DRAFT REMEDIAL ACTION PLAN

FOR

ADAIR PARK ARCHERY RANGE, YUMA, AZ.

VRP SITE CODE 505354-00

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY VOLUNTARY REMEDIATION PROGRAM

MAY 2020

Prepared for:



Yuma County Department of Public Works 4343 South Avenue 5 ½ E. Yuma, Arizona 85365





YUMA, AZ 85364



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List of Acronyms

ADEQ AOC A.R.S.	Arizona Department of Environmental Quality area of concern Arizona Revised Statute
bgs	below ground surface
DEUR	Declaration of Environmental Use Restriction
ECP	Engineering Control Plan
ft.	feet
IDW	Investigative Derived Waste
MDL mg/kg	Method Detection Limit milligrams per kilogram
NFA NHI NR	No Further Action National Highway Institute Non-residential
RAP RCRA	Remedial Action Plan Resource Conservation and Recovery Act
SBR SPLP SRL SWPPP	Setback Ratio Synthetic Precipitation Leaching Procedure Soil Remedial Level Stormwater Pollution Protection Plan
TCLP TFG	toxicity characteristic leaching procedures The Fehling Group
USBR USEPA	United States Bureau of Reclamation United States Environmental Protection Agency
VRP	Voluntary Remediation Program
XRF	X-ray Fluorescence

1.0 INTRODUCTION

This Remedial Action Plan (RAP) presents the remedial activities that will be implemented at the Adair Park Archery Range (site) located at 4760 South US Highway 95 and is accessed via Adair Park Road, approximately 12 miles north of Yuma, Arizona (Figure 1). In August 2000, an initial site assessment of the Adair Park Archery Range revealed the presence of elevated lead concentrations in the soil within the archery range. The subsequent investigation of the site discovered the site had previously been used for silver mine ore processing and that residual lead was discarded on site in the tailings from the silver ore mill. Remediation of the site that contained lead impacted soil and placing a gravel and double chip seal cap over the stockpiled contaminated soil (Figure 2). Yuma County entered the Voluntary Remediation Program (VRP) to address Arizona Department of Environmental Quality (ADEQ) concerns of residual lead contamination remaining at the site and the adequacy of the existing stormwater conveyance to protect the existing capped area of the site. Additional site characterization was performed in 2018 and 2019 in order to seek a No Further Action (NFA) letter from the ADEQ and having a Declaration of Environmental Use Restriction (DEUR) placed on the site.

2.0 SITE BACKGROUND

The site consists of 24 acres that was dedicated to Yuma County by the United States Bureau of Reclamation (USBR) in 1967 for rifle, pistol, and archery range uses. The archery range site is located in a dry ephemeral wash that is surrounded by the Gila River to the south, desert hills to the north and west and a shooting range to the east (Figure 2). The site currently consists of an archery range, several buildings, a shade structure, elevated shooting structures, archery targets and materials, and maintenance equipment.

2.1 PREVIOUS INVESTIGATIONS

An investigation of the site was performed in 2000. The investigation discovered that the site was formerly used as a silver ore mill during the late 1800s and early 1900s. The silver ore was brought to the site from the mine and processed at the mill. The tailings from the silver ore processing, which contained elevated lead concentrations, were placed in a tailings pond located on the site. The silver ore processing and associated tailings resulted in lead contaminated soil migrating throughout the site via stormwater runoff and wind-borne transportation.

Subsequent investigations by Yuma County and the ADEQ, through its Brownfields Site Cleanup Grant awarded by the US Environmental Protection Agency (USEPA) in 2004, revealed lead contaminated soil was present in the archery range and the archery practice area. Laboratory analytical results indicated that lead was present in the soil at concentrations up to 38,000 milligrams per kilogram (mg/kg). No other metals were detected in the soil that exceeded their respective soil remediation levels (SRLs). The lead contaminated soil was limited to an area within the boundaries of the site. In 2006, Yuma County entered the VRP and performed remedial activities at the site.

In 2006, the site was divided into three (3) areas of concern (AOCs) (Figure 2). Soil excavated from AOC 2 and AOC 3 was placed in AOC 1 where it was capped with a gravel base and a double



chip seal surface (Kleinfelder 2006). Fill from a nearby source was used to backfill the excavated areas in AOC 2. Soil excavated from AOC 3 created two stormwater retention basins currently used as part of the stormwater management system at the site. Additionally, engineering controls were constructed to divert stormwater around the capped area toward drainage channels on both sides of the capped area, into drainage channels through AOC 2 and into the retention basins located in AOC 3.

Following completion of the remediation, Yuma County intended to pursue an NFA and DEUR for the site. However, a reversion clause in the USBR dedication resulted in delaying the preparation of the NFA and DEUR. The archery range reopened in 2007 and Yuma County began inspection and maintenance of the engineering controls constructed to protect the integrity of the capped area.

ADEQ conducted a site inspection on March 5, 2014 and conducted a subsequent file review by the ADEQ VRP on March 7, 2014. The site inspection and file review indicated that several issues remain to be addressed at the site. Based on the ADEQ site inspection, the following recommendations were presented in a letter to Yuma County dated June 4, 2014:

- 1. An analysis of the stormwater conveyance should be prepared prior to application for a DEUR. The analysis should include an assessment of the stormwater flow and whether it is adequately diverted around the capped area or if peak flows result in flow across the top of the capped area.
- 2. Rip rap was used as a protective wall upstream (north) of the capped area instead of the originally designed concrete cutoff wall. The stormwater conveyance assessment should also evaluate the protectiveness of the rip rap wall and ensure the cap will not be undermined during a peak storm event.
- 3. An engineering control or calculation of a site specific alternate soil remediation standard should be prepared for the uncapped areas where lead may be present in concentrations greater than the established non-residential (NR) SRL.
- 4. Repair areas where the stormwater drainage channels have been eroded. All repairs or modifications to the erosion control system should be prepared and performed under the direction of an Arizona Professional Engineer.
- 5. Develop an alternate GPL for the site to evaluate potential impact to groundwater at the site.

Based on the file review conducted by ADEQ VRP, the ADEQ recommended the following in a letter dated March 7, 2014:

- 1. Approximately 35,000 to 40,000 cubic yards of fill material was used to replace the soil removed from AOC 2. The fill material was not certified clean and documentation that the fill material is free of environmental contaminants was not provided. Therefore, the ADEQ requested that the soil used as fill material be sampled and analyzed for Resource Conservation and Recovery Act (RCRA) eight (8) metals.
- 2. Protectiveness of groundwater was not evaluated during any of the assessments or remedial actions. Therefore, the ADEQ recommended eight (8) soil samples be collected and analyzed



for RCRA 8 total and leachable metals concentrations to enable the calculation of an alternate GPL for the site.

- 3. AOC 3 still contains lead in concentrations that exceed the NR SRL of 800 mg/kg. The ADEQ recommended the entire AOC 3 area be evaluated for RCRA 8 metals.
- 4. Based on previous investigations, lead contamination remains in the soil and engineering controls have been constructed to minimize exposure to the employees and users of the archery range. The ADEQ recommends a DEUR be submitted for approval. The DEUR should include the DEUR fee, an Engineering Control Plan (ECP), and proof of financial assurance.
- 5. The Phase II Environmental Site Assessment report did not document sample location or data used for background concentrations that were used to calculate the alternate background concentration cleanup levels. The ADEQ recommends conducting sampling to establish background concentrations for lead.

Based on this cap inspection and file review, Nicklaus Engineering, Inc. conducted additional site characterization and performed a stormwater conveyance evaluation for the site in 2019. The stormwater conveyance evaluation concluded several locations have experienced minor erosion that will be required to be repaired. Additionally, the channels downstream of the capped area will also require repair or upgrading in order to prevent stormwater overflow and erosion of the adjacent soil.

The distribution of lead in soil indicates that the top one feet of soil in several areas outside the capped area contain lead in concentrations greater than the NR SRL of 800 mg/kg. Additionally, the former tailings pile location contains lead in concentrations greater than 800 mg/kg and one location contains lead and cadmium in toxicity characteristic leaching procedures (TCLP) concentrations above their respective regulatory limit making the soil in the immediate area around this sample a characteristic hazardous waste due to its lead and cadmium toxicity.

Groundwater was encountered only on the southern third of the site, approximately along the northern edge of the detention basins located in AOC 3A and AOC 3B. The depth to groundwater in the southern area of the site is approximately 15 feet below ground surface (bgs). The portion of the site north of the detention basins, including the capped area and the former tailings pile area is underlain by shallow granitic bedrock and no groundwater is present in the alluvium. An alternate site-specific GPL of 50,899 mg/kg was calculated for lead at the site. No soil sample results exceeded the site specific GPL by the x-ray fluorescence (XRF) analyzer or by laboratory analysis.

The first attempt to evaluate groundwater quality resulted in sand heaving into the borehole preventing collection of a groundwater sample. A temporary groundwater monitoring well was installed at the site on November 6, 2019 and a groundwater sample was collected from the well on November 18, 2019. Lead was not detected in the groundwater at a concentration exceeding its laboratory reporting limit.



3.0 EXTENT OF CONTAMINATION

3.1 REMEDIATION GOALS

Soil remediation goals for the site are the non-residential SRL established by the ADEQ for metals. The arsenic non-residential SRL is 10 mg/kg and the non-residential (NR) SRL for lead is 800 mg/kg. To ensure that any existing soil contamination will not cause an exceedance of the aquifer water quality standard (AWQS), a site-specific GPL was calculated for lead utilizing *A Screening Method to Determine Soil Concentrations Protective of Groundwater Quality* (ADEQ 1996) methodology. The analytical results, in this case the method detection limit of 0.019 mg/L, for the SPLP analysis were entered into the model to calculate a site-specific GPL. The calculated site-specific GPL supersedes the minimum GPL for lead. A site-specific GPL of 50,899 mg/kg was calculated.

Constituent	Residential SRL	Non-Residential SRL	GPL	Comments	
Lead	400	800	50,899*	*Calculated site specific GPL value	
Arsenic	10	10	290**	**Minimum GPL	

Table 1 Site Specific Remediation Goals

3.2 EXTENT OF LEAD IN SOIL

3.2.1 Background Soil

Eight (8) background soil samples were collected from areas surrounding AOCs 1, 2 and 3 (Figure 3). The background samples were collected from a depth of 0.0 feet (ft) to 0.5 ft bgs at each location. Each location was screened for lead using the portable x-ray florescence (XRF) analyzer prior to sample collection for comparison purposes (Table 2). Arsenic was detected in all samples and range in concentration from 10 mg/kg to 15 mg/kg, all above the NR SRL of 10 mg/kg. The arsenic is believed to be naturally occurring and not related to the silver milling activities. Lead ranged in concentrations from 16 mg/kg to 620 mg/kg, below the NR SRL of 800 mg/kg. The results of the background soil sampling are summarized in Table 3.

3.2.2 AOC 2 EXTENT

At the time the soil was removed from AOC 2, the non-residential SRL for lead was 2,000 mg/kg but has subsequently been lowered to 800 mg/kg. Therefore, removal of contaminated soil may have only addressed lead to 2,000 mg.kg. Additionally, the backfill soil used to replace the soil that was removed from AOC 2 was not documented and the source of the fill material was not certified clean prior to backfilling. The objective of the soil sampling effort in AOC 2 was to assess the fill soil, both depth of fill and whether it contained any constituent of concern, and to assess the soil left in place below the fill.



Based on the estimated total area of AOC 2, approximately 13,000 square yards, and the estimated amount of fill material reported to be between 35,000 and 40,000 cubic yards of soil, the depth of fill was estimated to be between 2.5 and 3 feet in thickness in AOC 2. Based on the results of the soil sampling in AOC 2, the depth of fill ranged between 1 and 3.5-feet bgs, for an average depth of 2.2 feet bgs. Additionally, none of the samples collected from the fill in AOC 2 exceeded the residential SRL for lead of 400 mg/kg, ranging from 38 mg/kg to 370 mg/kg.

Eight (8) soil sample locations were sampled and a total of 16 soil samples and one duplicate sample were collected in AOC 2 for submission to the analytical laboratory (Figure 3). Each location was drilled using hollow stem auger (HSA) drilling techniques and were continuously sampled to a total depth of 6 feet bgs. The soil samples were screened every 6-inches from the surface to 5 feet bgs for lead using a portable XRF analyzer (Figure 3 and Table 2). Soil samples in AOC 2 were collected from the fill material at the surface, 0.0 ft to 0.5 ft bgs, and from the natural soil below the fill material with the highest XRF reading at each location and submitted to the laboratory for confirmation analysis.

The results of the laboratory analysis of the soil below the fill were compared to the current NR SRL for lead of 800 mg/kg and the site-specific GPL (Figure 4 and Table 2). Only one sample from AOC2, AOC2-6-4.0, a sample collected from the natural soil at 4 feet bgs, contained lead at a concentration of 1,600 mg/kg (Figure 4). No other sample from AOC 2 contained lead at a concentration greater than the NR SRL of 800 mg/kg. The laboratory analytical results for the soil sampling in AOC 2 are summarized in Table 4. The boring logs for each sample location are presented in Appendix A.

3.2.3 Soil in AOC 3

Based on historical soil data, the lead contamination was limited to the surface in AOC 3. Large parts of AOC 3 were excavated to create the stormwater detention areas on either side of the primary operating area of the Archery range. Yuma County subdivided AOC 3 into the following areas: the eastern detention pond area is identified as AOC 3A, the area between the two detention ponds, where no soil was excavated, is identified as AOC 3B, and the western detention pond area is identified as AOC 3C (Figure 2).

Thirty-two (32) soil samples were collected from 24 locations within AOC 3. Nine (9) samples from eight locations within AOC 3A, 13 samples from eight locations within AOC 3B and 11 samples and one duplicate sample were collected from eight locations within AOC 3C (Figure 4). Each location was drilled using HSA drilling techniques and were continuously sampled to a total depth of 6 feet bgs. The soil samples were screened every 6-inches from the surface to 6 feet bgs for lead using a portable XRF analyzer (Table 2). Soil samples from the surface, 0.0 ft to 0.5 ft bgs, at each location were submitted to the laboratory for analysis and a total of seven additional soil samples were collected in AOC 3 from deeper soil when the XRF screening indicated the lead concentration was above 800 mg/kg. Additionally, selected soil samples from seven locations in AOC 3B were used for lead leachability analysis using the synthetic precipitation leaching procedure (SPLP) and the results were used to calculate a site-specific GPL for lead.

Five soil samples collected from AOC 3 contained lead in concentrations greater than the NR SRL for lead of 800 mg/kg. Sample AOC3A-4-1 contained lead at a concentration of 1,800 mg/kg,



AOC3A-5-2 at 930 mg/kg, AOC3B-2-1 at 820 mg/kg, AOC3B-8-0.5 at 820 mg/kg and AOC3C-6-0.5 at 1,000 mg/kg. None of the samples collected for SPLP analysis contained lead at a concentration exceeding the method detection limit (MDL) of 0.019 mg/L. The laboratory analytical results for total metals in soil at AOC 3 are summarized in Table 4 and the SPLP results are summarized in Table 5. The boring logs for each sample location is presented in Appendix A.

3.2.4 Soil in Former Tailings Pile Area

During XRF screening for background sample locations, the former tailings pile area was also screened. Based on the initial screening, 13 locations were selected to be screened with the XRF analyzer (Figure 5). Eight (8) XRF screening locations contained lead ranging from 1,316 parts per million (ppm) to 15,000 ppm (Figures 5 and 6). Based on those readings, a soil sample was collected from the surface, 0.0 to 0.5 ft bgs, at the locations with the two highest readings, location TP-8 with a reading of 7,995 ppm and location TP-13 with a reading of 15,000 ppm. These samples were submitted for conformational laboratory analysis. In addition, both samples were submitted for TCLP analysis to test if the samples were a characteristic hazardous waste due to its lead toxicity. Sample TP-8 contained lead at a concentration of 5,800 mg/kg but was not detected above the TCLP analysis reporting limit of 0.5 mg/L. Sample TP-13 contained lead at a concentration of 12,000 mg/kg and TCLP analysis indicated lead was detected at a concentration of 57 mg/L, above the regulatory limit of 5 mg/L for lead, and cadmium was detected at a concentration of 1.4 mg/L, above the regulatory limit of 1 mg/L, making this sample a characteristic hazardous waste due to its lead and cadmium toxicity. The laboratory analytical results for the soil sampling in tailings pile area are summarized in Table 4.

3.3 EXTENT OF CONTAMINATION IN GROUNDWATER

The extent of groundwater at the site is limited. Based on the results of the drilling, it appears that only the southern third of the site is underlain by groundwater. Groundwater was not encountered on the northern portion of the site due to elevated bedrock (Figure 7). The results of the groundwater sample analysis from the temporary well indicated that the COCs were not present in concentrations exceeding their respective method detection limits and that groundwater was not impacted by the constituents of concern at the site.

3.4 RISK ASSESSMENT

The ADEQ obtained the assistance of The Fehling Group, LLC (TFG) to evaluate the reported concentrations of arsenic and lead in the soil, specifically in AOC 2 and AOC 3, and to perform a Human Health Risk Assessment on the residual concentrations of metals in the soil (TFG 2019). TFG concluded the background concentrations of arsenic and lead exceeded their respective calculated background concentration and further evaluation was warranted. Therefore, a human health risk assessment was performed to assess whether the residual concentrations of arsenic and lead were protective of human health. TFG concluded that the residual concentrations of arsenic and lead in AOC 2 and AOC 3 where protective of human health and the ADEQ concluded that no additional remediation was warranted in these two areas. The risk assessment conclusions do not apply to the former tailing area. The Risk Assessment prepared by TFG is presented in Appendix B.



3.5 STORMWATER CONVEYANCE EVALUATION

The stormwater conveyance evaluation was performed to assess the current condition of the conveyance system and to evaluate whether additional engineering controls would be required to comply with stormwater management regulations. The stormwater conveyance system evaluation included an evaluation of the following:

- A topographic survey of the area was conducted to evaluate stormwater flow over and around the capped area and through the rest of the site.
- The capacity of the stormwater conveyance around the capped area was evaluated.
- The upstream protective wall, the stormwater drainage channels, and the retention basins were evaluated.
- Proposed modifications to the stormwater conveyance system were prepared, including recommended upgrades to the stormwater conveyance system
- Proposed maintenance that should be performed on a regular basis to protect the integrity of the stormwater conveyance system.
- Preparation of construction drawings for the proposed modifications and/or maintenance to be implemented; and,

The updated stormwater conveyance evaluation report is presented in Appendix C. Based on the results of the evaluation the following conclusions and recommendations were presented.

3.5.1 Stormwater Runoff - Volume

The existing stormwater retention basins have the capacity to retain approximately 16% of the stormwater runoff generated by the watershed that flows through the site and into the Gila River during a 100-year, 2-hour storm event. However, the storm water retention capacity of both existing retention basins combined is approximately 5 times the capacity required to retain the storm water runoff from the capped surface. A portion of the excess storm water runoff generated by the watershed for the entire site leaving the existing retention basins is retained by Adair Park Road at the southern boundary of the site. Using an AutoCAD – Civil 3D surface model to calculate the stormwater storage capacity of the site with a low point of Adair Park Road as an outfall elevation; the percentage of storm water runoff from the entire site retained on site before overflow into the Gila River is approximately 30% (Appendix C). Adding additional stormwater retention for the site was not deemed practical as there are no viable options for significantly increasing the stormwater retention capacity of the site.

3.5.2 Stormwater Runoff – Capped Area Drainage Channels

The cap drainage channel that is located on the western side of the caped area does not have the capacity to carry the storm water runoff for a 100-year storm (Figure 2). The cap drainage channel that is located on the eastern side of the caped area does have the capacity to carry the storm water runoff for a 100-year storm. The western side of the cap is slightly lower than the eastern side and thus receives a higher volume of stormwater per event. The western bank of the western channel could potentially erode and undermine the capped area in a high flow storm event. It is recommended that at least an additional 6-inches of 6-inch rip-rap rock be installed on the top



portion of the west bank to increase the storm water carrying capacity of western cap drainage channel and minimize the potential for erosion and undermining of the capped area.

An inspection of the western cap drainage channel showed little signs of erosion through the majority of the channel. However, the north (upstream) end of western cap drainage channel near the protective rip-rap wall showed signs of erosion. To repair the erosion of the drainage channel; it is recommended that new 6-inch rip-rap rock be installed at the upstream ends of both the western and eastern drainage channels to protect the cap from potential damage during a high flow storm event.

3.5.3 Stormwater Runoff – Drainage Channels Downstream of Capped Area

The western and eastern drainage channels at the south end of the capped surface was also evaluated. It was determined that neither of the drainage channels had the capacity to carry the storm water runoff for a 100-year storm. Also, a site inspection of both downstream drainage channels showed significant signs of erosion outside of the channels indicating that the stormwater was not contained within the channels.

To repair the erosion and increase the storm water carrying capacity of both drainage channels, it is recommended that the drainage channel be reconstructed. The channels should be deepened, and the deepened channels should be lined with 6-inch rip-rap to prevent erosion of the channels.

3.5.4 Protective Rip-rap Wall

Rip-rap protective walls consist of a layer or facing of rock, dumped or hand-placed on channel and structure boundaries to limit the effects of erosion and is the most common type of erosional countermeasure due to its general availability, ease of installation and relatively low cost. Rip-rap design must account for several possible modes of failure. These include rip-rap particle erosion, substrate material erosion and mass failure.

3.5.4.1 Rip-Rap Wall Failure Modes

Particle Erosion

Particle erosion is the most common erosional mechanism for rip-rap walls. Particle erosion occurs when individual particles are dislodged by the hydraulic forces generated by the flowing water. Particle erosion can be initiated by abrasion, impingement of flowing water, eddy action/reverse flow, local flow acceleration, freeze/thaw action, ice, or toe erosion. Probable causes of particle erosion include: (1) stone size not large enough; (2) individual stones removed by impact or abrasion; (3) side slope of the bank so steep that the angle of repose of the rip-rap material is easily exceeded; and (4) gradation of rip-rap too uniform. (DOT 2009a)

Rip-rap particle erosion is minimized by sizing the rip-rap to withstand hydraulic and turbulence forces. Calculations for sizing the rock for the rip-rap wall can be found in Section 11.2 of the Stormwater Conveyance report (Appendix C). A site inspection to assess the steepness of the bank, gradation of rip-rap and inspect for missing stones is discussed below.

Substrate Particle Erosion

Substrate particle erosion occurs when the base material erodes and migrates through the rip-rap voids causing the rip-rap to settle. Substrate particle erosion is limited by placing a granular or



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geotextile filter between the rip-rap and the base material. A site inspection to evaluate the existing filter of the rip-rap wall is discussed below.

Mass Failure

Mass failure occurs when large sections of the rip-rap and/or base material slide or slump due to gravity forces. Mass failure can be caused by excess pore water pressures, bank steepness and loss of basal support through scour or channel migration. Also, a filter fabric that is too fine can clog and cause the buildup of pore water pressures in the underlying soil. Rip-rap that is large enough to resist all the hydraulic forces can fail if channel migration or scour undermines the toe support.

The following calculations estimate the scour depth of a transverse structure. Stormwater flow characteristics for the channel north of the protective rip-rap wall are used to determine the scour depth. A worse case water depth is estimated to be 1.0 feet.

$$Q = 355$$
 cfs, Depth = 1.00 ft., Velocity = 2.45 ft/s

Several commonly used countermeasures for channel instability or scour protection project transversely into the flow (e.g., spurs, dikes, and jetties) or intercept overbank flow as it returns to the main channel (e.g., guide banks). Estimating scour at the nose of these structures is critical to successful design. The following equation is used when the projecting embankment/abutment length is large in relation the flow depth (DOT, 2009b).

 $\frac{a}{v_1} > 25$ Use:

Where:

a =structure length projecting normal to the flow = 85 ft y_1 = average upstream flow depth in the main channel or on the overbank outside the influence of the structure = 1.0 ft

$$\frac{85}{1.0} = 85$$

Calculate Froude Number:

 $F_r = \frac{V}{(av)^{\frac{1}{2}}}$

Use:

V = average velocity = 2.45 ft/s Where: $g = \text{gravity} = 32 \text{ ft/ } \text{s}^2$ y_1 = depth of flow = 1.00 ft

$$F_r = \frac{2.45}{(32 \ x \ 1.00)^{\frac{1}{2}}} = 0.4331$$

Since $\frac{a}{v_1} > 25$ use Equation 4.1 (DOT 2009, Vol. I)

Use: $\frac{y_s}{y_s} = 4F_r^{0.33}$



Where:

 y_s = equilibrium depth of scour (measured from the mean bed level to the bottom of the scour hole), ft

 y_1 = average upstream flow depth in the main channel or on the

overbank outside the influence of the structure = 1.0 ft

 F_r = upstream Froude Number outside the influence of the structure = 0.4331

$$\frac{y_s}{1.0} = 4(0.4331^{0.33}) = 3.03 \text{ ft.}$$

Overtopping

Standard design criteria for protective rip-rap walls recommends that the rip-rap to be placed on the bank to an elevation at least 2.0 feet greater than the design high water level. As stated above a worse case water depth is estimated to be 1.0 feet. Therefore, a rip-rap wall height of 3.0 feet is recommended. The majority of the protective wall is greater than three feet in height and overtopping is not expected to represent a significant failure mode. However, the potential for overtopping will be evaluated as discussed below..

3.5.4.2 Rip-Rap Protective Wall Inspection

The protective capped area shown in Figure 3 is protected from erosion caused by stormwater runoff with a protective rip-rap wall located at the north end of the capped area. The design specifications of the rip-rap protective wall were not documented at the time of construction and therefore a detailed engineering structural analysis cannot be performed. In order to completely evaluate the structural adequacy of the rip-rap protective wall, a detailed inspection will be performed that will consist of the following tasks.

Inspection of rip-rap placement typically consists of visual inspection of the installation procedures and the finished surface. A previous visual inspection of the existing wall observed a dense, rough surface of well-keyed, graded rock, placed such that voids were minimized. Further inspection is required to evaluate the thickness of the rip-rap blanket, average size of the rip-rap, the slope it was placed on, what type of material the subbase is composed of, and the depth of the rip-rap into the stream bed.

The inspection will require a portion of the wall to be dismantled so that a detailed as-built can be prepared with sufficient detail that will allow for the structural analysis to be completed following the guidance for inspecting rip-rap protective walls presented in the National Highway Institute (NHI) training course 135047, "Stream Stability and Scour at Highway Bridges for Bridge Inspectors" (DOT 2009a).

3.5.4.3 Rip-Rap Protective Wall Design Recommendations

Since the rip-rap wall was installed without documentation, the evaluation of the rip-rap wall will include an inspection to determine how the wall was built. The results of the inspection will be compared to the minimum design criteria for a protective rip-rap wall. The following presents the minimum design requirements for a protective rip-rap wall:

• The rip-rap wall shall be a minimum of 3 feet in height, including the portion of the wall that is adjacent to the eastern and western drainage channels.



- The thickness of the rip-rap blanket shall be a minimum of 16 inches.
- The size of the rip-rap rock shall be a minimum of $D_{50} = 10$ inches
- The base of the rip-rap blanket shall have either a granular or geotextile fabric filter material installed.
- The maximum slope of the rip-rap wall and subbase shall be a slope no greater than 1:1.5
- The toe of the rip-rap wall shall be protected with either of the following:
 - Buried toe consisting of a rip-rap rock of $D_{50} = 10$ inches with a geotextile fabric filter material installed and shall be constructed 16 inches deep x 6.5 feet wide along the length of the toe of the protective rip-rap wall.
 - Mounded toe consisting of rip-rap rock that is a minimum of $D_{50} = 10$ inches constructed 32 inches deep x 3 feet in height along the length of the toe of the protective rip-rap wall.

If the visual inspection of the existing protective rip-rap wall identifies portions of the wall that do not meet at least the minimum requirements presented above, designs to remedy the deficiencies of the portions (or all) of the existing protective rip-rap wall that do not meet these requirements will be evaluated. The design remedy that best addresses any or all of the deficiency will be prepared and submitted to ADEQ for approval prior to implementation.

4.0 SUMMARY OF REMEDIAL ACTION

The analytical results indicated that metal constituents lead and cadmium are present in concentrations that are characteristic of hazardous waste in the tailings area of the site. The tailings area has not been completely characterized and therefore additional characterization will be performed to define the nature and extent of the impact to the soil by lead and cadmium. Following completion of the additional characterization of the tailings area, the tailings area will be capped to prevent exposure to the contaminated soil. Additionally, portions of the stormwater conveyance system require an upgrade and/or maintenance to maintain the protectiveness of the capped area...

4.1 PRE-REMEDIATION ACTIVITIES

Prior to the beginning of remedial activities, a site inspection will occur to document the existing conditions at the site. The results of this site inspection will be compared with the results of the remedial actions described below to evaluate the effectiveness of the remedial actions.

4.1.1 Permits

It is not anticipated that any permitting will be required to perform the characterization and remedial action activities. The soil borings will not penetrate ground water, therefore no drilling permit will be required.



4.1.2 Notice of Commencement

The ADEQ VRP will be sent written notification at least 7 days prior of the commencement of field activities to allow for the ADEQ to schedule a site visit during remedial activities.

4.1.3 Utility Clearance

Prior to any subsurface activities, the locations for the excavation area and each proposed ISCO injection location will be surveyed for underground utilities. Each cleared location will be marked and staked for utility clearance. Arizona 811 will be notified a minimum of 48 hours prior to excavation and injection activities to mark known existing underground utilities. In addition, an independent utility locator service will be used to ensure that each boring and injection location is clear of existing underground utilities.

4.1.4 Site Security and Mobilization

All equipment and field personnel will be mobilized to the site. Mobilization will include delivery of fencing for the laydown area, excavation and soil moving equipment, portable sanitary facilities, and other supplies as necessary.

A laydown area will be established to stage excavation-related equipment and stockpile equipment and other supplies, such as clean backfill and a stockpile of 6-inch rip-rap. The location of the laydown area has not been established. The laydown area will be secured with temporary fencing with a clearly marked entrance that may be secured with a chain and padlock. A notice will be posted on the fence next to the gate to provide the contact information for the corrective action contractor. Upon completion of the project, the laydown area will be returned to its original condition. The laydown area should also be used for portable sanitary facilities.

4.1.5 Clearing and Grubbing

Clearing and grubbing will be minimal at the site. Any vegetative growth within the drainage channels south of the capped area will be removed. The existing cobbles that line the two drainage channels south of the capped area will also be removed. Those materials will be reused, if possible.

4.1.6 Protection of Existing Site Features

No existing features at the site, primarily the Archery Range facilities, will be impacted by remedial activities. In the event that archery targets or other archery range object will be required to be moved, the objects will be replaced during site restoration activities.

4.1.7 Stockpile Area Construction

Any materials that will be brought on site for the construction of the cap, modification of the drainage channels or repair/maintenance of the existing cap will be stored at adjacent to the laydown area. Since the construction area is less than 1 acre, a Stormwater Pollution Prevention Plan (SWPPP) will not be required. However, best management practices will be implemented to prevent the stockpiled materials from impacting the site of the nearby Gila River during a storm event. Best management practices will include siting the stockpile area in an area that will not be impacted by flash flooding and will utilize berms, straw waddles and/or silt fences to prevent the materials from migrating away from the stockpile area during a storm event.



4.1.8 Establishment of Work Support and Decontamination Areas

Work areas will established to prevent public exposure to potentially lead impacted soil. The areas in which excavation of soil is occurring will be delineated with traffic barriers and caution tape.

4.2 TAILINGS PILE DELINEATION

Samples collected from the tailings pile area contained lead in concentrations that were characteristic of a hazardous waste. Therefore, the tailings pile area will be further characterized to define the extent of the area impacted by lead contaminated soil. Once the extent of the lead contaminated soil has been established, an engineered cap will be designed to prevent future exposure to the users of the archery range.

In order to fully characterize the tailings pile area, the entire area will be screened at the surface utilizing an XRF analyzer for lead in soil. The areas that contain the highest XRF readings will be further characterized by advancing up to four soil borings using a hollow stem auger drilling rig. Each soil boring will be continuously sampled from the surface to a total depth of six feet begs or refusal, whichever occurs first, with a California-modified split spoon sampler. Soil samples will be screened, collected and analyzed by the laboratory as described in the following sections.

4.2.1 Soil Sample Screening and Collection

A total of nine soil samples will be collected from 4 soil borings advanced in the tailings area and submitted to the laboratory for analyses. The following soil sampling procedures will be used.

- Soil samples will be collected from each soil boring continuously to a depth of 6 ft bgs by driving a California-modified split spoon sampler 18-inches into the soil to obtain 4 discrete soil samples per boring.
- The soil will be screened every 6-inches utilizing an XRF analyzer for lead content.
- Two soil samples from each boring with the highest XRF reading will be placed into 4-ounce glass jars.
- Each soil sample will be labeled and placed into a plastic baggie and stored in a cooler containing ice to maintain the sample at approximately 4° Celsius pending delivery to the laboratory.
- The split spoon sampler will be decontaminated prior to use. The split spoon sampler will be washed in tap water containing a non-phosphate detergent, such as Alconox[®], with a scrub brush, followed by a tap water rinse and a second rinse in deionized water. The split spoon sampler will be allowed to air dry prior to use. The decontamination water will be containerized for disposal as described in Section 3.2.5 below.
- A field duplicate soil sample will be collected at a frequency of one duplicate per twenty samples. Based on the estimated number of samples to be collected from the tailings area, one (1) duplicate soil samples will be collected. One duplicate soil sample will be collected from the sample with the highest XRF reading.
- An equipment blank will be collected from the spilt spoon sampler by pouring deionized water through the sampler into the appropriate sample containers supplied by the laboratory.



- One field blank sample will be collected from the water used for the second rinse in the decontamination procedure for the hand auger and hand sampler.
- A temperature blank sample will accompany each sample container shipped to the laboratory. The temperature blank will be used to ensure the temperature of the samples is maintained at approximately 4°Celcius.
- Each sample collected will be labeled with a unique sample identifier, date and time the sample was collected, preservation used, the sampler's initials and the analysis to be performed. Each sample will then be logged onto a chain-of-custody form for delivery to the laboratory.

4.2.2 Soil Sample Laboratory Analysis

Nine (9) soil samples will be analyzed for the following:

- RCRA 8 Metals using EPA Test Method 6010C/7471B.
- The Synthetic Precipitation Leaching Procedure (SPLP) extraction using EPA Test Method 1312 and analyzed for Lead using EPA Test Method 6010C. An alternative to the SPLP extraction is the Toxicity Characteristic Leaching Procedure (TCLP) extraction using EPA Test Method 1311. The analytical method for TCLP lead will remain the same.

The quality assurance/quality control procedures are presented in the abbreviated QAPP presented in Appendix D.

4.2.3 Record Keeping

Field notes and measurements will be recorded in a field notebook, which will be maintained by the Sampling Team Leader. Original copies of Chain of Custody forms, raw data, and analytical results will be maintained by the respective laboratories performing the analyses.

4.2.4 Laboratory Confirmation Analyses

Eight (8) soil samples and one duplicate soil sample will be collected from four soil borings advanced in the tailings area. The samples will be selected by after screening with an XRF analyzer for lead in soil.

4.2.5 Laboratory QA/QC

An equipment blank sample will be collected from the California-modified split spoon sampler and a field blank will be collected from the water used to decontaminate the sampler. Each sample container will

4.3 SITE RESTORATION

Site restoration activities will include deepening the drainage channels south of the capped area, repair of damaged portions of the stormwater conveyance in the capped area and capping the tailings pile area.

4.3.1 Stormwater Conveyance Upgrade and Maintenance

The stormwater drainage channels south of the capped area are not deep enough to contain water from a storm event. Inspection of the channels after a storm event indicated that water overflowed and eroded the soil surrounding the channels. Therefore, the channels will be deepened to ensure containment of future stormwater and to prevent erosion of the areas around the channels. Additionally, a small amount of damage to the cap has occurred where stormwater flows into the



drainage channel on the capped area and cap drainage channel that is located on the western side of the caped area does not have the capacity to carry the storm water runoff for a 100-year storm.

New 6-inch rip-rap rock will be installed at the upstream ends of both the western and eastern drainage channels to protect the cap from potential damage during a high flow storm event. Also a minimum of 6-inches of 6-inch rip-rap rock be installed on the top portion of the west bank of western cap drainage channel to increase the storm water carrying capacity over the capped area.

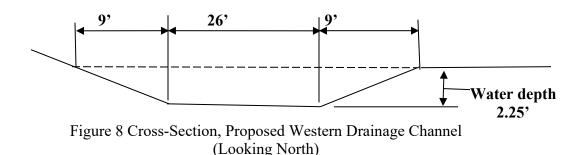
4.3.1.1 Stormwater Conveyance Upgrade

The stormwater conveyance upgrade to the western and eastern channels south of the capped area will provide the flow capacity required for each to contain stormwater flow from a 100- year storm. Each channel will be over excavated to provide the required drainage capacity as presented below. Since the soil in the drainage channels may contain lead above the NR SRL of 800 mg/kg, the excavated soil will be placed in the tailings pile area and capped with the tailings.

Western Channel Design

The existing western drainage channel is configured to manage 6.14 cfs. A 100-year storm could create as much as 325.41 cfs of flow within the channel. The existing stormwater carrying capacity is significantly less than the required storm water carrying capacity required for a 100-year storm and must therefore be upgraded to manage greater stormwater flow.

A new drainage channel has been designed to have the storm water carrying capacity required for the above referenced storm. The revised drainage channel cross-section, using 6" rip-rap rock, (Figure 8) and calculations are as follows:



Use:

Q = 325.41 cfs B = bottom width of channel = 26' Z = side Slopes = 4 S_o = channel bottom slope = 0.0122 ft/ft

 $\hat{\gamma}_s$ = unit weight of rip-rap rock = 165 lbs./sf

 χ = unit weight of water = 62.4 lbs./sf

Assume $D_{50} = 0.50$ ' Assume water depth = 2.25'



Using geometric properties of a trapezoid:

A = Bd+ Zd²
= 26(2.25) + 4 (2.25²)
= 58.50 + 20.25
= 78.75 sf
P = B + 2d
$$\sqrt{Z^2 + 1}$$

= 26 + 2 (2.25) $\sqrt{4^2 + 1}$
= 26 + 18.55
= 44.55'
R = A/P = 78.75/44.55 = 1.7677
T = B + 2dZ = 26 + 2 (2.25) (4) = 44
 $d_a = A/T = 78.75/44 = 1.7898$
Relative depth ration: $\frac{da}{D_{50}} = \frac{1.7898}{0.50} = 3.5796$

Determine Manning's N value:

(HEC 15, 2005, Equation 6.1)

Use:

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)}$$

Where: N = Manning's roughness coefficient d_a = average flow depth in the channel = 1.7898 ft D_{50} = median rip-rap size = 0.50 ft α = unit conversion constant = 0.262

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)} = \frac{(0.262) 1.7898^{0.1667}}{2.25 + 5.23 \log\left(\frac{1.7898}{0.50}\right)} = \frac{0.2887}{2.25 + 5.23 \log(3.5796)} = \frac{0.2887}{5.1466} = 0.0561$$

Use Manning's equation to determine maximum flow for rip-rap $D_{50} = 0.50$ ':

$$Q = 1.49/N (A)(R)^{2/3} S^{1/2}$$



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 $Q = 1.49/0.0561 (78.75) (1.7677)^{2/3} (0.0122)^{1/2}$ Q = 26.46 (78.75) (1.4620) (0.1105)Q = 336.63 cfs

Capacity

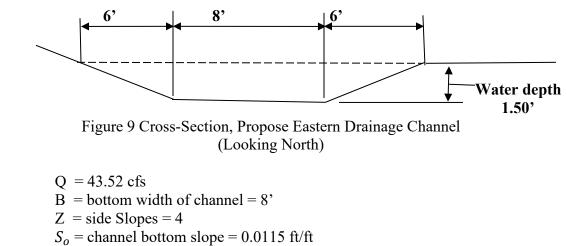
336.63 cfs

Therefore, the new design would provide a flow capacity of 336.63 cfs. This design represents the minimum design capacity for the western drainage channel to control the flow from a 100-year storm event, 325.41 cfs. Additionally, a foot path will be installed over the western channel to allow archers a means to retrieve errant arrows.

Eastern Channel Design

The existing eastern drainage channel is configured to manage 19.69 cfs. A 100-year storm could create as much as 43.52 cfs of flow within the channel. The existing stormwater carrying capacity is less than the required storm water carrying capacity required for a 100-year storm and must therefore be upgraded to manage greater stormwater flow.

A new drainage channel has been designed to have the storm water carrying capacity required for the above referenced storm. The revised drainage channel cross-section, using 6" rip-rap rock, (Figure 9) and calculations are as follows:



- γ_s = unit weight of rip-rap rock = 165 lbs./sf
- χ = unit weight of water = 62.4 lbs./sf

Assume $D_{50} = 0.50$ '

Assume water depth = 1.50'

Using geometric properties of a trapezoid:



Use:

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A = Bd+ Zd²
= 8(1.50) + 4 (1.50²)
= 12 + 9
= 21.00 sf
P = B + 2d
$$\sqrt{Z^2 + 1}$$

= 8 + 2 (1.50) $\sqrt{4^2 + 1}$
= 8 + 12.37
= 20.37'
R = A/P = 21.00/20.37 = 1.0309
T = B + 2dZ = 8 + 2 (1.50) (4) = 20
d_a = A/T = 21.00/20.00 = 1.0500
Relative depth ration: $\frac{da}{D_{50}} = \frac{1.0500}{0.50} = 2.100$

Determine Manning's N value:

(HEC 15, 2005, Equation 6.1)

Use:

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)}$$

Where: N = Manning's roughness coefficient d_a = average flow depth in the channel = 2.6042 ft D_{50} = median rip-rap size = 0.50 ft α = unit conversion constant = 0.262

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)} = \frac{(0.262) 1.0500^{0.1667}}{2.25 + 5.23 \log\left(\frac{1.0500}{0.50}\right)} = \frac{0.2641}{3.9352} = 0.0671$$

Use Manning's equation to determine maximum flow for rip-rap $D_{50} = 0.50$ ':

 $Q = 1.49/N (A)(R)^{2/3} S^{1/2}$ $Q = 1.49/0.0671 (21.00) (1.0309)^{2/3} (0.0115)^{1/2}$ Q = 22.21 (21.00) (1.0205) (0.1072)Q = 51.02 cfs



Capacity

51.02 cfs

Therefore, the new design would provide a flow capacity of 51.02 cfs. This design represents the minimum design capacity for the eastern drainage channel to control the flow from a 100-year storm event, 43.52 cfs.

The design specifications for both drainage channels will be prepared with any design changes implemented on the rip-rap wall and the cap design for the tailings pile area following completion of the tailings pile area evaluation.

4.3.1.2 Stormwater Conveyance Maintenance

A maintenance plan will be prepared as part of the ECP to define procedures for maintain the drainage channels in the future. The old drainage channels will be required to be periodically cleared of vegetation and other potential obstructions that may impede flow through the channels. Additionally, maintenance protocols will be established to repair any portion of the drainages that may be damaged by stormwater flow or for other reasons.

4.3.2 Tailings Pile Area Cap Installation

Following the completion of the tailing pile assessment and the extent of the area has been defined, a cap for the tailings pile area will be designed to prevent human contact with the impacted soil and to prevent erosion onto the Archery facility. At a minimum, the cap will include the following:

- Grading the area to be capped so that the stormwater run-off flows toward the eastern drainage channel.
- A minimum of 1 foot certified clean soil will be placed over the top of the lead impacted soil.
- A minimum of 2 inches asphalt chip seal will be placed over the clean fill.

Following the completion of the tailings pile area delineation, the cap design will be modified as necessary and will incorporate the design of the eastern drainage channel improvements to facilitate drainage from the capped area. The cap design will be submitted for approval by ADEQ and upon approval the cap will be installed following the approved design.

4.3.3 IDW Disposition

Auger cuttings will be placed back into each boring. Therefore, no soil investigative derived wastes (IDW) will be produced. Decontamination water and purge water will be containerized and disposed of following Federal, State and local regulation.

Soil removed from the drainage channels during deepening will be placed into the tailings area and capped with the tailings.

4.3.4 Demobilization

All equipment and field personnel will be demobilized from the site. Demobilization will include removal of fencing for the laydown area, excavation and soil moving equipment, portable sanitary facilities, and other supplies brought on the site. The laydown stockpile areas will also be restored to their original condition.



5.0 REPORTING

A Remedial Action Report will be prepared to document the result of the soil sampling in the tailings area, the modifications to the stormwater drainages and protective dam, and the capping of the tailings area. The Remedial Action Report will include as-built drawings for the tailings cap and the stormwater conveyance system and an engineering control plan to document the inspection/maintenance schedule. Following approval of the Remedial Action Report by ADEQ VRP and no further investigation and/or remediation is required, a no further action (NFA) letter will be prepared following the requirements of Arizona Revised Statute (A.R.S.) § 49-181. A DEUR, as required by A.R.S § 49-151 through 49-159, for the site will also be prepared by ADEQ following approval of the NFA letter.



6.0 REFERENCES

- ADEQ 1996. A Screening Method to Determine Soil Concentrations Protective of Groundwater Quality.
- ADEQ 2019. Review and Comments: Summary of Findings Report Letter. December 23.
- ADEQ 2014A. Adair Park Site Inspection Memorandum. March 7.
- ADEQ 2014B. Adair Park file Review Concerns at Site Letter. June 4.
- ADWR 2008. Well Abandonment Handbook. September.
- Kleinfelder 2006. Work Plan Lead Contaminated Soil Remediation, Adair Memorial Park, 4760 South Highway 95, Yuma, AZ 85366. April.
- Nicklaus Engineering, Inc. 2019. Summary of Findings at Adair Park Archery Range, Yuma, AZ. VRP Site Code 505354-00. June.
 - 2019. Groundwater Monitoring Report at Adair Park Archery Range, Yuma, AZ. VRP Site Code 505354-00. December.
- The Fehling Group (TFG) 2019. Summary of Findings at Adair Park Archery Range, Yuma, Arizona, Site Code 505354-00. December 16.
- U.S. Department of Transportation, 2009a. Federal Highway Administration, Chapter 5 of the Hydraulic Engineering Circular No. 23 Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance. Third Edition, Volume 1 -(Publication No. FWHA-NHI-09-111). September.

_____, 2009b. Design Guide 14 (DG14) of the U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 23, Volume 2 - Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance. Third Edition, Volume 2 (Publication No. FWHA-NHI-09-112). September.



