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A Freeport-McMoRan Company

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May 31, 2012

Mr. Eric Scott
Environmental Protection Specialist
Division of Reclamation, Mining and Safety
Department of Natural Resources
1313 Sherman St. Room 215
Denver, Colorado 80203

RE: Climax Mine, Permit No. M-1977-493, Technical Revision 22 – OSF Design Report and O&M Plan and Modification to Ceresco Ridge Haul Road Alignment

Dear Mr. Scott,

Attached please find Technical Revision (TR) 22 to the Climax Mine Reclamation Permit (M-77-493) that describes the design, stability, and operations and monitoring for the North 40 and McNulty Overburden Storage Facilities (OSFs). TR-22 is intended to satisfy DRMS regulatory requirements with regards to DRMS Rule 6. 5 and Rule 7.3, and provides additional information on the OSFs as discussed in the March 1, 2011 letter from Climax to DRMS responding to the November 10, 2010 AM-06 adequacy determination letter as well as the December 15, 2011 Climax response to the September 9, 2011 DRMS adequacy review letter for TR-18. The designs and monitoring plan for the OSFs will be incorporated into the Environmental Protection Plan (EPP) by DRMS approval of TR-22 and by reference in the EPP.

Also included in TR-22 is a description of the realignment of the Ceresco Ridge haul road from that originally shown in AM-06. The realignment results in waste rock material only being placed within the open pit and in the lowermost portion of the haul road, above 5 Shaft and within the Storke wastewater collection area.

Technical Revision 22 consists of the following documents enclosed with this letter:

- North 40 and McNulty Overburden Storage Facility Design Report (including Operation and Monitoring Plan)
- Ceresco Ridge Haul Road Realignment Narrative and Figures

Specific DRMS comments in the November 10, 2010 DRMS adequacy determination letter for AM-06 addressed by TR-22 are as follows:

<u>Exhibit U/Section (6) Comment</u>: Designated Chemical(s) and Material(s) Handling - Please state how the overburden material handling to be employed during operations will minimize the generation and impact of acid drainage as well as the volume of water requiring treatment during and after mining (material segregation, liners, capping, etc). How will acid drainage from the waste rock dumps be minimized, managed and collected (leachate capture system)?

Response: TR-22 includes operational and post mining plans for water management to minimize ARD formation and to collect and convey impacted water for treatment. Water management techniques include separation of impacted from non-impacted water, runon and runoff control berms and channels, and underdrains and toe seepage collection systems. Conceptual designs for these controls are included in the TR and, when completed, construction will be certified as required by Rule 7.3.2.

Exhibit U/Section (16) Comment: Describe QA/QC program and measures to be employed during construction of EPFs - What QA/QC processes are in place to ensure that the TSF dams and OSF are constructed and maintained according to specifications? See also stability monitoring comment for Rule 6.5(4).

Response: The OSF O&M plan in TR-22 includes a description of the QA/QC program that includes construction observation, inspection of materials for use in construction, survey control and field measurements, and appropriate field testing during construction to ensure that work is conducted and completed in accordance with the project-specific design and technical specifications.

Rule 6.5 Comment 2: What is the monitoring/documentation program that has been implemented to monitor for stability issues that may occur in the OSF and TSF dams during construction, operation and maintenance (phreatic surface monitoring, permanent inclinometers, etc)? This monitoring/documentation protocol should be clearly specified, and will be included as an enforceable condition of the permit when approved.

Response: The OSF stability monitoring program and examples of field inspection forms are included in the OSF O&M plan.

Rule 6.5 Comment 3: The introduction of the Geotechnical Stability Exhibit submitted with AM-06 states that the information submitted is a preliminary overview, and that the design at this time is not considered final. Obviously the long-term stability of the OSF and TSF features is a primary concern of the Division. While the preliminary evaluations appear in order, DRMS does not review/approve "preliminary designs" and will therefore require final design specification evaluation and approval before the site resumes mining and additional material is placed in the existing TSF or OSF facilities. Please consolidate and provide the CPT and laboratory data protocols and reporting referenced and used in the preliminary design modeling. Also, when submitting the final design specifications and evaluations, complete dynamic loading analysis for the TSF features will be required. These final design specifications and stability evaluations may be subject to third party review as outlined in Rule 7.4.3.

Response: The OSF Facility Design Report in TR-22 includes a stability analysis and final engineering designs.

Specific DRMS comments in the September 9, 2011 DRMS adequacy determination letter for TR-18 addressed by TR-20 are as follows:

T-4 Acid Forming Materials and Acid Mine Drainage

Although the Division's primary concern with the Overburden Storage Facility (OSFs) must be for the long term safety and stability of these features, the Division is also adamant that every reasonable measure be taken to minimize the impacts from, and the quantity of, ARD generated by the OSFs both while in operation and after final closure. Climax will need to commit to submitting, and receiving DRMS approval, of the OSF Operations and Monitoring Plan before these facilities are further enlarged. The OSF plan and the annual report should include at least annual stability monitoring/certification by a qualified engineer as well as the design and QA/QC plans for any structures, such as under-drains, associated with these features. DRMS may also require the use of "temporary" low permeability covers over areas of exposed waste rock if placement sequencing does not allow for final concurrent reclamation of dump areas as the mining progresses.

Response: The OSF design report and O&M plan in TR-22 addresses QA/QC for OSF and water control construction and stability monitoring. Climax can provide a summary of the stability monitoring results in future annual reclamation reports. As indicated in the original AM-06 response to this comment, low permeability covers for OSFs are not practical. Instead, the OSF designs focus on water management controls as Environmental Protection Facilities (EPFs) to minimize the formation of ARD. Water controls serving as EPFs will be certified in accordance with Rule 7.3.2 following construction.

Climax also has reviewed the OSF reclamation cost with the addition of the post-mining water control features. Although many of the water controls will be constructed during operations, a portion of the perimeter channels/berms and all of the reclaimed OSF surface diversion features will be constructed after mining ceases. Due to the potential for changes to the OSF footprint over time, detailed designs for these post-mining features will be developed as the OSFs are constructed and as-built information can be used. At this time, best engineering judgment suggests that the cost of post-mining water management controls may be in the range of $3,000,000 to over $4,000,000.

Climax believes there is sufficient financial assurance for this cost already in place as a result of changes to the post-closure East Side Channel and East Side Pipeline (ESP) described in our TR-21 comment-response letter to you of May 24, 2012. In short, Climax reevaluated the need for the converted East Side Channel and ESP upgradient of Robinson Pond and McNulty Gulch in light of the OSF water management design. The changes to the East Side Channel and ESP described in our May 24 letter represents a reclamation cost reduction of approximately $3,500,000 that can be used for financial assurance to cover other reclamation costs not specifically identified in AM-06, Exhibit L. Climax also has evaluated the conversion and utilization of the TDL to replace the ESP along the east side of Tenmile and Mayflower TSFs. This change represents an additional $2,500,000 cost reduction for ESP construction. These changes to the East Side Channel and ESP result in a total reduction of approximately $6,000,000 in closure cost that can be applied to other reclamation, including the OSFs.

Attached are two hard copies and an electronic copy (OSF report only) of the TR-22 documents and the $1,006.00 fee applicable to a 112d operation. Thank you for your review and consideration of TR-22. Please feel free to contact me at 719-486-7584 if you need any additional information.

Sincerely,

Raymond Lazuk
Environmental Manager

attachments

Ceresco Ridge Haul Road Realignment
Submitted with OSF Design and O&M Plan as Technical Revision 22

Description

The Ceresco Ridge Haul Road will be used to access ore along Ceresco Ridge during Phase 2 mining activities. The originally planned hauling route was along the southern perimeter of the Open Pit. The haul road was identified in AM-06 and included a large fill area southeast of the Open Pit (Figure AM-06-C-02) within the Arkansas River watershed. This large fill area also is identified in the Climax Environmental Protection Plan as a potential source of impacted water to the Arkansas River watershed, and a collection system was proposed to intercept potentially impacted runoff from this area and route it to treatment.

Climax has since re-evaluated the Ceresco Ridge haul route in light of environmental and geotechnical concerns and has developed a new alignment for the haul road that includes an in-pit route for hauling waste material to the North 40 and McNulty OSF areas. This has resulted in elimination of the large fill area southeast of the Open Pit. A small portion of the haul road along the southwestern pit perimeter will still be used to transport ore to the crusher, and some fill will be needed for road widening. However, all of the fill placed within the Arkansas River watershed will be within the capture radius of the existing Storke Wastewater collection system.

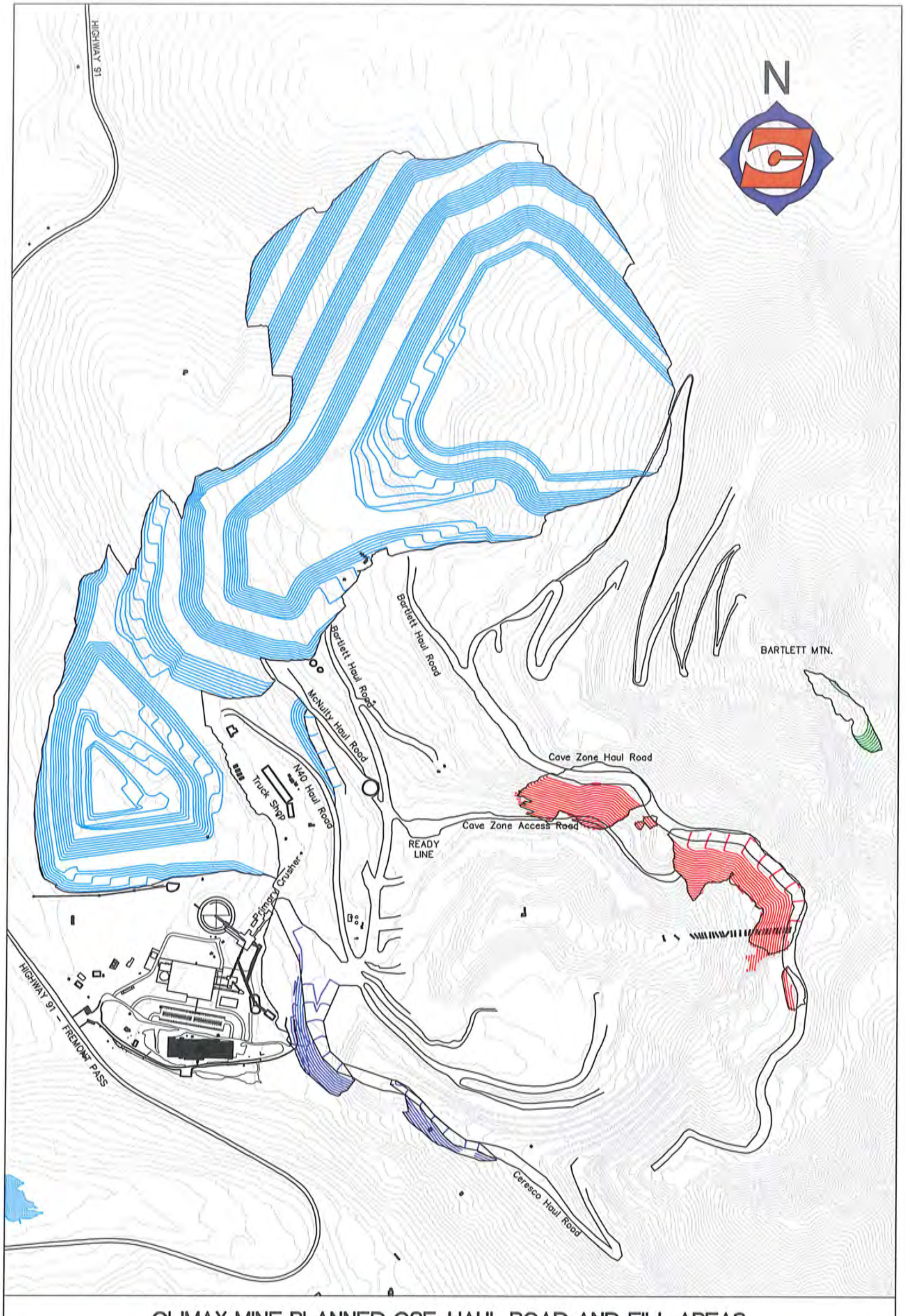
The attached figure shows the new Ceresco Ridge Haul Road alignment and fill placement both inside and outside of the open pit perimeter. Also shown is a small satellite dumping area within the Cave Zone at the top of Bartlett Mountain where waste rock will be placed as a result of preparing the top of Bartlett Mounting for Phase 3 mining activity.

Water Management

All drainage from the Ceresco Ridge Haul Road will be captured by existing Environmental Protection Facilities. Runoff along the haul road will be contained by berms and ditches. Runoff from the in-pit, OSF-route portion of the haul road will be directed to the pit bottom, where it will be collected with other storm water within the pit perimeter by the underground workings and pumped to treatment from 5 Shaft. Runoff from the crusher-route portion of the haul road will be directed to the Camp Area drainage system for subsequent treatment.

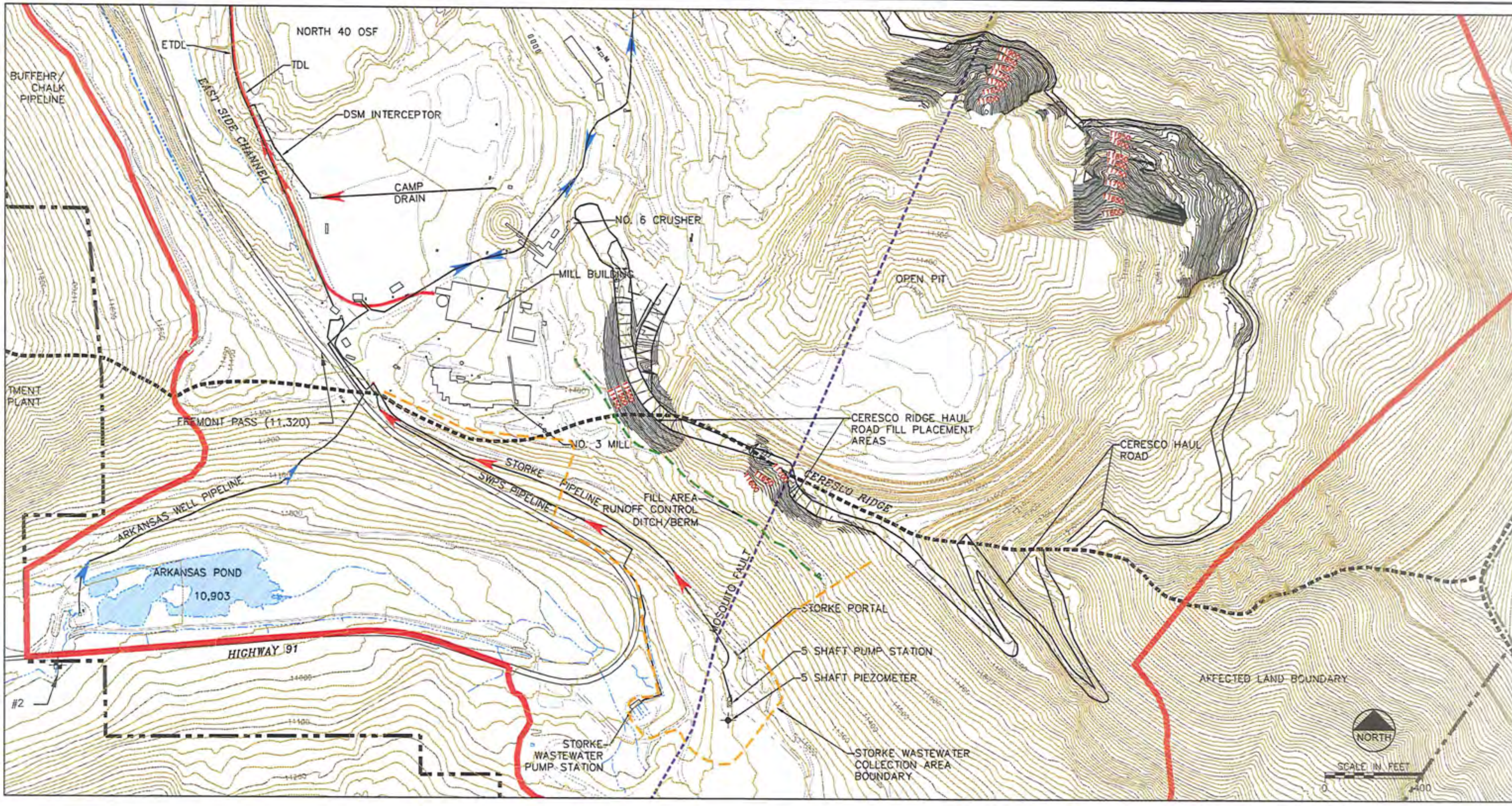
The area of new fill along the crusher-route portion of the haul road occurs within the Storke Wastewater collection system. This is shown on the attached water management figure. To minimize the extent of overland flow from these fill areas, Climax will construct a storm water diversion ditch and/or berm near the toe of the fill areas to route runoff towards the Camp Area drainage system. The approximate location of the ditch/berm is shown on the attached figure.

The Bartlett fill area will be contained entirely within a portion of the Cave Zone, a depression within the Open Pit that was created by underground mining. All drainage from this area will remain within the hydrologic capture area of the pit and underground workings.



CLIMAX MINE PLANNED OSF, HAUL ROAD AND FILL AREAS

	McNULTY AND NORTH 40 OSF		CAVE ZONE HAUL ROAD FILL	Climax Molybdenum	By: JD–DsW
	CERESCO HAUL ROAD FILL		UPPER BARTLETT DUMP	A Freeport-McMoRan Company	DATE: 5/07/12



AFFECTED LAND BOUNDARY
PROCESS/STORMWATER BOUNDARY
PROPERTY BOUNDARY
11200 EXISTING CONTOUR – MAJOR (100 FT INTERVALS)
EXISTING CONTOUR – MINOR (20 FT INTERVALS)
11750 FILL AREA CONTOUR – MAJOR (50 FT INTERVALS)
FILL AREA CONTOUR – MINOR (10 FT INTERVALS)
DIVERSION

CLIMAX MINE

LOWER CERESCO RIDGE FILL AREA WATER MANAGEMENT CONTROLS

PROJECT:	114-010619
DATE:	05/08/2012
LOCATION:	CLIMAX, CO

TETRA TECH

I:\Clients\Climax Mdy\Ceresco Ridge\C4D\C3D – Climax Mine\Design Work\Dwgs\Ceresco Ridge Drainage from Fill Areas-050412.dwg SAVED:5/8/12 PRINTED:5/8/12 BY:BEN.STEWART

DESIGN REPORT

NORTH 40 AND MCNULTY OVERBURDEN STORAGE FACILITY DESIGN REPORT

Climax Molybdenum Company – Climax Mine

Submitted To: Climax Molybdenum Company – Climax Mine
Highway 91 – Fremont Pass
Climax, Colorado 80429

Submitted By: Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228 USA

Distribution: 3 Copies – Climax Mine
2 Copies – Colorado Division of Reclamation, Mining and Safety
2 Copies – Golder Associates Inc.

May 2012 **113-81608**

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1.0 INTRODUCTION

1.1 Purpose

This report presents the Golder Associates Inc. (Golder) engineering evaluations and analyses for the proposed North 40 and McNulty overburden storage facility (OSF) designs. The report includes results of the field investigation, laboratory investigation, operations and monitoring (O&M) recommendations, and design calculations performed in support of the ultimate OSF designs. Both OSFs are located at the Climax Molybdenum Company – Climax Mine (Climax). The work presented in this report was performed to fulfill the scope of work titled "*Detailed Work Plan for Overburden Storage Facility Geotechnical Investigation and Design*", which was presented to Climax on 3 June 2011.

The primary focus of the work presented in this report is intended to demonstrate the geotechnical stability of the proposed expansions of the North 40 and McNulty OSFs, which are collectively designed to store 280 million tons (Mt) of mined overburden material. A conceptual OSF closure and water management plan is also provided.

1.2 OSF Design Overview

Climax is an open pit Molybdenum mine utilizing a truck/shovel operation. Ore extracted from the pit is sent to the mill for mineral extraction. Material with marginal mineralization at or slightly above the cutoff grade will be temporarily stockpiled in the low grade stockpile, located near the mill site, adjacent to Highway 91, on top of the south portion of the North 40 OSF, as shown on Drawing 14. The low grade stockpile is expected to be removed and processed near the end of mine operations, after extraction and processing of higher grade materials from the pit. The overburden materials excavated from the pit are trucked to the OSFs. Overburden material at the site consists of three different material types. The majority of the overburden will consist of igneous and metamorphic rock excavated from the mine pit, which is either unmineralized or contains uneconomical mineralization. The ore body is primarily quartz monzonite porphyry, while some migmatite is present surrounding the ore body. Approximately 30% of the overburden removed from the pit will consist of sedimentary rock, primarily derived from the Minturn Formation shale, siltstone, and sandstone.

This design report is focused on supporting the proposed North 40 and McNulty OSF designs. The designs for both facilities focus on meeting three goals:

- Design for long-term geotechnically stable slopes.
- Provide a generalized operations management plan for surface water and groundwater. More specifically, include the grades, channels, berms, drains, and hydraulic barriers necessary to maintain separation of contact water and non-contact water, to the extent practicable.

- Integrate design for closure concepts to maintain compatibility of the operational OSF configuration with eventual closure, and provide closure design concepts for guiding operations.

The term “contact” water, as used in this report, refers to precipitation-related water and groundwater that has flowed over, through, or otherwise been in contact with mined materials, including overburden. The term “non-contact” water, as used in this report, refers to precipitation-related water and groundwater that has not been in contact with mined materials. Water may retain its “non-contact” designation after being allowed to flow over or through engineered cover materials or engineered drainage layers derived from non-acid generating sources, as well as undisturbed native material.

The OSF designs presented in this report were developed jointly through collaboration between Climax and Golder. In order to guide the design process and form a framework for evaluating the suitability of the designs, Golder and Climax developed a set of project design criteria. These design criteria (presented in Appendix F) provide:

- Relevant design inputs (e.g., design storms, design seismic events, etc.)
- Guidance on which engineering analytical methods will be used
- Criteria for the design components (e.g., include underdrain system)
- Geometrical constraints (e.g., allowable slopes, bench widths, channel criteria, freeboard requirements, etc.)
- Acceptable factors of safety (FOS)

The designs developed for the McNulty and North 40 OSFs are presented in the project drawings (Drawings 1 through 15, attached). The grading plans shown on Drawings 13, 14, and 15 were developed from the Climax mine plan to illustrate intermediate OSF development for years 5, 10, and 15, respectively. The components of the design and the design process are described in the subsequent sections of this report. A summary of the major design components is provided below:

- During placement of overburden materials, intermediate OSF configurations will be compatible with the OSF stability requirements and water management strategy. An O&M plan will be implemented to facilitate conformance with these design objectives and criteria.
- The McNulty OSF will contain an underdrain system to capture existing water springs within the OSF footprint and transmit the water from springs to the toe of the OSF, to prevent contact between the captured water and overlying OSF fill material (see Drawings 3 and 12).
- The McNulty OSF will contain a contact stormwater collection system (CWCS), as shown in plan on Drawings 3 and 12. The purpose of this system is to collect contact stormwater internal to the OSF and transmit it to the east tailing delivery line (ETDL) or East Side Channel, and then to the Climax water treatment system prior to discharge.
- The overall final slope of the OSFs, during operations and after closure, will not exceed 2.4H:1V.

- During operations, this slope will be achieved by constructing nominal 200 ft high angle-of-repose lifts separated by 200 ft wide horizontal benches. The final operating OSF configuration is shown in plan on Drawing 3.
- Prior to closure, the OSF slopes will be regraded. The regraded interbench slopes will be 2H:1V and nominally 125 ft long. The regraded slopes will be separated by horizontal benches nominally 20 ft wide with a nominal 2% slope gradient.

- At closure, the toe limits of the OSFs will expand because of slope regrading. This is due to excavation of material from the operational lift crests and fill placement of material at the toes of the operational lifts. The operational limits of the OSFs have been located to be compatible with toe expansion at closure to provide a 2H:1V interbench outslope. The operational toe limits provide sufficient space to allow extension of the slope for the final reclamation limits plus a 50 foot (minimum) buffer between the closure toe limits and any critical utilities, property boundaries, watershed boundaries, or other areas where overburden materials cannot be placed. The final OSF closure configuration is shown in plan on Drawing 4.
- At closure, a reclamation cover will be constructed on the OSF. The objective of the reclamation cover will be to minimize erosion, reduce infiltration, minimize contact between stormwater and OSF fill material, and promote revegetation.
- At closure, channels constructed on the regraded benches will transport non-contact surface water to downdrains, which will run down the OSF outslopes to perimeter channels and/or water management berms, which will direct flows to either the East Interceptor System or other conveyances such as the East Side Channel which will be converted to a clean water diversion system when the Tenmile and Mayflower TSFs are reclaimed.
- The OSFs will be constructed with perimeter surface water channels and/or water management berms.
  - During operations, the perimeter berms and channels will be used to prevent non-contact stormwater from flowing onto the OSF surface, and to prevent runoff of contact stormwater from the OSFs to surrounding unimpacted areas.
  - Following completion and regulatory approval of reclamation, storm water run-off from the reclaimed OSFs will be classified as non-contact stormwater. The perimeter channels and berms will collect and convey non-contact stormwater flow to the East Interceptor System or other conveyances for discharge from the site (See Drawing 4). Where necessary, channels and/or berms will be utilized to prevent run-on from watersheds upgradient of the OSFs.
- At closure, additional toe drains will be constructed where required along the toes of both OSFs. The toe drains are intended to capture contact water internal to the OSFs at those locations where there is potential for contact water to exit the toes of the OSFs as seepage. The toe drains will transmit collected water to the toe of the facility and transfer it to the ETDL or other conveyance for treatment.

2.0 SITE CHARACTERIZATION

2.1 Review of Existing Information

2.1.1 Historical Reports and Documents

Golder reviewed available reports and other relevant information in order to develop an understanding of the North 40 and McNulty Gulch areas, identify available geotechnical information (e.g., existing boring logs, laboratory testing, piezometric data, geologic maps, etc.), and identify data gaps where additional data was required to support the geotechnical stability evaluation. Portions of the existing information were directly applicable for use as inputs for developing the geologic model and material parameters used in the stability evaluation. The available information was also used by Golder to focus the subsequent field and laboratory programs to collect additional information in those areas where insufficient information existed or where the greatest potential for geotechnical concerns were identified.

Golder completed a historical data review that included a review of aerial photographs, historical topography, and surface geologic maps of the Climax site. Photographs were available from 1938, 1944, 1955, 1956, 1957, 1958, 1967, 1969, 1971, 1977, 1978, 1979, 1980, 1985, 1990, and 2006. Historical topography was available from 1882, 1939, 1955, 1970, 1981, 1985, 1990, and 2010. Some photographs and topographic maps only showed portions of the site, and some of the photos were previously reproduced or scanned at relatively low resolution and were not useful. The primary focus of the historical data review was to estimate the depositional history and limits of the various materials within the footprint limits of the OSFs (e.g., buried tailing impoundments, mine waste, random fill, etc.) as well as the location of major geologic features with respect to the proposed OSFs (e.g., the Mosquito Fault). Other reports or information reviewed by Golder include the following:

- The proposed ultimate grading plan for the OSFs, provided by Climax on 17 February 2012
- Seismic hazard maps and data available on USGS seismic hazards program website
- *Slope Stability Evaluation For Feasibility Level Pit Design of Long Range Reserves at Climax Mine.* Call and Nicholas, Inc. August 2007
- *Geology of the Northern Part of the Tenmile Range, Summit County, Colorado*. USGS. 1963
- *Ore Deposits of the Kokomo-Tenmile District, Colorado*. USGS. 1971
- *The Climax Molybdenum Deposit, Colorado*. USGS. 1933
- Portions of the AM-06 permit amendment, including the following:
  - Exhibit C – Mining Plan Maps
  - Exhibit D – Mining Plan
  - Exhibit E – Reclamation Plan
  - Exhibit F – Reclamation Plan Maps

- Exhibit G – Water Information
- Exhibit I – Soils Information
- Exhibit K – Climate Information
- *McNulty OSF Cut-Off Design*. AMEC. November 2008

2.1.2 Overview of Existing Conditions

Drawing 2 depicts the existing conditions which are further discussed in this section. Based on review of the above referenced sources, the proposed McNulty and North 40 OSF areas are located between approximately 11,200 and 12,500 ft above sea level. Elevations are lowest along the western sides of the proposed OSFs, which are roughly parallel to the ancestral Tenmile Creek and Colorado Highway 91. The lower elevations are covered with glacial deposits, although much of the area has been modified by various mine and transportation construction projects. A historical tailing impoundment lies in the southwest corner of the proposed North 40 OSF, which was operated in the first half of the 20th century. After tailing deposition ceased, several buildings were constructed on the southern portion of the tailing, and a stockpile of fill or mine overburden has been placed on the northern portion.

The bedrock beneath the majority of the OSF footprints consists of various strata of the Minturn formation, which has been intruded locally by the Lincoln porphyry. Locally, the Minturn generally dips at 30 to 45 degrees in an east to north-northeast direction. Soils at the site are generally shallow, and are predominantly composed of residual and colluvial soils weathered from the underlying bedrock. The Mosquito Fault passes along the far northeast boundary of the McNulty OSF footprint, and several smaller splay faults lie within the northeast corner of the facility.

A general timeline of mine activity in the OSF footprint areas, as determined based on Golder's historical review of the topography and aerial photographs is provided below:

- Between 1882 and 1938 tailing placement begins.
- Between 1944 and 1955 tailing placement is complete and construction of mine buildings on the south tailings deposit occurs.
- Between 1971 and 1977 fill or mine overburden placement begins on the northern portion of the tailing impoundments which are covered with fill materials. Road construction and minor fill or mine overburden rock placement begins north of the tailing, adjacent to McNulty gulch.

In more recent years, starting in about 1971, fill and mine overburden has been placed north of the buried tailing impoundments, adjacent to the south side of McNulty Gulch, and within the south fork of the gulch. Based on the 2010 topography, it appears that a maximum thickness of approximately 300 feet of material has been placed in the south fork of the gulch. The average thickness outside the gulch is approximately 50 feet or less. The north fork of the McNulty Gulch does not currently contain any overburden materials. The north fork watershed contains several perennial springs within the proposed

OSF footprint. Non-contact stormwater and the perennial stream flows are directed into the East Interceptor and conveyed to Clinton Reservoir to the north, and ultimately discharges to the Tenmile Creek drainage basin.

The site receives an approximate average of 23 inches of precipitation per year. Average daily high and low temperatures range from 65° F and 39° F in July, respectively, to 25° F and 2° F in January. A detailed description of the climatic conditions at the site can be found in Exhibit K of the AM-06 permit amendment (Climax, 2010).

In disturbed areas and areas where fill or mine overburden material has been placed, vegetation is sparse. Undisturbed areas consist of a mixture of forested and grassy areas, with some short woody shrubs present adjacent to drainages and springs.

2.1.3 Existing Infrastructure

There is an extensive network of existing utilities and infrastructure at the Climax mine site. Where necessary, the OSF designs have been developed to avoid conflicts with these utilities. The OSF designs also consider how to appropriately integrate the proposed surface water management features with the existing channels and infrastructure. A summary list of the key existing utilities and other infrastructure within or adjacent to the OSF footprint areas is provided below:

- East Tailing Delivery Line (ETDL) –The ETDL runs roughly south to north on the east side of Highway 91 to just south of McNulty Gulch, and then remains on the west side of the highway to the sludge densification plant (SDP) (see Drawing 2). The ETDL currently collects contact water from the camp area and several other facilities. It is Golder understanding that the ETDL will remain undisturbed and active throughout operations and during the closure period. The ETDL may be used to transmit contact water collected from the OSF CWCS or perimeter channels to the Climax water treatment system.
- Tailing Delivery Line (TDL) – this line runs adjacent to the ETDL, and delivers tailing and water from the mill to the tailing impoundments. This pipeline also may be used to transmit contact water at closure.
- High pressure natural gas and above ground electrical lines – these utilities run north/south in a utility corridor along Highway 91 (see Drawing 2). These lines are more distant (west) than the ETDL, and will not be impacted by the OSFs.
- Camp drainage line – The camp drainage line is located along the south toe of the North 40 OSF, adjacent to the low grade ore stockpile, and removes contact water from the camp area. The line ties into the ETDL. Climax indicated this line should remain un-buried and in-service throughout operations and during the closure period for transmission of contact water.
- East Side Channel (ESC) – this channel transports contact water from the Camp area, North 40 OSF, Robinson Pond, and McNulty Gulch. The channel runs mostly on the west side of Highway 91, and will not be affected by OSF construction. The ESC can be utilized as an outlet for contact water from the North 40 and McNulty OSFs. At closure portions of the East Side Channel will be converted to a clean water diversion along the

east side of the Tenmile and Mayflower TSFs and can potentially be used to convey non-contact water from the North 40 and McNulty OSFs at that time.

- Miscellaneous decommissioned utilities – it is Golder's understanding that several decommissioned utilities (including gas and potentially communications lines) cross the northern portion of the North 40 and southern portion of the McNulty OSF footprints. Because the utilities are decommissioned, it is Golder's understanding that these utilities may be buried in-place during OSF construction.
- Clinton Ditch – this ditch has its origin in the headwaters of the Clinton Creek, and was used historically to divert non-contact water south towards McNulty gulch. The ditch is not currently in use but may be considered for future water diversions.
- East Interceptor – this channel and pipeline system collects non-contact surface water flows from McNulty Gulch and from the area between McNulty Gulch and Clinton Gulch. The channel and pipeline run east to west along the north side of McNulty gulch and then turns north and runs along Highway 91 to the Clinton Reservoir. The East Interceptor will be used as the discharge point for non-contact water collected on or around the McNulty OSF, including flows from the underdrain system and potentially from non-contact channels at closure.
- McNulty Interceptor – this channel diverts or has diverted flows from the central McNulty drainage north towards the East Interceptor. The McNulty Interceptor will be covered during OSF operations. The function of the McNulty Interceptor will be replaced by the McNulty OSF underdrain system and perimeter channels and berms.
- DSM Interceptors – this series of interceptors collect contact water from the camp and North 40 OSF areas and discharges into the ETDL. It is Golder's understanding that this interceptor collection system will generally remain in place during OSF operations, with some modifications to accommodate the camp area drains and OSF CWCS.
- Storage Tanks – there are several storage tanks along the haul road bounding the east side of the OSF. The OSFs will not impact these tanks during operations. Some tanks may be decommissioned at closure, allowing the OSF toe to move east during reclamation.
- Reclaim Pipeline – The reclaim pipeline is located along the south toe of the North 40 OSF, adjacent to the camp drainage line and along the Colorado Boulevard south of the truck shop. This buried pipeline conveys process water to the mill water storage tank and will remain in-service throughout operations.
- Utility Corridor – there are several pipelines to convey and distribute water and gas utilities to the storage tanks and the mill or appurtenant buildings. These pipelines are run west to east from the Mill building along the road below the Primary Crusher, turn south to north at the Truck Shop bench, turn west to east at the truck wash and run up to the bench above for connection to the storage tanks.
- Truck Shop, Truck Wash, Phillipson Warehouse, Maintenance Shop – these facilities lie on a bench just to the east of the southern North 40 OSF.

2.2 Field Investigation

2.2.1 Overview

The primary purpose of the field investigation was to collect the field data and soil/rock samples necessary to support the stability evaluation of the proposed North 40 and McNulty OSF designs. More specific objectives of the investigation were:

- Classify the foundation soils in accordance with the Unified Soils Classification System (USCS)
- Provide estimates of the depth to bedrock and the thickness of overlying strata (soil/fill/tailing) within and adjacent to the proposed OSF footprint
- Provide disturbed and undisturbed samples of soil and rock for laboratory testing
- Provide data on soil and rock types and distribution throughout the site
- Provide data on surface hydrology features based on field reconnaissance and groundwater elevations within the OSF footprint areas

To meet these goals, a test pit program and a geotechnical drilling program were completed. The field program also included visual observations, strike and dip measurements, point load testing of rock samples, and general site reconnaissance. A detailed description of the field program is included as Appendix A, which includes drilling methods, field testing methods and results, soil and rock sampling, test pit logs, boring logs, and a photographic log. The locations of the test pits and borings are shown on Drawing 2. Summaries of the test pit, drilling, and point load test programs are provided in the following sections.

2.2.2 Test Pit Program

2.2.2.1 Methods

The test pit program consisted of excavating, logging, and sampling 19 test pits between October 10 and October 13, 2011. The test pit program focused mainly on mapping, characterizing, and sampling the shallow materials within the OSF footprint areas. The test pits allow for the collection of larger soil samples and are more suited for sampling and characterizing gravelly and cobbly soils. The characteristics that were logged during the test pit program include density, color, weathering, grain size, angularity, structure, parent/source rock, plasticity and moisture as well as any pertinent observations made during the excavation (e.g., groundwater conditions, soil/fill density, strata strike and dip, etc.).

Moltz Construction was contracted to perform the test-pitting program and a John Deere 240D tracked excavator was utilized to excavate the test pits. All test pits were staked and cleared with the Climax's blue stake crew prior to excavation. Test pits were excavated a minimum of 4 ft (when hard conditions were encountered) and a maximum of 16 ft. Wherever possible, test pits were excavated to bedrock refusal. Representative samples of the various materials encountered were obtained as bulk (pail) samples for testing in Golder's Denver laboratory. All test pits were backfilled after excavation and logging activities were complete and compacted with the excavator bucket and excavator tracks.

2.2.2.2 Conditions Encountered

Four test pits were excavated in mine overburden materials. These pits include GA-11P-04, GA-11P-05, GA-11P-08, and GA-11P-10. The mine overburden in these test pits all classify as a well graded

GRAVEL (GW) with small variations in origin, gradation, color, and overall composition. These test pits varied in depth from about 4 ft BGS to about 10 ft BGS. No groundwater was encountered in any of these test pits.

Four test pits were excavated in non-waste rock fill materials that were generally located on or near mine roads, road embankments, or in the lay-down area. These pits include GA-11P-11, GA-11P-12, GA-11P-14, and GA-11P-19. These pits varied in depth from about 5 ft BGS to approximately 16 ft BGS, and no groundwater was encountered in any of these test pits. These materials were generally classified by the USCS as well graded SAND (SW) or well graded GRAVEL (GW).

Five test pits were excavated in areas containing residual soils weathered from the Lincoln Formation (Lincoln) porphyry. These test pits included GA-11P-01, GA-11P-03, GA-11P-09, GA-11P-15, and GA-11P-16. The total depth of these test pits varied from approximately 5 ft BGS to approximately 13.5 ft BGS, and no groundwater was encountered in any of these test pits. The Lincoln porphyry encountered in the test pits was generally characterized as a highly weathered weak rock to completely weathered very weak rock (i.e., residual soil). The residual soil was well graded SANDY GRAVEL (GW) or well graded GRAVELY SAND (SW) with some very weak cobbles and boulders. The bedrock structure was generally intact and visible, even in the completely weathered/residual soil zones. The in-situ rock was gray and massive with an aphanitic to very coarse crystalline structure. The soils above the Lincoln porphyry were generally sandy and were either colluvial or residual soils.

Four test pits were excavated in areas where the Minturn Formation (Minturn) was present at or near the surface. These test pits include GA-11P-02, GA-11P-06, GA-11P-13, and GA-11P-17. These test pits varied in depth from approximately 5 ft BGS to 15 ft BGS. Groundwater was encountered only in test pit GA-11P-06 where it was clearly seeping into the pit from a depth of approximately 4 ft. Sandstone was encountered at approximately 2 ft BGS in test pit GA-11P-13 and at approximately 4 ft in GA-11P-17. The strike and dip of the Minturn formation was measured as N100E at 40 degrees in GA-11P-13 at a depth of approximately 5 ft. The Minturn encountered in the test pits was characterized as a slightly to moderately weathered, thickly bedded, medium to coarse crystalline micaceous SANDSTONE. The thickly bedded sandstone layers were separated by thinner shale beds or clay infill (approximately 0.5 cm to 3 cm thick). The clay infills were generally red to orange low to highly plastic CLAY (CL-CH). The soils above the Minturn bedrock tended to be low plasticity SILT (ML) and low plasticity CLAY (CL) with some sand and gravel, and were generally a red-brown or maroon color.

Test pit GA-11P-07 was excavated in glacial till material. Directly above and next to the test pit, approximately 5 ft of native material was exposed and logged in addition to the 5 ft of material that was excavated below the ground surface. Seeping groundwater was encountered in this test pit at approximately 3 to 5 ft BGS. Hard digging was encountered at 5 ft BGS. The materials in this test pit were classified as low plasticity SILT (ML) and low plasticity CLAY (CL) with sand, gravel, and cobbles.

Finally, a single test pit was excavated east of Highway 91 and just west of the estimated limits of the historic tailing impoundments. The total depth of test pit GA-11P-18 was approximately 16 ft BGS, and ponded groundwater was noticeable at the base of the test pit prior to backfilling. The materials in the upper 4 ft of the test pit were characterized as poorly graded to well graded SAND (SP) with little gravel and cobbles and trace boulders. From 4 to 6 ft BGS, the material was classified as a SILTY SAND (SM) with gravel and from 6 to 16 ft BGS, the material was classified as a dense, dark gray, SILTY SAND (SM).

2.2.3 Geotechnical Drilling Program

2.2.3.1 Methods

The drilling program included 7 borings spread strategically throughout the footprint of the proposed OSF footprints. The program began on October 18 and continued through November 4, with a 5-day break during the drilling program. Drilling facilitated obtaining information and samples from deeper strata, in-situ measurement of soil strength and density through the use of standard penetration testing (SPT), and also allowed installation of temporary piezometers for measuring groundwater levels within the OSF foundations. During drilling a Golder engineer logged soil and rock types, moisture, density, color, weathering, strength, grain size, angularity, lithology, plasticity, structure, rate of advance and other characteristics. Disturbed samples of the major soil types were obtained for laboratory index testing to confirm the field characterization and classifications (e.g., grain size and Atterberg limits) and for reconstituting samples for large scale tests (e.g., proctors, direct shear tests, etc.). In addition to the disturbed samples, relatively undisturbed samples were obtained by pushing thin walled Shelby Tubes into fine grained horizons (e.g., silts and clays) for laboratory testing. These samples were utilized for triaxial strength tests, in-situ natural moisture and density measurements, and consolidation tests.

Due to the granular and variable nature of the expected drilling conditions, Golder recommended the use of sonic drilling for this project. Sonic drilling utilizes rotation and high frequency vibration to advance an inner core barrel and an outer casing, thus allowing for a continuous sample of soil or rock to be collected in the inner barrel. Sonic coring is particularly well suited for drilling through hard, coarse soils and soils prone to caving, such as coarse glacial, alluvial, and colluvial sediments as well as man-made fills and coarse mine overburden materials. Sonic drilling is also capable of drilling through silts, clays, and other soft soils. Most sonic rigs can also drill through intact bedrock, although at reduced rates and with some breakage. For this drilling program, a Boart Longyear GP24-300RS sonic drill rig was utilized. The rig was equipped to facilitate SPTs and Shelby Tube sampling at specified intervals. When competent bedrock was reached, the Boart drill rig was capable of switching over to HQ diamond bit triple barrel rock coring (2.5-inch diameter), which allowed for improved rock core recovery.

The depth of the 7 boreholes ranged from a minimum of approximately 30 ft to a maximum of approximately 300 ft with a total drilling depth of approximately 704 ft. Drilling was advanced to bedrock at 5 of the 7 boring locations.

The sonic drill rig provided continuous core samples for each hole with nearly 100% recovery. Soil and rock samples were returned in runs ranging from approximately 5 to 15 feet in length. Non-cohesive soils were generally returned in a disturbed state, however very dense, stiff, and/or cohesive soils were returned relatively intact and only slightly disturbed.

Each borehole location was staked and approved by the Climax blue stake crew prior to drilling. After drilling was completed at each borehole, a 1-inch diameter PVC standpipe was lowered to the base of the borehole prior to removal of the drill casing. The bottom 10 ft of each standpipe was slotted. These standpipes were used to facilitate water level measurements. Water levels were allowed to equilibrate until the piezometric levels stabilized between readings, generally for a minimum of 24 hours, before recording the final static water table elevation. At the end of the drilling program, all borings were backfilled with cuttings to the water table and with bentonite chips above the water table in accordance with Colorado requirements (2 CCR 402-2).

2.2.3.2 Conditions Encountered

The conditions encountered in each of the 7 borings, including approximate location, materials encountered, depth to bedrock, depth to groundwater, and total drilling depth are provided in Appendix A and summarized in Table 1. A more detailed summary is also provided below:

- GA-11B-20: This borehole was located near the base of McNulty Gulch. The total depth of the borehole was approximately 54 ft. Groundwater was measured at a depth of approximately 24.8 ft BGS. The upper 38.5 ft of material in this location consisted of colluvial soil weathered from the Minturn formation. This soil ranged from low plasticity SILT (ML) to SILTY SAND (SM) with gravel and little cobbles (COLLUVIAL – MINTURN). The cobbles and gravel were sub-rounded micaceous sandstone with R3 (medium strong) to R4 (strong) strength. From approximately 36.5 ft to 38.5 ft BGS, a number of porphyritic cobbles were encountered. At 38.5 ft BGS, there was a sharp transition from colluvial Minturn to residual soil weathered from the Lincoln porphyry. This residual porphyry extended from 38.5 ft to the bottom of the hole at 54 ft BGS. The residual porphyry was classified as dense, gray, SANDY GRAVEL (GW) with cobbles (RESIDUAL SOIL – LINCOLN).
- GA-11B-21: This borehole was located on the existing OSF within the southern portion of McNulty Gulch. The total depth of this borehole was approximately 78.5 ft. The static water table was measured at approximately 42.9 ft BGS. The upper 25 ft of material in this location was a loose to compact, brown to red-brown, well-graded, SANDY GRAVEL (GW) (MINE OVERBURDEN). Native ground was reached at 25 ft BGS and consisted initially of a very stiff maroon CLAY (CL) with some sand and trace to little gravel (RESIDUAL SOIL – MINTURN). This material appears to have weathered from the upper Minturn formation. The stiff clay transitioned into a compact, maroon SANDY GRAVEL (GW) with clay (RESIDUAL SOIL – MINTURN) at approximately 33 ft BGS and this material continued to a depth of approximately 43 ft BGS. At approximately 43 ft

BGS, the gravelly material transitioned into a weathered, but more intact SANDSTONE (MINTURN). Due to difficult drilling, Boart drilled with water from 43 to 60 ft BGS. This allowed for the recovery of 4 to 8 inch pieces of intact Minturn sandstone core. This material was moderately to slightly weathered, bedded (thick sandstone beds separated by thinner clay layers approximately 0.5 cm to 3 cm thick), fine to coarse crystalline SANDSTONE (MINTURN). At 60 ft BGS, Boart transitioned to triple barrel HQ rock coring in an attempt to obtain rock core samples for laboratory testing. Boart drilled 5 runs of core that returned a slightly weathered, bedded, maroon, very fine to coarse crystalline SANDSTONE (MINTURN). The Rock Quality Designation (RQD) for this interval ranged from 17 to 48. The strength ranged between R1 (weak) to R4 (strong).

- GA-11B-22: This borehole was located on a hillside on the edge of a mine road near the base of McNulty Gulch. The total depth of this hole was approximately 33.5 ft BGS. Groundwater reached equilibrium at approximately 12.0 ft BGS. The upper 10 ft of material in this location consisted of compact to dense, brown-gray CLAYEY SAND (SC) and SANDY GRAVEL (GW) with cobbles (FILL). The cobbles in the fill were mostly from the Lincoln porphyry. At 10 feet there was a transition to dense gray SANDY GRAVEL (GW) with fines (RESIDUAL SOIL – LINCOLN). This material was a residual soil derived from the Lincoln porphyry. From 10 ft to 28 ft BGS, the material gradually transitioned from residual soil to in-place but completely weathered PORPHYRY (LINCOLN) with strength between R0 (extremely weak) and R3 (medium strong). At 28 ft, Boart transitioned to triple barrel HQ rock coring in an attempt to obtain intact core. Boart drilled 2 runs with limited success. Approximately 1 ft of gravel was returned in run number 1 and the core barrel plugged during run number 2 due to lack of water during drilling.

- GA-11B-23: This borehole was located on top of the existing OSF just north of the lay-down yard and directly above the northern historic tailing impoundment. The total depth of this borehole was approximately 294 ft and the water table reached equilibrium at 179.8 ft BGS. The upper 179 ft of material in this location was classified as mine overburden. The mine overburden varied between well-graded GRAVEL (GW) and well-graded SAND (SW) (MINE OVERBURDEN). This mine overburden material was generally sub-angular to angular, with non-plastic to low-plasticity fines. Tailing was encountered at 179 ft BGS, and ranged from a non-plastic SILTY SAND (SM) to a low plasticity CLAYEY SILT (ML) (TAILING). The thickness of the tailing layer was approximately 56 ft in this location. From approximately 226 to 235 feet BGS there was a short transition zone where the tailing had infiltrated the native glacial till. Below 235 feet BGS, soils encountered consisted entirely of glacial till. The glacial till generally ranged from a well-graded GRAVEL (GW) with silt and clay to a CLAYEY SAND (SC) with gravel and cobbles (TILL). The exception was a low plasticity CLAY (CL) layer present from approximately 273 ft to 287 ft BGS.

- GA-11B-24: This borehole was located in the gravel crushing area directly above the northern most portion of the southern historical tailing impoundment. The total depth of this borehole was approximately 164.5 ft and the water table reached equilibrium at approximately 54.9 ft BGS. The upper 45 ft, at this location, was comprised of mine overburden. The mine overburden generally ranged from well-graded GRAVEL (GW) to CLAYEY GRAVEL (GW) to CLAYEY SAND (SC) (MINE OVERBURDEN), although there were some zones of low plasticity SANDY CLAY (CL). The tailing contact was located at approximately 45 ft BGS. The majority of tailing encountered in this location was comprised of low plasticity CLAYEY SILT (ML) (TAILING) with some thin layers of non-plastic, poorly graded, fine SILTY SAND (SM) (TAILING). The tailing layer was approximately 53 ft thick in this location. Below the tailing layer, drilling encountered glacial till. The glacial till in this location ranged from low plasticity SILT (ML) to SILTY SAND (SM) to CLAYEY SAND (SC) to well graded GRAVEL (GW) (TILL). All layers contained some sub-rounded gravel and cobbles of various origins and parent rock types. This borehole was terminated at 164.5 ft prior to reaching bedrock.

- GA-11B-25: This borehole was located in the lay-down yard near the southernmost toe of the proposed OSF. In addition, this borehole was located near the center of the southern historical tailing impoundment. The total depth of this borehole was approximately 193 ft, with static groundwater levels measured at approximately 33.9 ft BGS. The upper 7 ft of material in this location consisted of a well-graded GRAVEL (GW) (FILL). Mine overburden was encountered from 7 ft to 33.5 ft BGS and consisted of well-graded GRAVEL (GW) and CLAYEY SAND (SC) with gravel and cobbles (MINE OVERBURDEN). The tailing contact was at approximately 33.5 ft BGS. Tailing in this location consisted mainly of non-plastic, poorly graded, fine SILTY SAND (SM) with some thin layers of CLAYEY SILT (ML) (TAILING). The total thickness of the tailing layer in this location was approximately 38.5 ft. Below the tailing layer there was a 4 ft layer of stiff, dark brown, ORGANIC SILT (OL), before glacial till was encountered at 76 ft BGS. The glacial till layer continued for approximately 95 ft. The till in this area consisted mainly of well-graded SAND (SW) with gravel and cobbles and well graded SANDY GRAVEL (GW) (TILL). The Lincoln porphyry was encountered at approximately 171 ft BGS and can generally be described as a completely to moderately weathered bedrock or residual soil. The residual soils weathered from the porphyry in this location ranged from a stiff to hard, gray-brown CLAY (CL) with low plasticity to a dense, gray, poorly graded coarse SAND (SP), slightly moist and non-plastic (LINCOLN).
- GA-11B-26: This borehole was located on native ground above McNulty Gulch, near a mine road. The total depth of this borehole was approximately 36 ft BGS and the groundwater reached equilibrium at a depth of approximately 13.1 ft BGS. The soil in this location was comprised of material weathered from the Lincoln porphyry. This residual soil can generally be described as dense, gray, SANDY GRAVEL (GW) with cobbles. From 31 to 36 feet BGS, the residual material transitioned into a moderately weathered, massive, fine to very coarse crystalline PORPHYRY (LINCOLN) bedrock. The rock was highly fractured, but the larger cobbles returned had strength rated as R4 (strong).

2.2.3.3 SPT Test Results

Twenty (20) SPTs were performed in various materials during the drilling program. Two tests were performed in soils derived from the Minturn Formation, nine tests were performed in mine overburden materials, five tests were performed in the tailing materials, three tests were performed in the glacial till, and 1 test was performed in soil derived from the Lincoln porphyry.

Table 6 in Appendix A provides a summary of all the SPT tests performed throughout the drilling program. This table presents the field N values, the corrected N_{60} values, and the corrected $(N_1)_{60}$ values. The field N values are corrected for field conditions and normalized to standardized N_{60} values. The N value correction factors include hammer efficiency, borehole diameter, sampler type, and rod length. The N_{60} values are further corrected based on the effective overburden stress to produce normalized $(N_1)_{60}$ values.

$(N_1)_{60}$ values for soils derived from the Minturn formation ranged from 10 to 42. $(N_1)_{60}$ values for mine overburden varied between 6 and 27. $(N_1)_{60}$ values for tailing ranged from 6 to 9. $(N_1)_{60}$ values for the glacial till ranged from 18 to >50. The single test performed in the Lincoln porphyry gave a $(N_1)_{60}$ value of 29.

2.2.4 Point Load Testing

Thirteen point load tests were performed on samples of the Minturn sandstone collected from borehole GA-11B-21, eight point load tests were performed on samples of the Lincoln porphyry collected from borehole GA-11B-26, and thirty-five point load tests were performed on lump samples of mine overburden collected from the ground surface at various locations throughout the existing mine overburden piles in the North 40 and McNulty Gulch areas. All point load tests were performed using International Society for Rock Mechanics (ISRM) guidelines.

The results of the point load tests indicate variability in the strength of the Minturn sandstone, the Lincoln porphyry, and the mine overburden. Weathering, which varies considerably between samples, and preferential failure planes (i.e., bedding planes and/or joints) contribute significantly to the measured strengths. In order to perform a point load test, samples of a minimum size are required. Because weaker strata within the Minturn formation generally weathered to fragments too small for testing, the tests performed were biased towards the stronger rock that more frequently yielded samples of sufficient size for testing. The point load testing results from the Minturn sandstone, the Lincoln porphyry, and the mine overburden piles are presented in Tables 3, 4, and 5 of Appendix A, respectively. In summary, the unconfined compressive strength (UCS) of the Minturn samples ranged from 3 to 15 ksi with an average of 10 ksi. The UCS of the Lincoln porphyry samples ranged from 5 to 21 ksi, with an average of 12 ksi. The UCS of the mine overburden samples ranged from 3 to 27 ksi, with an average of 12 ksi.

2.3 Laboratory Testing Program

2.3.1 Methods

All laboratory testing was performed in either Golder's Denver or Atlanta certified geotechnical laboratories. All laboratory testing procedures are in accordance with the American Society for Testing and Materials (ASTM) standards where applicable. Soil samples were classified using the Unified Soil Classification System (USCS) (ASTM D2487). The laboratory tests performed on various samples and the associated standards are summarized below:

- Sieve Analysis – ASTM C117/C136
- Hydrometer/Sieve/Specific Gravity – ASTM D422
- Atterberg Limits – ASTM D4318
- Specific Gravity – ASTM D854
- Standard Proctor Compaction Testing – ASTM D698
- Modified Proctor Compaction Testing – AASHTO T180 Method A
- Minimum Index Density Determination – ASTM D4254
- Consolidated-Undrained (CU) Triaxial Compression – ASTM D4767
- One-dimensional Consolidation Testing – ASTM D2435

- Natural Density and Moisture Content – ASTM D2937 and D2216
- Large Scale Direct Shear Testing – ASTM D3080 (Modified)
- Jar Slake Durability Testing – Kentucky Method 64-514-02

The methodologies and results of all laboratory tests are presented in Appendix B. A summary of the test results is provided below.

2.3.2 Results Summary

Testing was strategically assigned to each material type in order to define the necessary index and engineering properties. The results of the index tests performed are summarized in Table 1 in Appendix B. Engineering testing consisted of a consolidation test on fine tailing and various strength tests. Strength tests included a staged consolidated undrained (CU) triaxial test on soil weathered from the Minturn Formation, two large scale direct shear tests on mine overburden samples, a large scale direct shear test on glacial till, a large scale direct shear test on soil weathered from the Lincoln Porphyry, and a series of CU triaxial tests on fine tailing samples extruded from Shelby tubes. Summaries of the results of all strength tests and of the consolidation testing results for the fine tailing are presented in Appendix B as Tables 2 and 3, respectively. A brief description of each material type, and summary of the laboratory test results, is provided below.

- Minturn Formation (and soils weathered from the formation) – this formation generally consists of interbedded shales, siltstones, and sandstones. In the North 40 and McNulty Gulch area, the formation tends to dip at approximately 30 to 45 degrees towards the east to north-northeast. Based on laboratory classifications, the formation tends to weather to silty or clayey SAND (SM, SC) near the surface. A staged CU triaxial test was performed on a sample of the finer grained clayey SAND (SC) soil weathered from the formation (obtained from GA-11B-21 at 28 ft). The sample was relatively undisturbed, and was taken from an intact piece of sonic core. The sample had 49% fines (material finer than the #200 sieve, or 0.075mm). The best-fit Mohr-Coulomb residual effective strength obtained from this test was 31 degrees with 0 cohesion.
- Lincoln Porphyry (and soils weathered from the formation) – this formation is a fine to coarsely crystalline volcanic porphyry, which has locally intruded into the host rock of the Minturn Formation. The rock is massive, with few evident foliations or bedding planes. Field classifications show that, depending on the degree of weathering, the formation tends to weather to well graded GRAVEL, SAND and silty or clayey SAND (GW, SW, SM, SC) near the surface. Laboratory testing of a typical sample confirm these findings, and classify the residual soil as a clayey SAND (SC) with 21% fines. A large scale direct shear test was performed on a sample of the clayey sand residual soil weathered from the formation (obtained from GA-11B-20 at 40-43 ft). The best-fit Mohr-Coulomb residual effective strength obtained from this test was 35 degrees with 18 psi cohesion.
- Glacial Till – glacial till is present in the lower parts of the valley containing the ancestral Tenmile Creek. Field classifications show the till tends to consist of a varying mix of compact to dense, well graded GRAVEL and SAND and silty to clayey GRAVEL and SAND (GW, SW, GM, GC, SM, SC). The till also contains some thin layers of stiff to hard low plasticity CLAY (CL). Laboratory tests performed on a sample judged to be representative of the till classified the material as a clayey GRAVEL (GC) with 25% fines. A large scale direct shear test was performed on a representative sample of the till (a

composite sample of material sampled from GA-11B-25 at 104-106 ft and GA-11B-23 at 249-251 ft). The best-fit Mohr-Coulomb residual effective strength obtained from this test was 31 degrees with 14 psi cohesion.

- Tailing – the tailing was created by historic milling of ores at the site, and is located in two historic impoundments on the south west side of the North 40 OSF footprint area. The tailing can be divided into two general facies depending upon the depositional distance from the decant location, beach tailing and fine tailing. The beach tailing consists of fine grained SILTY SAND (SM) with 25-36% fines, while the fine tailing consists of non-plastic SILT (ML) with 97-99% fines.

  A CU triaxial test was performed on undisturbed samples of the fine tailing obtained from Shelby tubes (GA-11B-24 at 51.5-53.6 ft). The best-fit Mohr-Coulomb residual effective strength obtained from this test was 33 degrees with no cohesion. Other testing included a 1D oedometer consolidation test on fine tailing (see Table 3, Appendix B), a specific gravity test, several natural moisture/density measurements, and determination of the minimum and maximum dry density for beach tailing. The median natural dry density for the tailing was approximately 98 pcf. The minimum and maximum dry densities of the beach tailing were measured to be 73.1 and 120.7 pcf, respectively. The specific gravity of the tailing was measured to be 2.75.

- Mine overburden (waste rock) – this material was derived from the overburden material excavated from the pit, which does not contain economic mineralization. This material was sampled from several locations in the North 40 and southern McNulty areas. Based on field classifications, mine overburden tends to consist of well graded GRAVEL, poorly graded GRAVEL, and some silty to clayey GRAVEL (GW, GP, GM, GC). Two laboratory analyses classified the mine overburden as clayey GRAVEL and as a poorly graded silty GRAVEL (GC and GP-GM). The two sieve analysis showed that 66-68% of the material is finer than ¾-inch, and that 9-14% of the material consists of silt and/or clay. However, note that the mine overburden rock samples taken to the laboratory were scalped of oversize material in the field, as transporting and testing representative samples of cobble to boulder sized rock is not practicable. The in-situ mine overburden rock material contains an estimated 15 to 40% oversize material, which should be considered when applying the results of the laboratory analyses.

  Jar slake testing was performed on two different samples of rock and both tests showed no degradation of the mine overburden over the 24 hour test period. Two large scale direct shear tests were performed on different samples of the mine overburden material (one sample from GA-11P-05, the other a composite sample of GA-11B-25 at 16 feet and GA-11B-23 at 38-40 ft). The best-fit Mohr-Coulomb residual effective strengths obtained from these tests, assuming no cohesion, were 35 degrees and 36 degrees, respectively, both with no cohesion.

- Miscellaneous Fill – miscellaneous fills are located throughout the site, with the majority occurring in the areas around the mine buildings and offices, in the vicinity of the laydown yard, and along roads and embankments. Relative to the other material types, the occurrence of miscellaneous fills is minor. No laboratory testing was conducted on miscellaneous fill materials. Based on field classifications, fills at the site consist primarily of well graded SAND and GRAVEL (SW, GW).

2.4 Material Design Strength Selection

This section describes the process used to select strength parameters for slope stability analysis. In general, strengths were selected based on an evaluation of data from several different sources, including:

- The results of the Golder laboratory test program

- Strengths developed in previous geotechnical reports
- Hoek-Brown strength envelopes (applicable for mine overburden, Minturn Formation, and Lincoln Porphyry). These strength envelopes were developed based on Golder point load data, laboratory UCS test data provided in previous reports, and on rock quality characteristics as encountered in the Golder field investigation
- Comparison with typical strength values published in the technical and scientific literature, such as the typical strength values published by Leps (1971) for rockfill (e.g., waste rock or mine overburden)

The strength envelopes for each material type were selected based on evaluation of the above information and engineering judgment, with the intent of realistically representing the actual strength, while with sufficient conservatism to account for inherent natural variability in material parameters and for potentially locally unfavorable conditions within the geologic units. In all cases, residual strengths were used for design rather than peak strengths. Peak strengths are determined by measuring the maximum resistance to shear provided by the sample during testing. This maximum resistance generally occurs at a relatively low strain (i.e., after relatively little shearing has occurred). For over consolidated clay or dense sand, the shear resistance generally decreases slightly after the peak and eventually reaches a steady residual value at large strains. For the OSF stability analysis, Golder considers residual strengths to be appropriate for design of the Climax OSFs. This is because some creep or movement of the mine overburden and shallow foundation soils may occur during initial loading of the OSF. Additional considerations for applying residual strengths include accounting for the potential of seismic deformations and/or previous slope displacements. However, because the Climax mine is not located in a highly seismic area, and no historical slides were identified or are known in the North 40 and McNulty areas, the use of residual strengths is not strictly necessary to counter these site factors. Nonetheless, residual strength were used for the OSF stability evaluations, which are believed to provide an inherent level of conservatism in the design.

The Call & Nicholas (2007) report contains summaries of historical laboratory test data and material strengths back-calculated from slope failures within the pit. The report is focused on samples and data collected from the Climax open pit area. The majority of the pit is excavated in the ore zone. The Mosquito Fault runs north/south through the western side of the pit, with the portion of the pit west of the fault excavated through the Minturn Formation and Lincoln Porphyry. Although the same formations outcrop along the pit west wall and within the OSF foundation areas, the portions of the formations (i.e., strata/beds) outcropping are different in both locations. As a result, although the data presented in the Call & Nicholas report was considered in the development of the design shear strength parameters for the OSF stability analysis, more weight was given to the laboratory test results and field data developed by Golder in the current OSF specific study. A table presenting a summary of the relevant data presented in the Call & Nicholas report is presented in Table 2. Tables showing the strength parameters selected by

Golder for the current static and pseudo-static stability analyses are shown in Tables 3 and 4, respectively.

2.4.1 Minturn Formation

The strength of the Minturn Formation, as determined by a 1984 back analysis of a pit slope failure, was reported as 29 degrees with 4.9 psi cohesion (Call & Nicholas, 2007). An additional rock-mass strength estimation performed by Call & Nicholas yielded a friction angle of 19 degrees with a cohesion of 33 psi. In their pit stability analysis, Call & Nicholas used a rock mass strength of 30.8 degrees with 895 psi cohesion.

Golder also considered the following additional factors in the determination of the Minturn Formation design shear strengths for the OSF stability analysis:

- One potential OSF failure mechanism is shearing through the shallow foundation soils or upper few feet of bedrock. The weathering of the bedrock is expected to decrease somewhat with depth, leading to increased shear strength. Also, as discussed below, the overlying mine overburden material is generally stronger than soils weathered from the Minturn Formation.
- Along the majority of the North 40 and McNulty OSF toes, the dip of the Minturn Formation is favorable. Specifically, the formation dips northeast, into the OSF facilities, in the opposite direction of the OSF outslopes. This means that any failure plane would cross through multiple beds of the formation, and could not preferentially fail along a single bedding plane or through an individual bed.

As previously reported in Section 2.3.2, Golder performed a CU triaxial test on an intact sample of clayey sand weathered from the Minturn Formation. The best-fit failure envelope for this test was found to be a standard Mohr-Coulomb envelope with a friction angle of 30.8 degrees, with a small magnitude of cohesion which was conservatively neglected.

For evaluation of the OSF stability under static conditions, Golder elected to use a standard Mohr-Coulomb failure envelope with a friction angle of 31 degrees and no cohesion. This value is considered conservative because the soil sample on which this strength is based is considered to represent "worst-case" strengths for the Minturn Formation materials encountered. The sample used in the CU test was a soil (completely weathered Minturn Formation material) with a high clay content relative to other Minturn-derived soils encountered during the field investigation. The field investigation suggests that beds with lower clay content and/or weathered to a lesser degree, which are expected to have higher strength, are common. Also, due to the dip of the bedding planes, critical slip surfaces must pass through multiple beds of the Minturn formation. Therefore, in the event that isolated, weaker beds exist, it is still highly unlikely that the average shear strength along the failure plane will be lower than the 31 degrees used in the analysis.

For the seismic stability analyses, strengths were reduced by 20% in accordance with the recommendations provided by Hynes-Griffin and Franklin (1984) for performing seismic analyses using the pseudo-static method. As a result, the strength of the Minturn during seismic events was modeled using a Mohr-Coulomb envelope with a friction angle of 24 degrees and no cohesion. Both the static and pseudo-static strength envelopes for the Minturn are shown in Figure 1.

2.4.2 Lincoln Porphyry

Similar to the Minturn Formation, Call & Nicholas (2007) presents a range of strength values derived from both back-analysis of historic slides within the pit and from laboratory testing. To summarize, the back-calculated strength for weathered porphyry along the west wall of the pit is reported as 27 degrees with 1.4 psi cohesion. The values developed by Call & Nicholas for use in the mine pit stability analysis vary, and range from 23.1 degrees with 21.9 psi cohesion for highly altered porphyry to 53.5 degrees with 1717 psi cohesion for deeper, less altered rock.

As discussed reported in Section 2.3.2, Golder performed a large scale direct shear test on a sample of clayey sand weathered from the porphyry. A standard Mohr-Coulomb failure envelope fit to the large scale direct shear test data provides a friction angle of 35 degrees with 18 psi cohesion. Based on Golder's evaluation of the laboratory test data and engineering judgment, a bi-linear Mohr-Coulomb envelope was determined to provide the best fit to the data and the best representation in-situ material behavior. The best-fit strength envelope can be described as follows:

- Friction angle of 50 degrees with no cohesion for vertical effective stresses below 50 psi
- Friction angle of 33 degrees with 29.2 psi cohesion for vertical effective stresses above 50 psi

Evidence shows that weathering of the porphyry generally decreases with depth (i.e., strength increases). As a result, the strengths provided by the direct shear test should be representative of the residual soils weathered from the porphyry near the surface, but are increasingly conservative for deeper potential failure planes. Also, because the porphyry is generally massive without preferentially oriented joint sets, there is little likelihood of failure through a continuous weak zone at depth. After weighing these factors, Golder elected to use the bi-linear Mohr-Coulomb envelope described above in the stability analysis.

For the seismic stability analyses, strengths were reduced by 20% in accordance with the recommendations provided by Hynes-Griffin and Franklin (1984) for performing seismic analyses using the pseudo-static method. As a result, the strength of the porphyry during seismic events was modeled using a bi-linear Mohr-Coulomb envelope described as follows:

- Friction angle of 44 degrees with no cohesion for vertical effective stresses below 50 psi

- Friction angle of 28 degrees with 23.3 psf cohesion for vertical effective stresses above 50 psi

Both the static and pseudo-static strength envelopes for the porphyry are shown in Figure 2.

2.4.3 Glacial Till

As discussed above, Golder performed a large scale direct shear test on a representative sample of glacial till obtained from the drilling program. A standard Mohr-Coulomb failure envelope fit to the large scale direct shear test data provides a friction angle of 31 degrees with 14 psi cohesion. However, similar to the porphyry, Golder believes that a bi-linear Mohr-Coulomb envelope provides both a more realistic representation of actual material behavior, and the best fit to the data. The bi-linear strength envelope can be described as follows:

- Friction angle of 44 degrees with no cohesion for vertical effective stresses below 50 psi
- Friction angle of 30 degrees with 18.7 psi cohesion for vertical effective stresses above 50 psi

Golder elected to use the bi-linear Mohr-Coulomb strength envelope for modeling the strength of the glacial till under static conditions. For the seismic stability analyses, strengths were reduced by 20% in accordance with the recommendations provided by Hynes-Griffin and Franklin (1984) for performing seismic analyses using the pseudo-static method. As a result, the strength of the glacial till during seismic events was modeled using a bi-linear Mohr-Coulomb envelope described as follows:

- Friction angle of 38 degrees with no cohesion for vertical effective stresses below 50 psi
- Friction angle of 25 degrees with 14.9 psi cohesion for vertical effective stresses above 50 psi

Both the static and pseudo-static strength envelopes for the glacial till are shown in Figure 3.

2.4.4 Mine Overburden

2.4.4.1 Theoretical Background

The distribution of the various-sized particles plays a significant role in determining the physical properties of the mine overburden materials. In general, the value of this friction angle will be a result of the following:

- Particle size distribution (increasing with increasing particle size);
- Particle shape (increasing with angularity);
- Strength and specific gravity of individual particles (increasing with degree of silicification); and
- Applied stress level (decreasing with increasing normal stress, resulting in a curvilinear envelope passing through the origin).

Research conducted by Fragaszy, et al. (1992) suggests that the strength of a soil with oversize particles may conservatively be characterized by the strength of the matrix material if the oversize particles are truly in a floating state. Conversely, the strength of the soil may be characterized by the properties of the oversize material if there is sufficient oversize particle to particle contact. Various researchers suggest that the shear strength properties of a soil having less than 40 percent oversize material are controlled largely by the soil matrix and that the strength properties of a soil with over 65 percent oversize material are controlled primarily by the properties of the oversize material. The strength properties of soils having between 40 and 65 percent oversize material are controlled by both the soil matrix and the oversize material. It has long been recognized (Holtz and Gibbs, 1956; Holtz, 1960) that an increase in the proportion of coarse material in an otherwise fine-grained granular soil results in an increased shear strength. Simons and Albertson (1960) present data that show, for instance, that the effect of scalping to allow laboratory testing may reduce the indicated angle of repose for the scalped material by 6 degrees compared with the field value for the full-sized material. Alternatively, when the voids in a coarse grained rock fill are filled with fines (i.e., a well graded material), the friction angle can be increased by as much as 10 degrees. The amount of granular fines required to have a significant beneficial effect on the shear strength of mine overburden is relatively small (Stratham, 1974). Leps (1970) presented friction angle data based on triaxial strength testing of large size (up to 200 mm) rockfill particles. This data suggests that the friction angle of durable compacted rock fill could be as high as 60 degrees at low normal stress levels and is likely to be at least 45 degrees at moderate stress levels. Given the lower densities of mine overburden materials, the above data suggests that more durable well graded mined overburden materials could be expected to have peak shear strengths on the order of 40 to 45 degrees at moderate stress levels.

Due to the granular nature of mine overburden materials, there should not be any cohesive strength at low stress levels (i.e., the strength envelope should pass through the origin of the normal stress vs. shear stress space). In some cases, attempting to fit a linear Mohr-Coulomb envelope to a given set of data will produce an apparent “cohesion”. It is generally understood that this “cohesion” is an artifact of attempting to fit a linear line to a curvilinear data set. As a result, mine overburden material strength is either modeled using a curvilinear envelope, the Mohr-Coulomb line is forced through the origin (resulting in a poorer fit to the data), or the best-fit Mohr-Coulomb line is used for the analysis with the understanding that the “cohesion” is an artifact of the curve-fitting process, realizing that the assumed strength will not be realistic at low effective stresses.

Curvilinear strength envelopes for mine overburden are commonly modeled in several ways. Leps (1970) presents three different curvilinear envelopes for high, medium, and low strength rockfill. Mine overburden can be modeled by assuming one of these envelopes, when appropriate. Alternately, the mine overburden strength can be modeled using a Hoek-Brown criteria (Hoek et al, 2002). The benefit of these first two methods is that they do not require site-specific laboratory testing, although knowledge of the source rock type, particle size, weathering characteristics, and engineering experience is necessary to utilize these methods appropriately. A third method is to perform laboratory shear testing and then best fit a strength envelope to the data (typically a power curve). The main drawback to laboratory testing is that it is not practicable to test a representative sample of mine overburden rock due to the extremely large particle sizes and the limited scale of most laboratory equipment. A common standard of care approach is to test a sample where oversize material has been screened off, with the understanding that the strengths indicated by the test are representative of the mine overburden matrix material only, and likely underestimate the field strength of the material by a significant degree.

2.4.4.2 Climax Mine Overburden Strength Development

Mine overburden material consists of blasted overburden rock. At the Climax mine, there are abundant fill areas where aged mine overburden is available for logging and sampling. The current mine overburden fills were produced using similar mining methods as are expected to be utilized for the future phases of OSF expansion at the mine, so the geotechnical properties of existing fills are expected to be representative of future fills.

Four test pits were excavated into mine overburden fills for the purpose of classification and sampling. Visual field estimates place the percent of oversize material between 15 and 40 percent. These test pits were excavated on the mine overburden fill top surfaces. The mine overburden fills are expected to be constructed using haulage truck placement methods. Placing mine overburden from a high face results in segregation of the material, with the coarsest and most durable rock preferentially being deposited near the toe of the slope. Therefore, the percentage of oversize material estimated in the test pit logs is expected to represent the lower end of values expected for the site.

As discussed above, two large scale direct shear tests were performed on samples of mine overburden collected from the site. The shear box was 12 inches by 12 inches, and as a result only the sampled material finer than 2 inches was used in the test. Assuming zero cohesion, the results indicate residual strengths of 35 to 36 degrees (linear Mohr-Coulomb). Figure 4 shows the results of the laboratory testing overlain with the Leps (1970) curves for low, average, and high strength rockfill. Also shown are linear Mohr-Coulomb and power curves which best fit the laboratory data. These two best-fit lines lie approximately midway between the Leps curves for low and average strength rockfill.

For the Climax mine overburden, the curvilinear power curve fit to the large scale direct shear test data was selected for use in stability modeling. This curve is considered representative of expected worst-case conditions within the OSFs for areas where overburden derived from igneous and/or metamorphic rock makes up the majority of the OSF fill. For the majority of the OSF this strength envelope is considered conservative, as the tests were performed only on the finer-grained matrix material, and was not corrected to account for the large amount of oversize material present in the OSFs. Note that approximately 30% of the overburden is expected to consist of sedimentary rock. The power curve described above is also considered representative for areas of the OSF containing average quantities of sedimentary rock derived overburden (i.e., approximately 30%). Golder considers the low strength Leps curve an appropriate “lower bound” strength envelope for the OSF. The low strength Leps envelope is suitable for evaluating the stability of the OSF in the event that a significant contiguous portion of the facility is constructed primarily from sedimentary overburden. The strength envelopes for the mine overburden are shown in Figure 4.

2.4.5 Tailing

Golder based the strength envelope for the tailing on the results of the series of 3 CU triaxial shear tests performed on undisturbed Shelby tube samples obtained during the 2011 field investigation. The tests were performed on samples of tailing fines. Although it is possible that the coarser beach tailing have a greater strength, Golder conservatively applied the same shear strength envelopes to both fine and beach tailing. To Golder’s knowledge, there is no other laboratory data specific to the historic tailing impoundments within the North 40 OSF footprint. A standard Mohr-Coulomb envelope provided the best fit to the Golder test data. Although the best-fit envelope shows a cohesive intercept, Golder conservatively neglected cohesion for the determination of the design shear strength. The resulting shear strength envelope is described by a friction angle of 33 degrees with no cohesion.

For the seismic stability analyses, Golder utilized the total stress strength parameters, also provided by the Golder laboratory tests. The tests show a total stress Mohr-Coulomb envelope characterized by a friction angle of 18 degrees and 12 psi cohesion. For the analysis, Golder conservatively neglected the cohesion, and simply used a friction angle of 18 degrees. Both the static and pseudo-static strength envelopes for the tailing are shown in Figure 5.

3.0 OSF STABILITY ANALYSES

The purpose of this analysis is to evaluate the global stability of the North 40 and McNulty OSFs. Calculations were performed to assess both the operational and post-closure OSF configurations under both static and seismic loading conditions. A liquefaction assessment was performed to verify that the historic tailing deposits will not liquefy (i.e., lose a significant amount of their strength) during earthquake events. In addition, a rockfall hazard evaluation was performed to evaluate potential hazards to Highway 91 resulting from rocks falling from the OSFs. The details of the stability evaluation and the liquefaction assessment are presented in Appendices C and D, respectively. The evaluations are summarized below.

3.1 Liquefaction Assessment

The objective of this analysis is to determine the potential for the historic tailing deposits to liquefy when subjected to the project maximum design earthquake (MDE) seismic event. The MDE has a peak bedrock acceleration of 0.14g and a reoccurrence interval of 1 in 2,475 years. Liquefaction is defined as a loss in strength due to a build-up of excess pore water pressure. The generation of this excess pore water pressure is most commonly attributed to cyclic undrained loading, such as that applied by an earthquake.

The design condition that was evaluated for liquefaction of the buried historic tailing impoundments is the existing condition, which is considered to represent the most critical condition for liquefaction to occur. This is because the potential for liquefaction of the historic tailing, where they are located within the footprint of the North 40 OSE, will decrease once the OSF is constructed as a result of the additional confining stresses and densification that will occur.

As a preliminary means of evaluating the nature of the historic tailing deposits three screening level methods that correlate index properties with liquefaction susceptibility were considered, including the Chinese Criteria (Wang 1979, Youd et al 2001), the Andrews and Martin Criteria (2000), and the Bray and Sancio Criteria (2006). These three screening methods provide criteria are that based on index properties including in-situ moisture content, grain size (notably fines content) of the materials, and Atterberg limits.

The Chinese screening criteria indicated that the tailing beach materials are potentially liquefiable and the tailing fines are likely not liquefiable. The Andrews and Martin screening criteria also indicated that the tailing beach materials are potentially liquefiable and that the tailing fines require more rigorous testing and analysis to determine their liquefaction potential. Finally, the Bray and Sancio screening criteria indicates that both the tailing beach and tailing fines may be potentially liquefiable.

Because these three simplified screening procedures did not eliminate the historic tailing impoundments from being classified as potentially liquefiable, a more rigorous liquefaction assessment was performed.

Two different approaches were used for the rigorous assessment. The critical stress ratio (CSR) predicted from the maximum design earthquake (MDE) was determined by the method proposed by Youd et al. (2001). After the determination of the CSR, two methods were used to estimate the cyclic resistance ratio (CRR) of the historic tailing deposits. Both methods are based on the in-situ state of the deposits, however, this in-situ state is measured by independent methods.

The first method utilizes the state parameter as recommended by Jefferies and Been (2006). The state parameter corresponding to no-liquefaction was determined from the three CU triaxial tests (see Section 2.3). The in-situ state of the soil was then developed by a continuous void ratio-effective stress relationship based on one-dimensional laboratory consolidation and by natural density results from Shelby tube samples obtained during the field investigation. Based on this state parameter analysis, the in-situ state of the soil indicates that shearing will cause dilation and thus strain hardening. Factors of safety calculated from this analysis range from 1.6 to 3.6.

The second rigorous method estimates the in-situ state of the tailing deposits through evaluation of SPT results. SPT values were recorded during the October-November 2011 field investigation and these values were correlated with CRR. The relationship between SPT blow counts and CRR was recommended by Idriss and Boulanger (2008) and is based on a database of SPT values recorded in locations subjected to earthquake loading where liquefaction has either occurred or not occurred. The blow counts recorded in the field were corrected for overburden stress, rod length, and hammer efficiency to obtain the $(N_1)_{60}$ blow count value. Next, these blow counts were corrected for fines content to determine the equivalent clean sand blow count values. Finally, CRR was determined by the Idriss and Boulanger (2008) relationship and this CRR was corrected for the earthquake magnitude and overburden stress. The factor of safety against liquefaction determined by this method ranges from 2.1 to 2.9. As a result, both rigorous liquefaction evaluation methods provide relatively high factor of safeties against liquefaction for the critical existing conditions. Additional stress confinement that will occur within the footprint limits of the North 40 OSF, once it is constructed, will further reduce the potential for liquefaction and any potential impacts to the North 40 OSF.

3.2 Global Stability

3.2.1 Method of Global Stability Analysis

Limit equilibrium stability analyses were performed with Rocscience's 2-D program, Slide 6.0. Factors of safety were computed based on Spencer's Method of Slices (Spencer 1967). The program uses various search algorithms to calculate factors of safety against failure for thousands of potential failure surfaces in order to find the most critical failure surface (or kinematic mechanism), and then computes the factor of safety for that surface. The program was used to evaluate both circular and non-circular (i.e., translational or block) failure surfaces. In addition, both deep and shallow failure surfaces were investigated. However, surficial veneer (infinite slope) slip surfaces were excluded from the results by constraining the failure surfaces to a minimum depth of 15 feet.

Earthquake (seismic) loading conditions were simulated using a pseudo-static approach. In an actual seismic event, the peak acceleration would be sustained for only a fraction of a second. Actual seismic time histories are characterized by multiple frequency attenuating motions. The accelerations produced by seismic events rapidly reverse motion and, generally, tend to build to a peak acceleration which quickly decays to lesser accelerations. Consequently, the duration during which a mass is actually subjected to a uni-directional, peak seismic acceleration is finite, rather than infinite. The pseudo-static analyses conservatively models seismic events as a force with constant acceleration and direction, i.e., an infinitely long seismic pulse. As a result, the standard of practice for geotechnical engineers is to take only a fraction of the predicted peak ground acceleration (PGA) when modeling seismic events using a pseudo-static analyses. A pseudo-static factor of safety of 1.0 is considered appropriate for water retention structures, when the structures are modeled using one-half the peak ground acceleration generated from the design earthquake (Hynes-Griffin and Franklin, 1984), with a strength reduction of 0.2 (80% of the strength parameters) applied to any potential strain softening materials. The Climax OSE earthquake loading conditions were evaluated consistent with the Hynes-Griffin and Franklin methodology (1984).

The minimum allowable factors of safety and the design seismic events are described in the project design criteria in Appendix F. The design earthquakes were developed using the 2008 National Seismic Hazard Maps developed by the USGS. The return intervals for the design earthquakes were selected based on standards of engineering practice for these types of facilities. These criteria are summarized below:

- Active Operations Criteria:
  - Minimum allowable static factor of safety is ≥1.4
  - Minimum allowable seismic (pseudo-static) factor of safety is ≥1.0
  - Operational basis earthquake (OBE) PGA is 0.06g (representing the 1-in-475-years event).
- Closure and Post-Closure Criteria:
  - Minimum allowable static factor of safety is ≥1.5
  - Minimum allowable seismic factor of safety is ≥1.0
  - Maximum design earthquake (MDE) PGA is 0.14g (representing the 1-in-2,475-years event)

The stability was evaluated with five cross-sections, the locations of which were selected to represent the most critical or worst case stability conditions (i.e., steepest foundations, highest stockpile locations, etc. These design sections are generally oriented perpendicular to the foundation and OSF slopes, in areas with steep grades and the greatest fill height. The cross-section locations are shown on Drawings 3 and 4 with cross-sections illustrated on Drawings 5 through 9.

3.2.2 Global Stability Analysis Assumptions

It is routine practice for mines to update the mine plan, and corresponding OSF loading plans, throughout the mine life cycle. These routine mine plan and OSF updates occur within the general framework established by the project design criteria. Therefore, the relevant parameters in the design criteria were used to construct the OSF outslopes for use in the stability design sections. Sections constructed in this manner are considered to represent the "worst-case" section geometry (i.e., steepest slopes) possible within the constraints of the design criteria. The current operational OSF grading plans were developed by Climax, and provided to Golder on February 27, 2012. Golder evaluated the plan, and found it to be consistent with the project design criteria (see Appendix F). The relevant design criteria are listed below:

- OSF toe limits used were defined following the procedure discussed in Section 7 (Closure Considerations)
- Operational scenario:
  - Inter-bench angle of repose slopes were modeled as 1.4H:1V (or 36 degrees)
  - Operational benches were modeled as 200 feet wide
  - The maximum height between benches was modeled as 200 feet
  - Overall operational slopes were thus approximately 2.4H:1V
- Closure scenario:
  - Inter-bench reclamation slopes were modeled as 2H:1V
  - Closure reclamation benches were modeled as 20 feet wide
  - The maximum height between benches was modeled as 56 feet (125 feet slope length)
  - Overall closure slopes were thus approximately 2.4H:1V

The distribution of various geologic materials was modeled based on the findings of the field investigation performed in October and November 2011. A geologic map of the site (USGS, 1971) was also used to support the interpretation of the geology between borings and test pits. The material strength parameters defined in Section 2.4 were used in the analysis.

Piezometric surfaces were modeled based on water levels measured in temporary piezometers installed in the 2011 borings. In areas without tailing deposits, the existing piezometric surface was measured an average of 14 feet below the native ground surface (i.e., 14 feet below the base of existing fills, or 14 feet below the present ground surface in areas with no fill). No perched water was encountered within any of the existing mine overburden fills. In areas with historic tailing deposits, the piezometric surface was located within the upper 10 feet of tailing deposits.

A sensitivity analysis was performed in order to evaluate the effect of varying piezometric levels on OSF stability. For the sensitivity analysis, a conservative, worst-case piezometric surface was assumed to exist at the top of native ground and at the surface of the historic tailing impoundments. Stability was evaluated along the two most critical cross-sections under static conditions.

3.2.3 Global Stability Analysis Results

Based on the analyses performed for this study, all computed factors of safety meet or exceed the factors of safety established by the Project Design Criteria, for both the maximum operational and closure slope scenarios. Factors of safety for the operational and post-closure OSF configurations are presented in Tables 5 and 6, respectively.

The sensitivity analysis showed that the factor of safety is relatively insensitive to changes in the phreatic surface. When conservative elevated phreatic levels were modeled at the base of the OSF, static factors of safety decreased by only 0.02 to 0.08 from the base case. The OSF underdrain system has been designed to prevent elevated phreatic levels at the base of the OSFs, primarily to minimize the potential to develop hydraulic head above the non-contact water underdrain system (see details 2 and 3 on Drawing 10). Therefore, while elevated phreatic levels at the base of the OSF are not anticipated to occur, increased piezometric levels beneath the OSFs are not predicted to create unstable conditions. As a result, installation of piezometers and regular monitoring of groundwater levels are not required as a component of the O&M plan.

3.3 Rockfall Hazard Evaluation

A rockfall evaluation was performed using the Colorado Rockfall Simulation Program (CRSP), Version 4.0. The purpose of the evaluation was to identify potential hazards to Highway 91 resulting from rocks falling from the OSFs. The rockfall run-out potential was evaluated along five (5) sections through the North 40 OSF and low grade ore stockpile area, where the distance between the OSF and Highway 91 is the least. At each cross-section location, CRSP was used to roll 1000 simulated 3-foot diameter rocks. The results show that none of the rocks will reach Highway 91.

4.0 WATER MANAGEMENT AND HYDROLOGIC DESIGN

4.1 Contact Water Collection System Conceptual Design

The purpose of the CWCS is to collect water that has contacted the McNulty OSF and reports to the toe. The CWCS components described below are conceptual in that they represent a general approach to collect and convey water at the OSFs. As the OSFs are constructed, final CWCS designs may be modified based on field conditions or if other construction materials are deemed to be more appropriate.

The CWCS piping system conceptual design consists of primary and secondary perforated corrugated polyethylene (PCPE) pipes placed within the McNulty Gulch drainages. At this time, it is envisioned that there would be two 18-inch diameter primary pipes, one within the main McNulty Gulch north fork, and one within the main McNulty Gulch south fork. Secondary CWCS collector pipes will be smaller (e.g., 10-inch diameter), and will be placed, if needed, in all side drainages reporting to the two main forks of the McNulty Gulch. CWCS Pipes will be protected with drain gravel or other suitable material, which will be wrapped with 12-oz/yd^2 non-woven geotextile or other suitable filter material.

