subsidence cracks to prevent downward migration of water and subsequent loss of springs and other water sources.

4.17.4 Mitigation of Subsidence Effects

The only structures that may be effected by subsidence are the natural gas pipeline which crosses the coal lease area and roads within the area.

Should the natural gas pipeline be damaged despite the planned subsidence prevention measures, the Permittee will arrange for its repair with the owner of the pipeline.

Any improved roads that are materially effected by subsidence will be repaired, regraded and resurfaced to restore them to their pre-subsidence usefulness and condition.

Hydrologic information for the past four years at the Skyline Mine indicates that there is a reasonably good correlation between the amount of mine water discharged and the amount of coal mined (see Figure 4.11.4-A). Our mine water is being produced from the Blackhawk Formation. Data from our approved water monitoring program indicates that our mine dewatering is not affecting any surface springs or seeps. Our experience is showing that the migration of water through the aquifer is extremely slow to the extent that the water should be considered "perched or trapped water."

At this point in time it is difficult to suggest any mitigation of impacts or reclamation on renewable resources that are impacted by undermining, since we can only assume those impacts and their effect. Mitigation measures will be contingent upon the findings of the subsidence monitoring program. As data is collected, methods of mitigation will be formulated. This will be done in coordination with appropriate regulatory agencies. Since subsidence may continue to occur after final mining, the monitoring program will continue until it is determined by the permitee in cooperation with the regulatory agency that it is no longer needed.

4.17.5 Subsidence Monitoring Program

The Permittee has chosen to establish a subsidence monitoring program using aerial photogrammetrics patterned after a program developed by the Manti-LaSal National Forest to determine the effects of underground coal mining on surface renewable resources and surface improvements. The monitoring program shall secure adequate baseline data prior to any subsidence to quantify the existing surface renewable resources and surface improvements on and immediately adjacent to the permit area. The baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison. The monitoring program will also establish a system to locate, measure, and quantify the progressive and final affect of underground mining activities on the surface renewable resources and surface improvements. The system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the permitted area. The continuum of data shall incorporate and be an extension of the baseline data.

A network of control monuments consistent with the desired photogrammetric map accuracy will be established over both the permit area and the immediate adjacent areas not expected to be disturbed by subsidence. The monuments will be constructed as survey control points for monitoring the effects of subsidence on surface renewable resources and surface improvements. The monuments will be located and tied to a state plane coordinate system which is the same for both the surface and mine control surveys. This will allow the surface survey to be superimposed over the subsurface mine workings. The monuments will have the X, Y, and Z coordinates accurately measured and established by ground survey methods.

The initial aerial photography will cover the entire permit area and will be either color or black and white, flown at a scale such that elevations to within one foot vertically and horizontally (±0.5') can be attained by photogrammetric methods. It is anticipated that the nominal or mean scale will be 1:6,000 for a 6" focal length camera, unless aerial constraints such as safety dictate flying at a high altitude, but will not exceed 1:7,200. This photography will be used for constructing the initial baseline surface map. It will also provide the master base to assist in documenting changes caused by subsidence.

To aid in the collection of additional base data on surface renewable resources, color infrared aerial photography (CIR) of the permit area may be utilized. If this technique is used, the photographs will be of the same scale as the other aerial photography.

Subsequent annual black and white or color photography for subsidence monitoring will cover the area mined and the area to be mined in the next 18 months (plus angle of draw). Subsequent CIR photography for monitoring surface resource trends will be flown as needed.

On all aerial photography for both the baseline data and subsequent flights, a photographic overlap of 30 percent between adjacent flight lines and an average of 60 percent overlap of photographs along the same flight line will be obtained. The baseline data will be digitized to show the undisturbed pre-subsided ground elevations and will use a grid with a nominal mean grid scale of 200 x 200 feet. The subsequent flights for subsidence will also be digitized using the same grid scale as the baseline to show the elevational deviation from the baseline elevations. The digitized information will be submitted annually to the regulatory agency after subsidence commences.

An on-the-ground visual inspection will be made annually of the ground surface of subsidence areas (including angle of draw).

This inspection will attempt to locate, photograph, and document the presence of subsidence effects to surface improvements, tension cracks, fissures and other surface effects.

The subsidence monitoring data could be used to determine: 1) the critical width across the pressure arch; 2) the draw angle; 3) the ratio of observed subsidence to predicted maximum subsidence (S/Smax); 4) the relationship between mining and onset of subsidence and the correspondence between the face advance and subsidence profile development; and 5) the bulking factor.

4.17.6 Subsidence Control

The Permittee plans to conduct the underground mining operations so as to prevent subsidence from causing material effect to the surface and to maintain the value and reasonable forseeable use of that surface in accordance with the preceeding subsidence control plan.

4.17.7 Public Notice

Since the surface ownership of the areas of planned subsidence is vested in the United States and is under the authority of the U.S. Forest Service, the annual subsidence monitoring report will be provided to them and to the regulatory authority.

Power transmission lines for underground mining and related activities in the permit area were designed and constructed to comply with the guidelines set forth in "Environmental Criteria for Electric Transmission System" (USDI, USDA (1970)). Power distribution was designed and constructed in accordance with REA Bulletin 61-10 "Powerline Contacts by Eagles and Other Large Birds".

If necessary, a wire fence will be erected and maintained around the perimeter of the portal area or portions thereof to protect grazing stock and wildlife. The fence design will be submitted to the regulatory authority prior to construction. Other ventilation shafts and structures will be similarly fenced, covered or otherwise protected if required. While the ponds contain no toxic-forming materials, the Permittee agrees to exclude wildlife from such ponds should it become necessary. No persistent pesticides will be used unless approved by the regulatory authority as part of a reclamation management plan.

The Permittee also agrees to participate in the prevention, supression, and control of forest, range, and coal fires, even though these fires may not be part of an approved management plan. The Permittee on occasion conducts a conservation training program for mine employees. This program conducted by personnel of the Utah Division of Wildlife Resources has been included as part of the routine mine training schedule.

Additional information on wildlife can be found in this document in Section 2.9 - TERRESTRIAL WILDLIFE and Section 2.10 - RAPTORS.

Power transmission lines for underground mining and related activities in the permit area were designed and constructed to comply with the guidelines set forth in "Environmental Criteria for Electric Transmission System" (USDI, USDA (1970)). Power distribution was designed and constructed in accordance with REA Bulletin 61-10 "Powerline Contacts by Eagles and Other Large Birds".

If necessary, a wire fence will be erected and maintained around the perimeter of the portal area or portions thereof to protect grazing stock and wildlife. The fence design will be submitted to the regulatory authority prior to construction. Other ventilation shafts and structures will be similarly fenced, covered or otherwise protected if required. While the ponds contain no toxic-forming materials, the Permittee agrees to exclude wildlife from such ponds should it become necessary. No persistent pesticides will be used unless approved by the regulatory authority as part of a reclamation management plan.

The Permittee also agrees to participate in the prevention, suppression, and control of forest, range, and coal fires, even though these fires may not be part of an approved management plan. The Permittee on occasion conducts a conservation training program for mine employees. This program conducted by personnel of the Utah Division of Wildlife Resources has been included as part of the routine mine training schedule.

Additional information on wildlife can be found in this document in Section 2.9 - TERRESTRIAL WILDLIFE and Section 2.10 - RAPTORS.

* The South Fork Breakout is located in an Elk Calving area. Construction of the face up area should be done after calving season. The road across the tributary to South Fork is a fishery, and is a contributing stream for aquatic insect drift to the fishery in Eccles Creek. Construction operations will be done in a manner to minimize disturbances and influences on the stream.

REPLACES	TEXT
Section 4.18.2 Page 4-84	Section 4.18.2 Page 4-84 Date 10/15/88

* Denotes change or addition

Power transmission lines for underground mining and related activities in the permit area were designed and constructed to comply with the guidelines set forth in "Environmental Criteria for Electric Transmission System" (USDI, USDA (1970)). Power distribution was designed and constructed in accordance with REA Bulletin 61-10 "Powerline Contacts by Eagles and Other Large Birds".

If necessary, a wire fence will be erected and maintained around the perimeter of the portal area or portions thereof to protect grazing stock and wildlife. The fence design will be submitted to the regulatory authority prior to construction. Other ventilation shafts and structures will be similarly fenced, covered or otherwise protected if required. While the ponds contain no toxic-forming materials, the Permittee agrees to exclude wildlife from such ponds should it become necessary. No persistent pesticides will be used unless approved by the regulatory authority as part of a reclamation management plan.

The Permittee also agrees to participate in the prevention, suppression, and control of forest, range, and coal fires, even though these fires may not be part of an approved management plan. The Permittee on occasion conducts a conservation training program for mine employees. This program conducted by personnel of the Utah Division of Wildlife Resources has been included as part of the routine mine training schedule.

Additional information on wildlife can be found in this document in Section 2.9 - TERRESTRIAL WILDLIFE and Section 2.10 - RAPTORS.

The South Fork Breakout is located in an Elk Calving area. Construction of the face up area should be done after calving * season. The tributary to South Fork is a contributing stream for aquatic insect drift to the fishery in Eccles Creek. Construction operations will be done in a manner to minimize disturbances and influences on the stream.

4.19 STREAM DIVERSIONS

The objective of the stream channelization and runoff diversion channelization program has been to minimize impacts to the surface water quality of the Skyline project area. Stream diversions and channelizations were undertaken pursuant to an approved Army Corps of Engineers 404 Permit, and with the approval of the regulatory authority and of the Division of Wildlife Resources. No additional diversions of Eccles Creek are planned until final reclamation, at which time the streams in the portal area will be returned to the surface.

4.19.1 Mine Site Stream Diversion

The confluence area of the three tributaries of Eccles Creek form a crowsfoot drainage pattern at the mine site. One tributary extends in a northerly direction, the second in a northwesterly direction and the third southwesterly. To ensure that the water quality of these streams was not degradated as a result of mine facilities operation and construction, the stream flow was diverted into CMP culverts located under the mine benches (See Map 3.2.1-1). The culverts are designed to safely pass the peak runoff of a 100 year, 24-hour precipitation event. The combined drainage area for these streams is approximately 801 acres. The precipitation from a 100 year, 24-hour rainstorm is expected to be about 3.70 inches. After infiltration losses, surface runoff will be approximately 0.031 inches based on the assumption that the overland flow from the majority of the watershed is essentially non-existent. The resulting peak runoff flow would be about 4.0 cfs. See Vaughn Hansen, May, 1980 report update in Appendix Volume A-1. The proposed culverts are designed such that during the winter months, adequate through-put spacing remains sufficient even if ice accummulates inside the culverts.

The culverts for use in the northern tributary are 48 inches in diameter and approximately 600 feet in length to a point of connection with a 72-inch diameter culvert. The northwest tributary culvert is 48-inches in diameter and approximately 736 feet long. This culvert connects into a 60-inch diameter culvert. The culvert for the southwest tributary is 48 inches in diameter and approximately 846 feet long, and also connects into the 60-inch culvert. The 60-inch culvert originates at the confluence of these two 48-inch culverts and continues for approximately 526 feet to the confluence with the north 48-inch culvert. From this point a 72-inch culvert extends for approximately 1,058 feet to a point beyond the portal area.

The inlet for each culvert was constructed of concrete with a trash rack installed to prevent drift material from plugging the culverts. Riprap was used at each inlet structure to minimize erosion. A rock structure was constructed immediately downstream of the outlet structure.

4.19.2 Mine Site Diversion Channels

Mine site diversion channels were designed and constructed around the perimeter of the disturbed area to prevent overland flow from reaching the sedimentation pond. These channels were designed to carry the peak flow resulting from a 100 year, 24-hour precipitation event. The precipitation from a 100 year, 24-hour rainstorm is expected to be approximately 3.7 inches. After infiltration losses, surface runoff is anticipated to be approximately 0.031 inches.

The channels were placed beyond the mine site facilities, as shown on Map 3.2.1-1. The channels are triangular or trapezoidal in shape. The triangular-shaped channels have 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. The triangular-shaped channels have a minimum depth of 3 feet and a top width of 9 feet. In addition, a minimum of 1 foot of freeboard will be maintained. The channels are riprapped or have CMP drop structures as needed to help reduce erosion. Trapezoidal-shaped channels have 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. Each trapezoidal-shaped channel has a minimum depth of 2 feet, a bottom width of 3 feet and a top width of 8 feet.

4.19.4 Coal Storage Diversion Channel

The coal storage diversion channel was designed and constructed to carry the peak runoff from a 10 year, 24-hour precipitation event. The peak runoff flow is expected to be approximately 35 cfs. The channel is located just south of the coal storage facility.

The triangular-shaped channel has a 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. A minimum depth of 1.5 feet and a maximum top width of 9 feet was constructed.

When the coal storage facility is no longer required, the channel will remain until the area has been stabilized. With the completion of revegetation and stabilization activities, the channel will be backfilled, topsoiled and revegetated.

4.19.5 Reclamation of Diversions and Channels - Portal Area

Reclamation after cessation of mining will be directed towards providing the needs of the macroinvertebrates since this area is not directly used by the fish of Eccles Canyon. Reclamation will include removal or burial of the culverts, replacing the stream into channels providing optimal substrates for macroinvertebrate production (rubble/gravel with diameters from 1/2 to 12 inches), revegetation of riparian zones, restoring riffle:pool ratios to approximately 3:1, installing trash catchers, and riprapping stream banks and channels where required for channel stability.

* The design of the reclaimed channels is shown in Map 4.4.2-1A and 4.4.2-1B and is generally described herein. The final design, with engineering documentation, is included in the Engineering Calculation section of Appendix Volume A-3.

The recently installed on-site NOAA weather station enables collection of precipitation data on a 15 minute basis. To

! REPLACES	!! TEXT !
! Section 4.19.5 Page 4-88	!!Section 4.19.5 Page 4-88 Date 7/15/87!

* Denotes change or addition

4.19.4 Coal Storage Diversion Channel

The coal storage diversion channel was designed and constructed to carry the peak runoff from a 10 year, 24-hour precipitation event. The peak runoff flow is expected to be approximately 35 cfs. The channel is located just south of the coal storage facility.

The triangular-shaped channel has a 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. A minimum depth of 1.5 feet and a maximum top width of 9 feet was constructed.

When the coal storage facility is no longer required, the channel will remain until the area has been stabilized. With the completion of revegetation and stabilization activities, the channel will be backfilled, topsoiled and revegetated.

4.19.5 Reclamation of Diversions and Channels - Portal Area

Reclamation after cessation of mining will be directed towards providing the needs of the macroinvertebrates since this area is not directly used by the fish of Eccles Canyon. Reclamation will include removal or burial of the culverts, replacing the stream into channels providing optimal substrates for macroinvertebrate production (rubble/gravel with diameters from 1/2 to 12 inches), revegetation of riparian zones, restoring riffle:pool ratios to approximately 3:1, installing trash catchers, and riprapping stream banks and channels where required for channel stability.
* The natural stream channels above the disturbed area contain a good natural supply of high quality macro-invertebrates. The stream channel stabilizaation work should provide an excellent environment for the natural drift of upstream macro-invetrebrates to become fully established in.

REPLACES	TEXT
Section 4.19 Page 4-88	Section 4.19 Page 4-88 Date 10/15/88

* Denotes change or addition

The design of the reclaimed channels is shown in Map 4.4.2-1A and 4.4.2-1B and is generally described herein. The final design, with engineering documentation, is included in the Engineering Calculation section of Appendix Volume A-3.

The recently installed on-site NOAA weather station enables collection of precipitation data on a 15 minute basis. To

* backfilling measure. The UDOT culvert in the southwest fork will be uncovered at the permit boundary and the stream will enter the open channel. The open channel will again enter a UDOT culvert going under SR 264 at the permit boundary at the east end of the disturbed area. Any culvert left in place will have a minimum of four feet of cover backfill over it.

The natural stream channels above the disturbed area contain a good natural supply of high quality macro-invertebrates. The stream channel stabilization work should provide an excellent environment for the natural drift of upstream macro-invertebrates.
* To assist in the adequacy review of the protal area channel reclamation effort, Maps 4.19.5-1 through 4.19.5-4 have been included, which show stream channel cross sections in the three forks above the disturbed area and in Eccles Creek below the disturbed area.

The design of the reclaimed channels is shown in Map 4.4.2-1A and 4.4.2-1B and is generally described herein. The final design, with engineering documentation, is included in the Engineering Calculation section of Volume 5.

The access roads to both well houses will be removed and will be reclaimed to UDOT specifications. At a minimum, this access road, pad and culvert will be removed, the stream channel reconstructed consistent with the existing channel, and the road slope to the creek will receive the same treatment as now exists above and below the pad.

The recently installed on-site NOAA weather station enables collection of precipitation data on a 15 minute basis. To

REPLACES	TEXT
Section 4.19 Page 4-88A	Section 4.19.5 Page 4-88A Date 5/9/89

* Denotes change or addition

complete determination of runoff coefficients, flood crest gauges will be installed in at least two of the stream culverts. Flow will be determined using pipe size and slope. Using the site specific runoff coefficients, the reclaimed stream channel will be appropriately sized and properly armored.

The North, Northwest and Southwest Forks and Eccles Creek below the forks will be built mostly on a slope between 2 percent and 4 percent with spaced drop areas where the slope varies from 10 percent to as high as 35 percent for short distances (Maps 4.4.2-1A and 4.4.2-1B).

In areas of steep slopes the channel will be rip-rapped with large rocks varying from one foot to three feet in diameter. Cobbles and coarse gravel will be placed among the boulders. The bottoms of the steep slopes will be protected by extending the large rock cover 50 to 100 feet beyond the place where the slope flattens out again.

The stream channel on the flatter slopes (2 percent to 4 percent) will be covered with coarse gravel (1-3 inches diameter) and rubble (up to one foot in diameter). The bottom of the channel will be shaped so that the depth of flow will approach six inches even during very small flows. Channels will be about 10 feet wide and 2 feet deep.

yes it should how are you going to do it?

Riparian vegetation should be plentiful along the stream and along any cut slopes near the stream.

4.19.6 Reclamation of Diversions and Channels - Loadout Area

The diverted section of Eccles Creek will be left in place after mining operations are complete, since restoration to the original channel would only cause unnecessary disturbance. The culvert into the loadout area will not be removed.

The diversion channels will be handled the same as those at the portal area.

complete determination of runoff coefficients, flood crest gauges will be installed in at least two of the stream culverts. Flow will be determined using pipe size and slope. Using the site specific runoff coefficients, the reclaimed stream channel will be appropriately sized and properly armored.

The North, Northwest and Southwest Forks and Eccles Creek below the forks will be built mostly on a slope between 2 percent and 4 percent with spaced drop areas where the slope varies from 10 percent to as high as 35 percent for short distances (Maps 4.4.2-1A and 4.4.2-1B).

In areas of steep slopes the channel will be rip-rapped with large rocks varying from one foot to three feet in diameter. Cobbles and coarse gravel will be placed among the boulders. The bottoms of the steep slopes will be protected by extending the large rock cover 50 to 100 feet beyond the place where the slope flattens out again.

The stream channel on the flatter slopes (2 percent to 4 percent) will be covered with coarse gravel (1-3 inches diameter) and rubble (up to one foot in diameter). The bottom of the channel will be shaped so that the depth of flow will approach six inches even during very small flows. Channels will be about 10 feet wide and 2 feet deep.

Riparian vegetation should be plentiful along the stream and along any cut slopes near the stream.

4.19.6 Reclamation of Diversions and Channels - Loadout Area

The diverted section of Eccles Creek will be left in place after mining operations are complete, since restoration to the original channel would only cause unnecessary disturbance. The culverts into the loadout area will not be removed since these culverts are replacements for those in place prior to construction.

4.19.7 Diversion Channel at Rock Disposal Site

A diversion channel has been installed as shown on Map 4.16.1-1B. The swale to redirect the drainage across the access road and into the original stream channel will be constructed of concrete as shown in Figure 4.19.7-1.

The swale outlet will be lined with 4 inch x 4 inch or larger rock to reduce exit velocity of water from the swale. Engineering calculations for the waste disposal site channel design are included in Appendix Volume A-3.

4.19.7 Diversion Channel at Rock Disposal Site

A diversion channel has been installed as shown on Map 4.16.1-1B. The swale to redirect the drainage across the access road and into the original stream channel will be constructed of concrete as shown in Figure 4.19.7-1.

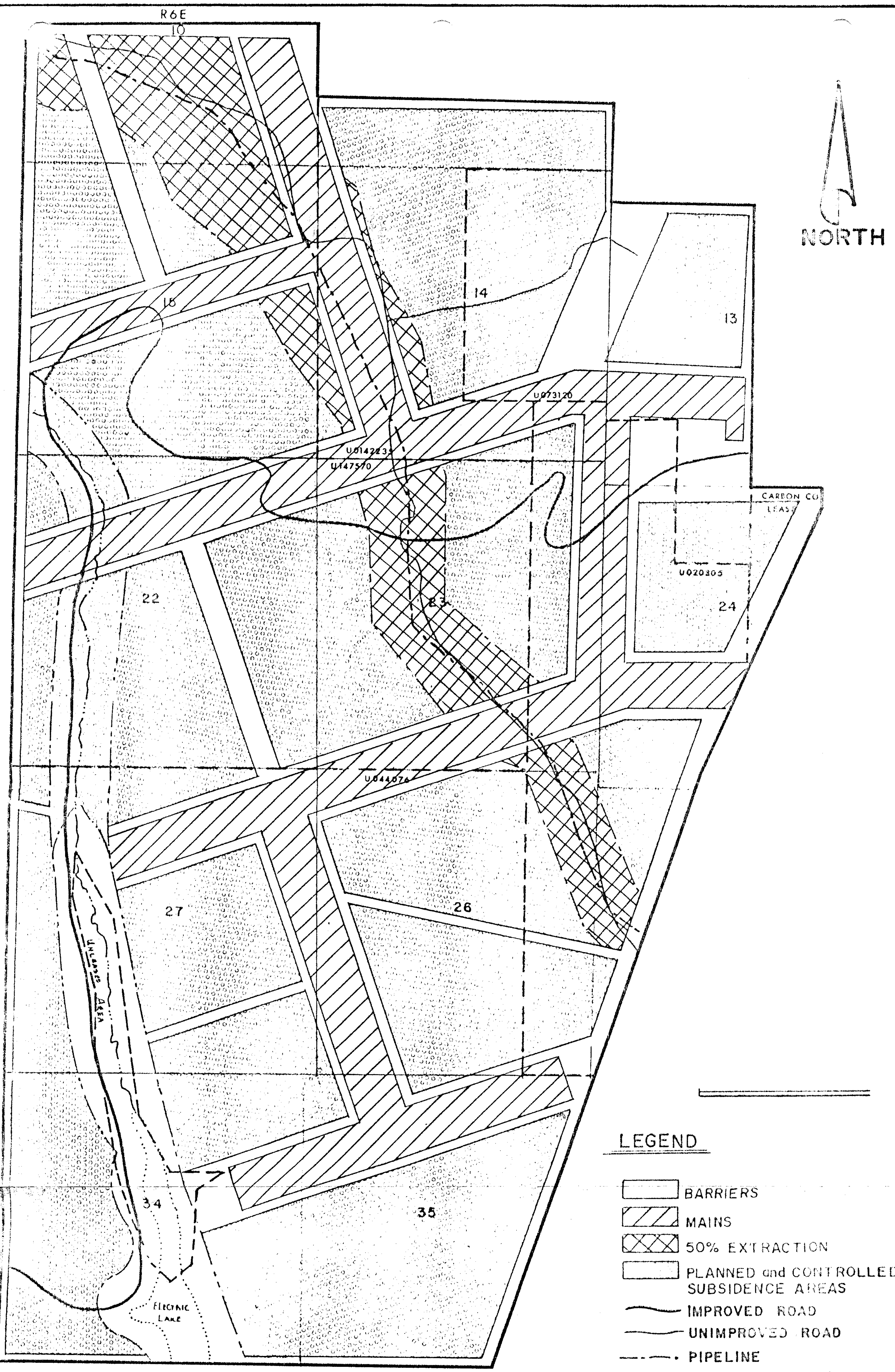
The swale outlet will be lined with 4 inch x 4 inch or larger rock to reduce exit velocity of water from the swale. Engineering calculations for the waste disposal site channel design are included in Appendix Volume A-3.

* 4.19.8 South Fork Breakout

A new road will be constructed which will cross a drainage way to the South Fork of Eccles Creek. This drainage way flows in all but extremely dry years. When the creek crossing is constructed, the top soil will be removed with a track hoe to help minimize disturbance to the channel itself. The culvert will be placed in the existing channel, and then the road fill placed over it.

During reclamation, the fill material will be removed and then the culvert lifted out of the channel. Top soil will then be placed back on the disturbed area with a track hoe and the area reseeded. Although no permanent disturbance to the channel is planned or expected, if it should occur it will be rip-rapped with a gradation of material from 4" to a maximum size of 38".

All culverts used for access to the area will be completely removed from the area during final reclamation.



UTAH FUEL CO.

EXTENT OF PLANNED & CONTROLLED SUBSIDENCE AREAS

DESIGNED BY: C HILTON	DATE: 6-30-86	DWG. NO. 4.17.1-1
DRAWN BY: M. BEHLING	SCALE	

Mine Access Road

The mine access road is classified as a Class I road and runs from the mine #3 portal to the maintenance complex area. Drawings 3.2.4-1 and 3.2.6-2A show a typical cross section of the mine access road and related ditches. Since the length of the road is approximately 1,200 feet, no road culverts were installed. As shown in the design, the steepest portion of the access road is a 10.0% grade sustained for 250 feet. No other grades on the access road exceeds 10.0%. There are no switchbacks on the access road. None of the access road cut exceeds 1h:1v in unconsolidated material and .025h:1v in rock. The access road is be 20 feet wide with a 4 foot height berm at the shoulder. The road is flat with a drainage ditch against the highwall. The drainage ditch has been designed to safely pass the peak from a 10 year, 24 hour precipitation event. No trash racks and debris basins have been installed, as the ditch will be cleaned periodically. The road is surfaced with crushed gravel. Once mining is completed, the road will be topsoiled and terraces will be constructed to prevent soil erosion

Water Tank Access Road

Access to the water tank area is via Utah State Highway SR-264.

