INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

December 13, 2016

C/015/0019
Received 12/14/16
Task #5348

Utah Division of Oil, Gas, and Mining
Coal Program
1594 West North Temple
Salt Lake City, UT 84114-5801

Subj: Amendment to Revise the Cottonwood/Wilberg Mine Reclamation Plan, PacifiCorp, Cottonwood/Wilberg Mine, C/015/0019, Emery County, Utah.

PacifiCorp, by and through its managing agent, Interwest Mining Company (IMC), hereby submits an amendment to revise its reclamation plan to the Cottonwood/Wilberg Mine permit. Cut and fill estimates have been recalculated utilizing Carlson Civil Software which allows three dimensional design for slopes as well as more accurate cut and fill estimates. The reclamation maps Plates 4-1, 4-1 and 4-3 in Volume 6 have been removed and replaced with updated maps to illustrate the new topography contours. These new Plates are included as Plate 4A through 4F

Several months have been spent discussing and coordinating with the Division and OSM to agree on a suitable plan that should withstand regulatory scrutiny. We feel we have now produced such a plan. The major concern by the regulatory agencies was the removal of the sediment ponds prior to waiting two years as required by R645-301-763. IMC believes it has designed a science based sediment and erosion control plan that proves to be the best technology currently available (BTCA) for protecting flows outside the permit area.

IMC has incorporated deep gouging techniques on steep slopes in place of the existing design for contour and collection ditches. Using this BTCA allows the removal of the sediment ponds at reclamation without the additional contributions of sediment to stream flow or outside the permit area. Justifying the revised sediment control techniques, IMC used RUSLE2 to model soil loss for the slopes in the disturbed and undisturbed areas. Results of this modeling found that the deep gouging and mulching techniques protects off-site areas from sedimentation until vegetation is established.

The intent of this proposed reclamation plan for the Cottonwood/Wilberg Mine is to completely replace the current plan found in Volume 2 Part 4. IMC proposes to remove and replace Part 4 with the newly revised text for the reclamation plan, appendices, and all associated maps. C1/C2 forms are attached which show what information should be added, removed, and/or replaced from multiple volumes of the MRP.

IMC proposes delaying any updates to the bond until the proposed plan is approved. Once approved, the bond will be updated to reflect the revised cut/fill estimates, revegetation activities, reduced demolition, etc.

If there is any questions or concerns with the submittal, please contact Dennis Oakley at 435-687-4825.

Sincerely,

Kenneth S Fleck

Kenneth Fleck
Geology and Environmental Affairs Manager

Enclosures

Cc File

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

Permittee: PacifiCorp

Mine: Cottonwood/Wilberg Mine **Permit Number:** C/015/0019

Title: Amendment to Revise Final Reclamation Plan for the Grimes Wash Facility, PacifiCorp, Cottonwood/Wilberg Mine, C/015/0019, Emery County, Utah

Description, Include reason for application and timing required to implement:

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

- ☐ Yes ☒ No 1. Change in the size of the Permit Area? Acres: _____ ☐ increase ☐ decrease.
- ☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
- ☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
- ☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
- ☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
- ☐ Yes ☒ No 6. Does the application require or include public notice publication?
- ☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
- ☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
- ☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
- ☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies? *Explain*: _____
- ☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
- ☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
- ☐ Yes ☒ No 13. Does the application require or include collection and reporting of any baseline information?
- ☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
- ☒ Yes ☐ No 15. Does the application require or include soil removal, storage or placement?
- ☐ Yes ☒ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
- ☒ Yes ☐ No 17. Does the application require or include construction, modification, or removal of surface facilities?
- ☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
- ☒ Yes ☐ No 19. Does the application require or include certified designs, maps or calculation?
- ☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
- ☒ Yes ☐ No 21. Have reclamation costs for bonding been provided?
- ☒ Yes ☐ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
- ☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

Kenneth Fleck — Kenneth S. Fleck — Manager of Environmental Affairs DECEMBER 14, 2013

Print Name — Sign Name, Position, Date

Subscribed and sworn to before me this 14 day of december, 2016

Mackenzi Grange

Notary Public

My commission Expires: March 16th, 2020 }

Attest: State of Utah } ss:

County of Emery

NOTARY PUBLIC
MACKENZI GRANGE
Commission No. [illegible]
Commission Expires
MARCH 16, 2020
STATE OF UTAH

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining

Form DOGM- C1 (Revised March 12, 2002)

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: PacifiCorp

Mine: Cottonwood/Wilbert Mine **Permit Number:** C/019/0019

Title: Amendment to Revise Final Reclamation Plan for the Grimes Wash Facility, PacifiCorp, Cottonwood/Wilberg Mine, C/015/0019, Emery County, Utah

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

Add	Replace	Remove	DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Volume 2, Part 4, Reclamation Plan (entire section including figures, tables, and appendices)
☒ Add	☐ Replace	☐ Remove	Volume 2, Part 4, Appendix A through Appendix I
☒ Add	☐ Replace	☐ Remove	Volume 2, Part 4, Drawings
☐ Add	☐ Replace	☒ Remove	Volume 6, Maps, 4-1: CM-10500-WB
☐ Add	☐ Replace	☒ Remove	Volume 6, 4-2: CM-10378-WB (1 of 2 and 2 of 2), 4-3: CM-10484-WB (1 of 2 and 2 of 2)
☐ Add	☐ Replace	☒ Remove	Volume 6, Map 4-2: 7704-C45 (3 of 3)
☐ Add	☐ Replace	☒ Remove	Volume 7, Appendix XV
☐ Add	☐ Replace	☒ Remove	Volume 7, Appenix XVI Part H
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	Received by Oil, Gas & Mining

Form DOGM - C2 (Revised March 12, 2002)

RECLAMATION PLAN

R645-301-200: Soils

240: Reclamation

Because the Cottonwood/Wilberg Mine was developed prior to the passage and establishment of SMCRA no topsoil was segregated during the development stage of the mine site. Therefore, the permittee proposes to segregate the upper 18" of the slope material prior to constructing final reclamation slopes. This will yield approximately 10,000 cubic yards of "substitute topsoil". Refer to Plate 4C in Maps Section for locations of substitute topsoil areas.

Prior to use of this as a topsoil source, samples shall be taken and analyzed to ensure suitability. Sample location and quality (refer to section 233) data shall be reported to the Division. This data (when collected) will be reported in Appendix A-1. The historical 1989 soil survey information for the Wilberg Mine is included in Appendix A-2. This soil information describes the soils of the fill pads constructed at the mine site. In 2001, these pads and other fills were sampled again to determine their suitability for use during reclamation. Refer to Appendix A-3 for the results of the sampling activities.

In May 2016, PacifiCorp retained RB&G Engineering to conduct a geotechnical investigation and stability analysis of the materials that will be used to construct the slopes. At that same time, PacifiCorp collected soil samples at these sites. The purpose of the collection of these samples was to determine suitability of these materials for a soil base for vegetation growth and if any of the materials were toxic or acid forming. Sample locations can be found in Appendix C-1 Figure 2. Sample evaluation analyzed the parameters found on Table 7 and Table 8 of the "Guidelines for Management of Topsoil and Overburden" (DOGM, 2008). Results of these sample are found in Appendix A-1.

At the time of reclamation, PacifiCorp will reduce the footprint of the Cottonwood/Wilberg mine site disturbed area by redistributing soil and spoil material to be consistent with the post mining land use and water drainage system. This will be accomplished by cutting and/or filling the existing mine site footprint in each of the two (2) disturbed canyons; Left Fork of the Grimes Wash and Right Fork of the Grimes Wash. These areas will be re-contoured as outlined on Plates 4B and 4C

Segregated topsoils will be stored in a location determined feasible by the reclamation contractor and protected so as not to be mixed with other soils or other contaminating materials. The topsoil piles shall also be stored in an area where the material is protected from compaction.

An additional topsoil source is located adjacent to the "old" Cottonwood/Wilberg waste rock site. Approximately 120 cubic yards is stored at this location (refer to Plate 4D in Maps Section). Prior to use as a topsoil source, samples shall be taken and analyzed to ensure suitability. Sample location and quality (refer to section 233) data shall be reported to the Division. This data (when collected) will be reported in Appendix A-1.

233: Topsoil Substitutes and Supplements

Because of the limited resources for topsoil, the suitability of topsoil substitutes will be determined. Fill material and/or overburden material shall be evaluated to determine its suitability as a topsoil substitute and to avoid surface placement of acid or toxic materials. Evaluation will analyze the parameters found on Table 7 and Table 8 of the "Guidelines for Management of Topsoil and Overburden" (DOGM, 2008). If analyses show that the acceptable criteria have not been met, then the extent of the toxic material will be determined and the entire volume of deficient material will be excavated and buried with at least four feet of an acceptable soil material. Results of these soil evaluations shall be made available to the Division and reported in Appendix A-1.

As topsoil is spread evenly over the reclaimed surface and/or overburden material, field examinations shall be randomly made to assess whether the material is suitable for topsoil. Assessments shall utilize the Field Soil Analysis Notes table found in Appendix A-1. Qualified staff shall record the date, sample ID, location, map ID, pH, conductivity, and whether the collected sample was good, fair, poor, or unacceptable. Those soils meeting the criteria of being poor or unacceptable shall be removed and buried with four feet of and acceptable material.

242.100: Topsoil Segregation

The segregated topsoils removed from identified areas will be redistributed to achieve approximate uniformity of thickness of approximately 4 inches. Placement of the soils shall be completed to prevent compaction. Various rocks and boulders will be randomly positioned throughout the reconstructed surface area to enhance vegetation establishment, create micro habitats and to help provide a natural esthetic appearance.

242.200: Topsoil Redistribution

Once the topsoils have been redistributed evenly over the reconstructed area, a weed-free alfalfa mulch shall be spread as outlined in R645-301-300: Biology. After mulching, deep gouges (pocks) shall be constructed as outlined in R645-301-500: Engineering. Pocks shall be placed in a random and continuous manner throughout the reconstructed surface area.

The process of placing mulch and pocks throughout the reconstructed surface is a treatment that will reduce the potential for slippage of the redistributed material and promote root penetration.

243: Soil Nutrients and Amendments

Nutrients and soil fertilizers will be applied at the completion of the pocking process. As outlined in R645-301-300: Biology, fertilizer shall be applied at the following rate:

Ammonium Nitrate	30-50 lbs/acre
Triple Phosphate	30-40 lbs/acre

Once the fertilizer is spread uniformly, the approved seed mix shall be applied. Refer to R645-301-300: Biology for the approved final reclamation seed mix.

244: Soil Stabilizaton

All exposed surface areas will be protected and stabilized to effectively control erosion. After the seed is applied, the entire area will be hydromulched with a wood fiber or other acceptable mulch and will be applied at a rate of at least 1500 lbs./acre for cover and protection. A tackifier (plantago or other similar tackifier) will be added to the mulch and applied at a rate recommended by the manufacturer (typically approximately 150 lbs/acre). Mulch and tackifier will be applied simultaneously.

244.300: Soil Stabilization of Rills and Gullies

Rills and gullies, which develop in areas that have been regraded and topsoiled, which disrupt the approved postmining land use, or reestablishment of the vegetative cover, or cause or contribute to violation of water quality standards for receiving streams, will be filled, regraded, or otherwise stabilized; topsoil will be replaced; and the areas will be reseeded or replanted.

R645-301-300: Biology

340: Reclamation Plan

341: Revegetation

To fulfill the requirements of the biological protection performance standards of the State Program, the permittee constructed test plot areas to determine the ideal revegetation strategy for final reclamation. These test plots were established on a fill slope at the mine site to test the final revegetation seed mix. The test plots were located in area W2-West (see Map 2-18 in Volume 5). Slope and vegetation test plots exposure are relatively constant throughout the area. Division approval was obtained prior to installation of the test plots. Observations indicated that moisture would be the primary factor affecting vegetation growth at the mine site. Therefore, the test plots were designed to test the final revegetation seed mix and plantings under various moisture conditions and mulch applications.

Because of the limited size of the slopes involved, the test plot sizes were limited. The plot layout and design is illustrated in Figure 3-1. The design provides for eight (8) seeding, mulch, and irrigation combinations.

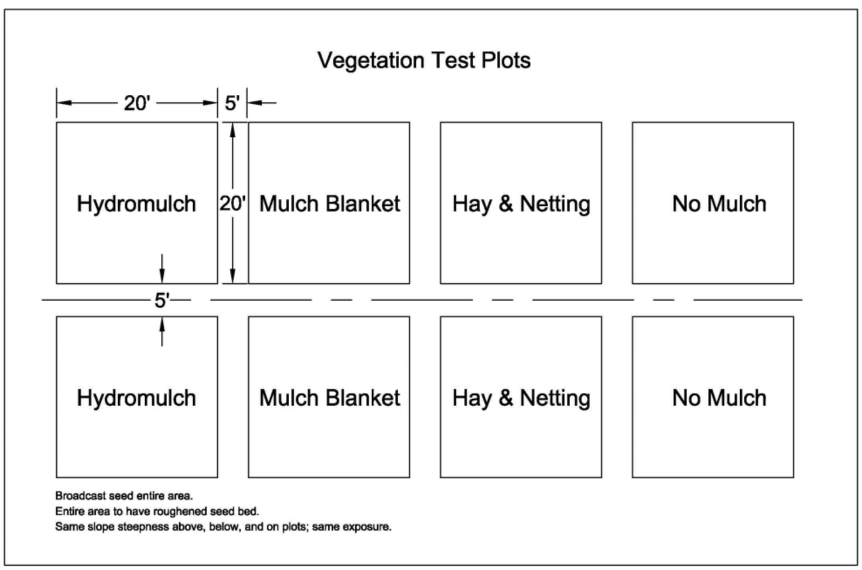


Figure 3-1: Vegetation Test Plots.

The test plot areas were divided into eight (8) individual plots, each one 20 feet by 20 feet. Each plot was separated from adjacent plots by a buffer area five (5) feet in width. Each plot was permanently staked and the entire test area was fenced. The test plots were installed in the fall of 1989 with seeding being done as late in the season as possible.

Prior to seeding, the test plot area was treated with Round-up herbicide per manufacturer's recommendations to remove existing vegetation. The soil surface was roughened using hand tools to prepare the seedbed.

The final revegetation seed mixture (detailed in the original final vegetation plan) was applied on all test plots. Following seeding, the fertilizer mixture was applied, per DOGM recommendations:

Ammonium Nitrate	30-50 lbs/acre
Triple Phosphate	30-40 lbs/acre

The plots were then hand-raked to cover the seed and fertilizer.

Following seed and fertilizer application, the various mulch treatments were applied as indicated in Figure 3-1. During the hydromulch application, adjacent plots were covered to prevent contamination due to overspray or wind drift. In the spring of 1991, containerized plants were planted.

Irrigation was applied during the first two (2) years (growing seasons) following seeding. After dicussion with the Division, irrigation was terminated after the second growing season. Irrigation began with the onset of spring and terminated at the first fall frost.

Irrigation was applied once per week unless determined otherwise based on soil moisture and plant vigor appearance. Soil moisture conditions were determined weekly by soil probing to a six (6) inch depth.

Irrigation was supplied from a water truck using a hand-held sprayer attached to a hose. The amount of water applied was quantified. Water was applied to the point of surface saturation or penetration to six (6) inches on the control plot. All irrigated plots were watered equally. Irrigation commenced in the early evening and completed by sundown.

Maintenance, monitoring and sampling methods and schedules were as specified in 342.220. A minimum of 15, 1/4 meter quadrants were evaluated per plot. Success standards were as specified for the reference area (refer to Volume 1, Part 2: Vegetation Information for the Wilberg Mine). Vegetation monitoring of this site was conducted between years 1989 through 1999. Both results of qualitative and quantitative analysis can be found in the Annual Reports between the said years.

The initial revegetation plan was designed using the results of the test plots that were installed in 1989 and monitored over several years. However, in 2015, during the rewrite of the Cottonwood/Wilberg Reclamation Plan, the Division, in cooperation with the United States Forest Service introduced a revised seed mix for planting the slopes of the reclaimed mine site. The revised seed mix is presented below in Table 3-3. All containerized plants were removed from the planting mix because of the poor success rates experienced on other similar projects.

341.100: Revegetation Timetable

Table 3-1 presents the timetable in which reclamation and revegetation will be conducted at the Cottonwood/Wilberg Mine site. Many of these listed operations will be conducted simultaneously. Reclamation activities will work from the upper elevations of the mine site to the lower elevations.

Table 3-1: Cottonwood/Wilberg Mine Reclamation Schedule.

#	Project	Estimated Schedule (months)
1	Structure Removal	All structures removed June 2015
2	Portal Closure	All portals were sealed in May 2001/Backfilled June 2015
3	Soil Salvaging	
4	Hauling, Backfilling, Compaction, Grading	
5	Install Raprap Channels	
6	Seedbed Preparation (Includes topsoil, hay mulch, pocking)	
7	Fertilizing/Seeding	
8	Hydromulching/Tackifying	
9	Sediment Control Structure Removal*	

*The sediment pond will be removed at the completion of all other reclamation activities above the pond.

Notice in the table above that backfill and grading activities and seeding activities are occurring simultaneously. This will occur as work progresses down canyons. Advantageously, seeding will occur during the fall season. However, if recontouring is completed in the spring of the year on the upper portions of the disturbed area, seeding will immediately follow.

Table 3-2: Cottonwood/Wilberg 10 year Responsibility Period Schedule.

#	10 Yr Revegetation and Monitoring	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year
1	Plant Monitoring Disease & Pest Control		✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Mine Water Discharge Monitoring*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Soil Stabilization Rills & Gullies		✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Contingent Seeding		✓			✓					
5	Revegetation Inventory for Bond Release				✓				✓	✓	✓
6	Maintenance (as needed)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*Monitoring of mine discharge will be conducted as required by the current UPDES permit (Outfall 001 in Cottonwood Canyon).

341.210: Seed Mixtures

Because all surface disturbances occurs within Forest Service land, the USFS has provided the Cottonwood/Wilberg Mine a final revegetation seed mix proposed for use (refer to Table 3-3). Plant species in the mix are currently in use by the Manti-LaSal National Forest and commonly occur on the Wasatch Plateau. The mix includes species, to establish a diverse, effective and permanent cover capable of achieving the postmining land use.

Wilberg Drain Field

Final revegetation at the drain field was completed in March 2015. This included roughening of the access road and reseeding it. The seed mix is shown below in Table 3-4.

This seed mix and planting rate is as requested by the BLM and approved by the DOGM. The introduction of Crested Wheatgrass is at the insistence of the BLM and as requested by DOGM.

Table 3-3: Cottonwood/Wilberg Mine Site Final Seed Mixture.

Common Name	Scientific Name	Equivalent PLS Lbs/Acre
GRASSES		
Western wheatgrass	*Agropyron smithii*	2
Bluebunch wheatgrass	*Agropyron spicatum*	3
Indian ricegrass	*Oryzposis hymenoides*	2
Needle and thread grass	*Stipa comata*	1
Thickspike wheatgrass	*Agropyron dasystachyum*	3
Basin Wildrye	*Leymus cinereus*	2
FORBS		
Blueleaf aster	*Aster glaucodes*	0.5
Small burnet	*Sanguisorba minor*	2
Lewis flax	*Linum Lewisii*	1
Palmer's Penstemon	*Penstemon palmari*	0.5
SHRUBS		
Serviceberry	*Amelanchier Alnifolia*	2
Fourwing saltbush	*Atriplex canescens*	2
Shadscale saltbush	*Atriplex confertifolia*	0.5
Big Wyoming Sagebrush	*Artemisia tridentate*	0.5
TOTAL		**22**

Table 3-4: Wilberg Drain Field Final Seed Mixture.

Common Name	Scientific Name	Equivalent PLS Lbs/Acre
GRASSES		
Western wheatgrass	*Agropyron smithii*	2
Indian ricegrass	*Oryzposis hymenoides*	2
Needle and thread grass	*Stipa comata*	2
Galleta	*Pleuraphis*	2
Crested wheatgrass	*Agronpyron cristatum*	1
FORBS		
Scarlet globemallow	*Sphaeralcea coccinea*	1
Yellow sweet clover	*Melilotus altissimus*	1
SHRUBS		
Fourwing saltbush	*Atriplex canescens*	2
Curlleaf mountain mahogany	*Cerocarpus ledifolius*	2
Ephedra Mormon Tea	*Ephedra viridis*	4
Vasey big sagebrush	*Artemisia tridentata var. vaseyana*	0.2
TOTAL		**19.2**

Reclamation of the Cottonwood Fan Portal Area – Cottonwood Canyon

Final reclamation of the Cottonwood Fan Portal in Cottonwood Canyon was completed in November 1998 and Phase III Bond Release was accepted on September 28, 2010 (refer to Volume 11). Approximately 1.86 acres of disturbance existed at this location. The disturbed area included the Trail Mountain Access (TMA) portal and belt portal, collectively called the Cottonwood Canyon Facilities. These facilities were demolished and final reclamation was completed in November 2014. Refer to R645-301-542.700 (Engineering Chapter) for a complete discussion of the sealing of the mine openings in this area. The approved seed mixture for this site is shown in Table 3-5.

Table 3-5: Cottonwood Fan Portal Area Final Seed Mixture.

Common Name	Scientific Name	Equivalent PLS Lbs/Acre
GRASSES		
Western wheatgrass	*Agropyron smithii*	3
Bluebunch wheatgrass	*Agropyron spicatum*	3
Indian ricegrass	*Oryzposis hymenoides*	3
Needle and thread grass	*Stipa comata*	1
Thickspike wheatgrass	*Agropyron dasystachyum*	1
Great Basin Wildrye	*Elymus ciaereus*	2
FORBS		
Blueleaf aster	*Aster glaucodes*	0.5
Utah Sweet Vetch	*Hedysarum boreale*	1
Lewis flax	*Linum lewisii*	1
Globemallow	*Sphaeralcea coccinea*	.05
Yarrow	*Achillea millefolius*	0.5
Palmer penstemon	*Penstemon palmeri*	1
SHRUBS		
Serviceberry	*Amelanchier alnifolia*	1
Fourwing saltbush	*Atriplex canescens*	2
Green Mormon Tea	*Ephedra viridis*	1
Wyoming big sagebrush	*Artemesia wyomingensis*	0.5
Big white rabbitbrush	*Chrysothamunus nauseosus*	0.5
TOTAL		**22.5**

Reclamation of the Soil and Rock Storage Area – North of Old Waste Rock Site

Once the soil and rock materials at this site are removed, the 1.86 acre area will be roughened and reseeded. The seed mixture found in Table 3-3 will be used to revegetate this site. Because of the flatness of this area, pocking is not proposed for sediment control.

342.220: Revegetation Methods

The following methods have been or will be utilized for revegetation activities at the Cottonwood/Wilberg sites.

1. Seedbed Preparation

Seeding will take place as contemporaneously as is practical following contouring/pocking of the area being reclaimed. Certified weed free alfalfa hay will be incorporated into the soil at a rate of 2000 lbs/acre. Fertilizer will be applied by hand and incorporated during this revegetation sequence. The rate of application will be 30-50 lbs/acre or as recommended by the manufacturer.

2 Deep Gouging or Pocking

Pocking techniques will mix the straw mulch into the upper portion of the soil. The pocks will be made using the bucket of a track-hoe or similar machine to roughen the disturbed area in a random and discontinuous fashion. Pockmarks created are approximately 3.0 to 6.0 feet square and 1.5 to 3.0 feet deep. The pockmarks are designed to capture and trap precipitation, influencing infiltration. Gouging/pocking controls erosion through water retention, thus enhancing vegetation growth.

3 Seeding

The seed mixture (refer to table above) will be broadcast using a “hurricane spreader” or applied using a hydro seeder. If the seed mixture is broadcast, seeding will take place immediately after pocking. If the seed mixture is hydro seeded, a small amount of wood fiber mulch will be added to mark the area of coverage during application.

4 Mulching

After the seed is applied, the entire area will be hydromulched with a wood fiber or other acceptable mulch and will be applied at a rate of at least 1500 lbs./acre for cover and protection. A tackifier (plantago or other similar tackifier) will be added to the mulch and applied at a rate recommended by the manufacturer (typically approximately 150 lbs/acre). Mulch and tackifier will be applied simultaneously.

Maintenance and Monitoring

1. Signs will be placed around the planted slopes for their protection.

2. Weed control will not be undertaken unless it is determined necessary due to weed dominance and delayed rate of succession. Studies indicate that competition from weeds, including Salsola kali, is greatly reduced within three (3) years after revegetation. Preliminary on-site studies support published reports on this matter. All noxious weeds will be eradicated if they become established on the site.

3. Rodent damage on revegetated areas will be assessed and species specific control measures will be implemented as necessary.

4. A site visit will be scheduled each spring to check on fitness of the sites and to check progress of the plant growth.

5. Annual monitoring will also include inspection for rills and gullies. Should these be present, they will be filled and the soil reseeded. Rill and gully repair will follow the regulations set forth in the Coal Rules R645-301-357.360 through R645-301-357.365. As needs for repairs is recognized, the Division will be notified and the affected area will be reported in the annual vegetation report.

6. Maintenance and monitoring activities will be reported in the Annual Vegetation Monitoring Report.

341.250: Measures Proposed to be used to Determine Revegetation Success.

Sampling for Ten Year Responsibility Period and Bond Release (refer to Table 3-2)

1. All sampling will be undertaken by a qualified person in the late summer for maximum plant growth.

2. The line intercept or ocular estimation methods will be used to measure cover and species composition.

3. The point-center quarter method or other acceptable method will be used to measure shrub and tree density.

4. Sample size for ground cover and shrub density will be tested at a 90 percent confidence level using a one-tail "t" test with a 10 percent change in the mean.

5. Productivity measurements will be a double sampling procedure of clipped plots and ocular estimates. Rectangular plots (1 square meter) will be randomly located in reference areas and revegetation sites. Sampling will be at the 90% confidence level.

6. The reference areas will be checked to detect any changes from man-induced activities and to verify they are in fair or better condition.

7. Revegetation Success:
   All vegetation sampling will be undertaken in the late summer for maximum plant growth. The line intercept or ocular estimation methods will be used to measure cover and species composition. The point-center quarter method will be used to measure shrub and tree density.

   Productivity measurements will be a double sampling procedure of clipped plots and ocular estimates. Rectangular plots (1 square meter) will be randomly located in reference areas and revegetation sites. Sampling will be at the 90% confidence level.

The reference area will be checked to detect any change from natural or man-induced activities and to verify they are in fair or better condition. Sampling of the reference sites at the time of bond release will be conducted concurrently with final reclamation sampling, using the same methodology used to sample the reclaimed areas.

The standards for success to be applied for ground cover and production of living plants on the reclaimed areas will be at least equal to 90% (with a 90% confidence level) to that of the respective reference area at the time of bond release. For example, the reclaimed riparian area will be compared to the riparian reference area for cover and production. Cover in the reclaimed areas will not be less than that required to achieve the approved post-mining land use.

Revegetation for tree and shrub species will be considered successful when the tree and shrub count in the reclaimed areas are similar at the time of bond release to the count in the reference area.

During the 4th year after revegetation, the point-center quarter or other accepted method will again be used to determine the density of trees and shrubs in the reclaimed areas. Locations of monitoring will be random within each of the reclaimed areas and recorded. This process will be repeated in the 8th year.

At the time of bond release, or after the 10 year responsibility period has passed, similarity between the reclaimed area and corresponding reference area will compare life forms and/or species present in each community by the use of similarity indices. Indices of similarity provide the means of mathematically comparing the plant communities in the two areas. One of, or a combination of the three indices found in the Vegetation Guidelines, Appendix B will be used to determine the similarity between the reclaimed and reference area. If another index (or combination thereof) is used, Division approval will be required. Similarity will be considered successful when the index value is at least 70% of the reference area.

All vegetation monitoring data will be reported annually. This report will contain a narrative of the actual monitoring methods used, results, and a discussion of the overall success or failure of each area. Raw data sheets will also be included in the annual reports. Standards attained at the time of bond release will be approved by the Division of Oil, Gas and Mining.

342: Fish and Wildlife

The portal facilities of the Cottonwood/Wilberg Mine are located in the lower reaches of a mountainous drainage called Grimes Wash (portal facilities demolition commenced in November 2014 and was completed in June 2015). This area consists of approximately 20 acres and is physically separated from the remaining undisturbed permit area by imposing and inaccessible cliffs that rise over 1,600 feet vertically from the portal area.

The east escarpment face of the Wasatch Plateau that includes the Cottonwood/Wilberg portal facilities is used extensively by nesting raptors. Most of the escarpment face is naturally inaccessible to humans so the birds are undisturbed by man. Nest sites in Grimes Wash are in inaccessible cliffs (refer to Annual Raptor Reports on file for raptor activity and nest status).

Excepting the occasional use for exploration, the wildlife inhabitants on top of East Mountain were unaffected during the mining operation and will require no special plans other than the hydrological and subsidence monitoring.

There are no prime fisheries located on the East Mountain plateau within the permit area.

A 69 KV line served as the power source of the Cottonwood/Wilberg complex. Mostly single pole and suspension insulators, this transmission line provided sufficient phase to phase and phase to ground clearance to preclude electrical contact of raptors including eagles. The power line structure types are approved as eagle-safe by USFWS by letter dated November 26, 1982 from the DOGM. This power line was removed by Rocky Mountain Power in March 2015.

Although Grimes Wash is not a fishery (considered an ephemeral drainage), it is a tributary to Cottonwood Creek (Straight Canyon) which is a limited fishery.

Protection from coal dust and increased sediments to these waters were by diversion of the natural flowing waters throughout piping systems past the mining area proper. Two sedimentation ponds were installed for control of sediment and coal dust from storm runoff waters within the portal facilities area. After reclamation, protection from increased sediments to the downstream waters will be by retention of sediment and precipitation on the slopes through the use of deep gouging techniques. The pocks are designed to capture and trap precipitation, influencing infiltration. Gouging/pocking serves to control erosion through water retention, thus enhancing vegetation growth. Refer to the Hydrology Chapter for a complete discussion of the sediment control plan.

During breeding seasons, disturbance by man can negatively affect the number of breeding territories for some species of wildlife. Disturbance can also interrupt courtship displays and preclude timely interaction between breeding animals. This can result in reduced reproductive success and ultimate reductions in population levels.

Early in the rearing process, young animals need the peace and tranquillity normally afforded by remote wildlands. It is also during this crucial period that young animals gain the strength and ability to elude man and other predators.

This especially applies to raptors which may be attracted to the cliff sites adjacent to the mine for a nest site. These species readily abandon nesting and rearing efforts if intruded upon by man. Any nest initiated adjacent to the existing facilities would not require cessation of operations because this nesting action signifies acceptance of the present situation. All raptor nests will be reported to UDWR in Price.

Information regarding mule deer seasonal distribution and numbers within the permit area is not available due to the dynamic characteristics of the deer herds involved. UDWR personnel indicate such information would not truly be representative of the demographics of the deer population; therefore, it is not available from the UDWR.

The final reclamation as planned will restore the stream channels and revegetate the disturbed sites. The planting mix of forbs, grasses, and shrubs is similar to the adjacent native plant communities and will provide food and cover for wildlife.

350: Performance Standards

Refer to 341.250 as outlined previously.

R645-301-400: Land Use

412: Reclamation Plan

Geographically, the site of the Cottonwood/Wilberg portals (surface operations) is restricted by a narrow canyon headed with two drainages, the Left and Right forks of Grimes Wash. Both tributaries are non-accessible beyond the portal site, limiting uses except for wildlife use.

Following mining, the plan is to restore the area affected by the mining operation to its pre-mining state. Principal land use after reclamation will be grazing and wildlife habitat. Grazing permits are presently issued for areas surrounding the disturbed area by both the US Forest Service and the Bureau of Land Management. Both agencies have stated that there are no foreseeable changes to land use.

According to the Manti-LaSal National Forest Land and Resource Management Plan (1986), the main portal area is within the Forest Service MMA classification. This classification emphasizes Leasable Mineral Development and includes areas where land surface is, or will be, used for mineral development facilities. The surrounding area is classified GWR, General Big Game Winter Range. The portal area is inaccessible from the top of East Mountain but will probably be utilized by BLM grazing permittees whose cattle would naturally migrate north into the portal area from the adjacent BLM allotments. This area will be re-established to meet the requirements of grazing and wildlife.

The Cottonwood Fan Portal site in Cottonwood Canyon is located on fee land within Forest Service grazing allotments. Postmining land use is basically wildlife habitat. Due to the steep slopes and exposed hard rock surfaces that are now present, the probability of range grazing is minimal. Approximately 7.47 acres of the total disturbed area of 9.33 acres were reclaimed (completed 1998) and Phase III Bond Release was granted on September 28, 2010 (refer to Volume 11).

Regarding the remaining 1.86 acres of disturbance (belt and intake portals), the land has been reclaimed (final reclamation completed in November 2014) to its approximate original slopes, drainages re-established, and vegetation planted to meet the reference area's cover, species density, and productivity as measured during reference area monitoring. Based on past experience with reclamation projects, ten years following reclamation (bond period) is sufficient time to manage the vegetation establishment of growth to meet the requirements of the post mine land use as stated.

PROTECTION OF PUBLIC PARKS AND HISTORIC PLACES

No public parks are located in or adjacent to the permit area. Cultural resource information contained in this application was based on field surveys contracted to AERC (Archeological Environmental Research Corporation) and conducted under the auspices of Richard Hauck.

Several separate surveys were conducted. Prior to the construction of the Wilberg Mine portal site and associated offsite facilities, archeological surveys were conducted. Results of these surveys disclosed several sites adjacent to Grimes Wash. These reports are included in the Environment Section in Volume 1.

During the planning of the Cottonwood Fan Portal site (site reclaimed in 1998, Phase III Bond Release in 2010) and utility corridor, an archeological survey was conducted. It also identified several sites. Although this project has since been reduced to only the fan portal area, this report is also included.

The delineated Old Johnson Mine area is outside the reclamation area of the Cottonwood Fan Portal site disturbance, and was protected from any disturbance. The roadway in front of the old portal was utilized for access into the disturbed area for reclamation of the Cottonwood Fan Portal. Final reclamation of the Cottonwood Fan Portal was completed in November 1998. A berm was established along the outside slope above the Johnson Mine weigh shed and other historic sites to provide protection and keep any material or rocks from entering the potential historic site area. The roadway was reclaimed as close to pre-existing conditions as possible.

For lands within the permit area not covered by planned surface disturbances, but yet could be affected by subsidence, a general 15 percent random archeological survey was conducted. The basis of this survey was extrapolated from requirements mandated by OSM for authorization to mine coal from the adjacent Des Bee Dove Mine (final bond release approved April 2013). Results of this survey are contained in the report found in the Environment Section in Volume 1.

R645-301-500: Engineering

541.300: Structure Removal

Once mining ceased, the surface facilities were dismantled and removed from the permit area. Starting at the mine portals, all belt lines, crushing and screening systems, electrical systems, truck loadouts, surface buildings and fan installations were removed and hauled from the permit area.

The concrete silo was demolished, broken up and buried against the east highwall cut in the lower parking lot. All other concrete foundations that would be above final grade were removed and stockpiled with the silo material or used to backfill portals. Refer to Items 1-A through 2-A in Appendix H for demolition of the structures at the Cottonwood/Wilberg Mine. Note: Demolition was completed in June 2015.

During construction of the facility, for safety reasons it was found necessary to install shotcrete on certain areas of the rock outcrop. In some cases it was necessary to secure loose boulders of the cliff face with chain link fencing prior to coating with shotcrete. During demolition, attempts were made remove the shotcrete from the cliff faces. This process could not be completed safely and without compromising the integrity of the cliff. Therefore, the shotcrete was left in place. Leaving the shotcrete in place does not affect the post mining land use described as grazing, wildlife, and recreation.

542: Narratives, Maps, and Plans

As depicted in R645-301-300: Biology, a timetable has been developed to show each major step for completing final reclamation of the Cottonwood/Wilberg Mine. This schedule is shown again below in Figure 5-1. A typical cross-section drawing illustrating the sequence of reclamation is found in the Maps Section as Plate. 4A.

Table 5-1: Cottonwood/Wilberg Mine Reclamation Schedule.

#	Project	Estimated Schedule (months)											
1	Structure Removal	All structures removed June 2015											
2	Portal Closure	All portals were sealed in May 2001/Backfilled June 2015											
3	Soil Salvaging	■	■	■									
4	Hauling, Backfilling, Compaction, Grading	■	■	■	■	■	■	■					
5	Install Raprap Channels			■	■	■	■	■	■	■			
6	Seedbed Preparation (Includes topsoil, hay mulch, pocking)									■	■	■	■
7	Fertilizing/Seeding									■	■	■	■
8	Hydromulching/Tackifying									■	■	■	■
9	Sediment Control Structure Removal*										■	■	

*The sediment pond will be removed at the completion of all other reclamation activities above the pond.

542.200: Backfilling and Grading Plan

Note: Reclamation design maps are found in the Maps Tab.

In general, the backfilling and grading of the disturbed areas will consist of removing the fill pads and backfilling the cut areas. The work will start in the upper areas of the disturbed area and systematically work downslope to the entrance gate. Prior to any earth moving to reconfigure the surface to the designs shown, the topsoil, as described in R645-301-200: Soils, shall be removed and stored for future use. Approximately 10,120 cubic yards of topsoil has been identified for use. Locations include those areas shown on Plate 4C and the Soil and Rock Storage Area located below the mine (refer to Plate 4D in the Maps Section).

Also shown on Plate 4C are the cross-sectional areas for cuts and fills. There are approximately 176,455 bank cubic yards (BCY) of material to be cut and approximately 155,830 BCY of material will be backfilled and graded within the disturbed areas. All fill slopes have been designed to be no greater than a 2 horizontal to 1 vertical gradient. Mass balance calculations of the cuts and fill show a difference of 12% between the cut and fill estimates, leaving approximately 20,625 BCY of extra material. This material will be used in areas where more fill could enhance the slope, or will be blended into the reclaimed slopes. Plate 4-2 displays the final topography of the reclaimed slopes. This plate also shows the final configuration of the designed channel in the Left and Right forks of the Grimes Wash. Detailed channel design is discussed in R645-301-700: Hydrology.

Rip-rap Installation and Drainage Structure Removal

During the backfilling and grading cycle, rocks suitable for rip-rap will be sorted from the excavation and placed in the restructured drainage channel. The majority of the material was originally taken from rock cuts; therefore, sufficient material for rip-rap is available.

As the backfilling and grading progresses and the drainage structures (culverts, etc.) are exposed they will be removed and disposed of off the permit area.

The ponds will be the last major structures to be removed during backfilling and grading operations. Justification for pond removal is discussed in R645-301-700: Hydrology. The access road will be completely removed and recontoured to the entrance gate.

There will be no facilities or permanent structures remaining after the completion of reclamation. The reclamation plan was design to comply with the post-mining land uses described in R465-301-400: Land Use.

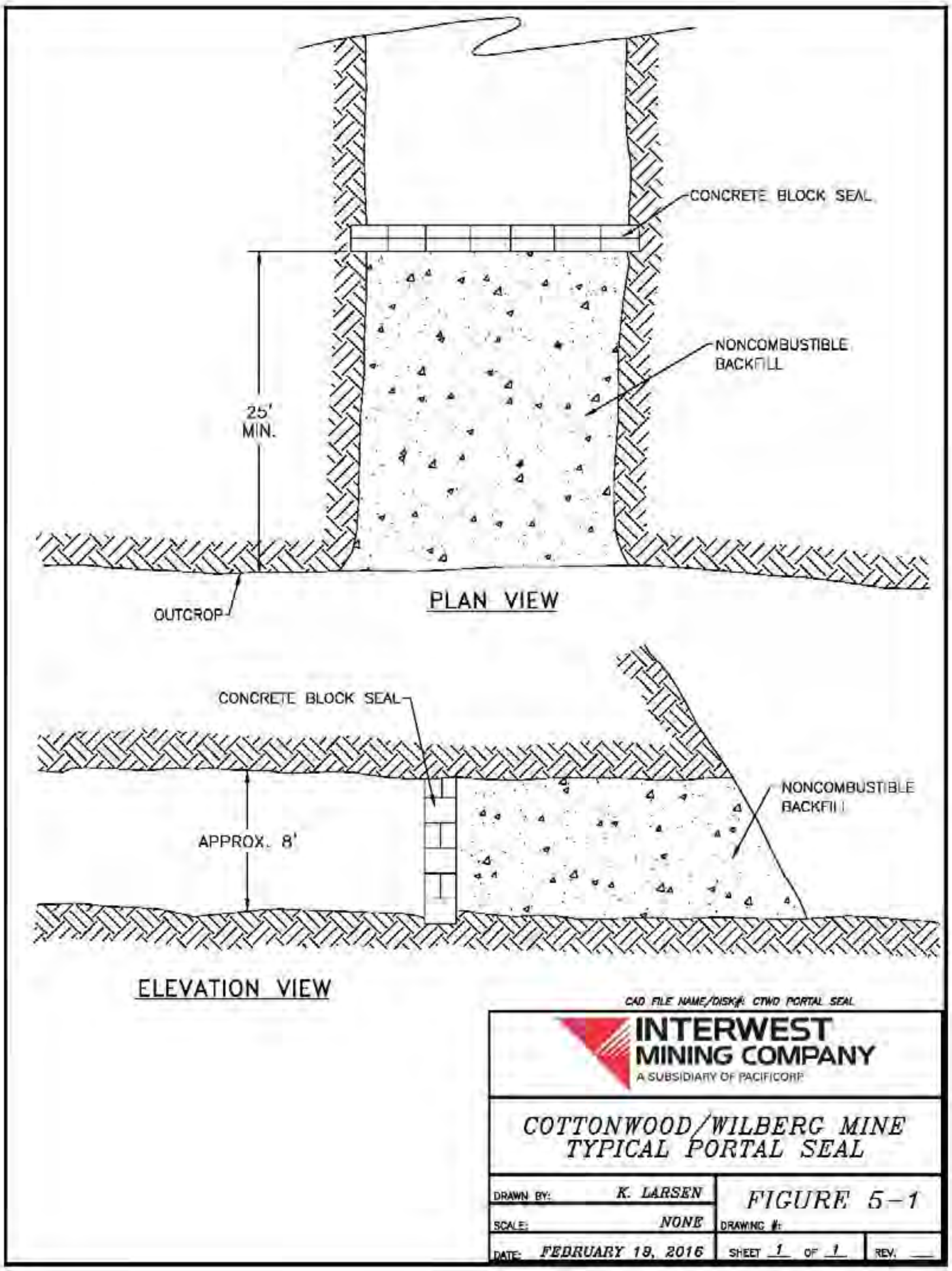
542.600: Roads

The asphalt from the service road, truck turn around, upper parking lot, portal bench, south Wilberg portals, and south Wilberg storage pad will be removed and disposed of off-site to an approved landfill or reclaimed to be utilized for other off-site road construction projects. Refer to Appendix H, Item 1-DD for quantities removed. No asphalt will be buried within the reclamation area.

542.700: Final Abandonment of Mine Openings and Disposal Areas

Mine Opennings

The Cottonwood/Wilberg portals and breakouts were completely sealed in 2001. The portals at the main Cottonwood/Wilberg site are all up-dip of the underground workings and require no drains or special hydrological containment seals (see Protection of the Hydrological Balance section in Volume 9). Seals were installed as shown on Figure 5-1 below.



Due to the natural dip of the strata, the Trail Mountain Access (TMA) portal in Cottonwood Canyon (final reclamation in November 2014) is the lowest within the existing Cottonwood/Wilberg mine permit area. Groundwater intercepted during the development of the TMA development entries flows to the TMA portal. To prepare for the permanent discharge, PacifiCorp installed a series of three sediment traps located 100 feet apart within the mine to settle out particles prior to discharge. A solid block seal (built to MSHA requirements) was constructed 25 feet inby the portal entrance. A French drain system was installed with 6" perforated PVC pipe behind the seal. A secondary decant pipe was installed at the bottom of the seal along with a backup decant line installed 2 feet from the roof. Each line was fitted with a shut-off valve. Durable drain rock of 2-4 inch sizing was placed over the perforated drain line. Pea sized gravel was placed over the drain rock as a filtering system. The thickness of the filtering system is approximately 4 feet thick.

Mine water is discharged through the seal into a 6 inch buried PVC that parallels the Emery County Road 506 for approximately 200 feet below the portal. The pipe drops into a 36 inch bypass culvert which discharges into the Cottonwood Canyon Creek. Since 2001 the discharge of mine water has averaged approximately 21 gpm. This discharge is considered permanent for post-mining land use. PacifiCorp currently possesses a UPDES permit (#UT0022896-001) for this site and monitors the quality and quantity on a monthly basis at the inlet of the 36" bypass culvert. At reclamation, Emery County Road Department requested that the 6 inch buried PVC line be left in place to keep ice from potentially building up in a road ditch in the winter and pushing ice onto the road. In a letter dated February 2015, Emery County Road Department committed to maintaining the line within their right of way. See Appendix I to review the letter from Emery County and the updated design drawing from 2001.

Disposal Areas

Old Waste Rock Site: Located 1.5 miles south of the Cottonwood/Wilberg Mine, this 48.62 acre site was originally designed as an open storage and truck loadout for the Cottonwood/Wilberg Mine. The Right-of-Way grant (UTU-37642) was issued by the Bureau of Land Management in 1977 but subsequent developments, specifically construction of a concrete storage silo for coal storage at the mine, changed the function of this site. A modification was submitted to use this site for storage of waste rock produced by underground development mining in the Cottonwood/Wilberg Mine.

The Right-of-Way UTU-37642 has also been modified to accommodate coal bed methane degasification activities conducted by Texaco Inc. Listed below is a list the acreage descriptions of the Right-of-Way including original grant, modifications and disturbance associated with the facility:

BLM Right-of-Way UTU-37642

Original Grant (1997)	48.62 acres
1997 Relinquishment (Texaco Well 35-14)	1.08 acres
1999 Relinquishment (Texaco Well 34-80)	12.98 acres
TOTAL RIGHT-OF-WAY UTU-37642	34.56 acres
Reclaimed Area (Phase III Released July 2009)	13.81 acres
2015 Relinquishment	32.7 acres
ROW and Disturbed Area Remaining	**1.86 acres**

Approximately 13.81 acres of the old waste rock site has been reclaimed. Material to cover the waste rock was taken from the perimeter berms. Phase 1 bond release was approved on July 22, 1999. Phase III bond release was approved July 22, 2009. In October 2015, the BLM approved relinquishment of 32.7 acres bringing the total right of way held by PacifiCorp to 1.86 acres.

The remaining 1.86 acres has been retained as a soil and rock storage area. This soil, which is native topsoil and subsoil from the Cottonwood Fan Portal area, will be used for topsoil for the Cottonwood/Wilberg mine site (refer to R645-301-200: Soils). Boulders will be used for riprap construction of the reconstructed channel, if needed. The soil quantity is approximately 120 cubic yards.

Once this material is removed from the site, the area will be roughened and reseeded as outlined in R645-301-300: Biology.

542.730: Disposal of Coal Mine Waste

Coal mine wastes that are uncovered during earthmoving activities shall be segregated and buried in fill areas and covered to ensure that the fill area is suitable for reclamation and revegetation compatible with the natural surroundings and the approved post-mining land use. All coal mine wastes will be covered with at least four feet of suitable fill.

542.740: Noncoal Mine Wastes

During the demolition of the mine site, all recoverable noncoal waste materials were collected and disposed of. Any noncoal waste recovered during earthwork activities will be collected and disposed off-site in an approved landfill.

550: Reclamation Design Criteria

Reclamation design criteria have been discussed in the previous section of 542. Any additional criteria will be discussed in the following sections.

552: Permanent Features

Small depressions, in the form of pocks (refer to R645-301-700: Hydrology for a complete discussion for sediment control measures) shall be constructed on all areas of the Cottonwood/Wilberg mine site reclaimed area. These pocks will retain moisture, minimize erosion, create and enhance wildlife habitat, and assist revegetation. The area for which these pocks will be developed is shown on the RUSLE map (Plate 4E) in the Maps Section.

Other features such as boulders and clusters of boulders will be randomly placed throughout the reclaimed surfaces to create habitat for small mammals, birds, and raptors. Boulders will be gathered on-site for this purpose during backfilling and grading activities.

553.100: Approximate Original Contour

The strategy of the reclamation plan is to design the final reclamation contours to achieve approximate original contour (AOC) criteria. Rock outcrops will be exposed to blend in with the natural topography of the area.

Fill slopes will be constructed to no greater than a 2 horizontal to 1 vertical gradient. Cut slopes will be created with that same criteria.

553.120: Highwall Elimination

Final reclamation of highwalls at the Cottonwood/Wilberg mines is accomplished in three phases; demolition, earthwork, and revegetation. These phases follow strict requirements set forth by the Utah Coal Rules R645-301-100 through 800. Highwalls at the Cottonwood/Wilberg mines were inventoried by Office of Surface Mining and the Division of Oil, Gas and Mining in 1997. Eighteen (18) areas of concern were identified and are listed in Appendix B. Eight (8) of the areas considered highwalls were constructed prior to the ruling (May 3, 1978) of the Surface Mining Control and Reclamation Act (SMCRA). Seven (7) portal highwalls were constructed after that date. Three (3) of the areas of concern have no associated highwalls. Sites constructed prior to May 3, 1978 need only to eliminate highwalls to the extent practicable using all reasonably available spoil. All post-SMCRA sites are required to completely eliminate highwalls. Appendix B exhibits the extent of backfill that will be used to eliminate as practicable or eliminate completely these highwalls. This is shown in a photo essay for each of these portals. All highwalls at the Cottonwood/Wilberg mines will be eliminated concurrently with final reclamation activities. A detailed cost estimation for all reclamation activities is located in Appendix H.

Table 5-2: Status of Cottonwood/Wilberg Portals.

Cottonwood/Wilberg Mines List of Portals (refer to Highwall Survey: Part 4 Appendix B)		
Location (Number of Portals)*	**Development Date**	**Status**
Grimes Wash		
Wilberg Mine Fan (1)	Prior to 1973	Sealed May 2001
Wilberg Fan Portal (1)	1978	Sealed with cement plug in 1985
Wilberg Belt Portal (1)	Prior to 1973	Sealed May 2001
Wilberg Intake Portal (1)	Prior to 1973	Sealed May 2001
Underground Offices (4)	1975-1976	(not a portal) Area backfilled in 2015
Shop Portals (1)	Prior to1973	(not a portal) Area backfilled in 2015
Old Portals behind water tank (2)	Prior to 1973	Sealed May 2001
Wilberg Intake Portals (3)	May 1977	Sealed with cement plug in 1985
Mine Access to Cottonwood (2)	1982	Sealed May 2001
Cottonwood Intake Portals (2)	1985	Sealed May 2001
Cottonwood Fan Access Tunnel (2)	1982	Sealed May 2001
Cottonwood Fan Portal (1)	1984	Sealed May 2001
Cottonwood Belt Portal (1)	1984	Sealed May 2001
Cottonwood Canyon		
Cottonwood Diesel Roadway (1)	1995	Sealed May 2001, Reclaimed Nov 2014
Cottonwood Belt Portal (1)	1995	Sealed May 2001, Reclaimed Nov 2014
Miller Canyon (3) (Reclaimed 6/1999)	1981	Reclaimed in 1999 Phase III Bond Release Accepted on October 4, 2010
Channnel Canyon Intakes (2) (Reclaimed 8/1997)	1989	Reclaimed in 1997 Phase III Bond Release Accepted March 1998

* Refer to Item 2-A in Appendix H.

553.130: Slope Stability

A slope stability analysis was performed by Johansen and Tuttle Engineering in 1989. The purpose of the study was to provide a maximum slope recommendation to which the borrow material could be constructed to achieve a safety factor of 1.3. The following is a summary of the results of the recommendation.

Maximum Height of Fill (H) = 60'
C = 0
γ = 120 pcf
Slope = 1.5H:1V
Ø = 40^{o} (min) SF = 1.3

Roberts & Schaefer specifications for Class C fills will be used.
(See information in Part 3, page 53 - Structural Stability)

In 2016, RB&G Engineering Inc. (RBG) performed a geotechnical investigation and slope stability analysis for the cut and fill slopes planned for construction at reclamation of the Cottonwood/Wilberg Mine site (refer to the full report in Appendix C). The geotechnical investigations required field work. A series of 7 test pits were excavated to depths up to 17 feet. Soil samples at various depths were collected and analyzed. Geotechnical properties of the collected samples were obtained by laboratory analysis according to the Unified Soils Classification System. In-place density tests were performed in the field using a nuclear density gauge. The results of lab and field investigations are found in Appendix C.

Based on the results of the slope stability analysis RBG recommends that all cut and fill slopes be constructed no steeper than 2H:1V. Lifts shall be placed at depths no greater than one foot and all rocks greater than 8" should be removed prior to compaction. Lifts should be compacted to at least 90% of the maximum laboratory density as determined by ASTM D 1557. At a minimum, Proctor tests should be performed for each 50,000 cubic yards of placed fill. Refer to the full report in Appendix C.

Pocking was also investigated as part of the slope stability analysis. The purpose of placing pocks on the surface of the constructed slopes is to capture runoff to prevent erosion of the reclaimed surfaces. There have been concerns expressed by the Division that the roughened surfaces may become unstable during wet conditions. RBG evaluated saturated slopes using an infinite slope stability approach as described in Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California (see citation in Report). Using this approach, RBG found that because of the strict compaction measures recommended, strength parameters results in a calculated factor of safety of 1.32 against slope instability.

RBG concluded that although a level of confidence in the results of the investigations proved satisfactory, RBG recommends that the slopes be constructed in consultation of geotechnical engineer. Field testing should be completed under his or her direct supervision. PacifiCorp intends to heed this recommendation and insure that a qualified geotechnical engineer be present on-site during slope construction.

A similar slope stability analysis was performed by RBG in 2001 for the soils of the former Des Bee Dove Mine site. The Des Bee Dove Mine site is located in close proximity to the Cottonwood/Wilberg Mine site and with a similar south facing aspect. RBG found that the soils of the study site consisted of silty gravel with sand, cobble and boulder sized rocks similar to the Cottonwood/Wilberg Mine site. A copy of this report is included in Appendix C.

RBG concluded that existing fill material was acceptable for slope restoration. Material (<4”-8”) should be placed in lifts not exceeding one foot in thickness. The fill should be compacted to an in-place unit weight equal to at least 90% of the maximum laboratory density as determined by ASTM D 1557-91. These fills should achieve a safety factor of 1.3 when placed at a slope of 2H:1V.

Rock fills (>+4”-8”) should be placed in lifts not exceeding three feet thickness. Rock fills should be track-walked using at least 4 passes of a D-9 or equivalent dozer. These fill should achieve a safety factor of 1.3 when placed at a slope of no greater than 1.25H:1V.

The technical staff at PacifiCorp has been involved in the construction and reclamation of similar slopes designed for the Cottonwood/Wilberg Mine. Various reclamation projects have been conducted at the Deer Creek Mine, Cottonwood/Wilberg Mine, and former Des Bee Dove Mine. No slope failures have ever been reported for any slope using the designs described above.

PacifiCorp has found that the sediment control measures described above and described in detail in the Hydrology Chapter have not only been successful from an erosion control standpoint, but using these techniques has quickened the growth of vegetation to a point where the vegetative performance standards on these sites surpass that of their respective reference areas.

560: Performance Standards

The reclamation operations conducted at the Cottonwood/Wilberg Mine will be carried out in accordance to the approved permit and the requirements of R645-301-510 through R645-301-553.

R645-301-700: Hydrology

761: General Requirements

Within the disturbed area of the Cottonwood/Wilberg Mine are two ephemeral drainages: Left Fork Grimes Wash, and Right Fork Grimes Wash. The Left Fork is by far the largest drainage. Both drainages drain an area of at least one square mile. The channels in these drainage systems will be restored to their original location as close as possible. The two drainage systems converge within the planned reclamation area of the Cottonwood/Wilberg Mine (refer to Plate 4B).

Construction of the mine site has created two large fill structures that were used for parking, material storage, and other necessary mining operation facilities. Reclamation consists of backfilling and regrading these fill structures to create stable reclaimed slopes and constructing a channel the follows the natural flow of the canyons.

Design, location, construction, and materials are carefully chosen to ensure a stable channel. As illustrated on Plate 4A, final reclamation activities will follow a reclamation sequence. The channels of the Left and Right forks of the Grimes Wash will be reconstructed utilizing a riprapped trapezoidal permanent channel design of sufficient size to accommodate a 100yr/24hr storm event. Regulation require a design for only a 100yr/6hr storm event.

As outlined in the previous discussions, the CMP culverts in the Left and Right forks of Grimes Wash will be removed in sections (refer to Plate 4A) as reclamation continues downslope. Although the canyon is considered ephemeral, flow typically occurs during large storm events. If during reclamation, flow is found to occur in either canyon, the water will be diverted through a sediment trap prior to entering the culvert. The sediment trap will treat storm water to protect from degrading the water quality downstream.

Sediment Control Measures for Reclamation as pertained to R645-301-752

All drop drains, culvert inlets, etc. that divert disturbed runoff to the sedimentation ponds which are located below areas where earthwork activities are being performed, shall be left in place so as to protect off-site areas from sedimentation. The use of straw bales, wattles, siltation fence, or other appropriate sediment control devices may be necessary to temporarily control sedimentation.

Once earthwork activities are completed in an area, permanent sediment control measures will be implemented. Permanent sediment control includes constructing a stable soil surface to establish a diverse, effective and permanent vegetative cover capable of achieving the postmining land use. A stable soil surface is established first by incorporating and mixing hay into the topsoil, deep gouging, seeding, and finally, applying an effective hydromulch and tackifier. Using these techniques, PacifiCorp has experienced outstanding success in establishing vegetation on its reclaimed sites.

742: Sedimentation Control Measures

The mining company contracted the development of a reclamation plan for the site in the 1980's. At the time, sediment ponds were considered best technology currently available (BTCA). In this previously developed reclamation plan, sediment control was provided for by the use of contour and collection ditches reporting to a sediment pond. Because of the high risk associated with ditch failures on steep slopes combined with bedrock exposures in the channel with exposed drops, PacifiCorp concluded that contour and collection ditches were not the best alternative for controlling runoff from reclaimed slopes. Ditch failure was predicted to be the result of concentrated flows leading to head cutting in the collection ditches and/or breaching of the contour ditches. Because of the presence of large drops of the natural bedrock within the disturbed areas, equipment access to repair these failed areas would likely be impossible.

As an alternative (and a present day industry standard for sediment and erosion control at mine sites) to constructing contour and collection ditches PacifiCorp proposes to utilize deep gouging/pocking techniques as the BTCA for sediment control measures. PacifiCorp and others have reported excellent success using this technique. Sediment transport models show that in using this technique the disturbed or reclaimed areas produce a reduced sediment load lower than that of the undisturbed or background areas. Modeling data utilizing RUSLE is shown in the Appendix E for the areas of the Cottonwood/Wilberg Mine. This data shows that sedimentation within the disturbed area is controlled through deep gouging, mulching, and tackifying practices, and produces similar or lesser amounts of sediment than the undisturbed areas.

The existing sediment ponds at the Cottonwood/Wilberg Mine are situated in the narrow canyon of the Grimes Wash at the lower ends of the disturbance. The ponds take up nearly the entire width of the canyon bottom in this area. Because of the ditch failure concerns mentioned above, PacifiCorp proposes to revise its practices for controlling sediment for final reclamation from utilizing a sediment pond to treat runoff from the disturbed areas (as initially proposed in the 1980's version) to more progressive, efficient, and effective techniques for controlling sediment and erosion. These techniques have been briefly mentioned in the preceding text. A complete and detailed discussion for on-site sediment and erosion control is included below. PacifiCorp considers these techniques an interim control measure during the establishment of a permanent vegetative cover. Refer to R645-301-300: Biology for vegetation requirements.

742.110: Sediment Control Measures Utilizing Best Technology Currently Available (BTCA)

Sediment transport will be controlled as required by R645-301-553 and R645-301-742 of the Utah Coal Regulations. Sediment control measures are designed using the BTCA. Two BTCA techniques for controlling erosion on-site and preventing sedimentation of the downstream areas off-site are possible and will be used at the Cottonwood Mine site; 1) control utilizing the current sediment control structures, and 2) control utilizing extreme roughening of the reclaimed surface. Each technique is discussed below.

Sediment Control Structures

Two sediment ponds exist which were constructed in support of the active mining and coal processing operations and are located below the mine site; north pond and south pond. The north pond collects runoff from the disturbed areas for the mine site through drop drains and buried culverts. At a certain level or volume, the north pond discharges, via a vertical stand pipe, into the south pond. The south pond, which provides a retention time for settling out solid particles, discharges into the main undisturbed culvert. At that point, runoff has been treated and discharges into the Grimes Wash. A Utah Pollutant Discharge and Elimination System (UPDES) point is retained for the discharge of the south pond (UT0022896-003). Both ponds together have a volume of 4 acre feet.

As mentioned above, reconstruction of the slopes in the disturbed areas and reclamation of drainage channels will begin at the northern and uppermost extents of the mine site and work downhill toward the sediment ponds. Reconstruction will occur in stages; i.e. as construction activities are occurring in one area, the area immediately below shall be established to collect runoff into the existing culverts and routed to the sediment ponds. The sediment ponds will remain in-place to treat runoff from the disturbed areas until those reclamation activities reach the ponds. Final reclamation slopes (slopes that are pocked, mulched, seeded, hydromulched, and tackified) will utilize extreme roughening (pocking) as the primary means for sediment control. These methods are described in detail below. Once final reclamation is completed in an area, the activities will proceed downhill towards the sediment ponds.

When the stages of final reclamation has reached the sediment ponds, the ponds will be removed and the land on which they were located will be recontoured as outlined on Plate 4C. Prior to sediment pond removal, temporary sediment control will be placed below this area to protect downstream areas. Temporary sediment control will utilize silt fence, straw bales, or wattles, etc. at the bottom of slopes to treat any runoff that may occur. The permanent channel through this area will be constructed. Construction terminates in the natural channel at the southern extents of the disturbed area. Final reclamation will be performed on the recontoured slope surfaces. Once completed, temporary sediment control will be removed and reclamation of the Cottonwood/Wilberg Mine will be complete.

<u>Extreme Roughening (Deep Gouging or Pocking)</u>

Deep gouging (pocking) techniques encourage water retention and enhances plant growth. These protective measures are designed to prevent additional contributions of sediment to the streamflow or runoff outside the permit area and are used as an "interim" control measure in lieu of siltation structures until the establishment of a permanent vegetative stand. This sediment control method is termed "interim" since the pocks are developed to trap precipitation and runoff on the reclaimed slopes reducing the sediment transport capacity of overland flow. Precipitation, runoff, and sediment are trapped in the pocks where vegetation utilizes these sources for water and nutritional needs. Once established on the reclaimed slopes (usually between two to four years), vegetation becomes the permanent sediment control measure.

Three mechanisms of sediment transport will occur within the confines of the reclaimed mine site: 1) sheet flow onto the reclaimed site from above the reclaimed slopes; 2) off-site flow in side channels that intersect the reclaimed site; and 3) runoff from the watershed above the site diverting its flow in the main ephemeral channels of the left and right forks of the Grimes Wash.

A fourth mechanism, sheet flow on the reclaimed slopes, has the potential to occur. However, the BTCA to control this mechanism is pocking the reclaimed surface to limit or eliminate sheet flow. Pocking of the reclaimed slopes is discussed in detail below.

Discussion of Pocking as a Sediment Control Measure

Design of sediment control measures are based on four known physical processes which cause erosion; raindrop impact, sediment transport by overland flow, overland flow detachment, and deposition (OSM, 1983).

Raindrop impact is the process when, during precipitation event, raindrops falling on the disturbed soils at such an intensity to cause soil particles to detach from the soil mass. These detached particles are free to be transported by either wind or water.

As more rainfall hits the soil surface, it begins to infiltrate this soil surface. If rain falls in excess of the infiltration rate of the soil, overland flow is produced. The transport capacity of the overland flow depends on two hydraulic conditions, velocity and flow depth. Velocity is dependent on slope steepness and slope roughness. Flow depth is dependent on the infiltration capacity of the soil and rainfall excess. If the sediment transport capacity of the flow exceeds the supply of sediment from raindrop detachment, then overland flow will tend to erode additional sediments from the soil surface. Non-cohesive soils will erode with less force produced by overland flow than cohesive soils. Once the force is greater than the cohesiveness of the soil mass, detachment occurs and the erosion process begins (OSM, 1983).

The fourth process is deposition. Deposition occurs when the transport capacity of the overland flow is reduced. Deposition of a sediment particle is dependent on the weight and size of the particle. As the sediment transport capacity decreases, the largest particles will settle out first. If the sediment transport capacity of the overland flow continues to decrease, the size of the remaining particles continues to decrease (Haan, et.al 1994). The weight and size of a particle is referred to as its resisting force. The applied force, as described above, results from the hydrodynamics of the flow.

The theories and concepts behind deep gouging (pocking) are to control the applied hydrodynamic forces to promote deposition. Pocking allows for this in numerous ways. Pocks reduce the length that overland flow will travel, reduce the overall velocity of overland flow, eliminate or greatly reduces the potential for concentrated flow to form by intercepting its flow path, reduce the overall transport capacity of the overland flow, promote infiltration on the slope verses allowing the flow to run off-site, and promotes deposition on the slope versus allowing sediment to be transported down slope. The latter two offer vegetation the needed water and nutrients to vigorously grow and establish. A deeper root penetration for plants provides stability to the slope that creates a long lasting stable slope.

Hydrologic Cycle and Pocks

Figure 7-1 illustrates the typical hydrodynamic process of precipitation falling on a reclaimed slope with a gradient of 2 horizontal and 1 vertical. When a raindrop hits the upper portion of the slope, noted by (1), the raindrop impact causes the detachment of soil particles. As the precipitation event continues and exceeds the infiltration rate of the soil mass, overland flow occurs and begins to transport the detached soil particles (2). As the flow continues down slope, the hydrodynamic forces applied cause detachment of soil particles of the soil mass (3). This detachment is where the rilling and concentrated flow regimes begin. The longer the slope is, the higher the velocity potential for flow, increasing its erosional force potential. Ideally, at some point on a slope, hydrodynamic forces are reduced and deposition occurs (4).

Figure 7-2 represents the same 2H:1V gradient slope. However in this example, pocks are placed in a random and discontinuous manor. The uppermost pocks collect overland flow from the undisturbed areas above the site. Any precipitation that falls in the disturbed area is captured within the pocks. Detached sediment particles originating from rainfall impact are also carried by sediment transport to the bottom of pocks where deposition occurs. Theoretically, flow detachment and erosion are eliminated. Water and sediment remain on the slope where they are utilized for plant growth.

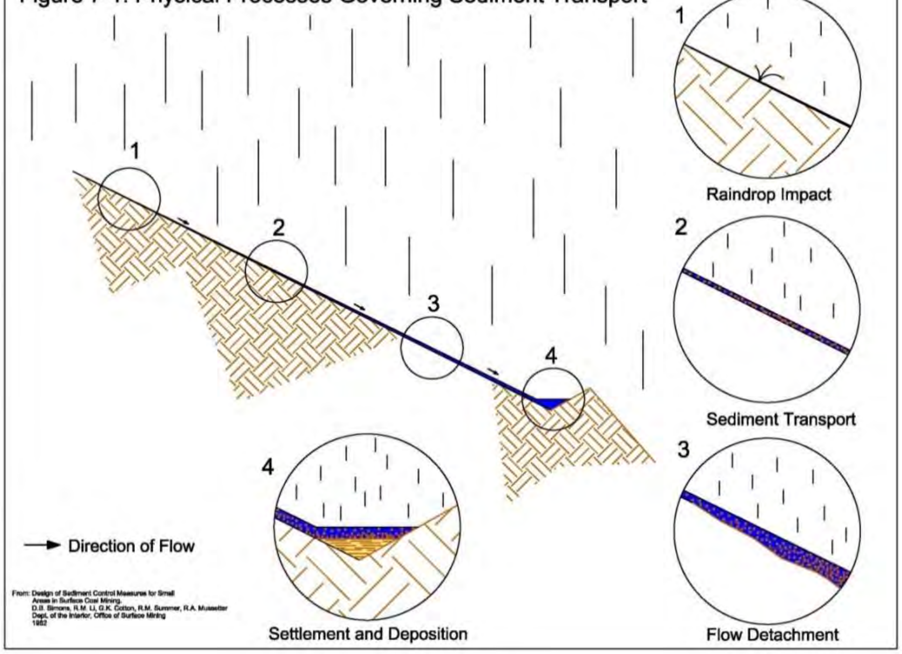


Figure 7-1: Physical Processes Governing Sediment Transport

<u>*Deep Gouging Standards*</u>

In April 2016, PacifiCorp's technical staff looked at the design hydrology of the site to determine whether a typical sized pock could contain the quantity of rainfall produced by a 100yr/6hr precipitation event. The pock design modeled the control of runoff using an inverted/truncated pyramid shaped figure. This shape is made as a track-hoe extends its bucket, stabs straight down, curls the bucket in creating the divot and then curls the bucket out to finish out the pock. Because of the 2:1 gradient of the hillslope, the inside wall of the pock will be greater than 2:1. However, past field experience has shown no issues with slope stability. The remaining three sides of the inside of the pock form to the angle of repose.

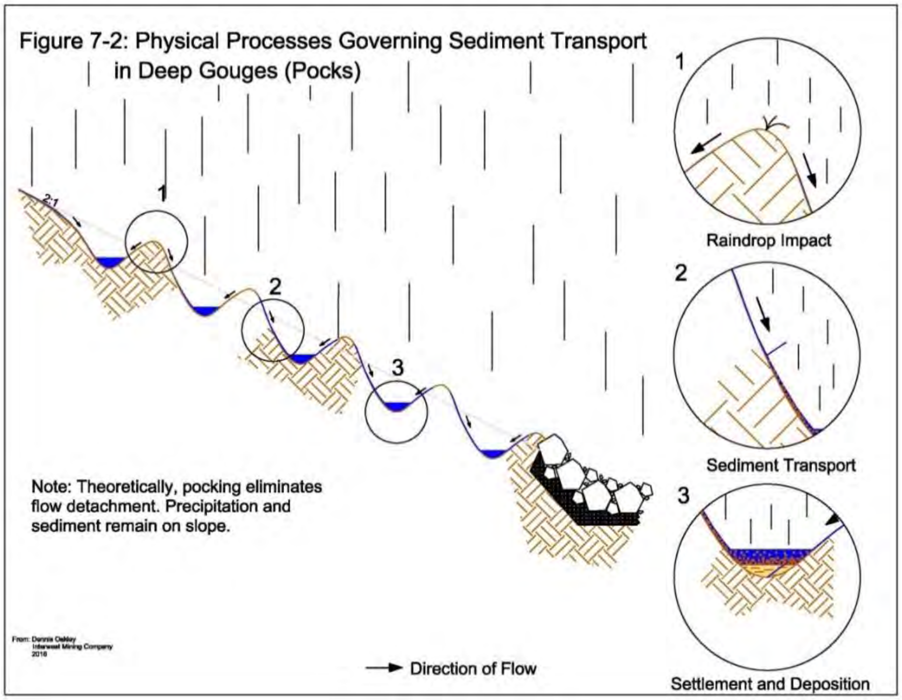
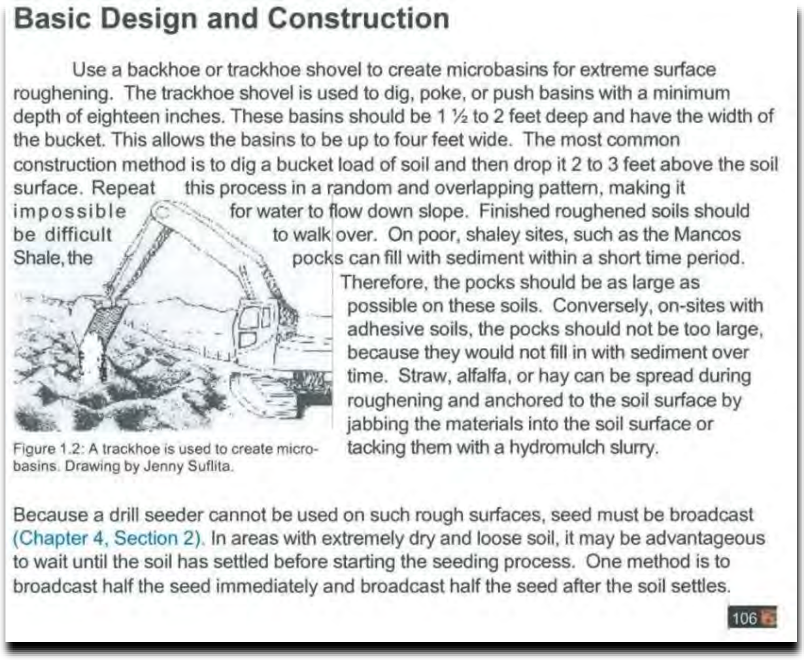


Figure 7-2: Physical Processes Governing Sediment Transport in Deep Gouges (Pocks)

While an inverted pyramid is not the exact shape of the inside of a pock, Interwest believes that this is a close representative shape of the pock created by the bucket of a track-hoe. Appendix D-4 contains calculations for surface runoff based on various storm events including the runoff of a 100yr/6hr precipitation event.

