SATURATION, %	36%	37%	40%
LIQUID LIMIT	N/R	REMOLDED VOID RATIO[2]	0.618	0.599	0.558
PLASTIC LIMIT	N/R	FINAL MOISTURE, %	25%	25%	20%
PLASTICITY 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]

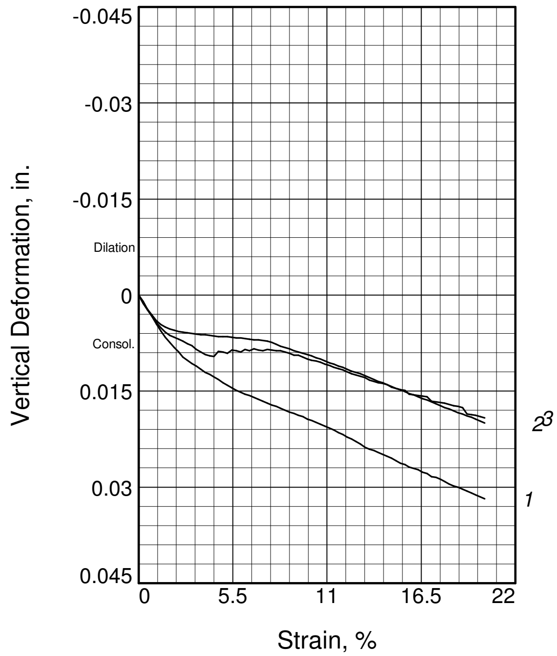
Note:
[1]N/R = Not reported
[2]Remolded sample inundated and consolidated at 100psf
[3]Residual shear stress obtained at 15% horizontal strain
[4] Direct shear testing performed on material passing #4 sieve only
[5] Visual Classification only. ASTM 2488

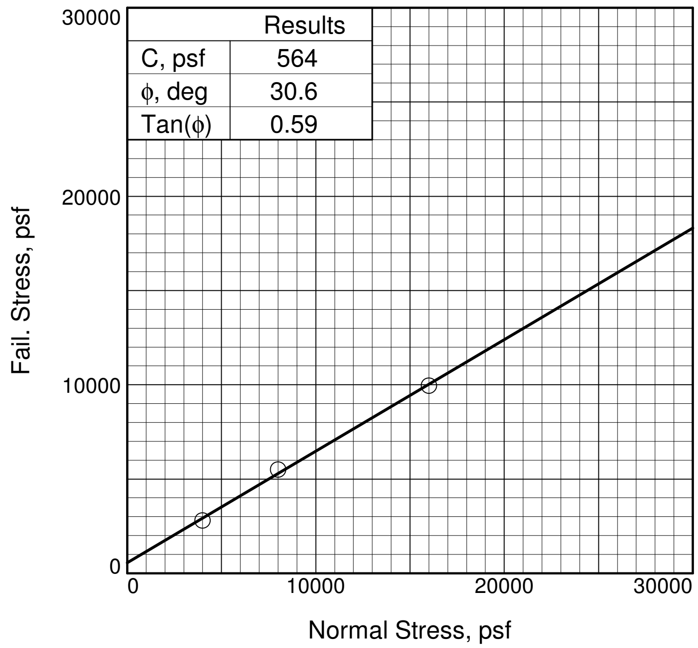
PROJECT NAME:	Hermosa Underground Project	BORING NO.:	TP-38
LOCATION:	N/R	SAMPLE NO.:	17-019-24
JOB NO.:	475.0014.008	DEPTH, feet:	0-7'
DATE:	2/21/2017		

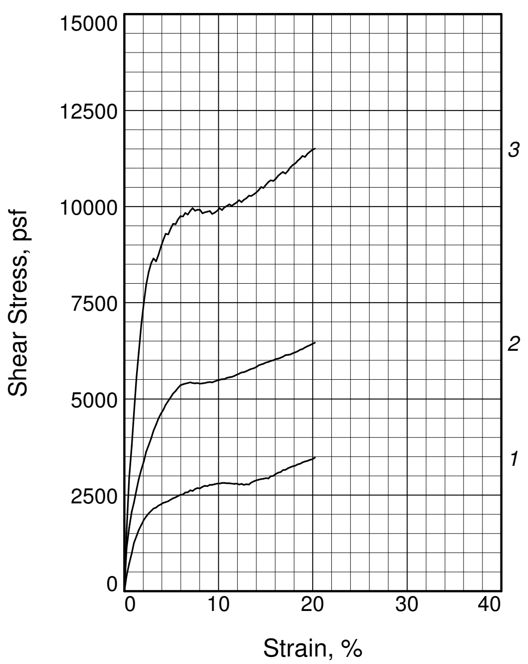




PROJECT NAME:	Hermosa Underground Project	BORING NO.:	TP-38
LOCATION:	N/R	SAMPLE NO.:	17-019-24
JOB NO.:	475.0014.008	DEPTH, feet:	0-7'
DATE:	2/21/2017		







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

Cursory interpretations provided require review by a professional engineer. Knight Piesold accepts no responsibility in subsequent analyses.

Tested By: EAG **Checked By:** JDB

DIRECT SHEAR TEST

4/10/2017

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

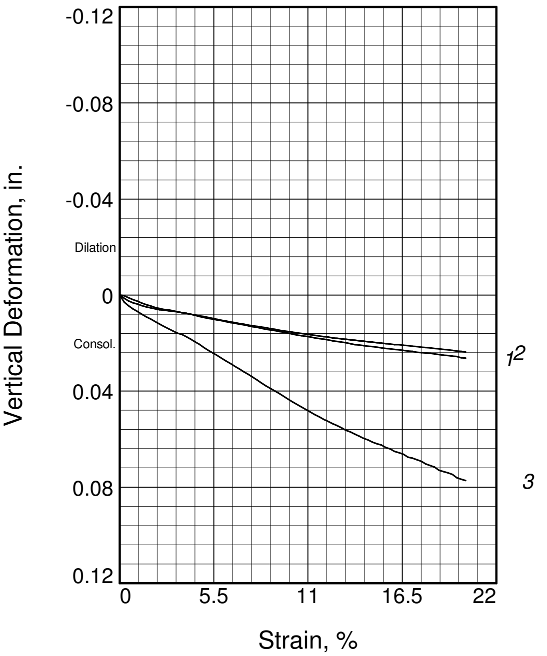
Test Readings for Specimen No. 3

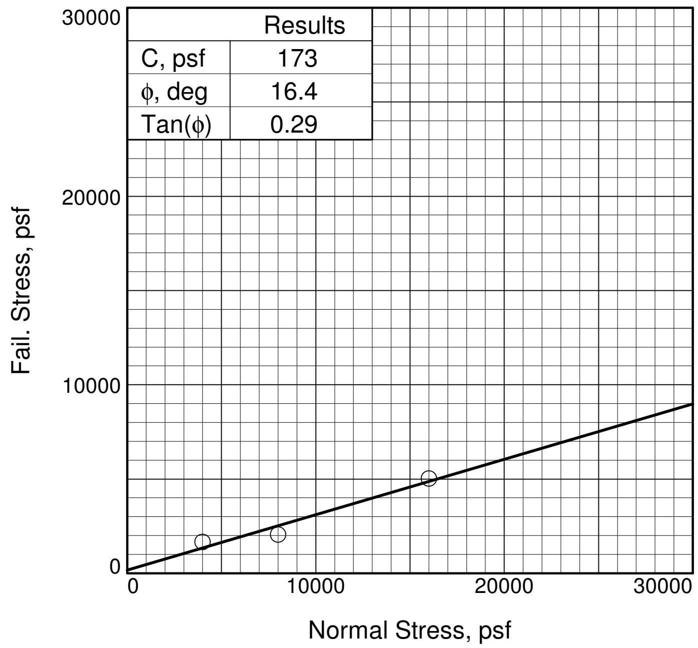
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
18	0.0900	3.6021	177.2	4.7	9274	-0.0092
19	0.0950	3.6508	179.6	4.9	9432	-0.0093
20	0.1000	3.6833	181.2	5.2	9550	-0.0095
21	0.1050	3.6671	180.4	5.4	9541	-0.0090
22	0.1100	3.6996	182.0	5.7	9660	-0.0091
23	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

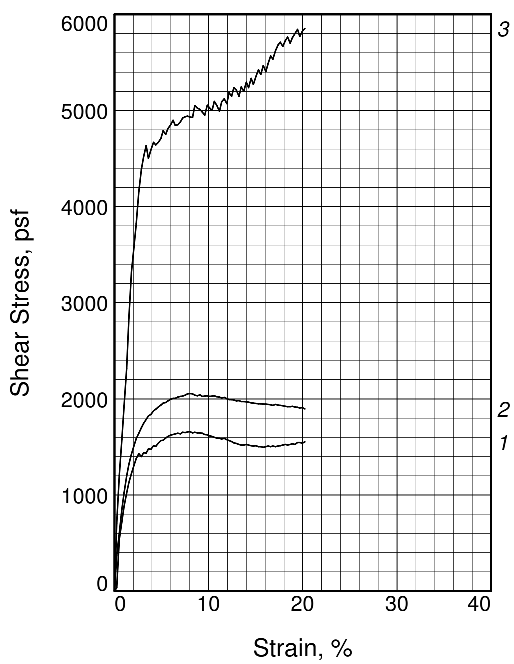
Test Readings for Specimen No. 3

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

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, %	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

DIRECT SHEAR TEST

4/13/2017

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

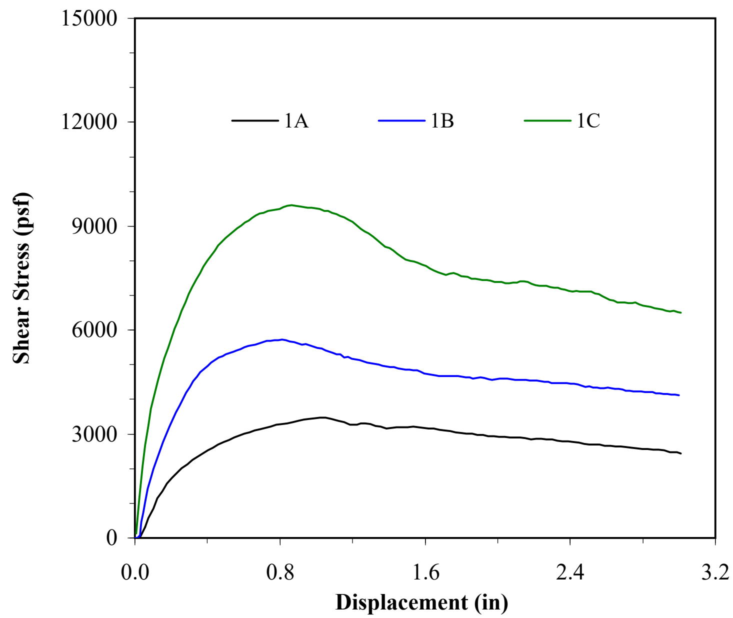
Test Readings for Specimen No. 3

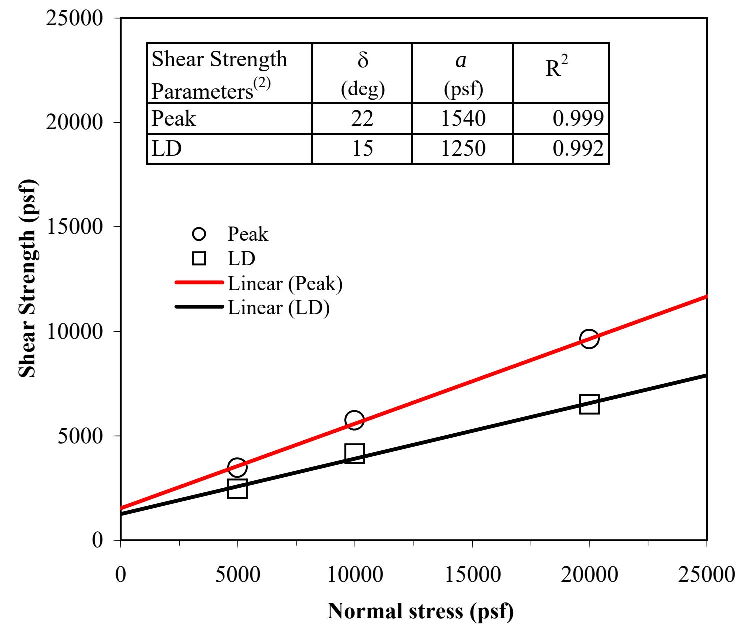
No.	Horizontal Def. Dial in.	Load Dial	Load lbs.	Strain %	Shear Stress psf	Vertical Def. Dial in.
65	0.3250	1.7980	88.5	16.8	5535	-0.0680
66	0.3300	1.8183	89.5	17.1	5621	-0.0685
67	0.3350	1.8305	90.1	17.4	5682	-0.0691
68	0.3400	1.8325	90.2	17.6	5713	-0.0698
69	0.3450	1.8102	89.1	17.9	5667	-0.0709
70	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.

DATE OF REPORT:	4/9/2017
FIGURE NO.	1
PROJECT NO.	SGI14024
DOCUMENT NO.	
FILE NO.	

SGI TESTING SERVICES, LLC

NewFields

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%**

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 G

APPENDIX G.1- TECHNICAL SPECIFICATIONS

APPENDIX G.2-CONSTRUCTION MATERIAL PROPERTIES

APPENDIX G.1

Technical Specifications

TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TECHNICAL SPECIFICATIONS

Prepared for:

Arizona Minerals Inc.
3845 North Business Center Drive, Suite 115
Tucson, AZ 85705

Prepared by:

NewFields

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

NewFields Job No. 475.0014.008
May 2017

Registered Professional Engineer (Civil)
CERTIFICATE NO.
63431
CRAIG M.
THOMPSON
Date Signed 5/24/17
ARIZONA, U.S.A.
EXPIRES 3/31/20

NewFields	CLIENT ARIZONA MINERALS INC.					PROJECT NO 475.0014.008
PROJECT TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE						
TITLE TECHNICAL SPECIFICATIONS FOR CONCRETE MATERIALS AND CONSTRUCTION						**SPECIFICATION NO.** 0014_SPT_CO
			APPROVALS			
REV	**DATE**	**PAGES**	**AUTHOR**	**REVIEW**	**CLIENT**	**REMARKS**
0	04/26/17	16	CMT	RMS		Issued for VRP
1	05/18/17	16	CMT	RMS		Issued for APP

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1. GENERAL

1.1. Scope

This specification defines the requirements for concrete materials and methods of construction for cast-in place concrete in the field, installation and quality control associated with the Arizona Minerals Inc. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage project.

Any alternatives or exceptions to this specification shall be submitted in writing to Arizona Minerals Inc. or its designated representative with the bid. The **Engineer** may modify these specifications based on the installation recommendations of the approved manufacturer.

The basis of this specification is ACI 301-10, "Specification for Structural Concrete." It is the intent of this specification to conform to the requirements of this document as a minimum standard.

The construction as it pertains to the Underdrain Collection Pond shall not be considered complete until the Arizona Department of Water Resource Director has approved the construction in writing. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** hired by the **Owner** to provide third party 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 Construction" Drawings for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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 the location 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.
- "The Standard" is ACI 301-10 "Specification for Structural Concrete."

1.3. Reviews

The **Contractor** shall, at the start and during the course of work where appropriate, meet with the **Engineer** and **Third Party Testing Contractor** for the review of the following:

- Proposed equipment and methods for storing constitutive components, mixing, and conveying concrete. The **Contractor** shall provide documentation that the concrete supplier meets industry certification.
- **Contractor's** Quality Control Program. The concrete supplier shall implement a Quality Control Plan to ensure that the **Owner's** and **Engineer's** performance requirements will be met.
- Inspection and testing of cement, aggregate, water, admixtures, reinforcement and storage of these materials.
- Proposed form material, form ties, and form release materials. The **Contractor** shall provide calculations for all concrete formwork and shoring, sealed by a Professional **Engineer** licensed to practice in Arizona for all pours in excess of 50 cubic yards.
- Concrete mix designs with regard to strength, performance, shrinkage, porosity, durability and suitability for project requirements. The concrete supplier shall submit documentation

to the satisfaction of the **Owner** demonstrating that the proposed mix design(s) will achieve the required strength, durability, and performance requirements.

- Periodical inspection of the mixing plant.
- Prior to the erection of formwork, or the placement of reinforcement, or concrete, the:
  - Proposed methods of placing concrete.
  - Proposed methods and materials for supporting and securing reinforcement items to be cast-in and formwork including details of the reinforcement chairs and spacers.
  - Proposed details and positions of construction and crack control joints.
  - Sampling and testing of concrete and inspection of concrete placement procedures.
  - Preparation of existing concrete for bonding to new concrete.
  - Proposed curing methods, stripping times and hot and cold weather protection, and
  - Concreting procedures.
- Immediately prior to concrete placement:
  - The inspection by the **Engineer** of formwork, reinforcement, cast-in items, and preparation of existing concrete. Inspection by the **Engineer** shall be for conformance with the project documents, but not for structural strength and stability, which is the sole responsibility of the **Contractor**.

1.4. Reference Standards and Publications

Only the major reference publications are listed below. The complete list shall include all the referenced documents included in the referenced publications below. The **Contractor** shall have a copy of the publications highlighted in bold onsite and provide access to the **Engineer** to the publications.

IBC 2012	(Second Printing): International Building Code.
ACI 301-10:	**"The Standard" Specifications for Structural Concrete. Methods of Test and Standard Practices for Concrete.**
ACI 318-11:	Building Code Requirements for Structural Concrete.
ACI 609:	Consolidation of Concrete.
ACI SP-4:	Formwork for Concrete.
ASTM A615 / A615M-046:	Standard Specification for Deformed and Carbon Steel Bars for Concrete Reinforcement.
ASTM C33-03:	**Standard Specification for Concrete Aggregates.**
ASTM C150-04a:	Standard Specification for Portland Cement.
ASTM C260-01:	Standard Specification for Air-Entraining Admixtures for Concrete.
ASTM C494/C494-04:	Standard Specification for Chemical Admixtures for Concrete.

ASTM C1017/C1017M-03:	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
ANSI/AWS D1-4:	Structural Welding Code – Reinforcing Steel.
ACI SP66 (2004):	ACI Detailing Manual.

1.5. Submittals

All proposals and submissions by the **Contractor** and all responses by the **Engineer** shall be in writing. Acceptance of the **Contractor's** proposals and submissions by the **Engineer** shall not relieve the **Contractor** of his responsibility for the work as defined by the contract.

Contractor submissions to the **Engineer** shall include qualifying documentation for all materials and products including:

- Proposed concrete mix proportions including supporting trial mix results and certification that the mix proportions will produce concrete of the specified quality and yield; anticipated slumps for each proposed mix before and after addition of superplasticizer.
- Documentation that the plant, equipment, and all materials to be used in the concrete comply with the requirements of ACI 301.
- Mill certificates for reinforcing steel.
- Reinforcing bar detail lists and placing drawings shall be submitted to the **Engineer** for his records.
- Mill certificates for cement and supplementary cementing materials.
- Description of the proposed concrete batching plant and conveying systems, including capacity, admixture provision batching system, cold weather capabilities, hot weather capabilities, quality control procedures.
- Note that submissions to the **Engineer** and reviews of submissions by the **Engineer** shall be completed prior to placing any concrete or doing any concrete work. The **Contractor** shall schedule the submissions to allow for at least two weeks for review by the **Engineer**.

The **Contractor** may petition the **Engineer** for the acceptance of:

- **Supplementary Cementing Materials** (fly ash, silica fume and granulated blast furnace slag). The petition shall include:
  - Identification of the source, information on its service record in concrete subjected to similar service, and test data showing conformance with Cementitious Materials Compendium including uniformity requirements.
  - Proposed dosage and timing of addition for each class of concrete as applicable.
- **Water-Reducing Admixture; Water-Reducing High Range Admixture** (Superplasticizer); **Accelerating Admixtures**. The petition shall identify the:

- Manufacturer.
- Proposed dosage, and timing of addition for each class of concrete, as applicable.
- Type of admixture (retarding, accelerating, normal set).

1.6. Quality Assurance

Records shall be kept by the **Contractor** for all submissions and for:

- Temperature of the plastic concrete and strength tests in accordance with sections 4.2.2.6 and 4.2.3 of the "The Standard". (See Section 1.2 of this specification for definition of "The Standard.")
- A certificate of accuracy of the scales at the batch plant.
- Air and concrete temperature at the time of concrete placement.
- Delivery tickets: The **Contractor** shall ensure that the records indicate where the delivered concrete was used so that remedial action can be taken if it is subsequently determined that the concrete is unsuitable for use.
- Temperature records, including methods used for the placement and curing of concrete when low temperature as specified in Section 5.3.2.1.b (Refers back to 4.2.2.6), or high temperature as specified in Section 5.3.2.1.C of "The Standard" are exceeded.

2. GENERAL

Table 1: Structural Class of Concrete

CLASS #	Structural Class Of Concrete:	Max. Size Aggregate (inches)	Total Ent. Air + 1%	28 Day Compressive Strength (psi)	Admixtures Required	Max. Water: Cement	Min-Max. slump (inches)
1.	Slabs, Beams, Columns and Walls	¾	6	4000	AEA	0.45	3-5
2.	Waterproof, Aggressive Exposure Hydraulic Structures	¾	6	4000	AEA &WRA	0.4	3-5

Notes:

1. **Concrete mix designs shall be based on trial mixes prepared by the Contractor and submitted to the Engineer for review. The trials shall use a minimum of three cement factors separated by 50 lbs/yd3 with air content approximating the maximum values in.**
   - **Reduce air to 3% for slabs to be steel troweled, except exterior slabs.**
   - **All cement shall be Type II**
   - **AEA = Air entraining agent. WRA = water reducing agent.**
   - **Water: Cement = Water -to- cementitious materials ratio.**
   - **Fine and coarse aggregate to be Normal -density aggregate UNO on drawings.**
2. **When concrete is to be placed by pump, properties shall be measured at discharge from the hose. The sand content of the pump mix, as a ratio by weight of total aggregate, shall not be increased more than 3% from the conventionally placed concrete.**
3. **Water reducing high range admixtures (superplasticizers) may be used to obtain higher slumps for workability subject to the Engineer's acceptance.**

2.1. Materials

2.1.1. Cements and Supplementary Cementing

Portland cement shall be Type II unless otherwise shown on the Drawings.

2.1.2. Aggregates

The requirements in ASTM C33 shall be modified as per Table 2 below.

Table 2: Grading Limits for Fine Aggregate (FA)

Total Passing Sieve: Percentage by Mass	US Standard Sieve Size No. /(mm)
100	3/8-in. (9.5mm)
95-100	4 (4.75mm)
80-100	8 (2.36mm)
50-85	16 (1.18mm)
25-60	30 (0.60mm)
5-30	50 (0.30mm)
0-10	100 (0.15mm)
0-3[A,B]	200 (0.075mm)

A For concrete not subject to abrasion, the limit for material finer than the No. 200 sieve (0.075mm) shall be 5.0% maximum.

B For manufactured fine aggregate if the material finer than the No. 200 sieve (0.075mm) consists of dust of fracture, essentially free of clay or shale, this limit shall be 5.0% maximum for concrete subject to abrasion, and 7.0% maximum for concrete not subject to abrasion.

The fineness modulus of the sand shall not be less than 2.3 or more than 3.1.

The grading limits for coarse aggregate vary depending on the maximum nominal particle size used in the mix. The grading requirements for coarse aggregates are shown in ASTM C33.

2.2. Admixtures

Unless otherwise specified herein or directed by the **Engineer**, the following admixtures shall be employed:

- An air-entraining agent, conforming to the requirements of ASTM C260. Air content between four to six percent will be required at the point of placement.
- A water-reducing agent conforming to ASTM C494.

Water-reducing admixtures and water-reducing high range admixtures (superplasticizers) shall meet the requirements of ASTM C494/494M-04, Standard Specification for Chemical Admixtures for Concrete.

Calcium chloride shall not be used. Admixtures containing chlorides may be used providing the total chloride ion content in the concrete does not exceed 0.1% by weight of cement.

2.3. Concrete Properties

Concrete strengths and maximum aggregate size shall be as per Tables 1 and 2.

Concrete shall be normal density concrete unless noted otherwise on the Drawings.

2.4. Quality Control

The evaluation of concrete quality shall be the responsibility of the **Contractor** and shall be carried out as outlined in Section 1.6 of “The Standard".

The **Contractor** shall provide a coordinator who shall be present at all times during concrete work and who shall be thoroughly trained and experienced in placing the types of concrete specified and who shall direct all the work performed under this Technical Specification. The coordinator shall have the authority to request that mixing trucks return to the batch plant if delivery times are exceeded or to interrupt work if any other quality issues are not being met. Per ASTM C94 Section 12.7: Discharge of the concrete shall be completed within 1.5 hours after the introduction of the mixing water to the cement. This limitation may be waived by the **Engineer**. Refer also to ACI 301-10 Section 4.1.2.10.

The **Third Party Testing Contractor** may elect to undertake independent testing but this shall not relieve the **Contractor's** responsibility to perform testing as described below.

Test results shall be reviewed by the **Engineer** within 5 working days of the testing.

A strength test shall comprise the testing of four test cylinders. A minimum of four test cylinders shall be taken for each day of placing, and there shall be at least one test for each 100 cubic yards of concrete and for each class of concrete.

One of the cylinders shall be tested at 7 days, two at 28 days and one at 56 days (if the 28-day break does not meet strength). The test results shall be the average of the two 28-day cylinders or if required the 56-day cylinder.

The concrete shall be considered to have met strength requirements if the average of every set of three consecutive strength tests for each class of concrete exceeds the specified strength and no individual strength test is more than 500 psi below the specified strength. If these strength requirements are not met, the **Engineer** will require adjustments to the mix proportions and additional testing as permitted by Section 1.6 of "The Standard".

Concrete failing to meet the specifications requirements may be required by the **Engineer** to be removed and replaced with concrete meeting the specification requirements. Such removal and replacement shall be at the **Contractor's** expense.

Accelerated strength tests shall not be used as an alternative to the standard cylinder test.

3. PRODUCTION AND DELIVERY

When concrete is mixed in truck mixers, a complete mixing cycle of 70 - 100 revolutions at mixing speed shall be completed before the truck leaves the plant.

Requirements of Section 4.3.2.1 of "The Standard" shall control the **Contractor's** additions of water to concrete (except super plasticized concrete) including:

The specified water-to-cement ratio shall not be exceeded.

No more than 90 minutes has elapsed from the time of batching to the start of discharge.

Addition of water is only at the start of discharge (i.e., not more than 10% of the concrete has been discharged).

A 30 revolution mixing cycle shall follow water additions.

Water may not be added more than once to a load.

The amount of water added and by whose authority shall be recorded on the delivery ticket.

4. FORMWORK, REINFORCEMENT, EMBEDDED METAL AND PRESTRESSING

4.1. Reinforcement

All reinforcement shall conform to ASTM A615/A615M-14.

All steel reinforcement shall be epoxy coated.

Reinforcement shall be provided in accordance with the requirements of ACI 318-5.

4.2. Hardware and Miscellaneous Materials

Dissimilar metals shall be electrically separated when embedded in concrete.

Aluminum including aluminum conduits shall not be embedded in concrete.

4.3. Storage of Reinforcement

Reinforcement shall be protected from corrosion. Special precautions shall be taken for winter conditions to ensure that reinforcement can be identified.

4.4. Formwork

The **Contractor** who places the concrete (the **Concrete Contractor**) is responsible for the adequacy of all formwork and falsework including metal deck formwork, and satisfying all codes and regulations governing formwork and falsework.

The design, fabrication, erection, and use of concrete formwork shall conform to the requirements of ACI SP-4.

Falsework for suspended concrete elements shall conform to ACI SP-4.

Unless otherwise shown on the drawings, forms shall be constructed to produce the final concrete Surface Class in the following locations:

Surface Class B

Normal Exposed Concrete – All interior and exterior columns, walls, beams, and underside of slabs.

Form Material: Form ply.

Resulting Surface: Free from honeycombing, large bug-holes or voids greater than 1/2" across and/or depth, fins or misalignments greater than 1/8".

Construction: Maximum deflection 1/270 of span; patching of form panels permitted.

Patching: Refer to Section 5.3.7 of “The Standard".

Surface Class C

All concrete not exposed to view such as buried foundations and non-exposed faces of retaining walls.

Form Material: Shiplap or form ply.

Resulting Surface: No specific requirements other than freedom from major voids or honeycomb. Minimum dimensions and reinforcement cover to be maintained.

Patching: Not normally required except in areas where reinforcement is exposed. Refer to Section 5.3.7 of “The Standard”.

For Surface Class B surfaces, exterior corners and edges exposed to view including horizontal edges of tank pads and curbs shall have 1" x 1" chamfers. Edges of slabs, curbs and pads shall be hand tooled.

All sharp corners for members composed of steel fiber-reinforced concrete shall have 1" x 1" chamfers or be rounded to a radius of 5/8".

4.4.1. Formwork Removal

Unless otherwise shown on the Drawings or advised by the **Engineer**, formwork must not be removed prior to the lapsed time after concrete placement (Minimum Stripping Time) according to the Table 3 below and as otherwise prescribed in the notes following the table.

Minimum stripping times are the lesser of Column A (Minimum Stripping Time) or Column B (Minimum Percentage of Specified 28 Day Strength).

Table 3: Stripping Time

	A Minimum Stripping Time (days):	B Minimum Percentage of Specified 28 Day Strength (%):
Foundation, pile caps, piers, grade walls, pedestals, columns, equipment bases less than 4 ft high	2	30
Foundation, pile caps, piers, grade walls, pedestals, columns, equipment bases greater than 4 ft high	4	60
Walls for liquid containment vessels	5	70
Edges of elevated slabs	2	30
Soffits of slabs without construction loads	7	70
Soffits of slabs with construction loads	14	85
Sides of beams and girders	7	70
Bottom of beams and girders without construction loads	14	85
Bottom of beams and girders with construction loads	21	90

Notes:
1. Minimum stripping time is the lesser of columns A or B, or as extended by Notes 2 through 5, below.
2. If retention of formwork is chosen as a means of curing, extend the stripping time to the required curing time. See Table 4 Minimum Cure Times.
3. If ambient temperatures are less than 50°F extend the stripping time to the satisfaction of the Engineer.
4. Stripping times "with construction loads" are based on superimposed construction loads equal to the load capacity of the member at the time that the loads are imposed, to a maximum equal to the design gravity temporary live load of the member. If the superimposed construction load is greater than this, extend the stripping time to the satisfaction of the Engineer. See Section 6 of this specification.
5. If more than 10% of supplementary cementitious material is incorporated in the mix, extend the stripping time to the satisfaction of the Engineer.

4.5. Fabrication and Placement of Reinforcement

Stirrups and ties of Grade 60 ksi material must meet the bending requirements of Grade 40 ksi steel.

Bar supports and side form spacers shall be non-conductive and shall be the type pre-approved by the **Engineer**.

Top reinforcement in slabs in process buildings subject to wash down (i.e. all floors with slopes) shall have a minimum cover of 2 3/8", unless otherwise shown on the drawings.

Reinforcement shall be securely tied at intersections with wire not less than 16 gage or clips. Slab reinforcement shall be carried on approved concrete pads or approved chairs providing support spacing of not more than 48". Top slab steel shall be carried on support bars of #5 minimum size supported not over 38" apart. Where temperature steel is used to support top slab steel and if temperature steel is 3/8" size, then supports shall not be over 35" apart.

Support bars or spacer bars placed directly on metal deck formwork shall be epoxy-coated or fiberglass or other non-metallic material.

Welding procedure for reinforcing bars is to be done in accordance with ANSI/AWS D1-4. Tack welding of reinforcing bars is not permitted. Reinforcing bars shall only be welded as shown on the drawings or as approved by the **Engineer** in writing.

4.6. Fabrication and Placement of Hardware and Other Embedded Items

Anchor bolts (rods) shall be placed to the tolerances listed in “The Standard". Templates should be used for placing anchor bolts for small equipment and tanks.

All other embedded metal such as door sills, beam support plates and trench angles, shall be set true within ± 1/8" of position shown on drawings.

5. PLACING, FINISHING AND CURING CONCRETE

5.1. Storage of Materials Used For Placing, Finishing, and Curing

Store so that materials are not affected by soil ground moisture.

5.2. Placing of Concrete

The **Contractor** shall notify the **Engineer** and **Third Party Testing Contractor** before placing any concrete. There shall be adequate notice such that the formwork, reinforcing and embedded metal placement can be reviewed. In no case, shall the notice be less than 24 hours. The **Contractor** shall verify all anchor bolts and embedded metal locations before placing concrete.

Concrete shall be deposited as closely as practical to its final position in horizontal or wedge-shaped layers not more than 18 inches deep. Lateral movement of the concrete by means of vibrators will not be permitted.

Concrete shall be dropped vertically, without lateral movement, into formwork without interference. Unconfined free fall shall be limited to 5 feet unless otherwise required or approved by the **Engineer**. If placement methods require free fall of more than 5 feet, the tremie method of placement will be required.

Proposed methods and equipment used for the concrete consolidation shall be in accordance with the report of ACI Committee 609 – “Consolidation of Concrete.”

5.2.1. Bonding Fresh Concrete to Rock or Hardened Concrete

Surfaces of hardened concrete shall be cleaned with high pressure jets or mechanical means to expose the coarse aggregate to a reveal of 1/4" and remove all laitance and loose material. Unless otherwise shown on drawings, bonding shall be accomplished by:

- Vertical Joints –Surface shall be dampened (but not saturated) immediately prior to placing fresh concrete.
- Horizontal Joints – For those horizontal joints in liquid-retaining structures or those specifically designated on the Drawings or by the **Engineer**, a 6" layer of special bonding mix shall be placed and be well vibrated to achieve maximum bond. The concrete to be used for this special bonding mix shall be the normal mix proportions with one-half the coarse aggregate removed and the slump increased to 5".
- For other horizontal joints, treat same as "Vertical Joints".

Where roughening of the rock or hardened concrete surface is specified, the surface shall be roughened to expose the coarse aggregate to a full amplitude of at least 1/4".

5.3. Joints

Joints shall be constructed and located as described on the Drawings. Whenever PVC waterstop is specified, it shall be wired to the reinforcing steel with all waterstop joints properly fused to provide a continuous seal.

5.4. Joint Filler

The joint filler shall be standard cork joint filler with an insoluble phenolic resin binder, conforming to ASTM Designation D 1752, Type 2.

All joints in the filler material shall be made tight so that mortar from fresh concrete will not seep through to the opposite concrete surface.

5.5. Joint Sealant

The **Contractor** shall supply and apply joint sealant complete with bond breakers and backup materials to expansion joints and elsewhere in concrete structures as shown on the Drawings or otherwise required by the **Engineer**.

Except as otherwise specified herein, surface bond breakers and backup materials shall be companion products of the joint sealant used for the work as recommended by the sealant manufacturer and approved by the **Engineer**.

5.6. Curing and Protection

All exposed concrete surfaces shall be cured as given in accordance with the requirements of Section 5.3.6 of “The Standard". Moist curing shall be used. Curing compounds are permitted for this exposure class of concrete if they are not environmentally damaging. In addition, surfaces which are to be; water-proofed, painted, coated, will receive a separate topping or grout, or is adjacent to a pour where good bond is required, shall be wet cured only (curing compounds are not permitted).

Curing may consist of formwork retained in place or an approved curing method. Approved methods are a, b, or c of Section 5.3.6.4 of "The Standard".

Unless otherwise shown on the drawings or advised by the **Engineer**, curing must be carried out for the lapsed time (Minimum Cure Times) according to the following table and otherwise prescribed in the notes below the table.

Minimum cure times are the lesser of Column A or Column B in Table 4.

Table 4: Minimum Cure Times

Element	A Cure Time (days):	B Time to Achieve Min. % of Specified Strength of:	C Method of Curing per Section 5.3.6 of “The Standard”
Foundations, pile caps, piers, grade walls, walls, pedestals, columns, equipment bases	7	70	Any
Top surfaces of slabs	7	70	As noted below or (3)

Notes:

1. The Contractor may establish the Minimum % of Specified Strength by testing field cure cylinders or by other non-destructive testing which is acceptable to the Engineer.

2. Cure times shown are based on minimum ambient temperatures of 50°F. For lower temperatures the Contractor shall extend the cure times to the satisfaction of the Engineer.

3. For accelerated strength concrete mixes cure times shall be the minimum defined in Table 4 above.

5.6.1. Curing of Slab Surfaces

Proper curing of slabs is essential and must be done as follows. Begin curing as soon as the plastic curing membrane can be applied without damage to the newly finished surface.

The concrete surface is to be wetted immediately after final finishing and covered with a 6 mil polyethylene membrane, clear or white, and secured in place with weights to prevent exposure of the concrete surface during the curing period. The membrane shall cover all exposed surfaces of the concrete.

Place the membrane flat, without wrinkles, to minimize mottled discoloration.

Edges shall be lapped 1-foot minimum and tape sealed.

Provide traffic protection to protect the concrete surface and the polyethylene curing membrane.

Leave the curing membrane undisturbed for a minimum of 7 days.

Maintain a film of water under the membrane and add water as required.

5.6.2. Hot Weather Protection

The plastic concrete temperature at time of placement shall not exceed temperatures in Section 5.3.6.5 of "The Standard". When the air temperature is expected to be 80°F or higher, suitable protection shall be provided as described in ACI 305R.

5.6.3. Cold Weather Protection

The minimum plastic concrete temperature at placement shall not be less than temperatures in Section 4.2.2.8 of "The Standard". When the air temperature is or is expected to fall lower than 41°F, suitable protection shall be provided as described in ACI 306R.

5.7. Finishing and Treatment of Slab Surfaces

The final floor finish shall be one of the following types:

- STEEL TROWEL: Dense hard surface obtained by multiple steel trowel passes.
- NON-SLIP SWIRL: Multiple steel trowel passes but with final pass of aluminum float.
- BROOM: Multiple steel trowel passes followed by brooming to the required texture.

Unless designated on the drawings, the following floor finishes shall be used in these areas:

- STEEL TROWEL: Control rooms, electrical rooms, dry process floors, warehouses, under FRP tanks.
- NON-SLIP SWIRL: All process floors that are rarely wetted with water.
- BROOM: Exterior concrete slabs with significant vehicular or people traffic, slabs in process areas that are frequently wetted or flooded or are subject to spillage of process materials, and under steel tanks.

5.8. Finishing of Formed Surfaces

Projecting imperfections shall be removed; depressed imperfections shall be patched by chipping to sharp margin and by filling with mortar. Patches exposed to view shall blend with surrounding surfaces. All patchwork shall be carried out immediately following the stripping of forms and while concrete is still green. Patches shall be properly installed and cured.

The required quality of formed surface shall be as designated in section 4.4 of this specification. The particular patching procedure required for each area shall be reviewed with the **Engineer** prior to starting.

6. CONSTRUCTION LOADS

The **Contractor** shall take precautions to ensure concrete is not damaged from construction loads prior to reaching its specified strength. The **Contractor** shall ensure concrete is not loaded in excess of its design capacity after reaching its specified compressive strength. The **Contractor** shall review plans for placing construction loads with the **Engineer**.

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PROJECT	TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE					
TITLE	TECHNICAL SPECIFICATIONS FOR CORRUGATED POLYETHYLENE PIPE MATERIALS AND CONSTRUCTION					**SPECIFICATION NO.** 0014_SPT_CPeP
			APPROVALS			
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1. GENERAL

This specification defines the requirements for Corrugated Polyethylene Pipe (CPeP) materials, installation, and quality control associated with the Arizona Minerals Inc. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage 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**.

Construction as it pertains to the Underdrain Collection Pond CPeP will not be considered complete until the ADWR Director has approved the construction in writing. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** hired by the **Owner** to provide third party 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 Construction" Drawings for Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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 D 3350. 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 DR (Dimensional Ratio) 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. 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.

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1. GENERAL

This specification defines the requirements for the earthwork construction activities for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project currently being contemplated by Arizona Minerals Inc. (**Owner**). 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 earthworks construction as it pertains to the Underdrain Collection Pond will not be considered complete until it has been approved by the ADWR Director in writing. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** hired by the **Owner** to provide third party 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 Construction" Drawings for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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.

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 Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage.

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 the 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, and 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 rainwater.

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 (including but not limited to the embankment, basin, and channel foundations) has been cleared and stripped to the satisfaction of the **Engineer**, the surface shall be prepared and approved by the **Third Party Testing Contractor** 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 90 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 **Third Party Testing Contractor** to allow the sampling and testing of materials prior to their excavation. The **Contractor** shall allow the **Engineer** and **Third Party Testing Contractor** 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 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 **Third Party Testing Contractor** 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**.

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, mine 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 90 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.

Rock 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 **Engineer**s' (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)
- 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**. If rockfill 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 – the 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 from the pit and stockpiled by the **Owner**.

The material gradation 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 4318

Laboratory testing (see Table 4) shall be completed on all low permeability soil layer sources prior to placement by the **Third Party Testing Contractor**. 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.

Placement Methods – The low permeability soil layer materials shall be placed in two successive lifts not to exceed 6 inches 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 sheepsfoot compactor or approved alternate. Smooth-drum finishing rollers shall be used to smooth the surface to remove the tracks from the sheepsfoot rollers and to embed small stones and rocks into the soil matrix in preparation for geomembrane liner 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 geomembrane 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**.

3.2.6.1. 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 shall be as follows:

Sieve Size (square openings)	Percent Passing (by dry weight)
1 1/2 inch (38 mm)	100
#200 (0.75mm)	0-10

The protective layer shall have a maximum plasticity index of 10 as determined by ASTM 4318. 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 80 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 being placed over the geomembrane. All oversized material that may damage the underlying geomembrane will 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 of 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 reasons. 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 parallel 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 **Third Party Testing Contractor** 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 **Third Party Testing Contractor** 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.

3.2.7. Drainage Aggregate (Select)

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:

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.

3.2.8. 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 **Third Party Testing Contractor** 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.

3.2.9. 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 and its largest dimension shall not be larger than 3 times its smallest dimension. Rounded gravel, cobble and boulders shall not be allowed unless otherwise approved by the **Engineer**. Riprap shall generally conform to the following gradation as determined by ASTM C136.

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 relief 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 materials 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**.

3.2.10. Road Wearing Course

Material Properties - The road wearing course shall generally conform to the following gradation requirements as determined by ASTM C136 and C117 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.

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.

3.3. Finished Surface Preparation of Areas to Receive Geomembrane Lining

Areas to receive geomembrane lining shall be approved low permeability soil layer free of angular particles over 3/4-inch diameter and hard objects that may damage the geomembrane. 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 (Sheepsfoot) 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.

3.5. Quality Assurance

The **Third Party Testing Contractor** 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 **Third Party Testing Contractor** will be final and conclusive in determining compliance with the Technical Specifications. Test Methods are listed in Table 1 of Section 5.0.

Each lift of fill will be approved by the **Third Party Testing Contractor** prior to placement of additional fill materials. Sufficient time shall be allowed by the **Contractor** for the **Third Party Testing Contractor** 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 **Third Party Testing Contractor**, 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 **Third Party Testing Contractor** will be performed in accordance with the latest test methods prescribed by the American Society for Testing and Materials (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).

3.5.1. Control Tests

Tests for gradation, moisture content, moisture density relationship (Proctor compaction test) and other tests where applicable will be made by the **Third Party Testing Contractor** 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 5.0 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.

3.5.2. Record Tests

The **Third Party Testing Contractor** 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.

4. QUALITY ASSURANCE 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. TESTING FREQUENCIES

The **Third Party Testing Contractor** 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 the American Society of Testing and Materials (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	D3017
C3, R3	Particle Size Distribution	D422 [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
R6b	Air Entry Permeameter	D5126
R7	Shear Strength	USACE EM-1110-2-1906
C8	Acid Generating Potential	EPA M600/2-78-054 3.2.3
C9	Methylene Blue Index of Clay	ASTM C837
C10	Free Swell Index	ASTM D5890
C11	Rigid Wall Falling Permeability	USBR 5600

Notes: C = Control Tests; R = Record Tests
[a] Hydrometer tests down to the 2-micron size will be carried out 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 (Basin Area)	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 (General Fill Placement)	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 1110-2-1911.		

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:Test frequencies are per lift unless indicated otherwise.		

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
C11	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
Note: *Frequency of testing for backfill for minor foundations shall be determined by the Project Field Engineer		

NewFields	CLIENT ARIZONA MINERALS INC.					PROJECT NO 475.0014.008
PROJECT	TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE					
TITLE	TECHNICAL SPECIFICATIONS FOR EARTHWORKS MATERIALS AND CONSTRUCTION					**SPECIFICATION NO.** 0014_SPT_EW
			APPROVALS			
REV	**DATE**	**PAGES**	**AUTHOR**	**REVIEW**	**CLIENT**	**REMARKS**
0	04/26/17	26	CMT	RMS		Issued for VRP
1	5/18/17	27	CMT	RMS		Issued for APP

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1. GENERAL

This specification defines the requirements for the earthwork construction activities for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project currently being contemplated by Arizona Minerals Inc. (**Owner**). 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 earthworks construction as it pertains to the Underdrain Collection Pond will not be considered complete until it has been approved by the ADWR Director in writing. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** hired by the **Owner** to provide third party 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 Construction" Drawings for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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.

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 Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage.

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 the 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, and 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 rainwater.

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 (including but not limited to the embankment, basin, and channel foundations) has been cleared and stripped to the satisfaction of the **Engineer**, the surface shall be prepared and approved by the **Third Party Testing Contractor** 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 90 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 **Third Party Testing Contractor** to allow the sampling and testing of materials prior to their excavation. The **Contractor** shall allow the **Engineer** and **Third Party Testing Contractor** 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 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 **Third Party Testing Contractor** 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**.

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, mine 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 90 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.

Rock 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 **Engineer**s' (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)
- 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**. If rockfill 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 – the 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 from the pit and stockpiled by the **Owner**.

The material gradation 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 4318

Laboratory testing (see Table 4) shall be completed on all low permeability soil layer sources prior to placement by the **Third Party Testing Contractor**. 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.

Placement Methods – The low permeability soil layer materials shall be placed in two successive lifts not to exceed 6 inches 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 sheepsfoot compactor or approved alternate. Smooth-drum finishing rollers shall be used to smooth the surface to remove the tracks from the sheepsfoot rollers and to embed small stones and rocks into the soil matrix in preparation for geomembrane liner 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 geomembrane 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**.

3.2.6.1. 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 shall be as follows:

Sieve Size (square openings)	Percent Passing (by dry weight)
1 1/2 inch (38 mm)	100
#200 (0.75mm)	0-10

The protective layer shall have a maximum plasticity index of 10 as determined by ASTM 4318. 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 80 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 being placed over the geomembrane. All oversized material that may damage the underlying geomembrane will 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 of 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 reasons. 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 parallel 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 **Third Party Testing Contractor** 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 **Third Party Testing Contractor** 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.

3.2.7. Drainage Aggregate (Select)

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:

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.

3.2.8. 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 **Third Party Testing Contractor** 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.

3.2.9. 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 and its largest dimension shall not be larger than 3 times its smallest dimension. Rounded gravel, cobble and boulders shall not be allowed unless otherwise approved by the **Engineer**. Riprap shall generally conform to the following gradation as determined by ASTM C136.

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 relief 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 materials 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**.

3.2.10. Road Wearing Course

Material Properties - The road wearing course shall generally conform to the following gradation requirements as determined by ASTM C136 and C117 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.

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.

3.3. Finished Surface Preparation of Areas to Receive Geomembrane Lining

Areas to receive geomembrane lining shall be approved low permeability soil layer free of angular particles over 3/4-inch diameter and hard objects that may damage the geomembrane. 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 (Sheepsfoot) 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.

3.5. Quality Assurance

The **Third Party Testing Contractor** 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 **Third Party Testing Contractor** will be final and conclusive in determining compliance with the Technical Specifications. Test Methods are listed in Table 1 of Section 5.0.

Each lift of fill will be approved by the **Third Party Testing Contractor** prior to placement of additional fill materials. Sufficient time shall be allowed by the **Contractor** for the **Third Party Testing Contractor** 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 **Third Party Testing Contractor**, 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 **Third Party Testing Contractor** will be performed in accordance with the latest test methods prescribed by the American Society for Testing and Materials (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).

3.5.1. Control Tests

Tests for gradation, moisture content, moisture density relationship (Proctor compaction test) and other tests where applicable will be made by the **Third Party Testing Contractor** 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 5.0 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.

3.5.2. Record Tests

The **Third Party Testing Contractor** 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.

4. QUALITY ASSURANCE 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. TESTING FREQUENCIES

The **Third Party Testing Contractor** 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 the American Society of Testing and Materials (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	D3017
C3, R3	Particle Size Distribution	D422 [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
R6b	Air Entry Permeameter	D5126
R7	Shear Strength	USACE EM-1110-2-1906
C8	Acid Generating Potential	EPA M600/2-78-054 3.2.3
C9	Methylene Blue Index of Clay	ASTM C837
C10	Free Swell Index	ASTM D5890
C11	Rigid Wall Falling Permeability	USBR 5600

Notes: C = Control Tests; R = Record Tests

[a] Hydrometer tests down to the 2-micron size will be carried out 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 (Basin Area)	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 (General Fill Placement)	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 1110-2-1911.		

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:Test frequencies are per lift unless indicated otherwise.		

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
C11	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
Note: *Frequency of testing for backfill for minor foundations shall be determined by the Project Field Engineer		

NewFields	CLIENT ARIZONA MINERALS INC.					PROJECT NO 475.0014.008
PROJECT	TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE					
TITLE	TECHNICAL SPECIFICATIONS FOR FENCE MATERIALS AND CONSTRUCTION					**SPECIFICATION NO.** 0014_SPT_FN
			APPROVALS			
REV	**DATE**	**PAGES**	**AUTHOR**	**REVIEW**	**CLIENT**	**REMARKS**
0	04/26/17	6	CMT	RMS		Issued for VRP
1	05/18/17	6	CMT	RMS		Issued for APP

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1. GENERAL

This specification defines the requirements for the fence materials and installation associated with the Arizona Minerals Inc. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage 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**.

Construction of the fence around the Underdrain Collection Pond will not be considered complete until the ADWR Director has approved the construction in writing. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the Consultant or **Engineer**ing Company hired by the **Owner** to provide third party 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 Construction" Drawings for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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. References

The latest issue of the following publications are part of this specification, except where replaced or revised by local codes or ordinances having jurisdiction, in which case the more stringent shall govern:

- ASTM A53, A116, A120, A121 F26
- AASHTO M181 and M120
- Chain Link Fence Manufactures Institute Product Manual

2. CHAIN-LINK FENCE

The chain-link fence shall be as shown on the drawings and consist of chain-link fabric in accordance with the latest edition of AASHTO M181 and as per the following:

- Fabric: Type I zinc-coated steel Class C (1.2oz/ft^2) or Type II aluminum coated steel (0.40 oz/ft^2)
- Size of Mesh: 2-inch
- Size of Wire: 6 gauge
- Diamond Count: Standard (27½)
- Height: 96-inches
- Tension Wire: Steel coil spring wire 7 gauge (0.177-inch) conforming to ASTM 824 with Class I zinc coating
- Wire Fasteners and Tie Clips: 11 gauge galvanized steel wire

Gates shall be constructed of chain link fabric to a height equal to the fence height. The gate chain link fabric shall conform to the fence fabric. Chain link fabric shall be attached to the gate frame by use of stretcher bars and tie wires. Gates shall be fitted with hinges that allow the gate to swing 180 degrees.

Chain-link fabric is to be attached to all fence and gate structures at 12-inch intervals vertically and at 18- inches horizontally.

Posts for corner panels, gate panels and line posts shall be steel round pipe or tubing to the requirements of AASHTO M181 Grade 2.

Posts, braces and gate frames shall conform to the following:

Table 1: End, Corner and Line Brace Posts

Fabric Height (Feet)	Minimum O.D. (inches)	Minimum Weight (lbs/ft)	Concrete Base Depth/Diameter (inches)
3 thru 6	2.375	3.65	34/12
>6 thru 8	2.875	5.79	40/12
>8 thru 12	2.875	5.79	40/12

Table 2: Line Posts

Fabric Height (Feet)	Minimum O.D. (inches)	Minimum Weight (lbs/ft)	Concrete Base Depth/Diameter (inches)
3 thru 6	1.900	2.72	28/12
>6 thru 8	2.375	3.65	36/12
>8 thru 12	2.375	3.65	40/12

Table 3: Gate Materials

Fabric Height (Feet)	Gate Frame Members		Interior Bracing Members	
	Minimum O.D. (inches)	Minimum Weight (lbs)	Minimum O.D. (inches)	Minimum Weight (lbs)
6 feet or less (Leaf width of 8 feet or less)	1.66	1.83	1.66	1.83
6 feet or less (Leaf width of over 8 feet)	1.90	2.28	1.66	1.83
Over 6 feet (Leaf width of 8 feet or less)	1.90	2.28	1.66	1.83
Over 6 feet (Leaf width of over 8 feet)	1.90	2.28	1.90	2.28
Note: Gate leaf shall have vertical interior bracing at maximum intervals of 8 feet and shall have horizontal interior member if fabric height is 8 feet or more.				

Table 4: Gate Strain Posts

Fabric Height (6 Feet or less)	Minimum O.D. (inches)	Minimum Weight (lbs)	Concrete Base Depth/Diameter (inches)
6 Feet or Less			
Gate Post (Gate leaf width up to and including 4 feet)	2.375	3.66	30/10
Gate Post (Gate leaf width over 4 to 10 feet)	2.875	5.80	36/12
Gate Post (Gate leaf width over 10 to 18 feet)	4.000	9.12	36/14
Gate Post (Gate leaf width over 18 to 24 feet)	6.625	18.99	42/16
Over 6 Feet to 12 Feet			
Gate Post (Gate leaf width up to and including 4 feet)	2.875	5.80	36/12
Gate Post (Gate leaf width over 4 to 10 feet)	4.000	9.12	36/14
Gate Post (Gate leaf width over 10 to 18 feet)	6.625	18.99	42/16
Gate Post (Gate leaf width over 18 to 24 feet)	8.625	28.58	48/18

Posts shall be placed a maximum of every 10 feet on center. Posts shall be placed in a vertical position, except where, in the opinion of the Owner, it would be more beneficial to place posts perpendicular to the slope of the ground. Changes in the horizontal alignment of the fence where the angle of deflection is 20 degrees or more shall be considered corners and corner posts shall be installed.

End, corner, and gate posts shall be braced with horizontal braces used as compression members, and adjustable truss rods shall be used as tension members. In-line braces shall be installed at a minimum of every 500 feet.

Miscellaneous fittings and hardware shall be commercial quality steel or better, or cast or malleable iron as appropriate to the item. The steel or iron shall have sufficient strength to provide a balanced design. Zinc coating shall be in accordance with AASHTO M232.

Tension bars shall not be less than 3/16 inch by ¾ inch and not less than 2 inches shorter than the normal height of the fabric.

Tension bands shall be formed from flat or beveled steel and shall have a minimum thickness of 0.078 and a minimum width of ¾ inch.

Barbed wire support arms shall be at an angle of 45 degrees and shall be fitted with clips or other means for attaching three strands of barbed wire. The top wire shall be approximately 12 inches vertically and horizontally from the top of the fence fabric and the other wires spaced uniformly between the top of the fabric and the top wire.

Tension wire shall be continuous between end or corner post and line brace post. A turnbuckle or other approved tightening device shall be used for each continuous span of tension wire.

Barbed wire shall consist of two 12.5-gauge galvanized wires twisted together with 14-gauge double point barbs installed at a minimum of 4 inches apart. Wire and barbs shall be zinc-coated steel, with a zinc coating of at least 0.3 oz/ft2 of coated surface area. The minimum breaking strength of each wire shall be 950 lb-force. The barbed wire shall conform to the requirements of ASTM A121.

The bottom of the fabric shall be placed tightly to the ground to prevent animals from securing access under the fence. Additionally, a small berm a minimum of 6 inches in height shall be created outside of the fence. The contractor shall level the ground to remove mounds or minor depressions under the fence.

3. BARBED WIRE FENCE

Barbed wire fence shall be constructed of four strands of wires. Strands shall be installed at distances of 42 inches, 30 inches, 18 inches, and 6 inches from the ground surface. The wire shall be fastened to end, corner, and gateposts by wrapping the wire around the posts and tying each strand back to itself. Barbwire shall be fastened to steel line posts using standard galvanized clips, and fastened to wood line posts using standard 9-gauge slash cut staples.

Barbed wire shall consist of two 12.5-gauge galvanized wires twisted together with 14-gauge double point barbs installed at a minimum of 4 inches apart. Wire and barbs shall be zinc-coated steel, with a zinc coating of at least 0.3 oz/ft^2 of coated surface area. The minimum breaking strength of each wire shall be 950 lb-force. The barbed wire shall conform to the requirements of ASTM A121.

Gates shall be constructed with a minimum of four strands of wire and have 3-inch diameter wood stays spaced at a minimum distance of 5 feet on center. All gates are to have a minimum width of 15 feet. Gates shall be secured using mechanical “rat trap” type fasteners.

Posts for corner, end, gate, and line braces shall be 2-inch diameter (3.66 lb/ft) galvanized steel pipe conforming to the requirements of AASHTO M181, Grade 2. Brace posts shall be installed a minimum of 36 inches in the ground, and set in concrete.

Line posts shall be standard steel “T” drive posts, minimum 6 feet in length installed to a depth of 30 inches below the ground surface. Line posts shall be manufactured from wrought iron, rail, or new billet steel, and shall have a minimum weight of 1.33 lb/ft. The anchor plates shall weigh a minimum of 0.67 lbs and have a minimum surface area of 18 square inches. Line posts shall be studded or have other approved provisions for holding the fabric in place on the post, and must be equipped with a suitable anchor plate. Line posts shall be painted in accordance with the requirements of AASHTO M281. Line posts shall be placed a maximum of every 16.5 feet on center, with galvanized twisted wire fence stays installed equidistant between each line post. Posts shall be placed in a vertical position, except where, in the opinion of the Owner, it would be more beneficial to place posts perpendicular to the slope of the ground. Changes in the horizontal alignment of the fence where the angle of deflection is 20 degrees or more shall be considered corners and corner posts shall be installed.

End, corner, and gateposts shall be braced with double horizontal H braces. H braces shall be constructed using 8 foot long, 4-inch diameter posts used for compression members, and 9-gauge brace wire for tension members. In-line braces shall be installed a minimum distance of every 1,300 feet.

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TITLE TECHNICAL SPECIFICATIONS FOR GEOSYNTHETIC CLAY LINER AND INSTALLATION						**SPECIFICATION NO.** 0014_SPT_GCL
			APPROVALS			
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1. GENERAL

This specification defines the requirements for geosynthetic clay liner (GCL) materials, installation, and quality control associated with the Arizona Minerals Inc. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage project.

Any alternatives or exceptions to this specification shall be submitted in writing to the **Owner** or its designated representative with the bid.

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1.1. Definition of Terms

- "**Owner**" is defined as Arizona Minerals Inc. (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).
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- "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 Construction" Drawings for the Tailings Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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. References

All tests shall be performed in accordance with the current edition of the ASTM, GRI or other Testing Standards as indicated below.

1.2.1. American Society for Testing and Materials (ASTM) Standards

- ASTM D638 Test Method for Tensile Properties of Plastics, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D882 Test Method for Tensile Properties of Thin Plastic Sheeting D 1141 Practice for Preparation of Substitute Ocean Water, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D1505 Test Method for Density of Plastics by the Density-Gradient Method D 4354 Practice for Sampling of Geosynthetics for Testing, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D4439 Terminology for Geosynthetics, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D4759 Practice for Determining the Specification Conformance of Geosynthetics, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes, ASTM International, West Conshohocken, PA, www.astm.org.

- ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5887 Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using Flexible Wall Permeameter, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5888 Practice for Storage and Handling of Geosynthetic Clay Liners D 5889 Practice for Quality Control of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5890 Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5891 Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5993 Test Method for Measuring the Mass Per Unit Area of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D5994 Test Method for Measuring the Core Thickness of Textured Geomembrane, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6102 Guide for Installation of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6141 Guide for Screening the Clay Portion of a GCL for Chemical Compatibility to Liquids, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6243 Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6496 Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6766 Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids, ASTM International, West Conshohocken, PA, www.astm.org.
- ASTM D6768 Test Method for Tensile Strength of Geosynthetic Clay Liners, ASTM International, West Conshohocken, PA, www.astm.org.

1.2.2. Geosynthetic Research Institute (GRI) Standards

- GM13 Test Properties, Testing Frequency and Recommended Warrant for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes, Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes, Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.
- GM18 Test Properties, Testing Frequency and Recommended Warrant for Flexible Polypropylene (fPP and fPP-R) Nonreinforced and Reinforced Geomembranes (Presently suspended as of May 3, 2004), Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org.

2. GEOSYNTHETIC CLAY LINER

The GCL shall consist of a reinforced product consisting of sodium bentonite encapsulated between two nonwoven geotextiles needle-punched together such as Bentomat DN, manufactured by CETCO, or an equivalent product reviewed and approved by the **Engineer**.

2.1. Manufacturer's Quality Control

GCL roll goods shall meet or exceed the minimum requirements stated herein. Finished roll goods shall also meet or exceed the **Manufacturer**'s published typical or average lot **Specifications** and these **Specifications**.

2.2. Warranty

The **Manufacturer** shall submit a proposed materials and installation warranty with the bid proposal. Terms and conditions of the warranty are to be agreed upon between the **Owner** and the **Manufacturer**.

2.3. Submittals Post-Award

2.3.1. General

The **Manufacturer** shall submit a complete description of their quality control program, as applicable, for manufacturing, handling, installing, testing, repairing and providing a completed lining in accordance with requirements of these **Specifications.**

The **Manufacturer** shall provide technical supervision and assistance as requested during installation of the lining system.

The **Manufacturer** shall submit for approval samples of the GCL materials proposed for use.

2.3.2. Certificates

Prior to delivery, **Contractor** shall submit **Manufacturer**'s Quality Control Certificate for each roll of material to the **Engineer** for approval. These certificates shall clearly indicate the roll or rolls that the results represent. Roll goods shipped to the project **site** that do not meet or exceed the **Manufacturer**'s published typical or average lot **specifications** and the **Specifications** stated herein shall be rejected. The **Manufacturer** must satisfy by affidavit to the **Engineer** and the **Project Manager** that the material he offers to furnish will meet, in every respect, the requirements set forth in these **Specifications**.

The Quality Control Certificate shall include the following information:

- Roll number and identification
- Results of quality control tests

Tests to be performed and minimum **specifications** shall include, but not be limited to the items presented in Table 3-1.

Table 2-1: Geosynthetic Clay Liner

Property	Test Method	Specification
Bentonite Swell Index	ASTM D5890	24 ml/2g min.
Bentonite Fluid Loss	ASTM D5891	18 ml max.
Bentonite Mass/Area	ASTM D5993	0.75 lb/ft^2 (3.6 kg/m^2) min.
GCL Grab Strength	ASTM D4632 ASTM D6768	150 lbs (660 N) MARV 37.5 lbs/in (66 N/cm) MARV
GCL Peel Strength	ASTM D4632 ASTM D6496	15 lbs (65 N) min. 2.5 lbs/in (4.4 N/cm) min.
GCL Index Flux	ASTM D5887	1 x 10^{-8} m^3/m^2/sec max.
GCL Hydraulic Conductivity	ASTM D5887	5 x 10^{-9} cm/sec max.
GCL Hydrated Internal Shear Strength	ASTM D5321 ASTM D6243	500 psf (24 kPa) typ. @ 200 psf 6,500 psf (311 kPa) typ. @ 10,800 psf

Materials failing to meet the prescribed requirements of Table 3-1 shall not be considered for a material substitution.

2.3.3. Interface Shear Test

GCL proposed for the project will require interface shear testing in contact with 60 mil HDPE as described in this section. The HDPE and GCL materials for testing shall be provided to the testing laboratory by the **Manufacturers**. The **Manufacturer** shall be responsible for conducting interface shear tests through a third party laboratory.

Interface testing shall be performed in accordance with ASTM D6243. Shearing shall take place under normal stresses of twenty-five (25), seventy-five (75) and two hundred (200) psi. Testing at each of the normal stresses shall be undertaken on individual samples, i.e., multi-stage testing of an individual sample of HDPE or GCL is not permitted. The testing shall be completed with sufficient displacement so that residual interface strength values can be determined.

3. GCL INSTALLATION

3.1. General

The geosynthetic clay liner (GCL) shall be installed within the areas shown on the **Drawings** or as directed by the **Engineer**.

The GCL rolls shall be stored so they are protected from ultraviolet light, puncture, dust, grease, moisture, mechanical abrasion, excessive heat or other damage. The rolls shall be stored on a flat smooth surface (minus one (1)-inch well graded gravel rolled with a smooth drum or equivalent) and not stacked more than two rolls high. Care shall be taken to maintain identification and **Manufacturer** data on the roll.

Prior to deployment of GCL, the **Installer** shall inspect and accept, with the **Engineer**, **CQA** and the **Project Manager**, all surfaces on which the GCL is to be placed. The surface on which the GCL is to be installed shall be free of sharp particles, rocks, or other objectionable material or debris to the satisfaction of the **Engineer**, **CQA**, the **Project Manager**, and the **Installer**. Sharp and/or objectionable objects shall be removed by raking, sweeping, or hand picking, as necessary.

Installation of the GCL shall be performed under the direction of a supervisor who has installed a minimum of 10,000,000 square feet (ft^2) of the specified type of GCL or similar. Installation shall be performed under the direction of an installer (who may also be the field installation supervisor or crew foreman) with installation experience of a minimum of 3,000,000 ft^2 of the GCL type specified or similar product, using the same type of equipment to be used in the current project. During the installation, the field installation supervisor or master installer shall be present. Qualified technicians employed by the **Installer** shall complete all patching and other operations.

The GCL shall be placed over the prepared surfaces using methods and procedures that ensure a minimum of handling. Adequate temporary and permanent anchoring devices and ballasting shall be provided to prevent uplift and damage due to wind. The **Installer** is solely responsible for the safety of his operations including decisions regarding deployment in adverse weather conditions and the amount of temporary anchoring and ballasting required. The **Contractor** shall take necessary precautions to protect the GCL from any damage, including prohibiting workers from smoking on or near the GCL and wearing foot apparel that would damage the membrane.

To the extent possible, seams shall be oriented parallel to the fall line, slope or grade of the ground. The panels shall be secured temporarily with sandbags or other approved ballasting method to hold them in place until the field seams have been completed and the GCL has been permanently anchored. Sandbags/ballast shall be removed from the GCL when they are no longer required to secure the GCL.

The **Installer** shall take into account that high winds are prevalent at the project **site** and may result in liner damage and delays. The **Installer** shall take all necessary measures to ensure that each panel is sufficiently ballasted to prevent damage or movement by wind.

The GCL shall be installed such that the product name printed on one side of the GCL is facing up (in contact with the HDPE geomembrane). The GCL shall be laid out and installed by trained technicians in accordance with the **Drawings**; the layout and details as presented in the approved shop **drawings**; and in accordance with the **Manufacturer**'s requirements.

Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the surface of the GCL. A temporary covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement. Sheet goods damaged from improper installation methods shall be removed and replaced at the **Installer's** expense.

The GCL seams shall be constructed by overlapping adjacent panel edges and ends. Seams shall be flat and without wrinkles. The **Installer** shall ensure that the overlap zone is not contaminated with loose soil or other debris. Seams shall be shingled in the direction of flow and overlapped in accordance with the **Manufacturer**'s specifications, or as follows (whichever is greater):

Along the edges of the area where there is no low permeability soil layer to overlap including over the top of berms, the longitudinal seam overlap shall be increased to twenty-four (24) inches for a distance equal to fifty (50) feet from the interior toe of the perimeter berm. End-of-roll overlapped seams within this area and the GCL termination along the low permeability soil layer interface shall be constructed with a minimum overlap of twenty-four (24) inches. Longitudinal seams (as applicable) and seams at the ends of the panels shall be constructed so they are shingled in the direction of the grade. All overlapped seams in the GCL shall be heat-tacked using a quick pass of a flame torch or hot-air gun (or equivalent) followed by a quick application of appropriate pressure provided by a roller, foot pressure or other means. Assessment of adequate seam tacking shall be made in the field by **CQA** based on visual observations.

During installation, the **Installer** shall give each field panel an "identification" code number consistent with the approved layout plan. The **CQA** and the **Engineer** shall agree upon the numbering system. The **Installer** shall update the layout plan as each panel is installed to show the location of each panel. A field panel is defined as the area of GCL that is to be seamed in the field (roll or portion of a roll cut in the field).

Bentonite-enhanced seams are required between overlapping end-of-roll panels and at the GCL termination along the low permeability soil layer interface. The underlying edge of the overlap (24 inches) shall be exposed and a continuous bead of granular sodium bentonite shall be applied twelve (12) inches from the edge of the underlying panel or low permeability soil layer material. Granular bentonite shall be placed continuously and evenly along the overlaps at a minimum rate of ¼-pound per linear foot. Supplemental bentonite shall be of the same type and quality as the material within the GCL.

The **Installer** shall only work on an area that can be completed in one working day. Completion is defined as the full installation of the GCL and placement of the HDPE geomembrane materials or protective waterproof tarps or plastic. GCL shall be covered immediately to protect it from precipitation that may occur during construction. Installation shall not take place during high humidity, rain, or other types of precipitation. Any GCL that becomes hydrated prior to coverage shall be removed and replaced at no additional cost to the **Owner**.

The GCL shall be installed such that vehicle traffic is minimized and damage to the material does not occur. Equipment which could damage the GCL should not be allowed to travel directly on it. Acceptable installation, therefore, shall ideally be accomplished such that the GCL is unrolled in front of backwards-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before GCL placement continues.

Rips or tears in the GCL shall be repaired completely by exposing the affected area, removing all foreign objects or soil, and then placing a patch over the defect with a minimum overlap of three (3) feet on all edges. Granular bentonite shall be placed between the patch and the repaired material at a minimum rate of ¼ pound per linear foot of edge.

An adequate amount of handling equipment, welding apparatuses, and test equipment shall be maintained on **Site** by the **Installer** to avoid delays due to problems with equipment failures.

3.2. HDPE Deployment over GCL

To the extent that is practical, direct vehicular contact with the GCL during HDPE deployment should be avoided or minimized. HDPE deployment equipment that must travel on the GCL shall consist of lightweight, low ground pressure vehicles. Any rutting or damage to the GCL due to vehicular traffic shall be removed, replaced or repaired to the satisfaction of the **Engineer** at the **Installer's** expense. The **Manufacturer** should be contacted with specific recommendations regarding appropriate equipment and procedures relative to HDPE deployment over the GCL.

Prior to HDPE deployment, the **Installer** shall notify the **Engineer** of the HDPE deployment equipment proposed to travel on the exposed GCL.

3.3. GCL Installation Construction Quality Control

A **Project Manager** appointed by the **Owner** will perform all of the construction management functions and ensure that the project is built in accordance with the project documents. Any questions with regard to the **Drawings** or **Specifications** associated with the **Work** shall be addressed to the **Engineer** for clarifications in accordance with the established project protocol. All proposed changes to the **Drawings** or **Specifications** shall be approved by the **Project Manager** and the **Engineer** prior to implementing the change.

Construction quality control (CQC) is the responsibility of the **Installer** and the **Installer** is responsible for the quality of the work. A formalized, third party **CQC** program is required for the GCL scope of work. The **Owner** will have a third party **CQA** program in place as described herein. Testing of the **Work** by **CQA** does not relieve the **Installer** of liability for substandard materials or end product work. All **CQC** test results and observation reports shall be provided to the **Project Manager** on Monday for the preceding week. A final **CQC** report shall be submitted to the **Project Manager** and the **Engineer** within 15 calendar days after the installation work has been completed.

3.4. GCL Installer Warranty

The **Installer** shall warrant the installation against workmanship defects a minimum of five (5) years from the date of installation or as mutually agreed prior to award of the **Contract** for supply between the **Owner** and the **Installer**. This warranty shall cover the cost of material, freight and duties, handling, labor, and equipment to replace or repair defective workmanship.

4. CONSTRUCTION QUALITY ASSURANCE (CQA) REQUIREMENTS

4.1. General

The **CQA** activities shall be performed under the direction of a Senior Technician or Field **Engineer** who has monitored the installation of a minimum of 5,000,000 square feet (ft^2) of the specified type of GCL or similar.

4.2. CQA Inspection and Review Requirements

The **Engineer** shall be the interpreter of the **Specifications**, and shall make observations as considered necessary to assess and accept the quality of the work. Continuous observations of construction operations shall be made by **CQA** under the direction of the **Engineer**.

The **Project Manager** shall be responsible for verification of lines and grades prior to acceptance of the completed work. The **Installer** shall be responsible for any surveying required during GCL placement. The **Installer** shall also be responsible for the preparation of record (as-built) **drawings** for all GCL covered areas. If the as-built **drawings** for the project will be prepared by the **Contractor** or a subcontractor to the **Contractor**, the name of the preparer of the **Drawings** shall be submitted to the **Project Manager** in writing for approval prior to deployment of any GCL.

4.3. Quality Assurance Reports

The **Engineer** shall submit reports of observations and tests made by **CQA** to the **Project Manager**. The reports shall be submitted to the **Project Manager** within two (2) to three (3) days. Items of non-conformance will be brought to the attention of the **Project Manager** as soon as possible, after identification.

A copy of all **CQA** reports will be maintained at the construction **Site**, and shall include the following:

- Date issued.
- Project title and number.
- Designation of material inspected.
- Observations regarding compliance or noncompliance with the **Drawings** and **Specifications**.

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- "**Installer**" and **"Installer Construction Quality Control (CQC)"** is defined as the qualified Contractor that has been hired to install the geomembrane and complete CQC activities for the specified Work.
- "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 Construction" Drawings for the Tailings Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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. References

All tests performed shall be in accordance with the current edition of the ASTM, GRI or other Testing Standards as indicated below.

1.2.1. American Society for Testing and Materials (ASTM) FOR CQC AND CQA:

- ASTM Standard D4437, "Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard D5199, "Standard Test Method for Measuring the Nominal Thickness of Geosynthetics", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard D5641, "Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard D5820, "Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard D5994, "Standard Test Method for Measuring Core Thickness of Textured Geomembrane", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard D6365, "Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard D6392, "Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods", ASTM International, West Conshohocken, PA, www.astm.org
- ASTM Standard 7240, "Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test)", ASTM International, West Conshohocken, PA, www.astm.org

1.2.2. Geosynthetic Research Institute (GRI):

- GRI GM 9, "Cold Weather Seaming of Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org
- GRI GM 10, "The Stress Crack Resistance of HDPE Geomembrane Sheet", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org
- GRI GM 13, "Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org
- GRI GM 14, "Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org
- GRI GM 17, "Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org
- GRI GM 19, "Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes", Geosynthetic Institute, Folsom, PA, www.geosynthetic-institute.org

2. GEOMEMBRANE

The geomembrane used for the storage facility as well as for the secondary and primary liner for the underdrain collection pond shall be 60 mil (1.5 mm) double textured High Density Polyethylene (HDPE) unless otherwise indicated on the Drawings. Where referred to as 60 mil HDPE liner on the drawings will mean double textured HDPE.

2.1. Manufacturer's Quality Control

The HDPE geomembrane shall be a high quality formulation containing approximately 97 percent polymer and 3 percent carbon black with antioxidants and heat stabilizers. It shall be resistant to ultraviolet (UV) rays. All resin shall be hexene-based, consist of all virgin material from the same manufacturer, shall not be intermixed, and no reclaimed polymer may be added to the resin. The manufacturing process shall not use more than 10 percent regrind. If regrind is used, it must be similar HDPE to the parent material.

The geomembrane material shall comprise HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures as applied to the mining industry. The material shall be produced to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. The geomembrane shall be supplied in roll form. Each roll shall be identified with labels indicating roll number, thickness, length, width, and manufacturer's name and date of manufacture.

The manufacturer's laboratory must be certified by Geosynthetic Accreditation Institute (GAI)/Laboratory Accreditation Program (LAP) for the tests being performed and shall have a third-party independent quality assurance program. All test results shall be provided to the **Engineer** and the rolls of material shall be clearly identified and correlate to the test results.

Extrudate rod or bead material shall be made from the same type of resin as the geomembrane and be from the same resin supplier as the resin used for manufacture of the geomembrane.

2.2. Manufacturer's Warranty

The material shall be warranted against manufacturer's defects as well as degradation due to UV light for exposed areas for a minimum of 20 years from the date of installation or as mutually agreed prior to award of the contract for supply between the **Owner** and the geomembrane manufacturer. This warranty shall cover the cost of material, freight and duties, handling, labor, and equipment to replace the defective or failed material.

2.3. Submittals Post-Award

The manufacturer shall furnish the following product data, in writing, to the **Owner** and the **Engineer** prior to shipment of the geomembrane material:

Resin data including the following:

- Certification stating that the resin meets the specification requirements and that it is all from the same manufacturer (see Table 4).
- Statement certifying no reclaimed polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).
- Copy of quality assurance and quality control certificates issued by resin supplier.

Geomembrane roll, extrudate rod and bead material:

- All rolls shall be delivered with labels affixed to or markings on the selvage edge clearly stating the manufacturer's name, product identification, material thickness, roll number, roll type, roll dimensions and roll weight.
- Copy of quality assurance and quality control certificates issued by the geomembrane manufacturer.
- Certification that the geomembrane material delivered to the project complies with these specifications.

- Certification that extrudate rod or bead is from one manufacturer, is the same resin type, and was obtained from the same resin supplier as used to manufacture the geomembrane rolls.

It is the **Installer's** responsibility to submit timely proposals (allowing a minimum of two weeks for approval). The **Installer** shall supply the **Owner** and **Engineer** with the following prior to commencement of work:

- Panel layouts of the liner that must be approved by the **Engineer** prior to commencing the Work. The submittal shall include a proposed field panel "identification" code numbering system.
- Resumes for the Master Welder and other welder's with a description of their qualifications and experience for approval prior to arrival on site.
- The **Installer** shall submit a copy of their Quality Control Manual prior to the start of installation of any geomembrane. If there are discrepancies between this Specification and the **Installer's** Quality Control Manual, the more stringent requirements will apply unless determined otherwise by the **Engineer**. The **Engineer** shall review and approve the **Installer's** Quality Control Manual including logs, inspection and testing methods and forms prior to the Installer commencing the Work.

2.4. Third Party Conformance Testing (Manufacturing)

During manufacturing of the geomembrane, samples shall be obtained and forwarded to a third party geomembrane quality assurance testing Laboratory (to be determined by the **Engineer** and **Owner**) by a representative of the **Engineer** for testing to ensure conformance with the Specifications.

Unless otherwise stated, samples shall be 3 feet long by the width of the roll shall be taken at a frequency of no less than one per 1,000,000 square feet or one per resin lot, whichever is less.

The conformance tests shall be performed to verify conformance to the design Specifications as listed on Table 1 for Smooth Geomembrane and Table 2 for Textured Geomembrane. The following conformance tests shall be performed on each conformance sample.

- Thickness (ASTM D5199)
- Density (ASTM D1505)
- Tensile Properties (ASTM D6693)
- Tear Resistance (ASTM D1004)
- Puncture Resistance (ASTM D4833)

- Carbon Black Dispersion (ASTM D5596)
- OIT (ASTM D3895)
- NCTL (ASTM D 5397)

3. GEOMEMBRANE INSTALLATION

3.1. General

The HDPE geomembrane shall be installed on the areas shown on the Drawings or as directed by the **Engineer**.

The geomembrane rolls shall be stored so they are protected from puncture, dust, grease, moisture, mechanical abrasion, excessive heat or other damage. The rolls shall be stored on a flat smooth surface (minus 1-inch well graded gravel rolled with a smooth drum or equivalent) and not stacked more than two rolls high. Care shall be taken to maintain identification and manufacturer data on the roll.

Prior to deployment of geomembrane, the **Installer** shall inspect and accept, with the **Engineer**, **CQA** and the **Owner**, all surfaces on which the geomembrane is to be placed. The surface on which the geomembrane is to be installed shall be free of sharp particles, rocks, or other debris to the satisfaction of the **Engineer**, **CQA**, the **Owner**, and the **Installer**. Sharp and/or objectionable objects shall be removed by raking, sweeping, or handpicking, as necessary.

Installation of the geomembrane shall be performed under the direction of a supervisor who has installed a minimum of 10,000,000 square feet (ft^2) of the specified type of geomembrane or similar. Seaming shall be performed under the direction of a master seamer (who may also be the field installation supervisor or crew foreman) with seaming experience of a minimum of 3,000,000 ft^2 of the geomembrane type specified or similar product, using the same type of seaming apparatus to be used in the current project. During the seaming, the field installation supervisor or master seamer shall be present. Qualified technicians employed by the **Installer** shall complete all seaming, patching, testing, and other welding operations.

The geomembrane shall be placed over the prepared surfaces using methods and procedures that ensure a minimum of handling. Adequate temporary and permanent anchoring devices and ballasting shall be provided to prevent uplift and damage due to winds. The **Installer** is solely responsible for the safety of his operations including decisions regarding deployment in adverse weather conditions and the amount of temporary anchoring and ballasting required. The **Contractor** shall take necessary precautions to protect the geomembrane from any damage, including prohibiting workers from smoking on or near the geomembrane and wearing foot apparel that would damage the geomembrane.

To the extent possible, seams shall be oriented parallel to the fall line, slope or grade of the ground. The panels shall be secured temporarily with sandbags or other approved ballasting method to hold them in place until the field seams have been completed and the geomembrane has been permanently anchored. Ballast material shall conform to the specified requirements for drainage material.

The **Installer** shall take into account that high winds are prevalent at the project site and may result in liner damage and delays. The **Installer** shall take all necessary measures to ensure that each panel is sufficiently ballasted to prevent damage or movement by wind. Fusion of panels and repairs will only be permitted under weather conditions allowing such work, and within the warranty limits of the geomembrane manufacturer, as approved by the **Owner** and the **Engineer**.

Horizontal field seams on slopes shall be kept to a minimum and require the approval of the **Engineer**. Horizontal seams on steep slopes shall be avoided where possible by cutting the liner at a 45-degree angle. Generally, horizontal seams are to be no closer than 10-feet from the toe of the slope. Horizontal seams shall be made by lapping the uphill material over the downhill material. Panels shall be shingled in a manner that prevents water from running beneath the liner or seam.

The geomembrane shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. The installed geomembrane shall contain sufficient slack material to allow for thermal expansion and contraction during the annual extreme temperatures expected at the site. Individual wrinkles should take the form of undulations in the liner but should not be large enough for the material to fold over on itself.

During installation, the **Installer** shall give each field panel an “identification” code number consistent with the approved layout plan. The **CQA** shall agree upon the numbering system. The **Installer** shall update the layout plan as each panel is installed to show the location of each panel. A field panel is defined as the area of geomembrane that is to be seamed in the field (roll or portion of a roll cut in the field).

Individual panels of geomembrane material shall be laid out in a pattern that will produce the least number of seams. The material shall be overlapped prior to welding. Extreme care shall be taken by the **Installer** in the preparation of the areas to be welded. The joint interface shall be cleaned and prepared according to industry standard procedures, those specified by the material manufacturer and those approved by the **Engineer**. Seaming shall not take place unless the panels are dry and clean. All sheeting shall be welded together by thermal methods. When placing panels together where one panel has been deployed previously, the adjacent panels will need to be allowed to equilibrate in temperature and slack before welding.

Any area showing damage due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The cost of replacing or repairing the geomembrane shall be borne solely by the **Installer**. Patching of panels to repair defects shall be limited. If excessive physical damage occurs to the geomembrane during or after installation (i.e. wind blowout, rock or equipment damage) the **Engineer** may require the damaged area to be replaced.

No “fish mouths” will be allowed within the seam area. Where “fish mouths” occur, the material shall be cut, overlapped, and the area shall be patched.

Geomembrane panels must have a finished overlap of 4 to 6-inches for double-wedge welding seams and minimum 6-inches for extrusion welding seams. Notwithstanding this provision, sufficient overlap shall be provided to allow shear and peel tests to be performed on any seam.

Handling and storage of the geomembrane material shall be in accordance with the manufacturer’s printed instructions. Persons walking or working on the geomembrane shall not engage in activities or wear foot apparel that could damage the geomembrane.

An adequate amount of handling equipment, welding apparatuses, and test equipment shall be maintained on site to avoid delays due to problems with equipment failures.

3.2. Geomembrane Installation Quality Control

3.2.1. General

The **Installer** shall be fully responsible for carrying out all quality control inspection and tests on the geomembrane and shall do so to the satisfaction of the **Engineer** and in accordance with this Specification and the **Installer’s** Quality Control Manual. On-site physical nondestructive and destructive testing shall be completed on all joints to ensure that watertight uniform seams are achieved on a continuous basis as installation proceeds. The **CQA** shall randomly witness destructive tests completed by the **Installer’s CQC**.

Fusion of panels and repairs will only be permitted under weather conditions allowing work that is in conformance to the Specifications and within the warranty limits imposed by the manufacturer and to the approval of the **Engineer**.

The **Installer** shall not have more than 500,000 square feet (ft^2) of geomembrane deployed at any time without final CQA/CQC and acceptance by the **CQA**. At the beginning of each day's work, the **Installer** shall provide the **CQA** with copies of all the previous days' reports (electronic format) as well as an update of the quantity and location of geomembrane placed.

3.2.2. Trial Welds

Trial welds shall be completed to verify the performance of the welding equipment and operator prior to performing production welds or if significant changes in temperature or weather conditions occur. No welding equipment or operator shall perform production welds until equipment and operator have successfully completed a trial weld and are approved by the **CQA**. The following procedures shall be followed for trial welds:

- Make trial welds under the same surface and environmental conditions as the production welds; i.e., in contact with subgrade and similar ambient temperature.
- Minimum of two trial welds per day per welding apparatus – one made prior to the start of work and one completed at mid-shift, work stoppages or for every 5 hours of seaming operations.
- Cut 10 each (5 for peel test, 5 for shear test) 1-inch-wide-by-6-inch long test strips from the trial weld.
- Quantitatively test specimens for peel adhesion and for bonded seam strength (shear).
- Trial weld specimens shall pass when the results shown in Table 3 are achieved in both peel and shear tests and:
  - The break, when peel testing, occurs by Separation in the plane of the sheet (SIP), not through adhesion failure separation (AD). When the seam separation is equal to or greater than 25% of the track width, it is a failed test.
  - The break is ductile.
- Repeat the trial weld, in its entirety, when the trial weld samples fail in either peel or shear as defined on Table 3 and above.

3.2.3. Field Seaming

The **Installer** shall have at least one Master Welder who shall provide direct supervision to other welders. Field seaming procedures and requirements shall include:

- The welding equipment shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the material to ensure changes in environmental conditions will not affect the integrity of the weld.
- The seam area shall be cleaned of dust, mud, moisture, and debris immediately ahead of the welding apparatus.

- The seam overlaps shall be aligned consistent with the requirements of the welding equipment being used. A 4-inch to 6-inch overlap shall be used for double-wedge welded seams and 6-inches for extrusion welded seams unless approved otherwise by the **Engineer**.
- Seaming shall not proceed when the ambient air temperature or adverse weather conditions jeopardize the integrity of the geomembrane installation. If adverse weather prevents work from being completed, the **Installer** shall make-up the work during a scheduled day off.
- Extrusion welding apparatus' shall be purged of heat-degraded extrudate before welding.
- The double-wedge fusion welding process shall be used unless alternate methods are approved by the **Engineer**. Extrusion welding shall be permitted to weld short seams to repair small areas where double-wedge welding is not feasible, and for caps and patches.

3.2.4. Field Seam and Panel Inspection and Testing

3.2.4.1. Nondestructive Testing and Inspection

The **Installer CQC** and **CQA** shall perform visual inspections of deployed and welded HDPE panels to identify defects, damage, or protrusion of sharp objects that may affect the integrity of the geomembrane. Defective or damaged areas shall be marked and repaired according to the Technical Specifications and the guidelines in the **Installer's** Quality Control Manual.

The **Installer's CQC** and **CQA** shall inspect each seam, marking their initials and date inspected at the end of each panel. Any area showing a defect shall be marked and repaired in accordance with the applicable repair procedures.

3.2.4.2. Continuity Testing

A maximum effort shall be made by the **Installer** to install a perfect geomembrane liner. This implies that all seams completed in the field, patches, and extrusions shall be tested and recorded. All failures shall be isolated and repaired as directed by the **Engineer** and **CQA**. A general testing procedure for the **Installer CQC** is as follows:

- Test all field seams and patches with interseam pressure, vacuum box, spark tester, or other approved methods. Non-destructive testing methods are discussed in following subsections.
- Isolate and repair all areas indicating any defects. Retest the repair.

3.2.4.3. Interseam Pressure Testing

Test procedure shall be in accordance with ASTM D5820 for interseam pressure for seams (for double-wedge welding only):

- Seal both ends of the seam to be tested by applying heat to the end of the seam via a heat gun until flow temperature is achieved. Clamp off the ends and let cool.
- Insert a pressure gauge with needle assembly into the end of the seam and seal.
- Pressurize the air channel between the two seams to between 30 psi and 35 psi. Following pressure stabilization, take the initial pressure reading, hold the pressure a minimum of 3 minutes and take a second reading.
- The allowable leak-down for the seam is 3 psi maximum.
- If the pressure does not drop below the maximum allowable 3 psi, open the air channel at the end away from the pressure gauge. Air should rush out and the pressure gauge should register an immediate drop in pressure, indicating that the entire length of seam has been tested. If this does not happen, either the air channel is blocked or the equipment is faulty, and the test is not valid.
- Enter the results of the leak test on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.
- Repair the area where the pressure gauge/needle assembly was installed and where the air was released.

3.2.4.4. Vacuum Box Testing

Where possible, the **Installer CQC** shall test all extrusion seams as follows:

- Mix a solution of liquid detergent and clean water and apply an ample amount to the area to be tested. If a seam contains excess overlap or loose edges, it must be trimmed before testing.
- Place a rigid transparent vacuum box over the area and apply a slight amount of downward pressure to the box to seat the seal strip to the liner.
- Apply a vacuum of 4 psi to 8 psi for a minimum of 10 seconds to the area. The **Installer CQC** shall examine the geomembrane through the viewing window for the presence of soap bubbles indicating a leak. If no bubbles appear after 10 seconds, consider the area leak free. Once the area is leak free, depressurize the box and move it over the next adjoining area with an appropriate overlap and repeat the process.
- Enter the results of the leak test on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

3.2.4.5. Spark Testing

Extrusion welded patches, caps, pipe boots, etc., in lieu of vacuum-box testing, shall be spark tested in accordance with ASTM D6365 and the following procedures:

- The seam shall be prepared for extrusion welding in accordance with the **Installer**'s procedures.
- Just prior to applying the extrusion bead, a small-gauge copper wire (18-gauge bare copper wire or equivalent) shall be placed into the seam. The wire should be grounded at one end and placed at the edge of the top sheet of the overlap seam. Tucking the wire under the edge of the top sheet will help hold the wire in place during welding, but this should be done prior to grinding to avoid the risk of contamination of the weld area. Electrically conductive tape placed along the edge of the overlying patch can also be used instead of copper wire.
- Apply the extrudate bead as normal and allow the weld to cool.
- Complete a calibration test on a trial seam containing a non-welded segment ensuring the identification of such a defect (non-welded segment) under the planned spark tester settings and procedures.
- Energize the spark tester and move the electrode wand near the trial seam to determine the maximum length of spark that can be generated. Adjust the output voltage setting until the spark length exceeds the greatest potential leak path distance. This is typically the diagonal distance from the embedded wire to the edge of the weld bead at a "T" joint.
- Once the output voltage has been set, testing can be started. Testing is performed by passing the electrode over the seams with the electrode in contact with the membrane or the extruded weld bead. The audible and visual indication of a spark provides the determination of a potential leak path.
- If a potential leak is detected the area can be repaired with a patch. Applying additional weld beads adjacent to the leaking weld is not an acceptable repair technique. This will only lengthen the leak path to the extent that the spark tester may not be capable of generating a spark of sufficient length to breach the lengthened gap.
- After patching, the seam must be retested until no defects are indicated.
- Enter the results of the spark test on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.
- When flammable gasses are present, use special care and precautions in the area to be tested.

3.2.4.6. Destructive Testing

Peel and shear seam strength testing shall be carried out on samples of seams removed from the installed panels. For these tests, the following procedures shall be followed:

- Coupon sampling of all field seams, including patches and repair areas, shall be taken by cutting perpendicular to the seams a sample approximately 36-inch long by a 6-inch wide (minimum) centered over the seam. This sample shall be cut into three 12-inch long samples and labeled with the sample number, date, time, location and seam number, and individually marked "**Owner** (Archive) Sample," "**CQA** Sample," and "**Installer CQC** Sample." The frequency and location shall be determined by the **CQA,** but shall not be less than one sample per 500-feet of field seams. These coupons shall be tested by the **Installer** on-site for peel (5 coupons) and shear seam strength (5 coupons) and thickness in accordance with ASTM D6392. The **CQA** shall also test the samples for conformance. If there is any discrepancy in the results, the **CQA** results will override the **Installer's**.

- Heat-welded seams shall be allowed to cool or warm to about 70°F prior to testing. Solvent seams, when used, shall be allowed to cure according to the manufacturer's recommendations. Additionally, at the **Engineer's** option, approximately 10 percent of the coupons (size 1-inch by 6-inches) shall be sent to an independent laboratory for confirmation testing. Should the lab and field tests conflict, installation shall halt until the conflict is resolved to the satisfaction of the **Engineer**.

Weld specimens shall pass the requirements for shear and peel presented in Table 3 and as follows:

- During testing, the break shall occur by Separation in the Plane of the sheet (SIP) not through adhesion failure separation (AD). When the seam separation is equal to or greater than 25% of the track width, it is a failed test.
- The break is ductile.

In the event of a failing test result, the following procedures shall be used:

- The **Installer** shall trace the weld to the ends of the seam in both directions and complete additional destructive test to ensure that the failure is isolated. Once the failing limits of the seam are isolated, that portion of the seam shall be reconstructed or capped. Welding the overlap is not acceptable.
- Seams welded prior to and after the failed seam using the same welding device and/or operator shall also be tested.
- Enter the results of the destructive testing on the appropriate documentation, indicating either a passed or a failed seam. If the seam fails, the repair work and subsequent testing should be recorded on the same document.

3.2.5. Repair Procedures

Damaged or defective geomembrane or seam areas failing a destructive or non-destructive test shall be repaired. Each repair requires a non-destructive test using either a vacuum box or spark testing methods. The **Installer** shall be responsible for repair of damaged or defective areas. The repair method shall be decided by the **Installer** but must be agreed upon by the **Engineer**. Procedures available include the following:

- Replacement: Remove damaged geomembrane or unacceptable seam and replace with acceptable geomembrane materials if the damage cannot be satisfactorily repaired.

- Patching: Used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Capping: Used to repair large lengths of failed seams.

Abrading and rewelding of small seam areas and welding the flap on fusion-welded seams are not acceptable repair procedures and shall not be accepted.

In addition, the following procedures shall be observed:

- Surfaces of the polyethylene that are to be repaired by extrusion welds shall be lightly abraded to ensure cleanliness.
- All geomembrane shall be clean and dry at the time of repair.
- Extend patches or caps at least 6-inches for extrusion welds and 4-inches for wedge welds beyond the edge of the defect, and round the corners of the patch material. The edges of all patches are to be beveled.

Furthermore, repair verification shall be performed as follows:

- Number, date, location, repair technician, CQC and test outcome of each patch.
- Non-destructively test each repair using methods specified in this Technical Specification.
- Enter the results of the repair procedures on the appropriate documentation, indicating the repair verification. If the repair fails, the repair work and subsequent testing should be recorded on the same document.

3.2.6. Installer's CQC Reporting and As-built

Installer's CQC will be responsible for recording and reporting the following information on a daily basis:

- Panel Deployment Log
- Seaming Log
- Trial Weld Test Results
- Destructive Testing Results
- Documentation of all seam and major patch repairs
- As-built information (in AutoCAD compatible format) showing the surveyed geomembrane panel layout, seams, location of destructive test samples, and the location of major repairs including repaired seams, major patches and capped areas

The reports shall be provided in hard copy and electronic format (Word and Excel) unless agreed otherwise with the **Owner** and **Engineer**.

The log formats shall be included in the **Installer's** Quality Control Manual and the format and information to be included on the logs is subject to approval by the **CQA**.

At the completion of the installation and prior to final payment, the **Installer** shall provide the **CQA** or **Engineer** and **Owner** the following information no later than 15 calendar days after the installation work has been completed:

- Completed as-built drawings (AutoCAD compatible format) showing the surveyed geomembrane panel layout, seams, location of destructive test samples, and the location of major repairs including repaired seams, major patches and capped areas.
- Completed QC documents (hard copy and electronic format) including the Panel Deployment Log, Seaming Log, Trial Weld Test Results, Destructive Testing Results, and Seam Repair Log.

3.3. Installer Warranty

The **Installer** shall warrant the installation against workmanship defects a minimum of 5 years from the date of installation or as mutually agreed prior to award of the contract for supply between the **Owner** and the **Installer**. This warranty shall cover the cost of material, freight and duties, handling, labor, and equipment to replace or repair defective workmanship.

4. CONSTRUCTION QUALITY ASSURANCE (CQA) REQUIREMENTS

4.1. General

The **CQA** activities shall be performed under the direction of a Senior Technician or Field Engineer who has installed a minimum of 5,000,000 square feet (ft^2) of the specified type of geomembrane or similar.

4.2. CQA Inspection and Review Requirements

The **CQA** shall be responsible for inspecting the geomembrane installation to ensure that the work is completed in accordance with the specifications. Inspections and review will include, but not be limited to the following:

- Random visual verification of trial welding results
- Random visual verification of production seaming operations
- Random visual verification of seam testing (air tests) results
- Random visual verification of vacuum box and spark testing
- Random verification of the **Installer CQC** destructive seam strength testing
- Final inspection and approval of completed geomembrane
- Review of the Installer CQC documentation

4.3. CQA Testing Requirements

The **CQA** shall be responsible for the following testing:

- Trial weld verification (10% minimum, randomly selected). Frequency to be increased at the discretion of the **CQA** if conflicting results occur.
- Destructive Test verification (100%). Additional test samples may be collected and tested at the discretion of the **CQA**.

4.4. CQA Reporting and Review of Installer CQC Information

CQA and the **Engineer** will be responsible for reviewing the information submitted by the **Installer's CQC**. This will include the panel deployment log, seaming log and trial weld and destructive testing results as well as the as-built information.

The **CQA** shall also produce a daily report (weekly reports may also be required) and a summary for testing completed (Trial Weld and Destructive Test Results) to document activities associated with installation of the geomembrane.

Table 1: HDPE Geomembrane - Smooth
(per GRI Test Method GM13 revision 12 dated 11/14/2014)

Properties	Test Method	Test Value		Testing Frequency (minimum)
		60 mil (1.5 mm)	80 mil (2 mm)	
Thickness (min. avg.) ▪ Lowest individual of 10 values	ASTM D5199	Nominal -10%	Nominal -10%	Each roll
Density mg/L (min.)	ASTM D1505/D792	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [1] (min. avg.) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	ASTM D6693 Type IV	 126 lbs/in 228 lbs/in 12% 700%	 168 lbs/in 304 lbs/in 12% 700%	20,000 lbs
Tear Resistance (min. avg.)	ASTM D1004	42 lbs	56 lbs	45,000 lbs
Puncture Resistance (min. avg.)	ASTM D4833	108 lbs	144 lbs	45,000 lbs
Stress Crack Resistance [2]	ASTM D5397 (Appendix)	500 hrs	500 hrs	Per GRI-GM10
Carbon Black Content (range)	ASTM D4218 [3]	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	ASTM D5596	Note 4	Note 4	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [5] a) Standard OIT	ASTM D3895	100 min.	100 min.	200,000 lbs
--OR--				
b) High Pressure OIT	ASTM D5885	400 min.	400 min.	
Oven Aging at 85°C [5, 6] a) Standard OIT (min. avg.) – % retained after 90 days	ASTM D5721 ASTM D3895	55%	55%	Each formulation
--OR--				
b) High Pressure OIT (min. avg.) – % retained after 90 days	ASTM D5885	80%	80%	
UV Resistance [7] Standard OIT (min. avg.)	ASTM D7238 ASTM D3895	N.R. [8]	N.R. [8]	Each formulation
--OR--				
High Pressure OIT (min. avg.) - % retained after 1,600 hrs [9]	ASTM D5885	50%	50%	

[1] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches.
[2] The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
[3] Other methods such as D1603 (Tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
[4] Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
[5] The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
[6] It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
[7] The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
[8] Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
[9] UV resistance is based on percent-retained value regardless of the original HP-OIT value.

Table 2: HDPE Geomembrane - Textured

(per GRI Test Method GM13 revision 12 dated 11/14/2014)

Properties	Test Method	Test Value		Testing Frequency (minimum)
		60 mils (1.5 mm)	80 mils (2.0 mm)	
Thickness (min. avg.)	ASTM D5994	Nominal (-5%)	Nominal (-5%)	Per roll
▪ Lowest individual for 8 out of 10 values		-10%	-10%	
▪ Lowest individual for any of the 10 values		-15%	-15%	
Asperity Height mils (min. avg.) [1]	D 7466	16 mil	16 mil	Every 2nd roll[2]
Density mg/L (min. avg.)	ASTM D1505/D792	0.940 g/cc	0.940 g/cc	200,000 lbs
Tensile Properties [3] (min. avg.)	ASTM D6693 Type IV			20,000 lbs
▪ Yield strength		126 lbs/in	168 lbs/in	
▪ Break strength		90 lbs/in	120 lbs/in	
▪ Yield elongation		12%	12%	
▪ Break elongation		100%	100%	
Tear Resistance (min. avg.)	ASTM D1004	42 lbs	56 lbs	45,000 lbs
Puncture Resistance (min. avg.)	ASTM D4833	90 lbs	120 lbs	45,000 lbs
Stress Crack Resistance [4]	ASTM D5397 (App.)	500 hrs	500 hrs	Per GRI-GM10
Carbon Black Content (range)	ASTM D4218 [5]	2.0-3.0%	2.0-3.0%	20,000 lbs
Carbon Black Dispersion	ASTM D5596	Note 6	Note 6	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) [7]				200,000 lbs
a) Standard OIT	ASTM D3895	100 min.	100 min.	
--OR--				
b) High Pressure OIT	ASTM D5885	400 min.	400 min.	
Oven Aging at 85°C [7, 8]	ASTM D5721			Each formulation
a) Standard OIT (min. avg.) - % retained after 90 days	ASTM D3895	55%	55%	
--OR--				
b) High Pressure OIT (min. avg.) - % retained after 90 days	ASTM D5885	80%	80%	
UV Resistance[9]	D7238			Each formulation
a) Standard OIT (min. avg.)	ASTM D3895	N.R.[10]	N.R.[10]	
--OR--				
b) High Pressure OIT (min. avg.) - % retained after 1,600 hrs [11]	ASTM D5885	50%	50%	

1 Of 10 readings; 8 out of 10 readings must be ≥ 14 mils, and the lowest individual reading must be ≥ 12 mils. Also see note 6.
2 Alternate the measurement side for double-sided textured sheet.
3 Machine direction (MD) and cross-machine direction (XMD) average values should be on the basis of five (5) test specimens each direction.
Yield elongation is calculated using a gauge length of 1.3 inches.
Break elongation is calculated using a gauge length of 2.0 inches.
4 P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
5 Other methods, such as D1603 (tube furnace) orD6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.
6 Carbon black dispersion (only near spherical agglomerates) for ten (10) different views: Nine (9) in Categories 1 or 2 and one (1) in Category 3.
7 The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
8 It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.
9 The condition of the test should be 20-hour UV cycle at 75°C followed by 4-hour condensation at 60°C.
10 Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV-exposed samples.
11 UV resistance is based on percent-retained value regardless of the original HP-OIT value.

Table 3: Seam Strength and Related Properties of Thermally Bonded Smooth and Textured HDPE Geomembranes (per GRI Test Method GM19 Revision 7 updated 11/4/2013)

Geomembrane Nominal Thickness	60 mil (1.5 mm)	80 mil (2.0 mm)
Hot Wedge Seams [1]		
Shear strength [2] (lbs/in.)	120	160
Shear elongation at break [3] (%)	50	50
Peel strength [2] (lbs/in.)	91	121
Peel separation (%)	25	25
Extrusion Fillet Seams		
Shear strength [2] (lbs/in.)	120	160
Shear elongation at break [3] (%)	50	50
Peel strength [2] (lbs/in.)	78	104
Peel separation (%)	25	25

[1] Also for hot air and ultrasonic seaming methods.

[2] Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values.

[3] Elongation measurements should be omitted for field testing.

Table 4: Raw Material Properties

Property	Test Method	HDPE
Density (g/cm^3)	ASTM D1505	$\geq$0.932
Melt Flow Index (g/10 min)	ASTM D1238 (190/2.16)	$\leq$1.0
OIT (minutes)	ASTM D3895 (1atm/200°C)	$\geq$100

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1. GENERAL

1.1. Scope

This specification defines the requirements for the manufacturing and installation of the geonet drainage layer associated with the Arizona Minerals Inc. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage project.

Any alternatives or exceptions to this specification shall be submitted in writing to the **Owner** or its designated representative with the bid.

Construction of the Geonet composite material as it pertains to the Underdrain Collection Pond will not be considered complete until it has been approved in writing by the ADWR Director. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** hired by the **Owner** to provide third party 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 Construction" Drawings for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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):

- D1238 – Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
- D1505 – Standard Test Method for Density of Plastics by the Density - Gradient Technique. (D792, Method B)
- D1603 – Standard Test Method for Carbon Black in Olefin Plastics. (D4218)
- D4761 – Standard Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
- D5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).
- D5199 – Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.

1.3.2. Environmental Protection Agency (EPA):

- Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.3.3. Geosynthetic Research Institute (GRI):

- GN-2 and GC-13 – Standard Guide for Joining and Attaching Geonets and Drainage Composites, September 25, 2012, www.geosynthetic-institute.org

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 geonet meets or exceeds the values specified herein.
- The **Contractor** shall submit, if required by the **Engineer**, manufacturer's quality control manual for the geonet to be delivered to the site.

1.5. Submittals during Manufacturing

- Manufacturer quality control certificates stating the name of the manufacturer, product name, length, width, roll number and any other pertinent information to fully describe the geonet.
- 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 geonet 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 geonet products.

1.6. Shipment, Storage and Handling

- 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.
- Delivery of rolls of geonet will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.
- The on-site storage location for the geonet shall be provided by the **Contractor** and shall protect the geonet from abrasions, excessive dirt and moisture. The area shall be level (no wooden pallets), smooth, protected from vandalism and close to the area being lined.
- The **Contractor** and **Installer** shall handle all geonet in such a manner as to ensure it is not damaged in any way.
- The **Installer** shall take all necessary precautions to prevent damage to the underlying layers during placement of the geonet.

1.7. Warranty

- The material shall be warranted, on a prorate basis against defects for a period of 5-yeard from the date of the geonet installation.
- Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geonet completion.

2. PRODUCT

2.1. Geonet Properties

The geonet shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure.

The geonet specified shall have the properties that meet or exceed the values listed in Table 1 below.

Table 1: Required Properties, Test Methods and Values for Geonet

Property	Test Method (ASTM)	Frequency (Minimum)	Units	Values			
Thickness, nominal	D5199	1/ 50,000 ft^2	mils (mm)	200 (5.0)	250 (6.3)	275 (7.0)	300 (7.6)
Density (minimum)	D1505/ D792, Method B	1/ 50,000 ft^2	g/cm3	0.94	0.94	0.94	0.94
Tensile Strength (Machine Direction)	D5035	1/ 50,000 ft^2	lbs./in. (N/mm)	45 (7.9)	55 (9.6)	65 (11.5)	75 (13.3)
Carbon Black Content	D4218/D1603[2]	1/ 50,000 ft^2	%	2-3	2-3	2-3	2-3
Melt Flow Index	D1238, 190°, 2.16kg	Per Resin Lot	g/10 minutes (max.)	≤1.0	≤1.0	≤1.0	≤1.0
Transmissivity[1]	D4716	1/ 500,000 ft^2	m^2/sec	$2x10^{-3}$	$3x10^{-3}$	$6x10^{-3}$	$8x10^{-3}$
Notes: [1] **Gradient of 0.1, normal load of 10,000psf (479 kN/m^2), water at 70°F (21°C), between steel plates for 15 minutes.** [2] **Modified.**							

3. EXECUTION

3.1. Quality Assurance

- The **Engineer** shall examine the geonet 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 Practice D 4354 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 Practice D 4759.

3.2. Installation

- The geonet roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the **Engineer**. At no time shall any vehicles (pickup trucks, cars, Gator Utility Vehicles (or similar), Four Wheeler ATV's (or similar) be driven on the geonet. If so, the **Engineer** shall be informed and inspect the area for damage or require replacement or repairs.
- If the project contains long, steep slopes, special care should be taken so that only full-length rolls are used at the top of the slope.
- In the presence of wind, all geonet shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.
- If the project includes an anchor trench at the top of the slopes, the geonet shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geonet.
- In applying fill material, no equipment can drive directly across the geonet. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.
- The top geomembrane shall be placed on the geonet in a manner that prevents damage to the geonet. Placement of the top geomembrane shall proceed immediately following the placement and inspection of the geonet.