At the toe limit of the OSF, berms would be constructed to direct flows from the PCPE pipes and drain rock into solid-wall high density polyethylene (HDPE) pipes. The solid pipe will exit the toe of the OSF and convey flows to the Climax contact water circuit via the ETDL and/or East Side Channel. The conceptual locations of the CWCS pipes are shown on Drawings 3 and 4, and conceptual level details of the system are shown on Drawing 10. As noted on the Drawings, the conceptual CWCS design will be advanced to a construction level following regulatory acceptance of the CWCS conceptual design approach.

Golder has designed the CWCS to collect and convey 100% of the 100-year, 24-hour design storm which, for design purposes, is conservatively assumed to infiltrate entirely into the OSF and report to the base. It is recognized that in actuality this will not occur as most of the precipitation that falls on the OSFs will runoff, evaporate, sublimate or be retained by the overburden. Also, once a reclamation cover is placed, there would be significantly less infiltration occurring. To provide for a conservative worst case scenario, the CWCS pipes were conservatively sized assuming the entire design storm will report to the CWCS pipes within a period of 48 hours. The CWCS pipes were also designed with a factor of safety of 2. The flow capacity of various pipe sizes was evaluated using Manning's equation. It should also be noted that the CWCS flow capacity conservatively neglects the very high permeability of the overburden that will occur at the base of the OSFs. This very high permeability is the result of the coarsest rocks being deposited at the base of the OSFs as material is placed from the crest. The detailed calculation for sizing the CWCS pipes is presented in Appendix G.

4.2 Underdrain Design

4.2.1 Description of Conceptual Underdrain System

The purpose of the underdrain system is to capture non-contact water entering McNulty Gulch through springs/shallow groundwater, and to convey those flows to the toe of the OSF while preventing contact with OSF material. Like the CWCS described previously, the underdrain components described below are conceptual in that they represent a general approach to collect and convey water at the OSFs. As the OSFs are constructed, final underdrain designs may be modified based on field conditions or if other construction materials are deemed to be more appropriate.

The underdrain system will conceptually consist of primary, secondary, and tertiary underdrains. At this time, it is envisioned that each underdrain will consist of PCPE pipes embedded in drainage rock and wrapped with 12-oz/yd^2 non-woven geotextile for protection. The dimensions, extent, and pipe sizes of the primary and secondary underdrains will be determined based on the results of baseline flow rate monitoring of springs, as further described in the following section. The drainage gravel will covered with a 1 foot thick layer of low permeability liner bedding fill, on top of which an 80-mil linear low density polyethylene (LLDPE) geomembrane will be installed. The geomembrane will extend approximately 20-feet on either side of primary and secondary underdrain centerlines (i.e., two roll widths will be fusion welded). Similarly, a full roll width (approximately 20 feet wide) will be installed over each tertiary underdrain. Geomembranes will be anchored with anchor trenches and capped with a layer of overliner fill, which is provided to protect the geomembrane from damage during mine overburden placement. Conceptual level underdrain details are provided on Drawing 10.

The primary and secondary underdrains will be constructed within the McNulty Gulch drainages. There will be two primary underdrains, one within the main McNulty Gulch north fork, and one within the main McNulty Gulch south fork. Secondary underdrains will be smaller, and will be placed, where needed, in secondary drainages reporting to the two main forks of the McNulty Gulch. Tertiary underdrains collect and convey flows from springs located outside of the drainages to the primary and secondary underdrains. It is also anticipated that tertiary underdrains will convey non-contact flows from presently unknown small springs that will be encountered during clearing and grubbing of the foundation soils (for future reclamation growth medium). Preliminary primary and secondary underdrain locations are shown on Drawings 3 and 4.

The two primary underdrains will terminate in concrete manholes. The purpose of these manholes is to capture flows from the underdrain systems and transfer the flows to solid wall HDPE pipes. The pipes carrying the underdrain flows will terminate in a third concrete manhole immediately below the toe of the McNulty OSF. The third manhole, which will also receive non-contact surface water flows from north of the OSF, will discharge to the East Interceptor or other clean water conveyance at closure. The concrete vaults will be constructed with overflow outlets located near the top of the manhole. In the event that upset conditions cause flows that exceed the capacity of the system, non-contact water will overflow into the CWCS. The primary non-contact underdrain pipelines also will be plumbed to allow bi-pass to the contact water circuit manhole if ever needed.

4.2.2 Underdrain System Sizing Calculations

The underdrain system will be designed with an appropriate factor of safety for the peak flows determined from baseline monitoring of surface water runoff in McNulty Gulch (per the design criteria included in Appendix F). It is anticipated that the final design will provide a safety factor of 5 for both the piping and granular drain components of the underdrain.

A baseline monitoring plan for obtaining flow data for sizing the primary and secondary underdrains is described in Section 6. Tertiary underdrains will be sized in accordance with the project design criteria based on spring flow rates observed in the field during construction.

4.3 Operational Surface Water Management

4.3.1 Overview of Conceptual Surface Water Management System

The primary component of the operational surface management system is a series of perimeter channels and/or water management berms designed to maintain separation of contact and non-contact stormwater occurring on and adjacent to the OSFs. In addition, four energy dissipaters and three concrete manholes are anticipated. The layout of the berms and/or channels, energy dissipaters, and concrete manholes is shown on Drawings 3 and 12, and is summarized below. Similar to the other water collection systems, the surface water management system described below is conceptual in that it represents an overall approach to collect and convey water at the OSFs. As the OSFs are constructed, final designs may be modified based on field conditions, updates to the mine plan, or if other construction materials are deemed to be more appropriate.

In this report, “energy dissipater” refers to a section of revetment (e.g., articulated concrete block (ACB) lined channel section with a flat, wide base designed to promote and contain a hydraulic jump. The purpose of the energy dissipater is to provide for a controlled transition of supercritical to subcritical flow at the base of the downdrains and other steep channel segments. “Manholes” are concrete vaults with vertical sides. Water can be transferred to the manhole, either as surface water flow entering from the top or from pipes discharging into the manhole. The advantages of concrete manholes are:

- Do not require a large area
- Effective at changing the flow direction of water, especially in a tight spaces
- Can be used to transfer water from surface channels to pipes

- Can be designed to capture water from multiple sources (i.e., underdrains and surface water channels)

Conceptual level details for energy dissipaters and manholes are shown on Drawings 11 and 12. As noted on the Drawings, it is anticipated that the conceptual surface water management details will be advanced to a final level of design once baseline flow data has been compiled and the conceptual water management strategy has been approved by DRMS.

The operational water management strategy for the North 40 OSF is to provide several perimeter channels and/or water management berms, each designed to collect contact water runoff from the OSF. Details of the operations perimeter channels and water management berm geometry are shown on Drawing 12. These features will be constructed when needed during OSF expansion at Climax. Drawings 13, 14, and 15 show the OSF plans at the end of years 5, 10, and 15 of operations, respectively. These drawings also show the proposed staged development of the operational water management systems.

An energy dissipater will is anticipated for the south side of the North 40 OSF, where water flowing east to west will undergo a sharp reduction in gradient. The water from this energy dissipater will be discharged into the camp drain system. A second energy dissipater may be located on the west side of the North 40 OSF, adjacent to the existing DSM interceptor, where the contact water flowing south along the OSF perimeter undergoes a sharp reduction in grade. The energy dissipater would discharge water to a concrete manhole. A second perimeter channel or water management berm, running south to north along the west side of the southern North 40 OSF and low grade stockpile area, will also discharge to the second concrete manhole. Water entering the concrete manhole will be transferred to a pipe, which will tie into the ETDL, East Side Channel, or other conveyance. Where feasible, the tops of OSFs also will be back-sloped to promote drainage off of the tops and into channels.

Note that water management berms and run-on collection channels are not proposed for the northeast side of the North 40 OSF. Water in this area will be managed using temporary channels and berms constructed along haul roads crossing through this area. Because haul road locations will change during the operational period, so will the location of the temporary water management structures.

The McNulty OSF will have two perimeter channels or water management berms. Both channels or berms will direct water to the low point at the base of the OSF, adjacent to the East Interceptor. Collected water will be directed into two energy dissipaters. Two additional concrete manholes will be used at the base of the McNulty OSF. One manhole will be used to capture contact water and outlet the flows to a pipe, which will then connect to the contact water circuit via the ETDL and/or East Side Channel. The second McNulty OSF manhole will capture non-contact water, and transfer the water to the East Interceptor. The non-contact manhole will also collect piped flows from the underdrain system.

4.3.2 Surface Water Design Methods and Assumptions

The details of the hydrologic and hydraulic calculations are provided in Appendix E, and are summarized below. Watersheds were delineated using the existing 2010 site topography and the current OSF grading plans provided by Climax. Additional hydrologic parameters (i.e., precipitation data, design methodology, SCS Curve Numbers (CN), etc.) are as specified in the project design criteria (Appendix F). The hydrologic analysis was completed using HEC-HMS modeling that incorporated SCS methodology to determine the peak discharges and runoff volumes generated by the design storm event. The design storms were defined based on climate data presented in Exhibit K of the AM-06 permit amendment. For operations, the design storm for use in designing temporary run-on/run-off channels was defined as the 10-year, 24-hour storm event (1.40 inches). For perimeter channels which will be utilized at closure in addition to during operations, the post-closure criteria were used. The post-closure channel design criteria consider both potential rainfall and potential snowmelt. The post-closure design storm was defined to be the more conservative (more severe) of either the 100-year, 24-hour storm event or the 10-year, 24-hour storm event superimposed with the estimated flow produced by the 100-year, 24-hour snowmelt event. Based on the available climate data, the 100-year, 24-hour storm event will produce a larger peak runoff, and will therefore be used as the basis for channel design. Based on data from the Climax weather station, the 100-year, 24-hour storm event is 1.99 inches.

The operations perimeter channels have been conceptually designed with 3H:1V side slopes. For constructability, and also to allow cleanout of sediment and snow, the base of the operations channels will be 5-ft wide. The channel will be 3.5 ft deep in order to convey the design storm while maintaining freeboard requirements. Alternately, water management berms have been designed with a height of 4 ft and 2.5H:1V slopes. Per the design criteria riprap or other revetment will be provided for permanent channels or other water conveyances (i.e., conveyances to be used post-closure, in addition to during operations) where velocities were calculated to exceed 5 ft/s during the design storm event. Temporary channels will be unlined, with Climax performing repairs as required. Riprap will primarily be used in perimeter channels and on the water management berms, while ACB will be used for the energy dissipaters required at major grade breaks between steeper and shallower segments.

4.4 Post-Closure Surface Water Management Strategy

4.4.1 Summary of Post-Closure Strategy

The post-closure surface water channels, water management berms, energy dissipaters, and manholes were designed using the same methodology used for the operational system. The details of the design calculations are provided in Appendix E. A summary of the post-closure water management strategy is provided below.

As discussed in Section 7, the outslopes of the OSFs will be regraded at closure from 200 feet high angle of repose interbench lifts to 2H:1V interbench slopes separated by 20 wide horizontal benches, that will provide a nominal 125 foot long slope length. Outslope channels will be constructed on each bench, which will collect sheet flow from the slope above it and convey the water to a downdrain. Closure and reclamation (C&R) of the OSFs will include a reclamation cover as described in Exhibit E to AM-06. Therefore, the post-closure flows are considered non-contact stormwater. Details showing typical bench channel and downdrain geometry are shown on Drawing 11.

A conceptual closure design illustrating the post-closure surface water channels and structures is shown on Drawing 4. At closure, the top surfaces of the OSFs will be backsloped and constructed or graded to promote runoff. Channels will then be constructed on the OSF top surfaces to prevent water from flowing over the crest and convey the non-contact runoff to downdrains that will flow to energy dissipaters at the base of the channels. Flows will generally exit the energy dissipaters into perimeter channels or along water management berms for conveyance to the East Interceptor or other conveyance for discharge from the site.

The North 40 OSF post-closure surface water management will conceptually include 5 downdrains. Each of the downdrains will have an energy dissipater at the toe, which will transfer water to non-contact perimeter channels or water management berms. One perimeter channel and/or berm will convey water around the southeast corner of the OSF, and then tie into the camp drain system (expected to be reclaimed for non-contact use). A second perimeter channel and/or berm will run south to north along the west side of the North 40 OSF and low grade ore stockpile area to the concrete manhole on the west side of the OSF, near the DSM interceptor. Where practicable, perimeter channels, berms, energy dissipaters, concrete manholes, and other water management structures constructed during operations will also be used during closure. The existing structures will be modified or upgraded, as necessary. Additional non-contact channels and/or berms will also be constructed where required.

As shown on Drawing 4, it is anticipated that the North 40 OSF closure strategy will require a non-contact water conveyance to transport non-contact flows north from the concrete manhole (near the DSM Interceptor) towards the East Interceptor or other conveyance. This function could be served by the reclaimed East Side Channel, a pipeline, or an additional channel constructed at closure.

There is a limited area on the north side of the North 40 OSF, between the OSF and the pit. During operations, run-off from this area will be managed with temporary channels and ditches constructed along haul roads. At closure, it is anticipated that run-off collection channels will collect and convey this water to the pit, where it will be managed with other pit inflows.

The conceptual closure plan for the McNulty OSF includes 5 downdrains, with four of the downdrains flowing to new energy dissipaters. The largest downdrain will flow into an energy dissipater at the base of McNulty Gulch constructed for operations, and then connect to the non-contact water manhole constructed for operations. The operations contact water manhole at the toe of McNulty OSF will be converted to a second non-contact water manhole to accommodate flow from the western perimeter channel or water management berm.

The operational perimeter channels and/or water management berms on the east and west sides of the gulch will be used to collect non-contact run-off and flows from the OSF, and may be upgraded if needed. Two of the downdrains will be constructed on the north side of the OSF. These downdrains will direct flows to energy dissipaters, and then to the perimeter channel or water management berm along the north side of the OSF, which will report to the energy dissipater at the toe of McNulty Gulch,

The remaining two downdrains flow to the toe of the OSF on the southeast side. After being collected in energy dissipaters, the water will flow to the southwest through a non-contact perimeter channel or along a water management berm. This perimeter channel or berm will connect to the North 40 OSF perimeter channel or berm, which continues around the southeast corner of the North 40 OSF before tying into the camp drain system.

4.4.2 Additional Toe Drain Design

The McNulty OSF CWCS will continue to operate at closure. As needed, additional CWCS toe drains will be constructed at select locations along the perimeter of the OSFs where there is potential for contact water to exit the toe of the OSFs as seepage, where operational perimeter channels or berms are no longer required. The additional toe drains are anticipated to consist of a perforated pipe placed in a drain rock filled trench oriented generally parallel to the OSF toe. As discussed above, there will be a number of non-contact surface water channels or water management berms along the perimeter of the OSFs during post-closure. The toe drain system will be designed to capture potential seepage flows before they can exit the OSF slopes and enter these conveyances. The additional toe drains will convey the collected water and transfer it to the ETDL or other conveyance for treatment. The flows captured by the toe drain system are anticipated to be small, as the majority of the contact water internal to the OSF will be captured and managed by the CWCS (see Section 4.1).

5.0 OSF OPERATION AND MONITORING

The investigations and analyses that have been conducted for the Climax OSFs demonstrate that after the final configuration for these facilities are completed, they will have adequate long-term stability. Given the magnitude of the size of the OSFs, it is not practical or realistic to evaluate all the potential intermediate development phases that will occur as the OSFs are developed. Rather, stability of the intermediate development stages will be managed by Climax based on the overall design criteria and an active monitoring program. As a result, Golder has developed an operation and monitoring (O&M) Plan to be used by Climax to support safe development of the OSFs during operations. It is anticipated that the O&M Plan will be a “living document” that is continually updated and improved upon to allow safe development of the OSFs to occur, if limited failures occur during early and intermediate stages of development.

The operation and monitoring plan is presented in Appendix H. The plan includes a discussion of performance and operational considerations, including:

- Construction on steep foundations
- Direction of OSF crest advance
- Selective placement of mine overburden based on material type
- Establishment of restricted access areas
- Water management and monitoring
- Winter Operations

It is well established that failures of mine OSFs are preceded by warning signals such as an increased rate of deformation, increased rate of cracking of the OSF platform, bulging of the OSF face, cracking and bulging at the OSF toe or increased rate of pore water pressure buildup in the OSF foundation. The OSF monitoring program has been developed to:

- Provide early warning of conditions that could lead to failure so that preventative measures can be taken;
- Provide early warning of impending failure so that personnel and equipment can be removed from the area at risk; and,
- Collect and assess data that will confirm or negate the assumptions made during the design studies and to provide data that will allow the design of the OSF to be modified during the life of the mine to improve the performance of the OSF.

A comprehensive OSF monitoring program consists of regular (each shift) visual inspection and of the OSF by the operating personnel, and periodic inspection and ongoing assessment of the accumulated data by the responsible mine engineer. Climax mine will institute a program for monitoring movements of the foundation downgradient of the OSFs, adjacent to the Highway 91. The operation and monitoring plan includes specific requirements regarding the types of monitoring, frequency of monitoring, reporting requirements, and steps to be taken in the event routine monitoring reveals failure warning signs. Monitoring requirements include

- Visual Inspections
- Crest displacement monitoring if indicated by the visual inspections
- Foundation displacement monitoring
- Engineer inspections

The O&M Plan also includes procedures for failure reporting and recommendations for back analysis and design parameter refinement, which can be used to improve monitoring procedures and update the OSF design to decrease the likelihood of future problems.

6.0 RECOMMENDATIONS TO FINALIZE OSF DESIGNS

The designs presented herein were developed using the available site and laboratory information, supplemented by the results of the 2011 Golder field and laboratory investigations performed in support of this report. Where site or laboratory data was not available, Golder used assumptions that are consistent with the current state of practice in the mining industry. It is anticipated that the Climax OSF designs will be finalized pending review by DRMS.

A conceptual design has been developed and design criteria have been established for the McNulty OSF underdrain system (Appendix F). However, data concerning the baseline runoff flows from the various drainages, springs and seeps has yet to be collected. There is no underdrain required for the North 40 OSF. Golder recommends monitoring the McNulty Gulch drainage network at several locations to provide data to appropriately size the underdrain system in each of the main drainages and sources of the watershed. Proposed monitoring locations are shown on Figure 6. Baseline flows should be collected monthly (when not covered with snow). Flows through the system are expected to be greatest during the spring snowmelt season, and it is most important to capture measurements of the peak flows during this time. Therefore, to the extent that access is available, flow measurements should be collected at a minimum bi-weekly frequency during the spring snowmelt. Measurements should be recorded for at least one full season prior to finalizing the underdrain design. Baseline measurements should include quarterly water quality indicators for the major springs and seeps to verify suitability to inclusion in the non-contact water circuit.

7.0 CLOSURE CONSIDERATIONS

Climax and Golder have developed closure design criteria (Appendix F), an OSF design that is compatible with the operational and post-closure OSF configurations, and a conceptual closure design, as shown in plan on Drawing 4.

As previously discussed, the operational OSF outslope will be constructed at an overall slope of 2.4H:1V by constructing a series of 200 ft high angle of repose lifts separated by 200 ft wide horizontal benches. At closure, the overall slope of the OSF outslopes will remain at 2.4H:1V. The interbench slopes will be regraded for compatibility with the closure configuration. Regrading of the angle of repose slopes will reduce maximum slope lengths to 125 feet (measured parallel to the slope), and reduce the interbench slope angle to a maximum of 2H:1V. Outslope drainage channels will be constructed in the reclamation benches. Regrading of the OSF outslopes will produce a more erosion resistant slope that will be stable in the long-term and facilitate cover soil placement, reclamation, and management of storm water falling on the OSF.

Dozers will perform cut-to-fill pushes to regrade the operational outslopes from angle of repose to a maximum of 2H:1V. This will result in an extension of the OSF outslope toe limits as material near the crest of the operational lifts is pushed down and placed as fill near the toe.

Golder has evaluated the proposed operational OSF toe for compatibility with closure. The evaluation included verifying that extension of the OSF outslope will not conflict with existing utilities, extend beyond property boundaries, extend into adjacent watersheds, or interfere with other features which may not be relocated at closure. Golder also verified that a sufficient offset will exist post-closure between the extended ultimate OSF closure slope and the critical features that have been identified (e.g., utilities, property boundaries, etc.), in order to allow sufficient space for perimeter channels, berms, and access roads. The results of this evaluation identified the following limitations to extension of the final closure slope that were considered in the development of the maximum operational OSF footprints:

- On the east side of the North 40 OSF, the OSF extents are limited by the truck shop, haul roads, utility corridor, and the open pit;
- The southern extents of the North 40 OSF are limited by several mine buildings and the camp drain system;
- On the west side of the North 40 OSF, the ETDL is the limiting feature;
- The north side of the North 40 is generally unlimited, and abuts directly with the southern sector of the McNulty OSF;
- The east and north sides of the McNulty OSF are limited by Climax property limits and by the hydrologic divide separating the McNulty Gulch and Clinton Creek drainages; and,
- On the west side of the McNulty OSF, the extents are ultimately limited by the ETDL.

The ultimate operational OSF grading plan is provided as Drawing 3 with the conceptual post-closure layout provided on Drawing 4. The ultimate OSF closure footprint covers more area than the operational OSF footprint, with the closure limits generally extending beyond the operational limits. However, the additional area covered by the post-closure OSF is minimized due to the compatibility between the overall operational and post-closure OSF slopes (i.e., both are 2.4H:1V).

Other aspects of the conceptual closure plan include placement of a reclamation cover on the OSF to facilitate revegetation, and continued management of surface water in order to maintain segregation of contact and non-contact flows. The objective of the reclamation cover will be to control erosion, reduce infiltration, prevent contact between stormwater and mine overburden, and promote revegetation. Revegetation of the OSF will follow the plan presented in Exhibit E of the AM-06 permit amendment.

Water management post-closure will be maintained through a network of surface water channels, water management berms, and other systems constructed during operations and after mining ceases. Where practicable, perimeter channels, berms, energy dissipaters, concrete manholes, and other water management structures constructed during operations will also be used during closure. The existing structures will be modified or upgraded, as necessary. Additional non-contact channels and/or berms will also be constructed where required.

The conceptual closure grading and water management plan illustrated on Drawing 4 provides for a “barber-pole” channel layout, e.g., top-surface and outslope channels that will convey runoff to steeper downdrains and then to perimeter channels or water management berms. While stormwater falling on the OSF during operations is considered contact water, stormwater falling on the OSF post-closure will remain non-contact stormwater due to the reclamation cover. As shown on Drawing 4 and discussed above in Section 4.3, the post-closure surface water network will include:

- Top surface channels will be constructed to collect and convey storm water runoff from the top surfaces of the OSF and direct it to downdrains.
- Channels will be constructed in the 20 ft wide benches on the regraded OSF outslopes to convey runoff from the reclaimed interbench slopes to the downdrains.
- Downdrain channels will collect water from the top surface and outslope bench channels and transmit the water down the OSF outslopes to energy dissipaters, located at the toe of the OSF, and then on to perimeter channels.
- Perimeter channels and/or water management berms will collect water from downdrains and convey the water along the toe of the OSF to the East Interceptor or other conveyance, where the non-contact water will be discharged.
- Run-on diversion channels/berms are anticipated to be constructed on the east sides of the North 40 and McNulty OSFs, as shown on Drawing 4.
- A toe drain network would be constructed along the toe of the OSFs in areas where water internal to the OSFs has potential to exit the OSFs as seepage near the toe of the slope.

The toe drain network will collect this contact water and transmit it to the ETDL or other contact water conveyance.

- The underdrain system will remain in service at closure to convey flows from springs within the McNulty OSF footprint, and transmit them to the toe of the slope while maintaining separation between the collected water and the overlying OSF material.

8.0 CLOSING

The analyses, conclusions, and recommendations presented in this report were prepared in accordance with the generally accepted standard of practice and standard of care for professional geotechnical engineering principles and practices at the time this report was prepared.

This report was prepared for the exclusive use of Climax for evaluating potential OSF designs and for supporting permit documents. The data and report may be provided to appropriate government agencies and/or prospective contractors for their information; however, our report, conclusions, and interpretations should not be construed as a warranty of actual subsurface conditions.

Golder appreciates the opportunity to provide support for the McNulty and North 40 OSF project. If you have questions regarding the information contained herein, please contact us at (303) 980-0540.

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TABLES

Table 1
Borehole Locations and Summary of Findings

Borehole ID	Date	Approximate Location	Summary of Materials Found	Depth to Native (ft)	Depth to Bedrock (ft)	Depth to Water Table (ft)	Total Depth (ft)	Northing[1]	Easting[1]	Elevation (ft asl)
GA-11B-20	11/3/2011	McNulty Gulch	0 to 38.5 ft: Colluvial material derived from the Minturn 38.5 to 54 ft: Weathered Lincoln Porphyry	0	38.5	24.8	54	12162	4936	11317
GA-11B-21	10/20/2011	Waste Rock in McNulty Gulch	0 to 25 ft: Waste Rock 25 to 43 ft: Weathered Minturn Sandstone 43 to 78.5: Minturn Sandstone with thin beds of shale and clay	25	43	42.9	78.5	11251	6420	11400
GA-11B-22	11/1/2011	McNulty Gulch	0 to 10 ft: Road fill 10 to 33.5 ft: Weathered Lincoln Porphyry	10	10	12	33.5	11562	4503	11400
GA-11B-23	10/24/2011	Waste Rock Pile on top of Tailings	0 to 179 ft: Waste Rock 179 to 235: Tailings 235 to 294 ft: Glacial Till	235	NA	179.8	294	7257	2855	11430
GA-11B-24	10/18/2011	Gravel Pit	0 to 45 ft: Waste Rock 45 to 98 ft: Tailings 98 to 164.5 ft: Glacial Till	98	NA	54.9	164.5	6241	2935	11330
GA-11B-25	10/21/2011	Laydown Yard	0 to 7 ft: Fill 7 to 33.5 ft: Waste Rock 33.5 to 72 ft: Tailings 72 to 171 ft: Glacial Till 171 to 193 ft: Weathered Lincoln Porphyry	72	171	33.9	193	5628	2903	11320
GA-11B-26	10/20/2011	Above McNulty Gulch	0 to 4 ft: Topsoil 4 to 36 ft: Weathered to Slightly Weathered Lincoln Porphyry	0	4	13.1	36	10023	3900	11682

[1]Northings and Eastings are listed based on the local mine coordinate system

Table 2
Summary of Previously Reported Minturn and Lincoln Formation Strengths[1]

Formation	Back Calculated or From Field/Laboratory Data	Where Values Were Originally Applied	General Notes	Rock Mass Information		Rock Mass Strength		Intact Rock Strength	Shear Strength Along Joints/Bedding Planes	
				RQD	GSI	phi (degrees)	c (psi)	UCS (psi)	phi (degrees)	c (psi)
Minturn Formation	Back Calculated	Pit West Wall		--	--	29.0	4.9	--	--	--
	Field / Lab Data	Pit West Wall		--	--	19.0	32.9	--	--	--
	Field / Lab Data	Pit West Wall		12	--	30.8	895.0	3607	15.8	4.1
Lincoln Porphyry	Back Calculated	Pit West Wall		--	--	27.0	1.4	--	--	--
	Field / Lab Data	Pit West Wall		--	--	--	--	5179	24.4	4.9
	Field / Lab Data	Pit West Wall	Very Altered Rock	--	--	23.1	21.9	--	--	--
	Field / Lab Data	Pit West Wall	Altered Rock	--	--	29.4	57.2	--	--	--
	Field / Lab Data	Pit West Wall	Upper Zone	--	--	33.1	515.0	2193	20.6	2.4
	Field / Lab Data	Pit West Wall	Transition Zone	--	--	41.7	946.0	5479	24.9	4.9
	Field / Lab Data	Pit West Wall	Lower Zone	--	--	53.5	1717.0	12967	27.3	4.9

[1] Values summarized from: Call and Nicholas, Inc. 2007. "Slope Stability Evaluation For Feasibility Level Pit Design of Long Range Reserves at Climax Mine."

Table 3
Strength Parameters Utilized for Static Stability Analysis

Soil Type	Total Unit Weight (pcf)	Failure Envelope Type	Failure Envelope Definition (psf)	Notes
Native Materials				
Minturn Formation	119	Mohr-Coulomb	$\tau' = \sigma'\tan(31°)$	This failure envelope was determined from the strength results of a staged undrained triaxial test with pore pressure measurements. No cohesion was included for conservatism.
LincolnPorphyry	117	Bi-Linear Mohr Coulomb	$\tau' = \sigma'\tan(50°)$ for $\sigma'<7200$ $\tau' = \sigma'\tan(33°)+4200$ for $\sigma'>7200$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests.
GlacialTill	123	Bi-Linear Mohr Coulomb	$\tau' = \sigma'\tan(44°)$ for $\sigma'<7200$ $\tau' = \sigma'\tan(30°)+2688$ for $\sigma'>7200$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests.
Overburden Materials				
Best Approximation Overburden Parameters	120	Power Function	$\tau' = 3.18\sigma'^{0.86}$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests. This envelope lies between the average and low envelopes developed by Leps (1971).
Lower Bound Overburden Parameters	120	Power Function	$\tau' = 2.02\sigma'^{0.90}$	This failure envelope was used to account for a higher proportion of weaker materials with in the OSF. This envelope is analagous to the low strength envelope developed by Leps (1971).
Tailings Materials				
Tailings Materials	100	Mohr-Coulomb	$\tau' = \sigma'\tan(33°)$	This failure envelope was determined from the residual strength results of a staged undrained triaxial test with pore pressure measurements. No cohesion was included for conservatism.

Table 4
Strength Parameters Utilized for Pseudo-Static Stability Analysis

Soil Type	Total Unit Weight (pcf)	Failure Envelope Type	Failure Envelope Definition (pcf)	Notes
Native Materials				
Minturn Formation	119	Mohr-Coulomb	$\tau' = \sigma'\tan(24°)$	This failure envelope was determined from the strength results of a staged consolidated undrained triaxial test with pore pressure measurements. No cohesion was included for conservatism. Values were reduced by 20% for the seismic condition.
Lincoln Porphyry	117	Bi-Linear Mohr Coulomb	$\tau' = \sigma'\tan(44°)$ for $\sigma'<7200$ $\tau' = \sigma'\tan(28°)+3360$ for $\sigma'>7200$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests with the values reduced by 20%.
Glacial Till	123	Bi-Linear Mohr Coulomb	$\tau' = \sigma'\tan(38°)$ for $\sigma'<7200$ $\tau' = \sigma'\tan(25°)+2150$ for $\sigma'>7200$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests with the values reduced by 20%.
Overburden Materials				
Best Approximation Overburden Parameters	120	Power Function	$\tau' = 3.18\sigma'^{0.86}$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests. This envelope lies between the average and low envelopes developed by Leps (1971).
Lower Bound Overburden Parameters	120	Power Function	$\tau' = 2.02\sigma'^{0.90}$	This failure envelope was used to account for a higher proportion of weaker materials with in the OSF. This envelope is analagous to the low strength envelope developed by Leps (1971).
Tailings Materials				
Tailings Materials	100	Morh-Coulomb	$\tau = \sigma\tan(18°)$	This failure envelope was determined from the residual strength results of a consolidated undrained triaxial test with pore pressure measurements. A total stress approach was utilized for the seismic condition.

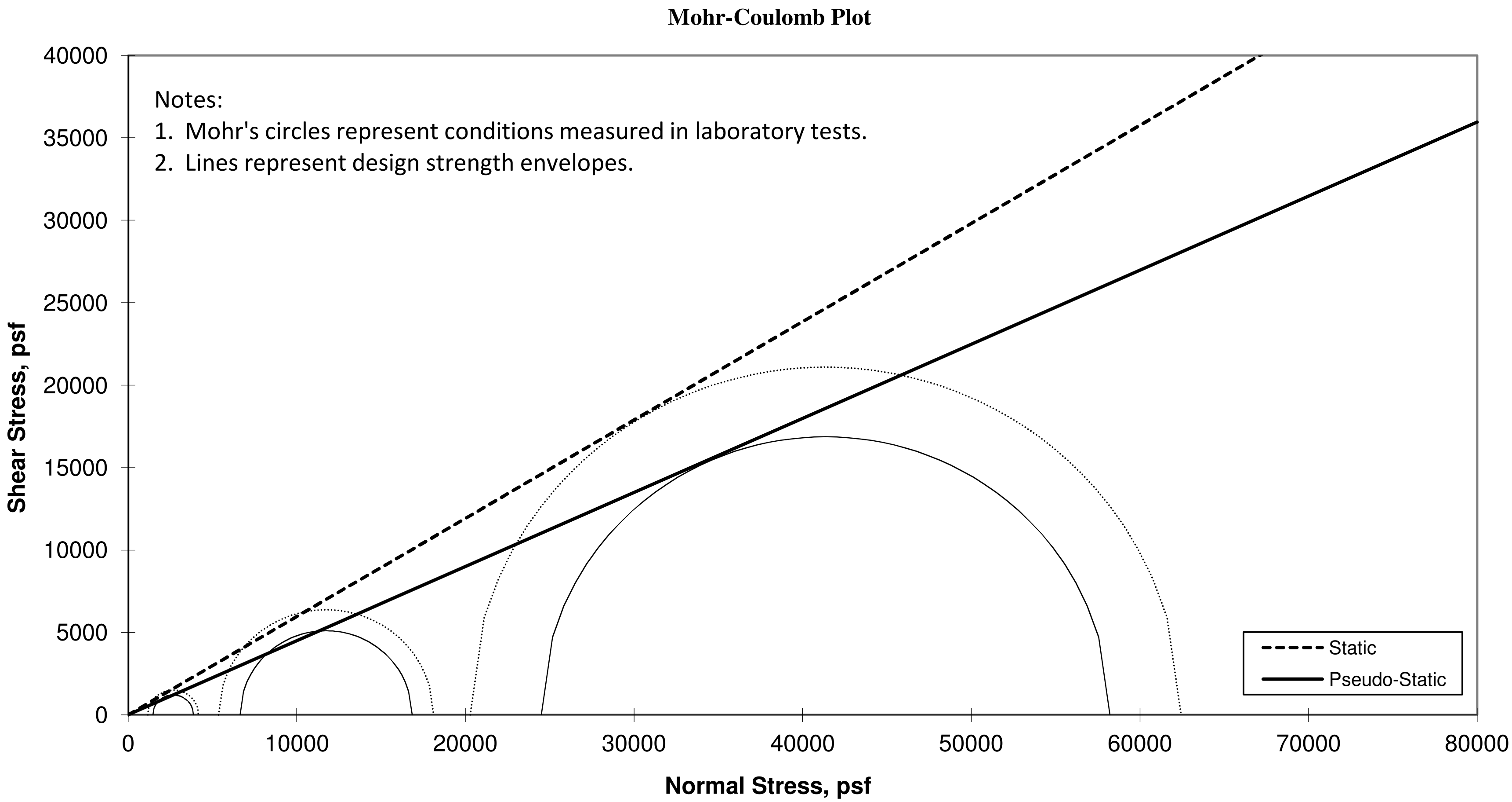
Table 5
Stability Analysis Results for the Maximum Operational OSF Configuration

Section	Seismicity	Minimum Factor of Safety- Reduced Strength Overburden	Minimum Factor of Safety- Best Approximation Overburden
A-A	static	1.40	1.59
A-A	pseudo-static	1.21	1.28
B-B	static	1.41	1.59
B-B	pseudo-static	1.25	1.34
C-C	static	1.40	1.49
C-C	pseudo-static	1.09	1.09
D-D	static	1.40	1.59
D-D	pseudo-static	1.26	1.28
E-E	static	1.55	1.57
E-E	pseudo-static	1.15	1.19

Table 6
Stability Analysis Results for the Post-Closure OSF Configuration

Section	Seismicity	Minimum Factor of Safety- Reduced Strength Overburden	Minimum Factor of Safety- Best Approximation Overburden
A-A	static	1.95	2.04
A-A	pseudo-static	1.24	1.30
B-B	static	1.92	2.00
B-B	pseudo-static	1.35	1.42
C-C	static	1.50	1.52
C-C	pseudo-static	1.00	1.00
D-D	static	1.70	1.73
D-D	pseudo-static	1.13	1.15
E-E	static	1.58	1.63
E-E	pseudo-static	1.10	1.10

FIGURES



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Denver, Colorado

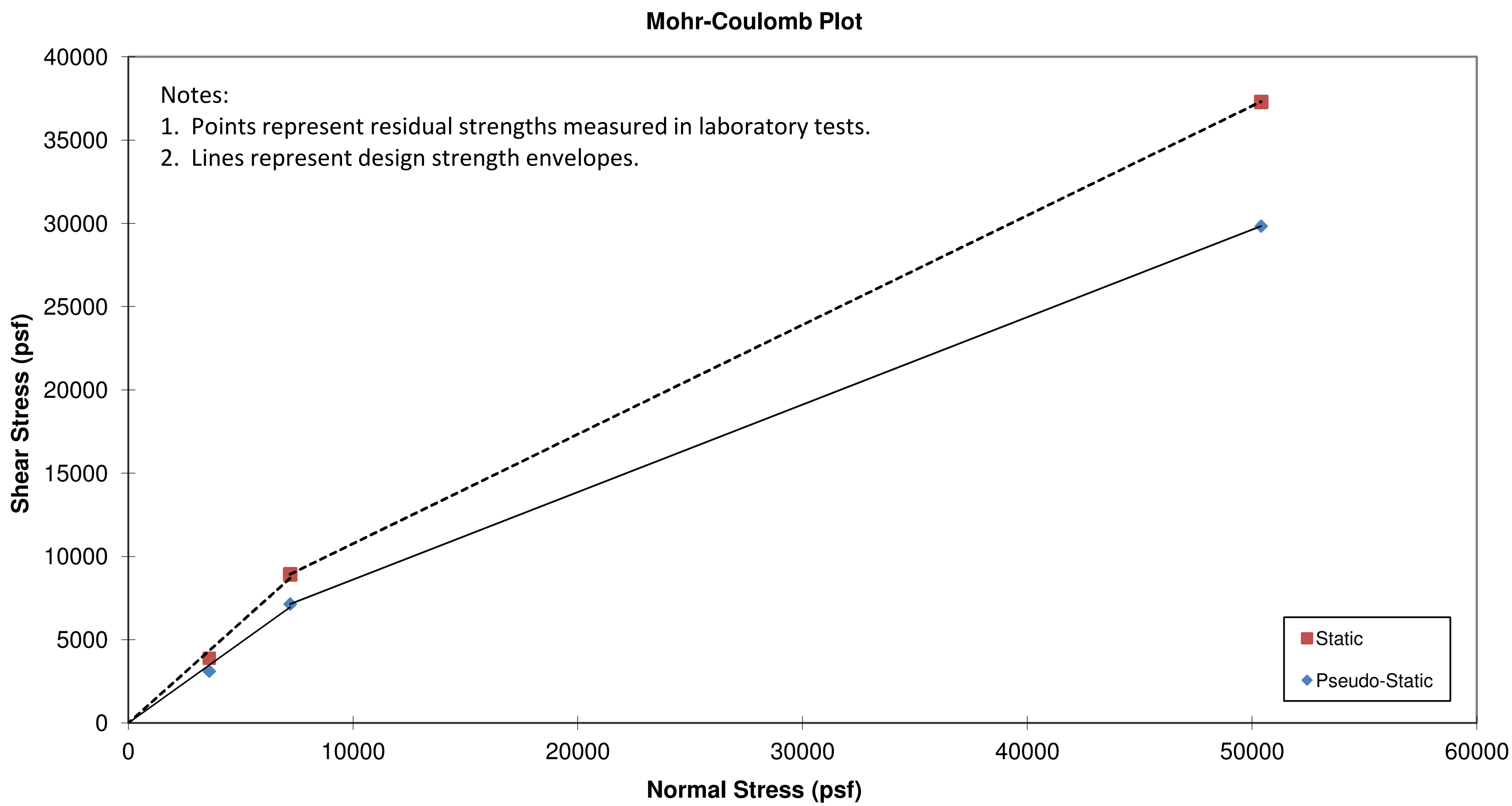
TITLE

Static and Pseudo-Static Design Strengths for the Minturn Formation

CLIENT/PROJECT

Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	1



Golder Associates

Denver, Colorado

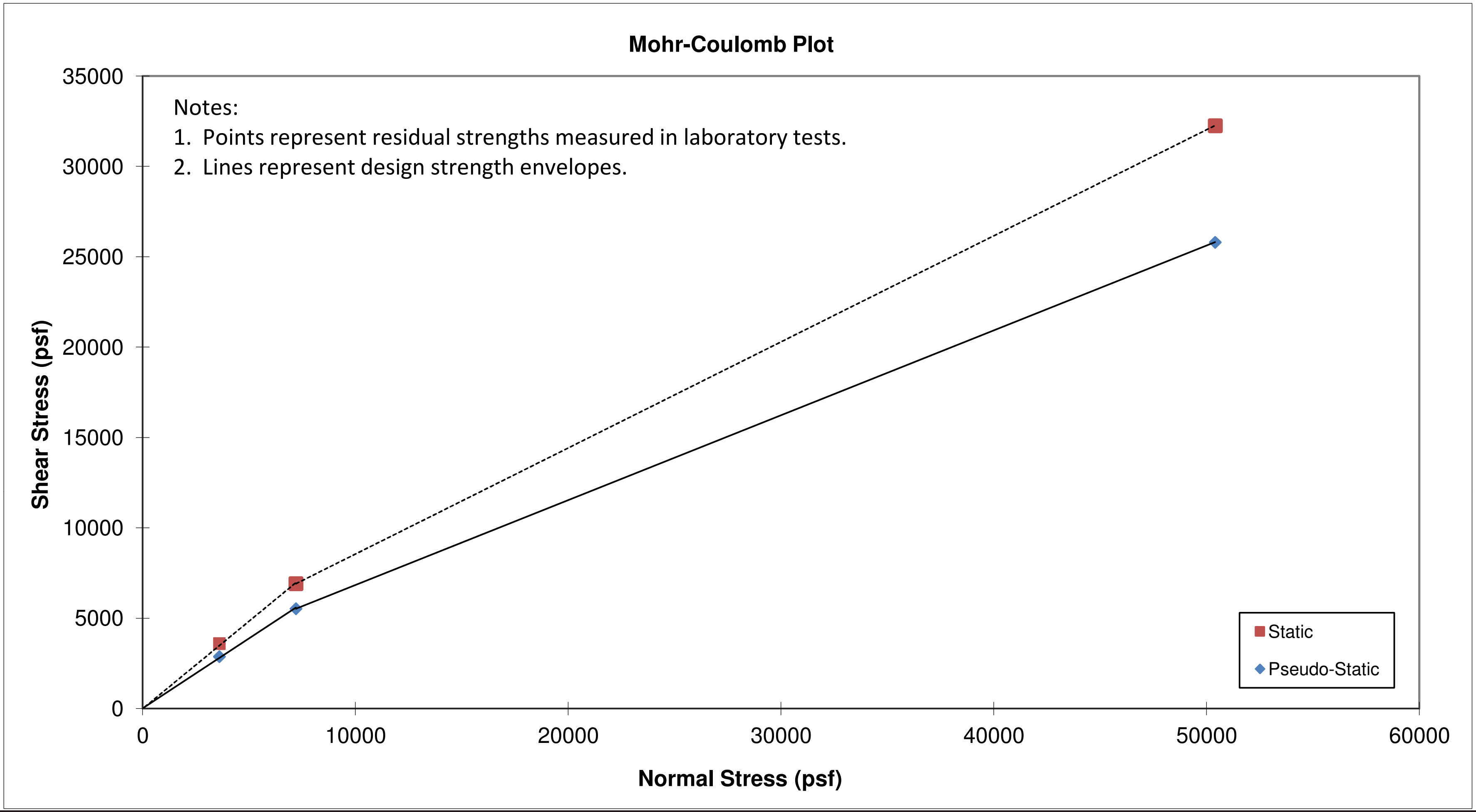
TITLE

Static and Pseudo-Static Design Strengths for the Lincoln Porphyry

CLIENT/PROJECT

Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	2



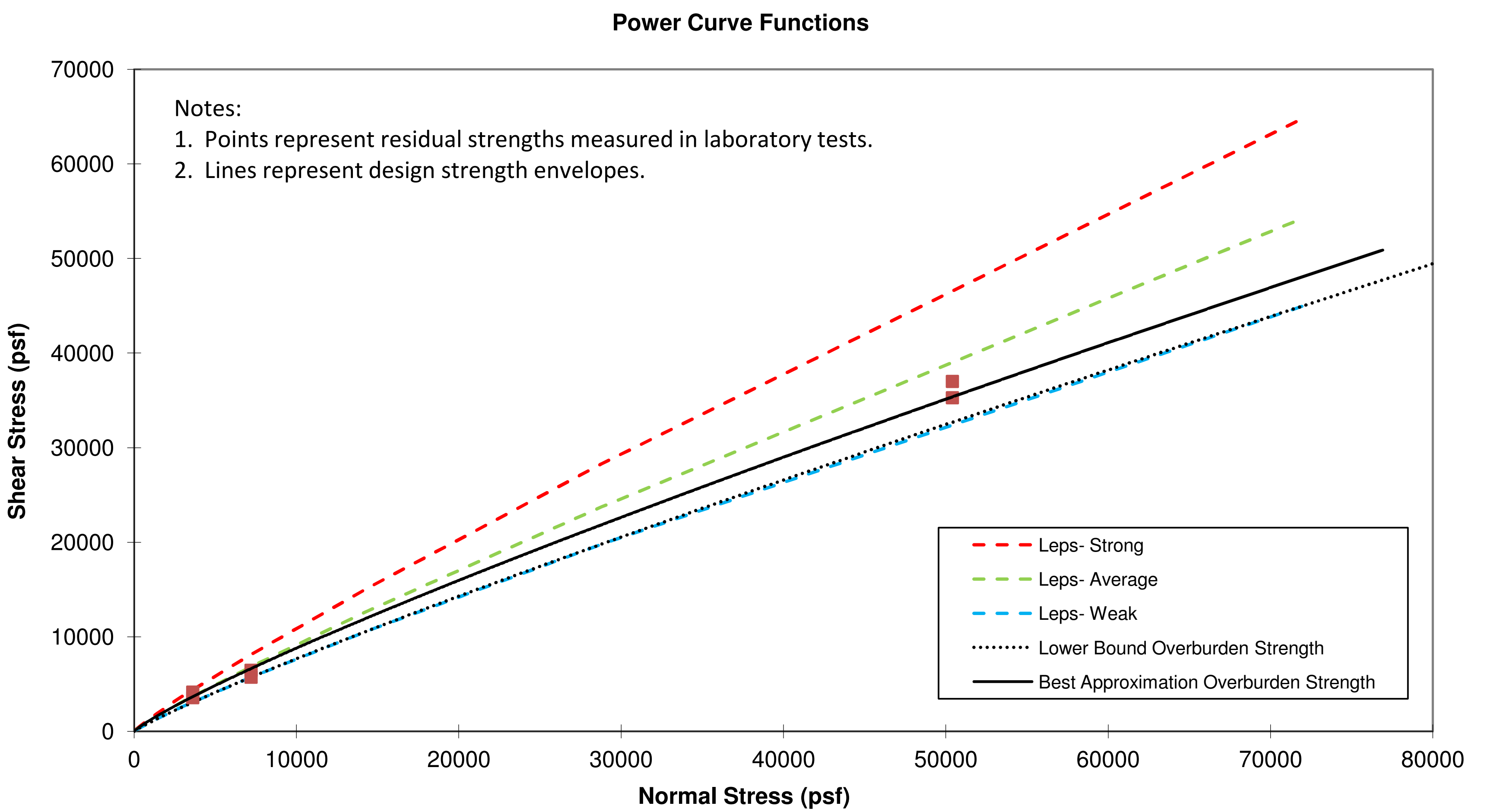
Golder Associates

Denver, Colorado

TITLE	**Static and Pseudo-Static Design Strengths for Glacial Till**				
DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	3

CLIENT/PROJECT

Climax Molybdenum, OSF Design



Golder Associates
Denver, Colorado

TITLE
Static and Pseudo-Static Design Strengths for Waste Rock

CLIENT/PROJECT
Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
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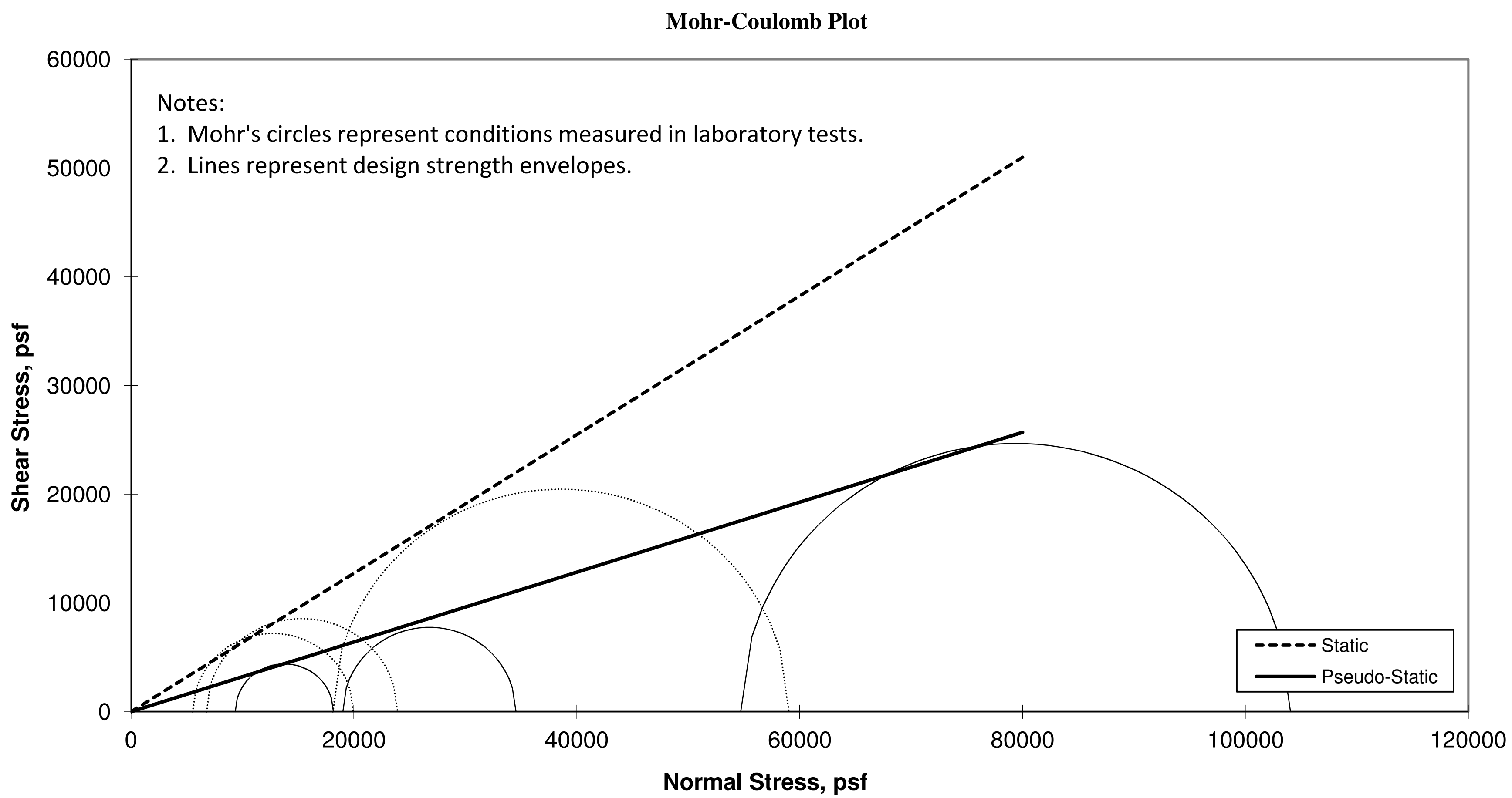

Golder Associates

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TITLE

Static and Pseudo-Static Design Strengths for Tailing

CLIENT/PROJECT

Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	5

LEGEND

- EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
- PROPOSED WASTE ROCK STOCKPILE TOPOGRAPHY (SEE REFERENCE 3)
- OSF BOUNDARY
- PROPOSED WATER MONITORING POINT

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. AERIAL PHOTOGRAPH TAKEN IN 2009, FROM USDA AERIAL PHOTOGRAPHY FIELD OFFICE.
3. PRELIMINARY WASTE ROCK STOCKPILE TOPOGRAPHY PROVIDED BY CLIMAX MINE, 24 APRIL 2012.

REV	DATE	REVISION DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
A	24MAY12	ISSUED FOR REPORT	DLG	DLG	BRB	BRB

PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES, COLORADO

TITLE

PRELIMINARY LOCATIONS FOR WATER MONITORING POINTS

Golder Associates
DENVER, COLORADO

FILE No. FIGURE 6
PROJECT No. 113-81608

FIGURE 6

Drawing File: J:\11JOBS\113-81608 Climax\Design Report\Rev3\Figures\ Figure 6.dwg | Layout: 11x17 Landscape | Modified: May 30, 2012 10:21 DGEIER | Plotted: 05/30/12 10:21am DGEIER

DRAWINGS

OVERBURDEN STORAGE FACILITY DESIGN DRAWINGS

CLIMAX MINE
LAKE AND SUMMIT COUNTIES
COLORADO

PREPARED FOR:
CLIMAX MOLYBDENUM

LIST OF DRAWINGS

GENERAL LEGEND

℄	CENTERLINE
CWCS	CONTACT WATER COLLECTION SYSTEM
EL.	ELEVATION
in	INCHES
MAX.	MAXIMUM
MIN.	MINIMUM
NOM.	NOMINAL
N.T.S.	NOT TO SCALE
OSF	OVERBURDEN STORAGE FACILITY
P.E.	POLYETHYLENE
TYP.	TYPICAL
ft	FEET
TBD	TO BE DETERMINED
2.5:1	2.5 HORIZONTAL TO 1 VERTICAL SLOPE
°	DEGREE
~	APPROXIMATELY
1/05 DETAIL NUMBER; DRAWING NUMBER WHERE DETAIL IS SHOWN	DETAIL CALL–OUT
A/5 SECTION LETTER; DRAWING NUMBER WHERE SECTION IS SHOWN; LINE WHERE SECTION IS CUT	CROSS–SECTION CALL–OUT

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BRENT R. BRONSON
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5-17-12

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PROJECT
CLIMAX MINE
LAKE AND SUMMIT COUNTIES, COLORADO

TITLE
COVER SHEET

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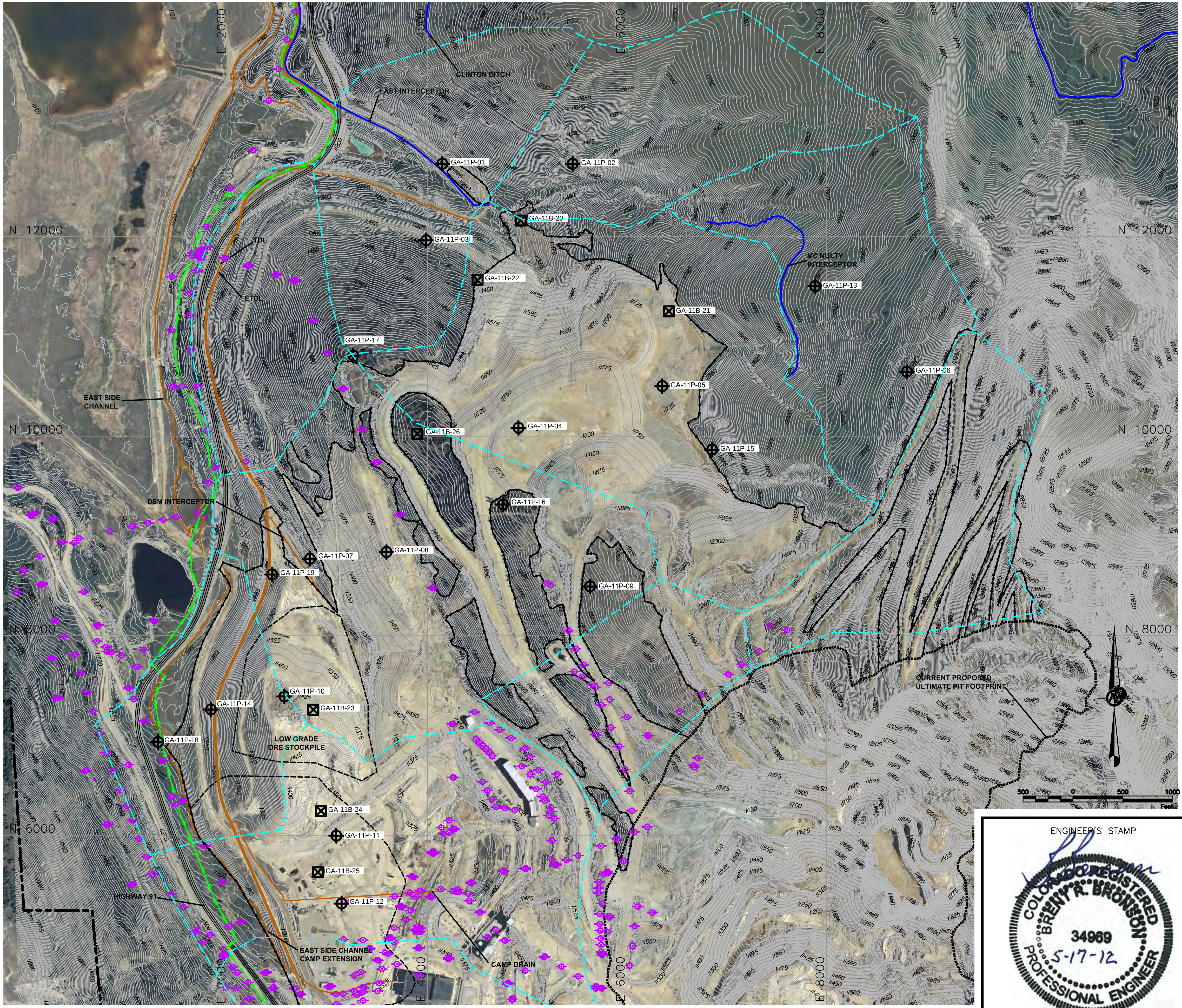
FILE No. 11381608H001
PROJECT No. 113–81608

1



LEGEND

11575	EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
	HYDROLOGIC SUB-BASINS
	EXISTING NON-CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 4)
	EXISTING CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 4)
	EXISTING HIGH PRESSURE GAS LINE (NOTE 3)
	APPROXIMATE LIMITS OF BURIED HISTORIC TAILING IMPOUNDMENTS
	APPROXIMATE LIMITS OF RECENT OVERBURDEN AND/OR FILL
	CLIMAX PROPERTY LIMITS
	EXISTING ABOVE GROUND ELECTRIC POWER POLE (SEE REFERENCE 4)
GA-11B-21	GOLDER 2011 TEST PIT LOCATION
GA-11P-06	GOLDER 2011 BOREHOLE LOCATION

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. AERIAL PHOTOGRAPHY TAKEN IN 2009, FROM USDA AERIAL PHOTOGRAPHY FIELD OFFICE.
3. CLIMAX MINE PROVIDED HIGH PRESSURE GAS LINE LOCATION 18 JANUARY 2010.
4. EXISTING CHANNELS, EXISTING ABOVE GROUND ELECTRICAL, AND EXISTING WATER PIPELINE LOCATIONS PROVIDED BY W. W. WHEELER AND ASSOCIATES, INC. 12 JANUARY 2012.

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

EXISTING CONDITIONS

Golder Associates

FILE No.	11381608H002
PROJECT No.	113-81608

2

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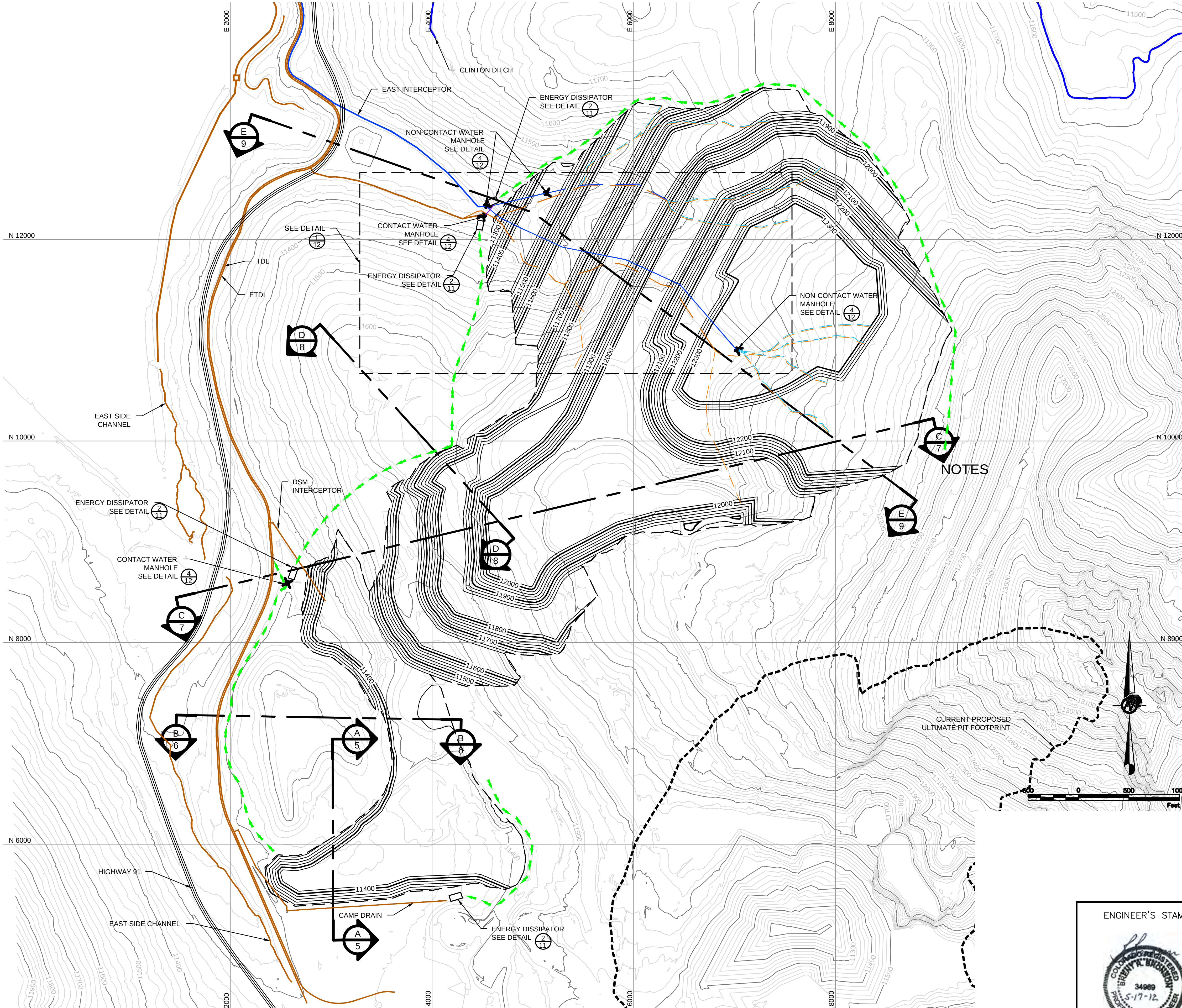

LEGEND

- 11500 — EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
- 11500 — PROPOSED OPERATIONS GRADING (SEE REFERENCE 3)
- PROPOSED OSF BOUNDARY
- OPERATIONS PERIMETER CHANNEL OR WATER MANAGEMENT BERM (SEE DETAILS) 2/12 AND 3/12
- EXISTING NON-CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 2)
- EXISTING CONTACT WATER CHANNELS / PIPES
- PROPOSED PRIMARY NON-CONTACT HDPE PIPE LOCATIONS (NOTE 2)
- PROPOSED PRIMARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
- PROPOSED SECONDARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
- PROPOSED PRIMARY CONTACT WATER PIPE LOCATIONS (NOTE 2)
- PROPOSED PRIMARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
- PROPOSED SECONDARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
- PROPOSED UNDERDRAIN BYPASS TO CONTACT MANHOLE

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.
2. THE PROPOSED UNDERDRAIN AND CONTACT WATER LAYOUT AND CONCEPTUAL DESIGN DETAILS ARE PROVIDED TO ILLUSTRATE THE GENERAL WATER MANAGEMENT STRATEGY. THE DESIGNS WILL BE DETAILED AND FINALIZED UPON CONFIRMATION OF THE DESIGN APPROACH.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. EXISTING CHANNELS AND EXISTING WATER PIPELINE LOCATIONS PROVIDED BY W. W. WHEELER AND ASSOCIATES, INC. 12 JANUARY 2012.
3. PROPOSED OPERATIONS GRADING PROVIDED BY CLIMAX MINE 23 APRIL 2012.

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CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

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TITLE

OSF PLAN - END OF OPERATIONS

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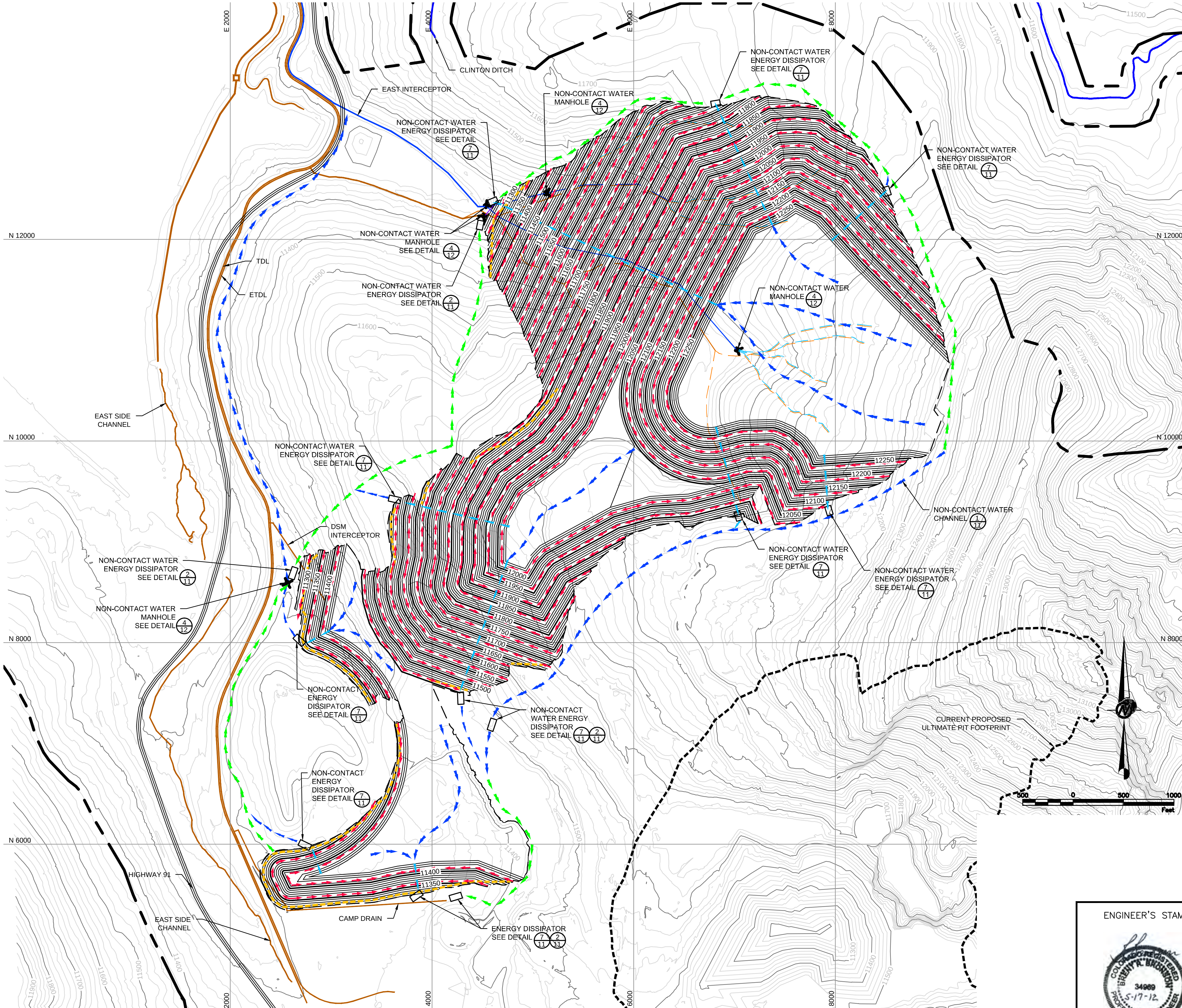
FILE No. 11381608H003
PROJECT No. 113-81608

3



LEGEND

11500	EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
11500	PROPOSED CLOSURE GRADING (SEE NOTE 3)
	PROPOSED OSF BOUNDARY
	CLIMAX AFFECTED LANDS BOUNDARY
	OPERATIONS BERM OR CHANNEL TO BE CONVERTED TO A CLOSURE BERM OR CHANNEL (SEE DETAILS) 1/11 AND 6/11
	PROPOSED PERIMETER/TOPSURFACE BERM OR CHANNEL TO BE CONSTRUCTED AT CLOSURE (SEE DETAILS) 1/11 AND 6/11
	PROPOSED DOWNDRAIN CHANNELS TO BE CONSTRUCTED AT CLOSURE (SEE DETAIL) 3/11
	PROPOSED OUTSLOPE CHANNELS TO BE CONSTRUCTED AT CLOSURE (SEE DETAIL) 4/11
	EXISTING NON-CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 2)
	EXISTING CONTACT WATER CHANNELS / PIPES
	PROPOSED TOE-DRAIN
	PROPOSED PRIMARY NON-CONTACT HDPE PIPE LOCATIONS (NOTE 2)
	PROPOSED PRIMARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
	PROPOSED SECONDARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED PRIMARY CONTACT WATER PIPE LOCATIONS (NOTE 2)
	PROPOSED PRIMARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
	PROPOSED SECONDARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED UNDERDRAIN BYPASS TO CONTACT MANHOLE

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.
2. THE PROPOSED UNDERDRAIN AND CONTACT WATER LAYOUT AND CONCEPTUAL DESIGN DETAILS ARE PROVIDED TO ILLUSTRATE THE GENERAL WATER MANAGEMENT STRATEGY. THE DESIGNS WILL BE DETAILED AND FINALIZED UPON CONFIRMATION OF THE DESIGN APPROACH.
3. THIS CONCEPTUAL OSF CLOSURE PLAN IS PROVIDED TO ILLUSTRATE THE ANTICIPATED FINAL CLOSURE TOE LIMITS AND CLOSURE STRATEGY FOR THE CLIMAX OSF'S. THE BARBER-POLE CLOSURE STRATEGY PROVIDES FOR RUNOFF CONVEYANCE FROM A SERIES OF TOP SURFACE AND OUT SLOPE CHANNELS TO DOWNDRAINS, THEN TO PERIMETER CHANNELS.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. EXISTING CHANNELS AND EXISTING WATER PIPELINE LOCATIONS PROVIDED BY W. W. WHEELER AND ASSOCIATES, INC. 12 JANUARY 2012.

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF PLAN - CONCEPTUAL CLOSURE PLAN

Golder Associates

FILE No. 11381608H004
PROJECT No. 113-81608

4

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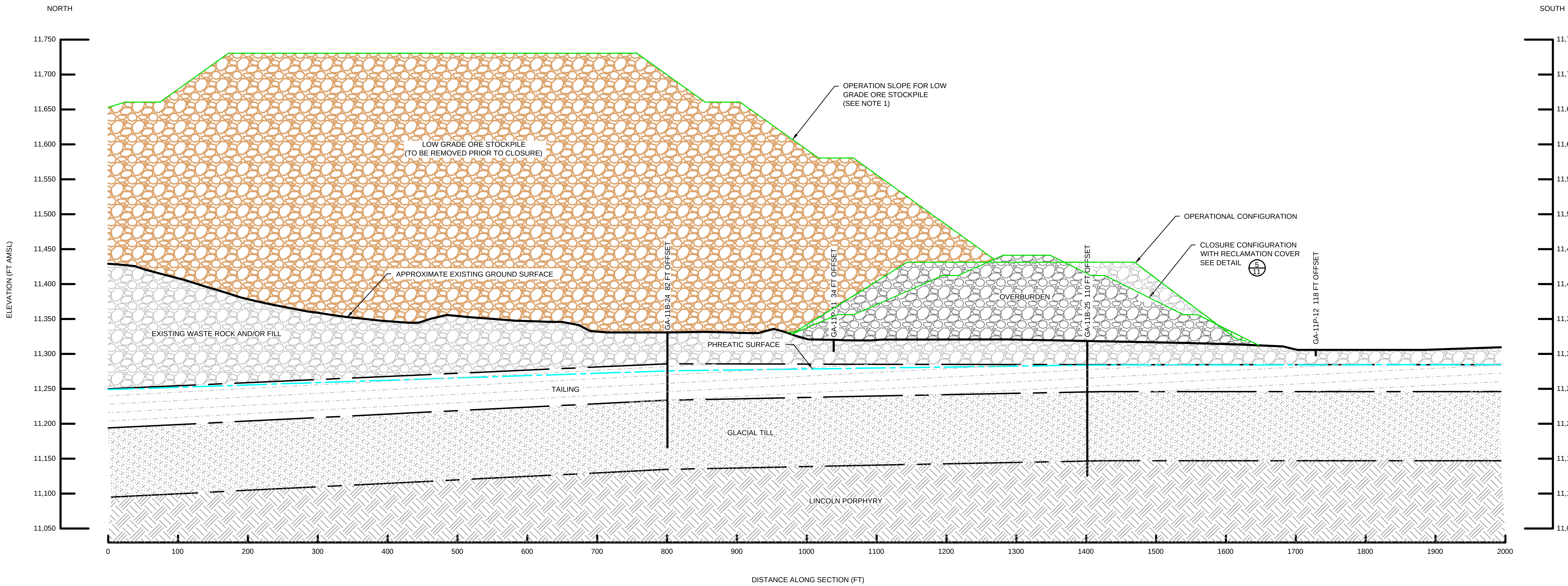

NOTES

1. THE LOW GRADE STOCKPILE SHOWN REPRESENTS THE MAXIMUM ANTICIPATED BUILD-OUT OF THE STOCKPILE. THE STOCKPILE WILL BE REMOVED PRIOR TO CLOSURE.

150 0 150 Feet

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF CROSS-SECTION A

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FILE No. 11381608H005
PROJECT No. 113-81608

5

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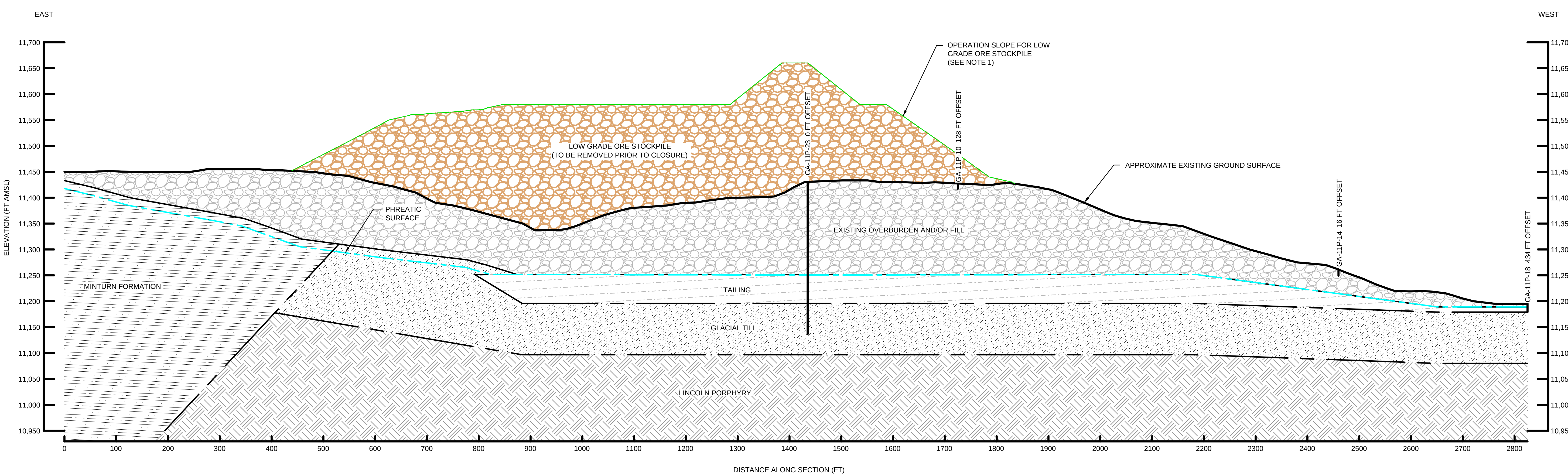

NOTES

1. THE LOW GRADE STOCKPILE SHOWN REPRESENTS THE MAXIMUM ANTICIPATED BUILD-OUT OF THE STOCKPILE. THE STOCKPILE WILL BE REMOVED PRIOR TO CLOSURE.

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CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF CROSS-SECTION B

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FILE No. 11381608H006
PROJECT No. 113-81608

6

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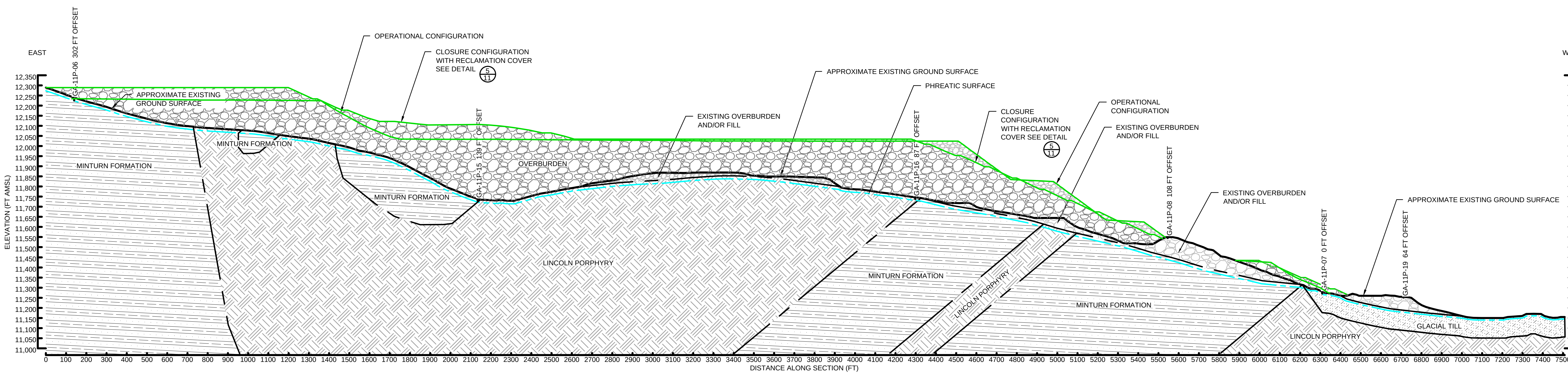

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF CROSS-SECTION C

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FILE No. 11381608H007
PROJECT No. 113-81608

7

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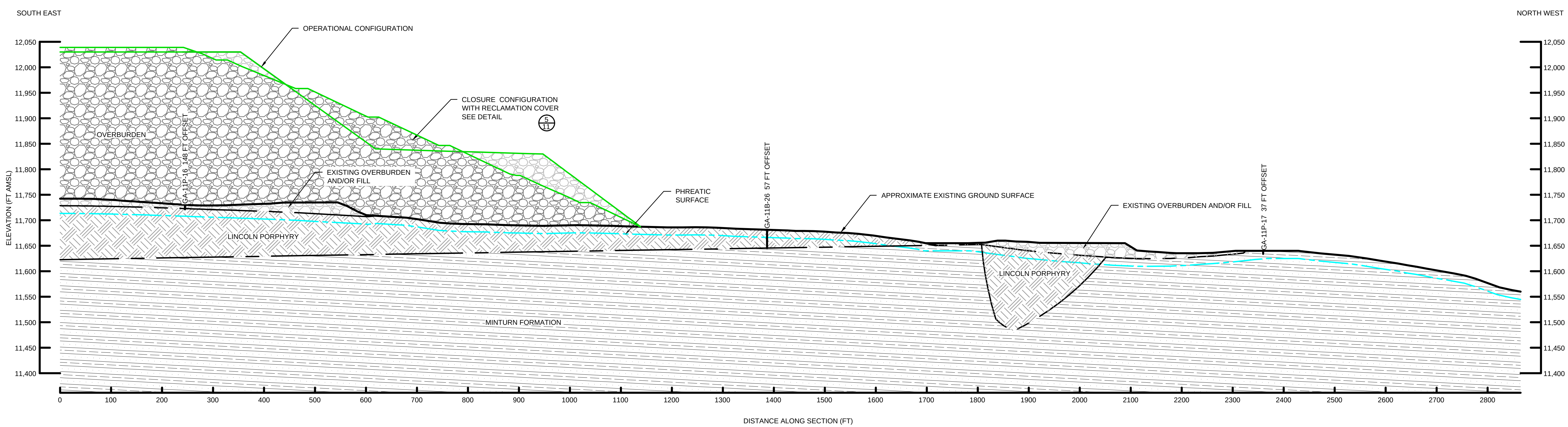

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REV	DATE	REVISION DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF CROSS-SECTION D

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FILE No. 11381608H008
PROJECT No. 113-81608

8

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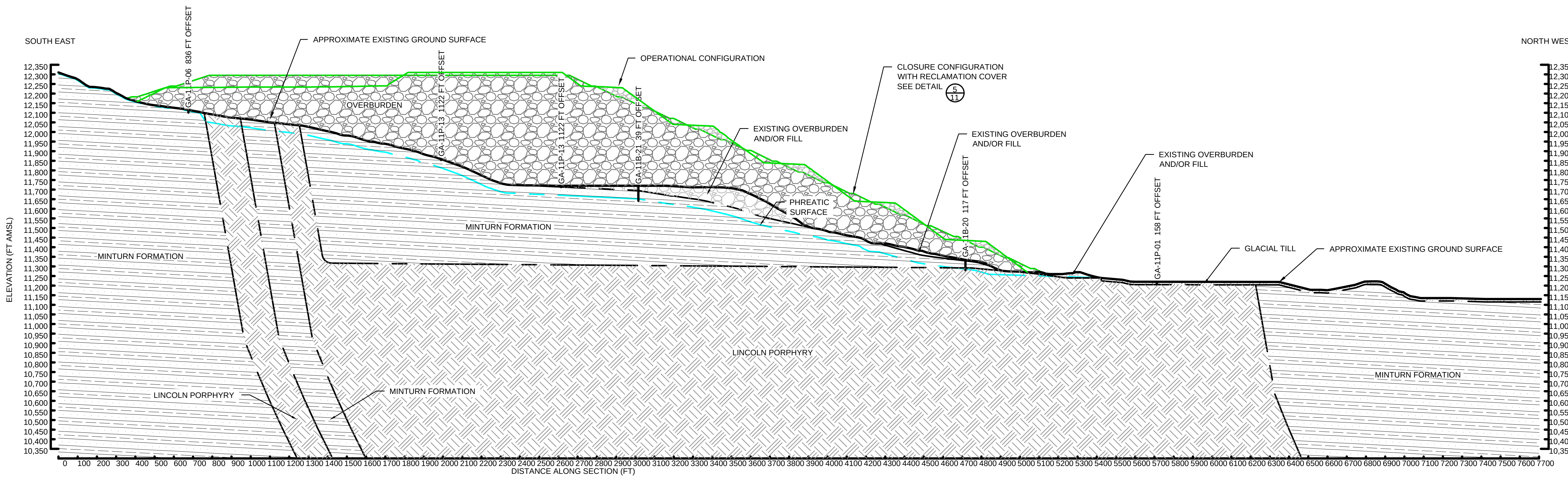

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BRENT R. BRONSON
34969
5-17-12

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A	5/16/12	ISSUED FOR DESIGN REPORT	DAR	DAR	DLG	BRB

PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF CROSS-SECTION E

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FILE No. 11381608H009
PROJECT No. 113-81608

9

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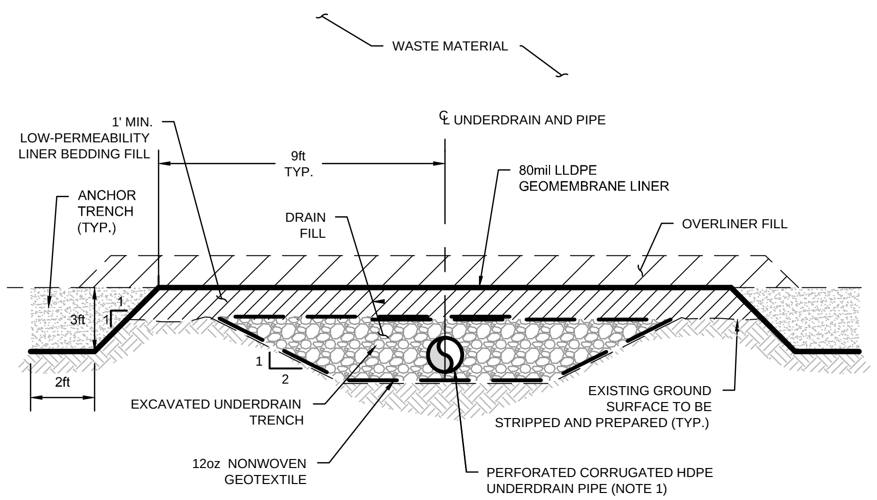
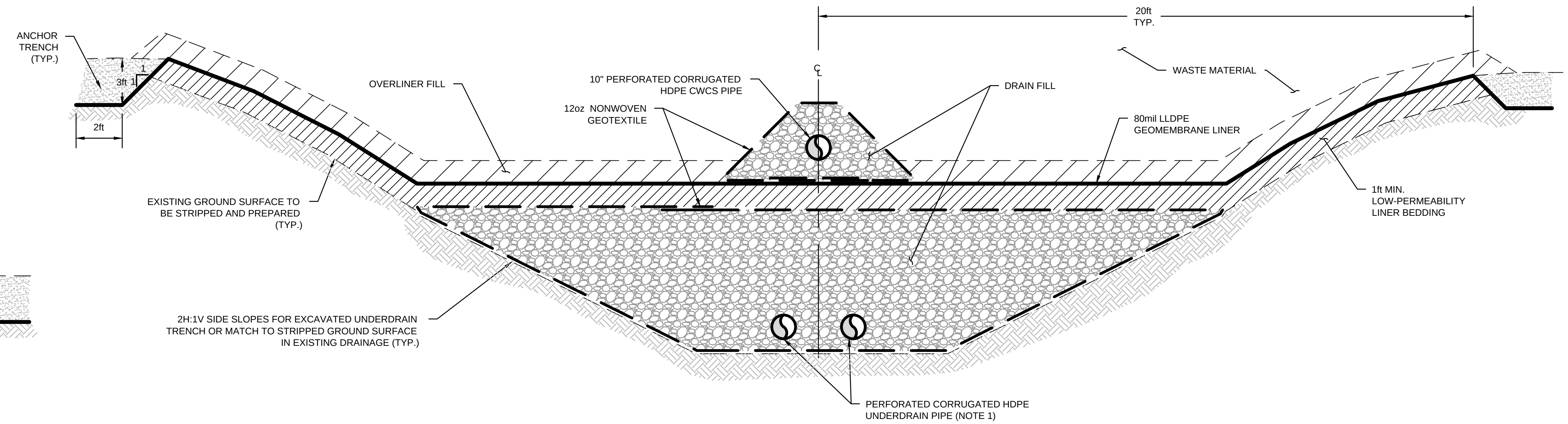
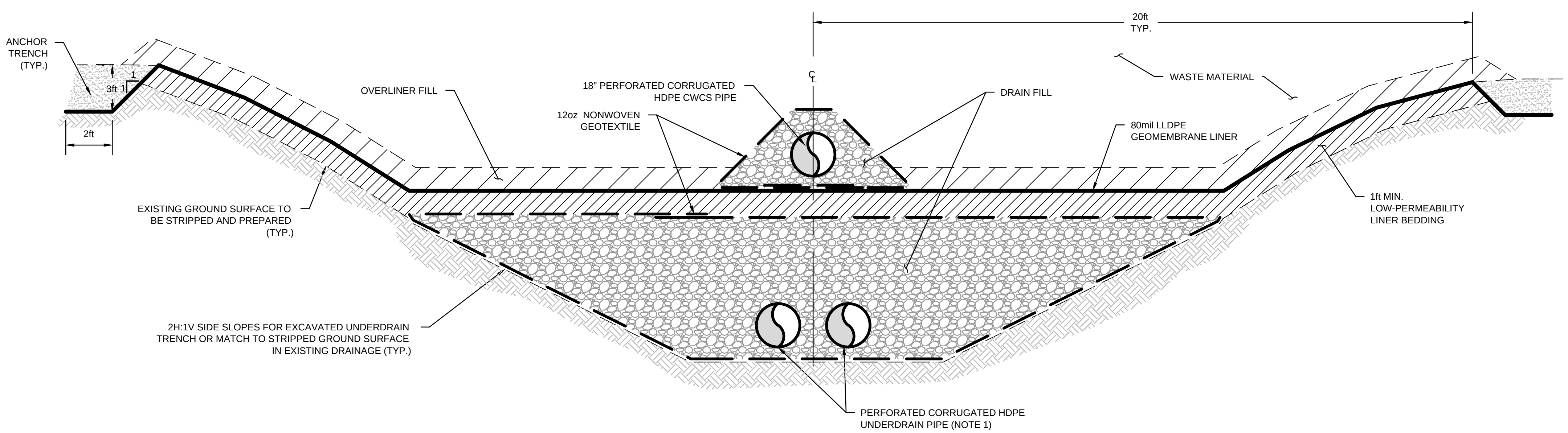


1/10 TERTIARY UNDERDRAIN SYSTEM
N.T.S.



2/10 SECONDARY CONTACT WATER COLLECTION SYSTEM (CWCS) AND UNDERDRAIN SYSTEM
N.T.S.



3/10 PRIMARY CWCS AND UNDERDRAIN SYSTEM
N.T.S.