4.20.2 Overland Conveyor Belt

The location of the upper two thirds of the conveyor is on a bench on the north slope of Eccles Canyon, while the lower one third will be supported by towers and trusses. The steepest portion of the conveyor is a negative 26.33 percent grade sustained for 430 feet. The average negative grade of the conveyor route is 9.39 percent and the average positive grade is 8.37 percent. Cut slopes along the route do not exceed 1h:1v in unconsolidated materials and 1h:4v in rock. As part of the air quality control program, the belt and transfer points will be enclosed to reduce fugitive dust.

Mine Access Road

The mine access road is classified as a Class I road and runs from the Mine #3 portal to the maintenance complex area. Drawings 3.2.4-1 and 3.2.6-2A show a typical cross section of the mine access road and related ditches. Since the length of the road is approximately 1,200 feet, no road culverts were installed. As shown in the design, the steepest portion of the access road is a 10.0% grade sustained for 250 feet. No other grades on the access road exceeds 10.0%. There are no switchbacks on the access road. None of the access road cut exceeds 1h:1v in unconsolidated material and .025h:1v in rock. The access road is be 20 feet wide with a 4 foot height berm at the shoulder. The road is flat with a drainage ditch against the highwall. The drainage ditch has been designed to safely pass the peak from a 10 year, 24 hour precipitation event. No trash racks and debris basins have been installed, as the ditch will be cleaned periodically. The road is surfaced with crushed gravel. Once mining is completed, the road will be topsoiled and terraces will be constructed to prevent soil erosion

Water Tank Access Road

Access to the water tank area is via Utah State Highway SR-264.

Breakout Area Access Road

The road which was constructed to obtain access to the breakout area in the South Fork of Eccles Creek will be reopened during final reclamation. After the face up area has been reclaimed, the new temporary access road will be returned to the approximate original contour and seeded with the approved seed mixture.

The access road up the side canyon will be reopened to accomplish final reclamation work at the breakout area. After reclamation work is completed at the breakout area, the road will be ripped, water barred and seeded with the approved seed mixture. All culverts used in the project will be removed from the area.

4.20.2 Overland Conveyor Belt

The location of the upper two thirds of the conveyor is on a bench on the north slope of Eccles Canyon, while the lower one third will be supported by towers and trusses. The steepest portion of the conveyor is a negative 26.33 percent grade sustained for 430 feet. The average negative grade of the conveyor route is 9.39 percent and the average positive grade is 8.37 percent. Cut slopes along the route do not exceed 1h:1v in unconsolidated materials and 1h:4v in rock. As part of the air quality control program, the belt and transfer points will be enclosed to reduce fugitive dust.

4.20.3 Railroad System

The grade of the railroad does not exceed 3 percent Cut slopes do not exceed 1h:1v in unconsolidated materials and 0.1h:4v in rock. Vegetation was cleared only to the width necessary to accommodate the track ballast and associated ditch construction.

The Denver and Rio Grande Western Railroad Company designed the rail haulage system and ensure that no refuse coal, acid producing or toxic material will be used in the rail ballast which will contaminate surface drainage. The rail haulage system was designed to maintain the water quality of runoff from the facilities in Pleasant Valley Creek. The Permittee supplied a detailed informational plan for construction and reclamation of the rail spur to the regulatory authority.

4.20.4 Loadout Access Road

The loadout access road is classified as a Class I road and runs from the truck dump area to the silo area. Drawing 4.4.2-1D shows a typical cross section of the access road. To prevent water from entering a disturbed area, a 30 inch CMP was installed half way down. As shown in Drawing 4.7.2-2, the as-built grade of the road is 7.03 percent. There are no switchbacks on the access road. None of the access road cuts exceed 1h:1v in unconsolidated material and 0.25h:1v in rock. The access road is 20 feet wide with a 4 foot high berm at the shoulder. The road is slightly tilted toward the berm so that water will stay on the disturbed area. No trash racks and debris basins have been installed as the road is periodically regraded. The road is surfaced with crushed gravel. Once mining is completed, the road will be topsoiled and terraces will be constructed to prevent soil erosion.

4.20.3 Railroad System

The grade of the railroad does not exceed 3 percent Cut slopes do not exceed 1h:1v in unconsolidated materials and 0.1h:4v in rock. Vegetation was cleared only to the width necessary to accommodate the track ballast and associated ditch construction.

The Denver and Rio Grande Western Railroad Company designed the rail haulage system and ensure that no refuse coal, acid producing or toxic material will be used in the rail ballast which will contaminate surface drainage. The rail haulage system was designed to maintain the water quality of runoff from the facilities in Pleasant Valley Creek.

*

4.20.4 Loadout Access Road

The loadout access road is classified as a Class I road and runs from the truck dump area to the silo area. Drawing 4.4.2-1D shows a typical cross section of the access road. To prevent water from entering a disturbed area, a 30 inch CMP was installed half way down. As shown in Drawing 4.7.2-2, the as-built grade of the road is 7.03 percent. There are no switchbacks on the access road. None of the access road cuts exceed 1h:1v in unconsolidated material and 0.25h:1v in rock. The access road is 20 feet wide with a 4 foot high berm at the shoulder. The road is slightly tilted toward the berm so that water will stay on the disturbed area. No trash racks and debris basins have been installed as the road is periodically regraded. The road is surfaced with crushed gravel. Once mining is completed, the road will be topsoiled and terraces will be constructed to prevent soil erosion.

INDEX

PART 5: CROSS REFERENCES

RECOVERY OF THE CUTTHROAT TROUT (*Salmo clarki*) FISHERY IN ECCLES CREEK, UTAH FROM COAL MINING IMPACTS

Walter K. Donaldson
Fisheries Manager
Utah Division of Wildlife Resources

Larry B. Dalton
Resource Analyst
Utah Division of Wildlife Resources

INTRODUCTION

Development and extraction of coal reserves can seriously jeopardize aquatic resources. A recent example involved the wild cutthroat trout fishery in Eccles Creek, Utah. Most of Utah's current coal production is occurring in the Wasatch Plateau and Book Cliffs bituminous fields located in Carbon and Emery counties (Wahlquist, 1981). The state produced approximately 13,141,000 tons of coal from 23 underground mines during 1985 (Utah Industrial Commission, Per. Comm.). Coal produced from these two fields is desirable in terms of high energy rating and low residuals of ash and sulphur. As a result, development of Utah's coal reserves is expected to continue.

STUDY AREA

Eccles Creek is located between the 8,640 and 7,880 foot elevations on the Wasatch Plateau in northwest Carbon County, Utah (Figure 1). It is a second order stream to Mud Creek, which flows into Scofield Reservoir (Hynes, 1972). Perennial base flows during winter (1.7 cfs) are sufficient to support wild cutthroat trout in 2.5 miles of stream. The Utah Division of Wildlife Resources (UDWR) ranks Eccles Creek as a valuable trout stream. Angling pressure is minimal due to the stream's small size, so its fishery value lies in production of wild cutthroat trout. Through the downstream migration process, cutthroat fingerlings eventually enter Scofield Reservoir from Eccles Creek and other similar tributaries (Livesay, 1979). Over 12,000 of these cutthroat trout are harvested annually from Scofield Reservoir (Donaldson, 1986).

Recent coal development in Eccles Canyon involves two companies - Valley Camp of Utah, Inc. (Belina Mines) and Utah Fuel Company, a subsidiary of Coastal

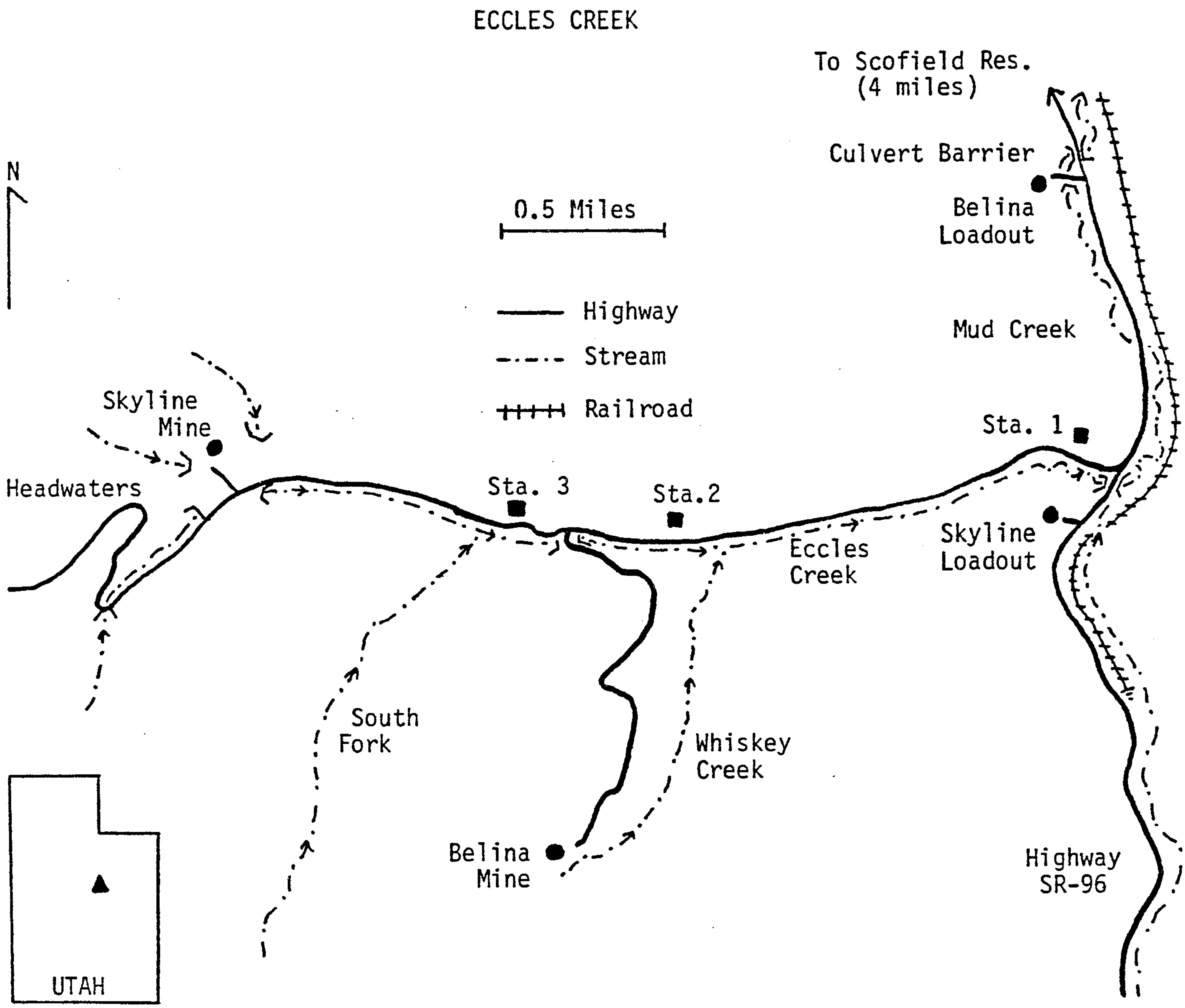


Figure 1. A map of the study area at Eccles Creek, Utah

States Energy Company (Skyline Mine). Road and mine facilities construction for the Belina Mines began in 1975. They are located at the head of Whiskey Creek, a small tributary entering Eccles Creek about 1.5 miles upstream from the Mud Creek confluence (Figure 1). Road and mine facilities construction for the Skyline Mine began in 1980. It is located on Eccles Creek about 2.75 miles upstream from the Mud Creek confluence. The Skyline Mine project included construction of a conveyor bench that paralleled the road from the mine to the mouth of Eccles Canyon, where a large coal loadout facility for railroad transport was constructed.

STUDY OBJECTIVES

Historical data, as collected by UDWR in 1971, identified a somewhat pristine trout fishery in Eccles Creek. As modern-day coal development began to degrade Eccles Creek drainage, UDWR initiated annual monitoring of the fishery. The purpose of this paper is threefold: 1) Identify degrading impacts to the fishery as they related to coal development; 2) Document mitigation and recovery measures as they partially restored the stream habitat; and 3) Monitor responses of the cutthroat trout fishery during both the degradation and restoration phases.

METHODS

Cutthroat trout were sampled from Eccles Creek using a battery operated backpack shocker. Sampling occurred annually during the first week in August between 1979-1986 . Representative samples were collected at three preselected stations (Figure 1):

Station 1. Located 0.3 miles above the Mud Creek confluence--length equals 0.1 mile.

Station 2. Located 1.3 miles above the Mud Creek confluence at Whiskey Creek--length equals 0.1 mile.

Station 3. Located 2.0 miles above the Mud Creek confluence below South Fork--length equals 0.25 miles (station length reduced to 0.1 miles in 1984).

The two-catch method (Zippon, 1958) was used to obtain population and standing crop estimates for each station. These data were combined to give an overall estimate for the entire 2.5 miles of inhabitable stream. All fish sampled were measured and weighed to obtain a physical condition index (^{K}tl), and to determine the age structure of the population (Lagler, 1959). Also, habitat conditions as they related to perturbations within the drainage were noted.

RESULTS

A. Impacts

The most degrading impact to Eccles Creek was the increased sediment loading into the system. Most sedimentation occurred during the coal development phase between 1975-1983. The primary sediment source was road and conveyor bench construction within the canyon. Secondary sources were mine facilities development and maintenance, and chronic mudslides. Peak impact years to the fishery from accumulative sediment deposition occurred between 1981-1983.

Road construction in Eccles Canyon occurred in two phases. The first was construction of 2.75 miles of road from the canyon mouth to the Belina Mines during 1975 and 1976. The second phase was the rebuilding of the entire highway by the Utah Department of Transportation (UDOT) (4.5 miles) from the Mud Creek confluence to the top of the Eccles Creek drainage between 1980-1984. Generally, widening of the narrow canyon floor through blasting and the use of earth moving equipment, translocating the stream to accommodate the new highway, and culvert placement for road crossings produced elevations in sediment loading. Destruction of riparian zone segments was common during all phases of highway construction. Most of the highway remained unsurfaced between 1975-1983 allowing movement of silt from its surface during precipitation events.

Surface disturbances during construction of both mine facilities created raw soil areas which allowed silt movement into the stream. In 1980, 4,200 feet of Eccles Creek headwaters were culverted to transport an uninhabited stream segment underground of the Skyline Mine area. Underground translocation allowed above ground facilities construction, and prevented a future of chronic surface disturbances. Through 1985, inadequate sizing of a settling pond at the Belina Mines passed sediments down into Whiskey Creek.

Major mudslides occurred near the Belina Mines highway turn off (1.75 miles upstream from the confluence) in 1977, 1978, and 1984. These slides resulted from soil instability created by construction of the Belina Mines access road, which is on a steep north exposed hillside. These mudslides inundated Eccles Creek with unconsolidated materials.

Much work has been done to demonstrate the negative impacts of sediment deposition on salmonids, particularly anadromous species in the logging areas of the Pacific northwest. Platts and Martin (1980) quoted numerous studies that correlated sediment increases into streams with new construction of logging roads. They also summarized studies documenting an increase in egg and fry mortality of salmon as silt and sand deposition increased. Shepard et. al. (1984) found that increased levels of fine sediments in spawning streams for bull trout reduced overall natural recruitment. Raleigh and Duff (1980), while summarizing trout habitat needs, stated that stream siltation is the major factor for loss of critical winter cover needed by juvenile trout. In addition, localized reduction of food (macroinvertebrates) for trout is expected as riffle areas are impacted with silt.

B. Mitigation/Recovery

Prior to 1980, most mitigation efforts were associated with the Belina Mines, and involved highway and mudslide debris being mechanically cleaned from the stream. Also, some temporary silt traps constructed of straw bales were utilized to reduce surface movement of sediment. After 1980, the Skyline Mine in concert with UDOT consolidated the stream channel and relocated it away from their loadout facilities and the newly constructed highway. Log and boulder structures were placed to create pool habitat after channel translocation. An intensive monitoring program of macroinvertebrates was undertaken to document changes in their populations relative to stream modifications (Winget, 1983). Most of the lower canyon highway had been asphalted and associated raw areas were revegetating by late 1983. Thousands of willow shoots were transplanted between 1983-1985 to reestablish the riparian habitat damaged during road construction. A reduction in sediments was apparent by 1985 after the highway was finished and revegetation success was progressing.

Record snow falls occurred in the drainage in 1983 and 1984 exceeding 200% of normal. Spring runoff in those years was beneficial by flushing large amounts of unconsolidated sediment downstream leaving a cleaner substrate. Unfortunately it destroyed all log structures built in 1981, and impacted existing riparian vegetation by eroding both stream banks. Saturated soils contributed to another mudslide at the Belina Mines highway turn-off in April, 1984. The Belina Mines, with technical assistance from UDWR, rechannelized 450 feet of stream away from the toe of the slide to safeguard Eccles Creek. This rechannelization was considered necessary to avoid future impacts from this chronic mudslide site.

As fish populations decreased from the impacts, UDWR initiated plans to stimulate natural reproduction by reestablishing access of spring-run cutthroat trout spawners from Scofield Reservoir. Very few reservoir spawners had accessed Eccles Creek during past years due to a 6 foot vertical migration barrier on Mud Creek. This barrier was located at a highway culvert about one mile downstream from the Eccles Creek confluence. Starting in 1981, both the Belina Mines and the Skyline Mine and with assistance from UDWR periodically placed boulders in a series of steps downstream from the culvert to develop a fish ladder. Energy dissipaters were also placed on the culvert's concrete apron to create resting pools during fish passage. This barrier was eliminated in 1984.

C. Response of Cutthroat Trout

Eccles Creek, prior to coal development, sustained a resident population of wild cutthroat trout. Population estimates during 1971 for the entire stream were 1,272 fish with a corresponding standing crop of 111.9 pounds (Figure 2). Physical condition of the fish (^{K}tl) was considered very good at 1.22. The population structure was composed mainly of juvenile trout; Age 1+ (53%) and Age 2+ (42%) (Figures 3 and 4). Adult trout (Age 3+ or over) comprised only 4% of the population. This dominance by juveniles was typical of other small headwater streams in the area with limited base flows.

The cutthroat fishery first began to decline in the 1.75 mile stream length below the Belina Mines highway turn-off after 1975. By 1979, the population and standing crop of trout had declined by 60% and 52%, respectively. The composition of surviving trout shifted towards older fish (Age 3+ or older), from 4% to 18%. The gradual decrease in juvenile trout abundance suggested poor survival of trout eggs and emerging fry in the spawning redds.

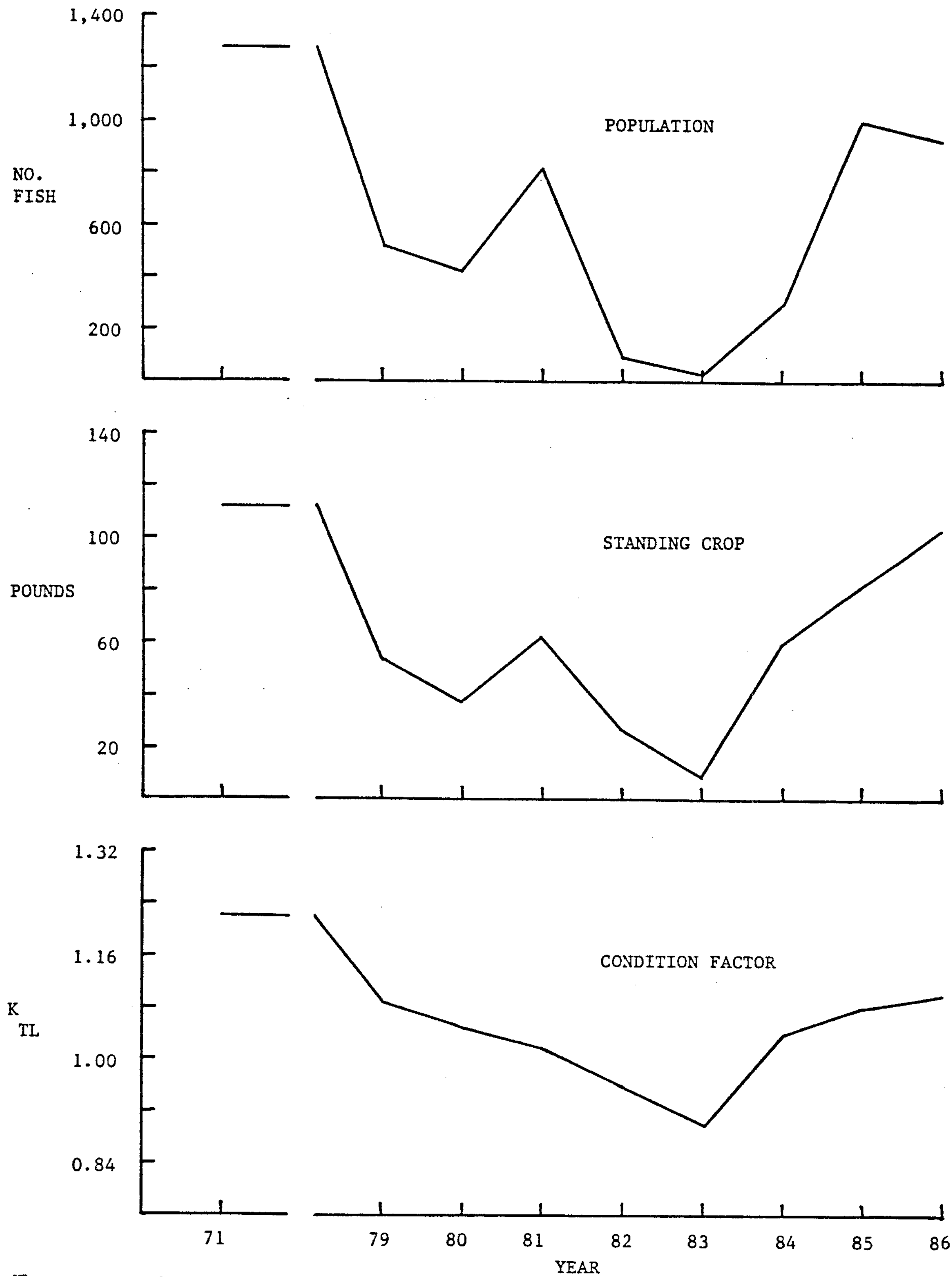


Figure 2. Estimates of the population, standing crop, and condition factor for cutthroat trout in Eccles Creek, Utah between 1971-1986.

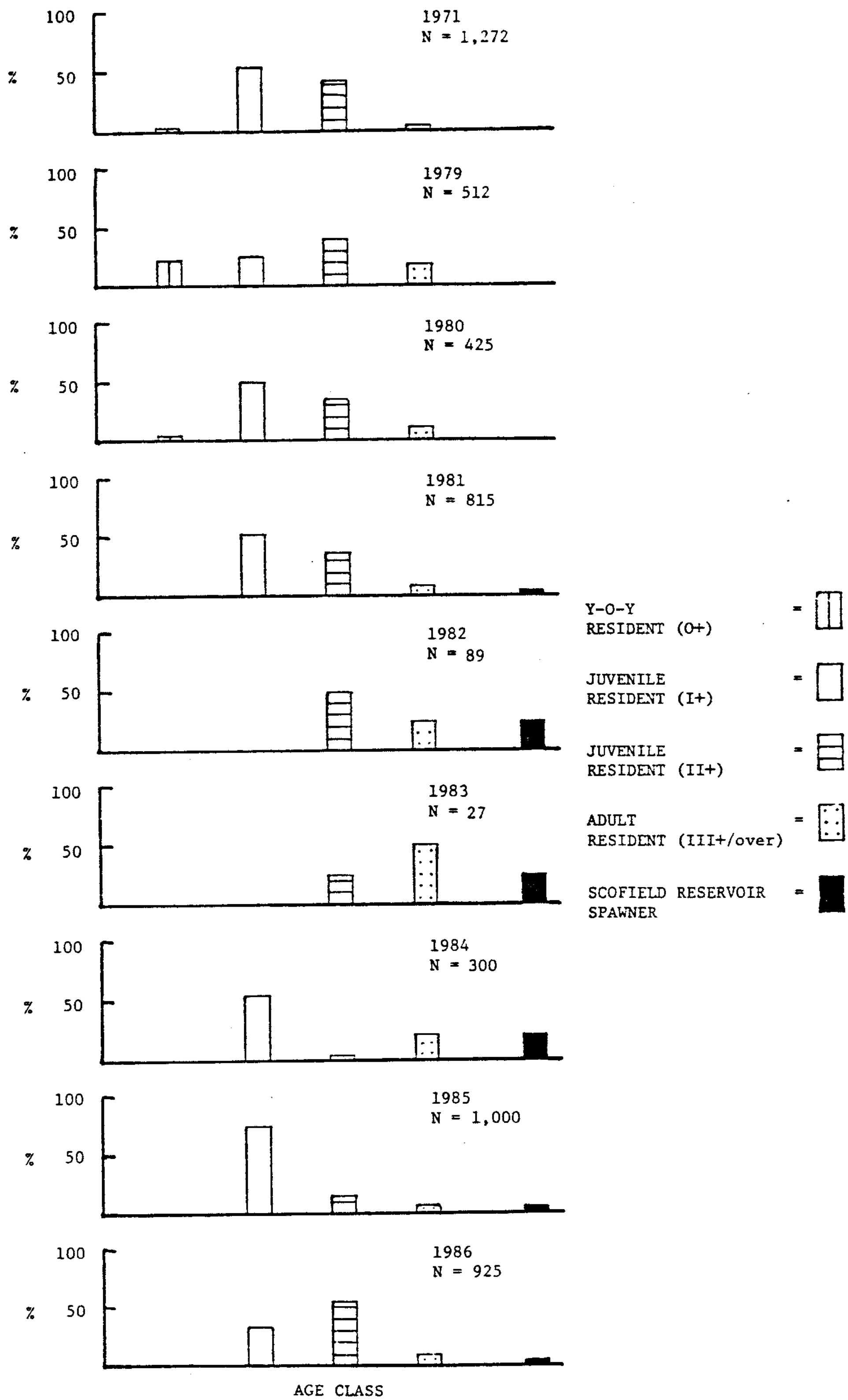


Figure 3. Relative age class structure of cutthroat trout in Eccles Creek, Utah between 1971-1986.

