Reclamation Plan Technical Revision No. 6

(Clarification and Response to Comments)

Front Range Aggregates Parkdale Quarry
Freemont County, Colorado

Colorado Division of Reclamation, Mining, and Safety Permit #M-1997-054

Prepared by

Front Range Aggregates, LLC

Original Submittal June 10, 2015
(Resubmitted September 30, 2015)

823 South Perry Street, Suite 210
Castle Rock, Colorado 80104
(303) 736-6422 / FAX (303) 736-6423

Reclamation Plan Technical Revision
Front Range Aggregates Parkdale Quarry
Freemont County, Colorado
Colorado Division of Reclamation, Mining, and Safety Permit #M-1997-054

Background

Front Range Aggregates, LLC (FRA) submitted Technical Revision Number 6 (TR6), which was received by the Division of Reclamation, Mining, and Safety (DRMS) on June 10, 2015 to address potential changes in reclamation slope geometry and pit liner design for reclamation of the Parkdale Quarry alluvial material mining pit. The purpose of this revision/clarification is to address comments prepared by DRMS staff regarding our June, 2015 TR6 submittal, as conveyed to us in a letter from Timothy Cazier dated July 1, 2015.

The Parkdale Quarry is located in Freemont County, Colorado approximately 12 miles west of Canon City. Originally permitted in 1998, the Parkdale Quarry is permitted to mine reserves of Quaternary alluvium (alluvial deposit), Precambrian granite (granite deposit), and an approximate five-acre area of Cretaceous Dakota sandstone (sandstone deposit). The Parkdale Quarry was initially owned and mined by Agile Stone, who operated the quarry from 1998 until 2002. The quarry was purchased by CIG in 2003, and mining of the site resumed in 2004. The quarry is currently operated by FRA, a subsidiary of CIG. The alluvial deposit was the initial deposit mined at the Parkdale Quarry, and as of June, 2015, provides the majority of the material being mined on the site. Mining of the alluvial deposit was initially limited to the material above high groundwater.

The alluvial deposit was originally permitted to be excavated only to the level of ground water. In 2008, the mine permit was amended to allow the alluvial deposit to be excavated to bedrock and to change the mine reclamation end use for the pit resulting from mining of the alluvial deposit to water storage. The walls of the alluvial deposit pit must be lined in order to meet the Colorado Office of the State Engineer's impermeability requirements. The current reclamation plan specifies 3:1 (horizontal to vertical) slopes with a 15-foot thick compacted clay liner underlying the surface of the reclaimed slopes. Packer testing indicates that the bedrock underlying the alluvial deposit is generally impervious enough to not require the placement of a floor liner. The approved reclamation plan anticipates that the alluvial reservoir will have a storage capacity of approximately 3,100 acre-feet.

Factor-of-safety (FOS) analyses performed for FRA by Applegate Associates, Inc. (Applegate) demonstrates that slopes steeper than the currently specified 3:1 (horizontal to vertical) can be constructed that meet or exceed Colorado State Engineer's requirements for factor-of-safety and with a leakage rate less than Colorado State Engineer Guidelines. Applegate performed FOS analyses of alternate designs with slopes of 2:1(horizontal to vertical), 1.75:1(horizontal to vertical), and 1.5:1(horizontal to vertical). The slopes analyzed has FOS' ranging from 2.226 for a 2:1 (horizontal to vertical) slope to 1.681 for a 1.5:1 (horizontal to vertical) slope. The minimum FOS for dam embankments specified in the Colorado Office of the State Engineer's *Rules and Regulations for Dam Safety and Dam Construction* is 1.5. Copies of the FOS analysis report, and supporting information are attached to this TR request.

Our proposed revision to the reclamation plan is to change from the prescriptive 3:1 slope and compacted clay liner currently specified in the reclamation plan to a standards-based design with a slope with a minimum FOS of 1.5, but not steeper than 1.5:1 (horizontal to vertical), and a liner that is designed to meet the Colorado State Engineer standards specified in *State Engineer Guidelines for Lining Criteria for Gravel Pits August 1999*.

Allowing steeper slopes and the use of an alternate liner design have several potential positive environmental impacts. Most of the clay required to construct the slopes as currently approved would have to be trucked to the site and would require approximately 8,000 truck trips. Additionally, most of the structural fill for the slopes will come from outside of the alluvial deposit. Increasing the slope angle from 3:1 (horizontal to vertical) to 2:1 (horizontal to vertical) would decrease truck trips needed to haul the fill by approximately a third. A steepening of the slope angle and the use of an alternate liner system would result in a decrease in traffic impacts and air pollution because of the reduction in truck trips. Allowing steeper slopes and the use of an alternate liner system would also increase the potential storage volume of the resulting reservoir to approximately 4,000 acre-feet or more.

DRMS Staff presented several comments/requests for additional information, based on our June TR6 submittal. We believe that the following section and the additional information attached to this document adequately addresses those comments.

RESPONSES TO DRMS COMMENTS

Comment 1

> Cover Letter, Last Paragraph: The closing paragraph proposes "Increasing the slope angle from 3:1 (horizontal to vertical) to 2:1 (horizontal to vertical)". Rule 3.1.5(7) of the Mineral Rules and Regulations of The Colorado Mined Land Reclamation Board for The Extraction of Construction Materials requires "*In all cases where a lake or pond is produced as a portion of the Reclamation Plan, all slopes, unless otherwise approved by the Board or Office, shall be no steeper than a ratio of 2:1 (horizontal to vertical ratio), except from 5 feet above to 10 feet below the expected water line where slopes shall be not steeper than 3:1.*" Please provide the following:
>
> a. The expected operating level of the water storage facility,
>
> b. Engineering drawings, sections, and/or details showing the expected water line/operating level and the 3H:1V side slopes where required by Rule 3.1.5(7).

Response to Comment 1

The purpose of TR6 is in part to formally request that the Board or DRMS Office consider Front Range Aggregates, LLC's request for variance from the 3:1 slope requirement in order to construct reclamation slopes for the reservoir that are steeper than 3:1, as allowed by Rule 3.1.5(7) of the *Mineral Rules and Regulations of the Colorado Mined Land Reclamation Board for t he Extraction of Construction Materials*. The data submitted with the our June request for TR6, as retransmitted herein, along with the additional information provided with this clarification demonstrate that slopes as steep as 1.5:1, constructed as shown in the attached Reclamation Slope Design Schematic, will meet the Colorado State Engineer standards for safety as specified in *State Engineer Guidelines for Lining Criteria for Gravel*

Pits August 1999. The attached Reclamation Slope Design Schematic shows the expected operating levels of the water storage facility and the relationship of the operating levels to the reservoir side slopes.

Comment 2

Applegate Group Memorandum – The opening paragraph mentions: a) the "proposed groundwater drain". The Division could not find any information on the groundwater drain; b) "Soil Strength parameters were determined from tests performed by North American Testing, Inc.", yet the attached lab report is from Geo-Logic Associates, and assumption No. 3 states "Soil Parameters for the undisturbed alluvium and bedrock were based on our previous analysis"; and c) "The section geometry was based off a figure provided by you (*David Bieber*)". Please provide the following:

a. Drawings and analyses related to the groundwater drain in order for the Division to understand the intent and evaluate its effectiveness,

b. Clarification on the source(s) for each soil parameter ("Slope Fill", "Native Alluvium", and "Native Shale Bedrock") used in the stability analyses, and

c. The section geometry based off a figure provided by David Bieber. This should include the final mined slope of the alluvium and the proposed liner for comparison to the slope stability analyses. (*Note: based on Comment No. 1 above, this section geometry should be revised.*)

Responses to Comment 2

The proposed groundwater drain referenced in the Applegate Group Memorandum is shown on the attached Reclamation Slope Design Schematic and Groundwater Drain Schematic Design Detail.

The reference in the Applegate Group Memorandum to soil strength parameters being determined from tests performed by North American Testing, Inc. is a typo. The soil strength parameters (phi angle = 35, cohesion = 630 pounds per square foot, dry density = 137 pounds per cubic foot) used by Applegate Group to model the reclamation slopes, as provided in their memorandum dated May 11, 2015, are those from the Geo-Logic Associates reports. Applegate Group has corrected the typo, and an updated copy referencing the correct laboratory is attached. North American Testing, Inc. performed gradation testing of the material proposed for construction of the reclamation slopes. A copy of that gradation report is attached herein. We are also appending a copy of a January 2008 Slope Stability Report prepared by Applegate Group from which they derived the soil parameters used for the undisturbed alluvium and bedrock.

The attached Groundwater Drain Schematic Design Detail includes the analysis used for design of the groundwater drain is attached.

Comment 3

Slope Stability Analyses: Based on the aforementioned Rule 3.1.5(7), the stability analyses should be re-run with the appropriate slope geometry. Please provide the updated analyses.

Response to Comment 3

It should not be necessary to rerun the stability analysis for slopes flatter than 2:1, as the analysis was run for slopes of 2:1, 1.75:1, and 1.5:1; all of which were demonstrated to have FOS values exceeding the minimum FOS of 1.5 for dam embankments specified in the Colorado Office of the State Engineer's *Rules and Regulations for Dam Safety and Dam Construction*. By the nature of the calculations used to perform FOS analysis, slopes flatter than those modeled will also have FOS values exceeding 1.5.

We look forward to hearing from you with regards to this request.