3.3. Seams and Overlaps

- Each component of the geonet will be secured to the like component at overlaps.
- Adjacent edges along the length of the geonet roll shall be overlapped a minimum of 4" or as recommended by the **Engineer**.
- The overlapped edges shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll length. Ties for connecting the seams shall be resistant to degradation due to ultraviolet light and should be compatible with the process solution for which it could be exposed. Ties should be installed such that the clasp of the tie is placed between the grids of the geonet.
- Adjoining rolls across the roll width should be shingled down in the direction of the slope a minimum of 1 foot overlap and joined together with cable ties spaced every foot along the roll width.

3.4. Repairs

- Prior to covering the deployed geonet, each roll shall be inspected by the **Installer** and the **Engineer** for damage resulting from construction.
- Any rips, tears or damaged areas on the deployed geonet greater than 2 inches shall be patched. The patch shall extend 6 inches beyond the damage and shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.3.

4. CERTIFICATION

At the completion of the geonet installation, the **Installer** shall provide the **Owner** with a certification stating that the geonet was installed and tested in accordance with these 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.

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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. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage project.

Any alternatives or exceptions to this specification shall be submitted in writing to the **Owner** or its designated representative with the bid.

Construction related to Geotextile placement as it pertains to the Underdrain Collection Pond will not be considered complete until it has been approved in writing by the ADWR Director. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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.

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- "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 D1883 – Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils
- ASTM D4354 – Practice for Sampling of Geosynthetics for Testing
- ASTM D4491 – Standard Test Method for Water Permeability of Geotextiles by Permittivity
- ASTM D4533 – Test Method for Trapezoidal Tearing Strength of Geotextiles
- ASTM D4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
- ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile
- ASTM D4759 – Practice for Determining the Specification Conformance of Geosynthetics
- ASTM D4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
- ASTM D4873 – Guide for Identification, Storage and Handling of Geotextiles
- ASTM D5261 – Test Method for Measuring Mass per Unit Area of Geotextiles
- ASTM D5494 – Test Method for the Determination of Pyramid Puncture Resistance of Unprotected and Protected Geomembranes
- ASTM D6241 – Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Product Using a 50-mm Probe
- ASTM D7238 – 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):

- M288-05 – Geotextile Specification for Highway Applications

1.3.3. Geosynthetic Research Institute (GRI):

- GRI GT12 (a) – Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials, Revision 1, December 18, 2012, www.geosynthetic-institute.org.
- GRI GT13 (a) – Test Methods and Properties for Geotextiles Used as Separation between Subgrade Soil and Aggregate, Revision 3: December 19, 2012 www.geosynthetic-institute.org.

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
Grab tensile strength	D4632	lb	230	300	370	450	500	630
Grab tensile elongation	D4632	%	50	50	50	50	50	50
Trap. tear strength	D4533	lb	95	115	145	200	215	290
Puncture (pin) strength	D4833	lb	120	140	170	250	300	390
UV resistance[2]	D7238	%	70	70	70	70	70	70

Table 2 – Alternative Puncture Test Methods to be Considered in Place of Pin Puncture, ASTM D4833, in Table 1

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 3, 4 and 5 below with the exception of AOS which is maximum average roll value (MaxARV) and UV stability which is a minimum average value:

Table 3– Geotextile Properties Class 1 (High Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation $\geq$ 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	50	50

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 2 (Moderate Survivability)

Property[1]	ASTM Test	Unit	Elongation < 50%	Elongation $\geq$ 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	50	50

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– 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	50	50

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 6 – 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 (unsoaked).
Source: Modified after Christopher, Holtz and DiMaggio

3. EXECUTION

3.1. Quality Assurance

- The **Engineer** or **Third Party Testing Contractor** 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 Practice D 4354 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 Practice D 4759.

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 **Third Party Testing Contractor**, 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 latter 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 **Third Party Testing Contractor**.
- 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 into the drainage system could occur. This is accomplished by ensuring sufficient overlap of seams of 18-inches minimum overlap 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.

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PROJECT TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE		
TITLE TECHNICAL SPECIFICATIONS FOR HIGH DENSITY POLYETHYLENE (HDPE) PIPE		**SPECIFICATION NO.** 0014_SPT_HDP0014_SPT_HDP.DOCX

REV	DATE	PAGES	APPROVALS: AUTHOR	REVIEW	CLIENT	REMARKS
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LIST OF TABLES

1. GENERAL

This specification defines the requirements for High-Density Polyethylene (HDPE) PE4710 pipe materials, installation, and quality control associated with the Arizona Minerals Inc (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage project.

Any alternatives or exceptions to this specification shall be submitted in writing to the Owner or its designated representative and shall be approved by the Engineer.

Construction of the High Density Polyethylene (HDPE) pipe in association with the Underdrain Collection Pond is not considered complete until it has been approved in writing by the ADWR Director. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** hired by the **Owner** to provide third party 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 Construction" Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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 pipework 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 SPI
- IPS Iron Pipe Sizing

1.3. HDPE Materials

Materials used for the manufacture of high-density polyethylene (HDPE) pipe and fittings shall have a standard thermoplastic material designation code of PE 4710 and comply with all requirements for ASTM D3350. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from the resin of the same specification and from the same raw material supplier. The dimensional and performance characteristics shall conform to the requirements of ASTM F714 for sizes 4-inches IPS and larger and conform to ASTM D3035 for sizes smaller than 4-inches IPS. In addition, materials used for the manufacture of the HDPE pipe and fittings shall meet the following physical property requirements listed in the table below:

Table 1: Physical Material Properties for HDPE Pipe (PE 4710)

Property	Unit	Standard	Nominal Value
Material Designation	-	ASTM F412	PE 4710
Cell Classification	-	ASTM D3350	445474 C (black)
Density (Natural)	gm/cc	ASTM D1505	0.947
Density (Black)	gm/cc	ASTM D1505	0.959
Melt Index	gm/10 minutes	ASTM D1238	< 0.08
Flexural Modulus	Psi	ASTM D790	140,000
Tensile Strength @ Ultimate	Psi	ASTM D638	5,000
Tensile Strength @ yield	Psi	ASTM D638	>3,600
PENT	hours	ASTM F1473	>500
ESCR	hours	ASTM D1693	>10,000
HDB at 73°F (23°C)	Psi	ASTM D2837	1,600
Color; UV Stabilizer	% C	ASTM D1603	Black with minimum 2% carbon black Color with UV Stabilizer
Modulus of Elasticity (long term)	Psi	ASTM D638	30,000

The pipe manufacturer's quality control system shall be certified by an appropriate independent body to meet the requirements of the ISO 9002 Quality Management Program.

All stub ends/flange adapters, shall be of at least the same wall thickness and pressure rating and the same resin type and manufacturer as the pipe to be joined, unless otherwise approved. Backing flanges for HDPE pipe shall be the convoluted type of ductile iron material (ASTM A536 grade range from 60/40/18 to 65/45/12, drilled to ANSI bolt circles, and have a pressure rating of 150 psi) unless otherwise approved by the **Engineer**.

Fabricated fittings intended for use in non-pressure or low pressure services may be manufactured from the same diameter and DR rating as used in the piping system (Note: The pressure rating of these fittings will be approximately only 75 percent of the straight pipe of the same DR). Fittings not intended for use in pressure service shall be clearly marked or tagged.

Fabricated fittings intended for use in pressure service shall meet or exceed the design pressure of the piping system and be fabricated from pipe of at least the next numerically smaller dimension ratio unless otherwise shown on the Drawings. Ends shall be machined to match the joining pipe DR.

Where HDPE and corrugated polyethylene (CPe) pipes are connected, manufactured fittings shall be used unless approved otherwise by the **Engineer**. All other joints shall be fused or flange-jointed as shown on the Drawings. Flange assembly bolts, when specified as machine bolts, shall conform to the requirements of ASTM A307, Grade A standard, square-head machine bolts conforming to ASME/ANSI B 18.2.1 with heavy hot-pressed hexagon nuts. Bolt length shall be such that, after joints are made up, bolts shall protrude through the nut by at least than ½ inch.

Stud bolts, when specified, shall be ASTM A193 Grade B7 with two-hex head nuts, ASTM A194 Grade 2H per each for above ground service and ASTM A193 Grade B8 with Stainless Steel nuts in accordance with ASTM A194. Alternately, commercial Grade 18-8 Stainless Steel bolts and nuts may be used for buried service.

Gaskets shall be used at all flanged connections and shall be full face, black nitrile rubber gaskets (Garlock style 9122 or equal), and $^{1}/_{8}$ inch thick.

1.4. Submittals

The **Contractor**'s HDPE pipe supplier shall submit to the **Owner** test data for each lot and a manufacturer's certification that all pipe and fittings under their 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. 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 all material furnished to him 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 by the **Owner**. This shall include the furnishing of all materials and labor required for the replacement of installed material discovered damaged prior to the final acceptance of the work.

1.6. Pipe Installation

1.6.1. General

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 Third Party Testing Contractor** 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 and/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.

Wherever obstructions not shown on the plans are encountered during the construction and where such obstructions interfere with the work to the 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.

1.6.2. Joining

1.6.2.1. Heat Fusion

Pipe and fittings shall be joined by one of the following types of thermal fusion in accordance with the manufacturer's recommended procedures: butt fusion, saddle fusion, or socket fusion.

Upon request, the manufacturer shall provide fusion training by authorized personnel or an authorized representative. The **Contractor** shall be responsible for ensuring that personnel have received proper training in accordance with the manufacturer's recommended procedure. Records of training shall be maintained by the **Contractor** and evidence of training shall not exceed 12 months from date of construction.

Butt fusions performed between pipe ends or pipe ends and fitting outlets shall be within the following allowable wall mismatches:

- 2 DR difference for pipe and fitting diameters 6-inch IPS and smaller
- 1 DR difference for above 6-inch through 18-inch
- No difference for diameters above 18-inch.

The difference in DR is determined from the following DR values: 7.3, 9, 11, 13.5, 17, 21, 26, and 32.5.

1.6.2.2. Other Methods of Joining

Polyethylene pipe and fittings where heat fusion is not possible may be joined together or to other materials through the use of electrofusion fittings; flange adapters with backup rings; mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material; or Mechanical Joint (MJ) adapters. All alternative joining methods and devices shall be approved by the Engineer. The manufacturer of the joining device shall be consulted for proper installation procedures.

1.6.3. Marking

Pipe and tubing shall be permanently marked in accordance with all applicable standards in accordance with this Specification. Marking, as follows, shall be continuously (or spaced at intervals not exceeding 5 feet) heat-stamped indent print and shall remain legible under normal handling and installation practices:

1. Name and/or trademark of the pipe manufacturer.
2. Nominal pipe size
3. Dimension Ratio
4. The letters PE followed by the polyethylene grade per ASTM D3350, followed by the Hydrostatic Design basis in 100's of psi, e.g., PE4710
5. Manufacturing Standard Reference, e.g., ASTM F714
6. A production code from which the date and place of manufacture can be determined

Fittings shall be marked on the body or hub. Marking shall be in accordance with the applicable standard depending on the fitting type. Marking on the fitting shall include the following whenever possible:

1. Nominal size and Outside Diameter (OD) base (such as 12-inch IPS)
2. Standard material code designation (such as PE 4710)
3. Dimension ratio
4. Pressure class if for pressure service

Mechanical fittings shall be marked with size, body material designation code, pressure rating, and the manufacturer's name or trademark.

1.6.4. Testing

The **Contractor** shall be responsible for field setup and performance of the fusion equipment and the fusion procedure used by the operator. Upon request, the **Contractor** shall verify the fusion quality by marking and testing in accordance with the manufacturer's recommended qualification procedure or by using Time-of-Flight ultrasonic testing. The **Contractor** shall be responsible for the necessary adjustments to the setup, equipment, operation, and fusion procedure. Fusions that fail the qualification procedure shall be remade.

Hydrostatic testing shall be conducted if required by the **Owner** to a minimum of 110 percent of the maximum operating pressure or design pressure, whichever is greater.

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TITLE TECHNICAL SPECIFICATIONS FOR GEOTECHNICAL INSTRUMENTATION MATERIALS AND CONSTRUCTION		**SPECIFICATION NO.** 0014_SPT_IN

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1. GENERAL

This specification defines the requirements for the geotechnical instrumentation materials and installation associated with the Arizona Minerals Inc. (**Owner**) Tailings and Potentially Acid Generating (PAG) Material, Placement and Storage project. Piezometers and settlement monuments will be installed to monitor the performance of the embankment.

Any alternatives or exceptions to this specification shall be submitted in writing to the **Owner** or its designated representative and shall be approved by the **Engineer.**

Geotechnical instrumentation installation as it pertains to the Underdrain Collection Pond is not considered complete until it has been approved in writing by the ADWR Director. Construction drawings and specifications specific to the Underdrain Collection Pond shall not be changed without written approval by the ADWR Director. All piezometers and associated installation elements shall be placed by a specialty contractor with experience in placement of instruments, proper routing and bedding of cable and connection to a terminal readout box. The owners 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 Arizona Minerals Inc. (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.
- "**Third Party Quality Control (QC) Contractor**" is defined as the **Consultant** or **Engineering Company** (to be determined) hired by the **Owner** to provide third party 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 Construction" Drawings for the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage 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.

2. PIEZOMETERS

Vibrating wire piezometers will be placed as shown on the Drawings. The vibrating wire piezometer consists of a transducer that uses a pressure sensitive diaphragm with a vibrating wire element attached to it. The diaphragm is welded to a capsule that is evacuated and hermetically sealed. Fluid pressures acting upon the outer face of the diaphragm cause deflections of the diaphragm and changes in tension and frequency of the vibrating wire. The changing frequency is sensed and transmitted to the readout device by electrical coil acting through the wall of the capsule. Piezometers incorporate a porous filter stone ahead of the diaphragm, which allows the fluid to pass through but prevents soil particles from impinging directly on the diaphragm.

2.1. Piezometer and Pressure Transducer

The piezometer shall have an average accuracy of 0.1 percent over its entire pressure range of 0 to 350 kPa (0 to 50 psi). Calibration data must be provided with each instrument. The transducer shall be capable of operation in temperatures from -20 to 80°C. The transducer shall have an over-pressurization capability of two times (2x) the rated pressure. Each piezometer shall be provided with a 50-micron sintered stainless steel filter. All materials shall be stainless steel except the vibrating wire. The interior shall be hermetically sealed to provide a stable, inert atmosphere around the wire to ensure long life of the gauge. Each piezometer shall be equipped with a thermistor with a range of -50°C to 60°C with an accuracy of ±1°C. Vibrating wire piezometers shall be as manufactured by Geokon, Inc., 48 Spencer Street, Lebanon, New Hampshire 03766, Model No. 4500HD Heavy Duty (350 kPa/50 psi), or approved equal.

2.2. Piezometer Cable

Each vibrating wire piezometer will be furnished with sufficient electrical cable for its required length, an additional 5 percent for slack, and an additional 10 feet per instrument connection to readout box. The cables shall be waterproof with good electrical properties. Each cable shall be four-conductor wires of commercially pure annealed copper or tinned copper. The conductors shall be installed with colored insulating-grade, 10-mil high-density polypropylene. All conductors in any single length of wire shall be insulated with the same type of material. The piezometer conductor insulation colors shall be red, white, black, and green. The four conductor wires shall be jacketed with extruded PVC temperature rated from -20°C to +80°C or other approved equivalent.

Each cable shall be attached to the appropriate piezometer and permanently marked with the number of the instrument to which it is attached. This marking shall be every 10 feet over the length of the cable and shall be placed on the cable by the instrument manufacturer prior to shipment to the construction site. Each cable shall be mounted on a reel and protected to prevent damage during shipping. Each reel shall be stenciled or labeled with the name of the instrument, and all wire ends shall be capped on the open end of the wire on the reel. The electrical cables shall be as supplied by Geokon, Model No. 02-500PE1, or approved equal.

2.3. Piezometer Readout Equipment

A Model GK-405 readout box will be used for collecting data from the piezometers and supplied by the **Contractor** to the **Owner** at the end of the Project.

All piezometer leads shall terminate at a common location as shown on the Drawings. All leads shall be clearly marked with each instrument number on the terminal panels. A lockable, waterproof, and dust-resistant steel Geokon Model 4999 Terminal Box is required to house the terminal ends of the cables at each location. The box shall be mounted on a reading platform as shown on the Drawings.

2.4. Piezometer Initial Readings

Upon receipt of the piezometers, their zero readings shall be checked and noted. Connections from the GK-405 readout are normally black-to-black and red-to-red, etc. The thermistor, included inside the body of each piezometer, is read on the green-and-white connectors.

Calibration data is supplied with each piezometer. This includes a zero reading at a specific temperature and barometric pressure. Zero readings at the site should coincide with the factory readings within a few digits after barometric and temperature corrections are made.

According to Geokon, the factory elevation is approximately 580 feet. Barometric pressure changes with elevation at a rate of approximately 0.16 psi per 3,280 feet.

For accurate results, total saturation of the filter is necessary prior to installation. For the low air entry filter normally supplied, this saturation occurs as the tip is lowered into water. Water is forced into the filter, compressing the air in the space between the filter stone and the pressure sensitive diaphragm. After a period, this air will dissolve into the water until the space and the filter are entirely filled with water. (To maintain saturation, the unit should be kept under water until installation.) Refer to the vendor's instruction manual for the proper procedure for saturating (de-airing) the filter tip.

It is important that the temperature of the piezometer be uniform and held constant. Otherwise, variations in temperature across the body of the piezometer will give rise to temperature transients and spurious readings. These are particularly noticeable if the piezometer is gripped momentarily in the hand.

When measuring the in situ zero pressure reading, the piezometer must be maintained in a constant temperature environment for a period of about 30 minutes.

2.5. Piezometer Installation

The piezometers will be installed as shown on the Drawings. Installation procedures will be as follows:

- Piezometers with adequate cable length will be fabricated in the factory. Actual field measurements will determine the specific lengths based on installation near the locations shown on the Drawings.
- Piezometers will be placed at each location and laid within a sand wrap as shown on the drawings.
- Piezometer cables to be placed in a protective HDPE pipe.
- Piezometer cable and protective HDPE pipe located outside the geomembrane limits and under an embankment fill will be constructed in accordance with the Drawings. Piezometer cables to be hand backfilled with fine grained materials to provide at least 6 inches of bedding and 12 inches of cover below/above the cables. Bentonite plugs may be required at select locations by the **Engineer**.
- Piezometer cable and protective HDPE pipe placed within the geomembrane limits to be constructed within the protective layer.
- **Contractor** will perform an as-built survey of all piezometer locations and elevations before covering with fill material.

- Piezometer cable leads will be protected by the **Contractor** while the remainder of the embankment is constructed.

3. SETTLEMENT MONUMENTS

Each settlement monument will consist of a 6-foot long, #10 rebar driven into the ground to depth or until refusal is achieved. At each settlement monument location, a 6-inch diameter hole will be excavated to a depth of 18 inches and a 4-inch diameter ABS pipe shall be installed and backfilled around the monument. The interior of the pipe shall be backfilled with hand-packed pea gravel. An aluminum cap will be placed on the rebar to provide a measuring platform for surveying.

APPENDIX G.2

Construction Material Properties

Agru GeoClay NN66

Geotextile Component

Geotextile Property	Test Method	Frequency	Minimum Average Roll Value
Upper Nonwoven, Mass/Unit Area, oz/yd²(g/m²)	ASTM D5261	200,000 sf	6.0 (200)
Lower Nonwoven, Mass/Unit Area, oz/yd²(g/m²)	ASTM D5261	200,000 sf	6.0 (200)

Bentonite Property[1]	Test Method	Test Method	Minimum Average Roll Value
Swell Index, ml/2 g min	ASTM D5890	100,000 lb	24
Moisture Content, %	ASTM D4643	100,000 lb	12% max
Fluid Loss, ml	ASTM D5891	100,000 lb	18 max

Finished GCL Property	Test Method	Test Method	Minimum Average Roll Value
Bentonite, Mass/Unit Area[2], lb/ft² (kg/m²)	ASTM D5993	40,000 sf	0.75 (3.6)
Tensile Strength[3], lb/in (N/cm)	ASTM D6768	40,000 sf	50 (87)
Peel Strength[3] lb/in (N/cm)	ASTM D6496	40,000 sf	3.5 (6.1)
Hydraulic Conductivity[4] cm/sec max	ASTM D5887	1/week	5×10^{-9}
Index Flux[4] m³/m²/sec max	ASTM D5887	1/week	1×10^{-8}
Internal Shear Strength[5] psf (kPa)	ASTM D6243	Periodically	500 (24) Typical

Supply Information

Roll Size	Width		Length		Area	
	ft	m	ft	m	ft²	m²
	15.5	4.7	150	45.7	2,325	216

Notes:
(1) Bentonite properties tests performed at a bentonite processing facility prior to shipment to GCL production facility.
(2) Reported at 0% moisture
(3) Tensile strength testing performed in MD using ASTM D 6768.
(4) Deaired, deionized water @5 psi maximum effective confining stress and 2 psi head pressure.
(5) Specimens are hydrated for 24 hours and sheared at 200 psf. Represent typical peak value.
Rolls weigh approximately 2,600 lbs, are supplied with two straps and wound on a 4.75" core.

500 Garrison Road, Georgetown, South Carolina 29440 (843) 546-0600 (800) 373-2478 Fax: (843) 527-2738
email: salesmkg@agruamerica.com www.agruamerica.com

BENTOMAT® DN

GEOSYNTHETIC CLAY LINER

BENTOMAT DN CERTIFIED PROPERTIES			
MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY $ft^2(m^2)$	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24 mL/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18 mL max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.6 kg/m^2) min
GCL Grab Strength[3]	ASTM D 6768	200,000 ft^2 (20,000 m^2)	50 lbs/in (88 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux[4]	ASTM D 5887	Weekly	1 x 10^{-8} m^3/m^2/sec max
GCL Hydraulic Conductivity[4]	ASTM D 5887	Weekly	5 x 10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

Bentomat DN is a reinforced GCL consisting of a layer of sodium bentonite between two nonwoven geotextiles, which are needlepunched together.

Notes

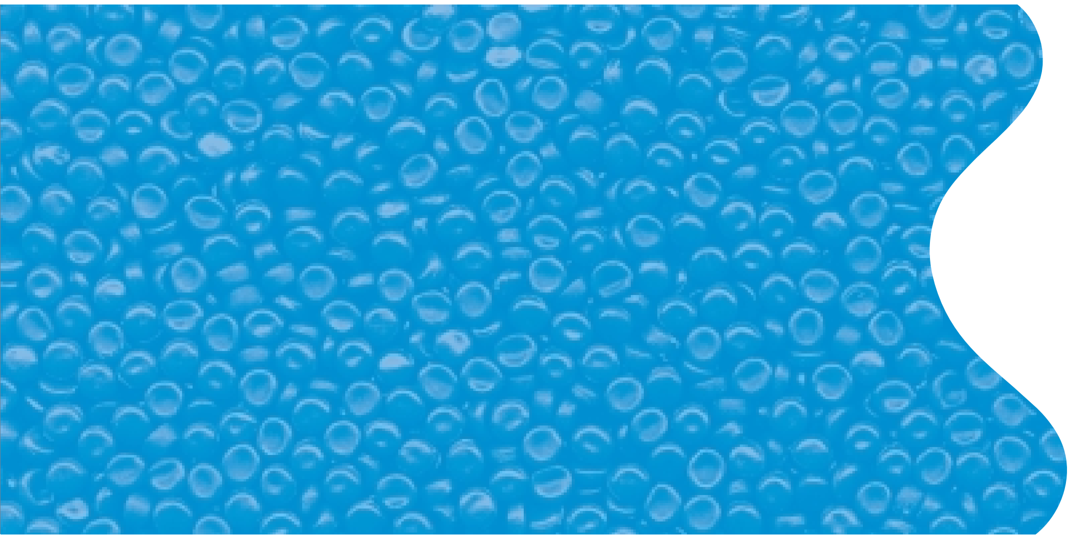
1 Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.
2 Bentonite mass/area reported at 0 percent moisture content.
3 All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.
4 Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5x10^{-9} cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.
5 Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

CETCO has developed an edge enhancement system that eliminates the need to use additional granular sodium bentonite within the overlap area of the seams. We call this edge enhancement, SuperGroove™, and it comes standard on both longitudinal edges of Bentomat® DN. It should be noted that SuperGroove™ does not appear on the end-of-roll overlaps and recommend the continued use of supplemental bentonite for all end-of-roll seams.

TR 401-BMDN 05/07

North America: 847.851.1800 | 800.527.9948 | www.CETCO.com

English



Polyethylene

Resistance to chemicals and other media

Lupolen (LDPE, HDPE)
Hostalen (HDPE)
Lupolex (LLDPE)
Luflexen (mLLDPE)

basell
Polyolefins

Formed in October 2000, Basell is owned equally by BASF and Shell. Basell and its joint ventures serve customers in more than 120 countries with materials produced in 18 countries. The company's network of joint ventures expands Basell's technology and market base and enables the company to follow key customers as they expand and globalize their operations.

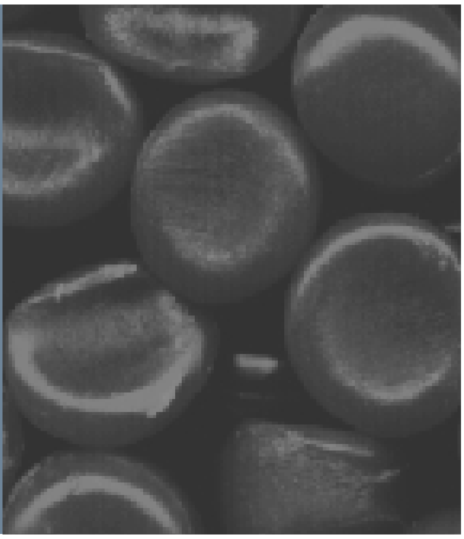
With research and development centers in Europe, North America and the Asia-Pacific region, Basell is continuing and expanding a technological heritage that dates back to the start of the polyolefins industry. The company is committed to continuously extending the property profile of its polyolefins portfolio and to developing with its customers a shared agenda for bringing new products to market as quickly as possible.

Basell is committed to strong Health, Safety and Environmental (HSE) performance. The company's products are used in countless consumer and industrial goods from food and drink packaging to car components, and from household products to underground piping.

Basell's corporate center is located in Hoofddorp, The Netherlands, near Amsterdam. The company has regional offices in Brussels, Belgium; Mainz, Germany; Elkton, Maryland, USA; São Paulo, Brazil; and Hong Kong, as well as sales offices in the major markets around the world.

About Basell

Basell develops, produces and markets polypropylene, polyethylene, advanced polyolefin materials and polyolefin catalysts and also develops and licenses polyolefin processes.



The Resistance to Chemicals

Lupolen, Lupolex, Luflexen and *Hostalen* resins are highly resistant to chemicals due to their hydrocarbon character and degree of crystallinity.

The proportion of crystalline matter in a linear, high-density polyethylene is about 70 to 80 %; in branched polyethylene of low to medium density, 40 to 45 %. The resistance to chemicals is thus reduced in this sequence. The adverse action of chemicals may consist of diffusion through the polyethylene articles, swelling or dissolving, or direct attack, e. g. by oxidation.

Polyethylene is not absolutely impermeable to gases. In fact some liquids, particularly aromatic, aliphatic, and low-boiling chlorinated hydrocarbons, e. g. benzene and carbon tetrachloride, may diffuse through polyethylene even at low temperatures. The higher the temperature and the lower the degree of crystallinity, the greater the diffusion rate.

Lupolen, Lupolex, Luflexen and *Hostalen* resins are completely resistant at room temperature to water, alkalis, solutions of salts, and inorganic acids[1)] (with the exception of those acids that are oxidizing agents). At low temperatures polar liquids, such as alcohols, organic acids, esters, ketones, etc. will generate a very slight swelling of the resins. In contrast aliphatic and aromatic hydrocarbons and their halogen derivatives are taken up more readily and cause considerable swelling.

Swelling is associated with a decrease in strength, but the original properties are restored upon evaporation of the liquid concerned. This is not the case with low-volatile substances, e. g., greases, oils, waxes, etc. Swelling and the related impairment of properties decreases with decreasing temperatures and with increases in crystallinity of the polyethylene.

At elevated temperatures, *Lupolen, Lupolex, Luflexen* and *Hostalen* resins are soluble in aliphatic, aromatic and chlorinated hydrocarbons to an extent depending on their density. The temperature at which these materials are dissolved increases with the degree of crystallinity. For instance, *Lupolen* resins with a density of 0.960 g/cm³ swell only slightly in benzene at the boiling point, whereas *Lupolen* resins with a density of 0.918 g/cm³ dissolve completely.

Despite their good resistance to chemicals, polyethylene mouldings are sometimes subject to environmental stress cracking if they are exposed to the simultaneous action of certain polar liquids and mechanical stresses, particularly tension or bending.

Notorious initiators of environmental stress cracking are silicone and essential oils, alcohols, organic acid, and aqueous solutions of surfactants, e. g., modern detergents, soaps, emulsifying agents etc. aqueous solutions of alkalis, e. g., caustic soda, soda or waterglass, may also give rise to environmental stress cracking, but not to a great extent.

Even if no external load is applied, high moulded-in stresses could favour environmental stress cracking if a moulded part gets in contact with any of the reagents mentioned above. Polyethylene with a low melt index is more resistant to environmental stress cracking.
The resistance to chemicals of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins is included in the attached tables. For the sake of convenience, all the products have been classified into two groups, viz.,

LDPE, LLDPE, mLLDPE
($\rho = 0.918 - 0.935$ g/cm³)

MDPE, HDPE
($\rho = 0.935 - 0.960$ g/cm³)

The results of such chemical resistance tests are often subject to external influences that are difficult to define. For instance, a polyethylene may be listed as resistant to some substances, but may be damaged if it is immersed in each one of them, one after the other. In addition, the temperature, mechanical load, duration of exposure and permissible tolerances can vary considerably in practice. In such cases, Basell should be contacted or practical tests should be conducted.

The purpose of the resistance tables is to give a preliminary idea on the performance of a given moulding or to facilitate selection of suitable grades.

This does not preclude the need to check the chemical resistance of the particular finished article under the specific service conditions as part of overall design testing, e. g. of drums for the transport of dangerous goods. The information listed is not necessarily valid for all applications.

Table

Plastic test specimens were immersed for 60 days in the test substance without mechanical stress and then tested for swelling, weight loss and tensile properties.

Test specimen:
50 mm x 25 mm x 1 mm and test specimen 1B according to ISO 527-2, with dimensions in the ratio 1:4, both taken from compression moulded sheet.

Explanation of symbols:

✚ = **resistant**
tensile strength at yield and elongation at break unchanged

○ = **limited resistance**
tensile strength at yield and elongation at break slightly reduced

▭ = **not resistant**
tensile strength at yield and elongation at break greatly reduced

▽ = **discolouration possible**

☆ = **and at boiling point**

☆☆ = **not applicable to welded joints**
(including joints produced by thermal bending); information available from us or the semifinished product manufacturer

1) Strong acids can cause shade changes, particularly in coloured material
Lupolen, Lupolex, Luflexen and *Hostalen* are trademarks owned or used by Basell

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Acetaldehyde	techn. grade	+	○	+	−
Acetaldehyde, aqueous	any	+	○	+	
Acetaldehyde + acetic acid	90:10	+		+	
Acetamide		+	+	+	
Acetic acid	100 %	+	○▽	+	○▽
Acetic acid, aqueous	70 %	+	+	+	+
Acetic anhydride	techn. grade	+	○▽	+	
Acetoacetic acid		+		+	
Acetone	techn. grade	+	+*	○	
Acetophenone		+		○	
Acetylene		+			
Acids, aromatic		+	+	+	
Acronal® dispersions	as supplied commerc.	+	○	+	
Acrylonitrile	techn. grade	+	+	+	○
Adipic acid, aqueous	saturated	+	+	+	+
Adipic ester		+	○		
Air	techn. grade	+	+	+	+
Aktivin® (chloramine, aqueous 1 %)		+	+	+	+
Allyl acetate		+	+ to ○	+	○
Allyl alcohol (2-propenol-1)	96 %	+	+	○	○
Allyl chloride		○	−	−	−
Aluminium chloride, aqueous	any	+	+	+	+
Aluminium chloride, solid		+	+	+	+
Aluminium fluoride	conc.	+	+	+	+
Aluminium hyroxide		+	+	+	+
Aluminium metaphosphate		+	+	+	+
Aluminium sulphate, aqueous	saturated	+	+	+	+
Aluminium sulphate, solid		+	+	+	+
Alum, aqueous	any	+	+	+	+
Amino acids		+	+	+	+
2-aminoethanol (ethanolamine)	techn. grade	+		+	
Ammonia, gaseous		+	+	+	
Ammonia, liquid		+		+	
Ammonia water	any	+	+	+	
Ammonium acetate, aqueous	any	+	+	+	+
Ammonium bicarbonate, aqueous	saturated	+	+	+	+
Ammonium carbonate, aqueous	any	+	+	+	+
Ammonium chloride, aqueous	any	+	+	+	+
Ammonium fluoride, aqueous	saturated	+	+	+	+
Ammonium hydrosulphide, aqueous	any	+	+	+	+
Ammonium metaphosphate		+	+	+	+
Ammonium nitrate, aqueous	any	+	+	+	+
Ammonium phosphate, aqueous	any	+	+	+	+
Ammonium sulphate, aqueous	any	+	+	+	+

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/mLLDPE at 20 °C	60 °C
Ammonium sulphide, aqueous	any	+	+	+	+
Ammonium thiocyanate		+	+	+	+
Amyl acetate	techn. grade	+	+	+	○
Amyl alcohol (C5 alcohols)	techn. grade	+	+	+	○
Amyl chloride	100 %	○	−	−	−
Amyl phthalate		+	○	○	○
Aniline	any	+	+	+	○
Aniline hydrochloride, aqueous	any	+	+	+	+
Animal oils		+	○	+	○
Aniseed		○	○ to −	−	−
Aniseed oil		○	−	−	−
Anisole		+	−	○	−
Anone (cyclohexanone)		+	○	○	−
Anthraquinone sulphonic acid, aqueous (susp.)		+	+	+	+
Antifreeze (automotive)	as supplied commerc.	+	+	+	+
Antimony chloride, anhydrous		+	+	+	+
Antimony pentachloride		+	+	+	+
Antimony trichloride		+	+	+	+
Aqua regia (HCl + HNO3)		−		−	
Aromatic oils		○	−	○	−
Arsenic acid, aqueous	any	+	+	+	+
Arsenic anhydride		+	+	+	+
Ascorbic acid		+	+	+	+
Asphalt		+	○▽	+	○▽
Aspirin®		+		+	
Barium hydroxide, aqueous	any	+	+	+	+
Barium salts, aqueous	any	+	+	+	+
Battery acid		+	+	+	+
Beater glue (animal glue)	as supplied commerc.	+	+		
Beef tallow		+	+ to ○	+	○
Beer		+	+	+	+
Beer sugar colouring	as supplied commerc.	+	+	+	+
Beeswax		+	○ to −	+	−
Benzaldehyde, aqueous	any	+	+ to ○	○	○
Benzaldehyde in isopropyl alcohol	1 %	+	+	+	○
Benzene	techn. grade	○	−	○	−
Benzene sulphonic acid		+	+	+	+
Benzoic acid, aqueous	any	+	+	+	+
Benzoyl chloride		○	○	−	
Benzyl alcohol		+	+	+	○
Benzyl chloride		○	−	−	
Bichromate – sulphuric acid	conc.	−		−	
Bismuth salts		+	+	+	+

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Bisulphite liquor		+	+		
Bitumen		+	○▽	+	○▽
Bleaching solution with 12.5 % active chlorine**		○	−	○	−
Bone oil		+	+	+	+
Borax (sodium tetraborate), aqueous	saturated	+	+	+	+
Boric acid, aqueous	any	+	+	+	+
Boric acid methyl ester		+	○ to −	+	−
Boron trifluoride		+	+ to ○	+	○
Brake fluid		+	+	+	○
Brandy		+	+	+	+
Bromic acid	conc.	−		−	
Bromine, liquid	100 %	−		−	
Bromine vapours		−		−	
Bromine water	cold saturated	+		+	
Bromochloromethane		−		−	
1,3-butadiene, gaseous	techn. grade	○	−		
Butanediol, aqueous	any	+	+	+	+
Butanetriol, aqueous	any	+	+	+	+
Butane, gaseous		+			
Butanol, aqueous	any	+	+	+	○
Butanone		+	○ to −	+	−
2-Butenediol-1,4	techn. grade	+		+	
2-Butinediol-1,4	techn. grade	+		+	
Butoxyl® (methoxybutylacetate)		+	○		
Butter		+		+	
Butylene glycol	techn. grade	+	+	+	+
Butyl acetate (acetic acid butyl ester)	techn. grade	+	○	+	○
Butyl acrylate		+	○	+	○
Butyl alcohol		+	+	+	○
Butyl benzyl phthalate		+	+	○	○
Butyl glycol (ethylene glycol monobutylether)	techn. grade	+		+	
Butyl phenol	techn. grade	+	+	○	
Butyl phenone	techn. grade	−		−	
Butyl phthalate (dibutyl phthalate)	techn. grade	+	○	○	○
Butyric acid, aqueous	any	+	○	+	○
Calcium carbide		+	+	+	+
Calcium carbonate		+	+	+	+
Calcium chlorate, aqueous	saturated	+	+	+	+
Calcium chloride, aqueous	saturated	+	+	+	+
Calcium hydroxide		+	+	+	+
Calcium hypochlorite, aqueous (suspension)	any	+	+	+	+
Calcium nitrate, aqueous	50 %	+	+	+	+
Calcium oxide (powder)		+	+	+	+

Substance	Concentration	Behaviour of MDPE/HDPE at		Behaviour of LDPE/LLDPE/ mLLDPE at	
		20 °C	60 °C	20 °C	60 °C
Calcium phosphate		✚	✚	✚	✚
Calcium sulphate		✚	✚	✚	✚
Calcium sulphide, aqueous	≤ 10%	○	○		
Camphor		○	▭	○	▭
Camphor oil		▭		▭	
Cane sugar, aqueous	any	✚	✚	✚	✚
Carbazole		✚	✚		
Carbolic acid (phenol)		✚	✚▽	○	○▽
Carbolineum	as supplied commerc.	✚		○	
Carbolineum, aqueous (for fruit trees)		✚▽	○▽	○▽	○▽
Carbonic acid, aqueous	any	✚	✚	✚	✚
Carbonic acid, dry	100%	✚	✚		
Carbon dioxide	100%	✚	✚		
Carbon disulphide		○	▭	○	▭
Carbon monoxide, gaseous	techn. grade	✚	✚		
Carbon tetrachloride		○	▭	▭	▭
Castor oil		✚	✚	✚	○
Caustic soda solution	any	✚	✚	✚	✚
Cetyl alcohol (hexadecanol)		✚	✚	✚	
Chloral hydrate, aqueous	any	✚	✚▽	✚	✚▽
Chloral (trichloroacetaldehyde)	techn. grade	✚	✚		
Chloramine, aqueous	saturated	✚		✚	
Chloric acid, aqueous	1%	✚	✚	✚	✚
Chloric acid, aqueous	10%	✚	✚	✚	✚
Chlorinated lime		✚	✚	✚	✚
Chlorine, aqueous solution (chlorine water)	saturated	✚	○	✚	○
Chlorine, gaseous, dry		○	▭	○	▭
Chlorine, gaseous, moist		○	▭	○	▭
Chlorine, liquid		▭		▭	
Chlorine bleaching solution with 12.5% active chlorine		○	▭	○	▭
Chloroacetic acid, aqueous	≤ 85%	✚	✚	✚	✚
Chloroacetic acid (mono), aqueous	any	✚	✚	✚	○
Chlorobenzene		○	▭	○	▭
Chloroformic acid ester		✚	○		
Chloroform	techn. grade	○ to ▭	▭	▭	▭
Chloropicrin		✚ to ○	▭		
Chlorosulphonic acid	techn. grade	▭	▭	▭	▭
Chrome alum (potassium chromic sulphate), aqueous	saturated	✚	✚	✚	✚
Chrome anode slime		✚	✚	✚	✚
Chrome salts, aqueous	any	✚	✚	✚	✚
Chromic acid, aqueous**	50%	○	▭▽	○	▭▽
Chromium trioxide, aqueous**	50%	○	▭▽	○	▭▽
Chromosulphuric acid		▭		▭	
Cider		✚	✚	✚	✚

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Citric acid, aqueous	saturated	✙	✙	✙	✙
Citrus fruit juices		✙	✙	✙	✙
Clophen® A 50 and A 60®		✙	○ to ▭		
Coal tar oil		✙▽	○▽	✙▽	○▽
Coconut oil		✙	○	✙	○
Coconut oil alcohol	techn. grade	✙	○	✙	○
Cod liver oil		✙	○	✙	○
Coffee extract		✙	✙	✙	✙
Cognac		✙		✙	
Cola concentrates		✙	✙	✙	✙
Common salt, aqueous	any	✙	✙	✙	✙
Coolants and lubricants for metalworking		○	○		
Copper chloride, aqueous	saturated	✙	✙	✙	✙
Copper cyanide, aqueous	saturated	✙		✙	
Copper fluoride, aqueous	saturated	✙	✙	✙	✙
Copper nitrate, aqueous	30%	✙	✙	✙	✙
Copper salts, aqueous	cold saturated	✙	✙	✙	✙
Copper sulphate, aqueous	any	✙	✙	✙	✙
Corn oil		✙	○	✙	○
Cottonseed oil	techn. grade	✙	✙	✙	○
Coumarone resins		✙	✙		
Creasote		✙	✙▽		
Cresol	100%	✙	○▽	○	▭
Cresol, aqueous	dilute	✙	✙▽	✙	
Crop protection agents, aqueous	as supplied commerc.	✙	✙	✙	✙
Crotonaldehyde	techn. grade	✙	○	○	
Crude oil		✙	○	✙	○
Cyclanone (fatty alcohol sulphonate)	as supplied commerc.	✙	✙	✙	
Cyclohexane		✙	✙	✙	▭
Cyclohexanol		✙	✙	✙	✙
Cyclohexanone (anone)		✙	○	○	▭
Decahydronaphthalene (Dekalin®)	techn. grade	✙	○	○	▭
Defoamers		✙	✙ to ○	✙	○
Detergents		✙	✙	✙	✙
Detergents, synthetic	end use concentration	✙	✙	✙	✙
Developer solutions (photographic)		✙▽	✙▽	✙▽	✙▽
Dextrin (starch gum), aqueous	18%	✙	✙	✙	✙
Dextrose, aqueous	any	✙	✙	✙	✙
1,2-Diaminoethane (ethylenediamine)	techn. grade	✙	✙	✙	○
1,2-Dibromoethane		○	▭	▭	▭
Dibutyl ether		✙ to ○	▭	○	▭
Dibutyl phthalate (butyl phthalate)	techn. grade	✙	○	○	○
Dibutyl sebacate		✙	○	○	○

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Dichloroacetic acid	techn. grade	✚	○▽	✚	▭
Dichloroacetic acid	50%	✚	✚	✚	✚
Dichloroacetic acid methyl ester		✚	✚	○	▭
Dichlorobenzene		○	▭	▭	▭
Dichlorodiphenyltrichloroethane (DDT, powder)		✚	✚	✚	✚
Dichloroethane		○	○	▭	▭
1,1-Dichloroethylene (vinylidene chloride)	techn. grade	▭	▭	▭	▭
Dichloromethane**		○	○*	▭	▭*
Dichloropropane		○	▭	▭	▭
Dichloropropene		○	▭	▭	▭
Diesel fuel		✚	○	✚	▭
Diethanolamine	techn. grade	✚		✚	
Diethylene glyol		✚	✚	✚	✚
2-Diethylhexylphthalate (DOP)		✚	○	✚	
Diethylketone		✚	○	○	▭
Diethyl ether		✚ to ○	○*	○	
Diglycolic acid, aqueous	30%	✚	✚	✚	✚
Diisobutylketone	techn. grade	✚	○ to ▭	○	▭
Diisoctyl phthalate	techn. grade	✚	○	○	
Diisopropyl ether		✚ to ○	▭	○	▭
Dimethylamine		✚	○	○	▭
Dimethyl formamide	techn. grade	✚	✚ to ○	✚	○
Dimethyl sulphoxide		✚	✚	✚	
Dinonyl phthalate (DNP)	techn. grade	✚	○	○	
Dioctyl phthalate		✚	○	○	
Dioxane		✚	✚	✚	○
Diphenylamine		✚	○	✚	○
Diphenyl oxide		✚	○	✚	○
Disodium phosphate		✚	✚	✚	✚
Disodium sulphate		✚	✚	✚	✚
Dodecylbenzenesulphonic acid		✚	○	✚	○
Drinking water, also chlorinated		✚	✚	✚	✚
Dyes		✚▽	✚▽	✚▽	✚▽
Eau de Javelle (potassium hypochlorite bleaching solution)		✚ to ○	▭	✚ to ○	▭
Eau de Labarraque (sodium hypochlorite bleaching solution)		✚ to ○	▭	✚ to ○	▭
Electrolytic baths for electroplating		✚ to ○	○	✚ to ○	○
Emulsifiers		✚	✚	✚	
Emulsions (photographic)		✚	✚	✚	✚
Ephetin®, aqueous	10%	✚	✚	✚	✚
Epichlorohydrin		✚	✚	✚	✚
Essential oils		✚	✚	✚	○
Esters, aliphatic	techn. grade	✚	✚ to ○	✚ to ○	○ to ▭
Ethane		✚	✚		

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Ethanolamine (2-aminoethanol)	techn. grade	+		+	
Ethanol	96%	+	+	+	+
Ethanol denatured with toluene	96% (v/v)	+		+	
Ethereal oils		○	▭	○	▭
Ether		+ to ○	○*	○	
Ethylenediamine tetraacetic acid		+	+	+	+
Ethylene		+	+		
Ethylene chloride		○	▭	○	▭
Ethylene chlorohydrin (chloroethanol)	techn. grade	+	+▽	+	+▽
Ethylene diamine (1,2-diaminoethane)	techn. grade	+	+	+	○
Ethylene dibromide		○	▭	○	▭
Ethylene dichloride (dichloroethane)		○	▭	○	▭
Ethylene glycol		+	+	+	+
Ethylene glycol monobutyl ether (butyl glycol)	techn. grade	+		+	
Ethylene oxide, gaseous		+	+		
Ethyl acetate (acetic acid ethyl ester)	techn. grade	+	○	○	▭
Ethyl alcohol	96%	+	+	+	+
Ethyl alcohol + acetic acid (fermentation mixture)	as used in production	+	+	+	+
Ethyl benzene	techn. grade	○		○	
Ethyl chloride (chloroethane)	techn. grade	○*		○*	
Ethyl ether (diethyl ether)	techn. grade	+ to ○	○*	○	
2-Ethyl hexanol		+	○	+	○
Euron® B		○	○		
Euron® G		+	+		
Fatty acids (>C6)		+	+ to ○	+	○
Fatty acid amides		+	○	+	○
Fatty alcohols		+	○	+	○
Fatty oils		+	○	+	○
Ferric alum (ferric ammonium sulphate), aqueous	saturated	+	+	+	+
Ferric chloride, aqueous	any	+	+	+	+
Ferric nitrate, aqueous	saturated	+	+	+	+
Ferric sulphate, aqueous	saturated	+	+	+	+
Ferrous chloride, aqueous	saturated	+	+	+	+
Ferrous sulphate, aqueous	saturated	+	+	+	+
Fertilizer salts, aqueous	any	+	+	+	+
Fixing salt, aqueous	any	+	+	+	+
Fixing salt, solid		+	+	+	+
Fluorine, gaseous		▭		▭	
Fluoroboric acid, aqueous		+	○	+	○
Fluorosilicic acid	any	+	+	+	+
Fluorosilicic acid, aqueous	any	+	+	+	+
Formaldehyde, aqueous	up to 40%	+	+	+	+
Formamide		+	+	+	+

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Formic acid, aqueous	10 %	+	+	+	+
Formic acid, aqueous	85 %	+	+	+	+
Frigen® 12 (Freon® 12)	100 %	○	−	○	−
Fructose (fruit sugar), aqueous	any	+	+	+	+
Fruit juices, fermented		+	+	+	+
Fruit juices, unfermented	any	+	+	+	+
Fruit pulp		+	+	+	+
Fuel oil		+	○	○	−
Fuming sulphuric acid ($H_2SO_4 + SO_3$)	any	−		−	
Furfurol		+	○	○	−
Furfuryl alcohol		+	+▽	+	+▽
Gas, manufactured	as supplied commerc.	+		+	
Gas, natural	techn. grade	+		+	
Gas, liquor		+	+	+	+
Gasoline, regular-grade (DIN 51635)		+	○	○	−
Gelatin		+	+	+	+
Genantin®		+	+		
Gin		+		+	
Glacial acetic acid (100 % acetic acid)	techn. grade	+	○▽	+	○▽
Glauber's salt, aqueous	any	+	+	+	+
Glucose, aqueous	any	+	+	+	+
Glue		+	+	+	+
Glycerin, aqueous	any	+	+	+	+
Glycerin chlorohydrin		+	+	+	+
Glycerol		+	+	+	+
Glycine		+	+	+	+
Glycolic acid, aqueous	up to 70 %	+	+	+	+
Glycolic acid butyl ester		+	+	+	
Glycol, aqueous	as supplied commerc.	+	+	+	+
Glysantin®		+	+	+	+
Grisiron® 8302		○	○		
Grisiron® 8702		+	+		
Halothan®		○	○ to −		
Heptane		+	○	+	−
Hexafluorosilicic acid, aqueous	40 %	+	+	+	+
Hexane		+	○	+	−
Hexanetriol		+	+	+	+
Honey		+	+	+	+
Hydraulic fluid		+	○	+	
Hydrazine hydrate		+	+	+	+
Hydrobromic acid, aqueous	50 %	+	+	+	+
Hydrochloric acid, aqueous	any	+	+	+	+

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at		Behaviour of LDPE/LLDPE/ mLLDPE at	
		20 °C	60 °C	20 °C	60 °C
Hydrocyanic acid		✚	✚	✚	✚
Hydrofluoric acid, aqueous	40-85 %	✚	○	✚	○
Hydrogen		✚	✚		
Hydrogen bromide, gaseous	techn. grade	✚	✚	✚	
Hydrogen chloride gas, dry and moist		✚	✚	✚	
Hydrogen peroxide, aqueous	10 %	○	▭	○	▭
Hydrogen peroxide, aqueous	30 %	○	▭	○	▭
Hydrogen peroxide	100 %	○	○	○	▭
Hydrogen sulphide, aqueous	saturated	✚	✚	✚	✚
Hydrogen sulphide, gaseous		✚	✚	✚	✚
Hydroquinone		✚▽	✚▽	✚▽	✚▽
Hydrosulphite, aqueous	up to 10 %	✚	✚	✚	✚
Hydroxylamine sulphate, aqueous	12 %	✚	✚	✚	✚
Hypochlorous acid		✚ to ○	○	○	
Ink		✚	✚	✚	✚
Iodine in potassium iodide solution	3 % iodine	✚	✚	✚	✚
Iodine tincture, DAB 6	as supplied commerc.	✚	○▽	✚	○▽
Isoamyl alcohol	techn. grade	✚	○	✚	○
Isobutyl alcohol (isobutanol)		✚	✚	✚	○
Isobutyric acid	techn. grade	✚	○	✚	○
Isooctane		✚	○	✚	▭
Isopropanol (isopropyl alcohol)	techn. grade	✚	✚	✚	✚
Isopropyl acetate	100 %	✚	○	✚	○
Isopropyl ether	techn. grade	✚ to ○	▭	○	▭
Jam		✚	✚	✚	✚
Kerosene		✚	○	○	▭
Ketones		✚ to ○	○ to ▭	✚ to ○	○ to ▭
Lactic acid, aqueous	any	✚	✚	✚	✚
Lactose (milk sugar)		✚	✚	✚	✚
Lanolin (wool fat)		✚	✚	✚	✚
Latex		✚	✚	✚	✚
Lead acetate, aqueous	any	✚	✚	✚	✚
Lead tetraethyl		✚		✚	
Lime		✚	✚	✚	✚
Lime water		✚	✚	✚	✚
Linseed oil	techn. grade	✚	✚	✚	○
Liqueur		✚	✚		
Liquid manure		✚	✚		
Liquid soaps		✚	✚	✚	✚
Lithium bromide		✚	✚	✚	✚

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Lubricating oils	techn. grade	✙	✙ to ○	✙	○
Lysol®		✙	○		
Machine oil		✙	○	✙	○
Magnesium carbonate		✙	✙	✙	✙
Magnesium chloride, aqueous	any	✙	✙	✙	✙
Magnesium fluorosilicate		✙	✙	✙	✙
Magnesium hydroxide		✙	✙	✙	✙
Magnesium iodide		✙	✙	✙	✙
Magnesium salts, aqueous	any	✙	✙	✙	✙
Magnesium sulphate, aqueous	any	✙	✙	✙	✙
Maleic acid, aqueous	up to 100 %	✙	✙	✙	✙
Malic acid, aqueous	50 %	✙	✙	✙	✙
Manganese sulphate		✙	✙	✙	✙
Margarine		✙	✙	✙	✙
Mash		✙	✙	✙	✙
Mayonnaise		✙		✙	
Menthol		✙	○	○	▭
Mercury		✙	✙	✙	✙
Mercury chloride		✙	✙	✙	✙
Mercury salts		✙	✙	✙	✙
Metal soaps		✙	✙	✙	✙
Methacrylic acid		✙	✙	✙	○
Methanol	techn. grade	✙	✙	✙	✙
Methoxybutanol		✙	○	✙	○
Methoxybutyl acetate (Butoxyl®)		✙	✙	✙	○
Methylamine, aqueous	32 %	✙		✙	
2-Methylbutanol-2	techn. grade	✙	○	✙	○
Methylene chloride** (dichloromethane)		○	○*	▭	▭*
Methylisobutyl ketone		✙	○ to ▭	✙	▭
Methyl acetate (acetic acid methyl ester)	techn. grade	✙		✙	
Methyl acrylate		✙	✙	✙	○
Methyl alcohol		✙	✙	✙	✙
Methyl benzene		○	▭	○	▭
Methyl benzoic acids (toluic acids)	saturated	○		○	
Methyl bromide, gaseous	techn. grade	▭		▭	
Methyl bromide (bromomethane), gaseous	techn. grade	▭		▭	
Methyl chloride (chloromethane), gaseous	techn. grade	○		▭	
Methyl cyclohexane		○	○ to ▭	○	▭
Methyl ethyl ketone	techn. grade	✙	○	○	▭
Methyl glycol		✙	✙	✙	✙
Methyl methacrylate		✙	✙	✙	○
4-Methyl pentanol-2		✙	✙ to ○▽	✙	○▽
Methyl propyl ketone		✙	○	○	▭

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
N-Methyl pyrrolidone		+	+	+	
Methyl salicylate (salicylic acid methyl ester)		+	○	+	○
Methyl sulphuric acid	50 %	+	+	+	+
Milk		+	+	+	+
Mineral oil	without additives	+	+ to ○	+	○
Mineral water		+	+	+	+
Molasses		+	+	+	+
Molasses wort		+	+	+	+
Monochloroacetic acid		+	○	+	○
Monochloroacetic acid ethyl ester		+	+	+	○
Monochloroacetic acid methyl ester		+	+	+	○
Monochlorobenzene		○	−	○	−
Mordants, metallic		+		+	
Morpholine		+	+	+	
Motor oil (heavy duty oil)		+	+ to ○	+	○
Mowilith® emulsions		+	+	+	+
Mustard		+	+	+	+
Nail polish remover		+	○	+	○
Naphthalene		+	−	+	−
Naphtha	techn. grade	+	○	+	○
Naphtha		+	○	+	○
Naphtha/benzene mixture	80/20	+	○	+	○
Nickel chloride		+	+	+	+
Nickel nitrate		+	+	+	+
Nickel salts, aqueous		+	+	+	+
Nickel sulphate, aqueous	any	+	+	+	+
Nicotine		+	+	+	+
Nicotinic acid	≤ 10 %	+		+	
Nitric acid**	25 %	+	+	+	+
Nitric acid**	50 %	○	−	○	−
Nitric acid	95 %	−	−	−	−
2,2‘,2“-Nitrilotriethanol (triethanolamine), aqueous	any	+	○	+	○
Nitrobenzene		+	○	○	−
Nitrocellulose		+		+	
o-Nitrotoluene		+	○	○	−
Nonyl alcohol (nonanol)		+	+	+	○
Nut oil		+		+	
Octyl cresol	techn. grade	○	−	○	−
Oils, ethereal		○	−	○	−
Oils, vegetable and animal		+	+ to ○	+	○
Oleic acid		+	○	+	○
Oleum		−	−	−	−

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Olive oil		+	+	+	○
Optical brighteners		+	+	+	+
Orange juice		+	+	+	+
Oxalic acid, aqueous	any	+	+	+	+
Oxygen		+	+	+	+
Ozone	50 ppm	○	–	○	–
Palmitic acid		+	+	+	+
Palmityl alcohol		+	+	+	+
Palm nut oil		+		+	
Paraffin, liquid		+	+	+	○
Paraffin wax emulsions	as supplied commerc.	+	○	+	○
Paraformaldehyde		+	+	+	+
Peanut oil	techn. grade	+		+	
Pentanol		+		+	
Peppermint oil		+		+	
Perchloric acid, aqueous	20%	+	+	+	+
Perchloric acid, aqueous	50%	+	○	+	○
Perchloric acid, aqueous	70%	+	–	+	–
Perchloroethylene		○	–	–	–
Petrol, regular-grade (DIN 51 635)		+	○	○	–
Petroleum		+	○	○	–
Petroleum ether		+	○	+	
Phenolic resin moulding compounds		+	+	+	+
Phenol		+	+▽	○	○▽
Phenyl ethyl alcohol		+	+	+	○
Phenyl hydrazine	techn. grade	○	○ to –	○	–
Phenyl hydrazine hydrochloride		+	–	+	–
Phenyl sulphonate (sodium dodecyl benzene sulphonate)		+	+	+	+
Phosgene, gaseous		○			
Phosgene, liquid	100%	–			
Phosphates, aqueous	any	+	+	+	+
Phosphoric acid, aqueous	50%	+	+	+	+
Phosphoric acid, aqueous	80% ... 95%	+	○▽	+	○▽
Phosphorus oxychloride		+	○	+	○
Phosphorus pentoxide	100%	+	+	+	+
Phosphorus trichloride		–	–	–	–
Photographic developers		+▽	+▽	+▽	+▽
Photographic emulsions	as supplied commerc.	+	+	+	+
Photographic fixing baths	as supplied commerc.	+	+	+	+
Phthalic acid, aqueous	50%	+	+	+	+
Phthalic acid dibutyl ester (dibutyl phthalate)	techn. grade	+	○	○	○
Phthalic ester		+	+ to ○	+	○
Picric acid, aqueous	1%	+		+	

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	Behaviour of MDPE/HDPE at 60 °C	Behaviour of LDPE/LLDPE/mLLDPE at 20 °C	Behaviour of LDPE/LLDPE/mLLDPE at 60 °C
Pineapple juice		+	+	+	+
Pine needle oil		+		+	
Plasticisers		+	○	○	○
Polyacrylic acid emulsions		+	+	+	+
Polyester plasticisers		+	+ to ○	○	○
Polyester resins		○	▭	○	▭
Polyglycols		+	+	+	+
Polysolvan® O (glycolic acid butyl ester)		+	+	+	○
Potassium aluminium sulphate, aqueous	any	+	+	+	+
Potassium bicarbonate, aqueous	saturated	+	+	+	+
Potassium bisulphate, aqueous	saturated	+	+	+	+
Potassium bisulphite, aqueous	saturated	+	+	+	+
Potassium borate, aqueous	1 %	+	+	+	+
Potassium bromate, aqueous	up to 10 %	+	+	+	+
Potassium bromide, aqueous	any	+	+	+	+
Potassium carbonate, aqueous	any	+	+	+	+
Potassium chlorate, aqueous	any	+	+	+	+
Potassium chloride, aqueous	any	+	+	+	+
Potassium chromate, aqueous	40 %	+	+	+	+
Potassium chromic sulphate (chrome alum), aqueous	saturated	+	+	+	+
Potassium cyanide, aqueous	any	+	+	+	+
Potassium dichromate, aqueous	any	+	+	+	+
Potassium ferrocyanide and ferricyanide, aqueous	any	+	+	+	+
Potassium fluoride, aqueous	any	+	+	+	+
Potassium hexacyanoferrate, aqueous	any	+	+	+	+
Potassium hydroxide		+	+	+	+
Potassium hydroxide, aqueous	any	+	+	+	+
Potassium hydroxide solution	50 %	+	+	+	+
Potassium hypochlorite, aqueous	saturated	○	▭	○	▭
Potassium iodide, aqueous	any	+	+	+	+
Potassium nitrate, aqueous	any	+	+	+	+
Potassium perborate		+	+	+	+
Potassium perchlorate, aqueous	up to 10 %	+	○	+	○
Potassium perchlorate, aqueous	1 %	+		+	
Potassium permanganate	20 %	+	+▽	+	+▽
Potassium permanganate, aqueous	up to 6 %	+	+▽	+	+▽
Potassium persulphate, aqueous	any	+	+	+	+
Potassium phosphate, aqueous	saturated	+	+	+	+
Potassium sulphate, aqueous	any	+	+	+	+
Potassium sulphide, aqueous	saturated	+	+	+	+
Potassium sulphite, aqueous	saturated	+	+	+	+
Potassium tetracyanocuprate, aqueous	saturated	+	+	+	+
Potassium thiosulphate, aqueous	saturated	+	+	+	+
Propane, gaseous	techn. grade	+			

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	60 °C
Propanol-(2) (isopropyl alcohol)		+	+	+	+
n-Propanol (n-propyl alcohol)		+	+	+	+
Propanol (propyl alcohol)		+	+	+	+
Propargyl alcohol, aqueous	7%	+	+	+	+
Propionic acid, aqueous	any	+	+	+	+
Propylene dichloride	100%	–		–	
Propylene glycol		+	+	+	+
Propylene oxide		+	+		
Pseudocumene		○	○		
Pyridine		+	○	+	○
Quinine		+	+	+	+
Release agents		+	+		
Roasting gases, dry	any	+	+		
Rubber dispersions (latex)		+	+	+	+
Sagrotan®		+	○	+	○
Salicylic acid		+	+	+	+
Salt brines	saturated	+	+	+	+
Saturated steam condensate		+	+	+	+
Sauerkraut (pickled cabbage)		+	+	+	+
Sea water		+	+	+	+
Silicic acid, aqueous	any	+	+	+	+
Silicone emulsion	as supplied commerc.	+	+	+	+
Silicone oil	techn. grade	+	+	+	+
Silver nitrate		+	+	+	+
Silver nitrate, aqueous	any	+	+	+	+
Silver salts, aqueous	cold saturated	+	+	+	+
Soap solution, aqueous	any	+	+	+	+
Soda (sodium carbonate), aqueous	any	+	+	+	+
Sodium acetate, aqueous	any	+	+	+	+
Sodium aluminium sulphate		+	+	+	+
Sodium benzoate, aqueous	any	+	+	+	+
Sodium bicarbonate, aqueous	saturated	+	+	+	+
Sodium bisulphate, aqueous	saturated	+	+	+	+
Sodium bisulphite, aqueous	saturated	+	+	+	+
Sodium borate		+	+	+	+
Sodium bromide		+	+	+	+
Sodium carbonate, aqueous	any	+	+	+	+
Sodium chlorate, aqueous	saturated	+	+	+	+
Sodium chloride, aqueous	any	+	+	+	+
Sodium chlorite, aqueous	50%	+		+	
Sodium chromate		+	+	+	+

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	Behaviour of MDPE/HDPE at 60 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 20 °C	Behaviour of LDPE/LLDPE/ mLLDPE at 60 °C
Sodium cyanide		+	+	+	+
Sodium dichromate		+	+	+	+
Sodium dodecylbenzenesulphonate		+	+	+	+
Sodium ferricyanide, aqueous	saturated	+	+	+	+
Sodium ferrocyanide		+	+	+	+
Sodium fluoride		+	+	+	+
Sodium hexametaphosphate, aqueous	saturated	+	+	+	+
Sodium hydroxide, aqueous	any	+	+	+	+
Sodium hydroxide, solid		+	+	+	+
Sodium hypochlorite, aqueous with 12.5 % active chlorine**		○	−	○	−
Sodium iron cyanide		+	+	+	+
Sodium nitrate, aqueous	any	+	+	+	+
Sodium nitrite, aqueous	any	+	+	+	+
Sodium perborate, aqueous	any	+	○	+	○
Sodium perchlorate, aqueous	any	+	+	+	+
Sodium peroxide, aqueous	saturated	○		○	
Sodium peroxide, aqueous	10 %	+	+	+	+
Sodium phosphate, aqueous	saturated	+	+	+	+
Sodium silicate		+	+	+	+
Sodium silicate, aqueous	any	+	+	+	+
Sodium sulphate, aqueous	cold saturated	+	+	+	+
Sodium sulphide, aqueous	any	+	+	+	+
Sodium tetraborate (borax), aqueous	saturated	+	+	+	+
Sodium thiosulphate, aqueous	saturated	+	+	+	+
Soft soap		+	+	+	+
Soya bean oil		+	+	+	○
Spermaceti		+		○	
Spindle oil		+ to ○	○	○	
Spirits		+		+	
Stain remover		+ to ○	○	○	
Starch, aqueous	any	+	+	+	+
Starch gum (dextrin), aqueous	18 %	+	+	+	+
Starch syrup		+	+	+	+
Stearic acid		+	○	+	○
Styrene		○	−	○	−
Succinic acid, aqueous	50 %	+	+	+	+
Sugar beet juice		+	+	+	+
Sugar syrup		+	+	+	+
Sulphates, aqueous solutions	any	+	+	+	+
Sulphur		+	+	+	+
Sulphuric acid, aqueous	up to 50 %	+	+	+	+
Sulphuric acid, aqueous	70 %	+	○	+	○
Sulphuric acid, aqueous	80 %	+	○	+	○
Sulphuric acid, aqueous	98 %	○ 1)	−	○	−

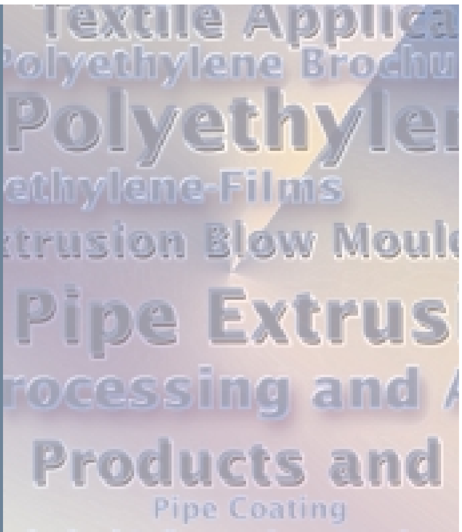
1) *Lupolen* and *Hostalen* blow mouldings that have been approved for use with dangerous filling substances are suitable for contact with e. g. 98 % Sulphuric acid

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	Behaviour of MDPE/HDPE at 60 °C	Behaviour of LDPE/LLDPE/mLLDPE at 20 °C	Behaviour of LDPE/LLDPE/mLLDPE at 60 °C
Sulphurous acid		+	+	+	+
Sulphuryl chloride (sulphonyl chloride)		–		–	
Sulphur dioxide, aqueous	any	+	+	+	+
Sulphur dioxide, gaseous		+	+		
Sulphur trioxide		–		–	
Tallow	techn. grade	+	+	+	+
Tannic acid (tannin), aqueous	10%	+	+	+	+
Tanning extracts, vegetable	as supplied	+		+	
Tartaric acid, aqueous	any	+	+	+	+
Tetrabromomethane		○ to –	–	–	–
Tetrachloroethane		○ to –	–	–	–
Tetrachloroethylene		○ to –	–	–	–
Tetrachloromethane (carbon tetrachloride)	techn. grade	○	–	–	–
Tetrahydrofuran	techn. grade	○ to –	–	–	–
Tetrahydronaphthalene (Tetralin®)	techn. grade	+	–	○	–
Thioglycolic acid		+	+	+	+
Thionyl chloride		–		–	
Thiophene		○	–	○	–
Tin (II) chloride, aqueous	any	+	+	+	+
Tin (IV) chloride, aqueous	saturated	+	+	+	+
Toluene	techn. grade	○	–	○	–
Toluic acids (methyl benzoic acids)	saturated	○		○	
Tomato juice		+	+	+	+
Transformer oil (insulating oil)	techn. grade	+	○	+	○
Tributyl phosphate		+	+	+	
Trichloroacetaldehyde (chloral)	techn. grade	+	+	○	–
Trichloroacetic acid	techn. grade	+	○ to –	○	–
Trichloroacetic acid, aqueous	50%	+	+	+	+
Trichlorobenzene		–	–	–	–
Trichloroethylene	techn. grade	○ to –	–	–	–
Tri-ß-chloroethylphosphate		+	+	+	
Tricresyl phosphate		+	+	+	
Triethanolamine		+	+▽	+	○▽
Triethanolamine (2,2‘2“-nitrilotriethanol), aqueous	any	+	○	+	○
Triethylene glycol		+	+	+	+
Trilon®		+	+		
Trimethylol propane, aqueous		+	+	+	+
Trimethyl borate		+	○ to –	+	–
Trioctyl phosphate		+	○	+	
Trisodium phosphate		+	+	+	+
Turpentine oil	techn. grade	+ to ○	–	○	–
Tutogen® U		+	+		
Tween® 20 and 80		+	–		
Two-stroke oil		+	○		

The resistance of *Lupolen, Lupolex, Luflexen* and *Hostalen* resins to chemicals

Substance	Concentration	Behaviour of MDPE/HDPE at 20 °C	Behaviour of MDPE/HDPE at 60 °C	Behaviour of LDPE/LLDPE/mLLDPE at 20 °C	Behaviour of LDPE/LLDPE/mLLDPE at 60 °C
Urea, aqueous	up to 33 %	+	+	+	+
Uric acid		+	+	+	+
Urine		+	+	+	+
Vaseline	techn. grade	+ to ○	○	○	○
Vaseline oil	techn. grade	+ to ○	○	○	○
Vinegar (wine vinegar)	as supplied commerc.	+	+	+	+
Vinylidene chloride (1,1-dichloroethylene)	techn. grade	–		–	
Vinyl acetate		+	+	+	○
Viscose spinning solutions		+	+	+	+
Vitamin C		+		+	
Vitamin preparations, dry (powder)		+		+	
Walnut oil		+	○	+	○
Washing up liquids	usual	+	+	+	+
Waste gases containing carbonic acid	any	+	+		
Waste gases containing carbon dioxide	any	+	+		
Waste gases containing carbon monoxide	any	+	+		
Waste gases containing hydrochloric acid	any	+	+		
Waste gases containing hydrogen fluoride	trace	+	+		
Waste gases containing nitrogen oxides	trace	+	+		
Waste gases containing sulphur dioxide	low	+	+		
Waste gases containing sulphuric acid (moist)	any	p	p		
Waste gases containing sulphur trioxide (fuming sulphuric acid)	trace	–		–	
Water, distilled		+	+	+	+
Waxes		+	+ to ○	+	○
Wax alcohols	techn. grade	○	○		
Whey		+	+	+	+
Whisky		+		+	
White spirit	techn. grade	+		○	
Wine		+		+	
Wine vinegar (table vinegar)	as supplied commerc.	+	+	+	+
Wood stains	end use concentration	+	+ to ○		
Xylene		○	–	○	–
Yeast		+	+	+	+
Zinc carbonate		+	+	+	+
Zinc chloride, aqueous	any	+	+	+	+
Zinc oxide		+	+	+	+
Zinc salts, aqueous	any	+	+	+	+
Zinc sludge		+	+	+	+

Substance	Concentration	Behaviour of MDPE/HDPE at		Behaviour of LDPE/LLDPE/ mLLDPE at	
		20 °C	60 °C	20 °C	60 °C
Zinc stearate		✣	✣	✣	✣
Zinc sulphate, aqueous	any	✣	✣	✣	✣



Literature

Resistance factor for pressure pipes

A special assessment is required when mechanical, chemical and, in some cases, thermal stresses occur together in applications such as pressure pipes or large tanks. Here the resistance factor (f_{CR}) gives vital information. It characterises the long-term behaviour of pipes in contact with a certain substance under pressure in relation to their long-term behaviour in contact with water under pressure. Resistance factors have been determined for polyethylene pipes in contact with a whole range of substances [1] [2] [3].

Note
The information submitted in this publication is based on our current knowledge and experience. In view of the many factors that may affect processing and application these data do not relieve processors from the responsibility of carrying out their own tests and experiments; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose. It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.

Literature

[1] E. Gaube, W. Müller, G. Diedrich: "Zeitstandfestigkeit von Rohren aus Hartpolyethylen und Polypropylen unter Einfluß von Chemikalien" (Creep strength of high-density polyethylene and polypropylene pipes in contact with chemical substances) Kunststoffe 56 (1996), pp 673 – 679

[2] G. Diedrich, B. Kempe, K. Graf: "Zeitstandfestigkeit von Rohren aus Polyethylen (HDPE) und Polypropylen (PP) unter Chemikalieneinwirkung" (Creep strength of polyethylene (HDPE) and polypropylene (PP) in contact with chemical substances) Kunststoffe 69 (1979), pp 470 – 476

[3] B. Kempe: "Prüfmethoden zur Ermittlung des Verhaltens von Polyolefinen bei der Einwirkung von Chemikalien" (Test methods to determine the behaviour of polyolefins in contact with chemical substances) Werkstofftechnik 15 (1984), pp. 157 – 172

Corporate centre

Basell N.V.
Hoeksteen 66
2132 MS Hoofddorp
The Netherlands
tel.: +31 20 44 68 644
fax: +31 20 44 68 649

Asia-Pacific Regional Office

Basell China Ltd.
22/F Hennessey Centre
Causeway Bay
Hong Kong
China
tel.: +852 2577 3855
fax: +852 2895 0905

Europe Regional Offices

Basell Polyolefins Company N.V.
Woluwe Garden
Woluwedal 24
1932 Zaventem (Brussels)
Belgium
tel.: +32 2 715 80 00
fax: +32 2 715 80 50

Basell Polyolefine GmbH
Rheinstraße 4G
55116 Mainz
Germany
tel.: +49 6131 207 0
fax: +49 6131 207 555

Australia Sales Office

Basell Australia Pty. Ltd.
Level 2, 191 Toorak Road
South Yarra VIC 3141
Melbourne
Australia
Tel. + 61 3 9829 9455
Fax + 61 3 9829 9431

You can find more about Basell by visiting our website at: www.basell.com

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APPENDIX H

APPENDIX H.1- LINER LEAKAGE CALCULATIONS
APPENDIX H.2-UNDERDRAIN COLLECTION PIPE
APPENDIX H.3- HYDROLOGY AND HYDRAULICS (STAGE 1)
APPENDIX H.4- HYDROLOGY AND HYDRAULICS (STAGE 2)
APPENDIX H.5- HYDROLOGY AND HYDRAULICS (CLOSURE)

APPENDIX H.1

Liner Leakage Calculations

Geomembrane Leakage Rate Underlain by Permeable Media	
Project:	Tailings and PAG Material Remediation, Placement and Storage
Client:	Arizona Minerals Inc
Facility:	Underdrain Collection Pond - LCRS Size
Engineer:	Craig Thompson
Date	24-Apr-17

NewFields

Inputs
Outputs

$$Q = n\left(0.6 \times a \times \sqrt{2gh}\right)$$ (Giroud, 1997)

Where: $$n = \left(A/43{,}560\ ft^2\right) \times DefectsPer\ Acre$$

$$a = \pi\left(d^2/4\right)$$

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

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 1 Defects Per Acre

Variable Inputs

English Units			Metric Units	
d (in)	0.444		d (m)	0.0113
A (ft^2)	68,994		A (m^2)	6,410
h (ft)	42.0		h (m)	12.8

Calculated Values

English Units			Metric Units	
n	2		n	2
a (ft^2)	1.08E-03		a (m^2)	1.00E-04
Q (ft^3/s)	0.053		Q (m^3/s)	0.002

Conversion

$$0.002\ \frac{m^3}{\sec} \times \frac{60\sec}{\min} \times \frac{264.1 gal}{m^3} = 23.9\ \frac{gal}{\min}$$

Assumptions

1. Above flow rate based upon Bernoulli's equation which describes free flow through an orifice. This condition is valid if the hydraulic conductivity of the underlying media is greater than 10e-1 m/s, which is valid for most gravels and geonets.
2. The typical installation damage assumes a circular defect diameter of approxiately 3.5 mm given good to excellent quality control.
3. Bernoulli's equations tends to overestimate leakage rate, as impedance to flow (geonet, gravel, etc.) is not considered.

References

1. Giroud, J.P. 1984. "Impermeability: The Myth and a Rational Approach". Proceedings of the International Conference on Geomembranes. Denver, CO. 1:157-162.
2. Giroud, J.P., Khire, M.V. and Soderman, K.L. 1997. "Liquid Migration Through Defects in a Geomembrane Overlain and Underlain by Permeable Media". Geosynthetics International. Vol 4, Nos. 3-4, pp. 293-321.

Geomembrane Leakage Rate Underlain by Permeable Media	
Project:	Tailings and PAG Material Remediation, Placement and Storage
Client:	Arizona Minerals Inc
Facility:	Underdrain Collection Pond - Alert Level 1
Engineer:	Craig Thompson
Date	24-Apr-17

NewFields

Inputs
Outputs

$$Q = n\left(0.6 \times a \times \sqrt{2gh}\right)$$ (Giroud, 1997)

Where: $$n = \left(A / 43{,}560\ ft^2\right) \times DefectsPer\ Acre$$

$$a = \pi\left(d^2/4\right)$$

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

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 1 Defects Per Acre

Variable Inputs

English Units		Metric Units	
d (in)	0.141	d (m)	0.0036
A (ft^2)	68,994	A (m^2)	6,410
h (ft)	42.0	h (m)	12.8

Calculated Values

English Units		Metric Units	
n	2	n	2
a (ft^2)	1.08E-04	a (m^2)	1.00E-05
Q (ft^3/s)	0.005	Q (m^3/s)	0.000

Conversion

$$0.000\ \frac{m^3}{sec} \times \frac{60\ sec}{min} \times \frac{264.1 gal}{m^3} = 2.4\ \frac{gal}{min}$$

Assumptions

1. Above flow rate based upon Bernoulli's equation which describes free flow through an orifice. This condition is valid if the hydraulic conductivity of the underlying media is greater than 10e-1 m/s, which is valid for most gravels and geonets.
2. The typical installation damage assumes a circular defect diameter of approxiately 3.5 mm given good to excellent quality control.
3. Bernoulli's equations tends to overestimate leakage rate, as impedance to flow (geonet, gravel, etc.) is not considered.

References

1. Giroud, J.P. 1984. "Impermeability: The Myth and a Rational Approach". Proceedings of the International Conference on Geomembranes. Denver, CO. 1:157-162.
2. Giroud, J.P., Khire, M.V. and Soderman, K.L. 1997. "Liquid Migration Through Defects in a Geomembrane Overlain and Underlain by Permeable Media". Geosynthetics International. Vol 4, Nos. 3-4, pp. 293-321.

Geomembrane Leakage Rate Underlain by Permeable Media	
Project:	Tailings and PAG Material Remediation, Placement and Storage
Client:	Arizona Minerals Inc
Facility:	Underdrain Collection Pond - Alert Level 2
Engineer:	Craig Thompson
Date	24-Apr-17

NewFields

Inputs
Outputs

$$Q = n\left(0.6 \times a \times \sqrt{2gh}\right)$$ (Giroud, 1997)

Where: $$n = \left(A / 43{,}560\ ft^2\right) \times DefectsPer\ Acre$$

$$a = \pi\left(d^2 / 4\right)$$

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

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 1 Defects Per Acre

Variable Inputs

English Units			Metric Units	
d (in)	0.444		d (m)	0.0113
A (ft^2)	68,994		A (m^2)	6,410
h (ft)	42.0		h (m)	12.8

Calculated Values

English Units			Metric Units	
n	2		n	2
a (ft^2)	1.08E-03		a (m^2)	1.00E-04
Q (ft^3/s)	0.053		Q (m^3/s)	0.002

Conversion

$$0.002\ \frac{m^3}{\sec} \times \frac{60\sec}{\min} \times \frac{264.1 gal}{m^3} = \quad 23.9\ \frac{gal}{\min}$$

Safety Factor

$$1.5 \quad 24\ \frac{gal}{\min} = 15.9\ \frac{gal}{\min}$$

Assumptions

1. Above flow rate based upon Bernoulli's equation which describes free flow through an orifice. This condition is valid if the hydraulic conductivity of the underlying media is greater than 10e-1 m/s, which is valid for most gravels and geonets.
2. The typical installation damage assumes a circular defect diameter of approxiately 3.5 mm given good to excellent quality control.
3. Bernoulli's equations tends to overestimate leakage rate, as impedance to flow (geonet, gravel, etc.) is not considered.

References

1. Giroud, J.P. 1984. "Impermeability: The Myth and a Rational Approach". Proceedings of the International Conference on Geomembranes. Denver, CO. 1:157-162.
2. Giroud, J.P., Khire, M.V. and Soderman, K.L. 1997. "Liquid Migration Through Defects in a Geomembrane Overlain and Underlain by Permeable Media". Geosynthetics International. Vol 4, Nos. 3-4, pp. 293-321.

Geomembrane Leakage Rate Underlain by Relatively Low Permeability Soil	
Project:	Tailings and PAG Material Remediation, Placement and Storage
Client:	Arizona Minerals Inc
Facility:	Tailings Storage Facility - Stage 1
Engineer:	Craig Thompson
Date	24-Apr-17

NewFields

Inputs
Outputs

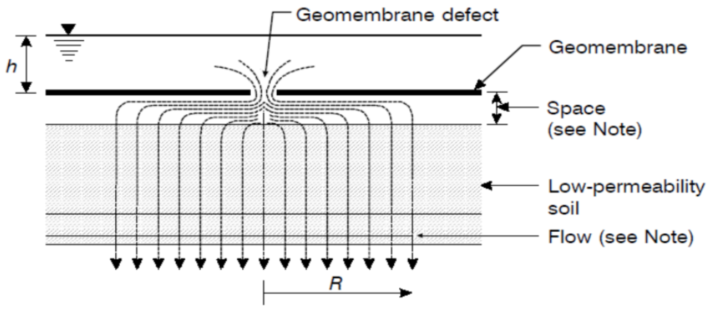


Figure 1. Liquid migration through a composite liner.

$$Q = C_{qo} a^{0.1} h^{0.9} k_s^{0.74} n$$ (Giroud, 1997)

Where: $n = \left(\frac{A}{43{,}560\ ft^2} \right) \times DefectsPerAcre$

$$a = \pi \left(\frac{d^2}{4} \right)$$

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

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

Contact Quality Factor, C_{qo}

Liner/Soil Contact	Factor (Circ. Defect)
Good	0.21
Poor	1.15

Assume 0.21 for Contact Quality

Variable Inputs

English Units		Metric Units	
d (in)	0.444	d (m)	0.0113
A (ft^2)	678,700	A (m^2)	63,053
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	31	n	31
a (ft^2)	1.08E-03	a (m^2)	1.00E-04
Q (ft^3/s)	5.47E-05	Q (m^3/s)	1.55E-06

Conversion

$$1.55E\text{-}06\ \frac{m^3}{\sec} \times \frac{60 \sec}{\min} \times \frac{264.1 gal}{m^3} = 0.0245\ \frac{gal}{\min}$$

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 Caulculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects". Geosynthetics International. Vol 4, Nos. 3-4, pp. 335-348.

Geomembrane Leakage Rate Underlain by Relatively Low Permeability Soil	
Project:	Tailings and PAG Material Remediation, Placement and Storage
Client:	Arizona Minerals Inc
Facility:	Tailings Storage Facility - Stage 2
Engineer:	Craig Thompson
Date	24-Apr-17

NewFields

Inputs
Outputs

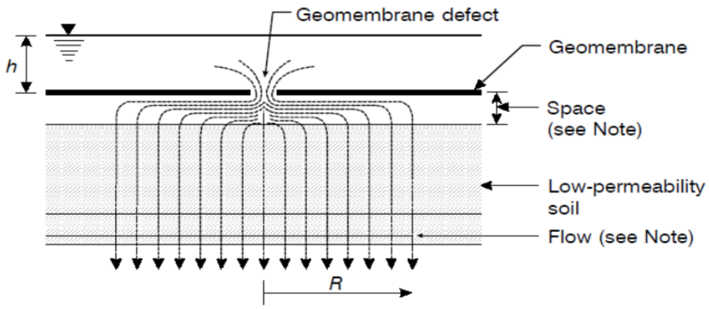


Figure 1. Liquid migration through a composite liner.

$$Q = C_{qo} a^{0.1} h^{0.9} k_s^{0.74} n$$ (Giroud, 1997)

Where: $n = \left(A / 43,560 \ ft^2 \right) \times DefectsPer \ Acre$

$$a = \pi \left(d^2 / 4 \right)$$

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

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

Variable Inputs

English Units		Metric Units	
d (in)	0.444	d (m)	0.0113
A (ft^2)	576,800	A (m^2)	53,586
h (ft)	1.5000	h (m)	0.4572
k_s (ft/sec)	3.3E-09	k_s (m/s)	1.0E-09

Calculated Values

English Units		Metric Units	
n	26	n	26
a (ft^2)	1.08E-03	a (m^2)	1.00E-04
Q (ft^3/s)	8.46E-06	Q (m^3/s)	2.39E-07

Conversion

$$2.39E\text{-}07 \ \frac{m^3}{\sec} \times \frac{60 \sec}{\min} \times \frac{264.1 gal}{m^3} = 0.0038 \ \frac{gal}{\min}$$

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 Caulculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects". Geosynthetics International. Vol 4, Nos. 3-4, pp. 335-348.

APPENDIX H.2

Underdrain Collection Pipe

NewFields	CALCULATION COVER SHEET		
Client	Arizona Minerals Inc	Preparer:	J. Almasy	04/24/17
Project	Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement, and Storage	Checked:	C. Thompson	04/24/17
Title	Underdrain Calculation	Revision:	A	

CALCULATION OBJECTIVE

Determine the underdrain collection pipe spacing

ASSUMPTIONS

1. Drainage layer permeability was modeled as $5.5x10^{-3}$ cm/sec ($1.8x10^{-4}$ ft/sec)
2. Tailings permeability was modeled as $7.2x10^{-6}$ cm/sec ($2.36x10^{-7}$ ft/sec)

METHODOLOGY

1. Area and length measurements were determined using AutoCAD Civil 3D.
2. Maximum head and collector pipe spacing calculated.

REFERENCES

1. AutoCAD Civil 3D version 2015.

CONCLUSIONS

1. Maximum underdrain collection spacing for lateral 4" dia CPe Underdrain Collection Pipe is 100 ft on center

Tailings and PAG Material Remediation, Placement, and Storage
Underdrain Spacing

$$h_{avg} = \left[\frac{21WL^2}{100k} + h_o^{\ 2} - Lh_o \tan\theta + \frac{L^2}{25}\tan^2\theta\right]^{0.5} - \frac{L}{5}\tan\theta$$

$$h_{max} = \left[\frac{21WL^2}{100k} + h_o^{\ 2} - Lh_o \tan\theta\right]^{0.5}$$

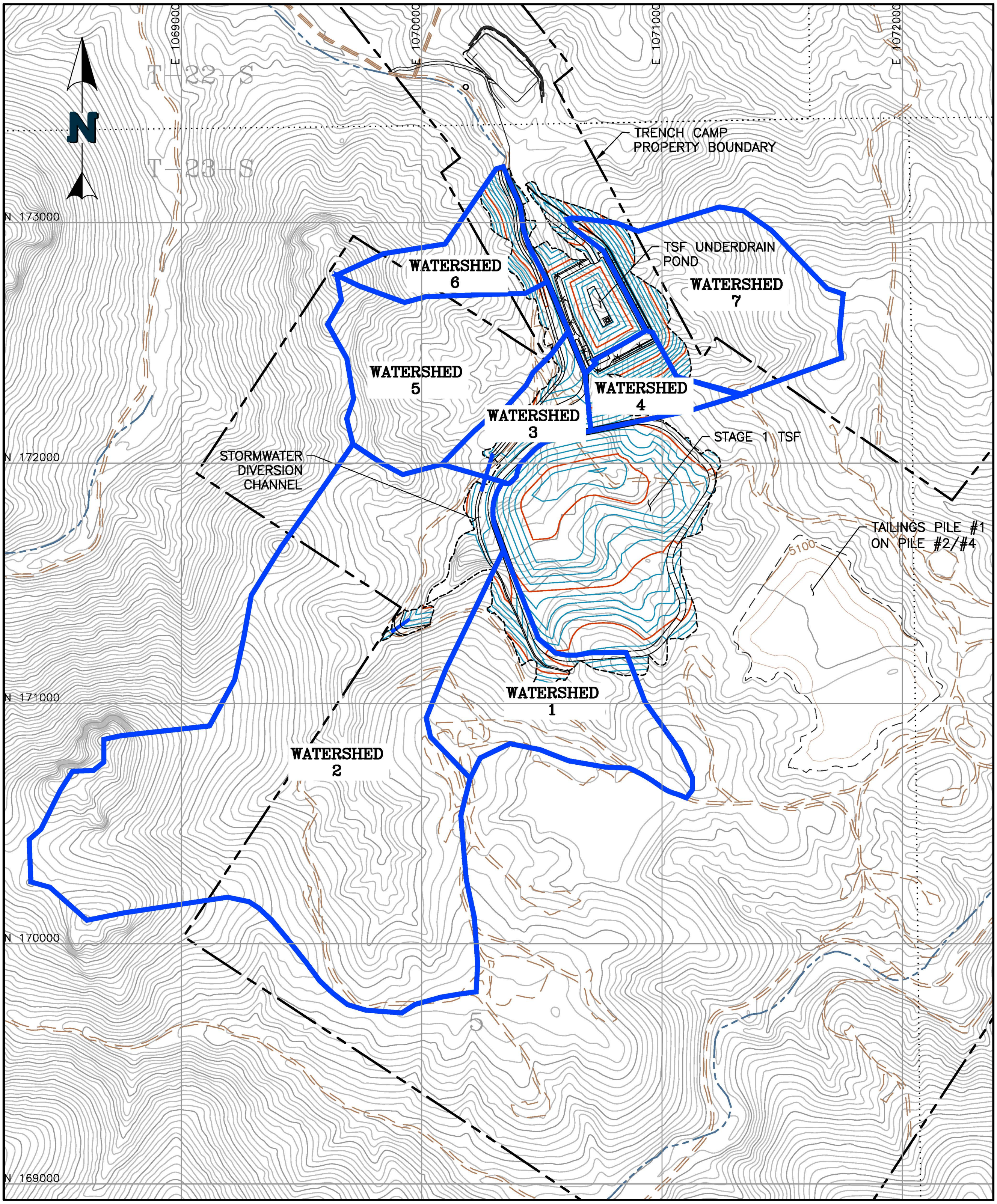
h	Height of the phreatic surface (ft)
h_o	Height of the phreatic surface at its exit (ft)
W	Infiltration rate (cfs/ft^2)
k	Permeability of material (ft/s)
L	Horizontal distance between pipes (ft)
θ	Pad Grade (radians)

Calculation assumption: L/5 and $L^2/25$ are assumed to be zero for maximum head calculation

W (cfs/sf)	Drain Layer Perm k (ft/sec)	Collector Spacing L (ft)	Collector Dia. h_o (ft)	Basin Slope (%)	Basin Slope (rad)	Equation Inputs					Head Average h_{avg} (ft)	Head Maximum h_{max} (ft)
						21/100 * W/k * L²	$h_o^{\ 2}$	L*h_o*tanθ	L²/25*tan²θ	L/5*tanθ		
Maximum Infiltration Rate												
2.4E-07	1.8E-04	90	0.33	0.50%	0.0050	2.24	0.11	0.15	0.01	0.09	1.39	1.48

APPENDIX H.3

Hydrology and Hydraulics (Stage 1)



LEGEND:

EXISTING GROUND CONTOURS

TSF CLOSURE CONTOURS

EXISTING ROADS/TRAILS

EXISTING DRAINAGES

PROPERTY BOUNDARY

SECTION LINES

WATERSHED BOUNDARY

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

0 300 600 FEET

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 WATERSHEDS– TAILINGS #1, #2 AND #4 IN PLACE

FILENAME: 14.008.023F

FIGURE NO.: 1

REVISION: 0

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\FIG\14.008.023F.dwg-5/20/2017 11:29 AM

STAGE 1 WATERSHEDS- TAILINGS #1, #2 AND #4 IN PLACE
HYDROLOGY ANALYSIS and STORMWATER CONTROL
WATERSHED CHARACTERISTICS and LAG TIME CALCULATION

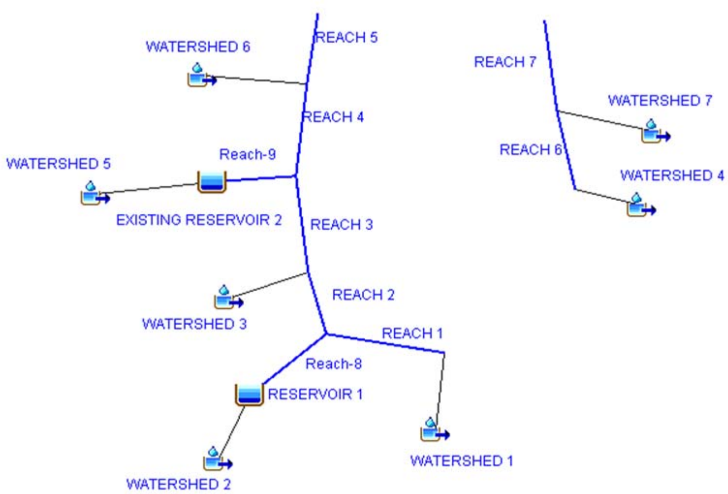
$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Input Values	

Ia = 0.2*S

Lag Time										
Watershed #	**Watershed Description**	**Area (ft^2)**	**Area (mi^2)**	**l (ft)**	**CN**	**y**	**S**	**t_p (hr)**	**t_p (min)**	**Ia**
1	EG External Watershed	506,342	0.0182	559	72	31.9%	3.89	0.04	2.7	0.78
2	EG External Watershed	2,670,779	0.0958	2,677	72	39.7%	3.89	0.14	8.4	0.78
3	EG External Watershed	169,348	0.0061	224	72	33.1%	3.89	0.02	1.3	0.78
4	EG External Watershed	152,016	0.0055	688	72	42.8%	3.89	0.05	2.7	0.78
5	EG External Watershed	573,108	0.0206	1,098	72	45.1%	3.89	0.06	3.9	0.78
6	EG External Watershed	239,718	0.0086	881	72	51.3%	3.89	0.05	3.0	0.78
7	EG External Watershed	652,505	0.0234	1,045	72	43.7%	3.89	0.06	3.8	0.78

Reach Data							
Reach #	**Reach Description**	**Length (ft)**	**High El. (ft)**	**Low El. (ft)**	**Slope (ft/ft)**	**Slope (%)**	**Mannings n**
1	External Diversion Channel	542	5,092.0	5,040.0	0.096	9.6	0.078
2	External Diversion Channel	391	5,040.0	5,027	0.033	3.3	0.078
3	External Diversion Channel	631	5,027.0	4,957	0.111	11.1	0.078
4	External Diversion Channel	429	4,957.0	4,929.0	0.065	6.5	0.078
5	External Diversion Channel	334	4,929.0	4,895.0	0.102	10.2	0.078
6	External Diversion Channel	317	4,957.3	4,955.8	0.005	0.5	0.035
7	External Diversion Channel	540	4,955.8	4,953.0	0.005	0.5	0.035



Project: Hermosa Stage 1 tails in pl Simulation Run: 100 yr 24 hour

Start of Run: 01Jan2015, 00:00 Basin Model: Dry Stack TSF
End of Run: 05Jan2015, 00:01 Meteorologic Model: 100 yr / 24 hr
Compute Time: 23May2017, 09:23:41 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
EXISTING RESERVOIR 2	0.0206	36.9	01Jan2015, 12:03	1.4
REACH 1	0.0182	41.0	01Jan2015, 11:58	2.0
REACH 2	0.1140	181.1	01Jan2015, 12:03	12.8
REACH 3	0.1201	184.9	01Jan2015, 12:04	13.5
REACH 4	0.1407	215.8	01Jan2015, 12:04	14.9
REACH 5	0.1493	220.4	01Jan2015, 12:05	15.9
REACH 6	0.0055	12.4	01Jan2015, 11:58	0.6
REACH 7	0.0289	62.8	01Jan2015, 12:00	3.2
Reach-8	0.0958	157.0	01Jan2015, 12:05	10.8
Reach-9	0.0206	36.9	01Jan2015, 12:03	1.4
RESERVOIR 1	0.0958	157.0	01Jan2015, 12:05	10.8
stage 1 temp N	0.0029	7.6	01Jan2015, 11:57	0.4
stage 1 temp S	0.0031	8.0	01Jan2015, 11:58	0.4
WATERSHED 1	0.0182	41.2	01Jan2015, 11:56	2.0
WATERSHED 2	0.0958	171.1	01Jan2015, 12:02	10.8
WATERSHED 3	0.0061	14.4	01Jan2015, 11:55	0.7
WATERSHED 4	0.0055	12.4	01Jan2015, 11:56	0.6
WATERSHED 5	0.0206	44.5	01Jan2015, 11:58	2.3
WATERSHED 6	0.0086	19.2	01Jan2015, 11:57	1.0
WATERSHED 7	0.0234	50.7	01Jan2015, 11:58	2.6

Worksheet for Stormwater Diversion Channel - Sta 0+00 to 13+80 1.7%

Project Description

Friction Method	Manning Formula	
Solve For	Normal Depth	

Input Data

Roughness Coefficient	0.064	
Channel Slope	0.01700	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	220.40	ft³/s

Results

Normal Depth	2.61	ft
Flow Area	48.25	ft²
Wetted Perimeter	26.03	ft
Hydraulic Radius	1.85	ft
Top Width	25.03	ft
Critical Depth	1.90	ft
Critical Slope	0.05473	ft/ft
Velocity	4.57	ft/s
Velocity Head	0.32	ft
Specific Energy	2.93	ft
Froude Number	0.58	
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	2.61	ft
Critical Depth	1.90	ft
Channel Slope	0.01700	ft/ft
Critical Slope	0.05473	ft/ft

Worksheet for Stormwater Diversion Channel - Sta 0+00 to 13+80 9.7%

Project Description

Friction Method	Manning Formula		
Solve For	Normal Depth		

Input Data

Roughness Coefficient		0.069	
Channel Slope		0.09700	ft/ft
Left Side Slope		2.50	ft/ft (H:V)
Right Side Slope		2.50	ft/ft (H:V)
Bottom Width		12.00	ft
Discharge		220.40	ft³/s

Results

Normal Depth		1.70	ft
Flow Area		27.54	ft²
Wetted Perimeter		21.13	ft
Hydraulic Radius		1.30	ft
Top Width		20.48	ft
Critical Depth		1.90	ft
Critical Slope		0.06362	ft/ft
Velocity		8.00	ft/s
Velocity Head		0.99	ft
Specific Energy		2.69	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		1.70	ft
Critical Depth		1.90	ft
Channel Slope		0.09700	ft/ft
Critical Slope		0.06362	ft/ft

Worksheet for Stormwater Diversion Channel - Sta 13+80 to 18+55

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.071	
Channel Slope	0.03100	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	181.10	ft^3/s

Results

Normal Depth	2.11	ft
Flow Area	36.51	ft^2
Wetted Perimeter	23.38	ft
Hydraulic Radius	1.56	ft
Top Width	22.56	ft
Critical Depth	1.70	ft
Critical Slope	0.06940	ft/ft
Velocity	4.96	ft/s
Velocity Head	0.38	ft
Specific Energy	2.49	ft
Froude Number	0.69	
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	2.11	ft
Critical Depth	1.70	ft
Channel Slope	0.03100	ft/ft
Critical Slope	0.06940	ft/ft

Worksheet for Stormwater Diversion Channel - Sta 18+55 to END

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.055	
Channel Slope	0.00600	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	5.00	ft
Discharge	41.00	ft³/s

Results

Normal Depth	1.83	ft
Flow Area	17.54	ft²
Wetted Perimeter	14.86	ft
Hydraulic Radius	1.18	ft
Top Width	14.16	ft
Critical Depth	1.06	ft
Critical Slope	0.05024	ft/ft
Velocity	2.34	ft/s
Velocity Head	0.08	ft
Specific Energy	1.92	ft
Froude Number	0.37	
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	1.83	ft
Critical Depth	1.06	ft
Channel Slope	0.00600	ft/ft
Critical Slope	0.05024	ft/ft

Worksheet for Underdrain Collection Pond Stormwater Diversion

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00500	ft/ft
Left Side Slope	1.50	ft/ft (H:V)
Right Side Slope	1.50	ft/ft (H:V)
Bottom Width	0.00	ft
Discharge	12.40	ft³/s

Results

Normal Depth	1.82	ft
Flow Area	4.97	ft²
Wetted Perimeter	6.56	ft
Hydraulic Radius	0.76	ft
Top Width	5.46	ft
Critical Depth	1.34	ft
Critical Slope	0.02610	ft/ft
Velocity	2.49	ft/s
Velocity Head	0.10	ft
Specific Energy	1.92	ft
Froude Number	0.46	
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	1.82	ft
Critical Depth	1.34	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02610	ft/ft

Worksheet for Underdrain Collection Pond Stormwater Diversion

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00500	ft/ft
Left Side Slope	1.50	ft/ft (H:V)
Right Side Slope	1.50	ft/ft (H:V)
Bottom Width	3.00	ft
Discharge	62.80	ft³/s

Results

Normal Depth	2.49	ft
Flow Area	16.73	ft²
Wetted Perimeter	11.96	ft
Hydraulic Radius	1.40	ft
Top Width	10.46	ft
Critical Depth	1.78	ft
Critical Slope	0.01970	ft/ft
Velocity	3.75	ft/s
Velocity Head	0.22	ft
Specific Energy	2.71	ft
Froude Number	0.52	
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	2.49	ft
Critical Depth	1.78	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.01970	ft/ft

Culvert Calculator Report
Stormwater Diversion Channel Culvert - Sta 13+80 to 15+20

Solve For: Headwater Elevation

Culvert Summary					
Allowable HW Elevation	5,038.00	ft	Headwater Depth/Height	1.23	
Computed Headwater Elevation	5,034.94	ft	Discharge	181.10	cfs
Inlet Control HW Elev.	5,034.75	ft	Tailwater Elevation	5,027.35	ft
Outlet Control HW Elev.	5,034.94	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,030.03	ft	Downstream Invert	5,027.24	ft
Length	140.00	ft	Constructed Slope	0.019929	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.93	ft
Slope Type	Steep		Normal Depth	1.79	ft
Flow Regime	Supercritical		Critical Depth	2.89	ft
Velocity Downstream	15.04	ft/s	Critical Slope	0.004474	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	5,034.94	ft	Upstream Velocity Head	1.35	ft
Ke	0.50		Entrance Loss	0.68	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,034.75	ft	Flow Control	Transition	
Inlet Type	Square edge w/headwall		Area Full	25.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
Stormwater Culvert - Flux Canyon Road

Solve For: Section Size

Culvert Summary					
Allowable HW Elevation	5,084.00	ft	Headwater Depth/Height	1.52	
Computed Headwater Elevation	5,083.32	ft	Discharge	171.10	cfs
Inlet Control HW Elev.	5,083.32	ft	Tailwater Elevation	5,069.30	ft
Outlet Control HW Elev.	5,083.26	ft	Control Type	Inlet Control	

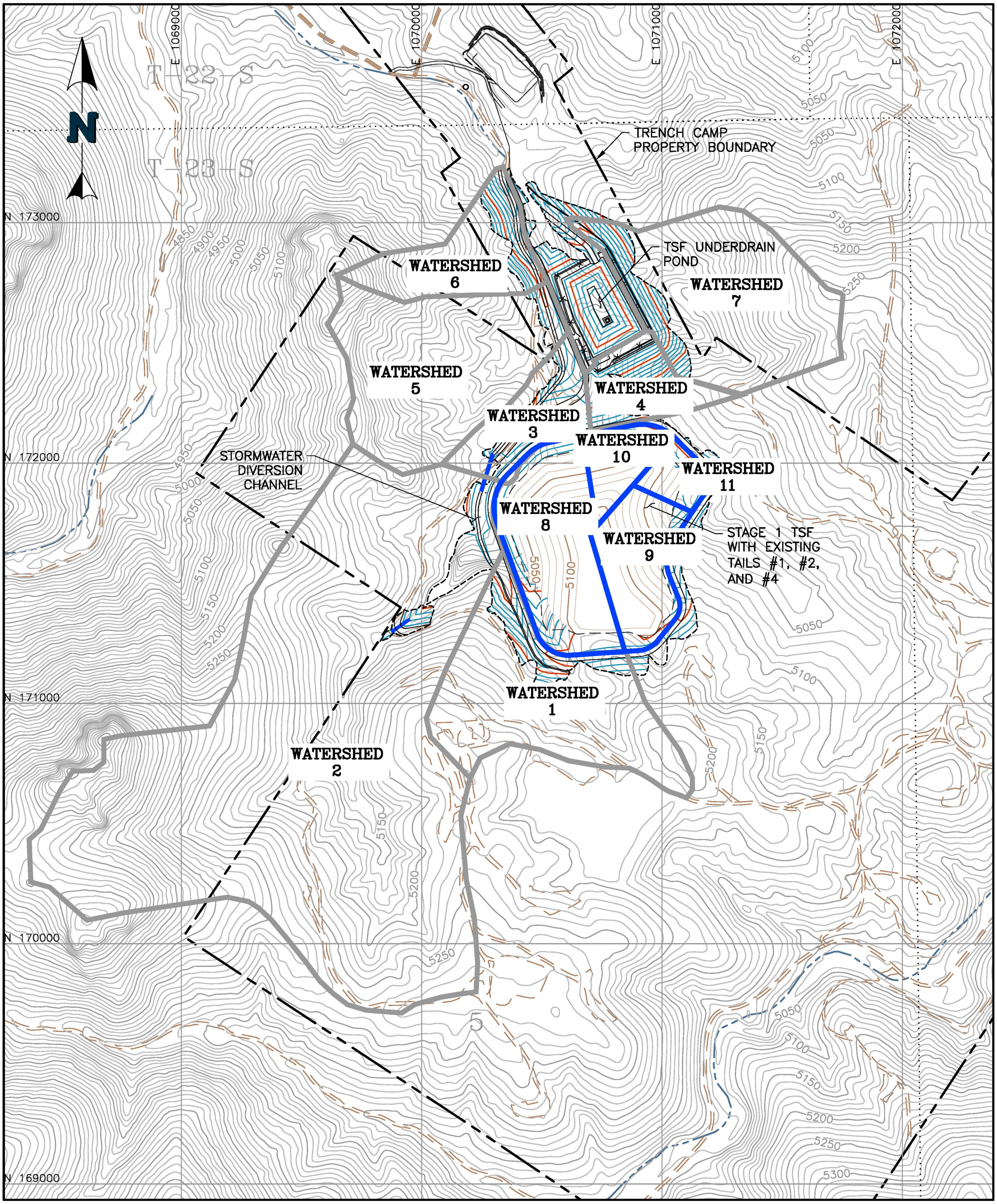
Grades					
Upstream Invert	5,078.00	ft	Downstream Invert	5,069.30	ft
Length	87.00	ft	Constructed Slope	0.100000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.40	ft
Slope Type	Steep		Normal Depth	1.19	ft
Flow Regime	Supercritical		Critical Depth	2.88	ft
Velocity Downstream	23.92	ft/s	Critical Slope	0.006117	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.	5,083.26	ft	Upstream Velocity Head	1.58	ft
Ke	0.50		Entrance Loss	0.79	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,083.32	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	19.2	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				



LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- WATERSHED BOUNDARY

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

0 300 600 FEET

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: STAGE 1 WATERSHEDS– TAILINGS #1, #2 AND #4 STACKED IN TSF

FILENAME	
14.008.022F	
FIGURE NO.	REVISION
2	0

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\FIG\14.008.022F.dwg-4/24/2017 6:43 PM

STAGE 1 WATERSHEDS- TAILINGS #1, #2 AND #4 STACKED IN TSF
HYDROLOGY ANALYSIS and STORMWATER CONTROL
WATERSHED CHARACTERISTICS and LAG TIME CALCULATION

