LAC MINERALS (USA) LLC
CUNNINGHAM HILL MINE RECLAMATION PROJECT
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October 8, 2021

Carmen Rose, Permit Lead Carmen.Rose@State.nm.us
Reclamation Specialist Mining and Minerals Division
Mining Act Reclamation Program 1
220 S. St. Francis Drive
Santa Fe, NM 87505

RE: Revised 2021 CCP update for MMD Permit No. SF002RE, LAC Minerals (USA) LLC Cunningham Hill Mine

Dear Ms. Rose:

This letter is to re-instate a formal request to revise Permit No. SF002RE by updating the Closeout/Closure Plan (CCP) for the LAC Minerals (USA) LLC, Cunningham Hill Mine Reclamation Project. On October 9, 2020, the New Mexico Mining and Minerals Division ("MMD") received an updated Closure/Closeout Plan ("CCP") from John Shomaker & Associates, Inc. (JSAI) on behalf of LAC Minerals (USA) LLC ("LAC"). Attached is a revision to the October 9, 2020 CCP. The updated and revised CCP details the scope of work for closure/closeout of the Cunningham Hill Mine under the New Mexico Water Quality Act and the New Mexico Mining Act. The Cunningham Hill Mine CCP update reflects changes due to ongoing reclamation activities and the request for a pit waiver.

A draft of the public notice pursuant to 19.10.5.502.D(9) NMAC has been provided via a separate email. It is our understanding, that the application fee for Permit Revision 20-1 received on August 7, 2020 will be applied to this Permit Revision Application submitted by LAC.

A hard copy of the revised CCP report will be sent by mail. Do not hesitate to contact me at (801) 990-4833 if you have any questions or concerns regarding this report.

Sincerely,

Kevin Hamatake

LAC Minerals (USA) LLC
Kevin Hamatake
Barrick Gold of North America, Inc.
Cunningham Hill

CC: (electronic copies)
C. Burton, LAC
D. Wykoff, LAC

Bcc: (electronic copies)
Brad Reid, NMED GWB
Friends of Santa Fe County, w/enclosure
Gold Fields Mining Company, w/enclosure

OCTOBER 2021

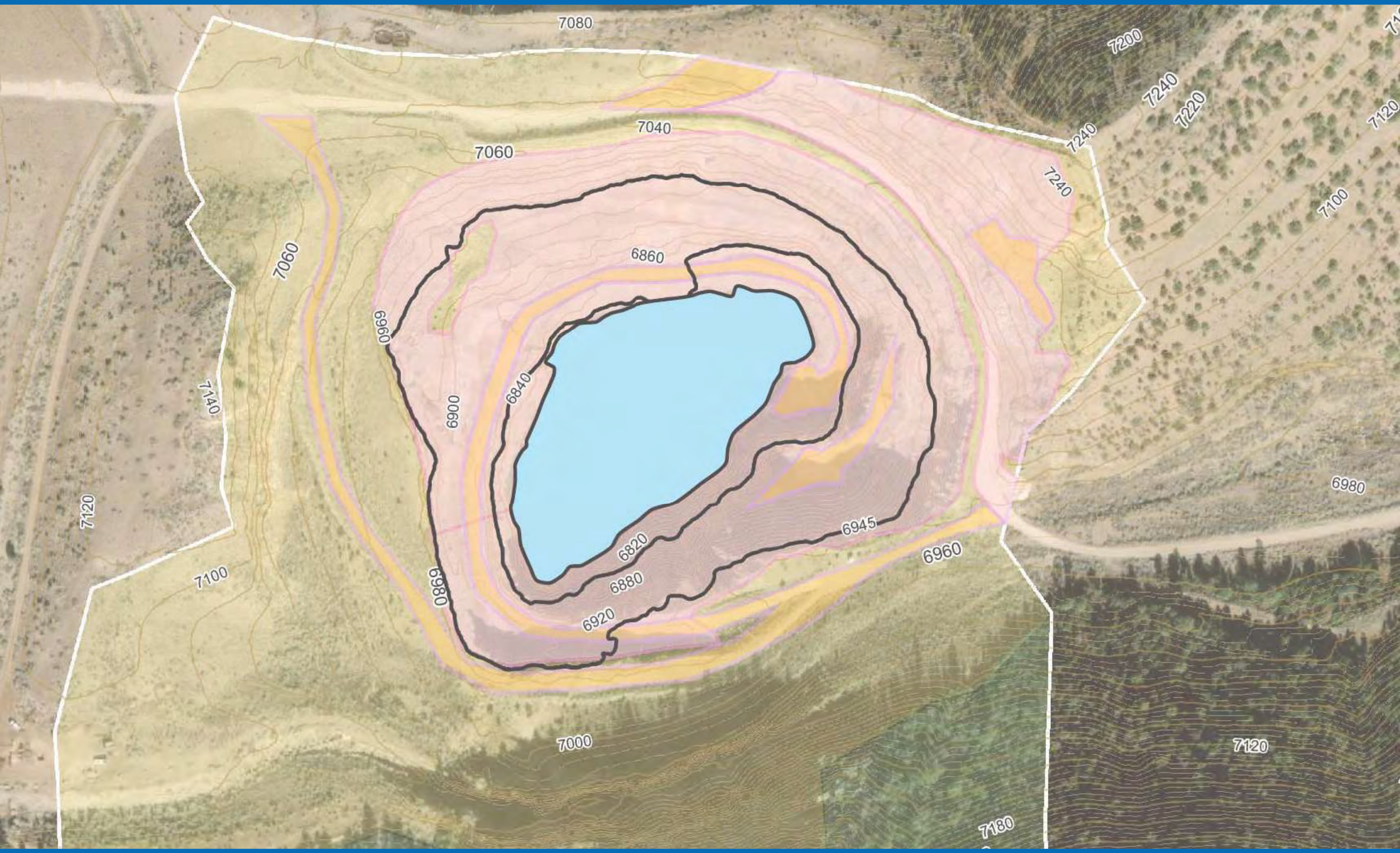
CUNNINGHAM HILL MINE RECLAMATION PROJECT
CLOSURE/CLOSEOUT PLAN UPDATE

prepared for

State of New Mexico
Energy, Minerals and Natural Resource Dept.
Mining and Minerals Division

on behalf of

LAC Minerals (USA) LLC
582 County Road #55
Cerrillos, New Mexico 87010



JSAI
JOHN SHOMAKER & ASSOCIATES, INC.
WATER-RESOURCE AND ENVIRONMENTAL CONSULTANTS
ALBUQUERQUE, NM * www.shomaker.com * 505-345-3407

CUNNINGHAM HILL MINE RECLAMATION PROJECT
CLOSURE/CLOSEOUT PLAN UPDATE

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prepared for:

State of New Mexico
Energy, Minerals and Natural Resource Department
Mining and Minerals Division

on behalf of:

LAC Minerals (USA) LLC
582 County Road #55
Cerrillos, New Mexico 87010

October 2021

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DEFINITIONS

AP-27 - the Abatement Plan for the Cunningham Hill Mine Open Pit Facility issued by the New Mexico Environment Department

ARD - Acid Rock Drainage

AWS - Acid Wall Seeps

CHMRP - Cunningham Hill Mine Reclamation Project

CCP - Closure/Closeout Plan

Closeout Plan means the *Cunningham Hill Mine Reclamation Project Closeout Plan* submitted February 1996 as a revision to permit SF002RE that provides a detailed description of how disturbed areas within permit area will be reclaimed to meet the requirements of the Act and the Rules. "Closeout Plan" also means those documents listed in Appendix A.

DP-55 - the Discharge Permit for the Cunningham Hill Mine Facility issued by the New Mexico Environment Department

Important Species - a species which provides at least 1 percent absolute ground cover or 2 percent relative cover

JSAI - John Shomaker & Associates, Inc.

LAC - LAC Minerals (USA) LLC

MMD - the New Mexico Mining and Minerals Division within the New Mexico Energy, Minerals and Natural Resources Department

NMAC - New Mexico Administrative Code

NAG - Non-Acid Generating material

NMED - the New Mexico Environment Department

NMMA - the New Mexico Mining Act, NMSA 1978, §69-36-1, et seq. (1993, as amended through 1999)

NMMA Rules - Title 19, Chapter 10, Parts 1 through 14 NMAC, and any amendments thereto

NMOSE - New Mexico Office of the State Engineer

NMSA - New Mexico Statutes Annotated

NMWQA - New Mexico Water Quality Act

NMWQCC - the New Mexico Water Quality Control Commission, and the regulations associated with title 20, Chapter 6, Parts 1 and 2, NMAC and any amendments thereto

NRCS - Natural Resources Conservation Service

Open Pit - the Cunningham Hill Mine Pit from which the ore bearing and non-ore bearing rocks have been removed by surface mining

Open Pit Water Body - the surface water and groundwater that has collected in the Cunningham Hill Mine Pit

Order - means the Director of MMD's Order approving the Permit Revision 96-1

Permit - the original permit, SF002RE, issued to LAC by MMD dated August 31, 1995

Permit Revision (96-1) - the December 12, 2020 permit revision which sets forth and approves a closeout plan for the Cunningham Hill mine

PMLU - Post Mining Land Use means a beneficial use or multiple uses which will be established on a permit area after completion of a mining project.

PRP - Permit Revision Package

Reclamation - the employment during and after a mining operation of measures designed to mitigate the disturbance of affected areas and permit areas and to the extent practicable, provide for the stabilization of a permit area following closure that will minimize future impact to the environment from the mining operation and protect air and water resources.

RUSLE - Revised Universal Soil Loss Equation

Self-Sustaining Ecosystem - reclaimed land that is self-renewing without augmented seeding, amendments, or other assistance, which is capable of supporting communities of living organisms and their environment. A self-sustaining ecosystem includes hydrologic and nutrient cycles functioning at levels of productivity sufficient to support biological diversity.

TDS - Total Dissolved Solids

Waste Rock Pile - all non-ore grade material from the Open Pit, exclusive of ore-grade material sent to the ore treatment unit

WQA - New Mexico Water Quality Act NMSA 1978 §§74-6-1 through 74-6-17

CUNNINGHAM HILL MINE RECLAMATION PROJECT CLOSURE/CLOSEOUT PLAN UPDATE

1.0 INTRODUCTION

The Cunningham Hill Mine Reclamation Project (CHMRP) is located in Santa Fe County, approximately 6 miles south of Cerrillos, New Mexico. The project is located entirely on private land on the East Ortiz Mine Grant. Figure 1 shows the regional location, and Figure 2 shows the LAC property boundary and reclaimed mine facilities. Gold Fields Operating Co.-Ortiz (Gold Fields) conducted mining and processing at the Cunningham Hill Mine from 1979 until 1987. The mine ceased operation in 1987. The original closeout plan was submitted by Pegasus Gold Corporation (Pegasus) and LAC Minerals (USA) LLC (LAC) in conformance with 19.10.5.506 NMAC and the New Mexico Mining Act (NMMA) Rules. Subsequently, the New Mexico Mining and Minerals Division (MMD) issued Permit No. SF002RE. In a letter dated September 26, 2019 to LAC, the MMD requested an update to the CHMRP Closure/Closeout Plan (CCP). This updated closeout plan addresses reclamation necessitated by Gold Fields' mining and processing operations under the responsibility of LAC.

1.1 Purpose of Plan

The updated CCP describes closure, remediation, and reclamation actions which LAC will take for those areas not yet fully reclaimed. Figure 3 is a site map showing the facilities that have undergone reclamation and financial release, and the facilities not yet fully reclaimed. The primary facilities requiring additional reclamation include:

1. Open Pit
2. Waste Rock Pile
3. RO Pond
4. Dolores Gulch Acid Rock Drainage (ARD) treatment system

CHMRP will be completed to the standards set forth in 19.10.5 NMAC as well as New Mexico Water Quality Control Commission (NMWQCC) regulations as specified in Discharge Plan DP-55 and Abatement Plan AP-27.

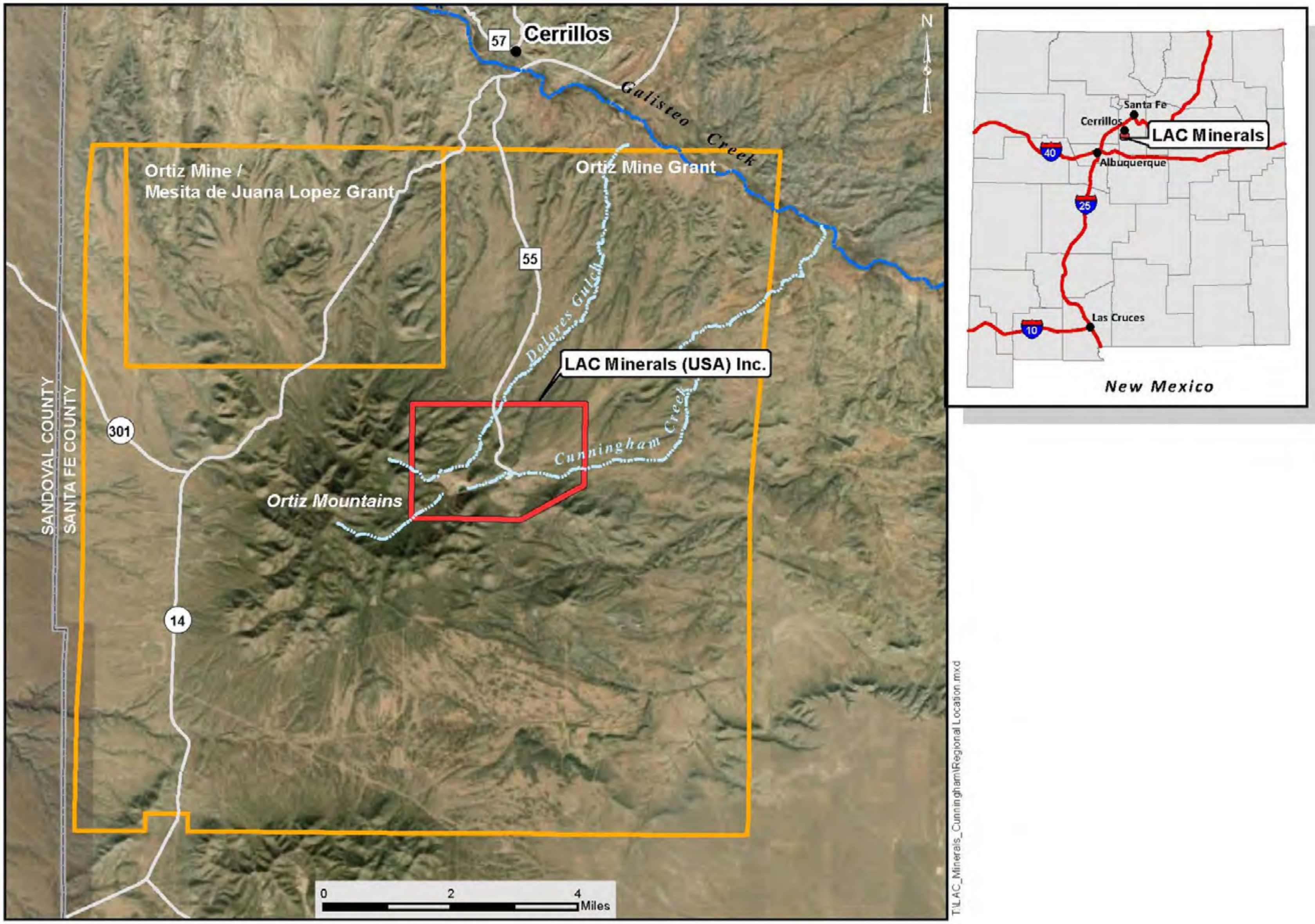

Figure 1. Regional map showing the location of LAC Minerals (USA) LLC property, Santa Fe County, New Mexico.

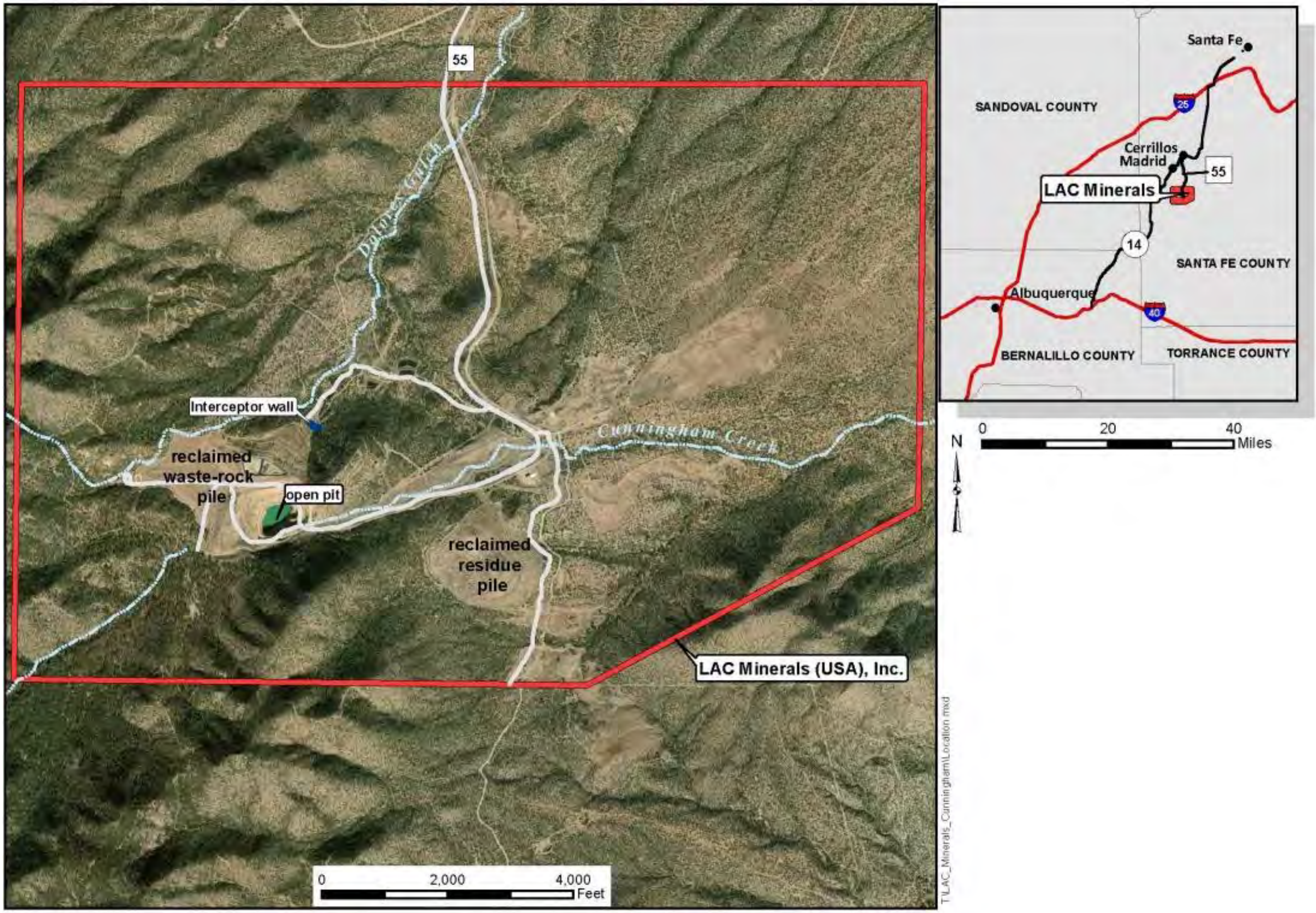

Figure 2. Map showing access roads and mine facilities, Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico.

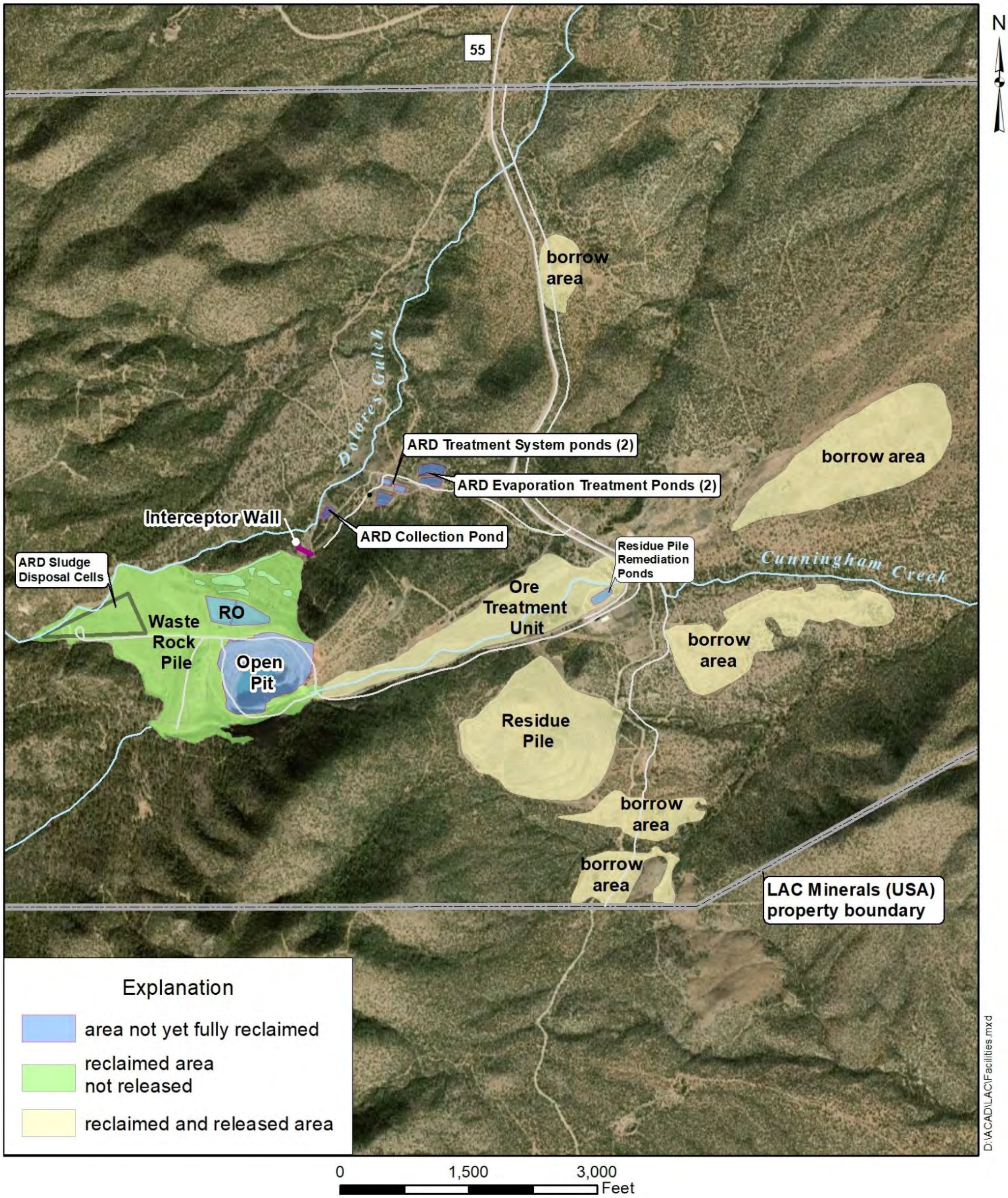

Figure 3. Aerial photograph showing locations of Gold Fields operation mining and processing units, and borrow areas used for reclamation.

1.2 Regulatory Authority

The New Mexico legislature enacted the New Mexico Mining Act (NMMA) requiring that closeout plans be put in place for applicable mines within the State in 1993. Rules to implement the requirements of the NMMA were promulgated in 1994. This CCP was prepared to comply with applicable regulations and requirements stipulated in the NMMA and NMAC Title 19, Chapter 10, Part 5, New Mexico Water Quality Act (NMWQA), and the New Mexico Water Quality Control Commission (NMWQCC) Regulations (NMAC Title 20, Chapter 6, Parts 2 and 4). The requirements of those laws are addressed in the conditions of LAC's permits SF002RE (permit revision 96-1), DP-55 (renewal permit pending), and AP-27 (re-issued 2002).

1.3 Project History

Mining in the vicinity of the CHMRP dates back at least to 1828, when gold was discovered by Mexican citizens. By 1865, the first stamp mill was operating in the Ortiz Mountains. Numerous owners and operators explored and mined in the area before Gold Fields developed the Cunningham Hill deposit in 1979.

Gold Fields developed and operated an open pit mine and processed the ore using cyanide heap leach methods. Waste rock material mined from the Open Pit was placed in the Waste Rock Pile. Ore was crushed and placed on an impervious asphalt leach pad, where it was leached with a dilute cyanide solution to extract the recoverable gold. Following leaching, the spent ore was rinsed with fresh water, removed from the leach pad, and placed in the Residue Pile. The mine operated until 1987 under New Mexico Environment Department (NMED) Discharge Plan 55 (DP-55).

Following Gold Fields operations, the mining and processing units remaining at CHMRP site included the Open Pit, Waste Rock Pile, ore treatment unit, Residue Pile, roads, and ancillary units. Operations had disturbed approximately 305 acres. For several of these units—including the Waste Rock Pile and the Residue Pile—groundwater is being remediated and protected under plans approved in DP-55 by the NMED pursuant to the NMWQA. The locations of mining, processing units, and borrow areas are shown on Figure 3.

Between 1996 and 2020, reclamation has been completed and financial release has been issued for most of the disturbed areas created by the Gold Field Operations (Fig. 3). Significant strides in groundwater and surface water remediation have been achieved, such as groundwater plume clean up downgradient of the Residue Pile, reduction in ARD generated from the Waste Rock Pile, reduction in contaminants in the Dolores Gulch groundwater plume downgradient of the Waste Rock Pile, and ARD source controls for the Open Pit water body.

Remaining reclamation efforts are required for the following units:

1. Open Pit reclamation and water treatment as required by AP-27
2. Final cleanup of Residue Pile groundwater plume (DP-55)
3. Removal and reclamation of Dolores Gulch ARD treatment system (SF002RE, DP-55)
4. Final cleanup of Dolores Gulch groundwater plume (DP-55)
5. Open Pit Reclamation (Permit No. SF002RE)
6. Waste rock pile erosion repairs (Permit No. SF002RE, DP-55)
7. RO Pond reclamation (Permit No. SF002RE, DP-55)
8. Residue Pile Remediation Treatment Ponds (Permit No. SF002RE, DP-55)

1.4 Description of Updated Plan

A significant portion of CHMRP has been reclaimed and released from financial assurance (Table 1; Fig. 3). The updated plan addresses the remaining facilities undergoing final reclamation efforts, which include the Open Pit, the Waste Rock Pile, ARD Treatment Facility in Dolores Gulch, Freshwater Makeup Ponds, and plugging and abandonment of monitoring wells. The acreage of disturbance is summarized in Table 1. This updated CCP also includes:

Appendix A - the NRCS soil survey information for the site,

Appendix B - an Updated Contingency Plan that describes measures which would be undertaken to address certain probable or possible future environmental conditions at CHMRP,

Appendix C - the CHMRP Forest Management Plan that addresses wildfire mitigation measures, forest health improvements, and invasive species management,

Appendix D - photographs of the current open pit conditions,

Appendix E - Open Pit evaluation report that addresses revised open pit filling scenarios and the revised AP-27 open pit remediation plan,

Appendix F - RO pond reclamation report that specifies closure design methods,

Appendix G - CHMRP revegetation monitoring procedures, and

Appendix H - report regarding justification for open pit waiver for self-sustain ecosystem requirements specified by the MMD, and request for open pit waiver.

Table 1. Disturbed acreage summary table for Cunningham Hill Mine Reclamation Project

unit	acreage disturbed	status
Open Pit	34.13	pit waiver requested for 14.53 acres; pending 19.60 acres reclaimed; revised AP-27 open pit pool reclamation plan in progress
Waste Rock Pile	71.43	pending; largely reclaimed, except for RO evap. pond
Residue Pile	47.82	reclaimed and released
Ore Treatment Unit and surface facilities	75.02	reclaimed and released
borrow areas	120.70	reclaimed and released
roads	11.60	primary access to remain for PMLU
ARD Treatment Facility	2.26	pending ARD mitigation
TOTAL	**362.96**	
Total released	243.54	
Total pending	107.82	
Total to remain for PMLU	11.60	

RO evap. – reverse osmosis evaporation
PMLU – post-mining land use
ARD – acid rock drainage

Documents cited in this CCP are incorporated by reference. Copies of all cited documents have been provided to the Mining and Minerals Division (MMD) of the New Mexico Energy, Minerals and Natural Resources Department, provided to the NMED, or appended as part of this updated plan.

2.0 PERMITS AND REGULATORY REQUIREMENTS

Section 69-36-11B(3) of the NMMA requires that the CCP specify the work to be done within a specific time frame that, if followed, will reclaim the physical environment to a condition that allows for the reestablishment of a self-sustaining ecosystem following closure, unless the Director waives the requirement to achieve a self-sustaining ecosystem. The CCP is required under 19.10.5.506 NMAC to contain:

1. a description of the work proposed and a schedule showing the incremental work to be performed and the time required for various phases of the closeout,
2. a list of all state and federal permits required and evidence that they have been issued or a schedule of anticipated issue dates,
3. a map of the permit area, and
4. additional information needed for the Director to evaluate the plan.

A description of the work proposed is contained in Sections 5.0, 6.0, and 7.0 of this updated CCP. A schedule for completion of the work to be performed in the closeout is contained in Section 8.0 of this updated CCP. A list of all state and federal permits is provided in Table 2. A map of the permit area is shown as Figure 2. Additional maps of the project area are provided in other figures included in this updated CCP. Design limits and general engineering specifications for the initial reclamation at CHMRP were submitted with the original CCP.

The CCP presents all of the information required by NMMA Rule 5.6 and, if followed, will achieve the requirements of Section 69-36-11B(3).

Discharge plan DP-55 has significant impact on the site groundwater reclamation requirements. It sets forth the specific plan for implementing the NMWQA and the NMWQCC regulatory requirements for protection and remediation of groundwater affected by the Waste Rock Pile and Residue Pile.

Alternative Abatement Plan AP-27 sets forth the surface water and groundwater protection standards and monitoring requirements for discharges associated with the Open Pit water body.

Table 2. Summary of Cunningham Hill Mine Reclamation Project Permits

permit/approval	agency	purpose
Discharge Plan DP-55 (renewed 11/20/2020)	NMED Groundwater Quality Bureau	discharges to groundwater from Residue Pile, Waste Rock Pile
Abatement Plan AP-27 (update in progress)	NMED Groundwater Quality Bureau	Open Pit surface-water standards and discharges to groundwater
Cunningham Hill Mine Reclamation Project Permit	New Mexico Energy, Minerals and Natural Resources Department, Mining and Minerals Division	Permit #SF002RE, issued August 1995 for the reclamation of disturbed lands related to the Gold Fields mining operation to achieve self-sustaining ecosystem status for the designated post mining land uses of wildlife and livestock
RG-32970, RG-3707-A, RG-18479, 4775, and RG-36607	New Mexico Office of the State Engineer	• pit dewatering • supply wells (PW77-1, PW79-2) • diversion from Upper Cunningham Gulch • Interceptor Wall ARD diversions • Dolores Gulch recovery wells • Residue Pile recovery wells • Guest House Well (RG-36607-POD3) approved 1997, amended 2015
National Stormwater Discharge Permit	U.S. EPA	submitted Notice of Intent September 1992; approval granted February 1993; modification of pollution prevention plan completed in 1996
NPDES Permit	U.S. EPA	permit for outflow from Open Pit into Cunningham Gulch
Section 404 Permits	U.S. Army Corps of Engineers	nationwide permits applicable to road crossings and other disturbances

3.0 EXISTING FACILITIES AND CONDITIONS

For the updated CCP, existing facilities include those that require reclamation or additional reclamation.

3.1 Location and Mine Permit Area

CHMRP is located on the northeast flank of the Ortiz Mountains, approximately 31 miles southwest of Santa Fe and approximately 46 miles northeast of Albuquerque, New Mexico. The legal description for the CHMRP area is as follows:

- An unsurveyed portion of Township 13 North, Range 8 East; and
- An unsurveyed portion of Township 13 North, Range 7 East.

The project is accessed by traveling south on Highway 14 from Santa Fe to County Road 55 and proceeding south on County Road 55 to the end of Gold Mine Road. Figures 1 and 2 show location and access.

3.2 Description of Existing Mine Facilities

3.2.1 Cunningham Hill Mine Open Pit

The Cunningham Hill Open Pit is located on the northeast flank of the Ortiz Mountains. Cunningham Hill forms the northeast side of the Open Pit. Excavation of the Open Pit began at an elevation of approximately 7,200 feet above mean sea level (ft amsl) on the south slope of Cunningham Hill. Mining ceased at the 6,665 ft amsl. Figure 4 presents a topographic map showing existing access roads. Mining activities associated with the Cunningham Hill Open Pit disturbed approximately 34 acres. The disturbed area now consists of:

1. reclaimed area around the Open Pit rim
2. Open Pit water body
3. access roads
4. areas to be reclaimed
5. inaccessible disturbed areas that are naturally reclaimed

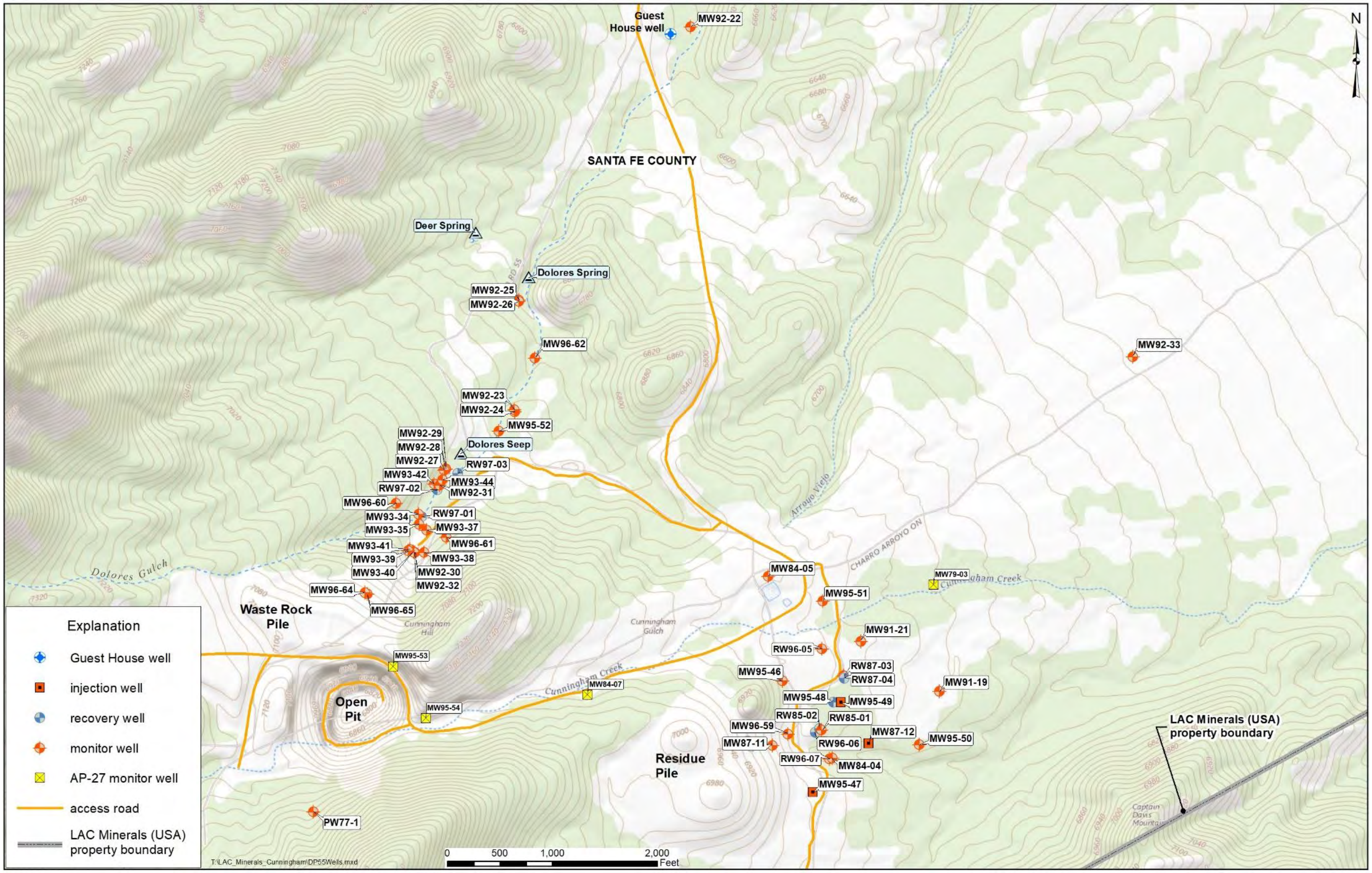

Figure 4. Topographic map of Cunningham Hill Mine Reclamation Project showing DP-55 and AP-27 groundwater monitoring networks.

The pre-mining surface elevation of groundwater in the Open Pit area was approximately 6,900 to 6,910 ft amsl near the center of the Open Pit and varied from about 6,925 ft amsl on the upgradient south side, to approximately 6,895 ft amsl on the downgradient northeast side (Hydro-Geo Consultants, Inc., 1994a). Dewatering from the open pit, PW77-01, and PW79-02 by Gold Fields during mining lowered the water level approximately 235 ft. The water level in the Open Pit rebounded from 6,660 to 6,780 ft amsl in the 10-year period after mining ceased. The surface elevation of the Open Pit waterbody was approximately 6,800 ft amsl as of June 2020.

Following the cessation of mining from the Cunningham Hill Open Pit in 1987, there has been localized raveling of slopes in the Open Pit, with the most pronounced area being the south wall. A geotechnical investigation was conducted to evaluate the probable long-term stability of the Cunningham Hill Open Pit slopes (Call & Nicholas, Inc., 1994). The Open Pit walls and topography were examined and pre-mining geology reports were reviewed in support of the study. The evaluation concluded that the current post-mining configuration is stable and that the probability of the occurrence of a large-scale slope failure is low. As previously noted, localized raveling of Open Pit walls will continue to occur naturally over time, with the upper south wall already being predominantly a talus slope. Localized raveling will not impact post-reclamation land uses or public safety.

Originally, it was predicted that the Open Pit would fill from the Upper Cunningham Gulch surface water diversions to an elevation of 6,900 ft amsl in 35 years (Adrian Brown Consultants, Inc., 1997). Furthermore, it was predicted that filling with stormwater would inundate Acid Wall Seeps (AWS) and improve water quality. Secondary benefits of the Open Pit filling included a more favorable Open Pit waterbody configuration for wildlife access. The study concluded that the Open Pit waterbody would not become acidic with time and would not detrimentally affect local surface and groundwater resources.

Infiltration of stormwater through fractures to the pit walls resulted in oxidation of sulfides causing AWS and degraded the quality of the Open Pit waterbody. The original remedy specified in AP-27 included Reverse Osmosis treatment to reduce sulfate and TDS concentrations followed by filling of the Open Pit with stormwater. Reverse Osmosis treatment was performed in 2002 and 2003. The treatment efforts were not successful for the long term because of the lack of AWS source controls and effects of RO treatment method on open pit pool water quality.

JSAI (2011) prepared a revised Open Pit waterbody reclamation plan for AP-27 to address source controls followed by treatment to meet AP-27 water quality standards. The revised AP-27 remediation plan was approved by NMED (2012). Implementation of source controls occurred between 2012 and 2018, and included: 1) repairs to the Upper Cunningham Gulch diversion to mitigate the infiltration of stormwater into fractures that report to the open pit, 2) stormwater controls in and around the Open Pit, and 3) resurfacing access roads and some bench areas with caliche. The revised AP-27 remediation plan does not rely on filling of the Open Pit with stormwater to meet water quality standards; instead, the revised plan relies on source controls to prevent AWS. As determined by long-term monitoring and model calibration, the Open Pit water body has achieved near steady-state level at 6,800 ft amsl elevation (JSAI, 2011; JSAI, 2020).

3.2.2 Reclaimed Waste Rock Pile

The Waste Rock Pile (Fig. 2) was created during the Cunningham Hill Mine Open Pit and heap-leach operations between 1979 and 1987. The Waste Rock Pile contains overburden (with disseminated pyrite) removed from the Cunningham Hill Mine Open Pit that was placed in Upper Dolores Gulch. The Waste Rock Pile covers an area of about 72 acres.

Leachate from the Waste Rock Pile discharged to groundwater in Dolores Gulch during the early 1990s. The leachate contained ARD with low pH, elevated total dissolved solids (TDS), and elevated metals concentrations. The ARD Interceptor Wall was constructed at the toe of the Waste Rock Pile prior to reclamation of the Waste Rock Pile in 1995.

Reclamation of the Waste Rock Pile included re-contouring, addition of lime to the upper 12 in. of scarified waste rock, placement of soil cover, construction of 5,000 ft of synthetically-lined stormwater channels, and re-vegetation (Golder Associates and Schafer and Associates, 1993). Approximately 300,000 cubic yards (yd^3) of rock-fill material were added to the Waste Rock Pile for re-contouring. Lime was applied to the re-contoured surface at 20 to 60 tons per acre, which resulted in an 8- to 10-in. layer. Approximately 155,000 yd^3 of imported cover soil was spread evenly across the Waste Rock Pile resulting in an average thickness of 18 in. This cover was applied in two “lifts.” The lower lift consisted of 6 to 8 in. of subsoil, which was a coarser material high in natural lime, while the upper lift consisted of 10 to 12 in. of topsoil composed of a sandy-clay loam.

The Waste Rock Pile reclamation was completed around 1996, but the vegetative cover did not mature until 2005. An RO evaporation pond was constructed on top of the Waste Rock Pile as part of the Open Pit water treatment conducted in 2002 to 2003. Between 2011 and 2016, significant improvements were made to shed stormwater runoff and reduce the potential for cover erosion. The stormwater diversion features also assisted with reducing infiltration and generation of ARD. During 2019, the East Groin stormwater channel was investigated and found to be a potential source for infiltrated stormwater into the Waste Rock Pile (WRP). In 2021, repairs to the East Groin stormwater channel were made by filling voids in the East Groin rip rap with a two-part polyurethane resin (Meridiam Partners, 2021).

The DP-55 groundwater monitoring system includes monitoring wells in Dolores Gulch downgradient of the ARD Interceptor Wall and two wells completed beneath the Waste Rock Pile. Monitoring wells are shown in Figure 4.

3.2.3 ARD Treatment Facility

The ARD treatment facility in Dolores Gulch is for treatment of intercepted leachate from the Waste Rock Pile, which consists of ARD. The ARD is collected behind a grouted Interceptor Wall in French drains, and reports to the ARD collection ponds. The collected ARD is gravity-fed from ARD collection ponds, to ARD treatment ponds and evaporation ponds. The ARD collection, treatment, and evaporation ponds are shown in Figure 3. The ponds are synthetically-lined, with liners that are made of 80-millimeter high-density polypropylene material. There is a network of monitoring wells downgradient of the ARD ponds that provide a leak detection system.

ARD in the collection pond downgradient of the Interceptor Wall (sometimes referred to as “pond A”) is transferred via gravity to a second collection pond (sometimes referred to as “pond B”) adjacent to two ARD treatment ponds. Before the ARD collection ponds reach capacity, the ARD is transferred to one of the two treatment ponds (synthetically-lined ponds adjacent to pond B), where it is treated with lime solution. The treated water is released to the two synthetically lined ARD evaporation ponds, located northeast of the treatment ponds, for passive evaporation. A 1-ft freeboard is maintained in all ponds. Three recovery wells are operated below the Interceptor Wall, and captured groundwater is discharged into ARD collection pond A.

To maintain capacity in the treatment ponds, sludge was removed and disposed of on top of the Waste Rock Pile in a designated disposal area (see Fig. 3). The NMED approved the sludge disposal plan as part of DP-55. ARD sludge was removed, disposed in the designated area, covered and revegetated. Vegetation surveys have been performed to evaluate revegetation efforts.

Visual inspections of the recovery wells, collection lines, and lined ponds are performed monthly (NMED, 2020). The visual inspection includes checking for the presence of leaks, condition of liners and equipment, and pond freeboard. During times of excessive precipitation events, more frequent visual inspections are made on the ARD flow, pond capacity, and freeboard.

In the event that the total storage capacity of the ARD system of 7.8 acre-feet is exceeded and all treated ARD cannot be evaporated, LAC will discharge the excess treated ARD to the permitted land application areas. The land application areas will only receive treated ARD on an emergency basis, such as during high precipitation, to avoid overflows or spills at the ARD treatment and evaporation ponds. The ARD flows to the collection pond and recovery wells are measured or metered, and the volume of water collected is reported quarterly to the NMED as part of the DP-55 monitoring report.

As a result of source controls implemented between 2011 to current, Waste Rock Pile ARD flows have significantly decreased to where only ARD ponds A and B have been utilized for discharge by evaporation. The lime treatment system and ponds have not been in use for over a decade.

3.2.4 Access and Haul Roads

All haul roads associated with Gold Field operations have been reclaimed, and only access roads remain at the site. As part of the CHMRP Forest Management Plan, access roads will be maintained for County and State firefighting needs and Post Mining Land Use (PMLU). Existing access roads are shown on Figure 4.

3.2.5 Ancillary Units

Remaining ancillary units include the Office/Maintenance shop building and surrounding area (see Fig. 3). Utilities constructed in support of the project include power lines, septic systems, and a water distribution system for the Office/Maintenance shop building. The Office/Maintenance shop building is a prefabricated structure located approximately 700 ft southeast of the reclaimed leach pad.

Previously existing aboveground tanks have been removed from the site. The tanks included a diesel tank, and an unleaded gasoline tank located in the vicinity of the Office/Maintenance shop building. The residual hydrocarbon-contaminated soils were excavated and removed from the site. A letter report was submitted to NMED describing the results of implementing the Corrective Action Plan (Camp Dresser & McKee, Inc., 1995).

The Office/Maintenance shop building and surrounding area has been designated for industrial use during reclamation and post-mining land use (Approved in MMD Permit Modification 17-1 for Permit No. SF002RE). No reclamation efforts are anticipated. Section 9.A.2 of Permit Modification 17-1 to Permit No. SF002RE requires a building inspection certification once every 5 years for the duration of Permit No. SF002RE.

3.3 Past and Current Land Uses

The pre-mining uses of the land at the site were primarily livestock grazing, wildlife habitat, and mineral exploration and development. Mineral exploration activity has occurred on and off since 1836. Figure 5 is a July 8, 1958 aerial photograph of the Open Pit and Waste Rock Pile areas prior to Gold Fields mining operation. Prior to mining, the Open Pit area was about 75 percent disturbed from historical mining, with about 25 percent undisturbed. Vegetation is relatively sparse for the undisturbed area.

PMLU, as anticipated by this updated CCP, is and will continue to be for wildlife habitat. Livestock grazing may occur in the future if landownership changes. Currently, no livestock graze on the permit area.

3.4 Environmental Setting

The environmental setting of the CHMRP area is described in the site assessment (WESTEC, 1994a) that was prepared pursuant to NMMA (69-36-5). The site assessment was submitted to the MMD on July 7, 1994. Updated site assessment information was included in the Permit Application (WESTEC, 1994b) submitted to MMD on December 29, 1994.

3.4.1 Topography

The CHMRP site is located on the northern flank of the Ortiz Mountains. The landscape is classified as fault-block mountains with low-hill landforms (NRCS, 2007). Slopes range from 20 to 50 percent. Land surface elevation ranges from 6,500 to 7,500 ft amsl (Fig. 4). In general, the topography is rugged with moderate to steep slopes throughout the permit area.

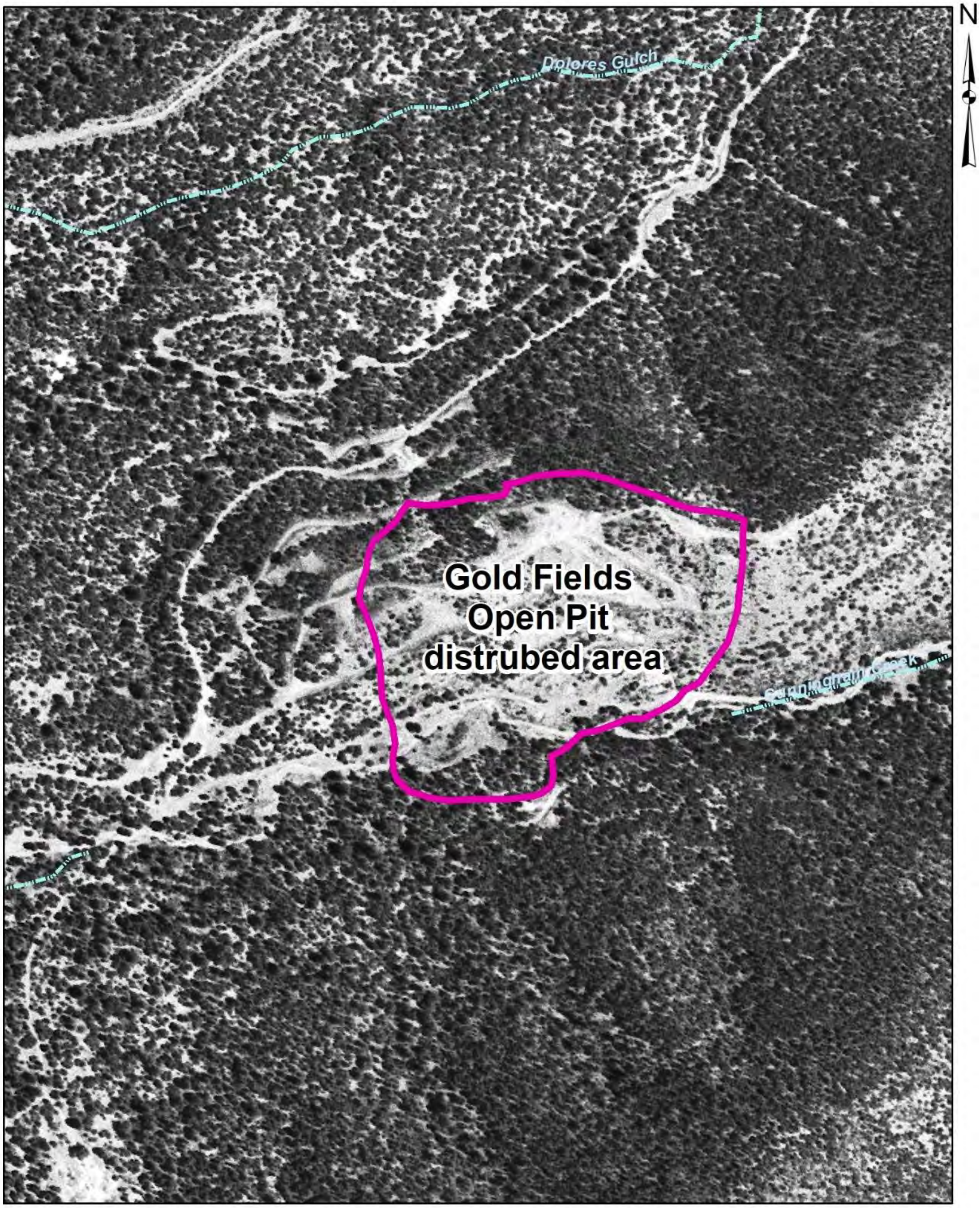

Figure 5. Aerial photograph from July 8, 1958, showing historic mining disturbance prior to Gold Fields mining operations.

Cunningham Hill, Cunningham Gulch, and Dolores Gulch are the primary topographic features in the permit area. Upper Cunningham Gulch, receiving watershed to the Open Pit, includes an area of about 1,300 acres with an elevation range of 7,000 to 8,900 ft amsl. The Waste Rock Pile and Residue Pile were re-contoured to match the undisturbed area topography.

3.4.2 Geology

The oldest rocks exposed in the CHMRP area are sedimentary rocks of the Cretaceous Mesaverde Group. They range from coarse-grained quartzites to fine-grained argillites and shales. Clastic sedimentary rocks of the early Tertiary Galisteo Formation unconformably overlie the Mesaverde rocks. Igneous rocks ranging in age from 62 to 30 million years before present intrude the Mesaverde and Galisteo section. Volcanics and volcanic-vent breccia associated with the intrusives locally host sulfide and gold mineralization (Lindquist, 1980; Maynard, 1990).

The northeast-trending Tijeras-Golden fault system and the northwest-trending La Bajada fault and dike trend converge in the Ortiz Mountains. Mineralization in the CHMRP area is associated with a pipe-like body near the intersection of the Tijeras-Golden fault zone and cross-cutting faults in Cunningham Gulch (Lindquist, 1980; Maynard, 1990). Mine dewatering primarily occurred from the open pit, PW77-01, and PW-79-02 completed in the Golden Fault zone. Some alluvium can be found along Dolores Gulch.

3.4.3 Climate

The project site is located in the Central Highlands climatic region of New Mexico. The area has a mild, semi-arid, continental climate, characterized by light precipitation totals, abundant sunshine, low relative humidity, and wide annual and daily temperature ranges.

Average annual precipitation for the Golden station, three miles southwest of the project site, at an elevation of 6,650 ft amsl, was 12.4 in. for the period 1944 to 1981, and 16.42 in. for the period 1979 to 1989 (NOAA, 1989). Most of the annual precipitation falls during the summer rainy season. Summer thunderstorms are usually brief but intense, and occur when moisture from the Gulf of California moves over the area. Annual precipitation measured at the site has ranged from 7.49 to 18.55 in./yr, and has averaged 13.27 in./yr over the last 22 years.

Winter precipitation is caused mainly by Pacific Ocean storm fronts moving from west to east. Most of the precipitation during the winter falls as snow. Average snowfalls for December through February are 4 to 5 in./month; however, snowfall events over 24 in. have been measured. In contrast, during drought years, a snowpack may not even develop.

Potential evapotranspiration has been estimated from regional weather station data to be 57.1 in./yr on average. Potential evapotranspiration is the maximum evaporation and plant transpiration that can occur given full availability of water, and is a function of geographical and climatic conditions. Average temperatures at CHMRP in 2019 ranged from 32 degrees Fahrenheit in the winter (January, February, and December) to 69 degrees Fahrenheit in the summer (June, July, and August).

LAC maintains a weather station on top of the reclaimed Waste Rock Pile near the RO evaporation pond, as well as a heated precipitation gage near the Office/Maintenance shop building. Weather station data were submitted as part of the annual DP-55 report, which primarily include temperature and daily precipitation.

Meteorological data for air quality baseline studies were collected during 1990 for the area. The monitoring station is located approximately 1.5 miles north of the village of Golden and approximately 1,000 ft east of New Mexico State Highway 14. Air quality in the project area is characterized as rural with negligible urban effects.

3.4.4 Surface Water

Surface water in the CHMRP area is primarily in the form of ephemeral streams that flow as the result of spring snowmelt and from summer rainfall.

In general, two watersheds contribute to surface-water flow in the CHMRP area: 1) the Dolores Gulch and 2) Cunningham Gulch watersheds. Flow in these watersheds is intermittent and no historical gaging stations existed. Runoff derived from Upper Cunningham Gulch diverted to the Open Pit has been measured since 2011 at an established weir equipped with a transducer (Table 3). Measured stormwater diversions are reported to the New Mexico Office of the State Engineer (NMOSE).

Measurable flows from Upper Cunningham Gulch did not occur until after repairs were made to the diversion channel in 2015 (Table 2). The relatively high flows recorded in 2019 are likely a result of watershed thinning that occurred in 2018 combined with a few large precipitation events.

The only permanent surface-water body at the mine site is the waterbody formed from the Open Pit. The elevation of the water in the Open Pit in June 2020 was 6,800 ft amsl, equivalent to a calculated water volume of about 190 acre-feet.

Table 3. Measure flow from Upper Cunningham Gulch

year	Upper Cunningham Gulch diversion channel weir flow (ac-ft)
2011	0.00
2012	0.00
2013	0.01
2014	0.00
2015	0.79
2016	0.15
2017	1.73
2018	1.54
2019	20.15
2020	

ac-ft - acre-feet

3.4.5 Groundwater

Subsurface waters in the CHMRP area lie in the alluvium and in the deeper bedrock, which consists of fractured weathered and unweathered igneous and sedimentary rocks. Hydraulic conductivity and storage coefficient for the bedrock units is exceptionally low except in the immediate vicinity of the fractured ore body at the Open Pit.

The groundwater is typically either a calcium-carbonate type, calcium-bicarbonate type, or calcium-sulfate type. The variability in water type occurs mainly due to differences in lithologies along groundwater flow paths. The DP-55 and AP-27 groundwater monitoring networks can be referenced from Figure 4. Additional groundwater characteristics can be referenced from DP-55 annual reports.

3.4.6 Soils

Soils in the permit area have been mapped by the Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service). Figure 6 is an NRCS (2007) soils map for the CHMRP area. The predominant soil type is the Pegasus extremely cobbly loam (map unit 514); previously mapped by the NRCS as Rock Outcrop (SCS, 1975). Pegasus extremely cobbly loam profile is typically less than 14 in. with the parent material consisting of slope alluvium and colluvium derived from monzonite. The soil has a water holding capacity of 1.2 in., and is considered well drained. NRCS soil survey information can be referenced from Appendix A.

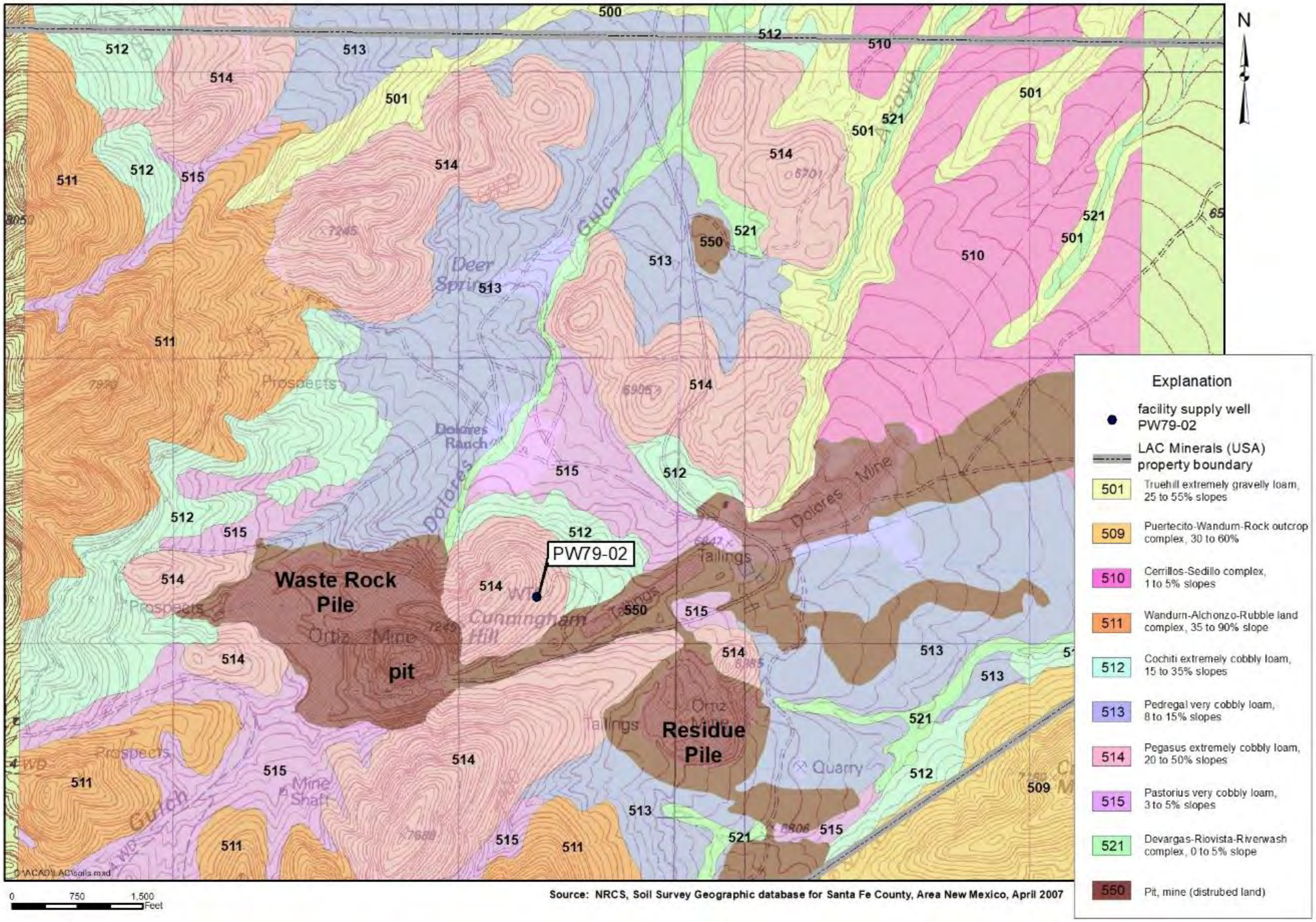

Figure 6. Soil survey map for Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico.

3.4.7 Vegetation

A vegetation baseline study was prepared for the CHMRP area (Elliott, 1991). This study identified and sampled eight native plant communities for species composition, canopy coverage, production, and the presence of rare or sensitive plants. The flora of the project area is composed of elements typical of the Rocky Mountains, Great Basin, and Sonoran/Chihuahuan Desert areas.

The lower elevations of the CHMRP area consist of blue grama grasses with less dominant grass species such as ring muhly, galleta, and Western wheatgrass. Vegetation within the mid-elevations of the project area include piñon pine, one-seed juniper woodland, Gambel oak, hairy grama grass, and mutton grass. Vegetation at the highest elevations includes a mixture of conifers such as piñon pine, Douglas fir, white fir, ponderosa pine, and Rocky Mountain juniper. Dominant shrubs at high elevations include rock-spiraea, chokecherry, and mockorange.

Sensitive plants are those species listed pursuant to the federal Endangered Species Act as threatened or endangered, or candidates for federal protection. In addition to federally designated species, the New Mexico Forestry and Resources Conservation Division (1995) has designated State List 1 species. State List 1 plant species are defined as follows:

- The taxon is listed as threatened or endangered under the provisions of the federal Endangered Species Act (16 U.S.C. Sections 1531 et seq.), or is considered proposed under the tenets of the Act; or
- The taxon is so rare across its range within the state and of such limited distribution and population size that unregulated collection could jeopardize its survival in New Mexico.

Surveys for threatened, endangered, and sensitive plant species were conducted in June 1991 (Elliot), in the vicinity of CHMRP. No federally threatened or endangered species were found in the CHMRP area. Wright's fishhook cactus, a State List 1 species, was identified in the Carache Canyon and Lucas Canyon areas of the Ortiz Mountains.

The NRCS (2007) includes the following potential native vegetation for Pegasus extremely cobbly loam: two-needle pinyon, one-seed juniper, true mountain mahogany, blue grama, and sideoats grama (see Appendix A).

3.4.8 Wildlife

Wildlife populations and habitat were surveyed during 1990 and 1991 within proximity to CHMRP (Metric Corporation, 1991). Three primary wildlife habitats were identified: piñon-juniper woodland habitat, upper slope habitat, and drainage habitat. No evidence of golden eagle nesting sites was observed in the environmental study area, which included the CHMRP site. One golden eagle nest site is known in the Ortiz Mountains; however, it is several miles away from CHMRP. Two red-tailed hawk nests (one abandoned), one possible Cooper's hawk territory, and one flammulated owl territory were recorded on the south side of the Ortiz Mountains. Wildlife observed within proximity to the project site are shown in Table 4, and photographs can be referenced from Appendix D. No threatened or endangered wildlife species were identified to occur within proximity to the CHMRP area.

Table 4. Wildlife observed within proximity to the Cunningham Hill Mine Reclamation Project site

common name	scientific name
desert cottontail rabbit	*Sylvilagus audubonii*
woodrat	*Neotoma lepida*
black-tailed jackrabbit	*Lepus californicus*
mule deer	*Odocoileus hemionus*
cougar	*Felis concolor*
bobcat	*Felis rufus*
coyote	*Canis latrans*
black bear	*Ursus americanus*
skunk	*Mephitis californium*
Bewick's wren	*Thryomanes bewickii*
plain titmouse	*Parus inornatus*
Rufous-sided towhee	*Pipilo erythrophthalmus*
mountain chickadee	*Parus gambeli*
red-breasted nuthatch	*Sitta canadensis*
white-breasted nuthatch	*Sitta carolinensis*
scrub jay	*Aphelocoma coerulescens*

Source: Metric Corporation, 1991.

4.0 RECLAMATION COMPLETED

Mining at the Cunningham Hill site ceased in 1987. Reclamation activities completed thus far for the Waste Rock Pile include grading, recontouring, placing soil cover, revegetating, diverting surface waters around and away from the Waste Rock Pile, re-completion of the Upper Cunningham Gulch surface-water diversion to the Open Pit, and stormwater controls within the Open Pit watershed. This work has been conducted pursuant to discharge plan DP-55 under the supervision of NMED to satisfy the requirements of the NMWQA and NMWQCC regulations. In addition, LAC has regraded and seeded the original borrow area; removed the crushing facilities; and removed the metallurgical laboratory and the process plant.

Reclamation of the units at CHMRP were completed so that the physical environment of the site would allow for the reestablishment of a self-sustaining ecosystem, pursuant to Section 69-36-11B(3) of the NMMA. Previous closure, remediation, and reclamation activities are discussed for each unit at CHMRP in the following sections.

4.1 Reclaimed Topography

Post-reclamation topography at the Cunningham Hill Mine site has been designed to blend with the surrounding natural topography and to ensure long-term stability. The post-reclamation topography provides effective protection from water and wind erosion and facilitates the reestablishment of productive vegetative communities which are beneficial to wildlife found in the project area. Post-reclamation topography for the Cunningham Hill Mine site is shown on Figure 4.

The Open Pit was designed to remain as a topographic depression containing a freshwater body. The Cunningham Gulch Diversion Channel was constructed to route surface-water flows from Upper Cunningham Gulch into the Open Pit. The channel has a grade of approximately 0.5 percent and was constructed with maximum side slopes of 2.5H:1V. An outlet control structure from the Open Pit at 6,990 ft amsl elevation and a channel were constructed to route flow from the Open Pit to the lower Cunningham Gulch drainage course.

The final Open Pit waterbody elevation will vary between 6,800 and 6,840 ft amsl (JSAI, 2020). Overall slopes in the Open Pit above the final Open Pit waterbody elevation will range from 1H:1V to 3H:1V. Catch benches are spaced vertically on the Open Pit walls at intervals generally ranging from 25 to 50 ft. The talus slope above the south wall of the Open Pit, which will not be disturbed, slopes at approximately 1.3H:1V.

The Waste Rock Pile has been regraded leaving maximum slopes of approximately 3H:1V. Benches were constructed on long slopes at intervals of approximately 35 vertical ft.

All structures in the ore treatment unit area, including crushers, leach pad, ponds, and process plant, have been removed, the area was regraded to blend with the surrounding topography, and the lower Cunningham Gulch drainage course was restored.

The Residue Pile surface was reconfigured to produce a more natural appearing land form which includes two minor hills. The Residue Pile side slopes were recontoured to an average overall slope of 3.5H:1V. Intermediate slopes of 3.0H:1V were separated by catch benches at intervals of approximately 35 ft. The surface of the Residue Pile was recontoured to promote surface water drainage toward the back and sides of the Residue Pile, from where a perimeter diversion ditch conveys the stormwater flows into natural drainage courses downgradient of the Residue Pile. In conjunction with the recontouring of the Residue Pile, the Residue Pile catchment pond was eliminated. Regrading of the east slope of the Residue Pile filled in the majority of the pond. The catchment embankment was regraded to the west to fill in the remainder of the pond.

The primary access roads will remain in place for post-mining land uses. Other roadways have been reclaimed and graded to blend with the surrounding topography.

4.2 Open Pit

In 1992, the uppermost portions of the north, west, and east sides of the Open Pit were graded and 8-ft-high berms were placed to intercept and divert runoff. The remaining berms were completed during reclamation. The existing Cunningham Hill Channel was blocked at its junction with Cunningham Gulch and the area regraded to direct surface water flowing in Upper Cunningham Gulch into the Open Pit via a new Cunningham Gulch Diversion Channel. Riprap was placed in the Open Pit along the path of flow as required to provide for erosion protection while the Open Pit is filling. An outlet control structure was constructed at the low point of the Open Pit crest at the 6,990-ft amsl elevation to regulate flows from the Open Pit waterbody.

In the event that the Open Pit filled, a channel was constructed to route flow from the Open Pit outlet control structure to the lower Cunningham Gulch channel when outflows occur (Adrian Brown Consultants, Inc., 1996). The channel is designed to carry the 100-year, 24-hour storm event (Adrian Brown Consultants, Inc., 1996).

The Open Pit perimeter was fenced with a 5-ft-high, five-strand wire fence. Approaches to the Open Pit were posted with weather-resistant metal signs warning of steep slopes in the Open Pit. Gates preventing vehicle access are maintained at the entrance to the property on the access road, and on the access road adjacent to the Open Pit area.

The Open Pit slopes on the northwest, west, and south walls above the Open Pit access road were locally regraded as practicable to achieve gradients of approximately 3H:1V or less. Regraded areas were covered with 12 in. of growth medium and seeded. Open Pit benches on the upper southeast wall above the access road were graded as practicable to blend with the adjacent talus slope. The benches were covered with 12 in. of growth medium and seeded. Figure 7 illustrates the current post-reclamation topography in the area of the Open Pit.

The uppermost portions of the north, west, and east sides of the Open Pit were graded and 8-ft-high berms were placed to intercept and divert runoff away from the edge of the Open Pit. Stormwater collecting on roadways in the Open Pit has been directed away from benches into the Open Pit waterbody.

In the mid-1990s, the original intent for reclamation of the Open Pit was to allow stormwater runoff from Upper Cunningham Gulch to fill the Open Pit and inundate the AWS. The Open Pit rim area was reclaimed with cover material, and filling of the Open Pit with stormwater was to reclaim the remaining benches and pit walls below the 6,945-ft amsl elevation. The CCP was approved in 1996, and then amended in 2001 to accommodate AP-27. As approved in 1996, approximately 7.24 acres of Open Pit walls and benches would remain un-reclaimed. Filling of the Open Pit with stormwater is to reclaim 13.8 acres of Open Pit benches and walls.

Figure 7 presents the Open Pit watershed and status of areas within the Open Pit watershed. The original Open Pit reclamation plan recognized 34.13 areas of disturbed area from the Gold Fields mining operation, and called for reclamation of 26.89 acres (78.8 percent of disturbed area). For the updated plan, the 1996 reclaimed areas were adjusted to include portions of the Open Pit watershed, which changes the total area from 34.13 acres to 40.26 acres (see Fig. 7; 70.51-acre watershed minus 30.25 undisturbed acres). The Open Pit waterbody has achieved a current steady-state water-level elevation of about 6,800 ft amsl, which has a surface area of 2.82 acres.

Over the last 6 years, approximately 3,500 yd^3 of caliche has been added to roads and accessible benches within the open pit.

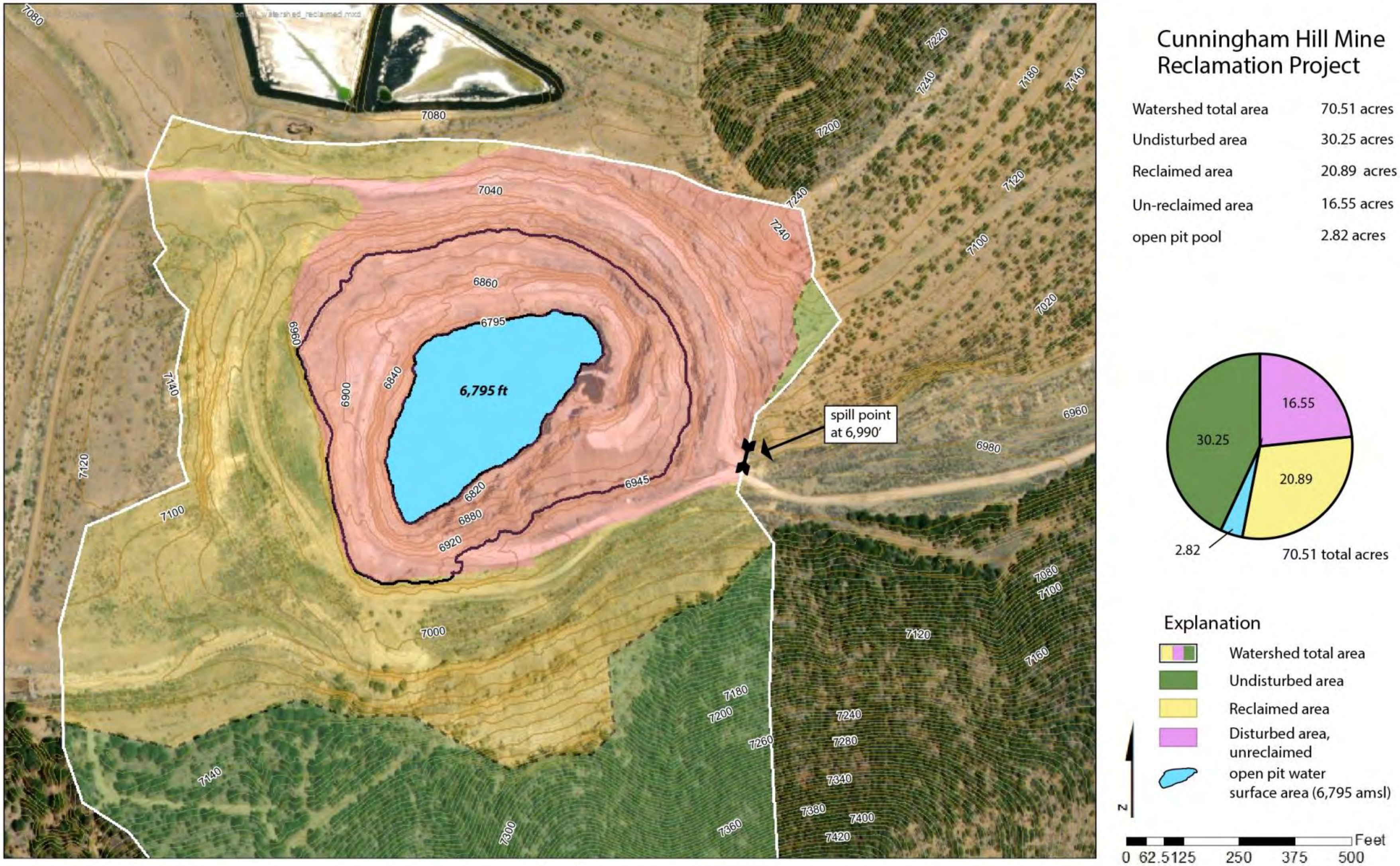

Figure 7. Aerial photograph of Open Pit showing undisturbed, disturbed, and reclaimed areas, Cunningham Hill Mine Reclamation Project.

4.3 Waste Rock Pile

The Cunningham Hill Waste Rock Pile is located west of the Open Pit (Fig. 3) and covers an area of approximately 72 acres. An estimated 10 million tons of waste material were mined from the Cunningham Open Pit and placed in the Waste Rock Pile.

The reclamation activities completed by LAC on the Waste Rock Pile relate to remediation measures that were approved by NMED in DP-55. These activities have been undertaken on the Waste Rock Pile in order to decrease runoff infiltration into the Waste Rock Pile, thereby lowering the volume of water flowing from the toe of the Waste Rock Pile. Specifically, the Waste Rock Pile has been recontoured and revegetated, and drainage control has been added. Monitoring has shown revegetation success with the reestablishment of a stable and productive vegetation community appropriate for PMLU. There has been a substantial decrease in the volume of water emanating from the toe of the Waste Rock Pile (see DP-55 annual reports).

4.3.1 Recontouring and Cover System

Between fall 1991 and spring 1992, a remediation plan (Golder Associates and Schafer & Associates, Inc., 1992) was prepared for the Waste Rock Pile. The plan was submitted to and approved by NMED under DP-55, and the remediation work was largely completed in October 1992. The work included regrading and recontouring to an overall slope of 3H:1V (horizontal to vertical), constructing diversion structures to control stormwater run-on, covering with growth medium and revegetating the Waste Rock Pile; and constructing the Interceptor Wall and treatment system to intercept and treat leachate.

The surface of the Waste Rock Pile was regraded in 1992 to a maximum overall slope of 3H:1V. Benches were constructed at intervals of approximately 35 vertical ft. The Waste Rock Pile was covered in two steps. First, a layer of lime was spread over the surface of the Waste Rock Pile and disked into the waste rock material. Then an 18-in.-thick layer of cover soil was applied. The cover was designed to reduce the infiltration of surface water into the Waste Rock Pile, limit oxygen diffusion, and provide the growth medium necessary to support revegetation. Subsequent to the lime addition and cover soil placement, the Waste Rock Pile was seeded.

In 1994, a site investigation was conducted (Schafer & Associates, Inc., 1995a) to evaluate 2.5 acres on the north face of the Waste Rock Pile which had not received adequate soil cover during previous reclamation activities. The site investigation concluded that the upper benches of the face of the Waste Rock Pile needed to be regraded to reestablish drainage to the east channel. Reclamation measures to increase top soil depth and regrade the drainage were completed in 1995.

The soil cover was seeded with grasses and forbs and growth medium was established. In addition, trees and shrubs, primarily consisting of piñon pine and ponderosa pine, were planted on north- and east-facing slopes. Initial vegetation surveys of the reclaimed Waste Rock Pile were conducted in September 1993, 1994, and 1995 (Metric Corporation, 1993, 1994, 1995c). Results of the vegetation monitoring program are presented in Table 5. As shown, the area reclaimed in 1992 and seeded in 1993 supported an herbaceous cover primarily consisting of annual grasses (0.3 percent). Perennial grasses and forbs account for the remaining vegetative cover (20.6 and 13.7 percent, respectively). A second planting program for the Waste Rock Pile and surrounding area was completed in July 1994, at which time over 13,310 tree and shrub seedlings were planted.

Vegetation monitoring results indicate that revegetation efforts conducted to date have been successful at re-establishing a productive vegetation community (Metric, 1995c, 1995d).

Cedar Creek Associates, Inc. has performed vegetation surveys of the reclaimed areas approximately every 3 years since 1999. An established reference area (approved by MMD in 1997) was sampled to facilitate comparison to the reclaimed areas. The 2017 revegetation survey indicated ground cover data and associated species diversity collected from the Waste Rock top and slopes areas are in excellent condition and readily pass bond release standards for ground cover and species diversity (Cedar Creek Associates, Inc., 2018).

Table 5. Vegetation monitoring results [1]

lifeform	reclamation year								
	1993 (percent cover)			mid-1990s (percent cover)			undisturbed [5] (percent cover)		
	1993 [1]	1994 [1]	1995 [2]	1993 [3]	1994 [3]	1995 [4]	1993	1994	1995
annual grass	17.0	0.2	0.3	0.0	0.1	0.3	0.0	0.0	0.0
perennial grass	2.9	7.7	20.6	18.5	16.7	22.5	24.5	25.7	21.6
forbs	7.3	17.4	13.7	6.6	2.1	8.8	3.2	3.3	3.9
shrubs	0.0	0.0	0.0	0.1	0.1	0.0	11.9	10.4	13.6
trees	0.0	0.1	0.0	4.5	3.6	0.0	0.0	0.0	0.0
litter	23.7	17.3	18.9	11.8	12.1	28.1	2.1	3.1	6.8
standing dead	0.0	7.3	1.5	5.0	3.0	5.9	0.0	0.0	0.0

Source: Metric Corporation, 1995c
[1] Includes transects PR-1, PR-2, PR-3 and PR-6.
[2] Includes transects PR-1, PR-2 and PR-3.
[3] Includes Transects PR(O)-4 and PR(O)-5.
[4] Includes transect PR(O)-5.
[5] Includes transect P-7.

4.3.2 Surface-Water Diversions

In 1992, four diversion structures were constructed to route surface water run-on from upgradient watersheds across and around the Waste Rock Pile (Fig. 8). The location of these diversion structures is specified in DP-55. Three of the structures are synthetically-lined channels referred to as the Cunningham Channel, Dolores Channel, and South Channel. The geomembrane-lined channel is known as the Rock Lined Channel or the East Groin Channel.

Cunningham Channel is blocked at the Upper Cunningham Gulch diversion, so surface water from Upper Cunningham Gulch routes into the Open Pit. Dolores Channel intercepts surface water from Dolores Gulch and routes it around the northwest boundary of the Waste Rock Pile for discharge into a separate subdrainage of Dolores Gulch. The South Channel collects runoff from the area immediately south of the Waste Rock Pile and directs it to the Cunningham Channel which runs across the top of the Waste Rock Pile and discharges into a separate subdrainage of Dolores Gulch. The East Groin Channel, located on the east side of the face of the Waste Rock Pile, intercepts runoff from the west slope of Cunningham Hill and collects runoff from the face of the Waste Rock Pile. These flows are then diverted into Dolores Gulch downgradient of the Waste Rock Pile and Interceptor Wall.

JSAI (2012) performed liner inspections on Cunningham and South Channels. Trees removed from the channels were found to be growing on top of the liner, and the liner was found to be in excellent condition.

During 2015, stormwater runoff from the north slope of the Waste Rock Pile was evaluated and improvements were made to shed stormwater to the west along the western edge of the Waste Rock Pile, and to convey collected stormwater into HDPE piping along the East Groin Channel. North slope stormwater runoff direction is illustrated on Figure 9.

The East Groin Channel was repaired during April 2021. The purpose of the East Groin stormwater channel was to limit infiltrated stormwater into the WRP. The repairs to the East Groin stormwater channel were made by filling voids in the East Groin rip rap with a two-part polyurethane resin (Meridiam Partners, 2021).

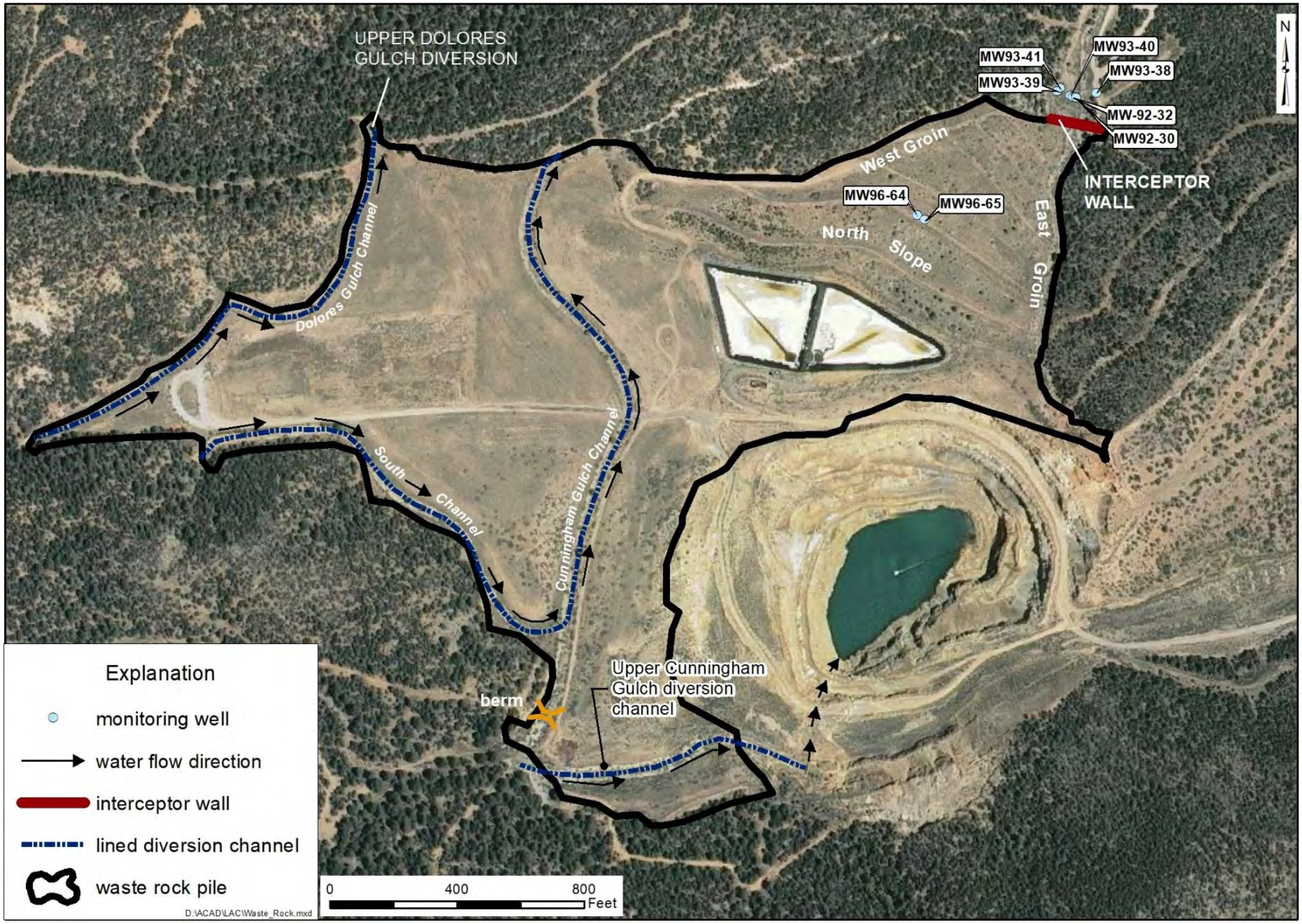

Figure 8. Map showing surface-water diversion channels, Waste Rock Pile, Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico.

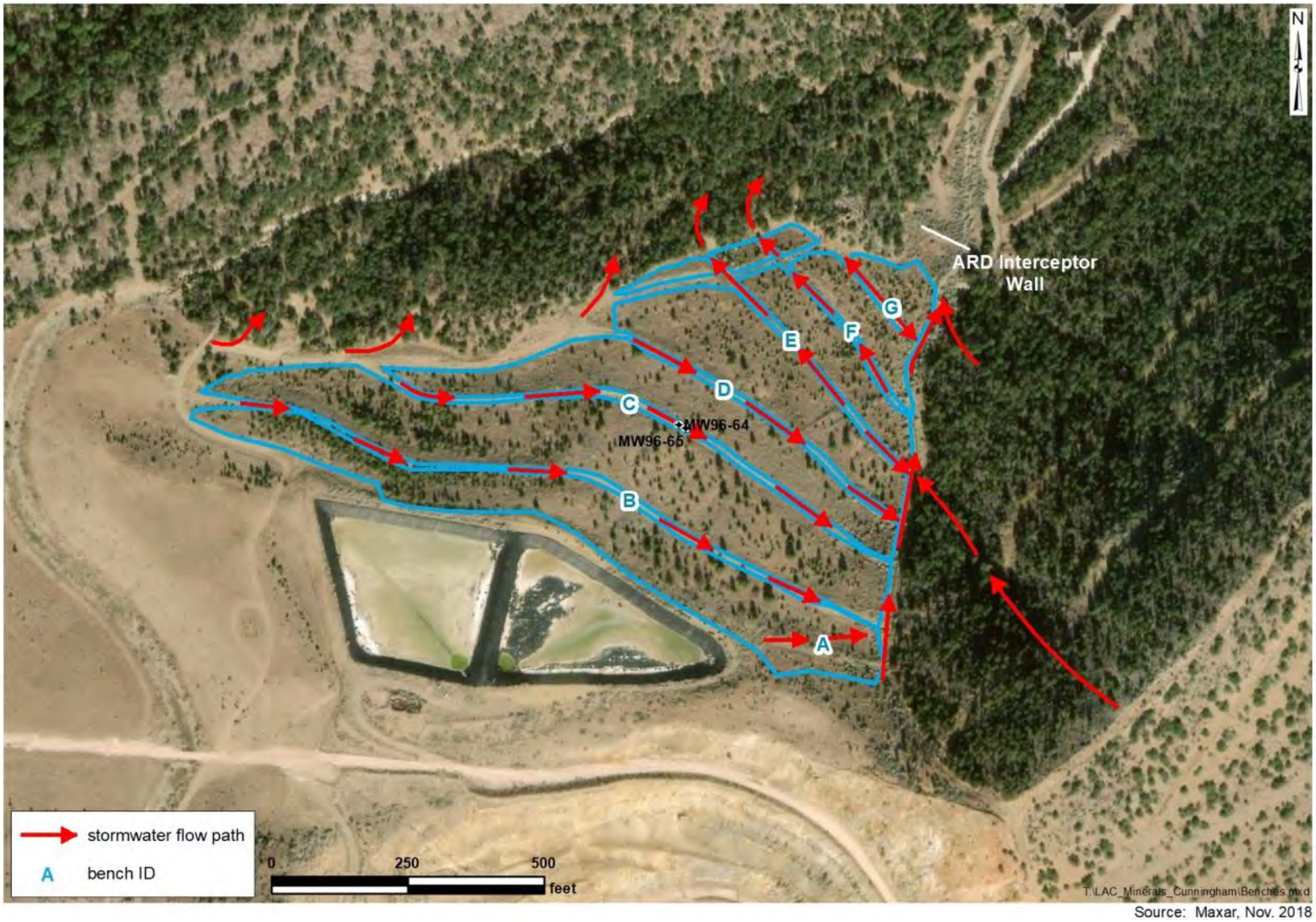

Figure 9. Aerial photograph showing direction of stormwater flow from benches on the north slope of the Waste Rock Pile, Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico.

4.3.3 ARD Mitigation

In December 1993, NMED required that LAC develop a plan for the remediation of a low-pH groundwater plume in Dolores Gulch, downgradient of the Waste Rock Pile. In response to this request a report was prepared (Hydro-Geo Consultants, Inc., 1994b) describing a proposed remedial plan which included installing a grout curtain underneath and at the ends of the Interceptor Wall. This work was incorporated into a modification to DP-55 that was approved by NMED in October 1994 (Secretary of Environment, 1994).

Groundwater monitoring conducted in 1993 after installation of the Interceptor Wall indicated the presence of low-pH water downgradient from the Interceptor Wall. A geophysical survey (Zonge Engineering and Research Organization, Inc., 1993) was conducted to identify zones of higher hydraulic conductivity. Based on results of the survey, a program was developed to remediate the plume of low-pH groundwater downgradient of the Interceptor Wall in Dolores Gulch.

The remediation plan included the installation of a grout curtain in the underlying bedrock near the Interceptor Wall. The grouting program is described in detail in *Report in Support of the Proposed First Modification of DP-55, Ortiz Project, Santa Fe County, New Mexico* (Hydro-Geo Consultants, Inc., 1994b) and *Grouting Program, Dolores Gulch, Ortiz Project* (Hydro-Geo Consultants, Inc., 1994c).

Evaluations of water-quality data and water-level data from monitoring wells downgradient of the grouted Interceptor Wall indicate that the grouted Interceptor Wall is working effectively to control the flow of ARD from the Waste Rock Pile (JSAI, 2020a).

The Interceptor Wall ARD collection system gravity drains ARD to collection ponds and treatment system; collectively called the ARD Treatment System. Impacted groundwater in Dolores Gulch downgradient of the Interceptor Wall is remediated by Dolores Gulch Recovery wells RW97-01, RW97-02, and RW97-03.

A soil moisture monitoring system was installed on the top and north face of the Waste Rock Pile and monitoring was performed from 2012 to 2016 (JSAI, 2016). The source of ARD was identified as originating from preferential flow path(s) rather than infiltration through cover. The soil moisture sensors showed that the store-and-release cover material performed as designed by limiting infiltration during a very wet monsoon season; meanwhile, repaired stormwater controls were effective in minimizing infiltration along preferential flow paths, and ultimately minimizing ARD (JSAI, 2016).

Additional investigation on the East Groin Channel of the Waste Rock Pile north slope was performed by JSAI (2019). It was recommended to remove the HDPE piping system and evaluate the option of installation of a liner type material that does not require removal of the boulders and riprap. The renewed DP-55 required a corrective action plan that addressed potential issues with the East Groin Channel stormwater controls. Repairs were implemented in April 2021 (see Section 4.3.2)

4.4 ARD Treatment System

In 1992, the leachate interceptor and ARD Treatment System were installed, with NMED approval under DP-55, to intercept alluvial and surface water in Dolores Gulch moving downgradient from the Waste Rock Pile and to chemically treat this low-pH water. The system consists of the following:

- An Interceptor Wall installed in bedrock across Dolores Gulch below the toe of the Waste Rock Pile;
- A collection system to transfer ARD collected at the Interceptor Wall via gravity to a lined collection pond;
- A lime treatment system with lined settling ponds; and
- Two lined ponds to evaporate lime-treated water.

Design details of the leachate interceptor and ARD Treatment System are contained in *Cunningham Hill Waste Rock Storage Facility Water Treatment and Reclamation Plan* (Golder Associates and Schafer & Associates, Inc., 1993). The lime and evaporative treatment system was designed to have the capacity to store the flow from the interceptor system, precipitation from a maximum wet year, and the precipitation from a 100-year, 24-hour storm event, while retaining adequate freeboard. Figure 10 is an aerial photograph showing the ARD Treatment System.

During February 2010, a weir box equipped with a transducer was installed on the line to ARD Collection Pond A. Continuous monitoring of ARD flows has been ongoing since March 2010. ARD flow averaged 7.3 acre-feet per year (ac-ft/yr) from 1991 to 2005, and from 2005 to 2019 ARD flow has averaged 0.7 ac-ft/yr (0.43 gpm). ARD flow was 0.23 ac-ft in 2020.

For the past 12 years, the lime treatment system and associated settling and evaporation ponds have not been needed because ARD flows have been significantly reduced as a result of stormwater controls implemented on the north slope (JSAI, 2020a). Currently, intercepted ARD is gravity drained to ARD Collections A and B, and evaporated.

Figure 10. Aerial photograph showing ARD Treatment Facilities, Dolores Gulch, Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico.

5.0 RECLAMATION PERFORMANCE OBJECTIVES

Additional reclamation activities to be completed in the future include:

- Waste Rock Pile - reclaiming the RO evaporation pond on top of the Waste Rock Pile, and improvements to the East Groin drainage, Waste Rock Pile cover maintenance and/or improvements, as needed;
- Open Pit – Open Pit water treatment as required by AP-27; Self-Sustaining Ecosystem evaluation, regrading, placing growth medium, and revegetating portions of the Open Pit;
- ARD Treatment System - remove the lime treatment system downgradient of the Waste Rock Pile Interceptor Wall; grading, recontouring, placing growth medium as necessary; and
- Residue Pile Treatment Ponds

Reclamation goals and objectives are designed to be consistent with the NMMA. The goals are to provide short-term and long-term stabilization, closure, and reclamation of the site. Short-term goals include interim reclamation activities and management practices to control and prevent soil loss emanating from water and wind erosion, and to promote wildlife use of the site. The long-term goal of reclamation is to establish a post-operation environment that is compatible with existing and future land uses. An additional goal at this site has been to remediate and protect groundwater and surface water to comply with the NMWQA and NMWQCC regulations. This goal is being actively pursued under the supervision of NMED pursuant to DP-55 and AP-27, as specified in the Updated Contingency Plan (Appendix B).

A wildlife impact analysis was completed (Metric Corporation, 1995b) in September 1995 to analyze the long-term implications for wildlife of implementing the reclamation measures proposed in the CCP. The study concluded that the reclamation plans to be implemented at the Cunningham Hill Mine site will produce vegetative communities similar to native surrounding areas and result in habitats that will be beneficial to the wildlife found in the project area. However, the study did not recognize that the pre-Gold Fields mining vegetative communities were stressed from historical human activities (for example, see Fig. 5).

The reclamation performance objectives should also reflect the undisturbed area as modified by the CHMRP Forest Management Plan (Wood, 2017) (see Appendix C). The Forest Management Plan calls for selective thinning to accomplish the following: 1) enhance the stand composition, 2) return ecosystem function by improving habitat and food for wildlife, and 3) reduce the risk of uncharacteristic fire. Approximately 250 acres in the permit area have already been treated. Total treatment area can be referenced from Appendix C.

Undisturbed reference area has been established for assessing reclamation success standards for the previously reclaimed areas (see Cedar Creek Associates, Inc., 2018). Additional reclamation of remaining disturbed areas related to the Open Pit should consider a separate reference area.

The following sections discuss the reclamation goals and PMLU at CHMRP and addresses remaining reclamation activities.

5.1 Open Pit

A waiver for the Open Pit Self Sustaining Ecosystem requirements is requested, as detailed in Appendix H. Given that the open pit has not, and likely will not, fill with stormwater as originally planned, it has been determined that the open pit cannot feasibly re-establish a self-sustaining ecosystem as defined by 19.10.1.7.S(2) NMAC. The PMLU will remain the same. The pit waiver is for 16.55 acres of un-reclaimed open pit walls and benches illustrated on Figure 7.

Reclamation performance objectives are to protect livestock and wildlife and to maintain water-quality standards specified in the NMED updated AP-27 permit (pending). AP-27 requires that the open pit pool meets applicable water-quality standards. Wildlife habitat has already been documented for the Open Pit waterbody (see photographic documentation in Appendix D), in which perimeter fencing will be installed to limit entry from humans and wildlife (see Section 6.1). Reclamation performance objectives include the following:

1. Plan according to the steady-state Open Pit waterbody elevation equal to or greater than 6,800 ft amsl

2. Perform water treatment on Open Pit waterbody following successful source control measures (in progress).

3. Reclaim portions of the Open Pit area that will assist with source controls, and sustain water-quality standards (see Fig. 7). Allow for natural revegetation of inaccessible pit walls and benches, such as what has already occurred over the last 25 years.

4. Adhere to water-quality protection requirements in AP-27 or AP-27 as may be updated in the future, such as pH mitigation.

As required by the NMMA Rules, the revised surface-water standards in 20.6.4.99 NMAC will replace the current AP-27 surface-water standards (see Appendices E and H). One of the Open Pit waterbody AP-27 performance standards will be meeting surface water quality standards for wildlife specified in 20.6.4.99 NMAC. As indicated in JSAI (2020 revised 2021), included as Appendix E to this CCP, "The January 2021 open pit water-quality results meet the revised surface water quality standards for wildlife, livestock, and secondary contact." Appendices E and H provide additional details on surface water quality standards and the Open Pit waterbody.

5.2 Waste Rock Pile

The reclamation performance objective for the reclaimed Waste Rock Pile is based on achieving a self-sustaining ecosystem for wildlife by performing four criteria:

1. Reclaim RO evaporation pond after successful completion of Open Pit waterbody treatment, as specified in DBS&A (2018),
2. Improve stormwater conveyance along the East Groin of the North Slope (completed),
3. Add soil-mulch-seed mix to localized areas eroded prior to completion of stormwater drainage improvements (a timeline to complete improvements will be provided with workplan), and
4. Limit the production of ARD to where passive treatment is self-sustaining.

5.3 ARD Treatment Facility

The reclamation performance objective for the ARD Treatment Facility is to remove components of the facility that are no longer needed, reclaim the disturbed area, and establish a self-sustaining ARD treatment system where passive treatment is available using only collection ponds A and B. Vegetation monitoring of reclaimed areas will be performed using the same methods are previous reclaimed areas that have been released.

6.0 RECLAMATION PLAN

This chapter discusses the methods and materials for implementing the final reclamation of remaining selected disturbed areas at CHMRP. The Office/Maintenance shop building and adjacent two freshwater ponds will remain for industrial PMLU. Access roads, as identified on Figure 4, will remain to accommodate site access, to implement the Forest Management Plan, and to provide access for emergency services such as firefighting.

6.1 Open Pit

Existing Open Pit reclaimed areas are shown on Figure 7. Reclamation of 21.92 acres around the open pit perimeter has been completed. A pit waiver is requested for 14.60 acres of disturbed area related to the open pit walls and benches.

The roadway around the northeast side of the Open Pit has been reduced to minimal size, and will be maintained for access to the Upper Cunningham Gulch area. Approximately 12 in. of caliche have already been added to access roads in and around the open pit. Some additional mulch and seed mix may be added to the area adjacent to the access roads and where needed to stabilize stormwater controls. As required by MMD, to prevent humans and wildlife from entering the pit area, an 8-ft-high chain-link fence buried 2 ft below ground where practicable, will be installed around the open pit perimeter.