Sincerely,

Front Range Aggregates, LLC

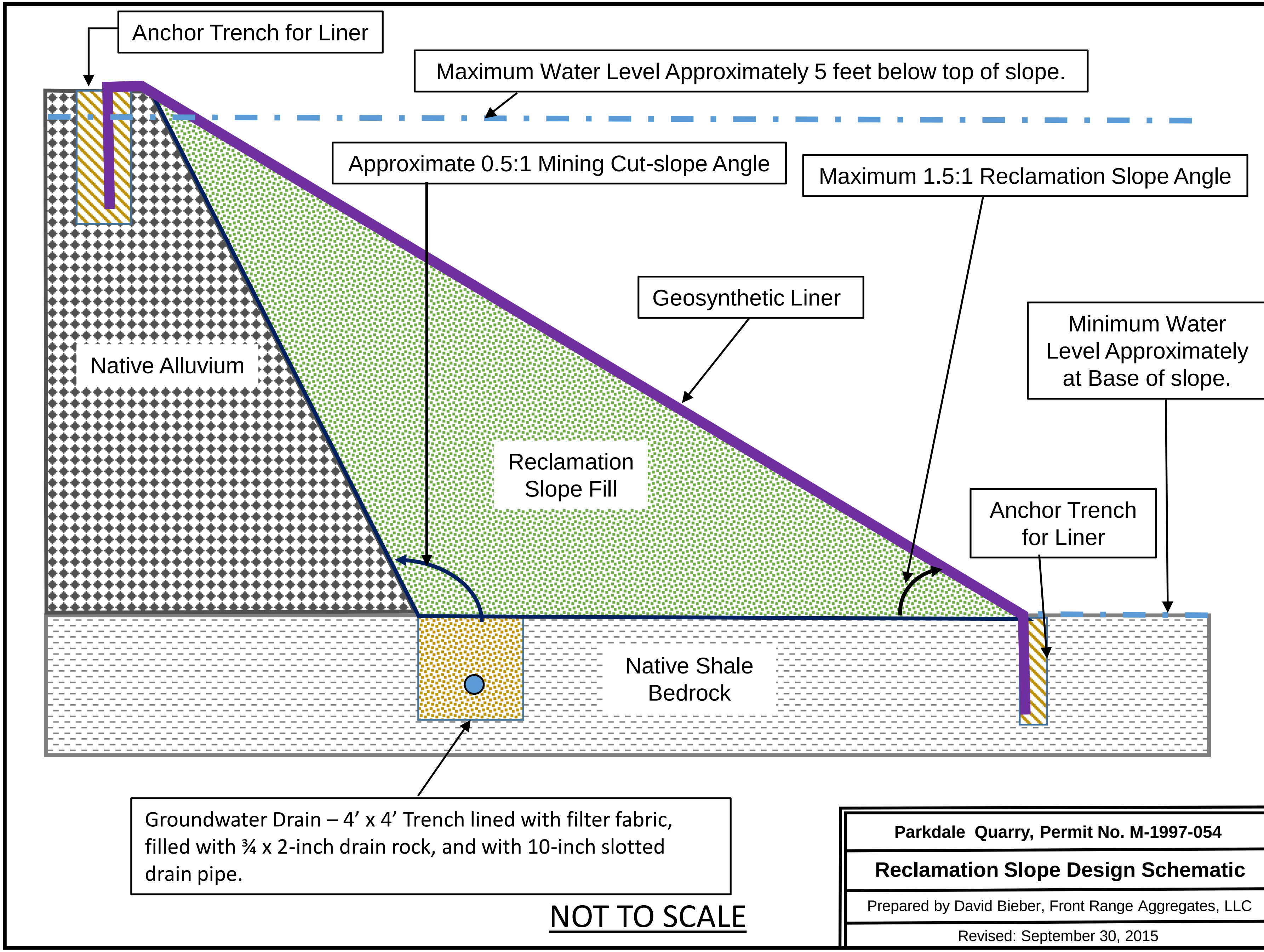
David W. Bieber, PG (CA, WY), PGP (CA), CEG (CA), CHG (CA)
Growth and Development Manager

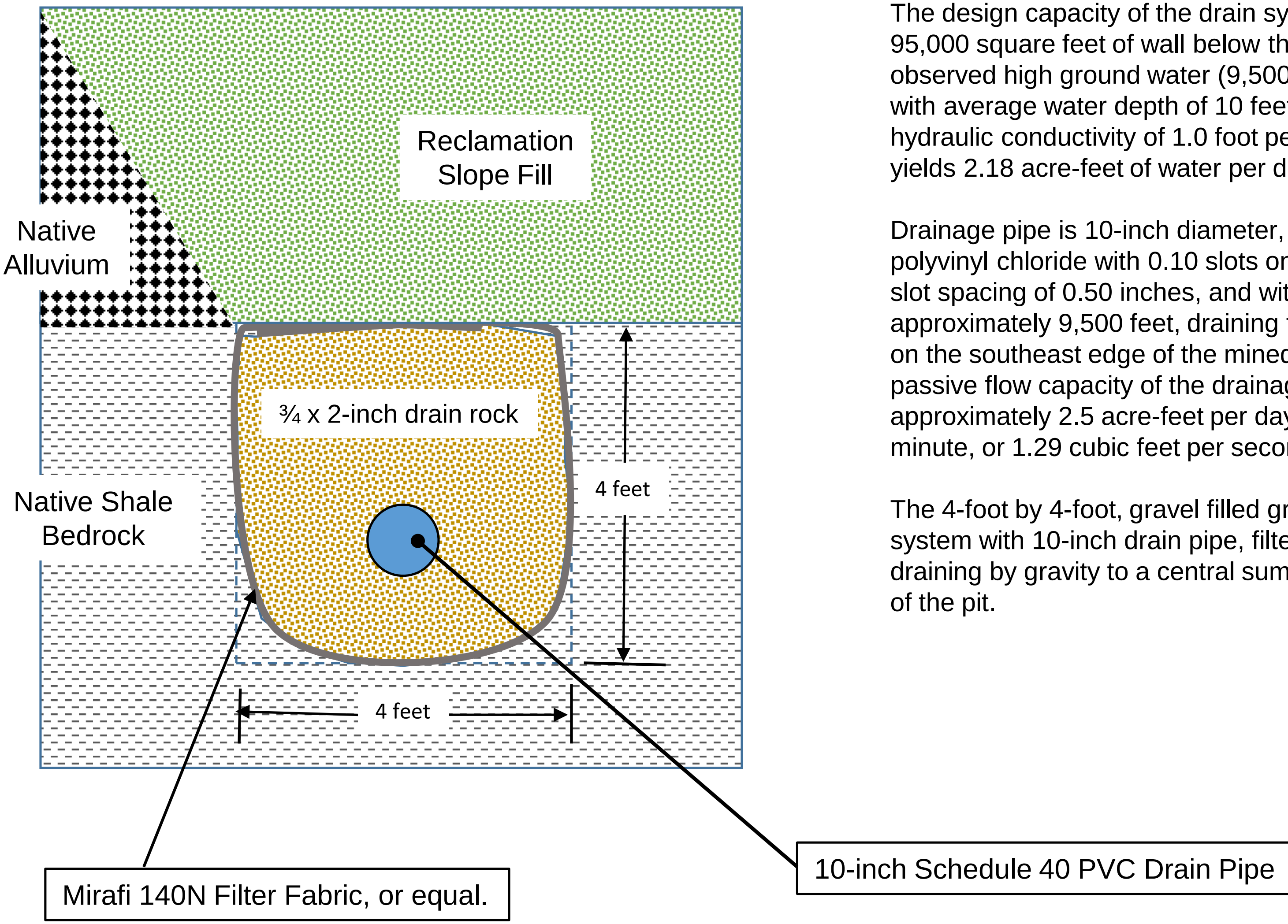
Attachments:

Reclamation Slope Design Schematic
Applegate Group Memorandum
Geo-Logic Associates Direct-shear Test Report
North American Testing, Inc. Gradation Test Report
January 2008 Slope Stability Report prepared by Applegate Group
Groundwater Drain Schematic Design Detail

Attachment 1

Reclamation Slope Design Schematic
and
Groundwater Drain Schematic Design Detail


Anchor Trench for Liner
Maximum Water Level Approximately 5 feet below top of slope.
Approximate 0.5:1 Mining Cut-slope Angle
Maximum 1.5:1 Reclamation Slope Angle
Geosynthetic Liner
Minimum Water Level Approximately at Base of slope.
Native Alluvium
Reclamation Slope Fill
Anchor Trench for Liner
Native Shale Bedrock
Groundwater Drain – 4’ x 4’ Trench lined with filter fabric, filled with ¾ x 2-inch drain rock, and with 10-inch slotted drain pipe.
NOT TO SCALE
Parkdale Quarry, Permit No. M-1997-054
Reclamation Slope Design Schematic
Prepared by David Bieber, Front Range Aggregates, LLC
Revised: September 30, 2015



DESIGN NOTES

The design capacity of the drain system assumes 95,000 square feet of wall below the maximum observed high ground water (9,500 linear feet of wall with average water depth of 10 feet), and an average hydraulic conductivity of 1.0 foot per day, which yields 2.18 acre-feet of water per day.

Drainage pipe is 10-inch diameter, schedule 40 polyvinyl chloride with 0.10 slots on an approximate slot spacing of 0.50 inches, and with a total length of approximately 9,500 feet, draining to a central sump on the southeast edge of the mined area The total passive flow capacity of the drainage pipe = approximately 2.5 acre-feet per day (580 gallons per minute, or 1.29 cubic feet per second).

The 4-foot by 4-foot, gravel filled groundwater drain system with 10-inch drain pipe, filter fabric wrapping, draining by gravity to a central sump at the east end of the pit.

Parkdale Quarry, Permit No. M-1997-054
Groundwater Drain Schematic Design Detail
Prepared by David Bieber, Front Range Aggregates, LLC
September 30, 2015

Attachment 2

Applegate Group Memorandum

Applegate Group, Inc.
Water Resource Advisors for the West

Memorandum

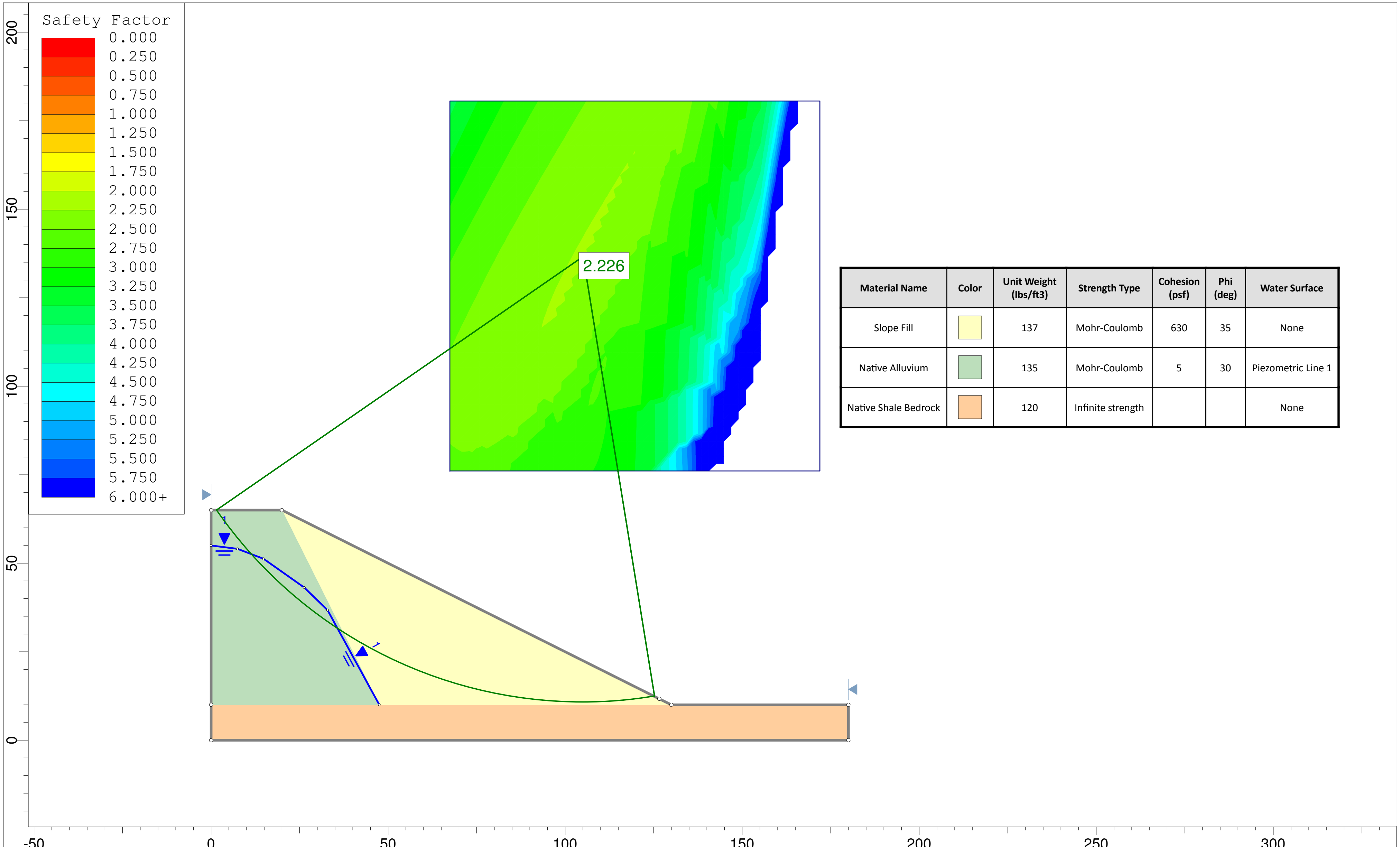
Date:	September 30, 2015	AG Job No.:	14-138
To:	David Bieber, PG		
From:	Craig Ullmann, PE		
Subject:	**Parkdale Slope Stability**		

