C/015/019 Incoming ✓
#5096

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

March 3, 2016

Draft pending OSM review.

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. Maps have been amended to illustrate the new contours.

The Sediment Control Plan was also revised to utilize best technology currently available (BTCA). IMC incorporated deep gouging techniques on steep slopes in place of the existing design for contour and collection ditches. Using 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.

A Redline/Strike-out copy of the revised text for the reclamation plan is included as well as the associated revised reclamation maps. C1/C2 forms are attached.

If there are any questions or concerns regarding the submittal of this plan, please contact Dennis Oakley at 435-687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Geology and Environmental Affairs Manager

Enclosures

Cc File
Scott Child

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 — Print Name

Kenneth S. Fleck — Sign Name, Position, Date — Manager of Environmental Affairs MARCH 3, 2016

Subscribed and sworn to before me this 3rd day of March, 20 16

Chris M Christensen
Notary Public

My commission Expires: April 24, 2019

Attest: State of Utah } ss:
County of Emery

NOTARY PUBLIC
CHRIS M CHRISTENSEN
Commission No. 682810
Commission Expires
APRIL 24, 2019
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.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Volume 2, Part 4, Reclamation Plan (entire section)
☐ Add	☒ Replace	☐ Remove	Volume 2, Part 4, Appendices
☒ Add	☐ Replace	☐ Remove	Volume 2 Part 4, Maps Section
☐ Add	☐ Replace	☒ Remove	Volume 6, Maps, 4-1: CM-10500-WB
☐ Add	☐ Replace	☒ Remove	Volume 6, Map 4-2: 7704-C45 (3 of 3)
☐ 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)
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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**
Note that the contents of Maps 4-1 and 4-2 were combined and amended into Map 4-2.	

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. The historical 1989 soil survey information for the Wilberg Mine is included in Appendix A. 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 for the results of the sampling activities.

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 as 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.

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.

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. 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). 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.

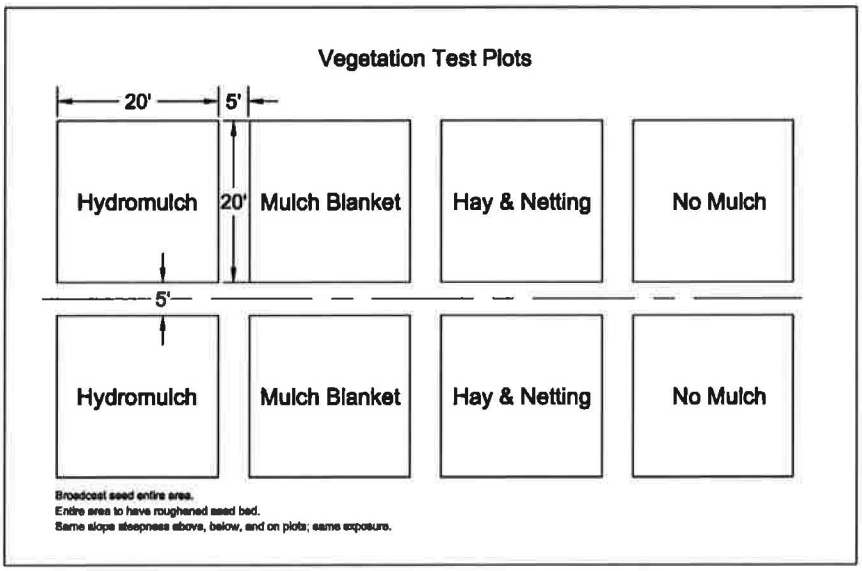


Figure 3-1: Vegetation Test Plots.

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 320.220. 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).

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 slope 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 top of the mine site to the bottom.

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				✓				✓	✓	✓

*Monitoring of mine discharge will be conducted as required by the current UPDES permit (Outfall 004 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.

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**

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.

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**

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.

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 exists at this location. The disturbed area includes 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. 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 were 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' feet square and 1.5' 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 or 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 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-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. The final 25% of the tree and shrub live plantings will be included in the 4th year density counts. 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 Wildlife Resources (DWR) and 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 active 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.

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 highway cut in the lower parking lot. All other concrete foundations that would be above final grade was removed and stockpiled with the silo material or used to backfill portals. Refer to Items 1-A and 2-A in Appendix G 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 area 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.

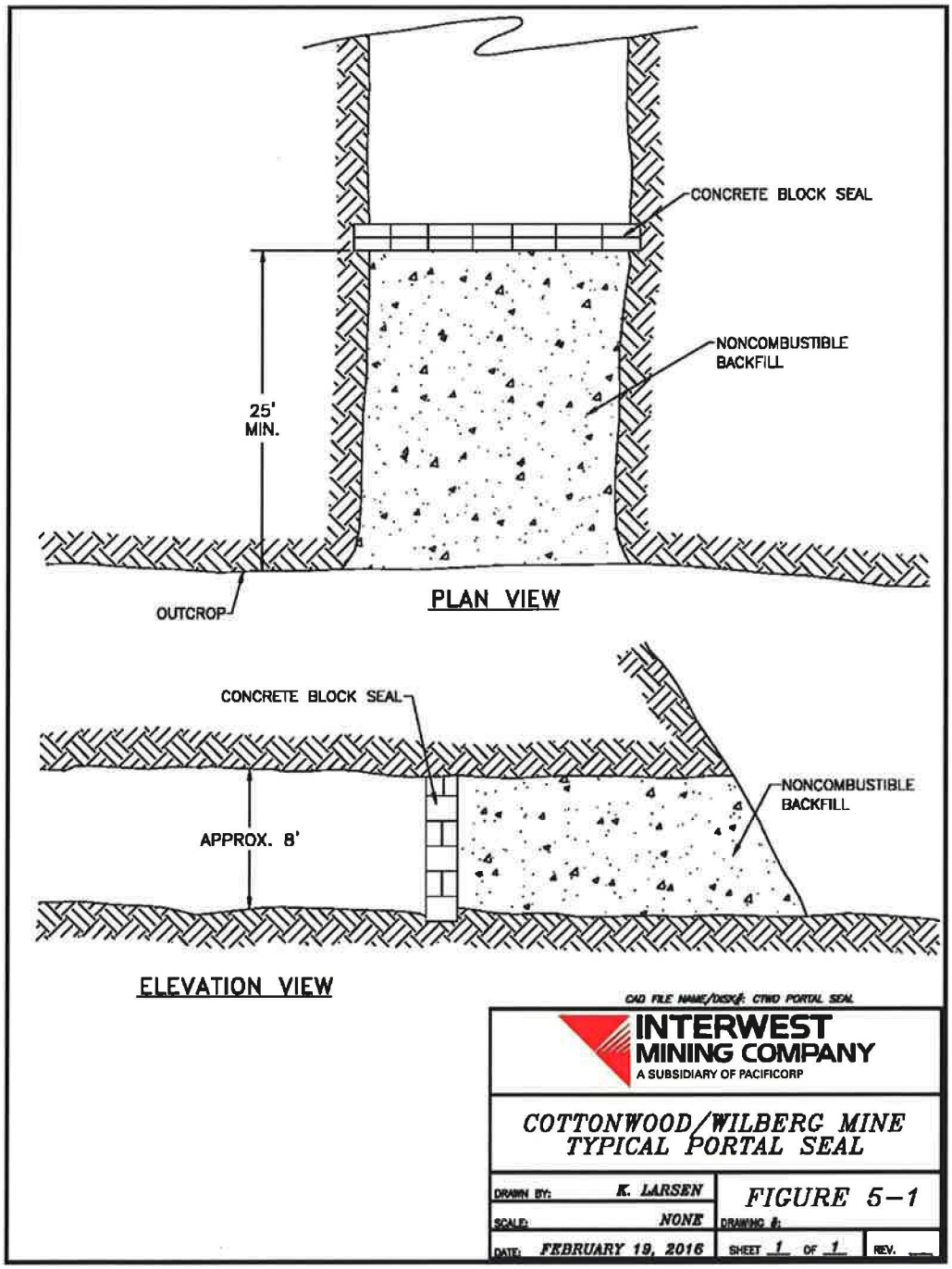
542.600: Roads

The asphalt and road base gravel 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 G, 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 flow 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.

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
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.

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. Detailed scheduling and cost estimations are located in Appendix G

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 G.

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 these.

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

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

A similar slope stability analysis was performed by RB&G Engineering Inc. (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. 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.

Because of the similarity of the sites, the recommendations made by RBG for Des Bee Dove will be used for slope development at the Cottonwood/Wilberg Mine. Refer to Appendix C for fill details of the stability analysis.

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 drainages: Left Fork Grimes Wash, and Right Fork Grimes Wash. The Left Fork is by far the largest drainage. 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 necessary facilities to mine coal. Reclamation consists of removing these fill structures and constructing a channel following the natural drainage of the canyons.

Design, location, construction and materials are carefully chosen to ensure stable channelization. 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 channel design of sufficient size to accommodate a 100 year, 24 hour storm event.

As outlined in the previous discussions, the CMP culvert in the Left and Right Fork of Grimes Wash will be removed in sections (refer to Plate 4A). Although the canyon is considered ephermal, flow typically occurs during 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 device may be necessary to temporarily control sedimentation.

Once earthwork activities are completed in an area, permanent sediment control will be installed. Permanent sediment control includes incorporating hay into the topsoil, deep gouging, seeding, and finally, applying hydromulch and tackifier to the surface.

742: Sedimentation Control Measures

The mining company contracted the development of a reclamation plan for the site in the 1980's. In this plan, sediment control was provided by the use of contour and collection ditches. Because of the erosional characteristics of the available soil materials combined with bedrock expressions in the channel with exposed drops PacifiCorp concludes that contour and collection ditches have a high probability for failures caused by concentrating overland flow which would cause head cutting in the collection ditches and/or breaching of the contour ditches. Because of the presence of large drops of the natural bedrock in the drainage areas, equipment access to repair these failed areas will likely be impossible.

As an alternative (and a present day industry standard for sediment and erosion control) to constructing contour and collection ditches is utilizing deep gouging/pocking techniques for sediment control. PacifiCorp and others have had excellent success using this technique. Sediment transport models show that in using this technique the disturbed or reclaimed areas produce a reduced sediment load 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 smaller 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. Because of the failure concerns mentioned above, PacifiCorp proposes to remove the sediment ponds as part of the final reclamation activity, but prior to the two (2) years after the last augmented seeding as dictated by R645-301-763.100. Justification for removing the ponds prior to the two (2) year requirement is fully detailed later in this chapter.

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

Sediment transport will be controlled as required by R645-301-552.100 and R645-301-742 of the Utah Coal Regulations. Best Technology Currently Available (BTCA) measures will utilize deep gouging (pocking) techniques which encourages water retention and enhances plant growth. These protective measures designed to prevent additional contributions of sediment to the streamflow or runoff outside the permit area will be used as a temporary control measure in lieu of siltation structures throughout the responsibility period. This sediment control method is termed temporary 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, vegetation becomes the permanent sediment control measure.

Discussion of Pocking as a Sediment Control Measure

Design of sediment control measures are based on 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, causing 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 attempt 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 mentioned 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.

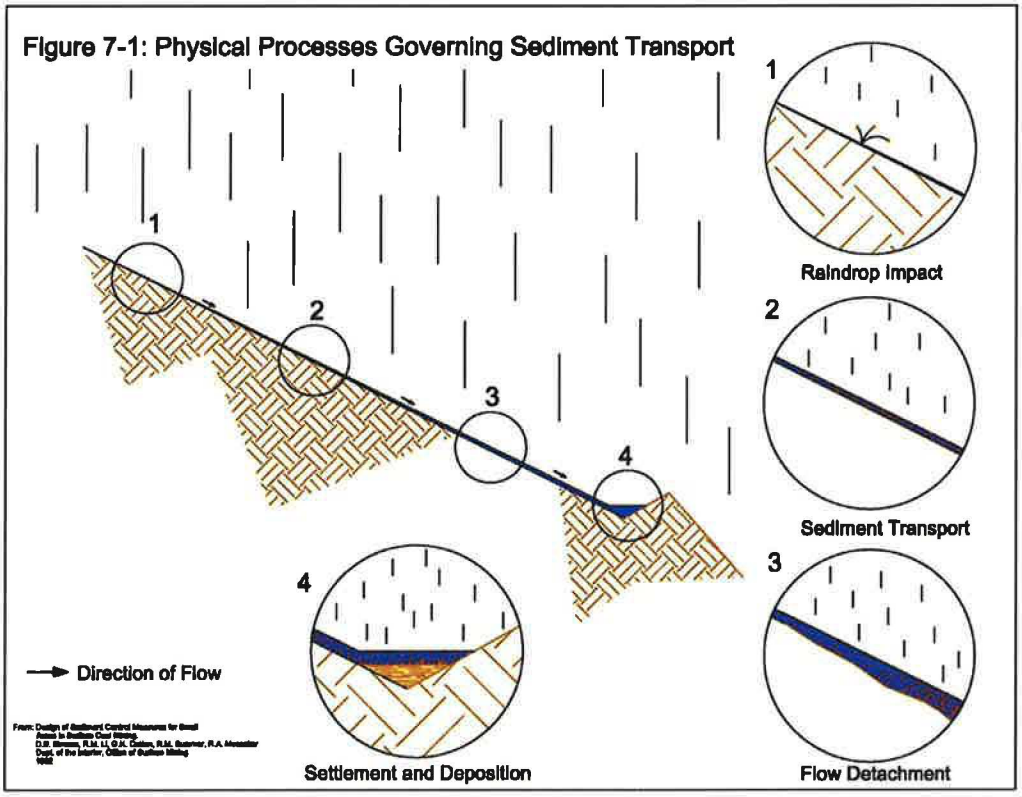
The theories and concepts behind deep gouging (pocking) are to control the applied hydrodynamic forces to promote deposition. Pocking allows for this in a multitude of ways. Pocks reduce the length that overland flow will travel, reduces the overall velocity of overland flow, eliminates or greatly reduces the potential for concentrated flow to form by intercepting its flow path, reduces the overall transport capacity of the overland flow, promotes 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 offers 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.

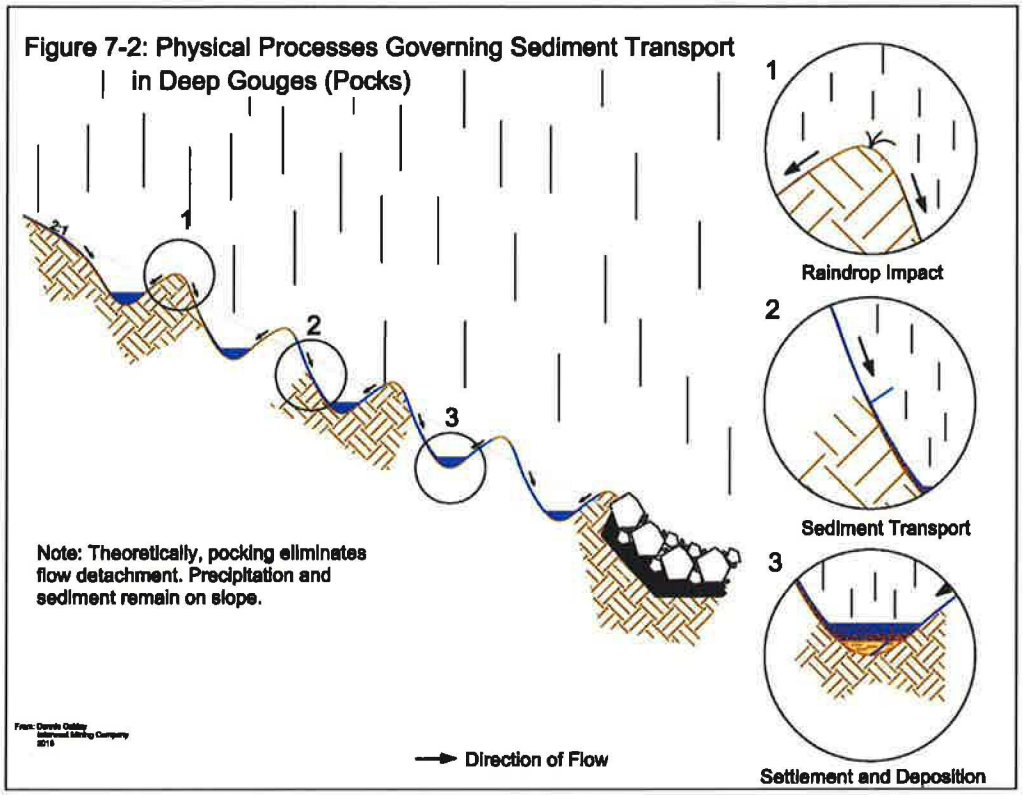
Hydrologic Cycle and Pocks

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 causes 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 continuous 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.





Deep Gouging Standards

In November 2105, Interwest Mining Company retained the services of EarthFax Engineering Group LLC to look at the design hydrology of the site to determine whether a typically sized pock could contain the quantity of rainfall produced by a 100yr/24hr precipitation event. Although the Utah Coal Regulations only require reclamation designs to use a 100yr/6hr event, the original drainage design was based on the 100yr/24hr event. Therefore, all hydrological analyses are based on the more severe of the two storm events.

As EarthFax reported, the design standard for deep gouging is generally as stated in DOGM's reclamation guide (UDOGM, Practical Guide to Reclamation in Utah). The gouges are constructed using a trackhoe to excavate multiple shallow pits into the regraded, topsoiled, and mulched slope. Mulch typically comprises of alfalfa spread at a rate of approximately 1 ton per acre and incorporated into the soil mass. Field experience indicates that the individual pocks have an approximate surface diameter of 3 to 6 feet and approximate depths of 1.5 to 3 feet. Pocks are constructed in a random, overlapping

pattern. This pattern eliminates any potential flow path on the slope to develop. 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.

Design Storm and Pocks

Several assumptions must be made when estimating volume of the captured precipitation from a 100yr/24hr event. The following assumptions are used:

1. Pocks are generally the shape of a trough.
2. The designed storm falls consistently throughout a 24 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 7-3, a pock is similar to the geometric configuration of a trough. Using the dimensions of a=3', b=1.5', h=1.5, and w=3' the total holding capacity (volume) is equal to 10.125 cubic feet. A large trough (or pock) with the dimensions of a=6', b=3', h=3', and w=6' has a volume of 81.0 cubic feet.

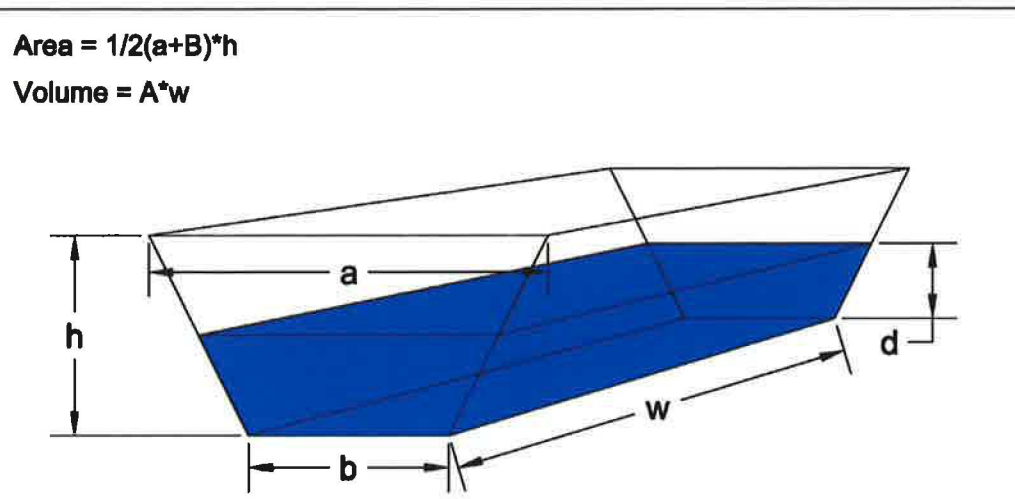


Figure 7-3: Modeling a Pock Using a Trough Shaped Geometric Figure

The 100yr/24hr event produces 3" (0.25') of rainfall in 24 hours (Note: rainfall amount was determined using the newest data supplied by the NOAA Atlas 14 Point Precipitation Frequency Estimates. 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 D). Evaluating the area that rainfall (3") would intersect in the top plane of the trough and multiplying by the depth of rainfall gives a volume of 2.25 cubic feet that accumulates in the bottom of the 3 foot trough (refer to calculations in Appendix D). The volume retained if assuming an infiltration rate of 0.05 inches per hour (most conservative estimate in Soil Group C) for 24 hours equates to approximately 1.35 cubic feet or 13% of the total capacity of the trough. The volume of a 3" (0.25') storm event accumulating in the larger 6 foot trough would be approximately 5.4 cubic feet or 7% of its entire holding capacity (assuming the same infiltration rate). Finding the depth (d) of water requires solving a quadratic equation. As calculated in Appendix D, the depth of water using the scenario of the 3 foot trough shows d = 0.227'. The depth of water in the 6 foot trough using this same scenario shows d = 0.513'.

Observing the cross-sectional view of the pock in Figure 4 and comparing it to the trough model, we can see that the volume of water remaining in the pock at the end of the 100yr/24hr 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/24hr storm event if all pocks installed on this slope are constructed as outlined.

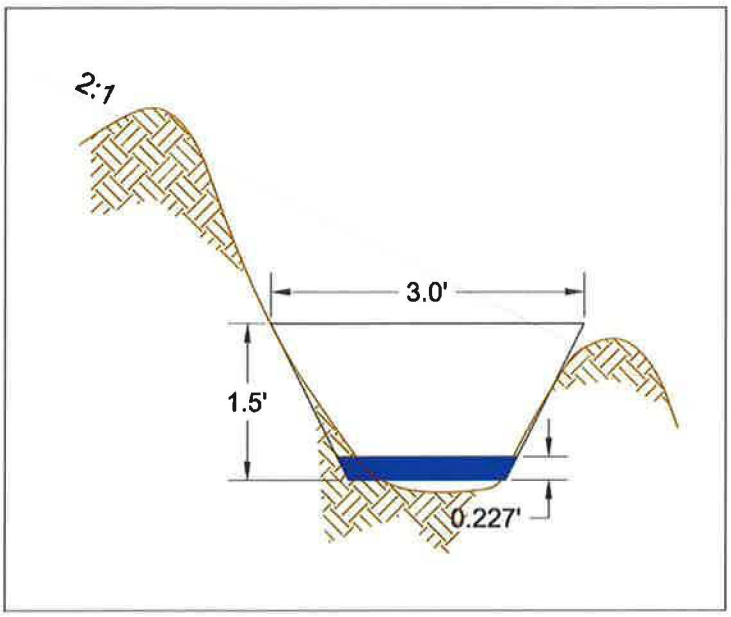


Figure 7-4: Theoretical Water Holding Capacity of a Standard Pock.

Overland Flow onto Site

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 of the area 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 flows. Runoff is modeled utilizing the Rational 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 considered from an area of 6 feet (width of a large pock) by 125 feet (NEH, Part 630, Chp 15). Calculations are shown in Appendix D.

The results show, the undisturbed area contributes 0.81 inches of excess precipitation. This translates to a volume of approximately 50.63 cubic feet. The largest pock has been shown a total capacity of 81 cubic feet. Therefore, we can conclude that runoff from the

undisturbed areas above the disturbed areas should not cause impact or damage, and the disturbed areas will contain the overland flow from the design storm, if the larger of the two modeled pocks is used at this transition area.

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. Although these other sites did not differentiate pock sizes at the undisturbed/disturbed transitional boundary, 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. Plate 4E shows these areas and where each calculation was 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 that shows the results of the modeling exercise. Also included are the inputs which were used to run the model. 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. 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 was 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 two slope profiles used were representative of the cut slopes and fill slopes for the entire site.

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 spaced evenly along the hillslope profile. 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 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.

As an example, site LS-2 in Appendix B 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 yield).

A summary of the sediment yields for LS-1, LS-2, and LS-3 is presented in Appendix B. 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 is a failure of the pocks on the slope, all sediment and water will be retained on the slope.

Justification for Removal of the Sediment Pond

The sediment control measures to be utilized at the Cottonwood/Wilberg mine for final reclamation integrate BTCA for sediment and erosion control rather than siltation structures. For the mining operation, siltation structures were constructed as part of the treatment for protecting the water quality downstream of the active mining facilities. Because most western mining operations are located in steep, narrow drainage canyons, undisturbed runoff from above the active mining area must be diverted under the operations, not around. The siltation structures are designed to provide treatment of the runoff from only the disturbed area.

However, R6456-301-763.100 requires that siltation structures remain in place for at least two years after last augmented seeding. Having to provide for two diversions (1-for the diversion of disturbed runoff, and 2-for the diversion for undisturbed runoff) for final reclamation of western mines like the Cottonwood/Wilberg mine, is inefficient, expensive, unproductive, and expands the risk of failure which could possibly extend the responsibility period longer than the required 10 years. Given the new and proven techniques (gouging/pocking), which control erosion, retain water and promote sedimentation on the slope, and encourage vegetation growth, PacifiCorp concludes that siltation structures are unnecessary and not suited for western mining reclamation project located in steep, narrow drainage canyons.

As discussed in the previous sections, sediment control measures were investigated utilizing the volume of a 100yr/24 hr design storm event. This storm event is more severe than the requirements of the Utah Coal Regulations which require the use of a 100yr/6hr event to model storm water and erosion and sediment control for reclamation. The geometric shape of the standard pock

structure has been analyzed and shown that a 3' wide x 3' long x 1.5' deep pock would contain the volume of the designed storm event.

The discussion shows that the estimated volume of runoff immediately above the disturbed boundary interface could be contained using a 6' wide x 6' long x 3' deep pock. A series of large pocks would be constructed at the interface between the disturbed and undisturbed boundary.

RUSLE2 has been used to model the sediment yield from two different slope profiles of differing gradients within disturbed area. These slope profiles were compared to a slope profile in the undisturbed area. It has shown that by employing certain support practices to control runoff and sedimentation, sediment will be retained on the slope. It has also shown that water quality in downstream areas from the reclaimed site would not be compromised.