Un-reclaimed portions of the Open Pit will remain as naturally reclaimed disturbed area. A Pit Wavier for self-sustaining ecosystem is requested, as described in Appendix H (Section 4.3).

No re-vegetation of the 14.60 acres of open pit walls, and benches are proposed. Native grasses, shrubs and trees have already been established in places of the Open Pit undisturbed area (see photographic documentation in Appendix D).

6.2 Waste Rock Pile

Closure of the RO evaporation pond includes removal of the upper portion of the HDPE liner, regrading and vegetation of the pond area, and installation of stormwater and subsurface seepage control measures (DBS&A, 2018). Total area is 3.85 acres. The report by DBS&A (2018) is included as Appendix F. The bottom and a 1-ft height of liner will be left in place in order to capture any seepage water that infiltrates the regraded soil cover. After the upper portion of liner is removed, regrading will commence using the stockpiled cover soil immediately surrounding the pond as a source of fill. The soil from the soil stockpile located northeast of the Office/Maintenance shop building will be used for the upper portion of soil cover.

A few areas of localized erosion on the North Slope have been identified by JSAI (2019). Erosion of these areas occurred before stormwater conveyance improvements were made between 2012 and 2016. Total area is less than 0.25 acre. These localized areas will be filled with soil-mulch mix stockpiled near the Office. The approved grass seed mix used for other WRP reclamation efforts will be placed after cover placement.

East Groin improvements will include the installation of a fill-type material that functions as a liner but does not require removal of the boulders and riprap, by creating a liner in the void spaces between the boulders and riprap. No soil cover or seed mix will be required.

6.3 ARD Treatment Facility

The first phase will include removal of lime treatment system, and ARD lime treatment ponds (also sometimes referred to as settling ponds) illustrated on Figure 10. Total area is 1.1 acres. The lime silo and all related lime treatment equipment will be removed from the site. Closure of the ARD treatment ponds includes removal of the upper portions of the HDPE liners, and regrading and vegetation of the pond area, and installation of stormwater control measures. The bottom and a 1-ft height of liner will be left in place in order to capture any seepage water that infiltrates the regraded soil cover. After the upper portion of liner is removed, regrading will commence using the soil immediately surrounding the ponds and lime treatment unit. Based on results from nearby monitoring well drilling, there is significant thickness of un-contaminated sulfide-free soil and colluvium. A minimum of 18 in. of soil cover will be placed over the reclaimed areas. Mulch from the stockpile located northeast of the Office/Maintenance shop building will be applied to the regraded area. A reclamation plan will be submitted to the MMD and NMED for approval 30 days prior to commencing the ARD treatment facility reclamation.

Closure and reclamation of ARD evaporation ponds will occur after ARD has reduced to an average flow rate of 0.5 ac-ft/yr for a 10-year period, with a maximum probable annual peak flow rate of 1.5 acre-feet. ARD evaporation ponds will be reclaimed in the same way as the treatment ponds. Following closure of the ARD evaporation ponds, a passive ARD treatment facility using collection ponds A and B will be implemented.

6.4 Residue Pile Remediation Ponds

The Residue Pile remediation ponds (Fig. 3) will be closed and reclaimed when DP-55 obligations are achieved. As specified in renewed DP-55, “the permittee shall implement the approved closure plan for each mine unit once it is no longer required as a component of the groundwater abatement systems." Closure of the Residue Pile Remediation ponds includes removal of the upper portions of the HDPE liners, and regrading and vegetation of the pond area, and installation of stormwater control measures. The bottom and a 1-ft height of liner will be left in place in order to capture any seepage water that infiltrates the regraded soil cover. After the upper portion of liner is removed, regrading will commence using the soil immediately surrounding the ponds.

Based on results from nearby monitoring well drilling, there is significant thickness of un-contaminated sulfide-free soil and colluvium. A minimum of 18 in. of soil cover will be placed over the reclaimed areas. Mulch from the stockpile located northeast of the Office/Maintenance shop building will be applied to the regraded area. A reclamation plan will be submitted to the MMD and NMED for approval 30 days prior to commencing the reclamation. Revegetation will be performed according to the specifications provided in Sections 6.5 through 6.7.

6.5 Growth Medium for Final Reclamation

Top soil or growth medium was not salvaged prior to the construction of mining and processing facilities at CHMRP, and growth medium produced on-site from borrow areas has been fully utilized. Growth medium for remaining reclamation projects will include soil and mulch stockpiled from previous projects at the site, and imported caliche. Stockpiled trees will need to mulched and mixed with stockpiled soil.

The growth medium volumes needed to reclaim the remaining facilities at CHMRP are presented in Table 6. The volume of available on-site growth medium is approximately 8,000 yd^3.

Table 6. Growth medium volume requirements

area	total volume (yd^3)
Open Pit	0
Waste Rock Pile	200
Reverse Osmosis (RO) Ponds	2,200
Acid Rock Drainage (ARD) Treatment Facility	2,420
Residue Pile Remediation Ponds	2,000

6.6 Seeding

Seeding techniques will be similar to those used previously to reclaim the Waste Rock Pile and the original borrow area. However, the shrub mix and seedlings will be exclusive of grass seedings, and will be sown in a mosaic pattern so that each seed mixture will be planted as a non-continuous strip running on the contour. This technique will minimize plant establishment competition, thereby allowing for a more hardy, tolerant plant population for long-term success. The approach to revegetation presented in the following sections is based on previously approved CCP, and reclamation methods employed.

Tables 7 and 8 present the proposed seed mixtures and application rates for use at CHMRP, except for the Waste Rock Pile and the original borrow area, which have already been revegetated using seed mixtures and application rates approved by MMD. The seed mixtures in Tables 7 and 8 were developed based on climatic conditions at the site and the pre-mining vegetative community. The species list includes warm season grasses, cool season grasses, and forbs.

The seed mixes in Tables 7 and 8 will be used on all areas to be reclaimed in the future after cover placement. Some substitutions to the proposed seed mixtures may be necessary depending on seed availability and seasonal conditions. Any substitutions will be evaluated for consistency with the proposed seed mixtures and the climatic conditions at the site and the pre-mining vegetative community. LAC will request approval of substitutions from MMD prior to seeding.

Seeding rates will vary according to seeding conditions and methods. In general, seeding rates will be doubled when broadcast seeding is used. Seeding will be coordinated to occur as soon after seedbed preparation as possible. Drill seeding will be used on all accessible slopes. Broadcast seeding or hydroseeding will be used on slopes which are narrow, small, or inaccessible by drill seeding equipment.

Grass hay or straw mulch at the rate of 1 ton/acre will be applied to drill-seeded areas, followed by application of a tackifier. Wood fiber mulch will be applied to hydroseeded areas at a rate of 2 tons/acre followed by application of a tackifier.

Table 7. Cunningham Hill Mine Reclamation Project Seed Mix 1 for warmer and drier site conditions

species	drill seed rate pure live seed (lbs/acre)	species characteristics
blue grama; *Bouteloua gracilis*	2.0	warm season
indian ricegrass; *Oryzopsis hymenoides*	1.0	warm season
sideoats grama; *Bouteloua curtipendula*	1.0	warm season
galleta; *Hilaria jamesii*	1.0	warm season
sand dropseed; *Sporobolus cryptandrus*	0.25	warm season
Great Basin wildrye; *Elymus cinereus*	2.0	cool season
purple prairie clover; *Petalostemum purpureum*	0.2	Forb
palmer penstemon; *Penstemon palmeri*	0.1	Forb
lewis flax; *Linum lewisii*	0.5	Forb
scarlet globemallow; *Sphaeralcea coccinea*	0.1	Forb
TOTAL	**8.15**	

Table 8. Cunningham Hill Mine Reclamation Project Seed Mix 2 for wetter and cooler site conditions

species	drill seed rate pure live seed (lbs/acre)	species characteristics
spike muhly; *Muhlenbergia wrightii*	0.5	warm season
blue grama; *Bouteloua gracilis*	2.0	warm season
indian ricegrass; *Oryzopsis hymenoides*	2.0	cool season
lewis flax; *Linum lewisii*	0.5	Forb
purple prairie clover; *Pentalostemum purpureum*	0.5	Forb
Rocky Mountain penstemon; *Penstemon strictus*	0.5	Forb
prairie coneflower; *Ratibida columnifera*	0.25	Forb
TOTAL	**6.25**	

6.7 Trees and Shrubs

Native tree and shrub species will be planted within the areas previously designated for tree planting where soil and water conditions will support growth. No trees are proposed for the RO evaporation pond reclamation area on the Waste Rock Pile. A map showing proposed grassland-revegetated and woodland revegetated units for the ARD Lime Treatment system and pond area and Residue Pile Remediation Pond area will be submitted with the perspective reclamation plans.

Favorable sites for trees and shrubs include drainages, east- and north-facing slopes. Table 9 lists tree and shrub species proposed for reclamation. Piñon pine will be planted on warmer and drier slopes, while ponderosa pine and piñon pine will be planted on cooler, wetter slopes. Tree and shrub species including one-seed juniper, Gambel oak, mountain mahogany, New Mexico Locust, fourwing saltbush, and skunkbush sumac will be planted in selected reclaimed areas.

Trees will be planted in groups at a closer spacing (4 to 8 ft), with planting groups spaced farther apart (50 to 75 ft). The pattern is designed to simulate the natural density and arrangement of trees. The planting pattern will be limited to areas such as the ARD lime treatment system and ponds. Containerized tree saplings will be planted one per hole.

Table 9. Woody species to be used for reclamation

species	drill seed rate pure live seed (lbs/acre)	value
piñon pine; *Pinus edulis*	sapling	seeds, cover
New Mexico Locust; *robinia neomexicana*	4.0	seeds, cover
ponderosa pine; *Pinus ponderosa*	sapling	seeds
Gambel oak; *Quercus gambelii*	3.0	cover, browse
mountain mahogany; *Cercocarpus montanus*	4.0	cover, browse
fourwing saltbush; *Atriplex canescens*	5.0	cover, browse, seeds
skunkbush sumac; *Rhus trilobata*	4.0	browse, berries, cover
chamisa; *Chrysothamnus nauseosus*	1.5	cover, seeds, browse
apache plume; *Fallugia paradoxa*	0.5	shrub
TOTAL	**22.0**	

The planting time will be determined by site conditions such as soil moisture, soil temperature, air temperature, aspect, and accessibility. Generally, mid-summer or early fall plantings are preferable to take advantage of late summer rains and winter precipitation. Nursery stock will not be handled when the air temperature is below freezing. Planting will not be conducted when the ground is frozen or completely dry.

Depending upon the condition of the planting area and the type of stock, trees and shrubs will be planted using hand tools and/or power-driven augers. Stems will be planted in the appropriate diameter hole according to the size container stock. Planting will involve placing the roots against the rear vertical wall of the hole and spreading the roots in a fan shape. Each hole will then be filled with moist soil. A shallow basin will be constructed around each seedling to trap water. Controlled release fertilizer or organic amendments will be applied in shallow pockets near each seedling.

Trees will be salvaged in the Forest Management plan areas to the extent practicable for use in revegetation of the reclamation areas suitable for trees. Piñon pines are amenable to salvage and replanting operations; however, junipers are not considered candidates for salvage because of their root system configuration.

Equipment-accessible benches and areas above the final Open Pit waterbody elevation that are impractical to regrade as described in the previous paragraph will be ripped, covered with growth medium and seeded with the appropriate seed mix. The westside roadway and access road corridors in the Open Pit above the final elevation of the Open Pit waterbody will be covered with caliche, 12 in. of growth medium, and seeded with appropriate seed mix. A roadway of minimal size will be maintained around the northeast side of the Open Pit for access during the post-reclamation monitoring period.

Portions of the Open Pit and pit slopes that cannot be reached by construction equipment but exhibit characteristics amenable to vegetative establishment will be seeded as practicable using the appropriate seed mix. The rock outcrop created by the exposed benches and walls will create habitat for deer, birds (canyon wren, cliff swallows), and rock squirrels, similar to the pre-mining Rock Outcrop Complex mapped by the NRCS (see Appendix A).

6.8 Revegetation Success Monitoring

Revegetation success will be evaluated based on the following factors:

- Comparison to an approved reference area representative of the pre-existing vegetation communities and/or desirable ecological conditions;
- Plant species present in the proposed (and planted) seed mixes; and
- The PMLU (wildlife and livestock grazing).

From a baseline vegetation survey conducted in 1991 (Elliot), existing vegetation at the mine site consists of 1) piñon pine/one-seed juniper/muttongrass in the lower elevations, 2) piñon pine/Gambel oak communities in the mid elevations, and 3) a mixed conifer/Gambel oak community in the higher elevations of the site. Because all three of these are late seral and perhaps disclimactic communities, certain allowances must be made when comparing them to early seral revegetated communities, otherwise comparisons would be scientifically invalid. The two principal allowances involve the density of woody species and the overall species composition. Details of these allowances are presented in subsequent sections.

Total vegetative cover, composition, and to a lesser degree density of woody species are important factors in determining the success of revegetation efforts. However, of primary importance to reclamation success is the achievement of soil stabilization. Without soil stability, revegetation efforts may regress along the successional continuum and thereby preclude the achievement of long-term land use goals. If revegetation success criteria are achieved, it can reasonably be assumed that soil stability will be achieved.

The long-term goal of revegetation efforts at the CHMRP site is to restore the permit area to a self-sustaining ecosystem which advances along the successional continuum. This does not necessarily mean that the reclaimed area will exactly replicate the surrounding vegetation communities, but that it will successfully support the designated post-mining land uses. In fact, it is a desirable condition that the reclaimed area not exactly match the surrounding vegetation communities as such community diversity adds significantly to the overall wildlife and habitat diversity of the project area. In this regard, the target reclamation communities include: 1) areas of grassland with grasses and forbs dominant, however, an occasional shrub and/or tree may occur; and 2) areas of grass/shrub/woodland which exhibit a significant herbaceous component, but also a sufficient density of woody plants to place the community structurally midway between the existing adjacent woodlands and the newly created and developing grasslands.

6.8.1 Proposed Revegetation Standards

Revegetation success[1] in revegetated units planted primarily as grassland will be assessed against performance standards for (1) vegetative ground cover, and (2) species diversity. Revegetated units planted as shrubland or woodland with woody plants for wildlife habitat must meet those same performance standards, plus a performance standard for woody plant density. Revegetation efforts will be considered successful when standards have been met at the end of the 12-year responsibility period.

1. Vegetative Ground Cover Standard

   Vegetative ground cover must meet at least one of the following two tests:

   a) the total vegetative ground cover (exclusive of annual species)[2] in the revegetated unit equals or exceeds 75 percent of the approved reference area's total vegetative ground cover (exclusive of annual species), with 90 percent statistical confidence; or

   b) the total vegetative ground cover (exclusive of annual species) in the revegetated unit equals or exceeds 50 percent of the approved reference area's total vegetative cover (exclusive of annual species) with 90 percent statistical confidence, and predicted values of soil loss using the Revised Universal Soil Loss Equation (RUSLE) are equal to or less than the comparison "T" value (see Section 4.4.4), which essentially is the soil genesis rate in tons per acre per year.

2. Species Diversity Standard

   Diversity, as indicated by number of important species[3] (exclusive of annual species and classified noxious weeds) in each revegetated unit, equals or exceeds 50 percent[4] of the number of important species (exclusive of annual species and classified noxious weeds) in the approved reference area.

3. Woody Plant Density Standard

   The density of live shrubs and trees (in revegetated units where shrubs and trees were specifically planted for wildlife habitat) must be 220 per acre or more. (This standard does not apply to grassland revegetated units.)

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1 The original proposal for determination of revegetation success (Metric Corporation, 1995) required modification to more appropriately account for the early stages of development (seral stages) of vegetative communities in revegetated units, and to facilitate a "same time" evaluation with a comparison area, thereby avoiding incorrect conclusions due to differences in climatic influences over time between comparison areas and the reclaimed areas.

2 Annual species are exempted in both the cover and diversity standards because the project area is in a favorable climatic environment (e.g., rainfall is sufficient to support a majority of perennial species).

3 An important species is defined as one which provides at least 1 percent absolute ground cover or 2 percent relative cover, and therefore, contributes more significantly to the community.

4 The value of 50 percent is used because the revegetated areas will be early seral communities and the approved reference area is late seral. It is a commonly accepted tenet of ecology that diversity in late seral communities is typically much greater than in early seral communities.

The reference area for final comparisons to previous reclamation efforts was reviewed and approved by MMD personnel on September 2, 1997. It is located as two side-by-side parcels immediately north of the "old topsoil borrow area" which in turn is immediately east of the main project facilities. The reference area is approximately 6.25 acres and is dominated by native grassland with scattered mature piñon and juniper (see Map 1 provided by Cedar Creek Associates (2020)). In the interest of maximal comparability between the late seral reference area and the early seral revegetated units, ground cover sampling in the reference area will exclude mature piñon and juniper trees (any tree over 5 feet in height). If a mature tree is intercepted by a sampling transect, the area internal to the "drip line" of the canopy of the tree will be skipped (i.e., the transect will be interrupted and then resumed on the opposite side of the tree). Ground cover of any immature trees intercepted by sampling efforts on either the reference or reclaimed area will be appropriately recorded and used in the comparison.

6.8.2 Revegetation Monitoring

Reclamation efforts will result in two vegetation types. The first type is a grassland community, with grasses and forbs dominant and a few shrub and tree species. The second type is piñon/juniper community.

Vegetation success will be monitored through annual inspections, as well as surveys of reclaimed areas in years 3, 5, 8, 11, and 12 following reclamation. Vegetative cover, tree and shrub density, productivity, and species diversity within revegetated areas and adjacent undisturbed plots will be sampled as described in the revegetation monitoring procedures outlined in Appendix G.

7.0 POST-RECLAMATION MONITORING AND MAINTENANCE

The post-reclamation monitoring program for CHMRP is set forth in detail in the Updated Contingency Plan which accompanies this CCP as Appendix B. References to Performance Standards in the following sections are to the Performance Standards presented in the Updated Contingency Plan. Waste Rock Pile and Dolores Gulch groundwater quality monitoring, performance standards and contingencies are to be specified in DP-55 renewal. The monitoring program will include:

- Open Pit water quality (AP-27 and NMAC);
- vegetation success;
- erosion control;
- drainage channel and diversion structure monitoring;
- slope stability;
- wildlife monitoring, including inspection for damage from burrowing animals;
- site security; and
- routine inspections of all reclaimed units to assess their condition and to detect any unusual conditions.

If the monitoring program described above reveals that repair of any reclaimed feature is required, then LAC will proceed with necessary repairs as specified in the Contingency Plan. The monitoring period under this CCP will be 12 years from the completion of reclamation activities, except for water-quality remediation under DP-55. If, at the end of 12 years, a monitored condition exists that does not meet NMMA requirements, monitoring and remedial actions for that condition will be extended beyond 12 years as determined by MMD.

7.1 Waste Rock Pile and Dolores Gulch Groundwater Monitoring

All groundwater monitoring, including monitoring of seeps and springs downgradient of the Waste Rock Pile, will be conducted in accordance with DP-55 under the supervision of NMED.

7.2 Open Pit Waterbody Monitoring

The monitoring schedules for the Open Pit waterbody are set forth in Performance Standard CHP-1: Open Pit Water Quality. The long-term monitoring program for the Open Pit waterbody is specified in Performance Standard CHP-2: Open Pit Hydrological Model.

7.3 Residue Pile Water-Quality Monitoring

Groundwater monitoring downgradient of the Residue Pile will be conducted in accordance with DP-55 under the supervision of NMED.

7.4 Revegetation Success Monitoring

Revegetation success monitoring will be conducted in accordance with Permit No. SF002RE in addition to Performance Standard SW-1: Vegetation Standards, and in Section 6.7 of this CCP. Monitoring results will be reported as provided in Performance Standard SW-1.

7.5 Erosion Control

Monitoring activities for control of erosion of the Residue Pile cover system will be conducted in accordance with DP-55 under the supervision of NMED. The monitoring program for the Residue Pile cover is set forth in Performance Standard RP-5: Breach of Low Permeability Layer. The general site-wide monitoring program for all reclaimed areas is set forth in Performance Standard SW-2: Erosion Control.

7.6 Drainage Channel and Diversion Structure Monitoring

Monitoring activities for the Residue Pile drainage structures and drainage channels will be conducted in accordance with DP-55 under the supervision of NMED. The monitoring program for the Residue Pile diversion structures and drainage channels is set forth in Performance Standard RP-5: Breach of Low Permeability Layer. The monitoring program for all other drainage channels and diversion structures is set forth in Performance Standard SW-3: Maintenance of Drainage Channels and Diversion Structures.

7.7 Slope Stability

The monitoring program for slope stability is set forth in Performance Standard SW-4: Slope Stability.

7.8 Wildlife Monitoring

The monitoring program for animal damage to the Residue Pile cover is set forth in DP-55 Performance Standard RP-5: Breach of Low Permeability layer. Additionally, the Open Pit water quality will be monitored for adverse wildlife impact as set forth in Performance Standard CHP-1: Open Pit Water Quality.

7.9 Site Security

Access roads to the permit area will be fenced and appropriate signs will be posted to discourage trespassing. The fencing and the signs will be inspected each quarter for signs of deterioration. The berms, fencing, and warning signs around the Open Pit will be inspected each quarter for signs of deterioration.

7.10 Reporting

As required by 10.5.509 NMAC, LAC will prepare annual reports and submit them to the MMD on or before April 30 of each year. The reports will describe reclamation activities completed the preceding calendar year and, at a minimum, will include the following information:

- Status of operation;
- Map(s) delineating the locations of disturbed areas and, if reclaimed, the year in which the work was completed;
- Number of acres disturbed, number of acres reclaimed during the reporting year, and number of acres which have not yet been reclaimed;
- An assessment of the current market value of any collateral posted as financial assurance;
- Compliance status of all existing State and Federal environmental permits held by LAC for CHMRP.

8.0 RECLAMATION SCHEDULE

The reclamation schedules for the Open Pit and Waste Rock Pile (RO pond) are contingent on successful completion of the Open Pit waterbody treatment as required by AP-27 (update is in progress by NMED). Water treatment began in 2021, and will continue for an additional three to 4 years (completed by 2025). Following water treatment, AP-27 requires meeting Performance Standard APS-1 which includes Trigger No. 1 (Open Pit pool exceeds 1,000 mg/L sulfate for a period of eight consecutive quarters) and Trigger No. 2 (Open Pit pool exceeds 600 mg/L sulfate but remains below 1,000 mg/L sulfate for a consecutive period of 8 years (32 quarters)), or according to requirements defined in the pending updated AP-27 permit.

The RO Pond reclamation will be performed 8 years after water treatment is completed and Performance Standard APS-1 has been met. The reclamation schedule for the ARD Treatment Facility is contingent on requirements to be specified in DP-55 renewal by the NMED (2020).

Estimates of completion times for CHMRP reclamation activities are given below:

- Waste Rock Pile planting (34 days)
- Open Pit reclamation (62 days)
- ARD Treatment Facility (31 days)

The start-up date for CHMRP reclamation activities is dependent upon permit approval, season, and required contractor mobilization time.

9.0 REFERENCES

Adrian Brown Consultants, Inc., 1996, Cunningham Hill Open Pit Recharge Model and Storm Channel Design: Draft report prepared for LAC Minerals (USA) Inc. and Pegasus Gold Corporation, January 10, 1996.

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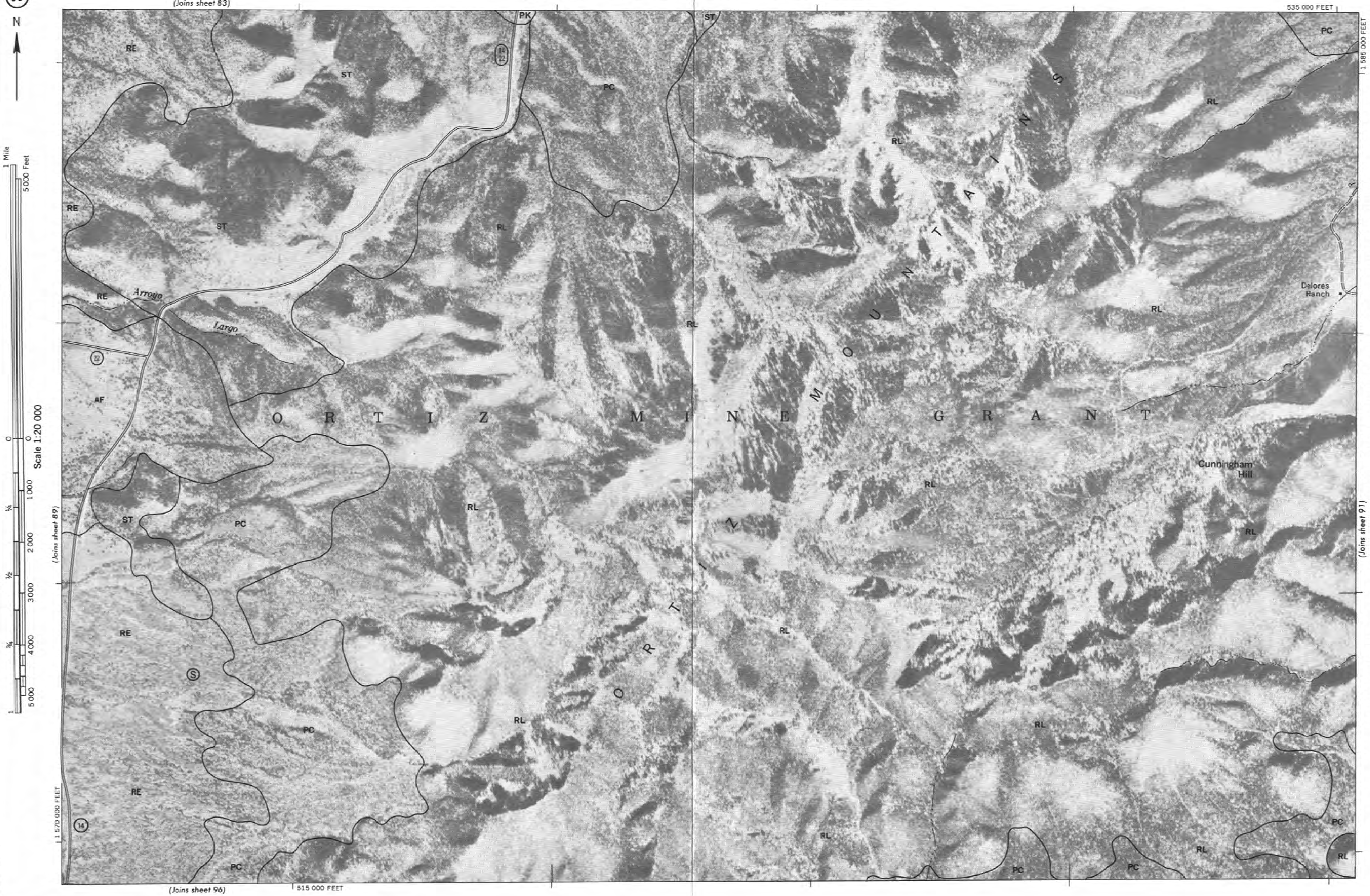
APPENDICES

Appendix A.

NRCS soil survey information



Photobase from 1953-1954 aerial photography. Positions of 5,000-foot grid ticks based on the New Mexico plane coordinate system, central zone, 1927 North American datum.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Forest Service, the United States Department of the Interior, Bureau of Indian Affairs, and the New Mexico Agricultural Experiment Station.

g, and making up the other 20 percent of this association, are Clovis, Fivemile, and Panky soils and granite, sandstone, shale, and limestone outcroppings.

Permeability is slow in the Rednun soil. Runoff is medium, and the hazard of erosion is moderate. Effective rooting depth is 40 to 60 inches. Available water holding capacity is 7.5 to 11 inches.

The Pena soil has a profile similar to that described as representative for the Pena series, except that the surface layer is dark-brown gravelly clay loam about 11 inches thick. Permeability is moderate in this soil. Runoff is slow to rapid, and the hazard of erosion is moderate to severe. Effective rooting depth in this soil is 12 to 30 inches or more to the strong lime zone. Available water holding capacity is 2 to 3.5 inches.

The soils in this association are used for range, as wildlife habitat, and for water supply. Areas covered with pinyon and juniper are a source of firewood and fenceposts. Rednun soil: Dryland capability subclass VIe; Loamy range site; wildlife habitat group F. Pena soil: Dryland capability subclass VIIe; Shallow range site; wildlife habitat group F.

Rednun-Travessilla association, undulating (RG).—This association consists of about 60 percent Rednun loam that has slopes of 1 to 5 percent and 30 percent Travessilla loam that has slopes of 5 to 9 percent. Included soils of the Bernal, Penistaja, and Galisteo series and sandstone outcrops make up the other 10 percent.

The Rednun soil has a profile similar to that described as representative for the Rednun series, except that bedrock is at a depth of 40 to 60 inches or more. Permeability is slow in this soil. Runoff is medium, and the hazard of erosion is moderate. Effective rooting depth in this Rednun soil is 40 to 60 inches. Available water holding capacity is 7.5 to 11 inches.

The Travessilla soil has the profile described as representative for the Travessilla series. Permeability is moderate in this soil. Runoff is rapid, and the hazard of erosion is moderate. Effective rooting depth in this soil is 6 to 18 inches. Available water holding capacity is 1 to 2 inches.

These soils are used for range, as wildlife habitat, and for water supply. Also, the Travessilla soils are a source of flagstone. Rednun soil: Dryland capability subclass VIe; Loamy range site; wildlife habitat group F. Travessilla soil: Dryland capability subclass VIIs; Shallow Sandstone range site; wildlife habitat group F.

Riverwash

Riverwash (RH) is in channels of intermittent arroyos and live streams. The material in this land type is commonly sandy, and it is subject to shifting during periods of normal high water. Areas are essentially barren. Pockets of gravel, cobblestones, and stones are common in places. This land type is nearly level to gently sloping. It is mostly in the northern third of the survey area but is present throughout. This land type was mapped mostly at low intensity. Some areas, however, are intermingled with areas of soils mapped at high intensity. Elevation ranges from 00 to 7,500 feet.

Included with this land type in mapping were small areas of Bluewing soils that occur as islands scattered throughout the wider streambeds.

Areas of this land type are used for water supply and as a source of sand and gravel. Dryland capability subclass VIIIw.

Rock Outcrop

Rock outcrop (RK) consists of areas essentially devoid of soil and vegetation. It is mostly on tops of mountain peaks above the timberline and on the side walls of cirques. Areas of it are valuable because of their scenic beauty. This land type is nearly level to very steep. It is mostly in the northeastern part of the survey area. Elevation ranges from 7,500 to 12,500 feet.

Areas of this land type are used for water supply. Dryland capability subclass VIIIs.

Rock outcrop-Chimayo complex, 45 to 100 percent slopes (RL).—This complex consists of about 70 percent Rock outcrop and about 20 percent Chimayo stony sandy loam. Included soils and the land type Rock slides make up the other 10 percent. The soils are in the Mirabal and Supervisor series. This complex is in the northeastern part of the survey area and on the Ortiz Mountains in the southern part.

The Chimayo soil has a profile similar to that described as representative for the Chimayo series, except that the surface layer is stony sandy loam. Slopes are generally more than 60 percent. Permeability is moderate in this soil. Runoff is rapid, and the hazard of erosion is severe. Effective rooting depth is 10 to 20 inches. Available water holding capacity is 1 to 2 inches.

The soils in this complex are used for range, as wildlife habitat, and for water supply. Pinyon and juniper are a source of firewood and fenceposts. Dryland capability subclass VIIs; Mountain Shale range site; wildlife habitat group F.

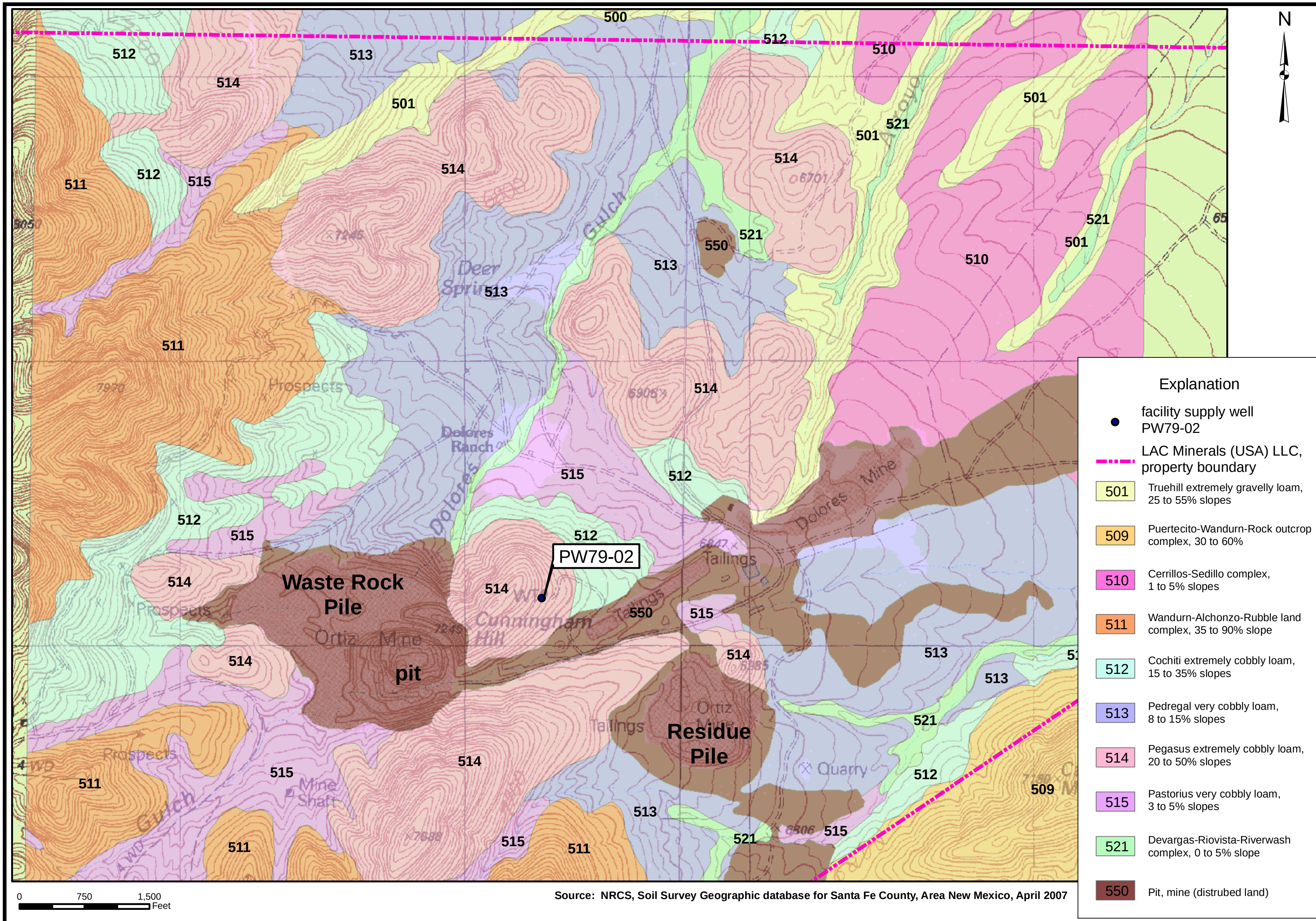
Rock Slides

Rock slides (RO) consist of loose rock material ranging from coarse gravel to boulders. This land type is steep to very steep. It is only at the higher elevations (9,000 to 12,500 feet) in the northeastern part of the survey area. The Rock slides are in the form of fans or aprons. They are made up of material deposited by snowslides, falling rock from cliffs, and material moved by glaciers. The rocks are moved by gravity when a down-cutting channel undermines their base. Stabilized slides commonly have scattered stands of spruce, but most Rock slides are barren.

Areas of this land type are used for water supply and to a limited extent have scenic value. Dryland capability subclass VIIIs.

Rough Broken Land

Rough broken land (RU) consists of very steep, very shallow soils on ridges and mesas that are broken by intermittent drainage channels. The surface layer of this land type ranges from sandy loam to loam. The colluvium at the base of the escarpments and along the drainageways is deep. This land type is in the northern third of the survey area. Elevation ranges from 6,600 to 7,200 feet. Mean annual precipitation is 12 to 15 inches, and the mean annual air temperature is 48° to 50° F. The frost-free season is 160 to 170 days.



C-5. Soils map of the facility, Cunningham Hill Mine Reclamation Project.

501—Truehill extremely gravelly loam, 25 to 55 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 5,500 to 7,400 feet (1,676 to 2,256 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Mean annual air temperature: 50 to 52 degrees F (10.0 to 11.1 degrees C)
Frost-free period: 150 to 170 days

Map Unit Composition

Truehill and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Truehill soils

Landscape: Fan piedmonts
Landform: Fan remnants (fig. 60)
Position on landform: Riser
Parent material: Alluvium derived from monzonite
Slope: 25 to 55 percent
Shape (down/across): Linear/linear
Surface fragments: About 2 percent well rounded stones; about 15 percent well rounded cobbles; about 41 percent well rounded gravel
Depth class: Very deep
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 2.8 inches (very low)
Shrink-swell potential: About 2.8 percent (low)
Runoff class: High
Calcium carbonate average in horizon of maximum accumulation: About 40 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 2 (slightly sodic)
Ecological site: Pinus edulis-Juniperus monosperma/Quercus gambelii/Bouteloua gracilis
Potential native vegetation: blue grama, New Mexico feathergrass, black grama, sideoats grama, galleta, oneseed juniper, twoneedle pinyon
Land capability subclass (nonirrigated): 8

Typical Profile

A—0 to 4 inches; extremely gravelly loam
Bt—4 to 7 inches; very gravelly clay loam
Btk—7 to 12 inches; very gravelly clay loam
Bk1—12 to 22 inches; extremely cobbly sandy loam
Bk2—22 to 40 inches; extremely gravelly coarse sandy loam
Bk3—40 to 49 inches; extremely gravelly coarse sand
Bk4—49 to 67 inches; extremely gravelly sandy clay loam
Bk5—67 to 80 inches; extremely gravelly loamy coarse sand

Minor Components Composition

Ildefonso and similar soils*:* About 5 percent
Cerropelon and similar soils*:* About 2 percent
Sedillo and similar soils*:* About 2 percent
Rock outcrop*:* About 1 percent

509—Puertecito-Wandurn-Rock outcrop complex, 30 to 60 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 6,100 to 7,600 feet (1,859 to 2,316 meters)
Mean annual precipitation: 10 to 15 inches (254 to 381 millimeters)
Mean annual air temperature: 48 to 52 degrees F (8.9 to 11.1 degrees C)
Frost-free period: 130 to 170 days

Map Unit Composition

Puertecito and similar soils: 60 percent
Wandurn and similar soils: 20 percent
Rock outcrop: 10 percent
Minor components: 10 percent

Component Descriptions

Puertecito soils

Landscape: Fault block mountains (fig. 67)
Landform: South-facing high hills
Position on landform: Shoulders, backslopes
Parent material: Colluvium derived from monzonite over residuum weathered from monzonite
Slope: 30 to 60 percent
Shape (down/across): Convex/convex
Surface fragments: About 2 percent angular stones; about 10 percent angular cobbles; about 50 percent angular gravel
Depth class: Shallow
Depth to restrictive feature: 10 to 20 inches to bedrock, lithic
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 1.2 inches (very low)
Shrink-swell potential: About 4.5 percent (moderate)
Runoff class: Very high
Calcium carbonate average in horizon of maximum accumulation: About 14 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 2 (slightly sodic)
Ecological site: Hills
Potential native vegetation: blue grama, Gambel oak, oneseed juniper, black grama, broom snakeweed, galleta, twoneedle pinyon
Land capability subclass (nonirrigated): 7s

Typical Profile

A—0 to 2 inches; extremely gravelly coarse sandy loam
Bt1—2 to 6 inches; very gravelly sandy clay loam
Bt2—6 to 10 inches; very gravelly clay loam
Btk—10 to 12 inches; very gravelly loam
2R—12 to 22 inches; cemented bedrock

Wandurn soils

Landscape: Fault block mountains (fig. 67)
Landform: North-facing high hills
Position on landform: Backslopes
Parent material: Slope alluvium and colluvium derived from monzonite
Slope: 30 to 60 percent
Shape (down/across): Linear/linear
Surface fragments: About 9 percent subangular stones; about 40 percent subangular cobbles; about 25 percent subangular gravel
Depth class: Deep
Depth to restrictive feature: 39 to 59 inches to bedrock, lithic; 39 to 59 inches to bedrock, paralithic
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 3.2 inches (low)
Shrink-swell potential: About 4.5 percent (moderate)
Runoff class: High
Calcium carbonate average in horizon of maximum accumulation: About 6 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 2 (slightly sodic)
Ecological site: Pinus edulis-Juniperus monosperma/Cercocarpus montanus-Chrysothamnus nauseosus/Bouteloua gracilis
Potential native vegetation: oneseed juniper, twoneedle pinyon, muttongrass, true mountain mahogany, sideoats grama
Land capability subclass (nonirrigated): 7s

Typical Profile

A—0 to 2 inches; extremely cobbly sandy clay loam
Bt1—2 to 7 inches; cobbly clay loam
Bt2—7 to 14 inches; very cobbly clay loam
Bt3—14 to 25 inches; extremely cobbly sandy clay loam
Btk—25 to 40 inches; extremely cobbly sandy clay loam
2Bt4—40 to 43 inches; sandy clay loam
2Cr—43 to 50 inches; cemented bedrock
2R—50 to 60 inches; cemented bedrock

Rock outcrop

Description: Rock outcrop consists of exposed monzonite bedrock. It occurs as steeply sloping bedrock, short cliffs, and knobs intermingled with the Puertecito and Wandurn soils.
Landscape: Fault block mountains (fig. 67)
Landform: High hills
Parent material: Monzonite
Slope: 40 to 160 percent
Shape (down/across): Linear/linear

Minor Components Composition

Paraje and similar soils: About 6 percent
Penistaja and similar soils: About 3 percent
Rubble land: About 1 percent

Figure 67.—An area of Puertecito-Wandurn-Rock outcrop complex, 30 to 60 percent slopes. The Puertecito soils are on areas with less trees. The Wandurn soils are on areas where the tree density exceeds 35 percent.

510—Cerrillos-Sedillo complex, 1 to 5 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 5,600 to 7,200 feet (1,707 to 2,195 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Mean annual air temperature: 50 to 52 degrees F (10.0 to 11.0 degrees C)
Frost-free period: 150 to 170 days

Map Unit Composition

Cerrillos and similar soils: 60 percent
Sedillo and similar soils: 30 percent
Minor components: 10 percent

Component Descriptions

Cerrillos soils

Landscape: Fan piedmonts (fig. 68)
Landform: Fan remnants (fig. 60)
Position on landform: Tread
Parent material: Eolian deposits derived from sandstone and shale over alluvium derived from monzonite
Slope: 1 to 3 percent
Shape (down/across): Linear/linear
Surface fragments: About 5 percent subrounded gravel
Depth class: Very deep
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 9.7 inches (high)
Shrink-swell potential: About 4.5 percent (moderate)
Runoff class: Low
Calcium carbonate average in horizon of maximum accumulation: About 28 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 2 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 1 (slightly sodic)
Ecological site: Loamy
Potential native vegetation: blue grama, black grama, galleta, ring muhly, broom snakeweed
Land capability subclass (nonirrigated): 6c

Typical Profile

A—0 to 4 inches; fine sandy loam
Bt—4 to 12 inches; clay loam
Btk—12 to 20 inches; clay loam
Bk1—20 to 36 inches; gravelly sandy clay loam
Bk2—36 to 46 inches; sandy clay loam
Bk3—46 to 59 inches; gravelly sandy clay loam
Bk4—59 to 86 inches; gravelly sandy clay loam
Bk5—86 to 94 inches; sandy clay loam

Sedillo soils

Landscape: Fan piedmonts (fig. 68)
Landform: Fan remnants (fig. 60)
Position on landform: Tread
Parent material: Eolian deposits and alluvium derived from sandstone, shale, and monzonite
Slope: 2 to 5 percent
Shape (down/across): Linear/linear
Surface fragments: About 5 percent subrounded gravel
Depth class: Very deep
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 5.9 inches (low)
Shrink-swell potential: About 3.4 percent (moderate)
Runoff class: Low
Calcium carbonate average in horizon of maximum accumulation: About 40 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 8 (slightly sodic)
Ecological site: Gravelly
Potential native vegetation: blue grama, black grama, galleta, New Mexico feathergrass, oneseed juniper, sideoats grama, twoneedle pinyon
Land capability subclass (nonirrigated): 6c

Typical Profile

A—0 to 3 inches; very fine sandy loam
BA—3 to 9 inches; loam
Btk—9 to 15 inches; very cobbly clay loam
Bk1—15 to 25 inches; extremely gravelly loam
Bk2—25 to 39 inches; very cobbly sandy loam
Bk3—39 to 52 inches; cobbly sandy clay loam
Bk4—52 to 69 inches; gravelly sandy clay loam
Bk5—69 to 80 inches; gravelly sandy loam

Minor Components Composition

Penistaja and similar soils*:* About 5 percent
Truehill and similar soils*:* About 3 percent
Ildefonso and similar soils*:* About 2 percent

Figure 68.—An area of Cerrillos-Sedillo complex, 1 to 5 percent slopes. The Cerrillos soils are in the foreground. The Sedillo soils are in the background, where the density of trees is greater.

511—Wandurn-Alchonzo-Rubble land complex, 35 to 90 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 6,200 to 8,900 feet (1,890 to 2,713 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 45 to 49 degrees F (7.2 to 9.4 degrees C)
Frost-free period: 110 to 150 days

Map Unit Composition

Wandurn and similar soils: 50 percent
Alchonzo and similar soils: 30 percent
Rubble land: 10 percent
Minor components: 10 percent

Component Descriptions

Wandurn soils

Landscape: Fault block mountains
Landform: South-facing mountains
Position on landform: Mountainflank
Parent material: Slope alluvium and colluvium derived from monzonite
Slope: 35 to 75 percent
Shape (down/across): Linear/linear
Surface fragments: About 10 percent subangular stones; about 40 percent subangular cobbles; about 25 percent subangular gravel
Depth class: Deep
Depth to restrictive feature: 39 to 59 inches to bedrock, lithic
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 3.7 inches (low)
Shrink-swell potential: About 4.5 percent (moderate)
Runoff class: High
Calcium carbonate average in horizon of maximum accumulation: None
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 0 (nonsodic)
Ecological site: Pinus edulis-Juniperus monosperma/Quercus gambelii/Bouteloua gracilis
Potential native vegetation: Gambel oak, twoneedle pinyon, muttongrass, oneseed juniper, sideoats grama, wolftail
Land capability subclass (nonirrigated): 7e

Typical Profile

A—0 to 3 inches; extremely cobbly loam
Bt1—3 to 11 inches; very cobbly sandy clay loam
Bt2—11 to 20 inches; very cobbly sandy clay loam
Bt3—20 to 30 inches; very gravelly sandy clay loam
Bt4—30 to 40 inches; extremely gravelly sandy clay loam
Bt5—40 to 47 inches; extremely gravelly sandy clay loam
R—47 to 57 inches; cemented bedrock

Alchonzo soils

Landscape: Fault block mountains
Landform: North-facing mountains
Position on landform: Mountainflank
Parent material: Slope alluvium and colluvium derived from monzonite
Slope: 45 to 90 percent
Shape (down/across): Linear/linear
Surface fragments: About 5 percent subangular stones; about 10 percent subangular cobbles; about 60 percent subangular gravel
Depth class: Moderately deep
Depth to restrictive feature: 20 to 39 inches to bedrock, lithic
Drainage class: Well drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity: About 0.9 inches (very low)
Shrink-swell potential: About 1.5 percent (low)
Runoff class: Very high
Calcium carbonate average in horizon of maximum accumulation: None
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 0 (nonsodic)
Ecological site: Pinus ponderosa-Juniperus scopulorum/Quercus gambelii
Potential native vegetation:
Common trees: ponderosa pine
Other plants: Gambel's oak, muttongrass, mountain muhly, sedge, eriogonum
Land capability subclass (nonirrigated): 8

Typical Profile

Oi—0 to 2 inches; slightly decomposed plant material
A—2 to 12 inches; extremely gravelly sandy loam
Bw1—12 to 27 inches; extremely gravelly sandy loam
Bw2—27 to 29 inches; very gravelly sandy loam
R—29 to 39 inches; cemented bedrock

Rubble land

Description: Rubble land consists of talus of irregularly shaped cobbles, stones, and boulders that are devoid of vegetation. It is on very steeply sloping backslopes below basalt cliffs and is the result of parts of the cliff breaking off and tumbling downslope.
Landscape: Fault block mountains
Landform: Mountains
Parent material: Monzonite
Slope: 40 to 80 percent
Shape (down/across): Linear/linear
Depth to restrictive feature: 0 to 10 inches to bedrock, paralithic

Minor Components Composition

Rock outcrop*:* About 6 percent
Cochiti and similar soils*:* About 3 percent
Pastorius and similar soils*:* About 1 percent

512—Cochiti extremely cobbly loam, 15 to 35 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 6,200 to 8,300 feet (1,890 to 2,530 meters)
Mean annual precipitation: 13 to 15 inches (330 to 381 millimeters)
Mean annual air temperature: 48 to 50 degrees F (8.9 to 10.0 degrees C)
Frost-free period: 140 to 160 days

Map Unit Composition

Cochiti and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Cochiti soils

Landscape: Fault block mountains
Landform: Mountains
Position on landform: Mountainbase
Parent material: Slope alluvium and colluvium derived from monzonite
Slope: 15 to 35 percent
Shape (down/across): Concave/concave
Surface fragments: About 3 percent subangular boulders; about 7 percent subangular stones; about 40 percent subangular cobbles; about 25 percent subangular gravel
Depth class: Very deep
Drainage class: Well drained
Slowest permeability: 0.06 to 0.2 in/hr (slow)
Available water capacity: About 4.7 inches (low)
Shrink-swell potential: About 6.0 percent (moderate)
Runoff class: High
Calcium carbonate average in horizon of maximum accumulation: None
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 0 (nonsodic)
Ecological site: Pinus edulis-Juniperus monosperma/Cercocarpus montanus-Chrysothamnus nauseosus/Bouteloua gracilis
Potential native vegetation: Gambel oak, twoneedle pinyon, mountain mahogany, blue grama, oneseed juniper, sideoats grama
Land capability subclass (nonirrigated): 7s

Typical Profile

A—0 to 4 inches; extremely cobbly loam
Bt1—4 to 10 inches; extremely cobbly clay loam
Bt2—10 to 31 inches; very cobbly clay loam
Bt3—31 to 57 inches; extremely cobbly sandy clay loam
BC—57 to 80 inches; extremely cobbly sandy loam

Minor Components Composition

Rubble land*:* About 3 percent
Predawn and similar soils*:* About 2 percent
Wandurn and similar soils*:* About 2 percent
Alchonzo and similar soils*:* About 2 percent
Pastorius and similar soils*:* About 1 percent

513—Pedregal very cobbly loam, 8 to 15 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 6,300 to 7,800 feet (1,920 to 2,377 meters)
Mean annual precipitation: 13 to 15 inches (330 to 381 millimeters)
Mean annual air temperature: 48 to 50 degrees F (8.9 to 10.0 degrees C)
Frost-free period: 140 to 160 days

Map Unit Composition

Pedregal and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Pedregal soils

Landscape: Fan piedmonts
Landform: Fan remnants
Position on landform: Tread
Parent material: Alluvium derived from monzonite
Slope: 8 to 15 percent
Shape (down/across): Linear/linear
Surface fragments: About 1 percent subrounded stones; about 15 percent subrounded cobbles; about 25 percent subrounded gravel
Depth class: Moderately deep
Depth to restrictive feature: 2 to 6 inches to abrupt textural change; 20 to 36 inches to petrocalcic
Drainage class: Well drained
Slowest permeability: 0.0 to 0.001 in/hr (impermeable)
Available water capacity: About 2.6 inches (very low)
Shrink-swell potential: About 3.5 percent (moderate)
Runoff class: Medium
Calcium carbonate average in horizon of maximum accumulation: About 60 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 2 (slightly sodic)
Ecological site: Juniperus monosperma-Pinus edulis/Fallugia paradoxa-Chrysothamnus nauseosus/Bouteloua hirsuta-Bouteloua gracilis
Potential native vegetation: oneseed juniper, true mountain mahogany, twoneedle pinyon, pricklypear, skunkbush sumac
Land capability subclass (nonirrigated): 7s

Typical Profile

Oi—0 to 1 inch; slightly decomposed plant material (fig. 69)
A—1 inch to 3 inches; very cobbly loam
Bt1—3 to 7 inches; very cobbly clay loam
Bt2—7 to 12 inches; very cobbly clay loam
Btk—12 to 18 inches; very cobbly clay loam
Bk1—18 to 25 inches; very gravelly sandy loam
Bkkm—25 to 33 inches; very gravelly sandy loam
2Bk2—33 to 42 inches; very gravelly loamy coarse sand
2Bk3—42 to 79 inches; extremely gravelly coarse sand

Minor Components Composition

Cochiti and similar soils: About 6 percent
Predawn and similar soils: About 3 percent
Pastorius and similar soils: About 1 percent

Figure 69.—Typical profile of Pedregal very cobbly loam, 8 to 15 percent slopes, with the dark surface, red subsoil, and white substratum. A well developed petrocalcic horizon, cemented by calcium carbonate, exists in this soil in the upper part of the white area. There are many rock fragments throughout this soil.

514—Pegasus extremely cobbly loam, 20 to 50 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 5,700 to 7,700 feet (1,737 to 2,347 meters)
Mean annual precipitation: 13 to 15 inches (330 to 381 millimeters)
Mean annual air temperature: 48 to 50 degrees F (8.9 to 10.0 degrees C)
Frost-free period: 140 to 160 days

Map Unit Composition

Pegasus and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Pegasus soils

Landscape: Fault block mountains
Landform: Low hills
Position on landform: Summits, backslopes, shoulders
Parent material: Slope alluvium and colluvium derived from monzonite
Slope: 20 to 50 percent
Shape (down/across): Convex/convex
Surface fragments: About 2 percent angular stones; about 35 percent angular cobbles; about 35 percent angular gravel
Depth class: Shallow
Depth to restrictive feature: 10 to 20 inches to bedrock, lithic
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 1.2 inches (very low)
Shrink-swell potential: About 4.5 percent (moderate)
Runoff class: Very high
Calcium carbonate average in horizon of maximum accumulation: None
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 0 (nonsodic)
Ecological site: Pinus edulis-Juniperus monosperma/Cercocarpus montanus-Chrysothamnus nauseosus/Bouteloua gracilis
Potential native vegetation: twoneedle pinyon, oneseed juniper, true mountain mahogany, blue grama, sideoats grama
Land capability subclass (nonirrigated): 6s

Typical Profile

A—0 to 4 inches; extremely cobbly loam
Bt1—4 to 10 inches; cobbly loam
Bt2—10 to 14 inches; very gravelly clay loam
2R—14 to 24 inches; cemented bedrock

Minor Components Composition

Rock outcrop*:* About 4 percent
Wandurn and similar soils*:* About 4 percent
Alchonzo and similar soils*:* About 2 percent

515—Pastorius very cobbly loam, 3 to 5 percent slopes

Map Unit Setting

Major Land Resource Area: 36
Elevation: 6,000 to 8,100 feet (1,829 to 2,469 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 43 to 45 degrees F (6.1 to 7.2 degrees C)
Frost-free period: 110 to 130 days

Map Unit Composition

Pastorius and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Pastorius soils

Landscape: Fault block mountains
Landform: Low stream terraces on valley floors
Position on landform: Tread
Parent material: Alluvium derived from monzonite
Slope: 3 to 5 percent
Shape (down/across): Linear/concave
Surface fragments: About 25 percent subrounded gravel; about 20 percent subrounded cobbles
Depth class: Very deep
Drainage class: Well drained
Slowest permeability: 0.6 to 2.0 in/hr (moderate)
Available water capacity: About 3.9 inches (low)
Shrink-swell potential: About 3.9 percent (moderate)
Runoff class: Medium
Calcium carbonate average in horizon of maximum accumulation: None
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 0 (nonsodic)
Ecological site: Pinus ponderosa/Festuca arizonica-Danthonia parryi
Potential native vegetation: ponderosa pine, Gambel oak, mountain muhly, muttongrass, blue grama
Land capability subclass (nonirrigated): 4c

Typical Profile

Oi—0 to 2 inches; slightly decomposed plant material
A—2 to 6 inches; very cobbly loam
Bt1—6 to 17 inches; very cobbly loam
Bt2—17 to 28 inches; extremely cobbly loam
Bt3—28 to 43 inches; extremely cobbly loam
Bt4—43 to 82 inches; extremely cobbly loam

Minor Components Composition

Pedregal and similar soils*:* About 5 percent
Cochiti and similar soils*:* About 3 percent
Riverwash*:* About 2 percent

521—Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded

Map Unit Setting

Major Land Resource Area: 36
Elevation: 5,400 to 7,400 feet (1,646 to 2,256 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Mean annual air temperature: 50 to 52 degrees F (10.0 to 11.1 degrees C)
Frost-free period: 140 to 170 days

Map Unit Composition

Devargas and similar soils: 50 percent
Riovista and similar soils: 30 percent
Riverwash: 10 percent
Minor components: 10 percent

Component Descriptions

Devargas soils

Landscape: Fan piedmonts (fig. 78 and fig. 79)
Landform: Stream terraces (fig. 60)
Position on landform: Tread
Parent material: Alluvium derived from monzonite and sandstone
Slope: 1 to 5 percent
Shape (down/across): Concave/linear
Surface fragments: About 5 percent rounded gravel
Depth class: Very deep
Depth to restrictive feature: 20 to 39 inches to strongly contrasting textural stratification
Drainage class: Well drained
Slowest permeability: 0.2 to 0.6 in/hr (moderately slow)
Available water capacity: About 3.9 inches (low)
Shrink-swell potential: About 2.3 percent (low)
Runoff class: Low
Calcium carbonate average in horizon of maximum accumulation: About 6 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 2 (slightly sodic)
Ecological site: Loamy
Potential native vegetation: blue grama, galleta, ring muhly, black grama, broom snakeweed
Land capability subclass (nonirrigated): 6c

Typical Profile

A—0 to 2 inches; sandy loam
Bt—2 to 6 inches; loam
Btk1—6 to 18 inches; loam
Btk2—18 to 30 inches; sandy loam
2BCk—30 to 60 inches; extremely cobbly coarse sand

Riovista soils

Landscape: Fan piedmonts (fig. 78 and fig. 79)
Landform: Flood plain steps on valley floors (fig. 60)
Position on landform: Tread
Parent material: Alluvium derived from monzonite
Slope: 0 to 2 percent
Shape (down/across): Linear/linear
Surface fragments: About 1 percent rounded stones; about 10 percent rounded cobbles; about 15 percent rounded gravel
Depth class: Very deep
Drainage class: Excessively drained
Slowest permeability: 6.0 to 20 in/hr (rapid)
Available water capacity: About 1.6 inches (very low)
Shrink-swell potential: About 1.5 percent (low)
Flooding hazard: Rare
Runoff class: Very low
Calcium carbonate average in horizon of maximum accumulation: None
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 1 (slightly sodic)
Ecological site: Gravelly
Potential native vegetation: blue grama, New Mexico feathergrass, black grama, galleta, juniper, sideoats grama, twoneedle pinyon
Land capability subclass (nonirrigated): 7s

Typical Profile

A1—0 to 5 inches; cobbly sandy loam
A2—5 to 14 inches; extremely cobbly sandy loam
C1—14 to 30 inches; extremely cobbly coarse sand
C2—30 to 60 inches; stratified coarse sand to extremely cobbly loamy sand

Riverwash

Description: Riverwash consists of unstable sand and gravel that is reworked by water so frequently that it supports little or no vegetation. Riverwash occurs in arroyos and is subject to frequent, extremely brief periods of flooding from prolonged high-intensity storms. In some places it is intermingled with the Riovista soil.
Landscape: Fan piedmonts (fig. 78 and fig. 79)
Landform: Channels on valley floors (fig. 60)
Parent material: Alluvium derived from mixed
Slope: 0 to 2 percent
Shape (down/across): Linear/linear
Surface fragments: About 5 percent rounded cobbles; about 20 percent rounded gravel
Drainage class: Excessively drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity: About 2.9 inches (very low)
Shrink-swell potential: About 1.5 percent (low)
Flooding hazard: Frequent
Runoff class: Negligible
Calcium carbonate average in horizon of maximum accumulation: About 1 percent
Gypsum average in horizon of maximum accumulation: About 1 percent
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)

Sodium adsorption ratio average in horizon of maximum accumulation: About 1 (slightly sodic)
Land capability subclass (nonirrigated): 8

Minor Components Composition

Penistaja and similar soils*:* About 6 percent
Ildefonso and similar soils*:* About 4 percent

Figure 78.—An area of Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded. This is a typical area of the Devargas soil.

Figure 79.—An area of Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded. This is a typical area of Riovista soil. Notice the amount of surface rock fragments and sparseness of vegetation as opposed to the Devargas soil in the previous picture.

550—Pits, mine

Map Unit Setting

Major Land Resource Area: 36
Elevation: 6,500 to 8,000 feet (1,981 to 2,438 meters)
Mean annual precipitation: 13 to 15 inches (330 to 381 millimeters)
Mean annual air temperature: 48 to 50 degrees F (8.9 to 10.0 degrees C)
Frost-free period: 140 to 170 days

Map Unit Composition

Pits, mine: 85 percent
Minor components: 15 percent

Component Descriptions

Pits, mine
Parent material: Mine spoil or earthy fill derived from monzonite
Slope: 8 to 40 percent
Shape (down/across): Convex/convex
Surface fragments: About 5 percent subrounded cobbles; about 35 percent subrounded gravel
Drainage class: Well drained
Slowest permeability: 0.6 to 2.0 in/hr (moderate)
Available water capacity: About 4.5 inches (low)
Shrink-swell potential: About 1.5 percent (low)
Runoff class: Medium
Calcium carbonate average in horizon of maximum accumulation: About 4 percent
Gypsum average in horizon of maximum accumulation: None
Salinity average in horizon of maximum accumulation: About 1 mmhos/cm (nonsaline)
Sodium adsorption ratio average in horizon of maximum accumulation: About 2 (slightly sodic)
Land capability subclass (nonirrigated): 8

Minor Components Composition

Pegasus and similar soils*:* About 5 percent
Pedregal and similar soils*:* About 4 percent
Cochiti and similar soils*:* About 2 percent
Wandurn and similar soils*:* About 2 percent
Alchonzo and similar soils*:* About 2 percent

Appendix B.

Updated Contingency Plan (JSAI, 2021)

CUNNINGHAM HILL MINE
RECLAMATION PROJECT
UPDATED CONTINGENCY PLAN

prepared by

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CUNNINGHAM HILL MINE RECLAMATION PROJECT
UPDATED CONTINGENCY PLAN

1.0 INTRODUCTION

This Updated Contingency Plan is submitted as part of the updated Closeout Plan (JSAI, 2021) for the Cunningham Hill Mine Reclamation Project. This plan, submitted on behalf of LAC Minerals (USA) LLC (LAC), includes activities conducted under the supervision of New Mexico Environment Department (NMED) to comply with the New Mexico Water Quality Act as defined in 20.6.2 and 20.6.4 New Mexico Administrative Code (NMAC).

This Updated Contingency Plan is intended to help fulfill the purposes of the New Mexico Mining Act (NMSA 1978 §§ 69-36-1 et seq) to promote responsible utilization and reclamation of lands affected by mining. In particular, it is intended to promote the closeout plan goal of reestablishing a self-sustaining ecosystem in the permit area, appropriate for the life zone of the surrounding areas, to the extent consistent with technical and economic feasibility and environmental soundness (19.10.5.507 NMAC).

Portions of this plan are also intended to promote compliance with the New Mexico Water Quality Act. In particular, they are intended to promote compliance with New Mexico water quality standards, which may be modified, if appropriate, due to an unreasonable burden (see 20.6.2.1210 NMAC) or on technological or economic grounds (20.6.2.4103.E NMAC).

The Updated Contingency and Closeout Plans address only those conditions in the permit area resulting from the "existing mining operation" (see the New Mexico Mining Act (NMSA 1978 § 69-36-3.E)) conducted by Gold Fields Operating Company - Ortiz ("Gold Fields") from 1979 through 1987. Any other conditions in the permit area are not subject to this Plan.

Throughout this plan "the appropriate State agency" shall refer to:

- New Mexico Environment Department (NMED) where the matter directly relates solely to water quality;
- New Mexico Energy, Minerals and Natural Resources Department Mining and Minerals Division (MMD) where the matter directly relates solely to non-water quality aspects of reclamation under the New Mexico Mining Act; or
- Both NMED and MMD in other cases.

Performance Standards and their associated contingency plans are arranged by facility in subsequent sections. Separate sections are included for specific performance standards that relate to the Waste Rock Pile and Dolores Gulch (Section 2.0), the Open Pit (Section 3.0), and the residue pile (Section 4.0). Specific performance standards and contingency plans that are not included in the foregoing sections are included in Section 5.0.

2.0 WASTE ROCK PILE AND DOLORES GULCH GROUNDWATER

Performance standards and contingencies for groundwater cleanup related to discharges from the Waste Rock Pile to Dolores Gulch are specified in DP-55: particularly in the DP-55 renewal that is underway.

Performance standards and contingencies related to reclaimed lands on the Waste Rock Pile and Dolores Gulch (water treatment system) can be referenced from Section 5.0.

3.0 CUNNINGHAM HILL OPEN PIT

3.1 Performance Standard CHP-1: Open Pit Water Quality

The quality of the water in the Cunningham Hill Open Pit water body shall meet applicable New Mexico surface water quality standards for **wildlife habitat, livestock watering, and limited aquatic life use**. Specifically, water in the Open Pit water body shall "be free from any substance at concentrations that are toxic to or will adversely affect plants and animals that use these environments for feeding, drinking, habitat, or propagation; can bioaccumulate; or might impair the community of animals in a watershed or the ecological integrity of surface waters of the state (20.6.4.900.G NMAC). LAC may propose revised standards which are based on a site-specific ecological risk assessment (Use Attainability Analysis as defined in 20.6.4.15 NMAC) to NMED for review and approval. The open pit pool surface water standards were updated according to 20.6.4.99 NMAC and NMED (2021). Applicable Open Pit water quality standards are summarized in Table 1. Sampling methods and frequency are specified in AP-27.

3.2 Contingency Plan CHP-1

Resampling: If a surface sample of the water body exceeds the surface water quality standards specified in Table 1, then LAC shall collect a conformation sample for analysis within 1 week of identified exceedance. The Cunningham Hill Open Pit pool sampling should be conducted in accordance with New Mexico Environment Department Surface Water Quality Bureau (NMED SWQB) Standard Operating Procedures for Lake Sampling (20.6.4.14.C.3 NMAC; SOP 12.1, Section 6.2 – Collecting Lake Water Samples), which is described as follows.

Open Pit Sampling SOP--Collecting Lake Water Samples for Chemical Analysis (Deep and Shallow Stations): Double rinse collection equipment with lake water when used for multiple sites, such as the Kemmerer, or 5-gallon carboy. Collect water samples in accordance with Subsection C Paragraph (3) of 20.6.4.14 NMAC. Use a plastic (acrylic) or fluoropolymer Kemmerer for collecting water chemistry (TDS, anions, metals).

During periods of lake stratification (**thermocline is present**) TDS, dissolved metals, and total metals, are integrated from the top, middle and bottom of the entire water column by taking three Kemmerer samples. If any of the Kemmerer samples fall at the same depth as the thermocline, collect from one meter above. For the bottom sample, keep the Kemmerer at least 1 meter away from the bottom to avoid stirring up sediments. Composite three 5-liter Kemmerer samples in a 5-gallon carboy. All water-quality samples are poured off from the composited sample into their respective containers; 1-liter Cubitainers® or other containers as prescribed by the analysis to be performed. Dissolved metal samples are typically filtered within 15 mins of sample collection and prior to being poured into 1-liter Cubitainers®. All lake samples which require preservation will be preserved within 15 minutes of sample collection in accordance with 40 CFR 136.3 (e) Table II. However due to wind, waves, weather and unforeseen events preservation may not occur within 15 mins of sample collection but as soon thereafter as practically possible.

When the lake is well mixed (**thermocline is not present**), all samples are collected from the top, middle, and bottom of the euphotic zone. Composite three 5-liter Kemmerer samples in a 5-gallon carboy. All water quality samples are poured off from the composited sample into their respective containers. Dissolved metal samples are typically filtered within 15 mins of sample collection and prior to being poured into 1-liter Cubitainers®. All lake samples which require preservation will be preserved within 15 mins of samples collection in accordance with 40 CFR 136.3 (e) Table II. However due to wind, waves, weather and unforeseen events preservation may not occur within 15 mins of sample collection but as soon thereafter as practically possible.

If re-sampling confirms that the pit water body exceeds the water quality standards, then appropriate exclusion measures should be taken as described below.

Restricting Wildlife Exposure: If the pit water body exceeds the standards for wildlife use, as described above, LAC shall take immediate measures to prevent, to the extent practicable, wildlife exposure to the pit water body. Unless inappropriate, alternative water sources for wildlife use shall be provided. In addition, a follow-up investigation shall be conducted as described below.

Follow-Up Investigation: A follow-up investigation, if required, shall be conducted by LAC to identify the reason for observed changes in water quality that cause exceedances of the wildlife water quality standards. The investigation may include additional water sampling and analysis, site investigation, source controls, and determination of potential effects on down-gradient surface-water or groundwater quality. If the investigation indicates that the changes in water quality are adversely affecting or will adversely affect wildlife using the pit water body, or will cause a failure in down-gradient water quality, then a mitigation plan shall be developed by LAC as described below.

Mitigation Plan: The mitigation plan, if required, will evaluate alternative measures for reducing the impacts associated with the pit water body identified in the follow-up investigation. LAC shall submit the plan to NMED for review and approval, after which LAC shall implement the approved plan in a timely manner.

Additionally, LAC shall submit annual reports for review by NMED describing the measures taken under the approved mitigation program, and the observed results. Alternatively, LAC may choose to remove a designated use by performing a “Use Attainability Analysis” (“UAA”) pursuant to 20.6.4.15 NMAC. If LAC seeks to remove a designated use or to propose site-specific surface water standards for the open pit water body, the NMED SWQB will be consulted regarding this process.

Table 1. Open Pit waterbody water-quality standards

constituent	unit	AP-27 groundwater discharge Standard	surface-water trigger level	Livestock Watering Standard	Wildlife Habitat Standard	Limited Aquatic Life - Acute Standard
alkalinity	mg/L		<20			
pH	S.U.	6 to 9				
chloride	mg/L	250				
Sulfate	mg/L	1,200 b				
TDS	mg/L	2,000 b				
conductance	µS/cm		6,300			
aluminum	mg/L	5				10.07
arsenic	mg/L	0.01		0.2		0.34
boron	mg/L	0.75		5.0		
cadmium	mg/L	0.005		0.05		0.0065
chlorine residual	mg/L				0.011	0.019
chromium III	mg/L					1.77
chromium VI	mg/L					0.016
chromium	mg/L	0.05		1.0		
cobalt	mg/L	0.2 b		1.0		
copper	mg/L	1		0.5		0.05
iron	mg/L	1				
lead	mg/L	0.002		0.1		0.28
manganese	mg/L	4.0 b				4.738
mercury	mg/L	0.002			0.01	0.0014
molybdenum	mg/L	1				7.920
nickel	mg/L	0.2				1.51
selenium	mg/L	0.05		0.05	0.005	0.02
silver	mg/L	0.05				0.035
vanadium	mg/L			0.1		
zinc	mg/L	10		25		0.564

b - applicable water-quality standard defined in NMAC 20.6.4.97.C.1(a)
TDS - total dissolved solids
S.U. - standard units
mg/L - milligrams per liter

3.3 Performance Standard CHP-2: Open Pit Hydrological Model

A hydrogeochemical model of the Open Pit water body was developed by LAC for predicting the rate of inflow and the water quality. The hydrogeochemical model was revised 1999, 2001, 2010, and 2020 (JSAI, 2020). Steady-state Open Pit water levels are predicted to range between 6,800 to 6,840 ft above mean seal level (amsl).

A hydrologic investigation shall be conducted by LAC if Open Pit water levels rise above 6,840 ft amsl to identify the changes in groundwater levels in portions of Dolores Gulch in the vicinity of the Waste Rock Pile that result from recovery of the water levels in the Open Pit. The investigation shall include an evaluation of the surface and groundwater quality down-gradient of the Open Pit, and an analysis of samples taken from AP-27 groundwater monitor wells to evaluate groundwater quality. Information used from the hydrologic investigation, the observed rate of inflow, rainfall, evaporation, and the observed Open Pit water chemistry shall be used to recalibrate the model and to refine the long-term prediction of water quality in the Open Pit water body.

3.4 Contingency Plan CHP-2

If the investigation(s) indicate that the Open Pit water body will fail to meet water quality standards for wildlife use, specified in CHP-1 above, the findings shall be reported by LAC to NMED within 7 business days. Additionally, LAC shall conduct a follow-up study and, if required, shall develop a mitigation plan as described in CHP-1.

If resampling results, four quarters of AP-27 sampling results, and the results of the hydrogeochemical model indicate that standards described in CHP-1 will be exceeded, then mitigation measures will be employed. Mitigation measures may include, but not be limited to, pH mitigation, membrane filtration treatment, or other water quality treatment methods. A mitigation workplan must be submitted to the NMED for approval, prior to commencing the work.

4.0 CUNNINGHAM HILL RESIDUE PILE

Performance standards and contingencies for groundwater cleanup related to discharges from the residue pile are specified in DP-55 as renewed November 20, 2020.

5.0 SITE-WIDE PERFORMANCE CRITERIA

5.1 Performance Standard SW-1: Vegetation Standards

Vegetation on the reclaimed residue pile, reclaimed Waste Rock Pile, reclaimed portions of the ore treatment unit area, borrow areas, reclaimed roads, and areas within the Open Pit where topsoil has been applied, shall be subject to the monitoring requirements and performance standards described below. Areas of the Open Pit where no topsoil has been applied, as well as roads used for permanent access, shall not be subject to vegetation standards.

Vegetation success will be monitored through annual inspections, as well as by surveys of the reclaimed areas in years 3, 5, 8, 11, and 12 following completion of reclamation activities. LAC shall submit reports to the appropriate State agency describing the results of these revegetation surveys within 90 days after completion of data collection and monitoring activities. The reports shall include an assessment of vegetation success. Climatic variation and its effects on vegetative growth rates will be considered in this assessment.

Vegetation establishment and success on the Waste Rock Pile shall be monitored through the establishment of six 50-meter transect lines.

Transect locations for all other reclaimed areas shall be selected by LAC in consultation with the appropriate State agency.

Vegetation success for all reclaimed areas shall be determined by comparison with historic record sampling. Historic record sampling shall be performed in representative undisturbed areas for a minimum of 5 years, with sampling not necessarily conducted during consecutive years. Vegetation inspections of all reclaimed areas shall follow the following guidelines:

- Visual inspections of vegetation cover by life-form will be conducted (including annual grass, perennial grass, forbs, shrubs, trees, litter, and standing dead). Evidence of dieback, subsidence, slope failures, or erosion will be noted.
- Inspections will be conducted on ten 1-meter frames spaced every 5 meters on each transect.
- Pedestrian traffic will be restricted to the downhill side of the transect line and people will not be allowed to walk on the plots.
- Vegetation monitoring will be conducted once each year during peak standing biomass.

Revegetation efforts shall be considered successful when the following conditions are met:

- The total vegetative cover of perennial species in each revegetated area is equal to or exceeds 90 percent of the historic record, with a 90-percent statistical confidence limit;
- The density of actively growing shrubs and trees is within a 90-percent statistical confidence of the historic record;
- The total annual herbaceous productivity is within a 90-percent statistical confidence of the historic record; and;
- Species diversity is as follows:
    - ◊ The reclaimed area has at least three grasses present and a relative herbaceous cover value equal to or greater than 5 percent, with no one grass species comprising more than 70 percent relative cover,
    - ◊ The reclaimed area has at least two species of trees and two species of shrubs present, with each species comprising no less than 5 percent or no greater than 95 percent of the relative density value.

5.2 Contingency Plan SW-1

If vegetation monitoring indicates that, due to natural or other causes, a reclaimed area does not exhibit the potential to achieve the revegetation standards described above, a report shall be prepared which describes the area in question, the situation as identified, and probable causes. This report shall be submitted by LAC to the appropriate State agency within 30 days of problem identification. A corrective action plan shall be submitted by LAC to the appropriate State agency for review and approval within 75 days of the date of problem identification. Following approval of the plan by the appropriate State agency, LAC shall implement the plan in a timely manner. The corrective actions to be taken may include, but need not be limited to, reestablishment of topsoil thickness, reseeding, and replanting of trees and shrubs.

5.3 Performance Standard SW-2: Erosion Standards

All reclaimed areas shall be inspected quarterly for 5 years following completion of reclamation activities for signs of excessive erosion. After the first 2 years of monitoring, LAC may propose to the appropriate State agency that inspection be conducted less frequently if appropriate. Routine monitoring shall include a visual assessment of rills and gullies. Erosion features deeper than 8 in. shall be repaired in a timely manner.

Erosion of applied cover-soil from the Waste Rock Pile shall not expose significant contiguous areas of sulfide-enriched waste rock or otherwise be allowed to significantly decrease the performance of the reclaimed soil cover in minimizing infiltration into the pile. Erosion of applied cover-soil from the residue pile shall not expose significant contiguous areas of the unclassified fill layer within the cover system.

Erosion of applied cover-soil from reclaimed haul roads, portions of the Open Pit in which cover-soil has been applied, the ore treatment area, and other reclaimed areas, shall not be permitted to significantly decrease the performance of the reclaimed soil cover in supporting vegetation.

5.4 Contingency Plan SW-2

If erosion features deeper than 8 in. develop, LAC shall repair the damaged areas in a timely manner. If large numbers of significant erosion features are evident during an inspection period (more than 25 rills per acre over an area of 1 acre or more), then a mitigation plan to prevent recurrence of the erosion shall be developed and implemented by LAC. Elements of such a mitigation plan may include, but need not be limited to, regrading or otherwise re-directing surface runoff away from the affected areas.

If potentially destructive levels of erosion are identified, LAC shall notify the appropriate State agency within 2 business days. In addition, LAC shall determine the extent of erosion and shall submit a report describing the situation identified and probable causes to the appropriate State agency within 30 days of the date of problem identification. A corrective action plan shall be submitted by LAC to the appropriate State agency for review and approval within 75 days of the date of problem identification. Following approval of the corrective action plan by the appropriate State agency, LAC shall implement the plan in a timely manner. This work may include, but need not be limited to, regrading, armoring of drainage features, reestablishment of topsoil thickness, reseeding, and replanting of trees and shrubs.

5.5 Performance Standard SW-3: Maintenance of Drainage Channels and Diversion Structures

All drainage channels and diversion structures installed during reclamation of the Cunningham Hill Mine shall be subject to the routine inspection and maintenance requirements described below.

In order to ensure that the drainage channels and diversion structures are functioning properly, they shall be inspected quarterly for signs of excessive erosion for 5 years following completion of residue pile reclamation activities. After the first 2 years of monitoring, LAC may propose to the appropriate State agency that inspection be conducted less frequently if appropriate. During the 5-year period, drainage channels and diversion structures shall be inspected as soon as possible following storm events in excess of 1 in. of rainfall in 24 hours for signs of deterioration and erosional damage as well as sedimentation.

During the remainder of the post-closure monitoring period described in SW-3., drainage channels and diversion structures shall be inspected after each storm event that exceeds the largest prior storm that has occurred since completion of reclamation. More frequent inspection may be required during the post-closure monitoring period by the appropriate State agency if the drainage channels and diversion structures are shown to require frequent maintenance or repair.

Routine inspections and inspections completed after major storm events shall be subject to the following requirements:

- Physical damage, trash build-up and sedimentation shall be recorded on field inspection sheets.
- Diversion intake and outflow areas shall be inspected for evidence of scouring or bypass.
- Any areas needed maintenance or repair shall be reported on the field inspection sheets.

5.6 Contingency Plan SW-3

If damage is noted, appropriate repairs shall be completed by LAC in a timely manner. A summary of all observed damage requiring repair shall be submitted by LAC annually to the appropriate State agency, including as-built reports verifying the completion of the required repair.

If significant damage or overflow is caused by storms that are smaller than the structure's storm design, LAC shall conduct an investigation to identify the cause of significant damage or overflow of diversions. A report shall be prepared by LAC, identifying the extent of the problem and the probable causes. The report shall be submitted by LAC to the appropriate State agency within 30 days of the date of problem identification. A corrective action plan shall also be submitted to the appropriate State agency for review and approval within 75 days of the date of problem identification. The corrective actions to be taken may include, but need not be limited to, regrading, armoring of drainage features, redesign and reconstruction of channel cross-section and alignment, replacement of topsoil, reseeding, and replanting of trees and shrubs. After approval by the appropriate State agency, LAC shall implement the plan in a timely manner.

5.7 Performance Standard SW-4: Slope Stability

Quarterly inspections of all reclaimed areas for evidence of slope instability shall be made in years 1, 2, 3, 4, and 5 following completion of reclamation activities. LAC shall submit a slope-stability report annually to the appropriate State agency, summarizing the findings of the quarterly inspections.

> **Waste Rock Pile:** The slopes and benches of the Waste Rock Pile shall remain in a stable condition.
>
> **Residue Pile**: The slopes and benches of the residue pile shall remain in a stable condition.
>
> **Other Reclaimed Areas:** The slopes of other areas throughout the permit area, including the ore treatment facility, borrow areas, reclaimed exploration roads, access roads, and other support facilities shall remain in a stable condition.

Mass instability, including slope failure and subsidence in the above areas, shall be subject to the contingency requirements described below.

5.8 Contingency Plan SW-4

Waste Rock Pile: If slope movement, subsidence, or other mass instability which threatens the performance of the reclaimed soil cover occurs, LAC shall notify the appropriate agency within 2 business days of problem discovery, and shall take timely action to prevent excessive entry of surface water into the waste rock pile. Additionally, a geotechnical investigation shall be conducted, and a report describing the cause of the failure and appropriate remedies for preventing future slope movement shall be submitted by LAC to the appropriate State agency for review. After review and approval of the plan by the appropriate State agency, LAC shall implement the corrective measures described in the plan in a timely manner.

Open Pit: If large-scale highwall failure occurs, LAC shall notify MMD within 2 business days of problem discovery, shall conduct a geotechnical investigation to determine the cause of such failure and shall propose a corrective action plan to MMD for review and approval. LAC shall implement the approved plan in a timely manner. Damage to adjacent portions of the Waste Rock Pile or to drainage diversions caused by the large-scale failure shall be promptly repaired by LAC.

If the currently unstable area on the southern highwall increases in extent by more than 100 vertical ft, then a geotechnical investigation shall be conducted to identify the cause of the problem and to develop an appropriate remedial action plan. (Minor raveling of the southern highwall is currently occurring. Analysis of this condition indicates that the shallow failure is expected to stabilize in a few years and the uphill extent of raveling is expected to remain within 100 vertical feet of current extent. No attempts to regrade this area will be made at present, because such actions would likely disturb more surface area than would naturally be affected.) LAC shall submit the proposed plan to MMD for review and approval. LAC shall implement the approved plan in a timely manner.

Residue Pile: If slope movement, subsidence, or other mass instability is observed in the reclaimed residue pile, LAC shall notify the appropriate State agency within 2 business days of problem discovery. A geotechnical investigation shall be conducted to ascertain the extent of the problem, and a report describing the situation as identified, including estimates of the volume affected by the instability and potential consequences of the instability with respect to its effect on the integrity of the impervious soil barrier and drainage features, shall be developed by LAC and submitted to the appropriate State agency within 30 days of the date of problem identification. A corrective action plan shall be submitted by LAC to the appropriate State agency for review and approval within 75 days of the date of problem identification. Any remedial measures undertaken in conjunction with the corrective action plan shall be completed by LAC in a timely manner which minimizes disturbance to reclaimed areas and meets all original design criteria for the residue pile.

Other Reclaimed Areas: If slope movement, subsidence or other failure which threatens the integrity of any other reclaimed area occurs, LAC shall notify the appropriate State agency within 30 days of problem discovery and shall repair any damage that could affect other reclaimed facilities in the timely manner.

If perimeter fences or signs are disturbed by slope movement, the fencing shall be immediately relocated or repaired as required.

5.9 Performance Standard SW-5: Newly Discovered Environmental Contamination

Newly discovered environmental contamination which is subject to the Cunningham Hill Mine Contingency Plan and which violates or threatens to violate State of New Mexico water quality standards or the New Mexico Mining Act shall be subject to the following contingency measures. Such newly discovered environmental contamination may include, for example, contaminated seeps, springs, or surface runoff.

5.10 Contingency Plan SW-5

Any suspected newly discovered environmental contamination shall be reported to the appropriate State agency within 2 business days of discovery. When notice is provided, LAC shall promptly determine whether the newly discovered environmental contamination requires routine repair, follow-up investigation, enactment of a mitigation plan, or emergency measures. Such determination shall be subject to review and approval by the appropriate State agency.

Routine Repairs: Newly discovered environmental contamination requiring no additional action other than routine repairs shall be remedied accordingly. The actions taken shall be documented and reported to the appropriate State agency in routine reports.

Follow-Up Investigation: If such contamination cannot be adequately remedied by routine repairs, then LAC shall investigate to determine whether the contamination is newly discovered environmental contamination. LAC shall (a) collect and analyze additional samples as appropriate to confirm whether the contamination in fact violates or threatens to violate New Mexico water quality standards or the New Mexico Mining Act, and (b) they shall determine whether the contamination is in fact the result of Gold Fields' mining activity. If the results of (a) and (b) indicate that contamination is newly discovered environmental contamination subject to the Cunningham Hill Mine Contingency Plan is confirmed, then (c) an analysis shall be conducted, as appropriate, to determine whether the change in concentration is statistically significant.

If newly discovered environmental contamination attributable to Gold Fields is confirmed as described above, then LAC shall conduct a site investigation to identify the source of the contamination. Elements of such an investigation may include, among other things, installation of additional groundwater monitor wells, collection of additional samples, measurement of additional constituents, and performance of aquifer tests.

Mitigation Plan: If the foregoing investigation confirms that the contamination is newly discovered environmental contamination, then an appropriate mitigation plan shall be developed by LAC and submitted to the appropriate State agency for review and approval after which the Companies shall implement the approved plan in a timely manner. Additionally, LAC shall submit annual reports for review by NMED describing the measures taken under the approved mitigation program, the observed results, and a summary of long-term implications.

Emergency Measures: If an environmental emergency arises, the contingency plan described in SW-6 shall be executed.

5.11 Performance Standard SW-6: Environmental Emergency

In the event of an environmental emergency, LAC shall take immediate action as necessary to minimize immediate environmental impacts.

5.12 Contingency Plan SW-6

LAC shall report the emergency to the appropriate State agency within 24 hours of discovery and shall describe emergency measures being taken and shall thereafter take no action disapproved by the appropriate State agency. Absent State agency approval (either formal or informal), in the event of an environmental emergency LAC shall not construct on-site any new remediation or reclamation facilities or structures that cannot subsequently be removed or mitigated, or undertake any new remediation or reclamation programs that are inconsistent with response actions detailed in DP-55, the Cunningham Hill Mine Reclamation Project Closeout Plan, or the Cunningham Hill Mine Reclamation Project Contingency Plan, which cannot subsequently be removed or mitigated.

6.0 REFERENCES

[EPA] U.S. Environmental Protection Agency, 1989, Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Interim Final Guidance, U.S. Govt. Print Office.

[JSAI] John Shomaker & Associates, Inc., 2020, Evaluation of Open Pit Closure-Closeout Plan and Abatement Plan AP-27, Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico: consultant's report prepared by John Shomaker & Associates, Inc. for LAC Minerals (USA) LLC, 26 p., figures, appendices.

[JSAI] John Shomaker & Associates, Inc., 2021, Cunningham Hill Mine Reclamation Project Closure/Closeout Plan Update: Prepared by John Shomaker & Associates, Inc. for Sate of New Mexico Energy, Minerals and Natural Resources Dept. Mining and Minerals Division on behalf of LAC Minerals (USA) LLC, revised October 2020, 53 p. plus appendices

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[NMED] New Mexico Environment Department, 2020, Approval of DP-55: Proposed Conditions, April 1993.

[NMED] New Mexico Environment Department, 1994, Approval of DP-55 Modification: Proposed Conditions, October 1994.

[NMED] New Mexico Environment Department, 2021, Letter regarding request for additional information, updates to AP-27, Cunningham Hill Mine Reclamation Project, LAC Minerals (USA) LLC, from Kurt Vollbrecht, Mining Environmental Compliance Section, Groundwater Quality Bureau to Davis Wykoff, LAC Minerals (USA) LLC, dated June 4, 2021, 5 p.

Pegasus Gold, 1993, DP-55 Contingency Plan, June 1993.

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Appendix C.

Cunningham Hill Mine Reclamation Project Forest Management Plan

FOREST MANAGEMENT PLAN FOR CUNNINGHAM HILL MINE RECLAMATION PROJECT

LAC MINERALS (USA) LLC
SANTA FE COUNTY, NEW MEXICO
2,968 Acres

February 2017

Prepared By: Rachel Wood, Forester
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Society of American Foresters' Certified Forester # 2029

Table of Contents

CUNNINGHAM HILL MINE RECLAMATION PROJECT
FOREST MANAGEMENT PLAN
Santa Fe County, New Mexico

February 20, 2017

I. PROPERTY DESCRIPTION

A. ACREAGE

The property totals 2,968 acres (4.6375 square miles) according to a survey dated 11/30/2000 and filed with the Santa Fe County Clerks office in plat book 461, page 27-28.

B. PROPERTY OWNERSHIP AND CONTACT INFORMATION

The property is owned by LAC MINERALS (USA) LLC / P.O. Box 29 / Elko, NV 89803

Primary Contact: David Wykoff, Project Manager / 505-471-0434 office / 505-252-9615 mobile

Physical and mailing address: 582 County Road 55 / Cerrillos, New Mexico 87010

C. PROPERTY LOCATION AND DIRECTIONS

The property is located in north-central NM, thirty-one drive miles south of Santa Fe, New Mexico, and about eight drive miles south of Los Cerrillos, NM. The land lies within the Ortiz Mine Land Grant.

Latitude and longitude: 035° 19' 50.79" N and 106° 08' 58.27" W.

Directions: From NM Hwy 14 (Turquoise Trail) near Los Cerrillos take NM Hwy 55/Goldmine Road easterly for 6 miles to the entrance gate. The office is a mile further.

The property is found on the Golden and Captain Davis Mountain NW, New Mexico U.S. Geological Survey (USGS) topographic maps.

D. GENERAL PROPERTY DESCRIPTION

1. VEGETATION COMMUNITIES

The property lies on the northeast quadrant of the Ortiz Mountains and the rolling foot slopes that level out to the northeast as they decrease in elevation. The most common vegetation type on the property is piñon-juniper woodland composed of Colorado piñon pine and one-seed juniper. Along the eastern boundary, where elevation is lowest at 6,500 feet above sea level, a small area of grassland and cholla is present. From that area one-seed juniper trees have seeded in and as elevation further increases piñon-pine begins to mix in with the juniper. On the higher elevations in the west and southwest more ponderosa pine is present with ponderosa pine forest covering an area in the southwest corner with occasional Douglas-fir and white fir trees.

2. GOLD MINING, RECLAMATION, AND REVEGETATION

The land has been mined for gold since 1822, which is prior to the California gold rush by over two decades. Prospect areas appear as an X on USGS topographic maps identifying where prospecting took place in the late 1800's. Many areas, such as in the ponderosa pine forest, have pit and mound topography that is the result of digging and piling of soil for gold mining. In the same ponderosa pine forest a large old wooden mine shaft stands, marked on USGS topographic maps as Mine Shaft. Over time, more and more advanced mining technologies were used that increased the impact on the land and water resources. Most recently the Cunningham Hill Mine was operated from 1979 to 1987. Soon after that time, the mine was closed and only reclamation work has been underway ever since. Reclamation and remediation work involves ground water monitoring, site maintenance, and water treatments to control the discharge of water contaminants from mine facilities in ground and surface water.

Primary reclamation areas cover three hundred some acres and are shown on the topographic maps included with this report. Reclamation areas include the following: 1) the Cunningham Hill mining pit with open water, 2) a waste rock pile, 3) residue pile, 4) ore treatment area, 5) borrow areas, 6) plastic lined evaporation ponds, 7) acid rock drainage treatment cells, 8) water treatment facilities, and about 100 monitoring and recovery wells and associated plastic piping that carry water or electric lines. Electric line is buried a few inches below ground that runs to the wells and pump houses. Water treatment facilities include two big pump houses, one north of the office, one in Dolores Gulch, and one small pump house over the well near the north entrance.

Soil borrow areas were recontoured for better drainage and revegetated by seeding and planting that included tree planting 15 years ago. In 2014 and 2015, a *Revegetation Success Evaluaion Report* was completed by Cedar Creek Associates and is in the office library that decribes in detail the current species and amounts of vegetation planted and existing in these areas.

3. STRUCTURES AND SURROUNDING LAND OWNERSHIPS

There is one office building, which is in use on the property. The property does not have a residence although there is an old adobe home and shed, now vacant and weedy, known as Dolores Ranch that is over 100 years old and where the town of Dolores once stood. Above ground electrical transmission lines run along the main road to near the office and veer down to near the water tank and also to the Dolores Gulch pump house. The Santa Fe County Fire Department has a radio communication tower north of the office next to the main road that they lease.

Eight or so homes and associated buildings are located within 650 to 1,200 feet north of the northern property line on the eastern side of the property in the Vista del Oro Subdivision. Santa Fe County owns the land west of Cunningham Hill Mine property that totals 2.1 square miles. The Lone Mountain Ranch owns property south of the tract boundary that covers 44.2 square miles. Ojos Creek Ranch LLC totals 2.6 square miles and lies towards the south end of the eastern property line and eastern end of the southern property line. The rest of the surrounding area has privately owned smaller parcels of land many without homes.

4. FENCING AND ACCESS

Access to the area is good on Turquoise Trail and Hwy 55/Gold Mine Road that leads to the main road that runs north/south through the property to the office. An important road veers off to the west near the property entrance gate that Santa Fe County uses since it provides the only access to their property. The County has been thinning trees along this road to widen it and make it more fire-safe for vehicles during wildfire events. There are many other roads that provide good access to many areas of the property due to active reclamation and monitoring work.

Barbed wire fencing runs along the south, east, and north property lines. The west boundary has a line of wide white tape/wire.

5. 2016 GOLDMINE FIRE

A 55-acre wildfire called the Goldmine Fire occurred June of 2016 that started by lightening on the adjacent ranch to the south. The fire moved onto the Cunningham Hill Mine property and burned some 10 acres near Captain Davis Mountain and the main road at the south end of Cunningham Hill Mine property. See Map E in this report for an aerial view of the burned area.

Figure 1: The 2016 Goldmine Fire burned area on Cunningham Hill Mine property (Area 5A).

The burned area was expensive to repair ($18,000) and involved recontouring and revegetating areas with dozer damage. It is interesting to note that in the Custom Soils Report, found in Appendix A of this report, the assigned rating for 'damage by wildfire' shows Captain Davis Mountain as very high. The only place on the property with that high of a rating. The rating is not referring to the risk or hazard of wildfire but to the damage resulting from a wildfire if one occurs.

E. FOREST MANAGEMENT MAPS

Maps are found at the end of this report and include the following: 1) Inventory Point Map, 2) Watershed Map, 3) Forest Management Map, 4) Aerial View Map, and 5) Aerial View of the Goldmine Fire. The USGS topographic maps in this report were last updated in 1990. The aerial photo image was taken June 9, 2014. Maps are found at the end of this report in the Map section.

F. FOREST MANAGEMENT UNITS

Based on topography, access, and forest conditions, the property has been divided into five primary forest management units and two other areas: 1) the steep and/or inaccessible mountainous areas, and 2) the revegetated, mine reclamation areas. The steep mountainous areas are not easily accessed and can be dangerous to work on so were broken out and not inventoried. Revegetated and reclamation areas need lower amounts of management at this time since trees there are young, up to 15 years old, and of low density. However, both of these areas are addressed as far as management in the Forest Stand Descriptions and Management Recommendations section later in this report. Below are the defined Management Units for this report.

Area A (648 acres): Steep Mountainous Areas
Area B (394 areas): Mine Reclamation and Revegetation Areas

Area 1 (214 acres): Southwest Corner (Watershed above Cunningham Hill Mine of ponderosa pine and piñon-juniper)
Area 2 (233 areas): West and Central (Near Dolores Ranch, dense piñon-juniper and some ponderosa pine especially along drainageways)
Area 3 (524 acres): Northern End (Rolling hills and footslopes of piñon-juniper woodland)
Area 4 (525 acres): Northeast Corner (One-seed juniper and piñon-juniper woodland)
Area 5 (430 acres): Southeast Corner (Captain Davis Mountain and surrounding areas of piñon juniper woodland)

II. LANDOWNER OBJECTIVES

1. WILDFIRE MITIGATION

Mitigate the risk of catastrophic wildfire to protect the forests, watersheds, and 30 some years of mine reclamation work. If wildfires take place on the property, damage to the revegetated areas, plastic piping on the ground, plastic lined ponds, and other reclamation infrastructure would be extremely detrimental. Revegetated areas need to be protected so fifteen years of planting, tree, shrub, and plant growth are not lost. The area of most concern is the Cunningham Hill Mine open pit that could fill with sediment and debris if a catastrophic wildfire occurred in the large watershed in the mountains above.

Besides the pit, primary infrastructure prioritized to protect from wildfire include but are not limited to the following:
1) Office, a metal building with a rubber coated roof;
2) Ponds;
3) Wells;
4) Electrical transmission lines;
5) Neighbors homes to the north; and
6) Radio tower owned by Santa Fe County Fire Department.

2. FOREST HEALTH IMPROVEMENT

Maintain, protect, and improve the health and vigor of the woodland and forest ecosystems on the property. Increase the forests resilience to any future disturbance from insects, diseases, mistletoe, and drought. Mitigating the risk of catastrophic wildfire is an important component in protecting forest health.

3. INVASIVE SPECIES MANAGEMENT

Many Siberian elm are growing along the mains roads likely due to seeds carried on vehicles. A few Russian olive trees were planted in the borrow revegetated areas. These trees species, introduced from other countries, are considered invasive noxious weed species since they quickly spread and outcompete native species of trees. There is an interest in controlling the spread of these trees while their numbers are still limited.

III. RESOURCE DESCRIPTION

A. PROPERTY CHARACTERISTICS

1. FOREST AND WOODLAND DESCRIPTION

The major forest type on the property is piñon-juniper woodland. The primary tree species in these woodlands are Colorado piñon pine (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*). A couple of Rocky Mountain junipers (*Juniperus scopulorum*) were found in the woodlands and they are found where planted by the road loop in Area 1. A couple of cottonwood trees (*Populus* spp.) were seen.

Ponderosa pine (*Pinus ponderosa*) is common in the southwest portion of the property where it sometimes forms 50% or more of the tree species in areas. Ponderosa pine forests as compared to piñon-juniper woodlands are typically found on more cool and moist areas such as at higher elevations, along drainageways and other concave shaped landforms and on cooler facing slope aspects (northwest to north to northeast facing) where less sun is received. The Forest Inventory Point Map, Map A, identifies where ponderosa pine makes up more than 50% of the tree density (square feet of basal area). Ponderosa pine forest is mainly found in Management Area 1A and also in Area 1B along draingeways.

The forests are dense to moderately thin depending upon topography, slope aspect, and soil type. Southerly facing steep mountainsides are typically dry with fewer and smaller trees and some with many dead trees. Some of the intermittent waterways are rocky. Area 3 (and Area 4) has some have deep eroded drainageways with islands of trees on pedastals of soil.