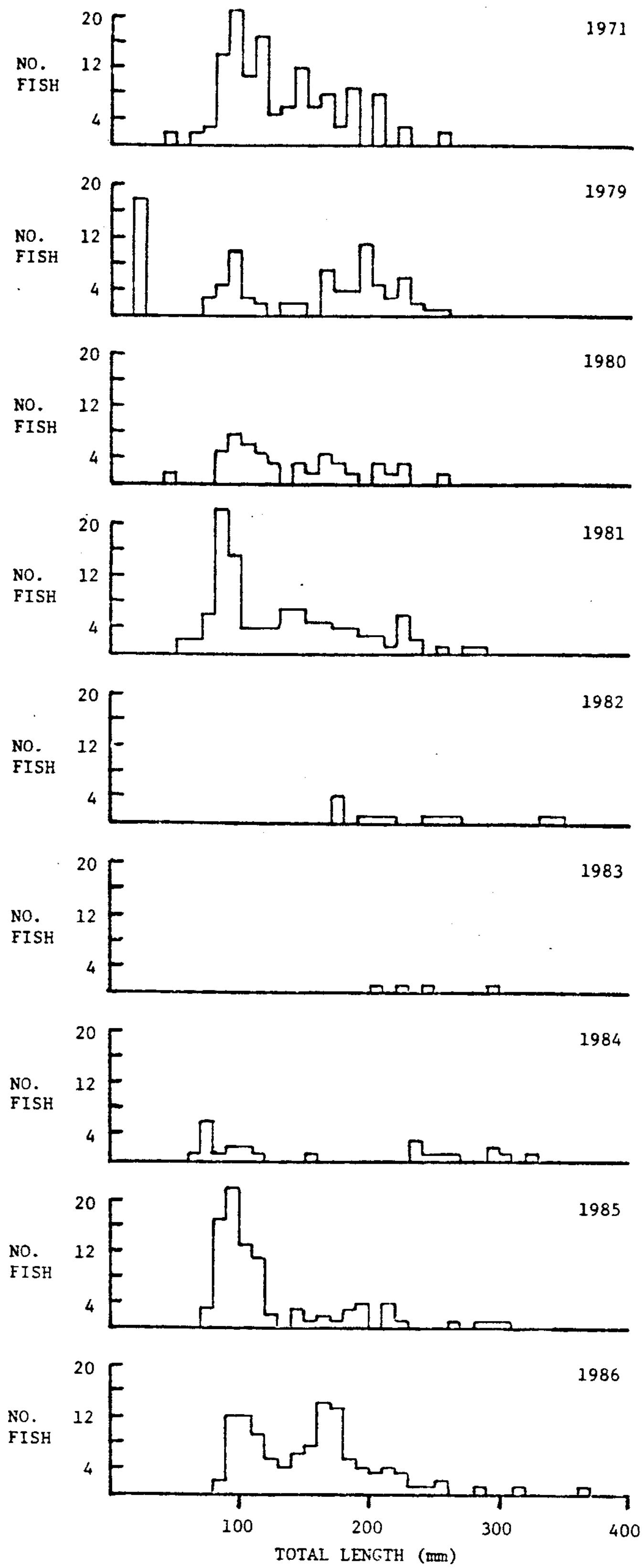


Figure 4. A comparison of length-frequency for cutthroat trout in Eccles Creek, Utah between 1971-1986.

Initiation of construction for the Skyline Mine in 1980 caused sediment impacts to peak during 1981-1983. The fish population declined to its lowest level in 1983 with a total of 27 trout at a standing crop of 8 pounds (Figures 2-4). Compared to the 1971 data, the population and standing crop of trout had declined by 98% and 93%, respectively. Very little, if any, natural recruitment occurred in 1981 or 1982. Fine sediments had accumulated to 18 inches or more over the substrate, as observed by UDWR fisheries biologists. Spawning activity probably occurred, but most of the trout eggs apparently suffocated in the redds. By 1983 only Age 2+ juveniles and adults were present composing 25% and 75% of the trout population. The condition (^{K}tl) of the fish dropped from 1.22 in 1971 to 0.90 in 1983. The cutthroat trout fishery in Eccles Creek had been virtually eliminated in 8 years.

An anomaly occurred in 1981 when the fishery seemed to increase in numbers and standing crop (Figure 2). This increase is misleading, since massive channel changes and impacts occurred in the upper stream section between the Belina Mines highway turn-off and the Skyline Mine facility. Numerous beaver dams were eliminated in this section, forcing large numbers of fish into the reconstructed stream channel where there was little cover. Most fish moved downstream naturally in 1981, or were flushed out during the 1982 spring runoff. The 1982 population structure verifies this anomaly as no Age 1+ fish were sampled, indicating no spawning success in 1981 (Figure 3).

Major mitigation efforts were initiated in 1981 to restore Eccles Creek. However, substantial improvements in the fishery from mitigation were not detected until 1984. Increased abundance of Age 1+ juveniles in 1985 indicated spawning success had again occurred in 1984. Juvenile trout (Ages 1+ and 2+) in 1985 comprised 90% of the fishery, which is similar to the 95% observed in 1971 (Figures 3 and 4). The population and standing crop of trout were 1,000 fish weighing 77 pounds in 1985. The population and standing crop had increased significantly since 1983, respectively approaching 79% and 69% of pre-impact levels. The standing crop continued to increase in 1986, approaching 93% of pre-impact levels. The 1986 population density declined somewhat from 1985 indicating continued survival of juvenile fish to the older adult life stage. Fish condition (^{K}tl) increased to 1.10 in 1986 from 0.90 in 1983. This significant recovery of the cutthroat trout fishery in Eccles Creek, though not completely reaching pre-impact levels, occurred in three years (Figures 2-4).

Natural recruitment was accelerated by the abundance of reservoir spawning cutthroats that utilized the stream starting in 1982 (Figure 3). Their increased abundance was a direct result of barrier elimination downstream on Mud Creek. They comprised between 21-25% of the total population during 1982-1984. Spawners were protected from angler harvest during their spring run under proclamation law starting in 1985.

MANAGEMENT IMPLICATIONS (SUMMARY)

1. Coal development adjacent to high elevation trout streams can cause severe sediment deposition. In this case the major source of sediment loading in Eccles Creek originated from highway construction, along with

other mine related projects. Deposition of sediments reduced the available area for spawning cutthroat trout, inflicted increased mortality on incubating eggs and emerging fry, and destroyed cover needed by juvenile trout for overwinter survival. Cutthroat trout in Eccles Creek, at the cumulative peak of sediment impact, produced no spawning success or recruitment to the fishery. After eight years of continual sediment loading, the trout population had been reduced by 98% and its standing crop by 93%.

2. Planning for impact avoidance and mitigation should be initiated simultaneously with project planning of the coal mine. The mitigation/recovery plan must be comprehensive. During construction, day-to-day monitoring must be ongoing, and any problems identified must be corrected. Recovery efforts in Eccles Creek focused on surfacing of the canyon highway and revegetating raw soil areas that resulted from mine related construction. In addition, reestablishment of riparian habitat, and channeling or culverting the stream away from potential sediment sources were completed. These efforts to reduce sedimentation worked well in Eccles Creek. Once sedimentation began to decrease, the population and standing crop of trout increased to near pre-impact levels at 73% and 93% respectively. Also, the population structure was again dominated by juvenile trout (Ages 1+ and 2+) rather than adults.

3. Impacts to streams can be so severe they actually eliminate the fishery's reproductive potential. The Eccles Creek fishery may have dropped below its critical reproductive threshold by 1983 when an estimated 22 adult cutthroat trout existed in the entire 2.5 miles of stream. UDWR at this point implemented actions to remove a barrier to allow access for migrating trout spawners from the reservoir downstream. The protection of adult trout from angling harvest during the spawning run was also initiated. As a result, the percent composition of adult cutthroats did increase by 21-25% between 1982-1984.

4. Recovery efforts of the magnitude implemented in Eccles Creek require constant coordination and large amounts of time, money and manpower. Timing of mitigation responses is critical, since decisions must be made on the available data and under existing legal authority. Impact monitoring programs should be scheduled to last the duration of the coal development project. If possible, the species selected for monitoring should also be the main target of management efforts. Usually, this species is at the highest trophic level in the stream, as were cutthroat trout in Eccles Creek. Short term or intermittent monitoring using non-management species, or too small sampling effort may produce misleading or inconclusive results.

LITERATURE CITED

Donaldson, W. K. 1986. "Fishery Status of Trout in Scofield Reservoir, Utah during 1984." Utah Div. Wild. Res., SERO Fishery Files, Price, Utah; 32 p.

Hynes, H. B. N. 1972. "The Ecology of Running Waters." Univ. Toronto Press; pp. 12-20.

Lagler, K. F. 1959. "Freshwater Fishery Biology." W. C. Brown Co., Dubuque, Iowa; pp. 131-148.

Livesay, J. 1979. "Eccles Creek Fishery Report." Utah Div. Wild. Res., SERO Fishery Files, Price, UTah 5 p.

Platts. W. S. and s. B. Martin 1980. "Livestock Grazing and Logging Effects on Trout." Proc. Wild Trout II, Yellowstone Natl. Park; pp. 34-46.

Raleigh, R. F. and d. A. Duff 1980. "Trout Stream Habitat Improvement: Ecology and Hydrology." Proc. Wild Trout II, Yellowstone Natl. Park; pp. 67-77.

Shepard, B. B., S. A. Leathe, T. M. Weaver, and M. D. Enk 1984. "Monitoring levels of fine sediments within tributaries to Flathead Lake, and impacts of fine sediments on bull trout recruitment." Proc. Wild Trout III, Yellowstone Natl. Park; pp. 146-156.

Wahlquist, W. L. (Ed.) 1981. "Atlas of Utah." Brigham Young Univ. Press, Provo, Utah; pp. 207-210.

Winget, R. N. 1983. "Response of a Trout Stream to Habitat Modifications." TAFS- Bonneville Chapter Publ.; 9 p.

Zippon, C. 1958. "The Removal Method of Population Estimation." J. Wildlife Mgt. 22 (1); pp. 82-90.

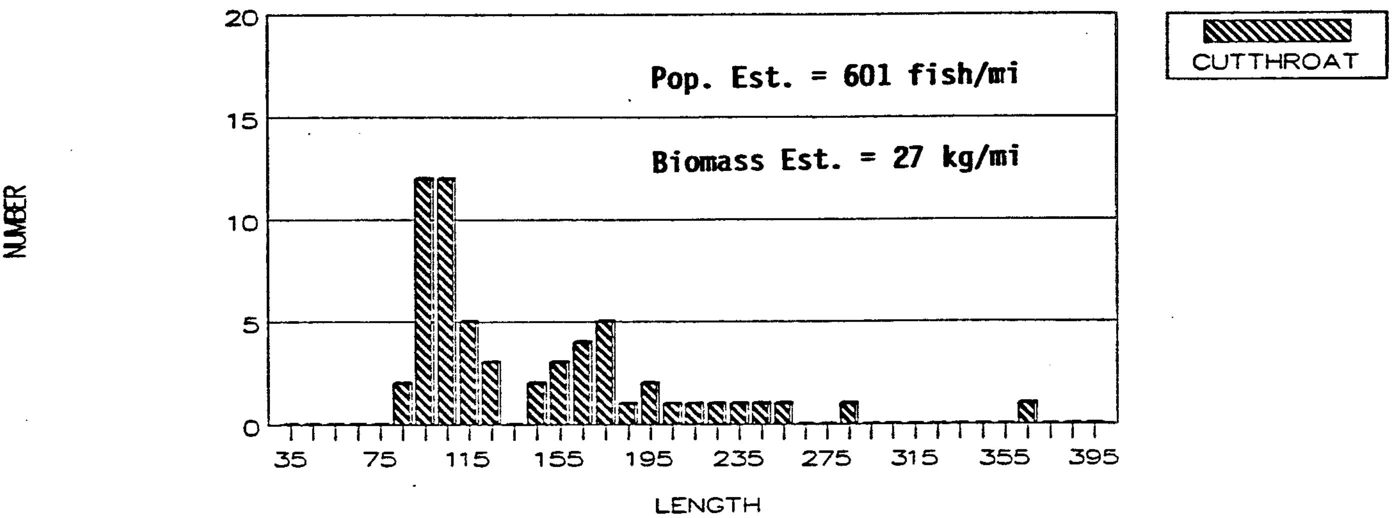
ACKNOWLEDGMENTS

The following groups participated directly in recovery efforts of Eccles Creek. Numerous personnel have been involved with this project over the past 11 years, so individual names will not be mentioned.

- Utah Fuel Company, a subsidiary of Coastal States Energy Company
- Valley Camp of Utah, Inc.
- Utah Department of Transportation
- U.S. Forest Service
- Southeastern Utah Association of Local Governments
- Carbon County Planning and Zoning
- Utah Department of Corrections (Adult Parole and Probation)
- Utah Department of Natural Resources (Divisions of Wildlife Resources; Oil, Gas & Mining; and Water Rights)

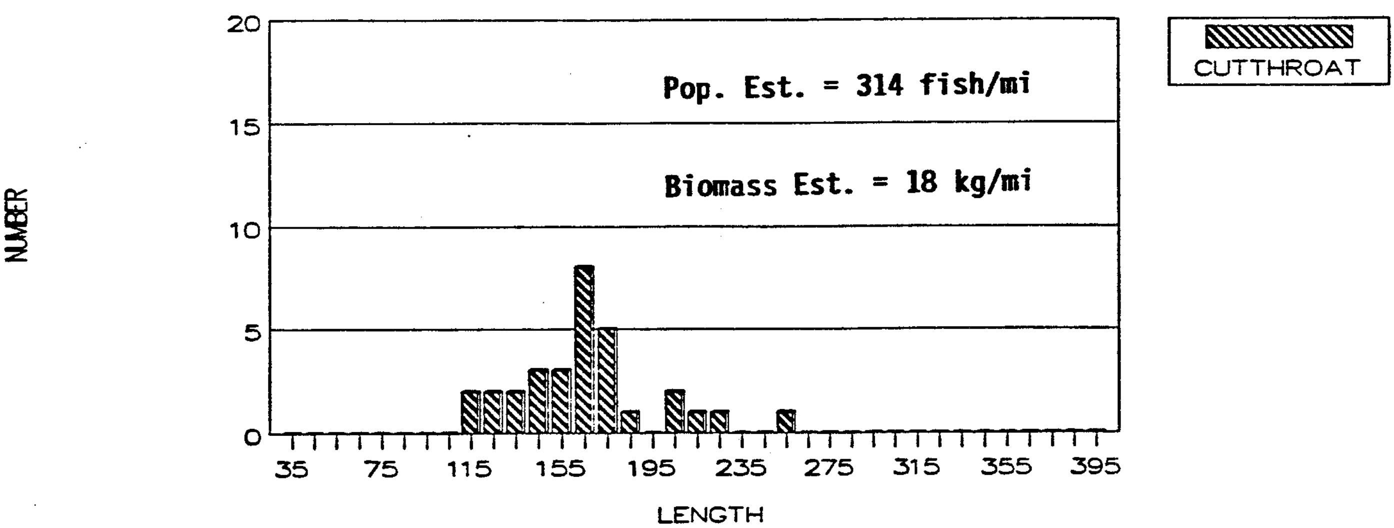
LENGTH–FREQUENCY GRAPH

ECCLES CREEK, STATION 1–3, 8/05/86



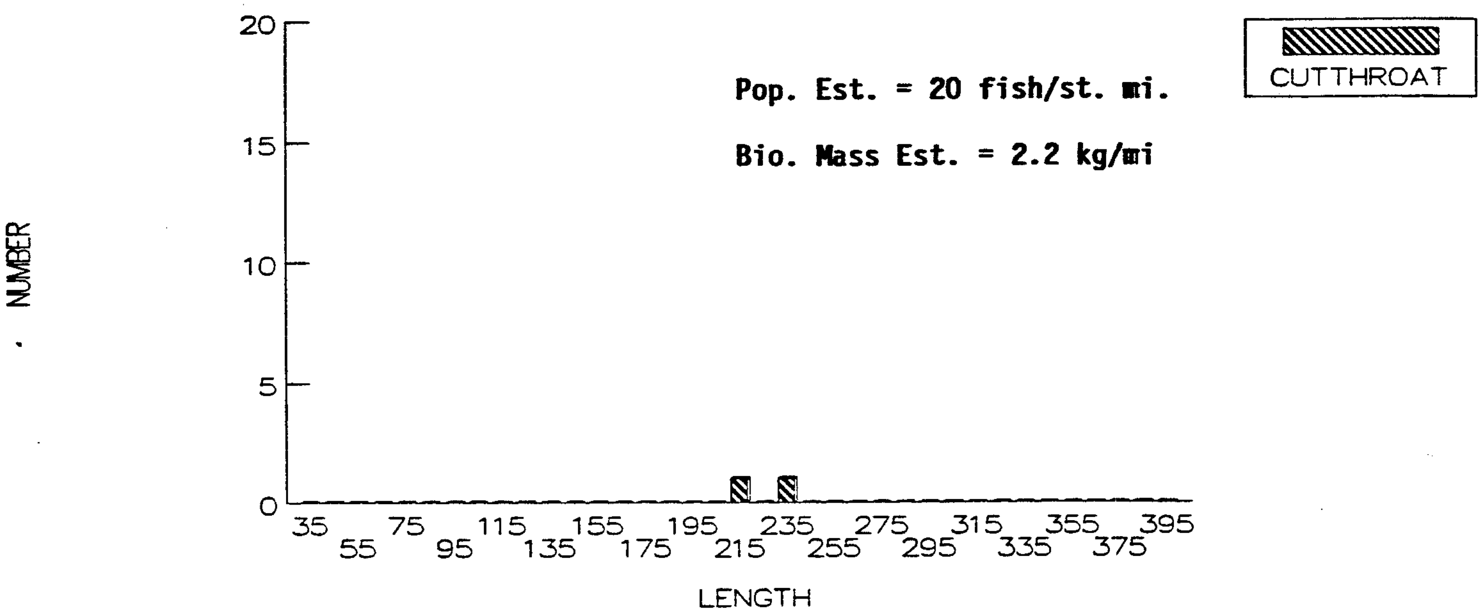
LENGTH–FREQUENCY GRAPH

ECCLES CREEK, STATION 1–1, 8/05/86



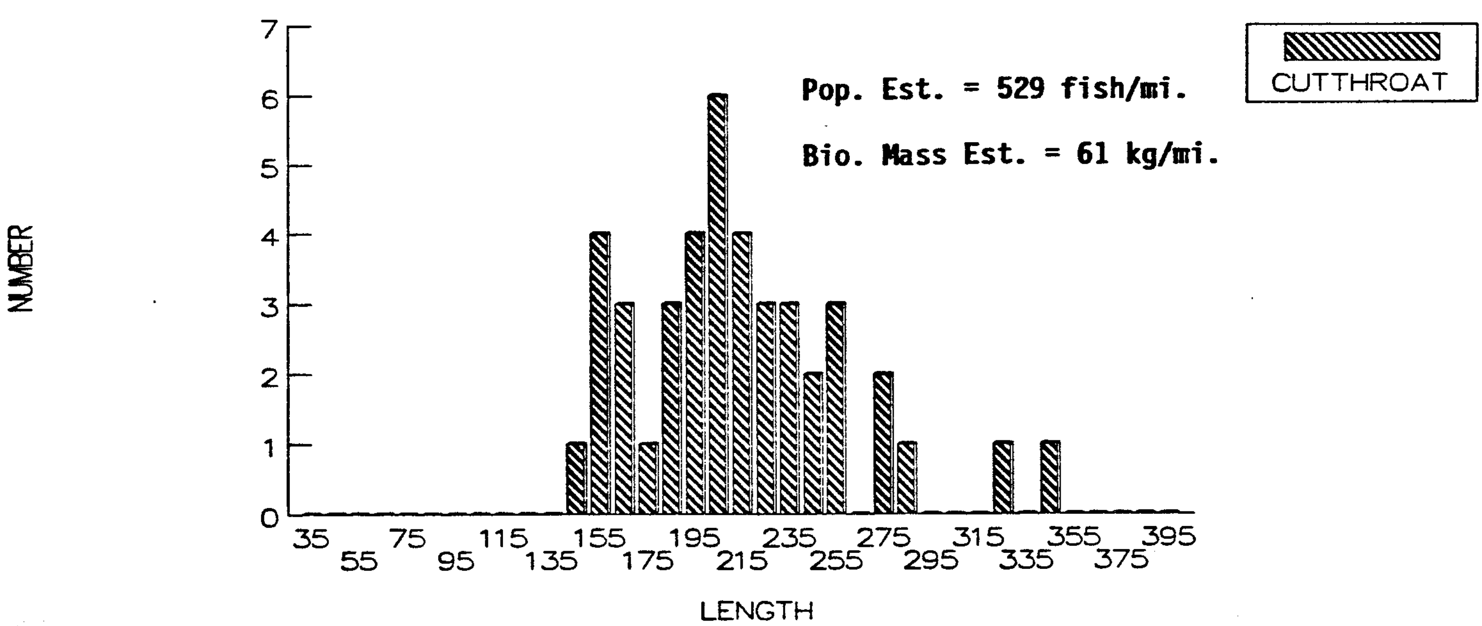
LENGTH–FREQUENCY GRAPH

ECCLES CREEK, STATION 1–3, 10/5/88



LENGTH–FREQUENCY GRAPH

ECCLES CREEK, STATION 1–1, 10/5/88



SKYLINE MINE / UTAH FUEL CO. REVEGETATION PLAN AND RECOMMENDATIONS. 8/19/88

SITUATION:

Cut slopes were made during conveyor belt pad and road construction. Slopes are generally very steep (50-120%). Soil material is coarse loamy C layers mixed with a high percent of gravel and rock. Most of the critical cuts are south exposure creating extremes in temperatures. The material is very low in organic matter. Active water erosion, sloughing, and dry ravel are occurring.

The company is bonded to obtain soil stabilization. It is required by law to revegetate. Several attempts have been completed in the past. This included hydromulch and seeding followed by jute netting. Conetainer plantings have been completed. There is poor to fair successes in these efforts, but most of the critical areas remain unstable. Attached is an approved plan and evaluation of results from 1981 to 1986 completed by Keith Zobel.

The company wants to initiate a long-term program of revegetation, rather than the past one-shot approaches.

The contact person is Keith Zobel, at the Skyline Mine Office.

CURRENT EXISTING VEGETATION:

There exists several areas, particularly on lower toe slopes and the conveyor bed itself, that have smooth brome, orchardgrass, intermediate wheatgrass, crested wheatgrass, rocky mountain penstemon, Kentucky bluegrass, sweetclover, western yarrow, and a variety of other herbaceus plants and weeds. Also many of the previouly planted shrubs are doing fair to good including blue elderberry, mountain big sagebrush, and woods rose.

Quaking aspen occurs infrequently on the cut slopes in small protected areas. Quaking aspen and snowberry with associated native understory plants exists above the cut areas. Some sprouting of quaking aspen has occurred in the cut areas on the uppermost parts of slopes.

Water is available for a drip irrigation system at the building complex area. This can be piped to the critical areas.

RECOMMENDATIONS-- EXISTING VEGETATION:

PRACTICE # 1 (See Maps): Fertilize most of the existing vegetaion on toe slopes, top of slope, and conveyor bed areas on treatments # 1, 2, 3, and 4. This would be done with hand applicator. If possible, work with aerial applicators to apply over entire area, as some vegetaion occurs throughout. Fertilizer will maximize growth with available moisture, increasing plant vigor, root growth, top growth, and ground cover. Increased size of existing vegetation will maximize micro-site areas for encroachment of new plants.

a. Apply 40-60 lbs/arce of Nitrogen in late fall or early spring (fall applied N. can leach out, but snow or other conditions could prevent spring application, a split application would be another alternative). Do this 2 years in a row. Evaluate results after 2nd year and determine if application can be reduced to one application every other year. Revise revegetation plan as needed to reflect evaluations.

fall, 1988 (spring, 1989 option)
fall, 1989 (spring, 1990 option)
evaluate summer of 1990, revise plan as needed.
fall, 1991 (spring, 1992 option)
fall, 1993 (spring, 1993 option)

EXPERIMENTAL TRIAL # 1 (See Map, treatment area #1): Set up an experimental fertilizer program for existing vegetation above cut-slopes (aspen zones).

aa. one area at 40-60 lbs./ac. of N in fall.
bb. Second area at twice this rate.
cc. Third area with about 60-80 lbs./ac. of a balanced fertilizer that will also provide high levels of phosphorus and sulfur such as 16-20 and/or a slow release starter fertilizer like 10-10-10.
dd. identify and leave a control area.
ee. Evaluate this after 1 year. Determine additional experimental design and/or continue another year with same rates. Evaluation should include understory (herbaceous) as a separate evaluation from overstory (aspen and shrubs).
ff. After third year, modify revegetation plan as determined from evalutions for remainder of areas above cut.