The discussion shows that by constructing pocks in a random and continuous pattern throughout the reclaimed slopes, the flow paths are eliminated and the flow lengths are reduced to the width and depth of the pock. It is shown that pocks will retain runoff and sediment on the slope to enhance vegetation growth.

Therefore, by employing these sediment control measures on the reclaimed slopes at the Cottonwood/Wilberg Mine, a sedimentation pond to collect runoff and sediment at the bottom extent of the disturbed area is not the best alternative for preventing additional contributions of suspended solids to stream flow for or runoff outside the permit area.

Alternatively, the Division has recommended leaving the existing ponds in place for two years after last augmented seeding while at the same time utilizing pocking as the primary means for sediment control for the slopes. No diversion ditches would be routed to this pond from the disturbed area. Undisturbed drainage would pass through existing ponds. Listed below are some concerns that PacifiCorp has with this recommendation:

- The undisturbed drainage area above the mine site (as reported in Left and Right Fork channel design) is 2599 acres. The volume of a 100yr/24hr storm event from this area is approximately 200 acre-feet. Total capacity of the existing ponds is approximately 4 acre-feet. The structural integrity of the ponds and their dams would be compromised by this volume of water.
- If a sediment pond would be constructed to handle the 200 acre-foot volume, its size would need to be approximately 50 times larger than the existing size of the ponds. There is insufficient room at the site to construct such pond.
- Because no diversion ditches will be constructed and routed through the ponds, the ponds would theoretically be treatment only for the undisturbed areas above the mine, as there will be no runoff from the slopes.
- If the ponds are not treating the disturbed area drainage, there is no reason to leave them in place
- The analysis presented here and numerous existing successful sites have shown that pocking will protect the water quality downstream of the reclaimed area and the ponds become impractical for sediment control.

Systematic Reclamation Procedures

Backfilling and grading will be conducted by starting in the upper reaches of the disturbed areas and then working down canyon. After each section is backfilled, graded, 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 continuous 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.

Drainage from a storm event that occurs during slope regrading will also be treated. When the undisturbed area culverts are removed, the remaining ends of the culverts will be left open. A small sediment basin will be constructed at the inlet of the culvert so that runoff will be treated before entering the undisturbed culvert. 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 as it enters 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 these 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.

762.100: Restoring the Natural Drainage Patterns

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 reclamation concept to address hydrological concerns 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 minic 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 withstand the expected flow.

Channel design is based on passing safely 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

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 design to carry the peak flows calculated for both east and west 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, and height, flow and velocity are summarized for various channel slopes in Appendix F. Hydrological procedures and calculations are described in the Appendix. Watersheds and subdrainages 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, Figure 7-2 and the channel design in Appendix F.

Table 7-2: Wilberg Mine Curve Number Derivations

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

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

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.

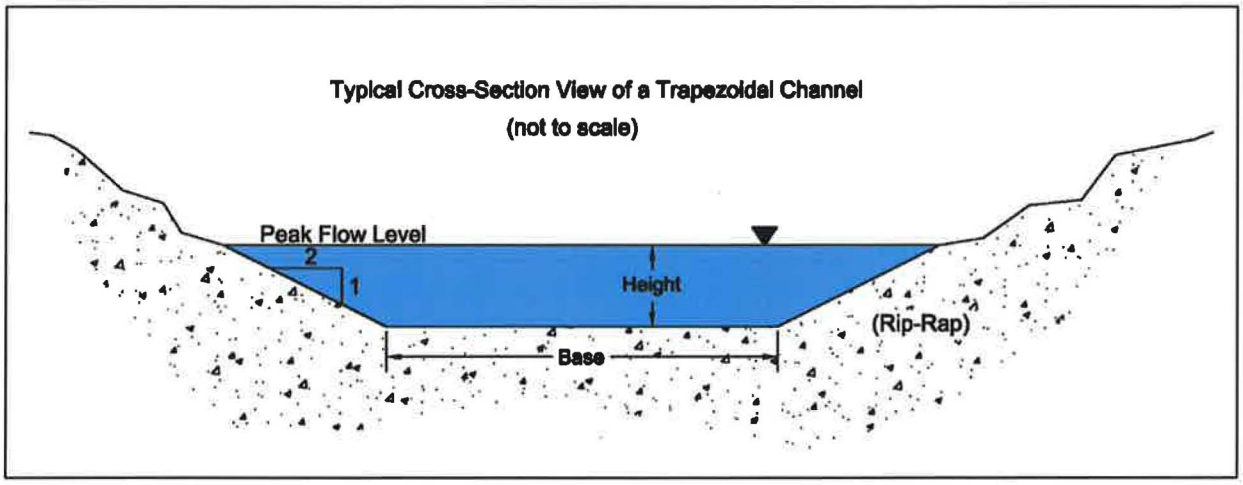


Figure 7-5: Typical Trapezoidal Channel

Filter and rip-rap gradation will consist of aggregate materials with weight and size approximating the following ratios:

d_{15} Filter	d_{15} Rip-rap
d_{85} Base	d_{85} Filter

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
D_{Max} / D_{50}	1.25	2
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:

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

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

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:

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

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.

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 view of the proposed reclamation contours. The ponds will be the last major structures to be removed during backfilling and grading operations. Pond removal rational was previously described. The access road will be completely removed and recontoured to the entrance gate.

763: Siltation Structures

The two siltation structures (sediment ponds) will be removed when all other reclamation above them are completed. Because of the reclamation techniques used, sediment will be retained within the disturbed area and therefore, no siltation structures will be needed.

Sediment control structures used to control sediment during the reclamation phase will be removed as they are no longer needed.

764: Structure Removal

A timetable has been constructed 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 1999 PacifiCorp drilled approximately 150 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 G.

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PacifiCorp – Interwest Mining Company

Appendix A

Soil Report for the Soils of the Wilberg Mine-1989

Cottonwood/Wilberg Mine Reclamation Plan

2016

SOIL RESOURCES OF THE WILBERG MINE AREA

A REPORT PREPARED FOR
UTAH POWER & LIGHT COMPANY

BY

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JUNE 1989

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JAN 24 2002
DIV OF OIL GAS & MINING

The information in this report is a revision of the soils data included in "Vegetation information of the Wilberg Mine", a report prepared for Utah Power and Light Company by Bio-Resources, Inc. in July, 1982. The taxonomic classification of the soils has been revised according to the soil survey of the Carbon Area, Utah-Parts of Carbon and Emery Counties (Issued 1988). Soils information on the waste rock storage site has been deleted from this revision as the work was not performed by Dr. A.R. Southard.

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Area Disturbed by Mining

The disturbed area of the Wilberg mine is about 18 acres (Table 3). Elevation varies from 7400 to 8000 feet. The general slope varies from 33-36 degrees. Annual precipitation averages about 8 inches. The topography is dominated by a southern exposure. The vegetation type disturbed by mining activities was a pinyon-juniper intermixing with the conifer (Table 4). Pinyon pine and Utah juniper were the dominant trees. However, white fir and Douglas fir were also present. Saskatoon serviceberry, low rabbitbrush and Cutler ephedra, cuneate saltbush and shadscale were important shrubs. Herbaceous plants included salina wildrye, bluebunch wheatgrass, Indian ricegrass, Uinta groundsel and corymbed eriogonum. Total aerial plant cover varied around 30-35 percent. Soils were probably Ustorthents.

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Reference Site

A reference site was established to represent the pinyon-juniper type disturbed by mining activities (Table 5). The reference site (4800 m^2) has a northeastern exposure with an elevation of 7500 feet. Slope varies around 35 degrees. Common plants include Utah juniper, pinyon pine, Douglas fir, Saskatoon serviceberry, Cutler ephedra low rabbitbrush, bluebunch wheatgrass, Indian ricegrass and salina wildrye (Table 6). Total plant cover is 38 percent with trees providing the majority of ground cover (Table 7). Shrub and tree densities are 1461 and 78 plants per acre, respectively (Tables 8 and 9). Saskatoon serviceberry is the most common shrub while Cutler ephedra and big sagebrush are the

least common. Pinyon pine is the most common tree while limber pine is the least common. Eighty-nine percent of the trees occur in the smallest DBH size class. The species diversity index is 2.77. The soil is a Lithic Ustorthent, loamy-skeletal, mixed, mesic family.

Wildlife and Livestock

The mining permit area is located within the Ferron Ranger District of the Manti-LaSal National Forest managed by the United States Forest Service. Both wildlife and livestock utilize the permit area for grazing. However, livestock grazing is limited to the higher elevations.

Deer, elk and moose utilize the area for grazing (Table 10). Deer have a greater impact on the vegetation than elk or moose because of their high numbers.

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Table 5. Similarity between the pinyon-juniper reference site and its respective disturbed area at the Wilberg Mine.

****

PARAMETER	REFERENCE	DISTURBED
Cover, %	37.5	30-35
Density, No./acre		
Shrub	1461	---
Tree	78	---
Species composition, s^1	22	20
Aspect	Northeastern	Northeastern
		Southwestern
Elevation, ft.	7500	7400-8000
Slope, degrees	33-37	33-36
Soil	Ustorthent	Ustorthent
Geology	Colluvium	Colluvium
H'	2.77	---
H'_{max}	2.77	---
J	1.00	---
Index of Similarity, %	----------70.8-------	

****

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[1]s = total plant species.

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Reference area

A reference area was established to represent the disturbed pinyon-juniper vegetation type (Table 5). The reference site (3000 m^2) has a southern exposure with an elevation of 7500 ft. Slope varies around 37 degrees. Common plants include Utah juniper, pinyon pine, Saskatoon serviceberry, cutler ephedra, galium, corymbed erigonum, western wheatgrass and salina wildrye (Table 6).

Total plant cover is 42 percent with grasses and woody plants providing the majority of cover (Table 7). Tree and shrub densities are 37 and 660 plants per acre, respectively (Tables 8 and 9). Low rabbitbrush and cutler ephedra are the dominant shrubs. The dominant trees are pinyon and Utah juniper. The species diversity index is 2.41. The soil is a Typic Ustorthent-Lithic Ustorthent-Rocky outcrop association.

Wildlife and Livestock

The mining permit area is located within the Ferron Ranger District of the Manti-LaSal National Forest managed by the United States Forest Service. Both wildlife and livestock utilize the permit area for grazing. However, livestock grazing is limited to the higher elevations. Very little wildlife and livestock grazing occurs on the steep slopes where the mine is located.

Deer, elk and moose utilize the area for grazing (Table 10). Deer have a greater impact on the vegetation than elk or moose because of their high numbers.

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Besides wildlife use, the area provides summer grazing for cattle (Table 11). Cattle grazing occurs on the East Mountain allotment of the Ferron Ranger District. For the past several years, there has been a 10 percent non-use of the available AUM's. During 1980 all AUM's were utilized. Overall range condition is fair.

Endangered or Threatened Plants

During the vegetation sampling, no endangered or threatened plant species were identified.

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Table 5. Similarity between the pinyon-juniper reference site and its respective disturbed area at the Cottonwood Portal Area.

****

PARAMETER	REFERENCE	DISTURBED
Cover, %	41.9	40-43
Density, No./acre		
Shrub	660	---
Tree	37	---
Species composition, s[1]	20	19
Aspect	S to SW	S to SW
Elevation, ft.	7300	7200
Slope, degrees	25-35	25-35
Soil	Ustorthent	Ustorthent
Geology	Colluvium	Colluvium
H'	2.41	---
H'_{max}	2.89	---
J	0.83	---
Index of Similarity, %	----------90.0-------	

****

[1]s = total plant species.

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Soils Information

Construction of the Wilberg Mine was begun and completed during the year 1978.

Approvals for the facilities were granted in early 1978 by the U.S. Geological Survey under 30 CFR 211 which required approximately the same soil conservation practices as SMACRA's interim regulations effective December 13, 1977.

Soil classifications (horizons) as delineated in the interim regulations were non-existent of so shallow as to preclude attempts of salvage and storage.

To meet initial or interim revegetation requirements and provide soil mapping for permanent regulatory permit application, a consultant was engaged to classify and test the existing soil (after construction) for acceptance as a plant growth medium.

Company's consultant is Dr. A.R. Southard, Soil Scientist, Utah State University, who under contract, performed the field work and prepared the following report and soils maps.

Southard reported three major conclusions:

1. Basically, no topsoil (Horizon A) exists in sufficient quantities to warrant stockpiling (based on adjacent areas).

2. Existing materials, selectively, are acceptable as a plant growth medium.

3. Final reclamation would be enhanced, especially sedimentation control, by induced grass species.

Further, no soil mapping of the disturbed area is possible (Southard).

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Overview

Portal and support facility areas for the Wilberg Mine are cut into steep, nearly perpendicular rock cliffs. The areas are dominated by rock outcrop, rubble land, and shallow soils.

Nowhere in the vicinity is there a source of material which would usually be referred to as "topsoil". Soil tests on the disturbed and undisturbed areas and coal waste show that the materials in the portal areas should support selected vegetative materials. These test results, therefore, preclude the recommendation for the procurement of topsoil for reclamation since the exposed materials are suitable growth media if properly managed. The one exception is that if during mining operations toxic substances are concentrated, it will be necessary to sample these areas periodically and take the necessary reclamation measures to dispose of or cover the areas in order to assure success of revegetation attempts.

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Soils Report of the Wilberg Mine (783.21)

(see Maps 2-17 and 2-18)

C- Cut Areas

These are areas disturbed in order to effectively gain sufficient work to carry out mining operations. Sandstone and bedrock are exposed. In general, these areas have chemical and physical properties which will support plant groeth. The major problems are steepness and aridity.

F- Fill Areas

These areas are nearly level (parking areas) and steep slopes (more than 25%). The material derived form sandstone and shale with some coal waste is capable of supporting plant growth. The parking lots and storage areas may have places where undesirable conditions for plant growth have developed; these areas must be covered with suitable growth media before revegetation can be successful.

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R-Ro - Rubble Land-Rock Outcrop, 60-80% slopes

Rubble land is covered by boulders and stones. The vegetation is limited to areas between stones and boulders and lichens.

Rock outcrop is exposed bedrock, mostly sandstone and shale. In general, the material derived from sandstone is suitable for growth media, especially juniper and

grasses. Material derived from shale is, in general, less suitable for plant growth; and efforts should be made to cover the shale with sandstone material to enhance reestablishment of native vegetation.

Ro-R-S - Rock Outcrop-Rubble Land-Lithic Ustorthents, 40-70% slopes.

Rock outcrop is dominantly from sandstone and shale. The boulders in the Rubble Land are from sandstone (75%).

Lithic Ustorthents are soils that are shallow and formed in material derived from sandstone. Permeability is moderately rapid in the soil material above the rock (25%).

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Taxonomic classification is loamy-skeletal, mixed, mesic Lithic Ustorthents. Pedon description follows:

A 0-4 inches; pale brown (10 YR 6/3) very gravelly loam; olive brown (2.5 Y 5/4) when moist; weak, fine granular structure; friable, slightly sticky, slightly plastic; few, fine, medium and coarse roots; common, fine and medium pores; 55% gravel; moderately calcareous, carbonates are disseminated; moderately alkaline (pH 8.3); abrupt wavy boundary.

C 4-14 inches; light gray (2.5Y 7/2) extremely flaggy, fine sandy loam; light yellowish brown (2.5Y 6/4) when moist; massive; very friable; few, fine, medium, and coarse roots; 40% flagstones and 30% channers; strongly calcareous, carbonates are disseminated; strongly alkaline (pH 8.8); abrupt, smooth boundary.

R 14 inches; sandstone

Included in mapping are areas of material which have sloughed and been deposited by gravity in small areas (less than 100 square feet). The soil material is deeper than Sunup soils, and is characterized in Table I, samples 1112-1116 (see Interim Stabilization section of the Revegetation section for soil analyses). These areas are of such limited extent that they are of no consequence as a local source of cover material for revegetation.

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GENERAL SOIL MAP OF THE PERMIT AREA

I-E-R Typic Ustochrepts-Lithic Ustorthents-Rock Outcrop
E loamy-skeletal, shallow association, 40-60% slopes.

These soils are mostly loamy-skeletal and lithic with areas of sandstone outcrops.

In this map unit, Typic Ustochrepts make up about 50%, Lithic Ustorthents about 25%, and Rock Outcrop and Rubble Land about 20%; included are small areas of Mollisols on north and east-facing slopes.

The Ustochrepts can be generally described as follows: pale brown gravelly loam or sandy loam surface layer, with 25% sandstone fragments, 35 cm thick, underlain by a pale brown gravelly or stony loam, with 35-50% sandstone fragments, 100 cm thick.

The Ustorthents are mostly shallow, underlain by rock within 50 cm of the surface.

Rubble Lands are those areas where the soils are covered by large boulders so close together that there is little area between the boulders for plants to grow.

Rock Outcrop is exposed areas of bedrock. These areas are often nearly vertical cliff walls in canyons.

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Mp Pachic Cryoborolls, loamy and loamy skeletal, 10-25%
B slopes.

These are dark-colored soils in which the surface soil is more than 50 cm thick. Included in mapping are Typic Cryoborolls, Mollic Cryoboralfs, and Typic Cryochrepts. Pachic Cryoborolls can be generally described as follows: a very dark grayish-brown loamy surface layer 60 cm thick, overlying a grayish-brown loamy subsoil 30 cm thick, and

underlain by a pale brown gravelly sandy loam substratum containing 50% sandstone fragments.

Mt C **Typic Cryoborolls, loamy and loamy-skeletal, 25-40% slopes**

These are dark-colored soils under mixed conifer, sagebrush, and grass. Included are areas of Pachic Cryoborolls and Mollic Cryoboralfs. Cryochrepts are on windswept ridges. The Typic Cryoborolls can be generally described as follows: a dark grayish brown loamy surface layer about 40 cm thick, underlain by a pale brown clayey subsoil 40 cm thick, over a light gray calcareous substratum with up to 50% sandstone fragments.

References

1. Soils maps of Utah Power and Light mine sites: Deer Creek, Deseret, and Wilberg.
2. General soils map of Utah.
3. Soils map of a test area in T14S, R5E through 9E.
4. Soils map of Northwest Carbon, Inc., Rilda Canyon and Trail Creek Mine sites.

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Cottonwood Fan Portal

Soils Information

A detailed soil survey of the proposed Cottonwood portal and surrounding area was carried out during late July 1979. The results, in part, are as follows:

Map Symbol AbG (Bb-Aa Complex)- This mapping unit is a complex consisting of Bb very stony and sandy loam- 70 to 80 percent slopes. It is about 40% of the landscape. It is on hillside slopes and ridges. Aa very stony sandy loam, 70 to 80 percent slopes is about 30 percent of the landscape and is on hillside slopes. Rock outcrops are about 30 percent.

The general location and extent of this mapping unit is mainly on east and west-facing slopes in the canyon bottom near the mine portal. It is moderately extensive.

Included with this unit in mapping are small areas of Cc stony sandy loam, 50 to 70 percent slopes.

Aa (abG) Very Stony Sandy Loam- This Aa soil is deep and well-drained. It occurs on very steep hillside slopes (70-80%) at elevations of 7200-7800 feet. This soil formed in colluvium derived mainly from sandstone and shale.

The average annual precipitation is 12 to 15 inches. Mean annual air temperature is 44 to 46 degrees F and the average frost-free season is 80 to 90 days. This soil occurs on the lower mainly west-facing slopes in the mine area. Slopes are 70 to 80 percent and are east and west-facing. They are medium in length and convex in shape. Vegetation is dominantly pinyon, bullgrass, ephedra, juniper, rabbitbrush, and serviceberry. Included in

mapping are small areas of Cc stony sandy loam, 50 to 70 percent slopes. Associated soils are Cc, Dd, and De soils.

In a typical profile the surface layer is brown, very stony sandy loam and loam about 11 inches thick. The underlying layer is light brownish gray, very gravelly loam about 2.4 inches thick. The next layer is pale brown, very cobbly clay loam to a depth of 5 feet. Other characteristics are the soil is calcareous throughout. It contains more than 35% rock fragments.

Permeability is rapid. Available water capacity is moderately low. Organic matter content in the surface layer is moderate. Effective rooting depth is about 60 inches. Surface runoff is rapid and erosion hazard is moderate under potential native vegetation and very high if vegetation is removed and the soil is left bare. Erodibility is high. This soil is used for wildlife habitat and recreation.

Typifying Pedon: (Colors are for dry soil unless otherwise noted). The location is between sealed up mine portals of Old Johnson Mine on the upper road. Section 25, T17S, R6E.

"A" horizon is 0 to 4 inches, brown (10YR 5/3), very stony sandy loam, very dark grayish brown (10 YR 3/2, moist); weak, thick platy structure that breaks to moderate fine granular; soft dry, very friable moist. slightly sticky and slightly plastic wet; common very fine roots; stones and boulders are about 35%; strongly calcareous, lime is disseminated; moderately alkaline (pH 8.0); clear smooth boundary. Note: stones range in diameter from 1 foot to 3 feet. A boulder is a rock fragment more than 3 feet in diameter.

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Bb (abG)- Very Stony Sandy Loams- The Bb soil is shallow and excessively drained. It occurs on very steep (70-80%) hillside slopes at elevations of 7200 to 7800 feet. This soil formed in colluvium derived mainly from sandstone and shale.

The average annual precipitation is 12 to 15 inches. Mean annual air temperature is 44 to 46 degrees F and the average frost-free season is 80 to 90 days. This soil occurs on hillside slopes in the mine area and on ridges and points in other parts of the survey area. Slopes are 70 to 80 percent and are west and east-facing. They are medium in length and convex in shape. Vegetation is dominantly bullgrass, rabbitbrush, serviceberry, and pinyon. Included in mapping are small areas of Cc stony sandy loam, 50 to 70 percent slopes. Associated soils are Cc, Dd, and De soils.

In a typical pedon the surface layer is brown, very stony sandy loam about four inches thick. The underlying layer is pale brown, very cobbly silt loam about 10 inches thick. Other characteristics include the soil is less than 10 inches deep over sandstone bedrock. It is strongly calcareous. Reaction is moderately rapid. Permeability is moderately rapid. Available water capacity is very low. Organic matter content in the surface layer is moderate. Effective rooting depth is about 14 inches. Surface runoff is medium and erosion hazard is medium under potential native vegetation and very high if vegetation is removed and the soil is left bare. Erodibility is high. This soil is used for wildlife habitat, recreation, and woodland.

Typifying Pedon: (Colors are for dry soil unless otherwise noted). The location is directly above second walled up opening on upper road (at old Johnson Mine). Section 25,

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T17S, R6E. The A horizon is 0 to 4 inches; brown (10 YR 5/3) very stony sandy loam, dark grayish brown (10 YR 4/3) moist; moderate, very fine, granular structure; soft dry, firm, moist, slightly sticky and slightly plastic wet; few, very fine roots; stones and boulders cover 25% of the surface; strongly calcareous, lime is disseminated; moderately alkaline (pH 8.0); clear, smooth boundary. Note: stones range in diameter from 1 foot to 3 feet. A boulder is a rock fragment more than 3 feet in diameter.

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REVEGETATION (UMC 817.111-.117)

Interim Stabilization and Vegetation Plan

There are five major fills at the Wilberg Mine with bare slopes generally with a south or southeast aspect. With the proposed reclamation plan these fills would provide the soil material for the final contouring and grading. Because no topsoil was stockpiled and the native soils on these steep slopes provide very little topsoil material, the fill material would need to become the planting medium. An off-site source is impractical. The fill material was tested in 1980 and again in 1983 for its physical and chemical properties.

The soil material in the fills was originally derived from sandstone and shale parent materials. The soil material particles are mostly sand with textures from sandy loams to loamy sands (Table I). The water holding capacity is low, typical of sandy soils.

They are calcareous soils as indicated by pH's of 7.5-8.5 and calcium carbonate equivalents above eight percent (Table II). Salt content is too low for any harmful affects on plants. Potassium, phosphates, and nitrogen, important plant nutrients, are very low indicating the need for fertilization to insure plant growth. The organic material is principally coal debris, the nitrogen percentage ratio is too low.

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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

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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

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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

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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

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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.

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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

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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.

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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).

Depth (cm)	Hydrometer Sand (%)	Hydrometer Silt (%)	Hydrometer Clay (%)	Texture	Available Water Atmospheres 1/3 (%)	Available Water Atmospheres 15 (%)	Saturation Percentage (%)
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).