NOTES

1. UNDERDRAIN PIPE AND GRANULAR DRAIN DIMENSIONS TO BE SIZED BASED ON PEAK BASELINE FLOWS TO PROVIDE A F.S. = 10 FOR CONVEYANCE THROUGH BOTH THE PIPE (F.S. = 5) AND DRAIN SYSTEMS (F.S. = 5).
2. TERTIARY UNDERDRAIN IS FOR CONVEYANCE OF MINOR SEEPS AND SPRINGS ENCOUNTERED DURING CONSTRUCTION.
3. UNDERDRAINS AND CWCS TO BE EXTENDED IN STAGES AS THE OSF IS ADVANCED UPGRADIENT

ENGINEER'S STAMP

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PROJECT
CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE
OSF TYPICAL WATER MANAGEMENT DETAILS

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FILE No. 11381608H010
PROJECT No. 113-81608

10

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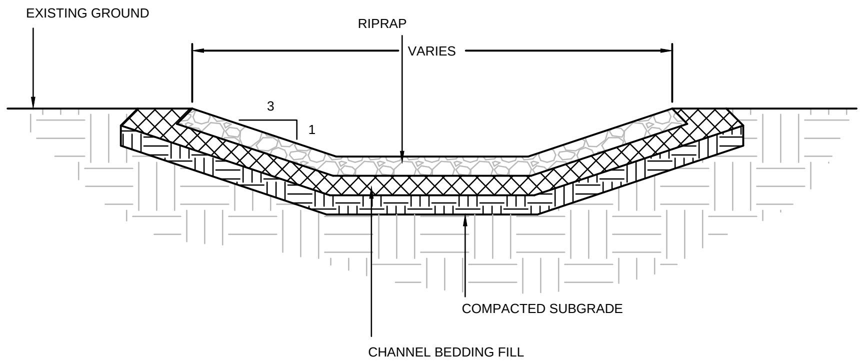

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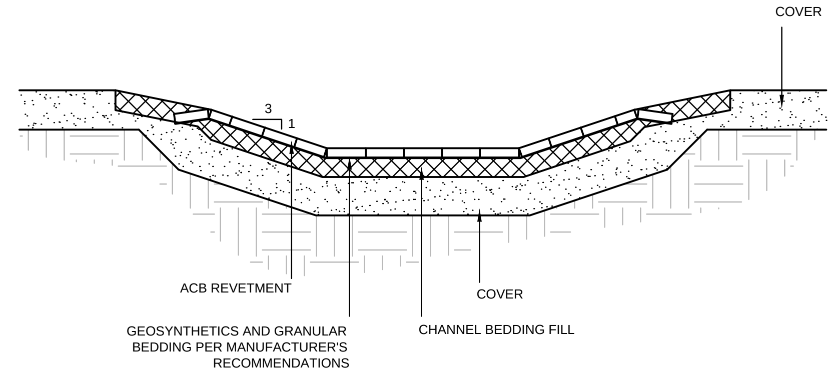

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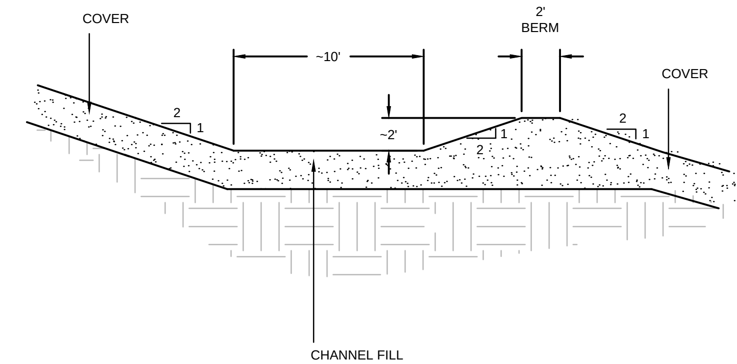

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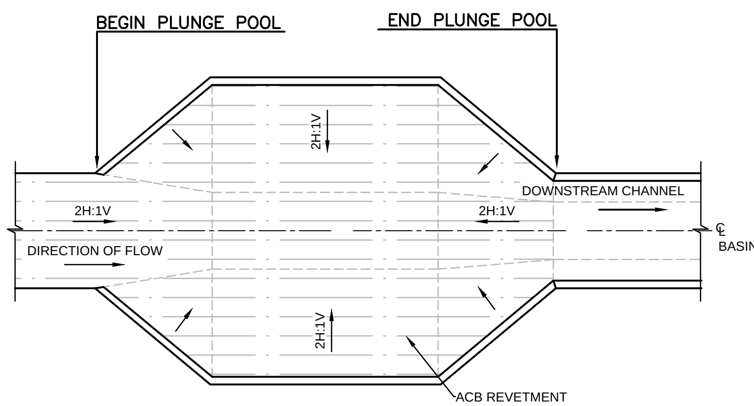

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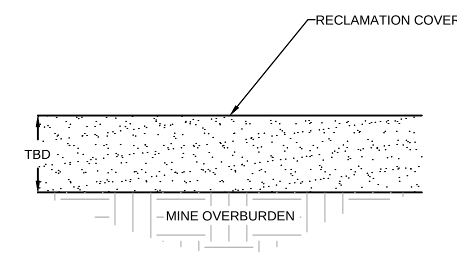

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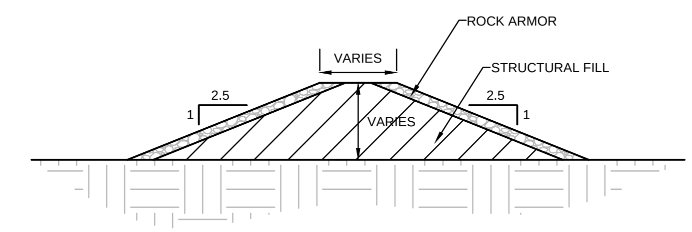

6/11 DIVERSION BERM
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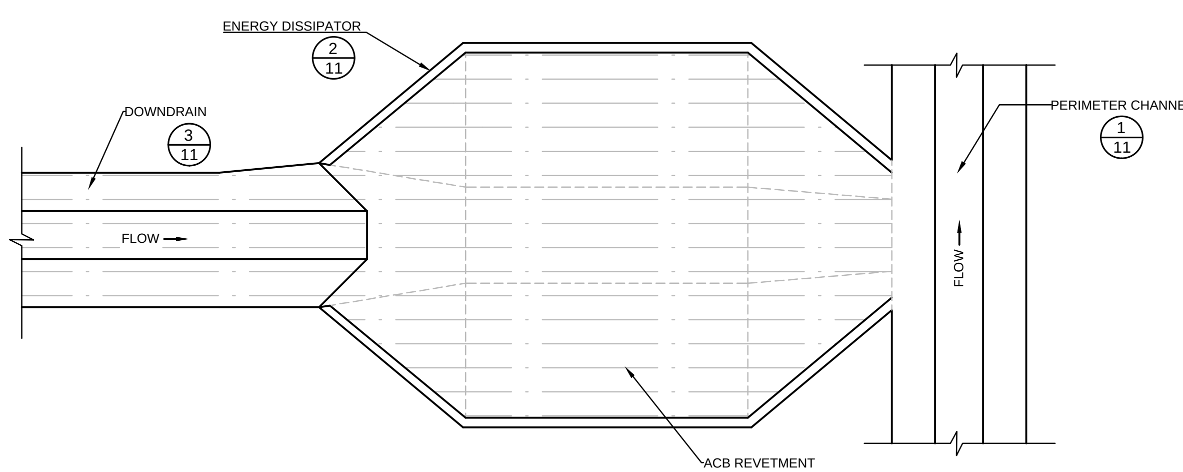

7/11 DOWNDRAIN ENERGY DISSIPATOR PLAN
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COLORADO REGISTERED PROFESSIONAL ENGINEER BRENT R. BRONSON 34969 5-17-12

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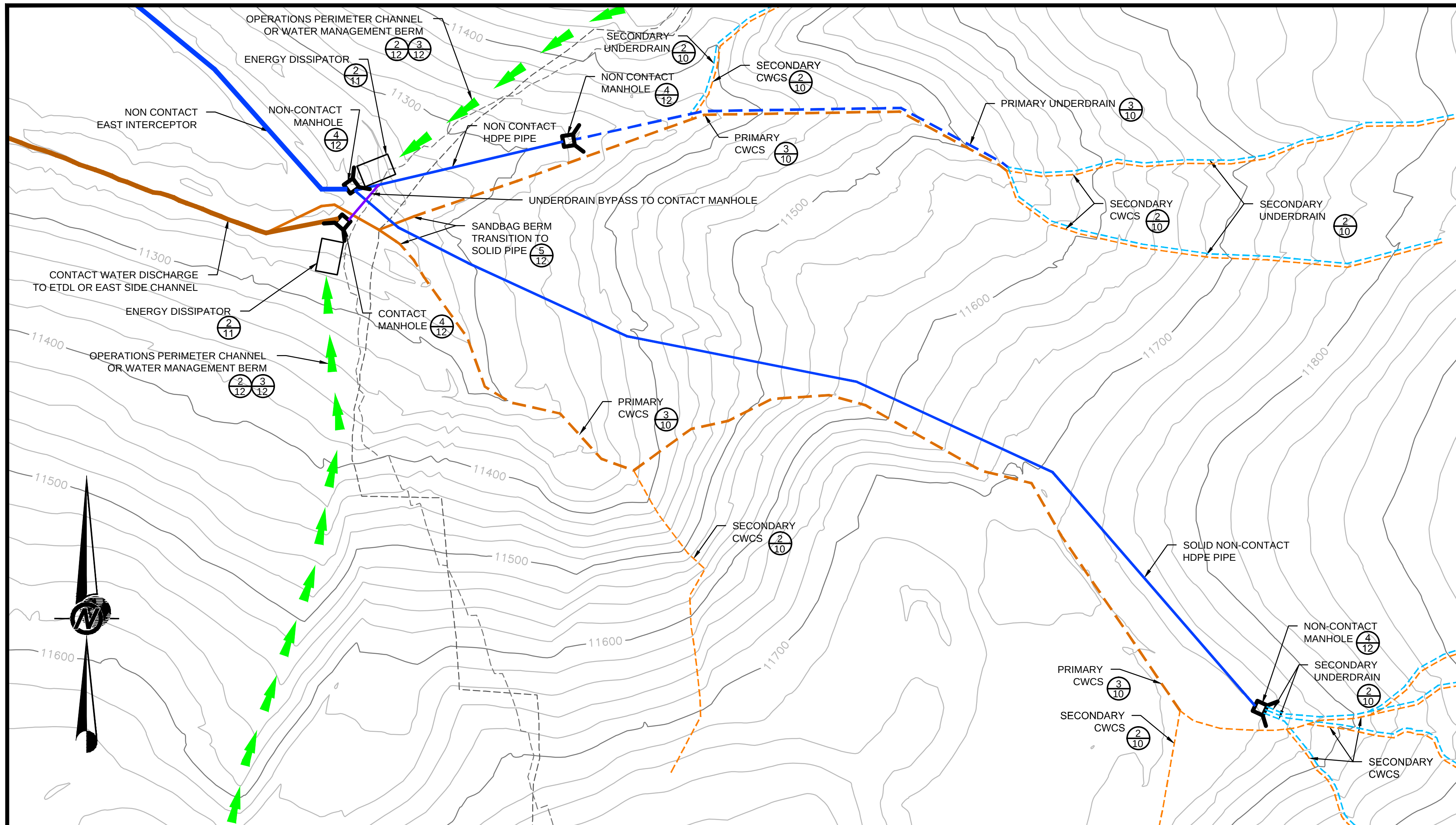
PROJECT
CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE
OSF CONCEPTUAL CLOSURE DETAILS

Golder Associates

FILE No. 11381608H011
PROJECT No. 113-81608

11



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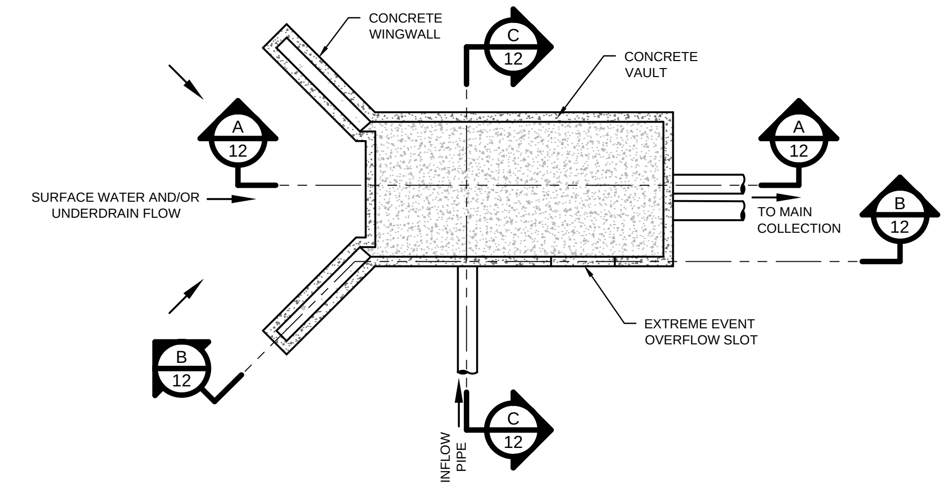

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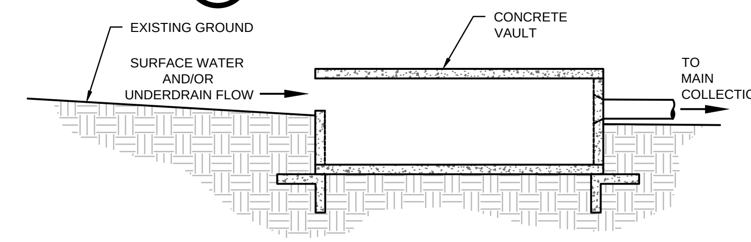

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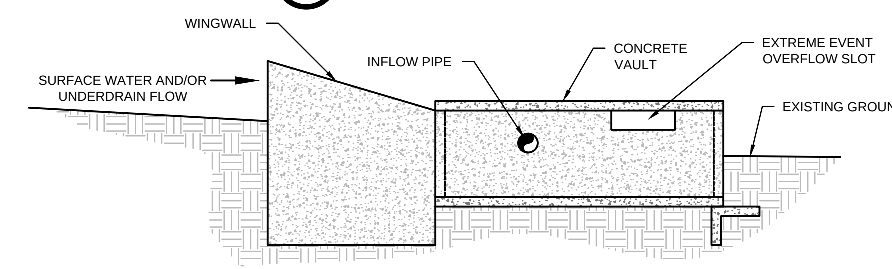

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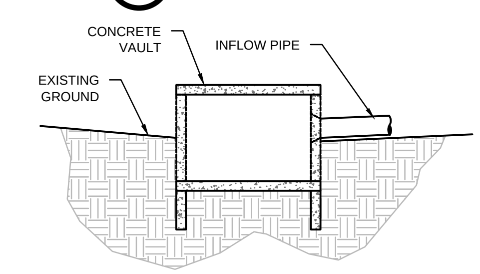

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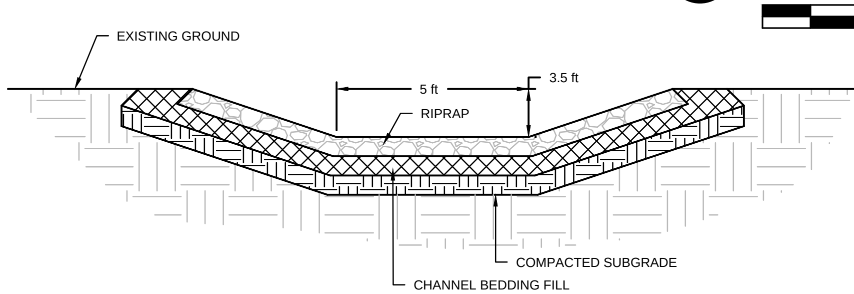

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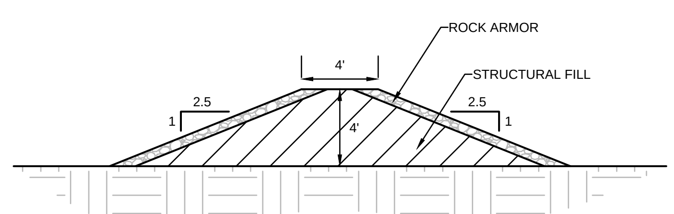

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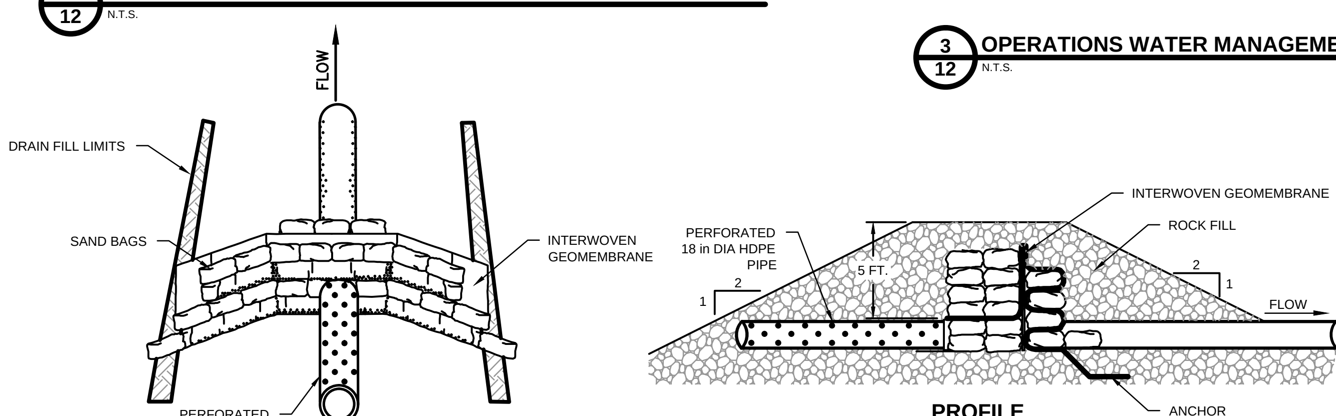

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

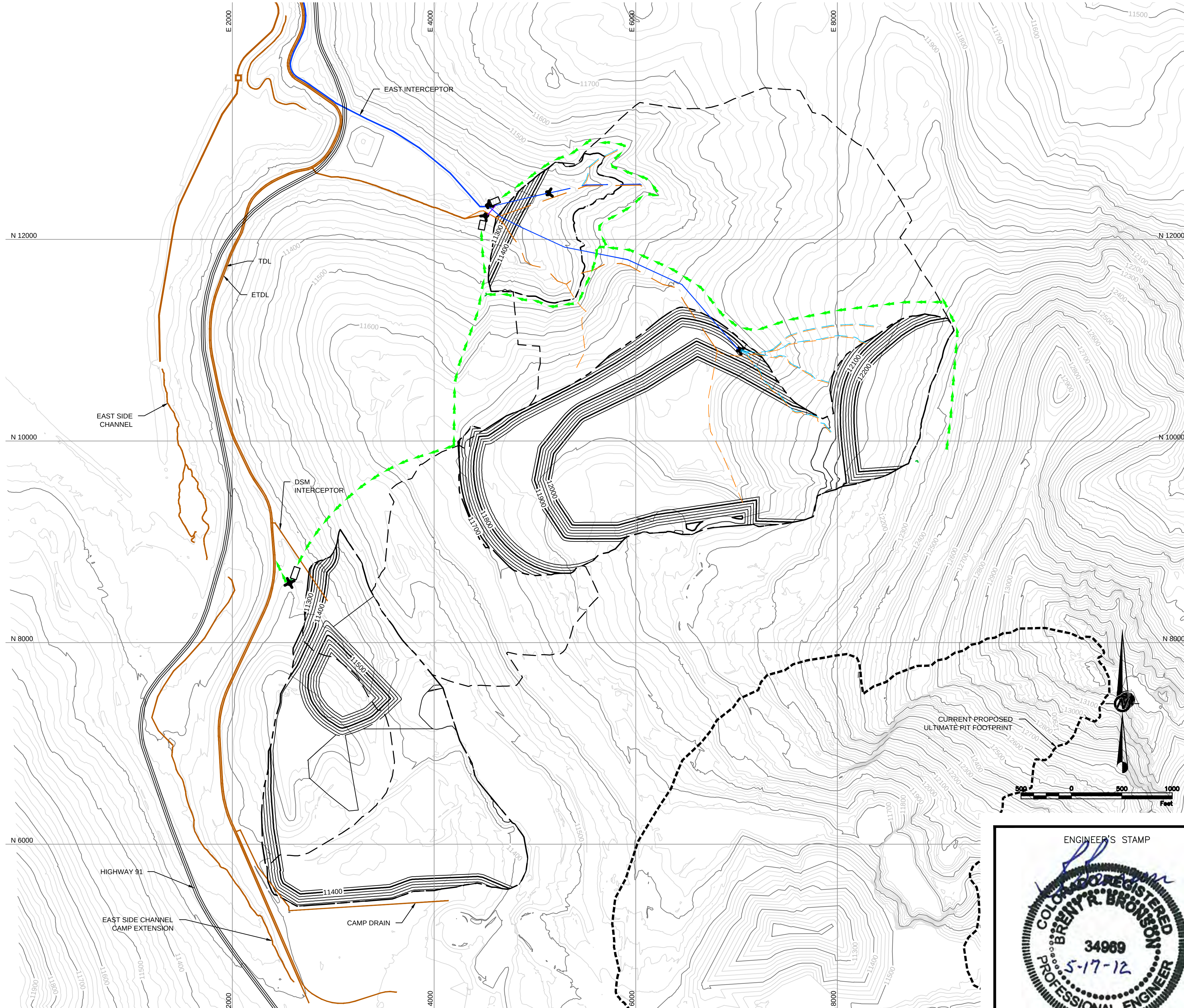
TITLE

OPERATIONS WATER MANAGEMENT STRAGEGY & CONCEPTUAL DESIGN DETAILS

Golder Associates

FILE No.	11381608H012
PROJECT No.	113-81608

12



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	PROPOSED OSF BOUNDARY
	OPERATIONS PERIMETER CHANNEL OR WATER MANAGEMENT BERM (SEE DETAILS) 2/12 AND 3/12
	EXISTING NON-CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 2)
	EXISTING CONTACT WATER CHANNELS / PIPES
	PROPOSED PRIMARY NON-CONTACT HDPE PIPE LOCATIONS (NOTE 2)
	PROPOSED PRIMARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
	PROPOSED SECONDARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED PRIMARY CONTACT WATER PIPE LOCATIONS (NOTE 2)
	PROPOSED PRIMARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
	PROPOSED SECONDARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED UNDERDRAIN BYPASS TO CONTACT MANHOLE

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.
2. THE PROPOSED UNDERDRAIN AND CONTACT WATER LAYOUT AND CONCEPTUAL DESIGN DETAILS ARE PROVIDED TO ILLUSTRATE THE GENERAL WATER MANAGEMENT STRATEGY. THE DESIGNS WILL BE DETAILED AND FINALIZED UPON CONFIRMATION OF THE DESIGN APPROACH.
3. SEE DRAWING 3 TO ILLUSTRATE THE ANTICIPATED FINAL TOE LIMITS AND WATER MANAGEMENT STRATEGY FOR THE CLIMAX OSF'S.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. EXISTING CHANNELS AND EXISTING WATER PIPELINE LOCATIONS PROVIDED BY W. W. WHEELER AND ASSOCIATES, INC. 12 JANUARY 2012.
3. PROPOSED OSF GRADING PROVIDED BY CLIMAX ON 4 APRIL 2012.

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

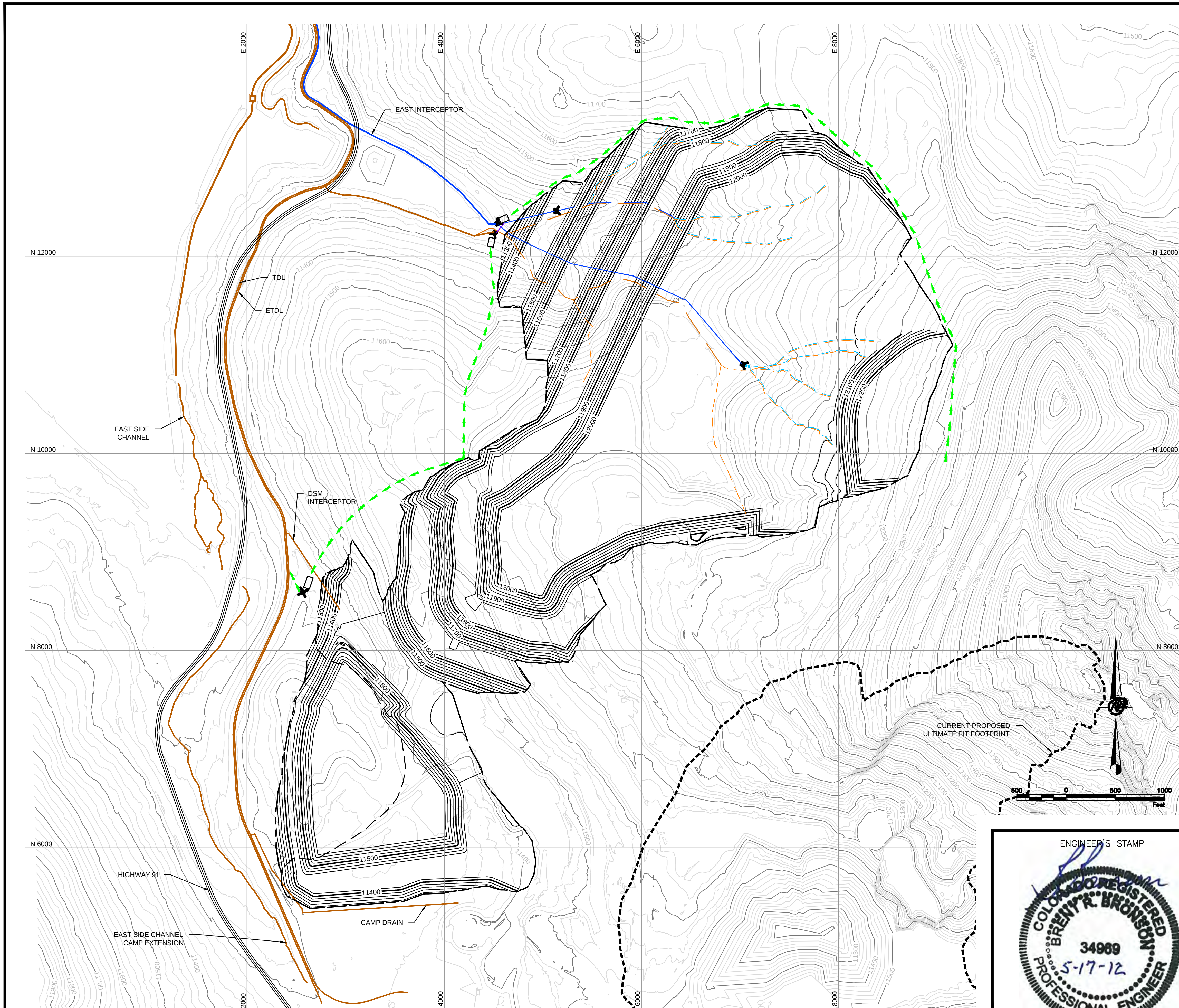
TITLE

OSF PLAN - END OF YEAR 5

Golder Associates

FILE No. 11381608H013
PROJECT No. 113-81608

13



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	PROPOSED OSF BOUNDARY
	OPERATIONS PERIMETER CHANNEL OR WATER MANAGEMENT BERM (SEE DETAILS) 2/12 AND 3/12
	EXISTING NON-CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 2)
	EXISTING CONTACT WATER CHANNELS / PIPES
	PROPOSED PRIMARY NON-CONTACT HDPE PIPE LOCATIONS (NOTE 2)
	PROPOSED PRIMARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
	PROPOSED SECONDARY UNDERDRAIN COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED PRIMARY CONTACT WATER PIPE LOCATIONS (NOTE 2)
	PROPOSED PRIMARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 3/10
	PROPOSED SECONDARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED UNDERDRAIN BYPASS TO CONTACT MANHOLE

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2. EXISTING CHANNELS AND EXISTING WATER PIPELINE LOCATIONS PROVIDED BY W. W. WHEELER AND ASSOCIATES, INC. 12 JANUARY 2012.
3. PROPOSED OSF GRADING PROVIDED BY CLIMAX ON 4 APRIL 2012.

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34969
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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF PLAN - END OF YEAR 10

Golder Associates

FILE No. 11381608H014
PROJECT No. 113-81608

14

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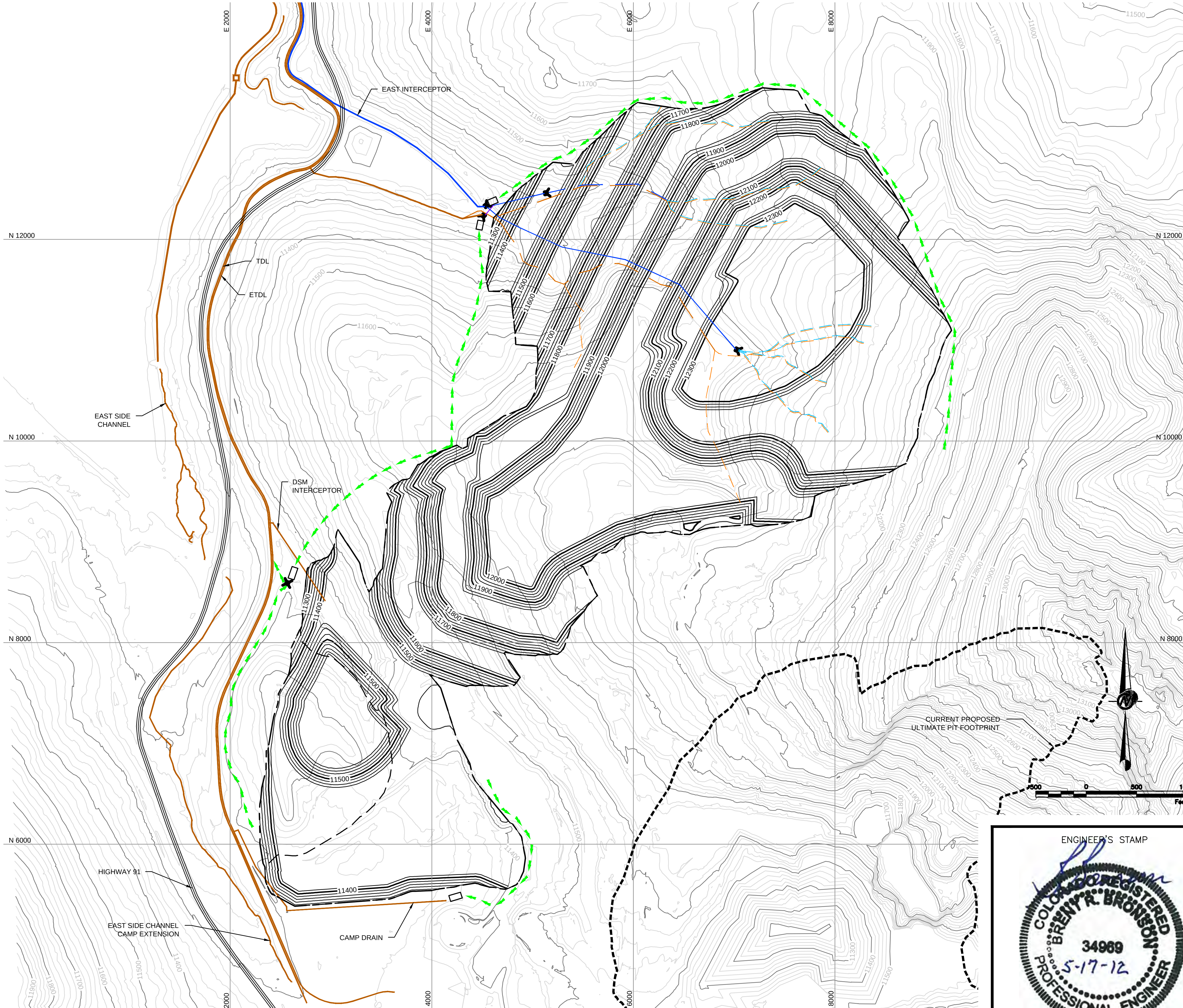

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	PROPOSED OSF BOUNDARY
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	EXISTING NON-CONTACT WATER CHANNELS / PIPES (SEE REFERENCE 2)
	EXISTING CONTACT WATER CHANNELS / PIPES
	PROPOSED PRIMARY NON-CONTACT HDPE PIPE LOCATIONS (NOTE 2)
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	PROPOSED SECONDARY CONTACT WATER COLLECTION PIPE LOCATIONS (NOTE 2) SEE DETAIL 2/10
	PROPOSED UNDERDRAIN BYPASS TO CONTACT MANHOLE

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.
2. THE PROPOSED UNDERDRAIN AND CONTACT WATER LAYOUT AND CONCEPTUAL DESIGN DETAILS ARE PROVIDED TO ILLUSTRATE THE GENERAL WATER MANAGEMENT STRATEGY. THE DESIGNS WILL BE DETAILED AND FINALIZED UPON CONFIRMATION OF THE DESIGN APPROACH.
3. SEE DRAWING 3 TO ILLUSTRATE THE ANTICIPATED FINAL TOE LIMITS AND WATER MANAGEMENT STRATEGY FOR THE CLIMAX OSF'S.

REFERENCES

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2. EXISTING CHANNELS AND EXISTING WATER PIPELINE LOCATIONS PROVIDED BY W. W. WHEELER AND ASSOCIATES, INC. 12 JANUARY 2012.
3. PROPOSED OSF GRADING PROVIDED BY CLIMAX ON 4 APRIL 2012.

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34969
5-17-12

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PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES COLORADO

TITLE

OSF PLAN - END OF YEAR 15

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FILE No.	11381608H015
PROJECT No.	113-81608

15

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APPENDIX A
FIELD INVESTIGATION RESULTS
(INCLUDES TEST PIT LOGS, BORING LOGS, AND PHOTOGRAPH LOG)

APPENDIX A

Date:	December 19, 2011	**Prepared by:**	D. Rugg
Project No.:	113-81608.2000	**Checked by:**	D. Geier
Projcect Title:	Climax Molybdenum OSF Design Report	**Reviewed by:**	B. Bronson
RE:	**FIELD INVESTIGATION RESULTS**		

This appendix is intended to provide a detailed summary of the Golder Associates Inc. (Golder) field investigation, performed in support of the Climax Molybdenum Mine (Climax) North 40 and McNulty Gulch Overburden Storage Facility (OSF) designs. The field investigation consisted of 19 test pits and 7 borings spread strategically throughout the footprint of the proposed OSFs. The field program also included visual observations, strike and dip measurements, and general site reconnaissance. The test pit program began on October 10 and continued through October 13. The drilling program began on October 18 and continued through November 4, with a 5-day break during the drilling program. The field investigation was completed in a total of 18 days. The following sections will describe the objectives of the field investigation program, the drilling and test pitting methods utilized on site, the general findings and results of the investigation, and a summary of the laboratory assignments.

1.0 OBJECTIVES OF FIELD PROGRAM

1.1 Overall Objectives

The main objective for this project phase was to collect the field data and soil/rock samples necessary to facilitate a defensible stability evaluation of the proposed 280 million ton (Mt) OSF that is to be constructed in the North 40 and McNulty Gulch areas. With this main goal in mind, the test pits and boreholes were strategically located to optimize the geotechnical information collected. The principal objectives of the field investigation program were the following:

- Classify the foundation soils in accordance with the Unified Soils Classification System (USCS)
- Provide estimates of the depth to bedrock (soil/fill/tailing thickness) within and adjacent to the proposed OSF footprint
- Provide disturbed and undisturbed samples of soil and rock for laboratory testing
- Provide data on soil and rock types and distribution throughout the site
- Provide data on groundwater elevations within the footprint of the OSF

1.2 Test Pit Objectives

The test pit program focused mainly on mapping, characterizing, and sampling the shallow materials within the vicinity of the OSFs (i.e., native soils, fills, and waste rock). The test pits allow for the collection

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of larger soil samples and are more suited for sampling and characterizing gravelly and cobbly soils. The characteristics that were logged during the test pit program include density, color, weathering, grain size, angularity, structure, parent/source rock, plasticity and moisture as well as any pertinent observations made during the excavation (e.g., groundwater conditions, soil/fill density, strata strike and dip, etc.).

1.3 Drilling Program Objectives

The drilling program focused on a number of objectives to supplement the test pit program. Geotechnical drilling is more suited for sampling and characterizing deeper soil and bedrock than test pitting. Drilling also facilitated in situ measurement of soil strength and density using standard penetration testing (SPT), and allowed installation of temporary piezometers for measuring groundwater levels within the OSF foundation. During drilling a Golder engineer logged soil and rock types, moisture, density, color, weathering, strength, grain size, angularity, lithology, plasticity, structure, rate of advance and other characteristics. Disturbed samples of the major soil types were obtained for laboratory index testing to confirm the field characterization and classifications (e.g., grain size and Atterberg limits) and for reconstituting samples for large scale tests (e.g., proctors, direct shear tests, etc.). In addition to the disturbed samples, undisturbed samples were obtained by pushing thin walled Shelby Tubes into critical materials. These samples were utilized for triaxial tests, direct shear tests, and consolidation tests.

In addition to general logging and sampling, the drilling program was designed to identify the limits of the known historical tailing deposits and to obtain undisturbed samples in order to characterize the material as accurately as possible by index, consolidation, and strength testing. Furthermore, depth to bedrock is required for the global stability analysis of the OSF and thus drilling was advanced to bedrock whenever possible.

2.0 METHODS

2.1 Test Pitting Methods & Sampling

As stated previously, the test-pitting program was designed to map, characterize, and sample the shallow soils within the footprint of the OSFs. Moltz Construction was contracted to perform the test-pitting program and a John Deere 240D tracked excavator was utilized to excavate the test pits. All test pits were staked and cleared with the Climax's blue stake crew prior to digging. Test pits were excavated a minimum of 4 ft (when hard conditions were encountered) and a maximum of 16 ft. Representative samples of the various materials encountered were obtained as bulk (pail) samples for testing in Golder's Denver laboratory. All test pits were backfilled after excavation and logging activities were complete and compacted with the excavator bucket and excavator tracks.

A description of the findings of the test-pitting program is provided in Section 3.1, test pit logs are provided in Attachment 1, select test pit photographs are shown in Attachment 3, and test pit locations are shown on Figure 1.

2.2 Drilling Methods & Sampling

Due to the granular and variable nature of the expected drilling conditions, Golder recommended the use of sonic drilling. Sonic drilling utilizes rotation and high frequency vibration to advance an inner core barrel and an outer casing, thus allowing for a continuous sample of soil or rock to be collected in the inner barrel. Sonic coring is particularly well suited for drilling through hard, coarse soils and soils prone to caving, such as coarse glacial, alluvial, and colluvial sediments as well as man-made fills and even very coarse waste rock materials. Sonic drilling is also capable of drilling through silts, clays, and other soft soils. Most sonic rigs can also drill through intact bedrock, although at reduced rates and with some breakage.

Boart Longyear (Boart) was selected as the drilling contractor for this program. Boart mobilized to site on October 18 with a GP24-300RS sonic drill rig, a support truck, and a supply/commuter truck. The rig was equipped to facilitate Standard Penetration Testing (SPT) at specified intervals and Shelby Tube sampling at specified intervals. When competent bedrock was reached, the Boart drill rig was also capable of switching over to rock coring methods using HQ triple barrel core (2.5-inch diameter), which allowed for recovery of high quality rock core.

Shelby tube samplers consist of a thin-walled steel tube 3 inches in diameter and 1/16 inch wall thickness. To collect a sample, the tube was lowered through the outer drill steel and then pushed into the ground at a slow, constant rate using pressure from the drill rig. Shelby tubes are the preferred method for obtaining undisturbed soil samples in softer soils.

A Standard Split Spoon sampler was used for the SPT sampler. The standard split spoon has an outer diameter of 2 inches and an inner diameter of 1.4 inches. SPTs were conducted using a standard SPT hammer with a weight of 140 lbs dropped a distance of 30 inches. The number of blows required to advance the SPT sampler is recorded for three consecutive runs of 6 inches each. These values are recorded on the boring logs and the cumulative value for the last 12 inches of driving is referred to as the N-value. Through published correlations, the N-value provides estimates of the relative density of cohesionless soils, consistencies of cohesive soils and estimates of strength. If more than 50 blows in single 6-inch interval are obtained, the blows were recorded as 50 blows per the number of inches penetrated.

Drilling was primarily advanced by using the sonic drilling method. Generally, water was not used during drilling in order to ensure the recovery of weak and/or highly clayey soil horizons. However, when extremely hard drilling was encountered Boart utilized water in order to maintain drilling efficiency. The depth of the seven boreholes ranged from a minimum of approximately 30 ft to a maximum of approximately 300 ft with a total drilling depth of approximately 704 ft. Drilling progress averaged approximately 55 ft per day throughout the drilling program, including moves and setup time.

The sonic drill rig provided continuous core samples for each hole with nearly 100% recovery, except for a few short stretches when the sample was unrecoverable. Soil from the sonic coring procedure was returned in runs ranging from approximately 5 to 15 feet in length. Non-cohesive soils were generally returned in a disturbed state, however very dense, stiff, and or cohesive soils were returned relatively intact and only slightly disturbed.

Each borehole location was staked and approved by the Climax blue stake crew prior to drilling and any holes that were offset or adjusted were cleared a second time prior to drilling. After drilling was completed at each hole, a 1-inch diameter PVC standpipe was lowered to the base of the hole prior to removal of the casing. The bottom 10 ft of each standpipe was slotted. These standpipes were used to facilitate water level measurements. With the exception of borehole GA-11B-20, the water level was allowed to equilibrate for a minimum of 24 hours before determining the final water table elevation. At the end of the drilling program, all borings were backfilled with cuttings to the water table and with bentonite chips above the water table in accordance with Colorado requirements (2 CCR 402-2).

A description of the findings of the drilling program is provided in Section 3.2, drillhole and borehole logs are provided in Attachment 2, select photographs are shown in Attachment 3, and borehole locations are shown on Figure 1.

3.0 FIELD INVESTIGATION SUMMARY

3.1 Summary of Test Pit Findings

Nineteen (19) test pits were excavated throughout the footprint of the OSF. The pits reached depths ranging from approximately 4 ft to 16 ft below ground surface (BGS). Wherever possible, test pits were excavated to bedrock refusal. Materials encountered included waste rock, fill, glacial till, residual and colluvial Lincoln Formation porphyry, and residual and colluvial Minturn Formation. Small seeps and groundwater were observed in a few test pits and tailing material was encountered in a single test pit. An overall description of the test-pitting program with the encountered material USCS descriptions is provided below. The test pit logs (presented in Attachment 1) represent Golder's interpretation of the geotechnical conditions encountered. The locations of the test pits are provided in Table 1 and on Figure 1. Select photos from the test pit program are provided in Attachment 3.

Four test pits were excavated in waste rock materials. These pits include GA-11P-04, GA-11P-05, GA-11P-08, and GA-11P-10. The waste rock in these test pits all classify as a well graded GRAVEL (GW) with small variations in origin, gradation, color, and overall composition. These test pits varied in depth from about 4 ft BGS to about 10 ft BGS. No groundwater was encountered in any of these test pits.

Four test pits were excavated in man-made fill materials that were generally located on or near mine roads, road embankments, or in the lay-down area. These pits include GA-11P-11, GA-11P-12, GA-11P-14, and GA-11P-19. These pits varied in depth from about 5 ft BGS to approximately 16 ft BGS, and no groundwater was encountered in any of these test pits. These materials were generally classified as well-graded SAND (SW) or well graded GRAVEL (GW).

Five test pits were excavated in areas that eventually reached the Lincoln Formation (Lincoln) porphyry. These test pits included GA-11P-01, GA-11P-03, GA-11P-09, GA-11P-15, and GA-11P-16. The total depth of these test pits varied from approximately 5 ft BGS to approximately 13.5 ft BGS, and no groundwater was encountered in any of these test pits. While the materials above the Lincoln porphyry were variable, the Lincoln porphyry itself was generally characterized as a highly weathered weak rock to completely weathered very weak rock (i.e., residual soil). This material could be classified as well-graded SANDY GRAVEL (GW) or well graded GRAVELY SAND (SW) with some very weak cobbles and boulders. The bedrock structure itself was generally intact and visible, even in the completely weathered/residual soil zones. The material was gray and massive with an aphanitic to very coarse crystalline structure. The soils above the Lincoln porphyry were generally sandy and were either colluvial or residual soils.

Four test pits were excavated in materials that were classified as being from the Minturn Formation (Minturn). These test pits include GA-11P-02, GA-11P-06, GA-11P-13, and GA-11P-17. These test pits varied in depth from approximately 5 ft BGS to 15 ft BGS. Groundwater was encountered only in test pit GA-11P-06 where it was clearly seeping into the pit from a depth of approximately 4 ft. Minturn sandstone was encountered at approximately 2 ft BGS in test pit GA-11P-13 and at approximately 4 ft in GA-11P-17. The strike and dip of the Minturn formation was measured as N100E at 40 degrees in GA-11P-13 at a depth of approximately 5 ft. The Minturn was characterized as a slightly to moderately weathered, thickly bedded, medium to coarse crystalline micaceous SANDSTONE. The thickly bedded sandstone layers were separated by thinner clay beds or infill (approximately 0.5 cm to 3 cm thick). The clay infills were generally red to orange low to highly plastic CLAY (CL-CH). The materials above the Minturn tended to be low plasticity SILT (ML) and low plasticity CLAY (CL) with some sand and gravel, and were generally a red-brown or maroon color.

Test pit GA-11P-07 was excavated in glacial till material. Directly above and next to the test pit, approximately 5 ft of native material was exposed and logged in addition to the 5 ft of material that was excavated below the ground surface. Seeping groundwater was encountered in this test pit at approximately 3 to 5 ft BGS. Hard digging was encountered at 5 ft BGS. The materials in this test pit were classified as low plasticity SILT (ML) and low plasticity CLAY (CL) with sand, gravel, and cobbles.

Finally, a single test pit was excavated east of Highway 91 and just west of the estimated limits of the historic tailing ponds. The total depth of test pit GA-11P-18 was approximately 16 ft BGS, and ponded water was noticeable at the base of the test pit prior to backfilling. The materials in the upper 4 ft of the test pit were characterized as poorly graded to well-graded SAND (SP) with little gravel and cobbles and trace boulders. From 4 to 6 ft BGS, the material was classified as a SILTY SAND (SM) with gravel and from 6 to 16 ft BGS, the material was classified as a dense, dark gray, SILTY SAND (SM). This silty sand material is believed to be from one of the historic tailing ponds, possibly transported by wind or a severe rain event.

3.2 Summary of Borehole Findings

Seven boreholes were drilled throughout the footprint of the OSF. The boreholes reached depths ranging from approximately 30 ft to a maximum of 300 ft BGS. A brief description of each borehole is provided below. The borehole logs (presented in Attachment 2) represent Golder's interpretation of the field conditions encountered. The locations of the boreholes are provided in Table 2 and on Figure 1. In addition, Table 2 provides a summary of the information provided below. Select photos from the drilling program are provided in Attachment 3.

- <u>GA-11B-20</u>: This borehole was located near the base of McNulty Gulch. The total depth of the borehole was approximately 54 ft. Groundwater was measured to be at a depth of approximately 24.8 ft BGS. Due to time constraints, the water level in this hole was only given approximately 4 hours to equilibrate. The upper 38.5 ft of material in this location consisted of colluvial soil from the Minturn formation. This material ranged from low plasticity SILT (ML) to SILTY SAND (SM) with gravel and little cobbles (COLLUVIAL – MINTURN). The cobbles and gravel were sub-rounded micaceous sandstone with R3 (medium strong) to R4 (strong) strength. From approximately 36.5 ft to 38.5 ft BGS, a number of porphyritic cobbles were encountered. At 38.5 ft BGS, there was a sharp transition from colluvial Minturn to residual Lincoln porphyry. This residual porphyry extended from 38.5 ft to the bottom of the hole at 54 ft BGS. The residual porphyry was classified as dense, gray, SANDY GRAVEL (GW) with cobbles (RESIDUAL SOIL – LINCOLN).
- <u>GA-11B-21</u>: This borehole was located on the existing OSF pile in McNulty Gulch. The total depth of this borehole was approximately 78.5 ft. The water table reached equilibrium in this location at approximately 42.9 ft BGS. The upper 25 ft of material in this location was a loose to compact, brown to red-brown, well-graded SANDY GRAVEL (GW) (WASTE ROCK). Native ground was reached at 25 ft BGS and consisted initially of a very stiff maroon CLAY (CL) with some sand and trace to little gravel (RESIDUAL SOIL – MINTURN). This material appears to have weathered from the upper Minturn formation. The stiff clay transitioned into a compact, maroon SANDY GRAVEL (GW) with clay (RESIDUAL SOIL – MINTURN) at approximately 33 ft BGS and this material continued to a depth of approximately 43 ft BGS. At approximately 43 ft BGS, the gravelly material transitioned into a weathered, but more intact SANDSTONE (MINTURN). Due to difficult drilling, Boart drilled with water from 43 to 60 ft BGS. This allowed for the recovery of 4 to 8 inch pieces of intact Minturn sandstone core. This material was moderately to slightly weathered, bedded (thick sandstone beds separated by thinner clay layers approximately 0.5 cm to 3 cm thick), fine to coarse crystalline SANDSTONE (MINTURN). At 60 ft BGS, Boart transitioned to triple barrel HQ rock coring in an attempt to obtain rock core samples for laboratory testing. Boart drilled five runs of core that returned a slightly weathered, bedded, maroon, very fine to coarse crystalline SANDSTONE (MINTURN).
- <u>GA-11B-22</u>: This borehole was located on a hillside on the edge of a mine road near the base of McNulty Gulch. The total depth of this hole was approximately 33.5 ft BGS. Groundwater reached equilibrium at approximately 12.0 ft BGS. The upper 10 ft of material in this location consisted of compact to dense, brown-gray CLAYEY SAND (SC)

and SANDY GRAVEL (GW) with cobbles (FILL). The cobbles in the fill were mostly from the Lincoln porphyry. At 10 feet, there was a transition to dense gray SANDY GRAVEL (GW) with fines (RESIDUAL SOIL – LINCOLN). This material was a residual soil derived from the Lincoln porphyry. From 10 ft to 28 ft BGS, the material gradually transitioned from residual soil to in-place but completely weathered PORPHYRY (LINCOLN) with strength, between R0 (extremely weak) and R3 (medium strong). At 28 ft, Boart transitioned to triple barrel HQ rock coring in an attempt to get intact core. Boart drilled two runs with little success. Approximately 1 ft of gravel was returned in run number 1 and the core barrel plugged during run number 2 due to lack of water during drilling.

- GA-11B-23: This borehole was located on top of the existing OSF just north of the lay-down yard and directly above the northern tailing pond. The total depth of this borehole was approximately 294 ft and the water table reached equilibrium at 179.8 ft BGS. The upper 179 ft of material in this location was classified as waste rock. The waste rock varied between well-graded GRAVEL (GW) and well-graded SAND (SW) (WASTE ROCK). This waste rock material was generally sub-angular to angular and non- to low-plasticity. The contact between waste rock and tailing material was at 179 ft BGS. The tailing material ranged from a non-plastic SILTY SAND (SM) to a low plasticity CLAYEY SILT (ML) (TAILING). The thickness of the tailing layer was approximately 56 ft in this location. From approximately 226 to 235 feet BGS there was a short transition zone where the tailing had infiltrated the native glacial till. Below 235 feet BGS, was nearly 60 feet of glacial till. The glacial till generally ranged from a well-graded GRAVEL (GW) with silt and clay to a CLAYEY SAND (SC) with gravel and cobbles (TILL). The exception was a low plasticity CLAY (CL) layer present from approximately 273 ft to 287 ft BGS.

- GA-11B-24: This borehole was located in the gravel crushing area and directly above the northern most portion of the southern tailing impoundment. The total depth of this borehole was approximately 164.5 ft and the water table reached equilibrium at approximately 54.9 ft BGS. The upper 45 ft, at this location, was comprised of waste rock. The waste rock generally ranged from well-graded GRAVEL (GW) to CLAYEY GRAVEL (GW) to CLAYEY SAND (SC) (WASTE ROCK), although there were some zones of low plasticity SANDY CLAY (CL). The tailing contact was located at approximately 45 ft BGS. The tailing in this locations were comprised mostly of low plasticity CLAYEY SILT (ML) (TAILING) with some thin layers of non-plastic, poorly graded, fine SILTY SAND (SM) (TAILING). The tailing layer was approximately 53 ft thick in this location. Below the tailing layer was glacial till material. The glacial till in this location ranged from low plasticity SILT (ML) to SILTY SAND (SM) to CLAYEY SAND (SC) to well graded GRAVEL (GW) (TILL). All layers contained some sub-rounded gravel and cobbles from various origins. This borehole was terminated at 164.5 ft prior to reaching bedrock.

- GA-11B-25: This borehole was located in the lay-down yard and was located beneath the southernmost toe of the proposed OSF. In addition, this borehole was located near the center of the southern tailing impoundment. The total depth of this borehole was approximately 193 ft and the phreatic surface reached equilibrium at a depth of approximately 33.9 ft BGS. The upper 7 ft of material in this location consisted of a well-graded GRAVEL (GW) (FILL). Waste rock was encountered from 7 ft to 33.5 ft BGS and consisted of well-graded GRAVEL (GW) and CLAYEY SAND (SC) with gravel and cobbles (WASTE ROCK). The tailing contact was at approximately 33.5 ft BGS. Tailing in this location consisted mainly of non-plastic, poorly graded, fine SILTY SAND (SM) with some thin layers of CLAYEY SILT (ML) (TAILING). The total thickness of the tailing layer in this location was approximately 38.5 ft. Below the tailing layer there was a 4 ft layer of stiff, dark brown, ORGANIC SILT (OL), before glacial till was encountered at 76 ft BGS. The glacial till layer continued for approximately 95 ft. The till in this area consisted mainly of well-graded SAND (SW) with gravel and cobbles and well graded SANDY GRAVEL (GW) (TILL). The Lincoln porphyry was encountered at approximately 171 ft BGS and can generally be described as a completely to moderately weathered bedrock or residual soil. The residual porphyry in this location ranged from a stiff to hard, gray-brown CLAY (CL) with low plasticity to a dense, gray, poorly graded coarse SAND (SP), slightly moist and non-plastic (LINCOLN).

- GA-11B-26: This borehole was located on native ground above McNulty Gulch, near a mine road. The total depth of this borehole was approximately 36 ft BGS and the groundwater reached equilibrium at a depth of approximately 13.1 ft BGS. The soil in this location was comprised of material weathered from the Lincoln porphyry. This residual soil can generally be described as dense, gray, SANDY GRAVEL (GW) with cobbles. From 31 to 36 feet BGS, the residual material transitioned into a moderately weathered, massive, fine to very coarse crystalline PORPHYRY (LINCOLN) bedrock.

4.0 FIELD TESTING, SAMPLING AND LABORATORY TESTING ASSIGNMENTS

This section describes the testing and sampling performed for the field investigation; the field testing is also described and the results summarized. Secondly, the samples collected are listed along with the reasoning for collecting each sample. Finally, the assigned laboratory testing and the logic for these assignments are described.

4.1 Field Testing

A number of field tests were performed during the investigation program including SPT and point load testing.

4.1.1 Field Point Load Testing

Thirteen point load tests were performed on samples of the Minturn sandstone collected from borehole GA-11B-21, eight point load tests were performed on samples of the Lincoln porphyry collected from borehole GA-11B-26, and thirty-five point load tests were performed on lump samples of waste rock collected from the ground surface at various locations throughout the existing waste rock piles in the North 40 and McNulty Gulch areas. Summaries of the point load testing results from the Minturn sandstone, the Lincoln porphyry, and the waste rock piles are presented in Tables 3, 4, and 5, respectively.

The results of the point load tests indicate the variability in the strength of the Minturn sandstone, the Lincoln porphyry, and the waste rock. Weathering, which varies considerably between samples, and preferential failure planes (i.e., bedding planes and/or joints) contribute significantly to the strength of each material type. Variability in the origin of the waste rock also plays a large role in the determination of its strength.

4.1.2 Standard Penetration Testing

Twenty (20) SPTs were performed in various materials during the drilling program. Two tests were performed in soils derived from the Minturn Formation, nine tests were performed in waste rock materials, five tests were performed in the tailing materials, three tests were performed in the glacial till, and one test was performed in soil derived from the Lincoln porphyry.

Table 6 gives a summary of all the SPT tests performed throughout the drilling program. This table presents the field N values, the corrected N_{60} values, and the corrected $(N_1)_{60}$ values.

The field N values are corrected for field conditions and normalized to the standardized N_{60} values. The N value field corrections include factors for hammer efficiency, borehole diameter, sampler type, and rod length. The N_{60} values are further corrected based on the effective overburden stress to produce the normalized $(N_1)_{60}$ value.

The SPTs performed in the materials derived from the Minturn Formation were performed in different materials. The first test, resulting in an $(N_1)_{60}$ value of 42, was performed in a colluvial material consisting of dense SILTY SAND (SM) with gravel and cobbles. The second test resulted in an $(N_1)_{60}$ value of 10 and was performed in a stiff clay found just above the contact with the Minturn sandstone. Both partially disturbed and undisturbed samples of this clay were taken for further strength testing in Golder's Denver laboratory.

The SPTs performed in the waste rock materials resulted in $(N_1)_{60}$ values ranging from 6 to 27 with an average of 16. The SPTs performed in the tailing materials were fairly consistent and resulted in $(N_1)_{60}$ values between 6 and 9 with an average of 7.

Three SPTs were performed in the glacial till; however, one of these SPTs was performed in a transition material between the tailing and the glacial till. This SPT resulted in an $(N_1)_{60}$ value of 18, while the other two tests both had blow counts that exceeded 50 blows in 6 inches.

Finally, a single SPT was performed in soil derived from the Lincoln porphyry, resulting in an $(N_1)_{60}$ value of 29.

4.2 Field Samples

A number of samples were collected from various locations and from various material types throughout the field investigation program. A list of the samples collected is presented in Table 7. The samples taken were a combination of disturbed and undisturbed samples, including bag samples, bucket (pail) samples, SPT samples, Shelby Tube samples, and intact sonic core samples.

4.3 Laboratory Testing Assignments

Select samples were chosen for various laboratory tests. Laboratory tests have been assigned on native soils (glacial till, Lincoln Porphyry, and Minturn), waste rock, and tailing. Tests to be performed include sieve and hydrometer analyses, Atterberg limit tests, natural moisture and density, standard Proctor testing, consolidated undrained triaxial testing with pore pressure measurements, one-dimensional consolidation testing, large-scale direct shear testing, and slake testing.

4.3.1 Native Soils

4.3.1.1 Glacial Till

A number of tests have been assigned on the glacial till materials. These tests have been assigned in order to identify the typical index properties of the glacial till material, provide USCS classifications, and to support determination of design strength parameters. Atterberg limit tests to determine plasticity and sieve analyses to determine grain size were assigned to bag samples from borehole GA-11B-24 at 132 ft BGS. A natural moisture content test was assigned to a bag sample from GA-11B-23 at 280 ft BGS. The sample from borehole GA-11B-24 is expected to be representative of the typical glacial till materials encountered throughout the drilling program, while the sample from borehole GA-11B-23 is representative of the weakest glacial till that was encountered on site. In addition, a natural moisture content determination, standard Proctor compaction test, and large scale direct shear test were assigned on a sample from GA-11B-25 at 104 to 106 ft BGS. The results of the water content determination and the standard Proctor compaction test will be utilized to determine the testing parameters to be used for the large-scale direct shear test. Three reconstituted till samples will be preconsolidated and sheared under normal stresses of 25 psi, 50 psi, and 350 psi. The glacial till material will be re-compacted to approximately 95% of the maximum density as determined by the standard proctor compaction test. The tests will be performed unconsolidated and undrained at a shear rate of approximately 0.04 inches per minute.

4.3.1.2 Lincoln Porphyry

A sieve analysis, Atterberg limit test, and large-scale direct shear test have been assigned to a Lincoln porphyry bucket sample from GA-11B-20 at 40 to 43 ft BGS. This material is expected to be representative of the residual soils derived from the Lincoln porphyry. In addition, a natural moisture content will be determined from a bag sample taken from borehole GA-11B-25 at 178 ft BGS. The large-scale direct shear test on this material will be run at the natural moisture content and a prescriptive sample preparation method will be applied to best simulate field conditions. Since this Lincoln porphyry material is an in situ, completely weathered rock with an in situ density that appeared high based on SPTs and drilling conditions, the large-scale direct shear test will be prepared by compacting the material in 3 to 4 lifts using moderate compactive effort prior to preconsolidating to the simulated normal stresses. The large-scale direct shear test will be run unconsolidated and undrained at a shear rate of 0.04 inches per minute and at normal stresses of 25 psi, 50 psi, and 350 psi.

4.3.1.3 Minturn Formation

Sieve analyses and Atterberg limit tests have been assigned to two samples derived from the Minturn Formation to support USCS classifications. The first set of sieve and Atterberg testing will be performed on a colluvial material sampled from borehole GA-11B-20 at a depth of 32 to 34 ft BGS. This material consisted of a dense silty sand with gravel and cobbles which is typical of the Minturn derived soils found during the field investigation. The second set of sieve and Atterberg testing will be performed on a sample of maroon clay found at a depth of 26 ft BGS in borehole GA-11B-21. This material is intended to represent the weakest Minturn material sampled during the investigation. In addition to the index testing, a staged consolidated undrained triaxial test has been assigned on the partially disturbed sonic core sample retrieved from GA-11B-21 at a depth of 27 ft BGS. The procedure for a staged triaxial test consists of consolidating the sample to the lowest confining stress and then shearing the sample to 5 percent strain. Once 5 percent strain is reached, the sample is consolidated to the next confining stress, and sheared further to 10% strain (an additional 5 percent strain). Finally, the sample is consolidated to the highest confining stress and sheared to failure (15 to 20 percent strain).

4.3.2 Waste Rock

Index tests including water content, Atterberg limits, sieve analyses, and slake testing have been assigned to two bucket samples of waste rock. The first sample came from test pit GA-11P-05 at a depth of 3 to 6 ft BGS while the second sample came from borehole GA-11B-25 at a depth of 16 ft BGS. In addition to the index tests, large-scale direct shear tests will be performed on each waste rock sample. The large-scale direct shear tests on this material will be conducted consistent with the moisture content determined during the index testing and a prescriptive sample preparation method will be applied to best simulate field conditions. The waste rock large-scale direct shear tests will be prepared by placing the material into the shear box in 3 to 4 lifts, with light tamping between lifts in order to create a stable soil matrix. The large-scale direct shear tests will be preconsolidated and sheared at a rate of 0.04 inches per minute and at normal stresses of 25 psi, 50 psi, and 350 psi.

4.3.3 Tailing

A number of tailing samples, both disturbed and undisturbed, were collected to characterize the tailing materials. As described earlier two distinct tailing types were encountered during the field investigation.

The first type was field classified as a poorly graded, fine, SILTY SAND (SM) (BEACH TAILING). This material was non-cohesive so it was extremely difficult to sample in an undisturbed state using Shelby Tubes. As a result, a number of SPTs were performed, and the recovered samples were collected for index testing. Atterberg limit tests and sieve and hydrometer analyses were assigned to samples from GA-11B-24 at 91 to 92 ft BGS, GA-11B-25 at 43.5 ft BGS, and GA-11B-25 at 55 ft BGS. Despite the difficulty in sampling this material, a Shelby tube was successfully collected from borehole GA-11B-25 at 42 ft BGS. Natural moisture and density tests have been assigned to this sample.

The second type of tailing material encountered was field classified as a CLAYEY SILT (ML-MH) (TAILING FINES). This material was more successfully sampled by Shelby tube than the silty sand tailings, as it was cohesive. A number of tests have been assigned to various Shelby tube samples of this material including sieve and hydrometer analyses (two), Atterberg limit tests (two), one in situ moisture and density test, one consolidated undrained triaxial envelope and a single one-dimensional consolidation test. The triaxial envelope will be performed on undisturbed Shelby tube samples at confining stresses of 25 psi, 100 psi, and 350 psi. The two lower confining stress samples will be taken from borehole GA-11B-24 at 51.5 to 53.6 ft BGS, while the 350 psi test will be taken from the Shelby sample at GA-11B-24 at 71 to 73.2 ft BGS. The one-dimensional consolidation test will be performed on an undisturbed sample extruded from the Shelby tube sample at 51.5 to 53.6 ft BGS from borehole GA-11B-24.

A summary of the laboratory assignments is presented in Table 8.

5.0 REFERENCES

Call and Nicholas, Inc. 2007. Slope Stability Evaluation for Feasibility Level Pit Design of Long Range Reserves at Climax Mine. August.

Code of Colorado Regulations, Department of Natural Resources, Division of Water Resources, 2 CCR 402-2. Rules and Regulations for Water Well Construction, Pump Installation, Cistern Installation, and Monitoring and Observation Hole/Well Construction.

List of Attachments

Tables 1 through 8
Figure 1
Attachment 1 – Test Pit Logs
Attachment 2 – Boring Logs
Attachment 3 – Select Photographs

TABLES

Table 1
Surveyed Test Pit Locations

Test Pit	Northing	Easting
GA-11P-01	12729	4150
GA-11P-02	12729	5456
GA-11P-03	11962	3988
GA-11P-04	10083	4912
GA-11P-05	10501	6354
GA-11P-06	10484	8765
GA-11P-07	8771	2821
GA-11P-08	8838	3589
GA-11P-09	8492	5630
GA-11P-10	7391	2566
GA-11P-11	5994	3087
GA-11P-12	5314	3139
GA-11P-13	11503	7887
GA-11P-14	7260	1830
GA-11P-15	9864	6852
GA-11P-16	9315	4758
GA-11P-17	10806	3256
GA-11P-18	6933	1299
GA-11P-19	8613	2443

All coordinates provided in "mine survey" coordinate system

Table 2
Borehole Locations and Summary of Findings

Borehole ID	Date	Approximate Location	Summary of Materials Found	Depth to Native (ft)	Depth to Bedrock (ft)	Depth to Water Table (ft)	Total Depth (ft)	Northing[1]	Easting[1]	Elevation (ft asl)
GA-11B-20	11/3/2011	McNulty Gulch	0 to 38.5 ft: Colluvial material derived from the Minturn 38.5 to 54 ft: Weathered Lincoln Porphyry	0	38.5	24.8	54	12162	4936	11317
GA-11B-21	10/20/2011	Waste Rock in McNulty Gulch	0 to 25 ft: Waste Rock 25 to 43 ft: Weathered Minturn Sandstone 43 to 78.5: Minturn Sandstone with thin beds of shale and clay	25	43	42.9	78.5	11251	6420	11400
GA-11B-22	11/1/2011	McNulty Gulch	0 to 10 ft: Road fill 10 to 33.5 ft: Weathered Lincoln Porphyry	10	10	12	33.5	11562	4503	11400
GA-11B-23	10/24/2011	Waste Rock Pile on top of Tailings	0 to 179 ft: Waste Rock 179 to 235: Tailings 235 to 294 ft: Glacial Till	235	NA	179.8	294	7257	2855	11430
GA-11B-24	10/18/2011	Gravel Pit	0 to 45 ft: Waste Rock 45 to 98 ft: Tailings 98 to 164.5 ft: Glacial Till	98	NA	54.9	164.5	6241	2935	11330
GA-11B-25	10/21/2011	Laydown Yard	0 to 7 ft: Fill 7 to 33.5 ft: Waste Rock 33.5 to 72 ft: Tailings 72 to 171 ft: Glacial Till 171 to 193 ft: Weathered Lincoln Porphyry	72	171	33.9	193	5628	2903	11320
GA-11B-26	10/20/2011	Above McNulty Gulch	0 to 4 ft: Topsoil 4 to 36 ft: Weathered to Slightly Weathered Lincoln Porphyry	0	4	13.1	36	10023	3900	11682

[1]Northings and Eastings are listed based on the local mine coordinate system

Table 3
Point Load Test Results for Minturn Sandstone

Field Information									Results		
Hole Number	Depth ft	Lithology	Foliation[1]	Test Type[2] (D, A, L, or S)	D, mm (Separation)	W,mm Axial & Lump Tests	Gauge Load (psi)	Failure Type[3] 1, 2, 3, 4 or 5	Is50 (psi)	UCS (psi)	ISRM R (Index)
GA-11B-21	43	Minturn	M	L	45	55	1328.546	1	422	10125	4
GA-11B-21	43	Minturn	M	L	55	55	2062.437	1	561	13454	4
GA-11B-21	43	Minturn	M	L	45	55	371.297	2	118	2830	2
GA-11B-21	43	Minturn	M	L	60	60	1511.293	1	359	8615	4
GA-11B-21	49	Minturn	L	D	95	na	3431.593	3	481	11548	4
GA-11B-21	49.5	Minturn	L	D	95	na	1424.271	2	200	4793	3
GA-11B-21	50	Minturn	L	D	95	na	3077.701	3	432	10357	4
GA-11B-21	52	Minturn	L	D	95	na	4603.498	3	645	15492	5
GA-11B-21	52	Minturn	R	A	85	95	3507.012	1	445	10689	4
GA-11B-21	50	Minturn	R	A	60	95	3208.235	1	534	12809	4
GA-11B-21	49.5	Minturn	R	A	25	95	1456.179	1	477	11458	4
GA-11B-21	49.5	Minturn	R	A	40	95	1885.491	1	429	10307	4
GA-11B-21	51	Minturn	R	A	75	95	2909.457	1	407	9771	4

[1] M= Massive, L= Parallel, R= Perpendicular
[2] D= Diametral test, A= Axial test, L= Lump test, S= Split core test
[3] Failure types:
1 = Failure through in-tact rock,
2 = Failure through existing healed structure,
3 = combination of failure types 1 and 2,
4 = Failure did not pass through loading points,
5 = Did not fail

Table 4
Point Load Test Results for Lincoln Porphyry

Field Information									Results		
Hole Number	Depth ft	Lithology	Foliation[1]	Test Type[2] (D, A, L, or S)	D, mm (Separation)	W,mm Axial & Lump Tests	Gauge Load (psi)	Failure Type[3] 1, 2, 3, 4 or 5	Is50 (psi)	UCS (psi)	ISRM R (Index)
GA-11B-26	36	Porphyry	M	D	100	na	5529	3	716	17184	5
GA-11B-26	19	Porphyry	M	L	50	80	1041	2	228	5471	3
GA-11B-26	20	Porphyry	M	L	70	110	3823	1	504	12090	4
GA-11B-26	21	Porphyry	M	D	100	na	2979	2	386	9259	4
GA-11B-26	24	Porphyry	M	D	100	na	3188	3	413	9908	4
GA-11B-26	35	Porphyry	M	L	70	95	2941	3	434	10421	4
GA-11B-26	35.5	Porphyry	M	L	55	105	2834	3	467	11201	4
GA-11B-26	36	Porphyry	M	D	100	na	6675	1	864	20745	5

[1] M= Massive, L= Parallel, R= Perpendicular

[2] D= Diametral test, A= Axial test, L= Lump test, S= Split core test

[3] Failure types:
1 = Failure through in-tact rock,
2 = Failure through existing healed structure,
3 = combination of failure types 1 and 2,
4 = Failure did not pass through loading points,
5 = Did not fail

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Table 5
Point Load Test Results for Waste Rock

Field Information									Results		
Hole Number	Depth ft	Lithology	Foliation[1]	Test Type[2] (D, A, L, or S)	D, mm (Separation)	W,mm Axial & Lump Tests	Gauge Load (psi)	Failure Type[3] 1, 2, 3, 4 or 5	Is50 (psi)	UCS (psi)	ISRM R (Index)
NA	0	Waste Rock	R	L	50	80	2077	1	455	10911	4
NA	0	Waste Rock	M	L	35	105	1703	1	398	9552	4
NA	0	Waste Rock	R	L	20	65	458	3	240	5753	3
NA	0	Waste Rock	R	L	20	85	299	3	127	3046	2
NA	0	Waste Rock	M	L	35	85	3252	1	895	21488	5
NA	0	Waste Rock	M	L	30	60	1891	3	769	18448	5
NA	0	Waste Rock	M	L	50	60	3852	1	1054	25292	5
NA	0	Waste Rock	R	L	35	60	2341	3	844	20263	5
NA	0	Waste Rock	M	L	30	60	953	3	387	9296	4
NA	0	Waste Rock	M	L	40	100	1300	3	284	6827	3
NA	0	Waste Rock	M	L	50	150	2950	3	397	9521	4
NA	0	Waste Rock	M	L	45	85	1920	3	435	10444	4
NA	0	Waste Rock	M	L	60	90	609	1	106	2536	2
NA	0	Waste Rock	M	L	45	70	2904	1	765	18356	5
NA	0	Waste Rock	M	L	60	70	2587	2	545	13089	4
NA	0	Waste Rock	M	L	45	85	2434	1	552	13236	4
NA	0	Waste Rock	M	L	45	70	2265	3	597	14322	4
NA	0	Waste Rock	M	L	60	85	6234	3	1130	27128	5
NA	0	Waste Rock	M	L	45	90	4386	3	951	22820	5
NA	0	Waste Rock	M	L	60	80	1285	2	244	5861	3
NA	0	Waste Rock	M	L	45	90	2721	3	590	14157	4
NA	0	Waste Rock	M	L	50	85	1001	2	209	5016	3
NA	0	Waste Rock	M	L	40	70	2382	1	687	16495	5
NA	0	Waste Rock	M	L	70	95	2834	1	418	10040	4
NA	0	Waste Rock	R	L	30	90	615	1	183	4381	3
NA	0	Waste Rock	M	L	65	105	1746	1	253	6063	3
NA	0	Waste Rock	M	L	20	90	554	2	225	5404	3
NA	0	Waste Rock	M	L	60	80	1131	3	215	5160	3
NA	0	Waste Rock	M	L	50	75	844	1	194	4662	3
NA	0	Waste Rock	M	L	40	80	2074	3	540	12953	4
NA	0	Waste Rock	M	L	35	90	806	1	212	5098	3
NA	0	Waste Rock	M	L	50	90	2118	3	423	10154	4
NA	0	Waste Rock	M	L	45	100	5654	1	1130	27109	5
NA	0	Waste Rock	M	L	55	80	1372	1	279	6695	3
NA	0	Waste Rock	M	L	35	85	4099	1	1129	27085	5

[1] M= Massive, L= Parallel, R= Perpendicular
[2] D= Diametral test, A= Axial test, L= Lump test, S= Split core test
[3] Failure types: 1 = Failure through in-tact rock,
2 = Failure through existing healed structure,
3 = combination of failure types 1 and 2,
4 = Failure did not pass through loading points,
5 = Did not fail

Golder Associates

Table 6
Standard Penetration Test Results and Corrections

Depth (ft)	Location	Material	N1	N2	N3	N	Rod Correction (C_r)	$N_{60}(1)$	$N_{60}(2)$	$N_{60}(3)$	N_{60}	Overburden Stress (psf) σ'_{vo}	Overburden Correction C_n	$(N_1)_{60}$
15	GA-11B-20	Colluvial Minturn	25	25	13	38	0.95	25	25	13	38	1725	1.11	42
25	GA-11B-21	Weathered Minturn	2	4	7	11	1	2	4	7	12	2875	0.86	10
15	GA-11B-23	Waste Rock	7	5	7	12	0.95	7	5	7	12	1725	1.11	13
30	GA-11B-23	Waste Rock	7	7	8	15	1	7	7	8	16	3450	0.78	12
50	GA-11B-23	Waste Rock	13	13	13	26	1	14	14	14	27	5750	0.61	17
65	GA-11B-23	Waste Rock	20	36	12	48	1	21	38	13	50	7475	0.53	27
10	GA-11B-24	Waste Rock/Fill	4	7	9	16	0.85	4	6	8	14	1150	1.36	19
25	GA-11B-24	Waste Rock	11	12	12	24	1	12	13	13	25	2875	0.86	22
10	GA-11B-25	Waste Rock	1	1	4	5	0.85	1	1	4	4	1150	1.36	6
20	GA-11B-25	Waste Rock	7	4	5	9	1	7	4	5	9	2300	0.96	9
30	GA-11B-25	Waste Rock	3	10	13	23	1	3	11	14	24	3450	0.78	19
61	GA-11B-24	Tailings	5	7	8	15	1	5	7	8	16	6634	0.57	9
73.2	GA-11B-24	Tailings	5	6	6	12	1	5	6	6	13	7276	0.54	7
91	GA-11B-24	Tailings	5	6	7	13	1	5	6	7	14	8212	0.51	7
44.5	GA-11B-25	Tailings	4	4	5	9	1	4	4	5	9	4456	0.69	7
55	GA-11B-25	Tailings	3	4	5	9	1	3	4	5	9	5008	0.65	6
225	GA-11B-23	Tailings/Till	21	22	21	43	1	22	23	22	45	23067	0.40	18
109.5	GA-11B-24	Glacial Till	>50			>50	1	>50	0	0	>50	9185	0.48	>50
85	GA-11B-25	Glacial Till	42	>50		>50	1	44	>50	0	>50	6586	0.57	>50
15	GA-11B-26	Lincoln Porphyry	9	12	13	25	0.95	9	12	13	25	1606	1.15	29

Notes: Hammer correction factor is equal to 1
Liner correction factor is equal to 1
Borehole diameter factor is equal to 1.05 (150 mm borehole)

Table 7
List of Samples

Borehole Samples					
Location	Depth (ft)	Material Sampled	Sample Type	Disturbed/ Undisturbed	Sample Amount
GA-11B-24	10-11.5	Waste Rock	SPT	Disturbed	1 bag
	23	CL/SC	Bucket	Disturbed	1 bucket
	23	CL	Sonic Core	Partially Disturbed	4 in.
	25-26.5	Waste Rock	SPT	Disturbed	1 bag
	32	CL	Bag	Disturbed	1 bag
	46	Tailings	Shelby	Undisturbed	0 in.
	46	Tailings	Sonic Core	Partially Disturbed	4 in.
	47-49	Tailings	Bag	Disturbed	1 bag
	51.5-53.6	Tailings	Shelby	Undisturbed	28 in.
	56.5-57.5	Tailings	Bag	Disturbed	1 bag
	59.8-61	Tailings	Sonic Core	Partially Disturbed	1 bag
	61-62.5	Tailings	SPT	Disturbed	1 bag
	71-73.2	Tailings	Shelby	Undisturbed	26.5 in.
	73.2-74.7	Tailings	SPT	Disturbed	18 in.
	91	Tailings	SPT	Disturbed	1 bag
	105-106	Glacial Till	Bag	Disturbed	1 bag
	109.5-109.7	Glacial Till	SPT	Disturbed	1 bag
	132	Glacial Till	Bag	Disturbed	1 bag
GA-11B-26	15	GW	SPT	Disturbed	1 bag
	22.5-23	CL	Bag	Disturbed	2 bags
GA-11B-21	25-26.5	Minturn	SPT	Disturbed	1 bag
	28	CL	Sonic Core	Partially Disturbed	1 bag
	31-32	CL	Shelby	Undisturbed	16 in.
	59	Minturn	Bag	Disturbed	1 bag
	60-78.5	Minturn Sandstone	HQ Core	na	15 ft.
GA-11B-25	10	Waste Rock	SPT	Disturbed	1 bag
	15-16	GW	Bag	Disturbed	1 bag
	16	Waste Rock	Bucket	Disturbed	1 bucket
	20-21.5	Waste Rock	SPT	Disturbed	1 bag
	30-31.5	Waste Dump	SPT	Disturbed	1 bag
	36-39	Tailings	Bucket	Disturbed	1 bucket
	40-42.5	Tailings	Shelby	Undisturbed	0 in.
	42-43.5	Tailings	Shelby	Undisturbed	30 in.
	43.5-45	Tailings	SPT	Disturbed	18 in.
	55-56.5	Tailings	SPT	Disturbed	18
	59-61	Tailings	Bucket	Disturbed	1 bucket
	71	Tailings	Bag	Disturbed	1 bag
	85-86.5	Glacial Till	SPT	Disturbed	1 bag
	104-106	Glacial Till	Bucket	Disturbed	1 bucket
	154	SW	Bag	Disturbed	1 bag
	172-174	Porphyry	Bag	Disturbed	1 bag
	178	Porphyry	Bag	Disturbed	1 bag

Table 7
List of Samples

Borehole Samples					
Location	**Depth (ft)**	**Material Sampled**	**Sample Type**	**Disturbed/ Undisturbed**	**Sample Amount**
GA-11B-23	15-16.5	Waste Rock	SPT	Disturbed	1 bag
	30-31.5	Waste Rock	SPT	Disturbed	1 bag
	38-40	Waste Rock	Bucket	Disturbed	1 bucket
	50-51.5	Waste Rock	SPT	Disturbed	1 bag
	65-66.5	Waste Rock	SPT	Disturbed	1 bag
	170	GW	Bag	Disturbed	1 bag
	181	Tailings	Bag	Disturbed	1 bag
	184	Tailings	Bag	Disturbed	1 bag
	185	Tailings	Shelby	Undisturbed	28 in.
	190	Tailings	Shelby	Undisturbed	28 in.
	192-193	Tailings	Sonic Core	Partially Disturbed	1 bag
	195-197.5	Tailings	Shelby	Undisturbed	23.5 in.
	205-206.5	Tailings	Shelby	Undisturbed	23 in.
	215-217	Tailings	Shelby	Undisturbed	28 in.
	225-226	Tailings	SPT	Disturbed	1 bag
	249-251	Glacial Till	Bucket	Disturbed	1 bucket
	268	SC	Bag	Disturbed	1 bag
	273	CL	Bag	Disturbed	1 bag
	276	CL	Bag	Disturbed	1 bag
Test Pit Samples					
Location	**Depth (ft)**	**Material Sampled**	**Sample Type**	**Disturbed/ Undisturbed**	**Sample Amount**
GA-11P-18	6-10	Sand	Bucket	Disturbed	1 bucket
GA-11P-14	4-5	GW	Bag	Disturbed	1 bag
GA-11P-11	10-14	GW	Bucket	Disturbed	1 bucket
	12	CL	Bag	Disturbed	1 bag
GA-11P-07	5-10	CL	Bucket	Disturbed	1 bucket
GA-11P-04	4-6	GW	Bucket	Disturbed	1 bucket
GA-11P-16	3-6	Porphyry	Bucket	Disturbed	1 bucket
GA-11P-08	2-4	GW	Bucket	Disturbed	1 bucket
GA-11P-17	2-4	Minturn	Bucket	Disturbed	1 bucket
GA-11P-03	3-5	SC	Bag	Disturbed	1 bag
GA-11P-02	6-8	CL	Bag	Disturbed	1 bag
GA-11P-15	2	GW	Bucket	Disturbed	1 bucket
GA-11P-05	4-6	Waste Rock	Bucket	Disturbed	2 buckets
GA-11P-13	4-6	Minturn Sandstone	Bucket	Disturbed	1 bucket
	6	Minturn Sandstone	Bag	Disturbed	1 bag
GA-11P-06	4-6	CL	Bucket	Disturbed	2 buckets
	15	Minturn Cobbles	Bag	Disturbed	1 bag
GA-11P-09	0.5-2	Porphyry	Bag	Disturbed	1 bag

Table 8
Summary of Laboratory Assignments

Material	Sample Type	Location	Tests to be Performed
Glacial Till	Bag	GA-11B-24 @ 132 ft	Sieve analysis, Atterberg limits
Glacial Till	Bag	GA-11B-23 @ 280 ft	Natural Moisture
Glacial Till	Bucket	GA-11B-25 @ 104 to 106 ft	Natural moisture, standard Proctor compaction, large scale direct shear
Lincoln porphyry	Bucket	GA-11B-20 @ 40 to 43 ft	Hydrometer and sieve analysis, Atterberg limits, large scale direct shear
Lincoln porphyry	Bag	GA-11B-25 @ 178 ft	Natural moisture
Minturn	Bucket	GA-11B-20 @ 32 to 34 ft	Sieve analysis, Atterberg limits
Minturn	Sonic Core	GA-11B-21 @ 26 ft	Hydrometer and sieve analysis, Atterberg limits, staged triaxial test
Waste Rock	Bucket	GA-11P-05 @ 3 to 6 ft	Water content, Atterberg limits, sieve analysis, slake, large scale direct shear
Waste Rock	Bucket	GA-11B-25 @ 16 ft	Water content, Atterberg limits, sieve analysis, slake, large scale direct shear
Tailings (Silty Sand)	SPT	GA-11B-24 @ 91-92 ft	Hydrometer and sieve analysis, Atterberg limits, modified proctor test, minimum and maximum density test[1]
Tailings (Silty Sand)	SPT	GA-11B-25 @ 43.5 ft	Hydrometer and sieve analysis, Atterberg limits
Tailings (Silty Sand)	SPT	GA-11B-25 @ 55 ft	Hydrometer and sieve analysis, Atterberg limits
Tailings (Silty Sand)	Shelby Tube	GA-11B-25 @ 42 ft	Natural moisture and density
Tailings (Silt)	Shelby Tube	GA-11B-24 @ 51.5 to 53.6 ft	Consolidated undrained triaxial, 1-dimensional consolidation, natural moisture, Hydrometer and sieve, Atterberg limits
Tailings (Silt)	Shelby Tube	GA-11B-24 @ 71-73.2 ft	Hydrometer and sieve analysis, Atterberg limits, natural moisture and density
Tailings (Silt)	Shelby Tube	GA-11B-23 @ 190 to 197.5 ft	Natural moisture and density

1) Modified proctor test and minimum/maximum density tests performed on composite sample of silty sand tailing including material from other sample intervals

FIGURES

LEGEND

EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)

PROPOSED WASTE ROCK STOCKPILE TOPOGRAPHY (SEE REFERENCE 3)

CHANNELS, DRAINAGES, DITCHES, AND GULCHES (SEE REFERENCE 4)

WASTE DUMP BOUNDARY

PRELIMINARY STABILITY SECTIONS

APPROXIMATE LIMITS OF HISTORIC TAILINGS IMPOUNDMENTS

APPROXIMATE LIMITS OF POTENTIAL TAILINGS OR TAILING IMPACTED SOIL

APPROXIMATE LIMITS OF RECENT WASTE ROCK / FILL

GA–11B–21 AS–BUILT BORING

GA–11P–06 AS–BUILT TEST PIT

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. AERIAL PHOTOGRAPH TAKEN IN 2009, FROM USDA AERIAL PHOTOGRAPHY FIELD OFFICE.
3. PRELIMINARY WASTE ROCK STOCKPILE TOPOGRAPHY PROVIDED BY CLIMAX MINE, 17 FEBRUARY 2012.

REV	DATE	REVISION DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
E	16MAY12	ISSUED FOR REPORT	DAR	JWR	DLG	BRB
D	4APR12	ISSUED FOR REPORT	DAR	JWR	DLG	BRB
C	6DEC11	ISSUED FOR REPORT	DAR	JWR	DLG	BRB
B	26MAY11	ISSUED FOR REPORT	DLG	JWR	DLG	BRB
A	01APR11	ISSUED FOR REPORT	DLG	JWR	DLG	BRB

PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES, COLORADO

TITLE

AS-BUILT BORING AND TEST PIT LOCATIONS (OVERLAIN ON AERIAL PHOTOGRAPH)

Golder Associates
DENVER, COLORADO

FILE No. 1138160B001 – FIG 1– AS–BUILT
PROJECT No. 113–81608

FIGURE 1

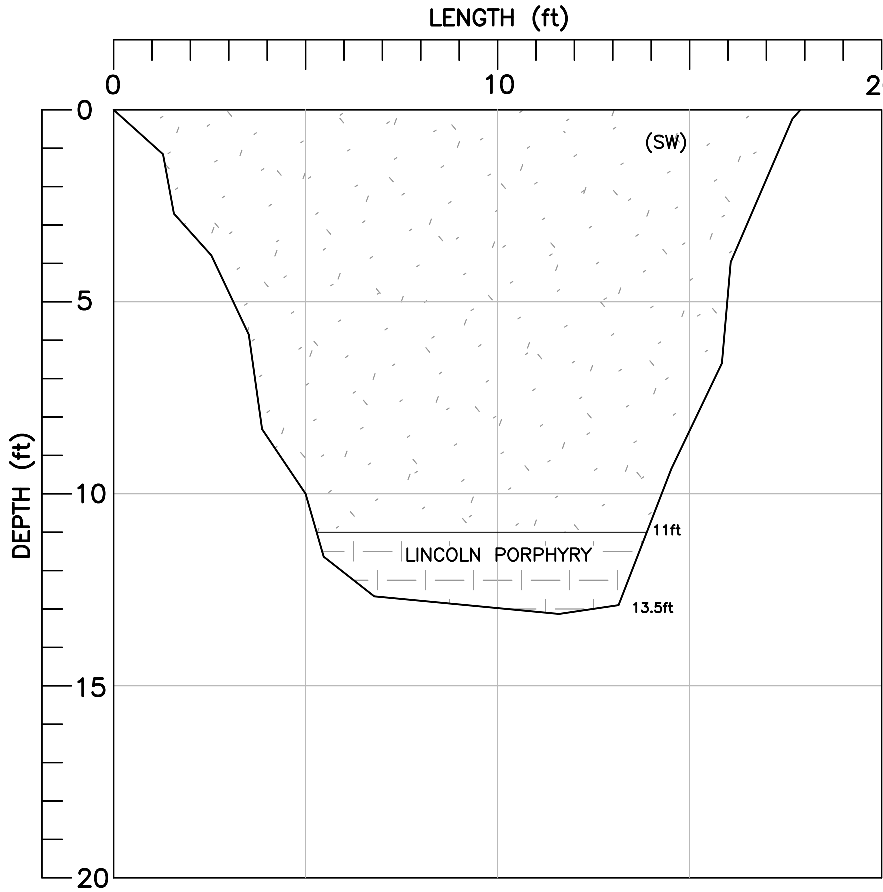
Drawing File: J:\11JOBS\113-81608 Climax\Design Report\Rev3\AppA – Field\Figure\ 1138160B001 – Fig 1– As–Built.dwg | Layout: 11x17 Landscape | Modified: May 16, 2012 09:00 DGEIER | Plotted: 05/30/12 8:40am DGEIER

ATTACHMENT 1
TEST PIT LOGS

TEST PIT LOG

No. GA–11P–01

TEMP 60 °F WEATHER Light Snow ENGINEER D. Rugg OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/11/11
COORDINATES N 12799 E 4150 ELEV. 11250 DATUM JOB 113–81608
LOCATION Climax Mine TIME 4:05 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–11 ft
Compact, red–brown, well graded with sub–angular to sub–rounded cobbles, gravelly SAND with some cobbles, few boulders, and little silt. 50% sand, 15% gravel, 10% cobbles, 5% boulders, remainder is silt and clay sized, non–plastic to low plasticity, slightly moist (SW)

11–13.5 ft
Highly to completely weathered, gray, aphanitic to very coarse crystaline, average of 1 mm diameter to maximum of 1 cm. Extremely weak rock (R0 strength) (LINCOLN PORPHYRY)

SPECIAL NOTES

No groundwater encountered.