The design standard for deep gouging is generally as stated in DOGM's reclamation guide. The insert in Figure 7-3 is taken directly from Utah Division of Oil, Gas, and Mining, Practical Guide to Reclamation in Utah.

Field experience indicates that the individual pocks have an approximate surface diameter of 3 to 6 feet and depths of 1.5 to 3 feet when constructed with a back-hoe. Pocks are excavated in a random, overlapping pattern. This pattern eliminates any potential flow path from developing on the slope. Additionally, after seeding the newly formed surface, a wood fiber hydromulch with tackifier is sprayed at a rate of approximately 1 ton per acre. The soil surface is nearly completely covered. Particle detachment is greatly reduced utilizing this hydromulching method.



Basic Design and Construction

Use a backhoe or trackhoe shovel to create microbasins for extreme surface roughening. The trackhoe shovel is used to dig, poke, or push basins with a minimum depth of eighteen inches. These basins should be 1 ½ to 2 feet deep and have the width of the bucket. This allows the basins to be up to four feet wide. The most common construction method is to dig a bucket load of soil and then drop it 2 to 3 feet above the soil surface. Repeat this process in a random and overlapping pattern, making it impossible for water to flow down slope. Finished roughened soils should be difficult to walk over. On poor, shaley sites, such as the Mancos Shale, the pocks can fill with sediment within a short time period. Therefore, the pocks should be as large as possible on these soils. Conversely, on-sites with adhesive soils, the pocks should not be too large, because they would not fill in with sediment over time. Straw, alfalfa, or hay can be spread during roughening and anchored to the soil surface by jabbing the materials into the soil surface or tacking them with a hydromulch slurry.

Figure 1.2: A trackhoe is used to create micro-basins. Drawing by Jenny Suflita.

Because a drill seeder cannot be used on such rough surfaces, seed must be broadcast (Chapter 4, Section 2). In areas with extremely dry and loose soil, it may be advantageous to wait until the soil has settled before starting the seeding process. One method is to broadcast half the seed immediately and broadcast half the seed after the soil settles.

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Figure 7-3: Page 106 of UDOGM, Practical Guide to reclamation in Utah.

As discussed previously in the Engineering Chapter, concerns have been expressed that the roughened surfaces may become unstable during wet conditions. RB&G Engineering (RBG) has evaluated saturated slopes using an infinite slope stability approach as described in Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California (see citation in Report). Using this approach, RBG found that because of the strict compaction measures recommended (refer to slope stability in Engineering), strength parameters result in a calculated factor of safety of 1.32 against slope instability. Refer to Appendix C-1 for the full report for slope stability for the Cottonwood/Wilberg Mine.

Design Storm and Pocks

Several assumptions must be made when estimating volume of the captured precipitation from a 100yr/6hr event (see Appendix D-1). The following assumptions are used:

1. Pocks are generally the shape of an inverted pyramid.
2. The designed storm falls consistently throughout a 6 hour period.

3. The amount of rainfall trapped in the trough is dependent on area of the plane where rain enters.
4. Physical properties of the soil are uniform throughout the depth.
5. Infiltration rates are constant throughout time with respect to a hydrologic soil group C (0.05 – 0.15 in/hr (Haan, et.al. 1994)).

As illustrated in Figure 7-4, a pock is similar to the geometric configuration of an inverted pyramid. Using the dimensions of a=3', b=1.5', h=1.5, the total holding capacity (volume) is equal to 7.9 cubic feet. A large pock with the dimensions of a=6', b=3', h=3', has a volume of 63.0 cubic feet.

$$V = \frac{(a^2 + ab + b^2)h}{3}$$

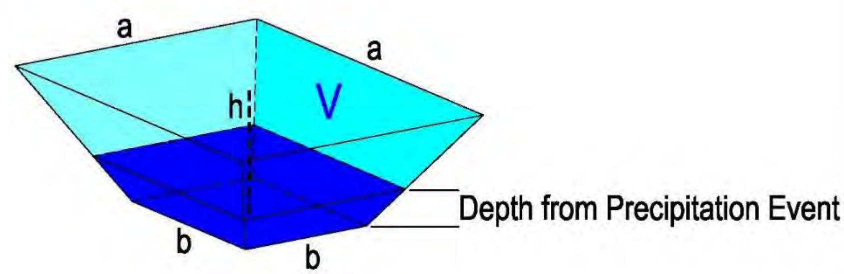

Figure 7-4: Modeling a pock using a truncated pyramid figure.

The 100yr/6hr event produces 2.25" (0.19') of rainfall in 6 hours[1]. Evaluating the area where rainfall (2.25") would intersect the top plane of the trough and multiplying by the depth of rainfall gives a volume of 1.69 cubic feet that accumulates in the bottom of the 3 foot trough (refer to calculations in Appendix D-2). The volume retained if assuming an infiltration rate of 0.05 inches per hour (most conservative estimate in Soil Group C) for 6 hours equates to approximately 1.39 cubic feet or 13.7% of the total capacity of the trough. The volume of the storm event

1 Note: rainfall amount was determined using the latest data supplied by the NOAA Atlas 14 Point Precipitation Frequency Estimates (see Appendix D-1). Estimates used for the main channel design utilized the NOAA Atlas 12 in which the data estimated a 100yr/24hr storm event at 3.5". Refer to Appendix F to review the hydrograph

accumulating in the larger 6 foot trough would be approximately 6.75 cubic feet or 7.8% of its entire holding capacity (assuming the same infiltration rate). Finding the depth (d) of water requires solving iteritively. As shown in Appendix D-2, the depth of water using the scenario of the 3 foot trough shows d = 0.54’ or 6.5”. The depth of water in the 6 foot trough using this same scenario shows d = 0.62’ or 7.4”.

Observing the cross-sectional view of the pock in Figure 7-5 and comparing it to the pock model, we observe that the volume of water remaining in the pock at the end of the 100yr/6hr storm event is entirely retained in pock and remains on the slope. Therefore, theoretically, there will be no runoff produced off a 2H:1V gradient slope from a 100yr/6hr storm event if all pocks installed on this slope are constructed as outlined.

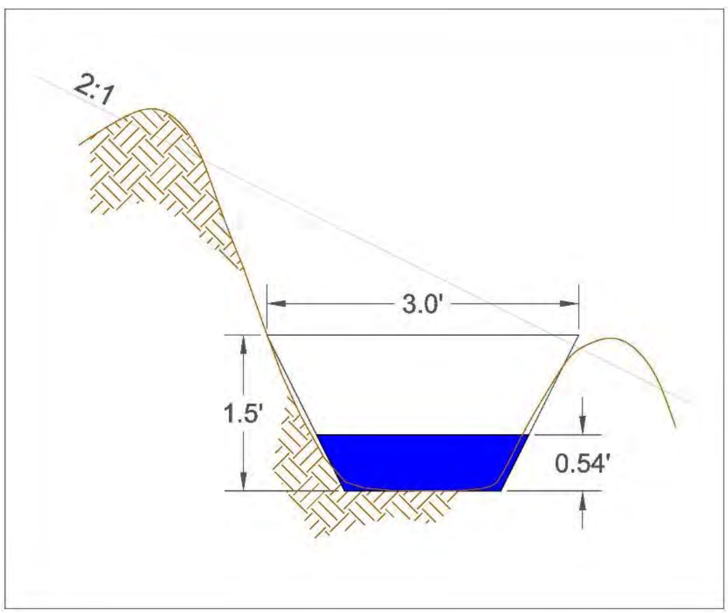

Figure 7-5: Theoretical Water Holding Capacity of a Standard 3’ Pock.

Note: Although the small slope on the inside of the pock is greater than 2:1, real construction results (noting from successful reclamation projects in the same general area as Cottonwood Mine) have demonstrated that the slope stability of the entire slope is not compromised. Slopes have remained stable and allowed for enhanced vegetation growth.

RB&G Engineering Inc. (RBG) evaluated the potential for instability issues utilizing deep gouging techniques on the proposed Cottonwood/Wilberg Mine reclaimed slopes. RBG recommended that fill slopes are constructed no greater than 2:1, rocks larger than 8" be removed, moisture conditioned, and compacted to at least 90 percent of the maximum laboratory density as determined by ASTM D 1557 and using equipment weighing at least 10 tons. The RBG report can be reviewed in Appendix C-1.

<u>*Overland Flow onto Site*</u>

Another source contributing to potential overland flow to the disturbed slopes is the runoff from the undisturbed areas above the site. The Division of Oil, Gas, and Mining expressed concerns about the areas where overland flow above the reclaimed surface could potentially impact these surfaces through channelized flow and erosion. PacifiCorp considers this a transitional area where pocks could be used to control these overland flow regimes. Runoff is modeled utilizing the Curve Number Method for estimating peak runoff rates for the area immediately above the reclaimed surface where overland flow transitions from undisturbed flow to disturbed flow. Runoff was simulated from a typical area above the disturbed area as shown below in Figure 7-6 and on Plate 4E. The illustrated area is an inter-basin area where sheet flow would flow directly onto the site and not into the side channels or gullies. EarthFax Engineering has evaluated five inter-basin areas above the disturbed area of the Cottonwood/Wilberg Mine site. Their report is found in Appendix D-4.

The results of these evaluations show that the undisturbed area contributes 0.34 inches of excess precipitation. This translates to a total volume (rainfall excess) which will flow into the disturbed area after infiltration is accounted for. The largest pock has been shown a total capacity of 63 cubic feet. Each inter-basin area has a boundary length (interface of the transition areas) that can contain a certain number of large pocks constructed along this border. Table 1 in the "*Adequacy of Reclamation Gouges at the Cottonwood Mine for Intercepting Runoff and Sediment from Adjacent Undisturbed Areas*" shows the runoff volume from each inter-basin area, number of rows needed to contain runoff (in both a truncated sphere and a truncated pyramid), and the time to fill one row of gouges with sediment.

When modeling the control capacity using a truncated pyramid shaped gouge, the report shows that runoff from the above inter-basin areas can be controlled by constructing one row of large gouges or pocks. Therefore, we can conclude that runoff flowing from the undisturbed areas above the disturbed areas will not cause impact or damage, and the disturbed areas will contain the overland flow from the design storm.

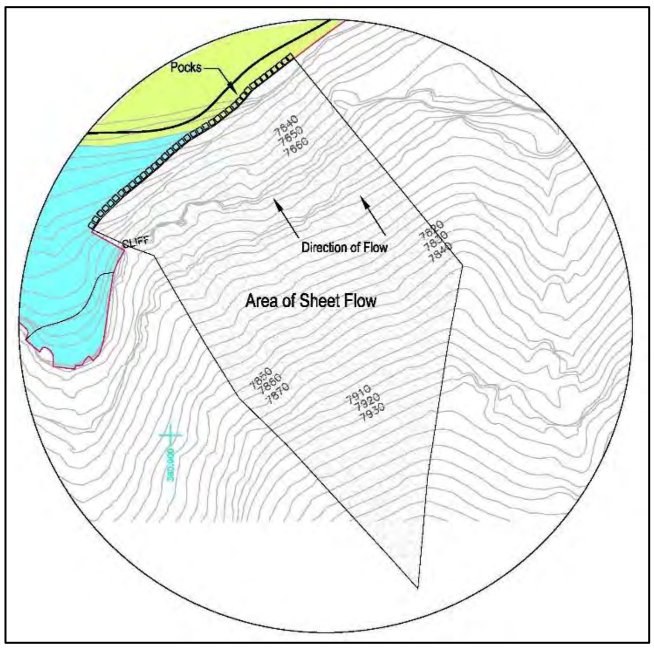

Figure 7-6: Model plot for evaluating runoff from the undisturbed area (refer to Plate 4E).

Observations from other sites utilizing deep gouging as the primary sediment control measure support the conclusion that pocking controls runoff and erosion on-site as well as controlling the runoff flowing onto the site from the undisturbed areas above. Although these other sites did not differentiate pock sizes along the transition area, there is no evidence of negative impacts. Pock size distribution for the Cottonwood/Wilberg reclamation will utilize the larger size pocks at this boundary as a superior protective measure.

742.111: Sediment Loss

Because the permittee is required to "prevent, to the extent possible, additional contributions of sediment to stream flow or to runoff outside the permit area," the BTCA techniques used for controlling sediment and erosion in the disturbed area must be proven.

Sediment loss was calculated using the Revised Universal Soil Loss Equation (RUSLE) to determine if reclamation practices would cause or contribute to the degradation of downstream water quality. RUSLE is a set of mathematical equations that estimates soil loss and sediment yield resulting from rill and interrill erosion. The equation uses the factors as follows:

$$A=RKLSCP$$

Where:

A = Average annual soil loss in tons per acre per year
R = Rainfall/runoff erosivity
K = Soil erodibility
LS = Hillslope length and steepness
C = Cover management
P = Support practice

Sediment loss for the Cottonwood/Wilberg mine site was determined by calculating the sediment loss from a detailed area of the proposed mine site reclamation; two slope profiles in the disturbed area and one profile in the undisturbed area. Plate 4E shows these areas where each profile and corresponding calculations were made. Each profile was identified by location (LS-1, LS-2, or LS-3). A horizontal slope length and slope gradient was determined using AutoCAD.

Using RUSLE2, the area selected to calculate sediment loss is considered representative for the entire disturbed drainage area. In other words, the average loss is determined from the reclaimed areas and then multiplied by an acreage factor. Two locations from the disturbed area used to model sediment yield were representative of all areas within site with respect to slope gradient. The RUSLE summary sheet is presented in Appendix E-2 that shows the results of the modeling exercise. Also included are the various inputs (slope length, control practice, soil complex, etc.)

which were used to run the model (refer to Appendix E-2). The RUSLE equation factors mentioned above are discussed below as explained by Foster and Toy, 2003.

R values in RUSLE2 are obtained from the Climate Worksheet in Appendix E-2. The R-factor is the expression of the erosivity of rainfall and runoff. The numeral value used for R in RUSLE2 must quantify the effect of raindrop impact and must also reflect the amount and rate of runoff likely to be associated with the rain. RUSLE2 considers how erosivity varies during the year by having an R value calculated for each month. A storm's erosivity index is the product of the storm's energy (E) and the maximum 30 minute intensity (I). The R value is the annual sum of these storm EI values. The R value used for the Cottonwood/Wilberg mine site is 13.

The K-factor is an expression of the inherent erodibility of the soil or surface material. The soil erodibility factor is the average long-term soil and soil profile response to the erosive powers of rainstorms (NRCS 1998). Although soil sampling and testing were not conducted at the Cottonwood Mine to create a site specific K-factor, the local Soil Survey conducted by the NRCS was used to determine the typical soils in the area of the Cottonwood Mine and choosing a similar soil within the RUSLE2 database. The Gerst-Strych-Rock Outcrop complex, with 30 to 65 percent slopes was chosen for this exercise. This complex compared well with the soil texture and slopes as found in the NRCS Soil Survey data set.

Topography was taken into account when calculating the LS-factor. This factor takes the hillslope length (L) and gradient (S) as contributing to erosion. If either one of these factors increase, total soil loss per unit area will also increase. The three slope profiles used were representative of the cut slopes and fill slopes for the entire disturbed site and the vegetation reference area outside the disturbed boundary.

The cover-factor (C) was determined for the soil in a disturbed state. A "disturbed state" in this case is the condition of the soil immediately after reclamation. In this condition, there is no effective root mass, no canopy cover and no height in which a raindrop can fall from or be intercepted by vegetation. Other ground cover entries were also used such as rock fragments and vegetative residue (i.e wood fiber mulch, tackifier). These entries were conservatively used since no data has been established relative to the pocking techniques.

The support practice (P) factor is probably the most important input when calculating sediment yield for the disturbed area. Although RUSLE2 does not include deep gouging practices in its database, it does allow credit for various roughness factors, terraces, and basins. The roughness of the RUSLE slope considers a maximum roughness of approximately 3 to 6 inch ridges contoured horizontally across the slope. The roughness factor used for modeling in RUSLE2 considers a roughening practice using a 10 inch moldboard plow. Three level terraces in the middle of the slope were also used to conservatively mimic the protection of pocking. PacifiCorp concludes that because RUSLE2 does not support deep gouging practices for modeling sediment yield, the results are very conservative in terms of total sediment yield from the site. In other words, RUSLE2 over-estimates the sediment production from the site.

As an example, site LS-2 in Appendix E-1 shows the slope profile using three supporting management practices; 1) bare ground only, 2) 10" moldboard plow roughness, and 3) a 10" moldboard plow roughness with three level terraces in the middle. With each practice used, the sediment yield is reduced substantially. The practice utilizing the roughness and terraces provides the highest protection to the slope (least sediment production).

A summary of the sediment yields for LS-1, LS-2, and LS-3 is presented in Appendix E-2. The summary shows that for the modeled slope profiles LS-1 and LS-2 utilizing the supporting practices for sediment control and comparing to the undisturbed slope profile, LS-3, protection was sufficient and would not cause or contribute to the degradation of downstream water quality. Regarding gouging/pocking, PacifiCorp concludes that unless there are failures of the pocks (risk is considered minor based on past experience and geotechnical considerations) on the slope, all sediment and water will be retained on the slope.

Systematic Reclamation Procedures

Backfilling and grading will be conducted by starting in the upper elevations of the disturbed areas and then working down canyon. After each section is backfilled, compacted, and topsoiled, the area will be covered with a hay mulch at a rate of 2000 lbs/acre. Once the mulch is evenly spread over the surface, deep gouging (pocking) techniques for sediment control will be used. These techniques require a track-hoe or similar machine to roughen the disturbed area in a random and overlapping fashion using its bucket. Pockmarks created are approximately 3.0' feet wide x 3’ long x 1.5' feet deep.

Once pocking is completed in an area, the area will be seeded (refer to R645-301-300: Biology) and sprayed with a wood-fiber mulch at a rate of at least 1500 lbs/acre. A tackifier will be added to the hydromulch at a rate of approximately 500 lbs/acre to stabilize the soil surface to minimize raindrop impact and erosion.

If, while re-establishing the slopes, a storm event occurs storm water runoff will be controlled and treated prior to leaving the site or entering the sediment pond. When the undisturbed area culverts are removed, the remaining ends of the culverts will be left in an open state. A small sediment basin will be constructed at the inlet of the culvert so that runoff will be treated before entering the undisturbed culvert. A sediment fence spillway will be constructed at the outlet end of the basin. Disturbed area culverts will be treated similarly. This will keep most of the sediment from unprotected slopes out of the ponds. Runoff from the disturbed areas will be treated again by the sediment pond. As reclamation of the slopes and channels reach the location of the ponds, the ponds will be removed starting with the North Pond and finishing with the South Pond. Once these ponds are removed, sediment control will be maintained by the deep gouging/pocking, mulching and tackifying techniques (mulching and tackifying are described in R645-301-300: Biology).

The intent of the presented sediment control measures is to prevent, to the extent possible, additional contributions of sediment to the ephemeral channel outside and downstream of the disturbed area. PacifiCorp has shown that the measures proposed will provide the protection needed in order to comply with the Utah Coal Regulations and Utah Water Quality Regulations.

Sediment control structures (silt fences, straw bales, straw wattles, etc.) used to control sediment during the reclamation phase will be removed as they are no longer needed.

742.300: Diversions

The 20 acre disturbed area lies within the confines of the Left and Right forks of the Grimes Wash. These drainages each drain an area greater than one square mile in size. The main drainage of each fork was diverted using corrugated metal culverts to by-pass ephermal flow below the disturbed area of the mine site. The flows within the disturbed area (surface flow) and/or onto the disturbed area (flow from above site) was controlled by routing all runoff to disturbed culverts and collected in two ponds, fines settled out, and discharged into the receiving stream below. This section addresses the design of diversion channels which drain a watershed of at least one square mile and less than one square mile.

742.320: Diversions of Perennial and Intermittent Streams and Ephemeral Streams that Drain a Watershed of at Least One Square Mile

During reclamation, buried diversion piping in the Right and Left forks of Grimes Wash will be excavated and removed in stages as described in the previous sections.

The concept to address hydrological concerns during reclamation will involve removing the buried diversion culverts and returning the channels to their natural configurations; bedrock channel with rifts, pools, and drops. Large boulders will be placed to mimic the ephemeral characteristics of the channel as found in the native areas above and below the disturbed area. Channels proposed on fill slopes shall include a riprap channel designed and built to endure the expected flow.

Channel design is based on safely passing a 100 year/24 hour storm event with 3.5 inches (NOAA Atlas 12) of precipitation as compared to the federal and state minimum requirements of 100 year/6 hour storm event. Refer to the Hydrologic calculations for final reclamation in Appendix F-1.

The drainage pattern consists of the main branch of Grimes Wash (Left Fork) and the Right Fork. Both drainages have steep gradients and side slopes and have scoured the channels to bedrock. At their confluence the grade downstream flattens rapidly allowing channels to be regraded to a moderate slope.

A rip-rapped channel designed to carry the peak flows calculated for both east and west (see watershed characteristics in Table 7-1) watersheds will be constructed as shown on Plate 4F. Although Plate 4F (and others) show a continuous riprapped constructed channel, the riprapped channel will only be constructed in those areas where the bedrock is not located (i.e. transition areas). It would be impossible to predict, without extensive subsurface investigation, where the bedrock will be intersected during channel reconstruction. Therefore, the design calls for a riprap channel along the entire length of the drainage. Watershed runoff characteristics are depicted in Table 7-1. The curve number derivation is shown in Table 7-2, where height, flow, and velocity are summarized for various channel slopes in Appendix F-1. Hydrological procedures and calculations are described in the Appendix. Watersheds are depicted on the drainage map Plate 4F.

Table 7-1: Wilberg Mine Watershed Characteristics.

Cottonwood/Wilberg Mine Watershed Characteristics					
Watershed	**Subdrainage**	**Area (acres)**	**Curve Number**	**Slope (%)**	**Drainage Density**
Wilberg West		1476			
	Ia	59	95	34	75.9
	Ib+c	1419	67	11	6.9
	Ib	798	54		
	Ic	621	64		
Wilberg East		1280			
	IIa	100	95	57	42.0
	IIb+c	1180	76	9	11.9
	IIb	480	84		
	IIc	700	71		

In the areas where bedrock is located and fill extends to the base of the channel, reconstruction will consist of a trapezoidal design using bedrock as a base with both filter and rip-rap sides whose slope will not be steeper than 2H:1V, refer to Figure 7-7 and the channel design in Appendix F.

Where the historic flows have carved a channel in the bedrock, no riprap shall be used in the side slopes. Where the channel consists of fill in the base and side slopes, both filter and riprap channel construction will be used. The following describes the specifications of the filter and riprap channel construction.

Table 7-2: Wilberg Mine Curve Number Derivations

*Vegetation type and cover estimates based on personal communications, 1980 and on-site observation.

Cottonwood/Wilberg Mine Curve Number Derivations			
Subdrainage	**Curve Number**	**Description***	**Hydrologic Class**
Wilberg West			
Ia	95	Excessively steep slopes with 20% Juniper/Grass cover	D
Ib+c	67	Composite value for Ib + Ic	
Ib	54	N-Aspect, moderate slope with 60% Ponderosa Pine cover	B
Ic	84	S-Aspect, moderate steep slope with 20% Juniper/Grass cover	C
Wilberg East			
IIa	95	Excessively steep slopes with 20% Juniper/Grass cover	D
IIb+c	76	Composite value for IIb + IIc	
IIb	84	S-Aspect, Moderate steep slope with 20% Juniper/Grass cover	C
IIc	71	West-Aspect, moderate slope with 40% cover	C

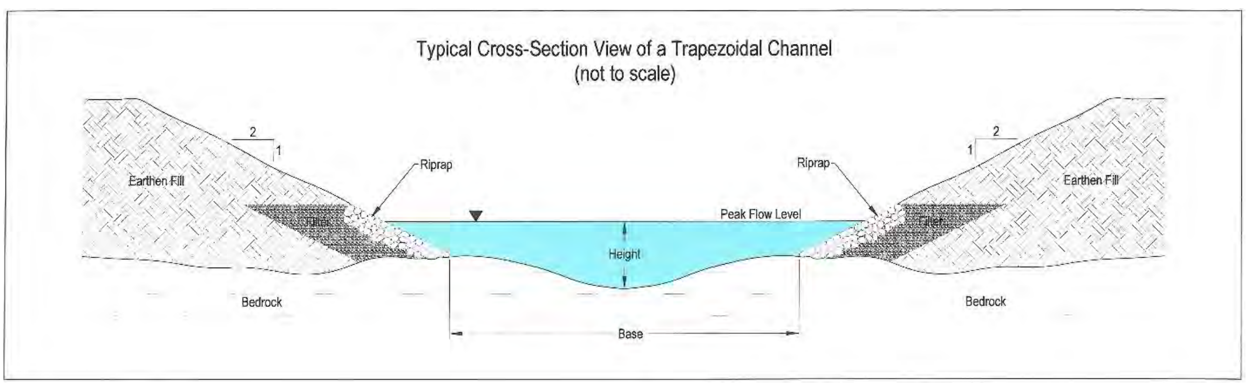

Figure 7-7: Typical Trapezoidal Channel with Bedrock Bottom.

Filter and rip-rap gradation (see Appendix F-1) will consist of aggregate materials with weight and size approximating the following ratios:

1)

$$\frac{D_{50}\ \text{Filter}}{D_{50}\ \text{Base}} < 40 \quad \text{also} \qquad \frac{D_{50}\ \text{Rip-rap}}{D_{50}\ \text{Filter}} < 40$$

2)

$$\frac{D_{15}\ \text{Filter}}{D_{15}\ \text{Base}} < 40 \quad \text{also} \qquad 5 < \frac{D_{15}\ \text{Rip-rap}}{D_{15}\ \text{Filter}} < 40$$

3)

$$\frac{D_{15}\ \text{Filter}}{D_{85}\ \text{Base}} < 5 \quad \text{also} \qquad \frac{D_{15}\ \text{Rip-rap}}{D_{85}\ \text{Filter}} < 5$$

Granular size gravel smaller than 3" and larger than #4 sieve. Sand smaller than #4 and larger than #200.

Rip-rap shall be composed of graded mixtures down to the one inch size particle such that 50 percent of the mixture by weight will be larger than the D_{50} size. This mixture will contain sufficient gradation to fill the void when placed. The diameter of the largest stone will be 1.25 x D_{50} and the rip-rap thickness will not be less than 1.5 times the largest stone diameter. Rip-rap D_{50} maximum will not exceed one-third the bottom width of the channel bottom.

RIP-RAP GRADATION

	Steep Slopes	Mild Slopes
$\frac{D_{Max}}{D_{50}}$	1.25	2
$\frac{D_{50}}{D_{10-20}}$	2-3	2-3

Determination of the mean rip-rap diameter (D_{50}) was based on maximum shear stress using the methodology presented by Anderson, et. al., (1970) as follows:

$$T_{max} = 5D_{50} \qquad (1)$$

$$T_0 = c\ 62.4\ d\ S \qquad (2)$$

where,

T_{max} =	the maximum shear stress than the rip-rap can sustain in pounds/sq. ft.
T_0 (T 0) =	the actual shear stress on the channel in pounds/sq. ft.
D_{50} =	the mean rip-rap diameter in feet
D =	the flow depth in feet
S =	the channel slope (ft/ft)
62.4 =	the unit weight of water in pounds/cu.ft.
C =	the channel shape coefficient (see following table)

Channel shape coefficients for sides of trapezoidal shaped channel with 2:1 side slopes:

Bottom width/depth	C
1.0	1.3
2.2	1.2
4.3	1.1
6.3	1.0

Two constraints associated with the use of equations 1 and 2 are:

1. T_{max} should be less than 15 pounds/sq.ft.
2. the maximum rip-rap size, D_{max}, should not exceed approximately 1/3 of the channel width.

Both constraints limit the mean rip-rap diameter to three feet for the channel conditions at the Wilberg site (assuming a 10-foot bottom width for the channel). By combining equations 1 and 2 with the Manning equation and assuming one dimensional flow, the following equation is obtained:

$$D_{50} = 9.8\, C\, (nq)^{0.6}\, S^{0.7} \qquad (3)$$

where the additional variables are:

n = Manning's roughness coefficient

q = discharge per unit width of channel

Equation 3 shows that with the rip-rap diameter fixed and the roughness and flow conditions established, the slope of the channel is the only variable that can be adjusted to meet rip-rap stability requirements.

Therefore, Equation 3 was used to establish criteria for maximum slope conditions along the channel reach, assuming a D_{50} of 3 feet. The difference between the actual slope conditions and the maximum allowable slope will be the fall that will have to be incorporated into drop structures along the channel profile. The fall will take place over natural ledges along the channel profile which will be excavated in bedrock during channel restoration.

Channel slope data, channel hydraulic data, and channel profiles for the Left Fork, Right Fork and Main channels are presented on Maps 4B.

Sidewall construction of the rip-rapped channel will incorporate a 9-inch granular filter on which a 4.50 foot thick rip-rap protective covering will be placed. Construction and placement of the rock will, where possible, enhance pooling and energy dissipation.

742.330: Diversion of Miscellaneous Flows

As cited by R645-301-742.331, diversion of miscellaneous flows "consists of all flows except for perennial and intermittent streams and ephemeral streams that drain a watershed of at least one square mile, maybe diverted away from disturbed areas if required or approved by the Division." These flows "include ground-water discharges and ephemeral streams that drain a watershed of less than one square mile." At the Cottonwood Mine, side channels above the disturbed will be routed through a diversion channel into the main drainage channels of the Left and Right Forks of the Grimes Wash.

As required by the Division, diversion channels have been designed for those side channels that drain through the reclaimed areas of the Cottonwood Mine from the undisturbed areas above the site. In 2016, EarthFax Engineering Group was retained to develop this design (refer to "*Cottonwood/Wilberg Mine Reclamation Side Channel Design"* in Appendix F-2). EarthFax has indicated that there are six side channels that drain through the site. The watersheds for these side channels are identified as RWS-1 thru RWS-6 and the channels are identified as RC-1 thru RC-6. Although R645-301-742.333 requires these side channels be designed based on a peak flow from a 10yr/6hr storm event, the side channels at the Cottonwood Mine have been designed based on a peak flow from a 25yr/6hr storm event.

Results of the design work show RC-1 thru RC-5 utilizing a 6 inch filter blanket with a d_{50} of 3 inches and the channel riprap sized for a d_{50} of 15 inches. Because the velocity of the flow, the designer incorporates a 3 foot diameter boulder every 10 to 15 feet along the channel bottom. This "obstruction" adds to the roughness of the channel to retard the velocity of the runoff.

Construction of the side channels will be conducted using the following processes:

At reclamation, all undisturbed and disturbed culverts will be removed. Slopes shall be constructed as outlined in the Engineering Section and on Plates 4B and 4C. Concentrated flows above the reclaimed site that route through side channels will be diverted over the reclaimed slope by constructing armored channels. These channels have been designed and are similar to the main channel design using a sized filter blanket and riprap protection. However, these channels will be constructed such that they blend in with the contributing natural subdrainage channel. The filter blanket and riprap will be placed as shown in the design in Appendix F-2, covered with soil, seeded, hydromulched, and tackified. Past experience with the Des Bee Dove Mine reclamation project has shown successful results utilizing this method. A temporary sediment control structure will be placed at the bottom of these reclaimed side channels to remove sediment protecting downstream waters. Maintenance of these sediment control structures will be conducted on an "as needed" basis throughout the responsibility period. Once it has been determined that the vegetation is sufficiently established to control erosion and sedimentation, these structures will be removed.

750: Performance Standards

Discharges of water from areas disturbed by coal mining and reclamation operations will be made in compliance with all Utah and federal water quality laws and regulations and with effluent limitations for coal mining promulgated by the U.S. Environmental Protection Agency set forth in 40 CFR Part 434.

The regulations in 40 CFR Part 434 apply to all mines where extraction of coal is or has taken place. Specific to the Cottonwood/Wilberg Mine is Subpart H – Western Alkaline Coal Mining operations. Western coal mining operations are surface or underground coal mining operations located in the interior United States, west of the 100th meridian west longitude, in an arid or semiarid environment with an average annual precipitation of 26 inches or less.

As stated in 40 CFR Part 434 Subpart H, drainage from the mine reclamation areas, brushing and grubbing areas, topsoil stockpiling areas, and regraded areas, shall meet the following requirements, before any treatment:

pH is equal to or greater than 6.0
Dissolved iron is less than 10 mg/L, and
Net alkalinity is greater than zero

Subpart H specifically requires operators to submit a site specific Sediment Control Plan to the permitting authority (in this case, the Utah Division of Oil, Gas, and Mining) designed to prevent an increase in the average annual sediment yield from pre-mined, undisturbed conditions. This Sediment Control Plan shall use a watershed modeling program to demonstrate the performance of those measures taken to control sedimentation and erosion at the site.

As outlined in **742: Sediment Control Measures**, PacifiCorp has proposed a plan to prevent an increase in the sediment yield at the outlet boundary of the disturbed area below the main mine site. Pocking has been proposed as the BTCA for controlling sediment and erosion of the reclaimed slopes. The RUSLE2 sediment modeling program has been utilized to estimate the expected yield from the reclaimed slopes. This data is compared to the expected yield (1.5 tons/acre/year) from pre-mined, undisturbed (baseline) slopes. This yield will become the baseline effluent limitation for the mine.

To monitor the performance of the proposed sediment control measures in the Sediment Control Plan, PacifiCorp will install (on an experimental basis) remote storm water samplers above the mine reclamation site in both the Left and Right Forks of the Grimes Wash (for collection of undisturbed storm water runoff), and below the reclamation site (for collection of undisturbed and reclaimed storm water runoff). This placement will allow observations of the contributions from runoff and sediment from the undisturbed upland watershed areas as well as potential runoff and sediment contributions from the reclaimed areas. Sampler results can be used to compare sediment production contributions to the predictive model (RUSLE2) results for both the undisturbed and reclaimed lands. Results from the study will permit verification of the predictive models and future reclamation plans utilizing alternative BTCA practices for sediment control.

Because of the ephemeral condition of the channels, the samplers will be set to automatically collect a storm water samples when a transducer (placed in the stream channel) detects flow. Data stored will be time, date, depth of flow, and flow velocity. The sampler will collect one sample for each recorded event. When necessary or at least once each quarter (samplers will be removed from November to March), sample bottles will be collected and the sediment production of the sample will be analyzed. Data collected will be reported to the Utah DOGM during the active quarters for two years or until vegetation is established on the site. The operator shall have the option at that time to leave the samplers in place to continue collecting data until bond release.

Each sampler will be battery powered with a solar panel recharge capability. Maintenance to the system will be at least quarterly or as needed to keep the system functioning properly.

Quantitative and Qualitative analysis will be performed on the data to monitor the performance of the pocks. Quantitative analysis will gather data from selected pocks by monitoring the rain fall, sediment production, erosion, and plant growth from both 6' and 3' pocks. Quantitative analysis will also be performed on a hillslope. This will be accomplished by delineating a transect along a hillslope profile. Identical data will be collected for the length of the transect as is collected for the individual pocks.

Qualitative data will be collected by photo documentation of the individual pocks and at certain distances along the length of the transect. Refer to Appendix G for a complete description of procedures that will be used to install data collection devices as well as the monitoring procedures that will be followed. Data will be collected once per quarter (April through October) and reported in the Annual Report.

A Geonor T-200B precipitation gage or similar measuring gage will be located centrally to the mine disturbed area to evaluate rainfall data as each storm relates to sediment production. Along the Wasatch Plateau, storm events can be very localized. A storm event can occur high above the site and send a tremendous amount of runoff and sediment flowing through the site. Likewise, a storm can occur generally over the disturbed area that may record higher sediment yields than the background yields skewing the data. The data from the T200B will also be reported in the Annual Report.

762.200: Reshaping Slopes to be Compatible to the Postmining Land Use

In general, the backfilling and grading of the disturbed areas will consist of removing the fill pads and backfilling the cut areas. The work will start in the upper areas of the disturbed area and systematically work downslope to the entrance gate. There is approximately 176,455 bank cubic yards (BCY) of material to be cut and approximately 155,830 BCY of material will be backfilled and graded within the disturbed areas. There is a difference of 12% between the cut and fill estimates, leaving approximately 20,625 BCY of extra fill material. This material will be used in areas where more fill could enhance the slope, or will be blended into the reclaimed slopes. See Plates 4A, 4B, and 4C in Maps Section for plan and cross-sectional views of the proposed reclamation contours. The ponds will be the last major structures to be removed during backfilling and grading operations. The access road will be completely removed and recontoured to the entrance gate.

The BTCA practices utilized in the reclaimed areas of the Cottonwood/Wilberg mine site provide for reduction and/or elimination of sheet flow on slopes, reduction and/or elimination of sediment contributions to stream flow, enhanced availability of water for plant growth, and slope stability through the use of mulches and soil binding tackifiers. All these practices work in concert to protect the downstream resources and enhance the probabilities for the disturbed lands to return to their pre-mining uses. Demonstrations have been made above and at existing reclamation projects which prove their effectiveness to deliver these stated protections.

763: Siltation Structures

The two siltation structures (sediment ponds) will be removed when all other reclamation above them has been completed. Because of the reclamation techniques used, sediment will be retained within the disturbed area and therefore, no siltation structures will be needed. Undisturbed drainage will pass through the site unaltered.

The sediment control measures to be utilized at the Cottonwood/Wilberg mine for final reclamation integrate an alternative BTCA for sediment and erosion control other than siltation structures.

The permittee has demonstrated throughout this chapter a superior, more practical approach for controlling erosion on the site and preventing additional contributions of sediment to stream flow or to runoff outside the permit area. These sediment control measures have been designed using the best technology currently available. Deep gouging is shown to eliminate sheet flow on slopes, provide for water retention on the slopes, reduce the overall sediment load as compared to background levels, and stabilize the surface for creating a robust vegetative stand.

The analysis presented in this chapter shows the science behind the deep gouging technology and has demonstrated that protection to the site as well as prevention of sediment to stream flow or to runoff outside the permit is possible. However, this technology is not new. The Coal Industry and the State, while conducting reclamation operations in Utah, has been practicing this technology for a number of years and has numerous existing successful sites as an example of the protection it affords.

Therefore, because of the impracticality for the use of siltation structures at the Cottonwood/Wilberg Mine, the demonstrations made in this chapter for an alternative sediment control measure as a BTCA, and the success of past reclamation projects using this technology, the permittee has presented that deep gouging techniques coupled with a well-designed mulching and revegetion program is the BTCA for the Cottonwood/Wilberg Mine and other mines with similar characteristics and conditions.

764: Structure Removal

A timetable has been generated for the removal of the siltation structures at the Cottonwood/Wilberg Mine. Included in the table is the sediment pond. See R645-301-300: Biology for more information.

R645-301-765: Permanent Casing and Sealing of Wells

There are no wells that require casing or sealing activities.

Surface Exploration Drill Holes

Initial stages of development required surface exploration drilling. From 1976 through 2001 (date of portal sealing) PacifiCorp drilled approximately 175 exploration holes.

Authority to conduct such activities was granted by the State of Utah, US Geological Survey and the US Forest Service and BLM. Privately-owned surface was secured separately.

All surface drilled exploration holes were reclaimed according to the US Geological Survey's published Drill Hole Plugging Procedure in the form of stipulations for approval.

Each exploration drill site has been reclaimed and approved by the appropriate agency.

R645-301-800: Bonding

PacifiCorp has provided cost estimates for reclamation of the Cottonwood/Wilberg Mine site. These estimates are found in Appendix H.

References

Anderson, Paintal, and Davenport, 1970, Tentative design procedure for rip-rap lined channels. University of Minnesota, National Cooperative Highway Research Program Report 108. Highway Research Board.

Foster and Toy, 2003, RUSLE2 User's Manual For Highly Disturbed Lands: Construction, Reclaimed, Mined, Landfills, Military Training Grounds, and Similar Lands, USDA-Natural Resources Conservation Service (NRCS).

Haan, et. al., 1994, Design Hydrology and Sedimentology for Small Catchments, Academic Press, San Diego, page 217.

United States Department of Agriculture – Agricultural Research Service, 1998, Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agriculture Handbook Number 703, Utah Supplement.

Simons, Li, and Associates, 1983, Design of Sediment Control Measures for Small Areas in Surface Coal Mining, DOI, Office of Surface Mining, Contract # J5110061, Chp. II, 2.1.

DOGM, 2008, Guidelines for Management of Topsoil and Overburden, Utah Division of Oil, Gas, and Mining.

PacifiCorp – Interwest Mining Company

Appendix A

Soil Sampling and Analysis Data-

- **A-1 : Substitute Soil Sample Analysis**
  : Field Sample Analysis
- **A-2 : 1989 Soil Sampling Program-Sample Results**
- **A-3 : 2001 Soil Sampling Program-Sample Results**

2016

PacifiCorp – Interwest Mining Company

Appendix A-1

Soil Sampling and Analysis Data

- Substitute Soil Sample Analysis
- Field Sampling Analysis

Cottonwood/Wilberg Mine Reclamation Plan

2016

Inter-Mountain Labs
Your Environmental Monitoring Partner
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Date: 5/17/2016

CLIENT: Energy West Mining Co
Project: Cottonwood Reclamation
Lab Order: S1605059

CASE NARRATIVE

Report ID: S1605059001

Samples CTW0116 Trench #1, CTW0216 Trench #2, CTW0316 Trench #5, CTW0416 Trench #6, CTW0516 Trench #6, CTW0616 Trench #7, and CTW0716 Trench #8 were received on May 4, 2016.

Samples were analyzed using the methods outlined in the following references:

U.S.E.P.A. 600/2-78-054 "Field and Laboratory Methods Applicable to Overburden and Mining Soils", 1978
American Society of Agronomy, Number 9, Part 2, 1982
USDA Handbook 60 "Diagnosis and Improvement of Saline and Alkali Soils", 1969
Wyoming Department of Environmental Quality, Land Quality Division, Guideline No. 1, 1984
New Mexico Overburden and Soils Inventory and Handling Guideline, March 1987
State of Utah, Division of Oil, Gas, and Mining: Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining, April 1988
Montana Department of State Lands, Reclamation Division: Soil, Overburden, and Regraded Spoil Guidelines, December 1994
State of Nevada Modified Sobek Procedure
Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Edition

All Quality Control parameters met the acceptance criteria defined by EPA and Inter-Mountain Laboratories except as indicated in this case narrative.

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Labs
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Soil Analysis Report

Energy West Mining Co
P.O. Box 310
Huntington, UT 84528

Report ID: S1605059001
Date Reported: 5/17/2016
Work Order: S1605059

Project: Cottonwood Reclamation
Date Received: 5/4/2016

Lab ID	Sample ID	Depths Feet	pH s.u.	Saturation %	Electrical Conductivity dS/m	Field Capacity %	Wilting Point %	CaCO3 %
S1605059-001	CTW0116 Trench #1	0-5	8.3	25.5	2.43	14.2	6.6	36.0
S1605059-002	CTW0216 Trench #2	0-5	7.7	26.3	9.27	21.4	7.6	38.6
S1605059-003	CTW0316 Trench #5	0-10	7.8	26.3	3.49	19.9	6.7	37.2
S1605059-004	CTW0416 Trench #6	0-5	8.8	23.4	1.82	10.8	6.6	41.8
S1605059-005	CTW0516 Trench #6	5-10	8.2	27.2	7.21	13.8	7.7	31.6
S1605059-006	CTW0616 Trench #7	0-5	8.8	31.5	0.77	12.2	7.7	34.4
S1605059-007	CTW0716 Trench #8	5-10	8.0	28.4	3.61	21.9	6.7	36.8

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential
Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

Reviewed by: Karen A Secor
Karen Secor, Soil Lab Supervisor

Inter-Mountain Labs

Your Environmental Monitoring Partner

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Soil Analysis Report

Energy West Mining Co

P.O. Box 310

Huntington, UT 84528

Report ID: S1605059001

Project: Cottonwood Reclamation

Date Received: 5/4/2016

Date Reported: 5/17/2016

Work Order: S1605059

Lab ID	Sample ID	Depths Feet	Calcium PE meq/L	Magnesium PE meq/L	Sodium PE meq/L	SAR	Sand %	Silt %	Clay %	Texture	Very Fine Sand %
S1605059-001	CTW0116 Trench #1	0-5	1.67	0.68	20.7	19.1	66.0	21.0	13.0	Sandy Loam	<0.1
S1605059-002	CTW0216 Trench #2	0-5	27.3	43.1	61.2	10.3	62.0	24.0	14.0	Sandy Loam	1.5
S1605059-003	CTW0316 Trench #5	0-10	21.5	14.5	14.6	3.43	64.0	24.0	12.0	Sandy Loam	3.8
S1605059-004	CTW0416 Trench #6	0-5	1.42	0.76	13.5	12.9	70.0	21.0	9.0	Sandy Loam	2.1
S1605059-005	CTW0516 Trench #6	5-10	2.42	2.12	78.9	52.3	64.0	25.0	11.0	Sandy Loam	<0.1
S1605059-006	CTW0616 Trench #7	0-5	2.82	1.06	5.36	3.85	66.0	22.0	12.0	Sandy Loam	<0.1
S1605059-007	CTW0716 Trench #8	5-10	16.1	32.3	7.39	1.50	60.0	26.0	14.0	Sandy Loam	<0.1

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Soil Analysis Report

Energy West Mining Co

P.O. Box 310
Huntington, UT 84528

Report ID: S1605059001

Date Reported: 5/17/2016

Work Order: S1605059

Project: Cottonwood Reclamation

Date Received: 5/4/2016

Lab ID	Sample ID	Depths Feet	CEC meq/100g	Available Sodium meq/100g	Exchangeable Sodium meq/100g	ESP %	Total Carbon %	TOC %
S1605059-001	CTW0116 Trench #1	0-5					5.5	1.1
S1605059-002	CTW0216 Trench #2	0-5					9.2	4.5
S1605059-003	CTW0316 Trench #5	0-10					5.9	1.4
S1605059-004	CTW0416 Trench #6	0-5					6.5	1.5
S1605059-005	CTW0516 Trench #6	5-10	7.36	5.67	3.52	47.8	6.2	2.4
S1605059-006	CTW0616 Trench #7	0-5					7.9	3.8
S1605059-007	CTW0716 Trench #8	5-10					5.5	1.1

These results apply only to the samples tested.

Abbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

Abbreviations used in acid base accounting: T.S.= Total Sulfur, AB= Acid Base, ABP= Acid Base Potential, PyrS= Pyritic Sulfur, Pyr+Org= Pyritic Sulfur + Organic Sulfur, Neutral. Pot.= Neutralization Potential

Miscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Soil Analysis Report
Energy West Mining Co.
P.O. Box 310
Huntington, Utah 84528

Project ID: Cottonwood Reclamation
Date Received: 5/4/2016

Report ID: S1605059001
Date Reported: 5/18/2016
Work Order: S1605059

Lab ID	Sample ID	Organic Matter %	Sand %	Silt %	Clay %	Very Fine Sand %	Texture	K-factor (t.ac.h/100acft.tf.in)	Structure s	Permeability p	M	Description
S1605059-001	CTW0116	1.9	66.0	21.0	13.0	0.1	Sandy Loam	0.05	1	2	1835.7	
S1605059-002	CTW0216	7.7	62.0	24.0	14.0	1.5	Sandy Loam	0.00	1	2	2193.0	
S1605059-003	CTW0316	2.4	64.0	24.0	12.0	3.8	Sandy Loam	0.12	2	2	2446.4	
S1605059-004	CTW0416	2.6	70.0	21.0	9.0	2.1	Sandy Loam	0.06	1	2	2102.1	
S1605059-005	CTW0516	4.1	64.0	25.0	11.0	0.1	Sandy Loam	0.12	3	2	2233.9	
S1605059-006	CTW0616	6.5	66.0	22.0	12.0	0.1	Sandy Loam	0.10	4	2	1944.8	
S1605059-007	CTW0716	1.9	60.0	26.0	14.0	0.1	Sandy Loam	0.12	2	2	2244.6	

These Results apply only to the samples tested.

Reviewed by: Karen Secor

Karen Secor, Soil Lab Supervisor

iml Inter-Mountain Laboratories, Inc.

CHAIN OF CUSTODY RECORD

Client/Project Name: Cottonwood Reclamation

Project Location: Cottonwood Mine

Sampler: (Signature)

Chain of Custody Tape No.

ANALYSES / PARAMETERS

Sample No./ Identification	Date	Time	Lab Number	Matrix	No. of Containers					Remarks
CTW0116	4/19/16	1200	51605059-001	Trench #1 0-5'	1	See Attached Table 4				
CTW0216	"	"	-002	Trench #2 0-5'	1					
CTW0316	"	"	-003	Trench #5 0-10'	1					
CTW0416	"	"	-004	Trench #6 0-5'	1					
CTW0516	"	"	-005	Trench #6 5-10'	1					
CTW0616	"	"	-006	Trench #7 0-5'	1					
CTW0716	"	"	-007	Trench #8 5-10'	1					

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
[illegible]	4/26/16	1600	[illegible]	5/4/16	1015
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by laboratory: (Signature)	Date	Time

Inter-Mountain Laboratories, Inc.

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35103

Cottonwood/Wilberg Mine Substitute Topsoil and Field Sampling Program

Date	Sample ID	Hole #	Depth (ft)	pH	Electrical Conductivity (uS)	Color (Dry)	Color (Wet)

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Appendix A-2

Soil Report for the Soils of the Wilberg Mine-1989

Cottonwood/Wilberg Mine Reclamation Plan

2016

SOILS OF THE WILBERG MINE SITE:

REPORT ON SOIL PHYSICAL AND CHEMICAL ANALYSES.

BY

A.R. Southard

and

T.H. Furst,

Soils Consultants

Logan, UT

15 JUNE 1989

Sampling of soil materials

Soil materials were sampled on 25 May 1989 with the assistance of Mr. Val Payne, Environmental Engineer, Utah Power and Light Company. Samples were collected from four different areas as shown on the enclosed map of sampling sites (Areas: W1, W2-west, W2-east, and W2-north). The area names (W1, W2-west, etc.) correspond to units established in a previous study[1] for map 2-18 of the Cottonwood-Wilberg Mine[2] The enclosed sampling map is an overlay for map 2-18 and details the distribution of sampling sites within the mine site.

Approximately one kilogram of soil material was collected in 15 cm increments to a depth of 45 cm at each sampling site. Equal volumes of soil material (less than 2 mm equivalent spherical diameter) were composited for each depth increment (0-15 cm, 15-30 cm, and 30-45 cm) for each of the four different sampling areas. Composite samples were derived from five sites in areas W1, W2-west, and W2-east, and from two sites in area W2-north.

The composite samples were submitted to the Utah State University Soil Test Laboratory, Logan, Utah, on 30 May 1989 for physical and chemical analyses. Soil texture was determined by the hydrometer method (Day, 1965; method 43-5). Available Water Capacity was determined by the water retention difference method (USDA-SCS, 1984; method 4C1). Saturation percentage was determined in the preparation of the saturation paste extract (percent by mass). Electrical conductivity and pH were determined on saturated paste extracts corrected to 25°C (Rhoades, 1982; methods 10-3.3, 10-3.2, and 10-2.3.1, respectively). The sodium adsorption ratio (SAR) was calculated on the water soluble concentrations of Ca, Mg, and Na (Rhoades, 1982; method 10-3.4). Organic carbon content was determined by the Walkley-Black procedure (Nelson and Sommers, 1982; method 29-3.5.2). Phosphorus and potassium content were determined by extraction with sodium bicarbonate at ph 8.5 (Olsen and Sommers, 1982; method 24-5.4). Rock volume (%) of the soil materials was estimated in the field based on a visual estimate of the amount of gravels, cobbles, and rock fragments excavated during sampling.

1. Barker, Jerry R. 1982 (July). Vegetation information for the Wilberg Mine. A report prepared for Utah Power and Light Company by Bio-Resources, Inc. Logan, UT.

2. Drawn by S.M. Child, Department of Mining and Exploration, Utah Power and Light Company. Drawing number CM-10346-WB. 10 November 1980.

RESULTS

Physical Analyses

Soil physical analyses for each area are reported in Appendix 1. All samples have sandy loam textures. However, clay contents of 20 percent with greater than 45 to 52 percent sand are borderline to the sandy clay loam textural category, and sand and silt contents tend to push the textures towards the loam textural category. The clay contents range from 17-20 percent, the silt contents from 19-29 percent, and sand contents from 54-61 percent. Overall, soil textures are similar and there is no evidence of clay illuviation from this analysis.

The available water capacities by water retention difference between 1/3 and 15 atmospheres are shown in Table 1 for all sampling areas and depth increments. Values range from 5.3-6.5 percent (mass basis). Conversion of percent water values to an inch/inch basis yields the data in Table 2.[3] While there is some variability in the available moisture content with depth in all areas, the differences are quite small and essentially insignificant. The available water content of these soils is roughly 0.03 inches of water per inch of soil. Thus, in the upper 18 inches of material there would be approximately 0.54 inches of water held between 1/3 and 15 atmospheres tension.

Table 1. Water retention difference values (Percent water, Pw).

Depth	**AREA**			
(cm)	**W1**	**W2-west**	**W2-east**	**W2-north**
	----------------% by mass----------------			
0-15	5.3	5.6	5.6	6.5
15-30	5.5	6.3	5.9	6.5
30-45	5.7	6.1	5.6	6.3

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3. From: Hanks and Ashcroft (1980:7-8).
 1. Pw/100= mass water content
 2. Mass water content X [bulk density (g/cm3) / density of water g/cm3)] X 1 cm = cm water/cm soil.
 3. [cm water/cm soil] / [2.54 cm/ 1 inch] = available water (in/in)

TABLE 2. Available water capacity.*

Depth (cm)	AREA W1	W2-west	W2-east	W2-north
	--------------------inch/inch--------------------			
0-15	.027-.031	.029-.033	.029-.033	.033-.038
15-30	.028-.032	.032-.037	.030-.035	.033-.038
30-45	.029-.034	.031-.036	.029-.033	.032-.037

* Values in this table are calculated by assuming bulk densities of 1.3 g/cm^3 and 1.5 g/cm^3 for the low and high estimates for each depth increment.

Saturation percentages are listed in Appendix 1. The values range from 26-31 percent and show little variation with depth or between sites. However, site W2-north had saturation percentages of 31% over all three depth increments and these values represent the high end of the range for all areas. The other three sites ranged from 26-29 percent water at saturation.

Field estimates of rock volume are included in Appendix 1. The average rock volume per area is given in Table 3. Area W1 had the highest estimated rock volume. However, it must be realized that soil samples were collected from areas that could be dug with a spade and thus these estimates are lower than what is actually present.

Table 3. Average rock volume of each area.

Area	Rock Volume
	-----%-----
W1	44
W2-west	13
W2-east	14
W2-north	10

In summary, the soil physical data indicates that the soils are texturally sandy loams but are close to the sandy clay loam and loam categories on the USDA textural triangle. The available water capacity and saturation percentage data indicate that most (60-65%) of the water that can be retained at saturation is held between zero and 1/3 atmospheres. Approximately 20 percent of the water held at saturation is retained as "available water". Thus, for the optimization of water used for seed germination, seedling establishment, and plant growth, light, frequent applications of irrigation water may be critical. In actuality, the presence of up to 50% rock volume in these materials will decrease the total water storage capacity by the volume of the rock present. In areas with larger volumes of rock in the upper 18 inches, the lack of available water may become limiting to plant growth and survival. In general, this data agrees with previous soils data gathered on soil materials at the Wilberg mine, although textures measured in areas W1 and W2 were loamy sands in the 1983 data set (Appendix 3).[4]

Chemical Analyses

A complete table of the results of chemical analyses is included in Appendix 2. Soil reaction (pH) ranged from 7.9-8.2 over all samples with no real differences with depth or between areas.

Electrical conductivity values indicated the presence of soluble salts in all depth increments in all areas. Area W1 had the lowest overall salt contents ranging from 2.9 dS/m in the 0-15 cm increment to 1.5-1.7 dS/m in the two lower increments. Areas W2-west and W2-east have electrical conductivities of the 0-15 cm increment between 9 and 10.5 dS/m, and between 6.3 and 8.2 dS/m in the lower increments. Area W2-north had the highest electrical conductivity of any 0-15 cm increment at 19 dS/m, with the lower increments in this area at 6.3 and 7.9 dS/m. The cause of the increased electrical conductivities is probably related to snow removal and salting operations during winter months. Areas W2-west and W2-east are adjacent to and below the roadway into the mine parking lot and area W2-north is adjacent to and below the parking lot itself. Area W1 had the lowest electrical conductivity values and is somewhat isolated from the major roadways.

Sodium adsorption ratio calculations reflected the trend seen in the results of electrical conductivity analysis. Areas W2-west, W2-east, and W2-north have SAR's of 12.8, 11.0, and 28.6, respectively, in the 0-15 cm increments. Thus, a sodic hazard exists in the upper layer of these materials and tends to decrease, but not disappear with depth. As stated before, the major source of sodicity is probably related to winter snow removal. Electrical conductivity values determined in 1980 for areas W1 and W2 show ECe's of 0.51 and 0.98 dS/m, respectively (Barker, 1982).

Organic carbon content ranged from 1.4-2.3 percent with the greatest amounts usually in the 0-15 cm increments. However, the data from area W1 reflected no decrease in organic carbon with depth.

Phosphorus contents of soil materials suggest the need for phosphorus fertilization. Only the 0-15 cm increment of area W1 has an above average phosphorus content. All others indicate that phosphorus should be applied. The USU Soil Test Lab recommendations suggest the application of 0-50 pounds P_2O_5 per acre for grasses and lawns for soil test levels between 1-10 ppm phosphorus.

Potassium contents of soil materials is generally adequate with the highest levels in the 0-15 cm increments. The USU Soil Test Lab does not recommend potassium fertilization for grasses, and only recommends potassium fertilization for alfalfa and other

4. Previous data was analyzed at the Utah State University Soil Test Laboratory. Methods used in 1980 and 1983 for soil analyses are the same as those used now.

intensively managed irrigated crops when soil test levels are below 75 ppm K. Zero to 50 pounds K_2O per acre are recommended for soil test levels of less than 75 ppm K.

In summary, this data substantiates that there has been an increase in soluble salts and exchangeable sodium since 1983 (Appendix 3). The major source of salts and sodium is most likely attributable to winter snow removal operations as no source of sodium has been previously detected in these soils. Soil reaction (pH) has remained relatively constant since the 1980 and 1983 data sets were collected (Appendix 3). Organic carbon contents are in general lower for areas W1 and W2 when compared with the previous data, but remain between roughly 1.5-2.0 percent. Levels of phosphorus and potassium are similar across all data sets.

Recommendations for soil management

Limited available water capacity, high electrical conductivities, and high sodium adsorption ratios suggest two avenues for soil management for plant growth. The limited available water capacity can be overcome to a certain extent by providing some form of irrigation. Problems associated with excess salts and high levels of exchangeable sodium can be handled along two pathways. First, an excess of irrigation water can be used to flush salts below the upper 18 inches of soil material. Secondly, amendments such as calcium sulfate (gypsum) may be used to effect an exchange process and replace sodium in the soil with calcium.

Given the steep (30-40%) slopes at these areas, revegetation efforts will be enhanced by providing a mulch and securing the mulch with a netting system. This will aid in the reduction of evaporative loss of soil water and stabilize the soil surface to withstand the impact of raindrops or overhead irrigation water.

Low levels of fertilization may enhance establishment of vegetative cover on this site. Surface application of 25-50 pounds per acre nitrogen in the form of ammonium nitrate (NH_4NO_3) followed by irrigation or rain would incorporate an immediate source of nitrogen in the soil. Mechanical tillage operations should be kept to a minimum on these sites due to the steepness of slope. Phosphorus fertilization may aid vegetation establishment and a rate of 10-30 pounds P_2O_5 per acre may be sufficient. Soil test levels of potassium suggest this element will not be limiting for plant growth.

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APPENDIX 1

PHYSICAL ANALYSES.

A. Results of soil testing for soil materials collected from the slope above and adjacent to the upper parking lot (Area W1). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 1-5).

	---------Hydrometer------				Available Water --Atmospheres--		Saturation
Depth	**Sand**	**Silt**	**Clay**	**Texture**	**1/3**	**15**	**Percentage**
(cm)	-------%--------				-------%-------		-----%----
0-15	56	26	18	Sandy loam	9.6	4.3	28
15-30	59	22	19	Sandy loam	10.7	5.2	29
30-45	61	19	20	Sandy loam	10.8	5.1	29

B. Results of soil testing for soil materials collected from the slope west of the Wilberg conveyor (Area W2, west). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 6-10).

	---------Hydrometer------				Available Water --Atmospheres--		Saturation
Depth	**Sand**	**Silt**	**Clay**	**Texture**	**1/3**	**15**	**Percentage**
(cm)	-------%--------				-------%-------		-----%----
0-15	59	22	19	Sandy loam	10.2	4.6	26
15-30	58	23	19	Sandy loam	11.1	4.8	28
30-45	58	23	19	Sandy loam	11.2	5.1	29

C. Results of soil testing on soil materials collected from the slope east of the Wilberg conveyor (Area W2-east). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 11-15).

	---------Hydrometer------				Available Water --Atmospheres--		Saturation
Depth	Sand	Silt	Clay	Texture	1/3	15	Percentage
(cm)	-----------%----				-------%-------		-----%----
0-15	58	23	19	Sandy loam	10.0	4.4	27
15-30	57	25	18	Sandy loam	10.6	4.7	28
30-45	60	21	19	Sandy loam	10.1	4.5	26

D. Results of soil testing on soil materials collected from the area below the parking lot and adjacent to road (Area W2-north). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 16 and 17).

	---------Hydrometer------				Available Water --Atmospheres--		Saturation
Depth	Sand	Silt	Clay	Texture	1/3	15	Percentage
(cm)	-------%--------				-------%-------		-----%----
0-15	54	29	17	Sandy loam	11.9	5.4	31
15-30	56	26	18	Sandy loam	12.1	5.6	31
30-45	57	25	18	Sandy loam	11.3	5.0	31

E. Field estimate of percent gravels, cobbles, and rock fragments (by volume).

Area W1:

Sampling Site	1	2	3	4	5
Rock Volume (%)	50	50	50	30	40

Area W2-west

Sampling Site	6	7	8	9	10
Rock Volume (%)	15	20	10	10	10

Area W2-east

Sampling Site	11	12	13	14	15
Rock Volume (%)	15	10	15	20	10

Area W2-north

Sampling Site	16	17
Rock Volume (%)	5-10	10

APPENDIX 2

CHEMICAL ANALYSES.

A. Results of soil testing for soil materials collected from the slope above and adjacent to the upper parking lot (Area W1). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 1-5).

Depth (cm)	pH	ECe dS/m	SAR	Ca	Mg	Na	P	K	O.C.
				------meq/L-----			---ppm--		-%-
0-15	8.0	2.9	3.4	10.2	8.0	10.2	19	276	2.2
15-30	8.2	1.5	2.7	4.8	4.2	5.7	1.3	163	2.0
30-45	8.1	1.7	2.5	6.1	5.4	5.9	1.7	101	2.2

B. Results of soil testing for soil materials collected from the slope west of the Wilberg conveyor (Area W2, west). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 6-10).

Depth (cm)	pH	ECe dS/m	SAR	Ca	Mg	Na	P	K	O.C.
				------meq/L-----			---ppm--		-%-
0-15	7.9	9.3	12.8	25.4	20.9	61.6	6.2	135	2.0
15-30	7.9	6.3	7.1	22.7	20.3	32.8	3.1	83	1.4
30-45	7.9	7.0	5.4	33.8	29.4	30.2	0.7	79	1.4

C. Results of soil testing on soil materials collected from the slope east of the Wilberg conveyor (Area W2-east). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 11-15).

Depth (cm)	pH	ECe dS/m	SAR	Ca	Mg	Na	P	K	O.C.
				------meq/L-----			---ppm--		-%-
0-15	7.8	10.5	11.0	45.0	20.7	62.8	3.1	99	2.3
15-30	7.9	7.1	7.0	32.5	25.1	37.3	1.4	69	1.6
30-45	7.9	8.2	7.1	34.4	33.5	41.6	1.5	66	1.5

D. Results of soil testing on soil materials collected from the area below the parking lot and adjacent to road (Area W2-north). Each depth increment represents a composite of 5 subsamples collected as indicated on enclosed sketch of mine site (Sampling sites 16 and 17).

Depth	**pH**	**ECe**	**SAR**	**Ca**	**Mg**	**Na**	**P**	**K**	**O.C.**
(cm)		**dS/m**		**------meq/L-----**			**---ppm--**		**-%-**
0-15	8.0	19.0	28.6	26.5	19.7	137.5	5.0	264	2.2
15-30	8.0	6.3	1.8	12.3	10.7	45.4	1.8	79	1.6
30-45	7.9	7.9	9.1	24.1	24.1	44.9	1.6	73	1.4

APPENDIX 3

Previous soils data for the Wilberg Mine.

TABLE I. SOILS PHYSICAL PROPERTIES

A. Randomly selected samples from spoil banks of the Wilberg area, 1980.

Sample #	Identification	pH	ECe
658	Upper fill, clay	7.8	6.8
659	Upper fill, brown sandy	8.1	3.8
660	Upper fill, gray shale	7.5	5.9
661	Lower fill, brown sandy	7.7	5.9
662	Lower fill, brown sandy	7.7	5.8

B. Samples of soil and spoil from the Wilberg Mine, 1980.

Sample #	Identification	Sand	Silt	Clay	Texture	pH	ECe
1112	0-6"	63	24	13	SL	8.2	0.6
1113	6-14"	63	26	11	SL	8.4	0.4
1114	14-21"	60	27	13	SL	8.0	1.2
1115	21-31"	57	28	15	SL	8.5	0.7
1116	31-45"	58	28	14	SL	8.4	1.5
1123	Coal waste					6.8	1.6
1124	Coal waste					6.9	1.7
1125	Coal waste					6.9	1.8

C. Fill soil material samples collected in 1983 from subsurface layers in fill (4-20 inches). Each sample (W1-W5) is a composite of ten subsamples from each fill slope.

Sample #	Identification	Sand	Silt	Clay	Texture	pH	ECe
W1	Upper fill	78.5	6.5	15	LS	8.5	.51
W2	Parking lot fill	79.5	13.5	8.5	LS	8.2	.98
W3	Sed. pond fill	75.0	12.5	12.5	LS	8.6	1.0
W4	Spoil bank	75.0	14.5	10.5	LS	7.8	.80
W5	Waste rock	72.0	10.0	18.0	SL	8.0	.10

D. Saturation percentage.

Sample #	W1	W2	W3	W4	W5
Saturation percentage	30	20	30	20	30

TABLE II. SOILS PRODUCTIVITY ANALYSIS

A. Randomly selected samples from spoil banks of the Wilberg area, 1980.

Sample #	Na(meq/L)	%K	P(ppm)
658	28.3	.010	1.4
659	11.3	.003	17.0
660	10.4	.005	0.0
661	8.0	.008	0.1
662	29.6	.010	0.5

B. Samples of soil and spoil from the Wilberg Mine, 1980.

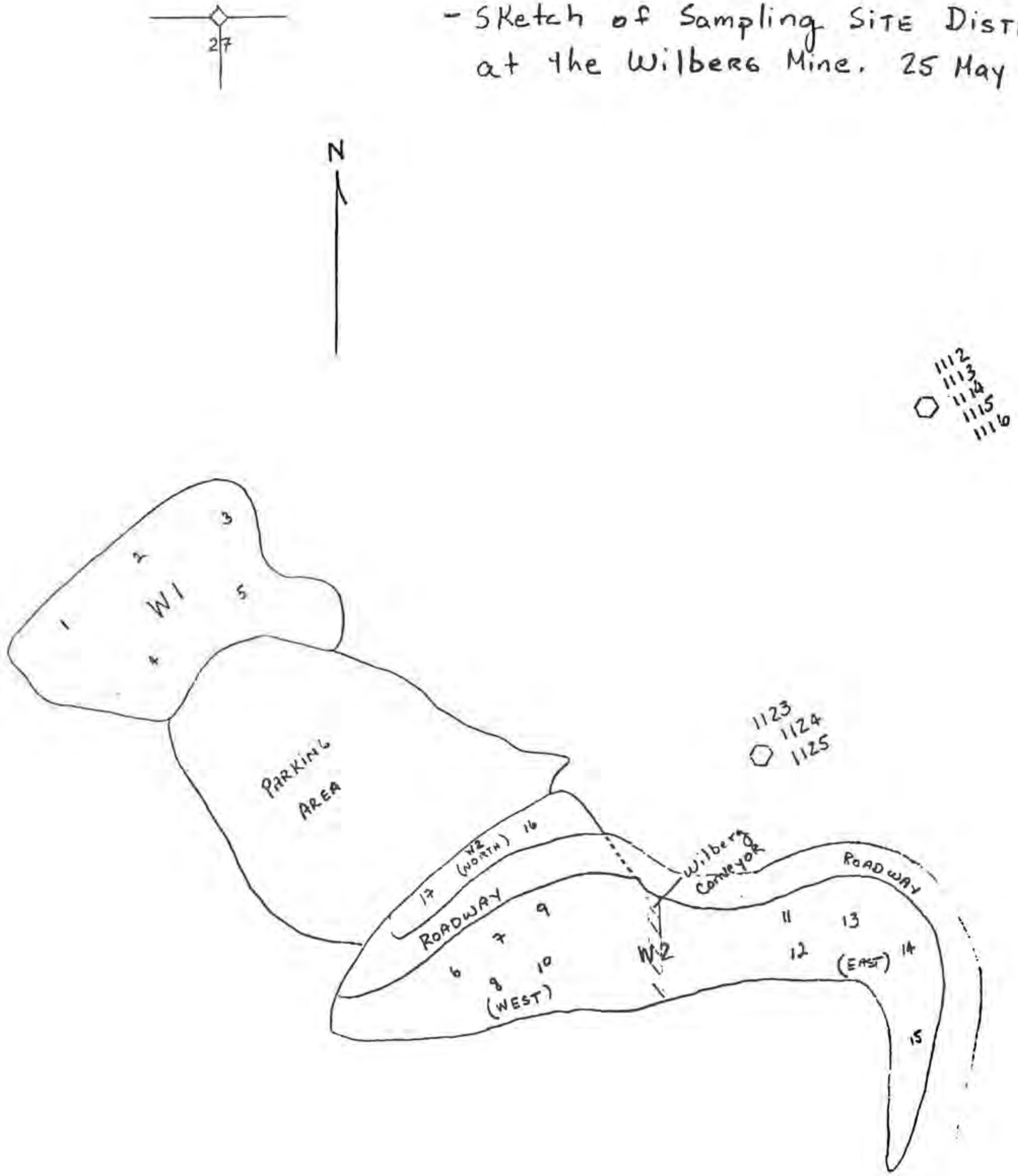
Sample #	SAR	%OM	(Ca+Mg)	Na(meq/L)	%K	P(ppm)
1112	0.3	4.4	5.2	0.5	0.02	2.9
1113	0.3	2.1	4.1	0.5	0.02	2.1
1114	0.4	1.3	9.7	0.9	0.02	0.6
1115	0.5	1.5	5.7	0.8	0.02	0.3
1116	0.4	1.3	14.5	1.2	0.02	0.1
1123	1.4		14.4	3.8	0.02	3.4
1124	1.5		15.0	4.1	0.02	4.5
1125	1.3		17.9	3.8	0.02	4.4

C. Fill soil material samples collected in 1983 from subsurface layers in fill (4-20 inches). Each sample (W1-W5) is a composite of ten subsamples from each fill slope.

Sample #	SAR	%OM (%N)	%Ca	%Mg	%Na	%K	P(ppm)	%CCE[1]
W1	2.29	5.50 (.085)	8.98	2.58	0.30	.088	.028	16.7
W2	0.06	12.22 (.266)	9.56	2.54	.082	.057	.035	16.5
W3	1.19	19.90 (.299)	7.50	2.23	.144	.052	.110	15.1
W4	0.06	10.98 (.254)	8.67	1.85	.072	.094	.055	16.5
W5	0.03	9.37 (.154)	14.5	1.79	.048	.067	.063	18.9

[1] Percent calcium carbonate equivalent

- Sketch of Sampling Site Distribution at the Wilberg Mine. 25 May 1989.