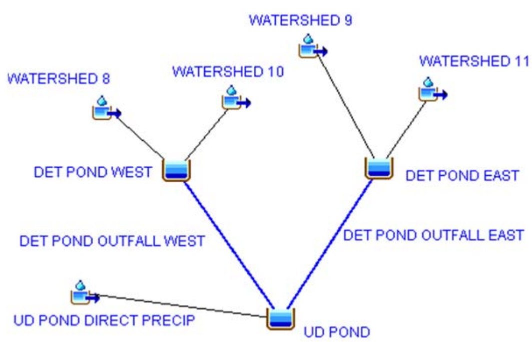
$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)

Input Values

Ia = 0.2*S

Lag Time										
Watershed #	**Watershed Description**	**Area (ft^2)**	**Area (mi^2)**	**l (ft)**	**CN**	**y**	**S**	**t_p (hr)**	**t_p (min)**	**Ia**
8	Stage 1 Dry Stack TSF (W)	325,845	0.0117	1,370	85	29.5%	1.76	0.06	3.8	0.35
9	Stage 1 Dry Stack TSF (S)	185,710	0.0067	835	85	26.4%	1.76	0.05	2.7	0.35
10	Stage 1 Dry Stack TSF (N)	88,460	0.0032	350	85	34.3%	1.76	0.02	1.2	0.35
11	Stage 1 Dry Stack TSF (E)	56,035	0.0020	350	85	32.3%	1.76	0.02	1.2	0.35



Project: Hermosa Stage 1 tails stack Simulation Run: 100 yr 24 hour

Start of Run: 01Jan2015, 00:00 Basin Model: Dry Stack TSF
End of Run: 05Jan2015, 00:01 Meteorologic Model: 100 yr / 24 hr
Compute Time: 23May2017, 09:24:30 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
DET POND EAST	0.0087	31.3	01Jan2015, 11:54	1.5
DET POND OUTFALL EAST	0.0087	31.3	01Jan2015, 11:54	1.5
DET POND OUTFALL WEST	0.0149	44.2	01Jan2015, 11:56	2.6
DET POND WEST	0.0149	44.2	01Jan2015, 11:56	2.6
UD POND	0.0267	87.9	01Jan2015, 11:54	4.9
UD POND DIRECT PRECIP	0.0031	14.1	01Jan2015, 11:52	0.8
WATERSHED 10	0.0032	11.7	01Jan2015, 11:53	0.6
WATERSHED 11	0.0020	7.3	01Jan2015, 11:53	0.3
WATERSHED 8	0.0117	42.8	01Jan2015, 11:53	2.0
WATERSHED 9	0.0067	24.5	01Jan2015, 11:53	1.2

HEC-15 RIPRAP DESIGN

Stage 1 Stormwater Diversion Channel **STA 0+00 to STA 5+17**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	12	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.099	ft/ft
Flow	Q	313.8	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**2**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	40.00	inch
	D_{75}	30.00	inch
	D_{50}	24.00	inch
	D_{30}	16.00	inch
	D_{15}	12.00	inch
	D_{10}	8.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**1.96**	ft
Area of Channel	A	33.12	ft^2
Wetted Perimeter	P	22.55	ft
Hydraulic Radius	R	1.47	ft
Wetted Top Width	T	21.80	ft
Calculated Average Flow Depth	D_a	1.52	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.760	
For $1.5 < D_a/D_{50} < 185$	n	0.173	
Q from mannings	Qi	116.12	ft^3/s
% Difference from Design Discharge		-63.00%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.067	
function(Froude number)	f(Fr)	1.083	
Froude number	Fr	1.354	
Velocity of flow	V	**9.473**	
effective roughness concrentration	b	0.309	
Roughness element geometry	f(REG)	8.818	
Channel geometry	f(CG)	0.439	
Q from mannings	Qi	298.90	ft^3/s
% Difference from Design Discharge		-4.75%	

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_*	2.500		
Reynolds number	R_e	4.11E+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_*	0.150		
From Table 6.1	SF	1.500		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	1.18	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.286	2.159	(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	59.01%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	ϴ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	1.18				
Difference to Chosen Riprap		58.98%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	5.65	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	21.19	°			
Shear Stress	τ	10.11	lb/ft^2			
Stability Number	η	0.33				
	Δ	1.68				
For S > 10%	D_{50}	1.98				
Difference to Chosen Riprap		98.88%		<	100%	TRUE

HEC-15 RIPRAP DESIGN

Stage 1 Stormwater Diversion Channel **STA 5+17 to 8+69**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	12	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.017	ft/ft
Flow	Q	309.8	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.75**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	15.00	inch
	D_{75}	11.25	inch
	D_{50}	9.00	inch
	D_{30}	6.00	inch
	D_{15}	4.50	inch
	D_{10}	3.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**3.03**	ft
Area of Channel	A	59.31	ft^2
Wetted Perimeter	P	28.32	ft
Hydraulic Radius	R	2.09	ft
Wetted Top Width	T	27.15	ft
Calculated Average Flow Depth	D_a	2.18	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		2.913	
For $1.5 < D_a/D_{50} < 185$	n	0.064	
Q from mannings	Qi	295.70	ft^3/s
% Difference from Design Discharge		-4.55%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.046	
function(Froude number)	f(Fr)	0.846	
Froude number	Fr	0.623	
Velocity of flow	V	**5.223**	
effective roughness concrentration	b	0.536	
Roughness element geometry	f(REG)	29.544	
Channel geometry	f(CG)	0.259	
Q from mannings	Qi	408.81	ft^3/s
% Difference from Design Discharge		31.96%	

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_*	1.288		
Reynolds number	R_e	7.94E+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_*	0.072		
From Table 6.1	SF	1.123		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.49	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.072	1.123	(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	64.84%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment					
Stone Angle of Repose	ϕ	42.5	°		
For 1.5 < Z < 5	K1	0.835			
	Θ	21.80	°		
	K2	0.84			
Stable D_{50}	$D_{50,s}$	0.49			
Difference to Chosen Riprap		64.82%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

Stage 1 Stormwater Diversion Channel **STA 11+44 - 13+80**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	12	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.097	ft/ft
Flow	Q	295.6	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**2**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	40.00	inch
	D_{75}	30.00	inch
	D_{50}	24.00	inch
	D_{30}	16.00	inch
	D_{15}	12.00	inch
	D_{10}	8.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**2**	ft
Area of Channel	A	34.00	ft^2
Wetted Perimeter	P	22.77	ft
Hydraulic Radius	R	1.49	ft
Wetted Top Width	T	22.00	ft
Calculated Average Flow Depth	D_a	1.55	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.773	
For $1.5 < D_a/D_{50} < 185$	n	0.169	
Q from mannings	Qi	121.78	ft^3/s
% Difference from Design Discharge		-58.80%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.069	
function(Froude number)	f(Fr)	1.040	
Froude number	Fr	1.232	
Velocity of flow	V	**8.694**	
effective roughness concrentration	b	0.312	
Roughness element geometry	f(REG)	8.960	
Channel geometry	f(CG)	0.437	
Q from mannings	Qi	297.03	ft^3/s
% Difference from Design Discharge		0.48%	

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_*	2.499		
Reynolds number	R_e	4.11E+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_*	0.150		
From Table 6.1	SF	1.500		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	1.18	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.286	2.159	(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	58.99%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	ϴ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	1.18				
Difference to Chosen Riprap		58.97%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	5.54	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	21.21	°			
Shear Stress	τ	10.11	lb/ft^2			
Stability Number	η	0.33				
	Δ	1.67				
For S > 10%	D_{50}	1.97				
Difference to Chosen Riprap		98.74%		<	100%	TRUE

Stage 1 Stormwater Diversion Channel **STA 15+20 - 18+55**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	12	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.031	ft/ft
Flow	Q	181.1	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.75**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	15.00	inch
	D_{75}	11.25	inch
	D_{50}	9.00	inch
	D_{30}	6.00	inch
	D_{15}	4.50	inch
	D_{10}	3.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**2.1**	ft
Area of Channel	A	36.23	ft^2
Wetted Perimeter	P	23.31	ft
Hydraulic Radius	R	1.55	ft
Wetted Top Width	T	22.50	ft
Calculated Average Flow Depth	D_a	1.61	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		2.147	
For $1.5 < D_a/D_{50} < 185$	n	0.071	
Q from mannings	Qi	179.14	ft^3/s
% Difference from Design Discharge		-1.08%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.053	
function(Froude number)	f(Fr)	0.829	
Froude number	Fr	0.694	
Velocity of flow	V	**4.999**	
effective roughness concrentration	b	0.455	
Roughness element geometry	f(REG)	21.430	
Channel geometry	f(CG)	0.301	
Q from mannings	Qi	240.25	ft^3/s
% Difference from Design Discharge		32.66%	

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_*	1.448		
Reynolds number	R_e	8.92E+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_*	0.079		
From Table 6.1	SF	1.154		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.58	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.079	1.154	(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	77.41%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	Θ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	0.58				
Difference to Chosen Riprap		77.38%		<	100%	TRUE

HEC-15 RIPRAP DESIGN

Stage 1 Stormwater Diversion Channel **STA 18+55 - 20+19, STA 22+22 to END**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	5	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.076	ft/ft
Flow	Q	41	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 the Flow Depth			
Initial Flow Depth Estimate	D_i	**1.05**	ft
Area of Channel	A	8.01	ft^2
Wetted Perimeter	P	10.65	ft
Hydraulic Radius	R	0.75	ft
Wetted Top Width	T	10.25	ft
Calculated Average Flow Depth	D_a	0.78	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.781	
For $1.5 < D_a/D_{50} < 185$	n	0.149	
Q from mannings	Qi	18.26	ft^3/s
% Difference from Design Discharge		-55.47%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.066	
function(Froude number)	f(Fr)	0.954	
Froude number	Fr	1.021	
Velocity of flow	V	**5.121**	
effective roughness concrentration	b	0.325	
Roughness element geometry	f(REG)	9.264	
Channel geometry	f(CG)	0.433	
Q from mannings	Qi	41.32	ft^3/s
% Difference from Design Discharge		0.79%	

NewFields

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_*	1.603		
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	1.287		
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	1.287	(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	58.89%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	ϴ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	0.59				
Difference to Chosen Riprap		58.86%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	4.35	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	24.41	°			
Shear Stress	τ	4.16	lb/ft^2			
Stability Number	η	0.38				
	Δ	1.36				
For S > 10%	D_{50}	0.80				
Difference to Chosen Riprap		80.27%		<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Stage 1 Stormwater Diversion Channel **STA 20+19 - 22+22**	NOTE: Gray boxes require input, Orange boxes require specific values, Red boxes are calculated

Step 1: Channel Design Parameters			
Bottom Width	B	5	ft
Side Slope	Z	2.5	x:1
Longitudinal Slope	S	0.183	ft/ft
Flow	Q	41	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**2**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	40.00	inch
	D_{75}	30.00	inch
	D_{50}	24.00	inch
	D_{30}	16.00	inch
	D_{15}	12.00	inch
	D_{10}	8.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**0.85**	ft
Area of Channel	A	6.06	ft^2
Wetted Perimeter	P	9.58	ft
Hydraulic Radius	R	0.63	ft
Wetted Top Width	T	9.25	ft
Calculated Average Flow Depth	D_a	0.65	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.327	
For $1.5 < D_a/D_{50} < 185$	n	-0.853	
Q from mannings	Qi	-3.34	ft^3/s
% Difference from Design Discharge		-108.14%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.071	
function(Froude number)	f(Fr)	1.355	
Froude number	Fr	1.474	
Velocity of flow	V	**6.770**	
effective roughness concrentration	b	0.230	
Roughness element geometry	f(REG)	4.683	
Channel geometry	f(CG)	0.545	
Q from mannings	Qi	40.15	ft^3/s
% Difference from Design Discharge		-2.07%	

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_*	2.238		
Reynolds number	R_e	3.68E+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_*	0.150		
From Table 6.1	SF	1.500		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.95	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.258	2.024	(Linear Interpolation)
$\geq 2x10^5$	0.15	1.5	

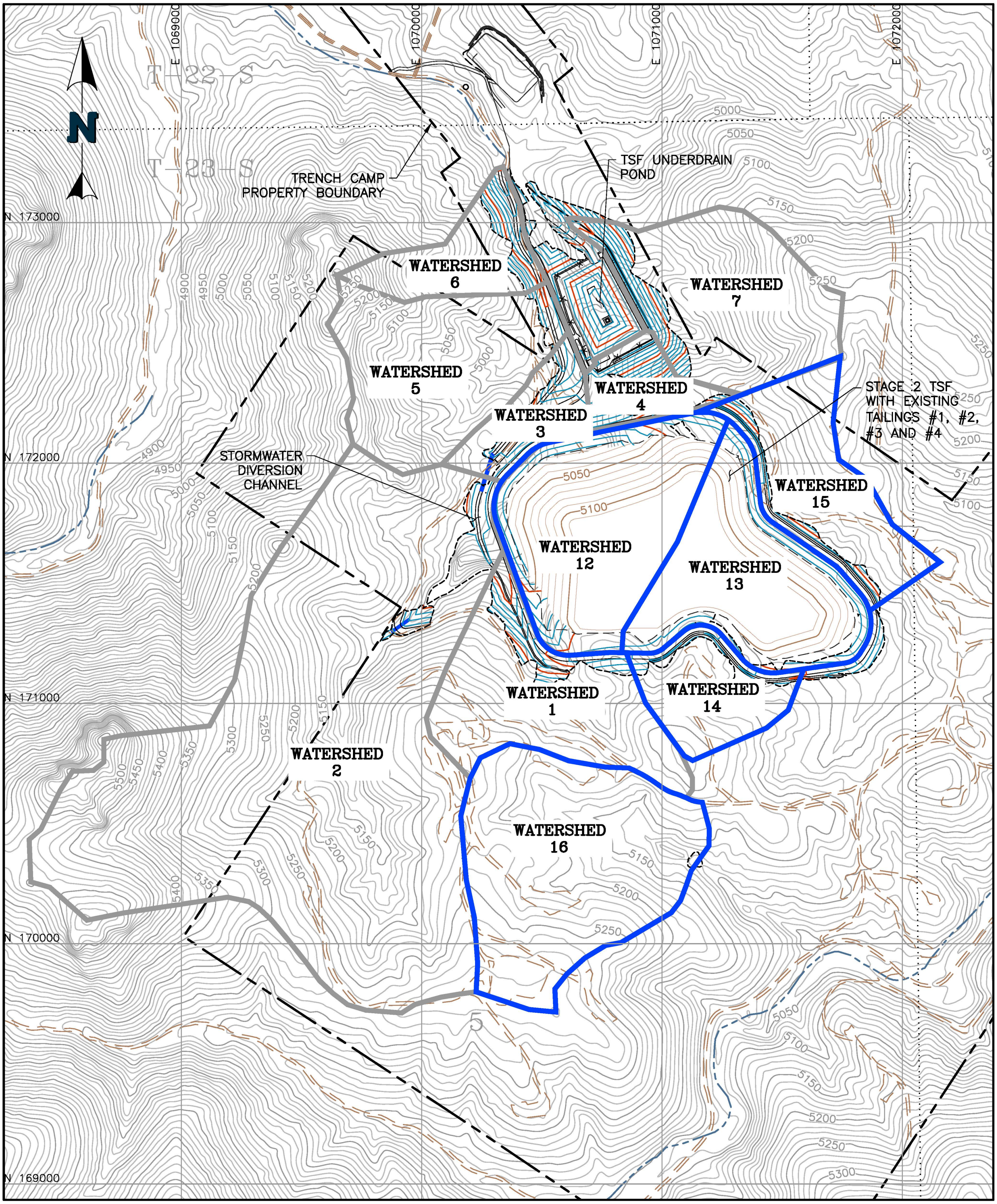
Step 7: Iterate Solution till Calculated D50 is Acceptably Smaller then Chosen D50				
Difference to Chosen Riprap	47.30%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	Θ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	0.95				
Difference to Chosen Riprap		47.28%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	10.37	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	16.80	°			
Shear Stress	τ	8.10	lb/ft^2			
Stability Number	η	0.26				
	Δ	1.76				
For S > 10%	D_{50}	1.66				
Difference to Chosen Riprap		83.03%		<	100%	TRUE

APPENDIX H.4

Hydrology and Hydraulics (Stage 2)



P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\FIG\14.008.021F.dwg-4/24/2017 8:26 PM

LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- WATERSHED BOUNDARY

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

0 300 600 FEET

NewFields	CLIENT ARIZONA MINERALS INC
PROJECT	TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE
TITLE STAGE 2 WATERSHEDS	FILENAME 14.008.021F; FIGURE NO. 3; REVISION 0

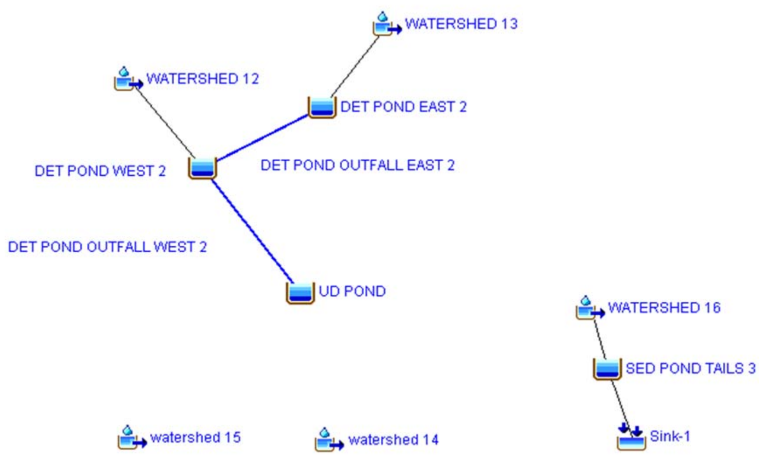
STAGE 2 WATERSHEDS
HYDROLOGY ANALYSIS and STORMWATER CONTROL
WATERSHED CHARACTERISTICS and LAG TIME CALCULATION

$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Input Values	

Ia = 0.2*S

Lag Time										
Watershed #	Watershed Description	Area (ft^2)	Area (mi^2)	l (ft)	CN	y	S	t_p (hr)	t_p (min)	Ia
12	Stage 2 Dry Stack TSF (W)	639345	0.0229	1230	85	24.3%	1.76	0.06	3.9	0.35
13	Stage 2 Dry Stack TSF (E)	543980	0.0195	1300	85	27.8%	1.76	0.06	3.8	0.35
16	Sediment Pond	803,919	0.0288	1,352	80	24.5%	2.50	0.08	4.9	0.50
15	Stage 2 North Diversion Channel	385,340	0.0138	1,100	72	31.1%	3.89	0.08	4.7	0.78
14	Stage 2 South Diversion Channel	232,070	0.0083	500	72	28.9%	3.89	0.04	2.6	0.78



Project: Hermosa Stage 2 Simulation Run: 100 yr 24 hour

Start of Run: 01Jan2015, 00:00 Basin Model: Dry Stack TSF
End of Run: 05Jan2015, 00:01 Meteorologic Model: 100 yr / 24 hr
Compute Time: 23May2017, 09:11:03 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
DET POND EAST 2	0.0195	62.9	01Jan2015, 11:55	3.4
DET POND OUTFALL EAST 2	0.0195	62.9	01Jan2015, 11:55	3.4
DET POND OUTFALL WEST 2	0.0424	77.8	01Jan2015, 12:00	7.4
DET POND WEST 2	0.0424	77.8	01Jan2015, 12:00	7.4
SED POND TAILS 3	0.0288	62.2	01Jan2015, 12:03	4.3
Sink-1	0.0288	62.2	01Jan2015, 12:03	4.3
UD POND	0.0424	77.8	01Jan2015, 12:00	7.4
WATERSHED 12	0.0229	83.8	01Jan2015, 11:53	4.0
WATERSHED 13	0.0195	71.3	01Jan2015, 11:53	3.4
watershed 14	0.0083	18.9	01Jan2015, 11:56	0.9
watershed 15	0.0138	28.8	01Jan2015, 11:59	1.5
WATERSHED 16	0.0288	78.9	01Jan2015, 11:58	4.3

Project: Hermosa Stage 2 Simulation Run: 50 yr 24 hour

Start of Run:	01Jan2015, 00:00	Basin Model:	Dry Stack TSF
End of Run:	05Jan2015, 00:01	Meteorologic Model:	50 yr / 24 hr
Compute Time:	26May2017, 14:41:34	Control Specifications:	Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
DET POND EAST 2	0.0195	57.0	01Jan2015, 11:55	2.9
DET POND OUTFALL EAST 2	0.0195	57.0	01Jan2015, 11:55	2.9
DET POND OUTFALL WEST 2	0.0424	73.6	01Jan2015, 12:00	6.4
DET POND WEST 2	0.0424	73.6	01Jan2015, 12:00	6.4
SED POND TAILS 3	0.0288	55.1	01Jan2015, 12:03	3.7
Sink-1	0.0288	55.1	01Jan2015, 12:03	3.7
UD POND	0.0424	73.6	01Jan2015, 12:00	6.4
WATERSHED 12	0.0229	73.0	01Jan2015, 11:53	3.4
WATERSHED 13	0.0195	62.2	01Jan2015, 11:53	2.9
watershed 14	0.0083	15.6	01Jan2015, 11:56	0.8
watershed 15	0.0138	23.9	01Jan2015, 11:59	1.3
WATERSHED 16	0.0288	67.4	01Jan2015, 11:58	3.7

Worksheet for Stage 2 TSF Stormwater Diversion Channel (North)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00500	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Discharge	28.80	ft³/s

Results

Normal Depth	2.20	ft
Flow Area	9.69	ft²
Wetted Perimeter	9.85	ft
Hydraulic Radius	0.98	ft
Top Width	8.81	ft
Critical Depth	1.67	ft
Critical Slope	0.02201	ft/ft
Velocity	2.97	ft/s
Velocity Head	0.14	ft
Specific Energy	2.34	ft
Froude Number	0.50	
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	2.20	ft
Critical Depth	1.67	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02201	ft/ft

Worksheet for Stage 2 TSF Stormwater Diversion Channel (South)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.01600	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Discharge	18.90	ft³/s

Results

Normal Depth	1.51	ft
Flow Area	4.57	ft²
Wetted Perimeter	6.76	ft
Hydraulic Radius	0.68	ft
Top Width	6.05	ft
Critical Depth	1.41	ft
Critical Slope	0.02328	ft/ft
Velocity	4.14	ft/s
Velocity Head	0.27	ft
Specific Energy	1.78	ft
Froude Number	0.84	
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	1.51	ft
Critical Depth	1.41	ft
Channel Slope	0.01600	ft/ft
Critical Slope	0.02328	ft/ft

Worksheet for Sed pond tails 3 channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.055	
Channel Slope	0.06600	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	6.00	ft
Discharge	67.40	ft^3/s

Results

Normal Depth	1.23	ft
Flow Area	10.39	ft^2
Wetted Perimeter	11.49	ft
Hydraulic Radius	0.90	ft
Top Width	10.91	ft
Critical Depth	1.35	ft
Critical Slope	0.04695	ft/ft
Velocity	6.49	ft/s
Velocity Head	0.65	ft
Specific Energy	1.88	ft
Froude Number	1.17	
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	1.23	ft
Critical Depth	1.35	ft
Channel Slope	0.06600	ft/ft
Critical Slope	0.04695	ft/ft

Culvert Calculator Report
Sed pond tails 3 culvert

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	5,120.00	ft	Headwater Depth/Height	1.87	
Computed Headwater Elevation	5,115.61	ft	Discharge	67.40	cfs
Inlet Control HW Elev.	5,115.61	ft	Tailwater Elevation	5,108.90	ft
Outlet Control HW Elev.	5,115.09	ft	Control Type	Inlet Control	

Grades

Upstream Invert	5,110.00	ft	Downstream Invert	5,108.90	ft
Length	110.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile

Profile	S2		Depth, Downstream	2.33	ft
Slope Type	Steep		Normal Depth	2.30	ft
Flow Regime	Supercritical		Critical Depth	2.62	ft
Velocity Downstream	11.42	ft/s	Critical Slope	0.007894	ft/ft

Section

Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	1				

Outlet Control Properties

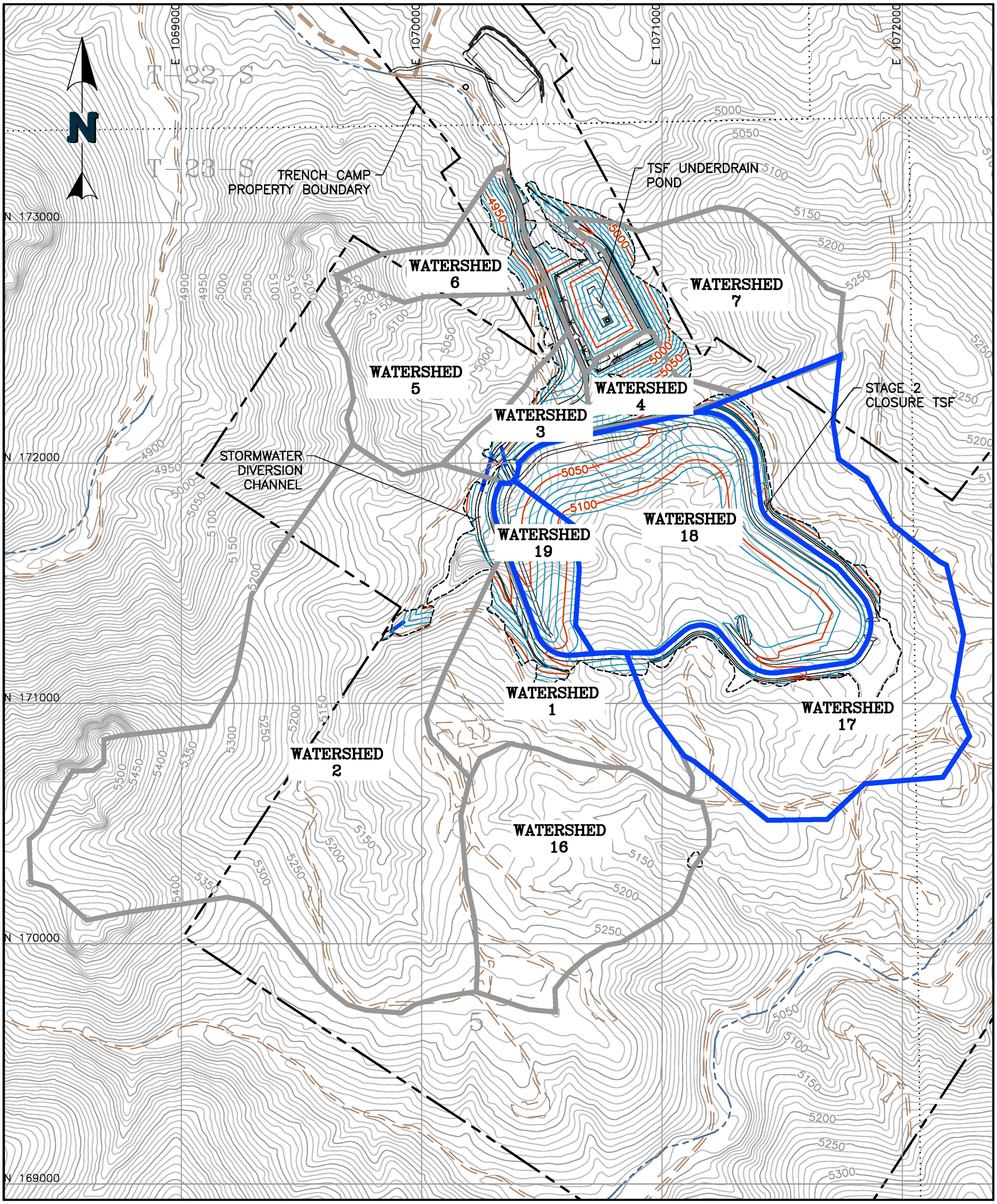
Outlet Control HW Elev.	5,115.09	ft	Upstream Velocity Head	1.64	ft
Ke	0.50		Entrance Loss	0.82	ft

Inlet Control Properties

Inlet Control HW Elev.	5,115.61	ft	Flow Control	N/A	
Inlet Type	Square edge w/headwall		Area Full	7.1	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

APPENDIX H.5

Hydrology and Hydraulics (Closure)



LEGEND:

- EXISTING GROUND CONTOURS
- TSF CLOSURE CONTOURS
- EXISTING ROADS/TRAILS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- SECTION LINES
- WATERSHED BOUNDARY

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

0 300 600 FEET

NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: CLOSURE WATERSHEDS

FILENAME: 14.008.020F

FIGURE NO.: 4

REVISION: 0

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\FIG\14.008.020F.dwg-5/17/2017 10:37 AM

CLOSURE WATERSHEDS
HYDROLOGY ANALYSIS and STORMWATER CONTROL
WATERSHED CHARACTERISTICS and LAG TIME CALCULATION

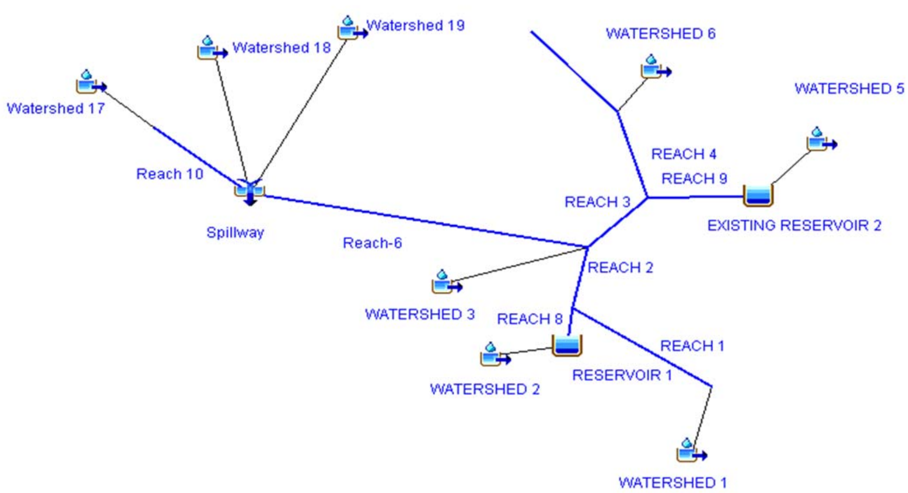
$$t_p = \frac{l^{0.8}(S+1)^{0.7}}{1900y^{0.5}}$$

t_p	Lag Time (hr.)
l	Length to Divide (ft)
y	Avg. Watershed Slope (%)
CN	Composite Curve Number
S	1000/CN-10 (in.)
Input Values	

Ia = 0.2*S

Lag Time										
Watershed #	**Watershed Description**	**Area (ft^2)**	**Area (mi^2)**	**l (ft)**	**CN**	**y**	**S**	**t_p (hr)**	**t_p (min)**	**Ia**
1	EG External Watershed	506,342	0.0182	559	72	31.9%	3.89	0.04	2.7	0.78
2	EG External Watershed	2,670,779	0.0958	2,677	72	39.7%	3.89	0.14	8.4	0.78
3	EG External Watershed	169,348	0.0061	224	72	33.1%	3.89	0.02	1.3	0.78
4	EG External Watershed	152,016	0.0055	688	72	42.8%	3.89	0.05	2.7	0.78
5	EG External Watershed	573,108	0.0206	1,098	72	45.1%	3.89	0.06	3.9	0.78
6	EG External Watershed	239,718	0.0086	881	72	51.3%	3.89	0.05	3.0	0.78
7	EG External Watershed	652,505	0.0234	1,045	72	43.7%	3.89	0.06	3.8	0.78
17	External	1,215,185	0.0436	1,840	72	25.8%	3.89	0.13	7.7	0.78
18	Internal East	971,731	0.0349	3,471	72	15.7%	3.89	0.27	16.4	0.78
19	Internal West	164,010	0.0059	826	72	30.0%	3.89	0.06	3.8	0.78

Reach Data							
Reach #	**Reach Description**	**Length (ft)**	**High El. (ft)**	**Low El. (ft)**	**Slope (ft/ft)**	**Slope (%)**	**Mannings n**
1	External Diversion Channel	542	5,092.0	5,040.0	0.096	9.6	0.078
2	External Diversion Channel	391	5,040.0	5,027	0.033	3.3	0.078
3	External Diversion Channel	631	5,027.0	4,957	0.111	11.1	0.078
4	External Diversion Channel	429	4,957.0	4,929.0	0.065	6.5	0.078
5	External Diversion Channel	334	4,929.0	4,895.0	0.102	10.2	0.078
6	External Diversion Channel	317	4,957.3	4,955.8	0.005	0.5	0.035
7	External Diversion Channel	540	4,955.8	4,953.0	0.005	0.5	0.035
10	External Reach	1980	5080	5030	0.025	2.5	0.078



Project: Hermosa Closure Simulation Run: 100 yr 24 hour

Start of Run: 01Jan2015, 00:00 Basin Model: Dry Stack TSF
End of Run: 05Jan2015, 00:01 Meteorologic Model: 100 yr / 24 hr
Compute Time: 23May2017, 16:03:11 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
EXISTING RESERVOIR 2	0.0206	36.9	01Jan2015, 12:03	1.4
REACH 1	0.0182	41.0	01Jan2015, 11:58	2.0
Reach 10	0.0436	79.7	01Jan2015, 12:09	4.9
REACH 2	0.1140	181.1	01Jan2015, 12:03	12.8
REACH 3	0.2045	295.6	01Jan2015, 12:07	22.9
REACH 4	0.2251	309.8	01Jan2015, 12:07	24.4
REACH 5	0.2337	313.8	01Jan2015, 12:07	25.3
Reach-6	0.0844	126.6	01Jan2015, 12:09	9.5
REACH 8	0.0958	157.0	01Jan2015, 12:05	10.8
REACH 9	0.0206	36.9	01Jan2015, 12:03	1.4
RESERVOIR 1	0.0958	157.0	01Jan2015, 12:05	10.8
Spillway	0.0844	126.6	01Jan2015, 12:09	9.5
WATERSHED 1	0.0182	41.2	01Jan2015, 11:56	2.0
Watershed 17	0.0436	80.2	01Jan2015, 12:02	4.9
Watershed 18	0.0349	44.7	01Jan2015, 12:10	3.9
Watershed 19	0.0059	12.8	01Jan2015, 11:58	0.7
WATERSHED 2	0.0958	171.1	01Jan2015, 12:02	10.8
WATERSHED 3	0.0061	14.4	01Jan2015, 11:55	0.7
WATERSHED 5	0.0206	44.5	01Jan2015, 11:58	2.3
WATERSHED 6	0.0086	19.2	01Jan2015, 11:57	1.0

Worksheet for East Closure Diversion Channel (Sta 0+00 to 5+42)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.055	
Channel Slope	0.02900	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	44.50	ft³/s

Results

Normal Depth	0.75	ft
Flow Area	12.68	ft²
Wetted Perimeter	19.05	ft
Hydraulic Radius	0.67	ft
Top Width	18.76	ft
Critical Depth	0.63	ft
Critical Slope	0.05404	ft/ft
Velocity	3.51	ft/s
Velocity Head	0.19	ft
Specific Energy	0.94	ft
Froude Number	0.75	
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	0.75	ft
Critical Depth	0.63	ft
Channel Slope	0.02900	ft/ft
Critical Slope	0.05404	ft/ft

Worksheet for East Closure Diversion Channel (Sta 5+42 to 26+81)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.044	
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	124.90	ft³/s

Results

Normal Depth	1.97	ft
Flow Area	39.31	ft²
Wetted Perimeter	25.62	ft
Hydraulic Radius	1.53	ft
Top Width	24.86	ft
Critical Depth	1.20	ft
Critical Slope	0.02875	ft/ft
Velocity	3.18	ft/s
Velocity Head	0.16	ft
Specific Energy	2.13	ft
Froude Number	0.45	
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	1.97	ft
Critical Depth	1.20	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02875	ft/ft

Worksheet for West Closure Diversion Channel (Sta 26+81 to End)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.055	
Channel Slope	0.03200	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	12.80	ft³/s

Results

Normal Depth	0.35	ft
Flow Area	5.56	ft²
Wetted Perimeter	16.88	ft
Hydraulic Radius	0.33	ft
Top Width	16.75	ft
Critical Depth	0.28	ft
Critical Slope	0.06910	ft/ft
Velocity	2.30	ft/s
Velocity Head	0.08	ft
Specific Energy	0.43	ft
Froude Number	0.71	
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	0.35	ft
Critical Depth	0.28	ft
Channel Slope	0.03200	ft/ft
Critical Slope	0.06910	ft/ft

Worksheet for TSF Closure Spillway

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.055	
Channel Slope	0.06600	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	126.60	ft³/s

Results

Normal Depth	1.09	ft
Flow Area	19.24	ft²
Wetted Perimeter	20.85	ft
Hydraulic Radius	0.92	ft
Top Width	20.43	ft
Critical Depth	1.21	ft
Critical Slope	0.04481	ft/ft
Velocity	6.58	ft/s
Velocity Head	0.67	ft
Specific Energy	1.76	ft
Froude Number	1.20	
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	1.09	ft
Critical Depth	1.21	ft
Channel Slope	0.06600	ft/ft
Critical Slope	0.04481	ft/ft

Worksheet for Stormwater Diversion Channel - Sta 0+00 to 18+55

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.064	
Channel Slope	0.01700	ft/ft
Left Side Slope	2.50	ft/ft (H:V)
Right Side Slope	2.50	ft/ft (H:V)
Bottom Width	12.00	ft
Discharge	313.80	ft³/s

Results

Normal Depth	3.13	ft
Flow Area	62.17	ft²
Wetted Perimeter	28.88	ft
Hydraulic Radius	2.15	ft
Top Width	27.67	ft
Critical Depth	2.34	ft
Critical Slope	0.05195	ft/ft
Velocity	5.05	ft/s
Velocity Head	0.40	ft
Specific Energy	3.53	ft
Froude Number	0.59	
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	3.13	ft
Critical Depth	2.34	ft
Channel Slope	0.01700	ft/ft
Critical Slope	0.05195	ft/ft

Culvert Calculator Report
TSF Closure Spillway Culverts

Solve For: Section Size

Culvert Summary

Allowable HW Elevation	5,030.00	ft	Headwater Depth/Height	1.21	
Computed Headwater Elevation	5,029.53	ft	Discharge	126.60	cfs
Inlet Control HW Elev.	5,029.29	ft	Tailwater Elevation	5,022.00	ft
Outlet Control HW Elev.	5,029.53	ft	Control Type	Entrance Control	

Grades

Upstream Invert	5,025.30	ft	Downstream Invert	5,021.27	ft
Length	84.00	ft	Constructed Slope	0.047976	ft/ft

Hydraulic Profile

Profile	S2		Depth, Downstream	1.41	ft
Slope Type	Steep		Normal Depth	1.23	ft
Flow Regime	Supercritical		Critical Depth	2.49	ft
Velocity Downstream	17.39	ft/s	Critical Slope	0.004596	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.	5,029.53	ft	Upstream Velocity Head	1.16	ft
Ke	0.50		Entrance Loss	0.58	ft

Inlet Control Properties

Inlet Control HW Elev.	5,029.29	ft	Flow Control	Transition	
Inlet Type	Square edge w/headwall		Area Full	19.2	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

HEC-15 RIPRAP DESIGN

NewFields

Closure Stormwater Diversion Channel (East) **STA 0+00 - 5+42**	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	0.055	ft/ft
Flow	Q	44.7	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**0.75**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	15.00	inch
	D_{75}	11.25	inch
	D_{50}	9.00	inch
	D_{30}	6.00	inch
	D_{15}	4.50	inch
	D_{10}	3.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**0.75**	ft
Area of Channel	A	12.66	ft^2
Wetted Perimeter	P	19.04	ft
Hydraulic Radius	R	0.66	ft
Wetted Top Width	T	18.75	ft
Calculated Average Flow Depth	D_a	0.68	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.900	
For $1.5 < D_a/D_{50} < 185$	n	0.122	
Q from mannings	Qi	27.60	ft^3/s
% Difference from Design Discharge		-38.25%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.075	
function(Froude number)	f(Fr)	0.935	
Froude number	Fr	0.758	
Velocity of flow	V	**3.532**	
effective roughness concrentration	b	0.243	
Roughness element geometry	f(REG)	7.879	
Channel geometry	f(CG)	0.445	
Q from mannings	Qi	44.90	ft^3/s
% Difference from Design Discharge		0.44%	

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_*	1.152		
Reynolds number	R_e	7.10E+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_*	0.067		
From Table 6.1	SF	1.097		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.41	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.067	1.097	(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	54.79%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	ϴ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	0.41				
Difference to Chosen Riprap		54.77%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	3.15	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	26.55	°			
Shear Stress	τ	2.15	lb/ft^2			
Stability Number	η	0.42				
	Δ	1.18				
For S > 10%	D_{50}	0.48				
Difference to Chosen Riprap		64.45%		<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Closure Stormwater Diversion Channel (East) **STA 5+42 - 18+74, STA 21+61 - 26+81**	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	124.9	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 the Flow Depth			
Initial Flow Depth Estimate	D_i	**2**	ft
Area of Channel	A	40.00	ft^2
Wetted Perimeter	P	25.77	ft
Hydraulic Radius	R	1.55	ft
Wetted Top Width	T	25.00	ft
Calculated Average Flow Depth	D_a	1.60	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		6.400	
For $1.5 < D_a/D_{50} < 185$	n	0.044	
Q from mannings	Qi	128.93	ft^3/s
% Difference from Design Discharge		3.23%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.031	
function(Froude number)	f(Fr)	0.889	
Froude number	Fr	0.435	
Velocity of flow	V	**3.123**	
effective roughness concrentration	b	0.641	
Roughness element geometry	f(REG)	59.131	
Channel geometry	f(CG)	0.172	
Q from mannings	Qi	179.37	ft^3/s
% Difference from Design Discharge		43.61%	

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_*	0.567		
Reynolds number	R_e	1.17E+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}	0.13	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
$\leq 4x10^4$	0.047	1	
$4x10^4<Re<2x10^5$	0.029	0.911	(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	51.76%	<	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}	$D_{50,s}$	0.13			
Difference to Chosen Riprap		51.96%	<	100%	TRUE

HEC-15 RIPRAP DESIGN

NewFields

Closure Stormwater Diversion Channel (East) STA 18+74 - 21+61	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	0.144	ft/ft
Flow	Q	124.9	ft^3/s

Step 2: Initial Riprap sizing			
Median Stone Size	D_{50}	**1.5**	ft
Stone Unit Weight	Ys	165	pcf
Riprap Calculation Gradation	D_{100}	30.00	inch
	D_{75}	22.50	inch
	D_{50}	18.00	inch
	D_{30}	12.00	inch
	D_{15}	9.00	inch
	D_{10}	6.00	inch

Step 3: Estimate the Flow Depth			
Initial Flow Depth Estimate	D_i	**0.9**	ft
Area of Channel	A	15.53	ft^2
Wetted Perimeter	P	19.85	ft
Hydraulic Radius	R	0.78	ft
Wetted Top Width	T	19.50	ft
Calculated Average Flow Depth	D_a	0.80	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.531	
For $1.5 < D_a/D_{50} < 185$	n	0.311	
Q from mannings	Qi	23.97	ft^3/s
% Difference from Design Discharge		-80.81%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.060	
function(Froude number)	f(Fr)	1.499	
Froude number	Fr	1.589	
Velocity of flow	V	**8.045**	
effective roughness concrentration	b	0.213	
Roughness element geometry	f(REG)	5.553	
Channel geometry	f(CG)	0.506	
Q from mannings	Qi	124.17	ft^3/s
% Difference from Design Discharge		-0.59%	

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_*	2.043		
Reynolds number	R_e	2.52E+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_*	0.150		
From Table 6.1	SF	1.500		
Specific Gravity of Stone	SG	2.64		
For S < 5%	D_{50}	0.79	ft	

Table 6.1. Selection of Shields' Parameter and Safety Factor			
Reynolds number	F_*	SF	
≤ $4x10^4$	0.047	1	
$4x10^4$<Re<$2x10^5$	0.183	1.662	(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	52.55%	<	100%	TRUE
IF FALSE GOTO STEP 2, ADJUST RIPRAP SIZE				

Step 8. Side Slope Assessment						
Stone Angle of Repose	ϕ	42.5	°			
For 1.5 < Z < 5	K1	0.835				
	Θ	21.80	°			
	K2	0.84				
Stable D_{50}	$D_{50,s}$	0.79				
Difference to Chosen Riprap		52.53%		<	100%	TRUE

Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	8.19	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	18.76	°			
Shear Stress	τ	6.75	lb/ft^2			
Stability Number	η	0.29				
	Δ	1.72				
For S > 10%	D_{50}	1.36				
Difference to Chosen Riprap		90.37%		<	100%	TRUE

HEC-15 RIPRAP DESIGN

Closure Stormwater Diversion Channel (East) **STA 26+81 - 30+94, STA 33+07 - END**	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	0.093	ft/ft
Flow	Q	12.8	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 the Flow Depth			
Initial Flow Depth Estimate	D_i	**0.28**	ft
Area of Channel	A	4.40	ft^2
Wetted Perimeter	P	16.51	ft
Hydraulic Radius	R	0.27	ft
Wetted Top Width	T	16.40	ft
Calculated Average Flow Depth	D_a	0.27	ft

Step 4: Estimate Manning's n and the Implied Discharge			
D_a/D_{50}		0.536	
For $1.5 < D_a/D_{50} < 185$	n	0.252	
Q from mannings	Qi	3.28	ft^3/s
% Difference from Design Discharge		-74.40%	
For $0.3 < D_a/D_{50} < 1.5$	n	0.064	
function(Froude number)	f(Fr)	1.636	
Froude number	Fr	0.991	
Velocity of flow	V	**2.912**	
effective roughness concrentration	b	0.141	
Roughness element geometry	f(REG)	3.618	
Channel geometry	f(CG)	0.559	
Q from mannings	Qi	12.98	ft^3/s
% Difference from Design Discharge		1.41%	

NewFields

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_*	0.916		
Reynolds number	R_e	3.76E+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}	0.34	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	0.993	(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	67.39%	<	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}	$D_{50,s}$	0.34				
Difference to Chosen Riprap		67.65%		<	100%	TRUE

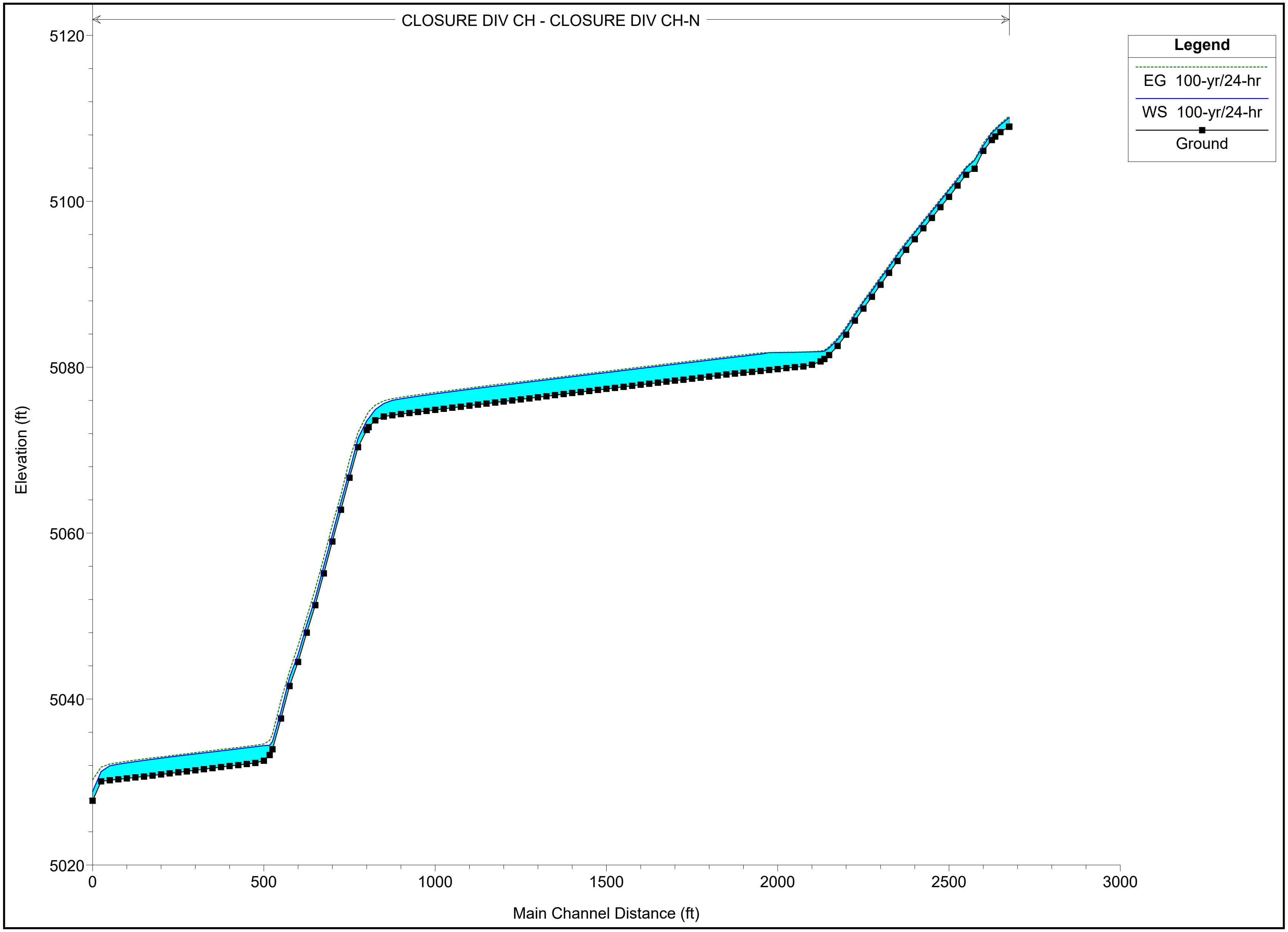
Step 9. Steep Grade Assessment						
Angle of Channel Bottom	α	5.31	°			
Angle b/t weight vector and the resultant in the plane of the side slope	β	32.57	°			
Shear Stress	τ	1.36	lb/ft^2			
Stability Number	η	0.56				
	Δ	1.16				
For S > 10%	D_{50}	0.39				
Difference to Chosen Riprap		78.18%		<	100%	TRUE

HEC-RAS Plan: Plan 08 River: CLOSURE DIV CH - Reach: CLOSURE DIV CH-N Profile: 100-yr/24-hr

Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Slope	Mann Wtd Total	Max Chl Dpth	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude # Chl
			(cfs)	(ft)	(ft/ft)		(ft)	(ft/s)	(sq ft)	(ft)	(ft)	
CLOSURE DIV CH-N	2676.2	100-yr/24-hr	44.70	5110.10	0.040974	0.075	1.10	3.52	12.71	15.13	15.48	0.68
CLOSURE DIV CH-N	2675	100-yr/24-hr	44.70	5110.07	0.036256	0.075	1.09	3.33	13.44	15.88	16.22	0.64
CLOSURE DIV CH-N	2650	100-yr/24-hr	44.70	5109.21	0.034055	0.075	0.87	3.02	14.78	19.31	19.65	0.61
CLOSURE DIV CH-N	2635.1	100-yr/24-hr	44.70	5108.61	0.043749	0.075	0.81	3.28	13.62	19.02	19.33	0.68
CLOSURE DIV CH-N	2625	100-yr/24-hr	44.70	5108.24	0.034087	0.075	0.86	3.03	14.77	19.30	19.63	0.61
CLOSURE DIV CH-N	2600	100-yr/24-hr	44.70	5106.71	0.102826	0.075	0.63	4.33	10.33	18.14	18.38	1.01
CLOSURE DIV CH-N	2575	100-yr/24-hr	44.70	5104.97	0.027183	0.075	1.04	2.26	19.74	33.77	34.21	0.52
CLOSURE DIV CH-N	2550	100-yr/24-hr	44.70	5104.00	0.046422	0.075	0.80	3.35	13.36	18.95	19.26	0.70
CLOSURE DIV CH-N	2525	100-yr/24-hr	44.70	5102.63	0.062027	0.075	0.73	3.67	12.18	18.70	18.98	0.80
CLOSURE DIV CH-N	2500	100-yr/24-hr	44.70	5101.35	0.044926	0.075	0.81	3.30	13.55	19.16	19.46	0.69
CLOSURE DIV CH-N	2475	100-yr/24-hr	44.70	5100.05	0.058063	0.075	0.76	3.59	12.44	18.78	19.06	0.78
CLOSURE DIV CH-N	2450	100-yr/24-hr	44.70	5098.79	0.045393	0.075	0.80	3.32	13.47	19.01	19.31	0.70
CLOSURE DIV CH-N	2425	100-yr/24-hr	44.70	5097.51	0.056161	0.075	0.75	3.56	12.55	18.70	18.99	0.77
CLOSURE DIV CH-N	2400	100-yr/24-hr	44.70	5096.22	0.048803	0.075	0.79	3.40	13.14	18.89	19.19	0.72
CLOSURE DIV CH-N	2375	100-yr/24-hr	44.70	5094.92	0.055315	0.075	0.75	3.54	12.62	18.75	19.04	0.76
CLOSURE DIV CH-N	2350	100-yr/24-hr	44.70	5093.57	0.053112	0.075	0.76	3.50	12.78	18.78	19.07	0.75
CLOSURE DIV CH-N	2325	100-yr/24-hr	44.70	5092.10	0.063513	0.075	0.72	3.70	12.07	18.61	18.89	0.81
CLOSURE DIV CH-N	2300	100-yr/24-hr	44.70	5090.71	0.051139	0.075	0.77	3.45	12.94	18.83	19.13	0.73
CLOSURE DIV CH-N	2275	100-yr/24-hr	44.70	5089.21	0.067798	0.075	0.70	3.78	11.81	18.53	18.80	0.84
CLOSURE DIV CH-N	2250	100-yr/24-hr	44.70	5087.85	0.046706	0.075	0.79	3.35	13.33	18.94	19.24	0.70
CLOSURE DIV CH-N	2225	100-yr/24-hr	44.70	5086.30	0.075542	0.075	0.68	3.92	11.41	18.42	18.68	0.88
CLOSURE DIV CH-N	2200	100-yr/24-hr	44.70	5084.68	0.057974	0.075	0.76	3.59	12.43	18.72	19.01	0.78
CLOSURE DIV CH-N	2175	100-yr/24-hr	44.70	5083.34	0.050858	0.075	0.78	3.45	12.97	18.85	19.15	0.73
CLOSURE DIV CH-N	2150	100-yr/24-hr	44.70	5082.33	0.034814	0.075	0.86	3.05	14.67	19.27	19.60	0.62
CLOSURE DIV CH-N	2136.2	100-yr/24-hr	44.70	5081.94	0.025513	0.075	0.94	2.75	16.25	19.68	20.04	0.53
CLOSURE DIV CH-N	2125	100-yr/24-hr	44.70	5081.88	0.003785	0.044	1.19	2.08	21.49	20.98	21.44	0.36
CLOSURE DIV CH-N	2100	100-yr/24-hr	44.70	5081.85	0.001480	0.044	1.56	1.52	29.50	22.81	23.42	0.23
CLOSURE DIV CH-N	2075	100-yr/24-hr	44.70	5081.82	0.001035	0.044	1.72	1.34	33.34	23.65	24.32	0.20
CLOSURE DIV CH-N	2050	100-yr/24-hr	44.70	5081.80	0.000905	0.044	1.79	1.28	34.89	23.95	24.64	0.19
CLOSURE DIV CH-N	2025	100-yr/24-hr	44.70	5081.78	0.000743	0.044	1.89	1.20	37.34	24.45	25.18	0.17
CLOSURE DIV CH-N	2000	100-yr/24-hr	124.90	5081.77	0.000690	0.044	1.99	1.22	102.25	61.25	63.29	0.17
CLOSURE DIV CH-N	1975	100-yr/24-hr	124.90	5081.75	0.000613	0.044	2.09	1.17	106.37	61.89	63.94	0.16
CLOSURE DIV CH-N	1950	100-yr/24-hr	124.90	5081.58	0.004522	0.044	2.03	3.07	40.71	25.14	25.92	0.43
CLOSURE DIV CH-N	1925	100-yr/24-hr	124.90	5081.46	0.004578	0.044	2.02	3.08	40.54	25.12	25.90	0.43
CLOSURE DIV CH-N	1900	100-yr/24-hr	124.90	5081.34	0.004717	0.044	2.00	3.11	40.12	25.03	25.81	0.43
CLOSURE DIV CH-N	1875	100-yr/24-hr	124.90	5081.22	0.004817	0.044	1.99	3.14	39.84	24.98	25.75	0.44
CLOSURE DIV CH-N	1850	100-yr/24-hr	124.90	5081.10	0.004956	0.044	1.98	3.17	39.44	24.89	25.65	0.44
CLOSURE DIV CH-N	1825	100-yr/24-hr	124.90	5080.97	0.004898	0.044	1.98	3.15	39.59	24.92	25.68	0.44
CLOSURE DIV CH-N	1800	100-yr/24-hr	124.90	5080.85	0.004918	0.044	1.98	3.16	39.55	24.92	25.68	0.44
CLOSURE DIV CH-N	1775	100-yr/24-hr	124.90	5080.73	0.004855	0.044	1.99	3.15	39.71	24.92	25.69	0.44
CLOSURE DIV CH-N	1750	100-yr/24-hr	124.90	5080.61	0.004853	0.044	1.99	3.14	39.73	24.96	25.72	0.44
CLOSURE DIV CH-N	1725	100-yr/24-hr	124.90	5080.49	0.004866	0.044	1.99	3.15	39.69	24.94	25.71	0.44
CLOSURE DIV CH-N	1700	100-yr/24-hr	124.90	5080.36	0.005025	0.044	1.97	3.18	39.25	24.85	25.61	0.45
CLOSURE DIV CH-N	1675	100-yr/24-hr	124.90	5080.24	0.004967	0.044	1.98	3.17	39.41	24.89	25.65	0.44
CLOSURE DIV CH-N	1650	100-yr/24-hr	124.90	5080.11	0.005025	0.044	1.97	3.18	39.25	24.86	25.61	0.45
CLOSURE DIV CH-N	1625	100-yr/24-hr	124.90	5079.99	0.004970	0.044	1.98	3.17	39.39	24.87	25.63	0.44
CLOSURE DIV CH-N	1600	100-yr/24-hr	124.90	5079.86	0.005023	0.044	1.97	3.18	39.26	24.86	25.62	0.45
CLOSURE DIV CH-N	1575	100-yr/24-hr	124.90	5079.74	0.004966	0.044	1.98	3.17	39.41	24.89	25.65	0.44
CLOSURE DIV CH-N	1550	100-yr/24-hr	124.90	5079.61	0.005032	0.044	1.97	3.18	39.24	24.86	25.61	0.45
CLOSURE DIV CH-N	1525	100-yr/24-hr	124.90	5079.48	0.004982	0.044	1.97	3.17	39.36	24.87	25.63	0.44
CLOSURE DIV CH-N	1500	100-yr/24-hr	124.90	5079.36	0.005052	0.044	1.97	3.19	39.18	24.84	25.59	0.45
CLOSURE DIV CH-N	1475	100-yr/24-hr	124.90	5079.23	0.005000	0.044	1.97	3.18	39.32	24.87	25.63	0.45
CLOSURE DIV CH-N	1450	100-yr/24-hr	124.90	5079.11	0.005069	0.044	1.96	3.19	39.13	24.83	25.59	0.45
CLOSURE DIV CH-N	1425	100-yr/24-hr	124.90	5078.98	0.005028	0.044	1.97	3.18	39.24	24.84	25.60	0.45
CLOSURE DIV CH-N	1400	100-yr/24-hr	124.90	5078.85	0.005100	0.044	1.96	3.20	39.05	24.82	25.58	0.45
CLOSURE DIV CH-N	1375	100-yr/24-hr	124.90	5078.72	0.005070	0.044	1.96	3.19	39.13	24.83	25.59	0.45
CLOSURE DIV CH-N	1350	100-yr/24-hr	124.90	5078.60	0.005037	0.044	1.97	3.18	39.22	24.84	25.60	0.45
CLOSURE DIV CH-N	1325	100-yr/24-hr	124.90	5078.47	0.004989	0.044	1.97	3.17	39.35	24.88	25.64	0.44
CLOSURE DIV CH-N	1300	100-yr/24-hr	124.90	5078.35	0.004935	0.044	1.98	3.16	39.49	24.88	25.65	0.44
CLOSURE DIV CH-N	1275	100-yr/24-hr	124.90	5078.23	0.004866	0.044	1.99	3.15	39.69	24.93	25.70	0.44
CLOSURE DIV CH-N	1250	100-yr/24-hr	124.90	5078.11	0.004867	0.044	1.99	3.15	39.69	24.95	25.71	0.44
CLOSURE DIV CH-N	1225	100-yr/24-hr	124.90	5077.99	0.004776	0.044	2.00	3.13	39.94	24.99	25.76	0.44
CLOSURE DIV CH-N	1200	100-yr/24-hr	124.90	5077.87	0.004768	0.044	2.00	3.12	39.97	25.00	25.77	0.44
CLOSURE DIV CH-N	1175	100-yr/24-hr	124.90	5077.73	0.005240	0.044	1.99	3.22	38.84	24.97	25.74	0.45
CLOSURE DIV CH-N	1150	100-yr/24-hr	124.90	5077.60	0.005274	0.044	1.98	3.23	38.72	24.91	25.67	0.46
CLOSURE DIV CH-N	1125	100-yr/24-hr	124.90	5077.47	0.005293	0.044	1.98	3.23	38.67	24.89	25.65	0.46
CLOSURE DIV CH-N	1100	100-yr/24-hr	124.90	5077.33	0.005354	0.044	1.96	3.24	38.49	24.82	25.58	0.46
CLOSURE DIV CH-N	1075	100-yr/24-hr	124.90	5077.20	0.005385	0.044	1.96	3.25	38.40	24.78	25.53	0.46
CLOSURE DIV CH-N	1050	100-yr/24-hr	124.90	5077.06	0.005460	0.044	1.94	3.27	38.20	24.72	25.47	0.46
CLOSURE DIV CH-N	1025	100-yr/24-hr	124.90	5076.93	0.005317	0.044	1.94	3.24	38.49	24.71	25.45	0.46
CLOSURE DIV CH-N	1000	100-yr/24-hr	124.90	5076.79	0.005364	0.044	1.93	3.25	38.38	24.68	25.42	0.46
CLOSURE DIV CH-N	975	100-yr/24-hr	124.90	5076.65	0.005596	0.044	1.91	3.30	37.82	24.57	25.30	0.47
CLOSURE DIV CH-N	950	100-yr/24-hr	124.90	5076.51	0.005766	0.044	1.90	3.34	37.43	24.48	25.21	0.48
CLOSURE DIV CH-N	925	100-yr/24-hr	124.90	5076.35	0.006022	0.044	1.87	3.39	36.88	24.38	25.10	0.49
CLOSURE DIV CH-N	900	100-yr/24-hr	124.90	5076.19	0.006442	0.044	1.84	3.47	36.03	24.20	24.91	0.50
CLOSURE DIV CH-N	875	100-yr/24-hr	124.90	5076.01	0.006972	0.044	1.80	3.56	35.05	23.98	24.68	0.52
CLOSURE DIV CH-N	850	100-yr/24-hr	124.90	5075.62	0.014771	0.044	1.57	4.62	27.03	22.06	22.62	0.74
CLOSURE DIV CH-N	825	100-yr/24-hr	124.90	5074.90	0.029124	0.044	1.31	5.83	21.41	20.55	21.03	1.01
CLOSURE DIV CH-N	805.6	100-yr/24-hr	124.90	5073.83	0.055848	0.044	1.04	7.22	17.31	19.73	20.13	1.36
CLOSURE DIV CH-N	800	100-yr/24-hr	124.90	5073.54	0.079951	0.060	1.11	6.61	18.89	20.15	20.58	1.20
CLOSURE DIV CH-N	775	100-yr/24-hr	124.90	5071.44	0.084878	0.060	1.08	6.74	18.53	20.11	20.53	1.24
CLOSURE DIV CH-N	750	100-yr/24-hr	124.90	5067.49	0.225602	0.060	0.81	9.26	13.49	19.00	19.31	1.94
CLOSURE DIV CH-N	725	100-yr/24-hr	124.90	5063.77	0.120791	0.060	0.95	7.55	16.54	19.76	20.13	1.46
CLOSURE DIV CH-N	700	100-yr/24-hr	124.90	5059.84	0.179506	0.060	0.85	8.60	14.52	19.25	19.57	1.75
CLOSURE DIV CH-N	675	100-yr/24-hr	124.90	5056.07	0.137013	0.060	0.92	7.87	15.87	19.59	19.94	1.54
CLOSURE DIV CH-N	650	100-yr/24-hr	124.90	5052.19	0.164197	0.060	0.87	8.36	14.95	19.34	19.67	1.68
CLOSURE DIV CH-N	625	100-yr/24-hr	124.90	5048.98	0.113261	0.060	0.98	7.39	16.89	19.84	20.21	1.41
CLOSURE DIV CH-N	600	100-yr/24-hr	124.90	5045.38	0.161314	0.060	0.90	8.31	15.03	19.34	19.68	1.66
CLOSURE DIV CH-N	575	100-yr/24-hr	124.90	5042.62	0.092118	0.060	1.05	6.90	18.09	20.16	20.56	1.28
CLOSURE DIV CH-N	550	100-yr/24-hr	124.90	5038.55	0.224251	0.060	0.89	9.24	13.52	19.06	19.32	1.93
CLOSURE DIV CH-N	525	100-yr/24-hr	124.90	5034.90	0.118272	0.060	0.96	7.48	16.69	19.91	20.26	1.44
CLOSURE DIV CH-N	517	100-yr/24-hr	124.90	5034.43	0.063194	0.060	1.17	6.09	20.52	20.77	21.21	1.08
CLOSURE DIV CH-N	500	100-yr/24-hr	124.90	5034.39	0.006895	0.044	1.81	3.55	35.21	24.05	24.74	0.52

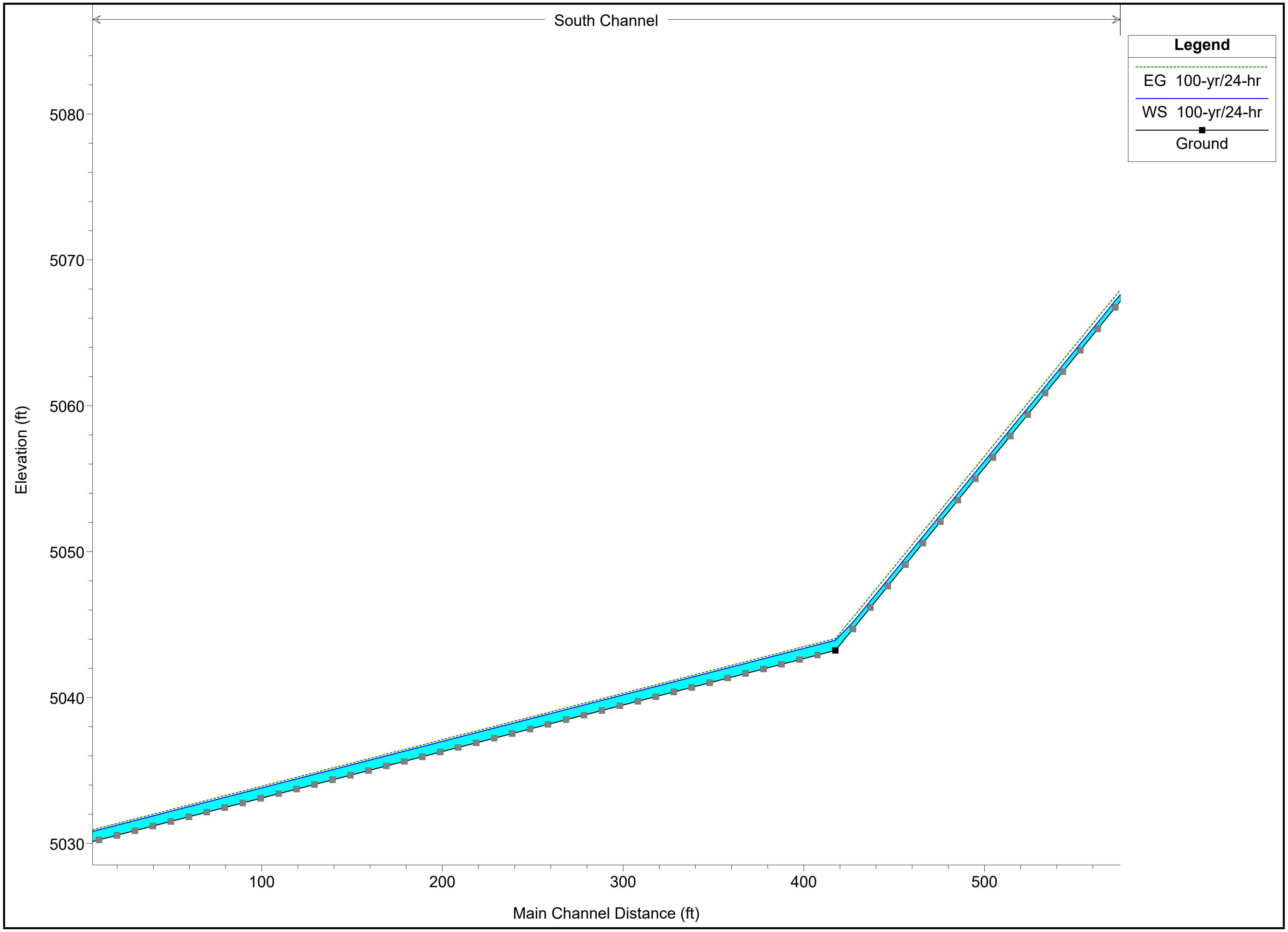
HEC-RAS Plan: Plan 08 River: CLOSURE DIV CH - Reach: CLOSURE DIV CH-N Profile: 100-yr/24-hr (Continued)

Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Slope	Mann Wtd Total	Max Chl Dpth	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude # Chl
			(cfs)	(ft)	(ft/ft)		(ft)	(ft/s)	(sq ft)	(ft)	(ft)	
CLOSURE DIV CH-N	475	100-yr/24-hr	124.90	5034.27	0.005007	0.044	1.97	3.18	39.28	24.83	25.59	0.45
CLOSURE DIV CH-N	450	100-yr/24-hr	124.90	5034.15	0.005064	0.044	1.97	3.19	39.14	24.82	25.58	0.45
CLOSURE DIV CH-N	425	100-yr/24-hr	124.90	5034.02	0.005024	0.044	1.97	3.18	39.24	24.84	25.60	0.45
CLOSURE DIV CH-N	400	100-yr/24-hr	124.90	5033.89	0.005093	0.044	1.96	3.20	39.07	24.82	25.57	0.45
CLOSURE DIV CH-N	375	100-yr/24-hr	124.90	5033.77	0.005071	0.044	1.97	3.19	39.11	24.81	25.56	0.45
CLOSURE DIV CH-N	350	100-yr/24-hr	124.90	5033.64	0.005027	0.044	1.97	3.18	39.24	24.84	25.60	0.45
CLOSURE DIV CH-N	325	100-yr/24-hr	124.90	5033.51	0.005091	0.044	1.96	3.20	39.08	24.83	25.58	0.45
CLOSURE DIV CH-N	300	100-yr/24-hr	124.90	5033.39	0.005061	0.044	1.97	3.19	39.16	24.84	25.59	0.45
CLOSURE DIV CH-N	275	100-yr/24-hr	124.90	5033.26	0.005038	0.044	1.97	3.19	39.21	24.83	25.59	0.45
CLOSURE DIV CH-N	250	100-yr/24-hr	124.90	5033.13	0.005106	0.044	1.96	3.20	39.03	24.81	25.57	0.45
CLOSURE DIV CH-N	225	100-yr/24-hr	124.90	5033.00	0.005081	0.044	1.96	3.19	39.10	24.82	25.57	0.45
CLOSURE DIV CH-N	200	100-yr/24-hr	124.90	5032.88	0.005046	0.044	1.97	3.19	39.19	24.83	25.59	0.45
CLOSURE DIV CH-N	175	100-yr/24-hr	124.90	5032.75	0.005004	0.044	1.97	3.18	39.30	24.85	25.61	0.45
CLOSURE DIV CH-N	150	100-yr/24-hr	124.90	5032.63	0.005075	0.044	1.96	3.19	39.12	24.82	25.58	0.45
CLOSURE DIV CH-N	125	100-yr/24-hr	124.90	5032.48	0.005478	0.044	1.92	3.28	38.09	24.61	25.35	0.46
CLOSURE DIV CH-N	100	100-yr/24-hr	124.90	5032.33	0.005943	0.044	1.88	3.37	37.04	24.41	25.13	0.48
CLOSURE DIV CH-N	75	100-yr/24-hr	124.90	5032.16	0.006553	0.044	1.83	3.49	35.81	24.15	24.85	0.50
CLOSURE DIV CH-N	50	100-yr/24-hr	124.90	5031.96	0.007733	0.044	1.75	3.69	33.84	23.75	24.42	0.55
CLOSURE DIV CH-N	25	100-yr/24-hr	124.90	5031.28	0.029255	0.044	1.20	5.79	21.56	20.99	21.45	1.01
CLOSURE DIV CH-N	0	100-yr/24-hr	124.90	5028.86	0.161148	0.044	1.11	9.56	13.07	21.19	22.08	2.15


CLOSURE DIV CH - CLOSURE DIV CH-N
Legend
EG 100-yr/24-hr
WS 100-yr/24-hr
Ground
Elevation (ft)
5120
5100
5080
5060
5040
5020
0
500
1000
1500
2000
2500
3000
Main Channel Distance (ft)

HEC-RAS Plan: Plan 01 River: South Reach: Channel Profile: 100-yr/24-hr

Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Slope	Mann Wtd Total	Max Chl Dpth	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude # Chl
			(cfs)	(ft)	(ft/ft)		(ft)	(ft/s)	(sq ft)	(ft)	(ft)	
Channel	693.8	100-yr/24-hr	12.80	5081.97	0.093091	0.064	0.52	3.95	3.24	7.58	7.77	1.07
Channel	684.77*	100-yr/24-hr	12.80	5081.13	0.093091	0.064	0.52	3.95	3.24	7.58	7.77	1.07
Channel	675.74*	100-yr/24-hr	12.80	5080.29	0.093091	0.064	0.52	3.95	3.24	7.58	7.77	1.07
Channel	666.71*	100-yr/24-hr	12.80	5079.45	0.093091	0.064	0.52	3.95	3.24	7.58	7.77	1.07
Channel	657.69*	100-yr/24-hr	12.80	5078.59	0.095957	0.064	0.51	3.99	3.21	7.55	7.75	1.08
Channel	648.66*	100-yr/24-hr	12.80	5077.76	0.090937	0.064	0.52	3.92	3.27	7.59	7.79	1.05
Channel	639.63*	100-yr/24-hr	12.80	5076.91	0.095957	0.064	0.51	3.99	3.21	7.55	7.75	1.08
Channel	630.6	100-yr/24-hr	12.80	5076.08	0.090937	0.064	0.52	3.92	3.27	7.59	7.79	1.05
Channel	620.92*	100-yr/24-hr	12.80	5074.48	0.241643	0.064	0.39	5.45	2.35	6.96	7.11	1.65
Channel	611.24*	100-yr/24-hr	12.80	5073.11	0.109363	0.064	0.49	4.17	3.07	7.46	7.65	1.15
Channel	601.55*	100-yr/24-hr	12.80	5071.56	0.199827	0.064	0.41	5.12	2.50	7.07	7.23	1.52
Channel	591.87*	100-yr/24-hr	12.80	5070.16	0.122098	0.064	0.48	4.33	2.95	7.39	7.57	1.21
Channel	582.19*	100-yr/24-hr	12.80	5068.64	0.179822	0.064	0.43	4.94	2.59	7.14	7.30	1.44
Channel	572.51*	100-yr/24-hr	12.80	5067.21	0.131804	0.064	0.47	4.45	2.88	7.33	7.51	1.25
Channel	562.83*	100-yr/24-hr	12.80	5065.71	0.168766	0.064	0.44	4.83	2.65	7.18	7.34	1.40
Channel	553.15*	100-yr/24-hr	12.80	5064.26	0.138822	0.064	0.46	4.53	2.83	7.30	7.48	1.28
Channel	543.46*	100-yr/24-hr	12.80	5062.77	0.162293	0.064	0.44	4.77	2.68	7.20	7.37	1.38
Channel	533.78*	100-yr/24-hr	12.80	5061.31	0.144672	0.064	0.45	4.59	2.79	7.27	7.45	1.31
Channel	524.10*	100-yr/24-hr	12.80	5059.85	0.155531	0.064	0.45	4.70	2.72	7.23	7.40	1.35
Channel	514.42*	100-yr/24-hr	12.80	5058.38	0.146876	0.064	0.45	4.61	2.78	7.26	7.44	1.32
Channel	504.74*	100-yr/24-hr	12.80	5056.91	0.156131	0.064	0.44	4.71	2.72	7.22	7.40	1.35
Channel	495.05*	100-yr/24-hr	12.80	5055.44	0.147994	0.064	0.45	4.62	2.77	7.26	7.43	1.32
Channel	485.37*	100-yr/24-hr	12.80	5053.97	0.154934	0.064	0.45	4.70	2.73	7.23	7.40	1.35
Channel	475.69*	100-yr/24-hr	12.80	5052.50	0.149691	0.064	0.45	4.64	2.76	7.25	7.42	1.33
Channel	466.01*	100-yr/24-hr	12.80	5051.03	0.154340	0.064	0.45	4.69	2.73	7.23	7.40	1.35
Channel	456.33*	100-yr/24-hr	12.80	5049.56	0.150263	0.064	0.45	4.65	2.75	7.25	7.42	1.33
Channel	446.65*	100-yr/24-hr	12.80	5048.09	0.153749	0.064	0.45	4.68	2.73	7.23	7.41	1.34
Channel	436.96*	100-yr/24-hr	12.80	5046.62	0.150837	0.064	0.45	4.65	2.75	7.25	7.42	1.33
Channel	427.28*	100-yr/24-hr	12.80	5045.15	0.150837	0.064	0.45	4.65	2.75	7.25	7.42	1.33
Channel	417.6	100-yr/24-hr	12.80	5043.92	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	407.66*	100-yr/24-hr	12.80	5043.61	0.031099	0.064	0.70	2.71	4.72	8.50	8.77	0.64
Channel	397.71*	100-yr/24-hr	12.80	5043.29	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	387.77*	100-yr/24-hr	12.80	5042.97	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	377.83*	100-yr/24-hr	12.80	5042.66	0.030942	0.064	0.70	2.71	4.73	8.50	8.77	0.64
Channel	367.89*	100-yr/24-hr	12.80	5042.34	0.032390	0.064	0.69	2.75	4.66	8.46	8.73	0.65
Channel	357.94*	100-yr/24-hr	12.80	5042.02	0.031980	0.064	0.69	2.74	4.68	8.47	8.74	0.65
Channel	348.00*	100-yr/24-hr	12.80	5041.70	0.032640	0.064	0.69	2.76	4.64	8.45	8.72	0.66
Channel	338.06*	100-yr/24-hr	12.80	5041.39	0.031416	0.064	0.70	2.72	4.71	8.49	8.76	0.64
Channel	328.11*	100-yr/24-hr	12.80	5041.08	0.031898	0.064	0.69	2.73	4.68	8.47	8.74	0.65
Channel	318.17*	100-yr/24-hr	12.80	5040.75	0.032640	0.064	0.69	2.76	4.64	8.45	8.72	0.66
Channel	308.23*	100-yr/24-hr	12.80	5040.44	0.031416	0.064	0.70	2.72	4.71	8.49	8.76	0.64
Channel	298.29*	100-yr/24-hr	12.80	5040.13	0.031817	0.064	0.70	2.73	4.69	8.48	8.74	0.65
Channel	288.34*	100-yr/24-hr	12.80	5039.80	0.032807	0.064	0.69	2.76	4.64	8.45	8.71	0.66
Channel	278.40*	100-yr/24-hr	12.80	5039.49	0.031257	0.064	0.70	2.72	4.71	8.49	8.76	0.64
Channel	268.46*	100-yr/24-hr	12.80	5039.17	0.032061	0.064	0.69	2.74	4.67	8.47	8.74	0.65
Channel	258.51*	100-yr/24-hr	12.80	5038.85	0.032308	0.064	0.69	2.75	4.66	8.46	8.73	0.65
Channel	248.57*	100-yr/24-hr	12.80	5038.54	0.031178	0.064	0.70	2.71	4.72	8.50	8.77	0.64
Channel	238.63*	100-yr/24-hr	12.80	5038.22	0.032143	0.064	0.69	2.74	4.67	8.47	8.73	0.65
Channel	228.69*	100-yr/24-hr	12.80	5037.90	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	218.74*	100-yr/24-hr	12.80	5037.59	0.030864	0.064	0.70	2.70	4.73	8.51	8.78	0.64
Channel	208.80*	100-yr/24-hr	12.80	5037.27	0.032640	0.064	0.69	2.76	4.64	8.45	8.72	0.66
Channel	198.86*	100-yr/24-hr	12.80	5036.96	0.031736	0.064	0.70	2.73	4.69	8.48	8.75	0.65
Channel	188.91*	100-yr/24-hr	12.80	5036.63	0.032807	0.064	0.69	2.76	4.64	8.45	8.71	0.66
Channel	178.97*	100-yr/24-hr	12.80	5036.32	0.031257	0.064	0.70	2.72	4.71	8.49	8.76	0.64
Channel	169.03*	100-yr/24-hr	12.80	5036.00	0.032061	0.064	0.69	2.74	4.67	8.47	8.74	0.65
Channel	159.09*	100-yr/24-hr	12.80	5035.68	0.032308	0.064	0.69	2.75	4.66	8.46	8.73	0.65
Channel	149.14*	100-yr/24-hr	12.80	5035.37	0.031178	0.064	0.70	2.71	4.72	8.50	8.77	0.64
Channel	139.20*	100-yr/24-hr	12.80	5035.05	0.032143	0.064	0.69	2.74	4.67	8.47	8.73	0.65
Channel	129.26*	100-yr/24-hr	12.80	5034.73	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	119.31*	100-yr/24-hr	12.80	5034.42	0.031099	0.064	0.70	2.71	4.72	8.50	8.77	0.64
Channel	109.37*	100-yr/24-hr	12.80	5034.10	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	99.43*	100-yr/24-hr	12.80	5033.78	0.032225	0.064	0.69	2.74	4.66	8.46	8.73	0.65
Channel	89.49*	100-yr/24-hr	12.80	5033.47	0.030942	0.064	0.70	2.71	4.73	8.50	8.77	0.64
Channel	79.54*	100-yr/24-hr	12.80	5033.15	0.032473	0.064	0.69	2.75	4.65	8.46	8.72	0.65
Channel	69.60*	100-yr/24-hr	12.80	5032.84	0.031817	0.064	0.70	2.73	4.69	8.48	8.74	0.65
Channel	59.66*	100-yr/24-hr	12.80	5032.51	0.032807	0.064	0.69	2.76	4.64	8.45	8.71	0.66
Channel	49.71*	100-yr/24-hr	12.80	5032.20	0.031257	0.064	0.70	2.72	4.71	8.49	8.76	0.64
Channel	39.77*	100-yr/24-hr	12.80	5031.88	0.032061	0.064	0.69	2.74	4.67	8.47	8.74	0.65
Channel	29.83*	100-yr/24-hr	12.80	5031.56	0.032308	0.064	0.69	2.75	4.66	8.46	8.73	0.65
Channel	19.89*	100-yr/24-hr	12.80	5031.25	0.030942	0.064	0.70	2.71	4.73	8.50	8.77	0.64
Channel	9.94*	100-yr/24-hr	12.80	5030.93	0.032390	0.064	0.69	2.75	4.66	8.46	8.73	0.65
Channel	0	100-yr/24-hr	12.80	5030.61	0.031980	0.064	0.69	2.74	4.68	8.47	8.74	0.65

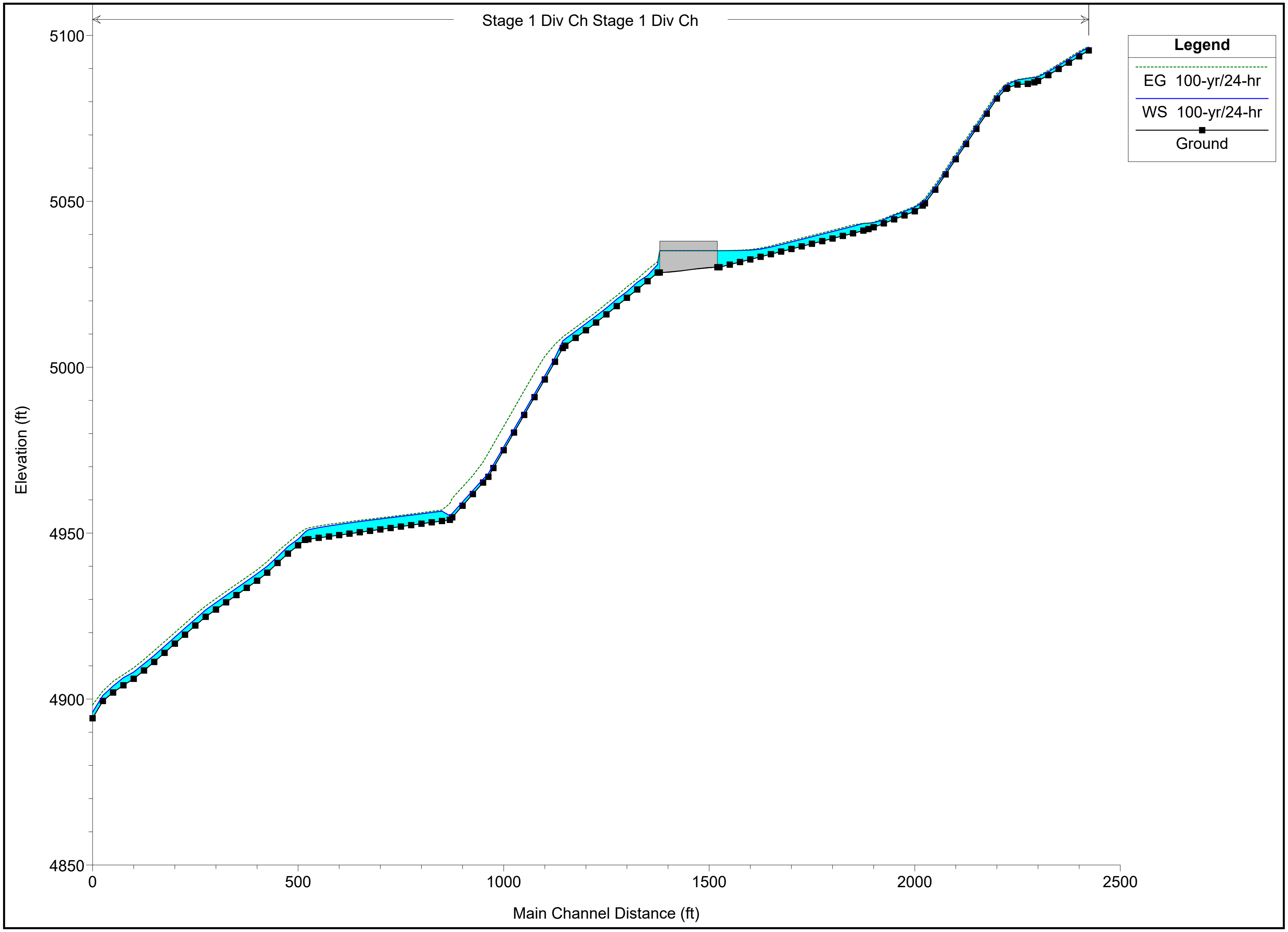

South Channel
Legend
EG 100-yr/24-hr
WS 100-yr/24-hr
Ground
Elevation (ft)
5080
5070
5060
5050
5040
5030
100
200
300
400
500
Main Channel Distance (ft)

HEC-RAS Plan: Plan 13 River: Stage 1 Div Ch Reach: Stage 1 Div Ch Profile: 100-yr/24-hr

Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Slope	Mann Wtd Total	Max Chl Dpth	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude # Chl
			(cfs)	(ft)	(ft/ft)		(ft)	(ft/s)	(sq ft)	(ft)	(ft)	
Stage 1 Div Ch	2423.43	100-yr/24-hr	41.00	5096.46	0.050432	0.066	0.99	3.41	12.02	21.01	21.68	0.80
Stage 1 Div Ch	2400	100-yr/24-hr	41.00	5094.78	0.073281	0.066	1.09	5.22	7.85	9.37	9.89	1.01
Stage 1 Div Ch	2375	100-yr/24-hr	41.00	5092.83	0.082268	0.066	1.04	5.30	7.74	10.00	10.42	1.06
Stage 1 Div Ch	2350	100-yr/24-hr	41.00	5090.94	0.076575	0.066	1.05	5.14	7.97	10.23	10.63	1.03
Stage 1 Div Ch	2325	100-yr/24-hr	41.00	5089.04	0.075506	0.066	1.05	5.12	8.02	10.26	10.66	1.02
Stage 1 Div Ch	2300	100-yr/24-hr	41.00	5087.49	0.043369	0.066	1.22	4.20	9.77	11.07	11.54	0.79
Stage 1 Div Ch	2291.1	100-yr/24-hr	41.00	5087.28	0.023031	0.066	1.43	3.34	12.28	12.16	12.71	0.59
Stage 1 Div Ch	2275	100-yr/24-hr	41.00	5087.07	0.011901	0.066	1.69	2.63	15.61	13.47	14.12	0.43
Stage 1 Div Ch	2250	100-yr/24-hr	41.00	5086.52	0.028668	0.066	1.35	3.62	11.34	11.76	12.28	0.65
Stage 1 Div Ch	2225	100-yr/24-hr	41.00	5085.23	0.074007	0.066	1.06	5.08	8.07	10.29	10.70	1.01
Stage 1 Div Ch	2222	100-yr/24-hr	41.00	5084.90	0.103678	0.071	1.00	5.44	7.54	10.02	10.40	1.10
Stage 1 Div Ch	2200	100-yr/24-hr	41.00	5081.84	0.167237	0.071	0.88	6.44	6.37	9.41	9.75	1.38
Stage 1 Div Ch	2175	100-yr/24-hr	41.00	5077.25	0.195071	0.071	0.85	6.80	6.03	9.24	9.56	1.48
Stage 1 Div Ch	2150	100-yr/24-hr	41.00	5072.70	0.173247	0.071	0.88	6.52	6.29	9.37	9.71	1.40
Stage 1 Div Ch	2125	100-yr/24-hr	41.00	5068.10	0.191127	0.071	0.85	6.75	6.08	9.27	9.60	1.47
Stage 1 Div Ch	2100	100-yr/24-hr	41.00	5063.54	0.176487	0.071	0.87	6.56	6.25	9.36	9.70	1.42
Stage 1 Div Ch	2075	100-yr/24-hr	41.00	5058.95	0.187895	0.071	0.86	6.71	6.11	9.28	9.61	1.46
Stage 1 Div Ch	2050	100-yr/24-hr	41.00	5054.38	0.179205	0.071	0.87	6.60	6.21	9.33	9.66	1.43
Stage 1 Div Ch	2025	100-yr/24-hr	41.00	5050.30	0.153085	0.071	0.90	6.24	6.57	9.53	9.88	1.32
Stage 1 Div Ch	2019.4	100-yr/24-hr	41.00	5049.66	0.105220	0.066	0.96	5.76	7.12	9.80	10.17	1.19
Stage 1 Div Ch	2000	100-yr/24-hr	41.00	5048.19	0.046387	0.066	1.19	4.30	9.54	10.98	11.44	0.81
Stage 1 Div Ch	1975	100-yr/24-hr	41.00	5046.91	0.054069	0.066	1.15	4.54	9.03	10.73	11.18	0.87
Stage 1 Div Ch	1950	100-yr/24-hr	41.00	5045.80	0.040032	0.066	1.24	4.08	10.06	11.21	11.68	0.76
Stage 1 Div Ch	1925	100-yr/24-hr	41.00	5044.45	0.063082	0.066	1.10	4.80	8.55	10.51	10.94	0.94
Stage 1 Div Ch	1900	100-yr/24-hr	41.00	5043.51	0.029779	0.066	1.34	3.67	11.19	11.69	12.21	0.66
Stage 1 Div Ch	1887.3	100-yr/24-hr	41.00	5043.37	0.010831	0.066	1.73	2.54	16.15	13.66	14.32	0.41
Stage 1 Div Ch	1875	100-yr/24-hr	41.00	5043.32	0.004480	0.066	2.15	1.84	22.32	15.76	16.59	0.27
Stage 1 Div Ch	1850	100-yr/24-hr	181.10	5042.47	0.032501	0.071	2.11	5.06	35.80	22.24	23.06	0.70
Stage 1 Div Ch	1825	100-yr/24-hr	181.10	5041.67	0.031704	0.071	2.10	5.00	36.22	22.50	23.31	0.69
Stage 1 Div Ch	1800	100-yr/24-hr	181.10	5040.89	0.031254	0.071	2.11	4.98	36.40	22.53	23.34	0.69
Stage 1 Div Ch	1775	100-yr/24-hr	181.10	5040.10	0.031522	0.071	2.10	4.99	36.30	22.53	23.33	0.69
Stage 1 Div Ch	1750	100-yr/24-hr	181.10	5039.31	0.031731	0.071	2.10	5.00	36.21	22.50	23.30	0.69
Stage 1 Div Ch	1725	100-yr/24-hr	181.10	5038.53	0.031237	0.071	2.11	4.97	36.41	22.54	23.35	0.69
Stage 1 Div Ch	1700	100-yr/24-hr	181.10	5037.74	0.031507	0.071	2.10	4.99	36.31	22.52	23.33	0.69
Stage 1 Div Ch	1675	100-yr/24-hr	181.10	5036.95	0.031650	0.071	2.10	5.00	36.25	22.51	23.32	0.69
Stage 1 Div Ch	1650	100-yr/24-hr	181.10	5036.19	0.029890	0.071	2.13	4.90	36.98	22.67	23.49	0.68
Stage 1 Div Ch	1625	100-yr/24-hr	181.10	5035.58	0.023457	0.071	2.30	4.42	40.99	24.40	25.33	0.60
Stage 1 Div Ch	1600	100-yr/24-hr	181.10	5035.28	0.010846	0.071	2.79	3.41	53.04	25.97	27.05	0.42
Stage 1 Div Ch	1575	100-yr/24-hr	181.10	5035.17	0.004692	0.071	3.47	2.52	71.72	29.35	30.68	0.28
Stage 1 Div Ch	1550	100-yr/24-hr	181.10	5035.12	0.002174	0.071	4.20	1.91	94.63	32.81	34.45	0.20
Stage 1 Div Ch	1525	100-yr/24-hr	181.10	5035.10	0.001108	0.071	4.95	1.51	120.16	35.77	37.76	0.14
Stage 1 Div Ch	1524.8	100-yr/24-hr	181.10	5035.10	0.001107	0.071	4.95	1.51	120.22	35.79	37.78	0.14
Stage 1 Div Ch	1519.8		Inl Struct									
Stage 1 Div Ch	1375	100-yr/24-hr	181.10	5031.78	0.007925	0.069	3.24	3.10	58.45	27.35	28.45	0.37
Stage 1 Div Ch	1374.8	100-yr/24-hr	295.60	5031.00	0.061466	0.069	2.47	7.41	39.91	23.59	24.43	1.00
Stage 1 Div Ch	1350	100-yr/24-hr	295.60	5027.64	0.169065	0.069	1.71	10.62	27.85	20.55	21.21	1.61
Stage 1 Div Ch	1325	100-yr/24-hr	295.60	5025.60	0.070518	0.069	2.17	7.81	37.83	22.86	23.69	1.07
Stage 1 Div Ch	1300	100-yr/24-hr	295.60	5022.79	0.125396	0.069	1.86	9.56	30.90	21.29	22.00	1.40
Stage 1 Div Ch	1275	100-yr/24-hr	295.60	5020.50	0.083556	0.069	2.07	8.29	35.64	22.37	23.17	1.16
Stage 1 Div Ch	1250	100-yr/24-hr	295.60	5017.85	0.110973	0.069	1.92	9.16	32.26	21.60	22.34	1.32
Stage 1 Div Ch	1225	100-yr/24-hr	295.60	5015.47	0.090746	0.069	2.03	8.54	34.62	22.14	22.92	1.20
Stage 1 Div Ch	1200	100-yr/24-hr	295.60	5013.16	0.092306	0.069	2.03	8.59	34.41	22.10	22.88	1.21
Stage 1 Div Ch	1175	100-yr/24-hr	295.60	5010.86	0.091670	0.069	2.03	8.57	34.49	22.11	22.89	1.21
Stage 1 Div Ch	1150	100-yr/24-hr	295.60	5008.55	0.092935	0.069	2.06	8.60	34.36	22.14	22.91	1.22
Stage 1 Div Ch	1144	100-yr/24-hr	295.60	5007.93	0.098203	0.069	2.16	8.76	33.74	22.03	22.80	1.25
Stage 1 Div Ch	1125	100-yr/24-hr	295.60	5002.88	0.104632	0.030	1.24	16.12	18.33	17.64	18.16	2.79
Stage 1 Div Ch	1100	100-yr/24-hr	295.60	4997.34	0.189372	0.030	1.04	19.56	15.11	17.07	17.48	3.67
Stage 1 Div Ch	1075	100-yr/24-hr	295.60	4991.98	0.210267	0.030	1.00	20.13	14.68	17.23	17.60	3.84
Stage 1 Div Ch	1050	100-yr/24-hr	295.60	4986.63	0.215472	0.030	0.99	20.15	14.67	17.52	17.87	3.88
Stage 1 Div Ch	1025	100-yr/24-hr	295.60	4981.29	0.215564	0.030	0.99	20.06	14.73	17.74	18.08	3.88
Stage 1 Div Ch	1000	100-yr/24-hr	295.60	4975.96	0.214060	0.030	0.99	19.95	14.82	17.91	18.24	3.87
Stage 1 Div Ch	975	100-yr/24-hr	295.60	4970.62	0.214570	0.030	0.99	19.92	14.84	18.01	18.34	3.87
Stage 1 Div Ch	962.8	100-yr/24-hr	295.60	4968.00	0.213536	0.030	1.02	19.94	14.82	17.89	18.23	3.86
Stage 1 Div Ch	950	100-yr/24-hr	295.60	4966.28	0.170706	0.030	1.05	18.20	16.24	19.03	19.35	3.47
Stage 1 Div Ch	925	100-yr/24-hr	295.60	4962.86	0.141020	0.030	1.11	17.05	17.34	19.43	19.77	3.18
Stage 1 Div Ch	900	100-yr/24-hr	295.60	4959.41	0.135461	0.030	1.15	17.02	17.37	18.88	19.26	3.13
Stage 1 Div Ch	875	100-yr/24-hr	295.60	4955.93	0.134622	0.030	1.16	17.19	17.20	18.29	18.69	3.13
Stage 1 Div Ch	869.1	100-yr/24-hr	295.60	4955.25	0.442605	0.064	1.25	15.40	19.19	18.84	19.28	2.69
Stage 1 Div Ch	850	100-yr/24-hr	295.60	4956.63	0.017236	0.064	2.95	4.86	60.77	29.13	30.14	0.59
Stage 1 Div Ch	825	100-yr/24-hr	295.60	4956.24	0.015638	0.064	2.99	4.64	63.72	30.57	31.54	0.57
Stage 1 Div Ch	800	100-yr/24-hr	309.80	4955.82	0.016458	0.064	3.00	4.75	65.28	31.51	32.46	0.58
Stage 1 Div Ch	775	100-yr/24-hr	309.80	4955.43	0.015697	0.064	3.03	4.65	66.64	32.03	32.98	0.57
Stage 1 Div Ch	750	100-yr/24-hr	309.80	4955.04	0.015233	0.064	3.07	4.62	66.99	31.70	32.68	0.56
Stage 1 Div Ch	725	100-yr/24-hr	309.80	4954.65	0.015207	0.064	3.10	4.67	66.29	30.76	31.78	0.56
Stage 1 Div Ch	700	100-yr/24-hr	309.80	4954.27	0.015117	0.064	3.15	4.72	65.64	29.78	30.87	0.56
Stage 1 Div Ch	675	100-yr/24-hr	309.80	4953.88	0.015024	0.064	3.18	4.77	64.98	28.80	29.97	0.56
Stage 1 Div Ch	650	100-yr/24-hr	309.80	4953.50	0.015066	0.064	3.23	4.84	64.07	27.71	28.99	0.56
Stage 1 Div Ch	625	100-yr/24-hr	309.80	4953.08	0.015864	0.064	3.23	4.99	62.05	26.42	27.82	0.57
Stage 1 Div Ch	600	100-yr/24-hr	309.80	4952.66	0.016292	0.064	3.24	5.09	60.87	25.53	27.05	0.58
Stage 1 Div Ch	575	100-yr/24-hr	309.80	4952.22	0.017132	0.064	3.23	5.22	59.37	24.76	26.39	0.59
Stage 1 Div Ch	550	100-yr/24-hr	313.80	4951.67	0.021338	0.064	3.10	5.65	55.50	24.19	25.78	0.66
Stage 1 Div Ch	525	100-yr/24-hr	313.80	4951.00	0.027040	0.064	2.86	6.01	52.25	25.26	26.48	0.74
Stage 1 Div Ch	516.8	100-yr/24-hr	313.80	4950.32	0.057490	0.067	2.35	7.55	41.56	23.65	24.56	1.00
Stage 1 Div Ch	500	100-yr/24-hr	313.80	4948.19	0.128605	0.067	1.87	10.03	31.30	21.39	22.11	1.46
Stage 1 Div Ch	475	100-yr/24-hr	313.80	4945.93	0.083067	0.067	2.11	8.60	36.49	22.58	23.39	1.19
Stage 1 Div Ch	450	100-yr/24-hr	313.80	4942.90	0.130315	0.067	1.87	10.07	31.15	21.35	22.07	1.47
Stage 1 Div Ch	425	100-yr/24-hr	313.80	4940.05	0.109157	0.067	1.96	9.47	33.15	21.81	22.57	1.35
Stage 1 Div Ch	400	100-yr/24-hr	313.80	4937.75	0.088217	0.067	2.09	8.79	35.70	22.37	23.17	1.23
Stage 1 Div Ch	375	100-yr/24-hr	313.80	4935.60	0.085558	0.067	2.09	8.69	36.11	22.48	23.28	1.21

HEC-RAS Plan: Plan 13 River: Stage 1 Div Ch Reach: Stage 1 Div Ch Profile: 100-yr/24-hr (Continued)

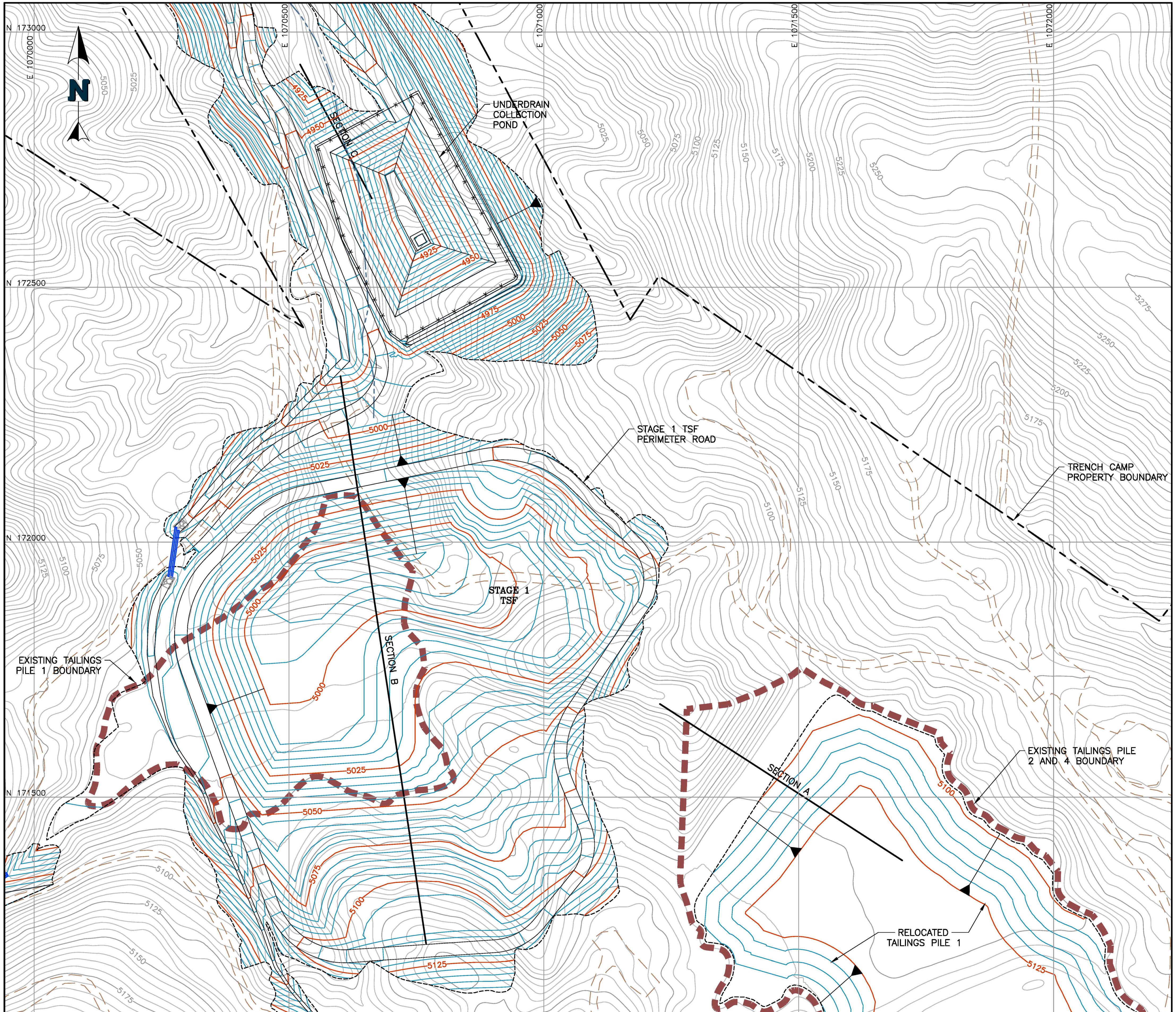
Reach	River Sta	Profile	Q Total	W.S. Elev	E.G. Slope	Mann Wtd Total	Max Chl Dpth	Vel Chnl	Flow Area	Top Width	W.P. Channel	Froude # Chl
			(cfs)	(ft)	(ft/ft)		(ft)	(ft/s)	(sq ft)	(ft)	(ft)	
Stage 1 Div Ch	350	100-yr/24-hr	313.80	4933.41	0.087370	0.067	2.09	8.76	35.84	22.42	23.22	1.22
Stage 1 Div Ch	325	100-yr/24-hr	313.80	4931.24	0.086528	0.067	2.09	8.73	35.95	22.42	23.22	1.22
Stage 1 Div Ch	300	100-yr/24-hr	313.80	4929.07	0.087166	0.067	2.09	8.75	35.88	22.43	23.24	1.22
Stage 1 Div Ch	275	100-yr/24-hr	313.80	4926.86	0.088334	0.067	2.08	8.79	35.70	22.38	23.18	1.23
Stage 1 Div Ch	250	100-yr/24-hr	313.80	4924.10	0.114033	0.067	1.94	9.62	32.63	21.68	22.42	1.38
Stage 1 Div Ch	225	100-yr/24-hr	313.80	4921.40	0.106124	0.067	1.98	9.38	33.47	21.88	22.64	1.34
Stage 1 Div Ch	200	100-yr/24-hr	313.80	4918.64	0.110681	0.067	1.96	9.52	32.98	21.76	22.51	1.36
Stage 1 Div Ch	175	100-yr/24-hr	313.80	4915.92	0.108354	0.067	1.96	9.44	33.23	21.84	22.59	1.35
Stage 1 Div Ch	150	100-yr/24-hr	313.80	4913.17	0.110069	0.067	1.96	9.50	33.04	21.78	22.53	1.36
Stage 1 Div Ch	125	100-yr/24-hr	313.80	4910.65	0.097905	0.067	2.02	9.11	34.43	22.10	22.88	1.29
Stage 1 Div Ch	100	100-yr/24-hr	313.80	4908.14	0.100700	0.067	2.01	9.20	34.09	22.02	22.79	1.30
Stage 1 Div Ch	75	100-yr/24-hr	313.80	4906.43	0.063153	0.067	2.28	7.81	40.18	23.35	24.23	1.05
Stage 1 Div Ch	50	100-yr/24-hr	313.80	4903.94	0.106819	0.067	1.97	9.40	33.40	21.87	22.63	1.34
Stage 1 Div Ch	25	100-yr/24-hr	313.80	4901.13	0.121914	0.067	1.70	9.25	33.94	25.48	26.01	1.41
Stage 1 Div Ch	0	100-yr/24-hr	313.80	4896.08	0.234788	0.067	1.86	11.81	26.57	22.66	23.06	1.92



Stage 1 Div Ch Stage 1 Div Ch
Legend
EG 100-yr/24-hr
WS 100-yr/24-hr
Ground
Elevation (ft)
5100
5050
5000
4950
4900
4850
0
500
1000
1500
2000
2500
Main Channel Distance (ft)

APPENDIX I

Stability Graphics



LEGEND:

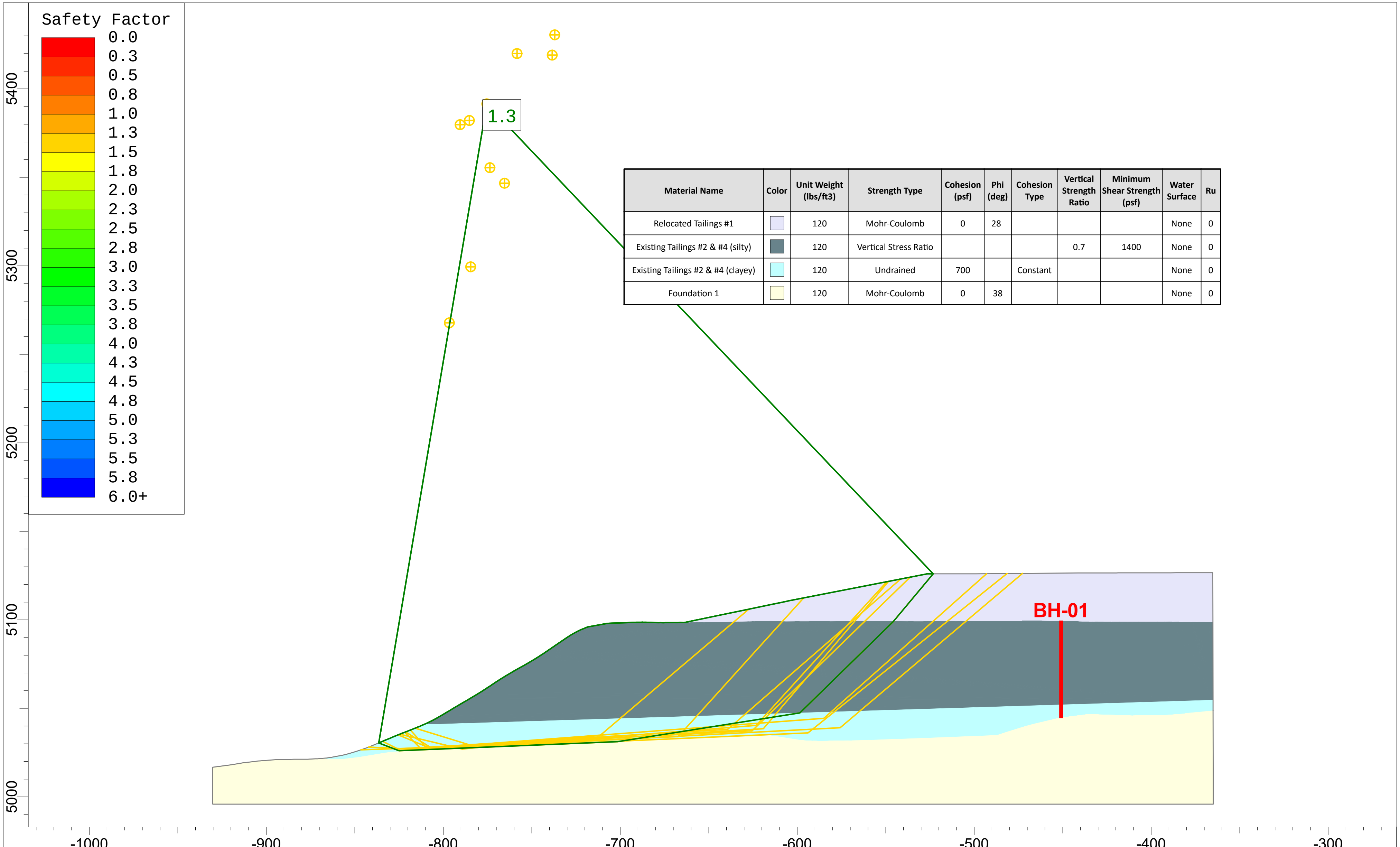
- EXISTING GROUND CONTOURS
- EXISTING ROADS/TRAILS
- STAGE 1 AND TEMPORARILY STACKED TAILINGS CONTOURS
- EXISTING DRAINAGES
- PROPERTY BOUNDARY
- EXISTING TAILINGS PILE LIMITS

0 100 200 FEET

EXISTING GROUND TOPOGRAPHY DEVELOPED FROM JUNE 15TH, 2016 DATA PROVIDED BY ARIZONA MINERALS. REMAINING EXISTING GROUND TOPOGRAPHY OUTSIDE THE LIMITS OF AMI SURVEY DATA CREATED FROM USGS DATA. DATA PROJECTED TO STATE PLANE ARIZONA CENTRAL NAD 83 FEET.