This memo summarizes the results of our slope stability analysis. As requested we have modified previous slope stability models to incorporate the proposed impermeable surface liner as well as the proposed groundwater drain. Soil Strength parameters were determined from tests performed by Geo-Logic Associates. The section geometry was based off a figure provided by you. Furthermore, the analysis was performed using the following assumptions:

1. The groundwater drain indicated on the provided drawing will be able to reduce the surrounding groundwater to at least the levels shown on the slope stability results. We have not reviewed the design of this drain but are available to do so upon request.
2. The impermeable liner is fully intact.
3. Soil Parameters for the undisturbed alluvium and bedrock were based on our previous analysis
4. The failure was assumed to not go through the bedrock.

The model was originally performed at a slope of 2:1 and subsequent models were performed at slopes of 1.75:1 and 1.5:1.

Please let us know if you have any further questions or require any additional services.

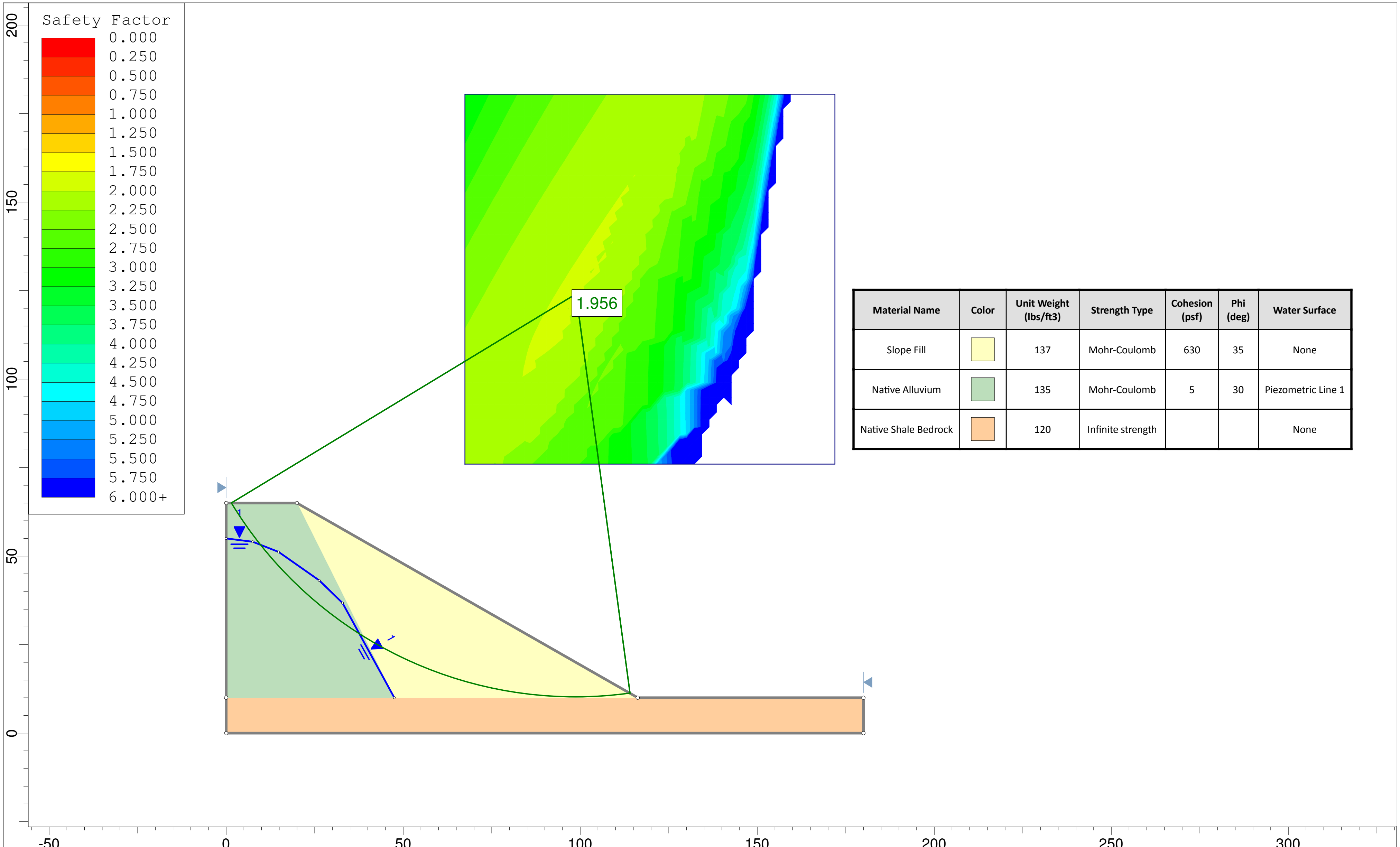


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Slope Fill		137	Mohr-Coulomb	630	35	None
Native Alluvium		135	Mohr-Coulomb	5	30	Piezometric Line 1
Native Shale Bedrock		120	Infinite strength			None

Date:	4/29/2015
File:	SS_EmbModel2_1.slim
Scale:	1:450

Proposed Parkdale Quarry Reclamation
Drained w/ Slope 2H:1V

Applegate Group, Inc.
WATER RESOURCE ADVISORS FOR THE WEST

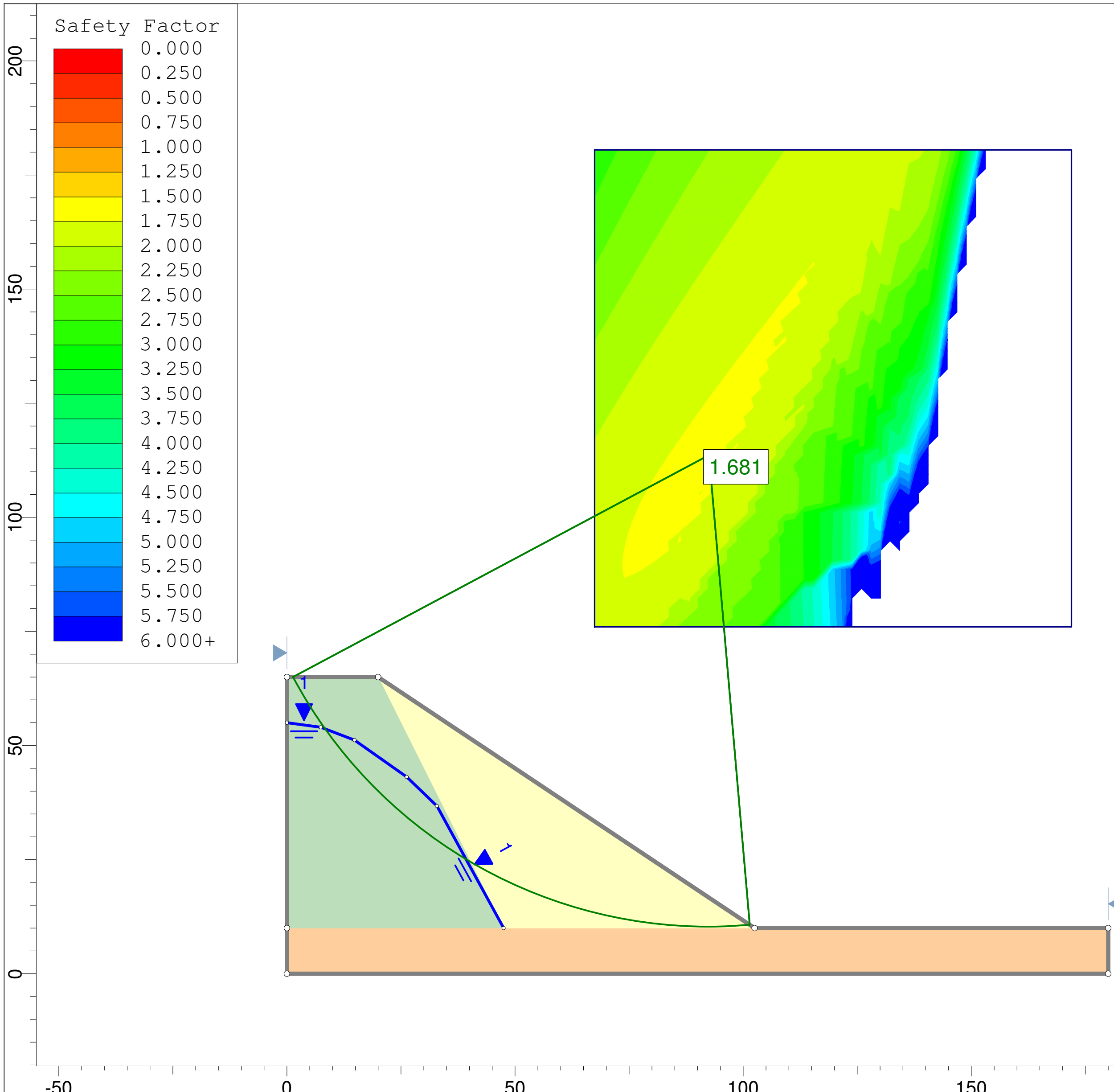


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Slope Fill		137	Mohr-Coulomb	630	35	None
Native Alluvium		135	Mohr-Coulomb	5	30	Piezometric Line 1
Native Shale Bedrock		120	Infinite strength			None