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USU #	ID	pH	ECe	NaHCO3 P	NaHCO3 K	% OC	SP	Ca	Mg	Na	SAR	Hydrometer Sand	Hydrometer Silt	Hydrometer Clay	Texture	ATM 1/3	ATM 15
			mmhos/cm	ppm	ppm	%	%	meq/L	meq/L	meq/L		%	%	%		%	%
1213	UPL A	8	2.9	19	276	2.2	28	10.2	8.0	10.2	3.4	56	26	18	Sandy loam	9.6	4.3
1214 w1	UPL B	8.2	1.5	1.3	163	2.0	29	4.8	4.2	5.7	2.7	59	22	19	Sandy loam	10.7	5.2
1215	UPL C	8.1	1.7	1.7	101	2.2	29	6.1	5.4	5.9	2.5	61	19	20	Sandy loam	10.8	5.1
1216	WOC A	7.9	9.3	6.2	135	2.0	26	25.4	20.9	61.6	12.8	59	22	19	Sandy loam	10.2	4.6
1217 w2-west	WOC B	7.9	6.3	3.1	83	1.4	28	22.7	20.3	32.8	7.1	53	23	19	Sandy loam	11.1	4.8
1218	WOC C	7.9	7	.7	79	1.4	29	33.8	29.4	30.2	5.4	58	23	19	Sandy loam	11.2	5.1
1219	EOK A	7.8	10.5	3.1	99	2.3	27	45.0	20.7	62.8	11.0	58	23	19	Sandy loam	10	4.4
1220 w2-east	EOK B	7.9	7.1	1.4	69	1.6	28	32.5	25.1	37.3	7.0	57	25	18	Sandy loam	10.6	4.7
1221	EOK C	7.9	8.2	1.5	66	1.5	26	34.4	33.5	41.6	7.1	60	21	19	Sandy loam	10.1	4.5
1222	BUL A	8	19	5	264	2.2	31	26.5	19.7	137.5	28.6	54	29	17	Sandy loam	11.9	5.4
1223 w2-north	BUL B	8	6.3	1.8	79	1.6	31	12.3	10.7	45.4	13.4	56	26	18	Sandy loam	12.1	5.6
1224	BUL C	7.9	7.9	1.6	73	1.4	31	24.1	24.1	44.9	9.1	57	25	18	Sandy loam	11.3	5

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Appendix A-3

2001 Soil Sampling Results

Cottonwood/Wilberg Mine Reclamation Plan

2016

1633 Terra Avenue
Sheridan, WY 82801

Note: Refer to drawings in this appendix for sample location.

Energy West Mining Co.
Huntington, UT

Client Project ID: Cottonwood Mine
Date Received: 04/04/01

Set #0101S06587
Report Date: 05/17/01

Lab Id	Sample Id	Hole #	Depths (Inches)	pH s.u.	Saturation %	EC mmhos/cm	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR	Available Sodium ppm	Exchangeable Sodium meq/100g
101S06587	CW8401	#5	12 - 18	7.4	25.4	5.27	21.7	15.3	21.2	4.93	0.55	0.01
101S06588	CW8501	#6	0 - 6	7.8	24.3	0.99	2.52	2.61	1.94	1.21	1.18	1.13
101S06589	CW8601	#6	6 - 12	7.7	25.2	0.71	2.04	2.39	1.59	1.07	0.46	0.42
101S06590	CW8701	#6	12 - 18	7.7	25.4	0.68	1.88	2.27	1.76	1.22	0.43	0.39
101S06591	CW8801	#7	0 - 6	7.6	28.1	0.47	2.44	1.06	1.06	0.80	0.40	0.37
101S06592	CW8901	#7	6 - 12	7.5	27.7	0.58	3.54	1.34	0.94	0.60	0.36	0.33
101S06593	CW9001	#7	12 - 18	7.2	29.5	2.27	23.5	5.35	1.23	0.32	0.46	0.42
101S06594	CW9101	#8	0 - 6	7.3	29.6	0.94	4.49	2.64	1.15	0.61	0.46	0.43
101S06595	CW9201	#8	6 - 12	7.3	29.7	0.89	4.19	2.93	1.35	0.72	0.46	0.42
101S06596	CW9301	#8	12 - 18	7.2	31.2	2.54	20.9	11.2	1.84	0.46	0.36	0.30
101S06597	CW9401	#9	0 - 6	7.2	35.6	2.91	18.5	16.0	4.06	0.98	0.70	0.56
101S06598	CW9501	#9	6 - 12	7.3	40.5	3.46	18.9	18.9	5.14	1.18	0.79	0.58
101S06599	CW9601	#9	12 - 18	7.4	37.6	3.76	20.3	21.6	5.97	1.30	0.79	0.57
101S06600	CW7001	#1	0 - 6	8.1	22.0	1.16	4.37	1.69	6.29	3.62	0.95	0.81
101S06601	CW7101	#1	6 - 12	7.6	27.2	4.75	9.78	4.16	29.6	11.2	2.19	1.38
101S06602	CW7201	#1	12 - 18	7.4	25.4	6.99	20.9	8.14	41.3	10.9	2.46	1.41

CTW mine

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iscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Huntington, UT

Client Project ID: Cottonwood Mine

Date Received: 04/04/01

Set #0101S06587

Report Date: 05/17/01

Lab Id	Sample Id	Hole #	Depths (Inches)	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	1/3 Bar %	15 Bar %
101S06587	CW8401	#5	12 - 18	20.4	63.0	23.0	14.0	SANDY LOAM	11.8	5.1
101S06588	CW8501	#6	0 - 6	16.4	60.0	26.0	14.0	SANDY LOAM	12.8	6.1
101S06589	CW8601	#6	6 - 12	18.5	62.0	25.0	13.0	SANDY LOAM	13.8	7.0
101S06590	CW8701	#6	12 - 18	19.2	63.0	24.0	13.0	SANDY LOAM	13.7	6.6
101S06591	CW8801	#7	0 - 6	25.1	40.0	40.0	20.0	LOAM	15.5	7.7
101S06592	CW8901	#7	6 - 12	15.4	46.0	36.0	18.0	LOAM	14.6	6.8
101S06593	CW9001	#7	12 - 18	28.2	44.0	37.0	19.0	LOAM	14.6	6.9
101S06594	CW9101	#8	0 - 6	30.6	40.0	41.0	19.0	LOAM	16.0	8.2
101S06595	CW9201	#8	6 - 12	20.8	41.0	40.0	19.0	LOAM	16.1	8.0
101S06596	CW9301	#8	12 - 18	16.0	40.0	42.0	18.0	LOAM	16.5	8.3
101S06597	CW9401	#9	0 - 6	28.4	38.0	38.0	24.0	LOAM	16.4	11.3
101S06598	CW9501	#9	6 - 12	24.9	35.0	37.0	28.0	CLAY LOAM	17.5	12.2
101S06599	CW9601	#9	12 - 18	30.5	40.0	38.0	22.0	LOAM	17.1	11.3
101S06600	CW7001	#1	0 - 6	25.6	66.0	22.0	12.0	SANDY LOAM	12.5	4.6
101S06601	CW7101	#1	6 - 12	23.7	63.0	25.0	12.0	SANDY LOAM	13.4	4.7
101S06602	CW7201	#1	12 - 18	30.9	68.0	20.0	12.0	SANDY LOAM	13.5	4.3

CTW Mine

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Energy West Mining Co.
Huntington, UT

Client Project ID: Cottonwood Mine
Date Received: 04/04/01

Set #0101S06587
Report Date: 05/17/01

Lab Id	Sample Id	Hole #	Depths (Inches)	TOC	Total Sulfur %	T.S. AB t/1000t	Neutral. Pot. t/1000t	T.S. ABP t/1000t	Boron ppm	Nitrogen-Nitrate ppm	TKN %	Selenium ppm
101S06587	CW8401	#5	12 - 18	1.2	<0.01	0.00	262	262	0.58	2.80	0.08	<0.02
101S06588	CW8501		0 - 6	2.7	0.02	0.62	328	328	0.92	3.74	0.11	<0.02
101S06589	CW8601	#6	6 - 12	3.1	0.02	0.62	337	336	1.05	2.88	0.12	<0.02
101S06590	CW8701		12 - 18	2.9	<0.01	0.00	335	335	1.10	3.62	0.12	<0.02
101S06591	CW8801		0 - 6	3.5	0.02	0.62	409	409	0.92	3.74	0.13	<0.02
101S06592	CW8901	#7	6 - 12	1.6	0.02	0.62	418	418	0.82	0.74	0.09	<0.02
101S06593	CW9001		12 - 18	1.3	<0.01	0.00	427	427	0.84	1.52	0.08	<0.02
101S06594	CW9101		0 - 6	4.9	0.03	0.94	406	405	0.99	13.2	0.18	<0.02
101S06595	CW9201	#8	6 - 12	5.7	0.03	0.94	393	392	0.89	7.62	0.17	<0.02
101S06596	CW9301		12 - 18	5.8	0.04	1.25	377	376	0.96	5.64	0.17	<0.02
101S06597	CW9401		0 - 6	1.3	0.02	0.62	271	271.	1.33	<0.02	0.08	<0.02
101S06598	CW9501	#9	6 - 12	0.8	0.03	0.94	239	238	1.13	1.44	0.08	<0.02
101S06599	CW9601		12 - 18	0.6	0.03	0.94	255	254	1.31	0.02	0.08	<0.02
101S06600	CW7001		0 - 6	2.0	<0.01	0.00	313	313	0.87	0.24	0.08	<0.02
101S06601	CW7101	#1	6 - 12	2.0	0.03	0.94	294	293	1.06	2.96	0.08	<0.02
101S06602	CW7201		12 - 18	2.7	0.03	0.94	267	266	0.83	0.60	0.11	<0.02

CTW Mine

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iscellaneous Abbreviations: SAR= Sodium Adsorption Ratio, CEC= Cation Exchange Capacity, ESP= Exchangeable Sodium Percentage

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Energy West Mining Co.
Huntington, UT

Client Project ID: Cottonwood Mine
Date Received: 04/04/01

Set #0101S06587
Report Date: 05/17/01

Lab Id	Sample Id	Hole #	Depths (inches)	pH s.u.	Saturation %	EC mmhos/cm	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR	Available Sodium ppm	Exchangeable Sodium meq/100g
101S06603	CW7301	CTW Mine #2	0 - 6	7.4	26.6	2.17	7.37	4.22	6 76	2.81	0.70	0.52
101S06604	CW7401	#2	6 - 12	7.4	26.1	2.55	14.0	8.40	5.08	1.52	0.61	0.48
101S06605	CW7501	#2	12 - 18	7.5	24.9	1.30	4.84	3.53	3.62	1.77	0.52	0.43
101S06606	CW7601	#3	0 - 6	7.3	30.0	3.28	22.8	20.1	2.13	0.46	0.41	0 35
101S06607	CW7701	#3	6 - 12	7.4	33.5	3.33	21.2	21.8	2.50	0.54	0.60	0.52
101S06608	CW7801	#3	12 - 18	7.2	33.0	3.54	21.3	24.6	2.78	0.58	0.54	0.45
101S06609	CW7901	#4	0 - 6	7.9	20.1	3.16	2.25	1.53	22 5	16.4	2.24	1.79
101S06610	CW8001	#4	6 - 12	7.5	23.0	6.97	5.50	3.54	49.5	23.3	3.13	1.99
01S06611	CW8101	#4	12 - 18	7.3	23.7	9.55	9.28	5.80	67.5	24.6	3.86	2.26
01S06612	CW8201	#5	0 - 6	7.4	25.7	2.22	4.44	2.91	10.0	5.24	0.96	0.70
01S06613	CW8301	#5	6 - 12	7.3	25.3	2.66	6.48	4.99	11.4	4.78	1.04	0.75

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Huntington, UT

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Date Received: 04/04/01

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Lab Id	Sample Id Hole #	Depths (inches)	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	1/3 Bar %	15 Bar %
101S06603	CW7301 } #2 (CTW Mine)	0 - 6	29.1	66.0	24.0	10.0	SANDY LOAM	15.3	4.4
101S06604	CW7401	6 - 12	34.4	62.0	25.0	13.0	SANDY LOAM	15.0	4.3
101S06605	CW7501	12 - 18	25.6	60.0	26.0	14.0	SANDY LOAM	13.8	3.9
101S06606	CW7601 } #3	0 - 6	27.3	30.0	56.0	14.0	SILT LOAM	17.3	4.8
101S06607	CW7701	6 - 12	25.6	24.0	56.0	20.0	SILT LOAM	18.7	6.6
101S06608	CW7801	12 - 18	23.8	22.0	56.0	22.0	SILT LOAM	18.7	6.6
101S06609	CW7901 } #4	0 - 6	25.2	58.0	28.0	14.0	SANDY LOAM	11.5	5.3
101S06610	CW8001	6 - 12	9.4	59.0	31.0	10.0	SANDY LOAM	12.0	4.7
101S06611	CW8101	12 - 18	28.7	60.0	26.0	14.0	SANDY LOAM	12.0	4.9
101S06612	CW8201 } #5	0 - 6	29.5	56.0	28.0	16.0	SANDY LOAM	13.1	5.6
101S06613	CW8301	6 - 12	17.0	59.0	25.0	16.0	SANDY LOAM	12.8	5.2

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Huntington, UT

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Date Received: 04/04/01

Set #0101S06587

Report Date: 05/17/01

Lab Id	Sample Id Hole #	Depths (inches)	TOC	Total Sulfur %	T.S. AB t/1000t	Neutral. Pot. t/1000t	T.S. ABP t/1000t	Boron ppm	Nitrogen-Nitrate ppm	TKN %	Selenium ppm
101S06603	CW7301 CTW Mine #2	0 - 6	2.2	0.02	0.62	365	364	0.46	3.14	0.10	<0.02
101S06604	CW7401 #2	6 - 12	1.5	0.02	0.62	351	351	0.47	0.44	0.07	<0.02
101S06605	CW7501 #2	12 - 18	1.7	<0.01	0.00	350	350	0.41	1.30	0.07	<0.02
101S06606	CW7601 #3	0 - 6	2.9	0.12	3.75	206	202	0.64	3.56	0.11	<0.02
101S06607	CW7701 #3	6 - 12	2.4	0.10	3.12	206	203	0.68	5.08	0.09	<0.02
101S06608	CW7801 #3	12 - 18	2.0	0.11	3.44	208	205	0.64	6.08	0.11	<0.02
101S06609	CW7901 #4	0 - 6	2.2	0.03	0.94	315	314	0.60	1.16	0.09	<0.02
101S06610	CW8001 #4	6 - 12	1.5	0.03	0.94	297	297	0.52	1.64	0.18	<0.02
101S06611	CW8101 #4	12 - 18	1.4	0.02	0.62	303	303	0.44	0.54	0.08	<0.02
101S06612	CW8201 #5	0 - 6	1.6	0.01	0.31	306	305	0.59	1.22	0.08	<0.02
01S06613	CW8301 #5	6 - 12	1.4	<0.01	0.00	318	318	0.52	1.22	0.07	<0.02

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Lab Id	Sample Id Hole #	Depths (Inches)	pH s.u.	Saturation %	EC mmhos/cm	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR	Available Sodium ppm	Exchangeable Sodium meq/100g
101S06596	CW9301 } # 3	12 - 18	7.2	31.2	2.54	20.9	11.2	1.84	0.46	0.36	0.30
101S06596D	CW9301 } CTW Mine	12 - 18	7.2	31.4	2.52	20 6	11.5	1 81	0.45	0.43	0.37
101S06612	CW8201 } # 5	0 - 6	7.4	25.7	2.22	4.44	2.91	10 0	5.24	0.96	0.70
101S06612D	CW8201 } CTW Mine	0 - 6	7.4	25.9	2.11	4.27	2.89	9.80	5.18	0.94	0.89

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Huntington, UT

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Date Received: 04/04/01

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Lab Id	Sample Id Hole #	Depths (Inches)	Coarse Fragments %	Sand %	Silt %	Clay %	Texture	1/3 Bar %	15 Bar %
101S06596	CW9301 } # 8	12 - 18	16.0	40.0	42.0	18.0	LOAM	16.5	8.3
101S06596D	CW9301 } CTW Mine	12 - 18	0.0	41.0	41.0	18.0	LOAM	16.8	8.3
101S06612	CW8201 } # 5	0 - 6	29.5	56.0	28.0	16.0	SANDY LOAM	13.1	5.6
101S06612D	CW8201 } CTW Mine	0 - 6	0.0	56.0	28.0	16.0	SANDY LOAM	13.1	5.6

bbreviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble, AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate
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Date Received: 04/04/01

Set #0101S06587

Report Date: 05/17/01

Lab Id	Sample Id Hole #	Depths (inches)	TOC	Total Sulfur %	T.S. AB t/1000t	Neutral. Pot. t/1000t	T.S. ABP t/1000t	Boron ppm	Nitrogen-Nitrate ppm	TKN %	Selenium ppm
101S06596	CW9301 #8	12 - 18	5.8	0.04	1.25	377	376	0.96	5.64	0.17	<0.02
101S06596D	CW9301 CTW mine	12 - 18	5.8	0.05	1.56	376	374	1.20	5.50	0.17	<0.02
101S06612	CW8201 #5	0 - 6	1.6	0.01	0.31	305	305	0.59	1.22	0.08	<0.02
101S06612D	CW8201 CTW mine	0 - 6	1.5	0.03	0.94	304	303	0.61	1.40	0.09	<0.02

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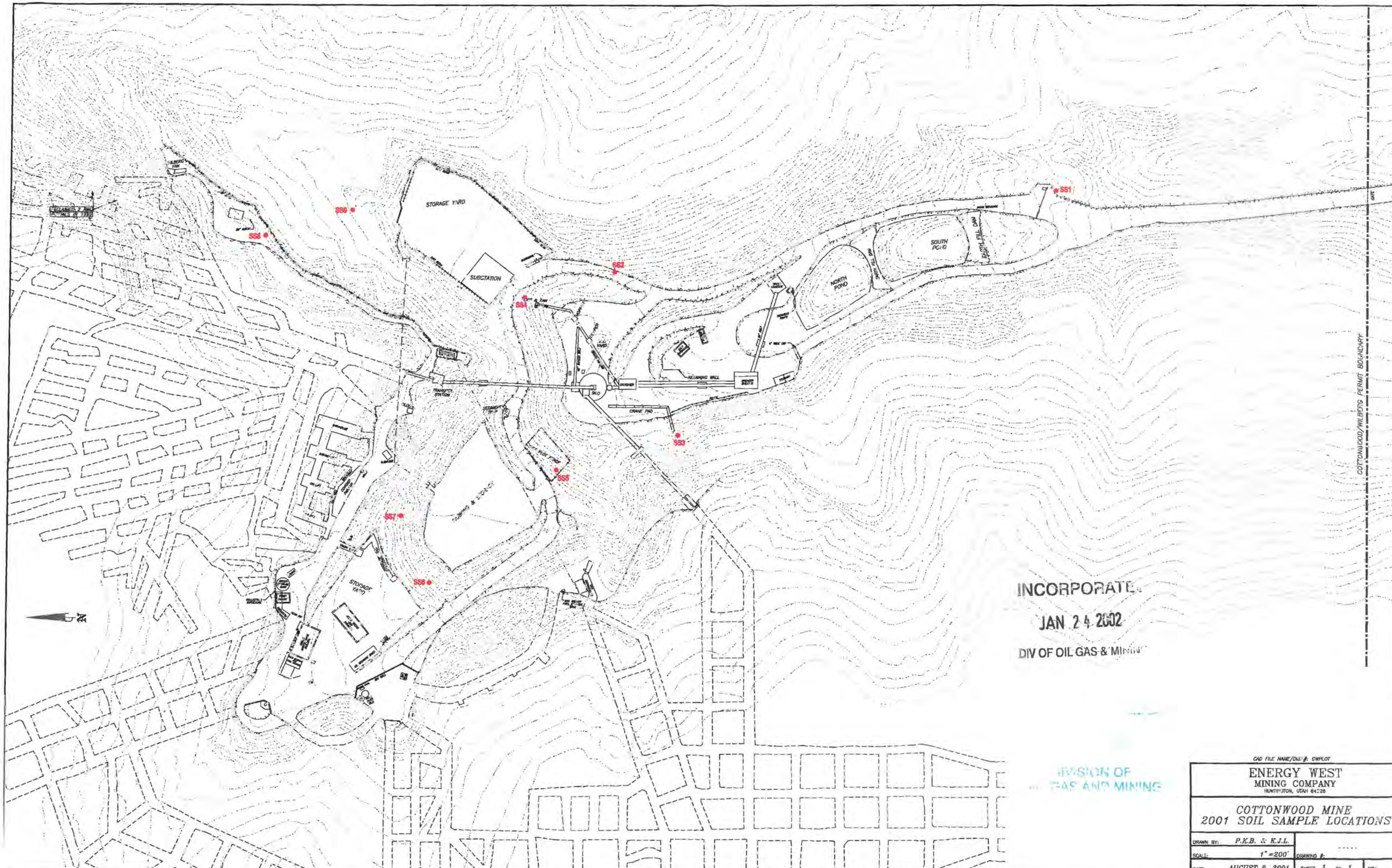

STORAGE YARD
SUBSTATION
SOUTH POND
NORTH POND
EARTH FILL DAM
SS1
SS2
SS3
SS4
SS5
SS6
SS7
SS8
SS9
CRANE PAD
RETAINING WALL
SILO
STORAGE YARD
COTTONWOOD/WILBERG PERMIT BOUNDARY
INCORPORATED
JAN 24 2002
DIV OF OIL GAS & MINING
CAD FILE NAME/DWG #: CWPLOT
ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528
COTTONWOOD MINE
2001 SOIL SAMPLE LOCATIONS
DRAWN BY: P.K.B. & K.J.L.
SCALE: 1"=200'
DRAWING #:
DATE: AUGUST 8, 2001
SHEET 1 OF 1
REV.

PacifiCorp – Interwest Mining Company

Appendix B

Highwall Elimination – Photo Essay

Cottonwood/Wilberg Mine Reclamation Plan

2016

Highwall Elimination

The following is a list of portal breakouts at the Cottonwood/Wilberg Mine that qualify as highwalls according to the Division of Oil Gas and Mining definition.

A. Wilberg Mine Fan - located on access road to Deer Creek 9th East portals Portal broke out prior to 1974
B. Wilberg Fan Portal - broke out in 1978-79 and now sealed and fan removed
C. Belt Portal in Wilberg
D Intake Portal Wilberg
E. Underground Offices
F. Old Portals - shop area
G. Old Portals - behind water tank area
H. Portals for Wilberg before fire - Now sealed, North East of waterfall area
I. Mine Access Tunnel to Cottonwood Mine Portals - Adjacent to waterfall
J. Cottonwood Intake Portals - Pad area for storage and access
K. Cottonwood Fan Access Tunnel
L. Cottonwood Fan Portal - Hiawatha coal seam, south of the waterfall area
M. Cottonwood Belt Portal - south of fan portal
N. Cottonwood Canyon Portal - new openings for use to Trail Mtn. Mine Diesel roadway.
O. Cottonwood Canyon Fan Portal Area. Belt Portal from Trail to Cottonwood, Tube Conveyor.
P. Cottonwood Canyon Portal Faceoff - Reclaimed in 1998.
Q. Miller Canyon Breakouts
R. Channel Canyon Breakouts – Reclaimed in 1997 (final bond release June, 1998)

As indicated on Drawing KS-1658D, portals A, C, D, E, F, G, and H are Pre-1978 time frame, B, I, J, K, L, M, N, and O are Post-1978, P-R have no associated highwalls. Drawings KS-1658D and KS-1659D show the locations of the highwall survey area. These drawings are included at the end of this appendix.

Highwall elimination is presented in two parts, those portals which were constructed prior to 1978 (pre-SMCRA), and those constructed after 1978 (post-SMCRA).

Pre-SMCRA

Sealing of portals A, C, D, E, F, and G will be conducted as outlined in Figure 1 of Volume 2 Part 4, Reclamation Plan. Portals H, have three intake portals which accessed the old Wilberg mine, were sealed in 1985 using a cement plug.

After surface structures are removed, backfilling and grading will be accomplished using existing berm material, crushed concrete structures, subsoil, and/or other available material to cover the portal and highwall area. These pre-SMCRA highwalls will be covered to a depth sufficient to maintain slope stability at a maximum slope of 1½:1 in confined areas. Confined areas are determined by the outslope near the highwall. If outslope is steep, the fill slope is restricted to that of the outslope. These areas will be compacted to the extent practical to minimize soil settling or shrinkage. In unconfined areas, such as portal H, fill slopes will be maintained at 2:1. A 20% shrinkage factor will be added to the fill depth at the highwall (i.e. if the highwall is 10ft to the top of the coal seam, then fill will be placed 2ft above coal seam). The highwalls will be backfilled and graded simultaneously with the final reclamation operations at the Cottonwood Mine. The photo essay in the following section displays the extent of fill of the above mentioned portals that will be typically used. Portals H are partially backfilled and will be blended into the surface contour during final reclamation operations. Refer to Plate 4-1 and 4-2 for final reclamation contouring and soil mass balance tables.

Post-SMCRA

Sealing of portals B, I, J, K, L, M, N, and O will be conducted as outlined in Figure 1 of Volume 2, Part 4, Reclamation Plan. Portal B, the Wilberg Fan Portal, was previously seal in 1985 using a cement plug.

After surface structures are removed, backfilling and grading will be accomplished using stored fill material, crushed concrete structures, existing berms, and/or other available material to cover the portals and highwall area to as close to original contour as possible (refer to mass balance tables in Plate 4-1 and 4-2). Portals, such as Portal B and L, will be reclaimed to blend in with the sandstone outcrop ledges and steep slopes of the canyon.

A - Wilberg Mine Fan - Broke out prior to 1973 - located on access road to Deer Creek 9th East portals - Pre-SMCRA.

- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing berm and other material cast down slope.
- Fan structure will be dismantled prior to backfilling and grading.
- Area to be backfilled is approximately equal to 15 ft. high by 30 ft wide.

B -Wilberg Fan Portal -- Broke out in 1978 or 1979. After mine fire in 1985 the portal was sealed with a cement plug – Post-SMCRA.

- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 2:1.
- Backfilling material will utilize broken up concrete structures, berm, fan pad area, and other material cast down slope.
- Area to be backfilled is approximately equal to 15 ft. high by 30 ft wide.

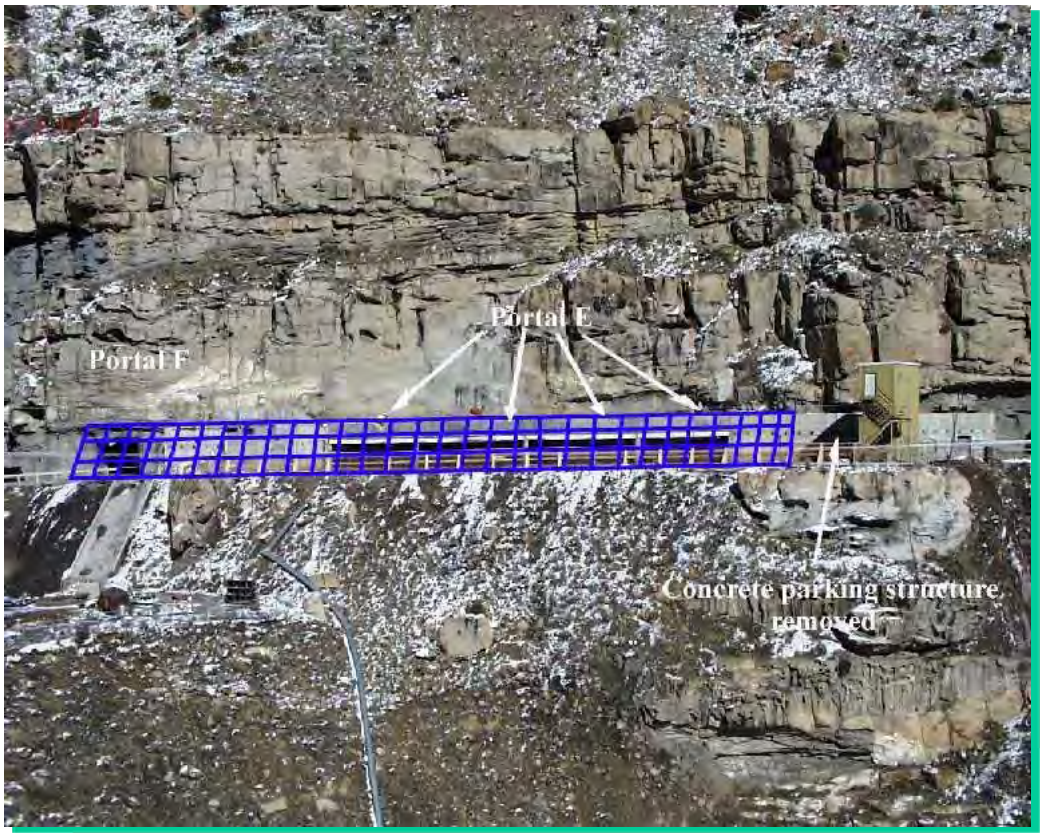
C - Belt Portal in Wilberg- Broke out prior to 1973 - Pre-SMCRA.

- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill material within the disturbed area, broken up concrete structures, and other available material.
- Shotcrete will be removed from all cut areas.
- Existing belt structure will be dismantled before backfilling and grading.
- Area to be backfilled is approximately equal to 15 ft. high by 40 ft wide.

D - Intake Portal Wilberg- Broke out prior to 1973 - Pre-SMCRA.

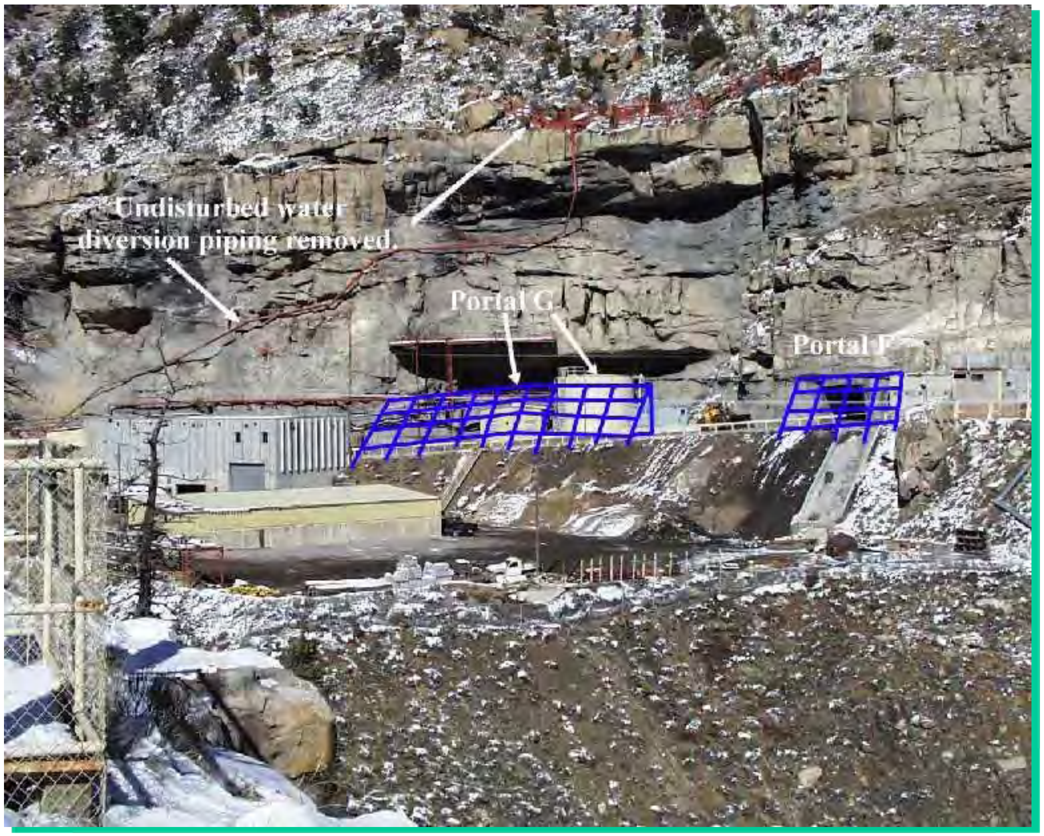
- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill material within the disturbed area, broken up concrete structures (Rhino Run), and other available material.
- Shotcrete will be removed from all cut areas.
- Existing structures will be dismantled before backfilling and grading.
- Area to be backfilled is approximately equal to 15 ft. high by 40 ft wide.

E - Underground Offices- Broke out prior to 1973 - Pre-SMCRA.
F - Old Portals - Diesel maintenane shop - area broke out prior to 1973 - Pre-SMCRA.



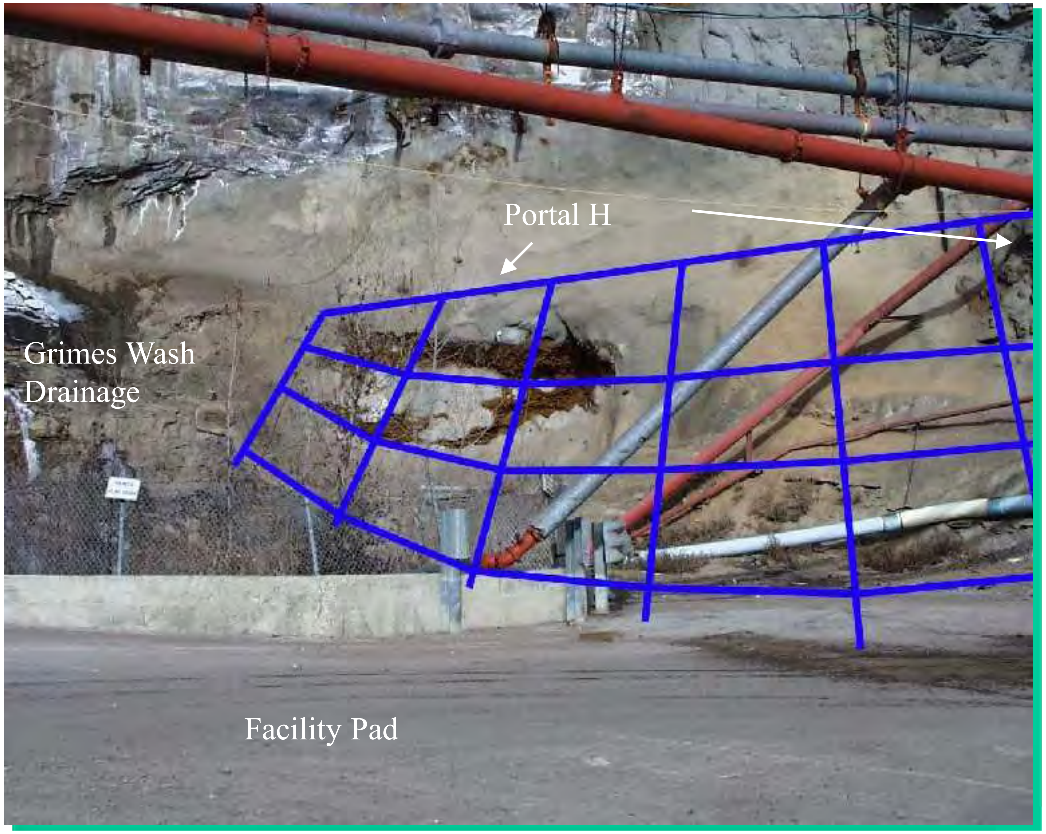
- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill material within the disturbed area, broken up concrete structures (Rhino Run), and other available material.
- Shotcrete will be removed from all cut areas.
- Existing structures will be dismantled before backfilling and grading.
- Areas to be backfilled at each of the five portals are approximately equal to 15 ft. high by 30 ft wide.

G - Old Portals - located behind water tank area. - portal constructed prior to 1973 - Pre-SMCRA.



- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill within the disturbed area, broken up concrete structures (building), and other available material.
- Shotcrete will be removed from all cut areas.
- Existing structures will be dismantled before backfilling and grading operations.
- Water diversion piping will be removed before backfilling and grading operations.
- Area to be backfilled is approximately equal to 15 ft. high by 30 ft wide.

H - Portals for Wilberg before fire - Broke out in May of 1977 and sealed in 1985, located north east of waterfall area.- Pre-SMCRA.



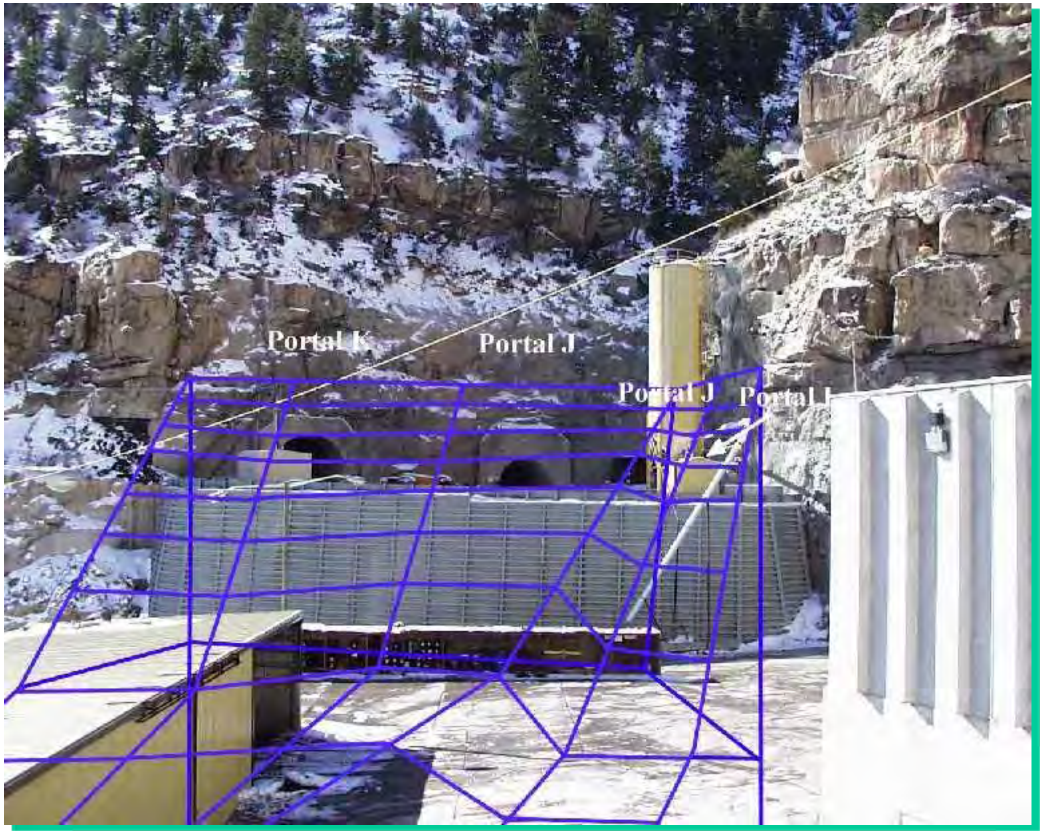
- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 2:1 or to a slope that visually and structurally enhances the drainage.
- Backfilling material will utilize the existing fill material of the pad.
- Shotcrete will be removed from the rock cliff faces.
- Existing structures will be dismantled before backfilling and grading operations.
- Area to be backfilled incorporates two portals 15 ft. high by 30 ft. wide.

I - Mine Access Tunnel to Cottonwood Mine Portals - Constructed in 1982 to access rock dust pad – not considered a highwall according to R645-Utah Coal Rules – located adjacent to waterfall.

- This portal is not an access to underground coal mining activities.
- Grids demonstrate the extent of fill material.
- Slope will be backfilled at approximately 2:1.
- Backfilling material will utilize the existing fill within the disturbed area, broken up concrete structures, and other available material.
- Shotcrete will be removed from all cut areas.
- Waterlines will be dismantled before backfilling and grading operations.

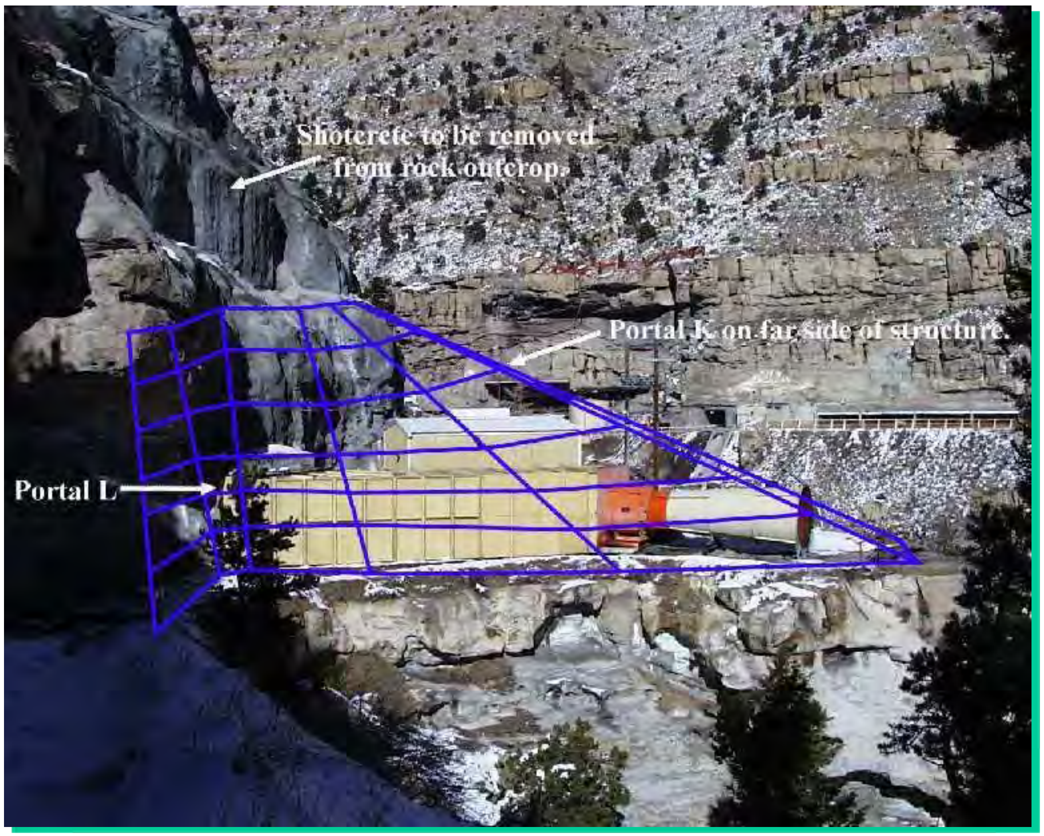
J - Cottonwood Intake Portals – Constructed in 1982 and 1985 - pad area used for storage and portal access. – Post-SMCRA.

K - Cottonwood Fan Access Tunnel – constructed in 1982 to access Cottonwood fan pad - not considered a highwall according to R645-Utah Coal Rules.



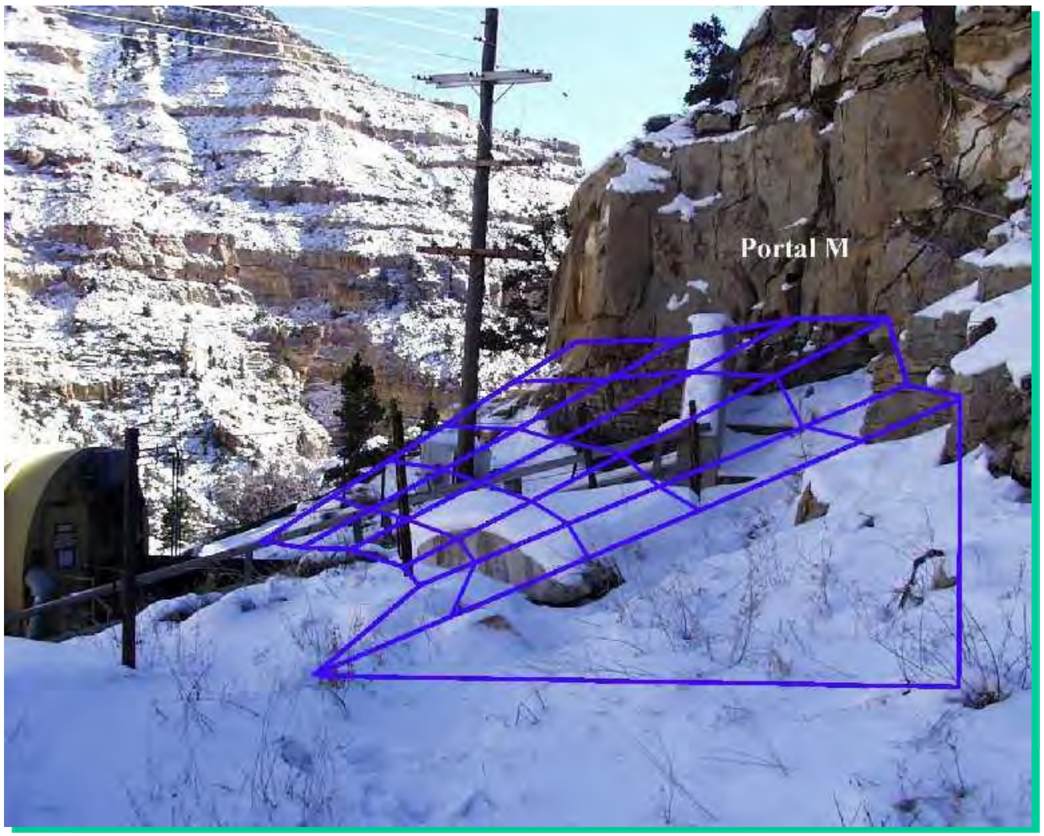
- Portal K is not an access to underground coal mining activities.
- Grids demonstrate the extent of fill material.
- Slope will be backfilled at approximately 2:1and/or blended with the natural rock outcrop and canyon slopes.
- Backfilling material will utilize the existing fill within the disturbed area, broken up concrete structures, and other available material.
- Buildings and surface structures will be dismantled and demolished prior to backfilling and grading activities.

L - Cottonwood Fan Portal – constructed in 1984 for the ventilation of the Cottonwood Mine – Post-SCRA.



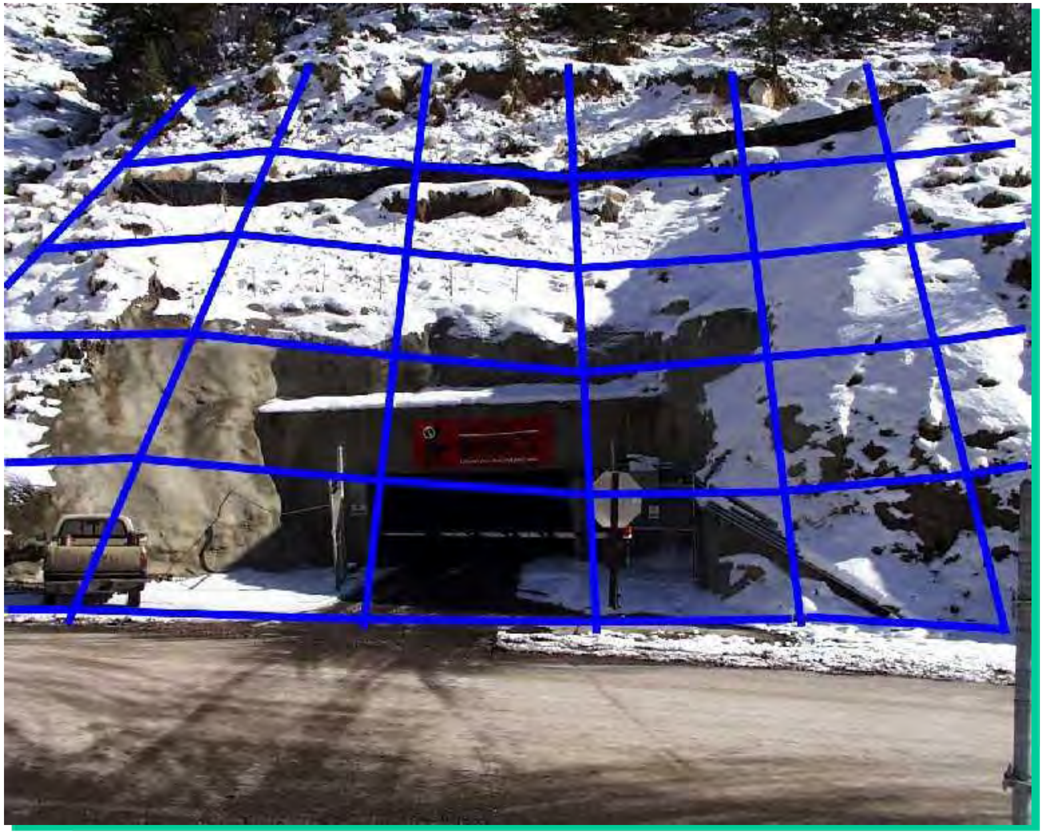
- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 2:1 and/or blend in with the rock outcrop.
- Backfilling material will utilize the existing fill within the disturbed area, broken up concrete structures (building), and other available material.
- Shotcrete will be removed from all cut areas.
- Existing structures, fan housing and building, will be dismantled before backfilling and grading operations.
- Area to be backfilled is approximately equal to 40 ft. high by 120 ft wide.

M - Cottonwood Belt Portal – Constructed in 1984 – located further to south of fan portal – Post-SMCRA.



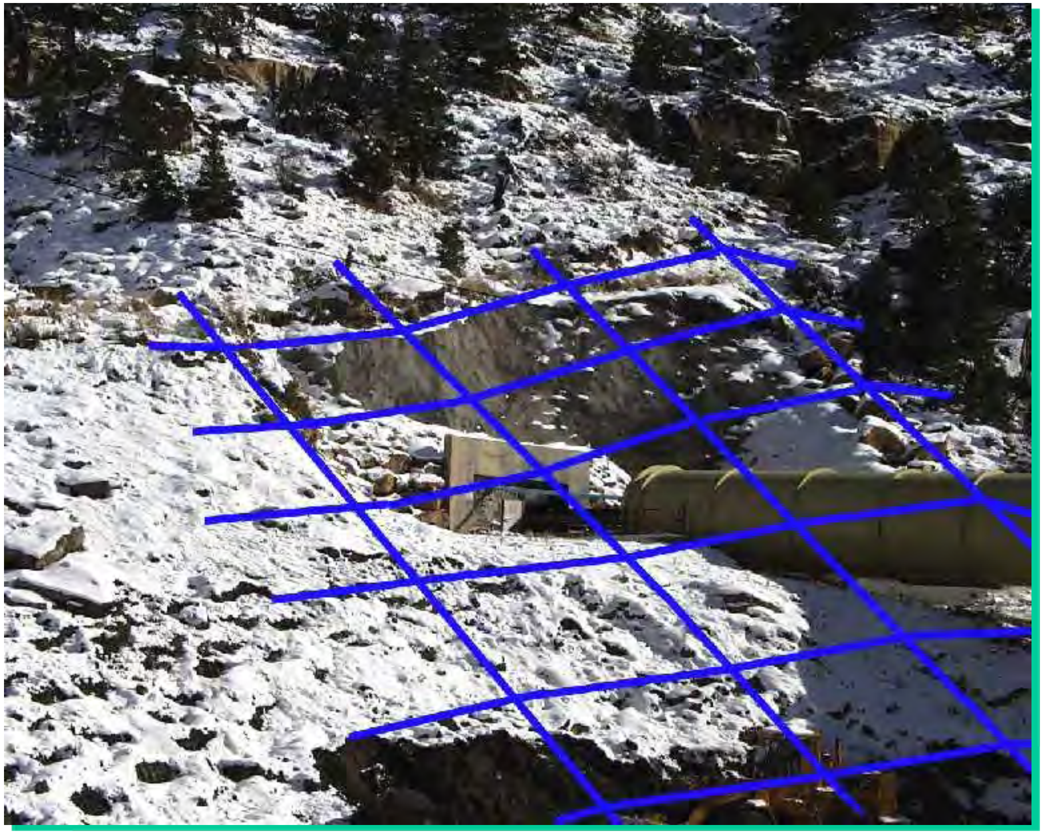
- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 2:1 while also blending in to the surrounding rock outcrops and slopes.
- Concrete portal casing will be broken up and used for fill material.
- Belt structurewill be dismantled prior to backfilling and grading.
- This portal is located on a steep remote point. Access is very limited. Safety must also be considered when determining fill material quantity. The portal will be filled to the extent possible.
- Area to be backfilled is approximately equal to 20 ft. high by 40 ft wide.

N - Cottonwood Canyon Portal – Constructed in 1995 to access the Trail Mtn. Mine in Cottonwood Canyon – Post-SMCRA.



- Grids demonstrate the extent of fill material on highwall
- Highwall is filled to match the contour of the existing slope.
- Portal structures will be removed prior to backfilling and grading.
- Area to be backfilled is approximately equal to 25 ft. high by 40 ft wide.

O - Cottonwood Canyon Fan Portal Area – Constructed in 1995 as a belt portal from Trail Mtn Mine to Cottonwood tipple facility – Post-SMCRA.



- Grids demonstrate the extent of fill material on highwall
- Highwall is filled to match the contour of the existing slope.
- Portal casing will be broken up and used as fill material.
- Belt structure will be dismantled prior to backfilling and grading activities.
- Area to be backfilled is approximately equal to 25 ft. high by 40 ft wide.

PacifiCorp – Interwest Mining Company

Appendix C

- C-1: RB&G Engineering - Geotechnical Invesigation and Stability Analyses – Wilberg Mine, 2016
- C-2: RB&G Engineering – Slope Stability Analysis of the Des Bee Dove Mine, 2001

Cottonwood/Wilberg Mine Reclamation Plan

2016

PacifiCorp – Interwest Mining Company

Appendix C-1

RB&G Engineering - Geotechnical Invesigation and Stability Analyses – Wilberg Mine, 2016

Cottonwood/Wilberg Mine Reclamation Plan

2016

GEOTECHNICAL INVESTIGATION AND STABILITY ANALYSES

WILBERG MINE

Emery County, Utah

Prepared for:
PacifiCorp

May 2016

RB&G ENGINEERING, INC.

201601-019

RB&G
ENGINEERING, INC.

May 19, 2016

PacifiCorp
Attn: Dennis Oakley
P.O. Box 310
Huntington, UT 84528

Re: Wilberg Mine
Geotechnical Investigation and Stability Analyses

Dear Mr. Oakley:

A Geotechnical Investigation and Slope Stability Analyses have been completed for the reclamation of the Wilberg Mine located in Emery County, Utah. The results of this study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

Brandon D. Horrocks, P.E.

REVIEWED BY:

Bradford E. Price, P.E., President

REGISTERED PROFESSIONAL ENGINEER
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BRADFORD E. PRICE
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GEOTECHNICAL INVESTIGATION AND
STABILITY ANALYSES

Wilberg Mine

Emery County, Utah

Prepared for:
PacifiCorp

May 2016

RB&G ENGINEERING, INC.

RB&G ENGINEERING, INC.

GEOTECHNICAL INVESTIGATION AND STABILITY ANALYSES

WILBERG MINE

EMERY COUNTY, UTAH

1 INTRODUCTION

This report outlines the results of slope stability analyses and a limited geotechnical investigation performed for the reclamation of the Wilberg Mine, located in Emery County, Utah. The analyses were completed at the request of PacifiCorp to assist in the design of the mine reclamation.

The purpose of this study was to evaluate the stability of the cut and fill slopes which are planned to be created during the mine reclamation work. The study does not address the stability of the native slopes in the area.

The information contained in the report is discussed under the following headings: Existing Site Conditions, Field Investigation Procedures, Subsurface Soil and Water Conditions, Slope Stability Analyses and Design Recommendations.

2 EXISTING SITE CONDITIONS

The study area is shown on the Vicinity Map included as Figure 1. The mine was developed near the location of a fork in the canyon. The mining activity occurred in the main canyon as well as within the two forks in the vicinity of the confluence.

The mine spoils appear to have been placed within the study area in a manner that created terraced fills. The fills have relatively flat tops and steep slopes. The steep fill slopes are generally oriented perpendicular to the canyon walls. PacifiCorp is in process of reclaiming the area. The structures which were constructed when the mine was in operation have been demolished. Rubble concrete from the demolished structures has been stockpiled at the site.

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3 FIELD INVESTIGATION PROCEDURES

The field investigations were performed by excavating test pits within the existing fill materials. The test pits were excavated using a CAT 320C trackhoe, which was provided by Nielson Construction. The purpose of the test pits was to obtain general information regarding the properties of the fill materials. In most cases, the test pits did not extend into underlying native deposits, which were beyond the maximum excavation depth of the equipment used. Bulk samples of the fill materials were obtained during the field investigations. During excavation, the test pits were logged by a geotechnical engineer. The test pit logs are presented in the appendix.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system is presented on the boring logs. A description of the Unified Soil Classification System (USCS) is presented in the appendix, and the meaning of the various symbols, shown on the logs, can be obtained from this figure.

In-place density tests were performed at select locations using a nuclear density gauge. The results of the tests, including dry density and moisture content, are shown on the boring logs.

4 SUBSURFACE SOIL AND WATER CONDITIONS

The characteristics of the subsurface material at the site were evaluated by excavating eight test pits to depths between 10 and 17 feet at the locations shown in Figure 2. The test pit numbers each include the prefix “16” on the site plan and logs to indicate the year the investigations were completed.

It will be observed from the test pit logs that the soils encountered during the investigation generally consisted of mixtures of gravel, sand, and silt. Cobbles and boulders up to about 4 feet in size were encountered at most of the investigation locations.

Coal was encountered in varying amounts at the locations of the test pits. The most notable amount of coal was encountered in Test Pit 16-03, where the materials were described as coal with silty sand and coal with gravel.

It will be noted from the test pit logs that the nuclear density tests resulted in dry densities between 102 and 120 pcf, and moisture contents between 6 and 16 percent.

The materials encountered during the investigations were generally described as moist; however, very moist to wet materials were encountered in Test Pit 16-07 above a layer of sandstone bedrock. It is evident from the investigations that some materials with moisture contents too high for proper compaction exist within the materials to be excavated, hauled, and re-compacted.

5 SLOPE STABILITY ANALYSES

Slope stability analyses were performed for several cross sections of the proposed reclamation work using the computer program Slope/W. Spencer's method, which satisfies both force and moment equilibrium was used during the stability analyses. The critical failure surfaces were identified during the analyses using a grid and radius approach. The potential failure surface having the lowest calculated factor of safety was then optimized by the computer program by iteratively adjusting points along the potential failure surface. The optimization routine generally resulted in critical failure surfaces somewhat distorted from circular shapes with slightly lower factors of safety.

Material properties used during the stability analyses are summarized in the following table:

Description	Unit Weight (pcf)	Internal Friction Angle – Φ (degrees)	Cohesion (psf)
Existing Fill	125	32	0
Proposed Fill	130	34	0
Native Overburden and Rock	120	0	5000
Coal	85	0	500

It will be noted from the above table that the existing fill which will remain in place and will be relied upon to sustain cut slopes was assumed to have an internal friction angle of at least 32 degrees. Based on the gravelly nature of the soils encountered during the subsurface investigations, we consider this to be a conservative approximation of the soil strengths.

It is anticipated that the existing fill materials within the center portion of the canyons will be excavated to resemble the natural slopes in the area. It is also anticipated that the excavated soils will be placed and compacted at other locations within the reclamation area. It is recommended that the fill materials placed during the reclamation work be compacted under controlled conditions. Additional recommendations for placing and compacting fill materials are given in the next section of this report. Assuming this recommendation is complied with, the strength parameters for proposed compacted fill will be conservative for the granular soils encountered during the subsurface investigations.

The primary purpose of the stability analyses was to evaluate the long term stability of the man-made slopes. The strength parameters used for the native overburden and rock deposits were selected to preclude these layers from controlling the critical factors of safety calculated during the stability analyses. The primary consequence of including these layers in the models is to create a surcharge load on the cut and fill slopes evaluated.

Coal seams were modeled during the stability analyses at the locations where cross sections provided to us by PacifiCorp indicated they are present. Since the coal seams are relatively thin layers between native overburden and rock deposits, the coal layers have minimal impact on the results of the stability analyses.

Stability analyses were performed for left fork cross sections at Stations 6+00, 7+00 and 10+00 as shown on Figure 2. Stability analyses were performed for right fork cross sections at Stations 11+00 and 12+00, also shown on Figure 2. Based on a visual inspection of the cross sections provided to us, the cross sections analyzed appear to represent the critical locations for reclamation work slope stability. The cross sections provided to us indicated the location of the existing and proposed ground surfaces. The cross sections indicated that cut and fill slopes up to about 100 feet high are planned for the reclamation work. For purposes of the stability analyses, we assumed that slopes shown on the cross sections significantly steeper than 2H:1V (Horizontal:Vertical) are native overburden and rock deposits.

Critical failure surfaces identified during the slope stability analyses were relatively shallow, and were generally contained within materials modeled as existing fill. Since the critical failure surfaces are relatively shallow, the material types modeled were selected based on the likely conditions near the surface of the slopes. It was not considered practical or necessary to identify the contact between the existing fill and native deposits beneath the proposed slopes. Graphics illustrating the slope stability analyses performed are included in the appendix of this report.

Pseudo-static stability analyses were performed to evaluate the proposed slopes during a seismic event. The pseudo-static coefficient used during the analyses was 0.05g, which, according to the 2008 USGS interactive deaggregation tool, is 50 percent of the peak ground acceleration for an earthquake having a 10 percent probability of exceedance in 50 years.

The results of the stability analyses are summarized in the following table:

Cross Section (See Figure 2)	Static Analysis Factor of Safety	Seismic Analysis Factor of Safety	Comments
LT Fork Sta 6+00	1.34	1.19	Cut & fill slopes ≥ 2H:1V
LT Fork Sta 7+00	1.08	n/p	Fill slope < 2H:1V
Modified LT Fork Sta 7+00	1.38	1.23	Cut & fill slopes ≥ 2H:1V
LT Fork Sta 10+00	1.43	1.26	Cut & fill slopes ≥ 2H:1V
RT Fork Sta 11+00	1.26	n/p	Cut slope < 2H:1V
Modified RT Fork Sta 11+00	1.32	1.13	Cut & fill slopes ≥ 2H:1V
RT Fork Sta 12+00	1.10	n/p	Cut slope < 2H:1V
Modified RT Fork Sta 12+00	1.39	1.22	Cut & fill slopes ≥ 2H:1V

*not performed

We recommend that cut and fill slopes in fill materials have a factors of safety against slope instability under static conditions of at least 1.3. We also recommend that these slopes have factors of safety against slope instability under pseudo-static seismic conditions of at least 1.1. It will be noted from the table above that at the locations where slopes modeled as fill materials (existing or proposed) were steeper than 2H:1V, factors of safety less than 1.3 were calculated. In these cases, the models were adjusted to slopes of 2H:1V, and adequate factors of safety were calculated. The calculated factors of safety under seismic conditions were greater than 1.1 for each of the conditions were static factors of safety were at least 1.3.

It is our understanding that PacifiCorp (Interwest Mining) has routinely excavated holes approximately 1 to 2 feet deep in the cut and fill slopes of mine reclamation sites. The primary purpose of the holes is to capture runoff water to prevent erosion of the slope surfaces. We understand that this erosion control measure has worked successfully at other sites where it has been used. We also understand that regulatory agencies have requested that the potential for shallow instability due to these excavated holes be evaluated.

The presence of the holes which are intended to capture water presents an increased risk that the soils within a couple feet of the ground surface will become saturated compared to a condition where the holes do not exist. We have performed an evaluation of the potential for instability due to this possible saturation using an infinite slope stability approach described in “Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California” (Blake et al., 2002). For purposes of these analyses, we have assumed that the soils within the upper 2 feet will have a total unit weight of 125 pcf, an internal friction angle of 32 degrees, and apparent cohesion of at least 70 psf. These strength parameters result in a calculated factor of safety of 1.32 against slope instability.

6 DESIGN RECOMMNEDATIONS

Based upon the results of the slope stability analyses, we recommend that cut and fill slopes within fill materials (existing and proposed) be no steeper than 2H:1V. During the excavation and processing operations, rocks larger than 8 inches should be removed from the materials. Prior to placement of the excavated and processed materials, we recommend that the soils be moisture conditioned such that they are no wetter than 2 percent over the optimum moisture content. The soils to be placed within fill zones should be placed in loose lifts no greater than 12 inches thick, and should be compacted to at least 90 percent of the maximum laboratory density as determined by ASTM D 1557 (modified Proctor). It is anticipated that the soils which will be used for fill materials will be sandy and gravelly granular soils with less than 30 percent passing the No. 200 sieve. Granular soils compacted to at least 90 percent of the maximum laboratory density should have an internal friction angle of at least 34 degrees. It is recommended that the compaction of the fill materials be verified by performing density testing in accordance with ASTM D 1556 (sand cone method) or ASTM D 6938 (nuclear gauge method). At least one density test should be performed for each 10,000 square feet (or portion thereof) of each lift of fill material placed. At least one classification test, including gradation and Atterberg limits, should be performed for each 10,000 cubic yards of material placed to verify and document the granular nature of the fill materials. Proctor tests should be performed for each different material used in the fill zones. At a minimum, at least one Proctor test should be performed for each 50,000 cubic yards of fill materials placed.

Based upon the results of the field investigations, it is anticipated that pockets of fill materials having large amounts of coal may be encountered during the reclamation work. Soils with a large percentage of coal within the matrix may not have long term strength characteristics necessary to provide adequate protection against slope instability. We recommend that materials with a large percentage of coal within the matrix not be used within the fill zones. The most efficient method to determine if the amount of coal within the fill matrix is acceptable will likely be by evaluating the densities of the fill materials as they are placed. Soils with large amounts of coal will tend to have lighter densities compared to materials without coal. We recommend that materials with a total unit weight less than 125 pcf not be used within the fill zones.

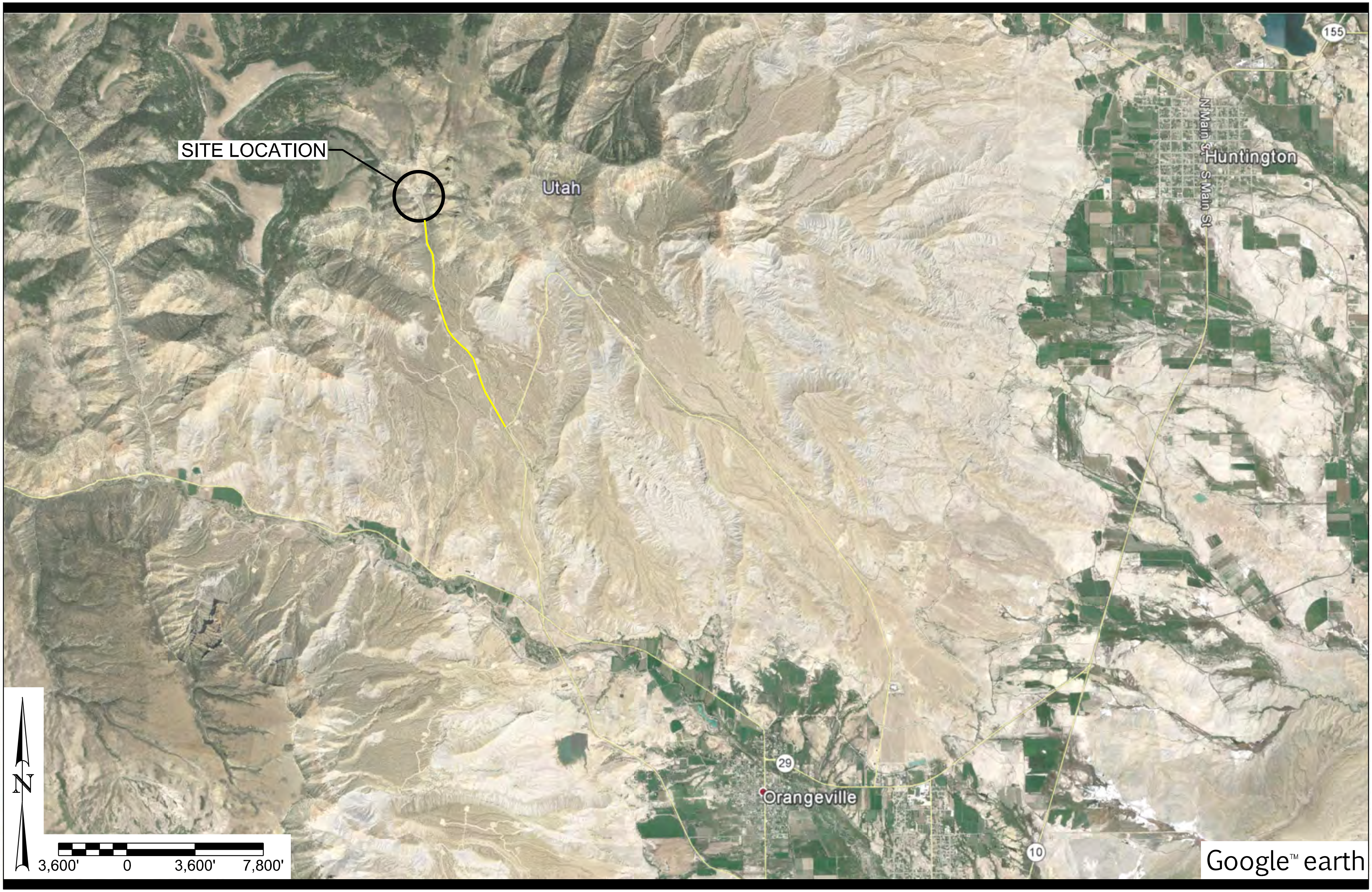
In order to provide the strength requirements necessary to protect against shallow slope failures during wet periods, the soils within the zone likely to become saturated must be well compacted. In areas where new fill zones will be constructed under controlled conditions, the necessary compaction of granular soils, as described above, should achieve the modeled strength parameters. The strength requirements estimated for evaluation of the shallow infinite slope instability condition may not exist at locations where cut slopes in existing fill materials, which may not be compacted to the standards described above, will be constructed. In order to provide adequate strength of these materials, we recommend large compaction equipment be used to compact the surface of the cut slopes as they are excavated. The cut slope surfaces should be compacted to at least 95 percent of the maximum laboratory density as determined by ASTM D 1557 using equipment weighing at least 10 tons. This action will likely result in some compaction of the underlying soils which will decrease the probability that shallow failure surfaces will develop under saturated conditions. The holes to prevent erosion should not be excavated until after the surface compaction treatment has been completed.

7 LIMITATIONS

The conclusions and recommendations presented in this report are based upon the results of the limited field investigations. Due to the limited nature of the investigations completed, we recommend that the reclamation work be performed in consultation with the geotechnical engineer. Field testing should be completed under the direct supervision of the geotechnical engineer. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout this site which could not be defined during this investigation. If conditions are encountered during construction which were not identified during the investigations, RB&G Engineering should be notified so that appropriate recommendations can be made.

The information contained in this report is provided for the specific location and purpose of the client named herein and is not intended or suitable for reuse by any other person or entity whether for the specified use, or for any other use. Any such unauthorized reuse, by any other party is at that party's sole risk and RB&G Engineering, Inc. does not accept any liability or responsibility for its use.

FIGURES



RB&G ENGINEERING, INC.