Depth (cm)	Hydrometer Sand (%)	Hydrometer Silt (%)	Hydrometer Clay (%)	Texture	Available Water Atmospheres 1/3 (%)	Available Water Atmospheres 15 (%)	Saturation Percentage (%)
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

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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--		
Depth (cm)	**Sand**	**Silt**	**Clay**	**Texture**	**1/3**	**15**	**Saturation Percentage**
	----------%----				-------%-------		-----%----
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--		
Depth (cm)	**Sand**	**Silt**	**Clay**	**Texture**	**1/3**	**15**	**Saturation Percentage**
	-------%--------				-------%-------		-----%----
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

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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

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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

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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 (cm)	pH	ECe dS/m	SAR	Ca	Mg	Na	P	K	O.C. -%-
				------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

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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

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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

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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

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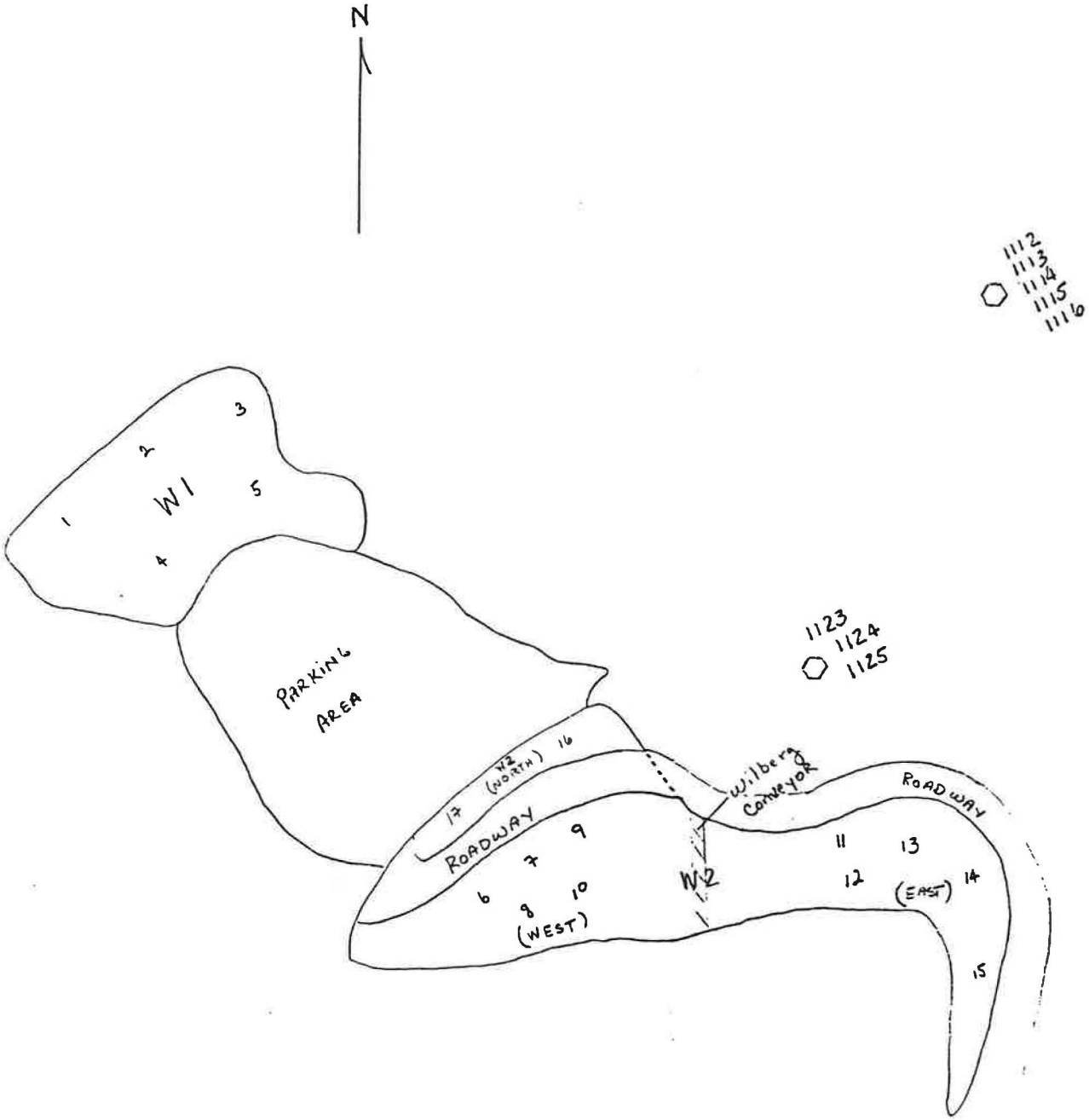
Sketch of Sampling Site Distribution at the Wilberg Mine. 25 May 1989.



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USU SOIL, PLANT, AND WATER ANALYSIS LABORATORY
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USU #	ID	pH	ECe	NaHCO3 P	NaHCO3 K	% OC	SP	Ca	Mg	Na	SAR	Sand	Silt	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	58	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-	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 east	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 W2-	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 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

2001 Soil Sampling Results

Cottonwood/Wilberg Mine Reclamation Plan

2016

nter-Mountain Laboratories, Inc.

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
01S06587	CW8401	#5	12 - 18	7.4	25.4	5.27	21.7	15.3	21.2	4.93	0.55	0.01
01S06588	CW8501	#6	0 - 6	7.8	24.3	0.99	2.52	2.61	1.94	1.21	1.18	1.13
01S06589	CW8601	#6	6 - 12	7.7	25.2	0.71	2.04	2.39	1.59	1.07	0.46	0.42
01S06590	CW8701	#6	12 - 18	7.7	25.4	0.68	1.88	2.27	1.76	1.22	0.43	0.39
01S06591	CW8801	#7	0 - 6	7.6	28.1	0.47	2.44	1.06	1.06	0.80	0.40	0.37
01S06592	CW8901	#7	6 - 12	7.5	27.7	0.58	3.54	1.34	0.94	0.60	0.36	0.33
01S06593	CW9001	#7	12 - 18	7.2	29.5	2.27	23.5	5.35	1.23	0.32	0.46	0.42
01S06594	CW9101	#8	0 - 6	7.3	29.6	0.94	4.49	2.64	1.15	0.61	0.46	0.43
01S06595	CW9201	#8	6 - 12	7.3	29.7	0.89	4.19	2.93	1.35	0.72	0.46	0.42
01S06596	CW9301	#8	12 - 18	7.2	31.2	2.54	20.9	11.2	1.84	0.46	0.36	0.30
1S06597	CW9401	#9	0 - 6	7.2	35.6	2.91	18.5	16.0	4.06	0.98	0.70	0.56
1S06598	CW9501	#9	6 - 12	7.3	40.5	3.46	18.9	18.9	5.14	1.18	0.79	0.58
1S06599	CW9601	#9	12 - 18	7.4	37.6	3.76	20.3	21.6	5.97	1.30	0.79	0.57
1S06600	CW7001	#1	0 - 6	8.1	22.0	1.16	4.37	1.69	6.29	3.62	0.95	0.81
1S06601	CW7101	#1	6 - 12	7.6	27.2	4.75	9.78	4.16	29.6	11.2	2.19	1.38
1S06602	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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reviations for extractants: PE= Saturated Paste Extract, H20Sol= water soluble,AB-DTPA= Ammonium Bicarbonate-DTPA, AAO= Acid Ammonium Oxalate

reviations 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, Neut. Pot.= Neutralization Potential

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

iewed By: _____

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, WY 82801

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)	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
01S06592	CW8901	#7	6 - 12	15.4	46.0	36.0	18.0	LOAM	14.6	6.8
01S06593	CW9001	#7	12 - 18	28.2	44.0	37.0	19.0	LOAM	14.6	6.9
01S06594	CW9101	#8	0 - 6	30.6	40.0	41.0	19.0	LOAM	16.0	8.2
01S06595	CW9201	#8	6 - 12	20.8	41.0	40.0	19.0	LOAM	16.1	8.0
01S06596	CW9301	#8	12 - 18	16.0	40.0	42.0	18.0	LOAM	16.5	8.3
01S06597	CW9401	#9	0 - 6	28.4	38.0	38.0	24.0	LOAM	16.4	11.3
01S06598	CW9501	#9	6 - 12	24.9	35.0	37.0	28.0	CLAY LOAM	17.5	12.2
01S06599	CW9601	#9	12 - 18	30.5	40.0	38.0	22.0	LOAM	17.1	11.3
01S06600	CW7001	#1	0 - 6	25.6	66.0	22.0	12.0	SANDY LOAM	12.5	4.6
01S06601	CW7101	#1	6 - 12	28.7	63.0	25.0	12.0	SANDY LOAM	13.4	4.7
1S06602	CW7201	#1	12 - 18	30.9	68.0	20.0	12.0	SANDY LOAM	13.5	4.3

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Sheridan, WY 82801

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
01S06591	CW8801		0 - 6	3.5	0.02	0.62	409	409	0.92	3.74	0.13	<0.02
01S06592	CW8901	#7	6 - 12	1.6	0.02	0.62	418	418	0.82	0.74	0.09	<0.02
01S06593	CW9001		12 - 18	1.3	<0.01	0.00	427	427	0.84	1.52	0.08	<0.02
01S06594	CW9101		0 - 6	4.9	0.03	0.94	406	405	0.99	13.2	0.18	<0.02
01S06595	CW9201	#8	6 - 12	5.7	0.03	0.94	393	392	0.89	7.62	0.17	<0.02
01S06596	CW9301		12 - 18	5.8	0.04	1.25	377	376	0.96	5.64	0.17	<0.02
01S06597	CW9401		0 - 6	1.3	0.02	0.62	271	271.	1.33	<0.02	0.08	<0.02
01S06598	CW9501	#9	6 - 12	0.8	0.03	0.94	239	238	1.13	1.44	0.08	<0.02
01S06599	CW9601		12 - 18	0.6	0.03	0.94	255	254	1.31	0.02	0.08	<0.02
11S06600	CW7001		0 - 6	2.0	<0.01	0.00	313	313	0.87	0.24	0.08	<0.02
11S06601	CW7101	#1	6 - 12	2.0	0.03	0.94	294	293	1.06	2.96	0.08	<0.02
1S06602	CW7201		12 - 18	2.7	0.03	0.94	267	266	0.83	0.60	0.11	<0.02

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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)	pH s.u.	Saturation %	EC mmhos/cm	Calcium meq/L	Magnesium meq/L	Sodium meq/L	SAR	Available Sodium ppm	Exchangeable Sodium meq/100g
		CTW Mine										
101S06603	CW7301	#2	0 - 6	7.4	26.6	2.17	7.37	4.22	6 76	2.81	0.70	0.52
101S06604	CW7401		6 - 12	7.4	26.1	2.55	14.0	8.40	5.08	1.52	0.61	0.48
101S06605	CW7501		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		6 - 12	7.4	33.5	3.33	21.2	21.8	2.50	0.54	0.60	0.52
101S06608	CW7801		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		6 - 12	7.5	23.0	6.97	5.50	3.54	49.5	23.3	3.13	1.99
01S06611	CW8101		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		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

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 %
		CTW Mine								
101S06603	CW7301	#2	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
01S06612	CW8201	#5	0 - 6	29.5	56.0	28.0	16.0	SANDY LOAM	13.1	5.6
01S06613	CW8301		6 - 12	17.0	59.0	25.0	16.0	SANDY LOAM	12.8	5.2

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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		6 - 12	1.5	0.02	0.62	351	351	0.47	0.44	0.07	<0 02
101S06605	CW7501		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		6 - 12	2.4	0.10	3.12	206	203	0.68	5.08	0.09	<0.02
101S06608	CW7801		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		6 - 12	1.5	0.03	0.94	297	297	0 52	1.64	0.18	<0.02
101S06611	CW8101		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		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	0.69

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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

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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	306	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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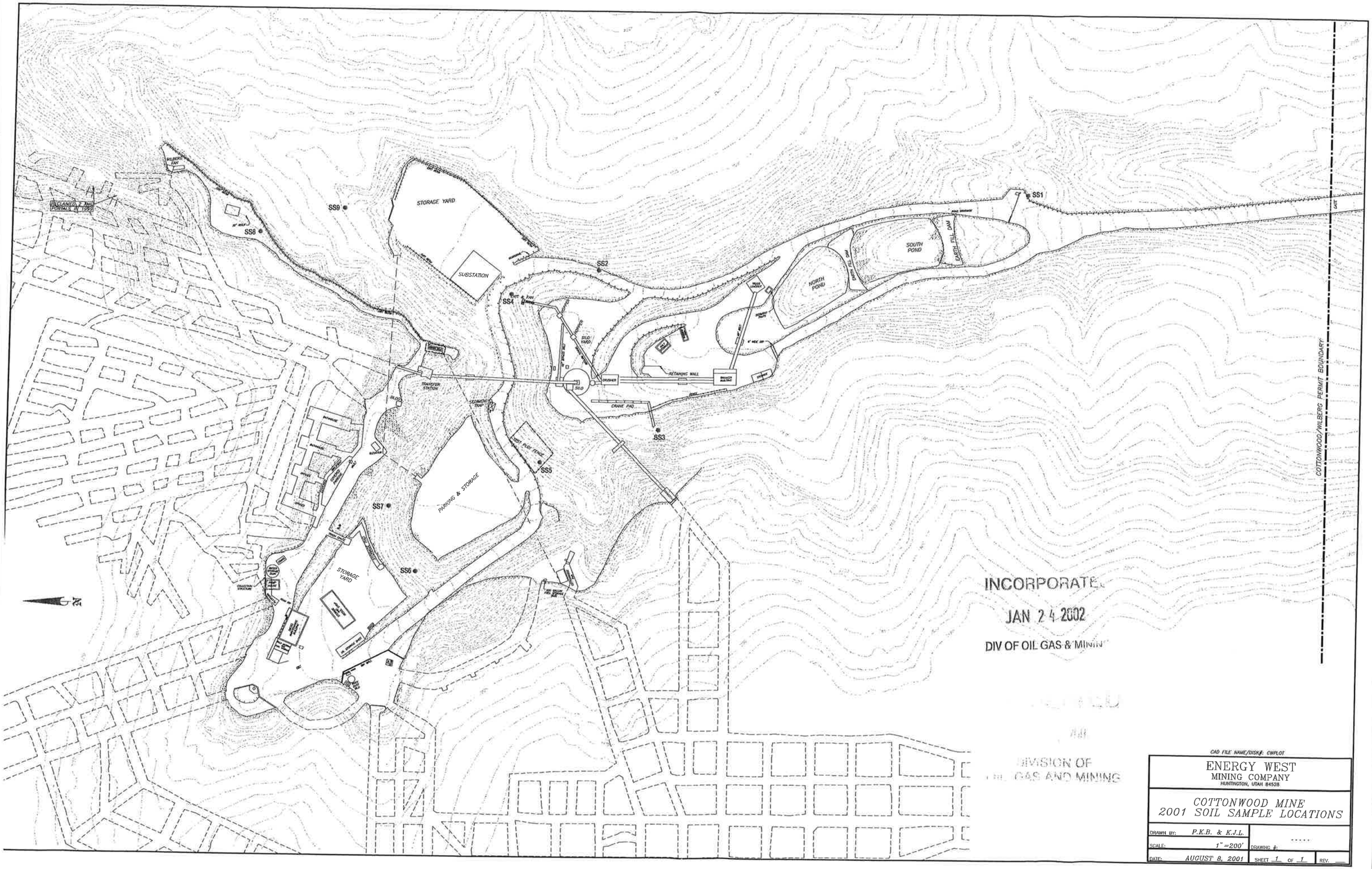

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CAD FILE NAME/DISK#: CWPLOT

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 A

Soil Sampling Analysis – Substitute Topsoil Sampling

Cottonwood/Wilberg Mine Reclamation Plan

2016

PacifiCorp – Interwest Mining Company

Appendix A

Field Soil Sampling Results

Cottonwood/Wilberg Mine Reclamation Plan

2016

Interwest Mining Company

Cottonwood/Wilberg Reclamation

Field Soil Analysis Notes

Date	Sample ID	Location	Map ID	Depth (ft)	pH	Conductivity (mmhos/cm)	Evaluation* (good, fair, poor, unexceptable)

* pH: Good = 6.1 - 8.2; Fair = 5.1 - 6.1, 8.2 - 8.4; Poor = 4.5 - 5.0, 8.5 - 9.0; Unacceptable = <4.5, >9.0
Conductivity: Good = 0 - 2; Fair = 2 - 8; Poor = 8 - 15; Unacceptable = >15

PacifiCorp – Interwest Mining Company

Appendix B

Highwall Elimination – Photo Essay

Cottonwood/Wilberg Mine Reclamation Plan

2016

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

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- 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.

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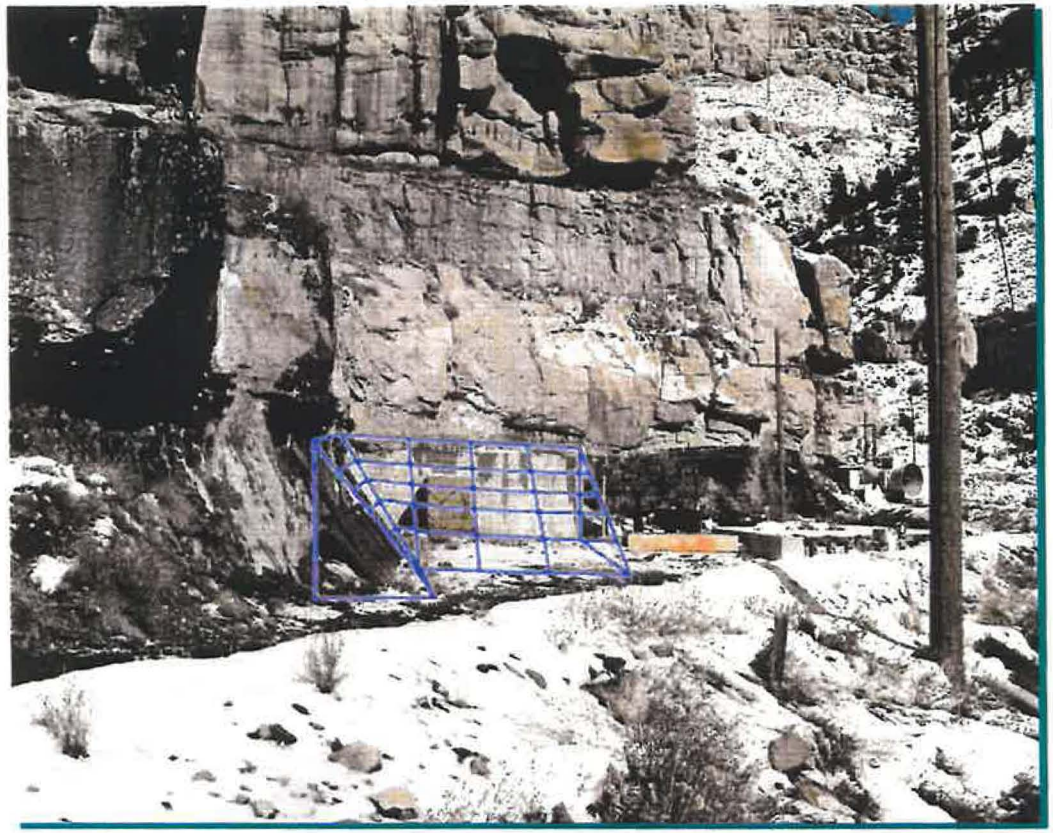

- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 2:1.
- Backfilling material will utilize broken up concrete structures, berm, fan pad area, and other material cast down slope.
- Area to be backfilled is approximately equal to 15 ft. high by 30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

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

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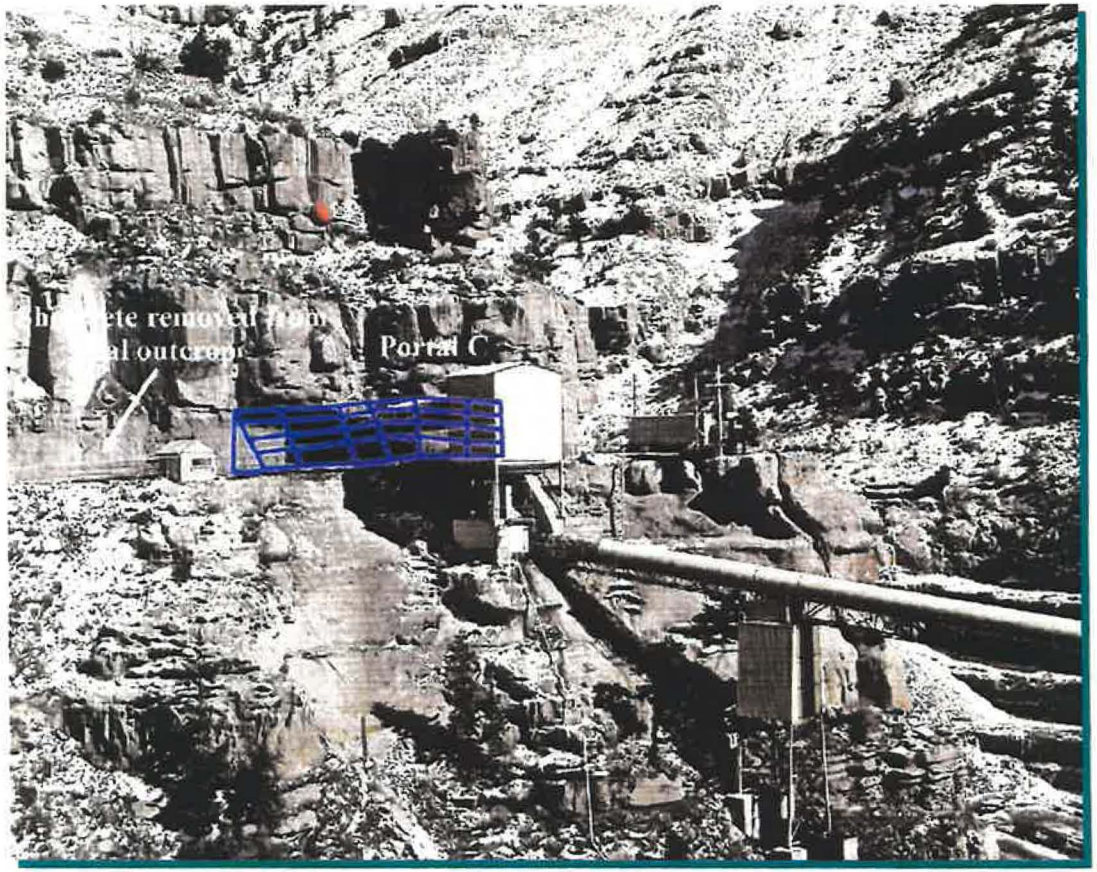

- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill material within the disturbed area, broken up concrete structures, and other 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.

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- 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.

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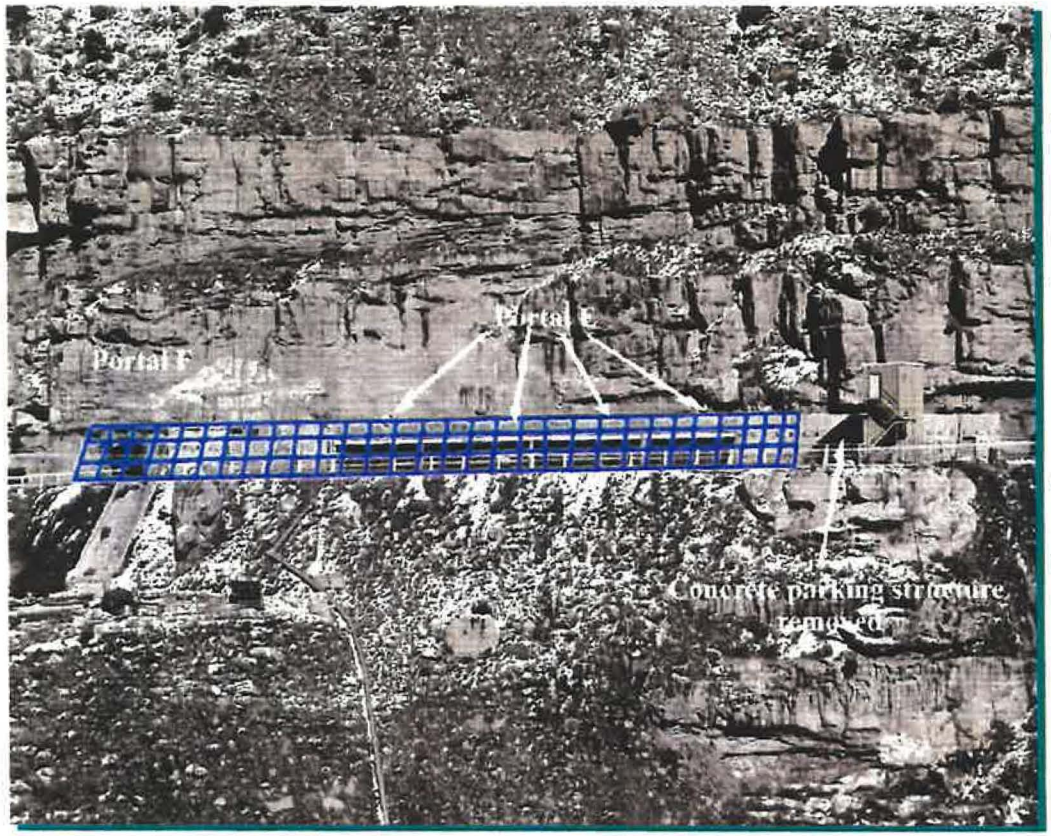

- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill material within the disturbed area, broken up concrete structures (Rhino 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.