Refusal met at approximately 13.5 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

ID	TYPE (NO.)	DEPTH (ft)

LEGEND

TEST PIT LOG

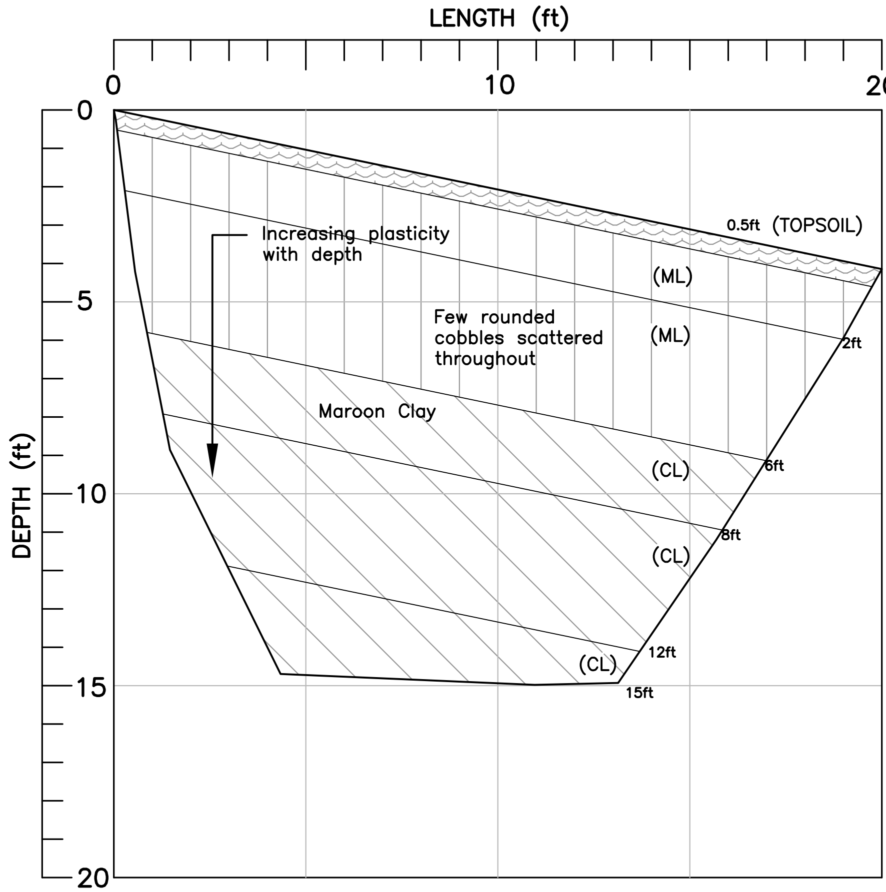
No. GA-11P-02

TEMP ____ °F WEATHER Overcast | ENGINEER D. Rugg | OPERATOR Larry

EQUIPMENT Deere 240 D | CONTRACTOR Moltz Construction | DATE 10/11/11

COORDINATES N 12729 E 5456 | ELEV. 11420 | DATUM ____ | JOB 113-81608

LOCATION Climax Mine | TIME 2:30 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0-0.5 ft
Organics, lots of roots and decomposed vegetation (TOPSOIL)

0.5-2ft
Firm, red-brown, clayey SILT, 75% silt, 15% clay, 5% gravel, 5% sand (ML)

2-6 ft
Firm, maroon, clayey SILT, more clay with depth, 50% silt, 30% clay, 10% gravel, 5% cobbles, 5% sand (ML)

6-8 ft
Stiff, maroon, silty CLAY, medium plastic, moist (CL)

8-12 ft
Firm to stiff, maroon, silty CLAY with sand and gravel, some cobbles. 35% silt and clay, medium to low plasticity, 30% medium to coarse sand, 10 to 15% gravel, gravel and cobbles are micaceous sandstone with R4 (strong rock) strength

12-15 ft
Same as above with more cobbles and gravel. 10 to 15% gravel and 5 to 10% cobbles

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 15 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

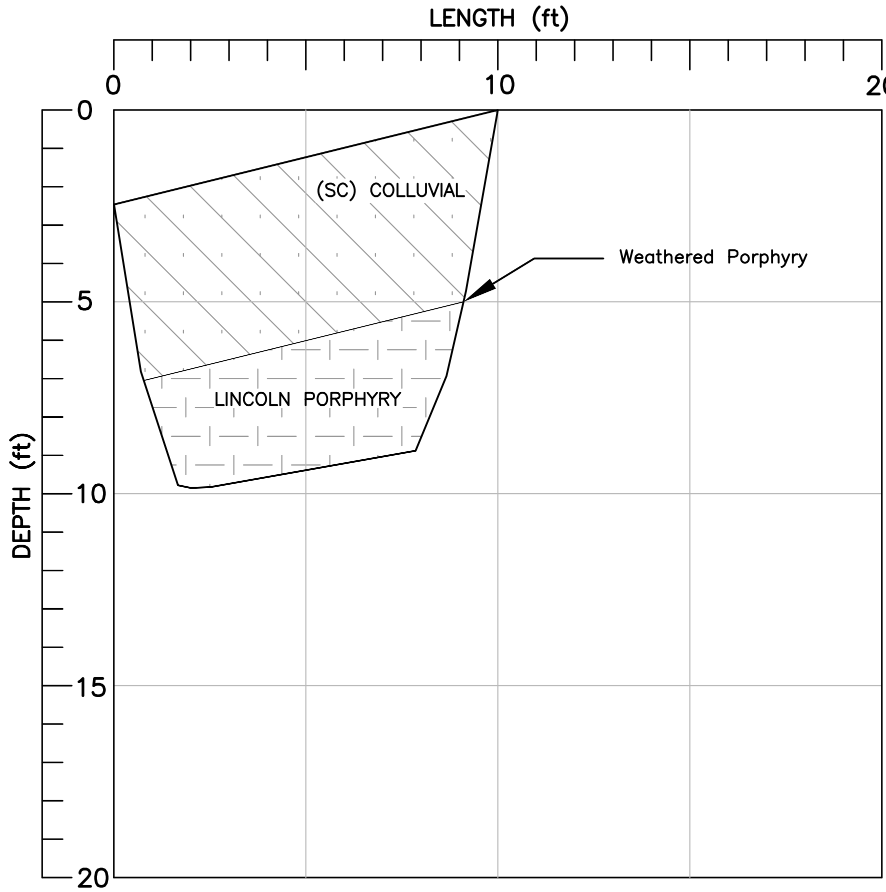
ID	TYPE (NO.)	DEPTH (ft)
GA-11P-02	Bag (1)	6-8

LEGEND

TEST PIT LOG

No. GA–11P–03

TEMP ____ °F WEATHER Partly Cloudy ENGINEER D. Rugg OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/12/11
COORDINATES N 11962 E 3988 ELEV. 11360 DATUM ____ JOB 113–81608
LOCATION Climax Mine TIME 8:00 AM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–5 ft
Loose to compact, dark brown, medium to coarse, clayey SAND (SC). 75% sand, 5% cobbles, trace small boulders (maximum 18 in diameter), 15% fines, low plasticity, moist, cobbles are sub–rounded (COLLUVIAL)

5–8 ft
Highly to completely weathered, blocky, aphanitic to 3mm crystaline, strength is R0 (extremely weak rock) (LINCOLN PORPHYRY)

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 8 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

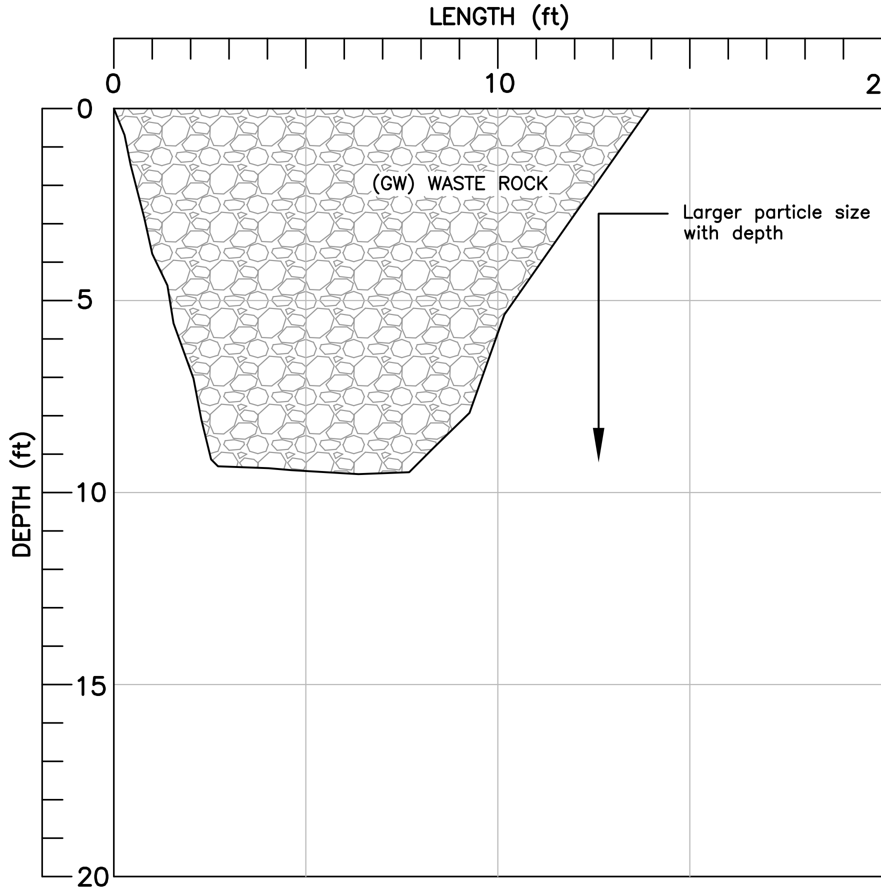
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–03	Bag (1)	3–5

LEGEND

TEST PIT LOG

No. GA–11P–04

TEMP ____ °F WEATHER Clear and Windy ENGINEER D. Rugg OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/12/11
COORDINATES N 10083 E 4912 ELEV. 11792 DATUM ____ JOB 113–81608
LOCATION Climax Mine TIME 1:00 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–2 ft
Compact, gray–tan, well graded, sandy GRAVEL, 40% gravel, 30% medium to coarse sand, 24% cobbles, 5% boulders, non–plastic, slightly moist (GW) (WASTE ROCK)

2–9 ft
Compact to dense, tan, well graded GRAVEL, non–plastic, slightly moist (GW). 40% gravel, 20% sand, 15% cobbles, 10% boulders, 5% fines (WASTE ROCK)

SPECIAL NOTES

Sand seems to be a pure quartz derivative, some fines from feldspars. Cobbles and boulders are mainly quartz with some feldspar and moly veins (low grade ore) and are aphanitic to very large quartz veins, cobbles and boulders are R5.

No groundwater encountered

Refusal met at approximately 9 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

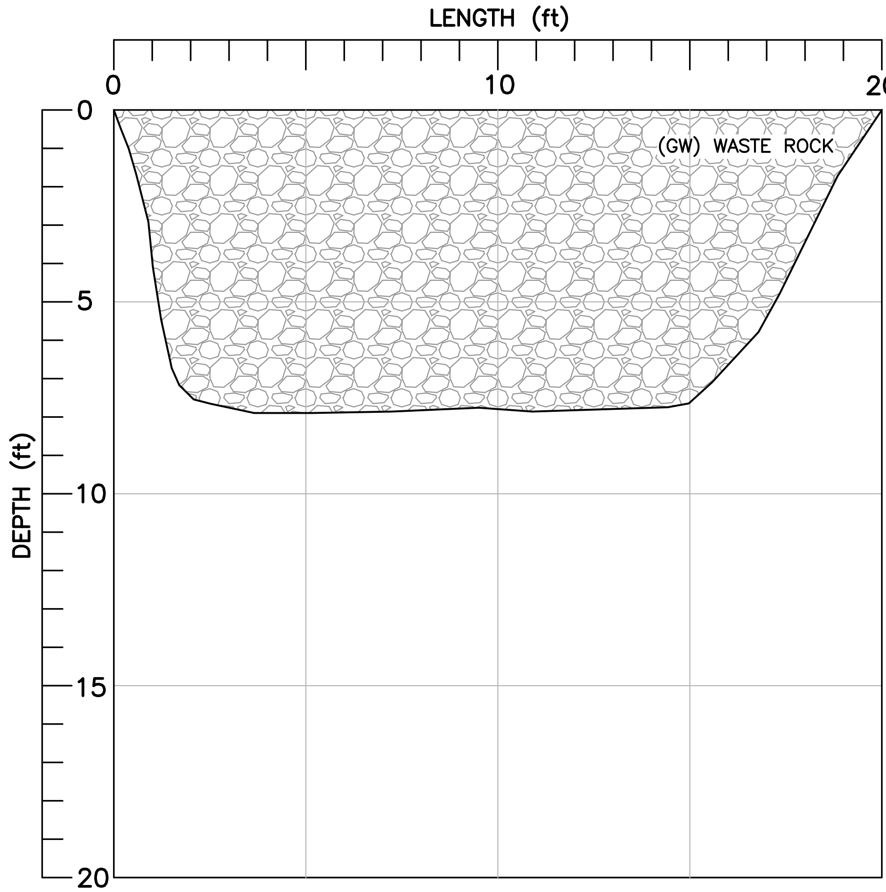
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–04	Pail (1)	4–6

LEGEND

TEST PIT LOG

No. GA-11P-05

TEMP ____ °F WEATHER Snow ENGINEER D. Rugg OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/11/11
COORDINATES N 10501 E 6354 ELEV. 11718 DATUM ____ JOB 113-81608
LOCATION Climax Mine TIME ____



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–7.5 ft
Compact, orange–brown with gray, more rust color with depth, GRAVEL (GW), 40% gravel, 10% cobbles, 5 to 10% boulders, 25% sand, 15% fines (WASTE ROCK)

SPECIAL NOTES

Cobbles and boulders are angular to sub–angular. Fines are silty clay, medium plastic, well graded, and moist.

Cobbles and boulders are not included in bucket samples.

No groundwater encountered

Refusal met at approximately 7.5 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

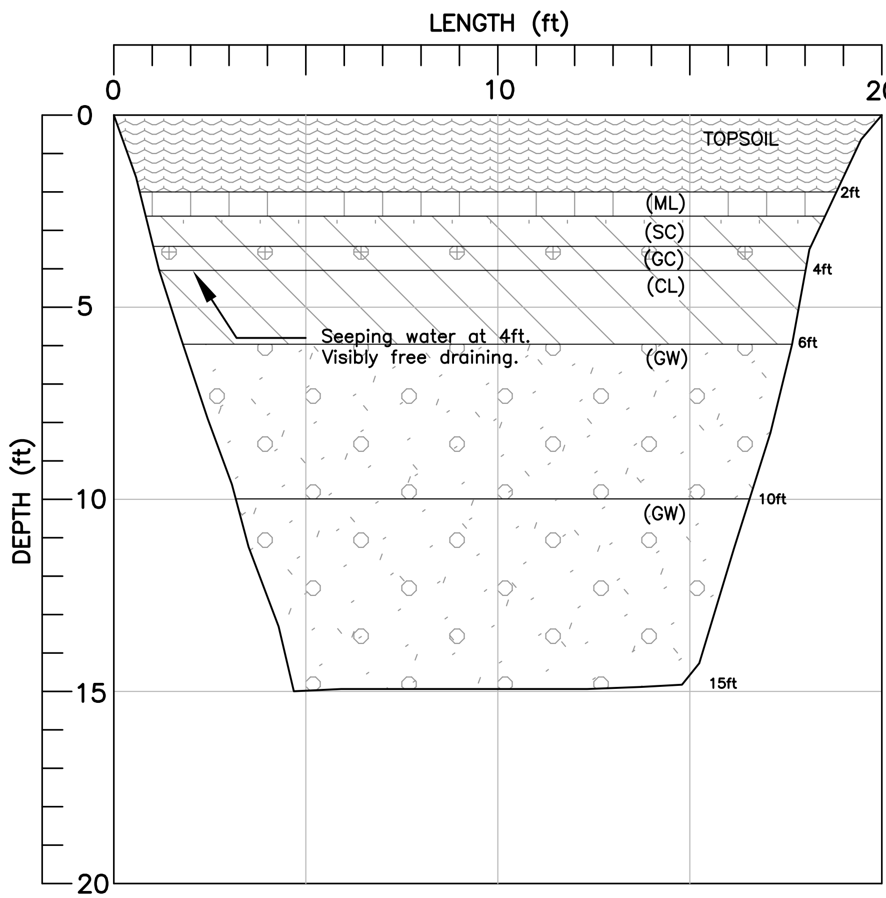
ID	TYPE (NO.)	DEPTH (ft)
GA-11P-05	Pail (2)	4-6

LEGEND

TEST PIT LOG

No. GA-11P-06

TEMP ____ °F WEATHER Clear
ENGINEER D. Rugg
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/10/11
COORDINATES N 10484 E 8765
ELEV. 12197
DATUM ____
JOB 113-81608
LOCATION Climax Mine
TIME 10:45 AM TO 11:05 AM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–2 ft
Loose, brown, organic SILT with roots, slow plasticity, slightly moist, (TOPSOIL)

2–4 ft
Loose, dark brown, clayey SILT, trace cobbles, little organics interbedded with Firm, gray, sandy CLAY with silt (SC), and Loose, very dark brown to black, clayey GRAVEL (GC) with severe iron staining. Gravel is R0 (extremely weak rock) strength

4–6 ft
Stiff, gray, gravelly CLAY, moist, medium plastic, trace sand

6–10 ft
Loose to compact, brown, well graded, gravelly SAND, slightly moist, non-plastic, trace cobbles, some silt, trace clay. Cobbles are R1 (very weak rock) strength, show some indications of bedding planes (strength is variable). More gravel and cobbles with depth.

10–12 ft
Gray-brown, gravelly SAND. 30% gravel, 15% cobbles, remainder is sand with interbedded stiff clay

12–15 ft
Same as above with harder cobbles (R1 thru R3- very weak to medium strong rock) and interbedded stiff clays.

SPECIAL NOTES

Material from 12 to 15 ft is part of the upper MINTURN formation.

Seeping water was encountered at about 4 ft below ground surface.

Refusal met at approximately 15 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)
4–6	1.5
12–15	2.5

SAMPLES

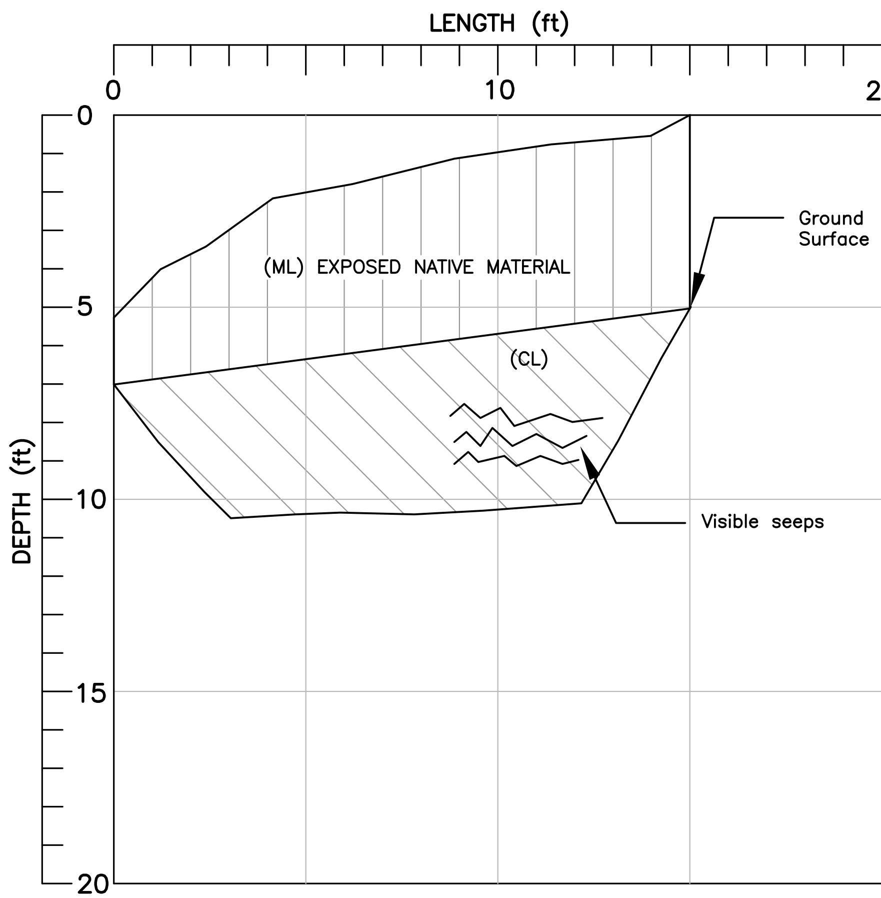
ID	TYPE (NO.)	DEPTH (ft)
GA-11P-06	Pail (2)	4–6
GA-11P-06	Bag (1)	15

LEGEND

TEST PIT LOG

No. GA–11P–07

TEMP ___ °F	WEATHER Clear and Windy	ENGINEER D. Rugg	OPERATOR Larry
EQUIPMENT Deere 240 D		CONTRACTOR Moltz Construction	DATE 10/12/11
COORDINATES N 8771	E 2821	ELEV. 11285 DATUM	JOB 113–81608
LOCATION Climax Mine		TIME 2:30 PM	



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–5 ft
Compact, tan, silty SAND with clay, slightly moist, medium plasticity (ML), cobbles are sub–rounded 40% medium to coarse sand, 30% silt, 20% clay, 10% cobbles

5–10 ft
Dense, gray–brown, sandy gravelly CLAY, moist to very moist, medium to high plasticity (CL), cobbles are sub–angular to angular, and range in strength from R0 to R4 (extremely weak to strong rock). 40% clay, 30% gravel, 20% sand, 10% cobbles

SPECIAL NOTES

Cobbles are LINCOLN PORPHYRY, some are completely weathered.

Cobbles are excluded from bucket sample.

Seeping groundwater encountered at approximately 8 to 10 ft.

Refusal met at approximately 10 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

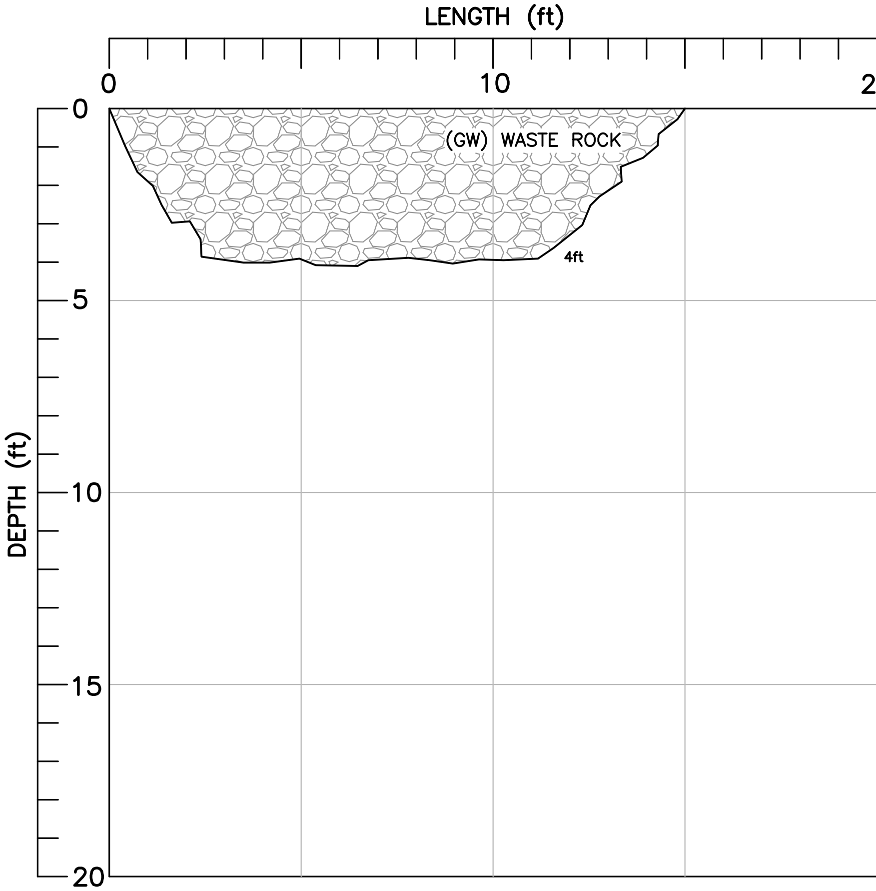
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–07	Pail (1)	5–10

LEGEND

TEST PIT LOG

No. GA-11P-08

TEMP ____ °F WEATHER Clear and Windy ENGINEER D. Rugg/ D. Geier OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/12/11
COORDINATES N 8838 E 3589 ELEV. 11560 DATUM ____ JOB 113-81608
LOCATION Climax Mine TIME 11:00 AM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0-4 ft
Loose to compact, mottled gray to orange-brown, well-graded, sub-angular sandy GRAVEL with some clay, some cobbles, and some boulders, medium plasticity, moist. 40% gravel, 20% cobbles, 10% boulders, 20% sand, 10% clay (WASTE ROCK)

Material appears sourced from near ore zone. Some pyrite moly veins, cobbles are R3 to R4 (medium strong to strong rock) strength.

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 4 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

ID	TYPE (NO.)	DEPTH (ft)
GA-11P-08	Pail (1)	2-4

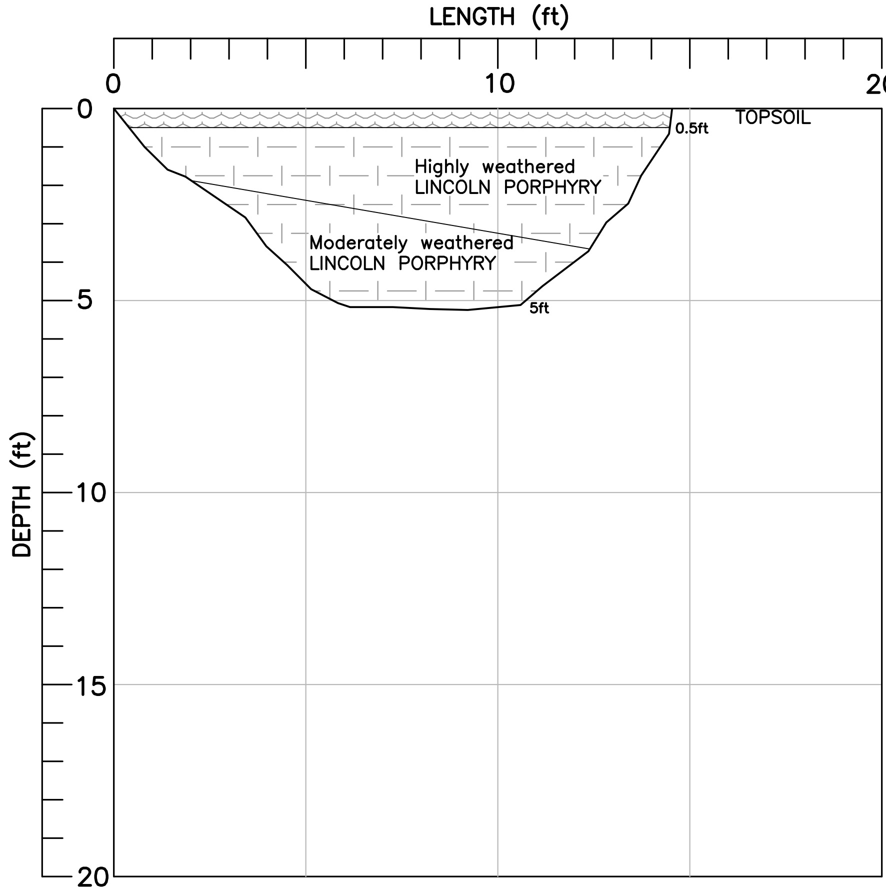
LEGEND

TEST PIT LOG

No. GA–11P–09

Golder Associates

TEMP 40 °F WEATHER Clear | ENGINEER D. Rugg/ D. Geier | OPERATOR Larry
EQUIPMENT Deere 240 D | CONTRACTOR Moltz Construction | DATE 10/12/11
COORDINATES N 8492 E 5630 | ELEV. 11840 | DATUM | JOB 113–81608
LOCATION Climax Mine | TIME 1:00 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–0.5 ft
Loose, brown, organic SILT with roots and plant material, moist (TOPSOIL)

0.5–3 ft
Highly weathered, gray with brown weathered surfaces, medium to coarsely crystaline, R2 (weak rock) strength LINCOLN PORPHYRY, 5 to 10% biotite, 10% quartz, remainder is feldspar. Weathers to 60% gravel, 20% sand, remainder is cobbles. Appears massive in–situ

3–5 ft
Becomes moderately weathered, less brown weathered faces, 10–15% sand, 30% gravel, remainder is cobbles. Cobbles are R3 (medium strong rock) strength (LINCOLN PORPHYRY)

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 5 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

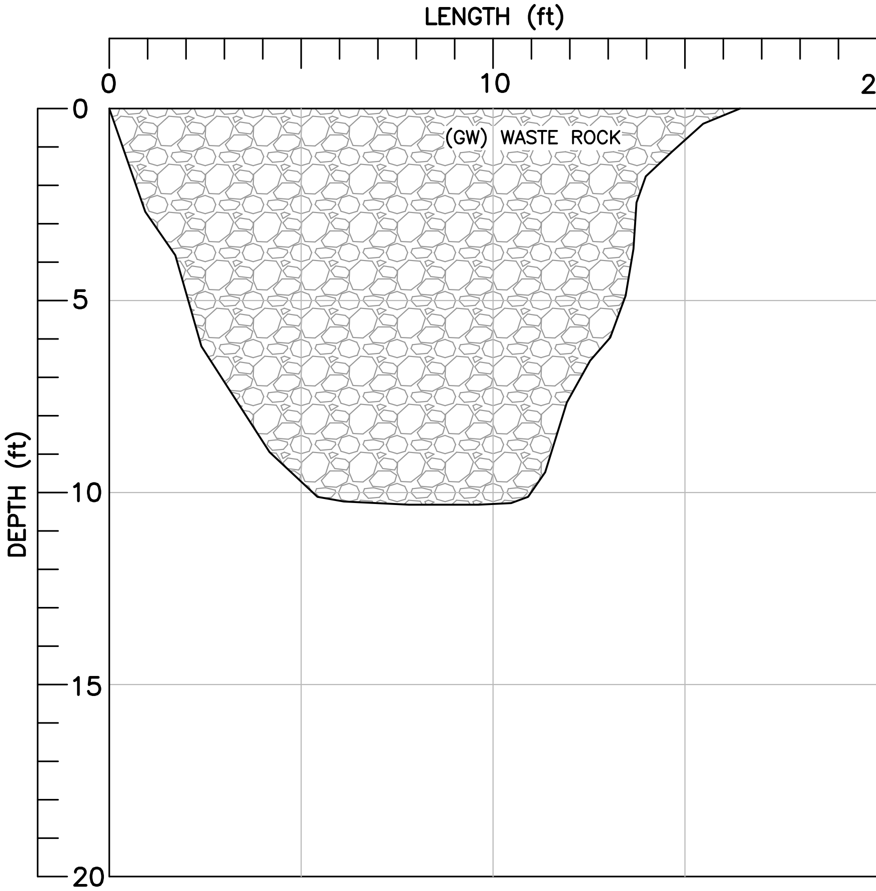
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–09	Bag (1)	0.5–2

LEGEND

TEST PIT LOG

No. GA-11P-10

TEMP ____ °F WEATHER Partly Cloudy ENGINEER D. Rugg/ D. Geier OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/13/11
COORDINATES N 7391 E 2566 ELEV. 11425 DATUM ____ JOB 113-81608
LOCATION Climax Mine TIME 12:35 PM TO 1:10 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0-4 ft
Loose, tan-brown, sandy GRAVEL with cobbles and boulders, slightly moist, non-plastic, 40% gravel, 20% sand, 20% cobbles, 20% boulders (WASTE ROCK)

4-6 ft
Same as above with more boulders

6-10 ft
Same as above, but slightly finer, 40% gravel, 40% sand, 15% cobbles, 5% boulders

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 10 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

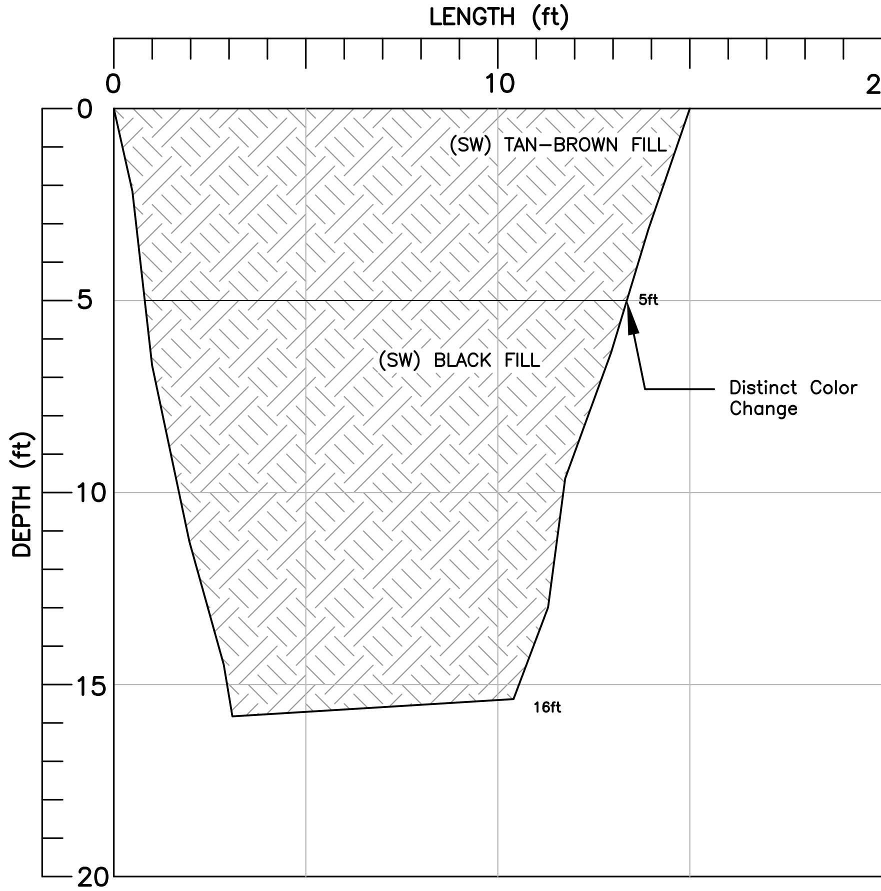
ID	TYPE (NO.)	DEPTH (ft)

LEGEND

TEST PIT LOG

No. GA-11P-11

TEMP ____ °F WEATHER Clear
ENGINEER D. Rugg
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/13/11
COORDINATES N 6003 E 3052
ELEV. 11320
DATUM
JOB 113-81608
LOCATION Climax Mine
TIME 10:00 AM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0-5 ft
Compact, brown, gravelly SAND with cobbles and boulders, slightly moist, non-plastic, cobbles and boulders are R3 to R5 (medium strong to very strong rock) strength. 40% sand, 35% gravel (angular), 15% angular cobbles, 5% silt (FILL)

5-12 ft
Compact, dark gray to black, gravelly SAND with cobbles, some boulders and fine, slightly moist, non-plastic. 40% medium to coarse sand, 20% gravel, 20% cobbles, 15% boulders, 5% fine (FILL). Cobbles and boulders are aphanitic to coarsely crystalline with gray to dark gray coloring. Micas are present

12 ft
Stiff, dark gray CLAY with sand and gravel, medium to high plasticity, slightly moist. Does not appear to be continuous

12-16 ft
Same as 5-12 ft with more boulders

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 16 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

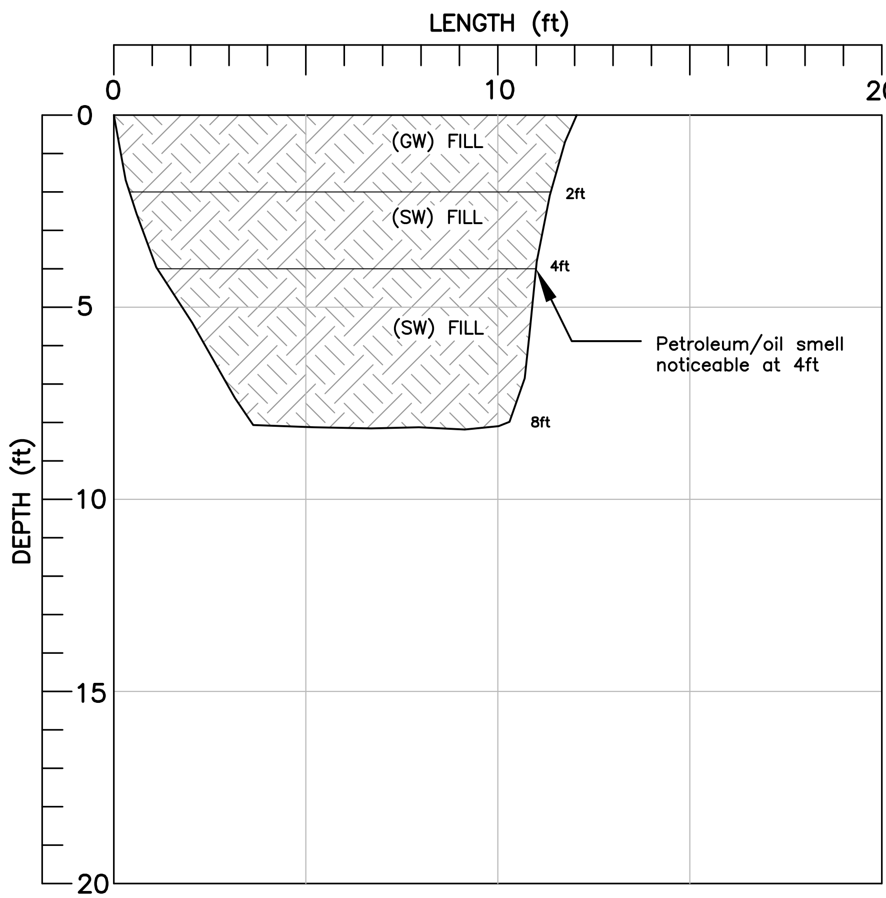
ID	TYPE (NO.)	DEPTH (ft)
GA-11P-11	Pail (1)	10-14
GA-11P-11	Bag (1)	12

LEGEND

TEST PIT LOG

No. GA-11P-12

TEMP ____ °F WEATHER Clear
ENGINEER D. Rugg
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/13/11
COORDINATES N 5314 E 3139
ELEV. 11305
DATUM ____
JOB 113-81608
LOCATION Climax Mine
TIME 1:20 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–2 ft
Compact, gray and tan sandy GRAVEL, slightly moist, non–plastic, 50% gravel, 20% cobbles, 20% sand, 10% boulders (FILL)

2–4 ft
Compact, gray–brown, gravelly SAND, slightly moist, non–plastic, lots of debris and wood present, 65% sand, 20% gravel, 10% cobbles, 5% boulders (FILL)

4–8 ft
Compact, dark gray to black, same composition as 2 to 4 ft but has distinct petroleum odor.

SPECIAL NOTES

Odor of petroleum at 4 to 8 ft. Found two 15 inch diameter by 2 ft tall steel containers and lots of various debris including wood.

No groundwater encountered

Excavation stopped at 8 ft due to debris found in test pit

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

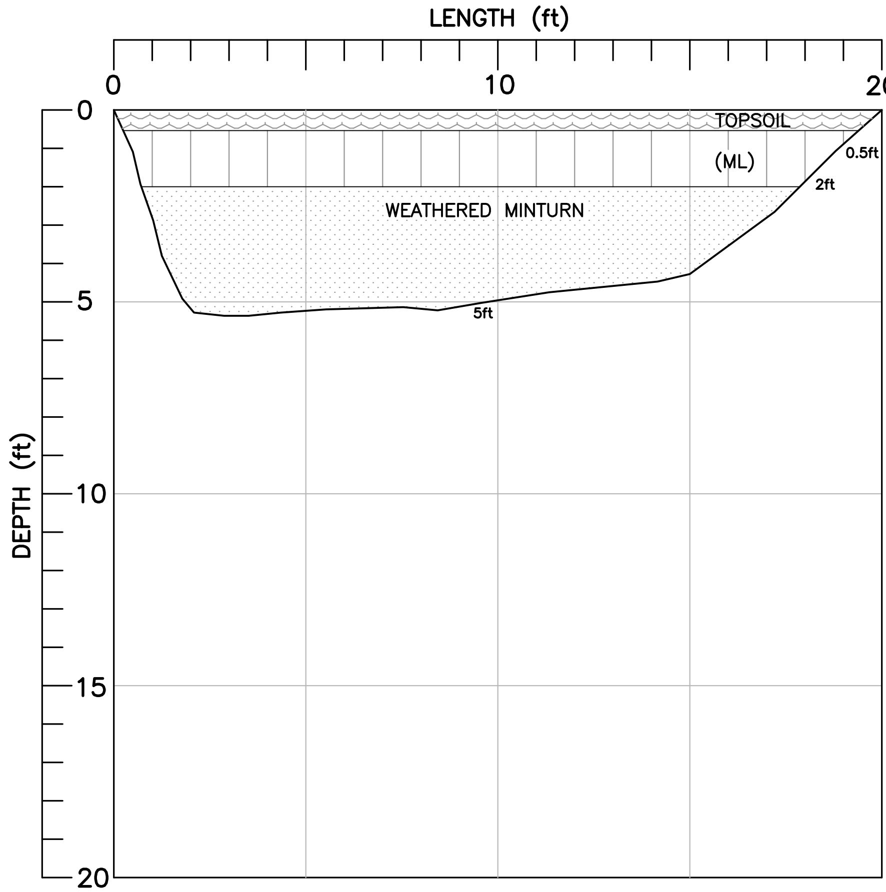
ID	TYPE (NO.)	DEPTH (ft)

LEGEND

TEST PIT LOG

No. GA-11P-13

TEMP ____ °F WEATHER Snow
ENGINEER D. Rugg
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/12/11
COORDINATES N 11503 E 7887
ELEV. 11975
DATUM
JOB 113-81608
LOCATION Climax Mine
TIME 9:00 AM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0-0.5 ft
Loose/soft, TOPSOIL. 30% organics, 30% silt

0.5-2 ft
Firm, maroon, silty SAND with clay, gravel and cobbles, 50% sand, 20% gravel, 5% cobbles, remainder is silt and clay, fines are medium plasticity

2-4 ft
Weathered bedrock of the Minturn formation, angular to sub-angular cobbles and boulders, strength is R3 to R4 (medium strong to strong rock).

5 ft
Bedrock encountered strike is N100E and dip is 40 degrees to the east. Bedrock is well cemented sandstone with some silt size crystals.

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 5 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

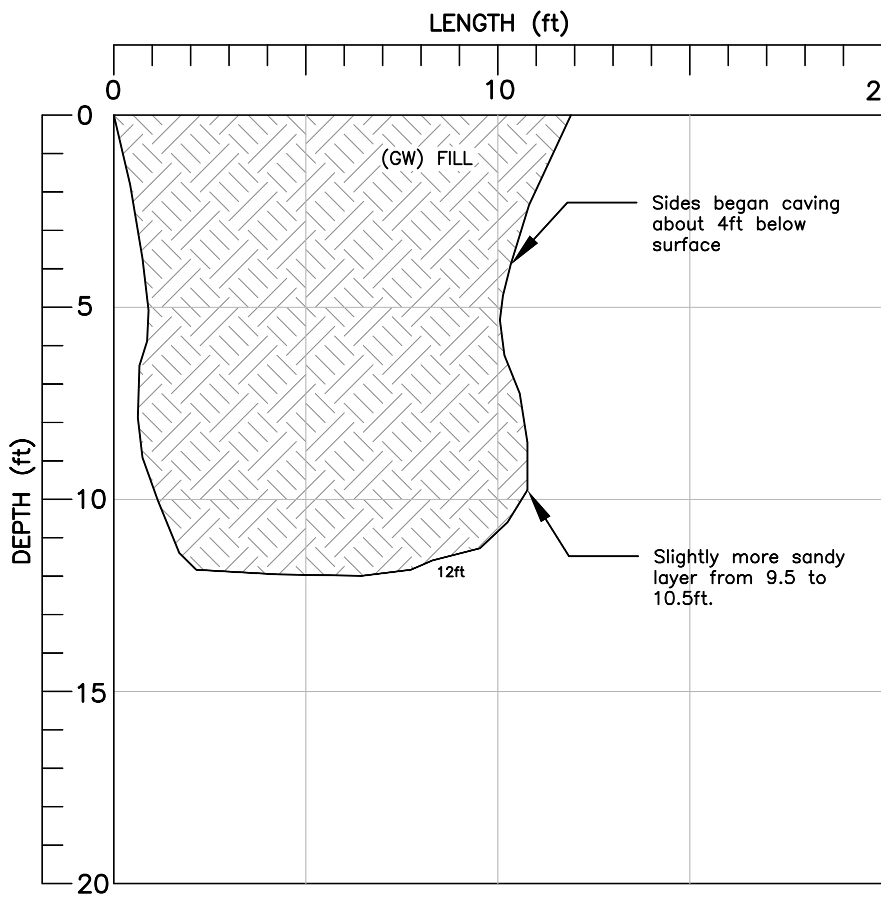
ID	TYPE (NO.)	DEPTH (ft)
GA-11P-13	Bag (1)	6
GA-11P-13	Pail (1)	4-6 ft

LEGEND

TEST PIT LOG

No. GA–11P–14

TEMP ____ °F WEATHER Clear ENGINEER D. Rugg OPERATOR Larry
EQUIPMENT Deere 240 D CONTRACTOR Moltz Construction DATE 10/13/11
COORDINATES N 7260 E 1830 ELEV. 11260 DATUM ____ JOB 113–81608
LOCATION Climax Mine TIME 8:00 AM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–12 ft
Compact to dense, tan to light brown, well graded sandy GRAVEL with cobbles and boulders, little clay, slightly moist, low plasticity, cobbles and boulders are sub–angular. 40% gravel, 20% medium to coarse sand, 20% cobbles, 10% boulders, 10% fines (FILL)

Encountered a sandy layer at approximately 10 ft with about 30% gravel and 30% sand as opposed to above.

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 12 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

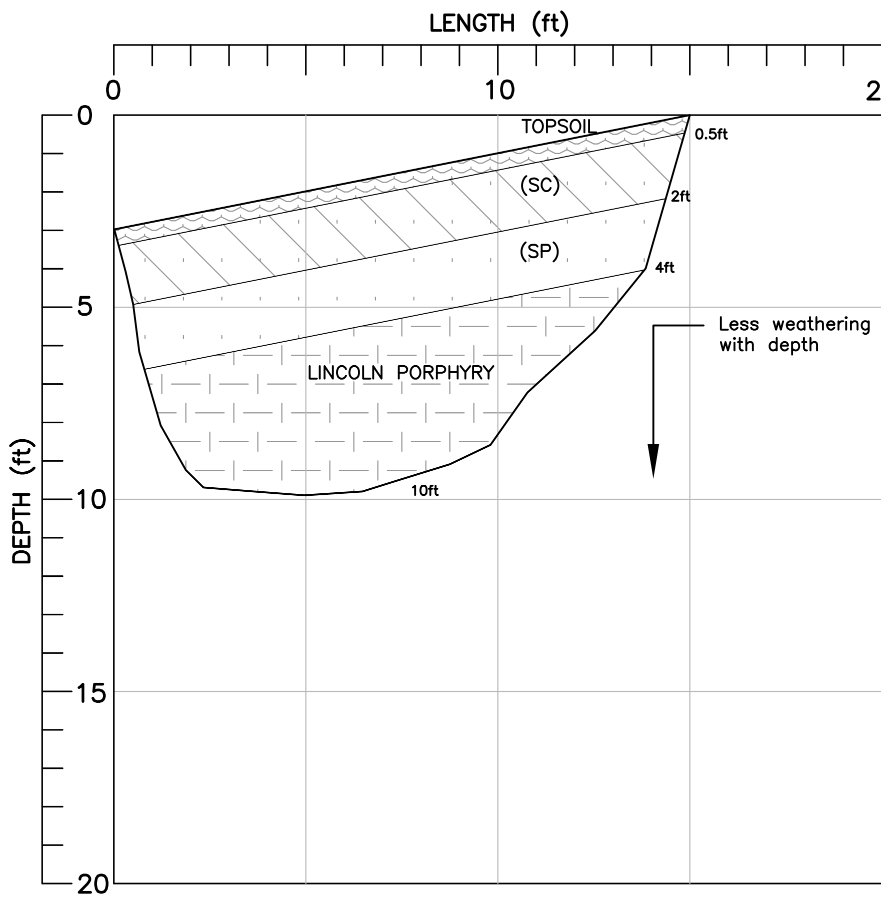
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–14	Bag (1)	4–5

LEGEND

TEST PIT LOG

No. GA-11P-15

TEMP ____ °F WEATHER Snow
ENGINEER D. Rugg/ D. Geier
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/11/11
COORDINATES N 9864 E 6852
ELEV. 11760
DATUM
JOB 113-81608
LOCATION Climax Mine
TIME 1:00 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0-0.5 ft
Organics, (TOPSOIL)

0.5-2 ft
Compact, tan-brown, fine to medium grained clayey SAND with some cobbles and trace boulders, slightly moist, medium plastic, cobbles and boulders are sub-angular, 50% sand, 20% clay, remainder is gravel and cobbles

2-4 ft
Compact, red-brown, weathered, gravelly SAND with little silt, slightly moist, non-plastic, 60% sand, 15% cobbles, 5 to 10% boulders

4-10 ft
Dense, maroon, angular to sub-angular cobbles and boulders with gravelly sand, moderately weathered R2 to R4 (weak to strong rock) strength (LINCOLN PORPHYRY)

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 10 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

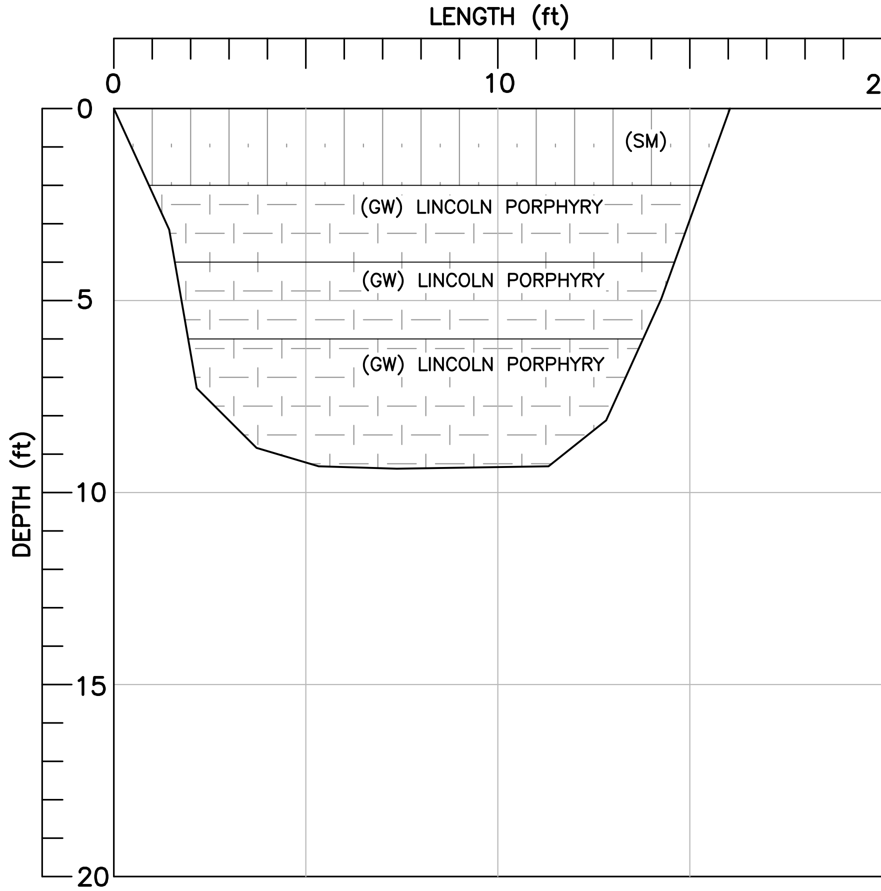
ID	TYPE (NO.)	DEPTH (ft)
GA-11P-15	Pail (1)	2

LEGEND

TEST PIT LOG

No. GA-11P-16

TEMP ___ °F WEATHER Clear	ENGINEER D. Rugg	OPERATOR Larry
EQUIPMENT Deere 240 D	CONTRACTOR Moltz Construction	DATE 10/12/11
COORDINATES N 9315 E 4758	ELEV. 11747 DATUM	JOB 113-81608
LOCATION Climax Mine	TIME 1:00 PM	



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–2 ft
Loose, brown, silty SAND, slightly moist, non-plastic, 60% sand, 30% silt, 5% gravel, 5% clay

2–4 ft
Highly weathered, massive, gray, LINCOLN PORPHYRY. Weathers to sandy GRAVEL, sub-angular gravel and cobbles, well graded, slightly moist, non-plastic, 40% gravel, 30% medium to coarse sand, 20% cobbles, 10% silt to fine sand

4–6 ft
Same as above with 25 to 30% cobbles, 30% gravel, 30% sand and trace silt, slightly moist, non-plastic (LINCOLN PORPHYRY)

6–9 ft
Same as above, more cobbles and more boulders with depth, sub-angular to angular cobbles and boulders with R3 to R4 (medium to strong rock) strength

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 9 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

ID	TYPE (NO.)	DEPTH (ft)
GA-11P-16	Pail (1)	3-6

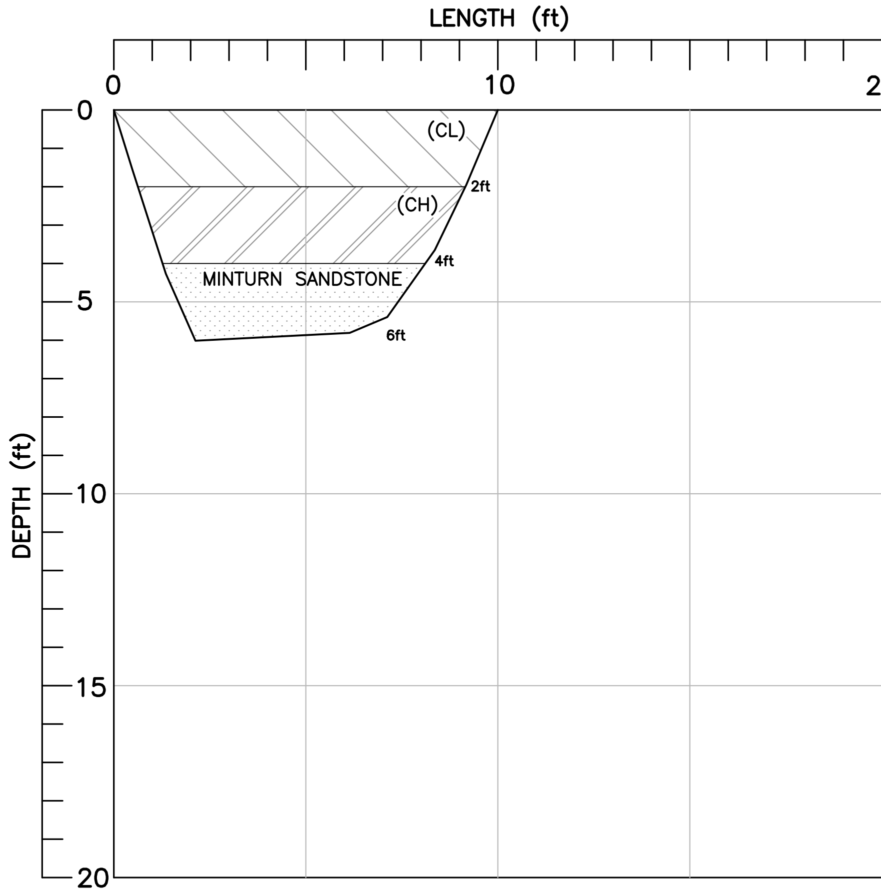
LEGEND

TEST PIT LOG

Golder Associates

No. GA–11P–17

TEMP ___ °F WEATHER Clear	ENGINEER D. Rugg/ D. Geier	OPERATOR Larry
EQUIPMENT Deere 240 D	CONTRACTOR Moltz Construction	DATE 10/12/11
COORDINATES N 10806 E 3256	ELEV. 11640 DATUM	JOB 113–81608
LOCATION Climax Mine	TIME	



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–2 ft
Loose, light brown, medium to coarse sand and clay with silt, little gravel, trace organics, silty sandy CLAY, low to medium plasticity, slightly moist, 35% clay, 30% silt, 30% sand, 5% gravel.

2–4 ft
Firm, dark brown, sandy CLAY, highly plastic, moist, 70% clay, 25% sand, 10% silt. Some angular cobbles at bottom of horizon.

4 ft
Contact with MINTURN, fairly sharp transition

4–6 ft
Slightly weathered, thickly bedded, gray, medium to coarse crystaline, R3 to R4 (medium to strong rock) strength, high micaceous SANDSTONE (MINTURN), smooth, planar joints (J, PL, S(4–6)), infilled with red–orange, high plasticity clay, about 1 mm thick or less

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 6 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

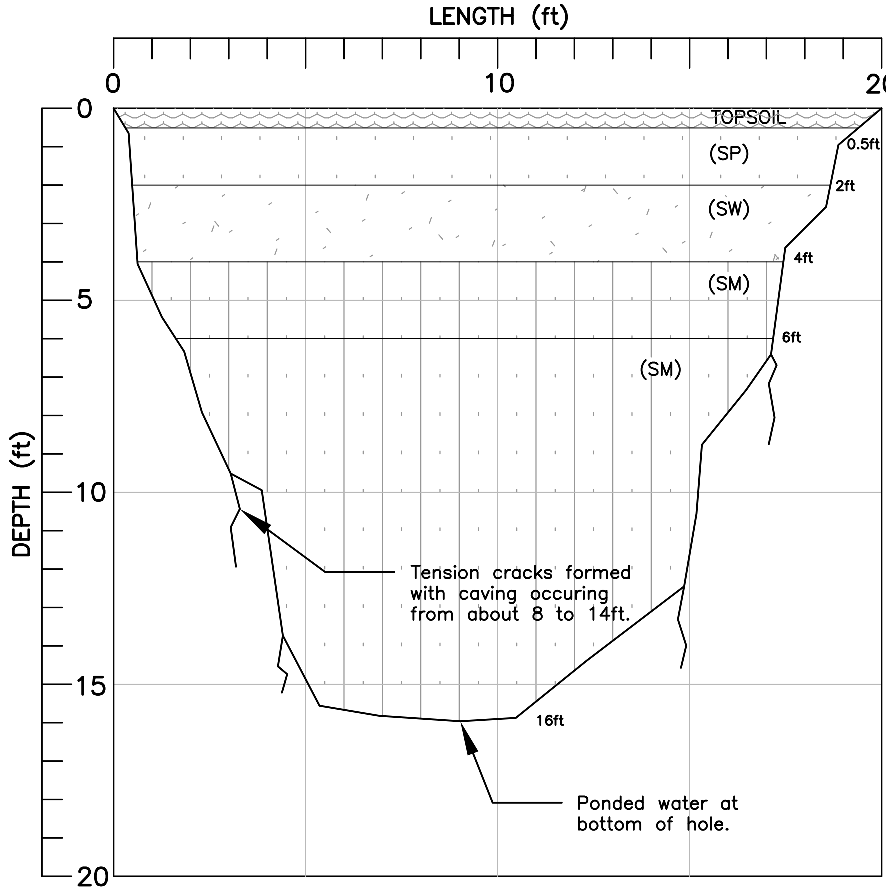
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–17	Pail (1)	

LEGEND

TEST PIT LOG

No. GA–11P–18

TEMP ___ °F WEATHER Clear
ENGINEER D. Rugg
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/13/11
COORDINATES N 6850 E 1339
ELEV. 11215
DATUM
JOB 113–81608
LOCATION Climax Mine
TIME



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–0.5 ft
Dark brown, TOPSOIL with organics

0.5–2 ft
Loose, tan SAND with little gravel and trace boulders, slightly moist, non–plastic, 85% fine to coarse sand, 10% gravel, 5% boulders, gravel and boulders are sub–rounded, mainly porphyry with R3 to R4 (medium to strong rock) strength

2–4 ft
Loose, red–brown, well graded, medium to coarse SAND, slightly moist, non–plastic, 70% sand, 10% gravel, 10% cobbles, 5% boulders, 5% silt, cobbles, boulders, and gravel are sub–rounded with R3 to R4 (medium to strong rock) strength and are from the PORPHYRY

4–6 ft
Loose, tan–gray, silty sand with gravel, slightly moist, non–plastic, 50% fine to coarse sand, 20% silt, 15% gravel, 10% cobbles, 5% boulders, cobbles and boulders are sub–rounded with R3 to R5 (medium to very strong rock) strength and from the PORPHYRY with aphanitic to 3 mm crystals

6–16 ft
Dense, dark gray, silty SAND, moist, non–plastic, 70% sand, 20% silt, 5% clay, 5% gravel/cobbles

SPECIAL NOTES

Ponded water encountered at 16 ft

Refusal met at approximately 16 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

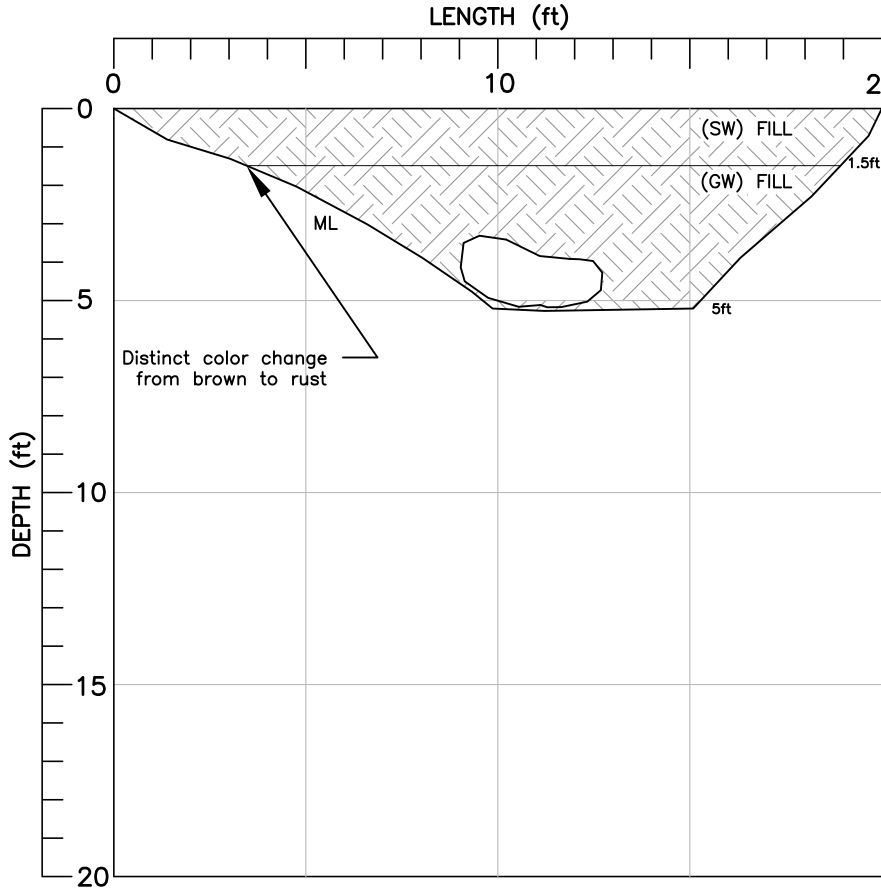
ID	TYPE (NO.)	DEPTH (ft)
GA–11P–16	Pail (1)	6–10

LEGEND

TEST PIT LOG

No. GA-11P-19

TEMP ____ °F WEATHER Clear
ENGINEER D. Rugg
OPERATOR Larry
EQUIPMENT Deere 240 D
CONTRACTOR Moltz Construction
DATE 10/12/11
COORDINATES N 8613 E 2443
ELEV. 11262
DATUM ____
JOB 113-81608
LOCATION Climax Mine
TIME 3:15 PM



LITHOLOGIC DESCRIPTIONS AND EXCAVATION NOTES

0–1.5 ft
Stiff/dense, dark brown, well graded, clay to SAND with boulders and some cobbles, 25% gravel, 25% clay, 20% medium to coarse sand, 20% cobbles, 10% boulders, moist, medium to high plasticity, cobbles and gravel vary in angularity from rounded to angular, some appear glaciated and others more recent, boulders are sub-rounded to angular (FILL)

1.5–5 ft
Dense to very dense, tan and rust colored, angular sandy GRAVEL with boulders, 30% gravel, 30% sand, 20% cobbles, 10% boulders, 10% fines, low plasticity fines, medium to coarse sand, gravel, cobbles and boulders are sub-angular to angular, veins in boulders appear oxidized with presence of mica and pyrite and are mainly from the PORPHYRY with smaller crystals than observed previously, mostly aphanitic (FILL)

5 ft
Further excavation prevented by a 6 foot diameter boulder

SPECIAL NOTES

No groundwater encountered

Refusal met at approximately 5 ft due to difficult excavation

Test pit backfilled with excavated material and compacted using bucket and excavator treads

POCKET PENETROMETER

DEPTH (ft)	STRENGTH (tsf)

SAMPLES

ID	TYPE (NO.)	DEPTH (ft)

LEGEND

ATTACHMENT 2
BORING LOGS

RECORD OF BOREHOLE GA-11B-20

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: McNulty Gulch

DRILLING METHOD: Roto Sonic
DRILLING DATE: 11/3/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 12,338.00 E: 5,103.00

ELEVATION: 11335
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ / WATER CONTENT (PERCENT)	REMARKS
0	Roto Sonic	0.0 - 7.0 Firm, maroon-brown, well-graded, gravelly SILT with clay and trace cobbles, moist, low plasticity, cobbles and gravel are sub-rounded micaceous sandstone derived from the Minturn (ML) (COLLUVIAL)	ML								
7.0		7.0 - 14.0 Loose to compact, brown, gravelly SAND with silt, clay and organics, slightly moist, low plasticity, gravel and cobbles are sub-rounded micaceous sandstone with R3 to R4 strength and derived from the Minturn (SW-SM) (COLUVIAL)	SW-SM	11342.0 7.0							
14.0		14.0 - 36.0 Dense, maroon, silty SAND with gravel and little cobbles, slightly moist, non-plastic, cobbles and gravel are sub-rounded micaceous sandstone with R3 to R4 strength and derived from the Minturn (SM) (COLLUVIAL)	SM	11349.0 14.0							
15					1	SPT	25-25-13	38	0.833 / 1.5	■ 38	
25											Water table @ 24.8 feet on 11/4 at 4:00 PM Water table @ 26.7 feet on 11/4 at 12:11 PM
32					2	GR			2		
36.0		36.0 - 37.0 Dense, maroon, silty SAND with gravel and little cobbles, slightly moist, non-plastic, gravel is a mix of micaceous sandstone and weathered porphyry (SM) (COLLUVIAL)	SM	11371.0 36.0	3	GR					
37.0		37.0 - 38.5 Firm, maroon, sandy SILT, moist, low to non-plastic (ML) (COLLUVIAL)	ML	11372.0 37.0							
38.5			GW	11373.5 38.5							

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-20

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: McNulty Gulch

DRILLING METHOD: Roto Sonic
DRILLING DATE: 11/3/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 12,338.00 E: 5,103.00

ELEVATION: 11335
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40) / WATER CONTENT (PERCENT) Wp W Wl (20 40 60 80)	REMARKS
40	Roto Sonic	38.5 - 54.0 Dense, gray, sandy GRAVEL with cobbles, moist, non-plastic (GW) (Residual LINCOLN PORPHYRY) *(Continued)*	GW			4	GR			3		
45												
50												
54		Boring completed at 54 ft.										
55												
60												
65												
70												
75												
80												

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-21

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Above McNulty Gulch

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/20/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 11,251.00 E: 6,420.00

ELEVATION: 11400
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40); WATER CONTENT (PERCENT) W_p —○W— W_l (20 40 60 80)	REMARKS
0	Roto Sonic	0.0 - 25.0 Loose to compact, brown to red-brown (more maroon with depth), well graded, sandy GRAVEL, slightly moist, low plasticity, gravel and cobbles are sub-angular to angular (GW) (WASTE ROCK)	GW								Hit boulder, lost 3 feet of recovery
20											Hit large boulder at 20 feet
25		25.0 - 32.0 Very stiff, maroon CLAY with some sand and trace to little gravel, moist, medium plastic, (CL) (Weathered MINTURN)	CL	11425.0 25.0	1	SPT	2-4-7	11	0.5 / 1.5	■ (11)	
					2	DS					Wrapped in-tact sonic core sample with plastic wrap and aluminum foil
30											Bottom of Shelby tube dented slightly
		32.0 - 33.0 Stiff, maroon, sandy CLAY, moist, medium plasticity, 60% clay, 40% medium to coarse sand (CL) (Weathered MINTURN)	CL	11432.0 32.0	3	SH			1.33 / 2.5		
35		33.0 - 43.0 Compact, maroon, sandy GRAVEL with clay and cobbles, slightly moist, non-plastic, 50% gravel, 30% fine to coarse sand, 15% cobbles, 5% fines (GW-GC) (Weathered MINTURN)	GW-GC	11433.0 33.0							Sonic coring without water from 36 to 43 feet
40											

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-21

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Above McNulty Gulch

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/20/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 11,251.00 E: 6,420.00

ELEVATION: 11400
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	REMARKS
40	Roto Sonic	33.0 - 43.0 Compact, maroon, sandy GRAVEL with clay and cobbles, slightly moist, non-plastic, 50% gravel, 30% fine to coarse sand, 15% cobbles, 5% fines (GW-GC) (Weathered MINTURN) *(Continued)*	GW-GC	11443.0 / 43.0						Water table at 42.9 feet on 10/21 @ 2:40 PM. Water table at 42.3 feet on 10/22 @ 12:00 PM and 10/23 @ 12:04 PM. Sonic coring with water from 43 to 60 feet
		43.0 - 45.0 Moderately weathered, massive, fine to coarse crystaline SANDSTONE (MINTURN)		11445.0 / 45.0	4	GR			2	
45		45.0 - 46.0 Moderately to highly weathered, maroon, thinly bedded (0.5mm to 2mm beds), slightly moist, medium to high plasticity SHALE (MINTURN)		11446.0 / 46.0						Material from 45 to 46 feet breaks down into pure highly plastic clay when handled with water
		46.0 - 49.0 Moderately weathered, bedded (1cm to 3cm thick), beds infilled with clay, SANDSTONE (MINTURN)		11449.0 / 49.0						
50		49.0 - 52.0 Slightly weathered, massive, maroon, fine to coarsely crystaline, SANDSTONE (MINTURN)		11452.0 / 52.0						6 sonic samples taken to be broken with Point Load Tester. Sonic core discontinuity data: J, PL, SM, with 60 degree fracture orientation.
55		52.0 - 60.0 Moderately to highly weathered, maroon, thinly bedded, fine to coarse crystaline structure in in-tact rock, beds are filled with medium to high plasticity clay, SANDSTONE (MINTURN)			5	GR				
60		*Continued as cored hole. See Drillhole log report.*								
65										
70										
75										
80										

PENETRATION RESISTANCE BLOWS / ft ■ 10 20 30 40
WATER CONTENT (PERCENT) W_p — W — W_l 20 40 60 80

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-22

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: McNulty Gulch

DRILLING METHOD: Roto Sonic
DRILLING DATE: 11/1/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 11,562.00 E: 4,503.00

ELEVATION: 11400
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE — DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES — NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft (10 20 30 40); WATER CONTENT (PERCENT) W_p W W_l (20 40 60 80)	REMARKS
0	Roto Sonic	0.0 - 1.5 Compact, brown, well graded, clayey SAND with gravel and cobbles, moist, low plasticity, cobbles are sub-rounded to sub-angular from Minturn and Lincoln Porphyry (FILL)	SW-SC		11401.5 1.5							
		1.5 - 6.5 Compact to dense, brown-gray, sandy GRAVEL with cobbles, well graded, slightly moist, non-plastic, cobbles are sub-rounded to sub-angular from various parent rocks	GW		11406.5 6.5							
5												More porphyritic gravel and cobbles with depth
		6.5 - 10.0 Clayey SAND, same as upper 1.5 feet	SW-SC		11410.0 10.0							
10		10.0 - 12.0 Dense, gray, sandy GRAVEL with fines, slightly moist, non to low plastic, gravel is R0 strength (LINCOLN PORPHYRY)	GW		11412.0 12.0							
		12.0 - 19.0 Grades to slightly more in-tact and large pieces of porphyry still with R0 strength, trace competent rock, slightly moist, low plasticity	GW		11419.0 19.0							Water table @ 12.5 ft on 11/4 @10:12 AM and @ 12.0 ft on 11/4 @ 3:43 PM
15												More competent Porphyry gravel and cobbles with depth
		19.0 - 23.5 Little cobbles, R0 to R2 strength	GW		11423.5 23.5							
20												Water table @ 19.3 ft on 11/3 @ 2:35 PM
		23.5 - 28.0 Dense, gray, sandy GRAVEL, slightly moist, R1 to R3 strength	GW									Began drilling the sonic core with water @ 23.5 ft (attempt to get in-tact core) Only about 1.5 ft of recovery from 23.5 to 28 ft. Fines (rock flour) washed away.
25												
		Continued as cored hole. See Drillhole log report.										
30												
35												
40												

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ / WATER CONTENT (PERCENT)	REMARKS
0	Roto Sonic	0.0 - 9.0 Compact, brown, well graded, sandy GRAVEL with cobbles and little fines, slightly moist, non-plastic, gravel and cobbles are sub-angular to angular with R3 to R4 strength (WASTE ROCK)	GW	11439.0 9.0							
9.0		9.0 - 16.5 Compact, yellow-tan, gravelly coarse SAND, with little clay and cobbles, slightly moist, non-plastic, sand and gravel is sub-angular to angular, cobbles are R3 strength (WASTE ROCK)	SW	11446.5 16.5	1	SPT	7-5-7	12	1 / 1.5	■	
16.5		16.5 - 25.0 Gravelly coarse SAND with clay, moist, slightly plastic (WASTE ROCK)	SW	11455.0 25.0							
25.0		25.0 - 31.5 Compact, brown, well graded sandy GRAVEL with clay and cobbles, slightly moist, non-plastic (WASTE ROCK)	GW	11461.5 31.5	2	SPT	7-7-8	15	1 / 1.5	■	
31.5		31.5 - 40.0 Compact, brown, well graded gravelly SAND, with clay, slightly moist, non to low plasticity, sub-angular to angular (WASTE ROCK)	SW	11470.0	3	GR			2		

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ / WATER CONTENT (PERCENT)	REMARKS
40	Roto Sonic	40.0 - 51.5 Compact, tan, sandy GRAVEL with cobbles and clay, moist, non-plastic, angular to sub-angular (WASTE ROCK)	GW	40.0							
50					4	SPT	13-13-13	26	0/1.5	■	
51.5		51.5 - 70.0 Gravelly SAND (WASTE ROCK)	SW	11481.5 51.5							
65					5	SPT	20-36-12	48	0.4/1.5	■	
70		70.0 - 95.0 Dense, tan, sandy GRAVEL with cobbles, boulders and little clay, slightly moist, non-plastic, sub-angular to angular (WASTE ROCK)	GW	11500.0 70.0							More boulders with depth
75											Hit large boulder
80											

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft (10 20 30 40) / WATER CONTENT (PERCENT) Wp W Wl (20 40 60 80)	REMARKS
80	Roto Sonic	70.0 - 95.0 Dense, tan, sandy GRAVEL with cobbles, boulders and little clay, slightly moist, non-plastic, sub-angular to angular (WASTE ROCK) *(Continued)*	GW									
85												Hit large boulder
90												
95		95.0 - 120.0 Dense, tan-gray, well graded, sandy GRAVEL with cobbles, boulders, and little clay, slightly moist, non-plastic, sub-angular to angular gravel and cobbles with R4 strength (WASTE ROCK)	GW		11525.0 95.0							
100												
105												
110												
115												
120					11550.0							

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	REMARKS
120	Roto Sonic	120.0 - 137.0 Dense, gray, well graded, sandy GRAVEL with cobbles, slightly moist, non-plastic, angular to sub-angular, R4 strength (WASTE ROCK)	GW	120.0	More large cobbles and boulders with depth
137		137.0 - 141.0 Dense, tan and brown, clayey SAND with gravel and cobbles, moist, low plasticity, angular to sub-angular (WASTE ROCK)	SC	11567.0 137.0	
141		141.0 - 147.0 Same as 120 to 137 feet	GW	11571.0 141.0	
147		147.0 - 152.0 Compact, brown-black silty SAND with gravel and little organics, slightly moist, non-plastic	SM	11577.0 147.0	Drilled through a piece of wood
152		152.0 - 156.0 Dense, tan, sandy GRAVEL with clay (WASTE ROCK)	GW	11582.0 152.0	Hit another piece of wood. Smells strongly of pine Off hole on 10/24 @ 5:31 PM, back on hole on 10/25 @ 8:00 AM.
156		156.0 - 160.0 Firm, dark brown, clayey SILT, moist, low plasticity	ML	11586.0 156.0	Drilled through steel and wood debris
160				11590.0	

SAMPLES: NUMBER | TYPE | BLOWS per 6 in (140 lb hammer, 30 inch drop) | N | REC / ATT

PENETRATION RESISTANCE BLOWS / ft ■ (10, 20, 30, 40)
WATER CONTENT (PERCENT) W_p — W — W_l (20, 40, 60, 80)

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft / WATER CONTENT (PERCENT)	REMARKS
160	Roto Sonic	160.0 - 164.0 Compact, gray-black, sandy GRAVEL with silt and little cobbles, slightly moist, non-plastic, sub-angular cobbles, mostly micaceous sandstone	GW	160.0 / 11594.0							
		164.0 - 165.0 Compact, brown, sandy GRAVEL with clay (WASTE ROCK)	GW	164.0 / 11595.0							
165		165.0 - 167.0 Stiff, gray, silty CLAY with sand, slightly moist, medium plastic	CL	165.0 / 11597.0							
		167.0 - 179.0 Compact, gray-black, sandy GRAVEL with silt, trace cobbles, slightly moist, non-plastic, sub-angular, mostly micaceous sandstone	GW	167.0 / 11609.0	6	GR					
175											Drilled run from 175 to 185 feet with regular coring bit, sample was lost. Re-drilled same run with "flapper" bit, approximately 7 feet of recovery
		179.0 - 180.0 Loose, tan, poorly graded fine silty SAND, moist, non-plastic (TAILINGS)	SP-SM	179.0 / 11610.0							
180		180.0 - 183.0 Soft, tan, clayey SILT, moist, low to medium plasticity (TAILINGS)	ML	180.0 / 11613.0	7	GR					Water table @ 179.8 feet on 11/2 at 7:50 AM, @ 180.0 on 11/3 at 2:55 PM and on 11/4 at 12:50 PM
		183.0 - 188.0 Poorly graded fine silty SAND (TAILINGS)	SP-SM	183.0 / 11618.0	8	GR					
185					9	SH			2.3 / 2.5		Only pushed 2" with Shelby (sample 9). Driller was asked to vibrate the tube and 4 more inches were pushed. Driller waited 5 minutes then pulled the Shelby. 28 inches of recovery in tube. Driller was asked to clean the hole better prior to pushing the next Shelby. Shelby (sample 10) was pushed 22 inches with 28 inches of recovery.
		188.0 - 189.0 Clayey SILT (TAILINGS)	ML	188.0 / 11619.0							
		189.0 - 190.0 Poorly graded fine silty SAND (TAILINGS)	SP-SM	189.0 / 11620.0							
190		190.0 - 191.0 Firm, gray, clayey SILT, moist, medium plasticity (TAILINGS)	ML	190.0 / 11621.0	10	SH			2.3 / 2.5		
		191.0 - 192.0 Loose, gray, silty SAND fine to coarse grained, moist, non-plastic (TAILINGS)	SM	191.0 / 11622.0							
		192.0 - 195.0 Firm, clayey SILT (TAILINGS)	ML	192.0 / 11625.0	11	DS			1		
195		195.0 - 215.0 Stiff, gray, clayey SILT, moist, medium plasticity (TAILINGS)	ML	195.0	12	SH			1.96 / 2.5		Shelby (sample 12) was pushed 16 inches with 23.5 inches of recovery.
200											

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40); WATER CONTENT (PERCENT) W_p W W_l (20 40 60 80)	REMARKS
200	Roto Sonic	195.0 - 215.0 Stiff, gray, clayey SILT, moist, medium plasticity (TAILINGS) *(Continued)*	ML								
205					13	SH			1.96 / 2.5		Shelby (sample 13) was pushed 16 inches with 23 inches of recovery.
210											
											∇ Water table @ 213.8 feet on 11/1 at 11:45 AM
215		215.0 - 220.0 Loose, gray, poorly graded fine silty SAND, moist, non-plastic (TAILINGS)	SP-SM	11645.0 215.0	14	SH			2.3 / 2.5		Shelby (sample 14) was pushed 13 inches with 28 inches of recovery.
220		220.0 - 225.0 Stiff, gray, clayey SILT (TAILINGS)	ML	11650.0 220.0							Off hole on 10/25 @ 6:00 PM, back on hole on 10/26 @ 8:45 AM in the snow.
225		225.0 - 226.0 Compact, gray-black silty SAND, fine to medium grained (TAILINGS)	SM	11655.0 225.0	15	SPT	21-22-21	43	1.1 / 1.5	■	Tailings appear to have infiltrated native Glacial Till
		226.0 - 228.0 Compact, tan-brown, silty SAND, fine to coarse grained, trace gravel, trace cobbles, moist, non-plastic (TAILINGS/TILL)	SM	11656.0 226.0							
230		228.0 - 232.0 Firm to stiff, tan, clayey SILT with trace gravel and trace cobbles, moist, low plasticity cobbles are sub-rounded (TAILINGS/TILL)	ML	11658.0 228.0							
		232.0 - 235.0 Compact, tan, silty SAND fine to coarse grained, little gravel, trace cobbles, sub-rounded (TAILINGS/TILL)	SM	11662.0 232.0							
235		235.0 - 260.0 Compact, brown, well-graded, sandy GRAVEL with cobbles and fines, slightly moist, non-plastic, sub-rounded gravel and cobbles from various parent rock (GLACIAL TILL)	GW	11665.0 235.0							More gravel and cobbles with depth
240											

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40); WATER CONTENT (PERCENT) W_p —○W— W_l (20 40 60 80)	REMARKS
240	Roto Sonic	235.0 - 260.0 Compact, brown, well-graded, sandy GRAVEL with cobbles and fines, slightly moist, non-plastic, sub-rounded gravel and cobbles from various parent rock (GLACIAL TILL) *(Continued)*	GW									
245												
250						16	GR			2		
255												Hit large porphyritic boulder, mostly rockflour returned in core, non-plastic
260		260.0 - 262.5 Compact to dense, brown clayey SAND with gravel and trace cobbles, medium to coarse sand, moist, low plasticity, sub-rounded, from various parent rock (GLACIAL TILL)	SC		11690.0 260.0							
		262.5 - 265.0 Well graded sandy GRAVEL with cobbles and fines (GLACIAL TILL)- same as 235	GW		11692.5 262.5							
265		265.0 - 273.0 Compact, brown clayey SAND with trace gravel and trace boulders, moist, low plasticity (GLACIAL TILL)	SC		11695.0 265.0	17	GR					
270												Large porphyritic boulder
		273.0 - 276.0 Compact, brown, sandy CLAY with gravel and trace cobbles, low plasticity, moist (GLACIAL TILL)	CL		11703.0 273.0	18	GR					
275		276.0 - 277.5 Very Stiff, red-brown CLAY with sand and trace gravel, slightly moist, medium plastic (GLACIAL TILL)	CL		11706.0 276.0	19	GR					
		277.5 - 279.0 Dense clayey SAND with gravel, moist, low plasticity (GLACIAL TILL)	SC		11707.5 277.5							
280			CL		11709.0 279.0	20	DS			1		Finished drilling on 10/26 @ 4:30 PM. Casing was

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-23

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Top of Waste Rock Pile

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/24/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 7,257.00 E: 2,855.00

ELEVATION: 11430
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40) / WATER CONTENT (PERCENT) Wp —○W— Wl (20 40 60 80)	REMARKS
280	Roto Sonic	279.0 - 287.0 Stiff to very stiff, brown to reddish-brown, silty CLAY with trace sand and trace cobbles, slightly moist to moist, medium plasticity (GLACIAL TILL) *(Continued)*	CL									left in hole and drillers left site to return 11/1. Due to stiff clay found at bottom of hole, 10 more feet of drilling was requested on 11/1.
285					11717.0 287.0							More sand and gravel with depth.
		287.0 - 289.0 Compact, brown, clayey SAND with gravel and cobbles, slightly moist, low plasticity (GLACIAL TILL)	SC		11719.0 289.0							
290		289.0 - 291.0 Compact, tan-brown, silty SAND, medium to coarse grained, moist, non-plastic (GLACIAL TILL)	SM		11721.0 291.0							
		291.0 - 294.0 Dense, brown, well graded sandy GRAVEL with cobbles, slightly moist, non-plastic (GLACIAL TILL)	GW									
295		Boring completed at 294 ft.										Bottom of hole @ 294 feet on 11/1 at 9:51 AM.
300												
305												
310												
315												
320												

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-24

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Gravel Pit

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/18/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 6,241.00 E: 2,935.00

ELEVATION: 11330
INCLINATION: 90

BORING METHOD: Roto Sonic

Soil Profile

DEPTH (feet)	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	REMARKS
0	0.0 - 18.0 Tan, well graded, sandy GRAVEL, some silt and cobbles, little clay, slightly moist, low plasticity (WASTE ROCK/FILL)	GW		Start drilling on 10/18 at 11:10 AM
5				Continued zones of gray and reddish-brown. Waste rock becomes non-plastic. Rock from multiple sources (Siltstone, low-grade ore, other silliceous rock types, some pyrite)
10				increased cobbles with depth Did not keep sample 1
15				Gray non-plastic rockflour in core indicative of drilling through boulder or large cobbles. Sonic casing was very hot when removed from drill hole
18	18.0 - 19.0 Stiff, red-brown, sandy CLAY with little gravel, slightly plastic (WASTE ROCK)	CL	11348.0 18.0	
19	19.0 - 25.0 Very stiff, dark gray CLAY with gravel and sand, high plasticity (WASTE ROCK)	CH	11349.0 19.0	Took bucket sample and "undisturbed" sonic core sample 4 inches long
25	25.0 - 30.0 Compact, gray clayey GRAVEL with sand, low plasticity, gravel is angular (WASTE ROCK)	GC	11355.0 25.0	Did not keep sample 4
30	30.0 - 36.0 Very stiff, gray to dark gray sandy CLAY with little gravel, low to medium plasticity, angular to sub-angular gravel (WASTE ROCK)	CL	11360.0 30.0	40% clay, 30% sand, 20% silt, 10% gravel
36	36.0 - 40.0 Compact, dark gray, clayey SAND with gravel and little cobbles (WASTE ROCK)	SC	11366.0 36.0	30% clay, 50% sand, 20% gravel
40			11370.0	

Samples

NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft
1	SPT	4-7-9	16	1.3 / 1.5	■ (16)
2	GR				
3	DS			0.3	
4	SPT	11-12-12	24	1.5	■ (24)
5	GR				

WATER CONTENT (PERCENT): W_p — W — W_l (20, 40, 60, 80)

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg/D.Geier
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-24

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Gravel Pit

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/18/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 6,241.00 E: 2,935.00

ELEVATION: 11330
INCLINATION: 90

BORING METHOD: Roto Sonic

SOIL PROFILE

DEPTH (feet)	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	REMARKS
40.0 - 45.0	Compact, dark gray, well graded, clayey GRAVEL, with some sand, some cobbles, little clay, little silt, slightly moist, angular (WASTE ROCK)	GW-GC	40.0 / 11375.0 45.0	10% clay, 10% silt, 20% cobbles, 20% sand, 40% gravel
45.0 - 47.0	Very stiff, orange-tan, uniform, clayey SILT, slightly moist, medium plastic (TAILINGS)	ML	11377.0 47.0	1 inch thick layer of wood and organics, mulch. No recovery from 46 to 47 feet took "undisturbed" sonic core and bag samples
47.0 - 50.0	Compact, tan, thinly bedded (beds approximately 5mm), poorly graded, fine silty SAND, low plasticity (TAILINGS)	SP-SM	11380.0 50.0	Grades to clayey SILT from 49 to 50 feet
50.0 - 56.5	Firm to stiff, light brown, clayey SILT, medium plasticity (TAILINGS)	ML	11386.5 56.5	Water table @ 54.9 feet on 10/21 at 4:00 PM and on 10/22 at 12:45 PM
56.5 - 57.5	Compact, gray, poorly graded, fine silty SAND, non to low plasticity (TAILINGS)	SP-SM	11387.5 57.5	
57.5 - 61.5	Clayey SILT (TAILINGS)	ML	11391.5 61.5	Water table @ 60.7 feet on 10/21 at 8:24 AM
61.5 - 62.5	Stiff, gray, clayey SILT with 1 to 2mm diameter rounded poorly graded sand (TAILINGS)	ML	11392.5 62.5	
62.5 - 63.0	Stiff, gray clayey SILT, moist, high plasticity (TAILINGS)	MH	11393.0 63.0	
63.0 - 68.0	Compact, gray, poorly graded, fine silty SAND, non-plastic, highly dilatent	SP-SM	11398.0 68.0	Water table @ 65.7 feet on 10/20 at 8:15 AM
68.0 - 76.0	Stiff, gray, laminated (beds approximately 1/2 to 2mm thick), clayey SILT to silty CLAY, moist, medium plasticity	MH	11406.0 76.0	Took bag of SPT (sample 14)
76.0 - 79.0	Compact, gray, poorly graded, fine silty SAND, moist, non-plastic, highly dilatent	SP-SM	11409.0 79.0	
79.0 -		MH		

Log continued on next page

SAMPLES

NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft
7	DS			0.3	
6	SH			0 / 2.5	
8	GR			2	
9	SH			2.3 / 2.5	
10	GR			1	
11	DS			0.2	
12	SPT	5-7-8	15	1.5 / 1.5	■
13	SH			2.2 / 2.5	
14	SPT	5-6-6	12	1.5 / 1.5	■

WATER CONTENT (PERCENT): W_p — W — W_l; 20 40 60 80

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg/D.Geier
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-24

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Gravel Pit

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/18/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 6,241.00 E: 2,935.00

ELEVATION: 11330
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40); WATER CONTENT (PERCENT) Wp W Wl (20 40 60 80)	REMARKS
80	Roto Sonic	79.0 - 81.0 Stiff, tan to gray, thinly bedded, clayey SILT, moist, medium plasticity *(Continued)*	MH	11411.0 / 81.0							
		81.0 - 97.0 Compact, gray, poorly graded, fine silty SAND, moist, non-plastic, highly dilatent	SP-SM	11427.0 / 97.0							Drillers off hole on 10/18 at 6:00 PM, back on hole on 10/19 at 8:20 AM
85, 90					15	SPT	5-6-7	13	1.5	■ (13)	
95		97.0 - 98.0 Compact, black, poorly graded, fine to medium coarse, silty SAND, non-plastic (TAILINGS)	SP-SM	11428.0 / 98.0							
		98.0 - 100.0 Very stiff, brown, SILT with roots and organics, low plasticity	ML	11430.0 / 100.0							
100		100.0 - 101.0 Loose to compact, orange-tan, gravelly SAND with silt and little clay	SM	11431.0 / 101.0							
105		101.0 - 109.5 Compact, tan-brown, silty SAND with gravel and little cobbles, gravel is sub-rounded, fines are non to low plasticity, gravel and cobbles are from various parent rock (GLACIAL TILL)	SM	11439.5 / 109.5	16	GR			1		
110		109.5 - 114.5 Compact, tan-gray, well graded, fine to coarse, clayey SAND with some gravel, and little silt, moist, medium plasticity (GLACIAL TILL)	SC	11444.5 / 114.5	17	SPT	>50	>50	1.5		
115, 120		114.5 - 123.0 Compact, orange-tan, well graded, silty SAND with some gravel and little cobbles, moist, low plasticity, gravel and cobbles are sub-rounded and from various parent rock (GLACIAL TILL)	SM								

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg/D.Geier
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-24

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Gravel Pit

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/18/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 6,241.00 E: 2,935.00

ELEVATION: 11330
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40) / WATER CONTENT (PERCENT) W_p W W_l (20 40 60 80)	REMARKS
120	Roto Sonic	114.5 - 123.0 Compact, orange-tan, well graded, silty SAND with some gravel and little cobbles, moist, low plasticity, gravel and cobbles are sub-rounded and from various parent rock (GLACIAL TILL) *(Continued)*	SM	11453.0 / 123.0							
		123.0 - 125.0 Compact, tan-gray, coarse, silty SAND with little gravel, moist, medium plasticity (GLACIAL TILL)	SM	11455.0 / 125.0							
125		125.0 - 128.0 Dense, reddish-brown, well graded, sandy GRAVEL, with cobbles and silt, moist, low plasticity (GLACIAL TILL)	GW	11458.0 / 128.0							
130		128.0 - 136.0 Compact, reddish-brown, well graded, clayey SAND with gravel and cobbles, moist, medium plasticity, gravel and cobbles are sub-rounded from various parent rock (GLACIAL TILL)	SW-SC	11466.0 / 136.0	18	GR					
135–140		136.0 - 144.0 Dense, reddish-brown, well graded, clayey SAND with gravel and cobbles, moist, low plasticity, sub-rounded, various parent rock (GLACIAL TILL)	SW-SC	11474.0 / 144.0							
145–160		144.0 - 164.5 Dense, tan-brown, sandy GRAVEL with clay and cobbles, slightly moist, low to medium plasticity, from various parent rock (GLACIAL TILL)	GW								Slower drilling through cobbles and boulders

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg/D.Geier
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-24

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Gravel Pit

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/18/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 6,241.00 E: 2,935.00

ELEVATION: 11330
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40); WATER CONTENT (PERCENT) W_p — W — W_l (20 40 60 80)	REMARKS
160	Roto Sonic	144.0 - 164.5 Dense, tan-brown, sandy GRAVEL with clay and cobbles, slightly moist, low to medium plasticity, from various parent rock (GLACIAL TILL) *(Continued)*	GW									Hit boulder at bottom of hole.
165		Boring completed at 164.5 ft.										
170												
175												
180												
185												
190												
195												
200												

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg/D.Geier
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-25

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Laydown Yard

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/21/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 5,628.00 E: 2,903.00

ELEVATION: 11320
INCLINATION: 90

BORING METHOD: Roto Sonic

PENETRATION RESISTANCE BLOWS / ft ■ (10, 20, 30, 40); WATER CONTENT (PERCENT) W_p —○W— W_l (20, 40, 60, 80)

DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	REMARKS
0.0 - 7.0 Loose, tan, well graded, sandy GRAVEL with clay, slightly moist, low plasticity (FILL)	GW	11327.0 / 7.0						
7.0 - 12.0 Loose, yellow-tan, well graded, sandy GRAVEL with cobbles, slightly moist, non-plastic, sub-angular to angular (WASTE ROCK)	GW	11332.0 / 12.0	1	SPT	1-1-4	5	0.25 / 1.5	
12.0 - 15.0 Compact, brown, clayey SAND with gravel and trace cobbles, slightly moist, low plasticity (WASTE ROCK)	SC	11335.0 / 15.0						
15.0 - 16.0 Compact, black sandy GRAVEL, slightly moist, non-plastic (WASTE ROCK)	GW	11336.0 / 16.0	2	GR				
16.0 - 20.0 Clayey SAND (WASTE ROCK)- same as 12 to 15 feet	SC	11340.0 / 20.0	3	GR				
20.0 - 33.5 Same as above, but moist and low to medium plasticity (WASTE ROCK)	SC	11353.5 / 33.5	4	SPT	7-4-5	9	0.75 / 1.5	
			5	SPT	3-10-13	23	1.5	SPT (sample 5) had distinct oil/petroleum smell. Encountered waste dump material from 31.5 to 33.5 feet. Did not handle or classify due to petroleum smell.
33.5 - 42.0 Loose, gray, poorly graded, silty fine SAND, moist, non-plastic (TAILINGS)	SP-SM							Water table @ 33.9 ft on 11/2 at 7:40 AM. Water table @ 34.8 ft on 11/1 at 10:10 AM
			6	GR			3	Off hole at 5:40 PM on 10/21. Continue drilling at 7:40 AM on 10/22.