Figure 1 VICINITY MAP

Wilberg Mine Reclamation

Emery County, Utah

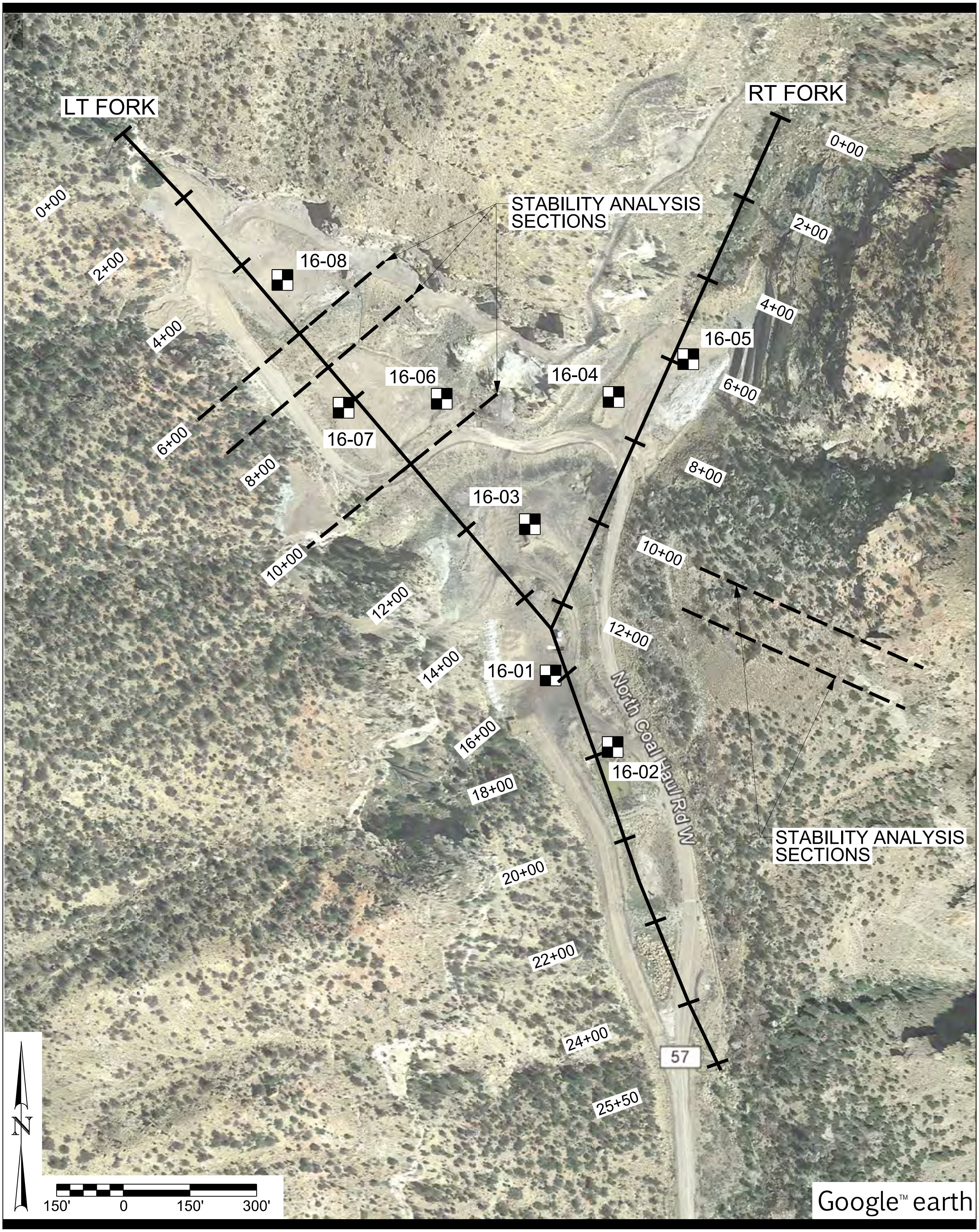


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Figure 2 SITE PLAN & TEST PIT LOCATIONS

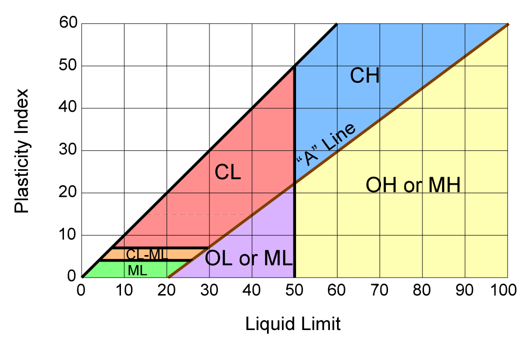
Wilberg Mine Reclamation

Emery County, Utah

APPENDIX

Unified Soil Classification System

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	**Gravels** *more than half of coarse fraction is larger than No. 4 sieve size*	**Clean Gravels** *little or no fines*	**GW**		Well graded gravels, gravel-sand mixtures, little or no fines	*For laboratory classification of coarse-grained soils* Determine percentage of gravel and sand from grain-size curve. Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows: **Less than 5%** GW, GP, SW, SP **More than 12%** GM, GC, SM, SC **5% to 12%** Borderline cases requiring use of dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 4 Between 1 and 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels With Fines *appreciable amount of fines*	**GM***	**d**	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
				u				
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	**Clean Sands** *little or no fines*	**SW**		Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$	Greater than 6 Between 1 and 3
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with Fines *appreciable amount of fines*	**SM***	**d**	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
				u				
			SC		Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	**Silts and Clays** *liquid limit is less than 50*		**ML**		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	*For laboratory classification of fine-grained soils*		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silt-clays of low plasticity			
	Silts and Clays *liquid limit is greater than 50*		**MH**		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			**Pt**		Peat and other highly organic soils			



Plasticity Chart

*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the PI is 6 or less, the suffix u used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example GW-GC, well graded gravel-sand mixture with clay biner.)

TEST PIT LOG

TEST PIT NO. 16-01

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION

CLIENT: INTERWEST MINING COMPANY

LOCATION: LAT: N 39.31879 / LONG: W 111.12235

DIGGING METHOD: CAT 320 C TRACKHOE

OPERATOR: NIELSON CONSTRUCTION

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201601.019

DATE STARTED: 4/19/16

DATE COMPLETED: 4/19/16

GROUND ELEVATION: NOT MEASURED

LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						GM	black, moist — SILTY GRAVEL W/SAND with coal								
			■		Bag	SM	lt. brown, moist — SILTY SAND W/GRAVEL								
	5		■		Bucket	GM	brown, moist — SILTY GRAVEL W/SAND cobbles & boulders, increasing with depth (~10%)	119.0	10.1						
	10														
	15						SILTY GRAVEL W/SAND some coal								
			■		Bucket	GM	brown & black, moist								
							BOH								

TP_LOGV1 TP.GPJ US EVAL.GDT 5/11/16

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 16-02

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION

CLIENT: INTERWEST MINING COMPANY

LOCATION: LAT: N 39.31835 / LONG: W 111.12186

DIGGING METHOD: CAT 320 C TRACKHOE

OPERATOR: NIELSON CONSTRUCTION

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201601.019

DATE STARTED: 4/19/16

DATE COMPLETED: 4/19/16

GROUND ELEVATION: NOT MEASURED

LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
	0–0.5					GM	black SILTY GRAVEL W/SAND with coal								
	0.5–7		■ (~6–7)		Bag	SM	brown, moist SILTY SAND W/GRAVEL								
	7–15					GM	brown, moist SILTY GRAVEL W/SAND								
	15						BOH								

Depth scale: 5, 10, 15

TP_LOGV1 TP.GPJ US EVAL.GDT 5/11/16

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 16-03

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION

CLIENT: INTERWEST MINING COMPANY

LOCATION: LAT: N 39.31970 / LONG: W 111.12251

DIGGING METHOD: CAT 320 C TRACKHOE

OPERATOR: NIELSON CONSTRUCTION

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201601.019

DATE STARTED: 4/19/16

DATE COMPLETED: 4/19/16

GROUND ELEVATION: NOT MEASURED

LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	0–14						COAL with SILTY SAND W/GRAVEL TO GRAVEL W/SILT & SAND								
	10		■		Bucket	SM/GP-GM	brown & black, moist	110.4	14.7						
	14–15					GP	brown, moist — POORLY GRADED GRAVEL								
	15–16		■		Bag	SP	brown, moist — POORLY GRADED SAND								
	16						BOH								

TP_LOGV1 TP.GPJ US EVAL.GDT 5/11/16

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 16-04

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION

CLIENT: INTERWEST MINING COMPANY

LOCATION: LAT: N 39.32048 / LONG: W 111.12185

DIGGING METHOD: CAT 320 C TRACKHOE

OPERATOR: NIELSON CONSTRUCTION

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201601.019

DATE STARTED: 4/19/16

DATE COMPLETED: 4/19/16

GROUND ELEVATION: NOT MEASURED

LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	0–10						SILTY GRAVEL W/SAND cobbles & boulders up to 4', slightly plastic								
	5		■		Bucket	GM	dk. brown, moist	111.2	15.5						
	10						BOH								

LEGEND:

DISTURBED SAMPLE — Bucket ◄ Type of Sample; 0.45 ◄ Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated Undrained Triaxial
- CU = Consolidated Undrained Triaxial
- HYD = Hydrometer
- DC = Dispersive Clay

RB&G ENGINEERING, INC.

TEST PIT LOG

TEST PIT NO. 16-05

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION
CLIENT: INTERWEST MINING COMPANY
LOCATION: LAT: N 39.32071 / LONG: W 111.12127
DIGGING METHOD: CAT 320 C TRACKHOE
OPERATOR: NIELSON CONSTRUCTION
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201601.019
DATE STARTED: 4/19/16
DATE COMPLETED: 4/19/16
GROUND ELEVATION: NOT MEASURED
LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	0–8						SILTY GRAVEL W/SAND difficult to excavate								
	~6		■		Bucket	GM	brown, moist, dense	120.8	6.5						
	8–14					GM	brown, moist SILTY GRAVEL W/SAND								
	14						BOH								

TP_LOGV1 TP.GPJ US EVAL.GDT 5/11/16

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; *0.45* ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 16-06

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION

CLIENT: INTERWEST MINING COMPANY

PROJECT NUMBER: 201601.019

LOCATION: LAT: N 39.32047 / LONG: W 111.12320

DATE STARTED: 4/19/16

DIGGING METHOD: CAT 320 C TRACKHOE

DATE COMPLETED: 4/19/16

OPERATOR: NIELSON CONSTRUCTION

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	0–1					GP-GM	brown, moist	GRAVEL W/SILT & SAND (roadbase)								
	1–15		■		Bucket	GM	dk. brown, very moist, loose	SILTY GRAVEL W/SAND cobbles & boulders up to 18" (~15%), slightly plastic	102.8	14.7						
	15							BOH								

TP_LOGV1 TP.GPJ US EVAL.GDT 5/11/16

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS

UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 16-07

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION

CLIENT: INTERWEST MINING COMPANY

PROJECT NUMBER: 201601.019

LOCATION: LAT: N 39.32041 / LONG: W 111.12397

DATE STARTED: 4/19/16

DIGGING METHOD: CAT 320 C TRACKHOE

DATE COMPLETED: 4/19/16

OPERATOR: NIELSON CONSTRUCTION

GROUND ELEVATION: NOT MEASURED

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
	0					GP-GM	brown, moist — GRAVEL W/SILT & SAND (roadbase)								
						GM	dk. brown, very moist to wet — SILTY GRAVEL W/SAND cobbles & boulders (~20%), slightly plastic								
	5		■		Bucket	GM	dk. brown, wet, loose								
							SANDSTONE								
	10						BOH								

TP_LOGV1 TP.GPJ US EVAL.GDT 5/11/16

RB&G ENGINEERING, INC.

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 16-08

SHEET 1 OF 1

PROJECT: WILBERG MINE RECLAMATION
CLIENT: INTERWEST MINING COMPANY
LOCATION: LAT: N 39.32119 / LONG: W 111.12445
DIGGING METHOD: CAT 320 C TRACKHOE
OPERATOR: NIELSON CONSTRUCTION
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201601.019
DATE STARTED: 4/19/16
DATE COMPLETED: 4/19/16
GROUND ELEVATION: NOT MEASURED
LOGGED BY: B. HORROCKS

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						GP-GM	brown, moist, dense; GRAVEL W/SILT & SAND (roadbase) difficult to excavate								
	5														
			■		Bucket	GM	dk. brown, moist	110.5	9.8						
							SILTY GRAVEL W/SAND few cobbles & boulders up to 16", slightly plastic								
	10														
							BOH								

LEGEND:

DISTURBED SAMPLE — Bucket ← Type of Sample; 0.45 ← Torvane (tsf)

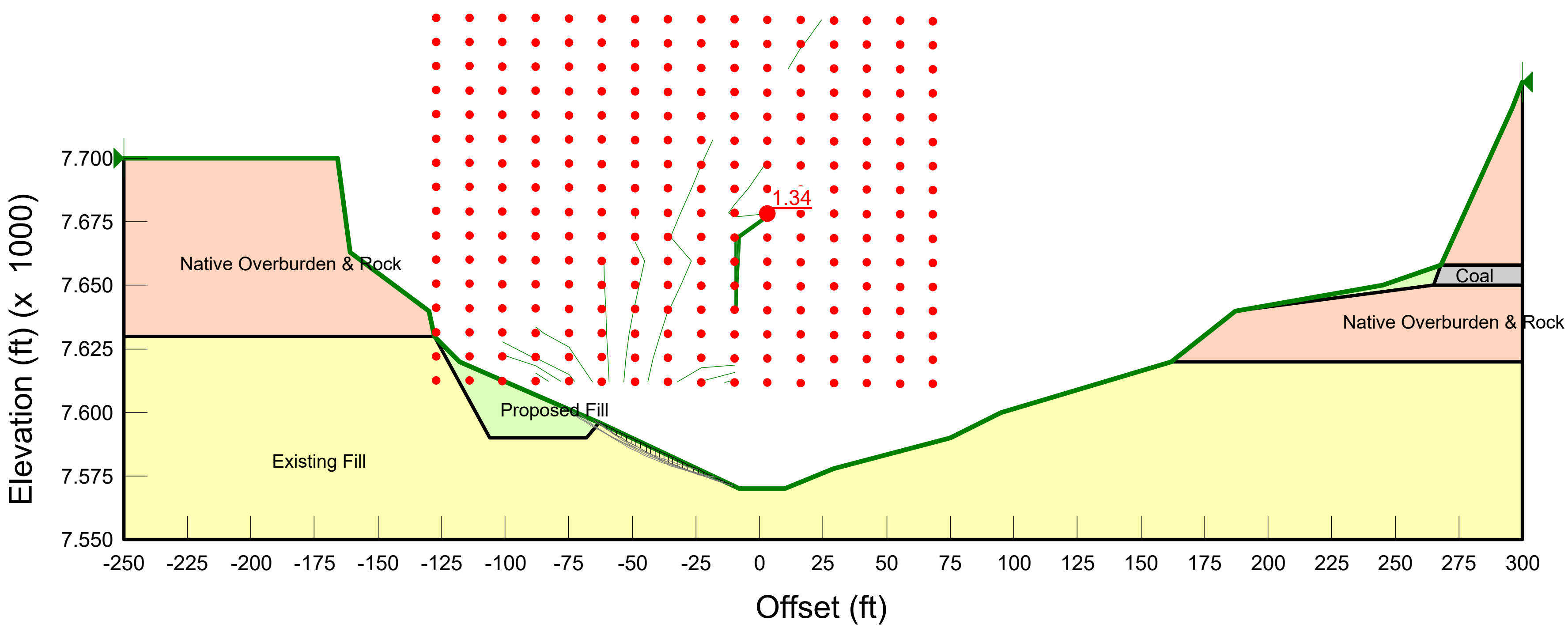
UNDISTURBED SAMPLE

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated Undrained Triaxial
CU = Consolidated Undrained Triaxial
HYD = Hydrometer
DC = Dispersive Clay

RB&G ENGINEERING, INC.

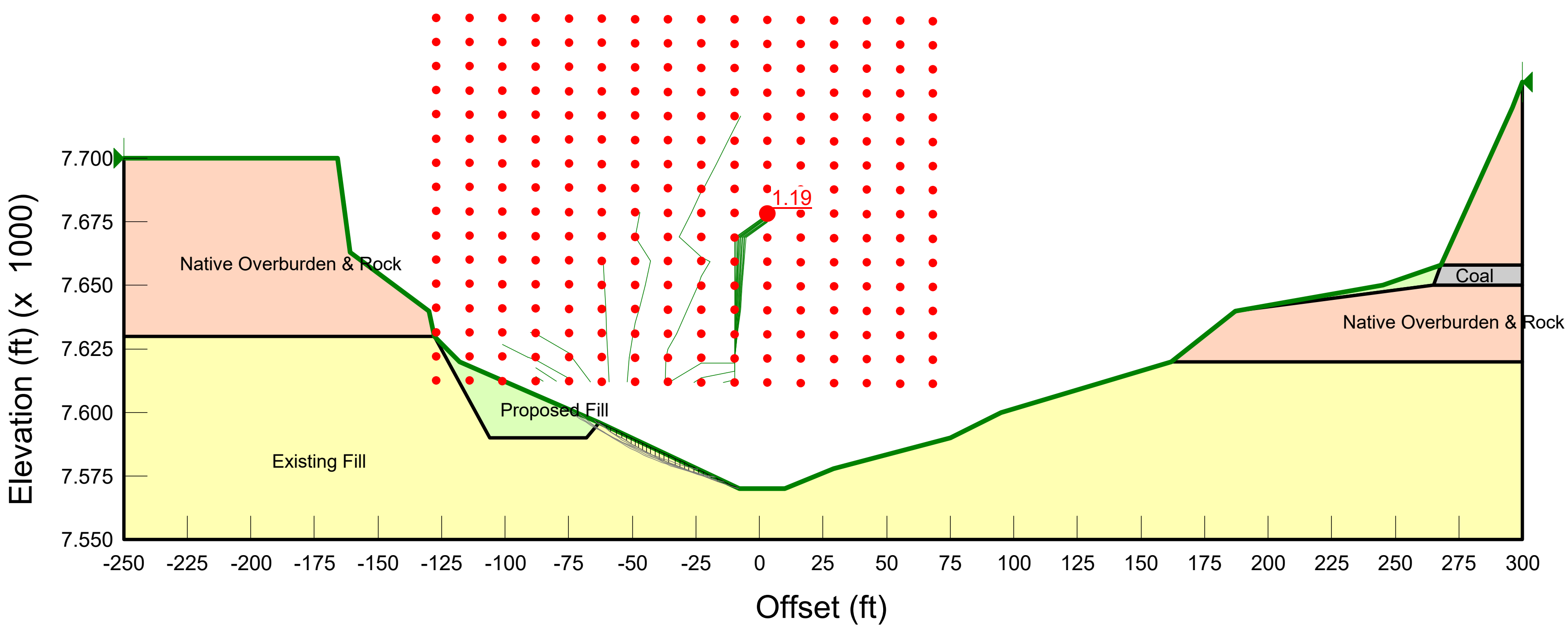
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 6+00
Static Conditions

Description: Existing Fill   Wt: 125   Cohesion: 0   Phi: 32
Description: Proposed Fill   Wt: 130   Cohesion: 0   Phi: 34
Description: Native Overburden & Rock   Wt: 120   Cohesion: 5000   Phi: 0
Description: Coal   Wt: 85   Cohesion: 500   Phi: 0



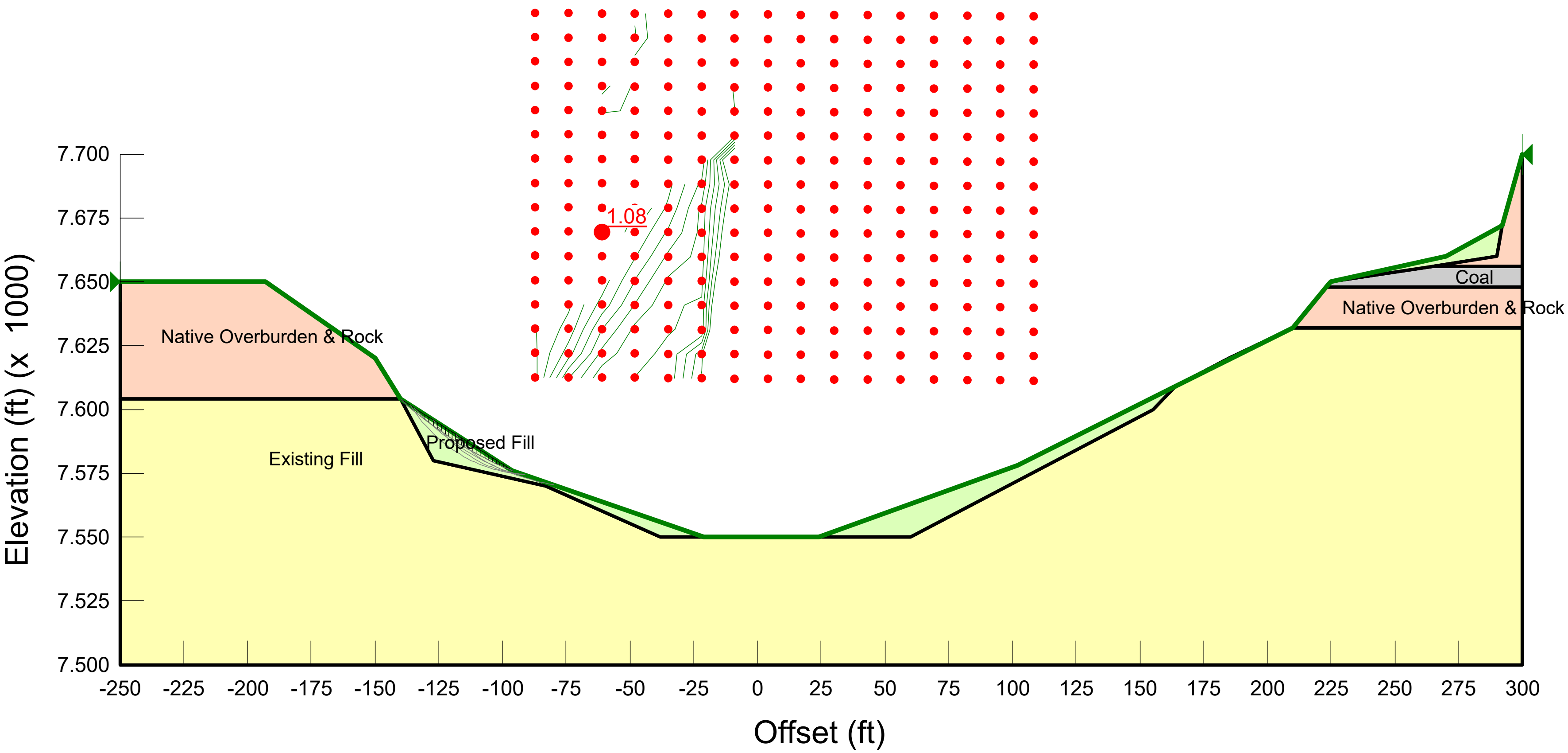
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 6+00
Seismic Analysis, k = 0.05g

Description: Existing Fill   Wt: 125   Cohesion: 0   Phi: 32
Description: Proposed Fill   Wt: 130   Cohesion: 0   Phi: 34
Description: Native Overburden & Rock   Wt: 120   Cohesion: 5000   Phi: 0
Description: Coal   Wt: 85   Cohesion: 500   Phi: 0



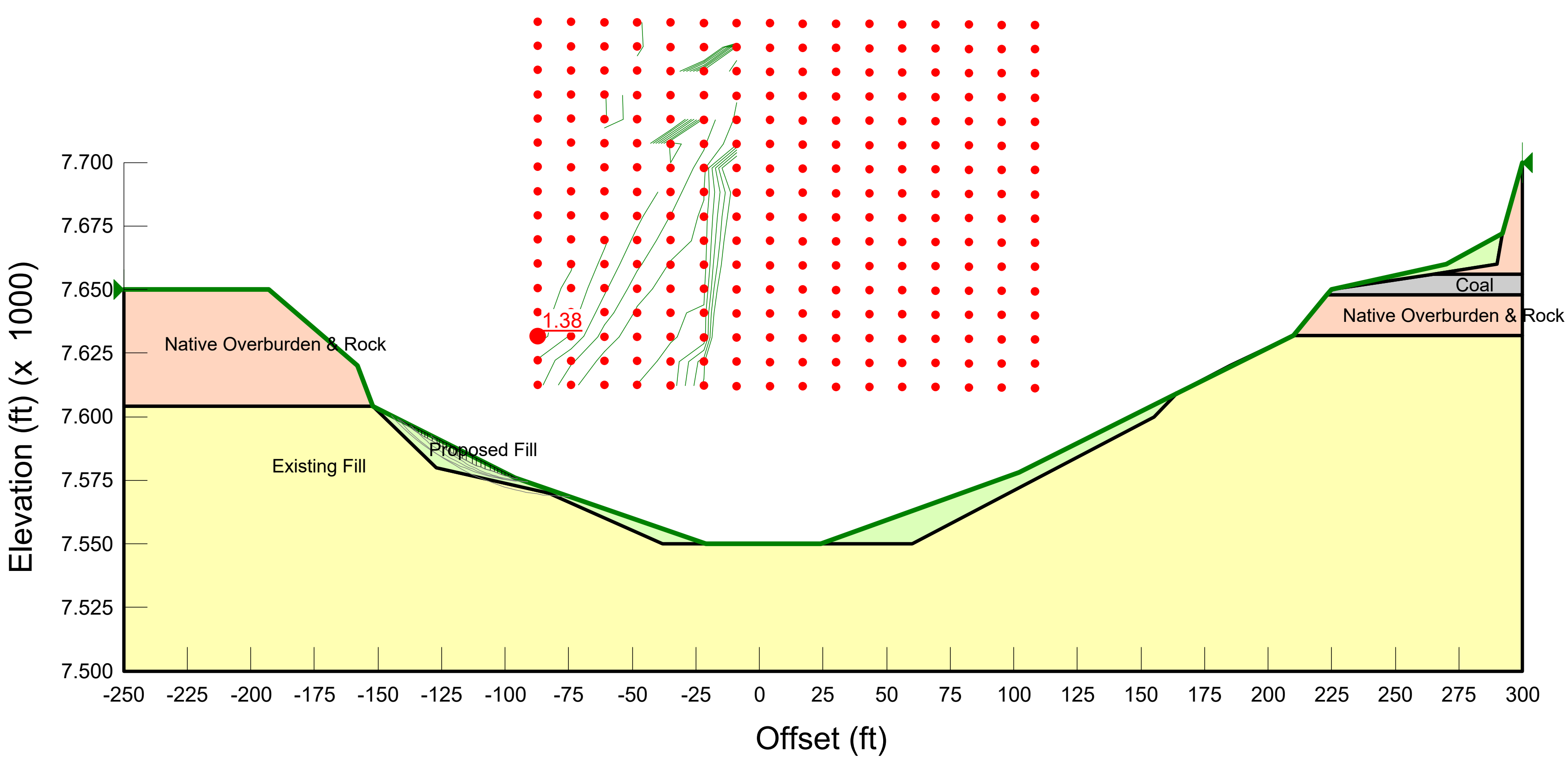
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 7+00
Static Conditions

Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 32
Description: Proposed Fill Wt: 130 Cohesion: 0 Phi: 34
Description: Native Overburden & Rock Wt: 120 Cohesion: 5000 Phi: 0
Description: Coal Wt: 85 Cohesion: 500 Phi: 0



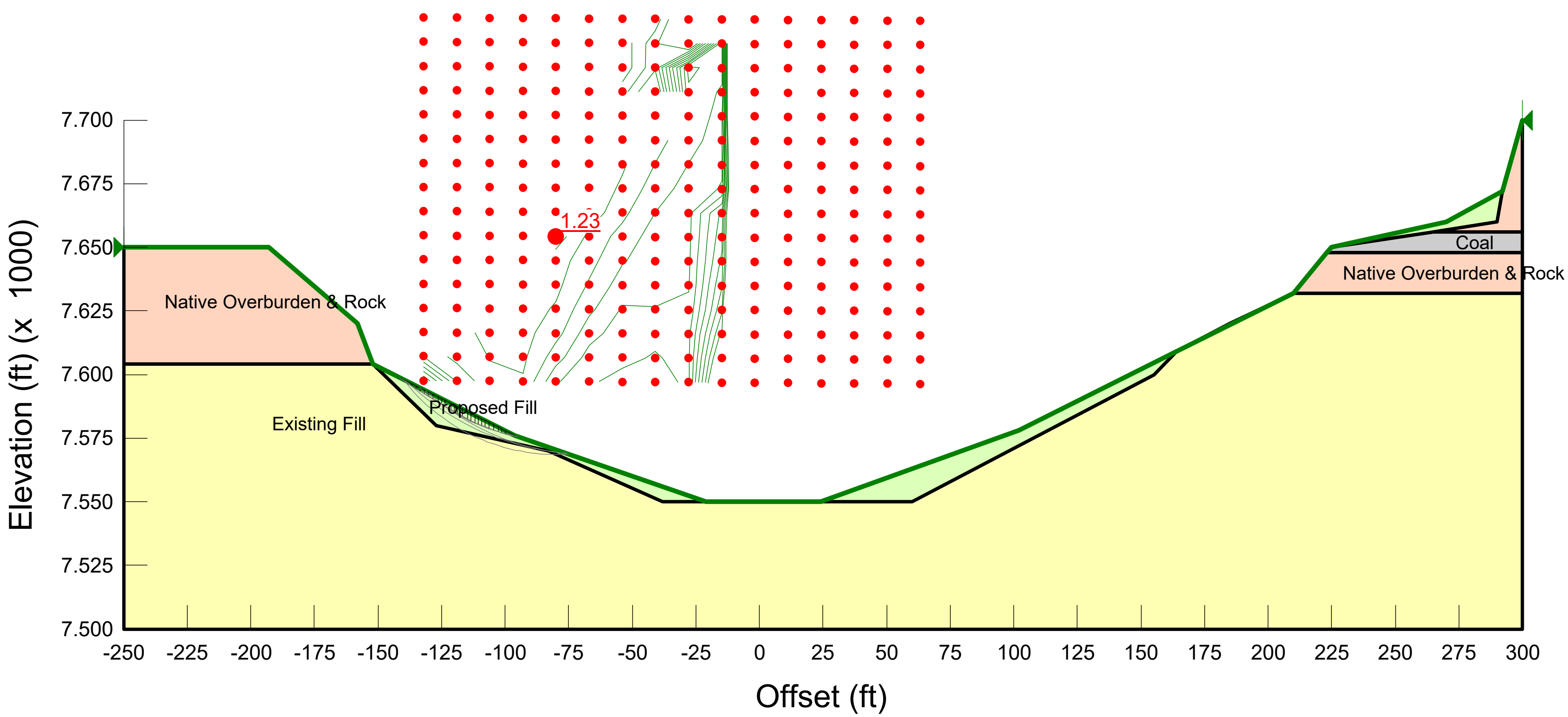
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 7+00 (Modified)
Static Conditions

Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 32
Description: Proposed Fill Wt: 130 Cohesion: 0 Phi: 34
Description: Native Overburden & Rock Wt: 120 Cohesion: 5000 Phi: 0
Description: Coal Wt: 85 Cohesion: 500 Phi: 0



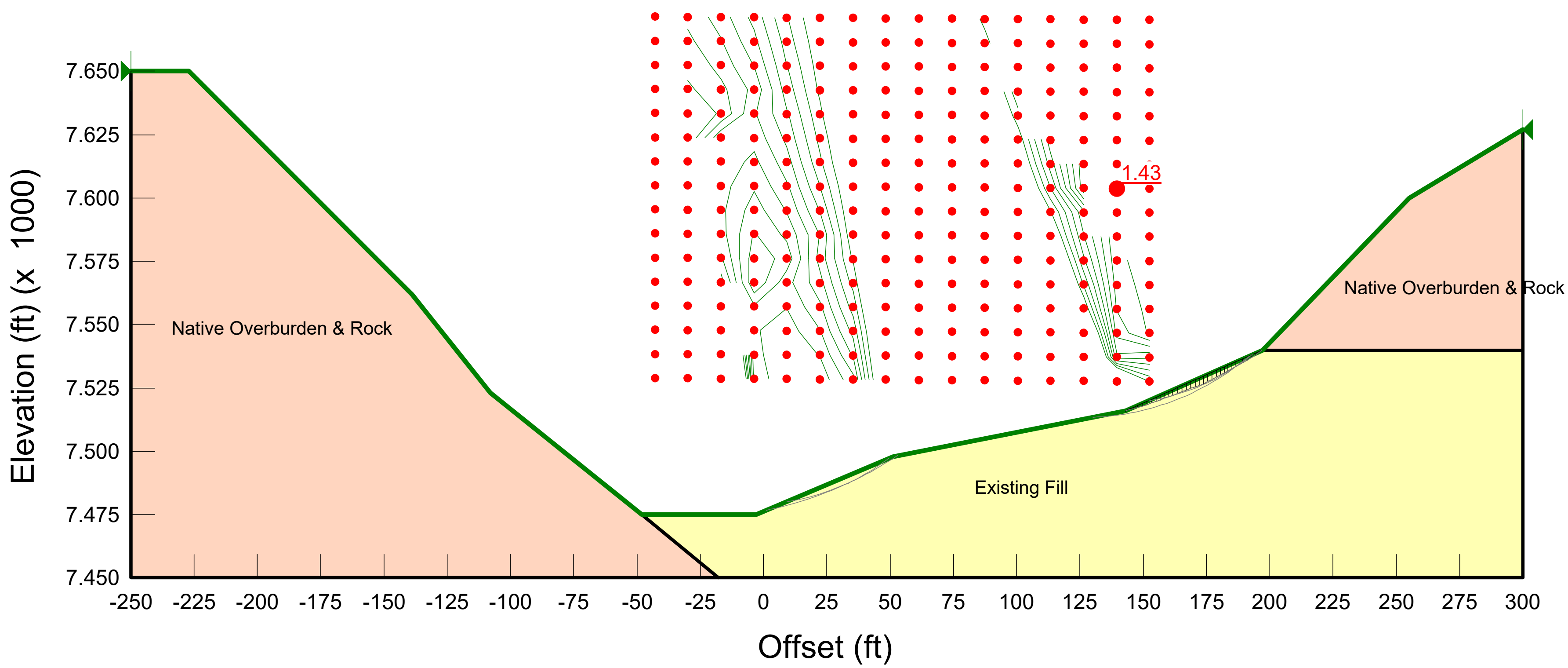
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 7+00 (Modified)
Seismic Analysis, k=0.05g

Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 32
Description: Proposed Fill Wt: 130 Cohesion: 0 Phi: 34
Description: Native Overburden & Rock Wt: 120 Cohesion: 5000 Phi: 0
Description: Coal Wt: 85 Cohesion: 500 Phi: 0



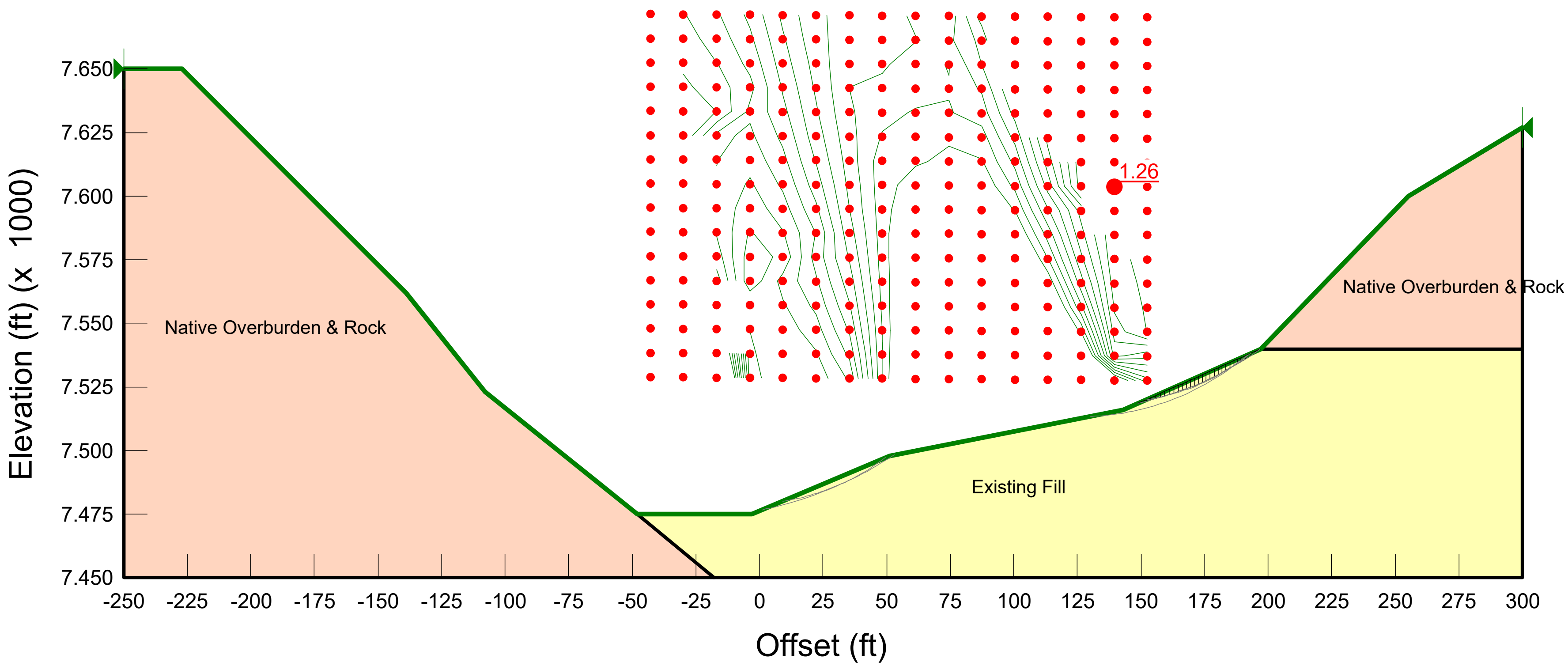
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 10+00
Static Conditions

Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 32
Description: Native Overburden & Rock Wt: 120 Cohesion: 5000 Phi: 0

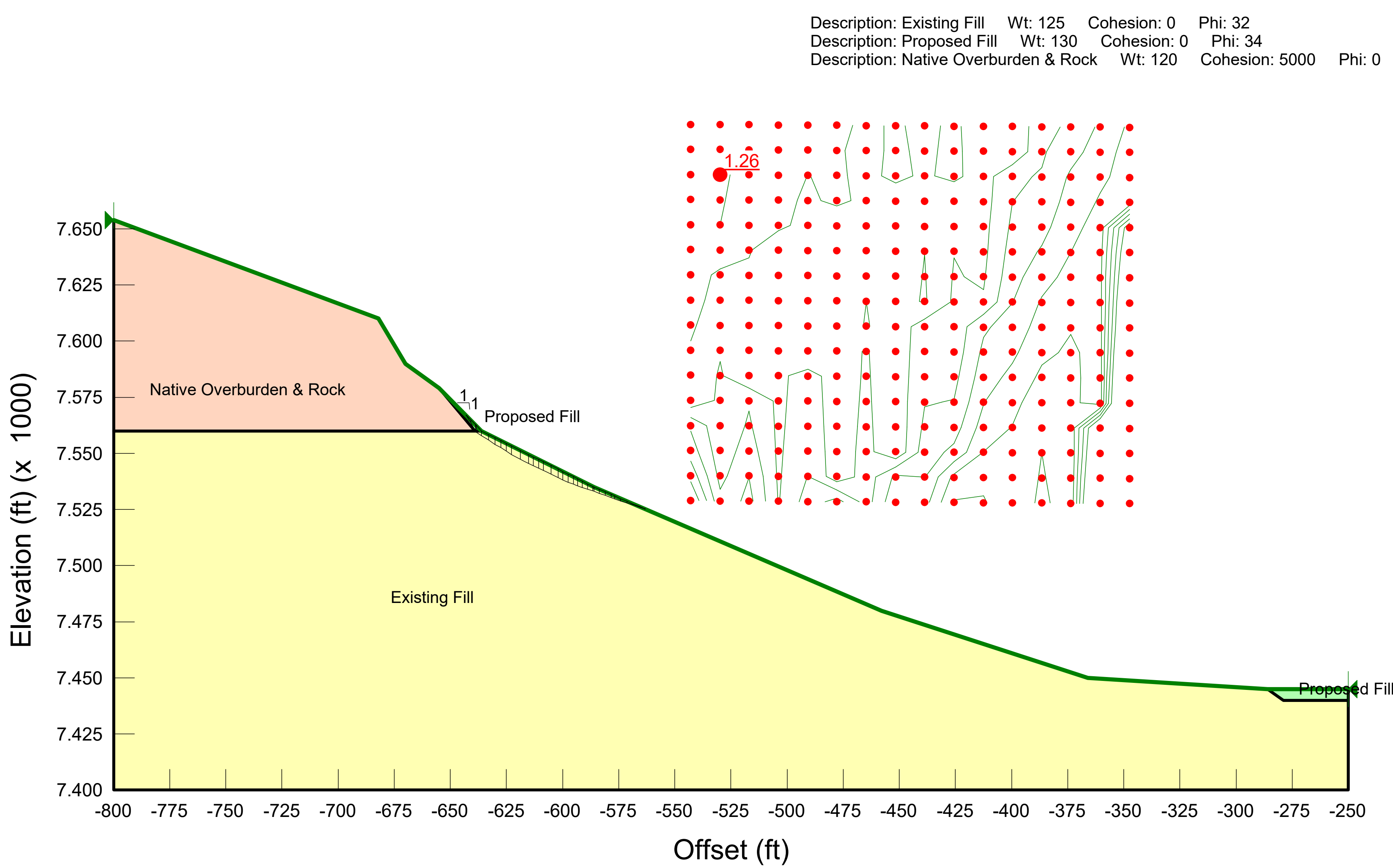


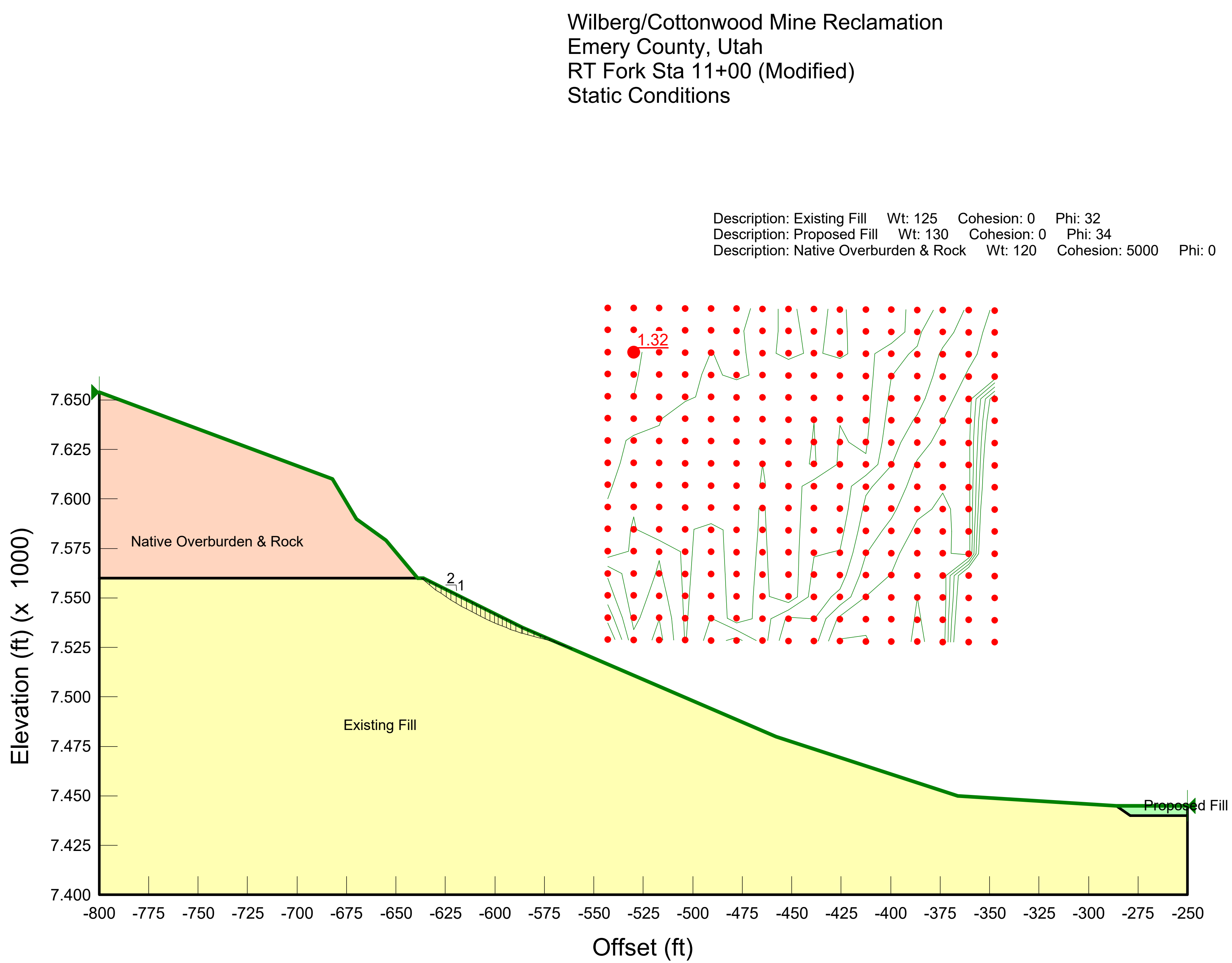
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
LT Fork Sta 10+00
Seismic Analysis, k=0.05g

Description: Existing Fill   Wt: 125   Cohesion: 0   Phi: 32
Description: Native Overburden & Rock   Wt: 120   Cohesion: 5000   Phi: 0



Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
RT Fork Sta 11+00
Static Conditions

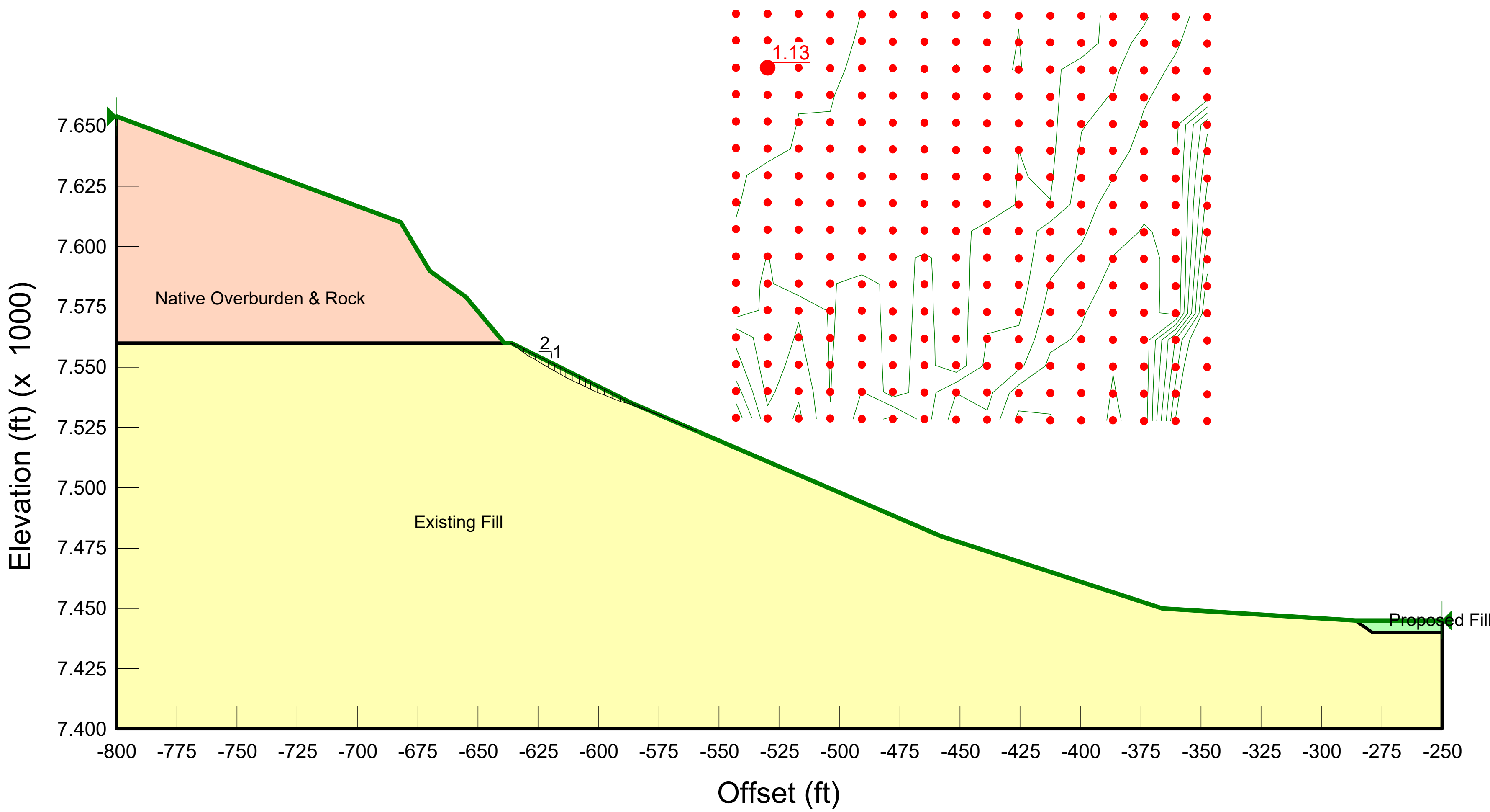




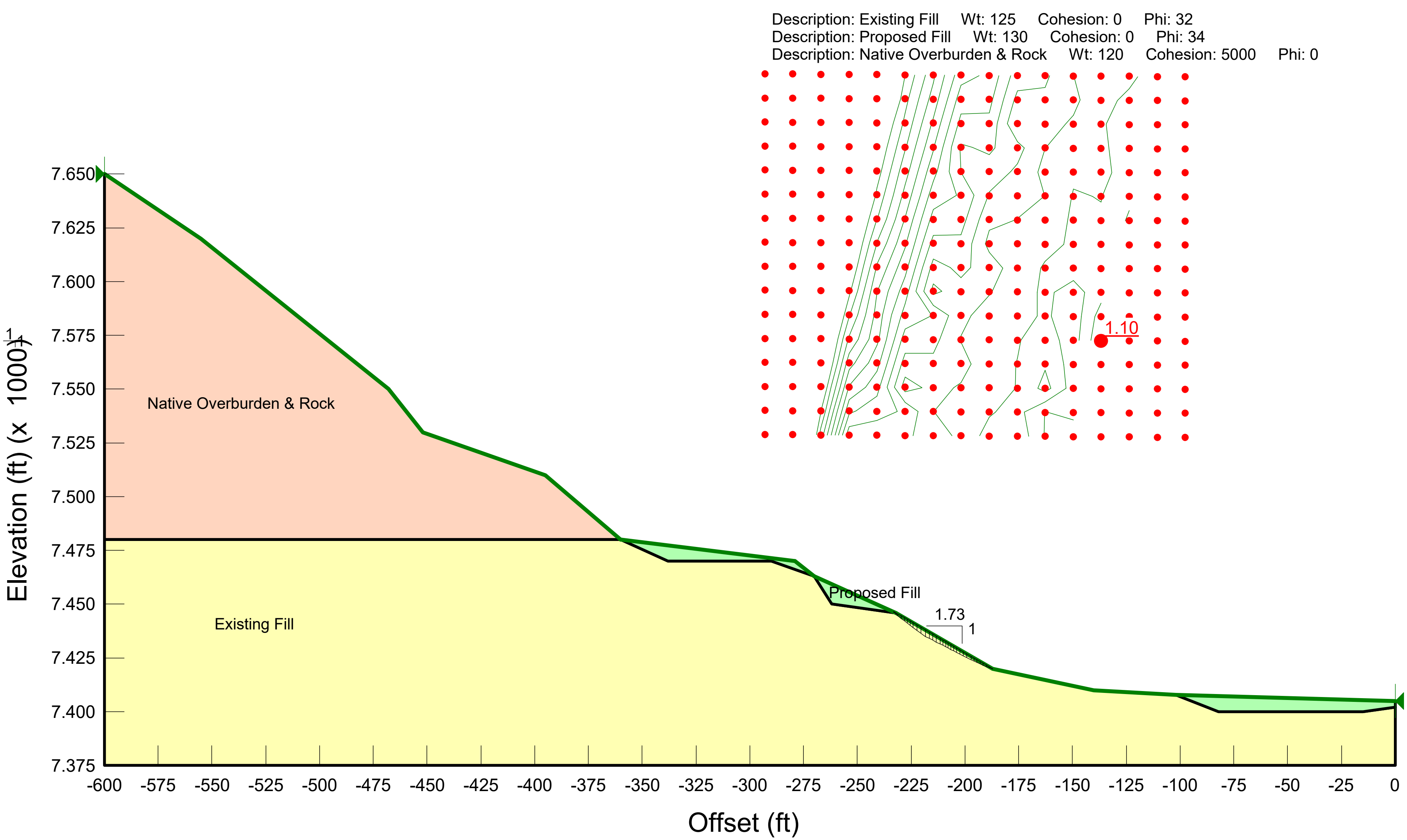
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
RT Fork Sta 11+00 (Modified)
Static Conditions
Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 32
Description: Proposed Fill Wt: 130 Cohesion: 0 Phi: 34
Description: Native Overburden & Rock Wt: 120 Cohesion: 5000 Phi: 0
1.32
Native Overburden & Rock
Existing Fill
Proposed Fill
2
1
Elevation (ft) (x 1000)
7.650
7.625
7.600
7.575
7.550
7.525
7.500
7.475
7.450
7.425
7.400
-800 -775 -750 -725 -700 -675 -650 -625 -600 -575 -550 -525 -500 -475 -450 -425 -400 -375 -350 -325 -300 -275 -250
Offset (ft)

Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
RT Fork Sta 11+00 (Modified)
Seismic Analysis, k=0.05g

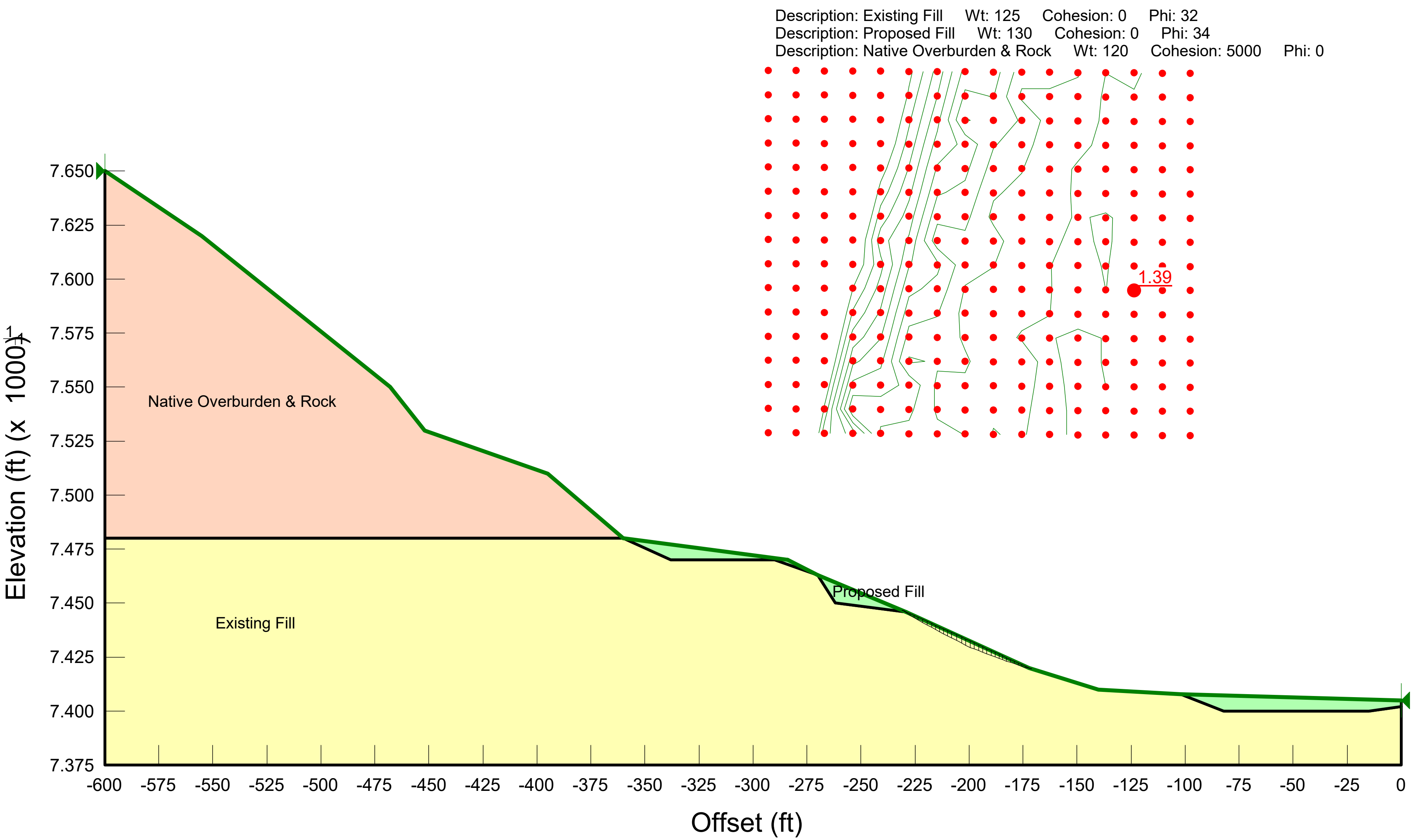
Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 32
Description: Proposed Fill Wt: 130 Cohesion: 0 Phi: 34
Description: Native Overburden & Rock Wt: 120 Cohesion: 5000 Phi: 0



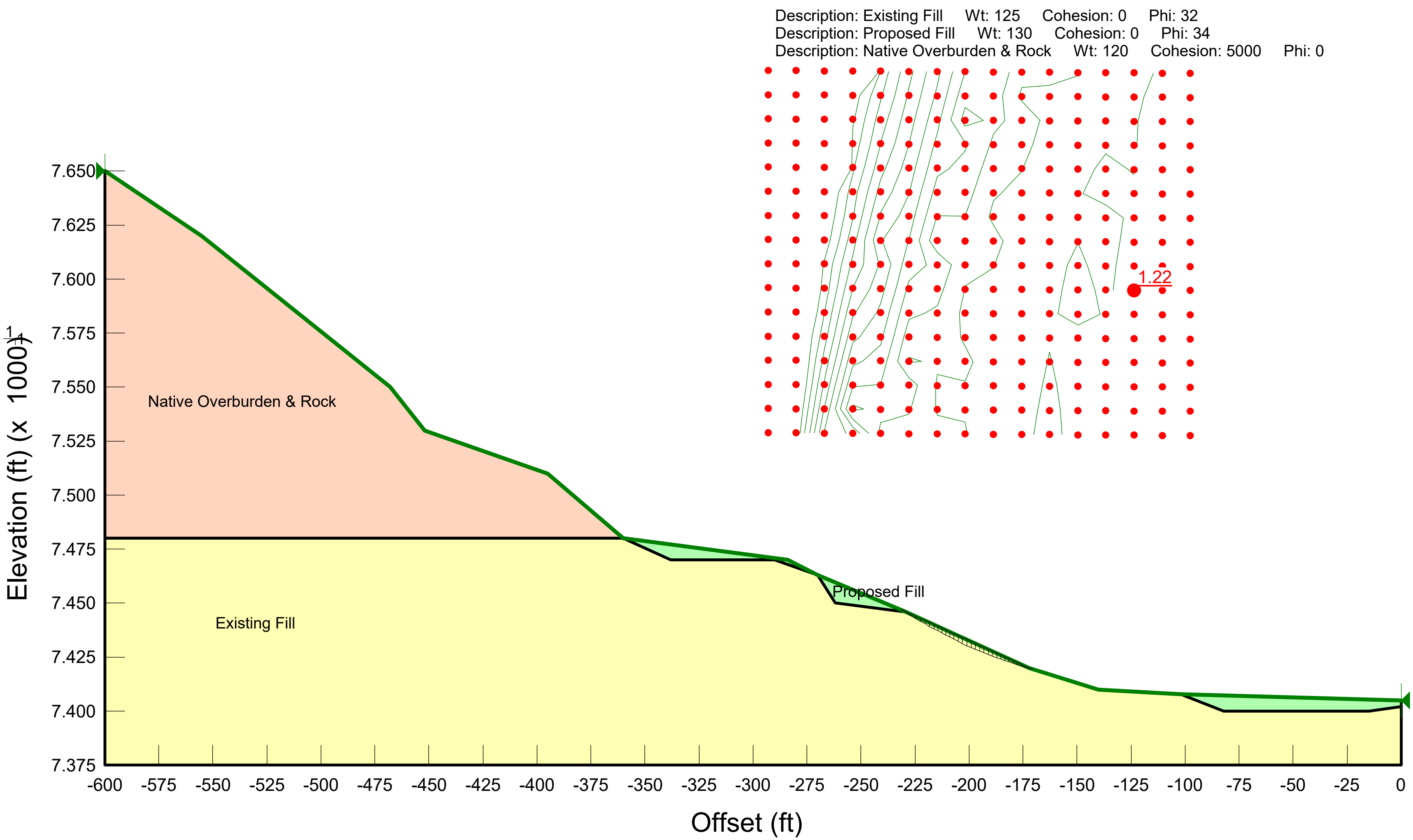
Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
RT Fork Sta 12+00
Static Conditions



Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
RT Fork Sta 12+00 (Modified)
Static Conditions



Wilberg/Cottonwood Mine Reclamation
Emery County, Utah
RT Fork Sta 12+00 (Modified)
Seismic Analysis, k=0.05g



PacifiCorp – Interwest Mining Company

Appendix C-2

RB&G Engineering – Slope Stability Analysis of the Des Bee Dove Mine, 2001

Cottonwood/Wilberg Mine Reclamation Plan

2016

RB&G ENGINEERING INC.
1435 WEST 820 NORTH
PROVO, UT 84601-1343
801 374-5771 Provo
801 521-5771 SLC

September 18, 2001

Dennis Oakley
Energy West
P.O. Box 310
Huntington, UT 84526

Dear Mr. Oakley:

In accordance with our proposal dated August 15, 2001, we have completed slope stability analyses for the proposed restoration work at the Des-Bee-Dove Mine in Emery County, Utah. The results of the analyses are discussed in the following sections of this report.

1. EXISTING SITE CONDITIONS

The existing topography, along with proposed reclamation topography, cross sections and profiles, are presented on Sheet 1. A visit was made to the site on June 28, 2001, and the panoramic photo presented in Figure 1 shows existing site conditions. It will be noted that near vertical cuts exist in the bedrock along Profiles B and C and Station 3+00. It appeared that several feet of granular fill from the cuts overlies the bedrock forming the level area at the toe of the cut, and that the fill extends down slope on the east side of the level area on a slope of about 1.1 horizontal to 1 vertical. Based upon visual observation, the fill consists of silty gravel with sand, cobble and boulder size rock.

2. SLOPE STABILITY ANALYSES

Analyses were performed for the cross sections at Profile B and Station 3+00 using assumed strength parameters for foundation fill, embankment fill, and rockfill. It was assumed that the foundation soils consist of loose to medium dense granular fill extending to a depth of at least 10 feet below the existing level surface. A friction angle of 32° with zero cohesion was conservatively assumed for this material. An enlargement of the existing cut slopes for the cross sections at Profile B and Station 3+00, shown on Sheet 1, are presented in Figures 2 and 3, along with the proposed reclaimed slope. Zero cohesion was assumed for the proposed embankment and rockfill, and the friction angle was varied to evaluate the required strength to achieve an acceptable factor of safety for the reclaimed slopes. The sensitivity of the factor of safety for the finished slope in relation to the strength of the earth fill and rockfill is shown in Figure 4. It will be noted from this figure that a friction angle of 34° for the embankment fill placed at a slope of 2H:1V and a friction angle greater than 45° for the rockfill placed at a slope of 1.25H:1V is required to achieve a factor of safety greater than 1.3. Presented in Figures 2 and 3 are the results of the analyses with strength parameters assumed to achieve a factor of safety greater than 1.3.

Figures 5 and 6 are the results of stability analyses showing the required strength parameters to achieve a factor of safety greater than 1.3, assuming a final reclaimed slope of 2H:1V. It will be noted that a friction angle of 34° with zero cohesion is required.

3. CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of the analyses outlined above, it is our opinion that the following conclusions and recommendations are applicable to the planned reclamation project:

- The fill which has been used to create the level pad and slope extending east of the level pad consists of silty gravel with sand, cobble and boulder size rock derived from the slope excavation.

- The existing fill material can be used for slope restoration. It is recommended that this material be processed by separating the minus 4" to 8" material from the oversize prior to placement.

- All minus 4" to 8" granular material should be placed in lifts not exceeding 1 foot in thickness. The fill should be compacted to an in-place unit weight equal to at least 90% of the maximum laboratory density as determined by ASTM D 1557-91. Granular fill meeting this compaction criteria should have a friction angle equal to or greater than 34°.

- All rockfill (+4" to 8") should be placed in lifts not exceeding 3 feet in thickness. This material should have a maximum size of 30 inches with less than 20% smaller than 1 inch. The rockfill should be track-walked using at least 4 passes of a D-9 or equivalent dozer. Rockfill meeting this criteria should have a friction angle equal to or greater than 45°.

- We recommend that earth fill slopes be equal to or greater than 2H:1V. Rockfill slopes can be constructed at 1.25H:1V.

- The stability analyses resulting in a factor of safety greater than 1.3 assume that no pore pressures will develop in the fill. It is recommended that rockfill or drain fill be placed beneath earth fill embankments.

It should be noted that the analyses and proposed finished slopes are based upon estimates of the shear strength parameters. These estimates are considered to be conservative for the silty gravel with sand and cobble, and the rockfill placed in accordance with recommendations outlined above. Since the estimates are based upon visual classification of surface materials, it is recommended that a geotechnical engineer observe the fill during construction, and that compaction testing be performed under the direction of a geotechnical engineer.

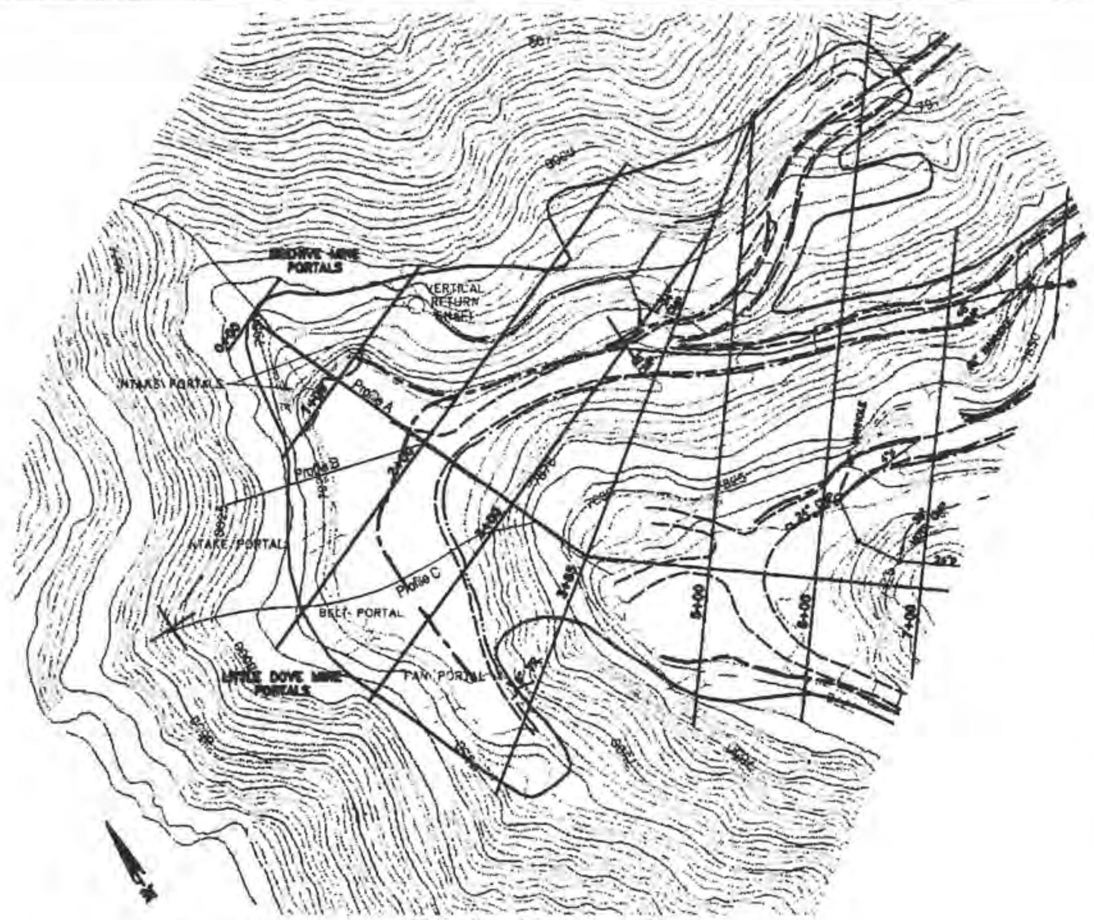
We appreciate the opportunity of performing these analyses for you. If there are any questions regarding the information contained herein, or if we can be of further assistance, please call.

Sincerely,

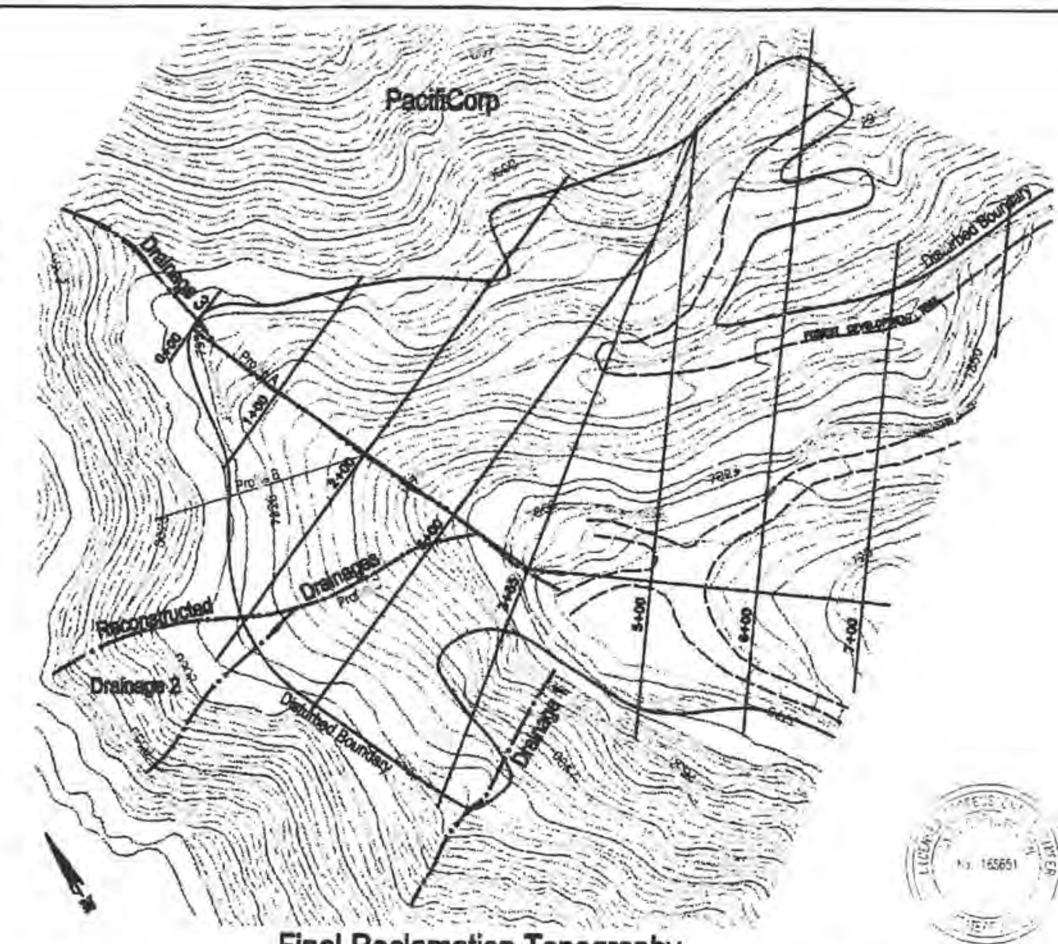
RB&G ENGINEERING, INC.