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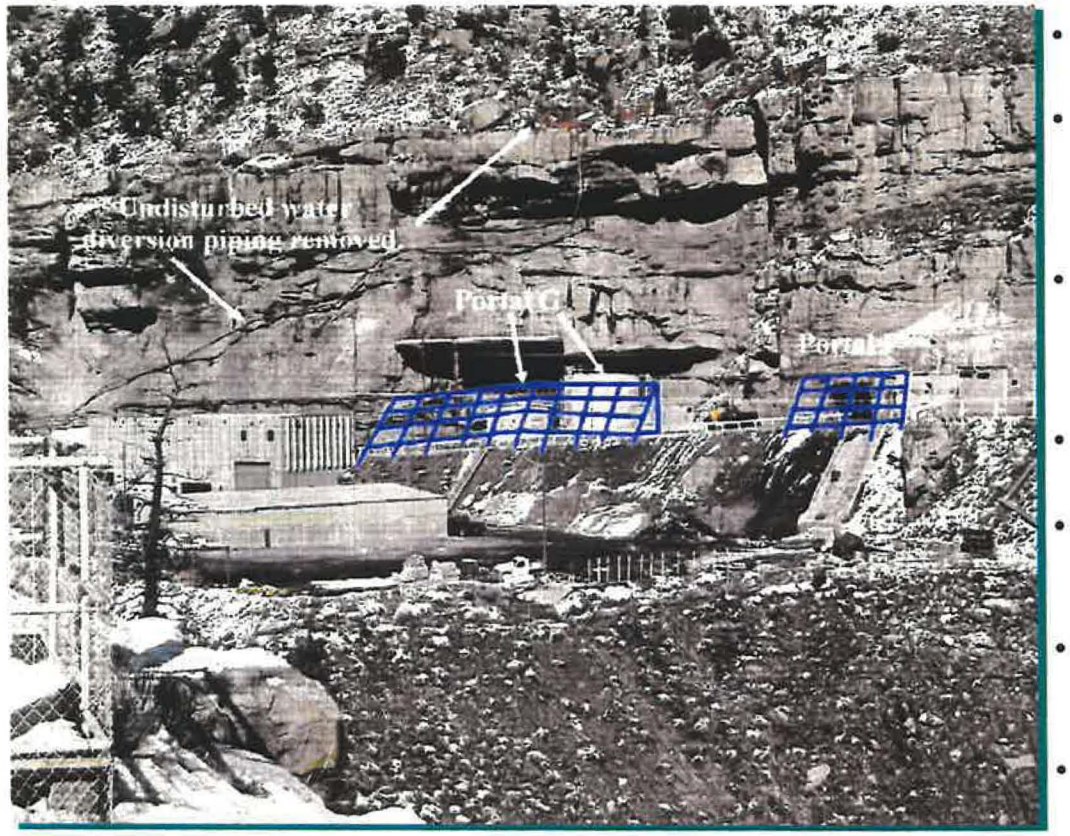
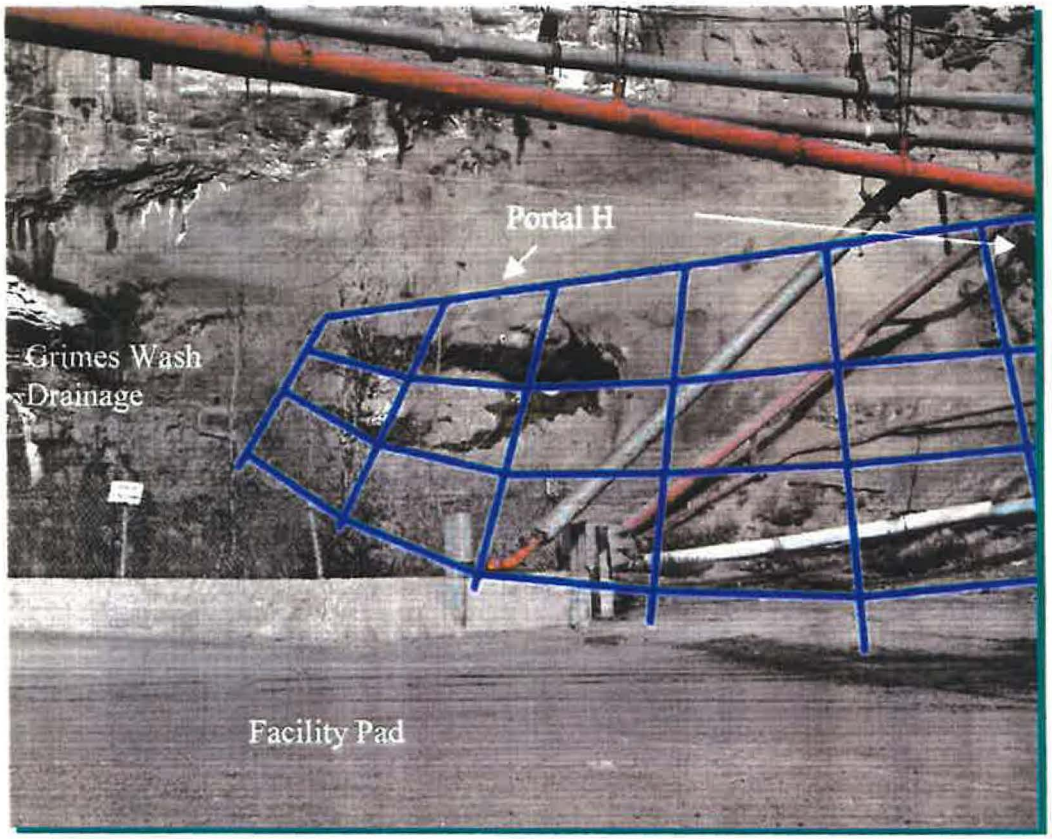


- Grids demonstrate the extent of fill material on highwall.
- Slope will be backfilled at approximately 1½:1and compacted to the extent practical to minimize soil shrinkage.
- Backfilling material will utilize the existing fill within the disturbed area, broken up concrete structures (building), and 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.

INCORPORATED
EFFECTIVE
FEB 25 1999
98E
UTAH DIVISION OIL, GAS AND MINING



- 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 highwallaccording to R645-Utah Coal Rules – located adjacent to waterfall.

INCORPORATED
EFFECTIVE:
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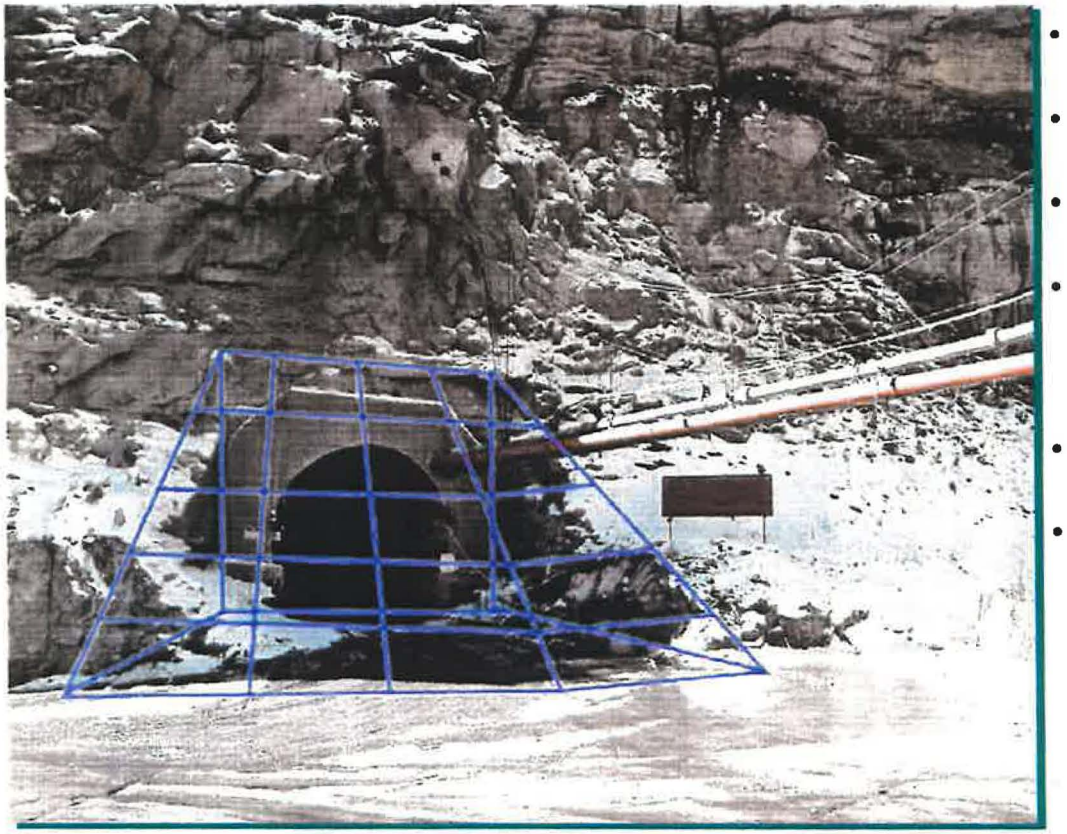
UTAH DIVISION OIL, GAS AND MINING



- 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.

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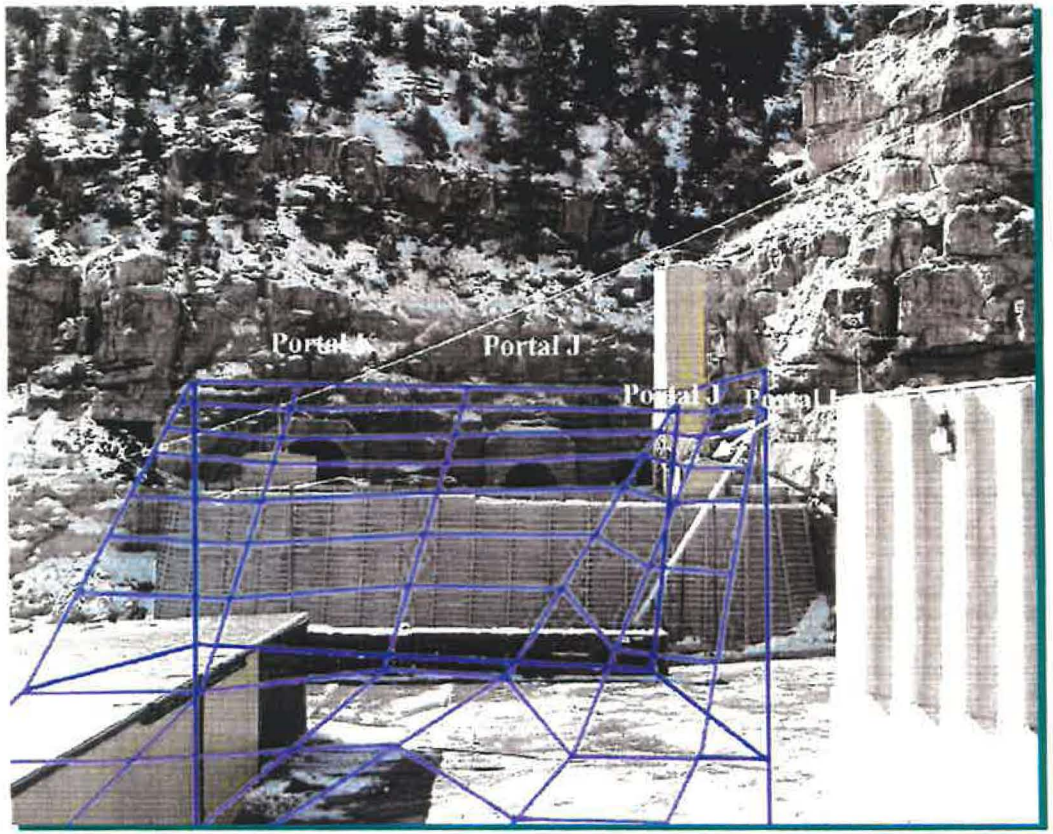
UTAH DIVISION OIL, GAS AND MINING

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.

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EFFECTIVE
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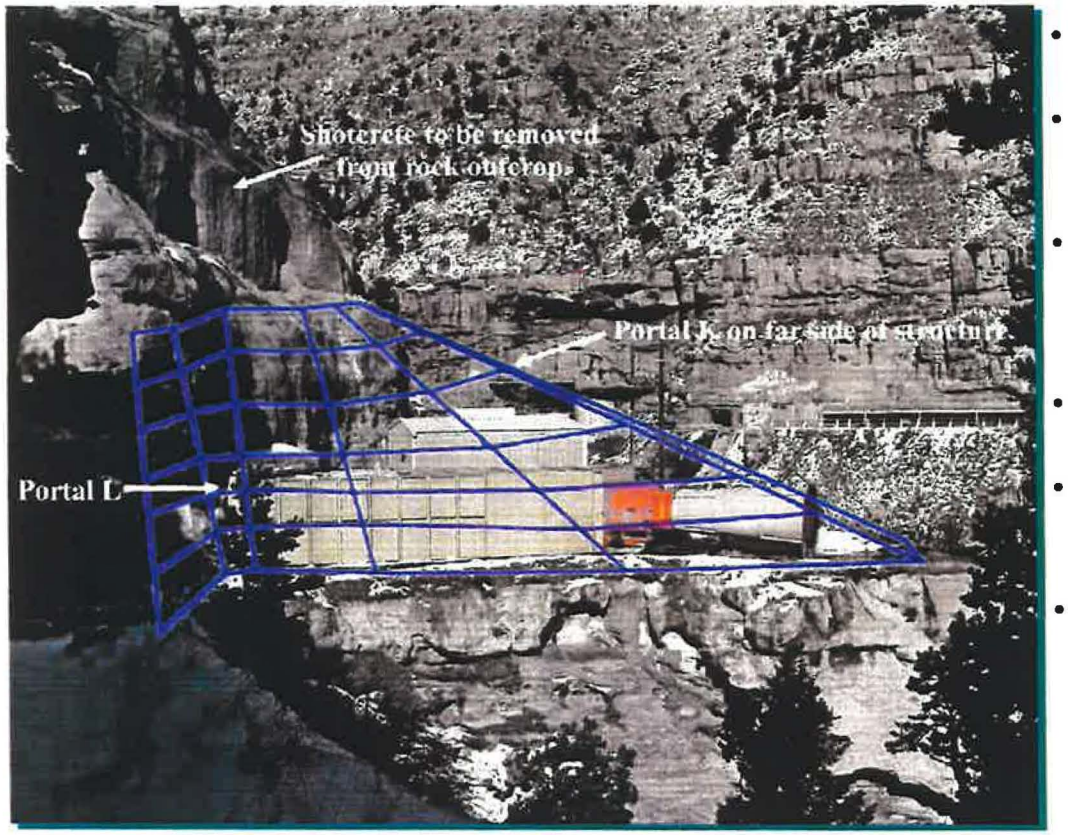
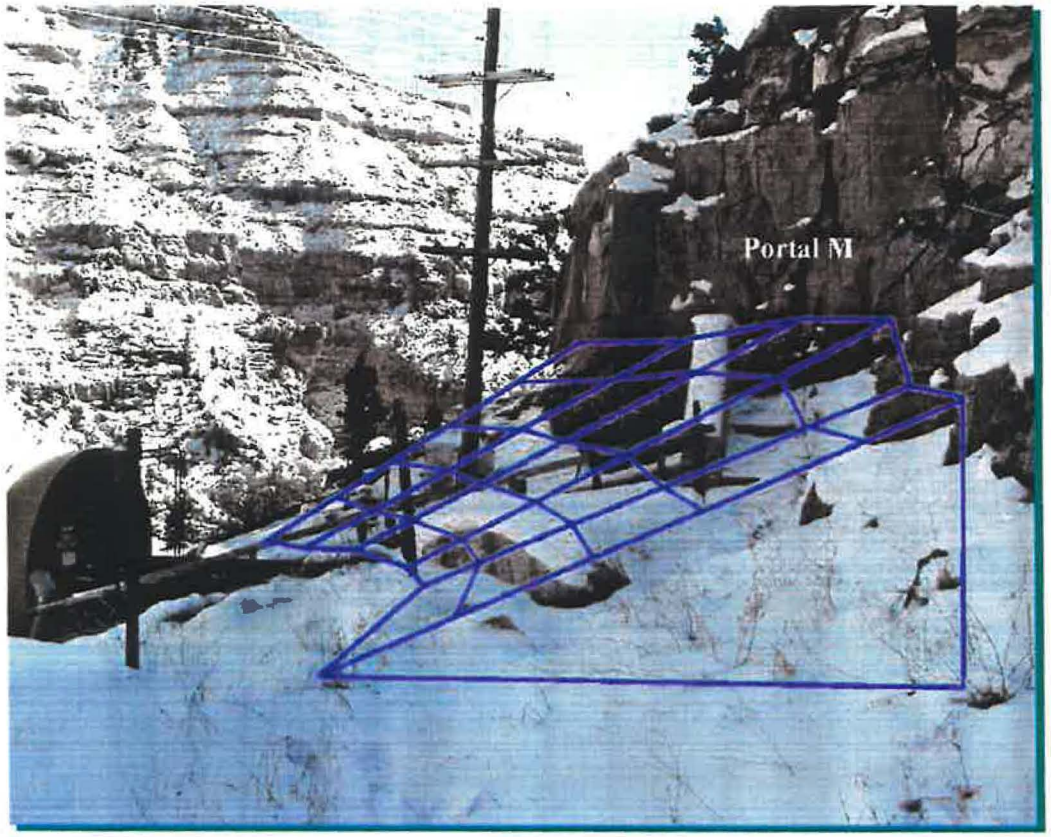
UTAH DIVISION OIL, GAS AND MINING



- 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.

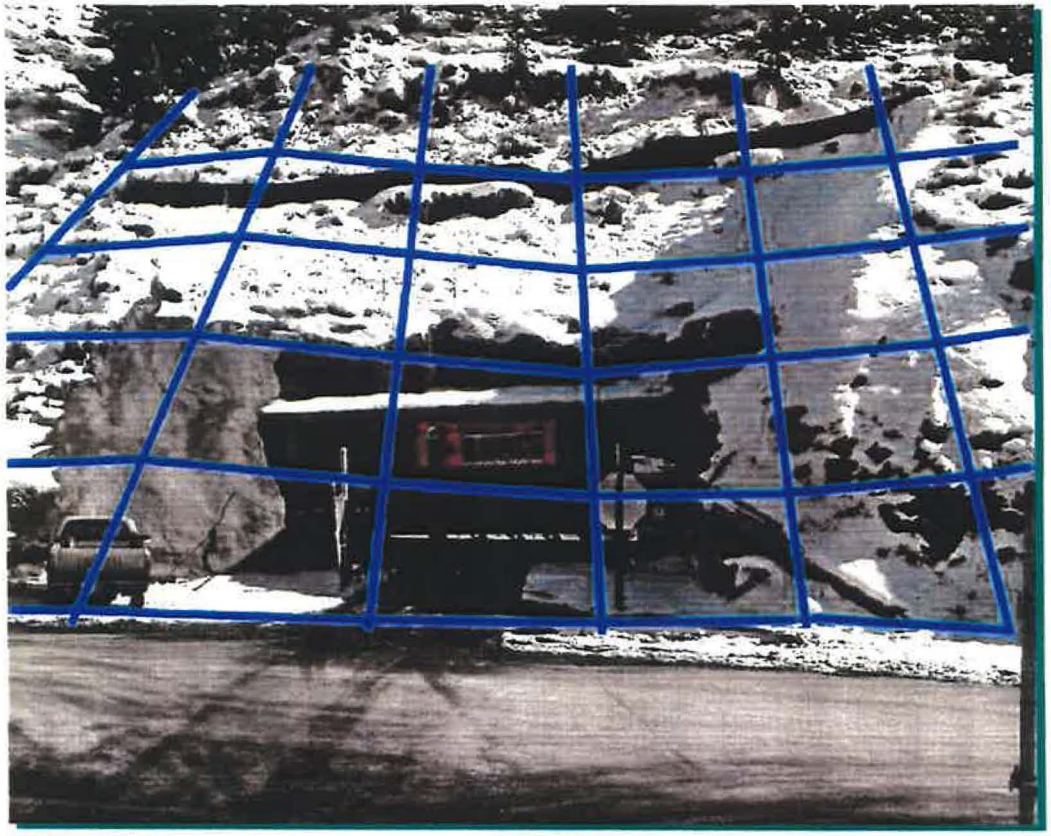
INCORPORATED
EFFECTIVE:
FEB 25 1999
UTAH DIVISION OIL, GAS AND MINING



- 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 TrailMtn. Mine in Cottonwood Canyon – Post-SMCRA.

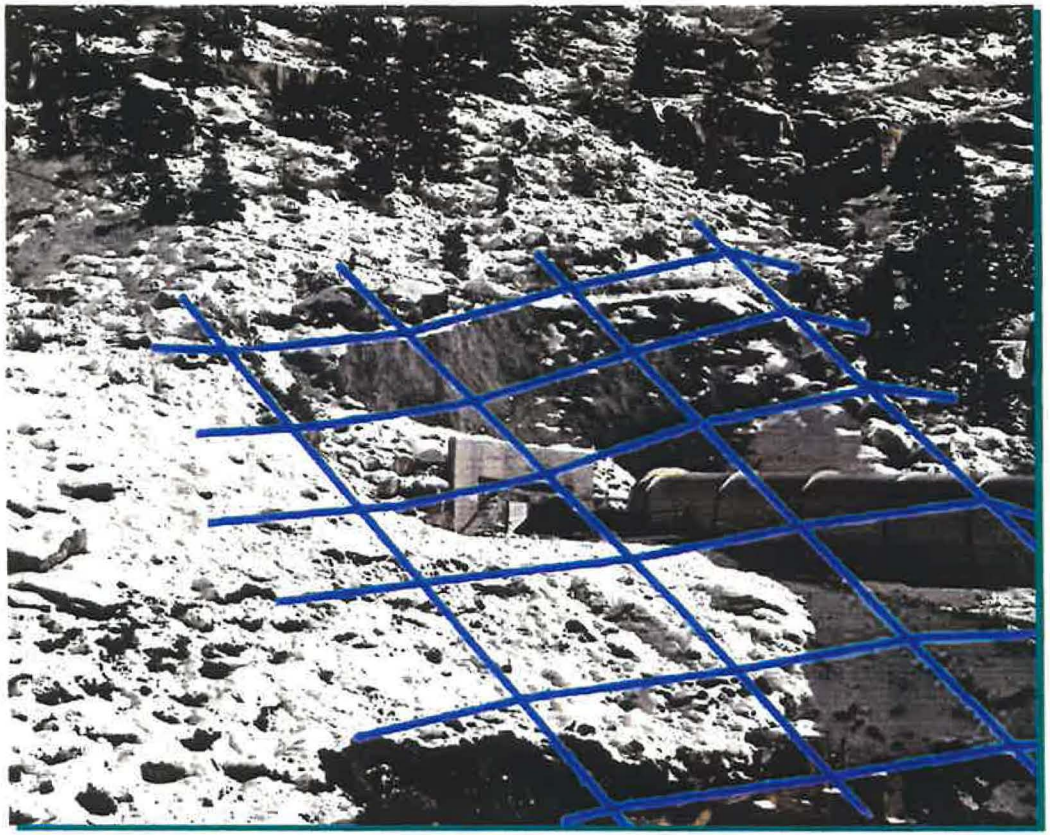
INCORPORATED
EFFECTIVE:
FEB 25 1999
UTAH DIVISION OIL, GAS AND MINING



- 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.

INCORPORATED
EFFECTIVE:
FEB 25 199
986
UTAH DIVISION OIL, GAS AND MINING



- 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

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.

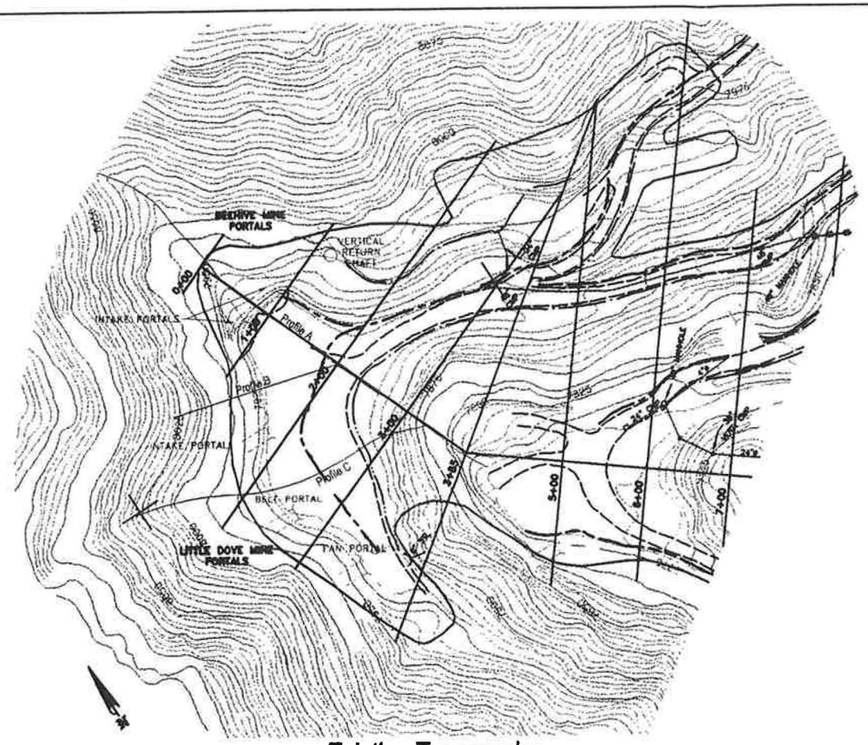
We appreciate the opportunity of performing these analyses for you. If there are any questions regarding the information contained herein, or if we can be of further assistance, please call.

Sincerely,

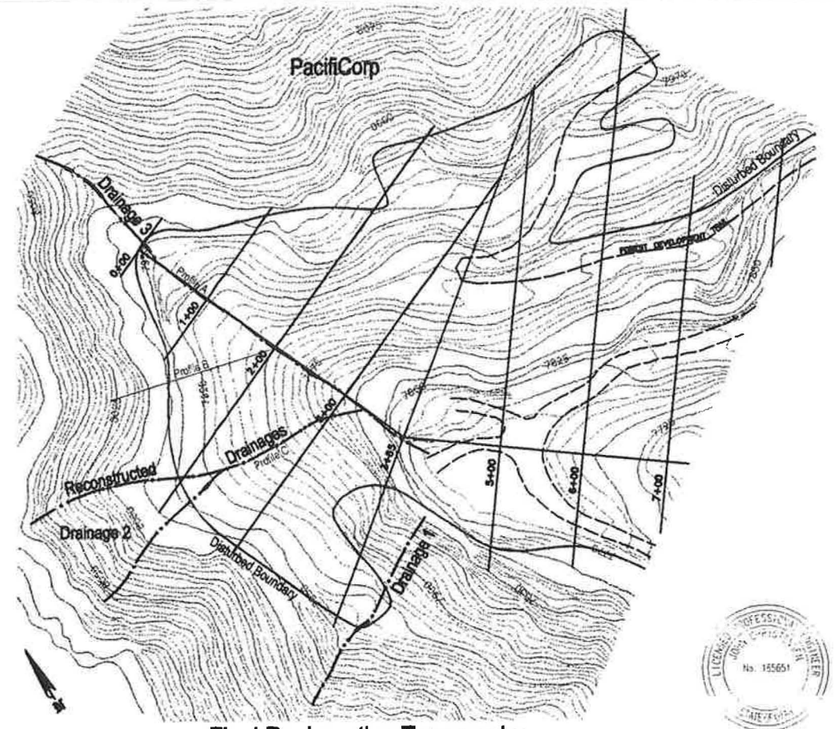
RB&G ENGINEERING, INC.