EXPERIMENTAL TRIAL # 2 (See map, treatment area #1): Aspen can sprout when cut. The trial would be to determine whether cutting some trees above the cut-slope (but close to edge) will stimulate sprouting in roots within the cut slope area.

a. Cut 20+ tree/shrubs of aspen above cut-slope at height of 20" +/- above ground. Paint cut top with flat latex paint. Late fall 1988 or early spring 1989 or both.

b. Evaluate late summer, 1989 and 1990. Revise revegetation plan as needed.

PRACTICE # 2, Drip irrigation of existing shrubs:

Many of the planted and established shrubs have low vigor and leader growth. There size has not increased significantly since planted. They are basically alive only.

Part of the planned drip irrigation system (see establishing new plants) should be used the first 2 years to improve these established plants. Liquid fertilizer applied through the drip system will be of tremendous help.

Spring and summer, 1989 and 1990:
1st half treatment # 1.
Spring and summer, 1991 and 1992:
2nd half treatment # 1.
Spring and summer, 1993 and 1994:
Treatment # 2.
Spring and summer, 1995 and 1996:
Treatment # 3

ESTABLISHING NEW VEGETATION:

More established shrubs would provide small micro-enviroments (shade, less extreme temperatures, organic matter and nutrient recycling) creating a medium for establishing herbaceous and woody species.

The Company's decision is to plant conetainer shrubs in small "safe" spots. Clumps or copses of plants are preferred to grid system. Thes safe spots would be small areas that are flatter slopes, protected by large rocks or existing vegetation, more soil, etc. Small safe spots can be developed with hand labor while planting also. Planting the entire area on a grid pattern in one year is high risk, exxpensive and usually results in high failure rates.

The maps indicate 4 treatment areas: treatments 1-3 are on south exposures, and # 4 on a north exposure. An additional area is indicated as an experimental study area. Plant material trials will be initiated here.

Revegetation will begin on treatment area 1 in 1989. The study area will be seeded in the fall of 1988. Evaluation of study area and treatment # 1 will result in revision of revegetation plan as needed to continue with treatment of area #1 and begin with area #2. Preliminary evaluation could result in treatment #2 beginning as soon as spring 1991.

PRACTICE # 3, SHRUB PLANTING IN treatment areas # 1-4:

1. Plant every other year in treatment area # 1-3 until adequate protection is achieved. Small numbers of container plants will be planted in selected "safe" spots, in connection with drip irrigation system. In each of the interim years, plant new plants for those that die. Also plant additional "safe" areas. Assuming a survival rate

between 33-50%, the target goal of the number of shrubs needed to obtain a 20% cover should be reached in 5-7 years.

a. Area and number of shrubs:

Treatment #1, 1st half: 1.3 ac.

Spring, 1989, with drip system-- 700 shrubs.

Spring, 1990, replace dead plants in above areas, add a few additional plants in other safe areas-- 700 shrubs.

Spring, 1991-1993. Plant 100-200 shrubs/year as needed to reach target cover of 20%.

Treatment #1, 2nd half: 1.3 ac.

Spring, 1991, with drip system-- 700 shrubs.

Spring, 1992, replace dead plants in above areas, add a few additional plants in other safe areas-- 700 shrubs.

Spring, 1993-1995. Plant 100-200 shrubs/year as needed to reach target cover of 20%.

Treatment # 2 : .8 acres.

Spring, 1993, with drip system-- 400 shrubs.

Spring, 1994, replace dead plants in above areas, add a few additional plants in other safe areas-- 400 shrubs.

Spring, 1995-1997, Plant 100-200 shrubs/year as needed to reach target cover of 20%.

Treatment # 3 : approx. 1.1 acres

Spring, 1995, with drip irrigation--600 shrubs.

Spring, 1996, replace dead plants in above areas, add a few additional plants in other safe areas--600 plants.

Spring, 1997-1999, plant 100-200 shrubs/year as needed to reach target cover of 20%.

Treatment # 4: .84 acres.

Spring, 1990-- 350 shrubs.

Spring, 1991-- 350 shrubs.

Spring, 1992-1994, plant 75-150 shrubs/year as needed to reach target cover of 20%.

Planting in safe spots will include planting in erosion blocks at base of slope.

Rodent control may be necessary.

b. Species to include:

Treatment areas #1-3:

The current successes of blue elderberry, woods rose and mountain big sagebrush.

Consider adding snowberry (propagated from softwood cuttings from the area) and chokecherry.

Treatment area #4: same spaecies as above, plus douglas fir.

c. Planting of most shrubs in treatments #1-3 will be in relation to new drip irrigation system. Planting can be done later in spring using drip-irrigation system, thus reducing frost damage.

Practice # 4: Irrigation System. Drip. Install a new drip irrigation system in treatment areas 1-3. System will include automatic fertilizer in-line. An irrigation system plan will be developed as an addendum to this plan by the SCS or private consultant. The basic concept includes 2 main supply lines. One line will come down the conveyor road. The second will go along the top of cut within the aspen zone. Secondary supply lines will tee off of these and go vertically up from the lower line 20-30 feet, and down from the upper line 20-30 feet. The individual plant emitters will come off these lines. All lines will be above ground due to rocky ground and probable high maintenance. After 2 years the emitters and secondary lines would be moved to start other plants at different locations along the treatment area. About 1500 emitters will be planned initially. Possibly the main supply line should be planned to supply enough water for 3000 or 4500 for future expansion. Drip irrigation will begin at the upper end.

Initial design guidelines might include:

aa. main supply lines 500 ft. each (plus distance from west end of treatment # 1 to source).

bb. 25 secondary supply lines from the bottom, and 12 from the top. Spaced at 20 ft. intervals along the bottom and 40 ft. intervals at the top. With about 40 emitters per line (each emitter line should not be the same length, they can vary from 2' to 10', emitters should be installed on-site following planting of conetainers in safe spots). The reason for the uneven distribution between top and bottom is there appears to be more safe spots and easier planting from the toe than from the top.

Water source is clean water from mining operation. Pipes and pumps exist at building complex, see map. The company will provide survey maps, source, gallons per minute available (SCS design can include needed gpm based on above criteria also), pressure, etc. to Price Field Office for design.

After the emitters are used to irrigate and fertilize newly planted shrubs for 2 years, the emitters will be moved to establish another set or group of newly planted shlrubs.

Treatment #1, 1st half: spring 1989
Treatment #1, 2nd half: spring 1991
Treatment #2: spring, 1993
Treatment #3: spring, 1995

Practice # 5: Irrigate new plants as planned, including in-line fertilizer. Irrigation schedule, plan, will be developed by SCS field office or private consultant.

Treatment #1, 1st half: growing season, 1989-90
Treatment #1, 2nd half, growing season, 1991-92

Treatment #2. growing season, 1993-94
Treatment #3. growing season, 1995-96

Practice # 6: Broadcasting grass/forb seed:

a. Broadcasting of seed is generally a high risk. It is a particularly high risk to broadcast a high rate in one year taking our chances with the set of climatic varibles that ocurr that year. But because there is soil movement each year with the current erosion, there is some probability that some seed will be covered to the right depth, have good effective moisture, temperature etc. and might germinate and survive.

b. Broadcast small amount of seed each fall for 5 years. If this is also done with an annual broadcast of fertilizer, the success chances are a little better. I would try broadcasting just prior to deciduous leaf drop in the fall. The leaves themselves might help some get started. This would be done hand.

Suggest:	lb./ac.	treat. 1	2	3	4	total
Lincoln smooth brome	1	2.6	.8	1.1	.8	5.3
Rosana western whgr.	1	2.6	.8	1.1	.8	5.3
Luna pubescent whgr.	1	2.6	.8	1.1	.8	5.3
Timothy	.5	1.3	.4	.6	.4	2.7
Durar hard fescue	.5	1.3	.4	.6	.4	2.7
Bandera Rocky Mtn. penstemon	.5	1.3	.4	.6	.4	2.7
Summit Louisiana sage	.2	.5	.2	.2	.2	1.3
Blueleaf aster	.5	1.3	.4	.6	.4	2.7
total						28.0

NOTE: Specify all certified seed for named cultivars.

Treatment areas #1-4, each year, fall, 1988-92.

Experimental trial # 3: Plant Materials Trials, Adaptation plots:

A small area as indicated on the maps will be used for an adaptation plant materials trial. In addition part of each mixture will be fertilized and a part will be fertilized and mulched with straw. See sketch map. Each mixture will be about 20 ft. wide and will go up the slope. The bottom half will be on the most gentle slope and the upper the steepest. The fertilizer will go up the slope, covering 1/2 of each plot or about 10 feet wide. Use balanced, starter, fertilizer such as 10-10-10 calculating N at 40 lbs/ac. Straw mulch will go across the slope in the middle covering about a third of each plot with half on the steeper slope and half on the gentle slope. Target amount will be 2500

lbs./acre (or 340 lbs. for site). Try to anchor the straw a little with spade. Jute netting is an alternative.
Each mixture will be broadcast and raked. Steel stakes will be driven between plots at the base. The SCS will provide seed. All other materials and labor will be supplied by the Company. Seed will be shipped about September 15, 1988. Seeding will be about Oct. 15. There will be 7 mixtures. An area about 140 ft. by 100 ft. is needed.

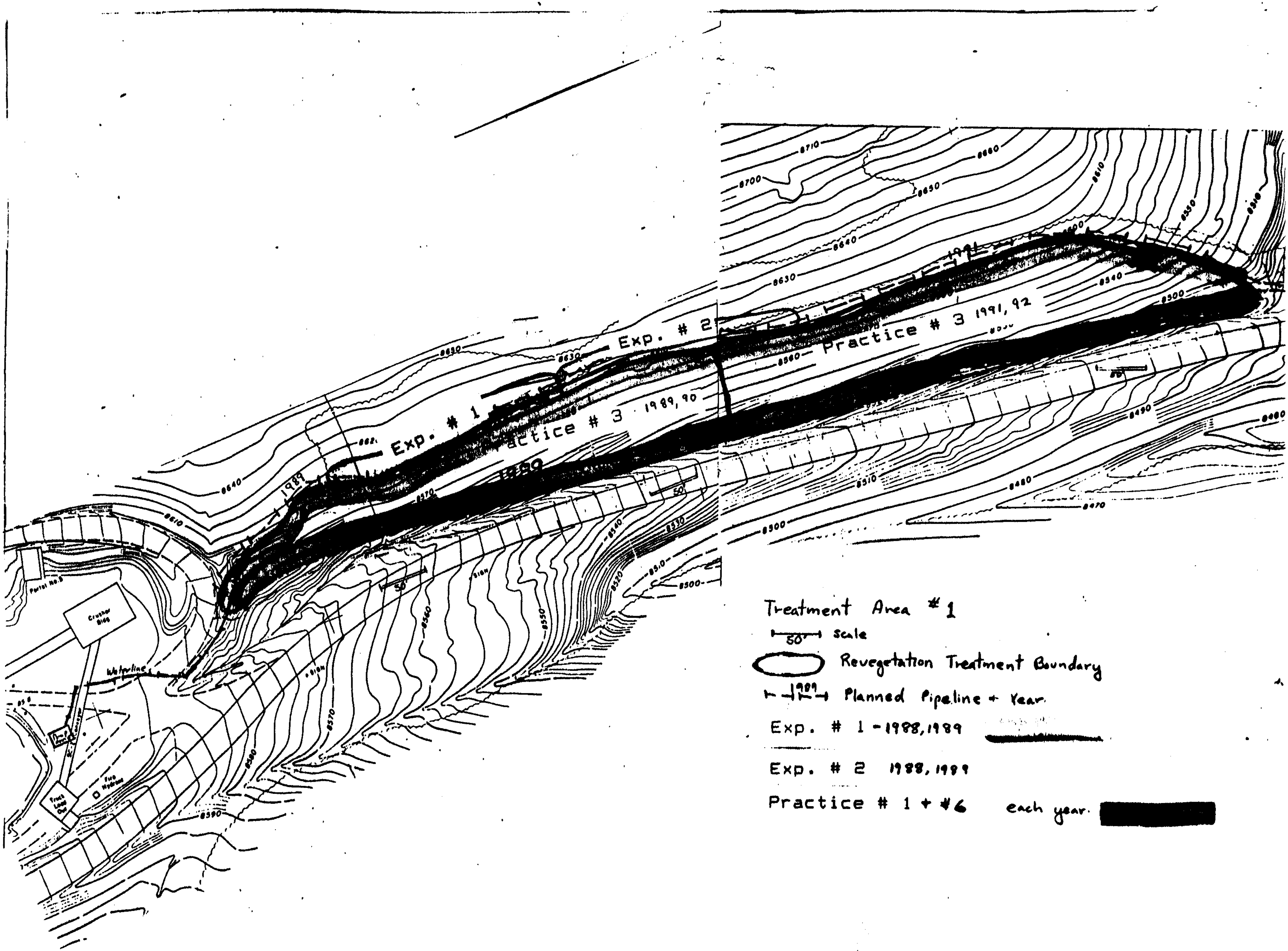
Mixtures:	lbs. for plot
1. Luna pubescent wheatgrass	1.0
Hycrest crested wheatgrass	.2
Manchar smooth brome	.24
Appar Lewis flax	.07
Kalo dwarf birdsfoot trefoil	.04
2. Topar pubescent wheatgrass	1.5
Ephraim crested wheatgrass	.15
Sodar streambank wheatgrass	.2
Delar small burnet	1.0
3. PI281863 Rush wheatgrass	1.5
P27 Siberian wheatgrass	.18
Critana thickspike wheatgrass	.15
Cedar Palmer penstemon	.1
4. Arriba western wheatgrass	.2
T36554 Mountain rye	.8
Sherman big bluegrass	.025
Summit Louisiana sage	.03
5. Rosana western wheatgrass	.35
Paiute orchardgrass	.08
Covar sheep fescue	.045
Bandera Rocky Mountain penstemon	.1
6. Tegmar intermediate wheatgrass	.7
Durar hard fescue	.06
T21076 Thickspike wheatgrass	.22
Lutana cicer milkvetch	.45
7. San Luis slender wheatgrass	.63
RS1 Agre X Agsp wheatgrass	.29
Cascade birdsfoot trefoil	.04
Blueleaf aster	.04
Western yarrow	.01

Evaluations will be made annually, for 5 years minimum, by the Price field office and Keith Zobel of Skyline Mine.

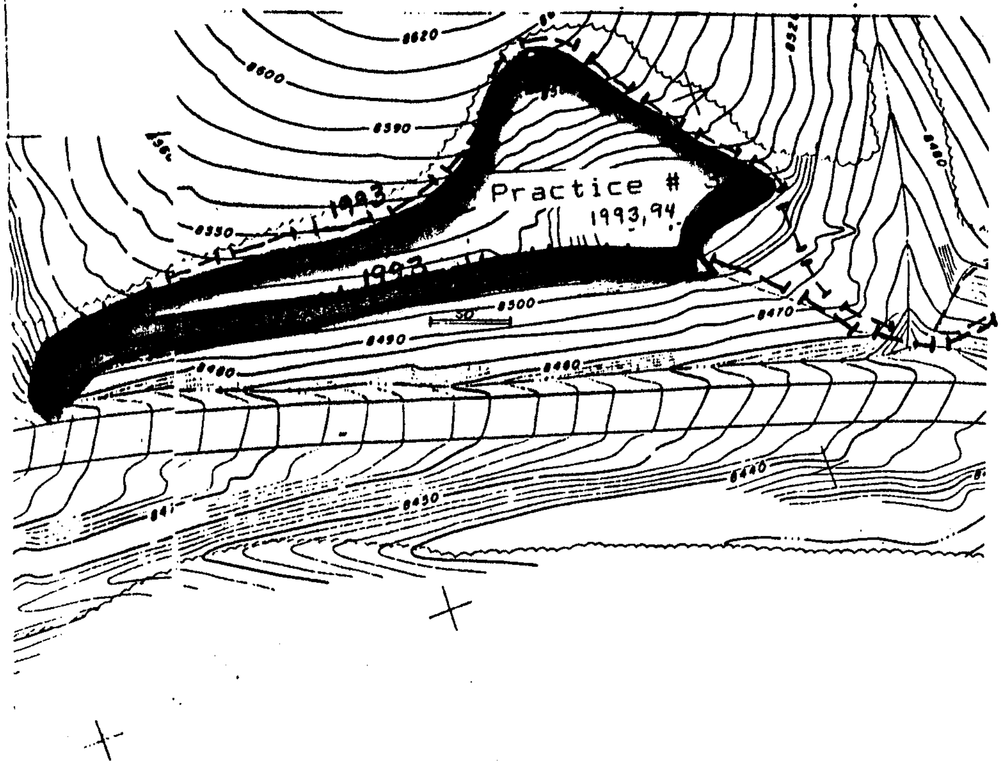
NOTE: Soil samples are needed prior to any work on each of the treatment areas and the adaptability plots. Keith Zobel agreed to take care of this. A copy of the report will be sent to Price field office and to Jacy Gibbs, Plant Materials Specialist, Boise, Idaho.

Summary by Year, Practice

PRACTICE	1988 Fall	1989 Sp.	1989 Fall	1990 Spr.	1990 Fall	1991 Spr.	1991 Fall	1992 Spr.	1992 Fall	1993 Spr.	1993 Fall	1994 Spr.	1994 Fall	1995 Spr.	1995 Fall	1996 Spr.	1996 Fall	1997 Spr.	1997 Fall
Practice 1 - Fertilizer	x	(x)	x	(x)	x	(x)	x	(x)	(x)				x						x
Practice 2 }- Drip Irrigation, Practice 5 } in-line fertilizer, existing vegetation, and new plants.		← Treatment #1, 1st half			→	← Treatment 1, 2nd half			→	← Treatment #2			→	← Treatment #3			→		
Practice 3- Shrub Planting with Drip System		x Treat. #1				x Treat. #1				x Treat. #2				x Treat. #3					
Replant and additional shrubs.				x Treat. #1				x Treat. #1				x Treat. #2				x Treat. #3			
Shrub Planting Treat. #4				x		x		(x)											
Practice 4- Install drip Irrig. system		x Treat. #1, 1st half				x Treat. #1, 2nd. half				x Treat. #2				x Treat. #3					
Practice 6 Broadcast grass + forb seed, all Treatment areas.	x		x		x		x		x										
Experimental Trial #1 fertilizer on Aspen	x		x	eval.															
Experimental Trial #2 Cutting Trial on Aspen	x		x	eval.															
Experimental Trial #3 - Plant Materials Trial	x	eval. →	→	→	→	→	→	→	→	→									



Exp. # 2
Exp. # 1
Exp.
Practice # 3 1989, 90
Practice # 3 1991, 92
1989
1991
8640
8630
8610
8570
8560
8550
8540
8530
8520
8510
8500
8490
8480
8470
8580
8590
8650
8660
8700
8710
50
Crusher Bldg
Waterline
Fire Hydrant
Treatment Area # 1
50' scale
Revegetation Treatment Boundary
1989 Planned Pipeline + Year
Exp. # 1 - 1988, 1989
Exp. # 2 1988, 1989
Practice # 1 + #6 each year