REGISTERED PROFESSIONAL ENGINEER NO.162291 BRADFORD E. PRICE 9/18/01 STATE OF UTAH

Bradford E. Price, P.E.
bep/jag



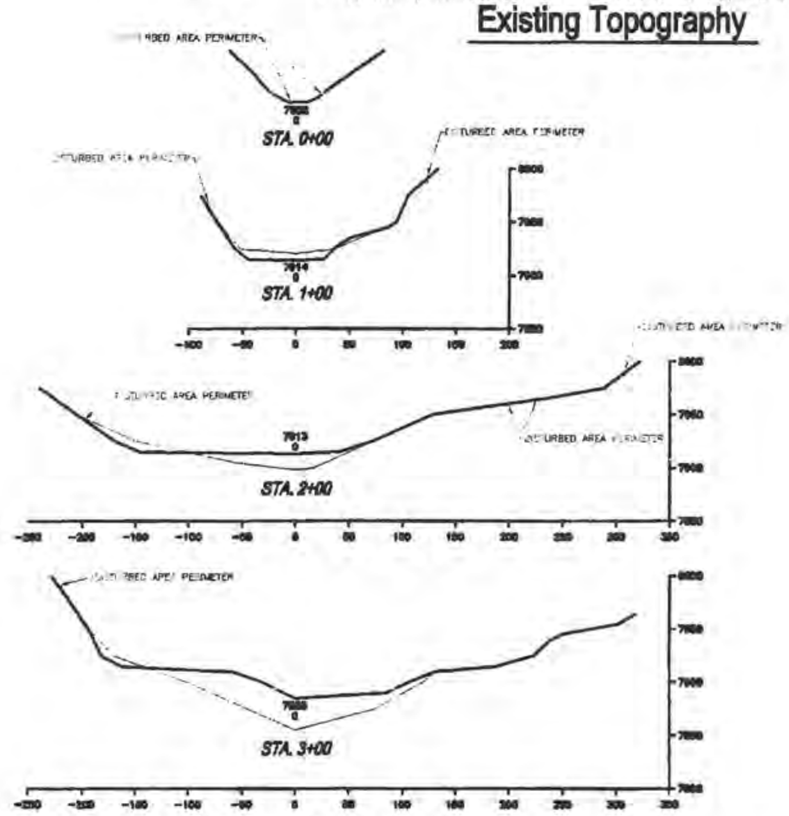
Existing Topography



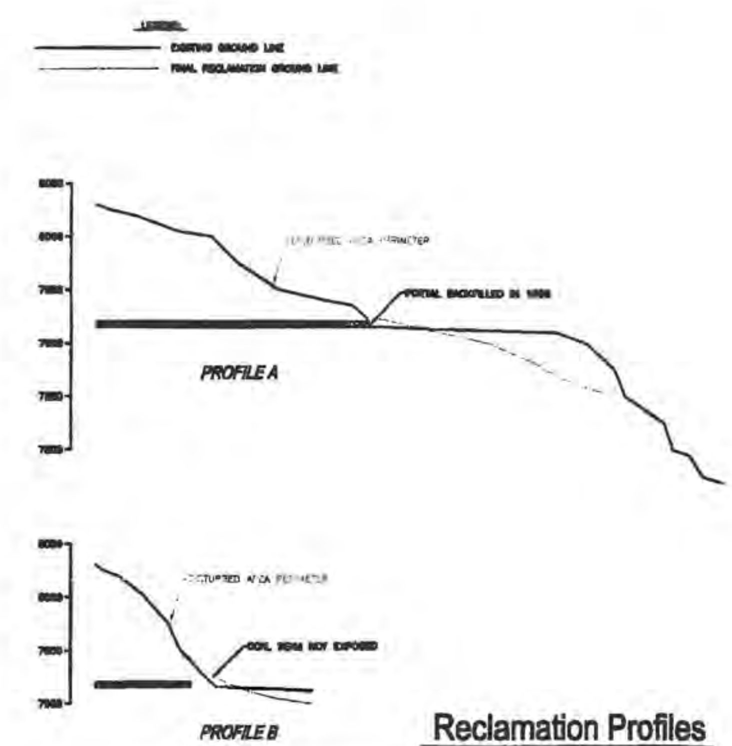
Final Reclamation Topography

I, JOHN CHRISTENSEN BEING A REGISTERED PROFESSIONAL ENGINEER IN THE STATE OF UTAH, DO HEREBY CERTIFY THAT THE INFORMATION CONTAINED ON THIS DRAWING IS TRUE AND ACCURATE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

JOHN CHRISTENSEN NO. 165651 DATE



Reclamation Cross Sections



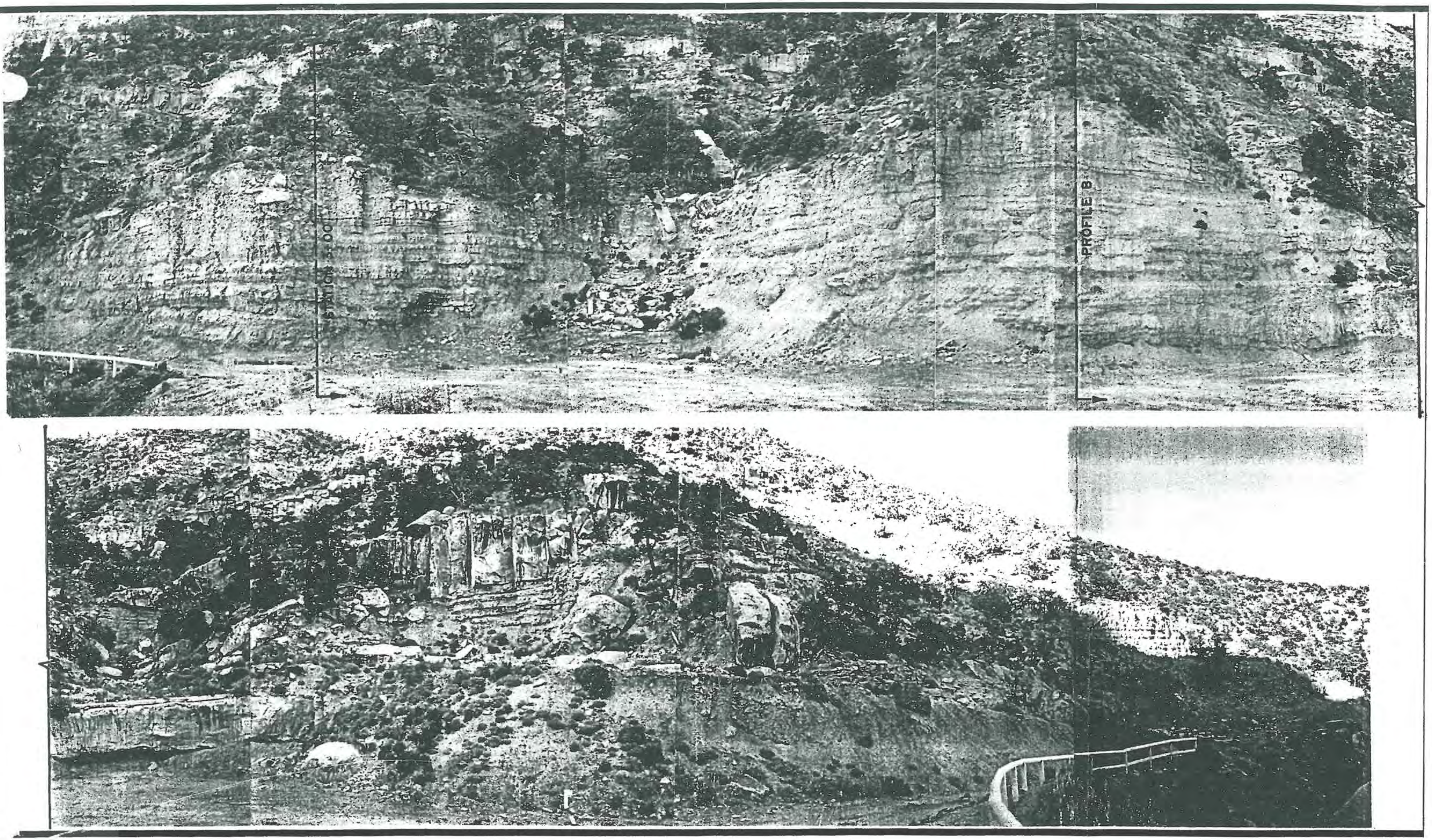
Reclamation Profiles

CAD FILE NAME/DISK#:

ENERGY WEST
MINING COMPANY
HUNTINGTON, UTAH 84528

DES–BEE–DOVE MINES
PHASE I RECLAMATION
PLAN VIEW & CROSS SECTIONS

DRAWN BY: K. LARSEN	CS1817C
SCALE: 1" =100'	DRAWING #:
DATE: MARCH 16, 2001	SHEET 1 OF 1 — REV. ___



RB&G ENGINEERING INC.
Provo, Utah

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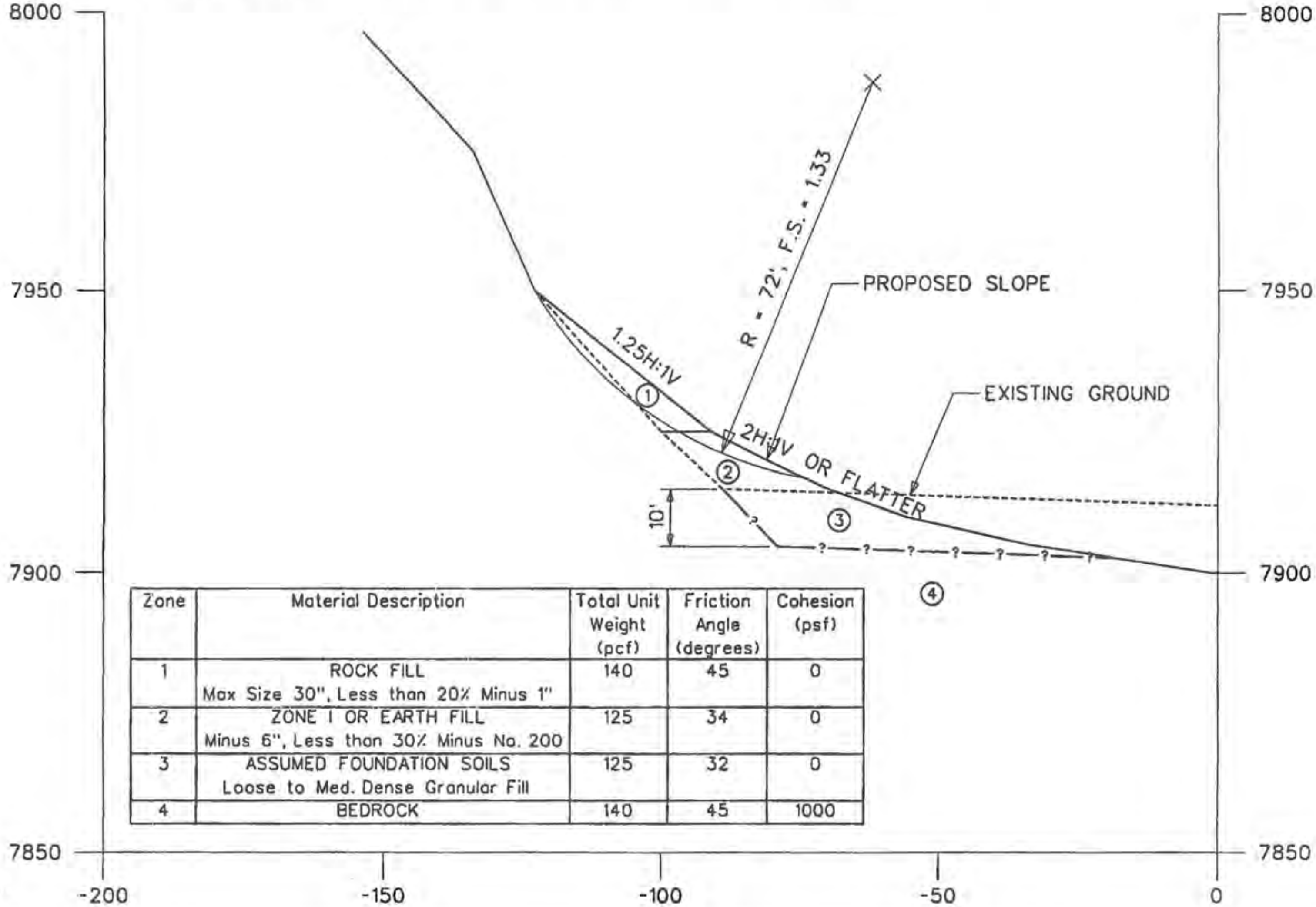
DES-BEE-DOVE MINE
Emery County, Utah

Figure 1

Existing Site Conditions

GENERAL NOTES:

1. ALL ROCKFILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 3 FEET IN THICKNESS.
2. ALL EARTH FILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 1 FOOT IN THICKNESS AND COMPACTED TO 90% OF THE MAXIMUM LABORATORY DENSITY AS DETERMINED BY ASTM-1557.



Zone	Material Description	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
1	ROCK FILL Max Size 30", Less than 20% Minus 1"	140	45	0
2	ZONE I OR EARTH FILL Minus 6", Less than 30% Minus No. 200	125	34	0
3	ASSUMED FOUNDATION SOILS Loose to Med. Dense Granular Fill	125	32	0
4	BEDROCK	140	45	1000

SCALE: 1" = 30'

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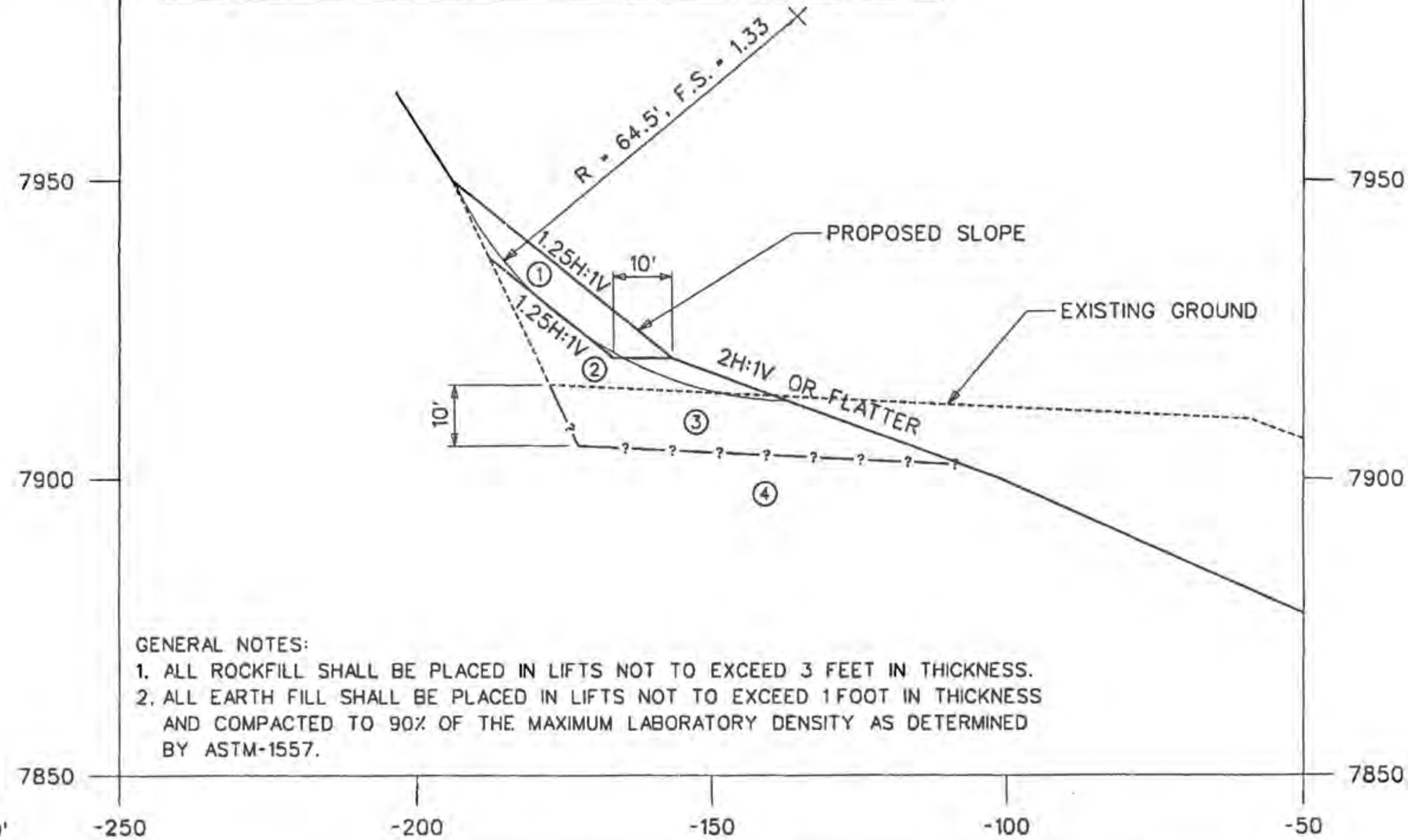
Provo, Utah

Figure 2 **SLOPE STABILITY ANALYSIS - PROFILE B OPTION 1**

Des-Bee-Dove Mine
Emery County, Utah

Zone	Material Description	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
1	ROCK FILL Max Size 30", Less than 20% Minus 1"	140	44	0
2	ZONE I OR EARTH FILL Minus 6", Less than 30% Minus No. 200	125	34	0
3	ASSUMED FOUNDATION SOILS Loose to Med. Dense Granular Fill	125	32	0
4	BEDROCK	140	45	1000



GENERAL NOTES:

1. ALL ROCKFILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 3 FEET IN THICKNESS.
2. ALL EARTH FILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 1 FOOT IN THICKNESS AND COMPACTED TO 90% OF THE MAXIMUM LABORATORY DENSITY AS DETERMINED BY ASTM-1557.

SCALE: 1" = 30'

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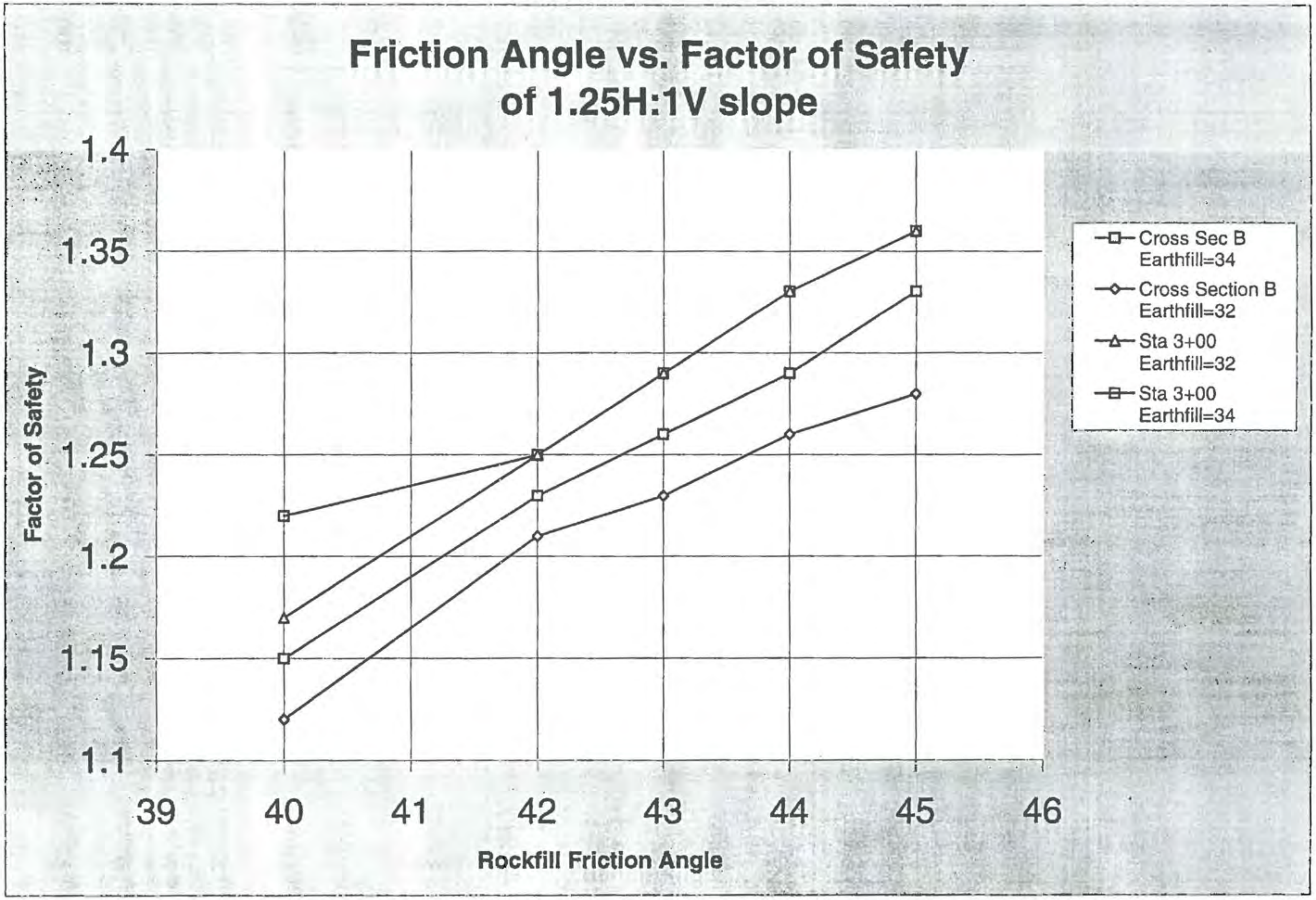
Provo, Utah

Figure 3 **SLOPE STABILITY ANALYSIS - STA. 3+00**

Des-Bee-Dove Mine
Emery County, Utah

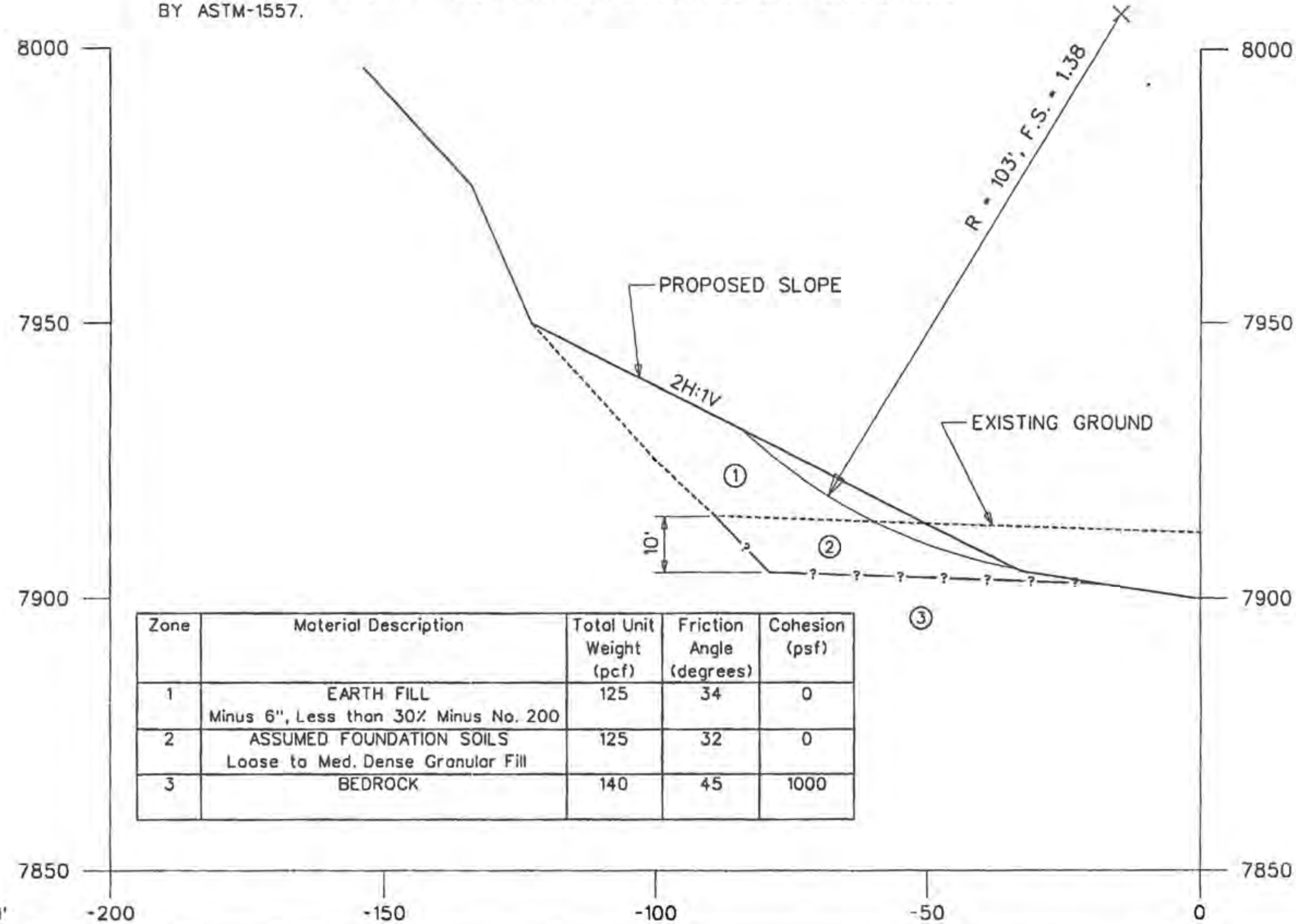


Friction Angle vs. Factor of Safety
of 1.25H:1V slope
Factor of Safety
1.4
1.35
1.3
1.25
1.2
1.15
1.1
39
40
41
42
43
44
45
46
Rockfill Friction Angle
Cross Sec B Earthfill=34
Cross Section B Earthfill=32
Sta 3+00 Earthfill=32
Sta 3+00 Earthfill=34

FIGURE 4

GENERAL NOTES:

1. ALL ROCKFILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 3 FEET IN THICKNESS.
2. ALL EARTH FILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 1 FOOT IN THICKNESS AND COMPACTED TO 90% OF THE MAXIMUM LABORATORY DENSITY AS DETERMINED BY ASTM-1557.



Zone	Material Description	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
1	EARTH FILL Minus 6", Less than 30% Minus No. 200	125	34	0
2	ASSUMED FOUNDATION SOILS Loose to Med. Dense Granular Fill	125	32	0
3	BEDROCK	140	45	1000

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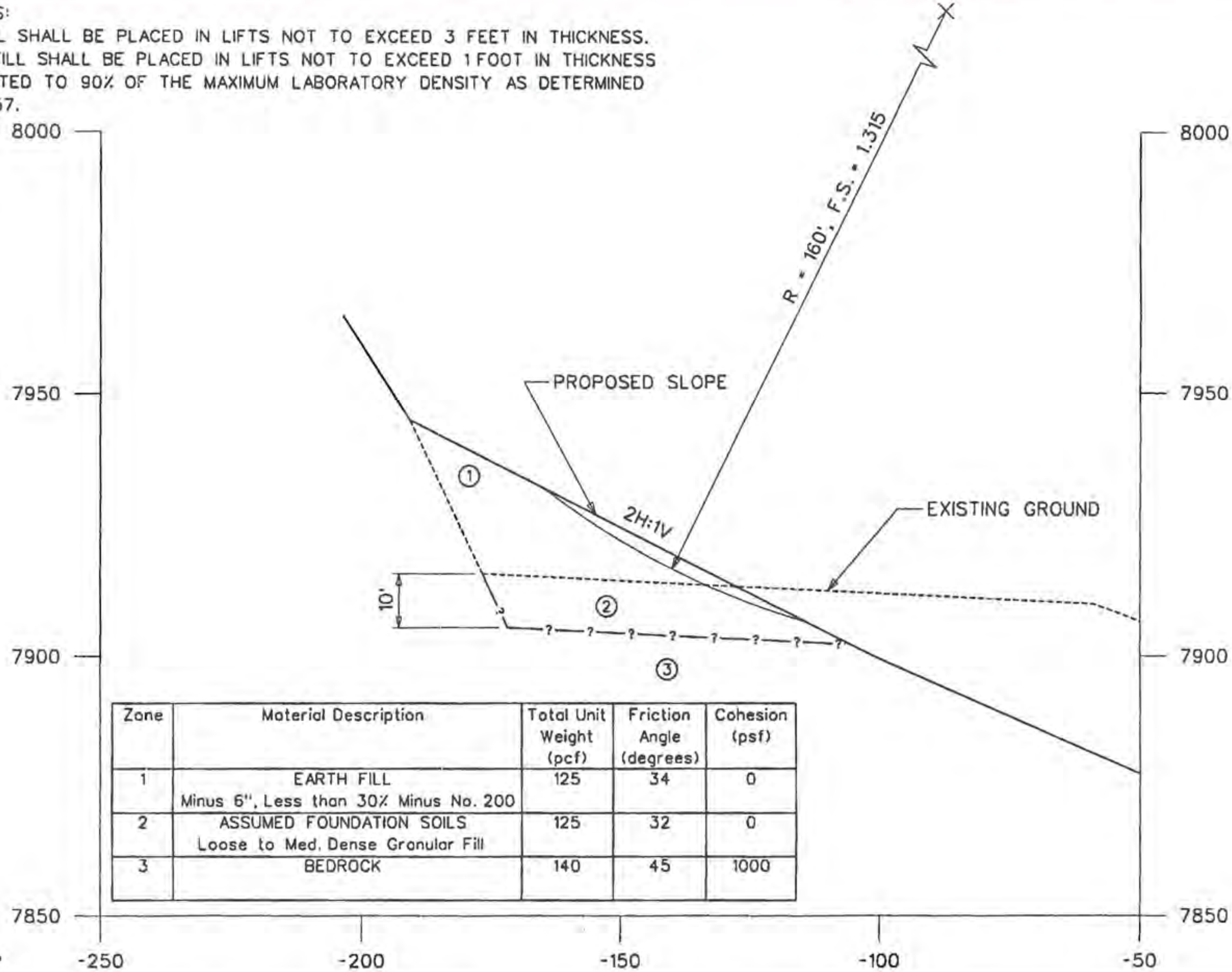
Provo, Utah

Figure 5 **SLOPE STABILITY ANALYSIS - PROFILE B**

Des-Bee-Dove Mine
Emery County, Utah

GENERAL NOTES:

1. ALL ROCKFILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 3 FEET IN THICKNESS.
2. ALL EARTH FILL SHALL BE PLACED IN LIFTS NOT TO EXCEED 1 FOOT IN THICKNESS AND COMPACTED TO 90% OF THE MAXIMUM LABORATORY DENSITY AS DETERMINED BY ASTM-1557.



Zone	Material Description	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
1	EARTH FILL Minus 6", Less than 30% Minus No. 200	125	34	0
2	ASSUMED FOUNDATION SOILS Loose to Med. Dense Granular Fill	125	32	0
3	BEDROCK	140	45	1000

SCALE: 1" = 30'

RB&G ENGINEERING INC.
Provo, Utah

Figure 6 **SLOPE STABILITY ANALYSIS - STA. 3+00**

Des-Bee-Dove Mine
Emery County, Utah

PacifiCorp – Interwest Mining Company

Appendix D

Precipitation Data and Other Calculations

- **D-1: NOAA Atlas 14 Point Precipitation Frequency Estimates**
- **D-2: Deep Gouge Geometry**
- **D-3: Runoff from Undisturbed to Disturbed**
- **D-4: Adequacy of Reclamation Gouges at the Cottonwood/Wilberg Mine for Intercepting Runoff and Sediment for Adjacent Undisturbed Areas**

Cottonwood/Wilberg Mine Reclamation Plan

2016

PacifiCorp – Interwest Mining Company

Appendix D-1

NOAA Atlas 14 Point Precipitation Frequency Estimates

Cottonwood/Wilberg Mine Reclamation Plan

2016

NOAA Atlas 14, Volume 1, Version 5
Location name: Huntington, Utah, USA*
Latitude: 39.3247°, Longitude: -111.1283°
Elevation: 8419.37 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.139 (0.121-0.163)	0.178 (0.156-0.211)	0.246 (0.212-0.287)	0.303 (0.259-0.356)	0.391 (0.326-0.461)	0.468 (0.383-0.554)	0.558 (0.447-0.663)	0.661 (0.514-0.792)	0.826 (0.613-1.01)	0.976 (0.698-1.22)
10-min	0.211 (0.184-0.248)	0.271 (0.237-0.321)	0.374 (0.322-0.438)	0.461 (0.394-0.542)	0.595 (0.497-0.701)	0.713 (0.583-0.843)	0.849 (0.680-1.01)	1.01 (0.783-1.21)	1.26 (0.933-1.54)	1.49 (1.06-1.85)
15-min	0.262 (0.228-0.308)	0.337 (0.294-0.397)	0.463 (0.400-0.543)	0.571 (0.488-0.672)	0.738 (0.616-0.869)	0.884 (0.723-1.04)	1.05 (0.843-1.25)	1.25 (0.971-1.50)	1.56 (1.16-1.91)	1.84 (1.32-2.29)
30-min	0.352 (0.307-0.415)	0.454 (0.396-0.535)	0.624 (0.538-0.731)	0.769 (0.658-0.905)	0.994 (0.830-1.17)	1.19 (0.973-1.41)	1.42 (1.14-1.69)	1.68 (1.31-2.01)	2.10 (1.56-2.56)	2.48 (1.77-3.09)
60-min	0.436 (0.380-0.513)	0.561 (0.490-0.662)	0.773 (0.666-0.904)	0.952 (0.814-1.12)	1.23 (1.03-1.45)	1.47 (1.21-1.74)	1.75 (1.41-2.08)	2.08 (1.62-2.49)	2.60 (1.93-3.17)	3.07 (2.19-3.82)
2-hr	0.531 (0.465-0.614)	0.671 (0.588-0.778)	0.893 (0.779-1.03)	1.09 (0.944-1.26)	1.40 (1.19-1.63)	1.68 (1.39-1.96)	2.00 (1.62-2.35)	2.37 (1.86-2.81)	2.95 (2.22-3.58)	3.49 (2.53-4.31)
3-hr	0.599 (0.533-0.685)	0.753 (0.668-0.864)	0.969 (0.859-1.11)	1.17 (1.02-1.34)	1.47 (1.27-1.69)	1.73 (1.47-2.00)	2.05 (1.70-2.39)	2.42 (1.97-2.85)	3.01 (2.36-3.62)	3.56 (2.69-4.35)
6-hr	0.787 (0.708-0.884)	0.978 (0.883-1.10)	1.21 (1.09-1.36)	1.41 (1.26-1.59)	1.70 (1.50-1.91)	1.95 (1.70-2.21)	2.25 (1.93-2.57)	2.59 (2.19-2.99)	3.19 (2.62-3.75)	3.73 (3.00-4.46)
12-hr	0.995 (0.904-1.10)	1.23 (1.12-1.36)	1.50 (1.36-1.67)	1.73 (1.56-1.93)	2.05 (1.82-2.29)	2.30 (2.03-2.58)	2.57 (2.24-2.90)	2.90 (2.50-3.30)	3.49 (2.96-4.03)	4.05 (3.38-4.74)
24-hr	1.17 (1.05-1.30)	1.45 (1.31-1.61)	1.79 (1.61-1.99)	2.06 (1.85-2.29)	2.42 (2.17-2.70)	2.70 (2.40-3.02)	3.00 (2.64-3.35)	3.29 (2.88-3.69)	3.69 (3.16-4.17)	4.09 (3.40-4.78)
2-day	1.39 (1.26-1.54)	1.73 (1.57-1.92)	2.13 (1.93-2.37)	2.47 (2.22-2.74)	2.93 (2.62-3.24)	3.29 (2.92-3.65)	3.67 (3.23-4.09)	4.05 (3.53-4.55)	4.59 (3.93-5.19)	5.01 (4.24-5.71)
3-day	1.55 (1.41-1.73)	1.94 (1.75-2.16)	2.40 (2.17-2.68)	2.78 (2.50-3.10)	3.31 (2.95-3.69)	3.73 (3.29-4.16)	4.16 (3.65-4.65)	4.61 (3.99-5.18)	5.22 (4.45-5.92)	5.71 (4.80-6.52)
4-day	1.72 (1.56-1.93)	2.15 (1.94-2.41)	2.67 (2.41-2.99)	3.10 (2.78-3.47)	3.69 (3.29-4.13)	4.16 (3.67-4.66)	4.65 (4.07-5.21)	5.16 (4.46-5.81)	5.86 (4.98-6.64)	6.41 (5.37-7.32)
7-day	2.10 (1.89-2.35)	2.63 (2.37-2.95)	3.29 (2.95-3.68)	3.83 (3.42-4.28)	4.56 (4.04-5.11)	5.15 (4.53-5.79)	5.77 (5.03-6.51)	6.41 (5.52-7.27)	7.29 (6.18-8.34)	8.00 (6.68-9.23)
10-day	2.43 (2.19-2.71)	3.04 (2.75-3.39)	3.79 (3.41-4.22)	4.39 (3.94-4.90)	5.21 (4.64-5.82)	5.85 (5.17-6.55)	6.52 (5.71-7.32)	7.19 (6.24-8.11)	8.12 (6.93-9.23)	8.85 (7.46-10.2)
20-day	3.32 (2.99-3.69)	4.17 (3.76-4.64)	5.22 (4.69-5.81)	6.05 (5.42-6.74)	7.17 (6.38-7.99)	8.05 (7.09-8.98)	8.94 (7.82-10.0)	9.86 (8.53-11.1)	11.1 (9.47-12.6)	12.1 (10.2-13.8)
30-day	4.07 (3.67-4.52)	5.10 (4.61-5.66)	6.34 (5.70-7.03)	7.30 (6.55-8.10)	8.59 (7.65-9.54)	9.57 (8.48-10.6)	10.6 (9.30-11.8)	11.6 (10.1-13.0)	12.9 (11.1-14.6)	14.0 (11.9-15.9)
45-day	5.05 (4.58-5.60)	6.33 (5.75-7.02)	7.86 (7.10-8.72)	9.06 (8.15-10.1)	10.7 (9.52-11.9)	11.9 (10.6-13.3)	13.2 (11.6-14.7)	14.5 (12.6-16.3)	16.3 (14.0-18.4)	17.7 (15.0-20.2)
60-day	6.03 (5.45-6.68)	7.59 (6.86-8.40)	9.44 (8.50-10.4)	10.9 (9.75-12.0)	12.7 (11.4-14.1)	14.2 (12.6-15.8)	15.6 (13.7-17.5)	17.1 (14.9-19.2)	19.1 (16.4-21.6)	20.6 (17.5-23.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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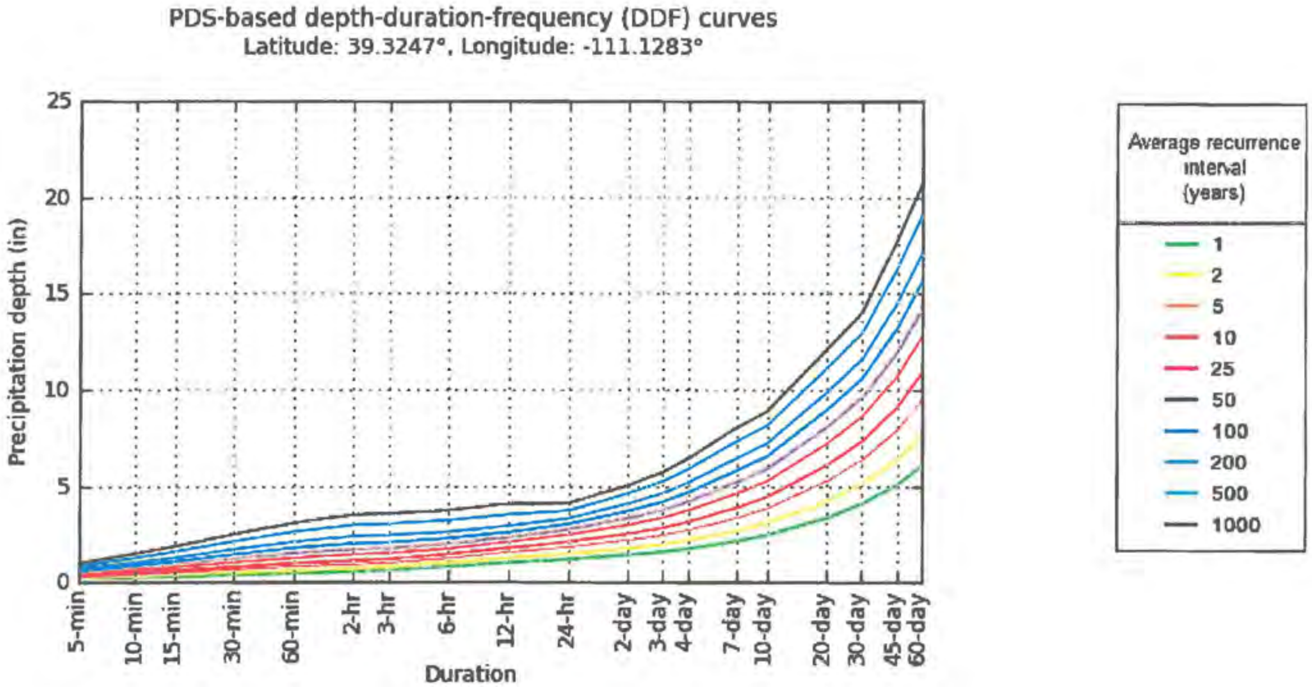
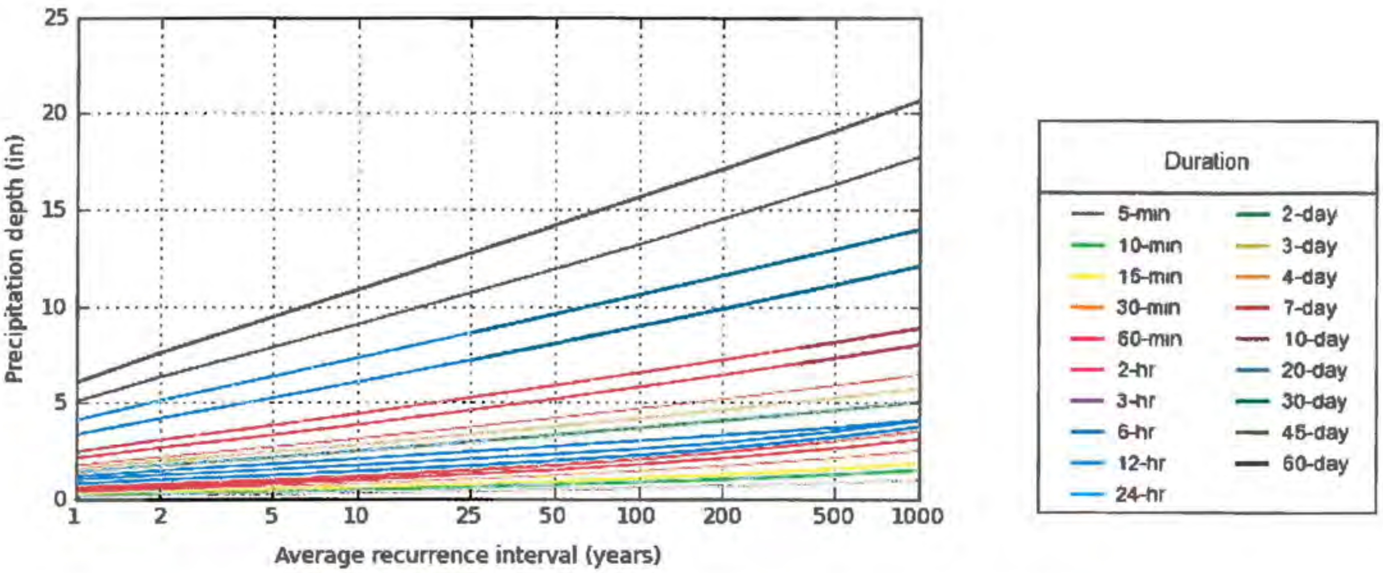
PF graphical





NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Thu Dec 8 16:13:17 2016

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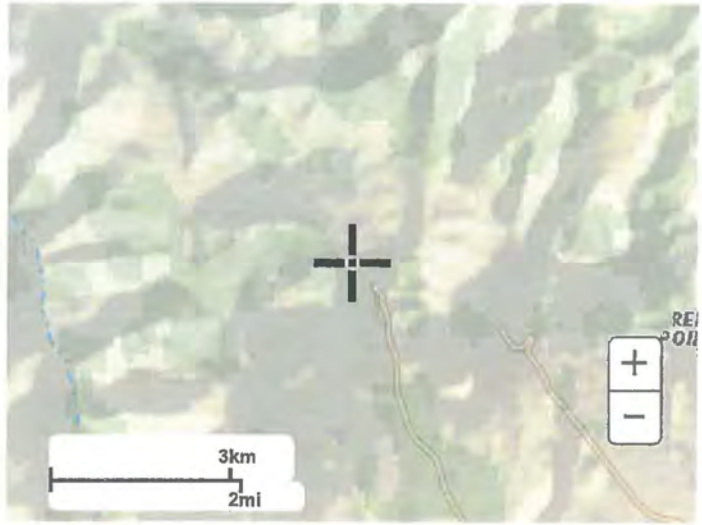
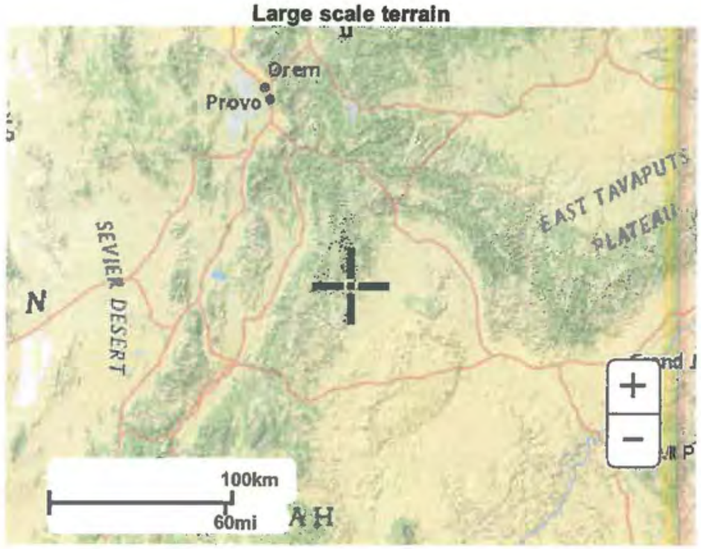
Maps & aerials

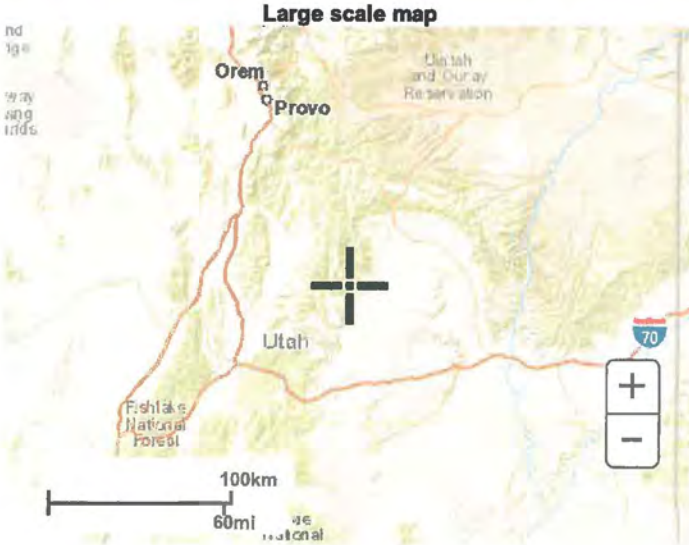
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

PacifiCorp – Interwest Mining Company

Appendix D-2

Deep Gouge Geometry

Cottonwood/Wilberg Mine Reclamation Plan

2016

Geometry of a Large and Small Pock

Based on the shape of an inverted, square truncated pyramid:

Volume: $$V = \frac{(a^2 + ab + b^2)h}{3}$$ where a = surface side length
b = base side length
h = depth

Pock Size	a (ft)	b (ft)	h (ft)	Volume (ft^3)
Large	6	3	3	63.0
Small	3	1.5	1.5	7.9

Depth of water in pock from direct precipitation during 100-yr, 6-hr event:

100-yr, 6-hr storm event = 2.25 in 0.1875 ft
(From National Weather Service Hydrometeorological Design Studies Center web site)

Pock Size	Top Width (ft)	Precipitation		% of Pock Volume	Iterative Calc of Precip Depth in Pock		
		Depth (ft)	Vol. (ft^3)		Depth (ft)	Width (ft)	Vol. (ft^3)
Large	6	0.19	6.75	10.7	0.615	3.615	6.747
Small	3	0.19	1.69	21.4	0.537	2.037	1.692

Check of Precipitation Volume Calcs

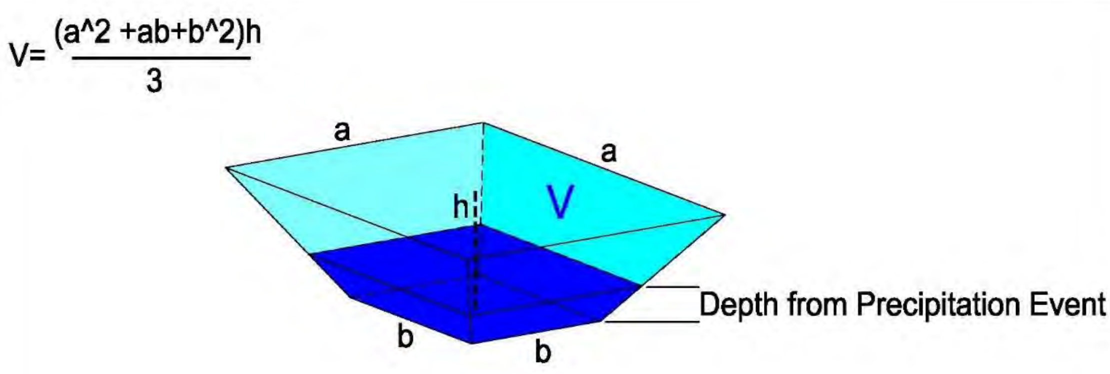

Figure 7-4: Modeling a pock using a truncated pyramid figure.

PacifiCorp – Interwest Mining Company

Appendix D-3

Runoff from Undisturbed to Disturbed

Cottonwood/Wilberg Mine Reclamation Plan

2016

Runoff from Undisturbed Area above Disturbed

	P (in)			Q (in)		Q (ft)	
	100 yr	10 yr		100 yr	10 yr	100 yr	10 yr
24 hr	3.00	2.06	S=3.89"	0.81	0.32	0.07	0.03
12 hr	2.57	1.73	CN=72*	0.57	0.19	0.05	0.02
6 hr	2.25	1.41		0.40	0.09	0.03	0.01

$$Q = \frac{(P - 0.2S)^2}{P + .8S}$$

Area of runoff plot = 2.7 acres=117612 sf
(refer to Plate 4E)

Volume of runoff (cf)

	100 yr	10 yr
24 hr	7917.3	3114.5
12 hr	5539.2	1834.5
6 hr	3960.6	865.7

Number of large pocks=	77	
Capacity of Pock =	63	cf
Capacity Total of Pocks=	**4851**	**cf**

These calculations show that the large pocks constructed along the disturbed/undisturbed interface are capable of controlling the runoff from the above undisturbed area.

Number of small pocks =	142	
Capacity of pock =	7.9	cf
Total runoff volume from plot =	1121.8	cf

Above calculations show that using only small pocks along the disturbed/undisturbed interface will not adequately control the runoff from the above undisturbed areas. Thus, large pocks will be constructed at this interface. It should be noted that field observatons of pocked, reclaimed areas using smaller pock have not shown any failures due to overfilling of the pocks by runoff at the disturbed/undisturbed interf

*Mt. Nebo Scientific, Reference Area Survey 2012, 53% Ground Cover Denisty
and TR-55 (1986) Table for determining runoff curve numbers for arid and semiarid rangelands.

PacifiCorp – Interwest Mining Company

Appendix D-4

Adequacy of Reclamation Gouges at the Cottonwood/Wilberg Mine for Intercepting Runoff and Sediment for Adjacent Undisturbed Areas

Cottonwood/Wilberg Mine Reclamation Plan

2016

ADEQUACY OF RECLAMATION GOUGES AT THE COTTONWOOD/WILBERG MINE FOR INTERCEPTING RUNOFF AND SEDIMENT FROM ADJACENT UNDISTURBED AREAS

Interwest Mining Company is responsible for reclaiming surface disturbance associated with the Cottonwood/Wilberg Mine complex in Emery County, Utah. To minimize the potential for erosion of the site during and following reclamation, Interwest has proposed to reclaim the site through the use of deep gouging. This method has been successfully applied at several mine sites in Utah during the past 20 years and was a major reason why the U.S. Office of Surface Mining Reclamation and Enforcement ("OSM") awarded Castle Gate Mining Company with the 2003 Excellence in Surface Coal Mining and Reclamation National Award.

As noted in "The Practical Guide to Reclamation in Utah" prepared by the Utah Division of Oil, Gas and Mining ("DOGM"),[1] "the process [of gouging] is repeated in a random and overlapping pattern, making it impossible for water to flow down slope." The gouges retain all precipitation, thereby precluding runoff and the generation of down-slope sediment. Gouging and the associated mulching and seeding also create a microenvironment that encourages rapid germination of seeds, thereby greatly enhancing revegetation success.

A prior document[2] evaluated the efficacy of deep gouging as a reclamation technique, including the potential volume of precipitation and sediment that might be captured by individual gouges within the slope and the appropriateness of the Revised Universal Soil Loss Equation ("RUSLE") as a predictor of sediment yields in reclaimed areas. The purpose of this current document is to present the results an evaluation of the ability of deep gouging to capture and retain runoff and sediment generated from undisturbed areas upslope from reclaimed areas at the Cottonwood/Wilberg Mine complex.

The design standard for deep gouging is generally as stated in DOGM's reclamation guide.[1] The gouges are constructed using a trackhoe to excavate multiple shallow pits into a regraded, topsoiled, and mulched slope. Soil from each excavated pit is placed around the rim of the pit. Field experience has indicated that individual pits have approximate surface diameters of 3 to 6 feet and approximate depths of 1.5 to 3 feet. Gouges are constructed in a random pattern with no downslope flow path remaining between gouges.

Potential Runoff Volumes

Figure 1 shows the boundaries of watersheds smaller than 1 square mile that drain toward the proposed reclaimed area. Runoff from these watersheds (labeled RWS-1 through RWS-6) will be controlled through the construction of open channels to convey flow to the larger reclamation channels at the site. The design of these reclamation tributary channels was provided previously. This figure also

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[1] Wright, M.A. and S. White (eds.). n.d. The Practical Guide to Reclamation in Utah. Utah Division of Oil, Gas and Mining. Salt Lake City, Utah. Downloaded from https://fs.ogm.utah.gov/pub/MINES/Coal_Related/RecMan/Reclamation_Manual.pdf.

[2] Letter from Richard B. White, EarthFax Engineering Group, to Dennis Oakley, Interwest Mining Company, dated November 17, 2015.

shows interbasin areas (labeled IBA-1 through IBA-5) that will contribute overland flow to reclaimed areas. This overland flow will be captured in the gouges at the upslope edges of the reclaimed areas.

The prior evaluation[2] recommended that larger gouges be placed at the boundary between the reclaimed area and the upslope undisturbed area. Therefore, for the purposes of this current evaluation, the quantity of overland flow that could discharge from the undisturbed area into the uppermost row of gouges was determined assuming the volume of each gouge could be estimated based on the geometry of (1) a truncated sphere with a surface diameter of 6 feet and a depth of 3 feet and (2) a truncated pyramid with a top width of 6 feet, and bottom width of 3 feet, and a depth of 3 feet. These geometries are typical of field observations.

In each case, the depth of runoff resulting from the 100-year, 6-hour precipitation event (2.25 inches, as determined from the National Weather Service Hydrometeorological Design Studies Center web site[3]) was calculated using a runoff curve number of 70 for the undisturbed area. This curve number was based on a ground cover density of 61% (36% understory + 17% litter + 8% overstory) as reported by Mt. Nebo Scientific in their 2011 vegetation monitoring report.[4] The quantity of precipitation falling directly into a gouge was added to the runoff volume to account for the total amount of water that might be captured by each gouge. Infiltration of water from the gouge during the precipitation event was ignored in order to make the estimate more conservative.

The runoff from each interbasin area resulting from a 100-year, 6-hour storm is presented in Table 1. This table also provides an indication of the length of each interbasin area at the upslope edge of the future reclaimed area and the number of gouges that will occupy each row of that length, based on a 6-foot gouge width. During construction, soil excavated from individual gouges is placed around the edges of the gouges. At the boundary between the undisturbed and reclaimed areas, this will result in the creation of a small berm at the upslope edge of the boundary. For the purpose of this evaluation, the presence of this berm was ignored, resulting in the assumption that all runoff and sediment originating in the undisturbed area will flow into the gouges at the upslope boundary of the reclaimed area.

As indicated in Table 1, sufficient capacity will be available in one row of gouges to contain all of the runoff from each undisturbed interbasin area. Minor quantities of water (depending on gouge geometry and the particular interbasin area) may flow from the first row to the second row of gouges during a 100-year, 6-hour precipitation event. This is in general agreement with the analyses presented in Appendix D of the Cottonwood/Wilberg reclamation plan.

The reclamation plan indicates that the entire disturbed area, from the upslope edge adjacent to the undisturbed area to the downslope edge adjacent to the primary reclamation channels, will be gouged. Thus, multiple rows of gouges will be constructed downslope from the first two rows, thereby providing additional runoff storage capacity and protection against erosion of the reclaimed surface.

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[3] National Weather Service Hydrometeorological Design Studies Center data base accessed at http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ut.

[4] Mt. Nebo Scientific, Inc. 2012. Vegetation Monitoring: Reference Areas. Project report prepared for Energy West Mining Company. Springville, Utah.

Potential Sediment Volumes

The potential quantity of sediment that might be yielded from undisturbed interbasin areas to the gouges was calculated using the Revised Universal Soil Loss Equation ("RUSLE"). This equation was developed by the USDA Agricultural Research Service[5] as an outgrowth of the original Universal Soil Loss Equation ("USLE")[6]. Revisions to the original equation occurred primarily in the form of updated research to better define the variables that are used in the equation. These updates also included computerized algorithms for selecting and calculating the variables used in the equation.

The Universal Soil Loss Equation was originally developed for use on agricultural lands. Nonetheless, the soil erosion principles are equally applicable to construction and mining sites. OSM considered RUSLE to be sufficiently applicable to the prediction of soil loss from reclaimed mine sites that the agency was largely responsible for developing one of the original updates to the model (known as RUSLE, version 1.06).[7] This version of the computer program included updates to the table of RUSLE variables that were specifically developed for predicting soil loss from reclaimed mine sites. These updates were retained in future editions of the model, including the current edition (known as RUSLE2).

The efficacy of RUSLE as a predictor of sediment yields on reclaimed mine sites was verified by Kapolka[8] and Winking[9]. Given the extensive use of USLE and RUSLE, the acceptance of these models by both OSM and NRCS, the research that has been done to provide inputs appropriate to construction and mining sites, and the research that has verified the applicability of RUSLE to reclaimed mine sites, it is reasonable to conclude that RUSLE is an appropriate model for estimating soil loss from the reclaimed Cottonwood/Wilberg mine complex.

The results of sediment yield calculations for the undisturbed area at the site are provided in Appendix E of the Cottonwood/Wilberg reclamation plan (see the results for profile LS-3, located as shown on Plate 4E of the reclamation plan). These calculations indicate that the average annual sediment yield from the undisturbed area will be 1.5 tons/acre. Utilizing this value and an assumed sediment density of 100 lb/ft^3, Table 1 indicates that a period of 40 to 66 years will be required to fill one row of gouges. At this slow fill rate, vegetation will adapt to the infilling of sediment and continue to provide adequate erosion protection.

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[5] Renard, K.G., G.R. Foster, G.A Weesies, D.K. McCool, and D.C. Yoder. 1997. Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE). Agriculture Handbook Number 703. USDA Agricultural Research Service. Tucson, AZ.
[6] Wischmeier, W.H. and D.D. Smith. 1960. A Universal Soil-Loss Equation to Guide Conservation Farm Planning. 7th International Congress on Soil Science. pp. 418-425.
[7] Galetovic, J. R. 1988. Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE) Version 1.06 on Mined Lands, Construction Sites, and Reclaimed Lands. U.S. Office of Surface Mining Reclamation and Enforcement. Denver, CO.
[8] Kapolka, N.M 1999. Effect of Slope Gradient and Plant Cover on Soil Loss on Reconstructed High Altitude Slopes. Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Land Rehabilitation. Montana State University. Bozeman, MT.
[9] Winking, S.R. 2002. Effect of Mechanical and Biological Enhancements on Erosion at High Elevation Disturbed Lands. Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Land Rehabilitation. Montana State University. Bozeman, MT.

Summary

The results presented herein indicate that the first row of gouges constructed at the boundary of the undisturbed and reclaimed areas of the Cottonwood/Wilberg Mine will generally be capable of containing the runoff and direct precipitation resulting from the 100-year, 6-hour precipitation event. Thus, the gouges will adequately protect downslope, reclaimed areas from erosion. These gouges will also have sufficient volume that a period of at least 40 years will be required before the gouges will infill with sediment yielded from upslope, undisturbed areas.

It is estimated that the rate of sediment infilling will be sufficiently slow that vegetation will adequately adapt and continue to provide long-term erosion protection on the reclaimed slopes. With typical reclaimed slope lengths of 50 to 150 feet between upslope undisturbed areas and the primary reclamation channels, multiple rows of gouges will be constructed on the reclaimed slopes. This will provide multiple lines of defense against erosion of the reclaimed site due to runoff from and sediment yielded by adjacent undisturbed areas.

As noted previously, deep gouging has been used as a reclamation technique at several Utah mine locations for the past 20 years. Field observations of reclaimed areas at the Willow Creek Mine, the Gordon Creek 2,7,8 Mine complex, and the Star Point Mine following significant storm events, some with estimated return periods in excess of 200 years, have shown no evidence of gouge failure.[10] Therefore, together with the data presented herein, deep gouging is considered an appropriate technique for reclamation of disturbed areas associated with the Cottonwood/Wilberg Mine.

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[10] See the following plans prepared by EarthFax Engineering and ultimately submitted to and approved by the Utah Division of Oil, Gas and Mining prior to field implementation:

"Plan for Repair of Reclamation Channels SPRD-30 and SPRD-31, Former Star Point Mine, Carbon County, Utah." Prepared by EarthFax Engineering, Inc. for Plateau Mining Corporation. Dated September 2012.

"Plan for Repair of Reclamation Channels CGRD-1, WCRD-4, and WCRD-5A at the Willow Creek Mine, Carbon County, Utah." Prepared by EarthFax Engineering Group, LLC for Plateau Mining Corporation. Dated September 2013.

"Plan for Repair of Reclamation Channel SD-6 at the Gordon Creek 2,7,8 Mine, Carbon County, Utah." Prepared by EarthFax Engineering Group, LLC for Bowie Resource Partners, LLC. Dated November 2014.

TABLE 1

Estimated Volume of Overland Flow and Sediment
Reaching Uppermost Reclamation Gouges
at the Cottonwood/Wilberg Reclaimed Site

Curve number =	70	(See Note #1)	S = 4.29
Precipitation depth (in) =	2.25		(Based on 100-yr, 6-hr event)
Unit area runoff (in) =	0.34		

Interbasin Watershed	Area (acres)	Boundary Length (ft)	Number of Gouges/Row	Total Runoff Volume (ft^3)
IBA-1	3.57	463	77	4,427
IBA-2	1.99	418	70	2,468
IBA-3	5.03	693	116	6,238
IBA-4	10.56	1379	230	13,096
IBA-5	4.98	655	109	6,176

Note: Gouges per row based on gouge width of 6 ft. See Figure 1 for interbasin watershed boundaries.

Calculations based on gouges shaped like a <u>truncated sphere</u> (6 ft surface diameter, 3 ft deep):

Single gouge area =	28.3	ft^2
Precip in single gouge =	5.3	ft^3
Single gouge volume =	56.5	ft^3

Interbasin	Total Gouge Volume (ft^3)			% Capacity in Excess of Runoff + Precip		
Watershed	1 Row	2 Rows	3 Rows	1 Row	2 Rows	3 Rows
IBA-1	4,351	8,701	13,052	-1.9	96.3	194.4
IBA-2	3,955	7,910	11,865	59.9	219.8	379.7
IBA-3	6,554	13,108	19,662	5.0	110.0	214.9
IBA-4	12,995	25,990	38,985	-0.8	98.4	197.6
IBA-5	6,159	12,317	18,476	-0.4	99.3	198.9

Calculations based on gouges shaped like a <u>truncated pyramid</u> (6 ft top width, 3 ft base width, 3 ft deep):

Sinale gouge area =	36.0	ft^2
Precip in single gouge =	6.8	ft^3
Single gouge volume =	63.0	ft^3

Interbasin	Total Gouge Volume (ft^3)			% Capacity in Excess of Runoff + Precip		
Watershed	1 Row	2 Rows	3 Rows	1 Row	2 Rows	3 Rows
IBA-1	4,851	9,702	14,553	9.4	118.8	228.2
IBA-2	4,410	8,820	13,230	78.2	256.4	434.6
IBA-3	7,308	14,616	21,924	17.0	134.1	251.1
IBA-4	14,490	28,980	43,470	10.6	121.2	231.8
IBA-5	6,867	13,734	20,601	11.1	122.1	233.2

Rate of <u>sediment infilling of gouges</u> from undisturbed area:

Sediment yield (from RUSLE calcs) =	1.5	tons/ac/yr
Assumed sediment density =	100	lb/ft^3

Interbasin Watershed	Area (acres)	Number of Gouges/Row	Gouge Volume per Row (ft^3)	Annual Sed Yield from IBA		Time to Fill One Row of Gouges (yr)
				Tons/yr	ft^3/yr	
IBA-1	3.57	77	4,351	5.36	107.1	40.6
IBA-2	1.99	70	3,955	2.99	59.7	66.2
IBA-3	5.03	116	6,554	7.55	150.9	43.4
IBA-4	10.56	230	12,995	15.84	316.8	41.0
IBA-5	4.98	109	6,159	7.47	149.4	41.2

Note: Gouge volume based on truncated sphere calculation (i.e., the smaller of the two calc methods).

Note:

1. Curve number based on ground cover density of 61% (36% understory + 17% litter + 8% overstory) as indicated by Mt. Nebo Scientific in their 2011 vegetation monitoring report. This curve number is based on an assumed Hydrologic Soil Group of "C". Determined from Figure 9.6 of NEH, Part 630, Hydrology.

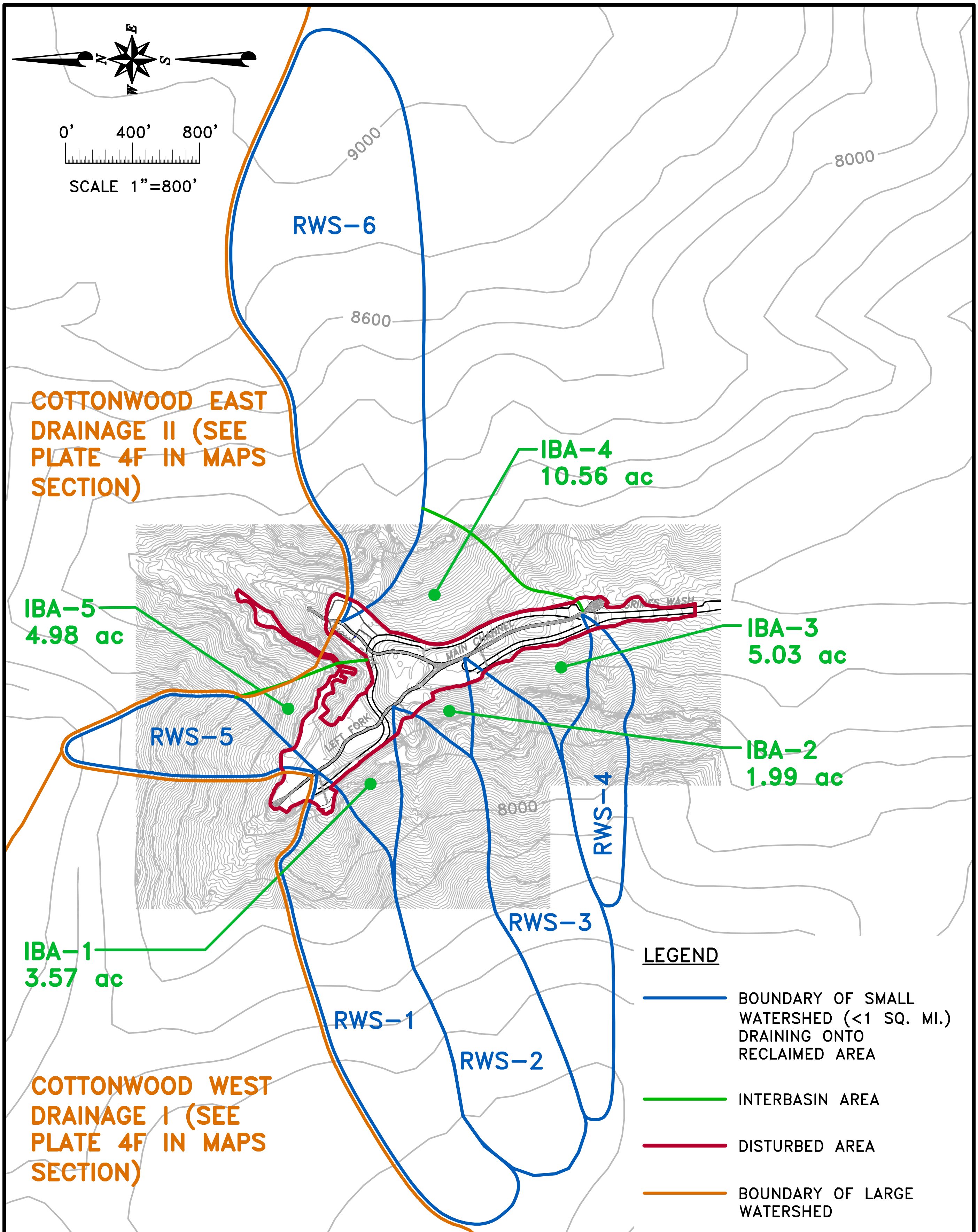

FIGURE 1. COTTONWOOD/WILBERG SIDE CHANNEL AND INTERBASIN RECLAMATION WATERSHEDS

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Appendix E

Revise Universal Soil Loss Equation (RUSLE)

- **E-1: RUSLE – Comparison of Sediment Control Management Practices**
- **E-2: RUSLE – Program Input Parameters and Sediment Delivery Results for Profiles LS-1, LS-2, and LS-3**

Refer to Plate-4E for Slope Profile Locations.

Cottonwood/Wilberg Mine Reclamation Plan

2016

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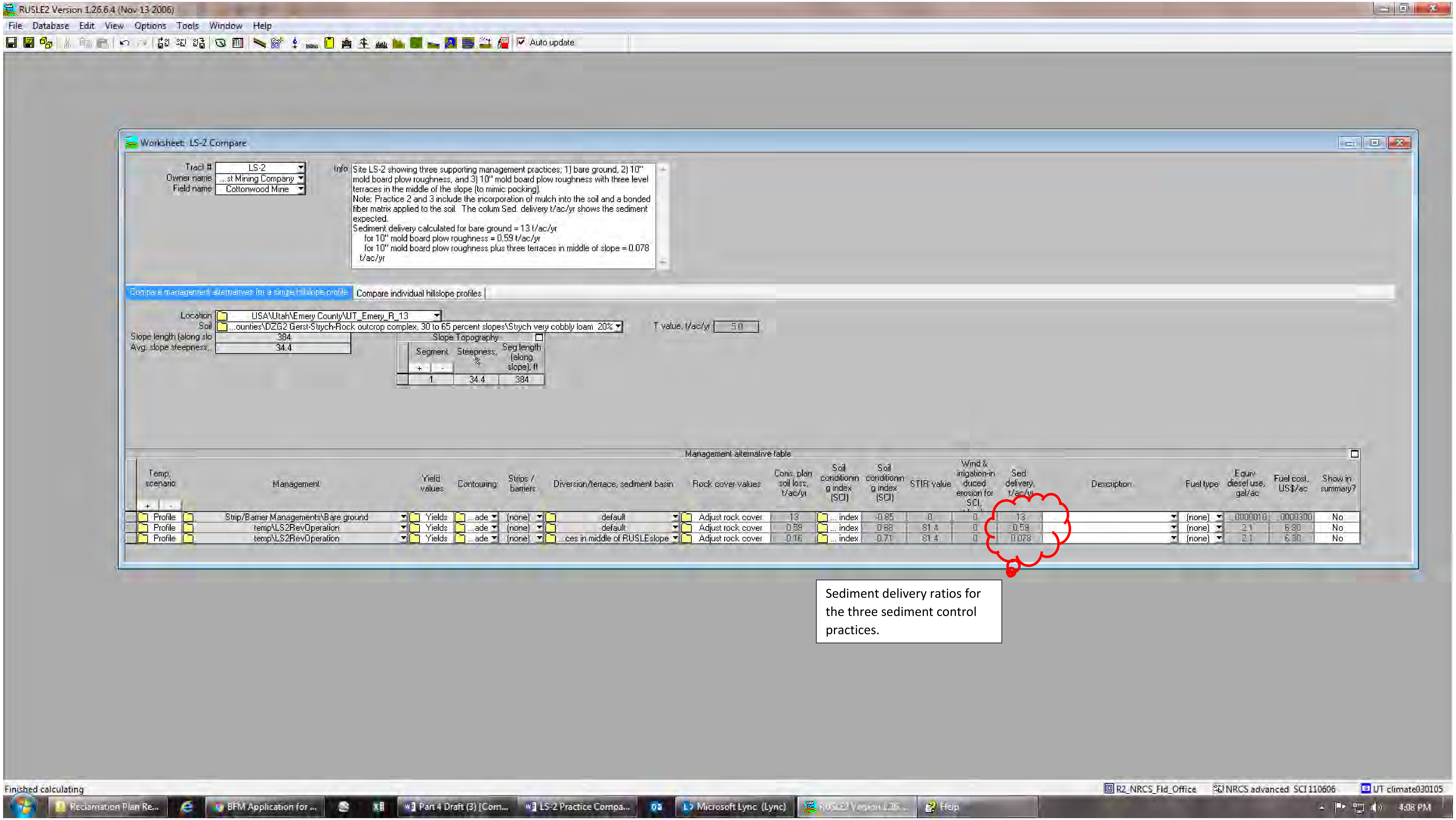
Appendix E-1

RUSLE – Comparison of Sediment Control Management Practices

Refer to Plate-4E for Slope Profile Locations.

Cottonwood/Wilberg Mine Reclamation Plan

2016



Using RUSLE to compare three sediment control practices for profile LS-2 (refer to Plate-4E).

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Appendix E-2

RUSLE – Program Input Parameters and Sediment Delivery Results for Profiles LS-1, LS-2, and LS-3

Refer to Plate-4E for Slope Profile Locations.

Cottonwood/Wilberg Mine Reclamation Plan

2016

RUSLE2 Worksheet Erosion Calculation Record

Info: Site LS-1 modeling the support management practice of a 10" mold board plow roughness and three level terraces in the middle of the slope (to mimic pocking).
Note: This profile includes incorporating mulch into the soil and the application of a bonded fiber matrix to the soil surface.