REGISTERED PROFESSIONAL ENGINEER
NO.162291
BRADFORD E. PRICE
STATE OF UTAH

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



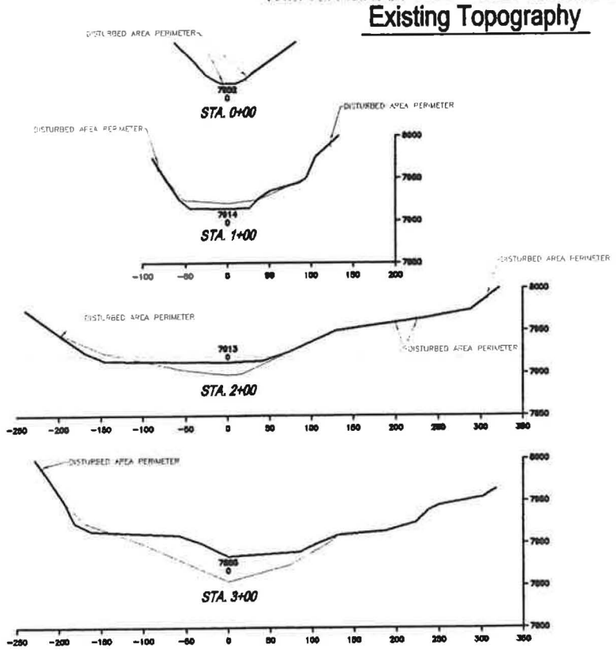
Existing Topography



Final Reclamation Topography

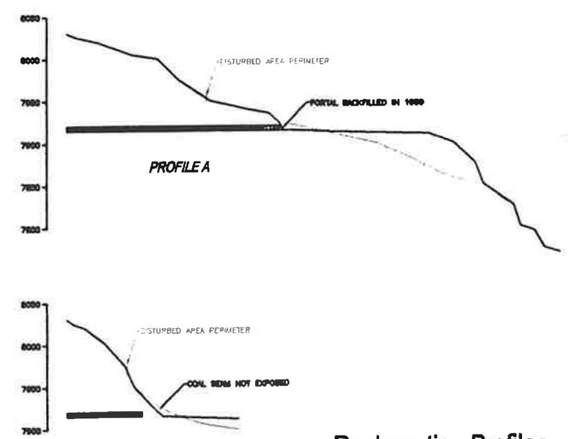
I, JOHN CHRISTENSEN BEING A REGISTERED PROFESSIONAL ENGINEER IN THE STATE OF UTAH, DO HEREBY CERTIFY THAT THE INFORMATION CONTAINED ON THIS DRAWING IS TRUE AND ACCURATE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

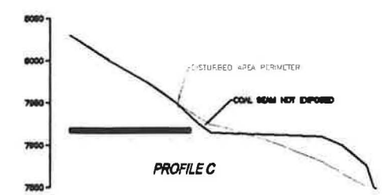
JOHN CHRISTENSEN NO. 165651 DATE



Reclamation Cross Sections

LEGEND
EXISTING GROUND LINE
FINAL RECLAMATION GROUND LINE





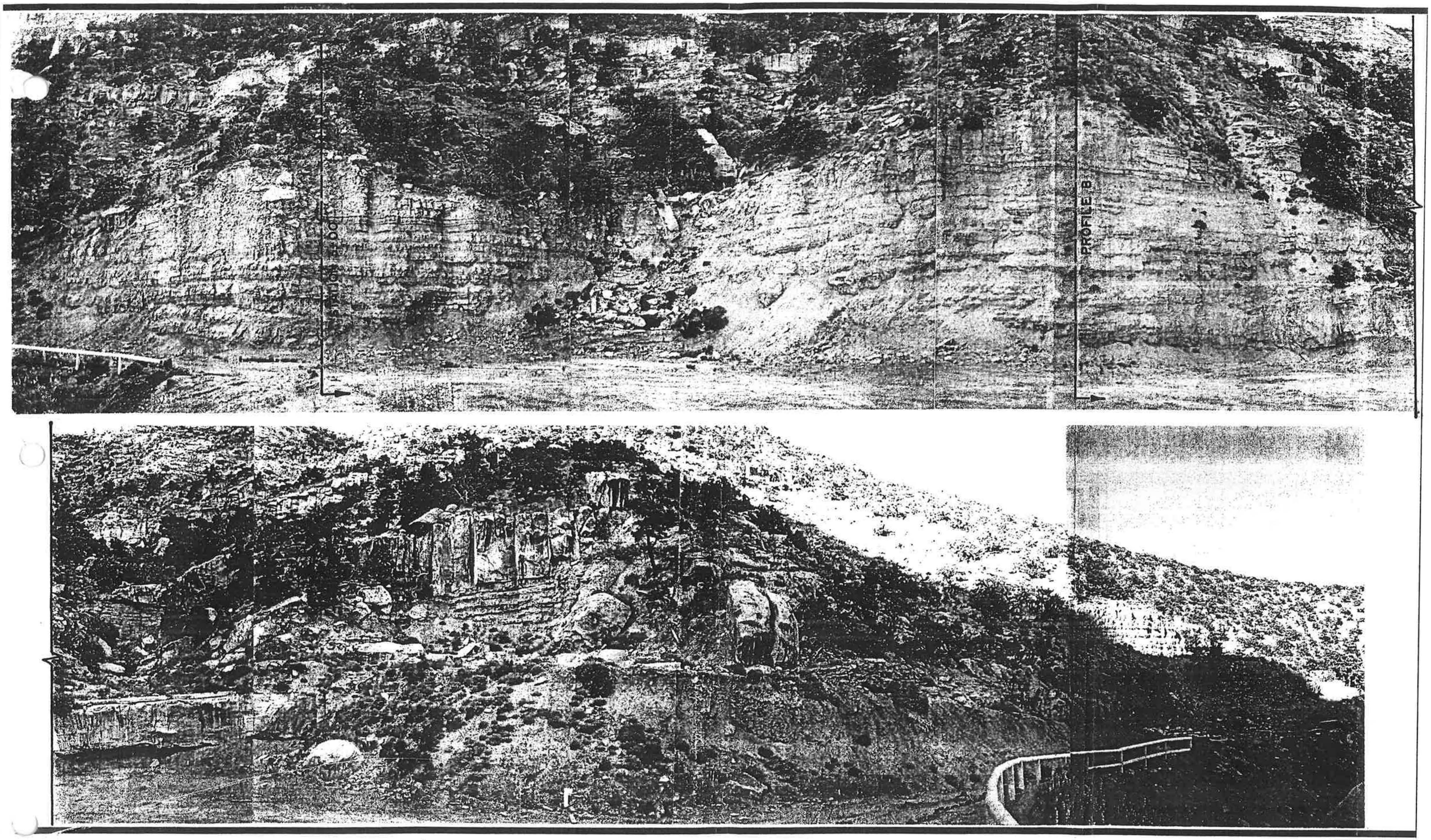
Reclamation Profiles

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. ___



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Provo, Utah

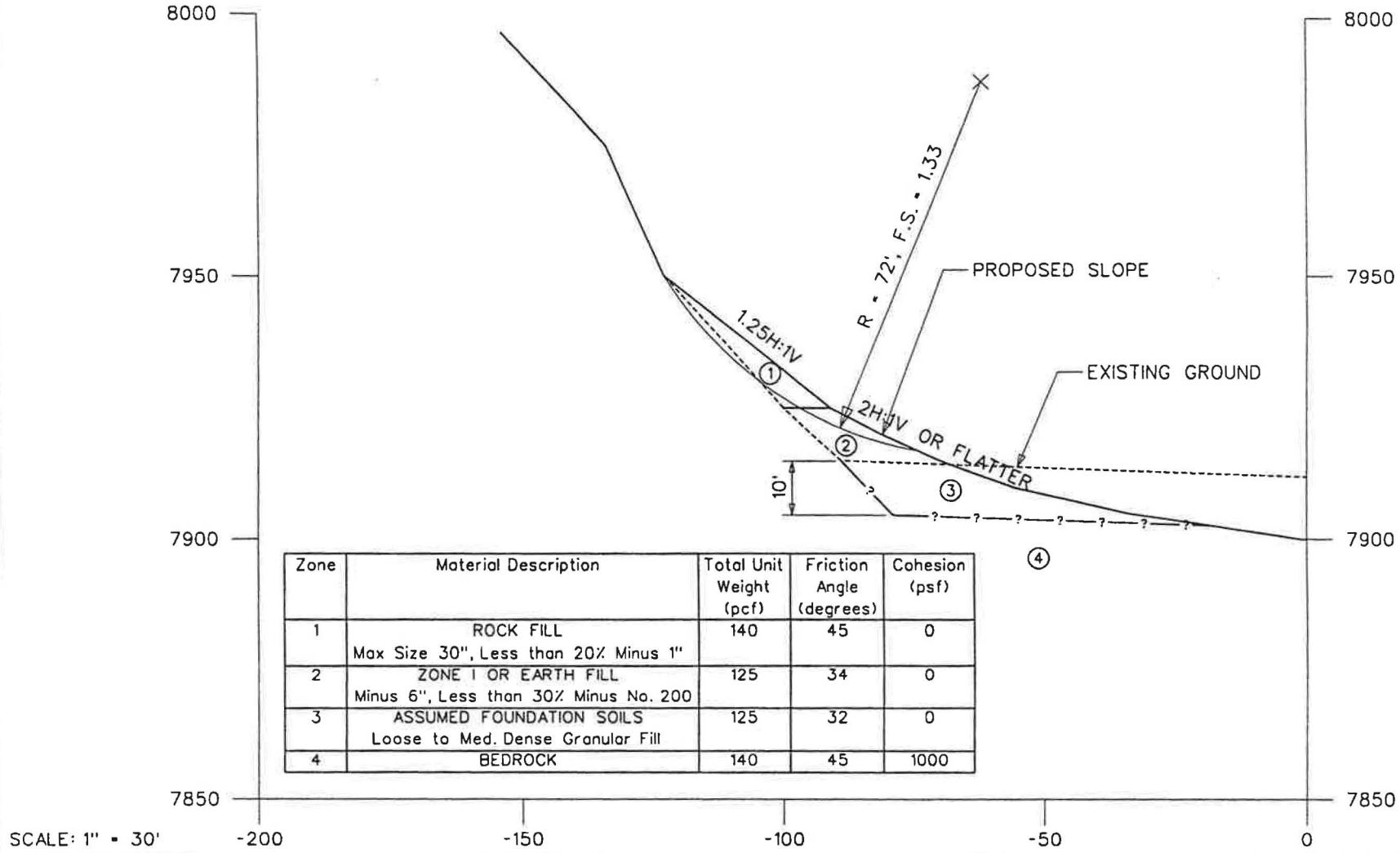
DES-BEE-DOVE MINE
Emery County, Utah

Existing Site Conditions

Figure 1

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

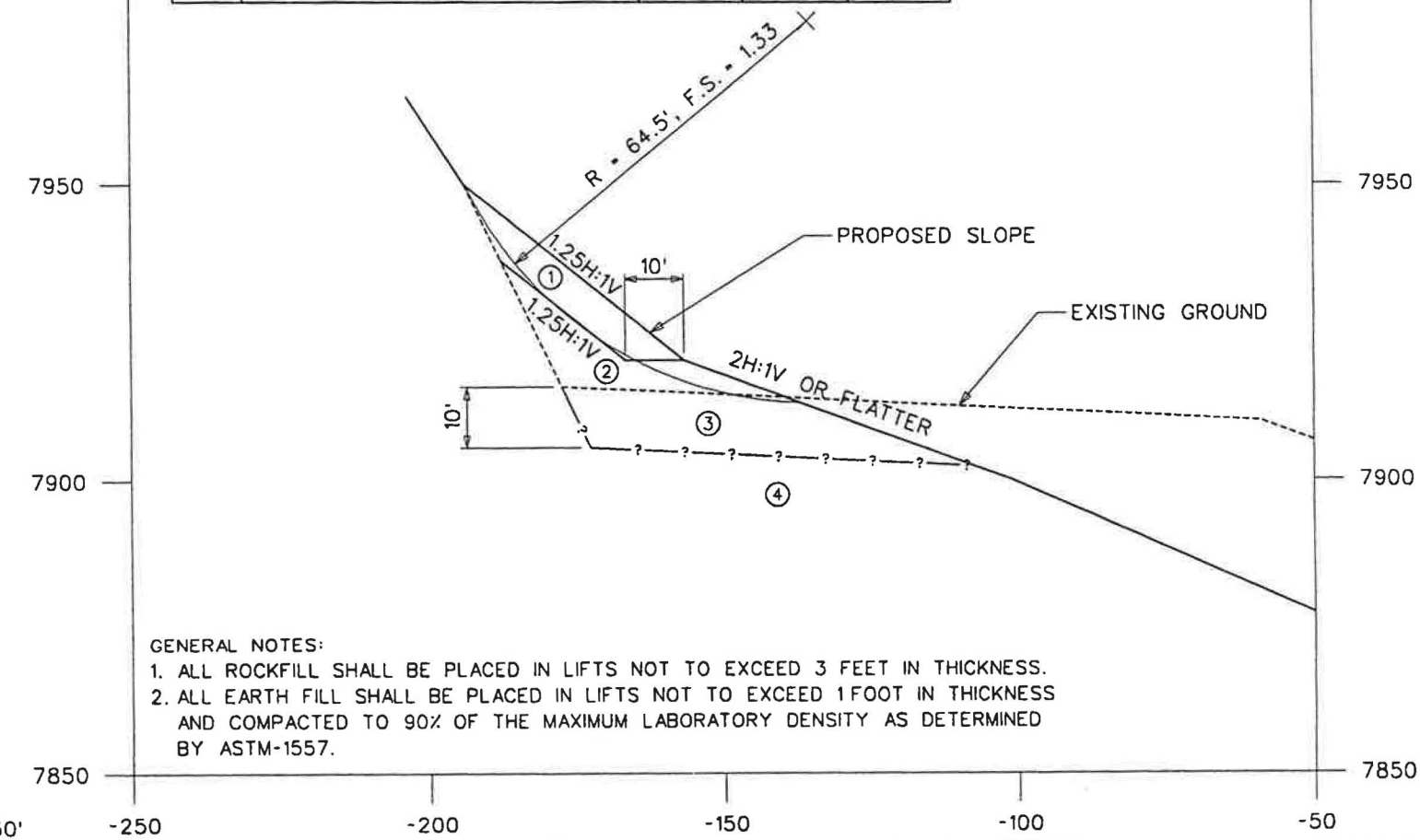
SCALE: 1" = 30'

RB&G ENGINEERING INC.
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

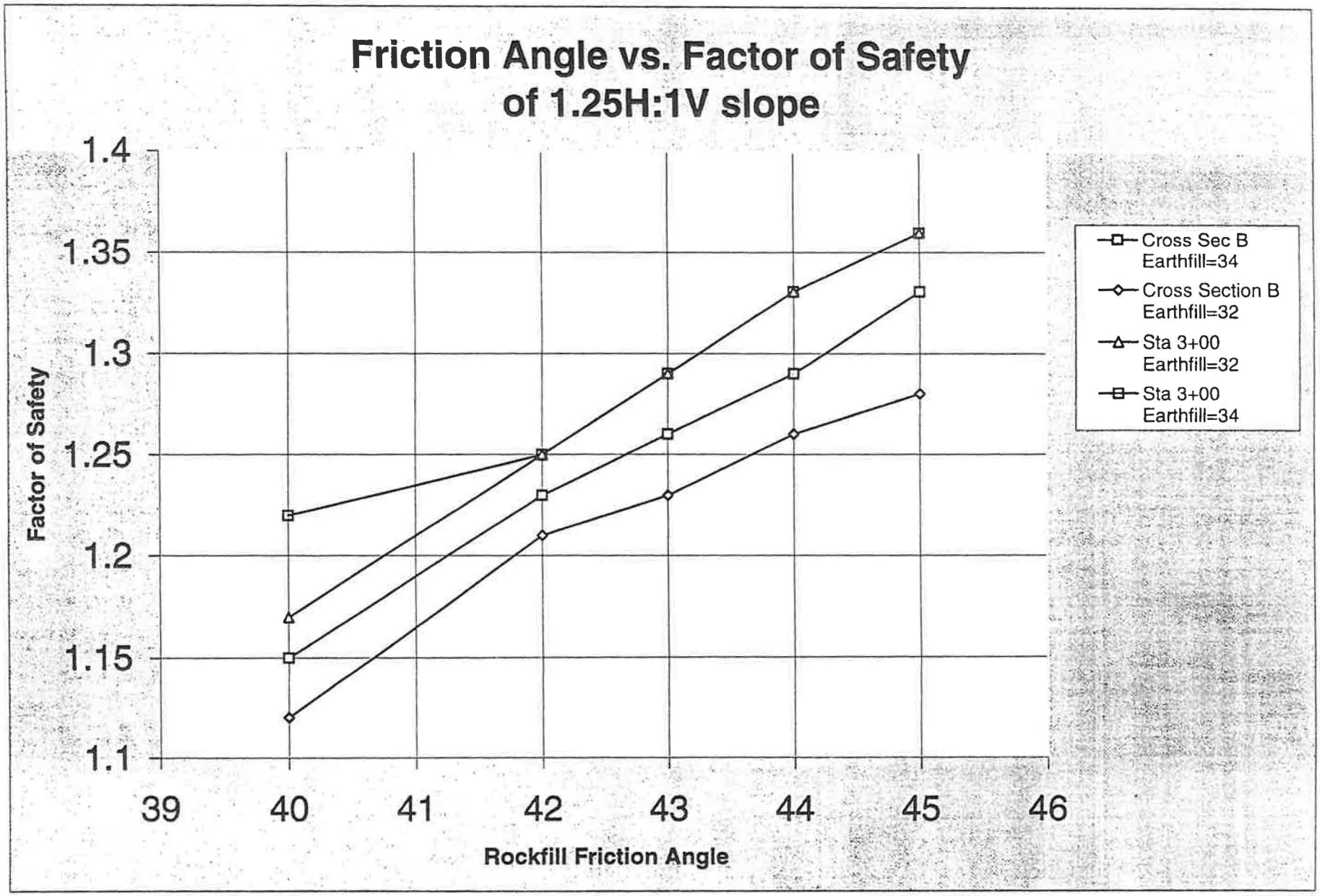
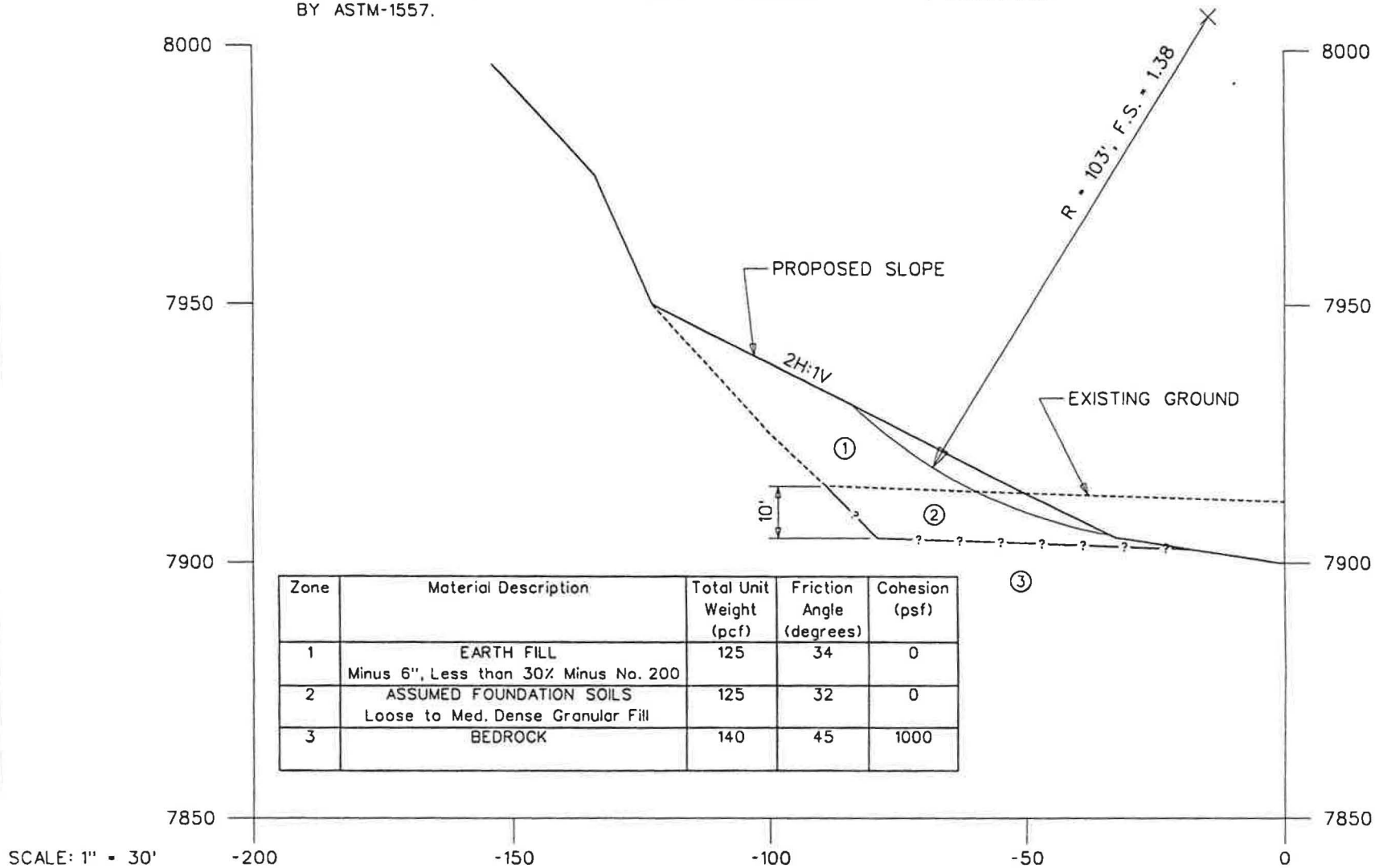

Friction Angle vs. Factor of Safety
of 1.25H:1V slope
Factor of Safety
1.4
1.35
1.3
1.25
1.2
1.15
1.1
39
40
41
42
43
44
45
46
Rockfill Friction Angle
Cross Sec B
Earthfill=34
Cross Section B
Earthfill=32
Sta 3+00
Earthfill=32
Sta 3+00
Earthfill=34

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

SCALE: 1" = 30'

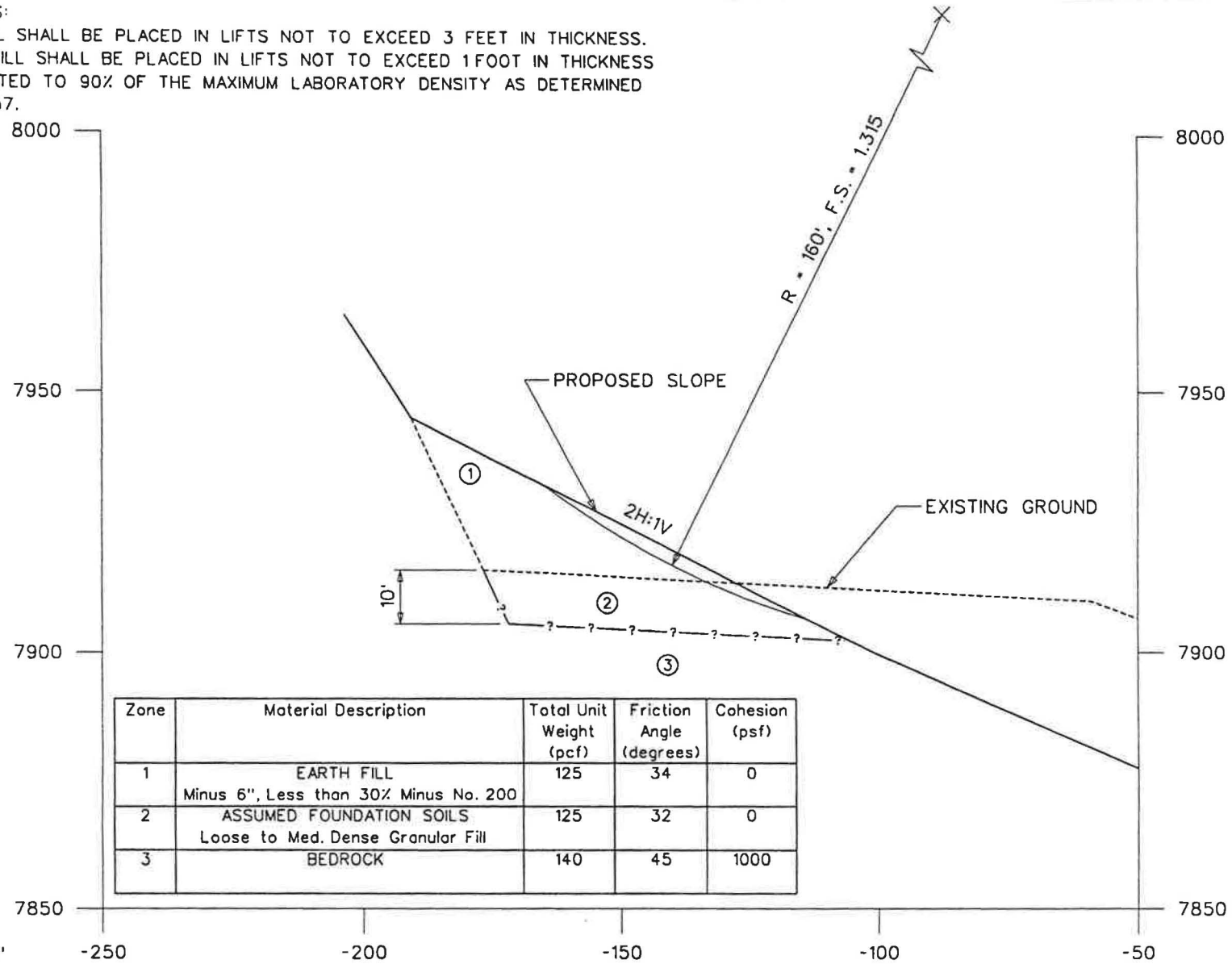
RB&G ENGINEERING INC.
Provo, Utah

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'

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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

Cottonwood/Wilberg Mine Reclamation Plan

2016

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: UT

DATA DESCRIPTION

Data type: precipitation depth **Units:** english **Time series type:** partial duration