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FIGURES

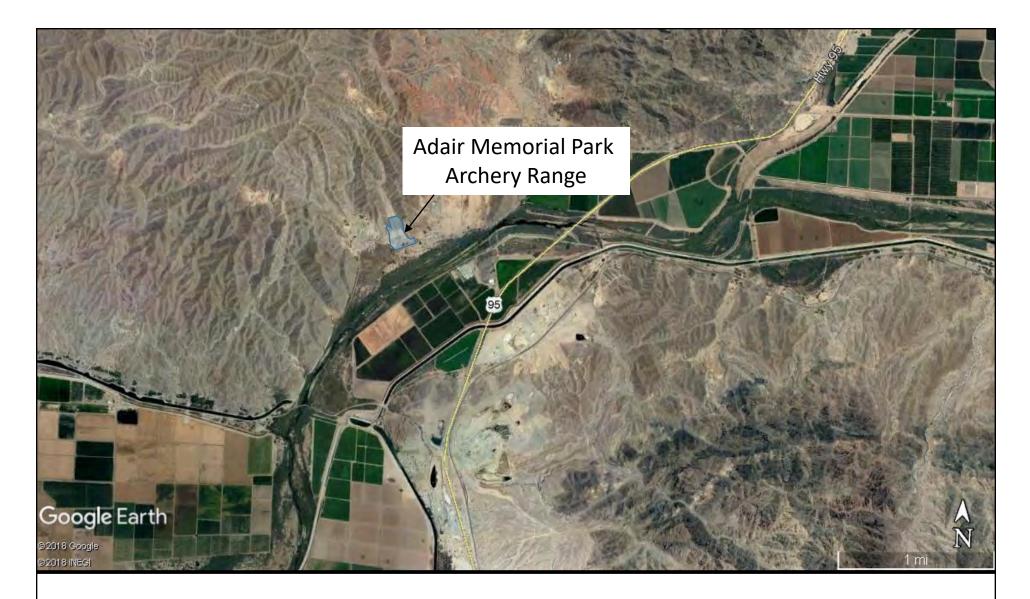
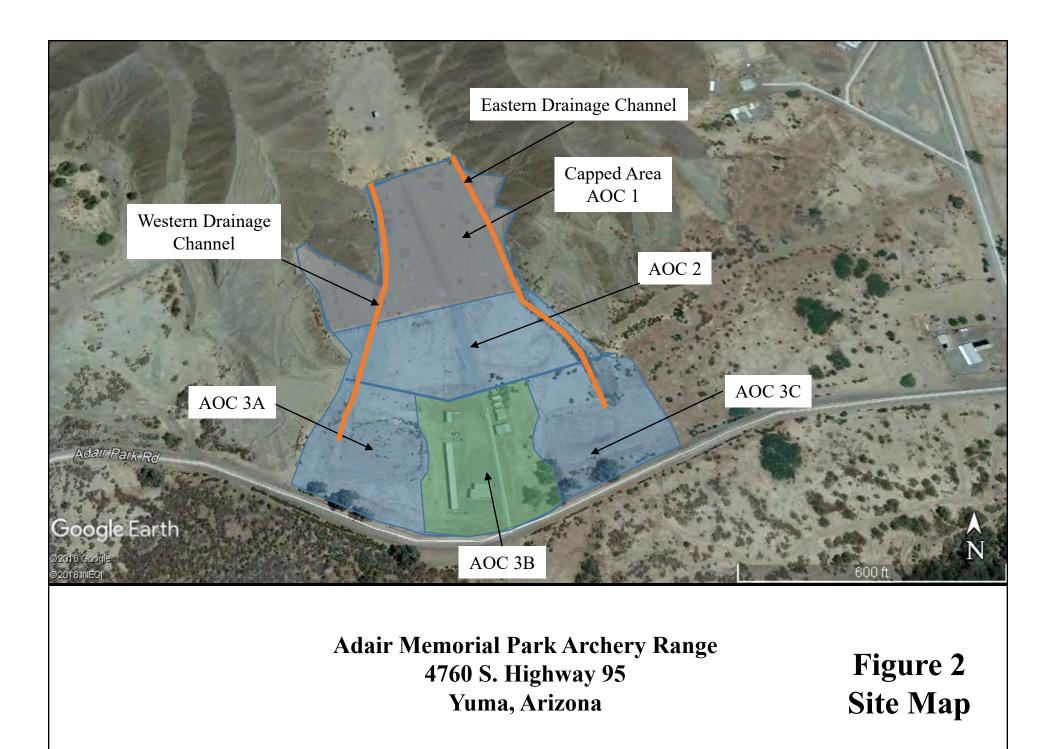
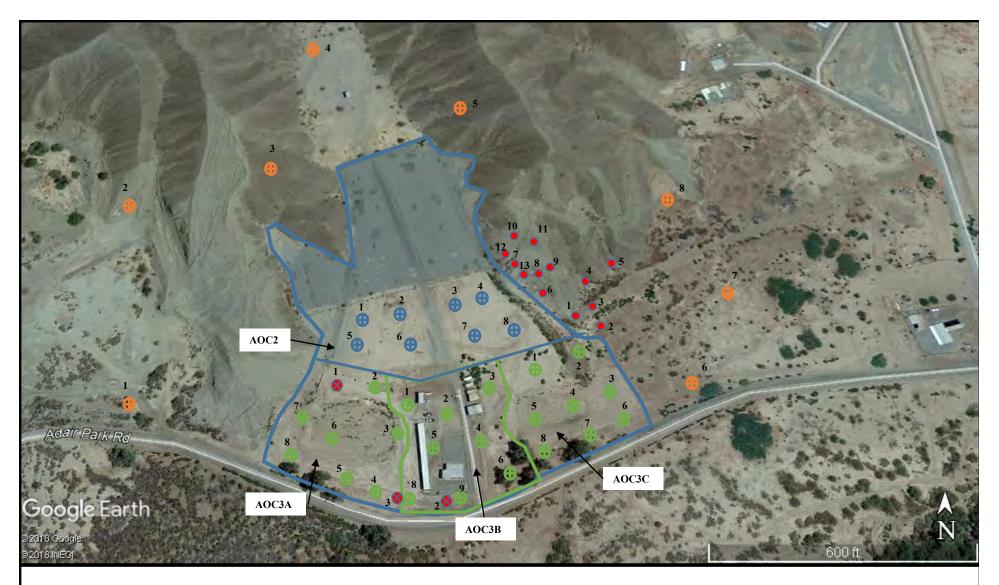


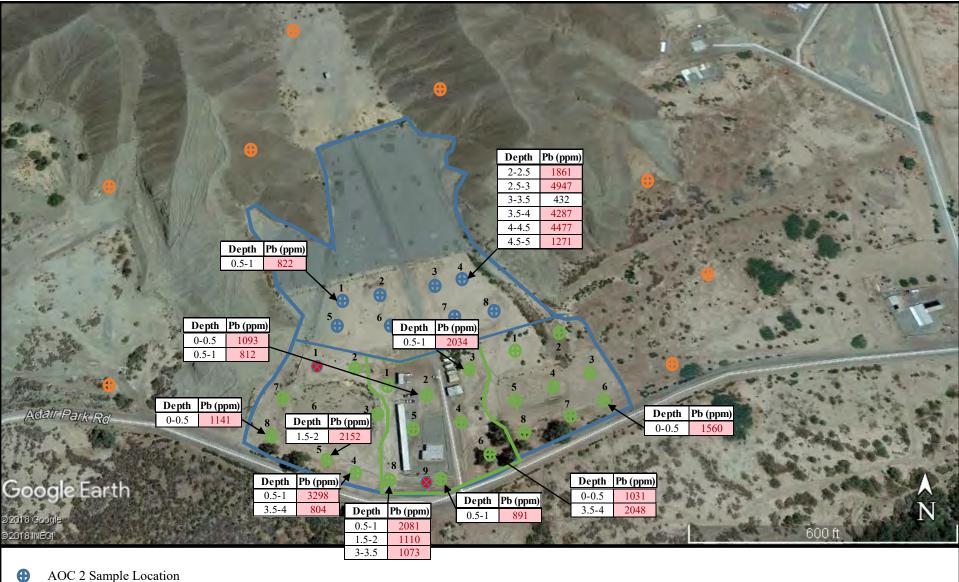
Figure 1 Site Location Map





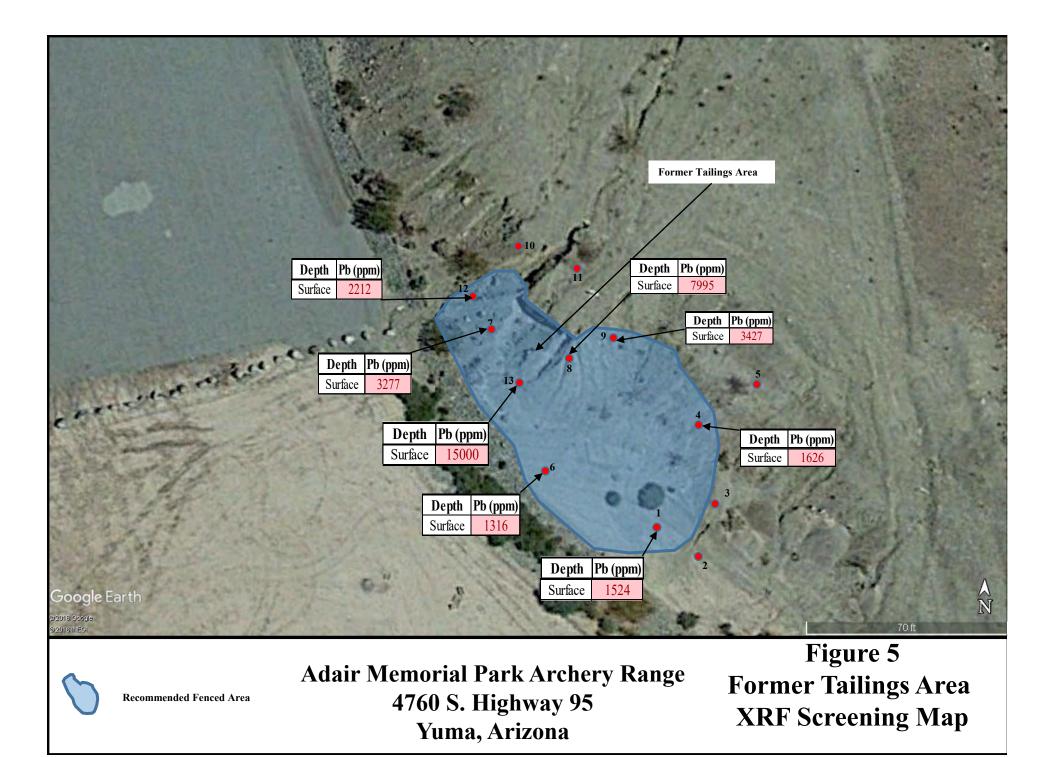
- OC 2 Sample Location
- AOC 3 Sample Location
- S Temporary Well and Soil Sample Location
- Background Sample Location
- XRF Reading From Tailings Pile

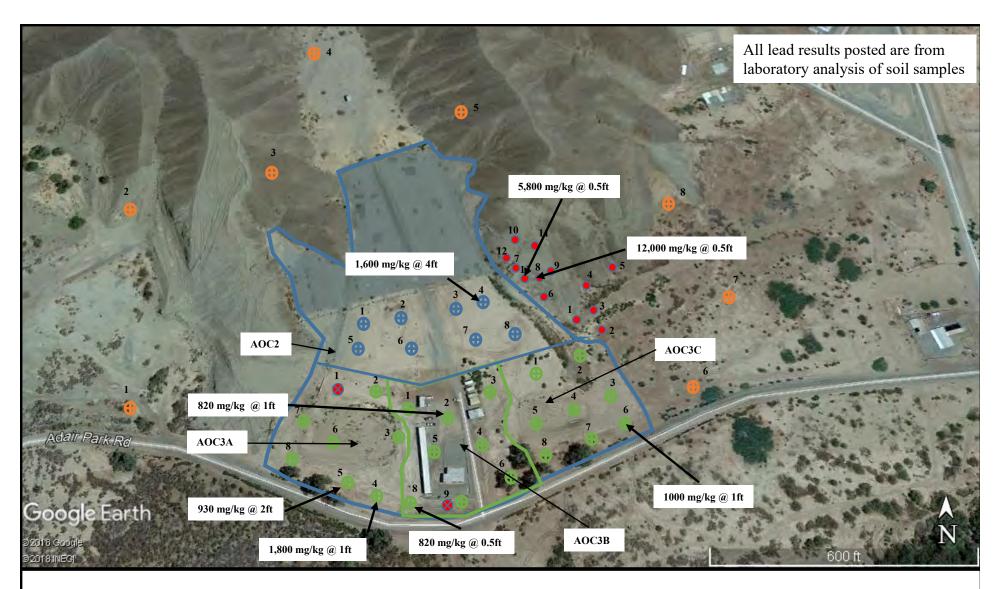
Figure 3 Sample Location Map



- AUC 2 Sample Location
- OC 3 Sample Location
- Temporary Well and Soil Sample Location
- Background Sample Location

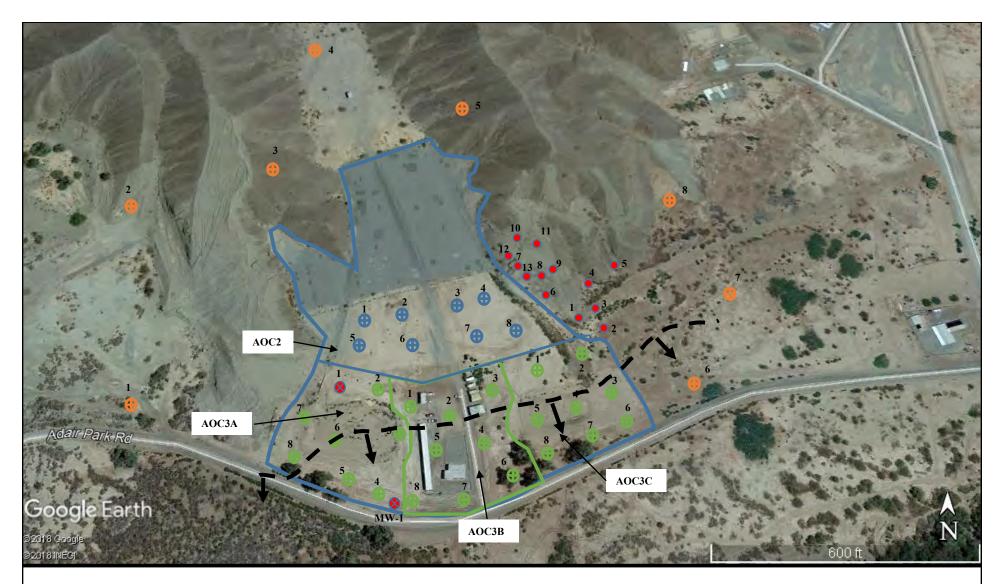
Figure 4 XRF Screening Lead Map





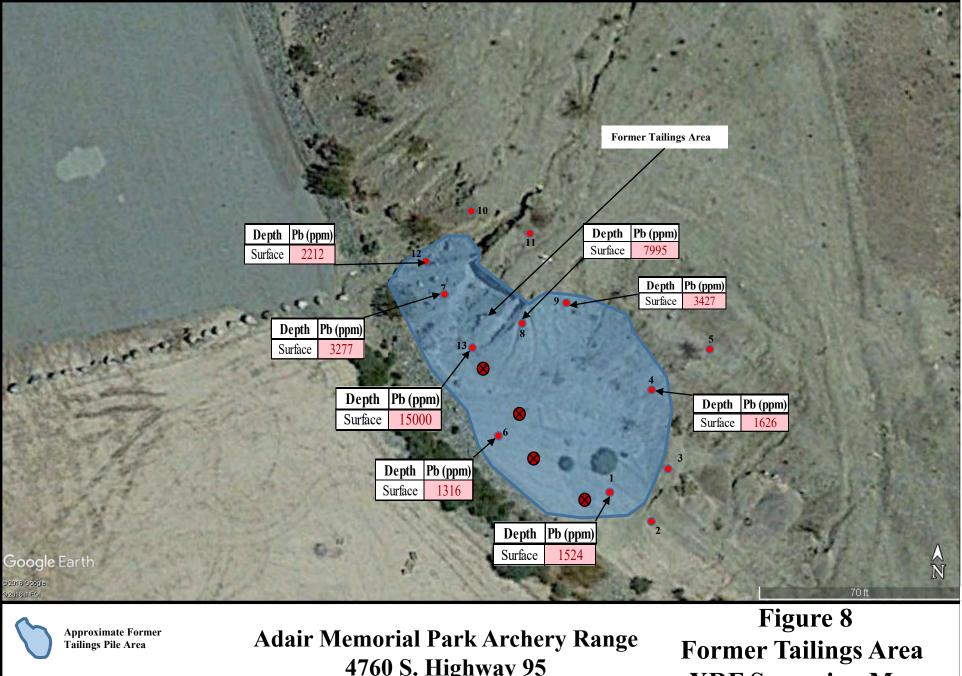
- OC 2 Sample Location
- AOC 3 Sample Location
- Solution Temporary Well and Soil Sample Location
- Background Sample Location
- XRF Reading From Tailings Pile

Figure 6 Lead Distribution Map



- AOC 2 Sample Location
- OcAOC 3 Sample Location
- Solution Temporary Well and Soil Sample Location
- Background Sample Location
- XRF Reading From Tailings Pile
- Approximate Groundwater Boundary

Figure 7 Groundwater Occurrence Map



Proposed Sample Location

4760 S. Highway 95 Yuma, Arizona

XRF Screening Map

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TABLES

Time	Date	Borehole	Depth	Ph (nnm)	$Ph + 2\sigma$	I ah (mơ/kơ)	Lab Dup (mg/kg)
	1/24/2019		0-0.5	10 (ppiii) 102	11	100	150
	1/24/2019		0-0.3	822	30	460	130
	1/24/2019	AOC2-1 AOC2-1	1-1.5	473	23	400	
	1/24/2019	AOC2-1 AOC2-1	1-1.3	148	13		
	1/24/2019	AOC2-1 AOC2-1	2-2.5	504	22		
	1/24/2019	AOC2-1 AOC2-1	2-2.3	19	7		
	1/24/2019	AOC2-1 AOC2-1	3-3.5	245	15		
	1/24/2019	AOC2-1 AOC2-1	3.5-4	18	7		
	1/24/2019		4-4.5	24	8		
	1/24/2019	AOC2-1 AOC2-1	4.5-5	134	<u> </u>		
						270	
	1/24/2019	AOC2-2	0-0.5	273	17	370	
	1/24/2019	AOC2-2	0.5-1	26	7		
	1/24/2019	AOC2-2	1-1.5	30	8		
	1/24/2019		1.5-2	163	13		
	1/24/2019	AOC2-2	2-2.5	15	7		
	1/24/2019	AOC2-2	2.5-3	22	7	70	
	1/24/2019	AOC2-2	3-3.5	94	13	73	
	1/24/2019	AOC2-2	3.5-4	15	7		
	1/24/2019	AOC2-2	4-4.5	17	7		
	1/24/2019	AOC2-2	4.5-5	55	9		
	1/23/2019	AOC2-3	0-0.5	74	15	58	
	1/23/2019	AOC2-3	0.5-1	70	11		
	1/23/2019	AOC2-3	1-1.5	32	11		
	1/23/2019	AOC2-3	1.5-2	40	11		
	1/23/2019	AOC2-3	2-2.5	40	10		
	1/23/2019	AOC2-3	2.5-3	29	10		
	1/23/2019	AOC2-3	3-3.5	112	15	43	
	1/23/2019	AOC2-3	3.5-4	35	8		
	1/23/2019	AOC2-3	4-4.5	24	10		
1440	1/23/2019	AOC2-3	4.5-5	93	14		
1305	1/23/2019	AOC2-4	0-0.5	59	9	34	
1307	1/23/2019	AOC2-4	0.5-1	33	8		
1309	1/23/2019	AOC2-4	1-1.5	22	7		
1311	1/23/2019	AOC2-4	1.5-2	59	9		
1313	1/23/2019	AOC2-4	2-2.5	1861	49		
1315	1/23/2019	AOC2-4	2.5-3	4947	99		
1317	1/23/2019	AOC2-4	3-3.5	432	22	330	
1320	1/23/2019	AOC2-4	3.5-4	4287	85	1600	
1322	1/23/2019	AOC2-4	4-4.5	4477	87		
1325	1/23/2019	AOC2-4	4.5-5	1271	51		

 Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole			Ŷ	Ā	Lab Dup (mg/kg)
			0-0.5		15 15		Lao Dup (ing/kg)
	1/24/2019 1/24/2019			74 70		68	
	1/24/2019		0.5-1 1-1.5	32	11 11		
	1/24/2019	AOC2-5 AOC2-5	1-1.3	40	11		
	1/24/2019	AOC2-5	2-2.5	40	11		
	1/24/2019	AOC2-5	2-2.3	29	10		
	1/24/2019	AOC2-5 AOC2-5	3-3.5	112	10		
	1/24/2019	AOC2-5	3.5-4	35	8		
	1/24/2019	AOC2-5	4-4.5	24	10	31	
	1/24/2019		4.5-5	93	14		
	1/24/2019	AOC2-6	0-0.5	307	19	150	
	1/24/2019	AOC2-6	0.5-1	44	9	100	
	1/24/2019	AOC2-6	1-1.5	39	8		
	1/24/2019	AOC2-6	1.5-2	144	13		
	1/24/2019	AOC2-6	2-2.5	93	13		
1156	1/24/2019	AOC2-6	2.5-3	17	7		
1158	1/24/2019	AOC2-6	3-3.5	249	17	94	
1200	1/24/2019	AOC2-6	3.5-4	0	13		
1202	1/24/2019	AOC2-6	4-4.5	0	12		
1204	1/24/2019	AOC2-6	4.5-5	93	10		
1430	1/24/2019	AOC2-7	0-0.5	577	25	150	
1432	1/24/2019	AOC2-7	0.5-1	25	7		
1434	1/24/2019	AOC2-7	1-1.5	62	10		
1436	1/24/2019	AOC2-7	1.5-2	103	11	46	
1438	1/24/2019	AOC2-7	2-2.5	13	6		
	1/24/2019	AOC2-7	2.5-3	14	7		
1442	1/24/2019	AOC2-7	3-3.5	79	10		
	1/24/2019	AOC2-7	3.5-4	20	7		
	1/24/2019	AOC2-7	4-4.5	15	7		
	1/24/2019	AOC2-7	4.5-5	28	8		
1218	1/23/2019	AOC2-8	0-0.5	200	14	38	
1220	1/23/2019	AOC2-8	0.5-1	29	8		
	1/23/2019	AOC2-8	1-1.5	22	7		
	1/23/2019	AOC2-8	1.5-2	52	8		
	1/23/2019	AOC2-8	2-2.5	17	7		
	1/23/2019	AOC2-8	2.5-3	0	15		
	1/23/2019	AOC2-8	3-3.5	337	18	14	
	1/23/2019	AOC2-8	3.5-4	20	7		
	1/23/2019	AOC2-8	4-4.5	28	7		
1236	1/23/2019	AOC2-8	4.5-5	89	10		

 Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Depth	Pb (ppm)	$Pb \pm 2\sigma$	Lab (mg/kg)	Lab Dup (mg/kg)
940	1/24/2019	AOC3A-1	0-0.5	171	15		
	1/24/2019		0.5-1	15	8		
	1/24/2019	AOC3A-1	1-1.5	17	7		
	1/24/2019	AOC3A-1	1.5-2	53	9		
	1/24/2019	AOC3A-1	2-2.5	42	8		
950	1/24/2019	AOC3A-1	2.5-3	52	9		
952	1/24/2019	AOC3A-1	3-3.5	50	8		
954	1/24/2019	AOC3A-1	3.5-4	44	8		
956	1/24/2019	AOC3A-1	4-4.5	0	18		
958	1/24/2019	AOC3A-1	4.5-5	81	10		
1004	1/24/2019	AOC3A-1	10-10.5	19	7		
1006	1/24/2019	AOC3A-1	10.5-11.0	0	20		
1008	1/24/2019	AOC3A-1	11-11.5	129	14		
1010	1/24/2019	AOC3A-1	15-15.5	0	20		
1013	1/24/2019	AOC3A-1	15.5-16.0	34	9		
1016	1/24/2019	AOC3A-1	16-16.5	0	12		
1018	1/24/2019	AOC3A-1	20-20.5	35	10		
1020	1/24/2019	AOC3A-1	20.5-21	0	18		
1022	1/24/2019	AOC3A-1	21-21.5	18	7		
1117	1/22/2019	AOC3A-2	0-0.5	112	14	70	
1119	1/22/2019	AOC3A-2	0.5-1	146	16		
1121	1/22/2019	AOC3A-2	1-1.5	13	4		
1123	1/22/2019	AOC3A-2	1.5-2	174	15		
1125	1/22/2019	AOC3A-2	2-2.5	19	9		
1126	1/22/2019	AOC3A-2	2.5-3	15	8		
1128	1/22/2019	AOC3A-2	3-3.5	65	6		
1130	1/22/2019	AOC3A-2	3.5-4	24	8		
1131	1/22/2019	AOC3A-2	4-4.5	0	7		
1133	1/22/2019	AOC3A-2	4.5-5	47	10		
1155	1/22/2019	AOC3A-3	0-0.5	335	22	130	
1157	1/22/2019	AOC3A-3	0.5-1	49	6		
1159	1/22/2019	AOC3A-3	1-1.5	0	7		
1201	1/22/2019	AOC3A-3	1.5-2	97	6		
1203	1/22/2019	AOC3A-3	2-2.5	31	5		
1205	1/22/2019	AOC3A-3	2.5-3	28	5		
1207	1/22/2019	AOC3A-3	3-3.5	95	7		
1209	1/22/2019	AOC3A-3	3.5-4	14	4		
1211	1/22/2019	AOC3A-3	4-4.5	284	2		
1213	1/22/2019	AOC3A-3	4.5-5	63	12		

Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Depth	Ph (nnm)	$Ph + 2\sigma$	Lah (ma/ka)	Lab Dup (mg/kg)
						Lab (Ing/Kg)	Lab Dup (ing/kg)
	1/22/2019		0-0.5	378	21	1900	
	1/22/2019		0.5-1	3298	67	1800	
	1/22/2019	AOC3A-4	1-1.5	40	6		
	1/22/2019	AOC3A-4	1.5-2	677	30		
	1/22/2019	AOC3A-4	2-2.5	20	5		
	1/22/2019	AOC3A-4	2.5-3	19	9		
	1/22/2019	AOC3A-4	3-3.5	539	27	270	
	1/22/2019	AOC3A-4	3.5-4	804	32	370	
	1/22/2019	AOC3A-4	4-4.5	31	10		
	1/22/2019	AOC3A-4	4.5-5	234	18		
	1/22/2019	AOC3A-5	0-0.5	177	16		
	1/22/2019	AOC3A-5	0.5-1	347	22	680	
	1/22/2019	AOC3A-5	1-1.5	16	5		
	1/22/2019	AOC3A-5	1.5-2	2152	53	930	
	1/22/2019	AOC3A-5	2-2.5	14	4		
	1/22/2019	AOC3A-5	2.5-3	19	4		
	1/22/2019	AOC3A-5	3-3.5	369	20		
	1/22/2019	AOC3A-5	3.5-4	23	5		
	1/22/2019	AOC3A-5	4-4.5	20	5		
858	1/22/2019	AOC3A-5	4.5-5	252	18		
1022	1/22/2019	AOC3A-6	0-0.5	649	27	47	
1023	1/22/2019	AOC3A-6	0.5-1	17	8		
1025	1/22/2019	AOC3A-6	1-1.5	19	8		
1027	1/22/2019	AOC3A-6	1.5-2	23	8		
1029	1/22/2019	AOC3A-6	2-2.5	18	7		
1031	1/22/2019	AOC3A-6	2.5-3	17	8		
1032	1/22/2019	AOC3A-6	3-3.5	20	9		
1034	1/22/2019	AOC3A-6	3.5-4	0	10		
	1/22/2019	AOC3A-6	4-4.5	0	8		
1038	1/22/2019	AOC3A-6	4.5-5	39	10		
932	1/22/2019	AOC3A-7	0-0.5	244	18	280	
	1/22/2019		0.5-1	13	4		
	1/22/2019	AOC3A-7	1-1.5	0	4		
936	1/22/2019	AOC3A-7	1.5-2	42	11		
938	1/22/2019	AOC3A-7	2-2.5	143	15		
	1/22/2019	AOC3A-7	2.5-3	0	7		
	1/22/2019	AOC3A-7	3-3.5	45	10		
942	1/22/2019	AOC3A-7	3.5-4	16	8		
	1/22/2019	AOC3A-7	4-4.5	17	8		
	1/22/2019	AOC3A-7	4.5-5	36	9		

Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Depth	Pb (ppm)	Pb $\pm 2\sigma$	Lab (mg/kg)	Lab Dup (mg/kg)
	1/22/2019		0-0.5	1141	38	540	248 2 4p (
	1/22/2019		0.5-1	23	9	540	
	1/22/2019	AOC3A-8	1-1.5	23	5		
	1/22/2019	AOC3A-8	1.5-2	434	22		
	1/22/2019	AOC3A-8	2-2.5	129	13		
	1/22/2019	AOC3A-8	2-2.3	21	9		
	1/22/2019	AOC3A-8	3-3.5	213	16		
	1/22/2019	AOC3A-8	3.5-4	215	16		
	1/22/2019	AOC3A-8	4-4.5	16	8		
	1/22/2019	AOC3A-8	4.5-5	159	22		
	1/21/2019	AOC3B-1	0-0.5	217	15	61	
	1/21/2019	AOC3B-1	0.5-1	794	29		
	1/21/2019	AOC3B-1	1-1.5	26	7		
	1/21/2019	AOC3B-1	1.5-2	199	15		
	1/21/2019	AOC3B-1	2-2.5	37	8		
1159	1/21/2019	AOC3B-1	2.5-3	24	10		
1200	1/21/2019	AOC3B-1	3-3.5	82	10		
1202	1/21/2019	AOC3B-1	3.5-4	0	18		
1203	1/21/2019	AOC3B-1	4-4.5	23	7		
1205	1/21/2019	AOC3B-1	4.5-5	53	11		
820	1/21/2019	AOC3B-2	0-0.5	1093	36	820	
822	1/21/2019	AOC3B-2	0.5-1	812	29	640	
823	1/21/2019	AOC3B-2	1-1.5	265	17		
825	1/21/2019	AOC3B-2	1.5-2	205	15		
829	1/21/2019	AOC3B-2	2-2.5	101	11		
830	1/21/2019	AOC3B-2	2.5-3	35	8		
831	1/21/2019	AOC3B-2	3-3.5	87	11		
	1/21/2019	AOC3B-2	3.5-4	0	14		
	1/21/2019	AOC3B-2	4-4.5	16	7		
	1/21/2019	AOC3B-2	4.5-5	56	9		
		AOC3B-3		604	26	570	
	1/21/2019		0.5-1	2034	60	770	
	1/21/2019		1-1.5	35	8		
	1/21/2019	AOC3B-3	1.5-2	196	14		
	1/21/2019	AOC3B-3	2-2.5	34	8		
	1/21/2019	AOC3B-3	2.5-3	19	7		
	1/21/2019	AOC3B-3	3-3.5	386	19		
	1/21/2019	AOC3B-3	3.5-4	19	7		
	1/21/2019	AOC3B-3	4-4.5	14	7		
1259	1/21/2019	AOC3B-3	4.5-5	212	15		

Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Depth	Ph (nnm)	$Ph + 2\sigma$	I ah (ma/ka)	Lab Dup (mg/kg)
							Lab Dup (ing/kg)
	1/21/2019		0-0.5	593	27	200	
	1/21/2019		0.5-1	66	10		
	1/21/2019	AOC3B-4	1-1.5	59	9		
	1/21/2019	AOC3B-4	1.5-2	56	12		
	1/21/2019	AOC3B-4	2-2.5	30	8		
	1/21/2019	AOC3B-4	2.5-3	26	8		
	1/21/2019	AOC3B-4	3-3.5	125	17		
	1/21/2019	AOC3B-4	3.5-4	24	10		
	1/21/2019	AOC3B-4	4-4.5	23	9		
	1/21/2019	AOC3B-4	4.5-5	56	13		
	1/21/2019	AOC3B-5	0-0.5	572	24	230	
	1/21/2019	AOC3B-5	0.5-1	530	26		
	1/21/2019	AOC3B-5	1-1.5	293	17		
	1/21/2019		1.5-2	412	22		
	1/21/2019	AOC3B-5	2-2.5	33	8		
935	1/21/2019	AOC3B-5	2.5-3	21	7		
937	1/21/2019	AOC3B-5	3-3.5	298	17		
939	1/21/2019	AOC3B-5	3.5-4	24	7		
940	1/21/2019	AOC3B-5	4-4.5	21	7		
941	1/21/2019	AOC3B-5	4.5-5	92	11		
1106	1/21/2019	AOC3B-6	0-0.5	1031	35	750	
1108	1/21/2019	AOC3B-6	0.5-1	334	25		
1110	1/21/2019	AOC3B-6	1-1.5	305	18		
1111	1/21/2019	AOC3B-6	1.5-2	773	28		
1113	1/21/2019	AOC3B-6	2-2.5	530	23		
1114	1/21/2019	AOC3B-6	2.5-3	0	19		
1116	1/21/2019	AOC3B-6	3-3.5	206	15		
1118	1/21/2019	AOC3B-6	3.5-4	2048	53		
1119	1/21/2019	AOC3B-6	4-4.5	37	9	17	
1120	1/21/2019	AOC3B-6	4.5-5	349	19		
1330	1/21/2019	AOC3B-7	0-0.5	189	14	120	
	1/21/2019		0.5-1	891	30	200	
	1/21/2019		1-1.5	24	8		
	1/21/2019	AOC3B-7	1.5-2	268	16		
	1/21/2019	AOC3B-7	2-2.5	18	7		
	1/21/2019		2.5-3	16	6		
	1/21/2019	AOC3B-7	3-3.5	50	12		
	1/21/2019	AOC3B-7	3.5-4	19	7		
	1/21/2019	AOC3B-7	4-4.5	21	7		
	1/21/2019	AOC3B-7	4.5-5	115	12		

Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Donth	Dh (nnm)	$\frac{1}{2}$	I ah (ma/lya)	Lab Dup (mg/kg)
Time						Lad (mg/kg)	Lab Dup (mg/kg)
		AOC3B-8	0-0.5	398	20		
		AOC3B-8	0.5-1	2081	54	820	
	1/21/2019		1-1.5	88	12		
	1/21/2019		1.5-2	1110	35		
	1/21/2019	AOC3B-8	2-2.5	27	7	15	
	1/21/2019	AOC3B-8	2.5-3	17	7		
	1/21/2019		3-3.5	1073	34		
	1/21/2019		3.5-4	27	7		
	1/21/2019	AOC3B-8	4-4.5	54	10		
	1/21/2019		4.5-5	253	23		
	1/23/2019	AOC3C-1	0-0.5	48	9	660	
	1/23/2019	AOC3C-1	0.5-1	28	8		
	1/23/2019		1-1.5	32	8		
	1/23/2019		1.5-2	338	18		
	1/23/2019	AOC3C-1	2-2.5	0	13		
	1/23/2019		2.5-3	0	12		
	1/23/2019		3-3.5	430	21	470	
	1/23/2019	AOC3C-1	3.5-4	14	6		
	1/23/2019	AOC3C-1	4-4.5	22	8		
	1/23/2019		4.5-5	351	19		
	1/23/2019	AOC3C-2	0-0.5	93	11	56	56
	1/23/2019		0.5-1	18	7		
	1/23/2019	AOC3C-2	1-1.5	19	7		
	1/23/2019	AOC3C-2	1.5-2	16	6		
	1/23/2019	AOC3C-2	2-2.5	21	7		
	1/23/2019	AOC3C-2	2.5-3	16	8		
	1/23/2019	AOC3C-2	3-3.5	29	7		
	1/23/2019	AOC3C-2	3.5-4	25	14		
	1/23/2019		4-4.5	0	7		
		AOC3C-2	4.5-5	25	5		
		AOC3C-3	0-0.5	356	19	230	
	1/23/2019	AOC3C-3	0.5-1	22	7		
	1/23/2019	AOC3C-3	1-1.5	19	7		
	1/23/2019	AOC3C-3	1.5-2	84	10		
	1/23/2019	AOC3C-3	2-2.5	23	8		
	1/23/2019	AOC3C-3	2.5-3	0	13		
	1/23/2019	AOC3C-3	3-3.5	50	8		
	1/23/2019	AOC3C-3	3.5-4	20	7		
	1/23/2019	AOC3C-3	4-4.5	17	7		
915	1/23/2019	AOC3C-3	4.5-5	33	7		

 Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Depth	Pb (nnm)	Pb $\pm 2\sigma$	Lab (mg/kg)	Lab Dup (mg/kg)
	1/23/2019		0-0.5	22	7	29	24% 2 4p (g,g)
	1/23/2019		0-0.3	22	8	29	
	1/23/2019	AOC3C-4	1-1.5	19	7		
	1/23/2019	AOC3C-4	1.5-2	22	7		
	1/23/2019	AOC3C-4	2-2.5	22	7		
	1/23/2019	AOC3C-4	2-2.3	28	8		
	1/23/2019	AOC3C-4	3-3.5	35	8		
	1/23/2019	AOC3C-4	3.5-4	31	7		
	1/23/2019	AOC3C-4	4-4.5	16	7		
	1/23/2019	AOC3C-4	4.5-5	16	6		
	1/23/2019	AOC3C-5	0-0.5	147	12	120	
	1/23/2019	AOC3C-5	0.5-1	129	13		
	1/23/2019	AOC3C-5	1-1.5	24	9		
	1/23/2019	AOC3C-5	1.5-2	28	7		
	1/23/2019	AOC3C-5	2-2.5	17	6		
1054	1/23/2019	AOC3C-5	2.5-3	0	13		
1056	1/23/2019	AOC3C-5	3-3.5	29	8		
1058	1/23/2019	AOC3C-5	3.5-4	19	6		
100	1/23/2019	AOC3C-5	4-4.5	16	6		
1103	1/23/2019	AOC3C-5	4.5-5	18	8		
826	1/23/2019	AOC3C-6	0-0.5	1560	43	1000	
828	1/23/2019	AOC3C-6	0.5-1	722	27	450	
832	1/23/2019	AOC3C-6	1-1.5	571	23		
835	1/23/2019	AOC3C-6	1.5-2	616	24		
837	1/23/2019	AOC3C-6	2-2.5	423	20		
840	1/23/2019	AOC3C-6	2.5-3	431	20		
	1/23/2019	AOC3C-6	3-3.5	433	20		
	1/23/2019	AOC3C-6	3.5-4	28	8		
	1/23/2019	AOC3C-6	4-4.5	32	8		
	1/23/2019	AOC3C-6	4.5-5	163	13		
		AOC3C-7	0-0.5	276	17	26	
	1/22/2019		0.5-1	234	16		
	1/22/2019	AOC3C-7	1-1.5	0	15		
	1/22/2019	AOC3C-7	1.5-2	231	17		
	1/22/2019	AOC3C-7	2-2.5	27	7		
	1/22/2019	AOC3C-7	2.5-3	30	8		
	1/23/2019	AOC3C-7	3-3.5	105	12		
	1/23/2019	AOC3C-7	3.5-4	14	7		
	1/23/2019	AOC3C-7	4-4.5	16	7		
803	1/23/2019	AOC3C-7	4.5-5	30	8		

 Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Time	Date	Borehole	Depth	Pb (ppm)	$Pb \pm 2\sigma$	Lab (mg/kg)	Lab Dup (mg/kg)
1238	1/22/2019	AOC3C-8	0-0.5	127	14	140	
1240	1/22/2019	AOC3C-8	0.5-1	45	6		
1242	1/22/2019	AOC3C-8	1-1.5	20	5		
1245	1/22/2019	AOC3C-8	1.5-2	36	5		
1248	1/22/2019	AOC3C-8	2-2.5	15	8		
1251	1/22/2019	AOC3C-8	2.5-3	17	4		
1253	1/22/2019	AOC3C-8	3-3.5	17	4		
1255	1/22/2019	AOC3C-8	3.5-4	59	13		
1258	1/22/2019	AOC3C-8	4-4.5	24	9		
1300	1/22/2019	AOC3C-8	4.5-5	24	5		
730	1/25/2019	BG-1	0.5	37	8	16	
745	1/25/2019	BG-2	0.5	85	10	620	
815	1/25/2019	BG-3	0.5	109	11	87	
832	1/25/2019	BG-4	0.5	24	7	23	
855	1/25/2019	BG-5	0.5	318	17	250	
914	1/25/2019	BG-6	0.5	151	13	90	
934	1/25/2019	BG-7	0.5	35	8	34	
959	1/25/2019	BG-8	0.5	167	14	85	
Former Tai	lings Area						
1030	1/25/2019	1	Surface	1524	8		
1034	1/25/2019	2	Surface	448	10		
1036	1/25/2019	3	Surface	626	11		
1038	1/25/2019	4	Surface	1626	7		
1042	1/25/2019	5	Surface	388	17		
1046	1/25/2019	6	Surface	1316	13		
1053	1/25/2019	7	Surface	3277	8		
1057	1/25/2019	8	Surface	7995	14	5800	
1059	1/25/2019	9	Surface	3427	7		
1105	1/25/2019	10	Surface	347	17		
1110	1/25/2019	11	Surface	583	13		
1115	1/25/2019	12	Surface	2212	8		
1120	1/25/2019	13	Surface	15000	14	12000	

Table 2 Summary of XRF Data with Labortory Data Comparison - Adair Memorial Park

Sample Name	Date	Unit	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
BG-1-0.5	1/25/2019	mg/kg	10	63	<0.49	13	16	<0.092	<4.9	<2.5
BG-2-0.5	1/25/2019	mg/kg	10	53	<0.49	12	620	<0.099	<4.9	<2.4
BG-3-0.5	1/25/2019	mg/kg	10	99	<0.5	15	87	<0.098	<5	<2.5
BG-4-0.5	1/25/2019	mg/kg	14	60	<0.5	11	23	<0.098	<5	<2.5
BG-5-0.5	1/25/2019	mg/kg	15	110	0.84	17	250	<0.1	<5	<2.5
BG-6-0.5	1/25/2019	mg/kg	13	170	<0.49	23	90	<0.09	<4.9	<2.5
BG-7-0.5	1/25/2019	mg/kg	12	120	<0.5	22	34	<0.099	<5	<2.5
BG-8-0.5	1/25/2019	mg/kg	14	110	<0.49	25	85	<0.1	<4.9	<2.5
Non Residential	l SRL	mg/kg	10	170,000	510	65	800	310	5,100	5,100

Table 3: Summary of Background Soil Samples - Adair Memorial Park

Note: mg/kg - milligram per kilogram

Table 4: Summary of Total Metals in Soil - Adair Memorial Park

Sample Name	Date	Unit	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
AOC2-1-0.5	1/24/2019	mg/kg	14	76	<0.5	16	100	<0.091	<5	<2.5
AOC2-1-0.5	1/23/2019	mg/kg	15	120	<0.49	21	150	<0.095	<4.9	<2.4
AOC2-1-1	1/24/2019	mg/kg	15	140	1	17	460	0.11	<4.9	<2.5
AOC2-2-0.5	1/24/2019	mg/kg	15	140	0.67	21	370	<0.097	<4.9	<2.5
AOC2-2-3.5	1/24/2019	mg/kg	13	120	<0.5	26	73	<0.095	<5	<2.5
AOC2-3-0.5	1/23/2019	mg/kg	20	83	<0.49	19	58	<0.1	<4.9	<2.4
AOC2-3-3.5	1/23/2019	mg/kg	14	130	<0.5	25	43	<0.094	<5	<2.5
AOC2-4-0.5	1/23/2019	mg/kg	13	86	<0.5	15	34	<0.097	<5	<2.5
AOC2-4-3.0	1/23/2019	mg/kg	22	85	<0.49	57	330	<0.095	<4.9	<2.4
AOC2-5-0.5	1/23/2019	mg/kg	17	59	<0.5	15	68	<0.089	<5	<2.5
AOC2-5-4.5	1/23/2019	mg/kg	15	130	<0.5	24	31	<0.087	<5	<2.5
AOC2-6-0.5	1/23/2019	mg/kg	17	120	0.77	21	150	<0.094	<4.9	<2.5
AOC2-6-3.5	1/23/2019	mg/kg	16	120	<0.49	22	94	<0.095	<4.9	<2.4
AOC2-6-4.0	1/23/2019	mg/kg	19	180	3.4	25	1600	<0.09	<4.9	<2.5
AOC2-7-0.5	1/24/2019	mg/kg	14	110	<0.49	19	150	<0.099	<4.9	<2.5
AOC2-7-2	1/24/2019	mg/kg	9.1	62	<0.49	14	46	<0.095	<4.9	<2.4
AOC2-8-0.5	1/23/2019	mg/kg	16	62	<0.49	9.1	38	<0.099	<4.9	<2.5
AOC2-8-3.5	1/23/2019	mg/kg	13	120	<0.49	20	14	<0.095	<4.9	<2.5
AOC3A-2-0.5	1/22/2019	mg/kg	13	110	<0.49	19	70	<0.088	<4.9	<2.4
AOC3A-3-0.5	1/22/2019	mg/kg	17	120	<0.49	16	130	<0.086	<4.9	<2.5
AOC3A-4-1	1/22/2019	mg/kg	23	310	3	29	1800	0.26	<4.9	<2.4
AOC3A-4-4	1/22/2019	mg/kg	16	170	1.2	25	370	<0.098	<4.9	<2.4
AOC3A-5-0.5	1/22/2019	mg/kg	18	200	1.4	25	680	0.22	<4.9	<2.5
AOC3A-5-2	1/22/2019	mg/kg	19	220	1.7	26	930	0.15	<4.9	<2.5
AOC3A-6-0.5	1/22/2019	mg/kg	15	140	<0.49	21	47	<0.092	<4.9	<2.5
AOC3A-7-0.5	1/22/2019	mg/kg	14	160	0.66	24	280	<0.089	<5	<2.5
AOC3A-8-0.5	1/22/2019	mg/kg	17	190	1.5	26	540	0.18	<5	<2.5
AOC3B-1-0.5	1/21/2019	mg/Kg	14	130	<0.49	21	61	<0.088	<4.9	<2.5
AOC3B-2-0.5	1/21/2019	mg/Kg	14	180	1.3	18	640	0.18	<4.9	<2.5
AOC3B-2-1	1/21/2019	mg/kg	19	230	1.6	24	820	0.12	<4.9	<2.4
Non Residentia	I SRL		10	170,000	510	65	800	310	5,100	5,100

Table 4: Summary of Total Metals in Soil - Adair Memorial Park

Sample Name	Date	Unit	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
AOC3B-3-0.5	1/21/2019	mg/Kg	16	190	1.8	23	570	<0.087	<5	<2.5
AOC3B-3-1	1/21/2019	mg/Kg	15	150	0.54	24	770	<0.095	<4.9	<2.5
AOC3B-4-0.5	1/21/2019	mg/Kg	15	120	<0.49	20	200	<0.096	<4.9	<2.5
AOC3B-5-0.5	1/21/2019	mg/Kg	11	110	0.52	13	230	<0.092	<4.9	<2.5
AOC3B-6-0.5	1/21/2019	mg/Kg	13	120	1.1	18	750	<0.092	<4.9	<2.4
AOC3B-6-4	1/21/2019	mg/Kg	8	120	<0.49	18	17	<0.091	<4.9	<2.5
AOC3B-7-0.5	1/21/2019	mg/Kg	12	130	<0.49	21	120	<0.1	<4.9	<2.4
AOC3B-7-1	1/21/2019	mg/kg	18	150	<0.5	26	200	<0.091	<5	<2.5
AOC3B-8-0.5	1/21/2019	mg/Kg	19	210	1.1	25	820	0.097	<4.9	<2.5
AOC3B-8-2	1/21/2019	mg/kg	8.5	120	<0.49	23	15	<0.098	<4.9	<2.4
AOC3C-15	1/23/2019	mg/kg	18	160	1.3	24	660	<0.094	<4.9	<2.5
AOC3C-1-3.5	1/23/2019	mg/kg	18	190	1.3	24	470	<0.09	<4.9	<2.4
AOC3C-2-0.5	1/23/2019	mg/kg	150	1700	<4.9	240	580	<0.098	<49	<24
AOC3C-2-0.5	3/8/2019	mg/Kg	14	140	<0.49	20	56		<4.9	<2.5
AOC3C-2-0.5-D	3/8/2019	mg/Kg	14	140	<0.49	20	56		<4.9	<2.5
AOC3C-3-0.5	1/23/2019	mg/kg	18	140	0.78	24	230	<0.1	<4.9	<2.5
AOC3C-4-0.5	1/23/2019	mg/kg	19	150	<0.5	24	29	<0.096	<5	<2.5
AOC3C-5-0.5	1/23/2019	mg/kg	17	140	<0.49	26	120	<0.098	<4.9	<2.5
AOC3C-6-0.5	1/23/2019	mg/kg	20	180	2.1	25	1000	<0.093	<5	<2.5
AOC3C-6-1.0	1/23/2019	mg/kg	12	140	<0.49	26	450	<0.095	<4.9	<2.4
AOC3C-7-0.5	1/22/2019	mg/kg	15	110	<0.49	20	26	<0.087	<4.9	<2.4
AOC3C-8-0.5	1/22/2019	mg/kg	13	130	1.8	22	140		<4.9	<2.5
TP-13-0.5	1/29/2019	mg/kg	31	610	39	7.8	5800	1.3	<5	6.5
TP-8-0.5	1/29/2019	mg/kg	47	1100	75	6.1	12000	1.8	<9.9	6.8

Note: mg/kg - milligram per kilogram

Non Residential SRL	10	170,000	510	65	800	310	5,100	5,100

Table 5: Summary of SPLP and TCLP Metals in Soil - Adair Memorial Park

Sample Name	Collection Date	Unit	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
AOC3B-1-1	1/21/2019	mg/L	<0.028	0.046	<0.003	<0.0055	<0.019	<0.0008	<0.026	<0.007
AOC3B-3-1	1/21/2019	mg/L	<0.028	0.13	<0.003	<0.0055	<0.019	<0.0008	0.035	<0.007
AOC3B-4-1	1/21/2019	mg/L	<0.028	<0.0035	<0.003	<0.0055	<0.019	<0.0008	<0.026	<0.007
AOC3B-5-1	1/21/2019	mg/L	<0.028	<0.0035	<0.003	<0.0055	<0.019	<0.0008	<0.026	<0.007
AOC3B-6-2.0	1/21/2019	mg/L	<0.028	<0.0035	<0.003	<0.0055	<0.019	<0.0008	<0.026	<0.007
AOC3B-7-1	1/21/2019	mg/L	<0.028	0.11	<0.003	<0.0055	<0.019	<0.0008	0.031	<0.007
AOC3B-8-1	1/21/2019	mg/L	0.031	0.11	<0.003	<0.0055	<0.019	<0.0008	<0.026	<0.007
TP-13-0.5	1/29/2019	mg/L	<0.028	<0.0035	<0.003	<0.0055	<0.019	<0.0008	<0.026	<0.007
TP-8-0.5	1/29/2019	mg/L	<0.028	<0.0035	1.4	<0.0055	57	<0.0008	<0.026	<0.007
TCLP Limit		mg/L	5.0	100	1.0	5.0	5.0	0.2	1.0	5.0

Note: mg/L - milligram per liter

Adair Park Archery Range Draft Remedial Action Plan VRP SITE CODE 505354-00

> APPENDIX A Boring Logs

N	- /	18 Yu Tel Fax	klaus Engi 51 W. 24th ma, AZ 853 ephone: (9 k: (928)726	Stree 364 928)34 5-6994	t 14-8374 1		E 1 OF 1
CLIENT	Yu	ma Cou	nty Depart	mento	of Public	Works PROJECT NAME Adair Park Archery Range	
						PROJECT LOCATION Yuma, AZ	
DATE S	STAR	TED <u>1</u> /	24/19		COMP	LETED 1/24/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILLI	NG C	ONTRA	CTOR Nic	klaus	Engineer	ing GROUND WATER LEVELS:	
ORILLIN	NG M	ETHOD	Hollow St	tem A	uger	AT TIME OF DRILLING	
						KED BY MLD AT END OF DRILLING	
NOTES	-	-				AFTER DRILLING	
0.0	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	ss	100	5-8-10 (18)			(Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, damp, gravel 25%, to 1 inch, subangular to subrounded, no odor, no stain.	XRF = 10
1							XRF = 82
-		400	7-7-6				XRF = 14
2.5	SS	100	(13)		2.5	5 (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, clay soft to medium stiff, damp, low plasticity, clay 20%, no odor, no stain.	XRF = 50
t							XRF = 19
	ss	100	6-5-5 (10)				XRF = 24
+)	-		ML			XRF = 18 XRF = 24
5.0	ss	100	4-8-13				XRF = 134
-//			(21)				
- 13	1			_	6.0	Bottom of borehole at 6.0 feet.	

LIENT	Yum		:: (928)726 nty Departm			Vorks PROJECT NAME Adair Park Archery Range			
						PROJECT LOCATION Yuma, AZ			
DATE ST	ARTI	ED _1/	24/19		COMPLI	ETED 1/24/19 GROUND ELEVATION HOLE SIZE 8 inches			
RILLIN	G CO	NTRAC		klaus	Engineerir	GROUND WATER LEVELS:	GROUND WATER LEVELS:		
RILLIN	g me	THOD	Hollow St	tem A	uger	AT TIME OF DRILLING			
OGGED	BY	BC		_	CHECK	ED BY MLD AT END OF DRILLING			
IOTES	_	-	_	_	200	AFTER DRILLING			
	SAMPLE I YPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA		
	SS	100	8-10-11 (21)		(Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loos to 1 inch, subangular to subrounded, no odor, no stain.	(Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, slightly damp, gravel 20%, to 1 inch, subangular to subrounded, no odor, no stain.	 XRF = 27 XRF = 26		
1							XRF = 30		
<u>5</u> SS	100	7-7-9 (16)	1	2.0	(CL-ML) Silty Clay - Moderate yellowish brown (10YR 5/4), damp, soft to stiff, low plasticity, no odor, no stain.	XRF = 16			
4							XRF = 15		
-V	SS	100	3-4-4 (8)	0			XRF = 94		
-//			(0)	CL- ML					XRF = 15
11							XRF = 17		
5.0	SS	100	2-3-3 (6)				XRF = 55		
11					6.0	Bottom of borehole at 6.0 feet.			