Oaks are present mostly in the ponderosa pine area, however are also in areas of piñon-juniper woodland. Oak species present are Gambel oak (*Quercus gambelii*) and wavy leaf oak (*Quercus undulata*). Siberian elm (*Ulmus pumila*) trees are along the main roads and in some of the revegetated borrow areas. Russian olive (*Elaeagnus angustifolia*) is present in revegation areas having been planted in low numbers.

The most common ground vegetation noted on the property was blue grama (*bouteloua gracilis*), a very drought tolerant bunchgrass, as well as broom snakeweed (*Gutierrezia sarothrae*), plains pricklypear (*Opuntia polyacantha*), walkingstick cactus/cane cholla (*Opuntia spinosior and/or Cylindropuntia imbricata*), banana yucca (*Yucca baccata*), and narrowleaf yucca (*Yucca glauca*). Others are mountain mahogany (*Cercocarpus* spp.), rubber rabbitbrush (*Chrysothamnus nauseosus*), Apache plume (*Fallugia paradoxa*), common mullein (*Verbascum thapsus*), and fourwing saltbush (*Atriplex canescens*). A few thistles were noted.

2. GENERAL HISTORICAL FACTORS AFFECTING THE CURRENT LAND RESOURCES

Many factors in the past influenced the current condition of the land. For thousands of years indigenous Americans occupied the general area who lit fires to improve game habitat and maintain travel corridors. Domestic livestock were introduced with the Spanish conquistadors in the 16th century. By the mid to late 1800's, many Native Americans were displaced by European settlers. Many forests were cleared near or just before the turn of the last century, as was much of the land in the United States when railroads became well established and agriculture was strong. Then land naturally seeded into woodlands and forests or was used for grazing. Many lands were overgrazed by sheep and goats in the early 1900's.

The homesteading begun in the19th century in New Mexico led to suppression of wildfires since they were seen as a hazard to lumber and ranching interests. As a result of fire suppression and logging of large trees, the open forests have turned into dense thickets of young, highly flammable trees where grasses and forbs have decreased. In areas heavily grazed by livestock, growth of shrubby species increased while fire-loving perennial grasses decreased. Ground fires are thought to have been more frequent before intensive grazing lowered the abundance of the perennial bunchgrasses and forb fuel types that had more continuity on the landscape so fires could be carried longer distances. Ground fires have become smaller in size and shrubby species and tree species have increased over time.

The natural historic fire regime in ponderosa pine forests has scientifically been found to average 3 to 10 years of frequency. Small ground and understory fires swept through forestlands quickly and the larger trees were not killed. In general, fires in ponderosa pine forest changed from natural, lower intensity ground fires to more intense, stand replacing crown fires which are increasing in intensity. The historic fire regime in piñon-juniper woodlands is thought to have been longer than that in ponderosa pine forests and was likely very variable depending on each stands characteristics and the amount and type of grasses present.

3. TOPOGRAPHY AND ELEVATION

Elevation is highest on the western edge of the property in the Ortiz Mountains that reach a high of 7,970 feet on the property and a low of 6,445 feet near the northeast corner. Elevation is 7,180 feet at the top of Captain Davis Mountain.

4. PRECIPITATION AND CLIMATE

The Cunningham Hill Mine has a weather station and the average annual precipitation totals 18 inches. Average precipitation in the general area varies widely from year to year and month to month. The largest amount of precipitation occurs in July and August during the summer monsoons that produce high intensity storms. These storms involve intense lightning activity, which can ignite multiple fires. The driest season is winter, with much of the precipitation falling as snow in the mountains and rain in lower parts.

Differences in elevation and slope aspect result in varying amounts of precipitation, moisture, and temperatures. In general, the higher the elevation, the cooler the temperature and the higher the amount of precipitation.

Spring is the windy season and winds prevail from the South and Southwest. Wind direction also varies with local topography. During natural wildfire ignition months of June, July and August, winds are mainly from the south, southwest, or southeast with variable speeds however they can be from any direction.

Climate Change

Climate change is resulting in warmer temperatures along with more frequent extreme weather events, such as intense rainstorms, drought, and heat waves in the Southwest. According to an article in the Santa Fe New Mexican dated June 5, 2014 the average New Mexico summer is 3.4 degrees Fahrenheit warmer now than in 1984 and the annual average temperature in New Mexico has increased 2 degrees Fahrenheit in the last 30 years.

Climate change is affecting forest health especially in the Southwest due to the already dry climate where deserts form a large part of the landscape. Increases in temperature reduce the amount of water available to trees and plants since it is lost to evaporation. Snowmelt in the Rocky Mountains has been found to be occurring earlier in the year and snowpack averages have decreased which also results in decreased water availability during hot summer conditions leading to increased wildfire risk and hazard. The frequency, severity, and size of wildfires and insect outbreaks in the West have been documented to be increasing due to drought and warmer temperatures that dry out vegetation making it more flammable. Bark beetles are attracted to water stressed trees. Less sap is present in tree trunks that can push bark beetles out of a tree. Less intense cold weather in the winter results in less kill of bark beetles that are burrowed underneath tree bark in winter. The combination of warming temperatures and drought are major stressors for trees. Scientists have found that often large trees are stressed most since it is harder to bring food and nutrients up to the top branches and needles, so the trees start dying back and declining.

Thinning has been found to allow more water, snow and nutrients to be available for remaining trees, shrubs, and ground cover, thereby improving forest health, and forest resilience to future weather changes and related events.

5. SOIL RESOURCES

A Custom Soils Resource Report for the property was created for this plan through the Natural Resources Conservation Service (NRCS) online Web Soil Survey (WSS). See Appendix A. The website used to create the plan is http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Table A below shows the names of the soil map units and the number of acres found on the property for each map unit and percentage of the total acreage for the property by map unit.

Table A: Soil Map Units

Cunningham Hill Mine Reclamation Project Property Soil Map Units			
Map Unit Symbol	**Map Unit Name**	**Acres**	**Percent Acreage**
501	Truehill extremely gravelly loam, 25 to 55 percent slopes	160.8	5.4%
509	Puertecito-Wandurn-Rock outcrop complex, 30 to 60 percent slopes	107.7	3.6%
510	Cerrillos-Sedillo complex, 1 to 5 percent slopes	414.2	14.0%
511	Wandurn-Alchonzo-Rubble land complex, 35 to 90 percent slopes	351.0	11.9%

512	Cochiti extremely cobbly loam, 15 to 35 percent slopes	209.2	7.1%
513	Pedregal very cobbly loam, 8 to 15 percent slopes	522.2	17.6%
514	Pegasus extremely cobbly loam, 20 to 50 percent slopes	539.5	18.2%
515	Pastorius very cobbly loam, 3 to 5 percent slopes	220.7	7.5%
521	Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded	79.2	2.7%
550	Pits, mine	356.2	12.0%
	Totals	2,961	100.0%

Ecological Site Descriptions:
Ecological Site Descriptions are mapped and displayed in the soil report and are the following:
F034XG134NM: Gravelly-Woodland of piñon pine-oneseed juniper / Gambel's oak / blue grama.
F035XG135NM: Steep Gravelly-Woodland of piñon pine-oneseed juniper / true mountain mahogany (*Cercocarpus montanus*)-rubber rabbitbrush / blue grama.
F036XA136NM: Oneseed juniper-piñon pine / Apacheplume / hairy grama-blue grama.
F048AY010NM: Ponderosa Pine Forest 17-25" of ponderosa pine / Arizona fescue-Parry's danthonia.

6. WATER RESOURCES / WATERSHED

Side slopes and drainages carry water periodically after heavy storm events such as during the monsoon season and during spring snowmelt. The primary water drainages on the property are Cunningham Gulch which flows water north/northeast into Cunningham Creek. Arroyo Viejo and Dolores Gulch flow intermittent surface water north and west off of the property into Galisteo Creek. From Galisteo Creek water flows into the Rio Grande. Surface water resources on the property are two springs, Dolores and Deer Spring, and a seep called Dolores Seep.

The Watershed Map, Map B, shows the intermittent and ephemeral drainageways on the property. The property is in the HUC4 Rio Grande Region watershed. Many smaller watersheds have been identified on Map B, by determining the way water flows along ridges onto and within the property.

The large water tank is on Cunningham Hill near the office that has a water pump and is kept half full during the summer to serve as a water source in the event of a wildfire. Retention and evaporation ponds sometimes have water. Reclamation drainage channels, diversion structures, retention ponds, and auxiliary erosion control features are often inspected especially after storm events for erosion or other damage and repaired as needed. The large open pit has water at the bottom that is closely monitored.

7. WILDLIFE

Wildlife in the general area are mule deer, black bear, mountain lion, bobcat, fox, coyote, skunk, chipmunk, tree squirrel, rat and other rodents, bats, lizard, and many birds such as rufous-sided towhee, mountain chickadee, sparrow, mourning dove, western scrub-jay, bushtit, warbler, pinyon jay, Clark's nutcracker, western bluebird, hairy woodpecker, hummingbird, raven, American kestrel, red-tailed hawk, Coopers hawk, and golden eagle. Snakes possibly present are wandering rattlesnake, prairie rattlesnake and western diamondback rattlesnake.

Figure 2: Bat Mine Safeguard Structure on Santa Fe County land.

A wildlife report titled '*Vertebrate Wildlife of the Ortiz Mountains, Santa Fe County, NM – An Environmental Baseline Study*' completed in 1991 by Pegasus Gold Corporation and Metric Corporation, was reviewed briefly in the office library that has detailed wildlife information.

A large abandoned mine on Santa Fe County land near the western boundary of the property has a box shaped metal structure on top that allows bats to fly in and out but protects humans from falling into the mine. For interesting information on the Real de Dolores Mine Safeguard Project and other history of the area please see: http://www.emnrd.state.nm.us/MMD/AML/RealdeDolores.html.

The revegetated areas have been planted with species that are beneficial to wildlife.

8. RECREATION AND AESTHETIC RESOURCES

The open plains and mountainous landscape afford incredible and beautiful views of the Sangre de Cristo Mountains towards Santa Fe as well as the Sandia Mountains. And of course there is the beauty and presence of the Ortiz Mountains and Captain Davis Mountain to enjoy.

IV. FOREST RESOURCE INVENTORY AND EVALUATION

A. SYSTEM OF FOREST INVENTORY AND DATA COLLECTION

After an initial meeting and tour of the property with David Wykoff, Project Manger, the forest was inventoried by Rachel Wood on the following dates in 2016: 11/2, 11/7, 11/8 - 11/10, 11/12, 11/14 - 11/16, 11/29, 12/1, 12/2, 12/4, and 12/5.

Inventory points were generally mapped every 10 acres on a square grid pattern running north/south and east/west across the 2,968 acres. In the ponderosa pine forest, points were laid out every 5 acres. In the less dense level areas to the northeast fewer points were inventoried since this area is more homogenous. Each points GPS coordinates were entered into a Garmin *eTrex* GPS (Global Positioning System) unit for navigation to each point. Steep mountain slopes, over 40%, and inaccessible areas were not inventoried. However, vegetation on steep areas was noted and is visible on aerial photos or *google earth*. Vegetation on revegetated areas was noted during field inventory and photos were taken. Photos were also taken at most all inventory plots. A total of 162 variable radius plots were measured throughout the forests and woodlands. Locations of each point are shown on the Inventory Point Map, Map A, at the end of this report.

Various measurements were taken at each plot and recorded. A 10-basal area[1] factor prism was used to measure the square feet of basal area per acre. A clinometer was used to determine percent slope and slope aspect was measured with a compass. A diameter tape was used as needed to measure tree diameter at breast height (DBH) for ponderosa pine and diameter at root collar (DRC) for piñon and juniper. Average height and crown base height was recorded. The amount of fuel loading was recorded as low, moderate, or high within 50 feet of each points plot center. Fixed plots measuring approximately 11.8 feet in radius were installed where the number of seedlings by species were recorded. The presence of insects, disease, mistletoe and other tree damage was documented when observed. Field sheets which have this data are found in Appendix B, Inventory Field Sheets.

Inventory data was divided into management areas then entered into a NM State University inventory software program to produce stand summary tables.

For more information on forestry and terms used please see Appendix C, What Is Basal Area & How Does It Relate to Forest Health, and Appendix M, Terminology for Forest Landowners.

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[1] *Basal area is a measurement technique used by foresters, (a) Basal area is the cross-sectional area in square feet of a tree trunk at breast height (4.5 feet above the ground) or at the root collar for piñon and juniper. As an example, the basal area of a tree that measures 14 inches in diameter at breast height (DBH) represents about 1 square foot of basal area per acre. (b) Basal area per acre is the sum sq. ft. of basal area of the individual trees within one acre of forest.*

V. FOREST PROTECTION

A. FOREST INSECTS AND DISEASES

Ponderosa pine and piñon pine trees occasionally had dwarf mistletoe infection. On one-seed juniper true mistletoe was present and was found sporadically in many areas. On the inventory field sheets each dot represents a tree recorded on the plot and dots are marked with an M when mistletoe was seen and often a written note was made. Ponderosa pine trees with mistletoe were given a rating of 1 to 6 with a 6 having the highest amount present and graded on each of three sections of a tree. The infections do appear severe on a stand level for any of these trees species but they are common in areas. The highest management concern is that for the ponderosa pine forest. When thinning in ponderosa pine, it is important to favor removing infested trees. It is also recommended to remove heavily infested piñon pine and one-seed juniper. For more on mistletoe please see Section 2 below.

Pitch moth was found on several piñon pine trees. The sign of pitch moth are patches of tree sap on tree trunks and large stems. However, pitch moth is not a concern at this time since it mainly affects the surface level of the tree. One piñon pine tree appeared to have pitch tubes of the *ips* bark beetle at point 124 in Area 3 as well as pitch moth. Since we are not currently in a drought, bark beetles will not be aggressive, however that can change very quickly when hot and dry weather starts and actively infested trees should be removed.

Piñon pine trees in each of the management areas have different levels of piñon pine mortality as shown in the following table.

Table B: Percent Tree Mortality by Management Area

Area 1A	<2% of all species of trees
Area 1B	3% to 5% piñon pine
Area 2	7.3% to 10.6% piñon pine
Area 3	.03% to .21% piñon pine
Area 4	1.8% to 4% piñon pine
Area 5A	26% to 29% piñon pine
Area 5B	13.5% to 17% piñon pine

Captain Davis Mountain, Area 5A, has the highest amount of piñon pine mortality at 26% to 29%. The piñon pine mortality is most likely due to several years of drought that ended in 2014 and some may also be related to the earlier drought period of 2002 to 2006. Overcrowding, topography, and/or soil factors often effect a trees ability to stay healthy. Piñon pine mortality agents could be piñon decline, pitch moth, dwarf mistletoe, fungal diseases, and bark beetles. On the dead piñon trees, bark beetles did not appear to be the mortality agent since signs were not common on the dead trees. Drought, especially warm drought, is the main driver of tree mortality.

Below is information on forest pests, mistletoe, and other damaging agents. There is prolific information about insects, diseases, mistletoe and other damaging agents online such as in the "US Forest Service Field Guide To Insects And Diseases of Arizona and New Mexico Forests" found at: http://www.fs.fed.us/r3/resources/health/field-guide. Some sections of this publication are included in the Appendix. See Appendix D, Forest Pests including bark beetles and mistletoe.

1. BARK BEETLES

When forests are under stress from overstocking, drought, dwarf mistletoe infection, or defoliation by insects or disease, large numbers of trees may be lost to bark beetle infestations. Bark beetles can infest spruce, fir, ponderosa pine, piñon pine and juniper. Beetles in the genus *Dendroctonus*, generally infest trees and fresh logging slash or blown down trees over 8 inches in diameter. Beetles in the genus *Ips*, attack smaller diameter trees, piñon pines and logging slash over four inches in diameter. Trees are often weakened by the introduction of blue-stain fungi by the beetles and trees are quickly girdled from the mining of egg laying females and growing larvae beneath the bark.

Bark beetle infestations usually appear as sawdust around the base of trees and pitch tubes that look like chewed bubble gum wads on the lower or upper trunks of trees. Pitch tubes are sap oozing where beetles have tried to or do enter the tree where they create channels just under the bark to lay eggs. Often trees are able to expel the beetles with their sap that pushes them out or kills them. Exit holes are formed when the larvae have matured and leave to fly to a new tree. The exit holes are just simple small holes the size of a pinhead. Browning trees and mortality can be signs of bark beetle activity and should be investigated.

It is recommended to remove slash and conduct treatments during colder months in order to reduce the threat of bark beetle infestation. During a conversation with a local Forest Service entomologist it was relayed that bark beetles can fly when the daily temperatures are over 65 degrees F and are more sluggish in cooler temperatures. Bark beetles can fly 3 miles or up to 20 miles if wind conditions are favorable. Bark beetles are attracted to turpines in tree resin and trees smell better to them when trees are under stress. Thousands of bark beetles can be in one tree.

It is important to continuously monitor the forests for bark beetles especially during and after drought. After a drought ends the trees are still susceptible for a year and more since it takes a while for the trees to recover from drought stress.

a. The western pine beetle (*Dendroctous brevicomis*) is most damaging in the far western United States and British Columbia, and its range extends into the Southwest and Mexico. This beetle usually occurs in one or a few widely scattered trees already weakened by drought, lightning, stagnation, root disease, or other disturbances. Although it usually creates small canopy gaps, the western pine beetle can cause much higher rates of mortality and increased fire hazard in drought and competition-stressed (overstocked) stands.

b. Engraver beetles (*Ips spp.*) are a common bark beetle in New Mexico especially known for extensive piñon pine mortality in 2003, however they also affect ponderosa pine and there numbers are increasing due to severe drought. Drought exacerbates their numbers since water stress weakens trees resistance since trees do not have enough sap to expel and kill the beetles. While bark beetles have a historic natural cyclical pattern of outbreaks the recent increases in temperature since the 1980's paints a new picture as to the severity and occurrence of future epidemics. Without cold and long winters the larvae are not killed under the tree bark so the beetle populations increase and the number of active days increase.

c. The roundheaded pine beetle (*D. adjunctus*) is the most common bark beetle that attacks pines in the Southwest, however currently, it is only *sometimes* found in northern New Mexico. Outbreaks of the roundheaded pine beetle are often accompanied by western pine and *Ips* beetles, which establish on poor sites or in mistletoe infested areas. Trees are attacked in groups of 3 to over 100. Smaller trees and those in dense thickets are most likely to be attacked.

d. The mountain pine beetle (*D. ponderosae*) is the most extensive bark beetle to attack ponderosa pine in western North America, however, it is currently *rare* in New Mexico.

2. DWARF AND TRUE MISTLETOE

Mistletoes are parasitic plants that gradually degrade tree vigor and may eventually kill their host trees over long periods of time because water and nutrients are diverted from the host tree to the mistletoe. Dwarf mistletoe (*Arceuthobium* spp.) is found on piñon and ponderosa pines and true mistletoe *(Phoradendron* spp.) is found on junipers. Both mistletoes are species-specific.

Figure 3: One seed juniper infected with juniper mistletoe (bright green) a true mistletoe.

Dwarf mistletoe spreads by shooting wind-borne seeds that stick to branches of trees they land on. To a lesser extent they are spread by birds. For true mistletoe, birds are the primary agent for spreading the seeds that are found in small fruit/berries. Symptoms of mistletoe infection include swelling at infection sites, formation of brooms in tree branches, and protruding fruiting bodies up to one foot long. Trees become misshapen and stunted and can eventually die from the loss of water and nutrients. Dwarf mistletoe can sometimes be controlled by removing infected branches (very light infections only) through pruning or through cutting of moderately or severely infected trees. Creating a 50-foot buffer around heavily infested ponderosa pine dwarf mistletoe groups of trees may help prevent its spread since it spreads by seeds shooting them up to 50 feet onto other trees.

True mistletoe was found on many juniper trees throughout the property however, infestation levels on a stand level were not high. During thinning treatments though, one-seed juniper trees with moderate to heavy mistletoe infestation are recommended to be favored for removal.

3. ROOT AND STEM DISEASES

Common root diseases are Armillaria or Shoestring Root Rot (*Armillaria* spp.) on Douglas-fir, ponderosa pine and spruce, and Annosus Root Rot (*Heterobasidion annosum*) on ponderosa pine and white fir. Root disease can be identified by fallen trees that have an absence of tree roots at their base. Annosus root rot is not common in our area but could be present. In the Southwest, it has been documented that many acres of ponderosa pine are seriously affected by root diseases which reduce growth by 10 percent region-wide or by 25 percent in severely damaged stands. Fifty years of selective logging has intensified the severity of the disease and lead to extensive mortality in all ages of ponderosa pine. Once annosus root rot is established, the disease affects trees within a slowly expanding, circular infection center and spreads from tree to tree is through root contacts. New infection centers begin by aerial spread of spores and infection of basal wounds and freshly cut stumps. Direct damage from infection is primarily heart rot, butt rot and rot of major roots that can lead to wind-throw and stem breakage. Often annosus root rot does not kill directly but produces considerable moisture stress and loss of vigor that predispose the tree to attack by bark beetles.

B. WILDFIRE RISK AND HAZARD - PROTECTION/FUELS

Wildfire <u>hazard</u> is the potential for a fire, once started, to burn and move across the landscape. The combination of fuels, weather, and topography create hazard conditions. On the other hand, wildfire <u>risk</u> represents the potential for a fire to start because of an ignition source such as lightning strikes or by human causes. Ponderosa pine forests often have frequent lightning strikes. Tall trees on ridges can attract lightning. Lightening ignitions are most common July through August, the monsoon season.

While understory ground fires can have very beneficial effects, if ground fires rise into the canopy during heavy wind events, drought, and warm weather, the fire can quickly become an intense damaging wildfire that can consume trees, plants, topsoil and cause erosion. Recommended wildfire mitigation work will involve reducing stand densities, removing dead trees and downed trees, and ladder fuels that are near the lower branches of medium and larger-sized trees. Thinning will focus on reducing the continuity of vertical and horizontal fuels.

It is important to limit the potential for erosion post-thinning so in some areas the need to thin to mitigate wildfire will be balanced with not opening up steeper areas too much since that will increase the amount of surface water flow that could erode soil during heavy storm events.

Fuels noted on the property besides high densities of the trees themselves were 1) low lying limbs sometimes dead, 2) small trees that are under and/or are touching larger trees called ladder fuels that can cause a ground fire to rise up into the larger trees canopies causing a crown fire, 3) heavy amounts of dead and downed trees and limbs. The property is susceptible to fires that originate on and off site caused by lightening or by human causes such as by nearby residents or travelers. The New Mexico Landscape Assessment Tool being GIS mapped by the NM Forest & Watershed Health Institute (NMFWRI) was reviewed for this report. In the assessment their is only one area on the property with a very high rating for wildfire hazard. This is in Area 1 in the southwest corner along Cunningham Gulch where ponderosa pine trees are prevalent. This is the most important area to treat. In addition many areas nearby in the Ortiz Mountains also had a very high rating. To view the Landscape Assessment Tool go to: arcg.is/2dmkmiY. It is important to note that portions of the Captain Davis Mountain unit have a high rating for wildfire hazard in the landscape assessment. Another important area to treat.

While it may not be possible to exclude fire from forestland, it is possible to modify fire behavior if and when it occurs depending on the fires severity. However, with drought, above average temperatures, and strong winds it may not be possible to affect or control an intense wildfire and it would be dangerous to attempt to do so.

A '*Santa Fe County Community Wildfire Protection Plan*' (CWPP) was prepared in 2008 by SWCA Environmental Consultants and Wildland Fire Associates that has valuable information on fire risk and hazard in the County as well as information on fire suppression and emergency preparedness, fire behavior, fuel models, fire regime condition classes and more. The CWPP is found in Appendix N. In the CWPP on page 29, the Cunningham Hill Mine property is mapped as Fire Regime Condition Class III which stands for a high departure from the central tendency of historical reference conditions. The property was also rated as high in the Composite Wildfire Risk Assessment mapped on page 54 of the CWPP.

Fuelbreaks:

A fuelbreak is a strategically located block or strip of land in which dense, heavy, or flammable vegetation cover has been thinned to a lower fuel volume and flammability condition. In most fuelbreaks tree density is reduced to levels of 40 to 60 square feet of basal area and lower limbs on trees are pruned. Fuelbreaks may provide an area in which firefighters can work to try and stop an oncoming fire. Fuelbreaks can drop a crown fire down to a ground fire and slow it down at least for a short period. Thinning treatments along property access roads could be used to create fuelbreaks. Fuelbreaks along the mountainous property boundaries would be challenging to install due to the steepness of slopes however it may be possible. The following recommendations for fuelbreaks were obtained from pages 61 and 62 of the Santa Fe County CWPP. Long-term maintenance of fuelbreaks is needed every 7-15 years to reduce regrowth.

Recommended Tree Crown Spacing in Shaded Fuelbreaks:

Slopes <10%: 10-foot minimum spacing;
Slopes <20%: 15-foot spacing;
Slopes <40%: 20-foot spacing;
Slopes >40%: 30-foot crown spacing.

Table C: Guidelines for Width of Fuelbreaks Based on Slope

Percent Slope	Typical Minimum Width (feet) - Uphill	Typical Minimum Width (feet) - Downhill	Total Width of Fuel Treatment (feet)
0-10%	150	150	300
10-20%	135	180	315
20-30%	120	200	320
30-40%	110	210	320
40-50%	100	230	330
50% & above	100	250+	350+

C. NOXIOUS WEEDS

Noxious weeds are non-native species of plants that come from other parts of the world that rapidly spread because they have no natural control mechanisms in North America. They are often referred to as invasive-exotic species of plants that can quickly crowd out and prevent the existence of native species of plants. The New Mexico legislature has targeted certain noxious weeds for management due to their detrimental environmental, economic and social effects.

Three classes of noxious weeds are defined for New Mexico as follows:

- ***Class A Weeds*** currently have limited distribution or are not yet found in New Mexico so the goal is to prevent new infestations and eliminate existing infestations.
- ***Class B Weeds*** are presently limited to particular areas within the state and the management priority is to contain them within their current area and prevent new infestations.
- ***Class C Weeds*** are widespread throughout New Mexico and the goal is long-term management and suppression.

A list of New Mexico noxious weeds is found in Appendix F. This list and more information on these species can be found through an online search and at the USDA NRCS website at https://plants.usda.gov/java/noxious?rptType=State&statefips=35.

Noxious weeds listed for Santa Fe County are found in Table D below and also in Appendix F, and can be found online by doing a County search at the following website http://weeds.nmsu.edu/databasesearch.php.

Table D: Santa Fe County Listed Noxious Weeds

Russian knapweed
jointed goatgrass/jointgrass
musk thistle/nodding thistle
diffuse knapweed
Canada thistle
bull thistle
field bindweed
Russian olive
Dyer's woad
perennial pepperweed
dalmatian toadflax
Scotch thistle
salt cedar
Siberian elm

Of the noxious weed species listed, Russian olive and Siberian elm were seen on the property. Removal of Russian olive and Siberian elm trees and seedlings is recommended. Others species were not seen but they could be present. If concerned about noxious thistle species in the future it is important to clearly identify them since many thistle species are native to New Mexico and are beneficial to butterflies and insects.

D. CULTURAL RESOURCES

New Mexico State Forestry Division Bernalillo District Special Projects Forester, Lawrence Crane, is authorized to review the New Mexico Cultural Resources Information System (NMCRIS) / Archaeological Resources Management System (ARMS) database. In his review he found multiple entrees for survey areas completed on the tract and within those survey areas multiple registered sites. Several detailed archaeological studies have been prepared for the Cunningham Hill Mine property that are in the office library. Information for the ARMS database likely came from these reports. Cultural resources will need to be identified and protected during thinning projects. Several cultural areas are fenced to identify and protect them. Recommendations on protecting cultural resources during thinning are described below in Section VI.F - Forest Management Guidelines.

Figure 4: Photo of Dolores taken in 1904-1905.

R. Wood checked the "Listed State and National Register Properties" document at the State Historic Preservation Office website: www.nmhistoricpreservation.org (click on preservation programs, then registers of cultural properties, then county) and found no historic resource entries for the tract. However, Dolores Ranch is an old adobe building and barn over 100 years old with an interesting history. Dolores Ranch started out as a store for the town of Dolores. Later it was used as a residence for the old ranch. In researching online the history of Dolores it appears that Thomas A. Edison erected a large plant at Dolores in 1900 on the property to extract gold with static electricity. The project failed and ended within a year. A couple of history links are as follows: <http://www.cerrillosnewmexico.com/surrounding-area> and <http://www.vocesdesantafe.org/social/index.php/explore-our-history/surrounding-communities-towns-and-pueblos/item/826-dolores-nm-the-wests-first-gold-rush>. As a clarification, there is no structure near the entrance to the property where some maps may reference a guest house well, only a well is there.

E. THREATENED AND ENDANGERED SPECIES

There is one endangered species listed by the US Fish and Wildlife Service for Santa Fe County, the Southwestern willow flycatcher (*Empidonax traillii extimus*). Threatened species listed are the Yellow-billed Cuckoo (Coccyzus americanus) and the Mexican spotted owl (*Strix occidentalis lucida*). A proposed threatened species is the North American wolverine (*Gulo gulo* *luscus*). This information is summarized in the table below. These listings are found on the US Fish and Wildlife Service Environmental Conservation Online System (ECOS) website at http://ecos.fws.gov/ecp.

Table E: T&E Species listed for Santa Fe County

Southwestern Willow Flycatcher (*Empidonax traillii extimus*)	Endangered
Yellow-Billed Cuckoo (Coccyzus americanus)	Threatened
Mexican Spotted Owl (*Strix occidentalis lucida*)	Threatened
North American Wolverine (*Gulo gulo luscus*)	Proposed Threatened Species

Brief descriptions of the Southwestern willow flycatcher and yellow-billed cuckoo (both birds) are below. They require riparian habitat along streams so are not likely on the property. A brief description is also provided for the Mexican spotted owl. Mexican spotted owl could be in the area but no sign of them was found during fieldwork. If they are seen notify your forester or the US Fish and Wildlife Service and protect and enhance their habitat. The '*Vertebrate Wildlife of the Ortiz Mountains, Santa Fe County, NM – An Environmental Baseline Study*' reviewed in the office covers habitat and surveys for the Mexican spotted owl. Mexican spotted owls have not been found on the property but they may be present elsewhere in the Ortiz Mountains.

- The southwestern willow flycatcher (*Empidonax traillii extimus*) is a small Neotropical migratory bird. The flycatcher's distribution follows that of riparian habitat and it depends upon dense tree and shrub communities associated rivers, swamps and other wetlands.

- Yellow-billed cuckoos are fairly large, long, and slim birds with a bill almost as long as their head and thick and slightly downcurved. The upper mandible of the bill is black and the lower mandible is yellow. Their blackish facemask is accompanied by a yellow eye ring. Yellow-billed Cuckoos use wooded habitat with dense cover and water nearby. In the West, nests are often placed in willows along streams and rivers, with nearby cottonwoods serving as foraging sites.

- The Mexican spotted owl *(Strix occidentalis lucida)* was listed as threatened April 14, 1993. Mexican spotted owls inhabit forested mountains and canyons with mature trees that create high, closed canopies, which are good for nesting. They prefer old-growth forests of white pine, Douglas-fir, and ponderosa pine; steep slopes and canyons with rocky cliffs. Most nest sites are natural tree cavities, although Mexican spotted owls also use caves, potholes in cliff ledges and stick nests built by other birds. More information is found in Appendix G.

F. ENDANGERED AND RARE PLANT SPECIES

A list of endangered plants in New Mexico is found in Appendix H and can be found at: http://www.emnrd.state.nm.us/SFD/ForestMgt/documents/NMENDANGEREDPLANTList_000.pdf.

Rare plants found in Santa Fe County are listed on the New Mexico Rare Plants List created by the New Mexico Rare Plant Technical Council. Rare plants listed for Santa Fe County are listed in the table below. For more information and photos see the Santa Fe County Rare Plants website at http://nmrareplants.unm.edu. None of these rare plants were seen during fieldwork but they could be present.

Table F: Santa Fe County Rare Plants

Scientific Name	Counties Found In - NM
Abronia bigelovii (Tufted sand verbena)	Rio Arriba, Sandoval, Santa Fe
Astragalus cyaneus (Cyanic milkvetch)	Rio Arriba, Santa Fe, Taos
Astragalus feensis (Santa Fe milkvetch)	Bernalillo, Hidalgo, Sandoval, Santa Fe, Torrance
Astragalus siliceus (Flint Mountains milkvetch)	Guadalupe, Santa Fe, Torrance
Cuscuta fasciculata (Not NMRPTC Rare) (Santa Fe dodder)	Santa Fe
Hackelia hirsuta (New Mexico stickweed)	Colfax, Mora, Rio Arriba, San Miguel, Santa Fe, Taos, Union
Mentzelia springeri (Springer's blazing star)	Los Alamos, Sandoval, Santa Fe
Mentzelia todiltoensis (Todilto stickleaf)	Bernalillo, Cibola, Santa Fe, Socorro
Muhlenbergia arsenei (Tough muhly)	Mckinley, Sandoval, Santa Fe
Opuntia viridiflora (Santa Fe cholla)	Santa Fe
Rubus aliceae (Santa Fe raspberry)	Santa Fe

VI. FOREST MANAGEMENT GUIDELINES

A. BARK BEETLES

No ponderosa pine trees were found with bark beetles. One piñon pine may have had bark beetles however they are not currently a concern due to the wetter years we have had since 2014 which deters beetle activity. However the stands should be monitored closely especially in times of future drought. Below are management recommendations for bark beetles that are recommended during forest and woodland treatments.

Favor thinning during late August to January or perhaps to February when bark beetle activity is slow due to cold weather. Bark beetles are attracted to freshly cut material and chips even though they cannot survive in chips or masticated debris. By harvesting in the fall, if beetles infest the cut slash, the woody material will desiccate so there is less chance the beetles will survive through the winter. During August to January, some slash under 3 inches in diameter can be left on the forest floor especially in sunny openings and away from living tree trunks.

Fell trees with signs of bark beetle infestation (pitch tubes, sawdust on the ground) as soon as possible especially in ponderosa pine and remove them from the forested area. Properly dispose of any tree trunks with bark beetles to ensure the beetles do not fly off to other areas whether on the property or elsewhere. Depending on the time of year the infested tree trunks can be placed in sunny locations away from other trees where they should either be chipped, cut into small pieces, burned, or even buried. If cutting, cut the trees into small, 1-foot pieces, or remove the bark, or score the bark to the cambium layer. This desiccates the food source for beetles since they feed on the cambium just under the bark.

Continuously monitor the forest and woodlands for bark beetles especially for a year or two after thinning treatments, during and following drought, and/or if outbreaks are in the surrounding area. If signs are found (boring dust or pitch tubes) fell and remove the trees as soon as possible and/or treat them so the beetles do not spread.

B. FOREST RESTORATION TREATMENTS

Thinning treatments are designed primarily to improve forest health, break up fuel continuity, increase soil-stabilizing grasses and shrubs and reduce the amount of downed woody debris and small trees which can act as fuel ladders and carry fire into the tree crowns. Treatments are recommended to enhance the diversity of vegetation (species, forest structure) and wildlife habitat over the landscape by creating clumps and openings. Treatments aim to restore forest structure and composition to a more historic condition when natural fire regimes were more frequent low intensity, understory fires the in ponderosa pine stands and to reduce the stand densities of piñon-juniper stands especially favoring piñon-pine. Thinning has been shown to enhance the health and vigor of the residual trees by giving them more room, sunlight, water, and nutrients to grow and mitigate the risk of catastrophic wildfire. Trees are also found to be more resistant to insect and disease outbreaks and the trees will increase in diameter and height faster.

A consulting forester or other forester is recommended to mark the trees on a small area (1-5 acres) to be left or removed using a single tree selection process where each tree or groups of trees are evaluated on whether it should stay or go. This will assist the thinning contractor with visualizing and understanding what the residual stand should consist of if they are not very experienced.

C. TREE REMOVAL, AND SLASH TREATMENTS

Thinning can be done by hand felling with chainsaws, feller bunchers, or a mastication machine that grinds trees vertically or horizontally. Skidders, chippers, pick-up-trucks and other mechanical equipment is also used.

Removing tree trunks (over 3 inches in size), treating slash (tops, limbs, and trunks under 3 inches in size) and dead and downed trees is a top priority. If too much woody debris from thinning is left on the ground, fire risk is higher than before treatment. Haul away trunks of trees over 3 inches in diameter for use as sawtimber, vigas, latillas, posts, poles, firewood, chips, and other small diameter wood products. Slash can be removed, chipped, piled, piled and burned, ground up with a mastication machine, or lopped and scattered to lay within 1 foot of ground level. In some areas where there are many dead trees per acre and access is difficult, delimbing and cutting these trees to lie within one foot of ground level may be appropriate.

1. PILING AND BURNING

For pile burning, felled trees are typically limbed and bucked in the woods then the limbs under 3 inches in diameter are piled and burned. Wood over 3 inches in diameter should be removed from the site. Placement of slash piles is very important. Piles should be placed in large openings to avoid the scorching of leave trees when the piles are burned. Building piles on top of logs or old stumps should be avoided so that both the amount of smoke and the chance for fire "creep" is reduced when the piles are burned. Pile burning should take place in the winter when snow is on the ground, or during an extended wet weather period. Piles should be monitored continuously as the piles burn down. They should be consolidated to help ensure complete and timely consumption. Also, monitor the burned pile sites the spring after burning. Seed with an appropriate seed mix if necessary. Opening size should determine pile size, with larger openings accommodating larger piles. Find experienced thinning and burning contractors before thinning begins to further define the size of the burn piles and the associated openings.

Prior to any pile burning, obtain a burn permit from the New Mexico Environment Department Air Quality Bureau. They can be contacted at (800) 224-7009. Also, contact the Santa Fe County Fire Department at 505-992-3070. The local volunteer Fire Departments are either the Madrid Volunteer Fire District at 505-424-8006 or Turquoise Trail Volunteer Fire District at 505-474-8282. Also, be sure to contact the Bernalillo District Office of the New Mexico Forestry Division at 505-867-2334.

It is interesting to note that the State Forestry Las Vegas District Office is not currently funding pile burning in cost-share programs due to fire hazard. They recommend piling material less than 3 inches in diameter and leaving it. The piles would still need to be far enough away from nearby standing trees in the event a fire did take place. Brush piles are favored for use by small animals.

2. MASTICATION

Thinning could be done with a mastication machine which leaves a layer of woody debris on the ground of different sizes. The machine grinds up standing trees and/or trees and slash lying on the ground. Final average mastication mulch depth should be less than 6 inches deep and be no deeper than 10 inches in one spot. Individual pieces should be less than 3 inches in diameter and less than 18 inches long. The masticated debris should be spread fairly evenly or bermed on the contour of slopes to slow water flow.

3. LOP AND SCATTER

Tops and small limbs can be lopped and scattered if the other practices above cannot be done. All material should be lopped to lay not over one and one half feet above ground level and be kept far enough away from the bases and driplines and any lower branches of residual trees. In more open areas slash can be left to cover up to 10% of the forest floor if it is lopped to within one to two feet of ground level and will not act as a ladder fuel.

4. CHIPPING

If chipping, chips should be no greater than two-inches deep (not an average of two inches) in all areas. Chips should not be near tree trunks to decrease the risk of insect, rot, and fire damage. Also avoid leaving chips within the area from a trees drip line to the trunk. Chips can be placed on access roads for stability when wet.

D. PRESCRIBED BURNING

More land managers and foresters are using prescribed fire in the form of broadcast burns as a tool to restore forests, woodlands, and grasslands to more historic conditions when fires naturally occurred due to lightening or when indigenous Americans set them for wildlife and brush management. Due to the amount of historic disturbance and extensive mine reclamation work, prescribed burning is not recommended.

E. NOXIOUS WEED CONTROL

If thinning in summer and fall ask that the forest workers check to ensure their vehicles and equipment are free from seeds of invasive weed species if they could have picked them up from a previous site they were working in. If so it is recommended that they wash the vehicles or at least the tires prior to entering the property.

Cut and remove Russian olive trees. Cut and remove the Siberian elm trees that are increasingly present on the property. See Appendix I, Field Guide for Managing Siberian Elm in the Southwest, and also in Appendix J, the Field Guide for Managing Russian Olive in the Southwest, both 2014 US Forest Service publications. Pulling out small seedlings will work but for larger-sized trees cutting them and immediately applying a layer of roundup from a spray bottle or with a brush can be effective. The NRCS may be available to make a site visit to assist with identifying other noxious weeds on the property and they may have cost-share funding for noxious weed control treatments.

F. RIPARIAN AREAS

Riparian areas are some of the most diverse, and productive areas in forestland for vegetation, wildlife and birds. It is important to protect these areas during any forest treatments by establishing a buffer zone. Riparian buffer zones (also known as streamside management zones, SMZ's) are important natural bio-filters that protect streams and other riparian areas from excessive sedimentation, surface runoff, erosion, and warm temperatures. The width of a riparian buffer zone depends on the steepness of the adjacent slopes and the type of waterway - whether perennial, intermittent, or ephemeral. Intermittent waterways carry water during high water events. Ephemeral water resources have defined stream channels where water runs less than half a year during heavy storms or rapid snowmelt.

Management Recommendations: A buffer zone of 50 to 160 feet is needed along intermittent and ephemeral waterways in the forested areas during treatments depending on slope. The wider width is needed where the side slopes are steepest. Buffer zone width should be determined according to the following table.

Table G: Recommended buffer zone width based on adjacent slope percent

Percent slope of land above stream	0	10	20	30	40	50
Buffer strip width on each side in feet	50	70	90	110	130	160

In the riparian buffer zones, keep heavy equipment out of the drainageways. Trees may be removed from the buffer zones as long as the drainageway is not disrupted and sufficient vegetation is left to protect water quality. Do not disturb more than 20% of the bare mineral soil in the buffer zone and leave at least 50% of the protective tree cover directly over the center of the arroyo. Follow the *Best Management Practices* (BMP's) found in the *"New Mexico Forest Practices Guidelines"* as described below.

G. EROSION CONTROL & NM BEST MANAGEMENT PRACTICES (BMP'S)

Use appropriate harvesting equipment and harvest and run mechanical equipment only in dry weather or on frozen ground to prevent rutting and compaction. Ensure the contractor follows the BMP's found in the "New Mexico Forest Practices Guidelines" prepared by the New Mexico Energy, Minerals and Natural Resources Department) Forestry Division to protect intermittent waterways from disturbance and debris accumulation. The EMNRD currently has a copy available on there website: http://www.emnrd.state.nm.us/SFD/Publications/documents/NMForestPracticesGuidelines2008.pdf. Or go to www.emnrd.state.nm.us and click on Divisions then State Forestry and from there » Forest Management » Forest Regulations » Forest Practices Guidelines.

Rock structures can be installed in drainages and headcuts to control water flow and decrease gully depth. A good publication to find out more about erosion control techniques is '*An Introduction to Erosion Control*' by Bill Zeedyk and Jan-Willem Jansens provided in Appendix O. These and other publications are found on the Quivira Coalition website, a Santa Fe based non-profit organization, at www.quiviracoalition.org.

H. MANAGEMENT OF CULTURAL RESOURCES

When thinning an area, procedures need to be in place to review reports on cultural resources and then identify those sites on the ground. A plan should be made on how to avoid and not disturb the cultural sites during thinning. It may be best to consult an archaeologist prior to the thinning treatment. Or the project manager could provide the thinning crew with a training on what to avoid and how to deal with the identified archaeological resources.

The archaeological sites and artifacts will need protection from any ground disturbance that could result from skidding trees. Thinning by hand with chainsaws may be acceptable as long as there is no skidding. In certain situations tree trunks and limbs may need to be hand carried lifting the entire piece off of the ground, rather than dragging them across a site. Chips should not cover sites. Removing trees could protect the sites since roots and plants would not invade sites. If any artifacts are found they should be left in place and not removed by anyone involved in the thinning project. If any new prehistoric or historic sites or materials are found, contact the Bernalillo State Forestry Division District or the New Mexico Historic Preservation Division.

SMU (Southern Methodist University)-In-Taos has an archaeology field school and thinning is taking place there. The Executive Director is an archeologist who is conducting trainings for contractors thinning there. Please contact me for their contact information if interested.

VII. OVERALL FOREST STANDS AND MANAGEMENT RECOMMENDATIONS

This forest plan encompasses a 10-year planning horizon, to the year 2027 but should be updated in 5 years. Your forest is recommended to be visited often by a forester to monitor changing conditions, study vegetation response, and to monitor for bark beetles, invasive species, disease, tree mortality, etc. and to plan any improvement activities. A management plan is a continual work in progress. New recommendations and changes are an expected and important part of the process as forest conditions and responses to treatments are evaluated and more is learned. The forest should especially be monitored during and following droughts and/or years with warmer than average annual temperatures.

This plan was prepared to the best of my knowledge and ability however no guarantees are implied as to the result of the plans recommendations as to protecting the area from damage from wildfire, insects and diseases especially during this time of increasing temperatures and more extreme weather conditions such as drought.

In the next section of this report, Section VIII, descriptions and management recommendations for five primary forest management units on the property are described. Immediately below are descriptions of two areas broken out of the primary stand units that have fewer management options due to 1) steepness/inaccessibility, and 2) the younger age and lower densities of trees on revegetated areas where treatments are less needed. Management recommendations for these areas are described below. In addition, overall general management priorities for the entire property are included in Section C below including for fire prevention around the office building and around reclamation infrastructure (wells, ponds, plastic piping, etc.) and electrical transmission lines on the property.

A. STEEP MOUNTAINOUS AREAS (648 Acres)

This area lies on the mountaintops and steep sideslopes of the Ortiz Mountains and in the southeast corner, Captain Davis Mountain.

Major Species: Pinon pine, one-seed juniper, some ponderosa pine, Douglas-fir, white fir perhaps some spruce at the highest elevations on cool facing slopes and concave shaped landforms.

Stand Stocking: Variable. Less dense on southerly facing slopes and convex landforms.

Slope: 35% to 90%

Soil Map Units (in descending order of percentage): Mostly 514 and 511.
514 - Pegasus extremely cobbly loam, 20 to 50 percent slopes;
511 - Wandurn-Alchonzo-Rubble land complex, 35 to 90 percent slopes;
515 - Pastorius very cobbly loam, 3 to 5 percent slopes;
512 - Cochiti extremely cobbly loam, 15 to 35 percent slopes;
501 - Truehill extremely gravelly loam, 25 to 55 percent slopes;
509 - Puertecito-Wandun-Rock outcrop complex, 30-60% slopes (Captain Davis Mountain).

MANAGEMENT RECOMMENDATIONS:

-When thinning on adjacent lower areas these areas can also be treated as contractor expertise and equipment allows.
-There is a road along the upper edges of Areas 1B and 2 that could be thinned on each side to create a fuelbreak and allow safer ingress and egress by wildfire fighting vehicles.
- In addition, fuelbreaks could be created along the boundary lines of the southern line and south end of the western boundary line. To determine the width of a fuelbreak please refer to Table B in Section V.B, on page 19. Residual density in the fuelbreak is recommended at 50 to 60 square feet of basal area per acre. As described in Area 3, thinning or a shaded fuelbreak along the west end of the northern property line where homes are is an important consideration.

B. RECLAMATION / REVEGETATION AREAS (394 Acres)

These areas need to be protected from wildfire. As it now stands these areas may provide a nice fuelbreak on a larger landscape level in the event of wildfire but a vast amount of reclamation work and expense could be lost if portions of them burned. The revegetated areas have 15-year old trees. Russian olive and Siberian elm are present in some of these areas. The office building is located in one of these areas.

Major Species: Ponderosa pine, piñon pine, one-seed juniper, Rocky Mountain juniper.

Slope: Nearly level, to steeper reclaimed mountainsides, the deep open pit.

Soil Map Units (in descending order of percentage):
550 - Pits, mine;
515 - Pastorius very cobbly loam, 3 to 5 percent slopes (Dolores evaporative pond area).

MANAGEMENT RECOMMENDATIONS:
- Remove and treat Siberian elm and Russian olive trees as described in Appendix I and J. Trees can be dug up and small trees can be pulled. Or a cut stump treatment can be used by cutting the tree and immediately applying an effective herbicide so they do not resprout.
- Prioritize thinning along the edges of the revegetated areas to protect them from wildfire. This is especially recommended in the dense wooland surrounding the Dolores Ranch reclamation area.

<u>Office Building:</u>
Only a small amount of the office building is flammable – just the wooden trim around windows. It is excellent that the office roof and sides are made of metal. At least 50% of the office building is surrounded by a gravel parking lot, concrete or bare soil. There is also a water hydrant with long hose in front of the office building.
-Keep shrubs, plants and grasses low within 30 feet of the building.
-You may want to surround weedy areas around the office foundation with rock or gravel to a width of 1 to 5 feet.
-Keep flammable materials at least 30 feet from the office or any other structures.
-Bury the propane tank underground <u>or</u> remove flammable material out to at least 15 feet.

<u>Reclamation/Revegetation Areas</u>
-Fire prevention buffers can be created around reclamation infrastructure by cutting any trees, and cutting or mowing weeds, and grasses low within 10-15 feet of wells, pump houses, plastic

piping and other reclamation infrastructure as prioritized by the Cunningham Hill Mine Project Manager.
-You may want to gravel around wells etc. to a width of 1 - 5 feet.
-You may want to obtain a portable water suppression pumper tank with trailer, more personal protective equipment (PPE), fire retardant gel in containers, and tools.

C. FOREST MANAGEMENT PRIORITIES

1. Thin the ponderosa pine forest and piñon-juniper woodland in the southwest corner (Areas 1A and 1B) to protect the open mine pit and other reclamation work below.
2. Thin piñon-juniper woodlands in other important watersheds especially in the watershed above the evaporation ponds near Dolores Ranch, below the water tower tank, and along the access road leading to Dolores Ranch (Area 2).
3. Conduct brush management around the office building,
4. Implement fire damage prevention around wells, pump houses, ponds, and other reclamation infrastructure by keeping vegetation mown or cut low at least 10-15 feet around them.
5. Fell and remove all trees that are or will soon reach into above ground electric transmission lines.
6. Remove Siberian elm and Russian olive trees wherever they exist.
7. Continue to thin as many acres of forest and woodlands as possible in areas 1, 2, 3 and 5.
8. Continue to improve firefighter access and travel along roads by thinning along them.
9. Thin to create buffers around revegetated areas.
10. Consider installing shaded fuelbreaks along property boundaries in the south, west and north as time and expenses allow.
11. Monitor for bark beetles and mortality of all species during and after drought.
12. Work with NM State Forestry Division, and contact the Natural Resources Conservation Service (NRCS), Santa Fe-Pojoaque Soil and Water Conservation District (SWCD), and the Nature Conservancy's Rio Grande Water Fund to seek and possibly obtain funds for thinning.

VIII. PRIMARY MANAGEMENT AREA DESCRIPTIONS AND RECOMMENDATIONS

Follow the guidelines in Sections VI and VII above during all forest treatments. Below are descriptions and management recommendations for the five primary management areas. Two of these primary units have further been divided to into smaller management areas.

A. AREA 1 (214 ACRES): Southwest Corner and Cunningham Hill Mine Watershed

Figure 5: Dense ponderosa pine forest of Area 1A.

The area east of Cunningham Gulch has the highest amount of ponderosa pine and is called Area 1A. The area west of Cunningham Gulch is called Area 1B and has more piñon-juniper woodland, however ponderosa pine occurs especially along primary drainageways. According to the NM Landscape Assessment tool, Cunningham Gulch in the southwest corner has a very high rating for the hazard of wildfire. The only place with that ranking on the property. This is the most important area to treat. Below are descriptions and management recommendations for each of the two areas.

1. AREA 1A (79 ACRES): SOUTHWEST CORNER - PONDEROSA PINE

Area 1A: Stand Summary Table (16 Points: 3-6, 8-14, 17, 18, 20-22)

	Ponderosa Pine	Piñon Pine	One-seed Juniper	Douglas-fir	Overall
Quadratic Mean Diameter (QMD):	10.08"	6.5"	6.23"	5.77"	7.82"
Basal Area (sqft):	68.13	27.50	19.38	4.38	119.38
Basal Area (%):	57.07	23.04	16.23	3.66	----
Trees per Acre:	122.93	119.42	91.42	24.07	357.84
Trees per Acre (%):	34.35	33.37	25.55	6.73	----

Ground Fuels: Moderate but higher where ladder fuels are prevalent.

Average Tree Height: Piñon-juniper 25 feet, ponderosa pine is variable with an average of 56 feet and some up to 75 feet.

Average Slope, Aspect: 23%, range of 5 to 65%, north to northwest, some pit-mound topography.

Soil Map Units (in descending order of percentage):
515 - Pastorius very cobbly loam, 3 to 5 percent slopes;
514 - Pegasus extremely cobbly loam, 20 to 50 percent slopes;

511 - Wandurn-Alchonzo-Rubble land complex, 35 to 90 percent slopes.

This stand is very overcrowded. This area has fewer than 2% dead trees but is very overcrowded and many understory ladder fuels are present. Mistletoe is present on ponderosa pine in some areas. One of the largest trees seen was a 40-inch diameter ponderosa pine treasure tree near inventory point 3. The high stand density in this area should be reduced to improve forest health and mitigate wildfire. Oak will likely increase if the stand is opened up since it responds to light and if cut it will sprout back.

MANAGEMENT RECOMMENDATIONS: Ponderosa Pine Forest Treatment

Tree Removal and Spacing

-Thin as many acres as possible in this stand to reduce the square feet of basal area to an average of 60 to 80 square feet/acre depending on slope (leave the higher density of 80 basal area on steeper areas.

-Remove trees that are dead, dying, suppressed, poorly formed (with curved or crooked stems, low forks or broken tops), that are diseased, damaged or that have insect or mistletoe infections to leave healthier, sound, and higher quality trees for the future.

-Create clumps of trees and openings leaving trees of various age and size classes to form more of an uneven-aged stand with more stand structural diversity horizontally and vertically.

-In general, when leaving 60 square feet of basal area per acre with an average residual stand diameter of 9 inches, the average number of trees per acre will total 134 (there are currently 287 trees per acre) and the average square spacing between trees will be 18 feet. See Appendix K, Stocking and Basal Area Spacing Guide. However apply the spacing rule loosely to avoid leaving a homogenous stand with little diversity.

-Favor leaving a diversity of species, especially leave all healthy Douglas-fir. Favor removing juniper however leave some especially larger sized juniper when they are not ladder fuels to protect diversity.

-Remove young trees that might act as ladder fuels during a ground or surface fire.

-Remove ladder fuels within 15 feet of a larger-sized trees dripline.

-Leave some quality seedlings and saplings when present in clumps and in openings or when openings can be created around them in order to retain this age class of trees that will grow into the future forest stand.

-Retain all trees with old-growth morphology (such as yellow-barked ponderosa pine or any species with large dropping limbs, twisted trunks, or flattened tops), regardless of size. However, remove tall trees especially ponderosa pine when they are on high ridge tops since they often act as lightening rods starting fires.

-Monitor larger ponderosa pine for thinning crowns and dieback. Remove if they are nearly dead or soon after they are dead in order to reduce fuel loading. If cut early enough they can be used to make valuable forest products.

-Favor leaving some larger-sized oak in openings that produce larger acorn crops for wildlife.

Slash Treatment Criteria

-Wood greater than 3" in diameter should be removed from the property and utilized as feasible (posts, poles, vigas, latillas, firewood, and lumber).

-Tree tops and limbs less than 3" in diameter should be chipped, masticated, and/or piled and/or burned in open areas.

-If chipping or masticating, the material may be left in the unit or spread on areas of bare soil or on roads.
-If chipping, chips should be no more than two inches in depth in any one location (not an average of two inches).
-Avoid leaving chips underneath trees from their drip line to their trunk.

Streamside Management Areas

-Chips or any masticated debris should not be introduced into intermittent and ephemeral drainages / streamside management areas.
-Drainageways should not be crossed with heavy equipment without prior approval from the landowner or managing forester.

Bark Beetle Precautions

-Favor thinning from late August to January or perhaps to February when bark beetle activity is slow due to cold weather.

Other

-Protect residual trees from damage during tree felling and when operating heavy equipment.
-Cut stumps as close to ground level as possible or no higher than 3 inches above ground level.
-Both stems of a forked tree will either be left uncut or both cut. Do not leave one side of a forked tree.

2. AREA 1B (135 ACRES): SOUTHWEST CORNER - Piñon-Juniper with Ponderosa Pine

This area consists mostly of piñon-juniper woodland with 17% to 26% ponderosa pine which is especially common along drainageways.

Area 1B: Stand Summary Table (15 Points: 1, 2, 7, 19, 23-29, 30-33)

	Piñon Pine	One-seed Juniper	Ponderosa Pine	Douglas-fir	Overall
Quadratic Mean Diameter (QMD):	6"	8.5"	9"	11"	7"
Basal Area (sqft):	51	37	32	2.7	123
Basal Area (%):	41	30.5	26	2	----
Trees per Acre:	243	94	72	4	413
Trees per Acre (%):	59	23	17	1	----

Fuels: Moderate.

Average Tree Height: Piñon-juniper 22 feet, ponderosa pine 56 feet.

Average Slope, Aspect: 24%, range of 5 to 50%, east, north, and south.

Soil Map Units (in descending order of percentage):

512 - Cochiti extremely cobbly loam, 15 to 35 percent slopes;

514 - Pegasus extremely cobbly loam, 20 to 50 percent slopes;

511 - Wandurn-Alchonzo-Rubble land complex, 35 to 90 percent slopes;

515 - Pastorius very cobbly loam, 3 to 5 percent slopes.

MANAGEMENT RECOMMENDATIONS: Piñon-Juniper Woodland with Ponderosa Pine Treatment

Thin as many acres as possible in this area to reduce the stand density to a healthier level. Treatments will enhance the health and vigor of the residual trees by giving them more room, sunlight, water, and nutrients to grow making them more resilient to insects, diseases, drought and warm-drought stress, and mistletoe. Understory forb and grass growth will increase due to more light reaching the ground benefitting wildlife and increasing diversity and perhaps decreasing the amount of erosion. The treatments will also break up fuel continuity and reduce ladder fuels and the amount of dead and downed trees.

Tree Removal and Spacing

-When thinning reduce the stand density to an average of 60 to 80 square feet of basal area per acre.

-Remove trees that are dead, dying, suppressed, poorly formed (with curved or crooked stems, low forks or broken tops), diseased, damaged or that have insect or mistletoe infections to leave healthier, sound, and higher quality trees for the future. See Appendix L, Thinning Guidelines.

-Favor leaving healthy ponderosa pine and any Douglas-fir to promote stand diversity.

-Favor leaving healthy piñon pine when overtopped or competing with one-seed juniper.

-Favor leaving some large and old healthy one-seed juniper trees.

-Favor leaving groups of trees and create openings to encourage more diverse stand structure.

-Remove young trees, slash, dead and downed trees that might act as ladder fuels during a ground or surface fire if they are near or touching surrounding larger trees and their overhanging branches. Remove trees from the drip line of larger piñon and juniper trees and within 15 feet of the drip line of any ponderosa pine

-Leave some quality seedlings and saplings when present in openings or when openings can be created around them in order to retain this age class of trees that will grow into the future forest stand.

-Thin and create fuelbreaks along roads to ensure good access for firefighters and to mitigate the risk of wildfire in general.

-Limit ground disturbance on steep areas and in drainages.

Slash Treatment

-Remove wood over three inches in diameter from the site for use as firewood, chips or other uses.

-Smaller material (slash) less than 3 inches in diameter should be masticated, chipped, or piled and burned in open areas.

-A very small amount of woody debris could be lopped and scattered to lie not more than 1 foot above ground level.

-If chipping, chips should be no more than two inches in depth in any one location (not an average of two inches).

-Avoid leaving chips underneath trees from their drip line to their trunk.

Other

-Protect residual trees from damage during tree felling and when operating heavy equipment.

-Cut stumps to less than 3 inches above ground level or as close to ground level as possible.

-If bark beetle signs are found (boring dust or pitch tubes) on any species of trees fell and remove the trees as soon as possible and treat them so the beetles do not spread.

B. AREA 2 (233 Acres): WEST AND CENTER, NEAR DOLORES RANCH AND BELOW WATER TANK - Piñon-Juniper Woodland

Area 2: Stand Summary Table (24 Points: 34-44, 46-52, 68-73)

	Piñon Pine	**One-seed Juniper**	**Ponderosa Pine**	**Overall**	***Dead (Piñon)***
Quadratic Mean Diameter (QMD):	6.4"	9.25"	10.25"	7.6"	*6"*
Basal Area (sqft):	69	77	5.4	151.2	*12*
Basal Area (%):	46	51	4	----	*7.3*
Trees per Acre:	312	164	9.5	485.4	*57*
Trees per Acre (%):	64	34	2	----	*10.6*

Fuels: Moderate to moderate high, some areas with many dead and downed trees, limbs.

Average Overstory Tree Height: 23 feet, range of 15-35, ponderosa pine taller.

Average Slope, Aspect: 20%, range of 5-38%, northeast, east, and north.

Soil Map Units (in descending order of percentage):
512 - Cochiti extremely cobbly loam, 15 to 35 percent slopes;
513 - Pedregal very cobbly loam, 8 to 15 percent slopes;
515 - Pastorius very cobbly loam, 3 to 5 percent slopes;
514 - Pegasus extremely cobbly loam, 20 to 50 percent slopes.

Figure 6: View of evaporation ponds near Dolores Ranch with dense piñon-juniper of Area 2 in the foreground.

This area consists mostly of piñon-juniper woodland with 2-4% ponderosa pine as shown in the table above. The stand density in this area is the highest on the property. The area is the watershed above and around the Dolores Ranch, the pump house, evaporations ponds, etc.

MANAGEMENT RECOMMENDATIONS: Piñon-Juniper Woodland Treatment
Thin as many acres as possible in this area to reduce the stand density to a healthier level. The treatments will break up fuel continuity and reduce ladder fuels and the amount of dead and downed trees.

Tree Removal and Spacing Criteria
-With a current average basal area of 151 square feet per acre, reduce stand density to an average of 70 to 80 square feet or remove a little over 50% of the stand density in a given area.

-Prioritize thinning everywhere in this area but especially along the road that goes from the main road down to Dolores Ranch as well as other roads, evaporative ponds areas, and level enough areas below the water tank on Cunningham Hill.
-Follow the rest of the recommendation for thinning found in Area 1B above.

C. AREA 3 (524 Acres): ROLLING HILLS AND FOOTSLOPES NORTH END - Piñon Juniper Woodland

Area 3: Stand Summary Table (41 Points: 53-55, 75-92, 115-134)

	One-seed Juniper	Piñon Pine	Ponderosa Pine	Overall
Quadratic Mean Diameter (QMD):	9.7"	6"	22"	8.7"
Basal Area (sqft):	100.5	17.5	.24	118
Basal Area (%):	85	15	.21	----
Trees per Acre:	197	88	.09	284.5
Trees per Acre (%):	69	31	.03	----

Fuels: Moderate, moderate high, some high.

Average Overstory Tree Height: 15-18 feet.

Average Slope, Aspect: 16%, range of 5-33%, aspect is variable. Steeper in less accessible area.

Soil Map Units (in descending order of percentage):

514 - Pegasus extremely cobbly loam, 20 to 50 percent slopes;
513 - Pedregal very cobbly loam, 8 to 15 percent slopes;
515 - Pastorius very cobbly loam, 3 to 5 percent slopes;
512 - Cochiti extremely cobbly loam, 15 to 35 percent slopes;
501 - Truehill extremely gravelly loam, 25 to 55 percent slopes;
510 - Cerrillos-Sedillo complex, 1 to 5 percent slopes;
521 - Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded (Dolores Gulch drainageway).

This area includes 58 acres of steep woodland that is difficult to access that lies along the eastern end of the northern property boundary line. Homes in the Vista del Oro subdivision are closest along that portion of the boundary. Dead trees average 12%. Many points have only one-seed juniper and at some points piñon pines recently died so only juniper was left. There are some deep eroded drainageways in this area. The access road to the Santa Fe County land veers off the main road at the gate in this area.

MANAGEMENT RECOMMENDATIONS: Piñon-Juniper Woodland

-Follow the treatment recommendations for piñon-juniper treatments described in Area 1B on as many acres as possible in this area.
-Remove invasive species of trees along the main road and elsewhere.
-Continue to thin and create fuelbreaks along the road that goes to Santa Fe County land and other roads.

-Widen the narrow cleared area along the northern fence line by homes as much as possible as time and expenses allow. Ideally a 300+ foot wide fuelbreak would be installed.

Figure 7: Northern boundary fence line.

-It would be valuable to have someone contact the closest neighbors near the northern boundary line to encourage them to thin up to the property line and create defensible space around their homes. The Cunningham Hill Mine northern property line is closer and easier to access from their driveways and land. Neighbors could be educated to expand their knowledge of wildfire mitigation and thinning benefits, cost-share funding available for treatments, and the Firewise Program. For more information see <http://www.firewise.org/usa/?sso=0>. Todd Haines is the Bernalillo District Liason for Firewise Communities who could assist in talking with them. Or a consulting forester could also communicate with the neighbors about thinning and the Firewise program.

D. AREA 4 (525 Acres): NORTHEAST LEVEL AREAS – Juniper Savanna and Piñon-Juniper Woodland

Area 4: Stand Summary Table (27 Points: 135-162, minus 140)

	One-seed Juniper	Piñon Pine	Overall
Quadratic Mean Diameter (QMD):	11"	5.75"	10.13"
Basal Area (sqft):	76	5	81
Basal Area (%):	94	6	----
Trees per Acre:	116	29	145
Trees per Acre (%):	80	20	----

Fuels: Low to moderate, one area was high that was heavy with blowdowns.

Average Overstory Tree Height: 13-14 feet.

Average Slope, Aspect: 4%, northeast and east.

Soil Map Units: Soil Map Units (in descending order of percentage):
Mostly 510 - Cerrillos-Sedillo complex, 1 to 5 percent slopes;
501 - Truehill extremely gravelly loam, 25 to 55 percent slopes;
521 - Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded.

This area has a high percentage of one-seed juniper savanna and one area along the fence consists of grassland with cholla and forbs only. This area has the lowest stand density of all the areas on the property. In a couple areas there were one-seed juniper with top dieback (points 152/154) likely resulting from recent drought.

MANAGEMENT RECOMMENDATIONS:

-Let this area grow.

-If time and expenses allow thin portions of the stand around the large revegetated area to create a wildfire prevention buffer. Follow the recommendations in Area 1B if thinning to create the buffer.

-The debris pile has decomposing wood mixed with soil that could smoulder a long time if fire is in it. However as discussed at the recent site visit it would be very time consuming to remove the wood and perhaps just leveling and spreading the piles out would be most appropriate.

E. AREA 5 (430 Acres): CAPTAIN DAVIS MOUNTAIN AND SURROUNDING AREAS - Piñon-Juniper Woodland

Water in this area flows into Cunningham Creek, an intermittent drainageway.

1. AREA 5A (143 ACRES): CAPTAIN DAVIS MOUNTAIN

Area 5A, has been separated since it has many dead trees and is more of a separate area from the rest of the property. The soils report identifies that damage from wildfire in this area is severe. This is the only area on the property with that rating. The severe rating for damage by fire is based on soil texture, slope, and surface layer thickness.

Figure 8: Dead and live trees in Area 5A.

Dead trees in this area make up 26 to 29% of the stand. As the table below shows there are more dead piñon pine trees than live. The mortality is likely due to trees being stressed by the recent drought that ended in 2014. Portions of this area have a high rating in the NM Landscape Assessment tool for the hazard of wildfire.

Area 5A: Captain Davis Mountain (11 Points: 93-103) with and without dead trees

	One-seed Juniper	**Piñon Pine**	**Overall**	***Dead (Piñon)***	***Overall with Dead Trees***
Quadratic Mean Diameter (QMD):	8.8"	5"	**7.65**	*7"*	*7.5"*
Basal Area (sqft):	85	17	**102**	*35.5*	*137*
Basal Area (%):	83	17	----	*26*	----
Trees per Acre:	198	121	**319**	*131*	*450*
Trees per Acre (%):	62	38	----	*29*	----

Fuels: Moderate to moderate high some areas of many blowdowns.

Average Overstory Tree Height: 13 feet.

Average Slope, Aspect: 16%, range of 3-24% (higher slopes are more), northwest and north.

Soil Map Units (in descending order of percentage):

Mostly 509 - Puertecito-Wandun-Rock outcrop complex, 30-60% slopes;
512 - Cochiti extremely cobbly loam, 15 to 35 percent slopes;
513 - Pedregal very cobbly loam, 8 to 15 percent slopes;
515 - Pastorius very cobbly loam, 3 to 5 percent slopes;
521 - Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded;
510 - Cerrillos-Sedillo complex, 1 to 5 percent slopes.

MANAGEMENT RECOMMENDATIONS:
Thin this woodland to a residual average basal area of 50 to 60 square feet per acre. Follow the recommendation described in Area 1A. Favor removing one-seed juniper trees when they are overtopping or very close to healthy piñon pine trees. Favor creating a mosaic of clumps and openings of various densities and a diversity of trees sizes and ages.

2. AREA 5B (287 ACRES): AREA SURROUNDING CAPTAIN DAVIS MOUNTAIN

Area 5B: Stand Summary Table (23 Points 56-67, 104-114)

	One-seed Juniper	**Piñon Pine**	**Ponderosa Pine**	**Overall**	***Dead (piñon)***	***Overall with Dead Trees***
Quadratic Mean Diameter (QMD):	9.4"	6"	7"	**8.5"**	*7"*	*8.25"*
Basal Area (sqft):	91	17	0.4	**108**	*17*	*125*
Basal Area (%):	84	15	0.4	----	*13.5*	---
Trees per Acre:	190	88	0.4	**278**	*59*	*337*
Trees per Acre (%):	68	31.5	0.15	----	*17*	----

Fuels: Moderate.

Average Overstory Tree Height: 14-15 feet.

Average Slope: 12%, range of 0 to 24% and sometimes steeper, east.

Soil Map Units (in descending order of percentage):

514 - Pegasus extremely cobbly loam, 20 to 50 percent slopes
513 - Pedregal very cobbly loam, 8 to 15 percent slopes;
515 - Pastorius very cobbly loam, 3 to 5 percent slopes;
521 - Devargas-Riovista-Riverwash complex, 0 to 5 percent slopes, flooded.

There are many important areas to treat in Area 5B and most of the terrain is fairly level.

MANAGEMENT RECOMMENDATIONS:
Thin on as many acres as possible. Thin this woodland to a residual average basal area of 50 to 60 square feet per acre. Follow the forest restoration treatment recommendations described in

Area 1A. Favor leaving healthy piñon pine trees when overtopped by one-seed juniper. Favor creating a mosaic of clumps and openings of various densities and a diversity of trees sizes and ages. Lop dead trees to less than 1 foot above ground level.

IX. CLOSING MANAGEMENT COMMENTS

A. FORESTRY ASSISTANCE

It is recommended to work with a forester to design, set up, and administer the recommended forest treatments. The forester is recommended to mark trees to be removed on at least a one-acre sample area to show forest workers what the treatment should look like. The forester is also recommended to flag project boundaries, prepare detailed treatment specifications and a draft contract, solicit bids from thinning contractors or handle negotiations, and administer the treatment to ensure the project is completed as specified. Consulting foresters can assist with this process or agencies can assist when projects are cost-shared.

B. HARVEST PERMITS

If any commercial products besides firewood are harvested on more than 25 acres contact the New Mexico State Forestry Bernalillo office at 505-867-2334 to obtain a harvest permit. In addition, if firewood is harvested on more than 75 acres a harvest permit is required.

C. COST-SHARE ASSISTANCE

Work with NM State Forestry Division Bernalillo District Office to obtain cost-share or other funding: Todd Haines, Bernalillo District Forester at 505-867-2334. In the future, you may want to check on cost-share or other funding programs that could become available through the Santa Fe-Pojoaque SWCD or Santa Fe NRCS both at 505-471-0410. In addition the Rio Grande Water Fund organized by The Nature Conservancy (TNC) continues to raise funds to do forest restoration treatments to protect water resources in the Rio Grande watershed. Contact them to see if any funds are available for the property. For more information see nature.org or *google* Rio Grande Water Fund, TNC.

D. FORESTRY TOOLS

You may want to purchase a prism, cruisers crutch, or angle gauge to measure the square feet of basal area in an area. These and other forestry tools such as diameter tapes, logging tapes to measure distances, and clinometers for measuring percent slope and tree height can be purchased from Forestry Suppliers at 800-647-5368 or www.forestry-suppliers.com. In addition, State Forestry can provide you with a basal area gauge at no charge upon request.

E. TREE FARM PROGRAM

The American Tree Farm System® is a nation wide community of nearly 60,000 landowners linked by a desire to manage their woodlands effectively. The program promotes effective management that includes producing continuous crops of trees to supply our nation's wood products needs, and simultaneously maintaining the forest to be aesthetically pleasing and beneficial to wildlife. Consider becoming part of the program. The program is very good for networking, education, sharing your successes and being recognized for the work you have accomplished.

It has been a pleasure working with you. Please feel free to contact me if you have any questions or would like me to assist with implementing the plan.

Respectfully submitted by:

Rachel C. Wood

Rachel C. Wood, Professional Forester

X. CHECKLIST AND RECORD OF MANAGEMENT ACTIVITIES

Practice Accomplished (include date)

______Conduct forest health/forest restoration treatments in Area 1A and 1B.
  ______Year, location, and number of acres treated.
  ______Year, location, and number of acres treated.
  ______Year, location, and number of acres treated.

______Conduct forest health/forest restoration treatments in Area 2 on as many acres as possible.
  ______Year, location, and number of acres treated.
  ______Year, location, and number of acres treated.
  ______Year, location, and number of acres treated.

______Conduct forest health/forest restoration treatments in Area 5 on as many acres as possible.
  ______Year, location, and number of acres treated.
  ______Year, location, and number of acres treated.

______Cut and remove invasive species of trees.

______Conduct needed tree removal along all electric transmission lines.

______Thin along roads to create buffers.
  ______Year, location and length
  ______Year, location and length

______Keep weeds low/mown around office and reclamation infrastructure.
  ______Year and location
  ______Year and location
  ______Year and location

______Conduct forest health/forest restoration treatments in Area 3 on as many acres as possible.
  ______Year, location, and number of acres treated.
  ______Year, location, and number of acres treated.

______Work with NM State Forestry Bernalillo District Office to check on the availability of cost-share or other funding programs: Todd Haines, Bernalillo District Forester at 505-867-2334.

______Possible cost-share or other funding could become available in the future through the Santa Fe-Pojoaque SWCD or Santa Fe NRCS both at 505-471-0410.

______Prior to any pile burning or prescribed burning contact the NM Environment Department Air Quality Bureau at (800) 224-7009. Also contact the Santa Fe County Fire Department at 505-992-3070 and the Bernalillo District Office of the New Mexico Forestry Division at 505-867-2334.

______Continuously monitor for bark beetles and mortality of all tree species especially during drought or if outbreaks are taking place on nearby areas.

______Monitor for invasive species of plants and trees.

______Keep accurate records of all forest and land improvement work for tax purposes, etc.

XII. MAPS

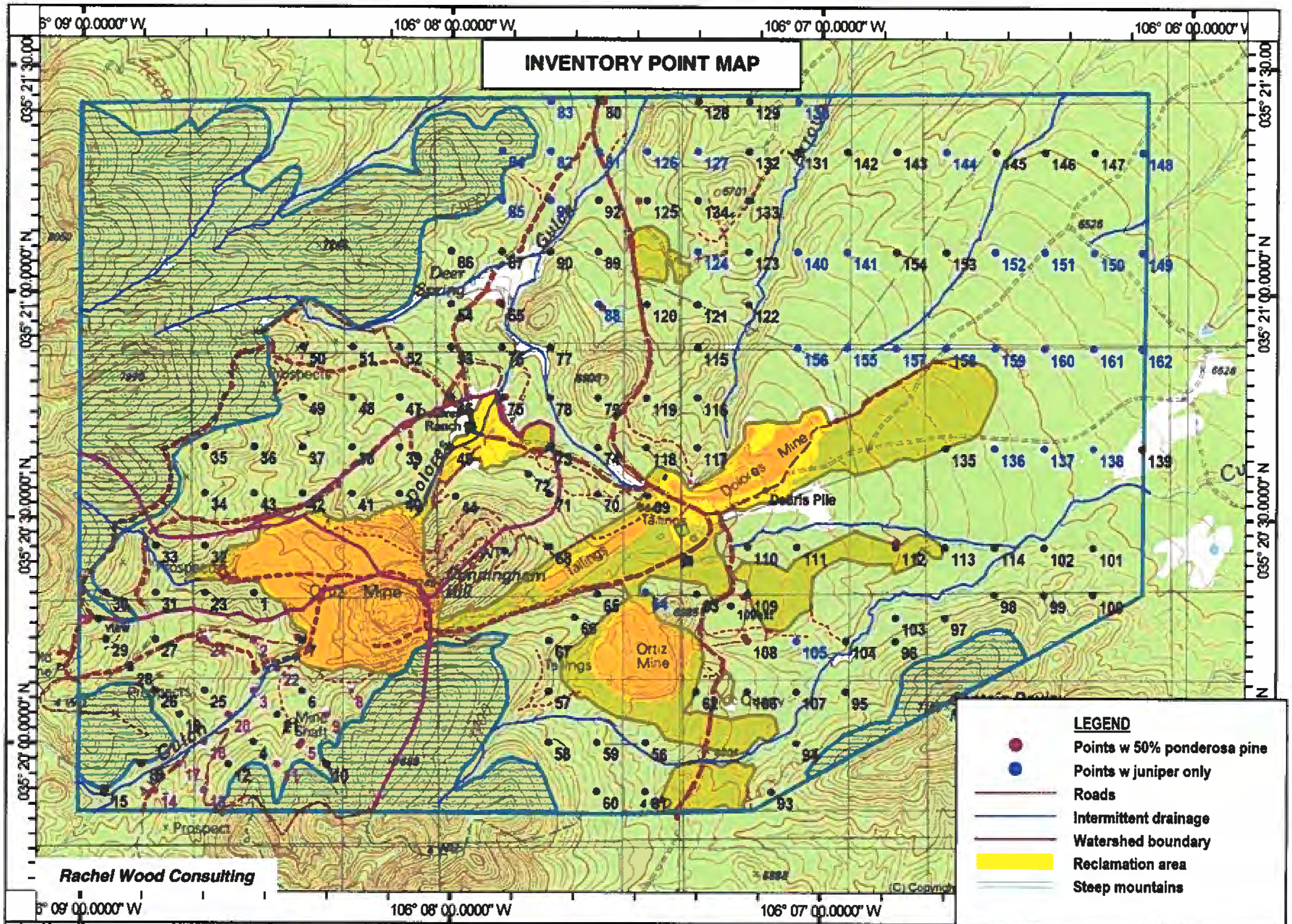
A. INVENTORY POINT MAP

B. WATERSHED MAP

C. AERIAL VIEW MAP

D. FOREST MANAGEMENT MAP

E. GOLD MINE FIRE AERIAL



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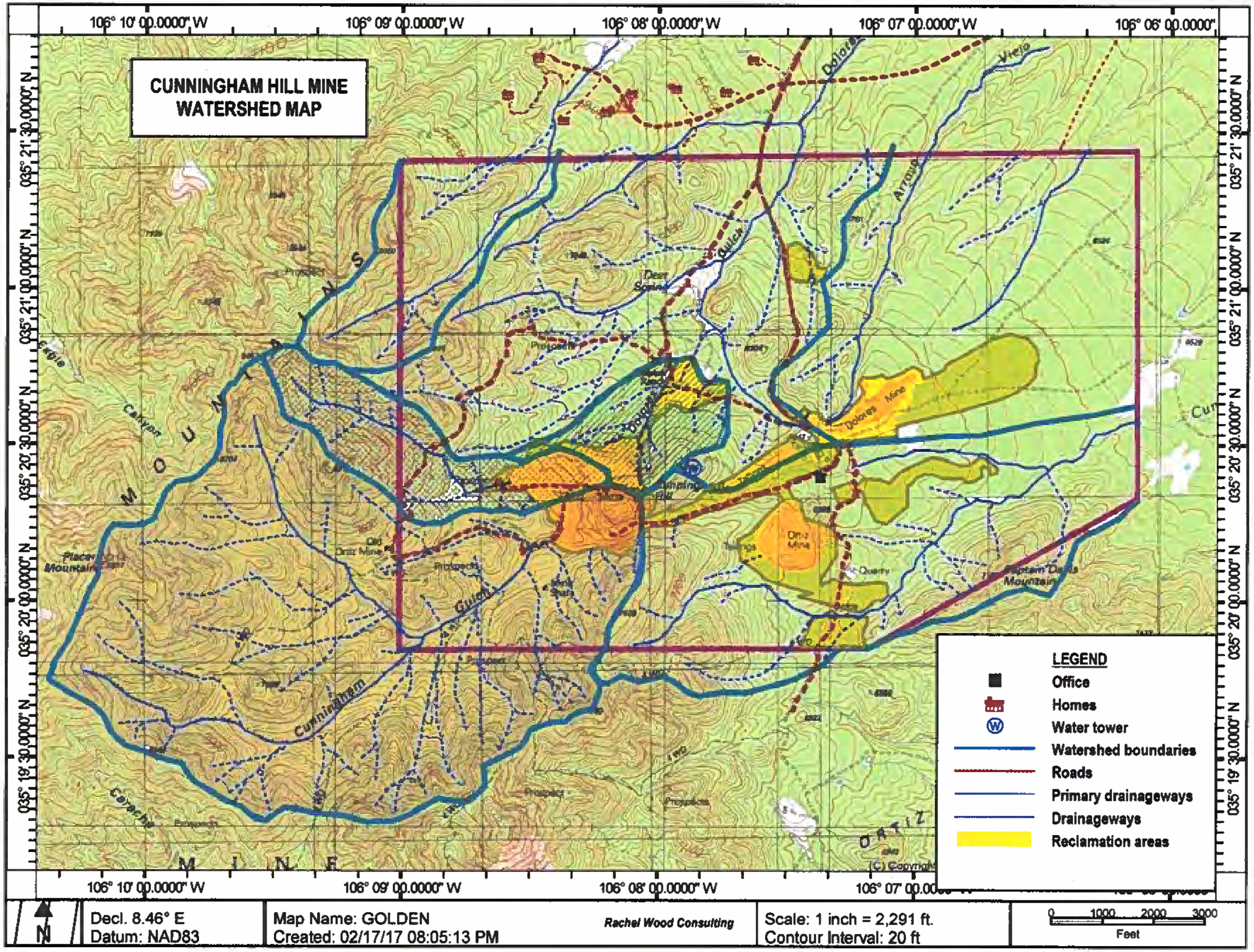
CUNNINGHAM HILL MINE
WATERSHED MAP
106° 10' 00.0000" W
106° 09' 00.0000" W
106° 08' 00.0000" W
106° 07' 00.0000" W
106° 06' 00.0000"
035° 21' 30.0000" N
035° 21' 00.0000" N
035° 20' 30.0000" N
035° 20' 00.0000" N
035° 19' 30.0000" N
LEGEND
Office
Homes
Water tower
Watershed boundaries
Roads
Primary drainageways
Drainageways
Reclamation areas
MOUNTAINS
Cunningham
Gulch
Dolores Mine
Ortiz Mine
Captain Davis Mountain
Placer Mountain
Canyon
Cerachs
Viejo
Dolores
Arroyo
Quarry
Prospect
Prospects
Deer Spring
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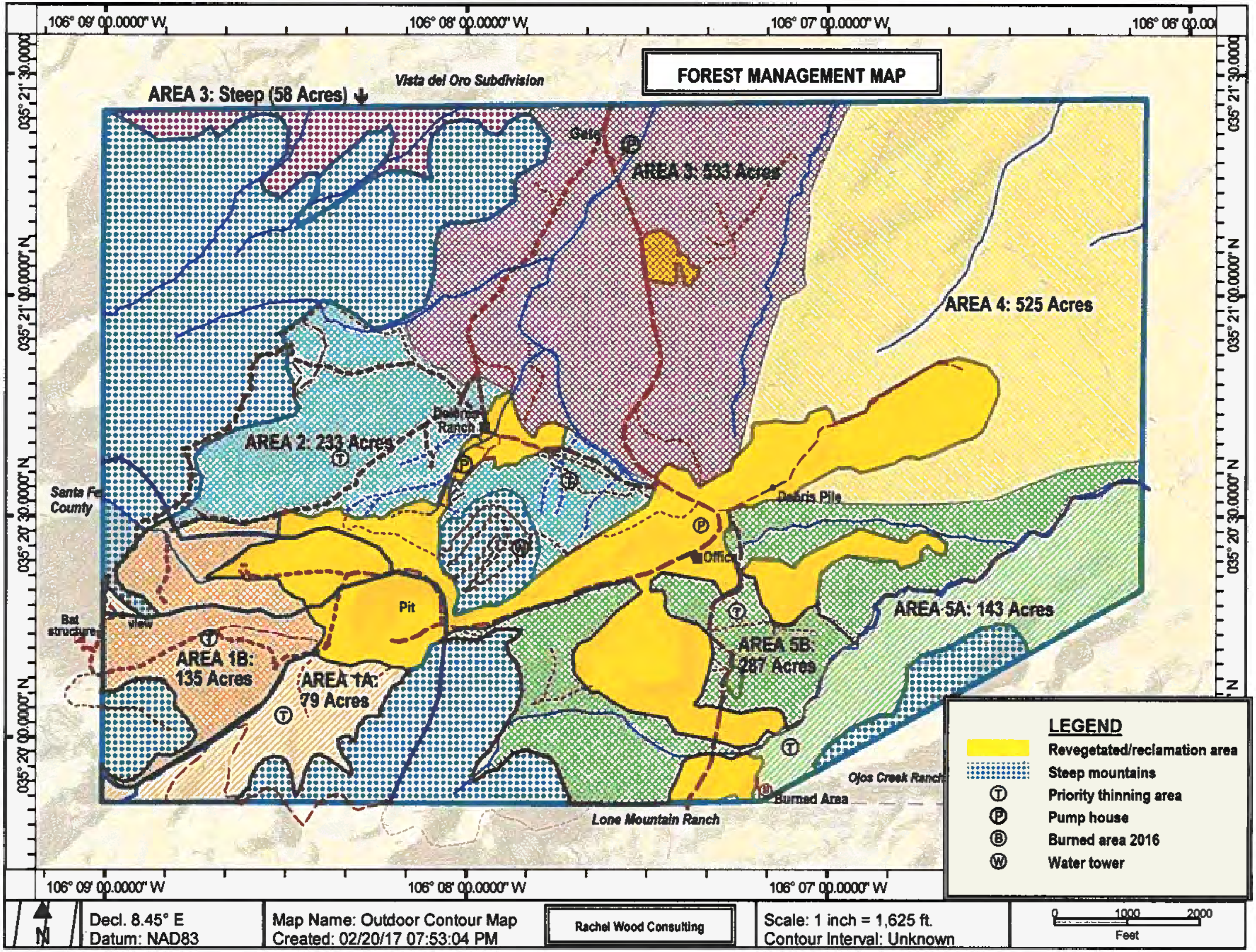

FOREST MANAGEMENT MAP
106° 09' 00.0000" W
106° 08' 00.0000" W
106° 07' 00.0000" W
106° 06' 00.00
035° 21' 30.0000
035° 21' 00.0000" N
035° 20' 30.0000" N
035° 20' 00.0000" N
AREA 3: Steep (58 Acres)
Vista del Oro Subdivision
Gate
AREA 3: 533 Acres
AREA 4: 525 Acres
AREA 2: 233 Acres
Ranch
Santa Fe County
Debris Pile
Office
Pit
AREA 5A: 143 Acres
AREA 5B: 287 Acres
Bat structure
view
AREA 1B: 135 Acres
AREA 1A: 79 Acres
Ojos Creek Ranch
Burned Area
Lone Mountain Ranch
LEGEND
Revegetated/reclamation area
Steep mountains
Priority thinning area
Pump house
Burned area 2016
Water tower
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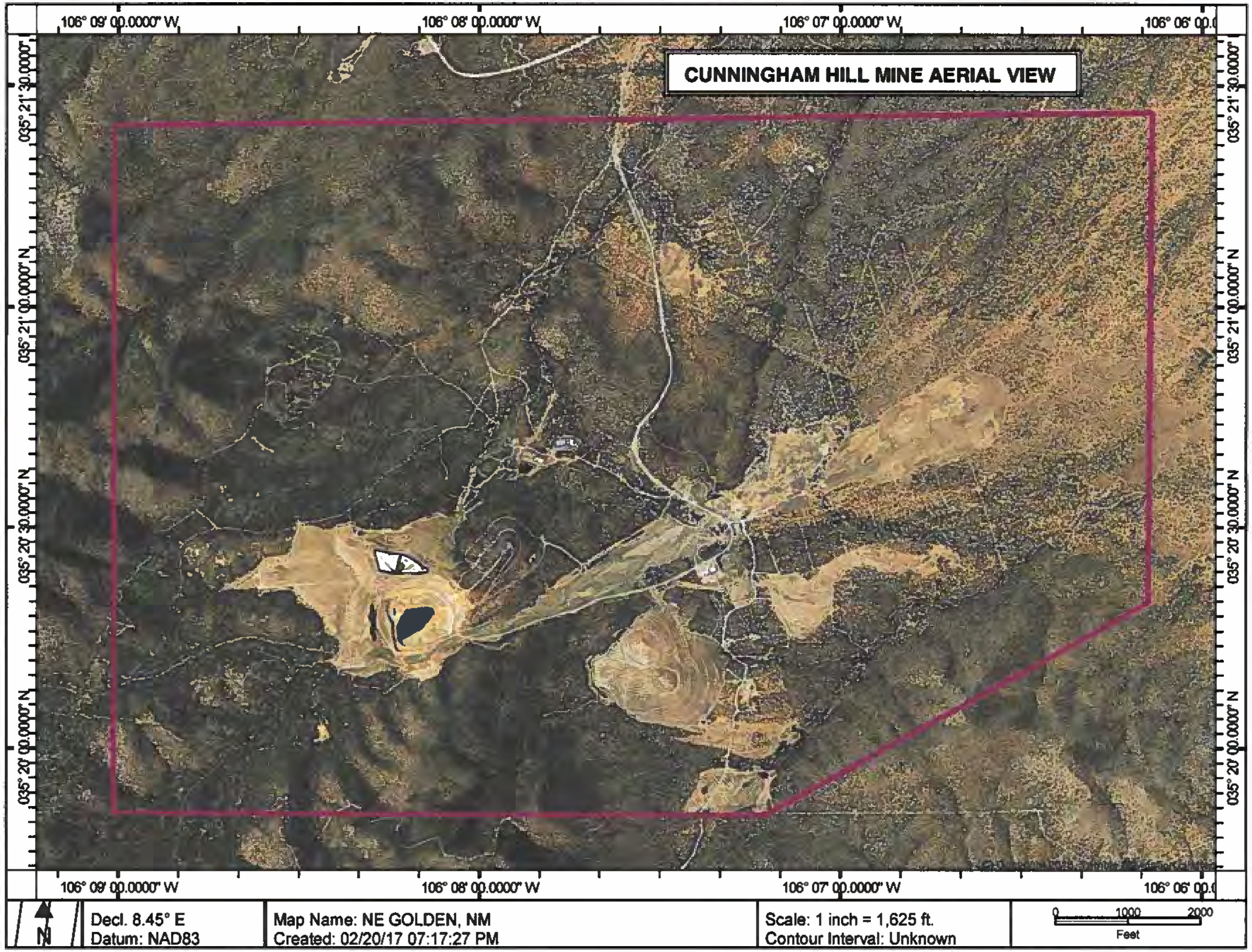
CUNNINGHAM HILL MINE AERIAL VIEW
106° 09' 00.0000" W
106° 08' 00.0000" W
106° 07' 00.0000" W
106° 06' 00.0
035° 21' 30.0000"
035° 21' 00.0000" N
035° 20' 30.0000" N
035° 20' 00.0000" N
N
Decl. 8.45° E
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Feet

Appendix D.

Photographs of native vegetation and wildlife in the Open Pit area at Cunningham Hill Mine Reclamation Project

Appendix D. Photographs showing native grasses, shrubs, trees, and wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

Appendix D. Photographs showing native grasses, shrubs, trees, and wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

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Appendix D. Photographs showing native grasses, shrubs, trees, and wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

Appendix D. Photographs showing evidence of wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

Appendix D. Photographs showing wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

Appendix D. Photographs showing wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

Appendix D. Photographs showing wildlife in the open pit area, Cunningham Hill Mine Reclamation Project.

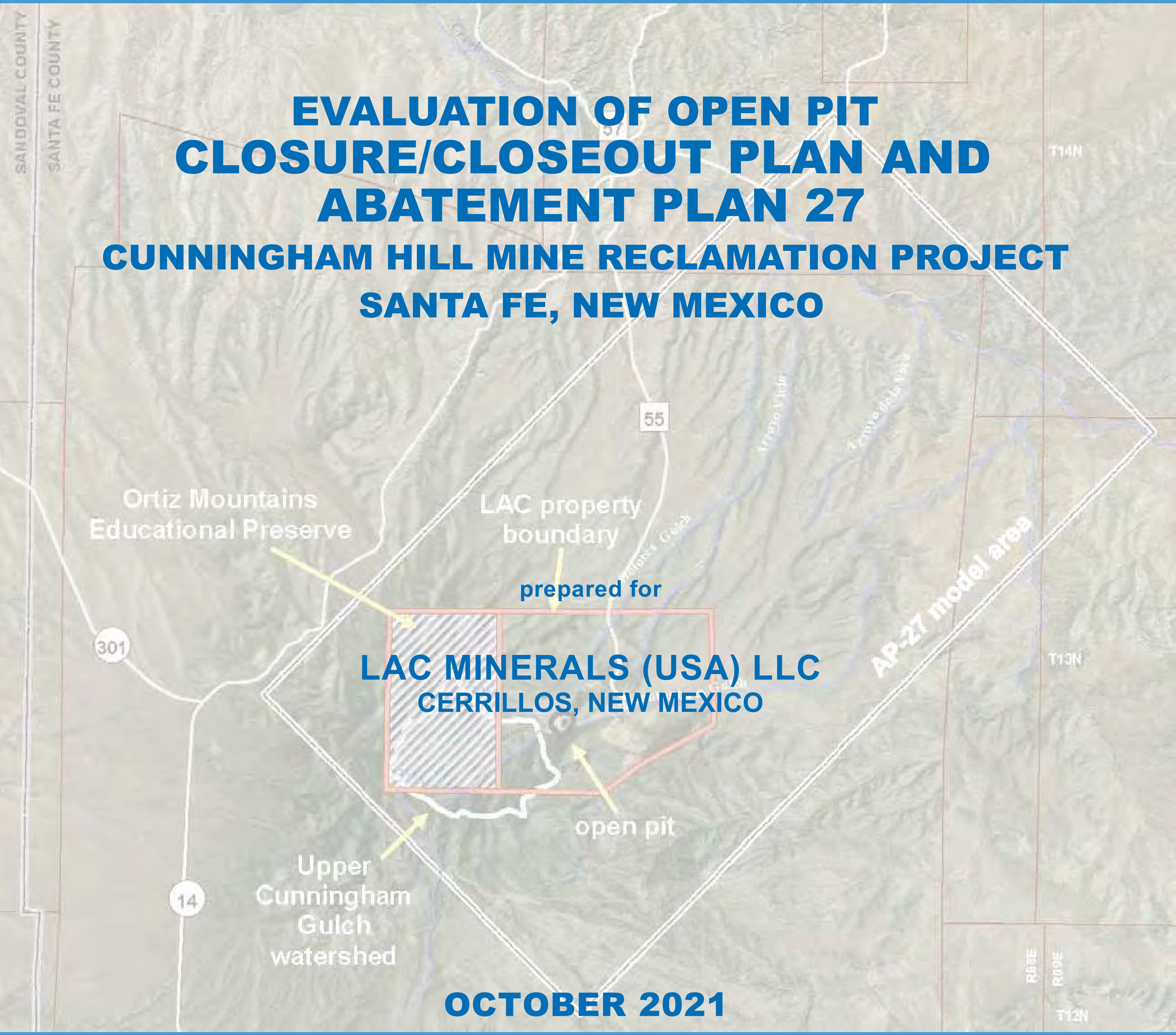
Appendix E.

Open Pit evaluation report by JSAI (2020)

EVALUATION OF OPEN PIT CLOSURE/CLOSEOUT PLAN AND ABATEMENT PLAN 27

CUNNINGHAM HILL MINE RECLAMATION PROJECT

SANTA FE, NEW MEXICO



prepared for

LAC MINERALS (USA) LLC

CERRILLOS, NEW MEXICO

OCTOBER 2021

JSAI

JOHN SHOMAKER & ASSOCIATES, INC.

WATER-RESOURCE AND ENVIRONMENTAL CONSULTANTS

ALBUQUERQUE, NM * www.shomaker.com * 505-345-3407

EVALUATION OF OPEN PIT CLOSURE/CLOSEOUT PLAN AND ABATEMENT PLAN 27,

CUNNINGHAM HILL MINE RECLAMATION PROJECT, SANTA FE COUNTY, NEW MEXICO

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Cerrillos, New Mexico 87010

October 2021

CONTENTS

page

TABLES

ILLUSTRATIONS

APPENDICES

(follow text)

Appendix A. Time-series concentration graphs for open pit pool constituents of concern and for AP-27 monitoring network

Appendix B. Membrane Filtration Treatment System Workplan

ABBREVIATIONS

ac-ft	acre feet
ac-ft/yr	acre-feet per year
AP-27	Abatement Plan 27
AWS	acid wall seepage
CCP	Closure/Closeout Plan
CHMRP	Cunningham Hill Mine Reclamation Project
DEM	Digital Elevation Model
ft amsl	feet above mean sea level
gpm	gallons per minute
HFO	hydrous ferric oxides
JSAI	John Shomaker & Associates, Inc.
LAC	LAC Minerals (USA), LLC
mg/L	milligrams per liter
MMD	Mining & Minerals Division of the Energy, Minerals & Natural Resource Department
NF	nanofiltration
NMED	New Mexico Environment Department
PHREEQC	PH REdox EQuilibrium program written in C
PMLU	Post-Mining Land Uses
PMP	Probable Maximum Precipitation
PZC	point of zero charge
RO	reverse osmosis
TDS	total dissolved solids
USGS	United States Geological Survey

EVALUATION OF
OPEN PIT CLOSURE/CLOSEOUT PLAN AND
ABATEMENT PLAN 27,
CUNNINGHAM HILL MINE RECLAMATION PROJECT,
SANTA FE COUNTY, NEW MEXICO

1.0 INTRODUCTION

John Shomaker & Associates, Inc. (JSAI) has prepared this report in response to the Mining and Minerals Division of the Energy, Minerals and Natural Resource Department (MMD) request (letter dated September 29, 2019) for Closure/Closeout Plan (CCP) revision for Permit No. SF002RE. The MMD-requested permit revision is based on changes to the Open Pit AP-27 reclamation plan. Locations of the Cunningham Hill Mine Reclamation Project (CHMRP) site and Open Pit are shown on Figure 1.

MMD concerns with the CCP are with the timing and reclamation of 13.8 acres of pit walls and benches by filling with stormwater (see Table 4; Fig. 12). The basis for these concerns is that the Open Pit has not filled as originally predicted.

LAC Minerals (USA), LLC (LAC), JSAI, MMD, and New Mexico Environment Department (NMED) representatives discussed CCP issues and options during a meeting held November 12, 2019. The group agreed that LAC will evaluate options and report back with justification for selected option before the MMD September 29, 2019 requested Permit Revision Application was due in 160 days (March 7, 2020).

As discussed during the meeting, there are three options to address these issues:

1. Clarify probability of Open Pit filling and timing with model considering a range of scenarios including the revised AP-27 reclamation plan.
2. Request a pit waiver and permit revision for Open Pit that does not fill.
3. Revision of CCP to address pit that does not fill and reclaim walls and benches.