Date:	4/29/2015
File:	SS_EmbModel1.75_1.slim
Scale:	1:450

Proposed Parkdale Quarry Reclamation
Drained w/ Slope 1.75H:1V

Applegate Group, Inc.
WATER RESOURCE ADVISORS FOR THE WEST



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Slope Fill		137	Mohr-Coulomb	630	35	None
Native Alluvium		135	Mohr-Coulomb	5	30	Piezometric Line 1
Native Shale Bedrock		120	Infinite strength			None

Date:	4/29/2015
File:	SS_EmbModel1.5_1.slim
Scale:	1:450

Proposed Parkdale Quarry Reclamation
Drained w/ Slope 1.5H:1V

Applegate Group, Inc.
WATER RESOURCE ADVISORS FOR THE WEST

Attachment 3

Geo-Logic Associates Direct-shear Test Report

Geo-**L**ogic **A**ssociates
143E Spring Hill Drive
Grass Valley, CA 95945
USA
T+1 530 272 2448
F+1 530 272 8533
www.geo-logic.com

DATE: March 20, 2015

TO: David Bieber
Front Range Aggregates
823 S. Perry Street, Suite 210
Castle Rock, CO

e-mail: dbieber@frontrangeaggregates.com

JOB NO: 2015.A042.100
LAB LOG: 3864.0

RE: **Lab Report: Parkdale Quarry**

Enclosed are results for: Samples Received - March 16, 2015

Code	Item	Quantity
1650	Direct Shear CD /pt, ASTM D-3080, 2.5 - 4"	3
1750	Large Box, 12' x 12" add / pt	3

Thank you for consulting Geo-Logic Associates for your material testing requirements. We look forward to working with you again. If you have any questions or require any additional information, please call us at 1-530-272-2448. This testing is based upon accepted industry practice as well as the for the test method listed. These results apply only to the samples supplied and tested for the above referenced job. This report shall not be reproduced except in full without written approval of Geo-Logic Associates.

Sincerely,

Prepared By: Kindra Hillman
Laboratory Manager

Reviewed By: Kenneth R. Criley
Technical Director

LARGE SCALE DIRECT SHEAR REPORT

Internal Shear

Report Date: March 19, 2015

Client / Project Name: FRONT RANGE AGGREGATES / PARKDALE QUARRY

Project No: 2015.A042.100

Superstrate: ⇦ Drainage layer

Material 1: ⇦ Gravel Overburden 01, SC-SM w/ Gravel — LSN: 3864A — Remolded

Material 2: ⇨ Gravel Overburden 01, SC-SM w/ Gravel — LSN: 3864A — Remolded

Substrate: ⇨ Drainage layer

PEAK STRENGTH

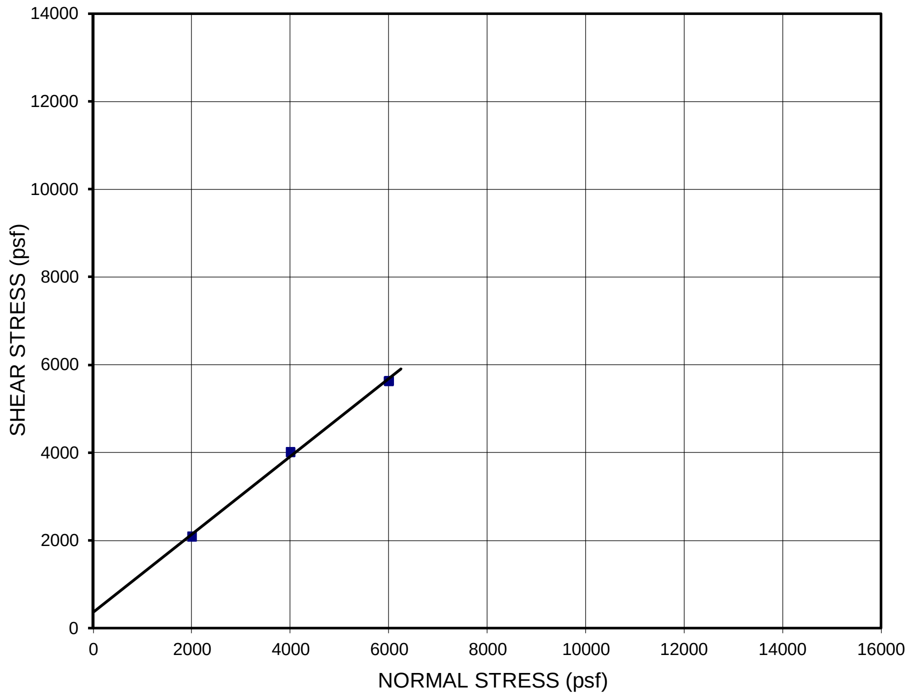
Test Point	Normal Stress psi	Normal Stress psf	Shear Stress psf	Secant Friction Angle
1.	13.9	2000	2100	46
2.	27.8	4000	4020	45
3.	41.7	6000	5640	43

Adhesion: 370 psf

Friction Angle: 42 degrees

Coefficient of Friction: 0.89

NOTE: GRAPH NOT TO SCALE



STRENGTH ENVELOPE

(at 1.5 in. displacement)

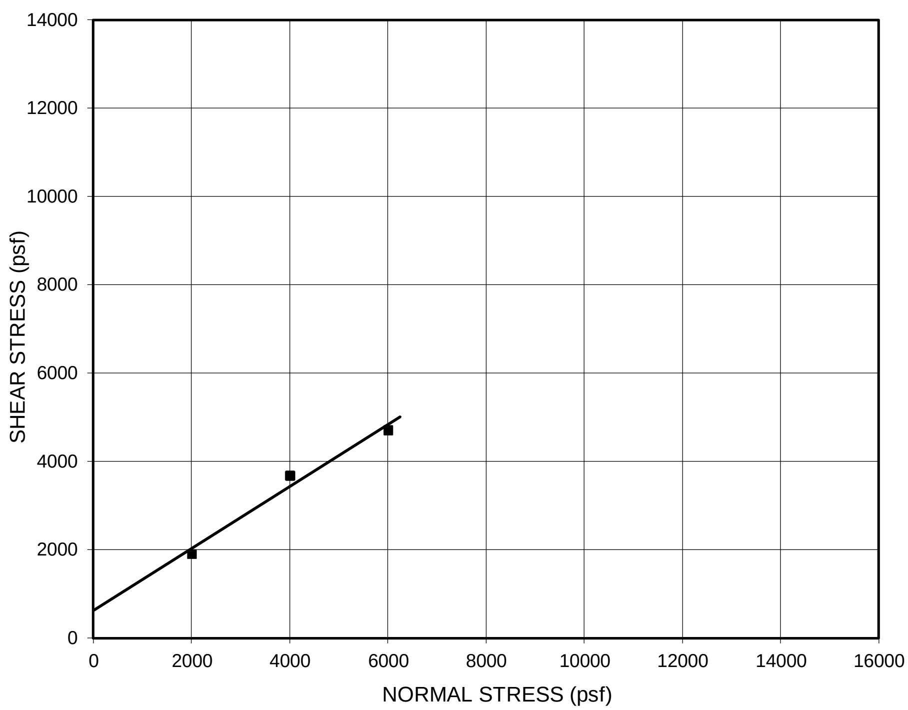
Test Point	Normal Stress psi	Normal Stress psf	Shear Stress psf	Secant Friction Angle
1.	13.9	2000	1910	44
2.	27.8	4000	3690	43
3.	41.7	6000	4720	38

Adhesion: 630 psf

Friction Angle: 35 degrees

Coefficient of Friction: 0.7

NOTE: GRAPH NOT TO SCALE



This testing is based upon accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job.

LARGE SCALE DIRECT SHEAR REPORT

Internal Shear

Geo-Logic ASSOCIATES

Report Date: March 19, 2015

Client / Project Name: FRONT RANGE AGGREGATES / PARKDALE QUARRY

Project No: 2015.A042.100

Superstrate: ⇦	Drainage layer			
Material 1: ⇦	Gravel Overburden 01, SC-SM w/ Gravel	*LSN:*	3864A	Remolded
Material 2: ⇨	Gravel Overburden 01, SC-SM w/ Gravel	*LSN:*	3864A	Remolded
Substrate: ⇨	Drainage layer			

DISPLACEMENT vs. SHEAR STRESS

Test Point	*Normal Stress*	
	psi	*psf*
1.	13.9	2000
2.	27.8	4000
3.	41.7	6000

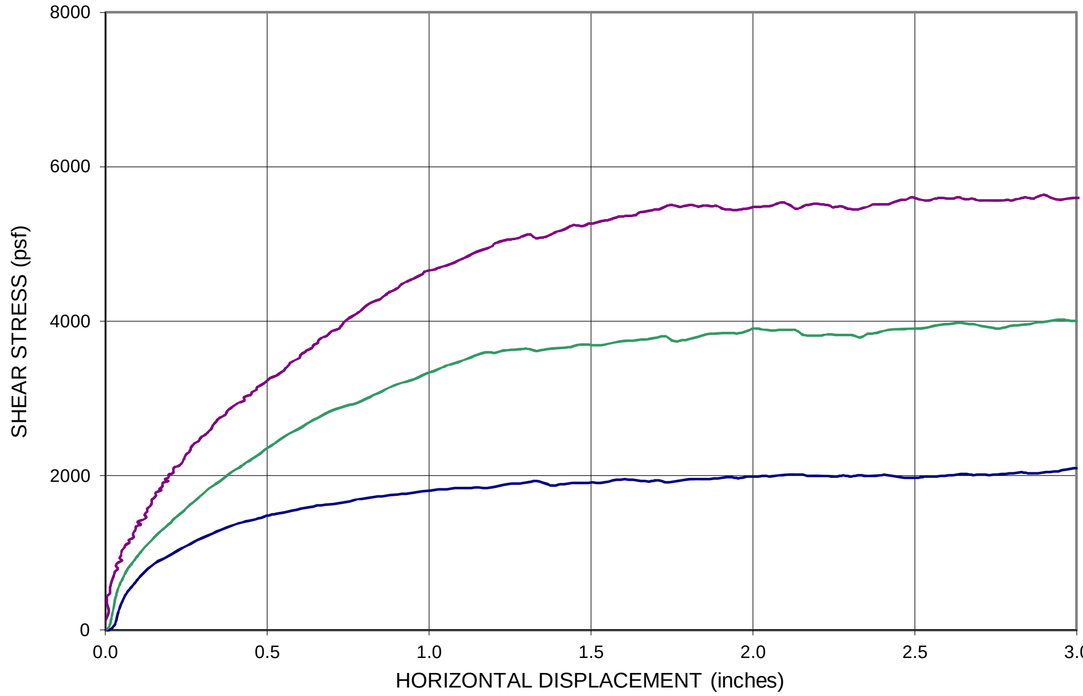
MOISTURE DATA:

(Soil)

Initial Water Content:
5.1%

Initial Dry Density:
137 pcf

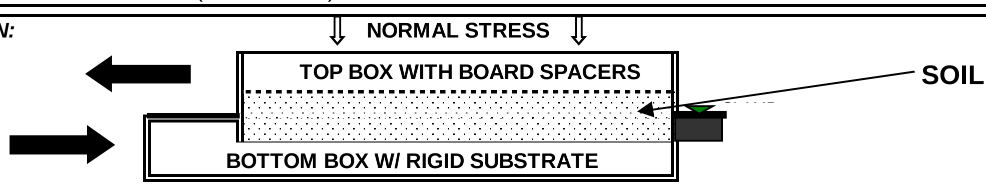
Final Water Content:(%)
1) 9.8 2) 7.6 3) 8



STANDARD CONDITIONS: ***SHEAR DISPLACEMENT RATE: 0.04 in/min***

1. The "gap" between shear boxes was set at 80 mil (2.0 mm)
2. The test specimens were flooded during testing unless otherwise noted.
3. High Normal Stresses, >5psi (35 kPa) was applied using air pressure.
4. Low Normal Stresses, <5psi (35 kPa) was applied using dead weights.
5. The tests were terminated after 3.0"(75 mm) of displacement unless otherwise noted.
6. Tests were performed in general accordance with ASTM procedure ASTM D-3080 using a Brainard-Killman LG-112 direct shear machine with an effective area of 12" x 12" (300 x300 mm).