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-25

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Laydown Yard

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/21/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 5,628.00 E: 2,903.00

ELEVATION: 11320
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft	REMARKS
40	Roto Sonic	33.5 - 42.0 Loose, gray, poorly graded, silty fine SAND, moist, non-plastic (TAILINGS) *(Continued)*	SP-SM		7	SH			0 / 2.5		Shelby (sample 7): driller said first 6 inches were stiff, then soft, then last 6 inches were stiff sample was pushed 18 inches Shelby (sample 8) was only pushed 11 inches with 600 lbs of force, but had full recovery
					8	SH			2.5 / 2.5		
45		45.0 - 50.0 Same as 33.5 to 42 feet, but very moist. Silty fine SAND (TAILINGS)	SP-SM	11365.0 / 45.0	9	SPT	4-4-5	9	1.5 / 1.5	9	
50		50.0 - 50.5 Firm, gray, clayey SILT, moist, medium plasticity (TAILINGS)	ML	11370.0 / 50.0							
		50.5 - 52.0 Same as 33.5 to 42 feet. Silty fine SAND (TAILINGS)	SP-SM	11370.5 / 50.5							
		52.0 - 53.0 Same as 50 to 50.5 feet. Clayey SILT (TAILINGS)	ML	11372.0 / 52.0							
55		53.0 - 67.0 Loose, gray, poorly graded, silty fine SAND, moist to very moist, non-plastic (TAILINGS)	SP-SM	11373.0 / 53.0	10	SPT	3-4-5	9	1.5 / 1.5	9	
60					11	GR			2		
65											
		67.0 - 67.5 Firm, gray, clayey SILT, moist, medium plasticity (TAILINGS)	ML	11387.0 / 67.0							
70		67.5 - 71.0 Same as 53 to 67 feet. Silty fine SAND (TAILINGS)	SP-SM	11387.5 / 67.5	12	GR					
		71.0 - 72.0 Loose, black, poorly graded, silty fine SAND with pyrite (TAILINGS)	SP-SM	11391.0 / 71.0							
75		72.0 - 76.0 Stiff, dark brown, ORGANIC SILT, moist, low-plasticity	OL	11392.0 / 72.0							
		76.0 - 79.0 Compact, red-tan, well graded, gravelly SAND with cobbles and clay, moist, non-plastic, cobbles are sub-rounded and from various parent rock (GLACIAL TILL)	GW	11396.0 / 76.0							60% sand, 20% gravel, 10% cobbles, 10% clay
80			SC	11399.0 / 79.0							

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

RECORD OF BOREHOLE GA-11B-25

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Laydown Yard

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/21/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 5,628.00 E: 2,903.00

ELEVATION: 11320
INCLINATION: 90

Boring method: Roto Sonic

DEPTH (feet)	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	REMARKS
80	79.0 - 81.0 Compact, brown, clayey coarse SAND, moist, non to low-plasticity (GLACIAL TILL) *(Continued)*	SC	11401.0 / 81.0						
	81.0 - 85.0 Dense, gray, medium to coarse, clayey SAND with little gravel and trace cobbles, moist, non-plastic, cobbles are sub-rounded and from various parent rock (GLACIAL TILL)	SC	11405.0 / 85.0						
85	85.0 - 90.0 Dense, brown-gray, clayey SAND, with little gravel and little cobbles, slightly moist to wet, non-plastic, cobbles are primarily micaceous sandstone	SC	11410.0 / 90.0	13	SPT	42->50	>50	1.5	Top of each sonic core run is very wet, indicating that we are well above the water table. Driller was not using water during drilling
90	90.0 - 94.0 Slightly to moderately weathered, gray , very fine to medium crystaline, micaceous SANDSTONE, strength is R4 to R5, weathered product is non-plastic rockflour with angular sand and gravel		11414.0 / 94.0						Hit a large boulder
95	94.0 - 101.0 Dense, gray, medium to coarse, clayey SAND with gravel and trace cobbles, moist, non-plastic, cobbles are sub-rounded and from various parent rock (GLACIAL TILL)	SC	11421.0 / 101.0						
100	101.0 - 103.0 Stiff, tan-gray, gravelly CLAY, slightly moist, medium plasticity (GLACIAL TILL)	CL	11423.0 / 103.0						
105	103.0 - 111.0 Dense, gray, medium to coarse, clayey SAND with gravel and trace cobbles, moist, non-plastic, cobbles are sub-rounded and from various parent rock (GLACIAL TILL)	SC	11431.0 / 111.0	14	GR			2	
110	111.0 - 113.0 Dense, tan, well graded, sandy GRAVEL, slightly moist, non-plastic (GLACIAL TILL)	GW	11433.0 / 113.0						
115	113.0 - 119.0 Dense, brown, well graded, clayey SAND with gravel and cobbles, slightly moist, non to low plasticity, cobbles are sub-rounded and from various parent rock (GLACIAL TILL)	SW-SC	11439.0 / 119.0						
120	119.0 - 124.0 Sandy GRAVEL (GLACIAL TILL)	GW							

PENETRATION RESISTANCE BLOWS / ft (10, 20, 30, 40); WATER CONTENT (PERCENT) W_p — W — W_l (20, 40, 60, 80): no data plotted.

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-25

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Laydown Yard

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/21/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 5,628.00 E: 2,903.00

ELEVATION: 11320
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft / WATER CONTENT (PERCENT)	REMARKS
120	Roto Sonic	119.0 - 124.0 Sandy GRAVEL (GLACIAL TILL) *(Continued)*	GW	11444.0 124.0							
125		124.0 - 130.0 Clayey SAND with gravel (GLACIAL TILL)	SW-SC	11450.0 130.0							
130		130.0 - 134.5 Sandy GRAVEL (GLACIAL TILL)	GW	11454.5 134.5							
135		134.5 - 138.5 Clayey SAND with gravel (GLACIAL TILL)	SW-SC	11458.5 138.5							
140–150		138.5 - 153.0 Sandy GRAVEL (GLACIAL TILL)	GW	11473.0 153.0							Driller indicated that material is getting harder
		153.0 - 154.0 Clayey SAND with gravel (GLACIAL TILL)	GW	11474.0 154.0	15	GR					
155		154.0 - 156.0 Brown, compact to dense, well graded SAND, moist, non-plastic (GLACIAL TILL)	SW	11476.0 156.0							
160		156.0 - 164.0 Hard, brown, gravelly CLAY with sand, slightly moist, low plasticity, gravel from various parent rocks (GLACIAL TILL)	CL								

Log continued on next page

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-25

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Laydown Yard
DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/21/2011
DRILL RIG: GP24-300RS
DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 5,628.00 E: 2,903.00
ELEVATION: 11320
INCLINATION: 90

DEPTH (feet)	BORING METHOD	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLE NUMBER	TYPE	BLOWS per 6 in (140 lb hammer, 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40); WATER CONTENT (PERCENT) Wp —○W— Wl (20 40 60 80)	REMARKS
160	Roto Sonic	156.0 - 164.0 Hard, brown, gravelly CLAY with sand, slightly moist, low plasticity, gravel from various parent rocks (GLACIAL TILL) *(Continued)*	CL	11484.0 164.0							Due to harder material, run from 161.5 to 162.5 was roto sonic cored with water, but water caused the core barrel to plug, so drilling was continued without water
165		164.0 - 166.0 Dense, gray silty SAND with gravel, slightly moist, non-plastic (GLACIAL TILL)	SM	11486.0 166.0							
		166.0 - 167.0 Same as 156 to 164 feet.	CL	11487.0 167.0							
170		167.0 - 171.0 Dense, brown, clayey SAND with gravel and cobbles of various origin (GLACIAL TILL)	SC	11491.0 171.0							Off hole at 6:00 PM on 10/22. Back on hole at 8:00 AM on 10/23
		171.0 - 176.0 Hard, completely weathered, gray, medium to coarse crystaline, PORPHYRY (LINCOLN PORPHYRY), weathered product is very stiff to hard, gray-brown, CLAY, slightly moist, low to medium plasticity	CL	11496.0 176.0	16	GR			2		Rock material appears in tact, but is completely weathered (saprolite). Does not feel or act like clay until significant water is added. Less weathering with depth.
175		176.0 - 184.0 Highly weathered, medium to very coarsely crystaline, RO strength, PORPHYRY (LINCOLN PORPHYRY), weathered material is dense, gray, poorly graded coarse SAND, slightly moist, non-plastic	SP	11504.0 184.0	17	GR					
185		184.0 - 193.0 Moderately weathered, massive, gray (green, black and pink crystals), medium to very coarse crystaline, R0 to R1 strength, PORPHYRY (LINCOLN PORPHYRY)									
195		Boring completed at 193 ft.									Finish drilling hole at 10:30 AM on 10/23
200											

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos
LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

RECORD OF BOREHOLE GA-11B-26

PROJECT: Climax Molybdenum
PROJECT NUMBER: 113-81608
LOCATION: Above McNulty Gulch

DRILLING METHOD: Roto Sonic
DRILLING DATE: 10/20/2011
DRILL RIG: GP24-300RS

DATUM: MSL
AZIMUTH: N/A
COORDINATES: N: 10,098.00 E: 3,925.00

ELEVATION: 11680
INCLINATION: 90

DEPTH (feet)	BORING METHOD	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC / ATT	PENETRATION RESISTANCE BLOWS / ft ■ (10 20 30 40) / WATER CONTENT (PERCENT) W_p —○W— W_l (20 40 60 80)	REMARKS
0	Roto Sonic	0.0 - 1.0 Loose, brown, well graded, SAND with gravel, organics, and silt, slightly moist, non-plastic (TOPSOIL)	SW		11681.0 1.0							
		1.0 - 4.0 Topsoil grades to Compact to dense, gray, sandy GRAVEL, slightly moist, non-plastic	GW		11684.0 4.0							
5		4.0 - 7.0 Compact to dense, gray, sandy GRAVEL, slightly moist, non-plastic, 40% gravel, 30% sand, 15% cobbles, 15% silt, cobbles are angular and derived from PORPHYRY (LINCOLN PORPHYRY)	GW		11687.0 7.0							
10		7.0 - 22.5 Dense, gray, sandy GRAVEL with cobbles, slightly moist, non-plastic, 20% sand, 20% cobbles, 10% fines. Fines are rockflour (from drilling), gravel and cobbles are angular and from PORPHYRY (LINCOLN PORPHYRY)	GW		11702.5 22.5							Water table @ 13.1 feet on 10/21 at 8:37 AM and @ 13.2 feet on 10/22 at 12:30 PM
15						1	SPT	9-12-13	25	1.5	■ (≈25)	
20												Large cobbles present with depth
		22.5 - 23.0 Soft to firm, gray, CLAY with gravel and cobbles, moist, medium plasticity	CL		11703.0 23.0	2	GR			0.5		Took two bag samples of clay
25		23.0 - 31.0 Dense, gray, sandy GRAVEL with cobbles (same as 7 to 22.5), slightly moist, large cobbles in core (LINCOLN PORPHYRY)	GW		11711.0 31.0							
30		31.0 - 36.0 Slightly to moderately weathered, massive, gray, fine to very coarse crystaline, R4 strength, PORPHYRY (LINCOLN PORPHYRY)										Drillers used lots of water to continue drilling in attempt to return intact Roto Sonic sized core
35		Boring completed at 36 ft.										
40												

SCALE: 1 in = 5 ft
DRILLING CONTRACTOR: Boart Longyear
DRILLER: Carlos

LOGGED: D.Rugg
CHECKED: D.Geier
DATE:

Golder Associates

ATTACHMENT 3
SELECT PHOTOGRAPHS

Climax Molybdenum OSF Design Report

PHOTO 1

Test Pit GA-11P-01

PHOTO 2

Material from Test Pit GA-11P-03

PHOTO 3

Test Pit GA-11P-04

PHOTO 4 Sandy Waste Rock In Test Pit GA-11P-04	
PHOTO 5 Test Pit GA-11P-05	
PHOTO 6 Test Pit GA-11P-06	

PHOTO 7

Exposed Material at Test Pit GA-11P-07

PHOTO 8

Seeping Water in Test Pit GA-11P-07

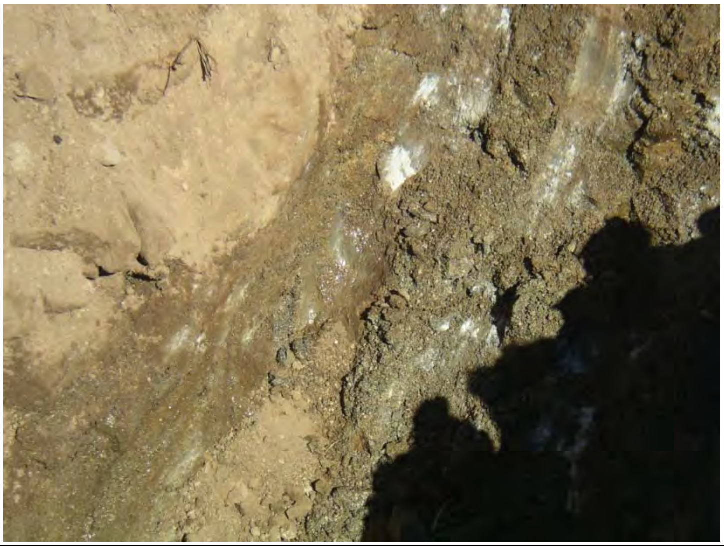


PHOTO 9

Waste Rock from Test Pit GA-11P-08

PHOTO 10

Test Pit GA-11P-10

PHOTO 11

Test Pit GA-11P-11

PHOTO 12

Black-Gray Sandy Fill from Test Pit GA-11P-11

PHOTO 13 Wood Debris from Test Pit GA-11P-12	
PHOTO 14 Test Pit GA-11P-13	
PHOTO 15 Minturn in Test Pit GA-11P-13	

PHOTO 16 Test Pit GA-11P-14	
PHOTO 17 Test Pit GA-11P-15	
PHOTO 18 Typical Fill in Test Pit GA-11P-14	

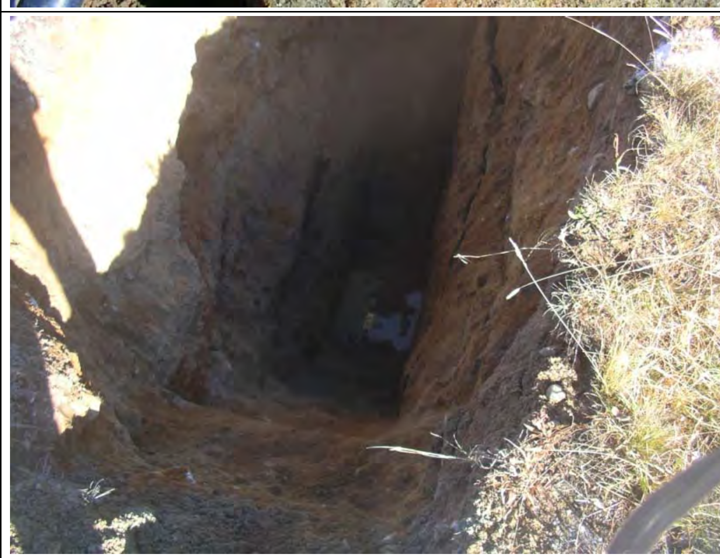
PHOTO 19 Typical Weathered Lincoln Porphyry in Test Pit GA-11P-16	
PHOTO 20 Orange Clay Infill from Test Pit GA-11P-17	
PHOTO 21 Test Pit GA-11P-18	

PHOTO 22 Test Pit GA-11P-19	
PHOTO 23 Typical Colluvial Minturn in GA-11B-20	
PHOTO 24 Typical Clayey Colluvial Minturn in GA-11B-20	

PHOTO 25 Contact between Colluvial Minturn and Residual Lincoln Porphyry in GA-11B-20	
PHOTO 26 Typical Residual Lincoln Porphyry in GA-11B-20	
PHOTO 27 Typical Waste Rock in GA-11B-21	

PHOTO 28

Upper Weathered Minturn from GA-11B-21

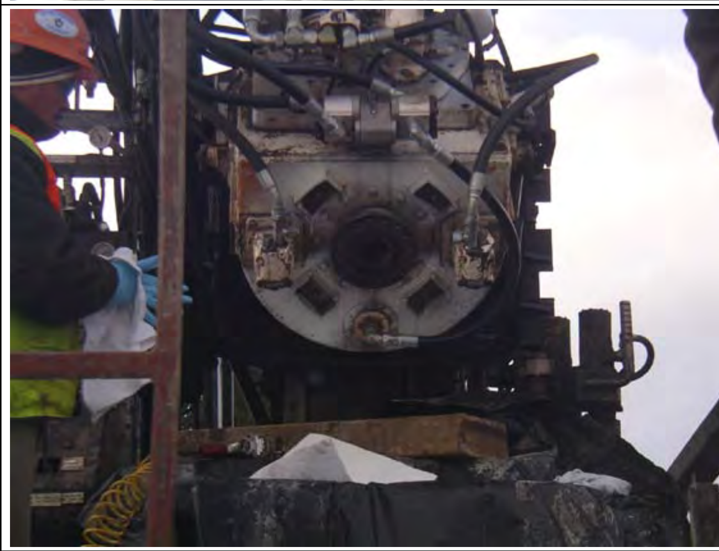
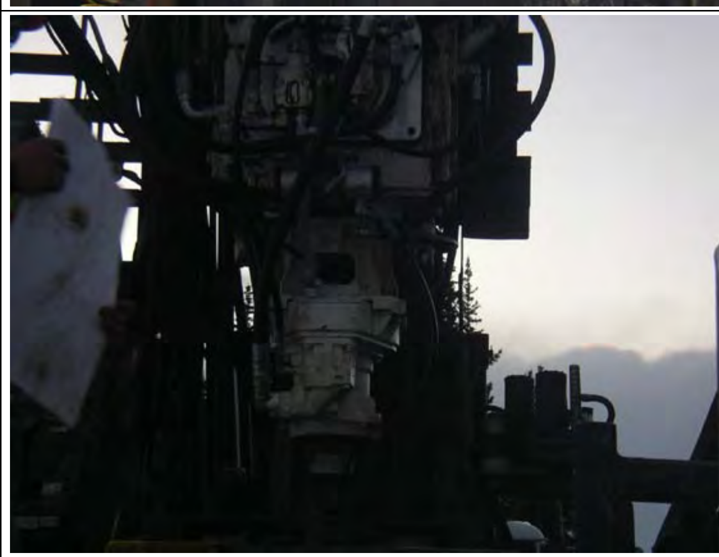
PHOTO 29

Minturn Core Returned by Sonic Drilling with Water in GA-11B-21

PHOTO 30

Typical Minturn Sandstone HQ Core from GA-11B-21

PHOTO 31 Typical Fill from GA-11B-22	
PHOTO 32 Typical Weathered Lincoln Porphyry from GA-11B-22	
PHOTO 33 Return from Sonic Drilling with Water in Weathered Lincoln Porphyry at GA-11B-22	

PHOTO 34 Sonic Coring Drillhead	
PHOTO 35 Sonic Drillhead Removed	
PHOTO 36 HQ Coring Head Attached	

Climax Molybdenum OSF Design Report

PHOTO 37

Typical Gravelly Waste Rock from GA-11B-23

PHOTO 38

Typical Sandy Waste Rock from GA-11B-23

PHOTO 39

Steel Debris Encountered in GA-11B-23

PHOTO 40 Typical Clayey Silt Tailings from GA-11B-23	
PHOTO 41 Transition Material between Tailings and Glacial Till in GA-11B-23	
PHOTO 42 Typical Glacial Till in GA-11B-23	

PHOTO 43

Stiff Clay Encountered in Glacial Till in GA-11B-23

PHOTO 44

Drill Rig Mobilized at GA-11B-24

PHOTO 45 Upper Tailings Contact at GA-11B-24	
PHOTO 46 Stratifications in Clayey Silt Tailings from GA-11B-24	
PHOTO 47 Typical Glacial Till from GA-11B-24	

PHOTO 48 Typical Waste Rock from GA-11B-25	
PHOTO 49 Upper Tailings Contact in Borehole GA-11B-25	
PHOTO 50 Typical Silty Sand Tailings from GA-11B-25	

PHOTO 51 Lower Tailings – Till Contact from GA-11B-25	
PHOTO 52 Typical Glacial Till in Borehole GA-11B-25	
PHOTO 53 Typical Weathered Lincoln Porphyry in GA-11B-25	

PHOTO 54 Typical Weathered Lincoln Porphyry in Borehole GA-11B-26	
PHOTO 55 Core Returned by Sonic Drilling with Water in Borehole GA-11B-26	

APPENDIX B
GEOTECHNICAL LABORATORY TESTING SUMMARY (INCLUDES TEST RESULTS)

APPENDIX B

Date:	February 17, 2012	**Prepared by:**	D. Rugg
Project No.:	113-81608.2000	**Checked by:**	D. Geier
Project Title:	Climax Molybdenum OSF Design Report	**Reviewed by:**	B. Bronson
RE:	**GEOTECHNICAL LABORATORY TESTING SUMMARY**		

This appendix is intended to summarize and provide the results of the laboratory-testing program performed in support of the Climax Molybdenum Mine (Climax) North 40 and McNulty Gulch Overburden Storage Facility (OSF) designs. T esting was performed on s amples collected as part of the Golder Associates Inc. (Golder) field investigation, which was conducted during October and November 2011. A summary of the field program is included in the main design report text and in Appendix A of the report, and includes all field observations, a description of the samples collected during the field program, and the rationale used for assigning various laboratory tests to select samples. Tests were performed on native soils, waste rock materials, and historic tailing materials in order to determine index properties and engineering properties for the design of the North 40 and McNulty overburden storage facility (OSF).

1.0 LABORATORY TESTING METHODS

All laboratory testing was performed by Golder in either our Denver Geotechnical Laboratory or our Atlanta Geotechnical Laboratory. All laboratory-testing procedures are in accordance with the American Society for Testing and Materials (ASTM) standards where applicable. Soil samples were classified using the Unified Soil Classification System (USCS) (ASTM D2487). The laboratory tests performed on various samples and the associated standards are summarized below:

- Sieve Analysis – ASTM C117/C136
- Hydrometer/Sieve/Specific Gravity – ASTM D422
- Atterberg Limits – ASTM D4318
- Specific Gravity – ASTM D854
- Standard Proctor Compaction Testing – ASTM D698
- Modified Proctor Compaction Testing – AASHTO T180 Method A
- Minimum Index Density Determination – ASTM D4254
- Consolidated-Undrained (CU) Triaxial Compression – ASTM D4767
- One-dimensional Consolidation Testing – ASTM D2435
- Natural Density and Moisture Content – ASTM D2937 and D2216
- Large Scale Direct Shear Testing – ASTM D3080 (Modified)
- Jar Slake Durability Testing – Kentucky Method 64-514-02

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2.0 LABORATORY TESTING RESULTS

A description of the materials encountered during the field program can be found in the main design report text and in Appendix A of the report. These materials included native soils (Glacial Till, Lincoln Porphyry, and Minturn Formation), waste rock materials, and historic tailing materials. Testing was strategically assigned to each material type in order to adequately identify their major index and engineering properties. The results of the index tests performed are summarized in Table 1. Detailed tables and plots of all index test results are presented in Attachment 1.

Engineering testing consisted of various strength tests on native materials, including a staged triaxial test, two large-scale direct shear tests, a single one-dimensional consolidation test on tailing fines and a series of consolidated undrained triaxial tests. A summary of the results of all strength tests is shown in Table 2 and a summary of the consolidation testing results for the tailing fines is presented in Table 3. Detailed laboratory results for all engineering tests are included in Attachment 2. Figures 1 through 6 display the Mohr-Coulomb failure envelopes for each series of strength tests (peak values are displayed for all tests and residual values are displayed where a drop from peak strength was observed, and residual strength values are relevant).

List of Attachments

Tables 1 through 3
Figures 1 through 6
Attachment 1 – Index Test Results
Attachment 2 – Engineering Test Results

TABLES

Table 1
Summary of Index Testing Results

Soil Type	Boring/Pit Number	Sample Depth (ft)	USCS Soil Classification	Moisture Content (%)	In-Situ Dry Density (pcf)	Specific Gravity	Atterberg Limits			Grain Size Distribution			Moisture/Density Relationship Standard		Jar Slake Index	Minimum Density (pcf)	Maximum Denisty (pcf)
							LL	PL	PI	% Finer 3/4"	% Finer #4	% Finer #200	Dry Density (pcf)	Moisture (%)			
Native Soils																	
Minturn Formation	GA-11B-20	32-34	SM	--	--	--	NP	NP	NP	85	51	17	--	--	--	--	--
	GA-11B-21	28	SC	--	--	--	28	15	13	98	88	49	--	--	--	--	--
Lincoln Porphyry	GA-11B-20	40-43	SC	--	--	--	28	18	10	90	63	21	--	--	--	--	--
	GA-11B-25	178	--	15.0	--	--	--	--	--	--	--	--	--	--	--	--	--
Glacial Till	GA-11B-24	132	GC	--	--	--	31	17	14	76	58	25	--	--	--	--	--
	GA-11B-25	104-106	--	7.8	--	--	--	--	--	--	--	--	129.5[1]	8.7	--	--	--
	GA-11B-23	249-251	--	6.9	--	--	--	--	--	--	--	--	--	--	--	--	--
Waste Rock Materials																	
Waste Rock	GA-11P-05	3-6	GP-GM	8.9	--	--	33	17	16	66	32	9	--	--	6	--	--
	GA-11B-25	16	GC	6.0	--	--	28	15	13	68	39	14	--	--	6	--	--
Tailing Materials																	
Tailing Beach	GA-11B-24	91-92	SM	--	--	--	NP	NP	NP	100	100	36	119.0[2]	10.1	--	73.1	120.7[3]
	GA-11B-25	43.5	SM	--	--	--	NP	NP	NP	100	100	26			--		
	GA-11B-25	55	SM	--	--	--	NP	NP	NP	100	100	25			--		
	GA-11B-25	42	--	26.9	97.8	--	--	--	--	--	--	--			--		
Tailing Fines	GA-11B-24	51.5-53.6	ML	31.9	--	2.75	NP	NP	NP	100	100	99	--	--	--	--	--
	GA-11B-24	71-73.2	ML	30.6	86	--	NP	NP	NP	100	100	97	--	--	--	--	--
	GA-11B-23	190-192	--	25.5	100.3	--	--	--	--	--	--	--	--	--	--	--	--

[1] Maximum dry density and corresponding moisture content determined by the standard Proctor method.
[2] Maximum dry density and corresponding moisture content determined by the modified Proctor method.
[3] Maximum dry density determined by compaction in a Proctor mold utilizing maximum compactive effort performed on soil at 2% below the optimum moisture content.

Table 2
Summary of Strength Testing Results

Soil Type	Boring/Pit Number	Sample Depth (ft)	Test Type	Peak		Residual	
				Cohesion (psi)	Friction Angle (degrees)	Cohesion (psi)	Friction Angle (degrees)
Native Materials							
Minturn Formation	GA-11B-21	28	Staged CU Triaxial	0	31	--	--
Lincoln Porphyry	GA-11B-20	40-43	Large Scale Direct Shear	16	38	18	35
Glacial Till	GA-11B-25 GA-11B-23	104-106 249-251	Large Scale Direct Shear	17	31	14	31
Waste Rock Materials							
Waste Rock	GA-11P-05	3-6	Large Scale Direct Shear	9	37	0	35
Waste Rock	GA-11B-25 GA-11B-23	16 38-40	Large Scale Direct Shear	6	37	0	36
Tailing Materials							
Tailing Fines	GA-11B-24	51.5-53.6	CU Triaxial	0	36	0	33

Table 3
Summary of Consolidation Testing Results

Soil Type	Boring/Pit Number	Sample Depth (ft)	Test Type	Initial		Final		Average Cv (ft^2/day)	Recompression Index C_r	Compression Index C_c	Swell Index C_s
				Void Ratio	Dry Density (pcf)	Void Ratio	Dry Density (pcf)				
Tailing Fines	GA-11B-24	51.5-53.6	One-Dimensional Consolidation	0.9	90.1	0.78	96.6	2.63	0.03	0.11	0.02

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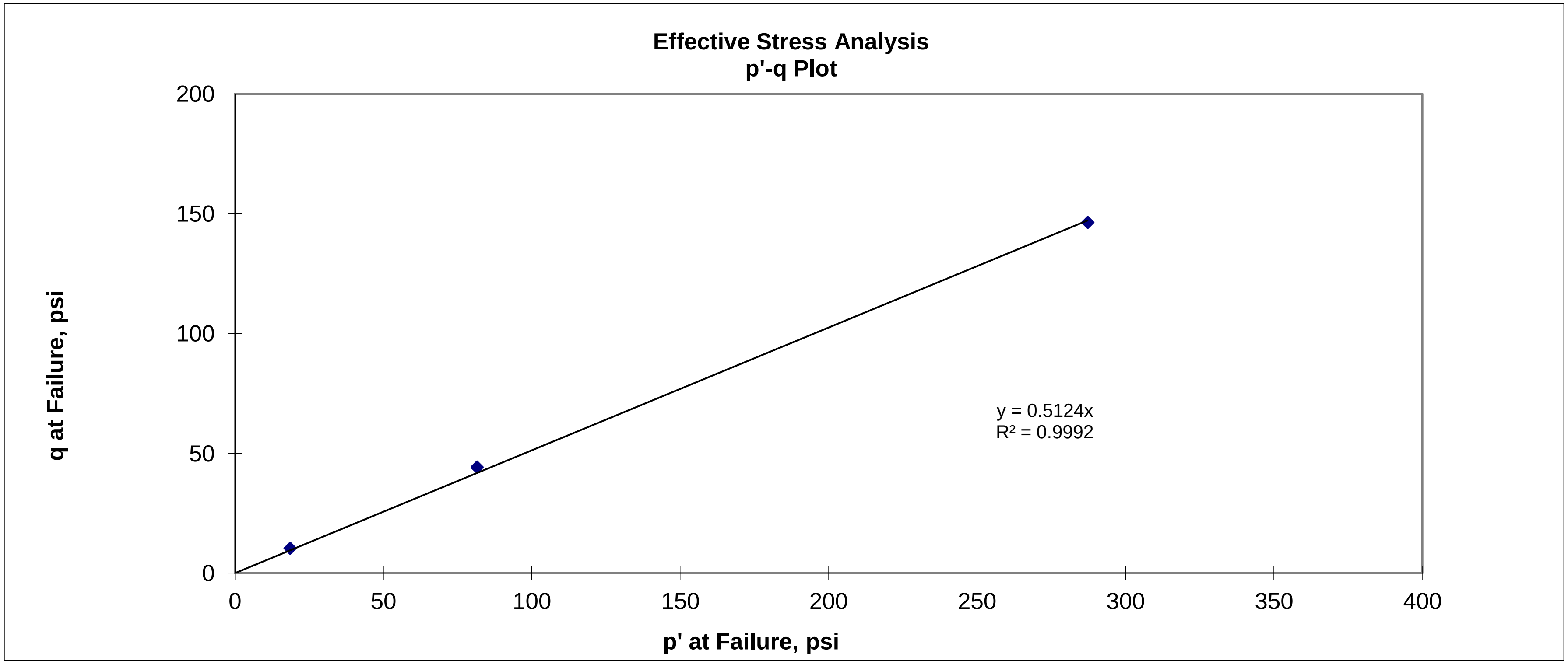
FIGURES



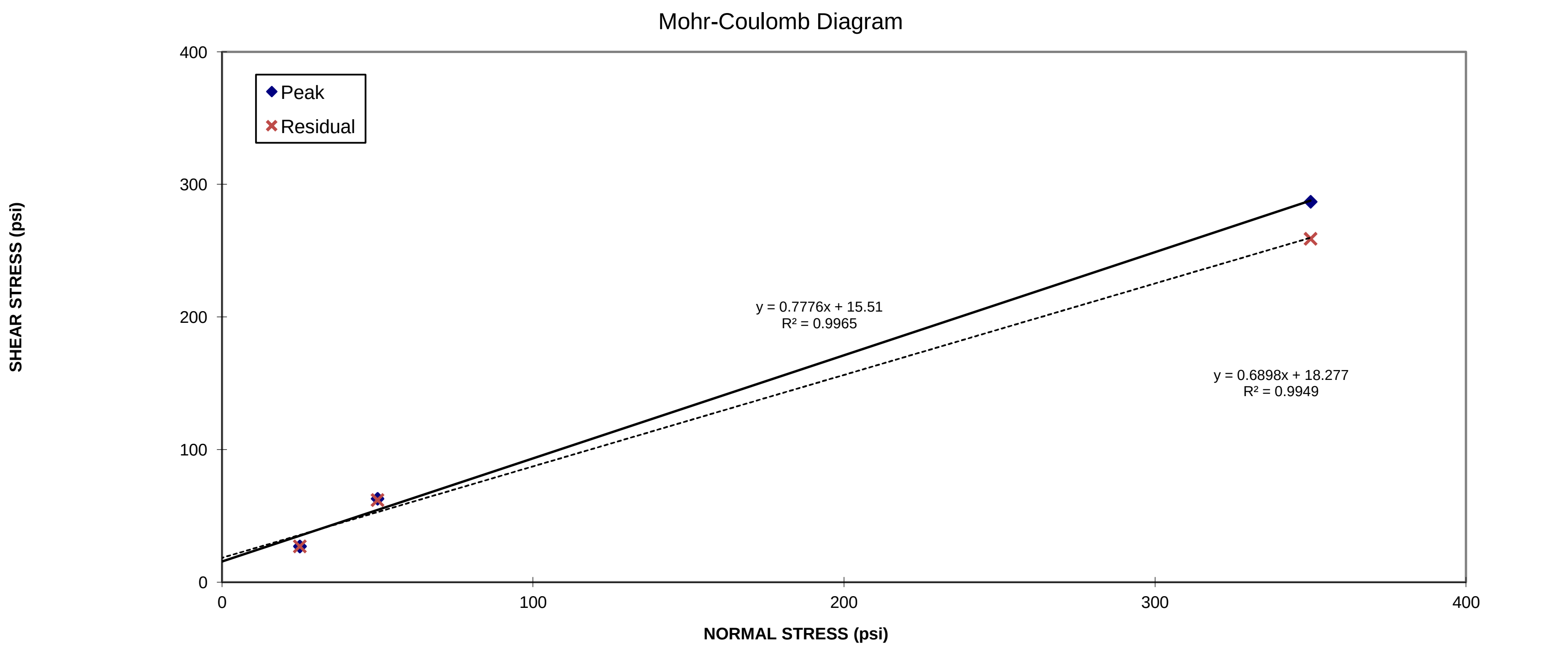
tan(ψ') =	**0.5124**	
a' =	**0**	**psi**
ϕ' =	**30.8**	**degrees**
c' =	**0**	**psi**

Golder Associates
Denver, Colorado

TITLE
Effective Stress Parameters for Staged Triaxial Test on Minturn Clay (GA-11B-21 @ 28 ft)

CLIENT/PROJECT
Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Jan-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	1



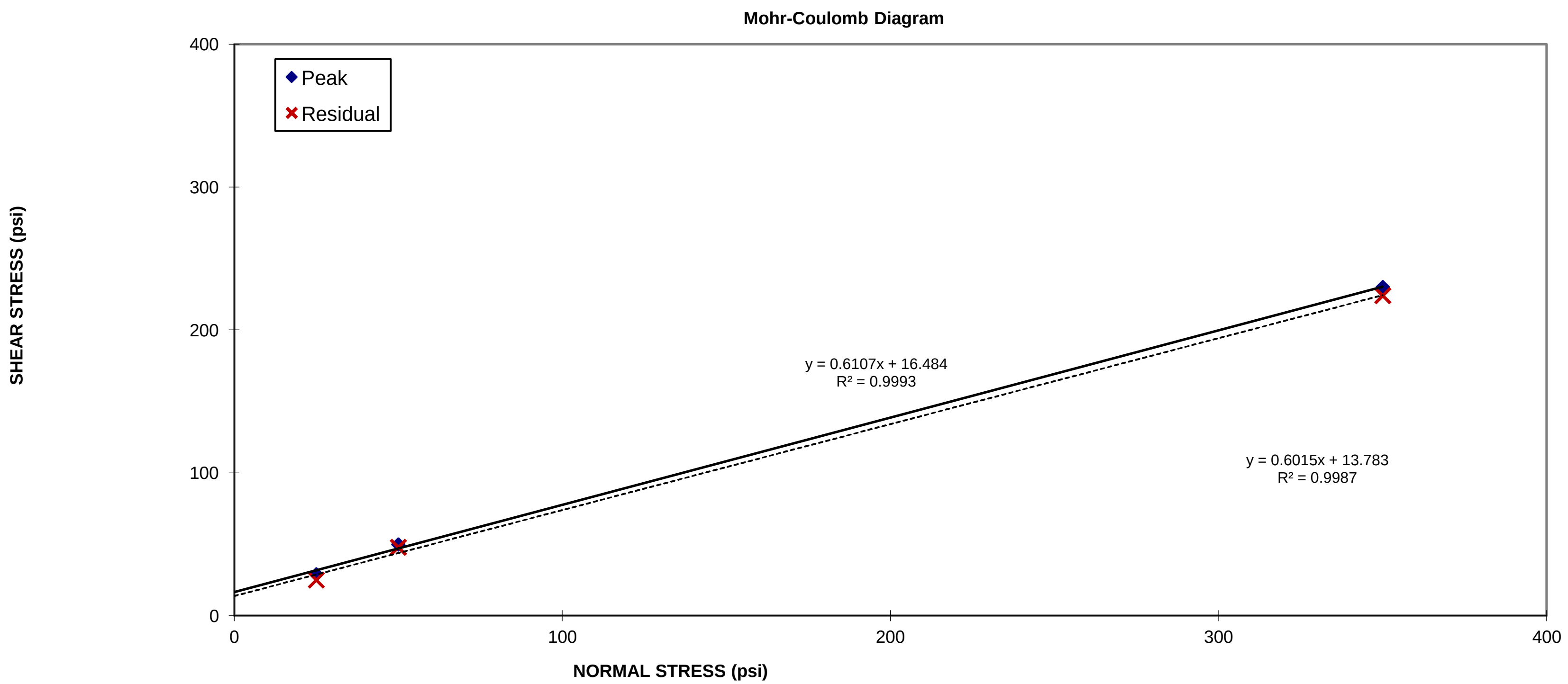
tan(ϕ')=	**0.7776**	
ϕ'=	**37.9**	**degrees (peak)**
C'=	**16**	**psi (peak)**
tan(ϕ')=	**0.6898**	
ϕ'=	**34.6**	**degrees (residual)**
C'=	**18**	**psi (residual)**

Golder Associates
Denver, Colorado

TITLE
Mohr-Coulomb Diagram for Large Scale Direct Shear on Lincoln Porphyry (GA-11B-20 @ 40-43 ft)

CLIENT/PROJECT
Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Jan-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	2



tan(ϕ')=	0.6107	
ϕ'=	31.4	degrees (peak)
C'=	16	psi (peak)
tan(ϕ')=	0.6015	
ϕ'=	31.0	degrees (residual)
C'=	14	psi (residual)

Golder Associates

Denver, Colorado

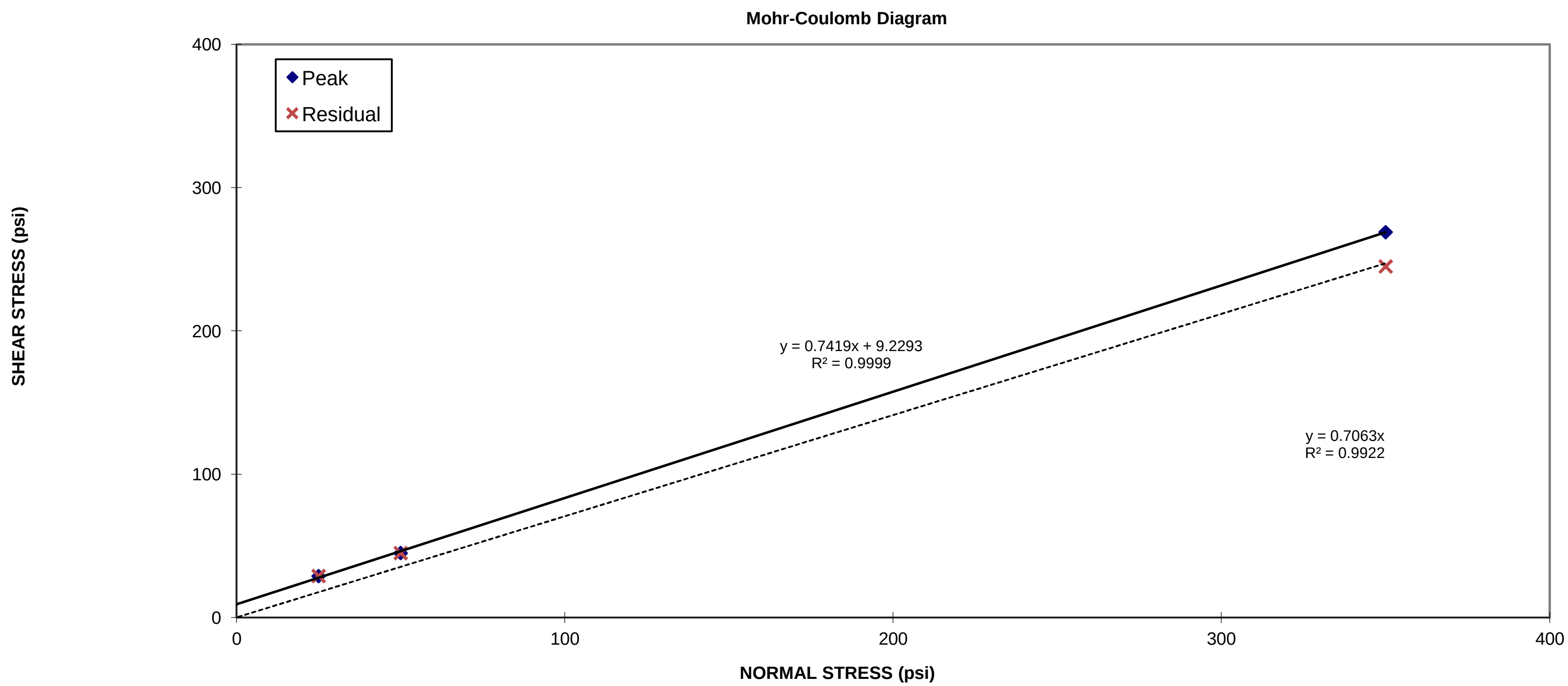
TITLE

Mohr-Coulomb Diagram for Large Scale Direct Shear on Glacial Till (GA-11B-25 @ 104-106 ft/GA-11B-23 @ 249-251 ft)

CLIENT/PROJECT

Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Jan-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	3



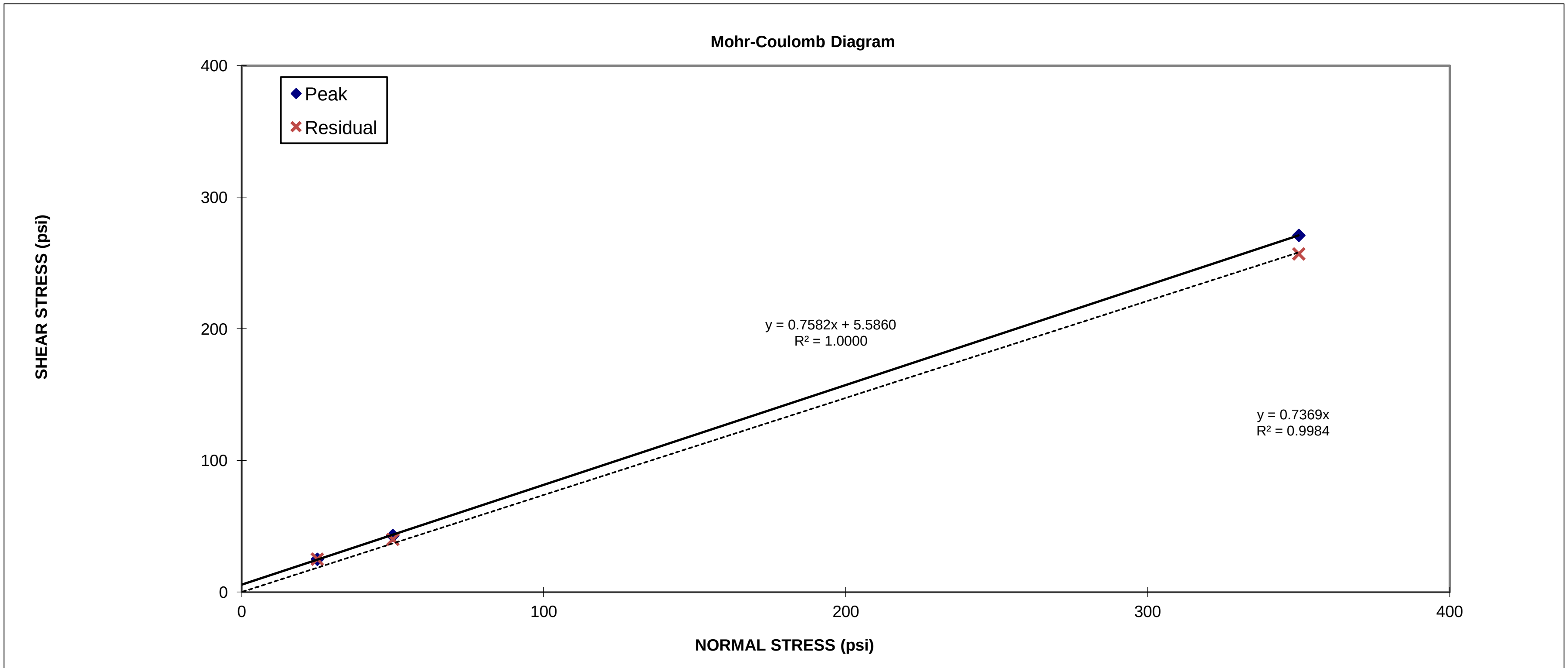
tan(ϕ')=	**0.7419**	
ϕ'=	**36.6**	**degrees (peak)**
C'=	**9**	**psi (peak)**
tan(ϕ')=	**0.7063**	
ϕ'=	**35.2**	**degrees (residual)**
C'=	**0**	**psi (residual)**

Golder Associates
Denver, Colorado

TITLE
Mohr-Coulomb Diagram for Large Scale Direct Shear on Waste Rock (GA-11P-05 @ 3-6 ft)

CLIENT/PROJECT
Climax Molybdenum, OSF Design

DRAWN	DAR	DATE	Jan-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	4



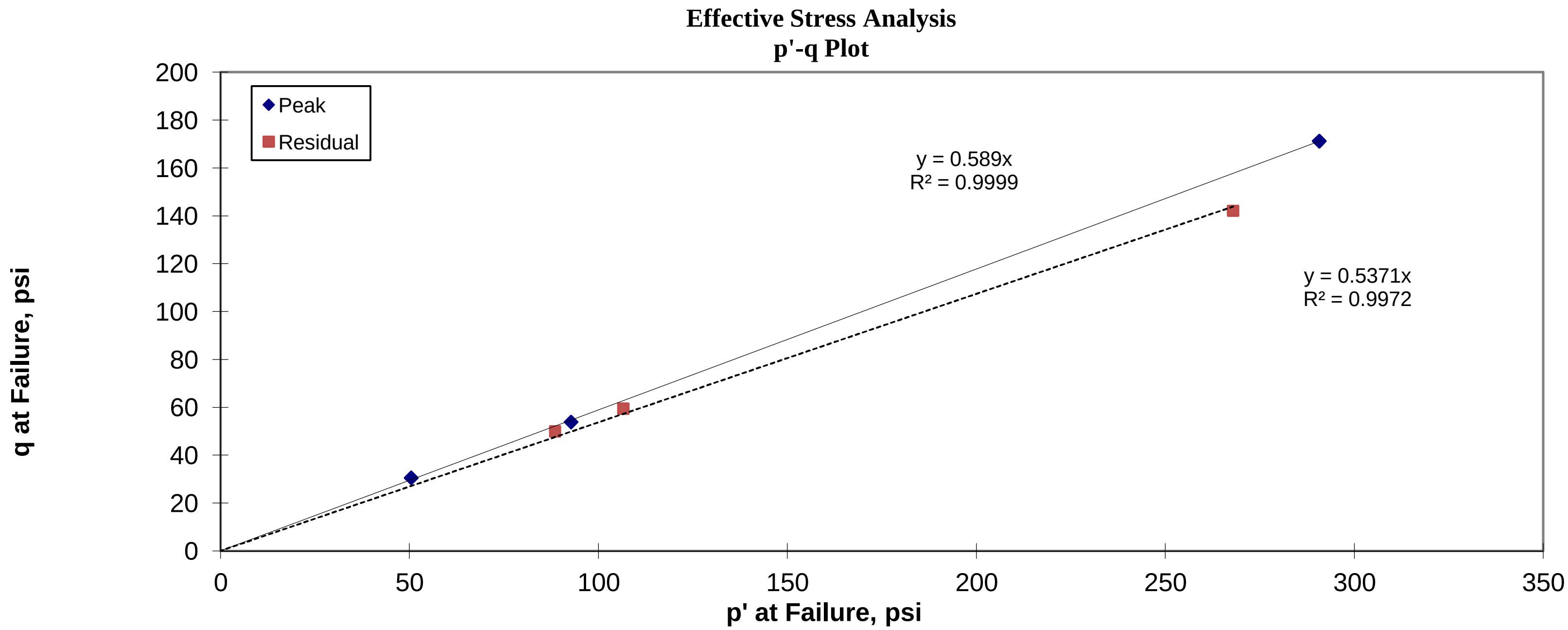
tan(ϕ')=	0.7582	
ϕ'=	37.2	degrees (peak)
C'=	6	psi (peak)
tan(ϕ')=	0.7369	
ϕ'=	36.4	degrees (residual)
C'=	0	psi (residual)

Golder Associates — Denver, Colorado

TITLE: **Mohr-Coulomb Diagram for Large Scale Direct Shear on Waste Rock (GA-11B-25 @ 16 ft/ GA-11B-23 @ 38-40 ft)**

CLIENT/PROJECT: **Climax Molybdenum, OSF Design**

DRAWN	DAR	DATE	Jan-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	5



tan(ψ') =	0.5890	
a' =	0	psi
ϕ' =	36.1	degrees (peak)
c' =	0	psi (peak)
tan(ψ') =	0.5371	
a' =	0	psi
ϕ' =	32.5	degrees (residual)
c' =	0	psi (residual)

Golder Associates
Denver, Colorado

TITLE

Effective Stress Parameters for CU Triaxial Test on Tailing Fines (GA-11B-24 @ 51.5-53.6 ft and 71-73.2 ft)

CLIENT/PROJECT

Climax Molybdenum, OSF Design

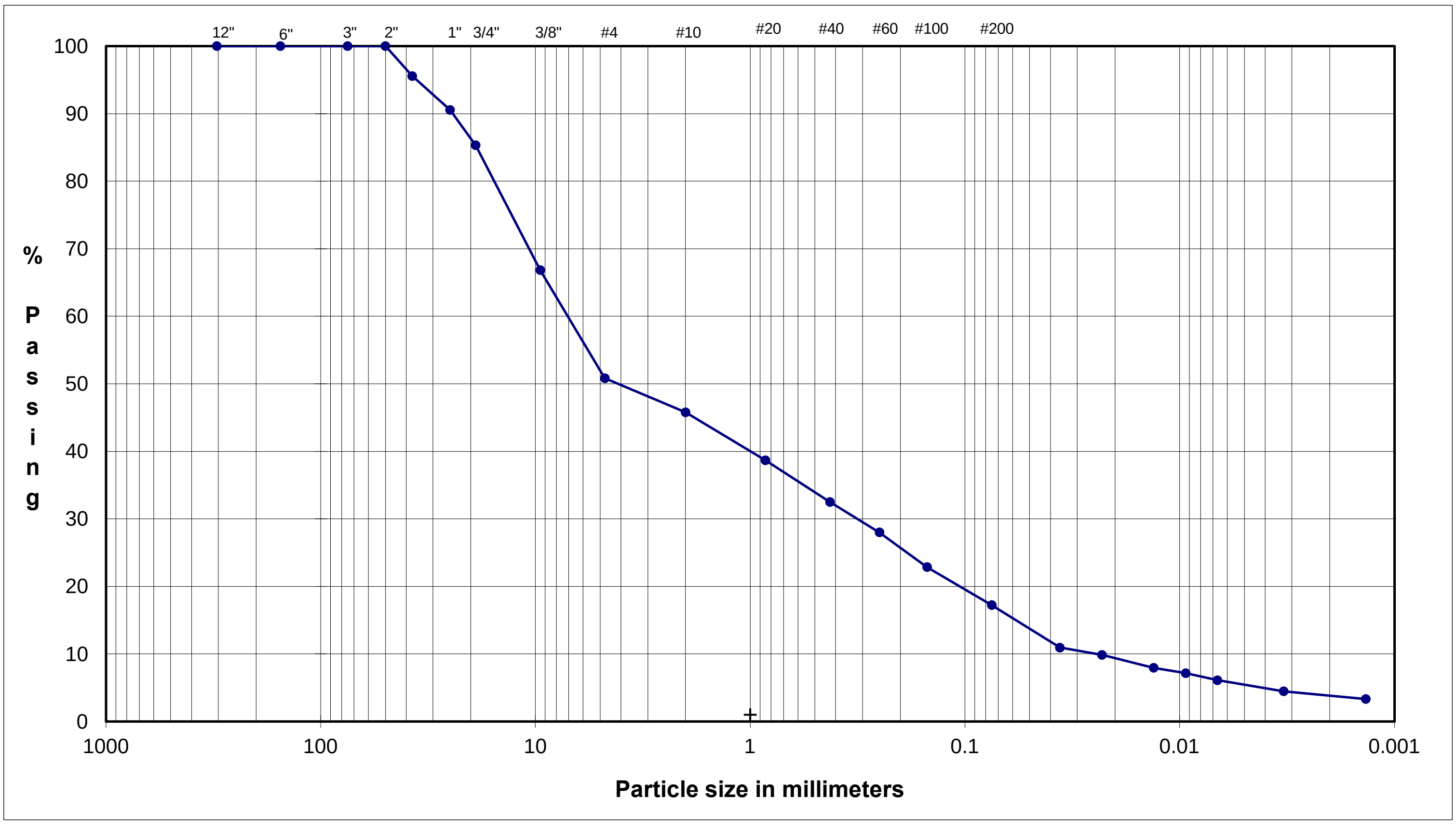
DRAWN	DAR	DATE	Jan-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	--
REVIEWED	BRB	FILE NO.	--	FIGURE NO.	6

ATTACHMENT 1
INDEX TEST RESULTS

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-20, B20-2 Depth (ft): 32-34
TYPE: Bag



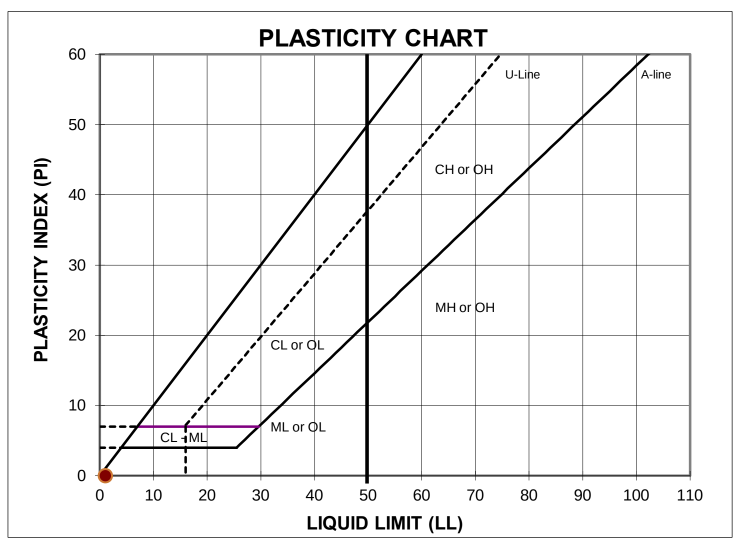
COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

U.S. Standard Sieves Sizes and Numbers

Sieve	Particle Size (mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	95.6		
1.0"	25.0	90.5		
0.75"	19.0	85.3	Coarse Gravel	9.46
0.375"	9.5	66.8		
#4	4.8	50.8	Fine Gravel	39.72
#10	2.00	45.8	Coarse Sand	5.04
#20	0.85	38.7		
#40	0.43	32.5	Medium Sand	13.28
#60	0.25	28.0		
#100	0.15	22.9		
#200	0.075	17.2	Fine Sand	15.25

Hydrometer Analysis

(mm)	%Finer	Classification	Percentage
0.036	10.9		
0.023	9.9		
0.013	8.0	Fines	
0.009	7.2	Silt or Clay	17.24
0.007	6.1		
0.003	4.5		
0.001	3.3		



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	NP	NP	NP	2.70

DESCRIPTION: Red silty gravel with sand

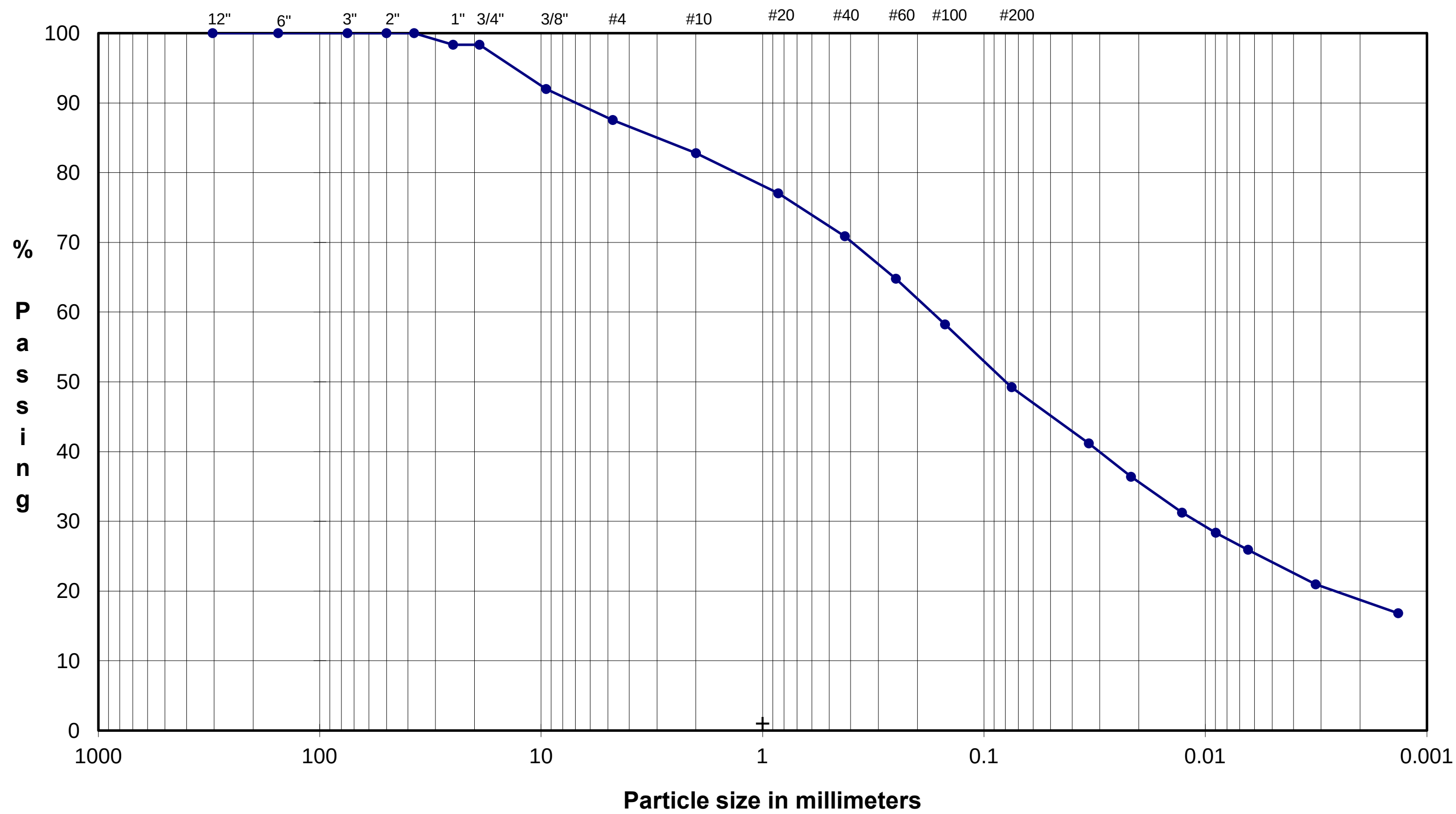
USCS: SM

TECH	BTC
DATE	11/15/2011
REVIEW	MB

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-21 (Sonic Core) Depth (ft): 28'
TYPE: Core



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

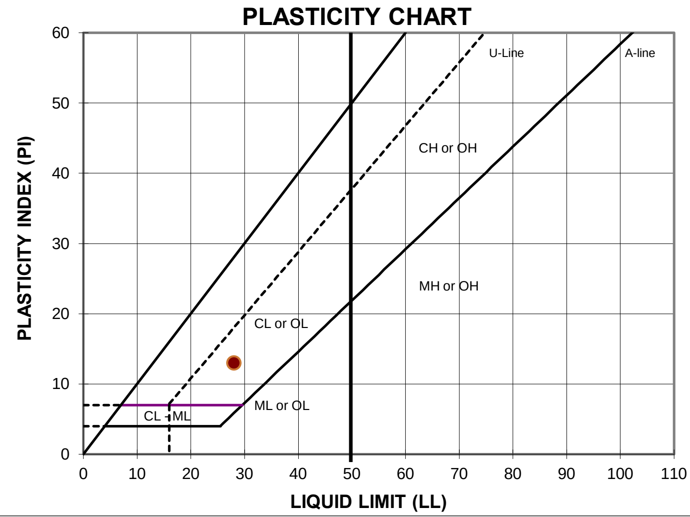
U.S. Standard Sieves Sizes and Numbers

Particle Size	(mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	100.0		
1.0"	25.0	98.3		
0.75"	19.0	98.3	Coarse Gravel	1.66
0.375"	9.5	92.0		
#4	4.8	87.5	Fine Gravel	10.79
#10	2.00	82.8	Coarse Sand	4.76
#20	0.85	77.0		
#40	0.43	70.9	Medium Sand	11.91
#60	0.25	64.8		
#100	0.15	58.2		
#200	0.075	49.2	Fine Sand	21.65

Hydrometer Analysis

(mm)	%Finer		
0.034	41.2		
0.022	36.4		
0.013	31.2		
0.009	28.4	Fines Silt or Clay	49.23
0.006	25.9		
0.003	21.0		
0.001	16.8		

PLASTICITY CHART



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	28	15	13	2.70

TECH	BTC
DATE	12/21/2011
REVIEW	MB

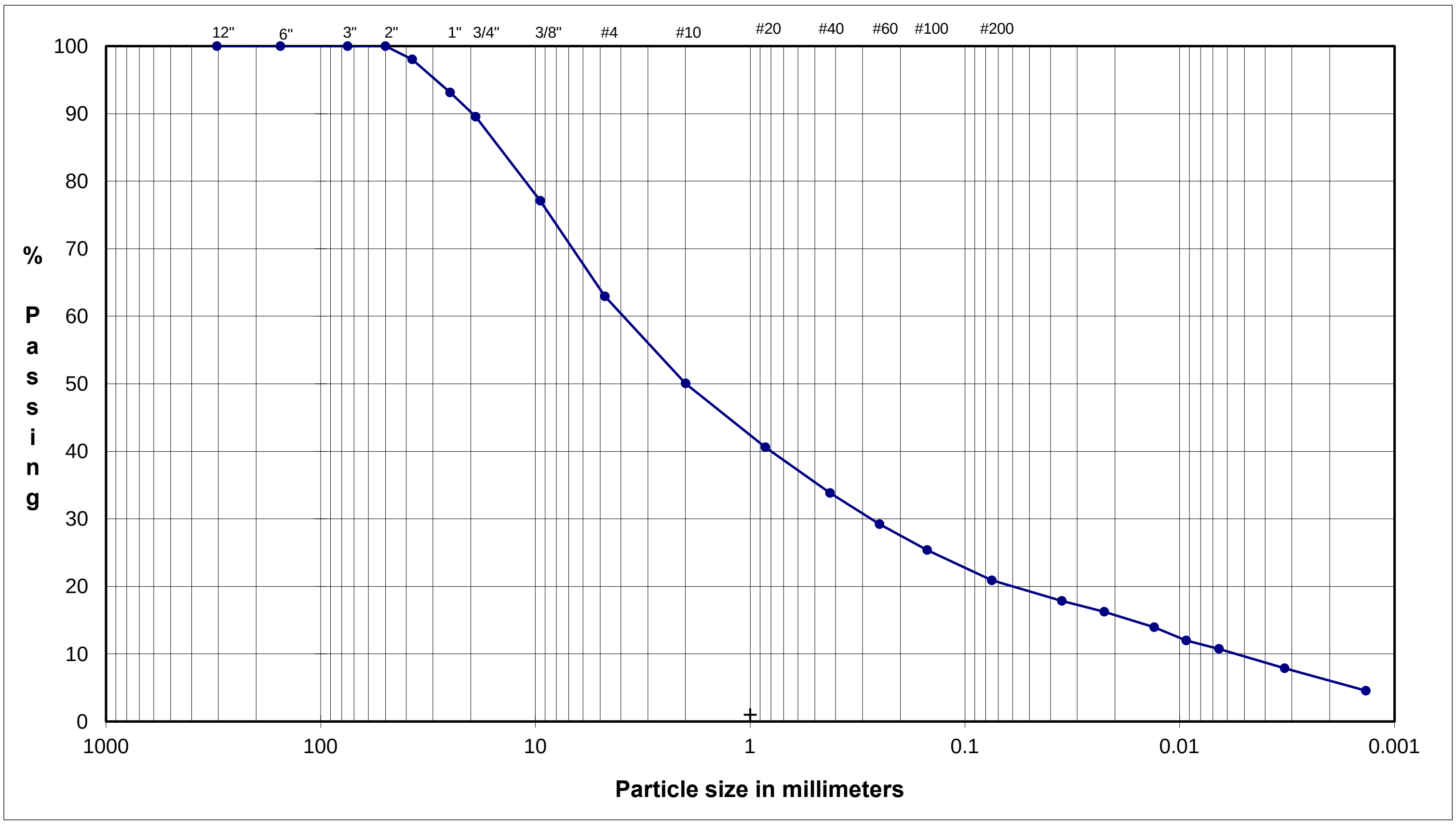
DESCRIPTION: Dry, reddish brown silt with small gravel.

USCS: SC

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-20, B20-4 Depth (ft): 40-43
TYPE: Bag



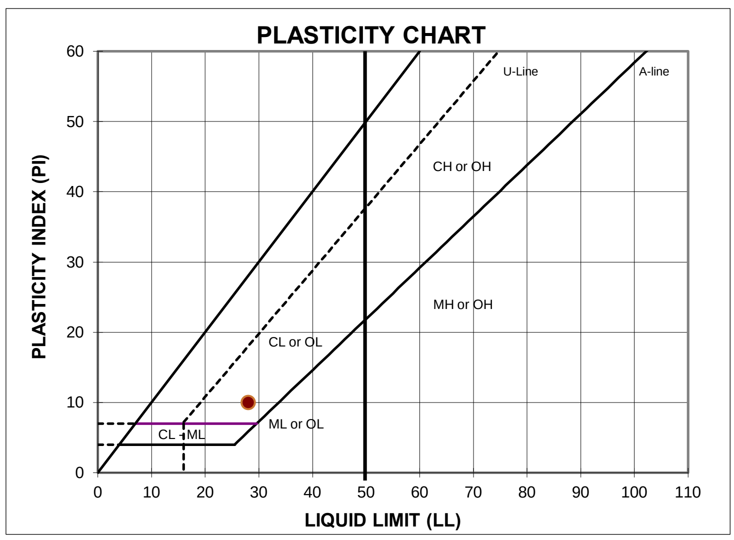
COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

U.S. Standard Sieves Sizes and Numbers

	Particle Size (mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	98.0		
1.0"	25.0	93.1		
0.75"	19.0	89.6	Coarse Gravel	6.86
0.375"	9.5	77.1		
#4	4.8	63.0	Fine Gravel	30.19
#10	2.00	50.1	Coarse Sand	12.88
#20	0.85	40.6		
#40	0.43	33.8	Medium Sand	16.23
#60	0.25	29.2		
#100	0.15	25.4		
#200	0.075	20.9	Fine Sand	12.94

Hydrometer Analysis

(mm)	%Finer		
0.035	17.9		
0.022	16.3		
0.013	14.0	Fines	
0.009	12.0	Silt or Clay	20.91
0.007	10.8		
0.003	7.9		
0.001	4.6		



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	28	18	10	2.70

DESCRIPTION: Gray clayey sand with gravel

USCS: SC

TECH	BTC
DATE	11/15/2011
REVIEW	MB

November-11 | 113-81608

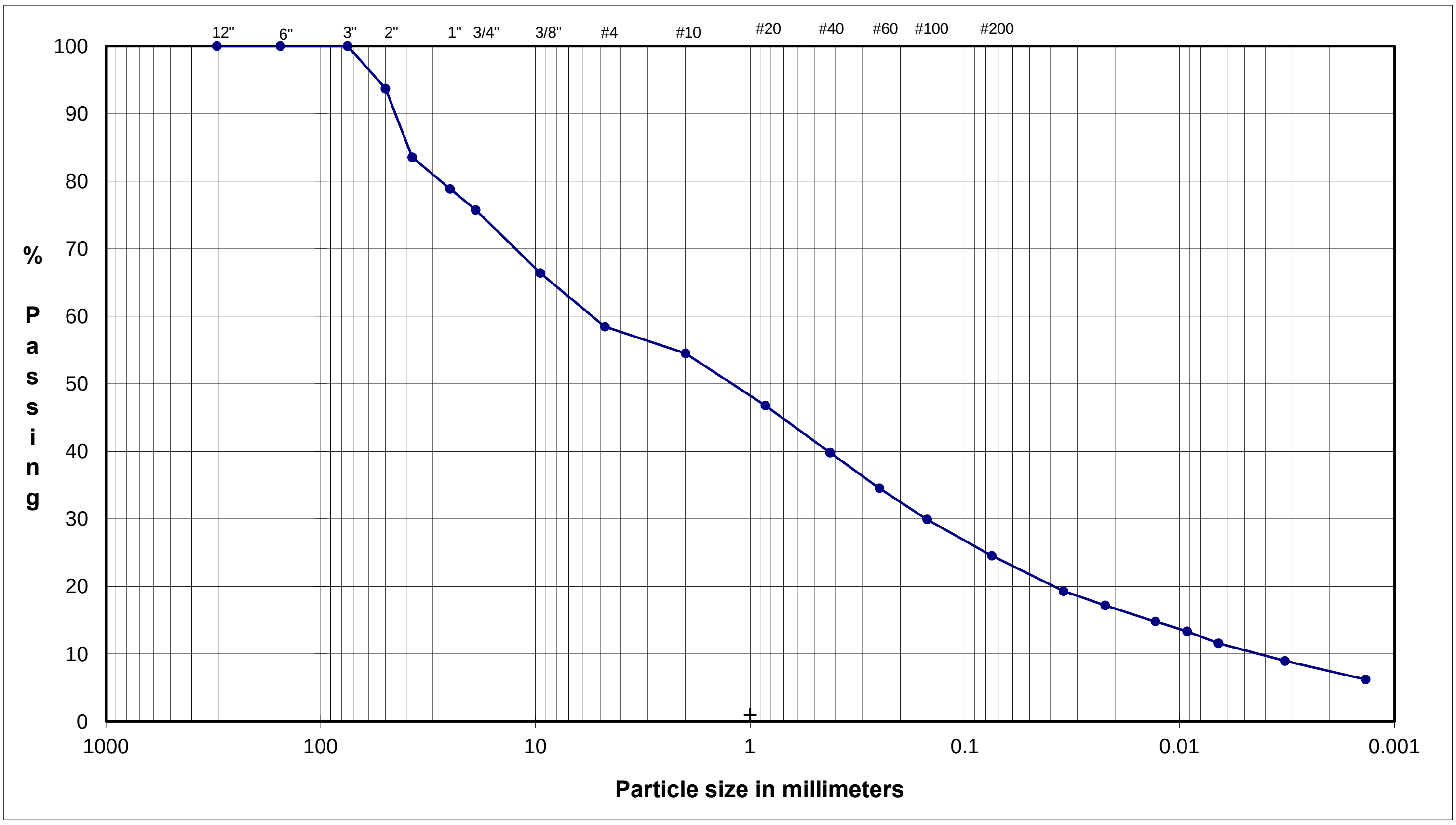
PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation

SAMPLE ID: GA-11B-24, B24-18 | Depth (ft): 132

TYPE: Bag



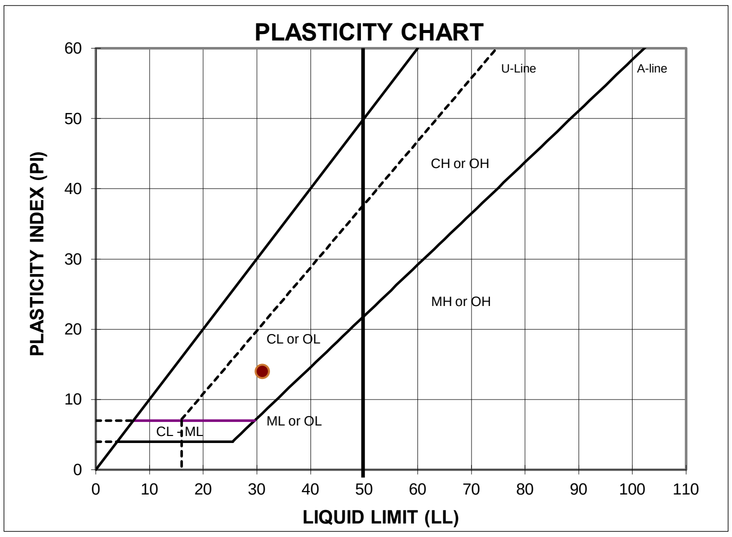
COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

U.S. Standard Sieves Sizes and Numbers

Particle Size	(mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	93.7		
1.5"	37.5	83.5		
1.0"	25.0	78.9		
0.75"	19.0	75.7	Coarse Gravel	21.15
0.375"	9.5	66.4		
#4	4.8	58.5	Fine Gravel	20.39
#10	2.00	54.5	Coarse Sand	3.94
#20	0.85	46.8		
#40	0.43	39.8	Medium Sand	14.71
#60	0.25	34.5		
#100	0.15	29.9		
#200	0.075	24.5	Fine Sand	15.26

Hydrometer Analysis

(mm)	%Finer		
0.035	19.3		
0.022	17.2		
0.013	14.8		
0.009	13.3	Fines Silt or Clay	24.54
0.007	11.6		
0.003	9.0		
0.001	6.2		



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	31	17	14	2.70

TECH	BTC
DATE	11/14/2011
REVIEW	MB

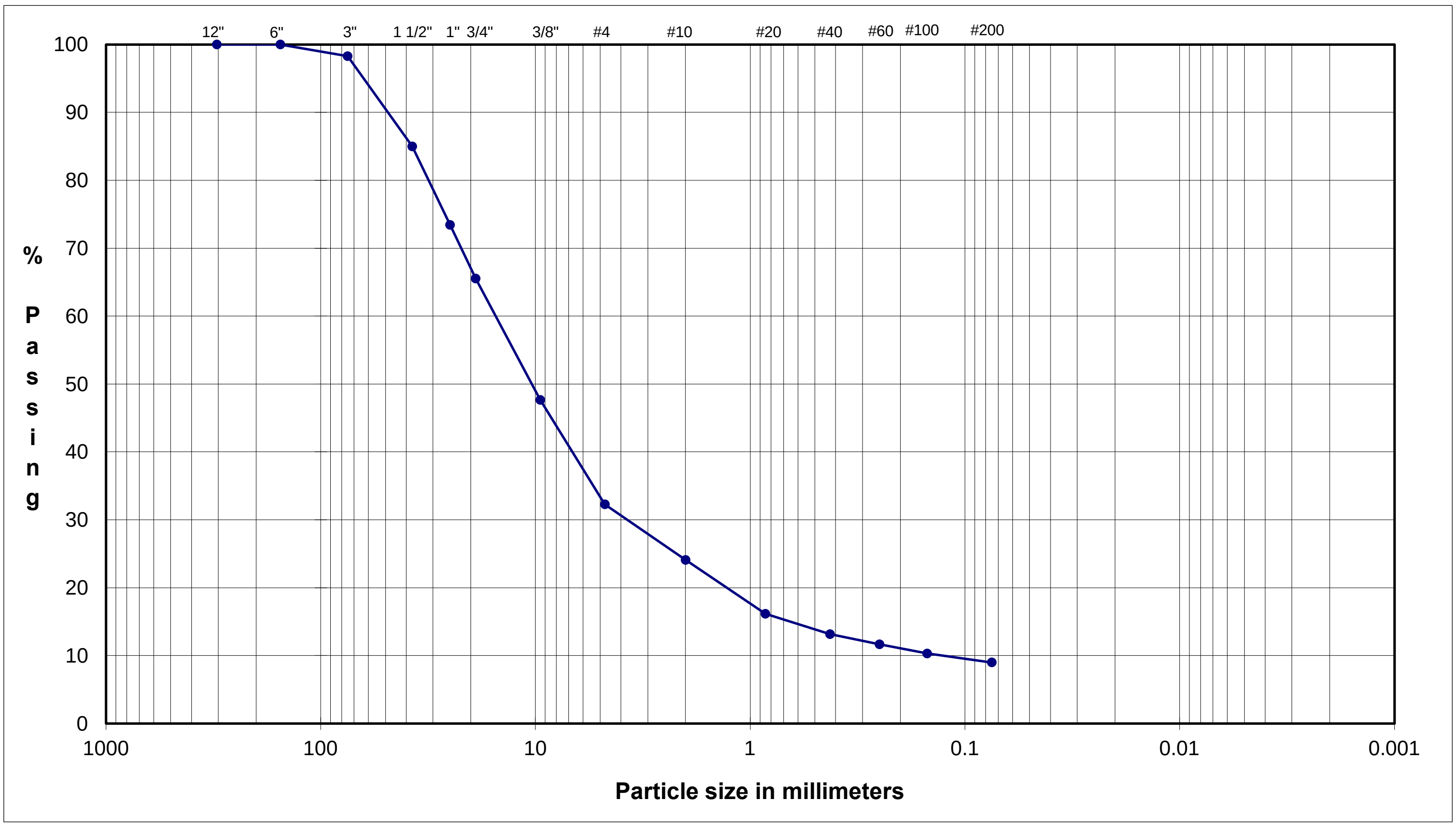
DESCRIPTION: Red clayey gravel with sand

USCS: GC

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D2487, D2488, D4318

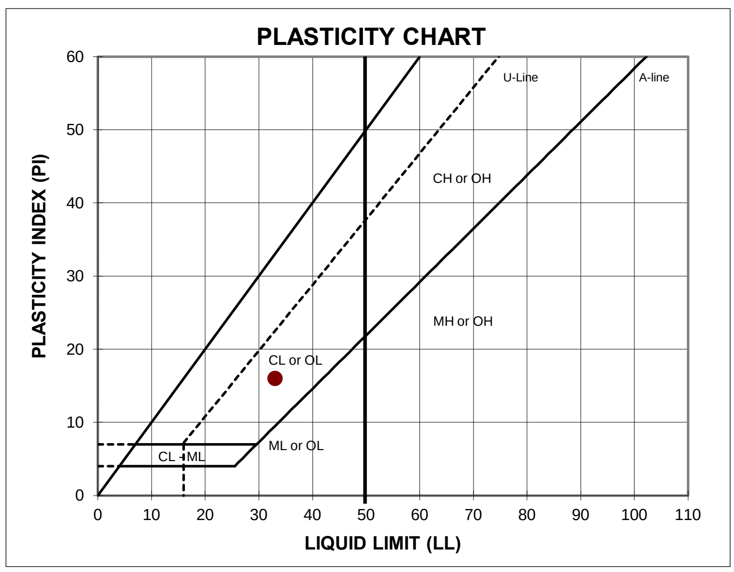
PROJECT NAME: Climax/Geotechnical Investigatio
SAMPLE ID: GA-11P-05, P05-1 Depth (ft) 3-6
TYPE: Pail



COBBLES	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay
	GRAVEL		SAND			FINES

U.S. Standard Sieves Sizes and Numbers

	Particle Size (mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	98.3	Cobbles	1.72
1.5"	37.5	85.0		
1.0"	25.0	73.4		
0.75"	19.0	65.5	Coarse Gravel	32.74
0.375"	9.5	47.7		
#4	4.8	32.3	Fine Gravel	33.24
#10	2.0	24.1	Coarse Sand	8.19
#20	0.9	16.2		
#40	0.4	13.2	Medium Sand	10.93
#60	0.3	11.7		
#100	0.2	10.3		
#200	0.1	9.0	Fine Sand	4.15
			Fines	9.01