The updated report, herein, addresses MMD comments submitted to LAC on April 21, 2021 and NMED comments submitted to LAC on June 4, 2021.

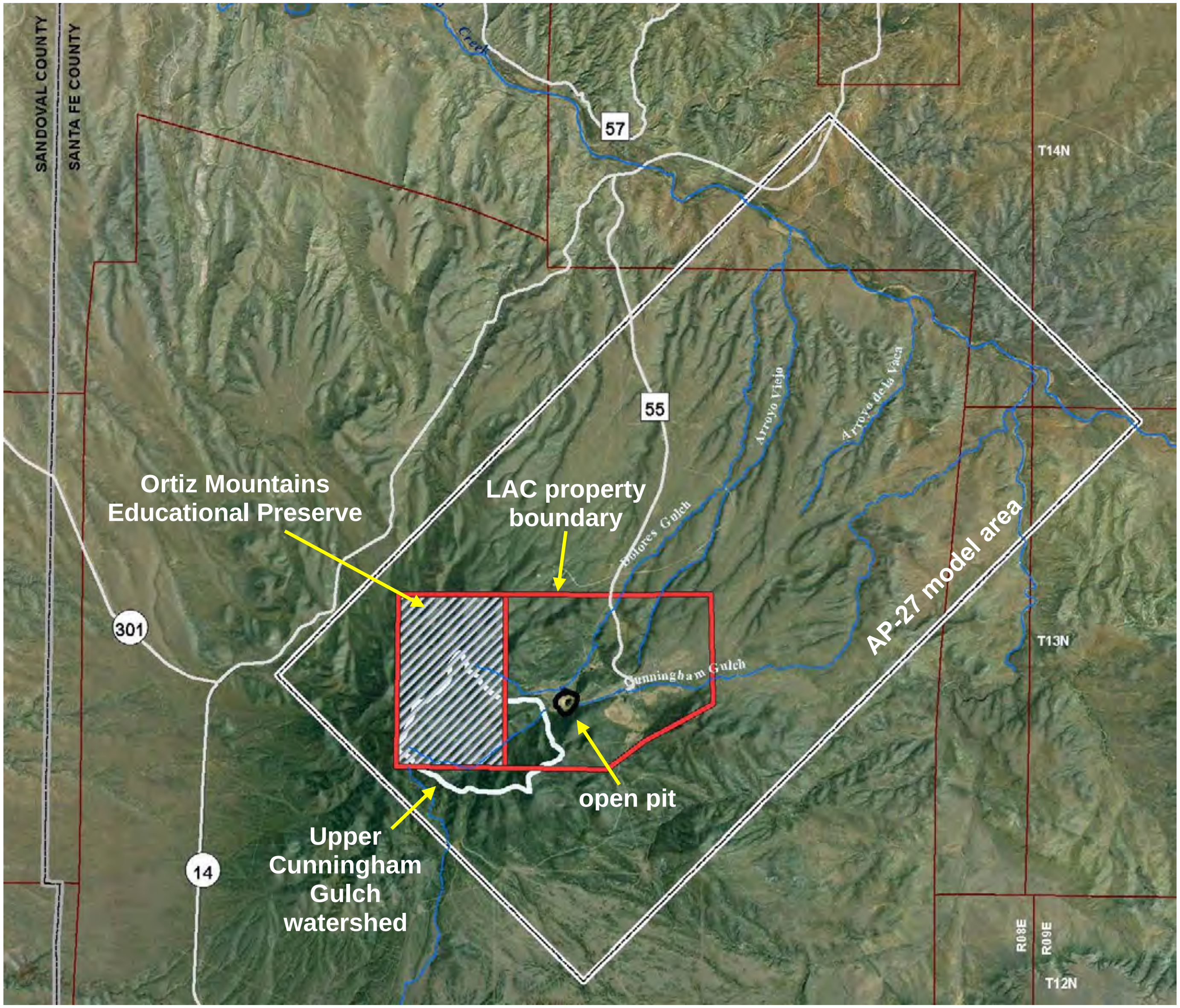


Figure 1. Map showing location of Cunningham Hill Mine Reclamation Project, the Open Pit, and receiving watershed, Santa Fe County, New Mexico.

1.1 Background

In the mid-1990s, the original intent for reclamation of the Open Pit was to allow stormwater runoff from Upper Cunningham Gulch to fill the pit and inundate the acid wall seepage (AWS). The pit rim area was reclaimed with cover material, and filling of the Open Pit with stormwater was to reclaim the remaining benches and pit walls below the 6,945-ft elevation. The CCP was approved in 1996, and then amended in 2001 to accommodate AP-27.

1.1.1 Closure/Closeout Plan (CCP)

The CCP for the Open Pit (Permit No. SF002RE) includes the following reclamation measures:

A. The uppermost portions of the north, west, and east sides of the Open Pit were graded and 8-ft-high berms were placed to intercept and divert runoff.

B. Cunningham Hill channel was blocked at its junction with Cunningham Gulch and the area was regraded to redirect surface water flowing in Cunningham Gulch into the Open Pit via a diversion channel. Erosion control measures were taken for flow paths into the pit. An outlet control structure was constructed at the low point of the Open Pit area to regulate flows. A channel was constructed to route flow from the Open Pit outlet control structure to the lower Cunningham Gulch channel when outflows occur.

C. The Open Pit was fenced and approaches to the Open Pit are posted to warn of steep slope hazards in the Open Pit. LAC will maintain gates preventing vehicle access to the entrance of the property and on the access road adjacent to the office site area.

D. Slopes on the northwest, west and south walls above the Open Pit access road were locally regraded as practicable to achieve gradients of approximately 3:1 or less. Regraded areas were covered with 12 in. of growth medium and reseeded. Open Pit benches on the upper southeast wall above the access road were graded. The benches were covered and reseeded.

E. Some benches were impractical to grade. They were ripped, covered with 12 in. of growth medium and reseeded. Roadways in the Open Pit above the final elevation of the Open Pit water body were ripped, covered with 12 in. of growth medium and reseeded. A roadway of minimal size was maintained around the northeast side of the Open Pit for access during the post-reclamation monitoring period. Following post-reclamation monitoring, the track will be reseeded.

F. Portions of the Open Pit and Open Pit slopes which cannot be reached by construction equipment but which exhibit characteristics amenable to vegetative establishment, including the upper portion of the south wall talus slope, were seeded as practicable.

G. Pit highwalls to be stabilized with wire mesh near the area of the access road.

Most of the items A through G listed above were implemented in the 1990s, and additional work has been performed as part of the 2011 revised reclamation plan (JSAI, 2011). In addition to requirements A through G, LAC installed stormwater conveyance and protection measures, caliche on road and benches, where accessible, as a source control measure, and thinned excessive undergrowth in the Upper Cunningham Gulch watershed.

The 1996 reclamation areas for the approved Open Pit CCP are illustrated on Figure 2. As approved, approximately 7.24 acres of Open Pit walls and benches remained un-reclaimed. Filling of the Open Pit with stormwater is to reclaim 13.8 acres of open pit benches and walls. Figure 3 is a graph of model-simulated open pit filling.

1.1.2 Abatement Plan 27 (AP-27)

The un-reclaimed Open Pit has been impacted by AWS, resulting in elevated concentrations of sulfate, total dissolved solids (TDS), manganese, and cobalt. AP-27 acknowledges, as the Open Pit fills, some of the impacted water will migrate into the surrounding groundwater. AP-27 applies to alternative abatement standards for sulfate, TDS, manganese, and cobalt in groundwater outside of the Open Pit and within a defined area inside the LAC property boundary. The gradual filling of the Open Pit with water is expected to reduce contaminant concentrations in the Open Pit and the impact on surrounding groundwater system.

Abatement Plan AP-27 requirements:

1. Impacts to groundwater quality shall be addressed through diversion of Upper Cunningham Gulch into the pit and short-term treatment of the Open Pit using reverse osmosis.
2. Comply with Performance Standard APS-1 and Contingency Plan APC-1.
3. Observe sulfate trigger levels for Open Pit pool as outlined in APS-1 and APC-1.
4. Surface water quality addressed as outlined in Performance Standard CHP-1.
5. Perform quarterly monitoring as outlined in CHP-1.
6. Perform monitoring of Open Pit pool and groundwater monitoring wells MW84-7 and MW79-3 as described in Performance Standard APS-1. NMED added monitoring requirements for MW95-53 and MW95-54 as part of the revised reclamation plan (JSAI, 2011) (see Fig. 4 for locations).

No diversion and a diversion of 82 acre-feet per year (ac-ft/yr) were simulated by JSAI (1999) (Fig 3). The model-simulated Open Pit filling graphs were submitted for AP-27 (NMED, 2002) and to the MMD to fulfill the requirements for a reclamation schedule for the Open Pit (MMD, 2002).

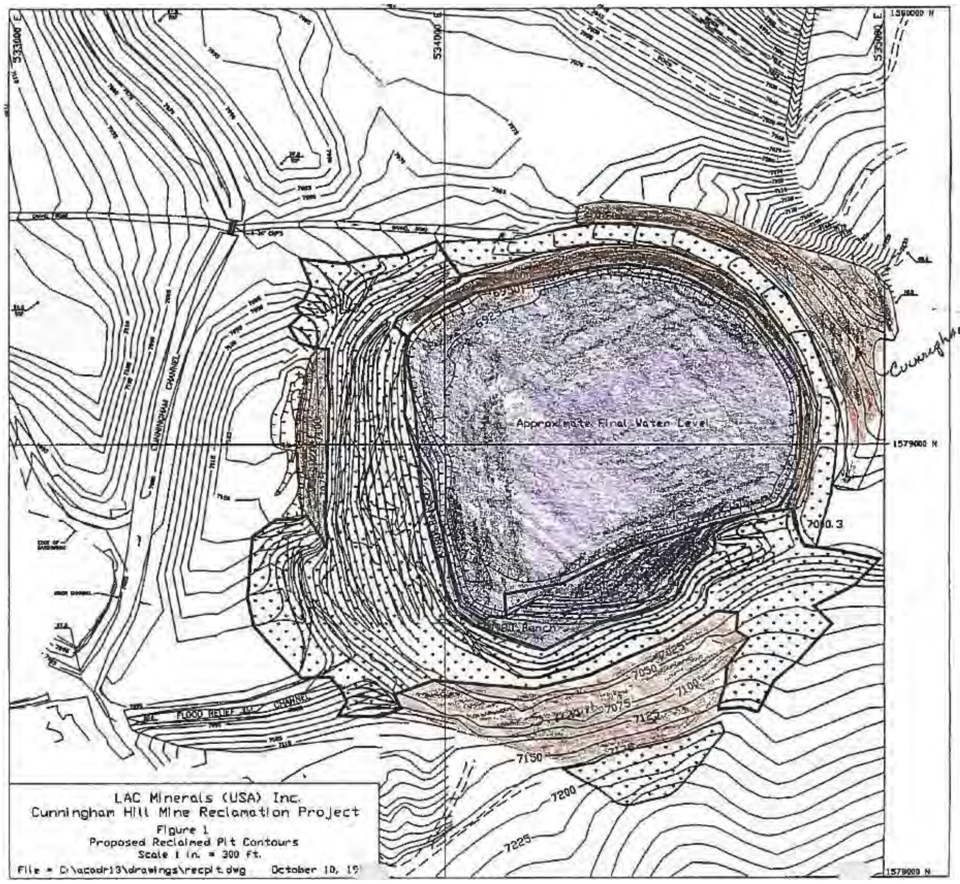


Figure 2. Map showing 1996 CCP Open Pit reclaimed areas.

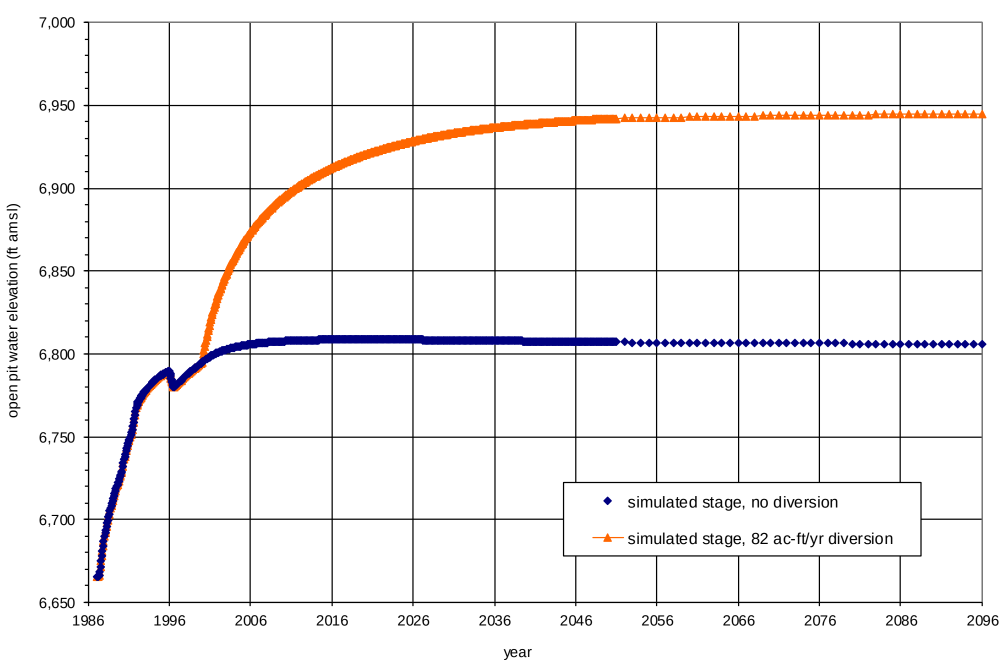


Figure 3. Graph of model-simulated Open Pit filling with no diversion and with 82 ac-ft/yr diversion (from JSAI (1999) original model).

Figure 4. Map showing locations of Open Pit and surrounding monitoring wells, Cunningham Hill Mine Reclamation Project, Santa Fe County, New Mexico.

1.1.3 Timeline

The following is a timeline regarding Open Pit AP-27 reclamation efforts and compliance:

2001	JSAI model report states Open Pit will fill to the 6,945-ft elevation in 50 years, considering: 1. an average runoff of 82 ac-ft/yr 2. maximum 100-year 24-hr precipitation event = 3.6 in.
2002	AP-27 issued (NMED, 2002) and CCP permit revision 96-1 to permit SF002RE (MMD, 2002)
2003	Reverse osmosis (RO) treatment completed, but removed more water than anticipated due to extreme drought and low treatment efficiency
2009	AP-27 pilot program employed to mitigate APC-1 Trigger No. 1 (JSAI, 2009)
2010	Model recalibrated as required by AP-27 APC-1 Trigger No. 2 (JSAI, 2011)
2011	Revised Open Pit Reclamation Plan submitted to NMED (JSAI, 2011)
2014	Status report regarding revised reclamation plan (JSAI, 2014)
2015 to 2018	Implement source controls: 1. repairs to Upper Cunningham Gulch diversion structures 2. stormwater controls for receiving runoff area west of pit 3. in pit stormwater controls 4. repair access roads by installing caliche base 5. cap largest remaining bench area with caliche and install runoff controls 6. thinning LAC controlled properties in receiving watershed
2018 to current	Implement Open Pit treatment
2019	Precipitation event 2.5 in. in less than 30 minutes occurred and generated 15 acre-feet runoff. The event was more concentrated than the 100-year 24-hr Probable Maximum Precipitation (PMP), and considered outside of the realm of probabilities known from existing datasets.

AP-27 water-quality standards are projected to be met after implemented source-water controls and Open Pit treatment.

2.0 REVISED OPEN PIT FILLING SCENARIOS

The purpose of this section is to clarify the probability of Open Pit filling and timing with the model, considering a range of scenarios including the revised AP-27 reclamation plan.

2.1 Calibrated Model

The AP-27 groundwater flow and transport model was updated and recalibrated in 2011 (JSAI, 2011). Improvements to the updated and recalibrated model included the following:

1. Revised Open Pit evaporation rate of 40 in./yr
2. Recalculated stormwater runoff rate from upper Cunningham Gulch to better reflect watershed conditions from 2001 to 2011 (0 to 14.5 ac-ft/yr).
3. Recalibration of vertical conductance in the Open Pit area.

The recalibrated model provided an excellent match to observed data (JSAI, 2011), and is the proper tool for evaluating stormwater runoff and pit filling scenarios. The biggest water budget component affecting the Open Pit filling and fill rate is stormwater runoff from Upper Cunningham Gulch.

2.2 Stormwater Runoff

Stormwater runoff from Upper Cunningham Gulch has been difficult to predict, because runoff rates and volumes depend on watershed conditions and precipitation patterns. In the late 1980s to late 1990s, the Upper Cunningham Gulch was predominately vegetated with ponderosa pine and limited under brush. Above-normal precipitation and snow pack resulted in measured runoff of near 80 ac-ft/yr. Adrian Brown (1997) estimated Upper Cunningham Gulch stormwater inflow to range from 40 to 160 ac-ft/yr. JSAI (1999) used an average value of 82 ac-ft/yr for Upper Cunningham Gulch stormwater runoff. A precipitation event during the first week of August 1999 resulted in approximately 500 ac-ft of runoff; however, almost all of the flow was diverted to Dolores Gulch.

From 1995 to current, the Upper Cunningham Gulch watershed became severely overgrown with underbrush, and intercepted most of the potential stormwater flows. Based on observed overgrowth conditions, JSAI (2011a) recalculated stormwater runoff from Upper Cunningham Gulch watershed at 14.5 ac-ft/yr. It was identified in 2009, that the Upper

Cunningham Gulch diversion channel infiltrated stormwater up-gradient of the weir rather than convey stormwater to the Open Pit. No significant stormwater was measured at the Upper Cunningham Gulch diversion channel weir from 2001 to 2015. Measurable quantities of diverted stormwater began in 2015 after the diversion channel was fixed (Table 1).

Table 1. Summary of annual precipitation and measured Upper Cunningham Gulch stormwater diversions

year	total precipitation (inches)	Upper Cunningham Gulch diversion channel weir flow (ac-ft)	Open Pit watershed drain(s) (ac-ft)	comments
2011	11.17	0.00		
2012	8.72	0.00		
2013	16.51	0.01		
2014	13.09	0.00		
2015	18.55	0.79	1.13	fixed UCG diversion
2016	12.96	0.15	0.30	
2017	15.46	1.73		watershed thinning
2018	13.97	1.54		watershed thinning
2019	16.78	20.15		

ac-ft - acre-feet
UCG - Upper Cunningham Gulch

2.2.1 Watershed Conditions

As identified in the revised AP-27 reclamation plan by JSAI (2011), the condition of the watershed affects the quantity of stormwater generated from Upper Cunningham Gulch. LAC began a watershed thinning project in 2017, and approximately 90 acres were mechanically thinned. Figure 5 is a map showing the areas thinned. It is likely the measured stormwater diversion in 2019 (Table 1) was partly a result of the thinning project.

Forest fires have a major effect on post-fire stormwater runoff. Typically, Ponderosa pine forests experience a fire return interval of 2 to 47 years (Fitzgerald, 2005). The longer the fire return interval or fire suppression, the higher the potential for fire intensity. There has not been a fire in Upper Cunningham Gulch watershed for over 40 years.

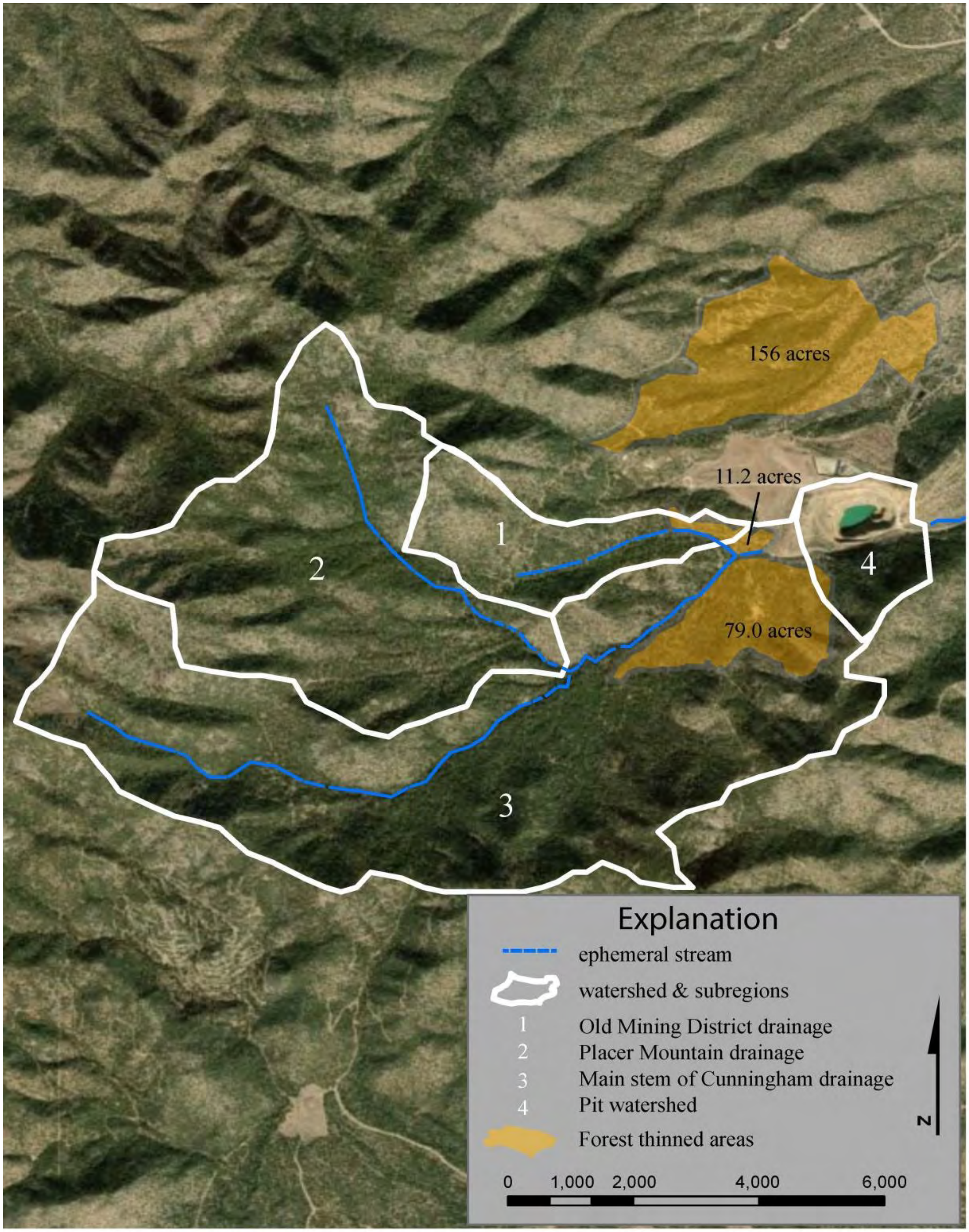


Figure 5. Aerial photograph showing Upper Cunningham Gulch watershed, watershed sub-regions, and Open Pit watershed area.

Post-fire runoff will be significantly greater than current conditions, and can be up to 45 percent of precipitation (Johansen et al., 2001). Post fire runoff could be as high as 172 ac-ft/yr (JSAI, 2011).

2.2.2 Precipitation Patterns

Over the last 20 years, measured annual precipitation at the Cunningham Hill Mine Reclamation Project has averaged 13.27 in./yr and varied from 7.49 to 18.55 in./yr. Snowpack, snowmelt rates, rain-on-snow events, and precipitation events are more important to stormwater runoff than annual precipitation. The frequency of these events and the magnitude are difficult to predict, particularly stormwater generated from rain-on-snow, and snowmelt events. For example, during August 2019, 2.5 in. of precipitation fell in less than 30 minutes. The event is more concentrated than the 100-year PMP, and considered outside of the realm of probabilities known from existing datasets.

2.2.3 Revised Stormwater Runoff Scenarios

Originally JSAI (1999) provided simulated Open Pit filling scenarios for two stormwater runoff conditions: 1) above-normal stormwater runoff conditions (82 ac-ft/yr), and 2) drought (no diversions of runoff) (Fig. 3). The updated model by JSAI (2011a) provided an evaluation of stormwater runoff calculations based on changes in watershed conditions and concluded the average stormwater runoff of 4.5 ac-ft/yr best represented 2001 to 2011 conditions. Effects of watershed thinning, and forest fire events on stormwater runoff, were not considered previously.

A summary of four potential stormwater runoff scenarios (A through D) is presented in Table 2, and described as follows:

1. Scenario A – no appreciable diversion of stormwater flows. This condition actually occurred from 2001 to 2014 (see Table 1), largely due to issues with the Upper Cunningham Gulch diversion structure; therefore, the minimum diversion scenario is not expected to occur in the future.
2. Scenario B - the minimum diversion of 4.2 ac-ft/yr, representative of persistent drought conditions with watershed over growth (no re-occurring forest fire).
3. Scenario C - the average diversion of 14.5 ac-ft/yr of stormwater flows with some watershed over growth conditions.
4. Scenario D - the average 14.5 ac-ft/yr of diverted stormwater flow with the inevitable re-occurring fires every 30 years generating 172 ac-ft per event.

Stormwater runoff Scenarios A through C most likely represent future conditions.

Table 2. Summary of potential stormwater runoff scenarios for Upper Cunningham Gulch watershed

scenario	stormwater runoff scenario	estimated diversion rate (ac-ft/yr)
A	no appreciable diversion of stormwater flows	0
B	minimum diversion of stormwater flows	4.2
C	average runoff with overgrowth	14.5
D	average runoff with overgrowth and 30-yr watershed fire frequency	14.5 (172 ac-ft)

ac-ft/yr - acre-feet per year

2.3 Model-Simulated Scenarios

The updated and recalibrated groundwater flow model (JSAI, 2011a) was used to evaluate Open Pit filling resulting from the stormwater runoff Scenarios A through C (Fig. 6). Current Open Pit water-level elevation is 6,798.5 feet above mean sea level (ft amsl). The model-predicted steady state Open Pit water level is 6,800 ft amsl, with the potential to rise to 6,840 ft amsl. Regardless of the scenario, near steady-state Open Pit water levels are observed today. The maximum expected Open Pit water level is 6,840 ft amsl (Fig. 6), which would require large stormwater events every 30 years and an average input of 14.5 ac-ft/yr of stormwater over the next 60 to 70 years. The observed rise in Open Pit water levels over the last 4 years has been at an average rate of 2.0 ft/yr (Fig. 7). The last 6 years have shown a 10-ft rise in water levels at PW77-01 (Fig. 7), indicating a change in groundwater recharge up-gradient of the Open Pit.

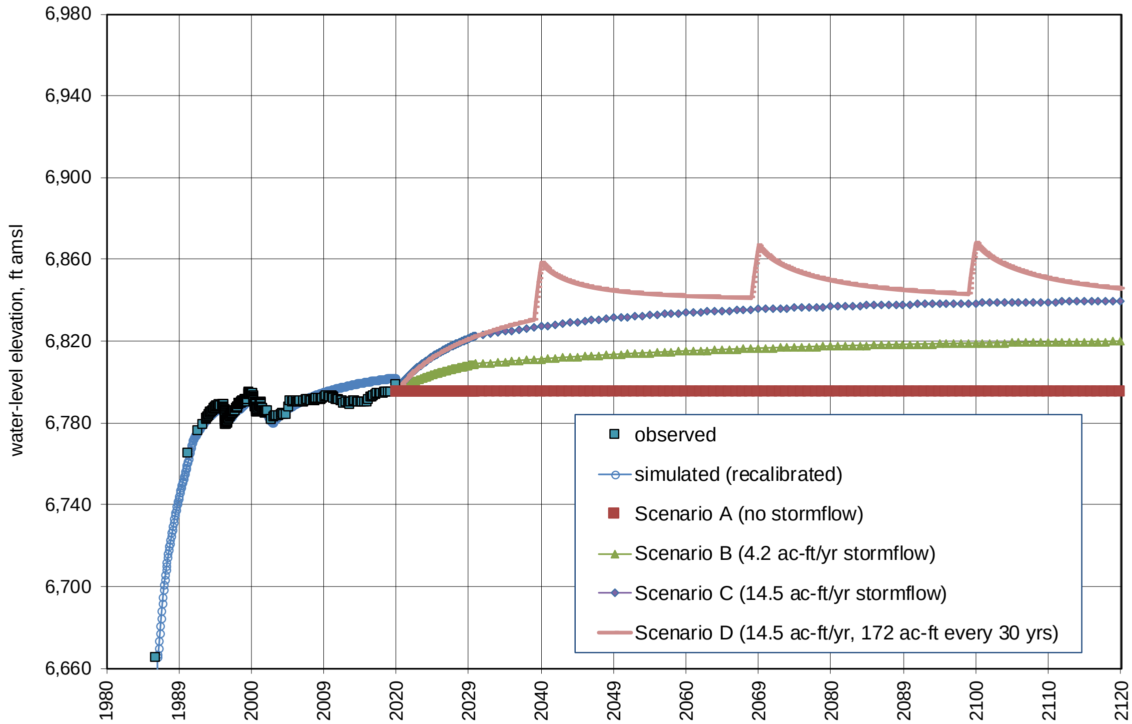


Figure 6. Graph of observed Open Pit water levels, model-calibrated water levels, and model-simulated pit filling scenarios.

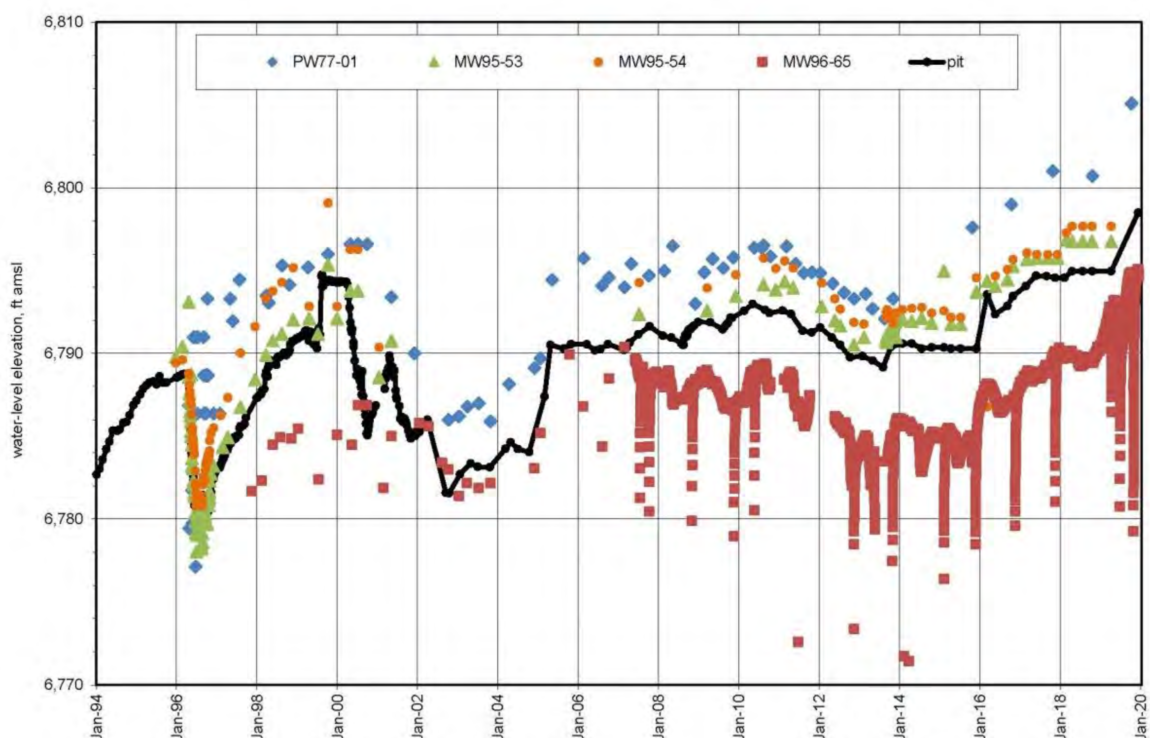


Figure 7. Graph showing observed water levels at the Open Pit and nearby monitoring wells, from 1994 through 2019.

Pre-mining groundwater levels for the Open Pit area ranged from 6,895 to 6,925 ft amsl (Hydro-Geo Consultants, 1994) (Fig. 8). The former up-gradient Open Pit dewatering well, PW77-01, had a water level of 6,920 ft amsl in 1977 (pre-mining), and currently has a water level of 6,805 ft amsl (Fig. 8). Open Pit dewatering wells PW77-01 and PW79-02 are connected to the same fracture system (Golden Fault Zone). PW77-01 is located up-gradient of the Open Pit and PW79-02 is located down-gradient of the Open Pit (Fig. 4). Water-level data from PW77-01 indicate the fracture system connected to the Open Pit has not readily recharged and recovered from dewatering during mining that occurred between 1979 and 1987. Recharge to groundwater system up-gradient of the Open Pit is needed for efficient pit filling with diverted stormwater.

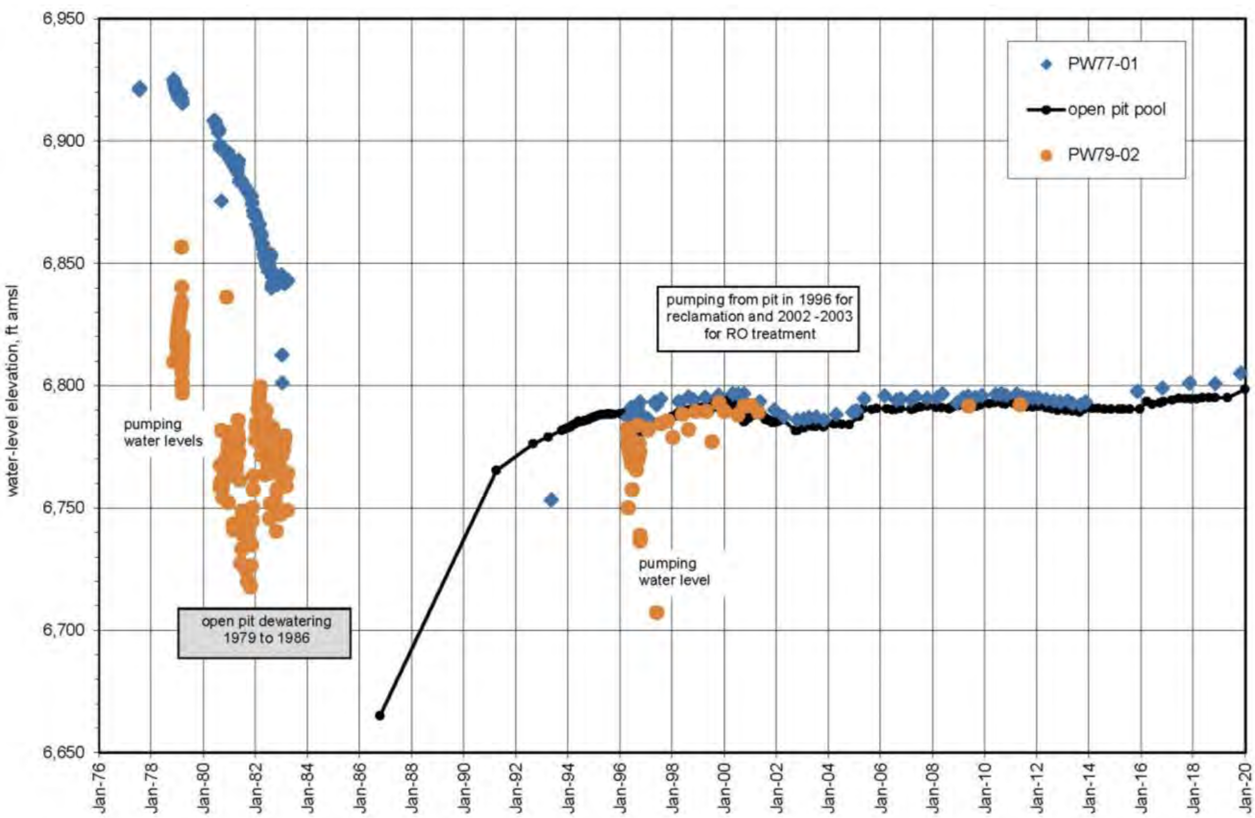


Figure 8. Graph showing observed water levels at the Open Pit and nearby dewatering wells, from 1976 through 2019.

3.0 ABATEMENT PLAN 27 (AP-27)

Implementation of the revised reclamation plan for AP-27 (JSAI, 2011) has resulted in significant progress with source controls. The revised plan called for implementing source controls first, followed by pit water treatment, then improvements to facilitating stormwater diversions for pit filling. It is important to note that the original plan involved partial filling of the Open Pit with diverted stormwater to an elevation of 6,925 ft amsl without the use of source controls. The first 10 years of AP-27 resulted in drought (JSAI, 2011; 2011a) with little to no Open Pit filling, and it was found to be difficult to maintain AP-27 surface water standards for pH and alkalinity, and groundwater trigger concentrations for sulfate and TDS. With implementation of source controls, it was concluded the AP-27 standards could be maintained without filling the Open Pit to 6,945 ft amsl with stormwater (JSAI, 2011).

3.1 Open Pit Pool Characteristics

Since 2002, water quality from the Open Pit pool has been sampled quarterly at pool depths of 4, 15, 45, and 75 ft, according to requirements set forth in AP-27. Water-temperature data with respect to pool depth have shown that system turns over and mixes seasonally. Presented as Figure 9 is a graph showing temperature profiles for year 2020. Temporary stratification occurs when a thermocline develops during the late summer months.

Geochemical modeling was performed on AP-27 2nd Quarter 2021 field and lab analyses results from the Open Pit pool utilizing PH REdox EQuilibrium program written in C (PHREEQC), an open-source program developed and distributed by the United States Geological Survey (USGS). The purpose of the geochemical equilibrium modeling was to evaluate current Open Pit chemistry and post nanofiltration (NF) treatment pit chemistry. The intent of the NF treatment is to achieve AP-27 alternative abatement standards for discharge to groundwater.

Based on the period of record (Appendix A), sulfate (SO_4^{2-}) and manganese (Mn) are the primary constituents of concern for meeting the Open Pit water-quality standards. Saturation indices (SI) show that the pit water is saturated with respect to iron (Fe) oxides, hydroxides, and oxyhydroxides, generally referred to herein as hydrous ferric oxides (HFO). The Open Pit pool is in near equilibrium with respect to SO_4^{2-} salts (e.g., gypsum).

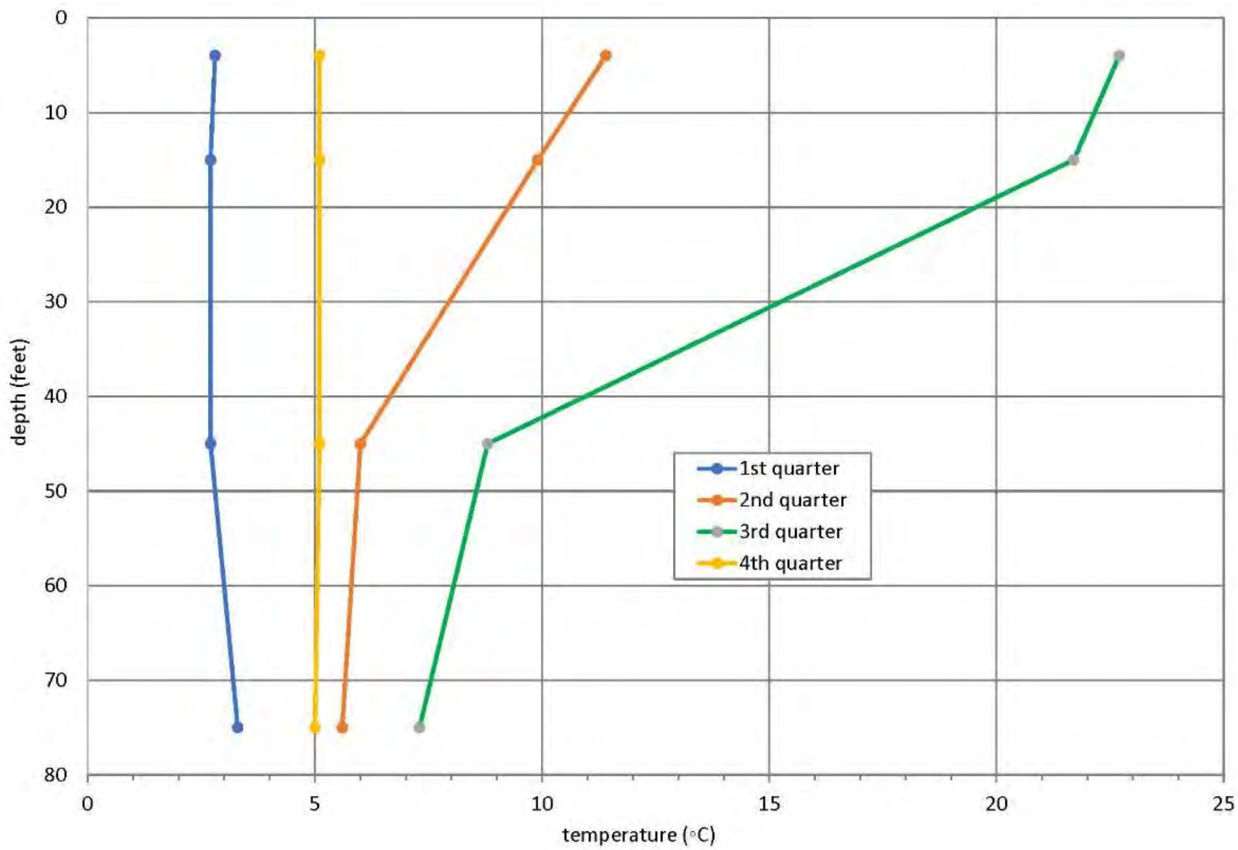


Figure 9. Graph showing Open Pit pool temperature profiles for year 2020.

In order to simulate the blending of NF-treated pit water with alkaline groundwater sources, sulfate was adjusted to the target concentration of 600 milligrams per liter (mg/L), and calcium was reduced to achieve a charge balance. Trace metal concentrations were adjusted down by the corresponding percentage reduction in dissolved solids, even though metal concentrations will be significantly reduced by NF treatment process (see Appendix B). The PHREEQC model simulation results for the NF treatment were similar to the current chemistry, but with lower positive saturation indices for sulfate salts. Mineral hardness will remain above 400 mg/L.

A mechanism that controls the concentration of dissolved metals in solutions is adsorption. Adsorption occurs when an adsorbate accumulates on a solid surface (i.e., ions in solution attaching onto mineral precipitates, specifically HFOs). Metal-oxide minerals, such as the HFOs, that are an abundant precipitate in the model-simulated pit water, and are one of the most important sorbent minerals in natural systems (Smith, 1999). When in contact with water, hydroxyl groups (OH^-) form on the surface of metal-oxide minerals (Stumm, 1992; Smith, 1999). The charge of the surface of the metal-oxide minerals is dependent on the pH of the water and as such pH is the controlling variable for surface-binding reactions of metals on oxide minerals. Under acidic conditions, the surface of metal-oxide minerals retain excess protons. This produces a net positive charge leading to anions being absorbed. Neutral and alkaline pH values will produce the opposite, where the surface of the metal-oxide minerals have a net negative charge. This results in metals being adsorbed onto the HFO (Smith, 1999).

The point of zero charge (PZC) is the range of pH values in which the net surface charge is zero (Stumm, 1992; Smith, 1999). As pH increases, cation adsorption will increase from zero to nearly 100 percent, typically within a pH range of 1 to 2 units (Smith, 1999). Generally, the PZC pH values for HFOs are 4.2 to 7.5 (Stumm, 1992; Smith, 1999). At pH values greater than 7.5, sorption curves of metals onto HFOs are approaching or at 100 percent (Smith, 1999).

The average field-measured pH for the pit water for 2nd Quarter 2021 was 7.28. When combined with the model-simulated results of the pit waters being saturated to super-saturated with respect to HFOs, an ideal environment for the sorption of trace metals onto HFOs is achieved.

3.2 Surface Water Quality Standards

Based on correspondence from the NMED (2021), AP-27 will be updated to include applicable surface-water standards related to 20.6.4.99 NMAC. As specified by NMED (2021), Open Pit pool surface water quality requirements are for protection of livestock watering, wildlife habitat, and limited aquatic life. Presented as Table 3 are the applicable water-quality standards for AP-27, as proposed by NMED (2021) for update, and the Open Pit pool 2nd Quarter 2021 water-quality results. Time-series graphs of selected constituent concentrations for the Open Pit pool can be referenced from Appendix A. Constituents of concern include sulfate, TDS, alkalinity, iron, and manganese.

Established AP-27 surface-water quality standards along with January 2020 Open Pit water quality results are summarized in Table 3.

Table 3. Summary of AP-27 groundwater and surface-water quality standards and monitoring results

constituent	unit	AP-27 groundwater discharge Standard	surface water trigger level	Livestock Watering Standard	Wildlife Habitat Standard	Limited Aquatic Life - Acute Standard	Open Pit water body (4 ft depth) [2] May 2021	comment
alkalinity	mg/L		<20				37	
pH	S.U.	6 to 9					7.6	
chloride	mg/L	250					23.8	
sulfate	mg/L	1,200 b					**1,570**	
TDS	mg/L	2,000 b					**2,340**	
conductance	µS/cm		6,300				2,670	
aluminum [1]	mg/L	5				10.07	<0.40	
arsenic	mg/L	0.01		0.2		0.34	<0.125	
boron	mg/L	0.75		5.0				
cadmium [1]	mg/L	0.005		0.05		0.0065	0.000527	
chlorine residual	mg/L				0.011	0.019	<0.0002	January 2020 lab analysis
chromium III [1]	mg/L					1.77		total chromium is less than Cr III standard
chromium VI	mg/L					0.016	na	need lab analysis
chromium	mg/L	0.05		1.0			<0.030	
cobalt	mg/L	0.2 b		1.0			0.0469	
copper [1]	mg/L	1		0.5		0.05	0.04	January 2020 lab analysis
iron	mg/L	1					<0.50	
lead [1]	mg/L	0.002		0.1		0.28	<0.0075	January 2020 lab analysis
manganese [1]	mg/L	4.0 b				4.738	2.23	
mercury	mg/L	0.002			0.01	0.0014	<0.00020	
molybdenum	mg/L	1				7.920	<0.008	January 2020 lab analysis
nickel	mg/L	0.2				1.51	0.0237	January 2020 lab analysis
selenium	mg/L	0.05		0.05	0.005	0.02	<0.0030	
silver [1]	mg/L	0.05				0.035	na	need lab analysis
vanadium	mg/L			0.1			<0.005	January 2020 lab analysis
zinc [1]	mg/L	10		25		0.564	0.164	

b AP-27 groundwater discharge standard
red indicates exceedance of applicable standard
CHMRP - Cunningham Hill Mine Reclamation Project

TDS - total dissolved solids
mg/L - milligrams per liter
µS/cm - microsiemens per centimeter

The Open Pit water-quality constituents of concern are likely manganese and copper for limited aquatic life. Open Pit manganese concentrations tend to spike then attenuate (Fig. 10). Manganese and copper concentrations will be significantly reduced when the Open Pit is treated for sulfate and TDS. A use-attainability analysis can be performed for limited aquatic life if elevated manganese concentrations are suspected to persist.

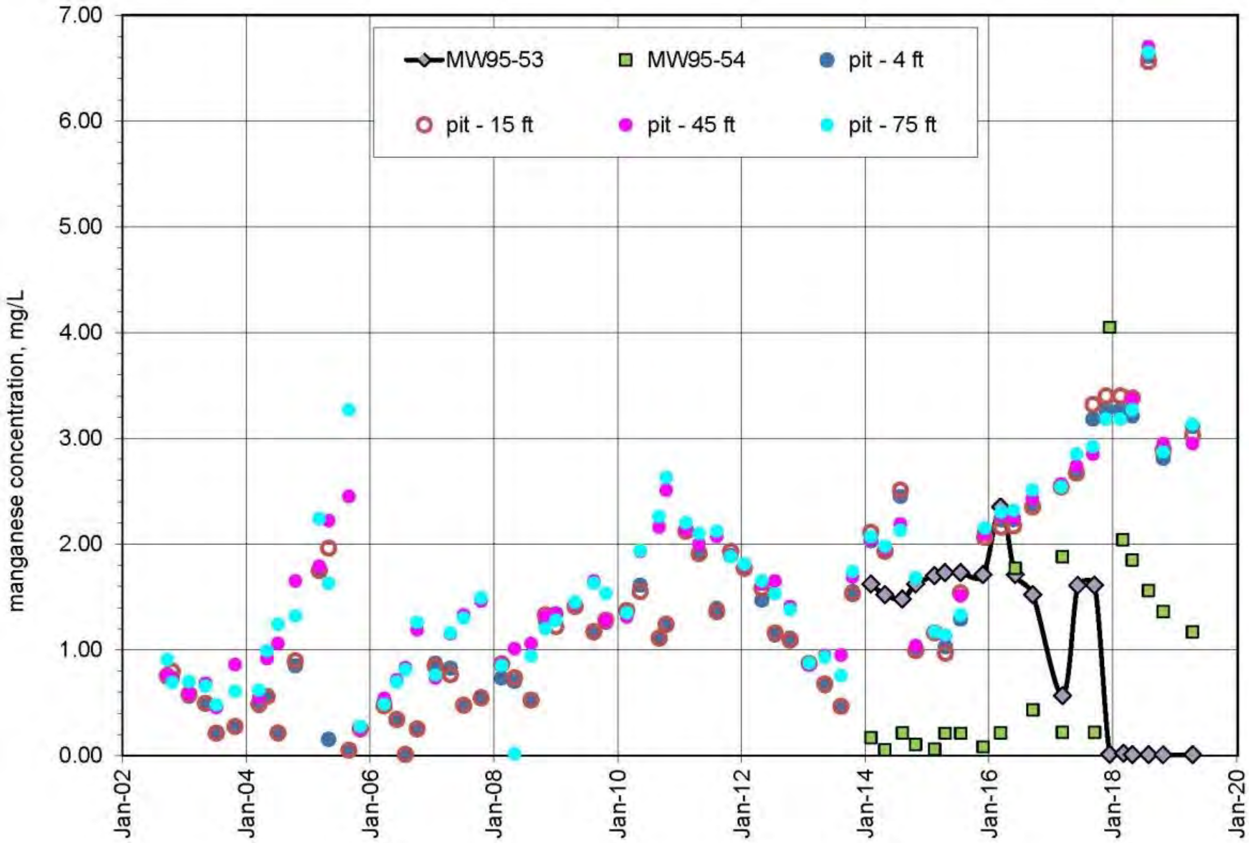


Figure 10. Graph showing manganese concentrations at the Open Pit and nearby monitoring wells, from 2002 through 2019.

3.3 Discharges to Groundwater

Based on observed water-level data (Figs. 6 and 7) and the recalibrated model (JSAI, 2011a), the Open Pit water body has been near equilibrium with the adjacent groundwater. As a result, there have been little to no discharges to groundwater over the past 19 years.

Model recalibration resulted in a maximum Open Pit discharge to groundwater rate of 7.5 gpm (12 ac-ft/yr); however, water-level data suggest that prior to 2019 the Open Pit pool is not discharging to groundwater on the down-gradient side of the pit at the pit perimeter wells MW95-53 or MW95-54 (Fig. 7). Recent water-quality data from MW95-53 suggest the Open Pit pool is discharging to groundwater as evidenced from elevated sulfate concentrations (Fig. 11).

The current Open Pit water quality does not meet the AP-27 groundwater discharge standards for sulfate and TDS (Table 3). Open Pit sulfate loading occurred after RO treatment (2002) and prior to implementation of source controls in 2014 (Fig. 11). Sulfate concentrations appear to have stabilized since implementation of source controls in 2014 (Fig. 11).

The post RO increase in sulfate concentrations activated AP-27 Performance Standard APS-1, Trigger 1: sulfate concentrations greater than 1,000 milligrams per liter (mg/L) for eight consecutive quarters. JSAI assisted LAC with implementing the contingency plan required under AP-27, and determined that treatment of Open Pit pool water could not be performed until source controls were implemented (JSAI, 2011).

Open Pit manganese concentrations have recently spiked above the AP-27 groundwater discharge standard of 4 mg/L (Fig. 10). Down-gradient monitoring well MW95-54 has been below AP-27 sulfate, TDS, and manganese standards for discharge to groundwater. Monitoring well MW95-53 is near or above the AP-27 sulfate, TDS, and manganese standards for discharge to groundwater (Figs. 10 and 11; Appendix A).

JSAI (2001; 2011) extensively evaluated the transport of solutes from the Open Pit to down-gradient groundwater. For the pit filling scenario, there is a greater rate of discharge to groundwater from the Open Pit pool, but lower solute concentrations due to dilution. For the drought scenario (no stormwater), there is a lower rate of discharge to groundwater (4 to 8 gpm) that results in a maximum transport distance of 750 ft down-gradient along the Golden Fault Zone toward dewatering well PW79-02. Pit perimeter monitoring well MW95-53 would have the highest sulfate and TDS concentrations due to its proximity to the Open Pit pool (300 ft down-gradient). Water-quality data from PW79-02 do not indicate impacts from the up-gradient open pit (Appendix A).

As described in the revised AP-27 remediation plan, with source controls in place, the Open Pit water body will need water treatment in order to meet the requirements of AP-27 groundwater standards. It is anticipated long-term AP-27 water quality standards will be obtained after water treatment and with continued inputs of diverted stormwater from Upper Cunningham.

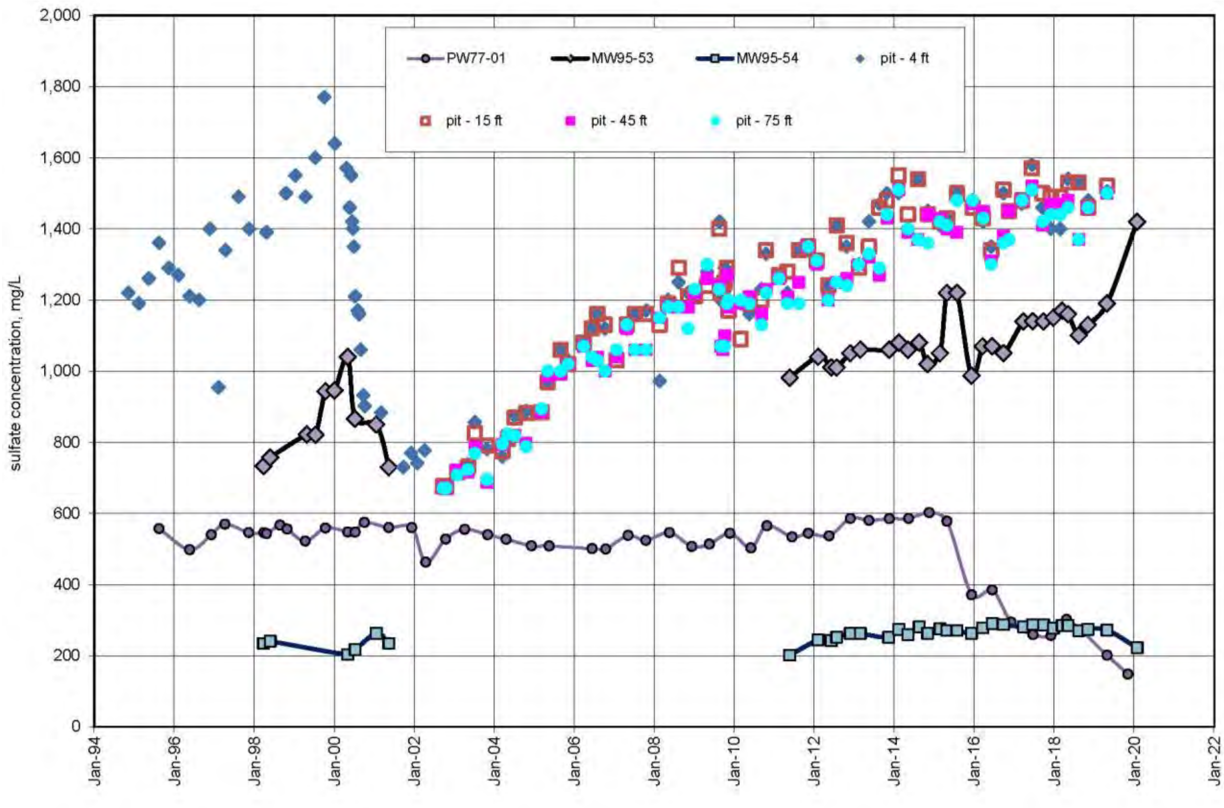


Figure 11. Graph showing sulfate concentrations at the Open Pit and nearby monitoring wells, from 1994 through 2020.

3.4 Open Pit Pool Source Controls and Water Treatment

Open Pit pool source controls have been implemented as part of the revised AP-27 remediation plan (JSAI, 2011a). The primary purpose of the source controls was to reduce or eliminate AWS in the open pit. Source controls include repairs to the Upper Cunningham Gulch Diversion, implementation of storm water controls, and covering open pit access roads with caliche. No AWS have been observed since source controls have been completed.

Open Pit pool water treatment has included pH mitigation and membrane filtration. The revised plan allows for the use of alkaline groundwater sources rather than hydrated lime for pH control. It was determined that nanofiltration (NF) water treatment with addition of alkaline groundwater would be the recommended treatment method (JSAI, 2011). A workplan for NF treatment and NMED approval is attached as Appendix B. It is expected that NF treatment will also improve water quality at MW95-53.

4.0 CLOSURE/CLOSEOUT PERMIT

The CCP is largely based on reclaimed areas for the Open Pit. The 1996 reclaimed areas were based on an Open Pit water elevation of 7,000 ft amsl (Fig. 2, Table 4). JSAI reconstructed the 1996 areas in GIS with a 2019 Digital Elevation Model (DEM) accurate to the 1-meter scale (Fig. 12). Reclaimed areas include the re-vegetated areas, and the surface area of the Open Pit water body (Fig. 12, Table 4). Un-reclaimed areas include the exposed Open Pit walls and benches.

The 1996 reclaimed areas were adjusted to include portions of the Open Pit watershed (Fig. 13), which changes the total area from 34.13 acres (Table 4) to 40.26 acres (Table 5). The changes in area reclaimed by elevation of Open Pit water surface were then evaluated. Open Pit water-surface elevation of 6,795, and 6,840 ft amsl were considered. The Open Pit water surface of 6,795 ft amsl represents current conditions. The Open Pit water surface of 6,840 ft amsl represents modeled stormwater diversion Scenarios B and C (Table 2).

Table 4. Summary of 1996 CCP Open Pit reclaimed and un-reclaimed areas

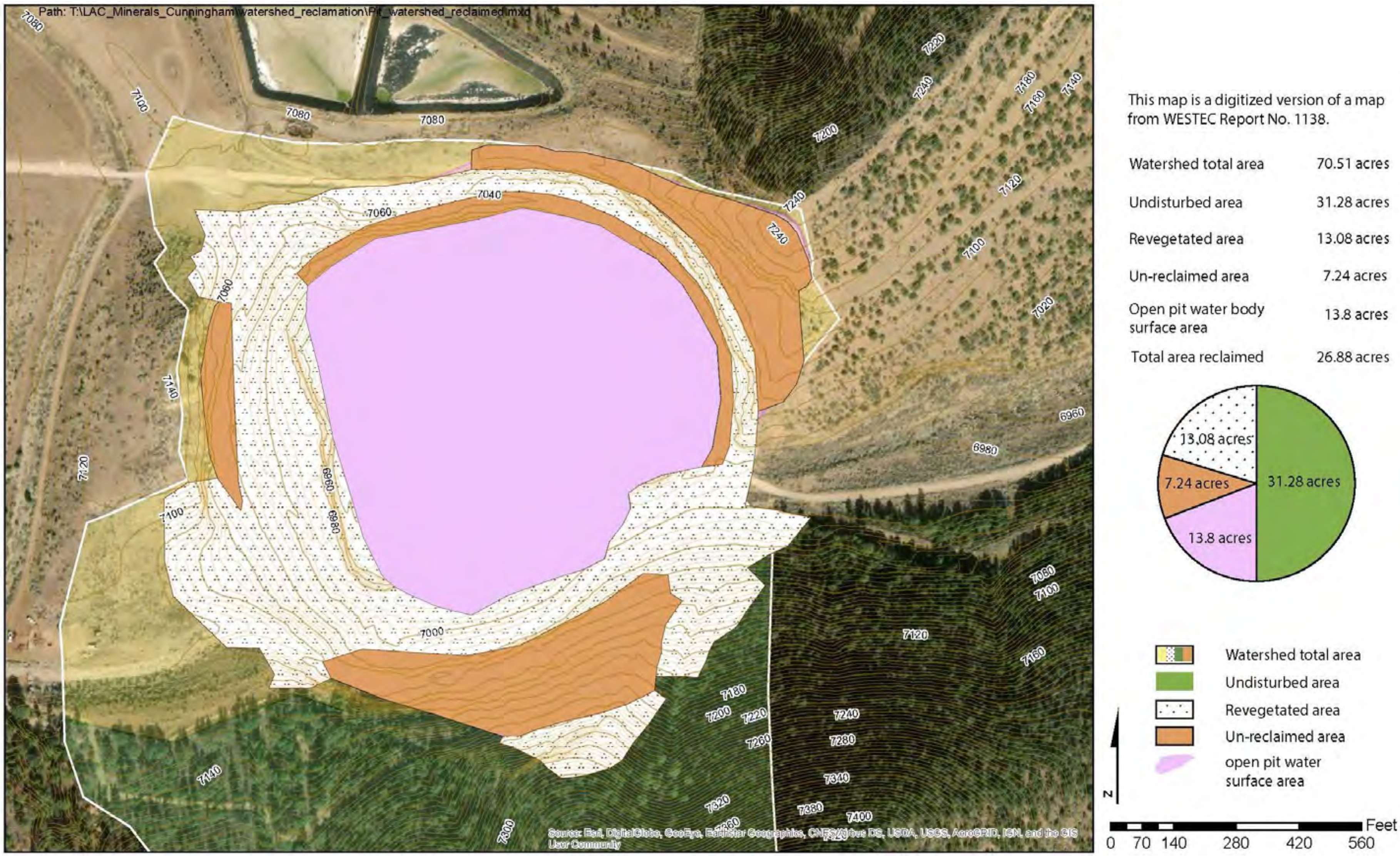
acreage	CCP 1996 acreage	percent of CCP 1996 acreage
area of Open Pit and high walls	34.13	100.0
area of Open Pit water surface	13.80	40.4
un-reclaimed areas of pit walls (total)	7.24	21.2
area revegetated	13.08	38.3
total area reclaimed	26.89	78.8

CCP – Closure/Closeout Plan

Table 5. Summary of reclaimed Open Pit watershed areas for different modeled water surface areas

acreage	Open Pit water surface at 6,795 ft amsl	percent of total acreage	Open Pit water surface at 6,840 ft amsl	percent of total acreage
area of Open Pit and high walls	40.26	100.0	40.26	100.0
area of Open Pit water surface	2.82	7.0	4.65	11.6
un-reclaimed areas of pit walls (total)	16.55	41.1	14.72	36.6
area revegetated	20.89	51.9	20.89	51.8
total area reclaimed	23.71	58.9	25.54	63.4

ft amsl - feet above mean sea level



Aerial photo April 27, 2020

Figure 12. Map showing 1996 reclamation plan for Cunningham Hill Mine Open Pit.

Aerial photographs showing the calculated reclaimed and un-reclaimed areas for Open Pit water elevations of 6,795 and 6,840 ft amsl are presented as Figures 12 and 13. The total reclaimed Open Pit watershed area slightly varies for each Open Pit water-surface elevation evaluated. The difference in area between an Open Pit water elevation of 6,795 ft amsl (current condition) and 6,840 ft amsl (maximum future condition) is about 1.8 acres.

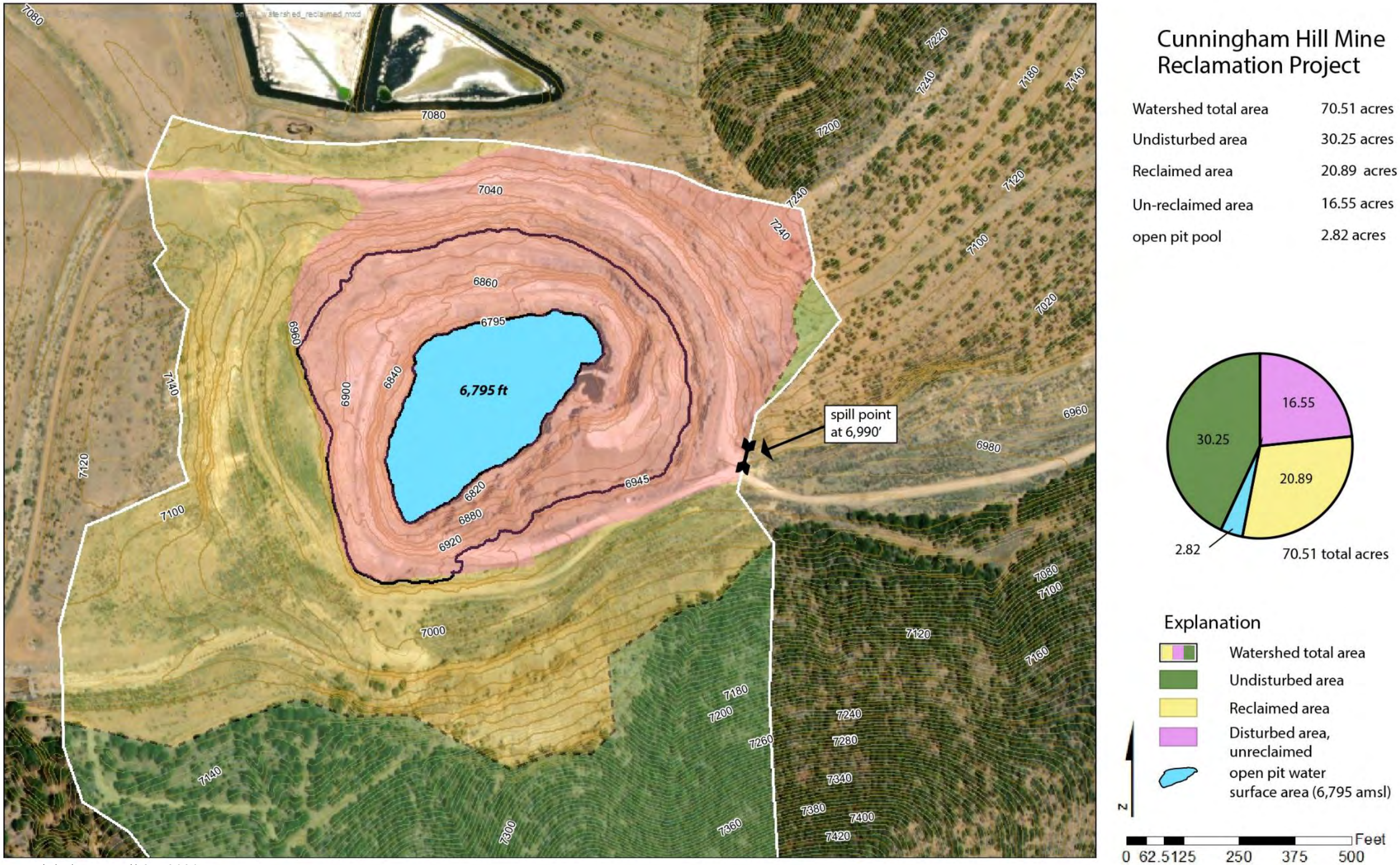
4.1 Post-Mining Land Use (PMLU)

The MMD regulations for mine closure are designed to achieve the requirements for Post-Mining Land Uses (PMLU) and a Self-Sustaining Ecosystem. The approved PMLU for the permit area are wildlife habitat and livestock grazing. The permit applicant has to demonstrate that the activities to be permitted or authorized will be expected to achieve compliance with all applicable air, water quality and other environmental standards if carried out as described in the Mining Act Closeout Plan, as required by §19.10.5.506.J(5) of the Rules. The Open Pit pool water quality standards will likely change to livestock, wildlife, and limited aquatic life. The underlining importance is the ability of the Open Pit to meet water quality suitable for the designated uses (Table 3).

4.2 Self-Sustaining Ecosystem

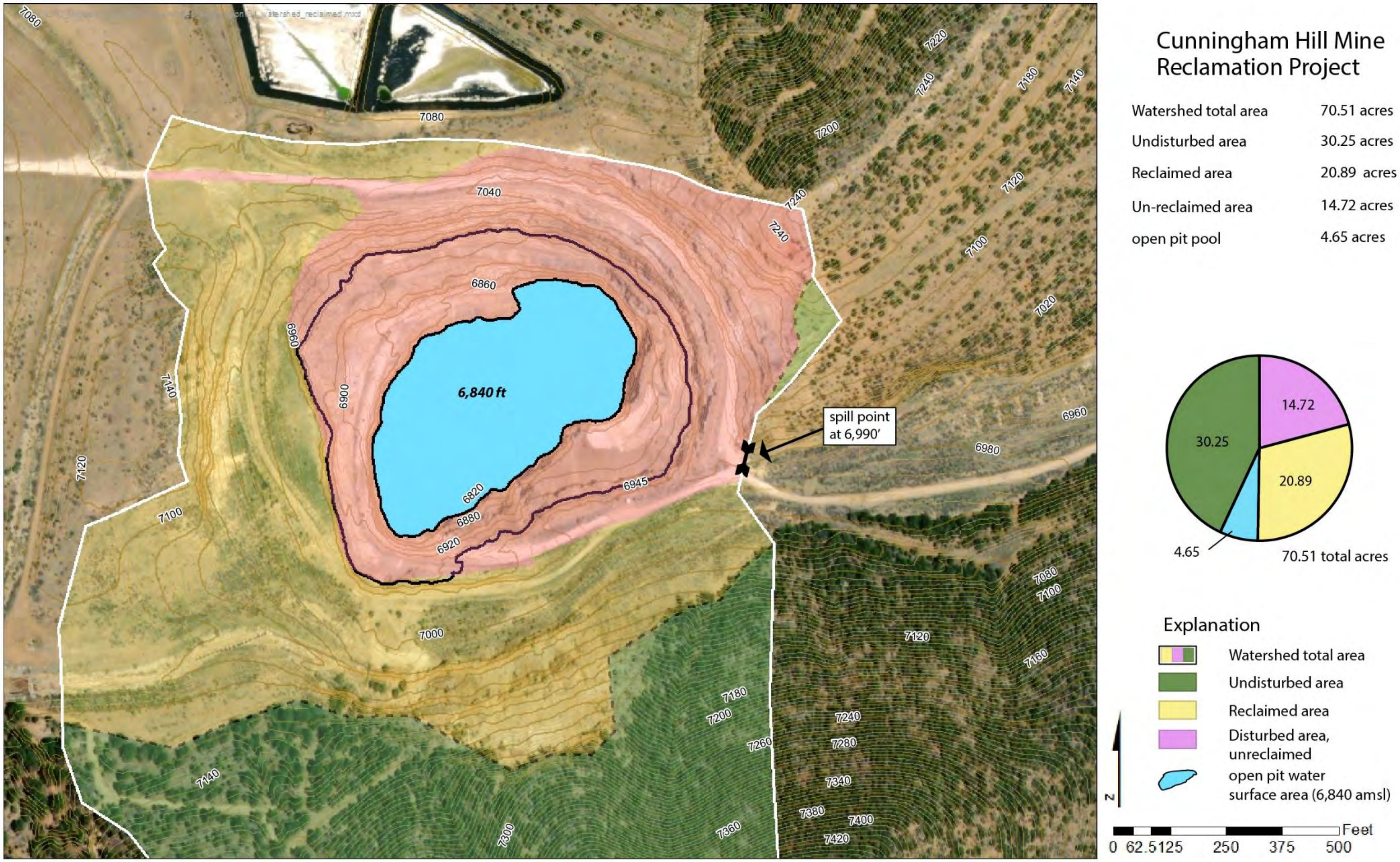
The MMD definition for "Self-sustaining ecosystem" is reclaimed land that is self-renewing without augmented seeding, amendments, or other assistance which is capable of supporting communities of living organisms and their environment. A self-sustaining ecosystem includes hydrologic and nutrient cycles functioning at levels of productivity sufficient to support biological diversity. The Open Pit will not meet the Self-Sustaining Ecosystem requirements, because the pit will not fill beyond its current level. However, the revised AP-27 reclamation plan includes source controls and does not require filling of the Open Pit beyond the current elevation to meet water-quality standards.

Prior to the Open Pit, there was no surface water for wildlife and livestock. The addition of a permanent water source that meets and self-maintains surface water quality standards will be an AP-27 requirement.



Aerial photo April 27, 2020

Figure 13. Map showing reclamation plan for Cunningham Hill Mine Open Pit with fill level of 6,795-ft elevation.



Aerial photo April 27, 2020

Figure 14. Map showing reclamation plan for Cunningham Hill Mine Open Pit with fill level of 6,840-ft elevation.

4.3 Evaluation of Permit Revision or Waiver

"Revision" means a modification to a permit that has a significant environmental impact and requires public notice and an opportunity for public hearing. The MMD regulations state the following for performance and reclamation standards and requirements:

19.10.5.507 PERFORMANCE AND RECLAMATION STANDARDS AND REQUIREMENTS:

> **A.** The permit area will be reclaimed to a condition that allows for re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas following closure unless conflicting with the approved post-mining land use. Each closeout plan must be developed to meet the site-specific characteristics of the mining operation and the site. The closeout plan must specify incremental work to be done within specific time frames to accomplish the reclamation.
>
> **B. Waiver for Pits and Waste Units** An operator may apply for a waiver for open pits or waste units from the requirement of achieving a post-mining land use or self-sustaining ecosystem. The operator must show that achieving a post-mining land use or self-sustaining ecosystem is not technically or economically feasible or is environmentally unsound. The Director may grant the waiver for an open pit or waste unit if he finds:
>
> > **(1)** measures will be taken to ensure that the open pit or waste unit will meet all applicable federal and state laws, regulations and standards for air, surface water and ground water protection following closure; and
> >
> > **(2)** the open pit or waste unit will not pose a current or future hazard to public health or safety.

The revised AP-27 remediation plan provided measures without a specific time frame to complete the reclamation. Open Pit pool pH mitigation has been ongoing since 1996, and it is unknown if AWS source controls will eliminate the need for re-occurring pH mitigation. The source control measures discussed in the AP-27 status report (JSAI, 2014) have been completed and implemented. A water treatment system has been designed and constructed, with the system startup in summer of 2021. The water treatment system will operate seasonally for several years until cleanup standards are achieved (Appendix B).

The Open Pit currently contains a continuous source of water that is accessible to wildlife and livestock that was not there prior to the Open Pit. Wildlife is currently using the Open Pit water, and there are no livestock on property. The current Open Pit pool chemistry meets the standards for wildlife, as long as pH controls measures are maintained. The CCP should be updated to provide additional technical analysis regarding the Justification for a pit waiver.

A pit waiver for SSE is recommended if LAC chooses not to stick with the CCP as written in 1996. The waiver would also result in an update of the required surface-water standards in AP-27 and update of the CCP. The reason for a waiver is the remaining exposed pit walls, and benches are considered to not achieve the PMLU.

5.0 CONCLUSIONS

5.1 AP-27

The revised AP-27 remediation plan called for implementing source controls first followed by improvements to facilitating stormwater diversions for pit filling. It is important to note that the original plan involved partial filling of the Open Pit with diverted stormwater to an elevation of 6,925 ft amsl without the use of source controls. The first 10 years of AP-27 resulted in drought (JSAI, 2011; JSAI, 2011a) with little to no Open Pit filling, and it was found to be difficult to maintain AP-27 surface water standards for pH and alkalinity, and groundwater trigger concentrations for sulfate and TDS. With the implementation of source controls, the AP-27 standards may be maintained without filling the Open Pit to 6,945 ft amsl with stormwater.

With source controls in place, the revised AP-27 remediation plan requires Open Pit water treatment in order to meet the requirements of AP-27 groundwater standards. It is anticipated long-term AP-27 water quality standards will be obtained after water treatment and with continued inputs of diverted stormwater from Upper Cunningham.

The expected steady-state Open Pit water levels is 6,800 with the potential for the pool level to rise to 6,840 ft amsl (Fig. 6). The observed rise in Open Pit water levels over the last 10 years has been at an average rate of 0.8 ft/yr (Fig. 7).

5.2 Closure/Closeout Plan (CCP)

The total reclaimed Open Pit watershed area varies for each Open Pit water surface elevation evaluated. The difference in area between an Open Pit water elevation of 6,795 ft amsl (current condition) and 6,945 ft amsl (previous estimate) is about 11 acres.

As long as AP-27 water-quality standards are maintained, the Open Pit should meet the PMLU for wildlife habitat and livestock watering. Prior to the Open Pit, there was no surface water for wildlife and livestock.

The CCP should be updated to provide additional technical analysis regarding the justification for a pit waiver for SSE. Based on the analysis of stormwater flows, the pit walls and benches will remain un-reclaimed.

6.0 REFERENCES

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APPENDIX

Appendix A.

Time-series concentration graphs for open pit pool constituents of concern

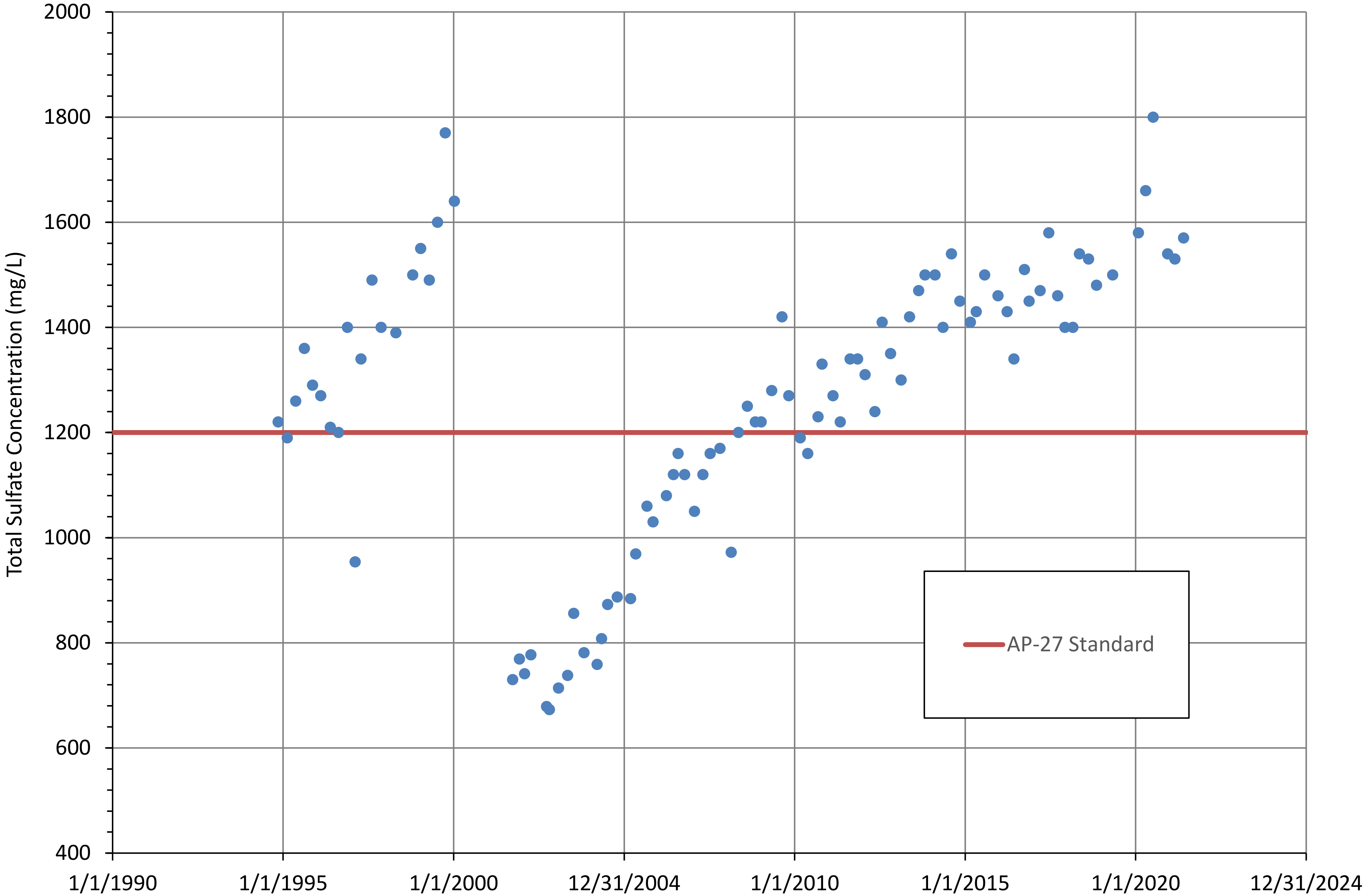

Figure A1. Time-series graph of sulfate Concentration 4 ft depth CHMRP Open Pit Water body.

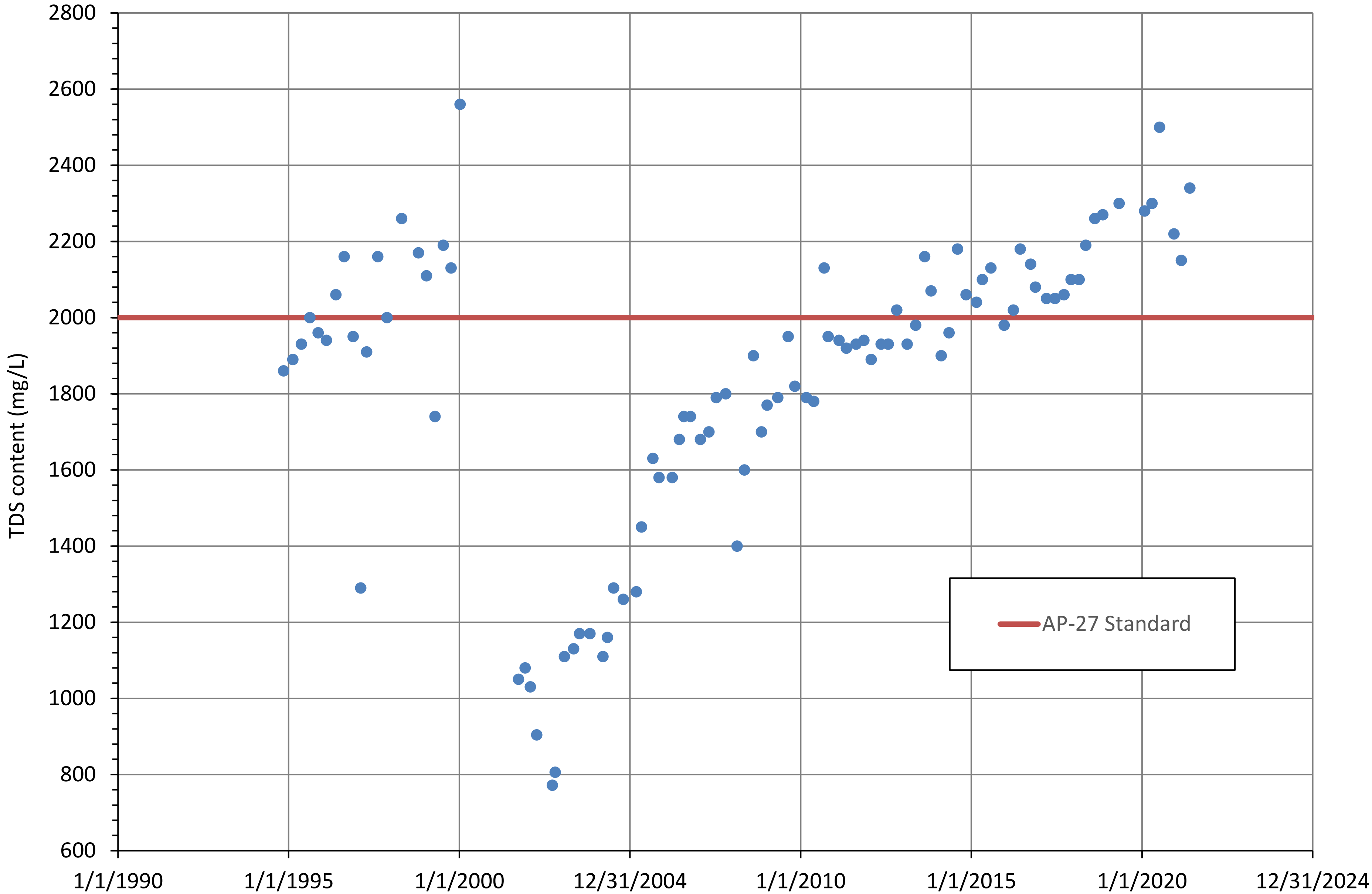

Figure A2. Time-series graph of Total Dissolved Solids 4 ft depth CHMRP Open Pit water body.

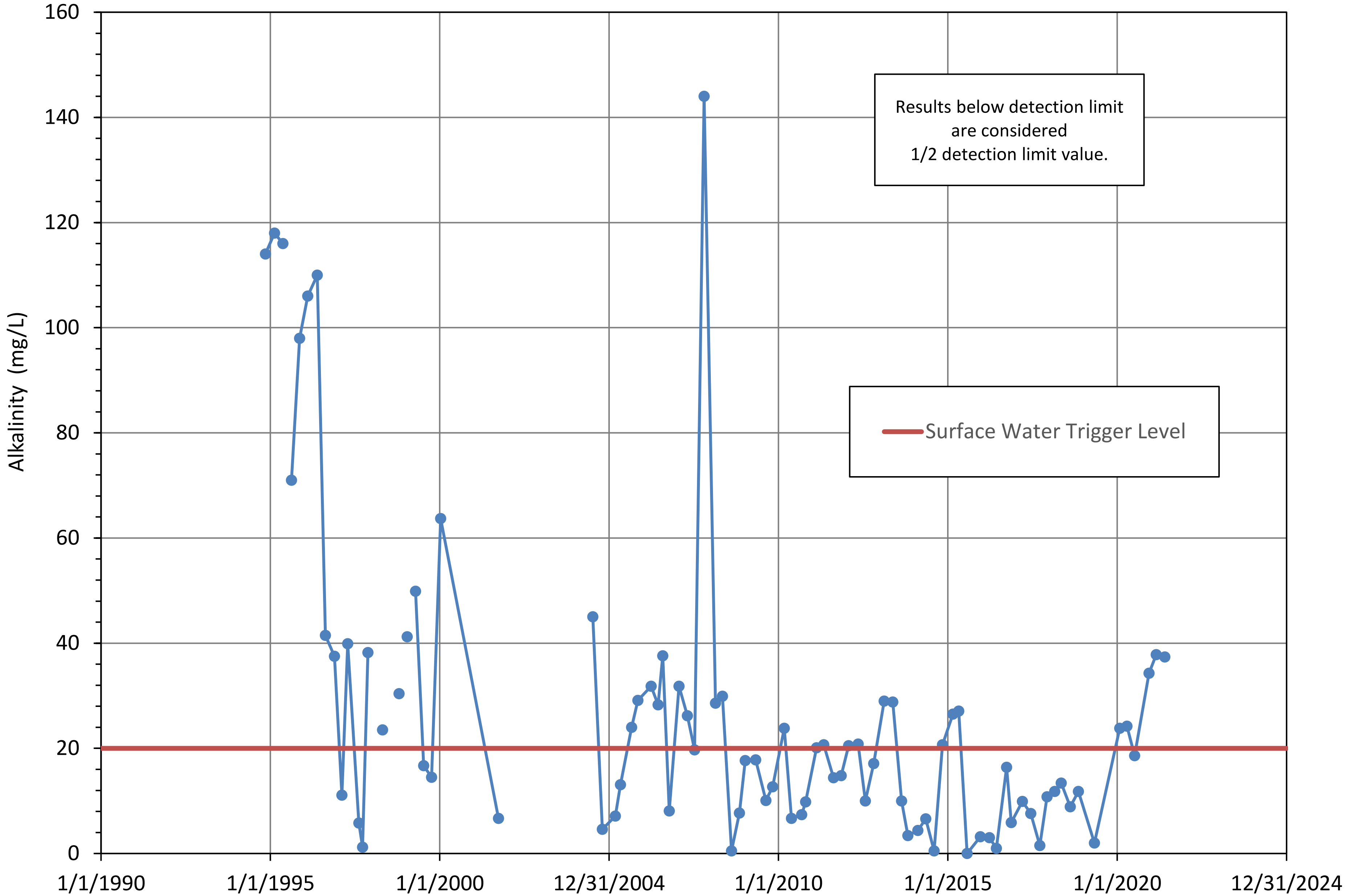

Figure A3. Time-series graph of Alkalinity, 4 ft depth CHMRP Open Pit water body.

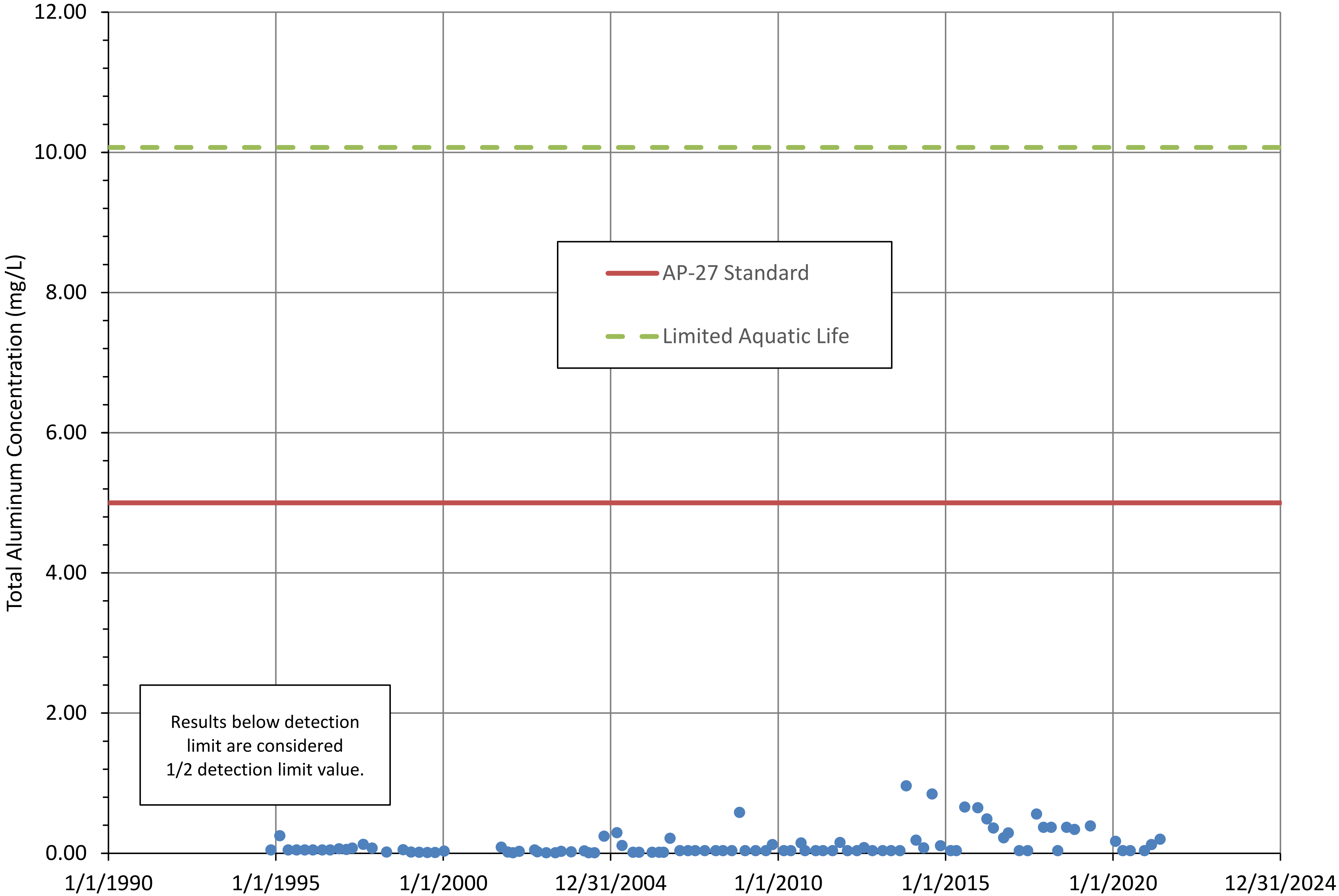

Figure A4. Time-series graph of Total Aluminum Concentration 4 ft depth CHMRP Open Pit water body.

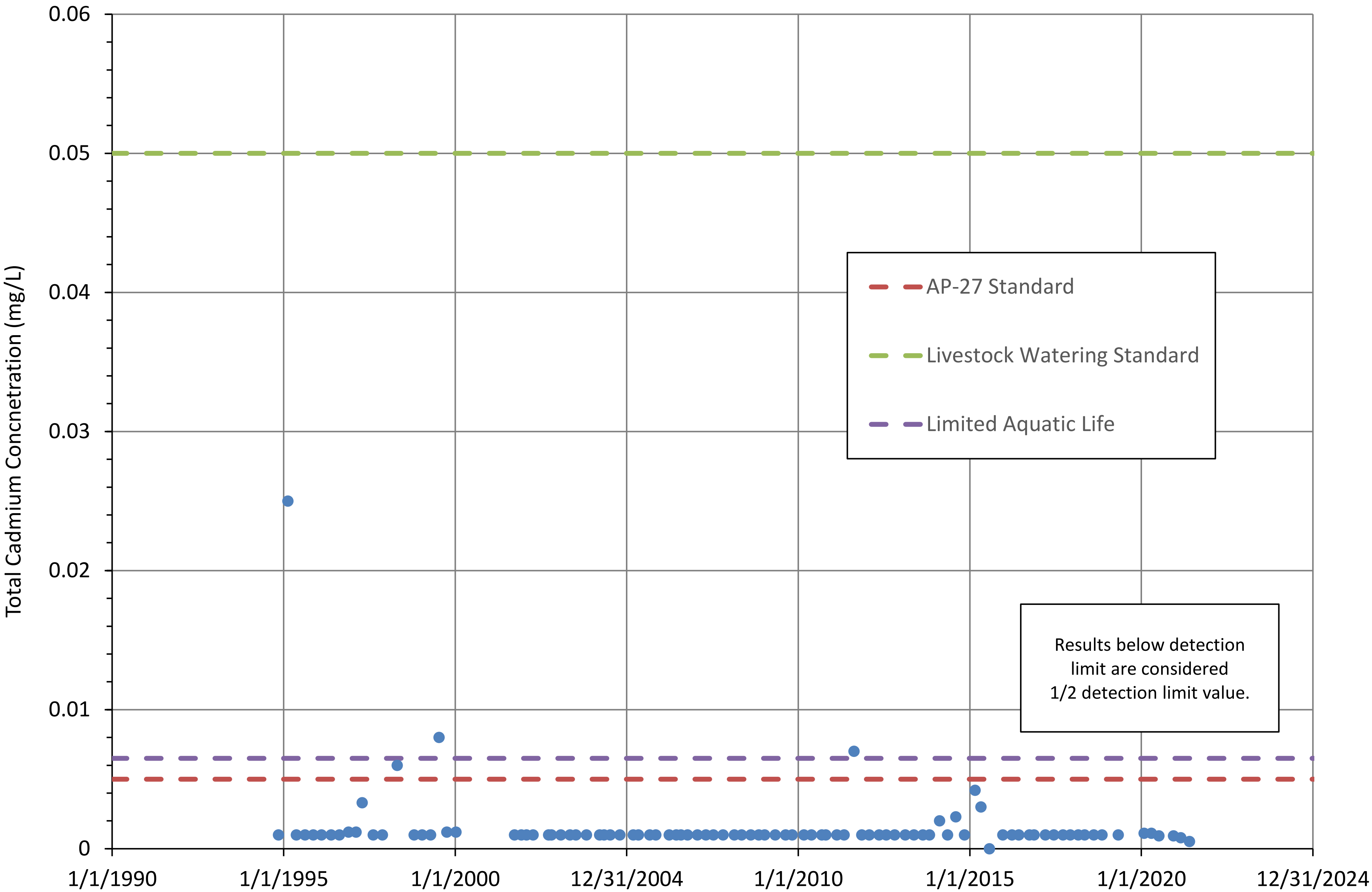

Figure A5. Time-series graph of Total Cadmium Concentration 4 ft depth CHMRP Open Pit water body.

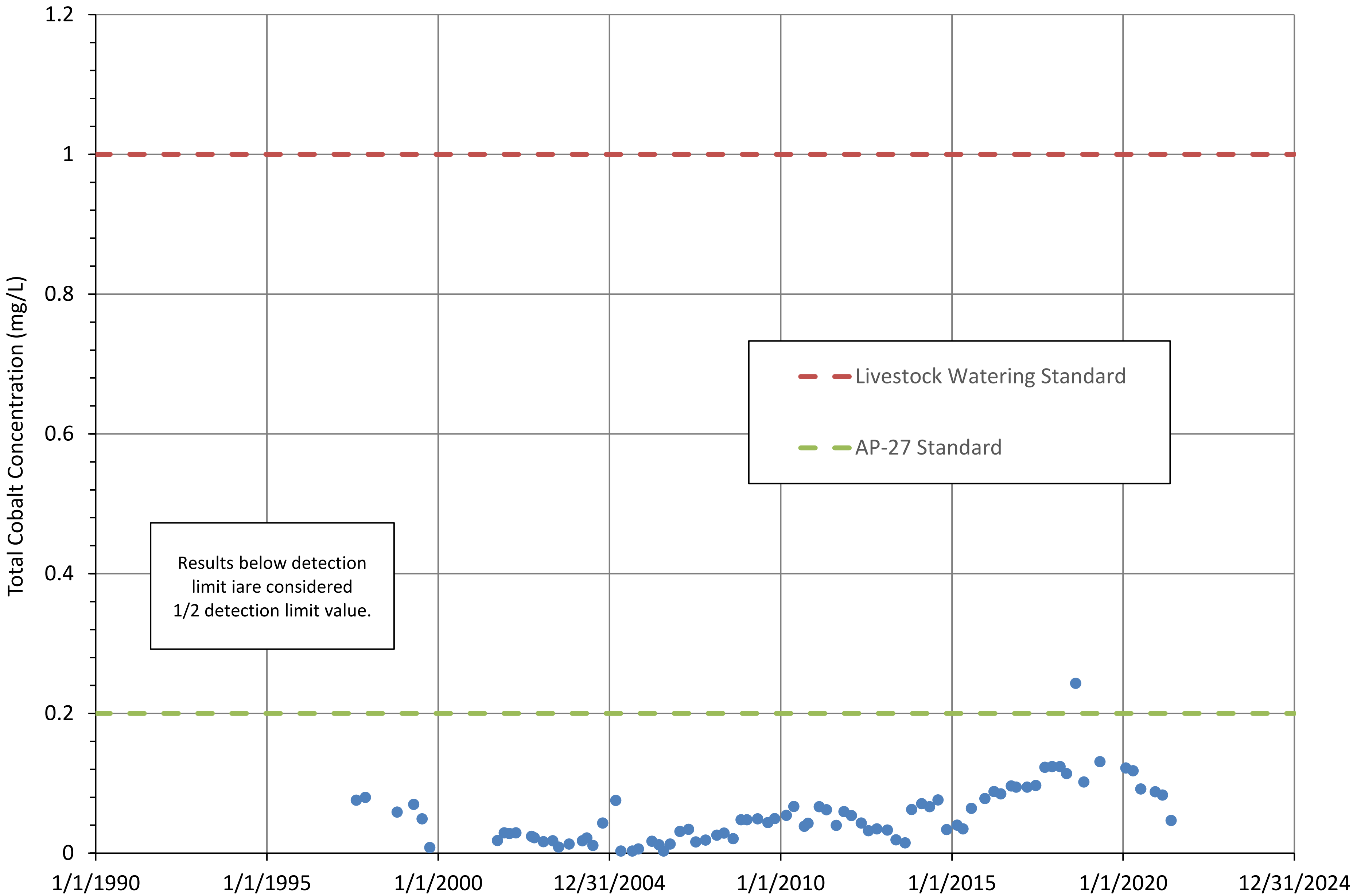

Figure A6. Time series graph of total Cobalt Concentration, 4 ft depth CHMRP Open Pit water body.