TEST ORIENTATION:



SPECIAL TEST NOTES:

1. The test method was modified to measure the internal shear characteristics of the gravel.
2. The gravel was remolded into both the upper and lower box to the specified dry density and water content.
3. Each test specimen was hydrated & consolidated for 24 hrs. at the specified normal stress, then sheared.
4. The test was performed in a "wet" or "flooded" condition.
5. Shearing occurred internally within the gravel.
6. The Friction Angle and Adhesion (or Cohesion) results given here are based on a mathematically determined best fit line.
7. Further interpretation should be conducted by a qualified professional experienced in geosynthetic and geotechnical engineering.

This testing is based upon accepted industry practice as well as the test method listed. These results apply only to the samples supplied and tested for the above referenced job.

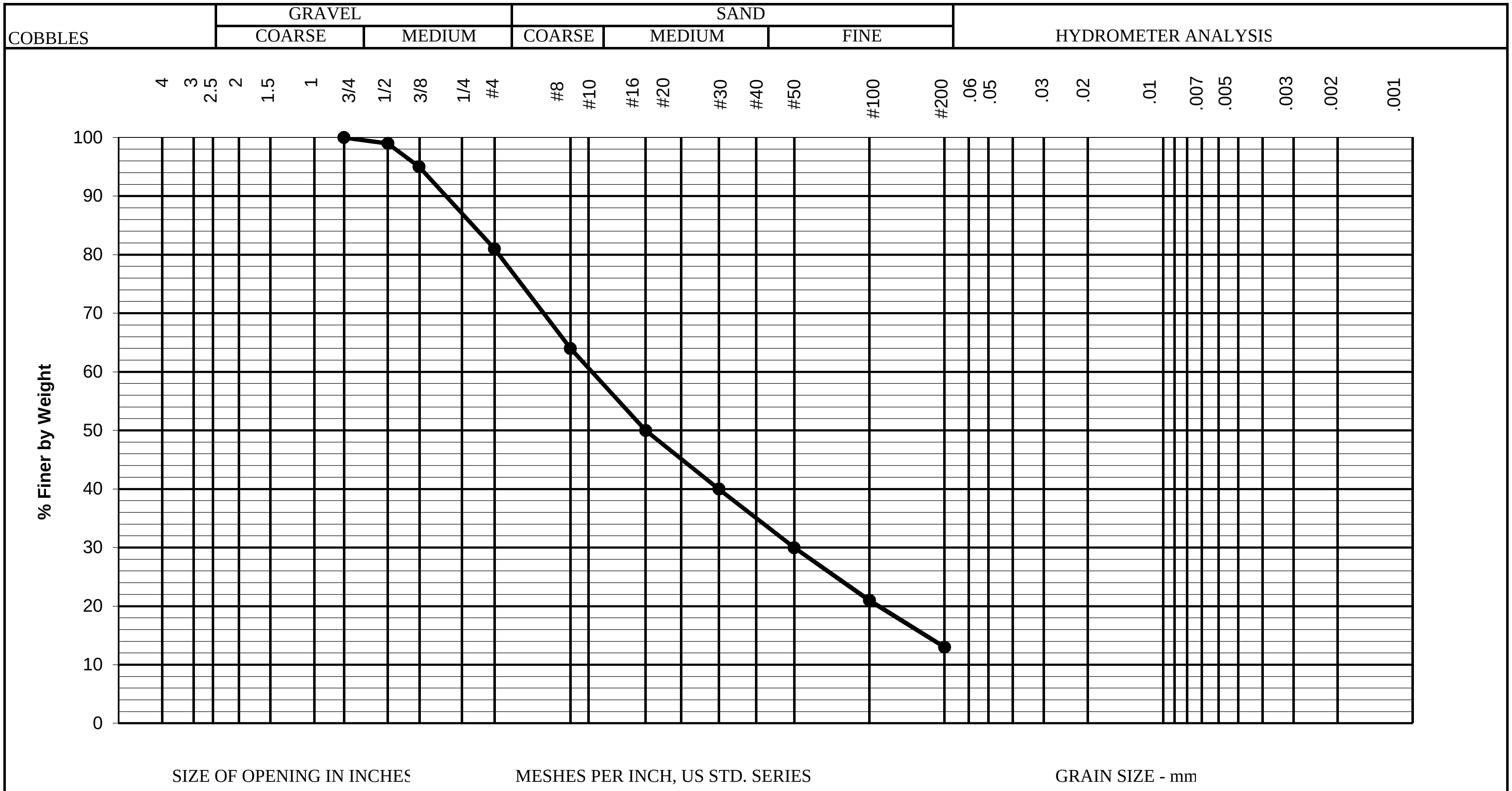
Attachment 4

North American Testing, Inc. Gradation Test Report

North American Testing, Inc.

5910 Buttermere Dr
Colorado Springs, CO 80906

Client Name:	Front Range Agg	Project: Submittal				Project Number:	14-02
Client Address:	1161 S. Perry St. #110, Castle Rock, CO 80104					Sample Number:	1
Source of Material:	Submitted: granite, overburden					Sample Date:	8/25/2014
Type of Material:	"SC-SM w/ gravel"	Sample Moisture	5.9%			Received in Lab Date:	8/25/2014
Test Procedure:	C 117, C 136, D 422, D 1140, D 2487, D 4318	Tested by:	HA	Date:	8/28/2014	Report Date:	9/3/2014



Particle Size, % Finer

6"	100	1"	100	#8	64	#40	-
3"	100	3/4"	100	#10	-	#50	30
2.5"	100	1/2"	99	#16	50	#100	21
2"	100	3/8"	95	#20	-	#200	13
1 1/2"	100	#4	81	#30	40	0.02mm	

Atterberg Limits

LL	33
PL	27
PI	6
Specific Gravity	

Attachment 5

January 2008 Slope Stability Report prepared by Applegate Group

SLOPE STABILITY REPORT
SAND AND GRAVEL MINING OPERATION

FOR

Parkdale Quarry
Fremont County, Colorado

Prepared for:

Front Range Aggregates, LLC
3655 Out West Drive
Colorado Springs, CO 80910

Prepared by:
Applegate Group, Inc.
WATER RESOURCE ADVISORS FOR THE WEST
1499 W. 120th Ave., Suite 200
Denver, CO 80234
Phone: 303-452-6611 Fax: 303-452-2759
www.applegategroup.com

January 2008
AG File No. 05-183

CERTIFICATION:

I hereby certify this Slope Stability Report for the Parkdale Aggregate Mine located approximately 10 miles west of Canon City for Front Range Aggregates, LLC was prepared by me or under my direct supervision.

Kallie Bauer

Kallie Bauer
Registered Professional Engineer
State of Colorado No. 37229

Table of Contents

Introduction

Front Range Aggregates, LLC proposes to mine the property located in Township 18 South, Range 72 West of the 6th Prime Meridian, Fremont County, Colorado. The property is bounded by the Arkansas River on the south and land owned by the Bureau of Land Management on the north. The proposed mining operation will extract gravel reserves near the Tallahassee Creek. A slope stability analysis was performed to analyze safe mining and reclamation conditions. This report contains an overview of geotechnical results and methodology used in the analysis of the proposed liner and shell material placed against the mining slopes.

Overview

The Division of Reclamation, Mining, and Safety mining plan proposes that the sand and gravel pit will be mined in one large cell. During mining the highwall will be mined at a near vertical slope a cross section is included showing the mining section. The reclamation plan proposes the future use for this property to be a lined water storage reservoir. The reservoir will cover an estimated 93.5 surface acres when full. Actual surface area will depend on the final configuration of the reservoir after reclamation is complete. The mined slope will be reclaimed with a zoned embankment constructed from on-site materials. A 15-ft wide clay liner will be constructed from clay bedrock materials against the 0.5H:1V mining highwall. A shell consisting of granite fines will be placed on the liner to create the final 3H:1V slopes. An exhibit illustrating a typical maximum cross section is included.

Geotechnical Data

A preliminary geotechnical investigation has been performed by J. A. Cesare and Associates, Inc. JAC estimated soil strength parameters based on their field exploration. The soil strength parameters were provided to Applegate Group, Inc. by JAC for use in this slope stability analysis. The JAC tests provided specific values for soil densities and material classifications. For the sand and gravel material, the JAC reports provided soil classification only. The *Design of Small Dams* book was used to establish densities for the SP-SM sand and gravel, and the value ranges for cohesion and friction angle based on all soil classifications. The values were used in a sensitivity analysis to determine conservative, worst-case scenarios. Table 1 represents a summary of the soil strength parameters that were used in this stability analysis.

Table 1. Soil Properties

Description	Max Dry Density (pcf)	Saturated Density (pcf)	Cohesion (psf)	Internal Friction Angle
Granite Fines	137.7	142.4	0-100	30-35
Clay Liner	124.0	128.0	100-1225	28-38
Bedrock	130.0	133.0	100-1225	28-38
Native Sand and Gravel	135.0	141.0	0-100	~30

Design Analysis and Criteria

The proposed mining and reclamation slopes were analyzed using the XSTABLE V5.208 DOS computer program. XSTABLE was designed to analyze the slope stability of an earth embankment subjected to several critical situations that may occur during the life of the embankment. Two cases dictated by the State Engineer were investigated: a steady state case and a rapid draw down case. Case 1: Assumes the embankment is in a steady state scenario; the required factor of safety 1.5. Case 2: Assumes the embankment is in a rapid draw down state; the required factor of safety is 1.2. For the mining conditions, the scenario of maximum highwall dewatering was the only scenario analyzed.