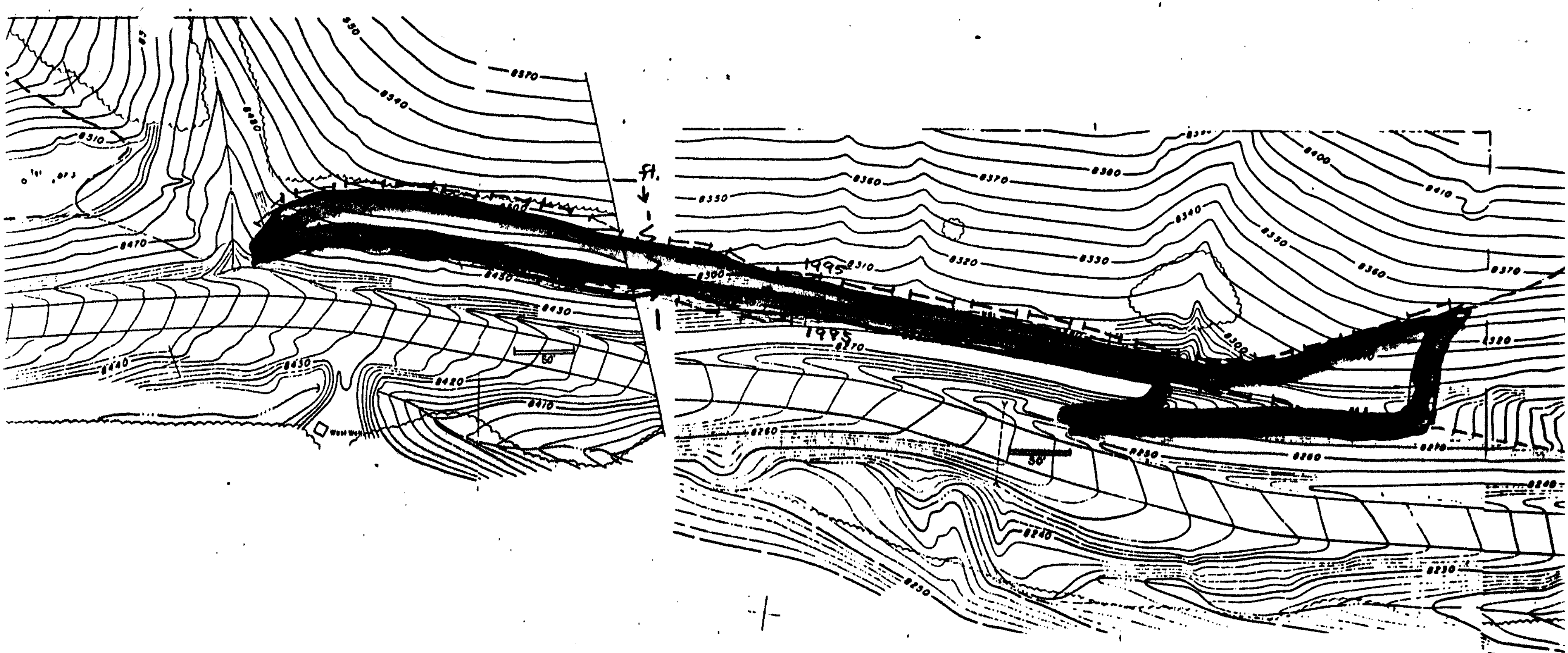


Treatment Area # 2

Practice # 1 + 6, each year

Treatment Area Boundary

1993 Pipeline + year

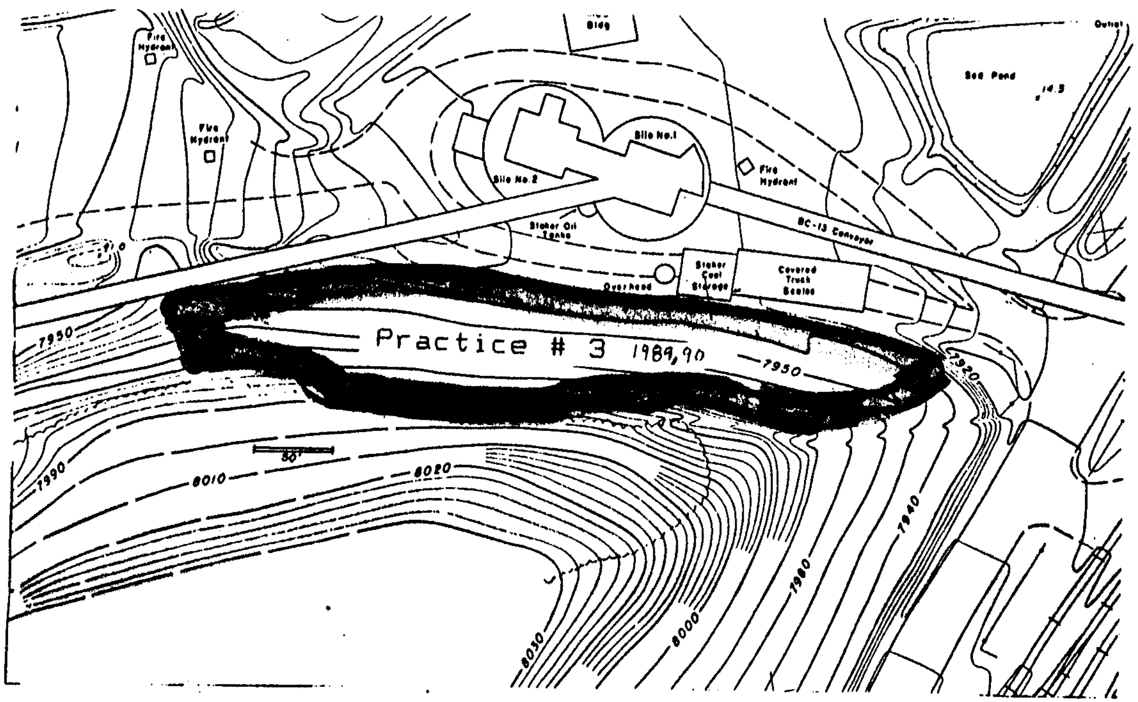


Treatment Area #3

Treatment Area Boundary

1795 Pipeline and year

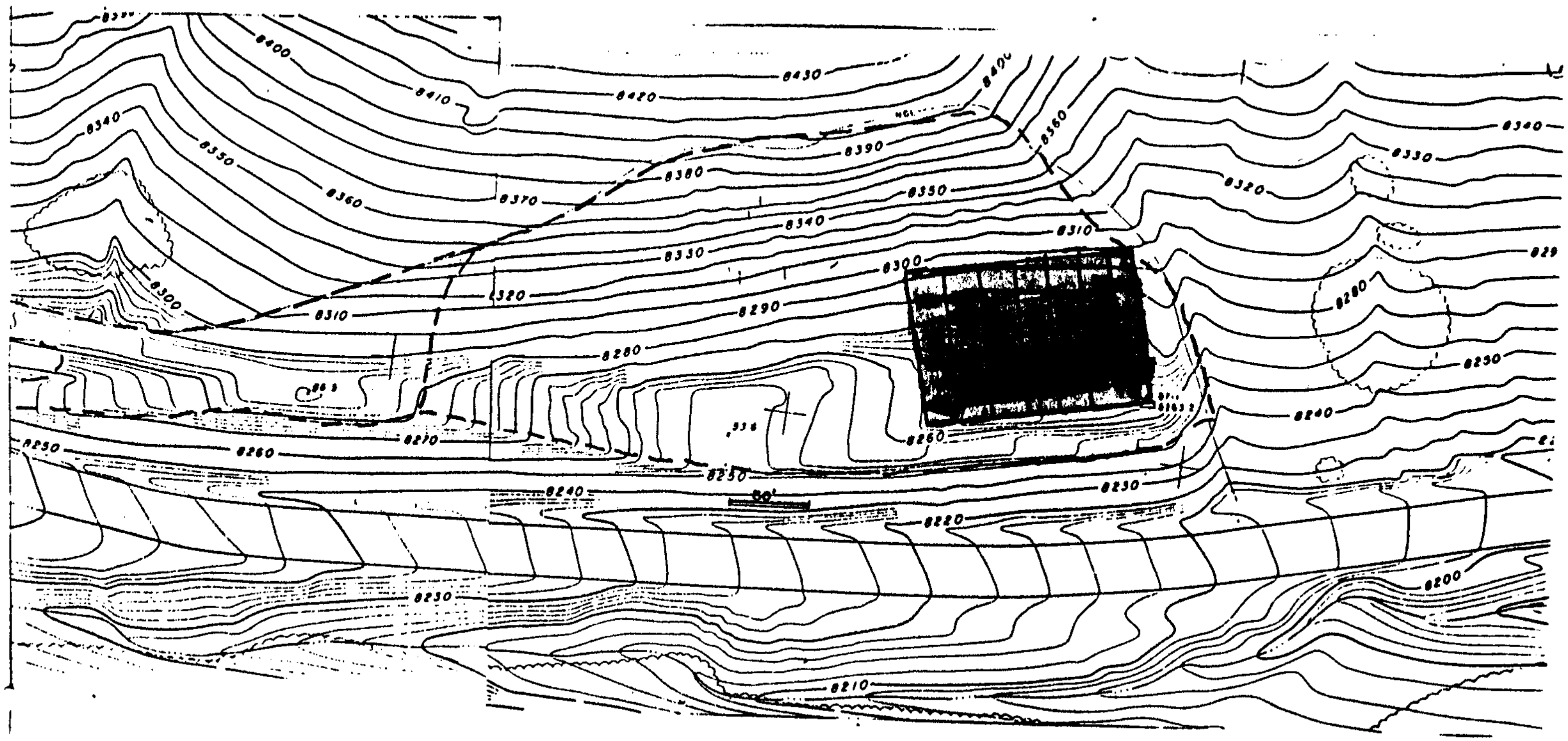
Practice # 1 + 6, each year



Treatment Area #4

Treatment Area Boundary

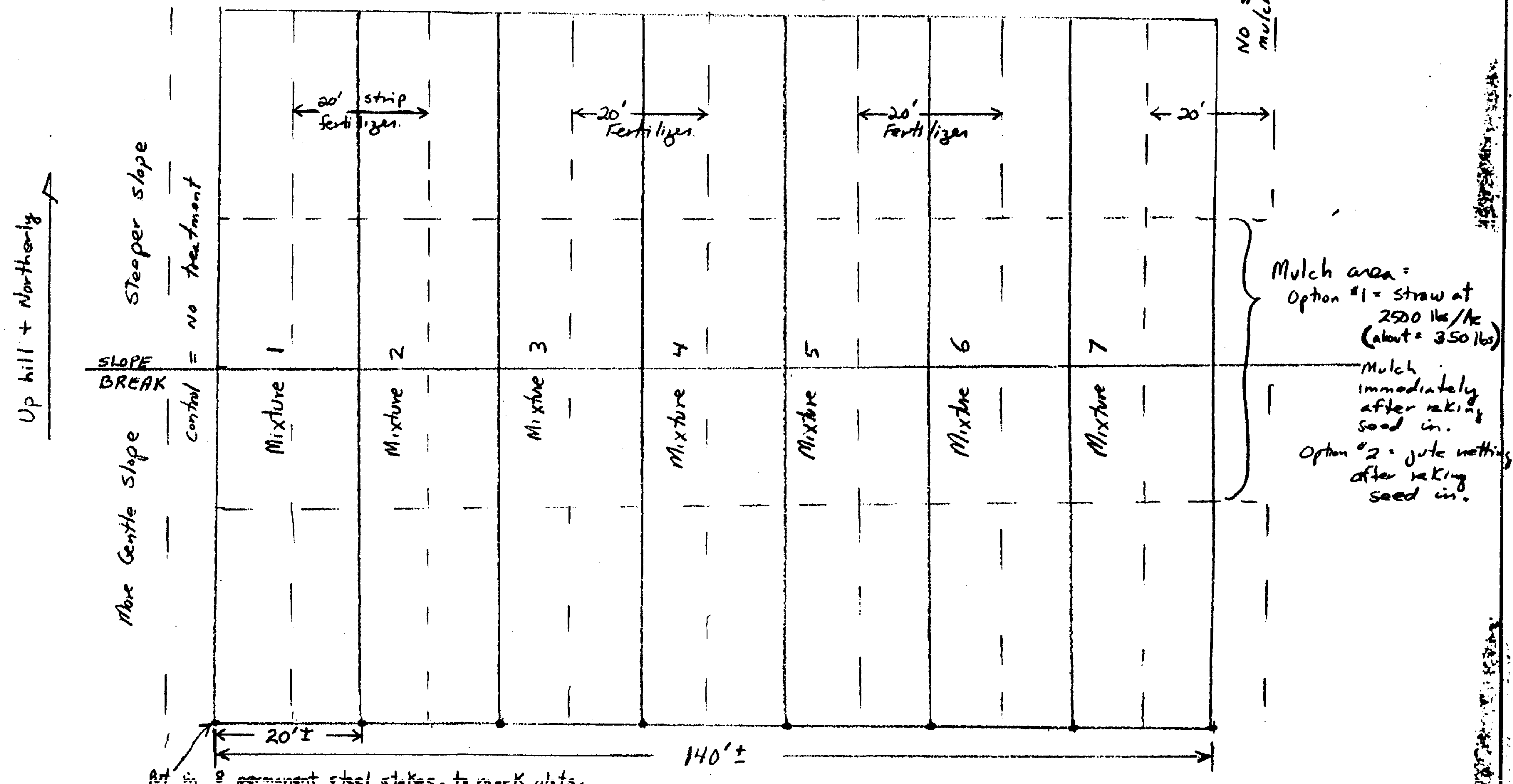
Practice # 1 + 6 each year.



Study Area - Experimental Trial #3

Plant Material Plots

'AYOUT AND DESIGN
SKYLINE MINE/UTAH FUEL COMPANY
PLANT MATERIAL ADAPTABILITY PLOTS
8/8/88 JLL



Fertilize: South to North in 20' strips, ½ to adjoining treatments, entire length, about 100' ±.
Use starter fertilizer, slow release, 10-10-10 or similar %, at 40 lbs/ac. N or about 7.3 lbs N on 75 lbs of 10-10-10.
Fertilize just prior to seeding, fall 1988.

Seeding: Each mixture is 20' x 100', broadcast, target 100 seeds/sq ft, raked in as well as possible. Goal is 50% overstory grass, 20% understory grass, 30% forb and legume. .046 acres each.
See Plan for mixes. Seed Fall of 1988.

TABLE 20 ADDENDUM
(1982 Vegetation Report)

ENDANGERED PLANT STUDIES, INC.
129 North, 1000 East
Orem, Utah 84057
(801) 225-7085

28 September 1988

Mr. Keith Welch
Coastal States Energy Company
175 East, 400 South
Suite 800
Salt Lake City, Utah 84111

Dear Mr. Welch:

On 23 September 1988, Mr. Ron Kass and I visited Eccles Canyon at the loadout area of the Skyline mine, where we reviewed the riparian reference site #1 in response to the deficiency noted for UMC - 783.19 in permit application. The purpose of the trip was to determine the density of woody plants, especially Picea pungens or blue spruce, which is the principal woody plant on the study site.

Findings of the investigation are on the attached page. The reference site is immediately north of the soil stockpile at the loadout area near the mouth of Eccles Canyon. It is marked at the west end by two steel markers, a piece of quarter inch rebar painted red and a standard six foot steel fence post with a welded crossbar of steel plate on which "S # 1" is marked with a welded bead. We painted the top of both markers with fluorescent orange paint. The study site is limited on the south by a canal and rotting bails of straw, marked by blue steel posts. The north boundary is the base of the foot slope of the adjacent mountain and road fill. The east edge of the site corresponds roughly with the easternmost blue steel marker along the canal north of the soil stockpile. Average width of the reference area is 77 feet and its length is 328 feet. The area is approximately 25,256 square feet, or 0.5798 of an acre. Eccles Creek meanders through the gently easterly sloping flood plain. Principal vegetation on the floodplain are grasses and grasslike plants. Occasional small patches of silver sagebrush (Artemisia cana) grow on higher terraces above old meander channels. Blue spruce trees occur in clumps throughout the reference site.

The woody plants are difficult to characterize by statistical methodology. The small patches of silver sagebrush would not necessarily show in randomly placed quadrats or transects. The point quarter method for determination of tree density is also flawed, but for a different reason. The trees tend not to be randomly spaced along the length of the site. They occur in clumps. And, the clumps are widely spaced, making multiple measurements of the same individual a reality. A hundred meter transect (328 feet) was placed from the red rebar randomly downstream along the axis of the streamcourse. Fourteen quadrats were spaced at approximately 7 m (22.96 ft) intervals along the transect. Several measurements were duplicates of the same individual due to clumping of individuals and spacing. And the small size of the reference area (due to environmental constraints, not preference of the samplers) precluded use of additional transects in the site. Mean distance for blue spruce trees is 27.9 feet (excluding those less than four feet in height), and the total number of trees per acre by this method is only 56. A test for adequacy of sample number (n min) indicated that 11 samples would have been adequate. The sampling technique is obviously in error. Actual count of specimens more than four feet in height was 69 (with multistemmed trees counted as a single individual), or 119 trees per acre. Eight juvenile plants less than four feet tall brought the total to 77 specimens of blue spruce in the reference site, or a total of 132.8 trees per acre.

I hope that this information will satisify requirements of the deficiencies noted.

Sincerely yours,

Stanley L. Welsh
President

TABLE 20 ADDENDUM (continued)

COASTAL STATES ENERGY
SKYLINE MINE
Loadout Area Riparian Reference Site #1.

Table 1. Tree Density

Location: T13S, R17E, SE 1/4 S17. Sample Size: 14

Point quarter method

$$n\ (\text{min}) = \frac{\left(\frac{1.64\ s}{(0.1)x}\right)^2}{4}$$

$\hat{x} = 27.9$ $s = 13.3$ $s^2 = 3.4$ $d^2 = 7.8$ $n\ (\text{min}) = 11$

Taxon	Mean distance	Frequency	Trees/acre
Picea pungens	27.9	100%	55.9

Belt transect method (including entire reference area)

Size: 77 ft x 328 ft or 25,256 feet (0.5798 acre)

Taxon	Number	Mean distance	Frequency	Trees/acre
Picea pungens				
(> 4 ft)	69	19.1	89.6%	119.0
(< 4 ft)	8	56.2	10.4%	13.8
Total	77	23.8	100%	132.8

Tree diameter

Taxon	Diameter 0-1"	1-3"	3-6"	6-12"	12-15"	>15"
Picea pungens	8	10	12	20	7	7

* 4.6.5 South Fork Breakout

Before any top soil is removed, all woody vegetation will be removed from the project area. Soils are basically a sandy loam mixture and have been classified by the S.C.S. as Uinta Family loam/tozc Family fine Sandy loam. Core sampling in the area shows that the soils vary in depth from 24 - 36+" in depth.

After the vegetation has been removed, the A & B horizons of soil will be removed using a track hoe. The track hoe will stack the soil where a front-end loader will pick it up and transport it to the storage area on the abandoned temporary Forest Service road. The front-end loader will spread the soil in approximately a two foot lift. By handling the soil in this manner, it will not be compacted in the storage area and the roots of the revegetation plants will penetrate the entire depth of the soil. This will allow the soil to maintain itself as viable top soil to be used during final reclamation. It is estimated that approximately 2,990 cubic yards of topsoil will be removed and stored.

As subsoils are encountered, they will be used to bring the new access road up to grade. Subsoil not used as road will also be stored on the abandoned temporary Forest Service road on a section below the topsoil storage. It is estimated that approximately 2,840 cubic yards of subsoil will be removed. Approximately 1,820 cubic yards of the subsoil will be used in the road fill and the remaining 1,020 cubic yards will be stored for final reclamation.

As the coal in the coal seam is encountered, it will be hauled out so as to eliminate the possibility of spontaneous combustion occurring.

Once the construction was complete, all of the disturbed area were seeded and all the roads that are on National Forest Lands and the disturbed areas were water barred and seeded with the mixture shown on Table 4.6-1. A combination of silt fences and strawbales were used to treat surface run-off from the disturbed area of the new road, the breakout pad and the topsoil-subsoil storage areas until adequate vegetation is established. The silt fences and strawbales were located as needed between the disturbed and undisturbed areas to treat run-off from the disturbed area.

At the end of the life of mine, the road into the breakout site will be reopened. The portals will be sealed as outlined in section 4.9. The area will then be returned to approximate original contour and the highwall eliminated by front-end loaders and track hoe type equipment. First the subsoil from the storage area and road will be uniformly placed in the breakout area. The topsoil will then be uniformly distributed over the area. If additional fill material is needed, the remainder of the small knob at the mouth of the canyon may be used.

The soil will be spread in a manner to provide a roughened surface so that seed, fertilizer and mulch can remain during germination and initial growth of the seedlings. Raking the surface prior to planting may also be needed to provide the necessary roughened surface.

The highwall at the breakout area will be eliminated by frontend and track hoe type equipment. If additional fill material is needed to return the area to approximate orignal contour, the remainder of the small knob at the mouth of the canyon may be used. The subsoil from the storage area will be uniformly placed in the breakout area, and then the topsoil will be uniformly spread over the area. The access road up the side canyon to the breakout area and the temporary road used for soil storage will then be return to aproximate original contour of surrounding terrain. The area where the knob was will also be contoured to blend in with the surrounding terrain.

Once the construction is complete, all of the disturbed area will be seeded and all the roads that are National Forest Lands and the disturbed areas will be water barred and seeded with the mixture shown on Table 4.6-1. A combination of silt fences and strawbales will be used to treat surface run-off from the disturbed area of the new road, the breakout pad and the topsoil-subsoil storage areas until adequate vegetation is established. The silt fences and strawbales will be located as needed between the disturbed and undisturbed areas to treat run-off from the disturbed area.

At the end of the life of mine, the road into the breakout site will be reopened. The portals will be sealed as outlined in section 4.9. The area will then be returned to approximate original contour and the highwall eliminated by front-end loaders and track hoe type equipment. First the subsoil from the storage area and road will be uniformly placed in the breakout area. The topsoil will then be uniformly distributed over the area.

The soil will be spread in a manner to provide a roughened surface so that seed, fertilizer and mulch can remain during germination and initial growth of the seedlings. Raking the surface prior to planting may also be needed to provide the necessary roughened surface.

Riparian zones were revegetated with handset seedlings of yellow willow, blue spruce, Woods rose and American red raspberry at intervals at 1/2-1 meter. Table 4.7-3 lists the seed mixture spread on the inter-spaces. Steep slopes which have been rip-rapped were not revegetated.

4.7.2 Final Reclamation Seeding Tillage and Mulching, Portal and Train Loadout Areas and Other Small Areas

* Seed mixture for final reclamation are shown on Tables 4.7-4, 4.7-5 and 4.7-6.

Seeding of the south-facing slopes (1h:3v) or lower flat areas will be conducted using a cyclone spreader. For slopes less than 2h:1v, seeding will be accomplished using a hydro-seeder. Plantings of shrubs and trees will be hand-set to ensure a plant cover of a permanent nature. Slopes of 2h:1v or steeper will be revegetated by hand-set planting techniques.

Tillage practices on level ground and on slopes flatter than 10h:1v will include leveling, tilling and mulching. All slopes up to 3h:1v will be mulched using 2,000 pounds per acre of straw or other inert mulch material which will be anchored by crimping. Slopes steeper than 3h:1v will be treated with hydro mulch. All hydro mulch will be applied at the rate of 2,000 pounds per acre plus 140 pounds of tacifer per acre.

Planting on slopes less than 10h:1v will be accomplished by drilling seed with a mechanical drill. Slopes between 10h:1v and 1.5h:1v will be seeded by hand broadcast and manually buried by raking. Mulch will be applied over the hand broadcast seed. The Permittee electes to revegetate areas with slopes greater than 1.5h:1v without topsoil; such areas will be treated to handset plantings in basins filled with topsoil and with hydromulch seeding in between. Where the substrate consists of outcroppings of stone, no attempt will be made to revegetate.

Revegetation on slopes steeper than 3h:1v will be undertaken as soon as possible following topsoil placement, mainly during spring and early fall. Where too steep for topsoil placement, planting will be followed immediately after the area becomes available during construction activities. Revegetation on slopes less steep than 3h:1v will follow topsoil placement.

The Permittee will create a natural appearance during post mining reclamation by extending tree and shrub planting past the toes of slopes. However, linkages will be left short or extended slightly as necessary to provide an irregular appearance. Grasses and forbs will be reestablished from seed. Trees will be planted as seedlings. The Permittee will additionally place rocks, originally designated as wind barriers, at the bottom of large rock cuts in an informal way so as to provide a more natural appearance. Maps 4.7.2-1 and 4.7.2-2 show where the different seed mixes will be utilized.

All riparian areas will be revegetated with handset seedlings as
* shown on Table 4.7-6. Table 4.7-3 lists the seed mixture to be used on the inter-spaces. Rip-rapped banks will be included in the revegetation process where physically possible.

Noxious plants invading the disturbed areas will be controlled by hand grubbing. Surveillance will be maintained annually during the period of liability. Acreage by type for each disturbed area is shown in Table 4.7-7.

4.7.3 Revegetation, Stabilization and Reclamation of the Conveyor Bench

Revegetation, stabilization and reclamation of the conveyor belt slopes have been evaluated during the middle of each growing

Table 4.7-7

The acreage and proportion of each disturbance area is as follows:

	Vegetation	Acreage	%
Loadout	Grass/Forb	6.8	76
	Spruce/Fir	2.2	24
		9.0	100
Portal Yard	Aspen	6.8	22
	Spruce/Fir	14.0	45
	Sagebrush	2.5	8
	Disturbed	7.8	25
		31.1	100
Water Tank and Well Pads	Aspen	.2	100
Conveyor Route	Sagebrush	3.8	63
	Aspen/Conifer	2.2	37
		6.0	100
Waste Rock Disposal	Already Disturbed	1.3	100
* South Fork Breakout	Aspen	.3	75
	Spruce/Fir	.1	25
		.4	100

		47.6	

! REPLACES	!! TEXT !
! Table 4.7-7 Page 4-37	!! Table 4.7-7 Page 4-37 Date 10/15/88 !

* Denotes change or addition

4.7.4 Irrigation, Portal & Train Loadout Areas

Since the species used for reclamation were known for their survival characteristics, it was felt that application of additional water will not be needed. Should 50 percent lower than average precipitation occur following the initiation of reclamation procedures, irrigation may be needed on a short-term basis. If irrigation is needed, an irrigation plan will be developed at that time and submitted to the Division of Oil, Gas and Mining for approval.

4.7.5 Monitoring Procedures, Portal, Train Loadout, Waste Rock Disposal Site, and South Fork Breakout Areas

The Permittee re-evaluated vegetative data collected and resubmitted data using a monitoring method designed to give empirical values sufficient to detect a 10 percent change in vegetative cover at a 90 percent statistical confidence interval. These data are from those communities disturbed and for established reference areas which will be used for comparison (aspen & sagebrush, reference area for south slopes; spruce-fir, reference area for north slopes; riparian, reference areas for the riparian zone and
* the waste Rock Reference Area for the waste rock disposal site). Vegetative parameters to be measured are: cover, density, productivity and species composition. Sampling of the approved reference area and revegetated area will occur for the last two years of the liability period and will meet sample adequacy tests for 90 percent confidence level with a 10 percent change in the mean.

A minimum of the following data will be provided: 1) canopy cover by species and total canopy cover excluding trees, 2) productivity by life form, and 3) density of woody species by life form (trees and shrubs). The Permittee will provide results of statistical analyses showing similarity between disturbance areas and reference areas.

REPLACES	TEXT
Section 4.7.5 Page 4-38	Section 4.7.5 Page 4-38 Date 1/10/89

* 4.7.8 South Fork Breakout

After the area has had the soils redistributed, as outlined in Section 4.6.5, the site will be revegetated. The aspen site will use the seed mixture shown on Table 4.7-4 while the spruce-fir site will use the mixture shown on Table 4.7-5. The area will be seeded by hydro-seeding. After the area has been seeded, it will be hydro-mulched at the rate of 2,000 pounds per acre plus 140 pounds of Tacifer.

Fertilizer rates and applications are discussed in the soil preparation and fertilizer plan (Section 4.5).

Culinary water usage at the mine site qualifies as a public water supply and will be treated to meet State of Utah primary and secondary water standards.

4.11.2 Monitoring Program

In order to concentrate on areas of immediate impact, surface water stations located in Eccles Canyon are sampled more frequently than those on Huntington Creek during the initial phases of mining. (See Sections 2.3 and 2.4.)

As mining progresses toward the Huntington Creek area, sampling frequency will be increased to more closely monitor mining impacts

Surface water monitoring will continue according to the monitoring schedule, presented in Section 2.3.7 and 2.4.5, throughout the mining and reclamation operations. Postmining data collection will continue on a quarterly basis at each of the stations until the reclamation effort is determined successful by the regulatory authority. The August samplings will continue to be analyzed according to Table 2.3.7-1 during the postmining period.

Water quality data collected from surface and ground water monitoring stations will be submitted quarterly to the regulatory authority. These reports will normally be submitted within 90 days of the end of each quarter depending upon the date of the laboratory analysis. An annual summary will also be prepared and submitted within 90 days after the end of each calendar year.

In addition to the above outlined monitoring program, NPDES discharge permit monitoring is conducted in accordance with the stipulated permit conditions. The monitoring program will continue on the sediment pond discharges until the revegetation effort
* is complete and a bond release is obtained. Water entering the ponds during the reclamation period will be monitored in accordance with State and Federal regulations in effect at that time.

REPLACES	TEXT
Section 4.11.2 Page 4-51	Section 4.11.2 Page 4-51 Date 7/15/87

TABLE 4.12-1

PROPOSED POSTMINING LANDUSE

Area	Present Ownersnip	Premining Landuse	Proposed Postmining Use	Alternative Use	Capacity To Support Proposed Use	Relationship To Existing Landuse Policies
Mine Site and Exploratory Excavations	USFS	Wildlife/ Grazing Habitat	Wildlife/ Grazing Habitat	Picnic Area	Adequate	Compatible
Conveyor and Pipeline	Private	Grazing	Grazing	Wildlife Habitat	Adequate	Compatible
Main Access Road	State	Forest Access and Service Road	State Road	None	Adequate	Compatible
Loadout	Private	Grazing, Picnic, and Stock Pens	Grazing, Picnic, and Stock Pens	Wildlife Habitat	Adequate	Compatible
Waste Rock Disposal	Private	Grazing	Grazing	Wildlife Habitat	Adequate	Compatible
* South Fork Breakout	USFS	Wildlife/ Grazing Habitat	Wildlife/ Grazing Habitat	Wildlife Habitat	Adequate	Compatible

! REPLACES	!! TEXT !
! Table 4.12-1 Page 4-56	!!Table 4.12-1 Page 4-56 Date 10/15/88 !

* Denotes change or addition

TABLE 4.12-1

PROPOSED POSTMINING LANDUSE

Area	Present Ownership	Premining Landuse	Proposed Postmining Use	Alternative Use	Capacity To Support Proposed Use	Relationship To Existing Landuse Policies
Mine Site and Exploratory Excavations	USFS	Wildlife/ Grazing Habitat	Wildlife/ Grazing Habitat	Picnic Area	Adequate	Compatible
Conveyor and Pipeline	Private	Grazing	Grazing	Wildlife Habitat	Adequate	Compatible
Main Access Road	State	Forest Access and Service Road	State Road	None	Adequate	Compatible
Loadout	Private	Grazing, Picnic, and Stock Pens	Grazing, Picnic, and Stock Pens	Wildlife Habitat	Adequate	Compatible
Waste Rock Disposal	Private	Grazing	Grazing	Wildlife Habitat	Adequate	Compatible
* South Fork Breakout	USFS	Wildlife/ Grazing Habitat	Wildlife/ Grazing Habitat	Wildlife Habitat	Adequate	Compatible

! REPLACES	!! TEXT !
! Table 4.12-1 Page 4-56	!!Table 4.12-1 Page 4-56 Date 10/15/88 !

* Denotes change or addition

Plugging of Small Diameter Openings

Exploratory holes and water wells not approved for abandonment monitoring or postmining landuse:

- Each hole will be cased and sealed with a cement plug.
- A monument will then be erected over sealed holes.

Backfilling of Ponds

* • Ponds will be drained, the sediment removed, then allowed to dry out.
- When the soil is dry, ponds will be backfilled.