JOHN SHOMAKER & ASSOCIATES, INC.

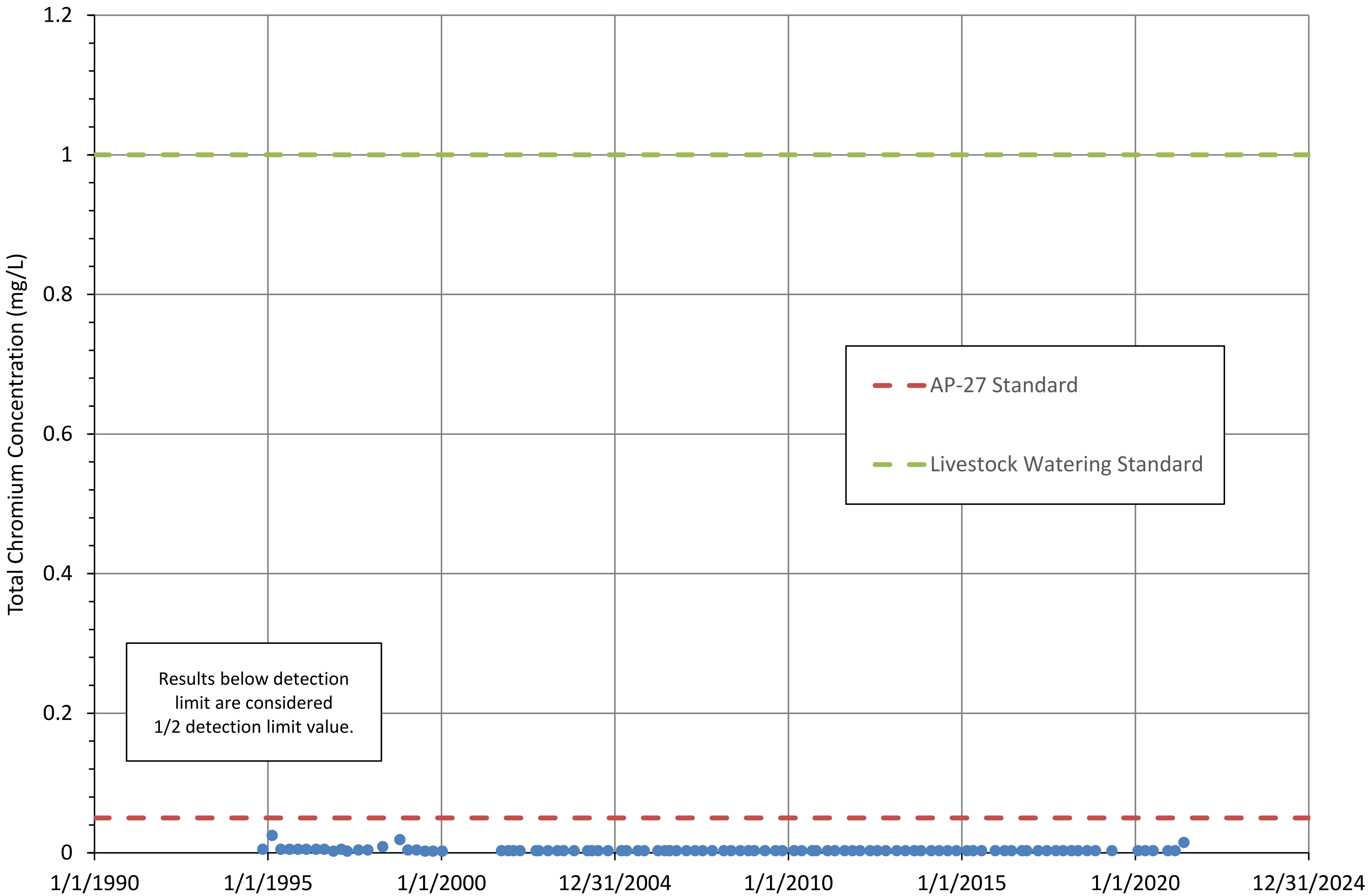

Figure A7. Time-series graph of total Chromium Concentration 4 ft Depth CHMRP Open Pit water body.

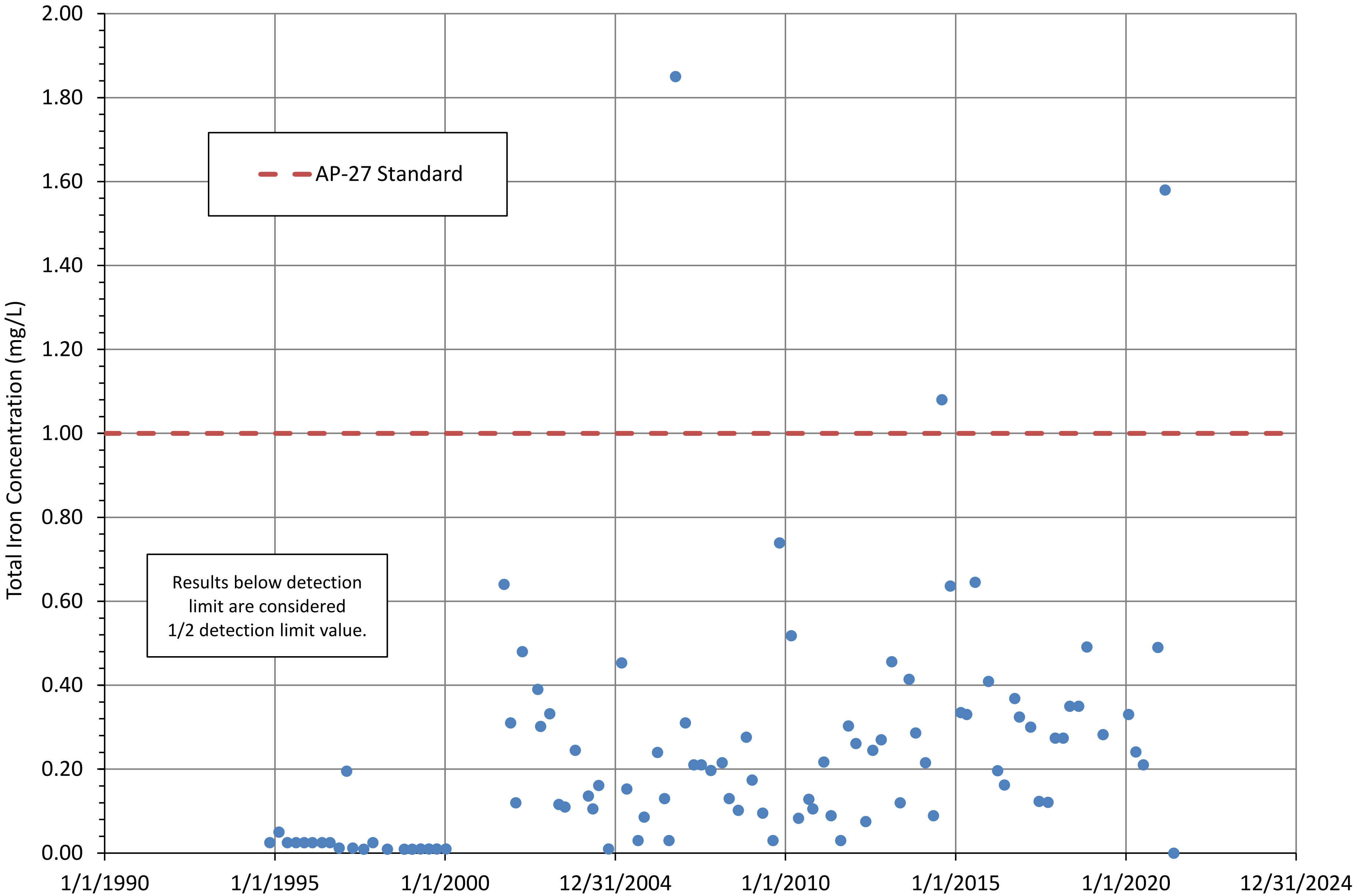

Figure A8. Times-series graph of total Iron Concentration 4 ft Depth CHMRP Open Pit water body.

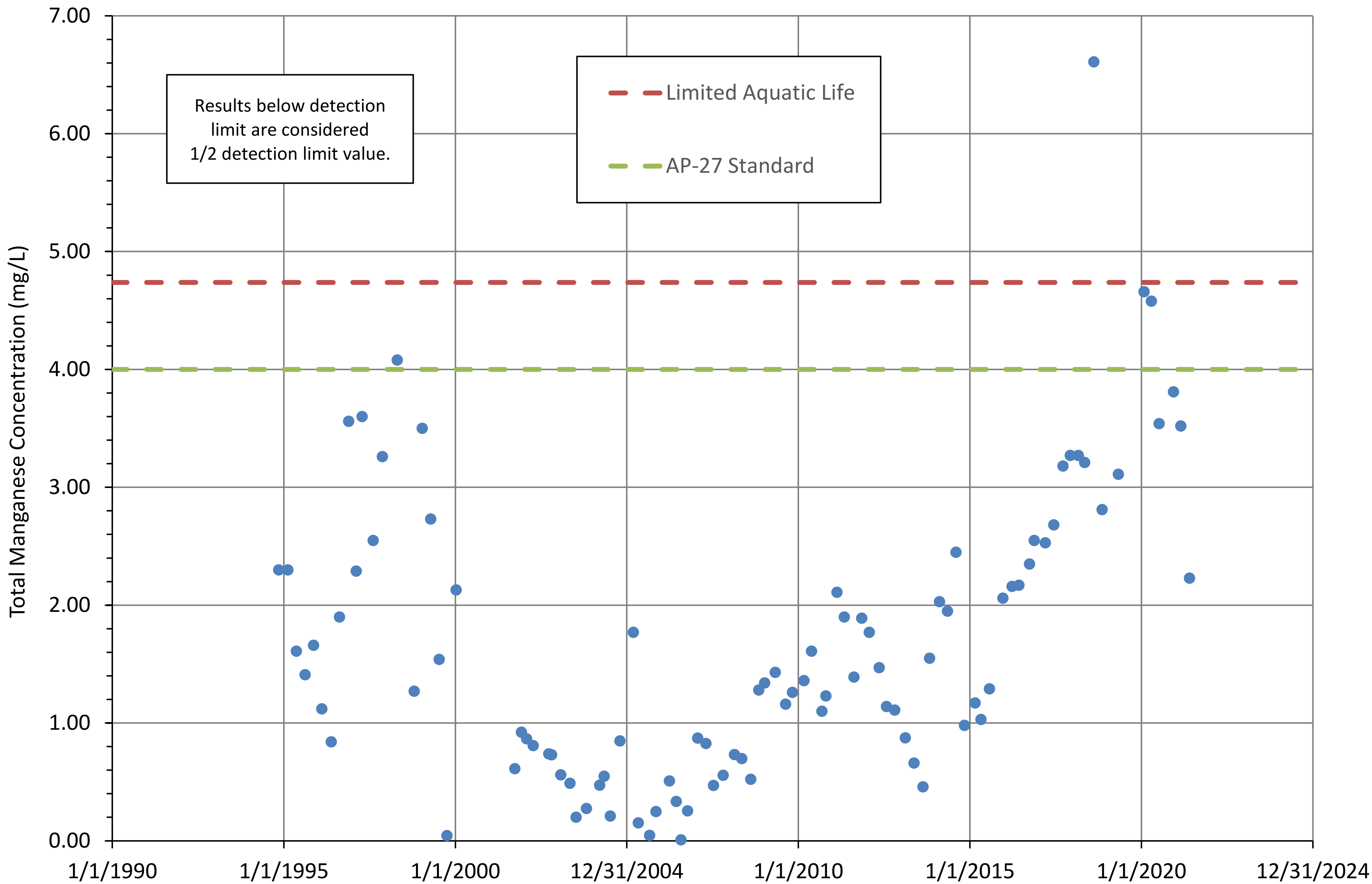

Figure A9. Time-series graph of total Manganese Concentration CHMRP Open Pit water body

JOHN SHOMAKER & ASSOCIATES, INC.

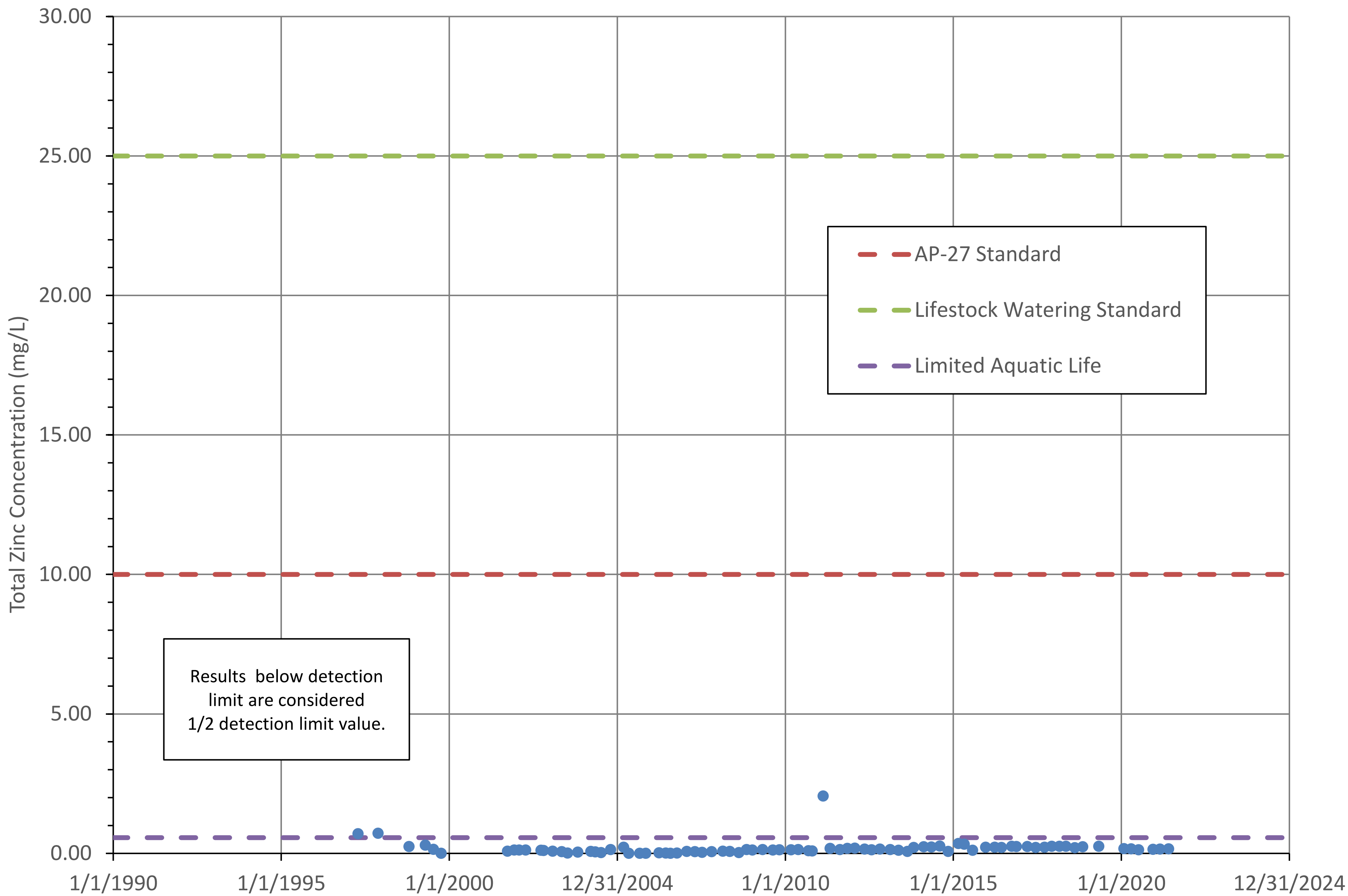

Figure A10. Time-series graph of total Zinc Concentration, 4 ft Depth CHMRP Open Pit water body.

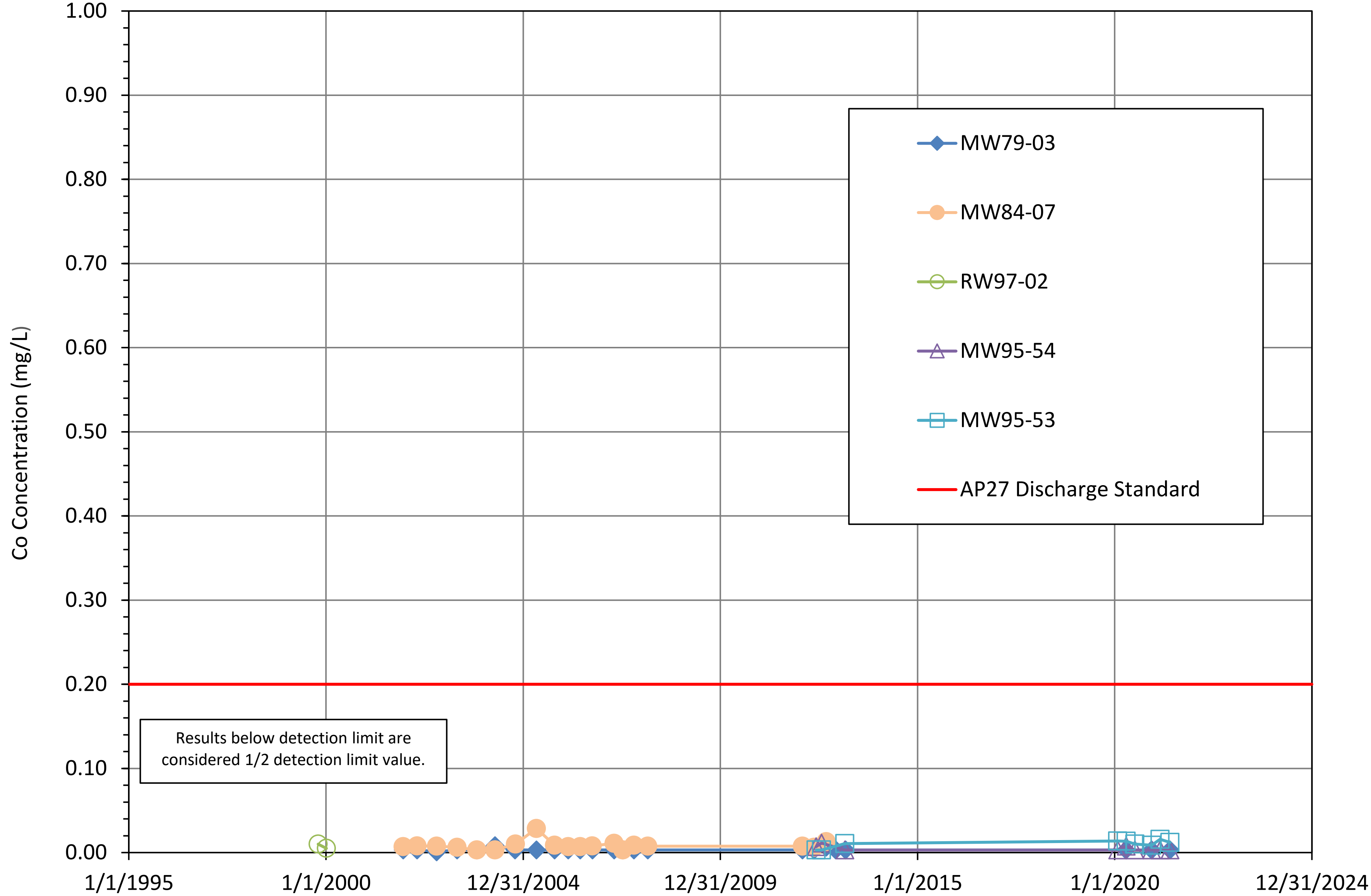

Figure A11. Time-series cobalt concentration graph for AP-27 monitoring network.

JOHN SHOMAKER & ASSOCIATES, INC.

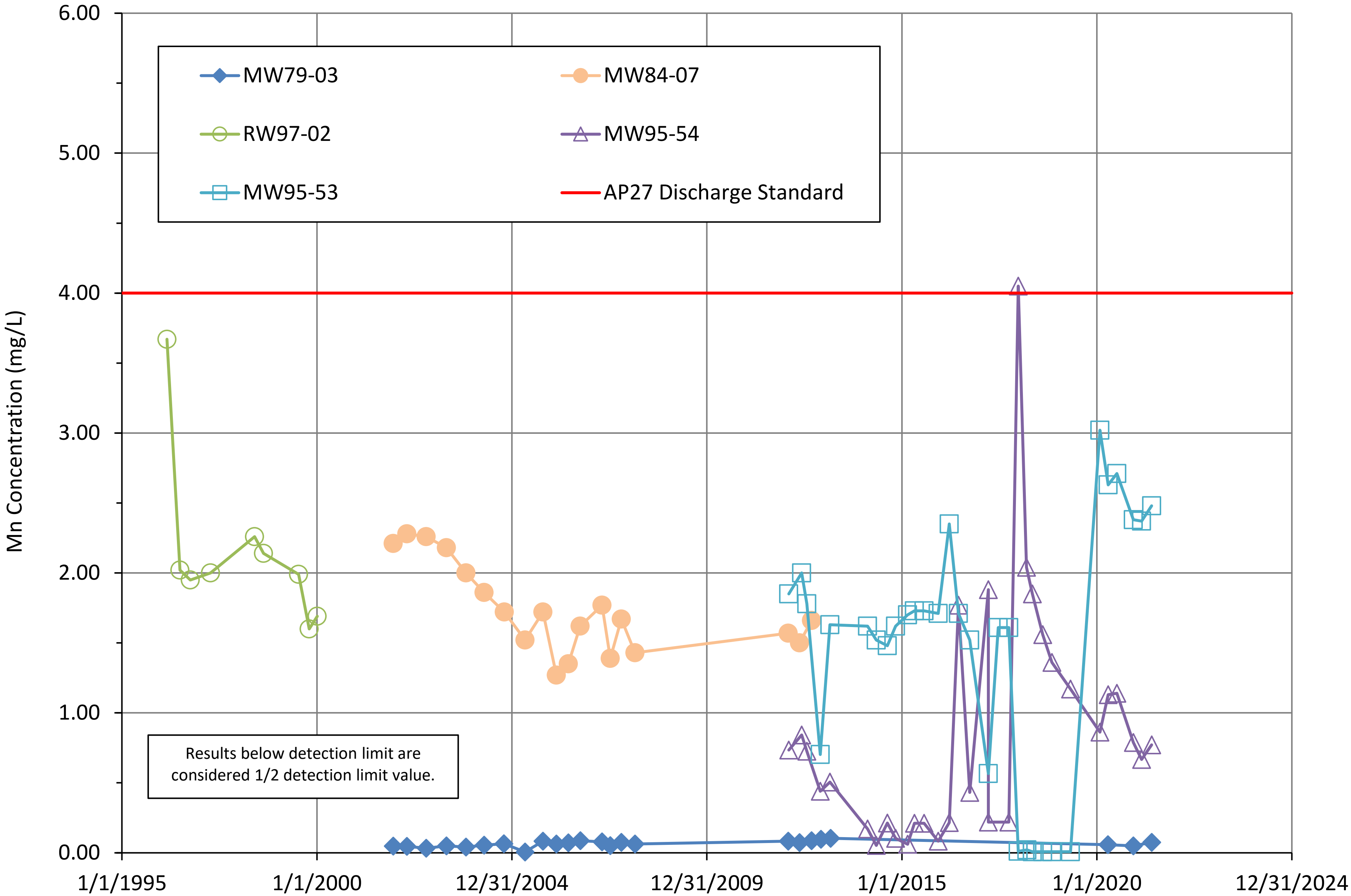

Figure A12. Time-series manganese concentration graph for AP-27 monitoring network.

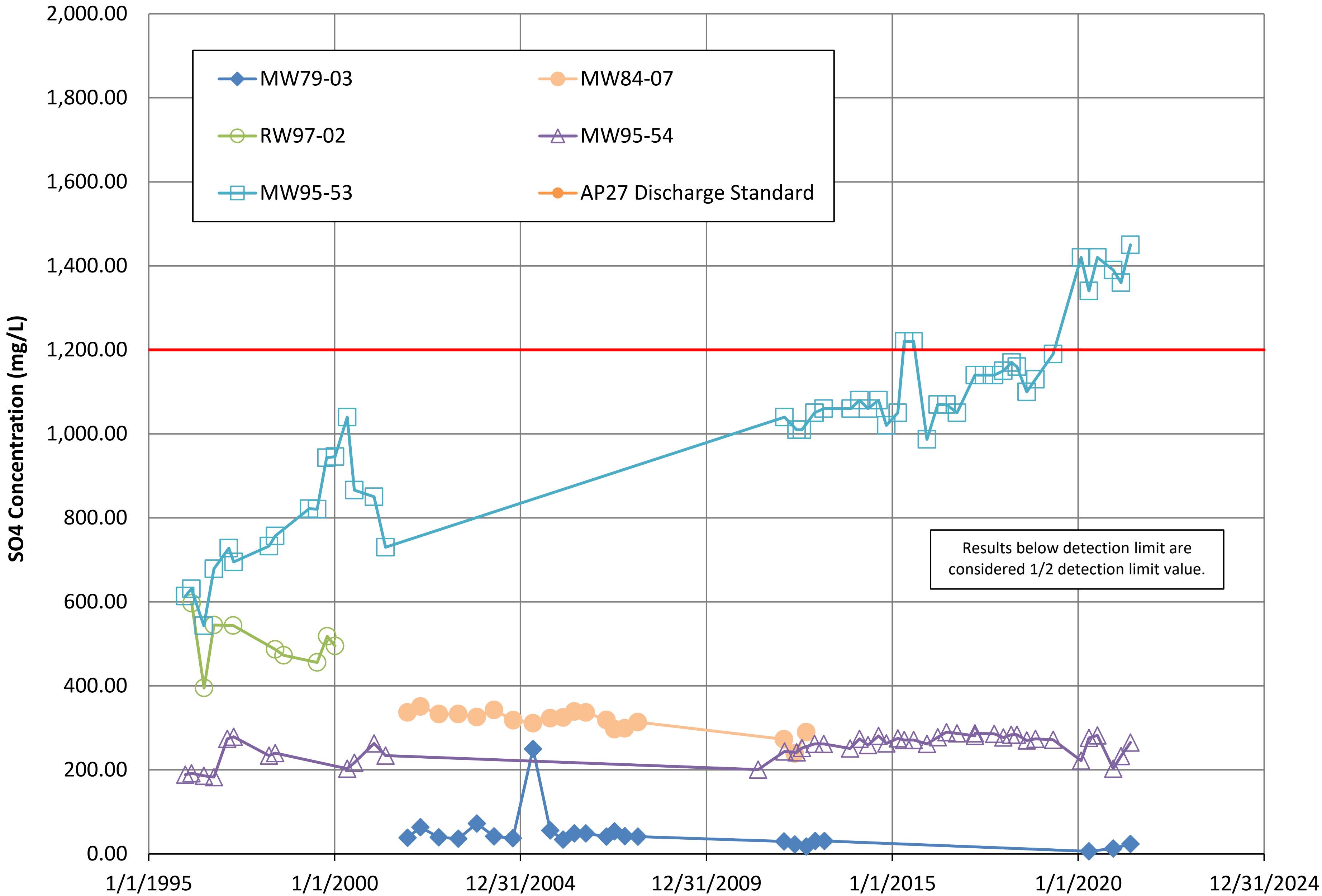

Figure A13. Time-series sulfate concentration graph for AP-27 monitoring network.

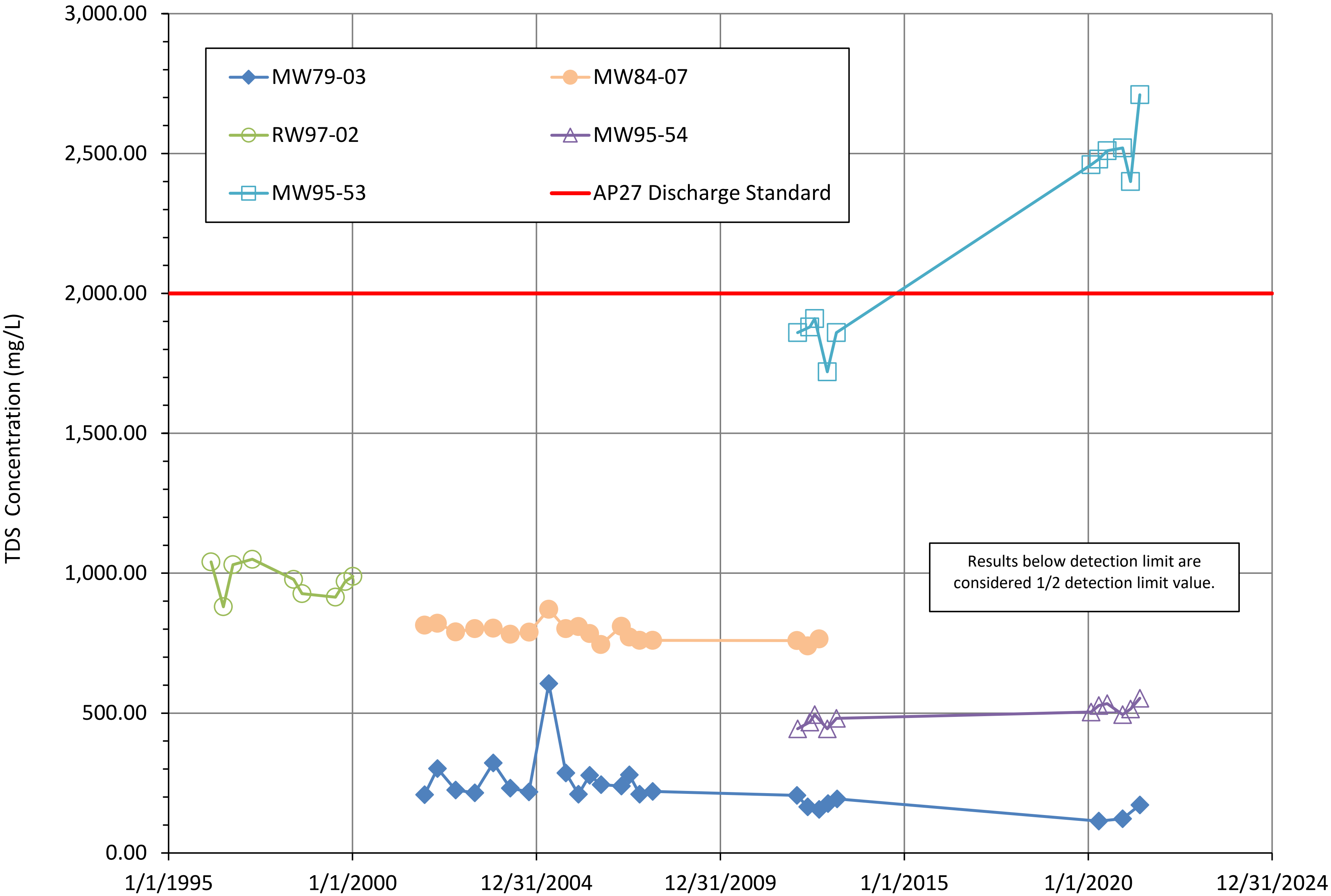

Figure A14. Time-series cobalt concentration graph for AP-27 monitoring network.

Appendix B.

Membrane Filtration Treatment System Workplan

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

NEW MEXICO
ENVIRONMENT DEPARTMENT

Ground Water Quality Bureau
1190 South St. Francis Drive (87505)
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Phone (505) 827-2900 Fax (505) 827-2965
www.env.nm.gov

BUTCH TONGATE
Cabinet Secretary

BRUCE YURDIN
Acting Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

October 29, 2018

David Wykoff
LAC Minerals (USA) LLC
Cunningham Hill Mine Reclamation Project
582 County Road #55
Cerrillos, New Mexico 87010

RE: Approval of Membrane Filtration Treatment System Work Plan for the Pit Lake, Cunningham Hill Mine Reclamation Project, Abatement Plan-27

Dear Mr. Wykoff,

The Mining Environmental Compliance Section (MECS) of the New Mexico Environment Department (NMED) has reviewed the submittal from LAC Minerals (USA), LLC (Permittee) titled *Membrane Filtration Treatment System Work Plan for the Pit Lake at Cunningham Hill Mine Reclamation Project Abatement Plan AP-27Draft Work Plan* (Draft Work Plan) dated June 29, 2018. The Draft Work Plan was prepared by JACOBS ch2m on behalf of the Permittee pursuant to the Re-Issued Abatement Plan 27 (AP-27), conditionally approved by NMED on October 31, 2002. The Draft Work Plan proposes to treat the open pit lake water using a nanofiltration process to reduce the concentrations of total dissolved solids (TDS), sulfate and calcium to levels that meet water quality criteria specified in the AP-27 Open Pit Pool Performance Standard and Contingency Plan included as Appendix A to AP-27.

Table 4 of the Draft Work Plan provides a schedule for implementation of the pit lake water treatment and indicates that a revised and final work plan will be submitted to NMED if NMED has any comments on the Draft Work Plan. NMED does not have any comments or recommended changes to the Draft Work Plan and as such the draft version may be considered a final version.

NMED hereby approves the Draft Work Plan dated June 2018 subject to the following conditions.

1. Any unauthorized discharges associated with the proposed pit lake membrane filtration system shall be reported and necessary corrective actions taken pursuant to Section 20.6.2.1203 NMAC.

2. The Permittee shall notify NMED via email within 7 days of completion of repairs to the brine pond liner.

3. An as-built report of the pit lake membrane filtration system shall be provided to NMED within 45 days of completion of construction.

4. The Permittee shall notify NMED via email a minimum of 7 days prior to the beginning of startup sampling of the pit lake filtration system.

5. Once routine operation of the filtration system is underway, sampling and reporting of the volume and water quality shall be as described in the Draft Work Plan.

6. The Permittee shall notify NMED via email of any significant problems encountered during operation of the filtration system within 7 days of discovery.

If you have any questions, please contact Jonathan Beyeler of the NMED Mining Environmental Compliance Section (MECS) at 505-827-2751 or jonathan.beyeler@state.nm.us.

Sincerely,

Jonathan Beyeler, Geologist, Permit Lead
Mining Environmental Compliance Section
New Mexico Environment Department

cc: Kurt Vollbrecht, Program Manager, MECS
Keith Ehlert, Operational Team Leader, MECS

Membrane Filtration Treatment System Work Plan for the Pit Lake at Cunningham Hill Mine Reclamation Project Abatement Plan AP-27

Final Work Plan

Prepared for:

LAC Minerals (USA) LLC

582 County Road #55

Cerrillos, New Mexico 87010

Prepared by:

9191 South Jamaica Street

Englewood, CO 80112

(303) 771-0900

November 2018

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ACRONYMS AND ABBREVIATIONS

AP-27	Abatement Plan-27
AWS	acid wall seepage
$CaCO_3$	calcium carbonate
DBNPA	2,2-dibromo-3-nitrilopropionamide
gpm	gallons per minute
HCO_3	bicarbonate
HDPE	high-density polyethylene
HOA	HAND-OFF-AUTO
JSAI	John Shomaker & Associates, Inc.
LAC	LAC Minerals (USA) LLC
mg/L	milligram(s) per liter
Na-EDTA	sodium ethylenediaminetetraacetic acid
NF	nanofiltration
NH_3-N	ammonia as nitrogen
NMED	New Mexico Environment Department
NO_3-N	Nitrate as nitrogen
NTU	nephelometric turbidity unit
PLC	programmable logic controller
RO	reverse osmosis
TDS	total dissolved solids

1.0 INTRODUCTION

The Cunningham Hill Mine Reclamation Project is owned and operated by LAC Minerals (USA) LLC (LAC). The site is a former open pit gold mine and heap leach facility located in Cerrillos, New Mexico, that was active from 1979 through 1987 (New Mexico Environment Department [NMED], 2002a). When mining activities ceased, surface runoff and groundwater began to partially fill the dewatered mine pit, resulting in a pit lake. The geology of the pit has contributed to the production of acid wall seepage (AWS), which has resulted in elevated concentrations of total dissolved solids (TDS), sulfate, manganese, and cobalt in the pit lake. Remediation of the pit lake and surrounding groundwater is directed by the NMED Ground Water Quality Bureau through Abatement Plan-27 (AP-27) (NMED, 2002b).

Remediation activities specified in AP-27 include implementing source control measures and directing stormwater runoff from Upper Cunningham Gulch and areas west of the pit to drain into the pit lake to reduce AWS. Reverse osmosis (RO) treatment of the pit lake was previously implemented to reduce TDS and sulfate concentrations; hydrated lime was added to the pit lake to buffer the water. While the implemented source control measures appear to have caused sulfate concentrations to stabilize, the pit lake water quality continues to exceed the AP-27 performance standards.

The additional AP-27 activities described in this work plan are intended to reduce TDS and sulfate concentrations in the pit lake by nanofiltration (NF) of pit lake water and disposal of NF brine.

1.1 Abatement History

In the mid 1990s, the original intent for reclamation of the open pit was to allow stormwater runoff from Upper Cunningham Gulch to fill the pit and inundate the AWS.

AP-27 (NMED, 2002b) allowed temporary discharges to groundwater from the open pit lake with TDS, sulfate, and manganese concentrations above standards. In addition, AP-27 includes surface-water standards that must be met, with pH (greater than 6.0) and alkalinity (greater than 20 milligrams per liter [mg/L] as calcium carbonate [$CaCO_3$]) determined to be the most critical to maintain.

During 2001 and 2002, RO treatment of the open pit lake was performed to reduce TDS and sulfate concentrations. Since 2003, TDS and sulfate concentrations have increased due to inputs from AWS sources. The RO treatment reduced TDS and sulfate concentrations, but the treatment also stripped the alkalinity from the open pit lake. As a result, hydrated lime was added to the open pit lake several times to buffer AWS inputs. The addition of hydrated lime to buffer the pit lake water resulted in increased calcium concentrations.

Open pit lake sulfate concentrations from AWS inputs remained greater than 1,000 mg/L from 2006 to 2010. This increase in sulfate activated AP-27 Performance Standard APS-1, Trigger 1: sulfate concentrations greater than 1,000 mg/L for eight consecutive quarters. LAC implemented the contingency plan required under AP-27 and determined that treatment of open pit lake water could not be performed until additional source controls were implemented.

In 2011, the NMED approved a Revised Open Pit Remediation Plan (John Shoemaker & Associates, Inc. [JSAI], 2011). The revised plan included recommendations for pH control of the open pit lake, for source controls to eliminate AWS inputs, and for treatment methods to reduce TDS and sulfate concentrations within the open pit lake. The revised plan also recommended establishing source controls before treating the open pit lake.

Implemented source controls included the following:

- Repairing Upper Cunningham Gulch diversion structures
- Implementing stormwater controls for receiving runoff from areas west of the pit
- Incorporating in-pit stormwater controls
- Repairing access roads by installing caliche base
- Capping of the largest remaining bench area with caliche and installing stormwater runoff controls

Pumping alkaline water from the residue pile recovery wells and Guest House Well to the open pit lake has improved pH control in the pit lake. The AWS inputs have been reduced, and sulfate concentrations have stopped increasing and are potentially decreasing, indicating that source controls are working. Input of clean stormwater runoff from Upper Cunningham Gulch has been significantly reduced by overgrowth, particularly underbrush, as evidenced when comparing precipitation and Upper Cunningham Gulch runoff data from the 1990s to the present (JSAI, 2017).

1.2 Objectives and Scope

The objective of the remediation activities specified in this work plan is to remove TDS, sulfate, and calcium from the pit lake to meet the AP-27 water quality criteria specified in the AP-27 Open Pit Pool Performance Standard and Contingency Plan (NMED, 2002b).

Open pit lake water will be treated using NF treatment. Clean water produced from the NF treatment system (permeate) will be pumped back to the open pit lake to reduce overall TDS, sulfate, and calcium concentrations, while brine water produced from the NF treatment system will be pumped to the onsite existing evaporation ponds for treatment though evaporation. Open pit lake water will be treated for approximately 5 months (May to September) each year. It is estimated that treatment will be required 3 to 4 years to meet the AP-27 water quality criteria.

2.0 MEMBRANE TREATMENT PLAN

2.1 Design

The treatment system will use conventional NF membrane desalination (Figure 1) to selectively remove sulfate and calcium ions while passing a portion of the bicarbonate ion to help limit further reduction in pit lake alkalinity. Like RO, NF produces relatively pure water as the flow stream and a concentrated salt brine and media backwash as the waste stream. The flow stream will pass through the existing land application pond and then be pumped back to the pit lake, and the waste flow from the treatment system will be sent to the existing brine ponds for evaporation (Figure 2).

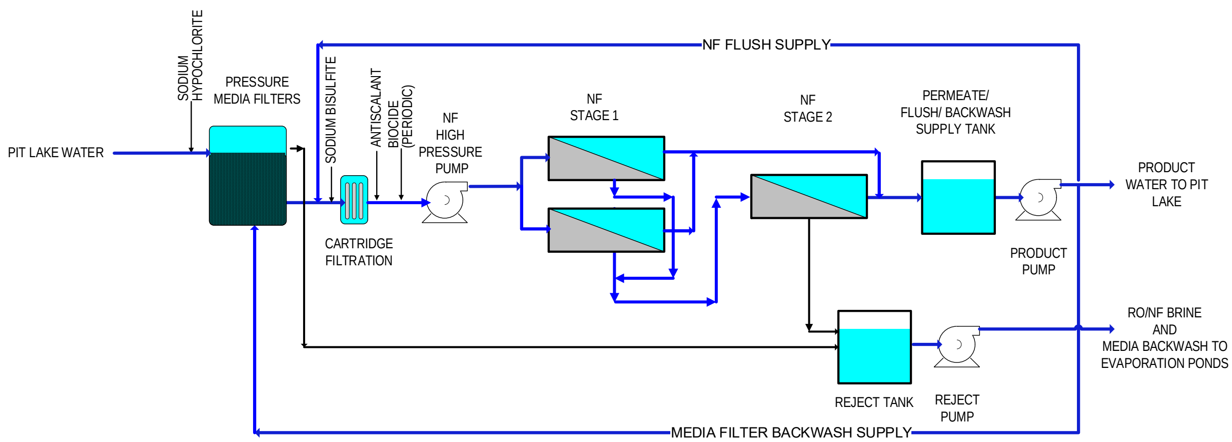

Figure 1. Conventional Membrane Desalination Process Flow Diagram

A new pump will extract water from the pit lake and pump the water to the inlet of the containerized NF unit. The pit lake pump (a self-priming centrifugal pump) will be placed in the beach area of the pit lake (Figure 2).

The NF unit will be a vendor-supplied packaged system containing filters, pumps, a four-stage NF membrane filtration, permeate and waste collection tanks, and chemical feeds. Feed water from the pit lake will be dosed with sodium hypochlorite to aid in the oxidation of manganese and iron and provide a constant regeneration source for the greensand filter media. The greensand will retain manganese and particulate matter, which will periodically be backwashed to the brine evaporation ponds. Greensand pressure media filtrate will proceed to the cartridge filters to remove finer particulates upstream of the NF membranes, while the periodic greensand pressure media filter backwash will be directed to the effluent tank for later disposal to the brine evaporation ponds. Sodium bisulfite will be injected into the process stream ahead of the cartridge filters to remove any remaining residual chlorine in the NF feed water, which would be detrimental to the NF membranes. Cartridge filter effluent will be dosed with antiscalant and, periodically, biocide to reduce NF membrane fouling. An NF high-pressure pump will elevate the pressure of the flow stream, which will then enter the four-stage NF membrane desalination system. Consumable process chemicals for the NF system are listed in Table 1.

EARTHWORK QUANTITIES

Gravel/Road Base Pad	Square Yards for Clearing/ Subgrade Prep	Cubic Yards for Pad
NF Treatment Package System	83.3	27.8
Pit Lake Pump	7.1	2.4
TOTAL	90	30.1

PIPELINE QUANTITIES

Pipeline	Linear Feet of 4" HDPE 4710	Linear Feet of 3" HDPE 4710	SDR	Road Crossings	Air/Vac Release Valve
PER	2,220	0	11	1	1
PLW	2,090	350	11	1	1
WAS	1,440	0	11	1	0
TOTAL	5,750	350	--	3	2

LEGEND:

- PER — NANOFILTRATION TREATMENT SYSTEM PERMEATE
- WAS — WASTE
- PLW — PIT LAKE WATER
- GHW — GUEST HOUSE WELL

NOTES:

1. TOPOGRAPHY SHOWN IS FROM LAC MINERALS (USA), LLC FILE "FIGURE1-ADJUSTED_UTM83.DWG" BY JOHN SHOMAKER & ASSOCIATES, INC. COORDINATE SYSTEM NOT IDENTIFIED, CONTOUR INTERVAL VARIES IN FILE.
2. IMAGE FROM GOOGLE EARTH.
3. PIPELINE LENGTHS INCLUDE 10% FOR PIPE SNAKING.

FIGURE 2
SITE PLAN
MEMBRANE FILTRATION TREATMENT SYSTEM WORK PLAN

ch2m:

Table 1. Consumable Process Chemicals

Chemicals (Part of NF System Package)	Purpose	Product
Sodium Hypochlorite	Manganese oxidation; regeneration of filter media	Generic
Sodium Bisulfite	Remove residual chlorine in NF feed	Generic
Antiscalant	Prevent NF membrane scaling	Avista Vitec 7000
Biocide	Prevent NF membrane fouling	DBNPA
NF Clean-in-Place Solution 1	Remove metal fouling	Citric Acid
NF Clean-in-Place Solution 2	Remove organic fouling	Versene 200 (Na-EDTA)

Notes:
DBNPA = 2,2-dibromo-3-nitrilopropionamide
Na-EDTA = Sodium ethylenediaminetetraacetic acid

Permeate from the NF system will be directed to the permeate/flush/backwash supply tank. A permeate pump included in the packaged system will pump permeate from the package system througha new 4-inch high density polyethylene (HDPE) pipe that will discharge the permeate back to the pit lake. The permeate pump will also supply clean water for pressure media filter backwashing and flushing of the NF membranes upon system shutdown. Brine (reject) from the NF membranes and backwash/flush streams will be directed to the waste tank. A combination of three waste pumps within the packaged system will operate based on the level in the waste tank and will pump from the package system to the existing brine ponds (Figure 2) for evaporation.

The brine ponds are existing evaporation ponds that sit atop the waste rock pile onsite and are regulated under AP-27. The brine ponds are lined with a single 60-mil HDPE geosynthetic liner. The brine ponds were developed for the previous RO treatment system that was used onsite, but they have been sitting idle since previous treatment stopped. The NF treatment system waste pumps will discharge via a new 4-inch HDPE pipeline to the brine ponds for evaporative disposal (Figure 2).

2.2 Construction

The NF treatment system will consist of both new equipment and reutilized equipment already onsite. Figure 2 presents an overall site plan showing both existing and new equipment to be used for the NF treatment system.

A new pit lake pump will be installed in the beach area on the northwest side of the pit lake. Power cable will be run from the power distribution located next to the new Water Treatment System at the pit rim. The pump intake will be located along the existing floating walkway over the water to the center of the pit. The pump intake will draw water from a depth between 15 and 45 feet in the pit lake. New 4-inch HDPE will be installed to convey the pit lake water to the NF treatment system.

The NF treatment system will be a vendor-supplied packaged system and will be located at the top of the pit near the road (Figure 2). The NF treatment system will be connected to electrical power via a new power cable from the existing onsite utility powerline. The existing utility power currently terminates on site about 1,500 ft from the new location of the Water Treatment System.Water (permeate) from the NF treatment system will be transferred to the pit lake via a new HDPE pipe connected to the treatment system.

The existing brine ponds will be used for evaporative disposal of NF brine. The NF brine will be discharged to the brine ponds from the NF treatment system via new 4-inch HDPE piping. The existing, in-place, 3-inch HDPE piping used to dewater the brine ponds and direct water to the acid rock drainage collection and treatment ponds will be removed.

The brine pond liners have minor known defects that must be repaired before use. Visible defects in the brine pond liners will be repaired by removing a section of liner larger than the defect, roughening the liner surface adjacent to the area to be patched, and then welding a patch in place. The patch (if suggested by the liner repair company) will be tested using the vacuum box method to verify its integrity. Repairs will be completed in a couple of phases in which, in 2018, the sidewalls and top of the liner will be patched and in 2019, prior to operation, sediment and water will be cleared from the bottoms and patched accordingly. After liner patching, the ponds will receive waste from the containerized NF treatment system.

After installation, and before the start of treatment operations, all new HDPE pipes will be leak tested using hydrostatic pressure testing. The pipes will be filled with water, air will be removed, and pressure will be applied and held. The pipes will be monitored for any pressure drops. If leaks are identified, they will be corrected before treatment operations begin.

2.3 Operations

The NF treatment system is expected to operate continuously withdrawing approximately 100 gallons per minute (gpm) of water from the pit late from May 1 to September 30 each year for an estimated 3 to 4 years.

2.3.1 *Pit Lake Pumping*

Manual valving on the pump discharge will be used to throttle the flow. The pump will be interlocked with the NF treatment system's programmable logic controller (PLC) via an unlicensed (licensing not required) 900-megahertz radio telemetry system. This system will consist of radio transmitters/receivers at the pump control panel and the NF treatment system. At system startup, the NF system PLC will allow an operator to turn on the pump to feed pit lake water to the NF unit. Upon system shutdown, the NF system PLC will send a signal to automatically turn off the pit lake pump. The pit lake pump will include a HAND-OFF-AUTO (HOA) control station at the pump. In HAND mode, the operator can control START-STOP at the HOA. In AUTO mode, STOP will be controlled based on commands from the NF treatment system PLC. Upon generation of a FAULT within the NF treatment system, the pit lake pump will shut down until the cause of the fault is investigated.

The pit lake pump discharge line will be equipped with a flowmeter that will shut down the pump if the discharge flow exceeds 150 gpm. The pit lake discharge line will also include a pressure indicator and high/low pressure switches that will shut down the pump if the discharge pressure exceeds the pump shutoff head or falls below 100 pounds per square inch.

A flowmeter located on the pit lake pump gravity feed portion of the pipeline, at the inlet to the NF treatment system container, will be used in tandem with flowmeters on the treatment system waste and permeate discharges to facilitate flow balance accounting within the NF treatment system.

2.3.2 *Nanofiltration Treatment System*

The NF packaged treatment system will be controlled via a PLC. Operators can make setpoints and process adjustments via a local control panel mounted within the container. The NF packaged treatment system will include pretreatment, NF membranes, a permeate pump, and waste pumps. The permeate pump will pump NF system permeate (clean water) back to the pit lake. The waste pumps will pump NF system brine and filter backwash waste to the brine ponds.

One greensand filter will periodically be taken out of service and backwashed, with the permeate pump supplying the backwash water.

If the system shuts down due to operator initiation or a fault (for example, high feed oxidation reduction potential to the NF membranes, low antiscalant flow, or high permeate conductivity), the pit lake pump will turn off, the NF high-pressure pump will turn off, the inlet valves to the greensand media filters will close, the NF system concentrate control valve will open fully, and the NF system will undergo a flush with permeate.

The permeate pump will serve three purposes. During normal operation, the pump will transfer NF permeate from the NF system to the pit lake. During the periodic greensand media backwash (approximately twice daily), the permeate pump will increase speed and permeate will be diverted to supply the media filter backwash. Upon system shutdown, the permeate pump will supply a source of clean water to flush the NF membranes.

The waste pumps will operate based on the level in the waste tank. When a high level is detected, one or more of the three waste pumps will turn on and discharge the waste to the brine ponds. During the backwash of the media filters, all three waste pumps will operate simultaneously to meet the increased flow demand. Each pump is equipped with a variable frequently drive to accommodate these varying flow conditions, with typical brine receiving at a rate of 19 gpm (one pump) versus backwash waste receiving, which may be up to 150 gpm (all three pumps). When a low level is detected, all waste pumps will turn off. The waste pump effluent line will be equipped with three flowmeters: one at the NF treatment package system discharge, one midway to the brine ponds, and one just upstream of the pipe split into each of the two brine ponds. The two flowmeters located midway and at the brine ponds will be battery-powered. The flowmeter at the NF package system discharge will tie back into the NF treatment package control system PLC directly, while the two battery-powered flowmeters will communicate via the radio telemetry system to facilitate flow accounting and leak detection. The line will also be equipped with a pressure indicator and high-pressure switch that will shut down the pump if the discharge pressure exceeds pump shutoff head.

2.3.3 *Land Application Pond and Pumping*

There will be no change to the current operation and use of the Land Application Ponds.

2.3.4 *Waste Disposal*

The containerized NF system will generate clean product water (permeate) and a continuous effluent stream consisting of pressure media filtration backwash and concentrated NF brine containing salts that were rejected by the membranes during treatment. This continuous waste from the system will require onsite disposal using the existing lined brine ponds. Table 2 shows the estimated water quality of the permeate, brine, and backwash waste. Water will be passively removed from the brine via evaporation, leaving the other brine constituents in the pond bottom as a salt layer. The salt concentration in the brine ponds will not be high enough to produce a significant salt buildup in the brine ponds, and no salt removal will be required during the treatment system operations (Figure 3).

To maintain performance, the NF membranes will require periodic chemical cleaning, estimated at a frequency of once per year. This clean-in-place waste will need to be collected and trucked offsite.

Table 2. Estimated Permeate, Brine, and Filter Backwash Water Quality

Constituent	Units	Permeate	Brine	Filter Backwash Waste
pH	s.u.	6.1	6.9	8.4
TDS	mg/L	270	10,800	2,271
Total Alkalinity as $CaCO_3$	mg/L	35	41	460
HCO_3 Alkalinity as $CaCO_3$	mg/L	3.2	10	430
Calcium	mg/L	31	2,074	420
Magnesium	mg/L	6	440	97
Potassium	mg/L	2	16	4.5
Sodium	mg/L	43	190	106
Sulfate	mg/L	130	7,092	1,570
Chloride	mg/L	40	66	33
Mercury	mg/L	<0.001	<0.001	<0.001
Total Recoverable Selenium	mg/L	<0.02	<0.02	<0.02
Total Recoverable Iron	mg/L	<0.1	0.3	12
Total Recoverable Manganese	mg/L	<0.1	0.3	130
Total Recoverable Aluminum	mg/L	<0.1	1.6	0.3
Total Recoverable Arsenic	mg/L	<0.1	<0.1	<0.1
Total Recoverable Chromium	mg/L	<0.03	<0.03	<0.03
Total Recoverable Cadmium	mg/L	<0.01	<0.01	<0.01
Total Recoverable Cobalt	mg/L	<0.1	0.5	0.1
Total Recoverable Zinc	mg/L	<0.1	1.2	0.3
Barium	mg/L	<0.01	0.13	0.02
Strontium	mg/L	0.2	6	1.6
Silica	mg/L	14	17	15

Constituent	Units	Permeate	Brine	Filter Backwash Waste
Fluoride	mg/L	1.3	1.3	1.3
NO_3-N	mg/L	<0.2	<0.2	<0.2
NH_3-N	mg/L	<0.1	<0.1	<0.1
Turbidity	NTU	<0.1	5	10
Total Suspended Solids	mg/L	<0.1	<5	10
Total Organic Carbon	mg/L	<1	<1	<1
Ortho-Phosphate	mg/L	<0.05	<0.05	<0.05

Notes:
HCO_3 = bicarbonate
NH_3-N = ammonia as nitrogen
NO_3-N = nitrate as nitrogen
NTU = nephelometric turbidity unit
s.u. = standard unit

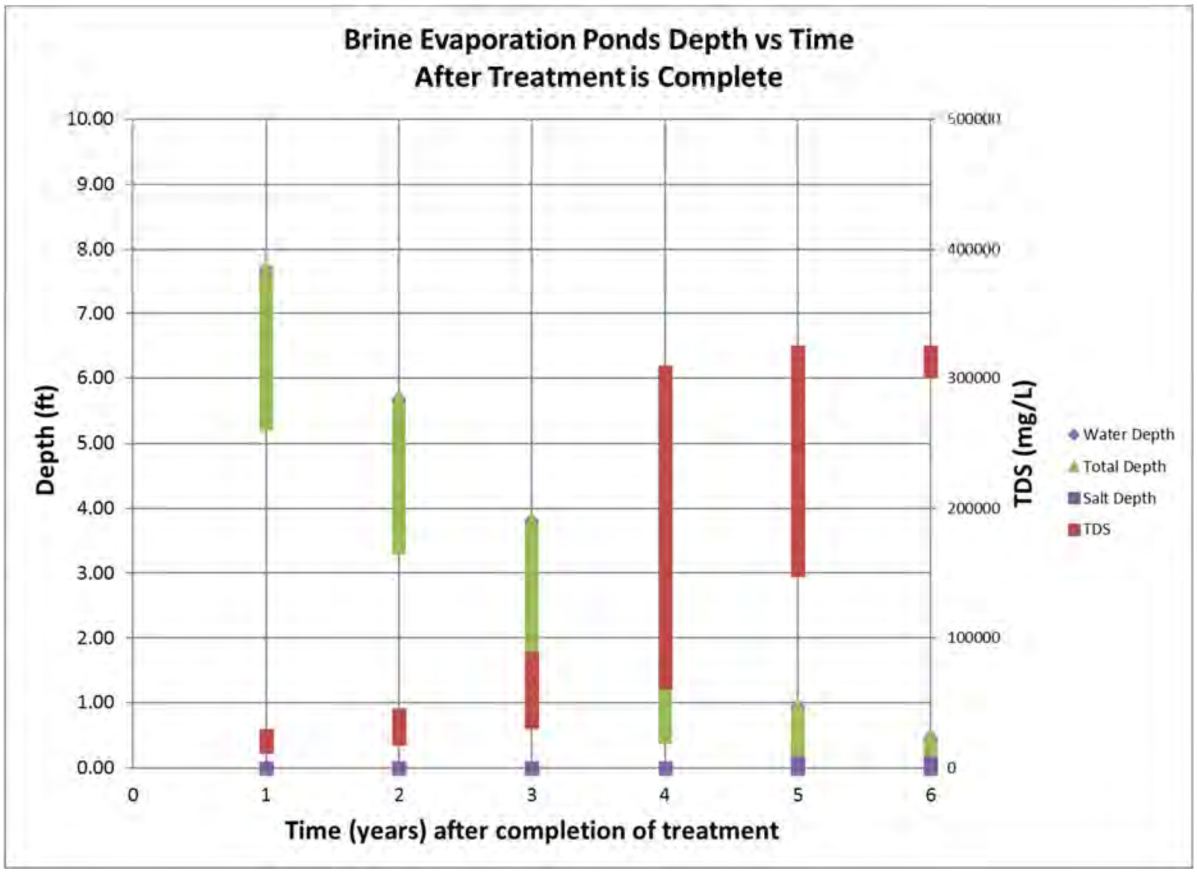

Figure 3. Brine Pond Depth and Salt Deposition over Time

2.4 Sampling Plan

2.4.1 *Startup Sampling*

LAC will conduct startup sampling to assure that the system is functioning as designed. Process streams to be sampled may include influent (pit lake water), permeate, and waste brine. Startup sampling is expected to be conducted for the first few weeks of operations and will be described in the treatment system specifications and documented in an as-built report.

2.4.2 *Operations Sampling*

Once routine operations are underway, water sampling will be conducted to demonstrate the water quality being discharged to the pit lake and brine being discharged to the brine ponds. Water discharged to the pit lake and brine ponds will be sampled quarterly during the months the treatment system is operating. The treatment system is expected to run from May through September each year, indicating that two quarterly samples would be collected each year. Samples will be analyzed for Profile 1 field parameters and the Profile 1 analyte suite listed in Table 1 of DP-55 (NMED, 2002a). Results will be reported to the NMED as part of the quarterly and annual monitoring reports provided to the NMED as required by AP-27. Table 3 summarizes the proposed sampling.

All other sampling, including pit lake water, required at the site will be conducted in accordance with approved documents (AP-27 and DP-55) and is not modified by this work plan.

Table 3. Proposed Sampling

Sampling Location	Analytes	Frequency
Permeate Discharge Line	Field Parameters: pH, water level, electrical conductivity Laboratory Analyte Suite: bicarbonate, calcium, copper, cobalt, cyanide (total), cyanide (weak acid dissociable), iron, manganese, nitrate as nitrogen, sulfate, TDS	Quarterly during treatment system operation months
Brine Discharge Line	Field Parameters: pH, water level, electrical conductivity Laboratory Analyte Suite: bicarbonate, calcium, copper, cobalt, cyanide (total), cyanide (weak acid dissociable), iron, manganese, nitrate as nitrogen, sulfate, TDS	Quarterly during treatment system operation months

2.5 Reporting

The following reporting will be completed as part of this project:

1. LAC will notify the NMED via e-mail within 7 days of completing all repairs to the brine pond liners.
2. LAC will notify the NMED via e-mail at least 7 days prior to the beginning of startup sampling of the NF treatment system.

3. LAC will notify the NMED of any unauthorized discharges from the NF treatment system, should they occur, in accordance with the New Mexico Administrative Code 20.6.2.1203.
4. LAC will notify the NMED via email of any significant problems encountered during operation of the NF treatment system within 7 days of discovery.
5. An as-built report will document the construction and startup of the pit lake water treatment system and will be submitted to the NMED within 45 days of completion of construction.
6. Continued operation of the NF treatment system and operations sampling results will be documented in the quarterly and annual reports provided to the NMED per the requirements of AP-27.

3.0 SCHEDULE

Construction and startup testing are expected to be completed by May 1, 2019. The treatment system is expected to operate continuously from May 1 to September 30 each year for an estimated 3 to 4 years.

Table 4. Proposed Schedule for Membrane Treatment of Pit Lake Water

Activity	Duration	Anticipated Start Date
Work Plan Preparation		
Submit Membrane Filtration Treatment System Work Plan to NMED	1 day	July 2018
NMED Review of Work Plan	90 days	July 2018
Revise Work Plan based on NMED comments, if required	15 days	October 2018
Submit Final Membrane Filtration Treatment System Work Plan to NMED	1 day	November 2018
Treatment System Design and Construction		
Develop treatment system specification	30 days	November 2018
Procure treatment system equipment	120 days	December 2018
Repair brine pond liners	15 days	March 2019
Treatment system construction onsite	120 days	March 2019
Treatment System Operations		
Treatment system commissioning	14 days	July 2019
Treatment system operations – Year 1	90 days	July 2019
Treatment system operations – Year 1	150 days	May 2020
Treatment system operations – Year 1	150 days	November 2019

4.0 REFERENCES

New Mexico Environment Department (NMED). 2002a. *Discharge Permit Modification and Renewal Cunningham Hill Mine Reclamation Project, DP-55*. New Mexico Environment Department, Ground Water Quality Bureau. September.

New Mexico Environment Department (NMED). 2002b. Re-issued: Stage 1 and Stage 2 Abatement Plan Approval for the Cunningham Hill Mine Reclamation Project, Cerrillos, New Mexico (AP-27). New Mexico Environment Department, Ground Water Quality Bureau. September.

John Shomaker & Associates, Inc. (JSAI). 2017. Technical Memorandum: Recommendations for Accelerating Open Pit Clean up at Cunningham Hill Mine Reclamation Project Site. John Shomaker & Associates, Inc. May.

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Appendix F.

Report by DBS&A (2018)

May 18, 2018

Mr. David Wykoff
LAC Minerals (USA) LLC
582 County Road 55
Cerrillos, New Mexico 87010

Re: Modified Evaporation Pond Closure Design, Cunningham Hill Mine Reclamation Project
Santa Fe County, New Mexico

Dear Mr. Wykoff:

Daniel B. Stephens & Associates, Inc. (DBS&A) is pleased to submit to LAC Minerals (USA) LLC (LAC) the attached drawing set (Attachment 1) for the proposed closure of two evaporation ponds at the Cunningham Hill Mine Reclamation Project located in Santa Fe County, New Mexico. Attachment 2 provides a bid table to use when bidding closure of the evaporation ponds.

The following sections describe the evaporation pond closure design and tasks associated with development of the design.

Design Basis

The basis for this design modification was to complete a grading plan for the design that uses available soil from the site to fill the area of the two evaporation ponds. The primary differences between this design and the previously submitted design (DBS&A, 2017) are that the bottom portions of the existing pond liners will remain in place and additional soil will be used for the cover. The additional soil will be obtained from a soil stockpile located northeast of the site office and from the area immediately around the ponds. The use of additional soil will result in a greater cover thickness than the previous design.

It is our understanding that the New Mexico Environment Department (NMED) suggested that in lieu of a minimum 3-foot cover requirement, the bottoms of the liners could be left in place in order to prevent seepage from potentially infiltrating the West Waste Rock Stockpile. Due to the limited availability of clean (non-acid generating) borrow material without substantial land disturbance, LAC decided to leave the bottoms of the liners in place, as suggested by NMED. Liner material that is removed from the side slopes and the anchor trenches will be placed on top of the remaining liners and buried.

Soil Sampling

During a July 19, 2017 site visit, DBS&A collected two soil samples from the soil stockpile located northeast of the site office and submitted them to the DBS&A Soil Testing & Research Laboratory in Albuquerque, New Mexico for analysis of physical and hydrologic properties.

Daniel B. Stephens & Associates, Inc.
6020 Academy Rd., NE, Suite 100 505-822-9400
Albuquerque, NM 87109-3315 FAX 505-822-8877

The purpose of these analyses was to determine the soil classification of the material and to provide hydraulic properties to support one-dimensional unsaturated flow modeling. Results of the laboratory analysis indicate that the soil stockpile material is a sandy silt with a greater than 10 percent coarse fraction based on the ASTM classification system. The saturated hydraulic conductivity of the soil ranges from 1.0×10^{-4} to 6.9×10^{-4} centimeters per second (cm/s) with the material compacted to 85 and 90 percent of maximum density as determined by ASTM D 698 (standard Proctor density) and corrected for the presence of oversized material (i.e., gravel). Moisture retention curves were developed for each of the samples. These curves were then used to obtain the van Genuchten parameters used in the one-dimensional unsaturated flow modeling. Results of the soil testing indicate a soil with good water storage characteristics. Laboratory reports are provided in Attachment 3.

Unsaturated Flow Modeling

DBS&A conducted one-dimensional unsaturated flow modeling using HYDRUS-1D to simulate the infiltration of precipitation through the proposed evaporation pond soil cover. HYDRUS-1D numerically solves the Richards equation for saturated/unsaturated water flow and is commonly used to determine soil water balances and to assess soil cover performance (Šimůnek et al., 2013). The primary purpose of the modeling was to determine whether meteoric water will infiltrate the proposed soil cover and potentially perch on the existing liners if portions of the liner are left in place. Results of the modeling effort indicate that the soil cover is capable of storing and releasing meteoric water through evapotranspiration under most precipitation events. However, large precipitation events that generate 2 inches of rain or more in one day resulted in the accumulation of some saturation above the remaining portions of the liners. Results of a sensitivity analysis showed that transpiration from vegetation is the primary driver of moisture removal from the soil profile, and that ponding on the liner occurs when root water uptake is limited.

The one-dimensional model was represented as a 100-centimeter vertical soil profile consisting of two soil types representing the two sources of soil that will be used to complete the design grading. The volume of the soil stockpile located northeast of the site office is estimated to be approximately 4,000 cubic yards (Wykoff, 2018). Due to the good quality of this soil, it will be used in the top of the soil cover. If placed in the top of the soil cover as a uniform layer, its thickness will be approximately 25 centimeters (cm). Therefore, the upper 25 cm of the model were assigned the hydrologic properties determined for the soil stockpile material (Attachment 3). The lower portion of the soil cover will consist of the existing material located in the immediate vicinity of the ponds, and is characterized as a sandy loam with gravel based on field observations. The hydraulic properties for the lower portion were assigned the values in the HYDRUS library for a sandy loam. The liner was simulated as a low-permeability layer placed at the base of the soil profile; it was assigned the characteristics of clay and was added to determine if saturation or ponding developed on top of the low-permeability layer.

Site-specific meteorological data were used to characterize the upper boundary of the model. Precipitation and temperature data for the 5-year period of 2013-2017 recorded at the on-site

Tower Meteorological station were used. The Hargreaves formula was used to calculate potential evapotranspiration using the minimum and maximum daily temperature data. Root water uptake was simulated using the S-shape curve model developed by van Genuchten, with parameters specified based on observed site vegetation. The lower boundary of the model was allowed to freely drain.

The model was run for a total of 20 years, with the 5-year meteorological record repeated four times. The initial condition of the soil profile was defined by pressure head and was estimated from the output of a previous model run to minimize the influence of the initial condition on the final model results. Figure 1 shows the percent saturation immediately above the low-permeability layer (simulated liner). Saturation accumulated four times during the 20-year model run as the result of the 2.38-inch precipitation event that was repeated four times. The precipitation event represents a 10-year return interval storm based on NOAA Atlas 14 (Perica et al., 2018) (Attachment 4). The HYDRUS-1D model is provided as Attachment 5.

Results of the one-dimensional unsaturated flow modeling show the potential to pond water on top of the liners. Therefore, a subsurface collection and conveyance system is included in the evaporation pond closure design in order to avoid the ponding of water on the liners.

Evaporation Pond Closure Design

DBS&A developed a design for regrading and contouring of the evaporation pond area. The design includes two primary components: (1) a stormwater surface capture inlet and conveyance piping, and (2) a subsurface seepage capture and conveyance system. Attachment 1 provides the design set, which consists of the following sheets:

- Sheet 1: Title sheet.
- Sheet 2: General notes and legend.
- Sheet 3: Site map showing existing topography.
- Sheet 4: Grading plan showing existing and the proposed new topography once regrading is complete.
- Sheet 5: Plan and Profile I showing the profile of a new conveyance pipeline that will run from the proposed drop inlet structure to an existing 6-inch-diameter, high-density polyethylene (HDPE) conveyance pipeline that runs to the bottom of the open pit.
- Sheet 6: Plan and Profile II showing a topographic profile of the pond area; shows both existing and new topography.
- Sheet 7: Stormwater Details I providing construction details for the proposed drop inlet structure and HDPE wye connection.
- Sheet 8: Stormwater Details II providing additional construction details for the proposed drop inlet structure.

- Sheet 9: Subsurface Collection Details providing construction details for the proposed seepage collection and conveyance system. The existing evaporation ponds are lined with 60-mil HDPE. The total lined area of the two ponds is 3.85 acres. The evaporation ponds and associated perimeter berms are constructed entirely with native material derived from the excavations for the ponds; fill was not imported to support construction of the two ponds. The perimeter berms are approximately 10 feet tall. Some excess soil not used for pond construction was placed along the south side of the ponds. A minimum of 6 inches of fine-grained bedding soil was placed and compacted beneath the HDPE liners (The Mines Group, 2000).

Closure of the two evaporation ponds includes removal of the upper portions of the HDPE liners, regrading and vegetation of the evaporation pond area, and installation of stormwater and subsurface seepage control measures. The bottom and a 1-foot height of liner will be left in place in order to capture any seepage water that infiltrates the regraded soil cover. After the upper portion of liner is removed, regrading will commence using the soil immediately surrounding the ponds as a source of fill. The soil immediately surrounding the ponds does contain sulfides and possibly some waste rock. Soil from the soil stockpile located northeast of the site office will be used for the upper portion of the soil cover.

The lowest elevation in the ponds, 7,070.3 feet above mean sea level (feet msl), is currently located at the sump in the western pond. The western pond sump is approximately 1 foot lower than the sump in the eastern pond. Regrading will raise the elevation at the western pond sump by 3.7 feet. The majority of the cover will have a thickness of at least 3 feet and up to 4.3 feet in locations farthest from the inlet. The minimum cover thickness over the liner is approximately 2.3 feet, and is located immediately north of the eastern pond sump. Pond side slopes will be regraded from the current slope of 2:1 to 6:1 (H:V). A 6:1 slope will minimize soil erosion and rilling. Once it is regraded, LAC will have the area seeded to help establish vegetation.

DBS&A estimated the amount of stormwater runoff from the evaporation pond area after the area is regraded (Attachment 4). The estimated peak discharge associated with the 25-year, 24-hour storm event is approximately 2.5 cubic feet per second (cfs). This discharge rate was used to size the conveyance line and drop inlet structure. A drop inlet structure to be constructed near the existing pond sump will be used to capture stormwater from the regraded pond area. A new 6-inch-diameter HDPE conveyance pipeline will be installed to convey stormwater from the drop inlet structure to an existing 6-inch-diameter HDPE conveyance pipeline that runs to the bottom of the open pit. The new conveyance pipeline will be installed below grade from the drop inlet structure until it crosses beneath two site roadways, where it will then run above ground. The new conveyance pipeline will be approximately 285 feet long.

A subsurface collection system will be installed at each pond to convey any seepage water that accumulates on the remaining portions of the pond liners. The systems will consist of quartzite gravel sumps wrapped in geotextile fabric that will be underlain by HDPE drains with 6-inch HDPE pipe boots. The pipe boots will be installed at the lowest elevation in each pond and will be connected to each other with a 6-inch conveyance line. The seepage conveyance line will connect with the stormwater conveyance line with a wye fitting. The new subsurface seepage conveyance line will be approximately 130 feet long.

The existing 6-inch-diameter HDPE conveyance pipeline currently joins with another pipeline near the bottom of the open pit. The union occurs before an existing flow meter. In order to accommodate the additional flow from the new drop inlet structure and conveyance pipeline, the two existing conveyance pipelines will need to be separated and a second flow meter will need to be installed. An additional length of approximately 190 feet of 6-inch HDPE will also be required to allow both lines to continue to discharge to the bottom of the open pit.

Closing

DBS&A developed a modified design for the closure of the evaporation pond area. The previously submitted design (DBS&A, 2017) was modified to use additional site soil to increase soil cover thickness and to use portions of the existing pond liners to capture any seepage water that infiltrates the soil cover. The design consists of removing portions of the existing pond liners, filling the area of the ponds using site soils, and installing stormwater and subsurface seepage capture systems.

We appreciate the opportunity to support LAC at the Cunningham Hill Mine Reclamation Project. Please contact us at (505) 822-9400 with any questions or comments.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

John Ayarbe, P.G.
Senior Hydrologist

Jeffrey Samson, P.E.
Engineer

JA/rpf
Attachments

References

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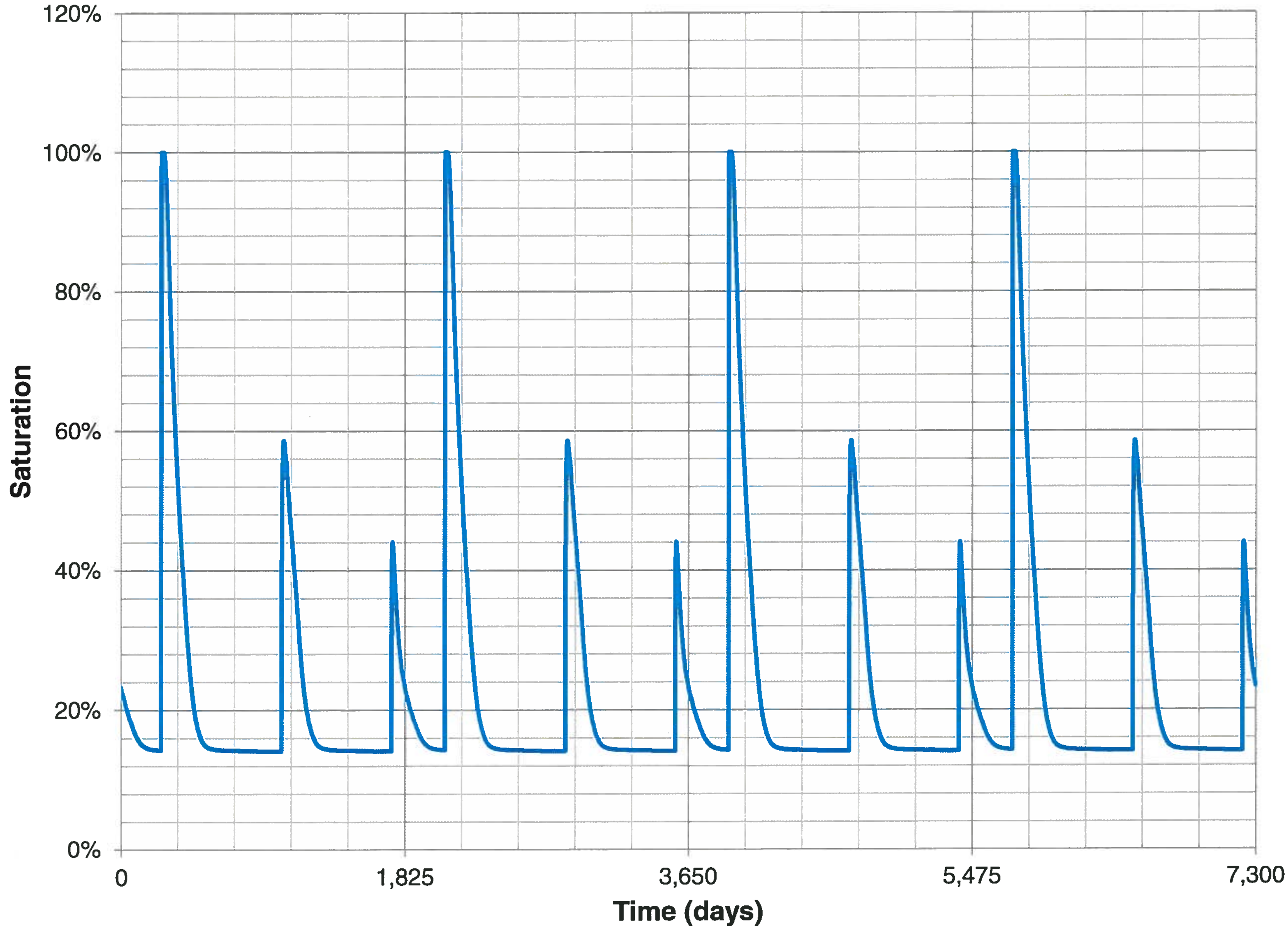
Figure



CUNNINGHAM HILL EVAPORATION POND REMOVAL

Modeled Saturation at Liner

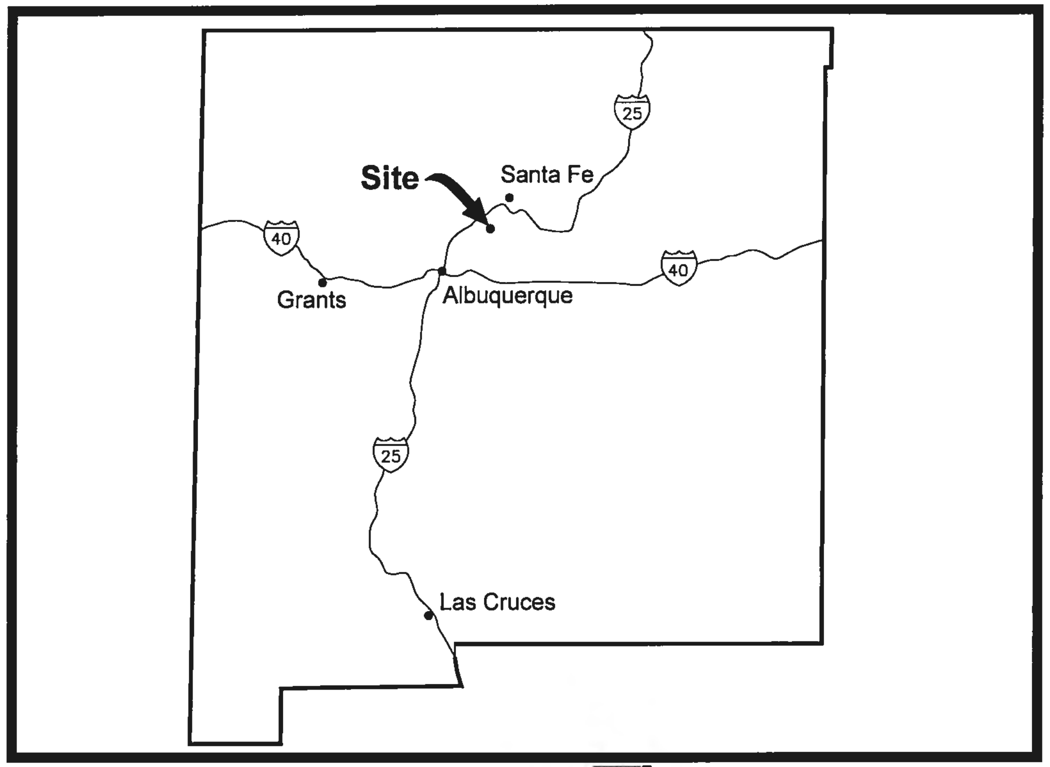
Figure 1

Daniel B. Stephens & Associates, Inc.

5/18/18

Attachment 1

Design Drawings



VICINITY MAP
NTS
NORTH

SITE MAP
NTS
NORTH

CUNNINGHAM HILL EVAPORATION POND REMOVAL

CUNNINGHAM HILL MINE RECLAMATION PROJECT

SANTA FE COUNTY, NEW MEXICO

PREPARED FOR
LAC MINERALS, INC.

INDEX OF DRAWINGS

NUMBER		TITLE	REVISION
		GENERAL	
1	G-0	TITLE SHEET	0
2	G-1	GENERAL NOTES & LEGEND	0
		CIVIL	
3	C-1	SITE MAP	0
4	C-2	GRADING PLAN	0
5	C-3	PLAN AND PROFILE I	0
6	C-4	PLAN AND PROFILE II	0
7	C-5	STORMWATER DETAILS I	0
8	C-6	STORMWATER DETAILS II	0
9	C-7	SUBSURFACE COLLECTION DETAILS	0

NO	DATE	BY	REVISION MADE

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DRAWN BY: JA
CHECKED BY: GP
DATE: 05/16/2016

CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXXICO
TITLE SHEET

JEFFREY SAMSON
NEW MEXICO
23686
PROFESSIONAL ENGINEER

JOB NO.
NM16.0177

SHEET 1 of 9
DWG NO. G-0

S:\PROJECTS\NM16.0177_CUNNINGHAM_POND_CLOSURE\CAD\PRODUCTION DRAWINGS\TITLE_SHEET.DWG

GENERAL CONSTRUCTION NOTES:

A. ALL WORK ON THIS PROJECT SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE AND LOCAL LAWS, ORDINANCES, AND REGULATIONS CONCERNING CONSTRUCTION SAFETY AND HEALTH.

B. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL REQUIRED CONSTRUCTION PERMITS AND APPROVALS OF LIKE KIND PRIOR TO START OF CONSTRUCTION.

C. PROJECT DOCUMENTS CONSIST OF THESE DRAWINGS, PROJECT CONTRACTS, AND ANY AND ALL SUBSEQUENT EXECUTED PROJECT DOCUMENTATION ISSUED AS, OR WITH, CHANGE ORDERS, AND RFI'S (REQUEST FOR INFORMATION.) THE CONTRACTOR SHALL REVIEW ALL PROJECT DOCUMENTS AND VERIFY ALL DIMENSIONS, QUANTITIES, AND FIELD CONDITIONS. ANY CONFLICTS OR OMISSIONS WITH THE DOCUMENTS SHALL BE REPORTED TO THE ENGINEER/PROJECT MANAGER FOR CLARIFICATION PRIOR TO PERFORMANCE OF ANY WORK IN QUESTION. IN THE EVENT THE CONTRACTOR DOES NOT NOTIFY THE ENGINEER/PROJECT MANAGER, THE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND ANY AND ALL EXPENSE FOR ANY REVISIONS NECESSARY OR CORRECTIONAL WORK REQUIRED.

D. THE LOCATION OF BURIED UTILITIES ARE BASED UPON INFORMATION PROVIDED TO THE ENGINEER BY OTHERS AND MAY NOT REFLECT ACTUAL FIELD CONDITIONS. EXISTING BURIED UTILITIES SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL USE ANY MEANS APPROVED BY THE ENGINEER/PROJECT MANAGER TO LOCATE UNDERGROUND UTILITIES INCLUDING, BUT NOT LIMITED TO, ELECTRONIC LOCATING EQUIPMENT AND/OR POT HOLING. ANY DAMAGE TO ANY OTHER UTILITIES AND/OR COLLATERAL DAMAGE CAUSED BY THE CONTRACTOR SHALL BE THE FULL RESPONSIBILITY OF THE CONTRACTOR.

E. EXISTING FENCING THAT IS NOT DESIGNATED FOR REMOVAL SHALL NOT BE DISTURBED. ANY FENCING THAT IS DISTURBED OR ALTERED BY THE CONTRACTOR SHALL BE RESTORED TO ITS ORIGINAL CONDITION AT THE CONTRACTOR'S EXPENSE. IF THE CONTRACTOR DESIRES TO REMOVE FENCING TO ACCOMMODATE CONSTRUCTION ACTIVITIES, THE CONTRACTOR SHALL OBTAIN THE OWNER'S WRITTEN PERMISSION BEFORE FENCE IS REMOVED. CONTRACTOR SHALL RESTORE THE FENCE TO ITS ORIGINAL CONDITION AT THE EARLIEST OPPORTUNITY TO THE SATISFACTION OF THE OWNER. WHILE ANY FENCING IS REMOVED, THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR SECURITY OF THE SITE UNTIL THE FENCE IS RESTORED.

F. AT THE END OF EACH WORK DAY, THE CONTRACTOR SHALL CLEAN AND PICK UP THE WORK AREA TO THE SATISFACTION OF THE ENGINEER/PROJECT MANAGER. AT NO TIME SHALL THE WORK BE LEFT IN A MANNER THAT COULD ENDANGER THE WORKERS OR THE PUBLIC.

G. ALL MATERIALS AND WORKMANSHIP SHALL CONFORM TO PROJECT PLANS, AS AMENDED AND REVISED BY THE ENGINEER. ALL INSTALLATION DETAILS ARE TYPICAL AND MAY BE CHANGED TO BETTER FIT EXISTING LOCAL CONDITIONS UPON APPROVAL BY THE ENGINEER.

H. ONLY THE CONTRACTOR SHALL BE RESPONSIBLE FOR SAFETY OF ALL WORK. ALL WORK, INCLUDING WORK WITHIN TRENCHES, SHALL BE IN ACCORDANCE WITH THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA).

I. REFERENCES MADE TO STANDARD SPECIFICATIONS AND STANDARD DRAWINGS REFER TO THE NEW MEXICO CHAPTER OF THE AMERICAN PUBLIC WORKS ASSOCIATION (NM–APWA) STANDARDS FOR PUBLIC WORKS CONSTRUCTION.

J. THE CONTRACTOR SHALL NOT INSTALL ITEMS AS SHOWN ON THESE PLANS WHEN IT IS OBVIOUS THAT FIELD CONDITIONS ARE DIFFERENT THAN SHOWN IN THE PLANS. SUCH CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER IN A TIMELY MANNER. IN THE EVENT THE CONTRACTOR DOES NOT NOTIFY THE ENGINEER IN A TIMELY MANNER, THE CONTRACTOR ASSUMES FULL RESPONSIBILITY AND EXPENSE FOR ANY REVISIONS NECESSARY, INCLUDING ENGINEERING DESIGN FEES.

K. EXISTING SITE IMPROVEMENTS WHICH ARE DAMAGED OR DISPLACED BY THE CONTRACTOR SHALL BE REMOVED AND REPLACED BY THE CONTRACTOR AT THE CONTRACTOR'S EXPENSE. REPAIRS SHALL BE APPROVED BY THE OWNER PRIOR TO CONSTRUCTION OF THE REPAIRS. REPAIRS SHALL BE ACCEPTED BY THE OWNER PRIOR TO FINAL PAYMENT.

L. CONTRACTOR TO COMPLETE PROCTORS ON NATIVE MATERIAL, AS DIRECTED BY THESE DRAWINGS OR THE ENGINEER.

SURVEY MONUMENTS, PROPERTY CORNERS, BENCHMARKS

M. THE CONTRACTOR SHALL NOTIFY THE OWNER AT LEAST SEVEN (7) DAYS BEFORE BEGINNING ANY CONSTRUCTION ACTIVITY THAT COULD DAMAGE OR DISPLACE SURVEY MONUMENTS, PROPERTY CORNERS, OR PROJECT BENCHMARKS SO THESE ITEMS MAY BE RELOCATED.

N. ANY SURVEY MONUMENTS, PROPERTY CORNERS, OR BENCHMARKS THAT ARE NOT IDENTIFIED FOR RELOCATION ARE THE RESPONSIBILITY OF THE CONTRACTOR TO PRESERVE AND PROTECT, RELOCATION OR REPLACEMENT OF THESE ITEMS SHALL BE DONE BY THE OWNER'S SURVEYOR AT THE EXPENSE OF THE CONTRACTOR.

DESIGN SURVEY

O. SURVEY PROJECT CONTROL WAS REFERRED TO THE NEW MEXICO STATE PLANE COORDINATE SYSTEM (NAD 27–CENTRAL ZONE) AND NGVD 29 VERTICAL DATUM.

P. THIS DESIGN IS BASED ON SURVEY INFORMATION PROVIDED BY OTHERS. THE ENGINEER CANNOT VALIDATE OR WARRANTY THIS INFORMATION. ANY DISCREPANCIES BETWEEN THE DESIGN AND SITE SURFACE CONDITIONS SHALL BE BROUGHT TO THE ENGINEER'S ATTENTION IMMEDIATELY.

CONSTRUCTION LIMITS

Q. SHALL BE AS SHOWN ON PLANS.

R. THE CONTRACTOR SHALL MAINTAIN A RECORD DRAWING SET OF PLANS AND PROMPTLY LOCATE ALL UTILITIES, EXISTING OR NEW, IN THEIR CORRECT LOCATION, HORIZONTAL AND VERTICAL. THIS RECORD SET OF DRAWINGS SHALL BE MAINTAINED ON THE PROJECT SITE AND SHALL BE AVAILABLE TO THE OWNER AND ENGINEER AT ANY TIME DURING CONSTRUCTION. RECORD INFORMATION SHALL INCLUDE HORIZONTAL AND VERTICAL COORDINATE CALLOUTS, LINE SIZES, LINE TYPES, BURIAL DEPTHS, AND ALL OTHER PERTINENT INSTALLATION INFORMATION. IN ADDITION ALL ITEMS THAT ARE INSTALLED EXACTLY AS DESIGNED SHALL BE NOTED AS SUCH.

EROSION CONTROL, ENVIRONMENTAL PROTECTION, AND STORM WATER POLLUTION PREVENTION PLAN

S. THE CONTRACTOR SHALL CONFORM TO ALL SANTA FE COUNTY, STATE OF NEW MEXICO, AND FEDERAL DUST AND EROSION CONTROL REGULATIONS. THE CONTRACTOR SHALL PREPARE AND OBTAIN ANY DUST CONTROL OR EROSION CONTROL PERMITS FROM THE APPROPRIATE REGULATORY AGENCIES.

T. THE CONTRACTOR SHALL ENSURE THAT NO SOIL ERODES FROM THE SITE ONTO ADJACENT PROPERTY BY CONSTRUCTION OF TEMPORARY EROSION CONTROL BERMS OR INSTALLING SILT FENCES AT THE PROPERTY LINES (OR LIMITS OF CONSTRUCTION WHERE DESIGNATED) AND WETTING SOIL TO PREVENT IT FROM BLOWING.

U. WATERING, AS REQUIRED FOR CONSTRUCTION DUST CONTROL, SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION AND NO MEASUREMENT OR PAYMENT SHALL BE MADE. CONSTRUCTION AREAS SHALL BE WATERED FOR DUST CONTROL IN COMPLIANCE WITH COUNTY AND STATE ORDINANCES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE OWNER, FOR AVAILABILITY AND USE OF WATER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SUPPLYING ALL EQUIPMENT AND MATERIALS NECESSARY FOR TRANSPORTATION AND USE OF WATER.

V. ALL WASTE PRODUCTS FROM THE CONSTRUCTION SITE, INCLUDING ITEMS DESIGNED FOR REMOVAL, CONSTRUCTION WASTE, CONSTRUCTION EQUIPMENT WASTE PRODUCTS (OIL, GAS, TIRES, ETC.), GARBAGE, GRUBBING, EXCESS CUT MATERIAL, VEGETATIVE DEBRIS, ETC. SHALL BE APPROPRIATELY DISPOSED OF OFFSITE UNLESS OTHERWISE DIRECTED BY THE ENGINEER/PROJECT MANAGER AT NO ADDITIONAL COST TO THE OWNER. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN ANY PERMITS REQUIRED FOR HAUL OR DISPOSAL OF WASTE PRODUCTS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO ENSURE THAT THE WASTE DISPOSAL SITE COMPLIES WITH APPROPRIATE REGULATIONS REGARDING THE ENVIRONMENT, ENDANGERED SPECIES, AND ARCHAEOLOGICAL RESOURCES.

W. THE CONTRACTOR SHALL REPORT AND CLEAN UP HAZARDOUS MATERIALS SPILLS IN ACCORDANCE WITH THE GOVERNING LAC MINERALS, INC. SPILL PREVENTION PLAN.

X. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE REGULATIONS CONCERNING SURFACE AND UNDERGROUND WATER. CONTACT WITH SURFACE WATER BY CONSTRUCTION EQUIPMENT AND PERSONNEL SHALL BE MINIMIZED. EQUIPMENT MAINTENANCE AND REFUELING OPERATIONS SHALL BE PERFORMED IN AN ENVIRONMENTALLY SAFE MANNER IN COMPLIANCE WITH COUNTY, STATE, AND EPA REGULATIONS.

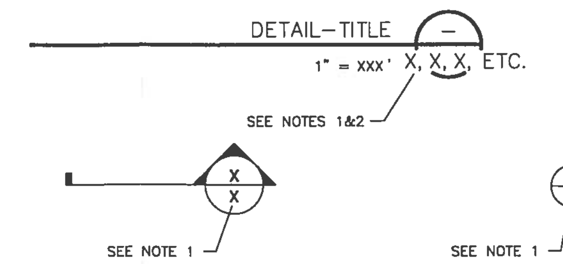
Y. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE REGULATIONS CONCERNING CONSTRUCTION NOISE AND HOURS OF OPERATION AS IMPOSED BY THE OWNER OR COUNTY AUTHORITIES.

MISCELLANEOUS SYMBOLS:

NOTE: SYMBOLS ARE NOT SHOWN TO SCALE ON PLAN OR PROFILE DRAWINGS, AND INDICATE APPROXIMATE LOCATION ONLY.

——— – ———	CENTERLINE
——C——	EXISTING CONVEYANCE LINE
——C——	NEW CONVEYANCE LINE
	COMPACTED BACKFILL
ø	DIAMETER
7050	EXISTING MAJOR CONTOUR LINE AND ELEVATION DESIGNATION
7049	EXISTING MINOR CONTOUR LINE AND ELEVATION DESIGNATION
—x——x—	EXISTING WIRE FENCE
7050	NEW MAJOR CONTOUR LINE AND ELEVATION DESIGNATION
7049	NEW MINOR CONTOUR LINE AND ELEVATION DESIGNATION
— — — — —	UNIMPROVED DIRT ROAD OR GRAVELED ROADWAY
× 6070.7	SPOT ELEVATION (FT MSL)
	SURVEY MONUMENT (PREVIOUS PROJECT)
	UNDISTURBED SOIL
× 7071.78'	SPOT ELEVATION
⊗ TPL–1 10.5'	TEST PIT LOCATION, DESIGNATION, AND DEPTH

LEGEND:



NOTES:

1. IF SECTION, DETAIL, SCHEMATIC, OR DIAGRAM IS DRAWN ON THE SAME SHEET THAT IT IS TAKEN FROM, THE SHEET NUMBER SHALL BE REPLACED WITH A HYPHEN.
2. IF THE SECTION, DETAIL, SCHEMATIC, OR DIAGRAM IS REFERENCED ON MULTIPLE SHEETS, ALL SHEETS SHOULD BE LISTED TO THE OUTSIDE RIGHT OF THE DETAIL–TITLE BUBBLE, AND SEPARATED WITH A COMMA.

ABBREVIATIONS:

AMSL	ABOVE MEAN SEA LEVEL
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BGS	BENEATH GROUND SURFACE
DIA	DIAMETER
DR	DIMENSION RATIO
EW	EACH WAY
HDPE	HIGH DENSITY POLYETHYLENE
INV	INVERT ELEVATION
LB	POUNDS
MIN	MINIMUM
NTS	NOT TO SCALE
PSI	POUNDS PER SQUARE INCH
SCH	SCHEDULE
SDR	STANDARD DIMENSION RATIO
STA	STATION
STD	STANDARD
TP	TOP OF PIPE
TPL	TEST PIT LOCATION
TYP	TYPICAL
WL	WATER LINE
H	HORIZONTAL
V	VERTICAL
VPI	VERTICAL POINT OF INFLECTION

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CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXXICO
GENERAL NOTES & LEGEND

JEFFREY SAMSON NEW MEXICO 23686 PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 2 of 9
DWG NO. G-1

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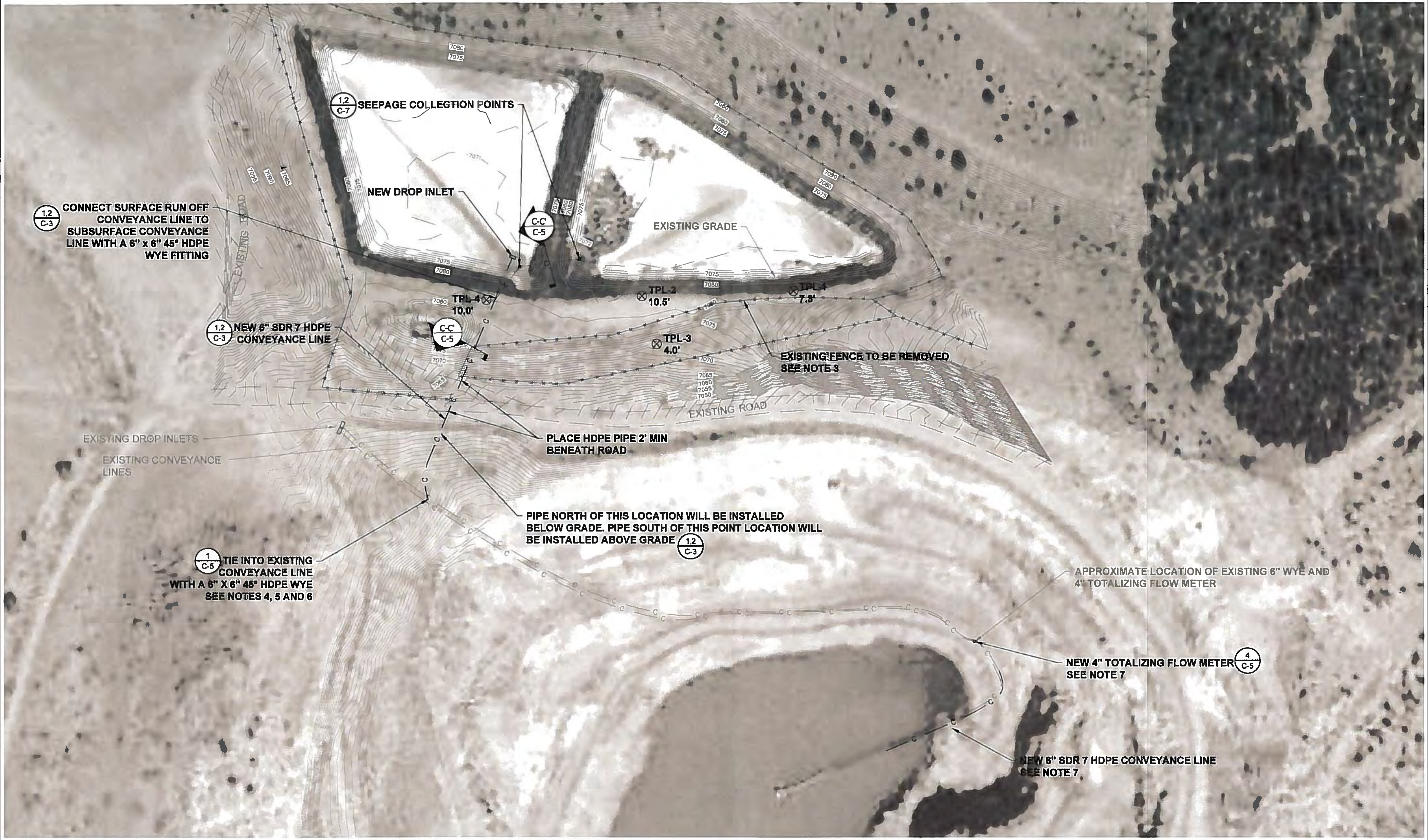

CONSTRUCTION NOTES:

1. TOPOGRAPHY LINES COME FROM SURVEY INFORMATION PROVIDED BY OTHERS.
2. NEW GRADING SEE SHEET C-2.
3. FENCE REMOVAL AS NEEDED. CONSULT OWNER PRIOR TO REMOVAL.
4. HDPE WYE CONNECTION TO BE MADE ON NORTHERN 6" LINE WHERE GRADE IS SUITABLE FOR EQUIPMENT.
5. FOLLOW HDPE MANUFACTURERS GUIDELINES FOR INSTALLATION. MINIMUM PIPE BEND RADIUS OF 38 FEET.
6. EXACT LOCATION OF EXISTING 6" HDPE LINES UNKNOWN. FINAL LOCATION OF WYE TO BE APPROVED BY ENGINEER OR CONTRACTOR IN FIELD.
7. REMOVE EXISTING 6" WYE FITTING AND INSTALL NEW 4" FLOWMETER. MATCH TO EXISTING FLOWMETER INSTALLATION. INSTALL APPROXIMATELY 190' OF 6" SDR 7 HDPE ALONGSIDE EXISTING LINE SO THAT BOTH LINES DISCHARGE INTO THE OPEN PIT.