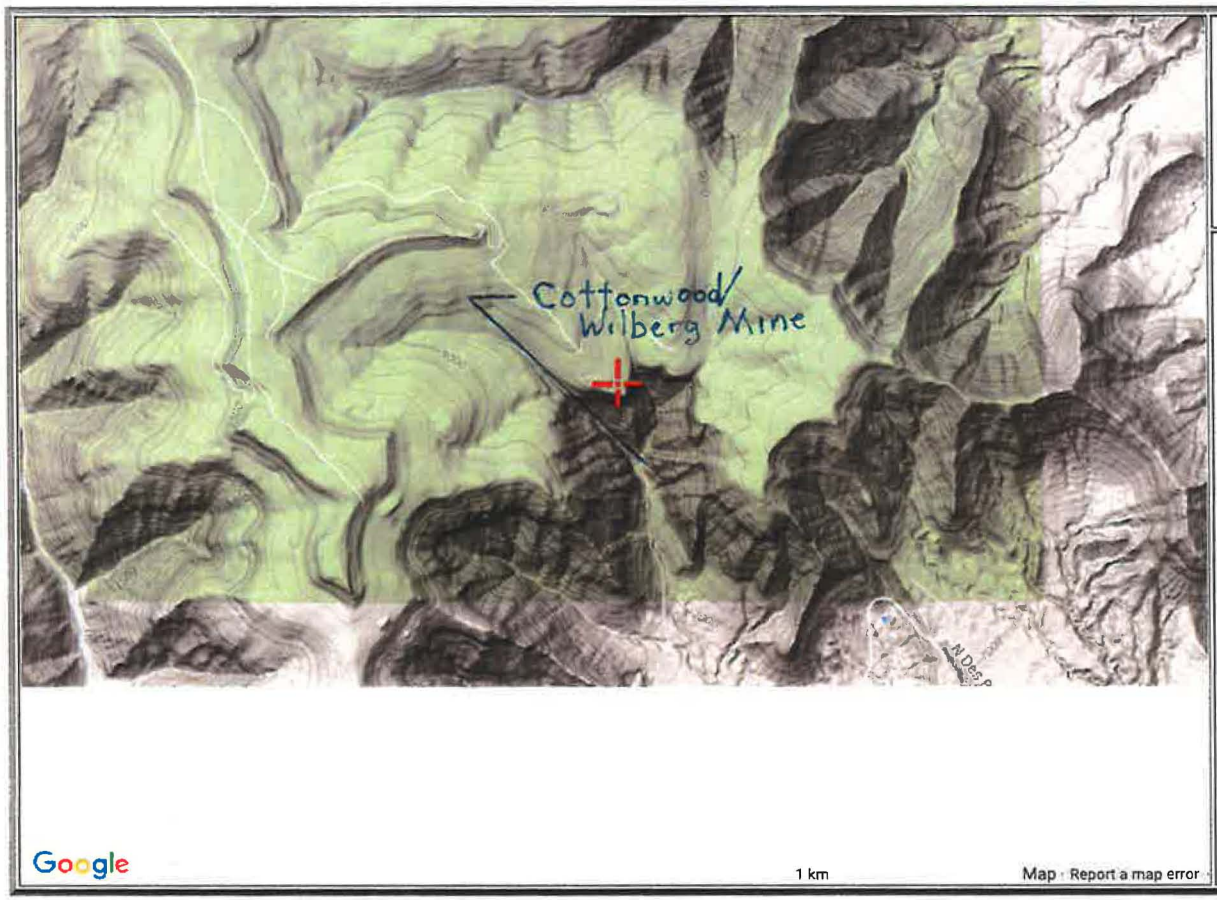
SELECT LOCATION

1. Manually:

a) Enter location (decimal degrees, use "-" for S and W): latitude: longitude: submit

b) Select station (click here for a list of stations used in frequency analysis for UT): select station

2. Use map:



a) Select location
(move crosshair or double click)

b) Click on station icon
(show stations on map)

LOCATION INFORMATION:
Name: Orangeville, Utah, US*
Latitude: 39.3263°
Longitude: -111.1245°
Elevation: 8865 ft*

* source: Google Maps

POINT PRECIPITATION F[illegible]JENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 1, Version 5

PF tabular PF graphical Supplementary information Print Page

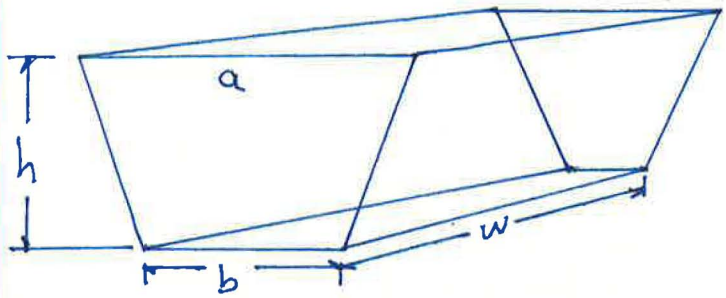
PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

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

Issoceles Trapezoid (Trough)



$A = \frac{1}{2}(a+b)h$

$V = Aw$

Trough #1

$a = 3'$ $h = 1.5'$ $\longrightarrow$ $A = \frac{1}{2}(3' + 1.5')1.5'$

$b = 1.5'$ $w = 3'$ $= 3.375'$

$V = 3.375 ft^2 \cdot 3' = \underline{\underline{10.125 ft^3}}$

Area of rainfall interception:

$= 3' \times 3' = 9 ft^2$

Trough #2

$a = 6'$ $h = 3'$ $A = \frac{1}{2}(6' + 3')3'$

$b = 3'$ $w = 6'$ $= 13.5 ft^2$

$V = 13.5 ft^2 \cdot 6' = \underline{\underline{81.0 ft^3}}$

Area of rainfall interception:

$6' \times 6' = 36 ft^2$

Total Capacity of Troughs:

100yr/24hr Event = 3.0" (0.25')

Trough #1 $\longrightarrow$ $9ft^2 \cdot 0.25' = 2.25 ft^3$

Trough #2 $\longrightarrow$ $36ft^2 \cdot 0.25' = 9.0 ft^3$

TOPS 35501

Calculate Infiltration assuming 0.05 in/hr.

$= 0.0042\ ft/hr$

$0.0042\ ft/hr \cdot 24\ hr. = 0.1\ ft$

Subtract out abstraction $0.25 - 0.1$

$= 0.15'$ total rainfall

Trough #1 $\rightarrow 9ft^2 \cdot 0.15' = \underline{\underline{1.35\ ft^3}} \rightarrow 13.3\%$ of full

Trough #2 $\rightarrow 36ft^2 \cdot 0.15' = \underline{\underline{5.4\ ft^3}} \rightarrow 6.67\%$ of full

---

What is the depth of water retained in pock after infiltration?

Calculate "a" in terms of "h"

$a = 3 = h + 1.5$

$\therefore \quad A = \frac{1}{2}(a+b)h$

$= \frac{1}{2}(h + 1.5 + 1.5)h$

$= \frac{h^2}{2} + \frac{3}{2}h$

$\underline{V = AW}$

$V = \left(\frac{h^2}{2} + \frac{3}{2}h\right)W$

$\frac{2V}{W} = h^2 + 3h$

With "V" & "W" known Solve the quadratic Eq

Trough #1 $0.9 = h^2 + 3h$

Depth Con't

$$0.9 = h^2 + 3h$$

$$2.25 + 0.9 = h^2 + h + 2.25$$

factoring a perfect square

$$(h+1.5)(h+1.5) = 3.15$$

$$h + 1.5 = 1.77$$

$$\underline{\underline{h = 0.227'}}$$

Trough #2

$$1.8 = h^2 + 3h$$

$$\underline{\underline{h = 0.513'}}$$

TOPS. 35501

Estimating Runoff from Areas Directly above Disturbed Boundary.

Question: Will uppermost pocks be Impacted by runoff from undisturbed area.

Curve Number Approach

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

Q = runoff or rainfall excess in inches

P = Precipitation (in.) 3 inches (100yr/24hr Event)

$$S = \frac{1000}{CN} - 10$$

S = Infiltration depth (in.)

CN estimated at 72 → ① Mt. Nebo Reference Area survey 2012 – 53% ground cover density

② USDS SCS (1972) Pinyon/Juniper – Grass Complex

∴ S = 3.89 inches

$$Q = \frac{(3 - 0.78)^2}{3 + 3.11} = \underline{0.81 \text{ inch}}$$

V = QA

Area equals width of pock (6 feet) times a length of 125 feet

see NEH Part 630 Chp 15

= 0.81" (125' x 6')

= 50.63 ft³

Volume of large pock equals 81 ft³

∴ Pock contains volume of design storm

PacifiCorp – Interwest Mining Company

Appendix E

Revise Universal Soil Loss Equation (RUSLE)

Cottonwood/Wilberg Mine Reclamation Plan

2016

RUSLE2 Worksheet Erosion Calculation Record

Info:

Inputs:
Tract #: LS-1
Owner name: Interwest Mining Company
Field name: Cottonwood Mine

Location: Utah\Emery County\UT_Emery_R_13
Soil: DZG2 Gerst-Strych-Rock outcrop complex, 30 to 65 percent slopes\Strych very cobbly loam 20%
Slope length (horiz): 240 ft
Avg. slope steepness: 51 %
##

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*	*Rock cover, %*
LS2RevOperation	c. perfect contouring no row grade	(none)	3 level terraces in middle of RUSLEslope	3.9	3.9	2.3	1.1	26

RUSLE2 Worksheet Erosion Calculation Record

Info:

Inputs:
Tract #: LS-2
Owner name: Interwest Mining Company
Field name: Cottonwood Mine

Location: Utah\Emery County\UT_Emery_R_13
Soil: DZG2 Gerst-Strych-Rock outcrop complex, 30 to 65 percent slopes\Strych very cobbly loam 20%
Slope length (horiz): 360 ft
Avg. slope steepness: 34 %
##

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*	*Rock cover, %*
Bare ground	c. perfect contouring no row grade	(none)	default	13	13	13	13	0
LS2RevOperation	c. perfect contouring no row grade	(none)	default	9.1	9.1	9.1	9.1	26
LS2RevOperation	c. perfect contouring no row grade	(none)	3 level terraces in middle of RUSLEslope	3.2	3.2	1.9	0.91	26

RUSLE2 Worksheet Erosion Calculation Record

Info: Reference Area on west side of canyon.

Inputs:
Tract #: LS-3
Owner name: Interwest Mining Company
Field name: Cottonwood Mine

Location: Utah\Emery County\UT_Emery_R_13
Soil: DZG2 Gerst-Strych-Rock outcrop complex, 30 to 65 percent slopes\Strych very cobbly loam 20%
Slope length (horiz): 150 ft
Avg. slope steepness: 65 %
##

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*	*Rock cover, %*
Ref#3 - Cool season grass; not harvested poor stand	default	(none)	(none)	1.5	1.5	1.5	1.5	36

PacifiCorp – Interwest Mining Company

Appendix F

Hydrological Calculations

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.

APPENDIX

HYDROLOGICAL PROCEDURES

AND

CALCULATIONS

AS USED FOR

FINAL RECLAMATION

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 (Map A-1) 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 (Map A-1) 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.

- 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
MEAN BASIN SLOPE:	12.75	PERCENT
DRAINAGE LENGTH:	18242.00	FEET
DRAINAGE DENSITY:	14.25	FEET/ACRE

We did not have this value. Was not used in the calculations

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

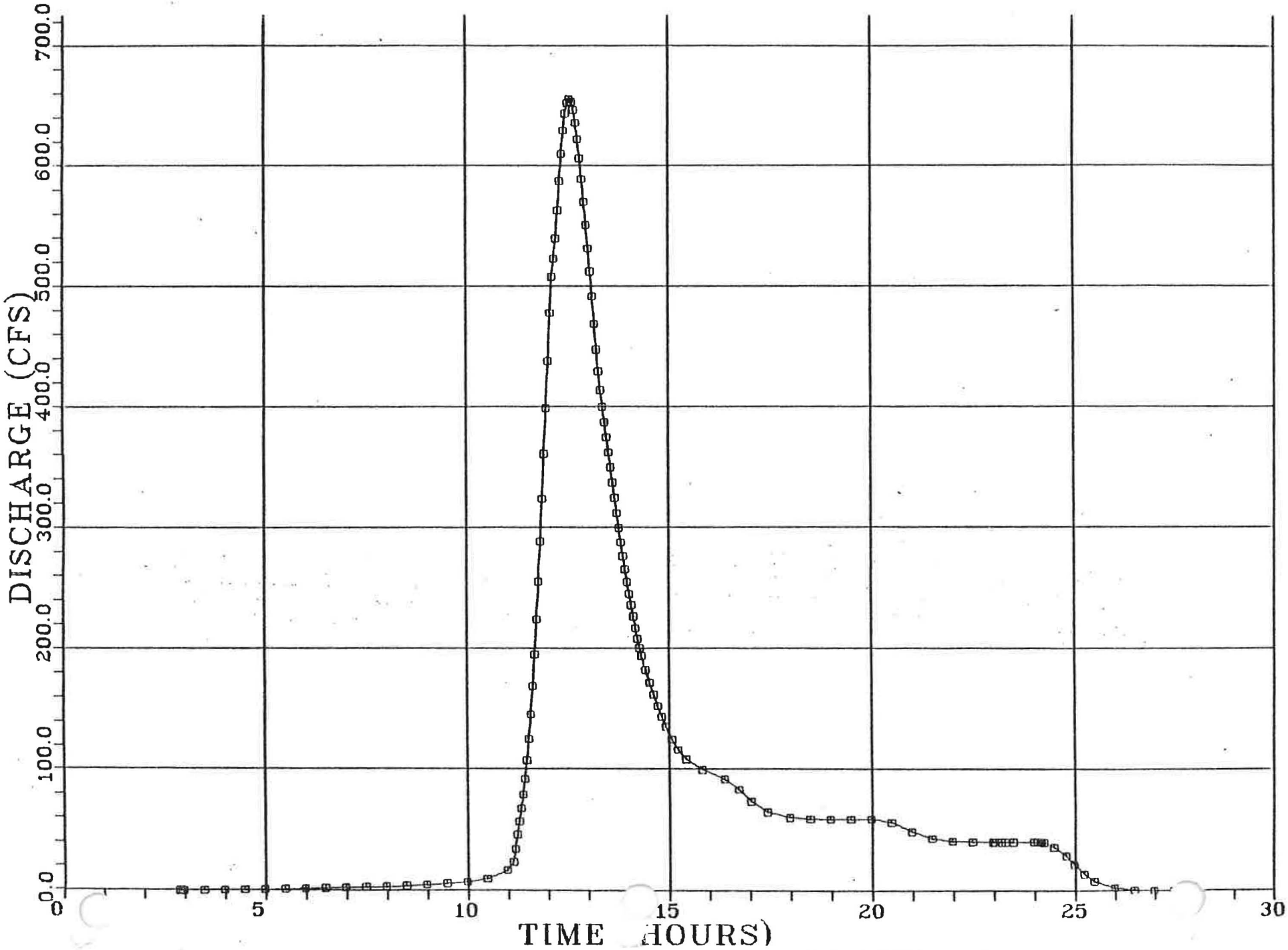
WATERSHED CHARACTERISTICS

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

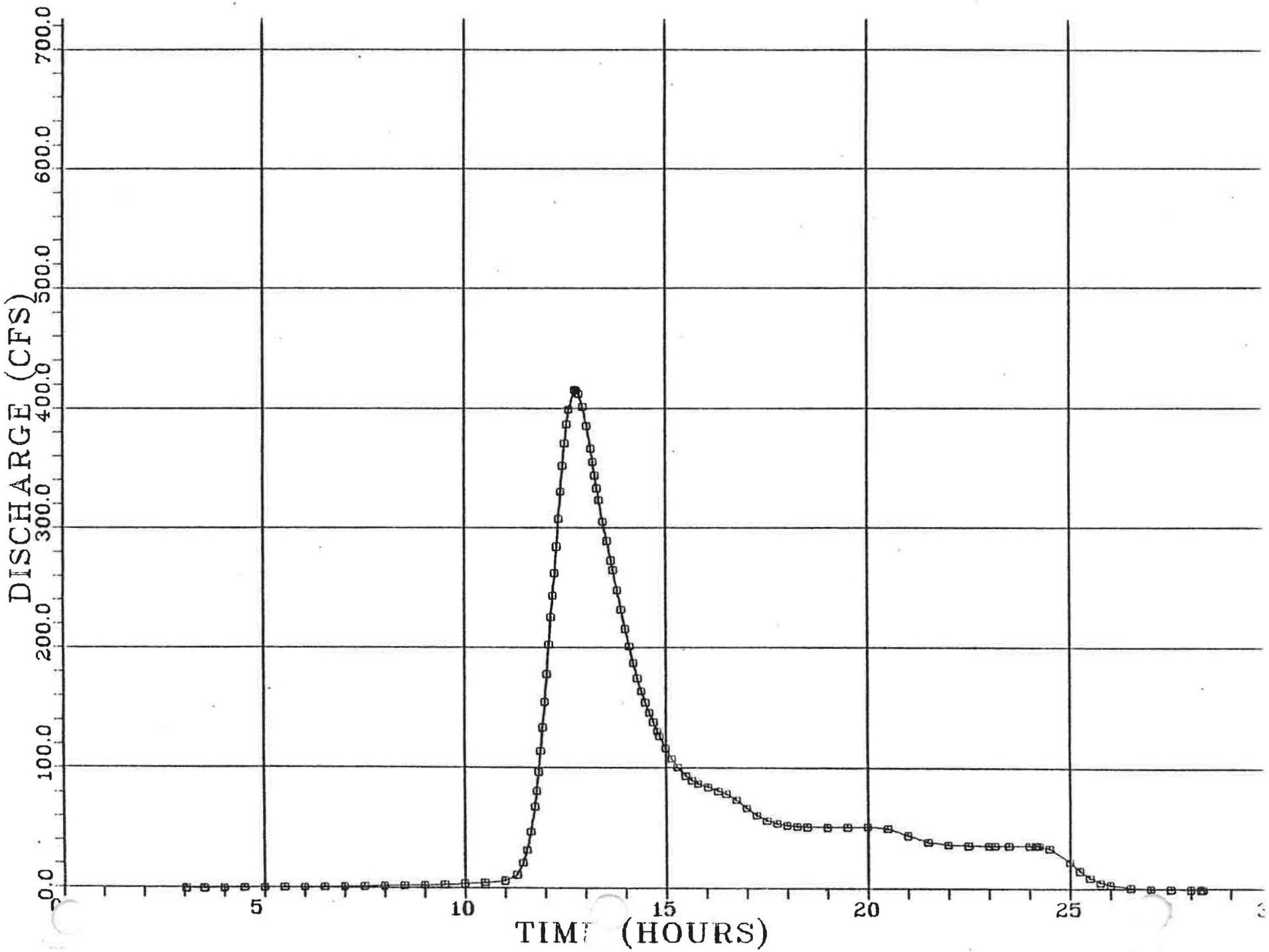
RUNOFF CHARACTERISTICS

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
HORI = 2.0 VERT = 1.0

ROUGHNESS COEFFICIENT
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

```
*****************************
*                           *
*                           *
*  HYDROGRAPH DETERMINATION *
*                           *
*                           *
*****************************
```

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	06500
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	

FLOOD HYDROGRAPH
****

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

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	35.81
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

$\frac{D_{15}\ \text{Upper}}{D_{85}\ \text{Lower}} < 5$ $\qquad$ D_{15} Upper $< 5\, D_{85}$ Lower

$5 < \frac{D_{15}\ \text{Upper}}{D_{15}\ \text{Lower}} < 40$ $\qquad$ $5\, D_{15}$ Lower $<$ D_{15} Upper; D_{15} Upper $< 40\, D_{15}$ Lower

$\frac{D_{50}\ \text{Upper}}{D_{50}\ \text{Lower}} < 40$ $\qquad$ D_{50} Upper $< 40\, D_{50}$ Lower

Filter Blanket Design

1st Layer: $D_{15} < 5(15)$ $\qquad$ $D_{15} < 75$ mm

$5(.015) < D_{15}$ $\qquad$ $0.075 < D_{15}$

$D_{15} < 40(.015)$ $\qquad$ $D_{15} < 0.6$ mm

$D_{50} < 40(0.25)$ $\qquad$ $D_{50} < 10.0$ mm

USE $D_{15} = 0.42$ mm $\qquad$ $D_{50} = 2.5\, D_{15} = 1.09$

$D_{50} = 1.09$ mm

$D_{85} = 2.0$ 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 $\qquad$ $D_{50} = 2.5(4.76) = 11.9$

$D_{50} = 12.0$ mm

$D_{85} = 25.4$ 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: $D_{15} < 760mm$
$190.5 mm < D_{15} < 1524 mm$
$D_{50} < 3800 mm$ $3800 > 914$ ✓

$D_{max} = 1.25 D_{50} = 1.25(3 ft) = 3.75 ft$

$\frac{D_{50}}{D_{15}} = 2.5$ $D_{15} = \frac{D_{50}}{2.5} = \frac{3.0}{2.5} = 1.2 ft = 366 mm$
$191 < 366 < 760$ ✓

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) $D_{50} = 1.09mm$ $D_{max} \sim 2.18 mm << 6 in$
Use 6" thickness

Layer 2: (Middle) $D_{50} = 12mm$ $D_{max} \sim 24mm << 6 in$
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. ✓