Methodology

The Bishop method was used in the computer analysis for determining the safety factors. The procedure utilizes a critical failure surface searching method to generate circular surfaces. The program automatically searches for the lowest factor of safety. 600-1200 separate failure surfaces were analyzed for each case. The same process was used in determining the safety factor for each case. For the given soil parameters, the factor of safety was determined. The cohesion and friction angle of the granite fines were then varied to determine the soil properties of the minimum allowable safety factor.

The mining embankment configuration shown in the computer analysis represents the estimated conditions for this site. If the mining conditions differ significantly from the estimated conditions, the slope stability will need to be reevaluated on a case by case basis. The mining highwall was found to be stable and well above the factor of safety.

The reclamation embankment analysis illustrates the slope failures consist of minor sloughing failures indicative of erosion and maintenance requirements. The attached results show the failure slopes and the associated property values and safety factor. The resulting property values are conservative for anticipated site conditions.

Slope Stability Results

The minimum safety factors required are 1.2 for the rapid draw down condition and 1.5 for steady state. This design criteria was used to establish the desired minimum safety factors for this project and should be considered conservative for evaluating reclaimed slopes against alluvial mining high walls. The calculated factors of safety are within the design criteria specified for this project and can be considered indicators of high wall performances under the various conditions. The results of the slope stability analysis are presented in Table 2.

Table 2. Slope Stability Analysis Results

Description	**Calculated Factor of Safety**	**Minimum Factor of Safety**
Dewatered mining highwall	1.207	1.2
Case 1 - Steady state reclamation slope	1.647	1.5
Case 2 - Rapid draw down reclamation slope	1.209	1.2

Conclusions and Recommendations

Case 1 - The resulting factor of safety of 1.647 is above the minimum requirement of 1.5 for the steady state case. The proposed reclamation embankment is satisfactory.

Case 2 – The resulting factors of safety of 1.207 and 1.209 are above the minimum requirement of 1.2 for the rapid draw down case. The proposed mining and reclamation embankments are satisfactory.

The following recommendations for monitoring of slope stability should be followed:

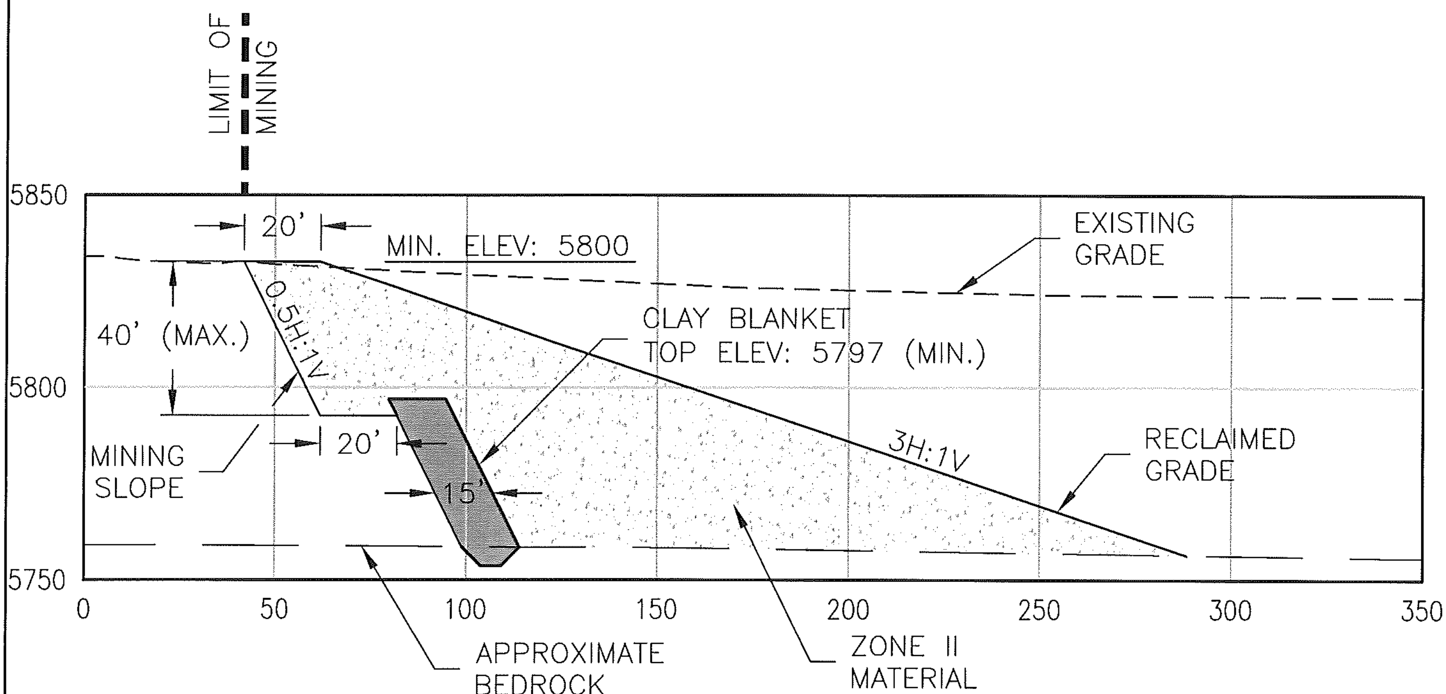
1. A visual inspection of the excavated highwalls should be done on a weekly basis for the first 6 months of mining. This inspection should consist of walking the existing ground and looking for any signs of stress cracks or other potential signs of slope failure. Some minor sluffing of highwalls is expected on any mine site. The intent of this inspection is to locate potential major slope failures that could potentially extend back into a structure.

2. A visual inspection should be done anytime after a major precipitation event that has saturated the ground using the same procedures. A major precipitation event would be defined as a storm that produces an intensity level reached once in 50 years on the average.

3. If a visual inspection detects signs of potential slope failure, qualified personnel should be contacted to evaluate and recommend remediation work to stabilize the area.

4. If no visible signs of slope failure are detected within the first 6 months, then the inspection period could be reduced to once per month or after every major precipitation event.

Maximum Section



N:\04113 Parkdale\Drawings\Figures\Parkdale DRMS Slope Stability.dwg 1/24/2008 4:46:24 PM EST

Date:	01/23/08
Job No:	05-183
Drawn:	LD
Design:	LKF
Checked:	
File:	Slope Stab. Exhibit
Scale:	1"=50' H&V

FRONT RANGE AGGREGATE, INC.

PARKDALE QUARRY

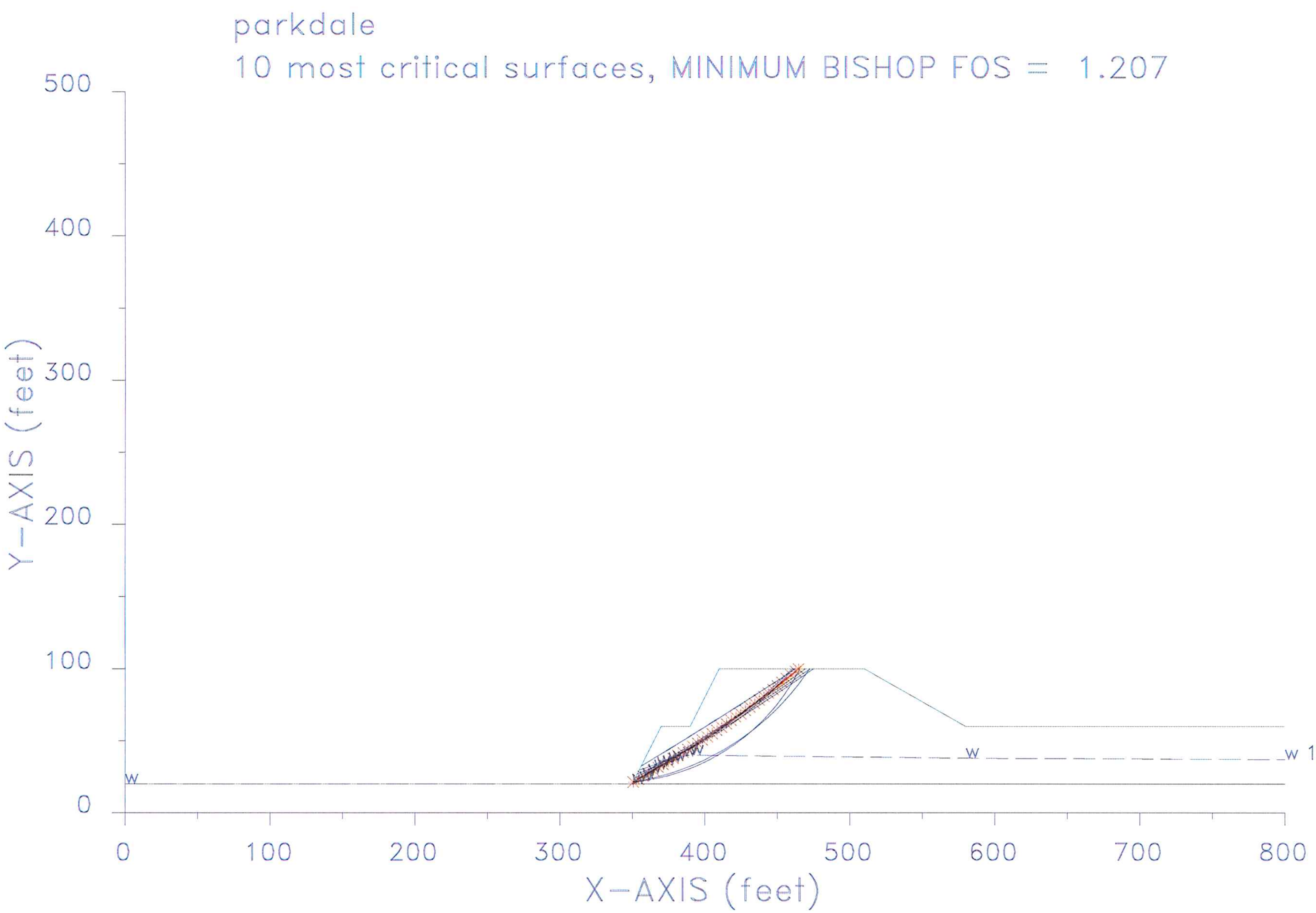
MINING and RECLAMATION CROSS-SECTION

Applegate Group, Inc.
Water Resource Advisors for the West
1499 West 120th Ave., Ste. 200
Denver, CO 80234-2728
(303) 452-6611
Fax: (303) 452-2759
email: info@applegategroup.com Website: ApplegateGroup.com

by: LineDesign

Dewatered mining highwall

M30 1-28-08 9:05



XSTABL File: M30   1-28-08   9:05

```
****************************************
*              X S T A B L             *
*                                      *
*       Slope Stability Analysis       *
*              using the               *
*           Method of Slices           *
*                                      *
*       Copyright (C) 1992 - 2006      *
*   Interactive Software Designs, Inc. *
*        Moscow, ID 83843, U.S.A.      *
*                                      *
*          All Rights Reserved         *
*                                      *
*  Ver. 5.208               96 - 1483  *
****************************************
```

Problem Description : parkdale

SEGMENT BOUNDARY COORDINATES
----

7 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	20.0	350.0	20.0	3
2	350.0	20.0	370.0	60.0	4
3	370.0	60.0	390.0	60.0	4
4	390.0	60.0	410.0	100.0	4
5	410.0	100.0	510.0	100.0	4
6	510.0	100.0	580.0	60.0	4
7	580.0	60.0	800.0	60.0	4

1 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	350.0	20.0	800.0	20.0	3

ISOTROPIC Soil Parameters

----

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	137.7	142.5	2.0	30.00	.000	.0	1
2	124.0	128.8	100.0	28.00	.000	.0	1
3	130.0	132.3	1200.0	38.00	.000	.0	1
4	112.0	125.0	200.0	35.00	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 14 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	20.00
2	350.00	20.00
3	355.00	22.00
4	357.00	24.00
5	361.00	27.00
6	365.00	30.00
7	367.00	32.00
8	371.00	33.00
9	375.00	35.00
10	378.00	36.00
11	385.00	39.00
12	390.00	40.00
13	580.00	38.00
14	800.00	37.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

900 trial surfaces will be generated and analyzed.