ATTERBERG LIMITS

M_c	LL	PL	PI
8.9	33	17	16

VISUAL DESCRIPTION: Wet, strong brown poorly graded gravel with clay and sand

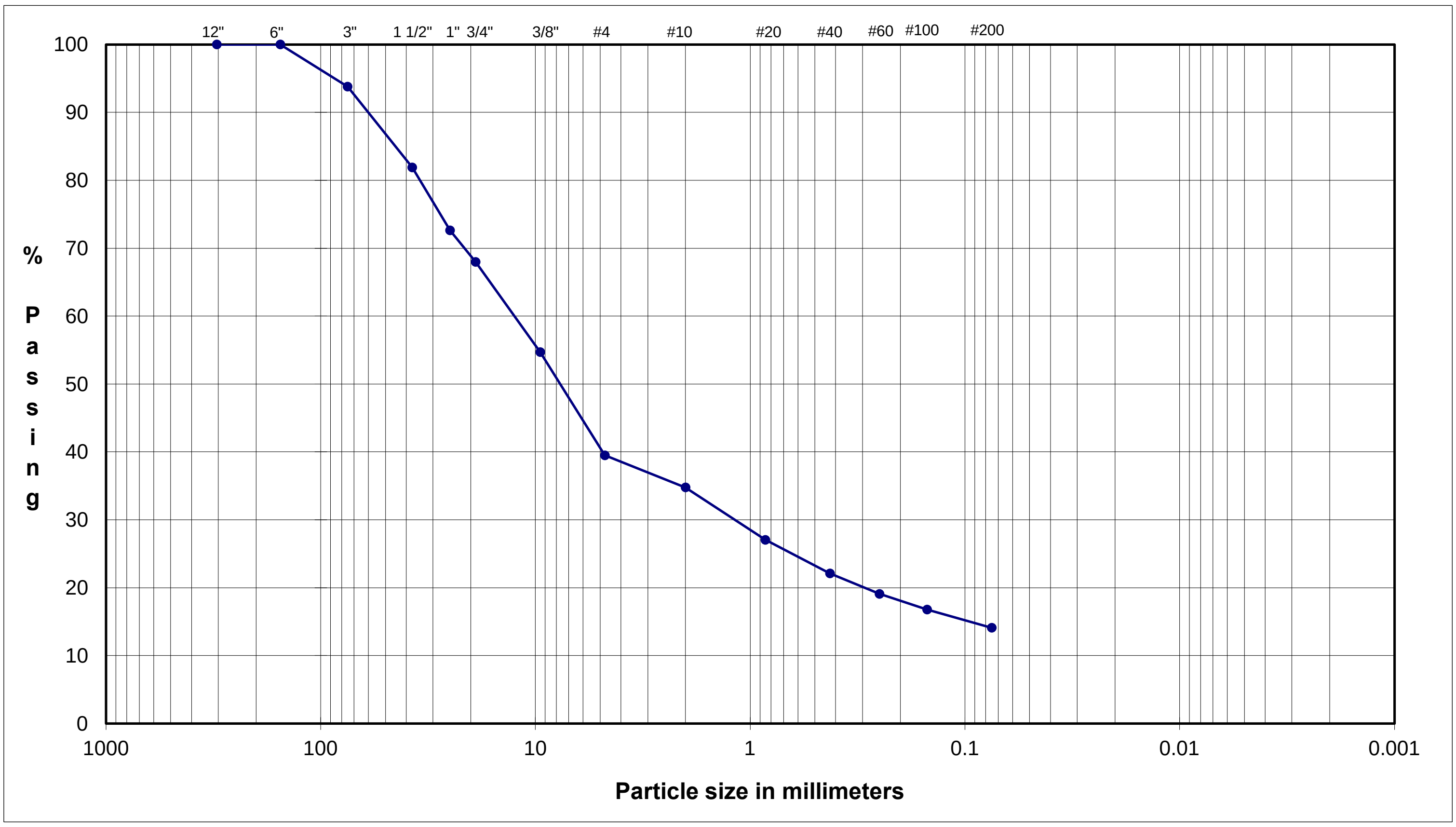
USCS: GP-GM

TECH	BTC
DATE	12/10/11
REVIEW	MB

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D2487, D2488, D4318

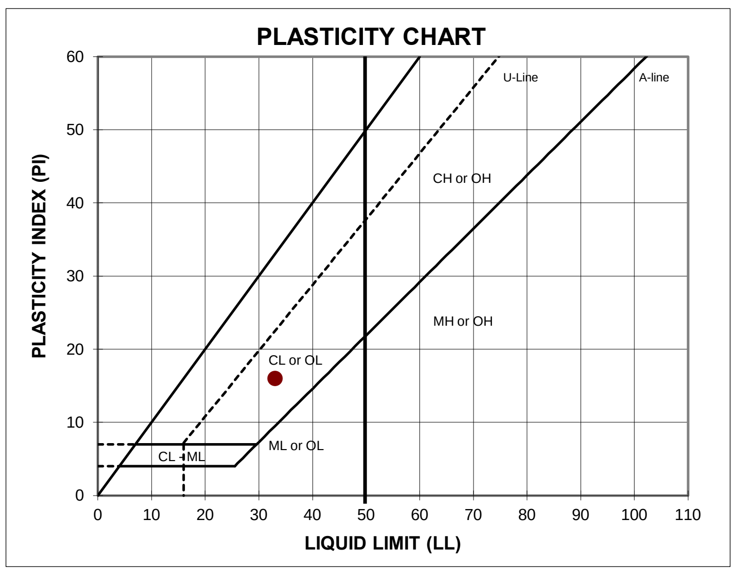
PROJECT NAME: Climax/Geotechnical Investigatio
SAMPLE ID: GA-11B-25, B25-3 Depth (ft) 16'
TYPE: Pail



COBBLES	GRAVEL: Coarse	GRAVEL: Fine	SAND: Coarse	SAND: Medium	SAND: Fine	FINES: Silt or Clay

U.S. Standard Sieves Sizes and Numbers

	Particle Size (mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	93.8	Cobbles	6.21
1.5"	37.5	81.9		
1.0"	25.0	72.6		
0.75"	19.0	68.0	Coarse Gravel	25.82
0.375"	9.5	54.7		
#4	4.8	39.5	Fine Gravel	28.48
#10	2.0	34.8	Coarse Sand	4.72
#20	0.9	27.0		
#40	0.4	22.1	Medium Sand	12.67
#60	0.3	19.1		
#100	0.2	16.8		
#200	0.1	14.1	Fine Sand	8.00
			Fines	14.11



ATTERBERG LIMITS

M_c	LL	PL	PI
6.0	28	15	13

DESCRIPTION: Moist, orange clayey gravel with sand

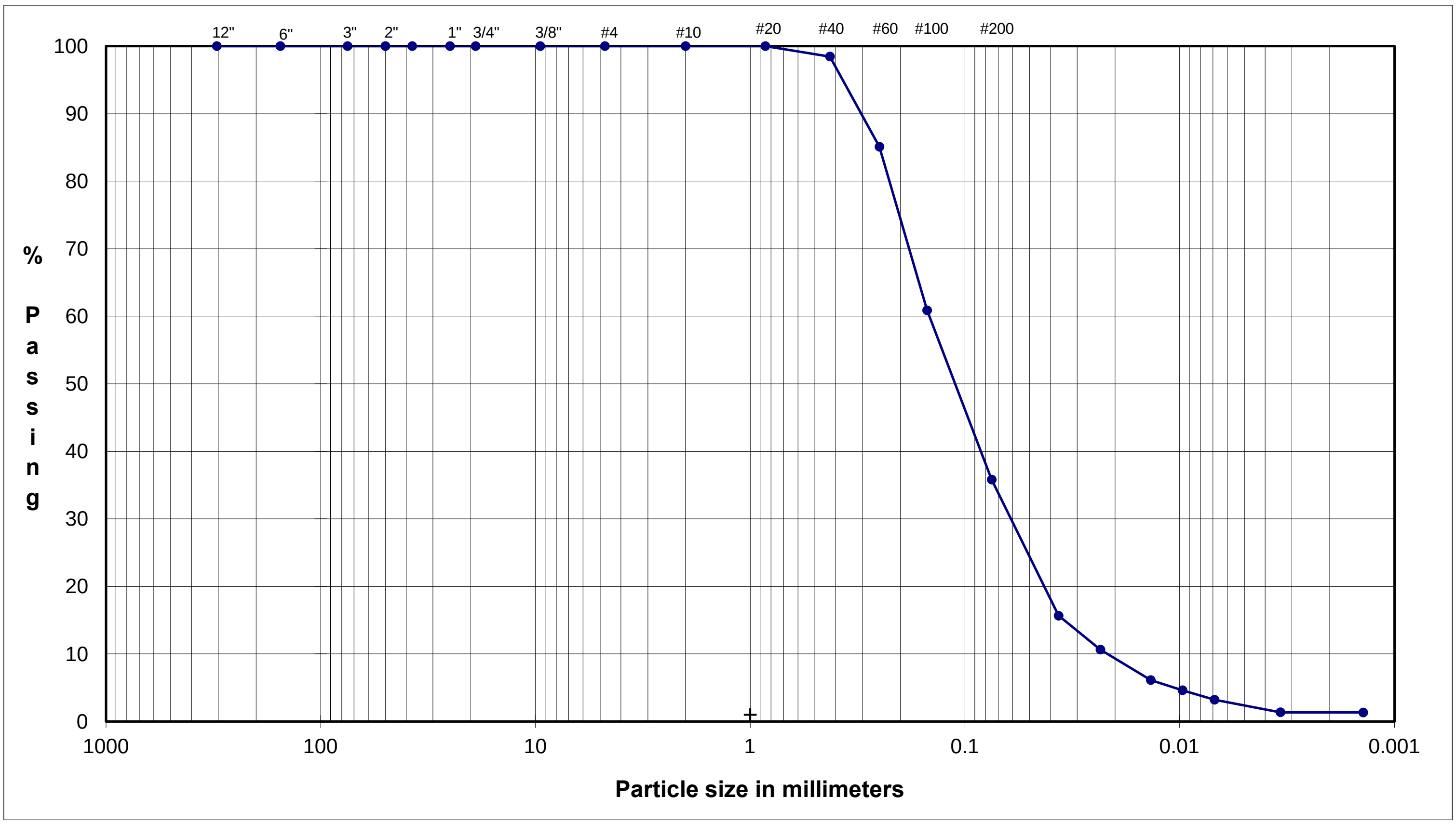
USCS: GC

TECH	BTC
DATE	12/8/11
REVIEW	MB

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-24, B24-15 Depth (ft): 91-92.5
TYPE: Bag



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

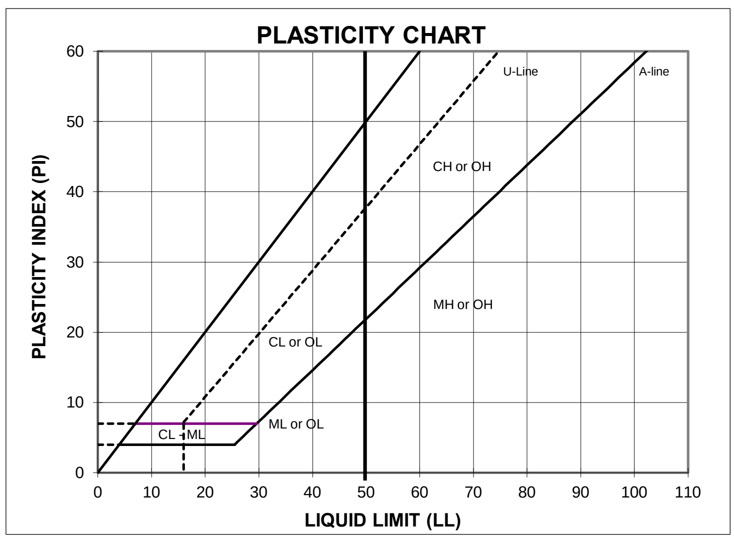
U.S. Standard Sieves Sizes and Numbers

	Particle Size (mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	100.0		
1.0"	25.0	100.0		
0.75"	19.0	100.0	Coarse Gravel	0.00
0.375"	9.5	100.0		
#4	4.8	100.0	Fine Gravel	0.00
#10	2.00	100.0	Coarse Sand	0.00
#20	0.85	100.0		
#40	0.43	98.5	Medium Sand	1.54
#60	0.25	85.1		
#100	0.15	60.9		
#200	0.075	35.8	Fine Sand	62.64

Hydrometer Analysis

(mm)	%Finer		
0.037	15.7		
0.023	10.6		
0.014	6.1	Fines	
0.010	4.6	Silt or Clay	35.82
0.007	3.2		
0.003	1.4		
0.001	1.3		

PLASTICITY CHART



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	NP	NP	NP	2.70

TECH	BTC
DATE	11/14/2011
REVIEW	MB

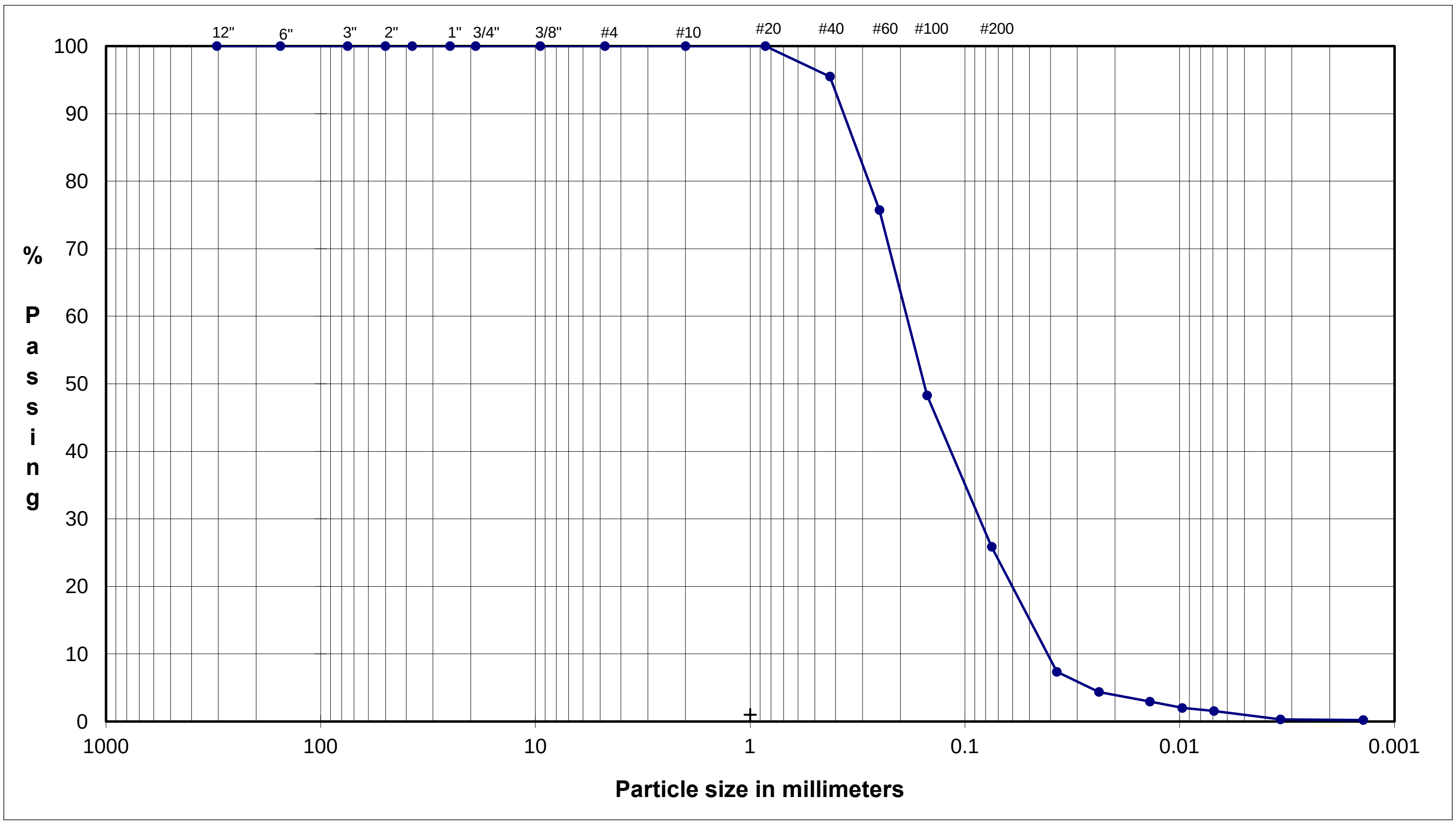
DESCRIPTION: Light yellowish brown silty sand

USCS: SM

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME:	Climax/Geotechnical Investigation
SAMPLE ID:	GA-11B-25, B25-10 — Depth (ft): 43.5-45
TYPE:	Bag



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

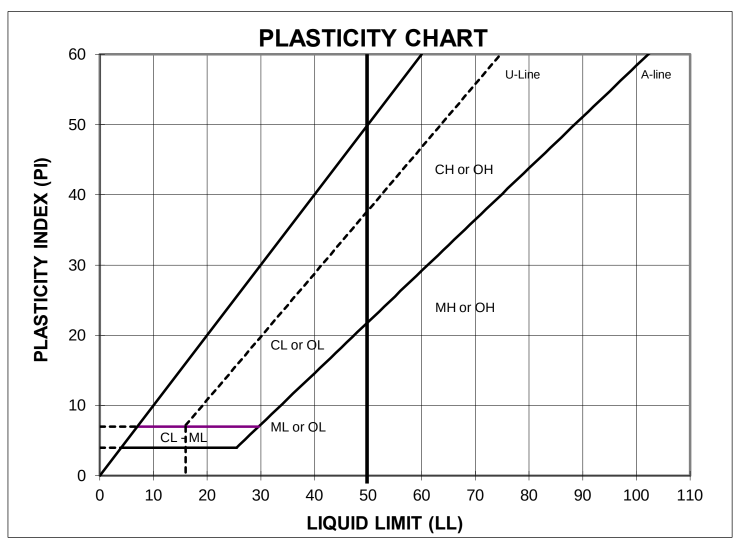
U.S. Standard Sieves Sizes and Numbers

Particle Size	(mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	100.0		
1.0"	25.0	100.0		
0.75"	19.0	100.0	Coarse Gravel	0.00
0.375"	9.5	100.0		
#4	4.8	100.0	Fine Gravel	0.00
#10	2.00	100.0	Coarse Sand	0.00
#20	0.85	100.0		
#40	0.43	95.5	Medium Sand	4.51
#60	0.25	75.7		
#100	0.15	48.3		
#200	0.075	25.9	Fine Sand	69.62

Hydrometer Analysis

(mm)	%Finer		
0.037	7.4		
0.024	4.4		
0.014	2.9		
0.010	2.0	Fines Silt or Clay	25.88
0.007	1.6		
0.003	0.3		
0.001	0.2		

PLASTICITY CHART



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	NP	NP	NP	2.70

DESCRIPTION: Gray silty sand

USCS: SM

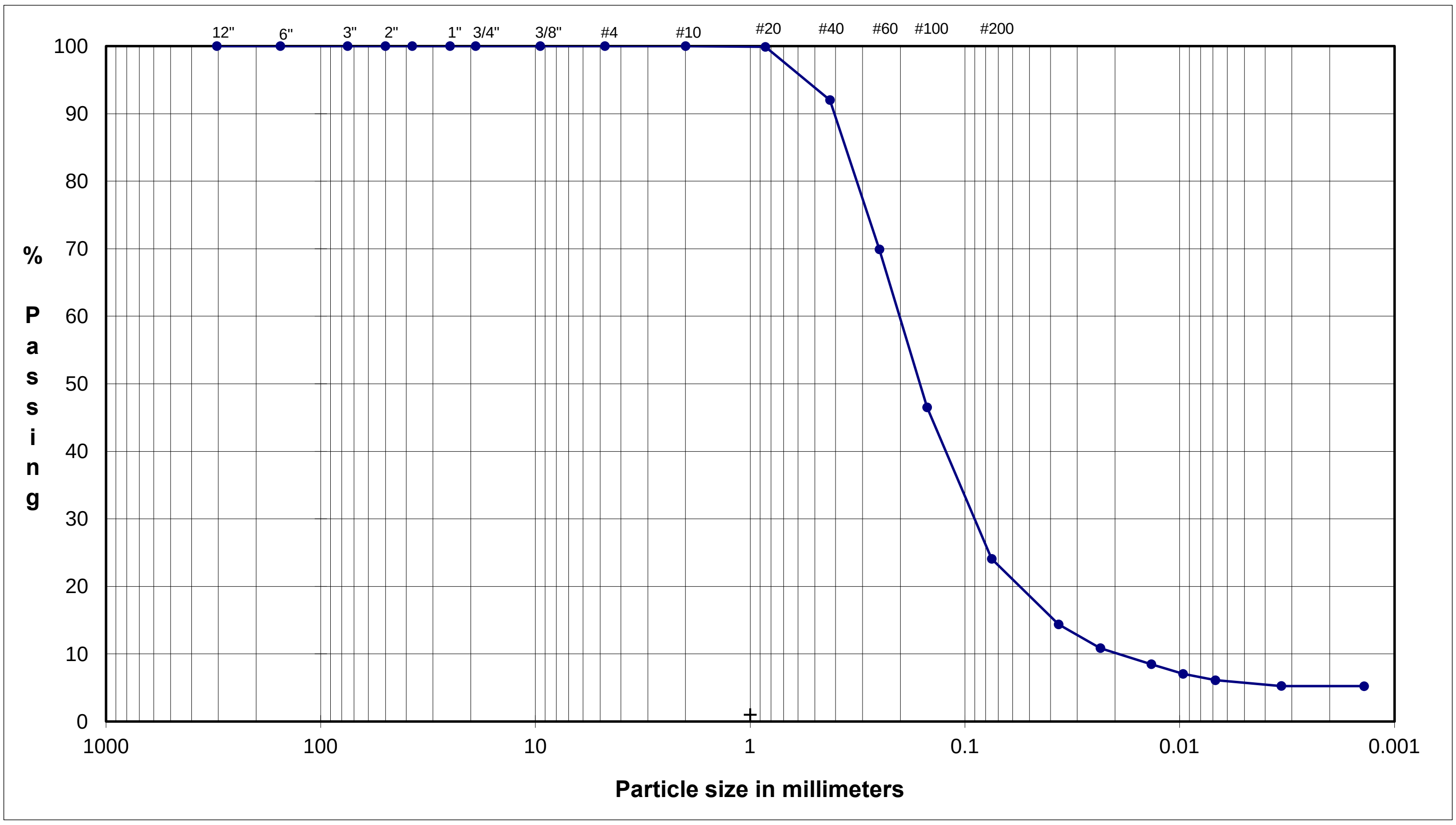
TECH	BTC
DATE	11/14/2011
REVIEW	MB

November-11 113-81608

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-25, B25-9 Depth (ft): 55
TYPE: Bag



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

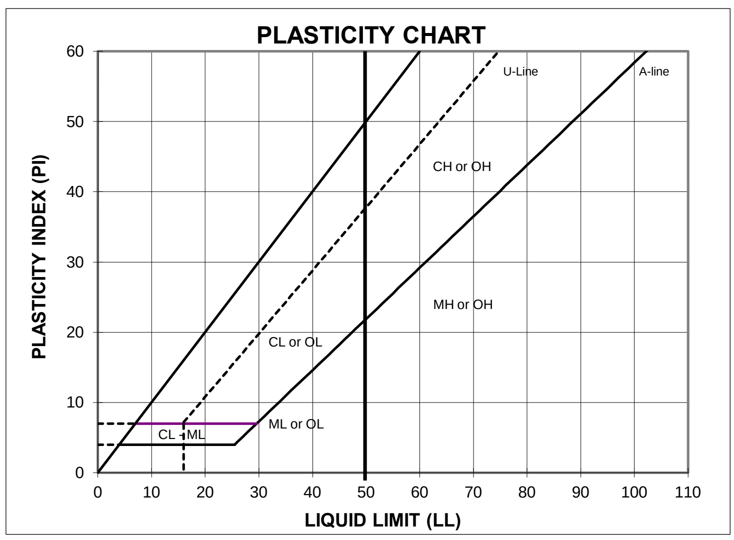
U.S. Standard Sieves Sizes and Numbers

Particle Size	(mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	100.0		
1.0"	25.0	100.0		
0.75"	19.0	100.0	Coarse Gravel	0.00
0.375"	9.5	100.0		
#4	4.8	100.0	Fine Gravel	0.00
#10	2.00	100.0	Coarse Sand	0.00
#20	0.85	99.9		
#40	0.43	92.0	Medium Sand	7.99
#60	0.25	69.9		
#100	0.15	46.5		
#200	0.075	24.1	Fine Sand	67.93

Hydrometer Analysis

(mm)	%Finer		
0.037	14.4		
0.023	10.9		
0.014	8.5		
0.010	7.1	Fines Silt or Clay	24.08
0.007	6.1		
0.003	5.3		
0.001	5.2		

PLASTICITY CHART



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
--	NP	NP	NP	2.70

DESCRIPTION: Pale yellow silty sand

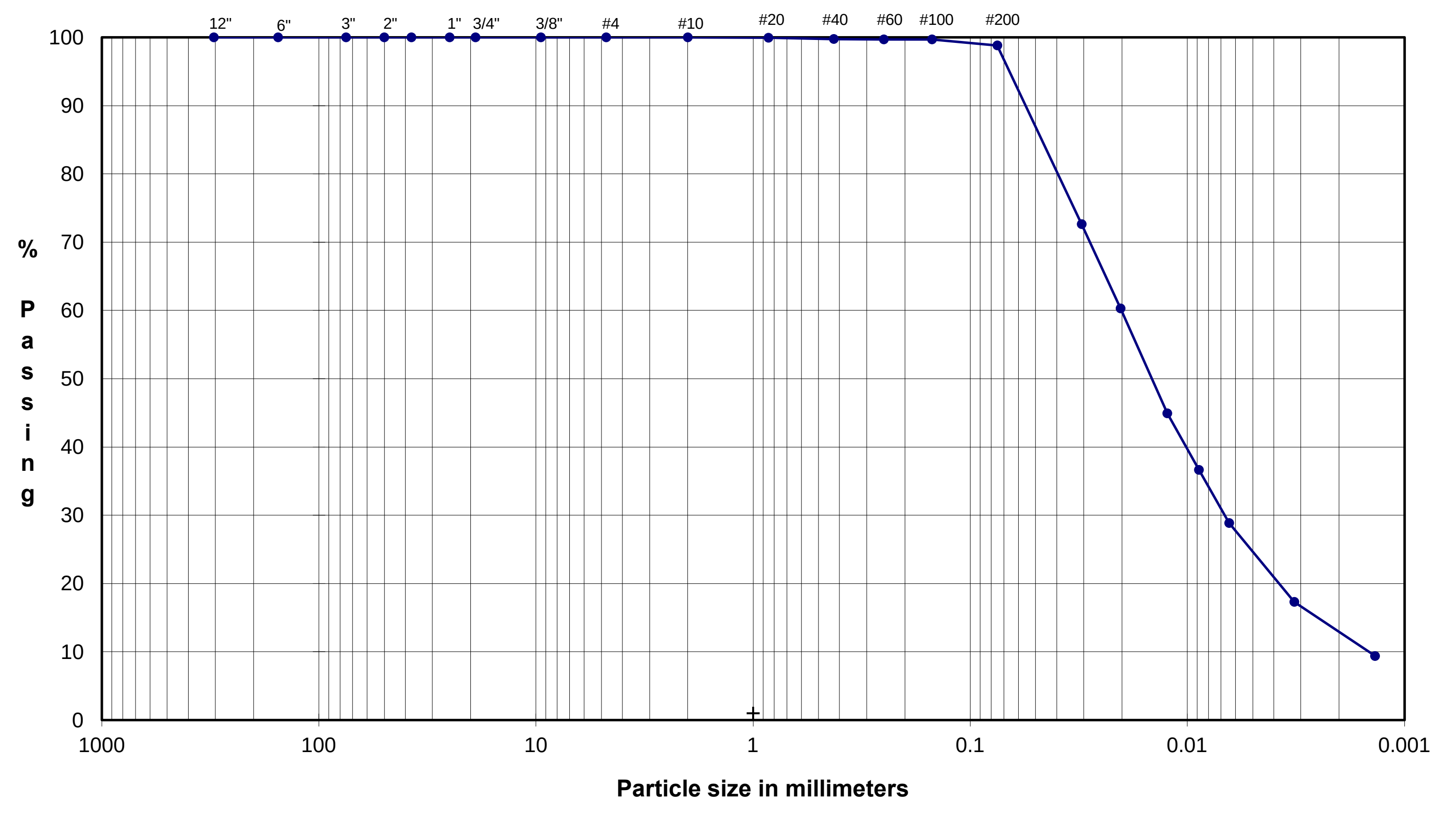
USCS: SM

TECH	BTC
DATE	11/14/2011
REVIEW	MB

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-24, B24-9 Depth (ft): 51.5-53.6
TYPE: Bag



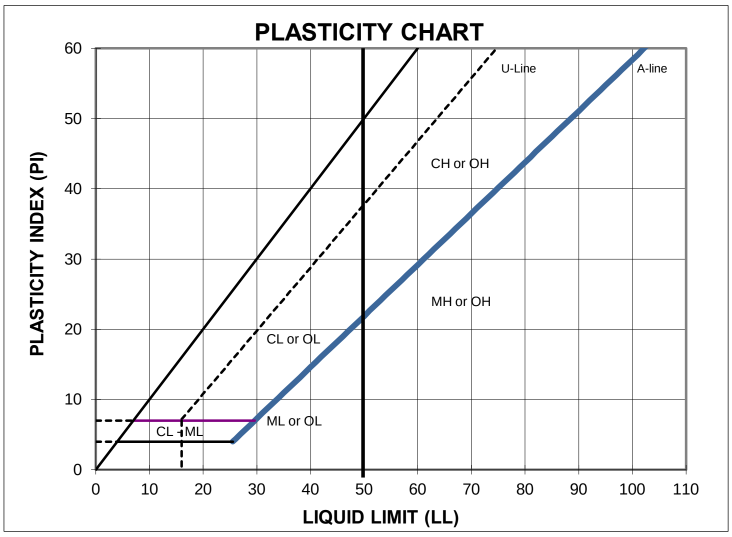
COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

U.S. Standard Sieves Sizes and Numbers

	Particle Size (mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	100.0		
1.0"	25.0	100.0		
0.75"	19.0	100.0	Coarse Gravel	0.00
0.375"	9.5	100.0		
#4	4.8	100.0	Fine Gravel	0.00
#10	2.00	100.0	Coarse Sand	0.00
#20	0.85	99.9		
#40	0.43	99.8	Medium Sand	0.24
#60	0.25	99.7		
#100	0.15	99.7		
#200	0.075	98.8	Fine Sand	0.94

Hydrometer Analysis

(mm)	%Finer		
0.031	72.6		
0.020	60.3		
0.012	44.9		
0.009	36.7	Fines Silt or Clay	98.82
0.006	28.9		
0.003	17.3		
0.001	9.4		



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
31.9	NP	NP	NP	2.70

DESCRIPTION: Light gray silt

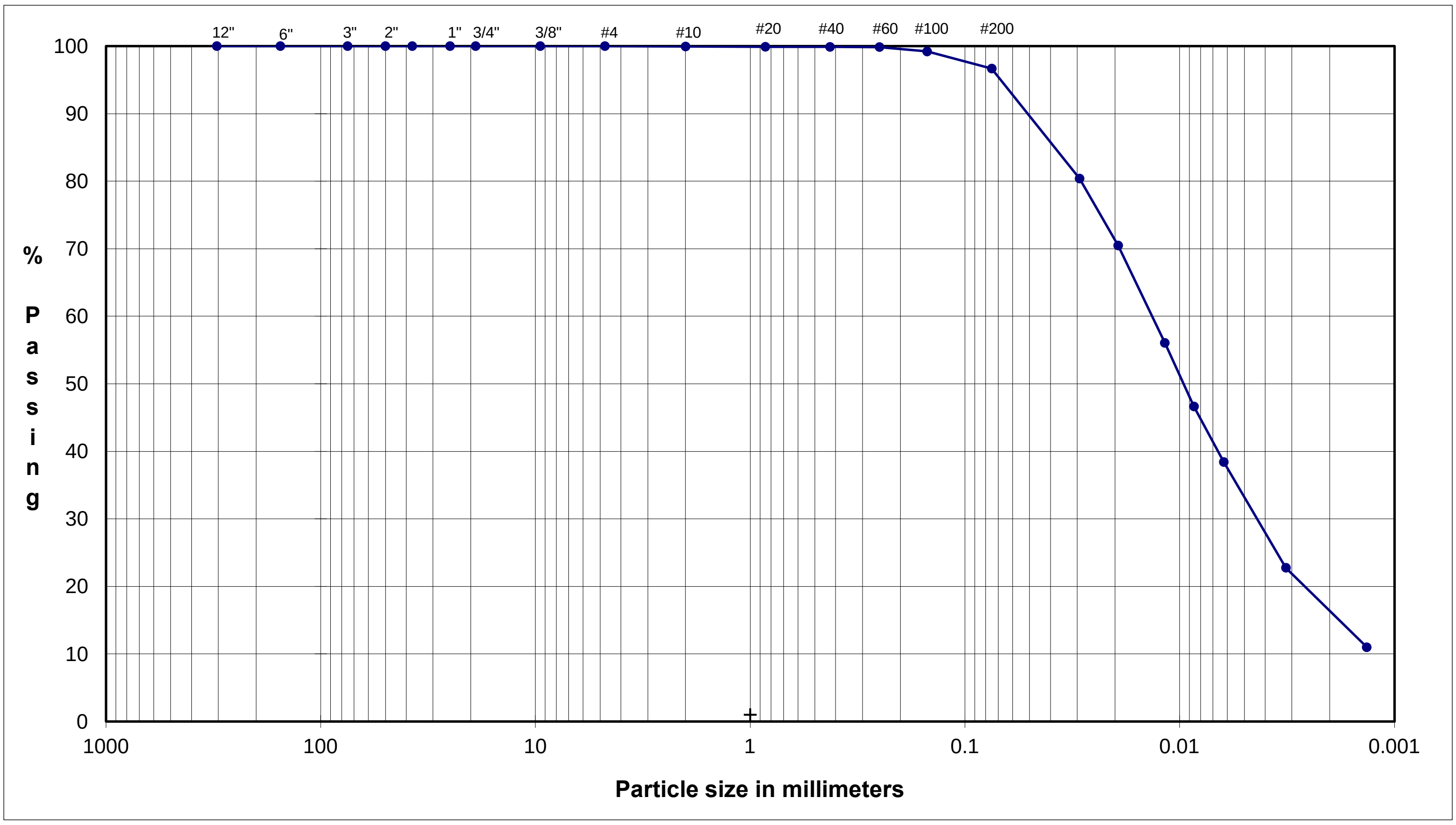
USCS: ML

TECH	JAM
DATE	12/13/2011
REVIEW	PRH

PARTICLE SIZE DISTRIBUTION & ATTERBERG LIMITS

ASTM D421, D422, D4318

PROJECT NAME: Climax/Geotechnical Investigation
SAMPLE ID: GA-11B-24, B24-13 Depth (ft): 71.0-73.2
TYPE: Post Triax



COBBLES	GRAVEL		SAND			FINES
	Coarse	Fine	Coarse	Medium	Fine	Silt or Clay

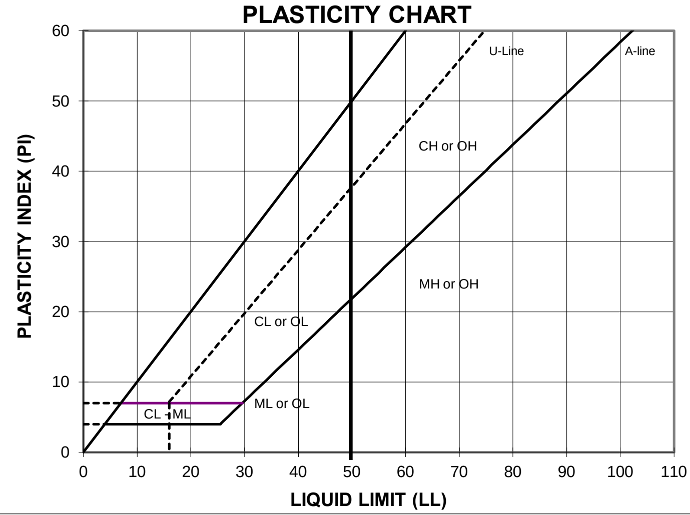
U.S. Standard Sieves Sizes and Numbers

Particle Size	(mm)	% Passing	Particle Size Classification	Percentage
12.0"	304.8	100.0		
6.0"	154.2	100.0		
3.0"	75.0	100.0	Cobbles	0.00
2.0"	50.0	100.0		
1.5"	37.5	100.0		
1.0"	25.0	100.0		
0.75"	19.0	100.0	Coarse Gravel	0.00
0.375"	9.5	100.0		
#4	4.8	100.0	Fine Gravel	0.00
#10	2.00	99.9	Coarse Sand	0.06
#20	0.85	99.9		
#40	0.43	99.9	Medium Sand	0.06
#60	0.25	99.9		
#100	0.15	99.2		
#200	0.075	96.7	Fine Sand	3.21

Hydrometer Analysis

(mm)	%Finer		
0.029	80.4		
0.019	70.5		
0.012	56.1	Fines	
0.009	46.6	Silt or Clay	96.67
0.006	38.4		
0.003	22.8		
0.001	11.0		

PLASTICITY CHART



ATTERBERG LIMITS

M_c(%)	LL	PL	PI	SpG (assumed)
30.6	NP	NP	NP	2.70

DESCRIPTION: Light gray silt.

USCS: ML

TECH	JAM
DATE	12/28/2011
REVIEW	PRH

Moisture Content and Density Summary

Soil Type	Boring/Pit Number	Sample Depth (ft)	Moisture Content		In-Situ Density	
			Delivered (%)	Natural (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
Lincoln Porphyry	GA-11B-25	178	15.0	--	--	--
Glacial Till	GA-11B-25	104-106	7.8	--	--	--
Glacial Till	GA-11B-23	249-251	6.9	--	--	--
Tailing Beach	GA-11B-25	42	--	26.9	124.2	97.8
Tailing Fines	GA-11B-24	71-73.2	--	30.6	166.7	86.0
Tailing Fines	GA-11B-23	190-192	--	25.5	125.9	100.3

MOISTURE / DRY DENSITY CURVE
ASTM D 698 Method B

Manual	Standard	Wet Method

PROJECT NAME: Climax/Geotechnical Investigation
PROJECT NUMBER: 113-81608
SAMPLE ID: GA-11B-25, B25-14 @ 104-106 (ft)
SAMPLE TYPE: Composite of GA-11B-25, B25-14 @ 104-106 & GA-11B-23, B23-16 @ 249-251

COMPACTION POINTS		
Specimen Number	Dry Density (pcf)	Moisture Content (%)
1	119.7	5.6%
2	126.6	6.8%
3	128.8	8.5%
4	128.8	10.0%
5	125.2	11.6%
6	121.0	13.5%

Maximum Dry Density (pcf)	129.5
Optimum Moisture (%)	8.7
Corrected Maximum Dry Density (pcf)	135.2
Corrected Optimum Moisture (%)	7.3
As-Received Moisture Content (%)	6.9
% Passing #4 sieve	70.6
% Passing 3/8" sieve	80.5
% Passing 3/4" sieve	88.6

DESCRIPTION: Moist, yellowish brown clayey gravel with sand and silt

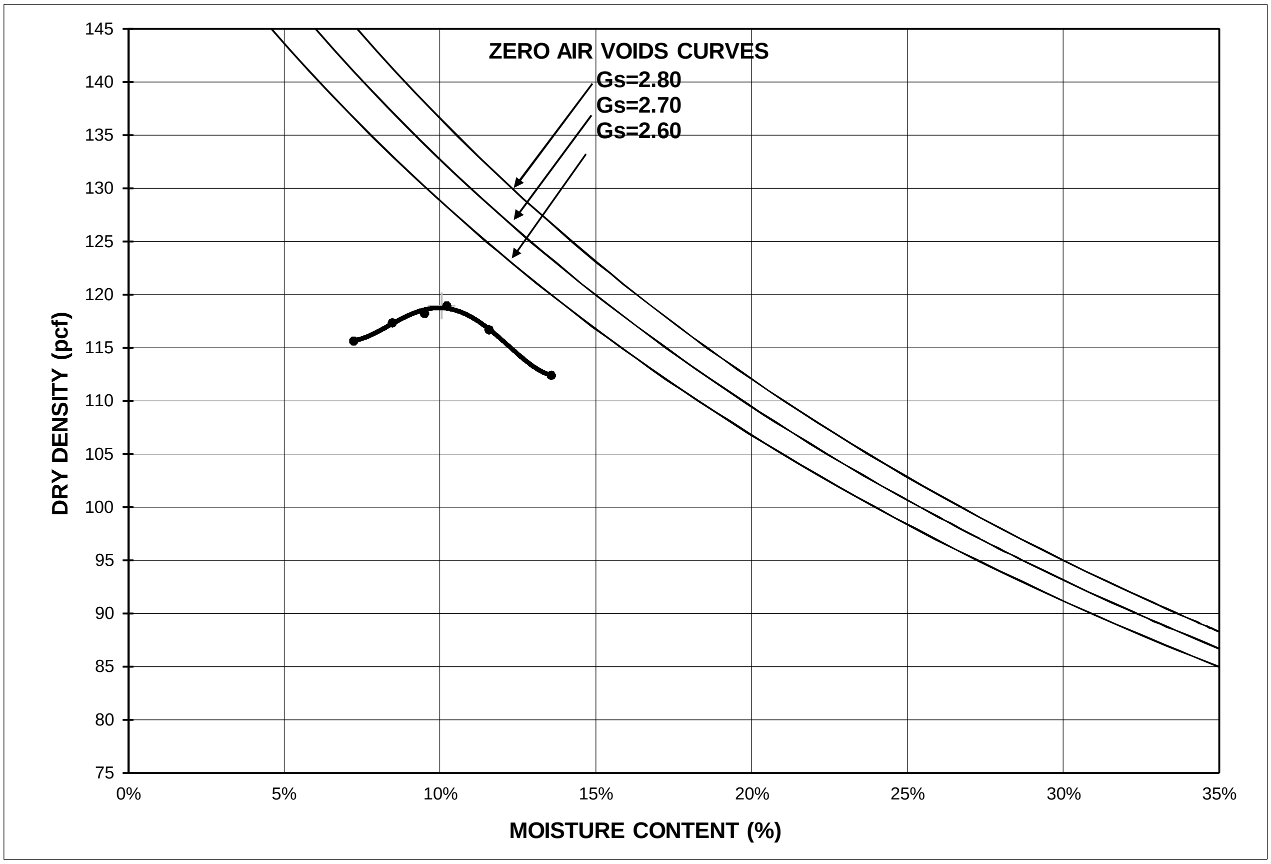
USCS: --

TECH	BTC
DATE	12-3-2011
REVIEW	MB

MOISTURE / DRY DENSITY CURVE
AASHTO T180 Method A

Manual	Modified	Wet Method

PROJECT NAME: **Climax/Geotechnical Investigation** SAMPLE TYPE: Pail, Tubes, Bags
PROJECT NUMBER: **113-81608**
SAMPLE ID: **Comp**



COMPACTION POINTS		
Specimen Number	Dry Density (pcf)	Moisture Content (%)
1	115.7	7.2%
2	117.4	8.5%
3	118.2	9.5%
4	119.0	10.2%
5	116.7	11.6%
6	112.4	13.6%

Maximum Dry Density (pcf)	**119.0**
Optimum Moisture (%)	**10.1**
Corrected Maximum Dry Density (pcf)	--
Corrected Optimum Moisture (%)	--
As-Received Moisture Content (%)	**7.4**
% Passing #4 sieve	**100.0**
% Passing 3/8" sieve	**100.0**
% Passing 3/4" sieve	**100.0**

DESCRIPTION Moist, light yellowish brown sandy SILT

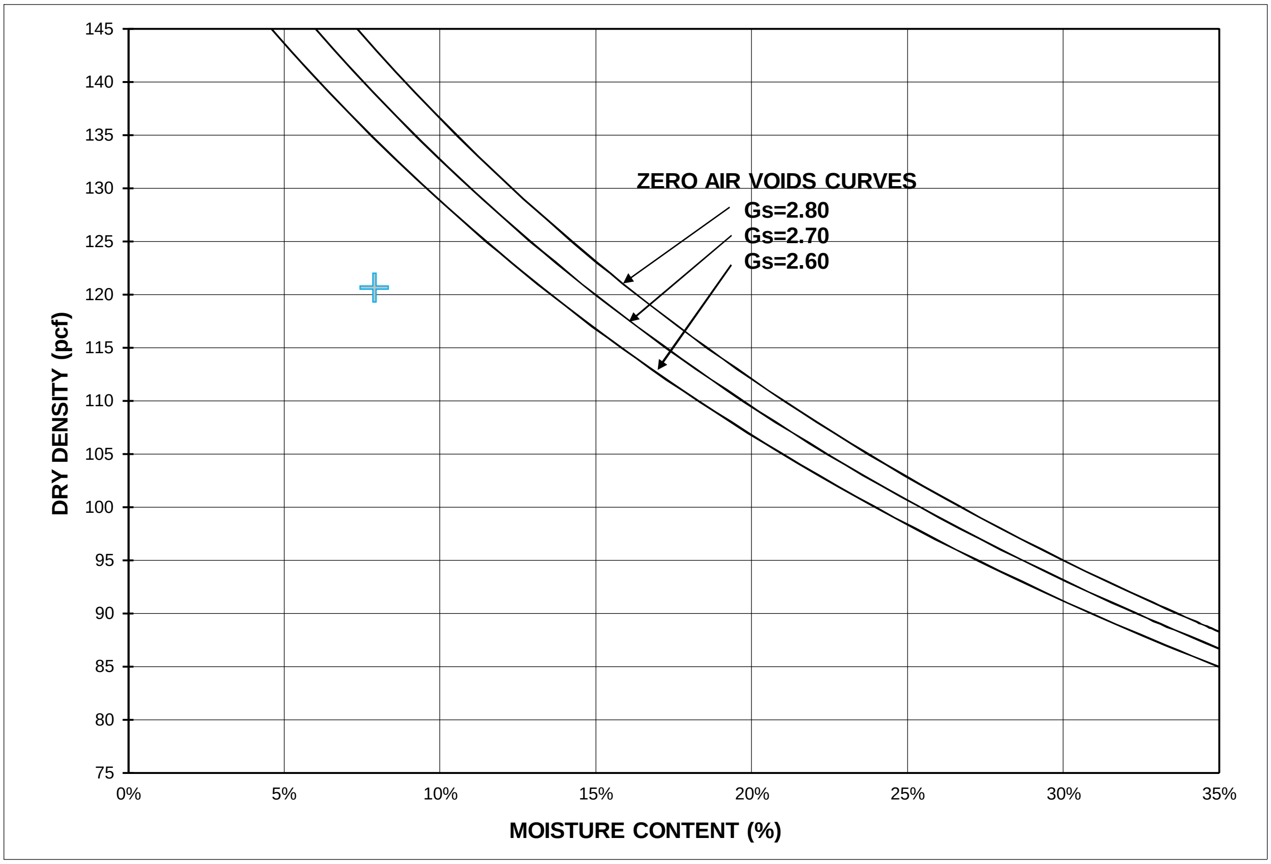
USCS --

TECH	BTC
DATE	12-10-2011
REVIEW	MB

MOISTURE / DRY DENSITY CURVE
Non ASTM Non ASSHTP Method A

Mechanical	Modified	Wet Method

PROJECT NAME: **Climax/Geotechnical Investigation**
PROJECT NUMBER: **113-81608**
SAMPLE ID: **Comp (Point to Oblivion)** DEPTH: -- SAMPLE TYPE: **Pail**



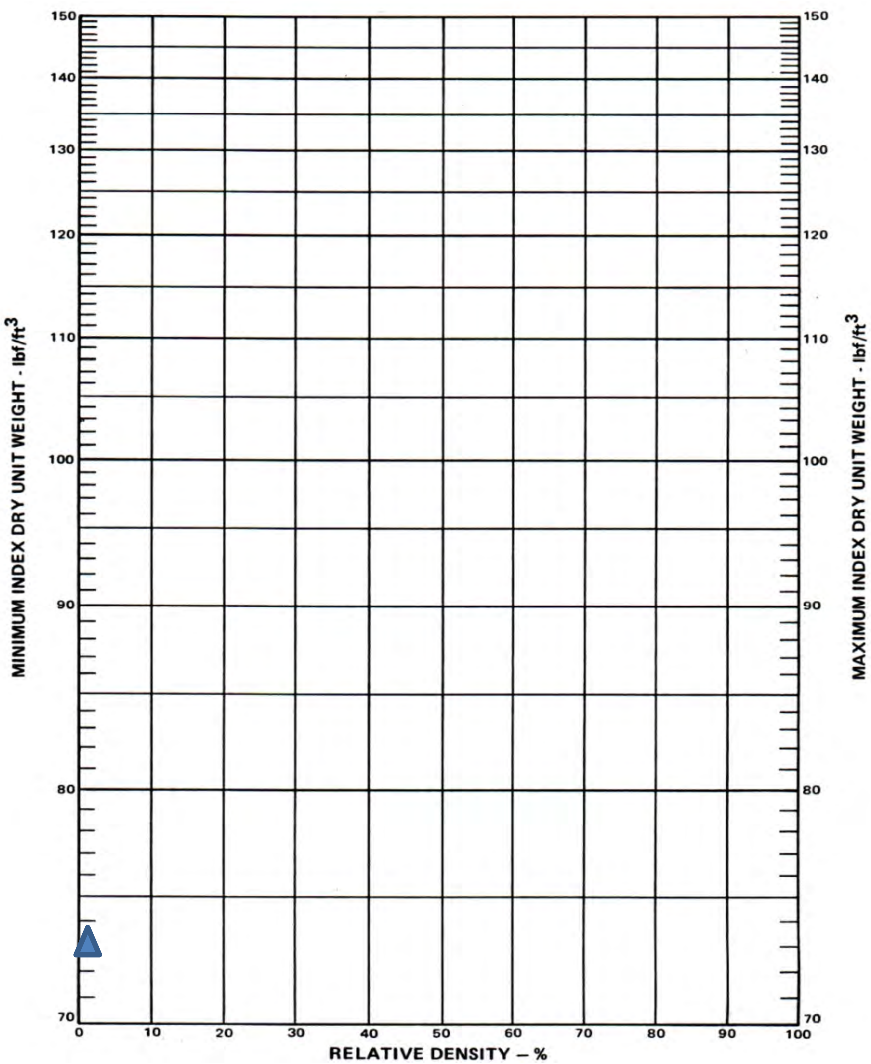
COMPACTION POINTS		
Specimen Number	Dry Density (pcf)	Moisture Content (%)
1	120.7	7.9%

Dry Density (pcf)	**120.7**
Moisture (%)	**7.9**
Corrected Dry Density (pcf)	--
Corrected Moisture (%)	--
As-Received Moisture Content	--
% Passing #4 sieve	**1.0**
% Passing 3/8" sieve	**1.0**
% Passing 3/4" sieve	**1.0**

DESCRIPTION Moist, light yellowish brown sandy SILT

USCS --

TECH	BTC
DATE	2-16-2012
REVIEW	MB



Minimum Index Dry Unit Weight (ASTM D 4254): 73.1 lb/ft^3

Maximum Index Dry Unit Weight (ASTM D 4253): -- lb/ft^3

`

Golder Associates, Inc. Denver, Colorado			**Title:** RELATIVE DENSITY TEST ASTM D4253 (Method B) and D4254		
Job Short Title: Climax/Geotechnical Investigation					
Sample No. Comp	Depth --	Reviewed: MB	**Date:** 12/2/2011	**Job Number:** 113-81051	**Figure:** 1

JAR SLAKE TEST

Kentucky Method 64-514-08
Revised 2/26/08
Supersedes KM 64-514-02
DATED 11/15/02

PROJECT TITLE	**CLIMAX/GEOTECHNICAL INVESTIGATION/CO**
PROJECT NUMBER	**113-81608**
SAMPLE ID	**B25-3/23-3**
SAMPLE DEPTH	-

SPECIMEN ID	1	2	3
APPROX. AMOUNT OF DRIED SPECIMEN (grams)	72.47	89.32	78.21
OBSERVATION SCHEDULE START TIME	9:32 a.m.	9:32 a.m.	9:32 a.m.
TEST FLUID	DISTILLED WATER	DISTILLED WATER	DISTILLED WATER
	JAR SLAKE INDEX*		
1/2 HOUR	6	6	6
1 HOUR	6	6	6
24 HOURS	6	6	6

***JAR SLAKE Category**		**Behavior**
1	-	Degrades to a pile of flakes or mud (Complete Breakdown).
2	-	Break rapidly and/or forms many chips.
3	-	Break slowly and/or forms many chips.
4	-	Break rapidly and/or develops several fractures.
5	-	Break slowly and/or develops few fractures.
6	-	No change.

NOTE: *Three (3) specimen was selected from sample received, selecting material different in appearance.*

TECH:	AK
DATE:	1/18/12
CHECKED BY:	AK
REVIEWED BY:	DA

JANUARY 2012 113-81608

JAR SLAKE TEST

Kentucky Method 64-514-08
Revised 2/26/08
Supersedes KM 64-514-02
DATED 11/15/02

PROJECT TITLE	**CLIMAX/GEOTECHNICAL INVESTIGATION/CO**
PROJECT NUMBER	**113-81608**
SAMPLE ID	**PO5-1 A**
SAMPLE DEPTH	**-**

SPECIMEN ID	**1**	**2**	**3**
APPROX. AMOUNT OF DRIED SPECIMEN (grams)	72.79	81.01	76.81
OBSERVATION SCHEDULE START TIME	9:33 a.m.	9:33 a.m.	9:33 a.m.
TEST FLUID	DISTILLED WATER	DISTILLED WATER	DISTILLED WATER
	JAR SLAKE INDEX*		
1/2 HOUR	**6**	**6**	**6**
1 HOUR	**6**	**6**	**6**
24 HOURS	**6**	**6**	**6**

***JAR SLAKE Category**		**Behavior**
1	-	Degrades to a pile of flakes or mud (Complete Breakdown).
2	-	Break rapidly and/or forms many chips.
3	-	Break slowly and/or forms many chips.
4	-	Break rapidly and/or develops several fractures.
5	-	Break slowly and/or develops few fractures.
6	-	No change.

NOTE: *Three (3) specimen was selected from sample received, selecting material different in appearance.*

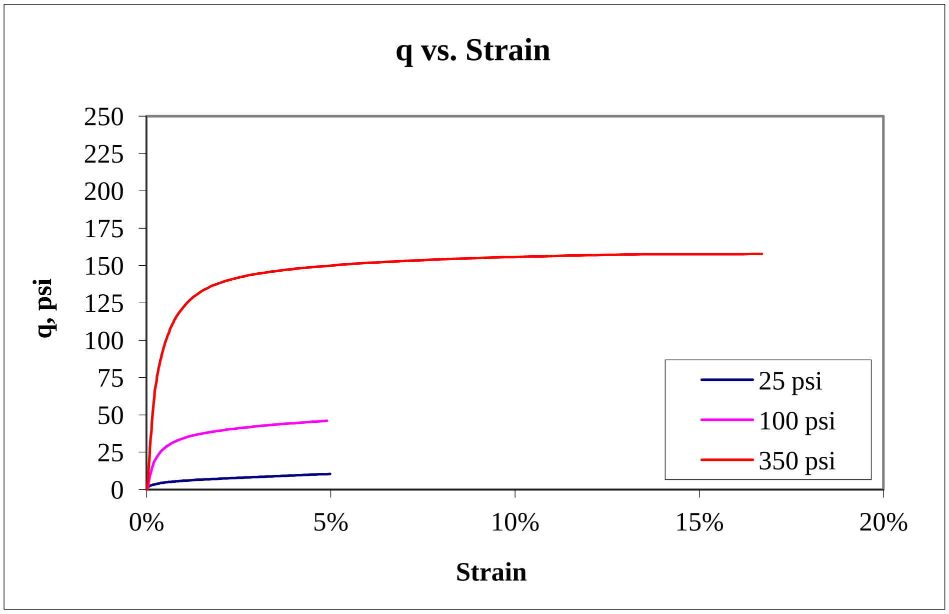
TECH:	AK
DATE:	1/18/12
CHECKED BY:	AK
REVIEWED BY:	JA

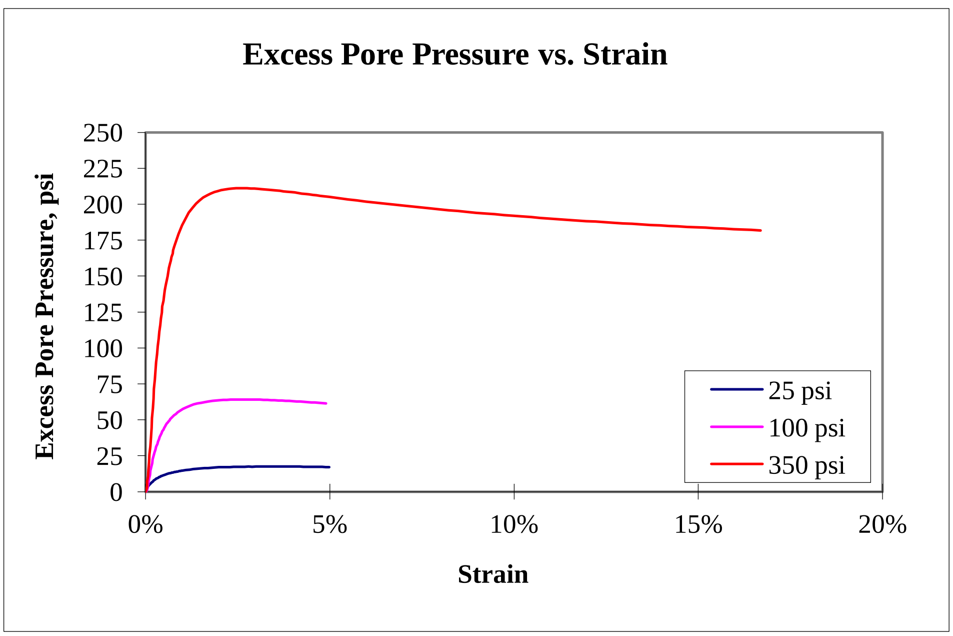
ATTACHMENT 2
ENGINEERING TEST RESULTS

	Point 1		Point 2		Point 3	
Boring # =	GA-11B-21		GA-11B-21		GA-11B-21	
Sample # =	Sonic Core		Sonic Core		Sonic Core	
Depth (ft) =	28		28		28	
Point # =	1		2		3	
	Initial		**Initial**		**Initial**	
Length =	20.80	cm	20.80	cm	20.80	cm
Diameter =	10.21	cm	10.21	cm	10.21	cm
Wet Weight =	3702.90	g	3702.90	g	3702.90	g
Area =	81.9	cm^2	81.9	cm^2	81.9	cm^2
Sample Area =	12.69	in^2	12.69	in^2	12.69	in^2
Volume =	1702.9	cm^3	1702.9	cm^3	1702.9	cm^3
Moisture Content =	13.9%		13.9%		13.9%	
Specific Gravity =	-		-		-	
Dry Weight of Solids =	3251.01	g	3251.01	g	3251.01	g
Wet Density =	2.17	g/cm^3	2.17	g/cm^3	2.17	g/cm^3
Dry Density =	1.91	g/cm^3	1.91	g/cm^3	1.91	g/cm^3
Wet Unit Weight =	135.7	pcf	135.7	pcf	135.7	pcf
Dry Unit Weight =	119.1	pcf	119.1	pcf	119.1	pcf
Cell Pressure =	75	psi	150	psi	400	psi
Back Pressure =	50	psi	50	psi	50	psi
Confining Pressure =	25	psi	100	psi	350	psi

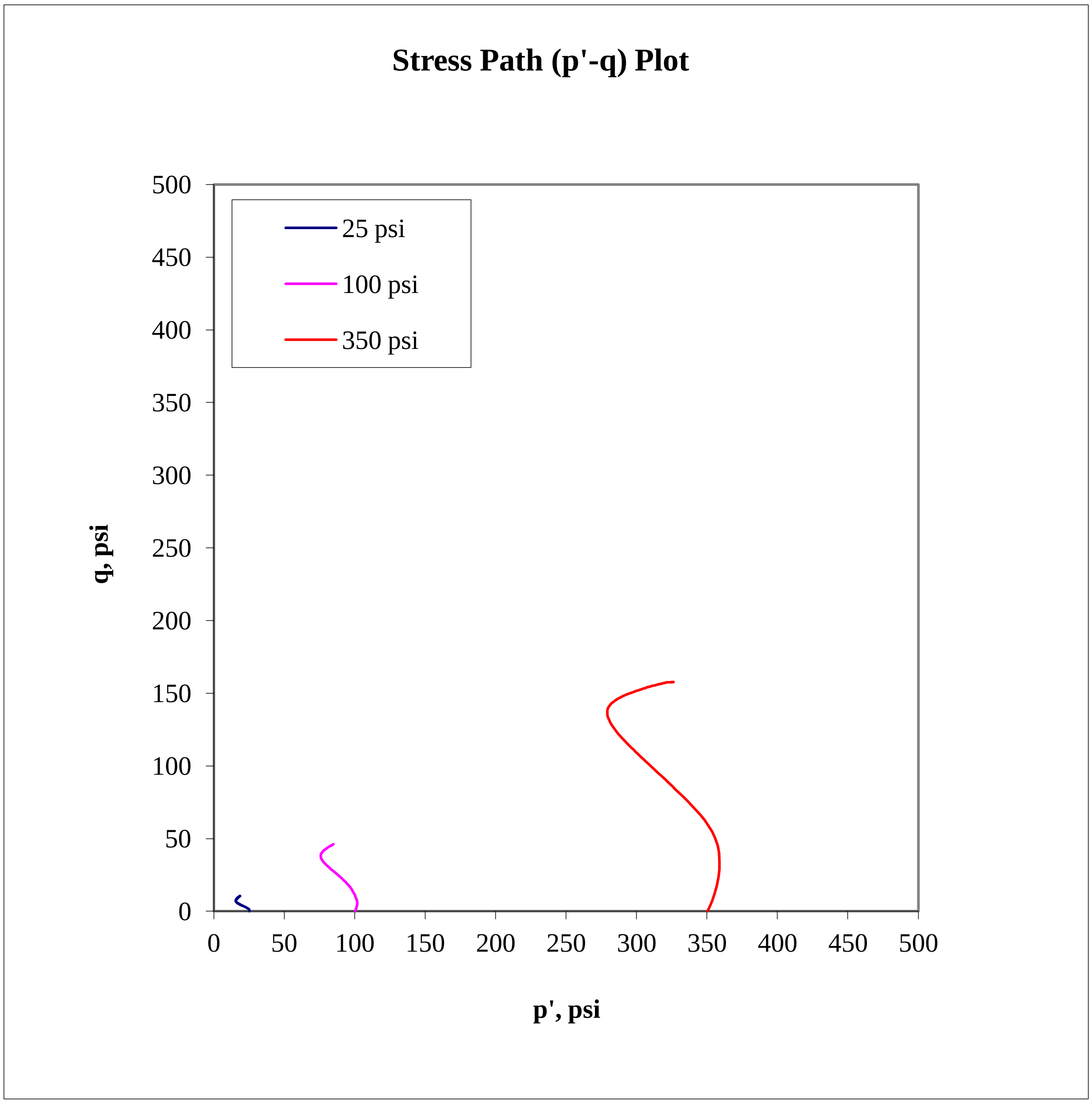
Notes:
Test was a multi-stage test.
Shear rate was 0.001 to 0.002 in./min. t_{50} was 10.2 min.
Sample was intact with ends trimmed flush.
Moisture content was taken from trimmings.
Peak was defined at the maximum principal stress ratio.

Golder Associates Inc. Denver, Colorado	**Title:** TRIAXIAL SHEAR TEST REPORT SAMPLE DATA AND CALCULATIONS			
Job Short Title: CLIMAX/GEOTECHNICAL INVESTIGATION				
Sample Number: GA-11B-21 Sonic Core @ 28'	**Reviewed:** JEO	**Date:** 12/10/2011	**Job Number:** 113-81608	**Figure:** 1

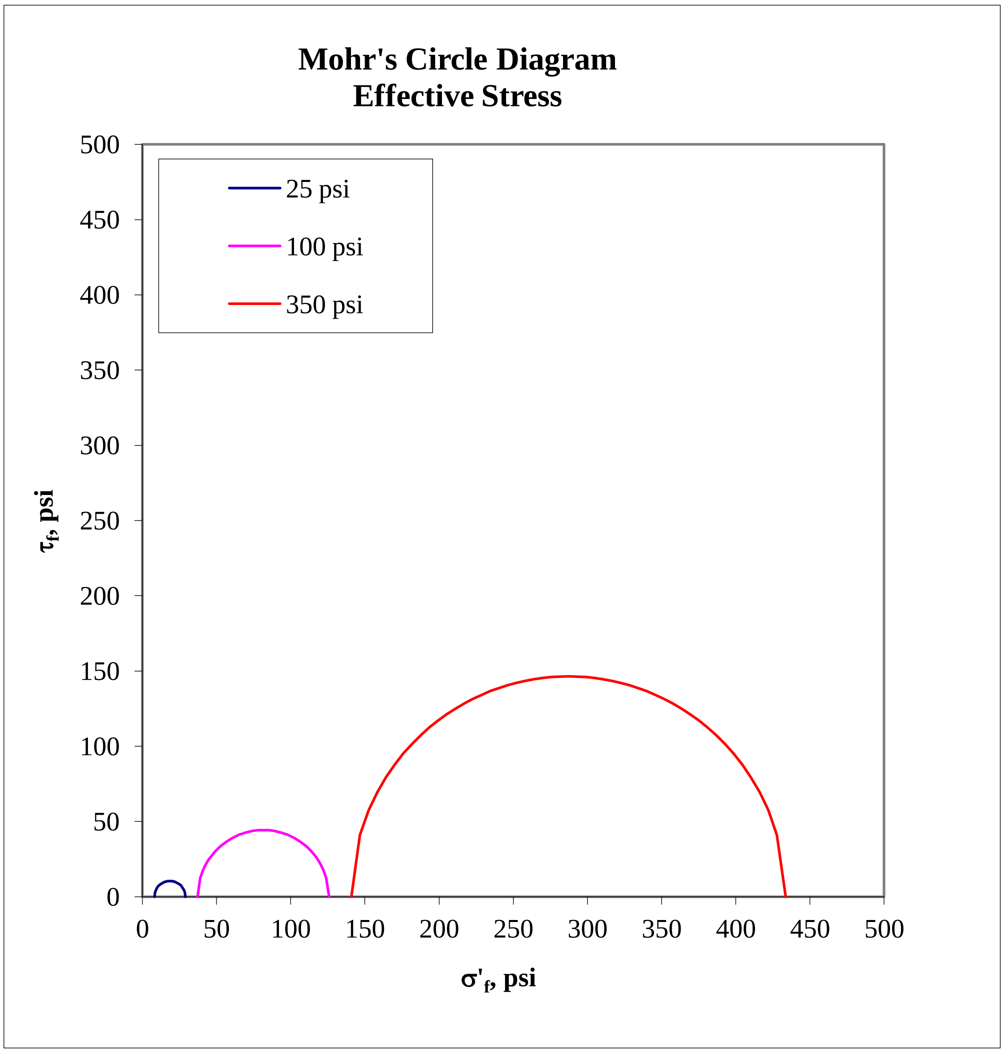




Golder Associates Inc. **Denver, Colorado**	**Title:** **C-U TRIAXIAL SHEAR DATA** **q AND EXCESS PORE PRESSURE PLOTS**			
Job Short Title: **CLIMAX/GEOTECHNICAL INVESTIGATION**				
Sample Number: **GA-11B-21 Sonic Core @ 28'**	**Reviewed:** **JEO**	**Date:** **12/10/2011**	**Job Number:** **113-81608**	**Figure:** **2**



Golder Associates Inc. Denver, Colorado	Title: C-U TRIAXIAL SHEAR DATA STRESS PATH PLOT			
Job Short Title: CLIMAX/GEOTECHNICAL INVESTIGATION				
Sample Number: GA-11B-21 Sonic Core @ 28'	Reviewed: JEO	Date: 12/10/2011	Job Number: 113-81608	Figure: 3



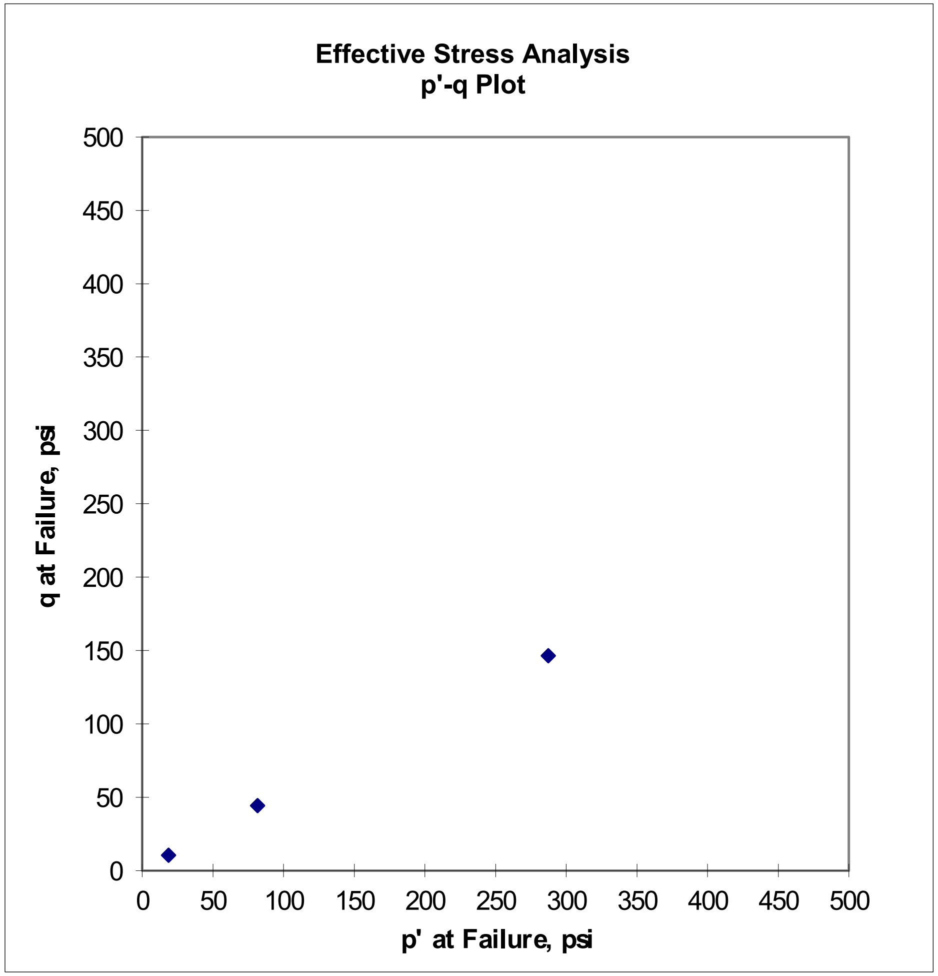
Golder Associates Inc. Denver, Colorado		Title: C-U TRIAXIAL SHEAR DATA MOHR'S CIRCLE DIAGRAM		
Job Short Title: CLIMAX/GEOTECHNICAL INVESTIGATION				
Sample Number: GA-11B-21 Sonic Core @ 28'	Reviewed: JEO	Date: 12/10/2011	Job Number: 113-81608	Figure: 4

Consolidated-Undrained Triaxial Lab Data
From: GOLDER ASSOCIATES INC.
Project: **CLIMAX/GEOTECHNICAL INVESTIGATION**
Project Number: **113-81608**

Sample Number GA-11B-21 Sonic Core @ 28'

Effective Stress Analysis

Point Number	p' (psi)	q (psi)
1	18.5	10.5
2	81.5	44.3
3	287.2	146.4

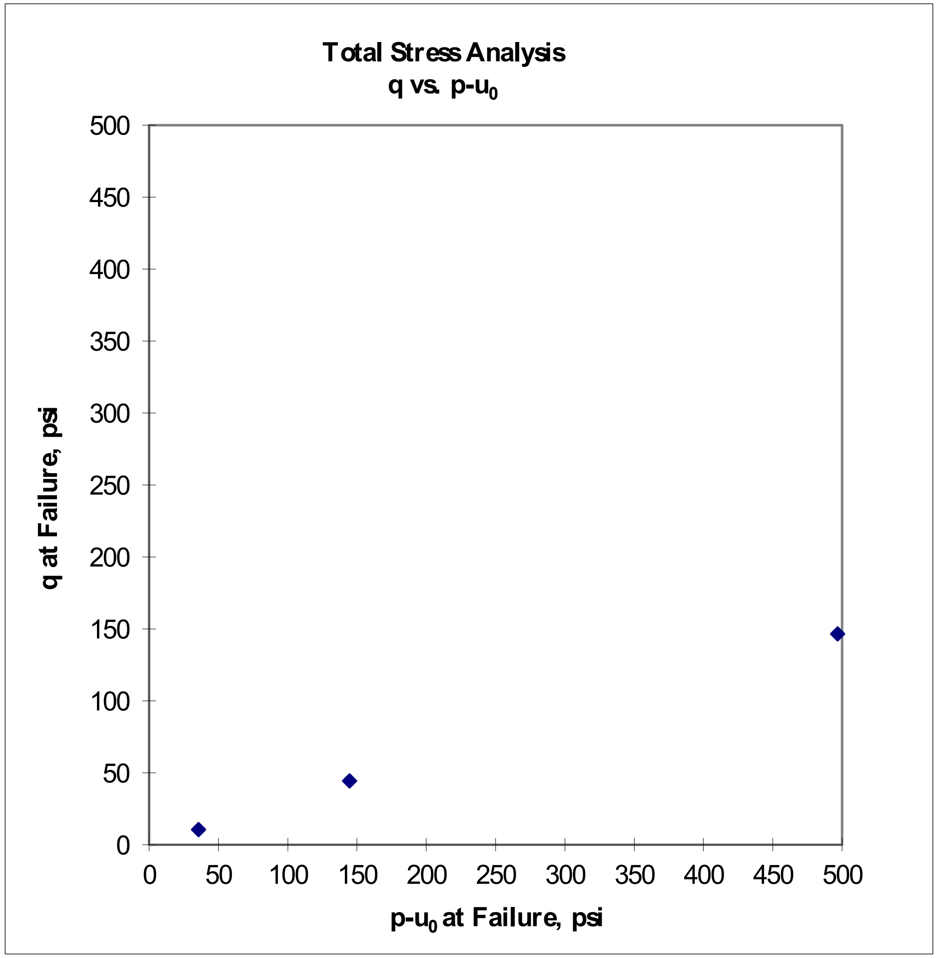


Consolidated-Undrained Triaxial Lab Data
From: GOLDER ASSOCIATES INC.
Project: **CLIMAX/GEOTECHNICAL INVESTIGATION**
Project Number: **113-81608**

Sample Number GA-11B-21 Sonic Core @ 28'

Total Stress Analysis

Point Number	$p-u_o$ (psi)	q (psi)
1	35.7	10.5
2	144.7	44.3
3	496.8	146.4



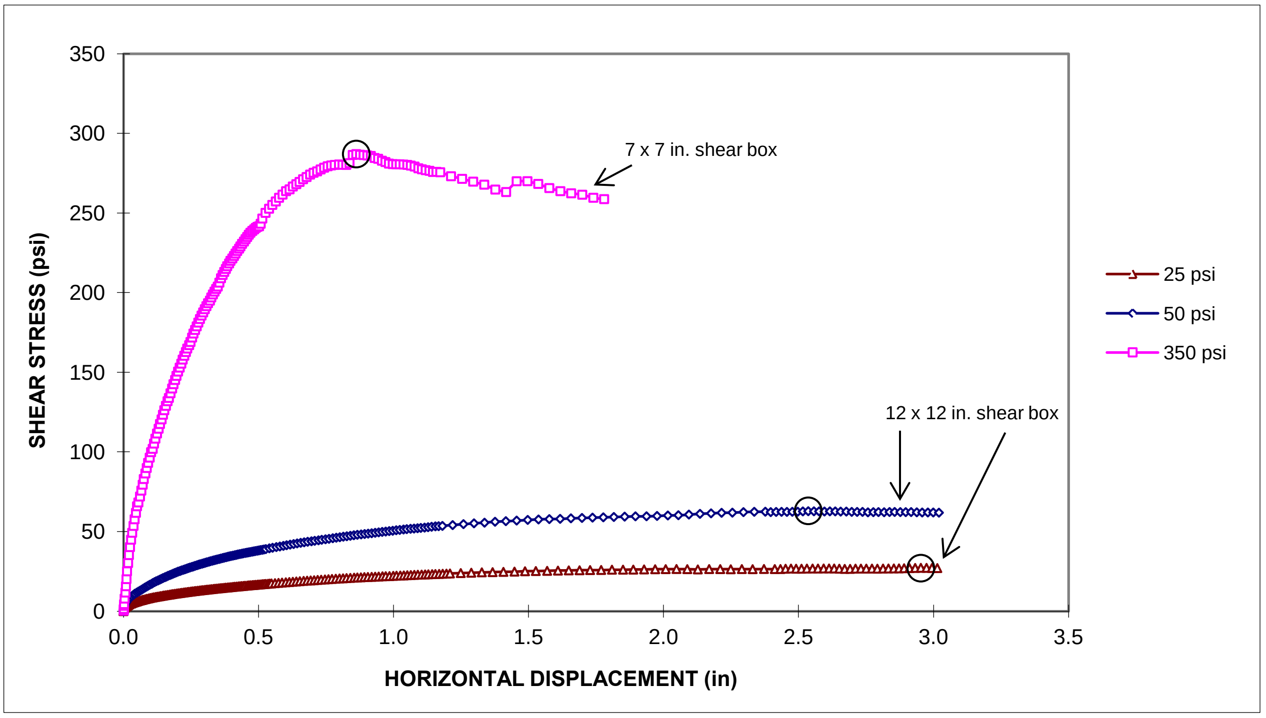

LINEAR METRIC UNITS AND SYMBOLS
1000 millimeters (mm) 1 meter (m)
To read length in centimeters omit the final zero after the
index line To read length in millimeters, include the final zero
8THS

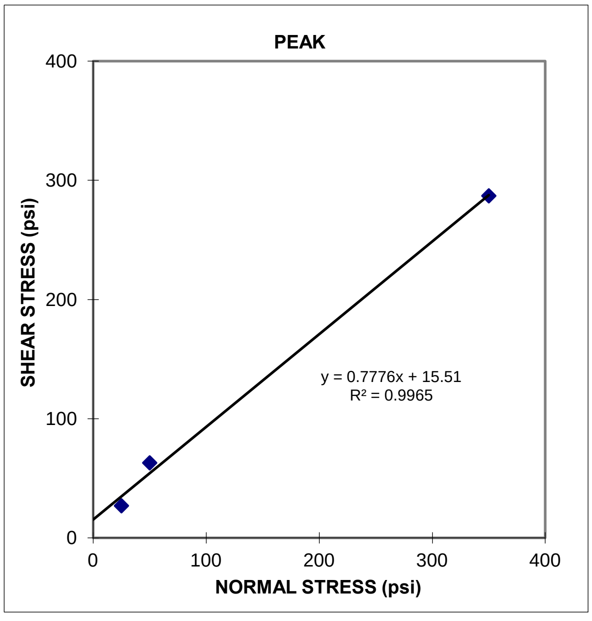
DIRECT SHEAR TEST RESULTS

ASTM D3080 MODIFIED

PROJECT NAME: CLIMAX/GEOTECHNICAL INVESTIGATION/CO
SAMPLE NUMBER: B20-2

SOIL CONDITIONS PLACED A DRY DENSITY OF 117.3 pcf AT A MOISTURE CONTENT OF 6.0%
TEST CONDITIONS: DRY, CONSOLIDATED 15 min AT NORMAL LOAD
SHEAR RATE: 0.04 in/min
SUBSTRATE: RIGID PLATES





Normal Stress (psi)	Shear Stress Peak[1] (psi)	Peak Friction Angle (°)	Peak Cohesion[2] (psi)
25	27		
50	63	37.9	15.5
350	287		

(1) The peak shear stresses for 25, 50, and 350 psi normal stresses were chosen at 2.953, 2.536, and 0.862 inches horizontal displacement, respectively.

(2) The cohesion value is based on the "best-fit" line which may not show true cohesion.

(3) The shear for the 350 psi point was terminated at 1.75 inches in horizontal displacement due to limitations of the test device.

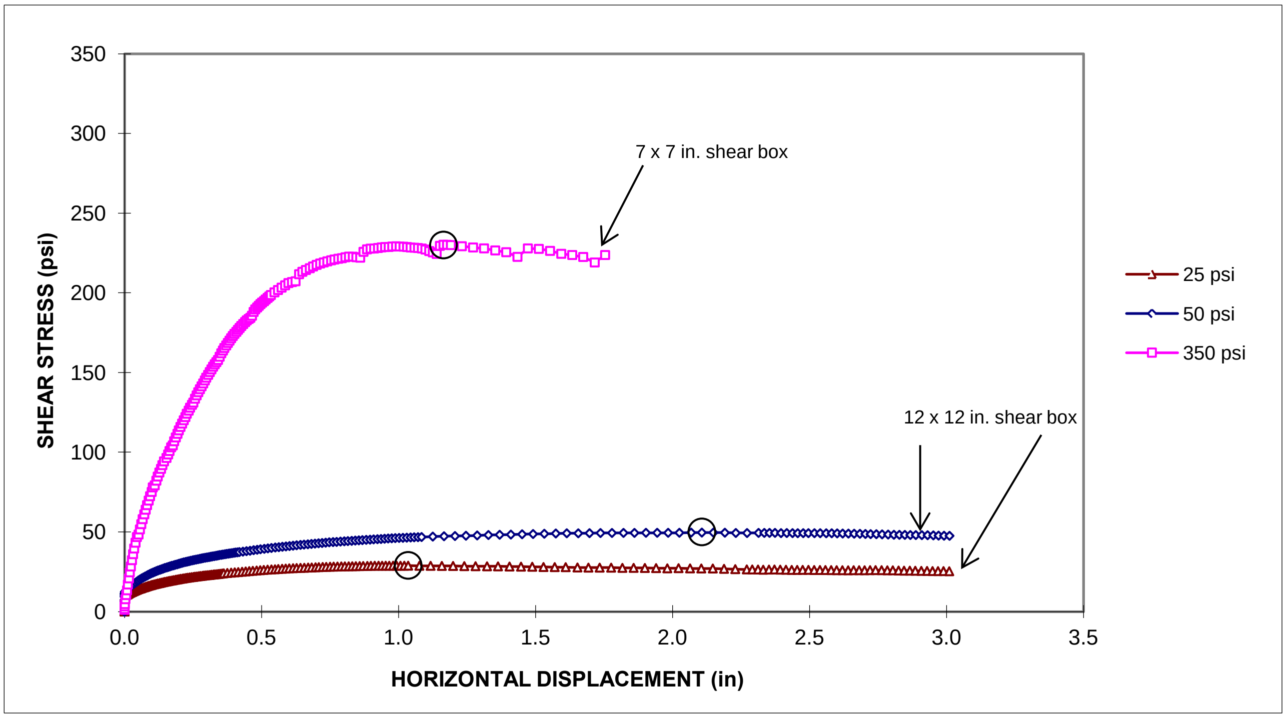
DECEMBER 2011 113-81608

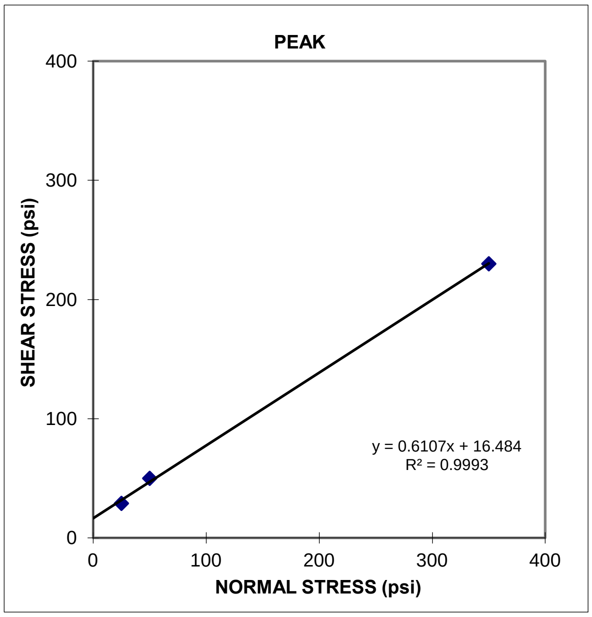
DIRECT SHEAR TEST RESULTS

ASTM D3080 MODIFIED

PROJECT NAME: CLIMAX/GEOTECHNICAL INVESTIGATION/CO
SAMPLE NUMBER: B25-14/B23-16

SOIL CONDITIONS PLACED A DRY DENSITY OF 122.8 pcf AT A MOISTURE CONTENT OF 7.3%
TEST CONDITIONS: DRY, CONSOLIDATED 15 min AT NORMAL LOAD
SHEAR RATE: 0.04 in/min
SUBSTRATE: RIGID PLATES





Normal Stress (psi)	Shear Stress Peak[1] (psi)	Peak Friction Angle (°)	Peak Cohesion[2] (psi)
25	29	31.4	16.5
50	50		
350	230		

(1) The peak shear stresses for 25, 50, and 350 psi normal stresses were chosen at 1.035, 2.107, and 1.164 inches horizontal displacement, respectively.

(2) The cohesion value is based on the "best-fit" line which may not show true cohesion.

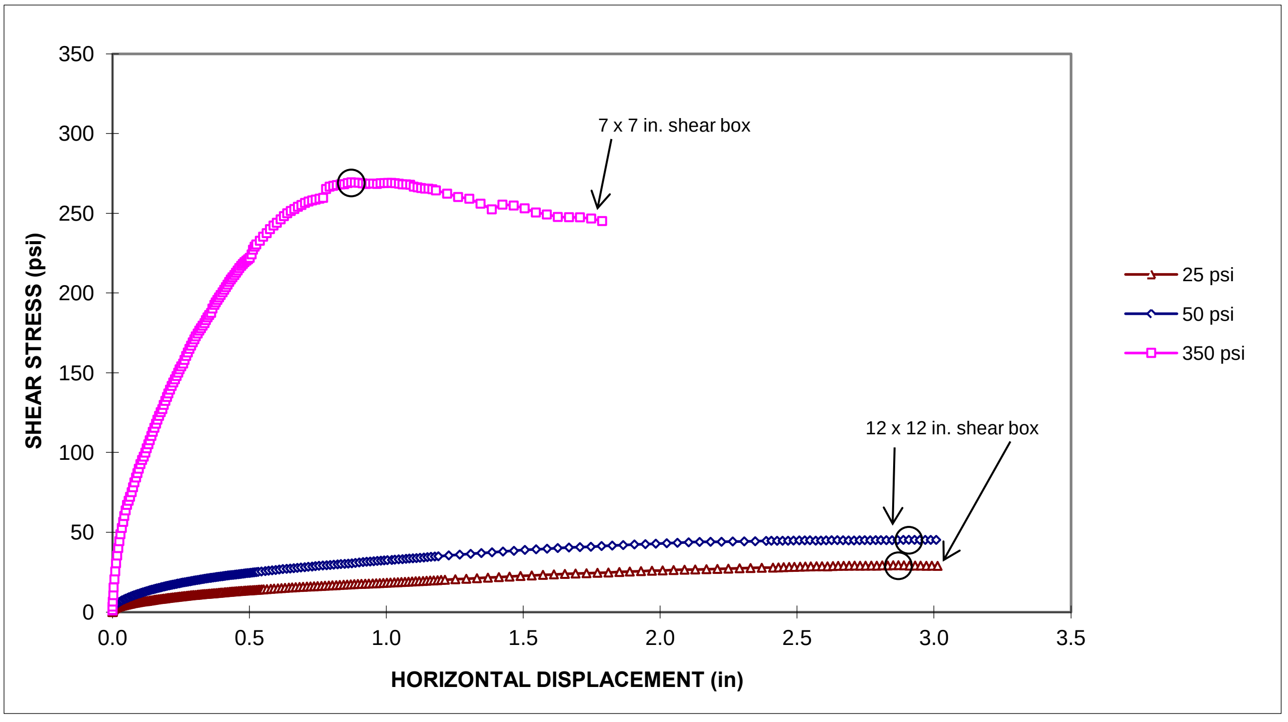
(3) The shear for the 350 psi point was terminated at 1.75 inches in horizontal displacement due to limitations of the test device.

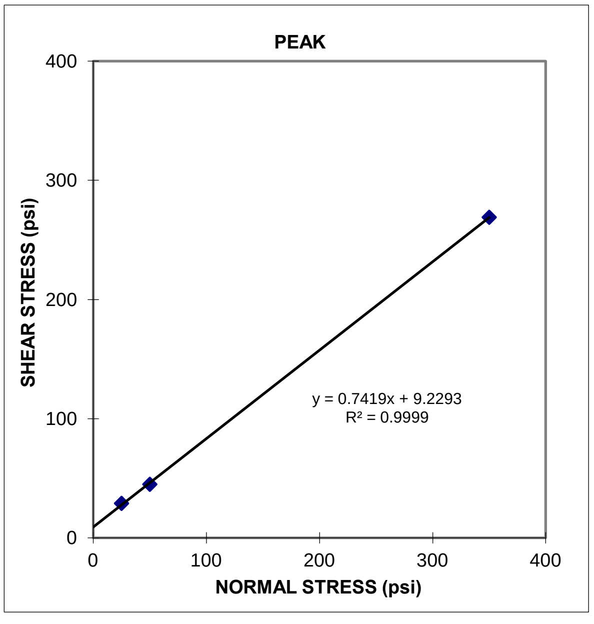
DIRECT SHEAR TEST RESULTS

ASTM D3080 MODIFIED

PROJECT NAME: CLIMAX/GEOTECHNICAL INVESTIGATION/CO
SAMPLE NUMBER: P05-1

SOIL CONDITIONS PLACED A DRY DENSITY OF 104.3 pcf AT A MOISTURE CONTENT OF 8.0%
TEST CONDITIONS: DRY, CONSOLIDATED 15 min AT NORMAL LOAD
SHEAR RATE: 0.04 in/min
SUBSTRATE: RIGID PLATES





Normal Stress (psi)	Shear Stress Peak[1] (psi)	Peak Friction Angle (°)	Peak Cohesion[2] (psi)
25	29		
50	45	36.6	9.2
350	269		

(1) The peak shear stresses for 25, 50, and 350 psi normal stresses were chosen at 2.870, 2.908, and 0.872 inches horizontal displacement, respectively.

(2) The cohesion value is based on the "best-fit" line which may not show true cohesion.

(3) The shear for the 350 psi point was terminated at 1.75 inches in horizontal displacement due to limitations of the test device.