NewFields	CLIENT: ARIZONA MINERALS, INC.
PROJECT	TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORGAE
TITLE	SLOPE STABILITY EVALUATION SECTIONS
FILENAME	14.008.014F
FIGURE NO.	1
REVISION	A

P:\Projects\0014.008 Hermosa Underground Trench Camp TSF\A-CAD\FIG\14.008.014F.dwg-4/3/2017 9:14 AM

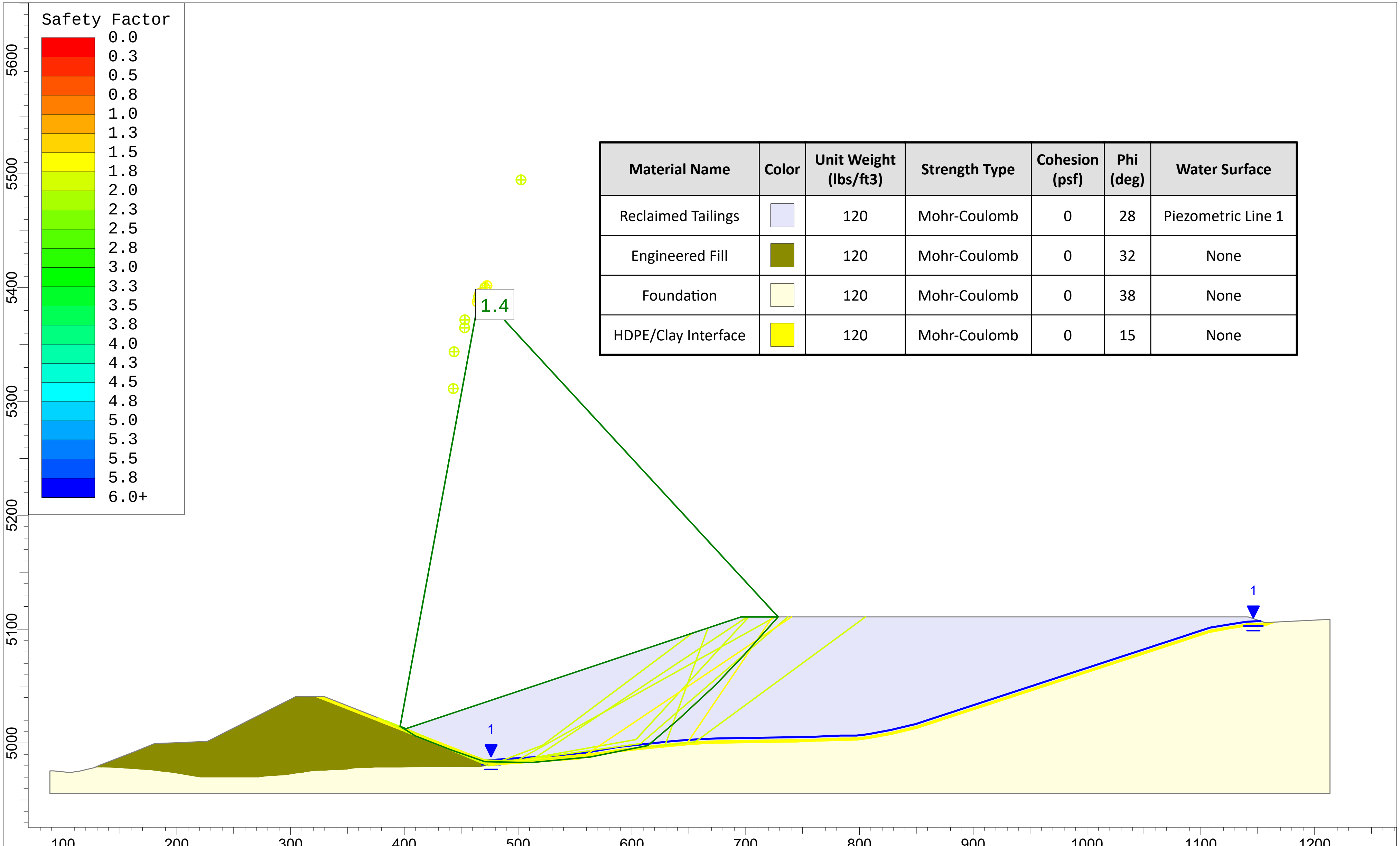


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface	Ru
Relocated Tailings #1		120	Mohr-Coulomb	0	28				None	0
Existing Tailings #2 & #4 (silty)		120	Vertical Stress Ratio				0.7	1400	None	0
Existing Tailings #2 & #4 (clayey)		120	Undrained	700		Constant			None	0
Foundation 1		120	Mohr-Coulomb	0	38				None	0

NewFields

SLIDEINTERPRET 7.023

Project	Hermosa Underground
Analysis Description	Section A - Existing Tailings Pile 1 Temporary Construction - Static Stability
Drawn By	
Scale	1:900
Company	Arizona Minerals, Inc.
Date	4/19/2017
File Name	ExistingTails_TempConstructionStability_RevA.slim

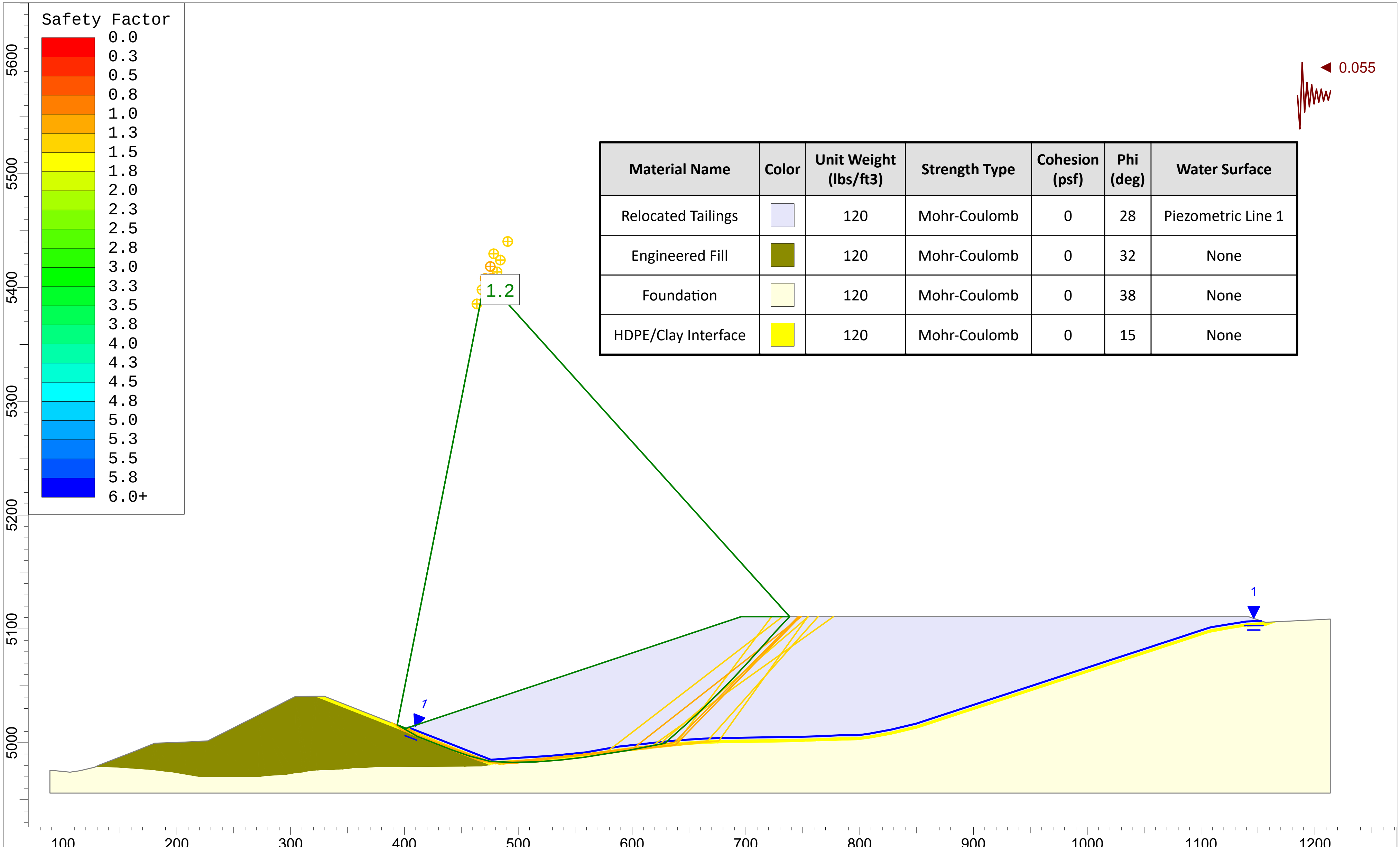


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Reclaimed Tailings		120	Mohr-Coulomb	0	28	Piezometric Line 1
Engineered Fill		120	Mohr-Coulomb	0	32	None
Foundation		120	Mohr-Coulomb	0	38	None
HDPE/Clay Interface		120	Mohr-Coulomb	0	15	None

NewFields

SLIDEINTERPRET 7.023

Project	Hermosa Underground		
Analysis Description	Section B - Stage 1 Tailings Storage Facility - Static Conditions		
Drawn By	*Scale* 1:1400	*Company*	Arizona Minerals, Inc.
Date	4/19/2017	*File Name*	Stage1_Static.slim

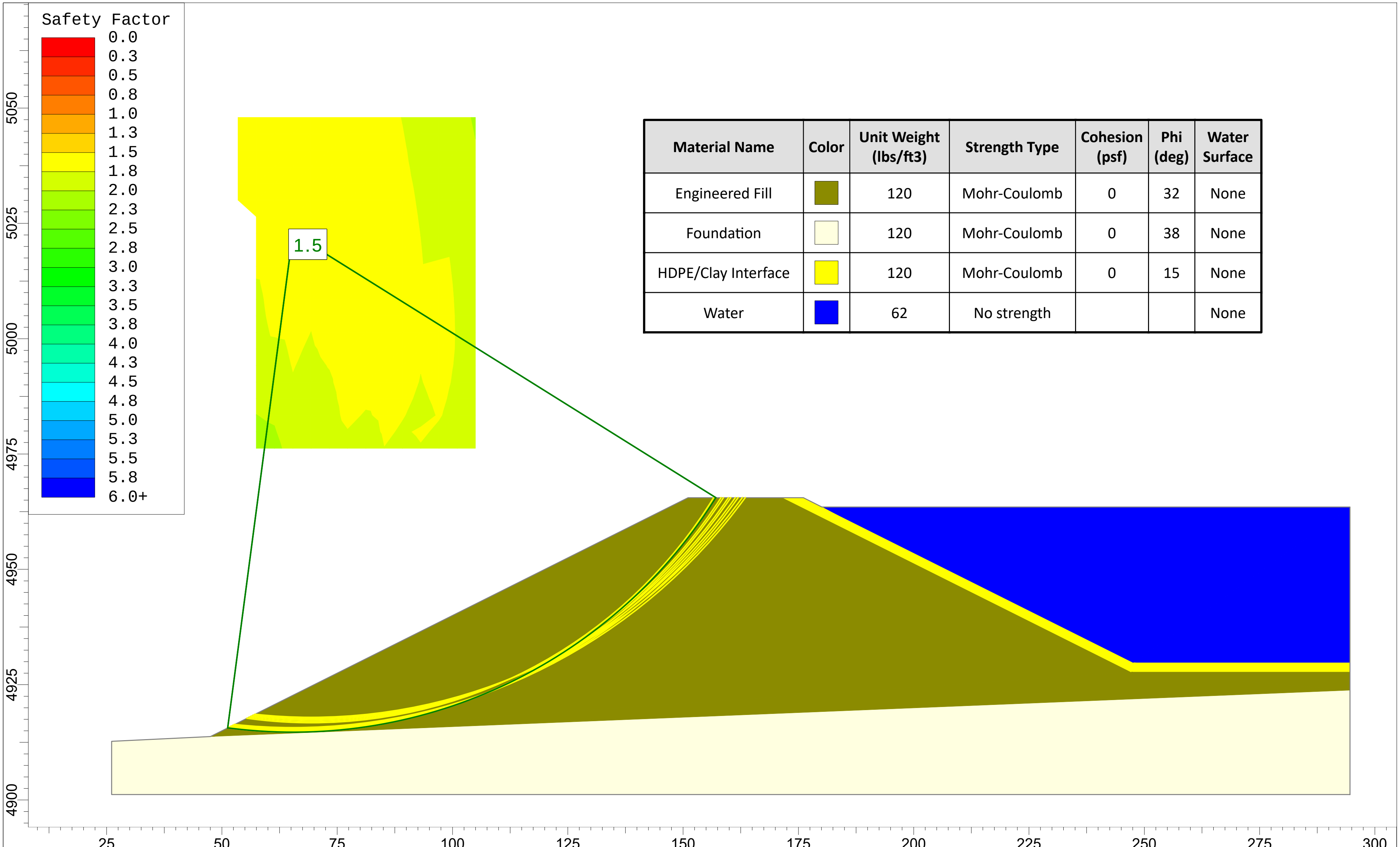


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Relocated Tailings		120	Mohr-Coulomb	0	28	Piezometric Line 1
Engineered Fill		120	Mohr-Coulomb	0	32	None
Foundation		120	Mohr-Coulomb	0	38	None
HDPE/Clay Interface		120	Mohr-Coulomb	0	15	None

NewFields

SLIDEINTERPRET 7.023

Project	Hermosa Underground
Analysis Description	Section B - Stage 1 Tailings Storage Facility - Pseudostatic Conditions
Drawn By	
Scale	1:1400
Company	Arizona Minerals, Inc.
Date	4/19/2017
File Name	Stage1_Pseudostatic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Engineered Fill		120	Mohr-Coulomb	0	32	None
Foundation		120	Mohr-Coulomb	0	38	None
HDPE/Clay Interface		120	Mohr-Coulomb	0	15	None
Water		62	No strength			None

NewFields

Project Hermosa Underground

Analysis Description Section C - Underdrain Pond - Static Conditions

Drawn By

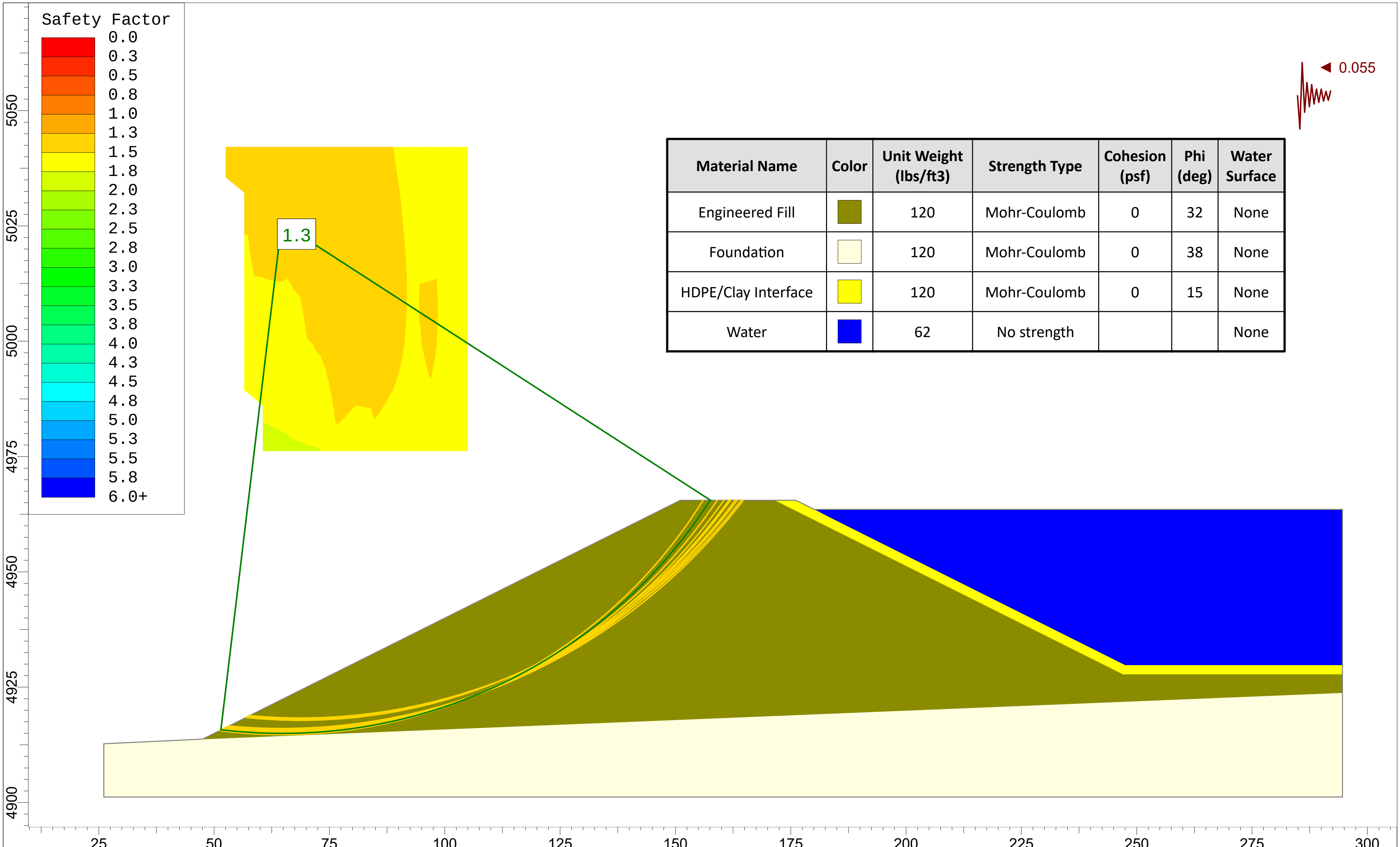
Scale 1:345

Company Arizona Minerals, Inc.

Date 4/19/2017

File Name Underdrain Pond_Static.slim

SLIDEINTERPRET 7.023



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Engineered Fill		120	Mohr-Coulomb	0	32	None
Foundation		120	Mohr-Coulomb	0	38	None
HDPE/Clay Interface		120	Mohr-Coulomb	0	15	None
Water		62	No strength			None

NewFields	*Project*	Hermosa Underground	
	Analysis Description	Section C - Underdrain Pond - Pseudostatic Conditions	
	Drawn By	*Scale* 1:345	*Company* Arizona Minerals, Inc.
SLIDEINTERPRET 7.023	*Date* 4/19/2017		*File Name* Underdrain Pond_Pseudostatic.slim

APPENDIX J

Water Balance

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Technical Memorandum

Date: April 21, 2017

To: Johnny Pappas, Arizona Minerals, Inc.

Cc: Mike Smith and Craig Thompson, NewFields

From: Troy Thompson and James Koehler

Re: Tailing Storage Facility Water Balance

1.0 Introduction

Ecological Resource Consultants, Inc. (ERC) was retained by Arizona Minerals, Inc. (AMI) to conduct a water balance analysis for planned initial operations at the proposed mine site located near Patagonia, Arizona. This water balance considers operations while Stages 1 and 2 of the Tailings Storage Facility (TSF) are constructed, existing tailings piles 1-4 are loaded from their existing location onto the lined TSF and the mine ramp/shaft is advanced. Major mine facilities as they relate to the water balance during this initial period include the TSF itself, the TSF underdrain (UD) pond, external water collection ponds adjacent to the different TSF stages and the water treatment plant (WTP). The purpose of this water balance analysis is to evaluate the fluctuation of water volumes in the TSF UD pond and the external fresh water detention pond as well as to define pumping requirements necessary to ensure both ponds can hold the normal daily runoff and the 100-year, 24-hour runoff volume. Results obtained from the water balance model are presented below.

2.0 Objectives

The TSF 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 the tailings or other potentially contaminated workings) to the natural environment. To meet this requirement, the UD and external ponds 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 understanding the mine's ability to manage water within the system.

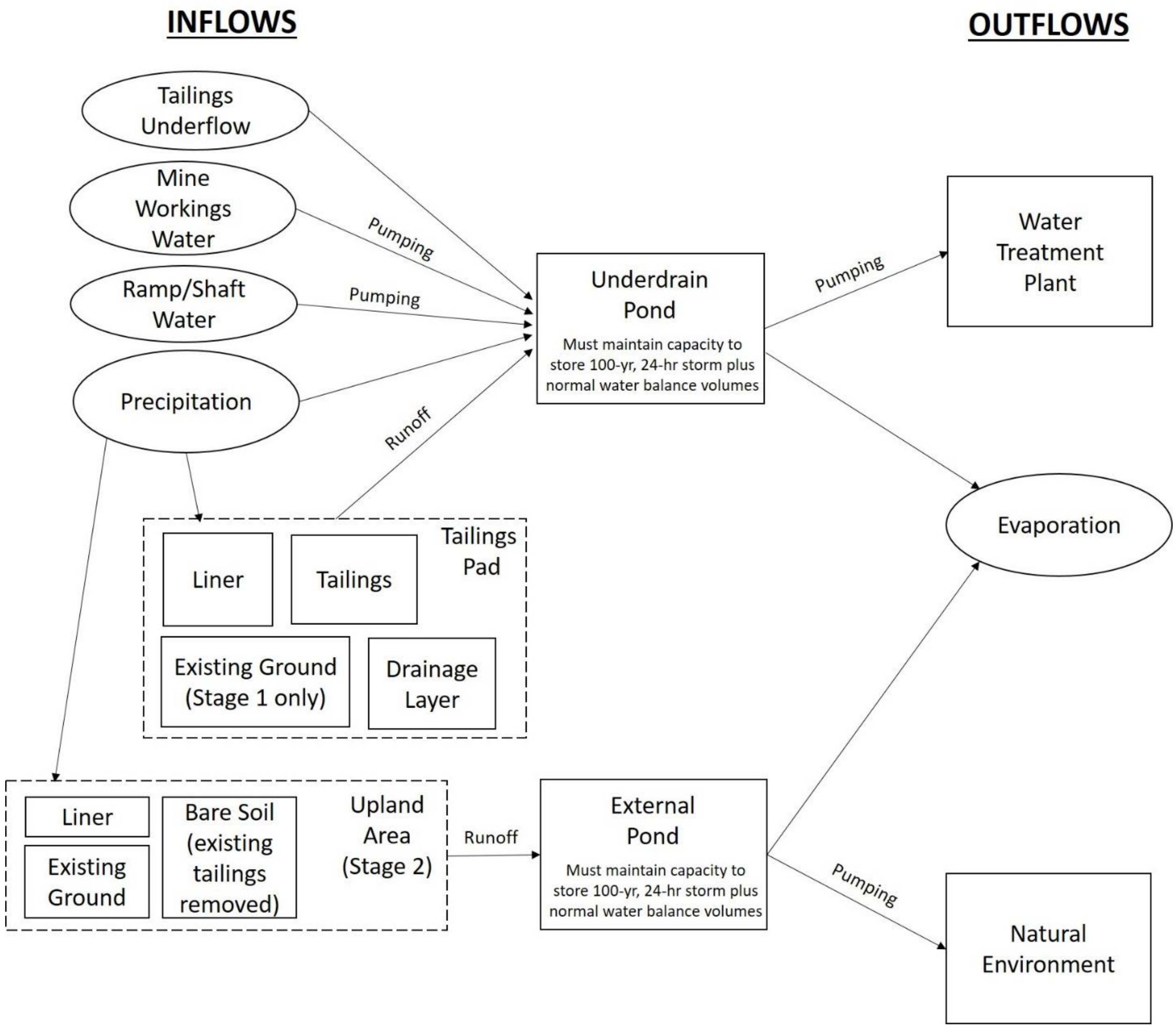
Water volumes reporting to the UD pond at any given time are dependent on the stage and configuration of the TSF pad, the runoff characteristics of exposed areas (i.e. liner, tailings, drainage layer, etc.) and daily precipitation and evaporation rates. Other factors that impact the water balance include: 1) the use of an external pond to capture runoff from upland areas tributary to the UD pond and 2) operational decisions such as the pumping capacity from the UD pond to the WTP and from the external pond to the natural environment. This water balance model was developed as a tool to aid in the design and operation of the TSF and assist with future water management decisions.

It is intended to be a tool that provides a better understanding of the effects of water management decisions for safe operations and closure of the facility.

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 resulting storage in the UD pond and external pond at the end of each day. **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 Tailings Management Facility Components

The water balance incorporates water inputs into the TSF system that vary by stage of operation. In Stage 1, inputs include direct precipitation on the UD pond and tailings pad. During the initial operations of the Stage 1 TSF before the existing tailing piles are moved onto the Stage 1 facility, runoff from the up-gradient basin (which includes existing tailings) is considered contact water and also needs to be collected in the UD pond. After the existing tailings piles have been relocated, runoff from the up-gradient basin will no longer be contact water. At this time an external pond is constructed to capture runoff from the upland basin. During this stage, inputs to the UD pond include direct precipitation on the UD pond and TSF. Runoff from the upland basin reports to the external pond. Water losses from the UD pond include evaporation and pumping to the WTP. Losses from the external pond include evaporation and pumped releases to the natural environment.

The model specifically tracks normal daily runoff to the UD and external ponds. Pond storage volumes are tracked against capacities. The model also calculates the amount of runoff that could be expected were the 100-year, 24-hour storm to occur at any point. This value is used to determine if runoff from the 100-year, 24-hour storm can be stored on any given day on top of the normal operating volume expected in the ponds. Pond capacities are based on filling curves provided by NewFields. Operating decisions such as the pumping capacities to the WTP and from the external pond greatly influence the TSF water balance. Miscellaneous water such as mine underground working water, tailings underflow and ramp/shaft development water are also included. Gains to and losses from the system are summarized in **Table 3.1.**

Table 3.1. TSF Water Balance Components by Stage

STAGE 1 Before Existing Tailings Piles Are Relocated	
UD Pond Water Gains	**UD Pond Water Losses**
Direct Precipitation	Pumping to WTP
Miscellaneous Water	Evaporation
Runoff from TSF Pad	
Runoff from Up-gradient Basin	
STAGE 1 After Existing Tailings Piles are Relocated	
UD Pond Water Gains	**UD Pond Water Losses**
Direct Precipitation	Pumping to WTP
Miscellaneous Water	Evaporation
Runoff from TSF Pad	
External Pond Water Gains	**External Pond Water Losses**
Direct Precipitation	Pumping to Natural Environment
Runoff from Upland Basin	Evaporation

STAGE 2	
UD Pond Water Gains	**UD Pond Water Losses**
Direct Precipitation	Pumping to WTP
Miscellaneous Water	Evaporation
Runoff from TSF Pad	
External Pond Water Gains	**External Pond Water Losses**
Direct Precipitation	Pumping to Natural Environment
Runoff from Upland Basin	Evaporation

4.0 Model Assumptions / Inputs

4.1 TSF Development

The TSF facility included in this water balance model will be constructed in two stages. During the first four months of the Stage 1 facility, all runoff from the up-gradient basin will report to the UD pond. After the first four months, the existing tailings in the upland areas will be removed and runoff from the up-gradient area will report to the external pond. The size and location of the external pond will vary as construction progresses. **Table 4.1** shows the approximate duration of each TSF Stage.

Table 4.1. TSF Water Balance Phases and Production

Stage 1	Beginning Month	Duration (Months)
1	March 2018	10
2	January 2019	14

Note: External Pond is operational in July 2018.

4.2 Climatologic and Hydrologic Inputs

4.2.1 *Precipitation*

A summary of the precipitation data for the water balance is presented below. Detailed background for the long-term climatologic data is presented in the ERC technical memorandum “Arizona Minerals Mine Site Climate Analysis” dated March 13, 2017 (ERC).

Daily precipitation values for the site from 2008-2015 were provided by AMI (AMI). For this daily model, these values were used to model daily precipitation during the period of TSF operation. **Appendix A** contains these daily values. **Table 4.2** presents precipitation totals for each month and year in the period of record.

Table 4.2. Monthly Precipitation Totals (2008-2015), in inches

Month	2008	2009	2010	2011	2012	2013	2014	2015	Average (in)
January	0.87	0.25	4.78	0.27	1.54	1.54	0.01	2.79	1.51
February	0.90	0.71	2.82	0.40	0.72	0.72	0.12	0.17	0.82
March	3.44	2.42	3.44	2.01	0.35	0.35	4.02	0.94	2.12
April	0.00	0.18	0.63	0.48	0.00	0.00	0.03	0.63	0.24
May	0.89	0.45	0.00	0.00	1.00	1.00	0.00	0.19	0.44
June	0.49	0.90	0.00	0.00	0.35	0.35	0.01	3.44	0.69
July	7.19	2.53	6.51	6.34	4.10	4.10	5.74	4.44	5.12
August	4.66	3.26	5.47	4.09	2.70	2.70	5.82	4.95	4.21
September	2.63	3.92	3.60	5.00	2.95	2.95	6.96	2.97	3.87
October	0.33	0.85	0.72	0.09	0.00	0.00	1.90	1.62	0.69
November	0.60	0.04	0.05	1.37	1.09	1.09	0.00	0.77	0.63
December	1.03	1.00	1.08	2.96	0.65	0.65	1.17	0.84	1.17
Total	**23.03**	**16.51**	**29.10**	**23.01**	**15.45**	**15.45**	**25.78**	**23.75**	**21.51**

4.2.2 *Runoff Coefficients*

Runoff is the portion of precipitation falling on a catchment that is not subsequently evaporated or infiltrated to the deep groundwater system. The model was configured so runoff into the UD pond from the TSF pad and tributary areas could be computed. Daily runoff from direct precipitation was estimated using runoff coefficients and the formula $Q=CPA$, where Q is the total daily runoff volume, C is the runoff coefficient, P is the daily precipitation and A is the tributary watershed area. Runoff coefficients were determined based on experience and engineering judgment. **Table 4.3** presents the runoff coefficient used for each type of tributary area. Note that for areas on the lined TSF including stacked tailings and the drainage layer, runoff includes the portion of precipitation that either directly runs off from the surface or infiltrates to the TSF liner and is conveyed to the UD pond.

Table 4.3. Daily Runoff Coefficients by Area Type

Tributary Area	Runoff Coefficient
Pond Surface	1.00
Exposed Liner	1.00
Existing Tailings	0.40
Stacked Tailings	0.50
Drainage Layer	0.30
Existing Ground	0.20
Bare Soil After Tails Removed	0.40

The runoff coefficient can be thought of as the percent of direct precipitation that becomes runoff. As an example, a runoff coefficient of 0.50 for stacked tailings assumes 50% of direct precipitation becomes runoff. The other 50% infiltrates into the tailings and eventually evaporates.

4.2.3 *Curve Numbers*

Soil Conservation Service (SCS) curve numbers were used to model the portion of runoff expected from a 100-year, 24-hour storm. 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. The use of curve numbers when modeling runoff from a large storm more accurately estimates runoff when a large volume of rain falls over a short period of time and soil is unable to absorb large amounts of moisture. Effective rainfall, E, using the SCS method, is defined as $E = (P\text{-}I)^2 / (P+S\text{-}I)$ where P is the daily precipitation, I is initial abstraction (or amount of rain absorbed before runoff is produced), and S is the moisture retention of the soil. Moisture retention is related to the curve number by the formula $S = (1000/CN) – 10$. **Table 4.4** presents the curve numbers and other variables used to calculate effective precipitation during the 100-year, 24-hour event for each type of tributary area. SCS curve numbers were determined based on published information, experience and engineering judgment.

Table 4.4. Curve Numbers and Effective Rainfall by Tributary Area (for 100-year, 24-hour Event)

Tributary Area	Curve Number	Initial Abstraction (in)	Soil Retention (in)	Effective Precipitation (in)
UD Pond	100	0	0	4.88
Exposed Liner	100	0	0	4.88
Existing Tails Impoundment (not on liner)	80	2.5	0.5	2.79
Tailings (on liner)	86	1.63	0.33	3.36
Drainage Layer	70	4.29	0.86	1.95
Existing Ground	72	3.89	0.78	2.11
Bare Soil After Tails Removed	75	3.33	0.67	2.35

The design depth of precipitation for the 100-year, 24-hour event is 4.88 inches (ERC).

4.2.4 Evaporation Losses

Daily evaporation losses were modeled for the UD pond and the external pond using monthly pond evaporation rates (ERC). Evaporation from the tailings portion of the TSF will be less than from the free water surface and in practice is dependent on multiple variables including tailings stacking patterns, tailings management and reclaim. For the water balance model, evaporation from surfaces other than ponds (such as tailings, existing ground, etc.) was modeled using runoff coefficients. In other words, whatever percentage of precipitation did not runoff was assumed lost to evaporation (or some other hydrological processes such as deep infiltration). 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 UD pond and external pond are included in **Table 4.5**.

Table 4.5. 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 Tailings Management Facility

4.3.1 TSF Geometry

Specific filling curves for the UD pond and external pond were provided by Newfields for each of the TSF stages (NewFields). These curves are presented in **Appendix B**. The model assumes a minimum freeboard of 2 feet would be required for the UD pond. No freeboard is assumed for the external pond.

4.3.2 TSF Tributary Area

For the purpose of this water balance, ERC used the total tributary drainage areas to the UD pond and external pond as provided by Newfields. **Table 4.6** presents the monthly configuration of areas tributary to the UD pond. **Table 4.7** presents the monthly configuration of areas tributary to the external pond.

Table 4.6. Monthly Configuration of Areas Tributary to UD Pond

Month	Exposed Liner (ft^2)	Tailings on Liner (ft^2)	Drainage Layer (ft^2)	Existing Ground (ft^2)	Bare Soil after Tailings Removed (ft^2)	Existing Tailings (ft^2)	Total Tributary Area (ft^2)
March-18	312,475	0	312,475	1,155,765	0	624,295	2,405,010
April-18	242,178	140,593	242,178	1,155,765	208,432	416,863	2,406,010
May-18	171,882	281,187	171,882	1,155,765	416,863	208,432	2,406,010
June-18	101,585	421,780	101,585	1,155,765	625,295	0	2,406,010
July-18	101,585	421,780	101,585	0	0	0	624,950
August-18	101,585	421,780	101,585	0	0	0	624,950
September-18	101,585	421,780	101,585	0	0	0	624,950
October-18	93,953	421,780	93,953	0	0	0	609,686
November-18	187,906	421,780	187,906	0	0	0	797,593
December-18	281,859	421,780	281,859	0	0	0	985,499
January-19	**375,813**	**421,780**	**375,813**	**0**	**0**	**0**	**1,173,405**
February-19	**297,976**	**577,453**	**297,976**	**0**	**0**	**0**	**1,173,405**
March-19	**220,139**	**733,127**	**220,139**	**0**	**0**	**0**	**1,173,405**
April-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
May-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
June-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
July-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
August-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
September-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
October-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
November-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
December-19	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
January-20	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**
February-20	**142,303**	**888,800**	**142,303**	**0**	**0**	**0**	**1,173,405**

Note: Normal font denotes Stage 1. **Bold** font denotes Stage 2.

Table 4.7. Monthly Configuration of Areas Tributary to External Pond

Month	Bare Soil after Tailings Removed (ft^2)	Existing Ground (ft^2)	Exposed Liner (ft^2)	Existing Tailings (ft^2)
March-18	0	0	0	0
April-18	0	0	0	0
May-18	0	0	0	0
June-18	0	0	0	0
July-18	625,295	1,109,500	46,265	0
August-18	625,295	1,109,500	46,265	0
September-18	625,295	1,109,500	46,265	0
October-18	552,696	1,032,410	46,265	0
November-18	480,098	955,320	46,265	0
December-18	407,499	878,230	46,265	0
January-19	**334,900**	**787,885**	**59,520**	**0**
February-19	**334,900**	**787,885**	**59,520**	**0**
March-19	**334,900**	**787,885**	**59,520**	**0**
April-19	**334,900**	**787,885**	**59,520**	**0**
May-19	**334,900**	**787,885**	**59,520**	**0**
June-19	**334,900**	**787,885**	**59,520**	**0**
July-19	**334,900**	**787,885**	**59,520**	**0**
August-19	**334,900**	**787,885**	**59,520**	**0**
September-19	**334,900**	**787,885**	**59,520**	**0**
October-19	**334,900**	**787,885**	**59,520**	**0**
November-19	**334,900**	**787,885**	**59,520**	**0**
December-19	**334,900**	**787,885**	**59,520**	**0**
January-20	**334,900**	**787,885**	**59,520**	**0**
February-20	**334,900**	**787,885**	**59,520**	**0**

Note: Normal font denotes Stage 1. **Bold** font denotes Stage 2.

4.4 Miscellaneous Inflows

Additional water that reports to the UD pond includes mine workings water, tailing runoff from existing tailings piles before they are relocated and ramp/shaft development water. **Table 4.8** presents the estimates of miscellaneous water as provided by AMI in gallons per minute (gpm).

Table 4.8. Miscellaneous Inflows to UD Pond

Month	Mine Workings Water (gpm)	Tailings Underflow (gpm)	Ramp/Shaft Water (gpm)
March-18	20	5	50
April-18	20	4	50
May-18	20	3	50
June-18	20	2	50
July-18	20	1	50
August-18	20	0	50
September-18	20	0	50
October-18	20	0	50
November-18	20	0	50
December-18	20	0	50
January-19	**20**	**0**	**50**
February-19	**20**	**0**	**50**
March-19	**20**	**0**	**50**
April-19	**20**	**0**	**50**
May-19	**20**	**0**	**50**
June-19	**20**	**0**	**50**
July-19	**20**	**0**	**50**
August-19	**20**	**0**	**50**
September-19	**20**	**0**	**50**
October-19	**20**	**0**	**50**
November-19	**20**	**0**	**50**
December-19	**20**	**0**	**50**
January-20	**20**	**0**	**50**
February-20	**20**	**0**	**50**

Note: Normal font denotes Stage 1. **Bold** font denotes Stage 2.

4.5 Pumping

It was assumed that pumping would be used to draw down water levels in the ponds over time. From the UD pond, water would be pumped to the WTP. The WTP has a capacity of 120 gpm so this was set as the maximum rate that water would be removed from the UD pond. From the external pond, it was initially assumed that water would be pumped to the natural environment at a rate of 100 gpm. Water in the external pond has not come into contact with tailings and can be released without treatment.

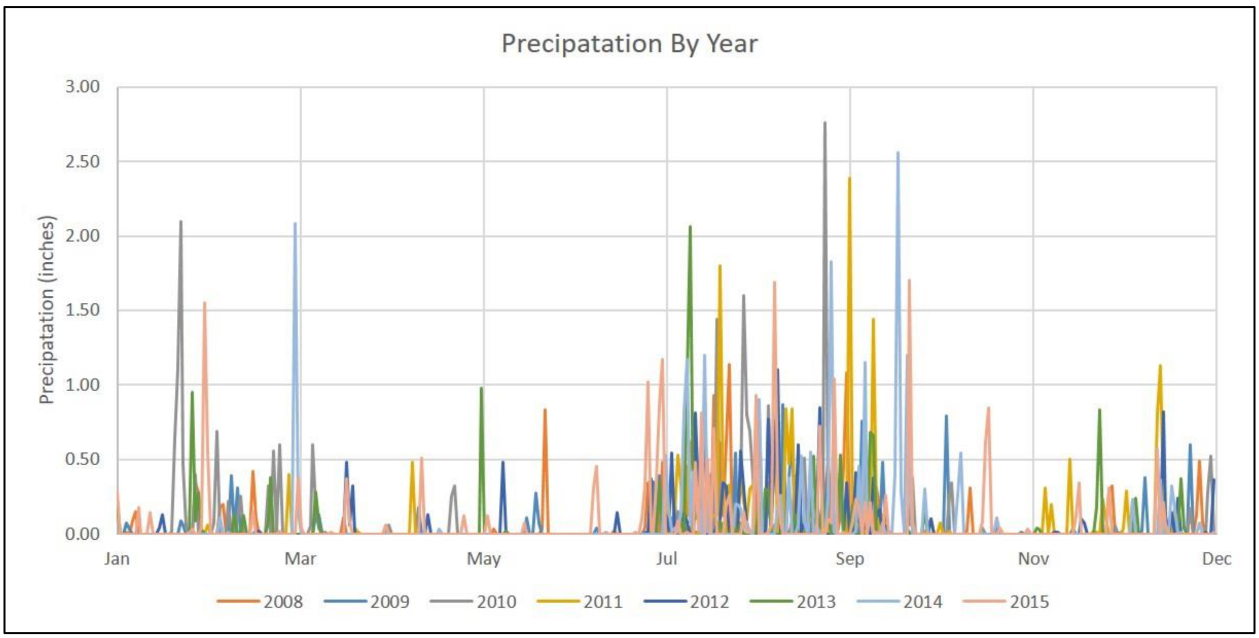
5.0 Model Runs and Results

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 UD pond and the external pond as the difference between inflows and outflows (as shown in **Table 3.1** above). Eight separate years of precipitation data were modeled in an attempt to capture annual variability. Peak pumping rates from UD pond to the WTP was set at 120 gpm while pumping rates from the external pond was altered to determine the amount of pumping necessary to ensure the ponds could hold the normal daily runoff volume (or the volume of runoff generated each day from precipitation) and also store runoff from the 100-year, 24-hour event at all times. Results obtained from the model runs are presented below.

5.1 Precipitation

Monthly precipitation values from each of the eight years of 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 UD Pond Capacity

Figure 5.2 presents the normal daily volume of contact water that is expected to be stored in the UD pond. It also shows the capacity of the UD pond with two feet of freeboard. **Figure 5.3** shows the normal daily runoff volume plus the runoff generated by the 100-year, 24-hour event compared with UD pond capacity (including 2 feet of freeboard below the spillway invert or seven feet below the dam crest). Both model runs assume 120 gpm of pumping capacity from the UD pond to the WTP.

Figure 5.2. UD Pond Capacity vs. Normal Daily Runoff Volume

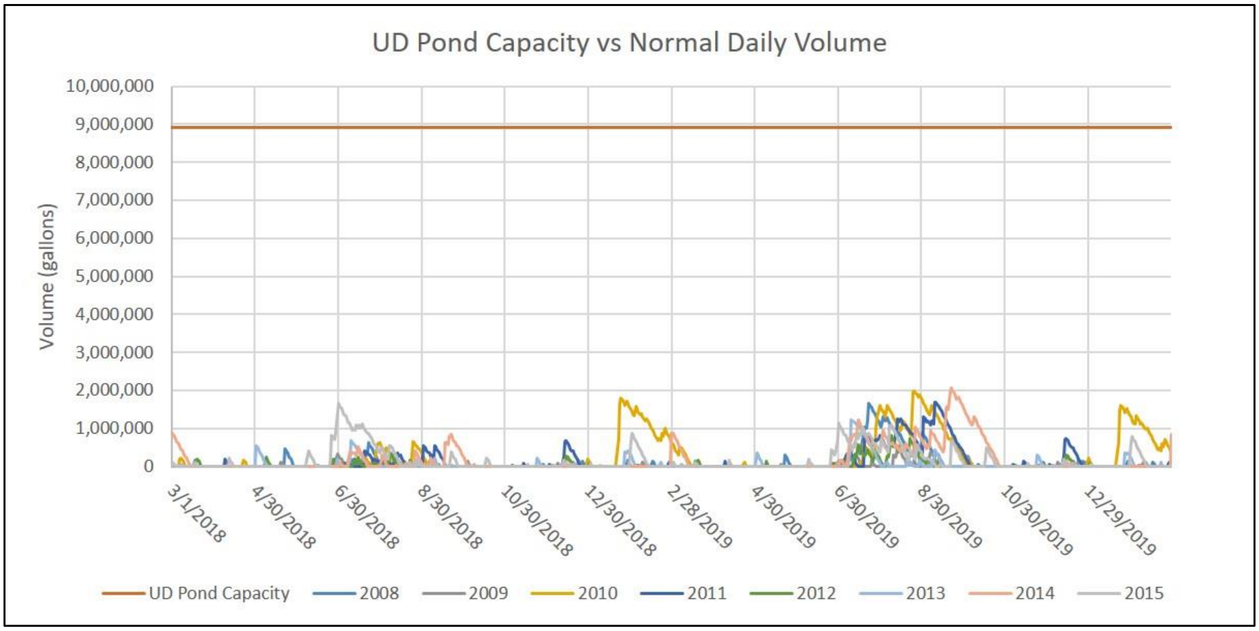
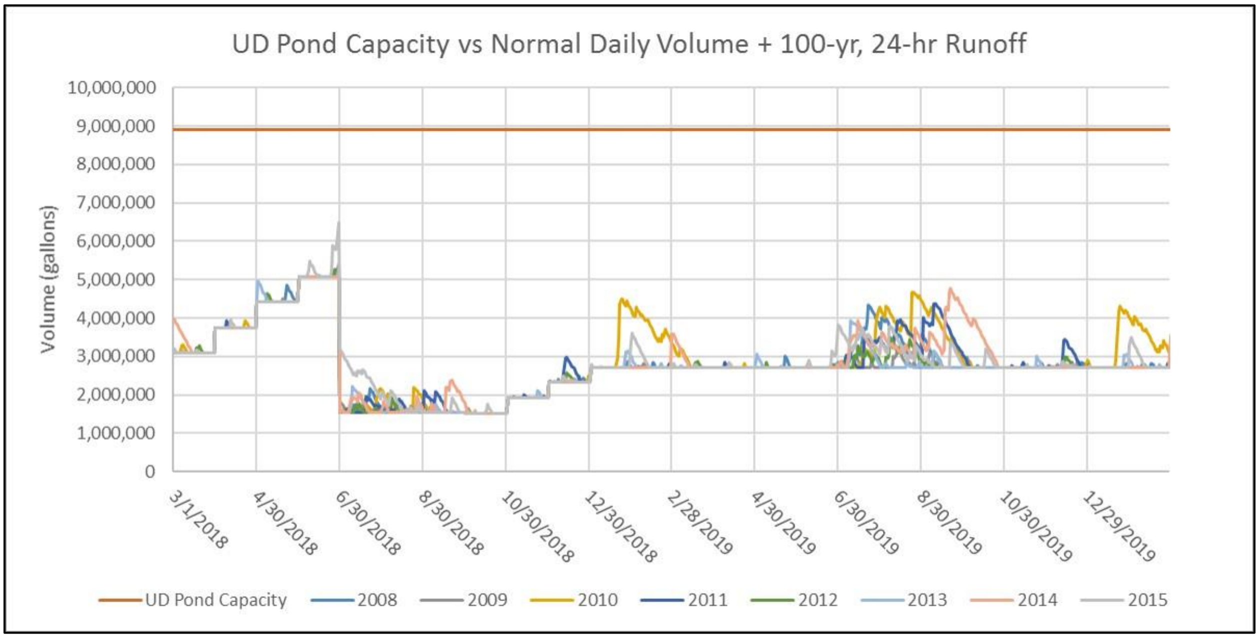


Figure 5.3. UD Pond Capacity vs. Normal Daily Runoff Volume plus 100-year, 24-hour Event Runoff



During Stages 1 and 2, the UD pond will have a capacity of 8.9 million gallons (gal) which includes 2 feet of freeboard below the spillway invert. The maximum amount of normal daily contact water stored in the UD pond is expected to be approximately 2.1 million gal. This would occur in a precipitation year similar to 2014. This means the available capacity (i.e. room for additional storage) in the UD pond, after normal daily inflows and outflows, is modeled as at a minimum value of approximately 6.8 million gal. The amount of runoff from the 100-year, 24-hour event varies based on the configuration of the TSF pad. The maximum value occurs during Stage 1 when all up-gradient areas are tributary to the UD pond. This amount is approximately 5.1 million gal. In Stage 2, after the external pond is constructed and the area tributary to the UD pond is reduced, the 100-year, 24-hour runoff is approximately 2.7 million gal. Overall, the planned WTP capacity of 120 gpm is sufficient for the UD pond to capture normal daily runoff volumes while maintaining sufficient capacity to store runoff from the 100-year, 24-hour event. As shown in **Figure 5.3,** the maximum volume of normal daily runoff and 100-year, 24-hour runoff would occur in Stage 1 during a precipitation year similar to 2015. This volume is about 6.7 million gal. The available capacity in the UD pond after normal daily runoff and runoff from the 100-year, 24-hour event is always at least approximately 2.2 million gal.

5.4 External Pond Capacity

Figure 5.4 presents the normal daily volume of runoff predicted to be stored in the external pond based on the eight years of daily precipitation records. **Figure 5.5** shows the normal daily runoff volume plus the runoff generated by the 100-year, 24-hour event compared with external pond capacity (assuming no freeboard). Both model runs assume that infrastructure exists to allow 100 gpm of pumping capacity from the external pond to the natural environment.

Figure 5.4. External Pond Capacity vs. Normal Daily Runoff Volume

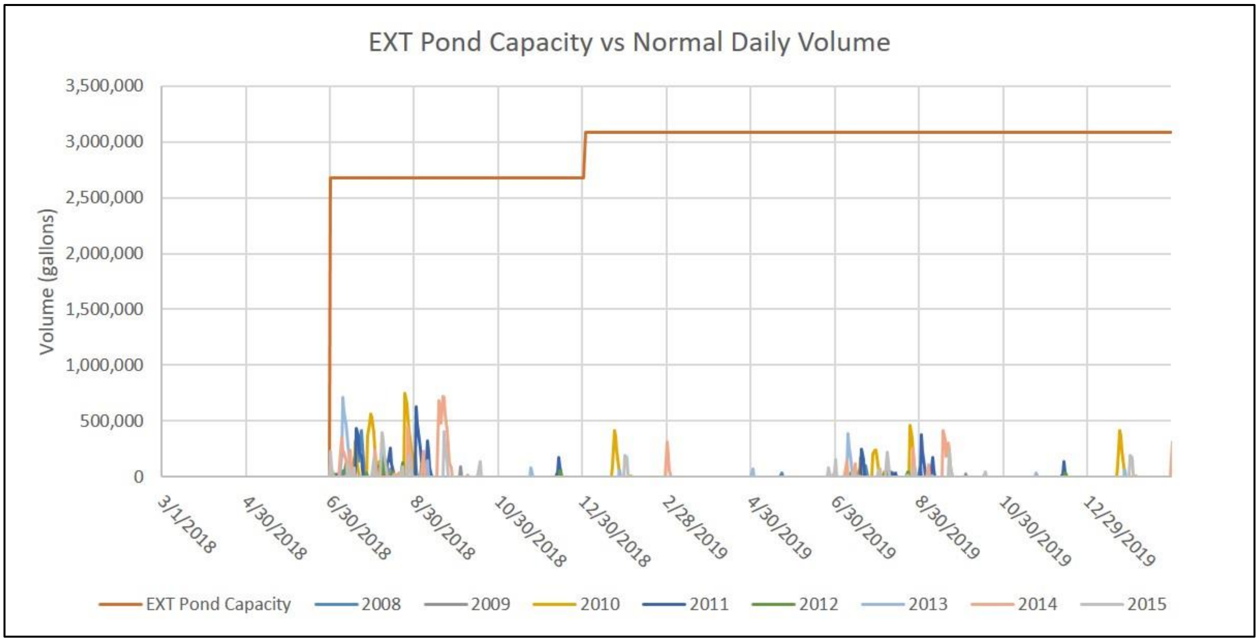
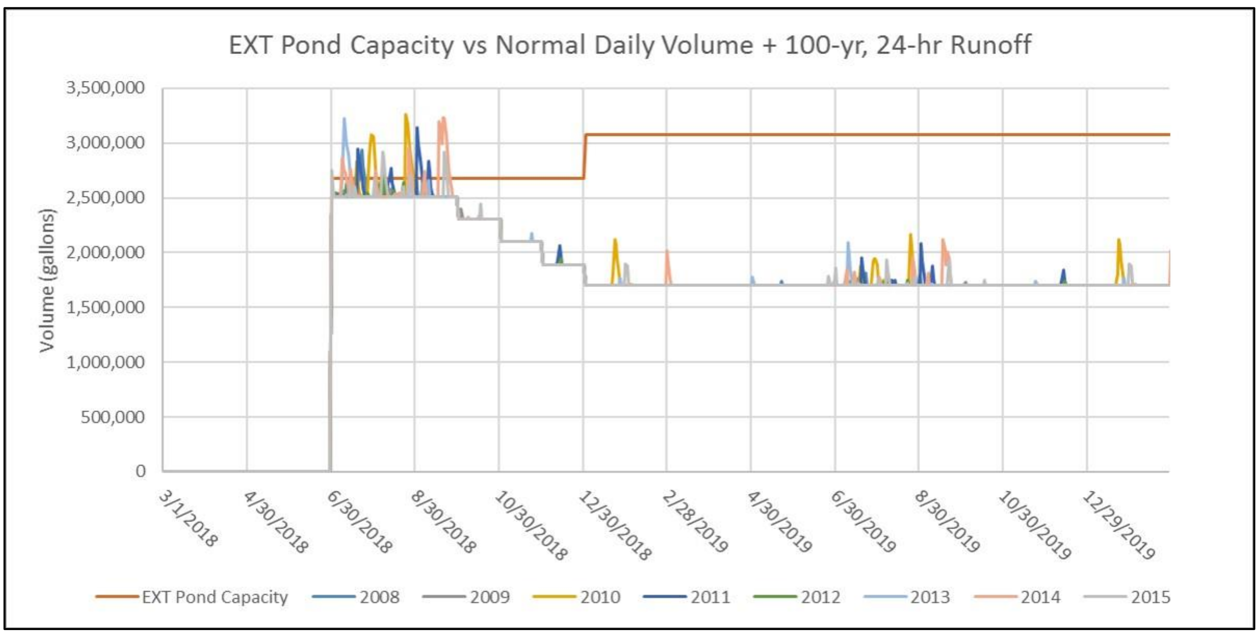


Figure 5.5. External Pond Capacity vs. Normal Daily Runoff Volume plus 100-year, 24-hour Event Runoff



During Stage 1, the external pond will have a capacity of about 2.7 million gal. In Stage 2, the external pond will have a capacity of approximately 3.1 million gal. The maximum amount of normal daily runoff expected is approximately 750,000 gal. This would occur in a precipitation year similar to 2010 while the Stage 1 external pond is in place. This means the available capacity (i.e. room for additional storage) in the external pond after normal daily runoff is always at least approximately 1.9 million gal. The amount of runoff from the 100-year, 24-hour event varies based on the configuration of the TSF as it impacts the amount of remaining watershed that contributes runoff to the external pond. The maximum runoff from the 100-year, 24-hour storm occurs during Stage 1 when the largest amount of upland area is tributary to the pond. This 100-year, 24-hour runoff volume is approximately 2.5 million gal. In Stage 2, after the area of up-gradient tributary to the external pond stabilizes, the 100-year, 24-hour runoff is reduced to approximately 1.7 million gal. As shown in **Figure 5.5,** the maximum volume of normal daily runoff and 100-year, 24-hour runoff would occur in Stage 1 during a precipitation year similar to 2010. This volume is about 3.3 million gal. This exceeds the Stage 1 capacity of the external pond by about 600,000 gal. During Stage 2, the maximum volume of normal daily runoff and 100-year, 24-hour runoff is approximately 2.2 million gal. This is about 900,000 gal less than the Stage 2 capacity of the external pond.

Overall, 100 gpm of pumping capacity to drawdown the external pond is not sufficient for the external pond to capture normal daily runoff volumes and store runoff from the 100-year, 24-hour event during Stage 1. Inspection of **Figure 5.5** illustrates that 100-year, 24-hour runoff volume is nearly equivalent to the Stage 1 internal pond capacity therefore nominal increases in the pumping rate from the external pond would not provide much relief. The model predicts that pumping capacity would have to be approximately 510 gpm to ensure sufficient capacity in the external pond for normal daily runoff and runoff from the 100-year, 24-hour event during Stage 1. At this critical time, the model predicts that there will be 2.2 million gal of excess capacity in the UD pond. In the event that the 100-year, 24-hour storm were to occur during the brief period when the Stage 1 external pond was in place, excess water would still be contained in the system as there is an excess volume of about 600,00s gallons in the external pond but more than 2 million gallons of remaining capacity in the TSF UD Pond. This is true for a pumping capacity as low as 30 gpm from the external pond. With 30 gpm pumping capacity, the maximum volume of normal daily runoff plus runoff from the 100-year, 24-hour event is 4.7 million gal. The external pond capacity is 2.7 million gal. This creates approximately 2 million gal of excess water which can be contained in the 2.2 million gallon excess capacity of the UD pond in Stage 1. Once the Stage 2 external pond is in place with its larger capacity and smaller tributary basin, 25 gpm will be sufficient pumping capacity to store the normal daily runoff volume and runoff from the 100-year, 24-hour event within the external pond.

5.4 Inflow vs Outflows

Figures 5.6 and **5.7** depict inflows vs outflows (in gpm) for the UD pond and external pond, respectively.

Figure 5.6. UD Pond Inflows vs. Outflows

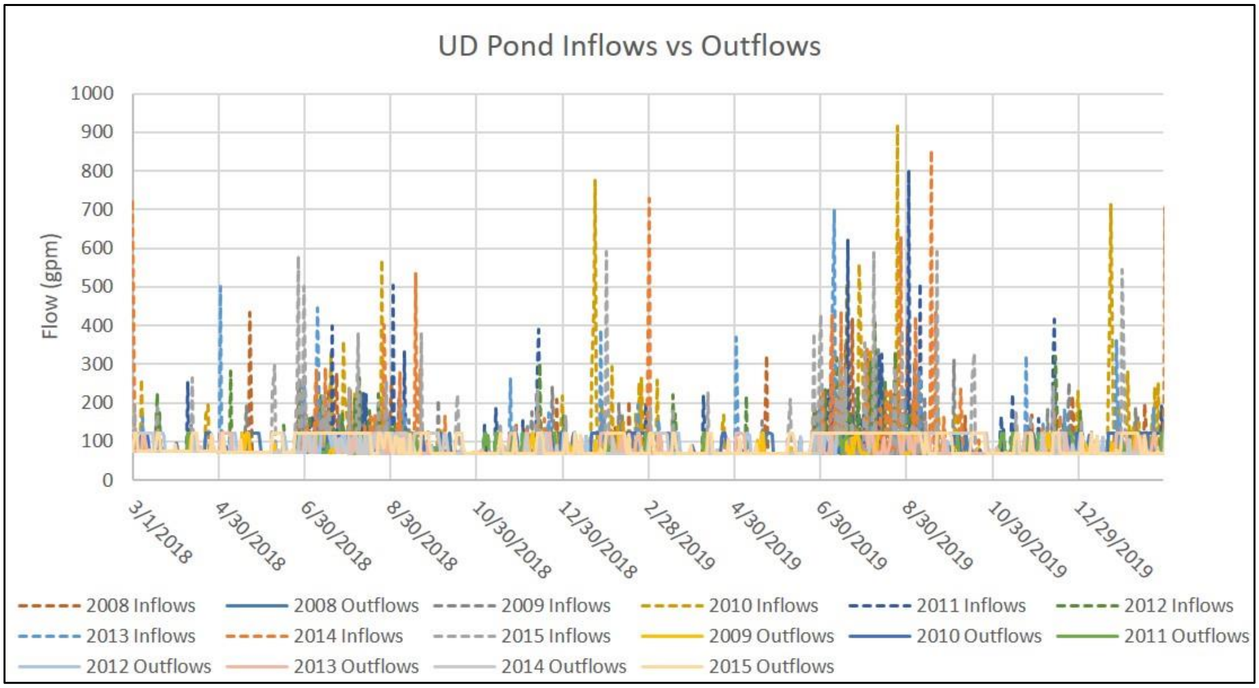
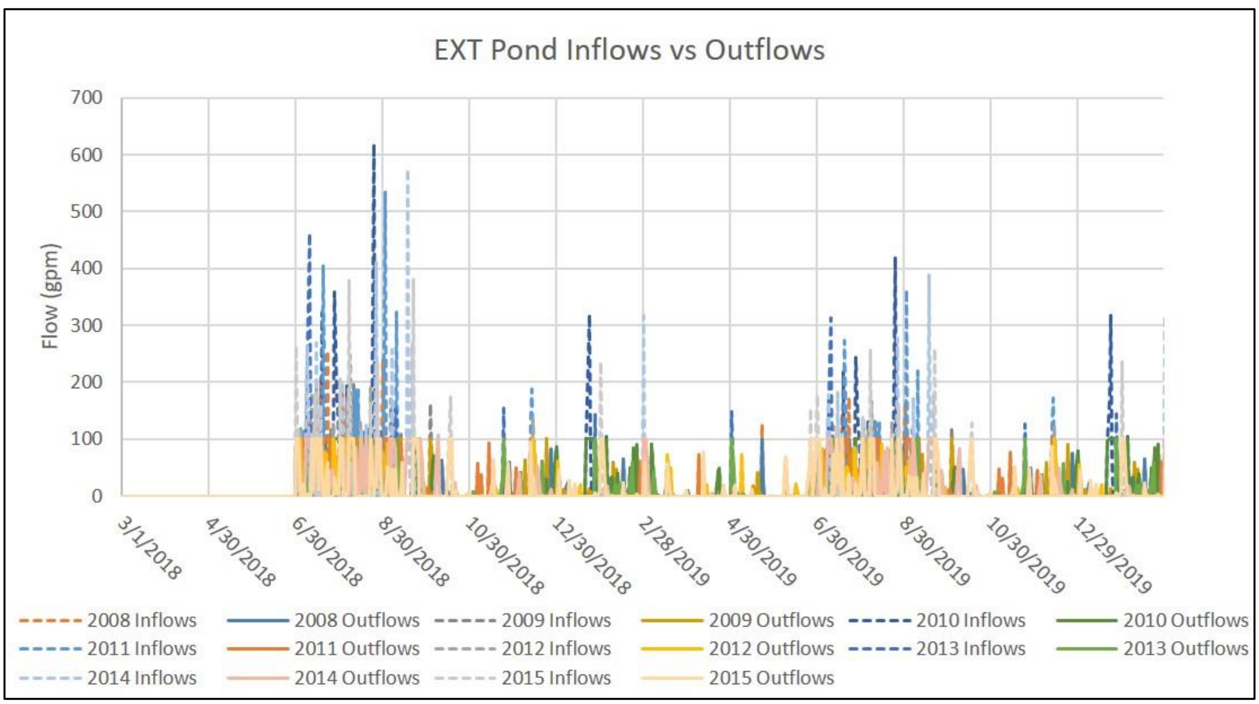


Figure 5.7. External Pond Inflows vs. Outflows



Figures 5.6 and **5.7** show that peak inflows to both ponds occur during the monsoon season (June, July and August) since precipitation is the largest source of water. Peak inflows to the UD pond range from approximately 250 gpm to 900 gpm. This includes mine workings water and ramp/shaft development water. Peak inflows to the external pond range from approximately 100 gpm to 600 gpm. Outflows from both ponds remain fairly constant and are primarily the result of pumping capacity. Evaporation accounts for only about 1-2 gpm.

6.0 Summary

Model results indicate that the capacity of the UD pond as designed (and with a pumping capacity of 120 gpm to the WTP) will be sufficient to store the anticipated contact water and capture runoff from the 100-year, 24-hour event at all times. The maximum UD pond volume from the combination of normal daily runoff and runoff from the 100-year, 24-hour event is approximately 6.7 million gal. The maximum capacity of the UD pond is about 8.9 million gal. This leaves a minimum of approximately 2.2 million gal of excess capacity.

Results also indicate that the capacity of the external pond as designed is adequate to contain runoff in normal operations but will not be sufficient to store the runoff generated by normal daily precipitation and capture runoff from the 100-year, 24-hour event during Stage 1. Assuming a pumping capacity of 100 gpm, the maximum volume from the combination of normal daily runoff and runoff from the 100-year, 24-hour event is approximately 3.3 million gal. The maximum capacity of the external pond at the same time (Stage 1) is approximately 2.7 million gal. Therefore, in the event of the 100-year, 24-hour storm, an excess volume of approximately 600,000 gallons is predicted to exist. This excess volume could be stored in the UD pond. During Stage 2, the maximum volume from the combination of normal daily runoff and runoff from the 100-year, 24-hour event is approximately 2.2 million gal. The maximum capacity of the external pond at the same time (Stage 2) is 3.1 million gal. This leaves a minimum of 900,000 gal of excess capacity.

As pumping capacity from the external pond varies from the assumed 100 gpm, more or less excess clean water would exist in the event that the 100-year, 24-hour storm happened to occur during the fall of 2018 before the Stage 2 TSF is constructed. For example, at 510 gpm, the full operational volume and the 100-year, 24-hour event could be stored in the Stage 1 external pond. At 30 gpm, approximately 2 million gal of excess volume would be generated during Stage 1. This excess could be contained in the modeled UD pond in Stage 1. During Stage 2, pumping of 25 gpm is sufficient to ensure that the external pond has the capacity to contain both normal daily runoff and runoff from the 100-year, 24-hour event.

Based on model results, the ponds could work as sized if, during Stage 1, excess water from the external pond is routed to the UD pond. During Stage 2, pumping of 25 gpm to the natural environment would be sufficient to store both normal daily runoff and runoff from the 100-year, 24-hour event. WTP pumping from the UD pond should remain 120 gpm.

7.0 References

Arizona Mining, Inc. “Precipitation Summary 2007-2014.xls”

Ecological Resources Consultants, Inc. (ERC). Arizona Mining Mine Site Climate Analysis. March 13, 2017.

Newfields, Arizona Mining Filling Curves and Stage Areas. Provided via emails in March and April, 2017.

Appendix A

Daily Site Precipitation (2008-2015)

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
1-Jan	0.00	0.00	0.00	0.21	0.00	0.20	0.00	0.29
2-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-Jan	0.01	0.07	0.00	0.00	0.00	0.00	0.00	0.00
5-Jan	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
6-Jan	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Jan	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
9-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
13-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-Jan	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
16-Jan	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
17-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19-Jan	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
20-Jan	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00
21-Jan	0.00	0.00	1.11	0.00	0.00	0.00	0.00	0.00
22-Jan	0.00	0.09	2.10	0.00	0.00	0.00	0.00	0.00
23-Jan	0.00	0.06	0.47	0.00	0.00	0.00	0.00	0.00
24-Jan	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
25-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
26-Jan	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.03
27-Jan	0.34	0.00	0.40	0.00	0.00	0.09	0.00	0.00
28-Jan	0.28	0.00	0.01	0.00	0.00	0.27	0.00	0.00
29-Jan	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.04
30-Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55
31-Jan	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.56
1-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-Feb	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00
3-Feb	0.00	0.00	0.69	0.00	0.00	0.00	0.00	0.00
4-Feb	0.18	0.00	0.00	0.00	0.00	0.00	0.11	0.00
5-Feb	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Feb	0.00	0.00	0.22	0.00	0.00	0.00	0.01	0.00
8-Feb	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00
9-Feb	0.00	0.01	0.00	0.00	0.00	0.13	0.00	0.00
10-Feb	0.00	0.31	0.10	0.00	0.00	0.00	0.00	0.00
11-Feb	0.00	0.00	0.25	0.00	0.00	0.01	0.00	0.00
12-Feb	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00
13-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site Daily Precip, inches (2008 - 2015)

	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
15-Feb	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.15
16-Feb	0.10	0.00	0.00	0.00	0.02	0.00	0.00	0.00
17-Feb	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
18-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-Feb	0.00	0.00	0.32	0.00	0.00	0.08	0.00	0.00
21-Feb	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00
22-Feb	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00
23-Feb	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
24-Feb	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.02
25-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27-Feb	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00
28-Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Mar	0.00	0.00	0.00	0.00	0.00	0.00	2.08	0.00
2-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.38
3-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
4-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6-Mar	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
7-Mar	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00
8-Mar	0.00	0.13	0.17	0.00	0.00	0.28	0.00	0.00
9-Mar	0.00	0.13	0.04	0.00	0.00	0.07	0.00	0.00
10-Mar	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
11-Mar	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
12-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
14-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17-Mar	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18-Mar	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.37
19-Mar	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.08
20-Mar	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00
21-Mar	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
22-Mar	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
23-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31-Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
1-Apr	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
2-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9-Apr	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.00
10-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Apr	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00
12-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51
13-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14-Apr	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
15-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
19-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22-Apr	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
23-Apr	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00
24-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
27-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-May	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
3-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
5-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6-May	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9-May	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00
10-May	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
11-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
16-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
17-May	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00
18-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-May	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00
21-May	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
22-May	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23-May	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31-May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
9-Jun	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.45
10-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
13-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-Jun	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-Jun	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00
17-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
23-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
25-Jun	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.32
26-Jun	0.34	0.00	0.00	0.00	0.02	0.00	0.00	1.02
27-Jun	0.00	0.10	0.00	0.00	0.37	0.00	0.00	0.02
28-Jun	0.08	0.35	0.00	0.00	0.00	0.00	0.00	0.01
29-Jun	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.34

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
30-Jun	0.00	0.39	0.00	0.00	0.00	0.35	0.00	0.86
1-Jul	0.48	0.05	0.00	0.00	0.00	0.00	0.00	1.17
2-Jul	0.00	0.08	0.04	0.23	0.13	0.03	0.53	0.00
3-Jul	0.05	0.12	0.00	0.03	0.02	0.00	0.17	0.00
4-Jul	0.11	0.01	0.00	0.41	0.54	0.00	0.02	0.00
5-Jul	0.07	0.20	0.00	0.14	0.00	0.00	0.04	0.00
6-Jul	0.00	0.00	0.15	0.53	0.00	0.00	0.01	0.09
7-Jul	0.00	0.04	0.00	0.33	0.00	0.08	0.15	0.00
8-Jul	0.60	0.14	0.05	0.01	0.14	0.00	0.82	0.00
9-Jul	0.12	0.01	0.06	0.45	0.08	1.04	1.17	0.01
10-Jul	0.62	0.00	0.01	0.05	0.00	2.06	0.06	0.00
11-Jul	0.40	0.00	0.01	0.00	0.00	0.09	0.42	0.00
12-Jul	0.32	0.29	0.01	0.00	0.81	0.10	0.26	0.48
13-Jul	0.32	0.48	0.01	0.00	0.25	0.15	0.19	0.02
14-Jul	0.02	0.34	0.05	0.00	0.00	0.11	0.00	0.81
15-Jul	0.00	0.01	0.00	0.00	0.91	0.00	1.20	0.00
16-Jul	0.00	0.00	0.01	0.00	0.00	0.18	0.01	0.50
17-Jul	0.00	0.00	0.40	0.10	0.00	0.01	0.00	0.00
18-Jul	0.93	0.00	0.00	0.12	0.00	0.00	0.00	0.71
19-Jul	0.57	0.03	1.44	0.13	0.06	0.01	0.00	0.00
20-Jul	0.61	0.05	0.01	1.80	0.09	0.09	0.00	0.00
21-Jul	0.12	0.00	0.07	0.24	0.34	0.00	0.00	0.00
22-Jul	0.62	0.00	0.00	0.00	0.32	0.00	0.00	0.19
23-Jul	1.14	0.13	0.23	0.33	0.00	0.00	0.00	0.26
24-Jul	0.00	0.00	0.00	0.08	0.00	0.06	0.00	0.00
25-Jul	0.09	0.54	0.00	0.02	0.00	0.02	0.20	0.00
26-Jul	0.00	0.00	0.22	0.00	0.00	0.00	0.20	0.00
27-Jul	0.00	0.00	0.27	0.40	0.56	0.07	0.17	0.00
28-Jul	0.00	0.00	1.60	0.22	0.31	0.00	0.03	0.15
29-Jul	0.00	0.00	0.80	0.09	0.05	0.00	0.08	0.01
30-Jul	0.00	0.00	0.69	0.30	0.00	0.00	0.01	0.01
31-Jul	0.00	0.01	0.38	0.33	0.00	0.00	0.00	0.03
1-Aug	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.93
2-Aug	0.82	0.00	0.00	0.03	0.00	0.21	0.90	0.00
3-Aug	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-Aug	0.00	0.01	0.00	0.00	0.01	0.30	0.00	0.00
5-Aug	0.34	0.26	0.86	0.01	0.77	0.29	0.00	0.01
6-Aug	0.00	0.00	0.02	0.01	0.13	0.00	0.00	0.06
7-Aug	0.01	0.00	0.06	0.76	0.48	0.00	0.00	1.69
8-Aug	0.00	0.00	0.00	0.00	1.10	0.00	0.19	0.25
9-Aug	0.13	0.00	0.00	0.20	0.00	0.00	0.26	0.07
10-Aug	0.00	0.87	0.00	0.00	0.00	0.00	0.00	0.00
11-Aug	0.00	0.00	0.00	0.84	0.00	0.01	0.00	0.00
12-Aug	0.00	0.37	0.02	0.47	0.00	0.00	0.38	0.00
13-Aug	0.09	0.66	0.00	0.84	0.00	0.00	0.00	0.00

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
14-Aug	0.39	0.00	0.03	0.00	0.05	0.13	0.00	0.00
15-Aug	0.00	0.00	0.06	0.35	0.60	0.00	0.06	0.00
16-Aug	0.00	0.00	0.39	0.02	0.01	0.00	0.52	0.00
17-Aug	0.00	0.00	0.51	0.00	0.07	0.00	0.08	0.00
18-Aug	0.00	0.00	0.00	0.11	0.00	0.06	0.00	0.00
19-Aug	0.00	0.00	0.00	0.18	0.46	0.16	0.55	0.00
20-Aug	0.00	0.21	0.00	0.00	0.00	0.52	0.00	0.00
21-Aug	0.00	0.26	0.00	0.02	0.12	0.01	0.06	0.00
22-Aug	0.09	0.01	0.00	0.00	0.85	0.04	0.00	0.72
23-Aug	0.00	0.03	0.13	0.15	0.00	0.24	0.00	0.00
24-Aug	0.28	0.15	2.76	0.10	0.00	0.06	0.00	0.00
25-Aug	0.48	0.43	0.18	0.00	0.00	0.11	0.24	0.10
26-Aug	0.18	0.00	0.04	0.00	0.00	0.00	1.83	0.07
27-Aug	0.12	0.00	0.13	0.00	0.00	0.00	0.01	1.04
28-Aug	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00
29-Aug	0.12	0.00	0.28	0.00	0.00	0.53	0.00	0.00
30-Aug	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.01
31-Aug	1.08	0.00	0.00	0.00	0.34	0.00	0.00	0.00
1-Sep	0.00	0.00	0.00	2.39	0.00	0.00	0.00	0.00
2-Sep	0.07	0.03	0.00	0.00	0.00	0.19	0.00	0.09
3-Sep	0.00	0.04	0.00	0.00	0.41	0.00	0.02	0.23
4-Sep	0.00	0.00	0.00	0.21	0.08	0.00	0.45	0.18
5-Sep	0.00	0.76	0.00	0.09	0.18	0.00	0.00	0.00
6-Sep	0.00	0.45	0.38	0.01	0.04	0.14	1.15	0.21
7-Sep	0.00	0.05	0.49	0.40	0.12	0.09	0.01	0.00
8-Sep	0.00	0.01	0.00	0.00	0.00	0.68	0.11	0.21
9-Sep	0.03	0.00	0.00	1.44	0.38	0.66	0.00	0.00
10-Sep	0.31	0.00	0.00	0.16	0.11	0.02	0.00	0.01
11-Sep	0.18	0.00	0.00	0.00	0.16	0.00	0.00	0.00
12-Sep	0.00	0.48	0.05	0.13	0.00	0.00	0.07	0.00
13-Sep	0.00	0.01	0.01	0.02	0.05	0.00	0.00	0.26
14-Sep	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
15-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00
17-Sep	0.00	0.00	0.00	0.00	0.00	0.00	2.56	0.00
18-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00
19-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
20-Sep	0.00	0.00	0.10	0.00	0.00	0.04	1.20	0.00
21-Sep	0.00	0.01	0.06	0.00	0.00	0.00	0.41	1.70
22-Sep	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.08
23-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-Sep	0.02	0.00	0.00	0.00	0.00	0.14	0.30	0.00
27-Sep	0.00	0.00	0.00	0.05	0.00	0.01	0.00	0.00

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
28-Sep	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00
29-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Sep	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Oct	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
2-Oct	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
3-Oct	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00
4-Oct	0.00	0.01	0.26	0.02	0.00	0.00	0.00	0.00
5-Oct	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00
6-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00
8-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00
9-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-Oct	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Oct	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-Oct	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.08
16-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61
17-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85
18-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
19-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-Oct	0.00	0.04	0.00	0.00	0.00	0.00	0.11	0.00
21-Oct	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.04
22-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28-Oct	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
29-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
31-Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-Nov	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
3-Nov	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
4-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-Nov	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00
6-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Nov	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00
8-Nov	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
9-Nov	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
10-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site Daily Precip, inches (2008 - 2015)

	2008	2009	2010	2011	2012	2013	2014	2015
12-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13-Nov	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
14-Nov	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
15-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
16-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34
17-Nov	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00
18-Nov	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
19-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21-Nov	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
22-Nov	0.00	0.00	0.00	0.01	0.00	0.18	0.00	0.00
23-Nov	0.00	0.00	0.00	0.00	0.00	0.83	0.00	0.00
24-Nov	0.00	0.00	0.00	0.23	0.00	0.01	0.00	0.00
25-Nov	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00
26-Nov	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.31
27-Nov	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28-Nov	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
29-Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Nov	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1-Dec	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
2-Dec	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00
3-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-Dec	0.00	0.00	0.00	0.22	0.00	0.00	0.23	0.00
5-Dec	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00
6-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7-Dec	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
8-Dec	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00
9-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12-Dec	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.57
13-Dec	0.00	0.00	0.00	1.13	0.02	0.00	0.36	0.00
14-Dec	0.00	0.00	0.00	0.25	0.82	0.00	0.00	0.21
15-Dec	0.00	0.00	0.00	0.01	0.12	0.00	0.00	0.06
16-Dec	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00
17-Dec	0.00	0.00	0.00	0.00	0.14	0.00	0.32	0.00
18-Dec	0.18	0.00	0.00	0.07	0.00	0.00	0.17	0.00
19-Dec	0.00	0.00	0.00	0.15	0.24	0.00	0.00	0.00
20-Dec	0.00	0.00	0.00	0.00	0.00	0.37	0.01	0.00
21-Dec	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
22-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23-Dec	0.16	0.60	0.17	0.00	0.00	0.00	0.00	0.00
24-Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-Dec	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26-Dec	0.49	0.00	0.00	0.00	0.00	0.00	0.07	0.00

Site Daily Precip, inches (2008 - 2015)

	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
27-Dec	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28-Dec	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
29-Dec	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00
30-Dec	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00
31-Dec	0.00	0.00	0.02	0.00	0.36	0.00	0.01	0.00

Summary Statistics (2008 - 2015)

	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Average (in)	0.05	0.03	0.07	0.06	0.04	0.04	0.06	0.07
Max (in)	1.14	0.87	2.76	2.39	1.10	2.06	2.56	1.70
Min (in)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix B

Filling Curves for Underdrain (UD) Pond and External Pond

TSF UD Pond

Elevation (ft)	Area (ft^2)	Volume (ft^3)	Volume (gallons)	Volume (ac-ft)
4,916.0	400	0	0	0.00
4,916.5	488	243	1,815	0.01
4,917.0	576	485	3,631	0.01
4,917.5	680	824	6,164	0.02
4,918.0	784	1,163	8,697	0.03
4,918.5	1,337	1,811	13,550	0.04
4,919.0	1,891	2,460	18,402	0.06
4,919.5	4,419	4,537	33,940	0.10
4,920.0	6,948	6,614	49,477	0.15
4,920.5	7,653	10,435	78,062	0.24
4,921.0	8,359	14,257	106,647	0.33
4,921.5	8,806	18,658	139,568	0.43
4,922.0	9,252	23,058	172,489	0.53
4,922.5	9,714	27,914	208,810	0.64
4,923.0	10,177	32,769	245,131	0.75
4,923.5	10,655	38,095	284,969	0.87
4,924.0	11,133	43,420	324,808	1.00
4,924.5	11,627	49,232	368,281	1.13
4,925.0	12,120	55,044	411,754	1.26
4,925.5	12,630	61,357	458,981	1.41
4,926.0	13,139	67,670	506,207	1.55
4,926.5	13,665	74,501	557,304	1.71
4,927.0	14,190	81,331	608,401	1.87
4,927.5	14,731	88,695	663,486	2.04
4,928.0	15,272	96,059	718,572	2.21
4,928.5	15,829	103,972	777,764	2.39
4,929.0	16,386	111,885	836,955	2.57
4,929.5	16,958	120,362	900,371	2.76
4,930.0	17,531	128,840	963,787	2.96
4,930.5	18,119	137,897	1,031,544	3.17
4,931.0	18,707	146,955	1,099,302	3.37
4,931.5	19,311	156,609	1,171,519	3.60
4,932.0	19,915	166,263	1,243,736	3.82
4,932.5	20,535	176,529	1,320,531	4.05
4,933.0	21,155	186,795	1,397,326	4.29
4,933.5	21,790	197,689	1,478,815	4.54
4,934.0	22,426	208,582	1,560,305	4.79
4,934.5	23,077	220,119	1,646,608	5.05
4,935.0	23,728	231,656	1,732,911	5.32
4,935.5	24,395	243,853	1,824,145	5.60
4,936.0	25,062	256,049	1,915,378	5.88
4,936.5	25,745	268,920	2,011,660	6.17
4,937.0	26,428	281,791	2,107,943	6.47
4,937.5	27,126	295,353	2,209,391	6.78
4,938.0	27,825	308,914	2,310,840	7.09
4,938.5	28,539	323,182	2,417,572	7.42
4,939.0	29,253	337,451	2,524,305	7.75
4,939.5	29,983	352,441	2,636,440	8.09
4,940.0	30,713	367,431	2,748,575	8.44

Elevation (ft)	Area (ft^2)	TSF UD Pond Volume (ft^3)	Volume (gallons)	Volume (ac-ft)	
4,940.5	31,459	383,159	2,866,229	8.80	
4,941.0	32,205	398,887	2,983,884	9.16	
4,941.5	32,966	415,369	3,107,176	9.54	
4,942.0	33,728	431,851	3,230,468	9.91	
4,942.5	34,505	449,102	3,359,515	10.31	
4,943.0	35,282	466,353	3,488,563	10.71	
4,943.5	36,075	484,389	3,623,484	11.12	
4,944.0	36,868	502,426	3,758,404	11.53	
4,944.5	37,677	521,263	3,899,316	11.97	
4,945.0	38,486	540,100	4,040,228	12.40	
4,945.5	39,310	559,754	4,187,248	12.85	
4,946.0	40,135	579,407	4,334,268	13.30	
4,946.5	40,975	599,894	4,487,515	13.77	
4,947.0	41,815	620,380	4,640,762	14.24	
4,947.5	42,671	641,714	4,800,354	14.73	
4,948.0	43,527	663,048	4,959,945	15.22	
4,948.5	44,399	685,246	5,125,999	15.73	
4,949.0	45,271	707,445	5,292,052	16.24	
4,949.5	46,158	730,522	5,464,686	16.77	
4,950.0	47,046	753,600	5,637,320	17.30	
4,950.5	47,949	777,573	5,816,651	17.85	
4,951.0	48,852	801,546	5,995,982	18.40	
4,951.5	49,771	826,430	6,182,129	18.97	
4,952.0	50,690	851,315	6,368,276	19.54	
4,952.5	51,625	877,126	6,561,357	20.14	
4,953.0	52,560	902,937	6,754,437	20.73	
4,953.5	53,510	929,691	6,954,568	21.34	
4,954.0	54,461	956,444	7,154,700	21.96	
4,954.5	55,427	984,156	7,362,001	22.59	
4,955.0	56,393	1,011,868	7,569,301	23.23	
4,955.5	57,375	1,040,555	7,783,888	23.89	
4,956.0	58,357	1,069,241	7,998,476	24.55	
4,956.5	59,355	1,098,917	8,220,468	25.23	
4,957.0	60,353	1,128,593	8,442,460	25.91	
4,957.5	61,366	1,159,274	8,671,974	26.61	
4,958.0	62,379	1,189,956	8,901,488	27.32	Maximum 100 yr storm elevation
4,958.5	63,409	1,221,659	9,138,643	28.05	
4,959.0	64,438	1,253,362	9,375,797	28.77	
4,959.5	65,483	1,286,102	9,620,711	29.52	
4,960.0	66,528	1,318,842	9,865,624	30.28	Spillway Invert Elevation (2' freeboard over 100 year storm)
4,960.5	67,589	1,352,635	10,118,414	31.05	
4,961.0	68,650	1,386,428	10,371,203	31.83	
4,961.5	69,726	1,421,290	10,631,987	32.63	
4,962.0	70,803	1,456,152	10,892,770	33.43	
4,962.5	71,895	1,492,098	11,161,665	34.25	
4,963.0	72,987	1,528,044	11,430,560	35.08	
4,963.5	74,095	1,565,090	11,707,684	35.93	
4,964.0	75,203	1,602,136	11,984,808	36.78	
4,964.5	76,327	1,640,298	12,270,279	37.66	
4,965.0	77,450	1,678,460	12,555,750	38.53	Pond Crest (5' Total freeboard from spillway invert)

External Detention Pond Stage 1

Elevation (ft)	Area (ft^2)	Volume (ft^3)	Volume (gallons)	Volume (ac-ft)
5,012.0	13	0	0	0.00
5,012.5	238	231	231	0.01
5,013.0	462	462	462	0.01
5,013.5	686	693	693	0.02
5,014.0	910	924	924	0.02
5,014.5	1,349	1,586	1,817	0.04
5,015.0	1,787	2,248	2,710	0.06
5,015.5	2,225	2,911	3,604	0.08
5,016.0	2,663	3,573	4,497	0.10
5,016.5	3,185	4,534	6,351	0.15
5,017.0	3,708	5,494	8,205	0.19
5,017.5	4,230	6,455	10,059	0.23
5,018.0	4,753	7,416	11,913	0.27
5,018.5	5,516	8,701	15,052	0.35
5,019.0	6,278	9,986	18,191	0.42
5,019.5	7,041	11,272	21,330	0.49
5,020.0	7,804	12,557	24,469	0.56
5,020.5	8,380	13,896	28,948	0.66
5,021.0	8,956	15,235	33,426	0.77
5,021.5	9,532	16,574	37,904	0.87
5,022.0	10,109	17,912	42,382	0.97
5,022.5	10,819	19,199	48,147	1.11
5,023.0	11,530	20,486	53,912	1.24
5,023.5	12,240	21,773	59,676	1.37
5,024.0	12,951	23,059	65,441	1.50
5,024.5	13,847	24,666	72,813	1.67
5,025.0	14,743	26,272	80,184	1.84
5,025.5	15,639	27,879	87,555	2.01
5,026.0	16,535	29,485	94,927	2.18
5,026.5	17,582	31,429	104,242	2.39
5,027.0	18,630	33,373	113,557	2.61
5,027.5	19,678	35,317	122,872	2.82
5,028.0	20,726	37,260	132,187	3.03
5,028.5	21,980	39,563	143,804	3.30
5,029.0	23,234	41,865	155,421	3.57
5,029.5	24,489	44,167	167,039	3.83
5,030.0	25,743	46,469	178,656	4.10
5,030.5	27,703	49,683	193,488	4.44
5,031.0	29,663	52,898	208,319	4.78
5,031.5	31,623	56,112	223,151	5.12
5,032.0	33,583	59,326	237,982	5.46
5,032.5	35,649	63,352	256,839	5.90
5,033.0	37,714	67,378	275,697	6.33
5,033.5	39,780	71,403	294,554	6.76
5,034.0	41,846	75,429	313,411	7.19
5,034.5	44,055	59,742	335,439	7.70
5,035.0	46,265	44,055	357,466	8.21

External Detention Pond Stage 2

Elevation (ft)	Area (ft^2)	Volume (ft^3)	Volume (gallons)	Volume (ac-ft)
5,064.0	37	0	0	0.00
5,064.5	255	236	236	0.01
5,065.0	472	472	472	0.01
5,065.5	689	708	708	0.02
5,066.0	906	944	944	0.02
5,066.5	1,267	1,522	1,758	0.04
5,067.0	1,628	2,100	2,572	0.06
5,067.5	1,989	2,678	3,386	0.08
5,068.0	2,350	3,256	4,200	0.10
5,068.5	3,003	4,270	6,028	0.14
5,069.0	3,657	5,285	7,857	0.18
5,069.5	4,310	6,299	9,685	0.22
5,070.0	4,964	7,313	11,513	0.26
5,070.5	5,704	8,707	14,735	0.34
5,071.0	6,444	10,101	17,957	0.41
5,071.5	7,184	11,494	21,179	0.49
5,072.0	7,924	12,888	24,401	0.56
5,072.5	8,854	14,558	29,293	0.67
5,073.0	9,784	16,228	34,185	0.78
5,073.5	10,713	17,897	39,077	0.90
5,074.0	11,643	19,567	43,968	1.01
5,074.5	13,229	22,083	51,376	1.18
5,075.0	14,815	24,598	58,783	1.35
5,075.5	16,401	27,114	66,191	1.52
5,076.0	17,987	29,630	73,598	1.69
5,076.5	19,990	33,219	84,595	1.94
5,077.0	21,994	36,809	95,592	2.19
5,077.5	23,997	40,398	106,589	2.45
5,078.0	26,001	43,988	117,586	2.70
5,078.5	28,244	48,234	132,829	3.05
5,079.0	30,487	52,481	148,073	3.40
5,079.5	32,730	56,728	163,316	3.75
5,080.0	34,974	60,974	178,560	4.10
5,080.5	37,182	65,426	198,255	4.55
5,081.0	39,390	69,878	217,950	5.00
5,081.5	41,599	74,329	237,646	5.46
5,082.0	43,807	78,781	257,341	5.91
5,082.5	46,343	83,525	281,781	6.47
5,083.0	48,879	88,270	306,220	7.03
5,083.5	51,415	93,014	330,660	7.59
5,084.0	53,951	97,759	355,100	8.15
5,084.5	56,736	77,247	383,467	8.80
5,085.0	59,520	56,736	411,835	9.45

APPENDIX K
Operations and Maintenance

NewFields
Perspective. Vision. Solutions.

9400 Station Street, Suite 300
Lone Tree, CO 80124

T: 720.508.3300
F: 720.508.3339

TECHNICAL MEMORANDUM

To: Johnny Pappas

From: Craig Thompson, P.E. – Project Manger
R. Michael Smith, P.E. – Project Principal

Project: Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project
Aquifer Protection Permit (APP) Best Available Demonstrated Control Technology (BADCT) Design

Project No: 475.0014.008

Subject: Aquifer Protection Permit- Operation and Maintenance Plan

Date: June 5, 2017

The purpose of this Technical Memorandum is to provide a guide detailing the Operations and Maintenance activities in association with the Tailings and Potentially Acid Generating (PAG) Material Remediation, Placement and Storage Project.

Tailings Storage Facility

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.
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.

Tailings Storage Facility (continued)

Item	Area to focus	Inspection Type and Frequency
Instrumentation	Piezometers	Vibrating wire piezometers for the embankment 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 make comparison of photos taken at different times in operational history more relevant.
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.

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.

Underdrain Collection Pond (continued)

Item	Area to focus	Inspection Type and Frequency
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.
Instrumentation	Piezometers	Vibrating wire piezometers for the 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.
	Monitoring Well	The monitoring well, located downstream of the Underdrain Collection Pond will be measured to define changes in depth to water on a monthly basis. A histogram of both depth to water and water quality in the well will be reported quarterly and as part of the Dam Safety Inspection
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 make comparison of photos taken at different times in operational history more relevant.

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. The water level measurements will be taken by dropping a cloth tape with a small weight on its lead end, down the slope of the pond. Measurements should be taken in an area that has a known elevation reference point such as the spillway sill (el 4,960 amsl). The measurement taken along the slope to the surface of the pond will be divided by a factor of 2.236 (2H:1V Pond slope) to directly compute the depth to the pond water surface. 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 quarterly.
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 of 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
Project Engineer

Reviewed by:

R. Michael Smith, P.E.
Principal

CMT/cmt

ATTACHMENT C

WATER TREATMENT PLANT DESIGN BY WATER ENGINEERING TECHNOLOGIES, INC.

Water
Engineering
Technologies, Inc.

TRENCH CAMP PROPERTY
WATER TREATMENT PLANT

ENGINEERING REPORT
AND
BADCT DEMONSTRATION

Prepared For

Arizona Minerals, Inc.

May 30, 2017

4691 Shandalyn Lane, Bozeman MT 59718 **(406) 585-7101 phone/fax**
wetsib@benowitz.net

TABLE OF CONTENTS

1.0 INTRODUCTION

This engineering report is provided by Water Engineering Technologies, Inc. (WET) to Arizona Minerals, Inc. (AMI) for the water treatment plant (WTP) located at the Trench Camp Property (Trench Camp, January Mine, and Norton Mine Claims) Project (Project) located in Santa Cruz County, AZ. This report contains sections on: WTP background; design criteria including water chemistry and flow rates; process design including a process flow diagram, process and instrumentation diagrams, mechanical equipment list, a facility general arrangement, and major equipment data sheets; and a cost estimate for capital expenditures (Capex) and annual operating expenditures (Opex).

This report is also intended to satisfy the Best Available Demonstrated Control Technology (BADCT) demonstration requirement pursuant to A.A. C R18-9-A202(A)(5) and ARS 49-243-B.1.

2.0 WTP BACKGROUND

AMI wants to engineer and install a water treatment plant capable of treating underdrain seepage and storm water runoff from a tailings storage facility (TSF) located on the Project property and water from the January Mine (Mine) workings. The flow rate from the TSF Underdrain Collection Pond (UP) is estimated to fluctuate up to a maximum of 120 gallons per minute (gpm) in reaction to monsoon rains, then fall to a minimum of less than ten gpm during extended dry periods. The flow rate from the Mine will also fluctuate up to a maximum of 120 gpm because of hydrologic influences from monsoon rains and dry periods. The maximum combined flow from both sources to the WTP will not exceed 120 gpm.

It is anticipated that treated water will be utilized for on-going mine exploration, dust control, 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. This discharge would be authorized under an AZPDES permit. The location of the proposed outfall is 31°28' 15" N 110°43'43" W.

3.0 DESIGN CRITERIA

3.1 FLOW RATES

Water sources to the WTP consist of TSF UP flow and January Mine water flow. It is understood both sources are heavily influenced by meteoric precipitation events and thus highly variable.

Several factors in addition to source flow variability must also be considered when selecting a WTP throughput value, including:

(1) water storage availability in the TSF UP;
(2) desired mine water level and drawdown resulting from mine water pumping; and
(3) WTP operation shift schedule.

AMI developed a water balance for the TSF, along with plans for installing a lined underdrain collection pond in conjunction with the TSF, so the amount of future water storage has already been determined (see Underdrain Pond Design in Section 8 of Attachment B of the Aquifer Protection Permit [APP] application). AMI has collected data that provide a good understanding of the effects of pumping and resulting drawdown of the January Mine workings, and have in place a dedicated mine water pumping system. AMI will operate the WTP on a variable shift schedule up to 24-hours per day as needed to respond to seasonal fluctuations in UP water volumes and mine water levels. Given all these factors, it was determined than a nominal WTP throughput to be used as a basis of design is 120 gpm. This flow rate will ensure the UP water level will not exceed the design water level as described in Section 5.6 of Attachment B of the APP application and that the water level in the January Mine workings will be kept below mine adit elevation. The two water sources will be combined prior to treatment, with the ratio of Mine water to UP water variable dependent on local meteorological conditions.

3.2 WATER CHEMISTRY

Water chemistry from mine water and the existing tailings seepage (worst-case surrogate for UP water) were characterized using water samples collected the week of January 9, 2017. In addition to characterizing the two separate water sources, these waters were combined in a 20:3 ratio (Mine to seep water) and characterized. Chemistries of these three water sources have been characterized and are shown in Table 3-1.

3.2.1 Water Treatability Jar Tests

Water treatability jar tests were performed using the two site waters and the combined site waters in a 20:3 ratio. This ratio of the two existing site waters was chosen as being a worst-case representation of the water chemistry of the water to be treated in the WTP before and after the UP is in place. The jar test protocol was developed using best professional judgement based on the site water chemistry and anticipated effluent requirements. Twelve different jar tests were undertaken on seep water and mixed water (mine to seep at 20:3) mimicking six different treatment processes consisting of:

- pH adjustment to 9.0
- pH adjustment to 9.0 plus aeration
- pH adjustment to 9.0 plus aeration and filtration
- pH adjustment to 10.5
- pH adjustment to 10.5 plus aeration
- pH adjustment to 10.5 plus aeration and filtration

Select results from the jar tests as well as potentially applicable Alum Gulch surface water quality standards and Aquifer Water Quality Standards (AWQS) that may be used as the basis for permit limits are shown in Table 3-1. Any discharge will be to a portion of Alum

Gulch classified as ephemeral; Table 3-1 includes aquatic and wildlife EDW standards in the event they are used as the basis for permit limits pursuant to A.A.C. R18-11-113.

Table 3-1
Water Quality and Jar Testing Results

																	Surface Water Quality Standards				
Constituent	Units	Mine Raw	Seep Raw	Mine + Seep Mixed 20:3	Seep pH 9.0	Seep pH 9.0 air	Seep pH 9.0 air + filter	Seep pH 10.5	Seep pH 10.5 air	Seep pH 10.5 air + filter	Mixed pH 9.0	Mixed pH 9.0 air	Mixed pH 9.0 air + filter	Mixed pH 10.5	Mixed pH 10.5 air	Mixed pH 10.5 air + filter	A&W (EDW) chronic (1)	A&W (EDW) acute (1)	AWQS	Partial Body Contact	Ag & Livestock Watering
Conductivity	µmhos/cm	4600	14000	6000		8100			4600			6000			5900						
Hardness	mg/L	2100	4200	2300	4000	4200	3900	1900	1800	1700	2900	3000	3000	2700	2800	2800					
Ca, Dissolved	mg/L	480	480	440	660	630	580	770	700	670	720	730	730	870	850	860					
Fe, Dissolved	mg/L	<0.0044	2.5	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.022	<0.0044	<0.022	<0.022	<0.0044	1				
Mg, Dissolved	mg/L	220	740	280	570	640	600	<3.0	19	18	280	280	280	130	160	150					
Al, Dissolved	mg/L	<0.0400	148	10.6	<0.400	<0.400	<0.40	<0.400	<0.40	<0.400	0.0701	<0.40	0.134	<0.40	<0.40	<0.40					
As, Dissolved	mg/L	0.00099	0.027	0.0030	0.00055	<0.0050	<0.0050	<0.0050	<0.00050	<0.0050	0.0010	0.00091	0.00070	<0.00050	0.00084	0.00056	0.15	0.34	0.05		
Be, Dissolved	mg/L	<0.00025	0.031	0.0045	<0.025	<0.025	<0.0025	<0.00025	<0.0025	<0.00025	<0.00025	<0.0025	<0.00025	<0.00025	<0.0025	<0.0025	0.0053	0.065	0.004		
Cd, Dissolved	mg/L	<0.00025	1.8	0.23	0.023	0.055	0.058	<0.00025	<0.00025	<0.00025	0.0080	0.010	0.011	<0.00025	0.00088	0.00064	0.00622	0.01912	0.005		
Cr, Dissolved	mg/L	0.00051	0.0027	0.00053	<0.00050	<0.0050	<0.00050	<0.0050	<0.00050	<0.0050	0.00072	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050			0.1		
Cu, Dissolved	mg/L	0.0015	2.4	0.35	0.0013	<0.0050	<0.0050	<0.0050	0.0015	<0.0050	0.00093	0.0011	0.0015	0.00075	0.00084	0.00079	0.02928	0.04962			
Mn, Dissolved	mg/L	56	1200	210	49	110	110	0.011	0.0076	0.079	96	100	100	0.30	2.2	1.4					
Ni, Dissolved	mg/L	0.062	1.2	0.23	0.028	0.034	0.034	0.047	0.026	0.041	0.051	0.059	0.060	0.040	0.051	0.056	0.16804	1.51289	0.1		
Pb, Dissolved	mg/L	<0.00050	0.015	<0.0050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.0050	<0.0050	<0.00050	<0.00050	<0.00050	0.01094	0.28085	0.05		
Se, Dissolved	mg/L	0.0022	0.073	0.0081	0.003	0.0025	0.0047	<0.0016	0.0022	0.0017	0.004	0.0029	0.0028	0.0017	0.002	0.0019			0.05		
Tl, Dissolved	mg/L	<0.00050	<0.0050	<0.0050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.0050	<0.0050	<0.0050	<0.00050	<0.00050	<0.00050	0.15	0.7	0.002		
Zn, Dissolved	mg/L	6.3	670	84	0.052	<0.40	<0.40	<0.40	<0.040	<0.40	0.071	0.060	0.057	<0.040	<0.040	<0.040	0.3793	0.3793			
Fe, Total	mg/L	21	2.5	21	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	<0.0044	0.34					
Al, Total	mg/L	<0.400	176	25.0	<2.00	<2.00	<2.00	<2.00	<0.00050	<2.00	<0.40	<0.40	0.131	<0.800	<2.00	<0.800					
As, Total	mg/L	0.048	0.029	0.054	<0.025	<0.0050	<0.025	<0.00050	<0.025	<0.025	<0.0050	<0.0050	<0.00050	<0.00050	<0.0050	<0.00050				0.28	0.2
Be, Total	mg/L	<0.0025	0.042	0.0058	<0.013	<0.013	<0.013	<0.013	<0.0025	<0.013	<0.0025	<0.00025	<0.00025	<0.0050	<0.0050	<0.0050				1.867	
Cd, Total	mg/L	0.0010	1.3	0.25	0.038	0.067	0.076	0.00052	<0.0025	0.0023	0.021	0.024	0.022	0.0035	0.0030	0.0064				0.7	0.05
Cr, Total	mg/L	<0.0050	<0.025	<0.0050	<0.025	<0.0050	<0.025	<0.025	<0.025	<0.025	<0.0050	<0.0050	0.0015	<0.010	<0.0050	0.0016					1
Cu, Total	mg/L	<0.0051	2.8	0.38	<0.025	<0.0050	<0.025	0.0068	<0.025	<0.025	0.0051	<0.0050	0.0054	0.0045	<0.0050	0.017				1.3	0.5
Mn, Total	mg/L	65	1200	200	51	98	120	0.99	1.1	1.7	110	110	100	4.5	5.2	8.0				130.667	
Ni, Total	mg/L	0.053	1.5	0.29	0.025	0.028	0.033	0.042	0.046	0.037	0.040	0.038	0.035	0.053	0.033	0.037				28	
Pb, Total	mg/L	0.0075	<0.025	0.011	<0.0050	0.00068	<0.0050	<0.0050	0.00083	<0.0050	0.0015	<0.00050	<0.00050	0.00090	<0.00050	0.0024				0.015	0.1
Se, Total	mg/L	0.0031	0.063	0.011	<0.008	0.0054	0.008	0.0017	<0.008	0.019	0.0028	0.0046	0.0019	0.0011	0.002	0.0018	0.002			4.667	0.05
Tl, Total	mg/L	<0.00050	<0.025	<0.00050	<0.0050	<0.00050	<0.0050	<0.0050	<0.00050	<0.0050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050				0.075	
Zn, Total	mg/L	6.6	680	91	<2.00	0.53	<2.00	0.58	<2.0	<2.00	0.83	0.83	0.47	0.60	<0.40	1.6				280	25
TDS	mg/L	3200	13000	4400		5800			3100			4400			4200						
SO4	mg/L	2200	8800	3100		4500			2300			3000			2900						
Notes:	(1) limits or hardness-based metals (cadmium, copper, lead, nickel, silver, zinc) are based on a hardness of 400																			

3.3 ALTERNATE DESIGNS

WET evaluated six treatment processes for the WTP to identify which would meet the discharge water quality goals. The alternatives evaluated are the same as those evaluated through the jar testing phase listed above, and briefly described below:

Reference Process. pH adjustment to 10.5 – lime is added to raw (untreated) water in a reaction tank and mixed thoroughly to raise the pH to 10.5. Water flows from the reaction tank to a clarifier where non-soluble metal hydroxides and gypsum are separated. Clarifier overflow is conveyed to a second reaction tank where acid is added so reduce the pH to less than 8.5. Clarifier underflow is de-watered for storage in the TSF.

Alternative 1. pH adjustment to 10.5 plus aeration- same as the Reference Process except air is added to the first reaction tank to oxidize metals in solution.

Alternative 2. pH adjustment to 10.5 plus aeration and filtration – same as Alternative 1, except a filter is added in-between the clarifier and the second reaction tank.

Alternative 3. pH adjustment to 9.0 – same as the Reference Process except pH is adjusted to 9.0.

Alternative 4. pH adjustment to 9.0 plus aeration – same as Alternative 1 except pH is adjusted to 9.0.

Alternative 5. pH adjustment to 9.0 plus aeration and filtration – same as Alternative 2 except pH is adjusted to 9.0.