Removal of Buildings

Office, shop, storage, changehouses, treatment buildings, explosive storage:

- Each structure will be removed.
- Removal or fracture of foundations will follow if they are close to the surface. Deeper foundations will be covered with at least six feet of dirt.

Equipment Removal

Mining equipment, conveyors, power structure and line, coal processing and handling equipment:

- The above mentioned items will be removed.
- Support structures will then be removed and foundations fractured and covered.

- Mulch - Wood mulch may be sprayed on terrace banks.
- Soil Retention Blanket - Wood fiber held by plastic net may be used on steeper banks.

Maintenance

Fencing, irrigation, and weed control will be used only as needed, according to operational testing results.

Regrading and Reseeding

Erosion that develops in completed areas will be minimized by repeated grading and seeding.

Success Monitoring and Extended Responsibility Period

Vegetation and water will be monitored during the applicable period of liability to determine success of abandonment reclamation. A determination of vegetation success will then be made.

Removal of Site Drainage Ditches and Sedimentation Ponds

After the disturbed areas are stabilized and runoff meets the suspended solids standard without detention time, the site drainage system will be removed. The site drainage system areas, including the sedimentation ponds, will be backfilled and revegetated.

Road Abandonment

The mine support roads will be reclaimed in the permit area. Culverts and blacktop surfacing material will be removed. Reclamation would then include recontouring, ripping, adding cross drains, water bars, topsoil and seed.

4.17 SUBSIDENCE CONTROL PLAN

This section describes in further detail the Permittee's mine plan design, ensuring subsidence effects of the Skyline Mine produce minimum environmental impact. Section 3.1 - SKYLINE MINING OPERATION PLAN describes in detail the proposed methods of coal extraction and mine development which were selected partly on subsidence and nonsubsidence criteria. Section 2.2 presents the detailed geological information which provided an analytical base for mine plan and subsidence control design. The following subsections describe the principal factors involved in measuring and controlling subsidence resultant of the proposed mining operations.

4.17.1 Subsidence Probability Survey

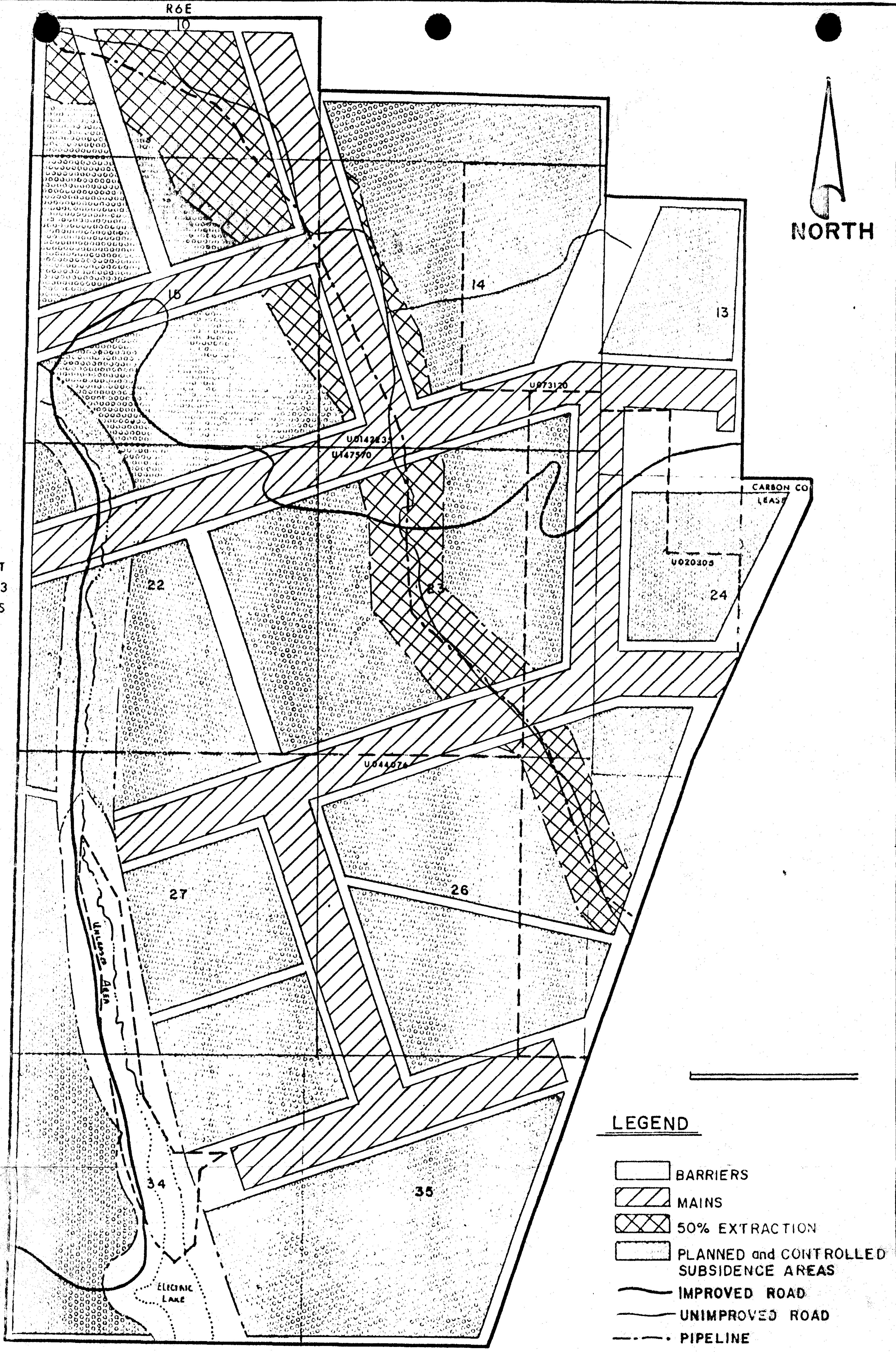
Careful review of the permit area shows that the following areas could face potential subsidence impact caused by mining: Mountain Fuel Supply gas pipeline, upper reaches of Electric Lake Reservoir, perennial streams of the permit area, and public roads which cross the permit area. These potential affected areas are identified on Map 4.17.1-1.

Springs, aquifers and aquifer recharge areas may also be affected by subsidence. Vegetation types are shown on Map 2.7.2-1.

4.17.2 Mining Methods

The mining methods to be used by the Permittee include longwall mining, room and pillar mining with pillar removal, and room and pillar mining with pillars left in place. Certain room and pillar mining systems are designed to provide full support and will prevent subsidence. Subsection 3.1.5 contains descriptions of the mining methods to be implemented.

Full extraction areas (room and pillar panels with pillar removal and longwall panels) are, by definition, planned and controlled



UTAH FUEL CO.		
EXTENT OF PLANNED & CONTROLLED SUBSIDENCE AREAS		
DESIGNED BY: C HILTON	DATE: 6-30-86	DWG. NO. 4.17.1-1
DRAWN BY: M. BEHLING	SCALE	

subsidence areas. The extent of these full extraction areas is shown on Map 4.17.1-1. Subsidence prediction work has shown the expected maximum planned and controlled subsidence will vary from 0 to 16 feet, assuming that the total cumulative extraction from the three mineable seams will not exceed 30 feet.

4.17.3 Subsidence Effect Prevention Measures

The mining plan has been designed in such a way as to align the full extraction panels as parallel as possible to main faults. This alignment should help prevent the formation of irregular saw-tooth subsidence cracks in the overlying surface lands. It is anticipated that the planned subsidence will result in a generally uniform lowering of the surface lands in broad areas, thereby limiting the extent of material effect to those lands and causing no appreciable change to present land uses and renewable resources. The Permittee established a subsidence monitoring program in the early stage of mining for use in reviewing the surface effect of mining and as an aid in future mine planning.

It is planned that coal support pillars will be left in place under the natural gas pipeline to prevent any surface movement for a 25-foot zone on each side of the pipeline. The width of the area of supportive mining is equal to 50 feet (25 feet on each side of the pipeline centerline no surface movement) plus the tangent of 22^{o} (assumed draw angle) multiplied by the overburden depth of the deepest mined coal bed:

- Nonsubsidence Mining Width = 50 feet + (tan 22^{o} x depth)

The width of the supportive mining area will be adjusted, as appropriate, when detailed subsurface information and monitoring provides a more accurate estimate of the draw angle. However, if appropriate details can be worked out with Mountain Fuel Supply Company, planned subsidence may occur beneath the gas pipeline.

There will be no mining caused subsidence under either the Electric Lake Reservoir or Upper Huntington Creek inlet to the reservoir, and no mining from which subsidence at a 22-degree (from vertical) angle of draw would influence either this reservoir inlet section of Upper Huntington Creek or the high-water level of Electric Lake Reservoir. Map 4.17.1-1 shows the buffer zone within which there will be no full extraction mining. The width of the buffer zone was calculated as follows:

- Buffer zone width = tan 22° x overburden depth

The width of the buffer zone has been calculated using the overburden depths to the deepest-lying coal seam.

The Permittee plans to review the results of subsidence surveys after an initial period of mining and reserves the right to modify the width of the buffer zone after submitting a minor modification to the mining plan. There is a very substantial tonnage of coal which lies to the west of Upper Huntington Creek and Electric Lake Reservoir, which the Permittee plans to mine.

The buffer zone width will also be adjusted, if appropriate, when a more accurate draw angle is determined. Panels within the buffer area will be room and pillar panels with supporting pillars left in place.

The sequence and timing of mining will be such that the upper reaches of Huntington Creek and/or its tributaries outside the buffer zone will be mined in the early stages of mining in the Huntington Creek drainage. This plan will allow an assessment to be made of the effect of subsidence on the upstream portion of Huntington Creek. Evaluation of the effects will be used to alter, if necessary, the extent and type of mining under the inlet waters of Huntington Creek into Electric Lake, in such a manner that environmental values are protected.

Drill holes show that there are bentonitic shale layers present which will probably swell and decompose into an impervious clay when wet. This characteristic is expected to seal possible subsidence cracks to prevent downward migration of water and subsequent loss of springs and other water sources.

4.17.4 Mitigation of Subsidence Effects

The only structures that may be effected by subsidence are the natural gas pipeline which crosses the coal lease area and roads within the area.

Should the natural gas pipeline be damaged despite the planned subsidence prevention measures, the Permittee will arrange for its repair with the owner of the pipeline.

Any improved roads that are materially effected by subsidence will be repaired, regraded and resurfaced to restore them to their pre-subsidence usefulness and condition.

Hydrologic information for the past four years at the Skyline Mine indicates that there is a reasonably good correlation between the amount of mine water discharged and the amount of coal mined (see Figure 4.11.4-A). Our mine water is being produced from the Blackhawk Formation. Data from our approved water monitoring program indicates that our mine dewatering is not affecting any surface springs or seeps. Our experience is showing that the migration of water through the aquifer is extremely slow to the extent that the water should be considered "perched or trapped water."

At this point in time it is difficult to suggest any mitigation of impacts or reclamation on renewable resources that are impacted by undermining, since we can only assume those impacts and their effect. Mitigation measures will be contingent upon the findings of the subsidence monitoring program. As data is collected, methods of mitigation will be formulated. This will be done in coordination with appropriate regulatory agencies. Since subsidence may continue to occur after final mining, the monitoring program will continue until it is determined by the permitee in cooperation with the regulatory agency that it is no longer needed.

4.17.5 Subsidence Monitoring Program

The Permittee has chosen to establish a subsidence monitoring program using aerial photogrammetrics patterned after a program developed by the Manti-LaSal National Forest to determine the effects of underground coal mining on surface renewable resources and surface improvements. The monitoring program shall secure adequate baseline data prior to any subsidence to quantify the existing surface renewable resources and surface improvements on and immediately adjacent to the permit area. The baseline data will be established so that future programs of observation can be incorporated at regular intervals for comparison. The monitoring program will also establish a system to locate, measure, and quantify the progressive and final affect of underground mining activities on the surface renewable resources and surface improvements. The system will utilize techniques which will provide a continuing record of change over time and an analytical method for location and measurement of a number of points over the permitted area. The continuum of data shall incorporate and be an extension of the baseline data.

A network of control monuments consistent with the desired photogrammetric map accuracy will be established over both the permit area and the immediate adjacent areas not expected to be disturbed by subsidence. The monuments will be constructed as survey control points for monitoring the effects of subsidence on surface renewable resources and surface improvements. The monuments will be located and tied to a state plane coordinate system which is the same for both the surface and mine control surveys. This will allow the surface survey to be superimposed over the subsurface mine workings. The monuments will have the X, Y, and Z coordinates accurately measured and established by ground survey methods.

The initial aerial photography will cover the entire permit area and will be either color or black and white, flown at a scale such that elevations to within one foot vertically and horizontally (±0.5') can be attained by photogrammetric methods. It is anticipated that the nominal or mean scale will be 1:6,000 for a 6" focal length camera, unless aerial constraints such as safety dictate flying at a high altitude, but will not exceed 1:7,200. This photography will be used for constructing the initial baseline surface map. It will also provide the master base to assist in documenting changes caused by subsidence.

To aid in the collection of additional base data on surface renewable resources, color infrared aerial photography (CIR) of the permit area may be utilized. If this technique is used, the photographs will be of the same scale as the other aerial photography.

Subsequent annual black and white or color photography for subsidence monitoring will cover the area mined and the area to be mined in the next 18 months (plus angle of draw). Subsequent CIR photography for monitoring surface resource trends will be flown as needed.

On all aerial photography for both the baseline data and subsequent flights, a photographic overlap of 30 percent between adjacent flight lines and an average of 60 percent overlap of photographs along the same flight line will be obtained. The baseline data will be digitized to show the undisturbed pre-subsided ground elevations and will use a grid with a nominal mean grid scale of 200 x 200 feet. The subsequent flights for subsidence will also be digitized using the same grid scale as the baseline to show the elevational deviation from the baseline elevations. The digitized information will be submitted annually to the regulatory agency after subsidence commences.

An on-the-ground visual inspection will be made annually of the ground surface of subsidence areas (including angle of draw).

This inspection will attempt to locate, photograph, and document the presence of subsidence effects to surface improvements, tension cracks, fissures and other surface effects.

The subsidence monitoring data could be used to determine: 1) the critical width across the pressure arch; 2) the draw angle; 3) the ratio of observed subsidence to predicted maximum subsidence (S/Smax); 4) the relationship between mining and onset of subsidence and the correspondence between the face advance and subsidence profile development; and 5) the bulking factor.

4.17.6 Subsidence Control

The Permittee plans to conduct the underground mining operations so as to prevent subsidence from causing material effect to the surface and to maintain the value and reasonable forseeable use of that surface in accordance with the preceeding subsidence control plan.

4.17.7 Public Notice

Since the surface ownership of the areas of planned subsidence is vested in the United States and is under the authority of the U.S. Forest Service, the annual subsidence monitoring report will be provided to them and to the regulatory authority.

Power transmission lines for underground mining and related activities in the permit area were designed and constructed to comply with the guidelines set forth in "Environmental Criteria for Electric Transmission System" (USDI, USDA (1970)). Power distribution was designed and constructed in accordance with REA Bulletin 61-10 "Powerline Contacts by Eagles and Other Large Birds".

If necessary, a wire fence will be erected and maintained around the perimeter of the portal area or portions thereof to protect grazing stock and wildlife. The fence design will be submitted to the regulatory authority prior to construction. Other ventilation shafts and structures will be similarly fenced, covered or otherwise protected if required. While the ponds contain no toxic-forming materials, the Permittee agrees to exclude wildlife from such ponds should it become necessary. No persistent pesticides will be used unless approved by the regulatory authority as part of a reclamation management plan.

The Permittee also agrees to participate in the prevention, suppression, and control of forest, range, and coal fires, even though these fires may not be part of an approved management plan. The Permittee on occasion conducts a conservation training program for mine employees. This program conducted by personnel of the Utah Division of Wildlife Resources has been included as part of the routine mine training schedule.

Additional information on wildlife can be found in this document in Section 2.9 - TERRESTRIAL WILDLIFE and Section 2.10 - RAPTORS.

The South Fork Breakout is located in an Elk Calving area. Construction of the face up area should be done after calving
* season. The tributary to South Fork is a contributing stream for aquatic insect drift to the fishery in Eccles Creek. Construction operations will be done in a manner to minimize disturbances and influences on the stream.

Power transmission lines for underground mining and related activities in the permit area were designed and constructed to comply with the guidelines set forth in "Environmental Criteria for Electric Transmission System" (USDI, USDA (1970)). Power distribution was designed and constructed in accordance with REA Bulletin 61-10 "Powerline Contacts by Eagles and Other Large Birds".

If necessary, a wire fence will be erected and maintained around the perimeter of the portal area or portions thereof to protect grazing stock and wildlife. The fence design will be submitted to the regulatory authority prior to construction. Other ventilation shafts and structures will be similarly fenced, covered or otherwise protected if required. While the ponds contain no toxic-forming materials, the Permittee agrees to exclude wildlife from such ponds should it become necessary. No persistent pesticides will be used unless approved by the regulatory authority as part of a reclamation management plan.

The Permittee also agrees to participate in the prevention, suppression, and control of forest, range, and coal fires, even though these fires may not be part of an approved management plan. The Permittee on occasion conducts a conservation training program for mine employees. This program conducted by personnel of the Utah Division of Wildlife Resources has been included as part of the routine mine training schedule.

Additional information on wildlife can be found in this document in Section 2.9 - TERRESTRIAL WILDLIFE and Section 2.10 - RAPTORS.

The South Fork Breakout is located in an Elk Calving area. Construction of the face up area should be done after calving
* season. The tributary to South Fork is a contributing stream for aquatic insect drift to the fishery in Eccles Creek. Construction operations will be done in a manner to minimize disturbances and influences on the stream.

REPLACES	TEXT
Section 4.18.2 Page 4-84	Section 4.18.2 Page 4-84 Date 1/10/89

* Denotes change or addition

4.19 STREAM DIVERSIONS

The objective of the stream channelization and runoff diversion channelization program has been to minimize impacts to the surface water quality of the Skyline project area. Stream diversions and channelizations were undertaken pursuant to an approved Army Corps of Engineers 404 Permit, and with the approval of the regulatory authority and of the Division of Wildlife Resources. No additional diversions of Eccles Creek are planned until final reclamation, at which time the streams in the portal area will be returned to the surface.

4.19.1 Mine Site Stream Diversion

The confluence area of the three tributaries of Eccles Creek form a crowsfoot drainage pattern at the mine site. One tributary extends in a northerly direction, the second in a northwesterly direction and the third southwesterly. To ensure that the water quality of these streams was not degradated as a result of mine facilities operation and construction, the stream flow was diverted into CMP culverts located under the mine benches (See Map 3.2.1-1). The culverts are designed to safely pass the peak runoff of a 100 year, 24-hour precipitation event. The combined drainage area for these streams is approximately 801 acres. The precipitation from a 100 year, 24-hour rainstorm is expected to be about 3.70 inches. After infiltration losses, surface runoff will be approximately 0.031 inches based on the assumption that the overland flow from the majority of the watershed is essentially non-existent. The resulting peak runoff flow would be about 4.0 cfs. See Vaughn Hansen, May, 1980 report update in Appendix Volume A-1. The proposed culverts are designed such that during the winter months, adequate through-put spacing remains sufficient even if ice accummulates inside the culverts.

The culverts for use in the northern tributary are 48 inches in diameter and approximately 600 feet in length to a point of connection with a 72-inch diameter culvert. The northwest tributary culvert is 48-inches in diameter and approximately 736 feet long. This culvert connects into a 60-inch diameter culvert. The culvert for the southwest tributary is 48 inches in diameter and approximately 846 feet long, and also connects into the 60-inch culvert. The 60-inch culvert originates at the confluence of these two 48-inch culverts and continues for approximately 526 feet to the confluence with the north 48-inch culvert. From this point a 72-inch culvert extends for approximately 1,058 feet to a point beyond the portal area.

The inlet for each culvert was constructed of concrete with a trash rack installed to prevent drift material from plugging the culverts. Riprap was used at each inlet structure to minimize erosion. A rock structure was constructed immediately downstream of the outlet structure.

4.19.2 Mine Site Diversion Channels

Mine site diversion channels were designed and constructed around the perimeter of the disturbed area to prevent overland flow from reaching the sedimentation pond. These channels were designed to carry the peak flow resulting from a 100 year, 24-hour precipitation event. The precipitation from a 100 year, 24-hour rainstorm is expected to be approximately 3.7 inches. After infiltration losses, surface runoff is anticipated to be approximately 0.031 inches.

The channels were placed beyond the mine site facilities, as shown on Map 3.2.1-1. The channels are triangular or trapezoidal in shape. The triangular-shaped channels have 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. The triangular-shaped channels have a minimum depth of 3 feet and a top width of 9 feet. In addition, a minimum of 1 foot of freeboard will be maintained. The channels are riprapped or have CMP drop structures as needed to help reduce erosion. Trapezoidal-shaped channels have 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. Each trapezoidal-shaped channel has a minimum depth of 2 feet, a bottom width of 3 feet and a top width of 8 feet.

4.19.4 Coal Storage Diversion Channel

The coal storage diversion channel was designed and constructed to carry the peak runoff from a 10 year, 24-hour precipitation event. The peak runoff flow is expected to be approximately 35 cfs. The channel is located just south of the coal storage facility.

The triangular-shaped channel has a 1.5 horizontal to 1.0 vertical (1.5h:1v) side slopes. A minimum depth of 1.5 feet and a maximum top width of 9 feet was constructed.

When the coal storage facility is no longer required, the channel will remain until the area has been stabilized. With the completion of revegetation and stabilization activities, the channel will be backfilled, topsoiled and revegetated.

4.19.5 Reclamation of Diversions and Channels - Portal Area

Reclamation after cessation of mining will be directed towards providing the needs of the macroinvertebrates since this area is not directly used by the fish of Eccles Canyon. Reclamation will include removal or burial of the culverts, replacing the stream into channels providing optimal substrates for macroinvertebrate production (rubble/gravel with diameters from 1/2 to 12 inches), revegetation of riparian zones, restoring riffle:pool ratios to approximately 3:1, installing trash catchers, and riprapping stream banks and channels where required for channel stability.
* The natural stream channels above the disturbed area contain a good natural supply of high quality macro-invertebrates. The stream channel stabilizaation work should provide an excellent environment for the natural drift of upstream macro-invetrebrates to become fully established in.

REPLACES	TEXT
Section 4.19 Page 4-88	Section 4.19 Page 4-88 Date 10/15/88

* Denotes change or addition

* backfilling measure. The UDOT culvert in the southwest fork will be uncovered at the permit boundary and the stream will enter the open channel. The open channel will again enter a UDOT culvert going under SR 264 at the permit boundary at the east end of the disturbed area. Any culvert left in place will have a minimum of four feet of cover backfill over it.

The natural stream channels above the disturbed area contain a good natural supply of high quality macro-invertebrates. The stream channel stabilization work should provide an excellent environment for the natural drift of upstream macro-invertebrates.
* To assist in the adequacy review of the protal area channel reclamation effort, Maps 4.19.5-1 through 4.19.5-4 have been included, which show stream channel cross sections in the three forks above the disturbed area and in Eccles Creek below the disturbed area.

The design of the reclaimed channels is shown in Map 4.4.2-1A and 4.4.2-1B and is generally described herein. The final design, with engineering documentation, is included in the Engineering Calculation section of Volume 5.

The access roads to both well houses will be removed and will be reclaimed to UDOT specifications. At a minimum, this access road, pad and culvert will be removed, the stream channel reconstructed consistent with the existing channel, and the road slope to the creek will receive the same treatment as now exists above and below the pad.

The recently installed on-site NOAA weather station enables collection of precipitation data on a 15 minute basis. To

The design of the reclaimed channels is shown in Map 4.4.2-1A and 4.4.2-1B and is generally described herein. The final design, with engineering documentation, is included in the Engineering Calculation section of Appendix Volume A-3.

The recently installed on-site NOAA weather station enables collection of precipitation data on a 15 minute basis. To

complete determination of runoff coefficients, flood crest gauges will be installed in at least two of the stream culverts. Flow will be determined using pipe size and slope. Using the site specific runoff coefficients, the reclaimed stream channel will be appropriately sized and properly armored.

The North, Northwest and Southwest Forks and Eccles Creek below the forks will be built mostly on a slope between 2 percent and 4 percent with spaced drop areas where the slope varies from 10 percent to as high as 35 percent for short distances (Maps 4.4.2-1A and 4.4.2-1B).

In areas of steep slopes the channel will be rip-rapped with large rocks varying from one foot to three feet in diameter. Cobbles and coarse gravel will be placed among the boulders. The bottoms of the steep slopes will be protected by extending the large rock cover 50 to 100 feet beyond the place where the slope flattens out again.

The stream channel on the flatter slopes (2 percent to 4 percent) will be covered with coarse gravel (1-3 inches diameter) and rubble (up to one foot in diameter). The bottom of the channel will be shaped so that the depth of flow will approach six inches even during very small flows. Channels will be about 10 feet wide and 2 feet deep.

Riparian vegetation should be plentiful along the stream and along any cut slopes near the stream.

4.19.6 Reclamation of Diversions and Channels - Loadout Area

The diverted section of Eccles Creek will be left in place after mining operations are complete, since restoration to the original channel would only cause unnecessary disturbance. The culverts into the loadout area will not be removed since these culverts are replacements for those in place prior to construction.

4.19.7 Diversion Channel at Rock Disposal Site

A diversion channel has been installed as shown on Map 4.16.1-1B. The swale to redirect the drainage across the access road and into the original stream channel will be constructed of concrete as shown in Figure 4.19.7-1.