	N	6	-1	185 Yur Tel	klaus Engi 51 W. 24th ma, AZ 853 ephone: (9 c: (928)726	Street 364 928)34	4-8374	BORING NUMBER	AOC2-3 PAGE 1 OF 1
ŀ	CLIEI	T	Yum	a Cou	nty Departr	ment o	of Public	Works PROJECT NAME Adair Park Archery Range	
	PRO	IECI	r NUI	MBER	018-0069)		PROJECT LOCATION Yuma, AZ	
Ŀ	DATE	ST	ARTE	ED 1/	23/19		COMP	LETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 incl	les
1	DRILI	ING	COI	NTRAC	TOR Nic	klaus	Enginee	ring GROUND WATER LEVELS:	
þ	DRILI	ING	ME.	THOD	Hollow St	em A	uger	AT TIME OF DRILLING	
þ	OGC	ED	BY	BC	_		CHECI	KED BY MLD AT END OF DRILLING	
þ	NOTE	s_		-		_		AFTER DRILLING	
	(¥)	SAMPIF TYPF	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
1 1	I - I	X	SS	100	8-8-9 (17)			(Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, slightly damp, gravel 3 to 2 inches, subangular to subrounded, no odor, no stain.	0%. XRF = 74 XRF = 70
-	4		-						XRF = 70 XRF = 32
-	2.5	V	ss	100	9-7-8 (15)				XRF = 40
-	1	4							XRF = 40
		\mathbb{N}				÷	3.	5	
-		V	ss	100	7-7-8			(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), loose to soft, low plasticity, no odor, no stain.	XRF = 112
-	-	Ą		100	(15)				XRF = 35
F.	1	T							XRF = 24
-	5.0	X	ss	100	5-7-8 (15)	ML			XRF = 93
		$\langle \rangle$							
-	- 1	1				-	6.0	Bottom of borehole at 6.0 feet.	_
	_								

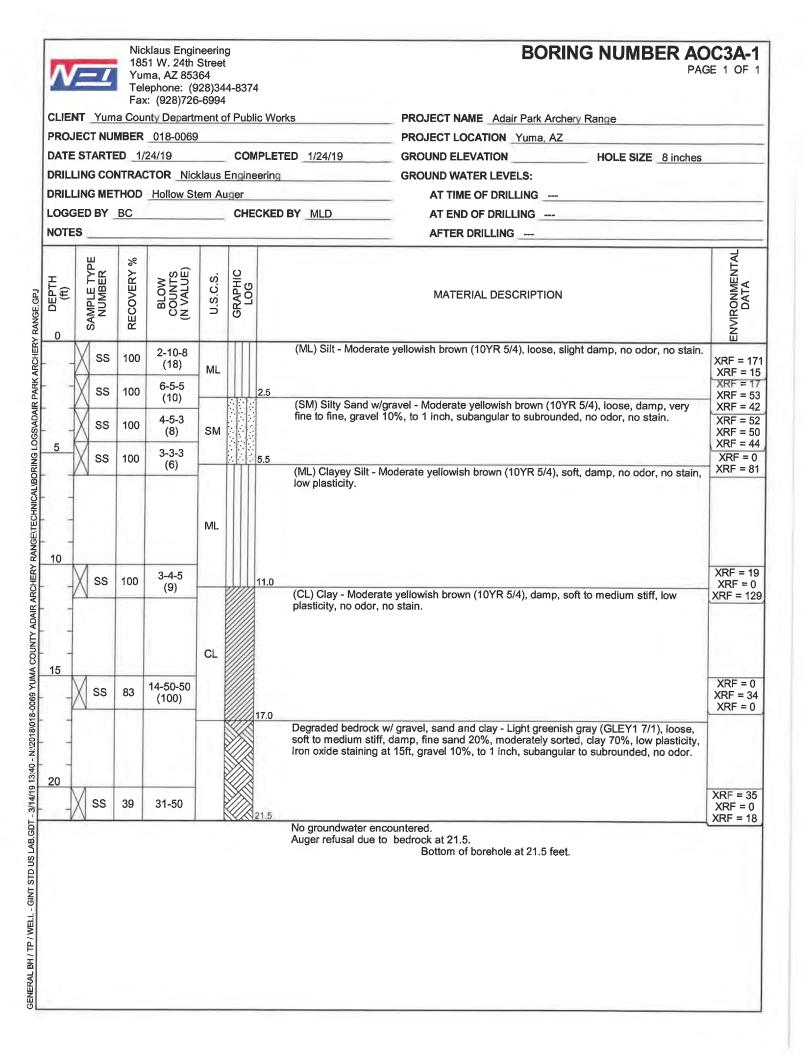
	V	_/	185 Yur Tel	klaus Engii 51 W. 24th ma, AZ 853 ephone: (9 c: (928)726	Street 364 928)34	t 14-8374	BORING NUMBER A	OC2-4 E 1 OF 1
CLI	ENT	Yum	na Cou	nty Departr	ment c	of Public Wo	rks PROJECT NAME Adair Park Archery Range	
PR	OJE	CT NU	MBER	018-0069	}		PROJECT LOCATION Yuma, AZ	
DA	TE S	TARTI	ED _1/	23/19		COMPLET	TED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRI	LLI	NG CO	NTRAC	CTOR Nic	klaus	Engineering	GROUND WATER LEVELS:	1.1
DRI	LLI	IG ME	THOD	Hollow St	tem A	uger	AT TIME OF DRILLING	-
LOC	GGE	DBY	вс		_	CHECKED	BY MLD AT END OF DRILLING	
NO	TES	_					AFTER DRILLING	
O DEPTH		SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
		ss	100	7-10-10 (20)	ML		(ML) (Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, dry, gravel 25%, to 2 inches, subangular to subrounded, no odor, no stain.	XRF = 273 XRF = 26
-	t	1						XRF = 30
2.5		ss	100	7-8-8 (16)		2.0	(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain.	XRF = 163
2.5								XRF = 15
								XRF = 22
		SS	100	8-8-7 (15)	ML			XRF = 94
	1							XRF = 15
5.0								XRF = 17
	-	SS	100	2-5-9 (14)				XRF = 55
						6.0		
	-	-	-			1 1 10.0	Bottom of borehole at 6.0 feet.	

	N	-1	188 Yui Tel	klaus Engir 51 W. 24th ma, AZ 853 ephone: (9 k: (928)726	Street 64 28)34	4-8374	BORING NUMBER A	OC2-5 E 1 OF 1
0		T Yun					Vorks PROJECT NAME Adair Park Archery Range	h
							PROJECT LOCATION Yuma, AZ	
1	DATE	START	ED _1/	24/19	-	COMPL	ETED 1/24/19 GROUND ELEVATION HOLE SIZE 8 inches	
1	RILL	ING CC	NTRA	CTOR Nic	klaus	Engineerii	ng GROUND WATER LEVELS:	
							AT TIME OF DRILLING	
ľ	.OGG	ED BY	BC	_	_	CHECK	ED BY MLD AT END OF DRILLING	
M	OTE	s	_				AFTER DRILLING	
	(#) (#)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
		ss	100	6-12-12 (24)	ML		(ML) (Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, damp, gravel 30%, to 2.5 inches, subangular to subrounded, no odor, no stain.	XRF = 164 XRF = 67
ŀ	+	1	-	-				XRF = 38
-	2.5	ss	100	10-11-12 (23)		2.0	(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, clay soft to medium stiff, damp, low plasticity, no odor, no stain.	XRF = 47
	2.5	(XRF = 0
-	1	1	1					XRF = 0
-	4	ss	100	6-10-9 (19)				XRF = 0
	1	$\langle \rangle$			ML			XRF = 17
Ē.,	5.0							XRF = 40
		ss	100	4-6-8 (14)				XRF = 25
	V							
		-				6.0	Bottom of borehole at 6.0 feet.	
								-

	N	-	1	185 Yur Tel	klaus Engir 51 W. 24th na, AZ 853 ephone: (9 c: (928)726	Stree 64 28)34	4-8374	BORING NUMBER	AOC2-6 AGE 1 OF 1
								Norks PROJECT NAME Adair Park Archery Range	<u> </u>
								PROJECT LOCATION Yuma, AZ	
	DATE	STA	RTE	D 1/	24/19		COMPL	ETED 1/24/19 GROUND ELEVATION HOLE SIZE 8 inche	S
l	DRILL	.ING	CON	ITRAC	TOR Nicl	klaus	Engineeri	ng GROUND WATER LEVELS:	
	DRILL	ING	MET	HOD	Hollow St	em A	uger	AT TIME OF DRILLING	
I	LOGG	EDE	BY_	BC			CHECK	ED BY MLD AT END OF DRILLING	
	NOTE	s		_		_		AFTER DRILLING	
	O DEPTH O (ft)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	1. I. I.	V.	SS	100	13-25-44 (69)			(ML) (Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, dry, gravel 25%, to 2 inches, subangular to subrounded, no odor, no stain.	2 XRF = 307 XRF = 44
-	-					ML			XRF = 39
-		VI			7-12-10				XRF = 144
	2.5	X S	SS	100	(22)	0			
Γ		$ \rangle$		-			2.8		XRF = 93
-		$\overline{\mathbf{A}}$						(ML) Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, damp, no odor, no stain.	XRF = 17
		X s	ss	100	4-4-4 (8)				XRF = 249
-		Ą			(0)	ML			XRF = 0
		1							XRF = 0
-	5.0) s	ss	100	2-3-4 (7)				XRF = 93
		1					6.0		1
								Bottom of borehole at 6.0 feet.	

PROJECT	NUMBER RTED <u>1/</u> CONTRAC METHOD	018-0069				
DATE STAI DRILLING I DRILLING I LOGGED B NOTES	RTED 1/ CONTRAC METHOD			DI PUDIIC VV	orks PROJECT NAME Adair Park Archery Range	
DRILLING DRILLING I LOGGED B NOTES	CONTRAC	24/19	,		PROJECT LOCATION Yuma, AZ	
DRILLING I LOGGED B NOTES	METHOD		_	COMPLE	TED 1/24/19 GROUND ELEVATION HOLE SIZE 8 inches	
			klaus	Engineerin	g GROUND WATER LEVELS:	
NOTES	BY BC	Hollow St	em Au	uger	AT TIME OF DRILLING	
				CHECKE	D BY MLD AT END OF DRILLING	
					AFTER DRILLING	
O DEPTH O (ft) SAMPLE TYPE	NUMBER RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	SS 100	7-10-9 (19)	ML	1.0	(ML) (Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, dry, gravel 30%, to 3 inches, subangular to subrounded, no odor, no stain.	XRF = 577
					(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, damp, clay 20%, soft, low plasticity, no odor, no stain.	XRF = 25
	1.7					XRF = 62
2.5	SS 100	6-6-5 (11)				XRF = 103
						XRF = 13
			ML			XRF = 14
s 🕺	SS 100	2-3-3 (6)				XRF = 74
						XRF = 20
5.0						XRF = 15
	SS 100	3-4-3 (7)				XRF = 28
	-			6.0		
					Bottom of borehole at 6.0 feet.	

N		-1	185 Yui Tel	klaus Engi 51 W. 24th ma, AZ 853 ephone: (9 c: (928)726	Street 364 928)34	4-8374	BORING NUMBER A	OC2-8 GE 1 OF 1
CLIEN	T	Yum					Norks PROJECT NAME Adair Park Archery Range	
							PROJECT LOCATION Yuma AZ	
							ETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches	
							ng GROUND WATER LEVELS:	
				Hollow St			AT TIME OF DRILLING	
							ED BY MLD AT END OF DRILLING	
NOTE							AFTER DRILLING	
(ff) 0.0	CAMPLE TVDF	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL
-	V	SS	100	7-8-12 (20)	ML		(ML) (Fill) Gravelly Silt - Pale yellowish brown (10YR 6/4), loose, dry, gravel 25%, to 2 inches, subangular to subrounded, no odor, no stain.	XRF = 20
4		-						XRF = 2 XRF = 2
-	V	SS	100	7-10-15	-	2.0	(SC) Clayey Sand - Moderate yellowish brown (10YR 5/4), loose to soft, damp, fine	XRF = 5
2.5	N	33	100	(25)			sand, 70%, clay 30%, low plasticity, no odor, no stain, well sorted.	XRF = 1
Ť	1							XRF = (
_	X	SS	100	6-8-9 (17)	sc			XRF = 33
+								XRF = 2
5.0	X	SS	100	3-4-4 (8)				XRF = 8
						6.0		
							Bottom of borehole at 6.0 feet.	



1	V	-	1	185 Yur Tele	klaus Engir 51 W. 24th na, AZ 853 ephone: (9 :: (928)726	Street 64 28)34	4-8374	BORING NUMBER AC	C3A-2 E 1 OF 1
CL	.IEN	п_	Yum	a Cou	nty Departr	nent o	of Public W	Vorks PROJECT NAME Adair Park Archery Range	
					018-0069				
								ETED 1/22/19 GROUND ELEVATION HOLE SIZE 8 inches	
								GROUND WATER LEVELS:	
DR	RILL	ING	MET	THOD	Hollow St	em Au	lger	AT TIME OF DRILLING	
							CHECK	ED BY MLD AT END OF DRILLING	
NC	DTE	s						AFTER DRILLING	
o DEPTH		SAMPLE TYPE	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	1							(ML) Silt - Moderate yellowish brown (10YR 5/4), loose, very slightly damp, no odor, no stain.	
1 1	-		SS	100	3-4-6 (10)				XRF = 112 XRF = 146
-	1	1				1	HIH.		XRF = 13
2.4	5	¥.	ss	100	5-5-6 (11)				XRF = 174
									XRF = 19
-	1	1				ML			XRF = 15
	-	VI.	ss	100	4-3-3				XRF = 65
-				100	(6)				XRF = 24
	1	1							XRF = 0
5.0			ss	100	3-4-4 (8)				XRF = 47
-	1								1.0
_	1	1				-	6.0	Bottom of borehole at 6.0 feet.	

	/=	1	185 Yur Tek	klaus Engi 51 W. 24th ma, AZ 853 ephone: (9 k: (928)726	Street 364 328)34	t 4-8374	BORING NUMBER AO	C3A-3 E 1 OF 1
CLIEI	NT _	Yum	a Cou	nty Departr	ment c	of Public W	orks PROJECT NAME Adair Park Archery Range	
PRO	JECT	NUN	MBER	018-0069	•		PROJECT LOCATION Yuma AZ	
DATE	E STA	ARTE	ED _1/	22/19		COMPLE	TED 1/22/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILI	LING	CON	NTRAC	CTOR Nic	klaus	Engineerin	g GROUND WATER LEVELS:	
DRILI	LING	MET	THOD	Hollow St	em Au	uger	AT TIME OF DRILLING	
LOGO	GED	BY	вс		_	CHECKE	D BY MLD AT END OF DRILLING	
NOTE	S						AFTER DRILLING	
0. DEPTH (ft)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
		SS	100	13-12-2 (14)			(ML) Gravelly Silt - Moderate yellowish brown (10YR 5/4), loose, damp, gravel 10%, to .5 inches, subangular to subrounded, no odor, no stain.	XRF = 335 XRF = 49
	$\left(\right)$	-			-			XRF = 0
	Ŋ.	SS	100	3-5-5 (10)	ML			XRF = 97
2.5	\mathbb{N}			(,		000		XRF = 31
	M					.0°		XRF = 28 XRF = 95
	Ň	SS	100	3-4-4 (8)		• • 4.0	(CL-ML) Silty Clay - Moderate yellowish brown (10YR 5/4), soft to medium stiff, damp, low plasticity, no odor, no stain.	XRF = 14
	$\left(\right)$							XRF = 284
5.0	X :	ss	100	3-3-5 (8)	CL- ML			XRF = 63
	1		-			222226.0	Bottom of borehole at 6.0 feet.	

N	1-	-1	185 Yur Tele	klaus Engi 1 W. 24th na, AZ 853 ephone: (9 :: (928)726	Street 364 928)34	4-8374)C3A-4 Se 1 OF 1
CLIE	NT	Yum					c Works PROJECT NAME Adair Park Archery Range	
PROJ	IEC	TNU	MBER	018-0069)		PROJECT LOCATION Yuma, AZ	
DATE	: S1	ARTE	ED _1/:	21/19		COM	PLETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILL	LIN	G CO	NTRAC		klaus	Engine	ering GROUND WATER LEVELS:	
DRILL	LIN	G ME	THOD	Hollow St	em A	uger	AT TIME OF DRILLING	
LOGO)EC	BY	BC			CHEC	CKED BY MLD AT END OF DRILLING	
NOTE	S					_	AFTER DRILLING	
0.0 (ft) 0.0		SAMPLE I YPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	V	SS	100	7-11-8 (19)			(ML) Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, very slightly damp, no odor, no stain.	XRF = 39
	$\left \right\rangle$			(19)	ML			XRF = 32
								XRF = 4
2.5	Y	SS	100	5-5-5 (10)	-		2.0 (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), damp, soft, low plasticity, no odor, no stain.	XRF = 67
2.0	\mathbb{N}							XRF = 2
								XRF = 19
-	Å	SS	100	4-6-6 (12)	ML			XRF = 53 XRF = 80
-				_				XRF = 3
5.0	V	SS	100	3-4-4 (8)				XRF = 23
-	\mathbb{N}			(3)				
	1						6.0 Bottom of borehole at 6.0 feet.	

	-/	185 Yui Tel	klaus Engii 51 W. 24th ma, AZ 853 ephone: (9 k: (928)726	Street 364 928)34	4-8374	BORING NUMBER AC)C3A-5 SE 1 OF 1
	Yum	na Cou	nty Departr	mento	of Public W	/orks PROJECT NAME Adair Park Archery Range	
PROJEC		MBER	018-0069)	_	PROJECT LOCATION Yuma, AZ	
DATE ST	TARTE	ED _1/	22/19		COMPLE	ETED 1/22/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILLIN	IG CO	NTRAC	CTOR Nic	klaus	Engineerin	g GROUND WATER LEVELS:	
			Hollow St			AT TIME OF DRILLING	
						ED BY MLD AT END OF DRILLING	
NOTES						AFTER DRILLING	
-	-	1	1	T	1 1		
O DEPTH O (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	SS	100	5-9-9 (18)	SM		(SM) Silty Sand - Moderate yellowish brown (10YR 5/4), loose to occasional medium dense, slightly damp, moderately sorted, fine sand, no odor, no stain.	XRF = 177 XRF = 317
- 4			-				XRF = 16
			1.1.1		2.0		
TV	SS	100	4-4-4			(SP) Fine Sand - Moderate yellowish brown (10YR 5/4), loose, slightly damp, well	XRF = 2152
2.5	00		(8)	SP		sorted, no odor, no stain.	XRF = 14
					3.5		XRF = 19
	SS	100	3-3-5 (8)			(CL) Silty Clay - Moderate yellowish brown (10YR 5/4), soft to medium stiff, damp, low plasticity, no odor, no stain.	XRF = 369
/ \							XRF = 23
5.0				CL			XRF = 20
\/	SS	100	3-4-4 (8)				XRF = 252
/							
11		-		-	6.0	Bottom of borehole at 6.0 feet.	

N	<u>_</u>	-1	185 Yur Tele	klaus Engir 51 W. 24th na, AZ 853 ephone: (9 <: (928)726	Street 64 28)34	t 14-8374	BORING NUMBER AC	DC3A-6 BE 1 OF 1
CLIEN	T	Yum	a Cou	nty Departr	nent c	of Public Works	PROJECT NAME Adair Park Archery Range	
PROJ	IEC.	t nui	MBER	018-0069	,		PROJECT LOCATION Yuma, AZ	
DATE	ST	ARTE	ED _1/	22/19		COMPLETED 1/22/	/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILL	INC	g COI	NTRAC	TOR Nic	klaus	Engineering	GROUND WATER LEVELS:	
DRILL	INC	G ME	THOD	Hollow St	em Au	uger	AT TIME OF DRILLING	
LOGO	ED	BY	BC			CHECKED BY MLD	AT END OF DRILLING	
NOTE	S	_					AFTER DRILLING	
0. DEPTH (ft)	SAMPIE TVDE	SAWITLE ITTE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	V	SS	100	3-5-5 (10)	SP	sorted,	and - Moderate yellowish brown (10YR 5/4), loose, damp, fine grained, well no odor, no stain.	XRF = 649 XRF = 17
	$\left(\right)$							XRF = 19
	V	SS	100	1-3-2		2.0 (CL) Sil odor, no	ty Clay - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no	XRF = 23
2.5	\mathbb{N}			(5)				XRF = 18
	1							XRF = 17
	X	SS	100	3-4-4 (8)	CL			XRF = 20
	Λ				UL.			XRF = 0
5.0	V							XRF = 0
	Å	SS	100	2-2-3 (5)				XRF = 39
				(c-==)		6.0		
							Bottom of borehole at 6.0 feet.	

N	-1	185 Yur Tele	klaus Engi 51 W. 24th ma, AZ 853 ephone: (§ c: (928)726	Street 364 928)34	t 4-8374	BORING NUMBER AC)C3A-7 Se 1 OF 1
CLIENT	Yum					Works PROJECT NAME Adair Park Archery Range	
						PROJECT LOCATION Yuma, AZ	
						LETED 1/22/19 GROUND ELEVATION HOLE SIZE 8 inches	
						ing GROUND WATER LEVELS:	
			Hollow St			AT TIME OF DRILLING	
						KED BY MLD AT END OF DRILLING	
-	_	1	1	1	1 1	AFTER DRILLING	
H (#)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
-	ss	100	7-9-8			(ML) Silt w/occasional gravel - Pale yellowish brown (10YR 6/4), loose, slightly damp, gravel (<5%) to 0.5 inches, subangular to subrounded, no odor, no stain.	XRF = 24
			(17)	hai			XRF = 1
			475	- ML			XRF = (
2.5	SS	100	4-7-5 (12)				XRF = 14
-	ss	100	3-3-6 (9)		3.0	0 (SM) Silty Sand w/occasional gravel - Medium yellowish brown (10YR 5/4), damp, fine sand, gravel (<5%) to 0.5 inches, subangular to subrounded, no odor, no stain.	XRF = 0 XRF = 4 XRF = 10
5.0				SM			XRF = 1
-	SS	100	4-3-3 (6)				XRF = 3
/ \					6.0)	

/V=	_/	185 Yun Tele	klaus Engir 1 W. 24th na. AZ 853 ephone: (9 : (928)726	Street 64 28)34	4-8374	BORING NUMBER AG	DC3A-8 GE 1 OF 1
CLIENT	Yum					Vorks PROJECT NAME Adair Park Archery Range	
PROJEC	T NU	MBER	018-0069)		PROJECT LOCATION Yuma AZ	
DATE SI	TARTE	ED _1/2	22/19		COMPL	ETED 1/22/19 GROUND ELEVATION HOLE SIZE 8 inches	
RILLIN	G CO	NTRAC	TOR Nic	klaus	Engineeri	GROUND WATER LEVELS:	
RILLIN	G ME	THOD	Hollow St	em Au	lger	AT TIME OF DRILLING	
OGGEE	BY	вС			CHECK	ED BY MLD AT END OF DRILLING	
OTES	_			_		AFTER DRILLING	
0.0 DEPIH	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL
						(ML) Silt - Pale yellowish brown (10YR 6/4), loose, slightly damp, no odor, no stain.	
	ss	100	3-7-7 (14)				XRF = 11
4							XRF = 2
-	SS	100	3-5-4				XRF = 43
2.5			(9)				XRF = 12
				ML			XRF = 2
-Ň	SS	100	3-5-6 (11)				XRF = 21
$\left(\right)$	_						XRF = 1
5.0	SS	100	3-5-5 (10)				XRF = 15
1			-		6.0		
						Bottom of borehole at 6.0 feet.	

		185 Yur Tele	klaus Engir 1 W. 24th na, AZ 853 ephone: (9 :: (928)726	Street 64 928)34	t 4-8374	BORING NUMBER AC	DC3B-1 GE 1 OF 1
CLIE	T Yum	na Cou	nty Departr	nent c	of Public M	Vorks PROJECT NAME Adair Park Archery Range	
PROJ	ECT NU	MBER	018-0069			PROJECT LOCATION Yuma, AZ	
DATE	STARTI	ED _1/	21/19		COMPL	ETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILL	ING CO	NTRAC		klaus	Engineerir	GROUND WATER LEVELS:	
DRILL	ING ME	THOD	Hollow St	em Au	Jger	AT TIME OF DRILLING	
LOGO	GED BY	BC			CHECK	ED BY MLD AT END OF DRILLING	
NOTE	s					AFTER DRILLING	
o DEPTH (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
		100	3-4-3 (7)			(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), loose, soft clay, damp, low plasticity, no odor, no stain.	XRF = 217
		_					XRF = 794 XRF = 26
		100	3-3-3				XRF = 199
2.5			(6)				XRF = 37
				ML			XRF = 24
		100	3-3-3 (6)				XRF = 82 XRF = 0
							XRF = 23
5.0		100	2-2-3 (5)				XRF = 53
							(
				-	6.0	Bottom of borehole at 6.0 feet.	1

-1	185 Yur Tele	klaus Engi 1 W. 24th na, AZ 853 ephone: (9 :: (928)726	Street 364 928)34	t 4-8374		DC3B-2 GE 1 OF 1
Yuma					c Works PROJECT NAME Adair Park Archery Range	
	IBER	018-0069)		PROJECT LOCATION Yuma, AZ	
ARTE	D 1/:	21/19		CON	PLETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
	ITRAC	TOR Nic	klaus	Engine	ering GROUND WATER LEVELS:	
BY	вс			CHE		
NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
SS	100	4-5-5 (10)	SM		sand, well sorted, no odor, no stain.	XRF = 109
		(,			1.0 (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), damp, soft, low plasticity, no odor, no stain.	XRF = 812
						XRF = 265
SS	100	5-4-5 (9)				XRF = 208
_	-					XRF = 35
ss	100	4-4-4 (8)	ML			XRF = 87
						XRF = 0
						XRF = 16
ss	100	3-4-3 (7)				XRF = 56
		_			6.0 Bottom of borehole at 6.0 feet.	
	NUM ARTE CON MET BY SS SS SS	NUMBER ARTED 1// CONTRAC METHOD BY BC NUMBER SS 100 SS 100	NUMBER 018-0069 ARTED 1/21/19 CONTRACTOR Nice METHOD Hollow Si BY BC NUMBER 018-0069 METHOD Hollow Si BY BC NUMBER % Method Hollow Si BY BC SS 100 4-5-5 (10) SS 100 5-4-5 (9) SS 100 5-4-5 (9) SS 100 4-4-4 (8) SS 100 4-3-3	NUMBER 018-0069 ARTED 1/21/19 CONTRACTOR Nicklaus METHOD Hollow Stem Ar BY BC SS 100 4-5-5 (10) SM SS 100 5-4-5 (9) ML SS 100 4-4-4 (8) ML	NUMBER $018-0069$ ARTED $1/21/19$ COM CONTRACTOR Nicklaus Engine METHOD Hollow Stem Auger By BC CHEI BY BC CHEI SS 100 $4-5-5$ SM 2000 SS 100 $5-4-5$ SM 2000 SS 100 $5-4-5$ ML ML SS 100 $4-4-4$ ML ML SS 100 $3-4-3$ (7) ML (1) SS 100 $3-4-3$ (7) (7) (1) (1)	NRTED 1/21/19 COMPLETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches CONTRACTOR Nicklaus Engineering GROUND WATER LEVELS: AT TIME OF DRILLING

N	1	-1	185 Yun Tele	klaus Engir 1 W. 24th na, AZ 853 ephone: (9 :: (928)726	Street 64 28)34	4-8374	BORING NUMBER AG	OC3B-3 GE 1 OF 1
CLIEN	T	Yum					Works PROJECT NAME Adair Park Archery Range	
PROJ	EC	T NUI	MBER	018-0069			PROJECT LOCATION Yuma, AZ	
DATE	ST	ARTE	D 1/2	21/19		COMP	LETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILL	IN	G COI	NTRAC	TOR Nic	klaus	Engineer	ing GROUND WATER LEVELS:	
DRILL	IN	G ME	THOD	Hollow St	em Au	lger	AT TIME OF DRILLING	
LOGG	ED	BY	вс			CHECH	KED BY MLD AT END OF DRILLING	
NOTE	s	-			_		AFTER DRILLING	1.1.1.1
o DEPTH o (ft)		NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	V	SS	100	5-10-10 (20)	SM		(SM) Silty Sand - Moderate yellowish brown (10YR 5/4), loose, slightly damp, well sorted, fine sand, no odor, no stain.	XRF = 604
	$\left \right\rangle$				ML		(ML) Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, damp, no odor, no stain.	XRF = 2034 XRF = 35
2.5	X	SS	100	4-3-3 (6)		2.) (SM) Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, damp, no odor, no stain.	XRF = 196
-					SM			XRF = 34 XRF = 19
-	XI	SS	100	4-3-2 (5)				XRF = 386
	11							XRF = 19
5.0	\langle					4.	(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain.	XRF = 14
-	Å	SS	100	3-4-4 (8)	ML			XRF = 212
1	1				_	6.0		
							Bottom of borehole at 6.0 feet.	

N	_,	18 Yu Te	cklaus Engi 51 W. 24th ma, AZ 853 lephone: (9 x: (928)720	Street 364 928)34	t 14-8374)C3B-4 3e 1 of 1
CLIENT	Yı					c Works PROJECT NAME Adair Park Archery Range	
						PROJECT LOCATION Yuma AZ	
						PLETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
						ering GROUND WATER LEVELS:	
			Hollow S			AT TIME OF DRILLING	
						CKED BY MLD AT END OF DRILLING	
						AFTER DRILLING	
	SAMPLE TYPE		BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	S	5 100	4-6-7 (13)	SP		(SP) Sand - Moderate yellowish brown (10YR 5/4), loose, damp, fine sand, well sorted, no odor, no stain.	XRF = 59 XRF = 6
t	1					1.5 (ML) Sandy Silt - Moderate yellowish brown (10YR 5/4), loose, damp, 20% fine sand, no odor, no stain.	XRF = 5
	s	5 100	6-5-6 (11)	ML			XRF = 5
2.5						20	XRF = 3
	s	\$ 100	3-3-4 (7)			(CL-ML) Silty Clay - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain.	XRF = 26 XRF = 12 XRF = 24
5.0	ss	5 100	3-3-3 (6)	CL- ML			XRF = 23
V							
_	1	_		1	MAN	6.0	-

PROJECT NUMBER 018-0069 PROJECT LOCAT DATE STARTED 1/21/19 COMPLETED 1/21/19 GROUND ELEVAT DRILLING CONTRACTOR Nicklaus Engineering GROUND WATER DRILLING METHOD Hollow Stem Auger AT TIME OF LOGGED BY BC CHECKED BY MLD AT END OF NOTES AT END OF AFTER DRIL AFTER DRIL H_(1) WATER NOTOS 000000000000000000000000000000000000	EVELS: RILLING RILLING ING ESCRIPTION YR 5/4), loose, damp, fine grained, well YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 XRF = 412
DATE STARTED 1/21/19 COMPLETED 1/21/19 GROUND ELEVAT DRILLING CONTRACTOR Nicklaus Engineering GROUND WATER DRILLING METHOD Hollow Stem Auger AT TIME OF LOGGED BY BC CHECKED BY MLD AT END OF NOTES AFTER DRIL AFTER DRIL AFTER DRIL MATERIAL U H H H NOTON NOTON MATERIAL 0.0 H H H NOTON NOTON NOTON MATERIAL 0.0 H H H NOTON NO	N HOLE SIZE 8 inches EVELS: RILLING RILLING ING ING ING ESCRIPTION ING ING YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 XRF = 293 XRF = 412
DRILLING CONTRACTOR Nicklaus Engineering GROUND WATER DRILLING METHOD Hollow Stem Auger AT TIME OF LOGGED BY BC CHECKED BY MLD NOTES AFTER DRIL AFTER DRIL H H BB S AFTER DRIL H H BB S AFTER DRIL 0.0 H H BB MATERIAL 0.0 SS 100 5-4-6 SP 2.5 SS 100 5-4-6 SP 2.5 SS 100 4-4-3 ML SP 2.0 SS 100 3-3-4 SP CL-ML SS 100 3-3-4 CL-ML SIlty Clay - Moderate yellowish browish brow of an odor, no stain.	EVELS: RILLING RILLING ING ESCRIPTION YR 5/4), loose, damp, fine grained, well YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 XRF = 412
DRILLING METHOD Hollow Stem Auger AT TIME OF LOGGED BY BC CHECKED BY MLD AT END OF NOTES AFTER DRIL AFTER DRIL AFTER DRIL Harder Warder State Matter Difference Matter Difference Harder State State State State Matter Difference O.0 State State State State Matter Difference Matter Difference O.0 State State State State State State Matter Difference O.0 State State State State State Matter Difference Matter Difference O.0 State State State State State Matter Difference O.0 State State State State State State Matter Difference Matter Difference O.0 State State State State State Matter Difference State Matter Difference State State State State State State	RILLING RILLING ING ESCRIPTION YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 XRF = 412
LOGGED BY BC CHECKED BY MLD AT END OF NOTES AFTER DRIL H State State State State AFTER DRIL H State State State State State State State AFTER DRIL H State	RILLING ING ESCRIPTION YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 XRF = 412
LOGGED BY BC CHECKED BY MLD AT END OF AFTER DRIL NOTES AFTER DRIL H G G G G G G G G G G G G G G G G G G G	RILLING ING ESCRIPTION YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 XRF = 412
NOTES AFTER DRIL H (H) (H) (H) (H) (H) (H) (H) (H) (H) (H	ESCRIPTION XRF = 572 XRF = 530 XRF = 293 XRF = 412 XRF = 412
0.0 (SP) Sand - Moderate yellowish brown (1 sorted, no odor, no stain. SS 100 5-4-6 (10) 2.5 SS 100 4-4-3 (7) 2.5 SS 100 4-4-3 (7) ML 2.5 SS 100 4-4-3 (7) ML SS 100 3-3-4 (7) SS 100 3-3-4 (7) SS 100 3-3-4 (7) <td< td=""><td>YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 h brown (10YR 5/4), loose sand, soft clay, XRF = 412</td></td<>	YR 5/4), loose, damp, fine grained, well XRF = 572 XRF = 530 XRF = 293 h brown (10YR 5/4), loose sand, soft clay, XRF = 412
sorted, no odor, no stain. SS 100 5-4-6 (10) SP 2.0 2.0 2.0 2.0 (ML) Clayey Sandy Silt - Moderate yellow damp, low plasticity, 20% fine sand, no of 3.0 (CL-ML) Silty Clay - Moderate yellowish b no odor, no stain.	XRF = 572 XRF = 530 XRF = 293 XRF = 412
2.5 SS 100 4-4-3 (7) (ML) Clayey Sandy Silt - Moderate yellow damp, low plasticity, 20% fine sand, no of 3.0 2.5 ML 3.0 3.0 (CL-ML) Silty Clay - Moderate yellowish b no odor, no stain. SS 100 3-3-4 (7) CL- ML CL- ML	h brown (10YR 5/4), loose sand, soft clay, XRF = 412
2.5 SS 100 4-4-3 (7) (ML) Clayey Sandy Silt - Moderate yellow damp, low plasticity, 20% fine sand, no of 3.0 2.5 ML 3.0 3.0 (CL-ML) Silty Clay - Moderate yellowish b no odor, no stain. SS 100 3-3-4 (7) CL- ML CL- ML	h brown (10YR 5/4), loose sand, soft clay. XRF = 412
SS 100 3-3-4 (7) CL- ML CL- ML	r, no stain.
SS 100 3-3-4 (7) CL- ML CL- ML	XRF = 33
	wn (10YR 5/4), soft, damp, low plasticity, XRF = 21 XRF = 298
	XRF = 24
	XRF = 21
5.0 SS 100 3-3-4 (7)	XRF = 92
6.0	
Bottom of bor	ole at 6.0 feet.
	hole at 6.0 feet.

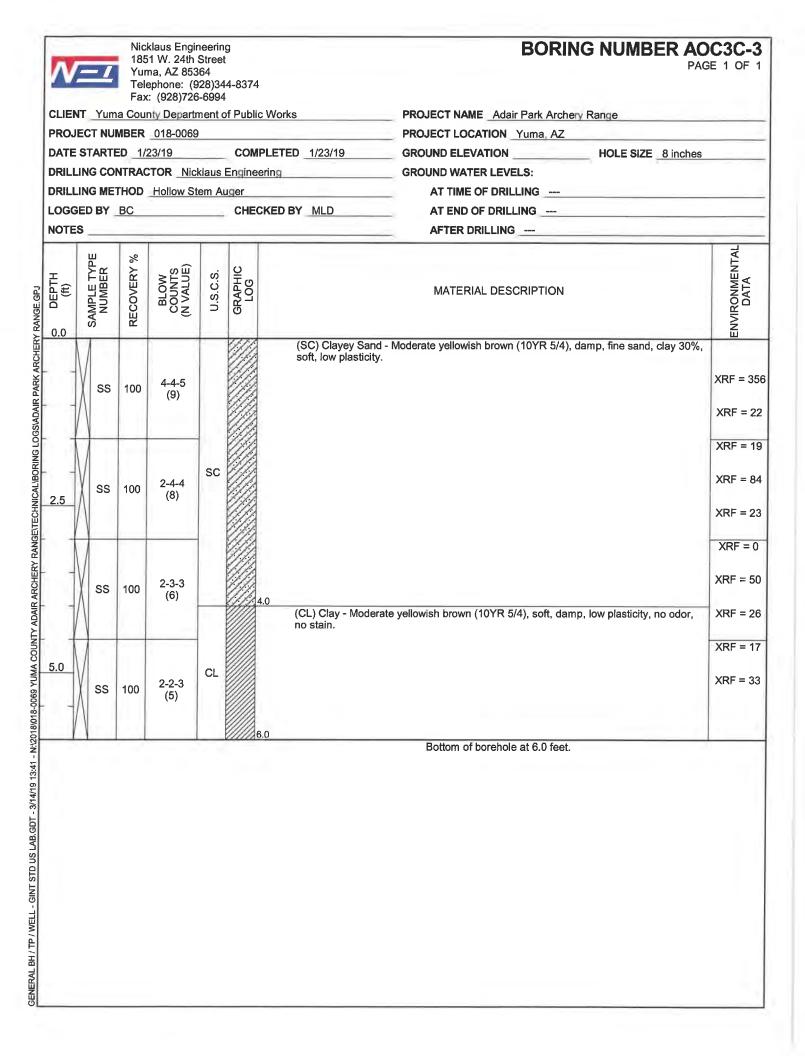
SS 100 (13) SM 1.5 XF 2.5 SS 100 4-5-5 (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain. XF 2.5 SS 100 4-5-5 ML SS	N	_/	188 Yui Tel	klaus Engii 51 W. 24th ma, AZ 853 ephone: (9 <: (928)726	Street 364 928)34	t 14-8374	BORING NUMBER AC)C3B-6 GE 1 OF 1
DATE STARTED 1/21/19 COMPLETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches DRILLING CONTRACTOR Nicklaus Engineering GROUND WATER LEVELS: AT TIME OF DRILLING	CLIEN	T Yum	na Cou	nty Departr	mento	of Public W	Vorks PROJECT NAME Adair Park Archery Range	\
DRILLING CONTRACTOR Nicklaus Engineering GROUND WATER LEVELS: DRILLING METHOD Hollow Stem Auger AT TIME OF DRILLING LOGGED BY BC CHECKED BY MLD AT END OF DRILLING NOTES AFTER DRILLING H B B B B 0.0 B B B B B 0.0 B B B B B B 0.0 B B B B B B B 0.0 B B B B B B B B 0.0 B <t< td=""><td>PROJE</td><td>ECT NU</td><td>MBER</td><td>018-0069</td><td>)</td><td></td><td>PROJECT LOCATION Yuma, AZ</td><td></td></t<>	PROJE	ECT NU	MBER	018-0069)		PROJECT LOCATION Yuma, AZ	
DRILLING METHOD Hollow Stem Auger AT TIME OF DRILLING	DATE	START	ED _1/	21/19		COMPLI	ETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
LOGGED BY BC CHECKED BY MLD AT END OF DRILLING	DRILL	ING CO	NTRA		klaus	Engineerin	GROUND WATER LEVELS:	
NOTES AFTER DRILLING	DRILL	ING ME	THOD	Hollow St	tem A	uger	AT TIME OF DRILLING	
Here Mathematical properties Matterial Description 0.0	LOGG	ED BY	BC			CHECKE	ED BY MLD AT END OF DRILLING	
0.0 -	NOTES	S					AFTER DRILLING	
SS 100 4-5-8 (13) SM Sand, Instruction XR 2.5 XS 100 4-5-5 (10) ML Instruction XF 2.5 XS 100 4-5-5 (10) ML Instruction XF 2.5 XS 100 4-5-5 (10) ML Instruction XF 2.5 XS 100 4-3-3 (6) SP (ML) Clayey Silt - Moderate yellowish brown (10YR 6/4), damp, loose, fine to very fine, no odor, no stain, well sorted. XF 5.0 XS 100 4-3-3 (6) SP (ML) Clayey Silt - Moderate yellowish brown (10YR 6/4), damp, loose, fine to very fine, no odor, no stain, well sorted. XF 5.0 SS 100 3-3-4 NI (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain. XF		SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
2.5 SS 100 4-5-5 (10) ML Image: Markow and the state of		ss	100		SM		sand,	
2.5 33 100 (10) ML XF 3.0 3.0 3.0 XF V SS 100 4-3-3 (6) SP SP SF XF 5.0 XF XF XF XF XF XF 5.0 SS 100 3-3-4 ML ML XF				4-5-5		<u> </u>	(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no	XRF = 305 XRF = 773
SS 100 4-3-3 (6) SP no stain, well sorted. XF 4.5 4.5 XR XR 5.0 SS 100 3-3-4 MI XF 5.0 SS 100 3-3-4 MI XF	2.5	SS	100		ML	3.0		XRF = 530
5.0 (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no XF odor, no stain.		ss	100	4-3-3 (6)	SP	45	(SP) Sand - Pale yellowish brown (10YR 6/4), damp, loose, fine to very fine, no odor, no stain, well sorted.	XRF = 0 XRF = 206 XRF = 2048
	5.0	ss	100	3-3-4 (7)	ML			XRF = 37 XRF = 349
Bottom of borehole at 6.0 feet.		-			<u></u>	6.0	Bottom of borehole at 6.0 feet.	

N	/	185 Yun Tele	klaus Engi 1 W. 24th na, AZ 853 aphone: (9 : (928)726	Street 364 928)34	t 4-837		OC3B-7 AGE 1 OF 1
CLIENT	Yum					c Works PROJECT NAME Adair Park Archery Range	
PROJEC	CT NU	MBER	018-0069)		PROJECT LOCATION Yuma, AZ	
DATE S	TARTI	ED 1/2	21/19		CON	PLETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	s
DRILLIN	IG CO	NTRAC		klaus	Engine	ering GROUND WATER LEVELS:	
DRILLIN	IG ME	THOD	Hollow St	em A	uger	AT TIME OF DRILLING	
LOGGEI	DBY	BC			CHE	CKED BY MLD AT END OF DRILLING	
NOTES						AFTER DRILLING	-
0.0 (ft)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL
	SS	100	3-8-10 (18)	SM		(SM) Silty Sand - Moderate yellowish brown (10YR 5/4), loose, slightly damp, fine sand, well sorted, no odor, no stain.	XRF = 18 XRF = 89
t						1.5 (ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, low plasticity clay, no odor, no stain.	XRF = 24
-1	SS	100	5-5-5 (10)				XRF = 26
2.5			(10)				XRF = 18
T							XRF = 16
TX	ss	100	4-3-4 (7)	ML			XRF = 50
1/							XRF = 19
5.0							XRF = 21
	SS	100	2-3-4 (7)				XRF = 11
1						3.0	
						Bottom of borehole at 6.0 feet.	

N		1	185 Yun Tele	klaus Engin 1 W. 24th na, AZ 853 ephone: (9	Street 64 28)34	4-8374	BORING NUMBER AC)C3B-8 GE 1 OF 1
CLIENT	rγ	'uma		: (928)726 ntv Departr			Norks PROJECT NAME Adair Park Archery Range	
							PROJECT LOCATION _Yuma, AZ	
							ETED 1/21/19 GROUND ELEVATION HOLE SIZE 8 inches	
							ing GROUND WATER LEVELS:	
				Hollow St			AT TIME OF DRILLING	
							XED BY MLD AT END OF DRILLING	
NOTES		-				OTILOT		
	_	-	-	(°	1	1	AFTER DRILLING	
0.0	SAMPLE TYPE	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
-			100	8-15-14			(ML) Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, slightly damp, no odor, no stain.	XRF = 39
-		SS	100	(29)				XRF = 20
-					ML			XRF = 8
2.5	s	s	100	6-4-4 (8)				XRF = 11
+		-						XRF = 1
-)	s	s	100	3-3-4 (7)				XRF = 10
-//						4.0	(SC) Clayey Sand - Moderate yellowish brown (10YR 5/4), loose, damp, low plasticity, 70% fine sand, well sorted, soft clay, no odor, no stain.	XRF = 2
	1				- 3	IA		XRF = 5
5.0	s	s	100	3-2-4 (6)	SC			XRF = 25
						In		
1	1	_	_			////6.0	Bottom of borehole at 6.0 feet.	1

~	Nicklaus Engineering 1851 W. 24th Street Yuma, AZ 85364 Telephone: (928)344-8374 Fax: (928)726-6994						BORING NUMBER AC	C3C-1 BE 1 OF 1			
			Fax	: (928)726	6-6994	Ļ					
							Vorks PROJECT NAME Adair Park Archery Range				
							PROJECT LOCATION Yuma, AZ				
							ETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches				
							GROUND WATER LEVELS:				
				Hollow St							
							ED BY MLD AT END OF DRILLING				
NOTE	T		-		T	1 1	AFTER DRILLING	ENVIRONMENTAL			
o OEPTH (ft)		SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION				
	SS 100 4-4-4 (8)				(SM) Silty Sand - Moderate yellowish brown (10YR 5/4), loose, damp, fine sand, well sorted, no odor, no stain.	XRF = 4					
1				(-)	SM			XRF = 2			
					3111			XRF = 33			
2.5	Å	SS	100	3-4-5 (9)				XRF = 0			
					-	3.0	(CL) Clay - Moderate yellowish brown (10YR 5/4), soft to medium stiff, damp, low plasticity, no odor, no stain.	XRF = 0			
-	X	SS	100	5-4-2 (6)				XRF = 43			
	$\langle \rangle$				CL			XRF = 14			
5.0	M							XRF = 23			
-	X	SS	100	6-5-4 (9)				XRF = 35			
	$\langle \rangle$			n		6.0					
							Bottom of borehole at 6.0 feet.				

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	Yur					C Works PROJECT NAME Adair Park Archery Range	
			018-0069			PROJECT LOCATION Yuma, AZ	
			-		COM	PLETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches	
						ering GROUND WATER LEVELS:	
			Hollow S			AT TIME OF DRILLING	
				_		CKED BY MLD AT END OF DRILLING	
OTES	_					AFTER DRILLING	
н (1 Д	- SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
	SS	100	2-4-3 (7)			(ML) Sandy Silt - Moderate yellowish brown (10YR 5/4), loose, damp, fine sand, well sorted, no odor, no stain.	XRF = 9
1				ML			XRF = 1
_							XRF = 1
2.5	SS	100	2-4-4 (8)				XRF = 1 XRF = 2
	SS	100	2-3-3 (6)			3.0 (CL-ML) Clayey Silt/Silty Clay - Moderate yellowish brown (10YR 5/4), damp, soft, low plasticity, no odor, no stain.	XRF = 1 XRF = 2 XRF = 2
5.0	SS	100	2-3-4 (7)	CL- ML			XRF = 0 XRF = 2
11						Bottom of borehole at 6.0 feet.	



N		1	185 Yun Tele	klaus Engi 1 W. 24th na, AZ 853 ephone: (9 : (928)726	Stree 364 928)34	t 14-8374	BORING NUMBER AC	DC3C-4 GE 1 OF 1
CLIEN	Т_	Yum	a Cour	nty Departm	ment o	of Public	Works PROJECT NAME Adair Park Archery Range	
							PROJECT LOCATION Yuma, AZ	
DATE	STA	RTE	D 1/2	23/19		COMP	PLETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILL	ING	CON	ITRAC		klaus	Enginee	ring GROUND WATER LEVELS:	
DRILL	ING	MET	HOD	Hollow St	em A	uger	AT TIME OF DRILLING	
LOGG	ED E	BY_	BC		_	CHEC	KED BY MLD AT END OF DRILLING	- T - S
NOTES	5						AFTER DRILLING	
o (ft)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL DATA
-							(CL-ML) Clayey Silt/Silty Clay - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain.	XRF = 22
	1					1	.5 (CH) Clay - Moderate yellowish brown (10YR 5/4), soft to medium stiff, medium	XRF = 27 XRF = 19
2.5	VI.	ss	100	2-3-2 (5)	сн		plasticity, no odor, no stain.	XRF = 22
2.5			_					XRF = 26
Λ	1				SP		(SP) Sand - Moderate yellowish brown (10YR 5/4), loose, damp, fine grained, well sorted, no odor, no stain.	XRF = 28
		ss	100	2-4-5 (9)		3	.5 (CH) Clay - Moderate yellowish brown (10YR 5/4), soft to medium stiff, medium plasticity, no odor, no stain.	XRF = 35 XRF = 31
5.0		ss	100	2-4-4	СН			XRF = 16 XRF = 16
-/	\mathbb{N}			(8)	-	5.	5 (SP) grades to 6" sand lense at 5.5 ft, pale yellowish brown (10YR 6/4), loose, damp,	
1	1				SP	6.	fine grained, well sorted, no odor, no stain.	
	_	-	-			10.	Bottom of borehole at 6.0 feet.	

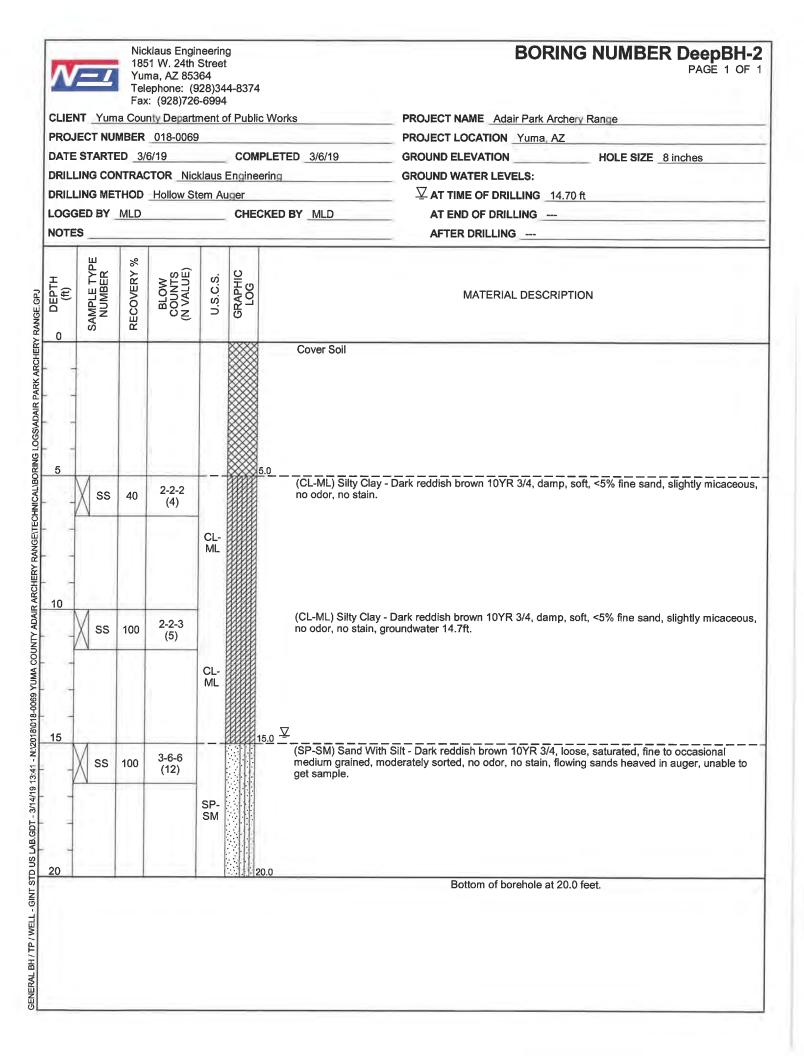
GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 3/14/19 13:41 - N:2018/018-0069 YUMA COUNTY ADAIR ARCHERY RANGE/TECHNICAL/BORING LOGSIADAIR PARK ARCHERY RANGE.GPJ

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CLIENT	Yun					lic Works PROJECT NAME Adair Park Archery Range	
PROJE	CT NU	MBER	018-0069	9		PROJECT LOCATION Yuma, AZ	
DATE S	TART	ED 1/:	23/19		CON	MPLETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILLIN	IG CO	NTRAC	TOR Nic	klaus	Engine	eering GROUND WATER LEVELS:	
DRILLIN	IG ME	THOD	Hollow St	tern A	uger	AT TIME OF DRILLING	
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NOTES				_		AFTER DRILLING	
0.0	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG		ENVIRONMENTAL DATA
-	SS	100	4-6-7 (13)			(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), damp, soft clay, low plasticity no odor, no stain.	XRF = 14
1				ML			XRF = 12
-				IVIL			XRF = 24
2.5	SS	100	3-2-4 (6)				XRF = 17
1			_			3.0 (CH) Clay - Moderate yellowish brown (10YR 5/4), high plasticity, soft to medium stiff, no odor, no stain.	XRF = 0
-/	SS	100	2-4-4 (8)	СН			XRF = 29
$\left\{ \right\}$	-						XRF = 16
5.0							
=	SS	100	4-5-5 (10)	SP		(SP) Sand - Moderate yellowish brown (10YR 5/4), damp, loose, fine grained, well sorted, no odor, no stain.	XRF = 18
/ \						6.0	
						Bottom of borehole at 6.0 feet.	