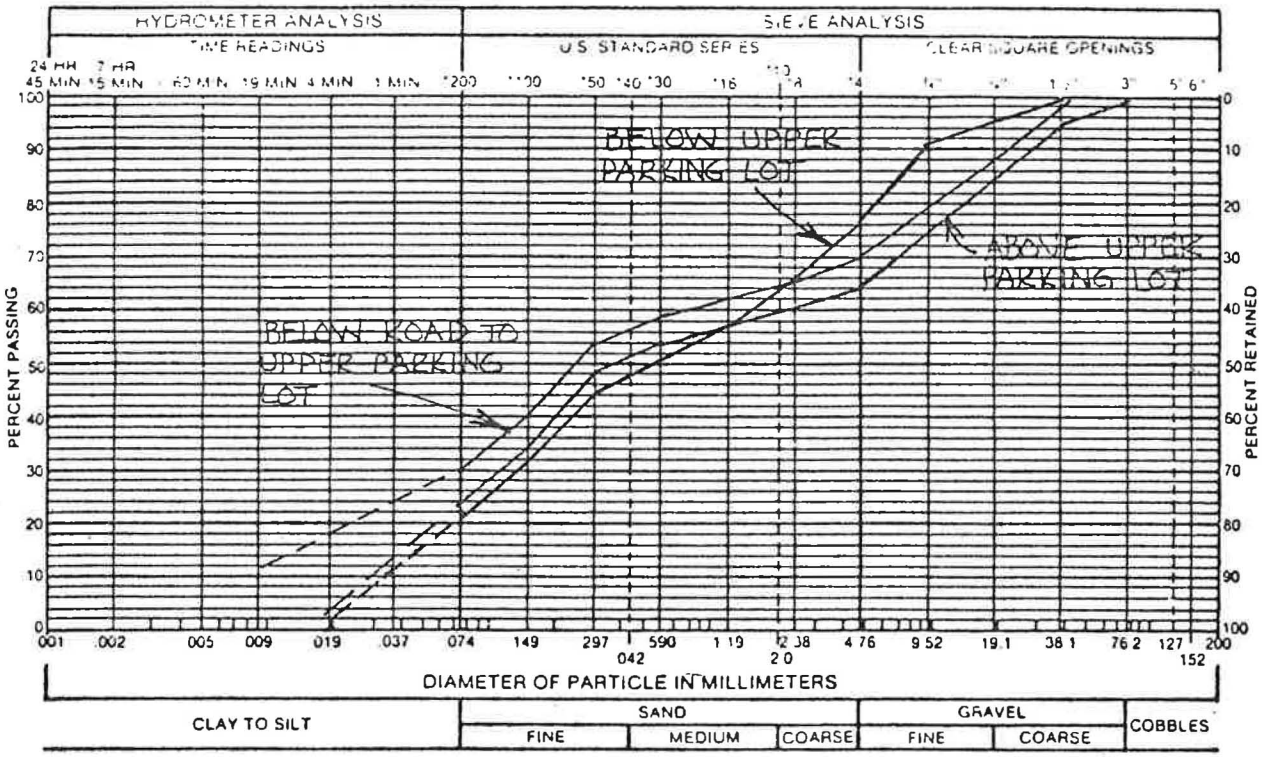
VAUGHN HANSEN ASSOCIATES
CONSULTANTS / ENGINEERS

COMPUTED _____ CLIENT _____
CHECKED _____ PROJECT WILBERG MINE
DATE 16 OCT 84 FEATURE _____

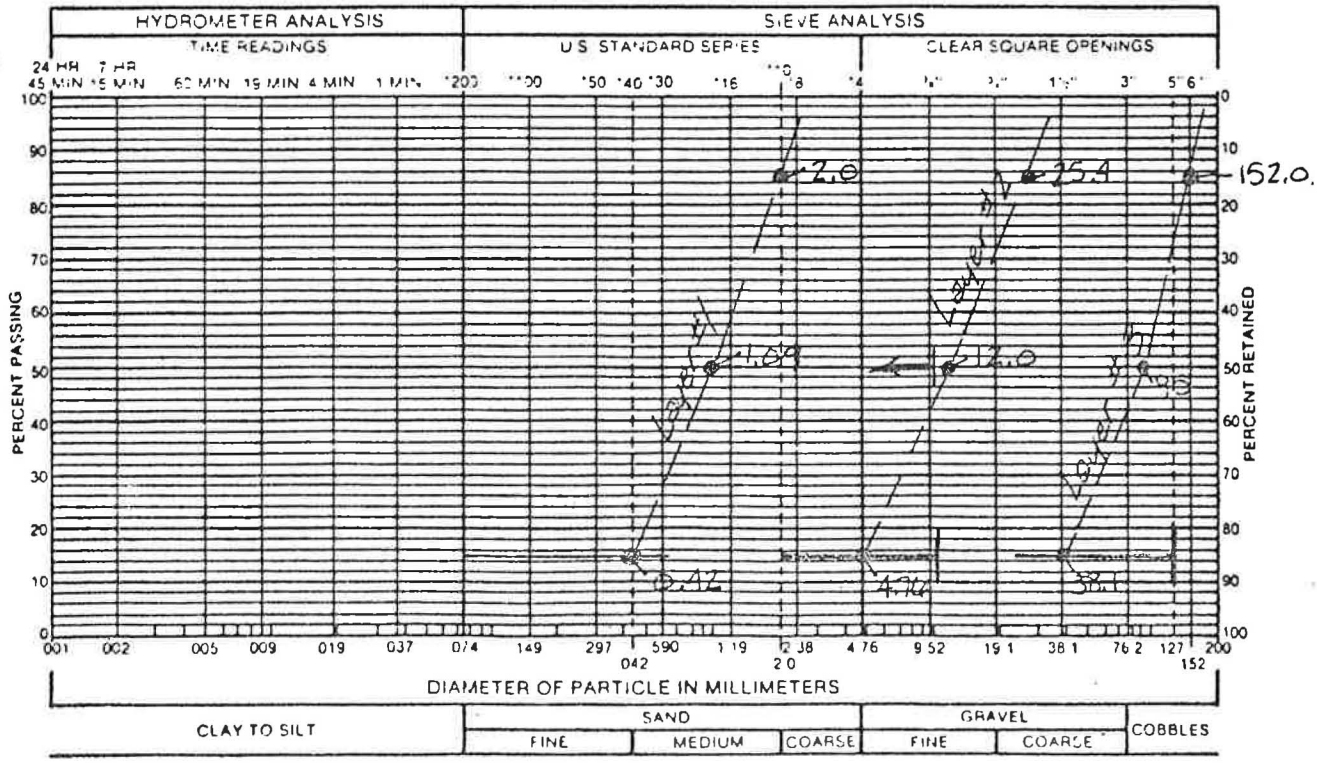
3/3

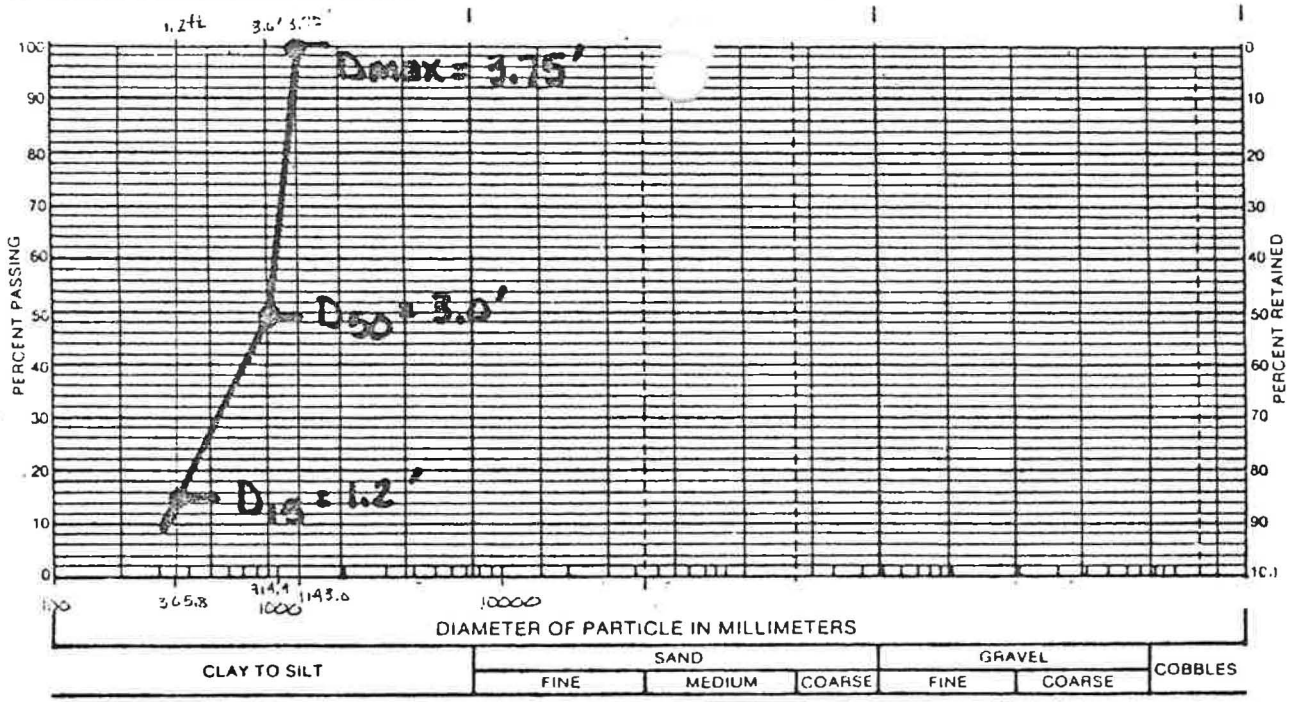
COMBINED SIEVE ANALYSES

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,

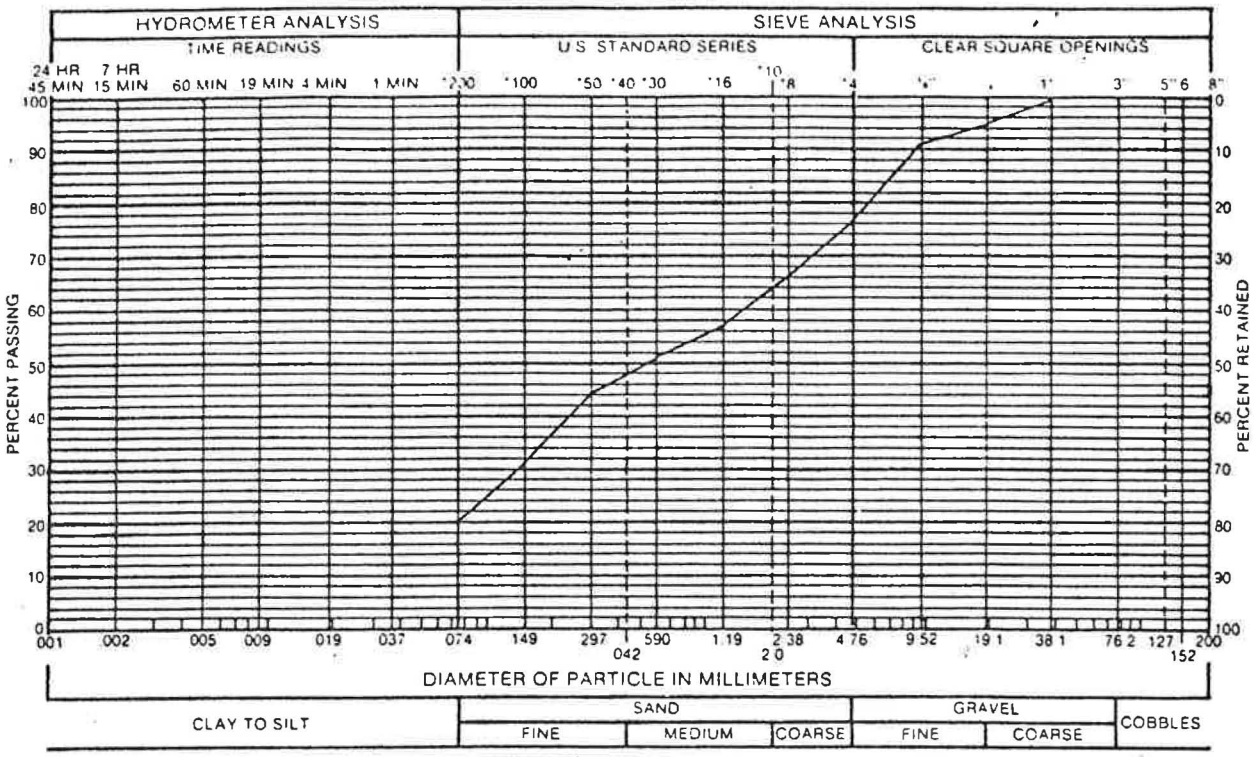
CHEN AND ASSOCIATES, INC.

REGISTERED PROFESSIONAL ENGINEER
NO. 6153
JAMES E. NORDQUIST
State of Utah

James E. Nordquist, P.E.

JEN/tc
Enclosures

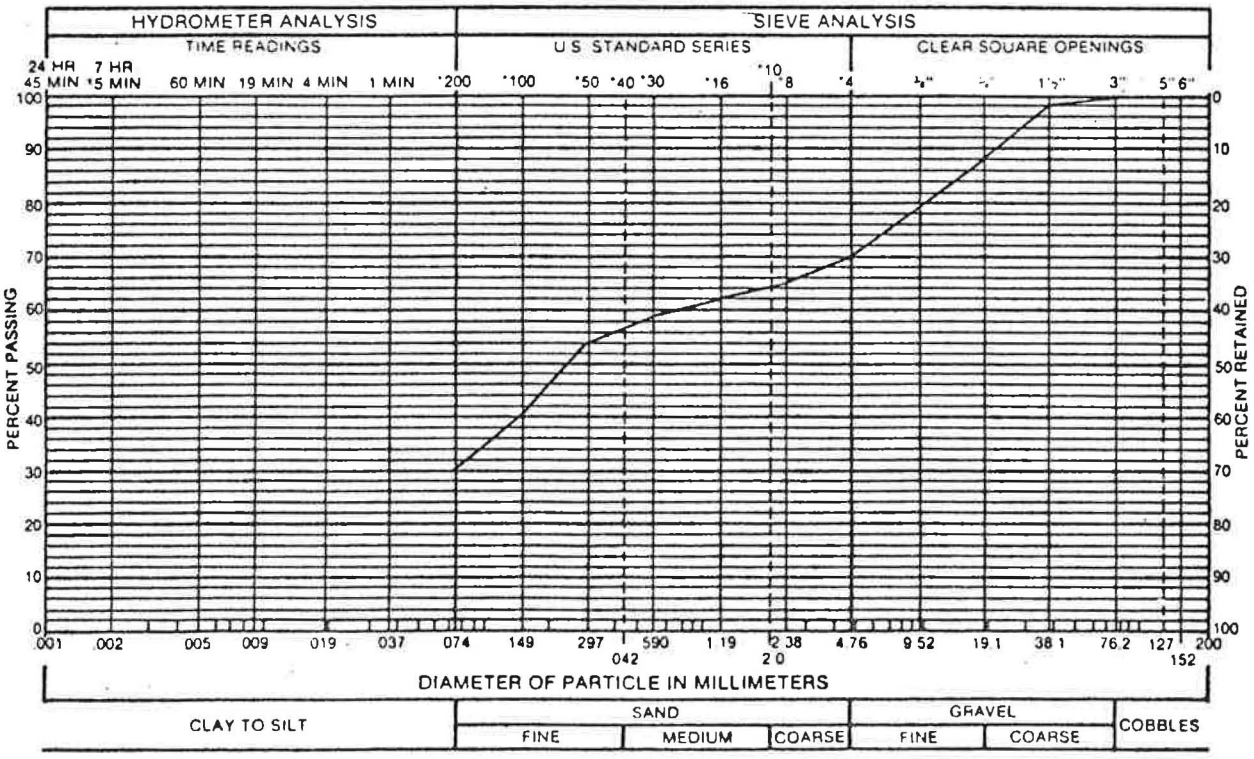
chen and associates, inc.



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



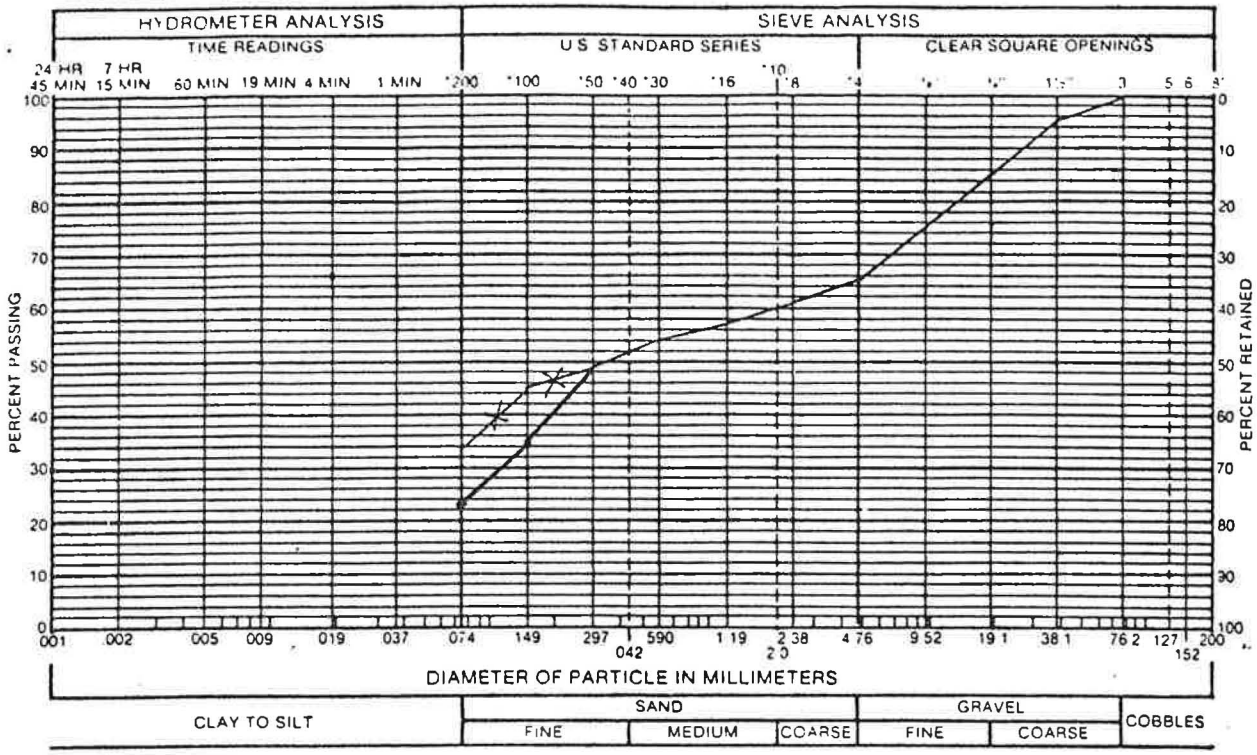
GRAVEL 30 % SAND 40 % SILT AND CLAY 30 %

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.

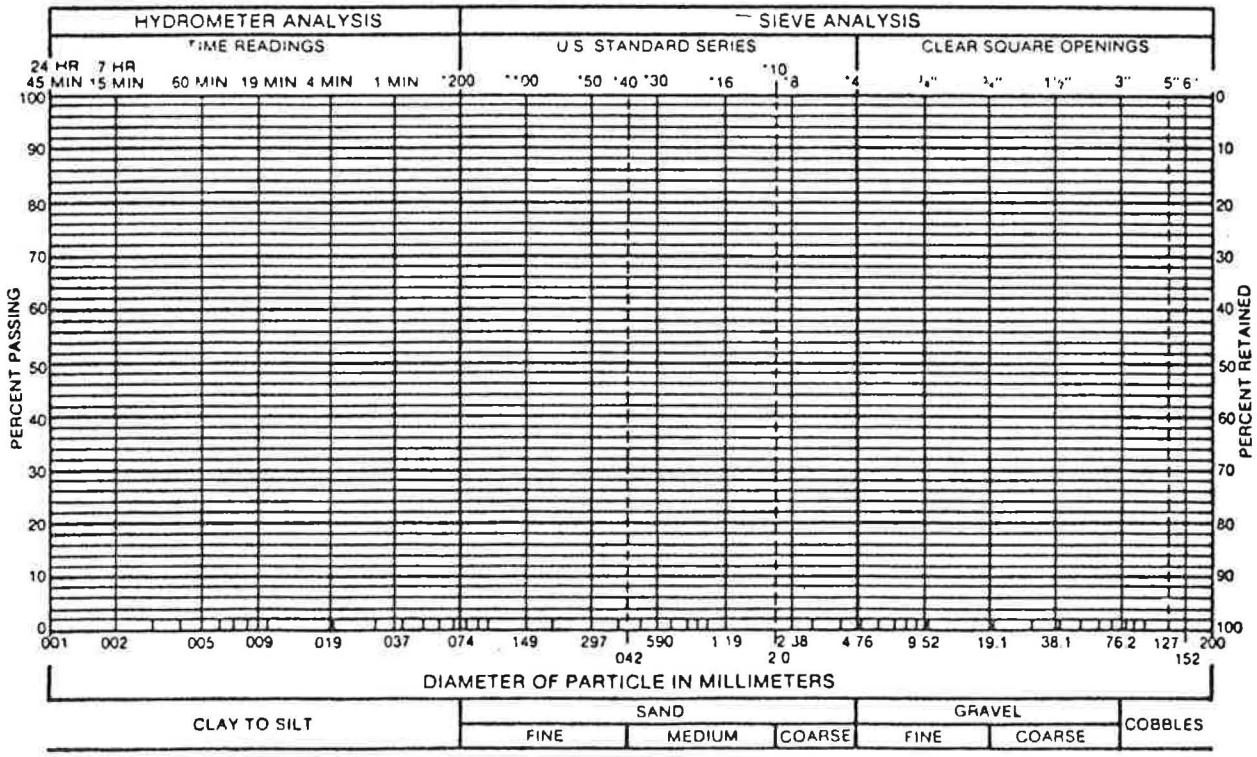


Corrected by Phone w/ Jim Hodquist 10/15/84

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



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 ~ 3.0' (USE 4.0')

∴ LENGTH = 0+4(4) = 16 ft from bottom of Large Rock Slope

RIPRAP SIZING

USE BACKWATER TO FIND FLOW DEPTH:

$Fr^2 = 1 = \frac{Q^2 B}{g A^3}$ $A = by + my^2$ $Q = 180$
$B = b + 2my$

Normal Upstream Depth assuming a 11% Slope
$y = 1.4$ ft

Mannings $n \approx 0.0395 D_{50}^{1/6}$ Use $D_{50} = 3.0$ ∴ $n \approx 0.05$

COMPUTER INPUT:
Use Starting depth = 1.4 ft

Transition Length = 8 ft
$\Delta Z = 4$ ft
$m = 2.0$
$B = 10.0$
} $S = 0.50$

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 G

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

Maps Section

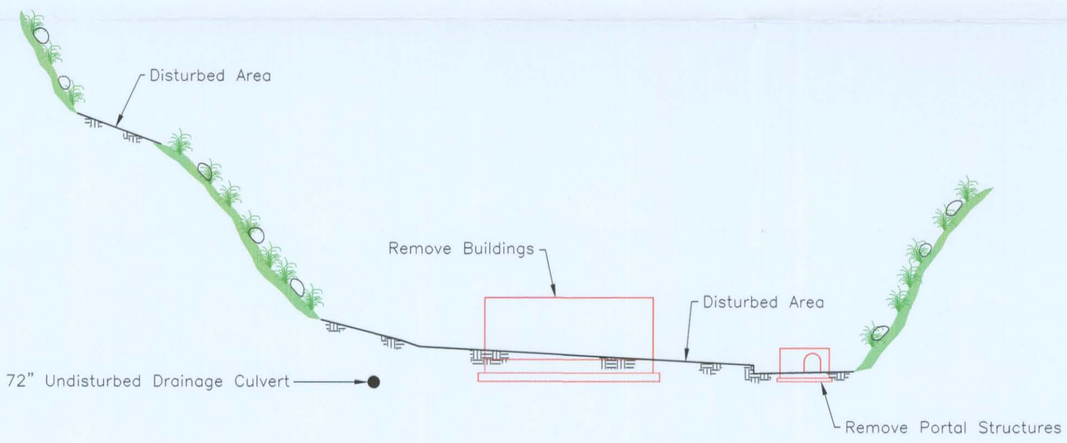
Cottonwood/Wilberg Mine Reclamation Plan

2016

COTTONWOOD MINE - TYPICAL RECLAMATION SEQUENCE

EXISTING CONDITION WITH STRUCTURES IN PLACE

a) Demolish buildings and dispose of metal offsite
b) Dispose of concrete footers and foundations



STEP 1

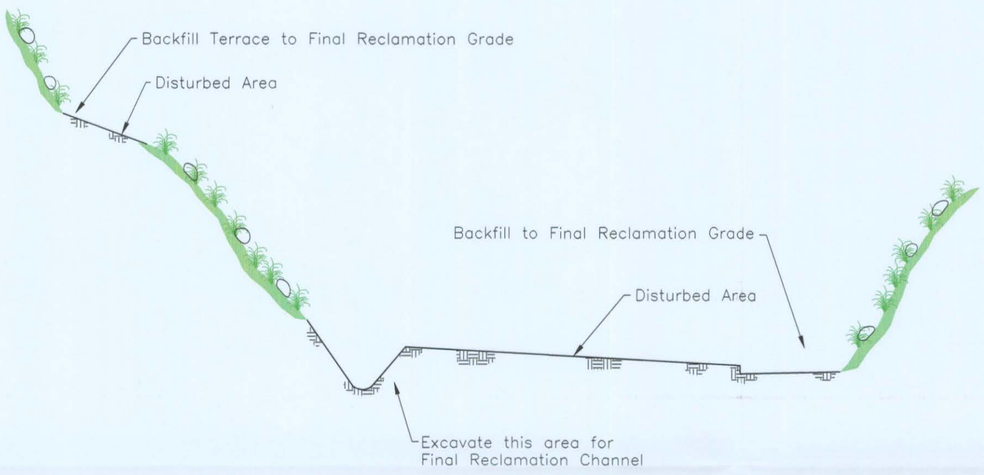
CONDITION AFTER REMOVAL OF STRUCTURES

a) Remove Undisturbed Drainage Culvert
b) Remove all culverts and buried drainage structures

STEP 2

STEP 2 CONDITION AFTER REMOVAL OF CULVERTS

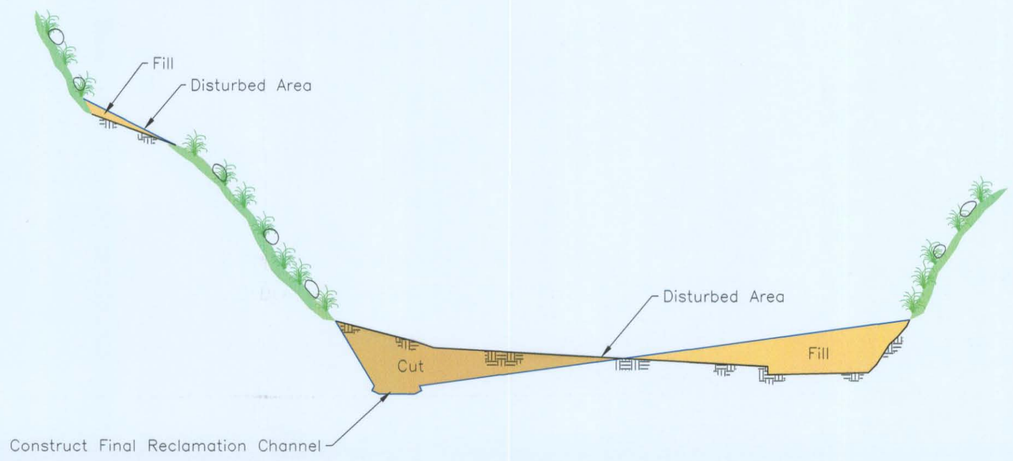
a) Excavate Soil for Construction of Final Reclamation Channel
b) Backfill Terraces, Highwalls and other areas for Final Reclamation