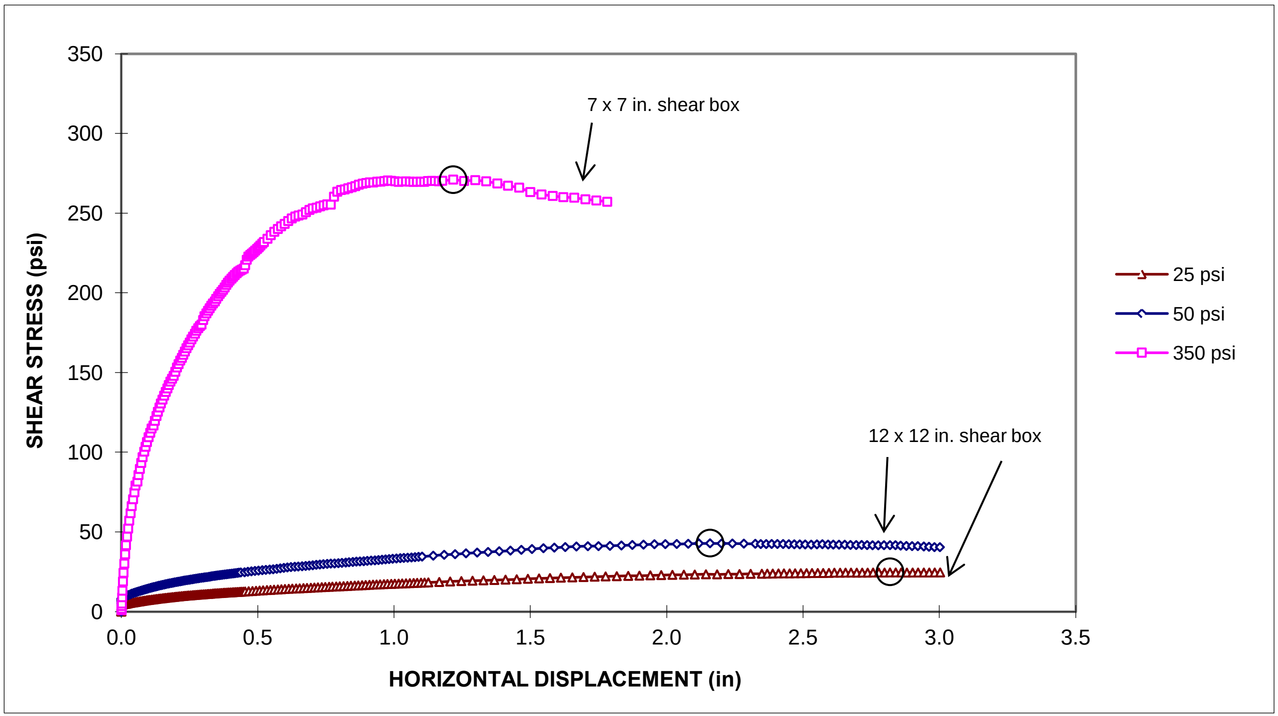
DECEMBER 2011 113-81608

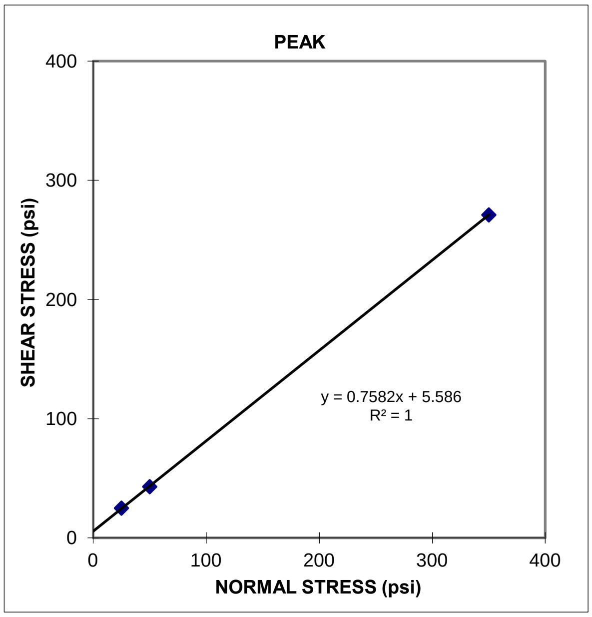
DIRECT SHEAR TEST RESULTS

ASTM D3080 MODIFIED

PROJECT NAME: CLIMAX/GEOTECHNICAL INVESTIGATION/CO
SAMPLE NUMBER: B25-3/B23-3

SOIL CONDITIONS PLACED A DRY DENSITY OF 101.9 pcf AT A MOISTURE CONTENT OF 6.0%
TEST CONDITIONS: DRY, CONSOLIDATED 15 min AT NORMAL LOAD
SHEAR RATE: 0.04 in/min
SUBSTRATE: RIGID PLATES





Normal Stress (psi)	Shear Stress Peak[1] (psi)	Peak Friction Angle (°)	Peak Cohesion[2] (psi)
25	25		
50	43	37.2	5.6
350	271		

(1) The peak shear stresses for 25, 50, and 350 psi normal stresses were chosen at 2.819, 2.159, and 1.217 inches horizontal displacement, respectively.

(2) The cohesion value is based on the "best-fit" line which may not show true cohesion.

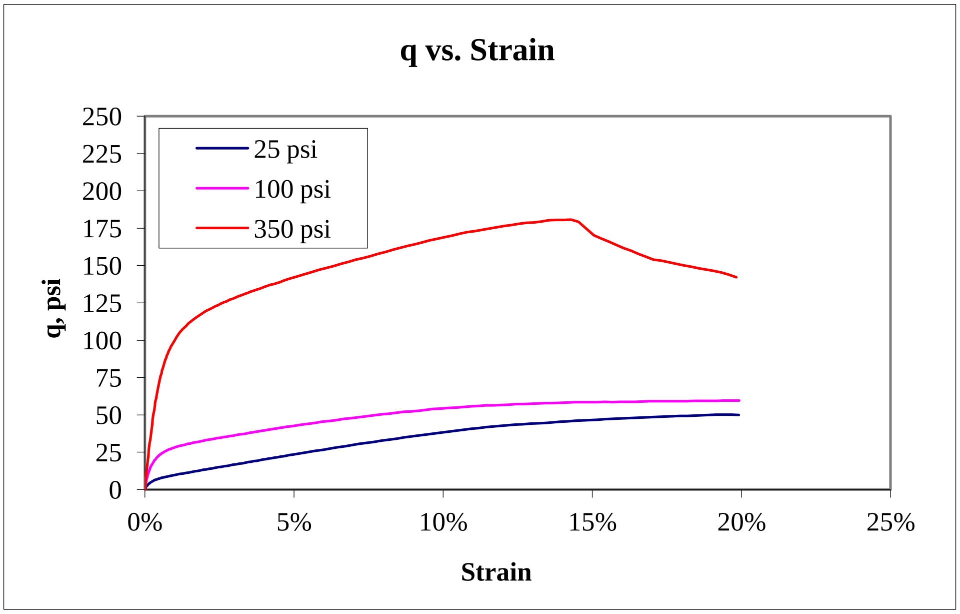
(3) The shear for the 350 psi point was terminated at 1.75 inches in horizontal displacement due to limitations of the test device.

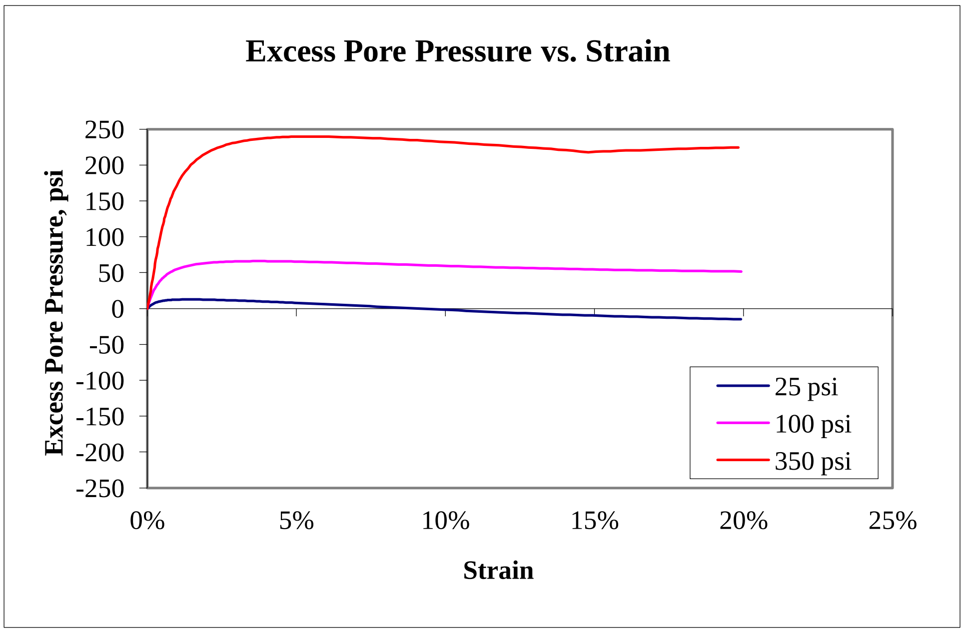
	Point 1		Point 2		Point 3	
Boring # =	GA-11B-24		GA-11B-24		GA-11B-24	
Sample # =	B24-9		B24-9		B24-13	
Depth (ft) =	51.5-53.6		51.5-53.6		71.0-73.2	
Point # =	1		2		3	
	Initial		**Initial**		**Initial**	
Length =	15.50	cm	16.27	cm	16.84	cm
Diameter =	7.27	cm	7.20	cm	7.26	cm
Wet Weight =	1233.37	g	1266.30	g	1306.90	g
Area =	41.5	cm^2	40.7	cm^2	41.4	cm^2
Sample Area =	6.43	in^2	6.31	in^2	6.42	in^2
Volume =	643.4	cm^3	662.4	cm^3	697.1	cm^3
Moisture Content =	32.6%		40.0%		25.8%	
Specific Gravity =	2.75		2.75		-	
Dry Weight of Solids =	930.14	g	904.50	g	1038.87	g
Wet Density =	1.92	g/cm^3	1.91	g/cm^3	1.87	g/cm^3
Dry Density =	1.45	g/cm^3	1.37	g/cm^3	1.49	g/cm^3
Wet Unit Weight =	119.6	pcf	119.3	pcf	117.0	pcf
Dry Unit Weight =	90.2	pcf	85.2	pcf	93.0	pcf
Cell Pressure =	65	psi	130	psi	380	psi
Back Pressure =	40	psi	30	psi	30	psi
Confining Pressure =	25	psi	100	psi	350	psi

Notes:
Shear rate was 0.005 in/min. t_{50} was 1.8 min. for Point #2.
Specimen consisted of undisturbed core samples with ends trimmed flush.
Moisture content was taken from trimmings.
Peak was defined at the maximum principal stress ratio.

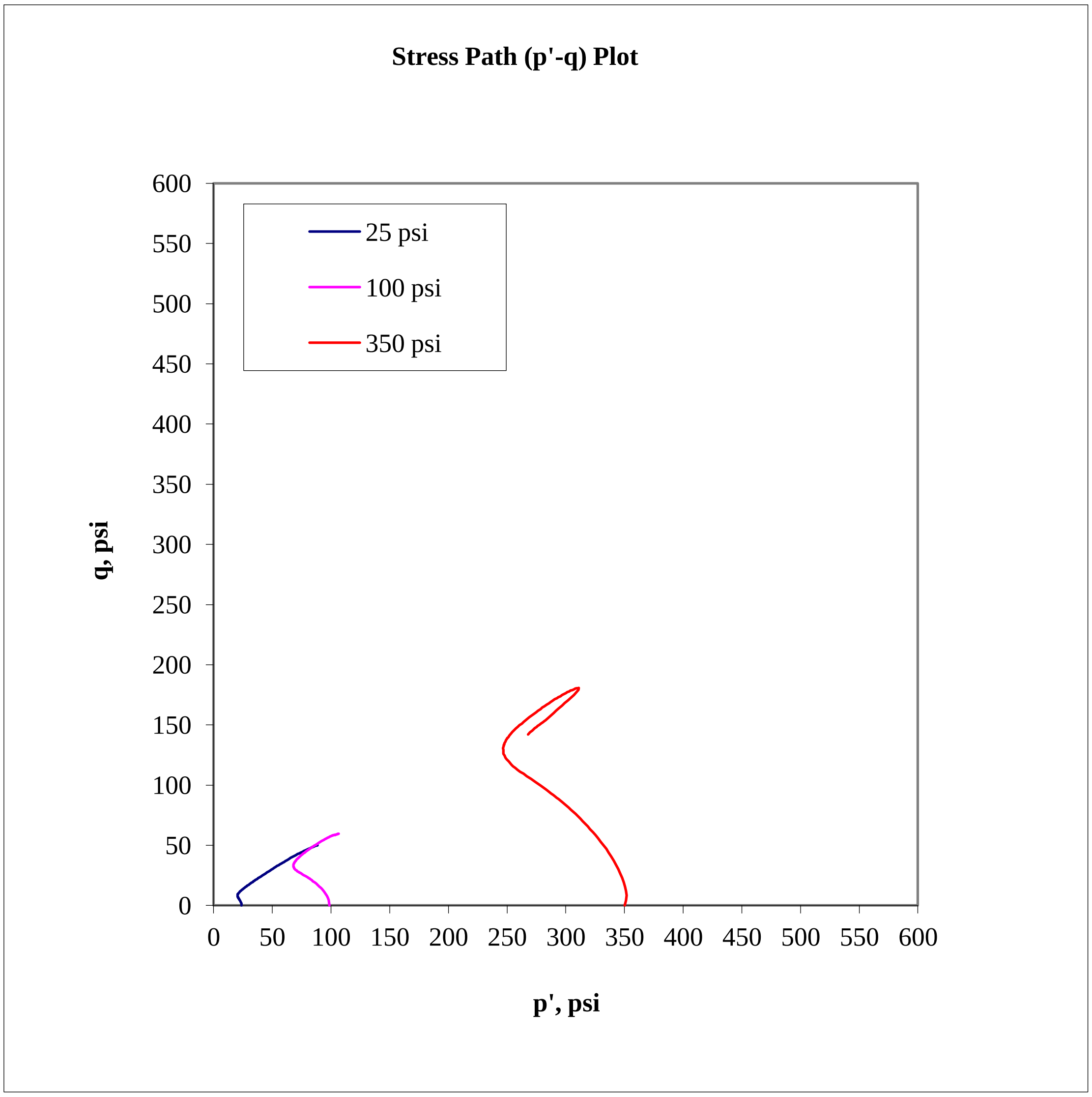
Golder Associates Inc. **Denver, Colorado**	**Title:** **TRIAXIAL SHEAR TEST REPORT** **SAMPLE DATA AND CALCULATIONS**
Job Short Title: **CLIMAX/GEOTECHNICAL INVESTIGATION**	

Sample Number:	Reviewed:	Date:	Job Number:	Figure:
GA-11B-24 B24-9/B24-13	**JEO**	**12/21/2011**	**113-81608**	**1**

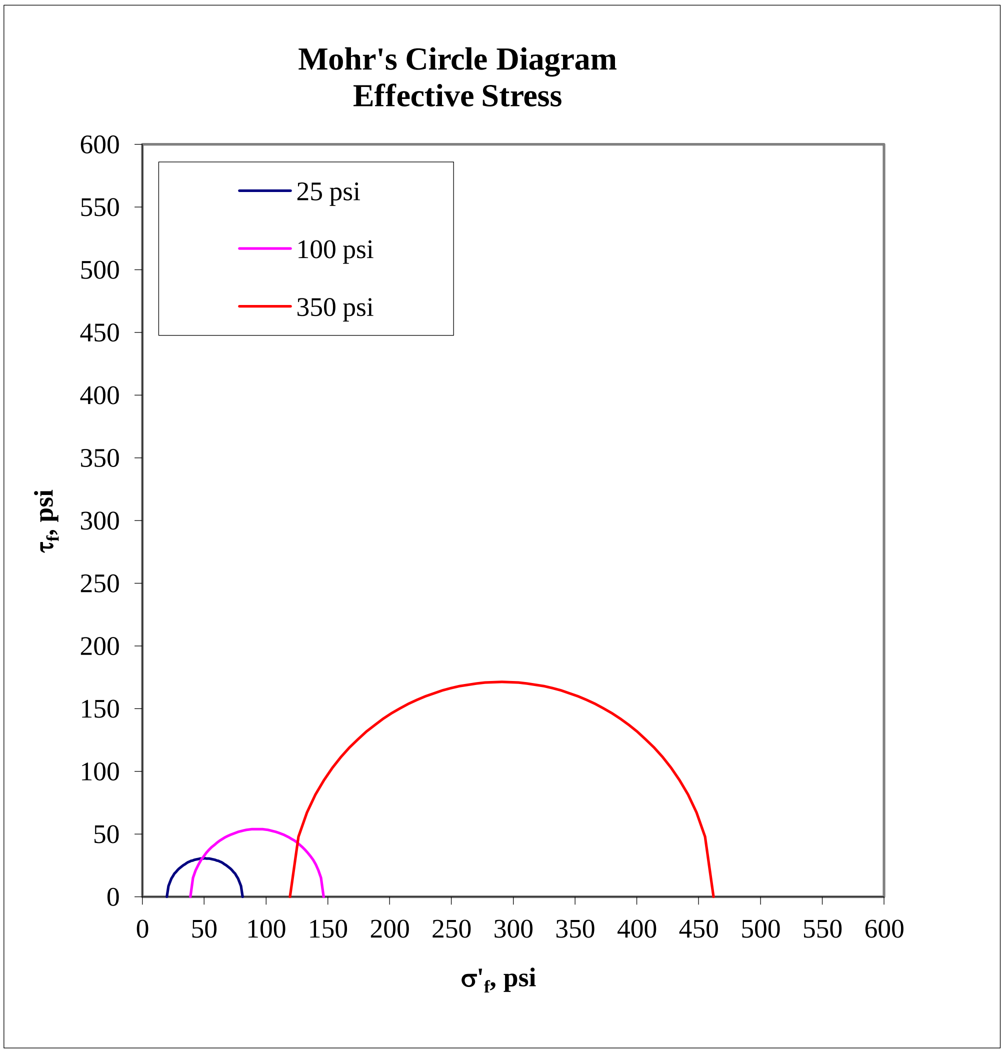




Golder Associates Inc. **Denver, Colorado**	**Title:** **C-U TRIAXIAL SHEAR DATA** **q AND EXCESS PORE PRESSURE PLOTS**			
Job Short Title: **CLIMAX/GEOTECHNICAL INVESTIGATION**				
Sample Number: **GA-11B-24 B24-9/B24-13**	**Reviewed:** **JEO**	**Date:** **12/21/2011**	**Job Number:** **113-81608**	**Figure:** **2**



Golder Associates Inc. Denver, Colorado	**Title:** C-U TRIAXIAL SHEAR DATA STRESS PATH PLOT			
Job Short Title: CLIMAX/GEOTECHNICAL INVESTIGATION				
Sample Number: GA-11B-24 B24-9/B24-13	**Reviewed:** JEO	**Date:** 12/21/2011	**Job Number:** 113-81608	**Figure:** 3

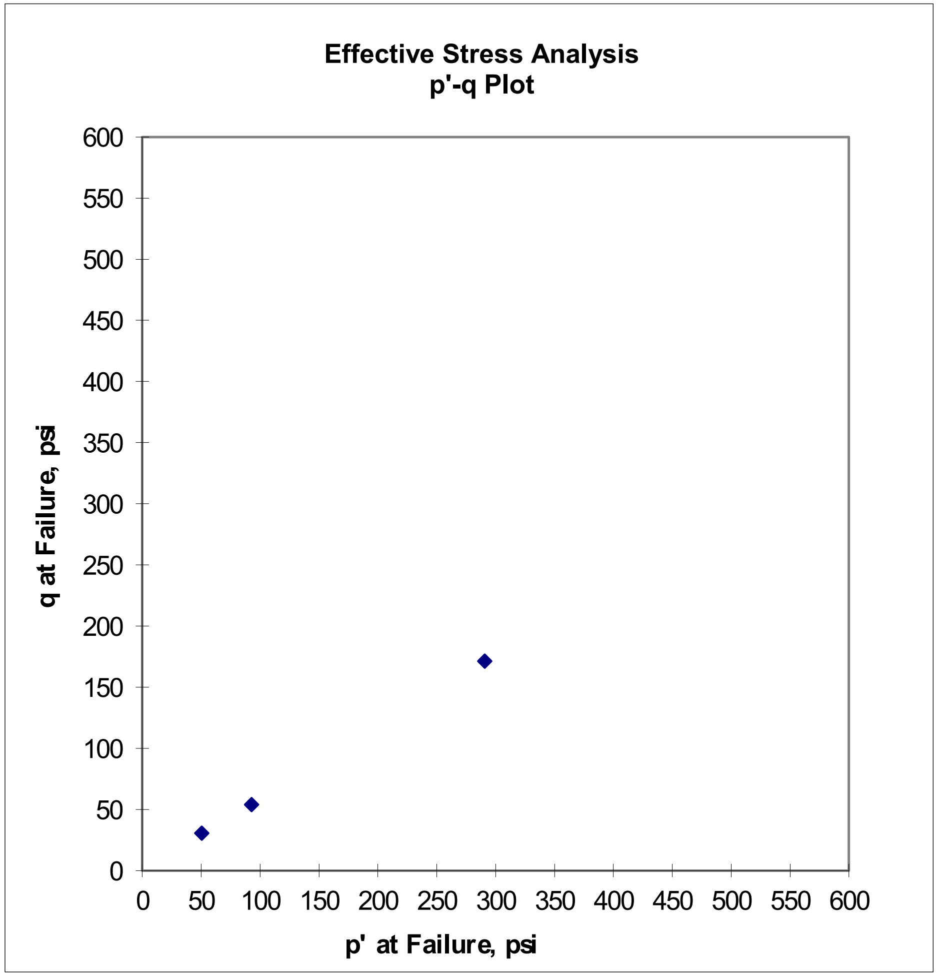


Golder Associates Inc. Denver, Colorado		**Title:** C-U TRIAXIAL SHEAR DATA MOHR'S CIRCLE DIAGRAM		
Job Short Title: CLIMAX/GEOTECHNICAL INVESTIGATION				
Sample Number: GA-11B-24 B24-9/B24-13	**Reviewed:** JEO	**Date:** 12/21/2011	**Job Number:** 113-81608	**Figure:** 4

Consolidated-Undrained Triaxial Lab Data
From: GOLDER ASSOCIATES INC.
Project: **CLIMAX/GEOTECHNICAL INVESTIGATION**
Project Number: **113-81608**

Sample Number	GA-11B-24 B24-9/B24-13
Effective Stress Analysis	

Point Number	p' (psi)	q (psi)
1	50.4	30.6
2	92.7	53.9
3	290.7	171.3

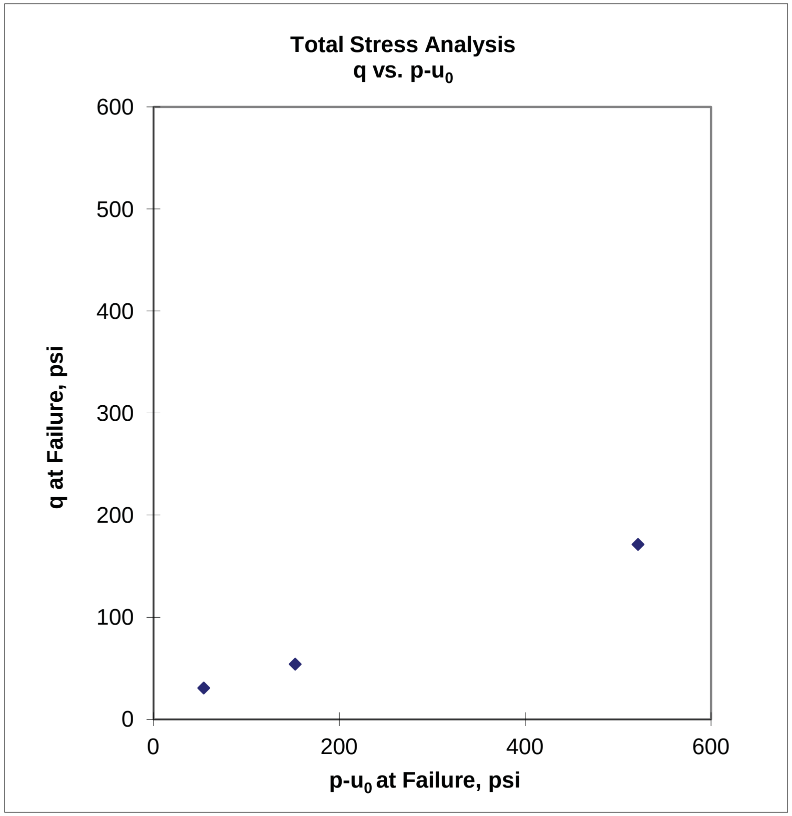


Consolidated-Undrained Triaxial Lab Data
From: GOLDER ASSOCIATES INC.
Project: Climax/Geotechnical Investigation
Project Number: 113-81608

Sample Number Boring GA-11B-24

Total Stress Analysis

Point Number	$p\text{-}u_o$ (psi)	q (psi)
1	54.1	30.6
2	152.5	53.9
3	521.4	171.3




25 psi


100 psi

350 psi

ONE-DIMENSIONAL CONSOLIDATION
ASTM D 2435

PROJECT NAME:	**Climax/Geotechnical Investigation**	**SAMPLE:**	**GA-11B-24 B24-9**	DATE	12/14/2011
PROJECT #:	**113-81608**	**DEPTH:**	**51.5-53.6 ft**	TECH	RJM
				REVIEW	JEO

SAMPLE DATA, GENERAL

height (in)	0.9955
diameter (in)	2.492
area (in^2)	4.878
volume (in^3)	4.856
specimen weight,wet (g)	151.95
specimen weight,dry (g)	115.17
water weight (g)	36.78

SAMPLE DATA, INITIAL

total height (in)	0.9955
height of solids (in)	0.5236
height of voids (in)	0.4719
void ratio	0.901
dry density (pcf)	90.1
moist density (pcf)	119.2

SAMPLE DATA, FINAL

total height (in)	0.9308
height of solids (in)	0.5236
height of voids (in)	0.4071
void ratio	0.777
dry density (pcf)	96.6
moist density (pcf)	126.1

VISUAL DESCRIPTION

Light gray, moist silt

LL:	NP
PL:	NP
PI:	NP
Gs:	2.75

MOISTURE CONTENT, INITIAL

tare #	B-7A
wt soil&tare,moist	195.92
wt soil&tare,dry	155.56
wt tare	29.18
wt moisture	40.36
wt dry soil	126.38
% moisture	31.9%

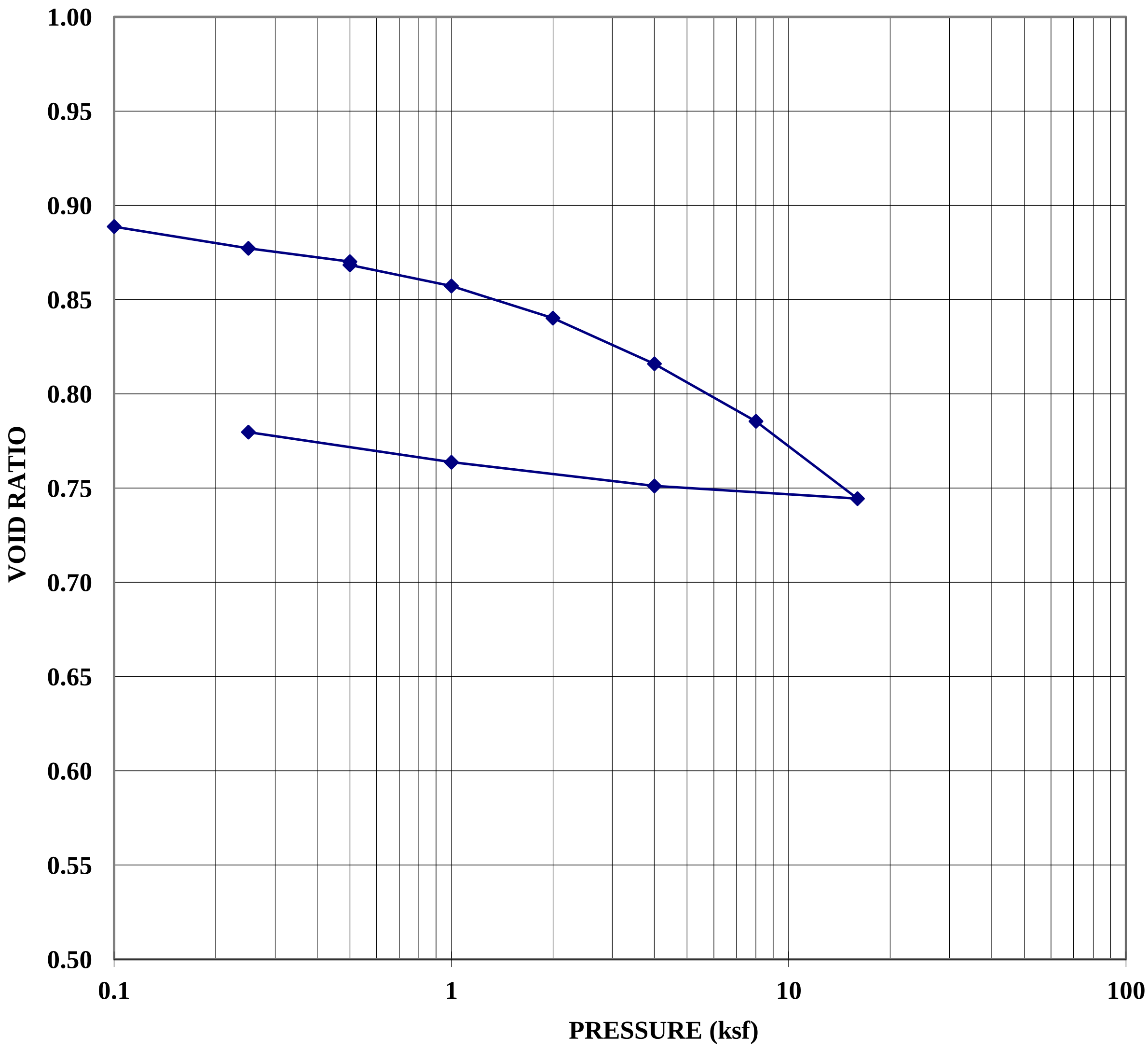
MOISTURE CONTENT, FINAL

tare #	M-5
wt soil&tare,moist	174.82
wt soil&tare,dry	140.40
wt tare	27.35
wt moisture	34.42
wt dry soil	113.05
% moisture	30.4%

PRESSURE (ksf)	h100 Sample Height	D50 Sample Height	t50 TIME (min)	Sample Density (pcf)	VOID RATIO e	DRAINAGE PATH (DOUBLE DRAINAGE) H (in)	H (cm)	DRAINAGE PATH (DOUBLE DRAINAGE) H^2 (in^2)	H^2 (cm^2)	COEFFICIENT OF CONSOLIDATION Cv (cm^2/sec)	(ft^2/day)	Cc
0.10	0.9878	-	-	90.9	0.889	-	-	-	-	-	-	-
0.25	0.9818	-	-	91.4	0.877	-	-	-	-	-	-	-
0.50	0.9780	-	-	91.8	0.870	-	-	-	-	-	-	-
0.50	0.9771	-	-	91.8	0.868	-	-	-	-	-	-	-
1.0	0.9713	0.9739	0.195	92.4	0.857	0.4869	1.2368	0.2371	1.5298	2.58E-02	2.40E+00	0.037
2.0	0.9624	0.9662	0.177	93.3	0.840	0.4831	1.2270	0.2334	1.5056	2.80E-02	2.61E+00	0.057
4.0	0.9497	0.9546	0.164	94.5	0.816	0.4773	1.2124	0.2278	1.4698	2.95E-02	2.75E+00	0.081
8.0	0.9338	0.9403	0.160	96.1	0.785	0.4702	1.1942	0.2211	1.4262	2.92E-02	2.73E+00	0.101
16.0	0.9123	0.9210	0.158	98.4	0.744	0.4605	1.1697	0.2121	1.3682	2.84E-02	2.65E+00	0.136
4.0	0.9158	-	-	98.0	0.751	-	-	-	-	-	-	-
1.0	0.9224	-	-	97.3	0.764	-	-	-	-	-	-	-
0.25	0.9308	-	-	96.4	0.780	-	-	-	-	-	-	-

GOLDER ASSOCIATES INC.
LAKEWOOD, COLORADO

ONE-DIMENSIONAL CONSOLIDATION



SAMPLE #:	GA-11B-24 B24-9 51.5-53.6 ft
DESCRIPTION:	Light gray, moist silt

DATE	12/14/2011
TECH	RJM
REVIEW	JEO

PROJECT NAME: Climax/Geotechnical Investigation
PROJECT #: 113-81608

GOLDER ASSOCIATES INC.
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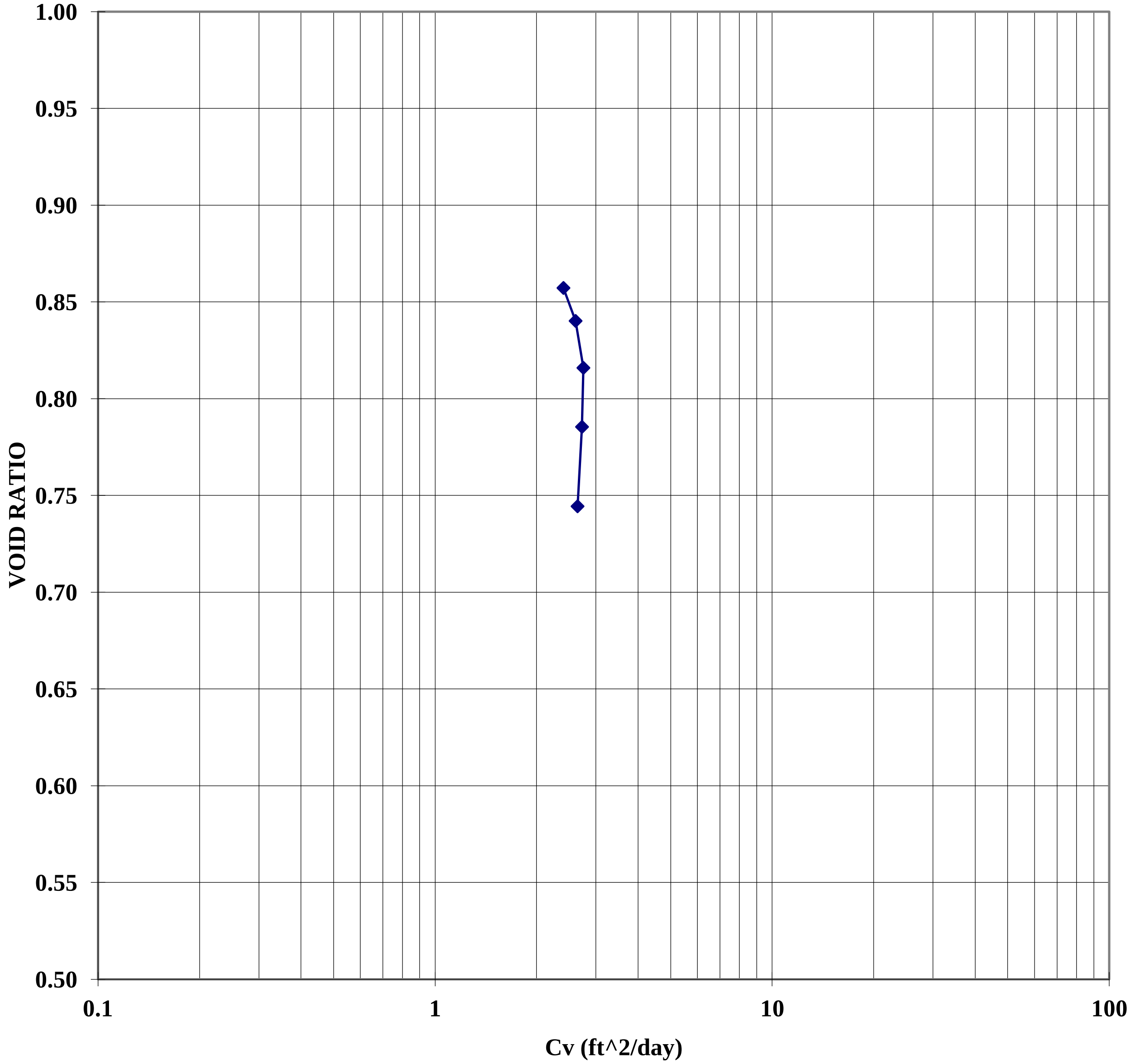
ONE-DIMENSIONAL CONSOLIDATION



SAMPLE #:	GA-11B-24 B24-9 51.5-53.6 ft
DESCRIPTION:	Light gray, moist silt

		DATE	12/14/2011
PROJECT NAME:	Climax/Geotechnical Investigation	TECH	RJM
PROJECT #:	113-81608	REVIEW	JEO

GOLDER ASSOCIATES INC.

LAKEWOOD, COLORADO

APPENDIX C
GEOTECHNICAL STABILITY ANALYSIS

APPENDIX C

Date:	April 24, 2012	**Prepared by:**	D. Rugg
Project No.:	113-81608.2000	**Checked by:**	D. Geier
Projcect Title:	Climax Molybdenum OSF Design Report	**Reviewed by:**	B. Bronson
RE:	**GEOTECHNICAL STABILITY ANALYSIS**		

1.0 OBJECTIVE

The objective of this appendix is to present the calculations performed to evaluate the global stability of the North 40 and McNulty overburden storage facilities (OSFs) at the Climax molybdenum mine in Climax, Colorado. A geotechnical field investigation consisting of 19 test pits and 7 boreholes was conducted in October and November 2011, and is summarized in the design report (Golder, 2012) and in Appendix A to the report. Representative samples collected during the field program were used to conduct a laboratory-testing program, the results of which are also presented in Appendix B of the design report. The results of the field investigation and laboratory testing program, in conjunction with other available information, including historical reports, existing topography, aerial photographs, and geologic maps, were analyzed to create the geologic cross sections including bedrock contacts and piezometric surfaces. The field and laboratory program results and historical reports were also used to determine the design parameters utilized in this analysis.

2.0 DESIGN CRITERIA

An OSF Loading Plan (OSF Plan) was provided to Golder by Climax on April 23, 2012. The OSF Plan utilizes an ultimate footprint that is consistent with the operational requirements, post-closure requirements, and project design criteria for the facility. Based on Climax's current OSF Plan, the majority (approximately 70%) of the overburden material will consist of igneous and metamorphic rock excavated from the pit which is either unmineralized or contains uneconomical mineralization. The remaining approximate 30% of the overburden removed from the pit will consist of sedimentary rock primarily derived from the Minturn Formation shale, siltstone, and sandstone.

It is common for mines to update OSF Loading Plans throughout the life of the project for a variety of reasons. These routine changes occur within the framework established by the project design criteria. Therefore, the relevant parameters in the design criteria were used to construct the OSF stability cross sections. Sections constructed in this manner are intended to represent the "worst-case" cross-section geometry (i.e., steepest slopes) possible within the constraints of the design criteria. The relevant design criteria are listed below:

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- The operational and closure toe limits of the OSF are shown along with the locations of the design cross sections in Figure 1
- Operational scenario:
  - Inter-bench angle of repose slopes were modeled as 1.4H:1V (or 36 degrees)
  - Operational benches were modeled as 200 feet wide
  - The maximum height between benches was modeled as 200 feet
  - Overall operational slopes were thus approximately 2.4H:1V
  - During operational stages, the low-grade ore stockpile, located in the southwest corner of the OSF footprint, may temporarily have angle of repose slopes in excess of 200 feet. These slopes were considered in the stability analysis.
- Closure scenario:
  - Inter-bench slopes were modeled as 2H:1V
  - Closure benches were modeled as 20 feet wide
  - The maximum height between benches was modeled as 56 feet
  - Overall closure slopes were thus approximately 2.4H:1V

By using the design criteria above, Golder has created the steepest slopes that accommodate the design criteria at each cross-section location. Other pertinent design criteria include the acceptable stability factors of safety and the design earthquake conditions as discussed below:

- Operational scenario:
  - Minimum allowable static factor of safety is 1.4
  - Minimum allowable seismic factor of safety is ≥1.0
  - Operational basis earthquake (OBE) peak ground acceleration (PGA) is 0.06g (representing the 1-in-475-years event).
- Closure scenario:
  - Minimum allowable static factor of safety is 1.5
  - Minimum allowable seismic factor of safety is ≥1.0
  - Maximum design earthquake (MDE) PGA is 0.14g (representing the 1-in-2,475-years event)

3.0 METHODS AND ASSUMPTIONS

- Primary stability analyses were performed with RocScience's 2-D limit equilibrium program, Slide 6.0. Factors of safety were computed based on Spencer's Method of Slices (Spencer 1967).
- Both circular and non-circular (block) failure surfaces were evaluated.
- Since approximately 30% of the OSF is expected to be comprised of overburden derived from the Minturn Formation shale, siltstone, and sandstone, two strength envelopes were utilized for the overburden material:

- Envelope 1: A conservative best approximation of the overburden material strength based on the residual strength obtained from two large scale direct shear tests performed on representative samples of overburden
- Envelope 2: A "lower bound" strength envelope defined by the Leps (1971) low strength curve. Golder considers this envelope to represent a lower bound strength for the OSF suitable for evaluating the stability of the OSF in the event that a significant contiguous portion of the facility is constructed from sedimentary overburden.

- Both deep and shallow failure surfaces were investigated. However, surficial veneer (infinite slope) slip surfaces were excluded from the results. Critical failure surfaces were constrained to a minimum depth of 15 feet.
- Veneer failures on the face of the dump become more common for the operational OSF configuration when the lower bound strength envelope is utilized. Thus, Golder has assumed and recommends that overburden material derived from the higher strength igneous or metamorphic rocks will be placed within 50 ft of the ultimate face of the OSF.
- The geometry, piezometric assumptions, and material parameters were obtained based on the field investigation performed in October and November 2011. In areas without tailing deposits, the existing piezometric surface was measured an average of 14 feet below the native ground surface (i.e., 14 feet below the base of existing fills, or 14 feet below the present ground surface in areas with no fill). No perched water was encountered within any of the existing overburden fills. In areas with historic tailing deposits, the piezometric surface was located within the upper 10 feet of tailing deposits.
- A sensitivity analysis was performed in order to evaluate the effect of varying piezometric levels on OSF stability. For the sensitivity analysis, a conservative, worst-case piezometric surface was assumed to exist at the top of native ground and at the surface of the historic tailing impoundments. Stability was evaluated along the two most critical cross-sections under static conditions.
- Design material parameters were determined based on a series of geotechnical laboratory tests conducted by Golder on samples of native soils (Lincoln Porphyry, Minturn Formation, and Glacial Till) and mine materials (overburden and tailing). These soil parameters are described in Section 4.0.
- Residual strength soil parameters were used for the static stability analysis wherever applicable.
- Seismic stability was evaluated using a pseudo-static analysis procedure generally following the Hynes-Griffin and Franklin method (1984). For this pseudo-static analysis, total stress shear strength parameters were used for the tailing materials, while 80 percent of the effective stress shear strength was used for all other materials (excluding the overburden material since straining and strength degradation due to shaking are expected to be minimal for this material). Seismic load coefficients of 0.03 for the OBE and 0.07 for the MDE (half the PGA for each case) were used for the pseudo-static analyses.

4.0 MATERIAL PARAMETERS

The material properties presented in Table 1 and Figure 2, and Table 2 and Figure 3 were used for the static and pseudo-static analyses, respectively. These parameters were selected based on a review of the available laboratory test data, historical reports, and engineering judgment. A more in-depth discussion of material strength selection is presented in the main text of the design report.

Table 1 presents the material properties used for the static stability analyses. A combination of Mohr-Coulomb and bi-linear Mohr-Coulomb failure envelopes were used for the native materials and tailing. A traditional Mohr-Coulomb failure envelope was used for the Minturn Formation. The envelope was obtained from a staged consolidated-undrained triaxial test performed on a relatively undisturbed sample of clayey residual soil weathered from the Minturn Formation. Bi-linear Mohr-Coulomb failure envelopes were constructed for both the Lincoln Porphyry and Glacial Till. For these materials, bi-linear envelopes were found to provide the best fit to the data provided by large-scale direct shear tests on reconstituted samples of these materials. The strength of the tailing material was determined by a series of consolidated-undrained triaxial tests on tailing fines. The Mohr-Coulomb envelope for tailing assumes no effective cohesion.

Two large scale direct shear tests were performed on samples of mine overburden collected from the site. The shear box was 12 inches by 12 inches, and as a result only the sampled material finer than 2 inches was used in the test. Assuming zero cohesion, the results indicate residual strengths of 35 to 36 degrees (linear Mohr-Coulomb). A power curve best fit the laboratory data lies approximately midway between the Leps (1971) curves for low and average strength rockfill.

For the Climax mine overburden, the curvilinear power curve fit to the large scale direct shear test data was selected for use in stability modeling. This curve is considered representative of expected worst-case conditions within the OSFs for areas where overburden derived from igneous and/or metamorphic rock makes up the majority of the OSF fill. For the majority of the OSF this strength envelope is considered conservative, as the tests were performed only on the finer-grained matrix material, and was not corrected to account for the large amount of oversize material present in the OSFs. Note that approximately 30% of the overburden is expected to consist of sedimentary rock. The power curve described above is also considered representative for areas of the OSF containing average quantities of sedimentary rock derived overburden (i.e., approximately 30%). Golder considers the low strength Leps (1971) curve an appropriate “lower bound” strength envelope for the OSF. The low strength Leps envelope is suitable for evaluating the stability of the OSF in the event that a significant contiguous portion of the facility is constructed primarily from sedimentary overburden.

Table 2 presents the material properties used for the pseudo-static stability analyses. For this case, all native soil shear strengths were reduced by 20 percent, in accordance with Makdisi and Seed (1977) to simulate the elastic reduction in strength (i.e., strain softening) that may be imparted by seismic shaking. This practice was also adopted by Hynes-Griffin and Franklin (1984) for pseudo-static stability analyses. This reduction factor was not applied to the overburden material since seismic shaking is not expected to produce strain softening conditions resulting from the development of excess pore pressure for the overburden materials. The results of a liquefaction screening analysis have shown that the tailing material will not liquefy under the expected seismic loading conditions.

5.0 RESULTS AND CONCLUSIONS

The stability analyses results are summarized in Tables 3 and 4 for the operations and closure scenarios, respectively. Cross-sections showing the critical failure mechanisms for each case considered are presented in Figures 4 through 33. Based on the analyses performed for this study and the summary of results presented in Tables 3 and 4, all computed factors of safety meet or exceed the factors of safety established by the Project Design Criteria, for both the maximum operational and closure slope scenarios.

The sensitivity analysis showed that the factor of safety is relatively insensitive to changes in the piezometric surface. When the worst-case groundwater conditions were modeled, static factors of safety decreased by only 0.02 to 0.08 from the base case. Although they are not anticipated to occur, increased piezometric levels beneath the OSFs would not create unstable conditions. As a result, installation of piezometers and regular monitoring of groundwater levels are not required as a component of the O&M plan.

6.0 REFERENCES

Golder Associates Inc. (Golder). 2012. *North 40 and McNulty Gulch Overburden Storage Facility Design Report.* April, 2012.

Hoek, E., C. Carranza-Torres, and B. Corkum. 2002. *Hoek-Brown criterion – 2002 edition*. *Proc. NARMS-TAC Conference*, Toronto, **1**, 267-273.

Hynes-Griffin, M.E., and A.G. Franklin. 1984. *Rationalizing the Seismic Coefficient Method*. Waterways Experiment Station, U.S. Army Corps of Engineers. Misc. Paper GL-84-13.

Leps, T.M. 1971. *Review of Shearing Strength of Rockfill*. Journal of the Soil Mechanics and Foundations Division, Proc. of the American Society of Civil Engineers. Vol. 96, No. SM4, pp. 1159-1170.

Makdisi, F.I., and H.B. Seed. 1977. *A Simplified Procedure for Estimating Earthquake-Induced Deformation in Dams and Embankments,* Report UCB/EERC-77/19, Earthquake Engineering Research Center, University of California, Berkeley, CA.

Spencer, E. 1967. *A Method of Analysis of the Stability of Embankments Assuming Parallel Inter-Slice Forces."* Geotechnique, Vol. XVII, No. 1, pp. 11-26.

List of Attachments

Tables 1 through 4
Figures 1 through 33

TABLES

Table 1
Strength Parameters Utilized for Static Stability Analysis

Soil Type	Total Unit Weight (pcf)	Failure Envelope Type	Failure Envelope Definition (psf)	Notes
Native Materials				
Minturn Formation	119	Mohr-Coulomb	τ' = σ'tan(31°)	This failure envelope was determined from the strength results of a staged undrained triaxial test with pore pressure measurements. No cohesion was included for conservatism.
LincolnPorphyry	117	Bi-Linear Mohr Coulomb	τ' = σ'tan(50°) for σ'<7200 τ' = σ'tan(33°)+4200 for σ'>7200	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests.
GlacialTill	123	Bi-Linear Mohr Coulomb	τ' = σ'tan(44°) for σ'<7200 τ' = σ'tan(30°)+2688 for σ'>7200	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests.
Overburden Materials				
Best Approximation Overburden Parameters	120	Power Function	$\tau' = 3.18\sigma'^{0.86}$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests. This envelope lies between the average and low envelopes developed by Leps (1971).
Lower Bound Overburden Strength Parameters	120	Power Function	$\tau' = 2.02\sigma'^{0.90}$	This failure envelope was used to account for a higher proportion of weaker materials with in the OSF. This envelope is analagous to the low strength envelope developed by Leps (1971).
Tailings Materials				
Tailings Materials	100	Mohr-Coulomb	τ' = σ'tan(33°)	This failure envelope was determined from the residual strength results of a staged undrained triaxial test with pore pressure measurements. No cohesion was included for conservatism.

Table 2
Strength Parameters Utilized for Pseudo-Static Stability Analysis

Soil Type	Total Unit Weight (pcf)	Failure Envelope Type	Failure Envelope Definition (pcf)	Notes
Native Materials				
Minturn Formation	119	Mohr-Coulomb	$\tau' = \sigma'\tan(24°)$	This failure envelope was determined from the strength results of a staged consolidated undrained triaxial test with pore pressure measurements. No cohesion was included for conservatism. Values were reduced by 20% for the seismic condition.
Lincoln Porphyry	117	Bi-Linear Mohr Coulomb	$\tau' = \sigma'\tan(44°)$ for $\sigma'<7200$ $\tau' = \sigma'\tan(28°)+3360$ for $\sigma'>7200$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests with the values reduced by 20%.
Glacial Till	123	Bi-Linear Mohr Coulomb	$\tau' = \sigma'\tan(38°)$ for $\sigma'<7200$ $\tau' = \sigma'\tan(25°)+2150$ for $\sigma'>7200$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests with the values reduced by 20%.
Overburden Materials				
Best Approximation Overburden Parameters	120	Power Function	$\tau' = 3.18\sigma'^{0.86}$	This failure envelope was determined from the residual strength results of a series of large scale direct shear tests. This envelope lies between the average and low envelopes developed by Leps (1971).
Lower Bound Overburden Strength Parameters	120	Power Function	$\tau' = 2.02\sigma'^{0.90}$	This failure envelope was used to account for a higher proportion of weaker materials with in the OSF. This envelope is analagous to the low strength envelope developed by Leps (1971).
Tailings Materials				
Tailings Materials	100	Mohr-Coulomb	$\tau = \sigma\tan(18°)$	This failure envelope was determined from the residual strength results of a consolidated undrained triaxial test with pore pressure measurements. A total stress approach was utilized for the seismic condition.

Table 3
Stability Analysis Results for the Maximum Operational OSF Configuration

Section	Seismicity	Minimum Factor of Safety- Lower Bound Overburden Strength[1]	Minimum Factor of Safety- Best Approximation Overburden
A-A	static	1.42	1.59
A-A	pseudo-static	1.21	1.28
B-B	static	1.41	1.59
B-B	pseudo-static	1.20	1.25
C-C	static	1.48	1.49
C-C	pseudo-static	1.09	1.09
D-D	static	1.45	1.59
D-D	pseudo-static	1.26	1.28
E-E	static	1.44	1.57
E-E	pseudo-static	1.15	1.19

[1]Minimum factors of safety for the lower bound overburden strength are for significant failures that span at least an entire operational lift. Single lift "veneer" failures were excluded. It was assumed and Golder recommends that 50 ft of material derived from igneous or metamorphic sources is placed at the ultimate face of the dump. Minimum factors of safety for single lift veneer failures are greater than 1.4.

Table 4
Stability Analysis Results for the Post-Closure OSF Configuration

Section	Seismicity	Minimum Factor of Safety- Lower Bound Overburden Strength	Minimum Factor of Safety- Best Approximation Overburden
A-A	static	1.95	2.04
A-A	pseudo-static	1.24	1.30
B-B	static	1.92	2.00
B-B	pseudo-static	1.19	1.27
C-C	static	1.50	1.52
C-C	pseudo-static	1.00	1.00
D-D	static	1.70	1.73
D-D	pseudo-static	1.13	1.15
E-E	static	1.58	1.63
E-E	pseudo-static	1.10	1.10

FIGURES

LEGEND

11975 / 11950	EXISTING GROUND TOPOGRAPHY (SEE REFERENCE 1)
solid red line	LIMITS OF OSF DURING OPERATIONS (2.4H:1V OVERALL SLOPES)
dashed red line	LIMITS OF OSF AT CLOSURE
solid black line	CLIMAX PROPERTY LIMITS
dashed black line	GAI STABILITY SECTIONS

NOTES

1. GRID SHOWS MINE SURVEY COORDINATES.

REFERENCES

1. 2010 TOPOGRAPHY PROVIDED BY CLIMAX MINE, 22 MARCH 2011.
2. AERIAL PHOTOGRAPH TAKEN IN 2009, FROM USDA AERIAL PHOTOGRAPHY FIELD OFFICE.

REV	DATE	REVISION DESCRIPTION	DESIGN	CADD	CHECK	REVIEW
B	4APR12	ISSUED FOR DESIGN REPORT	DLG	GSL	DLG	BRB
A	24FEB12	ISSUED FOR MEMORANDUM	DLG	GSL	DLG	BRB

PROJECT

CLIMAX MINE
LAKE AND SUMMIT COUNTIES, COLORADO

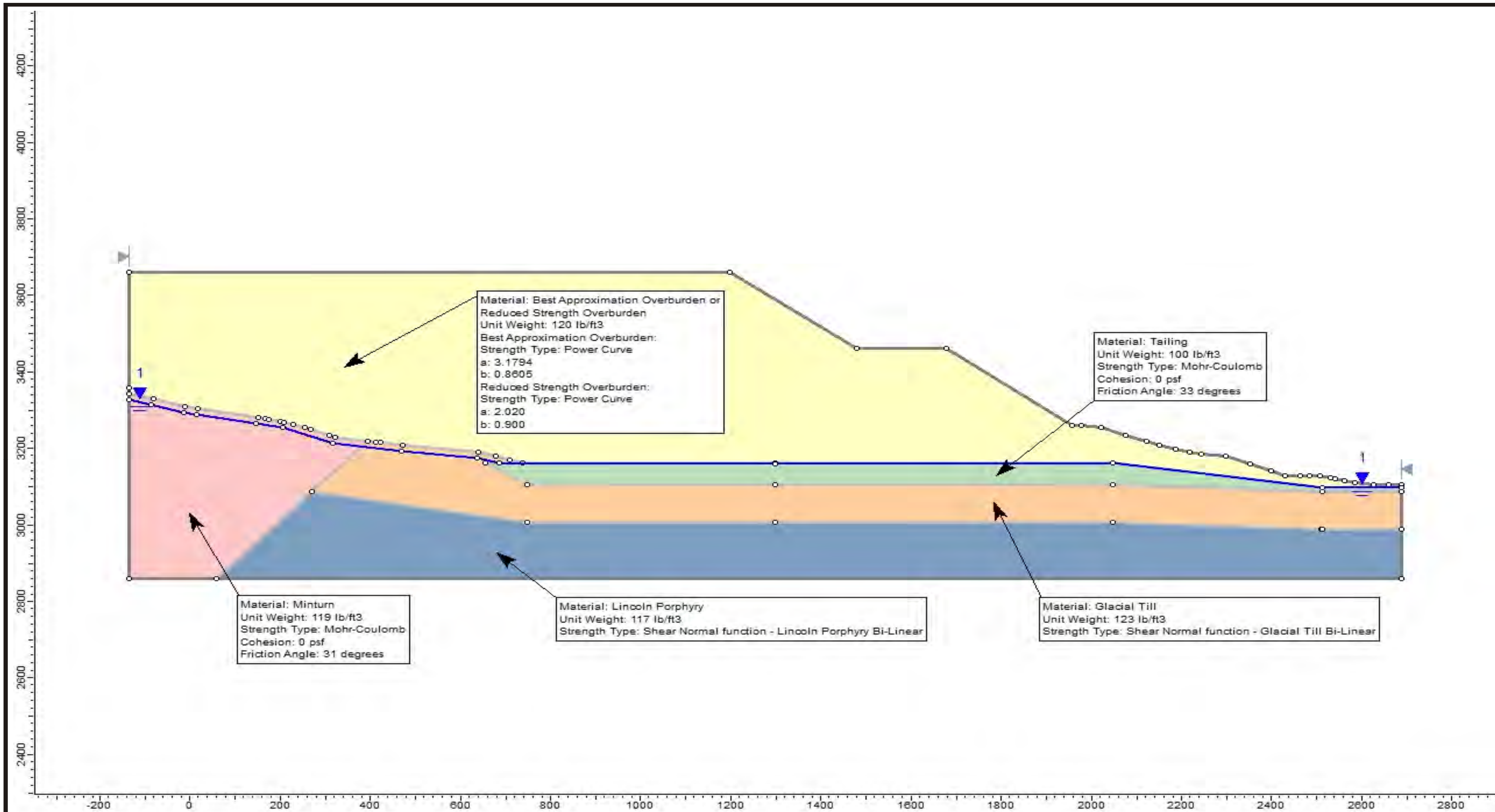
TITLE

OSF FOOTPRINT AND STABILITY SECTIONS

Golder Associates
DENVER, COLORADO

FILE No. 11381608C001_4APR12
PROJECT No. 113-81608

FIGURE 1



Golder Associates

Denver, Colorado

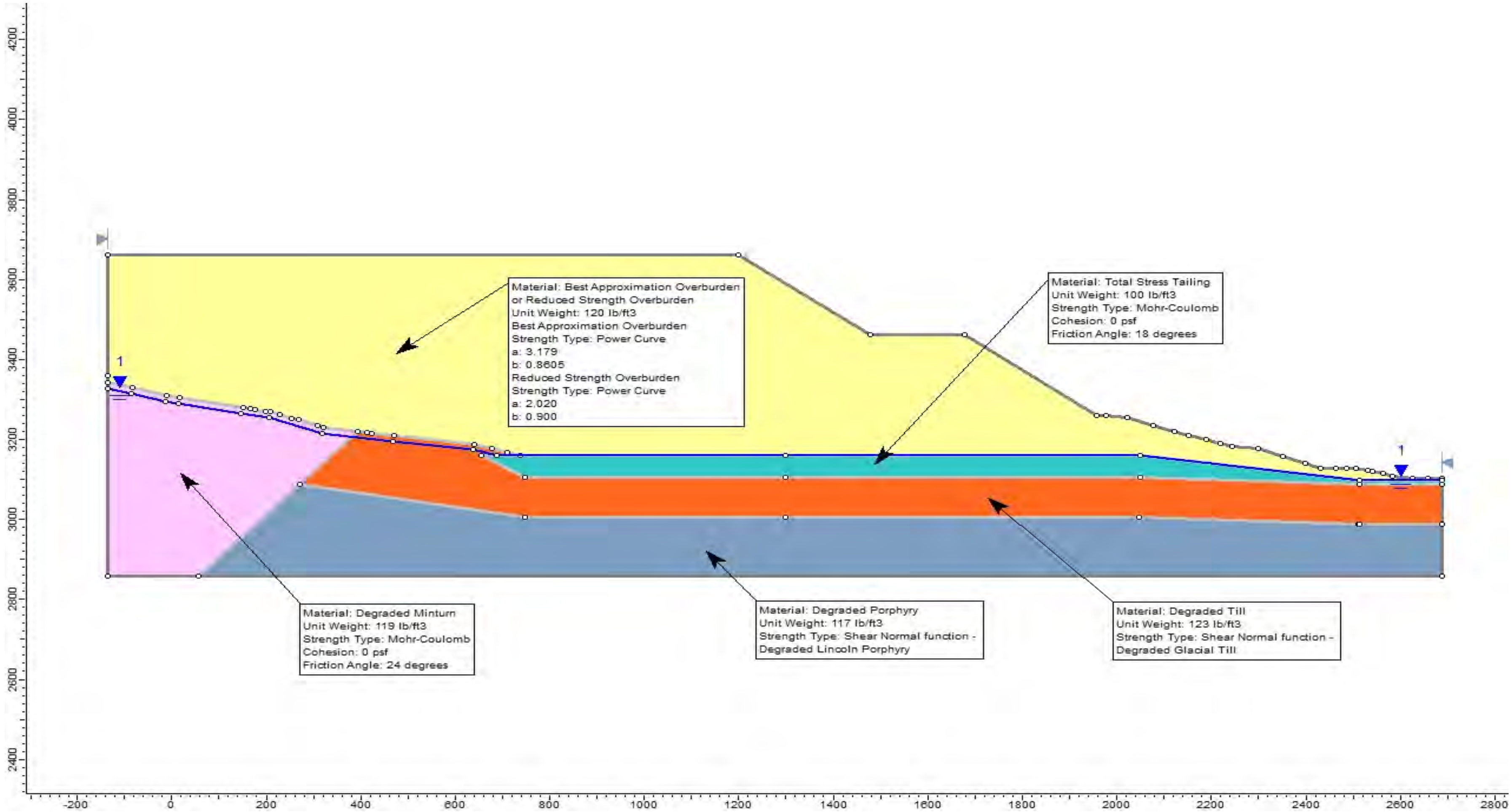
TITLE

Typical Cross-Section and Material Properties

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	2



Golder Associates, Denver, Colorado		TITLE	**Typical Cross-Section and Seismic Material Properties**		
CLIENT/PROJECT **Freeport McMoRan/Climax Molybdenum OSF Stability Analysis**	DRAWN	DAR	DATE Apr-12	JOB NO.	113-81608
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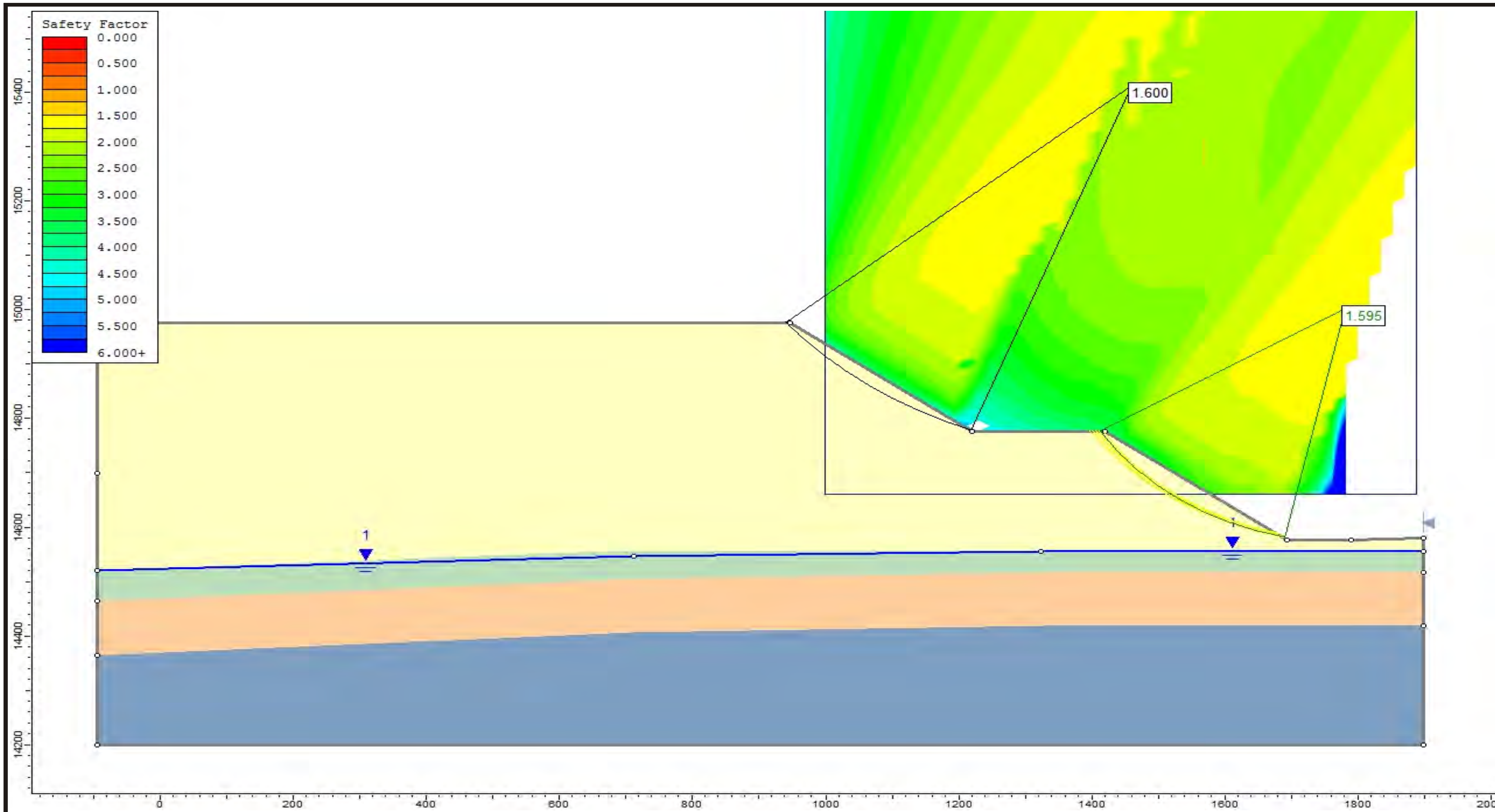


Golder Associates

Denver, Colorado

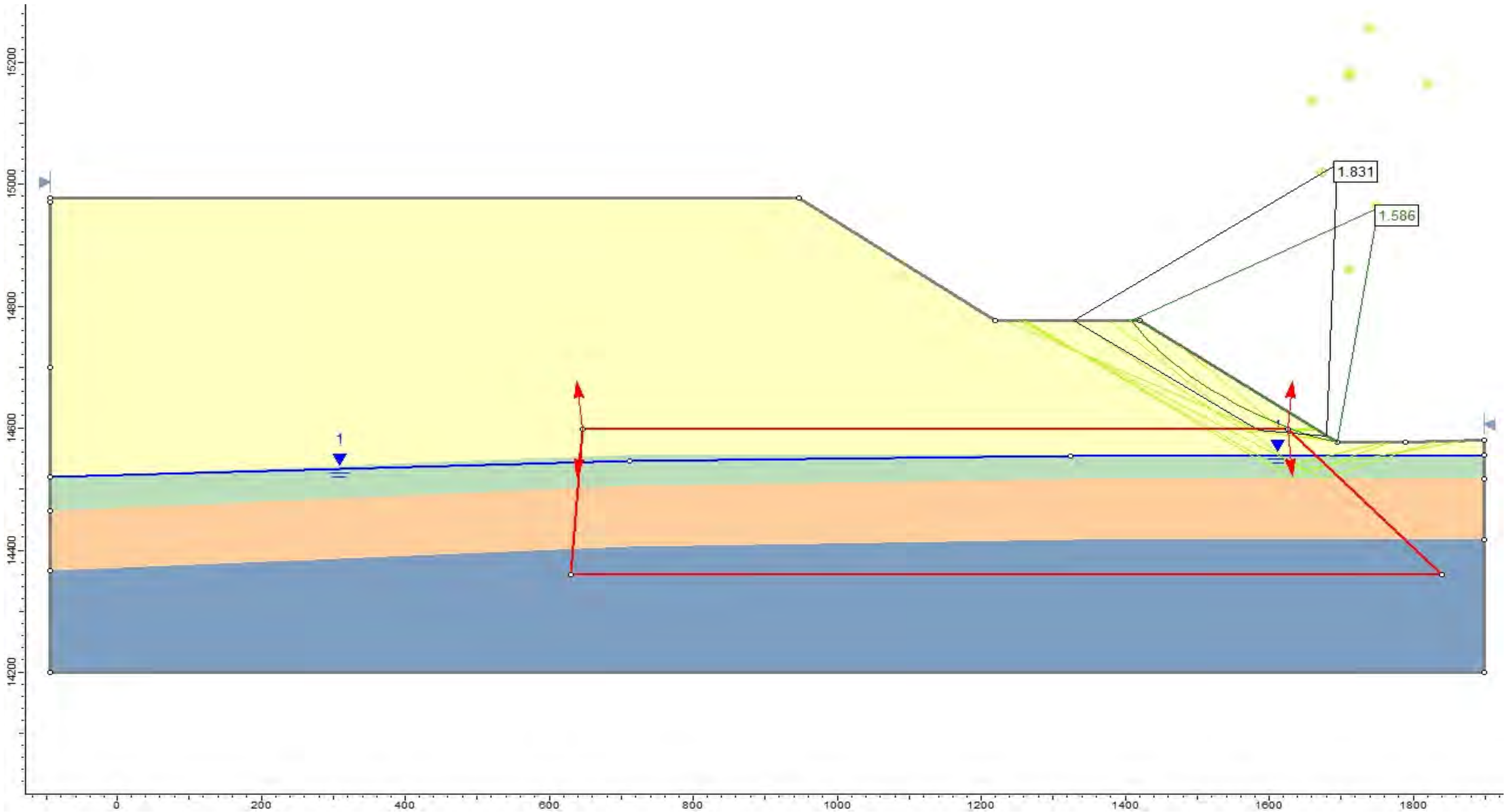
TITLE

Cross-Section A-A
Circular Analysis during Operations

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	4



Golder Associates

Denver, Colorado

TITLE

Cross-Section A-A
Block Analysis during Operations

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
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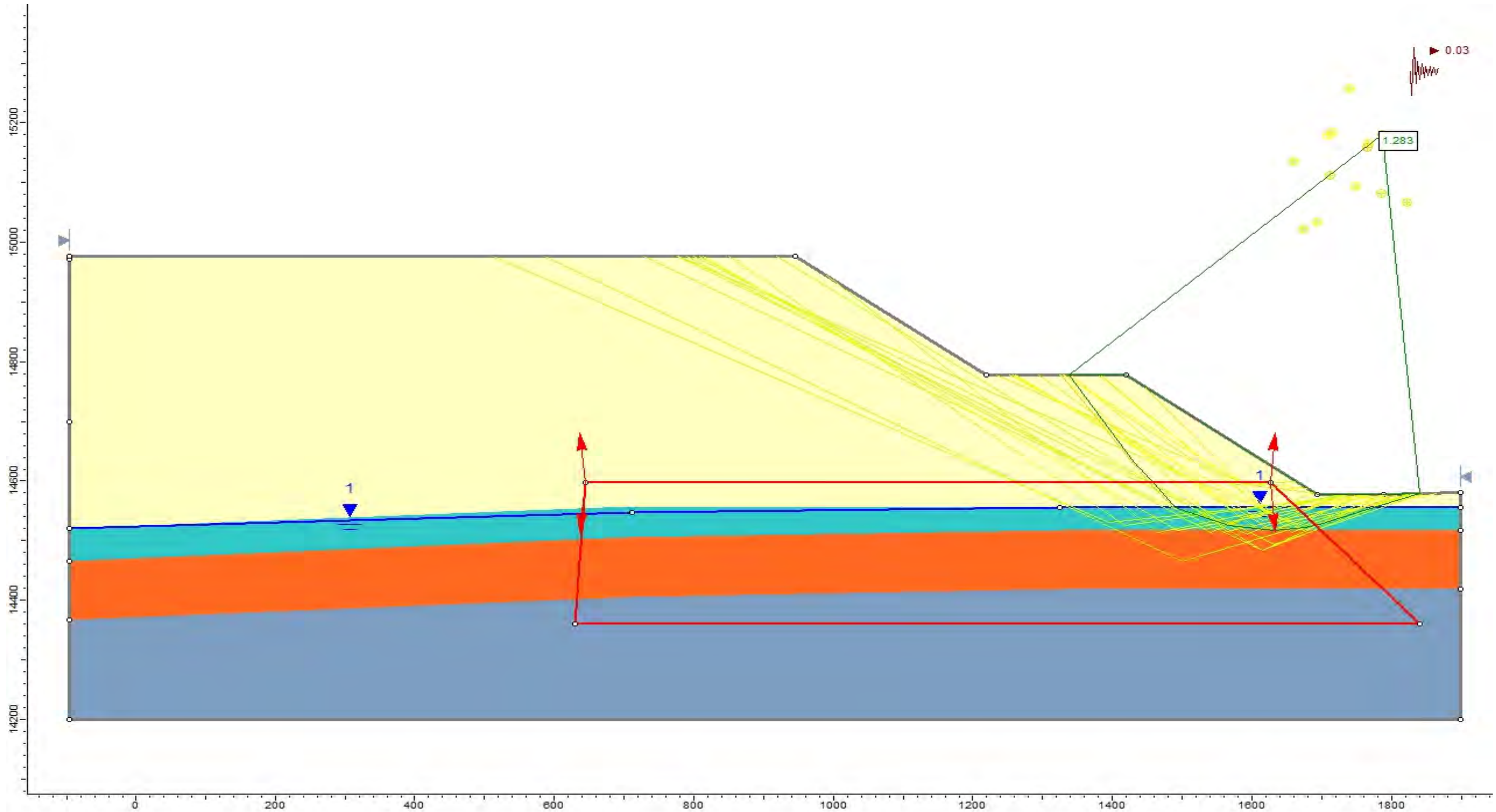
REVIEWED	BRB	FILE NO.		FIGURE NO.	5



Golder Associates

Denver, Colorado

TITLE

Cross-Section A-A Seismic Analysis
(Operational Seismic Coefficient = 0.03g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
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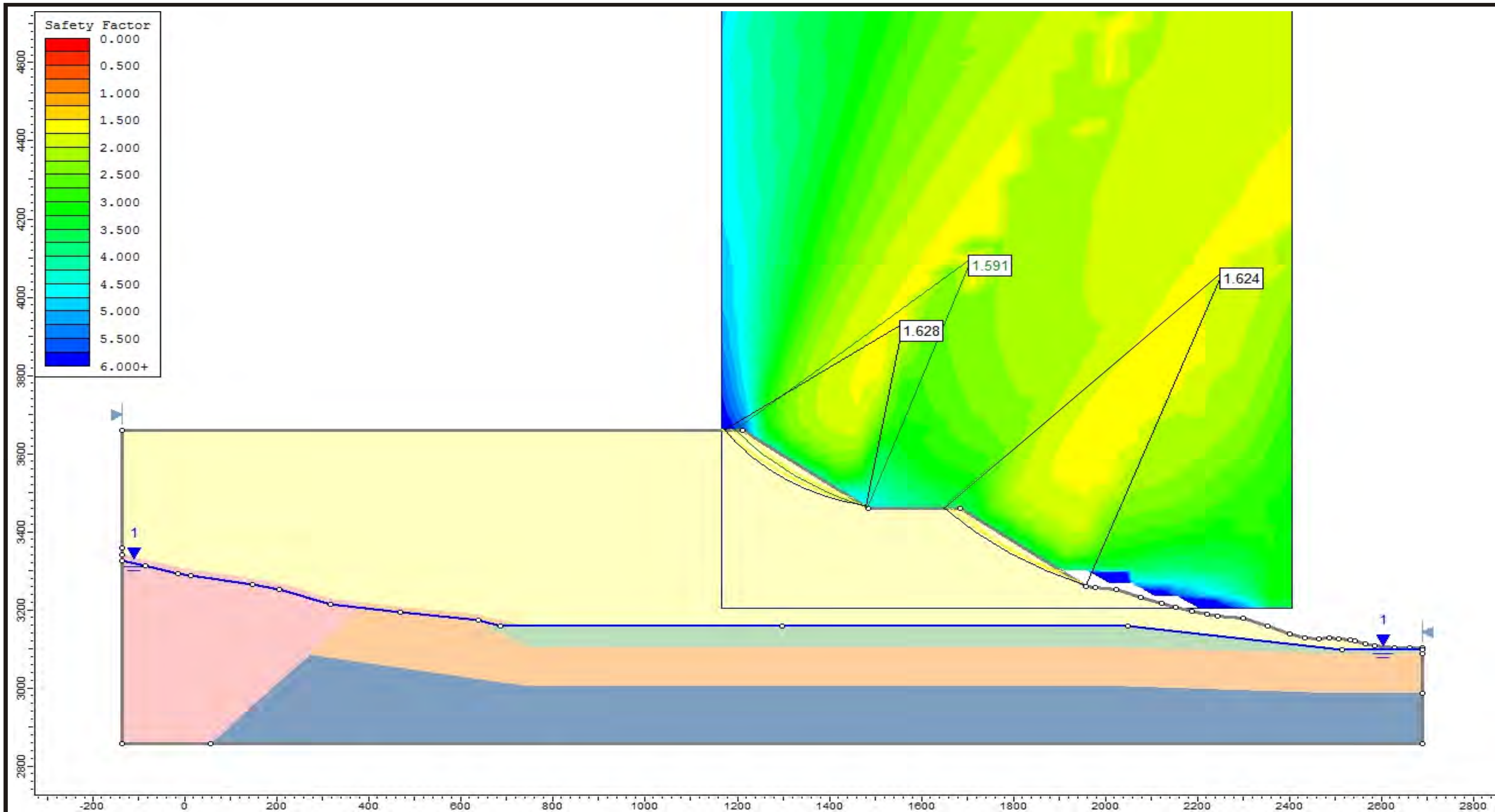

Golder Associates

Denver, Colorado

TITLE	Cross-Section B-B Circular Analysis during Operations				
DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
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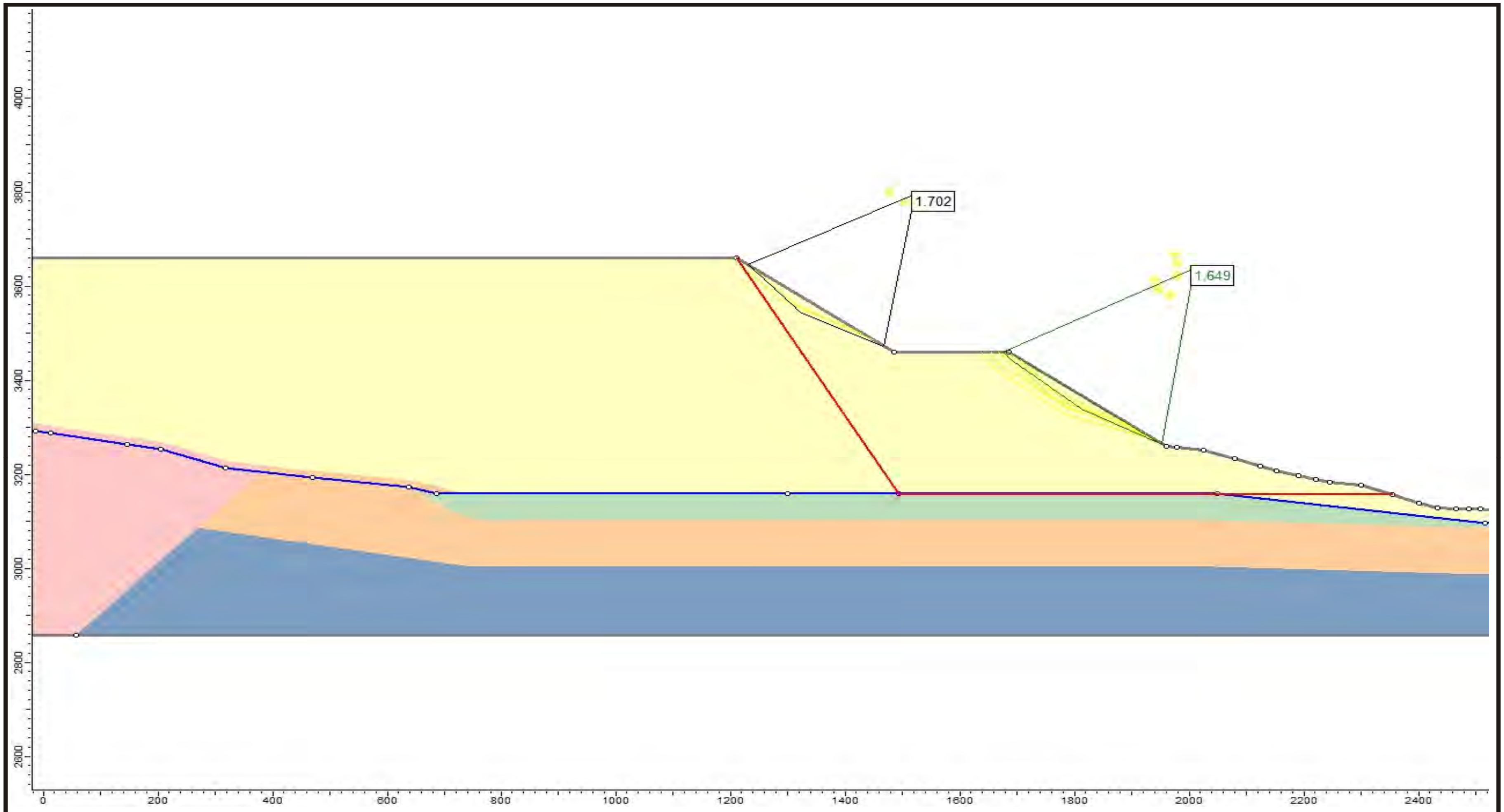
CLIENT/PROJECT
Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis



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Denver, Colorado

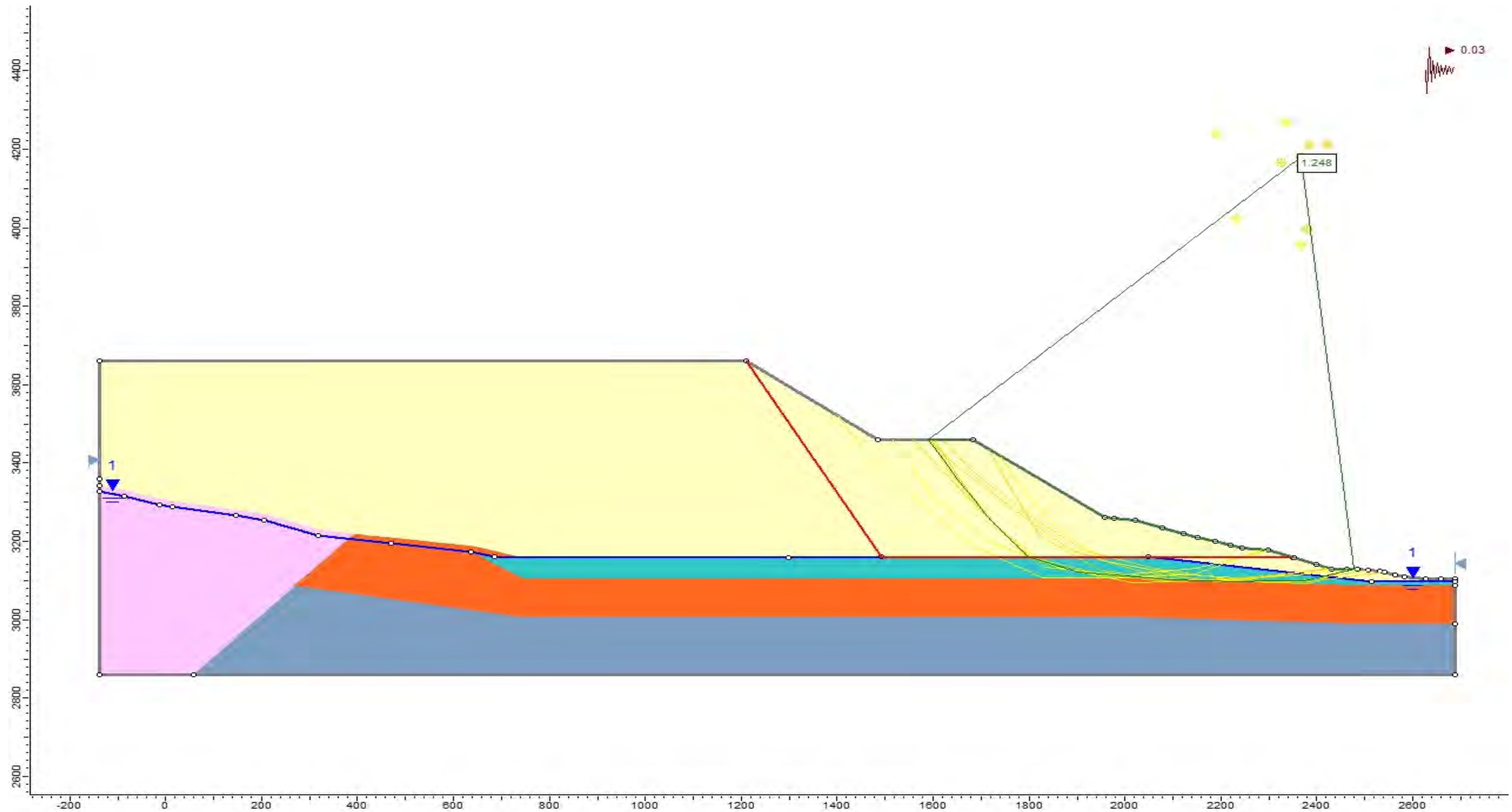
TITLE

Cross-Section B-B
Block Analysis during Operations

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	8



Golder Associates

Denver, Colorado

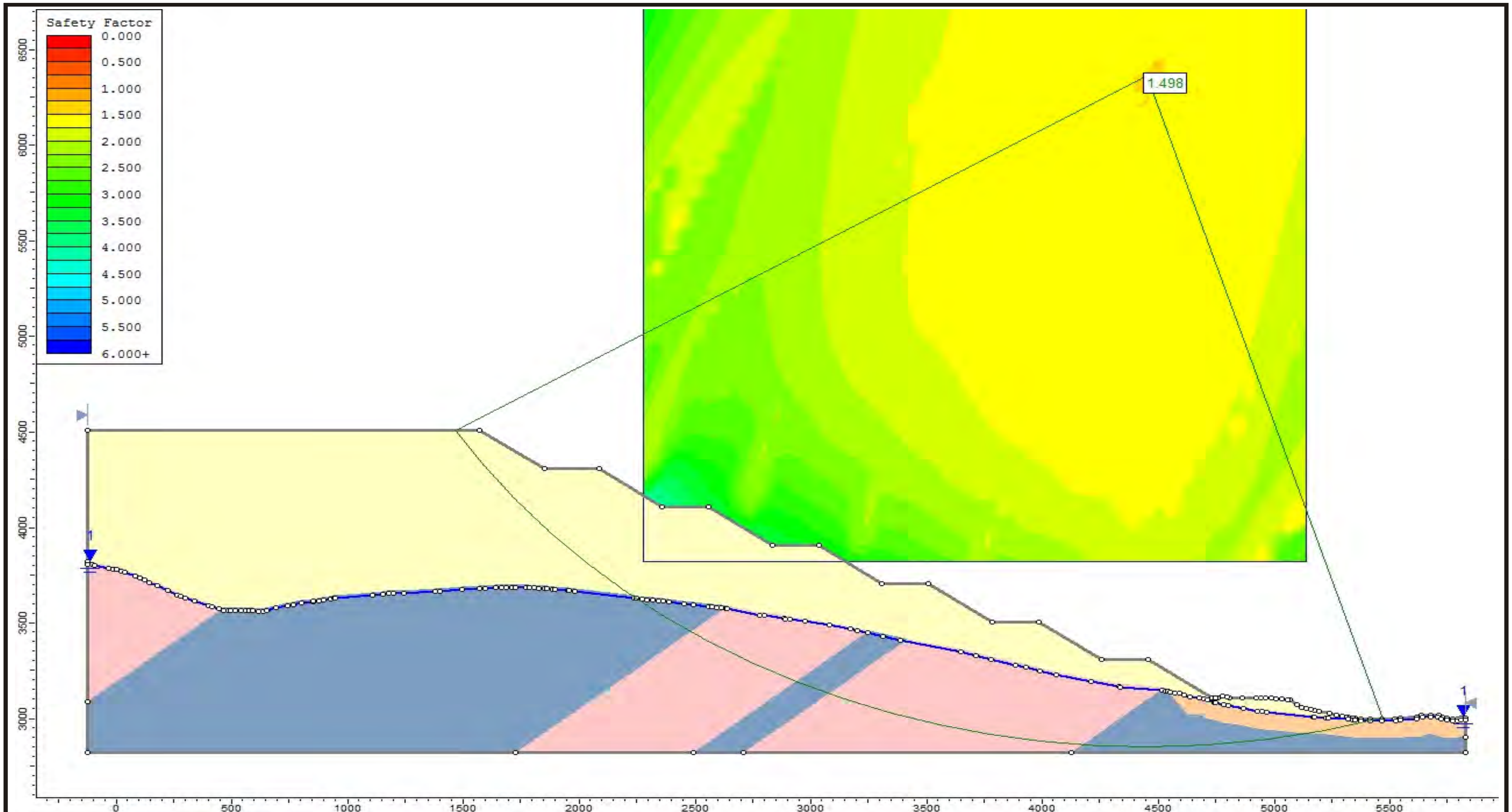
TITLE

Cross-Section B-B Seismic Analysis (Operational Seismic Coefficient = 0.03g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	9