R 018-0069 /23/19 CTOR Nick Hollow Ste	ent of F	COMPLETED 1/2: agineering er CHECKED BY ML	M19 GROUND ELEVATION HOLE SIZE 8 inches GROUND WATER LEVELS: AT TIME OF DRILLING Image: Comparison of the state of the sta				
/23/19 ACTOR Nick Mollow Ste MOTA MOTA A-6-7		COMPLETED 1/2: ngineering er CHECKED BY ML DE 0 (SC) C	M19 GROUND ELEVATION HOLE SIZE 8 inches GROUND WATER LEVELS: AT TIME OF DRILLING Image: Comparison of the state of the sta				
ACTOR Nick Hollow Stee MOTON BCONNLS MOTON Hollow Stee A-6-7		ngineering er CHECKED BY ML	GROUND WATER LEVELS: AT TIME OF DRILLING AT END OF DRILLING AFTER DRILLING MATERIAL DESCRIPTION				
Hollow Stee MOTE MOTE BLOONULS (N VALUE) 4-6-7	S. C.S. C.S. C.S. C.S. C.S. C.S. C.S. C		AT TIME OF DRILLING D AT END OF DRILLING AFTER DRILLING MATERIAL DESCRIPTION				
BLOW COUNTS (N VALUE) 4-9-2	U.S.C.S.	CHECKED BY ML	DAT END OF DRILLINGAFTER DRILLING				
BLOW BLOW COUNTS (N VALUE) 4-9-2	U.S.C.S.		DAT END OF DRILLINGAFTER DRILLING				
4-6-7		(SC) (MATERIAL DESCRIPTION	_			
4-6-7		(SC) (MATERIAL DESCRIPTION	UVIRONMENTAL DATA			
	sc	(SC) C well so		ENVIRONMENTAL DATA			
		1.0	C) Clayey Sand - Moderate yellowish brown (10YR 5/4), loose, damp, fine sand, Il sorted, clay 30%, soft, low plasticity, no odor, no stain.				
	SM	(SM) S	ilt - Pale yellowish brown (10YR 6/4), loose, slightly damp, no odor, no stain.	XRF = 72			
5-5-5 (10)		2.0 (SP) S sand, v	(SP) Sand - Pale yellowish brown (10YR 6/4), loose, slightly damp, very fine to fine sand, well sorted, no odor, no stain.				
	SP	3.0		XRF = 42			
2-3-4 (7)				XRF = 43 XRF = 43 XRF = 28			
	CL			XRF = 32			
3-3-4 (7)				XRF = 163			
<u> </u>	1	6.0	Dettern of bonchole of C.O.f				
	(7)	(7) CL 3-3-4	2-3-4 (7) CL 3-3-4 (7)	2-3-4 (7) CL 3-3-4 (7) CL			

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CLIENT	Yu	ma Cou	nty Depart	mento	of Publi	c Works PROJECT NAME Adair Park Archery Range	
PROJE		JMBER	018-0069	9		PROJECT LOCATION Yuma, AZ	
DATE S	TAR	TED _1/	22/19		COM	PLETED 1/23/19 GROUND ELEVATION HOLE SIZE 8 inches	
DRILLIN	NG CO	ONTRAC	TOR Nic	klaus	Engine	ering GROUND WATER LEVELS:	
DRILLIN	NG M	ETHOD	Hollow S	tem A	uger	AT TIME OF DRILLING	
		BC	_		CHE	CKED BY MLD AT END OF DRILLING	
NOTES	_					AFTER DRILLING	
0.0 (#)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL
1	1					(ML) Silt - Moderate yellowish brown (10YR 5/4), loose to medium dense, damp, no odor, no stain.	
	ss	100	5-6-9 (15)				XRF = 27
	1						XRF = 23
T				- ML			XRF = 0
1	ss	100	4-4-6 (10)				XRF = 23
2.5			(10)			3.0	XRF = 2
	1					(ML) Sandy Silt - Moderate yellowish brown (10YR 5/4), loose, damp, fine sand, moderately sorted, no odor, no stain.	XRF = 3
-V	ss	100	3-3-5 (8)	ML			XRF = 10
1/\				ML		(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain.	XRF = 1
5.0				CL		(CL) Silty Clay - Moderate yellowish brown (10YR 5/4), soft, damp, low plasticity, no odor, no stain.	XRF = 1 XRF = 3
X	SS	100	3-4-5 (9)			5.5	
1				SP		(SP) Sand - Moderate yellowish brown (10YR 5/4), damp, loose, fine, well sorted, no odor, no stain.	
						Bottom of borehole at 6.0 feet.	

PROJECT I DATE STAI DRILLING (DRILLING I	NUMBER RTED 1/ CONTRAC METHOD BY BC	018-0069 22/19 CTOR Nic Hollow St) klaus l cem Au	COMPL Engineeri Jger CHECK	Works PROJECT NAME _Adair Park Archery Range PROJECT LOCATION _Yuma, AZ LETED 1/22/19 GROUND ELEVATION HOLE SIZE _8 inches ng GROUND WATER LEVELS: AT TIME OF DRILLING ED BY _MLD AT END OF DRILLING	
DATE STAI DRILLING (DRILLING I LOGGED B NOTES	RTED 1/ CONTRAC METHOD BY BC	22/19 CTOR Nic Hollow St	klaus I em Au	COMPL Engineeri Jger CHECK	ETED 1/22/19 GROUND ELEVATION HOLE SIZE 8 inches ng GROUND WATER LEVELS: AT TIME OF DRILLING	
DRILLING (DRILLING I LOGGED B NOTES	CONTRAC METHOD BY BC	CTOR Nic Hollow St	klaus I em Au	Engineeri Jger CHECK	ng GROUND WATER LEVELS: AT TIME OF DRILLING	
	METHOD BY BC	Hollow St	em Au	uger CHECK	AT TIME OF DRILLING	
NOTES	BY BC			CHECK		
NOTES	%		_			
ų	* *					
DEPTH (ft) AMPLE TYPE	*				AFTER DRILLING	
ن 0.0	NUMBER	BLOW COUNTS (N VALUE)	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ENVIRONMENTAL
			1 7		(ML) Silty - Moderate yellowish brown (10YR 5/4), loose, damp, no odor, no stain.	
s	SS 100	3-7-8 (15)	ML			XRF = 127 XRF = 45
\uparrow						XRF = 20
2.5 S	SS 100	4-3-3 (6)	SP	2.0	(SP) Sand - Pale yellowish brown (10YR 6/4), loose, slight damp, fine grained, well sorted, no odor, no stain.	XRF = 36
2.5				2.0	(ML) Clayey Silt - Moderate yellowish brown (10YR 5/4), loose, damp, soft clay, low plasticity, no odor, no stain.	XRF = 15
M						XRF = 17
]	SS 100	3-2-3 (5)				XRF = 17
\square			ML			XRF = 59
5.0						XRF = 24
_// s	S 100	3-4-4 (8)				XRF = 29
	-			6.0		
					Bottom of borehole at 6.0 feet.	



Adair Park Archery Range Draft Remedial Action Plan VRP SITE CODE 505354-00

APPENDIX B Risk Assessment and Lead GPL Calculation



December 16, 2019

Scott Green

Manager, Voluntary Remediation Program Unit Arizona Department of Environmental Quality Remedial Projects Section, Voluntary Remediation Program 1110 West Washington Street, 6th Floor Phoenix, AZ 85007

RE: Summary of Findings at Adair Park Archery Range, Yuma, Arizona, Site Code 505354-00

Dear Mr. Green:

At your request, the Fehling Group, LLC (TFG) reviewed the "Summary of Findings at Adair Park Archery Range, Yuma AZ" (hereafter referred to as the "Report of Findings") submitted by Nicklaus Engineering Inc. (NEI) June 2019. NEI prepared the report on behalf of the Yuma County Department of Public Works to present the results of the investigations and voluntary remediation activities that have been conducted at the Adair Memorial Park Archery Range. This investigation was conducted to address the Arizona Department of Environmental Quality's (ADEQ) concerns to the No Further Action (NFA) request. The purpose of our analysis provided herein, is to document our assessment of potential human health risks associated with residual levels of inorganics, specifically arsenic and lead in the top 6 to 12 inches of soil at the site. It should be noted that these two chemicals are the only chemicals of potential concern (COPCs) addressed herein as they were detected in site soils at concentrations greater than the Arizona Non-Residential Soil Remediation Levels (SRLs) and/or site background (Table 1).

Summary of Site Background and Soil Investigation Data

As summarized in the Report, the Adair Memorial Park Archery Range is 24 acres dedicated to Yuma County by the United States Bureau of Reclamation (USBR) in 1967 for the expressed use as a rifle, pistol and archery range, thus only non-residential exposures would occur on site. The site is located at 4760 South US Highway 95 and is about 12 miles north of Yuma, Arizona (Figure 1).

The archery range is located in a dry ephemeral wash built on top of tailings surrounded by the Gila River to the south, desert hills to the north and west and a shooting range to the east (Figure 2). The site currently consists of an archery range, several buildings, a shade structure, elevated shooting structures, archery targets and materials and maintenance equipment.

The site was formerly used as a silver ore mill during the late 1800s and early 1900s. The tailings from the silver ore processing were placed in a tailings pond and the silver ore processing and

associated tailings resulted in lead contaminated soil via stormwater runoff and wind-borne transportation.

As shown in Figure 2, the site was divided into three areas of concern (AOCs) for the purpose of the environmental investigation: AOC 1 (area to the north) received impacted soil from AOCs 2 and 3 and was capped; AOC 2, and AOC 3, which was further broken into AOC 3a (archery haybales), 3b (archery parking), and 3c (drainage from AOC 1). Investigation sampling locations are provided in Figures 3 and 4. Soil analyses for metals by USEPA Method 6010C was used for this investigation. It should be noted that XRF samples collected for the purpose of approximately identifying areas of elevated metals concentrations were not included in this analysis because USEPA Method 6010C provides a higher degree of accuracy for soil concentrations.

Soil Investigations

Eight background soil samples were collected outside the AOCs (Figure 3). Background lead concentrations detected ranged from 16 to 620 mg/kg, and arsenic concentrations detected ranged from 10 to 15 mg/kg. A statistical analysis of site background by Neptune and Company, Inc. compared site background concentrations of metals to site metals data in AOCs 2 and 3. This analysis indicated that site metals concentrations were above background for only arsenic and lead (analysis not shown) indicating that further evaluation of AOC arsenic and lead concentrations was warranted.

AOC 2

In AOC 2, 10 soil samples were collected between 6 and 12 inches below ground surface (bgs) (Figures 2 and 4). Arsenic was detected ranging from 13 to 20 mg/kg, with a 95% upper confidence limit $(UCL)^1$ of 17 mg/kg. All of the arsenic soil concentrations are above the ADEQ non-residential SRL of 10 mg/kg. Lead was detected at concentrations ranging from 38 to 460, with a 95% UCL of 242 mg/kg, and all are below the ADEQ non-residential SRL of 800 mg/kg.

AOC 3a

In AOC3a, seven soil samples were collected from 6 and 12 inches bgs. Arsenic concentrations ranged from 3 to 23 mg/kg, while lead was detected at concentrations ranging from 47 to 1800 mg/kg. Both arsenic and lead are present in this AOC at concentrations in excess of their respective ADEQ non-residential SRLs.

AOC 3b

In AOC3b, 11 soil samples were collected from 6 and 12 inches bgs. Arsenic was detected at concentrations ranging from 11 to 19 mg/kg, with a 95% UCL of 16 mg/kg. All of the arsenic detected concentrations are greater than the ADEQ non-residential SRL of 10 mg/kg. Lead was detected ranging from 61 to 820 mg/kg, with a 95% UCL of 639 mg/kg. Although the maximum lead result of 820 mg/kg is detected above the ADEQ non-residential SRL of 800 mg/kg, the 95% UCL is below that SRL.

¹ All UCLs in this analysis were calculated using ProUCL version 5.1.1; USEPA, 2015.

AOC 3c

In AOC3c, 10 soil samples were collected from 6 and 12 inches bgs.² Arsenic was detected at soil concentrations ranging from 12 to 20 mg/kg, with a 95% UCL of 18 mg/kg. All of the arsenic detected concentrations are above the ADEQ non-residential SRL of 10 mg/kg. Lead was detected at soil concentrations ranging from 26 to 1000 mg/kg, with a 95% UCL of 505 mg/kg. Although the maximum value is above the ADEQ non-residential SRL of 800 mg/kg, the 95% UCL is below that SRL.

The ProUCL output files for each AOC is provided as Appendix A.

Exposure Assessment

Because arsenic and lead have been detected in one or more AOCs at concentrations above ADEQ non-residential SRLs, this technical memorandum further evaluates the potential health effects related to adolescent and adult exposures to arsenic and lead in surface soils at AOCs 2 and 3a, 3b, and 3c.

Exposure Assumptions

The ADEQ non-residential SRLs, and the USEPA regional screening levels (RSLs), are two sets of published soil risk-based soil screening criteria that may be used to assess potential health risks from exposures to soils that contain elevated levels of hazardous chemicals. Both SRLs and RSLs assume a non-residential (that is, commercial or industrial land use) exposure frequency of 225 to 250 days per year. However, a reduced exposure frequency of 45 days per year (approximately one visit per week) for an adolescent/adult was selected as a more appropriate value for the Adair Memorial Park Archery Range. This value presumes that park visitors do not go to the park more than once per week, averaged over many years of park visits. The Archery Range does not routinely have any park employees in the AOC areas, so the typical commercial/industrial exposure frequency (225 to 250 days per year) is not applicable to park employees. In addition, it was assumed that an adolescent/adult visitor is not exposed to ore tailings in AOC 1 (which is capped) or to the tailings pile located on a hillside above AOC 3c, as this area is above grade to all park use areas and is cordoned off to prevent exposure in this area.

The primary route of exposure for chemicals like arsenic and lead in soil is through incidental soil ingestions. The USEPA Adult Lead Model uses a default outdoor soil and indoor dust ingestion rate is 50 mg/day (USEPA, 2003). However given that the site is used for archery, it is likely that park users would be picking up arrows, targets, and other items off the ground and, as such, it is entirely likely that the soil contact rate and subsequent outdoor soil ingestion rate, may be higher (with no "indoor dust" ingested). Thus, twice the "normal" ingestion rate of 100 mg/day was used as a conservative, health protective, measures and that it was derived from on-site soil. This rate is consistent with that used by USEPA in the industrial/commercial Regional Screening Level

² It was noted in the laboratory report that USEPA Method 6010C required confirmation because the initial analysis produced a significant negative result for [one or more metals] (absolute value exceeded the reporting limit; Test America Job ID 550-116886-1, Revision 1; 3/18/19). In addition, the original preparation batch was reviewed, and it was noted that there was a data entry error in the weight of one of the soil samples. The weight was mistakenly listed as $1/10^{th}$ of the actual weight. In the initial analysis, the arsenic detection was 150 mg/kg; however, the re-analyses indicated an arsenic concentration of 14 mg/kg and the duplicate analysis confirmed the 14 mg/kg. Therefore, this analysis used the data from the re-analysis reported in March 2019.

(RSL) for arsenic (although it is recognized this latter value is once again inclusive of indoor dust and outdoor soil).

Arsenic RSL Adjustment

The USEPA risk-based, industrial/commercial (RSL) of 3 mg/kg (USEPA, 2019) was adjusted to account for the differences to the exposure frequency as noted above using a simple ratio approach (45 days/year versus 250 days/year). With this exposure parameter adjustment, the commercial/industrial RSL would increase to 17 mg/kg at a risk level of 1×10^{-6} .

Adult Lead Model

The USEPA adult lead model (USEPA, 2019) was used to calculate a soil RSL for the site. This model focuses on estimating fetal blood lead concentrations in pregnant women exposed to lead-impacted media and uses a fetal target lead blood level of 5 μ g/dL as the threshold at which adverse health effects might be observed. It is noted that the ADEQ still relies upon the previous blood lead target of 10 μ g/dL; however, the more protective newer level currently recommended by USEPA was used here. The adult lead model was set to calculate a target soil lead level such that there is a 95% probability that the fetal blood lead level will not exceed the 5 μ g/dL threshold.

As noted above, the exposure frequency and soil ingestion rate parameters were modified from the adult lead model defaults of 250 days/year and 50 mg/day to 45 days/year and 100 mg/day; respectively. The resultant RSL from the USEPA Adult Lead Model is 2,556 mg/kg as shown in Table 2. This value is compared to the 95%UCL of soil lead concentrations in each AOC.

Risk Characterization Summary

Arsenic

AOC	95% UCL (mg/kg)	Site-Specific RSL (mg/kg)	UCL Exceeds Site-Specific RSL?
AOC 3a	17	17	No
AOC 3b	16	17	No
AOC 3c	18	17	Yes

In all but AOC3c, the 95% UCLs for arsenic are at or below the site-specific RSL of 17 mg/kg. For AOC3c, the 95% UCL of 18 represents a risk of 1.06×10^{-6} ; essentially 1×10^{-6} as well such that this slight exceedance of the site-specific RSL may be considered equivalent to said RSL.

Lead

AOC	95% UCL (mg/kg)	Site-Specific RSL (mg/kg)	UCL Exceeds Site-Specific RSL?		
AOC 3a	242	2,556	No		
AOC 3b	820	2,556	No		
AOC 3c	1,000	2,556	No		

None of the lead 95% UCLS for AOCs 2, 3a, 3b, and 3c exceed the site-specific lead soil screening level of 2,556 mg/kg. It is worth noting that none of the detected concentrations individually exceed this RSL either.

Closing

This analysis assessed residual arsenic and lead levels in the top 6 and 12 inches of soil in which adolescents/adults may come into contact at the Adair Memorial Archery Range site. Several conservative (e.g., health protective) assumptions were relied upon as part of this analysis most notably, an outdoor soil ingestion rate that is at least twice that of the standard, default assumption. Based on this analysis, it does not appear that there would be significant exposure to lead and arsenic in soil above site-specific, health-based levels. It should be noted that the UCL for arsenic in AOC 3c is 18 mg/kg as compared to the site-specific RSL of 17 mg/kg. It is likely that this exceedance will not appreciably increase risk above the *de minimis* level of 10^{-6} but, ultimately, that is a decision for the site risk managers and regulators. It is recommended that the ore tailings locations in AOC 1 and the tailings pile located on the hillside above AOC 3c be posted with "No Trespassing" signs if they are not already.

We appreciate the opportunity to provide a review of the subject document. If you have any questions, please contact Kurt Fehling at (707) 478-3484.

Sincerely,

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Kurt A. Fehling Principal Health Scientist

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Joanne M. Otani Senior Health Scientist

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TABLES

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Table 1: Summary of Total Metals in Soil - Adair Memorial Park

Sample Name	Date	Unit	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
AOC2-1-0.5	1/24/2019	mg/kg	14	76	<0.5	16	100	<0.091	<5	<2.5
AOC2-1-0.5	1/23/2019	mg/kg	15	120	<0.49	21	150	<0.095	<4.9	<2.4
AOC2-1-1	1/24/2019	mg/kg	15	140	1	17	460	0.11	<4.9	<2.5
AOC2-2-0.5	1/24/2019	mg/kg	15	140	0.67	21	370	<0.097	<4.9	<2.5
AOC2-2-3.5	1/24/2019	mg/kg	13	120	<0.5	26	73	<0.095	<5	<2.5
AOC2-3-0,5	1/23/2019	mg/kg	20	83	<0.49	19	58	<0.1	<4.9	<2.4
AOC2-3-3.5	1/23/2019	mg/kg	14	130	<0.5	25	43	<0.094	<5	<2 <i>.</i> 5
AOC2-4-0.5	1/23/2019	mg/kg	13	86	<0.5	15	34	<0.097	<5	<2.5
AOC2-4-3.0	1/23/2019	mg/kg	22	85	<0.49	57	330	<0.095	<4.9	<2.4
AOC2-5-0.5	1/23/2019	mg/kg	17	59	<0.5	15	68	<0.089	<5	<2.5
AOC2-5-4.5	1/23/2019	mg/kg	15	130	<0.5	24	31	<0.087	<5	<2.5
AOC2-6-0.5	1/23/2019	mg/kg	17	120	0.77	21	150	<0.094	<4.9	<2.5
AOC2-6-3.5	1/23/2019	mg/kg	16	120	<0.49	22	94	<0.095	<4.9	<2.4
AOC2-6-4.0	1/23/2019	mg/kg	19	180	3.4	25	1600	<0.09	<4,9	<2.5
AOC2-7-0.5	1/24/2019	mg/kg	14	110	<0.49	19	150	<0.099	<4.9	<2.5
AOC2-7-2	1/24/2019	mg/kg	9.1	62	<0.49	14	46	<0.095	<4.9	<2.4
AOC2-8-0.5	1/23/2019	mg/kg	16	62	<0.49	9.1	38	<0.099	<4.9	<2.5
AOC2-8-3.5	1/23/2019	mg/kg	13	120	<0.49	20	14	<0.095	<4.9	<2.5
AOC3A-2-0.5	1/22/2019	mg/kg	13	110	<0.49	19	70	<0.088	<4.9	<2.4
AOC3A-3-0.5	1/22/2019	mg/kg	17	120	<0.49	16	130	<0.086	<4.9	<2,5
AOC3A-4-1	1/22/2019	mg/kg	23	310	3	29	1800	0.26	<4.9	<2.4
AOC3A-4-4	1/22/2019	mg/kg	16	170	1.2	25	370	<0.098	<4.9	<2.4
AOC3A-5-0.5	1/22/2019	mg/kg	18	200	1.4	25	⁻ 680	0.22	<4.9	<2.5
AOC3A-5-2	1/22/2019	mg/kg	19	220	1.7	26	930	0.15	<4.9	<2.5
AOC3A-6-0.5	1/22/2019	mg/kg	15	140	<0.49	21	47	<0.092	<4.9	<2.5
AOC3A-7-0.5	1/22/2019	mg/kg	14	160	0.66	24	280	<0.089	<5	<2.5
AOC3A-8-0.5	1/22/2019	mg/kg	17	190	1.5	26	540	0.18	<5	<2.5
AOC3B-1-0.5	1/21/2019	mg/Kg	14	130	<0.49	21	61	<0.088	<4.9	<2.5
AOC3B-2-0.5	1/21/2019	mg/Kg	14	180	1.3	18	640	0.18	<4.9	<2.5
AOC3B-2-1	1/21/2019	mg/kg	19	230	1.6	24	820	0.12	<4.9	<2.4
Non Residentia	al SRL		10	170,000	510	65	80 0	310	5,100	5,100

Page 1 of 2

Table 1: Summary of Total Metals in Soil - Adair Memorial Park

Sample Name	Date	Unit	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
AOC3B-3-0.5	1/21/2019	mg/Kg	16	190	1.8	23	570	<0.087	<5	<2.5
AOC3B-3-1	1/21/2019	mg/Kg	15	150	0.54	24	770	<0.095	<4.9	<2.5
AOC3B-4-0.5	1/21/2019	mg/Kg	15	120	<0.49	20	200	<0.096	<4.9	<2.5
AOC3B-5-0.5	1/21/2019	mg/Kg	11	110	0.52	13	230	<0.092	<4.9	<2.5
AOC3B-6-0.5	1/21/2019	mg/Kg	13	120	1.1	18	750	<0.092	<4.9	<2.4
AOC3B-6-4	1/21/2019	mg/Kg	8	120	<0.49	18	17	<0.091	<4.9	<2.5
AOC3B-7-0.5	1/21/2019	mg/Kg	12	130	<0.49	21	120	<0.1	<4.9	<2.4
AOC3B-7-1	1/21/2019	mg/kg	18	150	<0.5	26	200	<0.091	<5	<2.5
AOC3B-8-0.5	1/21/2019	mg/Kg	19	210	1.1	25	820	0.097	<4.9	<2.5
AOC3B-8-2	1/21/2019	mg/kg	8.5	120	<0.49	23	15	<0.098	<4.9	<2.4
AOC3C-15	1/23/2019	mg/kg	18	160	1.3	24	660	<0.094	<4.9	<2,5
AOC3C-1-3.5	1/23/2019	mg/kg	18	190	1.3	24	470	<0.09	<4.9	<2.4
AOC3C-2-0.5	1/23/2019	mg/kg	150	1700	.<4.9	240	580	<0.098	<49	<24
AOC3C-2-0.5	3/8/2019	mg/Kg	14	140	<0.49	20	56		<4.9	<2.5
AOC3C-2-0.5-D	3/8/2019	mg/Kg	14	140	<0.49	20	56		<4.9	<2.5
AOC3C-3-0.5	1/23/2019	mg/kg	18	140	0.78	24	230	<0.1	<4.9	<2.5
AOC3C-4-0.5	1/23/2019	mg/kg	19	150	<0.5	24	29	<0.096	<5	<2.5
AOC3C-5-0.5	1/23/2019	mg/kg	17	140	<0.49	26	120	<0.098	<4.9	<2.5
AOC3C-6-0.5	1/23/2019	mg/kg	20	180	2.1	25	1000	<0.093	<5	<2.5
AOC3C-6-1.0	1/23/2019	mg/kg	12	140	<0.49	26	450	<0.095	<4.9	<2.4
AOC3C-7-0.5	1/22/2019	mg/kg	15	110	<0.49	20	26	<0.087	<4.9	<2.4
AOC3C-8-0.5	1/22/2019	mg/kg	13	130	1,8	22	140		<4.9	<2.5

Note: mg/kg - milligram per kilogram

Non Residential SRL

10 170,000

510

65

800

310

5,100 Page 2 of 2

5,100

 Table 2: 'Calculations of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas

 U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

 Adair Memorial Archery Park

Variable	Description of Variable		GSDI and PbBo from Analysis of NHANES 2009-2014
PbB _{fetal} , 0.95	Target PbB in fetus (e.g., 2-8 µg/dL)	µg/dL	5
R _{fetal/maternal}	Fetal/maternal PbB ratio		0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD _i	Geometric standard deviation PbB		1.8
PbBo	Baseline PbB	µg/dL	0.6
IRs	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
AF _{s, D}	Absorption fraction (same for soil and dust)	·	0.12
EF _{s, D}	Exposure frequency (same for soil and dust)	days/yr	45
AT _{s, d}	Averaging time (same for soil and dust)	days/yr	365
· · · · · · · · · · · · · · · · · · ·	5% probability that fetal PbB exceeds target PbB	ppm (mg/kg)	2,556

Note: all input parameters are Model defaults with the exception of the Exposure frequency and Soil ingestion rate; see text for discussion.

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FIGURES

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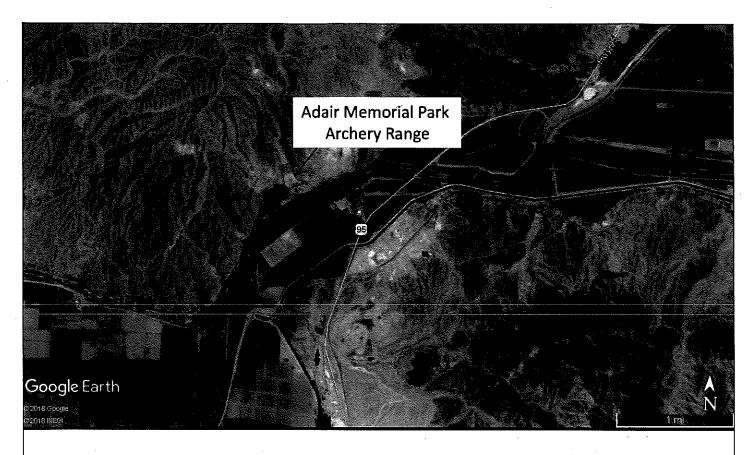
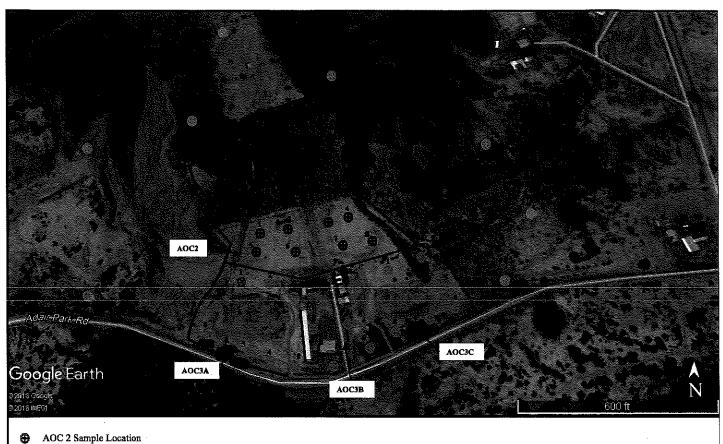


Figure 1 Site Location Map

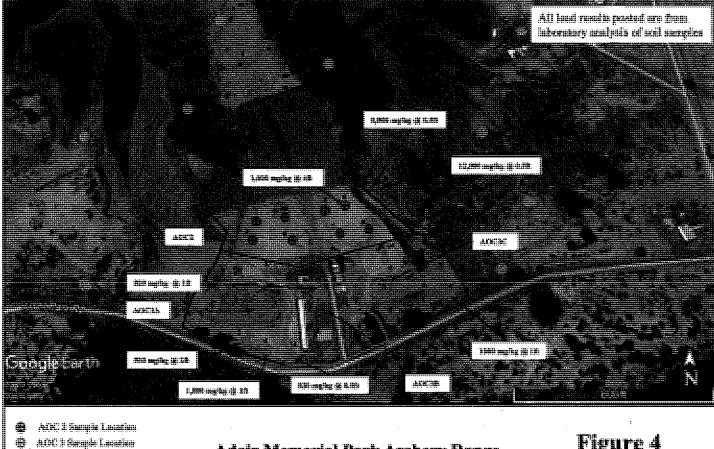
Capped Arm AOC 1 ACC 2 ACC 3C ACC 3A **gogle** Færth بيدية. منطقة AOC 38 Adair Memorial Park Archery Range

Figure 2 Site Map



- AOC 3 Sample Location
- Temporary Well and Soil Sample Location
- Background Sample Location
- XRF Reading From Tailings Pile

Figure 3 Sample Location Map



- Transportary Well and Soli Banglin Loonitora
- 📋 Euligeward Hangdis Counties
- 🛊 XIII Leading Press Tailings Pile

Figure 4 Lead Distribution Map .

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APPENDIX A

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7	A	в	C	D	E UCL Statist	F Ics for Unc	G ensored	Full D	H Jata Sets	 	 J	 ĸ		L
2								•	•		 	 		
3		User Selected												
4	Date	Time of Comp	itation	ProUCL 5.1	12/8/2019 2:	04:50 PM					 			
5		Fro	m File	NorkSheet.	xls					 				
6		Full Pre	cision	OFF										
7	C	Confidence Coe	ficient	95%										
8	Number of	Bootstrap Oper	ations	2008						 	 			
													•	

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	A	В	C	D	E	F	G H I J K I	L
9	ļ							
10	AOC2 0.5 ft	bas Ph						
11 12								
13						General	Statistics	
14			Total I	Number of C	Observations	9	Number of Distinct Observations	7
15							Number of Missing Observations	2 .
16					Minimum	34	Mean	124.2
17					Maximum	370	- Median	100
18					SD	103.7	Std. Error of Mean	34.58
19	ľ			Coefficien	t of Variation	0.835	Skøwness	1.877
20								
21							collected using ISM approach, you should use	
22		1					A (TRC, 2012) to compute statistics of interest.	
23							they UCL to estimate EPC (ITRC, 2012).	
24			Сперувлем С	UGL can be	computed u	Ing the Non	parametric and All UCL Options of ProUCL 5.1	
25	<u> </u>					Normal C	20E Last	
26			Sł	hapiro Wilk)	Test Statistic		Shapiro Wilk GOF Test	
27					Critical Value		Data Not Normal at 5% Significance Level	
28 29				,	Test Statistic	1	Lilliefors GOF Teat	
30			59	% Lilliefors (Critical Value	0.274	Data Not Normal at 5% Significance Level	
31					Data No	Normal at 5	% Significance Level	•
32	+							
33	1				As	suming Norr	mai Distribution	
34	 		95% No	mal UCL			95% UCLs (Adjusted for Skewness)	
35				95% Str	udent's-t UCl	188.5	95% Adjusted-CLT UCL (Chen-1995)	204.2
36							95% Modified-t UCL (Johnson-1978)	192.1
37]							
38	<u> </u>						GOF Test	
39	 		<u> </u>		Test Statistic	1	Anderson-Darling Gamma GOF Text	
40					Critical Value		Detected data appear Gamma Distributed at 5% Significand	ce Level
41					Test Statistic		Kolmogorov-Smirnov Gamma GOF Test	
42					Critical Value		Detected data appear Gamma Distributed at 5% Significance	ce Levei
43	ļ			Detected	cata appea	Gamma Da	aributed at 5% Significance Lavel	
44					· · · ·	Commo	Statistica	
45					k hat (MLE		k star (bias corrected MLE)	1.422
46	-			The	eta hat (MLE	·	Theta star (bias corrected MLE)	87.33
47					nu hat (MLE	·	nu star (bias corrected)	25.6
48	+				las corrected		MLE Sd (bias corrected)	104.2
49	-			,		1	Approximate Chi Square Value (0.05)	15.07
50 51			Adjus	sted Level o	f Significano	e 0.0231	Adjusted Chi Square Valua	13.4
52						1		-
53	1				A	suming Gan	nna Distribution	
54	1	95% Approx	dmate Gemm	ia UCL (use	when n>=50	211	95% Adjusted Gamma UCL (use when n<50)	237.4
55								
56							a) GOF Test	
57					Test Statisti		Shapiro Wilk Lognormal GOF Test	
58			5% S		Critical Valu		Data appear Lognormal at 5% Significance Level	
59	· · · ·		é		Test Statisti		Liliafors Lognormal GOF Test	
60				5% Lillejois	Critical Valu		Data appear Lognormal at 5% Significance Level at 5% Significance Level	
61					Dani abbee	Cognormal		
62					• •	Lognorm	al Statistics	
63 64				Minimum of	f Logged Dat	a 3.526	Mean of logged Data	4.555
65 65					f Logged Dat		SD of logged Data	0.769
66	-						· · · · ·	
67					As	suming Logn	ormal Distribution	
-68					95% H-UC		90% Chebyshev (MVUE) UCL	219.9
69					(MVUE) UC		97.5% Chebyshev (MVUE) UCL	324.9
70			99%	Chebyshev	(MVUE) UC	L 444.7	•	
71								
72							rtion Free UCL Statistics	
73				Data appea	ar to follow a	uiscemibie	Distribution at 5% Significance Level	
74					B1.			
75					Nonp 95% CLT UC		stribution Free UCLs 95% Jackknife UCL	188,5
76			0514		Bootstrap UC		95% Boctstrap-t UCL	232.2
\overline{n}					Bootstrap UC		95% Percentile Bootstrap UCL	
78					Bootstrap UC	1		
79					Aean, Sd) U		95% Chebyshev(Mean, Sd) UCL	275
80					Aean, Sd) U(99% Chabyshev(Mean, Sd) UCL	
81				,	,, _,			1
82 83						Suggeste	d UCL to Use	
83			95	5% Adjusted	d Gamma UC			
1 04						_1		ł
97		Note: Sugg	jəstions regar	ding the se	lection of a 9	5% UCL are	provided to help the user to select the most appropriate 95% UC	CL.
85	5 1							
86				Recommen	dations are I	based upon c	data size, data distribution, and skewness.	
	7		commendation	ns are based	d upon the re	sults of the t	simulation studies summarized in Singh, Maichle, and Lee (2006	
86 87	7		commendation	ns are based	d upon the re	sults of the t		

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-	A B C D E	F	G H J K	<u>.</u>	
91 02 Af	OC2 0.5-1 ft bgs Pb				
<u>52</u>					
93 94		General	Statistics		
95	Total Number of Observations	10	Number of Distinct Observations 8		•
96			Number of Missing Observations 1		
97	Minimum		Mean 157 Median 125		
98	Maximum	460		5.65	
99	SD Coefficient of Variation	144.4 0.915		1.46	
100		0.010			
101		Normal C	SOF Test		
102 103	Shapiro Wilk Test Statistic	0.792	Shapiro Wilk GOF Test		
104	5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level		
105	Lilliefors Test Statistic	0.322	Lillefors GOF Test		,
106	5% Lillefors Critical Value	0.262	Data Not Normal at 5% Significance Level		
107	Date Not	Normel at 5	% Significance Level		
108	A	rimine Nee	nal Distribution		
109	95% Normal UCL	solang Not	95% UCLs (Adjusted for Skewness)		· ·
110	95% Student's-t UCL	241.5	95% Adjusted-CLT UCL (Chen-1995) 255	5,4	
111			95% Modified-t UCL (Johnson-1978) 245		
<u>112</u> 113			· · · · · · · · · · · · · · · · · · ·		
114			GOF Test		
115	A-D Test Statistic		Anderson-Darling Gemme GOF Test		
116	5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Lo	evel	
117	K-S Test Statistic		Koknogorov-Smirnov Gamma GOF Test Detected data appear Gamma Distributed at 5% Significance Lu	ສາໜ	
118	5% K-S Critical Value	1	tributed at 5% Significance Level		
119					
120		Garama	Statistics		
121 122	k hat (MLE)	1.58	k star (blas corrected MLE) 1	1,172	· · · ·
123	Theta hat (MLE)	99.89	Theta star (bias corrected MLE) 13	34.6	
124	nu hat (MLE)	31,59		23.45	
125	MLE Mean (bias corrected) 157.8		45.7	
126				13.43 12.13	
127	Adjusted Level of Significance	0,0267	Adjusted Chi Square Value 1:		
128	A-	sumbar Gan	me Distribution		
129	95% Approximate Gamma UCL (use when n>=50		95% Adjusted Gamma UCL (use when n<50) 30	05	
130 131		1			
132		Lognarme	I GOF Test		·
133	Shapiro Wilk Test Statistic		Shapiro Wik Lognomal GOF Test		
134	5% Shapiro Wilk Critical Value	1	Data appear Lognormal at 5% Significance Level		
135	Lilliefors Test Statistic		Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level		
136	5% Lilliefors Critical Value		at 5% Significance Level		
137		r Loginormai			
138		Lognom	al Statistics		
139 140	Minimum of Logged Data			4.713	
141	Maximum of Logged Date	a 6.131	SD of logged Data	0.88	
142					
143			ormet Distribution		
144	95% H-UC 95% Chebyshev (MVUE) UC		90% Chebyshev (MVUE) UCL 29 97.5% Chebyshev (MVUE) UCL 43		
145	95% Chebyshev (MVUE) UC 99% Chebyshev (MVUE) UC				
146					
147	Nonparam	etric Olstribu	tion Free UCL Statistica		
<u>148</u> 149	Data appear to follow a	Discemible	Distribution at 5% Significance Level		
150					
151			stribution Free UCLs		
152	95% CLT UC			41.5	
153	95% Standard Bootstrap UC			65.8 33.6	
154	95% Hall's Bootstrap UC 95% BCA Bootstrap UC		95% Ferdentile Doolaarap OCL 22		
155	95% BCA Boolstrap UC 90% Chebyshev(Mean, 8d) UC		95% Chebyshev(Mean, Sd) UCL 38	356.8	4
156	97.5% Chebyshev(Mean, Sd) UC			512	
157 158		1			- -
158 159	· · · · · · · · · · · · · · · · · · ·	Suggeste	d UCL to Use		
160	95% Adjusted Gamma UC	L 305			
161					4
162			provided to help the user to select the most appropriate 95% UCL.		
163			late size, date distribution, and skewness.		
164	These recommendations are based upon the re	Suits of the s	imulation studies summarized in Singh, Maichle, and Lee (2006). sets; for additional insight the user πιαγ want to consult a statistician.	1.	
165	HOWEVER, SIMULATIONS LESTING ANY LOC COVER SHI KESS		eew, rei staaligstigt insignt are door ittigt want to oprise it abatabilitit.		4
166					

167 168 Ac 169	OC3a U.5 ft bgs Pb Total Number of Observations Minimum	General S	Statistics	
163 169 170 171 172 173 174 175 176 177 178 179 180 181 182	Total Number of Observations		Statistics	
170 171 172 173 174 175 176 177 178 179 180 181 182			Statistics	
171 172 173 174 175 176 177 178 179 180 181 182			Statistics	
172 173 174 175 176 177 178 179 180 181 182		6		
173 174 175 176 177 178 179 180 181 182	Minimum	-	Number of Distinct Observations	6
174 175 176 177 178 179 180 180 181 182	Minimum		Number of Missing Observations	2
175 176 177 178 179 180 181 181 182		47	Mean	291.2
176 177 178 179 180 180 181 182	Maximum	680	Median	205
176 177 178 179 180 180 181 182	SD	263,7	Std. Error of Mean	107.7
177 178 179 180 181 182	Coefficient of Variation	0.906	Skewness	0.73
178 179 180 181 182			· · · · · · · · · · · · · · · · · · ·	
179 180 181 182	Note: Sample alze is small (e.g., <10).	lf data are d	collected using ISM approach, you should use	
180 181 182			(ITRC, 2012) to compute statistics of interest.	
181 182			hey UCL to estimate EPC (ITRC, 2012).	
182		-	parametric and All UCL Options of ProUCL 5.1	
183		Normal G	CE Test	
	Shapiro Wilk Test Statistic	0.877	Shapiro Wilk GOF Test	
184	5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level	
185	-	0.229		
186	Lilliefors Test Statistic		Lillefore GOF Test	
187	5% Lilliafors Critical Value	0.325	Data appear Normal at 5% Significance Level	
188	Deta appea	ir Normal at	5% Significance Lave	
189			· · · · · · · · · · · · · · · · · · ·	
190		suming Nom	nal Distribution	
191	95% Normal UCL		\$5% UCLs (Adjusted for Skewness)	
192	95% Student's-t UCL	508.1	95% Adjusted-CLT UCL (Chen-1995)	502.5
193			95% Modified-t UCL (Johnson-1978)	513.5
194			·	
195		Gamma (GOF Test	
196	A-D Test Statistic	0.297	Anderson-Darling Gamma GOF Test	
196	5% A-D Critical Value	0.711	Detected data appear Gamma Distributed at 5% Significan	ca Lavel
	K-S Test Statistic		Kolmogorov-Smimov Gamma GOF Test	
198	5% K-S Critical Value		Detected data appear Gamma Distributed at 5% Significan	ce Level
199			tributed at 5% Significance Level	
200				
201		Gamma	Statistica	
202	L 1			0.752
203	k hat (MLE)		k star (bias corracted MLE)	387.1
204	Theta hat (MLE)	227,1	Theta star (bias corrected MLE)	
205	nu hat (MLE)	15,39	nu star (bias corrected)	9.027
206	MLE Mean (bias corrected)	291.2	MLE Sd (bias corrected)	335,7
207	,		Approximate Chi Square Value (0.05)	3.343
208	Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	2.223
209			······································	
210	Ası	suming Gam	ana Distribution	
211	95% Approximate Gamma UCL (use when n>=50))	786.2	95% Adjusted Gamma UCL (use when n<50)	1182
212	·····			
213		Lognoma	I GOF Test	
214	Shapiro Wilk Test Statistic	0.934	Shapiro Wilk Lognormai GOF Test	• •
215	5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level	
216	Lilliefors Test Statistic	0.167	Lillefors Lognormal GOF Test	
217	5% Lilliefors Critical Value	0,325	Data appear Lognormal at 5% Significance Level	
218	Deta appear	Lognormei	et 5% Significance Level	
219		•		
219		Lognom	al Statistics	
	Minimum of Logged Data	3.85	Mean of logged Data	5.236
221	Maximum of Logged Data		SD of logged Data	1.092
222				I
223	Δου	umina Loona	ormal Distribution	
224	95% H-UCL		90% Chebyshev (MVUE) UCL	690.6
225	95% Chebyshev (MVUE) UCI		97.5% Chebyshev (MVUE) UCL	
226	99% Chebyshev (MVUE) UCI	1		
227		1	1	I
228	۵۱	the Distance	tion Free UCL Statistics	
229				
230	uata appear to follow a l	JISCONIDIO L	Distribution at 5% Significance Level	
231			Huden Fred IOLA	
232			tribution Free UCLs	Fran :
233	95% CLT UCI	1	95% Jackknife UCL	1
234	95% Standard Bootstrap UC	1	95% Bootstrap-t UCL	1
235	95% Hall's Bootstrap UC	1	95% Percentile Bootstrap UCL	461.2
236	95% BCA Bootstrap UCI			
237	90% Chebyshev(Mean, Sd) UC		95% Chebyshev(Mean, Sd) UCL	
238	97.5% Chebyshev{Mean, Sd} UC	963,5	99% Chebyshev(Mean, Sd) UCL	1362
239	······································			
240		Suggester	I UCL to Use	
241	95% Student's-t UC	L 508.1		1
242				
242	Note: Suggestions regarding the selection of a 95	% UCL are i	provided to help the user to select the most appropriate 95% U	CL.
			ata size, data distribution, and skewness,	
244			mulation studies summarized in Singh, Maichle, and Lee (2006	ŝ).
245			ets; for additional insight the user may want to consult a statisti	
246				
247				