The swale outlet will be lined with 4 inch x 4 inch or larger rock to reduce exit velocity of water from the swale. Engineering calculations for the waste disposal site channel design are included in Appendix Volume A-3.

* 4.19.8 South Fork Breakout

A new road will be constructed which will cross a drainage way to the South Fork of Eccles Creek. This drainage way flows in all but extremely dry years. When the creek crossing is constructed, the top soil will be removed with a track hoe to help minimize disturbance to the channel itself. The culvert will be placed in the existing channel, and then the road fill placed over it.

During reclamation, the fill material will be removed and then the culvert lifted out of the channel. Top soil will then be placed back on the disturbed area with a track hoe and the area reseeded. Although no permanent disturbance to the channel is planned or expected, if it should occur it will be rip-rapped with a gradation of material from 4" to a maximum size of 38".

All culverts used for access to the area will be completely removed from the area during final reclamation.

ADDITION TO	TEXT
Section 4.19 Page 4-90	Section 4.19.8 Page 4-90 Date 10/15/88

Mine Access Road

The mine access road is classified as a Class I road and runs from the Mine #3 portal to the maintenance complex area. Drawings 3.2.4-1 and 3.2.6-2A show a typical cross section of the mine access road and related ditches. Since the length of the road is approximately 1,200 feet, no road culverts were installed. As shown in the design, the steepest portion of the access road is a 10.0% grade sustained for 250 feet. No other grades on the access road exceeds 10.0%. There are no switchbacks on the access road. None of the access road cut exceeds 1h:1v in unconsolidated material and .025h:1v in rock. The access road is be 20 feet wide with a 4 foot height berm at the shoulder. The road is flat with a drainage ditch against the highwall. The drainage ditch has been designed to safely pass the peak from a 10 year, 24 hour precipitation event. No trash racks and debris basins have been installed, as the ditch will be cleaned periodically. The road is surfaced with crushed gravel. Once mining is completed, the road will be topsoiled and terraces will be constructed to prevent soil erosion

Water Tank Access Road

Access to the water tank area is via Utah State Highway SR-264.

Breakout Area Access Road

The road which was constructed to obtain access to the breakout area in the South Fork of Eccles Creek will be reopened during final reclamation. After the face up area has been reclaimed, the new temporary access road will be returned to the approximate original contour and seeded with the approved seed mixture.

! REPLACES	!! TEXT !
! Section 4.20.1 Page 4-93	!!Section 4.20.1 Page 4-93 Date 10/15/88!

The access road up the side canyon will be reopened to accomplish final reclamation work at the breakout area. After reclamation work is completed at the breakout area, the road will be ripped, water barred and seeded with the approved seed mixture. All culverts used in the project will be removed from the area.

4.20.2 Overland Conveyor Belt

The location of the upper two thirds of the conveyor is on a bench on the north slope of Eccles Canyon, while the lower one third will be supported by towers and trusses. The steepest portion of the conveyor is a negative 26.33 percent grade sustained for 430 feet. The average negative grade of the conveyor route is 9.39 percent and the average positive grade is 8.37 percent. Cut slopes along the route do not exceed 1h:1v in unconsolidated materials and 1h:4v in rock. As part of the air quality control program, the belt and transfer points will be enclosed to reduce fugitive dust.

KAISER ENGINEERS

DESIGN CALCULATION INDEX

103-C | 10

JOB NUMBER	78097-411
JOB TITLE	SKYLINE PROJECT
AREA OR BUILDING	PORTALS SITE
CALCULATION DESCRIPTION	SIZING INTERCEPTOR DITCHES
DISCIPLINE	CIVIL

CALCULATIONS APPLY TO DRAWINGS AND REVISIONS SHOWN:

DRAWING	REV	DRAWING	REV	DRAWING	REV	DRAWING	REV

	(SIGNATURE)	(DATE)
DESIGN ENGINEER	B. Yelda	
CALCULATIONS CHECKED	[signature]	4.10.80
CALCULATIONS AGREE WITH DESIGN CRITERIA		
JOB ENGINEER	B. Yelda	4-10-80
DESIGN SUPERVISOR	[signature]	5/30/80
CALCULATIONS AGREE WITH APPVD. VENDOR DWGS.		

CALCULATION REVS	△	DATES	△	DATES	△	DATES	△	DATES
REVISION DESCRIPTION								
DESIGN ENGINEER								
CHECKER								
DESIGN SUPERVISOR								

STATUS: PRELIMINARY | FINAL (circled) | CHECK | VOID | HOLD | OTHER

REASON FOR VOID OR HOLD:

INDEX

SHEET NO.	DESCRIPTION
1	DESIGN CRITERIA / REFERENCES
2	TRIBUTARY DRAINAGE AREA OF INTERCEPTOR DITCHES
	AT PORTAL SITE
3, 4, 5, 6, 7, 8	
9, 10	DESIGN INTERCEPTOR DITCHES

KAISER
ENGINEERS

JOB No. 78097-411

SHEET 1 OF 10

SKYLINE MINE

FINAL DESIGN OF INTERCEPTOR DITCHES AT PORTAL AREA

DESIGNED BY B.Y. DATE 11-6-79

CHECKED BY [signature] DATE 1/10.80

DESIGN CRITERIA

METHOD - RATIONAL

Tc = TIME CONCENTRATION

C = RUNOFF COEFFICIENT = 0.30

D = DISTANCE IN FEET

S = SLOPE

$$T_c = \frac{1.8(1.1-C)\sqrt{D}}{\sqrt[3]{S}}$$

REFERENCE: F.A.A DEPARTMEN OF TRASPORTATION DATE 1970

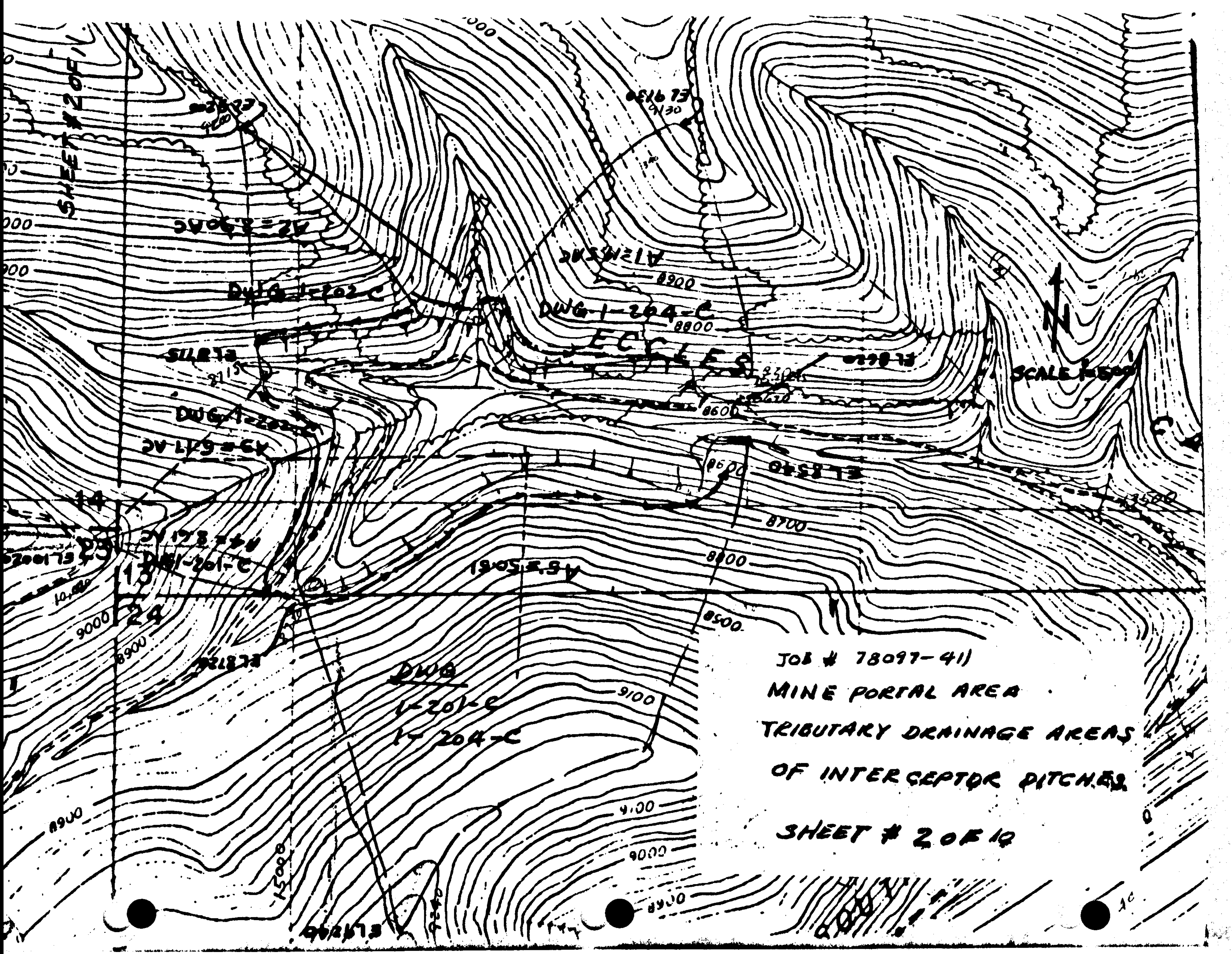
a. ACCORDING TO THE THEORY UNDERLYING THE RATIONAL METHOD, MAXIMUM DISCHARGE AT ANY POINT IN A DRAINAGE SYSTEM OCCURS WHEN:

1. THE ENTIRE AREA TRIBUTARY TO THAT POINT IS CONTRIBUTING TO THE FLOW.

2. THE RAINFALL INTENSITY PRODUCING SUCH FLOW IS BASED UPON THE RATE OF RAINFALL WHICH CAN BE EXPECTED TO FALL IN THE TIME REQUIRED FOR WATER TO FLOW FROM THE MOST REMOTE POINT OF THE AREA TO THE POINT BEING INVESTIGATED. THE "MOST REMOTE POINT" IS THE POINT FROM WHICH THE TIME OF FLOW IS GREATEST. IT MAY NOT BE AT THE GREATEST LINEAR DISTANCE FROM THE POINT UNDER INVESTIGATION.

NOTE

CALCULATIONS Form No. E-6 Rev. 10-71



DWG 1-202-C
DWG 1-204-C
ECCLES
N
8900
8800
8600
8700
8800
8500
9100
9000
14
13
23
24
DWG 1-201-C
DWG
1-201-C
1-204-C
JOB # 78097-41)
MINE PORTAL AREA
TRIBUTARY DRAINAGE AREAS
OF INTERCEPTOR DITCHES
SHEET # 2 OF 10

KAISER ENGINEERS

SKY LINE MINE FINAL DESIGN
OF INTERCEPTOR DITCHES
AT PORTAL AREA

JOB No. 78097
SHEET 3 OF 10
DESIGNED BY BY. DATE 11-6-7?
CHECKED BY PHC DATE 4.10.8?

CONTD

DESIGN INTERCEPTOR DITCHES:

AT PLANT AREA DWG 1-204-C
1-202-C
1-201-C

INTERCEPTOR DITCHES WILL BE LOCATE min 8' AWAY FROM THE TOP OF THE CUT. THE FLOW DISCHARGE WILL BE DESIGNED FOR 100 YERS STORM 24 HOUR PRECIPITATION EVENT.

6" FREEBOARD WILL BE PROVIDED FROM NATURAL GROUNDSURFACE AT LOW POINT TO THE WATER LEVEL INSIDE DITCH.

KNOWN

TOPO MAP OF THE PLANT AREA SCALE 1" = 500' (SEE sheet 2 OF 10
SHOWING THE WATER SHED AREAS OF EACH SEPERATE DITCH.
AREA MEASURED BY PLANIMETER. TYPE 235-A SERIAL No 231549
THE ROD WAS SET @ 10 PLANIMETER READ 1" = 100
SCALE = 1" = 500' 1" = 250000
P = 250000 / 100 = 2500 FACTOR

AREA NO	PLANIMETER READING	CP	AREA ft²	AREA Acres	L feet	H feet	S	⌀
A1 (DWG 1-204-C)	340	2500	850,000	19.51	1200'	510'	0.43	23.03°
A2 (DWG 1-202-C)	155	2500	387,500	8.90	1000'	485	0.49	25.87°
A3 (DWG 1-202-C)	90	2500	225,000	5.17	1050'	1305	1.24	51.18°
A4 (DWG 1-201-C)	150	2500	375,000	8.61	850'	1300'	1.53	56.8°
A5 (DWG 1-201-C 1-204-C)	880	2500	2,200,000	50.51	2600'	700'	0.27	15.07°

H = THE DEFFERENCE BETWEEN THE REMOTE POINT & THE LOW POINT OF THE AREA OF WATER SHED
L = THE HORIZONTAL DISTANCE FROM REMOTE POINT TO THE LOW POINT
D = THE LONG DISTANCE FROM TH REMOTE POINT TO THE LOW POINT ON THE SLOPE OF TERRAIN ~~FOR INFORMATION~~ ~~REFER TO ... SHEET NO~~

KAISER ENGINEERS

JOB NO. [illegible]

SHEET 3 OF 10

SKYLINE MINE FINAL DESIGN OF INTERCEPTOR DITCHES AT PORTAL AREA

DESIGNED BY K.H. DATE 11-6-7[illegible]

CHECKED BY [illegible] DATE 4.10.80

ϕ = THE SLOPE ANGLE

ϕ	$\cos\phi$	L	$D=\frac{L}{\cos\phi}$	AREA NO	TC	I	C	A	Q
23.03°	0.92	1200	1304.35'	A1	14.87	2.6	0.30	19.5	15.21
25.87°	0.90	1000	1111.11'	A2	13.13	2.75	0.30	8.90	7.34
51.18°	0.63	1050	1666.67'	A3	11.81	3.00	0.30	5.17	4.66
56.82°	0.55	850	1545.45'	A4	10.76	3.20	0.30	8.61	8.27
15.07°	0.97	2600	2680.41'	A5	25.13	1.90	0.30	50.51	28.79

$$T_C = \frac{1.8(1.1-C)\sqrt{D}}{\sqrt[3]{S}}$$

$$A_1 \quad T_{C_{A_1}} = \frac{1.8(1.1-0.30)\sqrt{1304.35}}{\sqrt[3]{43}} = \frac{1.8(1.1-0.30)\,36.12}{3.50} = 14.87 \text{ mint.}$$

(1.44)

$$T_{C A_2} = \frac{1.8(1.1-0.30)\sqrt{1111.11}}{\sqrt[3]{49}} = \frac{1.8(1.1-0.30)\,33.33}{3.65} = 13.13 \text{ mint.}$$

$$T_{C A_3} = \frac{1.8(1.1-0.30)\sqrt{1666.67}}{\sqrt[3]{124}} = \frac{1.8(1.1-0.30)\,40.82}{4.98} = 11.81 \text{ mint}$$

$$T_{C A_4} = \frac{1.8(1.1-0.30)\sqrt{1545.45}}{\sqrt[3]{153}} = \frac{1.8(1.1-0.30)\,39.31}{5.26} = 10.76 \text{ mint.}$$

$$T_{C A_5} = \frac{1.8(1.1-0.30)\sqrt{2680.41}}{\sqrt[3]{27}} = \frac{1.8(1.1-0.3)\,51.77}{2.97} = 25.13 \text{ mint.}$$

FROM RAINFALL INTENSITY DURATION CURVES SHEET NO.

$I_{A_1\,100} = 2.6$ INCH/HR

$I_{A_2\,100} = 2.75$ "

$I_{A_3\,100} = 3.00$ "

$I_{A_4\,100} = 3.20$ "

$I_{A_5\,100} = 1.90$ "

SKYLINE MINE

FINAL DESIGN OF INTERCEPTER DITCH

DESIGNED BY B.Y. DATE 11-6-79

CHECKED BY [illegible] DATE 4/10/8[illegible]

AREA A_1

THE SIZE OF DITCHES WILL BE UNIFORM SIZE AND WILL BE DESIGNED FOR THE Q DISCHAGE AT THE END OF THE DITCH. VELOCITY WILL CONTROL THE SIZE OF THE DITCH

$Q_{A_1} = 15.21$ cfs

n = Coefficient of Roughness FOR SILT CLAY OR SOFT SHALE = 0.020

v = Maximum Permissible Velocity FOR UN PAVED DITCH = 3.5 ft/sec

USING MANNING FORMULA

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$v = 3.5$ feet/sec

$Q = vA$

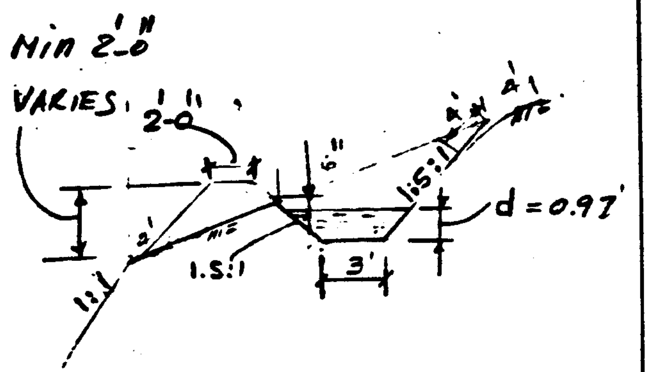
$15.21 = 3.5A$

$$A = \frac{15.21}{3.5} = 4.35 \text{ ft}^2$$

$4.35 = 3d + 1.5d^2$

$1.5d^2 + 3d - 4.35 = 0$

$$d = \frac{-3 \pm \sqrt{9 + 4 \times 1.5 \times 4.35}}{3} = 0.97$$



AREA $= 3d + 1.5d^2$

$P = 2\sqrt{2.25d^2 + d^2} + 3$

$R = \frac{A}{P}$

$$R = \frac{3d + 1.5d^2}{2\sqrt{2.25d^2 + d^2} + 3} = \frac{3d + 1.5d^2}{3.61d + 3}$$

$$R = \frac{3 \times 0.97 + 1.5 \times 0.97 \times 0.97}{3.61 \times 1.23 + 3} = 0.58$$

$R^{2/3} = 0.58^{.667} = 0.70$

$$\sqrt{S} = \frac{Q\,n}{1.486 \times A \times R^{2/3}}$$

$$\sqrt{S} = \frac{15.21 \times 0.020}{1.486 \times 4.74 \times 0.70} = 0.061697$$

$S = 0.003807$

$S = 0.38$ %

THIS DITCH WILL BE CONSTRUCTED UP TO THE 950' FROM THE HIGH POINT (UPSTREAM WEST TOWARD EAST) FROM THERE ON DUE TO STEEP SLOPE SHALL BE PROTECTED BY ERROSION CONTROL MATERIAL

AREA A2

THE SIZE OF DITCH WILL BE UNIFORM SIZE AND WILL BE DESIGNED FOR THE Q DISCHARGE AT THE END OF THE DITCH. VELOCITY WILL CONTROL THE SIZE OF THE DITCH.

$Q = 7.34$ C.F.S

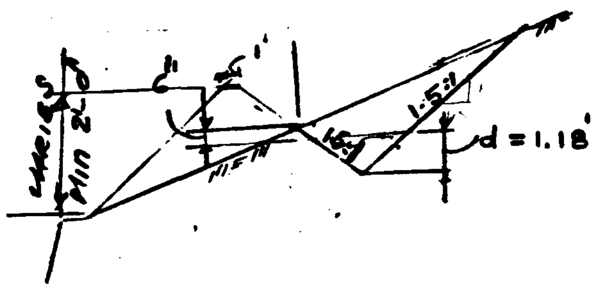
$n = 0.020$

$v = 3.5$ ft/sec

USING MANNING FORMULA

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$v = 3.5$ feet/sec



$Q = vA$

$$A = \frac{7.34}{3.5} = 2.097 \text{ ft}^2$$

$2.095 = 1.5d^2$

$$d^2 = \frac{2.095}{1.5} = 1.398$$

$d = 1.18'$

$$\sqrt{S} = \frac{Qn}{1.486 \times A \times R^{2/3}}$$

$$\sqrt{S} = \frac{7.34 \times 0.02}{1.486 \times 2.097 \times 0.622} = 0.0757$$

$S = 0.005737$

0.574 %

AREA $= 1.5d^2$

$P = 2\sqrt{d^2 + 2.25d^2}$

$$R = \frac{1.5d^2}{2\sqrt{d^2 + 2.25d^2}}$$

$$R = \frac{2.088}{2\sqrt{4.525}} = 0.490$$

$R^{2/3} = 0.490^{0.667}$

$R^{2/3} = 0.622$

THIS DITCH WILL BE CONSTRUCTED UP TO THE 750' FROM THE HIGH POINT (UPSTREAM EAST TOWARD WEST) FROM THERE ON DUE TO STEEP SLOPE SHALL BE PROTECTED BY ERROSION CONTROL MATERIAL

FOR LOCATION SEE GRADING PLAN DWG 1-202-C

KAISER ENGINEERS

SKYLINE MINE

FINAL DESIGN OF INTERCEPTOR DITCH

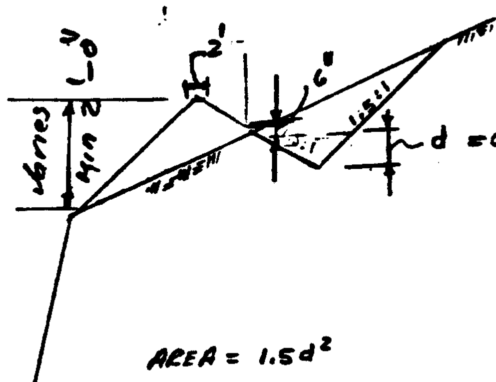
DESIGNED BY [signature] DATE 11-6-79

CHECKED BY [signature] DATE 4.10.80

AREA A3

THE SIZE OF DITCH WILL BE UNIFORM SIZE AND WILL BE DESIGNED FOR THE Q DISCHARGE AT THE END OF THE DITCH VELOCITY WILL CONTROL THE SIZE OF THE DITCH

$Q = 4.66$ c.f.s.



$n = 0.020$

$V = 3.5$ ft/sec

USING MANNING FORMULA

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

$V = 3.5$ FPS

$A = \frac{4.66 \text{ cfs}}{3.5 \text{ f.s}} = 1.33 \text{ Ft}^2$

$d = \sqrt{\frac{1.33}{1.5}} = 0.94'$

$\sqrt{S} = \frac{4.66 \times 0.02}{1.486 \times 1.33 \times 0.536} = 0.087985$

$S = 0.00774$

SLOPE 0.774 %

AREA $= 1.5d^2$

$P = 2\sqrt{d^2 + 2.25d^2}$

$R = \frac{1.5d^2}{2\sqrt{d^2 + 2.25d^2}}$

$R = \frac{1.33}{2\sqrt{0.884 + 1.988}} = \frac{1.33}{3.389} = 0.39$

$R^{2/3} = 0.39^{0.667}$

$R = 0.536$

THIS DITCH WILL BE CONSTRUCTED UP TO THE 400' FROM THE HIGH POINT UPSTREAM SOUTH TOWARD NORTH WEST @ AREA A3

SKY LINE MINE
FINAL DESIGN OF INTECEPTER DITCH

DESIGNED BY [illegible] DATE 11-6-79
CHECKED BY [illegible] DATE 4.10.80

AREA A4

THE SIZE OF DITCH WILL BE UNIFORM AND WILL BE DESIGNED FOR THE Q DISCHARGE AT THE END OF THE DITCH VELOCITY WILL CONTROL THE SIZE OF THE DITCH

$Q = 8.27$

$n = 0.020$

$V = 3.5$ ft/sec

V= 3.5 feet/sec.

USING MANNING FORMULA

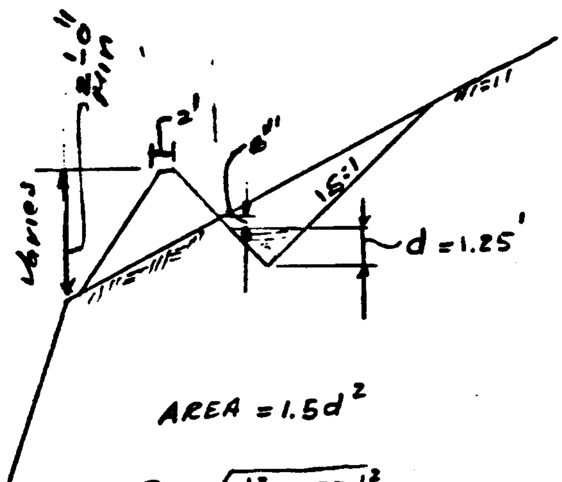
$$Q = \frac{1.486\, A R^{2/3} S^{1/2}}{n}$$

$V = 3.5$ feet/sec

$Q = VA$

$$A = \frac{8.27}{3.5} = 2.36 \text{ ft}^2$$

A= 2.36 ft²



$AREA = 1.5d^2$

$P = 2\sqrt{d^2 + 2.25d^2}$

$$R = \frac{1.5d^2}{2\sqrt{d^2 + 2.25d^2}}$$

$$R = \frac{1.5 \times 1.25 \times 1.25}{2\sqrt{1.25^2 + 2.25 \times 1.25^2}} = \frac{2.36}{4.51}\ 0.52$$

$R^{2/3} = 0.52^{0.667} = 0.65$

$2.36 = 1.5d^2$

$$d = \sqrt{\frac{2.36}{1.5}} = 1.25'$$

$$\sqrt{S} = \frac{Qn}{1.486 \times A \times R^{2/3}}$$

$$\sqrt{S} = \frac{8.27 \times 0.020}{1.486 \times 2.36 \times 0.65} = 0.07260$$

R= 0.65 ft

$S = 0.00527$

S=0.00527

$S = 0.527\ \%$

THIS DITCH WILL BE CONSTRUCTED UP TO 700' FROM THE HIGH POINT (UPSTREAM NORTH TOWARD SOUTH).