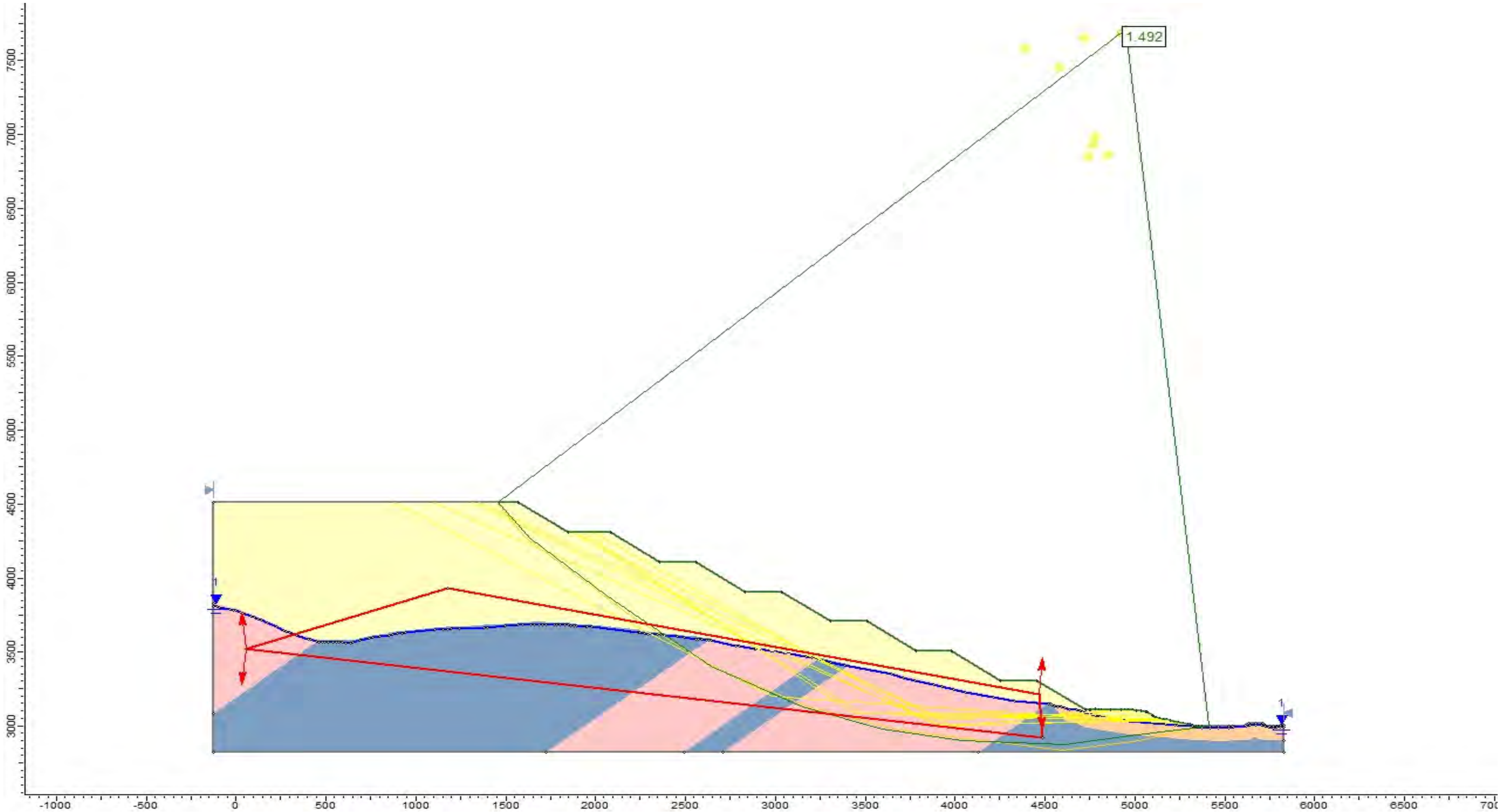


Golder Associates
Denver, Colorado

TITLE
Cross-Section C-C
Circular Analysis during Operations

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	10

CLIENT/PROJECT
Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis



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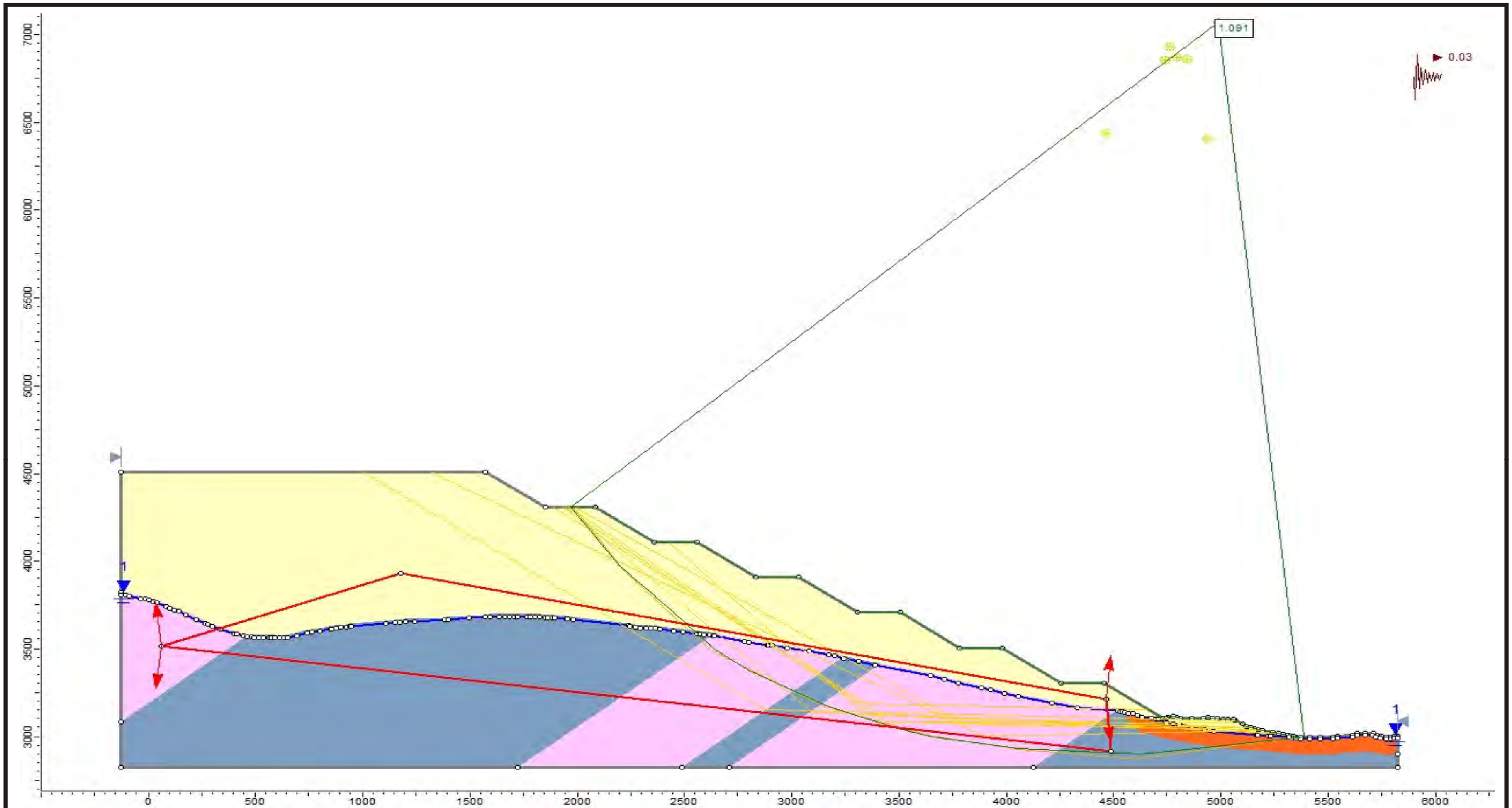
TITLE

Cross-Section C-C
Block Analysis during Operations

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	11



Golder Associates

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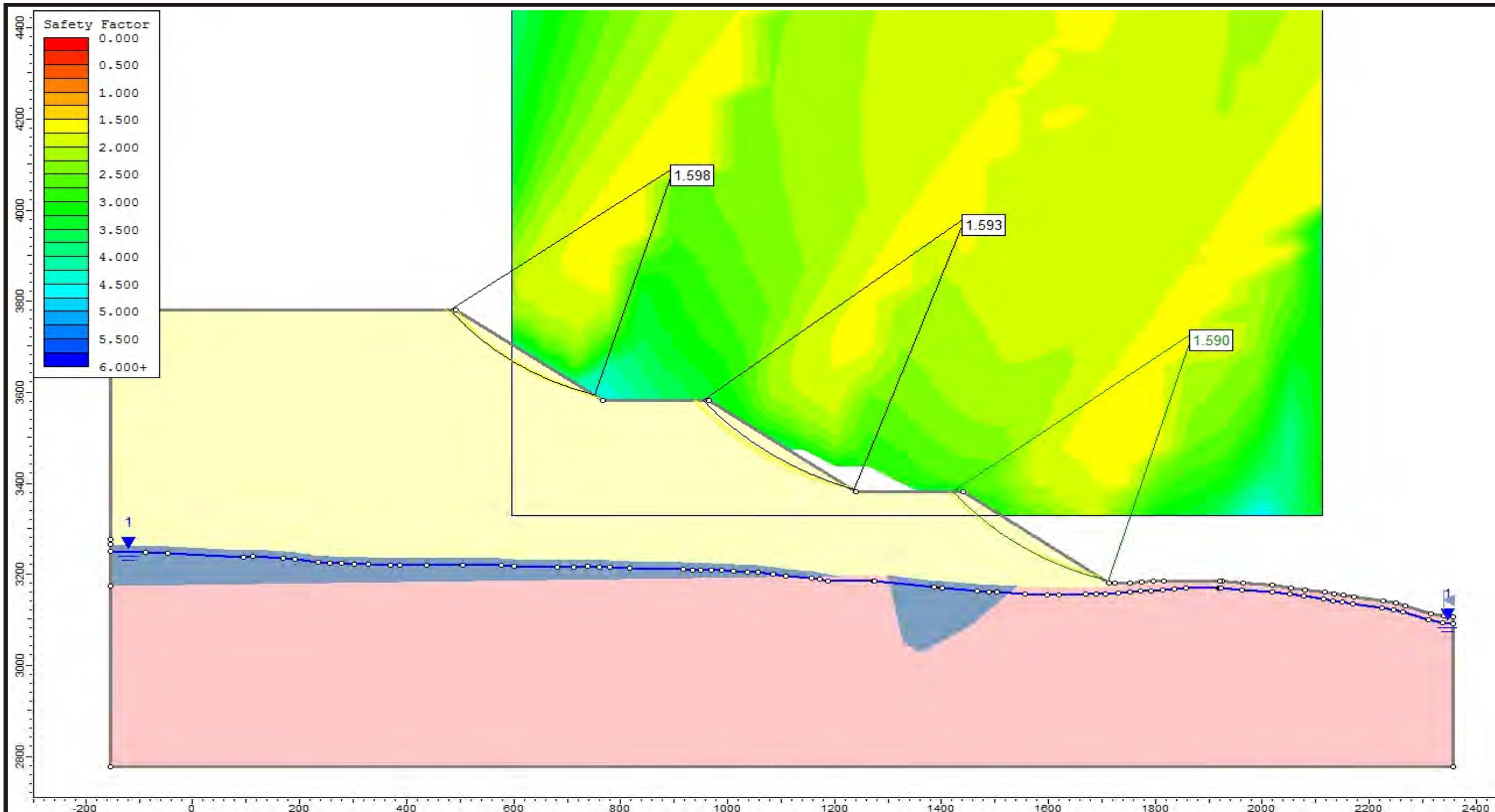
TITLE

Cross-Section C-C Seismic Analysis (Operational Seismic Coefficient = 0.03g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	12



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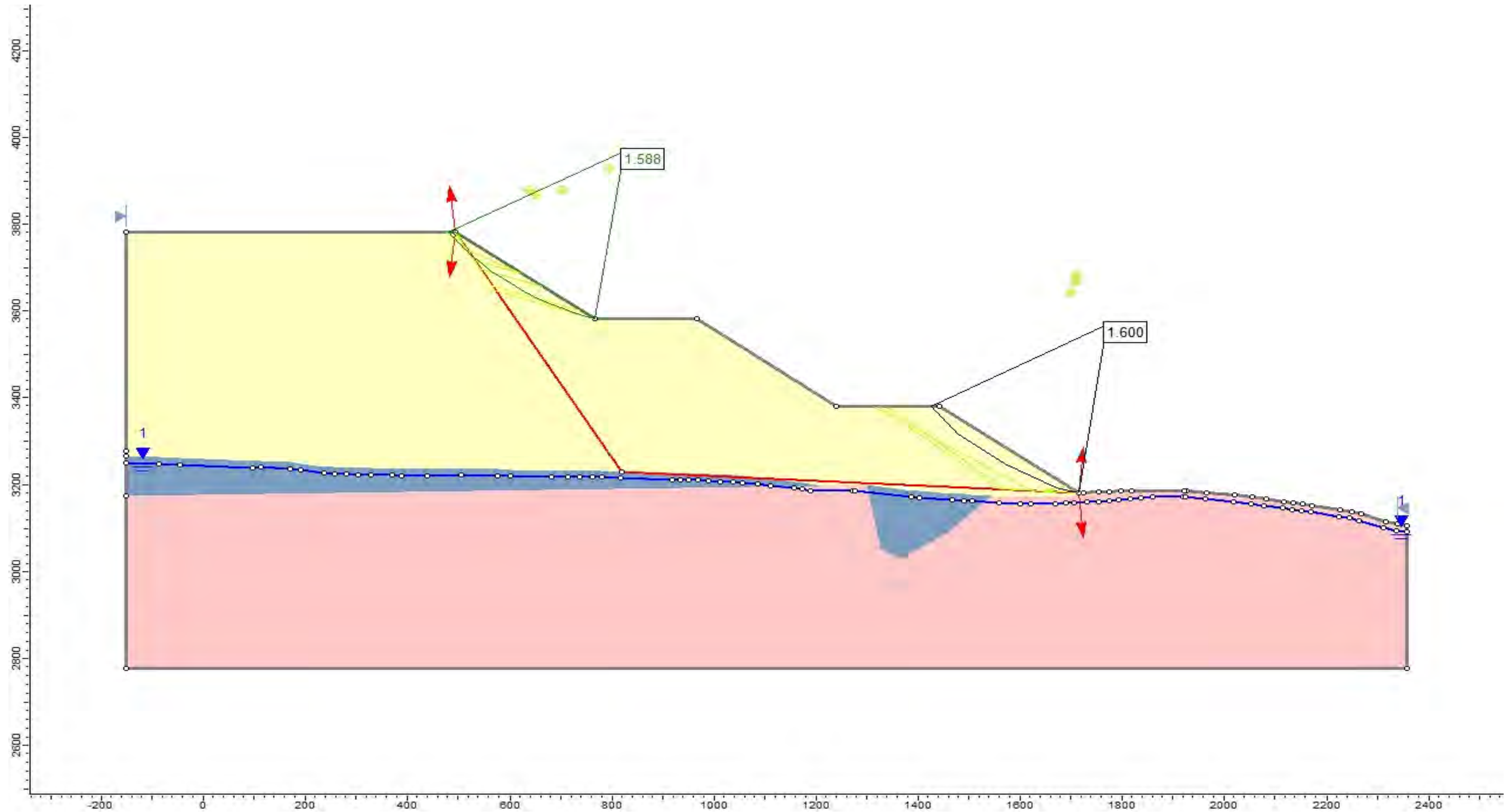
TITLE	**Cross-Section D-D Circular Analysis during Operations**				
DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	13

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis



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Denver, Colorado

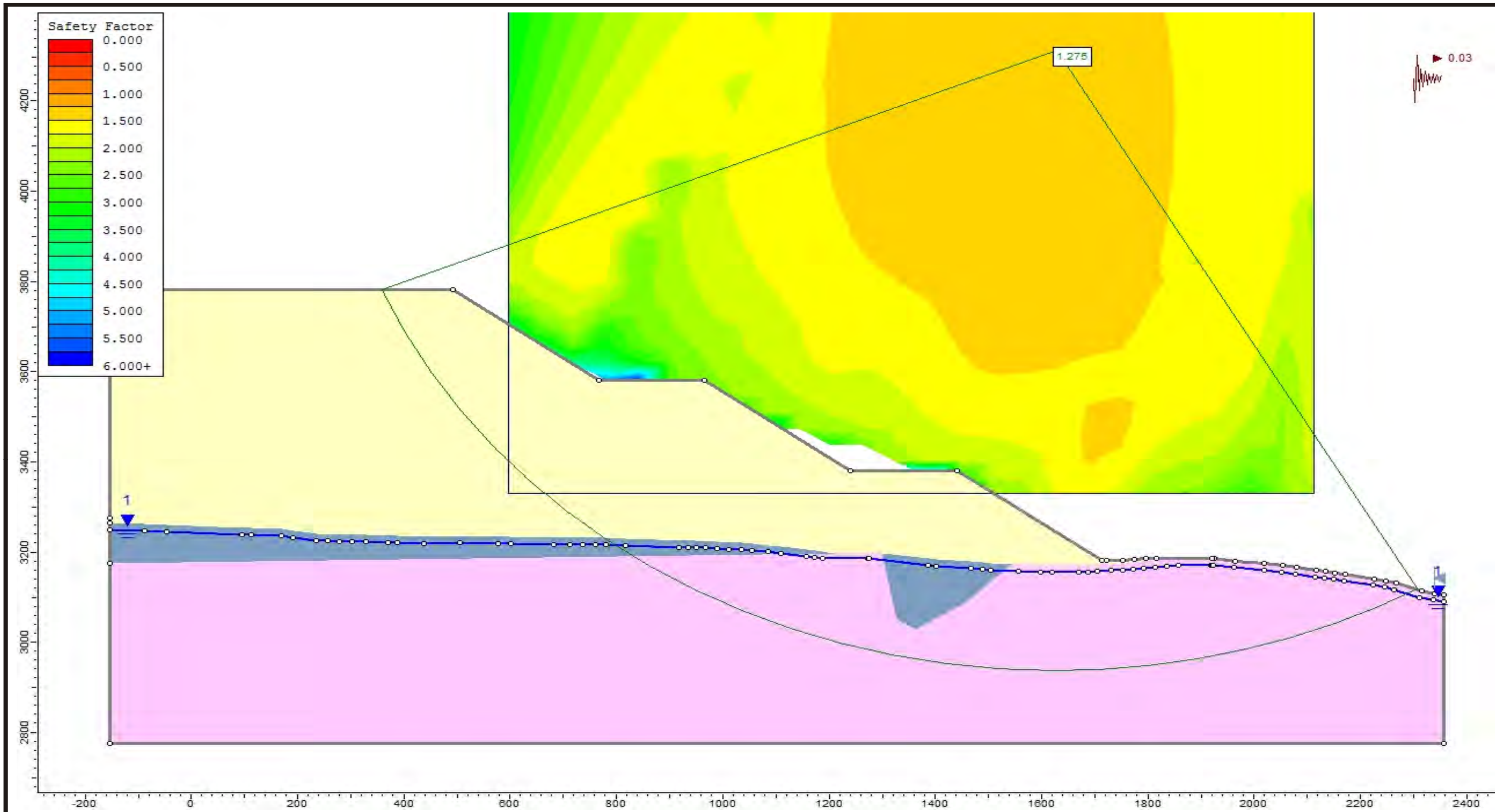
TITLE

Cross-Section D-D
Block Analysis during Operations

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	14

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis



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Denver, Colorado

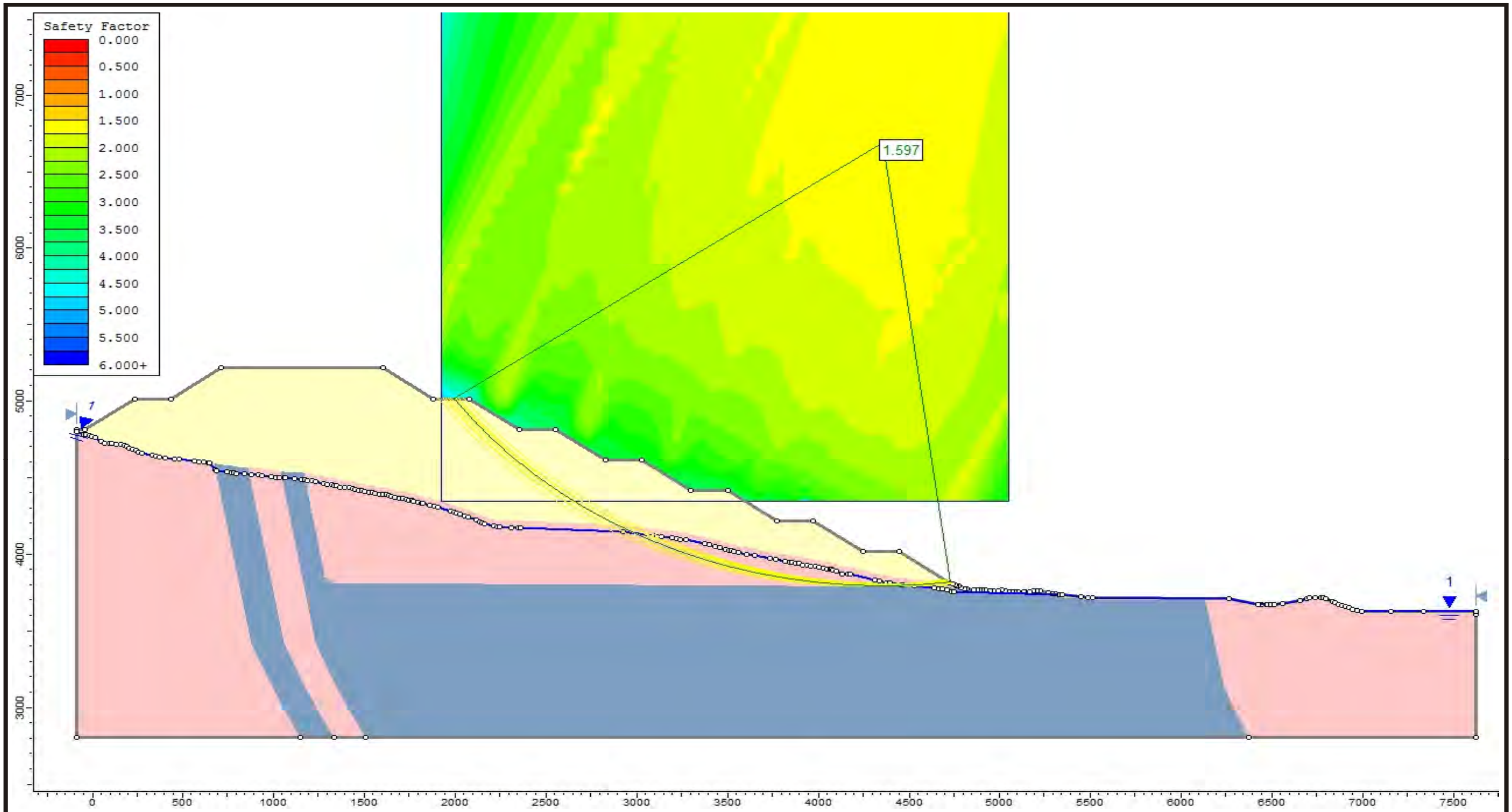
TITLE

Cross-Section D-D Seismic Analysis (Operational Seismic Coefficient = 0.03g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	15



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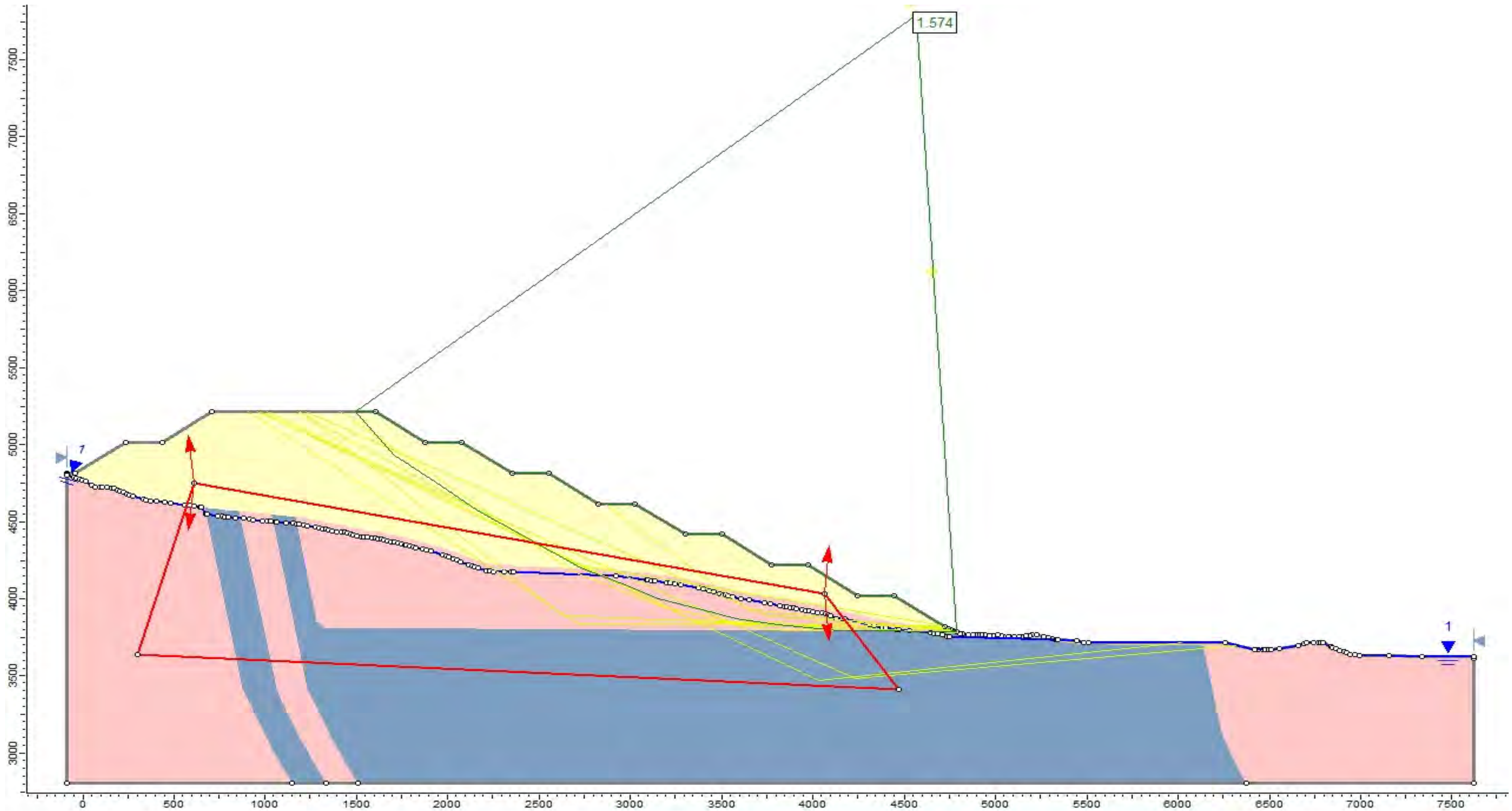
TITLE

Cross-Section E-E
Circular Analysis during Operations

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	16



Golder Associates
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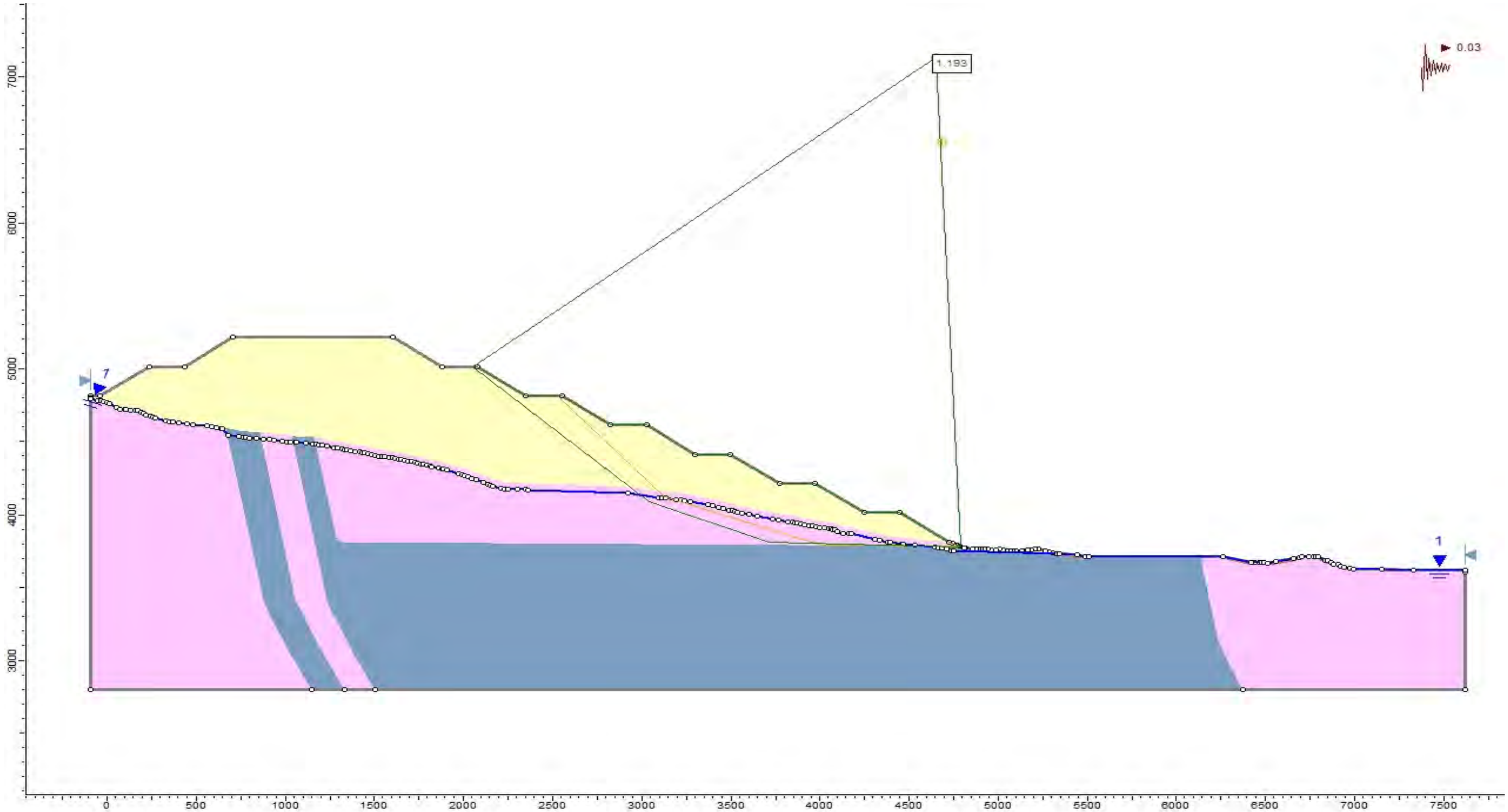
TITLE

Cross-Section E-E
Block Analysis during Operations

CLIENT/PROJECT
Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	17



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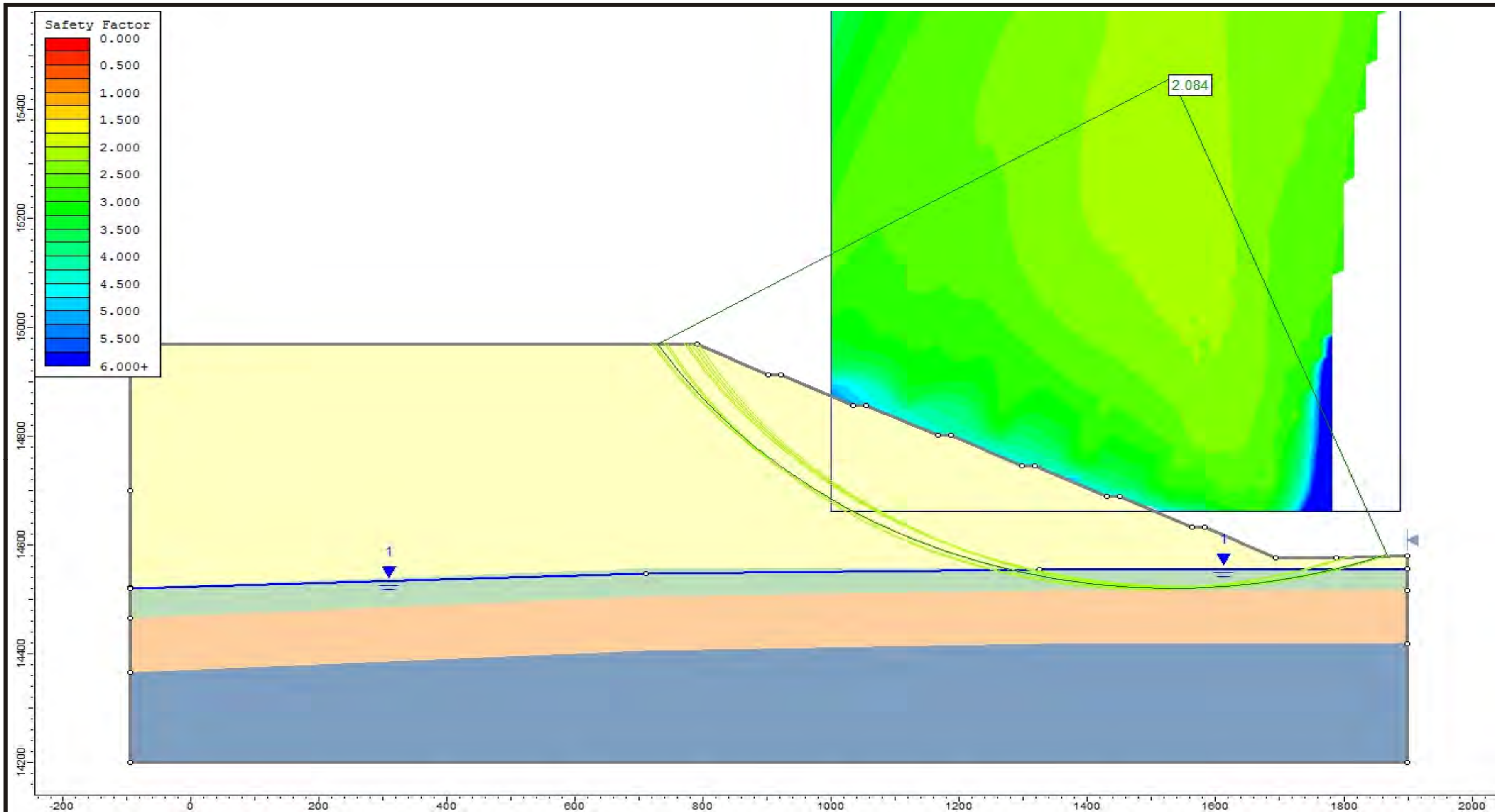
TITLE

Cross-Section E-E Seismic Analysis (Operational Seismic Coefficient = 0.03g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	18



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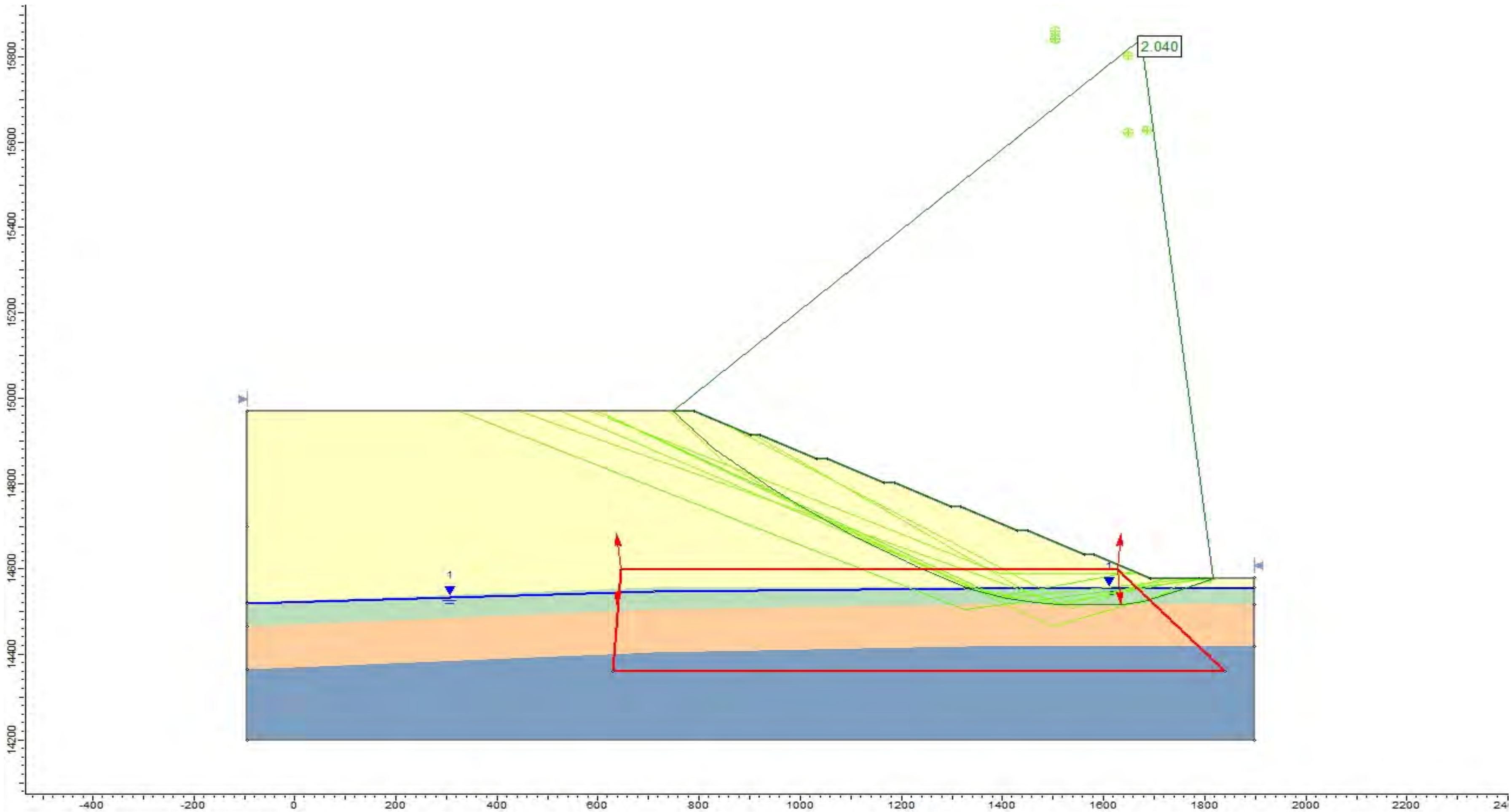
TITLE

Cross-Section A-A
Circular Analysis for Closure

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	19



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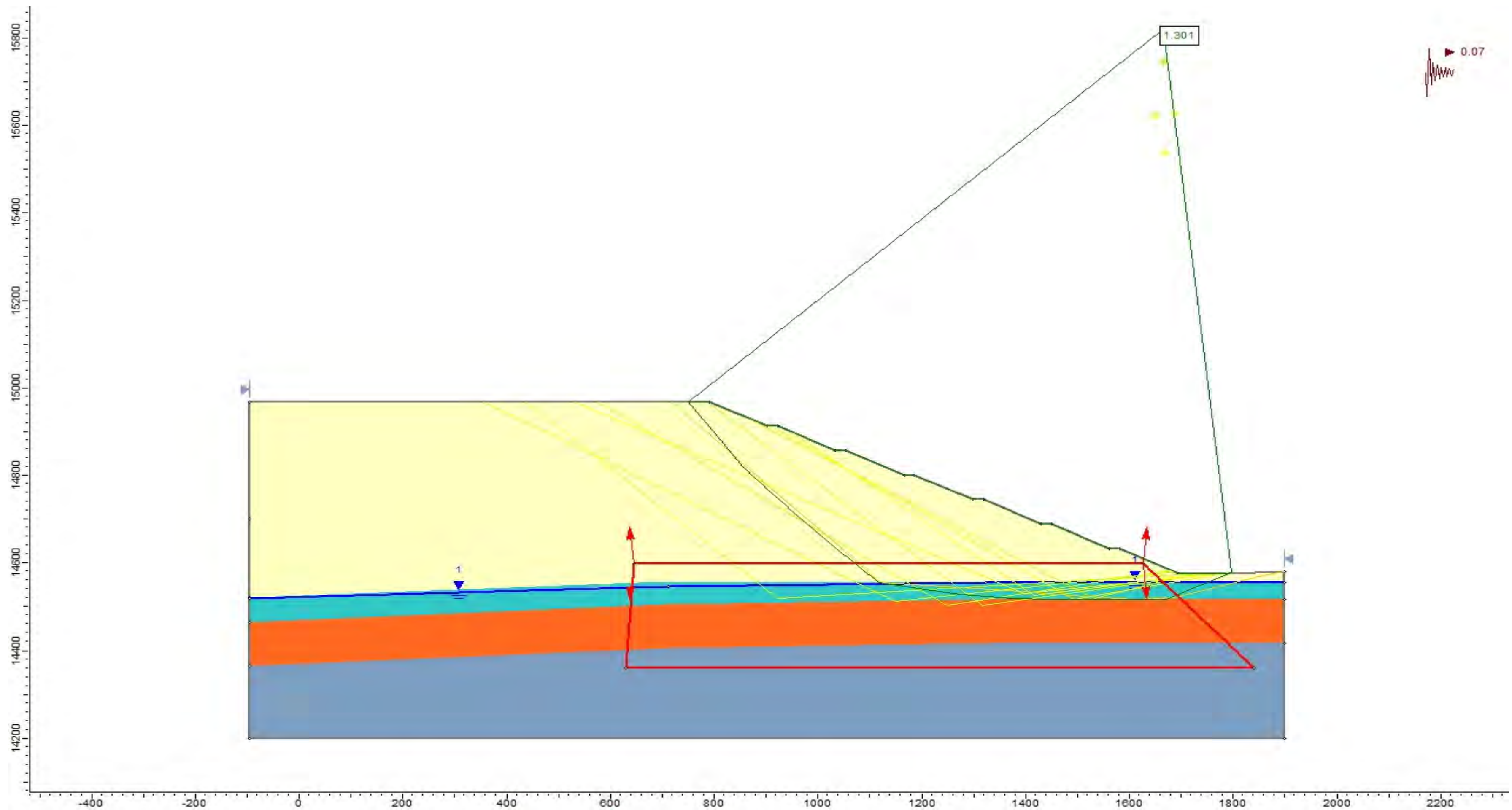
TITLE

Cross-Section A-A
Block Analysis for Closure

CLIENT/PROJECT: **Freeport McMoRan/Climax Molybdenum OSF Stability Analysis**	DRAWN **DAR**	DATE **Apr-12**	JOB NO. **113-81608**		
	CHECKED **DLG**	SCALE **NTS**	DWG. NO. **N/A**		
	REVIEWED **BRB**	FILE NO.	FIGURE NO. **20**		



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Denver, Colorado

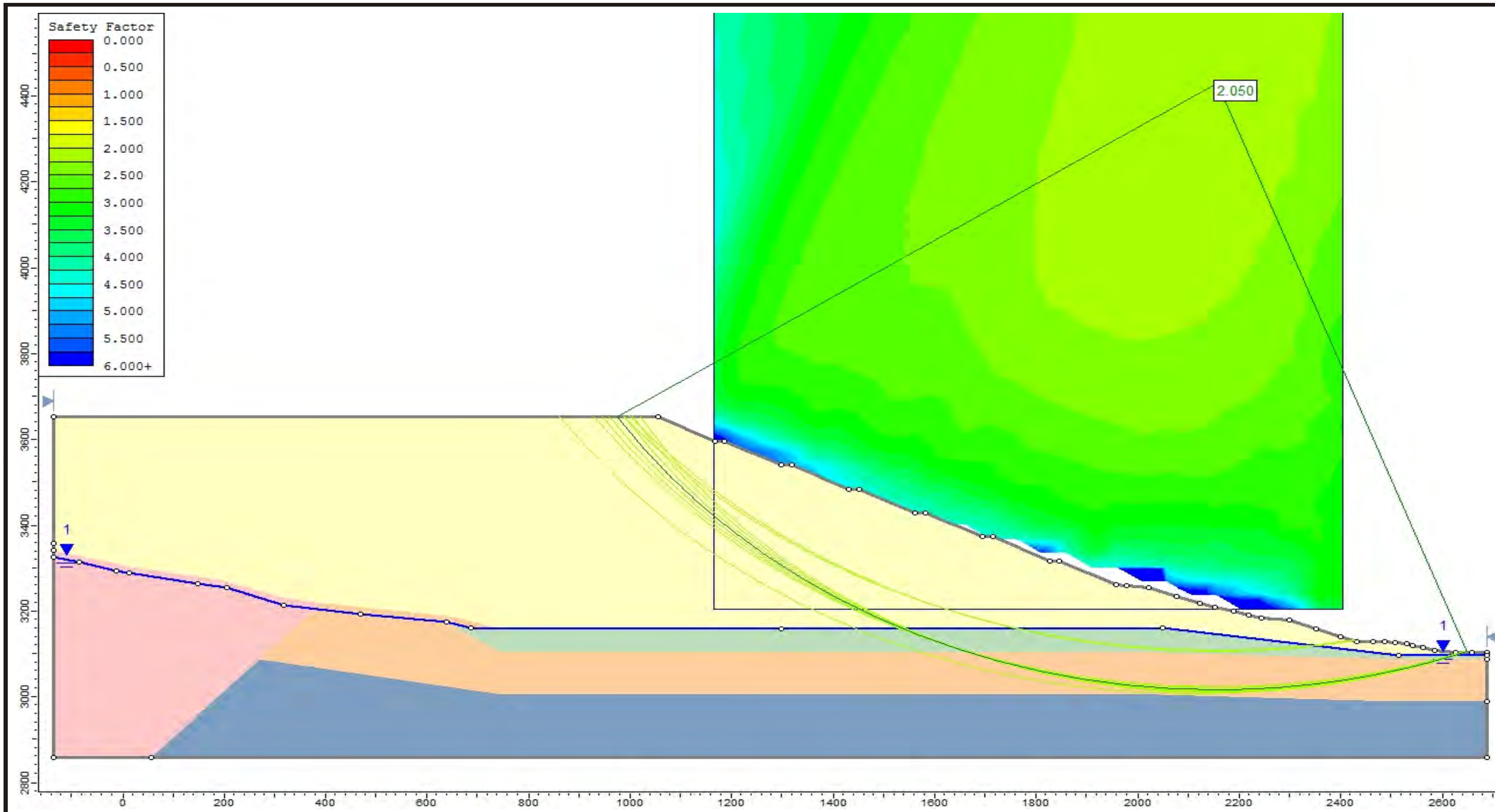
TITLE

Cross-Section A-A Seismic Analysis (Closure Seismic Coefficient = 0.07g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	21



Golder Associates

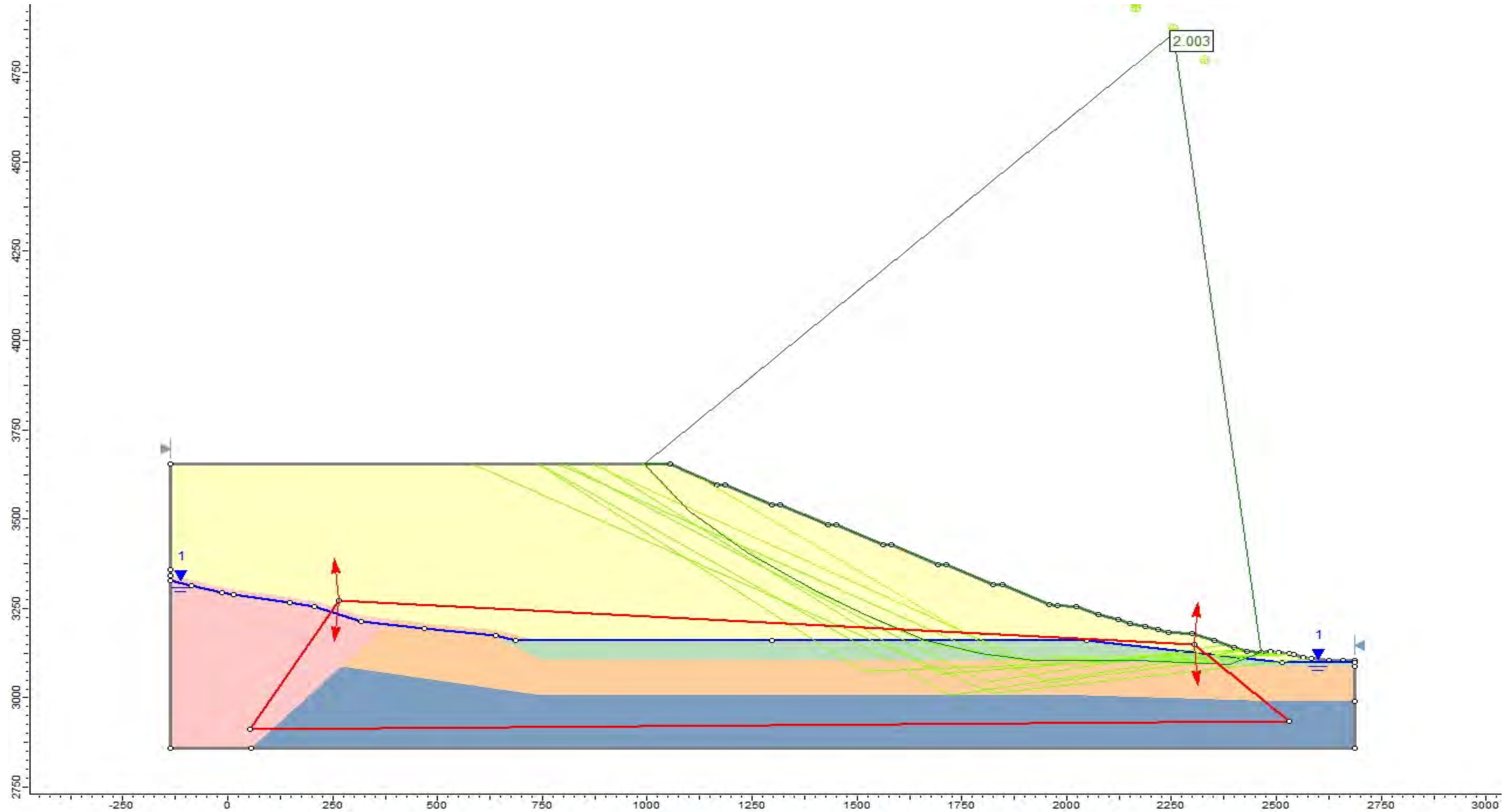
Denver, Colorado

TITLE

Cross-Section B-B
Circular Analysis for Closure

CLIENT/PROJECT
Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	22



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Denver, Colorado

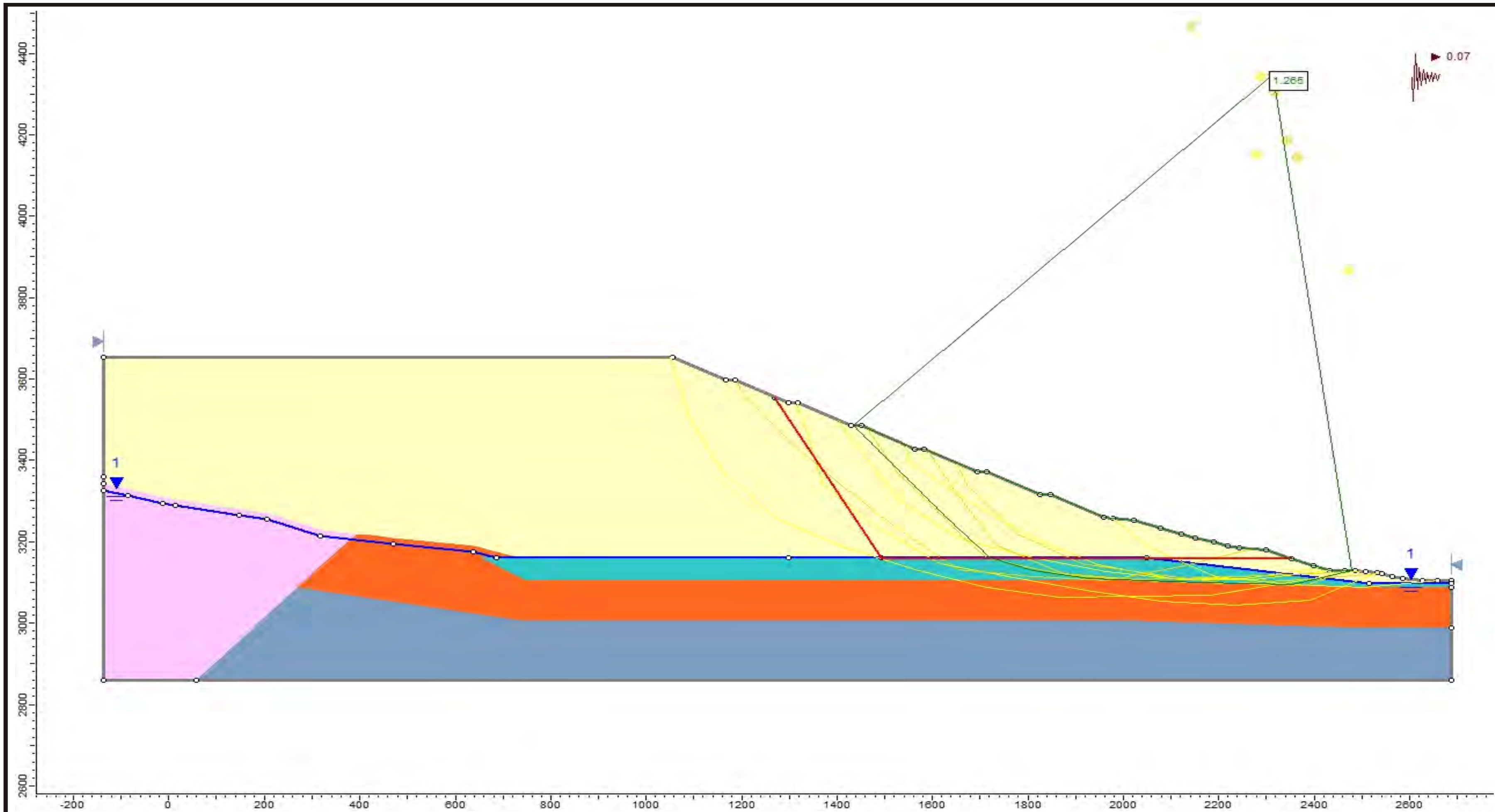
TITLE

Cross-Section B-B
Block Analysis for Closure

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	23



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Denver, Colorado

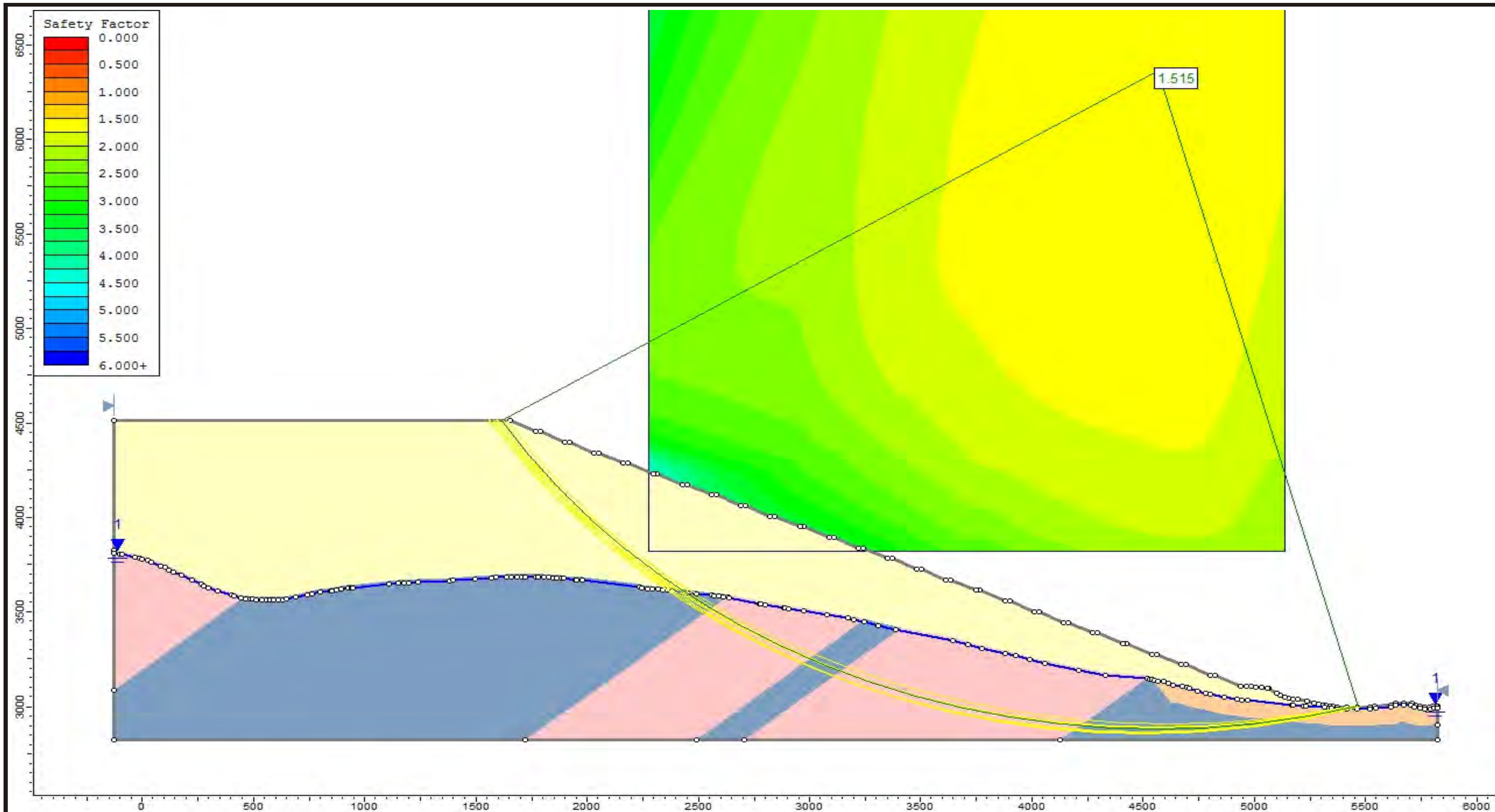
TITLE

Cross-Section B-B Seismic Analysis (Closure Seismic Coefficient = 0.07g)

CLIENT/PROJECT

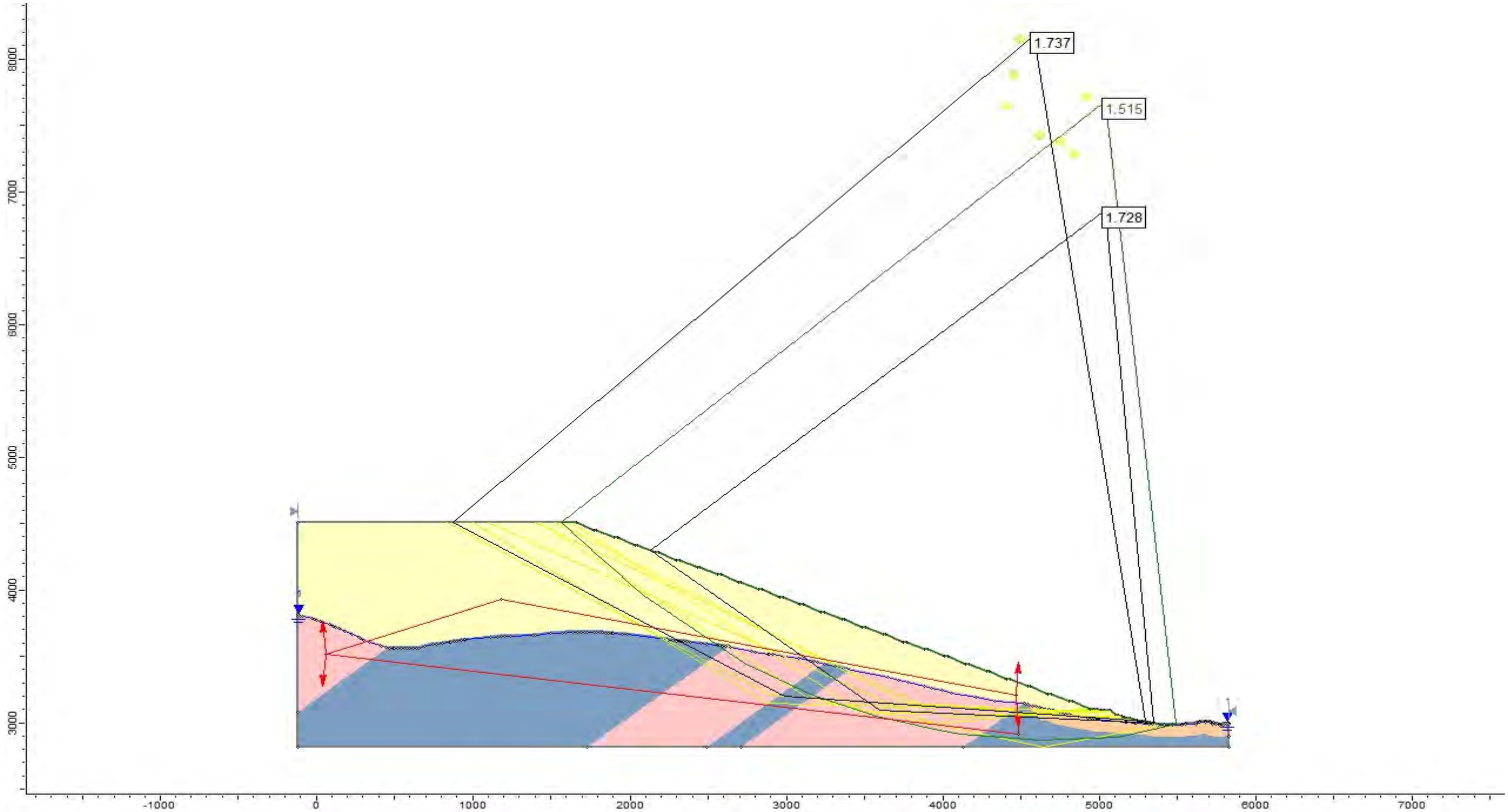
Freeport McMoRan/Climax Molybdenum OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	24



Golder Associates, Denver, Colorado	TITLE: **Cross-Section C-C Circular Analysis for Closure**
CLIENT/PROJECT: **Freeport McMoRan/Climax Molybdenum OSF Stability Analysis**	

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	25



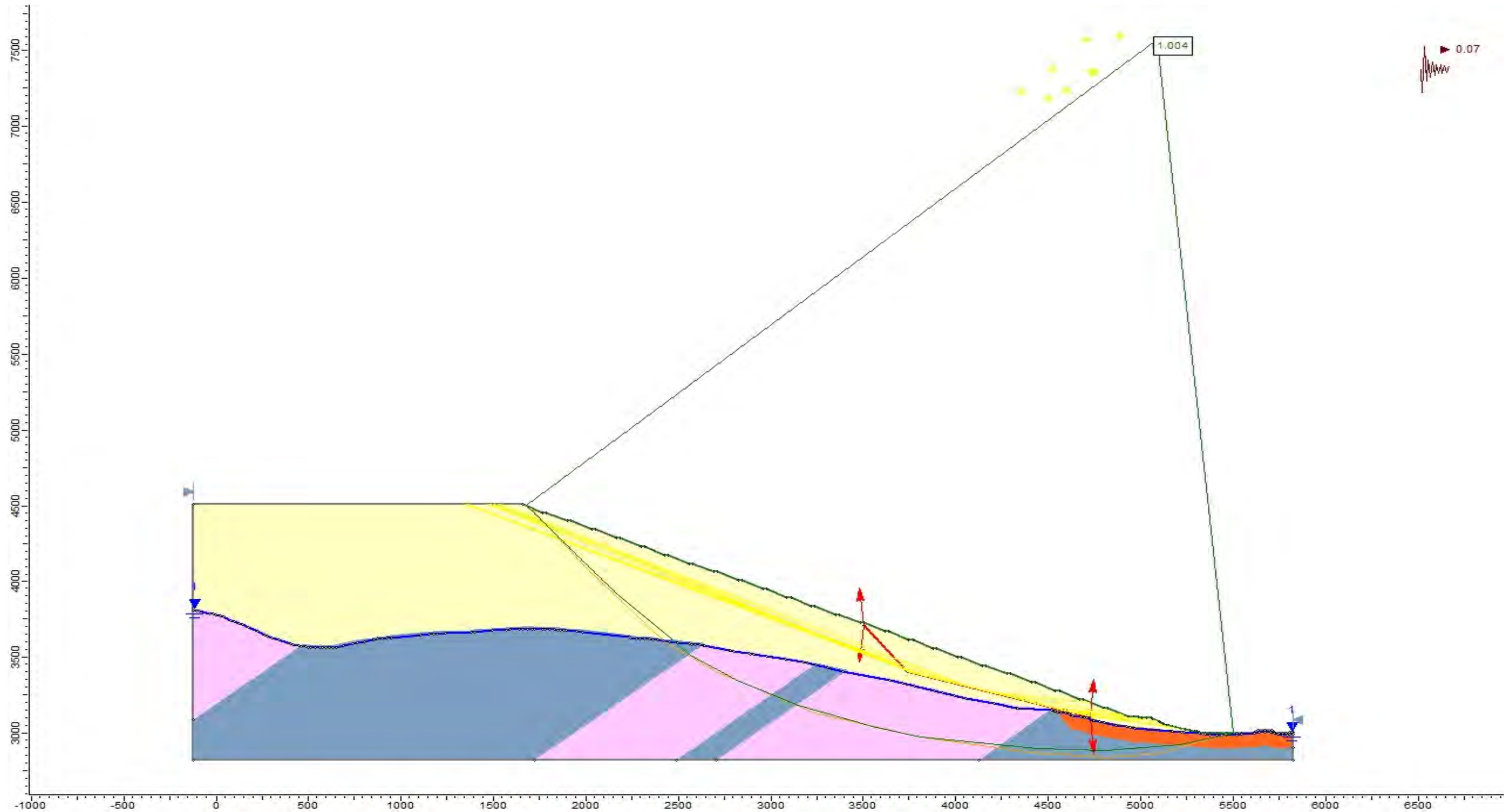
Golder Associates

Denver, Colorado

TITLE

Cross-Section C-C
Block Analysis for Closure

CLIENT/PROJECT Freeport McMoRan/Climax Molybdenum OSF Stability Analysis	DRAWN DAR	DATE Apr-12	JOB NO. 113-81608
	CHECKED DLG	SCALE NTS	DWG. NO. N/A
	REVIEWED BRB	FILE NO.	FIGURE NO. 26



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Denver, Colorado

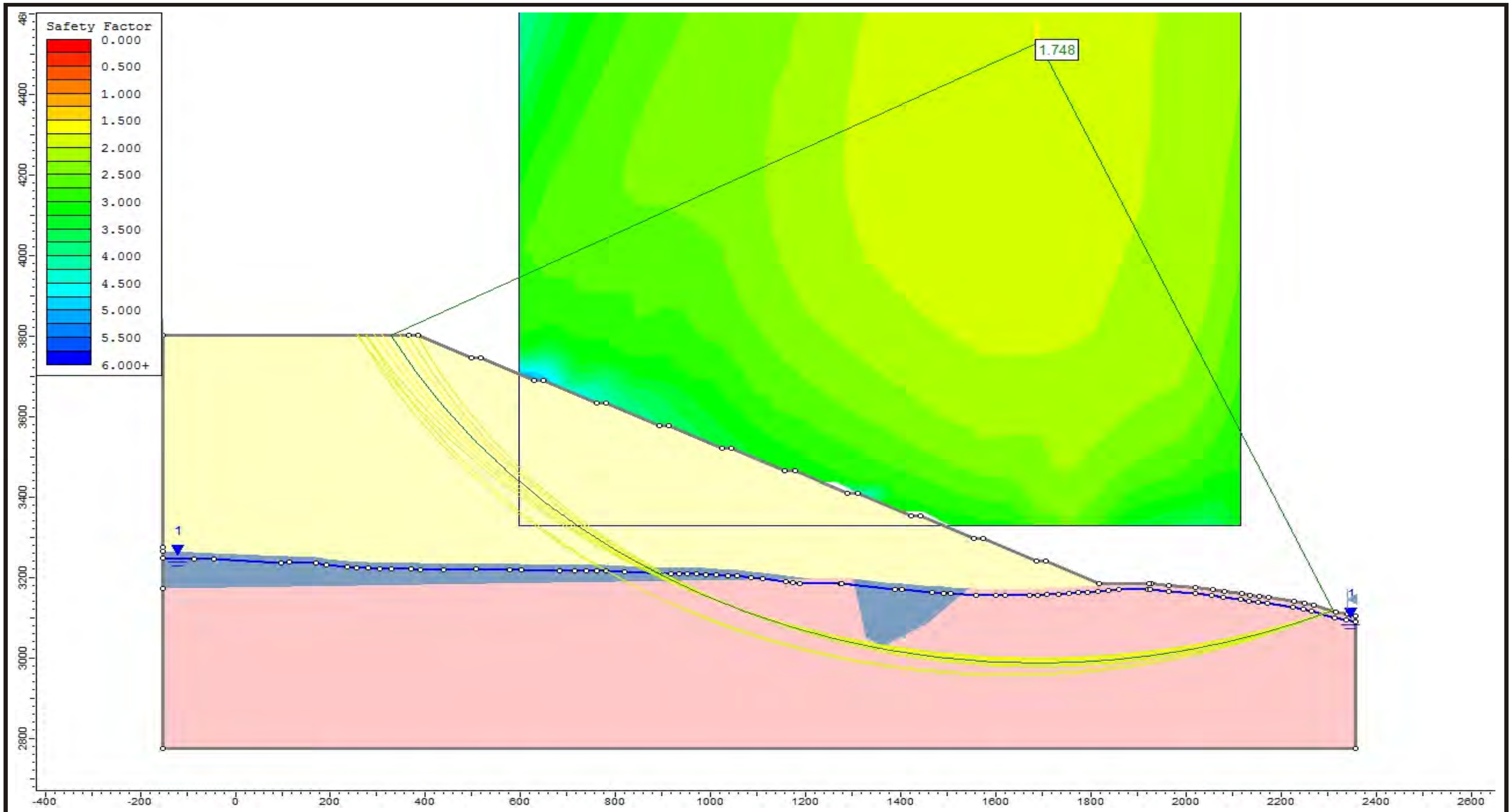
TITLE

Cross-Section C-C Seismic Analysis (Closure Seismic Coefficient = 0.07g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	27



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Denver, Colorado

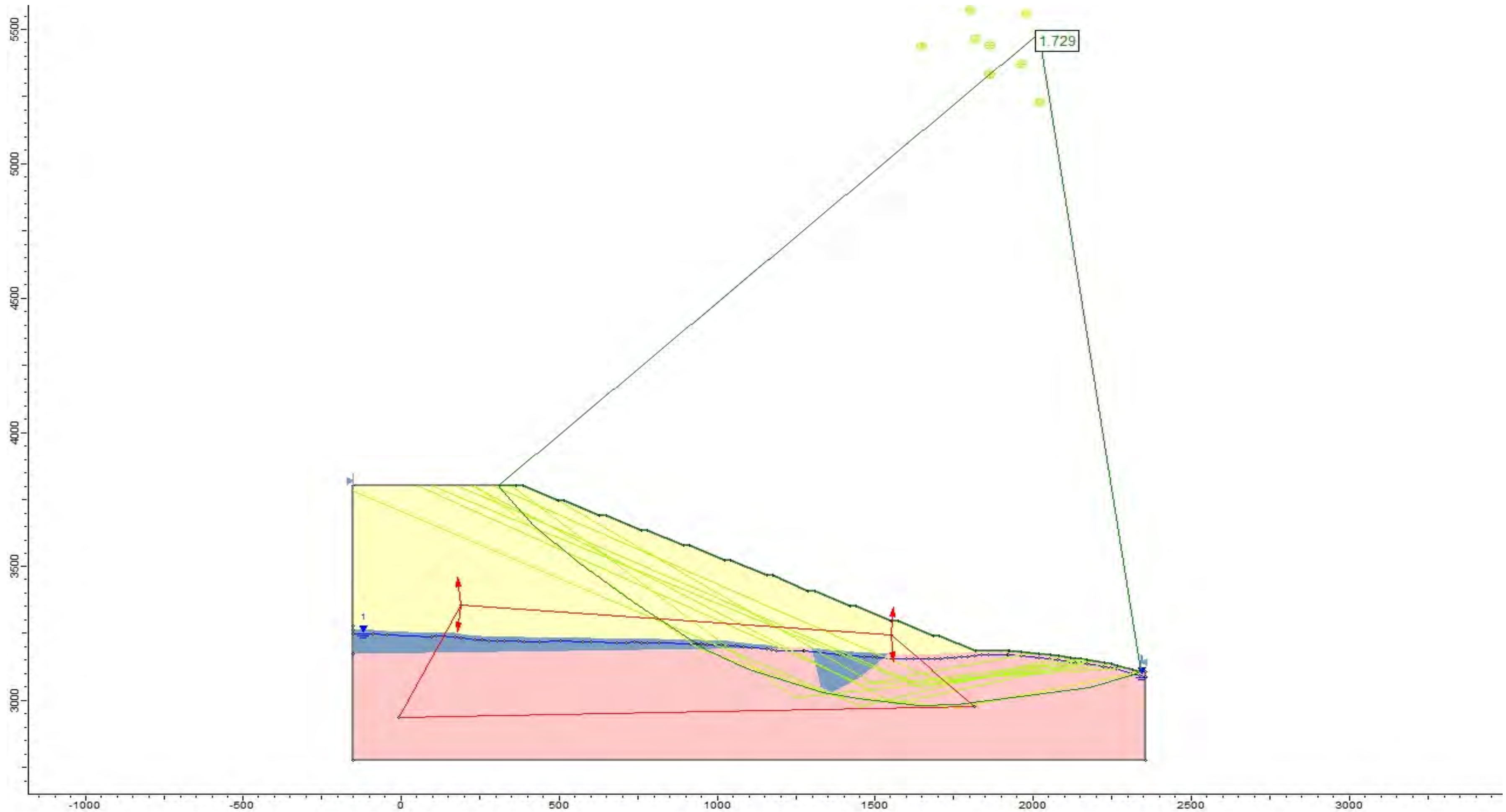
TITLE

Cross-Section D-D
Circular Analysis for Closure

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	28



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Denver, Colorado

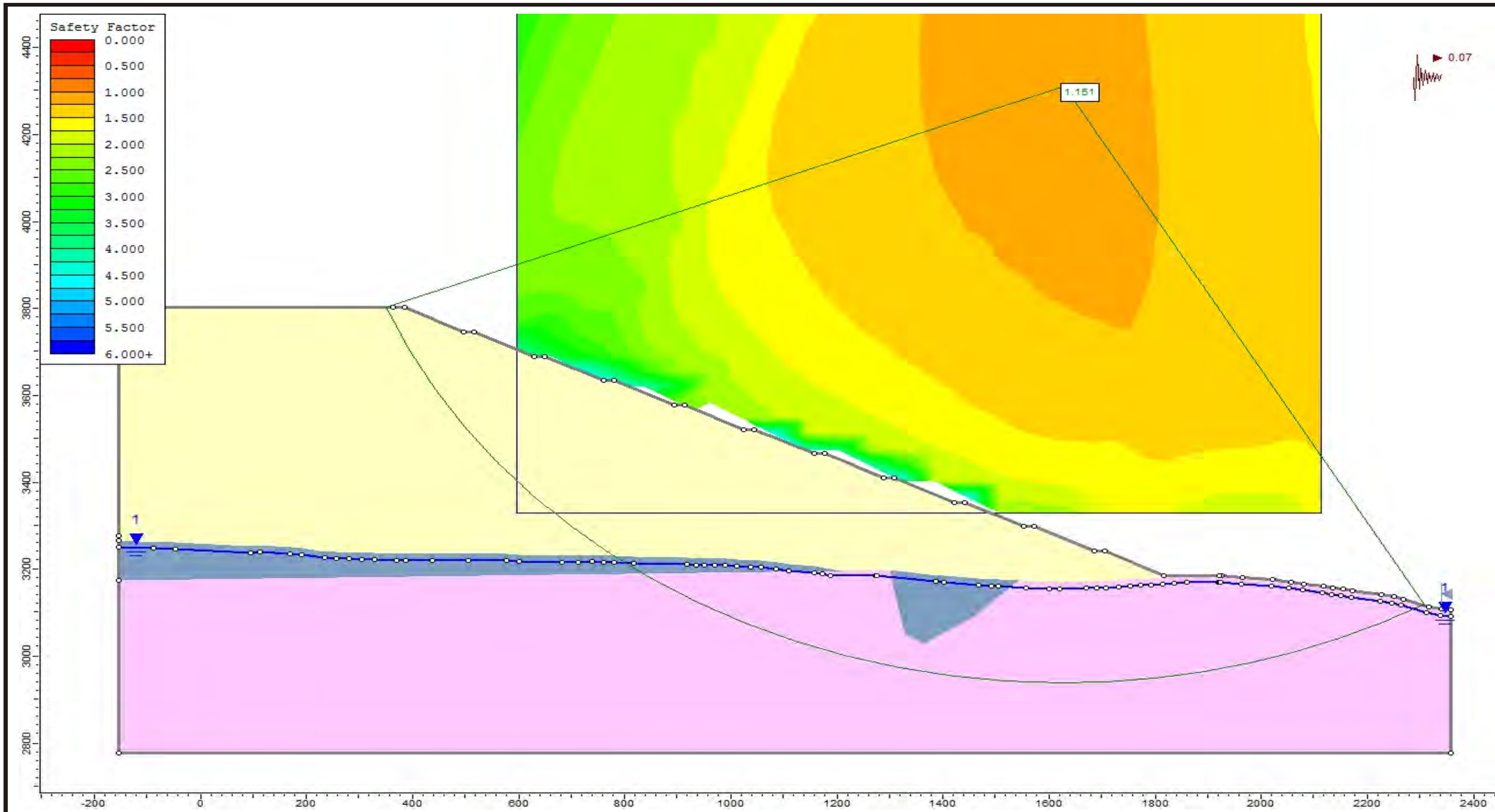
TITLE

Cross-Section D-D
Block Analysis for Closure

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	29



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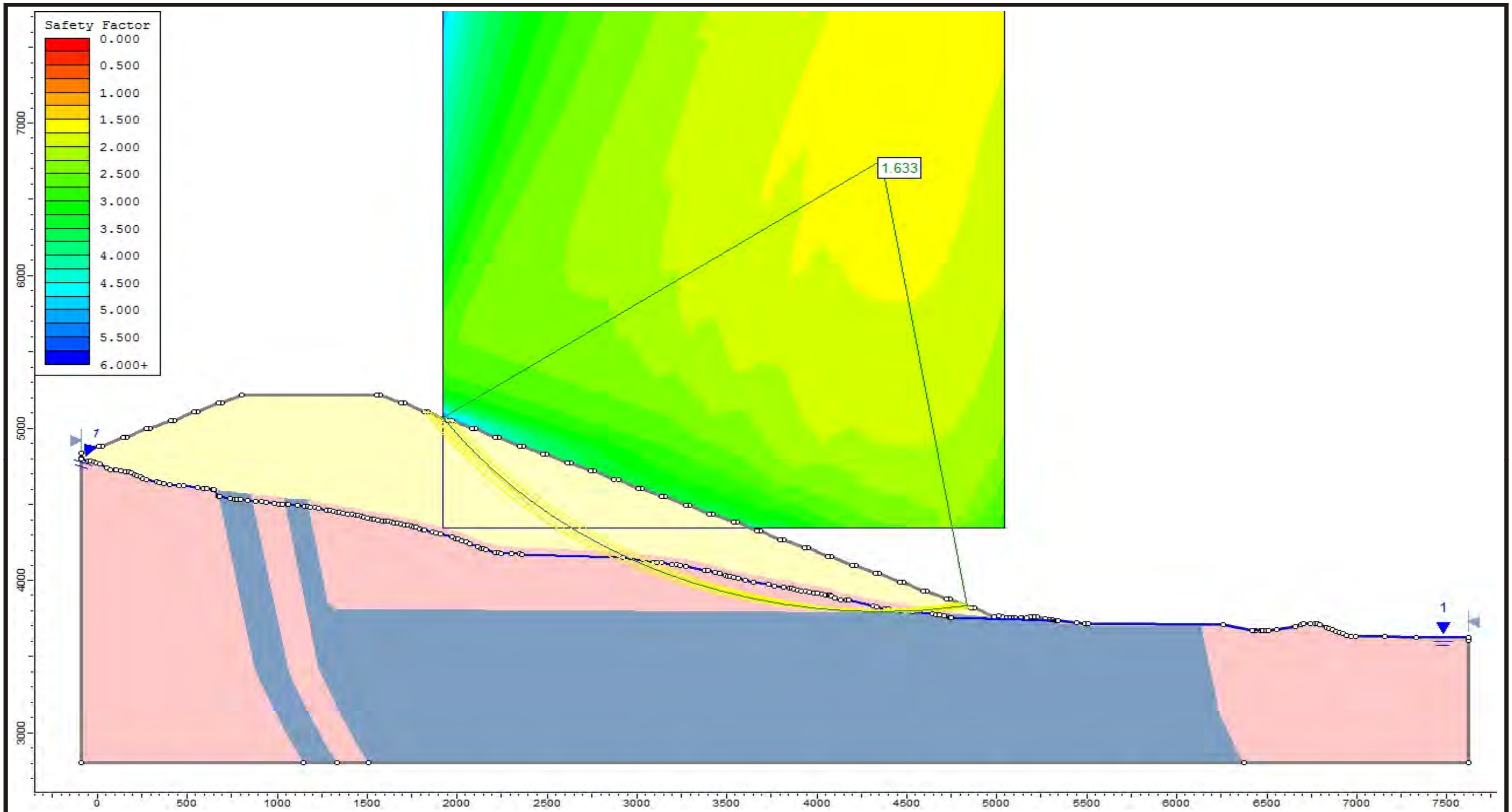
TITLE

Cross-Section D-D Seismic Analysis (Closure Seismic Coefficient = 0.07g)

CLIENT/PROJECT

Freeport McMoRan/Climax Molybdenum OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	30



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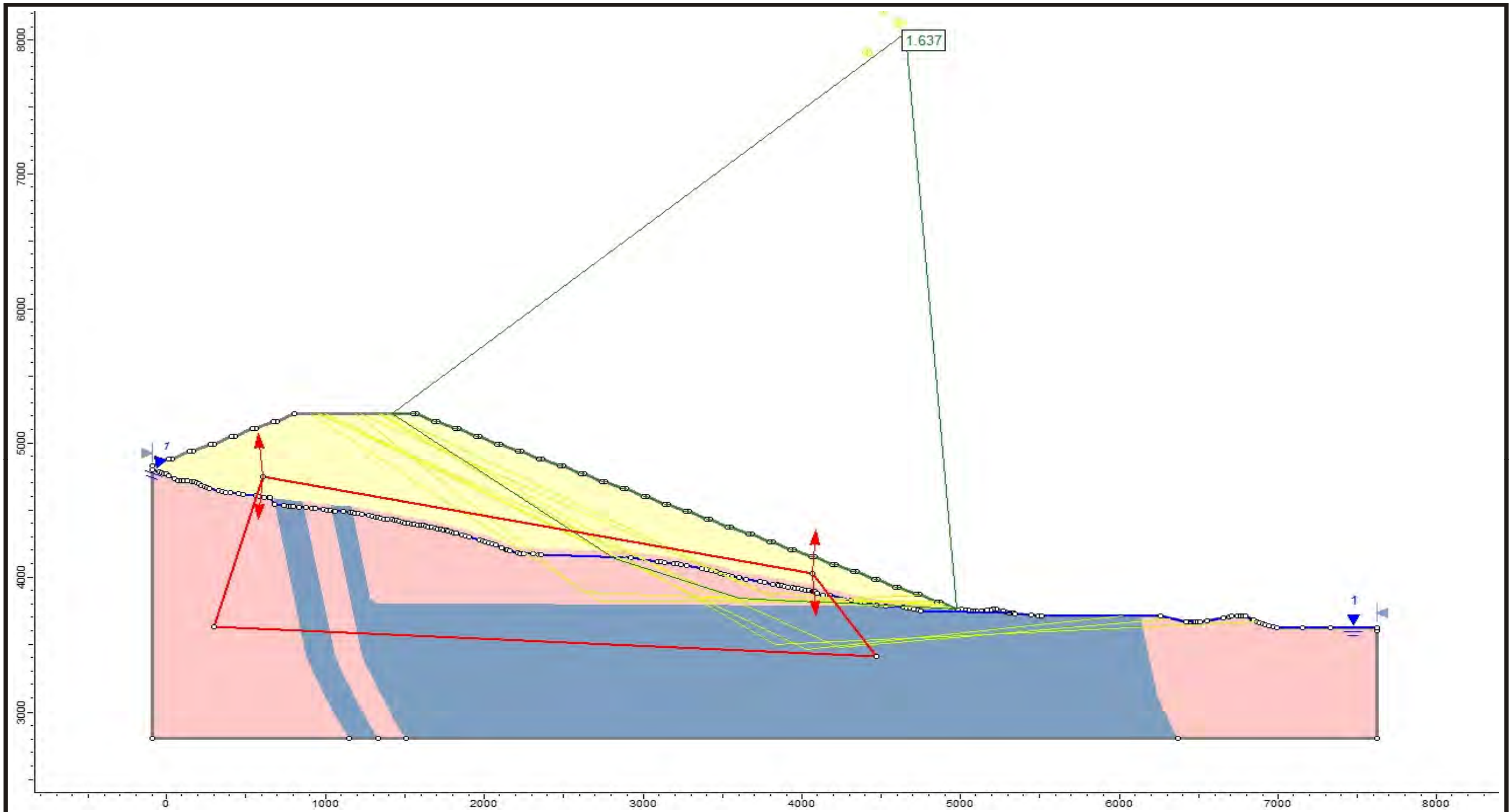
TITLE	**Cross-Section E-E Circular Analysis for Closure**				
CLIENT/PROJECT	**Freeport McMoRan/Climax Molybdenum OSF Stability Analysis**				
DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	31



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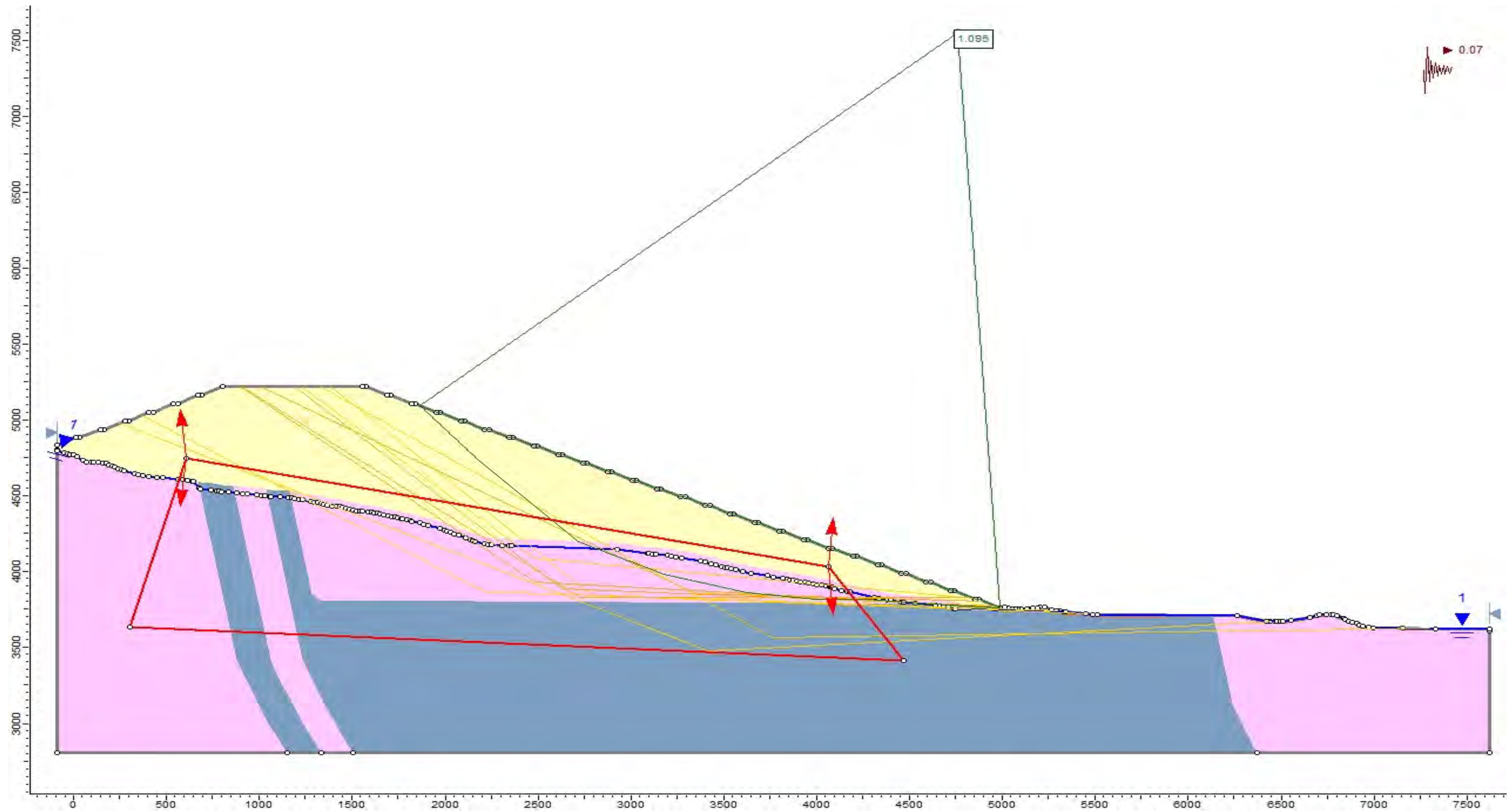
TITLE

Cross-Section E-E
Block Analysis for Closure

CLIENT/PROJECT
Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	32



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Denver, Colorado

TITLE
Cross-Section E-E Seismic Analysis
(Closure Seismic Coefficient = 0.07g)

CLIENT/PROJECT
Freeport McMoRan/Climax Molybdenum
OSF Stability Analysis

DRAWN	DAR	DATE	Apr-12	JOB NO.	113-81608
CHECKED	DLG	SCALE	NTS	DWG. NO.	N/A
REVIEWED	BRB	FILE NO.		FIGURE NO.	33