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	A B C D E	F	G H K	L
248	AOC3e 0.5-1 ft bgs PB			
140				
250		General	Statistics	
251	Total Number of Observations	7	Number of Distinct Observations	7
252	i utai iyünidet di OcselyaBolis	,	Number of Distinct Observations	1
253	Minimum	47	Number of Missing Observations Mean	506.7
254	Maximum	47	Median	280
255	Maximum SD	1800	Median Std, Error of Mean	280
256		1,222	Sid, Error or Mean Skewness	1,892
257	Coefficient of Variation	1.222	Jrewness	*****
258	Notes Councils also is small in	lf data	collected using ISM approach, you should use	
259			a (ITRC, 2012) to compute statistics of interest.	
260			hev UCL to estimate EPC (ITRC, 2012).	
261			parametric and All UCL Options of ProUCL 5.1	
262	Chiptysher OCL can be computed of			
263		Normal 0	IDE Test	
264	Shapiro Wilk Test Statistic	0.775	Shapiro Wilk GOF Test	
265	5% Shapiro Wilk Critical Value	0.803	Data Not Normal at 5% Significance Level	
266	Lillefors Test Statistic	0.803	Lillefore GOF Test	
267	5% Lillefors Critical Value	0.304	Data appear Normal at 5% Significance Level	
268			mal at 5% Significance Level	
269				
270	<u>Ан-</u>	umine Nor	nal Distribution	
271	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
272	95% Student's-t UCL	961,4	95% Adjusted-CLT UCL (Chen-1995)	1070
273	20 2 Guiden S-CUGE		95% Modified-t UCL (Johnson-1978)	989.2
274		L		
275		Gamme	30F Test	
276	A-D Test Statistic	0,25	Anderson-Darting Gamma GOF Test	
277	5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significant	ce Level
278	K-S Test Statistic	0,132	Kolmogorov-Smimov Gamma GOF Test	
279	5% K-S Critical Value	0,321	Detected data appear Gamma Distributed at 5% Significan	ce Level
280			ributed at 5% Significance Level	
281	-			
282	-	Gamma	Statistica	
283	k hat (MLE)		k star (bias corrected MLE)	0.596
284	Theta hat (MLE)	578.2	Theta star (bias corrected MLE)	850.2
285	nu hat (MLE)	12.27	nu star (bias corrected)	8.344
286	MLE Mean (bias corrected)		MLE Sd (bias corrected)	656.4
287		I	Approximate Chi Square Value (0.05)	2.936
288 289	Adjusted Level of Significance	0.0158	Adjusted Chi Square Value	2.058
∠ 89	,			
000			4	
290	As:	suming Gam	ma Distribution	
291	As 95% Approximate Gamma UCL (use when n>=50)	_	ima Distribution 95% Adjusted Gamma UCL (use when n<50)	2055
291 292		_		
291 292 293		1440		
291 292 293 294	95% Approximate Gamma UCL (use when n>=50)	1440 Lognorma	95% Adjusted Gamma UCL (use when n<50)	
291 292 293	95% Approximate Gamma UCL (use when n>=50)	1440 Lognorma	95% Adjusted Gamma UCL (use when n<50) IGOF Teat	
291 292 293 294 295	95% Approximate Gamma UCL (use when n>≃50) Shapiro Wilk Test Statistic	1440 Lognorma 0.967	95% Adjusted Gamma UCL (use when n<50) I GOF Test Shapiro Wilk Lognormal GOF Test	
291 292 293 294 295 296 297	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Littlefors Test Statistic 5% Littlefors Critical Value	Lognorma 0.967 0.803 0.14 0.304	95% Adjusted Gamma UCL (use when n<50) I GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefore Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level	
291 292 293 294 295 296	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Littlefors Test Statistic 5% Littlefors Critical Value	Lognorma 0.967 0.803 0.14 0.304	95% Adjusted Gamma UCL (use when n<50) IGOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal GOF Test	
291 292 293 294 295 296 296 297 298	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Littlefors Test Statistic 5% Littlefors Critical Value	Lognorma 0.967 0.803 0.14 0.304 Lognormal	95% Adjusted Gamma UCL (use when n<50) I GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level at 5% Significance Level	
291 292 293 294 295 296 297 298 299	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Littlefors Test Statistic 5% Littlefors Critical Value	Lognorma 0.967 0.803 0.14 0.304 Lognormal	95% Adjusted Gamma UCL (use when n<50) I GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefore Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level	
291 292 293 294 295 296 297 298 299 300	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Littlefors Test Statistic 5% Littlefors Critical Value	Lognorma 0.967 0.803 0.14 0.304 Lognorma 3.85	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Utiliefore Lognormal at 5% Significance Level at 5% Significance Level Statistics Mean of logged Data	2055
291 292 293 294 295 296 297 298 299 300 301	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Littlefors Test Statistic 5% Littlefors Critical Value Data appear	Lognorma 0.967 0.803 0.14 0.304 Lognorma Lognorma 3.85	95% Adjusted Gamma UCL (use when n<50) I GOF Test Data appear Lognormal GOF Test Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level I Statistics	2055
291 292 293 294 295 296 297 298 299 300 301 302	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data	1440 Lognorma 0.967 0.803 0.14 0.304 Lognorma 3.85 7.496	95% Adjusted Gamma UCL (use when n<50) GOF Test Control Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilllefors Lognormal at 5% Significance Level at 5% Significance Level Statistics SD of logged Data SD of logged Data	2055
291 292 293 294 295 296 297 298 299 300 301 302 303	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data	1440 Lognorma 0.967 0.803 0.14 0.304 Lognorma 3.85 7.496 rming Logno	95% Adjusted Gamma UCL (use when n<50) I GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillidors Lognormal at 5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data mmal Distribution	2055 5,559 1.312
291 292 293 294 295 296 297 298 299 300 301 302 303 304	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Deta appear Minimum of Logged Data Maximum of Logged Data S5% H-UCL	1440 Lognorma 0.967 0.803 0.14 0.304 Lognorma Lognorma 3.85 7.496 sming Logna 7270	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level Statistics Mean of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL	2055 5,559 1.312 1268
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Deta appear Minimum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebyshev (MVUE) UCL	1440 Lognorma 0.967 0.803 0.14 0.304 Lognorma 3.85 7.496 ming Lognor 7270 1610	95% Adjusted Gamma UCL (use when n<50) I GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillidors Lognormal at 5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data mmal Distribution	2055 5,559 1.312
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Deta appear Minimum of Logged Data Maximum of Logged Data S5% H-UCL	1440 Lognorma 0.967 0.803 0.14 0.304 Lognorma 3.85 7.496 ming Lognor 7270 1610	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level Statistics Mean of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL	2055 5,559 1.312 1268
291 292 293 294 295 296 297 298 299 300 301 302 300 301 302 303 304 305 306 307	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Deta appear Minimum of Logged Data Maximum of Logged Data St& H-UCL 95% Chebyshev (MVUE) UCL	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 ming Lognor 7.270 1610 3018	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level So Significance Level So Significance Level So So of logged Data So S	2055 5,559 1.312 1268
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebysher (MVUE) UCL 99% Chebysher (MVUE) UCL 99% Chebysher (MVUE) UCL	1440 Lognorms 0,967 0,803 0,14 Lognorms Lognorms 3,85 7,496 ming Logne 7270 1610 3018	95% Adjusted Gamma UCL (use when n<50) I GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Uillefors Lognormal at 5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL	2055 5,559 1.312 1268
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebysher (MVUE) UCL 99% Chebysher (MVUE) UCL 99% Chebysher (MVUE) UCL	1440 Lognorms 0,967 0,803 0,14 Lognorms Lognorms 3,85 7,496 ming Logne 7270 1610 3018	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level So Significance Level So Significance Level So So of logged Data So S	2055 5,559 1.312 1268
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL Nonpareme	1440 Lognorms 0.967 0.803 0.14 Lognorms 3.85 7.496 Jming Lognor 7270 1610 3018 Mric Distribut Discomible D	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level Statistics Mean of logged Data SD of logged Data	2055 5,559 1.312 1268
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilletors Test Statistic 5% Lilletors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL Nonpareme Data appear to follow a L	1440 Lognorms 0.967 0.803 0.14 Lognorms 3.85 7.496 3.85 7.496 3.018 7270 1610 3018 mic Distribut Scemible E	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level SD of logged Data	2055 5,559 1.312 1268 2085
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Deta appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL Nonpereme Data appear to follow a I Nonpe	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 rming Lognorms 7270 1610 3018 rric Distribut Discernible D rametric Distribut 891.6	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level at 5% Significance Level SD of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 10n Free UCL Statistics Instribution at 5% Significance Level bribution Free UCLs 95% Jackknife UCL	2055 5,559 1.312 1268 2085 961.4
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MUE) UCL 95% Chebyshev (MUE) UCL 95% Chebyshev (MUE) UCL 95% Chebyshev (MUE) UCL 1000000000000000000000000000000000000	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 rming Lognor 7270 1610 3018 mirc Distribut Discomble I emetic Distribut 891.6 867.3	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level SD of logged Data SD of logg	2055 5,559 1.312 1268 2085 2085 961.4 1570
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MVUE) UCL 000000000000000000000000000000000000	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 1 Lognorms 3.85 7.496 ming Logne 7270 1610 3018 mic Distribu Discernible I reametric Dis 891.6 867.3 2285	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level at 5% Significance Level SD of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 10n Free UCL Statistics Instribution at 5% Significance Level bribution Free UCLs 95% Jackknife UCL	2055 5,559 1.312 1268 2085 961.4
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Deta appear Minimum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 ming Lognor 7270 1610 3018 stric Distribut Reserved to Distribut 891.6 867.3 2285 1004	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal at 5% Significance Level d Statistics Mean of logged Data SD of logged Dat	2055 5.559 1.312 1268 2085 961.4 1570 912.4
291 292 293 294 295 296 297 298 299 300 301 302 303 304 306 307 308 309 310 311 312 313 314 315 316	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Standard Bootstrap UCI 95% Standard Bootstrap UCI 95% BCA Bootstrap UCI	1440 Lognorms 0.967 0.803 0.14 Lognorms 3.85 7.496 ming Logna 7270 1610 3018 ming Logna 7270 1610 3018 ming Logna 7270 1610 3018 ming Logna 7270 1610 3018 7270 1610 3018	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level Statistics Mean of logged Data SD of logged Data	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 306 307 308 309 310 311 312 313 314 315 316 317	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MUE) UCL 95% Lillefor T UCL 95% LT UCL 95% ECA Bootstrap UCL 95% BCA Boo	1440 Lognorms 0.967 0.803 0.14 Lognorms 3.85 7.496 ming Logna 7270 1610 3018 ming Logna 7270 1610 3018 ming Logna 7270 1610 3018 ming Logna 7270 1610 3018 7270 1610 3018	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal at 5% Significance Level d Statistics Mean of logged Data SD of logged Dat	2055 5,559 1.312 1268 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 298 299 300 301 302 303 304 303 304 305 306 307 308 309 310 311 313 313 314 315 316 317 318	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Standard Bootstrap UCI 95% Standard Bootstrap UCI 95% BCA Bootstrap UCI	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 iming Lognorms 7270 1610 3018 tric Distribut Bacemible D rametric Distribut 891.6 867.3 2285 1004 1209 1968	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level SD of logged Data SD of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Bootstrap-t UCL 95% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL 97% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Standard Bootstrap UCI 95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 ming Lognorms 7270 1610 3018 mic Distribut Discemble I 891.6 867.3 2285 1004 1209 1988 Suggested	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level Statistics Mean of logged Data SD of logged Data	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 298 299 300 301 302 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 316 316 317 318 319 319 319 310 311 312 313 319 310 311 312 313 314 315 316 317 318 319 310 311 312 316 317 318 319 310 311 312 312 312 312 312 312 312 312 312	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Chebyshev (MVUE) UCI 95% Standard Bootstrap UCI 95% Standard Bootstrap UCI 95% BCA Bootstrap UCI	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 ming Lognorms 7270 1610 3018 mic Distribut Discemble I 891.6 867.3 2285 1004 1209 1988 Suggested	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level SD of logged Data SD of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Bootstrap-t UCL 95% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL 97% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 297 298 299 300 301 302 303 300 300 300 300 300 300 300 300	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev (Mean, Sd) UCL 97.5% Chebyshev (Mean, Sd) UCL	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 Iming Lognorms 7270 1610 3018 stric Distribut Restric Distribut 2285 1004 1209 1968 Suggested 961.4	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal at 5% Significance Level d Statistics d Statistics d Statistics SD of logged Data SD of logg	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 297 298 300 301 302 303 300 301 302 303 306 307 308 309 310 311 313 314 315 316 317 318 319 311 312 313 314 315 316 317 318 319 320 321 321 321 321 321 321 321 321 321 321	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev (Mean, Sd) UCL 97.5% Chebyshev (Mean, Sd) UCL 95% Students-t UCL	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 sming Lognor 7270 1610 3018 stric Distribut Recentible D rametric Distribut 2285 1004 1209 1968 Suggested 961.4	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillidors Lognormal at 5% Significance Level Statistics Mean of logged Data SD of logged Data	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 301 311 312 313 314 315 316 317 318 316 317 318 319 320 321 322 323	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev (Maan, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Students-t UCL 95% Students-t UCL	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 sming Lognor 7270 1610 3018 stric Distribut Recentible D rametric Distribut 2285 1004 1209 1968 Suggested 961.4	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal at 5% Significance Level d Statistics d Statistics d Statistics SD of logged Data SD of logg	2055 2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527
291 292 293 294 295 296 297 298 297 298 297 298 297 298 300 301 302 303 304 305 306 307 308 309 301 311 312 313 314 315 316 317 318 319 320 321 318 319 320 321 319 310 311 312 313 314 315 316 317 318 319 320 321 321 321 321 321 321 321 321 321 321	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Lillefors Critical Value S5% Lillefors Critical Value 0 Data appear 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 95% Chata appear to follow a I Nonpareme Data appear to follow a I 95% Chebyshev (Mean, Sd) UCL 97.5% Chebyshev (Mean, Sd) UCL 95% Student's-t UCL 00% Chebyshev (Mean, Sd) UCL 95% Student's-t UCL 00% Chebyshev (Mean, Sd) UCL 00% Che	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 sming Lognorms 7270 1610 3018 mic Distribut Ecemible I 891.6 867.3 2285 1004 1209 1968 Suggested Stagesd upon	95% Adjusted Gamma UCL (use when n<50) GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level II Statistics I Mean of logged Data SD of logged Data	2055 5,559 1.312 1268 2085 2085 961.4 1570 912.4 1527 2835
291 292 293 294 296 297 298 297 298 299 300 301 303 303 303 303 304 305 303 303 303 304 305 306 307 308 309 310 311 312 313 314 316 317 318 319 320 321 312 313 314 316 317 318 319 320 321 322 323 324 325 326 300 300 301 300 300 300 300 300 300 300	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCI 95% Chebyshev (Mvan, Sd) UCI 95% Chebyshev (Mean, Sd) UCI 95% Student's-t	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 iming Lognorms 7270 1610 3018 tric Distribut Biscemible I 891.6 867.3 2285 1004 1209 1968 Suggested 961.4 ximate (e.g. based upon % UCL are j	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level at 5% Significance Level SD of logged Data SD of logged Data SD of logged Data SD of logged Data smal Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Bootstrap-t UCL 95% Doctstrap-t UCL 95% Doctstrap-t UCL 95% Chebyshev(Mean, Sd) UCL 95% Chebyshev(2055 5,559 1.312 1268 2085 2085 961.4 1570 912.4 1527 2835
291 292 293 294 295 296 297 298 299 300 301 302 303 303 304 305 306 307 303 303 304 305 306 307 303 303 304 305 300 301 303 303 304 305 300 301 303 303 304 305 306 307 303 304 305 306 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 308 307 307 308 307 307 308 307 307 308 307 307 308 307 307 307 307 307 307 307 307 307 307	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebysher (MVUE) UCL 95% Chebysher (MUE) UCL 95% Chebysher (MUE) UCL 95% Standard Bootstrap UCL 95% BCA Bootstrap UCL 95% Chebysher (Mean, Sd) UCL 97.5% Chebysher (Mean, Sd) UCL 95% Student's-t UCL 95% Student's-t UCL 95% Student's-t UCL 1000 000 000 000 000 000 000 000 000 00	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 Iming Lognor 77.496 Into Distribut Parametric Distribut 1610 3018 rametric Distribut 891.6 897.3 2285 1004 1209 1968 Suggested 961.4 % UCL are % UCL are	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal at 5% Significance Level d Statistics Mean of logged Data SD of logged Dat	2055 5.559 1.312 1268 2085 961.4 1570 912.4 1527 2835
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 307 308 309 310 311 312 313 314 315 316 317 318 319 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 327 328 329 300 300 300 300 300 300 300 300 300 30	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% H-UCL 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev (Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL When a data set follows an appro When applicable, it is suggested to use a UCL Note: Suggestions regarding the selection of a 95 Recommendations are based upon the res	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 Iming Lognorms 77.496 Intro Distribut B31.6 867.3 2285 1004 1209 1968 Suggested 961.4 ximate (e.g. based upon d WUCL are j sadd upon d	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal GOF Test Data appear Lognormal at 5% Significance Level d Statistics GMean of logged Data SD	2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527 2835
291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 307 308 309 300 301 307 307 308 309 300 301 311 312 313 314 315 316 317 317 318 319 320 321 322 323 324 325 326 327 328 326 327 328 326 327 328 327 328 326 327 328 329 327 328 327 328 327 328 327 328 327 328 327 328 327 327 328 327 327 328 327 328 327 327 328 327 327 328 327 327 328 327 327 328 327 327 328 327 327 328 327 327 328 327 327 328 327 327 327 327 327 327 327 327 327 327	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebysher (MVUE) UCI 95% Chebysher (MVUE) UCI 99% Chebysher (MVUE) UCI 99% Chebysher (MVUE) UCI 99% Chebysher (MVUE) UCI 95% Standard Bootstrap UCI 95% Standard Bootstrap UCI 95% Standard Bootstrap UCI 95% Chebysher (Mean, Sd) UCI 97.5% Chebysher(Mean, Sd) UCI 97.5% Chebysher(Mean, Sd) UCI 95% Student's-t UCI 95% Student's-t UCI 95% Student's-t UCI	1440 Lognorms 0.967 0.803 0.14 0.304 Lognorms 3.85 7.496 Iming Lognorms 77.496 Intro Distribut B31.6 867.3 2285 1004 1209 1968 Suggested 961.4 ximate (e.g. based upon d WUCL are j sadd upon d	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level UIIIdens Lognormal at 5% Significance Level d Statistics Mean of logged Data SD of logged Dat	2055 5.559 1.312 1268 2085 2085 961.4 1570 912.4 1527 2835

	A B C D E	F	GHIJK	L
332				
333	AOC3b 0.5 ft bgs Pb		•	
334		General S	Netline	
335		·, · · · · · · · · · · · · · · · · · ·	Number of Distinct Observations	8
336	Total Number of Observations	8	Number of Missing Observations	4
337	4 11-1	61	Nean	423,9
338	Minimum		Madian	400
339	Maximum SD		Std. Error of Mean	107.2
340			Skewness	0.107
341	Coefficient of Variation	0,715	Calification	
342	Mate: Consult also is small for a still) If data are a) cilected using ISM approach, you should use	
343			(ITRC, 2012) to compute statistics of interest.	
344			hev UCI, to estimate EPC (ITRC, 2012).	
345		-	parametric and All UCL Options of ProUCL 5.1	
346				
347		Normal G	DE Test	
348	Shapiro Wilk Test Statistic		Shaptro Wilk GOF Test	
349	5% Shapiro Wilk Critical Value		Data appear Normal at 5% Significance Level	
350	Littlefors Test Statistic		Lilllefors GOF Test	
351	5% Lilliefors Critical Value		Data appear Normal at 5% Significance Level	
352			5% Significance Level	
353				
354	A	sauming Nom	nel Distribution	
355	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
356	95% Student's-t UC	L 626.9	95% Adjusted-CLT UCL (Chen-1995)	604.5
357		+	95% Modified-t UCL (Johnson-1978)	627.6
358 359			· · · · · · · · · · · · · · · · · · ·	
359 360		Gamma	GCF Test	
361	A-D Test Statisti		Anderson-Darling Gamma GOF Test	
361	5% A-D Critical Value	- L	Detected data appear Gamma Distributed at 5% Significant	ce Levei
363	K-S Test Statisti	c 0.244	Kolmogorov-Smirnov Gamma GOF Test	
364	5% K-S Critical Valu	a 0.298	Detected data appear Gamma Distributed at 5% Significant	ce Level
365			tributed at 5% Significance Level	
365			······································	
367	-	Gamma	Statistics	
368	k hat (MLE	.) 1.671	k star (bias corrected MLE)	1,128
369	. Theta hat (MLE) 253,6	Theta star (bias corrected MLE)	375,8
370	nu hat (MLE	26,74	nu star (bias corrected)	18.05
371	MLE Mean (bias corrected	d) 423.9	MLE Sd (bias corrected)	399.1
372		I	Approximate Chi Square Value (0.05)	9.426
373	Adjusted Level of Significance	e 0.0195	Adjusted Chi Square Value	7.9
374				
375	A	ssuming Gam	ame Distribution	
376	95% Approximate Gamma UCL (use when n>=50)) 811.6	95% Adjusted Gamma UCL (use when n<50)	968.4
377				
378		Lognomsa	I GOF Test	
379	Shapiro Wilk Test Statist	ic 0.898	Shapiro Wilk Lognormal GOF Test	1
380		1	Data appear Lognormal at 5% Significance Level	
381	Lilliefors Test Statist		Lillefors Lognormal GOF Test	
382	5% Littlefors Critical Valu		Data appear Lognorma) at 5% Significance Level	
383	Data appe	ar Lognormal	at 5% Significance Level	
384				
385		-	al Statistics	5 784
386			Mean of logged Data	5.721
387		ita 6.709	SD of logged Data	0.96
38	h	aundura t	ormal Distribution	
389			90% Chebyshev (MVUE) UCL	916.3
39	OER Chabrishay (10/1/E) 1/		97,5% Chebyshev (MVUE) UCL 97,5% Chebyshev (MVUE) UCL	1421
39	ODR Chabrahau (H)(E)E) [](
392		1390	1	
393	Nonger	neitle Stetel	tion Free UCI. Statistics	
39	Deta annonria fallaria		Distribution at 5% Significance Level	
39				
39	kloor	parametric Div	stribution Free UCLs	
39			95% Jackknife UCL	626.9
39	958, Standard Booktrap I i		95% Bootstrap-t UCL	642.3
39	OFW, Hall's Beststras II		95% Percentile Bootstrap UCL	
40	OF9/ PCA Pentatran Li			
40	1 Chabyahay (Bisaan, Ed) 11		95% Chebyshev(Mean, Sd) UCL	891
40	07.5% Chaburbay/Moon Sdill		99% Chebyshev(Mean, Sd) UCL	
40	2	i	1	l
		Suggeste	d UCL to Use	
40	OFW Children + 11			
:40	<u> </u>			
40	7			N
40	New Suggestions reporting the colortion of a f	95% UCL are	provided to help the user to select the most appropriate 95% UC	-L.
40	8 Note: Suggestions regarding the selection of a S		provided to help the user to select the most appropriate 95% UC late size, data distribution, and skewness.	·L.
40 40	Note: Suggestions regarding the selection of a 5 Recommendations are	based upon o		
40 40 41	Note: Suggestions regarding the selection of a 5 Recommendations are These recommendations are based upon the These recommendations are based upon the	based upon o esults of the s	lata siza, data distribution, and skewness.	i).
40 40	Note: Suggestions regarding the selection of a 5 Recommendations are These recommendations are based upon the r Howaver, simulations results will not cover all Rea	based upon o esults of the s	lata size, data distribution, and skewness. simulation studies summarized in Singh, Maichle, and Lee (2006	i).

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	A B C D E	F	G H I J K	L
\$13				
¥14 ⁴	OC3b 0.5-1 ft bgs Pb			
115				
116		General S		
117	Total Number of Observations	11	Number of Distinct Observations	9
11B			Number of Missing Observations	1
119	Minimum	61		471
\$20	Maximum	820		570
1 21	SD	307.5	Std. Error of Mean	92.71
122	Coefficient of Variation	0.653	Skewness	-0,112
123				
124		Normal G		
125	Shapiro Wilk Test Statistic	0.844	Shapiro Wilk GOF Test	
126	5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level	
127	Lilliefors Test Statistic	0.238	Lillefors GOF Test	
\$28	5% Lillefors Critical Value	0,251	Data appear Normal at 5% Significance Level	
129	Data appear Appro	ximete Non	nal at 5% Significance Level	
130				
131	Ass	uming Norn	nzi Distribution	
132	95% Normal UC1.		95% UCLs (Adjusted for Skewness)	
133	95% Student's-t UCL	639	95% Adjusted-CLT UCL (Chen-1995)	620.1
134			95% Modified-t UCL (Johnson-1978)	638.5 ·
-				
435 436		Gamma (GOF Test	
	A-D Test Statistic	0.743	Anderson-Darling Gemma GOF Test	
<u>437</u>	5% A-D Critical Value	0,74	Data Not Gamma Distributed at 5% Significance Leve	
138	K-S Test Statistic	0.241	Kolmogorov-Smirnov Gamma GOF Test	
<u>439</u>	5% K-S Critical Value	0.259	Detected data appear Gamma Distributed at 5% Significance	e Level
440			Istribution at 5% Significance Level	
441				
442		Gamma	Statistics	
443	k hat (MLE)	1.827	k star (bias corrected MLE)	1,389
444	Theta hat (MLE)	257.8	Theta star (bias corrected MLE)	339.1
445	nu hat (MLE)	40.19	nu star (bias corrected)	30.56
446	MLE Mean (bias corrected)	471	MLE Sd (bias corrected)	399.6
447	MILE MEAN (DIAS CONSCIENT)	471	Approximate Chi Square Value (0.05)	18.93
448		0.0278	Adjusted Chi Square Value	17.46
449	Adjusted Level of Significance	0,0278	Aujusieu (in Square Value	17.40
450	A		Pintin day	
451		_	and Distribution	824.6
452	95% Approximate Gamma UCL (use when n>≈50))	760.2	95% Adjusted Gamma UCL (use when n<50)	024.0
453				
454			GOF Test	
455	Shapire Wilk Test Statistic	0.855	Shepiro Wilk Lognormal GOF Test	
456	5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level	
457	Lilliefors Test Statistic	0.25	Lillefors Lognarmal GOF Test	
458	5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level	
459	Data appear	Lognormal	at 5% Significance Level	
460	·····			
461			Mean of logged Data	5.857
462	Minimum of Logged Data			0.909
463	Maximum of Logged Date	6.709	SD of logged Data	0.808
464				
465			erral Distribution	935.9
466	95% H-UCL	1	90% Chebyshev (MVUE) UCL	
467	95% Chebyshev (MVUE) UCL		97.5% Chebyshev (MVUE) UCL	1410
468	99% Chebyshev (MVUE) UCI	. 1948		
469				
470			tion Free UCL Statistics	
471	Data appear to follow a D	uscemible [Distribution at 5% Significance Level	
472				
473			Induition Free UCLs	600
474	95% CLT UCI		95% Jackknife UCL	639 636.2
	95% Standard Bootstrap UC		95% Bootstrap-t UCL	
475		. 594.1	95% Percentile Bootstrap UCL	612.7
475 476	95% Hall's Bootstrap UC		t	
	95% BCA Bootstrap UCI	614.5		orr +
476	95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC	614.5 749.1	95% Chebyshev(Mean, Sd) UCL	875.1
476 477	95% BCA Bootstrap UCI	614.5 749.1	95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL	875.1 1393
476 477 478	95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC	614.5 749.1 1050	99% Chebyshev(Mean, Sd) UCL	
476 477 478 479	95% BCA Boctstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI	614.5 749.1 1050 Suggester		
476 477 478 479 480	95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC	614.5 749.1 1050 Suggester	99% Chebyshev(Mean, Sd) UCL	
476 477 478 479 480 481	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 97.5% Students-t UCI 95% Students-t UCI	614.5 749.1 1050 Suggester 639	99% Chebyshev(Mean, Sd) UCL I UCL to Use	
476 477 478 479 480 481 482	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 95% Student's-t UCI 95% Student's-t UCI When a data set follows an eppro	614.5 749.1 1050 Suggested 639 ximate (e.g.	99% Chebyshev(Mean, Sd) UCL I UCL to Use , normai) distribution passing one of the GOF test .	
476 477 478 479 480 481 482 483 484	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 95% Student's-t UCI 95% Student's-t UCI When a data set follows an eppro	614.5 749.1 1050 Suggested 639 ximate (e.g.	99% Chebyshev(Mean, Sd) UCL I UCL to Use	
476 477 478 479 480 481 482 483 484 485	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 95% Student's-t UCI 95% Student's-t UCI When a data set follows an appro When applicable, it is suggested to use a UCL	614.5 749.1 1050 Suggester 639 ximate (e.g. based upon	99% Chebyshev(Mean, Sd) UCL I UCL to Use , normai) distribution passing one of the GOF test . a distribution (e.g., gamma) passing both GOF tests in ProUCL	1393
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476 477 478 479 480 481 482 483 484 485 486 485 486 487	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 95% Student's-t UCI 95% Student's-t UCI When a data set follows an appro When applicable, it is suggested to use a UCL Note: Suggestions regarding the selection of a 95 Recommendations are bi	614.5 749.1 1050 Suggester 639 ximate (e.g. based upon % UCL are ased upon d	99% Chebyshev(Mean, Sd) UCL I UCL to Use , normai) distribution passing one of the GOF test . a distribution (e.g., gamma) passing both GOF tests in ProUCL provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness.	1393
476 477 478 479 480 481 482 483 484 483 484 485 486 486 486 487 488	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 95% Student's-t UCI 95% Student's-t UCI When a papilcable, it is suggested to use a UCL Note: Suggestions regarding the selection of a 95 Recommendations are based upon the ras	614.5 749.1 1050 Suggester 639 ximate (e.g. based upon % UCL are ased upon d iults of the s	99% Chebyshev(Mean, Sd) UCL I UCL to Use , normal) distribution passing one of the GOF test a distribution (e.g., gamma) passing both GOF tests in ProUCL provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness. imulation studies summarized in Singh, Maichle, and Lee (2006)	1393
476 477 478 479 480 481 482 483 484 485 486 486 487 488 489	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 97.5% Chebyshev(Mean, Sd) UCI 95% Student's-t UCI 95% Student's-t UCI When a papilcable, it is suggested to use a UCL Note: Suggestions regarding the selection of a 95 Recommendations are based upon the ras	614.5 749.1 1050 Suggester 639 ximate (e.g. based upon % UCL are ased upon d iults of the s	99% Chebyshev(Mean, Sd) UCL I UCL to Use , normai) distribution passing one of the GOF test . a distribution (e.g., gamma) passing both GOF tests in ProUCL provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness.	1393
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476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492	95% BCA Bootstrap UCI 90% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 95% Student's-1 UCI 95% Student's-1 UCI When a data set follows an appro When applicable, it is suggested to use a UCL Note: Suggestions regarding the selection of a 95 Recommendations are bus These recommendations are based upon the res However, simulations results will not cover all Real Note: For highty negatively-skewed data, confid	614.5 749.1 1050 Suggested 639 ximate (e.g. based upon % UCL are ased upon d suits of the s World data s	99% Chebyshev(Mean, Sd) UCL I UCL to Use , normai) distribution passing one of the GOF test . a distribution (e.g., gamma) passing both GOF tests in ProUCL provided to help the user to selact the most appropriate 95% UC ata size, data distribution, and skewness. imulation studies summarized in Singh, Maichia, and Lee (2006) ets; for additional insight the user may want to consult a statistic	1393
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495	AOC3c 0.5 ft bgs Pb		······································	
497				
498		General S		
499	Total Number of Observations	9	Number of Distinct Observations	8
500	Minimum	26	Number of Missing Observations Mean	257.4
501	Maaritum	1000	Median	120
502 503	SD	341.6	Std, Error of Mean	113.9
504	Coefficient of Variation	1.327	Skewness	1.732
505				
506			collected using ISM approach, you should use	ŧ
507	• • •		I (ITRC, 2012) to compute statistics of Interest. hev UCL to estimate EPC (ITRC, 2012).	
508		-	parametric and All UCL Options of ProUCL 5.1	
509 510		· · · · ·		
511		Normal G	OF Test	
512	Shapiro Wilk Test Statistic	0.721	Shapiro Wilk GOF Test	
513	5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level	
514	Lilliefors Test Statistic 5% Lilliefors Critical Value	0.31	Lillefors GOF Test Data Not Normal at 5% Significance Level	
515			% Significance Level	
516 517				
518	Ass	uming Norr	nel Distribution	
519	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
520	95% Student's-t UCL	469.2	95% Adjusted-CLT UCL (Chen-1995)	515
521			95% Modified-t UCL (Johnson-1978)	480.2
522		Gamme	GOF Test	
523	A-D Test Statistic	0.516	Anderson-Darling Gamma GOF Test	
524 525	5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significant	ce Level
526	K-S Test Statistic	0.207	Kolmogorov-Smimov Gamma GOF Test	
527	5% K-S Critical Value	0.289	Detected data appear Gamma Distributed at 5% Significant	ce Level
528	Detected data appear	Gamma Dis	tributed at 5% Significance Level	
529		Commo	Statistica	
530	k hat (MLE)	0.796	k star (bias corrected MLE)	0.605
531 532	These best (III E)	323,4	Theta star (bias corrected MLE)	425.7
533		14.33	nu star (bias corrected)	10,89
534		257.4	MLE Sd (bias corrected)	331
535			Approximate Chi Square Value (0.05)	4.503
536	Adjusted Level of Significance	0.0231	Adjusted Chi Square Valua	3,677
537	Asi	sumino Gan	ame Distribution	
538 539			95% Adjusted Gamma UCL (use when n<50)	762.2
540		L		
541		-	I GOF Test	
542	Eff. Chapter Mills Odting) Melus	1	Shapiro Wik Lognormai GOF Test Data appear Lognormal at 5% Significance Level	
543	I W- I T+ Ot-E-N-		Lilliefors Lognormal GOF Test	
544 545	50 J W-6 0-W		Data appear Lognormal at 5% Significance Level	
546	Bata assau	Lognormel	at 5% Significance Level	
547				
548			al Statistics	4 por
549	Mandaman of Langed Date		Mean of logged Data SD of logged Data	4.805
550	,			
551		uming Logn	ormal Distribution	
553	95% H-UCL	1	90% Chebyshev (MVUE) UCL	572.8
554	4 95% Chebyshev (MVUE) UCL		97.5% Chebyshev (MVUE) UCL	927.9
555		1333		
550		atric Distribu	ntion Free UCL Statistics	
55	Deta gapoar la failare e		Distribution at 5% Significance Level	
559			· · · · · · · · · · · · · · · · ·	
56	0 Nonpa		atribution Free UCLs	
56	1 95% CLT UCI		95% Jackhrife UCL 95% Bootstrap-t UCL	469.2 1094
56	OF# Holes Beatutran UCI		95% Bootstrap-t UCL 95% Percentile Bootstrap UCL	
56	OF POA Partner UC	1		
56	4	1	95% Chebyshev(Mean, Sd) UCL	753.8
56	67 FP: Chebushov/Moon, Sd) UC	1 968.6	99% Chebyshev(Mean, Sd) UCL	1391
56	· · · · · · · · · · · · · · · · · · ·			
56	8		d UCL to Use	
56		L 762.2	-	
57	Makes Dynamotics and adding the collection of a DE	% UCL are	provided to help the user to select the most appropriate 95% UC	CL.
57	The second stranger of		lata size, data distribution, and skewness.	
57	Z		imulation studies summarized in Singh, Maichle, and Lee (2006	i).
57	the second standards and the will be the second stands	World data	sets; for additional insight the user may want to consult a statisti	cian.
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General Statistics Total Number of Distinct Observations Matheman 10 Number of Misring Chasevations Manual 2 Michaum 20 Number of Misring Chasevations Michaum 20 Michaum 20 Number of Misring Chasevations Michaum 20 Status 0.20 Number of Misring Chasevations Michaum 20 Status 0.78 Shaple Wilk Test Status 0.78 Status 0.78 Shaple Wilk Test Status 0.78 Status 0.78 Shaple Wilk Collical Vision 0.42 Data Not Normal at SS Significance Level Data Not Normal at SS Significance Level Dista Not Normal at SS Significance Level 0.55 Michaum at SS Significance Level Dista Not Normal at SS Significance Level 0.55 Michaum at SS Significance Level Dista Not Normal GCF Test 0.56 Normal GCF Test Comma GCF Test Normal GCF Test Normal GCF Test A Test Statistic 0.79 Advatesch-Datific dist Significance S & OCINAL 0.55 Normal GCF Test Comma Statistics 0.71 Normal GCF Test	76 77 AOC			
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Maximum 1000 Median S0 227.8 Bitl. Error of Man 1 Coefficient of Vision 1.18 Skrunnes 2 Shapio Viki, Test Statistic 0.78 Shapio Viki, GOT Test Skrunnes Shapio Viki, Test Statistic 0.29 Lilletons GOT Test 2 Shapio Viki, Test Statistic 0.20 Lilletons GOT Test 2 Shapio Viki, Test Statistic 0.20 Lilletons GOT Test 2 Shapio Viki, Test Statistic 0.20 Lilletons GOT Test 2 Assuring Normal Distribution 95% Vicia (adjusted for Skravest) 2 2 Shapio Viki, Test Statistic 0.278 Acdenson-Derling Gamma GOT Test A-D Test Statistic 0.370 Derlected date appear Gamma GOT Test 2 Shapio Test 0.370 Derlected date appear Gamma GOT Test 2 Shapio Test 0.372 Derlected date appear Gamma GOT Test 2 Shapio Viki, Test Statistic 0.372 Acdenson-Derling Gamma GOT Test 2 Shapio Viki, Test Statistic 0.373 Acdenson-Derling Gamma G	50 51			
Sig 327.9 Sig Sig Coefficient of Variation 1.86 Bikwrines Bikwrines Normal GOF Test Shaple Wilk Cotical Value 0.842 Data Normal act 5% Significance Level Significance Critical Value 0.842 Data Normal act 5% Significance Level Coefficient Critical Value 0.252 Data Normal act 5% Significance Level Data Normal Libritorion 95% Libritor Critical Value 0.252 Data Normal act 5% Significance Level Data Normal Libritorion 95% Normal UCL 466.7 95% Adjunct-CL TUCL (Chen-11997) 6 SS Significance Level 0.753 Detected data appear Camma OCF Test 35% Normal UCL 466.7 95% Normal OCF Act Test Studiettic 0.730 Detected data appear Camma OCF Test 35% Normal UCL 456.7 20% Detected data appear Camma OCF Test SS K SC Official Value 0.735 Detected data appear Camma OCF Test 356.5 K star (bias connected MLE) 7.11 rest ast (bias connected MLE) 35.6 K star (bias connected MLE) 35.6 K star (bias connected MLE) 35.6 M star (bias connected MLE) 35.6 M star (bias conn	82			
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Normal GOF Test Shapiro Wilk Cast Statistic 0.781 Shapiro Wilk GOF Test Sty Shapiro Wilk Critical Value 0.822 Data Not Normal at 5% Significance Lawel Uilleion Test Statistic 0.222 Data Not Normal at 5% Significance Lawel Sty Difference Intered 0.222 Data Not Normal at 5% Significance Lawel Assuming Normal Distribution 95% Normal UCL 467.7 95% Modified UCL (Clonen 1959) 95% Normal UCL 467.7 95% Modified UCL (Clonen 1957) 4 Action Statistic 0.379 Detected data appear Camma GOF Test A-D Test Statistic 0.370 Detected data spear Camma GOF Test A-D Test Statistic 0.371 Detected data spear Camma GOF Test S% K-S Critical Value 0.725 Detected data spear Camma GOF Test S% K-S Critical Value 0.726 Detected data spear Camma GOF Test S% K-S Critical Value 0.727 Detected data spear Camma GOF Test S% K-S Critical Value 0.727 Detected data spear Camma GOF Test S% Hold Clone Spear Value 0.727 Actama Got Speare Value Math (DLE) 17.1 matate (D	84			
Shapiro Will GOP Test S% Shapiro Will Critical Value 0.842 Data Not Normal at 5% Significance Level Uillieon Critical Value 0.282 Data Not Normal at 5% Significance Level Stabilitors Critical Value 0.282 Data Not Normal at 5% Significance Level Assuming Normal Distribution 95% Normal UCL 95% Normal UCL 95% Normal UCL SS Shapiro Null Control 95% Normal UCL 466.7 95% Adjusted-CLT UCL (Chem-1957) 4 Actional Statistic 0.37 Detaced data separal Camma GOF Test 60% Monitorial UCL (Statistics) 5% Significance A-O Test Statistic 0.37 Detaced data separal Camma GOF Test 60% Monagenero-Simiron Comma GOF Test A-O Test Statistic 0.37 Detaced data separal Camma Distributed at 5% Significance 10% Signifi	85		1.180	Crewings 1.002
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Lilleious Text Statutie 0.282 Lilleious Color Text 0.84 Lilleious Color Text Data Not Normal at 5% Significance Level Data Not Normal at 5% Significance Level Data Not Normal at 5% Significance Level Assuming Normal Distribution 95% Normal UCL 95% Normal UCL 95% Normal UCL 65% Normal UCL 66% Statuter - 10CL 466.7 95% Normal UCL (John-1989) 4 Action Color Text 0.73 Detacted data appear Gamma Old Text 95% Normal UCL (John-1989) 4 Action Color Text 0.73 Detacted data appear Gamma Old Text 5% No Critical Value 0.73 Detacted data appear Gamma Old Text S% K-S Critical Value 0.73 Detacted data appear Gamma Old Text 6% Text S% K-S Critical Value 0.73 Detacted data appear Gamma Old Text 6% Text Data of the appear Gamma Old Text 0.75 Detacted data appear Gamma Old Text 6% Significance Distributed at 5% Significance 0.767 Approximate Citik appear Logenment Old Text 10% Significance ME Montplace 0.767 Approximate Citik appear Logenmal at 5% Significance Level 2% Data appear Logenmal Citik Significance Level ME M	87 88	Shapiro Wilk Test Statistic	0.788	Shapiro Wilk GOF Test
6% Lilleiors Critical Value 0.202 Date Not Normal at 5% Significance Level Jate Not Normal et 5% Significance Level Assuming Normal Distribution 95% Normal UCL 95% VICLE (Adjusted for Simwnees) 95% Normal UCL 05% Normal UCL (John normal Significance UCL (John normal Significance) Significance UCL 95% Normal UCL (John normal Significance) Addessee Test Addessee Test Addessee Test Addessee Test Normal Statistics K Statistical Statistic K Statistical Statistic Carama Statistics K Hat (MLE) 2.11 Test Statistical Statistics K Statistical Statistica Statistical Statistica Adjusted Level of Significance Level Matern to Statistical Statistica Carama Statistica Mater Statistical Statistica				

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654	Convert Civiliation								
655	Total Number of	Observatione	9			Nambo	of Distinct Obse	ervational	6
656 657							of Missing Obs		2
657 658		Minimum	13					Mean	15.67
659		Maximum	20					Median	15
660		SD	2.121				Std. Error	of Mean	0.707
661	Coefficie	nt of Variation	0,135				s	kewness	0.965
662									
663	Note: Sample size is an								
664	guidance provided in ITF	-		-	-				
665	For example, you						-		
666	Chebyshev UCL can be	e computed us	ng na Norp		ING AILUCE C	pours of Pr	000L.5.1		
667			Normal G	OF Test					
668 669	Shapiro Wilk	Test Statistic	0,929			Shapiro Wil	k GOF Test		
670	5% Shapiro Wilk		0,829	·····	Data appr		t 5% Significand	e Level	
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672	5% Lilliefors	Critical Value	0.274		Data app	aar Normai a	t 5% Significand	ce Level	
673		Data appea	r Normai at l	5% Significa	ance Level				
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676	95% Normal UCL	hudanita a Lico I	16.98				sted for Skewne		1202
677	95% 81	tudent's-t UCL	10.98				ed-CLT UCL (Ch		17.07
678									1 4 1 1 2
679 680			Gamma (GOF Test					
681	Q-A) Test Statistic	0.286	[Ander	son-Darling	Gamma GOF To	est	
682	5% A-D	Critical Value	0.72	Detecte		-	istributed at 5%		ce Level
683) Test Statistic	0,175		_		v Gamma GOF		
684	, · · ·	Critical Value	0.279				istributed at 5%	Significan	ce Level
685	Detecter	d data appear	Gamma Disl	tributed at 5	% Significan	ce Level			
686			Gamma	Statistic-					
687		k hat (MLE)	Gamma : 64,54			6	star (bias correc	ted Mi Ex	43.1
688	Th	neta hat (MLE)	0.243				star (bias correc star (bias correc		0.363
689 690		nu hat (MLE)					nu star (bias c		775.8
691	MLE Mean (t	vias corrected)	15.67				MLE Sd (bias o		2.386
692						Approximate	a Chi Square Va	ilue (0.05)	712.2
693	Adjusted Level o	of Significance	0.0231			A	djusted Chi Squ	are Value	699.3
694									
695			suming Gam	me Distribu					17.5-
696	95% Approximate Gamma UCL (use	when n>≐50))	17.07	L	95% A	ujusted Gam	mą UCL (use wi	nen n<50)	17.38
697			Looporter	GOF Test					
698					Sha	dro Wilk Loo	normal GOF Te		
699	Shabiro Will	k Test Statistic	0.953						
1 700	Shapiro Wilk 5% Shapiro Wilk	k Test Statistic Critical Value	0.953		Data appe	ar Lognorma	at o % Signinca		
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ĵ,		MLE Mean (blas c	orrected)	15.6				MLE Sd (bias		2.214
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68										
		Adjusted Level of Sign	nificance	0.0267		· · · · · · · · · · · · · · · · · · ·		djusted Chi Sq		908.9
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		e Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lillistora Test 5% Lilliefors Critic Date Maximum of Log Maximum of Log 95% Chebyshav (MV 99% Chebyshav (MV 99% Chebyshav (MV 99% Chebyshav (MV 99% Chebyshav (MV 95% Standard Boob 95% Hall's Boots 95% Hall's Boots 95% Chebyshev (Mean, 97.5% Chebyshev (Mean, 97.5% Chebyshev (Mean,	Asso r n>=50)) statistic cal Value statistic cal Value statistic cal Value statistic cal Value statistic cal Value a eppear ged Data ged Data ged Data (Vel) Value Value Value UCE) Value Value Value Value (Vel) Value Value Value (Vel) Value (Vel) Value Value Value Value (Vel) Value Val	uming Gam 16.82 Lognorms 0.943 0.842 0.202 0.262 Lognorms Lognorms 2.565 2.996 aming Lognorms 18.26 21.68 the Distribut Discernible D ametric Distribut 16.65 16.6 17.67 16.8 17.51 19.57 Suggested	I GOF Test	95% / Shu Data appi L Data L Data Data L Data Data L Data Data L Data Data Data Data Data Data Data Data	A vojustad Garma aptro Wilk Log aar Lognorma Wilefore Lognorma aar Log	djusted Chi Sqi ma UCL (uşe v normal QOF To d at 5% Signific onnal QOF Tos i at 5% Signific Mean of Ic SD of Ic SD of Ic Chebyshev (N chebyshev (N 95% Jac 95% Jac	when n<50) est cance Lavel t ance Lavel t ance Lavel t ance Lavel t ance Lavel t ance Lavel t ance Lavel t ance Lavel t ance Lavel t ance Lavel t t ance Lavel t ance Lavel t t ance Lavel t t t t t t t t t t t t t t t t t t t	908.9 17.05 2.74 0.124 17.43 19.41 18.77 16.6 18.37
		a Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lillietors Test 5% Lilliofors Critic Deb Minimum of Log Maximum of Log Maximum of Log 95% Chebyshav (MV 99% Chebyshav (MV 99% Chebyshav (MV 00 Data appear to 1	Asso r n>=50)) statistic cal Value statistic cal Value statistic cal Value statistic cal Value statistic cal Value a eppear ged Data ged Data ged Data (Vel) Value Value Value UCE) Value Value Value Value (Vel) Value Value Value (Vel) Value (Vel) Value Value Value Value (Vel) Value Val	uming Gam 16.82 Lognorms 0.943 0.842 0.202 0.262 Lognorms Lognorms 2.565 2.996 aming Lognorms 18.26 21.68 the Distribut Discernible D ametric Distribut 16.65 16.6 17.67 16.8 17.51 19.57 Suggested	I GOF Test	95% / Shu Data appi L Data L Data Data L Data Data L Data Data L Data Data Data Data Data Data Data Data	A vojustad Garma aptro Wilk Log aar Lognorma Wilefore Lognorma aar Log	djusted Chi Sqi ma UCL (uşe v normal QOF To d at 5% Signific onnal QOF Tos i at 5% Signific Mean of Ic SD of Ic SD of Ic Chebyshev (N chebyshev (N 95% Jac 95% Jac	uare Value when n<50) est anco Lavel acco Lavel a	908.9 17.05 2.74 0.124 17.43 19.41 18.77 16.6 18.37
69		e Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lilliefors Test 5% Lilliefors Critic Date Minimum of Log Maximum of Log Maximum of Log 95% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 00 Date appear to 1 , 95% Standard Boots 95% Hall's Boots 95% BCA Boots 95% Chebyshev (Mean, 97.5% Chebyshev (Mean, 97.5% Chebyshev (Mean, 95% Studer	Asso I Statistic: cal Value I Statistic cal Value I Statistic I	uming Gam 16.82 Lognorma 0.943 0.202 0.262 Lognorma Lognorma 2.565 2.996 ming Lognorma 16.83 18.26 21.68 tric Distribut 16.65 16.6 17.67 16.8 17.51 19.57 Suggested 16.77	I GOF Test I UCL to Use I UCL to Use I GOF Test I UCL to Use I GOF Test I GOF	95% / Shu Data appi L Data appi icance Leve ution	A vdjustad Garm aptro Wilk Log aar Lognorma Wilefors Lognorma al 90% 97.5% Cance Level 95% C 99% C	djusted Chi Sqi ima UCL (uşe w inormal GOF To di at 5% Signific onnal GOF Tes ii at 5% Signific Mean of Ic SD of Ic SD of Ic Chebyshev (Mean 95% Jac 95% Jac 95% Boot Percentile Boc	uare Value when n<50) est anco Lavel 4 anco Lavel 4 anco Lavel 4 AVUE) UCL AVUE) UCL 4 AVUE) UCL 4 AVUE) UCL 4 anco Lavel anco Lavel 4 anco Lavel 4 an	908.9 17.05 2.74 0.124 17.43 19.41 18.41 16.6 18.37 21.93
		e Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lilliefors Test 5% Lilliefors Critic Date Minimum of Log Maximum of Log Maximum of Log 95% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 95% Standard Boots 95% BLa Boots 95% BCA Boots 95% BCA Boots 95% Chebyshev (Mean, 97.5% Chebyshev (Mean, 97.5% Chebyshev (Mean, 97.5% Chebyshev (Mean,	Asso I Statistic Cal Value I Statistic I Statistic I Statistic I Cal Value I Statistic I Cal Value I Statistic I Statistic	uming Gam 16.82 Lognorma 0.943 0.262 Lognormal 2.565 2.996 aming Lognormal 2.565 2.996 aming Lognormal 18.26 21.68 18.26 21.68 tric Distribu Discernible D ametric Dis 16.65 16.65 16.65 16.65 17.67 16.8 17.51 19.57 Suggested 16.77 % UCL are	I GOF Test	95% / Shu Data appi L Data appi icance Leve ution	A vdjustad Garm aptro Wilk Log aar Lognorma illiefors Lognorma al 90% 97.5% 90% 97.5% 99% C 995% C 995% C	djusted Chi Sqi ma UCL (uşe w normal GOF To di at 5% Signific onnal GOF Tos ii at 5% Signific Mean of Ic SD of Ic SD of Ic Chebyshev (M chebyshev (M 95% Jac 95% Jac 95% Boot Percentile Boo Shebyshev(Mea Shebyshev(Mea	uare Value when n<50) est anco Lavel 4 anco Lavel 4 anco Lavel 4 AVUE) UCL AVUE) UCL 4 AVUE) UCL 4 AVUE) UCL 4 anco Lavel anco Lavel 4 anco Lavel 4 an	908.9 17.05 2.74 0.124 17.43 19.41 18.41 16.6 18.37 21.93
		e Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lilliefors Test 5% Lilliefors Critic Data Maximum of Log Maximum of Log 95% 95% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 95% Standard Boots 95% Standard Boots 95% BCA Boots 95% BCA Boots 95% Studer 95% Studer 95% Studer 95% Studer	Asso n r>=50)) Statistic: Satistic Satisti	uming Gam 16.82 Lognorme 0.943 0.943 0.202 0.262 Lognormal 2.565 2.996 uming Logno 18.23 18.26 21.68 18.26 21.68 tric Distribu Discornible D armetric Dis 16.65 16.65 17.67 19.57 Suggestec 16.77 % UCL are	I GOF Test I UCL to Use I UCL to Use I UCL to Use I GOF Test I UCL to Use I GOF Test I G	95% / Shu Data appi- L Data appi- licance Leve ution	A kdjusted Gam aptro Wilk Log aar Lognorma aar Lognorma a	djusted Chi Sq ma UCL (uşe w inormal GOF To at 15% Signific ormal GOF Tos it at 5% Signific Mean of Ic SD of Ic SD of Ic SD of Ic Chebyshev (Mean 95% Boot Percentile Boo chebyshev(Mean c	uare Value when n<50) est anco Lavel 4 anco Lavel 4 anco Lavel 4 anco Lavel 4 anco Lavel 4 AVUE) UCL 4 AVUE) UCL 4 AVUE) UCL 5 4 4 4 4 4 4 4 4 4 4 4 4 4	908.9 17.05 2.74 0.124 17.43 19.41 18.77 17.31 16.6 18.37 21.93
	Note: Suggestia	e Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lillistors Test 5% Lilliefors Critic Date Maximum of Log Maximum of Log 95% 95% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 99% Standard Boots 95% Studer 95% Studer	Asso rs=50)) statistic statistic statistic statistic statistic statistic statistic statistic statistic statistic ged Data ged Data ged Data ged Data ged Data () () () () () () () () () ()	uming Gam 16.82 Lognorma 0.943 0.842 0.202 0.262 Lognormal 2.565 2.996 aming Lognormal 16.83 18.26 21.68 arrebic Distribut 16.65 16.65 16.65 16.77 Suggested 19.57 Suggested 16.77 % UCL are used upon d ublict of the s	I GOF Test	95% / Shu Data appi L Data appi icance Leve	A kidjusted Gam aptro Wilk Log aar Lognorma illiefors Logne aar Lognorma il 90% 97.5%	djusted Chi Sq ma UCL (uşe w inormal GOF To d at 5% Signific ormal GOF Tos ii at 5% Signific Mean of Ic SD of Ic SD of Ic Chebyshev (N Chebyshev (N Chebyshev (N SD 5% Jac 95% Jac 95% Boot Percentile Boo chebyshev(Mea chebyshev(Mea chebyshev(Mea	uare Value when n<50) est anco Lovel at anco Lovel at at at at at at at at at at	908.9 17.05 2.74 0.124 17.43 19.41 16.77 17.31 16.6 18.37 21.93
	Note: Suggesti	e Gamma UCL (use wher Shapiro Wilk Test 5% Shapiro Wilk Critic Lilliefors Test 5% Lilliefors Critic Data Maximum of Log Maximum of Log 95% 95% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 99% Chebyshev (MV 95% Standard Boots 95% Standard Boots 95% BCA Boots 95% BCA Boots 95% Studer 95% Studer 95% Studer 95% Studer	Asso rs=50)) statistic statistic statistic statistic statistic statistic statistic statistic statistic statistic ged Data ged Data ged Data ged Data ged Data () () () () () () () () () ()	uming Gam 16.82 Lognorma 0.943 0.842 0.202 0.262 Lognormal 2.565 2.996 aming Lognormal 16.83 18.26 21.68 arrebic Distribut 16.65 16.65 16.65 16.77 Suggested 19.57 Suggested 16.77 % UCL are used upon d ublict of the s	I GOF Test	95% / Shu Data appi L Data appi icance Leve	A kidjusted Gam aptro Wilk Log aar Lognorma illiefors Logne aar Lognorma il 90% 97.5%	djusted Chi Sq ma UCL (uşe w inormal GOF To d at 5% Signific ormal GOF Tos ii at 5% Signific Mean of Ic SD of Ic SD of Ic Chebyshev (N Chebyshev (N Chebyshev (N SD 5% Jac 95% Jac 95% Boot Percentile Boo chebyshev(Mea chebyshev(Mea chebyshev(Mea	uare Value when n<50) est anco Lovel at anco Lovel at at at at at at at at at at	908.9 17.05 2.74 0.124 17.43 19.41 16.77 17.31 16.6 18.37 21.93