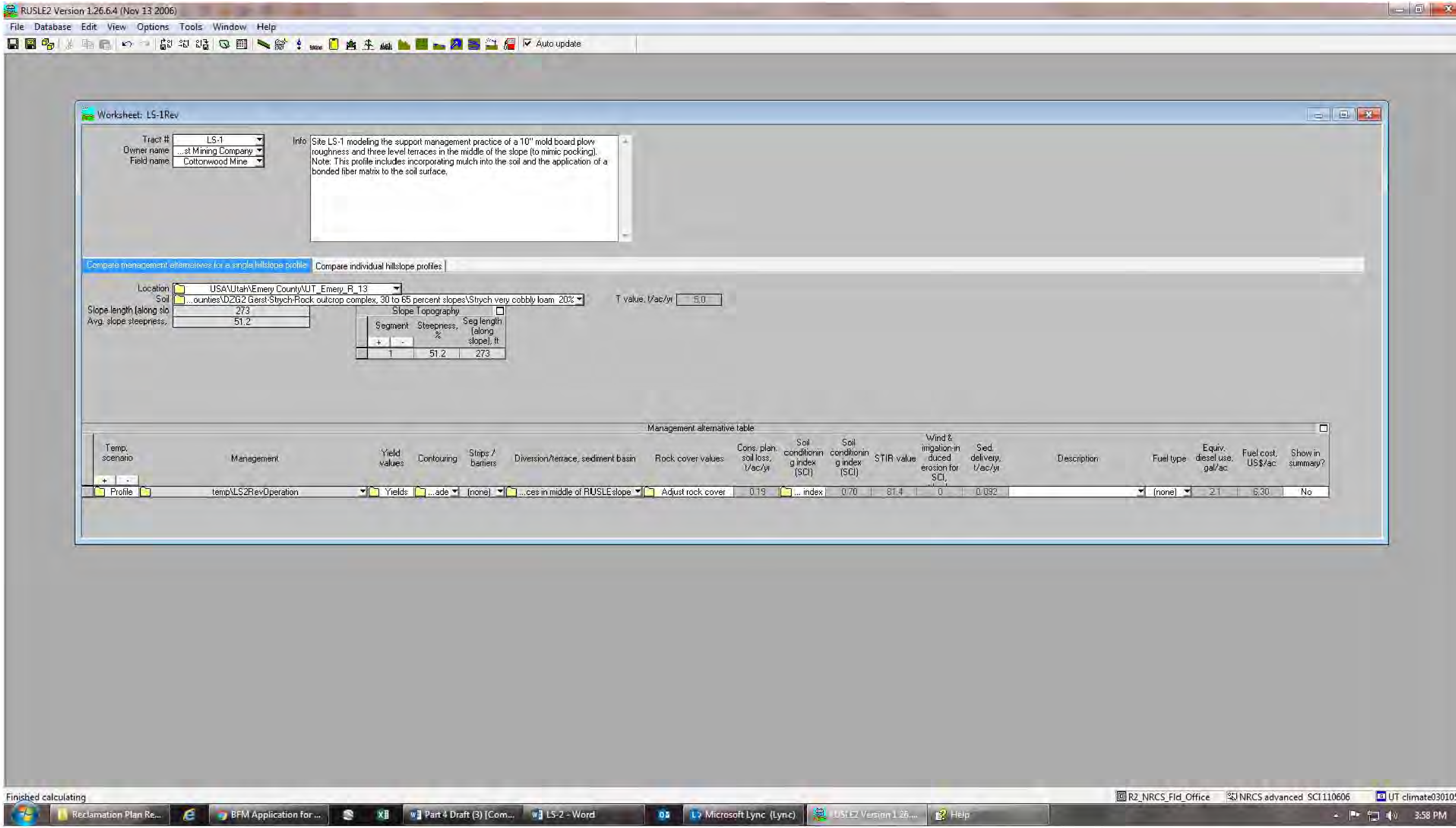
Inputs:

Owner name	***Location***	**--**
Interwest Mining Company	**Utah\Emery County\UT_Emery_R_13**	

Location	*Soil*	*Slope length (horiz)*	*Avg. slope steepness, %*
Utah\Emery County\UT_Emery_R_13	DZG2 Gerst-Strych-Rock outcrop complex, 30 to 65 percent slopes\Strych very cobbly loam 20%	243	51.2

Outputs:

Management	*Contouring*	*Strips / barriers*	*Diversion/terrace, sediment basin*	*Soil loss erod. portion, t/ac/yr*	*Soil detachment, t/ac/yr*	*Cons. plan. soil loss, t/ac/yr*	*Sed. delivery, t/ac/yr*
LS2RevOperation	c. perfect contouring no row grade	(none)	3 level terraces in middle of RUSLEslope	0.32	0.32	0.19	0.092



Profile LS-1: Sediment delivery of 0.092 t/ac/yr using 10" mold board plow roughness and three terraces in the middle of the slope (to mimic pocking). Note that additional sediment control practices utilizing incorporation of 2000 lbs of alfalfa hay mulch into the soil and the application of 2000 lbs/ac hydromulch w/tackfier are modeled on this slope profile.

RUSLE2 Worksheet Erosion Calculation Record

Info: Site LS-2 modeling the support management practice of a 10" mold board plow roughness and three level terraces in the middle of the slope (to mimic pocking).
Note: This profile includes incorporating mulch into the soil and the application of a bonded fiber matrix to the soil surface.

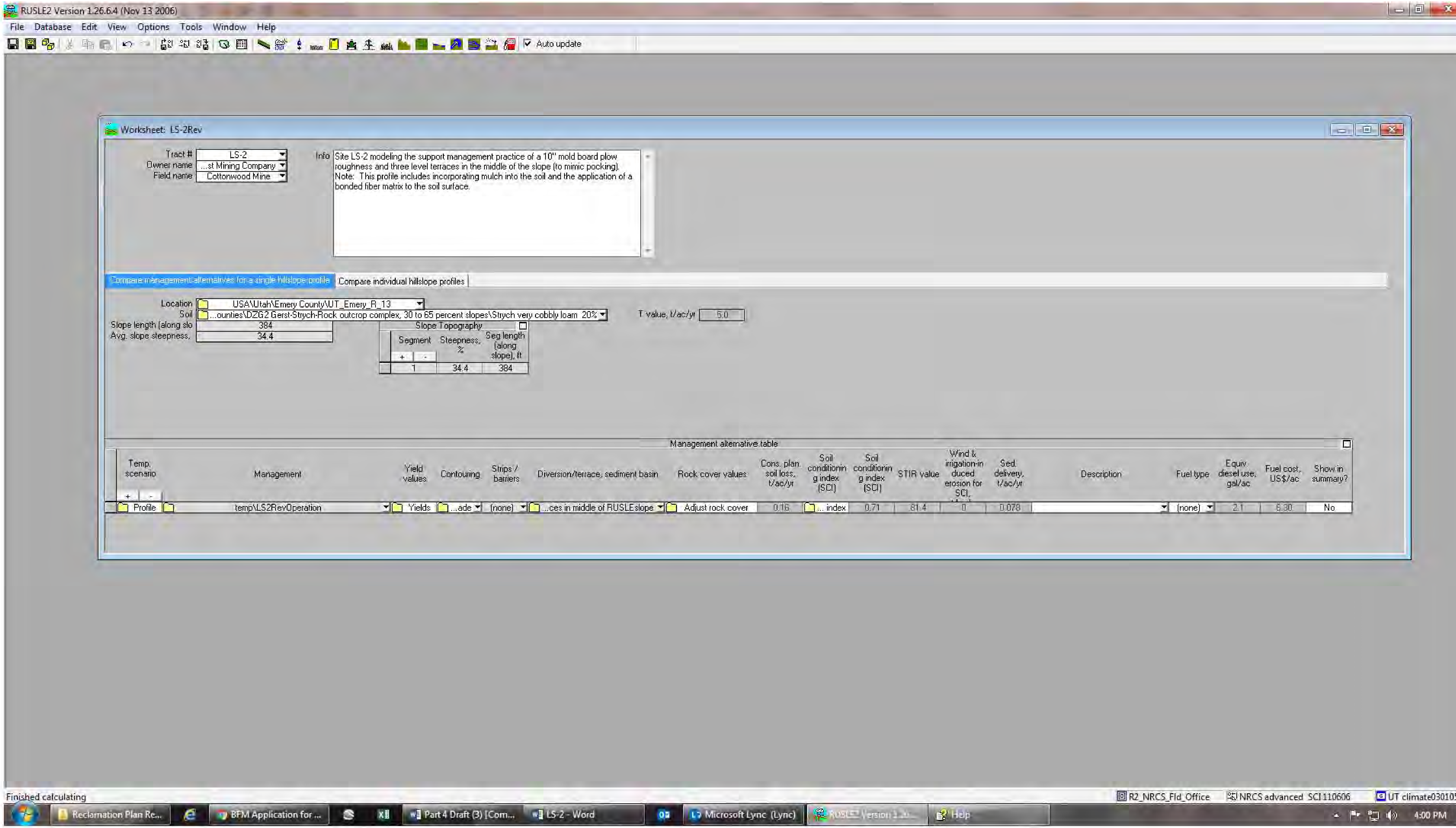
Inputs:

Owner name	***Location***	**--**
Interwest Mining Company	**Utah\Emery County\UT_Emery_R_13**	

Location	*Soil*	*Slope length (horiz)*	*Avg. slope steepness, %*
Utah\Emery County\UT_Emery_R_13	DZG2 Gerst-Strych-Rock outcrop complex, 30 to 65 percent slopes\Strych very cobbly loam 20%	363	34.4

Outputs:

Management	*Contouring*	*Strips / barriers*	*Diversion/terrace, sediment basin*	*Soil loss erod. portion, t/ac/yr*	*Soil detachment, t/ac/yr*	*Cons. plan. soil loss, t/ac/yr*	*Sed. delivery, t/ac/yr*
LS2RevOperation	c. perfect contouring no row grade	(none)	3 level terraces in middle of RUSLEslope	0.28	0.28	0.16	0.078



Profile LS-2: Sediment delivery of 0.078 t/ac/yr using 10" mold board plow roughness and three terraces in the middle of the slope (to mimic pocking). Note that additional sediment control practices utilizing incorporation of 2000 lbs of alfalfa hay mulch into the soil and the application of 2000 lbs/ac hydromulch w/tackfier are modeled on this slope profile.

RUSLE2 Worksheet Erosion Calculation Record

Info: Site LS-3: Reference Area on west side of canyon.

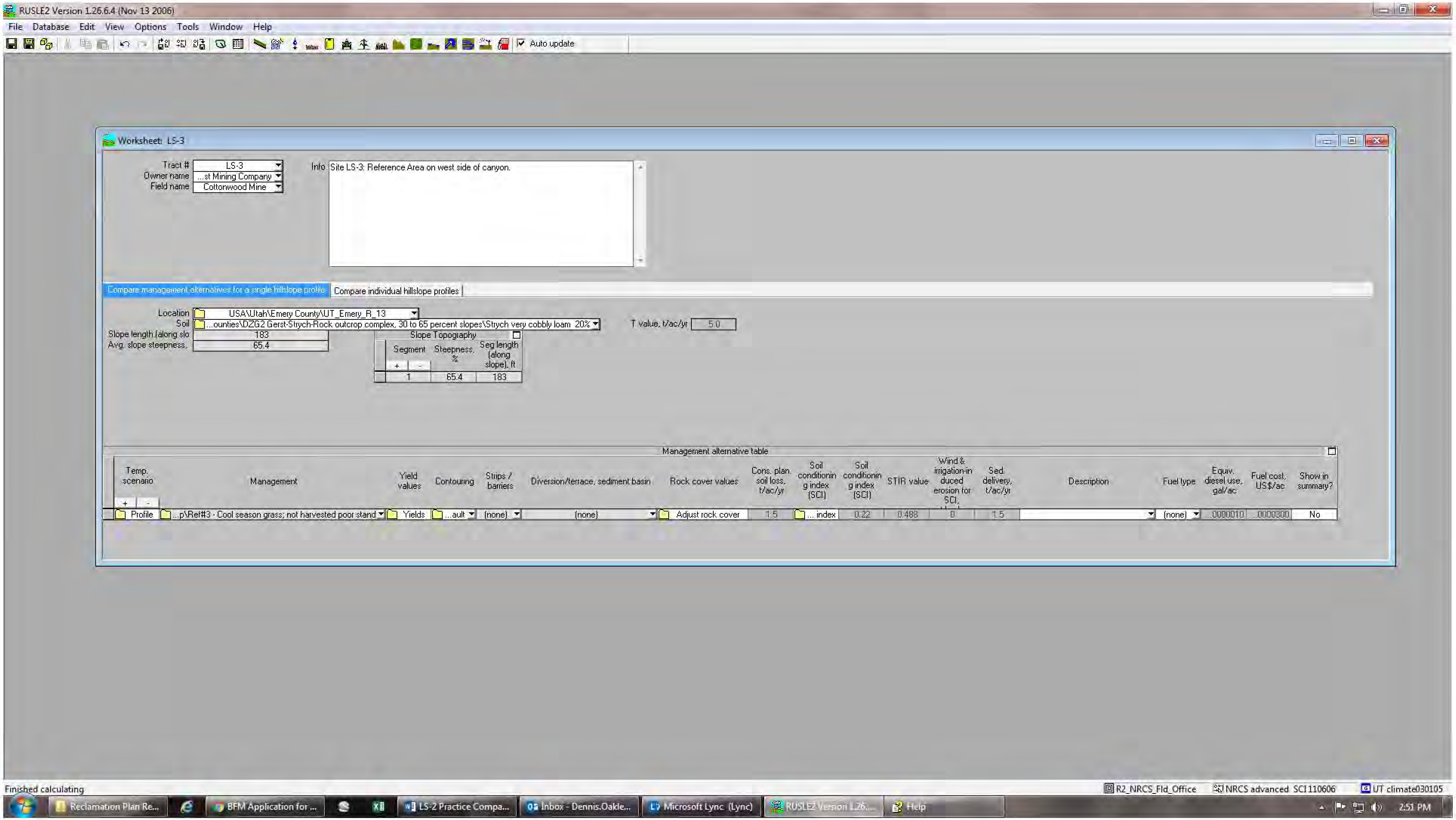
Inputs:

Owner name	***Location***	**--**
Interwest Mining Company	**Utah\Emery County\UT_Emery_R_13**	

Location	*Soil*	*Slope length (horiz)*	*Avg. slope steepness, %*
Utah\Emery County\UT_Emery_R_13	DZG2 Gerst-Strych-Rock outcrop complex, 30 to 65 percent slopes\Strych very cobbly loam 20%	153	65.4

Outputs:

Management	*Contouring*	*Strips / barriers*	*Diversion/terrace, sediment basin*	*Soil loss erod. portion, t/ac/yr*	*Soil detachment, t/ac/yr*	*Cons. plan. soil loss, t/ac/yr*	*Sed. delivery, t/ac/yr*
Ref#3 - Cool season grass; not harvested poor stand	default	(none)	(none)	1.5	1.5	1.5	1.5



Profile LS-3: Sediment delivery of 1.5 t/ac/yr. Cottonwood Pinyon/Juniper reference area below minesite

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Appendix F

Hydrological Procedures and Calculations for Wilberg East (Right Fork) and Wilberg West (Left Fork) Channels in Grimes Wash

- **F-1: Design for Watersheds Draining at Least One Square Mile**
- **F-2: Design for Watersheds Draining Less Than One Square Mile**

Cottonwood/Wilberg Mine Reclamation Plan

2016

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Appendix F-1

Design for Watersheds Draining at Least One Square Mile

Cottonwood/Wilberg Mine Reclamation Plan

2016

Cottonwood/Wilberg Reclamation Plan

Note: The following hydrological procedures and calculations as used for final reclamation presents the design of the final reclamation channel. This channel design was created by Vaughn Hansen and Associates in 1984. At the time of development, the plan was to leave in place a small section of road which serves as access to the mine. The design included dual 90" culverts under the road. As this is no longer the plan, PacifiCorp feels the channel has been designed using prudent engineering and hydraulic design procedures. Therefore, review of this appendix should only focus on the channel design and not the culvert design.

Secondly, the drainage map that accompanies this design has been updated to show current permit boundaries. The drainage areas have not changed.

Refer to watershed map on Plate 4F.

HYDROLOGICAL PROCEDURES AND CALCULATIONS

Procedures and calculations for determining peak discharge and volumes for the 100 year-24 hour storm event for each watershed and subdrainage (Plate 4F) utilize the Soil Conservation Service Curve Number Method (SCS, 1980; SCS, 1972). Distribution of rainful during a 24-hour storm event is depicted in Table A-1 and associated calculations utilize the technique reported in SCS, 1964.

TABLE A-1. Accumulation of Rainfall to 24 Hours.

Time (hrs)	P_x/P_{24}*
0	0
2	0.022
4	0.048
6	0.080
8	0.120
10	0.181
11	0.235
12	0.663
13	0.772
14	0.820
16	0.880
20	0.952
24	1.000

*Ratio of accumulated rainfall (P_x) to the 24-hour value (P_{24}).

The following steps were used in calculating peak and total flows for the 100 year-24 hour storm event.

- Watershed Characteristics Description

  Each watershed was delineated on the appropriate U.S.G.S. 7.5' quadrangle map. Subdrainages were evaluated and delineated (Plate 4F) based on direction of flow, slope, aspect, vegetative cover, and soil hydrologic group. Acreage of each subdrainage and watershed was determined using a polar planimeter.

Drainage density was also determined for each subdrainage and watershed from topographic maps.

- Curve Number Selection

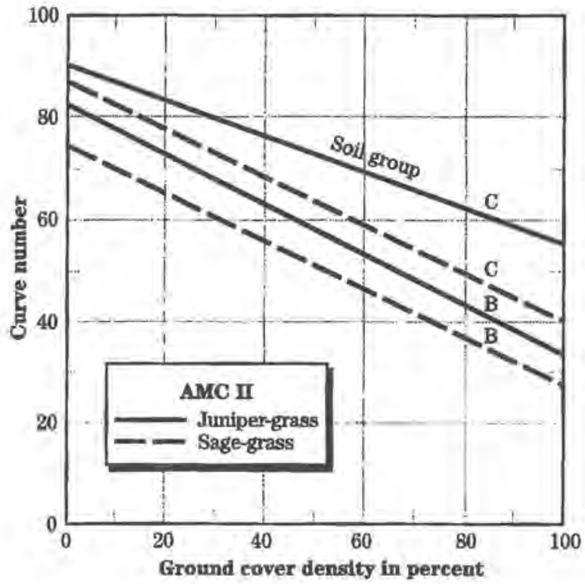
  Curve numbers (CN) were selected based on an analysis of drainage aspect, expected vegetative cover and hydrologic soil class. These parameter values were determined from topographic maps, field observations, and discussions with the Forest Hydrologist Manti-LaSal National Forest. Curve numbers were extrapolated from Figure S-3 (SCS, 1980) based upon the anticipated hydrologic soil cover complex.

  Lower portions of the drainages usually had excessively steep slopes (vertical in some cases) resulting in high CN values which represent low infiltration characteristics for the area. Where slopes moderated, as in Area IVa (Deer Creek), the CN was reduced to account for increased infiltration. North-facing slopes had the lowest CN values as reflected by higher vegetation density and more developed soils. Curve numbers for drainages with either eastern or western aspect were intermediate as compared to southern or northern slopes. It was generally assumed that cover density was near 40% in these areas and that soils were less developed (Soil Hydrologic Class C) than on northern slopes. Drainage areas IIc, IVd, and Va were assigned CN's in the intermediate range.

  Composite CN's were developed for the moderately sloped portions of all watersheds except Des-Bee-Dove (III) and Deer Drainage (V) based on area proportions. Steeply sloped areas were not included in the composite CN's as analysis showed that inclusion of steep slopes resulted in artifically reduced peak flows. The higher flow volumes obtained from a separate analysis of excessive and moderately steep slopes was determined to be more representative of the area.

Figure S-3:

Figure 9–2 Estimating runoff curve numbers of forest-range complexes in Western United States: juniper-grass and sage-grass complexes



Reprinted from SCS National Engineering Handbook (210-VI-NEH, July 2004) Part 630, Chapter 9, pate 9-4.

- Runoff Determination

To determine runoff in each subdrainage and watershed, the CN is applied in the following equations:

Eq 1.0 $$S = \frac{1000}{CN} - 10,$$

where, S, is a coefficient related to the soil and cover conditions of a specific watershed or subdrainage,

and, CN, is the curve number as extrapolated from Figure S-3 of SCS, 1980.

Eq 2.0 $$Q = \frac{(P-0.2S)^2}{P+0.8S},$$

where, P, is total storm rainfall in inches, and, Q, is actual direct runoff in inches.

The curve number method assumes that the amount of precipitation occurring five days preceding a storm is an indication of the antecedent moisture condition (AMC) of the soil. The moisture condition generally used is the average, AMC II. This average assumes between 1.4 and 2.1 inches preceding a flood event during a growing season or between 0.5 and 1.1 inches during a dormant season. If the AMC is greater than 2.1 or 1.1 inches respectively, a wet antecedent moisture condition (AMCIII) is presumed. If it is less than 1.4 or 0.5 inches respectively, a dry antecedent moisture condition (AMC I) is used. Distribution of flows for a 24-hour period were calculated utilizing this change in AMC as described.

- Peak Flow Determination

Once runoff (Q) had been calculated, peak flow was estimated based on a synthetic hydrograph (SCS, 1972). The following formulas were used:

Eq 3.0

$$T_p = 105.5 \left(\frac{A^{.3}}{S\sqrt{DD}} \right)^{.61}$$

where, T_p, is time to obtain peak flow in minutes, A, is the area of the watershed in acres, S, is the % slope,

and, DD, is the drainage density in ft/acre.

Eq 4.0

$$q_p = \frac{KAQ}{T_p},$$

where, K, is a constant (484), A, is the watershed area in mi^2, Q, is runoff in inches,

and, q_p, is the peak flow in cfs.

The T_p and q_p values are used to construct the synthetic hydrographs. Equation 3.0 is a modification of the SCS equation and produces more reasonable results for the terrain involved (Personal Communication, 1980a).

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*  HYDROGRAPH DETERMINATION *
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WATERSHED: WILBERG EAST
FLOOD EVENT: 100-YEAR/24-HR STORM

CLIENT: UTAH POWER & LIGHT CO.
PROJECT NUMBER: 0179-002
DATE: APRIL 5, 1982

USER: SAB

CALCULATION TIME INCREMENT: 0.05 HOURS

WATERSHED CHARACTERISTICS
****

AREA:	1280.00 ACRES	
MEAN ELEVATION:	0.00 FEET	← We did not have this value. Was not used in the calculations
MEAN BASIN SLOPE:	12.75 PERCENT	
DRAINAGE LENGTH:	18242.00 FEET	
DRAINAGE DENSITY:	14.25 FEET/ACRE	

RUNOFF CHARACTERISTICS
****

PEAK FLOW:	[redacted]	
TIME TO PEAK FLOW:	12.60 HOURS	
RUNOFF VOLUME:	[redacted]	
TOTAL STORM PRECIPITATION:	3.50 INCHES	
TOTAL STORM RUNOFF:	1.49 INCHES	
RUNOFF COEFFICIENT:	0.43	← percent of total ppt that became runoff.

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*  HYDROGRAPH DETERMINATION  *
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WATERSHED: WILBERG WEST
FLOOD EVENT: 100-YEAR/24-HR STORM

CLIENT: UTAH POWER & LIGHT CO.
PROJECT NUMBER: 0179-002
DATE: APRIL 5, 1982

USER: SAB

CALCULATION TIME INCREMENT: 0.05 HOURS

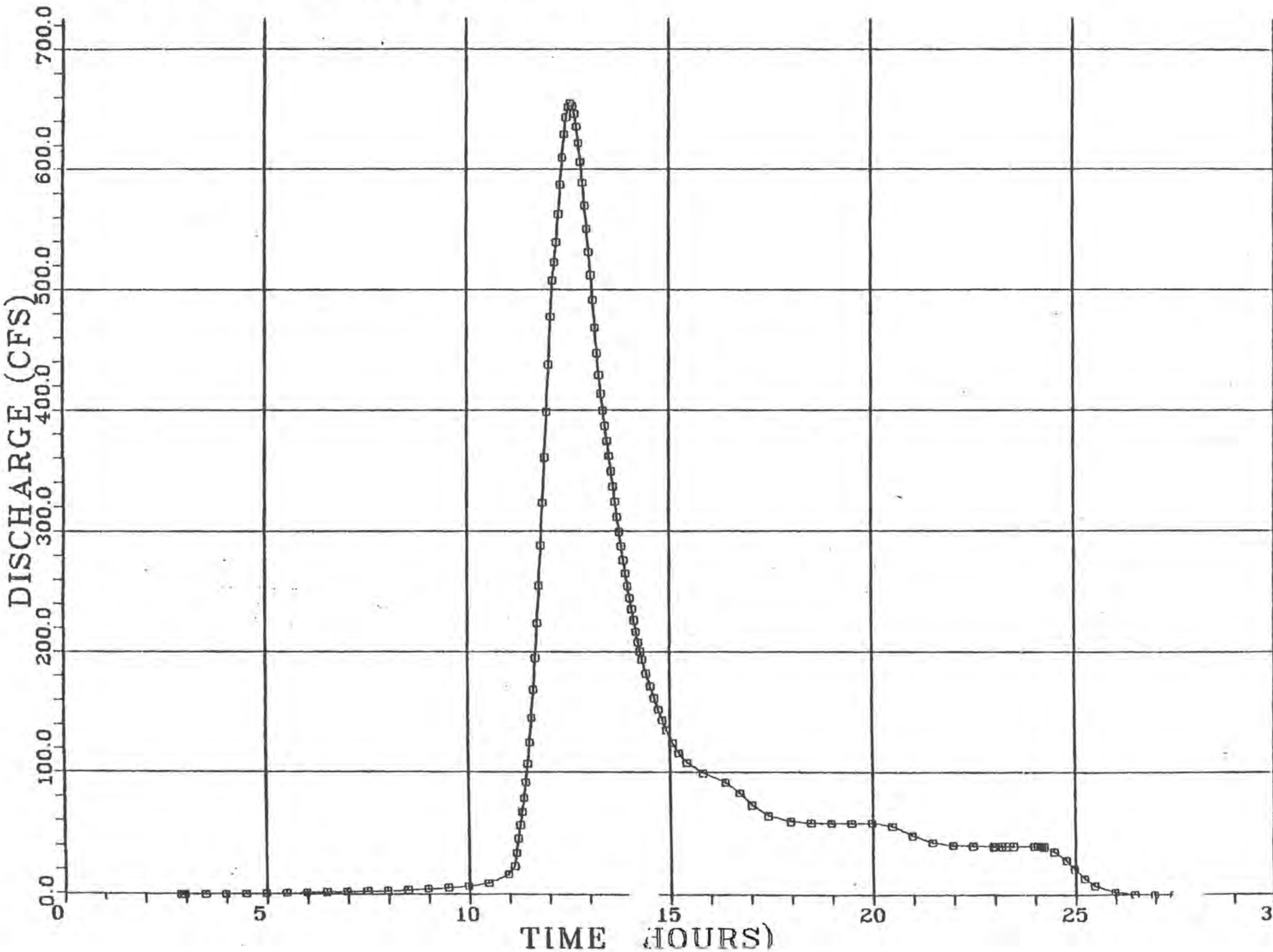
WATERSHED CHARACTERISTICS
****

AREA:	1478.00 ACRES
MEAN ELEVATION:	0.00 FEET
MEAN BASIN SLOPE:	11.92 PERCENT
DRAINAGE LENGTH:	14269.20 FEET
DRAINAGE DENSITY:	9.65 FEET/ACRE

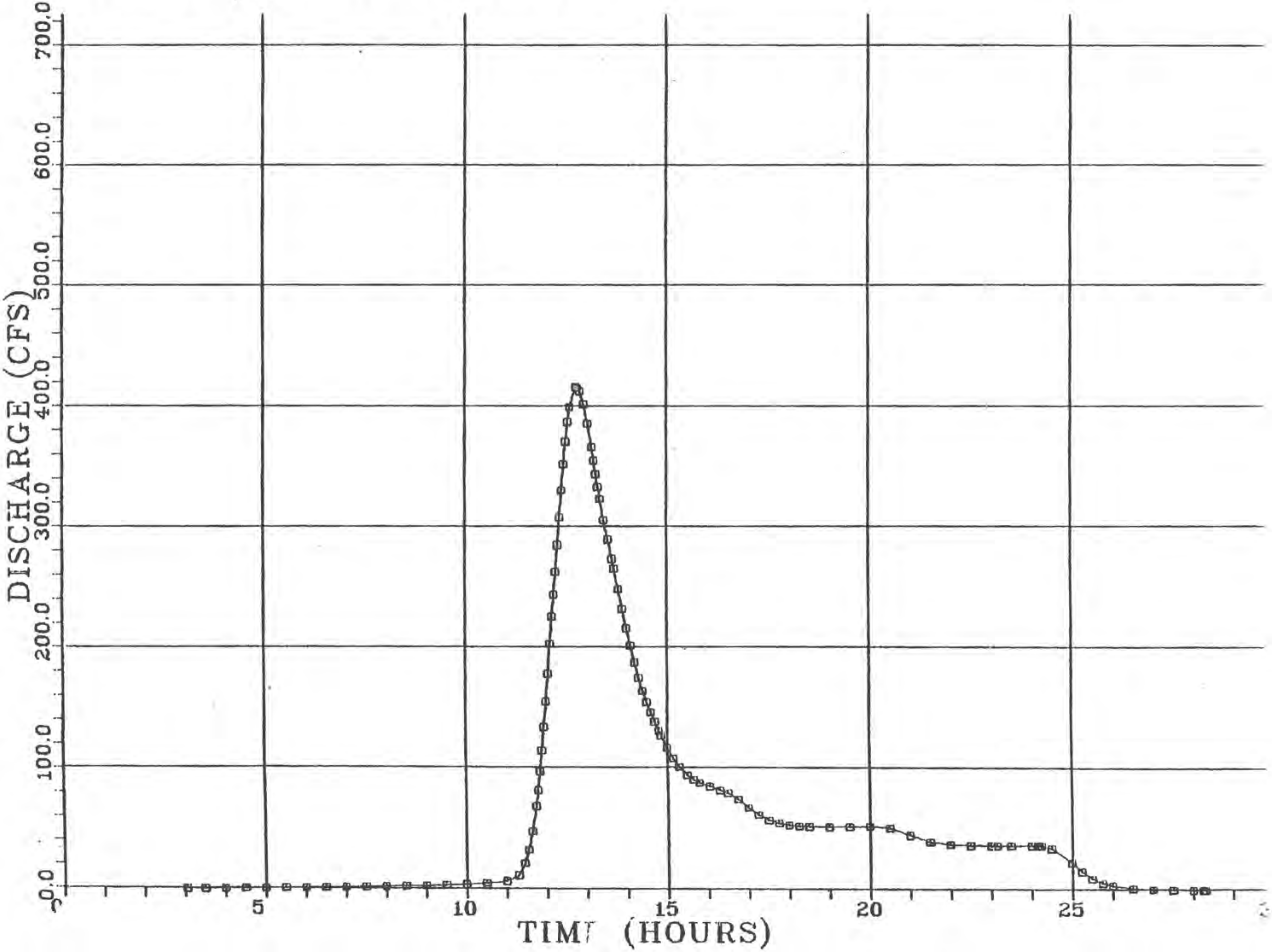
RUNOFF CHARACTERISTICS
****

PEAK FLOW:	[redacted]
TIME TO PEAK FLOW:	12.75 HOURS
RUNOFF VOLUME:	[redacted]
TOTAL STORM PRECIPITATION:	3.50 INCHES
TOTAL STORM RUNOFF:	0.94 INCHES
RUNOFF COEFFICIENT:	0.27

FLOOD HYDROGRAPH FOR WILBERG EAST WATERSHED
100 YEAR/24 HOUR STORM



FLOOD HYDROGRAPH FOR WILBERG WEST WATERSHED
100 YEAR/24 HOUR STORM



***** TRAPEZODIAL CHANNEL DESIGN *****

DATE: APRIL 5, 1982 BY: JSF
CLIENT: UTAH POWER & LIGHT CO. PROJECT: 0179-2

CHANNEL SIDE SLOPE ROUGHNESS COEFFICIENT
HORI = 2.0 VERT = 1.0 N = 0.050

***** LOCATION: WEST (I)
***** DESIGN FLOW = 416.3 CFS

CHANNEL SLOPE (%)	BASE WIDTH (FT)	WATER HEIGHT (FT)	CALCULATED FLOW (CFS)	CALCULATED VELOCITY (FT/SEC)
5.00	5	3.39	418.6	10.5
10.00	5	2.87	417.2	13.5
15.00	5	2.60	416.7	15.7

***** TRAPEZODIAL CHANNEL DESIGN *****

DATE: APRIL 5, 1982 BY: JSF
CLIENT: UTAH POWER & LIGHT CO. PROJECT: 0179-2

CHANNEL SIDE SLOPE
HORI = 2.0 VERT = 1.0

ROUGHNESS COEFFICIENT
N = 0.050

***** LOCATION: EAST (II)
***** DESIGN FLOW = 656.0 CFS

CHANNEL SLOPE (%)	BASE WIDTH (FT)	WATER HEIGHT (FT)	CALCULATED FLOW (CFS)	CALCULATED VELOCITY (FT/SEC)
5.00	5	4.18	657.3	11.8
10.00	5	3.56	657.0	15.2
15.00	5	3.24	658.7	17.7

***** TRAPEZODIAL CHANNEL DESIGN *****

DATE: APRIL 5, 1982 BY: JSF

CLIENT: UTAH POWER & LIGHT CO. PROJECT: 0179-2

CHANNEL SIDE SLOPE
HORI = 2.0 VERT = 1.0

ROUGHNESS COEFFICIENT
N = 0.050

***** LOCATION: I + II
***** DESIGN FLOW = 1072.3 CFS

CHANNEL SLOPE (%)	BASE WIDTH (FT)	WATER HEIGHT (FT)	CALCULATED FLOW (CFS)	CALCULATED VELOCITY (FT/SEC)
5.00	5	5.22	1075.0	13.3
10.00	5	4.47	1076.8	17.3
15.00	5	4.07	1074.2	20.1

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*  HYDROGRAPH DETERMINATION  *
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WATERSHED: WILBERG WEST
FLOOD EVENT: 100-YEAR/24-HR STORM

CLIENT: UTAH POWER & LIGHT CO.
PROJECT NUMBER: 0179-002
DATE: APRIL 5, 1982

USER: SAB

CALCULATION TIME INCREMENT: 0.05 HOURS

WATERSHED CHARACTERISTICS
****

AREA:	1478.00 ACRES
MEAN ELEVATION:	0.00 FEET
MEAN BASIN SLOPE:	11.92 PERCENT
DRAINAGE LENGTH:	14269.20 FEET
DRAINAGE DENSITY:	9.65 FEET/ACRE

RUNOFF CHARACTERISTICS
****

PEAK FLOW:	416.29 CFS
TIME TO PEAK FLOW:	12.75 HOURS
RUNOFF VOLUME:	115.41 ACRE-FEET
TOTAL STORM PRECIPITATION:	3.50 INCHES
TOTAL STORM RUNOFF:	0.94 INCHES
RUNOFF COEFFICIENT:	0.27

SUB-BASIN CHARACTERISTICS

NUMBER OF SUB-BASINS: 2

SUBBASIN NUMBER	AREA (ACRES)	CURVE NUMBER
1	1419.00	67.0
2	59.00	95.0

COMPOSITE CURVE NUMBER: 68.7

PRECIPITATION CHARACTERISTICS

STORM FREQUENCY: 100-YR
DURATION: 24-HR
INTENSITY: 3.50-IN

RAINFALL DISTRIBUTION

HOUR	RAINFALL (INCHES)
1	0.04
2	0.08
3	0.12
4	0.17
5	0.22
6	0.28
7	0.35
8	0.42
9	0.51
10	0.63
11	0.82
12	2.32
13	2.70
14	2.87
15	2.98
16	3.08
17	3.14
18	3.21
19	3.27
20	3.33
21	3.37
22	3.42
23	3.46
24	3.50

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
3.05	0.01
3.10	0.01
3.15	0.01
3.20	0.01
3.25	0.02
3.30	0.02
3.35	0.02
3.40	0.03
3.45	0.04
3.50	0.04
3.55	0.05
3.60	0.06
3.65	0.07
3.70	0.08
3.75	0.09
3.80	0.11
3.85	0.12
3.90	0.13
3.95	0.15
4.00	0.16
4.05	0.18
4.10	0.19
4.15	0.21
4.20	0.23
4.25	0.25
4.30	0.26
4.35	0.28
4.40	0.30
4.45	0.32
4.50	0.34
4.55	0.36
4.60	0.38

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
4.65	0.41
4.70	0.43
4.75	0.45
4.80	0.48
4.85	0.50
4.90	0.53
4.95	0.55
5.00	0.58
5.05	0.60
5.10	0.63
5.15	0.65
5.20	0.68
5.25	0.70
5.30	0.73
5.35	0.75
5.40	0.77
5.45	0.80
5.50	0.82
5.55	0.84
5.60	0.87
5.65	0.89
5.70	0.91
5.75	0.93
5.80	0.96
5.85	0.98
5.90	1.00
5.95	1.02
6.00	1.04
6.05	1.06
6.10	1.08
6.15	1.10
6.20	1.13

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
6.25	1.15
6.30	1.17
6.35	1.20
6.40	1.22
6.45	1.24
6.50	1.27
6.55	1.30
6.60	1.32
6.65	1.35
6.70	1.39
6.75	1.42
6.80	1.45
6.85	1.49
6.90	1.52
6.95	1.55
7.00	1.59
7.05	1.62
7.10	1.66
7.15	1.69
7.20	1.72
7.25	1.75
7.30	1.79
7.35	1.82
7.40	1.85
7.45	1.87
7.50	1.90
7.55	1.93
7.60	1.95
7.65	1.98
7.70	2.00
7.75	2.03
7.80	2.05

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
7.85	2.07
7.90	2.09
7.95	2.11
8.00	2.14
8.05	2.16
8.10	2.18
8.15	2.20
8.20	2.23
8.25	2.27
8.30	2.29
8.35	2.32
8.40	2.35
8.45	2.38
8.50	2.42
8.55	2.45
8.60	2.50
8.65	2.54
8.70	2.59
8.75	2.64
8.80	2.70
8.85	2.75
8.90	2.81
8.95	2.86
9.00	2.92
9.05	2.98
9.10	3.03
9.15	3.09
9.20	3.16
9.25	3.22
9.30	3.28
9.35	3.34
9.40	3.40

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
9.45	3.45
9.50	3.51
9.55	3.57
9.60	3.63
9.65	3.70
9.70	3.77
9.75	3.84
9.80	3.91
9.85	3.98
9.90	4.06
9.95	4.13
10.00	4.20
10.05	4.27
10.10	4.34
10.15	4.42
10.20	4.53
10.25	4.64
10.30	4.73
10.35	4.83
10.40	4.92
10.45	5.02
10.50	5.12
10.55	5.24
10.60	5.37
10.65	5.51
10.70	5.66
10.75	5.82
10.80	5.99
10.85	6.16
10.90	6.33
10.95	6.50
11.00	6.68

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
11.05	6.85
11.10	7.01
11.15	7.53
11.20	8.62
11.25	9.87
11.30	11.44
11.35	13.87
11.40	17.17
11.45	21.24
11.50	26.12
11.55	31.95
11.60	38.91
11.65	47.19
11.70	57.00
11.75	68.50
11.80	81.86
11.85	97.18
11.90	114.49
11.95	133.81
12.00	155.10
12.05	178.31
12.10	203.28
12.15	226.15
12.20	244.27
12.25	263.16
12.30	285.22
12.35	308.39
12.40	331.13
12.45	352.51
12.50	371.50
12.55	387.47
12.60	399.82

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
12.65	408.67
12.70	413.97
12.75	416.29
12.80	415.82
12.85	413.01
12.90	408.36
12.95	402.12
13.00	394.62
13.05	386.07
13.10	377.16
13.15	367.18
13.20	355.77
13.25	344.40
13.30	333.78
13.35	323.85
13.40	314.53
13.45	305.95
13.50	297.79
13.55	289.95
13.60	281.92
13.65	273.79
13.70	265.52
13.75	257.21
13.80	248.92
13.85	240.58
13.90	232.33
13.95	224.27
14.00	216.43
14.05	208.84
14.10	201.67
14.15	194.70
14.20	187.65

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
14.25	180.97
14.30	174.87
14.35	169.25
14.40	164.03
14.45	159.23
14.50	154.73
14.55	150.45
14.60	146.28
14.65	142.23
14.70	138.26
14.75	134.39
14.80	130.63
14.85	126.98
14.90	123.44
14.95	120.05
15.00	116.82
15.05	113.73
15.10	110.84
15.15	108.14
15.20	105.60
15.25	103.24
15.30	101.05
15.35	99.05
15.40	97.22
15.45	95.59
15.50	94.14
15.55	92.83
15.60	91.64
15.65	90.57
15.70	89.59
15.75	88.71
15.80	87.91

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FLOOD HYDROGRAPH
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WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
15.85	87.19
15.90	86.53
15.95	85.95
16.00	85.42
16.05	84.96
16.10	84.55
16.15	84.02
16.20	83.25
16.25	82.51
16.30	81.93
16.35	81.41
16.40	80.87
16.45	80.27
16.50	79.58
16.55	78.76
16.60	77.81
16.65	76.73
16.70	75.54
16.75	74.26
16.80	72.93
16.85	71.55
16.90	70.15
16.95	68.75
17.00	67.37
17.05	66.01
17.10	64.71
17.15	63.46
17.20	62.27
17.25	61.15
17.30	60.11
17.35	59.15
17.40	58.28

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
17.45	57.50
17.50	56.82
17.55	56.21
17.60	55.66
17.65	55.17
17.70	54.73
17.75	54.33
17.80	53.97
17.85	53.64
17.90	53.34
17.95	53.08
18.00	52.84
18.05	52.62
18.10	52.43
18.15	52.27
18.20	52.12
18.25	51.99
18.30	51.88
18.35	51.78
18.40	51.69
18.45	51.62
18.50	51.55
18.55	51.50
18.60	51.45
18.65	51.41
18.70	51.38
18.75	51.36
18.80	51.34
18.85	51.32
18.90	51.31
18.95	51.31
19.00	51.31

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
19.05	51.31
19.10	51.31
19.15	51.32
19.20	51.33
19.25	51.34
19.30	51.36
19.35	51.38
19.40	51.40
19.45	51.42
19.50	51.44
19.55	51.46
19.60	51.49
19.65	51.51
19.70	51.54
19.75	51.57
19.80	51.59
19.85	51.62
19.90	51.65
19.95	51.68
20.00	51.71
20.05	51.74
20.10	51.78
20.15	51.72
20.20	51.50
20.25	51.28
20.30	51.12
20.35	50.97
20.40	50.79
20.45	50.57
20.50	50.29
20.55	49.94
20.60	49.50

FLOOD HYDROGRAPH
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WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
20.65	48.99
20.70	48.42
20.75	47.79
20.80	47.13
20.85	46.44
20.90	45.73
20.95	45.02
21.00	44.32
21.05	43.62
21.10	42.95
21.15	42.30
21.20	41.69
21.25	41.10
21.30	40.56
21.35	40.05
21.40	39.59
21.45	39.18
21.50	38.82
21.55	38.50
21.60	38.21
21.65	37.95
21.70	37.72
21.75	37.51
21.80	37.31
21.85	37.14
21.90	36.98
21.95	36.84
22.00	36.71
22.05	36.59
22.10	36.49
22.15	36.40
22.20	36.32

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
22.25	36.24
22.30	36.18
22.35	36.12
22.40	36.07
22.45	36.02
22.50	35.98
22.55	35.95
22.60	35.92
22.65	35.89
22.70	35.87
22.75	35.85
22.80	35.84
22.85	35.82
22.90	35.81
22.95	35.61
23.00	35.80
23.05	35.80
23.10	35.79
23.15	35.79
23.20	35.79
23.25	35.80
23.30	35.80
23.35	35.80
23.40	35.81
23.45	35.82
23.50	35.82
23.55	35.83
23.60	35.84
23.65	35.85
23.70	35.86
23.75	35.87
23.80	35.88

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
23.85	35.89
23.90	35.90
23.95	35.91
24.00	35.92
24.05	35.93
24.10	35.95
24.15	35.93
24.20	35.95
24.25	35.76
24.30	35.25
24.35	34.74
24.40	34.35
24.45	33.98
24.50	33.56
24.55	33.05
24.60	32.41
24.65	31.61
24.70	30.65
24.75	29.55
24.80	28.30
24.85	26.95
24.90	25.53
24.95	24.04
25.00	22.53
25.05	21.01
25.10	19.50
25.15	18.01
25.20	16.57
25.25	15.19
25.30	13.87
25.35	12.62
25.40	11.44

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
25.45	10.36
25.50	9.37
25.55	8.48
25.60	7.69
25.65	7.00
25.70	6.36
25.75	5.78
25.80	5.26
25.85	4.78
25.90	4.35
25.95	3.95
26.00	3.59
26.05	3.26
26.10	2.95
26.15	2.68
26.20	2.43
26.25	2.21
26.30	2.00
26.35	1.82
26.40	1.65
26.45	1.49
26.50	1.35
26.55	1.23
26.60	1.11
26.65	1.01
26.70	0.91
26.75	0.83
26.80	0.75
26.85	0.68
26.90	0.61
26.95	0.55
27.00	0.50

FLOOD HYDROGRAPH

WATERSHED: WILBERG WEST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
27.05	0.45
27.10	0.41
27.15	0.36
27.20	0.33
27.25	0.29
27.30	0.26
27.35	0.24
27.40	0.21
27.45	0.19
27.50	0.17
27.55	0.15
27.60	0.13
27.65	0.12
27.70	0.10
27.75	0.09
27.80	0.07
27.85	0.06
27.90	0.05
27.95	0.04
28.00	0.03
28.05	0.03
28.10	0.02
28.15	0.01
28.20	0.01
28.25	0.01
28.30	0.00

FLOOD RUNOFF VOLUME 115.41 ACRE-FEET

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*  HYDROGRAPH DETERMINATION  *
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WATERSHED: WILBERG EAST
FLOOD EVENT: 100-YEAR/24-HR STORM

CLIENT: UTAH POWER & LIGHT CO.
PROJECT NUMBER: 0179-002
DATE: APRIL 5, 1982

USER: SAB

CALCULATION TIME INCREMENT: 0.05 HOURS

WATERSHED CHARACTERISTICS
****

AREA:	1280.00 ACRES
MEAN ELEVATION:	0.00 FEET
MEAN BASIN SLOPE:	12.75 PERCENT
DRAINAGE LENGTH:	18242.00 FEET
DRAINAGE DENSITY:	14.25 FEET/ACRE

RUNOFF CHARACTERISTICS
****

PEAK FLOW:	656.00 CFS
TIME TO PEAK FLOW:	12.60 HOURS
RUNOFF VOLUME:	159.27 ACRE-FEET
TOTAL STORM PRECIPITATION:	3.50 INCHES
TOTAL STORM RUNOFF:	1.49 INCHES
RUNOFF COEFFICIENT:	0.43

SUB-BASIN CHARACTERISTICS

NUMBER OF SUB-BASINS: 2

SUBBASIN NUMBER	AREA (ACRES)	CURVE NUMBER
1	100.00	95.0
2	1180.00	76.0

COMPOSITE CURVE NUMBER: 77.9

PRECIPITATION CHARACTERISTICS

STORM FREQUENCY: 100-YR
DURATION: 24-HR
INTENSITY: 3.50-IN

RAINFALL DISTRIBUTION

HOUR	RAINFALL (INCHES)
1	0.04
2	0.08
3	0.12
4	0.17
5	0.22
6	0.28
7	0.35
8	0.42
9	0.51
10	0.63
11	0.82
12	2.32
13	2.70
14	2.87
15	2.98
16	3.08
17	3.14
18	3.21
19	3.27
20	3.33
21	3.37
22	3.42
23	3.46
24	3.50

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
2.90	0.00
2.95	0.01
3.00	0.01
3.05	0.02
3.10	0.02
3.15	0.03
3.20	0.03
3.25	0.04
3.30	0.05
3.35	0.06
3.40	0.07
3.45	0.09
3.50	0.10
3.55	0.12
3.60	0.14
3.65	0.16
3.70	0.18
3.75	0.20
3.80	0.22
3.85	0.25
3.90	0.27
3.95	0.30
4.00	0.33
4.05	0.35
4.10	0.38
4.15	0.41
4.20	0.45
4.25	0.48
4.30	0.52
4.35	0.55
4.40	0.58
4.45	0.62

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
4.50	0.65
4.55	0.69
4.60	0.73
4.65	0.77
4.70	0.81
4.75	0.85
4.80	0.89
4.85	0.94
4.90	0.98
4.95	1.02
5.00	1.07
5.05	1.11
5.10	1.15
5.15	1.20
5.20	1.24
5.25	1.28
5.30	1.32
5.35	1.36
5.40	1.40
5.45	1.44
5.50	1.48
5.55	1.52
5.60	1.56
5.65	1.59
5.70	1.63
5.75	1.67
5.80	1.70
5.85	1.74
5.90	1.77
5.95	1.81
6.00	1.84
6.05	1.87

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
6.10	1.91
6.15	1.95
6.20	2.00
6.25	2.04
6.30	2.09
6.35	2.13
6.40	2.17
6.45	2.21
6.50	2.26
6.55	2.30
6.60	2.35
6.65	2.41
6.70	2.46
6.75	2.52
6.80	2.58
6.85	2.64
6.90	2.70
6.95	2.76
7.00	2.82
7.05	2.87
7.10	2.93
7.15	2.99
7.20	3.04
7.25	3.09
7.30	3.14
7.35	3.19
7.40	3.24
7.45	3.28
7.50	3.33
7.55	3.37
7.60	3.41
7.65	3.45

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
7.70	3.49
7.75	3.53
7.80	3.56
7.85	3.60
7.90	3.64
7.95	3.67
8.00	3.70
8.05	3.74
8.10	3.77
8.15	3.82
8.20	3.89
8.25	3.96
8.30	4.02
8.35	4.07
8.40	4.12
8.45	4.18
8.50	4.24
8.55	4.31
8.60	4.39
8.65	4.48
8.70	4.57
8.75	4.66
8.80	4.75
8.85	4.85
8.90	4.95
8.95	5.05
9.00	5.14
9.05	5.24
9.10	5.33
9.15	5.44
9.20	5.57
9.25	5.69

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
9.30	5.80
9.35	5.90
9.40	5.99
9.45	6.09
9.50	6.19
9.55	6.29
9.60	6.40
9.65	6.52
9.70	6.64
9.75	6.76
9.80	6.88
9.85	7.01
9.90	7.13
9.95	7.25
10.00	7.37
10.05	7.49
10.10	7.60
10.15	7.78
10.20	8.07
10.25	8.39
10.30	8.67
10.35	8.96
10.40	9.26
10.45	9.60
10.50	9.98
10.55	10.41
10.60	10.91
10.65	11.47
10.70	12.10
10.75	12.79
10.80	13.54
10.85	14.35

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
10.90	15.21
10.95	16.13
11.00	17.08
11.05	18.08
11.10	19.12
11.15	23.73
11.20	34.53
11.25	46.40
11.30	57.03
11.35	67.74
11.40	79.31
11.45	92.44
11.50	107.62
11.55	125.41
11.60	145.99
11.65	169.48
11.70	195.70
11.75	224.57
11.80	255.87
11.85	289.25
11.90	324.50
11.95	361.40
12.00	399.55
12.05	438.60
12.10	478.29
12.15	508.50
12.20	523.51
12.25	540.05
12.30	563.51
12.35	588.08
12.40	610.88
12.45	629.96

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
12.50	644.34
12.55	652.98
12.60	656.00
12.65	653.67
12.70	647.01
12.75	636.50
12.80	622.87
12.85	607.08
12.90	589.55
12.95	570.66
13.00	551.23
13.05	531.85
13.10	512.81
13.15	492.25
13.20	469.33
13.25	448.14
13.30	430.14
13.35	414.59
13.40	400.66
13.45	387.77
13.50	375.21
13.55	362.70
13.60	350.24
13.65	337.70
13.70	325.20
13.75	312.71
13.80	300.41
13.85	288.49
13.90	276.93
13.95	265.86
14.00	255.42
14.05	245.52

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
14.10	236.23
14.15	226.98
14.20	217.37
14.25	208.58
14.30	201.03
14.35	194.38
14.40	188.36
14.45	182.82
14.50	177.52
14.55	172.36
14.60	167.34
14.65	162.40
14.70	157.57
14.75	152.86
14.80	148.28
14.85	143.89
14.90	139.68
14.95	135.68
15.00	131.91
15.05	128.35
15.10	125.04
15.15	121.96
15.20	119.10
15.25	116.49
15.30	114.12
15.35	112.01
15.40	110.12
15.45	108.44
15.50	106.93
15.55	105.58
15.60	104.36
15.65	103.28

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
15.70	102.31
15.75	101.44
15.80	100.66
15.85	99.98
15.90	99.39
15.95	98.88
16.00	98.45
16.05	98.08
16.10	97.77
16.15	97.06
16.20	95.73
16.25	94.53
16.30	93.69
16.35	92.98
16.40	92.26
16.45	91.45
16.50	90.51
16.55	89.40
16.60	88.12
16.65	86.69
16.70	85.15
16.75	83.53
16.80	81.85
16.85	80.16
16.90	78.47
16.95	76.81
17.00	75.19
17.05	73.64
17.10	72.18
17.15	70.79
17.20	69.49
17.25	68.29

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
17.30	67.21
17.35	66.26
17.40	65.41
17.45	64.67
17.50	64.01
17.55	63.41
17.60	62.88
17.65	62.40
17.70	61.97
17.75	61.58
17.80	61.22
17.85	60.91
17.90	60.63
17.95	60.38
18.00	60.17
18.05	59.97
18.10	59.80
18.15	59.65
18.20	59.51
18.25	59.39
18.30	59.29
18.35	59.20
18.40	59.12
18.45	59.05
18.50	58.99
18.55	58.93
18.60	58.89
18.65	58.85
18.70	58.82
18.75	58.79
18.80	58.77
18.85	58.76

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
18.90	58.74
18.95	58.73
19.00	58.73
19.05	58.73
19.10	58.73
19.15	58.73
19.20	58.73
19.25	58.74
19.30	58.75
19.35	58.76
19.40	58.77
19.45	58.78
19.50	58.79
19.55	58.81
19.60	58.82
19.65	58.84
19.70	58.85
19.75	58.87
19.80	58.89
19.85	58.91
19.90	58.93
19.95	58.96
20.00	58.98
20.05	59.00
20.10	59.03
20.15	58.83
20.20	58.30
20.25	57.81
20.30	57.50
20.35	57.24
20.40	56.97
20.45	56.64

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
20.50	56.23
20.55	55.73
20.60	55.13
20.65	54.44
20.70	53.69
20.75	52.89
20.80	52.06
20.85	51.22
20.90	50.37
20.95	49.53
21.00	48.71
21.05	47.92
21.10	47.17
21.15	46.46
21.20	45.79
21.25	45.18
21.30	44.63
21.35	44.14
21.40	43.71
21.45	43.33
21.50	42.99
21.55	42.68
21.60	42.41
21.65	42.16
21.70	41.94
21.75	41.74
21.80	41.55
21.85	41.39
21.90	41.24
21.95	41.11
22.00	41.00
22.05	40.89

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
22.10	40.80
22.15	40.72
22.20	40.64
22.25	40.58
22.30	40.52
22.35	40.47
22.40	40.42
22.45	40.38
22.50	40.35
22.55	40.32
22.60	40.29
22.65	40.27
22.70	40.25
22.75	40.23
22.80	40.22
22.85	40.21
22.90	40.20
22.95	40.19
23.00	40.18
23.05	40.18
23.10	40.18
23.15	40.18
23.20	40.17
23.25	40.18
23.30	40.18
23.35	40.18
23.40	40.18
23.45	40.18
23.50	40.19
23.55	40.19
23.60	40.20
23.65	40.20

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
23.70	40.21
23.75	40.21
23.80	40.22
23.85	40.23
23.90	40.24
23.95	40.25
24.00	40.26
24.05	40.27
24.10	40.28
24.15	40.27
24.20	40.28
24.25	39.83
24.30	38.70
24.35	37.67
24.40	37.01
24.45	36.44
24.50	35.84
24.55	35.13
24.60	34.27
24.65	33.20
24.70	31.93
24.75	30.50
24.80	28.94
24.85	27.27
24.90	25.54
24.95	23.79
25.00	22.02
25.05	20.27
25.10	18.57
25.15	16.93
25.20	15.37
25.25	13.90

FLOOD HYDROGRAPH

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
25.30	12.51
25.35	11.24
25.40	10.08
25.45	9.06
25.50	8.15
25.55	7.35
25.60	6.63
25.65	5.98
25.70	5.40
25.75	4.88
25.80	4.40
25.85	3.96
25.90	3.57
25.95	3.21
26.00	2.89
26.05	2.60
26.10	2.35
26.15	2.11
26.20	1.90
26.25	1.71
26.30	1.54
26.35	1.38
26.40	1.24
26.45	1.12
26.50	1.00
26.55	0.90
26.60	0.81
26.65	0.73
26.70	0.65
26.75	0.58
26.80	0.52
26.85	0.47

FLOOD HYDROGRAPH
****

WATERSHED: WILBERG EAST
STORM: 100-YR/24-HR

TIME (HOURS)	DISCHARGE (CFS)
26.90	0.42
26.95	0.37
27.00	0.33
27.05	0.29
27.10	0.26
27.15	0.23
27.20	0.21
27.25	0.18
27.30	0.16
27.35	0.14
27.40	0.12
27.45	0.10
27.50	0.09
27.55	0.07
27.60	0.06
27.65	0.05
27.70	0.04
27.75	0.03
27.80	0.02
27.85	0.02
27.90	0.01
27.95	0.01
28.00	0.00

FLOOD RUNOFF VOLUME 159.27 ACRE-FEET

FINAL RECLAMATION
STREAMBED - GEOLOGY

Reconstruction of the channels of both the right and left forks of Grimes Wash will be located in bedrock of the Starpoint Sandstone and Masuk Shale. The upper portions of the channels where the natural Starpoint Sandstone escarpment exists is steep, up to 40% slope. But in these areas the competent bedrock outcrops of the Starpoint Sandstone should resist erosion. The lower reaches of the reconstructed channels will be a lower grade, averaging 15-20% slope and will be located in Masuk Shale bedrock. These reconstructed channels will closely follow the natural channels of the wash. See included profile in Map packet 4-2.

Reclamation of the streambed channels are based on straight and even grades. Where possible, the new stream channels will be located in the original channel bed.

Riprap and Filter Gradation Design

Known Specs:

Base Material – USING SOIL BELOW ROAD TO UPPER PARKING LOT (Critical Curve)

$D_{15} = 0.015$ mm

$D_{50} = 0.25$ mm

$D_{85} = 15$ mm

Channel Riprap – $D_{50} = 914.4$ mm $= 3.0$ ft

$\frac{D_{15}\ \text{Upper}}{D_{85}\ \text{Lower}} < 5$ $\quad D_{15}$ Upper $< 5\, D_{85}$ Lower

$5 < \frac{D_{15}\ \text{Upper}}{D_{15}\ \text{Lower}} < 40$ $\quad 5 D_{15}$ Lower $< D_{15}$ Upper; D_{15} Upper $< 40\, D_{15}$ Lower

$\frac{D_{50}\ \text{Upper}}{D_{50}\ \text{Lower}} < 40$ $\quad D_{50}$ Upper $< 40\, D_{50}$ Lower

FILTER BLANKET DESIGN

1st LAYER: $D_{15} < 5(15)$ $\quad D_{15} < 75$ mm

$5(.015) < D_{15}$ $\quad 0.075 < D_{15}$

$D_{15} < 40(.015)$ $\quad D_{15} < 0.6$ mm

$D_{50} < 40(0.25)$ $\quad D_{50} < 10.0$ mm

USE $D_{15} = 0.42$ mm $\quad D_{50} = 2.5\, D_{15} = 1.09$

$D_{50} = 1.09$ mm

$D_{25} = 2.0$ mm

2nd LAYER: $D_{15} < 10$ mm

$2.1 < D_{15}$

$D_{15} < 16.8$ mm

$D_{50} < 43.6$ mm

USE $D_{15} = 4.76$ mm $\quad D_{50} = 2.5(4.76) = 11.9$

$D_{50} = 12.0$ mm

$D_{35} = 25.4$ mm

APPENDIX XV
Addition 11/1/84

3rd Layer: $D_{15} < 127mm$
$23.8mm < D_{15} < 190.4mm$
$D_{50} < 480\ mm$

USE $D_{15} = 38.1\ mm$ $D_{50} : 2.5 D_{15} = 95.2$
$D_{50} = 95\ mm$
$D_{85} = 152\ mm$

Riprap Layer: $D_{15} < 760mm$
$190.5\ mm < D_{15} < 1524\ mm$
$D_{50} < 3800\ mm$ $3800 > 914$ ok

$D_{max} = 1.25 D_{50} = 1.25 (3 ft) = 3.75 ft$

$\frac{D_{50}}{D_{15}} = 2.5$ $D_{15} = \frac{D_{50}}{2.5} = \frac{3.0}{2.5} = 1.2 ft = 366\ mm$
$191 < 366 < 760$ ok

Therefore Use:

$D_{max} = 3.75 ft$
$D_{50} = 3.0 ft$
$D_{15} = 1.2 ft$

Filter Blanket Thickness: 6" Min or $1.25 D_{50}$

Layer 1: (Bottom) $D_{50} = 1.09mm$ $D_{max} \sim 2.18\ mm << 6in$
(Use 6" thickness)

Layer 2: (Middle) $D_{50} = 12mm$ $D_{max} \sim 24mm << 6in$
(Use 6" thickness)

Layer 3: (Top) $D_{50} = 95mm$ $D_{max} = 190mm = 7.48\ in$
(Use 8" thickness)

Check # of filters Req. using Coarse Soil Sample (Below Upper Parking Lot)

Soil: $D_{15} = 0.05\ mm$
$D_{50} = 0.40\ mm$
$D_{85} = 7.5\ mm$

1st Layer: $D_{15} < 37.5$
$.25\ D_{15} < 2.0$
$D_{50} < 16.0$

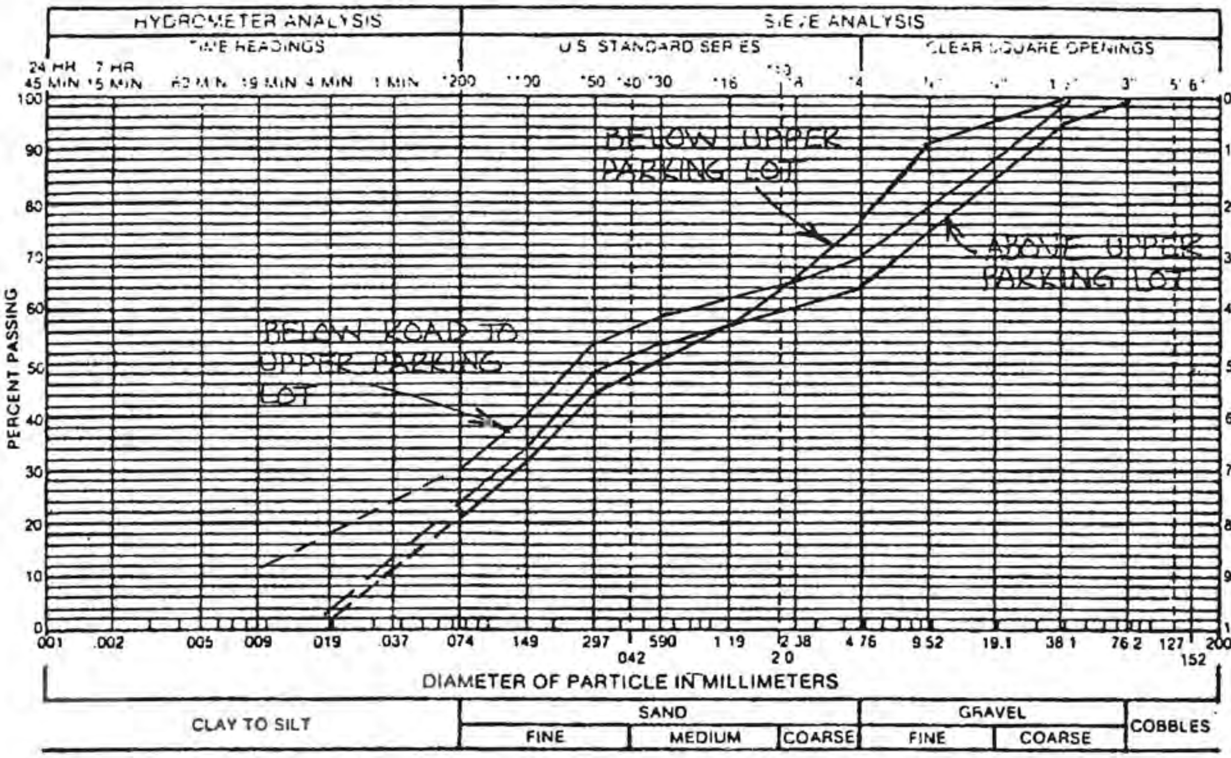
Meets Requirements of Soil Gradation Curve calculated on Previous Page for Layer 1. ok

VAUGHN HANSEN ASSOCIATES
CONSULTANTS / ENGINEERS

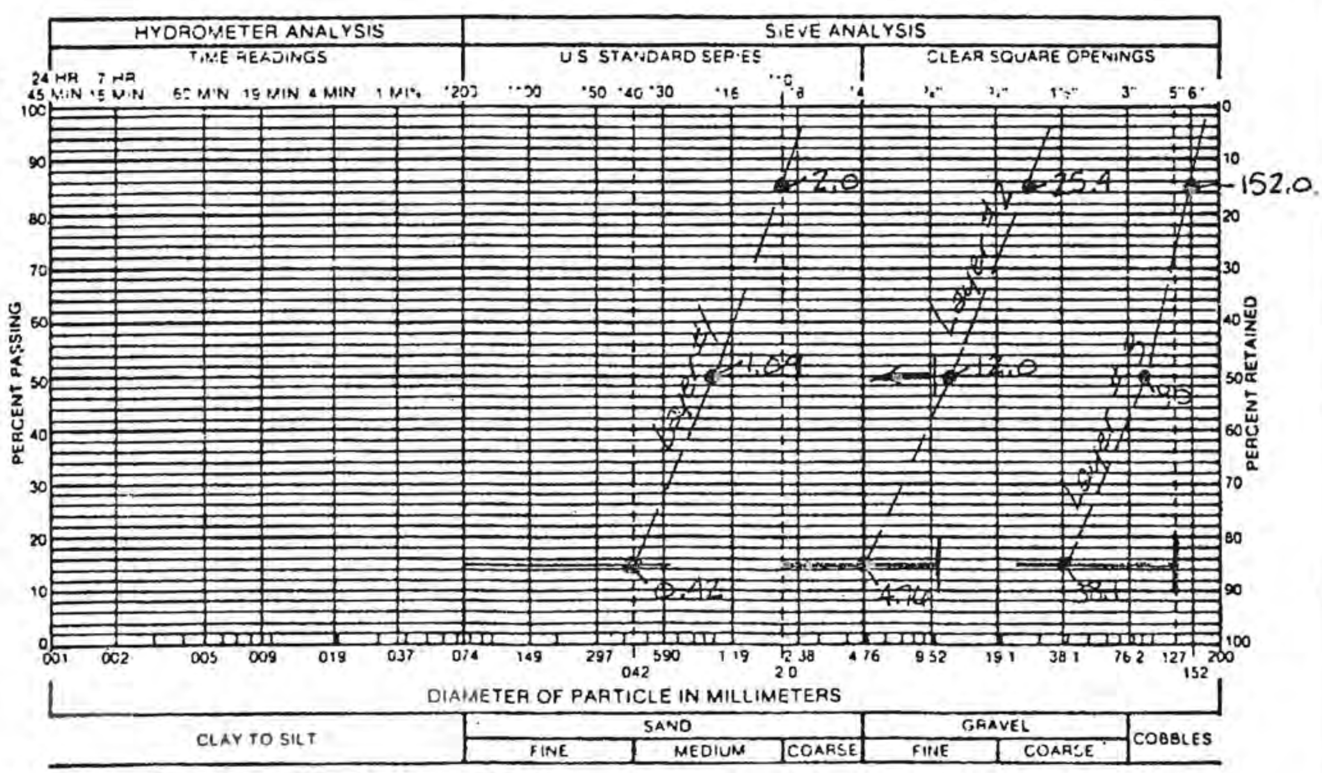
COMPUTED ____ CLIENT ____
CHECKED ____ PROJECT WILBERG MINE
DATE 16 OCT 84 FEATURE ____

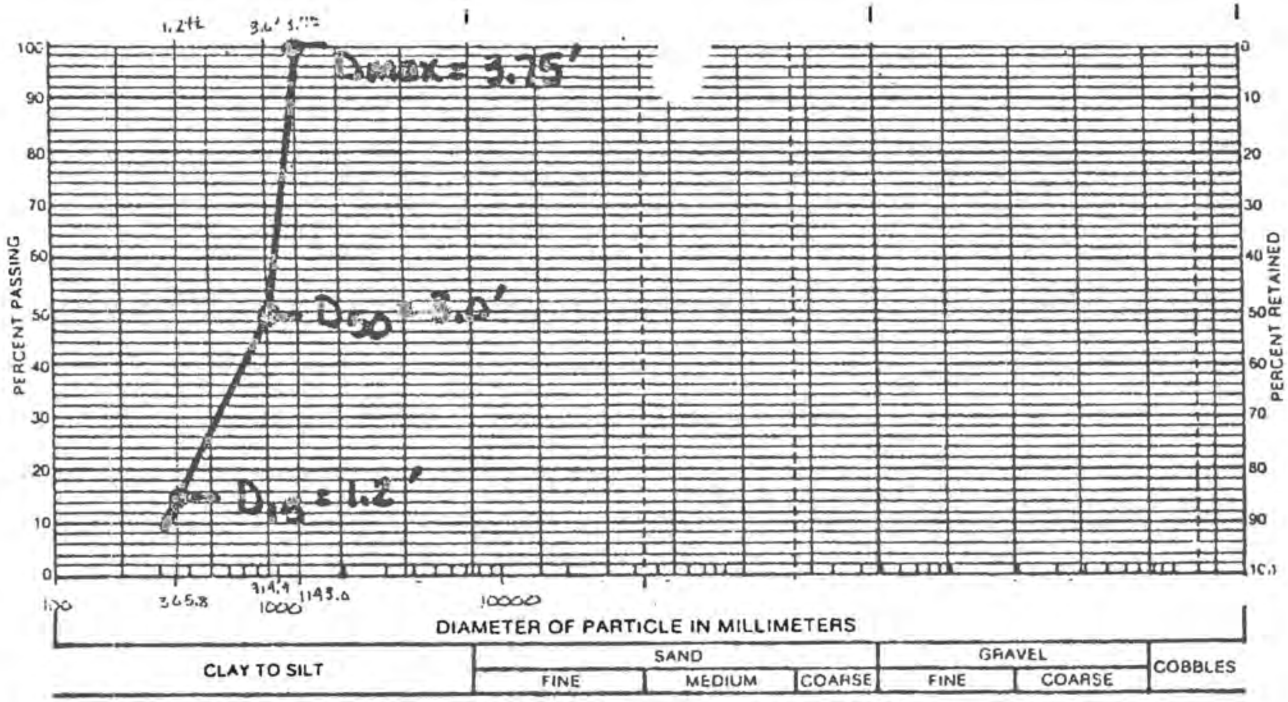
COMBINED SIEVE ANALYSES

MINE SAMPLES:



GRAVEL FILTERS:





GRAVEL % SAND % SILT AND CLAY %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF FROM

RIPRAP GRADATION FOR CHANNELS

#535884 **GRADATION TEST RESULTS** Fig. 2

chen and associates, inc.
CONSULTING ENGINEERS

SOIL & FOUNDATION
ENGINEERING
401 IRONWOOD DR. • SALT LAKE CITY, UTAH 84115 • 801/487-3661

October 12, 1984

Subject: Gradation Testing,
Wilberg Mine

Job No. 535884

Vaughn Hansen Associates
Waterbury Plaza Suite A
5620 South 1475 East
Salt Lake City, Utah 84121

Attention: Marv Allen

Gentlemen:

Chen and Associates, Inc. conducted gradation analyses on three samples of material submitted to our office from the Wilberg Mine parking lot areas. Enclosed are the test results.

If you have any questions or if we can be of further service, please call.