A comparison and evaluation of the six alternatives are shown in Table 3-2 below.
Alternatives are evaluated as to:

- whether it can produce an effluent that meets the discharge standard;
- its ease of operation, rated on a scale of 1-5 with 1 being the easiest to operate and 5 being the hardest to operate;
- its maintenance requirements, rated on a scale of 1-5 with 1 being the easiest to maintain and 5 being the hardest to maintain.

Table 3-2
Treatment Process Comparison

Alternative	Meets Discharge Standard	Ease of operation	Maintenance
Reference	Yes	1	1
Alternative 1	Yes	2	2
Alternative 2	Yes	4	4
Alternative 3	No (Cd exceedance)	1	1
Alternative 4	No (Cd exceedance)	2	2
Alternative 5	No (Cd exceedance)	4	4

3.4 AQUIFER LOADING

A comparison of the jar test for mixed (ph=10.5) water quality with the water quality observed in MW-3 (see Table 5 in the body of the APP application) indicates that the proposed discharge to Alum Gulch is very similar to the existing groundwater quality in the area of the WTP. It is expected that the discharge will not adversely impact groundwater quality, nor will it result in an exceedance of an AWQS at the point of compliance.

4.0 REFERENCE DESIGN

4.1 PROCESS SUMMARY

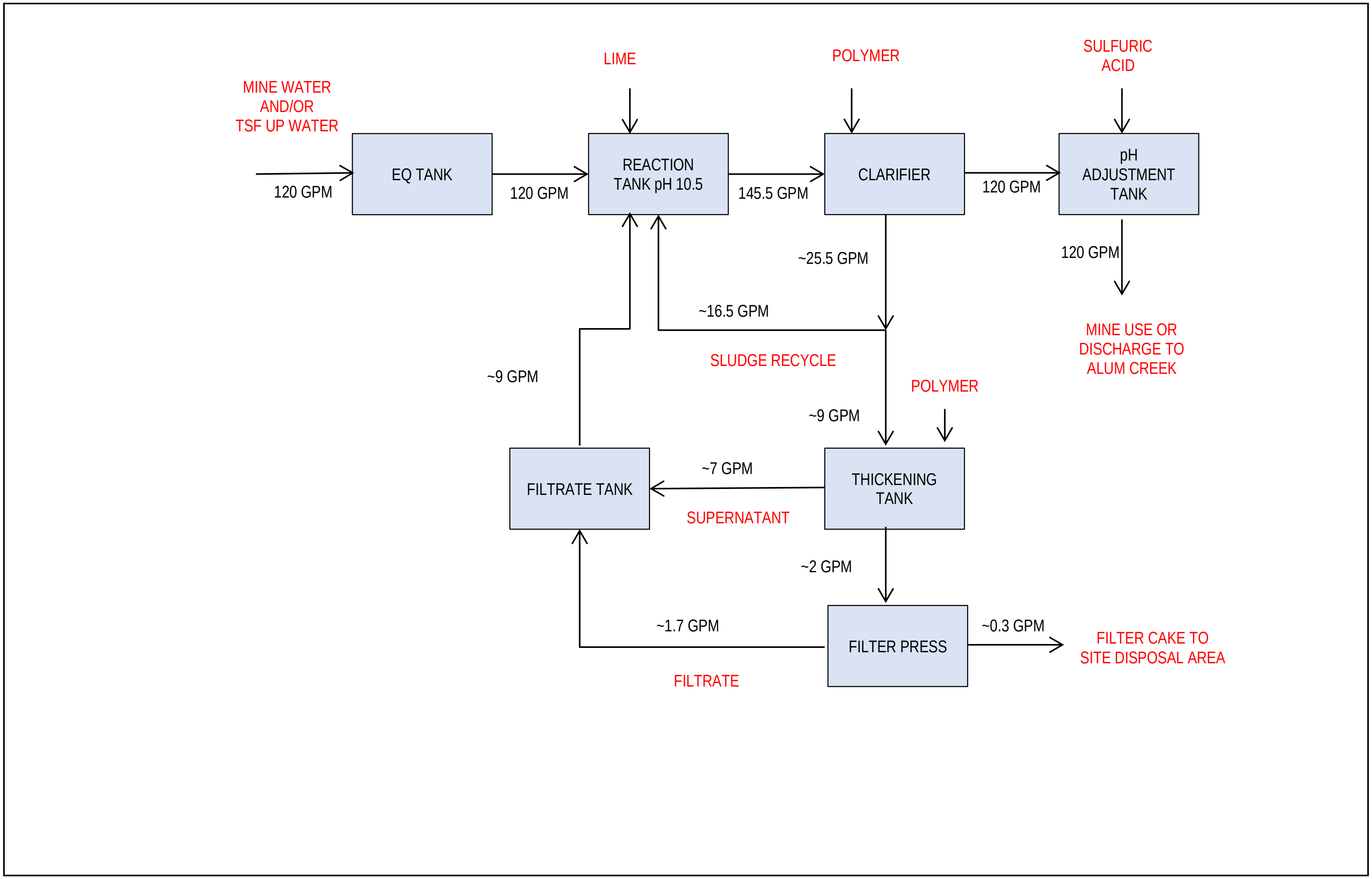
The reference treatment process for 100 percent mine water, or 100 percent UP water, or any combination of both waters for a total combined flow of 120 gpm producing effluent capable of meeting applicable surface water quality standards and AQWS consists of pH adjustment to 10.5 followed by liquid/solids separation. This process is summarized as follows:

- Mine water & UP water routed to equalization (EQ) tank.
- Water from the EQ tank is routed to a reaction tank with agitator for pH adjustment to 10.5 using hydrated lime.
- Water from the reaction tank is routed to a clarifier for liquid/solids separation. A flocculant is added to the clarifier to enhance hydroxide floc formation and settling.
- Clarifier overflow is routed to a reaction tank for pH adjustment to less than 8.5 using sulfuric acid.

- Water from the acid reaction tank is pumped back to a tank or tanks for use in exploration, dust control, or mine (mill and mine operations) for re-use, or discharge to Alum Gulch.
- Clarifier underflow sludge is primarily routed to a sludge thickening tank, with a portion of sludge recycled back to the lime reaction tank;
- Thickening tank overflow is routed back to the lime reaction tank;
- Thickening tank underflow is routed to a sludge filter press for dewatering;
- Dewatered sludge is routed to the TSF for permanent storage;

A block flow diagram (BFD) showing this treatment process is shown in Figure 4-1.

Figure 4-1


MINE WATER
AND/OR
TSF UP WATER
120 GPM
EQ TANK
120 GPM
LIME
REACTION
TANK pH 10.5
145.5 GPM
POLYMER
CLARIFIER
120 GPM
SULFURIC
ACID
pH
ADJUSTMENT
TANK
120 GPM
MINE USE OR
DISCHARGE TO
ALUM CREEK
~25.5 GPM
~16.5 GPM
SLUDGE RECYCLE
~9 GPM
POLYMER
~9 GPM
FILTRATE TANK
~7 GPM
SUPERNATANT
THICKENING
TANK
~2 GPM
~1.7 GPM
FILTRATE
FILTER PRESS
~0.3 GPM
FILTER CAKE TO
SITE DISPOSAL AREA

4.2 PROCESS DESCRIPTION

A description of the treatment process is described in the following paragraphs. Refer to the process flow diagram (PFD) and process and instrumentation diagrams (PID) in Appendix A for further information on equipment sizes, pipe sizes and materials, and instrumentation. Equipment data are found in the equipment data sheets contained in Appendix B.

EQ Tank. Mine water and UP water are pumped at a combined flow rate of 120 gpm to the 10,000-gallon equalization (EQ) tank. These waters are co-mingled in this tank then routed via gravity through a tank overflow pipe to the reaction tank. Flow rates of mine water and UP water are both measured on the inlet piping to the EQ tank.

Reaction Tank. Water from the EQ tank overflow is piped to the 4,500-gallon reaction tank for pH adjustment using hydrated lime supplied from the lime system. This tank utilizes an agitator to ensure adequate lime mixing into solution with the untreated water. The pH is adjusted to a pre-determined set point, which for the purposes of this design is assumed to be 10.5 based on the jar testing described in previous sections. The amount of hydrated lime to be added based on the jar tests is 1.0 g/l; the actual lime addition rate will be determined upon WTP startup and commissioning. The hydraulic residence time in the reaction tank is 30 minutes at the 120 gpm design flow. pH is measured using in the reaction tank. As the pH of the untreated water changes due to differing ratios of mine water to UP water, the amount of hydrated lime required to reach the pH set point will be adjusted based on the output signal from the pH probe controlling the amount of hydrated lime pumped from the lime system. pH adjusted water is routed via gravity through a tank overflow pipe to the clarifier.

Hydrated Lime System. The lime system will utilize a silo sized to store 1,700 cubic feet of hydrated lime at 35 pounds per cubic feet. The silo includes a single discharge cone providing one feed train. The system includes a dry product metering system and dilution equipment to produce a lime slurry. Fresh water from the fresh water tank is used to make up the lime slurry. The lime slurry is pumped to the reaction tank for pH adjustment. The silo system will be controlled by a PLC and will include an operator interface with local indication of conditions and alarms.

Fresh Water System. The fresh water system consists of a 2,000-gallon tank and forwarding pump. Fresh water is supplied to the tank from an on-site fresh water well. Fresh water is pumped to the lime system for dilution; Water is also pumped for use as service water in the WTP.

Flocculation System. The flocculation system consists of a chemical tote containing a liquid anionic polymer flocculant and two chemical feed pumps. Flocculant is pumped to the clarifier to assist with particle flocculation. The amount of flocculant to be added based on the jar tests is 1.0 mg/l; the actual flocculant addition rate will be determined upon WTP startup and commissioning. Flocculant is also pumped to the thickening tank to assist with thickening the solids in the tank.

Clarification. Water from the reaction tank overflow is fed to the clarifier for liquid/solids separation. Flocculant from the flocculation system is added to the clarifier center well to assist with hydroxide floc formation. As the flocs settle in the water column, an internal impeller circulates the solids within the center well to mix with incoming solids formed in the reaction tank. Solids separate in the water column within the tank and settle in the bottom of the tank. Clarified water overflows the internal weir at the top of the tank and is piped to the pH reaction tank. Sludge is formed in the clarifier as the gypsum and metal hydroxide solids formed in the reaction tank settle in the cone-shaped area of the clarifier bottom. The clarifier utilizes a slow-moving rake powered by a 1 h.p. motor to ensure the sludge continuously moves toward the center of the cone at the bottom of the clarifier. The sludge is pumped from the cone bottom to the sludge thickening tank. A portion of the pumped sludge is diverted back to the reaction tank where it mixes with the lime and untreated water. This sludge recycle helps solids formation to occur in the reaction tank as well as utilize un-reacted lime contained in the sludge.

Final pH adjustment. Clarifier overflow is routed to pH adjustment tank for pH adjustment to 8.5 using sulfuric acid. The acid will be fed from the acid feed system. A pH probe in the tank will relay a signal to the acid feed pump to regulate the acid feed rate from the chemical feed pump. Overflow from the pH adjustment tank will be routed to the mine supply pump for use at the mine site or discharged to Alum Creek.

Acid Feed System. The sulfuric acid system consists of a chemical tote containing 92% sulfuric acid, a chemical feed pump, and a secondary containment tray. The acid is pumped to the pH adjustment tank using a feed rate determined by the pH in the tank.

Mine Supply Pump. Overflow from the pH adjustment tank is piped to the mine supply pump for use at the mine. This pump is rated at 20 h.p., with a flow rate of 120 gpm. Treated water not needed for mining is diverted through a tee to the discharge pipe for discharge into Alum Creek. A sampling port and flow meter for effluent monitoring are located in-between the overflow from the pH adjustment tank and the mine supply pump / Alum Creek diversion valve tee.

Clarifier Sludge Forwarding Pump. Clarifier underflow sludge is pumped to the sludge thickening tank using an 1 h.p. centrifugal pump. The pump discharge is piped to the thickening tank, with a diversion valve in the pipe that enables some sludge to be recycled back to the reaction tank. The operator controls the amount of sludge recycle based on manual observation of solids formation in the reaction tank and subsequent settling in the clarifier. This is an iterative procedure that is undertaken as the mine water to UP water flow ratio changes. During periods of steady water ratios, the sludge recycle rate will remain constant.

Sludge Thickening Tank. Sludge from the clarifier underflow is pumped to the sludge thickening tank. This tank has a cone shaped bottom and slow-moving rake to concentrate the sludge in the tank bottom. This allows water to separate from the solids to create a supernatant which then flows out of the tank through the effluent piping. The supernatant flows by gravity to the filtrate tank. The remaining sludge is expected to be greater than approximately 5 percent solids by weight. The thickened sludge is pumped from the tank bottom to the filter press. Anionic polymer is fed to this tank from the flocculation system.

The flocculant feed rate will be optimized by the operator based on the actual sludge production rate occurring in the clarifier, but is expected to be on the order of 2-5 mg/l of clarifier sludge.

Thickened Sludge Forwarding Pump. Thickened sludge from the thickening tank is pumped to the filter press using a 0.75 h.p. progressive cavity pump. The pump operates in a non-continuous mode; that is, after the filter press completes a press cycle and is emptied the operator will manually engage this pump to remove sludge from the thickening tank and transfer it to the filter press for de-watering.

Filter Press. The 30-cubic foot (cf) filter press receives thickened sludge from the thickening tank and removes the free water from the sludge during a press run. Sludge is pumped in-between filter panels by the thickened sludge forwarding pump. The press uses pressurized air to force the water filtrate from the sludge to produce a filter cake, expected to be greater than 25 percent solids by weight. The press run is complete when the filtrate is completely removed from the solids. The filtrate flows by gravity pipe to the filtrate tank. The de-watered solids are manually removed from the filter panels by the operator. The filter cake falls from the filter panels into a collection area beneath the press. The operator removes the filter cake from the collection area using a backhoe or skid-steer type bucket for transport to the TSF. The frequency of the press run will be determined once the WTP is under operation, but is not expected to be more often than once per operating shift.

Filtrate Tank and Filtrate Pump. Supernatant from the sludge thickening tank and the filter press are routed by gravity to the filtrate tank. This tank supplies water to the 0.25 h.p. filtrate pump which transfers supernatant from the filtrate tank to the reaction tank for further treatment.

Plant Secondary Containment. The WTP process equipment and liquid chemicals are located on an engineered foundation and concrete slab. The slab utilizes a concrete perimeter curb that will contain all potential spills from process equipment. Any liquid spill that occurs will be collected and pumped back to the reaction tank for re-treatment.

4.3 PROCESS AND INSTRUMENTATION DIAGRAMS

PIDs for the entire WTP process are included in Appendix A.

4.4 FACILITY GENERAL ARRANGEMENT

The general arrangement of the WTP is shown on Sheet GA-101 in Appendix A.

4.5 MAJOR EQUIPMENT

The major equipment list is shown on Sheet MEL-101 in Appendix A.

The major equipment data are shown on Equipment Data Sheets in Appendix B.

4.6 CHEMICAL FIRST FILL REQUIREMENTS

Chemicals designated for use in the WTP include and their respective on-site storage capacities are:

- Hydrated lime – minimum 2,600 cubic feet, housed in the storage silo;
- Anionic dry polymer flocculant system - 12 lbs/day, 290-gallon tank ; and
- Sulfuric acid – 330-gallon tote with secondary containment.

4.7 SITING CONSIDERATIONS

The WTP will be constructed outside of the 100-year 24-hour storm flows at an approximate elevation of 4930 feet above mean sea level (see Appendix A Sheet C-102). It will be located uphill from the January Mine Adit, the primary influent source. Power is located nearby

As noted in the main application text, there were no identified drinking water wells identified within one-half mile, with the exception of a wildlife/stock water well (see Figure 9 in the APP application).

Seismicity and other geologic hazards are discussed in Sections 3.4 and 3.5 of the main text of this APP Application.

Potential erosion from the Alum Gulch discharge will be mitigated using erosion control measures similar to those depicted in Appendix A Sheet C-402.

4.8 OPERATIONS AND MONITORING

The WTP will be operated by State-licensed operators (names to be provided to ADEQ when available). The facility will utilize on-site operators as well as 24-hour remote monitoring capability of the process and alarm systems incorporated in the WTP.

WTP effluent will be regularly monitored utilizing a flow meter and sampling port that enables the plant operators to ensure the WTP is operating as intended, and ensure the effluent meets the appropriate -water quality standards as designated in the APP and AZPDES permits.

The plant operators will utilize operating protocols that include:

- Daily visual monitoring of reactions occurring in the reaction tank, clarifier, and pH adjustment tank;

- Continuous monitoring of the pH values in the reaction tank and pH adjustment tank utilizing process control instrumentation;

- Monitoring the flow rates of the mine water and UP water into the WTP and the flow rate leaving the WTP utilizing process control instrumentation;

- monitoring the water level in the mine and UP utilizing process control instrumentation; and

- monitoring the WTP chemical volumes retained on-site utilizing process control instrumentation and visual inspections.

The following data will be reported to ADEQ:

- Total volume of water treated: record daily, report quarterly;

- Total volume discharged to Alum Gulch: record daily, report quarterly;

- Monthly monitoring of water discharged to Alum Gulch (if none is discharged, no sampling required) will be analyzed for As, Ba, Be, Cd, Cr, F, Pb, Hg, Ni, Nitrate/Nitrite as N, Se, Tl. Metals will be analyzed as dissolved metals.

4.9 CLOSURE AND POST CLOSURE CONSIDERATIONS

At some time in the future, in concurrence with ADEQ, a passive treatment system will be constructed; whereby the water treatment plant can be decommissioned and either placed in standby or disassembled.

5.0 CONCLUSIONS

- WET evaluated six process options for water treatment of a mixture of tailings seepage and January Adit Discharge. The process selected involves pH adjustment to 10.5, liquid/solids separation, and pH adjustment to between 6.0 and 8.5

- The treated water discharge will not result in impacts to groundwater quality or result in AWQS exceedances at the point of compliance (POC).

APPENDIX A

PROCESS FLOW DIAGRAM

PROCESS AND INSTRUMENTATION DIAGRAMS

GENERAL ARRANGEMENT DIAGRAM

MECHANICAL EQUIPMENT LIST

ARIZONA MINERALS
JANUARY ADIT (NORTON MINE) VRP SITE
SANTA CRUZ COUNTY, ARIZONA
WATER TREATMENT SYSTEM

LEGAL DESCRIPTION

JANUARY & NORTON MINING CLAIMS
MINERAL SURVEYS (MS) NO.'S 745 & 929
LYING IN A PORTION OF UNSURVEYED SECTION 5, TOWNSHIP 23 SOUTH, RANGE 16 EAST, & SURVEYED SECTION 32, TOWNSHIP 22 SOUTH, RANGE 16 EAST, GILA AND SALT RIVER BASE AND MERIDIAN, SANTA CRUZ COUNTY, ARIZONA.

HARDSHELL NO. 7; JOSEPHINE; TRENCH NO. 2, TRENCH NO. 3; TRENCH NO. 4; TRENCH NO. 5; TRENCH NO. 6; TRENCH NO. 7; TRENCH NO. 8; TRENCH EXTENTION NO. 1; TRENCH EXTENTION NO. 2; TRENCH EXTENTION NO. 3; AND TRENCH EXTENTION 4 LOAD MINING CLAIMS, DESIGNATED AS SURVEY NO. 4222, BEING A PORTION OF SECTIONS 4 AND 5, TOWNSHIP 23 SOUTH, RANGE 16 EAST OF GILA AND SALT RIVER BASE AND MERIDIAN, SANTA CRUZ COUNTY, ARIZONA.

EARTHWORK QUANTITIES

SITE
CUT: 62089 CY
FILL: 1109 CY

BENCHMARK

BASIS OF ELEVATION: NE CORNER OF NORTON MINERAL CLAIM MS 929. POINT BEING A FOUND 1/2" REBAR WITH ALUMINUM CAP
ELEVATION = 4950.84 (NAVD 88)

BASIS OF BEARINGS

THE BASIS OF BEARING IS GRID, BASED ON ARIZONA STATE PLANE COORDINATES, CENTRAL ZONE NAD83. THE BASIS OF BEARING IS BETWEEN FOUND MONUMENTATION OF THE SE AND NE CORNER OF THE JANUARY MINERAL CLAIM MS 745.
BEARING BEING S 38°18'25" E.

MATERIAL QUANITIES

QTY	DESCRIPTION
1508 LF	UGE - UNDERGROUND ELECTRIC
4303 LF	3" SDR-17 HDPE
4122 LF	4" SDR-17 HDPE
308 LF	6" SDR-17 HDPE
1800 LF	6"-3" DUAL CONTAINMENT (SDR-17) HDPE
6 EA	6"-3" DUAL CONTAINMENT CLEANOUT
1 EA	6"-3" LOW POINT LEAK DETECTION STATION
128 LF	36" CMP, 14 GUAGE

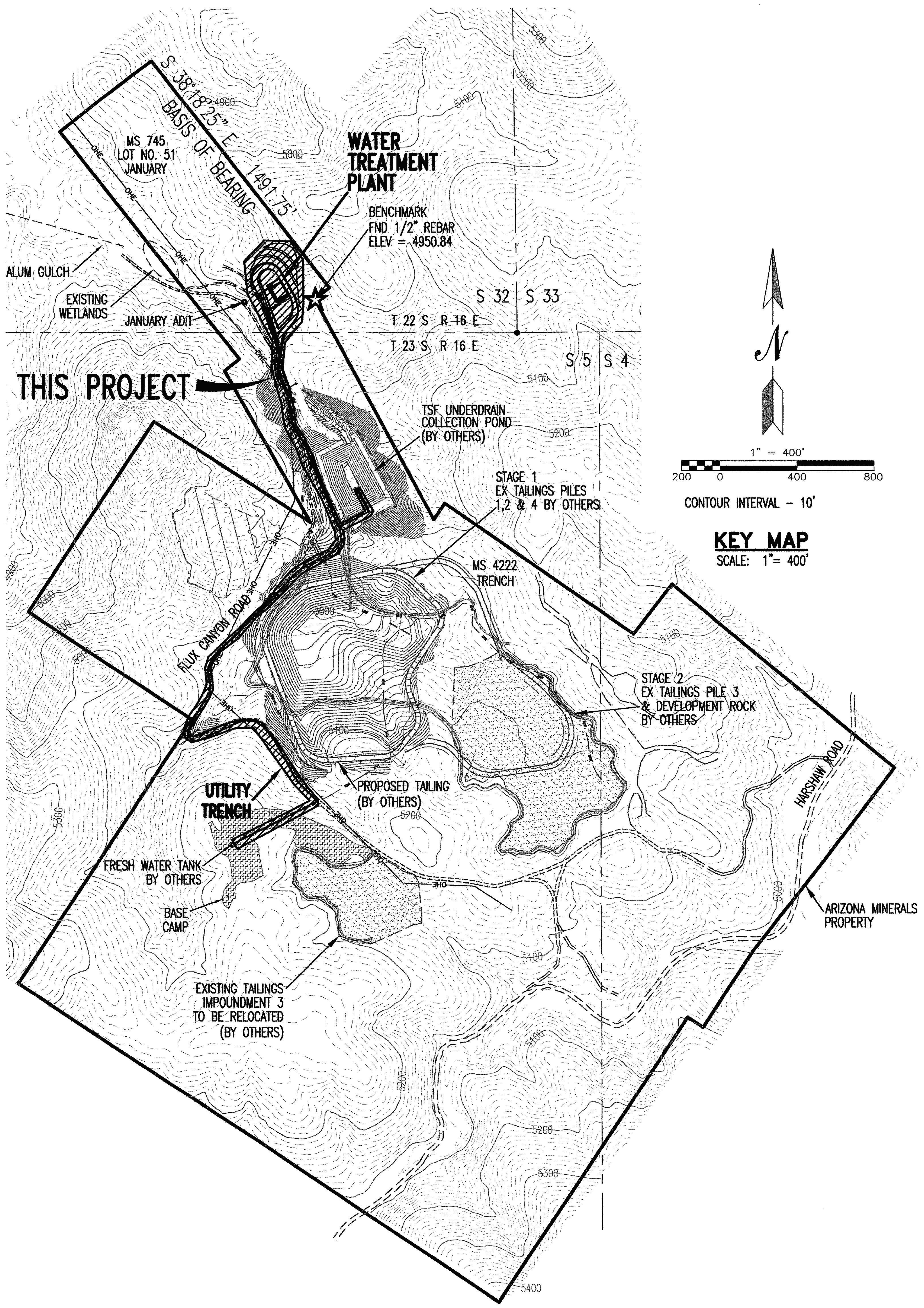
OWNER/DEVELOPER
ARIZONA MINERALS, INC.
3845 N. BUSINESS CENTER DRIVE, SUITE 115
TUCSON, ARIZONA 85705
CONTACT: JOHNNY PAPPAS
PHONE: (520) 485-1300
jpappas@arizonamining.com

CIVIL ENGINEER
CPE CONSULTANTS
3895 N. BUSINESS CENTER DRIVE, SUITE 115
TUCSON, ARIZONA 85705
CONTACT: RAUL PINA, P.E., R.L.S.
PHONE: (520) 545-7001
raul.pina@cpeconsultants.com

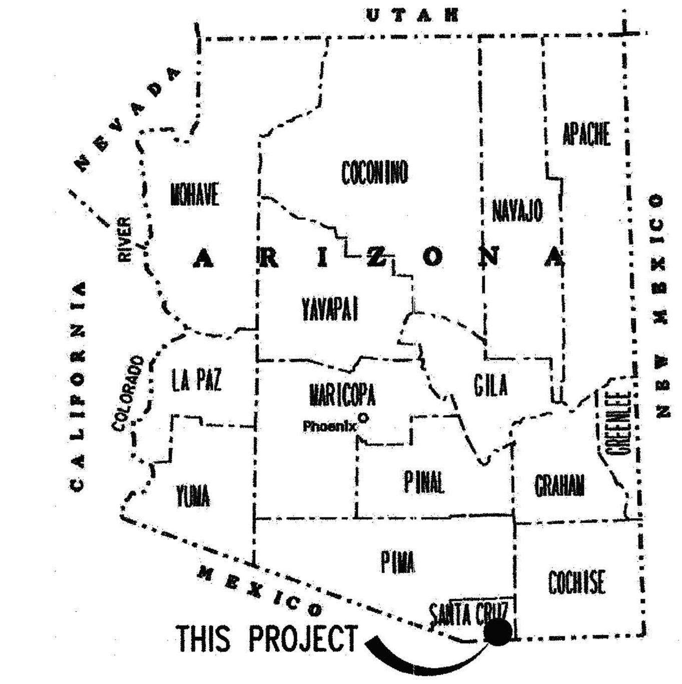
PROCESS ENGINEER
WATER ENGINEERING TECHNOLOGIES, INC.
4691 SHANDALYN LANE
BOSEMAN, MT 59718
CONTACT: SCOTT BENOWITZ, P.E.
PHONE: (406) 585-7101
wetsib@benowitz.net

ELECTRICAL ENGINEER
SGS NORTH AMERICA INC.
3845 N. BUSINESS CENTER DRIVE, SUITE 111
TUCSON, ARIZONA 85705
CONTACT: ALISTAIR RASQUINHA
PHONE: (520) 579-8315
alistair.rasquinha@sgs.com

STRUCTURAL ENGINEER
GREG GORDON and ASSOCIATES, LLC.
Structural Engineering Consultants
668 North 44th Street, Suite 223E
Phoenix, Arizona 85018
CONTACT: GREG GORDON
PHONE: (602) 95-4393
greg@greggordonandassociates.com

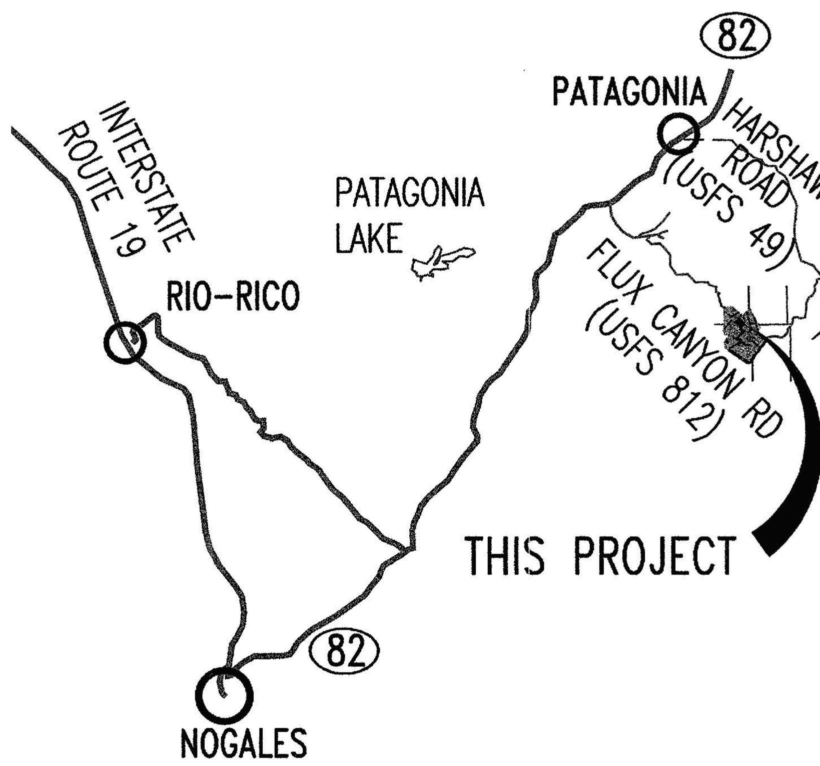


KEY MAP
SCALE: 1"= 400'



VICINITY MAP
NTS

SHEET INDEX



LOCATION MAP
NTS

AS-BUILT CERTIFICATION

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

REGISTERED ENGINEER/LAND SURVEYOR — DATE

REGISTRATION NUMBER

CPE CONSULTANTS
3895 N. Business Center Drive, Suite 115
Tucson, AZ 85705
520-545-7001

SGS

GGA GREG GORDON and ASSOCIATES, LLC.
Structural Engineering Consultants
668 North 44th Street, Suite 223E
Phoenix, AZ. 85018
PH. 602.955.4393

Water Engineering Technologies, Inc.
4691 Shandalyn Lane, Bozeman, MT 59718
406-585-7101

Contact Arizona 811 at least two full working days before you begin excavation
ARIZONA811
Call 811 or click Arizona811.com

NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
COVER SHEET
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY:
DRAWN BY: VJG LMOB
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

CPE CONSULTANTS
3895 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520-545-7001

DATE: MAY 2017
SCALE HORIZ.: AS-NOTED
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-01-COVER

SHEET: G-001
1 OF 37

100% PLANS PRINTED ON 05/15/2017

GENERAL NOTES

1. ALL WORK AND MATERIALS DESCRIBED IN THESE PLANS AND PERFORMED UNDER THIS CONTRACT SHALL BE CONSTRUCTED IN ACCORDANCE WITH MARICOPA ASSOCIATION OF GOVERNMENTS (MAG) UNIFORM SPECIFICATIONS AND STANDARD DETAILS FOR PUBLIC WORK CONSTRUCTION, 2017 EDITION (MAGSS2017 & MAGSD2017). AS SUPPLEMENTED BY SPECIAL NOTES AND SPECIFICATION CALLED OUT ON THE PLANS. WHERE INDICATED ON THE PLANS, FEDERAL, STATE AND/OR LOCAL STANDARD SPECIFICATIONS FOR ROAD AND SITE PREPARATION AND GRADING SHALL APPLY, AS NOTED.

2. THE CONTRACTOR SHALL ABIDE BY ALL LOCAL, STATE, AND FEDERAL LAWS, RULES AND REGULATIONS WHICH APPLY TO THE CONSTRUCTION OF THESE IMPROVEMENTS, INCLUDING FEDERAL, STATE AND/OR LOCAL REQUIREMENTS WITH RESPECT TO DUST CONTROL, HANDLING AND DISPOSITION OF HAZARDOUS MATERIALS, AND CONTROL OF STORMWATER DISCHARGES.

3. THE PROPERTY DIMENSIONS AND CULTURE INFORMATION SHOWN ON THESE DRAWINGS, INCLUDING THE TYPE, SIZE AND LOCATION OF EXISTING UTILITIES IS BASED ON THE BEST INFORMATION AVAILABLE TO THE OWNER, FROM THE MINERAL CLAIM SURVEYS OF RECORD. THE CONTRACTOR SHALL VERIFY ALL UTILITY LOCATIONS, CULTURE AND PROPERTY BOUNDARY, AS REQUIRED TO ENSURE THAT THE PROJECT CAN BE CONSTRUCTED PER THE APPROVED PLANS.

4. REFERENCE BASIS OF ELEVATIONS & PROJECT BENCHMARK IS THE NORTHEAST CORNER OF THE NORTON MINERAL CLAIM, MS 929, AS SHOWN ON THE PLANS. SAID BENCHMARK ELEVATION BEING 4,950.84' NAVD88. THE CONTRACTOR SHALL REFERENCE ALL ITS SURVEY TIES TO THE PROJECT BENCHMARK.

5. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL FIELD VERIFY THE HORIZONTAL AND VERTICAL LOCATIONS OF ALL POTENTIAL OBSTRUCTIONS INCLUDING ALL UNDERGROUND UTILITIES. SHOULD A CONFLICT EXIST, THE CONTRACTOR SHALL NOTIFY THE OWNER AND THE UTILITY PROVIDER, SO THAT THE CONFLICT CAN BE RESOLVED WITH A MINIMUM AMOUNT OF DELAY.

6. THE CONTRACTOR SHALL CONTACT ARIZONA BLUE STAKE (ARIZONA811, AT TELEPHONE (800) 782-5348) FOR THE LOCATION OF EXISTING UTILITIES, AT LEAST TWO (2) WORKING DAYS PRIOR TO ANY EXCAVATION.

7. A COMPLETE COPY OF ALL THE APPROVED PLANS, SPECIFICATIONS, REPORTS, FORMAL REVISIONS AND CORRESPONDING PERMITS SHALL BE KEPT IN AN EASILY ACCESSIBLE LOCATION AT THE PROJECT SITE.

8. ALL ELECTRICAL, TELEPHONE, CABLE TV, GAS AND OTHER UTILITY LINES, CABLES AND APPURTENANCES ENCOUNTERED DURING CONSTRUCTION THAT REQUIRE RELOCATION SHALL BE COORDINATED WITH THE CORRESPONDING UTILITY PROVIDER, TO DETERMINE APPROPRIATE REQUIREMENTS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF ALL NECESSARY UTILITY ADJUSTMENTS, TO THE SATISFACTION OF THE UTILITY OWNER. THE COST FOR THIS WORK IS CONSIDERED INCIDENTAL TO THE CONTRACT AND SHALL BE CONSIDERED AS INCLUDED IN THE CONTRACT UNIT PRICE FOR ONE OR MORE OF THE CONTRACT ITEMS.

9. THE CONTRACTOR MAY BE REQUIRED TO RESCHEDULE HIS ACTIVITIES TO ALLOW UTILITY CREWS TO PERFORM THEIR REQUIRED WORK, AND NO ADDITIONAL COMPENSATION WILL BE ALLOWED FOR DELAY OR INCONVENIENCES CAUSED BY UTILITY COMPANY WORK CREWS, OR UTILITY RELOCATION ACTIVITIES PERFORMED BY THE CONTRACTOR.

10. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING ALL EXISTING UTILITY LINES WITHIN THE CONSTRUCTION AREA, AT ITS SOLE EXPENSE. ANY DAMAGE TO EXISTING FACILITIES CAUSED BY CONSTRUCTION ACTIVITIES SHALL BE REPAIRED OR REPLACED TO THE FULL SATISFACTION OF THE UTILITY OWNER AND AT THE CONTRACTOR'S SOLE EXPENSE.

11. THE CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS FOR THE PROJECT PRIOR TO COMMENCING ANY CONSTRUCTION AND/OR CONSTRUCTION-RELATED ACTIVITIES (IE, BARRICADING, TOPSOIL DISTURBANCE, EXCAVATION, SWPPP, ETC).

12. THE CONTRACTOR SHALL COMPLY WITH ALL FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS CONTROLLING POLLUTION OF THE ENVIRONMENT. PRIOR TO THE START OF THE PROJECT CONSTRUCTION, THE CONTRACTOR SHALL CONTACT ALL AGENCIES RESPONSIBLE FOR AIR, NOISE, AND WATER QUALITY CONTROL REGULATIONS, TO DETERMINE THE APPROPRIATE STANDARDS WHICH ARE TO BE OBSERVED DURING CONSTRUCTION OPERATIONS. THE CONTRACTOR SHALL OBTAIN ALL PERMITS, PREPARE AND SUBMIT ALL FORMS, APPLICATIONS, AND/OR PLANS REQUIRED TO COMPLY WITH ALL FEDERAL, STATE AND LOCAL LAWS CONTROLLING POLLUTION OF THE ENVIRONMENT. THE CONTRACTOR SHALL ALSO MODIFY ALL PLANS, PERMITS, FORMS, APPLICATIONS AS REQUIRED TO DOCUMENT SITE CONDITION CHANGES, IN MAINTAIN COMPLIANCE WITH THE APPROPRIATE LAWS AND REGULATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY RECORDKEEPING AND/OR INSPECTIONS ASSOCIATED WITH THESE PERMITS, LAWS AND REGULATIONS. THE CONTRACTOR SHALL PROVIDE THE OWNER ONE ADDITIONAL COPY OF EACH REQUIRED PLAN, SUBMITTED FORM OR APPLICATION, AND ANY PLAN UPDATES AS THEY ARE SUBMITTED.

13. THE CONTRACTOR SHALL IMPLEMENT THE APPROPRIATE MEASURES AND CONTROLS THAT ENSURE STRICT COMPLIANCE WITH THE PROVISIONS OF AN APPROVED STORMWATER POLLUTION PREVENTION PLAN (SWPPP). THE CONTRACTOR SHALL MAINTAIN A COPY OF THE APPROVED SWPPP AT AN EASILY ACCESSIBLE LOCATION ON SITE.

14. TEMPORARY STORAGE OF ANY EQUIPMENT, MATERIAL OR OVERNIGHT PARKING OF CONSTRUCTION EQUIPMENT IS NOT ALLOWED IN THE SITE ACCESS ROADS NOIR IN THE PUBLIC RIGHT-OF-WAY. THE CONTRACTOR SHALL IMPLEMENT ALL MEASURES AND CONTROLS THAT ARE NECESSARY TO AT ALL TIMES PREVENT OBSTRUCTION AND/OR BLOCKAGE OF DRIVEWAYS AND/OR DESIGNATED TRAFFIC LANES. OVERNIGHT PARKING OF CONSTRUCTION VEHICLES ON PRIVATE PROPERTY IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

15. ALL ELECTRICAL WORK AND MATERIALS DESCRIBED IN THESE PLANS AND PERFORMED UNDER THIS CONTRACT SHALL BE CONSTRUCTED IN ACCORDANCE WITH APPLICABLE STANDARDS IN THE 2017 EDITION OF THE TUCSON ELECTRIC POWER COMPANY (TEP) ELECTRIC STANDARD REQUIREMENTS BOOK (TEPESR2017), AS SUPPLEMENTED BY SPECIAL NOTES AND SPECIFICATION CALLED OUT ON THE PLANS.

SWPPP NOTES

1. THE CONTRACTOR SHALL PREPARE A SWPPP ADDRESSING ALL CONSTRUCTION ACTIVITIES IN THE PROJECT, SUBMIT IT TO THE CORRESPONDING REVIEWING AGENCIES AND OBTAIN THE NECESSARY APPROVAL AND PERMITS PRIOR TO COMMENCING ANY CONSTRUCTION ACTIVITIES.

2. PRIOR TO COMMENCING LAND DISTURBING ACTIVITIES IN AREAS OTHER THAN INDICATED ON THESE PLANS (INCLUDING, BUT NOT LIMITED TO, OFF-SITE BORROW OR WASTE AREAS), THE CONTRACTOR SHALL SUBMIT A SUPPLEMENTARY SWPPP TO THE JURISDICTIONAL AGENCIES FOR REVIEW AND APPROVAL.

3. THE PLAN APPROVING AUTHORITY MUST BE NOTIFIED ONE WEEK PRIOR TO THE PRE-CONSTRUCTION CONFERENCE, ONE WEEK PRIOR TO THE COMMENCEMENT OF LAND DISTRUBING ACTIVITY, AND ONE WEEK PRIOR TO THE FINAL INSPECTION.

4. ALL EROSION AND SEDIMENT CONTROL MEASURES IN THE SWPPP ARE TO BE IMPLEMENTED PRIOR TO, OR AS THE FIRST STEP IN CONSTRUCTION.

5. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF ANY ADDITIONAL EROSION CONTROL MEASURES NECESSARY TO PREVENT EROSION AND SEDIMENTATION, AS DETERMINED BY THE APPROVING ALITHORITY.

6. ALL DISTURBED AREAS ARE TO DRAIN TO APPROVED SEDIMENT CONTROL FACILITIES ONSITE AT ALL TIMES DURING LAND DISTURBING ACTIVITIES AND DURING SITE DEVELOPMENT, UNTIL FINAL STABILIZATION IS ACHIEVED.

7. THE CONTRACTOR SHALL INSPECT ALL EROSION CONTROL MEASURES PERIODICALLY AND AFTER EACH RUNOFF.PRODUCING EVENT, IN ACCORDANCE WITH THE GUIDANCE IN THE APPROVED SWPPP DOCUMENT. ANY NECESSARY REPAIRS OR CLEANUP TO MAINTAIN THE EFFECTIVENESS OF EROSION CONTROL DEVICES SHALL BE MADE IMMEDIATELY, WITH THE APPROPRIATE LOG ENTRY IN THE SWPPP.

GRADING NOTES

1. ALL WORK RELATIVE TO SITE GRADING AND PREPARATION (IE, EXCAVATION, CLEARING AND GRUBBING, ROAD GRADING, GRAVEL INSTALLATION, ETC) SHALL BE CARRIED OUT IN CONFORMANCE WITH THE APPLICABLE SECTIONS OF MAGSS2017, AS NOTED ON THE PLANS.

2. BUILDING PAD PREPARATION AND BUILDING CONSTRUCTION SHALL CONFORM TO THE APPLICABLE SECTIONS OF THE INTERNATIONAL BUILDING CODE, 2012 EDITION (IBC2012), AS SHOWN ON THE PLANS.

3. NO GEOTECHNICAL ENGINEERING INVESTIGATION REPORT WAS PREPARED FOR THIS PROJECT. THE OWNER IS AWARE OF THIS AND ACCEPTS FULL RESPONSIBILITY. THE CONTRACTOR SHALL INVESTIGATE AND APPRISE HIMSELF OF ONSITE SOIL CONDITIONS AND INFORM THE OWNER AND THE ENGINEER ACCORDINGLY.

4. THE CONTRACTOR IS NOT AUTHORIZED TO PERFORM ANY WORK OUTSIDE OF THE PROPERTY BOUNDARIES OR CLEARING LIMITS IDENTIFIED IN THE PLANS. THE CONTRACTOR SHALL CLEARLY MARK THE PROJECT LIMITS PRIOR TO COMMENCING ANY CONTSRUC TION ACTIVITIES, AND THE MARKINGS SHALL BE MAINTAINED IN GOOD AND VISIBLE CONDITION FOR THE DURATION OF PROJECT CONSTRUCTION ACTIVITIES.

5. THE CONTRACTOR SHALL IMPLEMENT EROSION PROTECTION AND DUST CONTROL MEASURES NECESSARY FOR COMPLIANCE WITH THE CURRENT APPLICABLE ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY (ADEQ) SOIL EROSION AND DUST CONTROL REGULATIONS. DISTURBED AREAS AND LOCATIONS WITH EXPOSED SOIL SHALL BE WETTED PERIODICALLY TO PROTECT THEM FROM WIND EROSION AND/OR SEEDED WITH AN APPROVED NATURAL VEGETATIVE SEED MIX THAT RESTORES THEM TO THEIR NATURAL VEGETATED STATUS.

6. A BORROW SITE SHALL BE IDENTIFIED BY THE OWNER, AND THE CONTRACTOR SHALL VERIFY THAT IT CAN SUPPLY ACCEPTABLE FILL MATERIAL MEETING/EXCEEDING THE APPLICABLE PROVISIONS IN MAGSS2017, SECTION 211. THE OWNER WILL OBTAIN ALL THE NECESSARY GRADING AND EXCAVATION PERMITS IN ACCORDANCE WITH THE APPLICABLE LOCAL, STATE AND FEDERAL REGULATIONS.

7. DISPOSAL OF ANY EXCESS EXCAVATION SPOIL MATERIAL AND/OR UNSUITABLE MATERIAL SHALL BE AT AN APPROVED SITE/FACILITY, IN STRICT COMPLIANCE WITH ALL APPLICABLE ENVIRONMENTAL REGULATIONS. THE CONTRACTOR SHALL IDENTIFY A SUITABLE DISPOSAL SITE AND OBTAIN ALL THE NECESSARY PERMITS AND CLEARANCES FROM THE JURISDICTIONAL AGENCIES.

8. HAULING MATERIAL TO OR FROM BORROW/DISPOSAL SITES SHALL BE INCLUDED IN THE UNIT COST OF THE CORRESPONDING MATERIAL AND CONSIDERED INCIDENTAL TO THE PROJECT CONTRACT; NO SEPARATE MEASUREMENT OR PAYMENT SHALL BE MADE FOR THEM.

9. PRIOR TO WORKING ON ANY PROPOSED NEW GROUND DISTURBANCE NOT SHOWN IN THE APPROVED PLANS, THE CONTRACTOR SHALL NOTIFY THE PROJECT ENGINEER OR PROJECT MANAGER, AND OBTAIN APPROVAL OF THE REQUIRED PLAN REVISIONS.

10. PRIOR TO WORKING ON ANY ACCESS ROAD MODIFICATIONS OR ADDITIONS, REVISED PLANS MUST BE SUBMITTED TO THE PROJECT ENGINEER OR PROJECT MANAGER, AND THE REVISIONS MUST BE APPROVED BY THE CORRESPONDING AGENCIES.

11. PRIOR TO PERFORMING ANY WORK RELATED TO MODIFICATIONS OR ADDITIONS TO THE PROJECT SITE, THE APPROVED PLANS MUST BE REVISED TO REFLECT THE CHANGES, THE PROPOSED CHANGES MUST BE FIELD CHECKED BY THE PROJECT ENGINEER OR THE PROJECT MANAGER, AND THE CORRESPONDING PERMITS MUST BE UPDATED AS NEEDED PRIOR TO CONSTRUCTION.

12. ALL-WEATHER ACCESS SHALL BE MAINTAINED ON THE MAIN ACCESS ROUTE DESIGNATED BY THE OWNER WITHIN THE PROJECT SITE. TRAFFIC FLOW SHALL NOT BE OBSTRUCTED/INTERRUPTED FROM ACCESSING PUBLIC ROADS SERVING THE SITE.

13. THE OWNER SHALL IDENTIFY TO THE CONTRACTOR THOSE DRAINAGEWAYS THAT ARE SUBJECT TO CLEAN WATER ACT SECTION 404 PROVISIONS. THE CONTRACTOR SHALL CLEARLY MARK THEIR BOUNDARIES WITHIN THE PROJECT LIMITS AND AVOID ANY ACTIVITIES WITHIN THE MARKED AREAS.

PERMANENT SOIL STABILIZATION NOTES

1. ALL DISTURBED AREAS SHALL BE RESTORED TO THEIR ORIGINAL SITUATION, AS SOON AS POSSIBLE AFTER LAND DISTURBING/GRADING ACTIVITIES ARE COMPLETED. ALL RESTORED AREAS SHALL BE SEEDED AS NECESSARY, TO MEET SITE STABILIZATION REQUIREMENTS AND TO RETURN VEGETATIVE COVER TO ITS PRE-DISTURBANCE CONDITIONS.

2. RESTORED SEEDED AREAS SHALL BE PROTECTED UNTIL THE APPLIED SEED MIX HAS GERMINATED AND REACHED STABLE MATURITY. PROTECTION AND CARE OF SEEDED AREAS SHALL INCLUDE THE APPLICATION OF TEMPORARY IRRIGATION WATERING, CONTINUED UNTIL FINAL ACCEPTANCE OF THE RESTORATION WORK.

3. PRESERVING AND USING ONSITE TOPSOIL TO PROVIDE A SUITABLE GROWTH MEDIUM FOR VEGETATION USED TO STABILIZE DISTURBED AREAS IS ALLOWED, EXCEPT WHERE PRESERVATION OR IMPORTATION OF TOPSOIL IS THE MOST COST-EFFECTIVE METHOD OF PROVIDING A SUITABLE GROWTH MEDIUM.

4. LANDSCAPED AND SEEDED AREAS SHOULD BE TYPICALLY GRADED AT A 5:1 GRADIENT (AND A MAXIMUM 3:1 GRADIENT), UNLESS ADDITIONAL MEASURES ARE TAKEN TO PREVENT SLOUGHING AND EROSION.

5. OUTSIDE OF DISTURBED/GRADED AREAS, DRAINAGE FEATURES SHALL BE MAINTAINED IN THEIR NATURAL STATE AND UNOBSTRUCTED.

CULTURAL RESOUCE AND ENVIRONMENTAL NOTES

1. IF PREHISTORIC OR HISTORIC-ERA CULTURAL MATERIALS ARE ENCOUNTERED DURING CONSTRUCTION ACTIVITIES, ALL WORK IN THE IMMEDIATE VIVINITY OF THE FIND SHALL CEASE, UNTIL A QUALIFIED ARCHAEOLOGIST CAN EVALUATE THE FIND AND MAKE THE APPRPRIATE RECOMMENDATIONS. IF THE QUALIFIED ARCHAEOLOGIST DETERMINES THAT THE DISCOVERY REPRESENTS A POTENTIALLY SIGNIFICANT CULTURAL RESOURCE, ADDITIONAL INVESTIGATIONS MAY BE REQUIRED TO MITIGATE ADVERSE IMPACTS FROM PROJECT IMPLEMANTATION. CONSTRUCTION SHALL NOT RESUME UNTIL THE RESOURCE APPROPRIATE MEASURES ARE RECOMMNENDED OR THE MATERIALS ARE DETERMINED TO BE LESS THAN SIGNIFICANT.

2. IF PALEONTOLOGICAL RESORCES ARE ENCOUNTERED DURING GRADING AND SITE PREPARATION ACTIVITIES, ALL WORK IN THE IMMEDIATE VICINITY OF THE FIND SHALL CEASE UNTIL A QUALIFIED PALEONTOLOGIST CAN EVALUATE THE FIND AND MAKE THE APPROPRIATE RECOMMENDATIONS. IF THE QUALIFIED PALEONOTOLGIST DETERMINES THAT THE FOSSIL RECOVERY REPRESENTS A POTENTIALLY SIGNIFICANT PALEONTOLOGICAL RESOURCE, ADDITIONAL INVESTIGATIONS AND FOSSIL RECOVERY MAY BE REQUIRED TO MITIGATE ADVERSE IMPACTS FROM PROJECT IMPLEMENTATION. CONSTRUCTION SHALL NOT RESUME UNTIL THE RESOURCE APPROPRIATE MEASURES ARE RECOMMNENDED OR THE MATERIALS ARE DETERMINED TO BE LESS THAN SIGNIFICANT.

3. DISCOVERY DURING CONSTRUCTION OF ANY HUMAN OR UNIDENTIFIED ARTIFACTS OR OTHER UNKNOWN OBJECTS THAT ARE UNEARTHED OR OTHERWISE DISCOVERED REQUIRES CONSTRUCTION TO CEASE AND IMMEDIATE NOTIFICATION GIVEN TO THE PROJECT ENGINEER OR PROJECT MANAGER, WHO WILL CONTACT THE APPROPRIATE AUTHORITIES AND CONTACT A QUALIFIED ARCHEOLOGIST.

4. DISCOVERY DURING CONSTRUCTION OF ANY HAZARDOUS WASTE INDICATORS SUCH AS TIRES, OIL, LANDFILL WASTE, MINING WASTE ROCK OR OTHER POTENTIAL HAZARDOUS MATERIAL REQUIRES CONSTRUCTION TO CEASE AND IMMEDIATE NOTIFICATION GIVEN TO THE PROJECT ENGINEER OR PROJECT MANAGER, TO ESTABLISH CONTACT WITH THE APPROPRIATE JURISDICTIONAL AGENCIES AND AUTHORITIES, TO DETERMINE THE APPROPRIATE REMEDIAL ACTION TO BE IMNPLEMENTED.

5. ALL CONSTRUCTION ACTIVITIES WILL CEASE IMMEDIATELY, IF AN UNDOCUMENTED NATURAL RESOURCE IS ENCOUNTERED DURING CONSTRUCTION, SUCH AS MINE PORTALS, STREAMS, SPRINGS, WETILANDS, KARST FEATURES (SINKHOLES, FISSURES, CAVES), WILDLIFE HABITAT, ETC., THAT IS NOT CLEARLY MARKED IN THE APPROVED PLANS. PROJECT ENGINEER OR PROJECT MANAGER WILL BE IMMEDIATELY NOTIFIED, TO ESTABLISH CONTACT WITH THE APPROPRIATE JURISDICTIONAL AGENCIES AND AUTHORITIES, TO DETERMINE THE APPROPRIATE REMEDIAL ACTION TO BE IMPLEMENTED.

APPLICABLE CODE SPECIFICATIONS & STANDARDS:

2017 Edition of MARICOPA ASSOCIATION OF GOVERNMENTS (MAG)
UNIFORM STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION (MAGSS2017)
AND UNIFORM STANDARD DETAILS FOR PUBLIC WORKS CONSTRUCTION (MAGSD2017)

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STRUCTURAL EXCAVATION AND BACKFILL	206
BORROW EXCAVATION	210
FILL CONSTRUCTION	211
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2017 Edition of TUCSON ELECTRIC POWER COMPANY (TEP)
ELECTRIC STANDARD REQUIREMENTS BOOK (TEPESR2017)

ALL ELECTRIC EQUIPMENT AND PANELS TO BE PROVIDED WITH NEMA-4X ENCLOSURE MINIMUM.

FOR MATERIALS AND EQUIPMENT NOT LISTED IN GENERAL SPECIFICATIONS USE MANUFACTURER'S SPECIFICATIONS AND CONSULT THE ENGINEER.

Contact Arizona 811 at least two full working days before you begin excavation
ARIZONA811
Call 811 or click Arizona811.com

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
GENERAL NOTES, SPECIFICATIONS AND CLARIFICATIONS
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

Registered Professional Engineer (Civil) Certificate No. 15606 Raul Francisco G. Piña, Arizona, U.S.A. Expires 12/31/18

DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS [redacted]
3895 N. Business Center Dr. Suite 115 Tucson, AZ 85705
520-545-7001

DATE: MAY 2017
SCALE HORIZ. : N/A
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-02-GENERAL NOTES

SHEET: G-002
2 OF 37

100% PLANS PRINTED ON 05/15/2017

ABBREVIATIONS

ABBREVIATION	WORDS
A	
@	AT
AB	AGGREGATE BASE
ABC	AGGREGATE BASE COURSE
ABDN	ABANDONED
AC	ACRES
ACI	AMERICAN CONCRETE INSTITUTE
ADDL	ADDITIONAL
ADEQ	ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
ADJ	ADJACENT, ADJUSTABLE
AFF	AT FINISH FLOOR
AGG	AGGREGATE
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
ALUM	ALUMINUM
ALT	ALTERNATE
AMT	AMOUNT
ANG	ANGLE
APPROX	APPROXIMATE, APPROXIMATELY
APW	AEROBIC POLISHING WETLAND
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
ASSY	ASSEMBLY
ATS	ACTIVE TREATMENT SYSTEM
AUTO	AUTOMATIC
AUX	AUXILIARY
AVG	AVERAGE
AWWA	AMERICAN WATER WORKS ASSOCIATION
B	
BAL	BALANCE
BCR	BIOCHEMICAL REACTOR
BCSM	BRASS CAP SURVEY MONUMENT
BDRY	BOUNDARY
BF	BLIND FLANGE, BOTTOM FACE
BGN	BEGIN
BK	BACK, BOOK
BKFL	BACKFILL
BLDG	BUILDING
BM	BENCH MARK
BOR	BORROW
BOTT	BOTTOM
BP	BANK PROTECTION
BRG	BEARING
BTWN	BETWEEN
BW	BARBED WIRE
BV	BALL VALVE, BUTTERFLY VALVE
C	
C TO C	CENTER TO CENTER
C IN PL	COMPLETE IN PLACE
CALC OR (C)	CALCULATED
CAP	CAPACITY
CEM	CEMENT
CF	CUBIC FEET
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CHAN	CHANNEL
CHDPEPP	CORRUGATED HIGH-DENSITY POLYETHYLENE PLASTIC PIPE
C-I-P	CAST IN PLACE
℄	CENTER LINE
CLR	CLEAR
C/L	CHAIN LINK, CONTROL LINE
CMP	CORRUGATED METAL PIPE
CO.	COUNTY
COMP	COMPACT OR COMPACTION
CONC	CONCRETE
CONN	CONNECTION
COND	CONDUIT
CONST	CONSTRUCTION, CONSTRUCT
CONT	CONTINUOUS
COORD	COORDINATE
COR	CORNER
CORR	CORRECTION
CP	CONTROL POINTS
CPLG	COUPLING
CTR	CENTER
CTRD	CENTERED
CU	CUBIC
CULV	CULVERT
CV	CHECK VALVE
CWS	CALCULATED WATER SURFACE
CY, CU YD	CUBIC YARD OR CUBIC YARDS
D	
Δ	DELTA
DEG OR °	DEGREES
D	DEGREE OF CURVE
D	DEPTH
DA	DRAINAGE AREA
DBL	DOUBLE
DEMO	DEMOLITION
DEPT	DEPARTMENT
DG	DOWN GUY
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIP	DUCTILE IRON PIPE
DISCH	DISCHARGE
DN	DOWN
DR	DRIVE
DRN	DRAIN OR DRAINAGE
DTL	DETAIL
DWG	DRAWING
DWS	DESIGN WATER SURFACE
DWY	DRIVEWAY

ABBREVIATION	WORDS
E	
E	EAST
ELEC	ELECTRIC, ELECTRICITY
EA	EACH
ECC	ECCENTRIC
EF	EACH FACE
EG	EXISTING GRADE
EL	ELECTRICAL
ELEV	ELEVATION
ELB	ELBOW
EMB	EMBANKMENT
ENGR	ENGINEER
ENT	ENTRANCE
EP OR EOP	EDGE OF PAVEMENT
EQ	EQUATION
EQPMT	EQUIPMENT
EST	ESTIMATE
E/W	EACH WAY
EXC	EXCAVATION
EX, EXST	EXISTING
EXP	EXPOSED
EXP JT	EXPANSION JOINT
EXT	EXTEND OR EXTENSION
EXT	EXTERNAL
F	
'/FT	FEET PER FOOT
FAB	FABRICATION
FC	FLEXIBLE COUPLING
FCA	FLANGED COUPLING ADAPTER
FD	FOUND
FDN	FOUNDATION
FED	FEDERAL
F.F.E.	FINISHED FLOOR ELEVATION
FG	FINISHED GRADE
FIG.	FIGURE
FIN	FINISH
FL	FLOWLINE
FLEX	FLEXIBLE
FLG	FLANGE
FLR	FLOOR
FM	FORCE MAIN
FND	FOUND
FOW	FACE OF WALL
FPS	FEET PER SECOND
FR	FRAME
FST	FOREST
FT OR '	FOOT, FEET
FTG	FOOTING, FILLING
FURN	FURNISH OR FURNISED
FUT	FUTURE
FWD	FORWARD
G	
G	GAS
GA	GAUGE
GA	GENERAL ARRANGEMENT
GAL	GALLON
GB	GRADE BREAK
GND	GROUND
GND COMP	GROUND COMPACTION
GOV'T	GOVERNMENT
GPD	GALLONS PER DAY
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
GR	GRADE
GRB	GRUBBING
GSRM	GILA & SALT RIVER MERIDIAN
GV	GATE VALVE, GAS VALVE
H	
H, HT	HEIGHT
HDPE	HIGH DENSITY POLYETHYLENE
HDWR	HARDWARE
HGL	HYDRAULIC GRADE LINE
HGT	HEIGHT
HORIZ	HORIZONTAL
HP	HORSEPOWER
HW	HEADWATER
HWS	HIGH WATER SURFACE
I	
I	INDICATE
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
IF	INSIDE FACE
IMPR	IMPROVEMENT
IN OR "	INCH OR INCHES
INCL	INCLUDE, INCLUDED, OR INCLUSIVE
INSTM	INSTRUMENTATION
INSUL	INSULATE
INT	INTERIOR
INV	INVERT
IP	IRON PIN
J	
JT	JOINT
JCT	JUNCTION
L	
L	LEVEL, LENGTH
LAT	LATERAL
LB	POUND
LF	LINEAR FEET
LIN	LINE
LIN FT	LINEAR FEET
LOC	LOCATION

ABBREVIATION	WORDS
M	
(M)	MEASURED
MAG	MARICOPA ASSOCIATION OF GOVERNMENTS
MAINT	MAINTENANCE, MAINTAIN
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MEL	MECHANICAL EQUIPMENT LIST
MFR	MANUFACTURER
MH	MANHOLE
M&I	MUNICIPAL AND IDUSTRIAL
MI	MILE OR MILES
MIN	MINIMUM
MIW	MINE INFLUENCED WATER
'	MINUTES
MISC	MISCELLANEOUS
MJ	MECHANICAL JOINT
MO	MONTH
MOD	MODIFY OR MODIFIED
MON	MONUMENT
MRB	MANGANESE REMOVAL BED
MT	MOUNTAIN
MTD	WALL MOUNTED
MTG	MOUNTING
MTL	MATERIAL
MTL	METAL
MW	MONITORING WELL
MWS	MAXIMUM WATER SURFACE
N	
N	NORTH
N/A	NOT APPLICABLE
NATL	NATIONAL
NAD	NORTH AMERICAN DATUM
NAVD	NORHT AMERICAN VERTICAL DATUM
NE	NORTHEAST
NIC	NOT IN CONTRACT
NO	NUMBER
NOM	NOMINAL
NORM	NORMAL
NPI	NON PAY ITEM
NPT	NATIONAL PIPE TREAD
NTS	NOT TO SCALE
NW	NORTHWEST
NWS	NORMAL WATER SURFACE
O	
O&M	OPERATION & MAINTENANCE
OC	OF CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE, OVERFLOW
OH	OVERHEAD
OPNG	OPENING
OPP	OPPOSITE
ORIG	ORIGINAL
OVFL	OVERFLOW
P	
PAR	PARCEL
PE	POLYETHYLENE
PFD	PROCESS FLOW DIAGRAM
PG	PAGE
PIP	PROTECT IN PLACE
P&ID	PROCESS & INSTRUMENTATION DIAGRAM
PL	PLACE
P/L	PROPERTY LINE
POB	POINT OF BEGINNING
POE	POINT OF ENDING
PP	POWER POLE
PRELIM	PRELIMINARY
PREFAB	PREFABRICATED
PRESS	PRESSURE
PRI	PRIMARY
PRJ	PROJECT
PROP	PROPOSED
PROP	PROPERTY
PRT	PROTECTION
PRV	PROVISION OR PROVIDE
PS	PUMP STATION, PRESSURE SWITCH
PSI	POUNDS PER SQUARE INCH
PSIG	POUNDS PER SQUARE INCH, GAUGE
PSF	POUNDS PER SQUARE FOOT
PT	POINT
PV	PLUG VALVE, PRESSURE VALVE
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
Q	
Q	QUANTITY OF DRAINAGE RUNOFF, FLOW RATE (CFS)
QTY	QUANTITY OR QUANTITIES
QUAD	QUADRANT
R	
R	RANGE
(R)	RECORD
RAD	RADIUS
RB	REBAR
RC	REINFORCED CONCRETE
RD	ROAD
RDWY	ROADWAY
REBAR	REINFORCING BAR
RED	REDUCER
REF	REFER, REFERENCE
REINF	REINFORCE, REINFORCED, REINFORCING
RELOC	RELOCATE, RELOCATION OR RELOCATED
REM	REMOVE
REQD	REQUIRED
RET	RETAIN OR RETAINING
REV	REVISED OR REVISION
RT	RIGHT
RTE	ROUTE
RTN	RETURN
RWGV	RESILIENT WEDGE GATE VALVE

ABBREVIATION	WORDS
S	
S	SOUTH
SALV	SALVAGE
SB	SOIL BORING
SCHED	SCHEDULE
SD	STORM DRAIN
SDR	STANDARD DIMENSION RATIO
SE	SOUTHEAST
SEC	SECTION
SEC OR "	SECONDS
SF	SQUARE FEET
SG	SUBGRADE
SGL	SINGLE
SH	SHEET
SHLDR	SHOULDER
SHR	SHRINKAGE
SIM	SIMILAR
SK	SKEW
SL, S	SECTION LINE, SURVEY LINE
SM	SELECT MATERIAL
SP	SPACE, SPACES
SPCL	SPECIAL
SPEC	SPECIFICATIONS
SPEC'D	SPECIFIED
SPLY	SUPPLY
SQ	SQUARE
SQ FT	SQUARE FEET
SQ YD	SQUARE YARD
SR	STATE ROUTE
SST, SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
STL	STEEL
STRL	STRUCTURAL
STRUCT	STRUCTURE
SUR	SURVEY
SURF	SURFACE
SUSP	SUSPEND
SW	SOUTHWEST
SW	SWELL
SY	SQUARE YARDS
SYMM	SYMMETRICAL
T	
T	TOWNSHIP
T&B	TOP & BOTTOM
TB	THRUST BLOCK
TBM	TEMPORARY BENCH MARK
TDH	TOTAL DYNAMIC HEAD
TECH	TECHNICAL
TEMP	TEMPORARY
TF	TOP FACE
THD	THREAD
THK	THICK
THRD	THREADED
TO	TOP OF
TOP	TOP OF BANK
TOL	TOP OF LINING
TOP	TOP OF PIPE
TOPO	TOPOGRAPHY
TRANS	TRANSITION
TS	TOP OF SLOPE
TW	TOP OF WALL
TYP	TYPICAL
U	
U/G	UNDERGROUND
UBC	UNIFORM BUILDING CODE
UGND	UNDERGROUND
UNK	UNKNOWN
UNO	UNLESS NOTED OTHERWISE
USFS	UNITED STATES FOREST SERVICE
V	
VAR	VARIABLE
VERT	VERTICAL
VOL	VOLUME
W	
W	WATER, WEST
W	WIDE OR WIDTH
W/	WITH
WS	WATER STOP, WATER SURFACE
WSEL	WATER SURFACE ELEVATION
WWF	WELDED WIRE FABRIC
WV	WATER VALVE
X	
XFMR	ELECTRICAL TRANSFORMER
X-ING	CROSSING
X-SECT	CROSS SECTION
Y	
YD	YARD
YR	YEAR

PROCESS FLOW DIAGRAM LEGEND

PUMP DESIGNATIONS

- HORIZONTAL CENTRIFUGAL PUMP (M)
- SUBMERSIBLE PUMP (M)
- CHEMICAL INJECTION PUMP
- UNSPECIFIED PUMP
- ROTARY SCREW COMPRESSOR

MISC. DESIGNATIONS

- MIXER (M)
- VALVE
- MOTOR OPERATED (M)
- GRAVITY FLOW

VALVE DESIGNATIONS

- SOLENOID (S)
- GLOBE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- THREE WAY VALVE

PRESSURE RELIEF DEVICES

- PRESSURE RELEIEF (SAFETY) VALVE
- PRESSURE REDUCING REGULATOR

M — MAGNETIC FLOW METER

LINE SYMBOLS

- PRIMARY LINE SEGMENT
- ELECTRIC SIGNAL
- PNEUMATIC SIGNAL

CONTROLS

- XX — FIELD/LOCAL MOUNTED DEVICE
- XX — PANEL MOUNTED DEVICE

TAG DESCRIPTIONS

AC	AIR COMPRESSOR
AIC	ANALYSIS INDICATOR CONTROL
AS	AIR SUPPLY
CF	CHEMICAL FEED PUMP
CL	CLARIFIER
F	FLOW
FIC	FLOW INDICATOR CONTROL
FP	FILTER PRESS
P	PUMP
PL	PIPELINE
S	SCREEN
TK	TANK
V	VALVE

LEGEND

PROPOSED		EXISTING
★	BENCH MARK	
	PROPERTY LINE	
	SECTION LINE	
	UNPAVED ROAD	
5000	INDEX CONTOUR	5000
	INTERMEDIATE CONTOUR	
	FENCE	x x
	POWER/UTILITY POLE	PP
	OVERHEAD POWER LINE	OHE OHE
UGE UGE	UNDERGROUND ELECTRIC	UGE UGE
	MINE INFLUENCED WATER	MIW MIW
W DC	DUAL CONTAINMENT FORCE MAIN 6"/3"	
W 6"	OUTFALL – 6" HDPE	
W 4"	REUSE WATER MAIN – 4" HDPE	
W 3"	WELL WATER MAIN – 3" HDPE	
W 3"	FRESH WATER MAIN – 3" HDPE	
W 3"	CLEANOUT	
M	FLOW METER	
	WATER VALVE	
	CONCRETE VAULT	
	DRAINAGE PIPE CULVERT	
	RIP-RAP	
1.00%	GRADE	
	LOW POINT	
	HIGH POINT	
	STORM WATER FLOW DIRECTION	
5003.5	SPOT ELEVATION	(5000.2)
	SLOPE AND DIRECTION ARROW	
C C	GRADING LIMIT – DAYLIGHT LINE (CUT AREA)	
F F	GRADING LIMIT – DAYLIGHT LINE (FILL AREA)	
1 / C-XXX	DETAIL NUMBER/SHEET NUMBER	

INSTRUMENT IDENTIFICATION LETTERS

	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, FLAME, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USER'S CHOICE (TYPICALLY CONDUCTIVITY - ELECTRICAL)			CONTROL	CLOSED
D	USER'S CHOICE (TYPICALLY DENSITY OR SPECIFIC GRAVITY)	DIFFERENTIAL			DIVERT
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE OR GAUGING (DIMENSIONAL)		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	USER'S CHOICE (TYPICALLY MOISTURE OR HUMIDITY)	MOMENTARY			MIDDLE, INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE, RESTRICTION		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY OR HEAT DUTY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	TRANSMIT
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, UNCLASSIFIED FINAL	

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
ABBREVIATIONS AND LEGEND
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

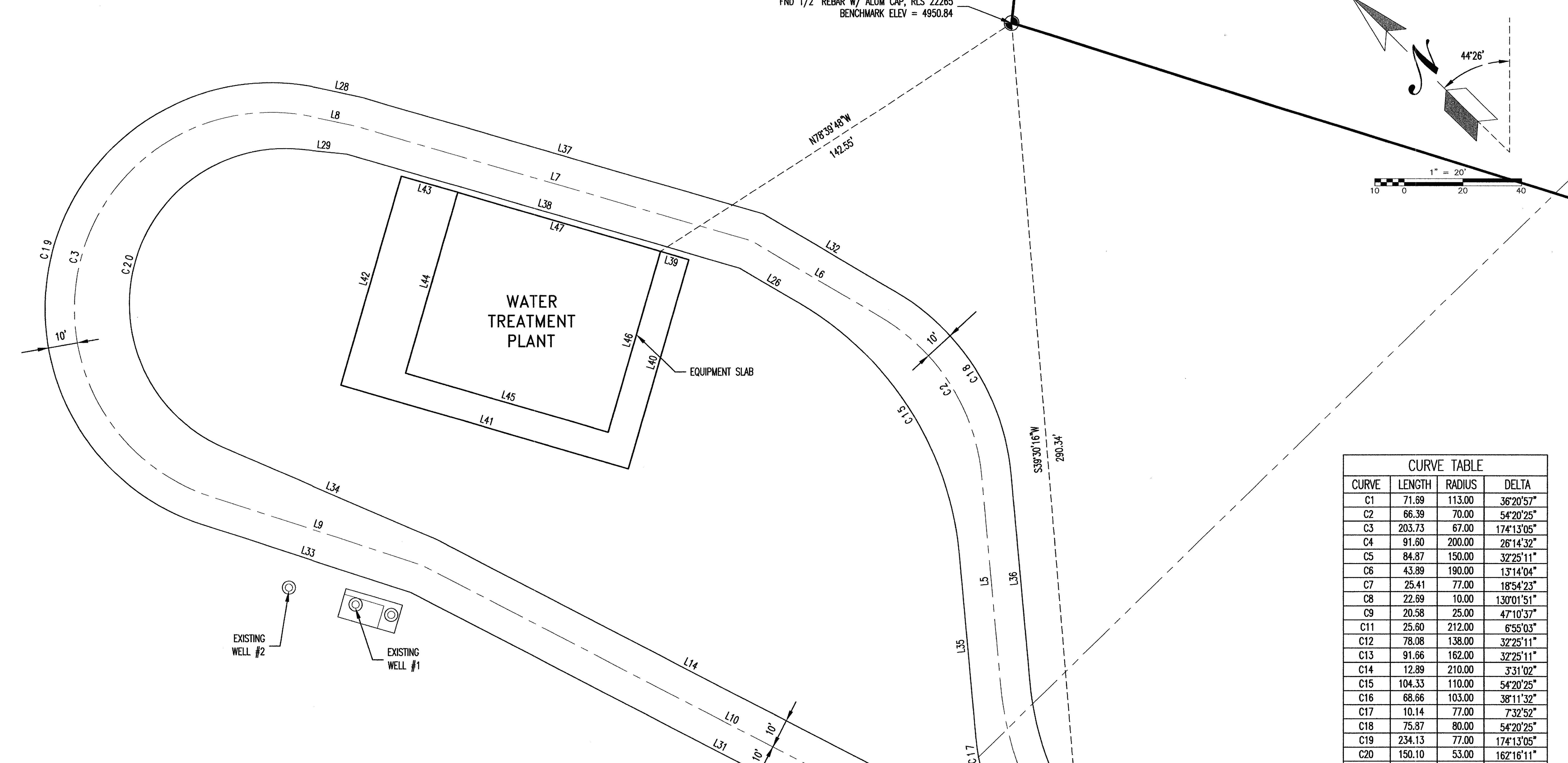
DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS
[redacted]
3895 N. Business Center Dr.
Suite 115 Tucson, AZ 85705
520-545-7001

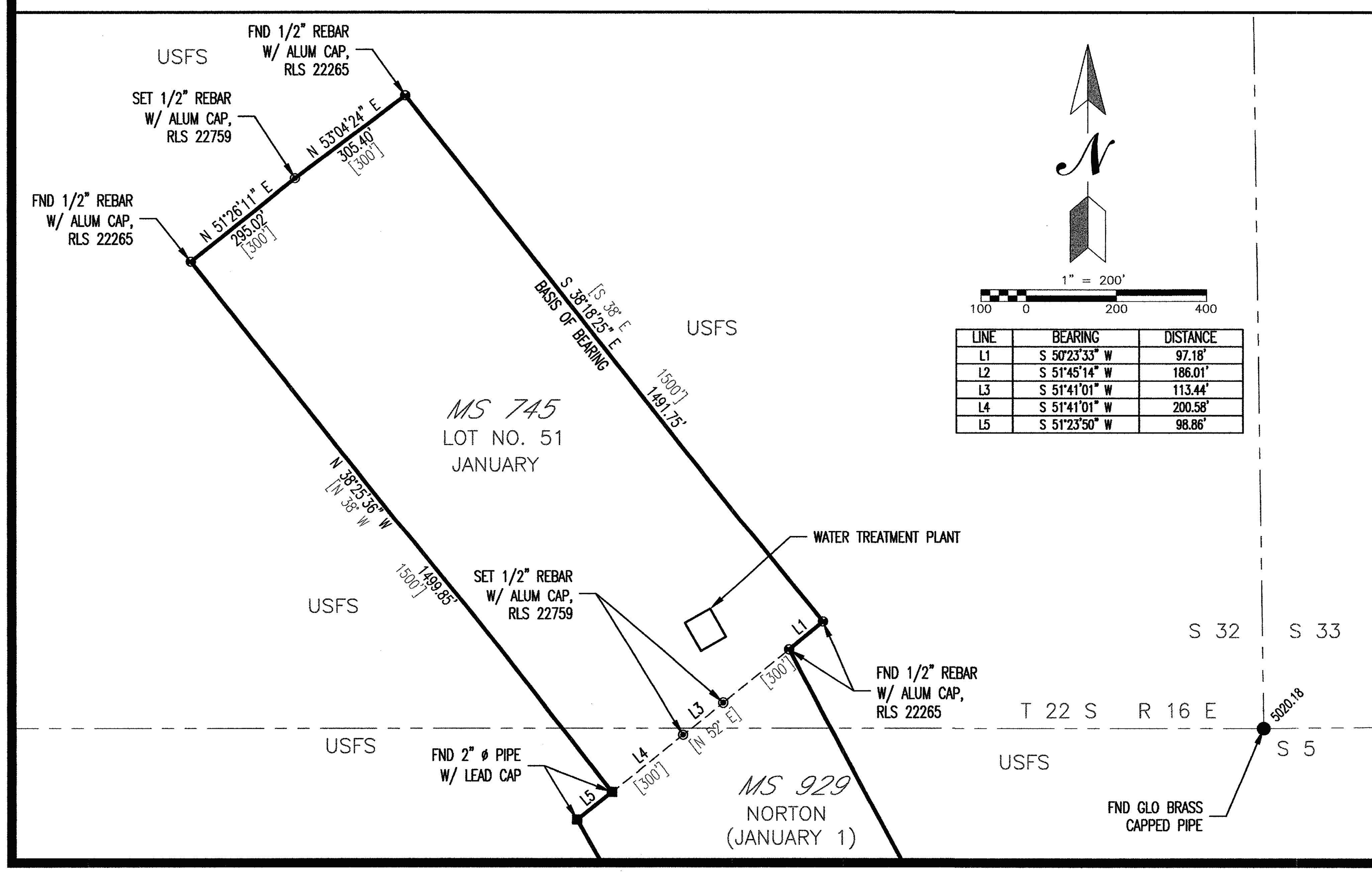
DATE: MAY 2017
SCALE HORIZ. : N/A
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-03-LEGEND

100% PLANS PRINTED ON 05/15/2017

LINE TABLE		
LINE	LENGTH	BEARING
L1	25.00	S32°58'54"E
L2	25.00	S35°25'46"E
L3	24.98	S40°04'03"E
L4	40.45	S39°22'55"E
L5	71.14	N39°04'11"E
L6	51.33	N15°16'14"W
L7	140.39	N29°34'19"W
L8	15.16	N33°37'38"W
L9	75.77	S27°50'43"E
L10	235.41	S18°26'50"E
L11	28.19	S07°47'42"W
L12	19.66	N07°47'42"E
L13	11.05	N39°22'55"W
L14	191.97	N18°26'50"W
L15	19.62	S39°22'55"E
L16	25.19	S40°04'03"E
L17	25.37	S35°25'46"E
L18	25.16	S32°58'54"E
L19	24.84	N32°58'54"W
L20	24.63	N35°25'46"W
L21	24.77	N40°04'03"W
L22	12.00	S57°21'47"W
L23	53.57	S00°52'39"W
L24	28.19	N07°47'42"E
L25	36.04	N07°47'42"E
L26	24.42	S15°16'14"E
L27	15.73	N18°26'50"W
L28	15.51	N33°37'38"W
L29	15.95	N40°09'57"W
L30	26.89	N18°26'50"W
L31	234.58	S18°26'50"E
L32	52.59	S15°16'14"E
L33	74.95	N27°50'43"W
L34	79.57	N22°26'08"W
L35	62.45	S39°04'11"W
L36	71.14	S39°04'11"W
L37	142.00	S29°34'19"E
L38	139.49	S29°34'19"E
L39	10.03	S29°34'19"E
L40	74.00	S60°25'41"W
L41	102.00	N29°34'19"W
L42	74.00	N60°25'41"E
L43	19.97	S29°34'19"E
L44	63.93	S60°25'41"W
L45	71.93	S29°34'19"E
L46	63.93	N60°25'41"E
L47	71.93	N29°34'19"W



CURVE TABLE			
CURVE	LENGTH	RADIUS	DELTA
C1	71.69	113.00	36°20'57"
C2	66.39	70.00	54°20'25"
C3	203.73	67.00	174°13'05"
C4	91.60	200.00	26°14'32"
C5	84.87	150.00	32°25'11"
C6	43.89	190.00	13°14'04"
C7	25.41	77.00	18°54'23"
C8	22.69	10.00	130°01'51"
C9	20.58	25.00	47°10'37"
C11	25.60	212.00	6°55'03"
C12	78.08	138.00	32°25'11"
C13	91.66	162.00	32°25'11"
C14	12.89	210.00	3°31'02"
C15	104.33	110.00	54°20'25"
C16	68.66	103.00	38°11'32"
C17	10.14	77.00	7°32'52"
C18	75.87	80.00	54°20'25"
C19	234.13	77.00	174°13'05"
C20	150.10	53.00	162°16'11"
C21	15.54	190.00	4°41'13"



LINE	BEARING	DISTANCE
L1	S 50°23'33" W	97.18'
L2	S 51°45'14" W	186.01'
L3	S 51°41'01" W	113.44'
L4	S 51°41'01" W	200.58'
L5	S 51°23'50" W	98.86'

LEGEND

- ● FOUND GLO BRASS CAPPED PIPE
- FOUND 2" DIAM. PIPE WITH LEAD CAP
- FOUND 1/2" DIAM. REBAR WITH ALUMINUM CAP, RLS 22265
- FOUND MOUND OF STONES, NOTHING SET
- SET 1/2" DIAM. REBAR WITH AN ALUMINUM CAP, RLS 22759 IN FOUND MOUND OF STONES
- [ ] RECORD BEARING AND OR DISTANCE, VARIOUS MINERAL SURVEYS
- ( ) RECORD BEARING AND OR DISTANCE, RLS 22265

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
HORIZONTAL CONTROL PLAN

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO. | REVISION | APPV'D | DATE

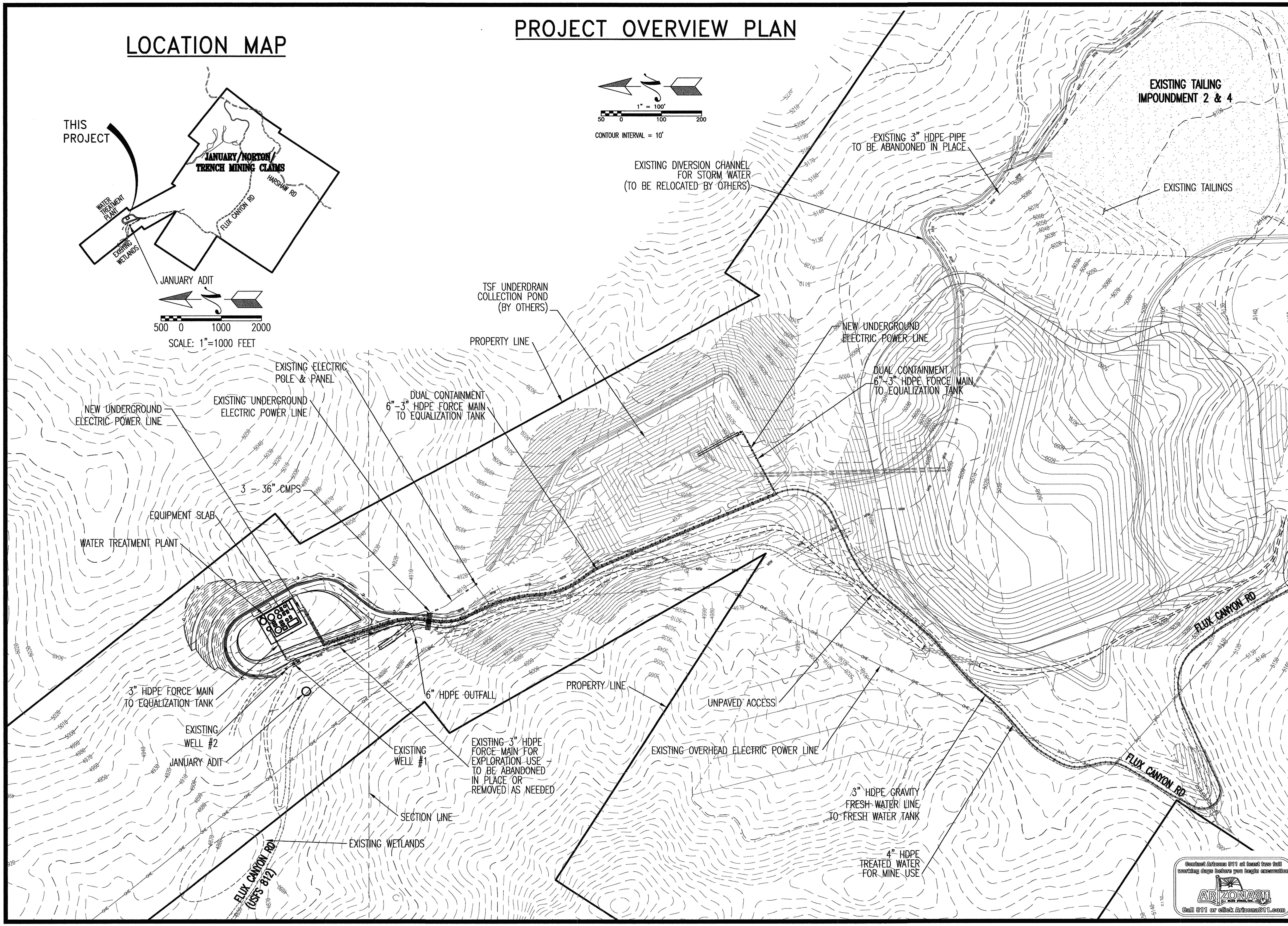
DESIGNED BY: | DRAWN BY: VG LMOB | CHK'D BY (DESIGN): | CHK'D BY (FIELD ENGR):

CPE CONSULTANTS
3865 N. Business Center Dr. Suite 115 Tucson, AZ 85705

DATE: MAY 2017
SCALE: HORIZ.: AS NOTED; VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-04-HORIZ-CTRL

SHEET: C-101
4 OF 37

100% PLANS PRINTED ON 05/15/2017



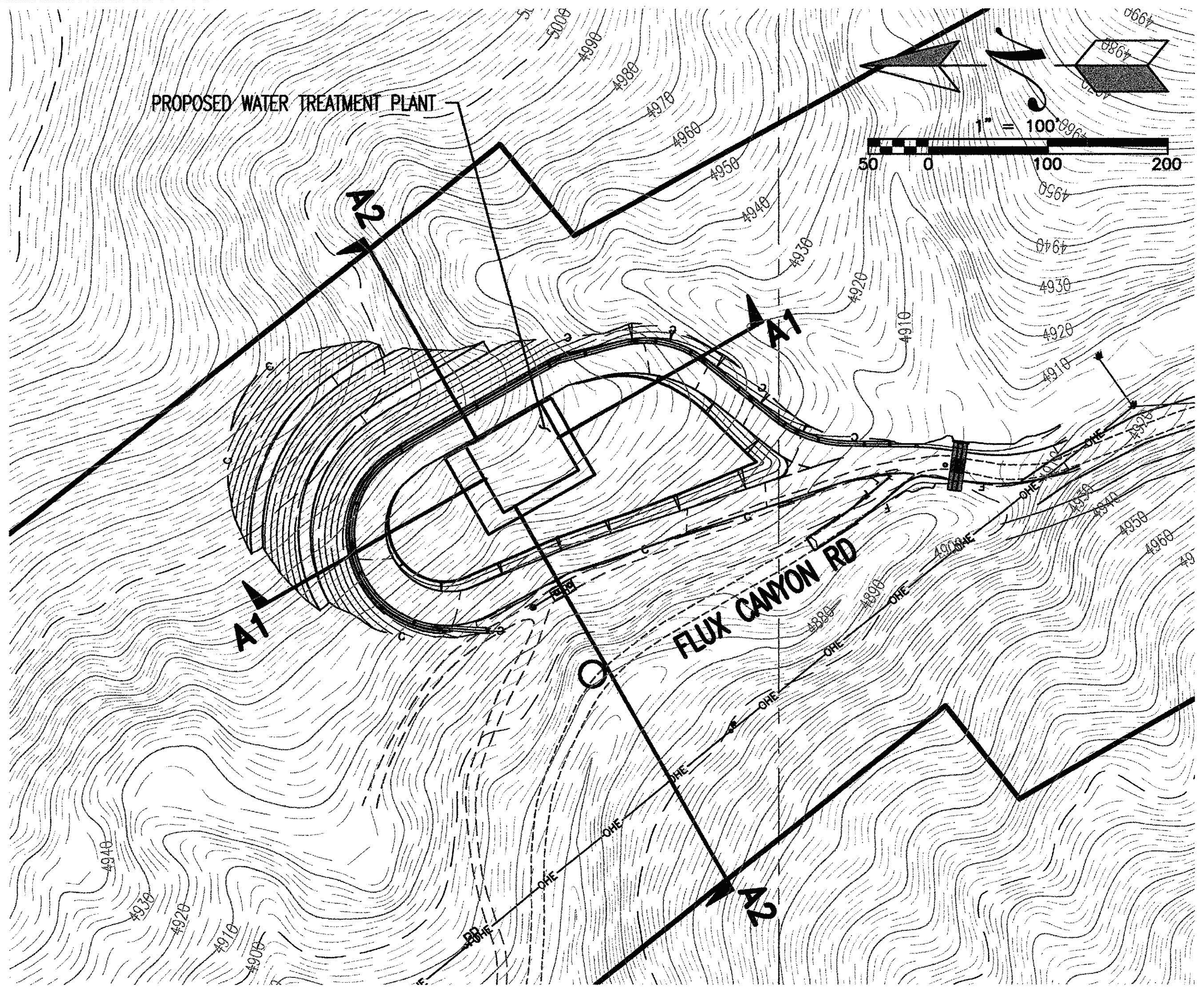
JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
PROJECT OVERVIEW
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO.	REVISION	APPV'D	DATE

CPE CONSULTANTS

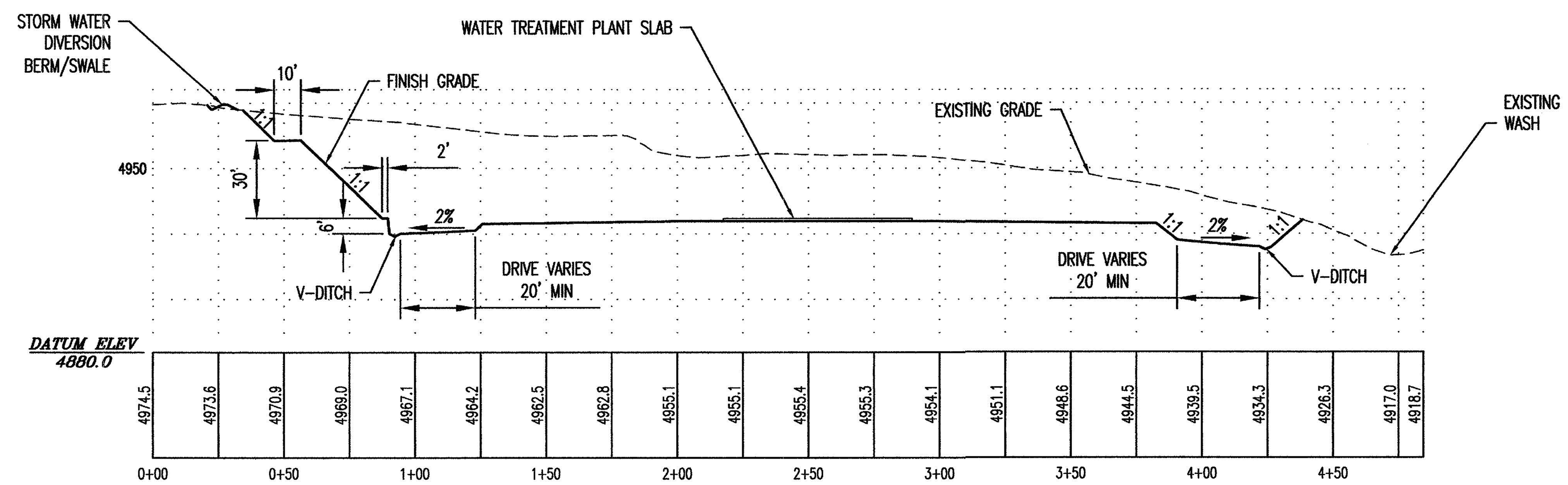
DATE: MAY 2017
HORIZ.: 1" = 100'
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-05-OVERVIEW
SHEET: C-102
5 OF 37

100% PLANS PRINTED ON 05/15/2017



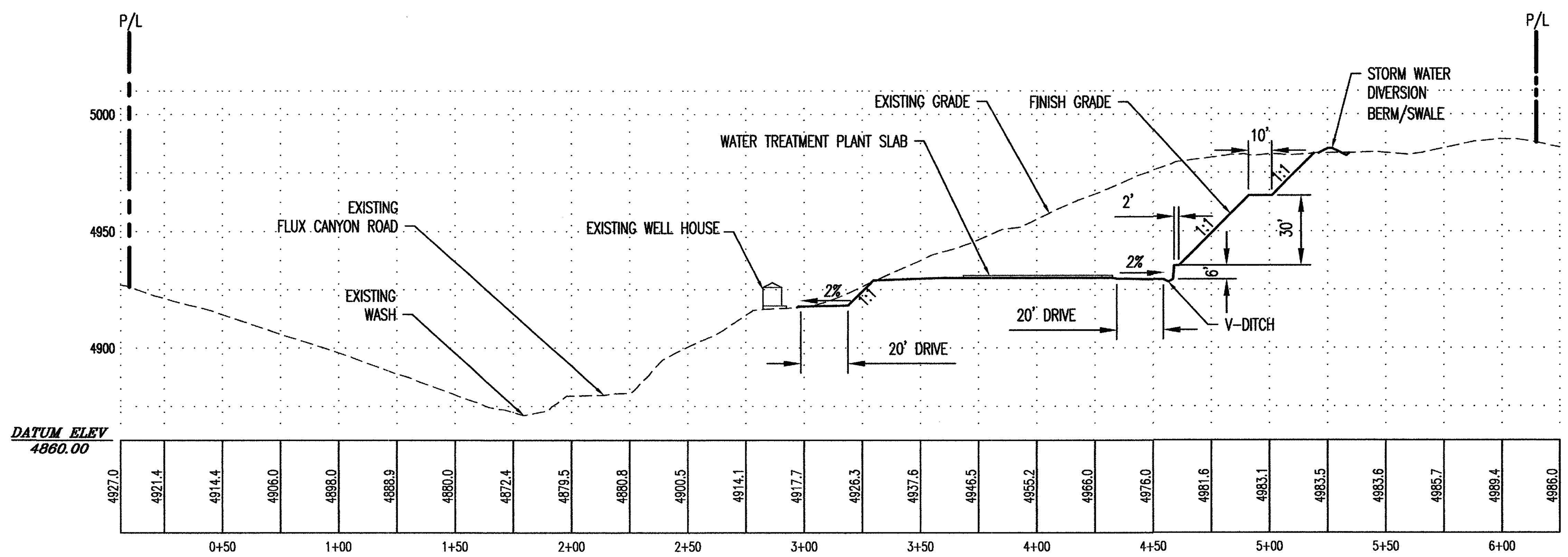
PROJECT OVERVIEW PLAN

SCALE: 1" = 100'



SECTION A1

SCALE: 1" = 40'



SECTION A2

SCALE: 1" = 40'

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
PROJECT OVERVIEW SECTIONS

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

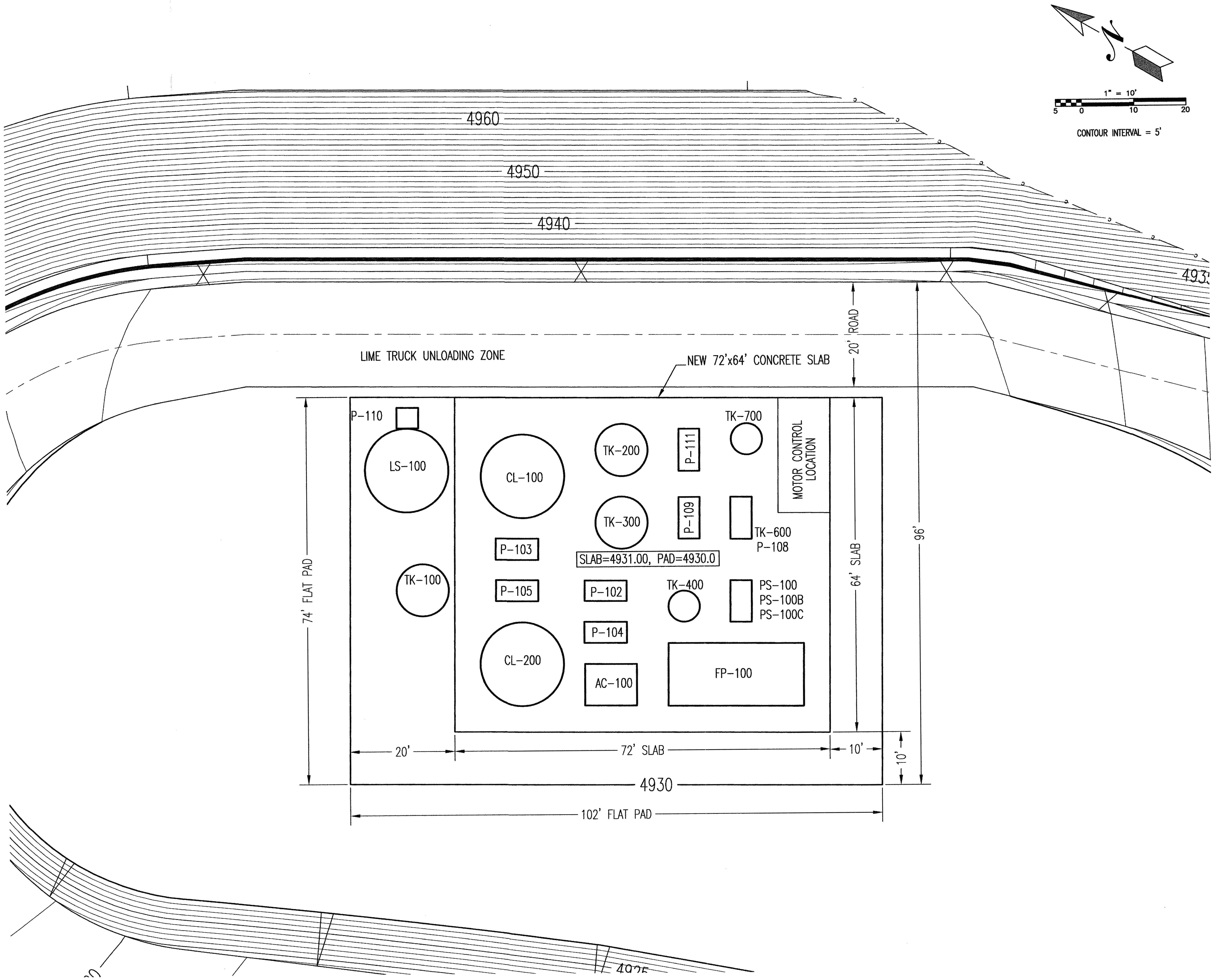
DESIGNED BY:
DRAWN BY: VG LMOB
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

CPE CONSULTANTS
3865 N. Business Center Dr. Suite 115 Tucson, AZ 85705
520-545-7001

DATE: MAY 2017
SCALE: HORIZ.: 1" = 40'
VERT.: 1" = 40'
JOB NO: 346.5
FILE NAME: 346.5-06-OVERVIEW-SECTIONS

SHEET: C-103
6 OF 37

100% PLANS PRINTED ON 05/15/2017



WATER TREATMENT PLANT
GENERAL ARRANGEMENT DIAGRAM

LEGEND

AC-100	AIR COMPRESSOR
FP-100	FILTER PRESS
CL-100	SOLIDS CONTACT CLARIFIER
CL-200	SLUDGE THICKENING TANK
LS-100	HYDRATED LIME SYSTEM
TK-100	EQUALIZATION TANK
TK-200	REACTION TANK
TK-300	pH ADJUSTMENT TANK
TK-400	FILTRATE TANK
PS-100	DRY POLYMER SYSTEM
TK-600	ACID TOTES
TK-700	FRESH WATER TANK
P-102	REACTION TANK & FORWARDING PUMP
P-103	SLUDGE PUMP
P-104	FILTER PRESS PUMP
P-105	FILTRATE PUMP
PS-100B	POLYMER FEED PUMP
PS-100C	POLYMER FEED PUMP
P-108	ACID FEED PUMP
P-109	RE-USE PUMP
P-110	LIME SLURRY PUMP
P-111	FRESH WATER PUMP

Registered Professional Engineer (Civil) — CERTIFICATE NO. 63837 SCOTT BENOWITZ — ARIZONA U.S.A. — EXPIRES: 03/31/2018

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM

WATER TREATMENT PLANT
GENERAL ARRANGEMENT DIAGRAM
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO. | REVISION | APPV'D | DATE

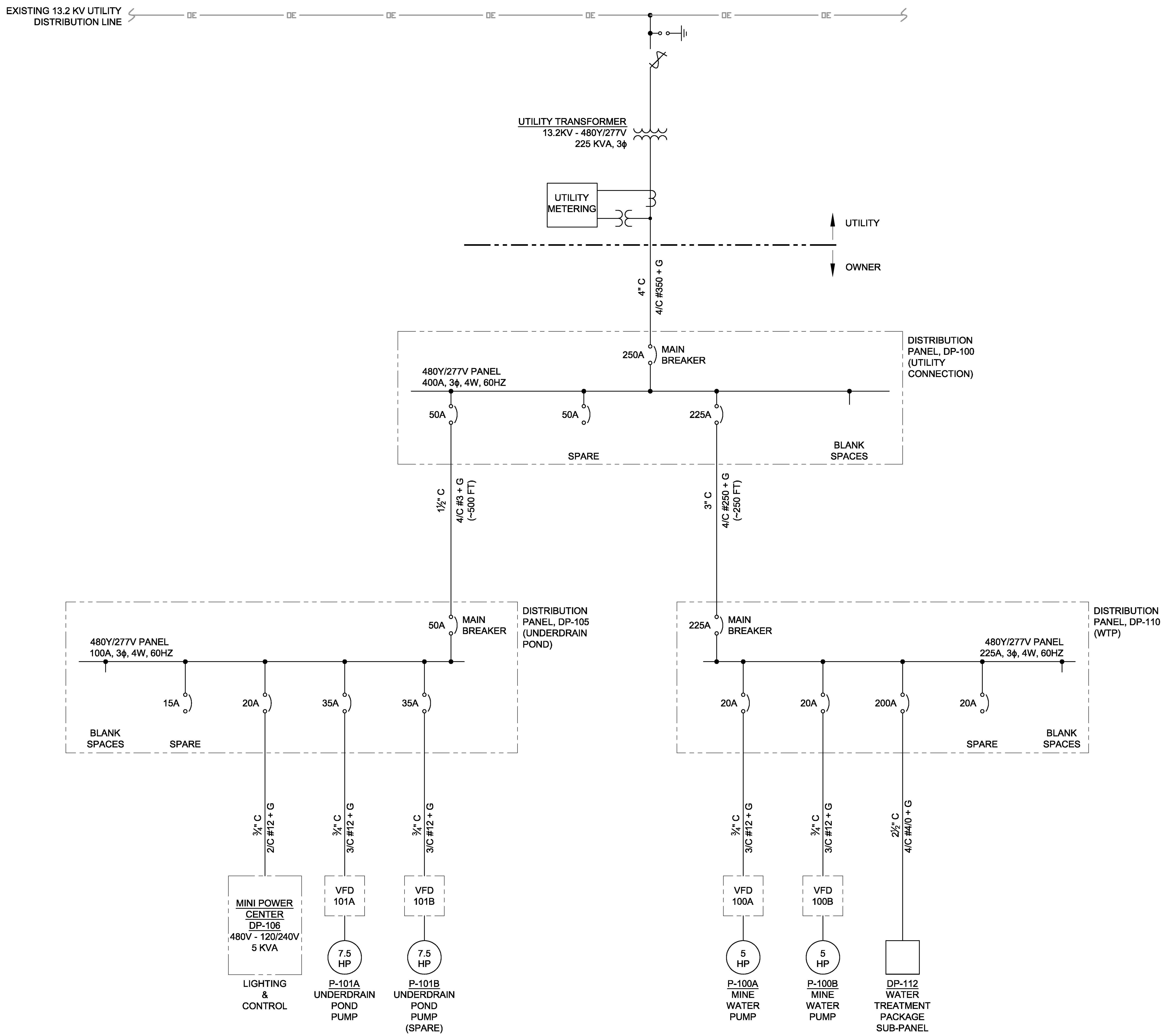
Water Engineering Technologies, Inc.

DESIGNED BY :
DRAWN BY : VIG
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

DATE: MAY 2017
SCALE HORIZ. : 1" = 10'
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-07-WTP PLANT OVERVIEW

SHEET: GA-101
7 OF 37

100% PLANS PRINTED ON 05/15/2017



NOTES:

1. ALL ELECTRICAL INSTALLATIONS SHALL CONFORM TO THE LATEST ADOPTED VERSION OF THE NATIONAL ELECTRICAL CODE (NEC) AND THE NATIONAL ELECTRIC SAFETY CODE (NFPA 70E). ALL WORK SHALL COMPLY WITH LOCAL, STATE, AND SERVING UTILITY CODE, REGULATIONS, ETC. ELECTRICAL INSTALLATIONS SHALL BE DESIGNED FOR SAFE OPERATION OF THE EQUIPMENT.
2. SCOPE OF WORK COVERED HEREIN CONSISTS OF ELECTRICAL INSTALLATIONS FOR PROCESS EQUIPMENT ONLY. ALL ITEMS NOTED HEREIN, SHOWN BY THE ELECTRICAL PLAN, OR REASONABLY TO BE INTERPRETED FROM THE PLANS NECESSARY TO COMPLETE THE ELECTRICAL SYSTEM SHALL BE PROVIDED & FIELD-INSTALLED UNDER THE WORK OF THIS SECTION, WHETHER SAME ARE SPECIFICALLY MENTIONED OR NOT.
3. COORDINATE WITH OWNER FOR REQUIRED TESTS IN CONNECTION WITH THE OPERATION OF THE EQUIPMENT. ALL TESTS SHALL BE MADE IN ACCORDANCE WITH LATEST STANDARDS OF THE NEC OR IEEE. CONTRACTOR SHALL PROVIDE ALL TESTING EQUIPMENT AND COORDINATE WITH OWNER FOR CONDUCTING TESTS. WRITTEN REPORTS SHALL BE MADE OF ALL TESTS. ALL FAULTS SHALL BE CORRECTED IMMEDIATELY.
4. FINAL ACCEPTANCE OF ALL ELECTRICAL INSTALLATIONS IS TO BE MADE AFTER THE CONTRACTOR HAS DEMONSTRATED THAT THE WORK FULFILLS THE REQUIREMENTS OF PLANS AND SPECIFICATIONS AND HAS FURNISHED ALL REQUIRED CERTIFICATES OF APPROVAL FROM STATE AUTHORITIES, MUNICIPAL AUTHORITIES AND UNDERWRITERS.
5. ALL PROCESS EQUIPMENT SHOWN IN THIS DRAWING IS BASED ON INFORMATION PROVIDED BY CPE CONSULTANTS DATED 11-MAY-2017. CONTRACTOR TO REFER TO VENDOR AND MANUFACTURER RECOMMENDATIONS FOR INSTALLING ALL EQUIPMENT.
6. INFORMATION IS PENDING ON WATER TREATMENT PACKAGE ELECTRICAL POWER REQUIREMENT. ELECTRICAL CONNECTION SHOWN IN THIS DRAWING IS FOR REFERENCE ONLY BASED ON INFORMATION PROVIDED BY CPE AND IS TO BE UPDATED UPON RECEIVING CERTIFIED INFORMATION.
7. ALL MATERIALS FURNISHED SHALL BE NEW AND SHALL BE UL LABELLED.
8. UTILITY INFORMATION, INCLUDING EXISTING OVERHEAD DISTRIBUTION LINE & NEW TRANSFORMER IS SHOWN FOR REFERENCE ONLY. CONTRACTOR TO COORDINATE WITH UTILITY FOR FINAL INSTALLATION OF UTILITY CONNECTION.
9. CONTRACTOR TO FIELD VERIFY EXISTING UTILITY CONNECTION RATED AT 230V, 200A, 3ϕ AND DISTRIBUTION. REMOVE EXISTING FEEDER FROM PANEL TO WELL #1 PUMP (P-100A). COORDINATE WITH OWNER FOR EXISTING WELL OPERATIONS TO REMAIN DURING CONSTRUCTION. COORDINATE WITH OWNER FOR REUSE OR DISPOSAL OF EXISTING FEEDER.
10. PANELBOARD INFO:
    - 10.a. DP-100: EATON PRL2a, 400A, 480Y/277V, 24 CKT, NEMA 3R 'OR' EQUAL
    - 10.b. DP-105: EATON PRL2a, 100A, 480Y/277V, 18 CKT, NEMA 3R 'OR' EQUAL
    - 10.c. DP-106: EATON P48G11S05CUB, 18 CKT, NEMA 3R 'OR' EQUAL
    - 10.d. DP-110: EATON PRL2a, 225A, 480Y/277V, 24 CKT, NEMA 3R 'OR' EQUAL
    - 10.e. DP-111: EATON P48G28T15CUB, 18 CKT, NEMA 3R 'OR' EQUAL
    - 10.f. DP-112: WATER TREATMENT SUB-PANEL (BY VENDOR).
11. VFD INFO:
    - 11.a. VFD-100A,B: GRUNDFOS CUE 91136883 + FILTER 96754976
    - 11.b. VFD-101A,B: GRUNDFOS CUE 91136884 + FILTER 96754976

(Seal: CERTIFICATE NO. 33902 THOMAS J. MOLL, ARIZONA, U.S.A., 5/15/17, EXPIRES: 9-30-17)

APPROVED
FOR CONSTRUCTION

REFERENCE DRAWINGS: DRAWING No.	REFERENCE
-	-

No.	BY/DATE	CKD/DATE	APP'D/DATE	DESCRIPTION
0	AR/15MAY17	TM/15MAY17	RP/15MAY17	FOR APPROVAL

REV. No.	PRINT RECORD
ISSUED	0
INTERNAL	15MAY17
CLIENT	15MAY17
VENDOR	
FIELD	

DRAWN	A. RASQUINHA	10APR17
CHECKED	T. MOLL	15MAY17
JOB COORD.	A. RASQUINHA	15MAY17
DEPT. HD.	A. RASQUINHA	15MAY17
MGR. ENG.	J. HOLLEY	15MAY17
PROJECT	A. RASQUINHA	15MAY17
CLIENT	R. PINA	15MAY17

CLIENT
ARIZONA MINERALS INC.
JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
PATAGONIA, AZ.