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	ABCDE	F	G H I J K	L
809	AOC3a 0.5 ft bgs As			
810 811				
812		General S	italistics	
813	Total Number of Observations	6	Number of Distinct Observations	5
814			Number of Missing Observations	2
815	. Minimum Maximum	13 18	, Mean Median	15,67 16
816	SD	1.966	Std. Error of Mean	0,803
817 818	Coefficient of Variation	0.126	Skewness	-0.254
819			······································	
820			ollected using ISM approach, you should use	
821			(ITRC, 2012) to compute statistics of interest.	
822		-	nev UCL to estimate EPC (ITRC, 2012). erametric and All UCL Options of ProUCL 5.1	
823		and are really		
824 825	· · · · · · · · · · · · · · · · · · ·	Normal G	OF Test	
826	Shapiro Wilk Test Statistic	0.927	Shapiro Wilk GOF Test	
827	5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level	
828	Lilliefors Test Statistic	0.251	Lillefors GOF Test	
829	5% Lilliefors Critical Value		Data appear Normal at 5% Significance Level 5% Significance Level	
<u>830</u> 831				
832	As	suming Norm	al Distribution	
833	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
834	95% Student's-t UCL	17.28	95% Adjusted-CLT UCL (Chen-1995)	16.9
835			95% Modified-t UCL (Johnson-1978)	17.27
836		Gamma (GOF Test	
837	A-D Test Statistic	0.347	Anderson-Darling Gamma GOF Test	
838 839	5% A-D Critical Value	0.697	Detected data appear Gamma Distributed at 5% Significance	e Levei
840	K-S Test Stafistic	0.27,4	Kolmogorov-Smirnov Gamma GOF Test	
841	5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance	ce Level
842	Detected data appear	Gamma Dis	tributed at 5% Significance Level	
843		Gamma	Statistico	
844 845	k hat (MLE)		k star (bias corrected MLE)	37,36
846	Theta hat (MLE)		Theta star (bias corrected MLE)	0,419
847	nu hat (MLE)	894	nu star (bias.corrected)	448.4
848	MLE Mean (bias corrected)	15.67	MLE Sd (bias corrected)	2.563
849			Approximate Chi Square Value (0.05)	400.3
850	Adjusted Level of Significance	0.0122	Adjustad Chi Square Value	363.7
851 852	As	suming Gam	me Distribution	
853	95% Approximate Gamma UCL (use when n>=50)) 17.55	95% Adjusted Gamma UCL (use when n<50)	18,31
854			·	
855	Shapiro Wilk Test Statistic		GOF Test Shapiro Wilk Lognormal GOF Test	
856	5% Shapiro Wilk Critical Value		Data appear Lognormal at 5% Significance Level	
857 858	Lilliefors Test Statistic		Lilliefors Lognormal GOF Test	
859	5% Lilliefors Critical Value	0.325	Data appear Lognormal at 5% Significance Level	
860	Data appear	Lognormal	at 5% Significance Level	
861		1	1 C tentester	
862	Minimum of Logged Data	-	al Statistics Mean of logged Data	2.745
863			SD of logged Data	0,128
865			· · · · · · · · · · · · · · · · · · ·	
866	Ana Ana	uming Logn	armei Distribution	
867	95% H-UCI		90% Chebyshev (MVUE) UCL	18.12
868	95% Chebyshev (MVUE) UC 99% Chebyshev (MVUE) UC	1	97.5% Chebyshev (MVUE) UCL	20.77
869		23.0		
870 871	N ¹	etric Distribu	tion Free UCL Statistics	
872	Dista passas in follow o	Discernible I	Distribution at 5% Significance Level	
873				
874			tribution Free UCLs	17 00
875	95% CLT UC 95% Standard Bootstrap UC		95% Jackknife UCL 95% Bootstrap-t UCL	17.28 17.29
876	OEX Holls Peetstern U/2		95% Percentile Bootstrap UCL	16.83
877	06% BCA Pastation LIC			
878	00% Chebuchev (Mean Sd) LK		95% Chebyshev(Mean, Sd) UCL	19.17
879		1 20.68	99% Chebyshev(Mean, Sd) UCL	23.65
879	97.5% Chebyshev(Mean, Sd) UC			
880 88 68	050 Shudoota UIC		UCL to Use	r
880 881 882 883	2 2 3 95% Students-t UC		i UCL to Use	
880 881 882 883	95% Student's-t UC	L 17.28	UCL to Use	н Я.,
880 881 882 883 884 884	95% Student's-t UC Note: Suggestions regarding the selection of a 95	L 17.28		ц.,
880 881 882 883	95% Student's-t UC Note: Suggestions regarding the selection of a 95 Recommendations are based upon the re-	17.28 5% UCL are ased upon d sults of the s	provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness. Imulation studies summarized in Singh, Maichle, and Lee (2006)).
881 881 882 883 884 885 885 885	95% Student's-t UC Note: Suggestions regarding the selection of a 95 Recommendations are b These recommendations are based upon the re-	17.28 5% UCL are ased upon d sults of the s	provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness.).
880 881 882 883 884 884 884 884 884 884 884 884 884	95% Student's-t UC Note: Suggestions regarding the selection of a 95 Recommendations are b These recommendations are based upon the re- However, simulations results will not cover all Reat	L 17.28 5% UCL are ased upon d sults of the s World data s	provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness. Imulation studies summarized in Singh, Maichle, and Lee (2006) lets; for additional insight the user may want to consult a statistic).
880 881 882 883 884 885 885 885 885 885 885 885 885 885	95% Student's-t UC Note: Suggestions regarding the selection of a 95 Recommendations are b These recommendations are based upon the re However, simulations results will not cover all Real Note: For highly negatively-skewed data, confid	L 17.28 5% UCL are ased upon d sufts of the s World data s lence limits (provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness. imulation studies summarized in Singh, Maichle, and Lee (2006) jets; for additional insight the user may want to consult a statistic e.g., Chen, Johnson, Lognormal, and Gamma) may not be).
880 881 882 883 884 885 885 885 885 885 885 885	95% Student's-t UC Note: Suggestions regarding the selection of a 95 Recommendations are b These recommendations are based upon the re- However, simulations results will not cover all Real Note: For highly negatively-skewed data, confid reliable. Chen's and Johnson's ma	L 17.28 5% UCL are ased upon d sufts of the s World data s lence limits (provided to help the user to select the most appropriate 95% UC ata size, data distribution, and skewness. Imulation studies summarized in Singh, Maichle, and Lee (2006) lets; for additional insight the user may want to consult a statistic).

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	A B C D E	F	GHIJK	L
893		· · · · · ·		
894	AOC3a 0.5-1 ft bgs As			
895	······································		-	
896		General	Statistics	
	Total Number of Observations	7	Number of Distinct Observations 6	6
897			Number of Missing Observations 1	1
898	Minimum	13	Mean 16	6.71
899	Maximum	23	Median 12	7
900	SD	3,302	Std. Error of Mean 1	1.248
901	Coefficient of Variation	0.198		1.129
902				
903	Note: Sample size is small (e.g. <10)	if data area	collected using ISM approach, you should use	
904			A (ITRC, 2012) to compute statistics of interest.	
905			her UCL to estimate EPC (TRC, 2012).	
906			parametric and All UCL Options of ProUCL 5.1	
907	Chebyanev OCL can be computed us			
908	·	Normal (3OF Test	
909	Shapiro Wilk Test Statistic	0.912	Shapiro Wilk GOF Test	
910	-		Data appear Normal at 5% Significance Level	
911	5% Shapiro Wilk Critical Value	0.803	Lillefors GOF Test	
912	Lilliefors Test Statistic	0.206		
913	5% Lilliefors Critical Value	0.304	Data appear Normal at 5% Significance Level	
914	Date appea	r Normai ac	5% Significance Level	
915			(
916		suming Norr	nal Distribution	
917	95% Normal UCL		95% UCLs (Adjusted for Skowness)	0.01
918	95% Student's-t UCL	19.14	1	9:34
919			95% Modified-t UCL (Johnson-1978) 1	9,23
920			· · · · · · · · · · · · · · · · · · ·	
921			GOF Test	
922	A-D Test Statistic	0.288	Anderson-Darling Gamme GOF Test	
923	5% A-D Critical Value	0,707	Detected data appear Gamma Distributed at 5% Significance L	evel
924	K-S Test Statistic	0,171	Kolmogorov-Smirnov Gamma GOF Test	
925	5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance L	.evel
926	Detected data appear	Gamma Dis	tributed at 5% Significance Level	
927	· · · · · · · · · · · · · · · · · · ·			
928		Gamma	Statistics	
929	k hat (MLÉ)	32.13	k star (blas corrected MiLE) 1	18.46
930	Theta hat (MLE)	0.52	Theta star (bias corrected Mi.E)	0.906
931	nu hat (MLE)	449.8	nu star (bias corrected) 25	58,4
932	Mi.E Mean (bias corrected)	16,71	MLE Sd (bias corrected)	3,891
			Approximate Chi Square Value (0.05) 22	22.2
933	Adjusted Level of Significance	0.0158	Adjusted Chi Square Value 21	12
934			4	
935	Ase	suming Gar	ma Distribution	
936	95% Approximate Gamma UCL (use when n>=50))	19.44	95% Adjusted Gamma UCL (use when n<50) 2	20.37
937	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	1		•
938 939		Lognorma	GOF Test	
	Shapiro Wilk Test Statistic	-	Shapiro Wilk Lognormal GOF Test	
940	5% Shapiro Wilk Critical Value	0,803	Data appear Lognormal at 5% Significance Level	
<u>941</u>	Lilliefors Test Statistic	0,174	Lillefors Lognormal GOF Test	
942	EW Hillinford Value		Data appear Lognormal at 5% Significance Level	
943			at 5% Significance Leval	
944				
945		Loanorm	al Statistics	
946	Minimum of Logged Data			2.801
947	Maximum of Logged Date			0,188
948		1		
949	Årri Årri	imina Loom	ormal Distribution	
950	95% H-UCL			20.27
951	(ISK Chobychey (M)(IS) UC			24.13
952	(00% Chohushou (MV/LIE) LICI			
953				
954	Nonnereme	tric Distrike	tion Free UCL Statistics	
955	Date papers to fellow of		Distribution at 5% Significance Level	
956				
957	Nanna Nanna	nametric Dia	tribution Free UCLs	
958	95% CITUCI			19.14
959	0E% Standard Boatstrap 1/0			19.92
960	OFP, Hall's Poststran UC			18.86
96	DEW BCA Restation LICI		20 % Leicentité Doctat als DOC	
962	POP Chabushay(Mass, Sd) UC		. 95% Chebyshev(Mean, Sd) UCL	22.15
963				22.15
964	97.5% Chebyshev(Mean, Sd) UCI	24.51	99% Chebyshev(Mean, Sd) UCL	23,13
965			415ML 6- 61	
966		+-	1 UCL to Use	
96	95% Student's t UCI	19.14	<u> </u>	
968		or 11=	A the first state of the set of the set	
96	· · · · · · · · · · · · · · · · · · ·		provided to help the user to select the most appropriate 95% UCL.	
			ata size, data distribution, and skewness.	
970				
970 97	These recommendations are based upon the res		imulation studies summarized in Singh, Maichle, and Lee (2006).	
	These recommendations are based upon the res		imulation studies summarized in Singh, Maichle, and Lee (2006). sets; for additional insight the user may want to consult a statistician	I.
97	These recommendations are based upon the res However, simulations results will not cover all Real V			1,

1 1	A B C D E	F	G H I J K	L
974		•	· · · · · · · · · · · · · · · · · · ·	
975	AOC3b 0.5 ft bgs As			
976			· · · · · · · · · · · · · · · · · · ·	
977		General \$		
978	Total Number of Observations	8	Number of Distinct Observations	7
979 098	Minimum	11	Number of Missing Observations Mean	4
980	Maximum	19	Median	14
981 982	SD	2.493	Std. Error of Mean	0.881
983	Coefficient of Veriation	0,175	Skewness	0.802
984	· · · · · ·			
985			oliected using ISM approach, you should use	
986			I (ITRC, 2012) to compute statistics of interest. nev UCL to estimate EPC (ITRC, 2012).	
987			erametric and All UCL Options of ProUCL 5.1	
988 989				
990		Normal G	OF Test	
991	Shapiro Wilk Test Statistic	• 0,958	Shapiro Wilk GOF Test	
992	5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level	
993	Lillefors Test Statistic 5% Elliefors Critical Value	0.165	Lillefors GOF Test Data appear Normal at 5% Significance Level	
994 995			5% Significance Level	
996				
997	Ast	uming Norm	nal Distribution	
998	95% Normal UCL		95% UCLs (Adjusted for Skewness)	
999	95% Student's-t UCL	15.92	95% Adjusted-CLT UCL (Chen-1995)	15,97
1000			95% Modified-t UCL (Johnson-1978)	15,96
1001	······	Gamma (3CF Test	
1002	A-D Test Statistic	0,181	Anderson-Danling Gamma GOF Test	
1004	5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significant	ce Level
1005	K-S Test Statistic	0,148	Kolmogorov-Smirnov Gamma GOF Test	
1006		0.294	Detected data appear Gamma Distributed at 5% Significant	ca Level
1007		Gerane Dis	bibuted at 5% Significance Level	
1008		Gamma	Statistics	
1009	h h ++ (ht) ["	38.96	k star (bias corrected MLE)	24.43
1011	These last /60 m	0,366	Theta star (bias corrected MLE)	0.583
1012		623.3	nu star (bias corrected)	390.9
1013	MLE Mean (bias corrected)	14.25	MLE Sd (bias corrected)	2.883
1014		0,0195	Approximate Chi Square Value (0.05) Adjusted Chi Square Value	346.1 335,4
1015		0,0,00		
			ma Distribution	
1016	Aas	suming Gam	Sistiluator,	
1016 1017 1018			95% Adjusted Gamma UCL (use when n<50)	16.61
1017	95% Approximate Gamma UCL (usa when n>=50))	16.1	95% Adjusted Gamma UCL (use when n<50)	16.61
1017 1018 1019 1020	95% Approximate Gamma UCL (use when n>∹50))	16.1 Lognonne	95% Adjusted Gamma UCL (use when n<50) GOF Test	16.61
1017 1018 1019 1020 1021	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic	16.1 Lognorma 0.983	95% Adjusted Gamma UCL (use when n<50) GOF Test Shapiro Wilk Lognormal GOF Test	16.61
1017 1018 1019 1020 1021 1022	95% Approximate Gamma UCL (use when n><50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	16.1 Lognonne	95% Adjusted Gamma UCL (use when n<50) GOF Test	16.61
1017 1018 1019 1020 1021	95% Approximate Gamma UCL (use when n><50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	16.1 Lognorme 0.983 0.818	95% Adjusted Gamma UCL (use when n<50) GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level	16.61
1017 1018 1019 1020 1021 1022 1023	95% Approximate Gamma UCL (use when n><50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value	16.1 Lognorma 0.983 0.818 0.136 0.283	95% Adjusted Gamma UCL (use when n<50) GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal GOF Test	16.61
1017 1018 1019 1020 1021 1022 1023 1024 1025	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear	16.1 Lognorme 0.983 0.818 0.136 0.283 Lognormal	95% Adjusted Gamma UCL (use when n<50) IGOF Test Shaplro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level	16.61
1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognorma	95% Adjusted Gamma UCL (use when n<50) IGOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level at 5% Significance Level	
1017 1018 1019 1020 1021 1022 1023 1024 1025 1025 1025	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliofors Test Statistic 5% Lilliefors Critical Value Data appear	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognorma 2.398	95% Adjusted Gamma UCL (use when n<50) IGOF Test Shaplro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level	2.644
1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefore Critical Value Data sppeer Minimum of Logged Data	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognorma 2.398	95% Adjusted Gamma UCL (use when n<50) GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level i Statistics Mean of logged Data	2.644
1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1025	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Deta sppeor Minimum of Logged Data Maximum of Logged Data	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal 2.398 2.944 ming Lognor	95% Adjusted Gamma UCL (use when n<50) IGOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data	2.644 0.17
10177 1018 1019 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S5% H-UCL 05% H-UCL 05% H-UCL 05% Critical Value 05% Critical	16.1 Lognomma 0.983 0.818 0.283 Lognormal Lognormal 2.398 2.944 aming Logna 16.14	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data	2.644 0.17 16.82
10177 1018 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Statistic Asse 95% H-UCL	16.1 Lognorma 0.983 0.818 0.283 Lognormal 2.394 2.944 anting Logna 16.14 17.99	95% Adjusted Gamma UCL (use when n<50) IGOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data	2.644 0.17
10177 1018 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data Statistic S% H-UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL	16.1 Lognorma 0.983 0.818 0.283 Lognormal 2.394 2.944 anting Logna 16.14 17.99	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data	2.644 0.17 16.82
1017 1018 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data Second State Second State St	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal 2.398 2.944 Iming Lognor 16.14 17.99 22.8	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data	2.644 0.17 16.82
10177 1018 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Tast Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data Statistic S% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL	15.1 Lognorma 0.983 0.818 0.283 Lognormal 2.398 2.944 ming Lognor 16.14 17.99 22.8 tric Distribut	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL	2.644 0.17 16.82
1017 1018 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Uillefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 90% Che	15.1 Lognorma 0.983 0.818 0.283 Lognormal Lognormal 2.398 2.944 aming Lognor 16.14 17.99 22.8 tric Distribut Discombine Distribut	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal q5% Significance Level Lilliefors Lognormal q5% Significance Level Lilliefors Lognormal q5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data SD of logged Data I Statistics Mean of logged Data SD of logged Data SD of logged Data I Statistics Mean of logged Data SD of logged Data I Statistics I Statis	2.644 0.17 16.82
1017 1018 1019 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Ch	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognormal 2.398 2.944 aming Lognor 16.14 17.99 22.8 toto Distribut camebric Distribut	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61
1017 1018 1019 1020 1021 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Uilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S5% Chebyshev (MVUE) UCL S5% C	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognormal 2.398 2.944 aming Lognor 16.14 17.99 22.8 tric Distribut Discrete/Lagranter rametric Distribut 15.7	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level If Statistics Mean of logged Data SD of logged Data Interfluction 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 10n Free UCL Statistics Istribution at 5% Significance Level Introductor Free UCLs 95% Jackknife UCL	2.644 0.17 16.82 19.61
10177 10181 10192 1020 1021 1022 1033 1034 103	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Cheb	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognormal 2.398 2.944 ming Lognormal 16.14 17.99 22.8 tric Distribut Discernible D 15.7 15.6	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61
10177 10181 1020 1021 1022 1022 1022 1022 102	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL	18.1 Lognorma 0.983 0.818 0.283 Lognormal 2.394 ming Lognormal 16.14 17.99 22.8 tric Distribut rametric Distribut 15.6 17.22	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level if Statistics Mean of logged Data SD	2,644 0.17 16,82 19,61 15,92 15,92
10177 10181 10192 1020 1021 1022 1033 1034 103	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% BCA Bootstrap UCL	16.1 Lognorma 0.983 0.818 0.283 Lognormal 2.398 2.944 aming Lognormal 16.14 17.99 22.8 tric Distribut 16.7 15.6 17.22 15.63 16.89	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level if Statistics Mean of logged Data SD	2,644 0.17 16,82 19,61 15,92 15,92
10177 1018 1020 1021 1022 1023 1033 1033 1033 1033 1033 1033 1033 1033 1033 1033 1034 1035 1036 1037 1036 1037 1036 1037 1037 1037 1038 1048	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value 5% Shapiro Wilk Critical Value 5% Lilliafors Test Statistic 5% Lilliafors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% BCA Bootstrap UCL 95% BCA Bootstrap UCL 95% BCA Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL	16.1 Lognorma 0.983 0.818 0.283 Lognormal 2.398 2.944 aming Lognormal 16.14 17.99 22.8 tric Distribut 16.7 15.7 15.7 15.63 17.22 15.63 16.89	95% Adjusted Gamma UCL (use when n<50) IGOF Test GOF Test Data appear Lognormal qt 5% Significance Level Lillefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level at 5% Significance Level 4 Statistics Mean of logged Data SD of logged Data Istribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Backtnife UCL 95% Jacktnife UCL 95% Bochstrap-t UCL	2.644 0.17 16.82 19.61 15.92 15.92 15.63
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Ulliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognormal Lognormal 16.14 17.99 22.8 tric Distribut 16.14 17.99 22.8 tric Distribut 16.7 15.6 17.22 15.6 17.22 15.6 17.22 15.83 19.75	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic S% Shapiro Wilk Critical Value Lilliefors Test Statistic S% Lilliefors Test Statistic S% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S% Chebyshev (MVUE) UCL S% Standard Bootstrap UCL S% Standard Bootstrap UCL S% Chebyshev(Mean, Sd) UCL S% Chebyshev	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognormal 2.398 2.944 aming Lognormal 16.14 17.99 22.8 tric Distribut Discretible D ametric Distribut 15.7 15.6 17.22 15.63 16.395 19.75 Suggestod	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal q5% Significance Level Lillefors Lognormal GOF Test Data appear Lognormal d5% Significance Level at 5% Significance Level I Statistics Mean of logged Data SD of logged Data I Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data I Statistics I Statistics I Statistics I Statistics I Statistics SD of logged Data SD of logged Data	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL 95% Student's-t UCL	16.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal Lognormal 2.398 2.944 aming Lognormal 16.14 17.99 22.8 tric Distribut Discretible D ametric Distribut 15.7 15.6 17.22 15.63 16.395 19.75 Suggestod	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value 5% Shapiro Wilk Critical Value 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data 95% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev (Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 97.5% Student's-t UCL 95% Student's-t UCL	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal 2.394 ming Lognormal 16.14 17.99 22.8 tric Distribut 15.7 15.6 17.22 15.63 16.39 19.75 Suggestoc 15.92	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09 23.02
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chebyshev (Mean, Sd) UCL 95% Chebyshev (Mean, Sd) UCL 97.5% Chebyshev (Mean, Sd) UCL 95% Student's-t UCL	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal 2.398 2.944 Infig Logna 16.14 17.99 22.8 tric Distribut 15.6 17.22 15.63 16.39 19.75 Suggested % UCL are j trade upon d	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal q5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09 23.02
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic S% Shapiro Wilk Critical Value Lilliefors Test Statistic S% Lilliefors Test Statistic S% Lilliefors Test Statistic S% Lilliefors Critical Value Lilliefors Test Statistic S% Lilliefors Critical Value Asset S% Chebyshev (MVUE) UCL S% Chebyshev (Mean, Sd) UCL S% Chebyshev (Mean, Sd) UCL S% S% Student*ct UCL S% S	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal 2.994 aming Lognormal 16.14 17.99 22.8 tric Distribut 16.57 15.6 17.22 15.6 17.59 Suggestoc 15.92 % UCL are tased upon d. utils of the si	95% Adjusted Gamma UCL (use when n<50) GOF Test GoF Test Data appear Lognormal at 5% Significance Level i Statistics Mean of logged Data SD of logged Data SS Statastaper UCL 95% Percentile Bootstrap-UCL <t< th=""><th>2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09 23.02</th></t<>	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09 23.02
1017 1018 1019 1022 1022 1022 1022 1022 1022 1022	95% Approximate Gamma UCL (use when n>=50)) Shapiro Wilk Test Statistic S% Shapiro Wilk Critical Value Lilliefors Test Statistic S% Shapiro Wilk Critical Value Lilliefors Test Statistic S% Lilliefors Critical Value Lilliefors Test Statistic S% Lilliefors Critical Value Lilliefors Test Statistic S% Child Value Lilliefors Test Statistic S% Chebyshev (MVUE) UCL S% Chebyshev (Mean, Sd) UCL S% Chebyshev (Mean, Sd) UCL S% Statent*e-t UCL S% Statent*e-t UCL S% Statent*e-t UCL S% These recommendations are based upon the res S% Howaver, simulations results will not cover all Real Norwaver, simulations results will not cover all Real Norwaver (Mean, Sd) UCL S% Chebyshev (Inter all Real Norwaver, simulations results will not cover all Real Norwaver all Real Norwaver all Real Norwaver (Smulations results will not cover all Real Norwaver all Real Norwav	15.1 Lognorma 0.983 0.818 0.136 0.283 Lognormal 2.994 aming Lognormal 16.14 17.99 22.8 tric Distribut 16.57 15.6 17.22 15.6 17.59 Suggestoc 15.92 % UCL are tased upon d. utils of the si	95% Adjusted Gamma UCL (use when n<50) GOF Test GOF Test Data appear Lognormal q5% Significance Level Lillefors Lognormal at 5% Significance Level at 5% Significance Level (Statistics Mean of logged Data SD of logg	2.644 0.17 16.82 19.61 15.92 16.19 15.63 18.09 23.02

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055				
056 A	0C3b 0.5-1 ft bgs As			
057		General S		
058	Total Number of Observations	11	Number of Distinct Observations	8
059			Number of Missing Observations	1 .
060 061	Minimum	11	Maan	15,09
062	Maximum	19	Median	15
J63	SD	2.7	Std. Error of Mean	0.814
164	Coefficient of Variation	0.179	Skewness	0.218
65		/I		
66		Normal G		
67	. Shapiro Wilk Test Statistic		Shapiro Wilk GOF Test	
68	5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level	
)69	Lilliefors Test Statistic	0.15	Lilliefors GOF Test	
70	5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level	
71	Data sppa	ar Normal at a	5% Significance Level	
72		aunda a Maran	el Distribution	
173	95% Normal UCL	snovi gnimua	al Distribution 95% UCLs (Adjusted for Skewness)	
174	95% Student's-t UCL	16.57	95% Adjusted-CLT UCL (Chen-1995)	16.49
75			95% Modified-t UCL (Johnson-1978)	16.58
)76		· ·		
77	•	Gamma G	GOF Test	
)78)79	A-D Test Statistic		Anderson-Darling Gemme GOF Test	
179	5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance	i Lovel
181	K-S Test Statistic	0.141	Kolmogorov-Smirnov Camma GOF Test	
82	5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance	a Lavel
83	Detected data appear	Gamma Dist	ributed at 5% Significance Level	
84				
085		Gamma		
986	k hat (MLE		k star (blas corrected MLE)	24,99
87	Theta hat (MLE		Theta star (bias corrected MLE)	0.604
88	nu hat (MLE			549.8
89	MLE Mean (blas corrected	15.09	MLE Sd (bias corrected)	3.019
90				496.5
91	Adjusted Lavel of Significance	0.0278 O	Adjusted Chi Square Value	488.2
92			- Plankudaa	
93		-	ma Distribution	17
<u>194</u>	95% Approximate Gamma UCL (use when л>=50)) 16.71	95% Adjusted Gamma UCL (use when n<50)	
095		Lognormal	GOF Test	
<u>196</u>	Shapiro Wilk Test Statistic		Shapiro Wilk Lognormal GOF Test	
397	5% Shapiro Wilk Critical Value		Data appear Lognormal at 5% Significance Level	
198 199	Lillefors Test Statistic	1	Liliefors Lognormal GOF Test	
	5% Lilliefors Critical Value		Data appear Lognormal at 5% Significance Level	
100 101			at 5% Significance Level	
102				
103		Lognorma	I Statistics	
104	Minimum of Logged Date		Mean of logged Data	2.699
105	Maximum of Logged Dat	ə 2.944	SD of logged Data	0.18
105				
107		~ -	mal Distribution	
108	95% H-UC	1	90% Chabyshev (MVUE) LICL	17,56
109	95% Chebyshev (MVUE) UC	1	97.5% Chebyshev (MVUE) UCL	20.23
110	99% Chebyshev (MVUE) UC	l. 23.27		
111		ALC 22 1	I	
112			ion Free UCL Statistics	
		uiscemible D	istribution at 5% Significance Level	
	Data appear to follow a			
113			with ution Error LICLe	
113 114	Norpe		ribution Free UCLs	10 57
113 114 115 116	Norpe 95% CLT UC	L 16.43	95% Jackknife UCL	16,57
13 14 15 16	Norp 95% CLT UC 95% Standard Bootstrap UC	L 16.43 L 16.37	95% Jackknife UCL (95% Bootstrap-tUCL	16.65
113 114 115 116 117	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% Hall's Bootstrap UC	L 16.43 L 16.37 L 16.47	95% Jackknife UCL	
113 114 115 116 117 118 119	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC	L 16.43 L 16.37 L 16.47 L 16.27	95% Jackknife UCL (95% Bootstrap-t UCL 95% Parcentile Bootstrap UCL	16,65 16,36
113 114 115 116 117 118 119 120	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC 95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53	95% Jackknife UCL 95% Bootstrap-LUCL 95% Parcentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL	16.65 16.36 18.64
113 114 115 116 117 118 119 120 121	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53	95% Jackknife UCL (95% Bootstrap-t UCL 95% Parcentile Bootstrap UCL	16,65 16,36
113 114 115 116 117 118 119 120 121 122	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC 95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18	95% Jackknife UCL 95% Bootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL	16.65 16.36 18.64
113 114 115 116 117 118 119 120 121 122 122	Norpe S5% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18 Suggested	95% Jackknife UCL 95% Bootstrap-LUCL 95% Parcentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL	16.65 16.36 18.64
113 114 115 116 117 118 119 120 121 122 123 124	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC 95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18 Suggested	95% Jackknife UCL 95% Bootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL	16.65 16.36 18.64
113 114 115 116 117 118 119 120 121 122 123 124 125	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 97.5% Student'st UC	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18 Suggested L 16.57	95% Jackknife UCL (95% Bootstrap-t UCL 95% Parcentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL UCL to Use	16.65 15.36 18.64 23.19
113 114 115 116 117 118 119 120 121 122 123 124 125 126	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% BCA Bootstrap UC 90% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 97.5% Student's-t UC 95% Student's-t UC	L 16.43 L 16.37 L 16.47 L 16.47 L 16.27 L 17.53 L 20.18 Suggested L 16.57	95% Jackknife UCL (95% Bootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL UCL to Use	16.65 15.36 18.64 23.19
113 114 115 116 117 118 119 120 121 121 122 123 124 125 126 127	Norpe 95% CLT UC 95% Standard Bootstrap UC 95% Hall's Bootstrap UC 95% Holl's Bootstrap UC 90% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 97.5% Chebyshev(Mean, Sd) UC 95% Student's-t UC 95% Student's-t UC Note: Suggestions regarding the selection of a 95 Recommendations are b	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18 Suggested L 16.57 S% UCL are p ased upon de	95% Jackknife UCL (95% Bootstrap-t UCL 95% Parcentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL UCL to Use	16,65 15.36 18.64 23.19
113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128	Norp 95% CLT UC 95% Standard Bootstrap UC 95% Hal's Bootstrap UC 95% Chabyshev[Mean, Sd) UC 97.5% Chebyshev[Mean, Sd) UC 97.5% Chebyshev[Mean, Sd) UC 95% Student's-t UC 95% Student's-t UC Note: Suggestions regarding the selection of a 99 Recommendations are b These recommendations are based upon the re-	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18 Suggested L 16.57 S% UCL are p ased upon dz suits of the sit	95% Jackknife UCL (95% Bootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL UCL to Use	16,65 16.36 18.64 23.19
113 114 115 116 117 118 119 120 121 121 122 123 124 125 126 127	Norp 95% CLT UC 95% Standard Bootstrap UC 95% Hal's Bootstrap UC 95% Chabyshev[Mean, Sd) UC 97.5% Chebyshev[Mean, Sd) UC 97.5% Chebyshev[Mean, Sd) UC 95% Student's-t UC 95% Student's-t UC Note: Suggestions regarding the selection of a 99 Recommendations are b These recommendations are based upon the re-	L 16.43 L 16.37 L 16.47 L 16.27 L 17.53 L 20.18 Suggested L 16.57 S% UCL are p ased upon dz suits of the sit	95% Jackknife UCL 95% Bootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL UCL to Use	16,65 16.36 18.64 23.19

C3c 0.5 ft bgs As				
·····	General S	atistics		
Total Number of Observations	9	Number of Distinct Observations	7	
		Number of Missing Observations	3	
			16.44	
			17 0.835	
Coefficient of Variation	0.152	Skewness	-0.0383	
	16 J	New March and Party 1014 Annual Annual Annual Annual		
Chebyshev UCL can be computed us	ing the Nonn	arametric and All UCL Options of ProUCL 5.1		
Shapiro Wilk Test Statistic				
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level		
Lilliefors Test Statistic	0,177	Lilliefors GOF Test		
Deta appea	r Normal at	% Significance Level		
_ A51	suming Norm	al Distribution		
95% Normal LICL		95% UCLs (Adjusted for Skewness)		
95% Student's-t UCL	18	95% Adjusted-CLT UCL (Chen-1995)	17.81	
		95% Modified-t UCL (Johnson-1978)	18	
	Gamme	OF Test		
A-D Test Statistic	0.406	Anderson-Darling Gamma GOF Test		
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significan	ice Leval	
K-S Test Statistic	0.197	Kolmogorov-Smirnov Gamma GOF Test	an I '	
			ICB LOVE	
	06			
	Gamma	tatistics	•	
		k star (bias corrected MLE)	31.88	
		Theta star (bias corrected MLE)	0.516	
		-	2.912	
		Approximate Chi Square Value (0.05)	519,3	
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	508.3	
			18.56	
Consequences of the second sec	l	Constant Catting Confine attell (200		
	_			
		Shapiro Wilk Lognormal GOF Test		
	0.829	Data appear Lognormal at 5% Significance Level		
-		Infam concerned COE Test		
Lilliøfors Test Statistic	0.188	Lilliefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level		
Lilliefors Test Statistic 5% Lilliefors Critical Value	0.188 0.274	Lilliefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level 15% Significance Level		
Lilliefors Test Statistic 5% Lilliefors Critical Value	0.188 0.274 Lognormal	Data appear Lognarmal at 5% Significance Level t 5% Significance Level		
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.188 0.274 Lognormal	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics		
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.188 0.274 Lognormal Lognorms 2.565	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data	2.789	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear	0.188 0.274 Lognormal Lognorms 2.565	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics	2.789	
Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data	0.188 0.274 Lognormal Lognorma 2.565 2.996	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data	2.789	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Ass S5% H-UCL	0.188 0.274 Lognormal 2.565 2.996 Iming Logno	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data SD of logged Data that Distribution 90% Chebyshev (MVUE) UCL	2.789 0.155 18,99	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Ass S5% H-UCL S5% Chabyshev (MVUE) UCL	0.188 0.274 Lognormal 2.565 2.996 ming Logno . 18.24 20.15	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data mel Distribution	2.789 0.155 18,99	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Ass S5% H-UCL	0.188 0.274 Lognormal 2.565 2.996 ming Logno . 18.24 20.15	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data SD of logged Data that Distribution 90% Chebyshev (MVUE) UCL	2.789 0.155 18,99	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Asso 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL	0.188 0.274 Lognormal 2.565 2.995 	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data SD of logged Data that Distribution 90% Chebyshev (MVUE) UCL	2.789 0.155 18,99	
Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chabyshev (MVUE) UCL 99% Chabyshev (MVUE) UCL Nonpereme	0.188 0.274 Lognormal 2.565 2.996 ming Logno 18.24 20.15 24.89	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data SD of logged Data mel Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL	2.789 0.155 18,99	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL Nonperame Data appear to follow e D	0.188 0.274 Lognormal 2.565 2.996 	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data Intel Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL on Free UCL Statistics stribution at 5% Significance Level	2.789 0.155 18,99	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Ass 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL Nonpereme Data appear to follow e f	0.188 0.274 Lognormal 2.565 2.996 ming Logno 18.24 20.15 24.89 stric Distribution Discernible D	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data mai Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 00 Free UCL Statistics stribution Free UCLs	2.789 0.155 18.99 21.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL Nonparame Data appear to follow a f Nonpa	0.188 0.274 Lognormal 2.565 2.996 ming Logno 18.24 20.15 24.89 tric Distribut Jiscernible D	Data appear Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 1000 Free UCL Statistics stribution Free UCLs 95% Jackknife UCL	2.789 0.155 18.99 21.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Ass 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL Nonpereme Data appear to follow e f	0.188 0.274 Lognormal 2.565 2.995 	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data mai Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 00 Free UCL Statistics stribution Free UCLs	2.789 0.155 18.99 21.75 18 18 17.89	
Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chabyshev (MVUE) UCL 99% Chabyshev (MVUE) UCL 95% CLT UCL 95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL 95% BCA Bootstrap UCL	0.188 0.274 Lognormal 2.565 2.995 18.24 20.15 24.89 tric Distribut Discernible D rattetric Dis 17.73 17.64	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data and Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Data Stibution at 5% Significance Level fibution Free UCLs 95% Jackknile UCL 95% Percentile Bootstrap-1 UCL	2.789 0.155 18.59 21.75 18 18 17.78	
Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chabyshev(Mean, Sd) UCL	0.188 0.274 Lognormal 2.565 2.996 ming Logno 18.24 20.15 24.89 stric Distribut Discernible D 17.82 17.73 17.64 17.67 18.95	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Bootstrap-t UCL 95% Dootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL	2.789 0.155 18.59 21.75 18 17,75 17,78 17,78 20.08	
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Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chabyshev(Mean, Sd) UCL	0.188 0.274 Lognormal 2.565 2.996 ming Logno 18.24 20.15 24.89 tric Distribut Discernible D rametric Distribut 17.82 17.73 17.64 19.55 21.66	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Bootstrap-t UCL 95% Dootstrap-t UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL	2.789 0.155 18.59 21.75 18 17,75 17,78 17,78 20.08	
Lilliofors Test Statistic 5% Lilliofors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Chabyshev(Mean, Sd) UCL	0.188 0.274 Lognormal 2.565 2.995 aming Lognor 18.24 20.15 24.89 bric Distribut 26.89 bric Distribut 24.89 bric Distribut 17.82 17.73 17.64 17.67 18.95 21.66 Suggested	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Debtyshev (MVUE) UCL 95% Jacktmile UCL 95% Deotstrap-1 UCL 95% Deotstrap-1 UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL	2.789 0.155 18.59 21.75 18 17,75 17,78 17,78 20.08	
Lilliofors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% BCA Bootstrap UCL 95% Chebyshev(Mean, Sc) UCL 97.5% Chebyshev(Mean, Sc) UCL	0.188 0.274 Lognormal 2.565 2.995 18.24 20.15 24.89 tric Distribut Discernible D rametric Dis 17.73 17.64 17.67 18.95 21.66 Suggested 18	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Jackknile UCL 95% Bootstrap-1 UCL 95% Percentile Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL 95% UCL to Use	2.789 0.155 18.59 21.75 18 17.89 17.78 20.08 24.75	
Lilliofors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Latistical Statistical Statistical Statistical Nonparame Data appear to follow a I Nonparame 95% Standard Bootstrap UCL 95% Chebyshev (Mean, Sci) UCL 97.5% Chebyshev (Mean, Sci) UCL 95% Student's-t UCL 95% Student's-t UCL	0.188 0.274 Lognormal 2.565 2.995 2.995 18.24 20.15 24.89 tric Distribut Discernible D 17.82 17.73 17.64 17.67 18.95 21.66 Suggested 18	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Doctstrap-t UCL 95% Doctstrap-t UCL 95% Doctstrap-t UCL 95% Percentile Boctstrap UCL 95% Chebyshev(Mean, Sd) UCL 93% Chebyshev	2.789 0.155 18.59 21.75 18 17.89 17.78 20.08 24.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Half's Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Staudents-t UCL 95% Staudents-t UCL 95% Staudents-t UCL	0.188 0.274 Lognormal 2.565 2.996 ming Logno 18.24 20.15 24.89 stric Distribut Discemble D 17.82 17.73 17.64 17.67 18.95 21.66 Suggested 18	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Bootstrap-t UCL 95% Bootstrap-t UCL 95% Chebyshev(Mean, Sd) UCL 93% Ch	2.789 0.155 18.99 21.75 17.89 17.89 17.78 20.08 24.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL 95% Hall's Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-1 UCL 95% Student's-1 UCL Note: Suggestions regarding the selection of a 35 Recommendations are based upon the res	0.188 0.274 Lognormal 2.565 2.996 	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Doctstrap-t UCL 95% Doctstrap-t UCL 95% Doctstrap-t UCL 95% Percentile Boctstrap UCL 95% Chebyshev(Mean, Sd) UCL 93% Chebyshev	2.789 0.155 18.99 21.75 21.75 21.75 21.75 21.75 20.08 24.75 20.08 24.75 21.25 20.08 24.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL 95% Hall's Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-1 UCL 95% Student's-1 UCL Note: Suggestions regarding the selection of a 35 Recommendations are based upon the res	0.188 0.274 Lognormal 2.565 2.996 	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Jackknife UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 1000 UCL to Use	2.789 0.155 18.99 21.75 21.75 21.75 21.75 21.75 20.08 24.75 20.08 24.75 21.25 20.08 24.75	
Lilliofors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% Hall's Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-t UCL 95% Student's-t UCL 95% Student's-t UCL Note: Suggestions regarding the selection of a 35 Recommendations are based upon the res These recommendations are based upon the res	0.188 0.274 Lognormal 2.565 2.995 ming Lognor 18.24 20.15 24.89 tric Distribut Discernible D rametric Dis 17.82 17.73 17.64 17.67 17.64 17.67 18.95 21.66 Suggested 18	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data SD of logged Data (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Jackknife UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Dootstrap-1 UCL 95% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 99% Chebyshev(Mean, Sd) UCL 1000 UCL to Use	2.789 0.155 18.99 21.75 21.75 21.75 21.75 21.75 20.08 24.75 20.08 24.75 21.25 20.08 24.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% BCA Bootstrap UCL 95% BCA Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-LUCL 95% Student's-LUCL 95% Student's-LUCL Note: Suggestions regarding the selection of a 35 Recommendations are based upon the res However, simulations results will not cover all Real 1 Note: For highly negatively-skewed data, confid	0.188 0.274 Lognormal 2.565 2.995 780 2.995 780 2.995 78	Data appear Lognormal at 5% Significance Level 15% Significance Level Statistics Mean of logged Data SD of logged Data SD of logged Data and Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 95% Jackknife UCL 95% Jackknife UCL 95% Jackknife UCL 95% Dotstrap-1 UCL 95% Dotstrap-1 UCL 95% Chebyshev(Mean, Sd) UCL 100 UCL to Use 100 UCL to Use	2.789 0.155 18.99 21.75 21.75 21.75 21.75 21.75 20.08 24.75 20.08 24.75 21.25 20.08 24.75	
Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 95% Standard Bootstrap UCL 95% Standard Bootstrap UCL 95% BCA Bootstrap UCL 95% BCA Bootstrap UCL 95% Chebyshev(Mean, Sd) UCL 97.5% Chebyshev(Mean, Sd) UCL 95% Student's-LUCL 95% Student's-LUCL 95% Student's-LUCL Note: Suggestions regarding the selection of a 35 Recommendations are based upon the res However, simulations results will not cover all Real 1 Note: For highly negatively-skewed data, confid	0.188 0.274 Lognormal 2.565 2.995 780 2.995 780 2.995 78	Data appear Lognormal at 5% Significance Level 15% Significance Level Stellation Stella	2.789 0.155 18.99 21.75 21.75 21.75 21.75 21.75 20.08 24.75 20.08 24.75 21.25 20.08 24.75	
	Minimum Maximum SD Coefficient of Variation Note: Sample size is small (e.g., <10), guidance provided in ITRC Tech Reg G For example, you may want to Chebyshev UCL can be computed ps Chebyshev UCL can be computed ps Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Critical Value Deta eppee Ass 95% Normal UCL 95% Student's-t UCL 95% Student's-t UCL 5% A-D Test Statistic 5% A-D Critical Value Chebyshev UCL can be computed ps Ass 95% Normal UCL 95% Student's-t UCL 95% Student's-t UCL 95% Student's-t UCL 95% A-D Critical Value Chebyshev UCL can be computed ps K-S Test Statistic 5% A-D Critical Value Detacted data appear k hat (MLE) mu hat (MLE) MLE Mean (bias corrected) Adjusted Level of Significance Stapiro Wilk Test Statistic	Total Number of Observations 9 Minimum 13 Maximum 20 SD 2,506 Coefficiant of Veriation 0.152 Note: Sample size is small (e.g., <10), if data are computed in TFRC Tech Reg Guide on ISM	<td>Minimum 13 Number of Missing Observations Maximum 20 Median Maximum 20 Median State 2,508 Stat. Error of Mean Coefficient of Veriation 0.152 Stewness Note: Sample size is smail (e.g., <10), if data are collected using ISM approach, you should use</td> guidence provided in ITRC Tech Reg Guide on ISM (TRC, 2012) to compute statistics of Interest. For example, you may want to use Chebyshev UCL to estimate EPC (TRC, 2012). Chebyshev UCL can be computed yising the Nonparametric and All UCL Options of ProUCL 5.1 Chebyshev UCL can be computed yising the Nonparametric and All UCL Options of ProUCL 5.1 Stappico Wilk Critical Value 0.228 Shapiro Wilk Critical Value 0.229 Data spear Normal at 5% Significance Level Lillefors Text Statistic 0.177 Lillefors GOF Test S% Students-t UCL 95% UCLs (Adjusted for Skewness) 95% Normal at 5% Significance Level Data spear Normal at 5% Normal UCL 95% UCLs (Adjusted for Skewness) 95% Modified 41 UCL (Johnson-1978) Gamma GOF Test A-D Test Statistic 0.406 Anderson-Derling Gamma GOF Test A-D Test Statistic 0.157 Detected data spear Gamma Distributed at 5% Signifi	Minimum 13 Number of Missing Observations Maximum 20 Median Maximum 20 Median State 2,508 Stat. Error of Mean Coefficient of Veriation 0.152 Stewness Note: Sample size is smail (e.g., <10), if data are collected using ISM approach, you should use

_	A B C D E	F	G H J K	
215				
216	ADC3c 0.5-1 ft bgs As			
217				
218		General S		
219	Total Number of Observations	10	Number of Distinct Observations	8
220			Number of Missing Observations	2
221	Minimum	12	Mean	16
222	Maximum	20	Median	16
223	ŚD	2.749	Std. Error of Mean	0.869
224	Coefficient of Variation	0.172	Skewness	0
225				
226		Normal G	OF Test	
227	Shapiro Wilk Test Statistic	0.939	Shapiro Wilk GOF Test	
228	5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level	
229	Lilliefors Test Statistic	0.167	Lilliofors GOF Test	
230	5% Lilliefors Critical Value	0.262	Data appear Normal at 5% Significance Level	
	Data appor	r Normal at l	5% Significance Level	
231				
232	<u>.</u>	suming Norm	al Distribution	
233	95% Normal UCL	• · · ·	95% UCLs (Adjusted for Skewness)	
234	95% Student's-t UCL	17.59	95% Adjusted-CLT UCL (Chen-1995)	17.43
235		(1100	95% Modified-t UCL (Johnson-1978)	17.59
236		l	ao is maxima-r non facilitadis, (910)	
237		Gamma (IOF Test	
238	A-D Test Statistic	0.356	Anderson-Darting Gamma GOF Test	
239				n lovel
240	5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significant	Le 1946;
241	K-S Test Statistic	0,184	Kolmogorov-Smimov Gamma GOF Test	
242	5% K-S Critical Value	0,266	Detected data appear Gamma Distributed at 5% Significant	ce Levei
243	Detected data appear	Gemma Dist	ributed at 5% Significance Level	
244	······································			
245		Gamma		
246	k hat (MLE)	37	k star (bias corrected MLE)	25.97
247	Theta hat (MLE)	0.432	Theta star (bias corrected MLE)	0.616
248	nu hat (MLE)	740	nu star (bias correctad)	519,4
249	MLE Mean (bias corrected)	16	MLE Sd (bias corrected)	3.14
250			Approximate Chi Square Value (0.05)	467.5
251	Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	458,9
252				
253	As		ma Distribution	
	As 95% Approximate Gamma UCL (use when n>=50)		me Distribution 95% Adjusted Gamma UCL (use when n<50)	18.11
253		17.77	95% Adjusted Gamma UCL (use when n<50)	18.11
253 254	95% Approximate Gamma UCL (use when n>=50)	17.77 Lognormal	95% Adjusted Gamma UCL (use when n<50) GOF Teet	18.11
253 254 255	95% Approximate Gemma UCL (use when n>=50) Shepiro Wilk Test Statistic	17.77 Lognormal 0.938	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test	18.11
253 254 255 256	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	17.77 Lognormal 0.938 0.842	95% Adjusted Gamma UCL (use when n<50) GOF Teet Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level	18.11
253 254 255 256 257 258	95% Approximate Gemma UCL (use when n>=50) Shepiro Wilk Test Statistic	17.77 Lognormal 0.938	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test	18.11
253 254 255 256 257	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value	17.77 Lognormal 0.938 0.842	95% Adjusted Gamma UCL (use when n<50) GOF Teet Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level	18.11
253 254 255 256 257 258 259	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value	17.77 Lognormal 0.938 0.842 0.174 0.262	95% Adjusted Gamma UCL (use when n<50) GOF Teet Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefans Lognormal GOF Test	18.11
253 254 255 256 257 258 259 260 261	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value	17.77 Lognormal 0.938 0.842 0.174 0.262	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal GOF Test Data appear Lognormal at 5% Significance Level	18.11
253 254 255 256 257 258 259 260	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear	17.77 Lognormal 0.938 0.842 0.174 0.262	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefars Lognormal at 5% Significance Level at appear Lognormal at 5% Significance Level IStatistics	
253 254 255 256 257 258 259 260 261 262	95% Approximate Gamma UCL (use when n>=50) Shapiro Wik Test Statistic 5% Shapiro Wik Critical Value Uillefors Test Statistic 5% Littlefors Critical Value Data appear Minimum of Logged Data	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal e Lognormal 2.485	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data	2.759
253 254 255 256 257 258 259 260 261 262 263	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal e Lognormal 2.485	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefars Lognormal at 5% Significance Level at appear Lognormal at 5% Significance Level IStatistics	
253 254 255 256 257 258 259 260 261 262 263 264 265	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal e Lognormal 2.485	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data	2.759
253 254 255 256 257 258 259 260 261 262 263 264 265 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wik Test Statistic 5% Shapiro Wik Critical Value Uillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal a 2.485 2.996	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level t 5% Significance Level Statistics Mean of logged Data	2.759
253 254 255 256 257 258 259 260 261 262 263 264 265 265 266 265	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal a 2.485 2.996	95% Adjusted Gamma UCL (use when n<50) GOF Teet Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level t 5% Significance Level I Statistics Mean of logged Data SD of logged Data	2.759
253 254 255 256 257 258 259 260 261 262 263 264 265 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Test Statistic 5% Lilliefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.596 ming Logno	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefars Lognormal at 5% Significance Level Data appear Lognormal at 5% Significance Level 1 Statistics Mean of logged Data SD of logged Data SD of logged Data	2.759 0.175
253 254 255 256 257 258 259 260 261 262 263 264 265 266 266 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal a Lognormal 2.485 2.996 ming Logno 17.86	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefans Lognormal at 5% Significance Level t 5% Significance Level 1 Statistics Mean of logged Data SD of logged Data SD of logged Data mal Distribution 90% Chebyshev (MVUE) UCL	2.759 0.175 18.66
253 254 255 256 257 258 259 260 261 262 263 264 265 265 266 265 266 265 266 265 266 265 266 265 266 265 266 265 265	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Uillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data S5% H-UCL 95% Chebyshev (MVUE) UCL	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.996 aming Logno 17.85 19.86	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefans Lognormal at 5% Significance Level t 5% Significance Level 1 Statistics Mean of logged Data SD of logged Data SD of logged Data mal Distribution 90% Chebyshev (MVUE) UCL	2.759 0.175 18.66
253 254 255 256 257 258 259 260 261 262 263 264 265 266 266 266 266 266 266 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.996 ming Logno 17.86 19.86 24.82	95% Adjusted Gamma UCL (use when n<50) GOF Test Shepiro Wilk Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefans Lognormal at 5% Significance Level t 5% Significance Level 1 Statistics Mean of logged Data SD of logged Data SD of logged Data mal Distribution 90% Chebyshev (MVUE) UCL	2.759 0.175 18.66
253 254 255 256 257 258 259 260 261 262 263 264 265 266 266 266 266 266 266 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Lillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.996 iming Logno 17.86 19.86 24.82 tric Distribut	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefars Lognormal at 5% Significance Level t 5% Significance Level I Statistics Mean of logged Data SD of logged Data SD of logged Data SD of logged Data 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL	2.759 0.175 18.66
253 254 255 257 258 259 260 261 262 263 264 265 266 266 266 266 266 266 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Uillefors Test Statistic 5% Lilliefors Trest Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL Nonparame Data appear to follow a L	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.996 iming Logno 17.86 19.86 24.82 tric Distribut	95% Adjusted Gamma UCL (use when n<50) GOF Test Shapiro Wilk Lognormal GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Uillefors Lognormal at 5% Significance Level 1 Statistics Mean of logged Data SD of logged Data SD of logged Data 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 00 Free UCL Statistics	2.759 0.175 18.66
253 254 255 256 257 258 259 260 261 262 263 264 265 266 266 266 266 266 266 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Uillefors Test Statistic 5% Lillefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 09% Chebyshev (MVUE) UCL	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.996 17.85 19.86 24.82 arring Logno 17.86 19.86 24.82	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lillefons Lognormal at 5% Significance Level t 5% Significance Level I Statistics Mean of logged Data SD of logged Data SD of logged Data mai Distribution 90% Chebyshev (MVUE) UCL 97.5% Chebyshev (MVUE) UCL 100 Free UCL Statistics Istribution at 5% Significance Level	2.759 0.175 18.66
253 254 255 256 257 258 259 260 261 262 263 264 265 266 266 266 266 266 266 266 266 266	95% Approximate Gamma UCL (use when n>=50) Shapiro Wilk Test Statistic 5% Shapiro Wilk Critical Value Uillefors Test Statistic 5% Lilliefors Critical Value Data appear Minimum of Logged Data Maximum of Logged Data 95% H-UCL 95% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 99% Chebyshev (MVUE) UCL 020% Chebyshev (MVUE) UCL 95% Chebyshev (MVUE) UCL 020% Chebyshev (DVUE) UCL 020% Ch	17.77 Lognormal 0.938 0.842 0.174 0.262 Lognormal 2.485 2.996 aming Logno 17.86 19.86 24.82 tric Distribution Iscomble D remetric Dist	95% Adjusted Gamma UCL (use when n<50) GOF Test Data appear Lognormal GOF Test Data appear Lognormal at 5% Significance Level Lilliefors Lognormal at 5% Significance Level to Sharificance Level Istatistics Mean of logged Data SD of logged Data statistics Interpret Statistics Interpret Statistics Interpret Statistics Istribution at 5% Significance Level Interpret Statistics	2.759 0.175 18.66 21.54
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Adair Park Archery Range Draft Remedial Action Plan VRP SITE CODE 505354-00

> APPENDIX C Updated Stormwater Conveyance Report

UPDATED STORMWATER CONVEYANCE EVALUATION for Adair Memorial Park Archery Range

YUMA COUNTY, ARIZONA

Prepared for:



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ATTACHMENT B – PRELIMINARY CONSTRUCTION COST ESTIMATE, SECTION THREE (OPTION 2 – SHOTCRETE)

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1.0 Objective

In August 2000, an initial site assessment of the Adair Park Archery Range revealed the presence of elevated lead concentrations in the soil and tailings within the archery range. In 2006 Yuma County entered the Arizona Department of Environmental Quality's (ADEQ) Voluntary Remediation Program (VRP) and prepared a work plan to remediate contaminated soil. Remediation activities in the work plan included excavating and relocating contaminated soil to an area within the site and capping it with a gravel base and a double chip seal surface. ADEQ conducted a subsequent field review of the project site to determine if additional characterization and remedial activities are necessary to meet the requirements for a No Further Action Determination (NFA). ADEQ made recommendations in their letter dated June 4, 2014 and September 2017 Summary. The Yuma County Department of Public Works retained Nicklaus Engineering Inc. to prepare a Stormwater Conveyance Evaluation Report that addresses the ADEQ site inspection recommendations.