SITE PLAN 1 C-1
1" = 60'-0"

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CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXICO

SITE PLAN

JEFFREY SAMSON NEW MEXICO 23686 PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 3 of 9
DWG NO. C-1

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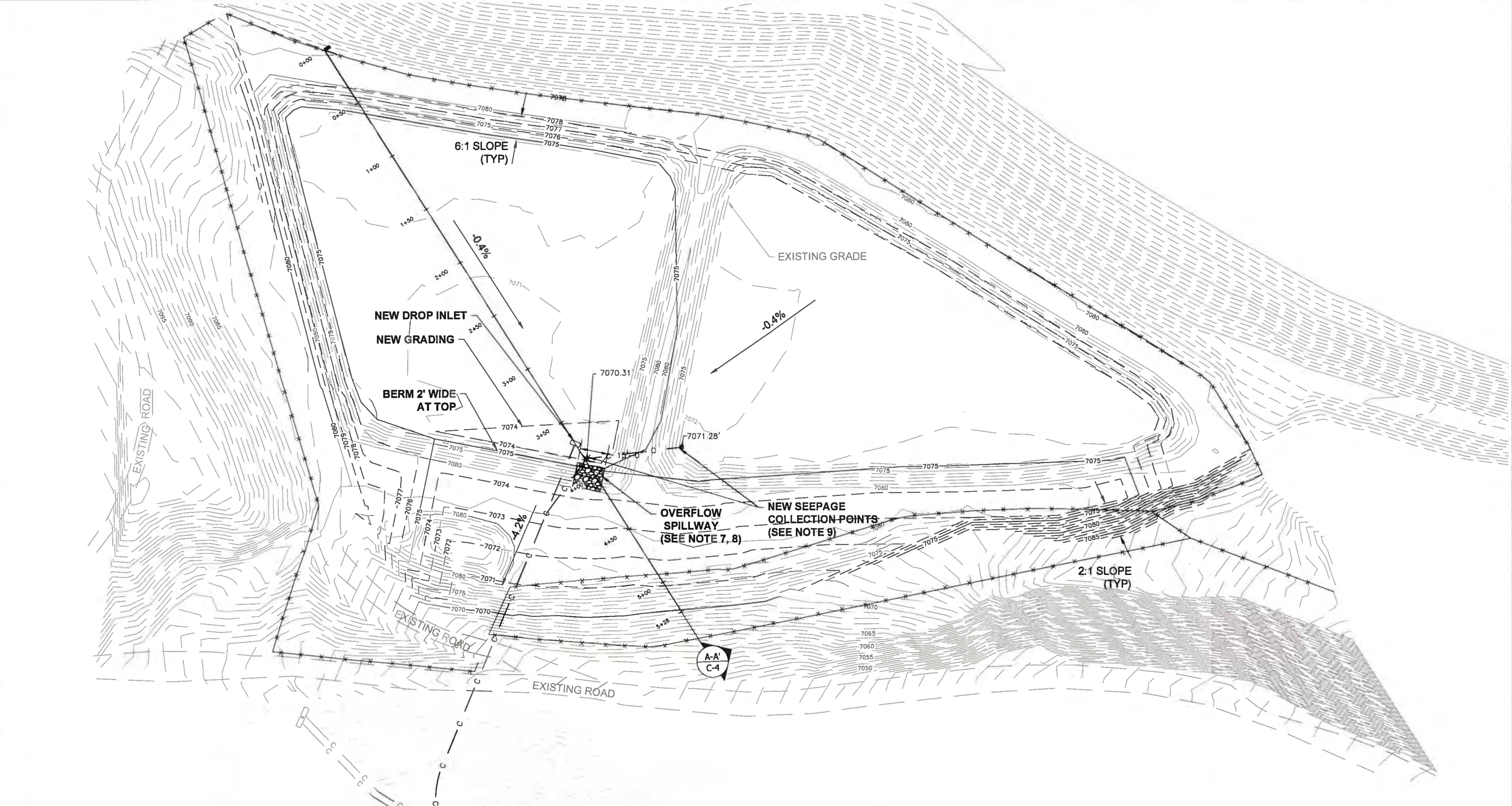

Cut/Fill Summary (Does Not Include Fill From Northeast of Site)

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
DESIGN OVER EXISTING	**1.000**	**1.000**	237122.31 Sq. Ft.	15045.65 Cu. Yd.	17356.98 Cu. Yd.	2311.33 Cu. Yd. <Fill>
Totals			237122.31 Sq. Ft.	15045.65 Cu. Yd.	17356.98 Cu. Yd.	2311.33 Cu. Yd. <Fill>

NORTH

0 40 ft

CONSTRUCTION NOTES:

1. TOPOGRAPHY LINES COME FROM SURVEY INFORMATION PROVIDED BY OTHERS.
2. ALL SIDE SLOPES TO BE CONSTRUCTED AT 6:1 (H:V) MAX.
3. CUT MATERIAL TO BE TEMPORARILY STOCKPILED ON SITE AT A LOCATION DETERMINED BY OWNER.
4. GRADE AREA TO DRAIN TOWARDS DROP INLET.
5. COMPACT ROAD TO WITHIN 10% OF ADJACENT IN SITU DENSITY AS DETERMINED BY FIELD DENSITY TEST.
6. UPON COMPLETION OF GRADING, SEEDING OF DISTURBED AREAS WILL BE COMPLETED BY OTHERS.
7. OVERFLOW SPILLWAY TO BE OVER EXCAVATED 2 FEET AND THEN COMPACTED IN PLACE IN 1-FOOT LIFTS TO 95% OF ASTM D698.
8. LINE TOP OF OVERFLOW SPILLWAY WITH ANGULAR ROCKS GREATER THAN ¾" FROM CUT, AND THE DOWNSLOPE WITH ANGULAR ROCKS GREATER THAN 4" FROM CUT.
9. SEEPAGE COLLECTION POINTS TO BE LOCATED AT THE LOWEST POINT IN EACH POND.
10. LINER LOCATED ON THE POND BOTTOM, INCLUDING A 1-FOOT LIP ALL THE WAY AROUND, WILL REMAIN IN PLACE.
11. CUT LINER ON WESTERN POND 2-FT ABOVE BOTTOM AND FOLD LINER BACK INTO EASTERN POND. REMOVE THE REQUIRED CUT TO CONNECT THE PONDS WITH A 1-FT LIP ON EITHER POND, AND THEN FOLD BACK LINER TO CREATE A LINED SURFACE BETWEEN THE PONDS. PLACE REQUIRED FILL ABOVE LINER PER ELEVATIONS IN DRAWING.

GRADING PLAN (1 / C-2)
1" = 40'-0"

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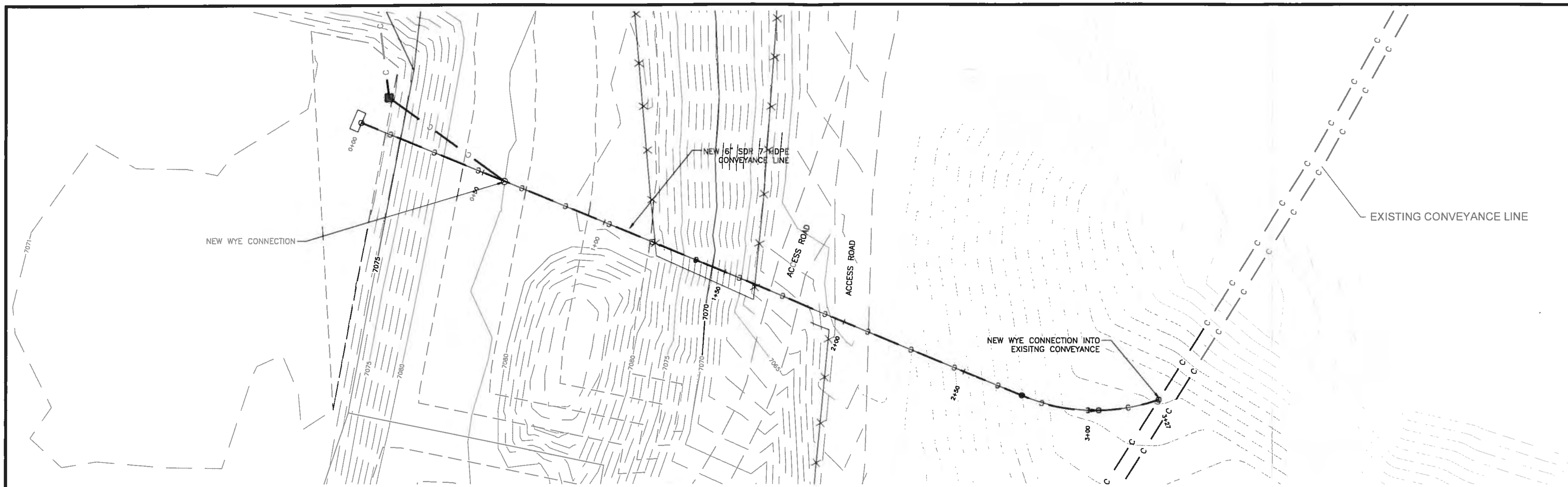
CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXXICO
GRADING PLAN

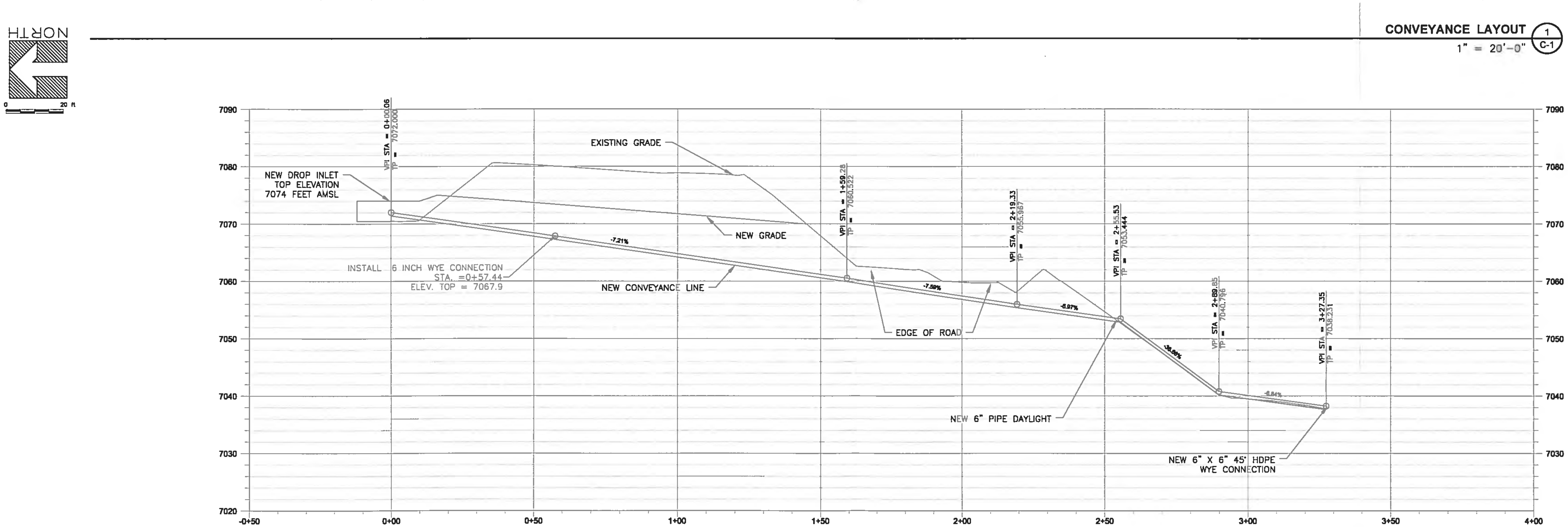
JEFFREY SAMSON NEW MEXICO 23686 PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 4 of 9
DWG NO. C-2



CONVEYANCE LAYOUT (1/C-1)
1" = 20'-0"



CONVEYANCE PLAN AND PROFILE (2/C-1)
1" = 20'-0"

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CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXICO

PLAN AND PROFILE I

JEFFREY SAMSON, NEW MEXICO, 23686, PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 5 of 9
DWG NO. C-3

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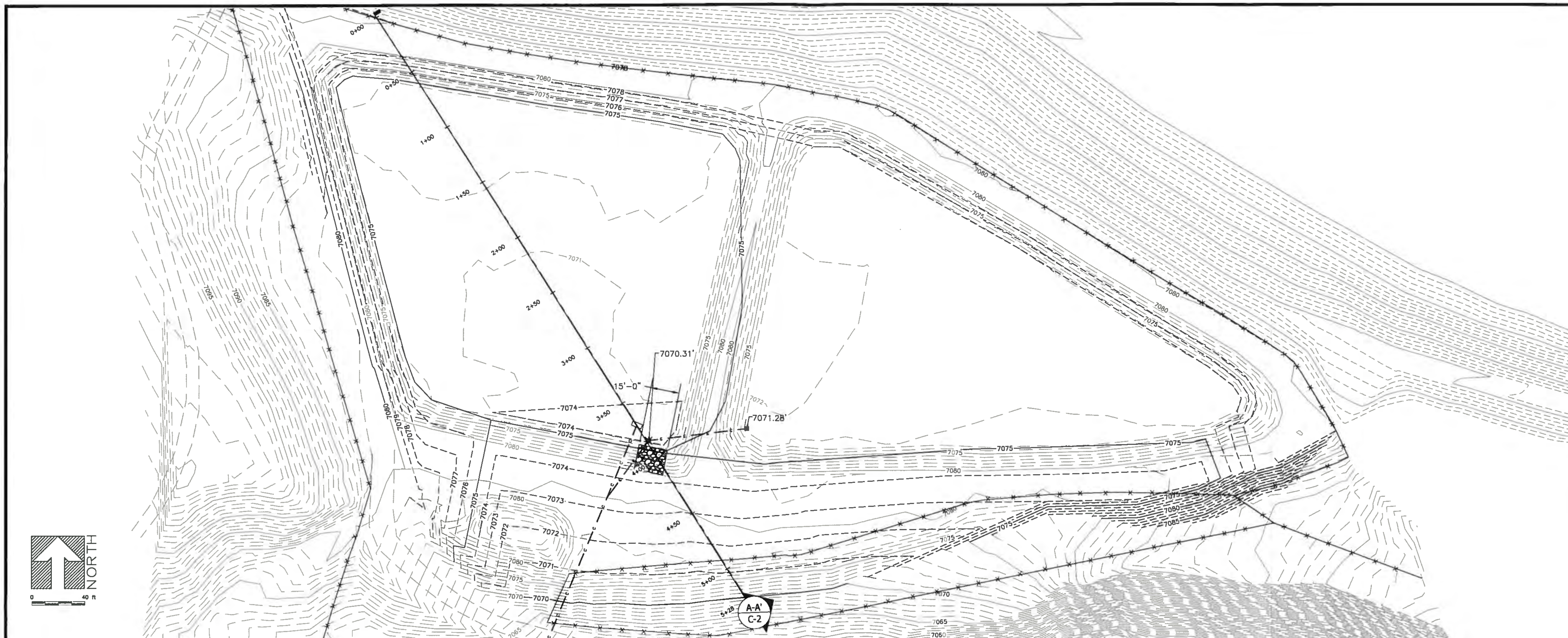
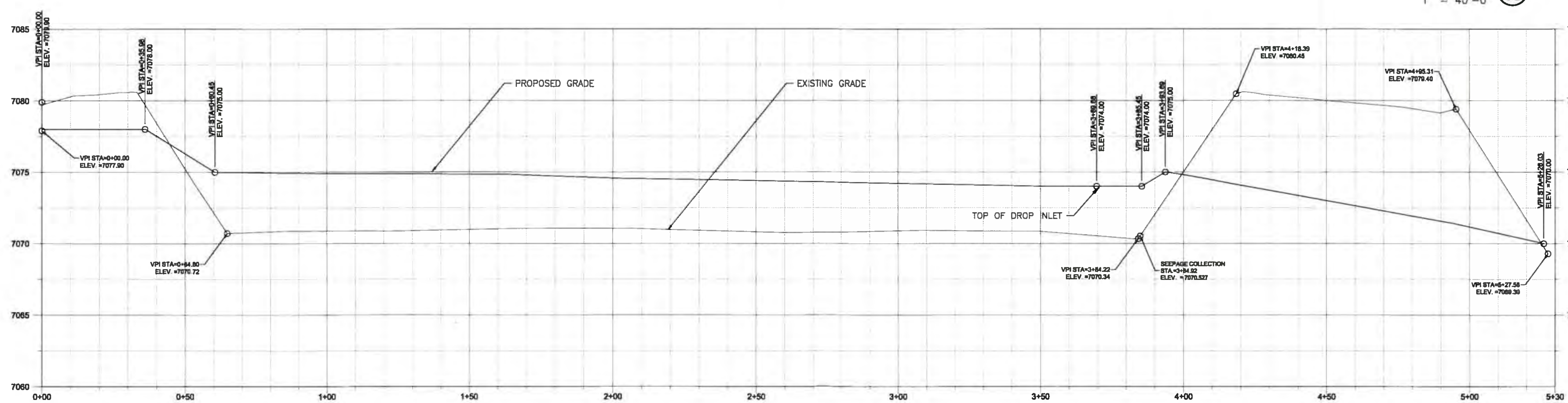


GRADING LAYOUT (1 / C-2)

1" = 40'-0"



A-A' GRADING PLAN AND PROFILE (A-A' / C-2)

HORIZ. SCALE 1" = 20'-0"
VERT. SCALE: X10

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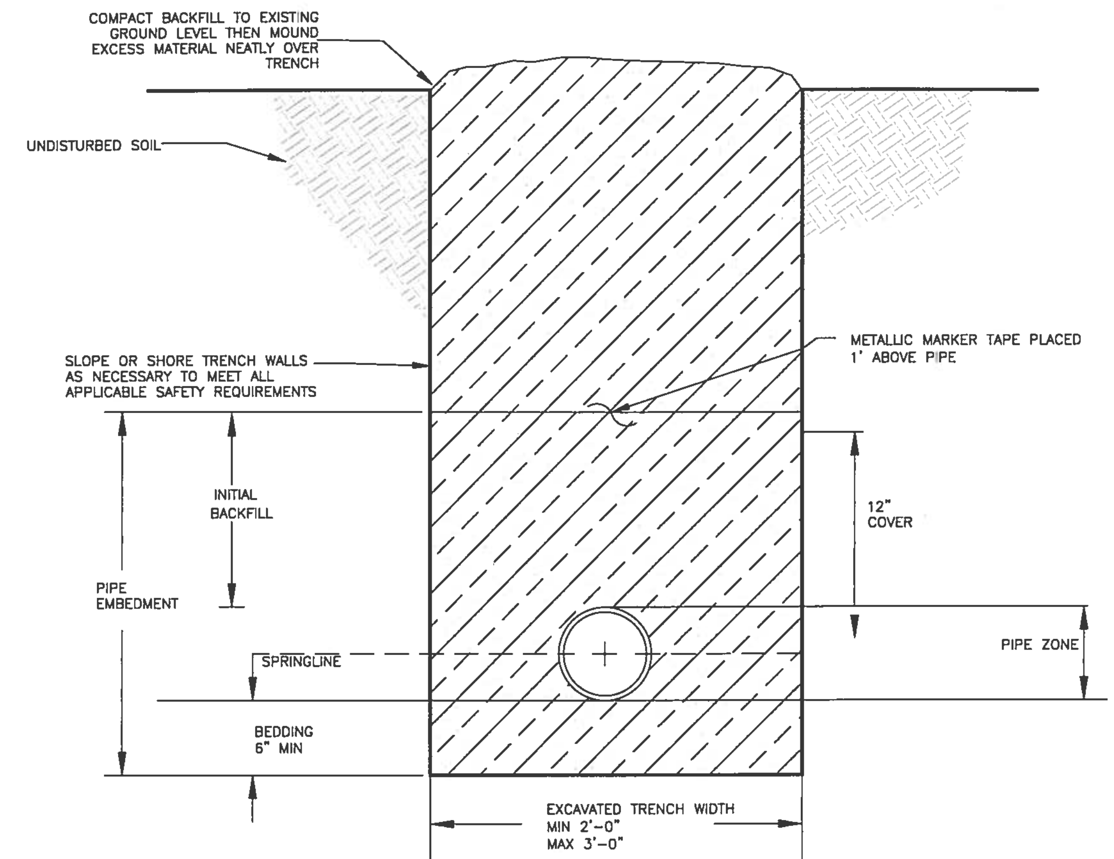
CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXXICO

PLAN AND PROFILE II

JEFFREY SAMSON, NEW MEXICO, 23688, PROFESSIONAL ENGINEER

JOB NO.
NM16.0177

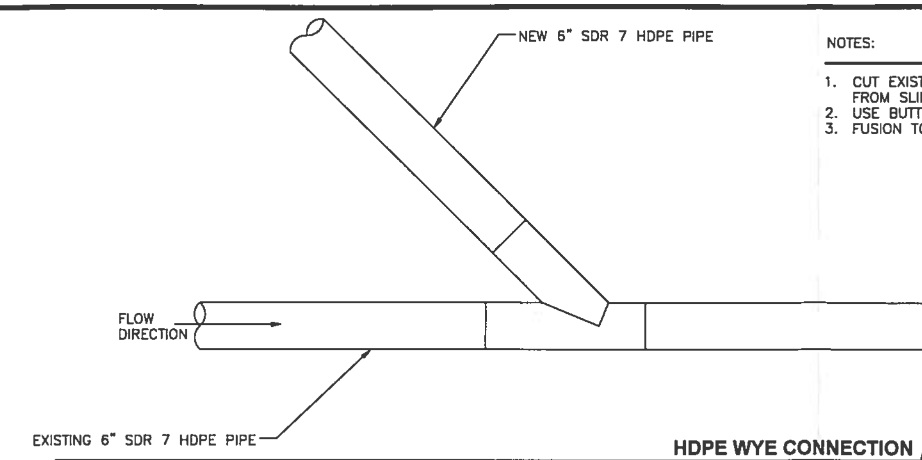
SHEET 6 of 9
DWG NO. C-4



NOTES:

1. ALL FILL TO BE NATIVE GRANULAR OR SANDY MATERIAL FREE OF STUMPS, ROOTS, AND ROCKS GREATER THAN 3" AND NO STONES LARGER THAN 1" WITHIN PIPE EMBEDMENT COMPACTED TO 90% OF ASTM D698. MAX 6" LIFTS TO 12" ABOVE TOP OF PIPE.

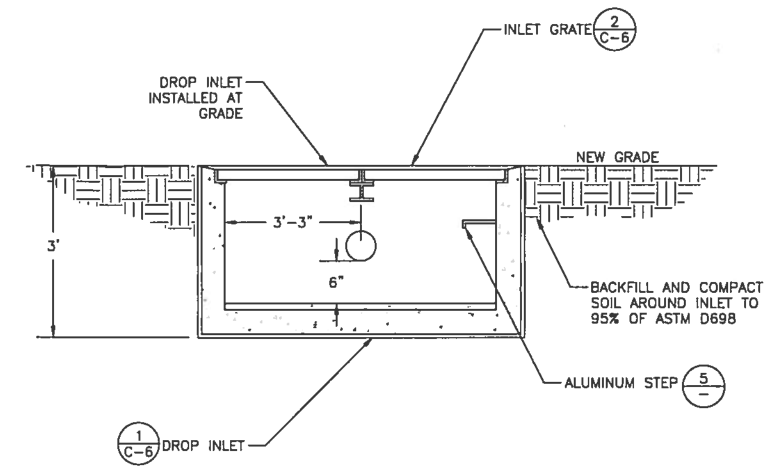
TYPICAL TRENCH SECTION (C-C' / C-1)
NTS



NOTES:

1. CUT EXISTING PIPE IN PLACE AND BRACE LOWER SECTION TO KEEP FROM SLIDING DOWN HILL.
2. USE BUTT FUSION METHOD TO INSTALL WYE FITTING.
3. FUSION TO BE COMPLETED BY A CERTIFIED WELDER.

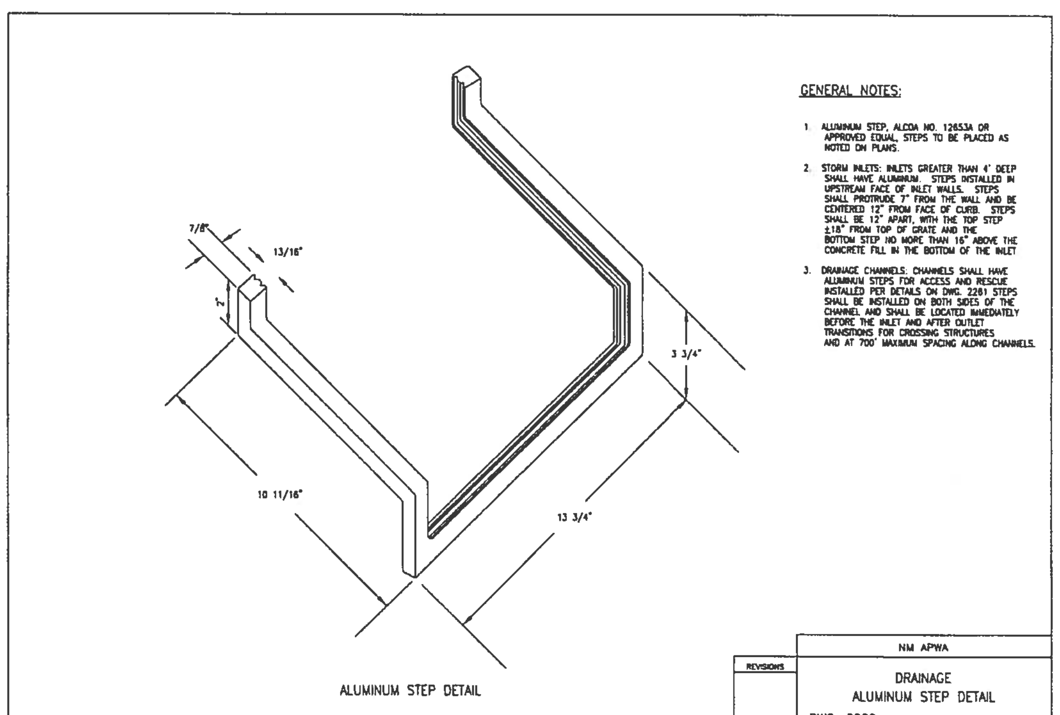
HDPE WYE CONNECTION (1 / C-1)
NTS



NOTES:

1. SEE PLAN AND PROFILE I (DWG C-3) FOR INLET GRADE AND PIPE INVERT ELEVATIONS.
2. CONTRACTOR TO COMPLETE WATER TIGHT CONNECTION BETWEEN CONCRETE AND 6" HDPE CONVEYANCE LINE.
3. CONTRACTOR TO TEST CONNECTION BETWEEN CONCRETE AND HDPE CONVEYANCE LINE BY POURING 500 GALLONS OF WATER IN THE INLET AND THEN OBSERVING FOR LEAKS.

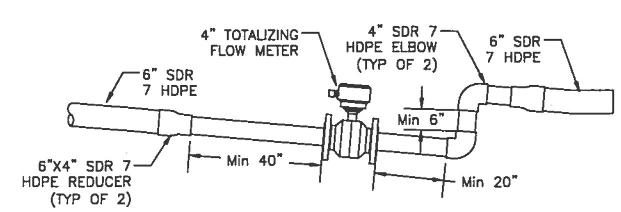
DRAINAGE STORM INLET CONFIGURATION (2 / C-1)
NTS



DRAINAGE ALUMINUM STEP DETAIL (5 / -)
NM APWA STANDARD DRAWING 2229 NTS

NOTES:

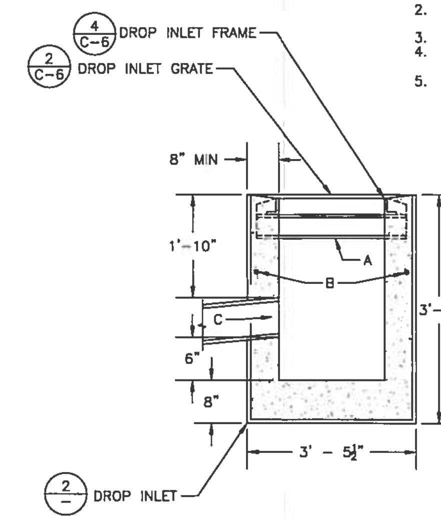
1. INSTALL A NEW 4" ELSTER EVOQ4" TOTALIZING FLOW METER ON ONE OF THE CONVEYANCE LINES, WITH THE EXISTING FLOWMETER AND ASSOCIATED 4" HDPE PIPE FITTINGS BEING INSTALLED ON THE ADJACENT LINE.
2. FINAL INSTALLATION SHOULD BE IDENTICAL TO THE EXISTING CONFIGURATION AND PLACEMENT.



FLOW METER ISTALLATION DETAIL (4 / C-1)
NTS

GENERAL NOTES:

1. FOR SINGLE GRATE TYPE INLET, DELETE CENTER SUPPORT AND MOVE ONE END WALL TO FORM NEW SINGLE GRATE INLET.
2. INLET GUTTER TRANSITION WILL BE SHOWN ON THE CONSTRUCTION PLANS.
3. OUTLET PIPE SIZE, PER DESIGN REQUIREMENT.
4. FOR FRAME & GRATING, SEE DWG. 2216, 2220 & 2221 (DWG C-6).
5. FOR CENTER SUPPORT ASSEMBLY, SEE DWG. 2215 (DWG C-6).



CONSTRUCTION NOTES:

A. CENTER SUPPORT ASSEMBLY
B. NO. 4 BARS 6" ON CENTER EACH WAY
C. CUT ONE HORIZONTAL AND ONE VERTICAL BAR MAX AT PIPE OPENING.

DRAINAGE STORM INLET DOUBLE "D" (3 / C-1)
NTS

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DATE: 05/18/2018

CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXICO
STORMWATER DETAILS I

JEFFREY SAMSON, NEW MEXICO, 23686, PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 7 of 9
DWG NO. C-5

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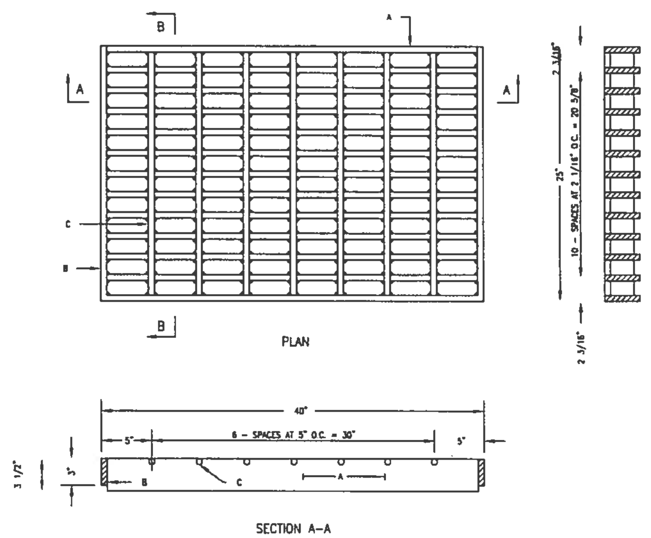


GENERAL NOTES:

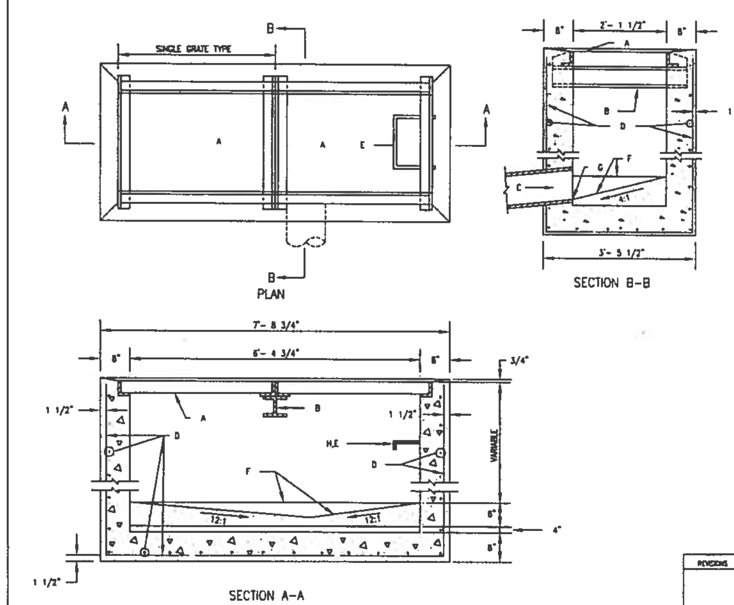
1. ALL BARS SHALL BE STRUCTURAL GRADE STEEL, GRADE A36
2. THE GRATE SHALL BE WELDED WITH 1/8" FILLET WELD AROUND BOTH SIDES OF CROSS BARS. 1/4" FILLET WELD BOTH SIDES OF BEARING BARS TO END BARS.
3. AFTER CLEANING SURFACE OF SCALE, RUST, OILS, ETC., PAINT GRATE WITH ONE SHOP COAT RED OXIDE, TWO FINISH COATS ALUMINUM PAINT (AASHTO M 69).
4. TOP OF CROSS BARS SHALL BE FLUSH WITH TOP OF GRATE.
5. GRIND WELDS FLUSH WITH BEARING BARS.
6. WHEN INSTALLED IN FRAME, PUSH TIGHT TO ONE SIDE, OTHER SIDE SHALL HAVE 1/2" MAX. OPENING. SPACERS WELDED TO FRAME MAY BE USED IF REQUIRED TO KEEP 1/2" SPACE OR LESS.

CONSTRUCTION NOTES:

A. BEARING BARS, (13) 1/2" X 3 1/2" X 39"
B. END BARS, (2) 1/2" X 3" X 25"
C. CROSS BARS, (7) 1/2" DIA. X 24".

REVISIONS | NM APWA | DRAINAGE STORM INLET GRATE | DWG 2220 | FEB 2006

DRAINAGE STORM INLET GRATE (2 / C-5)
NM APWA STANDARD DRAWING 2220 NTS



GENERAL NOTES:

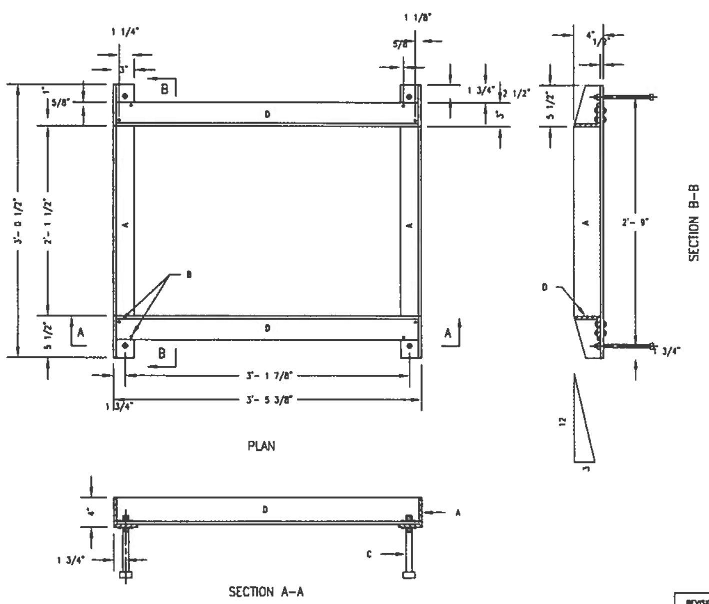
1. FOR SINGLE GRATE TYPE STORM INLET, DELETE CENTER SUPPORT AND MOVE ONE END WALL TO FORM NEW SINGLE GRATE INLET.
2. STORM INLET GUTTER TRANSITION WILL BE SHOWN ON THE CONSTRUCTION PLANS.
3. OUTLET PIPE SIZE, PER DESIGN REQUIREMENT.
4. FOR FRAME & GRATING, SEE DWG. 2216, 2220 & 2221.
5. FOR CENTER SUPPORT ASSEMBLY, SEE DWG. 2215.

CONSTRUCTION NOTES:

A. FRAME & GRATE.
B. CENTER SUPPORT ASSEMBLY
C. CUT ONE HORIZONTAL AND ONE VERTICAL BAR MAX. AT PIPE OPENING.
D. NO. 4 BARS AT 6" O.C. EACH WAY.
E. USE STANDARD STEPS, SEE DWG 2229
F. CONC. FILL, SEE NOTE C DWG. 2201.
G. INVERT PER DESIGN.
H. INSTALL STEPS ON DOWNSTREAM FACE.

REVISIONS | NM APWA | DRAINAGE STORM INLET DOUBLE "D" | DWG. 2206 | FEB 2006

DRAINAGE STORM INLET DOUBLE "D" (1 / C-5)
NM APWA STANDARD DRAWING 2206 NTS



GENERAL NOTES:

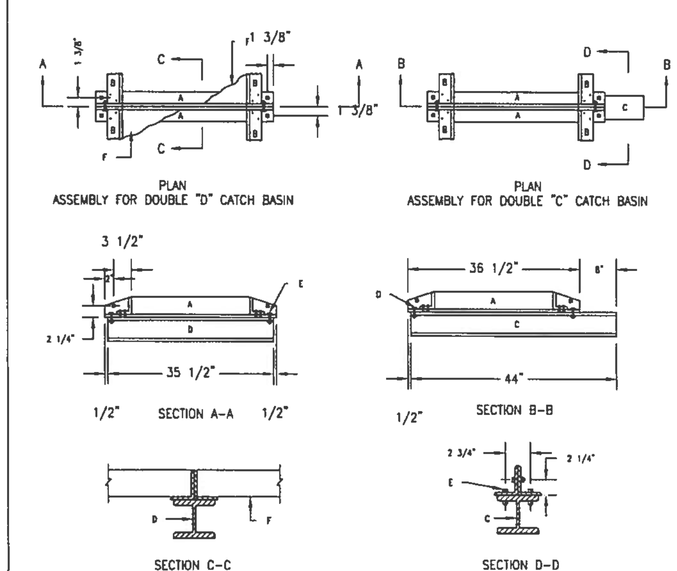
1. ALL EXPOSED METAL PARTS SHALL BE PAINTED PRIOR TO ASSEMBLY. WELDING, MACHINING AND DRILLING SHALL BE DONE PRIOR TO PAINTING. ALL DIMENSIONS ARE FINISH DIMENSIONS.
2. ALL PARTS SHALL BE OF STRUCTURAL STEEL, GRADE 36.
3. FOR CLEANING AND PAINTING OF FRAME SEE DWG. 2215, GENERAL NOTE NO 4.
4. FRAME MAY BE WELDED OR RIVETED

CONSTRUCTION NOTES.

A. 4" X 3" X 1/2" X 3" 1/2" ∠
B. 2 - 3/8" RIVETS AT EACH CORNER, SEE GENERAL NOTE NO. 5.
C. 4 - 1/2" X 8" BOLTS WITH SQUARE HEAD & NUT AT EACH CORNER. FOR ANCHORING FRAME INTO CONCRETE WALL.
D. 3 - 1/2" X 3" X 3/8" X 3'-4 3/8" ∠

REVISIONS | NM APWA | DRAINAGE STORM INLET FRAME | DWG 2216 | FEB 2006

DRAINAGE STORM INLET FRAME (4 / -)
NM APWA STANDARD DRAWING 2216 NTS



GENERAL NOTES.

1. ALL BOLTS USED IN CENTER SUPPORT ASSEMBLY SHALL BE 1/2".
2. FRAME MAY BE RIVETED OR WELDED
3. BOLTS (NOT RIVETS OR WELDS) SHALL BE USED TO JOIN TWO OR MORE FRAMES TOGETHER AND TO THE WF BEAM
4. AFTER CLEANING SURFACE OF SCALE, RUST, ETC., GRATING, FRAME AND CENTER SUPPORT SHALL BE PAINTED WITH ONE SHOP COAT RED OXIDE, TWO FINISH COATS ALUMINUM PAINT (AASHTO M 69).
5. FOR SINGLE TYPE CATCH BASIN, MOVE ONE END WALL TO FORM NEW SINGLE GRATE CATCH BASIN.

CONSTRUCTION NOTES:

A. 4" X 3" X 1/2" X 36 1/2" ∠
B. 3 1/2" X 3" X 3/8" X 40 3/8" ∠
C. 5 X 5 WF 18.5 FLANGE BEAM, FOR CATCH BASIN TYPE DOUBLE "C"
D. 5 X 5 WF 18.5 FLANGE BEAM, FOR CATCH BASIN TYPE DOUBLE "D"
E. 1/2" BOLTS, WITH NUTS TO SECURE ANGLE TO BEAM.
F. FOR FRAME & GRATE SEE DWGS. 2216, 2220, 2221

REVISIONS | NM APWA | DRAINAGE STORM INLET CENTER SUPPORT ASSEMBLY | DWG. 2215 | FEB 2006

DRAINAGE STORM INLET CENTER SUPPORT ASSEMBLY (3 / -)
NM APWA STANDARD DRAWING 2215 NTS

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Daniel B. Stephens & Associates, Inc.
ENVIRONMENTAL SCIENTISTS & ENGINEERS
6020 ACADEMY NE, SUITE 100
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(505) 822-9400

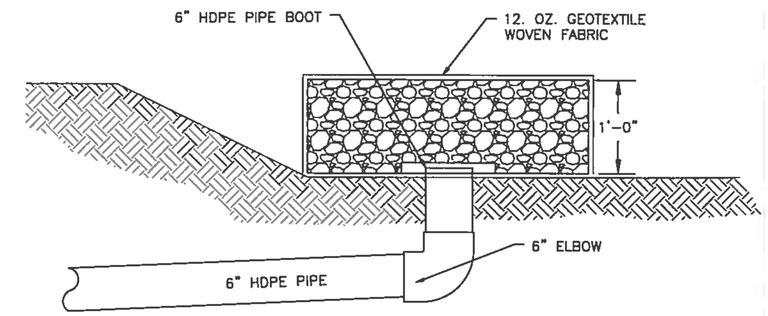
DESIGNED BY: JS
DRAWN BY: JS
CHECKED BY: GP
DATE: 05/16/2018

CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXICO
STORMWATER DETAILS II

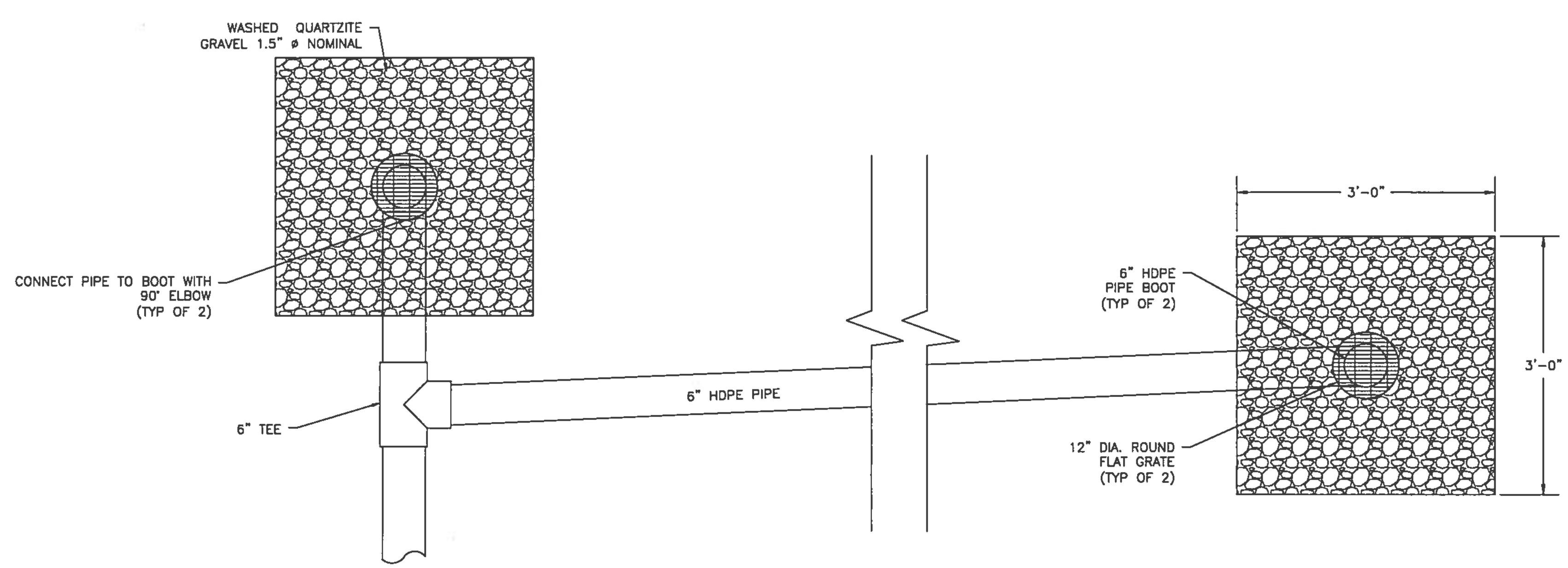
JEFFREY SAMSON NEW MEXICO 23686 PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 8 of 9
DWG NO. C-6



QUARTZITE GRAVEL SUMP ELEVATION VIEW (TYP OF 2) (1 / C-2)
NTS



QUARTZITE GRAVEL SUMP PLAN VIEW (2 / C-2)
NTS

NOTES:

1. PLACE QUARTZITE GRAVEL IN A NEAT PILE TO FORM SUMP, WRAP IN GEOTEXTILE OVER GRATE CAREFULLY, SO AS NOT TO MOVE THE GRATE DURING INSTALLATION.

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NO	DATE	BY	REVISION MADE
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ALBUQUERQUE, NM 87109
(505) 822-9400

DESIGNED BY: JS
DRAWN BY: JS
CHECKED BY: GP
DATE: 05/16/2018

CUNNINGHAM HILL EVAPORATION POND REMOVAL
SANTA FE COUNTY, NEW MEXICO

SUBSRUFACE COLLECTION DETAILS

JEFFREY SAMSON NEW MEXICO 23686 PROFESSIONAL ENGINEER

JOB NO. NM16.0177

SHEET 9 of 9
DWG NO. C-7

Attachment 2

Bid Table

Cunningham Reclamation Project

Evaporation Pond Removal

Item No	Description	Quantity	Units	Unit Price	Extended Price
1.1	Mobilization/demobilization	1	LS		$ -
1.2	Drop inlet structure, including grating, piping connections, and appurtenances, CIP	1	EA		$ -
1.3	Cutting and placement of a portion of the existing 60-mil HDPE pond liner	1	LS		$ -
1.4	Haul existing soil stockpile material from area northeast of site office to pond area. Quantity = ~4,000 CY; Distance = ~1 mile	1	LS		
1.5	Screening of existing soil located in the immediate vicinity of the ponds to create base layer to be placed directly on top of the liners	1	LS		
1.6	Site grading, including approximately 15,000 CY of cut, and 17,400 CY of fill	1	LS		
1.7	6" SDR 7 HDPE to tie into existing 6" SDR 7 HDPE conveyance line with a new 45° HDPE wye fitting	300	LF		$ -
1.8	Install new 6" Elster evoQ4 flanged flow meter near base of pit, including necessary flanges and HDPE pipeline materials, along with ~200 ft of 6" HDPE for line to flow into pit	1	LS		$ -
1.9	Install spillway, including subgrade preparation and compaction	1	LS		
2.0	Install seepage collection system, including quartzite gravel sump, HDPE wye fitting, HDPE drain, and associated piping and connections	2	LS		$ -
				Total	$ -

Notes:

HDPE = High density polyethylene
SDR = Standard dimension ratio
CIP = Complete in place

EA = Each
LF = Linear foot
LS = Lump sum

Attachment 3

Laboratory Reports

Laboratory Report for
Barrick Gold Corporation

Cunningham Hill

August 24, 2017

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

August 24, 2017

David Wykoff
Barrick Gold Corporation
582 County Road 55
Cerrillos, NM 87010
(505) 471-0434

Re: DBS&A Laboratory Report for the Barrick Gold Corporation Cunningham Hill Project

Dear Mr. Wykoff:

Enclosed is the report for the Barrick Gold Corporation, Cunningham Hill project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Barrick Gold Corporation and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines
Laboratory Manager

Enclosure

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
TP-1																X	X				X	X
TP-1 (85%)	X	X				X																
TP-1 (90%)	X	X				X																
TP-2																X	X				X	X
TP-2 (85%)	X	X				X																
TP-2 (90%)	X	X				X																

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
Two samples were hand delivered on July 19, 2017. Each sample arrived in two 5-gallon buckets sealed with lids. Both samples were received in good order.

Sample Preparation and Testing Notes:
The samples were subjected to particle size analysis and Atterberg limits testing.

Each sample was subjected to standard proctor compaction testing. A portion of each sample was remolded into a testing ring to target 85% and 90% of the respective maximum dry bulk density at the respective optimum moisture content. The sub-samples were then extruded from the testing rings and were subjected to saturated hydraulic conductivity testing via the flexible wall method. The actual percentage of maximum dry bulk density achieved was added to each sub-sample ID.

Particles larger than 4.75 mm were removed from the bulk material prior to remolding the sub-samples. Oversize correction calculations are provided since the removed fraction is larger than 5% of the bulk sample mass.

Porosity calculations are based on the use of an assumed specific gravity value of 2.65.

Summary of Sample Preparation/Volume Changes

	Proctor Data		Target Remold Parameters[1]			Actual Remold Data			Volume Change Post Saturation[2]		
Sample Number	Optimum Moisture Content (%, g/g)	Max. Dry Density (g/cm³)	Moisture Content (%, g/g)	Dry Bulk Density (g/cm³)	% of Max. Density (%)	Moisture Content (%, g/g)	Dry Bulk Density (g/cm³)	% of Max. Density (%)	Dry Bulk Density (g/cm³)	% Volume Change (%)	% of Max. Density (%)
TP-1 85%	17.8	1.67	17.8	1.42	85%	17.8	1.42	85%	1.43	-0.8%	85.8%
TP-1 90%	17.8	1.67	17.8	1.50	90%	18.0	1.49	90%	1.50	-0.7%	90.3%
TP-2 85%	18.1	1.68	18.1	1.43	85%	18.4	1.43	85%	1.43	+0.1%	85.0%
TP-2 90%	18.1	1.68	18.1	1.51	90%	18.2	1.51	90%	1.49	+1.1%	89.0%

[1]Target Remold Parameters: Provided by the client: 85% and 90% of maximum dry density at optimum moisture content.

[2]Volume Change Post Saturation: Volume change measurements were obtained after saturated hydraulic conductivity testing.

Notes:

"+" indicates sample swelling, "-" indicates sample settling, and "---" indicates no volume change occurred.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
TP-1	17.0	NA	---	---	NA	NA	NA
TP-1 (85%)	NA	NA	17.8	25.2	1.42	1.67	46.5
TP-1 (90%)	NA	NA	18.0	26.9	1.49	1.76	43.6
TP-2	13.8	NA	---	---	NA	NA	NA
TP-2 (85%)	NA	NA	18.4	26.3	1.43	1.69	46.1
TP-2 (90%)	NA	NA	18.2	27.5	1.51	1.79	43.0

NA = Not analyzed
--- = This sample was not remolded

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head Flexible Wall	Method of Analysis: Falling Head Flexible Wall
TP-1 85%	8.5E-04	6.9E-04		X
TP-1 90%	1.4E-04	1.2E-04		X
TP-2 85%	4.6E-04	4.1E-04		X
TP-2 90%	1.2E-04	1.0E-04		X

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
TP-1	0.00038	0.070	0.14	368	12	WS/H	Sandy silt with gravel s(ML)g	Loam †	(Est)
TP-2	0.00067	0.055	0.076	113	9.5	WS/H	Sandy silt s(ML)	Loam †	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
TP-1	18.6	29.8	36.5	15.2
TP-2	10.2	30.0	45.0	14.9

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
TP-1	38	25	13	ML
TP-2	36	25	11	ML

— = Soil requires visual-manual classification due to non-plasticity

Summary of Proctor Compaction Tests

Sample Number	Measured: Optimum Moisture Content (% g/g)	Measured: Maximum Dry Bulk Density (g/cm^3)	Oversize Corrected: Optimum Moisture Content (% g/g)	Oversize Corrected: Maximum Dry Bulk Density (g/cm^3)
TP-1	17.8	1.67	14.6	1.79
TP-2	18.1	1.68	16.1	1.75

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received: Gravimetric (%, g/g)	Moisture Content: As Received: Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded: Gravimetric (%, g/g)	Moisture Content: Remolded: Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
TP-1	17.0	NA	---	---	NA	NA	NA
TP-1 (85%)	NA	NA	17.8	25.2	1.42	1.67	46.5
TP-1 (90%)	NA	NA	18.0	26.9	1.49	1.76	43.6
TP-2	13.8	NA	---	---	NA	NA	NA
TP-2 (85%)	NA	NA	18.4	26.3	1.43	1.69	46.1
TP-2 (90%)	NA	NA	18.2	27.5	1.51	1.79	43.0

NA = Not analyzed

--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-1
Project Name:	Cunningham Hill
Date Sampled:	7/17/17

	As Received	Remolded
Test Date:	3-Aug-17	---
Field weight of sample* (g):	1748.20	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	389.37	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	1161.41	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	17.0	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by:	C. Krous
Data entered by:	C. Krous
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 (85%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

	As Received	Remolded
Test Date:	NA	10-Aug-17
Field weight of sample* (g):		376.21
Tare weight, ring (g):		0.00
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		319.46
Sample volume (cm^3):		225.43
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		17.8
Volumetric Moisture Content (% vol):		25.2
Dry bulk density (g/cm^3):		1.42
Wet bulk density (g/cm^3):		1.67
Calculated Porosity (% vol):		46.5
Percent Saturation:		54.1

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
— = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-1 (90%)
Project Name:	Cunningham Hill
Date Sampled:	7/17/17

	As Received	Remolded
Test Date:	NA	10-Aug-17
Field weight of sample* (g):		398.21
Tare weight, ring (g):		0.00
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		337.49
Sample volume (cm^3):		226.00
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.0
Volumetric Moisture Content (% vol):		26.9
Dry bulk density (g/cm^3):		1.49
Wet bulk density (g/cm^3):		1.76
Calculated Porosity (% vol):		43.6
Percent Saturation:		61.6

Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not analyzed
— = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2
Project Name: Cunningham Hill
Date Sampled: 7/17/17

	As Received	Remolded
Test Date:	3-Aug-17	---
Field weight of sample* (g):	1344.78	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	268.11	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	945.78	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.65	
Gravimetric Moisture Content (% g/g):	13.8	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: C. Krous
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-2 (85%)
Project Name:	Cunningham Hill
Date Sampled:	7/17/17

	As Received	Remolded
Test Date:	NA	10-Aug-17
Field weight of sample (g):*		379.89
Tare weight, ring (g):		0.00
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		320.91
Sample volume (cm^3):		224.49
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.4
Volumetric Moisture Content (% vol):		26.3
Dry bulk density (g/cm^3):		1.43
Wet bulk density (g/cm^3):		1.69
Calculated Porosity (% vol):		46.1
Percent Saturation:		57.0

Laboratory analysis by:	D. O'Dowd
Data entered by:	C. Krous
Checked by:	J. Hines

Comments:

* Weight including tares

NA = Not analyzed

— = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 (90%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

	As Received	Remolded
Test Date:	NA	10-Aug-17
Field weight of sample* (g):		402.46
Tare weight, ring (g):		0.00
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		340.44
Sample volume (cm^3):		225.28
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.2
Volumetric Moisture Content (% vol):		27.5
Dry bulk density (g/cm^3):		1.51
Wet bulk density (g/cm^3):		1.79
Calculated Porosity (% vol):		43.0
Percent Saturation:		64.1

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Saturated Hydraulic Conductivity

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis	
			Constant Head Flexible Wall	Falling Head Flexible Wall
TP-1 85%	8.5E-04	6.9E-04		X
TP-1 90%	1.4E-04	1.2E-04		X
TP-2 85%	4.6E-04	4.1E-04		X
TP-2 90%	1.2E-04	1.0E-04		X

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties

Initial Mass (g):	376.21
Diameter (cm):	6.141
Length (cm):	7.611
Area (cm^2):	29.62
Volume (cm^3):	225.43
Dry Density (g/cm^3):	1.42
Dry Density (pcf):	88.5
Water Content (%, g/g):	17.8
Water Content (%, vol):	25.2
Void Ratio (e):	0.87
Porosity (%, vol):	46.5
Saturation (%):	54.1

Post Permeation Sample Properties

Saturated Mass (g):	423.88
Dry Mass (g):	319.46
Diameter (cm):	6.115
Length (cm):	7.612
*Deformation (%)**:*	0.01
Area (cm^2):	29.37
Volume (cm^3):	223.55
Dry Density (g/cm^3):	1.43
Dry Density (pcf):	89.2
Water Content (%, g/g):	32.7
Water Content (%, vol):	46.7
Void Ratio(e):	0.85
Porosity (%, vol):	46.1
Saturation (%):*	101.4

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	18.6
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ A ☐ B ☑ C
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	8/11/17 820
B-Value (% saturation) post to test:	0.99	8/11/17 901

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated or skewed during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

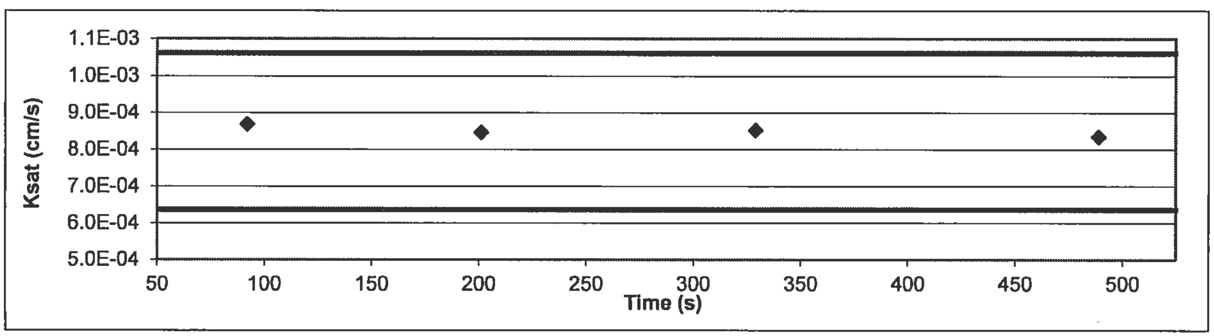
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	08:50:22	21.5	11.00	19.00	1.21	2.39	92	1.00	12%	9.00E-04	8.68E-04
11-Aug-17	08:51:54	21.5	11.50	18.50	1.06						
Test # 2:											
11-Aug-17	08:51:54	21.5	11.50	18.50	1.06	2.39	109	1.00	14%	8.77E-04	8.46E-04
11-Aug-17	08:53:43	21.5	12.00	18.00	0.91						
Test # 3:											
11-Aug-17	08:53:43	21.5	12.00	18.00	0.91	2.39	128	1.00	17%	8.83E-04	8.52E-04
11-Aug-17	08:55:51	21.5	12.50	17.50	0.76						
Test # 4:											
11-Aug-17	08:55:51	21.5	12.50	17.50	0.76	2.39	160	1.00	20%	8.64E-04	8.34E-04
11-Aug-17	08:58:31	21.5	13.00	17.00	0.61						

***Average Ksat* (cm/sec):** **8.50E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 6.92E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 6.37E-04

Ksat (+25%) (cm/s): 1.06E-03

Oversize Correction Data Sheet

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-1 85%
Project Name:	Cunningham Hill
Date Sampled:	7/17/17
Split (3/4", 3/8", #4):	#4
Calculated Porosity of Fines (% vol):	46.5

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	18.57	81.43	100.00
Bulk Density (g/cm^3):	2.65	1.42	1.55
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	26.73	26.73
Total Volume (cm^3):	7.01	57.46	64.47
Volumetric Fraction (%):	10.87	89.13	100.00
Mass Fraction (%):	18.57	81.43	100.00
Ksat (cm/sec):	NM	8.5E-04	6.9E-04

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties		Post Permeation Sample Properties		Test and Sample Conditions	
Initial Mass (g):	398.21	*Saturated Mass (g):*	438.61	*Permeant liquid used:*	Tap Water
Diameter (cm):	6.148	*Dry Mass (g):*	337.49	*Sample Preparation:*	☐ In situ sample, extruded
Length (cm):	7.613	*Diameter (cm):*	6.125		☑ Remolded Sample
Area (cm^2):	29.69	*Length (cm):*	7.613	*Number of Lifts:*	3
Volume (cm^3):	226.00	*Deformation (%)**:*	0.00	*Split:*	#4
Dry Density (g/cm^3):	1.49	*Area (cm^2):*	29.46	*Percent Coarse Material (%):*	18.6
Dry Density (pcf):	93.2	*Volume (cm^3):*	224.31	*Particle Density(g/cm^3):*	2.65 ☑ Assumed ☐ Measured
Water Content (%, g/g):	18.0	*Dry Density (g/cm^3):*	1.50	*Cell pressure (PSI):*	81.0
Water Content (%, vol):	26.9	*Dry Density (pcf):*	93.9	*Influent pressure (PSI):*	80.0
Void Ratio (e):	0.77	*Water Content (%, g/g):*	30.0	*Effluent pressure (PSI):*	80.0
Porosity (%, vol):	43.6	*Water Content (%, vol):*	45.1	*Panel Used:*	☐ A ☑ B ☐ C
Saturation (%):	61.6	*Void Ratio(e):*	0.76	*Reading:*	☑ Annulus ☑ Pipette
		Porosity (%, vol):	43.2		
		Saturation (%):*	104.3		

		Date/Time
B-Value (% saturation) prior to test*:	1.00	8/11/17 822
B-Value (% saturation) post to test:	1.00	8/11/17 1005

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated or skewed during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

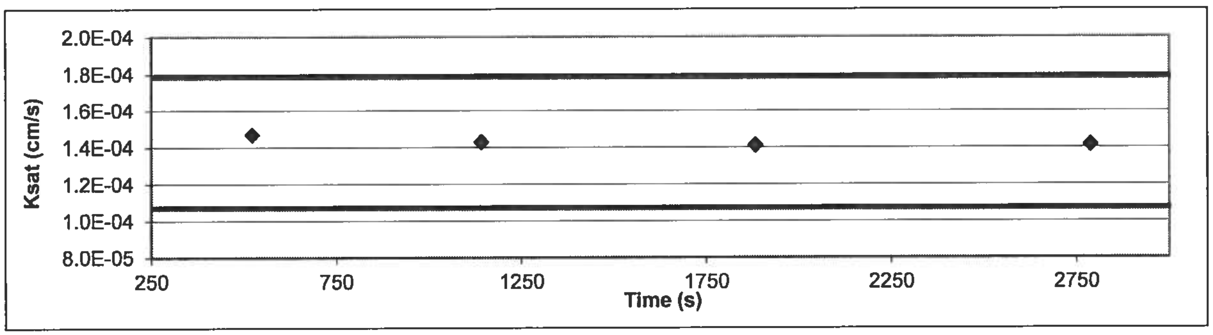
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	09:14:18	21.5	11.00	19.00	1.21	2.31	522	1.00	12%	1.52E-04	1.46E-04
11-Aug-17	09:23:00	21.5	11.50	18.50	1.06						
Test # 2:											
11-Aug-17	09:23:00	21.5	11.50	18.50	1.06	2.31	619	1.00	14%	1.48E-04	1.43E-04
11-Aug-17	09:33:19	21.5	12.00	18.00	0.91						
Test # 3:											
11-Aug-17	09:33:19	21.5	12.00	18.00	0.91	2.31	741	1.00	17%	1.46E-04	1.41E-04
11-Aug-17	09:45:40	21.5	12.50	17.50	0.76						
Test # 4:											
11-Aug-17	09:45:40	21.5	12.50	17.50	0.76	2.31	905	1.00	20%	1.46E-04	1.41E-04
11-Aug-17	10:00:45	21.5	13.00	17.00	0.61						

***Average Ksat* (cm/sec):** **1.43E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 1.16E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 1.07E-04

Ksat (+25%) (cm/s): 1.78E-04

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 43.6

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	18.57	81.43	100.00
Bulk Density (g/cm^3):	2.65	1.49	1.63
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	23.80	23.80
Total Volume (cm^3):	7.01	54.53	61.54
Volumetric Fraction (%):	11.39	88.61	100.00
Mass Fraction (%):	18.57	81.43	100.00
Ksat (cm/sec):	NM	1.4E-04	1.2E-04

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties

Initial Mass (g):	379.89
Diameter (cm):	6.127
Length (cm):	7.614
Area (cm^2):	29.48
Volume (cm^3):	224.49
Dry Density (g/cm^3):	1.43
Dry Density (pcf):	89.2
Water Content (%, g/g):	18.4
Water Content (%, vol):	26.3
Void Ratio (e):	0.85
Porosity (%, vol):	46.1
Saturation (%):	57.0

Post Permeation Sample Properties

Saturated Mass (g):	426.42
Dry Mass (g):	320.91
Diameter (cm):	6.135
Length (cm):	7.603
*Deformation (%)**:*	0.15
Area (cm^2):	29.56
Volume (cm^3):	224.74
Dry Density (g/cm^3):	1.43
Dry Density (pcf):	89.1
Water Content (%, g/g):	32.9
Water Content (%, vol):	46.9
Void Ratio(e):	0.86
Porosity (%, vol):	46.1
Saturation (%):*	101.8

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	10.2
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☑ D ☐ E ☐ F
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	8/11/17 825
B-Value (% saturation) post to test:	0.99	8/11/17 922

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

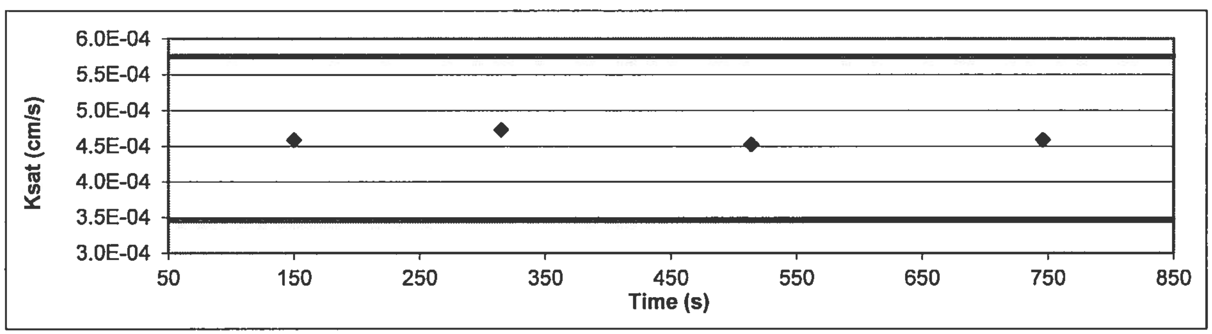
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	09:07:18	21.5	10.00	19.00	1.37	2.35	150	1.00	11%	4.75E-04	4.58E-04
11-Aug-17	09:09:48	21.5	10.50	18.50	1.22						
Test # 2:											
11-Aug-17	09:09:48	21.5	10.50	18.50	1.22	2.35	165	1.00	13%	4.90E-04	4.72E-04
11-Aug-17	09:12:33	21.5	11.00	18.00	1.06						
Test # 3:											
11-Aug-17	09:12:33	21.5	11.00	18.00	1.06	2.35	199	1.00	14%	4.69E-04	4.52E-04
11-Aug-17	09:15:52	21.5	11.50	17.50	0.91						
Test # 4:											
11-Aug-17	09:15:52	21.5	11.50	17.50	0.91	2.35	232	1.00	17%	4.75E-04	4.59E-04
11-Aug-17	09:19:44	21.5	12.00	17.00	0.76						

***Average Ksat* (cm/sec): 4.60E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 4.14E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 3.45E-04

Ksat (+25%) (cm/s): 5.75E-04

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 46.1

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	10.18	89.82	100.00
Bulk Density (g/cm^3):	2.65	1.43	1.50
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	28.94	28.94
Total Volume (cm^3):	3.84	62.83	66.67
Volumetric Fraction (%):	5.76	94.24	100.00
Mass Fraction (%):	10.18	89.82	100.00
Ksat (cm/sec):	NM	4.6E-04	4.1E-04

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties

Initial Mass (g):	402.46
Diameter (cm):	6.139
Length (cm):	7.611
Area (cm^2):	29.60
Volume (cm^3):	225.28
Dry Density (g/cm^3):	1.51
Dry Density (pcf):	94.3
Water Content (%, g/g):	18.2
Water Content (%, vol):	27.5
Void Ratio (e):	0.75
Porosity (%, vol):	43.0
Saturation (%):	64.1

Post Permeation Sample Properties

Saturated Mass (g):	440.85
Dry Mass (g):	340.44
Diameter (cm):	6.173
Length (cm):	7.610
*Deformation (%)**:*	0.01
Area (cm^2):	29.93
Volume (cm^3):	227.75
Dry Density (g/cm^3):	1.49
Dry Density (pcf):	93.3
Water Content (%, g/g):	29.5
Water Content (%, vol):	44.1
Void Ratio(e):	0.77
Porosity (%, vol):	43.6
Saturation (%):*	101.1

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	10.2
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ D ☐ E ☑ F
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.98	8/11/17 828
B-Value (% saturation) post to test:	0.99	8/11/17 1022

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

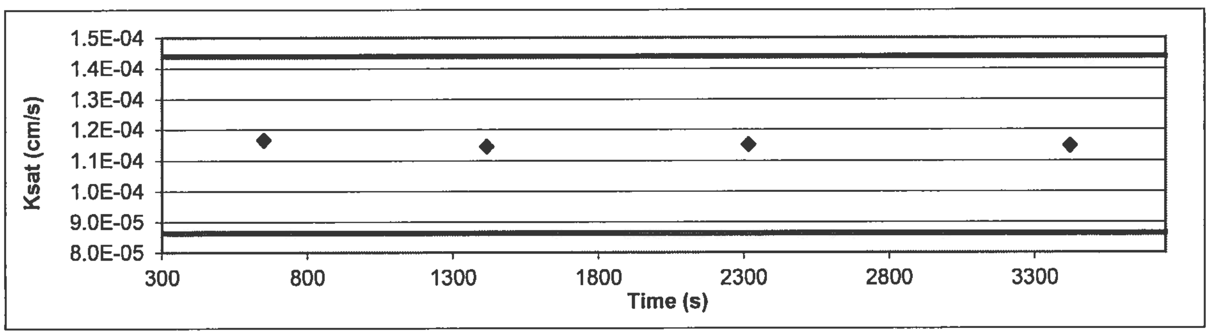
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	09:21:54	21.5	11.00	19.00	1.21	2.32	651	1.00	12%	1.21E-04	1.17E-04
11-Aug-17	09:32:45	21.5	11.50	18.50	1.06						
Test # 2:											
11-Aug-17	09:32:45	21.5	11.50	18.50	1.06	2.32	765	1.00	14%	1.19E-04	1.14E-04
11-Aug-17	09:45:30	21.5	12.00	18.00	0.91						
Test # 3:											
11-Aug-17	09:45:30	21.5	12.00	18.00	0.91	2.32	900	1.00	17%	1.19E-04	1.15E-04
11-Aug-17	10:00:30	21.5	12.50	17.50	0.76						
Test # 4:											
11-Aug-17	10:00:30	21.5	12.50	17.50	0.76	2.32	1105	1.00	20%	1.19E-04	1.15E-04
11-Aug-17	10:18:55	21.5	13.00	17.00	0.61						

***Average Ksat* (cm/sec):** **1.15E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 1.03E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 8.64E-05

Ksat (+25%) (cm/s): 1.44E-04

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 43.0

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	10.18	89.82	100.00
Bulk Density (g/cm^3):	2.65	1.51	1.58
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	25.54	25.54
Total Volume (cm^3):	3.84	59.44	63.28
Volumetric Fraction (%):	6.07	93.93	100.00
Mass Fraction (%):	10.18	89.82	100.00
Ksat (cm/sec):	NM	1.2E-04	1.0E-04

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Particle Size Analysis

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
TP-1	0.00038	0.070	0.14	368	12	WS/H	Sandy silt with gravel s(ML)g	Loam †	(Est)
TP-2	0.00067	0.055	0.076	113	9.5	WS/H	Sandy silt s(ML)	Loam †	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
TP-1	18.6	29.8	36.5	15.2
TP-2	10.2	30.0	45.0	14.9

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Test Date: 15-Aug-17

Initial Dry Weight of Sample (g): 18129.39
Weight Passing #10 (g): 14280.67
Weight Retained #10 (g): 3848.73
Weight of Hydrometer Sample (g): 74.85
Calculated Weight of Sieve Sample (g): 95.02

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	18129.39	100.00
	2"	50	1004.20	1004.20	17125.19	94.46
	1.5"	38.1	419.40	1423.60	16705.79	92.15
	1"	25	467.70	1891.30	16238.09	89.57
	3/4"	19.0	438.50	2329.80	15799.59	87.15
	3/8"	9.5	605.60	2935.40	15193.99	83.81
	4	4.75	431.00	3366.40	14762.99	81.43
	10	2.00	482.33	3848.73	14280.67	78.77
-10			(Based on calculated sieve wt.)			
	20	0.85	3.30	23.47	71.55	75.30
	40	0.425	4.85	28.32	66.70	70.19
	60	0.250	4.11	32.43	62.59	65.87
	140	0.106	7.85	40.28	54.74	57.61
	200	0.075	5.64	45.92	49.10	51.67
	dry pan		1.76	47.68	47.34	
	wet pan			47.34	0.00	

d_{10} (mm): 0.00038 — d_{50} (mm): 0.070
d_{16} (mm): 0.0026 — d_{60} (mm): 0.14
d_{30} (mm): 0.025 — d_{84} (mm): 9.9

Median Particle Diameter--d_{50} (mm): 0.070
Uniformity Coefficient, Cu--$[d_{60}/d_{10}]$ (mm): 368
Coefficient of Curvature, Cc--$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 12
Mean Particle Diameter--$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 3.3

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: ML

ASTM Soil Classification: Sandy silt with gravel s(ML)g
USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Falance
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

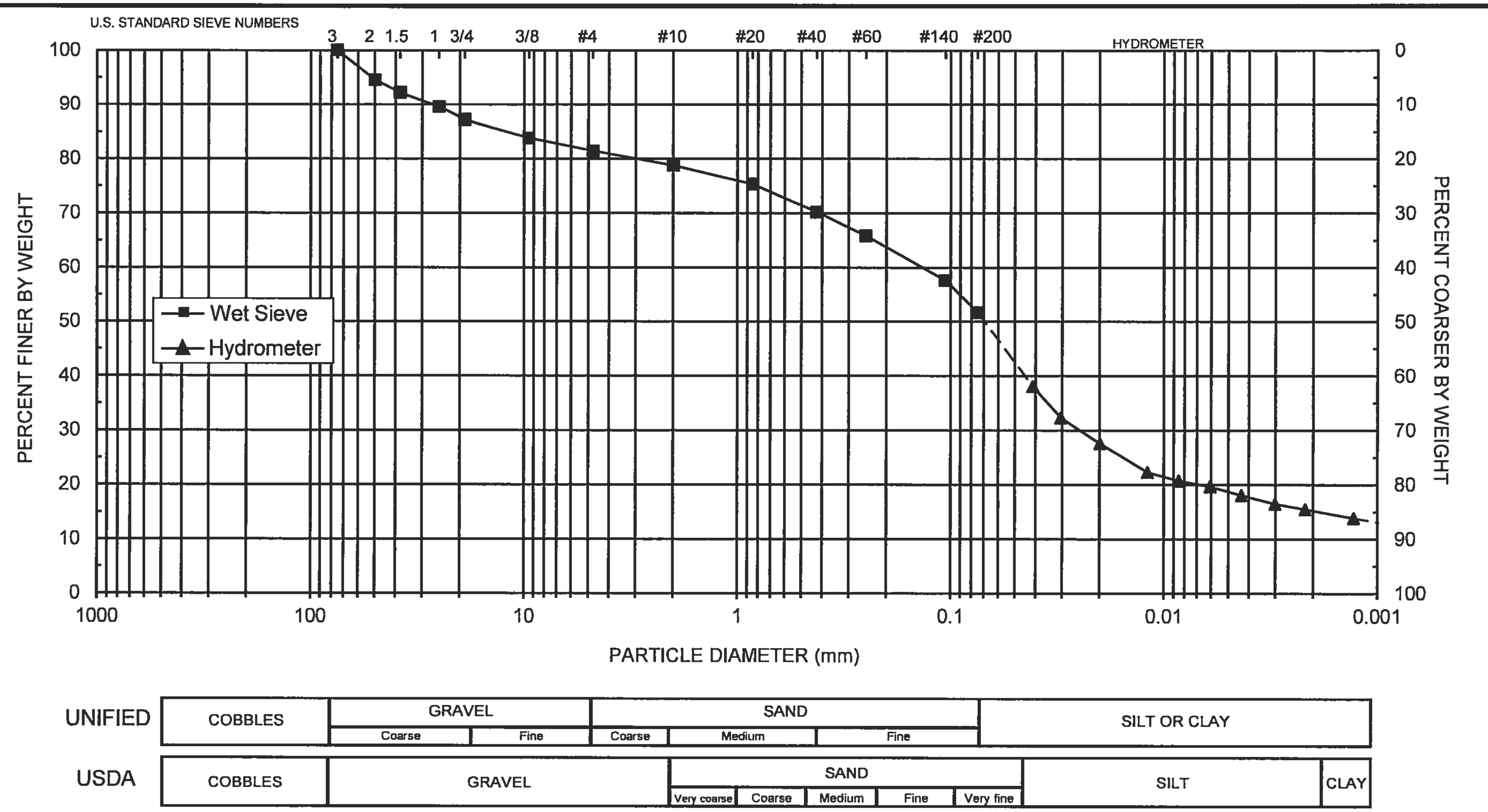
Job Name:	Barrick Gold Corporation	*Type of Water Used:*	DISTILLED
Job Number:	DB17.1190.00	*Reaction with H_2O_2:*	NA
Sample Number:	TP-1	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Cunningham Hill	*Assumed particle density:*	2.65
Date Sampled:	7/17/17	*Initial Wt. (g):*	74.85
Test Date:	8-Aug-17	*Total Sample Wt. (g):*	18129.39
Start Time:	9:00	*Wt. Passing #10 (g):*	14280.67

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
8-Aug-17	1	21.6	41.5	5.4	36.1	9.5	0.04117	48.3	38.0
	2	21.6	36.0	5.4	30.6	10.4	0.03047	40.9	32.2
	5	21.6	31.5	5.4	26.1	11.1	0.01994	34.9	27.5
	15	21.6	26.5	5.4	21.1	12.0	0.01193	28.2	22.2
	30	21.6	25.0	5.4	19.6	12.2	0.00852	26.2	20.7
	60	21.6	24.0	5.4	18.6	12.4	0.00607	24.9	19.6
	120	21.5	22.5	5.4	17.1	12.6	0.00434	22.9	18.0
	252	21.5	21.0	5.4	15.6	12.9	0.00302	20.9	16.4
	483	22.1	20.0	5.3	14.7	13.0	0.00218	19.6	15.5
9-Aug-17	1417	21.5	18.5	5.4	13.1	13.3	0.00129	17.5	13.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bland
Data entered by: C. Krous
Checked by: J. Hines



d_{10} = **0.00038**	d_{30} = **0.025**	d_{50} = **0.070**	d_{60} = **0.14**	C_u = **368**	C_c = **12**

SAMPLE NUMBER	DATE SAMPLED	ASTM CLASSIFICATION	USDA CLASSIFICATION
TP-1	**7/17/17**	**Sandy silt with gravel s(ML)g**	**Loam †**

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Test Date: 15-Aug-17

Initial Dry Weight of Sample (g): 17935.11
Weight Passing #10 (g): 15651.95
Weight Retained #10 (g): 2283.16
Weight of Hydrometer Sample (g): 78.09
Calculated Weight of Sieve Sample (g): 89.48

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	17935.11	100.00
	2"	50	0.00	0.00	17935.11	100.00
	1.5"	38.1	0.00	0.00	17935.11	100.00
	1"	25	543.10	543.10	17392.01	96.97
	3/4"	19.0	202.39	745.49	17189.62	95.84
	3/8"	9.5	586.70	1332.19	16602.92	92.57
	4	4.75	494.10	1826.29	16108.82	89.82
	10	2.00	456.87	2283.16	15651.95	87.27
-10			(Based on calculated sieve wt.)			
	20	0.85	2.68	14.07	75.41	84.27
	40	0.425	3.46	17.53	71.95	80.41
	60	0.250	3.89	21.42	68.06	76.06
	140	0.106	8.27	29.69	59.79	66.82
	200	0.075	6.24	35.93	53.55	59.85
	dry pan		1.45	37.38	52.10	
	wet pan			52.10	0.00	

d_{10} (mm): 0.00067 d_{50} (mm): 0.055
d_{16} (mm): 0.0024 d_{60} (mm): 0.076
d_{30} (mm): 0.022 d_{84} (mm): 0.81

Median Particle Diameter--d_{50} (mm): 0.055
Uniformity Coefficient, Cu--[d_{60}/d_{10}] (mm): 113
Coefficient of Curvature, Cc--[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 9.5
Mean Particle Diameter--[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.29

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: J. Falance
Data entered by: C. Krous
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Test Date: 8-Aug-17
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.65

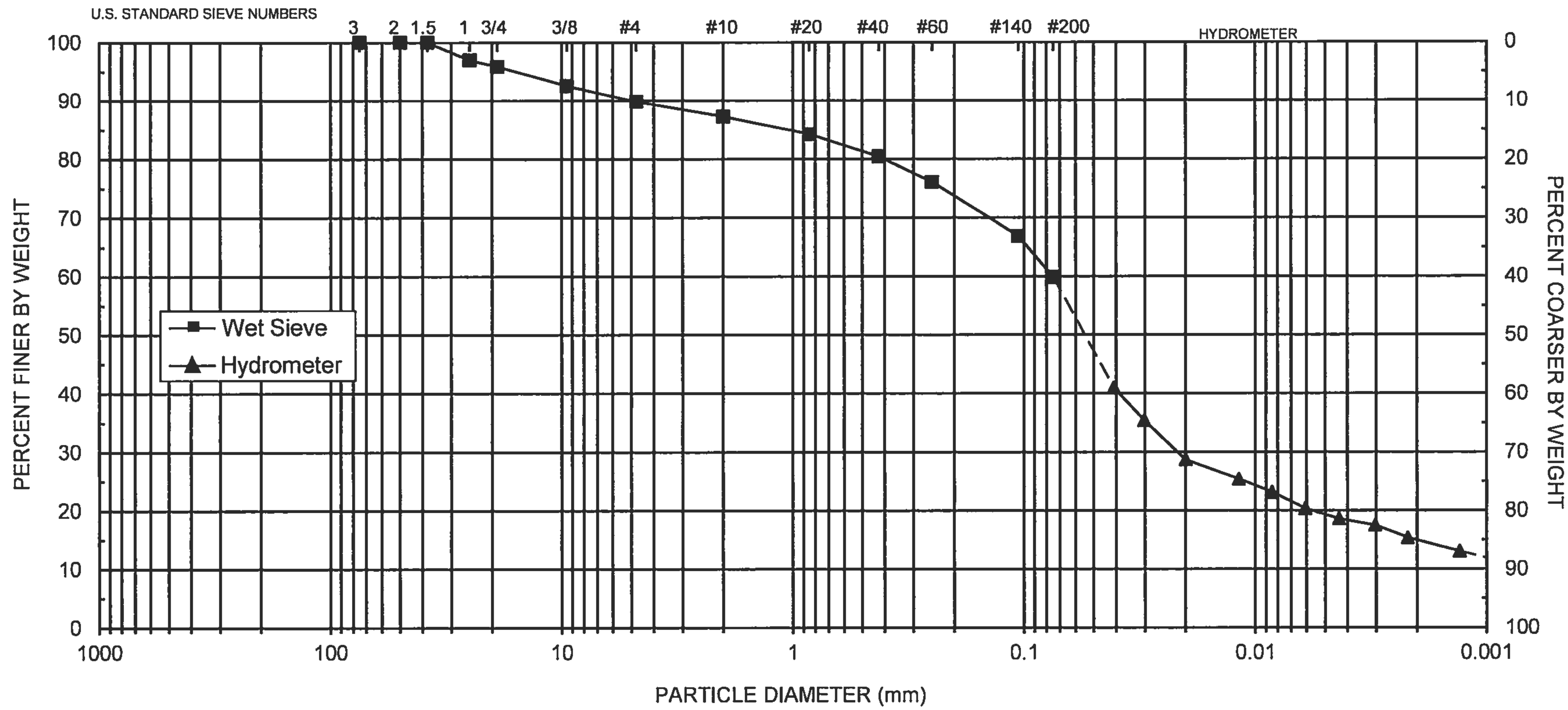
Initial Wt. (g): 78.09
Total Sample Wt. (g): 17935.11
Wt. Passing #10 (g): 15651.95

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	L (cm)	D (mm)	P (%)	% Finer
8-Aug-17	1	21.6	42.0	5.4	36.6	9.4	0.04100	46.9	40.9
	2	21.6	37.0	5.4	31.6	10.2	0.03022	40.5	35.4
	5	21.6	31.0	5.4	25.6	11.2	0.02001	32.8	28.7
	15	21.6	28.0	5.4	22.6	11.7	0.01181	29.0	25.3
	30	21.6	26.0	5.4	20.6	12.0	0.00846	26.4	23.1
	60	21.6	23.5	5.4	18.1	12.4	0.00609	23.2	20.3
	120	21.4	22.0	5.4	16.6	12.7	0.00436	21.3	18.6
	250	21.5	21.0	5.4	15.6	12.9	0.00303	20.0	17.5
	480	22.5	19.0	5.3	13.7	13.2	0.00219	17.5	15.3
9-Aug-17	1413	21.5	17.0	5.4	11.6	13.5	0.00131	14.9	13.0

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bland
Data entered by: C. Krous
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY		
		Coarse	Fine	Coarse	Medium	Fine			

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.00067**	d_{30} = **0.022**	d_{50} = **0.055**	d_{60} = **0.076**	C_u = **113**	C_c = **9.5**

SAMPLE NUMBER	DATE SAMPLED	ASTM CLASSIFICATION	USDA CLASSIFICATION
TP-2	**7/17/17**	**Sandy silt s(ML)**	**Loam** †

† Greater than 10% of sample is coarse material

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

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Atterberg Limits/ Identification of Fines

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
TP-1	38	25	13	ML
TP-2	36	25	11	ML

--- = Soil requires visual-manual classification due to non-plasticity

Atterberg Limits

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-1
Project Name:	Cunningham Hill
Date Sampled:	7/17/17
Test Date:	11-Aug-17

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	26	25	18
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	121.58	120.14	117.35
Weight of pan plus dry soil (g)	120.40	119.12	116.39
Weight of pan (g):	117.28	116.40	113.88
Gravimetric moisture content (% g/g):	37.82	37.50	38.25
Liquid Limit:	38		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	119.38	119.90
Weight of pan plus dry soil (g)	118.00	118.54
Weight of pan (g):	112.56	113.16
Gravimetric moisture content (% g/g):	25.37	25.28
Plastic Limit:	25	

Results

Percent of Sample Retained on #40 Sieve:

Liquid Limit:	38
Plastic Limit:	25
Plasticity Index:	13
Classification:	ML

Comments:

— = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Atterberg Limits

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-2
Project Name:	Cunningham Hill
Date Sampled:	7/17/17
Test Date:	11-Aug-17

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	23	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	121.12	121.18	120.42
Weight of pan plus dry soil (g)	119.96	119.62	118.46
Weight of pan (g):	116.65	115.31	113.22
Gravimetric moisture content (% g/g):	35.05	36.19	37.40
Liquid Limit:	36		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	119.22	124.58
Weight of pan plus dry soil (g)	118.39	122.91
Weight of pan (g):	115.16	116.11
Gravimetric moisture content (% g/g):	25.70	24.56
Plastic Limit:	25	

Results

Percent of Sample Retained on #40 Sieve:

Liquid Limit:	36
Plastic Limit:	25
Plasticity Index:	11
Classification:	ML

Comments:

— = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Proctor Compaction

Summary of Proctor Compaction Tests

Sample Number	Measured: Optimum Moisture Content (% g/g)	Measured: Maximum Dry Bulk Density (g/cm³)	Oversize Corrected: Optimum Moisture Content (% g/g)	Oversize Corrected: Maximum Dry Bulk Density (g/cm³)
TP-1	17.8	1.67	14.6	1.79
TP-2	18.1	1.68	16.1	1.75

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Test Date: 8-Aug-17

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 18.57
Mass of fines material (g): 81.43
Mold weight (g): 4371
Mold volume (cm^3): 944.58

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm^3)	Moisture Content (% g/g)
1	6035	954.51	865.80	210.00	1.55	13.53
2	6165	929.94	831.83	210.85	1.64	15.80
3	6225	1115.43	987.49	269.32	1.67	17.81
4	6229	1048.31	911.30	212.72	1.64	19.61
5	6169	1040.06	886.09	210.03	1.55	22.77

Soil Fractions

Coarse Fraction (% g/g): 18.6
Fines Fraction (% g/g): 81.4

Properties of Coarse Material

Assumed particle density (g/cm^3): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm^3)	Moisture Content of Composite (% g/g)
1	1.68	11.02
2	1.76	12.87
3	1.79	14.51
4	1.77	15.97
5	1.68	18.55

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: A. Bland
Data entered by: C. Krous
Checked by: J. Hines

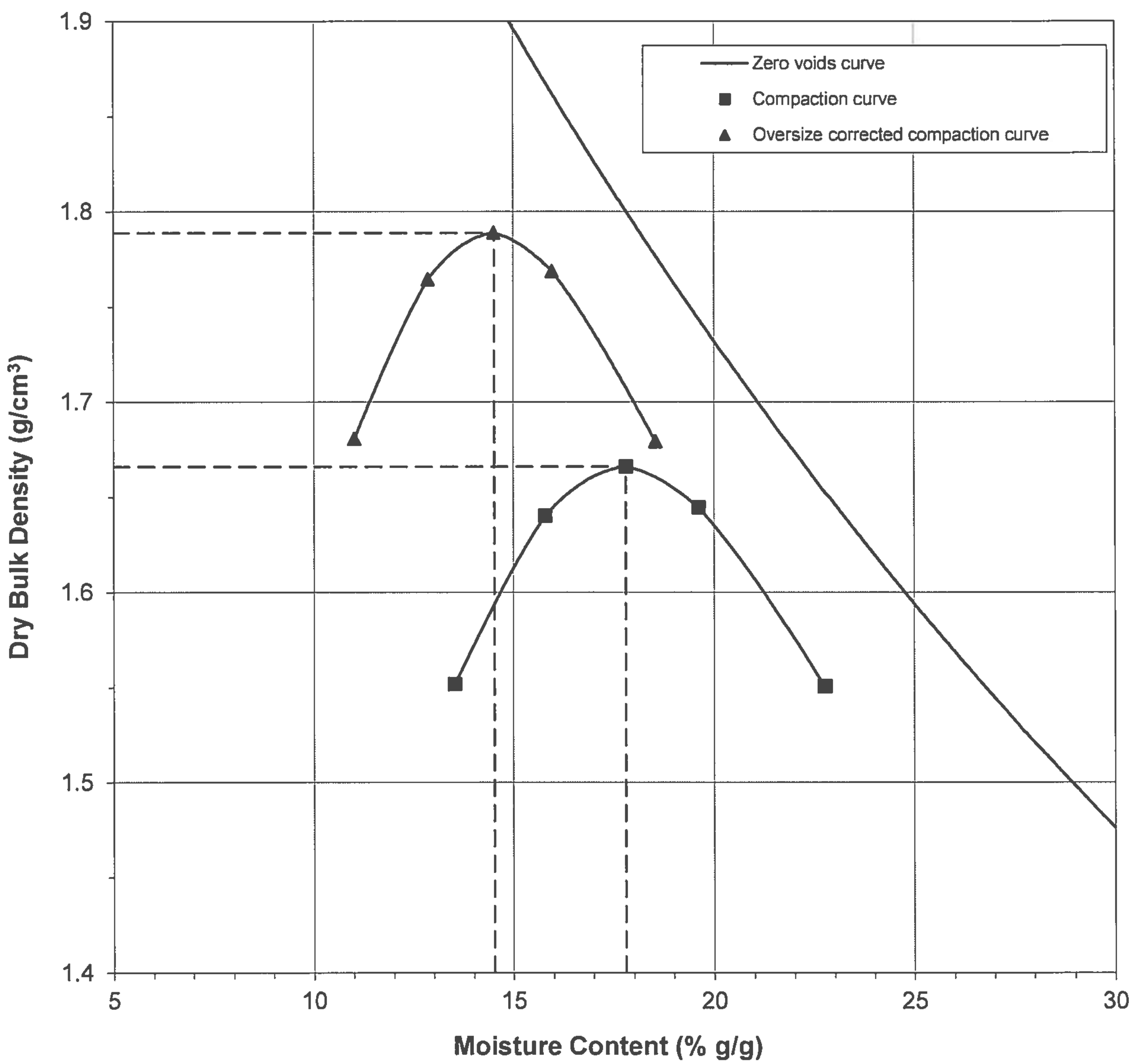
Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data Points with Fitted Curve

Sample Number: TP-1

	Measured	Corrected
Optimum Moisture Content (% g/g):	17.8	14.5
Maximum Dry Bulk Density (g/cm^3):	1.67	1.79

Test Date: 8-Aug-17



— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: A. Bland
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Proctor Compaction Data

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Test Date: 8-Aug-17

As Received Moisture Content (% g/g): NA

Split (3/4", 3/8", #4): #4
Mass of coarse material (g): 10.18
Mass of fines material (g): 89.82
Mold weight (g): 4371
Mold volume (cm³): 944.58

Compaction Method: Standard A
Preparation Method: Dry
Type of Rammer: Mechanical

Trial	Weight of Mold and Compacted Soil (g)	Weight of Container and Wet Soil (g)	Weight of Container and Dry Soil (g)	Weight of Container (g)	Dry Bulk Density (g/cm³)	Moisture Content (% g/g)
1	6101	1183.06	1070.72	269.68	1.61	14.02
2	6187	1116.66	1002.02	293.40	1.65	16.18
3	6246	1057.25	935.96	268.89	1.68	18.18
4	6222	1085.88	938.68	210.76	1.63	20.22
5	6147	1070.52	919.71	266.50	1.53	23.09

Soil Fractions

Coarse Fraction (% g/g): 10.2
Fines Fraction (% g/g): 89.8

Properties of Coarse Material

Assumed particle density (g/cm³): 2.65
Assumed Initial Moisture Content (% g/g): 0.0

Oversize Corrected Values for Dry Bulk Density and Moisture Content

Trial	Dry Bulk Density of Composite (g/cm³)	Moisture Content of Composite (% g/g)
1	1.67	12.60
2	1.72	14.53
3	1.74	16.33
4	1.70	18.16
5	1.60	20.74

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

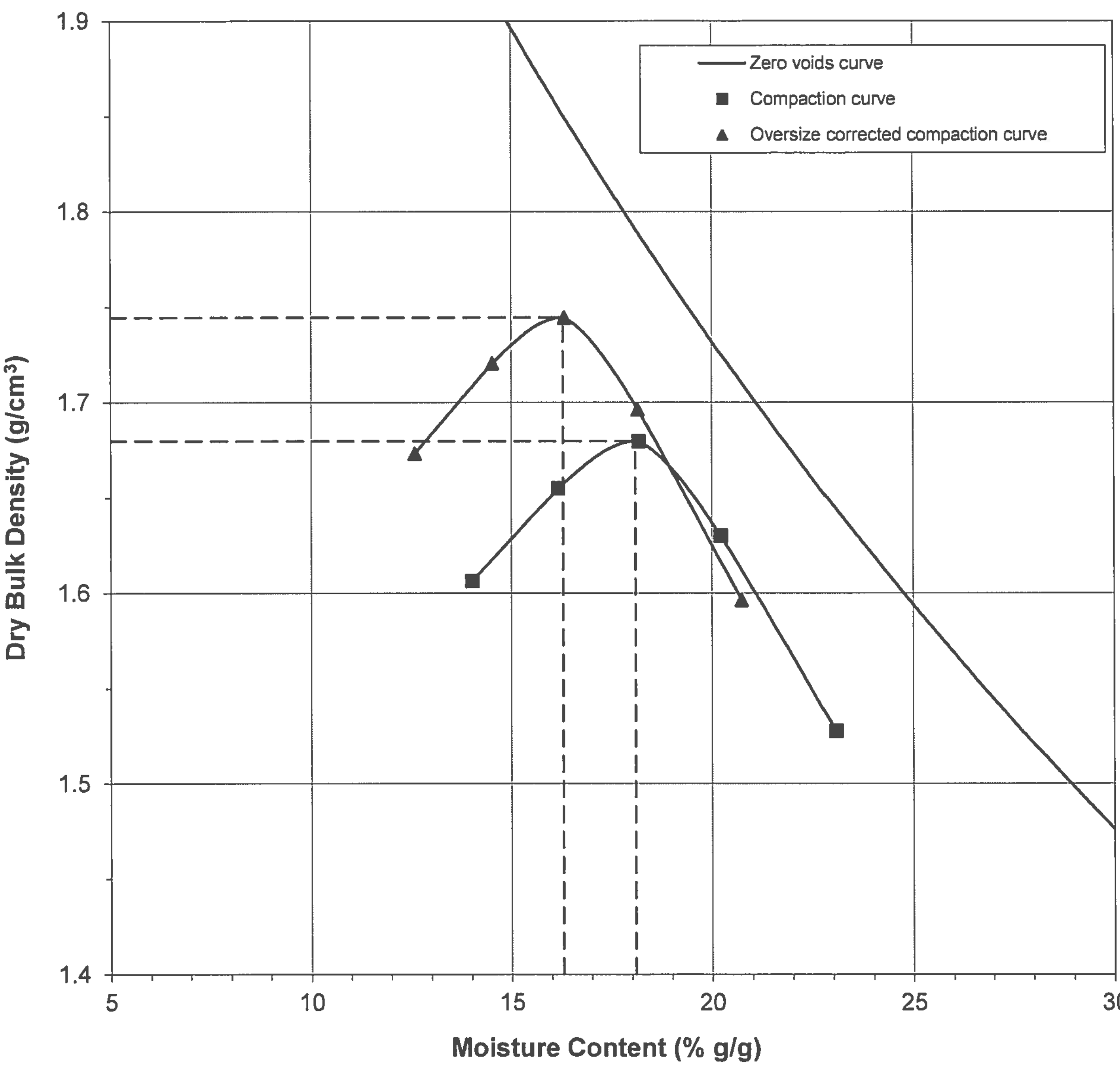
Laboratory analysis by: A. Bland
Data entered by: C. Krous
Checked by: J. Hines

Proctor Compaction Data Points with Fitted Curve

Sample Number: TP-2

	Measured	Corrected
Optimum Moisture Content (% g/g):	18.1	16.3
Maximum Dry Bulk Density (g/cm^3):	1.68	1.74

Test Date: 8-Aug-17



— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: A. Bland
Data entered by: C. Krous
Checked by: J. Hines

Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263, ASTM D2216
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity:	
Falling Head Rising Tail: (Flexible Wall)	ASTM D5084
Particle Size Analysis:	ASTM D7928, ASTM D6913
USCS (ASTM) Classification:	ASTM D7928, ASTM D6913, ASTM D2487
USDA Classification:	ASTM D7928, ASTM D6913, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Standard Proctor Compaction:	ASTM D698

Laboratory Report for
Barrick Gold Corporation

Cunningham Hill

December 21, 2017

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

December 21, 2017

David Wykoff
Barrick Gold Corporation
582 County Road 55
Cerrillos, NM 87010
(505) 471-0434

Re: DBS&A Laboratory Report for the Barrick Gold Corporation Cunningham Hill Project

Dear Mr. Wykoff:

Enclosed is the report for the Barrick Gold Corporation, Cunningham Hill project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Barrick Gold Corporation and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines
Laboratory Manager

Enclosure

Daniel B. Stephens & Associates, Inc.
Soil Testing & Research Laboratory
4400 Alameda Blvd. NE, Suite C
Albuquerque, NM 87113
505-889-7752
FAX 505-889-0258

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
TP-1 (85%)	X	X				X	X	X		X	X			X								
TP-1 (90%)	X	X				X	X	X		X	X			X								
TP-2 (85%)	X	X				X	X	X		X	X			X								
TP-2 (90%)	X	X				X	X	X		X	X			X								

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall
[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity
[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
Two samples were hand delivered on July 19, 2017. Each sample arrived in two 5-gallon buckets sealed with lids. Both samples were received in good order.