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

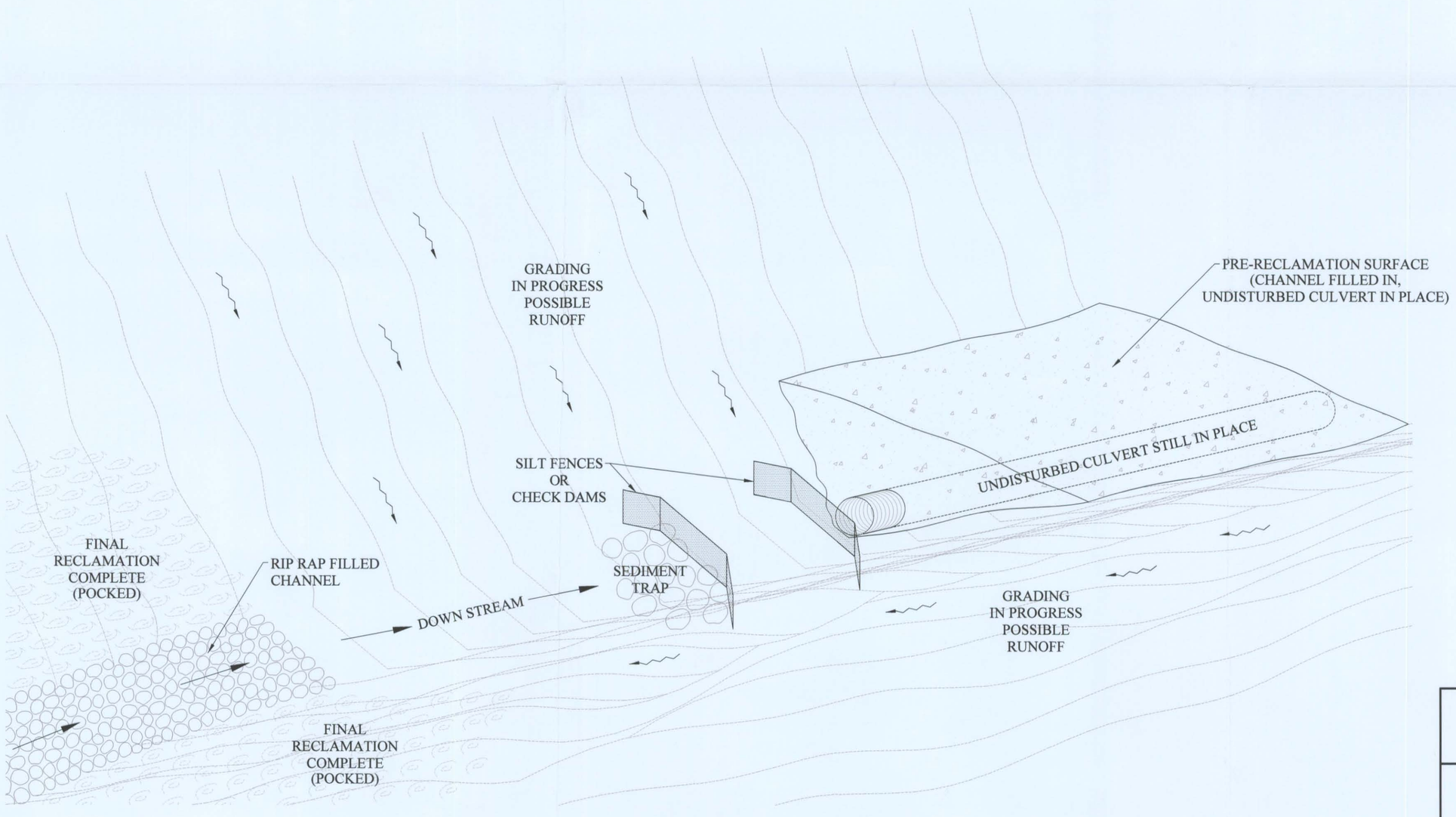


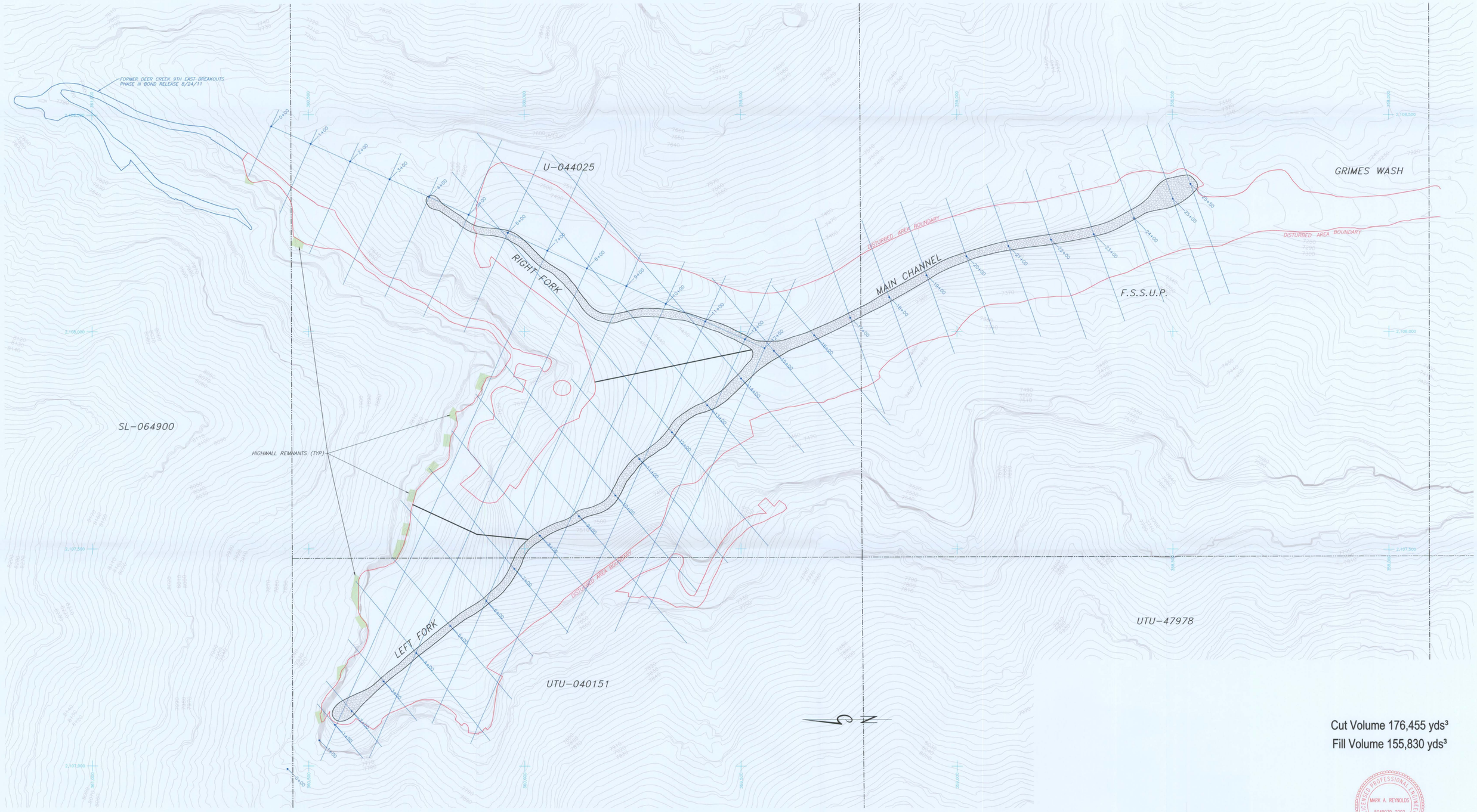
PLATE 4A

CAD FILE NAME/DISK#: PLATE 4A

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD MINE
SEQUENCE OF RECLAMATION

DRAWN BY:	K. LARSEN	.....	
SCALE:	NONE	DRAWING #:	
DATE:	FEBRUARY 22, 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}x1.25
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

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

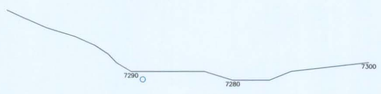
CAD FILE NAME/DISK#: PLATE 4B

PLATE 4B

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

COTTONWOOD/WILBERG MINE
FINAL RECLAMATION MAP

DRAWN BY: K. LARSEN
SCALE: 1"=100'
DATE: JULY 24, 2015
DRAWING #: CM-10378-WB
SHEET 1 OF 2
REV.



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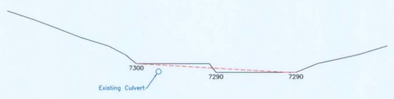

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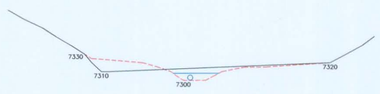

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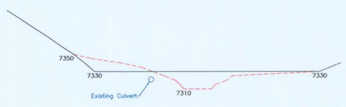
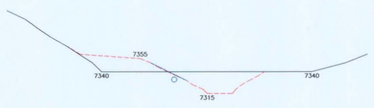


STA. 23+00



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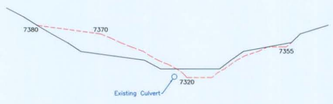
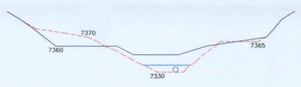
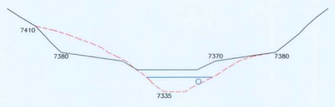


STA. 21+00



STA. 20+00



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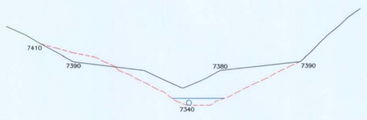
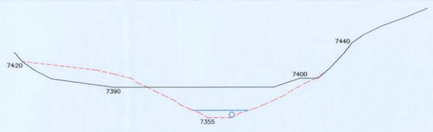


STA. 18+00



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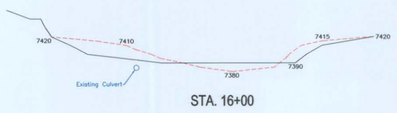

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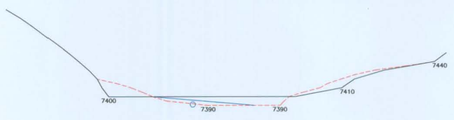
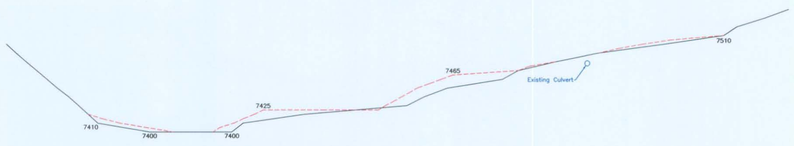


STA. 15+00

MAIN CHANNEL



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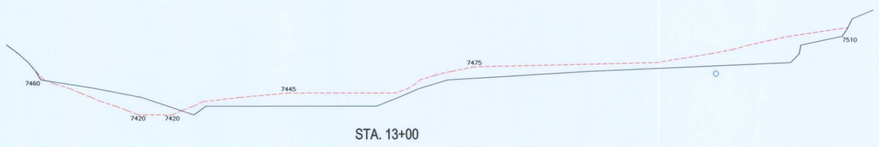

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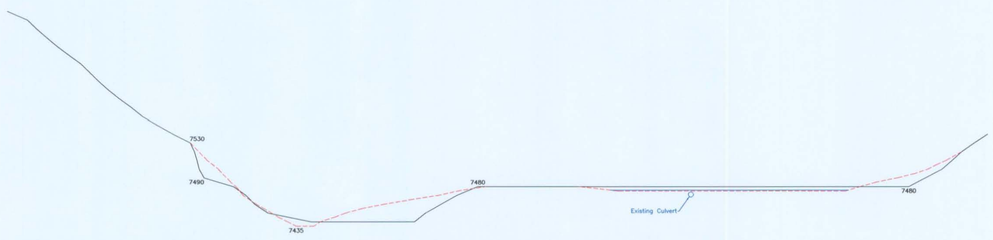

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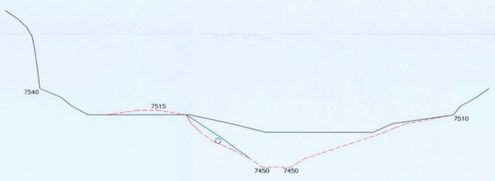

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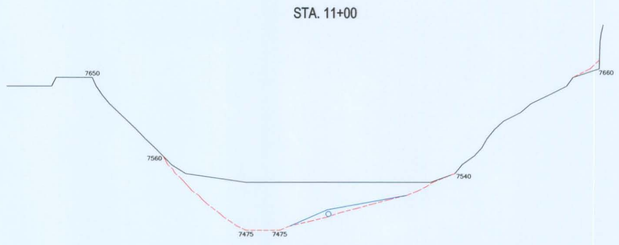

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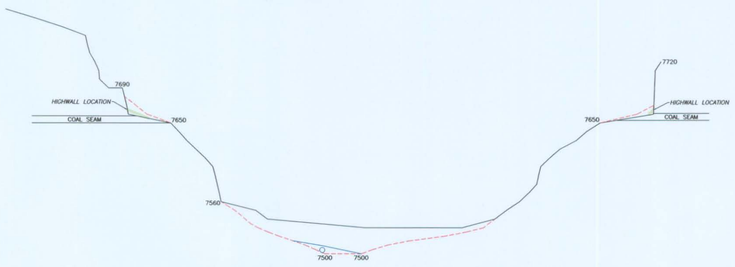

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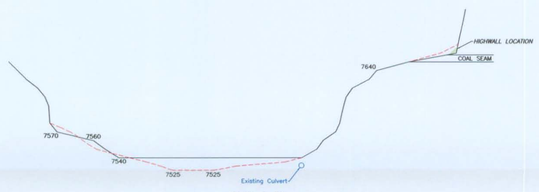

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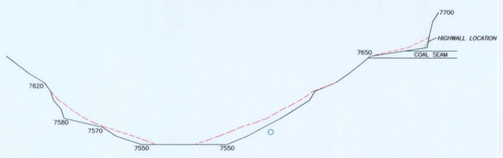

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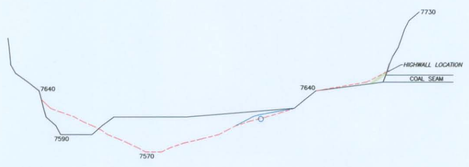

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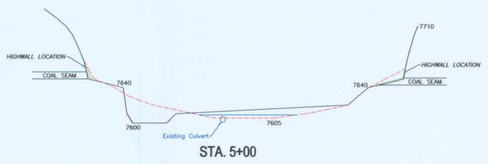

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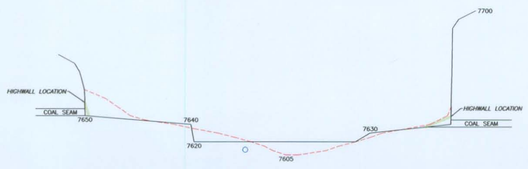

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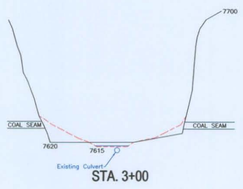

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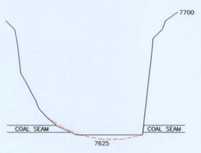
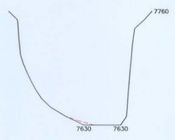


STA. 2+00



STA. 1+50

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

PLATE 4C

CAD FILE NAME/DISK#: PLATE 4C

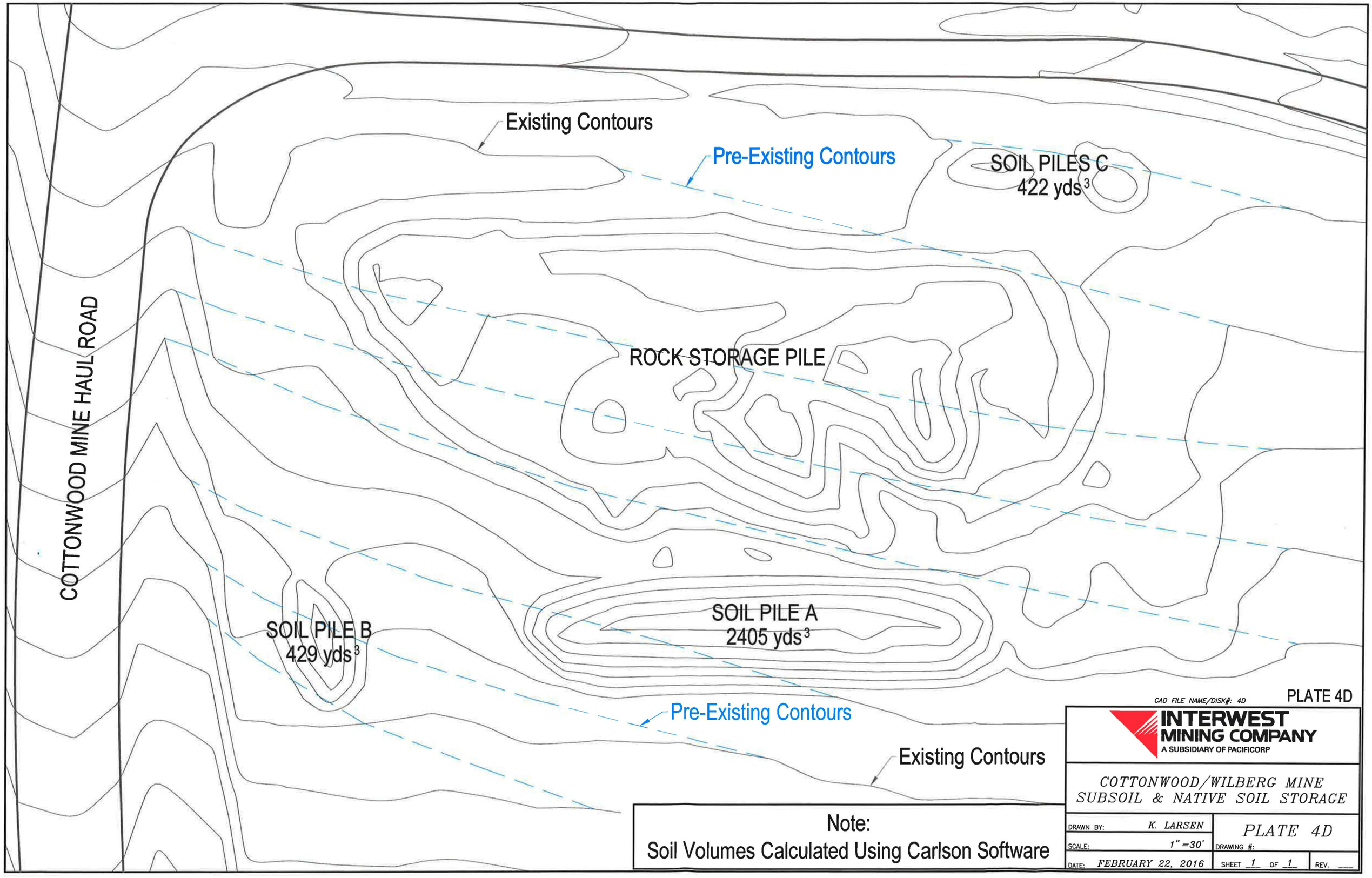
INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

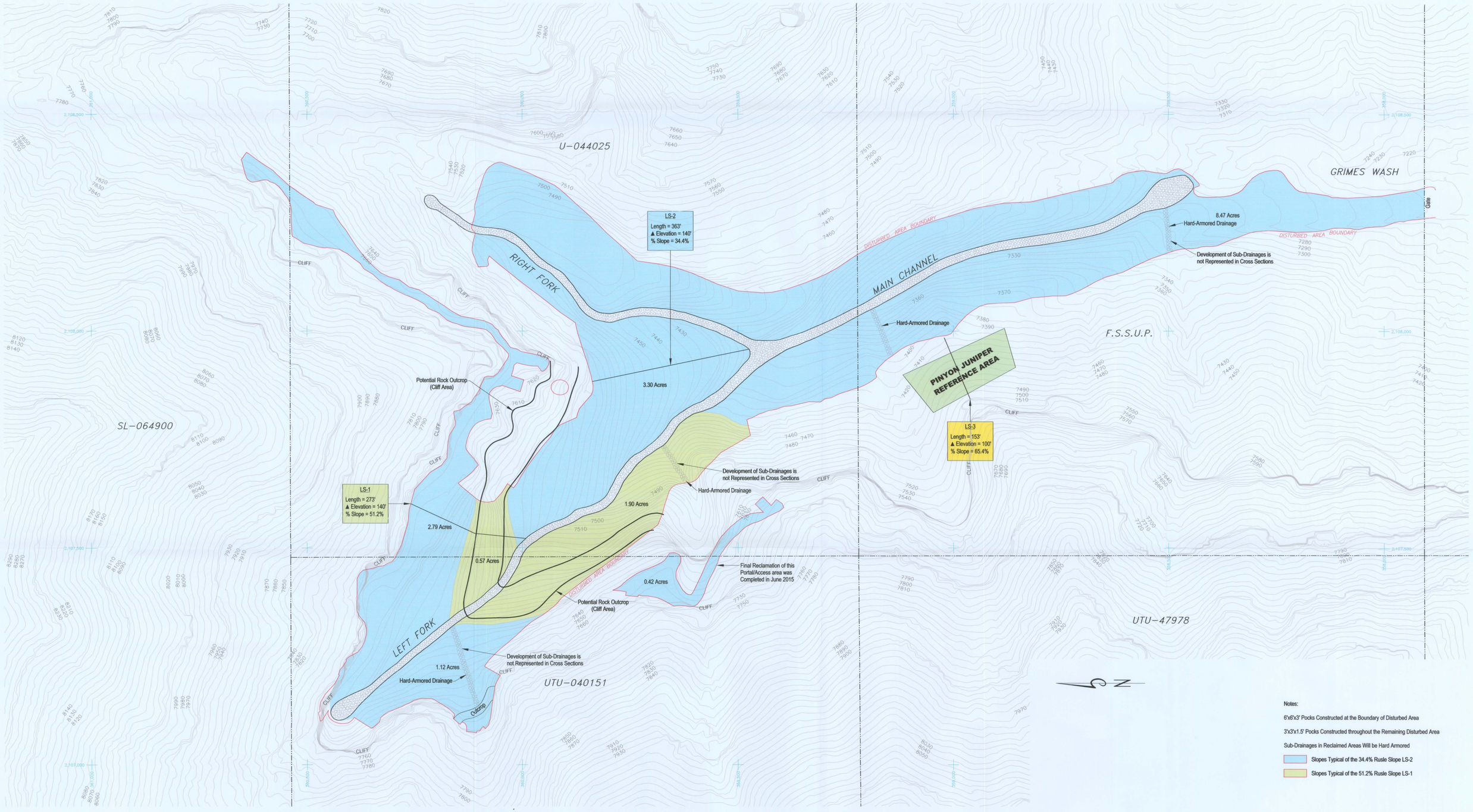
COTTONWOOD/WILBERG MINE
DISTURBED MINE PLAN AREA
CROSS SECTIONS

DRAWN BY: K. LARSEN
SCALE: 1"=100'
DATE: JULY 24, 2015
DRAWING #: CM-10484-WB
SHEET 1 OF 2
REV. ___

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	

NOTE:
SEE CM-10378-WB SHEET 1 OF 2 FOR LOCATION OF CROSS SECTIONS


Existing Contours
Pre-Existing Contours
SOIL PILES C
422 yds3
COTTONWOOD MINE HAUL ROAD
ROCK STORAGE PILE
SOIL PILE A
2405 yds3
SOIL PILE B
429 yds3
Pre-Existing Contours
Existing Contours
Note:
Soil Volumes Calculated Using Carlson Software
CAD FILE NAME/DISK#: 4D
PLATE 4D
INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP
COTTONWOOD/WILBERG MINE
SUBSOIL & NATIVE SOIL STORAGE
DRAWN BY: K. LARSEN
SCALE: 1"=30'
DATE: FEBRUARY 22, 2016
PLATE 4D
DRAWING #:
SHEET 1 OF 1
REV.



Notes:

6'x6'x3' Pocks Constructed at the Boundary of Disturbed Area

3'x3'x1.5' Pocks Constructed throughout the Remaining Disturbed Area

Sub-Drainages in Reclaimed Areas Will be Hard Armored

Slopes Typical of the 34.4% Rusle Slope LS-2

Slopes Typical of the 51.2% Rusle Slope LS-1

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.
7/2015	ADDED RUSLE LENGTH SLOPES FOR SOIL LOSS CALCS	DCO	

DRAWN BY: K.J.L. & D.C.O.
SCALE: 1"=100'
DATE: FEBRUARY 12, 2016
DRAWING #: .....
SHEET 1 OF 1
REV. ___

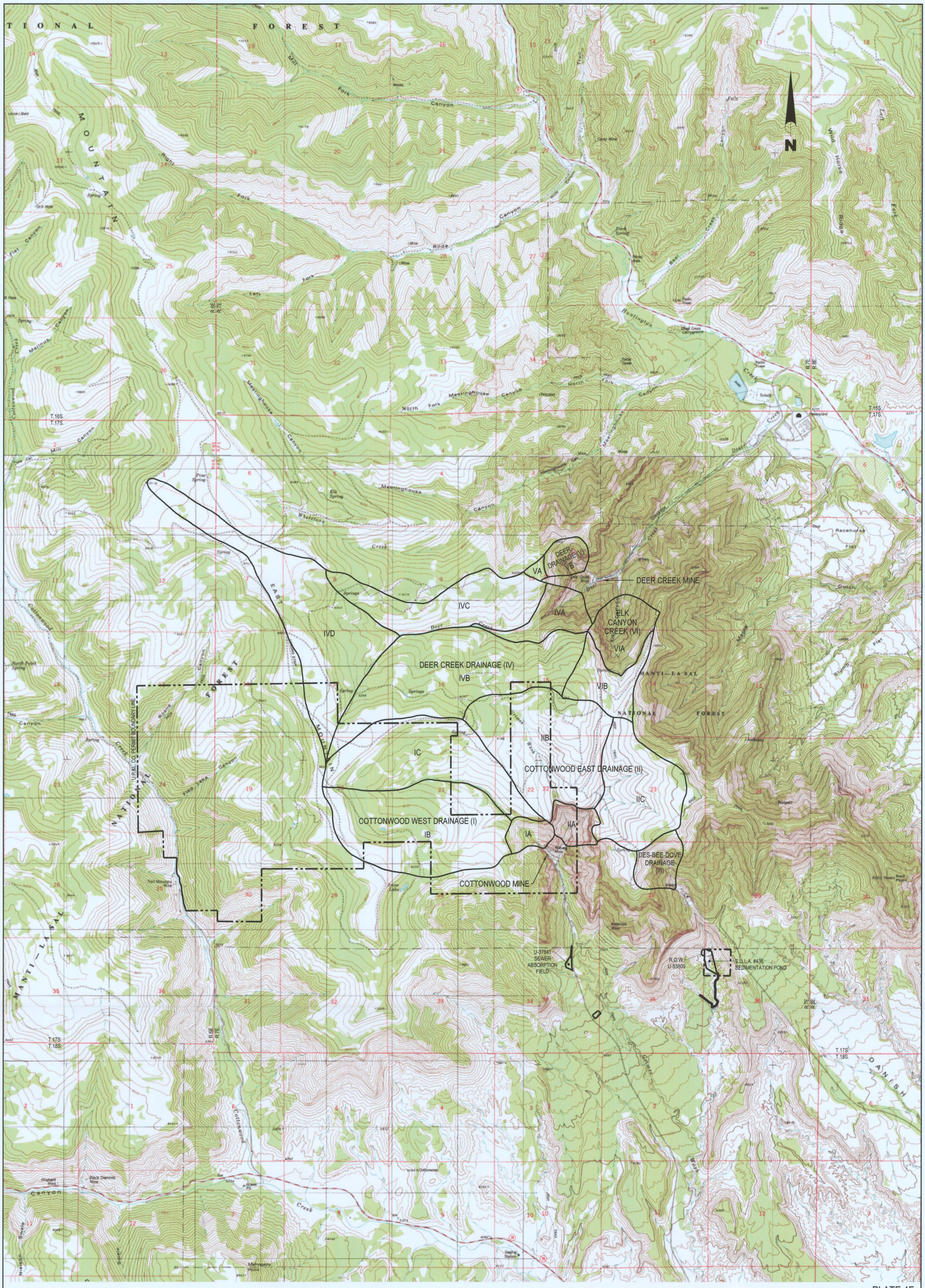


PLATE 4F

CAD FILE NAME/DISK#: PLATE 4F

INTERWEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

EAST MOUNTAIN PROPERTY
DEER CREEK & COTTONWOOD MINES
HYDROLOGIC AREA DRAINAGE MAP

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	

DRAWN BY: K. LARSEN
SCALE: 1" =2000'
DATE: FEBRUARY 25, 2016
DRAWING #: CM-10529-EM
SHEET 1 OF 1
REV.