Sincerely,

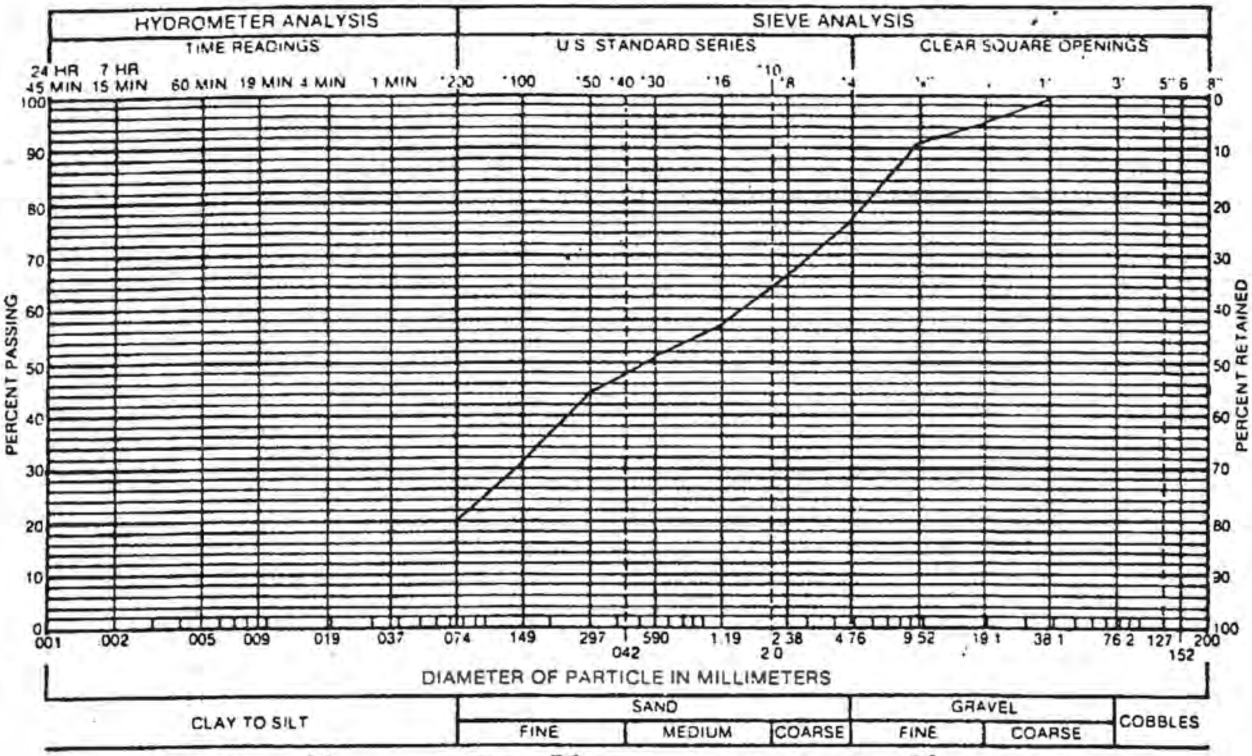
CHEN AND ASSOCIATES, INC.

REGISTERED PROFESSIONAL ENGINEER
NO. 6153
JAMES E.
NORDQUIST
State of Utah

James E. Nordquist, P.E.

JEN/tc
Enclosures

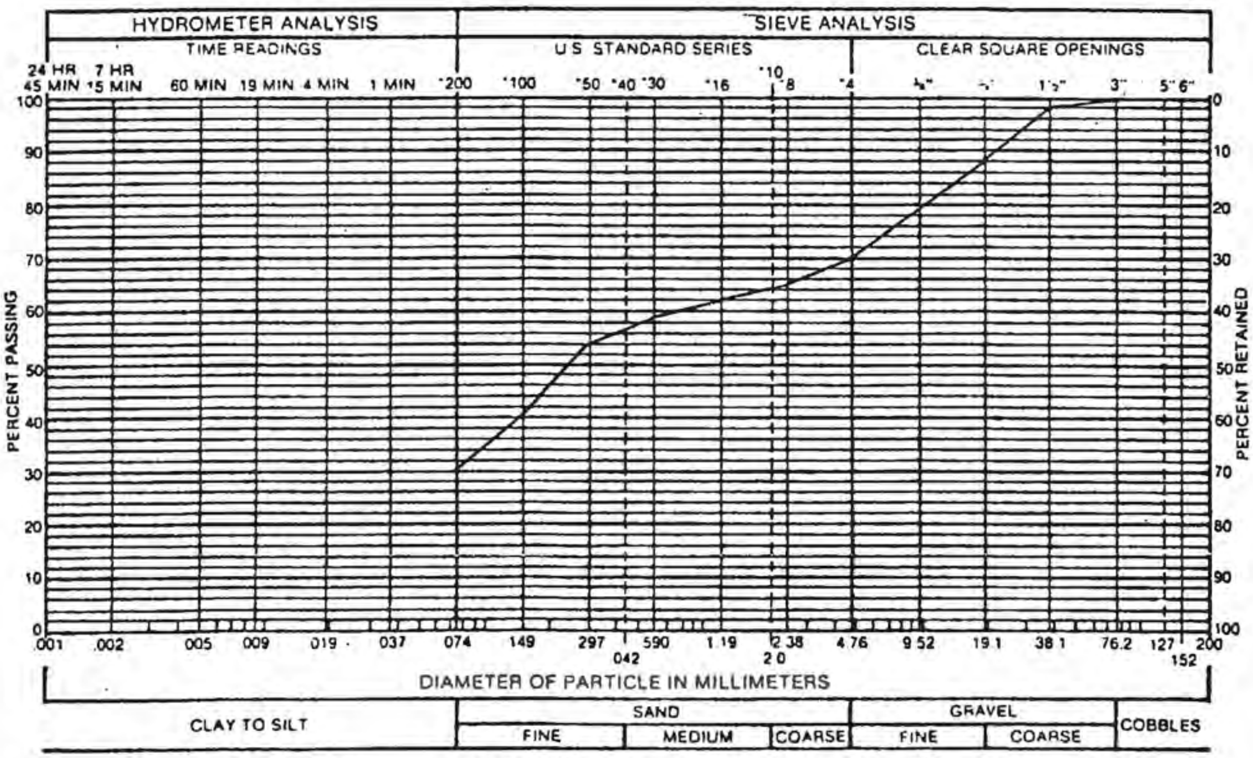
chen and associates, inc.



GRAVEL 24 % SAND 56 % SILT AND CLAY 20 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF Silty and Gravelly Sand FROM Wilberg Mine
Soil below upper parking lot



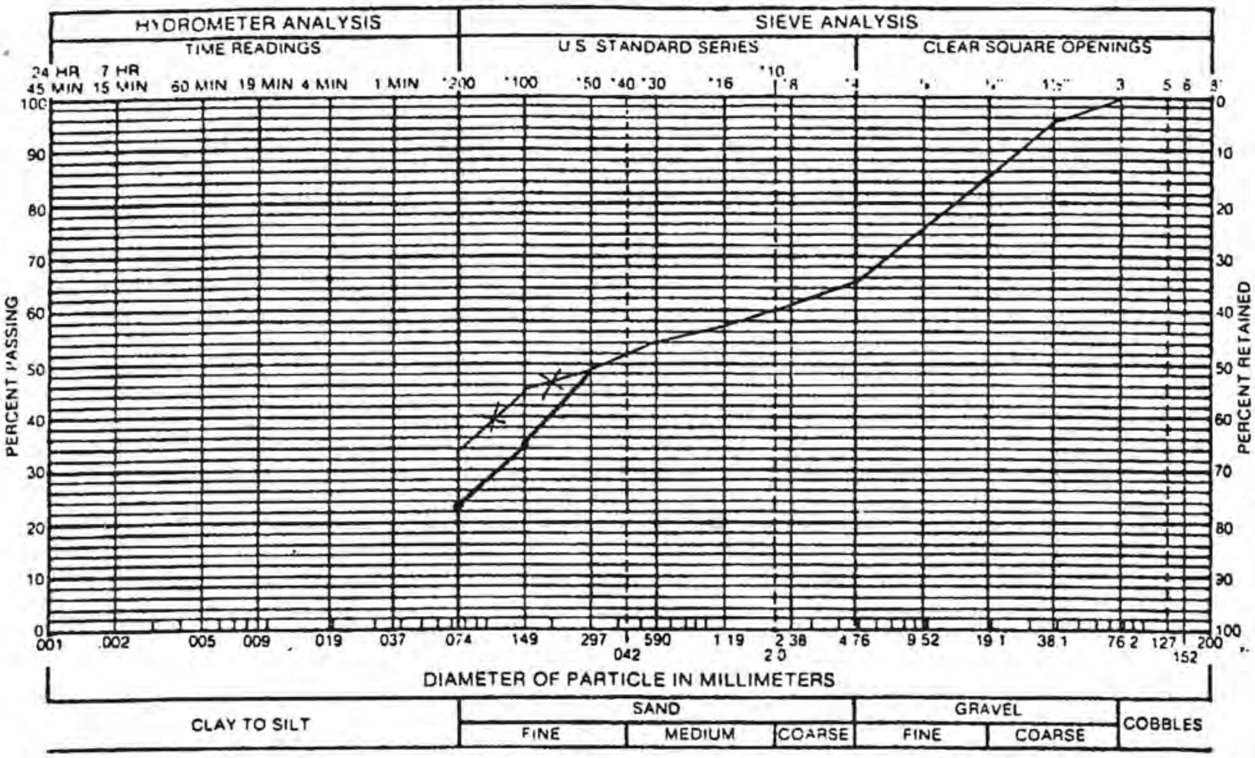
GRAVEL 30 % SAND 40 % SILT AND CLAY 30 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF Clayey Sand & Gravel FROM Wilberg Mine
Soil below road to upper parking lot

#535884 GRADATION TEST RESULTS Fig. 1

chen and associates, inc.

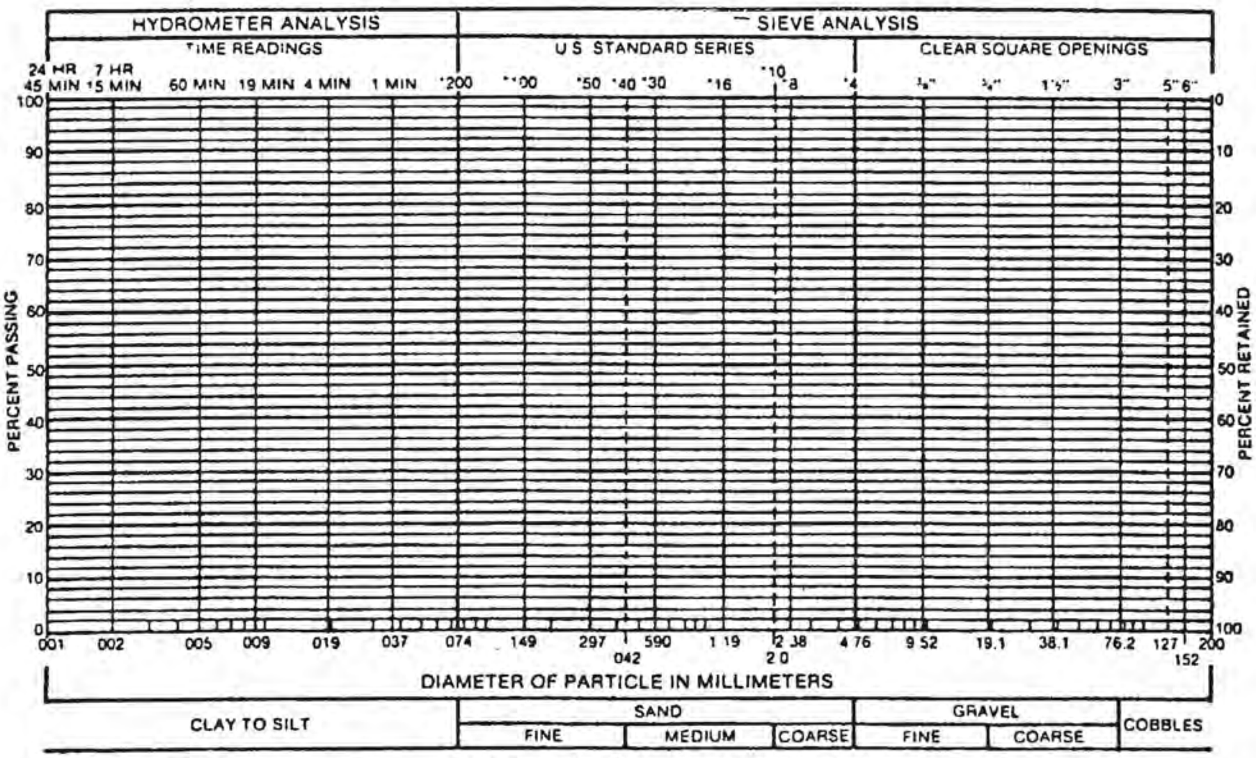


GRAVEL 35 % SAND 42 % SILT AND CLAY 23 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF Silty Sand and Gravel FROM Wilberg Mine
Soil above the upper parking lot

Corrected by Phone w/ Jim Hodquist 10/15/84



GRAVEL % SAND % SILT AND CLAY %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF FROM

#535884

GRADATION TEST RESULTS

Fig. 2

DROP DESIGN

MAX. ALLOWABLE DROP HEIGHT = 5.0'

RIPRAPPED CHANNEL REQUIRED DOWNSTREAM OF DROP

1, LENGTH = IMPACT LENGTH + 4 EXIT DEPTH
(SIMONS + Li ASSOC. DENVER COLORADO)

IMPACT LENGTH ≈ 0 ft
EXIT DEPTH: Max Depth ~ 3.6' (USE 4.0')

∴ LENGTH = 0+4(4) = 16 ft from bottom of Large Rock Slope

RIPRAP SIZING

USE BACKWATER TO FIND FLOW DEPTH:

$$Fr^2 = 1 = \frac{Q^2 B}{g A^3} \qquad A = by + my^2 \qquad Q = 180$$
$$B = b + 2my$$

Normal Upstream Depth assuming a 11% Slope
$y = 1.4$ ft

Mannings $n = 0.0395\, D_{50}^{1/6}$ Use $D_{50} = 3.0$ ∴ $n \simeq 0.05$

COMPUTER INPUT:

Use Starting depth = 1.4 ft

Transition Length = 8 ft } S = 0.50
$\Delta z = 4$ ft
$M = 2.0$
$B = 10.0$

Downstream Length = 25
$S = 0.11$
$M = 2.0$
$B = 10.0$

Riprap Size = Dmin = 3.0'

Projecting Curves (fig 5.3)

{ OSM Manual Shows that a $D_{50} = 3.0'$ will work up to 40% Slopes. 50% Slopes are ok up to a flow rate of 170 cfs }

Since we are using a Dmin = 3.0' our D_{50} would be larger than that shown. ∴ ok

Supercritical Flow

TRAP	TO TRANSITION TO		TRAP		
	N	S	M	B	L
TRAP	0.050	0.110	2.0	10.0	0.0
TRANS	0.050	0.500			8.0
TRAP	0.050	0.110	2.0	10.0	25.0

Q= 180.00

INDEP. VAR., X	DEP. VAR., Y	DERIVATIVE DY/DX	INCREMENT DLX	FR2
+0.000	1.40	-2.316280E-01	+0.500	2.728
+0.500	1.31	-1.444382E-01	+0.500	3.545
+1.000	1.24	-1.133992E-01	+0.500	4.059
+1.500	1.19	-8.750348E-02	+0.500	4.675
+0.000	1.40	-2.316280E-01	+0.250	2.728
+0.250	1.35	-1.825423E-01	+0.250	3.109
+0.500	1.31	-1.527428E-01	+0.250	3.436
+0.750	1.27	-1.302069E-01	+0.250	3.758
+0.000	1.40	-2.316280E-01	+0.125	2.728
+0.125	1.37	-2.051009E-01	+0.125	2.915
+0.250	1.35	-1.845761E-01	+0.125	3.090
+0.375	1.33	-1.675909E-01	+0.125	3.262
+1.375	1.20	-9.398389E-02	+0.125	4.499
+2.375	1.13	-6.227015E-02	+0.125	5.569
+3.375	1.07	-4.455226E-02	+0.125	6.504
+4.375	1.03	-3.331258E-02	+0.125	7.320
+5.375	1.00	-2.562613E-02	+0.125	8.028
+6.375	0.98	-2.010367E-02	+0.125	8.641
+7.375	0.96	-1.599657E-02	+0.125	9.168
+8.125	0.95	+3.214738E-02	+0.063	9.451
+8.188	0.96	+3.206005E-02	+0.063	9.388
+8.250	0.96	+3.197264E-02	+0.063	9.325
+8.313	0.96	+3.188513E-02	+0.063	9.263
+9.375	0.99	+3.037850E-02	+0.250	8.310
+10.625	1.03	+2.856346E-02	+0.500	7.392
+12.125	1.07	+2.633564E-02	+1.000	6.515
+13.125	1.10	+2.482959E-02	+1.000	6.036
+14.125	1.12	+2.331577E-02	+1.000	5.627
+16.125	1.17	+2.030084E-02	+2.000	4.972
+18.125	1.20	+1.736900E-02	+2.000	4.484
+20.125	1.23	+1.459965E-02	+2.000	4.116
+24.125	1.28	+9.806848E-03	+4.000	3.630
+28.125	1.31	+6.220286E-03	+4.000	3.352
+32.125	1.33	+3.776247E-03	+4.000	3.194
+36.125	1.35	+2.228037E-03	+4.000	3.103

PacifiCorp – Interwest Mining Company

Appendix F-2

Design for Watersheds Draining Less Than One Square Mile

Cottonwood/Wilberg Mine Reclamation Plan

2016

COTTONWOOD/WILBERG MINE
RECLAMATION SIDE CHANNEL DESIGN

Watershed Areas and Slopes

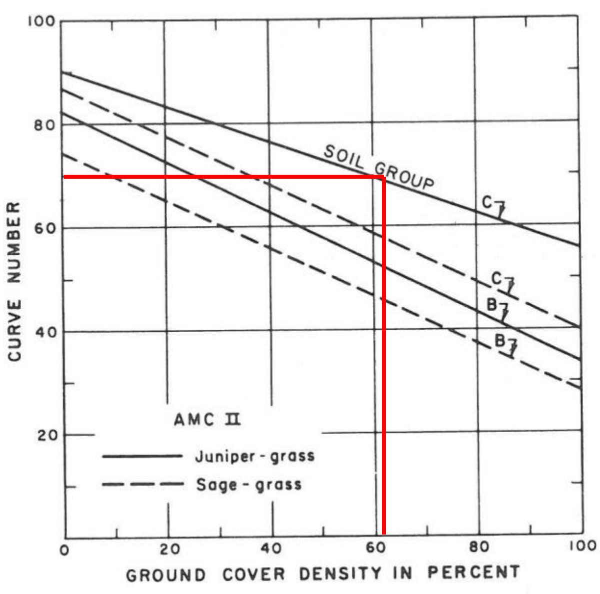
Watershed	Area (ft^2)[a]	Area (acres)	Contour Length (ft)[b]	Contour Interval (ft)	Average Slope (%)
RWS-1	1,523,999	35.0	4,900	200	64.3
RWS-2	1,572,280	36.1	4,250	200	54.1
RWS-3	1,194,458	27.4	3,650	200	61.1
RWS-4	455,798	10.5	1,950	200	85.6
RWS-5	487,630	11.2	2,050	200	84.1
RWS-6	2,716,022	62.4	7,200	200	53.0

[a] AutoCAD determination from Figure 1
[b] Measured from Figure 1

Curve Number

Data from the Cottonwood Mine Site Pinyon-Juniper Reference Area (Mt. Nebo Scientific. 2012. Vegetation Monitoring: Reference Areas, 2011, Energy West Mine Areas. Project report submitted to Energy West Mining Company. Springville, UT):

Average cover density = 8.0% (overstory)
36.2% (understory)
17.0% (litter)
61.2%



Graphical CN = 70. Increase to CN=80 to account for steep, rocky slopes.

Source of figure: NRCS National Engineering Handbook 630.

Reclamation Channel Slopes

RC-1: 25'/95' = 26.3%
RC-2: 25'/60' = 41.7%
RC-3: 25'/55' = 45.5%
RC-4: 20'/95' = 21.1%
RC-5: 15'/30' = 50.0%
RC-6: 25'/50' = 50.0%

Manning's Roughness Coefficient

Arcement and Schneider (1989)[1] indicate that a typical base "n" value for uniform channels constructed with cobbles averages 0.040. Preliminary calculations indicated that channels with this roughness constructed at the above-noted steepness would produce velocities near or in excess of 10 ft/s for all channels except RC-4. Therefore, boulder obstructions will be added to the design to increase the channel roughness in all channels except RC-4.

Arcement and Schneider (1989) indicate that an "appreciable" obstruction that occupies 15% to 50% of the channel bottom will result in an increase in the roughness coefficient of 0.020 to 0.030. With a 6 ft bottom width, a 3 ft diameter boulder would occupy 50% of the channel bottom. Therefore, the design roughness coefficient was set at:

$$n = 0.040 + 0.030$$
$$= 0.070$$

Precipitation Depths

R645-301-742.333 requires that permanent diversions of ephemeral streams draining less than one square mile be designed to safely convey the peak flow resulting from a 10-year, 6-hour precipitation event. Given the 10-year bonding requirement of the regulations, the ephemeral side channels at the site will be designed based on the peak flow resulting from the 25-year, 6-hour precipitation event. Precipitation data used for peak flow calculations were obtained from the National Weather Service Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/ - see Attachment A).

Calculation Results

Peak flows and associated channel velocities were determined using HydroCAD, version 10.0. The results of these calculations for both the 10-year, 6-hour event and the 25-year, 6-hour event are provided in Attachment B. Design riprap sizing is presented in Table 1, based on methods presented by Brown and Clyde (1989).[2] Design filter blanket requirements are provided in Table 2, also based on methods presented by Brown and Clyde (1989). Reclamation channel cross sections are presented in Figures 2 and 3 based on the two design riprap sizes.

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[1] Arcement, G.J. and V.R. Schneider. 1989. Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains. USGS Water Supply Paper 2335. Washington, D.C.
[2] Brown, S.A. and E.S. Clyde. 1989. Design of Riprap Revetment. Hydraulic Engineering Circular No. 11. U.S. Department of Transportation, Federal Highway Administration. McLean, Virginia.

TABLE 1

Reclamation channel RipRap Sizing
Cottonwood/Wilberg Mine Complex

Precipitation event: 25-yr, 6-hr
Bank angle = 2 :1 = 26.57 degrees = 0.464 radians
Riprap material angle of repose = 39 degrees = 0.681 radians

K1 = 0.704

Channel	Design Velocity (ft/s)	Flow Depth (ft)	Median Riprap Diameter		
			Calculated (ft)	Calculated (in)	Planned (in)
RC-1	7.11	0.65	0.755	9.1	15
RC-2	8.05	0.55	1.192	14.3	15
RC-3	7.71	0.47	1.133	13.6	15
RC-4	7.75	0.37	1.297	15.6	15
RC-5	6.74	0.34	0.890	10.7	15
RC-6	10.05	0.68	2.086	25.0	24

Method Reference:

Brown, S.A. and E.S. Clyde. 1989. Design of Riprap Revetment. Hydraulic Engineering Circular No. 11. U.S. Departmnt of Transportation, Federal Highway Administration. McLean, Virginia.

TABLE 2

Reclamation Channel Riprap Filter Design

Design median diameter (in):

Riprap:	15	
Filter	3	
Base	0.25	(Strych Series, stony sandy loam)

Ideal calculated or measured gradations (inches):

Size Class	Riprap	Upper Filter	Base Soil
D_{100}	24	4.8	0.4
D_{85}	19.5	3.9	0.325
D_{50}	15	3	0.25
D_{15}	7.5	1.5	0.125

Calculated gradations based on:

D_{100} = 1.5 D_{50} to 1.7 D_{50}

D_{85} = 1.2 D_{50} to 1.4 D_{50}

D_{50} = 1.0 D_{50} to 1.1 D_{50}

D_{15} = 0.4 D_{50} to 0.6 D_{50}

Filter gradation criteria:

D_{15}(coarser layer)/D_{85}(finer layer) < 5

5 < D_{15}(coarser layer)/D_{15}(finer layer) < 40

Filter gradation check:

Layers Compared	D_{15}(coarse)/D_{85}(fine)	D_{15}(coarse)/D_{15}(fine)	OK?
Riprap vs. Upper	1.9	5.0	Yes
Upper vs. Lower	4.6	12.0	Yes
Criterion	< 5	5 - 40	

Design median diameter (in):

Riprap:	24	
Filter	3	
Base	0.25	(Strych Series, stony sandy loam)

Ideal calculated or measured gradations (inches):

Size Class	Riprap	Upper Filter	Base Soil
D_{100}	38.4	4.8	0.4
D_{85}	31.2	3.9	0.325
D_{50}	24	3	0.25
D_{15}	12	1.5	0.125

Calculated gradations based on:

D_{100} = 1.5 D_{50} to 1.7 D_{50}

D_{85} = 1.2 D_{50} to 1.4 D_{50}

D_{50} = 1.0 D_{50} to 1.1 D_{50}

D_{15} = 0.4 D_{50} to 0.6 D_{50}

Filter gradation criteria:

D_{15}(coarser layer)/D_{85}(finer layer) < 5

5 < D_{15}(coarser layer)/D_{15}(finer layer) < 40

Filter gradation check:

Layers Compared	D_{15}(coarse)/D_{85}(fine)	D_{15}(coarse)/D_{15}(fine)	OK?
Riprap vs. Upper	3.1	8.0	Yes
Upper vs. Lower	4.6	12.0	Yes
Criterion	< 5	5 - 40	

Reference:

Brown, S.A. and E.S. Clyde. 1989. Design of Riprap Revetment. Hydraulic Enigneering Circular No. 11. U.S. Department of Transportation, Federal Highway Administration. McLean, VA.

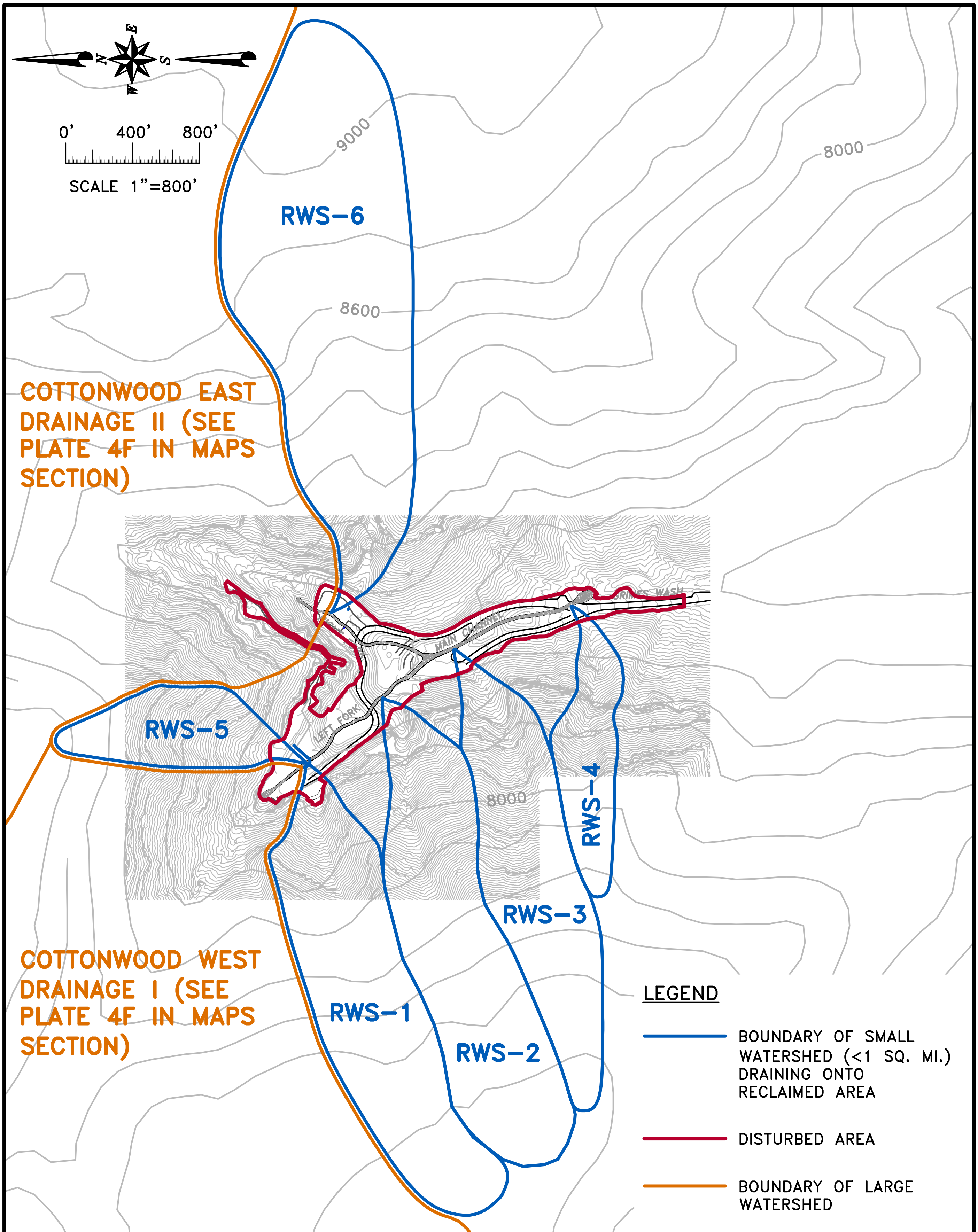
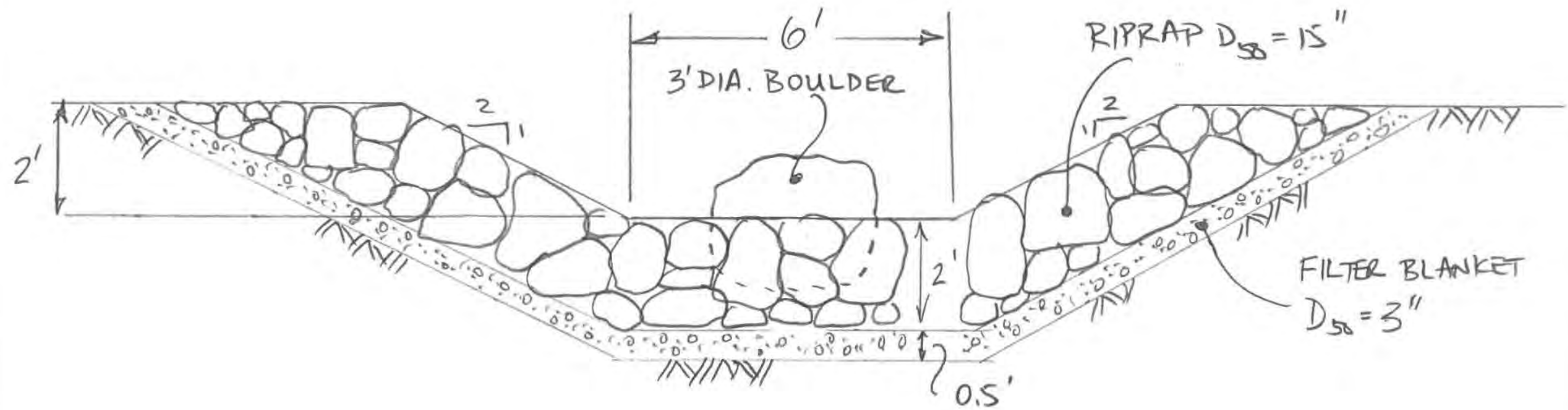


FIGURE 1. COTTONWOOD/WILBERG SIDE CHANNEL RECLAMATION WATERSHEDS

G:\UC1633 - Interwest Mining\01 - Cottonwood-Wilberg rec plan\DWG\FIGURE 1 - Side channel design.dwg, 8/10/2016 4:55:17 PM

FIGURE 2



GENERIC RECLAMATION CHANNEL
(RC-1 THRU RC-5)

Scale: 1" = 3'

NOTE: BOULDER OBSTRUCTIONS TO BE PLACED RANDOMLY WITHIN THE CHANNEL BOTTOM AT A LONGITUDINAL SPACING OF 10' TO 15' ALONG THE LENGTH OF THE CHANNEL. BOULDERS NOT REQUIRED AT RC-4.

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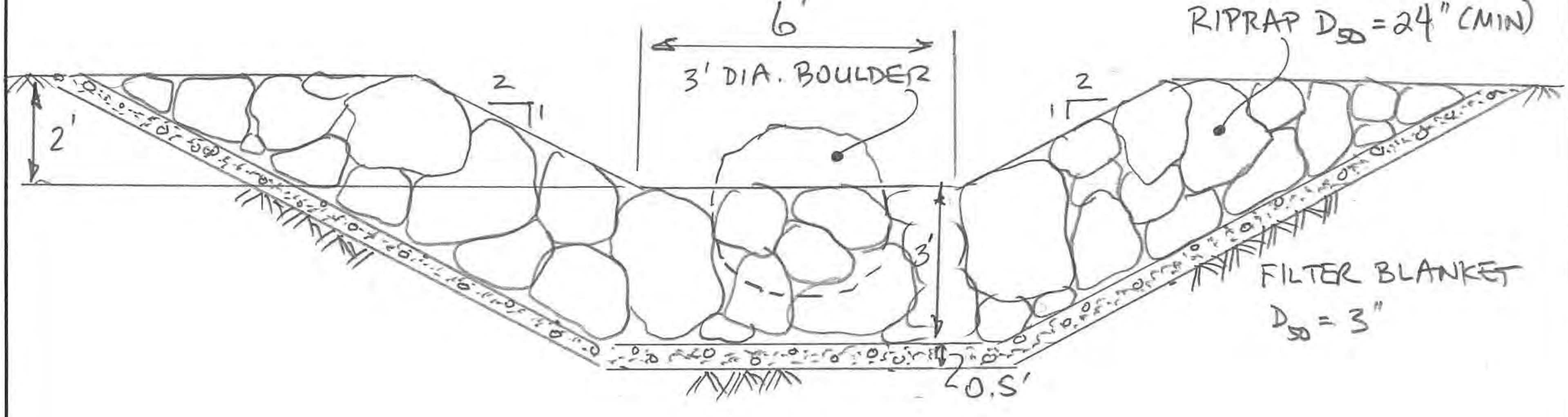
PROJECT UC-1633-01 PAGE ____ OF ____
COMPUTED PAL DATE 6 Jan 2016
CHECKED ____ DATE ____

FIGURE 3



RECLAMATION CHANNEL RC-6

SCALE: 1" = 3'

NOTE: BOULDER OBSTRUCTIONS TO BE PLACED RANDOMLY WITHIN THE CHANNEL BOTTOM AT A LONGITUDINAL SPACING OF 10' TO 15' ALONG THE LENGTH OF THE CHANNEL.

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ENGINEERS / SCIENTISTS

PROJECT UC-1653-01 PAGE ___ OF ___
COMPUTED TDN DATE 2 May 2016
CHECKED ___ DATE ___

ATTACHMENT A

Precipitation Depth-Duration-Frequency Data

NOAA Atlas 14, Volume 1, Version 5
Location name: Orangeville, Utah, US*
Latitude: 39.3214°, Longitude: -111.1248°
Elevation: 7621 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.139 (0.121-0.163)	0.178 (0.156-0.211)	0.246 (0.212-0.287)	0.303 (0.259-0.356)	0.391 (0.326-0.461)	0.468 (0.383-0.554)	0.558 (0.447-0.663)	0.661 (0.514-0.792)	0.826 (0.613-1.01)	0.976 (0.698-1.22)
10-min	0.211 (0.184-0.248)	0.271 (0.237-0.321)	0.374 (0.322-0.438)	0.461 (0.394-0.542)	0.595 (0.497-0.701)	0.713 (0.583-0.843)	0.849 (0.680-1.01)	1.01 (0.783-1.21)	1.26 (0.933-1.54)	1.49 (1.06-1.85)
15-min	0.262 (0.228-0.308)	0.337 (0.294-0.397)	0.463 (0.400-0.543)	0.571 (0.488-0.672)	0.738 (0.616-0.869)	0.884 (0.723-1.04)	1.05 (0.843-1.25)	1.25 (0.971-1.50)	1.56 (1.16-1.91)	1.84 (1.32-2.29)
30-min	0.352 (0.307-0.415)	0.454 (0.396-0.535)	0.624 (0.538-0.731)	0.769 (0.658-0.905)	0.994 (0.830-1.17)	1.19 (0.973-1.41)	1.42 (1.14-1.69)	1.68 (1.31-2.01)	2.10 (1.56-2.56)	2.48 (1.77-3.09)
60-min	0.436 (0.380-0.513)	0.561 (0.490-0.662)	0.773 (0.666-0.904)	0.952 (0.814-1.12)	1.23 (1.03-1.45)	1.47 (1.21-1.74)	1.75 (1.41-2.08)	2.08 (1.62-2.49)	2.60 (1.93-3.17)	3.07 (2.19-3.82)
2-hr	0.531 (0.465-0.614)	0.671 (0.588-0.778)	0.893 (0.779-1.03)	1.09 (0.944-1.26)	1.40 (1.19-1.63)	1.68 (1.39-1.96)	2.00 (1.62-2.35)	2.37 (1.86-2.81)	2.95 (2.22-3.58)	3.49 (2.53-4.31)
3-hr	0.599 (0.533-0.685)	0.753 (0.668-0.864)	0.969 (0.859-1.11)	1.17 (1.02-1.34)	1.47 (1.27-1.69)	1.73 (1.47-2.00)	2.05 (1.70-2.39)	2.42 (1.97-2.85)	3.01 (2.36-3.62)	3.56 (2.69-4.35)
6-hr	0.787 (0.708-0.884)	0.978 (0.883-1.10)	1.21 (1.09-1.36)	1.41 (1.26-1.59)	1.70 (1.50-1.91)	1.95 (1.70-2.21)	2.25 (1.93-2.57)	2.59 (2.19-2.99)	3.19 (2.62-3.75)	3.73 (3.00-4.46)
12-hr	0.995 (0.904-1.10)	1.23 (1.12-1.36)	1.50 (1.36-1.67)	1.73 (1.56-1.93)	2.05 (1.82-2.29)	2.30 (2.03-2.58)	2.57 (2.24-2.90)	2.90 (2.50-3.30)	3.49 (2.96-4.03)	4.05 (3.38-4.74)
24-hr	1.17 (1.05-1.30)	1.45 (1.31-1.61)	1.79 (1.61-1.99)	2.06 (1.85-2.29)	2.42 (2.17-2.70)	2.70 (2.40-3.02)	3.00 (2.64-3.35)	3.29 (2.88-3.69)	3.69 (3.18-4.17)	4.09 (3.40-4.78)
2-day	1.39 (1.26-1.54)	1.73 (1.57-1.92)	2.13 (1.93-2.37)	2.47 (2.22-2.74)	2.93 (2.62-3.24)	3.29 (2.92-3.65)	3.67 (3.23-4.09)	4.05 (3.53-4.55)	4.59 (3.93-5.19)	5.01 (4.24-5.71)
3-day	1.55 (1.41-1.73)	1.94 (1.75-2.16)	2.40 (2.17-2.68)	2.78 (2.50-3.10)	3.31 (2.95-3.69)	3.73 (3.29-4.16)	4.16 (3.65-4.65)	4.61 (3.99-5.18)	5.22 (4.45-5.92)	5.71 (4.80-6.52)
4-day	1.72 (1.56-1.93)	2.15 (1.94-2.41)	2.67 (2.41-2.99)	3.10 (2.78-3.47)	3.69 (3.29-4.13)	4.16 (3.67-4.66)	4.65 (4.07-5.21)	5.16 (4.46-5.81)	5.86 (4.98-6.64)	6.41 (5.37-7.32)
7-day	2.10 (1.89-2.35)	2.63 (2.37-2.95)	3.29 (2.95-3.68)	3.83 (3.42-4.28)	4.56 (4.04-5.11)	5.15 (4.53-5.79)	5.77 (5.03-6.51)	6.41 (5.52-7.27)	7.29 (6.18-8.34)	8.00 (6.68-9.23)
10-day	2.43 (2.19-2.71)	3.04 (2.75-3.39)	3.79 (3.41-4.22)	4.39 (3.94-4.90)	5.21 (4.64-5.82)	5.85 (5.17-6.55)	6.52 (5.71-7.32)	7.19 (6.24-8.11)	8.12 (6.93-9.23)	8.85 (7.46-10.2)
20-day	3.32 (2.99-3.69)	4.17 (3.76-4.64)	5.22 (4.69-5.81)	6.05 (5.42-6.74)	7.17 (6.38-7.99)	8.05 (7.09-8.98)	8.94 (7.82-10.0)	9.86 (8.53-11.1)	11.1 (9.47-12.6)	12.1 (10.2-13.8)
30-day	4.07 (3.67-4.52)	5.10 (4.61-5.66)	6.34 (5.70-7.03)	7.30 (6.55-8.10)	8.59 (7.65-9.54)	9.57 (8.48-10.6)	10.6 (9.30-11.8)	11.6 (10.1-13.0)	12.9 (11.1-14.6)	14.0 (11.9-15.9)
45-day	5.05 (4.58-5.60)	6.33 (5.75-7.02)	7.86 (7.10-8.72)	9.06 (8.15-10.1)	10.7 (9.52-11.9)	11.9 (10.6-13.3)	13.2 (11.6-14.7)	14.5 (12.6-16.3)	16.3 (14.0-18.4)	17.7 (15.0-20.2)
60-day	6.03 (5.45-6.68)	7.59 (6.86-8.40)	9.44 (8.50-10.4)	10.9 (9.75-12.0)	12.7 (11.4-14.1)	14.2 (12.6-15.8)	15.6 (13.7-17.5)	17.1 (14.9-19.2)	19.1 (16.4-21.6)	20.6 (17.5-23.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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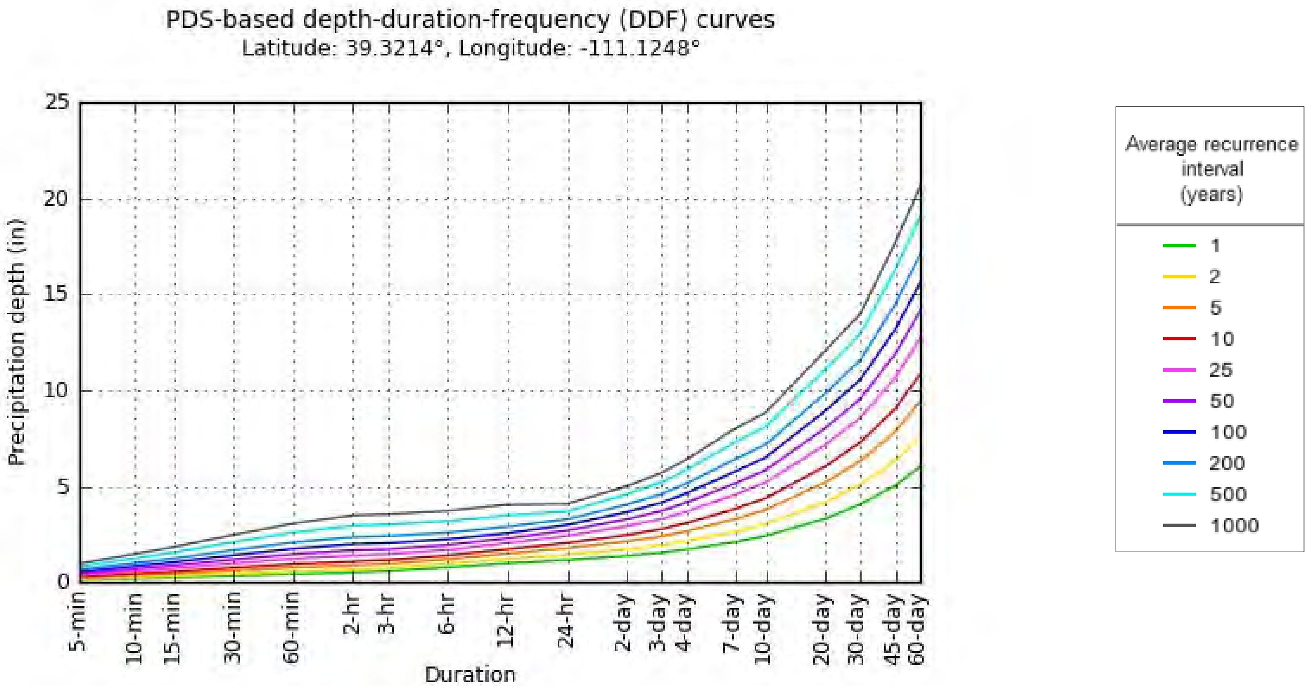
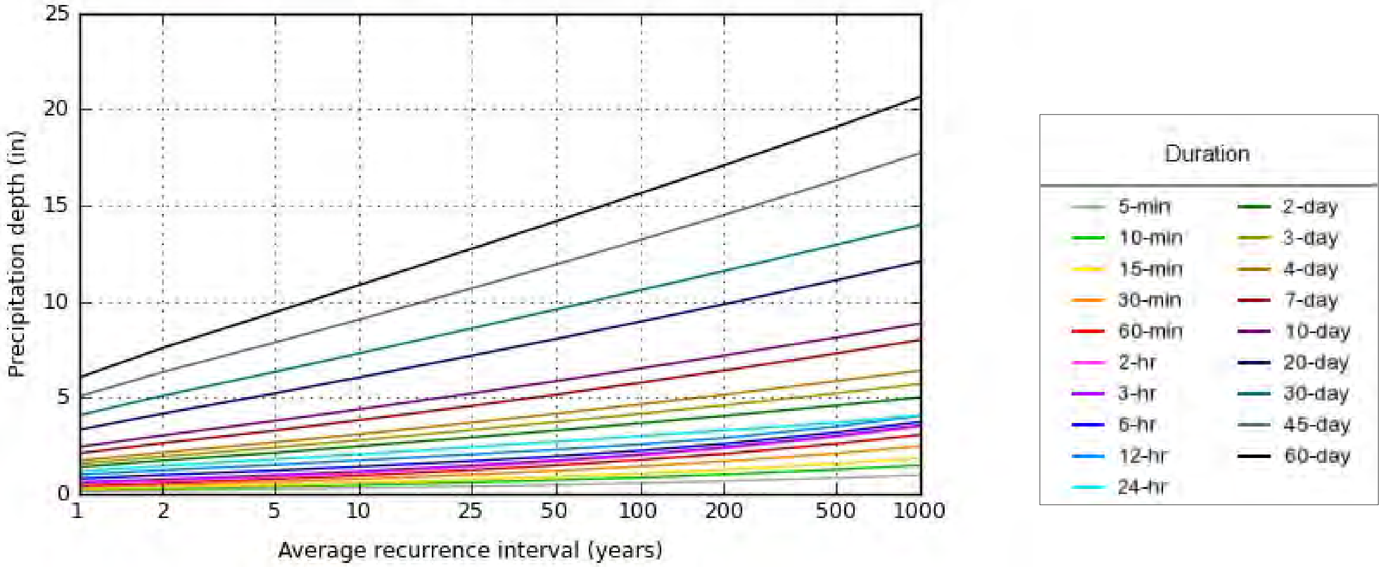
PF graphical





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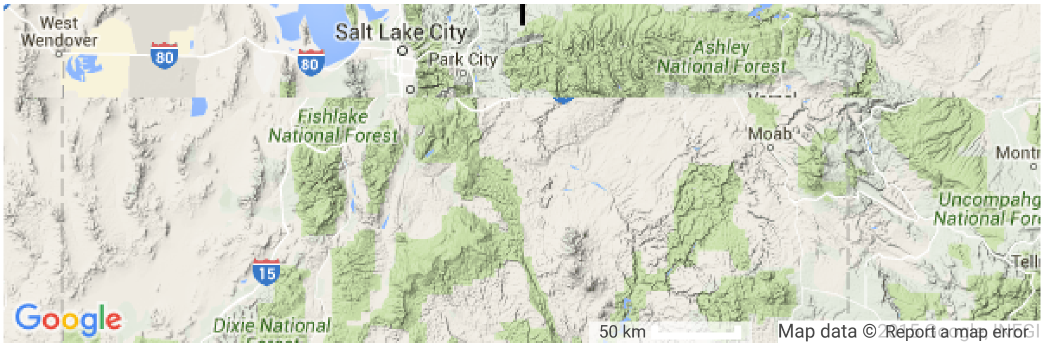
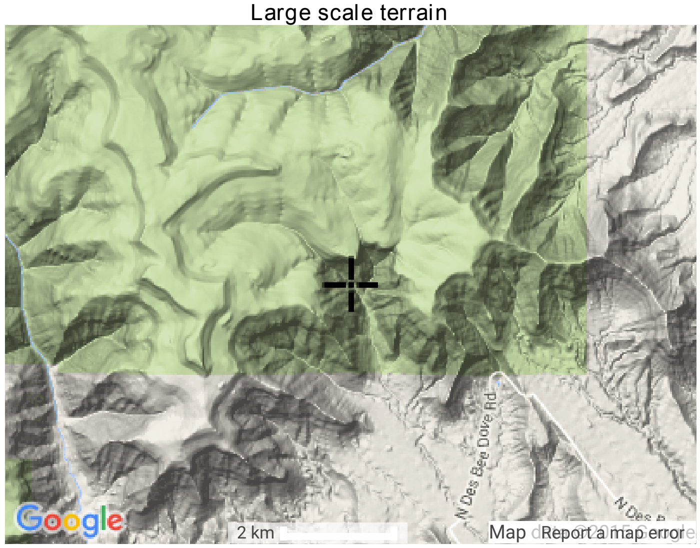
Maps & aerials

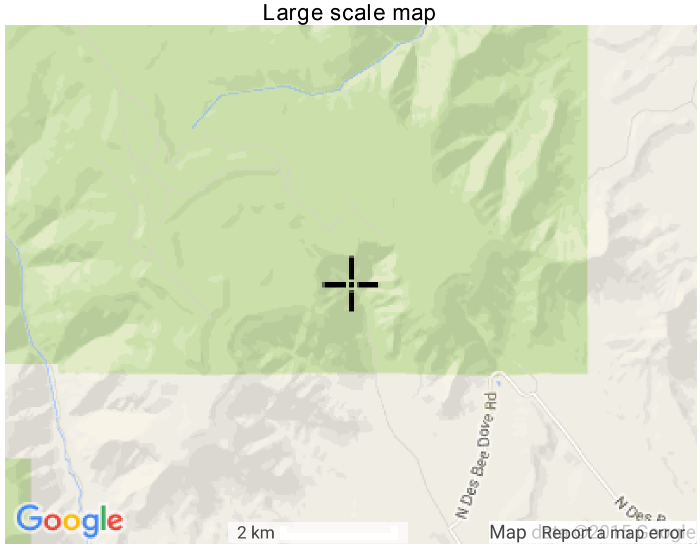
Small scale terrain



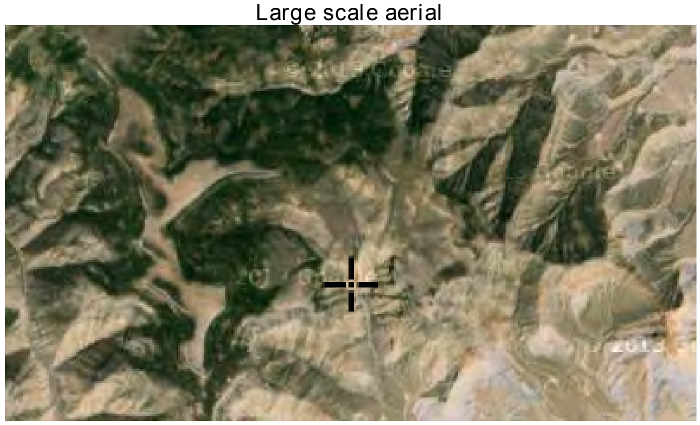
Large scale terrain



Large scale map



Large scale aerial



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ATTACHMENT B

HydroCAD Output

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment RWS-1: Watershed Runoff Area=35.000 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=2,850' Slope=0.6430 '/' Tc=9.2 min CN=80 Runoff=18.19 cfs 0.708 af

Subcatchment RWS-2: Watershed Runoff Area=36.100 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=3,050' Slope=0.5410 '/' Tc=10.5 min CN=80 Runoff=17.15 cfs 0.731 af

Subcatchment RWS-3: Watershed Runoff Area=27.400 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=3,050' Slope=0.6110 '/' Tc=9.9 min CN=80 Runoff=13.60 cfs 0.554 af

Subcatchment RWS-4: Watershed Runoff Area=10.500 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=1,850' Slope=0.8510 '/' Tc=5.6 min CN=80 Runoff=7.51 cfs 0.212 af

Subcatchment RWS-5: Watershed Runoff Area=11.200 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=1,520' Slope=0.8410 '/' Tc=4.8 min CN=80 Runoff=8.44 cfs 0.227 af

Subcatchment RWS-6: Watershed Runoff Area=62.400 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=3,350' Slope=0.5300 '/' Tc=11.5 min CN=80 Runoff=27.51 cfs 1.263 af

Subcatchment RWS-7: Watershed Runoff Area=39.100 ac 0.00% Impervious Runoff Depth=0.24"
Flow Length=2,600' Slope=0.8170 '/' Tc=7.6 min CN=80 Runoff=21.91 cfs 0.791 af

Reach RC-1: Channel Avg. Flow Depth=0.46' Max Vel=5.77 fps Inflow=18.19 cfs 0.708 af
n=0.070 L=250.0' S=0.2630 '/' Capacity=264.42 cfs Outflow=16.62 cfs 0.708 af

Reach RC-2: Channel Avg. Flow Depth=0.38' Max Vel=6.50 fps Inflow=17.15 cfs 0.731 af
n=0.070 L=110.0' S=0.4170 '/' Capacity=332.96 cfs Outflow=16.43 cfs 0.731 af

Reach RC-3: Channel Avg. Flow Depth=0.33' Max Vel=6.21 fps Inflow=13.60 cfs 0.554 af
n=0.070 L=130.0' S=0.4550 '/' Capacity=347.80 cfs Outflow=13.20 cfs 0.554 af

Reach RC-4: Channel Avg. Flow Depth=0.26' Max Vel=6.25 fps Inflow=7.51 cfs 0.212 af
n=0.040 L=150.0' S=0.2110 '/' Capacity=314.47 cfs Outflow=6.81 cfs 0.212 af

Reach RC-5: Channel Avg. Flow Depth=0.24' Max Vel=5.43 fps Inflow=8.44 cfs 0.227 af
n=0.070 L=160.0' S=0.5000 '/' Capacity=364.59 cfs Outflow=7.68 cfs 0.227 af

Reach RC-6: Channel Avg. Flow Depth=0.48' Max Vel=8.28 fps Inflow=27.51 cfs 1.263 af
n=0.070 L=150.0' S=0.5000 '/' Capacity=364.59 cfs Outflow=27.24 cfs 1.263 af

Reach RC-7: Channel Avg. Flow Depth=0.42' Max Vel=7.68 fps Inflow=21.91 cfs 0.791 af
n=0.070 L=100.0' S=0.5000 '/' Capacity=364.59 cfs Outflow=21.94 cfs 0.791 af

Total Runoff Area = 221.700 ac Runoff Volume = 4.487 af Average Runoff Depth = 0.24"
100.00% Pervious = 221.700 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment RWS-1: Watershed

Runoff = 18.19 cfs @ 3.11 hrs, Volume= 0.708 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	35.000	80	
	35.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	2,850	0.6430	5.19		**Lag/CN Method,**

Summary for Subcatchment RWS-2: Watershed

Runoff = 17.15 cfs @ 3.12 hrs, Volume= 0.731 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	36.100	80	
	36.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	3,050	0.5410	4.82		**Lag/CN Method,**

Summary for Subcatchment RWS-3: Watershed

Runoff = 13.60 cfs @ 3.12 hrs, Volume= 0.554 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	27.400	80	
	27.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	3,050	0.6110	5.12		**Lag/CN Method,**

Summary for Subcatchment RWS-4: Watershed

Runoff = 7.51 cfs @ 3.06 hrs, Volume= 0.212 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	10.500	80	
	10.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	1,850	0.8510	5.47		**Lag/CN Method,**

Summary for Subcatchment RWS-5: Watershed

Runoff = 8.44 cfs @ 3.05 hrs, Volume= 0.227 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	11.200	80	
	11.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	1,520	0.8410	5.23		**Lag/CN Method,**

Summary for Subcatchment RWS-6: Watershed

Runoff = 27.51 cfs @ 3.14 hrs, Volume= 1.263 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	62.400	80	
	62.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	3,350	0.5300	4.86		**Lag/CN Method,**

Summary for Subcatchment RWS-7: Watershed

Runoff = 21.91 cfs @ 3.09 hrs, Volume= 0.791 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 10-yr, 6-hr Rainfall=1.41"

	Area (ac)	CN	Description
*	39.100	80	
	39.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	2,600	0.8170	5.74		**Lag/CN Method,**

Summary for Reach RC-1: Channel

Inflow Area = 35.000 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 18.19 cfs @ 3.11 hrs, Volume= 0.708 af
Outflow = 16.62 cfs @ 3.13 hrs, Volume= 0.708 af, Atten= 9%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.77 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 2.29 fps, Avg. Travel Time= 1.8 min

Peak Storage= 791 cf @ 3.12 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 264.42 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 250.0' Slope= 0.2630 '/'
Inlet Invert= 0.00', Outlet Invert= -65.75'

Summary for Reach RC-2: Channel

Inflow Area = 36.100 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 17.15 cfs @ 3.12 hrs, Volume= 0.731 af
Outflow = 16.43 cfs @ 3.14 hrs, Volume= 0.731 af, Atten= 4%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.50 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.83 fps, Avg. Travel Time= 0.6 min

Peak Storage= 280 cf @ 3.13 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 332.96 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 110.0' Slope= 0.4170 '/'
Inlet Invert= 0.00', Outlet Invert= -45.87'

Summary for Reach RC-3: Channel

Inflow Area = 27.400 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 13.60 cfs @ 3.12 hrs, Volume= 0.554 af
Outflow = 13.20 cfs @ 3.12 hrs, Volume= 0.554 af, Atten= 3%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.21 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.62 fps, Avg. Travel Time= 0.8 min

Peak Storage= 284 cf @ 3.12 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 347.80 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 130.0' Slope= 0.4550 '/'
Inlet Invert= 0.00', Outlet Invert= -59.15'

Summary for Reach RC-4: Channel

Inflow Area = 10.500 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 7.51 cfs @ 3.06 hrs, Volume= 0.212 af
Outflow = 6.81 cfs @ 3.07 hrs, Volume= 0.212 af, Atten= 9%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.25 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.44 fps, Avg. Travel Time= 1.0 min

Peak Storage= 176 cf @ 3.06 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 314.47 cfs

4.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 150.0' Slope= 0.2110 '/'
Inlet Invert= 0.00', Outlet Invert= -31.65'

Summary for Reach RC-5: Channel

Inflow Area = 11.200 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 8.44 cfs @ 3.05 hrs, Volume= 0.227 af
Outflow = 7.68 cfs @ 3.06 hrs, Volume= 0.227 af, Atten= 9%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.43 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.01 fps, Avg. Travel Time= 1.3 min

Peak Storage= 249 cf @ 3.06 hrs
Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 364.59 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 160.0' Slope= 0.5000 '/'
Inlet Invert= 0.00', Outlet Invert= -80.00'

Summary for Reach RC-6: Channel

Inflow Area = 62.400 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 27.51 cfs @ 3.14 hrs, Volume= 1.263 af
Outflow = 27.24 cfs @ 3.15 hrs, Volume= 1.263 af, Atten= 1%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.28 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.59 fps, Avg. Travel Time= 0.7 min

Peak Storage= 500 cf @ 3.15 hrs
Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 364.59 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.5000 '/'
Inlet Invert= 0.00', Outlet Invert= -75.00'

Summary for Reach RC-7: Channel

Inflow Area = 39.100 ac, 0.00% Impervious, Inflow Depth = 0.24" for 10-yr, 6-hr event
Inflow = 21.91 cfs @ 3.09 hrs, Volume= 0.791 af
Outflow = 21.94 cfs @ 3.10 hrs, Volume= 0.791 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.68 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.13 fps, Avg. Travel Time= 0.5 min

Peak Storage= 290 cf @ 3.09 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 364.59 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 100.0' Slope= 0.5000 '/'
Inlet Invert= 0.00', Outlet Invert= -50.00'

Time span=1.00-30.00 hrs, dt=0.05 hrs, 581 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment RWS-1: Watershed Runoff Area=35.000 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=2,850' Slope=0.6430 '/' Tc=9.2 min CN=80 Runoff=33.13 cfs 1.135 af

Subcatchment RWS-2: Watershed Runoff Area=36.100 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=3,050' Slope=0.5410 '/' Tc=10.5 min CN=80 Runoff=31.46 cfs 1.171 af

Subcatchment RWS-3: Watershed Runoff Area=27.400 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=3,050' Slope=0.6110 '/' Tc=9.9 min CN=80 Runoff=24.88 cfs 0.889 af

Subcatchment RWS-4: Watershed Runoff Area=10.500 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=1,850' Slope=0.8510 '/' Tc=5.6 min CN=80 Runoff=13.63 cfs 0.341 af

Subcatchment RWS-5: Watershed Runoff Area=11.200 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=1,520' Slope=0.8410 '/' Tc=4.8 min CN=80 Runoff=15.07 cfs 0.363 af

Subcatchment RWS-6: Watershed Runoff Area=62.400 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=3,350' Slope=0.5300 '/' Tc=11.5 min CN=80 Runoff=49.97 cfs 2.024 af

Subcatchment RWS-7: Watershed Runoff Area=39.100 ac 0.00% Impervious Runoff Depth=0.39"
Flow Length=2,600' Slope=0.8170 '/' Tc=7.6 min CN=80 Runoff=39.75 cfs 1.268 af

Reach RC-1: Channel Avg. Flow Depth=0.65' Max Vel=7.11 fps Inflow=33.13 cfs 1.135 af
n=0.070 L=250.0' S=0.2630 '/' Capacity=264.42 cfs Outflow=31.74 cfs 1.135 af

Reach RC-2: Channel Avg. Flow Depth=0.55' Max Vel=8.05 fps Inflow=31.46 cfs 1.171 af
n=0.070 L=110.0' S=0.4170 '/' Capacity=332.96 cfs Outflow=30.87 cfs 1.171 af

Reach RC-3: Channel Avg. Flow Depth=0.47' Max Vel=7.71 fps Inflow=24.88 cfs 0.889 af
n=0.070 L=130.0' S=0.4550 '/' Capacity=347.80 cfs Outflow=24.35 cfs 0.889 af

Reach RC-4: Channel Avg. Flow Depth=0.37' Max Vel=7.75 fps Inflow=13.63 cfs 0.341 af
n=0.040 L=150.0' S=0.2110 '/' Capacity=314.47 cfs Outflow=12.77 cfs 0.341 af

Reach RC-5: Channel Avg. Flow Depth=0.34' Max Vel=6.74 fps Inflow=15.07 cfs 0.363 af
n=0.070 L=160.0' S=0.5000 '/' Capacity=364.59 cfs Outflow=14.32 cfs 0.363 af

Reach RC-6: Channel Avg. Flow Depth=0.68' Max Vel=10.05 fps Inflow=49.97 cfs 2.024 af
n=0.070 L=150.0' S=0.5000 '/' Capacity=364.59 cfs Outflow=49.55 cfs 2.024 af

Reach RC-7: Channel Avg. Flow Depth=0.60' Max Vel=9.31 fps Inflow=39.75 cfs 1.268 af
n=0.070 L=100.0' S=0.5000 '/' Capacity=364.59 cfs Outflow=39.66 cfs 1.268 af

Total Runoff Area = 221.700 ac Runoff Volume = 7.190 af Average Runoff Depth = 0.39"
100.00% Pervious = 221.700 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment RWS-1: Watershed

Runoff = 33.13 cfs @ 3.10 hrs, Volume= 1.135 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	35.000	80	
	35.000		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.2	2,850	0.6430	5.19		**Lag/CN Method,**

Summary for Subcatchment RWS-2: Watershed

Runoff = 31.46 cfs @ 3.12 hrs, Volume= 1.171 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	36.100	80	
	36.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	3,050	0.5410	4.82		**Lag/CN Method,**

Summary for Subcatchment RWS-3: Watershed

Runoff = 24.88 cfs @ 3.11 hrs, Volume= 0.889 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	27.400	80	
	27.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.9	3,050	0.6110	5.12		**Lag/CN Method,**

Summary for Subcatchment RWS-4: Watershed

Runoff = 13.63 cfs @ 3.05 hrs, Volume= 0.341 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	10.500	80	
	10.500		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	1,850	0.8510	5.47		**Lag/CN Method,**

Summary for Subcatchment RWS-5: Watershed

Runoff = 15.07 cfs @ 3.05 hrs, Volume= 0.363 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	11.200	80	
	11.200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	1,520	0.8410	5.23		**Lag/CN Method,**

Summary for Subcatchment RWS-6: Watershed

Runoff = 49.97 cfs @ 3.13 hrs, Volume= 2.024 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	62.400	80	
	62.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.5	3,350	0.5300	4.86		**Lag/CN Method,**

Summary for Subcatchment RWS-7: Watershed

Runoff = 39.75 cfs @ 3.08 hrs, Volume= 1.268 af, Depth= 0.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Type II 24-hr 6.00 hrs 25-yr, 6-hr Rainfall=1.70"

	Area (ac)	CN	Description
*	39.100	80	
	39.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	2,600	0.8170	5.74		**Lag/CN Method,**

Summary for Reach RC-1: Channel

Inflow Area = 35.000 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 33.13 cfs @ 3.10 hrs, Volume= 1.135 af
Outflow = 31.74 cfs @ 3.12 hrs, Volume= 1.135 af, Atten= 4%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.11 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.62 fps, Avg. Travel Time= 1.6 min

Peak Storage= 1,179 cf @ 3.11 hrs
Average Depth at Peak Storage= 0.65'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 264.42 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 250.0' Slope= 0.2630 '/'
Inlet Invert= 0.00', Outlet Invert= -65.75'

Summary for Reach RC-2: Channel

Inflow Area = 36.100 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 31.46 cfs @ 3.12 hrs, Volume= 1.171 af
Outflow = 30.87 cfs @ 3.12 hrs, Volume= 1.171 af, Atten= 2%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.05 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.25 fps, Avg. Travel Time= 0.6 min

Peak Storage= 427 cf @ 3.12 hrs
Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 332.96 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 110.0' Slope= 0.4170 '/'
Inlet Invert= 0.00', Outlet Invert= -45.87'

Summary for Reach RC-3: Channel

Inflow Area = 27.400 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 24.88 cfs @ 3.11 hrs, Volume= 0.889 af
Outflow = 24.35 cfs @ 3.12 hrs, Volume= 0.889 af, Atten= 2%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.71 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.02 fps, Avg. Travel Time= 0.7 min

Peak Storage= 420 cf @ 3.11 hrs
Average Depth at Peak Storage= 0.47'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 347.80 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 130.0' Slope= 0.4550 '/'
Inlet Invert= 0.00', Outlet Invert= -59.15'

Summary for Reach RC-4: Channel

Inflow Area = 10.500 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 13.63 cfs @ 3.05 hrs, Volume= 0.341 af
Outflow = 12.77 cfs @ 3.06 hrs, Volume= 0.341 af, Atten= 6%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.75 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.82 fps, Avg. Travel Time= 0.9 min

Peak Storage= 261 cf @ 3.06 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 2.00' Flow Area= 16.0 sf, Capacity= 314.47 cfs

4.00' x 2.00' deep channel, n= 0.040
Side Slope Z-value= 2.0 '/' Top Width= 12.00'
Length= 150.0' Slope= 0.2110 '/'
Inlet Invert= 0.00', Outlet Invert= -31.65'

Summary for Reach RC-5: Channel

Inflow Area = 11.200 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 15.07 cfs @ 3.05 hrs, Volume= 0.363 af
Outflow = 14.32 cfs @ 3.06 hrs, Volume= 0.363 af, Atten= 5%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.74 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.30 fps, Avg. Travel Time= 1.2 min

Peak Storage= 363 cf @ 3.05 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 364.59 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 160.0' Slope= 0.5000 '/'
Inlet Invert= 0.00', Outlet Invert= -80.00'

Summary for Reach RC-6: Channel

Inflow Area = 62.400 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 49.97 cfs @ 3.13 hrs, Volume= 2.024 af
Outflow = 49.55 cfs @ 3.14 hrs, Volume= 2.024 af, Atten= 1%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.05 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.13 fps, Avg. Travel Time= 0.6 min

Peak Storage= 746 cf @ 3.14 hrs
Average Depth at Peak Storage= 0.68'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 364.59 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 150.0' Slope= 0.5000 '/'
Inlet Invert= 0.00', Outlet Invert= -75.00'

Summary for Reach RC-7: Channel

Inflow Area = 39.100 ac, 0.00% Impervious, Inflow Depth = 0.39" for 25-yr, 6-hr event
Inflow = 39.75 cfs @ 3.08 hrs, Volume= 1.268 af
Outflow = 39.66 cfs @ 3.09 hrs, Volume= 1.268 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.31 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 3.61 fps, Avg. Travel Time= 0.5 min

Peak Storage= 429 cf @ 3.08 hrs
Average Depth at Peak Storage= 0.60'
Bank-Full Depth= 2.00' Flow Area= 20.0 sf, Capacity= 364.59 cfs

6.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 100.0' Slope= 0.5000 '/'
Inlet Invert= 0.00', Outlet Invert= -50.00'

PacifiCorp – Interwest Mining Company

Appendix G

Sediment Control Measures – Evaluation Plan

Cottonwood/Wilberg Mine Reclamation Plan

2016

Appendix G

Procedures for Gathering Quantitative and Qualitative Data Collection for Determining of Deep Gouging Performance as a Best Technology Currently Available alternative.

Quantitative Analysis

Remote storm water samplers shall be placed as shown on Plate 4E. The main body of the sampler shall be placed out of the channel and mounted securely so that wind or water cannot move it from its designated location.

The transducer and suction line shall be properly secured in the channel in order to collect the data from any flows that exist.

Individual Gouges

After final reclamation has been completed on the slopes (includes incorporation of hay mulch, deep gouging, seeding, hydromulching/tackifying), the permittee will install a staff gauge in the bottom of the selected gouge to measure sediment production that collects in the bottom of the pock. The staff gauge will be attached to a carsonite sign post and secured in the ground. The staff gauge shall read in increments of 0.02 feet.

Two six foot gouges and two three foot gouges with opposite aspects will be monitored (refer to their general placement location on Plate 4E). The monitoring points of the six foot gouges shall be located in the upper reaches of the drainage and lower reaches of the drainage. The monitoring point for the three foot gouges shall be located in the middle of a slope and the bottom of a slope.

A rain gauge will be installed next to the gouge which the sediment staff gauge was installed. The rain gauge will collect rainfall data specific to the gouge it is placed beside.

After installation, the gouges shall be located by GPS and accurately plotted on Plate 4E. A placard shall be installed at each location showing the site ID.

Transect Profile

Two fifty foot transects shall be delineated within the disturbed area (refer to their general placement location on Plate 4E). One shall be located in the Left Fork and one in the Right Fork. The location of each transect shall be marked on the top and bottom with T-posts. A staff gauge shall be placed in the bottom of the uppermost gouge and lowermost gouge to measure sediment production of either end of the transect line. A rain gauge shall be placed near the middle of the transect line and will represent rainfall volume for the entire length of the line.

After installation, the transect lines shall be located by GPS and accurately plotted on Plate 4E. A placard shall be installed at each location showing the site ID.

Precipitation Gauge

A precipitation gauge shall be placed at the confluence of the Left and Right forks of the Grimes Wash (refer to its general placement location on Plate 4E). The base of the gauge support shall be placed in concrete to ensure a solid foundation. This location was selected because of the easy access and central location of the confluence.

Monitoring

Monitoring will be conducted at least quarterly and during the 3rd week of the 3rd month of the quarter. Data collected is as follows:

Remote Storm water Samplers	Site ID (S1, S2, S3) Time Date Depth of Flow (feet) Flow Velocity (cfs) Sediment Volume (laboratory analysis)
Individual Gouges	Site ID (TP1, TP2, TP3, TP4) Date Depth of sediment as recorded on staff gauge (feet) Rain gauge reading (inches) Estimated cover (% Rock, % Living)
Transect Lines	Site ID (TL1, TL2) Date Depth of sediment in top gouge (feet) Depth of sediment in bottom gouge (feet) Rain gauge reading (inches)
Precipitation Gauge	Download data logger – daily rainfall (inches)

Qualitative Analysis

Photo documentation will be recorded for each S, TP and TL site. Three photos of each of the S and TP sites will be documented; staff gauge, rain gauge, aerial photo of site (approximately 5' above). The TL sites shall photo document the same information at the top and bottom gouge and a photo viewing the transect from top down and a photo viewing from bottom up.

A dialogue concerning the general condition of the sites will also be presented which discusses sedimentation, erosion, condition of gouges, and cover. Quantitative and qualitative analysis shall be reported to the Division on a quarterly basis. Data from a quarter shall be due within 30 days after the end of that quarter.

PacifiCorp – Interwest Mining Company

Appendix H

Bonding Calculations

Cottonwood/Wilberg Mine Reclamation Plan

2016

Bond Estimates

Note: Upon conditional approval of the revised reclamation plan, the bond will be re-calculated to reflect the newly revised cut and fill estimates of the earthwork activities. PacifiCorp does not expect the bond estimate to significantly change since the cut and fill estimates of the revised plan are similar to the existing plan.