SGS
SGS North America Inc.
Tucson Arizona

DRAWING TITLE
ELECTRICAL
SINGLE LINE DIAGRAM

PROJECT No.	490-04	DRAWING No.	REV. No.
SCALE	NONE	66-EL-001	0
DATE	15MAY17		

INSTRUMENT NUMBERING

LIT – XXX
- SEQUENCE (XXX)
- FUNCTIONAL INDENTIFICATION (LIT)

IDENTIFICATION LETTERS FOR FORMING INSTRUMENT OR FUNCTION IDENTIFICATIONS

	FIRST LETTER		SUCCEEDING LETTERS		
LETTER	MEASURED OR INITIATING VARIABLES	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION				
C	CONDUCTIVITY			CONTROL	CLOSE
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE (ELECTRICAL)		SENSOR (PRIMARY ELEMENT)		
F	FLOW	RATIO	FREQUENCY		
G	GAUGE		GLASS VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATOR		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE			
L	LEVEL		LIGHT		LOW
M	HUMIDITY		MONITOR		MIDDLE, INTERMEDIATE
N	VIBRATION				
O	TORQUE		ORFICE	OPERATOR	OPEN
P	PRESSURE, VACUUM		POINT, (TEST)		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIOACTIVITY		RECORDER		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VISCOSITY			VALVE	
W	WEIGHT, FORCE		WELL		
X	UNCLASSIFIED		EXTRACTOR	UNCLASSIFIED	
Y	EVENT, STATE OR PRESENCE			RELAY, COMPUTE, CONVERT	
Z	POSITION, DIMENSION			DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

INSTRUMENT SYMBOL

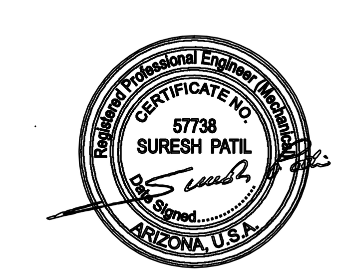
- INSTRUMENT, LOCAL MOUNTED
- INSTRUMENT FUNCTION ACCESSIBLE FROM OPERATOR CONSOLE
- I — INSTRUMENT INTERLOCK
- PLC — PROGRAMMABLE LOGIC CONTROLLER
- I/P — CURRENT TO PNEUMATIC CONVERTER
- VFD — VARIABLE FREQUENCY DRIVE

EQUIPMENT DESIGNATION

CODE	DESCRIPTION
P	- PROCESS PUMP
TK	- TANK

LINE DESIGNATION

- PROCESS FLOW
- EXISTING PROCESS FLOW
- BYPASS PROCESS FLOW
- EXISTING BYPASS PROCESS FLOW
- INTERMITTENT FLOW
- EXISTING INTERMITTENT FLOW
- DEDICATED ELECTRICAL SIGNAL
- EXISTING DEDICATED ELECTRICAL SIGNAL
- DATA LINK
- EXISTING DATA LINK



EXPIRES 06/30/2017

APPROVED
FOR CONSTRUCTION

REFERENCE DRAWINGS

DRAWING No.	REFERENCE

REVISIONS

No.	BY/DATE	CKD/DATE	APP'D/DATE	DESCRIPTION
0	AR/15MAY17	SP/15MAY17	RP/15MAY17	APPROVED FOR CONSTRUCTION

REV. No.	PRINT RECORD					
ISSUED	0					
INTERNAL	15MAY17					
CLIENT	15MAY17					
VENDOR						
FIELD						

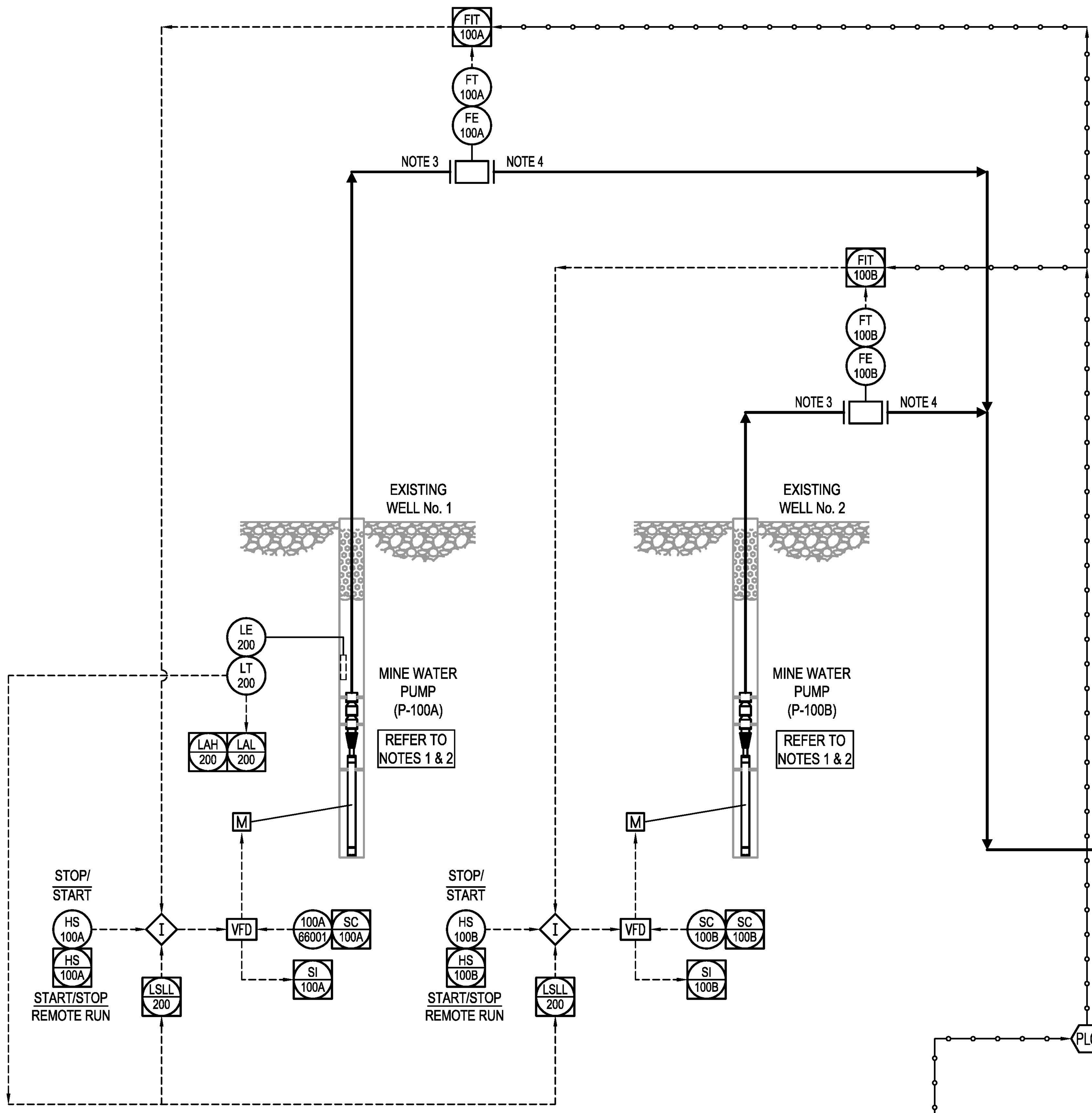
DRAWN	A. RASQUINHA	26APR17
CHECKED	S. PATIL	15MAY17
JOB COORD.	A. RASQUINHA	15MAY17
DEPT. HD.	S. PATIL	15MAY17
MGR. ENG.	J. HOLLEY	15MAY17
PROJECT	A. RASQUINHA	15MAY17
CLIENT	R. PINA	15MAY17

CLIENT
ARIZONA MINERALS INC.
JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
PATAGONIA, AZ.

SGS
SGS North America Inc.
Tucson Arizona

DRAWING TITLE
P&ID
SYMBOLS & DESIGNATIONS
INDEX

PROJECT No. 490-04
SCALE AS NOTED
DATE 15MAY17
DRAWING No. 66-PD-001
REV. No. 0

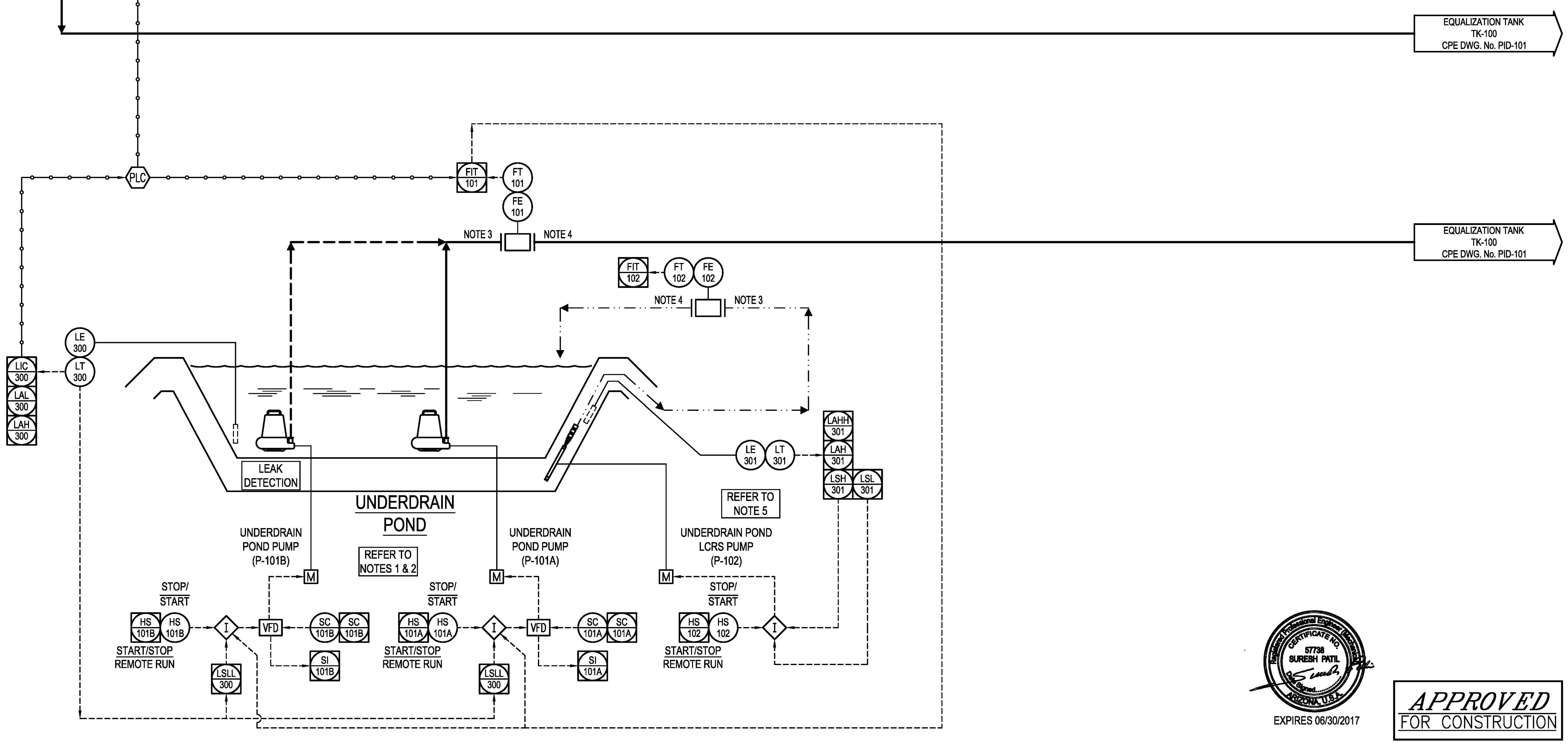


UNDERDRAIN POND AND JANUARY ADIT PUMPING SEQUENCING

UNDERDRAIN POND PUMPING							
DEPTH OF WATER, FT	VOLUME AT DEPTH, GAL	PUMP FLOWRATE, GPM	HOURS OF SAFE OPERATION BEFORE SHUT-OFF (LOW LEVEL)	DAYS OF SAFE OPERATION BEFORE SHUT-OFF (LOW LEVEL)	ALARM STATUS	JANUARY ADIT PUMPING FLOWRATE, GPM	WATER TREATMENT PLANT PRODUCTION, GPM
0	0					120	**120**
4	15,388					120	**120**
5	48,817	PUMP OFF	LOW LEVEL SHUT-OFF		LSLL	120	**120**
6	106,065	0-60	16	1		0-120	**120**
7	171,931	0-60	34	1		0-120	**120**
8	244,595	0-60	54	2		0-120	**120**
9	324,293	0-60	77	3	LAL	0-120	**120**
10	411,261	120	50	2		0	**120**
15	963,390	120	127	5		0	**120**
20	1,723,099	120	233	10		0	**120**
25	2,738,863	120	374	16		0	**120**
30	4,030,631	120	553	23		0	**120**
35	5,627,863	120	775	32		0	**120**
40	7,559,933	120	1,043	43		0	**120**
43 MAX Storage	8,892,242	120	1,228	51	LAH	0	**120**
45 OVERFLOW	9,923,304	120	1,371	57		0	**120**

NOTES:

1. INFORMATION SHOWN IN THIS DRAWING IS USED AS THE BASIS FOR INSTRUMENTATION AND CONTROL DESIGN FOR WELL PUMPS (P-100A, P-100B) AND POND PUMPS (P-101A, P-101B) ONLY. SEE NOTE 2.
2. ALL PROCESS AND MECHANICAL INFORMATION, INCLUDING PUMPS, PIPING, FLOWRATE, OPERATIONAL PHILOSOPHY, VALVES AND PRESSURE GAUGES IS DESIGNED BY CPE CONSULTANTS (CPE) AND WATER ENGINEERING TECHNOLOGIES INC. REFER TO PFD-101 AND PID-101. INFORMATION IN THIS DRAWING IS BASED ON LATEST DRAWINGS PROVIDED BY CPE VIA EMAIL DATED 12-MAY-2017.
3. MINIMUM 5 PIPE DIAMETERS STRAIGHT RUN (UPSTREAM).
4. MINIMUM 2 PIPE DIAMETERS STRAIGHT RUN (DOWNSTREAM).
5. LEAK DETECTION SHOWN IN THIS DRAWING IS DESIGNED BY NEWFIELDS. REFER TO NEWFIELDS DRAWING (DWG #A420 - REV 'B' - DATED 31-MAR-2017) FOR DETAILS. PUMP INFORMATION PROVIDED BY CPE VIA EMAIL, DATED 09-MAY-2017.
6. PUMPING SEQUENCE FROM UNDERDRAIN POND AND JANUARY ADIT WELL PUMPS SHOWN IN THIS DRAWING IS PROVIDED BY CPE. INFORMATION SHOWN IN FOR REFERENCE ONLY. CONTRACTOR TO FIELD-ADJUST LEVEL REQUIREMENTS FOR POND AND WELLS PER DIRECTION FROM OWNER. PUMP SHALL NOT BE OPERATED BELOW MINIMUM FLOW RATE RECOMMENDED BY MANUFACTURER.
7. REFER TO CPE DOCUMENTS FOR INSTRUMENT AND VFD DETAILS.



DRAWING No.	REFERENCE
-	-

REFERENCE DRAWINGS

No.	BY/DATE	CKD/DATE	APP'D/DATE	DESCRIPTION
0	AR/15MAY17	SP/15MAY17	RP/15MAY17	APPROVED FOR CONSTRUCTION

REVISIONS

REV. No.	PRINT RECORD
ISSUED	0
INTERNAL	15MAY17
CLIENT	15MAY17
VENDOR	
FIELD	

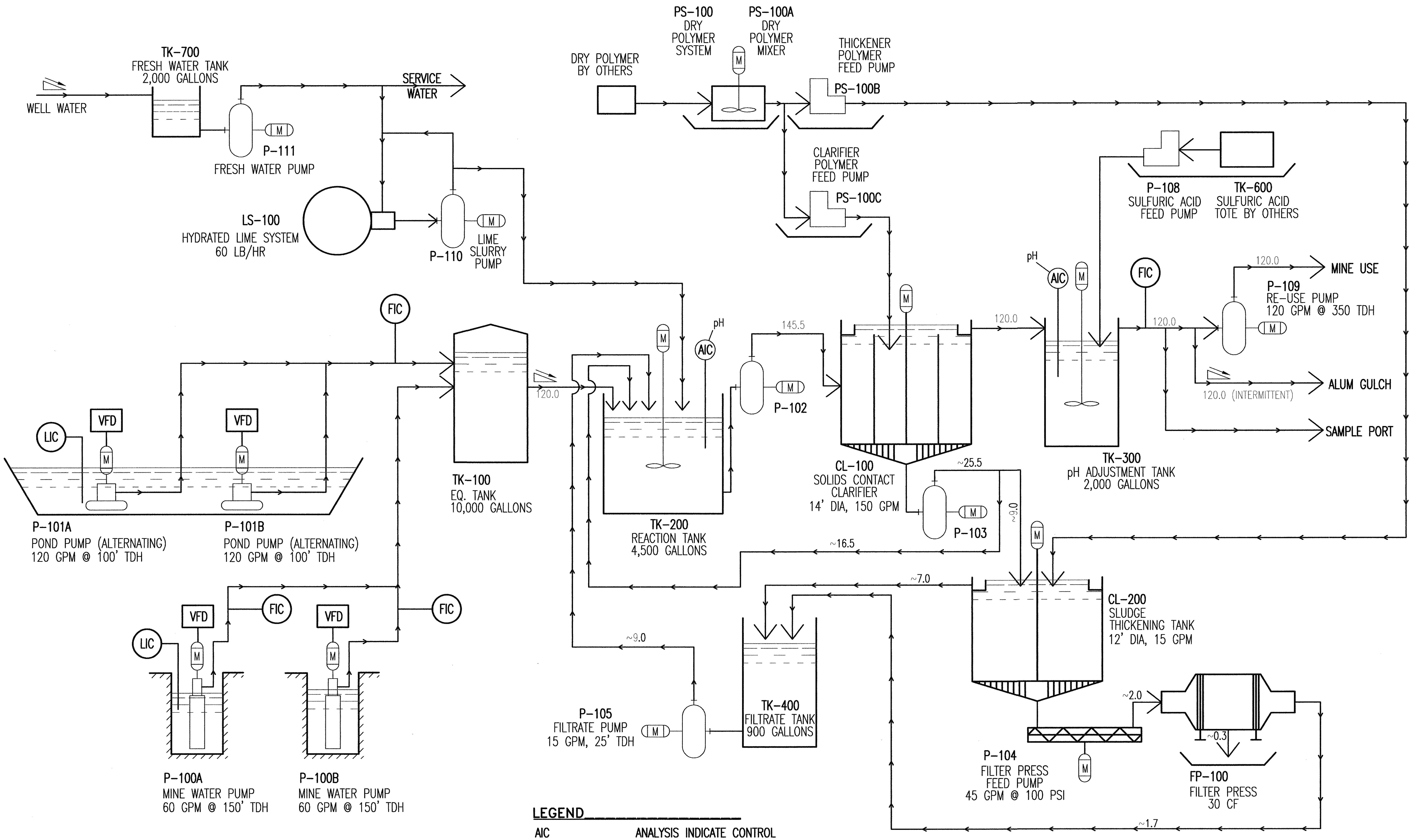
DRAWN	A. RASQUINHA	26APR17
CHECKED	S. PATIL	15MAY17
JOB COORD.	A. RASQUINHA	15MAY17
DEPT. HD.	S. PATIL	15MAY17
MGR. ENG.	J. HOLLEY	15MAY17
PROJECT	A. RASQUINHA	15MAY17
CLIENT	R. PINA	15MAY17

CLIENT
ARIZONA MINERALS INC.
JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
PATAGONIA, AZ.

SGS
SGS North America Inc.
Tucson Arizona

DRAWING TITLE
P&ID
WELL PUMPS
& UNDERDRAIN POND PUMPS

PROJECT No.	DRAWING No.	REV. No.
490-04	66-PD-002	0
SCALE AS NOTED		
DATE 15MAY17		



LEGEND

AIC	ANALYSIS INDICATE CONTROL
LIC	LEVEL INDICATOR CONTROL
VFD	VARIABLE FREQUENCY DRIVE
40.0	FLOW RATE
FIC	FLOW MEASUREMENT
pH	pH MEASUREMENT
(symbol)	GRAVITY FLOW

Registered Professional Engineer (Civil) CERTIFICATE NO. 63837 SCOTT BENOWITZ ARIZONA U.S.A. EXPIRES: 03/31/2018

NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
WTP PROCESS FLOW DIAGRAM

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

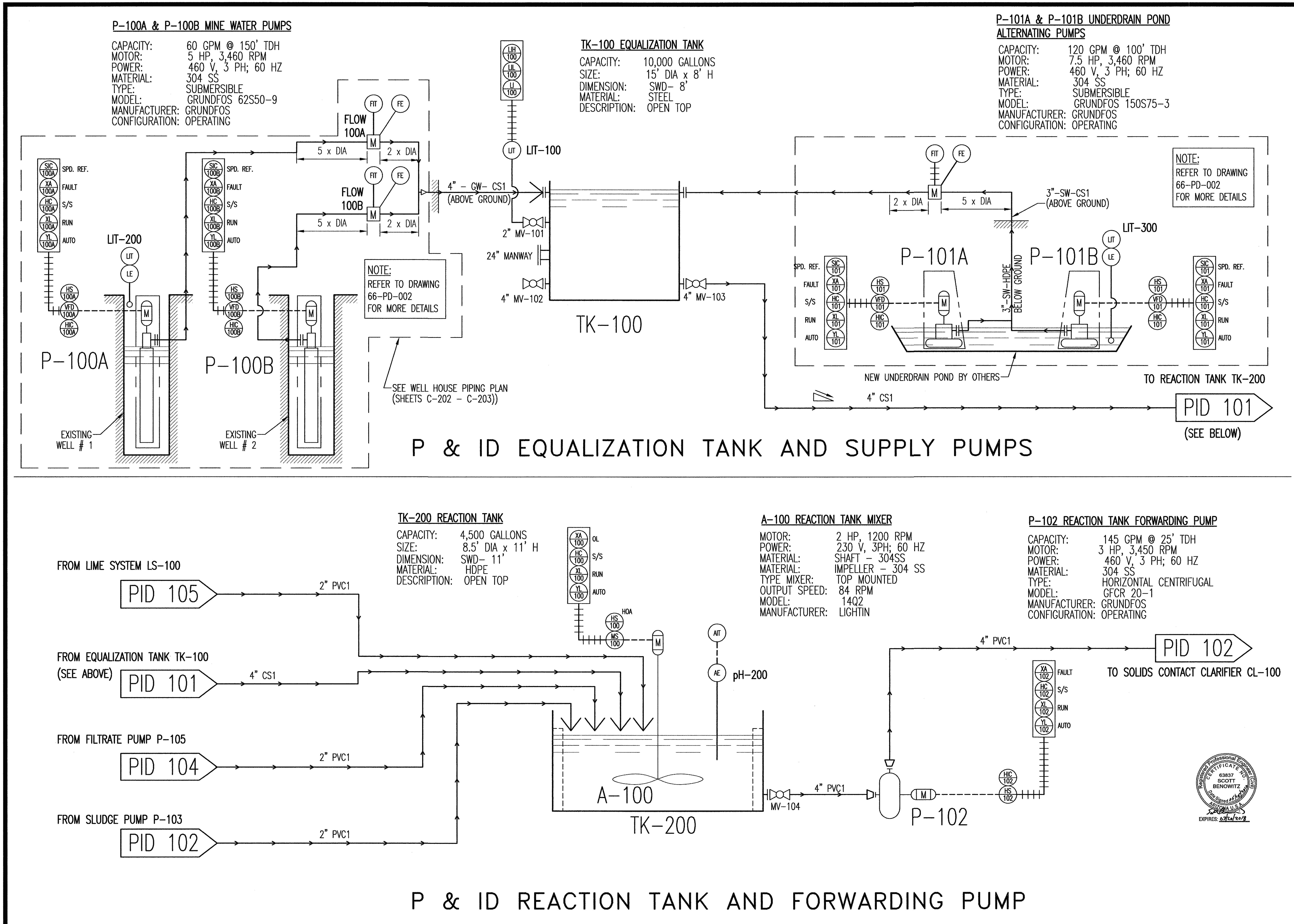
DESIGNED BY: SJB
DRAWN BY: VIG
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

Water Engineering Technologies, Inc.

DATE: MAY 2017
HORIZ.: N/A
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-11-PFD 101-WTP-PROCESS FLOW

SHEET: PFD-101
11 OF 37

100% PLANS PRINTED ON 05/15/2017



NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE WATER TREATMENT SYSTEM

P & ID
EQUALIZATION TANK & FORWARDING PUMPS
REACTION TANK & FORWARDING PUMP

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY: SIB
DRAWN BY: VIG
CHK'D BY (DESIGN):
CHK'D BY (FIELD DRAW):

Water Engineering Technologies, Inc.

DATE: MAY 2017
HORIZ.: N/A
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5–12–PID 101–EQ & REACTION TANKS

SHEET: PID–101
12 OF 37

100% PLANS PRINTED ON 05/15/2017

CL-100 PACKAGE

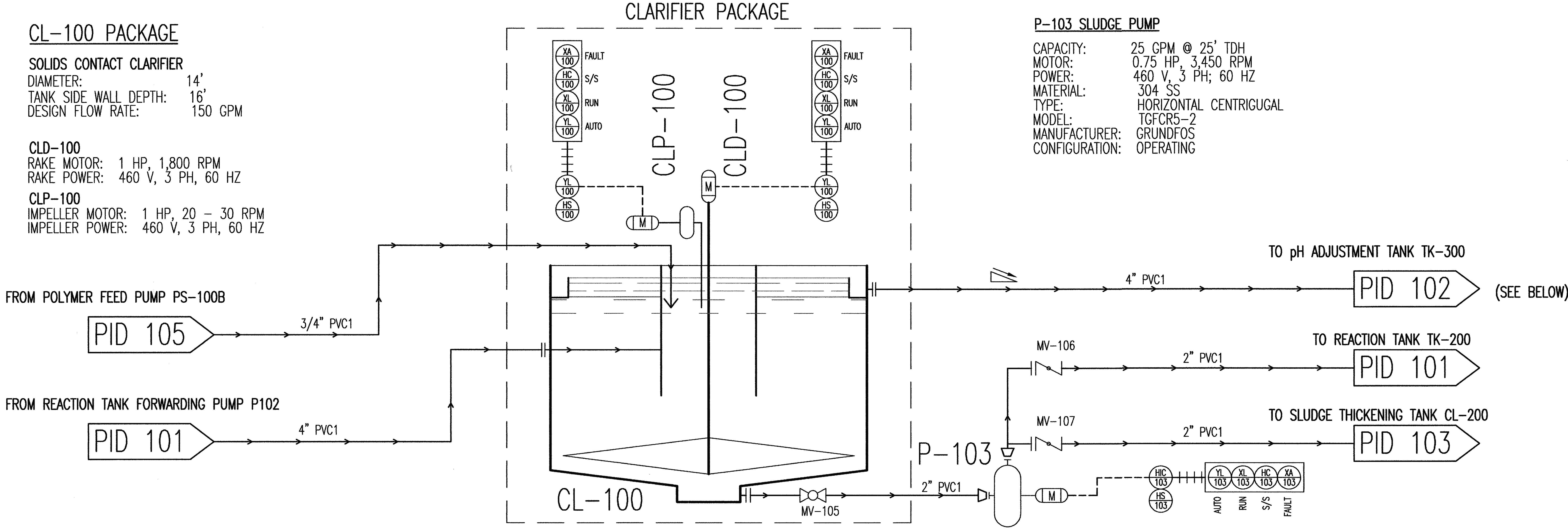
SOLIDS CONTACT CLARIFIER
DIAMETER: 14'
TANK SIDE WALL DEPTH: 16'
DESIGN FLOW RATE: 150 GPM

CLD-100
RAKE MOTOR: 1 HP, 1,800 RPM
RAKE POWER: 460 V, 3 PH, 60 HZ

CLP-100
IMPELLER MOTOR: 1 HP, 20 - 30 RPM
IMPELLER POWER: 460 V, 3 PH, 60 HZ

P-103 SLUDGE PUMP

CAPACITY:	25 GPM @ 25' TDH
MOTOR:	0.75 HP, 3,450 RPM
POWER:	460 V, 3 PH; 60 HZ
MATERIAL:	304 SS
TYPE:	HORIZONTAL CENTRIGUCAL
MODEL:	TGFCR5-2
MANUFACTURER:	GRUNDFOS
CONFIGURATION:	OPERATING



P & ID SOLIDS CONTACT CLARIFIER & SLUDGE PUMP

A-200 pH ADJUSTMENT TANK MIXER

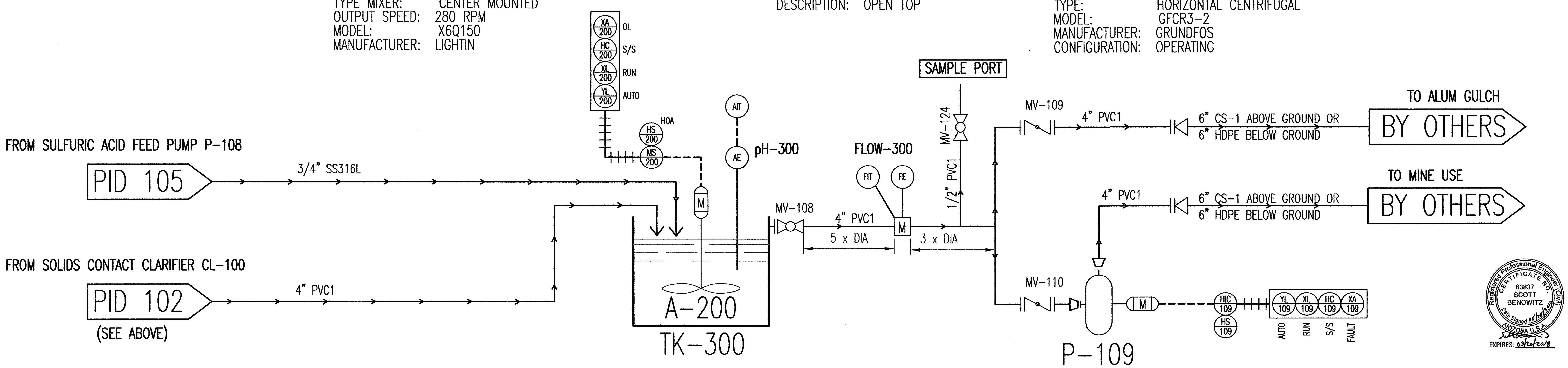
MOTOR:	1.5 HP, 1,725 RPM
POWER:	230 V, 3PH; 60 HZ
MATERIAL:	SHAFT - 304 SS
MATERIAL:	IMPELLER - 304 SS
TYPE MIXER:	CENTER MOUNTED
OUTPUT SPEED:	280 RPM
MODEL:	X6Q150
MANUFACTURER:	LIGHTIN

TK-300 pH ADJUSTMENT TANK

CAPACITY:	2,000 GALLONS
SIZE:	8' DIA x 6' H
DIMENSION:	SWD - 6'
MATERIAL:	HDPE
DESCRIPTION:	OPEN TOP

P-109 RE-USE PUMP

CAPACITY:	120 GPM @ 350' TDH
MOTOR:	20 HP, 3,450 RPM
POWER:	240 V, 3 PH; 60 HZ
MATERIAL:	304 SS
TYPE:	HORIZONTAL CENTRIFUGAL
MODEL:	GFCR3-2
MANUFACTURER:	GRUNDFOS
CONFIGURATION:	OPERATING



P & ID pH ADJUSTMENT TANK & RE-USE PUMP

Registered Professional Engineer (Civil) CERTIFICATE NO. 63837 SCOTT BENOWITZ ARIZONA U.S.A. Date Signed 05/15/17
EXPIRES: 03/20/2018

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM

P & ID
SOLIDS CONTACT CLARIFIER & SLUDGE PUMP
pH ADJUSTMENT TANK & RE-USE PUMP
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY: SIB
DRAWN BY: VG
CHK'D BY (DESIGN):
CHK'D BY (FIELD SHOP):

Water Engineering Technologies, Inc.

DATE: MAY 2017
SCALE: HORIZ.: N/A VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-13-PID 102-CLARIFIER & pH ADJ
SHEET: PID-102
13 OF 37

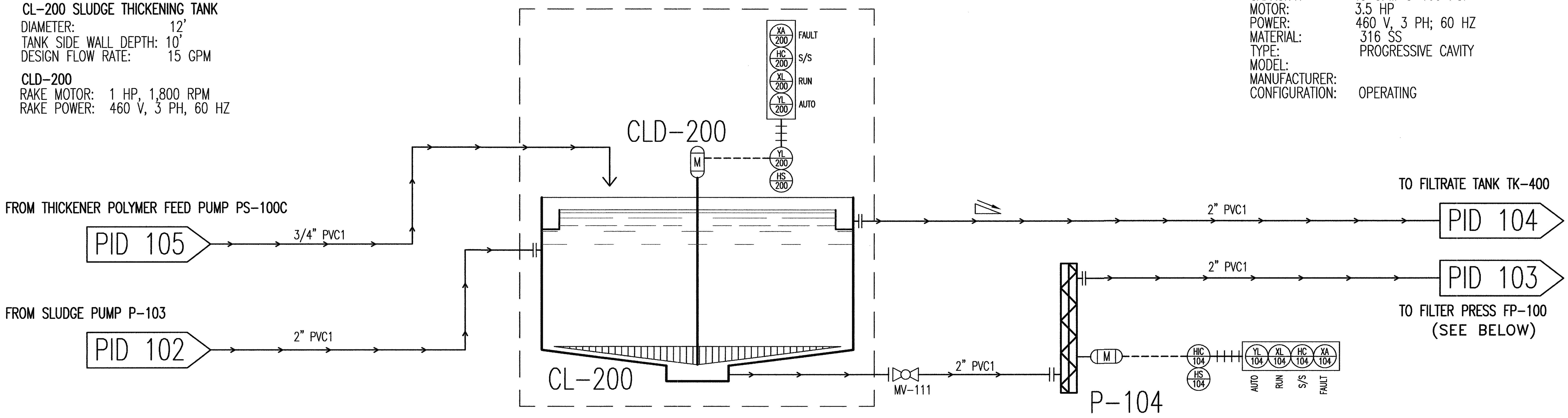
CL-200 SLUDGE THICKENING TANK PACKAGE

CL-200 SLUDGE THICKENING TANK
DIAMETER: 12'
TANK SIDE WALL DEPTH: 10'
DESIGN FLOW RATE: 15 GPM

CLD-200
RAKE MOTOR: 1 HP, 1,800 RPM
RAKE POWER: 460 V, 3 PH, 60 HZ

P-104 FILTER PRESS FEED PUMP

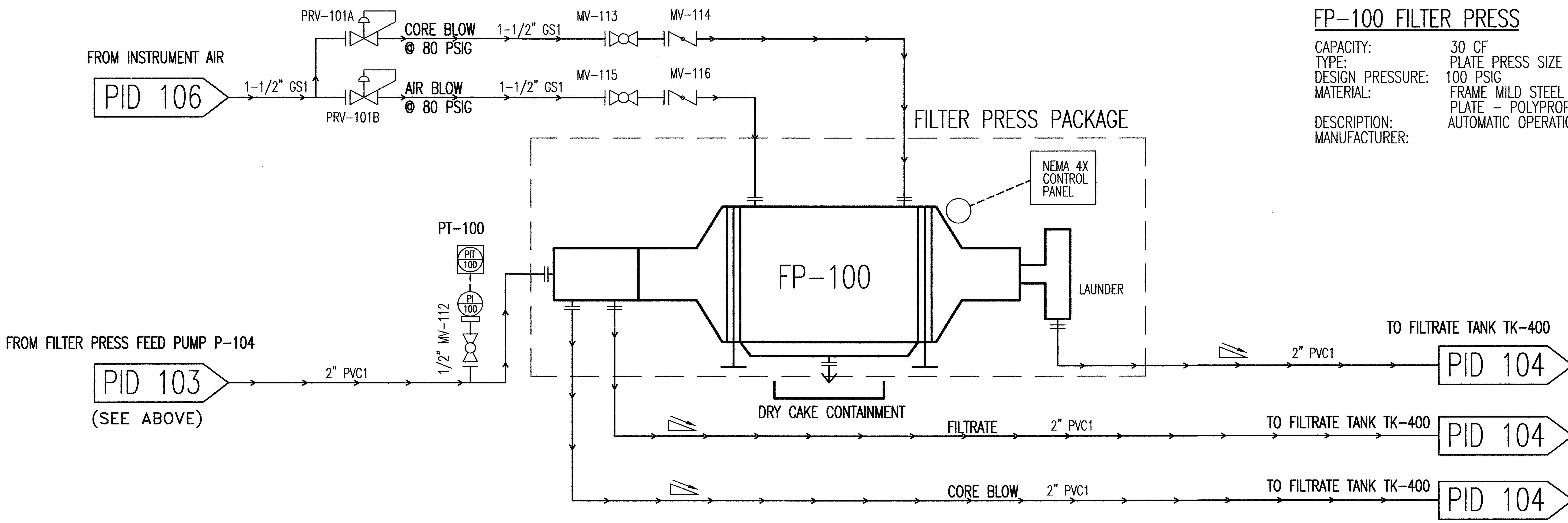
CAPACITY: 45 GPM @ 100 PSI
MOTOR: 3.5 HP
POWER: 460 V, 3 PH; 60 HZ
MATERIAL: 316 SS
TYPE: PROGRESSIVE CAVITY
MODEL:
MANUFACTURER:
CONFIGURATION: OPERATING



P & ID SLUDGE THICKENING TANK & FILTER PRESS FEED PUMP

FP-100 FILTER PRESS

CAPACITY: 30 CF
TYPE: PLATE PRESS SIZE 800 MM
DESIGN PRESSURE: 100 PSIG
MATERIAL: FRAME MILD STEEL
PLATE – POLYPROPYLENE
DESCRIPTION: AUTOMATIC OPERATION
MANUFACTURER:



Registered Professional Engineer (Civil)
CERTIFICATE NO. 63837
SCOTT BENOWITZ
ARIZONA U.S.A.
EXPIRES: 03/31/2018

P & ID FILTER PRESS

NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
P & ID
SLUDGE THICKENING TANK & FILTER PRESS FEED PUMP
FILTER PRESS
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY: SJB
DRAWN BY: VG
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

Water Engineering Technologies, Inc.

DATE: MAY 2017
SCALE HORIZ.: N/A
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-14-PID 103-SLUDGE THICK TANK &

SHEET: PID-103
14 of 37

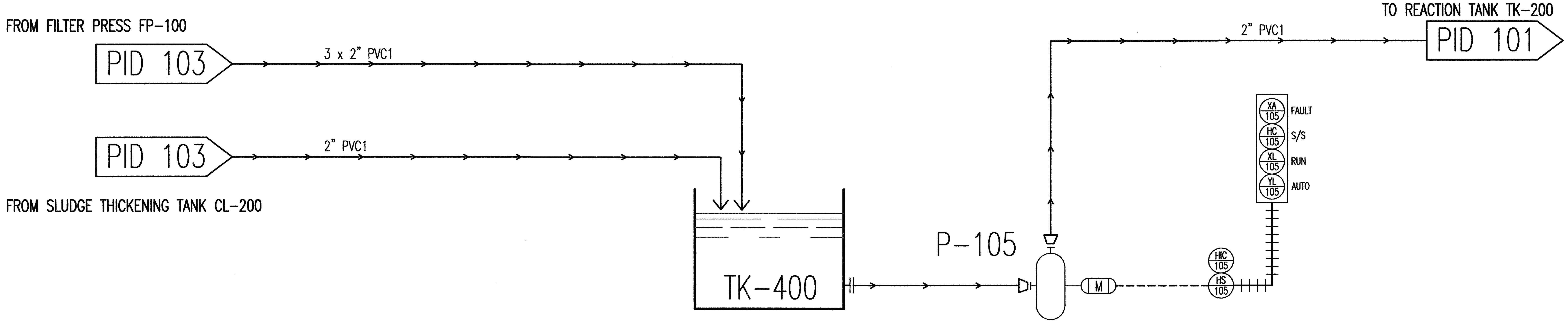
100% PLANS PRINTED ON 05/15/2017

TK-400 FILTRATE TANK

CAPACITY: 900 GALLONS
SIZE: 5' DIA x 7' H
DIMENSION: SWD - 7
MATERIAL: HDPE
DESCRIPTION: OPEN TOP

P-105 FILTRATE PUMP

CAPACITY: 15 GPM @ 25' TDH
MOTOR: 0.33 HP, 3,450 RPM
POWER: 460 V, 3 PH; 60 HZ
MATERIAL: 304 SS
TYPE: HORIZONTAL CENTRIFUGAL
MODEL: GFCR3-2
MANUFACTURER: GRUNDFOS
CONFIGURATION: OPERATING



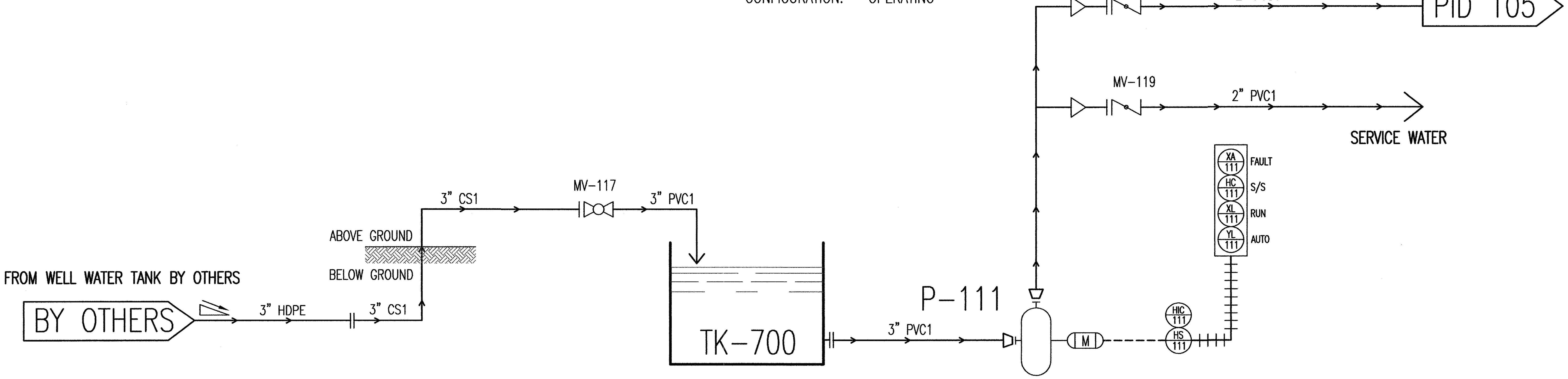
P & ID FILTRATE TANK & FILTRATE PUMP

TK-700 FRESH WATER TANK

CAPACITY: 2,000 GALLONS
SIZE: 8' DIA x 6' H
DIMENSION: SWD - 6'
MATERIAL: HDPE
DESCRIPTION: OPEN TOP

P-111 FRESH WATER PUMP

CAPACITY: 10 GPM @ 20' TDH
MOTOR: 0.33 HP, 3,450 RPM
POWER: 460 V, 3 PH; 60 HZ
MATERIAL: 304 SS
TYPE: HORIZONTAL CENTRIFUGAL
MODEL: CR3-2
MANUFACTURER: GRUNDFOS
CONFIGURATION: OPERATING



P & ID FRESH WATER TANK & PUMP

Registered Professional Engineer (Civil) CERTIFICATE NO. 63837 SCOTT BENOWITZ ARIZONA U.S.A. EXPIRES: 03/26/2018

NO. | REVISION | APP'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM

P & ID
FILTRATE TANK & FILTRATE PUMP
FRESH WATER TANK & PUMP

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY: SIB
DRAWN BY: VG
CHK'D BY (DESIGN):
CHK'D BY (FIELD EXAM):

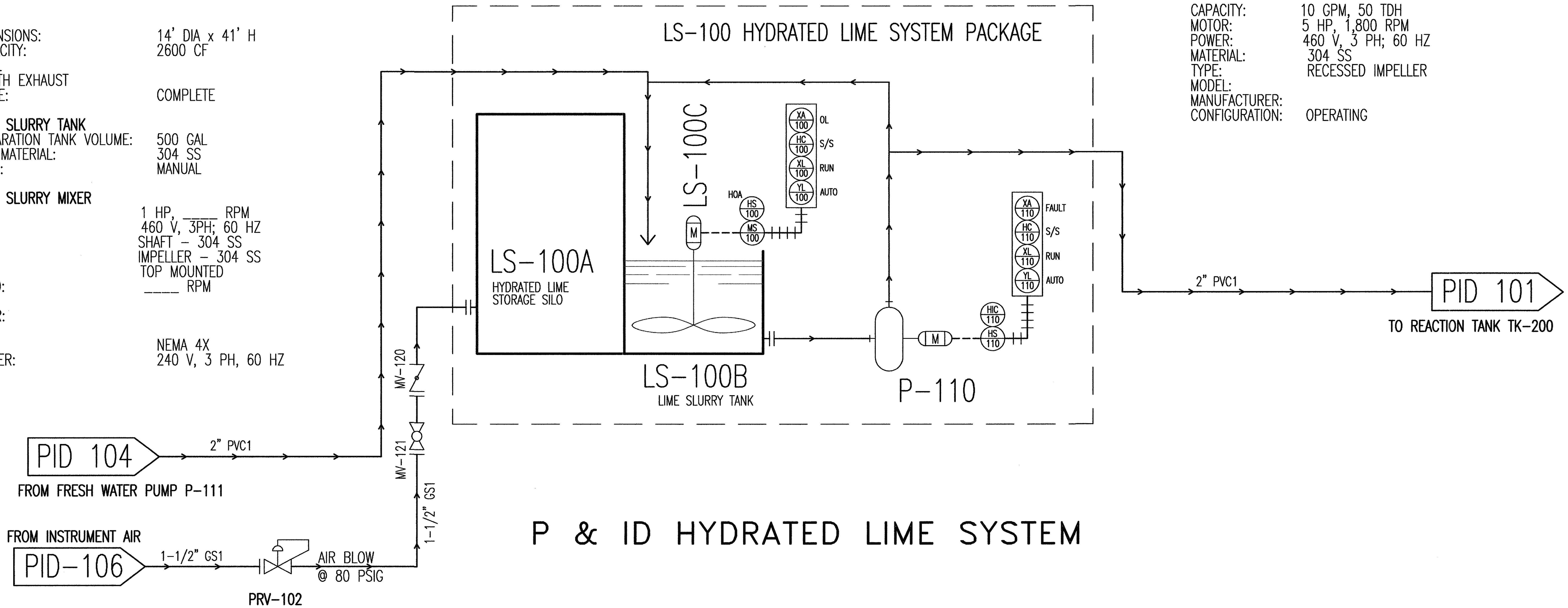
Water Engineering Technologies, Inc.

DATE: MAY 2017
SCALE: HORIZ.: N/A
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-15-PID 104-FILTRATE & FRESH WAT

SHEET: PID-104
15 OF 37

100% PLANS PRINTED ON 05/15/2017

P & ID HYDRATED LIME SYSTEM



LS-100 HYDRATED LIME SYSTEM PACKAGE

LS-100A

OVERALL DIMENSIONS:	14' DIA x 41' H
STORAGE CAPACITY:	2600 CF
MATERIAL:STEEL	
SILO SKIRT WITH EXHAUST	
TRUCKFILL LINE:	COMPLETE

LS-100B LIME SLURRY TANK

SLURRY PREPARATION TANK VOLUME:	500 GAL
SLURRY TANK MATERIAL:	304 SS
FLUSH SYSTEM:	MANUAL

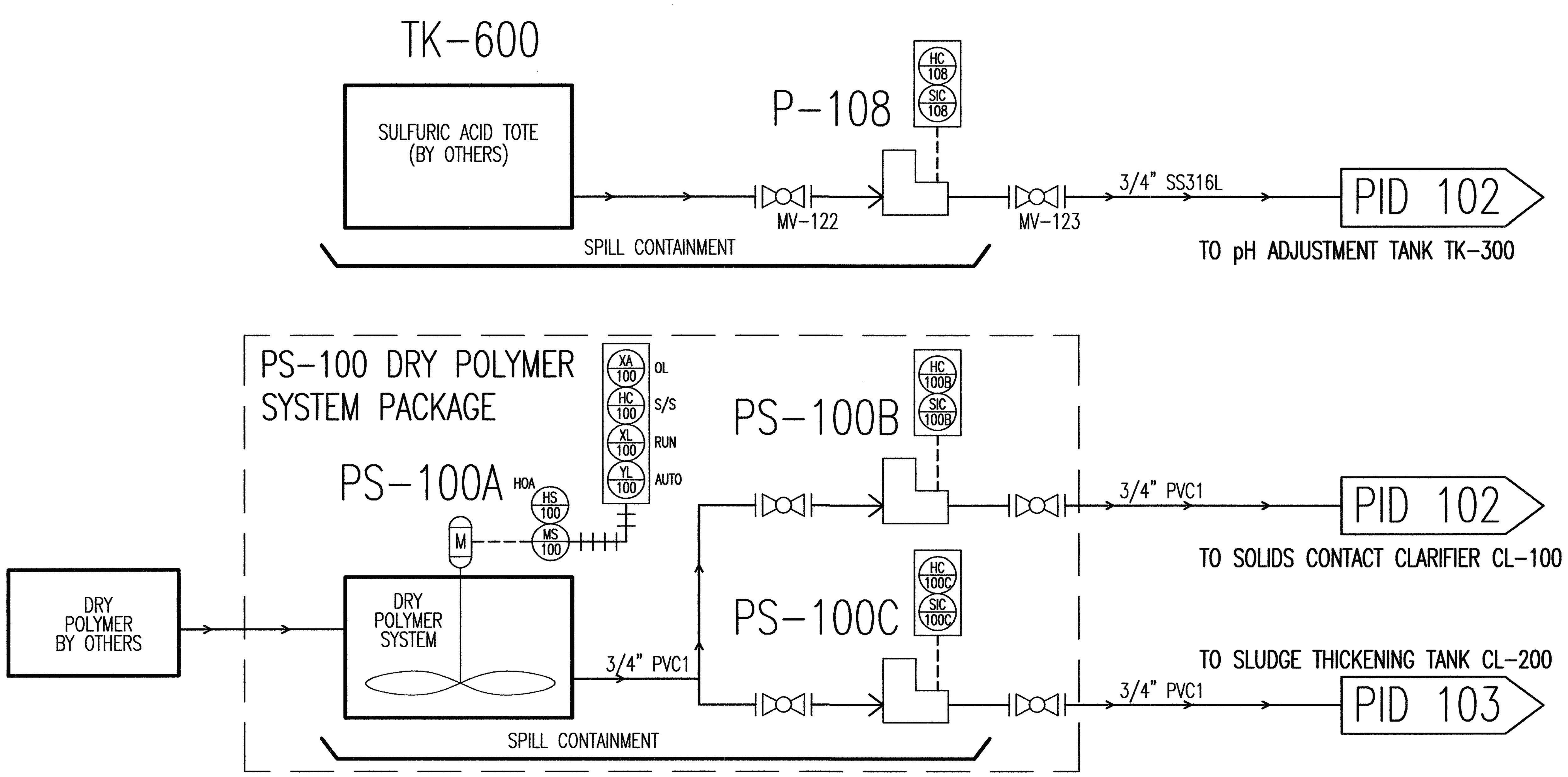
LS-100C LIME SLURRY MIXER

MOTOR:	1 HP, ____ RPM
POWER:	460 V, 3PH; 60 HZ
MATERIAL:	SHAFT - 304 SS
MATERIAL:	IMPELLER - 304 SS
TYPE MIXER:	TOP MOUNTED
OUTPUT SPEED:	____ RPM
MODEL:	
MANUFACTURER:	
CONTROLS:	NEMA 4X
CONTROL POWER:	240 V, 3 PH, 60 HZ

P-110 LIME SLURRY PUMP

CAPACITY:	10 GPM, 50 TDH
MOTOR:	5 HP, 1,800 RPM
POWER:	460 V, 3 PH; 60 HZ
MATERIAL:	304 SS
TYPE:	RECESSED IMPELLER
MODEL:	
MANUFACTURER:	
CONFIGURATION:	OPERATING

P & ID CHEMICAL FEED PUMPS



P-108 SULFURIC ACID FEED PUMP

CAPACITY:	1.5 GPH, 50 PSIG
MOTOR:	0.25 HP, 1 - 100%
POWER:	120 V, 1 PH; 60 HZ
MATERIAL:	PVC WETTED PARTS
TYPE:	DIAPHRAGM
MODEL:	
MANUFACTURER:	
CONFIGURATION:	ONLINE

PS-100A DRY POLYMER MIXER

MOTOR:	0.25 HP, 120 RPM
POWER:	460 V, 1 PH; 60 HZ
MATERIAL:	SHAFT - 304 SS
MATERIAL:	IMPELLER - 304 SS
TYPE MIXER:	TOP MOUNTED
MODEL:	
MANUFACTURER:	
CONTROLS:	NIMA 4X

PS-100B, POLYMER FEED PUMP

CAPACITY:	30 GPH, 50 PSIG
MOTOR:	0.25 HP, 1 - 100%
POWER:	120 V, 1 PH; 60 HZ
MATERIAL:	304 SS
TYPE:	PERISTALTIC
MODEL:	
MANUFACTURER:	
CONFIGURATION:	ONLINE

PS-100C POLYMER FEED PUMP

CAPACITY:	30 GPH, 50 PSIG
MOTOR:	0.25 HP, 1 - 100%
POWER:	120 V, 1 PH; 60 HZ
MATERIAL:	304 SS, PVC
TYPE:	PERISSTALTIC
MODEL:	
MANUFACTURER:	
CONFIGURATION:	ONLINE

Registered Professional Engineer (Civil) CERTIFICATE NO. 63837 SCOTT BENOWITZ ARIZONA U.S.A. EXPIRES: 03/31/2018

NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
P & ID
HYDRATED LIME SYSTEM
CHEMICAL FEED PUMPS
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY: SIB
DRAWN BY: VG
CHK'D BY (DESIGN):
CHK'D BY (FIELD EXAM):

Water Engineering Technologies, Inc.

DATE: MAY 2017
HORIZ.: N/A
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-16-PID 105-LIME SYSTEM & CHEM

SHEET: PID-105

100% PLANS PRINTED ON 05/15/2017

AC–100 AIR COMPRESSOR

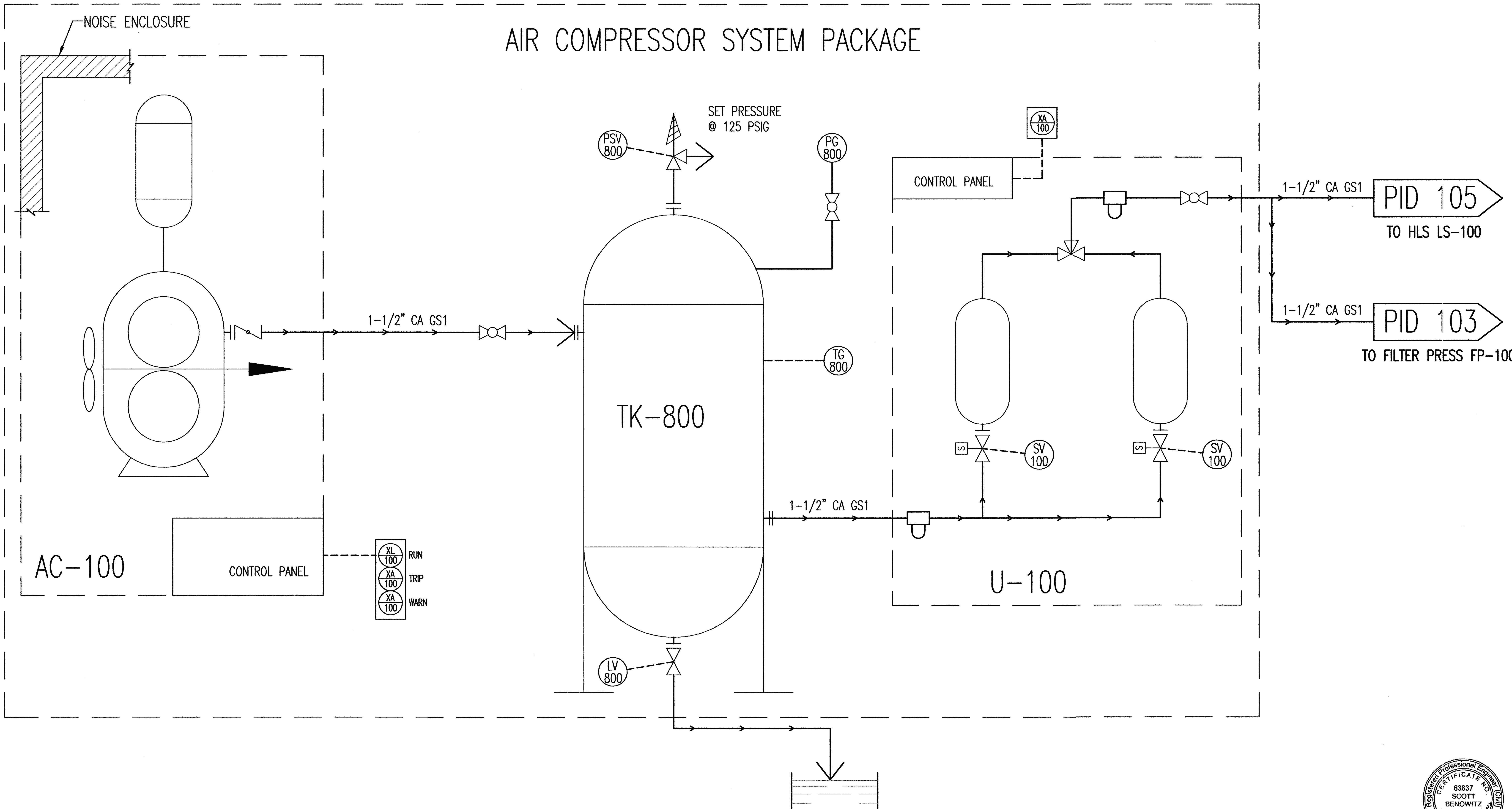
CAPACITY: 100 CFM @ 125 PSIG
MOTOR: 30 HP
POWER: 480 V, 3 PH, 60 HZ
MATERIAL: CAST IRON
TYPE: ROTARY SCREW AIR COOLED
MANUFACTURER:
MODEL:

TK–800 PLANT AIR RECEIVER

CAPACITY: 250 GALLONS
SIZE: ___ DIA x __ H
MATERIAL: CS
DESCRIPTION: ASME VESSEL

U–100 INSTRUMENT DRYER

CAPACITY: 100 CFM
SIZE: ___ DIA x __ H
TYPE: HL DESICCANT DRYER
MANUFACTURER:
MODEL:



P & ID AIR COMPRESSOR SYSTEM

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
P & ID
AIR COMPRESSOR SYSTEM
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO. | REVISION | APPV'D | DATE

DESIGNED BY: SIB
DRAWN BY: VIG
CHK'D BY (DESIGN):
CHK'D BY (FIELD DSGN):

Water Engineering Technologies, Inc.

DATE: MAY 2017
SCALE: HORIZ.: N/A
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-17-PID
105-LIME SYSTEM & CHEM

SHEET: PID-106
17 OF 37

100% PLANS PRINTED ON 05/15/2017

REV NO.	EQUIPMENT NO.	EQUIPMENT DESCRIPTION	DUTY	EQUIPMENT TYPE	DESIGN CAPACITY/MISC. INFO.	EQUIPMENT SUPPLIED BY	P&ID NO.	P&ID REV.	SPEC NUMBER	MODEL/SIZE/ MANUFACTURER	DESIGN PRESS. (psig)	DESIGN TEMP. (F)	MATERIAL OF CONSTRUCTION	PUMP DIFF. HEAD (ft)	MOTOR RATING HP/RPM	VFD	VOLT/PHASE/HZ	DIMENSIONS	WEIGHT (lbs)	TECHNICAL NOTES
A	P-100A, P-100B	MINE WATER PUMP	ONLINE	SUBMERSIBLE	60 GPM @ 150 FT TDH EACH	TBD	101	A	TBD	62550-9/5 HP/GRUNDFOS	65	AMBIENT	304 SS	150	5/3450	YES	460/3/60	TBD	TBD	
A	TK-100	EQUALIZATION TANK	ONLINE	VERTICAL OPEN TOP	10,000 GAL	TBD	101	A	TBD	15' DIA X 8'H	N/A	AMBIENT	STEEL	N/A	N/A	N/A	N/A	15' DIA X 8' H	TBD	
A	P-101A	UNDERDRAIN POND PUMP	ONLINE	SUBMERSIBLE	120 GPM @ 100 FT TDH	TBD	101	A	TBD	150575-3/7 HP/GRUNDFOS	43	AMBIENT	304 SS	100	7.5/3450	YES	460/3/60	TBD	TBD	
A	P-101B	UNDERDRAIN POND PUMP	ONLINE	SUBMERSIBLE	120 GPM @ 100 FT TDH	TBD	101	A	TBD	150575-3/7 HP/GRUNDFOS	43	AMBIENT	304 SS	100	7.5/3450	YES	460/3/60	TBD	TBD	
A	TK-200	REACTION TANK	ONLINE	VERTICAL OPEN TOP	4,500 GAL	TBD	101	A	TBD	8.5' DIA X 11' H	N/A	AMBIENT	HDPE	N/A	N/A	N/A	N/A	8.5' DIA X 11' H	TBD	
A	A-100	REACTION TANK MIXER	ONLINE	AGITATOR	N/A	TBD	101	A	TBD	14Q2/2 HP/LIGHTIN	N/A	AMBIENT	316 SS	N/A	2/1200	NO	230/3/60	SHAFT 2" x 68.5" 38" IMPELLER DIA	TBD	
A	P-102	REACTION TANK FORWARDING PUMP	ONLINE	HORIZONTAL CENTRIFUGAL	145 GPM @ 25 FT TDH	TBD	101	A	TBD	GFCR20-1/3 HP/GRUNDFOS	10	AMBIENT	304 SS	25	3/3450	NO	460/3/60	TBD	TBD	
A	CL-100	SOLIDS CONTACT CLARIFER	ONLINE	LIQUID/SOLIDS SEPARATION	150GPM	TBD	102	A	TBD	CONTACT CLARIFIER /14-FT/TBD	N/A	AMBIENT	304 SS	N/A	N/A	N/A	N/A	14' DIA X 16' H	16,500	WATER WEIGHT 144,000 LBS
A	CLD-100	CLARIFIER RAKE DRIVE MOTOR	ONLINE	DIRECT COUPLED	5000 FT-LBS @ 12 FPM	TBD	102	A	TBD	TBD/1/TBD	N/A	AMBIENT	304 SS	N/A	1/1800	NO	460/3/60	TBD	N/A	INCLUDED IN CLARIFIER PACKAGE
A	CLP-100	CLARIFER IMPELLER PUMP	ONLINE	IMPELLER PUMP	1 HP, 20-30 RPM	TBD	102	A	TBD	TBD/1/TBD	N/A	AMBIENT	304SS	N/A	1/20-30	NO	460/3/60	TBD	N/A	INCLUDED IN CLARIFIER PACKAGE
A	P-103	SLUDGE PUMP	ONLINE	HORIZONTAL CENTRIFUGAL	25 GPM @ 25 FT TDH	TBD	102	A	TBD	TGFCR5-2/0.75 HP/GRUNDFOSS	10	AMBIENT	304 SS	25	0.75/3450	NO	460/3/60	TBD	TBD	
A	TK-300	pH ADJUSTMENT TANK	ONLINE	VERTICAL OPEN TOP	2,000 GAL	TBD	102	A	TBD	8' DIA X 6' H	N/A	AMBIENT	HDPE	N/A	N/A	N/A	N/A	8' DIA X 6' H	TBD	
A	A-200	pH ADJUSTMENT TANK MIXER	ONLINE	AGITATOR	N/A	TBD	102	A	TBD	X6Q150/1.5 HP/LIGHTIN	N/A	AMBIENT	316 SS	N/A	1.5/1725	NO	230/3/60	SHAFT 1" x 56" 19" IMPELLER DIA	TBD	
A	P-109	RE-USE PUMP	ONLINE	HORIZONTAL CENTRIFUGAL	120 GPM @ 350 FT TDH	TBD	102	A	TBD	GFCR3-2/20 HP/GRUNDFOS	150	AMBIENT	304 SS	350	20/TBD	NO	460/3/60	TBD	TBD	
A	CL-200	THICKENING TANK	ONLINE	LIQUID/SOLIDS SEPARATION	15 GPM/10,000 GAL	TBD	103	A	TBD	CONVENTIONAL THICKENER/12'/TBD	N/A	AMBIENT	304 SS	N/A	N/A	NO	N/A	12' DIA X 10' H	11,900	WATER WEIGHT 63,500 LBS
A	CLD-200	THICKENER RAKE DRIVE MOTOR	ONLINE	DIRECT COUPLED	5000 FT-LBS @ 20 FPM	TBD	103	A	TBD	TBD	N/A	AMBIENT	304 SS	N/A	1/1800	NO	460/3/60	TBD	INCLUDED	INCLUDED IN THICKENER PACKAGE
A	P-104	FILTER PRESS FEED PUMP	ONLINE	PROGRESSIVE CAVITY	45 GPM @ 100 PSI	TBD	103	A	TBD	TBD/3.5/TBD	100	AMBIENT	316 SS	230	3.5/N/A	NO	460/3/60	TBD	TBD	
A	FP-100	FILTER PRESS	ONLINE	PLATE/FRAME/CLOTH	30 CF, 100 PSIG	TBD	103	A	TBD	TBD/30 CF/TBD	100	AMBIENT	PP PLATES/CLOTHS/304 SS PLATE FRAME	N/A	7.5	NO	460/3/60	TBD	10,000	SOLIDS WEIGHT 2,500 LBS
A	FP-100A	FILTER PRESS HYDRAULIC PUMP		HORIZONTAL CENTRIFUGAL	TBD	TBD	N/A	N/A	TBD	TBD	TBD	AMBIENT	TBD	TBD	5/TBD	NO	460/3/60	TBD	TBD	INCLUDED IN FILTER PRESS PACKAGE
A	TK-400	FILTRATE TANK	ONLINE	VERTICAL OPEN TOP	900 GAL	TBD	104	A	TBD	5' DIA X 7' H	N/A	AMBIENT	HDPE	N/A	N/A	N/A	N/A	5' DIA X 7' H	TBD	
A	P-105	FILTRATE PUMP	ONLINE	HORIZONTAL CENTRIFUGAL	15 GPM @ 25 FT TDH	TBD	104	A	TBD	GFCR3-2/0.33 HP/GRUNDFOS	10	AMBIENT	TBD	25	0.33/3450	NO	460/3/60	TBD	TBD	
A	TK-700	FRESH WATER TANK	ONLINE	VERTICAL OPEN TOP	2,000 GAL	TBD	104	A	TBD	8' DIA X 6' H	N/A	AMBIENT	HDPE	N/A	N/A	N/A	N/A	8' DIA X 6' H	TBD	
A	P-111	FRESH WATER PUMP	ONLINE	HORIZONTAL CENTRIFUGAL	10 GPM @ 20 FT TDH	TBD	104	A	TBD	CR3-2/0.33 HP/GRUNDFOS	5	AMBIENT	304 SS	10	0.33/3450	NO	460/3/60	TBD	TBD	
A	LS-100	HYDRATED LIME SYSTEM	ONLINE	HYDRATED LIME SYSTEM	60 LB/HR	TBD	105	A	TBD	TBD	N/A	AMBIENT	SEE INDIVIDUAL COMPONENTS	N/A	N/A	N/A	N/A	SEE COMPONENTS	46,000	FULL SILO LIME WEIGHT 47 TONS
A	LS-100A	LIME SILO	ONLINE	STORAGE SILO	2600 CF	TBD	105	A	TBD	TBD/2600/TBD	N/A	AMBIENT	STEEL	N/A	N/A	N/A	N/A	14' H X 41' DIA	TBD	INCLUDED IN LIME SYSTEM
A	LS-100B	LIME SLURRY TANK	ONLINE	MIXING TANK	500 GAL	TBD	105	A	TBD	TBD/5' DIA X 6' H/TBD	N/A	AMBIENT	304SS	N/A	N/A	N/A	N/A	5' DIA X 6' H	TBD	INCLUDED IN LIME SYSTEM
A	LS-100C	LIME SLURRY MIXER	ONLINE	AGITATOR	TWO IMPELLERS	TBD	105	A	TBD	TBD	N/A	AMBIENT	304 SS	N/A	1/TBD	NO	460/3/60	TBD	TBD	INCLUDED IN LIME SYSTEM
A	LS-100D	SILO BIN VIBRATORY ACTIVATOR	ONLINE	VARIABLE FORCE VIBRATORY ACTIVATOR	N/A	TBD	N/A	N/A	TBD	TBD	N/A	AMBIENT	TBD	N/A	1.5/TBD	N/A	460/3/60	TBD	TBD	INCLUDED IN LIME SYSTEM
A	LS-100E	LIME VOLUMETRIC FEEDER	ONLINE	SCREW TYPE FEEDER	1,400 LB/DAY	TBD	N/A	N/A	TBD	TBD	N/A	AMBIENT	304SS	N/A	1/TBD	YES	460/3/60	TBD	TBD	INCLUDED IN LIME SYSTEM
A	LS-100F	SILO DUST COLLECTOR	ONLINE	PULSE JET TYPE	300 SF MEDIA	TBD	-	-	TBD	TBD	N/A	AMBIENT	CS HOUSING, POLYESTER MEDIA	N/A	2/TBD	NO	460/3/60	TBD	TBD	INCLUDED IN LIME SYSTEM
A	P-110	LIME SLURRY PUMP	ONLINE	RECESSED IMPELLER HORIZONTAL CENTRIFUGAL	10GPM @ 50 FT TDH	TBD	105	A	TBD	TBD/5/TBD	TBD	AMBIENT	304 SS	TBD	5/1800	NO	460/3/60	TBD	TBD	INCLUDED IN LIME SYSTEM
A	TK-600	SULFURIC ACID TOTE	ONLINE	VERTICAL CLOSED TOP	~ 345 LBS/DAY	VENDOR	105	A	TBD	TBD	TBD	AMBIENT	TBD	N/A	N/A	N/A	N/A	TBD	TBD	
A	P-108	SULFURIC ACID FEED PUMP	ONLINE	DIAPHRAGM METERING PUMP	1.5 GPH @ 50 PSIG	TBD	105	A	TBD	TBD	50	AMBIENT	PVC	TBD	0.25/N/A	NO	120/1/60	TBD	TBD	> 92% SULFURIC ACID
A	PS-100	POLYMER SYSTEM	ONLINE	DRY POLYMER SYSTEM	~ 2 LBS/DAY	VENDOR	105	A	TBD	TBD		AMBIENT	304 SS	N/A	N/A	NO	N/A	TBD	TBD	INCLUDED IN POLYMER SYSTEM
A	PS-100A	POLYMER SYSTEM MIXER	ONLINE	AGITATOR	0.25 HP	TBD	105	A	TBD	TBD	N/A	AMBIENT	304 SS	N/A	TBD	NO	460/3/60	TBD	TBD	INCLUDED IN POLYMER SYSTEM
A	PS-100B	CLARIFIER POLYMER FEED PUMP	ONLINE	DIAPHRAGM METERING PUMP	0.5 GPH @ 50 PSIG	TBD	105	A	TBD	TBD	50	AMBIENT	PVC	TBD	0.25/TBD	NO	120/1/60	TBD	TBD	INCLUDED IN POLYMER SYSTEM
A	PS-100C	THICKENER POLYMER FEED PUMP	ONLINE	DIAPHRAGM METERING PUMP	0.5 GPH @ 50 PSIG	TBD	105	A	TBD	TBD	50	AMBIENT	PVC	TBD	0.25/TBD	NO	120/1/60	TBD	TBD	INCLUDED IN POLYMER SYSTEM
A	AC-100	AIR COMPRESSOR	ONLINE	ROTARY SCREW AIR COOLED	100 CFM @ 125PSIG	TBD	106	A	TBD	TBD	125	AMBIENT	CAST IRON	N/A	30/TBD	N/A	480/3/60	TBD	TBD	
A	TK-800	AIR RECEIVER TANK	ONLINE	ASME VESSEL	250 GAL	TBD	106	A	TBD	TBD	125	AMBIENT	CS	N/A	TBD	N/A	N/A	TBD	TBD	
A	U-100	INSTRUMENT DRYER	ONLINE	DESICCANT DRYER	100 CFM	TBD	106	A	TBD	TBD	125	AMBIENT	TBD	N/A	N/A	N/A	N/A	TBD	TBD	
A	pH-200, pH-300	pH SENSOR/TRANSMITTER	ONLINE	DIFFERENTIAL ELECTRODE/ANALYZER	0-14 pH	TBD	101, 102	A	TBD	TBD	ATMOSPHERIC	AMBIENT	ELECTRODE-GLASS, NEMA 4X HOUSING	N/A	N/A	N/A	120 VAC	TBD	TBD	
A	FLOW 100A, FLOW 100B	MAGNETIC FLOW METER	ONLINE	MAGNETIC FLOW METER	0-100 GPM	TBD	101	A	TBD	TBD/2"/TBD	ATMOSPHERIC	AMBIENT	CARBON STEEL TUBE/TEFLON LINER	N/A	N/A	N/A	N/A	TBD	TBD	
A	FLOW 300	MAGNETIC FLOW METER	ONLINE	MAGNETIC FLOW METER	0-150 GPM	TBD	102	A	TBD	TBD/4"/TBD	ATMOSPHERIC	AMBIENT	CARBON STEEL TUBE/TEFLON LINER	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-101	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	101	A	TBD	TBD/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-102	GLOBE VALVE	NORMALLY CLOSED	GLOBE VALVE	N/A	TBD	101	A	TBD	TBD/4"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-103	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	101	A	TBD	TBD/4"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-104	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	101	A	TBD	TBD/4"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-105	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	102	A	TBD	TBD/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-106	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	102	A	TBD	TBD/2"/TBD	150	AMBIENT	304SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-107	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	102	A	TBD	TBD/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-108	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	102	A	TBD	TBD/4"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-109	BUTTERFLY VALVE	NORMALLY CLOSED	BUTTERFLY VALVE	N/A	TBD	102	A	TBD	TBD/4"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-110	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	102	A	TBD	TBD/4"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-111	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	103	A	TBD	TBD/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-112	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	103	A	TBD	TBD/1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-113	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	103	A	TBD	TBD/1-1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-114	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	103	A	TBD	TBD/1-1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-115	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	103	A	TBD	TBD/1-1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-116	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	103	A	TBD	TBD/1-1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-117	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	104	A	TBD	TBD/3"/TBD	300	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-118	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	104	A	TBD	TBD/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-119	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	104	A	TBD	TBD/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-120	BUTTERFLY VALVE	NORMALLY OPEN	BUTTERFLY VALVE	N/A	TBD	103	A	TBD	TBD/1-1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-121	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	103	A	TBD	TBD/1-1/2"/TBD	150	AMBIENT	304 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-122	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	105	A	TBD	TBD/3/4"/TBD	150	AMBIENT	316 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-123	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	105	A	TBD	TBD/3/4"/TBD	150	AMBIENT	316 SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	MV-124	GLOBE VALVE	NORMALLY OPEN	GLOBE VALVE	N/A	TBD	102	A	TBD	TBD/1/2"/TBD	150	AMBIENT	304SS	N/A	N/A	N/A	N/A	TBD	TBD	
A	LIT-100	DIFFERENTIAL PRESSURE TRANSMITTER	OPERATING	DIFFERENTIAL PRESSURE TRANSMITTER	N/A	TBD	101	A	TBD	TBD	N/A	AMBIENT	316 SS	N/A	N/A	N	N/A	TBD	TBD	
A	LIT-200	DIFFERENTIAL PRESSURE TRANSMITTER	OPERATING	DIFFERENTIAL PRESSURE TRANSMITTER	N/A	TBD	101	A	TBD	TBD	N/A	AMBIENT	316 SS	N/A	N/A	N	N/A	TBD	TBD	
A	LIT-300	DIFFERENTIAL PRESSURE TRANSMITTER	OPERATING	DIFFERENTIAL PRESSURE TRANSMITTER	N/A	TBD	101	A	TBD	TBD	N/A	AMBIENT	316 SS	N/A	N/A	N	N/A	TBD	TBD	
A	PT-100	PRESSURE TRANSMITTER	OPERATING	PRESSURE TRANSMITTER	N/A	TBD	103	A	TBD	TBD	N/A	AMBIENT	316 SS	N/A	N/A	N	N/A	TBD	TBD	
A	PRV-101A	PRESSURE REDUCING VALVE	OPERATING	PRESSURE REDUCING VALVE	60 CFM	TBD	103	A	TBD	TBD/1.5"/TBD	80	AMBIENT	304 SS	N/A	N/A	N	N/A	TBD	TBD	
A	PRV-101B	PRESSURE REDUCING VALVE	OPERATING	PRESSURE REDUCING VALVE	125 CFM	TBD	103	A	TBD	TBD/1.5"/TBD	80	AMBIENT	304 SS	N/A	N/A	N	N/A	TBD	TBD	
A	PRV-102	PRESSURE REDUCING VALVE	OPERATING	PRESSURE REDUCING VALVE	125 CFM	TBD	105	A	TBD	TBD/1.5"/TBD	80	AMBIENT	304 SS	N/A	N/A	N	N/A	TBD	TBD	

MECHANICAL EQUIPMENT LIST

63837 SCOTT BENOWITZ
EXPIRES: 03/31/2018

Water Engineering Technologies, Inc.

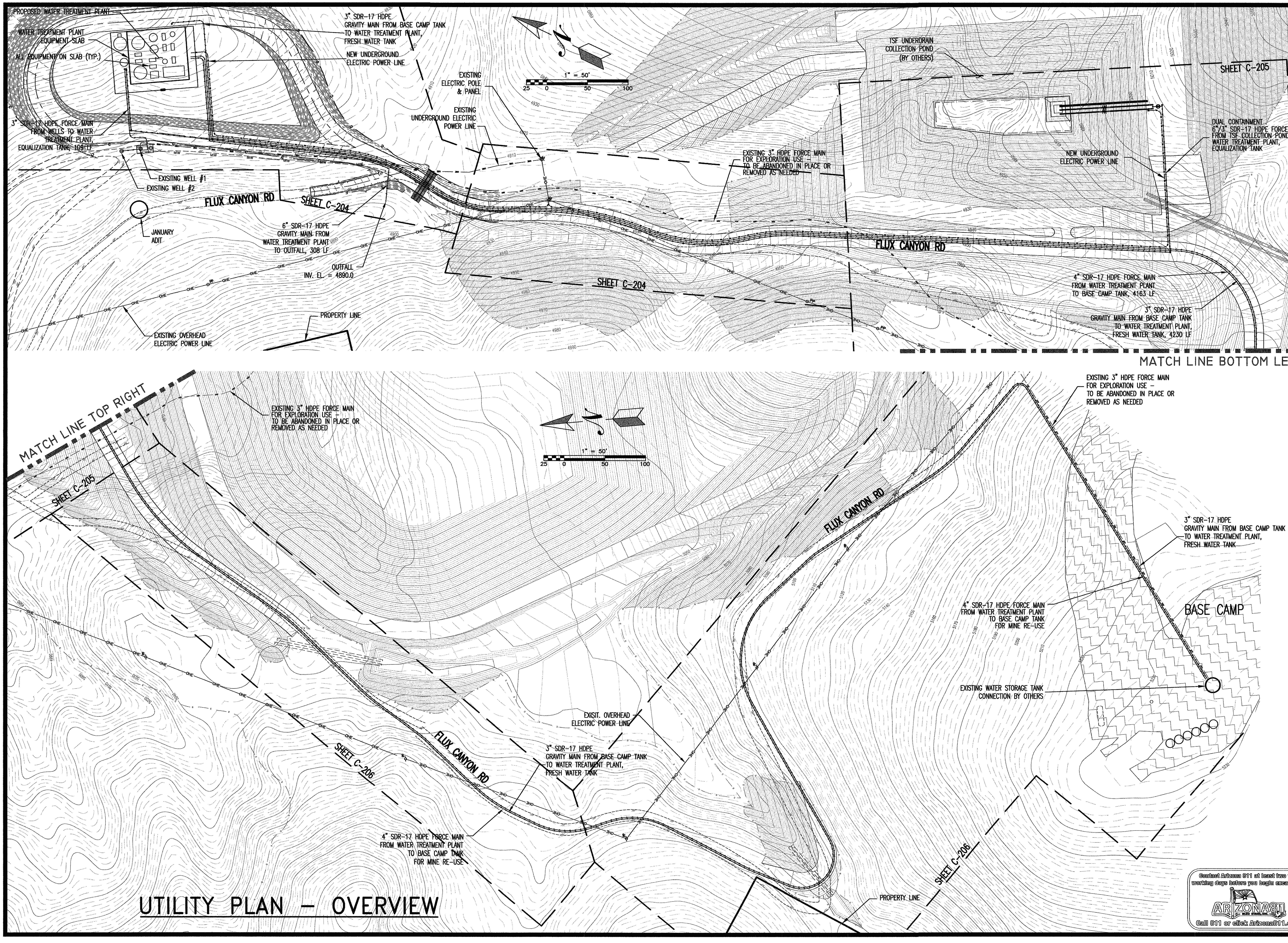
NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
MECHANICAL EQUIPMENT LIST
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY :
DRAWN BY : VG
CHK'D BY (DESIGN) :
CHK'D BY (FIELD DSGN) :

DATE: MAY 2017
SCALE: HORIZ. : N/A
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-18-MEL

100% PLANS PRINTED ON 05/15/2017



UTILITY PLAN - OVERVIEW

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
UTILITY PLAN - OVERVIEW

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY:
DRAWN BY: VG LMOB
CHK'D BY (DESIGN):
CHK'D BY (FIELD EXAM):

CPE CONSULTANTS
3860 N. Business Center Dr. Suite 116 Tucson, AZ 85705
520-545-7001

DATE: MAY 2017
SCALE HORIZ.: 1" = 50'
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-19-UTILITY-OV

SHEET: C-201
19 OF 37

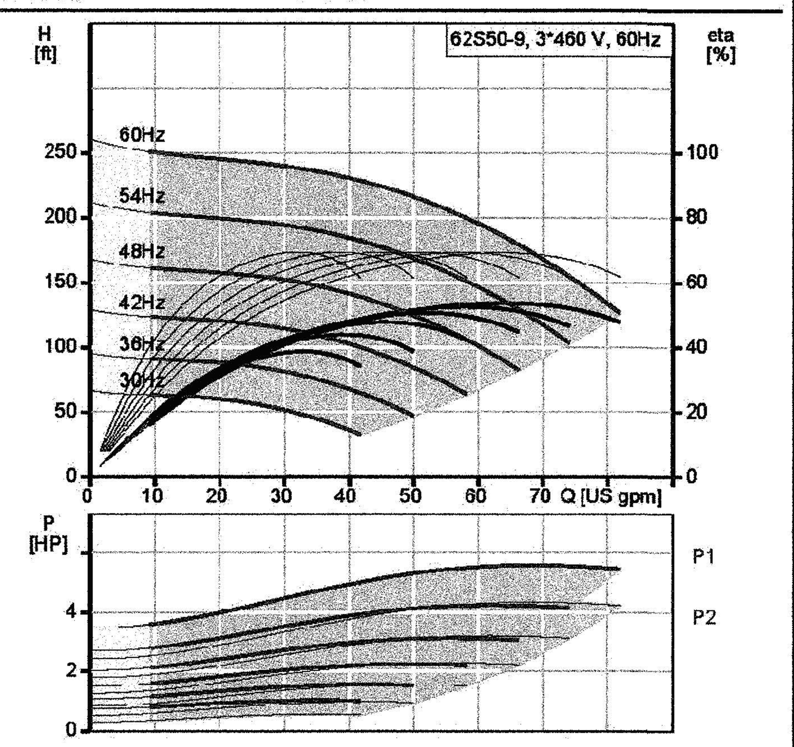
100% PLANS PRINTED ON 05/15/2017

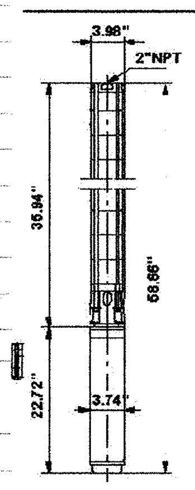
GRUNDFOS

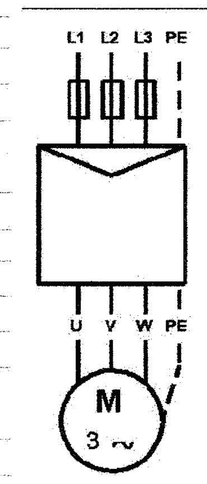
Company name:
Created by:
Phone:

Date: 5/2/2017

Description	Value
General information:	
Product name:	62S50-9
Product No.:	98924617
EAN:	5712603666099
Price:	On request
Technical:	
Speed for pump data:	3450 rpm
Rated flow:	57.7 US gpm
Rated head:	192.3 ft
Impeller reduc.:	NONE
Shaft seal for motor:	HM/CER
Curve tolerance:	ISO9906:2012 3B
Stages:	9
Model:	A
Valve:	YES
Motor version:	T40
Materials:	
Pump:	Stainless steel
	EN 1.4301
	AISI 304
Impeller:	Stainless steel
	EN 1.4301
	AISI 304
Motor:	Stainless steel
	DIN W.-Nr. 1.4301
	AISI 304
Installation:	
Maximum ambient pressure:	870 psi
Pump outlet:	2"NPT
Motor diameter:	4 inch
Liquid:	
Pumped liquid:	Water
Maximum liquid temperature:	104 °F
Q_OpFluidTemp:	68 °F
Density:	62.29 lb/ft³
Electrical data:	
Motor type:	MS4000
Applic. motor:	NEMA
Rated power - P2:	5 HP
	5 HP
KVA code:	J
Main frequency:	60 Hz
Rated voltage:	3 x 440-460 V
Service factor:	1,15
Rated current:	8,65-8,65 A
Starting current:	550-590 %
Cos phi - power factor:	0,83-0,80
Rated speed:	3460-3470 rpm
Axial load max:	992 lb
Enclosure class (IEC 34-5):	IP68
Insulation class (IEC 85):	F
Motor protection:	NONE
Thermal protec:	external
Built-in temperature transmitter:	No







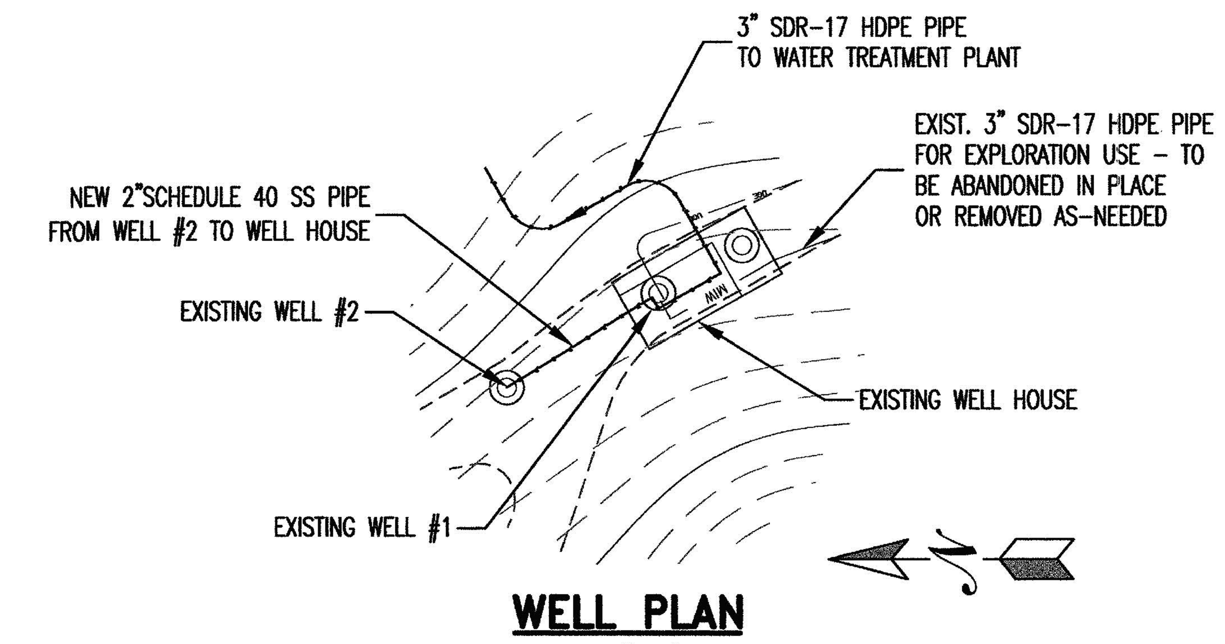
Printed from Grundfos Product Center [2017.02.034] 4/7

GRUNDFOS

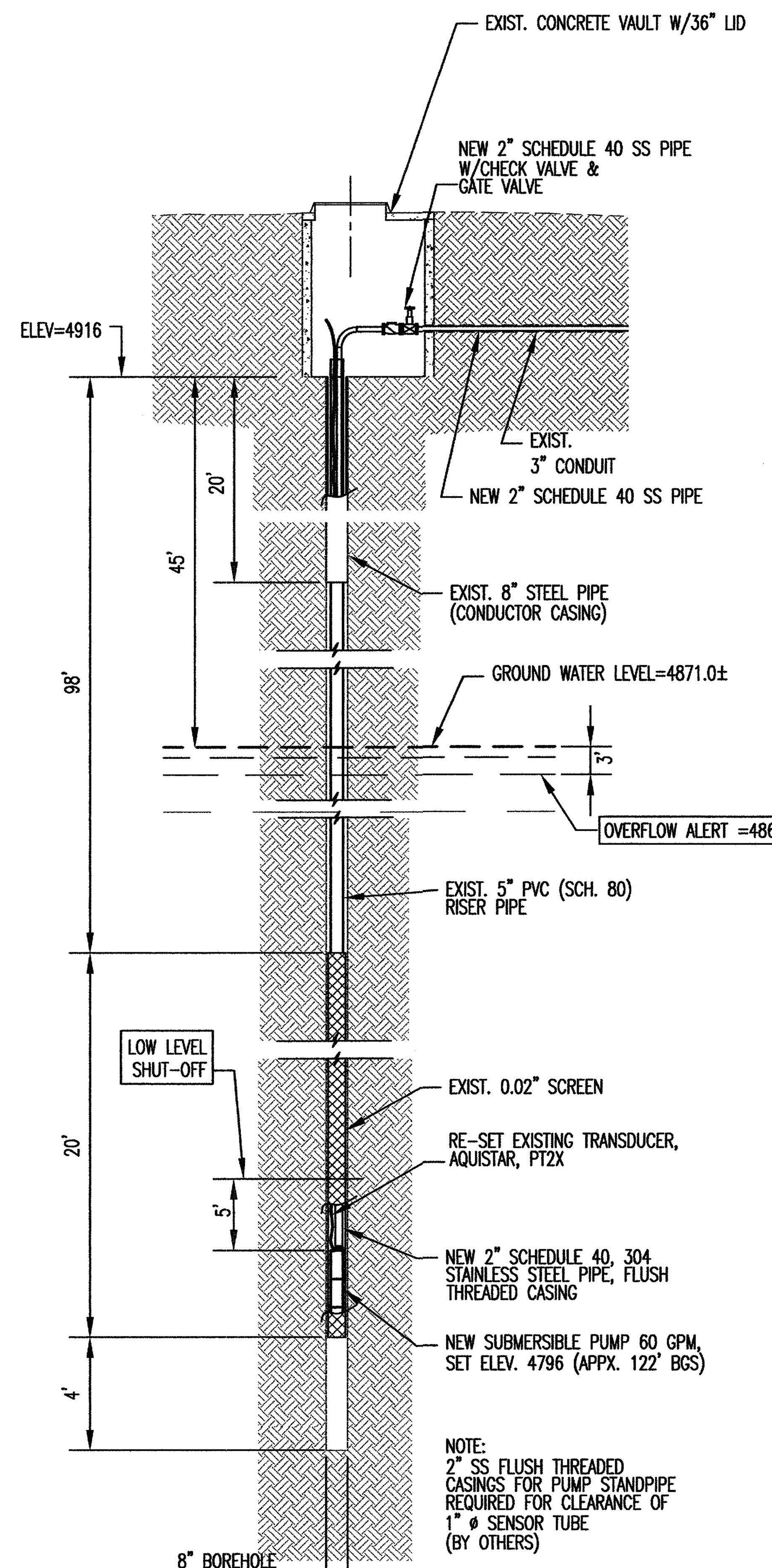
Company name:
Created by:
Phone:

Date: 5/2/2017

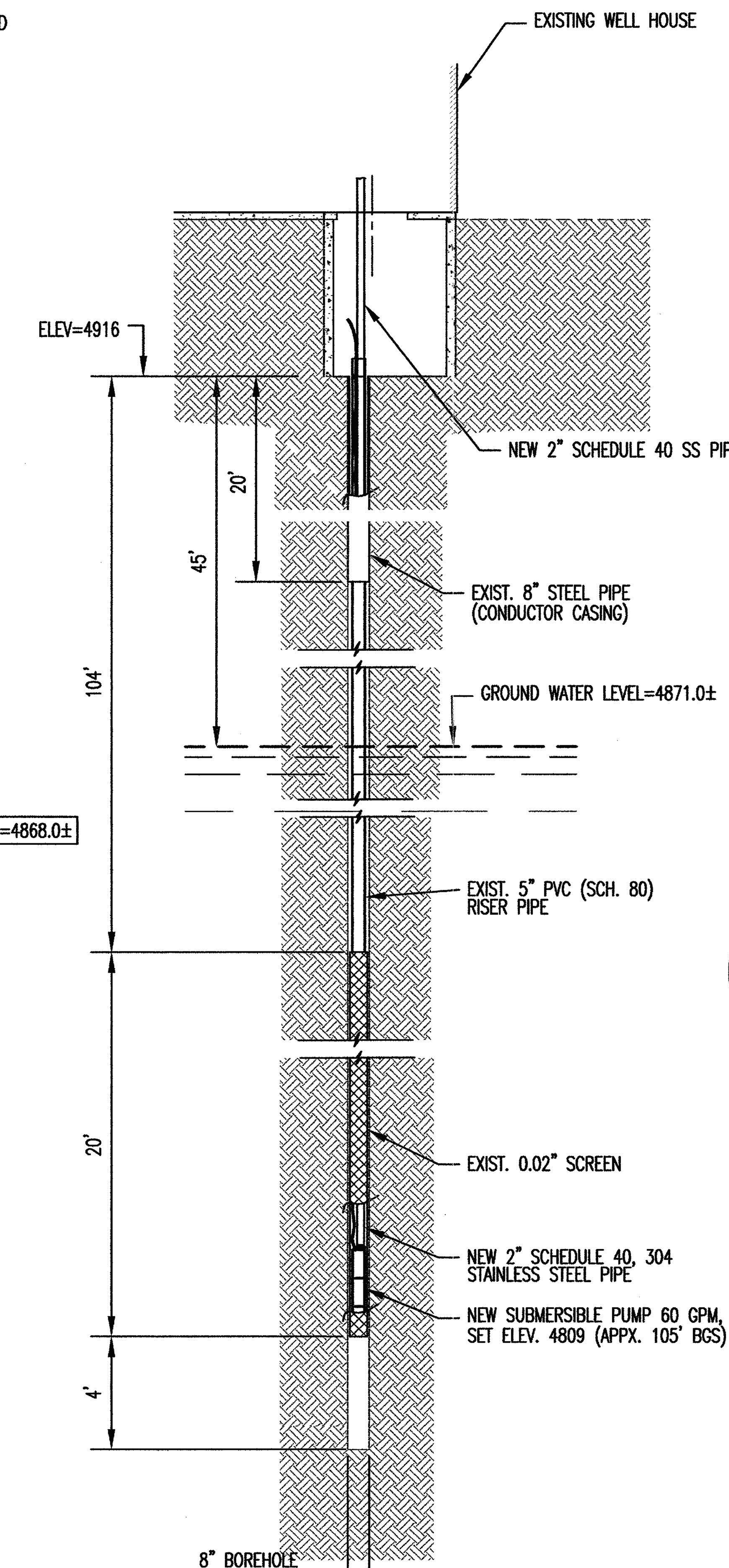
Description	Value
Motor Number:	96405811
Others:	
ErP status:	EuP Standalone/Prod.
Net weight:	71.9 lb
Gross weight:	127 lb
Shipping volume:	7.06 ft³



WELL PLAN
SCALE: 1"=20'



EXISTING WATER WELL #2
SECTION FOR ADIT
SCALE: 1"=4'



EXISTING WATER WELL #1
SECTION FOR ADIT
SCALE: 1"=4'

NO.	REVISION	APP'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
WATER WELL AND PUMP DETAILS
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD CHECK) :

CPE CONSULTANTS
3865 N. Business Center Dr. Suite 115 Tucson, AZ 85705
520-545-7001

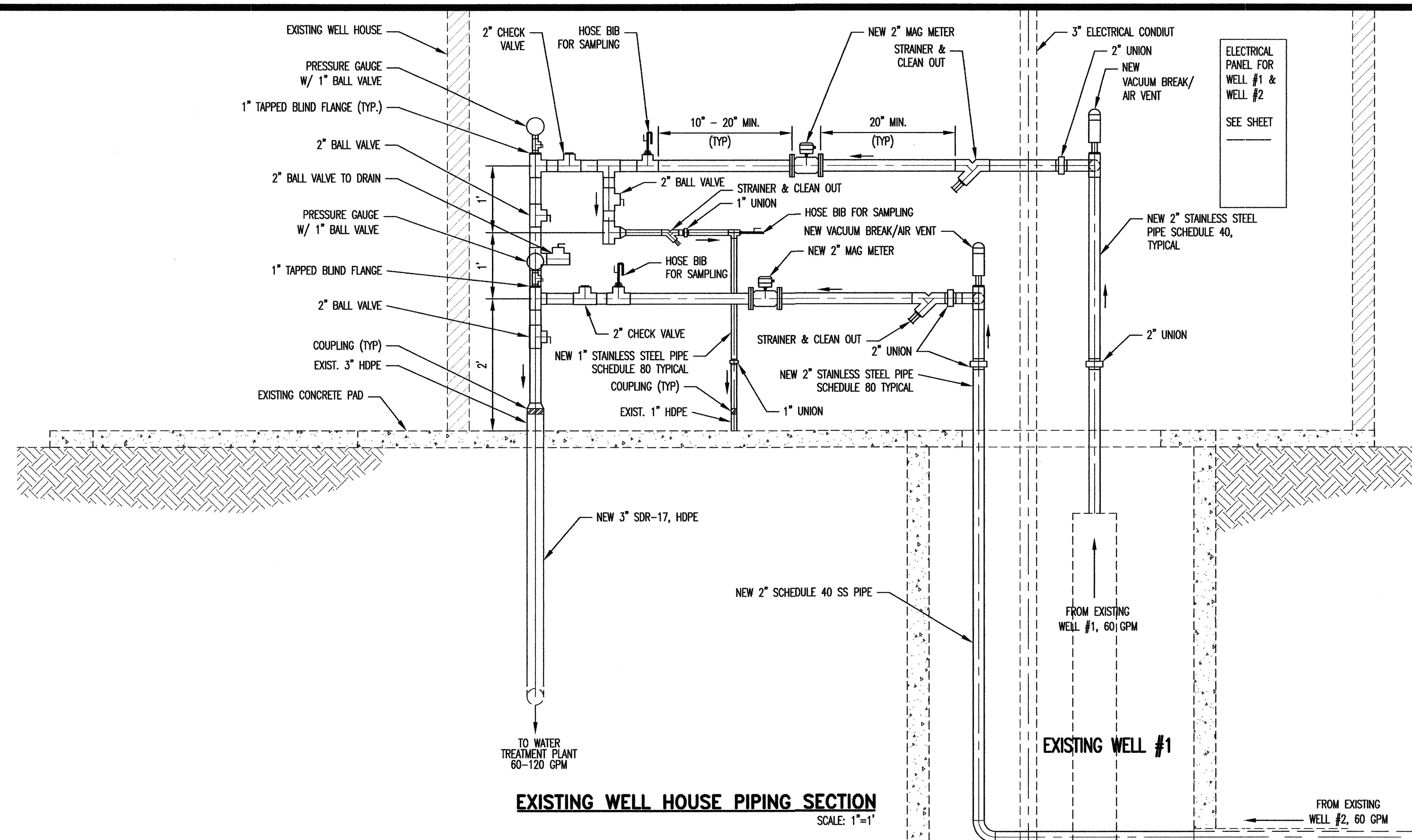
DATE: MAY 2017
SCALE: HORIZ. : AS NOTED
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-20-WELL-DETAILS

SHEET: C-202
20 OF 37

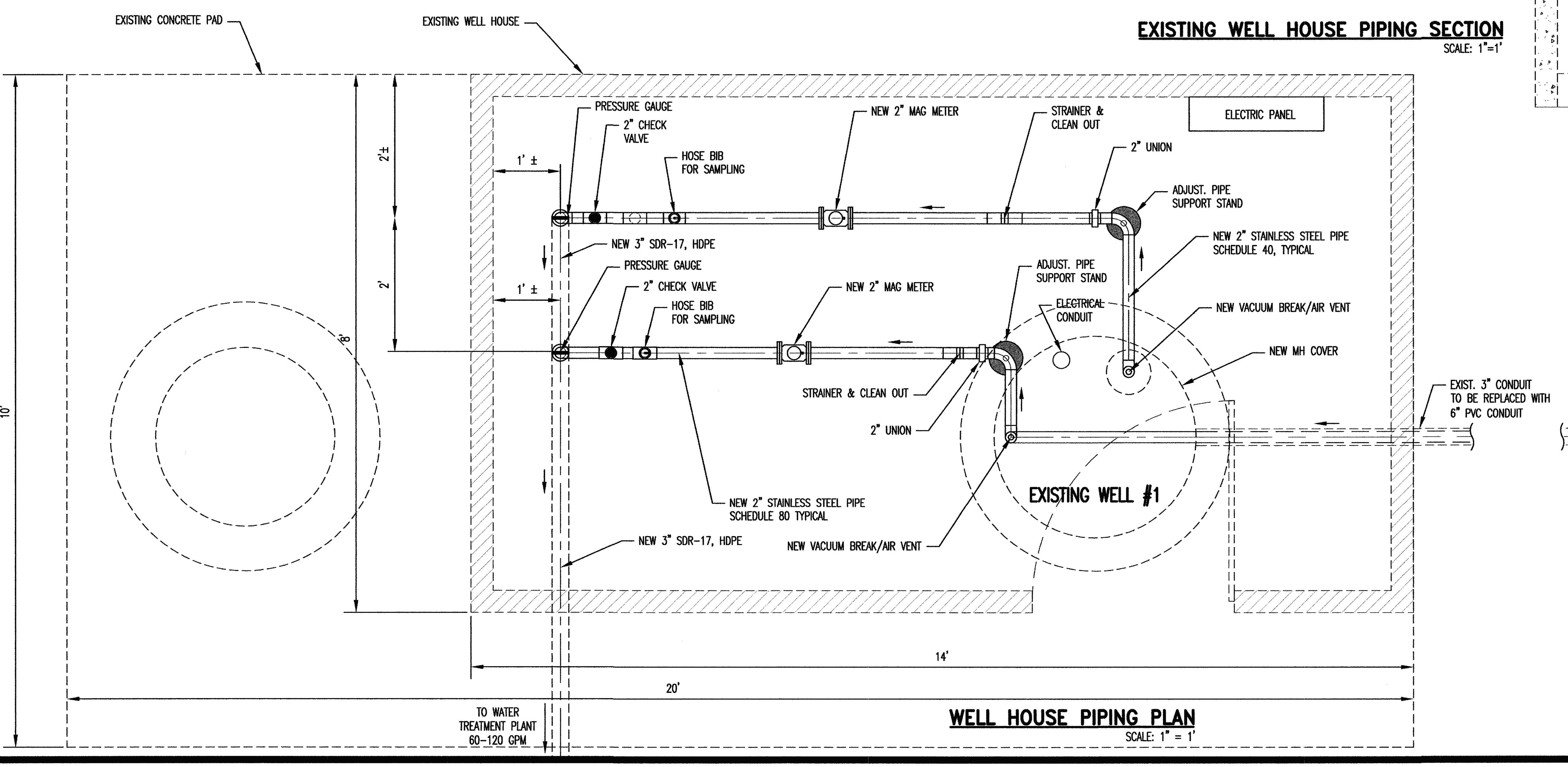
100% PLANS PRINTED ON 05/15/2017

PARTS LIST

QTY	DESCRIPTION
64 LF	2" STAINLESS STEEL PIPE, SCHEDULE 40
3 EA	COUPLING – HDPE TO STAINLESS STEEL
4 EA	2" UNION
2 EA	VACUUM BREAK/AIR VENT
2 EA	2" STRAINER/CLEANOUT
2 EA	2" MAG METER
2 EA	2" HOSE BIB/SAMPLING POINT
2 EA	2" CHECK VALVE
2 EA	PRESSURE GAUGE W/ 1" BALL VALVE, W/ 1" TAPPED BLIND FLANGE
4 EA	2" BALL VALVE
7 EA	2"x2" TEE
2 EA	2" 90° BEND
2 EA	3"x2" REDUCER
1 EA	2"x1" REDUCER
5 LF	1" STAINLESS STEEL PIPE, SCHEDULE 40
1 EA	1" HOSE BIB/SAMPLING POINT
2 EA	1" UNION
1 EA	1"x1" TEE
2 EA	ADJUSTABLE PIPE SUPPORT STAND
1 EA	36" HDPE MANHOLE COVER
21 LF	6" PVC PIPE (CONDUIT)



EXISTING WELL HOUSE PIPING SECTION
SCALE: 1"=1'



WELL HOUSE PIPING PLAN
SCALE: 1" = 1'

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ARIZONA811
Call 811 or click Arizona811.com

NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
WELL HOUSE PIPING PLAN
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