Sample Preparation and Testing Notes:
The samples were subjected to standard proctor compaction testing. A portion of each sample was remolded into a testing ring to target 85% and 90% of the respective maximum dry bulk density at the respective optimum moisture content. Each of these remolded sub-samples was subjected to initial properties analysis, saturation, and the hanging column and pressure chamber portions of the moisture retention testing. Secondary sub-samples were also prepared, using the same target remold parameters. The secondary sub-samples were then extruded from the testing ring and were subjected to saturated hydraulic conductivity testing via the flexible wall method.

The actual percentage of maximum dry bulk density achieved was added to each sub-sample ID.

Separate sub-samples were obtained for the dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

Particles larger than 4.75 mm were removed from the bulk material prior to remolding the sub-samples. Oversize correction calculations are provided since the removed fraction is larger than 5% of the bulk sample mass.

Porosity calculations are based on the use of an assumed specific gravity value of 2.65.

Summary of Sample Preparation/Volume Changes

	Proctor Data		Target Remold Parameters[1]			Actual Remold Data			Volume Change Post Saturation[2]			Volume Change Post Drying Curve[3]		
Sample Number	Opt. Moist. Cont. (%, g/g)	Max. Dry Density (g/cm³)	Moist. Cont. (%, g/g)	Dry Bulk Density (g/cm³)	% of Max. Density (%)	Moist. Cont. (%, g/g)	Dry Bulk Density (g/cm³)	% of Max. Density (%)	Dry Bulk Density (g/cm³)	% Volume Change (%)	% of Max. Density (%)	Dry Bulk Density (g/cm³)	% Volume Change (%)	% of Max. Density (%)
TP-1 (85%)	17.8	1.67	17.8	1.42	85%	17.8	1.42	85.2%	1.42	---	85.2%	1.42	---	85.2%
TP-1 (90%)	17.8	1.67	17.8	1.50	90%	17.8	1.50	90.0%	1.50	---	90.0%	1.50	---	90.0%
TP-2 (85%)	18.1	1.68	18.1	1.43	85%	17.6	1.43	85.1%	1.43	---	85.1%	1.43	---	85.1%
TP-2 (90%)	18.1	1.68	18.1	1.51	90%	18.0	1.51	89.9%	1.51	---	89.9%	1.51	---	89.9%

[1]Target Remold Parameters: Provided by the client: 85% and 90% of the respective maximum dry density at the respective optimum moisture content.

[2]Volume Change Post Saturation: Volume change measurements were obtained after saturated hydraulic conductivity testing.

[3]Volume Change Post Drying Curve: Volume change measurements were obtained throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point.

Notes:

"+" indicates sample swelling, "-" indicates sample settling, and "---" indicates no volume change occurred.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

	Moisture Content						
	As Received		Remolded				
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
TP-1 (85%)	NA	NA	17.8	25.2	1.42	1.67	46.6
TP-1 (90%)	NA	NA	17.8	26.7	1.50	1.77	43.4
TP-2 (85%)	NA	NA	17.6	25.2	1.43	1.69	45.9
TP-2 (90%)	NA	NA	18.0	27.2	1.51	1.79	42.8

NA = Not analyzed
— = This sample was not remolded

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head Flexible Wall	Method of Analysis: Falling Head Flexible Wall
TP-1 85%	8.5E-04	6.9E-04		X
TP-1 89%	1.4E-04	1.2E-04		X
TP-2 85%	4.6E-04	4.1E-04		X
TP-2 90%	1.2E-04	1.0E-04		X

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
TP-1 (85%)	0	48.7
	10	46.7
	43	37.3
	125	32.8
	337	29.6
	4895	16.4
	36611	10.7
	296762	7.2
	848426	4.9
TP-1 (90%)	0	44.5
	10	44.1
	43	39.2
	125	34.2
	337	31.2
	8362	14.5
	43749	10.7
	287992	7.3
	848426	5.2
TP-2 (85%)	0	47.1
	10	46.6
	43	45.4
	125	34.6
	337	30.3
	8668	15.9
	75567	10.3
	568437	6.6
	848426	5.6
TP-2 (90%)	0	42.3
	16	42.2
	68	37.1
	149	34.3
	337	31.8
	26107	14.2
	131860	10.7
	402821	8.4
	848426	5.9

Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
TP-1 (85%)	0.0556	1.1958	0.00	48.91	0.00	43.59
TP-1 (90%)	0.0190	1.2129	0.00	44.48	0.00	39.39
TP-2 (85%)	0.0211	1.2315	1.36	47.89	1.28	45.12
TP-2 (90%)	0.0144	1.1884	0.00	42.47	0.00	39.88

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

NR = Not requested

NA = Not applicable

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
TP-1 (85%)	NA	NA	17.8	25.2	1.42	1.67	46.6
TP-1 (90%)	NA	NA	17.8	26.7	1.50	1.77	43.4
TP-2 (85%)	NA	NA	17.6	25.2	1.43	1.69	45.9
TP-2 (90%)	NA	NA	18.0	27.2	1.51	1.79	42.8

NA = Not analyzed

--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 (85%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

	As Received	Remolded
Test Date:	NA	8-Nov-17
Field weight of sample* (g):		502.14
Tare weight, ring (g):		126.46
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		318.87
Sample volume (cm^3):		225.14
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		17.8
Volumetric Moisture Content (% vol):		25.2
Dry bulk density (g/cm^3):		1.42
Wet bulk density (g/cm^3):		1.67
Calculated Porosity (% vol):		46.6
Percent Saturation:		54.2

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = This sample was not remolded

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis Constant Head Flexible Wall	Method of Analysis Falling Head Flexible Wall
TP-1 85%	8.5E-04	6.9E-04		X
TP-1 89%	1.4E-04	1.2E-04		X
TP-2 85%	4.6E-04	4.1E-04		X
TP-2 90%	1.2E-04	1.0E-04		X

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties	
Initial Mass (g):	376.21
Diameter (cm):	6.141
Length (cm):	7.611
Area (cm^2):	29.62
Volume (cm^3):	225.43
Dry Density (g/cm^3):	1.42
Dry Density (pcf):	88.5
Water Content (%, g/g):	17.8
Water Content (%, vol):	25.2
Void Ratio (e):	0.87
Porosity (%, vol):	46.5
Saturation (%):	54.1

Post Permeation Sample Properties	
Saturated Mass (g):	423.88
Dry Mass (g):	319.46
Diameter (cm):	6.115
Length (cm):	7.612
*Deformation (%)**:*	0.01
Area (cm^2):	29.37
Volume (cm^3):	223.55
Dry Density (g/cm^3):	1.43
Dry Density (pcf):	89.2
Water Content (%, g/g):	32.7
Water Content (%, vol):	46.7
Void Ratio(e):	0.85
Porosity (%, vol):	46.1
Saturation (%):*	101.4

Test and Sample Conditions	
Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded; ☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	18.6
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ A ☐ B ☑ C
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	8/11/17 820
B-Value (% saturation) post to test:	0.99	8/11/17 901

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated or skewed during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

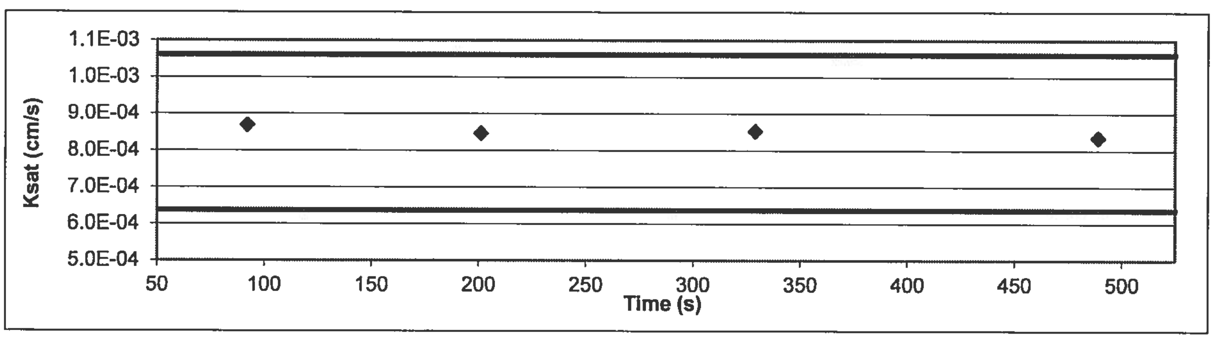
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	08:50:22	21.5	11.00	19.00	1.21	2.39	92	1.00	12%	9.00E-04	8.68E-04
11-Aug-17	08:51:54	21.5	11.50	18.50	1.06						
Test # 2:											
11-Aug-17	08:51:54	21.5	11.50	18.50	1.06	2.39	109	1.00	14%	8.77E-04	8.46E-04
11-Aug-17	08:53:43	21.5	12.00	18.00	0.91						
Test # 3:											
11-Aug-17	08:53:43	21.5	12.00	18.00	0.91	2.39	128	1.00	17%	8.83E-04	8.52E-04
11-Aug-17	08:55:51	21.5	12.50	17.50	0.76						
Test # 4:											
11-Aug-17	08:55:51	21.5	12.50	17.50	0.76	2.39	160	1.00	20%	8.64E-04	8.34E-04
11-Aug-17	08:58:31	21.5	13.00	17.00	0.61						

***Average Ksat* (cm/sec):** **8.50E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 6.92E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 6.37E-04

Ksat (+25%) (cm/s): 1.06E-03

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 46.5

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	18.57	81.43	100.00
Bulk Density (g/cm^3):	2.65	1.42	1.55
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	26.73	26.73
Total Volume (cm^3):	7.01	57.46	64.47
Volumetric Fraction (%):	10.87	89.13	100.00
Mass Fraction (%):	18.57	81.43	100.00
Ksat (cm/sec):	NM	8.5E-04	6.9E-04

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 89%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties

Initial Mass (g):	398.21
Diameter (cm):	6.148
Length (cm):	7.613
Area (cm^2):	29.69
Volume (cm^3):	226.00
Dry Density (g/cm^3):	1.49
Dry Density (pcf):	93.2
Water Content (%, g/g):	18.0
Water Content (%, vol):	26.9
Void Ratio (e):	0.77
Porosity (%, vol):	43.6
Saturation (%):	61.6

Post Permeation Sample Properties

Saturated Mass (g):	438.61
Dry Mass (g):	337.49
Diameter (cm):	6.125
Length (cm):	7.613
*Deformation (%)**:*	0.00
Area (cm^2):	29.46
Volume (cm^3):	224.31
Dry Density (g/cm^3):	1.50
Dry Density (pcf):	93.9
Water Content (%, g/g):	30.0
Water Content (%, vol):	45.1
Void Ratio(e):	0.76
Porosity (%, vol):	43.2
Saturation (%):*	104.3

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	18.6
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ A ☑ B ☐ C
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	8/11/17 822
B-Value (% saturation) post to test:	1.00	8/11/17 1005

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated or skewed during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

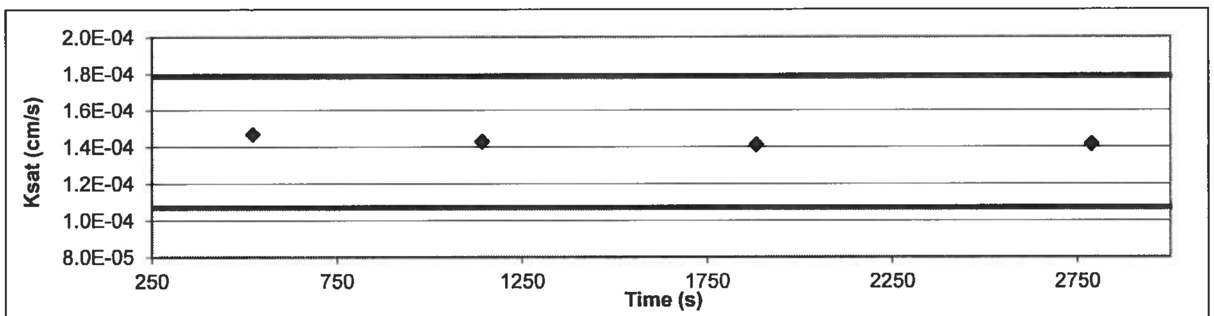
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 89%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	09:14:18	21.5	11.00	19.00	1.21	2.31	522	1.00	12%	1.52E-04	1.46E-04
11-Aug-17	09:23:00	21.5	11.50	18.50	1.06						
Test # 2:											
11-Aug-17	09:23:00	21.5	11.50	18.50	1.06	2.31	619	1.00	14%	1.48E-04	1.43E-04
11-Aug-17	09:33:19	21.5	12.00	18.00	0.91						
Test # 3:											
11-Aug-17	09:33:19	21.5	12.00	18.00	0.91	2.31	741	1.00	17%	1.46E-04	1.41E-04
11-Aug-17	09:45:40	21.5	12.50	17.50	0.76						
Test # 4:											
11-Aug-17	09:45:40	21.5	12.50	17.50	0.76	2.31	905	1.00	20%	1.46E-04	1.41E-04
11-Aug-17	10:00:45	21.5	13.00	17.00	0.61						

***Average Ksat* (cm/sec):** **1.43E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 1.16E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 1.07E-04

Ksat (+25%) (cm/s): 1.78E-04

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 89%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 43.6

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	18.57	81.43	100.00
Bulk Density (g/cm^3):	2.65	1.49	1.63
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	23.80	23.80
Total Volume (cm^3):	7.01	54.53	61.54
Volumetric Fraction (%):	11.39	88.61	100.00
Mass Fraction (%):	18.57	81.43	100.00
Ksat (cm/sec):	NM	1.4E-04	1.2E-04

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties

Initial Mass (g):	379.89
Diameter (cm):	6.127
Length (cm):	7.614
Area (cm^2):	29.48
Volume (cm^3):	224.49
Dry Density (g/cm^3):	1.43
Dry Density (pcf):	89.2
Water Content (%, g/g):	18.4
Water Content (%, vol):	26.3
Void Ratio (e):	0.85
Porosity (%, vol):	46.1
Saturation (%):	57.0

Post Permeation Sample Properties

Saturated Mass (g):	426.42
Dry Mass (g):	320.91
Diameter (cm):	6.135
Length (cm):	7.603
*Deformation (%)**:*	0.15
Area (cm^2):	29.56
Volume (cm^3):	224.74
Dry Density (g/cm^3):	1.43
Dry Density (pcf):	89.1
Water Content (%, g/g):	32.9
Water Content (%, vol):	46.9
Void Ratio(e):	0.86
Porosity (%, vol):	46.1
Saturation (%):*	101.8

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	10.2
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☑ D ☐ E ☐ F
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	8/11/17 825
B-Value (% saturation) post to test:	0.99	8/11/17 922

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

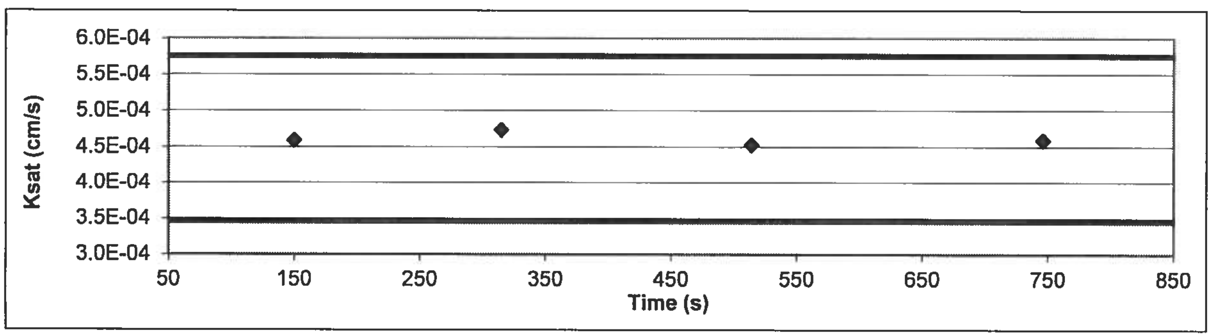
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	09:07:18	21.5	10.00	19.00	1.37	2.35	150	1.00	11%	4.75E-04	4.58E-04
11-Aug-17	09:09:48	21.5	10.50	18.50	1.22						
Test # 2:											
11-Aug-17	09:09:48	21.5	10.50	18.50	1.22	2.35	165	1.00	13%	4.90E-04	4.72E-04
11-Aug-17	09:12:33	21.5	11.00	18.00	1.06						
Test # 3:											
11-Aug-17	09:12:33	21.5	11.00	18.00	1.06	2.35	199	1.00	14%	4.69E-04	4.52E-04
11-Aug-17	09:15:52	21.5	11.50	17.50	0.91						
Test # 4:											
11-Aug-17	09:15:52	21.5	11.50	17.50	0.91	2.35	232	1.00	17%	4.75E-04	4.59E-04
11-Aug-17	09:19:44	21.5	12.00	17.00	0.76						

***Average Ksat* (cm/sec): 4.60E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 4.14E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 3.45E-04

Ksat (+25%) (cm/s): 5.75E-04

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 85%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4
Calculated Porosity of Fines (% vol): 46.1

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	10.18	89.82	100.00
Bulk Density (g/cm^3):	2.65	1.43	1.50
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	28.94	28.94
Total Volume (cm^3):	3.84	62.83	66.67
Volumetric Fraction (%):	5.76	94.24	100.00
Mass Fraction (%):	10.18	89.82	100.00
Ksat (cm/sec):	NM	4.6E-04	4.1E-04

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Remolded or Initial Sample Properties	
Initial Mass (g):	402.46
Diameter (cm):	6.139
Length (cm):	7.611
Area (cm^2):	29.60
Volume (cm^3):	225.28
Dry Density (g/cm^3):	1.51
Dry Density (pcf):	94.3
Water Content (%, g/g):	18.2
Water Content (%, vol):	27.5
Void Ratio (e):	0.75
Porosity (%, vol):	43.0
Saturation (%):	64.1

Post Permeation Sample Properties	
Saturated Mass (g):	440.85
Dry Mass (g):	340.44
Diameter (cm):	6.173
Length (cm):	7.610
*Deformation (%)**:*	0.01
Area (cm^2):	29.93
Volume (cm^3):	227.75
Dry Density (g/cm^3):	1.49
Dry Density (pcf):	93.3
Water Content (%, g/g):	29.5
Water Content (%, vol):	44.1
Void Ratio(e):	0.77
Porosity (%, vol):	43.6
Saturation (%):*	101.1

Test and Sample Conditions	
Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	#4
Percent Coarse Material (%):	10.2
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ D ☐ E ☑ F
Reading:	☑ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.98	8/11/17 828
B-Value (% saturation) post to test:	0.99	8/11/17 1022

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

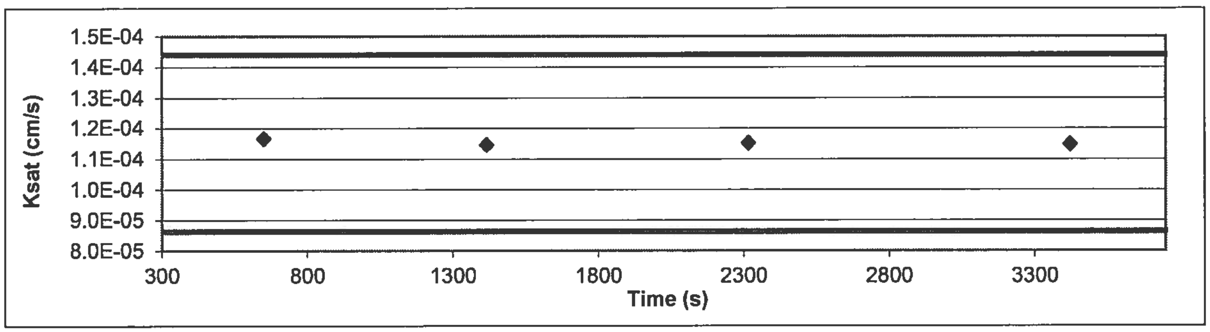
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 90%
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
11-Aug-17	09:21:54	21.5	11.00	19.00	1.21	2.32	651	1.00	12%	1.21E-04	1.17E-04
11-Aug-17	09:32:45	21.5	11.50	18.50	1.06						
Test # 2:											
11-Aug-17	09:32:45	21.5	11.50	18.50	1.06	2.32	765	1.00	14%	1.19E-04	1.14E-04
11-Aug-17	09:45:30	21.5	12.00	18.00	0.91						
Test # 3:											
11-Aug-17	09:45:30	21.5	12.00	18.00	0.91	2.32	900	1.00	17%	1.19E-04	1.15E-04
11-Aug-17	10:00:30	21.5	12.50	17.50	0.76						
Test # 4:											
11-Aug-17	10:00:30	21.5	12.50	17.50	0.76	2.32	1105	1.00	20%	1.19E-04	1.15E-04
11-Aug-17	10:18:55	21.5	13.00	17.00	0.61						

***Average Ksat* (cm/sec): 1.15E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 1.03E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 8.64E-05

Ksat (+25%) (cm/s): 1.44E-04

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name:	Barrick Gold Corporation
Job Number:	DB17.1190.00
Sample Number:	TP-2 90%
Project Name:	Cunningham Hill
Date Sampled:	7/17/17
Split (3/4", 3/8", #4):	#4
Calculated Porosity of Fines (% vol):	43.0

	Coarse Fraction*	Fines Fraction	Composite
Subsample Mass (g):	10.18	89.82	100.00
Bulk Density (g/cm^3):	2.65	1.51	1.58
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	25.54	25.54
Total Volume (cm^3):	3.84	59.44	63.28
Volumetric Fraction (%):	6.07	93.93	100.00
Mass Fraction (%):	10.18	89.82	100.00
Ksat (cm/sec):	NM	1.2E-04	1.0E-04

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NM = Not measured
* = Porosity and moisture content of coarse fraction assumed to be zero.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Characteristics

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm³/cm³)
TP-1 (85%)	0	48.7
	10	46.7
	43	37.3
	125	32.8
	337	29.6
	4895	16.4
	36611	10.7
	296762	7.2
	848426	4.9
TP-1 (90%)	0	44.5
	10	44.1
	43	39.2
	125	34.2
	337	31.2
	8362	14.5
	43749	10.7
	287992	7.3
	848426	5.2
TP-2 (85%)	0	47.1
	10	46.6
	43	45.4
	125	34.6
	337	30.3
	8668	15.9
	75567	10.3
	568437	6.6
	848426	5.6
TP-2 (90%)	0	42.3
	16	42.2
	68	37.1
	149	34.3
	337	31.8
	26107	14.2
	131860	10.7
	402821	8.4
	848426	5.9

[##] Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
TP-1 (85%)	0.0556	1.1958	0.00	48.91	0.00	43.59
TP-1 (90%)	0.0190	1.2129	0.00	44.48	0.00	39.39
TP-2 (85%)	0.0211	1.2315	1.36	47.89	1.28	45.12
TP-2 (90%)	0.0144	1.1884	0.00	42.47	0.00	39.88

— = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Barrick Gold Corporation	*Dry wt. of sample (g):*	318.87
Job Number:	DB17.1190.00	*Tare wt., ring (g):*	126.46
Sample Number:	TP-1 (85%)	*Tare wt., screen & clamp (g):*	27.66
Project Name:	Cunningham Hill	*Initial sample volume (cm^3):*	225.14
Date Sampled:	7/17/17	*Initial dry bulk density (g/cm^3):*	1.42
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	46.55

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	13-Nov-17	13:07	582.68	0	48.72
	20-Nov-17	18:15	578.14	10.0	46.70
	27-Nov-17	16:45	557.00	43.0	37.31
	5-Dec-17	12:15	546.74	125.0	32.76
Pressure plate:	14-Dec-17	8:30	539.56	337	29.57

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	10.0	---	---	---	---
	43.0	---	---	---	---
	125.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TP-1 (85%)

Initial sample bulk density (g/cm³): 1.42

Fraction of test sample used (<2.00mm fraction) (%): 78.77

Dry weight of dew point potentiometer sample* (g): 149.30

Tare weight, jar (g): 117.28

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	28-Nov-17	15:10	154.01	4895	16.42
	21-Nov-17	10:30	152.37	36611	10.68
	16-Nov-17	11:40	151.37	296762	7.23

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	4895	---	---	---	---
	36611	---	---	---	---
	296762	---	---	---	---

Dry weight of relative humidity box sample* (g): 58.24

Tare weight (g): 31.75

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	10-Nov-17	13:00	59.40	848426	4.89

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

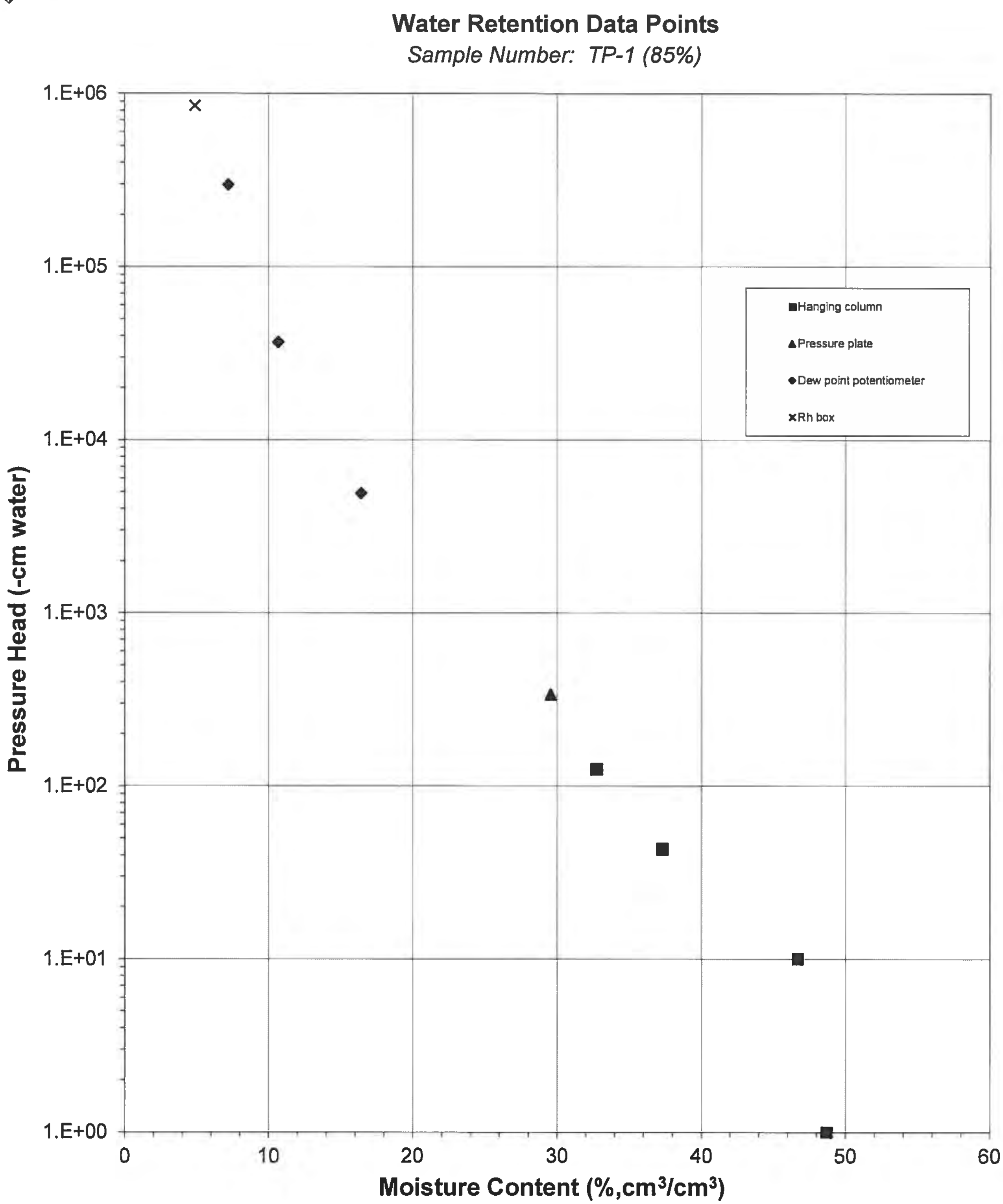
[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '—' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

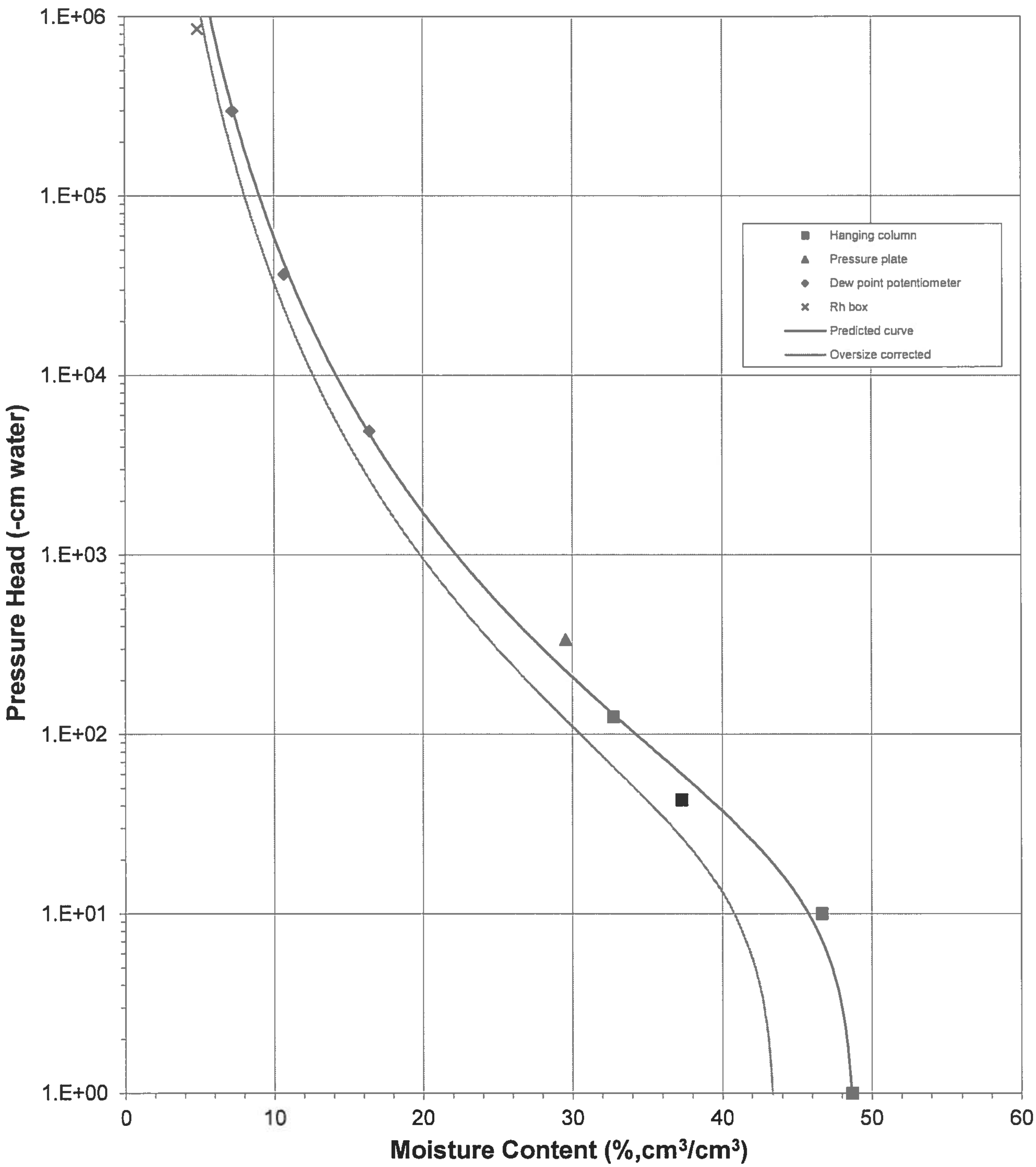
‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

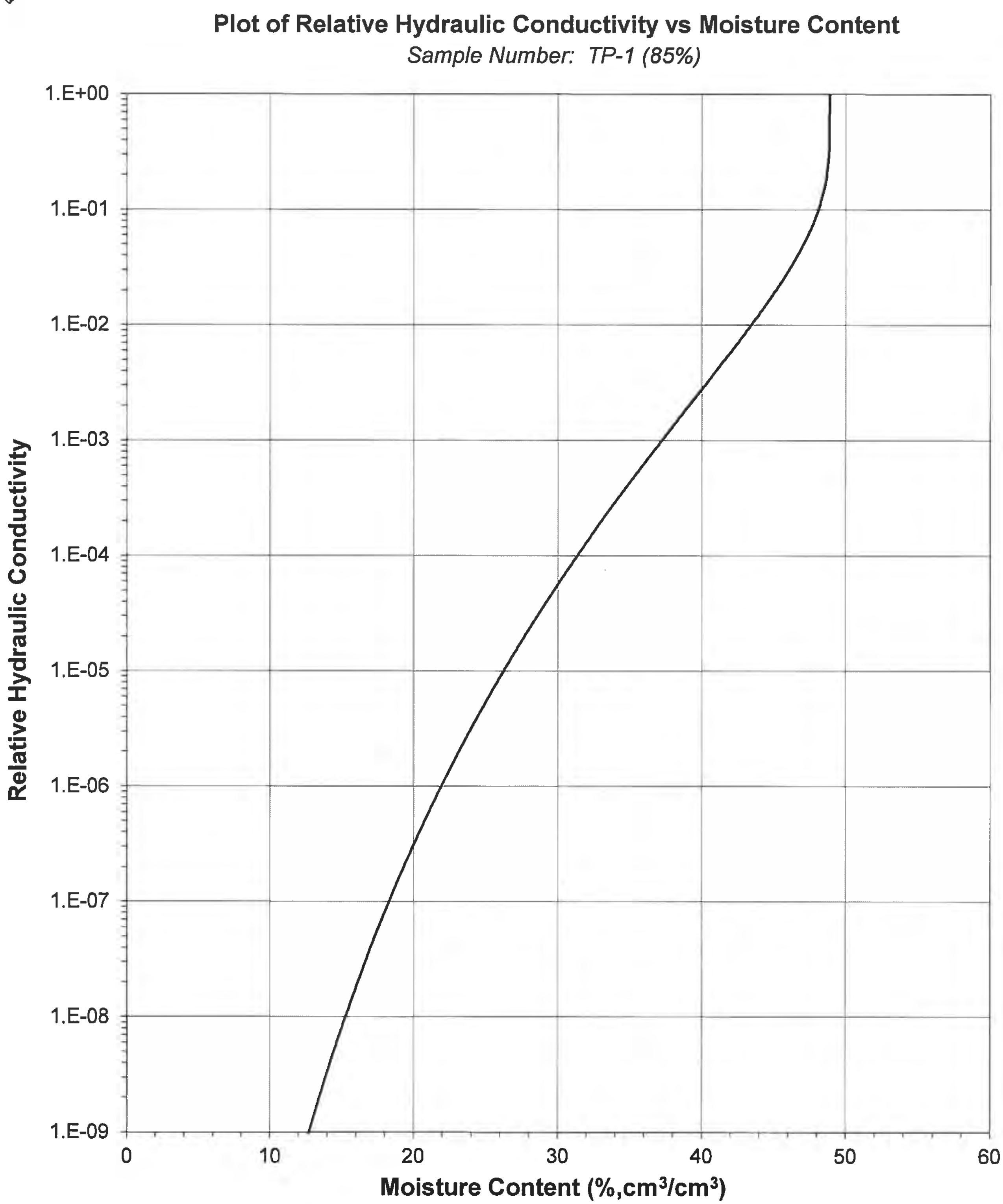
Laboratory analysis by: M. Garcia/A. Bland
Data entered by: C. Krous
Checked by: J. Hines


Water Retention Data Points
Sample Number: TP-1 (85%)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Pressure Head (-cm water)
0
10
20
30
40
50
60
Moisture Content (%,cm³/cm³)
Hanging column
Pressure plate
Dew point potentiometer
Rh box

Predicted Water Retention Curve and Data Points

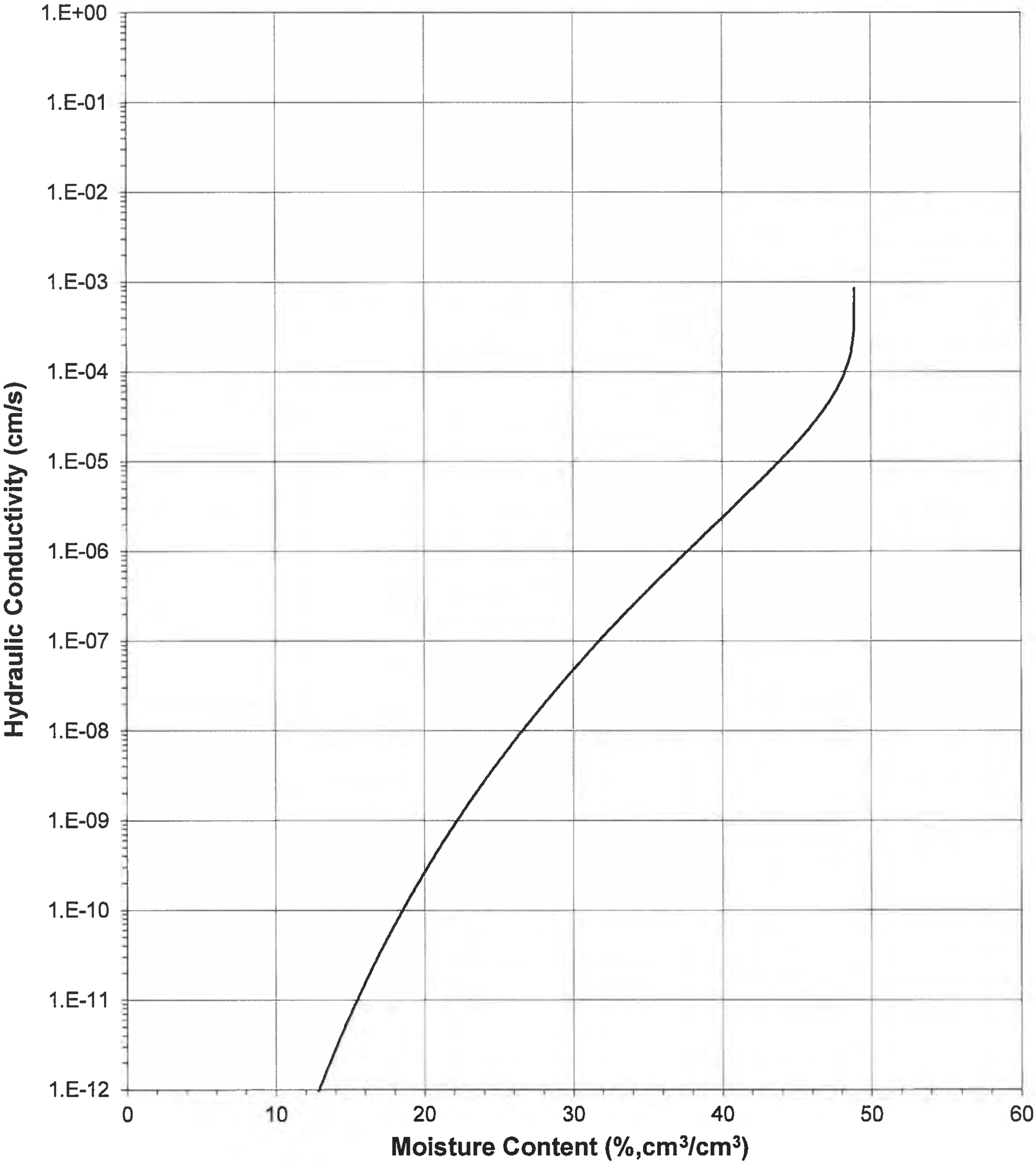
Sample Number: TP-1 (85%)




Plot of Relative Hydraulic Conductivity vs Moisture Content
Sample Number: TP-1 (85%)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
Relative Hydraulic Conductivity
0
10
20
30
40
50
60
Moisture Content (%,cm3/cm3)

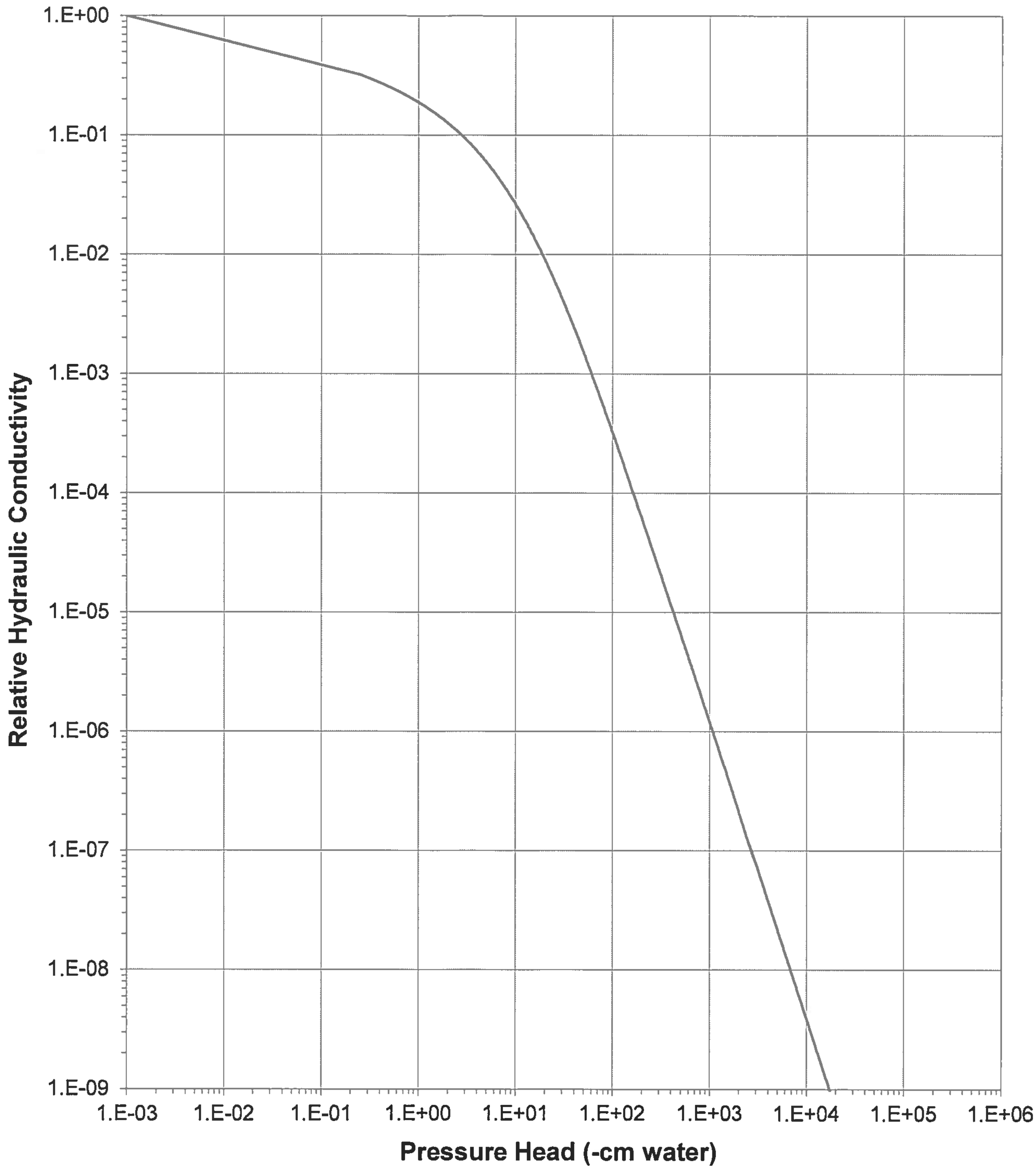
Plot of Hydraulic Conductivity vs Moisture Content

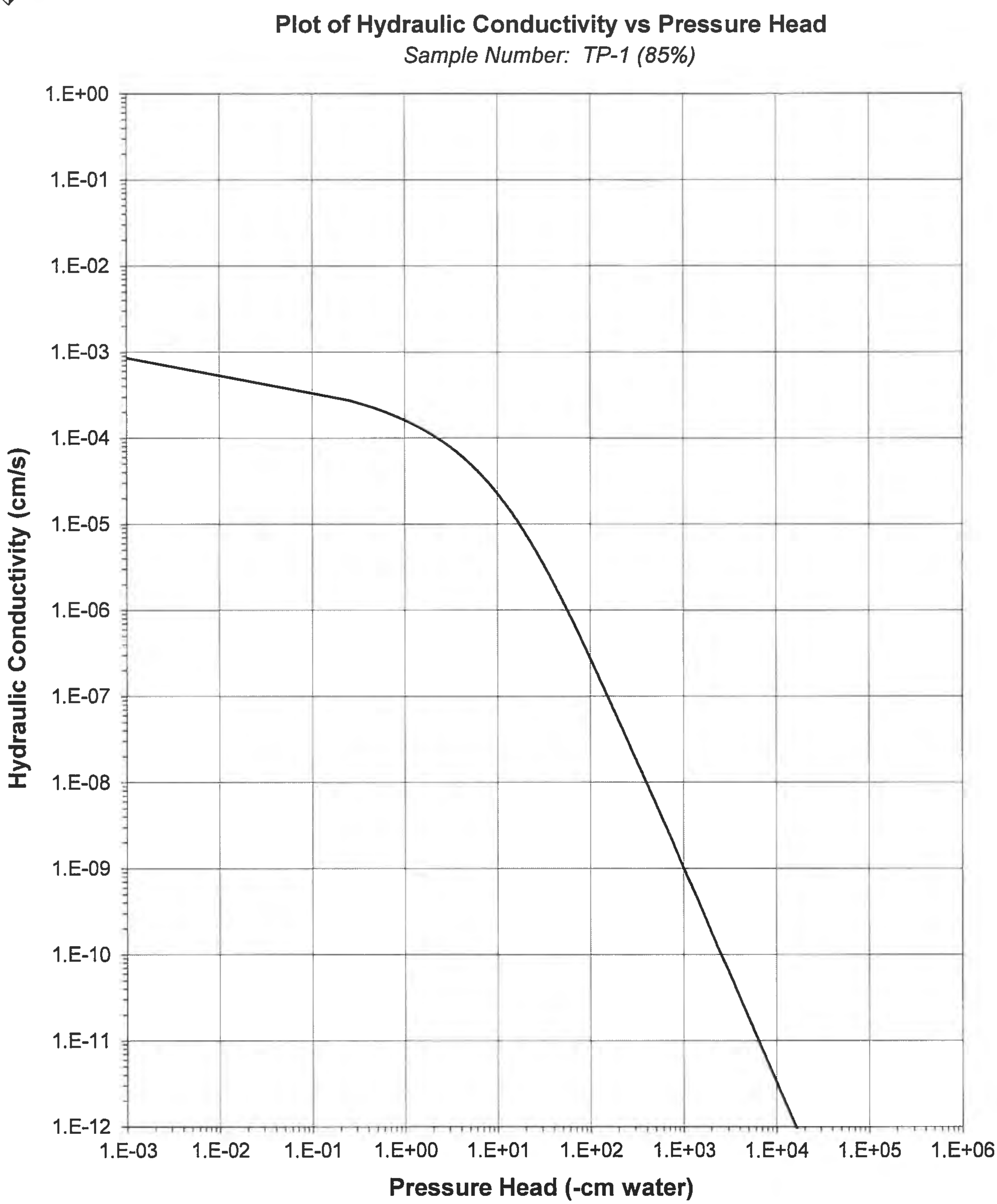
Sample Number: TP-1 (85%)



Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TP-1 (85%)




Plot of Hydraulic Conductivity vs Pressure Head
Sample Number: TP-1 (85%)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
Hydraulic Conductivity (cm/s)
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
Pressure Head (-cm water)

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 (85%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	18.57	81.43	100.00
Mass Fraction (%):	18.57	81.43	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.42	1.55
Calculated Porosity (% vol):	0.00	46.55	41.50
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	26.77	26.77
Total Volume (cm^3):	7.01	57.49	64.50
Volumetric Fraction (%):	10.86	89.14	100.00
Initial Moisture Content (% vol):	0.00	25.23	22.49
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.42	1.55
Calculated Porosity (% vol):	0.00	46.55	41.50
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	26.77	26.77
Total Volume (cm^3):	7.01	57.49	64.50
Volumetric Fraction (%):	10.86	89.14	100.00
Saturated Moisture Content (% vol):	0.00	48.91	43.59
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.42	1.55
Calculated Porosity (% vol):	0.00	46.55	41.50
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	26.77	26.77
Total Volume (cm^3):	7.01	57.49	64.50
Volumetric Fraction (%):	10.86	89.14	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	8.5E-04	6.9E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Barrick Gold Corporation	*Dry wt. of sample (g):*	334.84
Job Number:	DB17.1190.00	*Tare wt., ring (g):*	128.14
Sample Number:	TP-1 (90%)	*Tare wt., screen & clamp (g):*	26.81
Project Name:	Cunningham Hill	*Initial sample volume (cm^3):*	223.11
Date Sampled:	7/17/17	*Initial dry bulk density (g/cm^3):*	1.50
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	43.37

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	13-Nov-17	11:00	589.11	0	44.52
	20-Nov-17	18:15	588.25	10.0	44.13
	27-Nov-17	16:45	577.21	43.0	39.18
	5-Dec-17	12:15	566.19	125.0	34.24
Pressure plate:	14-Dec-17	8:30	559.35	337	31.18

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	10.0	---	---	---	---
	43.0	---	---	---	---
	125.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TP-1 (90%)

Initial sample bulk density (g/cm^3)*:* 1.50
Fraction of test sample used (<2.00mm fraction) (%): 78.77

Dry weight of dew point potentiometer sample* (g)*:* 147.87
Tare weight, jar (g)*:* 116.37

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	22-Nov-17	11:15	151.74	8362	14.50
	20-Nov-17	12:05	150.73	43749	10.73
	15-Nov-17	11:45	149.83	287992	7.34

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	8362	---	---	---	---
	43749	---	---	---	---
	287992	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 58.24
Tare weight (g)*:* 31.75

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	10-Nov-17	13:00	59.40	848426	5.19

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '—' denotes no volume change occurred.

* Weight including tares

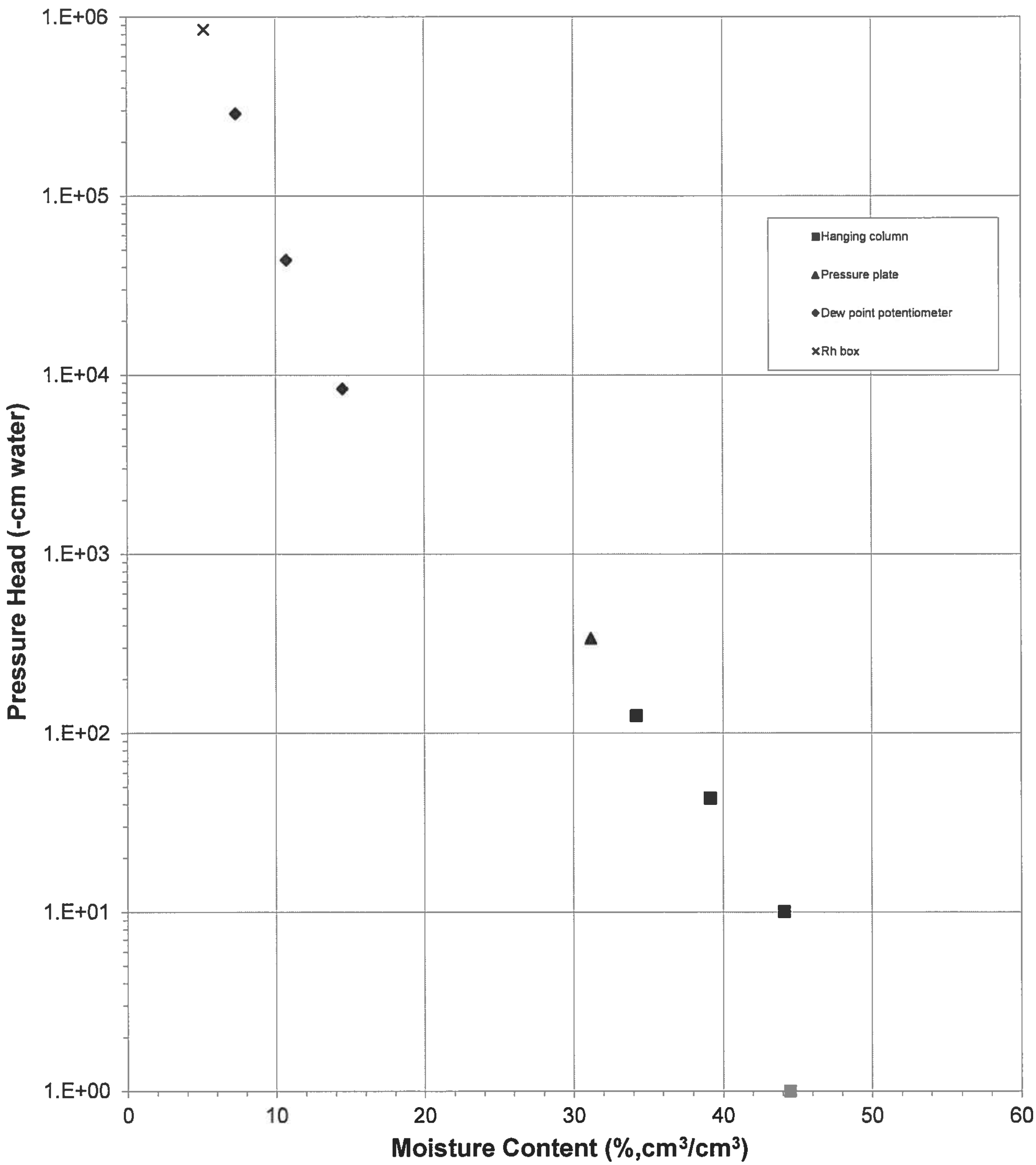
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: M. Garcia/A. Bland
Data entered by: D. O'Dowd
Checked by: J. Hines

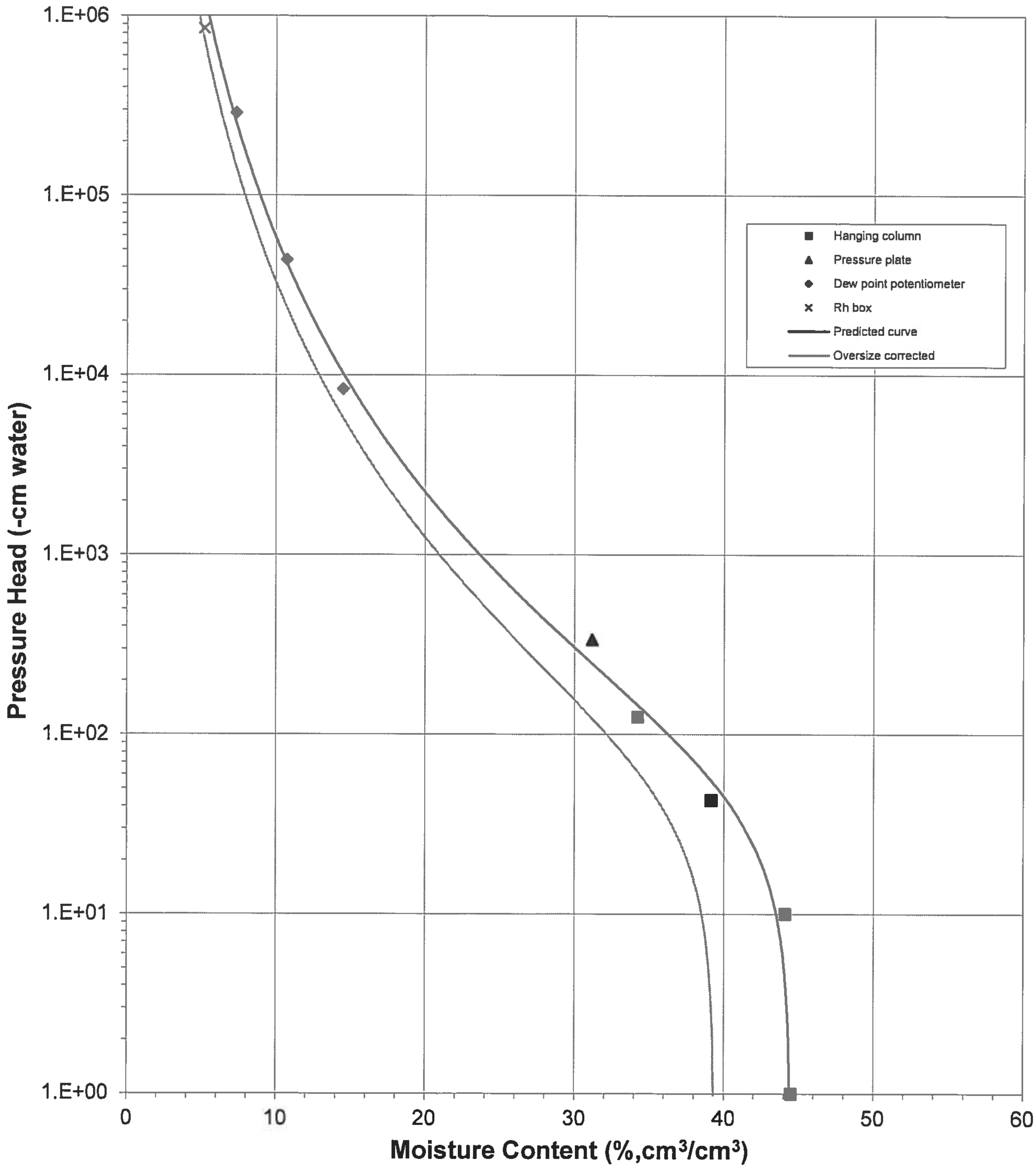
Water Retention Data Points

Sample Number: TP-1 (90%)



Predicted Water Retention Curve and Data Points

Sample Number: TP-1 (90%)



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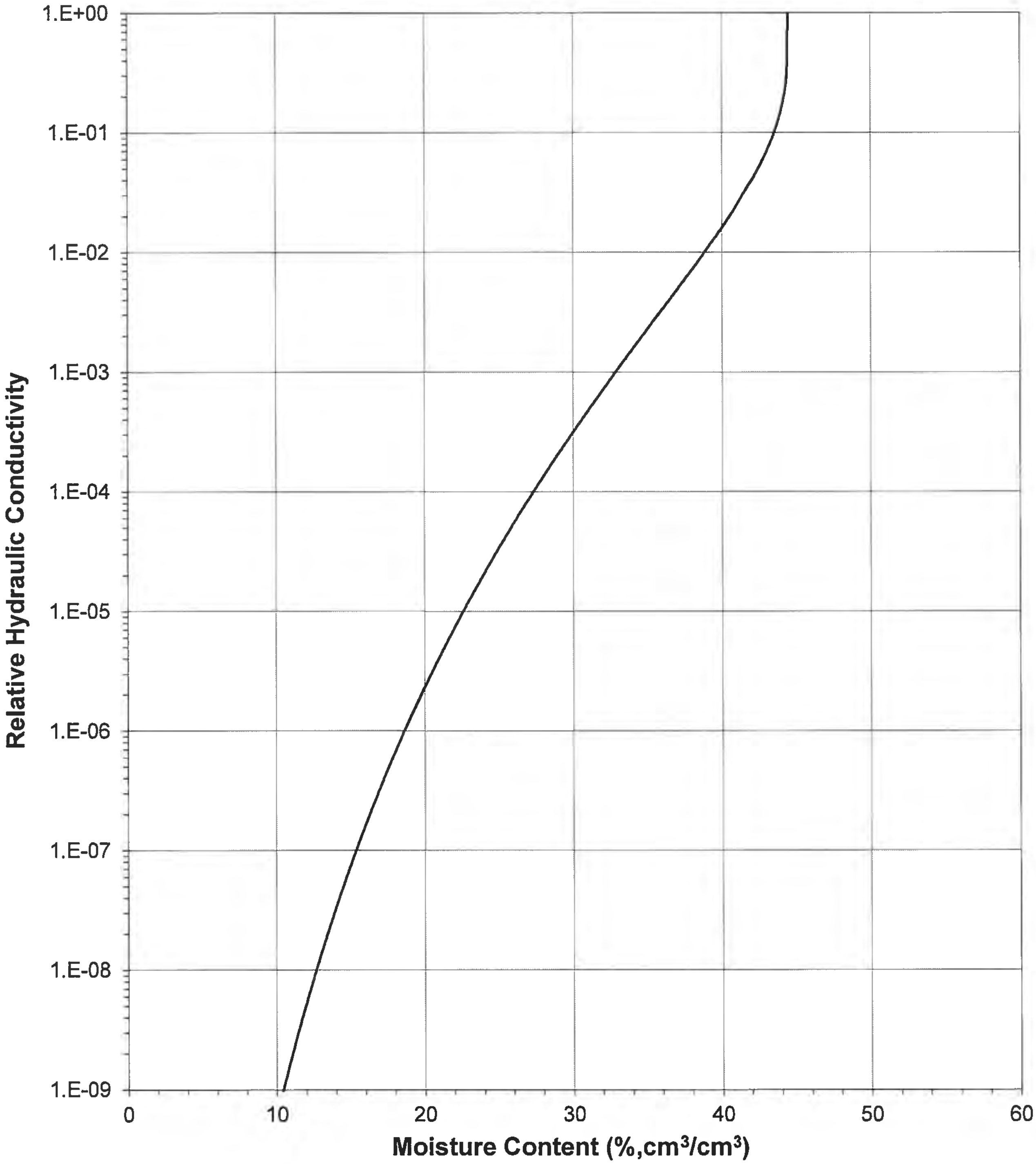
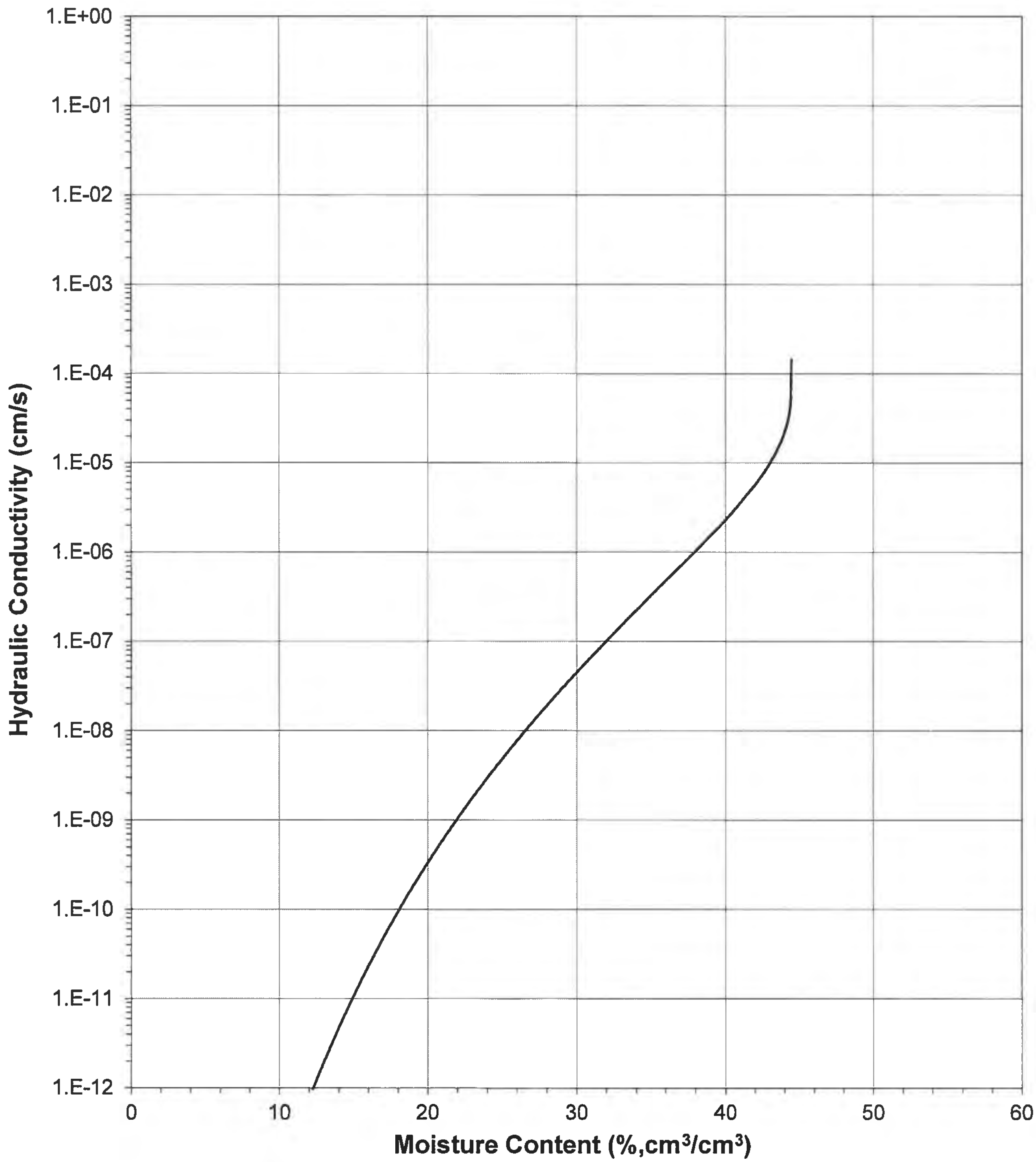
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TP-1 (90%)



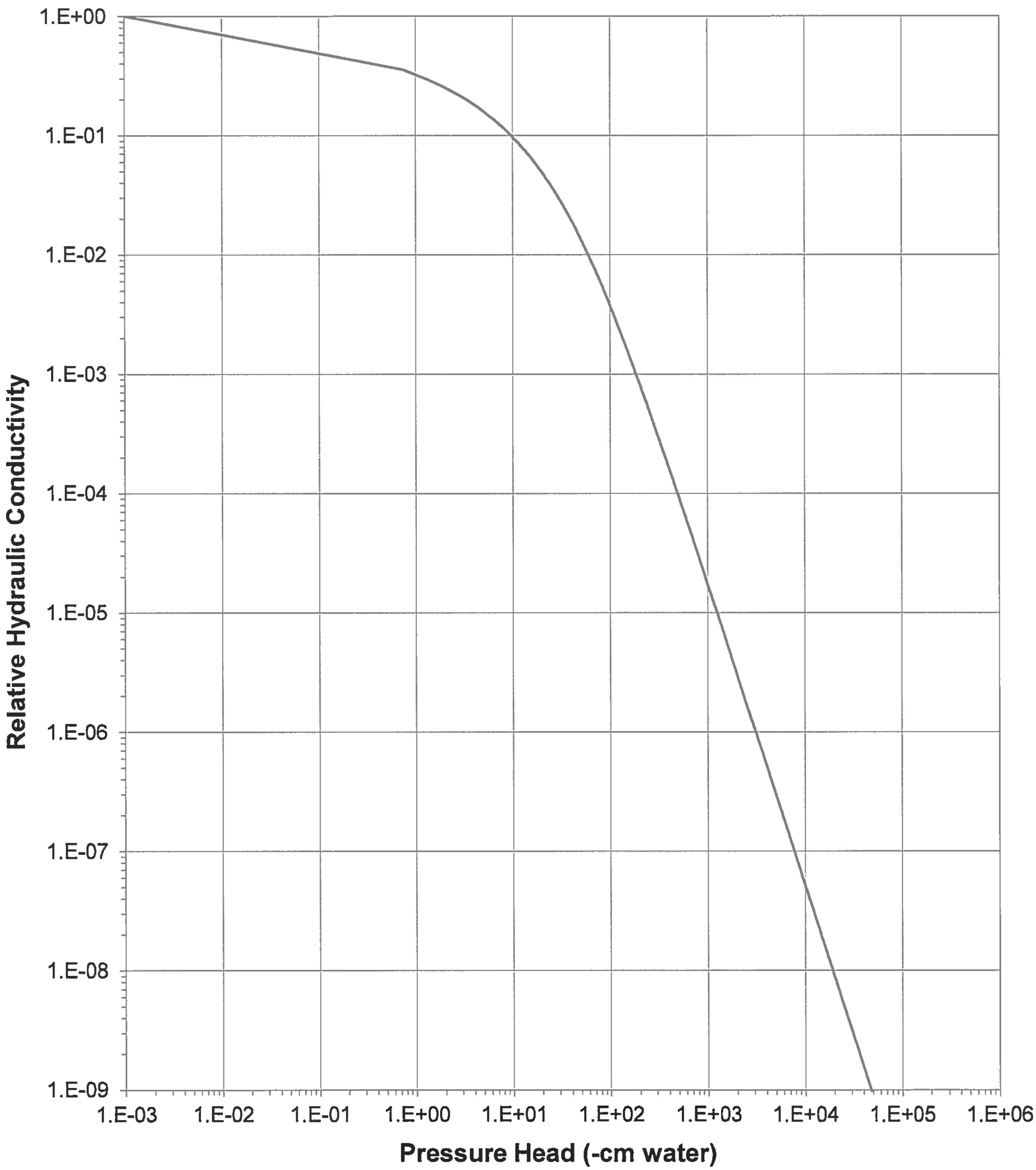
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TP-1 (90%)



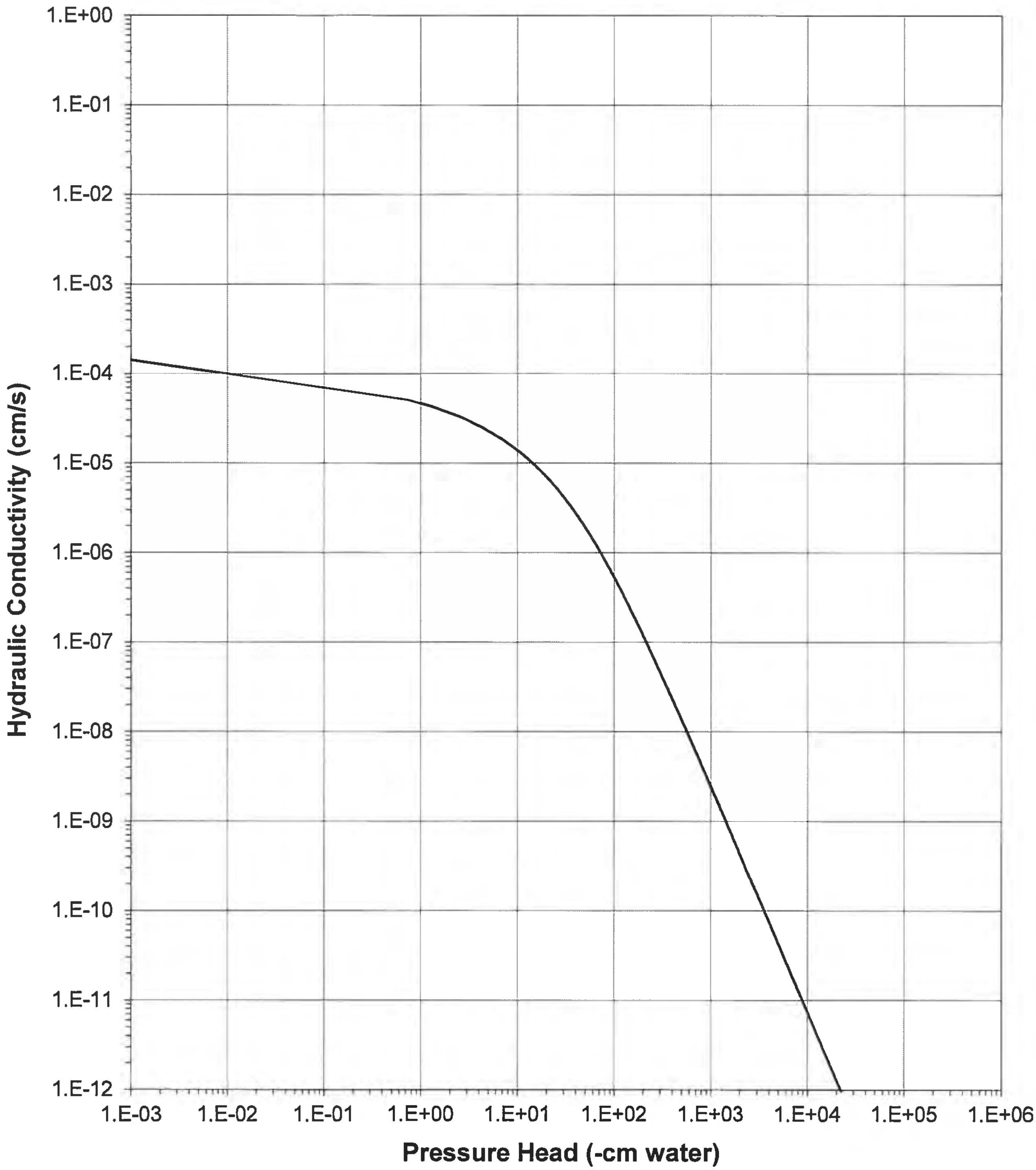
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TP-1 (90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP-1 (90%)



Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-1 (90%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	18.57	81.43	100.00
Mass Fraction (%):	18.57	81.43	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.50	1.63
Calculated Porosity (% vol):	0.00	43.37	38.41
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	23.53	23.53
Total Volume (cm^3):	7.01	54.26	61.27
Volumetric Fraction (%):	11.44	88.56	100.00
Initial Moisture Content (% vol):	0.00	26.73	23.67
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.50	1.63
Calculated Porosity (% vol):	0.00	43.37	38.41
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	23.53	23.53
Total Volume (cm^3):	7.01	54.26	61.27
Volumetric Fraction (%):	11.44	88.56	100.00
Saturated Moisture Content (% vol):	0.00	44.48	39.39
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.50	1.63
Calculated Porosity (% vol):	0.00	43.37	38.41
Volume of Solids (cm^3):	7.01	30.73	37.74
Volume of Voids (cm^3):	0.00	23.53	23.53
Total Volume (cm^3):	7.01	54.26	61.27
Volumetric Fraction (%):	11.44	88.56	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	1.4E-04	1.2E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Barrick Gold Corporation	*Dry wt. of sample (g):*	318.63
Job Number:	DB17.1190.00	*Tare wt., ring (g):*	133.21
Sample Number:	TP-2 (85%)	*Tare wt., screen & clamp (g):*	27.97
Project Name:	Cunningham Hill	*Initial sample volume (cm^3):*	222.21
Date Sampled:	7/17/17	*Initial dry bulk density (g/cm^3):*	1.43
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	45.89

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	13-Nov-17	13:15	584.48	0	47.10
	20-Nov-17	18:15	583.32	10.0	46.58
	27-Nov-17	16:45	580.65	43.0	45.38
	5-Dec-17	12:15	556.68	125.0	34.59
Pressure plate:	14-Dec-17	8:30	547.17	337	30.31

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	10.0	---	---	---	---
	43.0	---	---	---	---
	125.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TP-2 (85%)

Initial sample bulk density (g/cm^3): 1.43

Fraction of test sample used (<2.00mm fraction) (%): 87.27

Dry weight of dew point potentiometer sample* (g): 146.70

Tare weight, jar (g): 117.66

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	22-Nov-17	11:15	150.40	8668	15.94
	17-Nov-17	10:20	149.09	75567	10.28
	13-Nov-17	10:05	148.23	568437	6.58

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	8668	---	---	---	---
	75567	---	---	---	---
	568437	---	---	---	---

Dry weight of relative humidity box sample* (g): 56.61

Tare weight (g): 39.42

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	10-Nov-17	13:00	57.38	848426	5.60

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

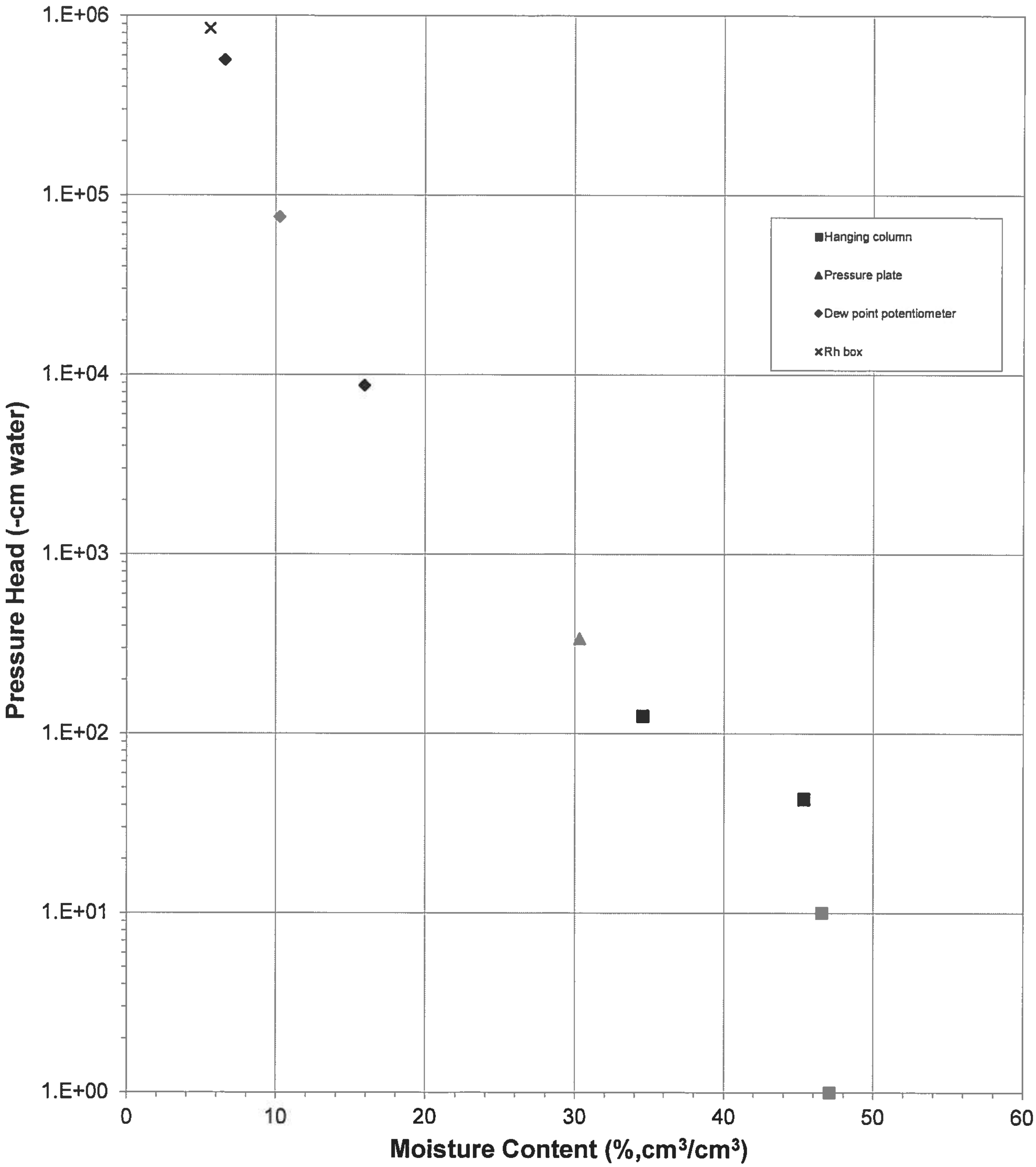
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: M. Garcia/A. Bland
Data entered by: C. Krous
Checked by: J. Hines

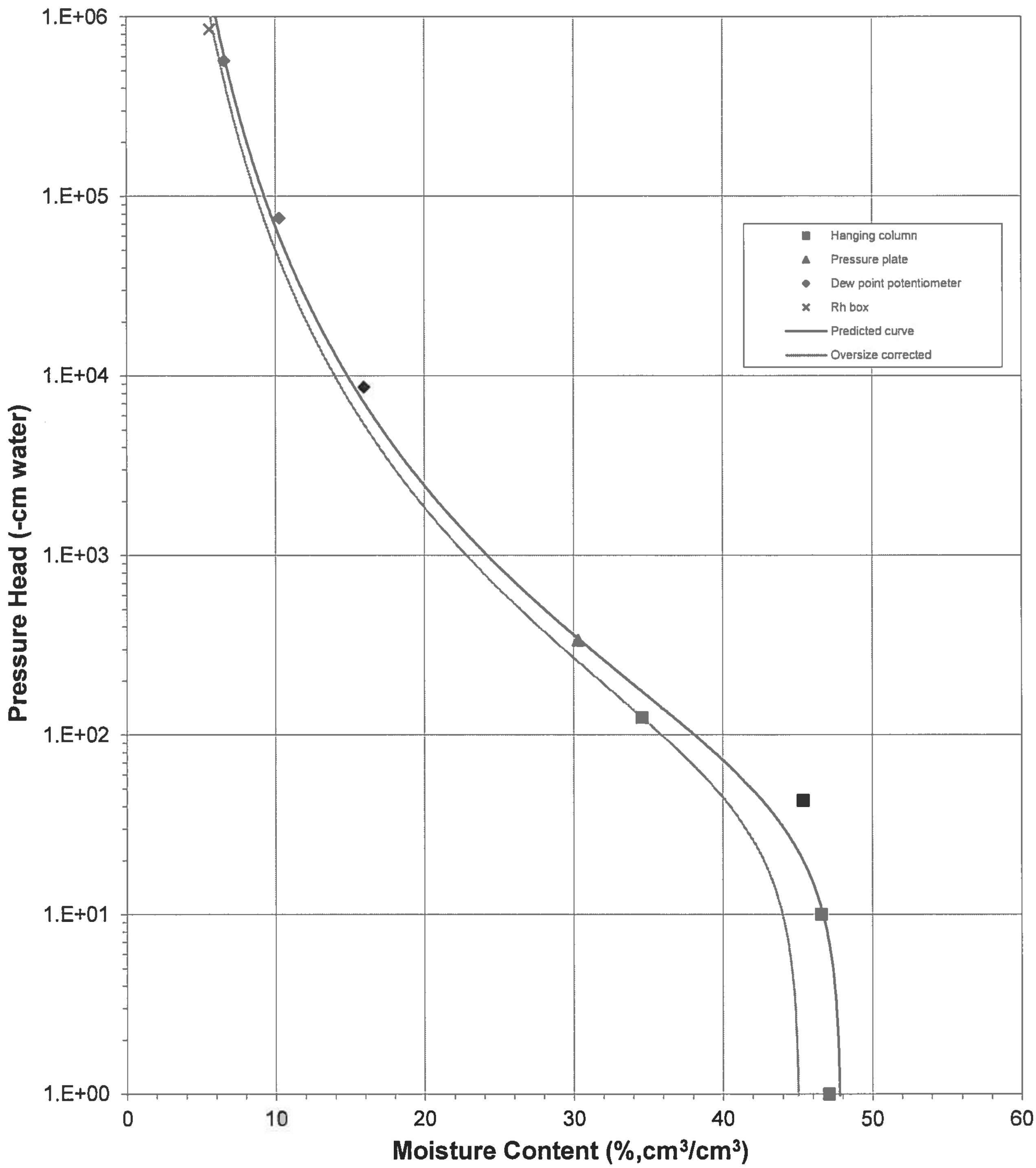
Water Retention Data Points

Sample Number: TP-2 (85%)



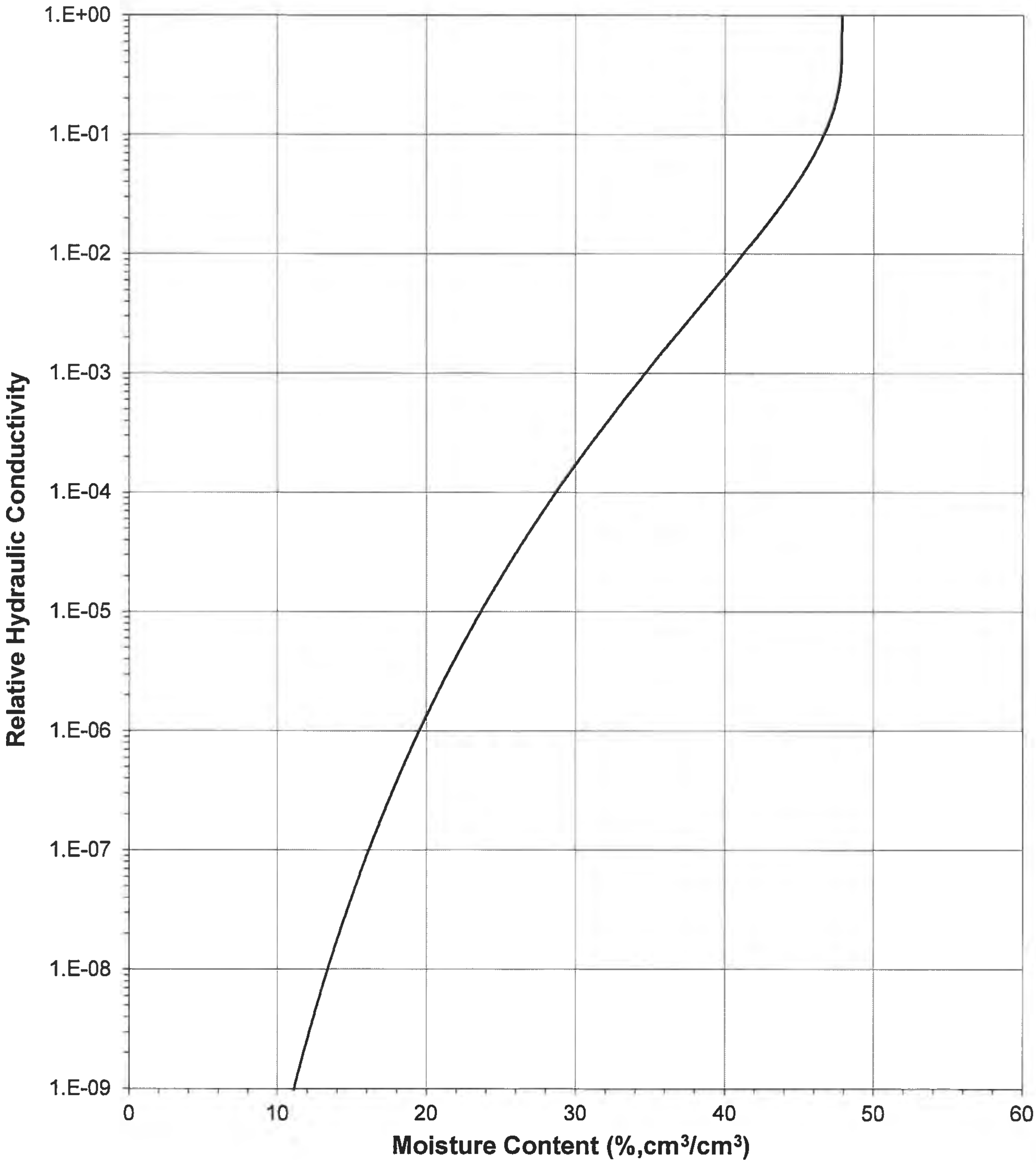
Predicted Water Retention Curve and Data Points

Sample Number: TP-2 (85%)



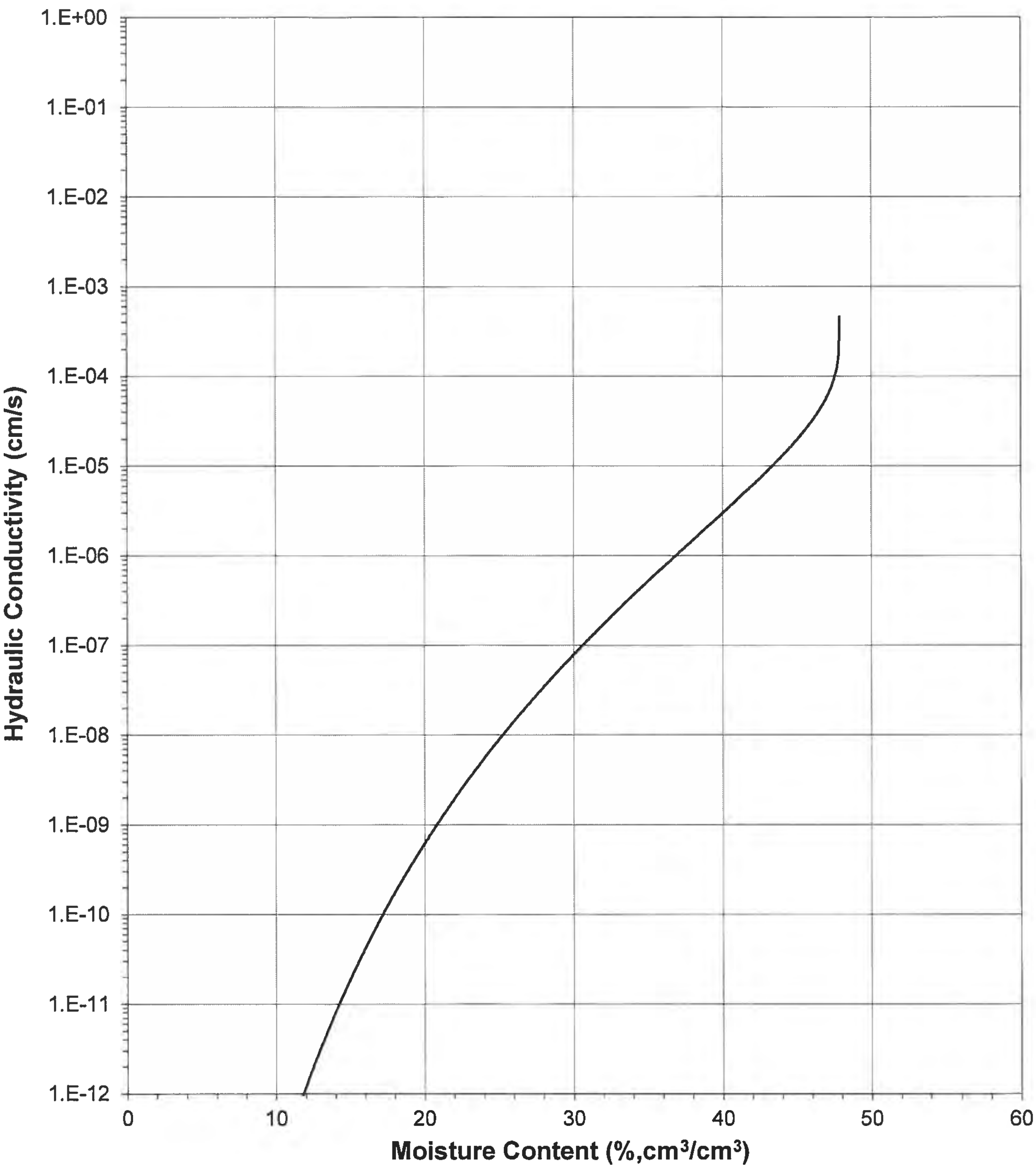
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TP-2 (85%)

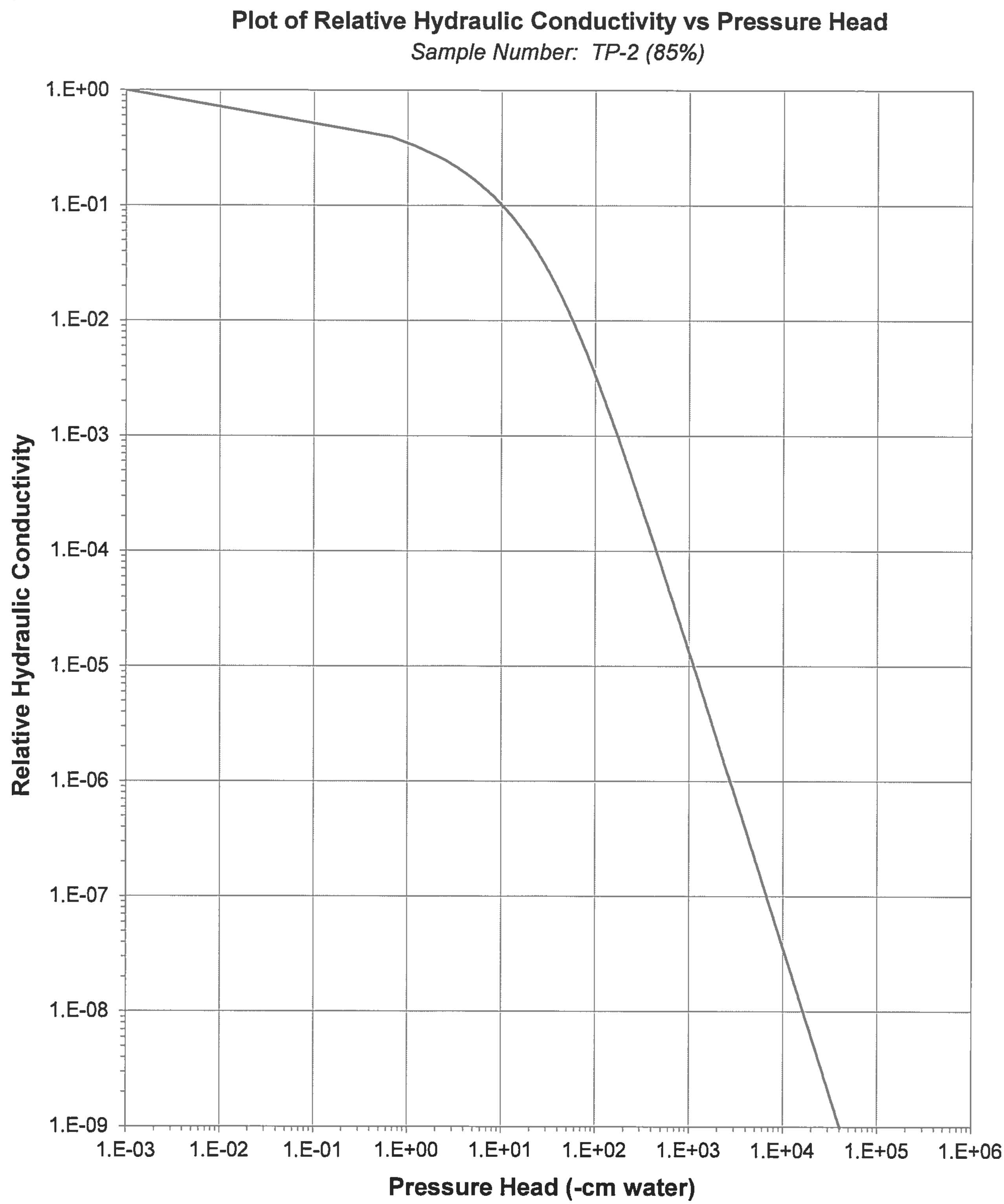


Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TP-2 (85%)

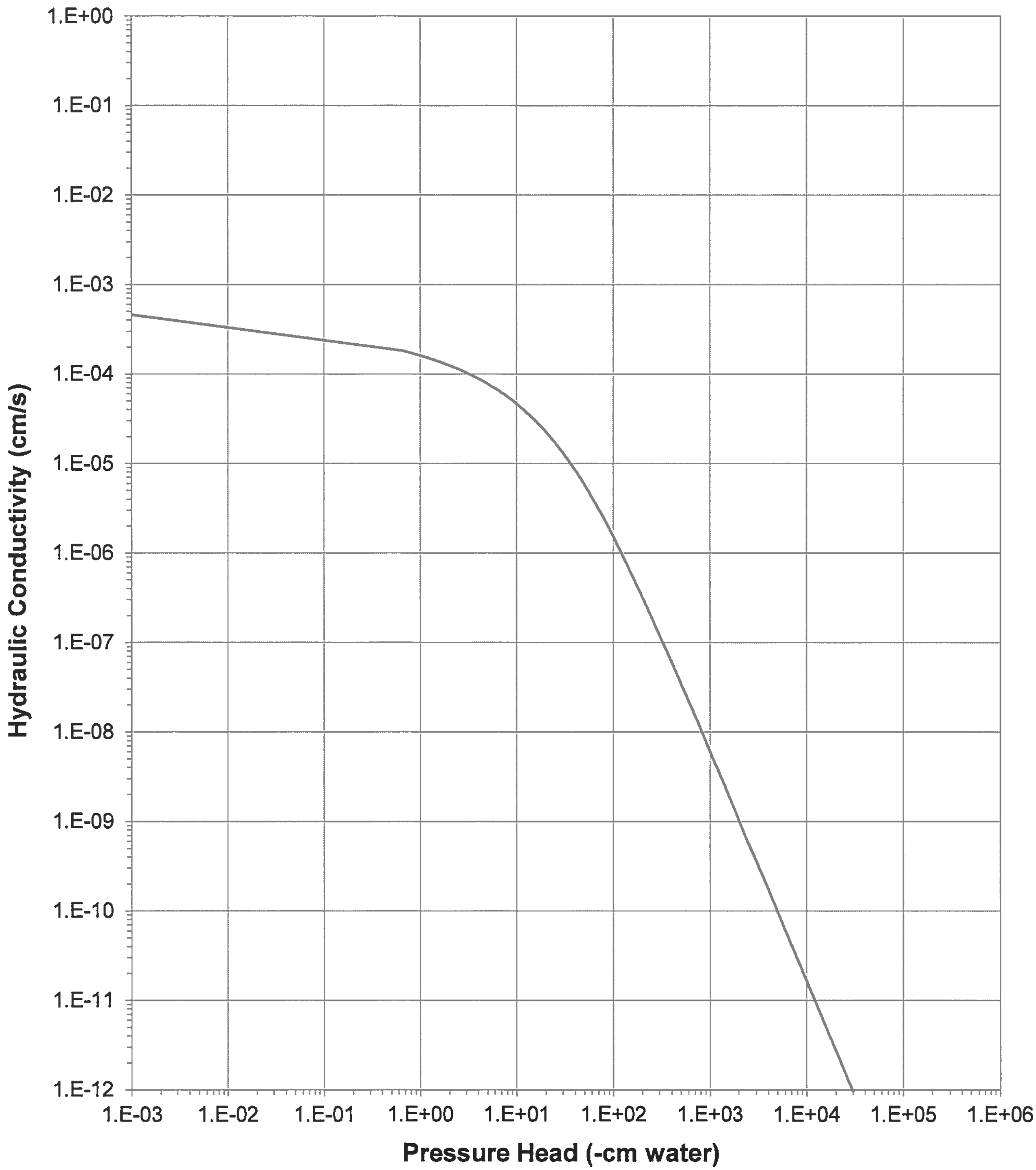


Daniel B. Stephens & Associates, Inc.