FOR LOCATION SEE TOPO SHEET NO 1-201-C

SKYLINE

FINAL DESIGN OF INTERCEPTOR DITCH

DESIGNED BY BJ. DATE

CHECKED BY SAK DATE 6/10/8_

AREA A5

THE SIZE OF DITCH WILL BE UNIFORM AND WILL BE DESIGNED FOR THE Q DISCHARGE AT THE DITCH. VELOCITY WILL CONTROL THE SIZE OF THE DITCH

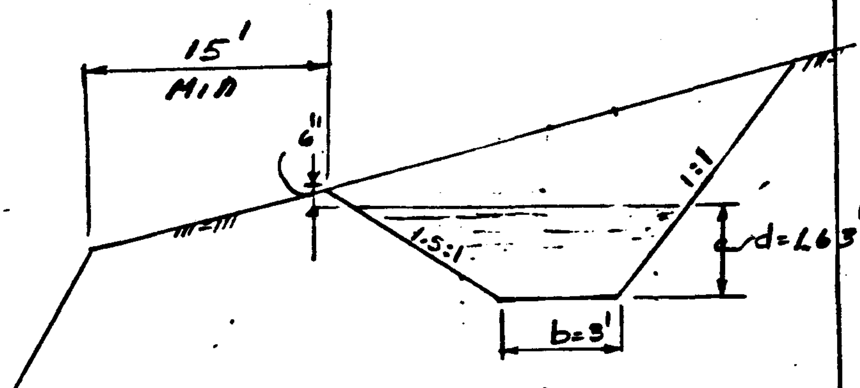
$Q = 28.79$ C.F.S.

$V = 3.5$ ft/sec

$$Q = \frac{1.486\, A R^{2/3} S^{1/2}}{n}$$

$Q = VA$

$$A = \frac{28.79}{3.5} = 8.226 \text{ ft}^2$$



ASSUMED $b = 2d$

$$\text{AREA} = 2d^2 + \frac{1.5d^2}{2} + \frac{d^2}{2}$$

$$\text{AREA} = 3.25d^2$$

$$P = \sqrt{2d^2} + \sqrt{2.25d^2 + d^2} + 2d$$

$$P = 3.2170d$$

$$R = \frac{3.25d^2}{3.2170d} = 0.6229d$$

$8.226 = 3.25d^2$

$$d^2 = \frac{8.226}{3.25} = 2.531$$

$d = 1.59'$

$b = 3.18'$

BEING MORE PRACTICAL NUMBER. Say
$b = 3'$

$$\text{AREA} = 3d + \frac{1.5d^2}{2} + \frac{d^2}{2}$$

$$\text{AREA} = 3d + 1.25d^2$$

$$P = 1.4142d + 1.802775d + 3 = 3.216975d + 3$$

$$R = \frac{3d + 1.25d^2}{3.216975d + 3}$$

$$1.25d^2 + 3d - 8.226 = 0$$

$$d = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$d = \frac{-3 \pm \sqrt{9 + 41.130}}{2.50} = 1.632'$$

$$R = \frac{\overset{4.896}{3 \times 1.632} + \overset{3.329}{1.25 \times 1.632 \times 1.632}}{3.216975 \times 1.632 + 3} = 0.997$$

$$R^{2/3} = 0.997^{0.667} = 0.998$$

$b = 3'$

$A = 8.226$

$d = 1.632'$

SKY LINE MINE

FINAL DESIGN OF INTERCEPTER DITCH.

DESIGNED BY BY DATE

CHECKED BY [illegible] DATE 4.10.8[illegible]

CONT'd AREA 5

$$\sqrt{S} = \frac{Qn}{1.486 \times A \times R^{2/3}}$$

$$\sqrt{S} = \frac{28.79 \times 0.020}{1.486 \times 8.226 \times 0.998} = 0.0472$$

$S = 0.00223$

$S = 0.223\ \%$

S=0.00223

THIS DITCH WILL BE CONSTRUCTED UP TO THE 800 FRM THE STA 4+00 POINT (UPSTREAM WEST TOWARD EAST) FROM THEREON DUE TO STEEP SLOP SHALL BE PROTECTED BY ERROSION CONTROL MATERIAL.

FOR LOCATION SEE TOPO SHEET No. 1-201-C
1-204-C

SHEET # 10

PROJECT TITLE: SKYLINE MINE

PROJECT NO.: 78097-

CALCULATED BY BM. DATE 11-6-79

CHECKED BY ______ DATE ______

Point From	Point To	Area No.	Indiv. Area A_1, Acres	Indiv. Run-off Coeff. "C"	$A_1 \times C$	$\Sigma A_1 C$	Total Time to Entrance of Section Min.	Time of Flow in Section Min.	Total Time to End of Section Min.	i in/hr	$Q = i \Sigma C A_1$ cfs	Length of Ditch Ft.	Slope of Ditch Ft./Ft.	Size at End Section: Ditch (D, d)	Size at End Section: Culvert	Avg. Vel. in Ditch fps Max	Vel. in Culvert fps Shape	Invert Elevation: Ditch In	Invert Elevation: Ditch Out	Invert Elevation: Culvert at End Section In	Invert Elevation: Culvert at End Section Out
A1			19.5	0.30	5.85				14.87	2.6	15.21	950'	0.0028	D=1.73' d=1.23		3.5	1.5:1				
A2			8.90	0.30	2.67				13.13	2.75	7.34	750	0.0057	D=1.68 d=1.18'		3.5	3' 1.5:1				
A3			5.17	0.30	1.55				11.81	3.00	4.66	400'	0.0077	D=1.44 d=0.94'		3.5	1.5:1				
A4			8.61	0.30	2.58				10.76	3.20	8.27	700'	0.00527	D=1.75 d=1.25		3.5	1.5:1				
A5			50.51	0.30	15.15				25.13	1.90	28.79	1900'	0.0022	D=2.13' d=1.63'		3.5	1:1 3'				

TRAIN LOADOUT
UNDISTURBED AREA DRAINAGE

DESIGN CRITERIA

RATIONAL METHOD

T_c : TIME CONCENTRATION

C : RUNOFF COEFFICIENT - 0.30 / discuss assumptions

D : DISTANCE

S : SLOPE

T_c : $1.8\,(1.1-C)\,\sqrt{D}\,/\,\sqrt[3]{S}$

AREA	PLANIMETER READING	FACTOR	AREA FT²	AREA (ACRES)	L FEET	H FEET	S SLOPE	φ
UDA₁	101	13,698	1,383,498	31.76	3500	1200	.34	18.92
UDA₂	17	13,698	232,866	5.35	400	106	.27	14.84
UD₃	7	13,698	95,886	2.20	450	80	.18	10.08

Cos φ	D = L/cos φ	T_c	I	C	A	Q
.9459	3,700	27.37	1.20	.30	31.76	11.43
.9666	413.81	9.87	2.00	.30	5.35	3.21
.9846	457.06	11.86	1.80	.30	2.20	1.19

T_c : $1.8\,(1.1-C)\,\sqrt{D}\,/\,\sqrt[3]{S}$

$T_{c\,UDA_1}$: $1.8(1.1-.30)\sqrt{3,700}\,/\,\sqrt[3]{.34}$

: $(1.44)(60.83)\,/\,3.20$

: $87.59\,/\,3.20$

: 27.37 MINUTE

$T_{c\,UDA_2} = 1.8(1.1-.3)\sqrt{413.81} / \sqrt[3]{27}$

$= 1.44(20.34)/2.97$

$= 29.29/2.97$

$= 9.87$ MINUTES

$T_{c\,UDA_3} = 1.8(1.1-.30)\sqrt{457.06} / \sqrt[3]{18}$

$= 1.44(21.38)/2.60$

$= 30.79 / 2.66$

$= 11.86$ MINUTES

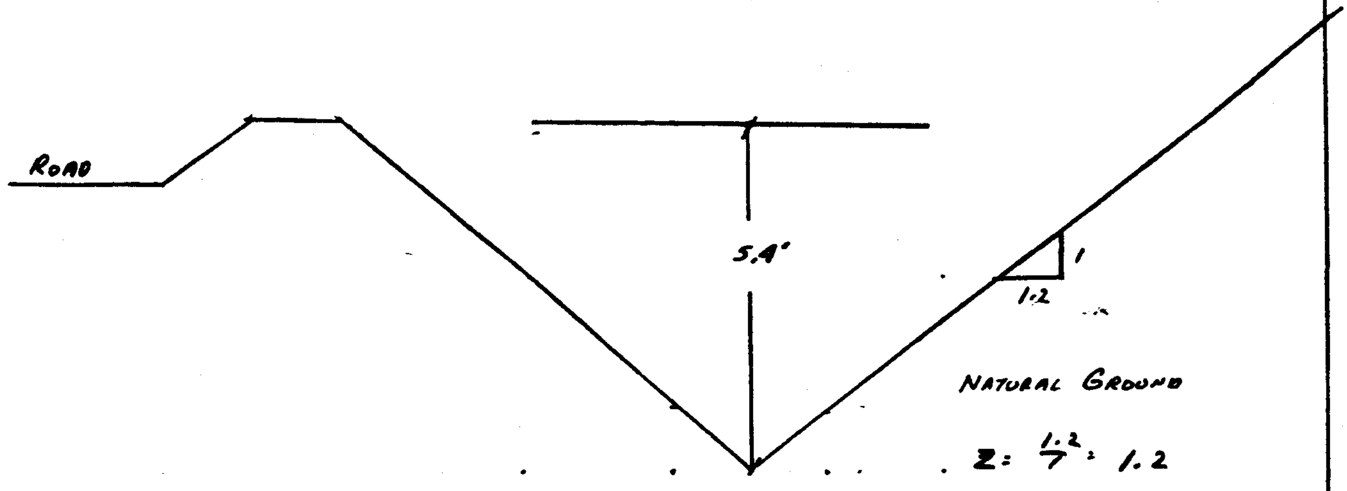
FROM RAINFALL INTESITY DURATION CURVE

$I_{UDA_1, 10} = 1.20$ IN/HR

$I_{UDA_2, 10} = 2.00$ IN/HR

$I_{UDA_3, 10} = 1.80$ IN/HR

AREA - UDA,



$Z = \frac{1.2}{1} = 1.2$

DESIGN FOR THE Q DISCHARGE AT THE END OF THE DITCH. VELOCITY WILL CONTROL THE SIZE OF THE DITCH

$Q = 11.43$ CFS

$n_1 = .035$

$V = 6.0$ FT/SEC

USING MANNING FORMULA

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = VA$$

$$A = 11.43 \text{ cfs} / 6.0 \text{ fps} = 1.91 \text{ ft}^2$$

$$A = z d^2$$

$$1.91 \text{ ft}^2 / 1.2 = d^2$$

$$1.59 = d^2$$

$$d = 1.26 \text{ ft.}$$

$$R = 2d / 2\sqrt{z^2+1}$$

$$= 2(1.26) / 2\sqrt{(1.2)^2+1}$$

$$= 2.52 / 3.12$$

$$R = .81$$

$\sqrt{S} = Q n / 1.486 R^{2/3} A$

$= 11.43 \text{ cfs} (.035) / 1.486 (.81)^{2/3} \; 1.91 \text{ ft}^2$

$= .4 / 2.47$

$\sqrt{S} = .16$

$S = .03$ or 3%

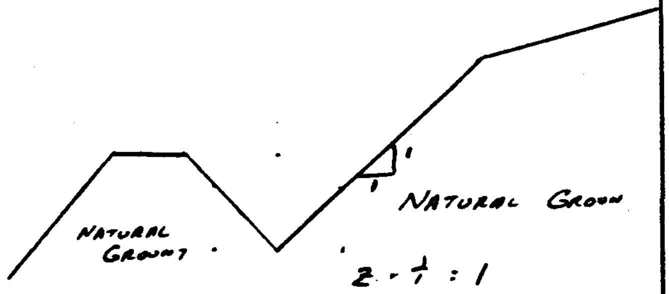
DITCH IS ALL RIGHT NO ERROSION PROTECTION NEEDED

AREA - UDA_2

Q = 3.21 CFS

n = .035

V = 6 FT/SEC



USING MANNING FORMULA

$Q = 1.486/n \; A R^{2/3} S^{1/2}$

$Q = VA$

$A = 3.21 \text{ CFS} / 6 \text{ FPS} = .54 \text{ FT}^2$

$A = z d^2$

$.54 \text{ FT}^2 = d^2$

$d = .73$ FT.

$R = 2d / 2\sqrt{z^2+1}$

$= 1.46 / 2.83$

$= .52$

$\sqrt{S} = Qn / 1.486 (R)^{2/3} A$

$= 3.21 (.035) / 1.486 (.52)^{2/3} .54$

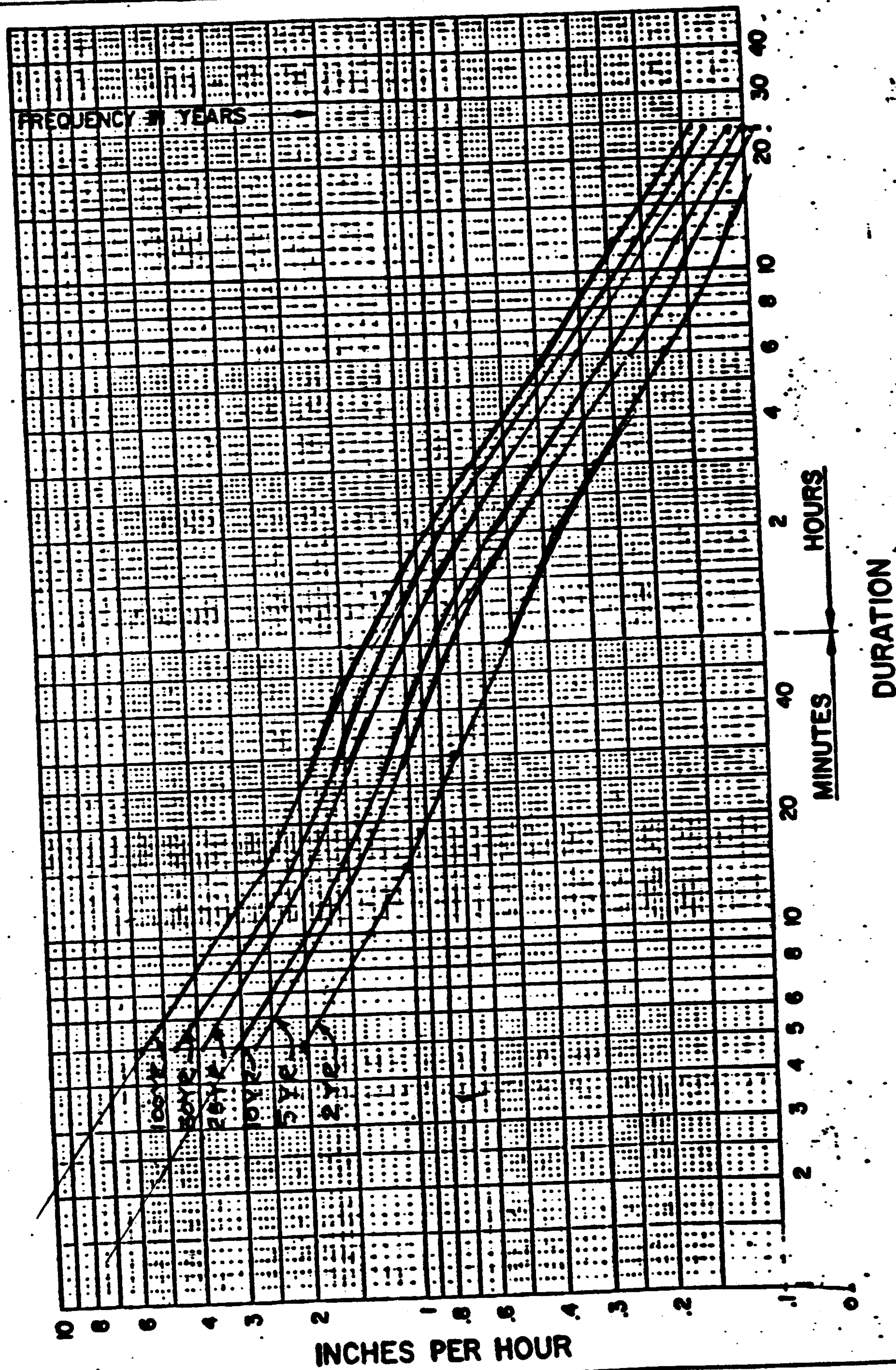
$= .11 / .52$

$\sqrt{S} = .22$

$S = .05$ OR 5%

DITCH IS ALL RIGHT NO ERROSION CONTROL NEEDED

RAINFALL INTENSITY DURATION CURVES



TRAIN LOADOUT
CULVERT DESIGN

AREA	PLANIMETER READING	FACTOR	AREA FT²	AREA ACRES	L FEET	H FEET	S SLOPE	∅
CA_1	2028	40	81,120	1.86	490	20	.04	2.39

COS ∅	D = L/COS ∅	T_c	I	C	A	Q
.9992	490.41	11.36	2.25/3.05	.65	1.86	2.72/3.19

$$T_c = 1.8(1.1-C)\sqrt{D}/\sqrt[3]{S}$$

$$= 1.8(1.1-.65)\sqrt{490.41}/\sqrt[3]{4}$$

$$= .81(22.16)/1.58$$

$$= 17.95/1.58$$

$$= 11.36$$

FROM RAINFALL INTENSITY DURATION CURVES

	10	100
I_{CA_1} =	2.25	3.05

BURIED 30" CMP

Q = 11.43 CFS - 100YR - 24HR

L = 294' FT

S = 29/294 = .08 FT/FT

DETERMINE DIAMETER OF THE PIPE

$$Q = 2.58\, D^{5/2}$$

$$11.43 \text{ CFS} = 2.58\, D^{2.5}$$

$$D = (11.43/2.58)^{1/2.5}$$

.4

$$D = 1.81 \text{ FT} \times 12 = 22 \text{ INCHES}$$

A 30" ∅ CULVERT WAS SIZED. IT WILL HANDLE THE FLOW

BURIED 24"ϕ CMP - 100 YR - 24 HR

$Q = DA_1 + DA_2 + DA_3 + MD_2 + CA_1$

$= 2.06 + 1.76 + 2.12 + .46 + 3.69$

$= 10.09$ CFS

$L = 90$ FT

$S = 10/90 = .11$

$Q = 2.58 D^{2.5}$

$10.09 \text{ CFS} = 2.58 D^{2.5}$

$D = \left(\frac{10.09}{2.58}\right)^{1/2.5} = 1.73 \text{ FT} \times 12 = 20.71$ USE 21 INCHES

A 24"ϕ CULVERT WAS SIZED. IT WILL HANDLE THE FLOW.

CULVERTS AT SUBSTATION

$Q = 10.29$ CFS

$L = 40$

$Q = 2.58 D^{2.5}$

$10.29 \text{ CFS} = 2.58 D^{2.5}$

$D = (10.29/2.58)^{1/2.5} = 1.74 \text{ FT} \times 12 = 20.87$ USE 21 INCH

FIND HW/D FOR GIVEN CONDITION

a) $HW = D \therefore HW/D = 1.0$

b) $HW = D+2$ $D = 1.33' \therefore HW = 2.67'$

$HW/D = 2.67/1.33 = 2.01$

FIND ENTRANCE LOSS COEF. FOR INLET SECTION

$K_e = 0.5$

$K_b = 1.0$

BERNOULLI EQUATION

$$V_1^2/2g + y_1 + z_1 = V_2^2/2g + y_2 + z_2 + \Sigma H_L$$

S×L+H

$$S \times L + H = \Sigma H_L$$
$$(.01)(45) + H = \Sigma H_L$$
$$.45 + H = \Sigma H_L$$

$$\Sigma H_L = V^2(.0660)$$

$$V = \sqrt{\Sigma H_L / .0660}$$

a) $H = 0$

$V = \sqrt{.45/.0660}$

$= 2.61$ FPS

b) $H = 1$

$V = \sqrt{1.45/.0660}$

$V = 4.69$ FPS

c) $H = 2$

$V = \sqrt{2.45/.0660}$

$= 6.09$

d) $H = 3$

$V = \sqrt{3.45/.0660}$

$= 7.23$ FPS

1.40

	H_L	V	Q
a)	.45 FT	2.61 FPS	3.64 CFS
b)	1.45 FT	4.69 FPS	6.57 CFS
c)	2.45 FT	6.09 FPS	8.51 CFS
d)	3.45 FT	7.23 FPS	10.12 CFS

HYDROLOGY STUDY
CULVERT EAST END ON
TRAIN LOADOUT

SOIL TYPE	PERCENT	TYPE	CN
UINTA FAMILY LOAN	50%	B	55
TOZE FAMILY FINE SANDY LOAM	35%	B	55
COMODORE BOULDERY LOAM	10%	D	77
MIDFORK FAMILY BOULDERY LOAM	5%	B	55

LAND USE IS WOOD AND FOREST LAND WITH GOOD COVER

$CN = [.5(55) + .35(55) + .1(77) + .05(55)]/(.5+.35+.10+.05)$

$= 27.50 + 19.25 + 7.70 + 2.75 / 1$

$= \underline{57.20}$ USE $\underline{57}$

$S = 1000/CN - 10$

$= 1000/57.20 - 10$

$= 17.48 - 10$

$= \underline{7.48}$

AREA OF THE WATER SHED.

$220 \times .0149 \, IN^2 = 3.28 \, IN^2 \times 22.96$ ACRES/IN² = $\underline{75.26 \text{ ACRES}}$

75.26 ACRES × 43,560 SQ.FT./ACRES = $\underline{3,278,451.05 \text{ SQ.FT.}}$

TIME PARAMETERS

CONCENTRATION TIME

$t_c = .0078\ L^{0.77}\ (L/H)^{0.385}$

$L = 5,100$ FT

$H = 1,360$ FT

$t_c = .0078\ (5,100)^{0.77}\ (5,100/1360)^{0.385}$

$= .0078\ (715.86)\ (1.66)$

$= 9.29$ MIN. USE 9.00 MIN.

LAG TIME

$t_L = L^{0.8}(S+1)^{0.7} / 1900\ Y^{0.5}$

$Y = \Sigma c_i \times i / \text{AREA IN SQ.FT}$

$i = 80$ FT

$A = 3,278,451.05$ SQ.FT.

ΣC_i

	CONTOUR
100	-9280
600	-9200
550	-9120
600	-9040
600	8960
600	8,880
650	8,800
700	8,720
725	8,640
800	8,560
925	8,480
1075	8,400
1300	8,320
1500	8,240
1625	8,160
2025	8,080
2000	8000
300	7920
16,675 FT.	

y = 16,675 FT × 80 FT / 3,278,451.05 SQ. FT

= .41 OR 41 %

t_L = $(5,100)^{.8}$ $(7.48+1)^{.7}$ / 1900 $(41)^{.5}$

= (924.82)(4.47) / 1900 (6.40)

= 4,133.95 / 12,165.94

= .34 HRS

= 20.39 MIN USE 20 MINS

t_L = .6 t_c

20 = .6(t_c)

t_c = .556 t_c = 33.33 MINS

t_c = 0.578 HRS

PEAK FLOW USING SCS CURVE METHOD

EVENT	PEAK FLOW
2 YR. - 24 HR	
10 YR. - 24 HR	1.36 CFS
25 YR. - 24 HR	4.75 CFS
50 YR. - 24 HR	9.26 CFS
100 YR. - 24 HR.	15.13 CFS

CULVERT SELECTION

USE 100 YR - 24 HR EVENT - 15.13 CFS

SIZE OF CULVERT - FLAT SLOPE

$$Q = 2.58 \ D^{2.5}$$

$$D = (Q/2.58)^{1/2.5}$$

$$= (15.13/2.58)^{.40}$$

$$= 2.03 \text{ FT} \times 12 \text{ IN/FT}$$

$$= 24.35 \text{ FT}$$

USE A 30 IN. CULVERT

REFERENCE

1. BARFIELD, B.J., R.C. WARNER AND C.T. HAAN, 1985
APPLIED HYDROLOGY AND SEDIMENTOLOGY FOR DISTURBED AREAS. OKLAHOMA TECHNICAL PRESS, STILLWATER OKLAHOMA

2. HANDBOOK OF STEEL DRAINAGE AND HIGHWAY CONSTRUCTION, PRODUCTS AMERICAN IRON AND STEEL INSTITUTE, WASHINGTON D.C. THIRD EDITION

3. SOIL SURVEY OF CARBON AREA, UTAH, UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Hydrology Study
Culvert at South Fork

Soil Type	Percent	Type	CN
Uinta Family Loam	40%	B	55
Toze Family Fine Sandy Loam	28%	B	56
Comodore Bouldery Loam	8%	D	77
Midfork Family Bouldery Loam	4%	B	55
Trag Stony Loam	10%	C	77
Croydon Loam	6%	B	66
Falon Stony Sandy Loam	3%	C	77
Rock Outcrop	1%	D	83

$$CN = \frac{[.4(55) + .28(55) + .08(77) + .04(55) + .1(77) + .06(66) + .03(77) + .01(83)]}{.4 + .28 + .08 + .04 + .1 + .06 + .03 + .01}$$

$= 22 + 15.40 + 6.16 + 2.20 + 7.7 + 3.96 + 2.31 + .83 / 1$

$= 60.56$ use $\underline{61}$

$S = 1000/CN - 10$

$= 1000/61 - 10$

$= 16.39 - 10 = 6.39$

Area of the Water Shed

$3295 \times .0149 \text{ in}^2 = 49.1 \text{ in}^2 \times 22.96 \text{ acre/in}^2 = 1{,}127.34$ acres

$1{,}127.34$ acres $\times 43{,}560 \text{ ft}^2/\text{acre} = 49{,}106{,}930.4$ sq ft.