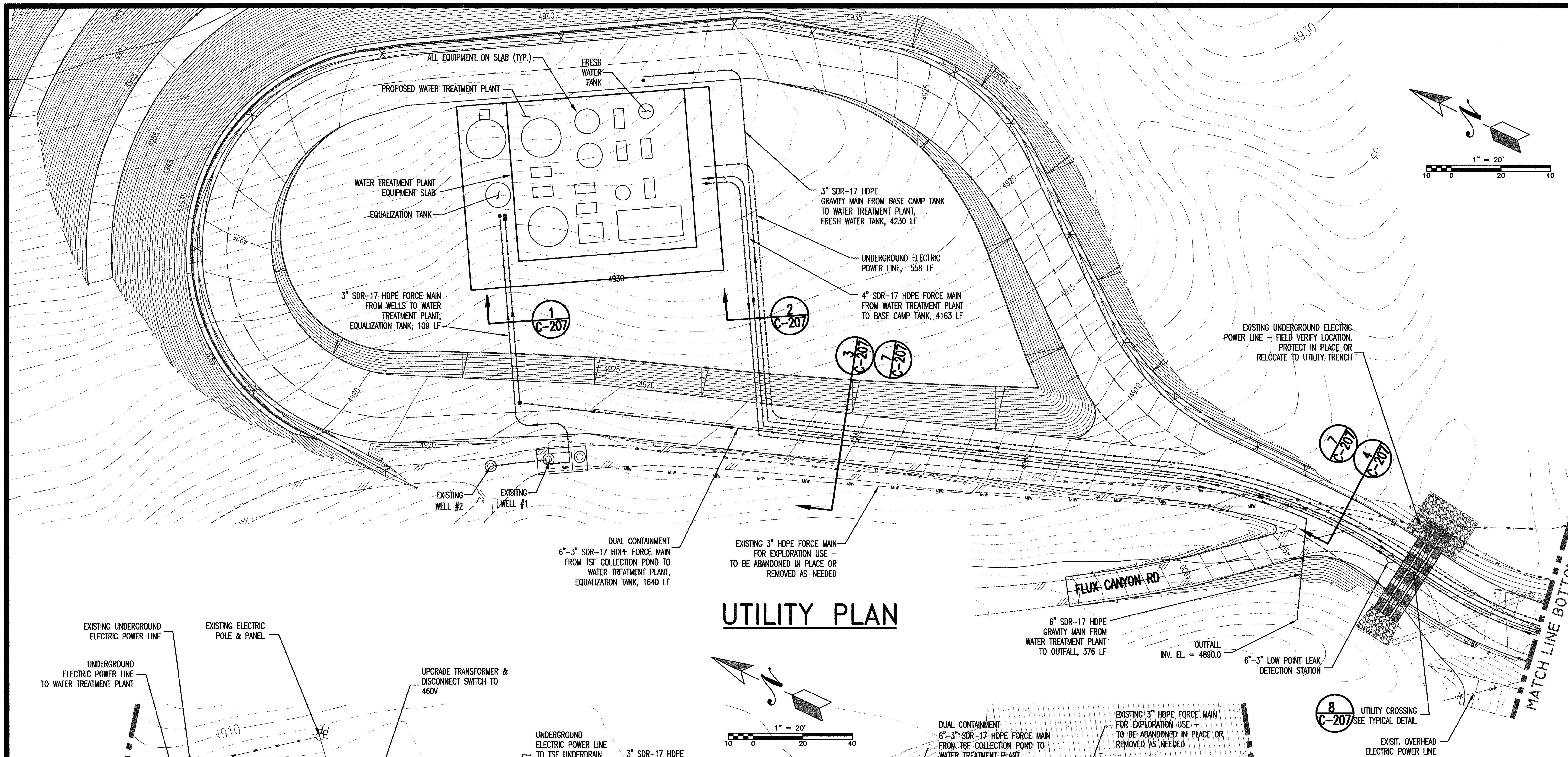
DESIGNED BY :
DRAWN BY : VG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS
3865 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520-545-7001
[redacted]

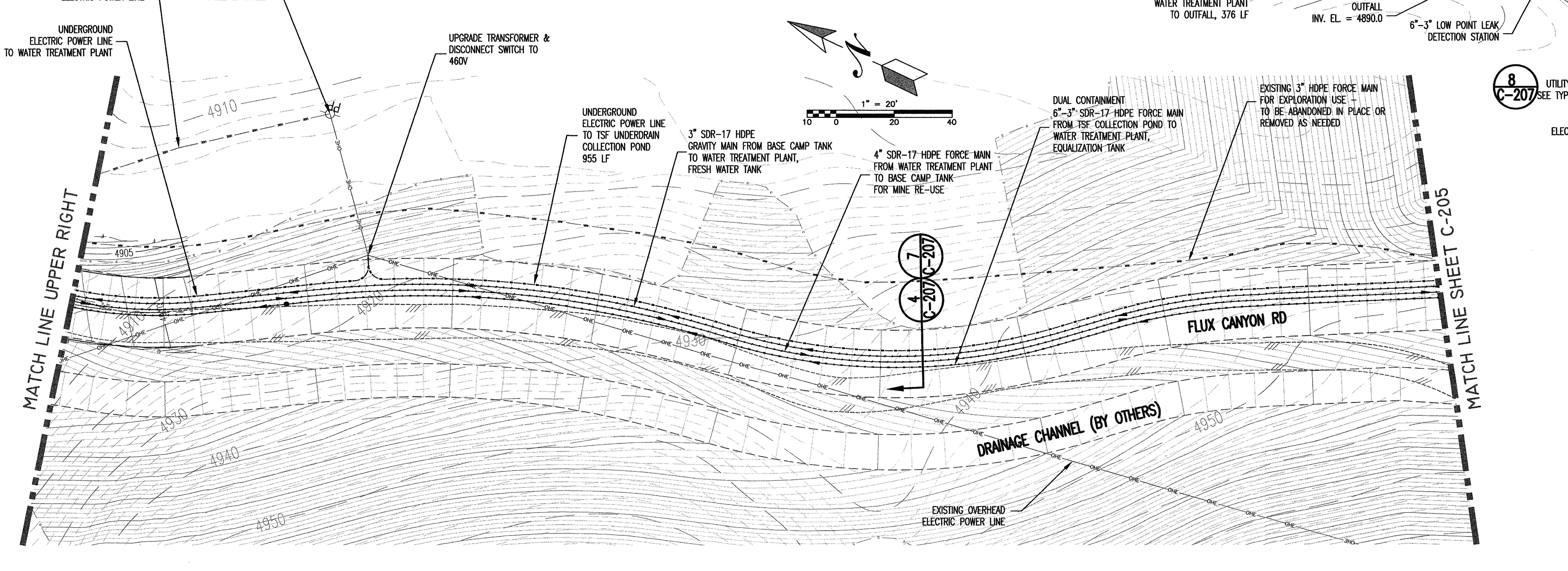
DATE: MAY 2017
HORIZ. : AS NOTED
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-21-WELL-PIPING-PLAN

SHEET: C-203
21 OF 37

100% PLANS PRINTED ON 05/15/2017



UTILITY PLAN



MATERIAL QUANITIES	
QTY	DESCRIPTION
1508 LF	UGE - UNDERGROUND ELECTRIC
4303 LF	3" SDR-17 HDPE
4122 LF	4" SDR-17 HDPE
308 LF	6" SDR-17 HDPE
1800 LF	6" - 3" DUAL CONTAINMENT PIPE
6 EA	6"-3" DUAL CONTAINMENT CLEANOUT
1 EA	6"-3" LOW POINT LEAK DETECTION STATION

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
UTITILITY PLAN

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

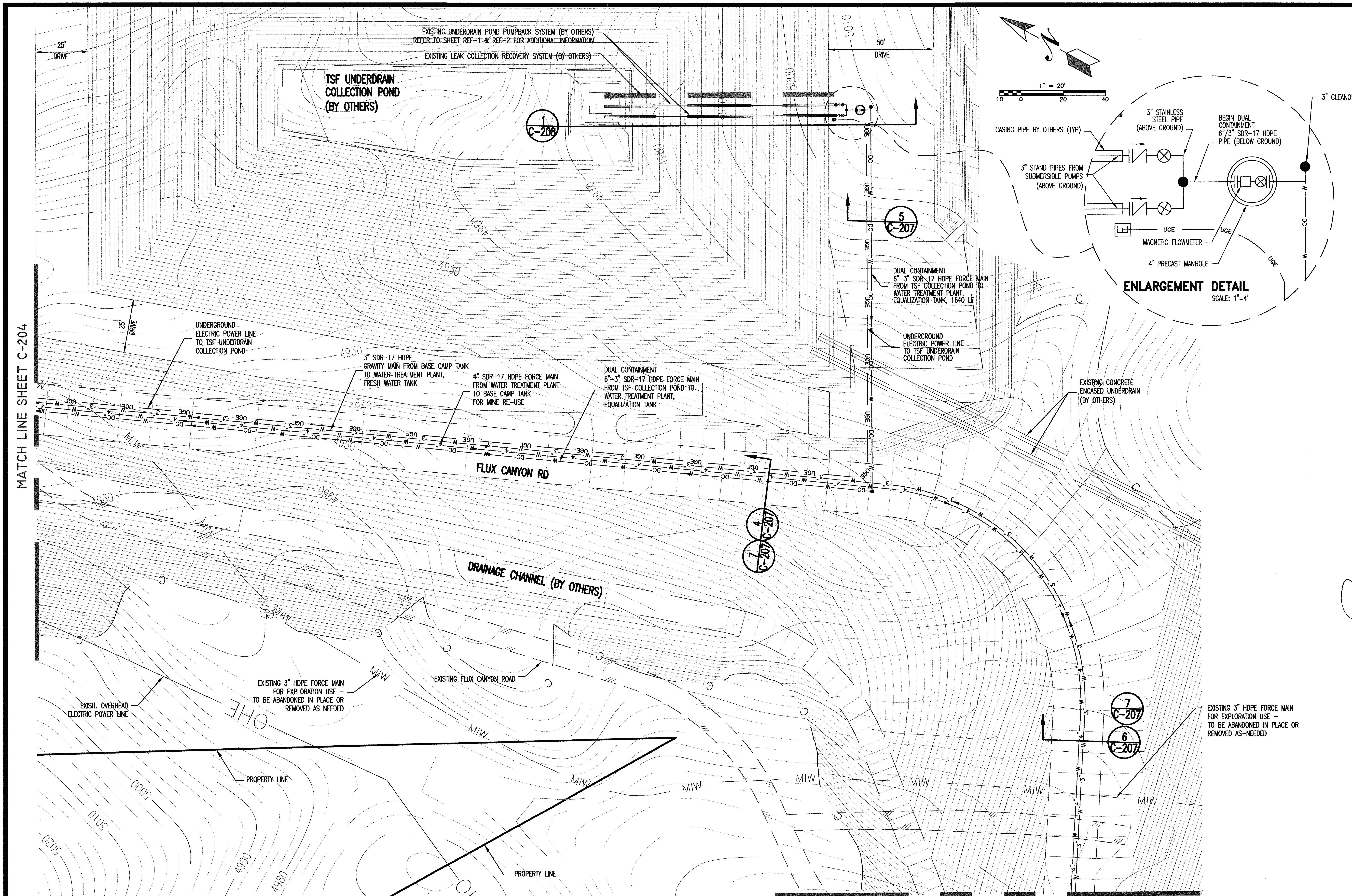
Registered Professional Engineer (Civil) CERTIFICATE NO. 15606 Raul Francisco G. Piña ARIZONA, USA Expires 12/31/18

DESIGNED BY :
DRAWN BY : LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS [redacted]
3805 N. Business Center Dr. Suite 115 Tucson, AZ 85705
520-545-7001

DATE: MAY 2017
SCALE HORIZ. : 1" = 20'
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-22-UTILITY

100% PLANS PRINTED ON 05/15/2017



UTILITY PLAN

Contact Arizona 811 at least two full working days before you begin excavation
ARIZONA811
Call 811 or click Arizona811.com

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
UTITILITY PLAN

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

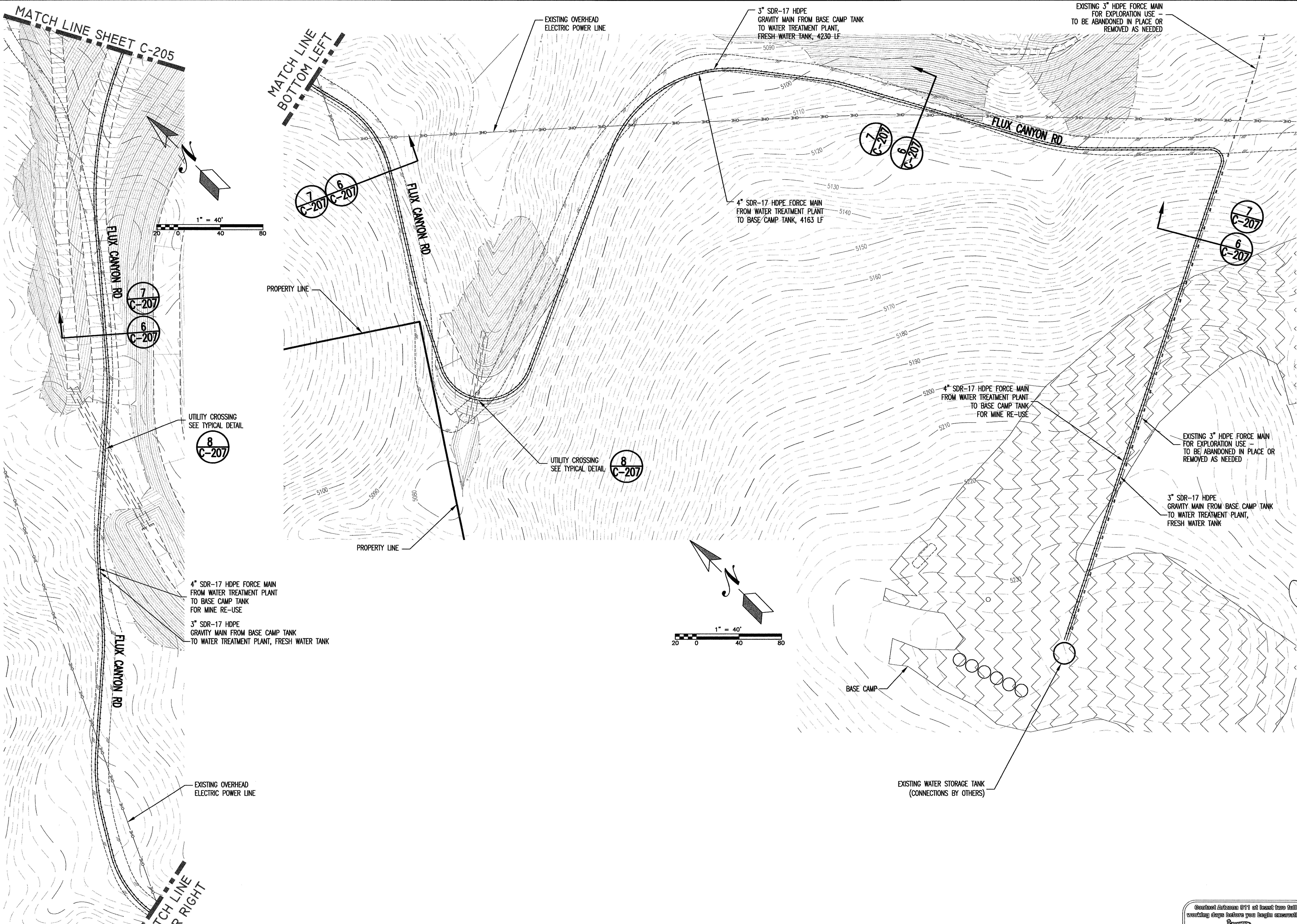
NO. | REVISION | APP'V'D | DATE

CPE CONSULTANTS
[redacted]

DATE: MAY 2017
HORIZ.: 1" = 20'
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-22-UTILITY

SHEET: C-205
23 OF 37

100% PLANS PRINTED ON 05/15/2017



UTILITY PLAN

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
UTITILITY PLAN

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

Registered Professional Engineer (Civil) Certificate No. 15606 Raul Francisco G. Pino ARIZONA, U.S.A. Expires 12/31/18

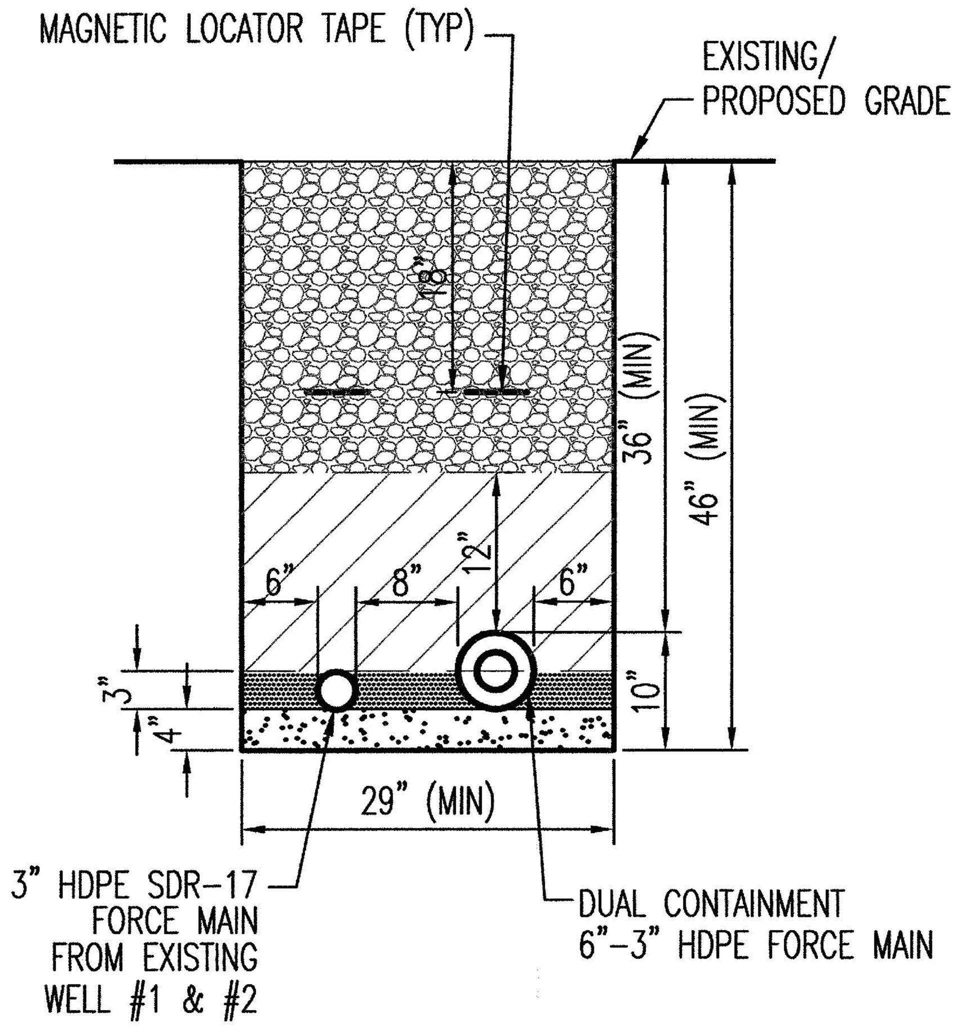
DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS
[redacted]
3895 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520-545-7001

DATE: MAY 2017
SCALE: HORIZ. : 1" = 40'
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-24-UTILITY-3

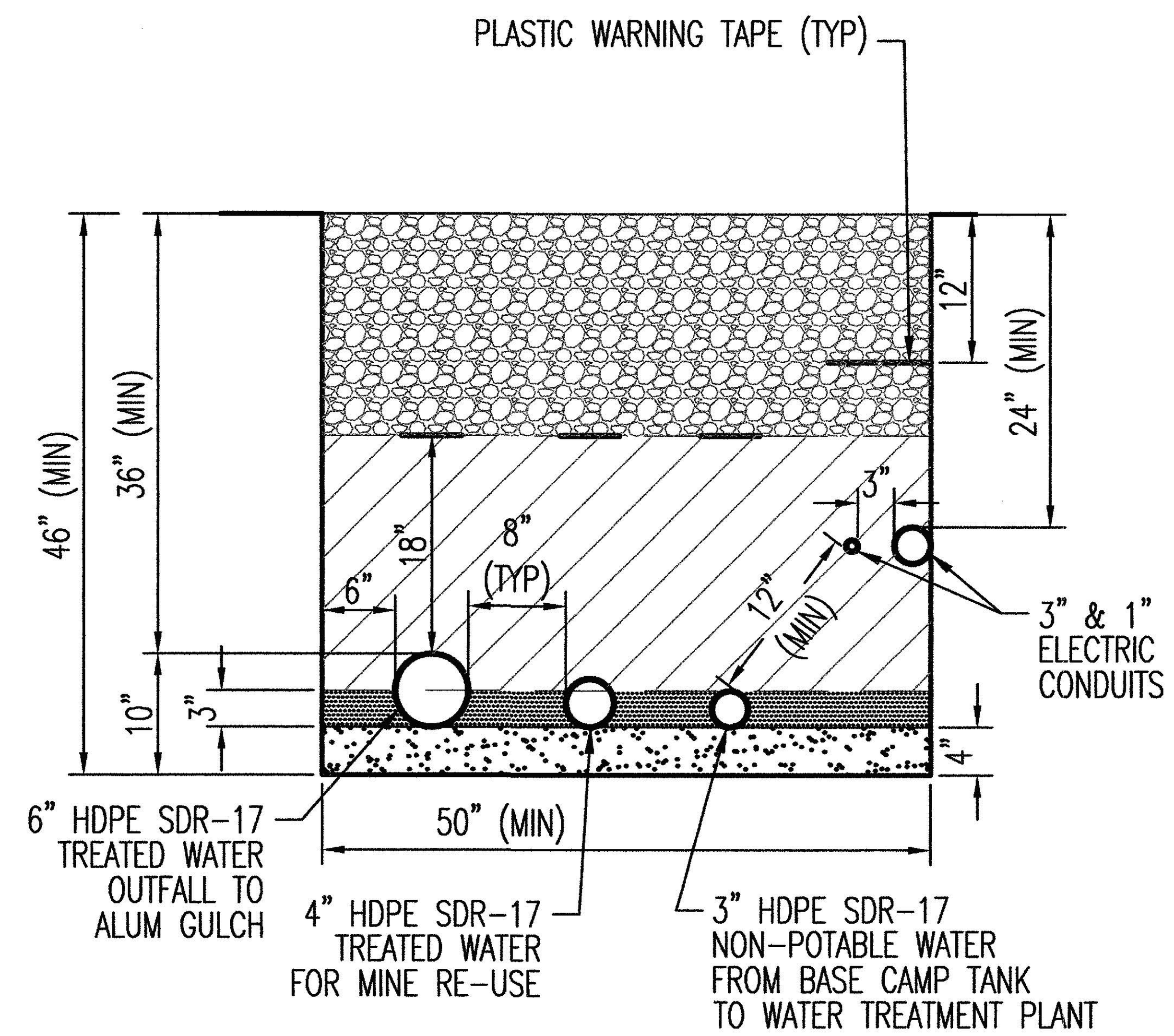
SHEET: C-206
24 of 37

100% PLANS PRINTED ON 05/15/2017



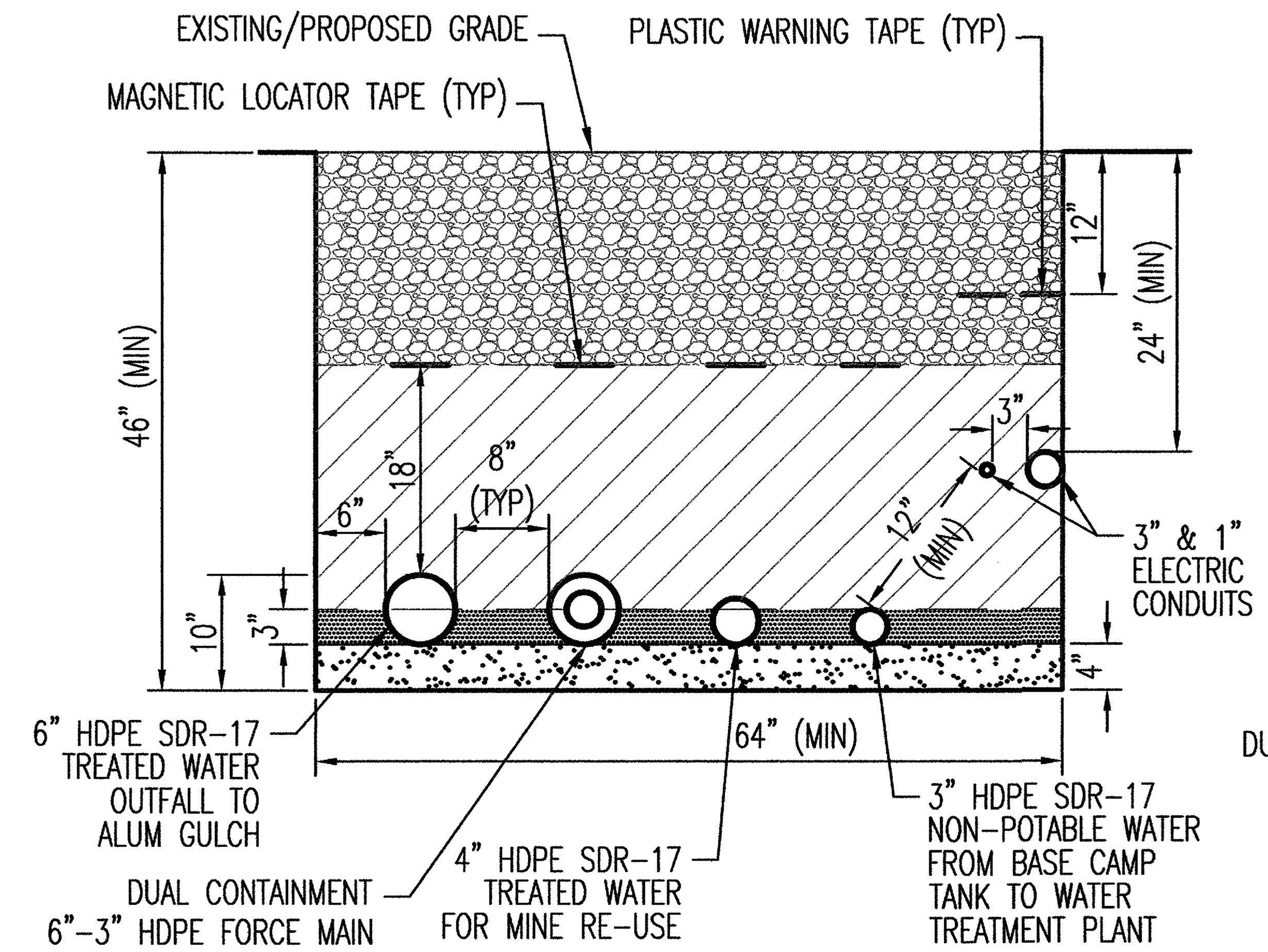
① TYPICAL UTILITY TRENCH DETAIL

SCALE: 1"=1'



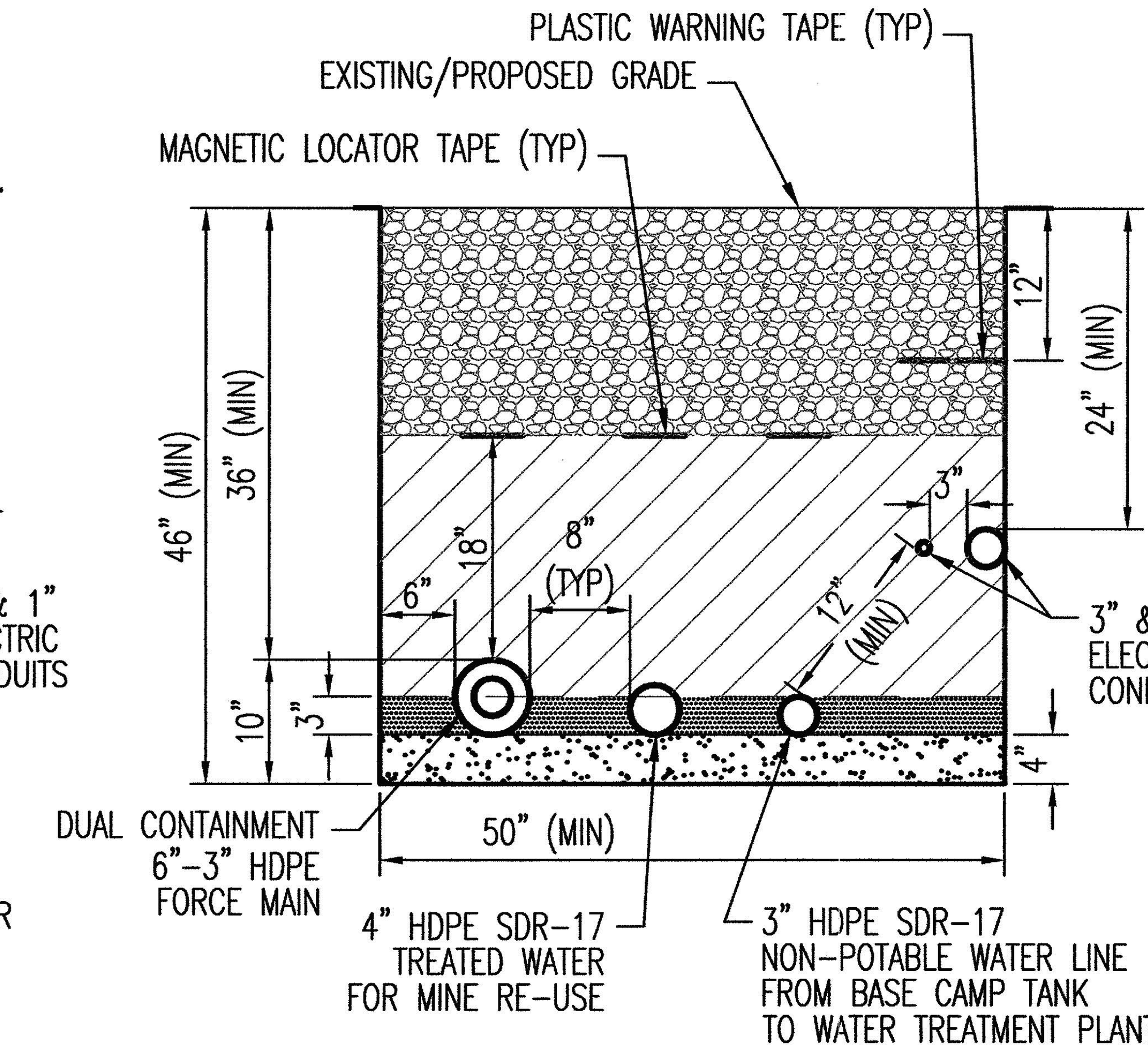
② TYPICAL UTILITY TRENCH DETAIL

SCALE: 1"=1'



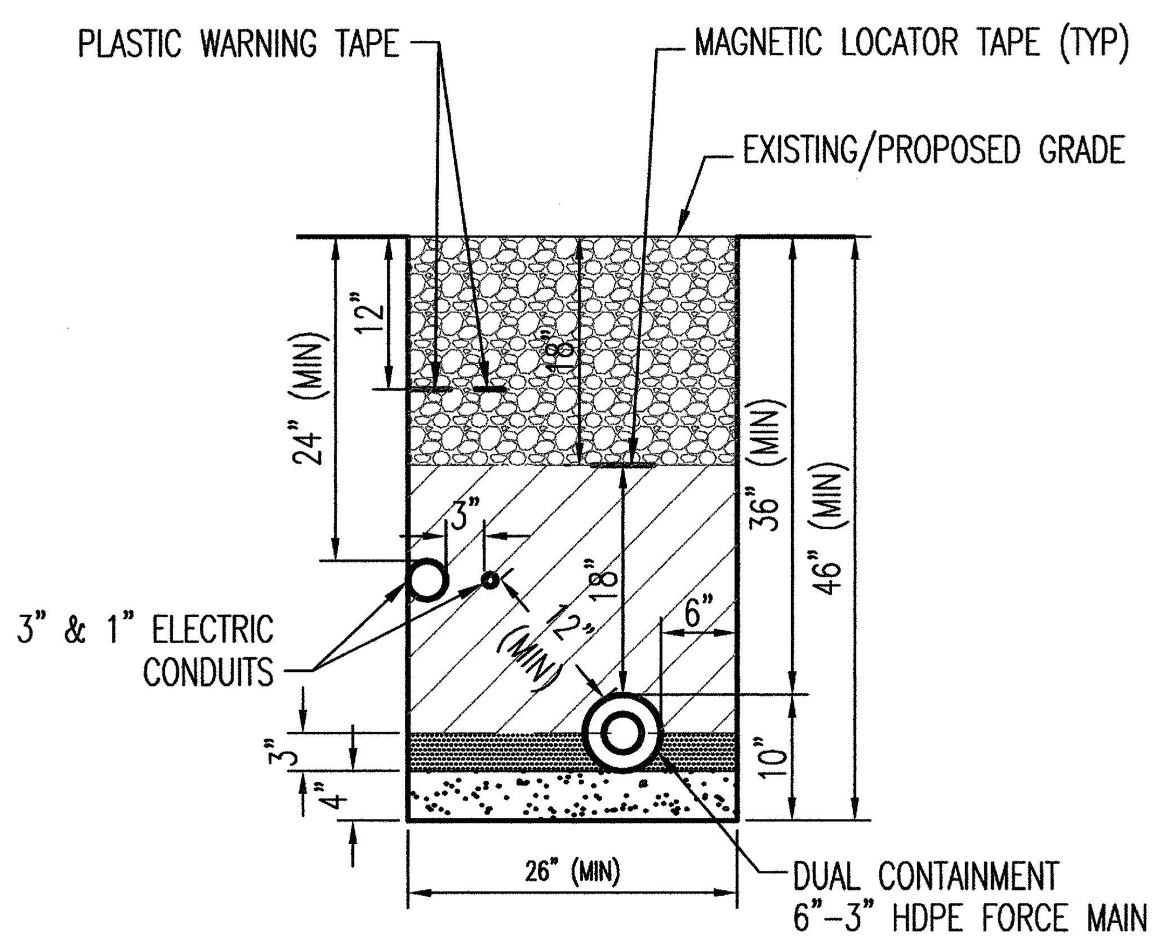
③ TYPICAL UTILITY TRENCH DETAIL

SCALE: 1"=1'



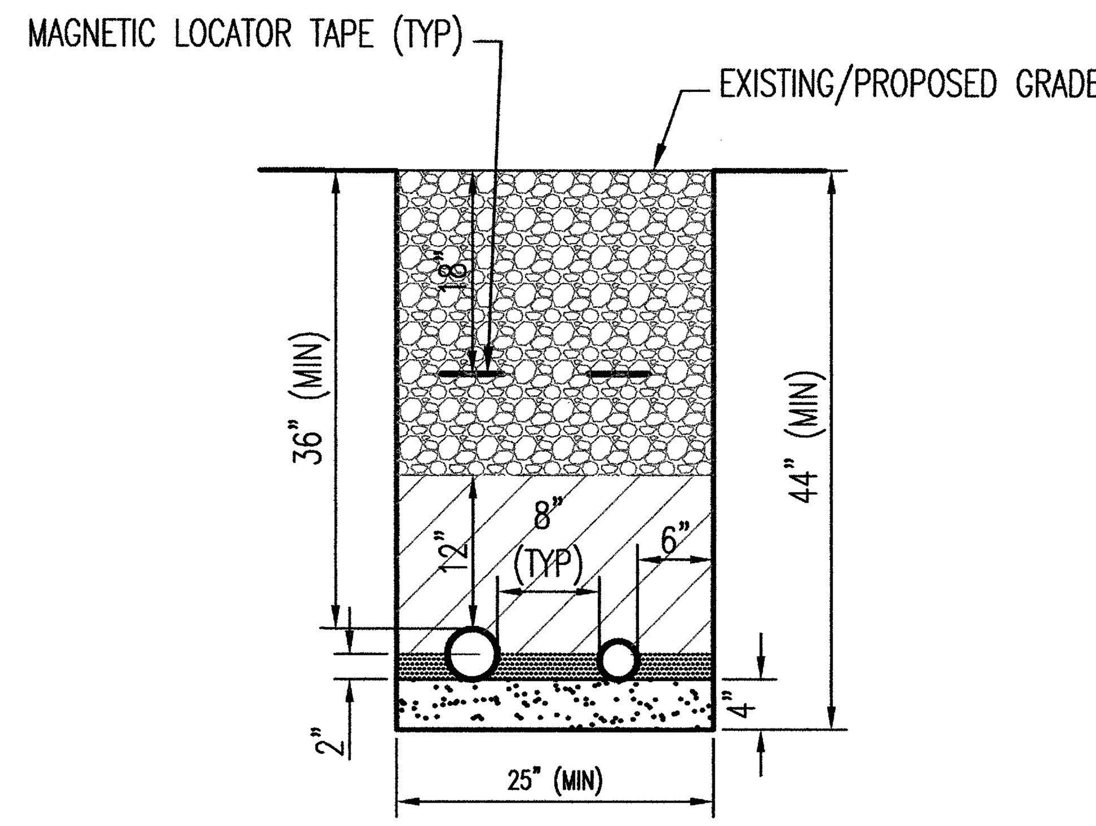
④ TYPICAL UTILITY TRENCH DETAIL

SCALE: 1"=1'



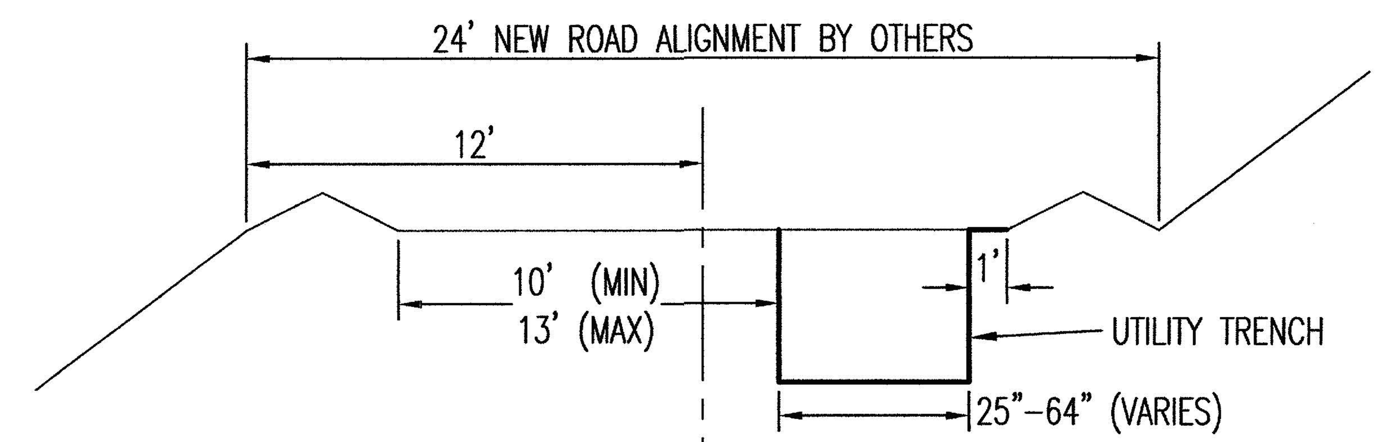
⑤ TYPICAL UTILITY TRENCH DETAIL

SCALE: 1"=1'



⑥ TYPICAL UTILITY TRENCH DETAIL

SCALE: 1"=1'



⑦ NEW FLUX CANYON ROAD TYPICAL SECTION WITH UTILITY TRENCH

SCALE: 1"=4'

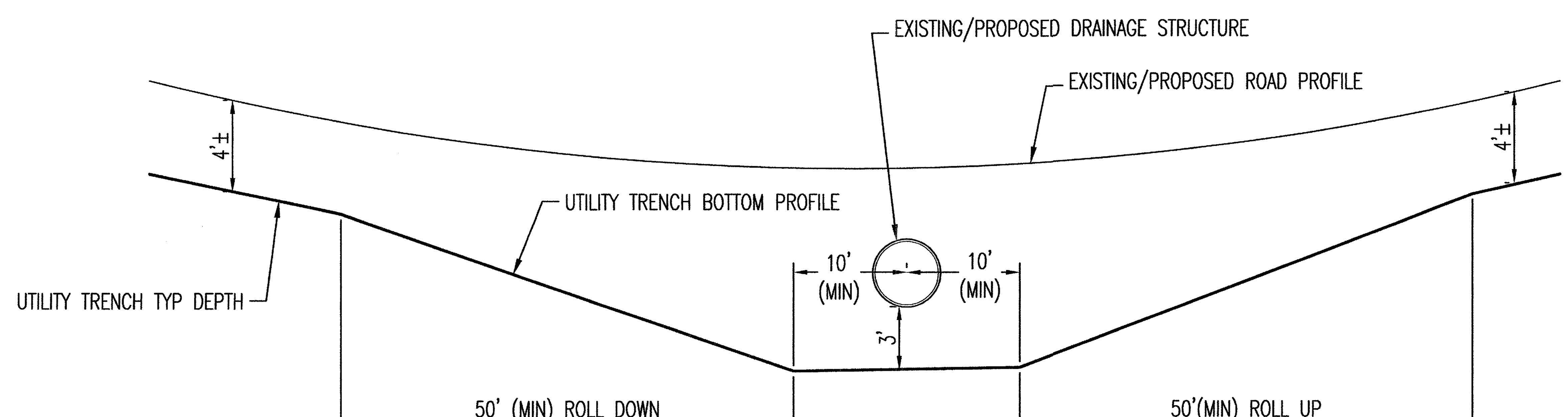
UTILITY TRENCH BACKFILL MATERIAL LEGEND

FINAL BACKFILL CONSISTING OF NATIVE MATERIAL WITH ROCKS/DEBRIS REMOVED. TO BE COMPACTED TO 95%

INITIAL BACKFILL CONSISTING OF ABC PER MAG SPEC. SECTION 702. TO BE COMPACTED TO 95%

HAUNCHING CONSISTING OF ABC PER MAG SPEC. SECTION 702.

BEDDING CONSISTING OF ABC PER MAG SPEC. SECTION 702.



⑧ UTILITY TRENCH TYPICAL CROSSING WITH DRAINAGE STRUCTURE

SCALE: N.T.S.

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NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
UTILITY – DETAILS

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY:
DRAWN BY: VG LMOB
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

CPE CONSULTANTS
3866 N. Business Center Dr. Suite 116 Tucson, AZ 85705
520-545-7001
[redacted]

DATE: MAY 2017
HORIZ.: NTS
VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-25-UTILITY-DETAILS

SHEET: C-207
25 of 37

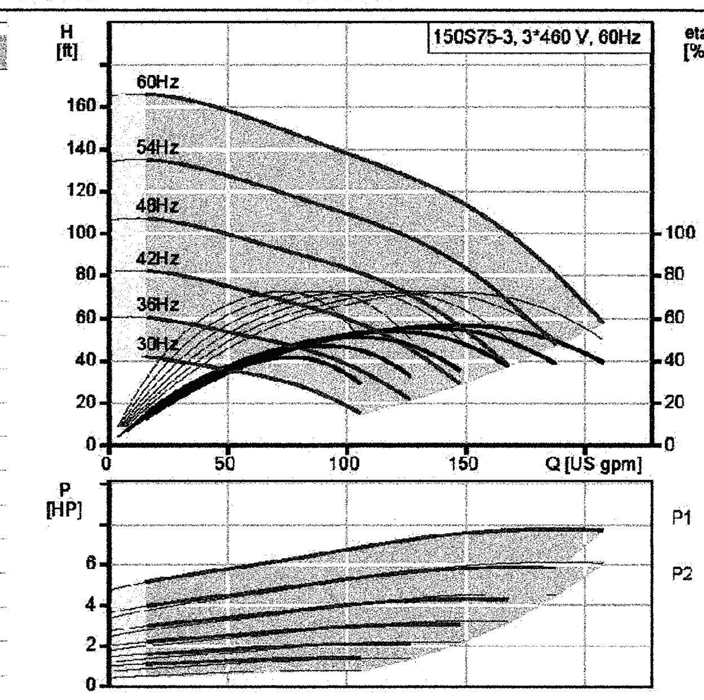
100% PLANS PRINTED ON 05/15/2017

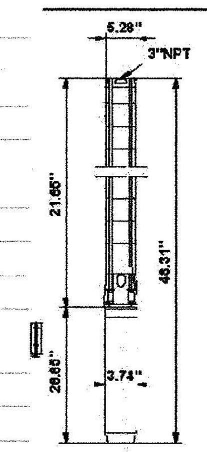
GRUNDFOS

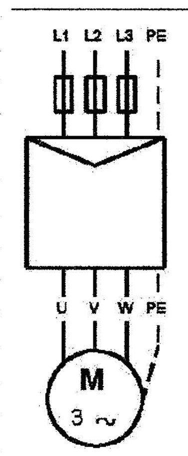
Company name:
Created by:
Phone:

Date: 5/3/2017

Description	Value
General information:	
Product name:	150S75-3
Product No.:	13B63603
EAN:	5700391427435
Price:	On request
Technical:	
Speed for pump data:	3450 rpm
Rated flow:	159 US gpm
Rated head:	101.7 ft
Impeller reduc.:	NONE
Shaft seal for motor:	HM/CER
Approvals on nameplate:	CE,EAC,CSA
Curve tolerance:	ISO9906:2012 3B
Stages:	3
Model:	B
Valve:	YES
Motor version:	T40
Materials:	
Pump:	Stainless steel
	EN 1.4301
	AISI 304
Impeller:	Stainless steel
	EN 1.4301
	AISI 304
Motor:	Stainless steel
	DIN W.-Nr. 1.4301
	AISI 304
Installation:	
Maximum ambient pressure:	870 psi
Pump outlet:	3"NPT
Motor diameter:	4 inch
Liquid:	
Pumped liquid:	Water
Maximum liquid temperature:	104 °F
Q_OpFluidTemp:	68 °F
Density:	62.29 lb/ft³
Electrical data:	
Motor type:	MS4000
Applic. motor:	GRUNDFOS
Rated power - P2:	7.5 HP
	7.5 HP
KVA code:	J
Main frequency:	60 Hz
Rated voltage:	3 x 440-460 V
Starter:	1
Service factor:	1,15
Rated current:	12,8-12,6 A
Starting current:	570-620 %
	67 A
Cos phi - power factor:	0.87-0.82
Rated speed:	3440-3460 rpm
Axial load max:	992 lb
Motor efficiency at full load:	81.0 %
Start. method:	direct-on-line







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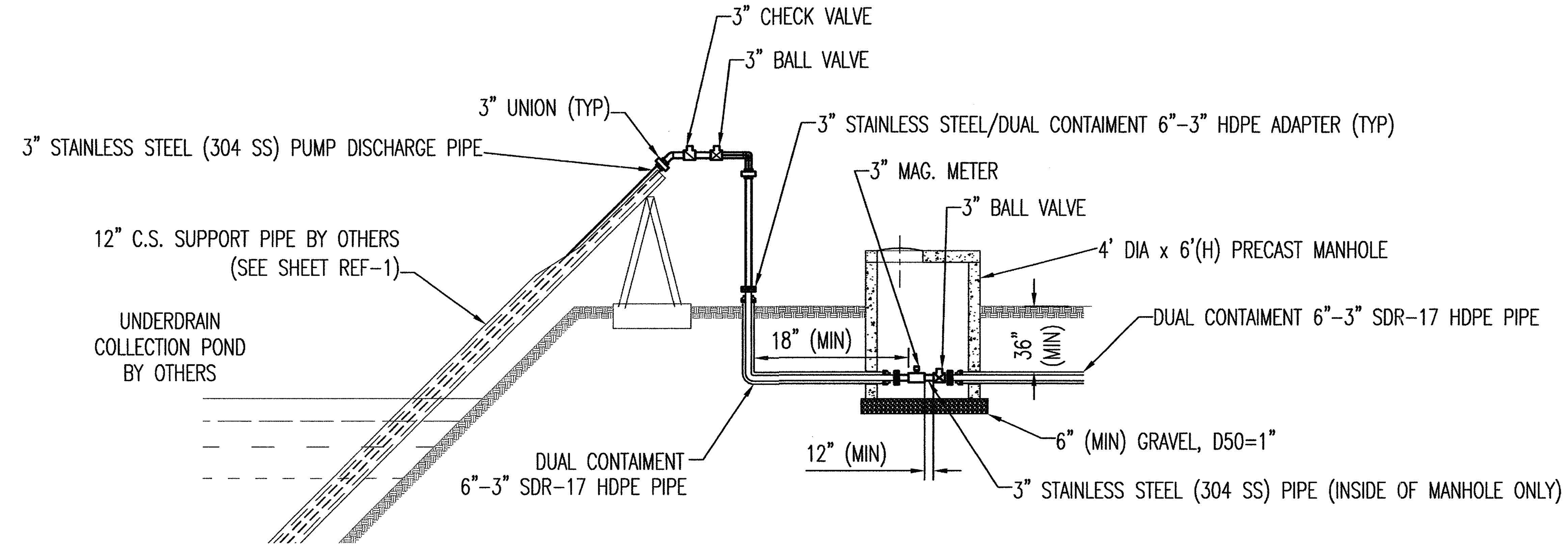
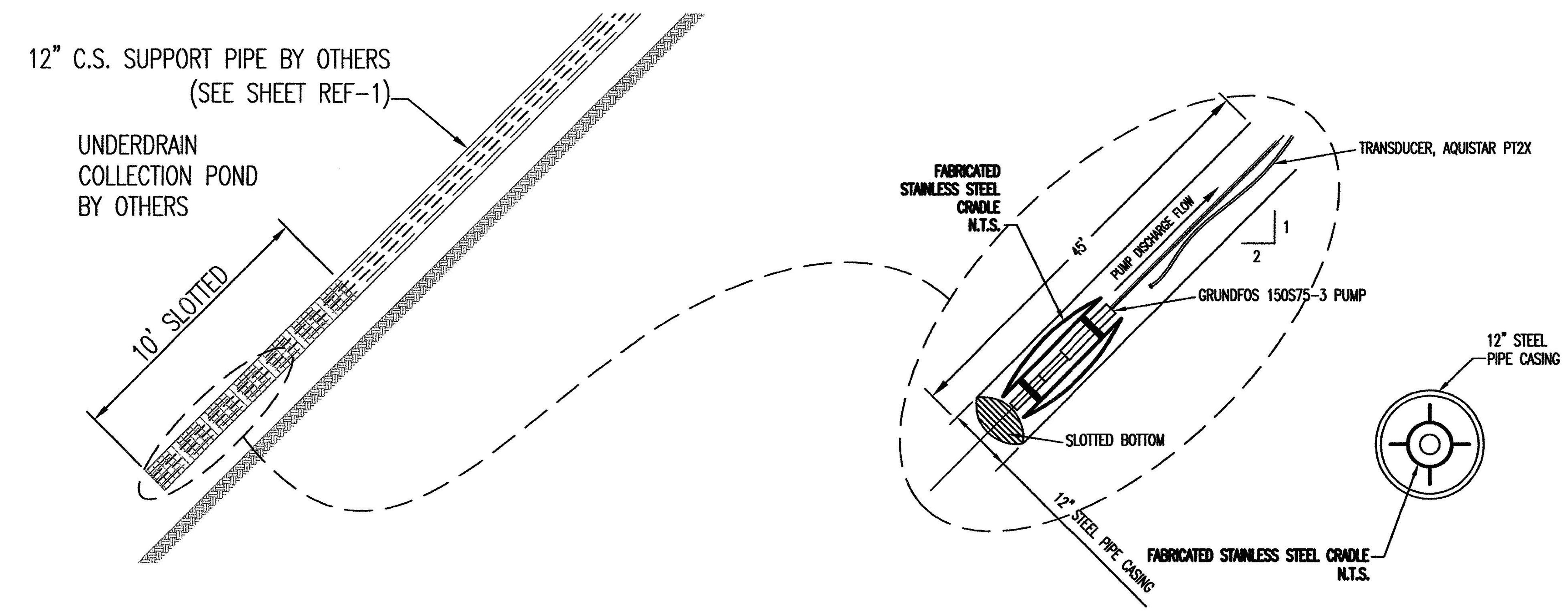
GRUNDFOS

Company name:
Created by:
Phone:

Date: 5/3/2017

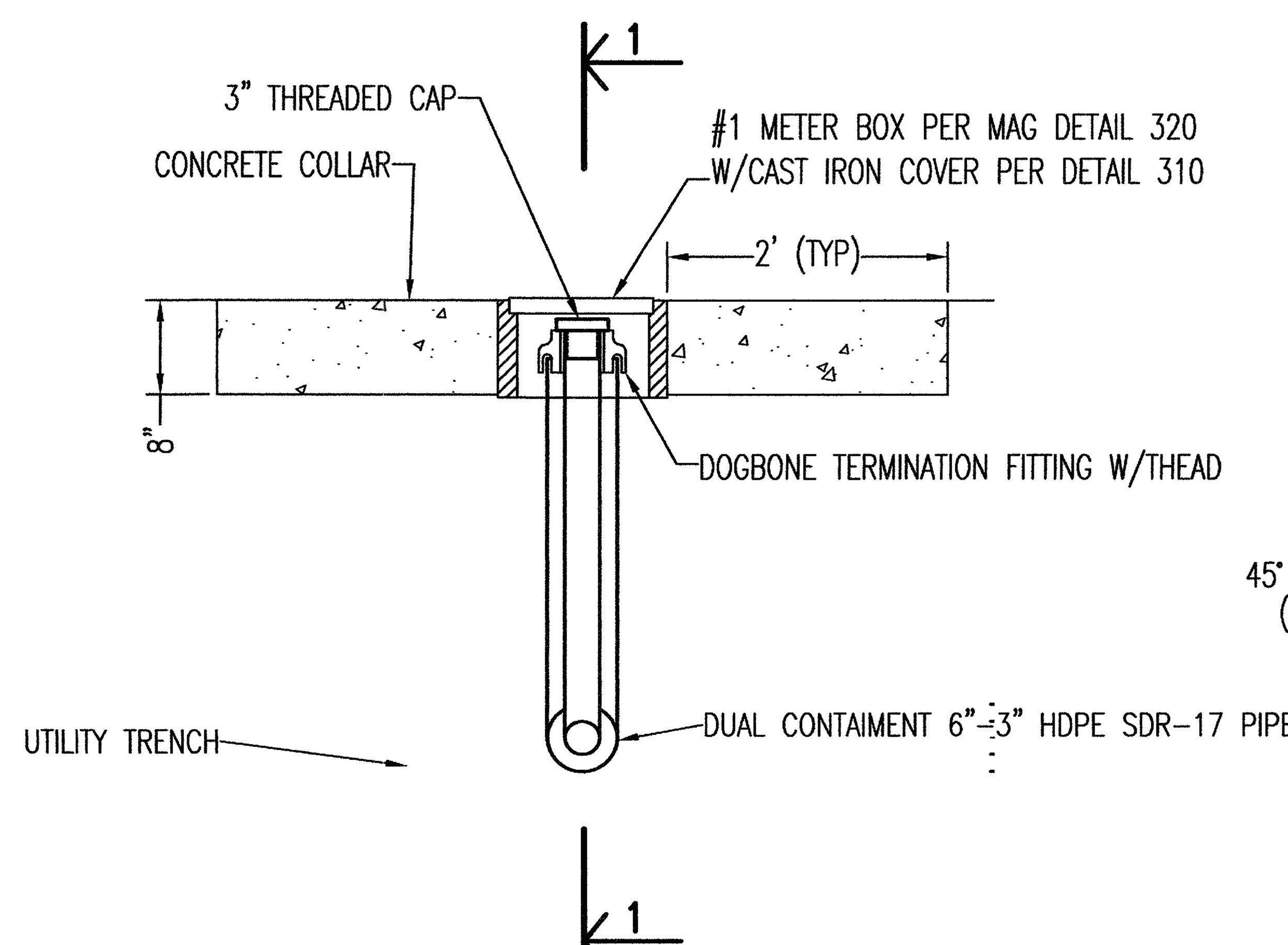
Description	Value
Enclosure class (IEC 34-5):	IP68
Insulation class (IEC 85):	F
Motor protection:	NONE
Thermal protec:	external
Built-in temperature transmitter:	yes
Motor Number:	96405814
Cable number:	798887
Controls:	
Heather:	K56
Others:	
ErP status:	EuP Standalone/Prod.
Net weight:	80.5 lb
Gross weight:	84.9 lb
Shipping volume:	0.74 ft³
Sales region:	Namreg

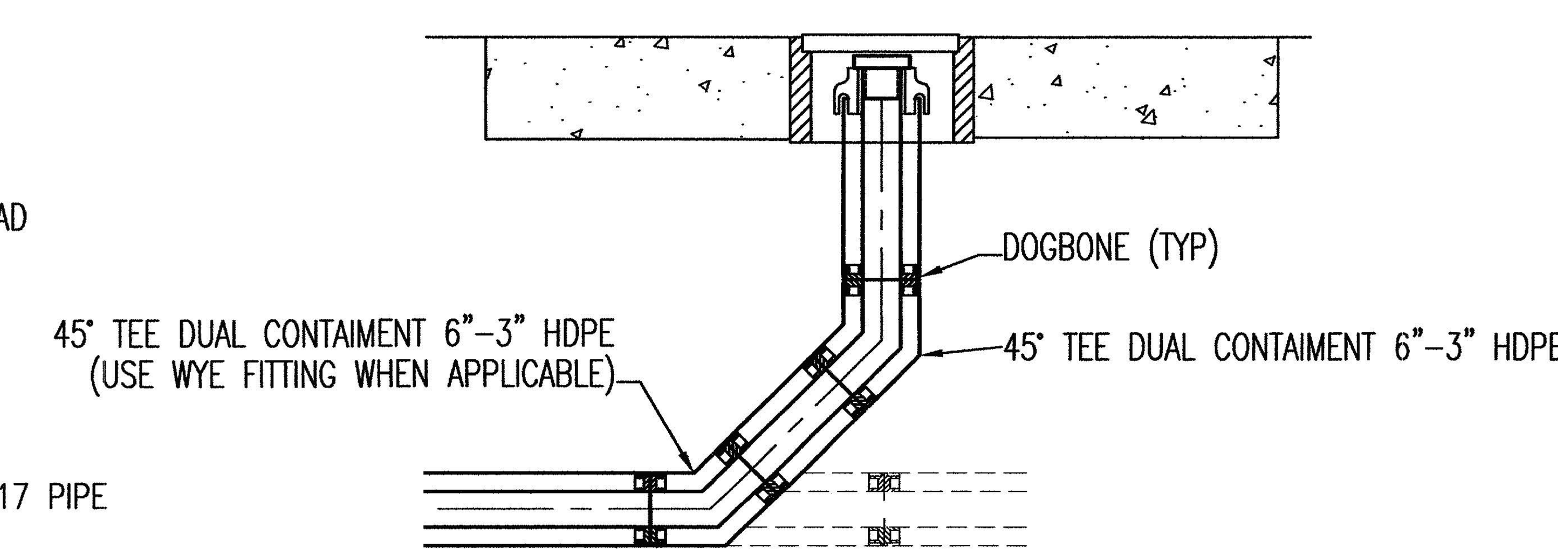




1 UNDERDRAIN POND PUMP DETAIL

SCALE: N.T.S.





SECTION 1 - 1

2 DOUBLE CONTAINMENT PIPE CLEANOUT TYPICAL DETAIL

SCALE: 1"=1'

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE

WATER TREATMENT SYSTEM

UTILITY - POND PUMP DETAILS

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

Registered Professional Engineer (Civil) CERTIFICATE NO. 15606 Raul Francisco G. Piña Date Signed ARIZONA, U.S.A. Expires 12/31/18

DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS
[redacted] 3895 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520-545-7001

DATE: MAY 2017
SCALE HORIZ. : NTS
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-25-UTILITY-DETAIL-2

SHEET: C-208
26 OF 37

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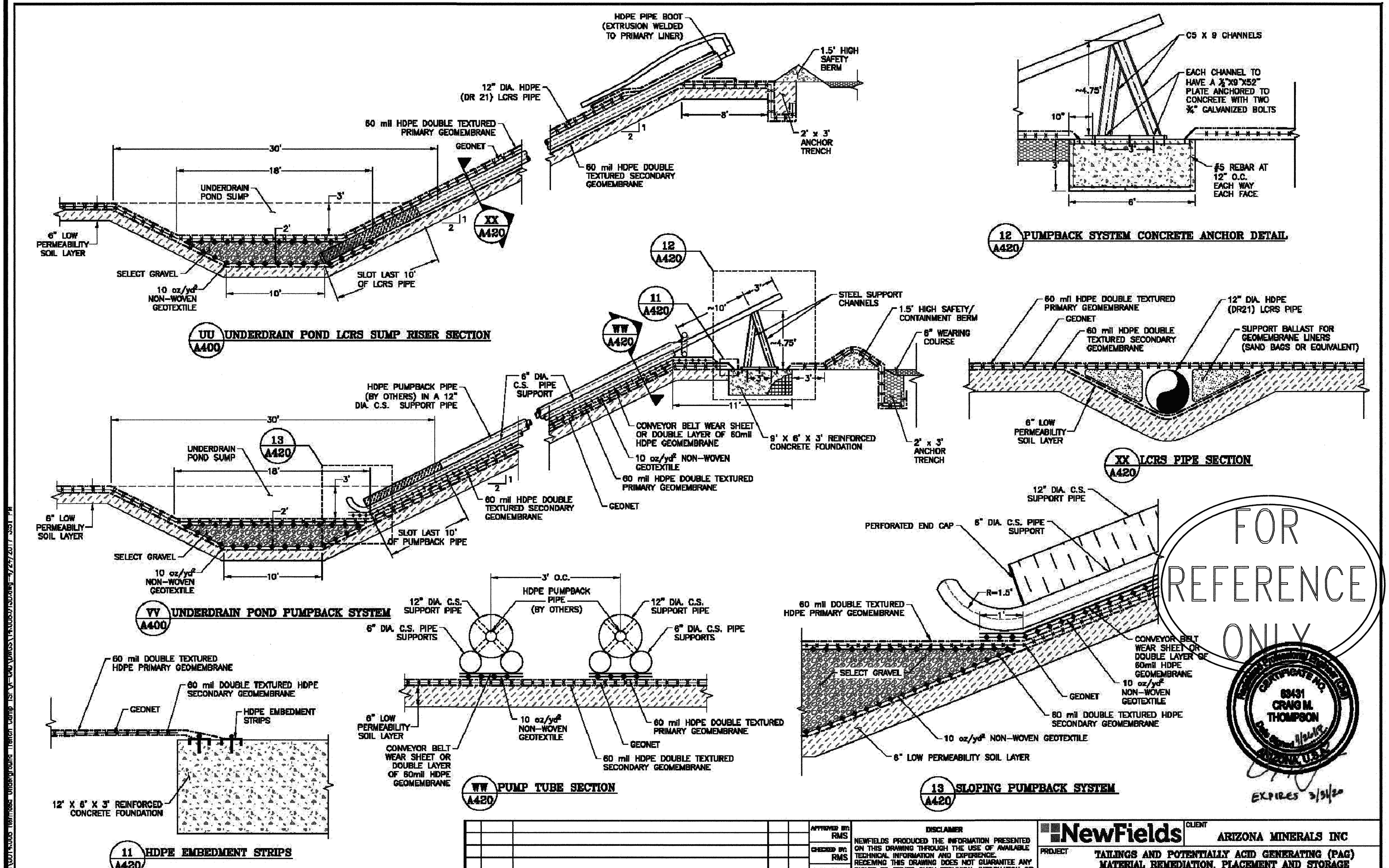

0	04/26/17	ISSUED FOR VOLUNTARY REMEDIATION PROGRAM	JEA	CMT
REV	DATE	DESCRIPTION	TECH	ENG

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER
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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 2 OF 2)

FILENAME: 14.008.013D
DRAWING NO.: A420
REVISION: 0

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
POND PUMPBACK SYSTEM (FOR REFERENCE ONLY)
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO.	REVISION	APPV'D	DATE

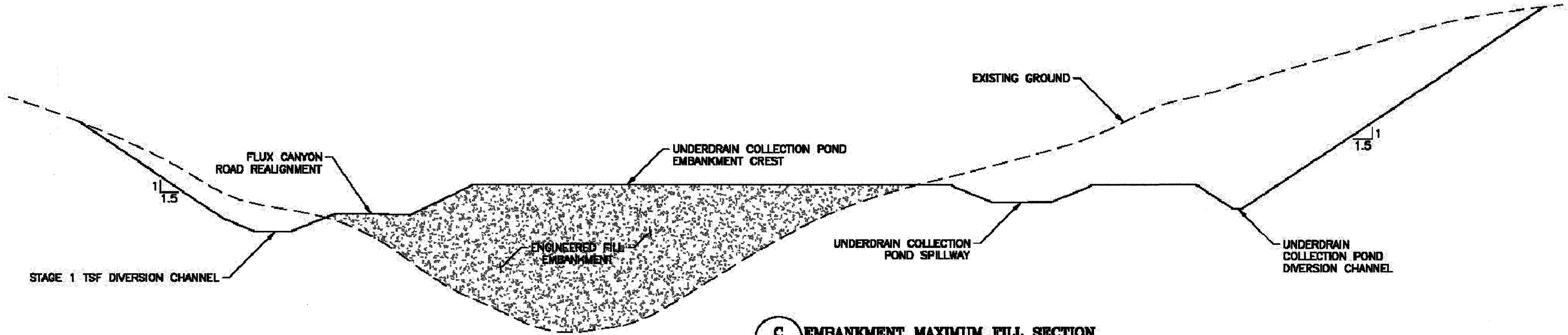
DESIGNED BY:
DRAWN BY: VG LMOB
CHK'D BY (DESIGN):
CHK'D BY (FIELD DATA):

CPE CONSULTANTS
3695 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520-545-7001

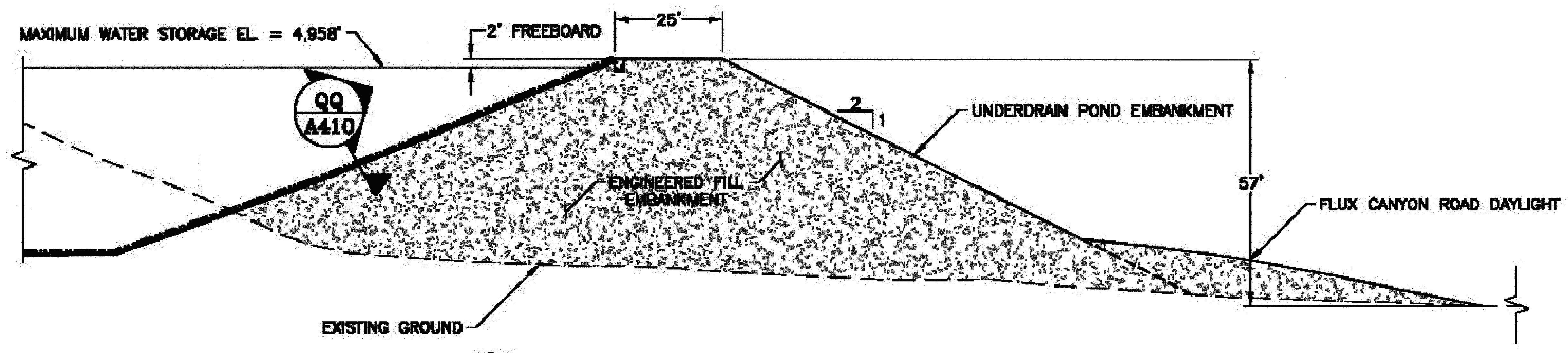
DATE: MAY 2017
SCALE: HORZ.: N/A VERT.: N/A
JOB NO: 346.5
FILE NAME: 346.5-27-POND PUMPBACK

SHEET: REF-1
27 OF 37

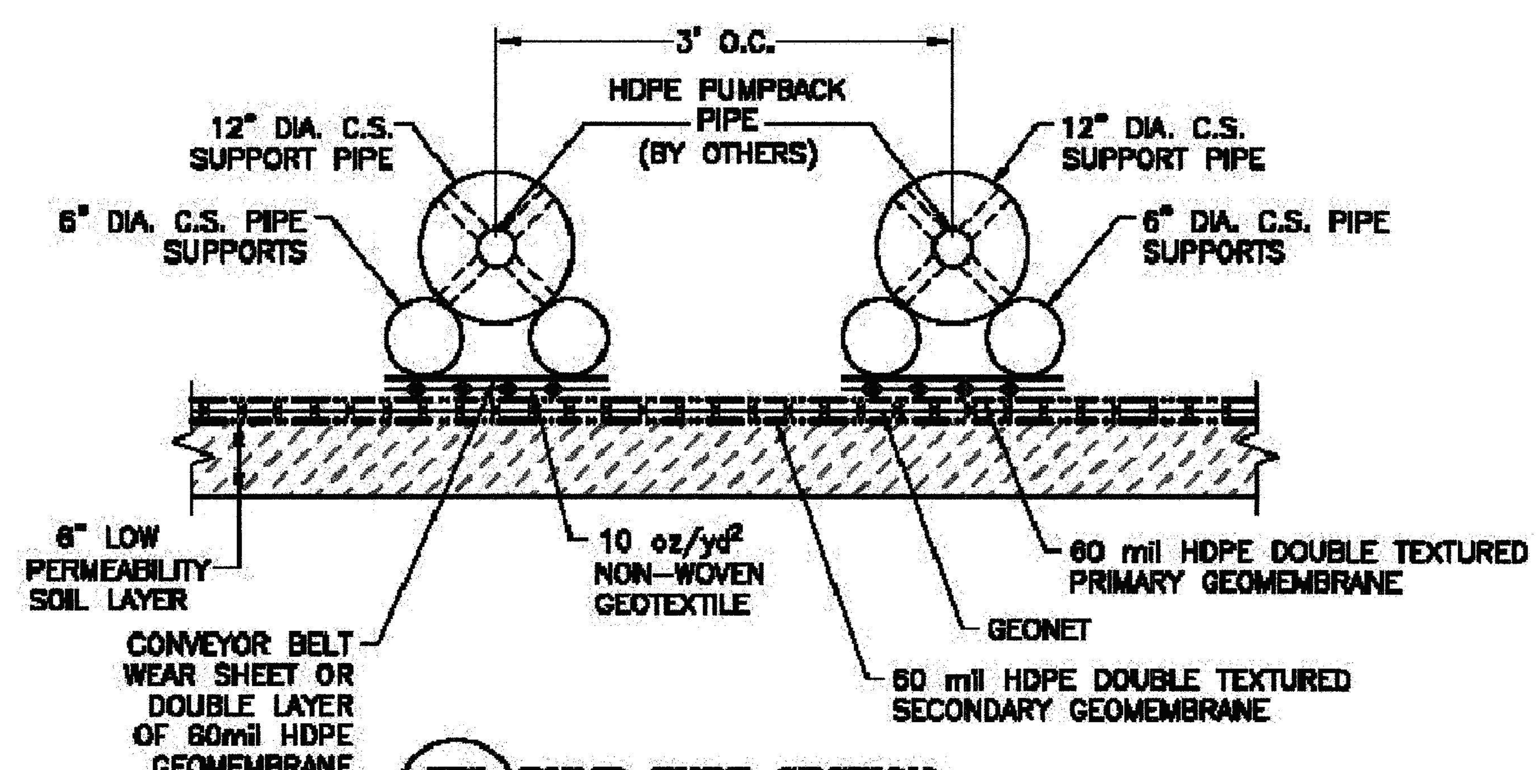
100% PLANS PRINTED ON 05/15/2017



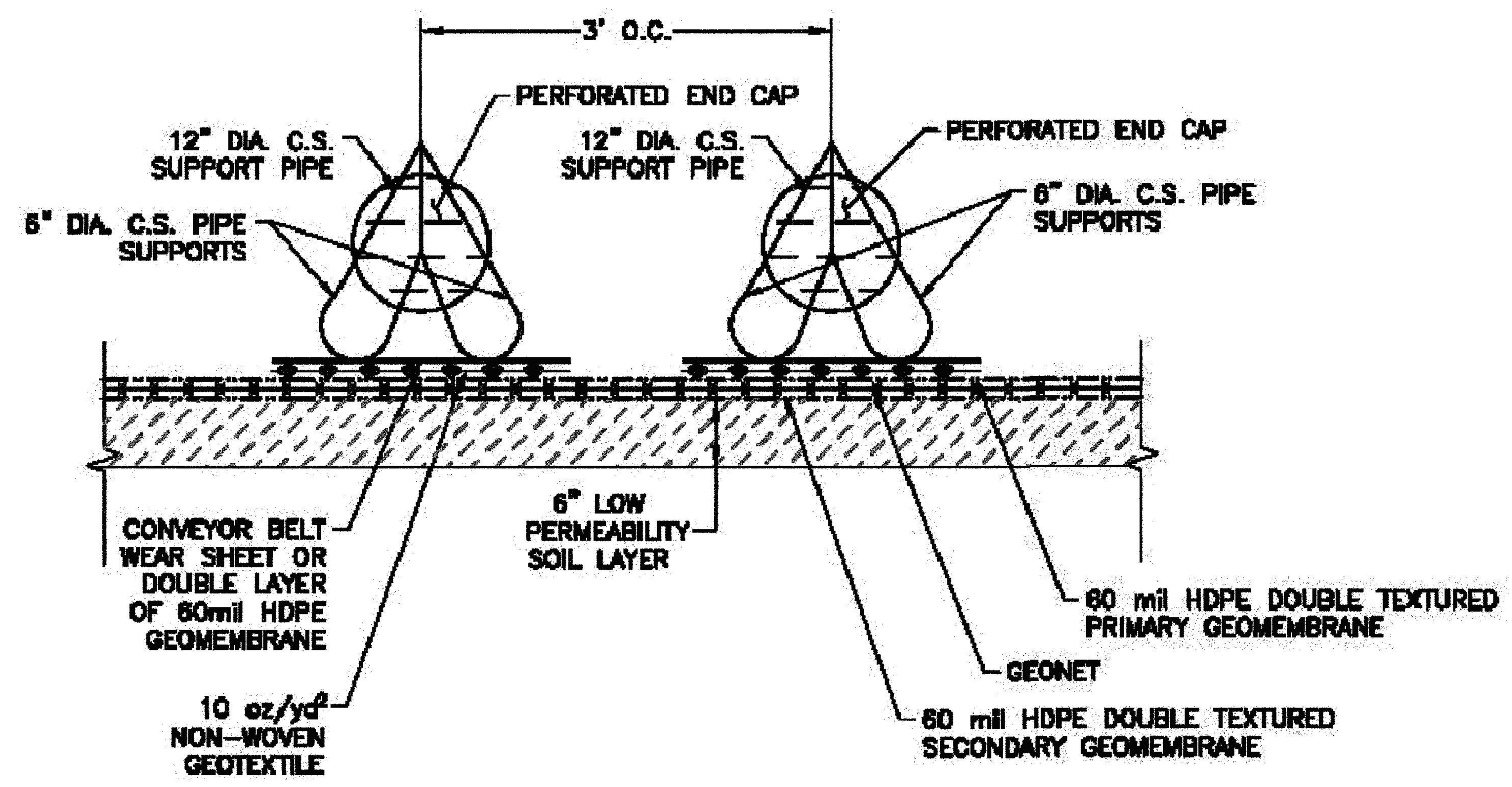
C / A402 EMBANKMENT MAXIMUM FILL SECTION



B / A402 EMBANKMENT MAXIMUM FILL SECTION



WW / A420 PUMP TUBE SECTION



A / A420 PUMP TUBE SECTION

FOR REFERENCE ONLY

REV	DATE	DESCRIPTION	TECH	ENG
0	04/26/17	ISSUED FOR VOLUNTARY REMEDIATION PROGRAM	JEA	CMT

APPROVED BY: RMS
CHECKED BY: RMS
DESIGNED BY: CMT
DRAWN BY: JEA

DISCLAIMER

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NewFields

CLIENT: ARIZONA MINERALS INC

PROJECT: TAILINGS AND POTENTIALLY ACID GENERATING (PAG) MATERIAL REMEDIATION, PLACEMENT AND STORAGE

TITLE: UNDERDRAIN COLLECTION POND SECTIONS AND DETAILS (SHEET 3 OF 3)

FILENAME: 14.008.077D
DRAWING NO.: A430
REVISION: 0

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
POND PUMPBACK SYSTEM (FOR REFERENCE ONLY)

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

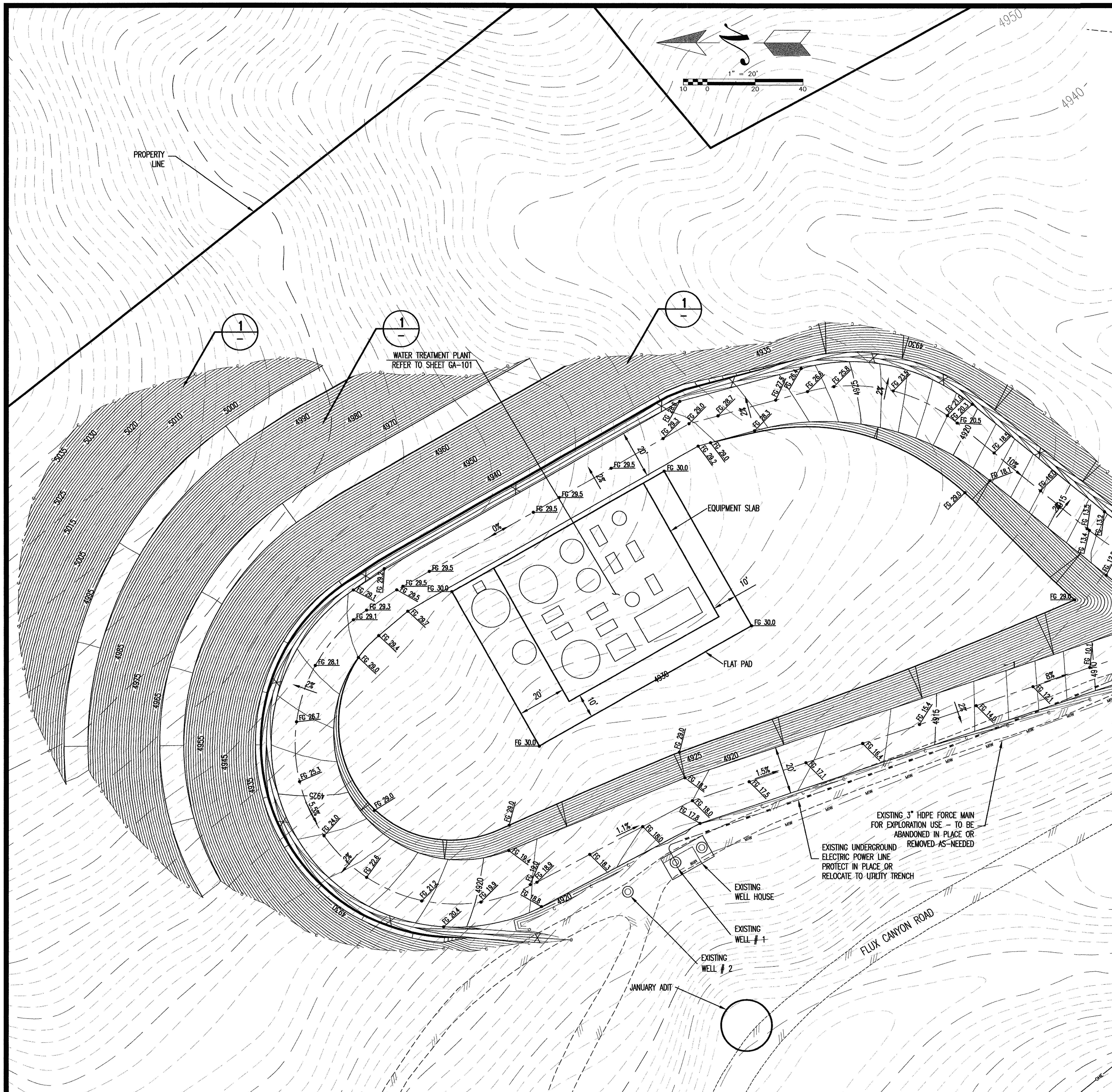
DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

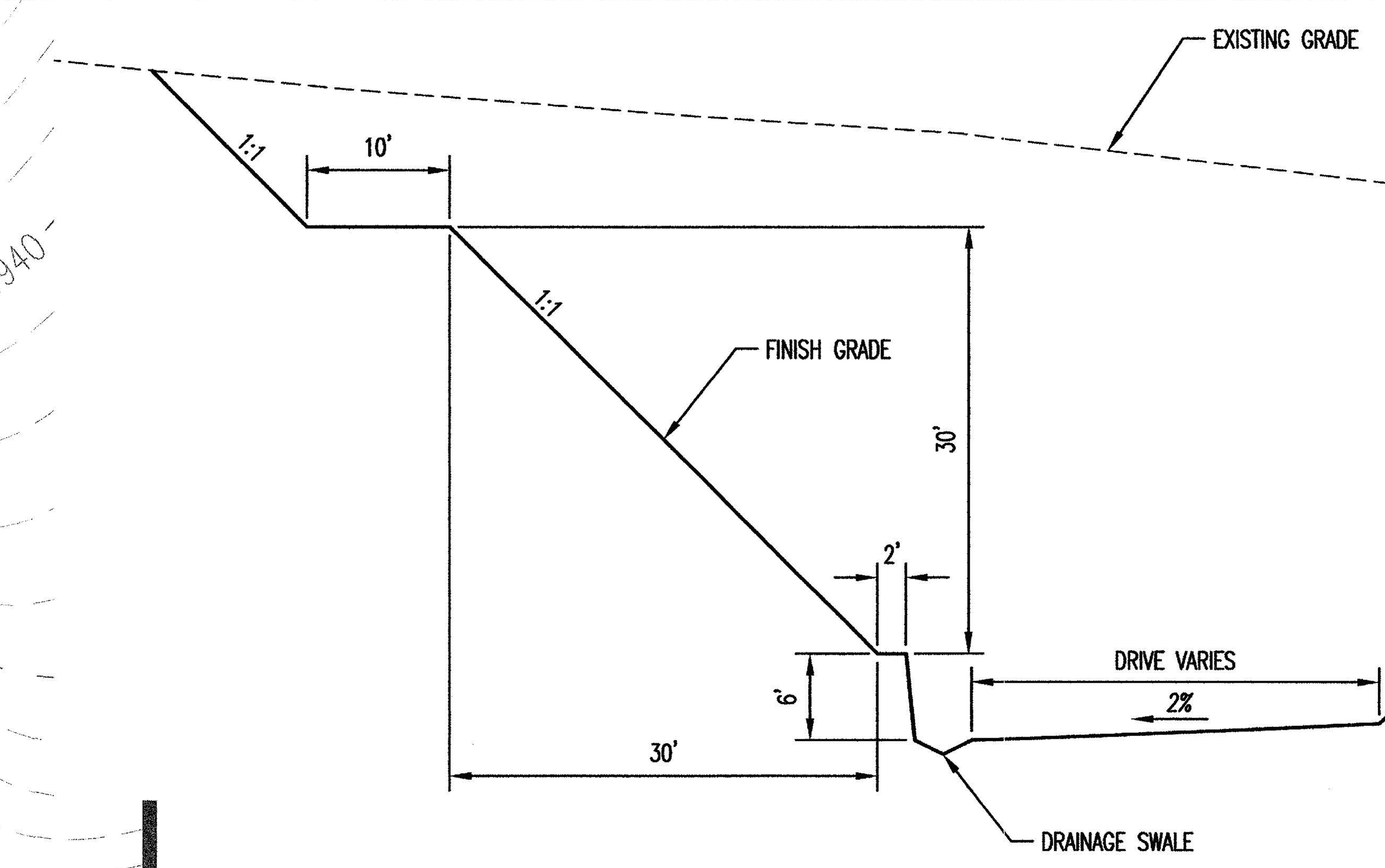
CPE CONSULTANTS
3865 N. Business Center Dr. Suite 115 Tucson, AZ 85705
520-546-7001

DATE: MAY 2017
SCALE: HORIZ. : N/A
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-28-POND PUMPBACK

SHEET: REF-2
28 OF 37

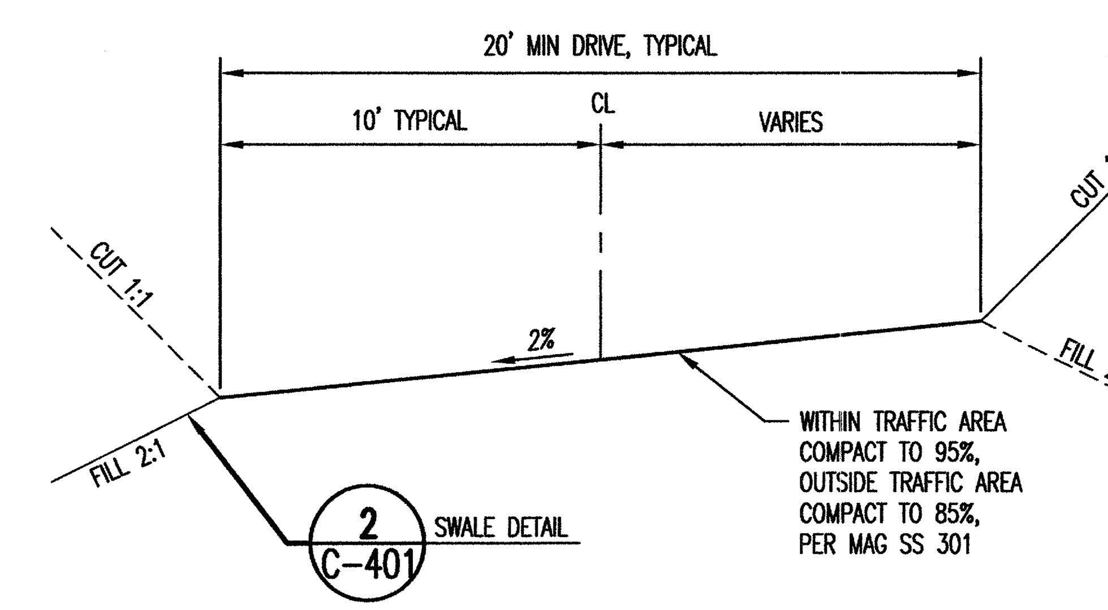
100% PLANS PRINTED ON 05/15/2017





1 WALL CUT DETAIL

SCALE: N.T.S.



TYPICAL DRIVE SECTION

SCALE: N.T.S.

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NO. | REVISION | APPV'D | DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
GRADING PLAN – 1

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

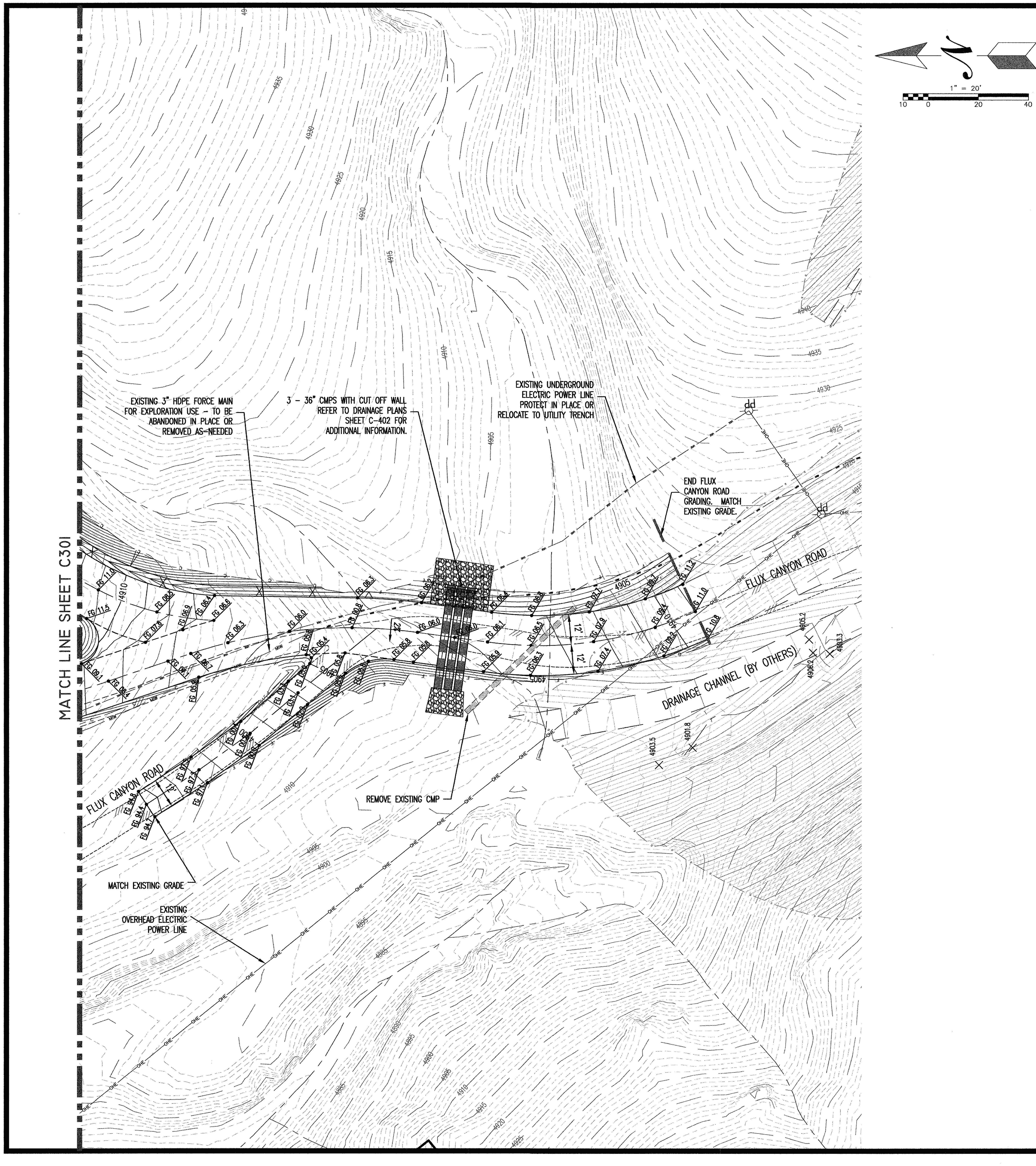
DESIGNED BY :
DRAWN BY : LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD DWGS) :

CPE CONSULTANTS
3695 N. Business Center Dr. Suite 115 Tucson, AZ 85705
[redacted]

DATE: MAY 2017
HORIZ. : 1" = 20'
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-29-GRADING-1

SHEET: C-301
29 OF 37

100% PLANS PRINTED ON 05/15/2017



JANUARY ADIT (NORTON MINE) VRP SITE

WATER TREATMENT SYSTEM

GRADING AND DRAINAGE OVERVIEW PLAN

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO.	REVISION	APPV'D	DATE

DESIGNED BY :
DRAWN BY : LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD DATA) :

Registered Professional Engineer (Civil) 15606 Raul Francisco G. Pina ARIZONA, U.S.A. Expires 12/31/18

CPE CONSULTANTS
[redacted] 3895 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520-545-7001

DATE: MAY 2017
SCALE: HORIZ. : 1" = 20'
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-30-GRADING-2

SHEET: C-302
30 OF 37

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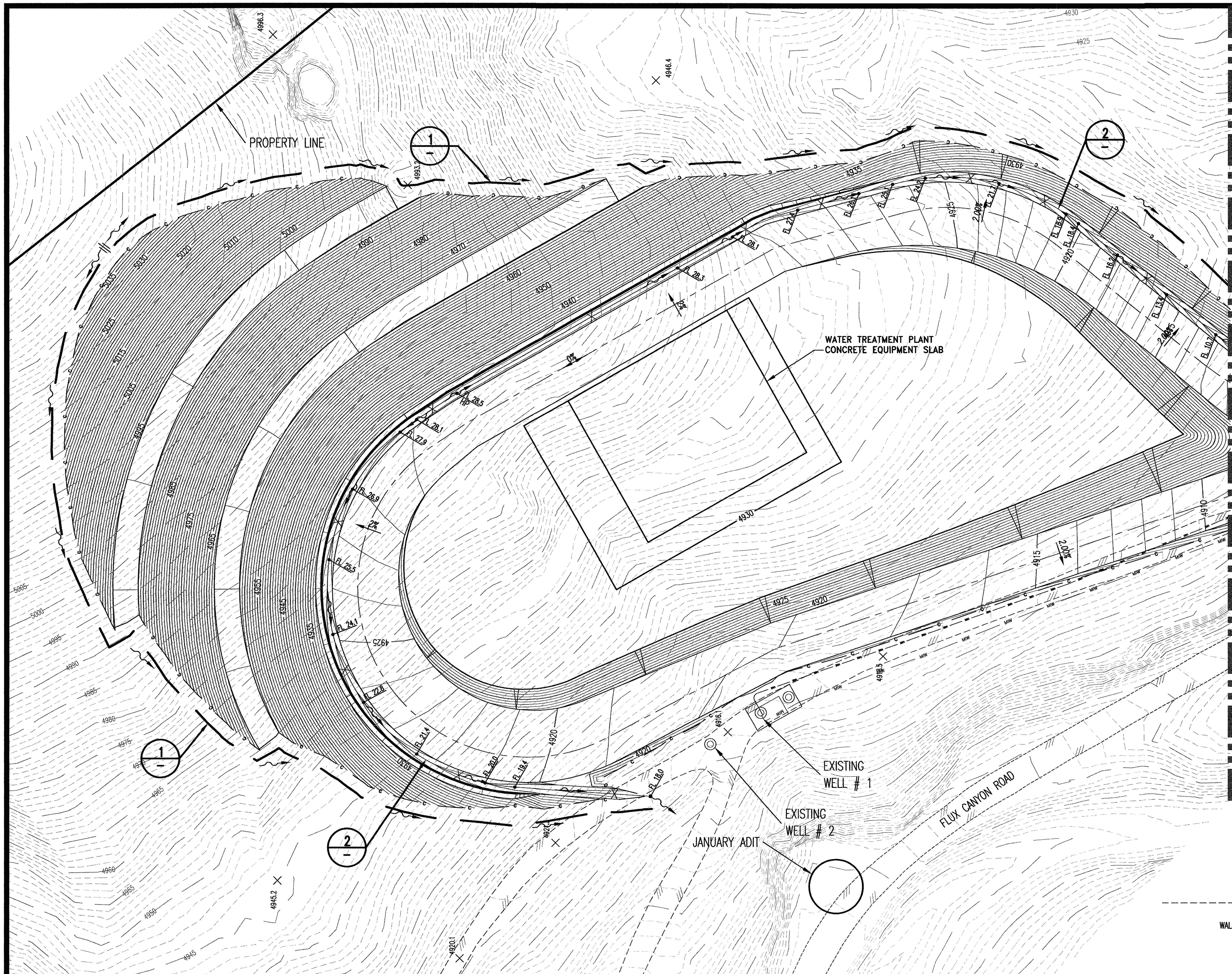
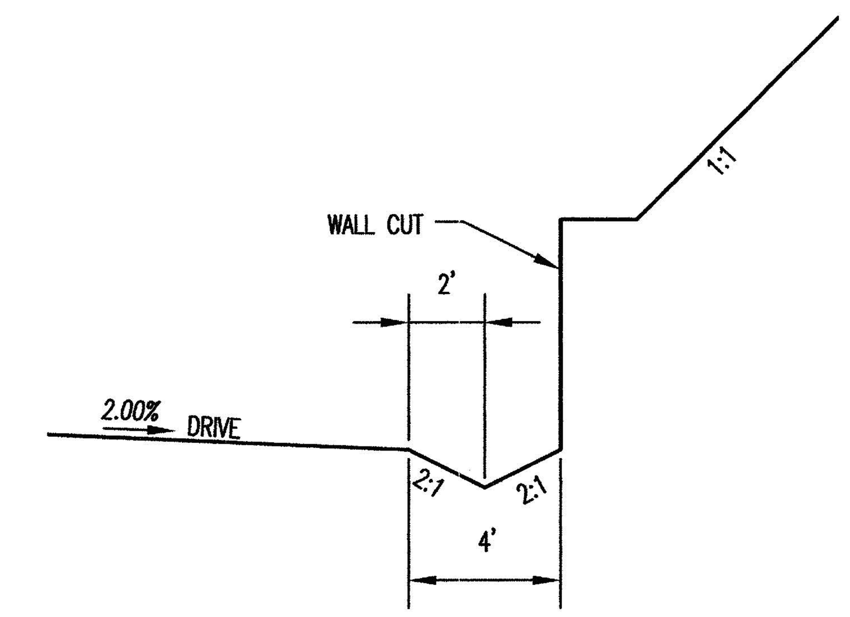
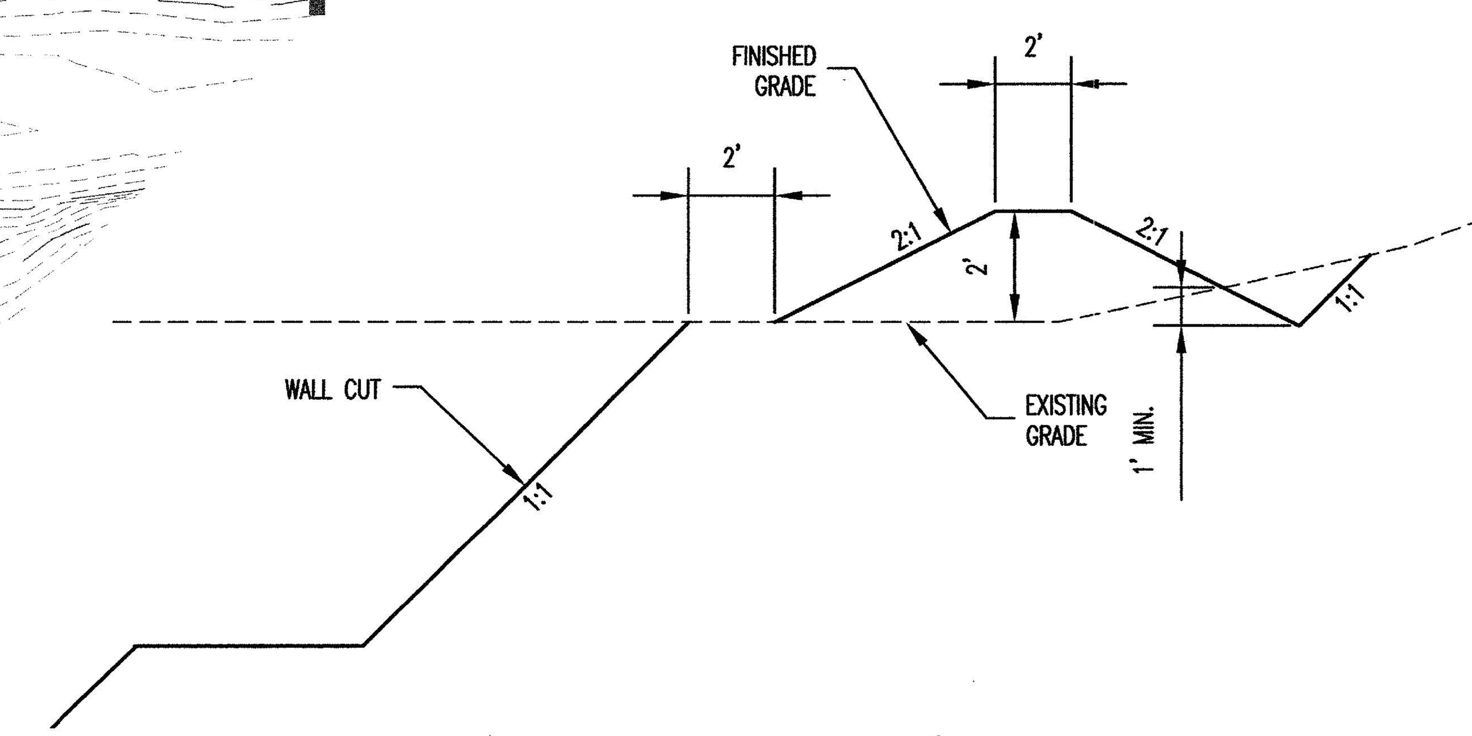




② DRAINAGE SWALE DETAIL
SCALE: N.T.S.



① STORM WATER DIVERSION BERM/SWALE DETAIL
SCALE: N.T.S.