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP-2 (85%)



Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 (85%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	10.18	89.82	100.00
Mass Fraction (%):	10.18	89.82	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.43	1.50
Calculated Porosity (% vol):	0.00	45.89	43.24
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	28.74	28.74
Total Volume (cm^3):	3.84	62.64	66.48
Volumetric Fraction (%):	5.78	94.22	100.00
Initial Moisture Content (% vol):	0.00	25.22	23.76
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.43	1.50
Calculated Porosity (% vol):	0.00	45.89	43.24
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	28.74	28.74
Total Volume (cm^3):	3.84	62.64	66.48
Volumetric Fraction (%):	5.78	94.22	100.00
Saturated Moisture Content (% vol):	0.00	47.89	45.12
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.43	1.50
Calculated Porosity (% vol):	0.00	45.89	43.24
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	28.74	28.74
Total Volume (cm^3):	3.84	62.64	66.48
Volumetric Fraction (%):	5.78	94.22	100.00
Residual Moisture Content (% vol):	0.00	1.36	1.28
Ksat (cm/sec):	NM	4.6E-04	4.1E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 (90%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Dry wt. of sample (g): 333.73
Tare wt., ring (g): 132.47
Tare wt., screen & clamp (g): 27.94
Initial sample volume (cm^3): 220.36
Initial dry bulk density (g/cm^3): 1.51
Assumed particle density (g/cm^3): 2.65
Initial calculated total porosity (%): 42.85

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	14-Nov-17	9:25	587.34	0	42.30
	21-Nov-17	10:35	587.11	16.0	42.19
	28-Nov-17	15:45	575.91	68.0	37.11
	5-Dec-17	12:30	569.68	149.0	34.28
Pressure plate:	14-Dec-17	8:30	564.29	337	31.83

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	16.0	---	---	---	---
	68.0	---	---	---	---
	149.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TP-2 (90%)

Initial sample bulk density (g/cm^3)*:* 1.51
Fraction of test sample used (<2.00mm fraction) (%): 87.27

Dry weight of dew point potentiometer sample* (g)*:* 141.90
Tare weight, jar (g)*:* 114.26

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	22-Nov-17	10:20	144.88	26107	14.24
	20-Nov-17	12:25	144.14	131860	10.72
	16-Nov-17	11:45	143.65	402821	8.36

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	26107	---	---	---	---
	131860	---	---	---	---
	402821	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 56.61
Tare weight (g)*:* 39.42

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	10-Nov-17	13:00	57.38	848426	5.92

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '—' denotes no volume change occurred.

* Weight including tares

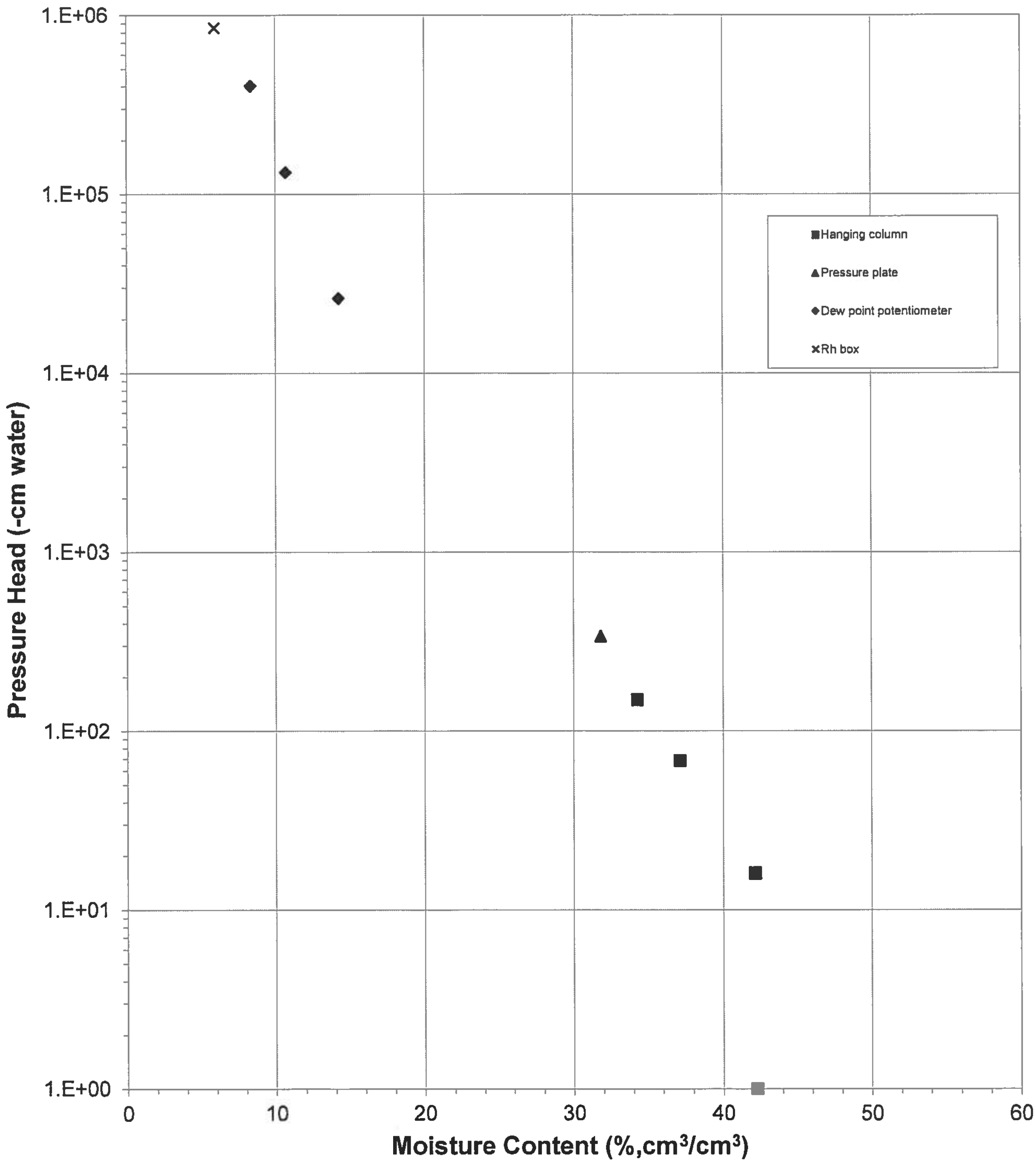
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

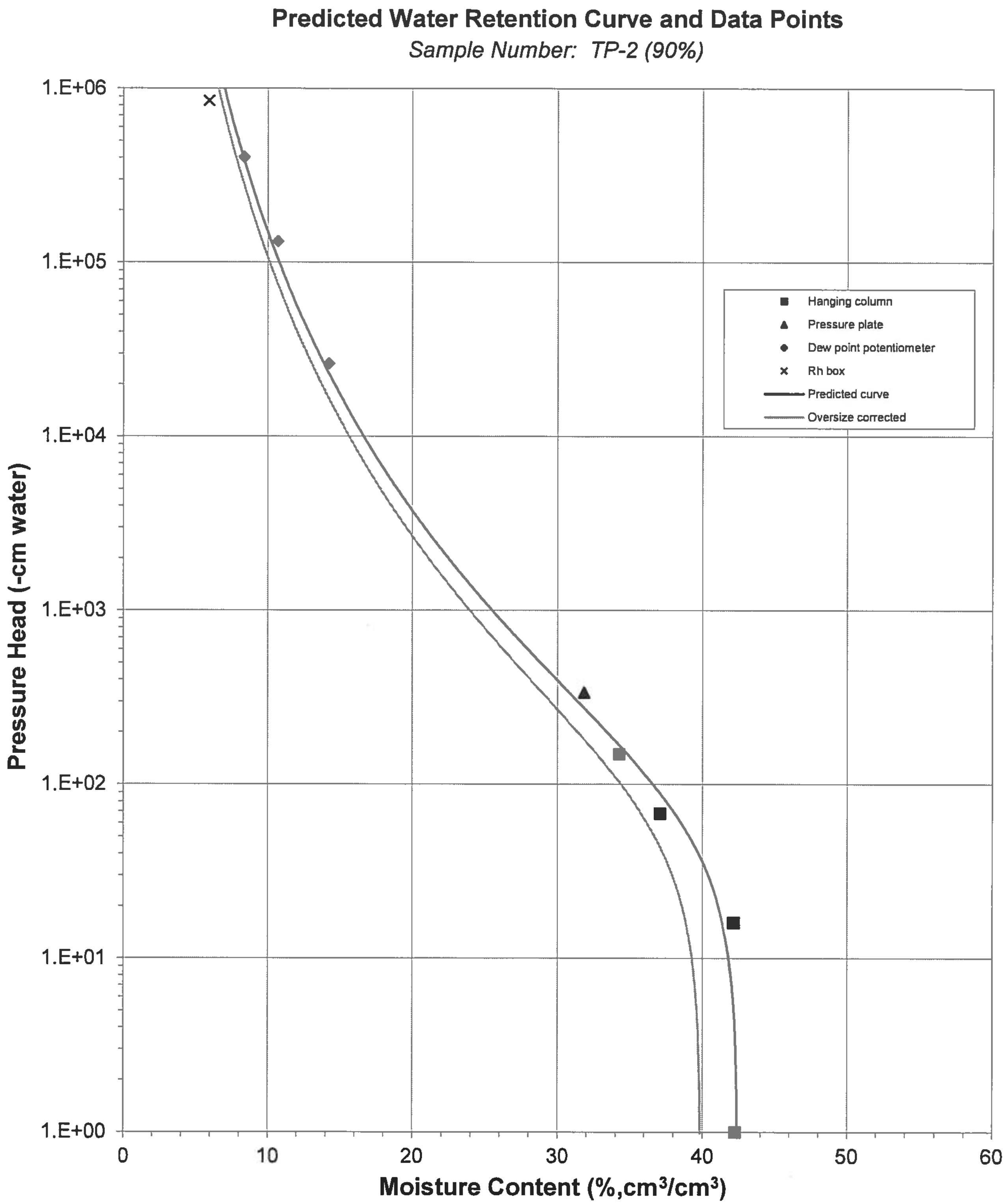
‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: M. Garcia/A. Bland
Data entered by: C. Krous
Checked by: J. Hines

Water Retention Data Points

Sample Number: TP-2 (90%)

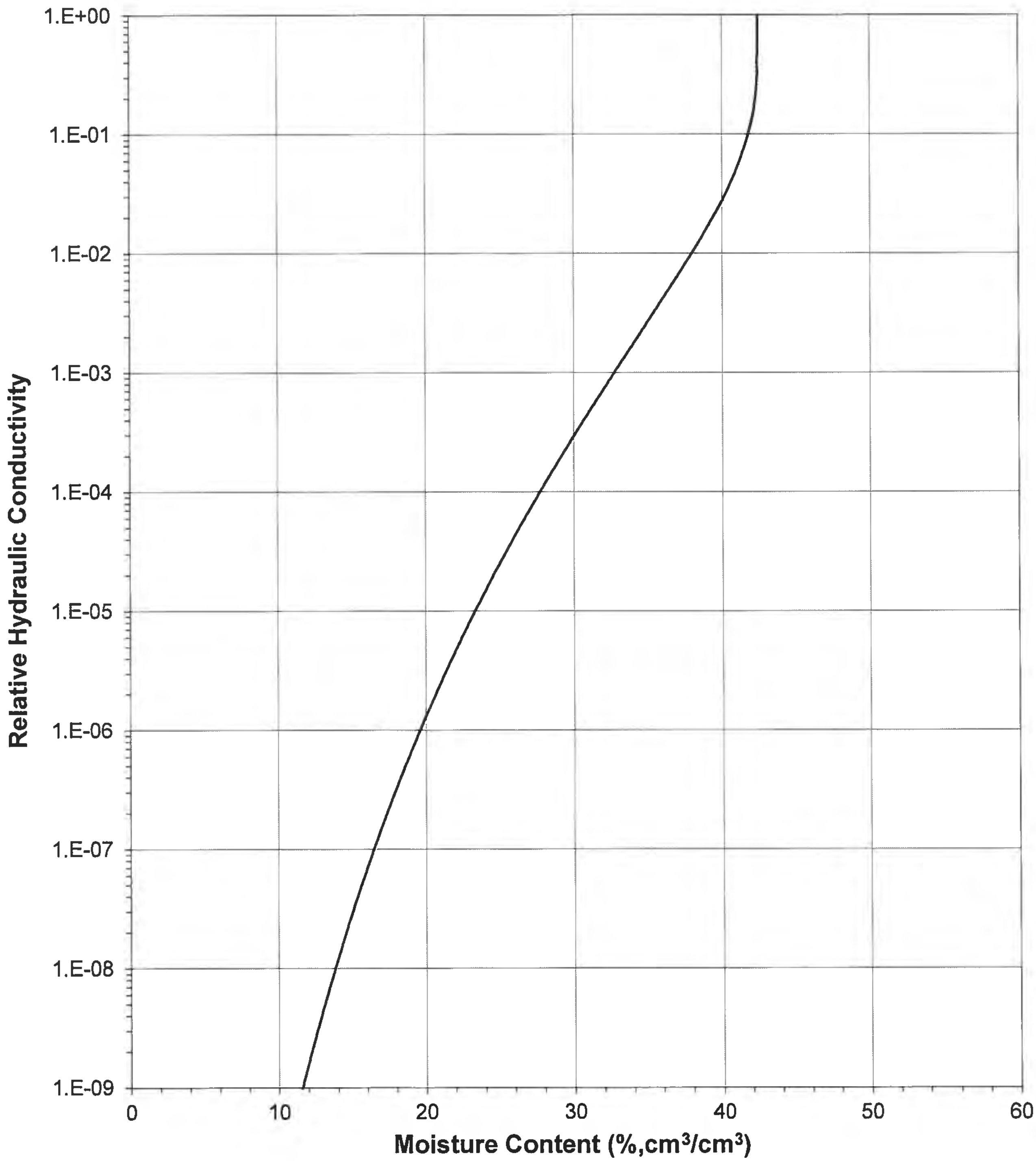




Predicted Water Retention Curve and Data Points
Sample Number: TP-2 (90%)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Moisture Content (%,cm³/cm³)
0
10
20
30
40
50
60
Hanging column
Pressure plate
Dew point potentiometer
Rh box
Predicted curve
Oversize corrected

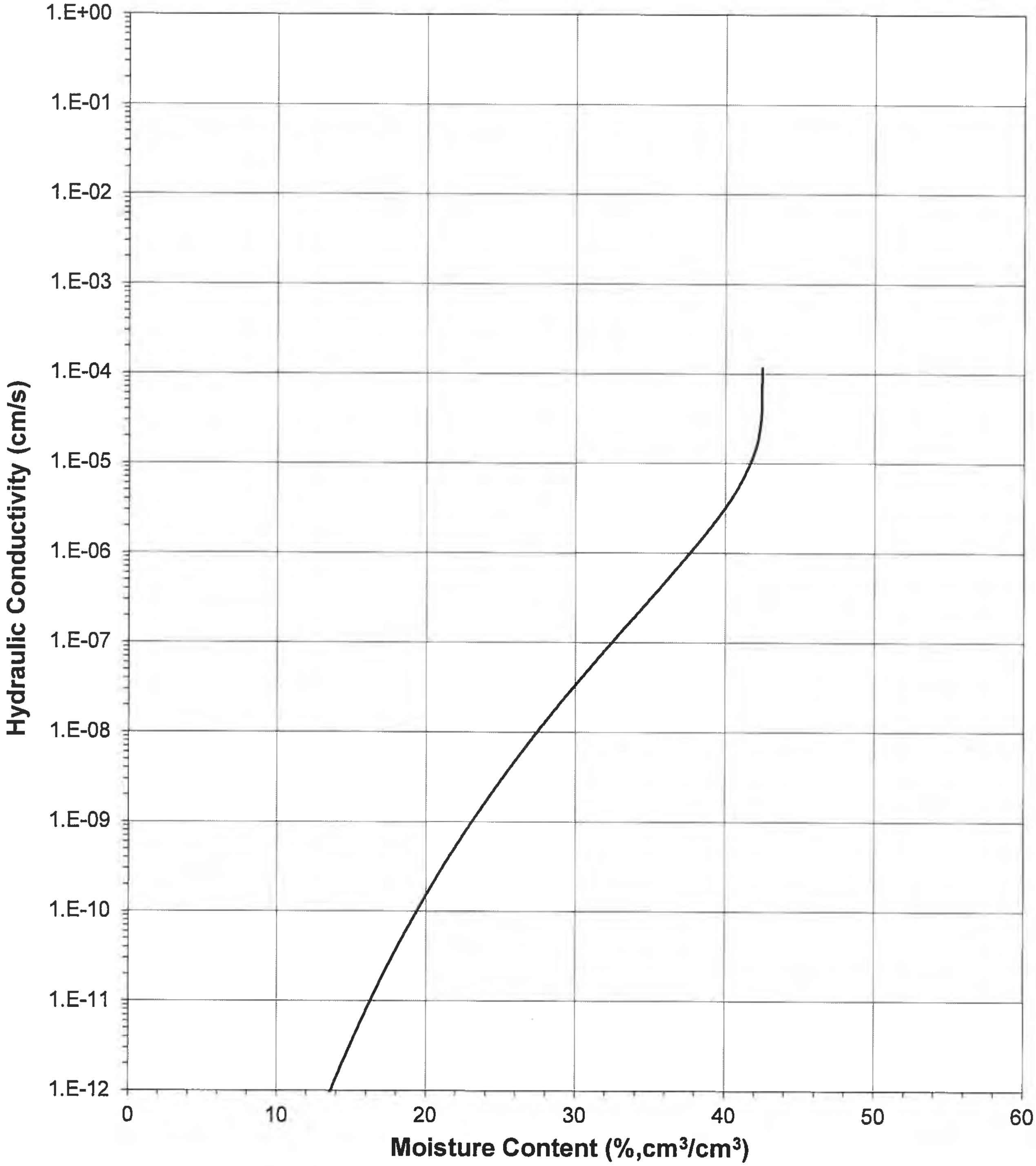
Plot of Relative Hydraulic Conductivity vs Moisture Content

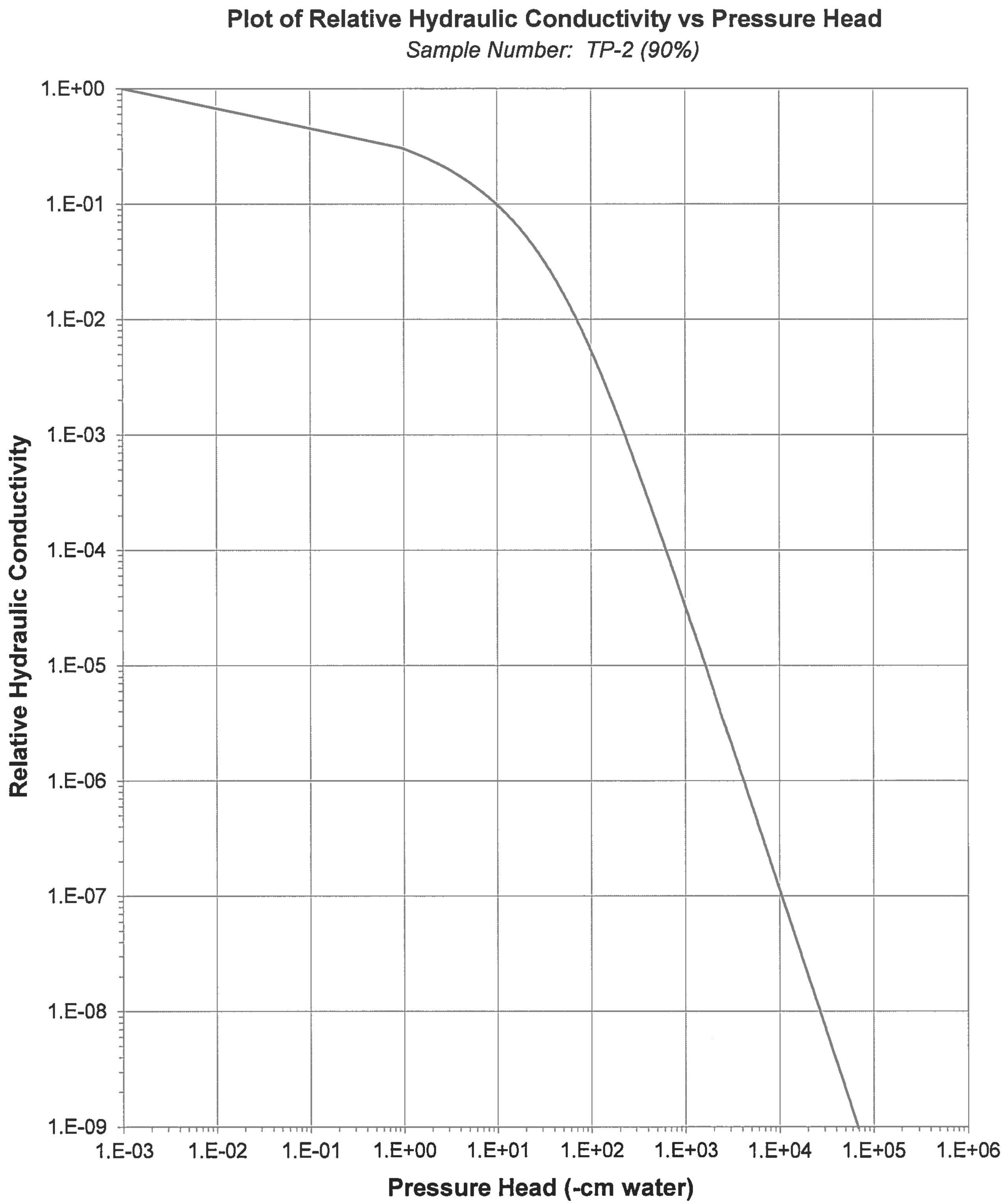
Sample Number: TP-2 (90%)



Plot of Hydraulic Conductivity vs Moisture Content

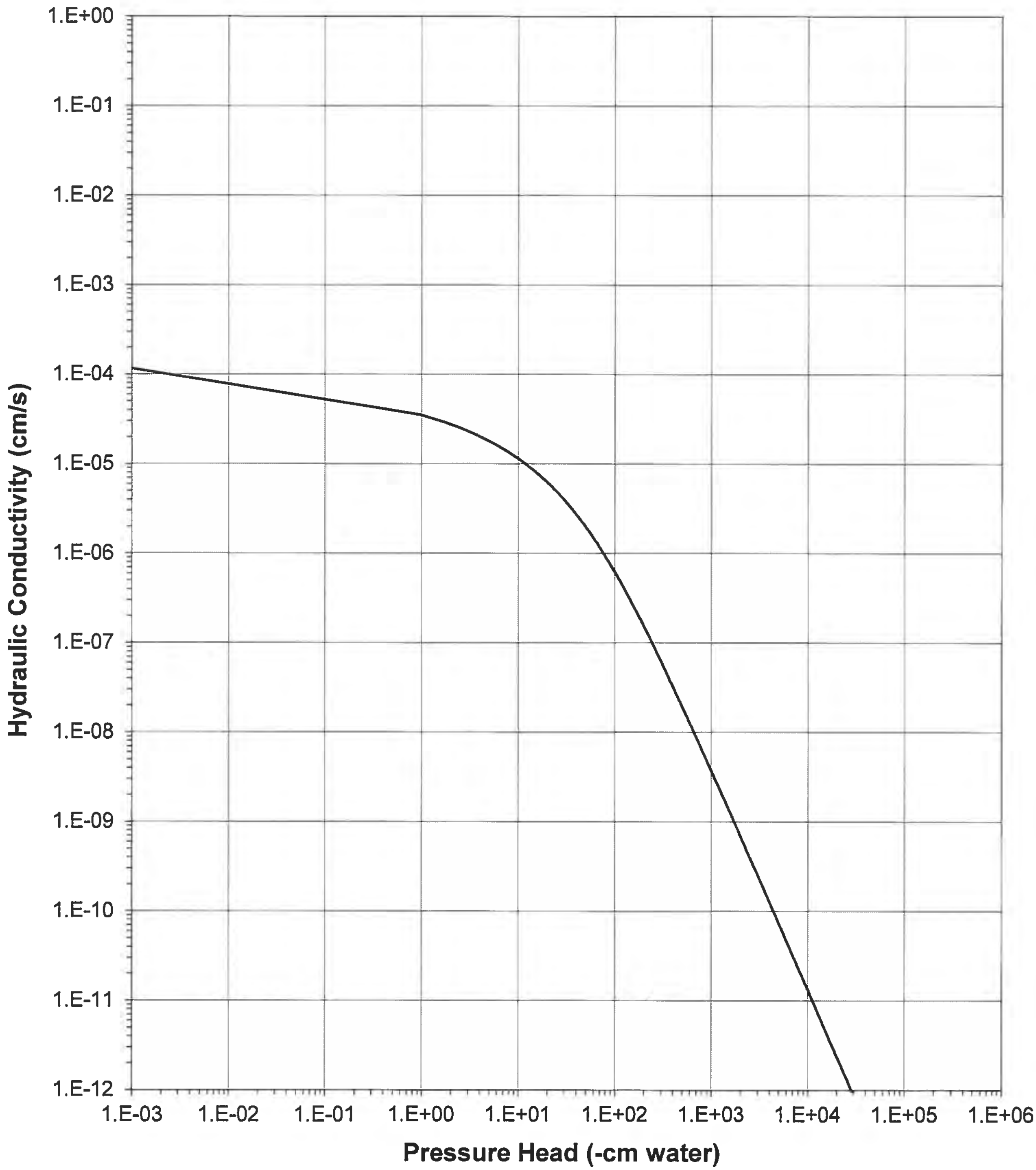
Sample Number: TP-2 (90%)




Plot of Relative Hydraulic Conductivity vs Pressure Head
Sample Number: TP-2 (90%)
Relative Hydraulic Conductivity
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
Pressure Head (-cm water)

Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP-2 (90%)



Oversize Correction Data Sheet

Job Name: Barrick Gold Corporation
Job Number: DB17.1190.00
Sample Number: TP-2 (90%)
Project Name: Cunningham Hill
Date Sampled: 7/17/17

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	10.18	89.82	100.00
Mass Fraction (%):	10.18	89.82	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.51	1.58
Calculated Porosity (% vol):	0.00	42.85	40.24
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	25.41	25.41
Total Volume (cm^3):	3.84	59.30	63.15
Volumetric Fraction (%):	6.09	93.91	100.00
Initial Moisture Content (% vol):	0.00	27.23	25.57
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.51	1.58
Calculated Porosity (% vol):	0.00	42.85	40.24
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	25.41	25.41
Total Volume (cm^3):	3.84	59.30	63.15
Volumetric Fraction (%):	6.09	93.91	100.00
Saturated Moisture Content (% vol):	0.00	42.47	39.88
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.51	1.58
Calculated Porosity (% vol):	0.00	42.85	40.24
Volume of Solids (cm^3):	3.84	33.89	37.74
Volume of Voids (cm^3):	0.00	25.41	25.41
Total Volume (cm^3):	3.84	59.30	63.15
Volumetric Fraction (%):	6.09	93.91	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	1.2E-04	1.0E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: C. Krous
Checked by: J. Hines

Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263, ASTM D2216
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity:	
Falling Head Rising Tail: (Flexible Wall)	ASTM D5084
Hanging Column Method:	ASTM D6836 (modified apparatus)
Pressure Plate Method:	ASTM D6836 (modified apparatus)
Water Potential (Dewpoint Potentiometer) Method:	ASTM D6836
Relative Humidity (Box) Method:	Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis. Part 1. American Society of Agronomy, Madison, WI; Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991

Attachment 4

Peak Discharge Calculation

Introduction

The drop inlet structure and hdpe pipe that will drain the reclaimed area will be sized to handle the peak discharge (runoff) from the 25-year, 24-hour storm. This calculation determines the peak discharge.

Assumptions

1. Site area is 5.00 acres[3]
2. Based on NRCS soil classification system the soil is Group C
3. Land use is unimproved and is defined as fallow, straight row, or bare soil with a curve number of 91

Variables/Conversion Factors

1 hr =	3600	sec
1 acre-ft =	43,560	ft^3
1 ft =	12	inches
CN=	91	

Outline of Approach

The rational method for calculating the peak runoff (applicable to watersheds less than 200 acres)[1]

$$Q_P = CiA$$ (Equation 8.11)

where

Q_p = peak discharge (acres-in/hr)

C = dimensionless runoff coefficient

i = rainfall intensity (in/hr)

A = drainage area (acres)

Intensity is determined from a depth-duration-frequency curve and the time of concentration for the watershed:

$$i = \frac{P}{t_c}$$ (Equation 4-21)

where

P = depth of rainfall for the design storm of duration tc

tc = time of concentration for the watershed

Time of concentration of the watershed can be estimated using the curve number

First, the NRCS lag equation is used to calculated the lag time for the watershed[1]:

$$t_L = \frac{l^{0.8}(1{,}000 - 9CN)^{0.7}}{1{,}900CN^{0.7}Y^{0.5}}$$ (Equation 8.3)

where

t_L = lag time of watershed (hr)

l = hydraulic length from the outlet to the most hydraulically remote point in the watershed (ft)

Y = average land slope of the watershed in percent

Time of concentration is related to lag time:

$$t_c = \frac{5}{3}t_L$$ (Equation 8.7)

Calculation

From GIS figures, the hydraulically most distant point is

l = 550 ft

The average land slope of the watershed, measured from the design grading contours, is

slope (Y) 0.015 ft/ft

Therefore,

t_L = 1.1 hr

tc = 1.8 hr

Based on the design storm for a duration similar to the time of concentration

From NOAA Atlas 14 [2], P = 1.94 inches

therefore,

i = 1.08 in/hr

For land use of "unimproved", C can vary from 0.1-0.3 (Wurbs, 2002 Table 8.2), increased by 15% for storm interval greater than 10 year

0.35 selected as conservative (will produce more runoff)

Peak Discharge Calculation

Qp =	1.85	acre-in/hr
	1.87	cfs

Consider factor of safety for pipe and channel sizing:

	1.2	factor of safety
Qp =	2.24	cfs

References

1. Wurbs, Water Resources Engineering (2002)
2. NOAA Atlas 14, Volume 1, Version 5, point precipitation frequency estimates (latitude 35.3296°, longitued -106.1511°)
3. Areas taken from ACAD

NOAA Atlas 14, Volume 1, Version 5
Location name: Cerrillos, New Mexico, USA*
Latitude: 35.3296°, Longitude: -106.1511°
Elevation: 7338.19 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.217 (0.187-0.252)	0.282 (0.242-0.328)	0.376 (0.322-0.437)	0.446 (0.381-0.518)	0.542 (0.461-0.629)	0.615 (0.521-0.712)	0.692 (0.583-0.801)	0.770 (0.646-0.891)	0.875 (0.728-1.01)	0.961 (0.794-1.12)
10-min	0.331 (0.285-0.384)	0.429 (0.368-0.499)	0.572 (0.490-0.665)	0.679 (0.580-0.788)	0.825 (0.701-0.957)	0.936 (0.793-1.08)	1.05 (0.887-1.22)	1.17 (0.983-1.36)	1.33 (1.11-1.54)	1.46 (1.21-1.70)
15-min	0.410 (0.353-0.476)	0.532 (0.456-0.618)	0.709 (0.607-0.824)	0.842 (0.718-0.977)	1.02 (0.870-1.19)	1.16 (0.984-1.34)	1.30 (1.10-1.51)	1.45 (1.22-1.68)	1.65 (1.37-1.92)	1.81 (1.50-2.11)
30-min	0.552 (0.476-0.641)	0.716 (0.615-0.832)	0.955 (0.818-1.11)	1.13 (0.967-1.32)	1.38 (1.17-1.60)	1.56 (1.32-1.81)	1.76 (1.48-2.04)	1.96 (1.64-2.26)	2.22 (1.85-2.58)	2.44 (2.02-2.84)
60-min	0.683 (0.589-0.793)	0.886 (0.761-1.03)	1.18 (1.01-1.37)	1.40 (1.20-1.63)	1.71 (1.45-1.98)	1.93 (1.64-2.24)	2.17 (1.83-2.52)	2.42 (2.03-2.80)	2.75 (2.29-3.19)	3.02 (2.50-3.51)
2-hr	0.796 (0.678-0.948)	1.02 (0.868-1.22)	1.34 (1.14-1.60)	1.60 (1.35-1.90)	1.94 (1.64-2.31)	2.22 (1.86-2.63)	2.52 (2.09-2.97)	2.82 (2.33-3.32)	3.24 (2.65-3.82)	3.58 (2.90-4.22)
3-hr	0.856 (0.735-1.01)	1.08 (0.931-1.29)	1.41 (1.21-1.67)	1.67 (1.42-1.97)	2.03 (1.72-2.40)	2.31 (1.95-2.73)	2.62 (2.19-3.08)	2.93 (2.43-3.44)	3.36 (2.76-3.95)	3.71 (3.03-4.36)
6-hr	0.984 (0.853-1.16)	1.24 (1.07-1.46)	1.58 (1.37-1.86)	1.85 (1.60-2.17)	2.22 (1.90-2.60)	2.51 (2.14-2.94)	2.82 (2.38-3.29)	3.13 (2.63-3.64)	3.54 (2.96-4.13)	3.88 (3.21-4.52)
12-hr	1.14 (0.999-1.31)	1.44 (1.26-1.65)	1.81 (1.58-2.08)	2.10 (1.83-2.42)	2.50 (2.17-2.87)	2.81 (2.44-3.22)	3.13 (2.70-3.59)	3.46 (2.96-3.97)	3.90 (3.31-4.47)	4.24 (3.58-4.87)
24-hr	1.32 (1.20-1.48)	1.66 (1.50-1.85)	2.08 (1.87-2.32)	2.41 (2.17-2.68)	2.86 (2.56-3.18)	3.21 (2.87-3.57)	3.57 (3.18-3.96)	3.94 (3.48-4.37)	4.43 (3.89-4.92)	4.82 (4.20-5.34)
2-day	1.48 (1.33-1.64)	1.85 (1.67-2.05)	2.32 (2.10-2.57)	2.69 (2.43-2.98)	3.20 (2.88-3.54)	3.59 (3.22-3.97)	4.00 (3.57-4.42)	4.42 (3.92-4.88)	4.98 (4.39-5.51)	5.42 (4.74-6.01)
3-day	1.62 (1.47-1.78)	2.02 (1.84-2.23)	2.52 (2.30-2.78)	2.92 (2.66-3.21)	3.47 (3.14-3.81)	3.88 (3.50-4.26)	4.32 (3.88-4.74)	4.76 (4.25-5.22)	5.35 (4.75-5.88)	5.81 (5.13-6.40)
4-day	1.76 (1.61-1.92)	2.20 (2.01-2.40)	2.73 (2.50-2.99)	3.16 (2.88-3.44)	3.73 (3.40-4.07)	4.18 (3.79-4.56)	4.63 (4.19-5.05)	5.10 (4.59-5.56)	5.72 (5.11-6.25)	6.21 (5.51-6.79)
7-day	2.08 (1.91-2.27)	2.60 (2.39-2.83)	3.21 (2.94-3.50)	3.69 (3.38-4.02)	4.33 (3.96-4.73)	4.83 (4.40-5.26)	5.33 (4.84-5.81)	5.83 (5.28-6.36)	6.50 (5.84-7.11)	7.02 (6.27-7.68)
10-day	2.35 (2.17-2.56)	2.94 (2.71-3.20)	3.64 (3.35-3.96)	4.19 (3.85-4.57)	4.94 (4.53-5.37)	5.51 (5.03-6.00)	6.10 (5.55-6.64)	6.69 (6.06-7.29)	7.48 (6.74-8.16)	8.09 (7.24-8.84)
20-day	3.20 (2.95-3.48)	4.00 (3.68-4.34)	4.89 (4.50-5.32)	5.58 (5.12-6.07)	6.47 (5.93-7.03)	7.13 (6.51-7.75)	7.78 (7.09-8.46)	8.42 (7.65-9.16)	9.24 (8.36-10.1)	9.85 (8.88-10.8)
30-day	3.98 (3.67-4.31)	4.96 (4.58-5.37)	6.04 (5.57-6.54)	6.85 (6.31-7.42)	7.88 (7.24-8.53)	8.63 (7.92-9.35)	9.36 (8.57-10.1)	10.1 (9.20-10.9)	11.0 (9.97-11.9)	11.6 (10.5-12.7)
45-day	4.94 (4.58-5.32)	6.15 (5.70-6.62)	7.40 (6.85-7.97)	8.32 (7.69-8.97)	9.48 (8.74-10.2)	10.3 (9.48-11.1)	11.1 (10.2-12.0)	11.9 (10.8-12.8)	12.8 (11.7-13.9)	13.5 (12.3-14.7)
60-day	5.72 (5.31-6.16)	7.13 (6.62-7.68)	8.59 (7.96-9.26)	9.63 (8.93-10.4)	10.9 (10.1-11.8)	11.9 (10.9-12.8)	12.7 (11.7-13.8)	13.6 (12.5-14.7)	14.6 (13.4-15.9)	15.4 (14.0-16.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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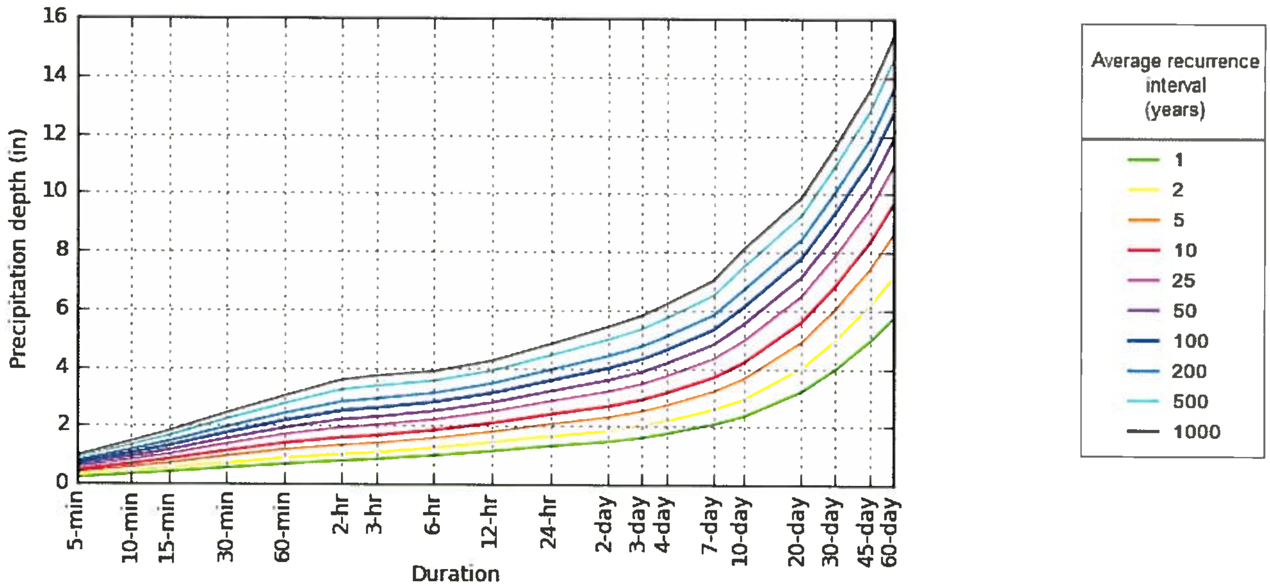
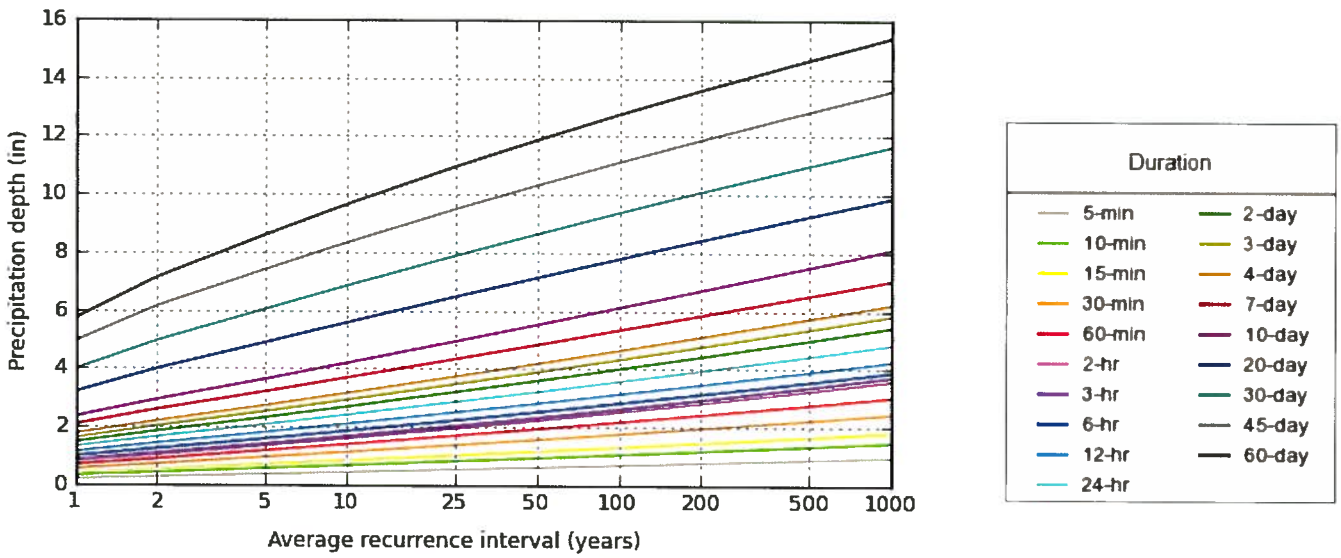
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 35.3296°, Longitude: -106.1511°





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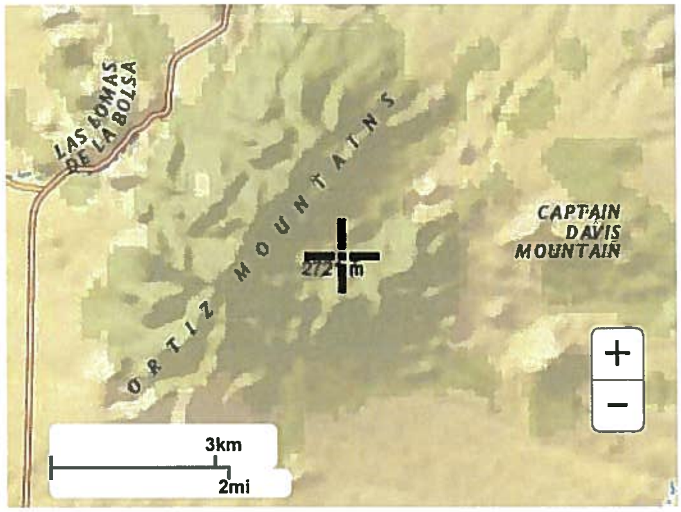
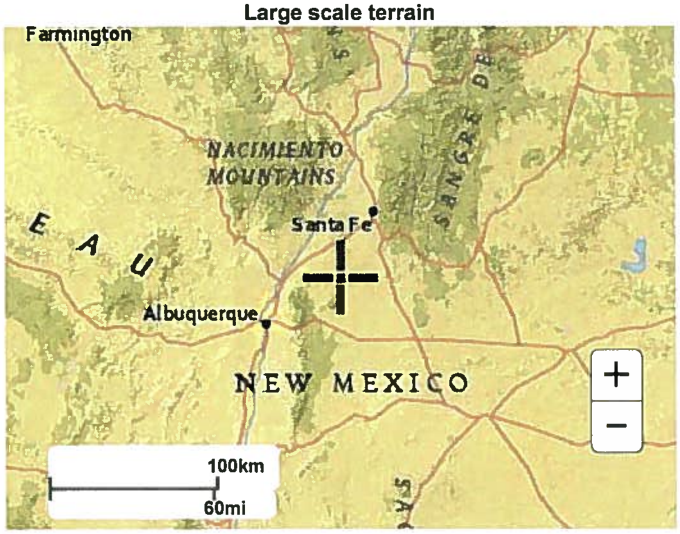
Maps & aerials

Small scale terrain



Large scale terrain



Large scale map

Large scale aerial

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Attachment 5

HYDRUS-1D Modeling Results

Appendix G.

CHMRP revegetation monitoring procedures

Revegetation Monitoring Procedures

Monitoring and eventual testing will involve sampling of ground cover and, where appropriate, woody plant density, within each revegetated unit under consideration for bond release, and in the reference area. Species diversity information will be calculated from the ground cover data. Sampling for ground cover will be accomplished utilizing the point-intercept procedure using modern instrumentation (e.g. lasers or optics) along transects of 100 intercepts each. Long belt transects or near total population enumeration will be used for woody plant density determination. Woody plants will be classified by age class and species.

If the ground cover evaluation results in a "gray area" determination (between 50 and 75 percent of the reference area's ground cover value), then this aspect of success will be determined by evaluating the stability of the soil using the RUSLE protocol, described in Section 4.4.4 below.

Sampling

The first step of the vegetation protocol will be to obtain samples of the ground cover and, where appropriate, of woody plant density, from each revegetated unit to be evaluated. [A revegetated unit consists of a defined area based on managerial criteria (e.g., areas with common revegetation procedures and initiation times, areas with a defined function such as a borrow area, or areas with other unique designations or segregation)]. Ground cover, but not woody plant density, samples also will be obtained from the reference area. Sampling will occur during the peak biomass period of the year (late summer) and sampling locations will be determined utilizing a systematic (bias-free) method with a random start.[i] This systematic procedure also provides proportionate representation from across each reclaimed unit for such characteristics as aspect.

Sample Site Location. The systematic procedure for sample location in both a revegetated unit and the reference area will occur in the following stepwise manner. First, a fixed point of reference will be selected for the area to facilitate location of the systematic grid in the field. Second, a systematic grid of appropriate dimensions will be selected to provide a reasonable number (e.g., 20) of coordinate intersections which could be used for the initial set of sample sites. Third, a scaled representation of the grid will be overlain on field maps of the target unit extending along north/south and east/west lines. Fourth, the initial placement of this grid will be implemented by selection of two random numbers (an X

[i] Systematic sampling is superior to other sample distribution procedures because it forces representation from across the reclaimed unit. It accounts better for heterogeneous expressions of multiple seedings or revegetation conditions by "forcing" a patterned distribution of samples. This method thus minimizes the risk that significant pockets will be either entirely missed or overemphasized.

and Y distance) to be used for locating the first coordinate from the fixed point of reference, thereby making the effort unbiased. Fifth, where an excess number of potential sample points (grid intersections) is indicated by overlain maps, the excess will be randomly chosen for elimination (unless it is later determined that additional samples are necessary for meeting sampling adequacy). Sixth, utilizing a handheld compass and pacing techniques, the sample points will be located in the field.

Ground Cover Determination. Ground cover at each sampling site will be determined utilizing the point-intercept methodology (Bonham 1989) as illustrated on Exhibit 1. This methodology has been utilized for range studies for over seventy (70) years and will occur as follows: First, a transect of 10 meters length will be extended from the starting point of each sample site toward the direction of the next site to be sampled. Then, at each one-meter interval along the transect, a "laser point bar" or "optical point bar" will be situated vertically above the ground surface, and a set of 10 readings recorded as to hits on vegetation (by species), litter, rock, or bare soil. Hits will be determined at each meter interval as follows. When a laser point bar is used, a battery of 10 low-energy (0.5 mW), 635 nM - λ lasers situated along the bar at 10 centimeter intervals will be activated and the variable intercepted by each of the narrow (0.020") focused beams will be recorded (see Exhibit 1). If an optical point bar is used, intercepts will be recorded based on the item intercepted by fine crosshairs situated within each of 10 optical scopes located at 10 centimeter intervals. In either situation, a total of 100 intercepts per transect will be recorded resulting in 1 percent cover per intercept. This methodology and instrumentation facilitates the collection of the most

Woody Plant Density Determination. Woody plant density will be determined in one of two manners depending upon a visual evaluation of the variability of the expressed population by an experienced field ecologist. If the population of woody plants appears to be sufficiently homogenous across the revegetated unit, density will be determined through a systematic sampling protocol utilizing large quadrats or belts. If the population appears to be too heterogeneous, enumeration of the entire population, or nearly the entire population, may be the only reliable means available to determine density of woody plants. (Newly establishing woody plant communities are often so inherently variable that no sampling protocols presently known to the scientific community could be practically or cost-effectively used to obtain a viable estimate of the population's parameters.)

If it is determined that belt sampling can be used, belts will be sized to absorb as much of the "between sample" variability as possible, and then fixed at this size for the duration of the sampling effort. Typical belt dimensions might be 2 meters X 50 meters, however, it is possible that 4 meter X 100 meter belts could be utilized. Then all woody plants rooted within each belt would be recorded by species and age class. Seedlings (one year old plants) will not be counted toward the total as this age class has extraordinarily high mortality rates.

If near-total population enumeration is deemed most appropriate then the following protocol would be initiated. First, the various stands of woody plants within a revegetated unit would be delineated and their respective acreages determined. Then beginning with the largest stands and working down to the smallest, each will be subjected to total count procedures until a large percent of the area (e.g., 90%) has been counted. This procedure maximizes use of personnel and resources, and the vast majority of the population will be entirely enumerated with the worst possible error equivalent to the uncounted portion of the population (e.g., 10%). If total enumeration were impractical, an alternative procedure would involve randomly selecting stands to be counted until a large proportion of the acreage (e.g., 50%) has been selected. Then the value obtained can be extrapolated with confidence to the entire population.

Counting procedures would occur as follows. Once a stand of woody plants is delineated, it would be subdivided into long manageable strips using hip chain thread or similar means and observers would progress slowly across each strip, shoulder to shoulder, recording each plant by species and age class. Use of hand-held "tally meters" facilitate uninterrupted viewing of the subject area and appropriate communication among the observers will preclude gaps in the field of coverage or duplication of effort (overlapping fields of view).

Sampling Adequacy. Data collection will continue within each discrete sampling unit (revegetated unit or reference area) for each variable until a statistically adequate sample has been obtained. Adequacy of sampling will be achieved when, for each discrete unit, the number of samples actually collected (n) provides a level of precision within 10% of the true mean with 90% confidence (n_{min}), i.e., when $n_{min} \leq n$. Then n_{min} is calculated as follows:

$$\mathbf{n_{min} = (\mathit{t}^2 \mathit{s}^2) / (0.1\bar{\mathit{x}})^2}$$

where:

n = the number of actual samples collected with a minimum of 10 in each unit;

t = the value from the *t* distribution for 90% confidence with n-1 degrees of freedom;

s^2 = the variance of the estimate as calculated from the initial samples;

$\bar{x}$ = the mean of the estimate as calculated from the initial samples.

As indicated above, this formula provides an estimate of the sample mean to within 10% of the true population mean (μ) with 90% confidence. Calculations of the mean and variance will be based on "total vegetation ground cover" exclusive of litter or, in the case of woody plant density, "total live plants" (two years old or older). Furthermore, a minimum sample size of ten (10) samples will be collected from each discrete revegetated unit or the reference area. If the initial ten samples do not provide an adequate estimate of the mean (e.g., the inequality above is false), additional samples will be collected until the inequality is satisfied. However, in no case will more than 40 ground cover transects or woody plant density samples be collected in any given sampling unit.

Ground Cover Comparison Standard

After adequate sampling, the comparison process will be initiated by calculating the mean ground cover value for non-annual plants only (non-annual ground cover, or "NAGC") for each revegetated unit and the reference area. The test for revegetation success for ground cover will include the following steps.

Step 1: The first step is to determine whether the mean NAGC of the revegetated unit(s) exceeds 75 percent of the mean NAGC for the reference area. If $\overline{x}_{(rv)} \geq 0.75\ (\overline{x}_{(co)})$, then the ground cover test has been passed and the soils are assumed to be stable.

Step 2: If the mean NAGC of the revegetated unit equals or exceeds 50% (but is less than 75%) of the mean NAGC for the reference area, then a "gray area" determination will be conducted to evaluate soil stability. The evaluation of soil stability using the RUSLE model is detailed in subsection 4.4.4 below.

Species Diversity Standard

Revegetated units that pass the ground cover standard will also be evaluated for composition (species diversity).[ii] Prior to testing, the number of important species must be determined for the revegetated unit and for the reference area. An important species is one that is not an annual species or noxious weed (as defined by the county extension service) and that contributes at least 1% absolute ground cover (or 2% relative cover)[iii] to the area. Passing this test will satisfy the species diversity standard.

Under this test the number of important species for the revegetated unit must equal or exceed 50% of the number of important species identified from the reference area. If so, then the composition (diversity) standard has been passed which then indicates successful composition (diversity) for an early to mid-seral community. The specific species identified as important from each of the two areas do not need to be identical.

[ii] For these tests, no statistical confidence level formulas will be used.

[iii] "Relative cover" for a species refers to the percentage of total vegetation ground cover in an area that is attributable to this individual species.

Woody Plant Density Standard

The woody plant density standard will be met if either the sample mean (using an adequate sample, described above) or the population mean (if the majority of the population is counted rather than sampled) exceeds 220 plants per acre. If the revegetated unit's value is greater than 180 but less than 220 plants per acre, the Companies may consult with MMD to determine if the actual density is adequate to support the intended post-mining land use. If MMD determines the density is adequate for this purpose, the test is passed.

Soil Stability Protocol for "Gray Area" Evaluations

For those revegetated units with NAGCs between 50% and 75% of the reference area NAGC, a "gray area" evaluation protocol will be used to determine whether the potential for soil erosion is sufficiently low, and for surface stability sufficiently high, to conclude that stability has been achieved, and therefore, vegetation ground cover is adequate. The protocol to be used is the Revised Universal Soil Loss Equation (RUSLE), which employs site-specific climatic, edaphic, topographic, and vegetation data. The standard will be met if the soil loss value determined by RUSLE for the revegetated unit is less than the "T" value appropriate to the site.

The RUSLE equation (model) is the best available for predicting potential soil loss at Cunningham Hill.

Efforts to predict soil erosion from croplands mathematically were initiated approximately 50 years ago. A variety of factors were considered in attempting to develop prediction equations. All of these earlier equations were essentially State or regional in nature and were applicable only under limited climatic/edaphic conditions. These equations were considered useful, however, and an effort was initiated to develop an equation which would be applicable nationally under a variety of site conditions. Work on this was begun in the mid-1950's by the Agricultural Research Service. From this work the Universal Soil Loss Equation (USLE) was developed and refined during the 1960's and 1970's. Continued refinements were made to the equation and the associated parameters based on site-specific research and general use by the public. Additional data was continually gathered in an effort to update the equation and make it more useful (Renard et al. 1992).

Based on this additional data and refinement, the RUSLE equation was developed. Though still influenced by basic agronomic values in some instances, and using the same overall parameters as the USLE, the RUSLE equation is considered to be a significant step forward in more accurately predicting the potential for erosion under a variety of conditions. Where the original USLE arrived at a potential soil erosion value through simple multiplication of selected parameter values, the RUSLE employs a computer-based model which involves sub-routines for various parameters to ultimately predict potential soil erosion. Revisions and improvements in assessing values for the parameters which are used in RUSLE have also been made which render the model more useful. Once believed applicable only to agronomic situations, RUSLE is now considered to be applicable to construction sites as well. The term "construction sites" also includes mine sites if appropriate care is taken in applying this erosion prediction model (Renard et al. 1992).

Though a reasonably advanced tool, it should be noted that there are limits with respect to the applicability of the model. This model predicts erosion potential as a result of sheet and rill erosion. Gully erosion is not a part of the predicative capability of RUSLE. Where gullying may occur, the bearing that this type of erosion would have on soil stability must be judged independently. RUSLE also does not, in and of itself, predict potential sedimentation. Soil loss is predicted, but not the eventual fate of the eroded material. RUSLE is a predictive model and must be used as such in the comparative sense against values which exhibit the same level of potential accuracy. This is the intent of the application of this model as a part of the overall revegetation success protocol discussed in this document.

The RUSLE model is based on six parameters utilized to estimate or quantify the factors which affect the potential for soil erosion. The RUSLE model is as follows (Renard et al. 1992):

$$\mathbf{A}\ \text{(soil loss in tons/acre/year)} \quad = \quad \mathbf{R \bullet K \bullet L \bullet S \bullet C \bullet P.}$$

"**R**" represents the rainfall-runoff erosivity factor. The effects that climate, in terms of amount of incident precipitation, storm intensity, etc. have on erosion are accounted for by this factor. Values for this factor are taken directly from soil surveys and related documents developed for and within the State of New Mexico by the Natural Resource Conservation Service (NRCS) (formerly Soil Conservation Service).

The "**K**", or soil erodibility, factor is related to the integrated effect of rainfall, runoff, and infiltration on soil loss. It is typically considered to be the soil loss rate/unit for a specified soil as measured on a standard plot experimentally. K-factors to be used for this protocol may be taken from a standard nomograph developed for this purpose (NRCS 1992) since the surface growth medium may not directly correspond to any recognized soil series. The factors to be considered in developing the appropriate K-factor are texture, percent organic matter, soil structure, and permeability. Alternately, average values for K-factors for growth medium textures occurring in the area to be evaluated may be used if considered appropriate, especially given that topsoil was obtained from borrow areas in the vicinity.

Slope length (**L**) and gradient (**S**) will be combined into one factor using charts developed for this purpose. Data have shown that this method offers the best means of integrating the effects of these two factors into the equation. Slope length accounts for the effect topography has on erosion potential. Lengths will be measured in the field to supply the correct data for the L-factor and compound slopes will be defined if existing. A maximum length of 400 feet will typically be assumed since surface runoff usually concentrates within this distance. Slope lengths up to 1,000 feet, however, are possible. Slope steepness, or gradient, is a representation of the percent slope and will also typically be determined in the field to supply the most relevant data. Slope percents may be taken from post-reclamation contour maps if the maps accurately represent site conditions.

The cover-management factor (**C**) reflects the effect of vegetation and related management practices on erosion rates. This factor will be based largely on site-specific data collected from, or which is estimated to be relevant to, each area for which revegetation success is being evaluated. The type of vegetation currently existing on site, estimated soil roughness, measured soil surface percent cover (vegetation, coarse fragments, litter, other non-erodible material) and height, measured plant canopy cover, and estimated above- and below-ground plant biomass factors will all be used to develop the C-factor using a computer program sub-routine run. This factor may be the most influential factor in determining potential erosion from a site.

The "**P**", or support practice, factor takes into account the effects of mechanical practices applied to the surface of the growth medium to increase infiltration, reduce runoff, and decrease erosion. Such practices include ripping, pitting, and contour furrowing and result in a parameter value of less than 1.0. A value of 1.0 may be appropriate where no support practices have been employed on the reclaimed area. The effects that basic tillage or fertility practices have on erosion potential are included in the cover management factor of the equation.

Following data collection and parameter development, the RUSLE model will be implemented for each area requiring an evaluation. A potential "soil" erosion value “A” in tons/acre/year of growth medium loss will be estimated by the model. This value will be compared to an acceptable soil loss tolerance value (T) which would be taken from the National Soils Handbook (NRCS 1993) for the type of surface materials for the area being evaluated. The value will be assigned based on the limiting properties of the subsurface growth medium and/or geologic layers present beneath the reclaimed units. Criteria for assigning a "T" value include the physical and chemical characteristics of subsurface layers and the properties of soil moisture and temperature as influenced by climate. This process accounts for the weatherability and suitability as a growth medium of the subsurface materials (i.e. rate of genesis of suitable sub-soils). Acceptable soil loss tolerances typically range from 1 to 5 tons/acre/year depending upon subsoil and growth medium characteristics. The local office of the NRCS or a certified soil scientist will be consulted to help calculate and agree upon the "T" values for the types of reclaimed sites to be evaluated.

In lay terms, the “T” value approximates the rate of soil genesis. If the potential loss of growth medium as predicted by the model (“A”) is less than or equal to the "T" value, the area will be considered stable and the test passed. If the potential loss is greater than the "T" value, the area will not be considered sufficiently stable and the area will fail the success test.

Contingency Plan and Conditions for Final Bond Release

If at any time during or after Monitoring Year 5 for a revegetated unit, monitoring indicates significant potential for failure to meet any of the foregoing revegetation performance standards, the Companies will document such findings in a report to MMD within 60 days of problem identification. The report will describe the area of concern, the perceived problem, and the probable causes. Within 45 days of submission of the report, the Companies will submit a corrective action plan, with an implementation schedule, to MMD for review and approval. Following MMD approval, the corrective action plan will be implemented by the Companies.

If a revegetated unit fails to meet a performance standard following Year 11 monitoring after the Companies' substantial compliance with Sections 4.1, 4.2, and 4.3 of this Plan, and after the application of any appropriate corrective action procedures, the Companies may request a revision of the performance standard for any revegetated unit(s) on the grounds that either:

(a) a revised performance standard is appropriate under 19 NMAC 10.2 Subpart 5, § 507.A (the permit area will be reclaimed to a condition that allows for re-establishment of a self-sustaining ecosystem appropriate for the life zone of the surrounding areas); or

(b) the Companies qualify for a waiver under 19 NMAC 10.2 Subpart 5, § 506.C (the unit will meet all applicable federal and state laws, regulations and standards for air, surface water and ground water protection and will not pose a current or future hazard to public health or safety); or

(c) the Companies qualify for a variance under 19 NMAC Subpart 10 (the standard imposes undue economic burden, and the variance will not result in a significant threat to human health, safety, or the environment).

Once all applicable revegetation performance standards have been met for a revegetated unit, and all other permit-related reclamation requirements for that unit have been satisfied, then conditions for final bond release and release from future responsibility will also be met and sureties covering that respective unit will be released.

References

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Appendix H.

Pit Waiver justification report (JSAI, 2021)

CUNNINGHAM HILL MINE
OPEN PIT WAIVER JUSTIFICATION, PERMIT NO. SF002RE, SANTA FE COUNTY, NEW MEXICO

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October 8, 2021

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ILLUSTRATIONS

ABBREVIATIONS

ac-ft	acre feet
ac-ft/yr	acre feet per year
ARD	acid rock drainage
AWS	acid wall seepage
CHMRP	Cunningham Hill Mine Reclamation Project
CCP	Closure/Closeout Plan
ft amsl	feet above mean sea level
gpm	gallons per minute
JSAI	John Shomaker & Associates, Inc.
LAC	LAC Minerals (USA), LLC
MMD	Mining and Minerals Division
NF	nanofiltration
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NMWQCC	New Mexico Water Quality Control Commission
PMLU	Post Mining Land Use
RO	reverse osmosis
SSE	self-sustaining ecosystem
TDS	total dissolved solids

CUNNINGHAM HILL MINE
OPEN PIT WAIVER JUSTIFICATION,
PERMIT NO. SF002RE,
SANTA FE COUNTY, NEW MEXICO

1.0 INTRODUCTION

This report was prepared for the Mining and Minerals Division (MMD) to provide technical and economic infeasibility and environmental unsoundness arguments in support of a request for a waiver from a self-sustaining ecosystem (SSE) for the LAC Minerals (USA), LLC (LAC) Cunningham Hill Mine Reclamation Project (CHMRP) reclaimed Open Pit (Fig. 1). This pit wavier justification report is based upon the requirements of the New Mexico Mining Act, New Mexico Statutes Annotated (NMSA) 1978, §69-36-1, et seq. (1993, as amended through 2001), particularly 19.10.5.507 of the New Mexico Administrative Code (NMAC). This report also addresses specific waiver-related comments in MMD's April 21, 2021, letter on CHMRP Updated Closure/Closeout Plan (CCP), Permit No. SF002RE (JSAI, 2020a).

1.1 CCP Background

In the original 1996 Closure-Closeout Plan (Westec, 1996), it was expected that the pit would recover to the pre-mining groundwater level condition of 6,900 feet above mean sea level (ft amsl), and that the addition of surface water from Upper Cunningham Gulch would cause the Open Pit to completely fill to the spill elevation of 6,990 ft amsl. The filling of the Open Pit with water would mitigate water-quality issues and reclaim pit benches and walls by submergence.

In 2002, Alternative Abatement Plan AP-27 was issued by the New Mexico Environment Department (NMED) which included alternative abatement standards for groundwater outside of the pit area, performance standards for pit filling by diverted stormwater, and a contingency plan. In addition, the NMED required reverse osmosis (RO) treatment of the Open Pit pool. In 2001, the CCP was updated (revision 96-1) to include reclamation plan specified in AP-27.

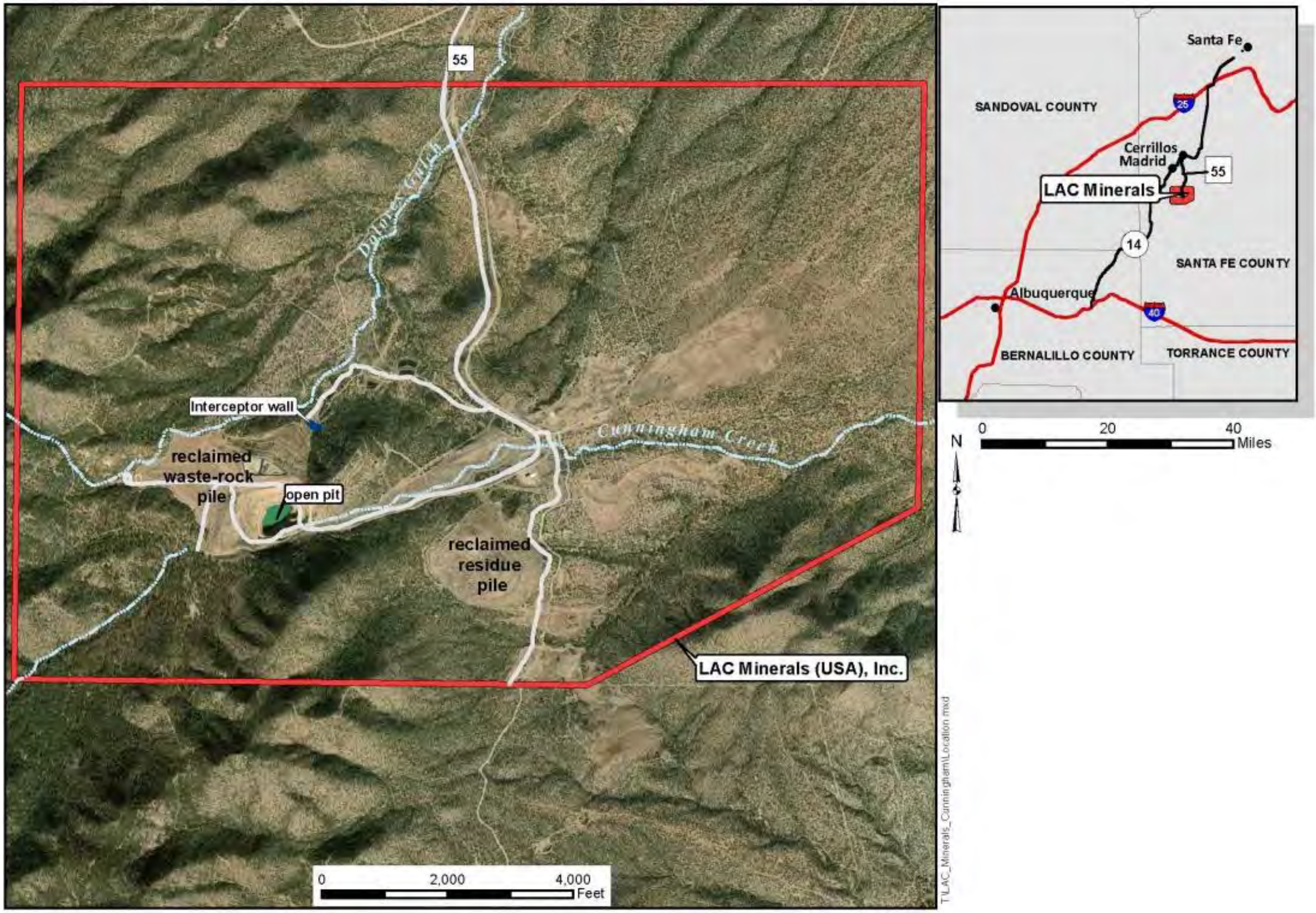


Figure 1. Aerial photograph of Cunningham Hill Mine Reclamation Project showing locations of LAC property boundary, Open Pit, and other reclaimed facilities.

Due to lingering drought conditions and the dewatering and geochemical effects of the required RO treatment in 2002, the Open Pit was not filling to the proposed schedule, RO treatment had stripped the Open Pit pool of alkalinity needed for buffering capacity, and water-quality triggers for sulfate and total dissolved solids (TDS) were enacted by 2009. A pilot program was implemented to determine if neutralization of in-pit generated acid wall seepage (AWS) could be remediated with alkaline water sources from the Residue Pile recovery system (JSAI, 2010). It was recommended by JSAI (2010) to perform acid rock drainage (ARD) source control measures, and replace the use of hydrated line for ARD mitigation with on-site alkaline water sources such as from Residue Pile recovery system and the Guest House Well.

JSAI (2011a) prepared a revised Open Pit waterbody reclamation plan for AP-27 to address source controls and Open Pit pool treatment to meet AP-27 water-quality standards. Implementation of source controls occurred between 2012 and 2018, and included: 1) repairs to the Upper Cunningham Gulch diversion, 2) stormwater controls in and around the Open Pit, and 3) resurfacing access roads and some bench areas with caliche. The revised AP-27 remediation plan does not rely on filling of the Open Pit with stormwater to meet water-quality standards; instead, the revised plan relies on source controls to minimize AWS. The revised AP-27 reclamation plan was approved by NMED (2012), and implemented as follows:

2012 – Evaluate and design stormwater runoff source controls

2014 – Obtain New Mexico Office of the State Engineer water right permit for the use of on-site alkaline water sources to add to Open Pit and build buffering capacity

2015 – Perform pilot program to evaluate addition of alkaline water sources

2016 – Repairs to Upper Cunningham Gulch Channel

2017 – Add caliche to all roads within the pit watershed and to selected benches

2018 – Performance monitoring of source controls

2019 – Design and install nanofiltration (NF) treatment system

2021 – Begin NF treatment

MMD letter dated September 26, 2019 stated "The current and original CCP for Cunningham Hill was submitted on March 1, 1996 and approved by the MMD in Permit Revision 96-1 to Permit No. SF002RE on December 13, 2002. The 1996 CCP describes a reclamation plan that is no longer accurate regarding the reclamation of the Open Pit, and will be changed significantly to meet the requirements of the New Mexico Mining Act, NMSA 1978, §69-36-1, et seq. (1993, as amended through 1999). The status of the Open Pit and the need to change the reclamation plan of the Open Pit in the 1996 CCP…"

The CCP was updated by JSAI (2020a), which included the Open Pit as achieving a self-sustaining ecosystem by completion of the AP-27 updated reclamation plan and additional reclamation measures of accessible disturbed areas by addition of caliche, growth medium, mulch, and seeding. On April 21, 2021, the MMD provided a letter to LAC regarding technical comments on application for revision 20-1 Closure/Closeout Plan Update, Cunningham Hill Mine, Permit No. SF002RE. The MMD does not consider the Open Pit a self-sustaining ecosystem as defined in 19.10.1.7 NMAC, and recommended modifying the application to request a pit waiver as described in 19.10.5.507.B NMAC.

1.2 Regulatory Requirements

The regulatory requirements for a pit waiver are defined in 19.10.5.507 NMAC Performance and Reclamation Standards and Requirements:

> **B. Waiver for Pits and Waste Units** An operator may apply for a waiver for open pits or waste units from the requirement of achieving a post-mining land use or self-sustaining ecosystem. The operator must show that achieving a post-mining land use or self-sustaining ecosystem is not technically or economically feasible or is environmentally unsound. The Director may grant the waiver for an open pit or waste unit if he finds:
>
> **(1)** measures will be taken to ensure that the open pit or waste unit will meet all applicable federal and state laws, regulations and standards for air, surface water and ground water protection following closure; and
>
> **(2)** the open pit or waste unit will not pose a current or future hazard to public health or safety. [7-12-94, 2-15-96; 19.10.5.507 NMAC Rn, 19 NMAC 10.2.5.507, 05-15-2001]

1.3 Objective

The objective of this report is to show that achieving a self-sustaining ecosystem (SSE) for the Open Pit is not technically or economically feasible, or is environmentally unsound as defined in 19.10.5.507.B NMAC. LAC is not requesting a change to the Post Mining Land Use (PMLU). The CHMRP Open Pit PMLU of wildlife habitat and livestock watering will be maintained by meeting applicable Open Pit water-quality standards established by the New Mexico Water Quality Control Commission (NMWQCC) and requirements defined in 19.10.5.507.B(2) NMAC.

The MMD, the New Mexico Mining Act, NMSA 1978, §69-36-1, et seq. (1993, as amended through 1999), has specific requirements for a SSE that cannot be met for an open pit that is not fully reclaimed by filling, backfilling, or reclamation of all pit walls and benches. The objective of this waiver justification is to demonstrate that it is technically infeasible to achieve SSE status for the CHMRP Open Pit.

2.0 CHMRP OPEN PIT BACKGROUND

The CHMRP site is owned by LAC Minerals (USA) LLC, and the property boundary is defined by the red line on Figure 1. The Open Pit is within the CHMRP site boundary (Fig. 1).

2.1 Open Pit History

The CHMRP Open Pit was created during the Goldfields' mining operation that occurred between 1979 and 1987. The pit had been mined to a total depth of 536 ft, and consisted of 34.13 acres of disturbed area. The mined waste rock was deposited in Dolores Gulch which is now the reclaimed Waste Rock Pile, and the processed ore was deposited and formed the Residue Pile, which is also reclaimed.

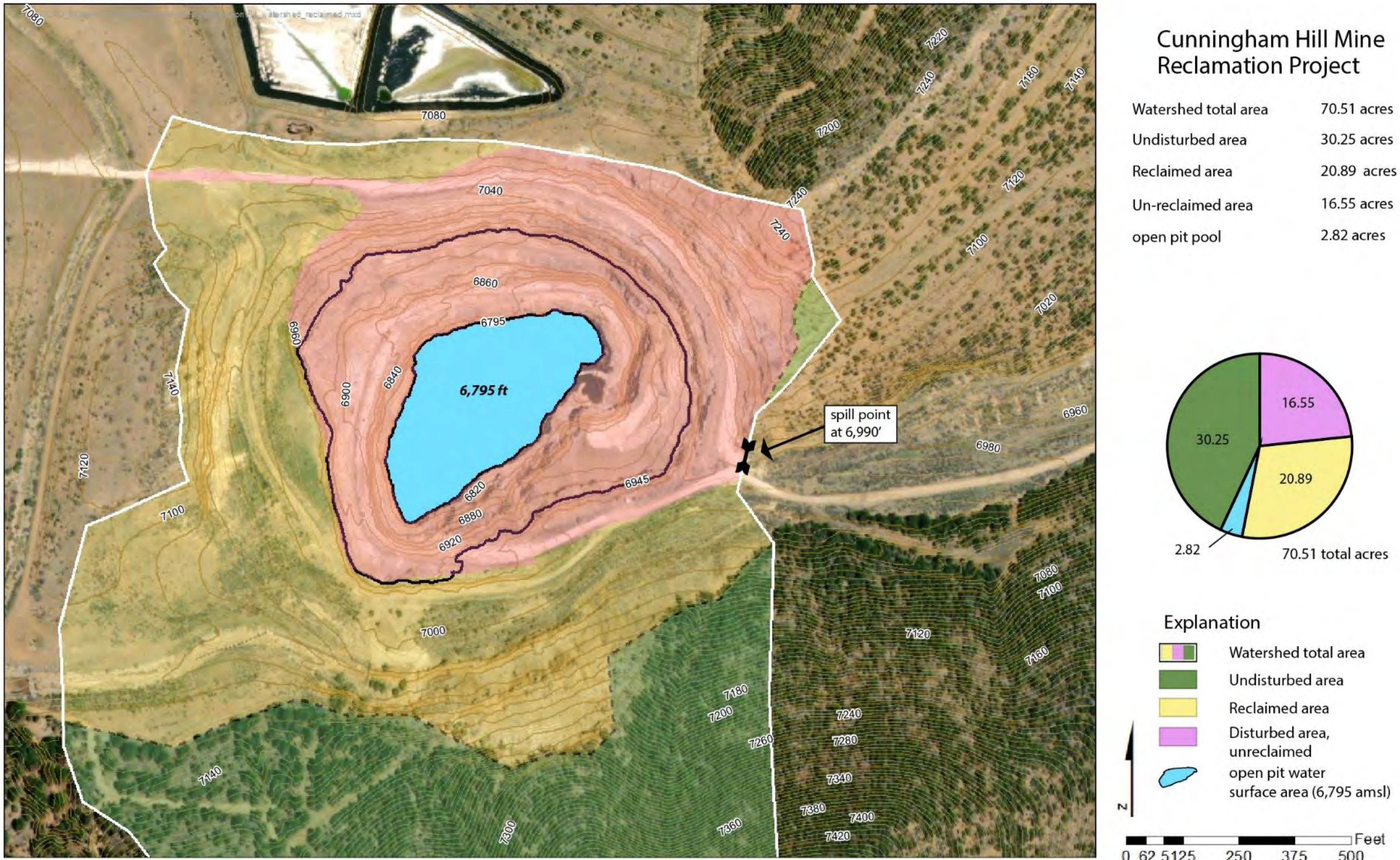
After mining ceased in 1987, the Open Pit began to fill with groundwater and stormwater runoff generated from within the Open Pit watershed. In the 1990s, about 21 acres of the uppermost portions of the accessible areas of the Open Pit were reclaimed (Fig. 2) (also see JSAI, 2020a). The Open Pit pool is currently at an elevation of 6,800 ft amsl, and accumulated sediment has partially filled in about 35 ft of the pit bottom to where the maximum pool depth is currently about 100 ft.

2.2 Original Conceptual Closeout Design

The conceptual closeout design is described in the CCP (JSAI, 2020a), and AP-27 (NMED, 2002). Most of the remaining disturbed area, such as the pit walls and benches, would be reclaimed by filling with stormwater from Upper Cunningham Gulch (Adrian Brown Consultants, Inc., 1996) to the 6,945 ft amsl elevation (Fig. 2). It was predicted that pit filling would take approximately 35 years, provided that Upper Cunningham Gulch would generate an average of 101 acre-feet per year (ac-ft/yr) of stormwater. The filling of the Open Pit with stormwater was critical to reclamation of disturbed area and to improving water quality of the Open Pit. Environmental permits, water right permits, and infrastructure were in place for diversion of Upper Cunningham Gulch stormwater to the Open Pit by 2001. It was estimated that Open Pit filling would be completed by year 2036.

2.3 Relevant Studies

Since the issue of AP-27 in 2001, there have been a number of studies conducted by LAC to evaluate the feasibility of implementing the Open Pit reclamation and remediation specified in the CCP and AP-27.



Aerial photo April 27, 2020

Figure 2. Aerial photograph of Open Pit showing undisturbed, disturbed, and reclaimed areas, Cunningham Hill Mine Reclamation Project.

2.3.1 Open Pit Pool Filling

A calibrated groundwater flow model was developed for AP-27 (JSAI, 1999), in which the model was updated in 2001 (JSAI, 2001) to evaluate the effects of NMED-required Open Pit RO treatment, in 2011 (JSAI, 2011) when AP-27 Triggers 1 and 2 were enacted, and in 2020 (JSAI, 2020) as part of the CCP update.

Since about 2010, the Open Pit pool has been in pseudo-equilibrium with the surrounding water table where it may seasonally act as a sink, discharge to groundwater, or neither (JSAI, 2014). The addition of stormwater to the Open Pit would primarily increase storage with some lost to evaporation as the pool area increases in size and lost to groundwater outflow. Model-simulated groundwater outflow has ranged between 4 to 8 gallons per minute (gpm). Figure 3 is a graph showing the observed and model-simulated Open Pit water levels. Observed water levels have closely followed the "no diversion" simulation.

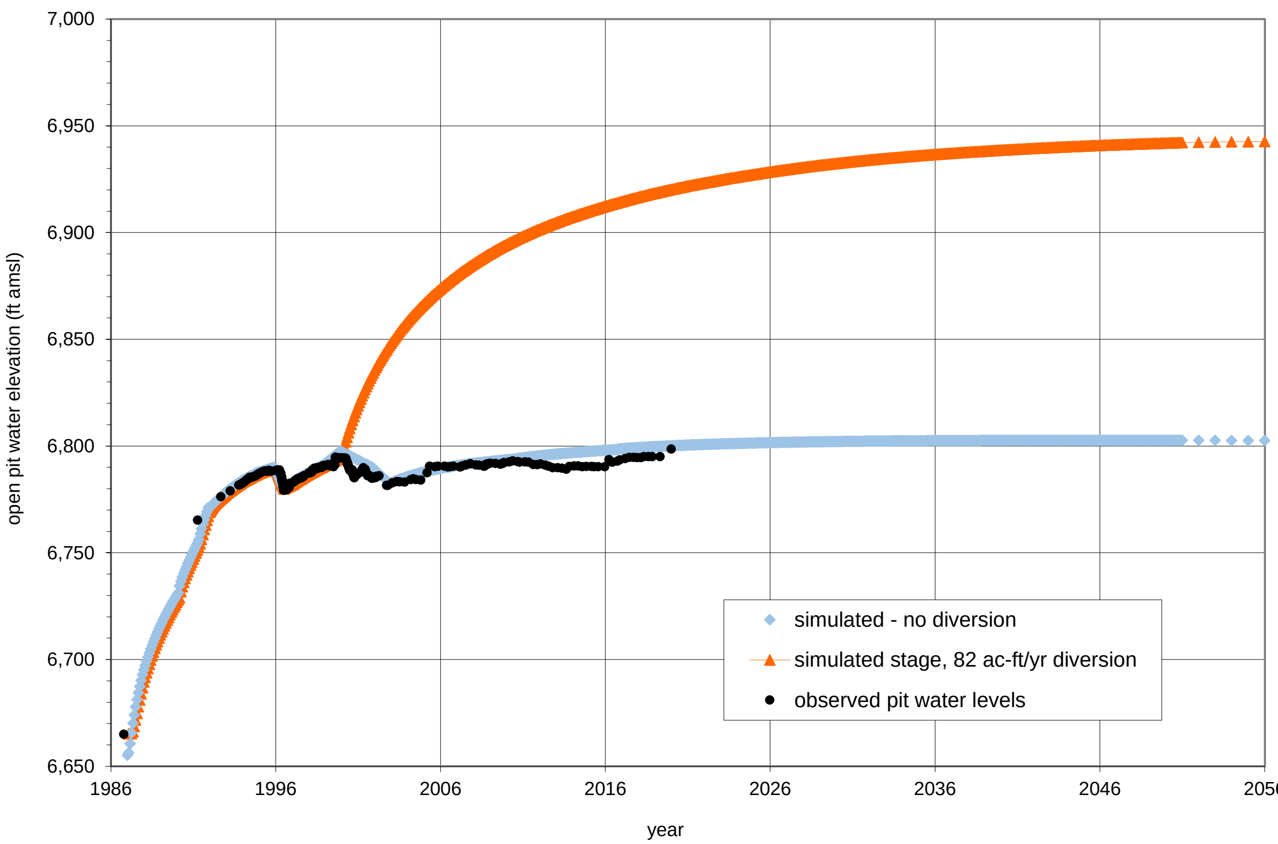


Figure 3. Graphs showing observed Open Pit water levels and model-simulated Open Pit water levels (with and without stormwater diversion).

Considering there no losses to evaporation or groundwater outflow, approximately 890 acre-ft of water is needed to fill the Open Pit from 6,800 to 6,945 ft amsl. The Upper Cunningham Gulch watershed is not able to produce the needed runoff for pit filing under the current watershed and climate conditions (JSAI, 2010; 2011). The ongoing drought conditions and increase in vegetation are primary issues limiting runoff from Upper Cunningham Gulch and resulted in an overly conservative model projection of the ability to fill the pit with water. The effects of these conditions on runoff were extensively examined by JSAI (2011; 2020), and it was concluded that the Open Pit would fill to about 6,810 ft amsl elevation rather than the originally modeled 6,945 ft amsl elevation.

There are no alternate water sources that can be used to fill the Open Pit. The only identified groundwater sources on-site, not connected to the Open Pit, include Residue Pile plume recovery wells and the Guest House Well (JSAI, 2010; JSAI, 2014). The recovery wells yield approximately 4 gpm or less, and the maximum capacity of the Guest House Well is about 15 gpm. At a minimum, a groundwater source capable of continuously yielding more than 100 gpm for 10 years is needed to fill the Open Pit. In the last 45 years of investigation, no such groundwater source disconnected from the Open Pit has been identified in the area.

2.3.2 Open Pit Pool Water Quality

Extensive water-quality modeling of the Open Pit pool was initially performed by Adrian Brown Consultants, Inc. (1996), and solute-transport modeling of Open Pit pool discharges to groundwater was modeled by JSAI (1999; 2001). Additional Open Pit pool water-quality evaluations were performed by JSAI (2010; 2011a). It has always been recognized that AWS discharges have suppressed Open Pit pool pH and contributed to elevated dissolved solids (particularly sulfate, TDS, and metals). Past geochemical modeling (Adrian Brown Consultants, Inc., 1996; JSAI, 2001; JSAI 2010) has considered the impact of AWS on the Open Pit pool chemistry. The buffering capacity of the Open Pit pool and the rate and volume of introduced AWS have been the primary factors controlling Open Pit pool chemistry. Maintaining pH control in the Open Pit pool is required for meeting water-quality standards.

Because the Open Pit was expected to fill with stormwater, interim AWS source controls were not considered as part of the original CCP and AP-27 plans. From 1997 to 2010, pH mitigation was performed by addition of hydrated lime (JSAI, 2011a). The Open Pit sulfate concentrations increased from 2003 to 2007, which initiated AP-27 Performance Standard APS-1

Trigger No. 1. A pilot remediation program was implemented to mitigate AWS effects on the Open Pit pool chemistry, and a detailed water-quality evaluation was performed (JSAI, 2010). It was concluded that source controls needed to be implemented before water-quality mitigation efforts can be effective and Open Pit pool chemistry could be predicted with confidence. Figure 4 is a time-series graph of Open Pit pool pH with notation regarding measures implemented for pH mitigation.

From 2015 to current, extensive AWS source-control measures were implemented as part of the revised AP-27 reclamation plan (JSAI, 2011a; 2014; 2020) (see Section 1.1). It was identified that the primary cause of AWS was the infiltration of stormwater from Upper Cunningham Gulch through the lined channel into waste rock, which recharged the Golden Fault fracture system to the pit walls on the west side (JSAI, 2011). AWS has not been observed since the Upper Cunningham Gulch diversion channel was properly repaired, in Open Pit watershed stormwater controls constructed, and covering selected benches and roads with caliche. With AWS source controls successfully implemented, treatment of the Open Pit pool with NF has begun in 2021. NF treatment is to primarily remove calcium and sulfate while preserving the Open Pit pool alkalinity. In addition, alkaline groundwater source from the Residue Pile plume recovery system and the Guest House well are added to the Open Pit to maintain chemical alkaline balance and to replace volume losses from the NF treatment process. It is anticipated that after completion of NF treatment, the open pit water chemistry will be maintained with maintenance of Open Pit source controls.

2.4 Reclamation Efforts

As shown on Figure 2, approximately 21 acres around the Open Pit perimeter have been reclaimed by regrading, addition of cover soil, and re-vegetation. With an approved pit waiver, the 16.55 acres of Open Pit walls and benches will remain un-reclaimed. Open Pit access roads have been improved with stormwater controls and covered with caliche. The Open Pit pool will likely stay around the current size of about 2.8 acres. The repaired Upper Cunningham Gulch channel will remain in place to allow clean stormwater to flow to the Open Pit pool.

JSAI (2011a) prepared a revised AP-27 reclamation plan that was based on pilot studies and Open Pit pool investigations between 2009 and 2011. The plan primarily included AWS source controls and water treatment (see Section 1.1).

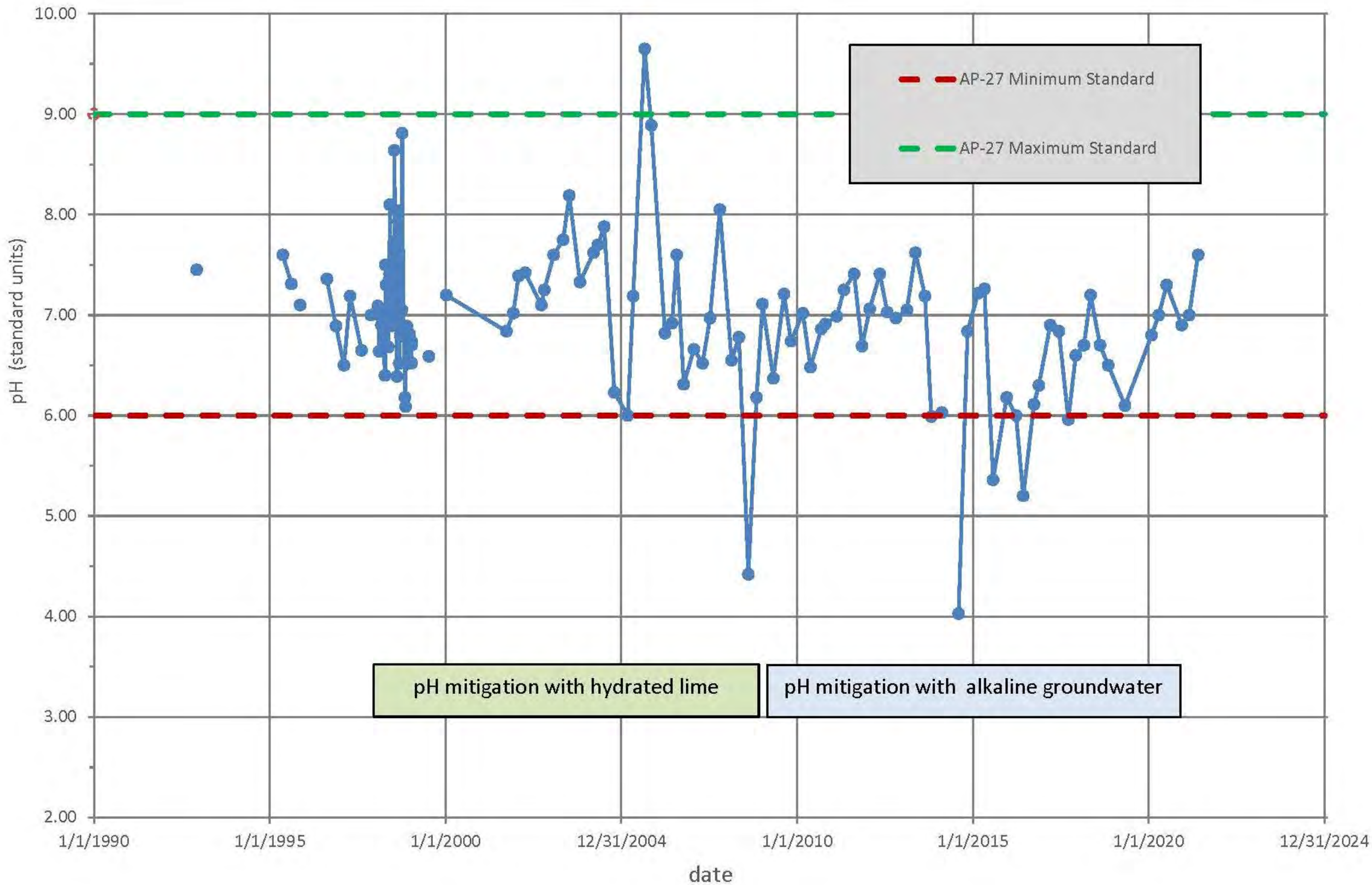


Figure 4. Time-series graph of Open Pit pool lab pH (4 ft depth) and pH mitigation measures.

Ongoing reclamation efforts related to the CHMRP Open Pit revised plan (JSAI, 2011) primarily include water treatment with NF. The NMED approved the water-treatment system workplan in 2018, and the system was constructed between 2019 and 2020. Water treatment began during the summer of 2021, with 1,582,560 gallons (4.9 ac-ft) treated as of August 2021. It was proposed to operate the treatment system seasonally, and the anticipated treatment goal of achieving AP-27 water quality criteria would be achieved in about 4 years (Jacobs, 2018).

An 8-ft chain-link fence will be installed around the Open Pit to restrict access to wildlife and humans (see updated CCP). No other reclamation activities are currently planned, except monitoring the performance of and maintaining source controls and post-treatment Open Pit pool water quality.

3.0 OPEN PIT WAIVER JUSTIFICATION ARGUMENTS

The CHMRP Open Pit waiver justification for SSE requirements is based on a combination of economic and technical infeasibility, and environmental unsoundness considerations.

The MMD (1998) published guidelines for SSE and how it is used in the context of the New Mexico Mining Act Rules. The MMD definition of SSE is as follows:

> **"Self-sustaining ecosystem"** means reclaimed land that is self-renewing without augmented seeding, amendments, or other assistance which is capable of supporting communities of living organisms and their environment. A self-sustaining ecosystem includes hydrologic and nutrient cycles functioning at levels of productivity sufficient to support biological diversity

The most important MMD factor for evaluating SSE is "any post-mine land use that will involve continued maintenance and input by man will not be considered self-sustaining ecosystems." In other words, perpetual care for achieving post-mining land use and maintenance of source controls is not self-sustaining.

3.1 Likelihood of Pit Filling with Stormwater

Revised stormwater runoff scenarios were evaluated by JSAI (2011; 2020), and none of the scenarios generated enough stormwater to fill the Open Pit to the 6,945 ft amsl elevation as anticipated in the original CCP. Significant changes to watershed conditions and above-normal precipitation for a prolonged time are required to fill the Open Pit. It is technically infeasible to rely on prolong periods of above-normal precipitation to achieve reclamation goals with set schedules.

LAC has invested in a watershed management program that involves selective thinning (JSAI, 2020a); however, LAC property only includes a portion of the Upper Cunningham Gulch watershed. With partial ownership of the watershed, it is technically not feasible to fully implement management programs for increasing watershed yield. Furthermore, re-occurring watershed management practices for maintaining yield to the Open Pit may not be considered as self-sustaining.

3.2 Feasibility of Backfilling

Backfilling the Open Pit to the 6,945 ft elevation would require at least 2,000,000 yd^3 of material. The only available material on-site is the material that was mined from the Open Pit mine and placed in the Waste Rock Pile. Excavating the Waste Rock Pile for Open Pit backfill material would create over 100 acres of disturbed land that would require reclamation; however, the Waste Rock pile material is not suitable for Open Pit backfill due to the sulfide content and acid generating characteristics as demonstrated by the acid rock drainage (ARD) generated from the toe of the Waste Rock Pile when infiltration of meteoric water has occurred in the past (see DP-55 annual reports). A backfilled Open Pit would behave as a flow through system, where recharge to the backfill material would generate ARD and discharge to groundwater which is environmentally unsound. Backfilling the Open Pit with waste rock is environmental unsound, and would likely cause groundwater quality degradation.

There are no other available sources for backfilling the Open Pit other than imported material. The closest known source for imported backfill is 43 miles away located near Moriarty, New Mexico. This is the same source used for covering access roads with caliche. Theoretically, the quarry can produce 2,000,000 cubic yards of material (personal communication with EnviroWorks, LLC). Presented in Table 1 is an estimate to import fill material from the Moriarty quarry, which is purely based on the cost of material, trucking, and placement; no other costs are included.

The time to backfill by importing material is estimate to take 15.4 years, which is based on trucking 500 yd^3/day for 5 days/week. The cost analysis demonstrates that backfill with imported material is economically infeasible. The trucking route would suffer significant damage, and communities along the trucking route, such as Madrid, would be significantly impacted. For the reasons stated above, importing material for Open Pit backfill would be economically and technically infeasible.

Table 1. Estimated cost to backfill CHMRP Open Pit

item	unit	unit cost	quantity	cost
backfill material cost	yd^3	$40.00	2,000,000	$80,000,000
load/haul/place/reveg	yd^3	$42.50	2,000,000	$85,000,000
dust suppression/road maintenance	month	$68,369	185	$12,648,265
construction management/support	month	$33,770	185	$6,247,450
indirect items (engineering, contingency, insurance, contractor profit, contract admin)	lump sum	$44,736,479	1	$44,736,479
			TOTAL	$228,632,194

Calculation tool Parshley et al., 2012

4.0 ENVIRONMENTAL CONTROL MEASURES

CHMRP Open Pit environmental control measures are specified in Alternative Abatement Plan AP-27 (NMED, 2002). AP-27 measures and future revisions of AP-27 measures will ensure that the Open Pit will meet all applicable federal and state laws, regulations and standards for air, surface water and ground water protection following closure.

4.1 Surface Water

The current Open Pit pool water chemistry meets applicable surface water standards (as defined by NMED, 2021). With implemented Open Pit source controls (2012 to 2019) the concentration of dissolved metals are expected to be maintained at concentrations less than applicable surface water standards.

4.1.1 Chemical Treatment Methods

Surface water standards will also be maintained by implementing pH control as defined in the revised AP-27 remediation plan (JSAI, 2011). Open Pit pool chemical treatment methods include pH mitigation with alkaline groundwater sources and nanofiltration treatment. NMED issued permits DP-55 and AP-27 allow for the use of on-site alkaline groundwater sources from the Guest House well and Residue Pile Recovery wells for Open Pit pool pH mitigation.

4.2 Groundwater

The NMED approved membrane filtration treatment system work plan has been implemented, and the Open Pit pool is currently being treated to remove sulfate and TDS for compliance with AP-27 groundwater discharge standards. NF treatment is currently in progress, and is primarily for mitigating Open Pit pool sulfate and TDS concentrations so AP-27 standards for groundwater discharge are maintained. NF treatment is expected to be completed by 2024, at which time it is expected that pit-lake water quality will be sustained by the continued maintenance of source controls that ae currently in place.

5.0 ACCESS CONTROLS

LAC owns the property containing the Open Pit, which allows for implementation of controls to ensure the Open Pit will not pose a current or future hazard to public health or safety.

5.1 Human Health and Safety

Human health and safety concerns regarding the Open Pit are primarily controlled by limited access to authorized personnel. The entrance to the LAC property is secured with a locking access gate and perimeter fencing with signs. The Open Pit access road is maintained to prevent hazards related to access for permit compliance.

5.2 Wildlife and Stock

Measures to protect wildlife include those in AP-27 to maintain surface water quality standards and specific requires in the CCP, such as fencing. No other access controls are anticipated to protect wildlife. Currently, LAC does not graze livestock, and will likely not graze livestock in the future, unless it is determined to be beneficial for watershed health.

6.0 REQUEST FOR WAIVER

As described in Section 3.0, the following alternatives were considered for reclamation of the Open Pit:

A. Reclamation by revegetating the Open Pit slopes (as discussed in the updated CCP)
B. Reclamation by filling with stormwater from Upper Cunningham Gulch
C. Reclamation by filling with high yield supply wells
D. Reclamation by backfilling the Open Pit

It is not technically feasible to completely reclaim the Open Pit. However, it is technically feasible to reclaim portions of the Open Pit so:

1. the recontoured and vegetated perimeter areas achieve the SSE requirements, and
2. that water quality standards for PMLU are maintained for the Open Pit pool.

Therefore, LAC is requesting an SSE waiver for a portion of the Open Pit. The following has been reclaimed in an effort to comply with applicable state laws, regulations, and standards:

- The pit perimeter has been recontoured with successfully established growth medium
- AWS source controls have been implemented
- The upper Cunningham Gulch stormwater water conveyance has been repaired and made functional
- Stormwater controls have been implemented, such as collection on the northside, and properly established in pit drainage controls
- All access roads and some bench areas have been covered with caliche
- pH mitigation plan has been implemented so the Open Pit pool pH is maintained

For the various reasons discussed in Section 3.0, LAC is requesting an SSE waiver for the un-reclaimed Open Pit walls and benches, which consist of 16.55 acres.

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