PacifiCorp – Interwest Mining Company

Appendix I

TMA Access Portals – Cottonwood Canyon (TMA001 Permanent Mine Discharge)

Letter from Emery County

Cottonwood/Wilberg Mine Reclamation Plan

2016


MINE SEAL HITCHED INTO ROOF A MINIMUM OF 4"
OBSERVATION TUBE
BACKUP DECANT 6" SCLAIR W/SHUTOFF 2' BELOW ROOF
GRANITE PEA GRAVEL (4' HIGH)
PRIMARY DECANT (6" PVC PIPE-250 PSI)
FILTER SYSTEM
2"-4" GRANITE DRAIN ROCK
Profile of Discharge
6" PERFORATED PIPE
MINE SEAL HITCHED INTO RIB A MINIMUM OF 4"
FILTER SYSTEM
BACKUP DECANT 6" SCLAIR W/SHUTOFF 2' BELOW ROOF
2% GRADE
SECONDARY DECANT (6" PVC PIPE) WITH SHUTOFF VALVE
GRANITE PEA GRAVEL
PRIMARY DECANT (6" PVC PIPE-250 PSI) WITH SHUTOFF VALVE
2"-4" GRANITE DRAIN ROCK
Plan View of Discharge
NOTE: SEAL CONSTRUCTED PER 30CFR PT.75.335 "CONSTRUCTION OF SEALS"
LIFTING HANDLE
4'-0"
DOME TOP HINGE
4'-0"
Removed
Plan View of Metering Manhole
Metering Manhole Removed as Part of
Final Reclamation November 2014
2" NPT COUPLING
3" PARSHALL FLUME
8"
4'-2"
4'-0"
2"
2"
6"
CONCRETE PAD
6'-0" x 6'-0"
Profile of Metering Manhole
Metering Manhole Removed as Part of
Final Reclamation November 2014
PUBLIC ROAD
BATHHOUSE
SHOP
OFFICE
GATE
INTAKE PORTAL
GRAVEL SEDIMENT TRAPS 2' HIGH AT APPROX. 100' INTERVALS FROM THIS POINT OUTBY
SOLID BLOCK SEAL AND FRENCH DRAIN TO DISCHARGE WATER
6" PVC PIPE
UPDES UT-0022896-001
COUNTY ROAD
BELT PORTAL
SOLID BLOCK SEAL
SOLID BLOCK STOPPING 3' HIGH TO DIVERT WATER
17
18
19
Plan View of Trail Mountain Access
HOLES DRILLED 360° AROUND PIPE
1" ø HOLE
6" PVC PIPE (250 PSI)
6" PERFORATED PVC PIPE
1" ø HOLES
APPROX. 2"
6"
Typ. Hole Pattern for 6" Perforated PVC Pipe
Metering Manhole Removed as Part of
Final Reclamation November 2014
Removed
Note:
Demolished and Backfilled Nov. 2014
See Plan View of Trail Mountain Access
INTAKE PORTAL
SEAL
0+00-97.42
0+25-94.93
0+50-92.80 (PORTAL LINER)
0+75-91.94 (STOP SIGN)
1+00-90.58 (EDGE OF CONCRETE)
1+25-77.84
1+50-86.78
1+75-83.87
2+00-81.99
2+25-81.28
2+50-79.35
2+65-77.92
2+75-76.54
2+87-76.23
COVER EXPOSED PIPE WITH DIRT
6" YELLOWMINE PIPE
FIELD DETERMINE POINT TO BURY PIPE AT A MINIMUM DEPTH OF 3'
7.2% SLOPE
6" YELLOWMINE (250 PSI) PIPE
TO 36" CULVERT
Profile of 6" PVC Discharge and Drainage System
Removed
CAP
24" PVC PIPE
6" PVC PIPE
6" PVC PIPE
FLOW
FLOW
7.2% SLOPE
MAX. 2% SLOPE
12"
24"
4'x4'x4" CONCRETE PAD W/BELTING ON TOP
Dissipater Detail Removed as Part of
Final Reclamation November 2014
LICENSED PROFESSIONAL ENGINEER
JOHN CHRISTENSEN
No. 165651
STATE OF UTAH
I, JOHN CHRISTENSEN BEING A REGISTERED PROFESSIONAL ENGINEER IN THE STATE OF UTAH, DO HEREBY CERTIFY THAT THE INFORMATION CONTAINED ON THIS DRAWING IS TRUE AND ACCURATE TO THE BEST OF MY KNOWLEDGE AND BELIEF.
5/21/01
JOHN CHRISTENSEN NO. 165651
DATE
Note:
Portals Backfilled in October 2014
Final Reclamation Completed in November 2014
Emery County Accepted Maintenance Responsibility
of Drain Line from Portal to 36" Culvert, UPDES
Discharge Point at 36" Culvert is Monitored Monthly
12-12-2016
REVISED TO AS BUILT AND RECLAIMED CONDITIONS, REMOVED METERING MANHOLE/DISSIPATER ADDED NOTATIONS
KJL
DATE
REVISIONS
BY
CHK
CAD FILE NAME/DISK#: TMA-DISCHARGE.DWG
INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP
COTTONWOOD MINE
TMA-INTAKE PORTAL
MINE DISCHARGE/DRAINAGE MANIFOLD
DRAWN BY: K. LARSEN
SCALE: NONE
DRAWING #:
DATE: MAY 11, 2001
SHEET 1 OF 1
REV.

EMERY COUNTY

Road Department

February 4, 2015

PacifiCorp
15 North Main Street
P. O. Box 310
Huntington, Utah 84528
Dennis Oakley
Senior Mine Engineer

Mr. Oakley,

PacifiCorp has a water discharge line draining from the Cottonwood Mine/Trail Mt. access portal. Currently this line is buried under the bar ditch and draining into a drop box and culvert structure crossing county road #506. Emery County Road Department wishes to leave this in place as is to better facilitate maintenance. Leaving the line underground will keep ice from building up in the winter. Emery County will maintain this line as our own from now on.

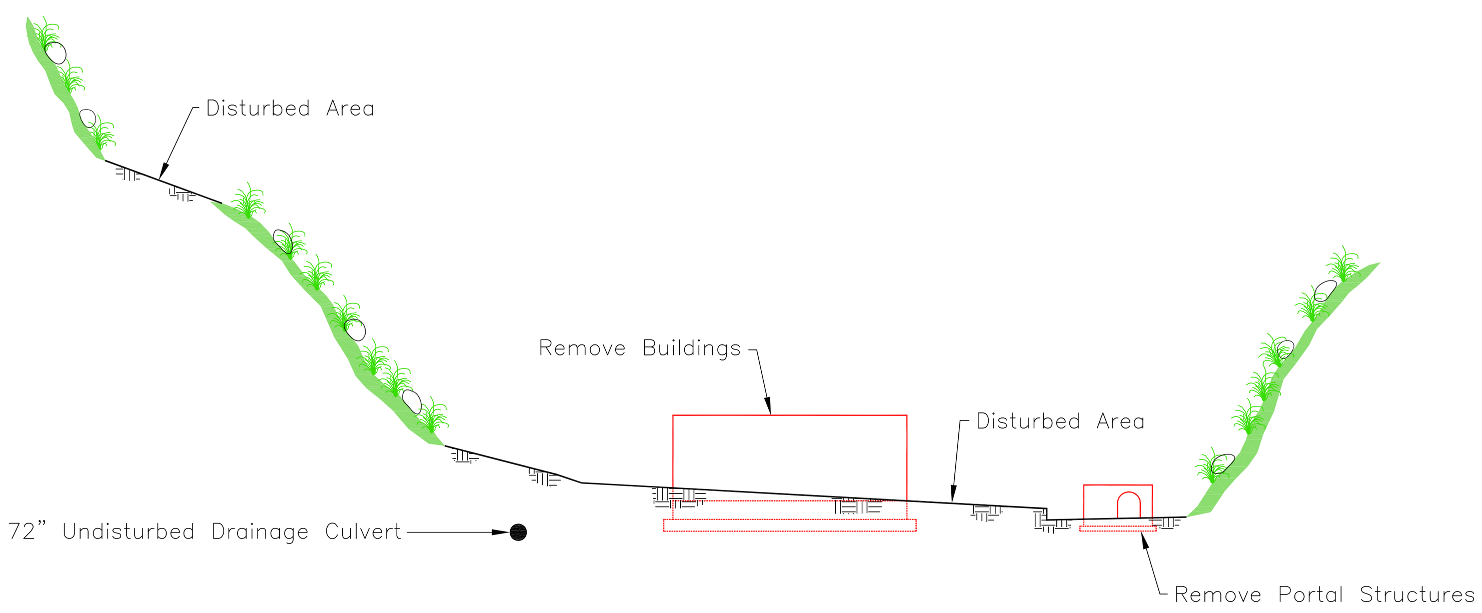
Sincerely,

Wayde S. Nielsen
Emery County Road Supervisor

COTTONWOOD MINE - TYPICAL RECLAMATION SEQUENCE

EXISTING CONDITION WITH STRUCTURES IN PLACE

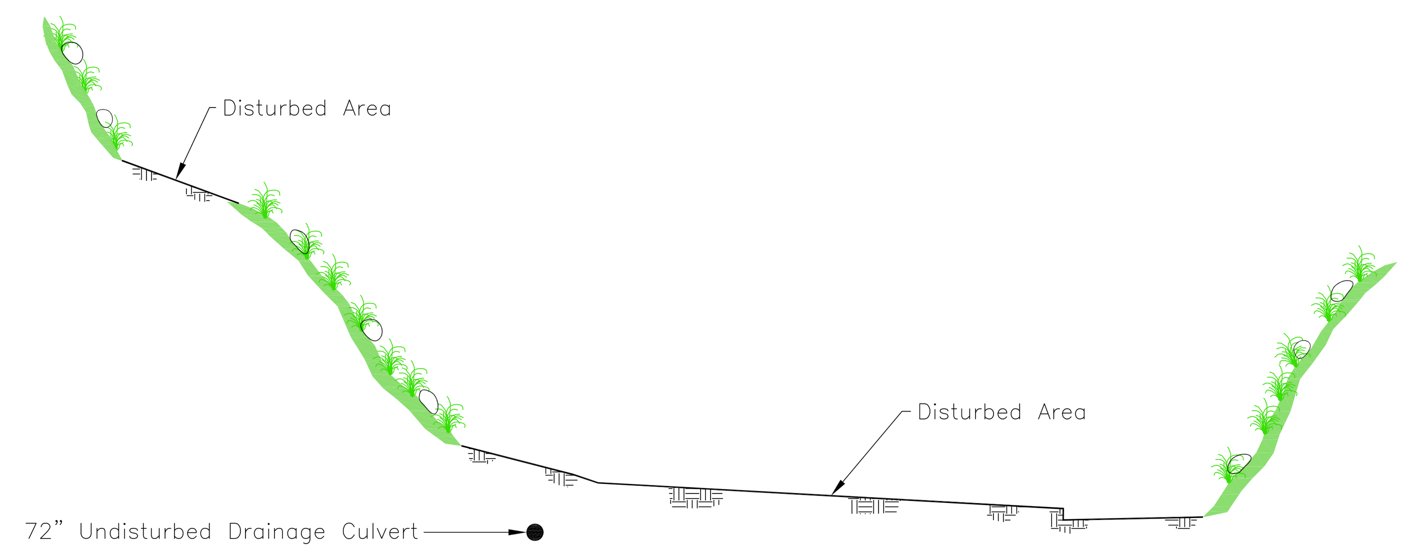
a) Demolish buildings and dispose of metal offsite (Completed 2nd Quarter of 2015)
b) Dispose of concrete footers and foundations



STEP 1

CONDITION AFTER REMOVAL OF STRUCTURES

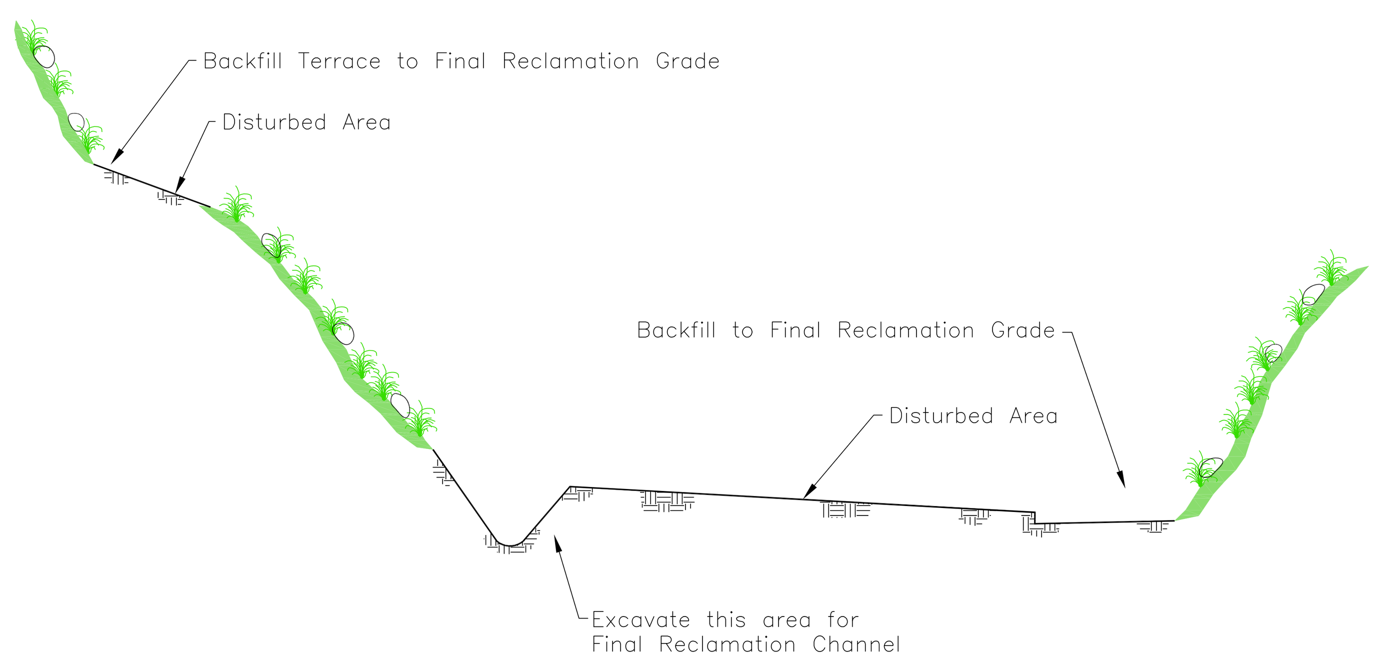
a) Remove Undisturbed Drainage Culvert
b) Remove all culverts and buried drainage structures



STEP 2

STEP 2 CONDITION AFTER REMOVAL OF CULVERTS

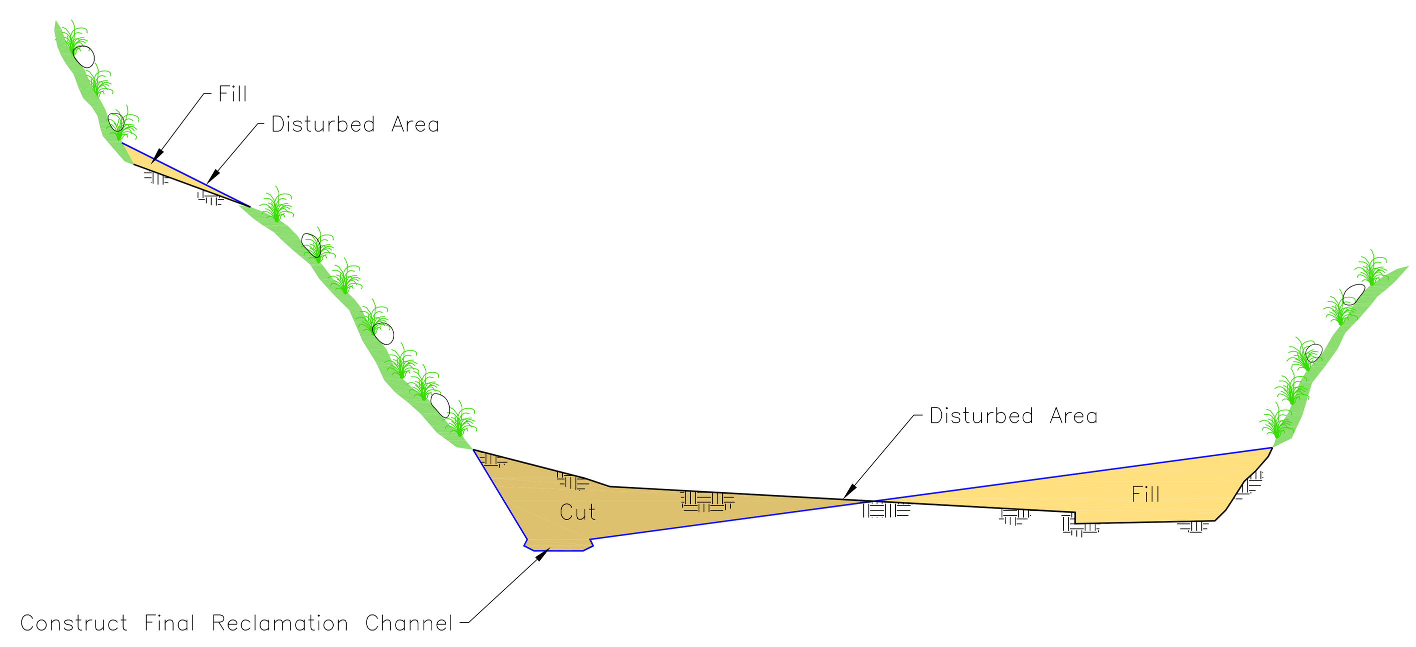
a) Excavate Soil for Construction of Final Reclamation Channel
b) Backfill Terraces, Highwalls and other areas for Final Reclamation



STEP 3

CONDITION DURING BACKFILLING AND GRADING OPERATIONS

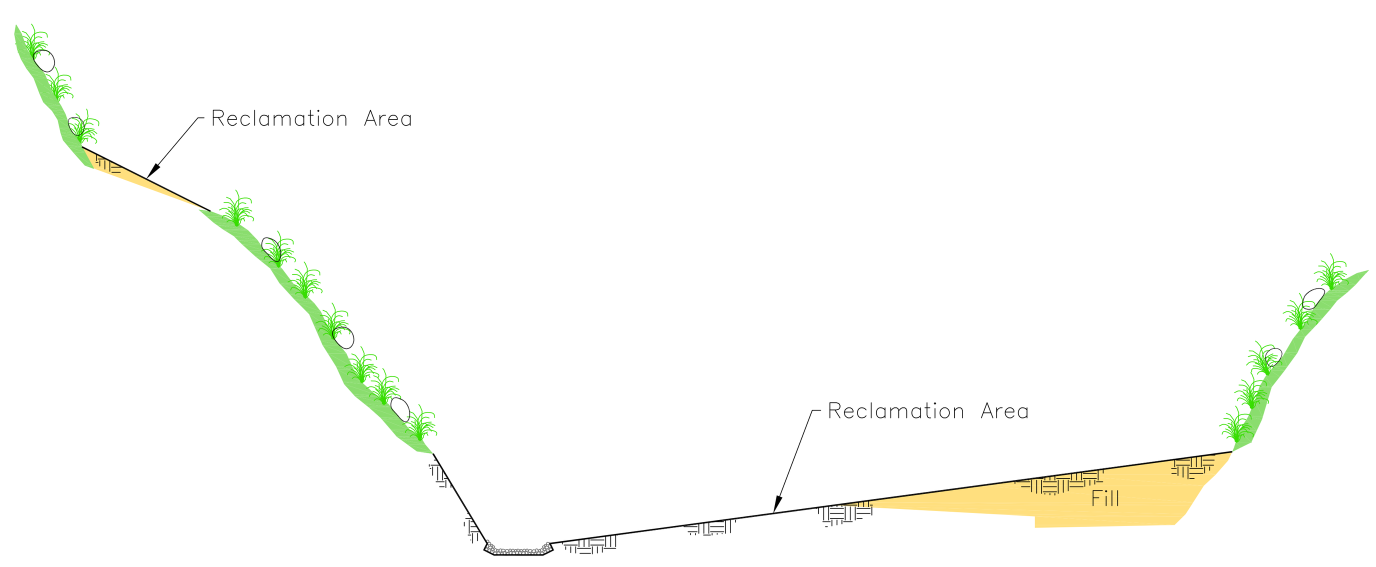
a) Construct Final Reclamation Channel
b) Construct Deep Gouging techniques on fill areas
c) Roughen areas on final contoured slopes



STEP 4

CONDITION AFTER CONSTRUCTION OF FINAL RECLAMATION CHANNEL

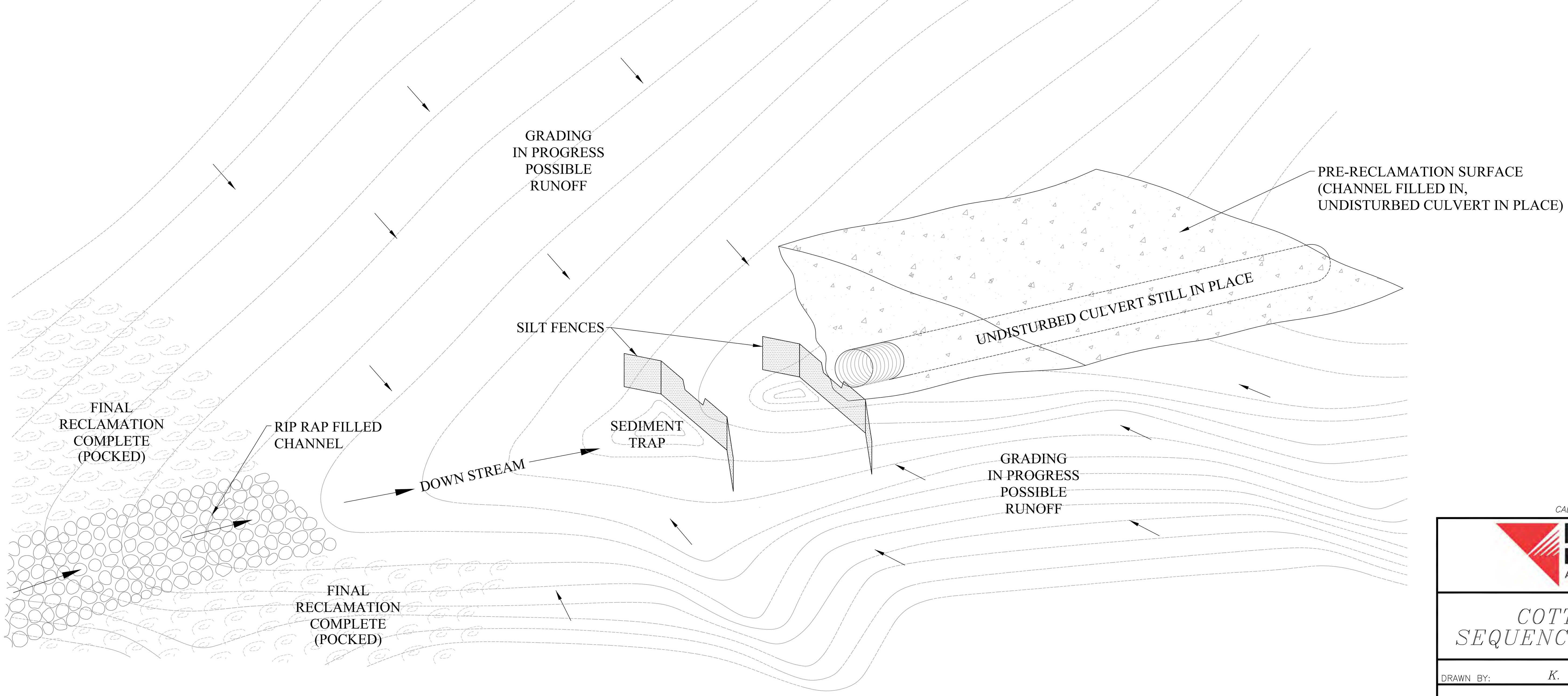
a) Perform Soil Preparation
b) Apply Seed Mix & Mulching



STEP 5

CONDITION AT 10 YEAR RESPONSIBILITY PERIOD

a) Reclaimed areas meet Performance Standards



CAD FILE NAME/DISK#: PLATE 4A

PLATE 4A

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD MINE
SEQUENCE OF RECLAMATION

DRAWN BY:	K. LARSEN		
SCALE:	NONE	DRAWING #:	
DATE:	JULY 14, 2016	SHEET 1 OF 1	REV.

Cut Volume 176,455 yds³
Fill Volume 155,830 yds³

DRAINAGE	FROM STATION	TO STATION	100 YEAR FLOW (cfs)	MAX. CHANNEL SLOPE %	BOTTOM WIDTH (ft)	WATER DEPTH (ft) *	RIPRAP THICKNESS (ft) **
RIGHT FORK	0+00	9+00	656	7%	10	2.6	3.75
LEFT FORK	0+00	2+00	NA	NA	NA	NA	NA
	2+00	4+60	416	2%	10	2.9	3.75
	4+60	16+00	416	11%	10	1.7	3.75
MAIN CHANNEL	16+00	22+63	1070	5%	10	3.6	3.75
	22+63	23+40	1070	0%	10	11	3.75

NOTES:

1. SEE SHEET 2 FOR PROFILES
2. THIS MAP IS BASED ON THE HUNTER PLANT STATE PLANE COORDINATE DATUM,
3. HUNTER PLANT C.A.F. = 1.0003022, EAST MTN. C.A.F. 1.000435
   T.17S., R.7E. S.L.B. & M.
4. * ALL CHANNELS WILL BE CONSTRUCTED TO PROVIDE A 2.0' FREE BOARD
5. ** D_{50} = 3.0' RIPRAP, MAXIMUM RIPRAP = $D_{50} \times 1.25$
6. MAXIMUM SLOPE FOR RIPRAP STABILITY, DETERMINED FROM EQUATION $D_{50} = 9.8\ C\ (nq)^{0.6}\ S^{0.7}$
7. MANNING n = .035 FOR COMPOSITE BEDROCK AND RIPRAP CHANNEL
8. REFER TO APPENDIX F FOR SIDE CHANNEL DRAINAGE AREAS

DATE	REVISIONS	BY	CHK.
7-24-15	REVISED TO REFLECT A SINGLE PHASE RECLAMATION VS. 2 PHASES	KJL	
5-29-15	REVISED UTILIZING CARLSON SOFTWARE & AEROQUEST TOPOGRAPHY	KJL	
10-31-11	ADDED 9TH EAST BREAKOUT PHASE III BOND RELEASE DELINEATION	KJL	
12-20-00	CONVERTED DRAWING TO AUTOCAD/REVISED MASS BALANCE TABLE	KJL	
8-29-89	REVISED CONTOUR LINES & MASS BALANCE TABLE	J&T	TJF
8-31-89	REVISED UP&L CO. PERMIT BOUNDARY LEASE U-044025	KJL	TJF
6-1-89	CHANGED CONTOUR LINES & ADDED MASS BALANCE TABLE		LJG
3-1-89	REVISED TITLE BLOCK TO INCLUDE COTTONWOOD MINE	JRG	
11-5-84	REVISED RIPRAP THICKNESS	SMC	
8-7-84	REVISED DRAINAGE TABLE	SMC	
5-1-84	REALIGNED DIVERSION CHANNELS TO ORIGINAL FORMATION	SMC	
1-13-84	ADDED SHEET 2 & PROFILE STATIONING	SMC	
11-12-83	UPDATED FINAL RECLAMATION CONTOURS	SMC	
29 SEPT 83	PROPERTY BOUNDARY REVISED TO INCLUDE SPECIAL USE PERMITS	AWB	SMC
9-22-81	ADDED FEDERAL COAL LEASE U-47978	SMC	SMC

LICENSED PROFESSIONAL ENGINEER
MARK A. REYNOLDS
5049079-2202
STATE OF UTAH

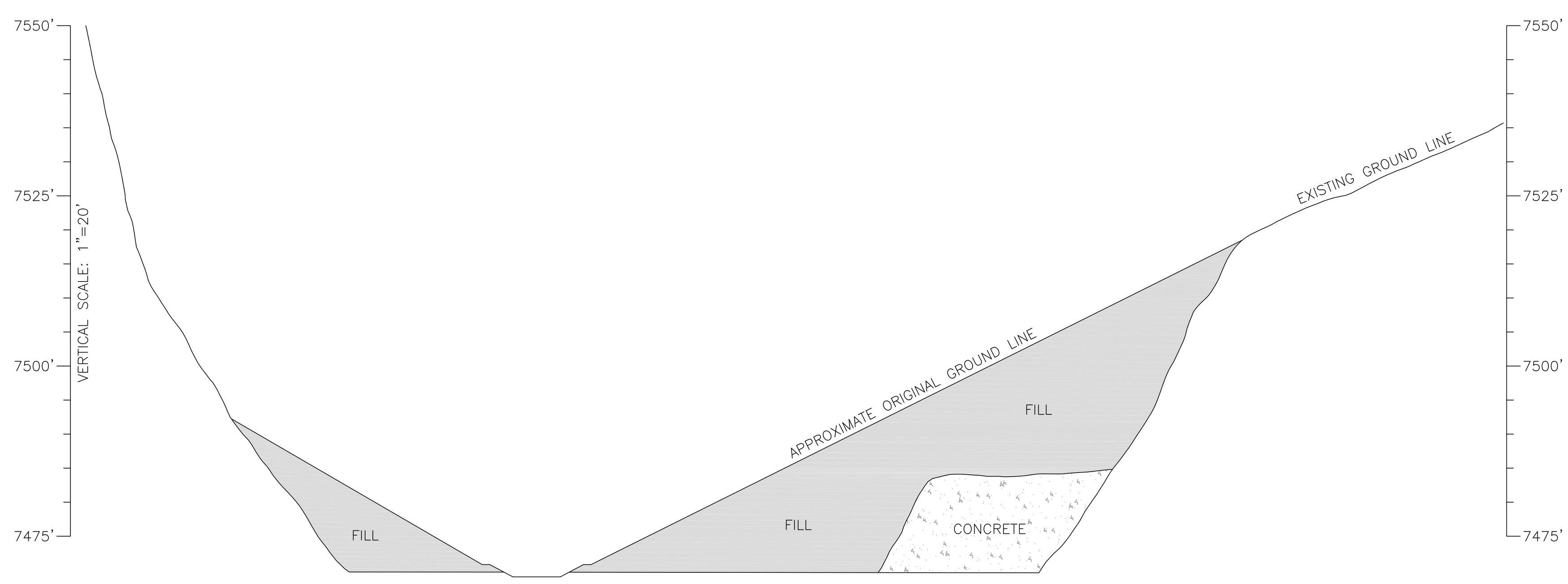
CAD FILE NAME/DISK#: PLATE 4B

PLATE 4B

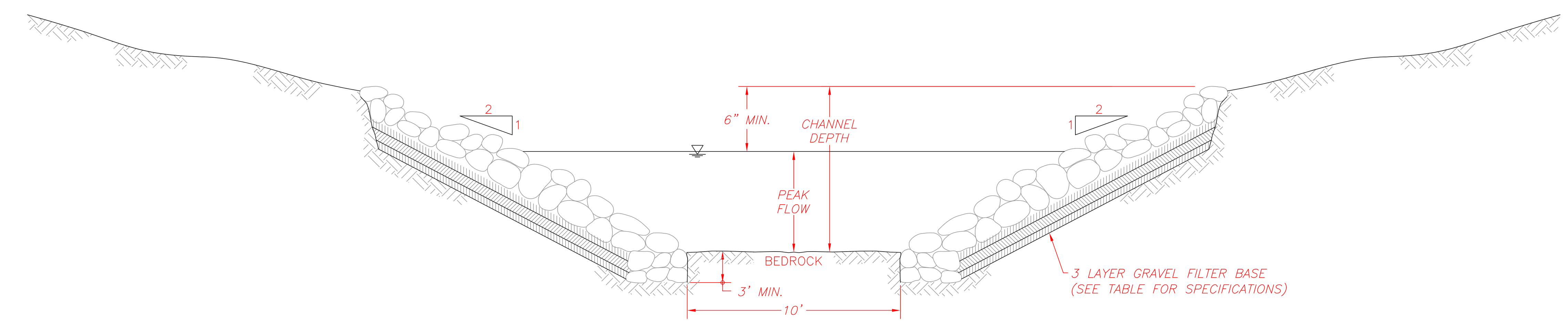
INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD/WILBERG MINE
FINAL RECLAMATION MAP

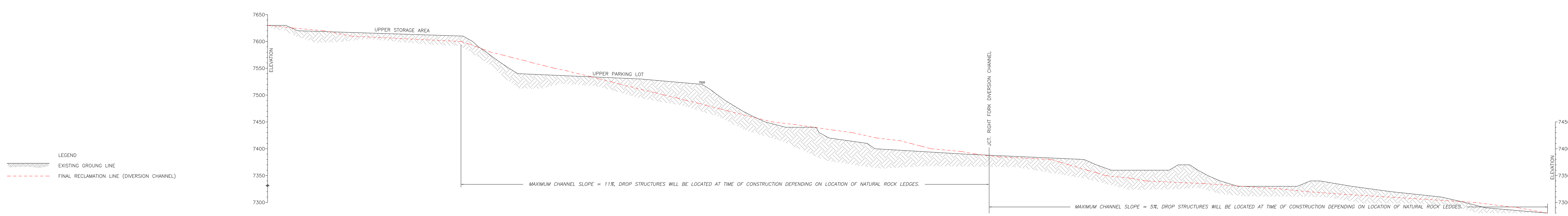
DRAWN BY: K. LARSEN
SCALE: 1"=100'
DATE: JULY 14, 2016
DRAWING #: CM-10378-WB
SHEET 1 OF 2
REV.



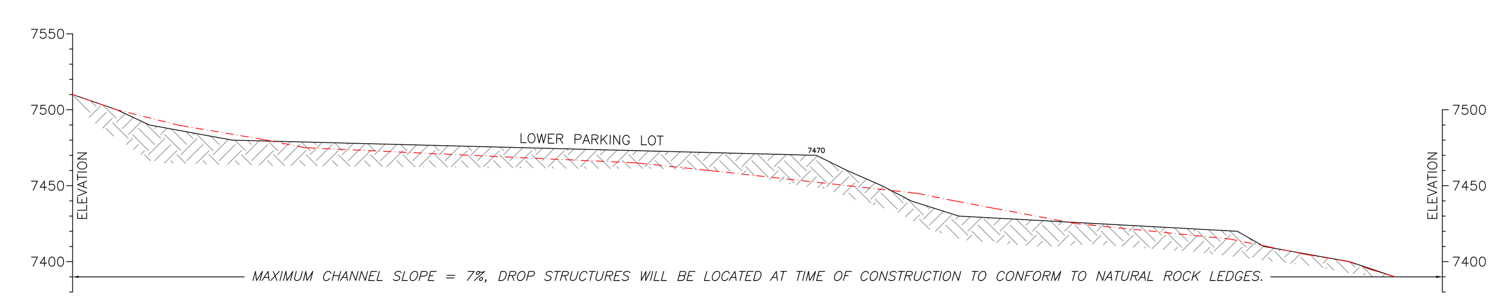
TYPICAL CROSS SECTION
HORIZONTAL SCALE: 1"=40'



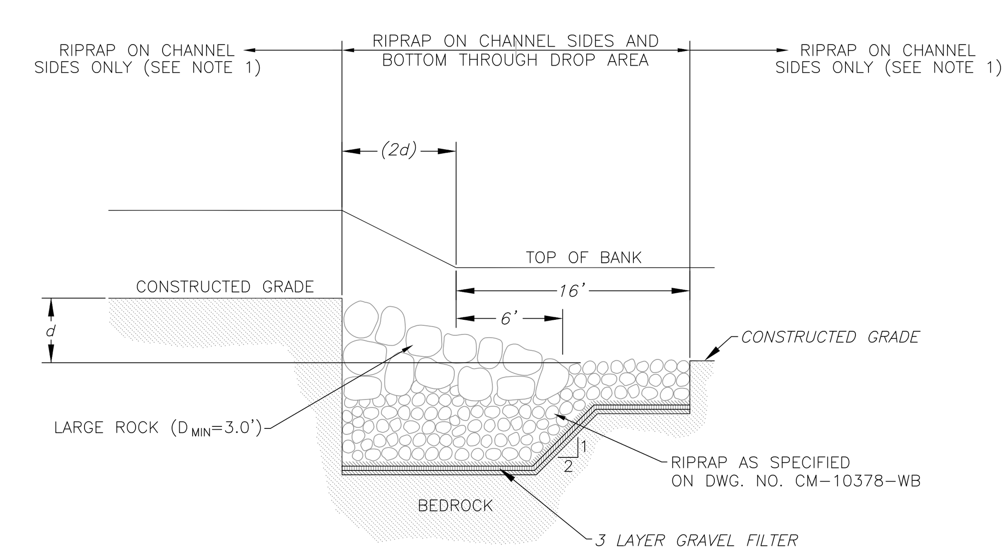
TYPICAL CHANNEL DRAINAGE CROSS SECTION
NO SCALE



LEFT FORK



RIGHT FORK

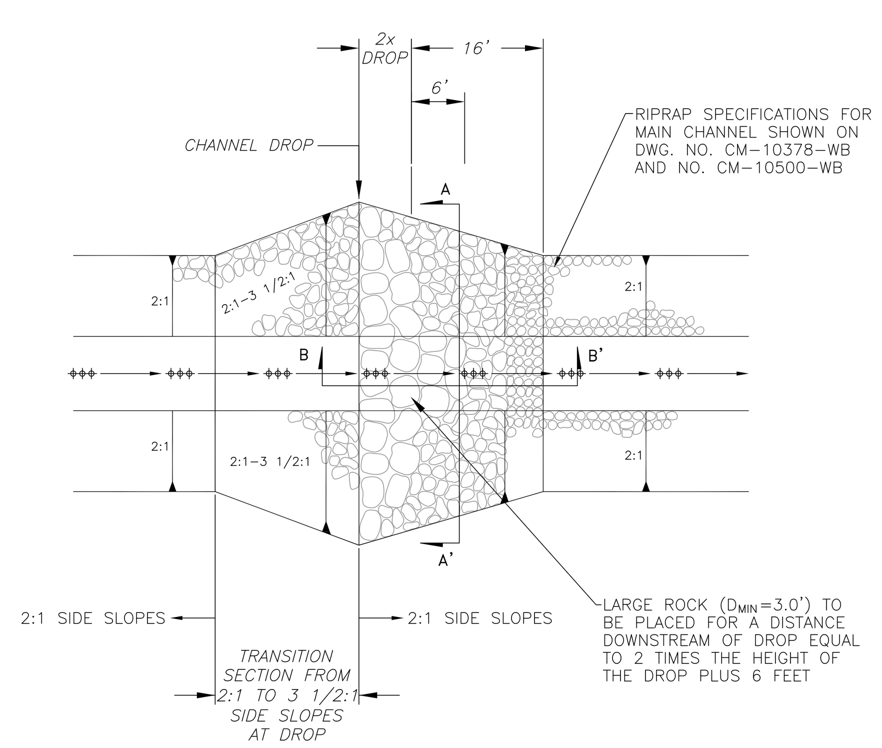


SECTION B-B'
TYPICAL DROP STRUCTURE RIPRAP DETAILS
NOT TO SCALE

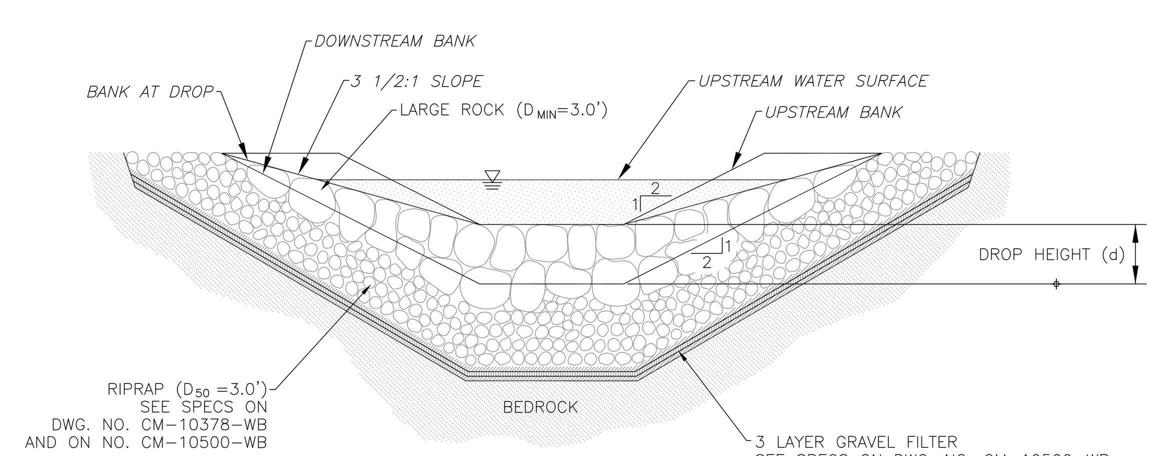
GRAVEL FILTER & RIPRAP SPECIFICATIONS					
	D_{15} (MM)	D_{50} (MM)	D_{85} (MM)	D_{MAX} (FT)	THICKNESS (INCHES)
BOTTOM LAYER	0.42	1.09	2.00	–	6
MIDDLE LAYER	4.76	12.00	25.40	–	6
TOP LAYER	38.10	95.00	152.00	–	8
RIPRAP	365.00	914.00	–	3.75	

NOTES:

1. CHANNEL BOTTOM IS TO BE RIPRAPPED WHEN COMPETENT BEDROCK IS NOT FOUND.
2. MAX. CHANNEL SLOPE VARIES BETWEEN 5 AND 11 PERCENT.
3. MAX. DROP HEIGHT (d) IS 5 FEET.
4. CONSTRUCTED DROP HEIGHT TO BE DETERMINED IN FIELD.



TYPICAL DROP STRUCTURE - PLAN VIEW
NOT TO SCALE



TYPICAL SECTION A-A'
NOT TO SCALE

8. REFER TO APPENDIX F FOR SIDE CHANNEL DRAINAGE AREAS

LICENSED PROFESSIONAL ENGINEER
MARK A. REYNOLDS
5049079-2202
STATE OF UTAH

PLATE 4B

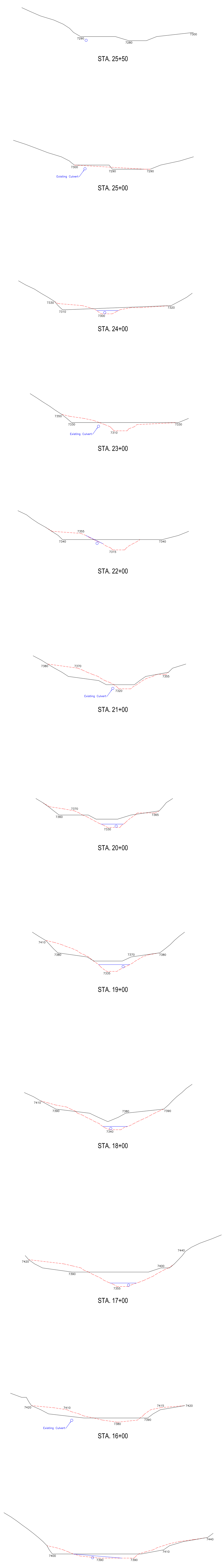
CAD FILE NAME/DISK#: PLATE 4B

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

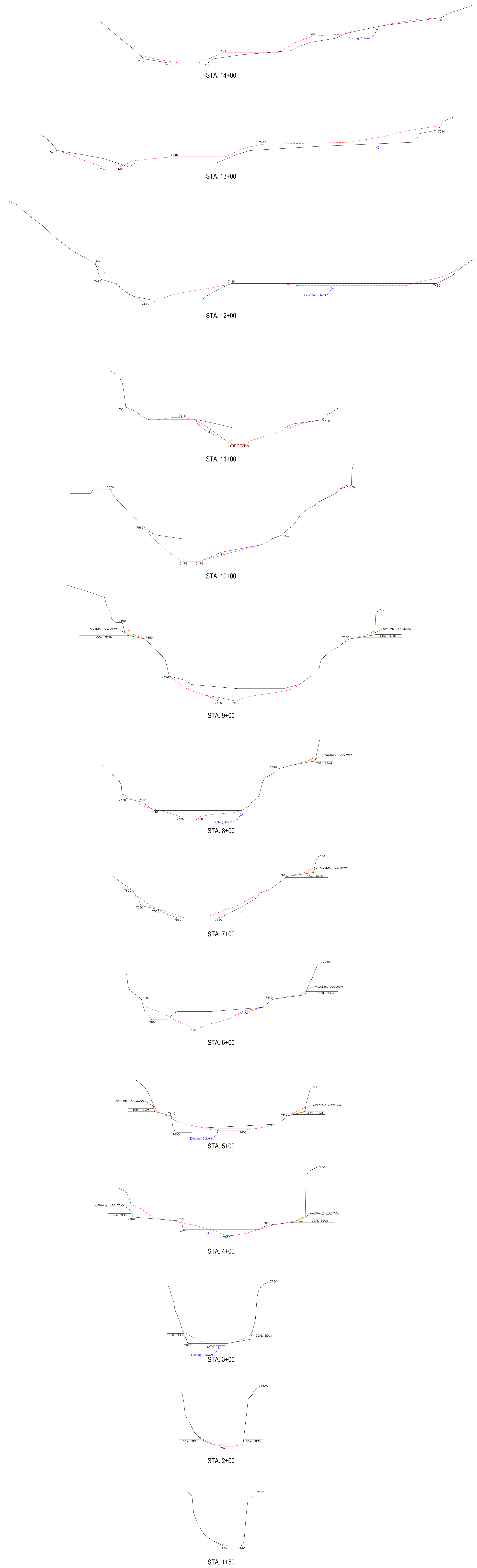
DATE	REVISIONS	BY	CHK.
7-24-15	REVISED TO REFLECT A SINGLE PHASE RECLAMATION VS. 2 PHASES	KJL	
5/29/15	REVISED UTILIZING CARLSON SOFTWARE & AEROQUEST TOPOGRAPHY	KJL	
1/3/01	CONVERTED TO AUTOCAD	KJL	
3/1/89	CHANGED TITLE BLOCK	JRG	
10/25/84	ADDED TYPICAL DROP STRUCTURE CROSS SECTION	AWB	SMC
8/7/84	REVISED CHANNEL PROFILE TO INCLUDE DROP STRUCTURES	SMC	SMC
5/3/84	PROFILE REVISED TO MATCH REVISED DIVERSION CHANNEL	LJG	SMC

COTTONWOOD/WILBERG MINE
FINAL RECLAMATION MAP

DRAWN BY: K. LARSEN
SCALE: 1"=100'
DATE: JULY 14, 2016
DRAWING #: CM-10378-WB
SHEET 2 OF 2
REV.



MAIN CHANNEL



LEFT FORK

Cut Volume 176,455 yds³

Fill Volume 155,830 yds³

LEGEND

EXISTING GROUND LINE

FINAL RECLAMATION LINE

LICENSED PROFESSIONAL ENGINEER
MARK A. REYNOLDS
5049079-2202
STATE OF UTAH

NOTE:
SEE CM-10378-WB SHEET 1 OF 2 FOR LOCATION OF CROSS SECTIONS

CAD FILE NAME/DISK#: PLATE 4C

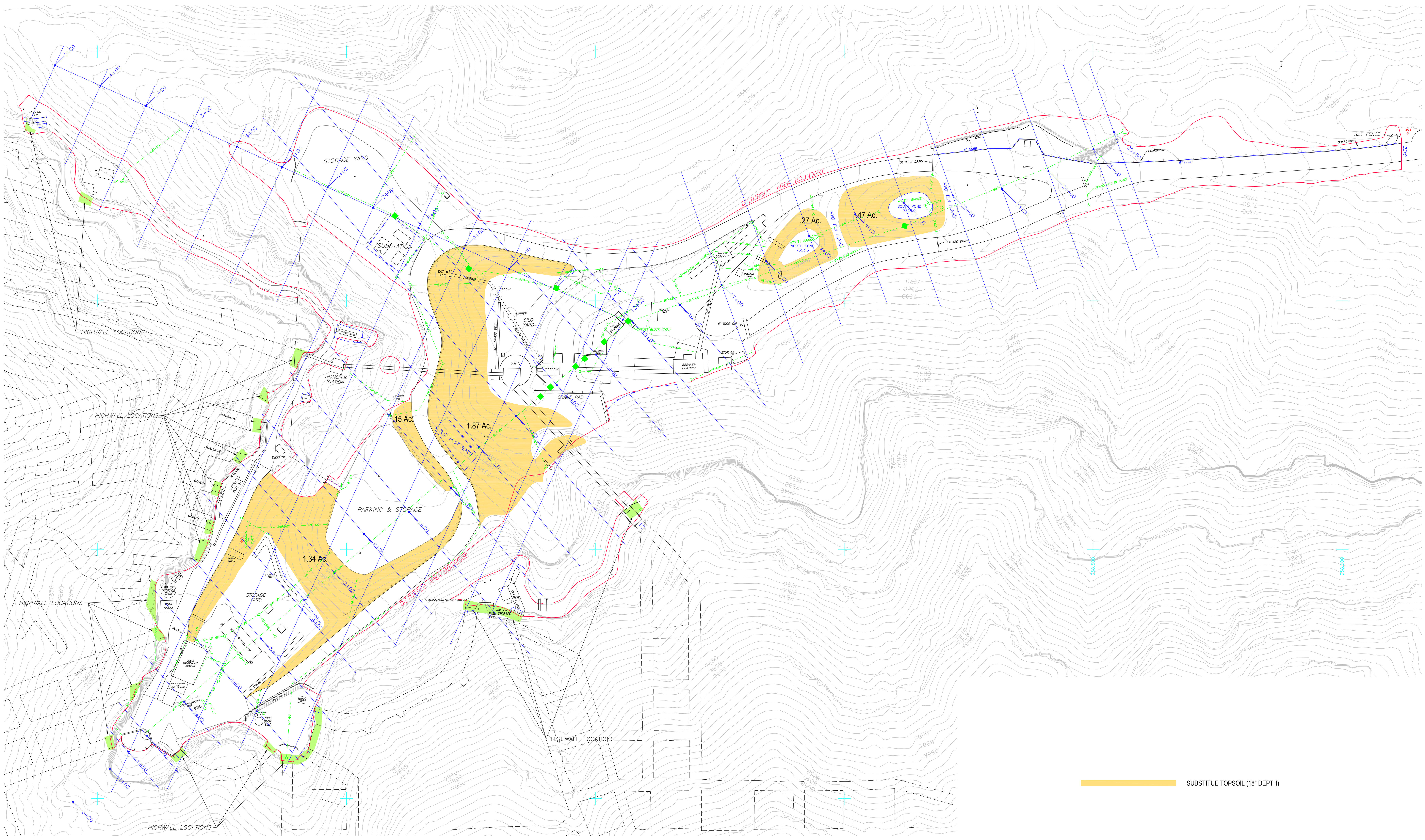
PLATE 4C

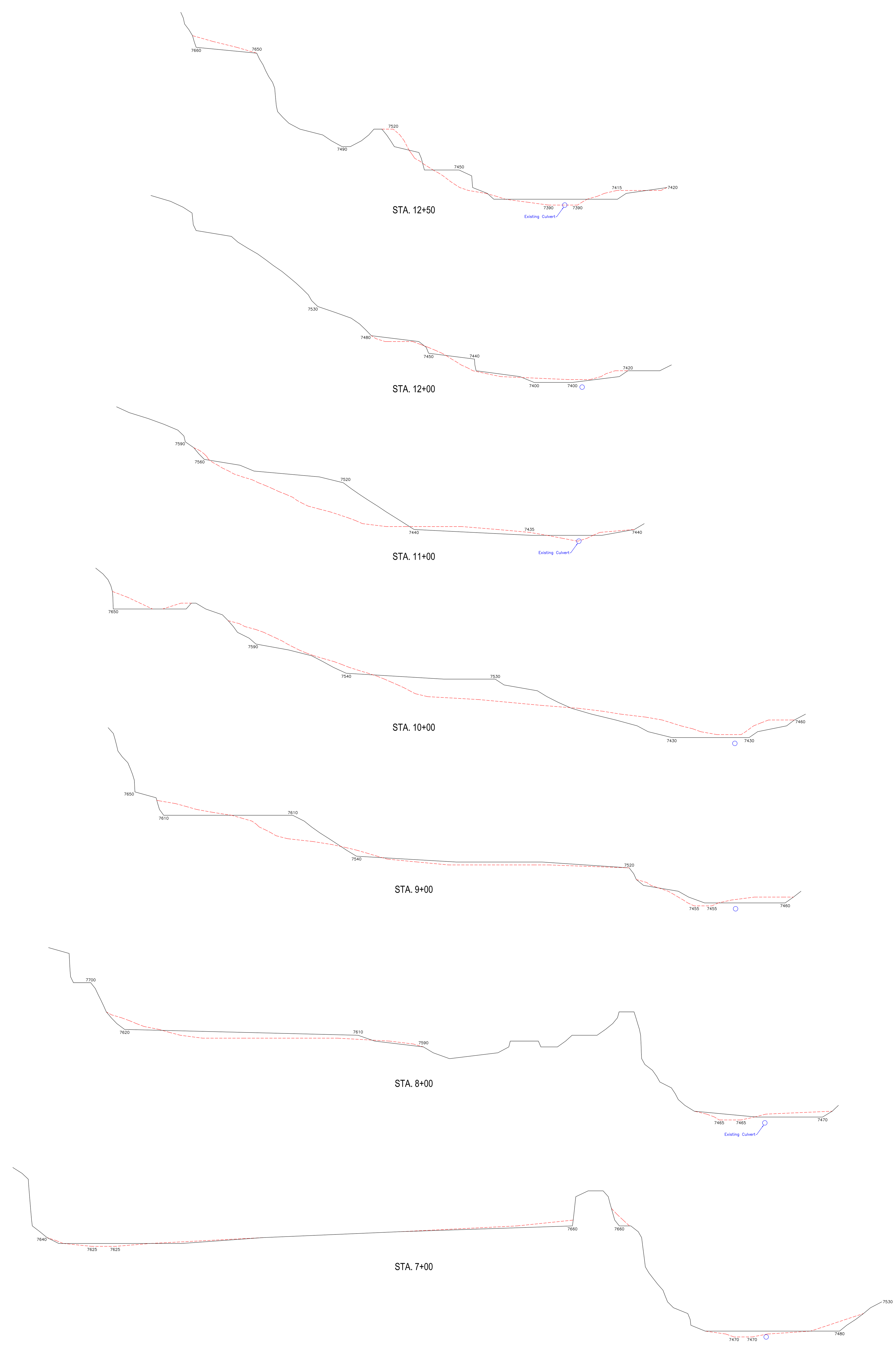
DATE	REVISIONS	BY	CHK.
7-24-15	REVISED TO REFLECT A SINGLE PHASE RECLAMATION VS. 2 PHASES		
5-29-15	REVISED UTILIZING CARLSON SOFTWARE & AEROQUEST TOPOGRAPHY	KJL	
11-13-01	ADDED SUBSTITUTE TOPSOIL LOCATIONS	KJL	
4-21-01	CONVERTED DRAWING TO AUTOCAD	KJL	

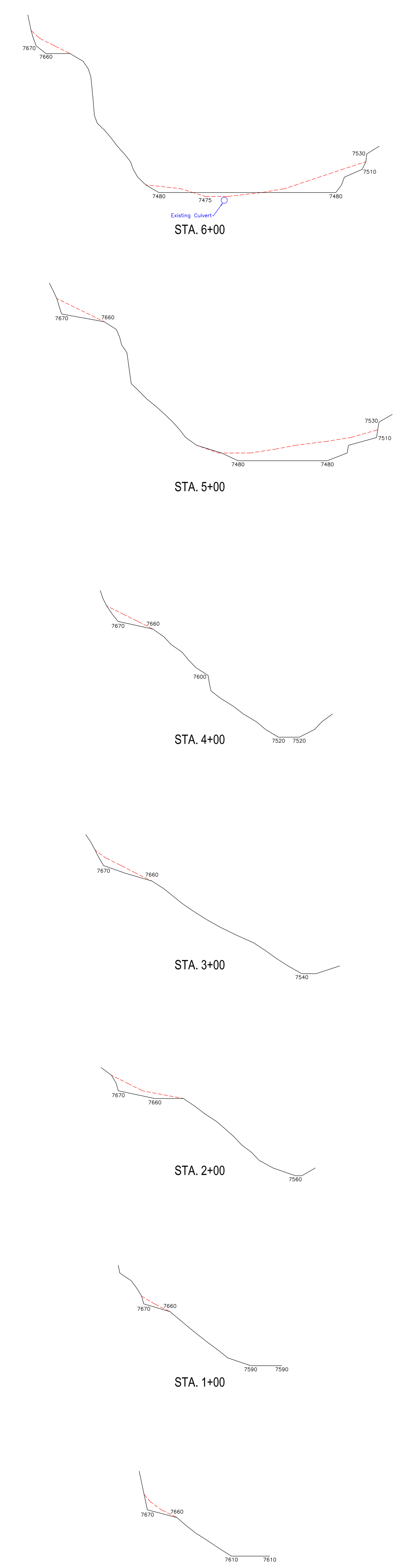
INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD/WILBERG MINE
DISTURBED MINE PLAN AREA
CROSS SECTIONS

DRAWN BY: K. LARSEN
SCALE: 1"=100'
DATE: JULY 14, 2016
DRAWING #: CM-10484-WB
SHEET 1 OF 2
REV. ___







Cut Volume 176,455 yds³

Fill Volume 155,830 yds³

LEGEND

EXISTING GROUND LINE

FINAL RECLAMATION LINE

LICENSED PROFESSIONAL ENGINEER
MARK A. REYNOLDS
5049079-2202
STATE OF UTAH

NOTE:
SEE CM-10378-WB SHEET 1 OF 2 FOR LOCATION OF CROSS SECTIONS

CAD FILE NAME/DISK#: PLATE 4C

PLATE 4C

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD/WILBERG MINE
DISTURBED MINE PLAN AREA
CROSS SECTIONS

DATE	REVISIONS	BY	CHK.
8-22-15	REVISED DISTURBED AREA BOUNDARY AT THE RIGHT FORK	KJL	
7-24-15	REVISED TO REFLECT A SINGLE PHASE RECLAMATION VS. 2 PHASES	KJL	
5-29-15	REVISED UTILIZING CARLSON SOFTWARE & AEROQUEST TOPOGRAPHY	KJL	
11-13-01	ADDED SUBSTITUTE TOPSOIL LOCATIONS	KJL	
4-21-01	CONVERTED DRAWING TO AUTOCAD	KJL	

DRAWN BY: K. LARSEN

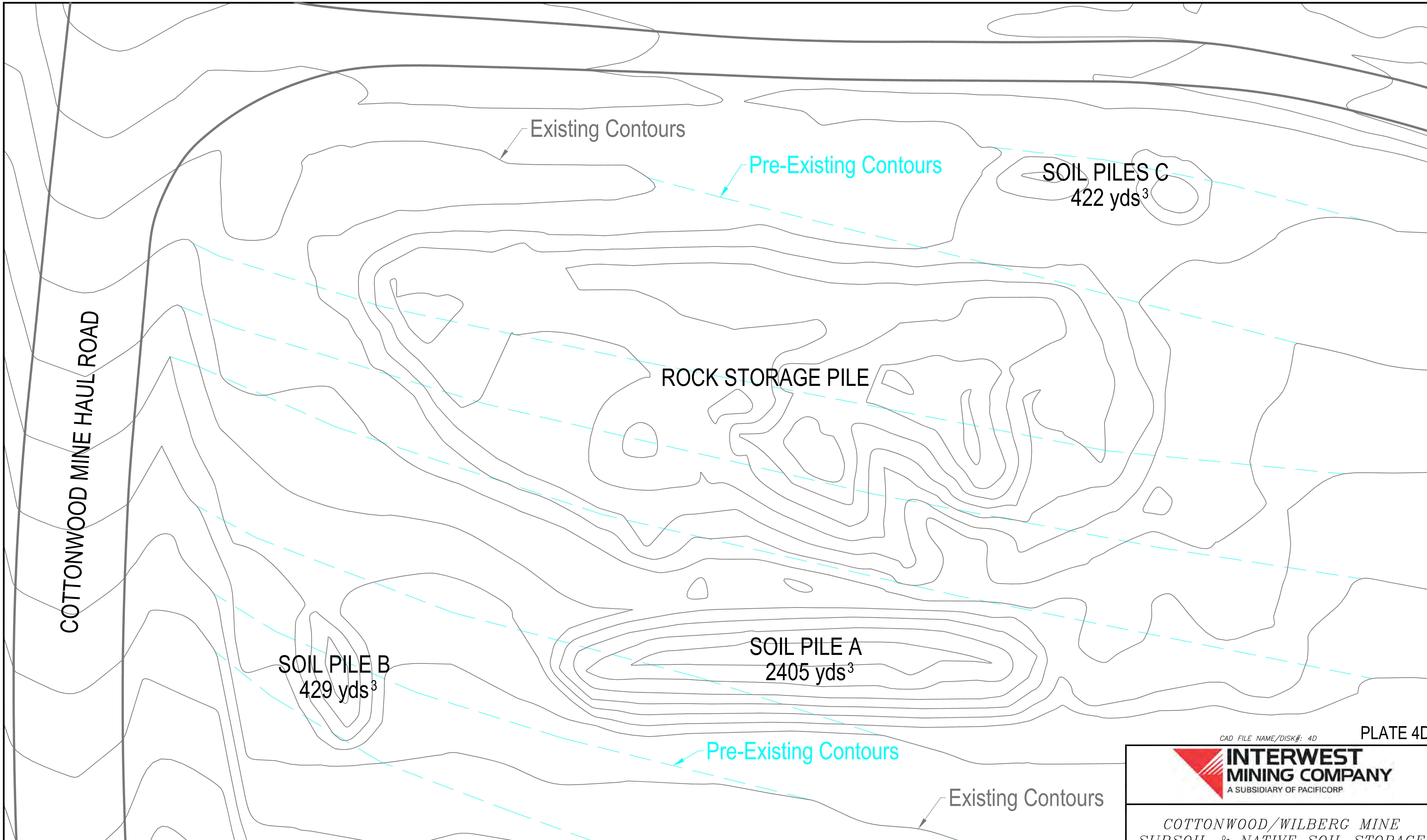
SCALE: 1"=100'

DATE: JULY 14, 2016

DRAWING #: CM-10484-WB

SHEET 2 OF 2

REV. ___



Note:
Soil Volumes Calculated Using Carlson Software

PLATE 4D

CAD FILE NAME/DISK#: 4D

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD/WILBERG MINE
SUBSOIL & NATIVE SOIL STORAGE

DRAWN BY:	K. LARSEN	DRAWING #: PLATE 4D	
SCALE:	1" =30'		
DATE:	JULY 14, 2016	SHEET 1 OF 1	REV.

Legend:

- Slopes Typical of the 34.4% Rusle Slope LS-2
- Slopes Typical of the 51.2% Rusle Slope LS-1
- ⊗ Remote Samplers
- Ⓦ Weather Station
- ⊙ Gauge Evaluation Locations
- Transect Profiles

Notes:

- 6'x6'x3' Gouges Constructed at the Boundary of Disturbed Area
- 3'x3'x1.5' Gouges Constructed throughout the Remaining Disturbed Area
- Sub-Drainages in Reclaimed Areas are Designed as Found in Appendix F

CAD FILE NAME/DISK#: PLATE 4E

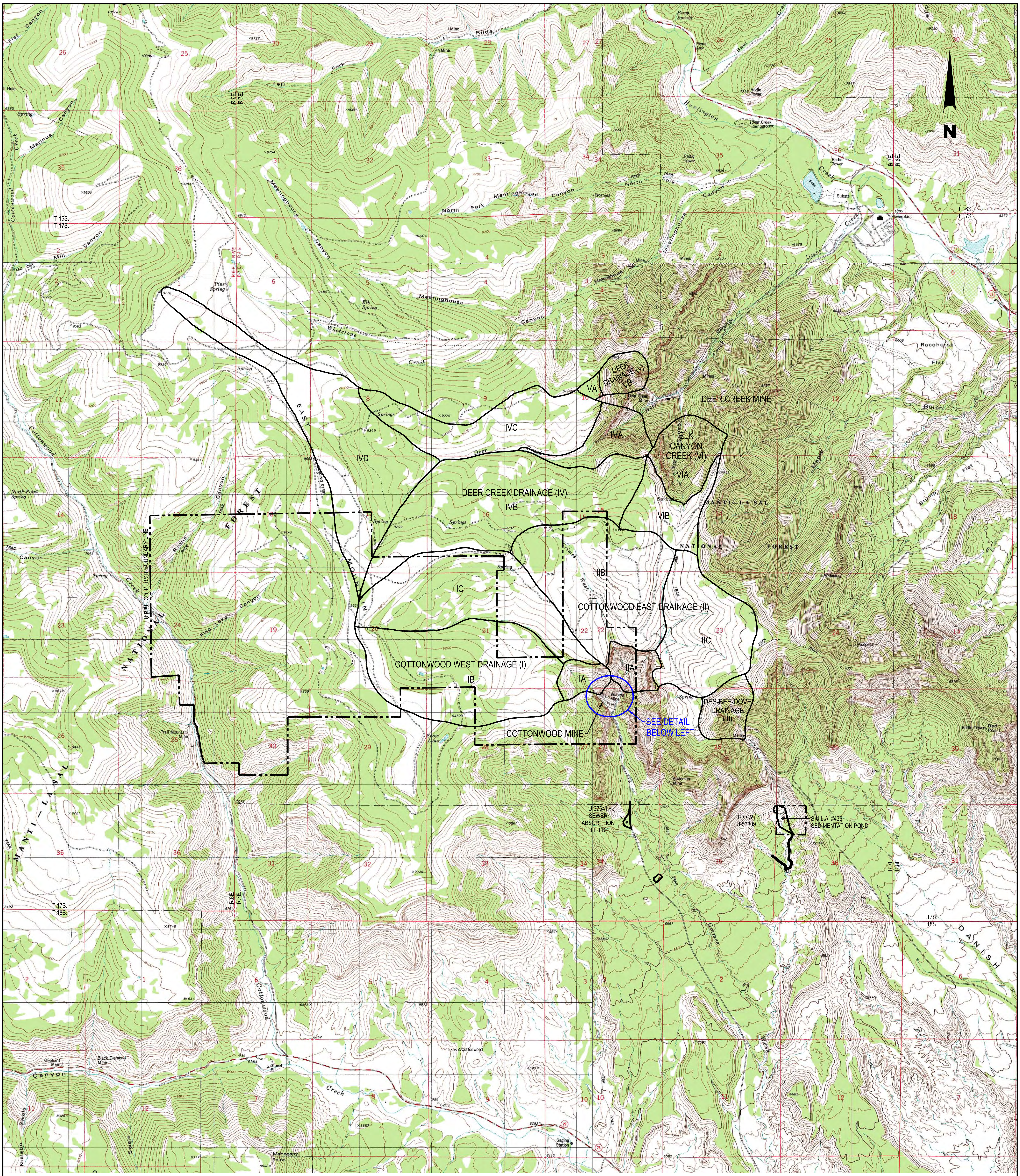
PLATE 4E

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

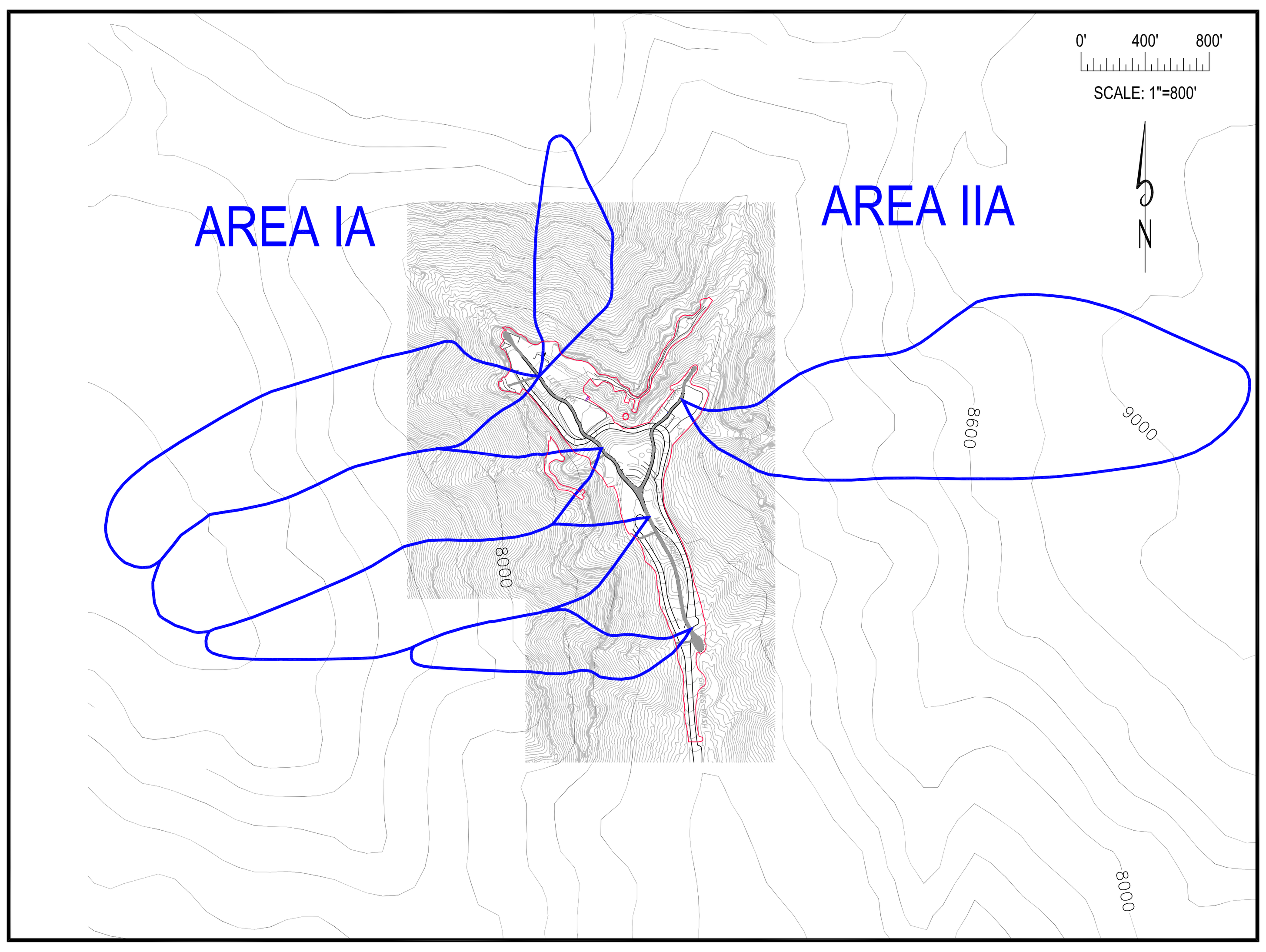
COTTONWOOD/WILBERG MINE
FINAL RECLAMATION MAP
RUSLE SLOPES FOR SOIL LOSS CALCS

DATE	REVISIONS	BY	CHK.
8/22/2015	ADDED GOUGE LOCATIONS AROUND DISTURBED PERIMETER, REMOTE SAMPLERS, WEATER STATION, GAUGE EVALUATION LOCATIONS, TRANSECT PROFILES, NOTES, AND LEGEND	KJL	
7/2015	ADDED RUSLE LENGTH SLOPES FOR SOIL LOSS CALCULATION	DCO	

DRAWN BY: K.J.L. & D.C.O.
SCALE: 1"=100'
DATE: AUGUST 22, 2016
DRAWING #: PLATE 4E
SHEET 1 OF 1
REV.



NOTES:
REFER TO APPENDIX F FOR SIDE CHANNEL DRAINAGE IN AREAS IA AND IIA.
SEE DETAIL BELOW LEFT



COTTONWOOD/WILBERG SIDE CHANNEL - RECLAMATION WATERSHEDS

DATE	REVISIONS	BY	CHK.
2-25-16	REVISED COTTONWOOD PERMIT BOUNDARY	KJL	
4-10-12	REVISED TO REFLECT PHASE 3 BOND RELEASE OF THE COTTONWOOD WASTE ROCK SITE	KJL	
11-5-86	REVISED TO INCLUDE SEC. 31, 32 & 33 T.16S. R.7E. & SEC. 36 T.16S. R.6E. INTO MINE PERMIT AREA	KJL	

CAD FILE NAME/DISK#: PLATE 4F

PLATE 4F

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY
DEER CREEK & COTTONWOOD MINES
HYDROLOGIC AREA DRAINAGE MAP

DRAWN BY: K. LARSEN
SCALE: 1"=2000'
DATE: AUGUST 22, 2016
DRAWING #: CM-10529-EM
SHEET 1 OF 1
REV. ___