30 Surfaces initiate from each of 30 points equally spaced
along the ground surface between x = 330.0 ft
and x = 370.0 ft

Each surface terminates between x = 460.0 ft
and x = 510.0 ft

Unless further limitations were imposed, the minimum elevation
at which a surface extends is y = .0 ft

4.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined
within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface
is specified by 36 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	350.69	21.38
2	354.16	23.36
3	357.63	25.36
4	361.09	27.37
5	364.53	29.41

6	367.96	31.46
7	371.39	33.52
8	374.80	35.61
9	378.20	37.71
10	381.60	39.83
11	384.98	41.97
12	388.35	44.12
13	391.71	46.30
14	395.06	48.48
15	398.39	50.69
16	401.72	52.91
17	405.03	55.15
18	408.34	57.41
19	411.63	59.68
20	414.91	61.97
21	418.18	64.28
22	421.43	66.60
23	424.68	68.94
24	427.91	71.29
25	431.13	73.67
26	434.34	76.06
27	437.53	78.46
28	440.72	80.88
29	443.89	83.32
30	447.05	85.77
31	450.20	88.24
32	453.33	90.73
33	456.45	93.23
34	459.56	95.75
35	462.66	98.28
36	464.74	100.00

**** Simplified BISHOP FOS = 1.207 ****

The following is a summary of the TEN most critical surfaces

Problem Description : parkdale

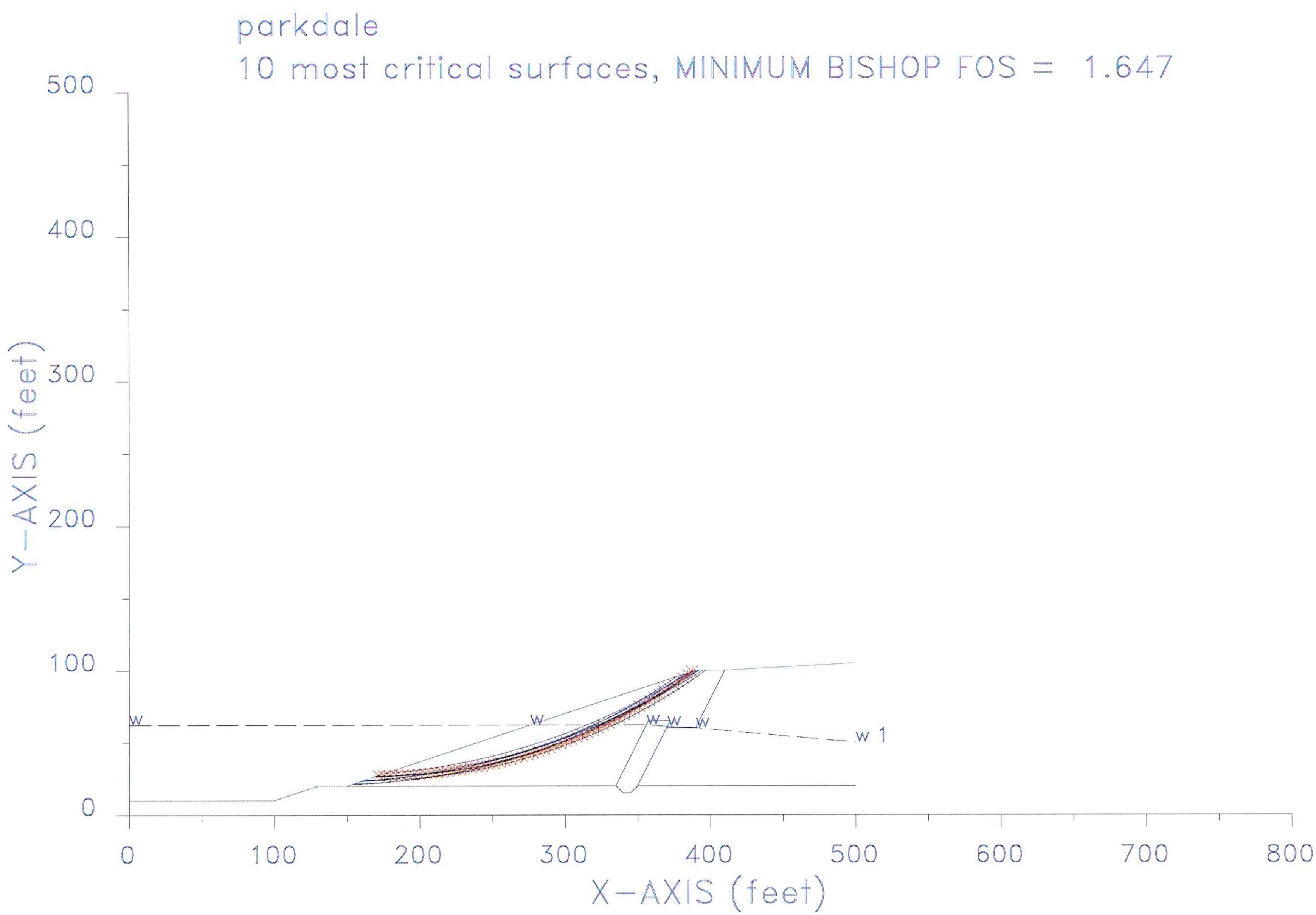
	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.207	-36.93	705.70	786.47	350.69	464.74	1.451E+08
2.	1.238	233.87	315.42	312.32	353.45	460.00	5.614E+07

3.	1.277	-832.67	1990.95	2297.73	350.69	472.65	4.547E+08
4.	1.284	-313.36	1183.32	1336.59	352.07	469.52	2.480E+08
5.	1.295	279.81	258.19	240.53	354.83	460.98	4.524E+07
6.	1.296	-495.91	1498.24	1702.30	350.69	475.06	3.550E+08
7.	1.315	337.12	164.53	143.79	350.69	465.62	4.117E+07
8.	1.334	322.32	198.58	179.46	350.69	472.28	5.235E+07
9.	1.347	-1245.45	2666.41	3082.73	356.21	462.40	4.245E+08
10.	1.350	-1637.62	3287.37	3817.08	356.21	462.56	5.246E+08

* * * END OF FILE * * *

Case 1 - Steady state reclamation slope

5 1-28-08 9:20


parkdale
10 most critical surfaces, MINIMUM BISHOP FOS = 1.647
Y-AXIS (feet)
500
400
300
200
100
0
X-AXIS (feet)
0
100
200
300
400
500
600
700
800
w
w
w w
w
w 1

XSTABL File: 5   1-28-08   9:20

```
*****************************************
*              X S T A B L              *
*                                       *
*       Slope Stability Analysis        *
*             using the                 *
*          Method of Slices             *
*                                       *
*       Copyright (C) 1992 - 2006       *
*   Interactive Software Designs, Inc.  *
*       Moscow, ID 83843, U.S.A.        *
*                                       *
*          All Rights Reserved          *
*                                       *
*  Ver. 5.208                96 - 1483  *
*****************************************
```

Problem Description : parkdale

SEGMENT BOUNDARY COORDINATES
----

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	10.0	100.0	10.0	3
2	100.0	10.0	130.0	20.0	3
3	130.0	20.0	150.0	20.0	3
4	150.0	20.0	390.0	100.0	1
5	390.0	100.0	410.0	100.0	1
6	410.0	100.0	500.0	105.0	4

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	150.0	20.0	335.0	20.0	3
2	335.0	20.0	357.5	65.0	2
3	357.5	65.0	372.5	65.0	2
4	335.0	20.0	340.0	15.0	3
5	340.0	15.0	345.0	15.0	3
6	345.0	15.0	350.0	20.0	3

7	350.0	20.0	370.0	60.0	4
8	370.0	60.0	372.5	65.0	1
9	370.0	60.0	390.0	60.0	4
10	390.0	60.0	410.0	100.0	4
11	350.0	20.0	500.0	20.0	3

ISOTROPIC Soil Parameters
----

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	137.7	142.5	2.0	30.00	.000	.0	1
2	124.0	128.8	100.0	28.00	.000	.0	1
3	130.5	132.3	100.0	28.00	.000	.0	1
4	112.0	125.0	200.0	30.00	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 6 coordinate points

****
PHREATIC SURFACE,
****

Point No.	x-water (ft)	y-water (ft)
1	.00	62.00
2	276.00	62.00
3	356.00	62.00
4	370.50	61.00
5	390.00	60.00
6	500.00	50.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

600 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 30 points equally spaced along the ground surface between x = 140.0 ft
and x = 180.0 ft

Each surface terminates between x = 360.0 ft
and x = 410.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

4.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 59 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	171.72	27.24
2	175.72	27.23
3	179.72	27.27
4	183.72	27.36