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JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
DRAINAGE PLAN - 1 & DETAILS
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO.	REVISION	APPV'D	DATE

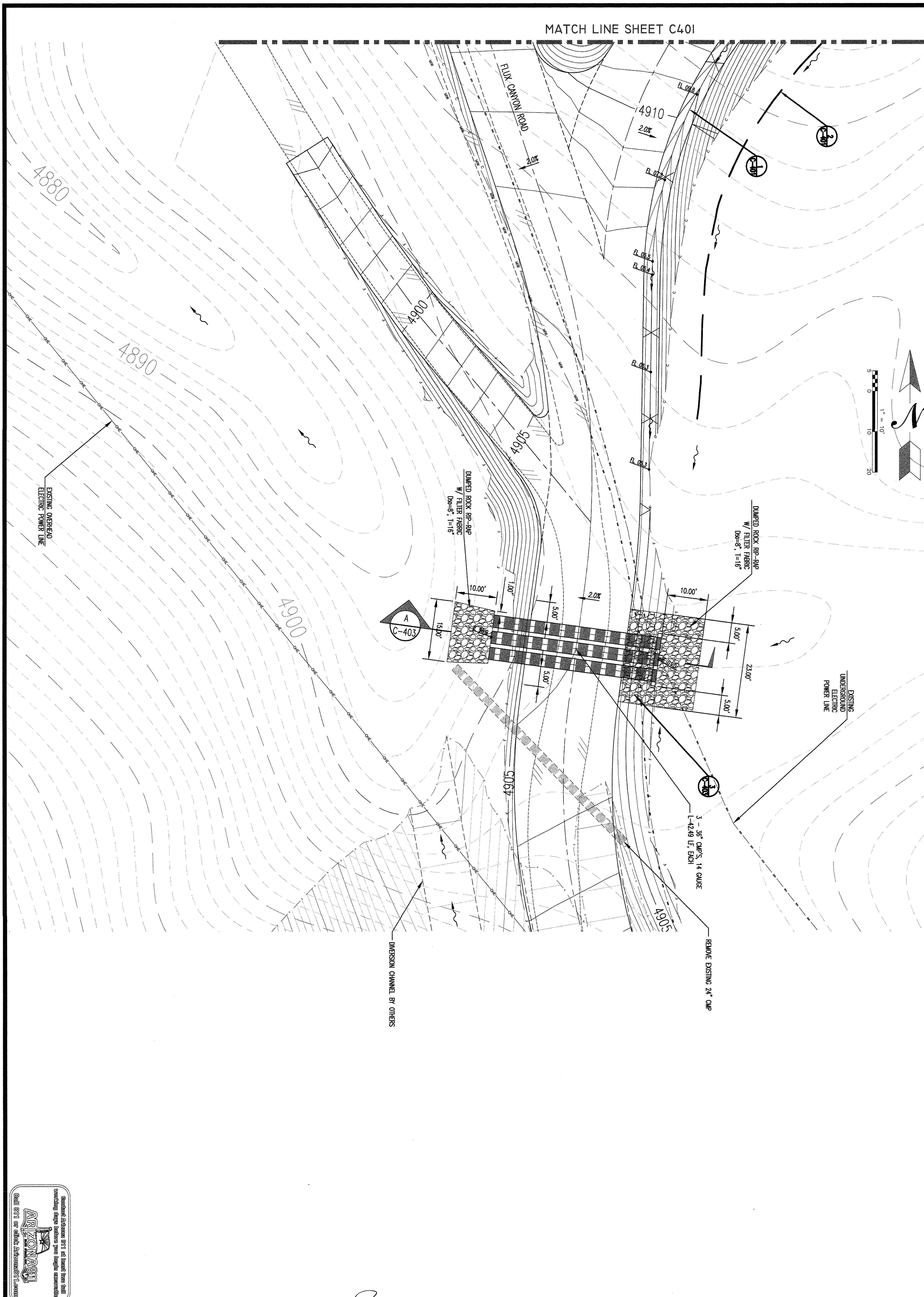
DESIGNED BY :
DRAWN BY : VG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD ENGR) :

CPE CONSULTANTS
3895 N. Business Center Dr. Suite 115 Tucson, AZ 85705 [redacted]

DATE: MAY 2017
SCALE HORIZ. : 1" = 20'
VERT. : N/A
JOB NO: 346.5
FILE NAME: 346.5-31-DRAINAGE-1

SHEET: C-401
31 OF 37

100% PLANS PRINTED ON 05/15/2017



SHEET: C-402 32 of 37	DATE: MAY 2017	CPE CONSULTANTS	DESIGNED BY :	JANUARY ADIT (NORTON MINE) VRP SITE
	SCALE HORIZ. : 1" = 10'		DRAWN BY : VIG LMOB	WATER TREATMENT SYSTEM
	VERT. : N/A		CHK'D BY (DESIGN) :	DRAINAGE PLAN – 2
	JOB NO: 346.5	3695 N. Business Center Dr. Suite 115 Tucson, AZ 85705 520•545•7001	CHK'D BY (FIELD ENGR) :	SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA
	FILE NAME: 346.5-32-DRAINAGE-2			

Registered Professional Engineer (Civil) Certificate No. 15606 Raul Francisco G. Pino ARIZONA, U.S.A. Expires 12/31/18

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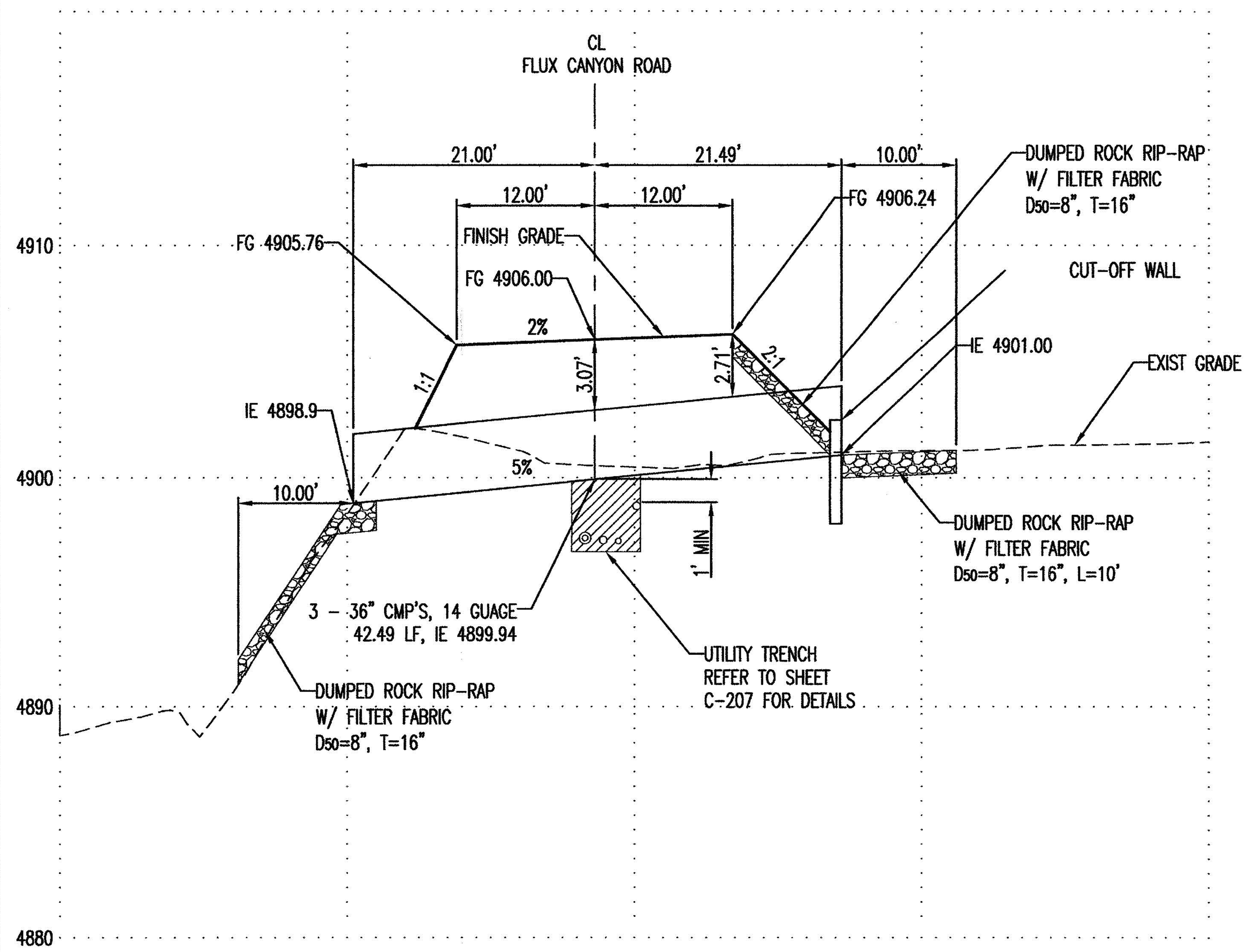
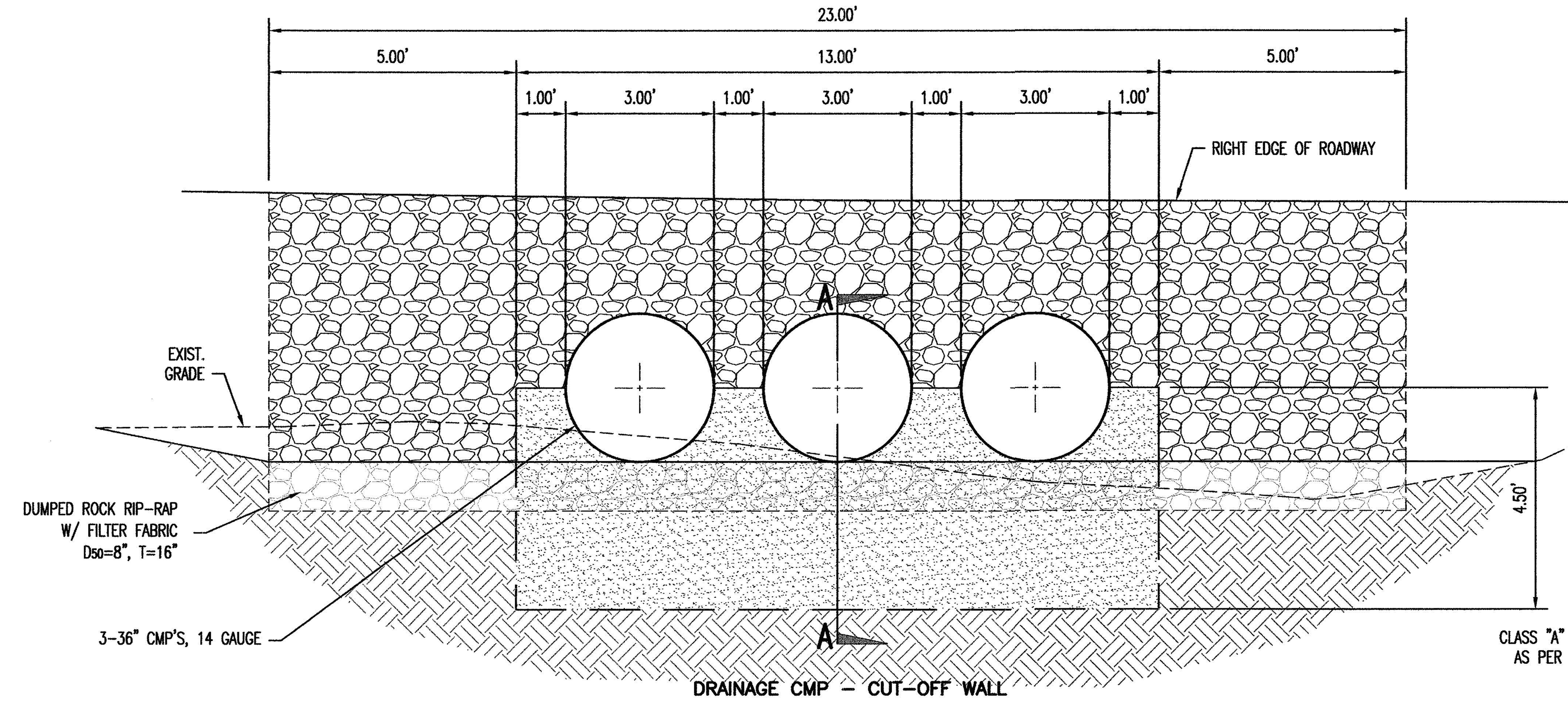


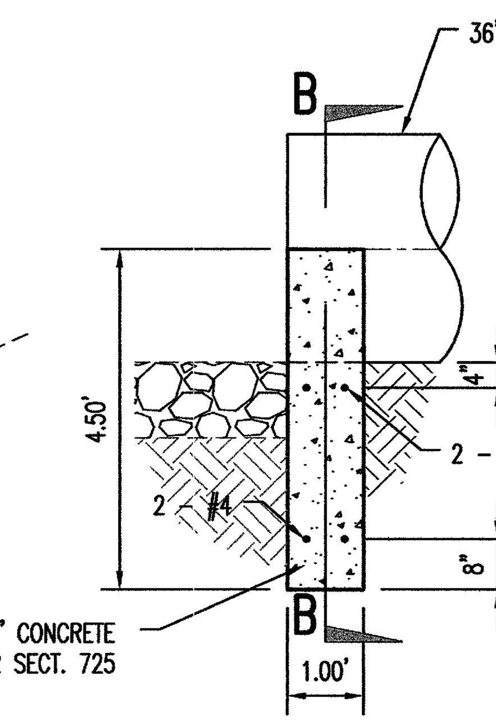
FLUX CANYON ROAD – DRAINAGE CMP SECTION

SECTION (A)

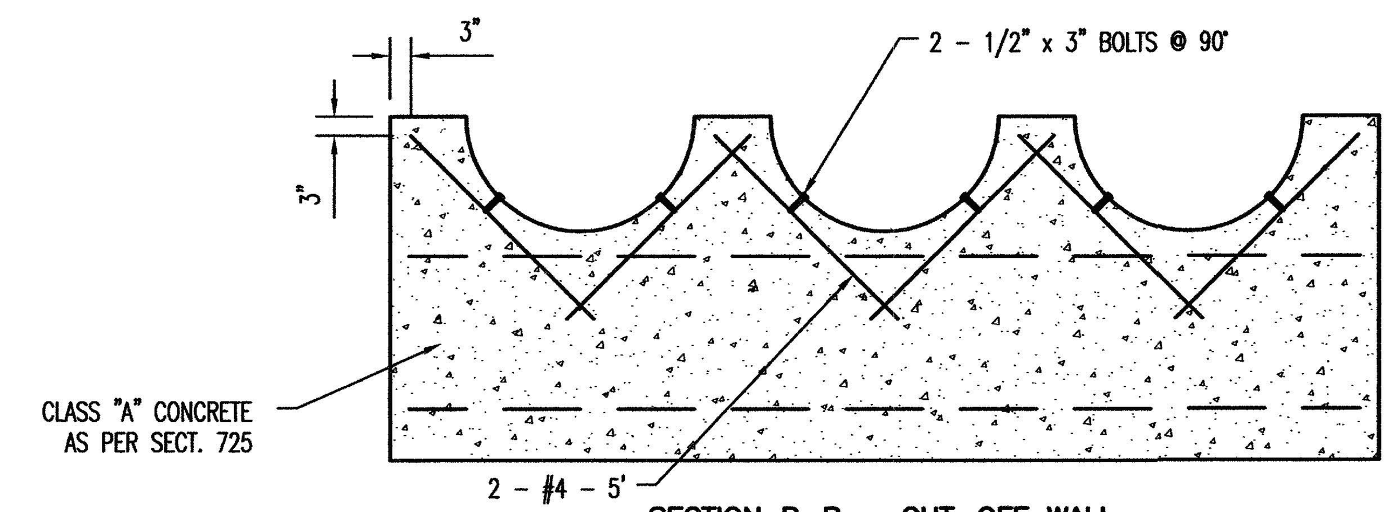
SCALE: 1" = 10' H
1" = 5' V



DRAINAGE CMP – CUT-OFF WALL



SECTION A-A – CUT-OFF WALL



SECTION B-B – CUT-OFF WALL

(3) CONCRETE CUT-OFF WALL DETAIL

SCALE: 1" = 2'

NO.	REVISION	APPV'D	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
DRAINAGE DETAILS

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

DESIGNED BY :
DRAWN BY : VIG LMOB
CHK'D BY (DESIGN) :
CHK'D BY (FIELD DATA) :

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3865 N. Business Center Dr.
Suite 115 Tucson, AZ 85705
520-545-7001

DATE: MAY 2017
SCALE HORIZ. : AS-NOTED
VERT. : N/A
JOB NO: 346.5
FILE NAME:
346.5-33-DRAINAGE-DTL-1

SHEET: C-403
33 OF 37

100% PLANS PRINTED ON 05/15/2017

ABBREVIATIONS

AB	Anchor Bolt
ADD	Addition
AGGR	Aggregate
A/C	Air Condition
ALT	Alternate
AL	Aluminum
ACI	American Concrete Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute
AWS	American Welding Society
&	And
L	Angle
APPROX	Approximate
ARCH	Architect or Architectural
ASPH	Asphalt
ASSY	Assembly
AVG	Average
B PL	Base Plate
BRG	Bearing
M	Bending Moment
BOT	Bottom
BLDG	Building
B/D	Bottom of Deck
CC	Carried Column
CIP	Cast In Place
CG	Center of Gravity
CLG	Ceiling
CEN	Center
C/C	Center to Center
C	Channel
CLR	Clear
COL	Column
CJ	Control Joint
CONC	Concrete
CONN	Connection
CONST	Construction
CONT	Continuous
CMP	Corrugated Metal Pipe
CMU	Concrete Masonry Units
CF	Cubic Foot
CY	Cubic Yard
DBL	Double
DET	Detail
DIAG	Diagonal
DIA	Diameter
DIM	Dimensions
DO	Ditto
2L	Double Angle
DF	Douglas Fir
DWG	Drawing
EA	Each
EF	Each face
EW	Each way
ELECT	Electric or Electrical
E	East
ELEV	Elevation
ENGR	Engineer
EQ	Equal
EQUIP	Equipment
EST	Estimate
ETC	Etcetera
EXCAV	Excavate
EXIST	Existing
EJ	Expansion Joint
EXT	Exterior
X-HVY	Extra Heavy
X-STR	Extra Strong
FAB	Fabrication
FF	Far Face
FS	Far Side
FT or '	Feet or Foot
FBM	Feet Board Measure
FIG	Figure
FIN	Finish
FLR	Floor
FD	Floor Drain
FTG	Footing
FND	Foundation
FRMG	Framing
GA	Gage or Gauge
GALV	Galvanize
GI	Galvanized Iron
GEN	General (Notes)
GLB	Glu lam Beam
GR	Grade
GRND	Ground
GSN	General Structural Notes
HGT	Height
HEX	Hexagon
HORIZ	Horizontal
S	I Beam
IN or "	Inches
INCL	Include or Included
ID	Inside Diameter
JST	Joist
JT	Joint
K	Kip (1,000 lbs)
KO	Knockout
LAM	Laminated
LGTH	Length
LT	Light
LG	Long
LONGIT	Longitudinal
LHE	Low Hydrogen Electrode
LLBB	Long Leg Back To Back
LLH	Long Leg Horizontal
LLV	Long Leg Vertical
MB	Machine Bolt
MFR	Manufacturer
MK	Mark
MAX	Maximum
MET	Metal
MATL	Material
MAX	Maximum
MECH	Mechanical
MED	Medium
MEZZ	Mezzanine
MIN	Minimum
MIN	Minute
MISC	Miscellaneous
MIX	Mixture
MULT	Multiple
NF	Near Face
NS	Near Side
NOM	Nominal
N	North
NTS	Not to Scale
#	Number
OC	On Center
OPNG	Opening
OPP	Opposite
ORIG	Original
OD	Outside Diameter
d	Penny (Nails, etc)
PERM	Permanent
PERP	Perpendicular
PC	Piece, Pile Cap
PL	Plate
PLYWD	Plywood
PT	Point
LB	Pound
PCF	Pounds Per Cubic Foot
PSF	Pounds Per Square Foot
PSI	Pounds Per Square Inch
PROJ	Project
QTR	Quarter
RAD	Radius
REF	Reference
REINF	Reinforce, Reinforced, Reinforcement, or Reinforcing
REQD	Required
REV	Revise or Revision
RD	Round
SCHED	Schedule
SECT	Section
SHT	Sheet
SIM	Similar
S	South
SPECS	Specifications
SQ	Square
STD	Standard
STL	Steel
STK	Stock
STRUCT	Structural
SYM	Symmetrical
SF	Strut Force
TAN	Tangent
THK	Thick
THRU	Through
TOL	Tolerance
T & G	Tongue & Groove
T & B	Top and Bottom
T/C	Top of Concrete
T/F	Top of Footing or Top of Foundation
T/W	Top of Concrete Wall
T/M	Top of Masonry
T/S	Top of Steel
TOT	Total
TRANS	Transverse
TYP	Typical
UN	Unless Noted
UNO	Unless Noted Otherwise
VIF	Verify in the Field
VERT	Vertical
WWF	Welded Wire Fabric
W	West
W	Wide Flange
W/	With
W/O	Without
WP	Work Point
YD	Yard

SYMBOL LEGEND

LEGEND:

SLOPE DIRECTION DOWN

SPAN DIRECTION

(00'-0") STEEL ELEVATION

00'-0" MISCELLANEOUS ELEVATION

00'-0" FLOOR OR STEEL ELEVATION

[00] REQUIRED NUMBER OF HEADED SHEAR STUDS

RIGID CONNECTION

C=0" CAMBER UP

GSN = GENERAL STRUCTURAL NOTES

UNO = UNLESS NOTED OTHERWISE

INDICATES TUBE COLUMN

INDICATES WIDE FLANGE COLUMN

INDICATES STD PIPE COLUMN

INDICATES BEAM SPLICE

INDICATES MAS CONTROL JOINT

500# INDICATES MECH'L EQUIPMENT ON ROOF. VERIFY SIZE & LOCATION W/ARCH'L & MECH'L DWGS

INDICATES OPNG IN ROOF OR FLR. VERIFY SIZE & LOCATION W/ARCH'L & MECH'L DWGS. ALL OPNGS & OPNG FRMG NOT NECESSARILY SHOWN ON PLAN

F1 INDICATES FOOTING SIZE. SEE SCHEDULE.

SYMBOLS AND ABBREVIATIONS FOR CONCRETE (as per ACI)

#	To Indicate Size of Deformed Bar.
⌀	Plain Rounds, as Spirals
@ AT	Spacing Center to Center
	Direction in Which Bars Extend
	Limits of Area Covered By Bars
BT	Bent
BOT	Bottom
CL	Clear
CT	Column Tie
EF	Each Face
EW	Each Way
FF	Far Face
IF	Inside Face
NF	Near Face
OF	Outside Face
PL	Plain Bar
STIR	Stirrup
SP	Spiral
STR	Straight
T	Top

DRAWING LIST

100% CD (05/15/17)

SG-101	ABBREVIATIONS, SYMBOL LEGEND AND DRAWING LIST	o
SG-102	GENERAL STRUCTURAL NOTES	o
S-101	FOUNDATION & SLAB PLAN	o
S-102	DETAILS	o

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NO. | REVISION | APPVD. | DATE

JANUARY ADIT (NORTON MINE) VRP SITE

WATER TREATMENT SYSTEM

ABBREVIATIONS, SYMBOL LEGEND AND DRAWING LIST

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

Registered Professional Engineer (Structural) 28024 GREGORY M. GORDON ARIZONA, U.S.A. Expires 12/31/19

DESIGNED BY: GMG
DRAWN BY: MBT
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

GGA
GREG GORDON and ASSOCIATES, LLC.
Structural Engineering Consultants
668 North 44th Street, Suite 220E
Phoenix, AZ 85008
PH. (602) 955-4300
GGA PROJECT NO. 4037

DATE: MAY 2017
SCALE HORIZ.: VERT.:
JOB NO: 346.5
FILE NAME:

SHEET: SG-101

100% PLANS PRINTED ON 05/15/2017

A. GENERAL

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS PRIOR TO STARTING CONSTRUCTION. THE ARCHITECT SHALL BE NOTIFIED OF ANY DISCREPANCIES OR INCONSISTENCIES.

2. DO NOT SCALE THE DRAWINGS.

3. GENERAL STRUCTURAL NOTES AND TYPICAL DETAILS APPLY UNLESS NOTED OTHERWISE ON PLANS, ELEVATIONS, DETAILS AND SPECIFICATIONS. IN CASE OF CONFLICT THE GREATER REQUIREMENT GOVERNS.

4. SEE THE ARCHITECTURAL DRAWINGS FOR THE FOLLOWING:
   a. SIZE AND LOCATION OF DOOR AND WINDOW OPENINGS.
   b. SIZE AND LOCATION OF INTERIOR AND EXTERIOR NON-BEARING PARTITIONS.
   c. SIZE AND LOCATION OF CONCRETE CURBS, FLOOR DRAINS, SLOPES, DEPRESSED AREAS, CHANGES IN LEVEL, CHAMFERS, GROOVES, INSERTS, ETC.
   d. SIZE AND LOCATION OF FLOOR AND ROOF OPENINGS.
   e. FLOOR AND ROOF FINISHES.
   f. STAIR FRAMING AND DETAILS.
   g. DIMENSIONS NOT SHOWN ON STRUCTURAL DRAWINGS.
   h. CEILING ASSEMBLIES.
   i. EXTERIOR WALL ASSEMBLIES.

5. SEE MECHANICAL, PLUMBING AND ELECTRICAL DRAWINGS FOR THE FOLLOWING:
   a. PIPES, SLEEVES, HANGERS, TRENCHES, WALL FLOOR AND ROOF OPENINGS, DUCT PENETRATIONS ETC. , EXCEPT AS SHOWN NOTED.
   b. ELECTRICAL CONDUIT RUNS, BOXES, OUTLETS IN WALLS AND SLABS.
   c. CONCRETE INSERTS FOR ELECTRICAL, MECHANICAL OR PLUMBING FIXTURES.
   d. SIZE AND LOCATION OF MACHINE OR EQUIPMENT BASES, ANCHORS FOR MOUNTS.
   ESTABLISH AND VERIFY ALL OPENINGS AND INSERTS FOR MECHANICAL, ELECTRICAL AND PLUMBING WITH APPROPRIATE TRADES, DRAWINGS AND SUB-CONTRACTORS PRIOR TO CONSTRUCTION.

6. THE CONTRACT STRUCTURAL DRAWINGS AND SPECIFICATIONS REPRESENT THE FINISHED STRUCTURE. THEY DO NOT INDICATE THE METHOD OF CONSTRUCTION.

7. THE STRUCTURAL ENGINEER SHALL NOT HAVE CONTROL OF CHARGE OF, AND SHALL NOT BE RESPONSIBLE FOR, CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES, FOR SAFTY PRECAUTIONS AND PROGRAMS IN CONNECTION WITH THE WORK, FOR THE ACTS OR OMMISIONS OF THE CONTRACTOR, SUB-CONTRACTORS OR ANY OTHER PERSONS PERFORMING AN OF THE WORK, OR FOR THE FAILURE OF ANY OF THEM TO CARRY OUT THE WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.

8. THE CONTRACTOR SHALL PROVIDE ALL MEASURES NECESSARY TO PROTECT THE STUCTRURE DURING CONSTRUCTION. SUCH MEASURES SHALL INCLUDE, BUT NOT BE LIMITED TO BRACING AND SHORING FOR LOADS DUE TO HYDROSTATIC, EARTH, WIND OR SEISMIC FORCES, CONSTRUCTION EQUIPMENT, ETC. OBSERVATION VISITS TO THE SITE BY THE STUCTURAL ENGINEER SHALL NOT INCLUDE INSPECTION OF THE ABOVE ITEMS.

9. NOTIFY THE STUCTRUAL ENGINEER THROUGH THE ARCHITECT WHEN DRAWINGS BY OTHERS SHOW OPENINGS, POCKETS, ETC., NOT SHOWN ON THE STRUCTURAL DRAWINGS, BUT WHICH ARE LOCATED IN THE STRUCTURAL MEMBER.

10. ALL SPECIFICATIONS AND CODES NOTED SHALL BE THE LATEST APPROVED EDITIONS AND REVISIONS BY THE GOVERNMENTAL AGENCY HAVING JURISDICTION OVER THIS PROJECT.

11. COST OF ADDITIONAL FIELD AND OFFICE WORK NECESSITATED BY REQUESTS BY THE CONTRACTOR FOR AN OPTION OF DUE TO ERRORS OR OMMISSIONS IN CONSTRUCTION SHALL BE BORNE BY THE CONTRACTOR. OPTIONS ARE FOR CONTRACTOR'S CONVENIENCE. HE SHALL BE RESPINSIBLE FOR ALL CHANGES NECESSARY IF HE CHOOSES AN OPTION AND HE SHALL COORDINATE ALL DETAILS.

12. ANY ENGINEERING DESIGN PROVIDED BY OTHERS AND SUBMITTED FOR REVIEW SHALL BEAR THE SEAL OF AN ENGINEER REGISTERED IN NEVADA.

13. UNLESS NOTED OTHERWISE, DETAILS ON STRUCTURAL DRAWINGS ARE TYPICAL AS INDICATED BY CUTS, REFERENCES OR TITLE.

14. CONTRACTOR SHALL INVESTIGATE THE SITE DURING CLEARING AND EARTH WORK OPERATIONS FOR FILLED EXCAVATIONS OR BURIED STRCTURES SUCH AS CESSPOOLS, CISTERNS, FOUNDATIONS, UTILITIES, ETC. IF ANY SUCH STRUCTURES ARE FOUND, THE STRUCTURAL ENGINEER SHALL BE NOTIFIED IMMEDIATELY THROUGH THE ARCHITECT.

15. CONTRACTOR SHALL VERIFY ALL DIMENSIONS WITH ARCHITETURAL DRAWINGS.

16. CONSTRUCTION MATERIALS SHALL BE SPREAD OUT WHEN PLACED ON FRAMED FLOORS OR ROOFS. THE CONSTRUCTION MATERIAL LOAD SHALL NOT EXCEED THE DESIGN LIVE LOAD PER SQUARE FOOT. PROVIDE ADEQUATE SHORING AND/OR BRACING WHERE STRUCTURE HAS NOT ATTAINED DESIGN STRENGTH.

17. ALL CONSTRUCTION MEETING OR CROSSING EXPANSION OR SHRINKAGE CONTROL JOINTS IN FLOORS OR ROOFS MUST HAVE PROVISIONS TO ACCOMMODATE MOVEMENT OR MUST BE DELAYED UNTIL THE JOINT IS CLOSED.

18. SHOP DRAWINGS SUBMITTED TO THE STRUCTURAL ENGINEER BY THE ARCHITECT FOR REVIEW SHALL CONSIST OF FIVE OPAQUE SETS.

19. ALL SHOP DRAWINGS AND SUBMITTALS MUST BE REVIEWED AND STAMPED BY THE CONTRACTOR PROIR TO SUBMITTAL. ALL SHOP DRAWINGS SHALL BE ORIGINAL DOCUMENTS AND SHALL NOT REPRODUCTIONS OF THESE CONTRACT DOCUMENTS. SHOP DRAWINGS AND SUBMITTALS SHALL BE ACCOMPANIED BY SEALED CALCULATIONS AS REQUIRED BY THE SPECIFICATIONS. NO FABRICATIONS SHALL PROCEED BEFORE SHOP DRAWINGS COVERING THAT WORK HAVE BEEN APPROVED. SEE SPECIFICATIONS FOR SYSTEMS AND MATERIALS THAT REQUIRED SUBMITTALS.

20. MECHANICAL LOADS: SEE PLANS.

B. CODE AND DESIGN CRITERIA

1. ALL WORK SHALL CONFORM TO THE MINIMUM STANDARDS OF THE FOLLOWING CODES:
   a. THE 2012 EDITION OF THE INTERNATIONAL BUILDING CODE.
   b. OTHER REGULATING AGENCIES WHICH HAVE AUTHORITY OVER ANY PORTION OF THE WORK.
   c. THOSE CODES AND STANDARDS LISTED IN THESE NOTES AND IN THE PROJECT SPECIFICATIONS.

2. DESIGN LIVE LOADS:
   a. ROOF——— Lr = 20x(R1 R2) PSF (R1 AND R2 PER IBC)

3. SEISMIC DESIGN DATA:
   a. LONG/LAT——— 110.728 W, 31.471 N
   b. BUILDING RISK CATEGORY——— III
   c. IMPORTANCE FACTOR (I_e)——— 1.25
   d. Ss——— 0.230g
   e. S1——— 0.067g
   f. SITE CLASS——— B
   g. SDS——— 0.154g
   h. SD1——— 0.045g
   i. SEISMIC DESIGN CATEGORY——— A
   j. ANALYSIS PROCEDURE——— EQUIVALENT LATERAL FORCE PROCEDURE

4. WIND DESIGN DATA:
   a. BASIC WIND SPEED——— 115 MPH (ULTIMATE)
   b. EXPOSURE——— C

C. FOUNDATION

1. FOUNDATION:
   a. DESIGN PER IBC SECTION 1806
   b. FOOTING SHALL BEAR ON FIRM UNDISTURBED OR COMPACTED SOIL AT 1'-6" MIN BELOW FINISHED GRADE OR NATURAL GRADE, WHICH EVER IS LOWER. ALLOWABLE BEARING = 1500 PSF.

2. CONTRACTOR SHALL PROVIDE FOR PROPER DEWATERING OF EXCAVATIONS FROM SURFACE WATER, GROUND WATER, SEEPAGE, ETC.

3. CONTRACTOR SHALL PROVIDE FOR THE DESIGN AND INSTALLATION OF ALL CRIBBING, SHEATHING AND SHORING REQUIRED TO SAFELY AND ADEQUATELY RETAIN THE EARTH BANKS AND ANY EXISTING STRUCTURE.

4. ALL EARTHWORK, FOOTING DEPTHS, AND EXCAVATIONS FOR FOUNDATIONS SHALL BE INSPECTED BY THE SOILS ENGINEER TO VERIFY ASSUMED ALLOWABLE SOIL BEARING AND LOW SETTLEMENT AND SWELL POTENTIAL, AND TO MAKE ANY ADDITIONAL RECOMMENDATIONS.

5. EXCAVATIONS FOR FOOTINGS SHALL BE APPROVED BY THE GEOTECHNICAL ENGINEER PRIOR TO PLACING THE CONCRETE AND REINFORCING. THE CONTRACTOR SHALL NOTIFY THE GEOTECHNICAL ENGINEER WHEN THE EXCAVATIONS ARE READY FOR INSPECTION. THE GEOTECHNICAL ENGINEER SHALL SUBMIT A LETTER OF COMPLIANCE TO THE OWNER.

6. ALL EXCAVATIONS SHALL BE PROPERLY BACKFILLED. DO NOT PLACE BACKFILL BEHIND RETAINING WALLS BEFORE CONCRETE OR MASONRY HAS ATTAINED FULL DESIGN STRENGTH. CONTRACTOR SHALL BRACE OR PROTECT ALL BUILDING AND PIT WALLS BELOW GRADE FROM LATERAL LOADS UNTIL ATTACHING FLOORS ARE COMPLETELY IN PLACE AND HAVE ATTAINED FULL DESIGN STRENGTH. CONTRACTOR SHALL PROVIDE FOR DESIGN, PERMITS AND INSTALLATION OF SUCH BRACING AND PROTECTION.

7. FOOTING BACKFILL AND UTILITY TRENCH BACKFILL WITHIN THE BUILDING PERIMETER SHALL BE MECHANICALLY COMPACTED IN LAYERS, TO THE APPROVAL OF THE GEOTECHNICAL ENGINEER. FLOODING WILL NOT BE PERMITTED.

8. ALL ABANDONED FOOTINGS, UTILITIES, ETC., THAT INTERFERE WITH THE NEW CONSTRUCTION SHALL BE REMOVED.

D. CONCRETE

1. ALL PHASES OF WORK PERTAINING TO THE CONCRETE CONSTRUCTION SHALL CONFORM TO THE 'BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE', ACI 318, AND THE `SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS', ACI 301, LATEST EDITIONS, WITH MODIFICATIONS AS NOTED ON THE DESIGN DRAWINGS OR SPECIFICATIONS.

2. REINFORCED CONCRETE DESIGN IS BY THE ULTIMATE STRENGTH DESIGN METHOD.

3. CONCRETE MIXES SHALL BE DESIGNED BY A QUALIFIED TESTING LABORATORY AND SHALL BEAR THE WET SEAL OF A CIVIL ENGINEER LICENSED IN THE STATE OF NEVADA FOR REVIEW BY THE STRUCTURAL ENGINEER THROUGH THE ARCHITECT.

4. SCHEDULE OF STRUCTURAL CONCRETE 28-DAY STRENGTHS AND TYPES:

LOCATION IN STRUCTURE	STRENGTH (PSI)	TYPE
FOOTINGS	3000	HARD ROCK
SLAB ON GRADE	3000	HARD ROCK
CONCRETE WALLS	3000	HARD ROCK
ALL CONCRETE UNO	3000	HARD ROCK

CONCRETE IN CONTACT WITH SOIL SHALL HAVE A MAXIMUM WATER TO CEMENTATIOUS MATERIAL RATIO OF 0.55

5. PORTLAND CEMENT SHALL CONFORM TO ASTM C150, TYPE II.

6. CONCRETE MIXES MAY CONTAIN FLY ASH. THE FLY ASH CONFORM TO ASTM C618 CLASS F AND THE LOSS OF IGNITION SHALL BE LIMITED TO 2%. THE ADDITION RATE SHALL NOT EXCEED 15% OF THE CEMENT WEIGHT. THE CONTRACTOR SHALL SUBMIT ALL CERTIFICATES SHOWING THE FLY ASH CONFORMS TO THE ABOVE CRITERIA.

7. AGGREGATE FOR HARD ROCK CONCRETE SHALL CONFORM TO ALL REQUIREMENTS AND TESTS OF ASTM C33 AND PROJECT SPECIFICATIONS. EXCEPTIONS MAY BE USED ONLY WITH PERMISSION OF THE STRUCTURAL ENGINEER THROUGH THE ARCHITECT.

8. FORMS FOR CONCRETE SHALL BE LAID OUT AND CONSTRUCTED TO PROVIDE THE SPECIFIED CAMBERS SHOWN ON THE DRAWINGS.

9. DRYPACK SHALL BE ONE PART CEMENT AND 2 3/4 PARTS WITH JUST ENOUGH WATER TO HYDRATE CEMENT AND FORM A BALL SHOWING MOISTURE ON THE SURFACE WHEN SQUEEZED. IT SHALL BE RAMMED IN TIGHT TO MAXIMUM DENSITY ATTAINABLE. MINIMUM 28 DAY STRENGTH TO BE 5000 PSI.

10. IN LIEU OF DRYPACK, GROUT SHALL BE NON-SHRINK, NON-METALLIC; U.S. GROUT CORP. FIVE STAR GROUT; ASTM C-827, C-191, AND C-109 OR PRIOR APPROVED EQUAL, MIXED AND INSTALLED PER MANUFACTURER'S RECOMMENDATION. MINIMUM COMPRESSIVE STRENGTH 5000 PSI IN 7 DAYS AND 7,000 PSI AT 28 DAYS.

11. CONCRETE MIXING OPERATIONS, ETC., SHALL CONFORM TO ASTM C94.

12. PLACEMENT OF CONCRETE SHALL CONFORM TO ACI STANDARD 304 AND PROJECT SPECIFICATIONS. SANDBLAST ALL CONCRETE SURFACES AGAINST WHICH CONCRETE IS TO BE PLACED.

13. IF COLUMNS AND WALLS ARE PLACED WITH A FLOOR, TWO HOURS MUST ELAPSE BETWEEN END OF COLUMN OR WALL POUR AND BEGINNING OF THE FLOOR POUR.

14. PLACING OF CONCRETE SHALL CONFORM TO ACI 305 ``HOT WEATHER CONCRETING" WHEN APPLICABLE.

15. CLEAR COVERAGE OF CONCRETE OVER REINFORCING BARS BE AS FOLLOWS:
   a. CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH ——— 3"
   b. CONCRET EXPOSED TO EARTH OR WEATHER:
      i. NO. 6 THROUGH NO. 18 BAR ——— 2"
      ii. NO. 5 BAR AND SMALLER ——— 1 1/2"
   c. CONCRETE NOT EXPOSED TO WEATHER OR IN CONTACT WITH GROUND
      i. SLABS, WALLS, JOISTS:
         1. NO. 14 AND NO. 18 BAR ——— 1 1/2"
         2. NO. 11 BAR AND SMALLER ——— 3/4"
      ii. BEAMS, COLUMNS:
         1. PRIMARY REINFORCEMENT, TIES, STIRRUPS, SPIRALS ——— 1 1/2"
   d.SLABS ON GRADE (FROM TOP)——— 1 1/2"

16. ALL REINFORCING BARS, ANCHOR BOLTS AND OTHER CONCRETE INSERTS SHALL BE WELL SECURED IN POSITION PRIOR TO PLACING CONCRETE.

17. MECHANICAL PIPES AND ELECTRICAL CONDUITS WHICH PASS THROUGH SLAB ON GRADE, CONCRETE ON STEEL DECK, FRAMED CONCRETE FLOORS AND WALLS DO NOT REQUIRE SLEEVES, UNLESS OTHERWISE INDICATED IN THE PROJECT SPECIFICATIONS, MECHANICAL OR ELECTRICAL DRAWINGS. IF SLEEVES ARE REQUIRED, INSTALL SLEEVES BEFORE PLACING CONCRETE. DO NOT CUT ANY REINFORCING WHICH MAY INTERFERE WITH SLEEVE PLACEMENT. CORING OPENINGS IN CONCRETE IS NOT PERMITTED. NOTIFY THE STRUCTURAL ENGINEER THROUGH THE ARCHITECT IN ADVANCE OF CONDITIONS NOT SHOWN ON THE STRUCTURAL DRAWINGS. NO PIPES OR ELECTRICAL CONDUIT SHALL PASS THROUGH CONCRETE BEAMS OR COLUMNS UNLESS SPECIFICALLY DETAILED.

18. EXCEPT FOR SLABS ON GRADE AND CONCRETE ON STEEL DECK, EMBEDDED ELECTRICAL CONDUITS OR MECHANICAL PIPES (OTHER THAN THOSE PASSING THROUGH) OUTSIDE DIAMETER SHALL NOT EXCEED 30 PERCENT OF THE SLAB THICKNESS AND SHALL BE PLACED BETWEEN THE TOP AND BOTTOM REINFORCING, UNLESS SPECIFICALLY DETAILED OTHERWISE. CONCENTRATIONS OF ELECTRICAL CONDUITS OR MECHANICAL PIPES SHALL BE AVOIDED EXCEPT WHERE DETAILED OPENINGS ARE PROVIDED. FOR SLABS ON GRADE, UNLESS OTHERWISE DETAILED, NO PIPES OR CONDUITS SHALL BE PLACED WITHIN THE INDICATED CONCRETE SLAB THICKNESS AND SHALL BE LOCATED BELOW THE SLAB.

19. PROJECTING CORNERS OF BEAMS, WALLS, COLUMNS, ETC., SHALL BE FORMED WITH A 3/4 IN. CHAMFER, UNLESS OTHERWISE NOTED ON ARCHITECTURAL DRAWINGS.

20. CURING COMPOUNDS USED ON CONCRETE THAT IS TO RECEIVE A RESILIENT TILE FINISH SHALL BE APPROVED BY THE FINISH APPLICATOR BEFORE USE.

21. MODULUS OF ELASTICITY OF CONCRETE, WHEN TESTED IN ACCORDANCE WITH ASTM C469, SHALL BE AT LEAST THE VALUE GIVEN BY THE EQUATIONS IN SECTION 8.5.1 OF ACI 318 FOR THE SPECIFIED CONCRETE 28-DAY STRENGTH.

22. MINIMUM STRENGTH FOR REMOVAL OF FORMS AND SHORING SHALL BE 75% OF SPECIFIED STRENGTH AT 28 DAYS.

23. WHEN SPAN L EXCEEDS 10'-0" CAMBER UP ALL CONCRETE BEAMS AND SLABS L/400 AT MIDSPAN. CAMBER UP ALL OVERHANGS L/300 AT EDGE OF CANTILEVER. RECORD CAMBERS AT UNDERSIDES OF STRUCTURE IMMEDIATELY BEFORE AND AFTER RESHORING AND IMMEDIATELY AFTER DESHORING.

24. ALL CONCRETE NOT SPECIFICALLY SHOWN WITH REINFORCEMENT SHALL BE REINFORCED IN THE SAME MANNER AS SIMILAR CONDITIONS OR WITH REINFORCEMENT MEETING THE MINIMUM REQUIREMENTS OF ACI-318.

E. REINFORCING STEEL

1. ALL REINFORCING STEEL SHALL BE DETAILED AND PLACED IN CONFORMANCE WITH THE `BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE' (ACI 318) AND THE `MANUAL OF STANDARD PRACTICE FOR REINFORCED CONCRETE CONSTRUCTION' BY CRSI AND WCRSI, AS MODIFIED BY THE PROJECT DRAWINGS AND SPECIFICATIONS.

2. DEFORMED REINFORCING BARS SHALL CONFORM TO THE REQUIREMENTS OF ASTM A615 GRADE 60, EXCEPT TIES, STIRRUPS AND REINFORCING BARS IN NON-STRUCTURAL CONCRETE SUCH AS SLABS ON GRADE, WHICH MAY BE GRADE 40, UNLESS NOTED OTHERWISE.

3. WELDING OF REINFORCING SHALL BE WITH LOW HYDROGEN ELECTRODES IN CONFORMANCE WITH 'RECOMMENDED PRACTICES FOR WELDING REINFORCING STEEL, ETC.', AMERICAN WELDING SOCIETY, AWS D1.4. WELDING OF REINFORCING STEEL IS LIMITED TO A706 REBAR.

4. ALL REINFORCING BAR BENDS SHALL BE MADE COLD.

5. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A185.

6. MINIMUM LAP OF WELDED WIRE FABRIC SHALL BE 6 INCHES OR ONE FULL MESH AND ONE HALF, WHICH EVER IS GREATER.

7. SPLICES SHALL BE MADE ONLY AS AND WHERE INDICATED ON THE STRUCTURAL DRAWINGS.

8. DOWELS BETWEEN FOOTINGS AND WALLS OR COLUMNS SHALL BE THE SAME GRADE, SIZE, SPACING AND NUMBER AS THE SPECIFIED VERTICAL REINFORCING, U.N.O.

9. ALL BARS SHALL BE MARKED SO THEIR IDENTIFICATION CAN BE MADE WHEN THE FINAL IN-PLACE INSPECTION OCCURS.

10. PROVIDE SHOP DRAWINGS AND FABRICATE AFTER THE ARCHITECT'S REVIEW. ALL SPLICE LOCATIONS ARE SUBJECT TO APPROVAL. PLACE REBAR PER CRSI STANDARDS.

F. STRUCTURAL CONSTRUCTION OBSERVATION

1. IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSPECT ALL STRUCTURAL WORK FOR CONFORMANCE WITH THE CONTRACT DOCUMENTS. ANY STRUCTURAL CONSTRUCTION OBSERVATION PROVIDED BY OTHERS DOES NOT RELIEVE HIM FROM THIS RESPONSIBILITY. ANY STRUCTURAL DEVIATIONS FROM THE CONTRACT DOCUMENTS THAT ARE FOUND AT A LATER DATE AND ARE DECLARED TO BE SIGNIFICANT BY THE STRUCTURAL ENGINEER SHALL BE CORRECTED BY THE CONTRACTOR WITH ALL DISPATCH.

2. THE STRUCTURAL CONSTRUCTION OBSERVER IS NOT AUTHORIZED TO DIRECT OR APPROVE ANY CHANGES FROM THE CONTRACT DOUCMENTS. IF THE CONTRACTOR WISHES TO QUESTION THE STRUCTURAL CONSTRUCTION OBSERVER'S INTERPRETATION OF THE CONTRACT DOCUMENTS, HE MAY DO SO DIRECTLY WITH THE ARCHITECT OR THE STRUCTURAL ENGINEER.

3. THE STRUCTURAL CONSTRUCTION OBSERVER IS NOT AUTHORIZED TO STOP OR DELAY WORK. IF THE CONTRACTOR ELECTS TO CONTINUE WITH A CERTAIN WORK AFTER BEING NOTIFIED BY THE STRUCTURAL CONSTRUCTION OBSERVER THAT SUCH WORK IS UNACCEPTABLE, HE DOES SO AT HIS OWN RESPONSIBILITY AND RISKS CORRECTING THE WORK AT A LESS OPPORTUNE TIME.

4. THE CONTRACTOR IS RESPONSIBLY FOR PROVIDING ADEQUATE FACILITIES FOR THE STRUCTURAL CONSTRUCTION OBSERVER TO ALLOW HIM TO PERFORM HIS WORK SAFELY AND EFFICIENTLY.

G. QUALITY ASSURANCE PLAN AND STATEMENT OF SPECIAL INSPECTION

1. THE SEISMIC FORCE RESISTING SYSTEM CONSIST OF ORDINARY STEEL MOMENT FRAMES, ORDINARY STEEL CONCENTRIC BRACED FRAMES AND LIGHT FRAMED WALLS WITH WOOD SHEAR PANEL.

2. PROVIDE SPECIAL INSPECTIONS AND TESTING AS REQUIRED BY IBC 2012 SECTIONS 1704 AND 1708 AND OTHER APPLICABLE SECTIONS OF THIS CODE, INCLUDING THE APPLICABLE STANDARDS REFERENCED BY THIS CODE.

3. THE OWNER SHALL EMPLOY AND PAY FOR SERVICES OF AN INDEPENDENT TESTING LABORATORY TO PERFORM THE FOLLOWING SPECIFIED TESTING:
   a. CONCRETE TEST CYLINDERS AND RELATED CONCRETE SLUMP TEST AS SPECIFIED PER SPECIFICATIONS SECTION 03300.
   b. FIELD TESTING OF WELDS REQUIRED BY IBC. SHOP TESTING OF WELDS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. PROVIDE SHOP TESTING AND ANALYSIS OF STRUCTURAL STEEL SECTIONS IN ACCORDANCE WITH AWS D1.1 AND SPECIAL INSPECTION REQUIREMENTS OF IBC.

4. SPECIAL INSPECTION AND LABORATORY REPORTS:
   AFTER EACH INSPECTION AND TEST, PROMPTLY SUBMIT COPY OF LABORATORY REPORT TO OWNER, ARCHITECT/ ENGINEER, AND TO CONTRACTOR. REPORTS SHALL INCLUDE:
   a. DATE ISSUED
   b. PROJECT TITLE AND NUMBER
   c. NAME OF INSPECTOR
   d. DATE AND TIME OF SAMPLING OR INSPECTION
   e. IDENTIFICATION OF PROJECT SPECIFICATIONS SECTION
   f. LOCATION OF PROJECT
   g. TYPE OF INSPECTION OR TEST
   h. DATE OF TESTS
   i. RESULTS OF TESTS
   j. CONFORMANCE WITH CONTRACT DOCUMENTS

5. STRUCTURAL OBSERVATION SHALL BE OBSERVED FOR ITEMS LISTED IN ITEM 1 OF THIS SECTION.

6. STRUCTURAL OBSERVATION REPORTS SHALL BE PROMPTLY DISTRIBUTED TO THE OWNER AND CONTRACTOR THROUGH THE ARCHITECT.

7. SPECIAL INSPECTION IS TO BE PROVIDED IN ADDITION TO INSPECTIONS CONDUCTED BY THE DEPARTMENT OF BUILDING AND SAFETY AND SHALL NOT BE CONSTRUED TO RELIEVE THE OWNER OR HIS AUTHORIZED AGENT FROM REQUESTING THE PERIODIC AND CALLED INSPECTIONS REQUIRED BY SECTION 1704 OF THE INTERNATIONAL BUILDING CODE. SPECIAL INSPECTION IS REQUIRED FOR THE FOLLOWING:

   a. CONCRETE CONSTRUTION (IBC 1704.4 AND TABLE 1704.4)
      i. REINFORCING STEEL ——— PERIODIC
      ii. BOLTS INSTALLED PRIOR TO AND DURING CONCRETE PLACEMENT ——— CONTINUOUS
      iii. MIX DESIGN ——— PERIODIC
      iv. AT THE TIME FRESH CONCRETE IS SAMPLED ——— CONTINUOUS
      v. INSPECTION OF CONCRETE PLACEMENT ——— CONTINUOUS
      vi. INSPECTION FOR MAINTENANCE OF SPECIFIED CURING TECHNIQUES ——— PERIODIC

H. CONCRETE AND MASONRY ADHESIVE ANCHORS

1. ADHESIVE ANCHORS SHALL NOT BE USED UNLESS SPECIFICALLY DETAILED ON DRAWINGS OR APPROVED BY THE STRUCTURAL ENGINEER.

2. ADHESIVE ANCHORS IN NORMAL-WEIGHT HARDROCK CONCRETE SHALL BE BY HILTI, INC. (ICC NO. ESR-2322; HIT-RE 500-SD ADHESIVE), SIMPSON STRONG-TIE COMPANY, INC. (ICC NO. ESR-2508; SET-XP ADHESIVE) OR ICC APPROVED EQUIVALENT WITH ALLOWABLE VALUES EQUAL TO OR EXCEEDING THOSE OF SPECIFIED ANCHOR AS STIPULATED IN THEIR RESPECTIVE ICC ENGINEERING REPORT.

3. ADHESIVE ANCHORS IN GROUT-FILLED MASONRY UNITS SHALL BE BY HILTI, INC. (ICC NO. ESR-1967; HIT HY-150 ADHESIVE), SIMPSON STRONG-TIE COMPANY, INC. (ICC NO. ESR-1772; SET ADHESIVE) OR ICC APPROVED EQUIVALENT WITH ALLOWABLE VALUES EQUAL TO OR EXCEEDING THOSE OF SPECIFIED ANCHOR AS STIPULATED IN THEIR RESPECTIVE ICC ENGINEERING REPORT.

4. ADHESIVE ANCHORS IN HOLLOW MASONRY UNITS SHALL BE BY HILTI, INC (ICC NO. ESR-2659; HIT-HY 20 ADHESIVE), SIMPSON STRONG-TIE COMPANY, INC (ICC NO. ESR-1772; SET ADHESIVE) OR ICC APPROVED EQUIVALENT WITH ALLOWABLE VALUES EQUAL TO OR EXCEEDING THOSE OF SPECIFIED ANCHOR AS STIPULATED IN THEIR RESPECTIVE ICC ENGINEERING REPORT. SCREEN TUBE PER ICC REPORTS SHALL BE USED IN HOLLOW MASONRY UNITS.

5. MINIMUM EMBEDMENT IN NORMAL-WEIGHT HARDROCK CONCRETE SHALL BE THE TABULATED VALUE IN THE ICC REPORT THAT EXCEEDS SIX BOLT DIAMETERS OF THE ANCHOR SPECIFIED BUT NOT LESS THAN AS INDICATED ON PLANS OR IN DETAILS.

Contact Arizona 811 at least two full working days before you begin excavation
ARIZONA811
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NO.	REVISION	APPVD.	DATE

JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
GENERAL STRUCTURAL NOTES
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

(Structural) Registered Professional Engineer 32624 GREGORY M. GORDON Date Signed ARIZONA, U.S.A. Expires 12/31/19

DESIGNED BY: GMG
DRAWN BY: MBT
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

GGA
GREG GORDON and ASSOCIATES, LLC.
Structural Engineering Consultants
668 North 44th Street, Suite 223E
Phoenix, AZ 85008
PH. (602) 265-1630
GGA PROJECT NO. 4037

DATE: MAY 2017
SCALE HORIZ.:
VERT.:
JOB NO. 346.5
FILE NAME:

SHEET: SG-102
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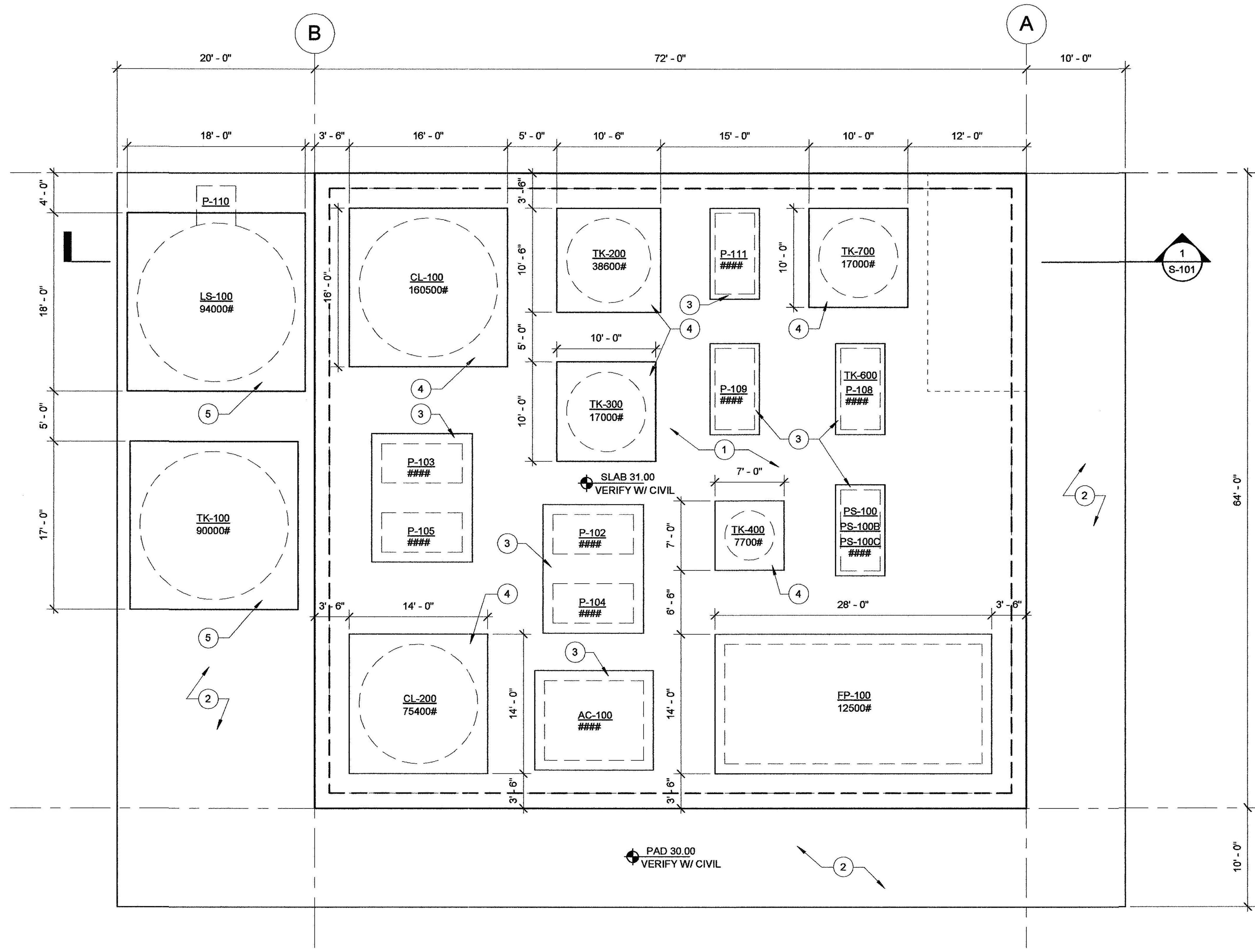
100% PLANS PRINTED ON 05/15/2017

GENERAL NOTES:

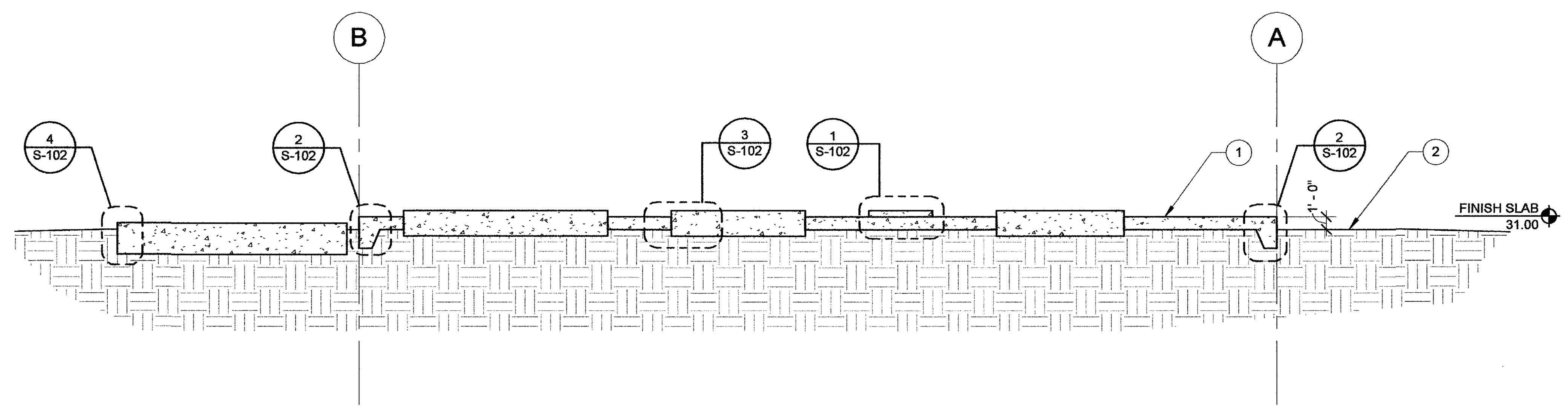
A. TOP OF CONCRETE SLAB ON GRADE USGS ELEVATION = 4931.00', TYPICAL UNLESS NOTED OTHERWISE THUS, 31.00
B. VERIFY ALL DIMENSIONS, FLOOR SLOPES AND ELEVATIONS WITH ARCHITECTURAL, CIVIL, AND METAL BUILDING DRAWINGS.
C. ALL CONDUIT AND PIPING SHALL BE PLACED BELOW SLAB ON GRADE.

SHEET NOTES: (#)

1. SLAB ON GRADE TO BE 12" THICK WITH #4 AT 12" O.C. EACH WAY TOP & BOTTOM. LOCATE TOP BARS 1 1/2" CLEAR FROM TOP OF SLAB AND BOTTOM BARS 3" CLEAR FROM BOTTOM OF SLAB.
2. FLAT GRADED DIRT PAD, SEE CIVIL.
3. EQUIPMENT BASE PAD, SEE DETAIL 1/S-102
4. EQUIPMENT FOUNDATION, SEE DETAIL 3/S-102
5. EQUIPMENT FOUNDATION, SEE DETAIL 4/S-102



A WATER TREATMENT PLANT EQUIPMENT FOUNDATION PLAN
SCALE: 1/8" = 1'-0"



1 SECTION THROUGH SLAB ON GRADE
SCALE: 1/8" = 1'-0"

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JANUARY ADIT (NORTON MINE) VRP SITE
WATER TREATMENT SYSTEM
FOUNDATION & SLAB PLAN
SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

NO.	REVISION	APPVD	DATE

Expires: 03/31/19

DESIGNED BY: GMG
DRAWN BY: MBT
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

GGA
GREG GORDON and ASSOCIATES, LLC.
Structural Engineering Consultants
668 North 44th Street, Suite 223E
Phoenix, AZ. 85018
PH. 602.955.4393
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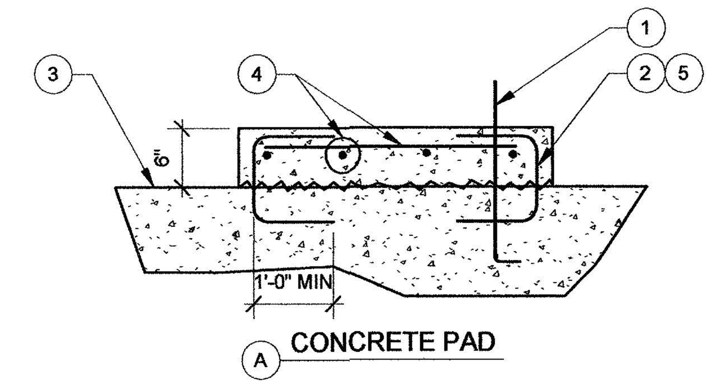
SHEET: S-101
36 OF 37

100% PLANS PRINTED ON 05/15/2017

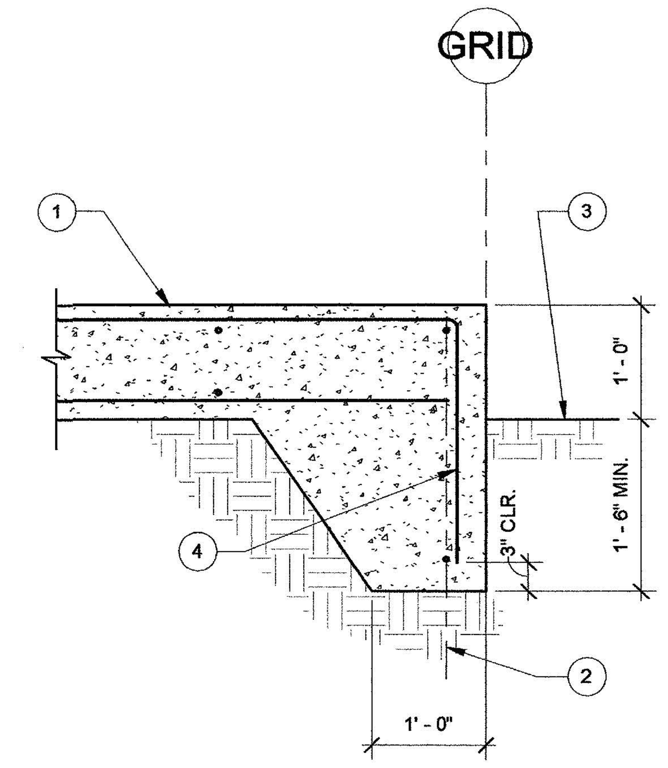


1. ANCHOR BOLTS AS REQ'D.
2. #4 DOWELS AT 24" O.C. AROUND PERIMETER OF PAD, AND NOT LESS THAN ONE AT EACH CORNER OF PAD.
3. TOP OF SLAB ON GRADE, SEE PLAN.
4. #4 AT 12" O.C. EACH WAY.
5. DOWEL MAY BE DRILLED & EPOXIED 3" INTO SLAB AT CONTRACTORS OPTION

COORD. LOCATIONS, DIMENSIONS, ANCHORAGES & SUPPORTS REQUIREMENTS FOR MECHANICAL UNITS TO CONC BASES WITH EQUIP. MFR/ SUPPLIER, ARCH'L, MECH'L & ELECT'L DWGS. EQUIP MFR/ SUPPLIER TO PROVIDE ALL SUPPORTS NOT SHOWN.

1 EQUIPMENT BASE AND PAD

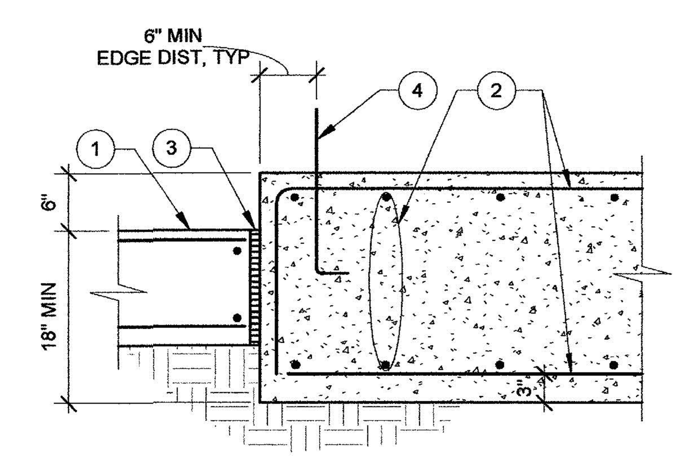
SCALE: 3/4" = 1'-0"



1. SLAB ON GRADE, SEE PLAN
2. 2-#5 CONT.
3. FINISH GRADE, SEE CIVIL.
4. BEND SLAB REINF. DOWN

2 EDGE OF SLAB

SCALE: 3/4" = 1'-0"

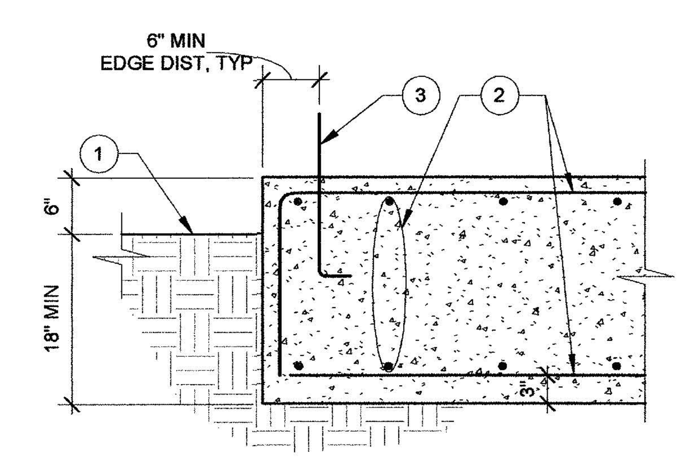


1. SLAB ON GRADE, SEE PLAN.
2. #5 @ 12" O.C. EACH WAY TOP & BOTTOM.
3. 1 1/2" COMPRESSIBLE MATERIAL -4 SIDES.
4. ANCHOR BOLTS AS REQ'D.

COORD. LOCATIONS, DIMENSIONS, ANCHORAGES & SUPPORTS REQUIREMENTS FOR MECHANICAL UNITS TO CONC BASES WITH EQUIP. MFR/ SUPPLIER, ARCH'L, MECH'L & ELECT'L DWGS. EQUIP MFR/ SUPPLIER TO PROVIDE ALL SUPPORTS NOT SHOWN.

3 EQUIPMENT FOUNDATION

SCALE: 3/4" = 1'-0"



1. FINISHED GRADED PAD, SEE CIVIL DWGS.
2. #5 @ 12" O.C. EACH WAY TOP & BOTTOM.
3. ANCHOR BOLTS AS REQ'D.

COORD. LOCATIONS, DIMENSIONS, ANCHORAGES & SUPPORTS REQUIREMENTS FOR MECHANICAL UNITS TO CONC BASES WITH EQUIP. MFR/ SUPPLIER, ARCH'L, MECH'L & ELECT'L DWGS. EQUIP MFR/ SUPPLIER TO PROVIDE ALL SUPPORTS NOT SHOWN.

4 EQUIPMENT FOUNDATION

SCALE: 3/4" = 1'-0"

NO. | REVISION | APPV'D. | DATE

JANUARY ADIT (NORTON MINE) VRP SITE

WATER TREATMENT SYSTEM

DETAILS

SECTION 32, T22S, R16E & SECTION 5, T23S, R16E, G&SRM, SANTA CRUZ COUNTY, ARIZONA

Registered Professional Engineer (Structural) 26024 GREGORY M. GORDON ARIZONA, U.S.A. Expires 03/31/19

DESIGNED BY: GMG
DRAWN BY: MBT
CHK'D BY (DESIGN):
CHK'D BY (FIELD ENGR):

GGA
GREG GORDON and ASSOCIATES, LLC.
Structural Engineering Consultants
668 North 44th Street, Suite 223E
Phoenix, AZ 85008
PH: 602.955.1650
GGA PROJECT NO. 4037

DATE: MAY 2017
SCALE HORIZ.:
VERT.:
JOB NO. 346.5
FILE NAME:

100% PLANS PRINTED ON 05/15/2017

APPENDIX B

EQUIPMENT DATA SHEETS

EQUIPMENT DATA SHEET

DATE	Arizona Minerals Inc Water Treatment Plant	
PROJECT		
Equipment Type:	**Agitator**	
Item:	Reaction Tank Mixer	
Tag No.	A-100	
Manufacturer	Lightin	
Model	14Q2	
Size	2 HP	
Mounting	Overhead, center	
RPM	1200	rpm
Design BHP	2	hp
Coupling Type		
Reaction Forces		
Vertical (Direction)	1100	lb
Bending Moment	15000	in-lb
Torsional	3150	in-lb
Drive:		
Reducer Model Number		
Reducer Ratio	14.06	
AGMA Service Rating		
V-Belt Sheaves		
Drive		
Driven		
Electric Motor:		
Manufacturer		
HP	2	hp
RPM	1200	rpm
Volts	230	
Cycle	60	
Phase	3	
Temperature Rise (°C over 40 °C ambient)		°C
Insulation Class		
Enclosure	TEFC	
Frame Size	184TC	
FLA		
Impeller:		
Quantity	1	
Diameter	38	in
Type	A510E	
Material	316 SS	
Lining		
Speed	84	rpm
Shaft:		
Material	316 SS	
Diameter	2	in
Length	68.5	in
Lining		
Static Runout of Shaft		in/ft
Shaft/Impeller will operate at % of the System Critical Frequency		
Seal Type		
Lining: List Rubber Specification Used		
Weight:		
Shipping	464	lb
Heaviest Item for Installation	464	lb
Heaviest Item for Maintenance	464	lb

EQUIPMENT DATA SHEET

DATE	Arizona Minerals Inc Water Treatment Plant	
PROJECT		
Equipment Type:	**Agitator**	
Item:	pH Adjustment Tank Mixer	
Tag No.	A-200	
Manufacturer	Lightin	
Model	X6Q150	
Size	1.5 HP	
Mounting	Overhead, center	
RPM	1725	rpm
Design BHP	1.5	hp
Coupling Type		
Reaction Forces		
Vertical (Direction)	510	lb
Bending Moment	8700	in-lb
Torsional	650	in-lb
Drive:		
Reducer Model Number		
Reducer Ratio	6	
AGMA Service Rating		
V-Belt Sheaves		
Drive		
Driven		
Electric Motor:		
Manufacturer		
HP	1.5	hp
RPM	1725	rpm
Volts	230	
Cycle	60	
Phase	3	
Temperature Rise (°C over 40 °C ambient)		°C
Insulation Class		
Enclosure	TFEC	
Frame Size		
FLA		
Impeller:		
Quantity	1	
Diameter	19	in
Type	A310	
Material	316 SS	
Lining		
Speed	280	rpm
Shaft:		
Material	316 SS	
Diameter	1	in
Length	56	in
Lining		
Static Runout of Shaft		in/ft
Shaft/Impeller will operate at % of the System Critical Frequency		
Seal Type		
Lining: List Rubber Specification Used		
Weight:		
Shipping	216	lb
Heaviest Item for Installation	216	lb
Heaviest Item for Maintenance	216	lb

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plant

EQUIPMENT TYPE **Solids Contact Clarifier**

Item:	Mine water clarifier
Tag No.	CL-100

FUNCTIONAL DESCRIPTION Liquid/solids separator to remove suspended solids from water stream

PROCESS DESIGN REQUIREMENTS

Design flow, gpm @ mgl/ TSS	145gpm @ 1,200 mg/l
Pressure	ATM
Water temperature, °F	40-85

GENERAL

Pumped Liquid	Water
Specific Gravity (SG)	1
pH	10.5

PROCESS TANKS

Diameter, feet-inches	14-0
Tank side wall height, feet-inches	16-0
Tank side wall water depth, feet-inches	15-0
Design flow rate	145 gpm
Location of use	Inside

EQUIPMENT ASSEMBLY

Bridge structures	Beam, mild steel
Bridge walkway type	Half-span, beam design
Rake arm type	Beam, 304LSS
Rake arm quantity	2
Tank type	Anchor channel, steel bottom, false bottom, 304SS
Tank bottom slope	0:12
Shell thickness, inches	0.25
Floor thickness, inches	0.25
Shipping wieght, pounds	TBD
Design style	Shop assembled
Center Shaft diameter, inches	2, 304SS
Reaction well type	Cylindrical
Reaction well diameter, feet	6
Impeller diameter,feet	2
Number of launders	TBD
Inlet pipe diameter, inches	4

DRIVE ASSEMBLY

Duty Torque	5000 ft-lbs
Rake tip speed	15 fpm
Rake motor size, h.p.	1
Motors, RPM/VAC/ph/Hz	1800/460/3/60
Impeller motor size,h.p.	1
Impeller speed, RPM	20-30

INSTRUMENTATION

Control Panel	NEMA 4X, 304SS

SURFACE PREPARATION AND COATINGS

Non-submerged coating, 1st, 2nd	Epoxy, Urethane
Drive, 1st, 2nd	Epoxy, Urethane

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plant

EQUIPMENT TYPE	**Thickening Tank**
Item:	Thickening Tank
Tag No.	CL-200
FUNCTIONAL DESCRIPTION	Liquid/solids separator to thicken suspended solids in clarifier sludge

PROCESS DESIGN REQUIREMENTS

Design flow, gpm @ mgl/ TSS	15 gpm @ 20,000 mg/l
Pressure	ATM
Water temperature, °F	40-85

GENERAL

Pumped Liquid	Water
Specific Gravity (SG)	1
pH	10.5

PROCESS TANKS

Diameter, feet-inches	12-0
Tank side wall height, feet-inches	10-0
Tank side wall water depth, feet-inches	9-0
Design flow rate	15 gpm
Location of use	Inside

EQUIPMENT ASSEMBLY

Bridge structures	Half span
Bridge walkway type	Beam design
Rake arm type	Low-drag beam
Rake arm quantity	2
Tank type	Anchor channel, steel bottom, false bottom, 304SS
Tank bottom slope	0:12
Shell thickness, inches	0.25
Floor thickness, inches	0.25
Shipping wieght, pounds	TBD
Design style	Shop assembled
Center Shaft diameter, inches	4"

DRIVE ASSEMBLY

Continuous Torque	5000 FT-LBS
Rake tip speed	20 FPM
Rake motor size, h.p.	1
Motors, RPM/VAC/ph/Hz	1800/460/3/60

INSTRUMENTATION

Control Panel	NEMA 4X, 304SS

SURFACE PREPARATION AND COATINGS

Non-submerged coating, 1st, 2nd	Epoxy, Urethane
Drive, 1st, 2nd	Epoxy, Urethane

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Mining

EQUIPMENT TYPE	**Filter Press**
Item:	Filter Press
Tag No.	FP-100

OPERATING DATA

Utility Requirements	
Voltage, V	460/120
Phase	3/1
Frequency, Hz	60
Environment:	
Indoor/outdoor	Indoor
Corrosive	No
Properties of the Slurry:	
Batch Size, gpm	2
Filtration Rate, gpm/ft 2	By Vendor
Solids Present, % by weight	3-5
Specific Gravity	
Viscosity, cp	
pH	10.5
Properties of the Solids:	
Material	metal hydroxide and gypsum
Rate, stph	
Density, lb/ft3	
Specific Gravity of Solids	
Properties of the Liquid:	
Material	Water
Specific Gravity	~1
Viscosity, cp	
Process Requirements:	
Filter Cloth	By Vendor
Final Squeeze Pressure, psig	120
Nominal Cylinder Oil Pressure, psig	5,000
Maximum Air Pressure, psig	100
Operating Schedule:	
hours/day	24
days/week	7
% Availability	95

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plant

EQUIPMENT TYPE **Hydrated Lime System**

Item:	Lime System
Tag No.	LS-100

Storage Silo	
Material of Construction	Steel
Diameter x Overall Height	14' x 41'
Manway	
Size	24"
Location	Roof
Cone Bottom Angle	60
Discharge Nozzle Size	5'
Bin Activator (Option)	Vibratory
Quantity	1
Manufacturer	TBD
Size	2600 cf
Model Number	
Air Consumption	
Electrical Requirement	460V
Air Connection	
Size	
Type	
Fill Pipe	
Diameter	4"
Wall Thickness	sch 40
Material of Construction	carbon steel
Bin Vent Filter	
Manufacturer	TBD
Size	
Model Number	
Area of Media	280 sf
Media Material	Polyester
Nominal Rating	micron
Cleaning Device	Air
Controls (Describe)	
Electrical Enclosure	
Feeder	
Manufacturer/Model	
Maximum Capacity	5 cf
Minimum Capacity	
Motor HP	1
SCR Drive Manufacturer	
Slurry Tank	
Capacity	500 gal
Diameter	5'
Height	6'
Materials of Construction	304 SS

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plant

EQUIPMENT TYPE	**Hydrated Lime System**
Item:	Lime System
Tag No.	LS-100

Agitator		
Manufacturer/Model		
Motor	480V/3PH/60HZ	
RPM		
Motor HP	1	
Instrumentation		
Level Probes	High, Low	
Flowmeters		
Programmable Controller		
Number of Pieces to Assemble		
Largest Component for:		
Shipping		lb
Erection		lb
Maintenance		lb
Largest Piece for Shipping		ft x ft x ft
Number of Boxes Shipped		
Total Shipping Volume		
Total Shipping Weight		lbs
Heaviest Item Handled for Erection		lbs
Heaviest Item Handled for Maintenance		lbs

EQUIPMENT DATA SHEET

DATE	10-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Submersible Pump**
Item:	Mine Water Pump
Tag No.	P-100A, P-100B

OPERATING DATA

Pumped Liquid	Water
Liquid Temperature, °F	50
Specific Gravity (SG)	1
pH	5.8
Flow Rate, gpm	60
Total Dynamic Head, feet	150

MATERIALS

Pump	304 Stainless Steel
Impeller	304 Stainless Steel
Motor	

INSTALLATION

Pump outlet, " NPT	2

ELECTRICAL DATA

Rated Power, HP	5
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3460

OTHERS

VFD	P-100A yes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Horizontal Centrifugal Pump**
Item:	Underdrain Pond Pump
Tag No.	P-101A P-101B

OPERATING DATA

Pumped Liquid	TSF Underdrain Water and Stormwater
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.00
pH	5.8 - 6.5
Flow Rate, gpm	120
Total Dynamic Head, feet	100

MATERIALS

Pump	304 Stainless Steel
Impeller	304 Stainless Steel
Motor	

INSTALLATION	Outside
Pump outlet, " NPT	TBD

ELECTRICAL DATA

Rated Power, HP	7
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3460

OTHERS

VFD	Yes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Horizontal Centrifugal Pump**
Item:	Reaction Tank Forwarding Pump
Tag No.	P-102

OPERATING DATA

Pumped Liquid	Water
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.0
pH	10.5
Flow Rate, gpm	150
Total Dynamic Head, feet	25

MATERIALS

Pump	304 SS
Impeller	304 SS
Motor	

INSTALLATION	Inside
Pump outlet, " NPT	TBD

ELECTRICAL DATA

Rated Power, HP	3
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3450

OTHERS

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Horizontal Centrifugal Pump**
Item:	Sludge Pump
Tag No.	P-103

OPERATING DATA

Pumped Liquid	Clarifier sludge
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.02
pH	10.5
Flow Rate, gpm	26
Total Dynamic Head, feet	25

MATERIALS

Pump	304 SS
Impeller	304 SS
Motor	
INSTALLATION	Inside
Pump outlet, " NPT	TBD

ELECTRICAL DATA

Rated Power, HP	0.75
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3450

OTHERS

EQUIPMENT DATA SHEET

DATE	10-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Progressive Cavity Pump**
Item:	Filter Press Feed Pump
Tag No.	P-104

OPERATING DATA

Pumped Liquid	Water
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.1
pH	10.5
Flow Rate, gpm	45
Total Dynamic Head, feet	230

MATERIALS

Pump	304 SS
Impeller	304 SS
Motor	

INSTALLATION	Inside
Pump outlet, " NPT	TBD

ELECTRICAL DATA

Rated Power, HP	3.5
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	N/A

OTHERS

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Horizontal Centrifugal Pump**
Item:	Filtrate Pump
Tag No.	P-105

OPERATING DATA

Pumped Liquid	Water
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.0
pH	10.5
Flow Rate, gpm	15
Total Dynamic Head, feet	25

MATERIALS

Pump	304 SS
Impeller	304 SS
Motor	

INSTALLATION	Inside
Pump outlet, " NPT	2

ELECTRICAL DATA

Rated Power, HP	0.33
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3450

OTHERS

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plan

EQUIPMENT TYPE	**Chemical Feed Pump**
Item:	Sulfuric acid feed pump
Tag No.	P-108

OPERATING REQUIREMENTS

Utility Requirements

Voltage, V	110
Phase	1
Frequency, Hz	60

Environment:

Indoor/outdoor	Indoor
Corrosive	No

General Requirements

Pump	1 x 100%, each
Flow rate, gph	1.5
Motor h.p./strokes	0.25, 1-100
Speed control	local/PLC
Inlet/Outlet diameter, inches	TBD
Maturation tank	N/A
Valves	TBD

Materials

Head and Fittings	Acid Resistant
Balls	Acid Resistant
Check Valve	Acid Resistant
Tubing and Connections	Acid Resistant

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Horizontal Centrifugal Pump**
Item:	Re-use Pump
Tag No.	P-109

OPERATING DATA

Pumped Liquid	Water
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.0
pH	8.5
Flow Rate, gpm	120
Total Dynamic Head, feet	350

MATERIALS

Pump	304 SS
Impeller	304 SS
Motor	

INSTALLATION	Inside
Pump outlet, " NPT	TBD

ELECTRICAL DATA

Rated Power, HP	20
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3450

OTHERS

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Pla

EQUIPMENT TYPE	**Horizontal Centrifugal Pump**
Item:	Fresh Water Pump
Tag No.	P-111

OPERATING DATA

Pumped Liquid	Water
Liquid Temperature, °F	40-85
Specific Gravity (SG)	1.0
pH	7
Flow Rate, gpm	10
Total Dynamic Head, feet	20

MATERIALS

Pump	304 SS
Impeller	304 SS
Motor	
INSTALLATION	Inside
Pump outlet, " NPT	2

ELECTRICAL DATA

Rated Power, HP	0.33
Frequency, Hz	60
Phase	3
Voltage, V	460
Rated Speed, RPM	3450

OTHERS

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant
EQUIPMENT TYPE	**Chemical Feed System**
Item:	Dry Polymer System
Tag No.	PS-100
OPERATING REQUIREMENTS	
Utility Requirements	
Voltage, V	120/460
Phase	1/3
Frequency, Hz	60
Environment:	
Indoor/outdoor	Indoor
Corrosive	No
General Requirements	
Feed Pumps	2 x 100%
Piping	PVC
Capacity, lb/day	12
Valves	TBD
Measurement	Precise polymer dilution
Control System	PLC
Mixer	
Motor h.p./RPM	0.25/120
Impeller size	
Material	304 SS
Tanks	
Mix Tank Capacity, gal	130
Day Tank Capacity, gal	160
Material	304 SS
Pumps	
Flow Rate, Max gph	30
Motor H.P.	0.25
V/P/HZ	120/1/60
Speed Control Range	1-100%
Type	Peristaltic
Notes	

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plan
EQUIPMENT TYPE	**Carbon Steel Storage Tank**
Item:	Equalization Tank
Tag No.	TK-100
FUNCTIONAL DESCRIPTION	Mixing and equalization of mine water and Underdrain Pond water
GENERAL REQUIREMENTS	
Location, Inside/outside	Outside
Tank life, years	30
Standard design guidelines	AWWA, NSF
FLUID PARAMETERS	
Fluid Description	Water
Specific Gravity	1
Fluid Temperature Range, °F	40-90
pH	5.8-6.5
Solids Content	N/A
Particle Size	N/A
TANK PARAMETERS	
Diameter, feet-inches	15-0
Height, feet-inches	8-0
Nominal Volume, gallons	10,000
Working Volume, gallons	10,000
Material of Construction	carbon steel, bolted or welded
Bottom Option	Flat bottom
Minimum Thickness:	
Shell	
Bottom	
Baffles	None
Foundation to be Provided	By Owner
Exterior Paint	Epoxy coated
FLANGE OPENINGS	
Inlet diameter, inches	4
Inlet diameter, inches	3
Probe diameter, inches	TBD
Outlet diameter, inches	4
Outlet diameter, inches	4
Drain diameter, inches	4
Overflow diameter, inches	4

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plan

EQUIPMENT TYPE	**Reaction Tank**
Item:	Reaction Tank
Tag No.	TK-200
GENERAL REQUIREMENTS	
Location, Inside/outside	Inside
Tank life, years	20
FLUID PARAMETERS	
Fluid Description	Water
Specific Gravity	1
Fluid Temperature Range, °F	40-85
pH	10.5
Solids Content	
Particle Size	
TANK PARAMETERS	
Diameter, feet-inches	8-6
Height, feet-inches	Nov-00
Nominal Volume, gallons	4,500
Working Volume, gallons	4,500
Material of Construction	High Density Polyethylene
Corrosion Allowance	
Minimum Thickness:	
Shell	
Bottom	
Roof	
Roof	Open top
Bottom	Flat
Upcomers	N/A
Baffles	Three
Foundation to be Provided	By others
Exterior Paint	NA
FLANGE OPENINGS	
Inlet diameter, inches	
Inlet diameter, inches	N/A
Manhole diameter, inches	N/A
Probe diameter, inches	N/A
Outlet diameter, inches	4
Outlet diameter, inches	
Drain diameter, inches	4
Overflow diameter, inches	
Vent diameter, inches	

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plan

EQUIPMENT TYPE	**pH Adjustment Tank**
Item:	pH Adjustment Tank
Tag No.	TK-300

GENERAL REQUIREMENTS

Location, Inside/outside	Inside
Tank life, years	20

FLUID PARAMETERS

Fluid Description	Water
Specific Gravity	1
Fluid Temperature Range, °F	40-85
pH	8.5
Solids Content	
Particle Size	

TANK PARAMETERS

Diameter, feet-inches	8-0
Height, feet-inches	6-0
Nominal Volume, gallons	2,000
Working Volume, gallons	2,000
Material of Construction	High Density Polyethylene
Corrosion Allowance	
Minimum Thickness:	
Shell	
Bottom	
Roof	
Roof	Open top
Bottom	Flat
Upcomers	N/A
Baffles	None
Foundation to be Provided	By others
Exterior Paint	NA

FLANGE OPENINGS

Inlet diameter, inches	
Inlet diameter, inches	N/A
Manhole diameter, inches	N/A
Probe diameter, inches	N/A
Outlet diameter, inches	3
Outlet diameter, inches	
Drain diameter, inches	2
Overflow diameter, inches	
Vent diameter, inches	

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plan

EQUIPMENT TYPE	**Filtrate Tank**
Item:	Filtrate Tank
Tag No.	TK-400
GENERAL REQUIREMENTS	
Location, Inside/outside	Inside
Tank life, years	20
FLUID PARAMETERS	
Fluid Description	Water
Specific Gravity	1
Fluid Temperature Range, °F	40-85
pH	10.5
Solids Content	
Particle Size	
TANK PARAMETERS	
Diameter, feet-inches	5-0
Height, feet-inches	7-0
Nominal Volume, gallons	900
Working Volume, gallons	900
Material of Construction	High Density Polyethylene
Corrosion Allowance	
Minimum Thickness:	
Shell	
Bottom	
Roof	
Roof	Open top
Bottom	Flat
Upcomers	N/A
Baffles	None
Foundation to be Provided	By others
Exterior Paint	NA
FLANGE OPENINGS	
Inlet diameter, inches	
Inlet diameter, inches	N/A
Manhole diameter, inches	N/A
Probe diameter, inches	N/A
Outlet diameter, inches	2
Outlet diameter, inches	
Drain diameter, inches	2
Overflow diameter, inches	2
Vent diameter, inches	

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Inc Water Treatment Plan

EQUIPMENT TYPE	**Water Tank**
Item:	Fresh Water Tank
Tag No.	TK-700
GENERAL REQUIREMENTS	
Location, Inside/outside	Inside
Tank life, years	20
FLUID PARAMETERS	
Fluid Description	Water
Specific Gravity	1
Fluid Temperature Range, °F	40-85
pH	7
Solids Content	
Particle Size	
TANK PARAMETERS	
Diameter, feet-inches	8-0
Height, feet-inches	6-0
Nominal Volume, gallons	2,000
Working Volume, gallons	2,000
Material of Construction	High Density Polyethylene
Corrosion Allowance	
Minimum Thickness:	
Shell	
Bottom	
Roof	
Roof	Open top
Bottom	Flat
Upcomers	N/A
Baffles	None
Foundation to be Provided	By others
Exterior Paint	NA
FLANGE OPENINGS	
Inlet diameter, inches	
Inlet diameter, inches	N/A
Manhole diameter, inches	N/A
Probe diameter, inches	N/A
Outlet diameter, inches	2
Outlet diameter, inches	
Drain diameter, inches	2
Overflow diameter, inches	
Vent diameter, inches	

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Magnetic Flow Meter**
Item:	Magnetic flow meter
Tag No.	FLOW-100A, FLOW 0100B

OPERATING REQUIREMENTS

General

Service	Mine water pumps P-100B and P-100B
Process Fluid	Water
Line Size, in.	2

Process Conditions

Flow rate, max gpm	60
Velocity, fps	6.2
Temperature, F	50-60

Connections

Line size, in.	2
Line Material	Stainless Steel
Type and Rating	300# flange
End Connection	300# flange

Meter/Sensor

Tube Size, in.	2
Tube/Liner Material	Carbon steel/teflon
Excitation AC/DC	DC
Electrode Material	316 SS
Enclosure Rating	NEMA 4X
Flow Range	0-100 gpm

Transmitter

Range	0-100 gpm
Mounting	pipe mounting
Case Material/Rating	Aluminum/NEMA 4X
Indicator (local/remote)	Remote
Transmitter Output	4-20 mA with Hart
Automatic Temperature Compensation	yes
Power	120VAC
Accuracty	+/- 0.5% of rate

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Magnetic Flow Meter**
Item:	Magnetic flow meter
Tag No.	FLOW-300

OPERATING REQUIREMENTS

General

Service	pH Adjustment Tank TK-300
Process Fluid	Water
Line Size, in.	4

Process Conditions

Flow rate, max gpm	120
Velocity, fps	3.1
Temperature, F	50-90

Connections

Line size, in.	4
Line Material	PVC
Type and Rating	300# flange
End Connection	300# flange

Meter/Sensor

Tube Size, in.	4
Tube/Liner Material	Carbon steel/teflon
Excitation AC/DC	DC
Electrode Material	316 SS
Enclosure Rating	NEMA 4X
Flow Range	0-150 gpm

Transmitter

Range	0-150 gpm
Mounting	pipe mounting
Case Material/Rating	Aluminum/NEMA 4X
Indicator (local/remote)	Remote
Transmitter Output	4-20 mA with Hart
Automatic Temperature Compensation	yes
Power	120VAC
Accuracty	+/- 0.5% of rate

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Differential Pressure Transmitter**
Item:	Diferential Pressure Transmitter
Tag No.	LIT-100

OPERATING REQUIREMENTS

General

Service	TK-100
Process Fluid	Water

Element

Calibration	0-8 feet
Output Signal	4-20 mA with Hart
Accuracy	+/- 1.0% of measured range
Power Supply	Loop powered
Ambient Temperature Limits	32-120F
Case Material	316 SS
Indicator	4 line LCD side mounted

Process Data

Fluid Material State	Water
Level Empty	0 ft
Level Full	8 ft
Vessel Height	8 ft
Possible Vacuum	No

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Differential Pressure Transmitter**
Item:	Diferential Pressure Transmitter
Tag No.	LIT-200

OPERATING REQUIREMENTS

General

Service	Mine Water Well Casing
Process Fluid	Water

Element

Calibration	0-25 ft
Output Signal	4-20 mA with Hart
Accuracy	+/- 1.0% of measured range
Power Supply	Loop powered
Ambient Temperature Limits	32-120F
Case Material	316 SS
Indicator	4 line LCD side mounted

Process Data

Fluid Material State	Water
Level Empty	0 ft
Level Full	25
Vessel Height	50
Possible Vacuum	No

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Differential Pressure Transmitter**
Item:	Diferential Pressure Transmitter
Tag No.	LIT-300

OPERATING REQUIREMENTS

General

Service	Underdrain Pond Pump Casing
Process Fluid	Water

Element

Calibration	0-20 feet
Output Signal	4-20 mA with Hart
Accuracy	+/- 1.0% of measured range
Power Supply	Loop powered
Ambient Temperature Limits	32-120F
Case Material	316 SS
Indicator	4 line LCD side mounted

Process Data

Fluid Material State	Water
Level Empty	0 ft
Level Full	20 ft
Vessel Height	20 ft
Possible Vacuum	No

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**pH Transmitter**
Item:	pH Transmitter
Tag No.	pH-200, pH 300

OPERATING REQUIREMENTS

General

Service	Reaction tank TK-200, pH adjustment tank TK-300
Electrical Area Classification	General
Distance Sensor/Transmitter	33 feet max

Process Conditions

Operating Pressure, PSI	Atmospheric
Maximum Temperature, F	90
Operating Specific Gravity	1

Sensor

Combination Electrode Design	Differential Electrode
Type of Installation	Submersion Mount
Type of Reference Electrode Junction	Triple
Type of Measuring Electrode	General Purpose
Measuring Electrode Material	Glass
Body Material	PEEK
Process Connection	1" NPT
Electrical Connections	Quick-connect cable

Transmitter

Type	pH Analyzer
Input	pH Sensor
Outputs	4020 mA for pH and temperature
Accuracy	+/- 0.01 pH
Measured Range	0-14 pH
Automatic Temperature Compensation	yes
Local Indication	Graphic dot matrix LCD
Power	120VAC
Enclosure Housing	NEMA 4x
Mounting	2" pipe or surface mount

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Pressure Reducing Valve**
Item:	Pressure Reducing Valve
Tag No.	PRV-101A

OPERATING REQUIREMENTS

General

Service	Filter Press core blow
Line Size	2"

Body

Type	Pressure Reducing Valve
Body Size/Port Size	1"/0.563"
End Conn. & Rating	1" NPT
Material	304 SS
Diaphragm Material	CR
Seat	Comp
Valve Disk	CR
Main Spring	304 SS

Actuator

Type	Direct operated
Material	N/A
Spring Range	70-150 psig
Pressure Setting	80 psi

Service

Fluid	Instrument air
Upstream Pressure	100-125 psi
Flow	60 scfm
Set Pressure	80 psig
Temp Max/Operating	120 F/90 F

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Pressure Reducing Valve**
Item:	Pressure Reducing Valve
Tag No.	PRV-101A

OPERATING REQUIREMENTS

General

Service	Filter Press air blow
Line Size	2"

Body

Type	Pressure Reducing Valve
Body Size/Port Size	1"/0.563"
End Conn. & Rating	1" NPT
Material	304 SS
Diaphragm Material	CR
Seat	Comp
Valve Disk	CR
Main Spring	304 SS

Actuator

Type	Direct operated
Material	N/A
Spring Range	70-150 psig
Pressure Setting	80 psi

Service

Fluid	Instrument air
Upstream Pressure	100-125 psi
Flow	125 scfm
Set Pressure	80 psig
Temp Max/Operating	120 F/90 F

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Pressure Reducing Valve**
Item:	Pressure Reducing Valve
Tag No.	PRV-102

OPERATING REQUIREMENTS

General

Service	Lime System air blow
Line Size	1-1/2"

Body

Type	Pressure Reducing Valve
Body Size/Port Size	1"/0.563"
End Conn. & Rating	1" NPT
Material	304 SS
Diaphragm Material	CR
Seat	Comp
Valve Disk	CR
Main Spring	304 SS

Actuator

Type	Direct operated
Material	N/A
Spring Range	70-150 psig
Pressure Setting	80 psi

Service

Fluid	Instrument air
Upstream Pressure	100-125 psi
Flow	125 scfm
Set Pressure	80 psig
Temp Max/Operating	120 F/90 F

Notes

EQUIPMENT DATA SHEET

DATE	25-Apr-17
PROJECT:	Arizona Minerals Water Treatment Plant

EQUIPMENT TYPE	**Pressure Transmitter**
Item:	Pressure Transmitter
Tag No.	PT-100

OPERATING REQUIREMENTS

General

Service	FP-100
Process Fluid	Sludge

Process Conditions

Pressure	100 psig
Temperature	90 F
Density	
Process Connection	1/2" FNPT

General

Element Type	316 SS diaphragm
Enclosure Material/Rating	Aluminum/NEPA 6P
Mounting	316 SS brackets
Power Supply	Loop powered

Transmitters

Output	4-20 mA with Hart
Transmitter Range	0-600
Calibration Range	0-150
Elevation/Suppression	None
Damping	None
Indicator	Digital display
Accuracy	+/- 0.075% of span

Unit

Body	Manufacturer Standard, Rating NEMA 6P
Diaphragm Material	316 SS
Overrange	600 PSIG
Hi Pressure Side	Connection: 1/2 MNPT 1/4" FNPT; Material: 316 SS
Drain/Vent	None
Wetted O-rings	None
Diaphragm Seal	None

Notes

ATTACHMENT D

CLEAN WATER ACT SECTION 404 JURISDICTIONAL DETERMINATION

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, U.S. ARMY CORPS OF ENGINEERS
3636 N. CENTRAL AVE, SUITE 900
PHOENIX, AZ 85012-1939

October 13, 2016

Tom Klimas
WestLand Resources, Inc.
1750 South Woodlands Village Blvd.
Flagstaff, Arizona 86001

SUBJECT: Approved Jurisdictional Determination Regarding Geographic Jurisdiction

Dear Mr. Klimas:

I am responding to your request (File No. SPL-2016-00752-MWL) dated June 10, 2016, for an approved Department of the Army jurisdictional determination (JD) for the January Adit Passive Treatment System project site (Sections 4 and 5, Township 23 South, Range 16 East) located southeast of the Town of Patagonia, Santa Cruz County, Arizona.

Based on available information, I have determined waters of the United States do not occur on the project site. The basis for our determination can be found in the enclosed Approved Jurisdictional Determination (JD) form(s).

This letter includes an approved jurisdictional determination for the January Adit Passive Treatment System project site. If you wish to submit new information regarding this jurisdictional determination, please do so within 60 days. We will consider any new information so submitted and respond within 60 days by either revising the prior determination, if appropriate, or reissuing the prior determination. If you object to this or any revised or reissued jurisdictional determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and Request for Appeal (RFA) form. If you wish to appeal this decision, you must submit a completed RFA form within 60 days of the date on the NAP to the Corps South Pacific Division Office at the following address:

Tom Cavanaugh
Administrative Appeal Review Officer
U.S. Army Corps of Engineers
South Pacific Division, CESPD-PDS-O, 2042B
1455 Market Street
San Francisco, California 94103-1399

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR Part 331.5 (see below), and that it has been received by the Division Office by December 12, 2016.

This determination has been conducted to identify the extent of the Corps' Clean Water Act jurisdiction on the particular project site identified in your request, and is valid for five years from the date of this letter, unless new information warrants revision of the determination before the expiration date. This determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service prior to starting work.

Thank you for participating in the regulatory program. If you have any questions, please contact me at 602-230-6953 or via e-mail at Michael.W.Langley@usace.army.mil. Please help me to evaluate and improve the regulatory experience for others by completing the customer survey form at http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey.

Sincerely,

Sallie Diebolt

Sallie Diebolt
Chief, Arizona Branch
Regulatory Division

Enclosure(s)

ATTACHMENT E

PMA DELINEATION MEMO BY ECOLOGICAL RESOURCE CONSULTANTS, INC.

Ecological Resource Consultants, Inc.
35715 US Hwy. 40, Suite D204 ~ Evergreen, CO ~ 80439 ~ (303) 679-4820

Technical Memorandum

Date: **May 18, 2017**

To: **Johnny Pappas, Arizona Minerals, Inc.**

Cc: **Greg Hess and Alison Jones, Clear Creek Associates**

From: **Troy Thompson**

Re: **Water Treatment Plant Release – Pollutant Management Area Evaluation**

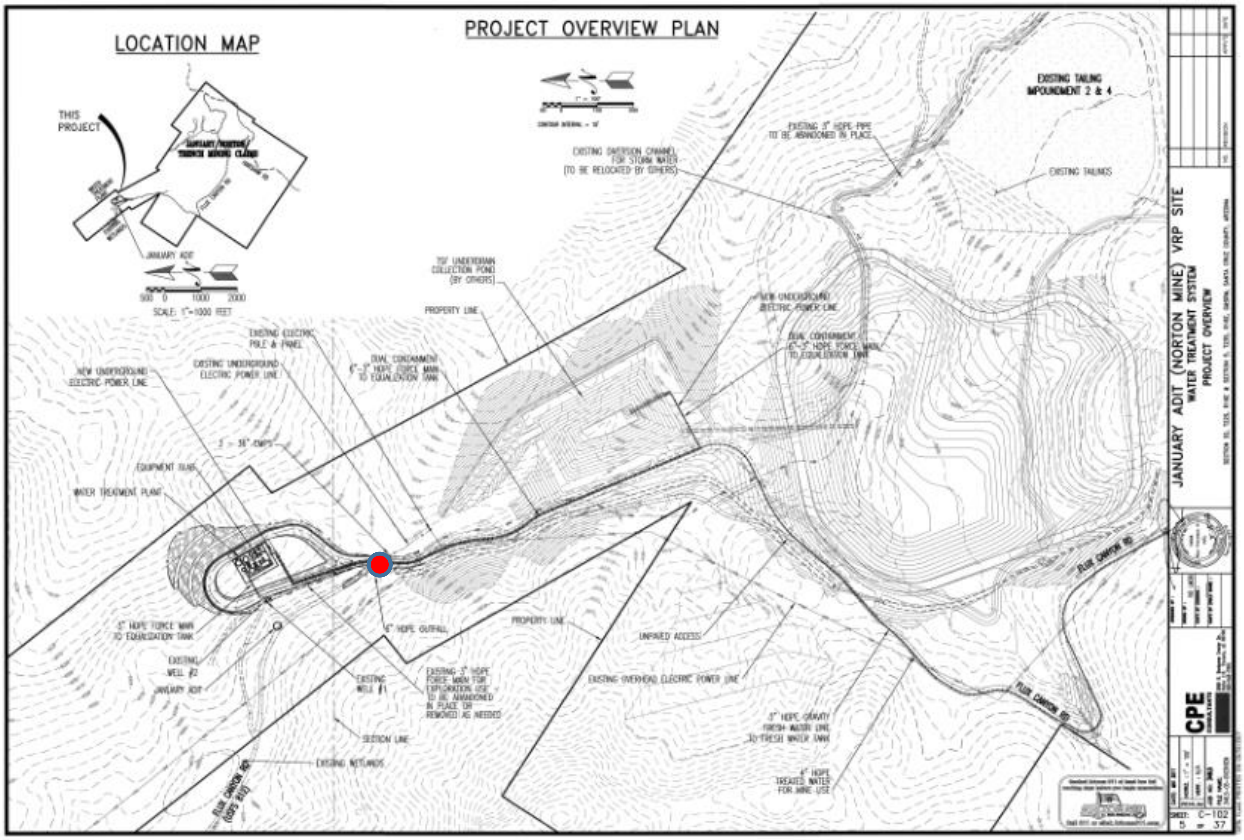
Introduction

As a component of permitting, Arizona Minerals, Inc. (AMI) needed to define the anticipated maximum extent that releases of treated water from its planned water treatment facility to define the Pollutant Management Area (PMA). Ecological Resource Consultants, Inc. (ERC) completed an evaluation to determine the anticipated extent of this zone. The analysis included an evaluation of treatment releases, infiltration capacity of the receiving streambed and hydraulics of the receiving water. Site conditions, assumptions used for the assessment, calculations methods and results are presented herein.

Water Treatment and Releases

A water treatment plant (WTP) will be utilized to treat contact water that is encountered at the mine that cannot be utilized. A water balance was completed to estimate the amount of excess water that would require treatment (ERC 2017). Results of the water balance were used to establish that the WTP will be designed to have a maximum treatment capacity of 120 gallons per minute (gpm). Releases from the WTP are predicted to range from 0 gpm to 120 gpm with an average release rate on the order of 80-90 gpm. Water released from the WTP will meet State surface water standards and numeric Aquifer Water Quality Standards. To define the PMA, the maximum WTP capacity of 120 gpm was used. Treated water will be conveyed from the WTP to the its discharge point along Alum Gulch. **Figure 1** is a general overview plan of the site with the release point identified by the red circle.

Figure 1 – WTP Release Point Location



Alum Gulch Conditions

The upstream portion of Alum Gulch is impaired due to total and dissolved cadmium, copper, zinc as well as acidity (ADEQ 2007). Based on ADEQ's 2007 evaluation Alum Gulch was classified as an intermittent stream from the January Adit downstream for approximately two miles to a point that is approximately 800 meters downstream of the World's Fair Mine. Alum Gulch was classified as ephemeral for areas upstream of the January Adit and from the point 800 meters downstream of the World's Fair Mine to its confluence with Sonoita Creek (ADEQ 2007). The 2007 report states that baseflows in the intermittent reach were evaluated in 2003 and ranged from 0.001 to 3 cubic feet per second (cfs) at various locations along the intermittent reach. The January Adit and the World's Fair Mine are the only observed constant drainages in the Alum Gulch Watershed (ADEQ 2007).

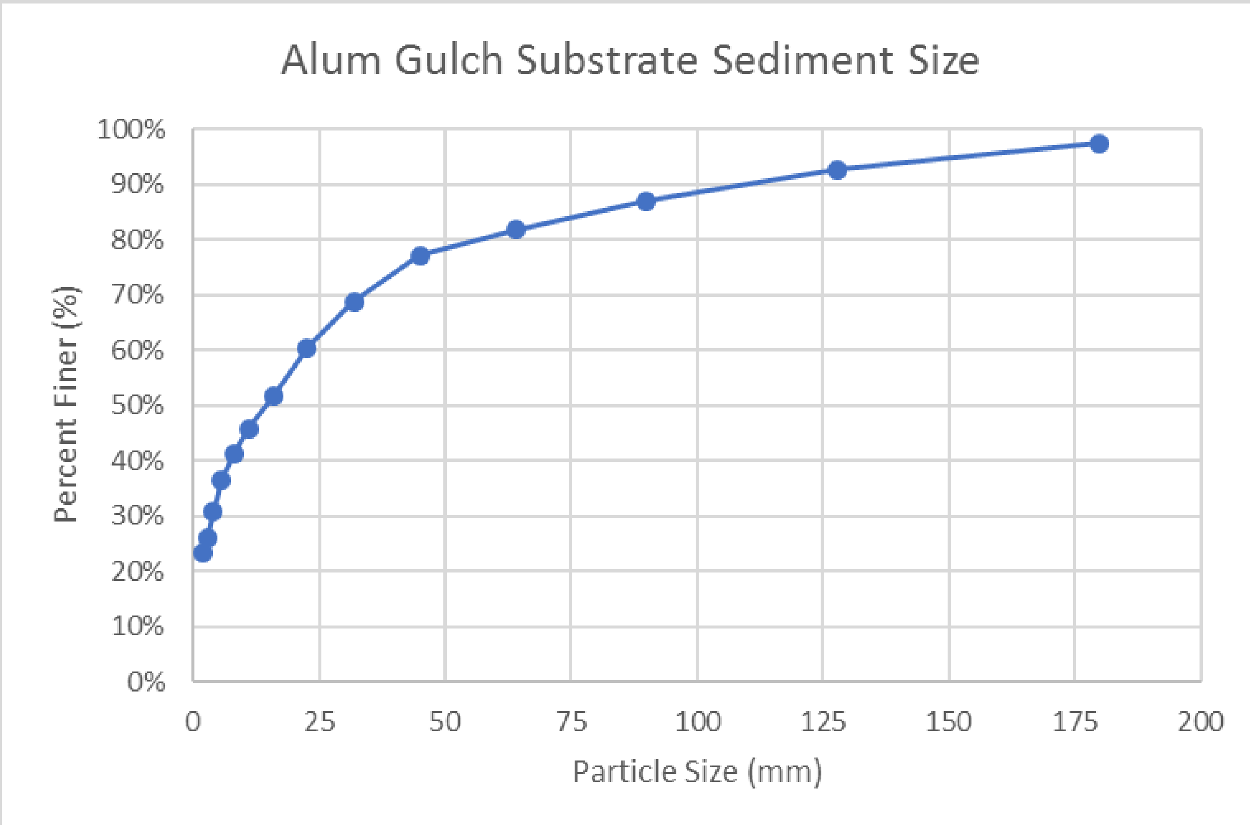
Alum Gulch, from the January Adit downstream to approximately ½ miles below the confluence with Humboldt Canyon, was evaluated by ERC in April of 2017 and was classified as an ephemeral stream. At the time of ERC's evaluation, the stream was dry along its bed with only isolated areas where localized seeps provided a surface expression of water. In all areas where seeps were identified, the area of moist soil was very limited in extent as water was observed to infiltrate back into the ground surface within feet of the seep. ERC's observations in April are similar to conditions observed throughout the year and surface water is typically observed throughout the stream in response to larger precipitation events (personal communications 2017). ERC's field observations and recent experience of AMI are different than previous field evaluations in that prior work characterized Alum Gulch below the January Adit as an intermittent stream whereas current conditions suggest the stream is ephemeral.

The difference between previous and current assessments is believed to be the result of management of the January Adit. At the time of the previous ADEQ assessments, the January Adit was observed to be the only constant source of water upstream of the World's Fair Mine and the adit defined the upstream extent of the intermittent stream segment. AMI is currently managing groundwater levels such that the January Adit is no longer discharging. As AMI moves forward with its mine plan, the January Adit will no longer release to Alum Gulch and the only releases will be from the water treatment plant. The removal of the adit release from Alum Gulch therefore appears to be the reason the stream has transitioned from intermittent to ephemeral.

Sediment Sampling

As a part of ERC's field investigation, sediment sampling was conducted to evaluate substrate conditions. Sampling was completed using Wohlman Pebble Counts following methods outlined in Bunte and Abt (Bunte and Abt 2001). Sampling was completed in the streambed downstream of Humboldt Canyon at 31°28'28" North, 110°44'1" West at an elevation of approximately 4840 feet above mean sea level (amsl). A total of 192 particles were sampled and the D_{50} of the material was found to be about 15 millimeters, which is a gravel. The material was field classified as a well graded gravel with sands and cobbles. The finer material was observed to be dominated by sands with minimal clay or silt material present; it was free draining. The resulting gradation curve is provided in **Figure 2**.

Figure 2 – Gradation Curve for Alum Gulch Substrate



Infiltration rates for the bed material were estimated using the observed soil types and standard published rates. For the purpose of this analysis a conservative rate of 0.9 inches per hour or 1.8 feet per day was selected.

Calculation of Stream Distance

In order to estimate the length of stream that would be wetted due to WTP releases of 120 gpm, ERC first calculated the surface area. Surface area can be calculated directly based on the discharge rate from the WTP and the streambed infiltration. The peak WTP release rate of 120 gpm equates to a flow rate of 23,143 cubic feet per day. Dividing this flow rate by the infiltration capacity of 1.8 feet per day results in an area of 12,857 square feet.

In order to estimate the distance from the release WTP release point needed to provide approximately 13,000 square feet of wetted channel perimeter, ERC completed a hydraulic assessment of the stream. The relationship between flow and wetted perimeter in Alum Gulch was estimated based on the Manning's Equation. For calculations, a Manning's N value of 0.15 was selected. This high value was used as it reflects the relatively high flow resistance that occurs for low flows. With flows on the order of 120 gpm, flows will be confined to a small section of the overall streambed. ERC assumed a triangular channel with 10:1 side slopes for our evaluation. A longitudinal slope of 5.8% was used in the evaluation. Based on the Manning's N value and the channel geometry, a relationship between flow and wetted perimeter was obtained. This relationship is provided on **Table 1**.

Table 1 – Relationship between Flow Rate and Wetted Perimeter in Alum Gulch

Flow (gpm)	Wetted Perimeter (ft)
120	2.9
110	2.8
100	2.7
90	2.6
80	2.5
70	2.3
60	2.2
50	2
40	1.9
30	1.7
20	1.5
15	1.3
10	1.1
8	1
5	0.9
3	0.7
1	0.5

Water released from the WTP would be a maximum of 120 gpm near the release point and decrease in the downstream direction as infiltration acted to reduce the remaining surface flows. Table 1 indicates that for a flow range of 1 to 120 gpm, the wetted perimeter remains nearly constant and only changes by less than 2.5 feet. Given how little the wetted perimeter is expected to reduce as flows move in the downstream direction, an average flow wetted perimeter of 2 feet was used.

Using an average wetted perimeter of 2 feet, the distance below the WTP discharge point where water is expected to remain on the surface was determined by dividing 12,857 square feet by 2 feet to obtain an estimate of about 6,430 feet or 1.22 miles.

Comparison of Results

In an attempt to validate the calculated results, ERC utilized information from the TMDL report as a data point for comparison. While the TMDL report was written to evaluate a different condition, it does provide information that is useful when estimating the distance that flows can be expected to remain at the surface through this section of Alum Gulch.

Two pieces of information from the TMDL study that are pertinent to this evaluation are the flow rates observed in Alum Gulch and the aerial extent of Alum Gulch that was determined to be intermittent. From a flow standpoint, the report indicates that flow rates in Alum Gulch were observed to range from

0.001 to 3 cfs. The report also states that Alum Gulch is an intermittent stream from the January Adit for approximately 2 miles downstream (ADEQ 2007).

The maximum release from the WTP is 120 gpm, which equates to approximately 0.27 cfs, which is within the range and on the lower end of flows observed by the ADEQ. For a WTP release rate of 120 gpm ERC is estimating that water would remain at the surface for approximately 1.2 miles. This is about 60% of the approximately 2-mile area that the ADEQ determined to be intermittent with the observed flows of up to 3 cfs. Given that the WTP release rate is at the lower end of the flow rates evaluated by ADEQ and the stream distance that ERC calculated where water will be observed at the surface is about 60% of the stream length determined to be intermittent by ADEQ, the results of our calculations are consistent with past field observations.

Conclusions

The purpose of this evaluation was to estimate the length of the Pollutant Management Area (PMA) in Alum Gulch that would result from planned WTP releases. The evaluation considered peak WTP release rates, conditions of the streambed and hydraulic properties of the channel to estimate the distance of expected surface flows. Using a peak WTP flow rate of 120 gpm the maximum extent of the PMA was estimated to be approximately 1.22 miles.

Calculated results were then compared to past evaluations of Alum Gulch that were completed for TMDL evaluations. These past studies suggest that with flows in Alum Gulch as high as 3 cfs, an approximately 2-mile stretch of the stream has intermittent flows, downstream of this point Alum Gulch was found to be ephemeral. We believe these past observations lend credibility to the calculated 1.22 mile length of the PMA from the WTP discharge point.

References

Arizona Department of Environmental Quality (ADEQ). 2007. TMDL Implementation Plan for Cadmium, Copper, Zinc and Acidity – Alum Gulch HUC #15050301-561A & B. Publication No. OFR 07-03. March.

Bunte, Kristin and Abt, Steven. 2001. Sampling Surface and Subsurface Particle-Size Distributions in Wadable Gravel- and Cobble-Bed Streams for Analyses in Sediment Transport, Hydraulics, and Streambed Monitoring. Rocky Mountain Research Station, Forest Service, United States Department of Agriculture. May.

Ecological Resource Consultants, Inc. 2017. Technical Memo - Tailings Storage Facility Water Balance. April 21.

Personal Communications. 2017. Johnny Pappas, Arizona Minerals, Inc. May.