This report analyzes the current conditions and the effects of stormwater runoff on the current upstream protective rip-rap wall, the protective capped surface, drainage channels, and the southern retention basins. Furthermore, upon the found conditions this report proposes recommendations and modifications to the current stormwater conveyance system.

2.0 Project Location

The Adair Park Archery Range is situated in the western portion of Adair Park which is located at 4760 South US Highway 95 at the intersection of Highway 95 and Adair Park Road in Yuma County, Arizona. The site is located approximately 12 miles northeast of Yuma, Arizona on the southern base of the Laguna Mountains. It can be described as being located within Section 5, Township 8 South, Range 21 West of the Gila and Salt River Base and Meridian in Yuma County, Arizona.

The site comprises mostly undeveloped desert with several improvements and structures suitable for rifle, pistol and archery ranges.

The area of analysis falls in within a dry ephemeral wash that drains into the Gila River. The watershed area of analysis is enclosed on the North, East and West by mountain ridge lines and bordered in the south by Adair Park Road. An aerial image with boundaries is depicted in Figure 2.0.



Figure 2.0 Aerial image with site boundaries

3.0 Geohydrology

The existing terrain of the watershed area is undeveloped desert, it is a dry ephemeral wash enclosed by mountain ridges. The soil condition as defined by the U.S. Department of Agriculture Soil Conservation Service is of the Laposa-Rock outcrop classification for the mountain area and of the Indio-Ripley-Lagunita classification for the dry wash area. The Laposa-Rock outcrop classification is moderately deep steep, well drained, extremely gravelly soils, and rock outcrops on hills and mountains. The Indio-Ripley-Lagunita classification is deep, nearly level to gently sloping, well drained and somewhat excessively drained, silty and sandy soils on flood plains, low terraces and alluvial fans and in drainageways.

According to the Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map No. 04027C1245F, with an effective date of January 16, 2014, for Community No. 040099, in Yuma County, Arizona; approximately 600 feet of the southernmost portion of the site is located within Flood Zone AE and the remainder of the site is located within Flood Zone AE is described as "special flood hazard areas subject

to inundation by the 1% annual chance flood". Flood Zone X is described as "areas determined to be outside the 0.2% annual chance floodplain".

According to the January 2018 revision of the U.S. Bureau of Reclamation Depth to Groundwater Map for the Wellton – Mohawk Valley, the average depth to groundwater at the area of the bottom of the existing retention basins is approximately 10 feet. On March 06, 2019 soil borings were performed at the site and groundwater was encountered at a depth of 14.70 feet. Additionally, a second soil boring at the middle of the site indicated that groundwater is only present under the southern portion of the site, primarily due to the presence of shallow bedrock under the site.

4.0 Methodology

The methodology used to obtain the stormwater quantification and movement is based upon calculations utilizing the rational method with input data from the Public Works Standards for Yuma County Volume III, Storm Drainage Facilities, August 21, 2006 along with the Drainage Policies and Standards Manual for Maricopa County, Arizona, August 22, 2018 Revision. On the other hand, the water dynamics around the areas of interest was modeled utilizing the geographic data from the topographic survey and using the HEC RAS US Army software.

5.0 Area Definition

The terrain was divided into four areas based upon changes in topography, and geomorphic compositions. Figure 5.0 shows the areas enclosed within the site. Based upon steepness for times of concentration purposes; Area A is denoted entirely as mountainous and having a steepness of more than 20%. Areas B/B1 are also labeled as mountainous with an approximate steepness of 5% and ends north of the protective capped surface. Areas C/C1 contains the existing capped surface that was built based on a previous environmental evaluation. This area consists of relocated in-site material, imported aggregate base course and a double chip seal surface. Areas D/D1 are desert range land with several structures and rip rap channels. Area E is desert range land with several structures and the existing retention basins. The purpose of the splitting the terrain was to quantify the generation of stormwater runoff and its effects on the protective wall, stormwater drainage channels, capped surface, and the stormwater retention capacity of the existing retention basins.

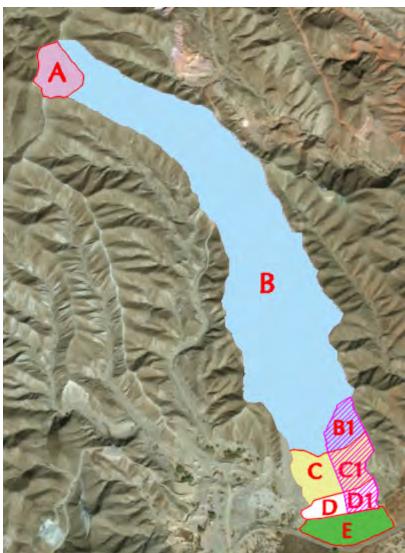


Figure 5.0 Areas Within the Site.

6.0 Storm water Runoff Volume Calculations

Storm Water Drainage Areas:

To quantify the storm water runoff water imputed to the existing retention basins, rainfall from the entire site (Areas A, B/B1, C/C1, D/D1 and E as shown in Figure 5.0) and a 100-year, 2-hour storm was used.

Figure 6.0 denotes the terrain types present at the site and they are differentiated with distinct colors.

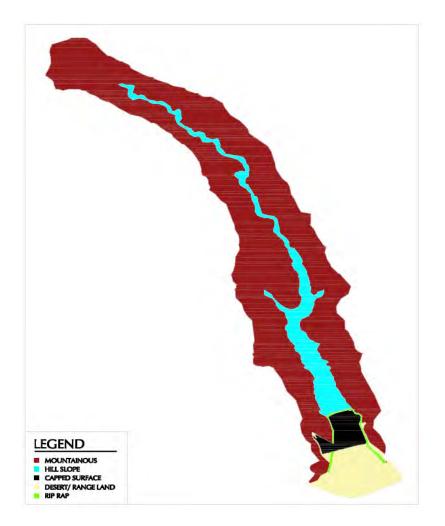


Figure 6.0: Site Terrain Types.

Table 6.0 summarizes the distinct types of terrains and characteristics obtained from the calculated areas shown in Figure 6.0. The "C" Factor for the Desert/Range Land has been determined from Appendix C, Runoff Curve Numbers by Soil Type & Zoning Classification, Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006. The remaining terrain types are not shown in the Public Works Standards for Yuma County. The Drainage Policies and Standards for Maricopa County, Arizona, August 22, 2018 was used to determine the "C" Factor for the Mountainous, Hillslope and Cap Surface terrain types. The "C" Factor for Cap Surface was determined from Table 6.3, Rational Method Developed Condition C Coefficients. The "C" Factors for the Mountainous and Hillslope terrain types was determined from Table 6.4, Rational Method Natural Condition C Coefficients. The "C" Factor for the Rip-Rap terrain type was estimated.

TYPE OF TERRAIN	"C" FACTOR	AREA (ACRE)	СхА
MOUNTAINOUS	0.95	88.89	84.45
HILLSLOPE	0.69	12.28	8.47
CAP SURFACE	0.88	3.71	3.26
DESERT/ RANGE LAND	0.88	9.00	7.92
RIP-RAP	0.90	0.62	0.56
TOTAL	N/A	114.50	104.66

Table 6.0 Terrain Characteristics and Areas for the Entire Site.

A "C" factor of the various terrains was weighted with the result shown in the following calculation:

$$C_w = \frac{\sum (C \times A)}{\sum A}$$

$$C_w = \frac{104.66}{114.5} = 0.91$$

The storm water runoff – Entire Site for a 100-year, 2-hour storm is as follows: The Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006, Section 3.2.6 Retention and Detention Basins, Paragraph B, states if the rational method is used, the 100-year, 2-hour storm or 2.44 inches of total rainfall shall be used.

Use Rational Method: Q = CIA

Where:

Q = Peak Runoff Rate in cubic feet per second (CFS)

C = Weighted "C" as shown above (unitless)

I = Rainfall Intensity for 100-year, 2-hour storm as specified by Appendix A "Rainfall Intensity-Duration-Frequency Relationship for Yuma, Arizona" of Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006

A = Runoff Area in acres

$$Q = CiA$$

$$C = 0.91$$

$$i = 1.22 \frac{in}{hr}$$

$$A = 114.50 \ acres$$

$$Q = CiA = (0.91)(1.22)(114.50) = 127.12 CFS$$

Storm water Runoff Volume – Entire Site:

The storm water runoff volume for the entire site (Areas A, B/B1, C/C1, D/D1 and E - Figure 5.0) was calculated to analyze current retention basins conditions and verify

capacities. This volume was obtained considering a 100-year, 2hr-storm. The equation shown in Appendix E, Rational Method, Retention and Detention Basin Volume Design Data Sheet, Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006 was used to calculate the storm water runoff volume as follows:

Use: $V = \frac{1}{2}(2 tc)Q \times 3,600 \frac{sec}{hr}$

Where: V = volume in cubic feet Q = Discharge in cubic feet per second(shown below)tc = time of construction in hours

$$V = \frac{1}{2}(2 x 2)127.12 \times 3,600 = 915,264 ft^3$$

The storm water runoff – entire site for a 100-year, 2-hour storm is as follows:

Use Rational Method: Q = CIA

Where: Q = Peak Runoff Rate in cubic feet per second (CFS)

C = Weighted "C" as shown above (unitless)

I = Rainfall Intensity for 100-year, 2-hour storm as specified by Appendix A "Rainfall Intensity-Duration-Frequency Relationship for Yuma, Arizona" of Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006

A = Runoff Area in acres

$$Q = CiA$$

$$C = 0.91$$

$$i = 1.22 \frac{in}{hr}$$

$$A = 114.50 \ acres$$

Q = CiA = (0.91)(1.22)(114.50) = 127.12 CFS

Storm water Runoff Volume – capped surface:

The two existing retention basins were constructed as a part of Yuma County's remediation activities conducted in 2006. The existing retention basins were designed to accommodate the storm water runoff from the capped surface (Areas C/C1- Figure 5.0) constructed during those remediation activities. Calculations to analyze the capacities of the current retention basins compared to the capped surface were conducted. This volume was obtained considering a 100-year, 2hr-storm. The equation shown in Appendix E, Rational Method, Retention and Detention Basin Volume Design Data Sheet, Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006 was used to calculate the storm water runoff volume as follows:

Use: $V = \frac{1}{2}(2 tc)Q \times 3,600 \frac{sec}{hr}$

Where: V = volume in cubic feet Q = Discharge in cubic feet per second (shown below)tc = time of construction in hours

 $V = \frac{1}{2}(2 x 2)3.98 \times 3,600 = 28,656 ft^3$

The storm water runoff – capped surface for a 100-year, 2-hour storm is as follows:

Use Rational Method: Q = CIA

Where: Q = Peak Runoff Rate in cubic feet per second (CFS)

C = Weighted "C" as shown above (unitless)

I = Rainfall Intensity for 100-year, 2-hour storm as specified by Appendix A "Rainfall Intensity-Duration-Frequency Relationship for Yuma, Arizona" of Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006

A = Runoff Area in acres

$$Q = CiA$$

$$C = 0.88$$

$$i = 1.22 \frac{in}{hr}$$

$$A = 3.71 \ acres$$

Q = CiA = (0.88)(1.22)(3.71) = 3.98 CFS

7.0 Current Retention Basins Capacities

Considering the topographic survey, it was possible to calculate the volume of both existing retention basins found on site. The calculation is as follows:

Use:

$$V = h\left(\frac{A_{TOP} + A_{BOT}}{2}\right)$$

Where:

h = depth of water, ft

 A_{TOP} = area at top of retention basin, ft^2

 A_{BOT} = area at bottom of retention basin, ft^2

East Retention Basin:

Average Top Elevation	= 1	62.28
Average Bottom Elevation	<u>= 1</u>	<u>59.74</u>
Average <i>h</i>	=	2.54

$$A_{TOP} = 41,515 ft^{2}$$

$$A_{BOT} = 23,690 ft^{2}$$

$$W = 2 f 4 (41,515+23,690)$$

 $V = 2.54 \left(\frac{41,515+23,690}{2} \right) = 82,810 \, ft^2$

West Retention Basin:

Average Top Elevation	=	163.08
Average Bottom Elevation	=	160.61
Average <i>h</i>	=	2.47

$$A_{TOP}$$
 = 37,238 ft^2
 A_{BOT} = 15,487 ft^2

$$V = 2.47 \left(\frac{37,238+15,487}{2}\right) = 65,115 \, ft^2$$

Therefore, the capacity of both retention basins is:

Retention Basins Volume = East Basin + West Basin = 82,810
$$ft^3$$
 + 65,115 ft^3
= 147,925 ft^3

 $\begin{aligned} \textit{Retention Basins Capacity(entire site)} &= \frac{\textit{Retention Basins Volume}}{\textit{Runoff} - \textit{entire site}} = \frac{147,925 \textit{ ft}^3}{915,264 \textit{ ft}^3} \\ &= 0.1616 = 16.16\% \end{aligned}$

$$\begin{aligned} \textit{Retention Basins Capacity(capped area}) &= \frac{\textit{Retention Basins Volume}}{\textit{Runoff} - \textit{capped surface}} = \frac{147,925 \textit{ ft}^3}{28,656 \textit{ ft}^3} \\ &= 5.1621 = 516.21\% \end{aligned}$$

The storm water retention capacity of both existing retention basins combined equals 16.16% of the retention capacity required to retain 100% of the storm water runoff generated by the entire site for a 100-year, 2-hour storm. However, the storm water retention capacity of both existing retention basins combined is approximately 5 times the capacity required to retain the storm water runoff from the capped surface. A portion of the excess storm water runoff generated by the entire site leaving the existing retention basins is retained by Adair Park Road at the southern boundary of the site. Therefore, the stormwater storage capacity of the site was calculated using a low point of Adair Park Road as an outfall elevation. Calculations from an AutoCAD – Civil 3D surface model are as follows:

Name	Туре	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
East Basin Volume	full	1.000	1.000	74548,51	3863.77	0.00	3863.77 <cut></cut>
West Basin Volume	full	1.000	1.000	83579.86	5810.63	0.00	5810.63 <cut></cut>
Totals					_		
				2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total				158128.37	9674.39	0.00	9674.39 <cut></cut>

Overfill Volume = $9674.39 yd^3 = 261208.5 ft^3$

Capacity = $\frac{Overfill \, Volume}{Total \, Area \, Runoff} = \frac{261208.5 \, ft^3}{885,096 \, ft^3} = 0.2951 = 29.51\%$

Considering the volume calculated with the surface model, the percentage of storm water runoff from the entire site retained on site before overflow occurs at Adair Park Road is approximately 30%.

8.0 Channel Analysis

The two existing channels found in this project are a vital component in the design as they transport storm water runoff generated from most of the terrain into the existing retention basins. Considering the difference in elevation at the north end of each of the channels and based on flow models; the two channels were analyzed with different flow inputs. Each channel was analyzed in two different areas. One, as they flow around the capped surface and two, the desert area between the capped surface and the existing retention basins. Figure 8.0 shows these four areas of analysis. Sections One and Two originate at north end of the capped surface and run south to the south end of the capped surface (Area C/C1, Figure 5.0). Sections Three and Four flow through the desert area between the south end capped surface and the existing retention basins (Area D/D1, Figure 5.0). The storm water runoff created by Areas A, B, and C shown in Figure 5.0 flow through the channel in Section One (Figure 8.0), while the storm water runoff from Areas B1 and C1 flow through the channel in Section Two. The storm water runoff created by Areas A, B, C and D (Figure 5.0) flow through the channel in Section Three, while the storm water runoff from Areas B1, C1 and D1 flow through the channel in Section Four. For that reason, different times of concentration are calculated and used for the analysis of each channel.

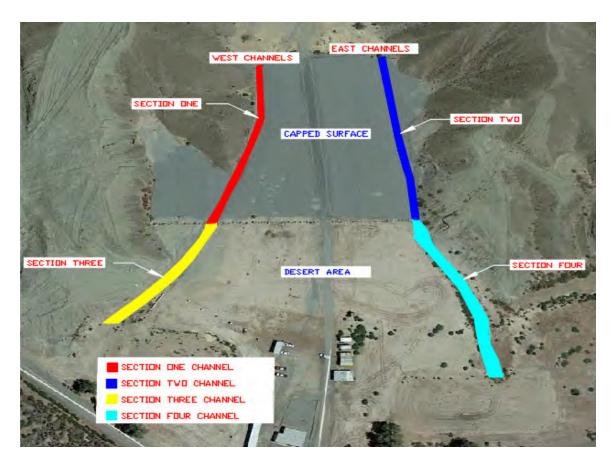


Figure 8.0 Storm water Drainage Channels.

Time of Concentration:

Time of concentration represent the accumulation of water from the furthest location of the tributary area to the point of interest. Due to changes in topography and geomorphic compositions, the time of concentration for each area was calculated separately and then combined for a total time of concentration.

The Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006, Section 3.2.5 Rational Method, Paragraph A, states "The equation, Q = CiA, may be used to compute peak runoff from urbanized areas up to 10 acres or non-urbanized areas up to 80 acres". Since the total area of the subject site is approximately 114.50 acres, this method was not used. However, Section 3.1 of the Drainage Design Manual for Maricopa County, Hydrology, December 14, 2018 states that the Rational Method can be used op to 160 acres. Equation 3.2 of this manual is used to calculate the time of concentration as shown below:

(Maricopa Drainage Design, Equation 3.2)

$$T_c = 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38}$$

Where:	T_c	=	time of concentration, in hours
	L	=	length of the longest flow path, in miles
	K_b	=	watershed resistance coefficient
	S	=	watercourse slope, in feet/mile
	i	=	rainfall intensity, in inches/hour.

8.1 Drainage Channel – Section One

Time of Concentration – Section One (Areas A, B, & C, Figure 5.0)

Area A:

L = 557 ft (0.1055 mi) $K_b = 0.05$ (Table 6.6, Maricopa Co. Drainage Policies and Standards) S = $\frac{621-429}{0.1055} = 1819.91$ i = 2.17 in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)

$$T_{cA} = 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38}$$

$$T_{cA} = 11.4(0.1055)^{0.5}(0.05)^{0.52}(1819.91)^{-0.31}(2.17)^{-0.38}$$

$$T_{cA} = 0.0567 hr = 3.40 min$$

Area B:

$$\begin{split} \text{L} &= 5535 \text{ ft} (1.0483 \text{ mi}) \\ K_b &= 0.03 \text{ (Table 6.6, Maricopa Co. Drainage Policies and Standards)} \\ \text{S} &= \frac{429 - 171}{1.0483} = 246.11 \\ \text{i} &= 2.17 \text{ in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)} \\ & T_{cB} &= 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38} \\ T_{cB} &= 11.4(1.0483)^{0.5}(0.03)^{0.52}(246.11)^{-0.31}(2.17)^{-0.38} \\ & T_{cB} &= 0.2548 \text{ }hr = 15.29 \text{ }min \end{split}$$

Area C:

L = 436 ft (0.0826 mi) $K_b = 0.015$ (Table 6.5, Maricopa Co. Drainage Policies and Standards) S = $\frac{171-168}{0.0826} = 36.32$ i = 2.17 in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)

$$\begin{split} T_{cC} &= 11.4 L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38} \\ T_{cC} &= 11.4 (0.0826)^{0.5} (0.015)^{0.52} (36.32)^{-0.31} (2.17)^{-0.38} \\ T_{cC} &= 0.0903 \ hr = 5.42 \ min \end{split}$$

Adding the three the times of concentration shown above, give a total time of concentration from the furthest part of the tributary at the north end of the site to the south end of the capped surface. This total time of concentration is:

$$T_{C SECTION ONE} = t_{cA} + t_{cB} + t_{cC} = 3.40 \min + 15.29 \min + 5.42 \min = 24.11 \min$$

The rainfall intensity from a 100-year storm correlating to this time of concentration was estimated to be 4.00 in/hr. using the Rainfall Intensity, Duration, Frequency Relationship for Yuma. This correlation and graph are shown in Figure 8.1-1

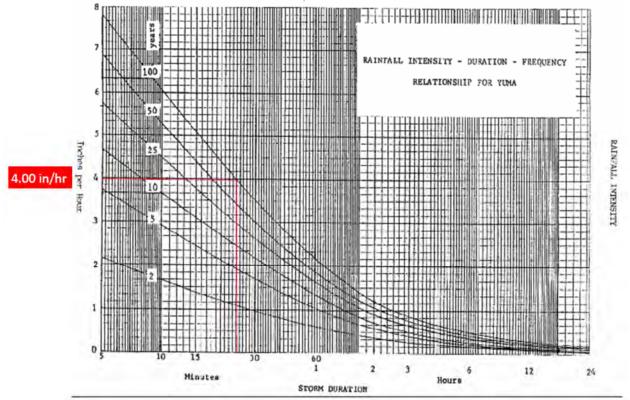


Figure 8.1-1 Rainfall Intensity - Duration – Frequency Relationship for Yuma (Section One)

Storm water Runoff – Section One:

The Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006, Section 3.8 Open Channel Standards, Paragraph 3.8.1, states that open channels shall convey the 100-year storm peak runoff within the banks. The storm water runoff for Section One with a 100-year storm, calculated $T_c = 24.11$ minutes is calculated using the Rational Method:

Where:

Q = Peak Runoff Rate in cubic feet per second (CFS) C = Weighted "C" as shown below (unitless)

- I = Rainfall Intensity as shown below (unitiess)
- A = Runoff Area in acres

Figure 8.1-2 denotes the terrain types present at Section One and are differentiated with distinct colors. Important to note that the hatched area, represents the drainage area for the east channels.

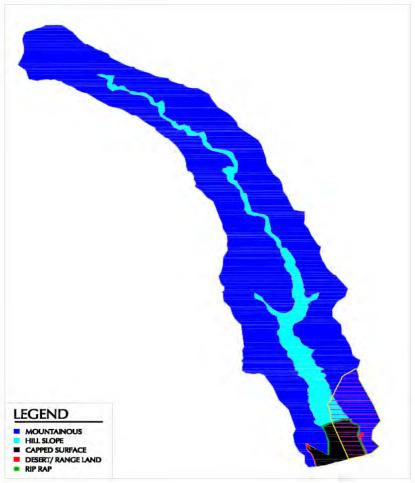


Figure 8.1-2 Types of Terrain Found for Section One.

Table 8.1-1 summarizes the distinct types of terrains and characteristics obtained from the calculated areas shown in Figure 8.1-2. The sources for the "C" Factors are discussed in the preparation of Table 6.0.

TYPE OF TERRAIN	"C" FACTOR	AREA (ACRE)	СхА
MONTAINOUS	0.95	82.79	78.65
HILLSLOPE	0.69	11.62	8.02
CAP SURFACE	0.88	1.86	1.64
DESERT/ RANGE LAND	0.88	0.10	0.09
RIP RAP	0.90	0.12	0.11
TOTAL	N/A	96.49	88.51

Table 8.1-1 Terrain Characteristics and Areas for Section One

The weighted "C" factor is then:

$$C_w = \frac{\sum (C \times A)}{\sum A}$$

Use Rational Method:

$$Q = CiA$$

$$C = 0.92$$

$$i = 4.00 \frac{in}{hr}$$

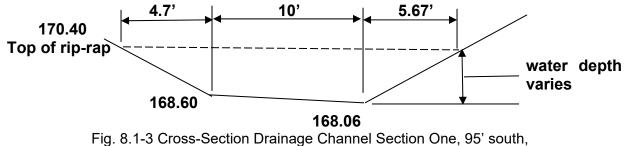
$$A = 96.49 \ acres$$

 $C_w = \frac{88.51}{96.49} = 0.92$

Q = CiA = (0.92)(4.00)(96.49) = 355.08 CFS

Capacity Provided: Drainage Channel Section One

A worse case location for Drainage Channel Section One has been identified as being located approximately 95 feet south of the protective rip-rap wall. At this location, the east bank and bottom of the channel consist of a double chip seal surface and the west bank is constructed out of 6" rip-rap rock. A cross-section of Drainage Channel Section One at this location is shown in Figure 8.1-3.



Looking North

The high-water elevation was calculated at the top of the rip-rap on the west bank of the drainage channel. Using the Manning's Formula, the worst case, storm water carrying capacity for the Drainage Channel Section One is as Follows:

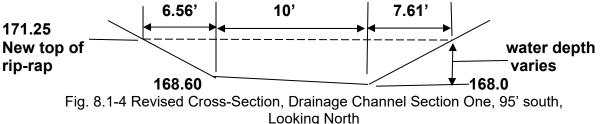
A = $\frac{1}{2}$ (4.7' x 1.80') + (10' x 1.80') + $\frac{1}{2}$ (10' x 0.54') + $\frac{1}{2}$ (5.67' x 2.34) = 31.56 sf WP = 20.37' R = A/WP = 31.56/20.37 = 1.5493 S = 0.73% N = 0.029 (N value weighted from N values for double chip seal surface (asphalt) and 6" rip-rap rock as shown on Tables 2.1 and 2.2, U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 15, Third Edition (Publication No. FWHA-NHI-05-114, September 2005) Design of Roadside Channels with Flexible Linings.

Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.029 (31.56) (1.5493)^{2/3} (0.0073)^{1/2} Q = 51.38 (31.56) (1.3389) (0.0854) Q = 185.41 cfs **Velocity** 185.41 cfs / 31.56 sf = 5.87 fps **Analysis** 185.41 cfs provided < 355.08 cfs required.

Drainage Channel Section One (Option 1 – Additional 6" Rip-rap Rock, west bank)

The storm water carrying capacity provided at a worse case location of the Drainage Channel Section One, with a high-water elevation at the top of the rip-rap on the west bank of the drainage channel, is less than the required storm water carrying capacity required for a 100-year storm, calculated Tc = 24.11 minutes.

The grade break that defines the eastern limits of the east bank of the drainage channel is calculated to be approximately 11.33 feet east of the eastern edge of the calculated high-water elevation. Adding rip-rap rock to the west bank of the drainage channel will allow the high-water elevation to be raised. If the high-water elevation is raised by 0.85 feet, the drainage channel will have the storm water carrying capacity required for the above referenced storm. This revision will contain the storm water runoff within the drainage channel with the eastern edge of the high-water elevation calculated to be approximately 9.27 feet east of the existing eastern edge of the existing drainage channel. The revised drainage channel cross-section (Figure 8.1-4) and calculations are as follows:



Using the Manning's Formula, the worst case, storm water carrying capacity for the Drainage Channel Section One is as Follows:

A = $\frac{1}{2}(6.92' \times 2.65') + (10' \times 2.65') + \frac{1}{2}(10' \times 0.54') + \frac{1}{2}(7.73' \times 3.19) = 50.70 \text{ sf}$ WP = 24.65' R = A/WP = 50.70/24.65 = 2.0568 S = 0.73% N = 0.29 (As described above) Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.029 (50.70) (2.0568)^{2/3} (0.0073)^{1/2} Q = 51.38 (50.70) (1.6174) (0.0854) Q = 359.81 cfs **Velocity** 359.81 cfs / 50.70 sf = 7.10 fps **Analysis** 359.81 cfs provided > 355.08 cfs required.

8.2 Drainage Channel – Section Two

Time of Concentration – Section Two (Areas B1, & C1, Figure 5.0)

Area B1:

L = 293 ft (0.0555 mi) $K_b = 0.03$ (Table 6.6, Maricopa Co. Drainage Policies and Standards) S = $\frac{174-171}{0.0555} = 54.05$ i = 2.17 in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)

$$T_{cB1} = 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38}$$

$$T_{cB1} = 11.4(0.0555)^{0.5}(0.03)^{0.52}(54.05)^{-0.31}(2.17)^{-0.38}$$

$$T_{cB1} = 0.0938 hr = 5.63 min$$

Area C1:

L = 436 ft (0.0826 mi) $K_b = 0.015$ (Table 6.5, Maricopa Co. Drainage Policies and Standards) S = $\frac{171-168}{0.0826} = 36.32$ i = 2.17 in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)

$$T_{cC1} = 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38}$$

$$T_{cC1} = 11.4(0.0826)^{0.5}(0.015)^{0.52}(36.32)^{-0.31}(2.17)^{-0.38}$$

$$T_{cC1} = 0.0903 hr = 5.42 min$$

The total time of concentration is:

$$T_{C \text{ SECTION TWO}} = t_{cB1} + t_{cC1} = 5.63 \text{ min} + 5.42 \text{ min} = 11.05 \text{ min}$$

The rainfall intensity from a 100-year storm correlating to this time of concentration was estimated to be 5.83 in/hr. using the Rainfall Intensity, Duration, Frequency Relationship for Yuma. This correlation and graph are shown in Figure 8.2-1.

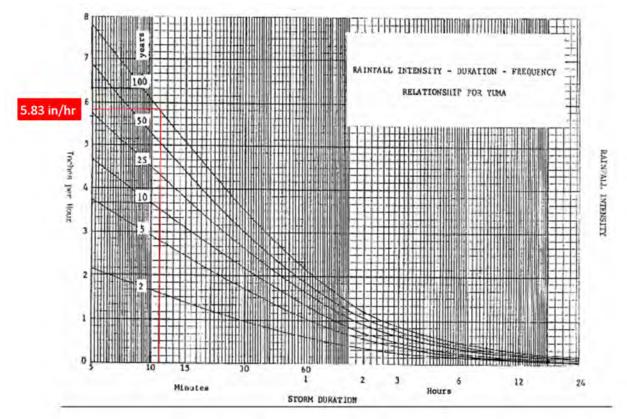


Figure 8.2-1 Rainfall Intensity - Duration – Frequency Relationship for Yuma (Section Two)

Storm water Runoff – Section Two:

The Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006, Section 3.8 Open Channel Standards, Paragraph 3.8.1, states that open channels shall convey the 100-year storm peak runoff within the banks. The storm water runoff for Section One with a 100-year storm, calculated $T_c = 11.05$ minutes is calculated using the Rational Method:

Q = CIA

Where: Q = Peak Runoff Rate in cubic feet per second (CFS)

C = Weighted "C" as shown below (unitless)

I = Rainfall Intensity as shown in Figure 8.5

A = Runoff Area in acres



Figure 8.2-2 Types of Terrain Found in Section Two (hatched area).

Table 8.2-1 summarizes the distinct types of terrains and characteristics obtained from the calculated areas shown in Figure 8.2-2. The sources for the "C" Factors are discussed in the preparation of Table 6.0.

TYPE OF TERRAIN	"C" FACTOR	AREA (ACRE)	СхА
MONTAINOUS	0.95	4.75	4.51
HILLSLOPE	0.69	0.66	0.46
CAP SURFACE	0.88	1.85	1.63
DESERT/ RANGE LAND	0.88	0.08	0.07
RIP RAP	0.90	0.21	0.19
TOTAL	N/A	7.55	6.86

Table 8.2-1 Terrain Characteristics and Areas for Section Two

The weighted "C" factor is then:

$$C_w = \frac{\sum(C \times A)}{\sum A}$$
$$C_w = \frac{6.86}{7.55} = 0.91$$

Use Rational Method:

$$Q = CiA$$

$$C = 0.91$$

$$i = 5.83 \frac{in}{hr}$$

$$A = 7.55 \ acres$$

$$Q = CiA = (0.91)(5.83)(7.55) = 40.06 CFS$$

Capacity Provided: Drainage Channel Section Two

A worse case location for Drainage Channel Section Two has been identified as being located approximately 260 feet south of the protective rip-rap wall. A cross-section of the drainage channel at this location is shown in Figure 8.2-3.

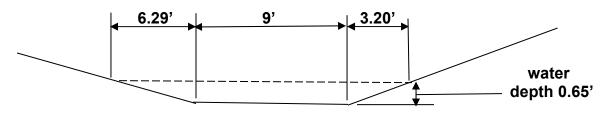


Figure 8.2-3 Cross-Section, Drainage Channel Section Two, 260' south, Looking North

Using the Manning's Formula, the worst case, storm water carrying capacity for the East Drainage Channel (Section Two) is as Follows:

 $\begin{array}{l} \mathsf{A} = \frac{1}{2} \ (6.29' \ x \ 0.65') + (9' \ x \ 0.65') + \frac{1}{2} \ (3.20' \ x \ 0.65) = 8.93 \ \text{sf} \\ \mathsf{WP} = 18.49' \\ \mathsf{R} = \mathsf{A}/\mathsf{WP} = 8.93/188888.49 = 0.4830 \\ \mathsf{S} = 0.70\% \\ \mathsf{N} = 0.016 \ (\text{Tables } 2.1, \ \mathsf{U.S. Department of Transportation, Federal Highway} \\ \mathsf{Administration, Hydraulic Engineering Circular No. 15, Third Edition (Publication No. 15) \\ \mathsf{N} = 0.016 \ (\mathsf{Tables } 1.1, \ \mathsf{U.S. Department of Image is a state of the explicit o$

Administration, Hydraulic Engineering Circular No. 15, Third Edition (Publication No. FWHA-NHI-05-114, September 2005) Design of Roadside Channels with Flexible Linings.

Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.016 (8.93) (0.4830)^{2/3}(0.0070)^{1/2} Q = 93.13 (8.93) (0.6156) (0.0837) Q = 42.85 cfs

Velocity 42.85 cfs / 8.93 sf = 4.80 fps **Analysis** 42.85 cfs provided > 40.96 cfs required

The storm water carrying capacity provided at a worse case location of Drainage Channel Section Two, with a water depth of 0.65 feet is greater than the required storm water carrying capacity required for a 100-year storm, calculated Tc = 11.05 minutes.

The existing drainage channel will contain the storm water runoff within the drainage channel with the eastern edge of the high-water elevation calculated to be approximately 5.80 feet east of the eastern edge of the existing eastern edge of the existing drainage channel.

8.3 Drainage Channel – Section Three

Time of Concentration – Section Three (Areas A, B, C & D Figure 5.0)

Adding the time of concentration for Area D to the time of concentration calculated for Section One, as shown above, gives the time of concentration for Section Three:

Area D:

L = 333 ft (0.0631 mi) $K_b = 0.025$ (Table 6.5, Maricopa Co. Drainage Policies and Standards) S = $\frac{168-164}{0.0631} = 63.39$ i = 2.17 in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)

$$\begin{split} T_{cD} &= 11.4 L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38} \\ T_{cD} &= 11.4 (0.0631)^{0.5} (0.025)^{0.52} (63.39)^{-0.31} (2.17)^{-0.38} \\ T_{cD} &= 0.00866 \ hr = 5.20 \ min \end{split}$$

Total time of concentration for Section Three is:

 $T_{C SECTION THREE} = T_{C SECTION ONE} + T_{cD} = 24.11 \min + 5.20 \min = 29.31 \min$

The rainfall intensity from a 100-year storm correlating to this time of concentration was estimated to be 3.58 in/hr. using the Rainfall Intensity, Duration, Frequency Relationship for Yuma. This correlation and graph are shown in Figure 8.3-1.

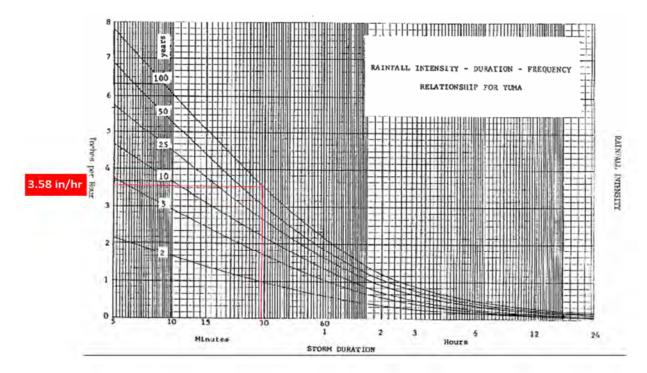


Figure 8.3-1 Rainfall Intensity - Duration – Frequency Relationship for Yuma (Section Three)

Storm water Runoff – Section Three:

The Public Works Standards for Yuma County, Volume III, Storm Drainage Facilities, August 21, 2006, Section 3.8 Open Channel Standards, Paragraph 3.8.1, states that open channels shall convey the 100-year storm peak runoff within the banks. The storm water runoff for Section Three with a 100-year storm, calculated $T_c = 29.31$ minutes is calculated using the Rational Method:

Q = CIA

Where:

Q = Peak Runoff Rate in cubic feet per second (CFS)

C = Weighted "C" as shown below (unitless)

I = Rainfall Intensity as shown in Figure 8.8

A = Runoff Area in acres

Figure 8.9 denotes the terrain types present at the site and they are differentiated with distinct colors.

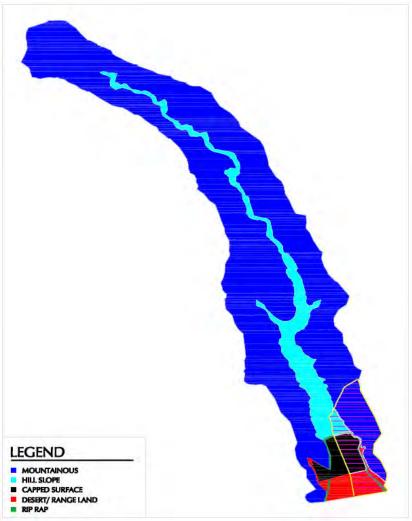


Figure 8.3-2 Types of Terrain Found in Section Three

Table 8.3-1 summarizes the distinct types of terrains and characteristics obtained from the calculated areas shown in Figure 8.3-2. The sources for the "C" Factors are discussed in the preparation of Table 6.0.

TYPE OF TERRAIN	"C" FACTOR	AREA (ACRE)	СхА
MONTAINOUS	0.95	83.5	79.33
HILLSLOPE	0.69	11.62	8.02
CAP SURFACE	0.88	1.86	1.64
DESERT/ RANGE LAND	0.88	1.58	1.39
RIP RAP	0.90	0.23	0.21
TOTAL	N/A	98.79	90.59

Table 8.3-1 Terrain Characteristics and Areas for Section Three

The weighted "C" factor is then:

$$C_w = \frac{\sum (C \times A)}{\sum A}$$

$$C_w = \frac{90.59}{98.79} = 0.92$$

Use Rational Method:

$$C = 0.92$$
$$i = 2.42 \frac{in}{hr}$$
$$A = 98.80 \ acres$$

Q = CiA

Q = CiA = (0.92)(3.58)(98.80) = 325.41 CFS

Capacity Provided: Drainage Channel Section Three

A worse case location for Drainage Channel Section Three has been identified as being located approximately 195 feet south of the southern end of the capped section (Area C, Figure 5.0). This drainage channel consists of loos cobble and rip-rap (see Figure 9.5). A cross-section of the West Drainage Channel at this location is shown in Figure 8.3-3.

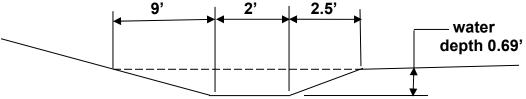


Figure 8.3-3 Cross-Section, Drainage Channel Section Three, 195' south, Looking North

Using the Manning's Formula, the worst case, storm water carrying capacity for the West Drainage Channel (Section Three) is as Follows:

 $\begin{array}{l} \mathsf{A} = \frac{1}{2} \left(5.60' \ x \ 0.69' \right) + \left(2' \ x \ 0.69' \right) + \frac{1}{2} \left(2.5' \ x \ 0.60' \right) = 4.17 \ \text{sf} \\ \mathsf{WP} = 10.10' \\ \mathsf{R} = \mathsf{A}/\mathsf{WP} = 4.17/10.10 = 0.4129 \\ \mathsf{S} = 1.22\% \qquad \mathsf{N} = 0.062 \ (\mathsf{N} \ \text{value from Table7.7, Drainage Design Manual for Maricopa County, Arizona, December 14 ,2018)} \end{array}$

Q = $1.49/N (A)(R)^{2/3} S^{1/2}$ Q = $1.49/0.062(4.17) (0.4129)^{2/3} (0.0122)^{1/2}$ Q = 24.03(4.17) (0.5545) (0.1105)Q = 6.14 cfs

Velocity

6.14 cfs / 4.17 sf = 1.47 fps

Analysis

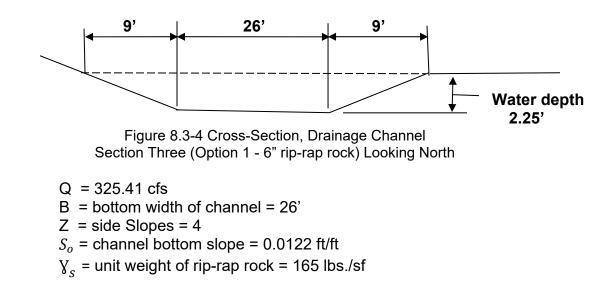
Use:

6.14 cfs provided < 325.41 cfs required

Drainage Channel Section Three (Option 1 – 6" Rip-rap Rock)

The storm water carrying capacity provided at a worse case location of Drainage Channel Section Three is less than the required storm water carrying capacity required for a 100-year storm, calculated Tc = 29.31 minutes.

A new drainage channel has been designed to have the storm water carrying capacity required for the above referenced storm. The revised drainage channel cross-section, using 6" rip-rap rock, (Figure 8.3-4) and calculations are as follows:



 γ = unit weight of water = 62.4 lbs./sf

Assume $D_{50} = 0.50$ ' Assume water depth = 2.25'

Using geometric properties of a trapezoid:

A = Bd+ Zd²
= 26(2.25) + 4 (2.25²)
= 58.50 + 20.25
= 78.75 sf
P = B + 2d
$$\sqrt{Z^2 + 1}$$

= 26 + 2 (2.25) $\sqrt{4^2 + 1}$
= 26 + 18.55
= 44.55'
R = A/P = 78.75/44.55 = 1.7677
T = B + 2dZ = 26 + 2 (2.25) (4) = 44
 $d_a = A/T = 78.75/44 = 1.7898$
Relative depth ration: $\frac{da}{D_{50}} = \frac{1.7898}{0.50} = 3.5796$

Determine Manning's N value:

Use:

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)}$$

Where:

N = Manning's roughness coefficient

 d_a = average flow depth in the channel = 1.7898 ft

- D_{50} = median rip-rap size = 0.50 ft
- α = unit conversion constant = 0.262

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)} = \frac{(0.262) 1.7898^{0.1667}}{2.25 + 5.23 \log\left(\frac{1.7898}{0.50}\right)} = \frac{0.2887}{2.25 + 5.23 \log(3.5796)} = \frac{0.2887}{5.1466} = 0.0561$$

(HEC 15, 2005, Equation 6.1)

Use Manning's equation to determine maximum flow for rip-rap $D_{50} = 0.50$ ':

S = 1.22%, A = 50.00 sf, R = 1.4930, N = 0.0561

Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.0561 (78.75) (1.7677)^{2/3} (0.0122)^{1/2} Q = 26.46 (78.75) (1.4620) (0.1105) Q = 336.63 cfs

Velocity

336.63 cfs / 78.75 sf = 4.27 fps

Analysis

336.63 cfs provided > 325.41 cfs required

Drainage Channel Section Three (Option 2 – shotcrete)

The storm water carrying capacity provided at a worse case location of Drainage Channel Section Three is less than the required storm water carrying capacity required for a 100-year storm, calculated Tc = 29.31 minutes.

A new drainage channel has been designed to have the storm water carrying capacity required for the above referenced storm. The revised drainage channel cross-section, using shotcrete, (Figure 8.3-5) and calculations are as follows:

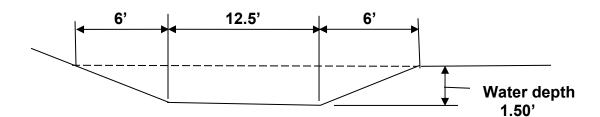


Figure 8.3-5 Cross-Section, Drainage Channel Section Three (Option 2 - shotcrete) Looking North

Using the Manning's Formula, storm water carrying capacity for Drainage Channel Section Three (Option 2) is as Follows:

A = $\frac{1}{2}$ (6' x 1.50') + (12.5' x 1.50') + $\frac{1}{2}$ (6' x 1.50') = 27.75 sf

WP = 24.50'

R = A/WP = 27.75/24.50 = 1.1327 S = 1.22%

Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.015(27.75) (1.1327)^{2/3}(0.0122)^{1/2} Q = 99.33(27.75) (1.0866) (0.1105) Q = 330.96 cfs

Velocity

330.96 cfs / 27.75 sf = 11.93 fps

Analysis

330.96 cfs provided > 325.41 cfs required

8.4 Drainage Channel – Section Four

Time of Concentration – Section Four (Areas B1, C1 & D1 Figure 5.0)

Adding the time of concentration for Area D1 to the time of concentration calculated for Section Two, as shown above, gives the time of concentration for Section Four:

Area D1:

L = 333 ft (0.0631 mi) $K_b = 0.025$ (Table 6.5, Maricopa Co. Drainage Policies and Standards) S = $\frac{168-164}{0.0631} = 63.39$ i = 2.17 in/hr. (100-year, 60-minute storm, NOAA ATLAS 14, April 21, 2017)

$$T_{cD1} = 11.4L^{0.5}K_b^{0.52}S^{-0.31}i^{-0.38}$$

$$T_{cD1} = 11.4(0.0631)^{0.5}(0.025)^{0.52}(63.39)^{-0.31}(2.17)^{-0.38}$$

$$T_{cD1} = 0.0866 hr = 5.20 min$$

Total time of concentration for Section Four is:

 $T_{C \ SECTION \ FOUR} = T_{C \ SECTION \ TWO} + t_{cD1} = 11.05 \ min + 5.20 \ min = 16.25 \ min$

The rainfall intensity correlating to the time of concentration was estimated to be 3.25 in/hr. using the Rainfall Intensity, Duration, Frequency Relationship for Yuma. This correlation and graph are shown in Figure 8.4-1.