5	187.72	27.49
6	191.72	27.66
7	195.71	27.88
8	199.70	28.15
9	203.69	28.46
10	207.67	28.81
11	211.65	29.22
12	215.63	29.66
13	219.60	30.15
14	223.56	30.69
15	227.52	31.27
16	231.47	31.90
17	235.41	32.57
18	239.35	33.29
19	243.28	34.05
20	247.19	34.86
21	251.10	35.71
22	255.00	36.60
23	258.89	37.54
24	262.77	38.52
25	266.63	39.55
26	270.49	40.62
27	274.33	41.74
28	278.16	42.89
29	281.97	44.10
30	285.77	45.34
31	289.56	46.63
32	293.33	47.96
33	297.09	49.33
34	300.83	50.75
35	304.55	52.21
36	308.26	53.71
37	311.95	55.26
38	315.62	56.84
39	319.28	58.47
40	322.91	60.14
41	326.53	61.85
42	330.13	63.60
43	333.70	65.39
44	337.26	67.22
45	340.79	69.09
46	344.31	71.00
47	347.80	72.96
48	351.27	74.95
49	354.71	76.98
50	358.14	79.05
51	361.53	81.16
52	364.91	83.30
53	368.26	85.49
54	371.58	87.71
55	374.88	89.97
56	378.16	92.27
57	381.41	94.61
58	384.63	96.98

59	387.54	99.18

**** Simplified BISHOP FOS = 1.647 ****

The following is a summary of the TEN most critical surfaces

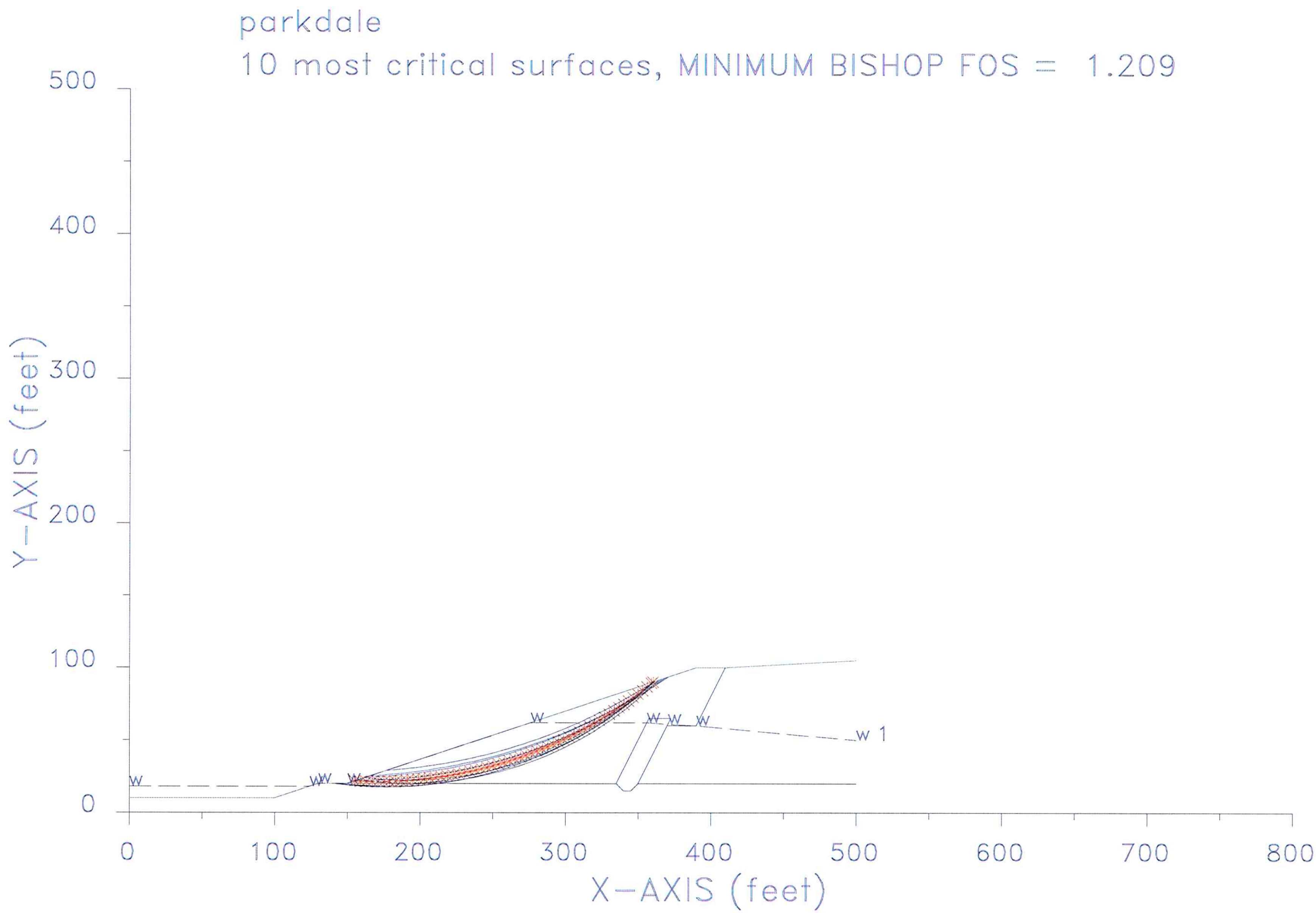
Problem Description : parkdale

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.647	174.35	379.08	351.85	171.72	387.54	5.638E+07
2.	1.648	146.27	470.25	444.51	168.97	392.23	6.470E+07
3.	1.649	171.82	375.26	348.48	170.34	382.07	5.265E+07
4.	1.650	146.98	442.40	420.76	155.17	391.51	7.387E+07
5.	1.650	140.88	454.17	433.10	153.79	390.16	7.240E+07
6.	1.651	160.62	398.05	371.82	168.97	376.96	4.935E+07
7.	1.651	132.09	483.44	461.14	159.31	386.51	6.439E+07
8.	1.651	139.89	484.82	457.62	175.86	384.83	5.148E+07
9.	1.653	131.47	509.79	487.10	160.69	394.80	7.655E+07
10.	1.653	165.07	415.74	391.73	162.07	396.93	7.805E+07

* * * END OF FILE * * *

Case 2 - Rapid draw down reclamation slope

RD10 1-28-08 9:12



XSTABL File: RD10   1-28-08   9:12

```
****************************************
*              X S T A B L             *
*                                      *
*       Slope Stability Analysis       *
*              using the               *
*           Method of Slices           *
*                                      *
*       Copyright (C) 1992 - 2006      *
*   Interactive Software Designs, Inc. *
*       Moscow, ID 83843, U.S.A.       *
*                                      *
*          All Rights Reserved         *
*                                      *
*  Ver. 5.208              96 - 1483   *
****************************************
```

Problem Description : parkdale

SEGMENT BOUNDARY COORDINATES
----

6 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	10.0	100.0	10.0	3
2	100.0	10.0	130.0	20.0	3
3	130.0	20.0	150.0	20.0	3
4	150.0	20.0	390.0	100.0	1
5	390.0	100.0	410.0	100.0	1
6	410.0	100.0	500.0	105.0	4

11 SUBSURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	150.0	20.0	335.0	20.0	3
2	335.0	20.0	357.5	65.0	2
3	357.5	65.0	372.5	65.0	2
4	335.0	20.0	340.0	15.0	3
5	340.0	15.0	345.0	15.0	3
6	345.0	15.0	350.0	20.0	3

7	350.0	20.0	370.0	60.0	4
8	370.0	60.0	372.5	65.0	1
9	370.0	60.0	390.0	60.0	4
10	390.0	60.0	410.0	100.0	4
11	350.0	20.0	500.0	20.0	3

ISOTROPIC Soil Parameters

----

4 Soil unit(s) specified

Soil Unit No.	Unit Weight Moist (pcf)	Unit Weight Sat. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Parameter Ru	Pore Pressure Constant (psf)	Water Surface No.
1	137.7	142.5	2.0	30.00	.000	.0	1
2	124.0	128.8	100.0	28.00	.000	.0	1
3	130.5	132.3	100.0	28.00	.000	.0	1
4	112.0	125.0	5.0	30.00	.000	.0	1

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 9 coordinate points

****

PHREATIC SURFACE,

****

Point No.	x-water (ft)	y-water (ft)
1	.00	18.00
2	124.00	18.00
3	130.00	20.00
4	150.00	20.00
5	276.00	62.00
6	356.00	62.00
7	370.50	61.00
8	390.00	60.00
9	500.00	50.00

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

600 trial surfaces will be generated and analyzed.

20 Surfaces initiate from each of 30 points equally spaced along the ground surface between x = 140.0 ft
and x = 180.0 ft

Each surface terminates between x = 360.0 ft
and x = 410.0 ft

Unless further limitations were imposed, the minimum elevation at which a surface extends is y = .0 ft

4.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

Factors of safety have been calculated by the :

* * * * * SIMPLIFIED BISHOP METHOD * * * * *

The most critical circular failure surface is specified by 57 coordinate points

Point No.	x-surf (ft)	y-surf (ft)
1	155.17	21.72

2	159.17	21.55
3	163.17	21.42
4	167.17	21.36
5	171.17	21.34
6	175.17	21.38
7	179.16	21.47
8	183.16	21.62
9	187.16	21.82
10	191.15	22.07
11	195.14	22.38
12	199.12	22.74
13	203.10	23.16
14	207.07	23.63
15	211.04	24.15
16	215.00	24.72
17	218.95	25.35
18	222.89	26.03
19	226.82	26.77
20	230.74	27.56
21	234.65	28.40
22	238.55	29.29
23	242.44	30.24
24	246.31	31.23
25	250.17	32.28
26	254.02	33.39
27	257.85	34.54
28	261.66	35.74
29	265.46	37.00
30	269.24	38.31
31	273.00	39.67
32	276.74	41.07
33	280.47	42.53
34	284.17	44.04
35	287.86	45.60
36	291.52	47.21
37	295.16	48.87
38	298.78	50.57
39	302.37	52.33
40	305.94	54.13
41	309.49	55.98
42	313.01	57.88
43	316.50	59.83
44	319.97	61.82
45	323.41	63.86
46	326.83	65.94
47	330.21	68.07
48	333.57	70.25
49	336.90	72.47
50	340.19	74.74
51	343.46	77.05
52	346.69	79.40
53	349.89	81.80
54	353.06	84.24
55	356.20	86.72

56	359.30	89.25
57	360.33	90.11

**** Simplified BISHOP FOS = 1.209 ****

The following is a summary of the TEN most critical surfaces

Problem Description : parkdale

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	1.209	170.29	318.35	297.01	155.17	360.33	4.533E+07
2.	1.223	159.49	366.73	344.56	156.55	368.55	5.053E+07
3.	1.228	152.11	396.97	372.66	163.45	366.53	4.461E+07
4.	1.237	171.73	304.99	286.46	142.76	361.67	5.210E+07
5.	1.238	192.07	263.94	241.79	162.07	360.01	4.165E+07
6.	1.241	177.13	285.83	268.22	141.38	360.65	5.206E+07
7.	1.241	178.19	284.92	267.09	144.14	361.24	5.196E+07
8.	1.244	151.49	412.17	383.95	177.24	360.71	3.328E+07
9.	1.244	146.45	425.53	400.62	166.21	370.71	4.610E+07
10.	1.246	192.77	261.45	241.33	157.93	363.91	4.725E+07

* * * END OF FILE * * *