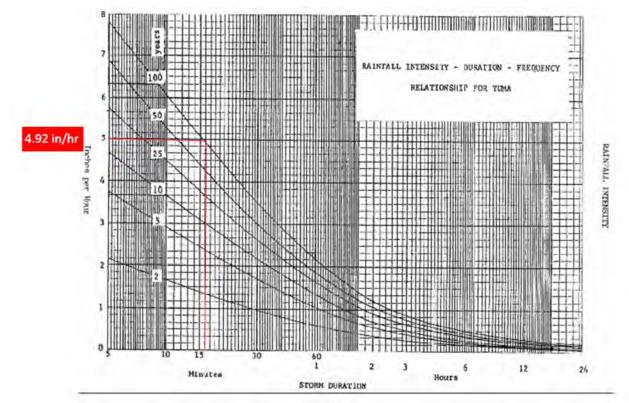


Figure 8.4-1 Rainfall Intensity - Duration – Frequency Relationship for Yuma (Section Four)

Storm water Runoff – Section Four:

The storm water runoff for Section Four with a 100-year storm, calculated $T_c = 16.25$ minutes is calculated using the Rational Method:

Q = CIA

Where:

C = Weighted "C" as shown below (unitless)

- I = Rainfall Intensity as shown in Figure 8.12
- A = Runoff Area in acres





Table 8.4-1 summarizes the distinct types of terrains and characteristics obtained from the calculated areas shown in Figure 8.4-2. The sources for the "C" Factors are discussed in the preparation of Table 6.0.

TYPE OF TERRAIN	"C" FACTOR	AREA (ACRE)	СхА
MONTAINOUS	0.95	5.16	4.90
HILLSLOPE	0.69	0.66	0.46
CAP SURFACE	0.88	1.85	1.63
DESERT/ RANGE LAND	0.88	1.66	1.46
RIP RAP	0.90	0.39	0.35
TOTAL	N/A	9.72	8.80

Table 8.4-1 Terrain Characteristics and Areas for Section Four.

The weighted "C" factor is then:

$$C_w = \frac{\sum (C \times A)}{\sum A}$$

$$C_w = \frac{8.80}{9.72} = 0.91$$

$$Q = CiA$$

$$C = 0.91$$

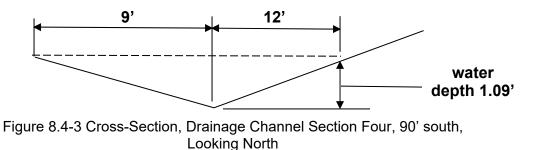
$$i = 4.92 \frac{in}{hr}$$

$$A = 9.72 \ acres$$

Q = CiA = (0.91)(4.92)(9.72) = 43.52 CFS

Capacity Provided: Drainage Channel Section Four

A worse case location for Drainage Channel Section Four has been identified as being located approximately 90 feet south of the southern end of the capped section (Area C, Figure 5.0). This drainage channel consists of loos cobble and rip-rap (see Figure 9.6). This A cross-section of Drainage Channel at this location is shown in Figure 8.4-3.



Use Rational Method:

Using the Manning's Formula, the worst case, storm water carrying capacity for the East Drainage Channel – Section Four is as Follows:

 $\begin{array}{l} \mathsf{A} = \frac{1}{2} \left(9' \ x \ 1.09'\right) + \frac{1}{2} \left(12' \ x1.09\right) = 11.45 \ \text{sf} \\ \mathsf{WP} = 21' \\ \mathsf{R} = \mathsf{A}/\mathsf{WP} = 11.45/21 = 0.5452 \\ \mathsf{S} = 1.15\% \qquad \mathsf{N} = 0.062 \ (\mathsf{N} \ value \ from \ Table7.7, \ Drainage \ Design \ Manual \ for \ Maricopa \ County, \ Arizona, \ December \ 14 \ ,2018) \end{array}$

Q = $1.49/N (A)(R)^{2/3} S^{1/2}$ Q = $1.49/0.062(11.45) (0.6674)^{2/3} (0.0115)^{1/2}$ Q = 24.03(11.45) (0.6674) (0.1072)Q = 19.69 cfs

Velocity

19.69 cfs / 11.45 sf = 1.72 fps

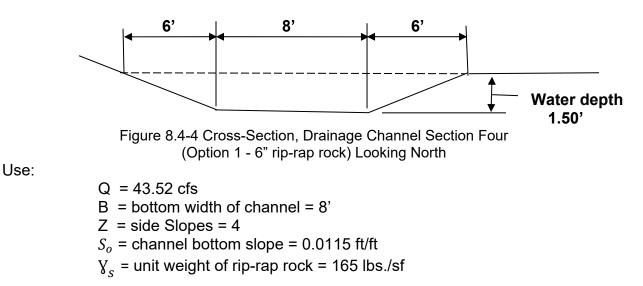
Analysis

19.69 cfs provided < 43.52 cfs required

Drainage Channel Section Four (Option 1 – 6" Rip-rap Rock)

The storm water carrying capacity provided at a worse case location of Drainage Channel Section Four is less than the required storm water carrying capacity required for a 100-year storm, calculated Tc = 16.25 minutes.

A new drainage channel has been designed to have the storm water carrying capacity required for the above referenced storm. The revised drainage channel cross-section, using 6" rip-rap rock, (Figure 8.4-4) and calculations are as follows:



 Υ = unit weight of water = 62.4 lbs./sf Assume $D_{50} = 0.50$ ' Assume water depth = 1.50'

Using geometric properties of a trapezoid:

A = Bd+ Zd²
= 8(1.50) + 4 (1.50²)
= 12 + 9
= 21.00 sf
P = B + 2d
$$\sqrt{Z^2 + 1}$$

= 8 + 2 (1.50) $\sqrt{4^2 + 1}$
= 8 + 12.37
= 20.37'
R = A/P = 21.00/20.37 = 1.0309
T = B + 2dZ = 8 + 2 (1.50) (4) = 20
d_a = A/T = 21.00/20.00 = 1.0500
Relative depth ration: $\frac{da}{D_{50}} = \frac{1.0500}{0.50} = 2.100$

Determine Manning's N value:

(HEC 15, 2005, Equation 6.1)

Use:

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)}$$

Where:

N = Manning's roughness coefficient

 d_a = average flow depth in the channel = 2.6042 ft

 D_{50} = median rip-rap size = 0.50 ft

$$\alpha$$
 = unit conversion constant = 0.262

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)} = \frac{(0.262) 1.0500^{0.1667}}{2.25 + 5.23 \log\left(\frac{1.0500}{0.50}\right)} = \frac{0.2641}{2.25 + 5.23 \log(2.100)} = \frac{0.2641}{3.9352} = 0.0671$$

Use Manning's equation to determine maximum flow for rip-rap $D_{50} = 0.50$ ':

S = 1.15%, A = 21.00 sf, R = 1.0309, N = 0.0671

Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.0671 (21.00) (1.0309)^{2/3} (0.0115)^{1/2} Q = 22.21 (21.00) (1.0205) (0.1072) Q = 51.02 cfs

Velocity

51.02 cfs / 21.00 sf = 2.43 fps

Analysis

51.02 cfs provided > 43.52 cfs required

Drainage Channel Section Four (Option 2 – shotcrete)

The storm water carrying capacity provided at a worse case location of Drainage Channel Section Four is less than the required storm water carrying capacity required for a 100-year storm, calculated Tc = 16.25 minutes.

A new drainage channel has been designed to have the storm water carrying capacity required for the above referenced storm. The revised drainage channel cross-section, using shotcrete, (Figure 8.4-5) and calculations are as follows:

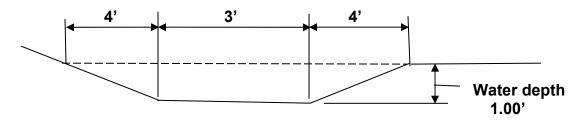


Figure 8.4-5 Cross-Section, Drainage Channel Section Four (Option 2 – shotcrete) Looking North

Using the Manning's Formula, storm water carrying capacity for Drainage Channel Section Four (Option 2) is as Follows:

A = $\frac{1}{2}$ (4' x 1.00') + (3' x 1.00') + $\frac{1}{2}$ (4' x 1.00') = 7.0 sf WP = 11' R = A/WP = 7.0/11.0 = 0.6364 S = 1.15% Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.015(7.0) (0.6364)^{2/3}(0.0115)^{1/2} Q = 99.33(7.0) (0.7399) (0.1072) Q = 55.15 cfs

Velocity

55.15 cfs / 7.0 sf = 7.88 fps

Analysis

55.15 cfs provided > 43.52 cfs required

9.0 Protective Rip-Rap Wall Analysis

9.1 Overview

Chapter 5 of the U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 23, Volume 1 - (Publication No. FWHA-NHI-09-111, September 2009) Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance – Third Edition, states: rip-rap consists of a layer or facing of rock, dumped or hand-placed on channel and structure boundaries to limit the effects of erosion. It is the most common type of countermeasure due to its general availability, ease of installation and relatively low cost. Rip-rap design must account for several possible modes of failure. These include rip-rap particle erosion, substrate material erosion and mass failure.

9.2 Failure Modes

Particle Erosion:

Particle erosion is the most considered erosion mechanism. Particle erosion occurs when individual particles are dislodged by the hydraulic forces generated by the flowing water. Particle erosion can be initiated by abrasion, impingement of flowing water, eddy action/reverse flow, local flow acceleration, freeze/thaw action, ice, or toe erosion. Probable causes of particle erosion include: (1) stone size not large enough; (2) individual stones removed by impact or abrasion; (3) side slope of the bank so steep that the angle of repose of the rip-rap material is easily exceeded; and (4) gradation of rip-rap too uniform. (DOT 2009, Vol. I)

Rip-rap particle erosion is minimized by sizing the rip-rap to withstand hydraulic and turbulence forces. Calculations for sizing the rock for the rip-rap wall can be found in Section 11.2 of this report. A site inspection to assess the steepness of the bank, gradation of rip-rap and inspect for missing stones is discussed in Section 10.0 of this report.

Substrate Particle Erosion:

Substrate particle erosion occurs when the base material erodes and migrates through the rip-rap voids causing the rip-rap to settle.

Substrate particle erosion is limited by placing a granular or geotextile filter between the

rip-rap and the base material. A site inspection to evaluate the existing filter of the riprap wall is discussed in Section 10.0 of this report.

Mass Failure:

Mass failure occurs when large sections of the rip-rap and/or base material slide or slump due to gravity forces. Mass failure can be caused by excess pore water pressures, bank steepness and loss of basal support through scour or channel migration. Also, a filter fabric that is too fine can clog and cause the buildup of pore water pressures in the underlying soil. Rip-rap that is large enough to resist all the hydraulic forces can fail if channel migration or scour undermines the toe support. Scour calculations are shown below:

The following calculations estimate the scour depth of a transverse structure. Storm water flow characteristics for the channel north of the protective rip-rap wall are used to determine the scour depth. A worse case water depth is estimated to be 1.0 feet.

Several commonly used countermeasures for channel instability or scour protection project transversely into the flow (e.g., spurs, dikes, and jetties) or intercept overbank flow as it returns to the main channel (e.g., guide banks). Estimating scour at the nose of these structures is critical to successful design. Equation 4.1 (DOT 2009, Vol I) is used when the projecting embankment/abutment length is large in relation the flow depth.

Use:

$$\frac{a}{y_1} > 25$$

Where:

a = structure length projecting normal to the flow = 85 ft y_1 = average upstream flow depth in the main channel or on the overbank outside the influence of the structure = 1.0 ft

$$\frac{85}{1.0} = 85$$

Calculate Froude Number:

Use:

$$F_r = \frac{V}{(gy)^{\frac{1}{2}}}$$

Where:

V = average velocity = 2.45 ft/s q = gravity = 32 ft/s²

$$y_1$$
 = depth of flow = 1.00 ft

$$F_r = \frac{2.45}{(32 x \ 1.00)^{\frac{1}{2}}} = 0.4331$$

Since
$$\frac{a}{y_1}$$
 > 25 use Equation 4.1 (DOT 2009, Vol. I)

Use:

 $\frac{y_s}{y_1} = 4F_r^{0.33}$

Where:

: y_s = equilibrium depth of scour (measured from the mean bed level to the bottom of the scour hole), ft

 y_1 = average upstream flow depth in the main channel or on the overbank outside the influence of the structure = 1.0 ft

 F_r = upstream Froude Number outside the influence of the structure = 0.4331

$$\frac{y_s}{1.0} = 4(0.4331^{0.33}) = 3.03$$
 ft.

Overtopping:

Chapter 4 (DOT 2009) recommends that rip-rap to be placed on the bank to an elevation at least 2.0 feet greater than the design high water level. As stated above a worse case water depth is estimated to be 1.0 feet. Therefore, a rip-rap wall height of 3.0 feet is recommended. A site inspection to evaluate the height is discussed in Section 10.0 of this report.

10.0 Site Inspection

The protective capped area shown as Areas C and C1 in Figure 5.0 is protected from erosion caused by storm water runoff with a protective rip-rap wall located at the north end of the capped area.

Inspection of rip-rap placement typically consists of visual inspection of the installation procedures and the finished surface. Since the existing rip-rap wall was installed without NEI's on-site inspection and as-built drawings from the construction of the existing rip-rap wall could not be obtained, this report includes a visual inspection of the finished surface only.

A visual inspection of the existing wall observed a dense, rough surface of well-keyed, graded rock, placed such that voids were minimized (Figures 10.0 thru 10.3). Further inspection is required to determine the thickness of the rip-rap blanket and to determine if a filter material was installed.

Guidance for inspecting rip-rap presented in the National Highway Institute (NHI) training course 135047, "Stream Stability and Scour at Highway Bridges for Bridge Inspectors" was followed as shown below:

1. Rip-rap should be angular and interlocking.

No flat sections of broken concrete or rounded rock was observed.

2. Rig-rap should have a granular or synthetic geotextile filter between the rip-rap and the subgrade material.

Further inspection is required to determine what type or if a filter material was installed.

3. Rip-rap should be well graded.

The existing rip-rap appeared to be well graded with a rock size of approximately $D_{50} = 10^{\circ}$.

The existing rip-rap wall was also inspected for indicators of problems as follows:

1. Has rip-rap been displaced downstream?

No signs of displacement were observed.

2. Has angular rip-rap blanket slumped down slope?

No signs of slumping were observed.

3. Has angular rip-rap material been replaced over time by smoother river run material?

No river run material was observed in the rip-rap wall.

4. Has rip-rap material physically deteriorated, disintegrated, or been abraded over time?

No deterioration was observed.

5. Are there holes in the rip-rap blanket where the filter has been exposed or breached?

No holes in the rip-rap wall were observed.



Figure 10.0 Protective Rip-rap Wall Looking South (10-03-2018)



Figure 10.1 Protective Rip-rap Wall Looking East (10-03-2018)



Figure 10.2 Protective Rip-rap Wall Looking South (10-03-2018)



Figure 10.3 Protective Rip-rap Wall Rip-Rap Size (10-03-2018)

A site inspection of the protective capped area (Areas C & C1, Fig. 5.0) and drainage channel Sections One and Two (Figure 8.0) showed little signs of erosion (Figures 10.4 & 10.5). However, the north end of the drainage channels Sections One and Two (Fig. 8.0) located on either side of the protective rip-rap wall showed signs of erosion (Figure 10.6). Drainage channel Sections Three and Four (Fig. 8.0) were inspected and they were not well defined and showed signs of erosion (Figures 10.7 & 10.8). The desert area between the capped area and retention basins (Areas D & D1, Fig. 5.0) showed signs of erosion (Figure 10.9).



Fig. 10.4 Drainage Channel Section One (Capped Area) – Looking North (10-03-2018)



Fig. 10.5 Drainage Channel Section Two (Capped Area) – Looking South (10-03-2018)



Figure 10.6 North End of Drainage Channel Section One – Looking East (10-03-2018)



Fig. 10.7 Drainage Channel Section Three Looking North (10-04-2018)



Fig. 10.8 Drainage Channel Section Four Looking South (10-04-2018)



Fig. 10.9 East Side of Desert Area - Looking North (10-03-2018)

11.0 Rip-Rap Calculations

11.1 Size New Rip-Rap Rock for Drainage Channels

New rip-rap was designed to improve the north and south ends of drainage channel Sections One and Two and to replace drainage channels Sections Three and Four. It was determined that drainage channel Section One is a worse case location for the design of the new rip-rap as that location has the highest velocity and Q value. The calculations to size the new rip-rap have been prepared in accordance with Chapter 6, Section 6.3.1 of the U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 15, Third Edition (Publication No. FWHA-NHI-05-114, September 2005) Design of Roadside Channels with Flexible Linings as follows:

Use:

Q = 355 cfs B = bottom width of channel = 10' Z = side Slopes = 2.58 S_o = channel bottom slope = 0.0073 ft/ft Y_s = unit weight of rip-rap rock = 165 lbs./sf Y = unit weight of water = 62.4 lbs./sf Assume D_{50} = 0.50' Assume water depth = 3.90' Using geometric properties of a trapezoid:

$$A = Bd + Zd^{2}$$

= 10(3.90) + 2.58 (3.90²)
= 39.00 + 39.24
= 78.24 sf
$$P = B + 2d \sqrt{Z^{2} + 1}$$

= 10 + 2 (3.90) $\sqrt{2.58^{2} + 1}$
= 10 + 21.58
= 31.58'
$$R = A/P = 78.24/31.58 = 2.4775$$
$$T = B + 2dZ = 10 + 2 (3.90) (2.58) = 30.12$$
$$d_{a} = A/T = 78.24/30.12 = 2.5976$$
Relative depth ratio: $\frac{da}{D_{50}} = \frac{2.5976}{0.50} = 5.1952$

Determine Manning's N value:

(HEC 15, 2005, Equation 6.1)

Use:

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)}$$

Where:

N = Manning's roughness coefficient

 d_a = average flow depth in the channel = 2.5976 ft

 D_{50} = median rip-rap size = 0.50 ft

 α = unit conversion constant = 0.262

$$N = \frac{\alpha d_a^{0.1667}}{2.25 + 5.23 \log\left(\frac{da}{D_{50}}\right)} = \frac{(0.262) 2.5976^{0.1667}}{2.25 + 5.23 \log\left(\frac{2.5976}{0.5}\right)} = \frac{0.3072}{2.25 + 5.23 \log(5.1952)} = \frac{0.3072}{5.9926} = 0.0513$$

Use Manning's equation to determine maximum flow for rip-rap $D_{50} = 0.50$ ':

S = 0.73%, A = 78.24 sf, R = 2.4775, N = 0.0513

Q = 1.49/N (A)(R)^{2/3} S^{1/2} Q = 1.49/0.0513 (78.24) (2.4775)^{2/3} (0.0073)^{1/2} Q = 29.04 (78.24) (1.8310) (0.0854) Q = 355.28 cfs

Analysis

355 cfs required = 355.28 cfs estimated Estimated value is within 5% of the design Q value.

Shear Velocity

(HEC 15, 2005, Equation 6.10)

Where:

Use:

 $V_{\rm c}$ = shear velocity, ft/s

 $R_e = \frac{V_* D_{50}}{v}$

 $V_* = \sqrt{gdS}$

- g = gravitational acceleration = 32.2 ft/s²
- d = maximum channel depth = 3.90 ft
- S = channel bottom slope = 0.0073 ft/ft

$$V_* = \sqrt{gdS} = \sqrt{(32.2)(3.90)(0.0073)} = 0.9575$$
 ft/s

Reynold's Number

(HEC 15, 2005, Equation 6.9)

Use:

Where:

 R_e = particle Reynold's number, dimensionless

 V_* = shear velocity = 0.9575 ft/s

v = kinematic viscosity = 1.217 x 10⁻⁵

$$R_e = \frac{V_* D_{50}}{v} = \frac{(0.9575)(0.5)}{1.217 \times 10^{-5}} = 3.9 \times 10^4$$

Since $R_e \leq 4 \ge 10^4$, $F_* = 0.047$, SF = 1.0 and the channel slope is less than 5% use the following to calculate minimum stable D_{50} :

$$SG = \frac{Y_s}{Y_w} = \frac{165}{62.4} = 2.64$$

(HEC 15, 2005, Equation 6.8)

$$D_{50} = \frac{SFdS_0}{F_*(SG-1)} = \frac{(1)(3.90)(0.0073)}{(0.047)(2.64-1)} = 0.37 \text{ ft}$$

Since 0.37 feet is the minimum allowable size of rip-rap rock use $D_{50} = 0.50$ ft (6")

Determine maximum depth of flow in channel for rip-rap $D_{50} = 0.50$ ':

(HEC 15, 2005, Equation 3.10)

Use:

$$d \leq \frac{t_p}{(SF) \, \Im \, S_o}$$

Where:

d = depth of flow in channel

 t_p = permissible shear stress for the channel lining rip-rap D_{50} = 0.50' has a permissible shear stress of t_p = 2.41 lbs/sf (shown below)

γ = unit weight of water, lbs/sf

 S_o = channel bottom slope, ft/ft

$$SF$$
 = safety factor = 1.0

$$d \le \frac{t_p}{(SF) \, \Im \, S_o} = \frac{2.41}{(1.0) \, (62.4)(0.0073)} = 5.29'$$

Analysis

3.49' maximum depth of flow > 3.23 estimated above

Permissible shear stress for $D_{50} = 0.50$ ft (6"):

(HEC 15, 2005, Equation 6.7)

Use:

e: $t_p = F_*(Y_s - Y)D_{50}$

Where:

 t_p = permissible shear stress for the channel lining

 F_* = Shield's parameter, dimensionless

 γ_s = specific weight of the stone, lbs/sf

 γ = specific weight of water, lbs/sf

 D_{50} = mean rip-rap size, ft

$$t_p = F_*(Y_s - Y)D_{50} = 0.047(165 - 62.4)0.50 = 2.41$$
 lbs/sf

11.2 Rip-Rap Rock for Protective Rip-Rap Wall

The following calculations estimate the adequacy of the existing rip-rap blanket for the protective rip-rap wall. Storm water flow characteristics for the western half of the wall is used, as it has been determined to be a worse case location.

Determine Set Back Ratio:

Since the protective rip-rap wall extends west to the northern end of the Western Drainage Channel - Section One (Figure 8.0), the Set Back Ratio (SBR) equals zero and since the SBR < 5 the storm water flow characteristics of the Western Drainage Channel – Section One will be used for these calculations.

Q = 355 cfs, Depth = 3.25 ft., Velocity = 7.10 ft/s

Calculate Froude Number:

Use:

$$F_{r} = \frac{V}{(gy)^{\frac{1}{2}}}$$

Where:

V = average velocity = 7.10 ft/s

 $g = \text{gravity} = 32 \text{ ft/} \text{ s}^2$

y = depth of flow = 3.25 ft

$$F_r = \frac{7.10}{(32 x \ 3.25)^{\frac{1}{2}}} = 0.70$$

Since $F_r < 0.80$ use Equation 14.1 from Section 14.3, Design Guide 14 (DG14) of the U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 23, Volume 2 - (Publication No. FWHA-NHI-09-112, September 2009) Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance – Third Edition, as follows:

Use:

$$\frac{D_{50}}{y} = \frac{K}{(S_s - 1)} \left(\frac{V^2}{gy}\right)$$

Where:

 D_{50} = mean rip-rap size, ft

- V = characteristic average velocity in the contracted section = 7.10 ft/s
- S_s = specific gravity of rip-rap rock = 2.65
- $g = \text{gravity} = 32 \text{ ft/ } \text{s}^2$
- y = depth of flow = 3.25 ft
- K = 0.89 for spill through abutment

$$\frac{D_{50}}{3.25} = \frac{0.89}{(2.65-1)} \left(\frac{7.10^2}{(32)\ 3.25}\right) = \frac{0.89}{1.65} \left(\frac{50.4100}{104.000}\right) = 0.5394(0.4847) = 0.2615$$

$$D_{50} = 0.2615(3.25) = 0.8497$$
 ft

Determine rip-rap extents:

Use Step 6 of DG14.

- Extend rip-rap into floodplain 2(depth of flow) = 2(3.25) = 6.5 ft
- Vertical extent of rip-rap = depth of flow + 2' = 3.25' + 2' = 5.25 ft
- Rip-rap blanket thickness = $1.5(D_{50}) = 1.5(0.85') = 1.28$ ft

12.0 Conclusions and Recommendations

12.1 Storm water Runoff - Volume

The existing stormwater retention basins have the capacity to retain approximately 16% of the stormwater runoff generated by the entire site for a 100-year, 2-hour storm. However, the storm water retention capacity of both existing retention basins combined is approximately 6 times the capacity required to retain the storm water runoff from the capped surface. A portion of the excess storm water runoff generated by the entire site leaving the existing retention basins is retained by Adair Park Road at the southern boundary of the site. Using an AutoCAD – Civil 3D surface model to calculate the stormwater storage capacity of the site with a low point of Adair Park Road as an outfall elevation; the percentage of storm water runoff from the entire site retained on site before overflow occurs at Adair Park Road is approximately 30%.

12.2 Storm water Runoff - Drainage Channels

Section One:

Drainage Channel Section One is located on the west side of Area C (Fig. 5.0). It originates at the north end of the capped surface and runs south to the south end of the capped surface. In Section 8.1, the storm water carrying capacity of Drainage Channel Section One was calculated at a worse case location. It was determined that at that location it did not have the capacity to carry the storm water runoff for a 100-year storm, calculated Tc = 24.11 minutes.

To increase the storm water carrying capacity of drainage channel Section One; it is recommended that additional 6" rip-rap rock be installed at the west bank of drainage channel Section One. A revised channel for Drainage Channel Section One was sized in "Drainage Channel Section One (Option 1 – Additional 6" Rip-Rap Rock, west bank)" of Section 8.1 and a revised cross-section for Drainage Channel Section One is shown in Figure 8.1-4. The new 6" rip-rap rock was sized in Section 9.1.

A site inspection of Drainage Channel Section One, showed little signs of erosion (Figures 9.2 & 9.3). However, the north end of Drainage Channel Section One located on the west side of the protective rip-rap wall showed signs of erosion (Figure 9.4).

To repair the erosion of the drainage channel; it is recommended that new 6" rip-rap rock be installed at the north and south ends of Drainage Channel Section One.

Section Two:

Drainage Channel Section Two is located within Area C1 (Fig. 5.0). It originates at the north end of the capped surface and runs south to the south end of the capped surface. In Section 8.1, the storm water carrying capacity of Drainage Channel Section Two was calculated at a worse case location. It was determined that at that location it has the capacity to carry the storm water runoff for a 100-year storm, calculated Tc = 11.05 minutes.

A site inspection of Drainage Channel Section Two, showed little signs of erosion (Figures 9.2 & 9.3).

However, to prevent erosion of the north and south ends of Drainage Channel Section Two; it is recommended that new 6" rip-rap rock be installed at the north and south ends of the drainage channel. New rip-rap rock was sized in Section 9.1.

Section Three:

Drainage Channel Section Three is located within Area D (Fig. 5.0). It originates at the south end of the capped surface and runs south through the desert area to the existing retention basin located on the west side of Area E (Fig. 5.0). In Section 8.3 the storm water carrying capacity of Drainage Channel Section Three was calculated at a worse case location. It was determined that at that location it did not have the capacity to carry the storm water runoff for a 100-year storm, calculated Tc = 29.31 minutes. Also, a site inspection of Drainage Channel Section Three, showed signs of erosion (Fig. 9.5).

To repair the erosion and increase the storm water carrying capacity of Drainage Channel Section Three, it is recommended that the drainage channel be reconstructed. Two options have been presented: Option 1 - 6" rip-rap rock and Option 2 – shotcrete. A revised channel for Drainage Channel Section Three was sized in "Drainage Channel Section Three (Option 1 – 6" Rip-Rap Rock)" of Section 8.3 and a revised cross-section for Drainage Channel Section Three (Option 1) is shown in Figure 8.3-4. The new 6" rip-rap rock was sized in Section 9.1. To reduce maintenance costs, a second revised channel for Drainage Channel Section Three was sized in "Drainage Channel Section 9.1.

Three (Option 2 – shotcrete)" of Section 8.3 and a revised cross-section for Drainage Channel Section Three (Option 2) is shown in Figure 8.3-5.

Both options have the capacity to carry the storm water runoff for a 100-year storm, calculated Tc = 29.31 minutes. Preliminary construction cost estimates for Option 1 - 6" rip-rap rock, Option 2 – shotcrete and have been prepared. The preliminary costs for both options are as follows:

Option 1 – 6" rip-rap rock	\$ 49,350.90 (includes estimated costs for 10- years of maintenance)
Option 2 – 4" shotcrete	\$ 121,464.53

Section Four:

Drainage Channel Section Four is located within Area D1 (Fig. 5.0). It originates at the south end of the capped surface and runs south through the desert area to the existing retention basin located on the east side of Area E (Fig. 5.0). In Section 8.4 the storm water carrying capacity of Drainage Channel Section Four was calculated at a worse case location. It was determined that at that location it did not have the capacity to carry the storm water runoff for a 100-year storm, calculated Tc = 16.25 minutes. Also, a site inspection of Drainage Channel Section Four, showed signs of erosion (Fig. 9.6 & Fig. 9.7).

To repair the erosion and increase the storm water carrying capacity of Drainage Channel Section Four, it is recommended that the drainage channel be reconstructed. Two options have been presented: Option 1 - 6" rip-rap rock and Option 2 – concrete. A revised channel for Drainage Channel Section Four was sized in "Drainage Channel Section Four (Option 1 – 6" Rip-Rap Rock)" of Section 8.4 and a revised cross-section for Drainage Channel Section Four is shown in Figure 8.4-4. The new 6" rip-rap rock was sized in Section 9.1. To reduce maintenance costs, a second revised channel for Drainage Channel Section Four was sized in "Drainage Channel Section Four (Option 2 – shotcrete)" of Section 8.4 and a revised cross-section for Drainage Channel Section Four was sized in "Drainage Channel Section Four (Option 2 – shotcrete)" of Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section Four (Option 2 – shotcrete)" of Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section Four (Option 2 – shotcrete)" of Section 8.4 and a revised cross-section for Drainage Channel Section Four 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section 8.4 and a revised cross-section for Drainage Channel Section Four (Option 2) is shown in Figure 8.4-5.

Both options have the capacity to carry the storm water runoff for a 100-year storm, calculated Tc = 16.25 minutes. Preliminary construction cost estimates for Option 1 - 6" rip-rap rock, Option 2 – shotcrete have been prepared. The preliminary costs for both options are as follows:

Option 1 – 6" rip-rap rock	\$ 49,350.90 (includes estimated costs for 10- years of maintenance)
Option 2 – 4" shotcrete	\$ 70,150.80

12.3 Protective Rip-rap Wall

The north end of the protective capped area shown as Areas C and C1 in Figure 5.0 is protected from erosion caused by storm water runoff with a protective rip-rap wall. A site inspection of the protective rip-rap wall showed no holes, slumping or signs of erosion on the face of the protective rip-rap wall (Figures 10.0 thru 10.3) and no improvements are proposed.

Although the height of the protective rip-rap wall and the size of the rip-rap (as shown in Figures 10.0 thru 10.3) appear to meet the requirements stated in Section 11.2, an additional site inspection will be required to verify the height, depth of the rip-rap blanket, size of the rip-rap rock and filter material that comprise the protective rip-rap wall.

Also to meet the requirements stated in Section 11.2, it is proposed that a buried toe riprap bed consisting of D_{50} = 10" rock and geotextile fabric be constructed 16" deep x 6.5'

wide along the length of the toe of the protective rip-rap wall. An alternative to the buried toe rip-rap bed described above, Chapter 4 (DOT 2009) allows a mounded toe rip-rap mound to be constructed at the ambient bed elevation two times the layer thickness and as high as the maximum scour depth.

Since the rip-rap wall was installed without documentation, the evaluation of the rip-rap wall will include an inspection to determine how the wall was built. The results of the inspection will be compared to the minimum design criteria for a protective rip-rap wall. The following presents the minimum design requirements for a protective rip-rap wall:

- The rip-rap wall shall be a minimum of 3 feet in height, including the portion of the wall that is adjacent to the eastern and western drainage channels.
- The thickness of the rip-rap blanket shall be a minimum of 16 inches.
- The size of the rip-rap rock shall be a minimum of D_{50} = 10 inches
- The base of the rip-rap blanket shall have either a granular or geotextile fabric filter material installed.
- The maximum slope of the protective rip-rap wall and subbase shall be a slope no greater than 1:1.5
- The toe of the rip-rap wall shall be protected with either of the following:
 - Buried toe consisting of a rip-rap rock of D_{50} = 10 inches with a geotextile fabric filter material installed and shall be constructed 16 inches deep x 6.5 feet wide along the length of the toe of the protective rip-rap wall.
 - Mounded toe consisting of rip-rap rock that is a minimum of $D_{50} = 10$ inches constructed 32 inches deep x 3 feet in height along the length of the toe of the protective rip-rap wall.

If the visual inspection of the existing protective rip-rap wall identifies portions of the wall that do not meet at least the minimum requirements presented above, designs to remedy the deficiencies of the portions (or all) of the existing protective rip-rap wall that do not meet these requirements will be evaluated. The design remedy that best addresses any or all the deficiency will be prepared and submitted to ADEQ for approval prior to implementation.

ATTACHMENT A

PRELIMINARY CONSTRUCTION COST ESTIMATE, SECTION THREE (OPTION 1 – 6" RIP-RAP ROCK)

	PRELIMINARY CONSTRUCTION COST ESTIMATE DRAINAGE CHANNEL SECTION THREE (Option 1 - 6" rip-rap rock) Adair Park Archery Range								
Item	n Description Estimated Quantity Unit Cost								
1	Mobilization	1	LS	\$	7,500.00	\$	7,500.00		
2	Traffic Control & Project Sign	1	LS	\$	3,500.00	\$	3,500.00		
3	SWPPP Plans & Implementation	1	LS	\$	3,500.00	\$	3,500.00		
4	Clearing & Grubbing	1	LS	\$	5,000.00	\$	5,000.00		
5	Earthwork	971	CY	\$	0.65	\$	631.15		
6	New 6" Rip-Rap Rock (12" deep) w/ Geotextile Fabric	1,647	CY	\$	7.25	\$	11,940.75		
7	7 Maintenance Costs (10-years) 10 YR \$ 2,000.00								
SECTION A - SUBTOTAL (Items 1 - 7)							52,071.90		
SECTION B - CONTINGENCY (10% of SECTION A)						\$	5,207.19		
	TOTAL PROBABLE CONSTRUCTION COST (SECTIONS A + B)					\$	57,279.09		

ATTACHMENT B

PRELIMINARY CONSTRUCTION COST ESTIMATE, SECTION THREE (OPTION 2 – SHOTCRETE)

	PRELIMINARY CONSTRUCTION COST ESTIMATE DRAINAGE CHANNEL SECTION THREE (Option 2 - shotcrete) Adair Park Archery Range								
Item	em Description Estimated Quantity Unit Unit Cost								
1	Mobilization	1	LS	\$	7,500.00	\$	7,500.00		
2	Traffic Control & Project Sign	1	LS	\$	3,500.00	\$	3,500.00		
3	SWPPP Plans & Implementation	1	LS	\$	3,500.00	\$	3,500.00		
4	Clearing & Grubbing	1	LS	\$	5,000.00	\$	5,000.00		
5	Earthwork	342	CY	\$	0.65	\$	222.30		
6	New shotcrete 4" thick w/rebar & joints	907	SY	\$	100.00	\$	90,700.00		
SECTION A - SUBTOTAL (Items 1 - 6)							110,422.30		
SECTION B - CONTINGENCY (10% of SECTION A)						\$	11,042.23		
	TOTAL PROBABLE CONSTRUCTION COST (SECTIONS A + B)					\$	121,464.53		

ATTACHMENT C

PRELIMINARY CONSTRUCTION COST ESTIMATE, SECTION FOUR (OPTION 1 – 6" RIP-RAP ROCK)

	PRELIMINARY CONSTRUCTION COST ESTIMATE DRAINAGE CHANNEL SECTION FOUR (Option 1 - 6" rip-rap rock) Adair Park Archery Range								
ltem	Description Estimated Quantity Unit Unit Cost								
1	Mobilization	1	LS	\$	2,500.00	\$	2,500.00		
2	Traffic Control & Project Sign	1	LS	\$	1,500.00	\$	1,500.00		
3	SWPPP Plans & Implementation	1	LS	\$	1,500.00	\$	1,500.00		
4	Clearing & Grubbing	1	LS	\$	5,000.00	\$	5,000.00		
5	Earthwork	338	CY	\$	0.65	\$	219.70		
6	New 6" Rip-Rap Rock (12" deep) w/ Geotextile Fabric	1,951	SY	\$	7.25	\$	14,144.75		
7	7 Maintenance Costs (10-years) 10 YR \$ 2,000.00								
SECTION A - SUBTOTAL (Items 1 - 7)							44,864.45		
SECTION B - CONTINGENCY (10% of SECTION A)							4,486.45		
	TOTAL PROBABLE CONSTRUCTION COST (SECTIONS A + B)					\$	49,350.90		

ATTACHMENT D

PRELIMINARY CONSTRUCTION COST ESTIMATE, SECTION FOUR (OPTION 2 – SHOTCRETE)

	PRELIMINARY CONSTRUCTION COST ESTIMATE DRAINAGE CHANNEL SECTION FOUR (Option 2 - shotcrete) Adair Park Archery Range								
Item	m Description Estimated Quantity Unit Unit Cost								
1	Mobilization	1	LS	\$	2,500.00	\$	2,500.00		
2	Traffic Control & Project Sign	1	LS	\$	1,500.00	\$	1,500.00		
3	SWPPP Plans & Implementation	1	LS	\$	1,500.00	\$	1,500.00		
4	Clearing & Grubbing	1	LS	\$	5,000.00	\$	5,000.00		
5	Earthwork	113	CY	\$	0.65	\$	73.45		
6	New shotcrete 4" thick w/rebar & joints	532	SY	\$	100.00	\$	53,200.00		
SECTION A - SUBTOTAL (Items 1 - 6)							63,773.45		
	SECTION B - CONTINGENCY (10% of SECTION A)						6,377.35		
	TOTAL PROBABLE CONSTRUCTION COST (SECTIONS A + B)					\$	70,150.80		

Adair Park Archery Range Draft Remedial Action Plan VRP SITE CODE 505354-00

APPENDIX D Abbreviated Quality Assurance Project Plan

Abbreviated Quality Assurance Project Plan

1. Title and Approvals:

Project Name: Adair Park Archery Range Remedial Action Plan

Approvals: Joshua Scott, Director Yuma County Department of Public Works

Approvals: John Patricki, PM ADEQ VRP

Project Manager(s): Michael Daniel, RG

Sampling Team Leader(s): Brad Closson

Quality Assurance Coordinator(s): Michael Daniel, RG Eric Gardner, PG

2. Distribution List:

Client: Joshua Scott, Director Yuma County Department of Public Works Project Manager: Michael Daniel, RG ADEQ VRP Project Manager: John Patricki, Sampling Team Leader: Brad Closson Quality Assurance Coordinators: Michael Daniel, RG and Eric Gardner, PE Sampling Team Members: Brad Closson Laboratory: TestAmerica, Inc. Phoenix, AZ

3. Project Description / **Background:** The Adair Park Archery Range (site) is located at 4760 South US Highway 95 approximately 12 miles north of Yuma, Arizona and is accessed via Adair Park Road (Figure 1). The site consists of 24 acres that was dedicated to Yuma County by the United States Bureau of Reclamation (USBR) in 1967 for rifle, pistol, and archery range uses. The archery range site is located in a dry ephemeral wash that is surrounded by the Gila River to the south, desert hills to the north and west and a shooting range to the east (Figure 2).

An investigation of the site was performed in 2000 due to a case of lead poisoning. The investigation discovered that the site was formerly used as a silver ore mill during the late 1800s and early 1900s. The silver ore was brought to the site from the mine and processed at the mill. The tailings from the silver ore processing, which contained elevated lead concentrations, were placed in a tailings pond located on the site. The silver ore processing and associated tailings resulted in lead contaminated soil migrating throughout the site via stormwater runoff and wind-borne transportation.

Subsequent investigations by Yuma County and the ADEQ, through its Brownfields Site Cleanup Grant awarded by the US Environmental Protection Agency (USEPA) in 2004, revealed lead contaminated soil was present in the archery range and the archery practice area. Laboratory analytical results indicated that lead was present in the soil at concentrations up to 38,000 milligrams per kilogram (mg/kg). No other metals were detected in the soil that exceeded their respective soil remediation levels (SRLs). The lead contaminated soil was limited to within the boundaries of the site. In 2006, Yuma County entered the Voluntary Remediation Program (VRP).

Adair Park Archery Range Remedial Action Plan VRP Site Code 505354-00

In 2006, the site was divided into three (3) areas of concern (AOCs) (Figure 2). Soil excavated from AOC 2 and AOC 3 was placed in AOC 1 where it was capped with a gravel base and a double chip seal surface. Fill from a nearby source was used to backfill the excavated areas in AOC 2. Soil excavated from AOC 3 created two stormwater retention basins currently used as part of the stormwater management system at the site. Additionally, engineering controls were constructed to divert stormwater around the capped area toward drainage swales on both sides of the capped area, into drainage channels through AOC 2 and into the retention basins located in AOC 3.

A follow on site evaluation was conducted between 2018 and 2019 to evaluate the stormwater conveyance system around and over the capped area, to evaluate soil conditions and to evaluate groundwater quality at the site. The stormwater conveyance evaluation concluded several locations have experienced minor erosion that will be required to be repaired. Additionally, the channels downstream of the capped area will also require repair or upgrading in order to prevent stormwater overflow and erosion of the adjacent soil.

The distribution of lead in soil indicates that the top one feet of soil in several areas outside the capped area contain lead in concentrations greater than the NR SRL of 800 mg/kg. Additionally, the former tailings pile location contains lead in concentrations greater than 800 mg/kg and one location contains lead and cadmium in toxicity characteristic leaching procedures (TCLP) concentrations above their respective regulatory limit making the soil in the immediate area around this sample a characteristic hazardous waste due to its lead and cadmium toxicity.

Groundwater was encountered only on the southern third of the site. The depth to groundwater in the southern area of the site is approximately 15 feet below ground surface (bgs). The portion of the site north of the detention basins, including the capped area and the former tailings pile area is underlain by shallow granitic bedrock and no groundwater is present in the alluvium. An alternate site-specific GPL of 50,899 mg/kg was calculated for lead at the site. No soil sample results exceeded the site specific GPL by the x-ray fluorescence (XRF) analyzer or by laboratory analysis. A temporary groundwater monitoring well was installed at the site on November 6, 2019 and a groundwater sample was collected from the well on November 18, 2019. Lead was not detected in the groundwater at a concentration exceeding its laboratory report limit

4. Project Technical Design:

Site(s) to be sampled: Soil sampling will be conducted to evaluate the concentrations of Resource Conservation and Recovery Act (RCRA) eight (8) metals, specifically lead, from the former tailings pile area (Figure 3).

Sampling Points: Nine (9) soil samples will be collected from the tailings pile area from 4 locations (Figure 3).

Sample Type(s): All soil samples collected will be grab samples.. Soil samples collected from soil boring samples to collected continuously from the surface to a depth of 5 feet bgs. Samples will be selected based on the results of screening the samples with a x-ray fluorescence (XRF) analyzer. The two samples with the highest XRF reading will be submitted to the laboratory for analysis. One duplicate sample will be collected from the sample with the highest XRF reading.

Parameters to be measured: All soil samples will be analyzed for RCRA 8 Metals using EPA Test Method 6010C/7471B. Additionally, two (2) soil samples collected from the tailings pile area will undergo Synthetic Precipitation Leaching Procedure (SPLP) extraction using EPA Test

Method 1312 and analyzed for Lead using EPA Test Method 6010C. An alternative to the SPLP extraction that may be used is the Toxicity Characteristic Leaching Procedure (TCLP) extraction using EPA Test Method 1311.

Quality Control (QC) Activities: An equipment blank sample will be collected from the hand driven sampler and a field blank will be collected from the water used to decontaminate the sampler.

Locational Information / Documentation: See Figure 3

Special Sample Requirements: None are applicable for this scope of work.

5. Project Organization and Task Responsibilities:

Project Manager is responsible for comprehensive oversight and final decision making for the Project.

Quality Assurance (QA) Coordinator will facilitate with proper planning documents and is available to review and approve plans. Questions regarding validity and usability of data will be directed to the QA Coordinator.

Sampling Team Leader is responsible for:

- Assembling sampling team and briefing members on requirements of the project
- Supervising preparation of equipment
- Overall collection of samples, record keeping, and delivery to laboratory
- Safety of field personnel
- Overall coordination and documentation of field activities related to the project

6. Special Training Requirements: None

7. **Project Schedule:** Project schedule is presented as Figure 5 in the Work Plan.

8. Field Sampling Table:

Matrix	Analyte	# Samples	Sample Volume ¹	Container	Preservation	Holding Time
Soil	RCRA 8 Metals	9	8 ounces	8 ounce glass jar	4° C ± 2° C	6 months
Soil	TCLP Lead	2	8 ounces	8 ounce glass jar	4° C ± 2° C	6 months

¹For volume, give QA sample volume followed by a slash and the regular sample volume (i.e. 500ml/100ml)

9. Field Sampling Requirements:

Nine (9) soil samples will be collected from four soil borings advanced in the former tailings pile area. The soil samples will be continuously collected from the surface to a depth of 5 ft bgs at each location (Figure 3).

Procedures for the collection of soil and groundwater samples are detailed in the Remedial Action Plan (RAP) for Adair Memorial Park Archery Range.

10. Sample Handling and Custody Requirements: Each sample collected will be labeled with a unique sample identifier, date and time the sample was collected, preservation used, the sampler's initials and the

Adair Park Archery Range Remedial Action Plan VRP Site Code 505354-00 analysis to be performed. Each sample will then be logged onto a chain–of–custody form for delivery to the laboratory. All samples will be sent to the laboratory via UPS overnight delivery.

11. Analytical Method Requirements: Nine (9) soil samples will be analyzed for the following:

• RCRA 8 Metals using EPA Test Method 6010C/7471B.

Two (2) soil samples will also be analyzed for:

• The Synthetic Precipitation Leaching Procedure (SPLP) extraction using EPA Test Method 1312 and analyzed for Lead using EPA Test Method 6010C. An alternative to the SPLP extraction is the Toxicity Characteristic Leaching Procedure (TCLP) extraction using EPA Test Method 1311. The analytical method for TCLP lead will remain the same.

Analyte	Matrix	Analytical Method	Laboratory Name	Reporting Limit	Units of Reporting Limit
Lead	Soil	6010	TestAmerica	1	mg/kg
TCLP Lead	Soil	6010	TestAmerica	0.5	mg/L

12. Other Data Quality Indicators:

Representativeness: The soil samples from the former tailing pile area will be collected from a depth of 0.0 ft to 5 ft bgs at each location. All sample locations have been randomly selected to provide the best representative coverage over each of the sample area.

Comparability: The soil sample results will be compared to the Residential Soil Remediation Levels (R SRLs) for lead, and other metals as necessary. The calculated site specific GPL supersedes the minimum GPL for assessment of potential to impact groundwater and the NR SRL for lead, 800 mg/kg, will be used if the reported concentration is lower than the calculated GPL value.

Completeness: The completeness goal is 100 percent for each media to be sampled and will be met by collecting all anticipated samples.

13. Peer Review: Wood Environmental and Infrastructure will provide peer review of plans and reports presenting evaluation of the laboratory analytical results.

14. Instrument, Equipment, and Supplies Testing and Maintenance Requirements:

Instruments will be calibrated and maintained in accordance with manufacturer instructions and the procedures outlined in appropriate Standard Operating Procedures (SOPs). Sample containers will be new certified pre-cleaned containers.

Laboratory equipment will be tested, calibrated, and maintained in accordance with SOPs approved by each respective laboratory.

15. Assessments / Oversight:

Formal field audits by QA personnel are not anticipated for this project. Identification of problems related to technical performance will be the responsibility of the technical staff working on this project. The Sampling Team Leader will assess any problems that arise in the field, and make modifications to technical procedures, if needed, and will communicate with the Project Manager and any technical staff. Any changes in technical procedures will be documented in field notes and highlighted in reports related to this project.

Adair Park Archery Range Remedial Action Plan VRP Site Code 505354-00 Laboratory personnel will perform self audits and institute corrective actions in accordance with their respective written procedures.

16. Data Review, Validation, and Usability:

Data from other laboratories will be initially validated by the laboratory performing the analysis. The data will be reviewed and verified by TestAmerica, Inc. The data will also be verified by Nicklaus Engineering using the ADEQ data verification form attached to the QAPP. Third party validation is not required for this project.

Any questions regarding the verification and usability of the data will be discussed with the VRP Project Manager and decisions made appropriately.

17. Documentation and Records:

Field notes and measurements will be recorded in a field notebook, which will be maintained by the Sampling Team Leader. Original copies of Chain of Custody, raw data, and analytical results will be maintained by the respective laboratories performing the analyses.

At the end of each day, the Sampling Team Leader will prepare a summary of the sampling activities for the day. The summary will be in writing but may be submitted either as a hard copy or electronically. The summary should include the following:

- Name of Sampling Team Leader and Team Members
- Number of samples collected by matrix
- Locations samples
- On-site measurements made and results obtained at each location (including times)
- Disposition of all samples (where they were delivered for analysis)
- Air bill numbers for all shipped samples
- Photocopies of Chain of Custody
- Noteworthy observations at each sampling location

18. Data Management

A list electronic of copies and formats needed for reports and data include PDF copies of the laboratory reports as well as Electronic Data Deliverables (EDDs) in Microsoft Excel format.

In the event a groundwater well is required to be installed, groundwater quality data will be uploaded to ADEQ's database in the EDD format specified in Groundwater Data Submittal Guidance Document (Version 3.4).

Copies of all Plans, Reports, and Drawings will be provided to Yuma County and ADEQ for their files. NEI will also maintain an archive of all project plans, reports and drawings in their Yuma, AZ Office.