CHAPTER III

OPERATION PLAN

RECEIVED
APR 20 1982
DIVISION OF
OIL, GAS & MINING

CHAPTER III

OPERATION PLAN

		Page No.
3.1	Scope	III-1
3.2	Associated Facilities	III-1
3.2.1	Site Selection and Preparation	III-1
3.2.2	Buildings and Structures	III-1
3.2.2.1	Office/Bathhouse/Shop/Warehouse	III-1
3.2.2.2	Transfer Building	III-1
3.2.2.3	Fuel Storage	III-2
3.2.2.4	Lubrication Building	III-2
3.2.3	Coal Handling, Processing, Prep and Storage	III-2
3.2.3.1	Hopper Pit	III-2
3.2.3.2	Raw Coal Reclaim Conveyor	III-2
3.2.4	Power System	III-3
3.2.4.1	Electrical Power Distribution System	III-3
3.2.5	Water Supply System	III-4
3.2.6	Sewer System	III-4
3.2.7	Transportation, Roads, Parking Areas	III-4
3.2.7.1	Access Road	III-4
3.2.7.2	Emery Surface Mine Haulroads	III-5
3.2.7.3	Parking Areas	III-14
3.2.8	Fire Protection Plan	III-14
3.3	Mine Plan	III-15
3.3.1	Mining Methods	III-15
3.3.1.1	Overburden Removal	III-15
3.3.1.2	Coal Loading and Transportation	III-15
3.3.2	Pit Sequences	III-15
3.3.3	Coal Conservation and Recovery	III-15
3.3.4	Equipment Selection	III-16
3.3.4.1	Overburden Removal	III-16
3.3.4.2	Coal Removal	III-16
3.3.5	Operations Schedule	III-16

3.3.6 Explosives III-17

3.4 Environmental Protection III-19

3.4.1 Preservation of Land Use III-19

3.4.1.1 Projected Impacts of Mining on Current and Future Land Use III-19

3.4.1.2 Control Measures to Mitigate Impacts III-19

3.4.2 Protection of Human Values III-19

3.4.2.1 Projected Impacts of Mining on Human Values - Historical and Cultural III-19

3.4.2.2 Control Measures to Mitigate Impacts III-20

3.4.3 Protection of Hydrologic Balance III-20

3.4.3.1 Projected Impacts of Mining III-21

3.4.3.2 Control Measures to Mitigate Impacts III-22

3.4.3.3 Monitoring Plans III-22

3.4.4 Preservation of Soil Resources III-23

3.4.4.1 Projected Impacts of Mining on Soil Resources III-23

3.4.4.2 Control Measures to Mitigate Impacts III-23

3.4.5 Protection of Vegetative Resources III-23

3.4.5.1 Projected Impacts of Mining on Vegetative Resources III-24

3.4.5.2 Mitigating Measures to be Employed to Reduce Impacts on Vegetative Resources III-24

3.4.5.3 Vegetative Monitoring Procedures III-24

3.4.6 Protection of Fish and Wildlife III-24

3.4.6.1 Projected Impacts of Mining on Fish and Wildlife III-24

3.4.6.2 Recommended Mitigation Measures to be Used to Protect Fish and Wildlife III-25

3.4.6.3 Recommended Monitoring Procedures III-25

3.4.7 Protection of Air Quality III-26

3.4.8 Waste Disposal Plans III-26

3.4.8.1 Projected Impacts of Disposal and Methods on the Environment III-26

		3.4.8.2 Control Measures to Mitigate Impacts	III-26
3.5	Reclamation Plan		III-27
	3.5.1	Comtemporaneous Reclamation	III-27
	3.5.2	Soil (SPGM) Removal and Storage	III-27
		3.5.3.1 Disposition of Dams, Ponds, and Diversions	III-31
		3.5.3.2 Removal of Surface Structures	III-31
	3.5.4	Backfilling and Grading Plans	III-31
		3.5.4.1 Recontouring	III-32
		3.5.4.2 Removal or Reduction of Highwalls	III-32
		3.5.4.3 Variance from the 180 Day Backfilling and Grading Requirement	III-33
		3.5.4.4 Terracing and Erosion Control	III-34
		3.5.4.5 SPGM Redistribution and Stabilization	III-34
	3.5.5	Revegetation Plan	III-34
		3.5.5.1 Seedbed Preparation and Soil Amendments	III-35
		3.5.5.2 Seeding and Transplanting	III-36
		3.5.5.3 Mulching	III-38
		3.5.5.4 Irrigation	III-38
		3.5.5.5 Weed Control	III-39
		3.5.5.6 Management	III-39
		3.5.5.7 Standards and Methods for Demonstrating Reclamation Success	III-39
	3.5.6	Schedule of Reclamation	III-42
	3.5.7	Cost Estimate for Reclamation	III-43
		3.5.7.1 Cost Estimate For Each Step of Reclamation	III-43
		3.5.7.2 Forecast of Performance Bond Liability During Permit Term and Forecast of Liability for Life-of-Mine	III-46

3.0 OPERATION PLAN

3.1 Scope

This chapter explains the future operations for the Emery Surface Mine. Construction of the mine will begin in late 1982. The mine facilities will remain in operation until the coal has been removed from the area for mining through the five year permit term and until the coal has been removed from the extended mine plan area. The facilities will be operated in conjunction with the coal preparation plant. Coal from the surface mine may be blended with coal from the underground mine for processing and shipped from the preparation plant. A permit application for construction of the preparation plant facility is currently being reviewed by the Division of Oil, Gas, and Mining and the operation and reclamation plans for the preparation plant area are discussed in that application.

3.2 Associated Facilities

3.2.1.0 Site Selection and Preparation

Plate III-1 indicates the areas to be affected for the Emery Surface Mine. The area shown includes all surface facilities for the mine, electrical substation, power distribution, materials handling system, parking area and haul roads. The following is a description of each facility necessary to operate the surface mine.

3.2.2 Buildings and Structures

3.2.2.1 Office/Bathhouse/Shop/Warehouse

Approximate Construction Date: January, 1983

The facility will house the change room/shower facilities for staff and hourly employees, offices for Operations and Engineering, warehouse and shop facilities to support the Surface Mine equipment. This building will be of a preengineered metal construction with overhead bridge cranes in the shop area to facilitate maintenance of the coal trucks, dozers, scrapers and other miscellaneous mine equipment.

3.2.2.2 Transfer Building

Approximate Construction Date: Spring of 1983

This building will be of a pre-engineered metal construction. The purpose of this building is to act as a transfer point for the raw surface coal conveyors. Eventually, as the coal quality dictates, the secondary coal crushing circuit will be located here.

3.2.2.3 Fuel Storage

Approximate Construction Date: Spring of 1983

This facility will be two (2) separate above-grade, diked fuel storage tanks with pumps and valving to allow filling of machinery and trucks. This facility will have one (1) gasoline tank and one (1) diesel tank separated so as to allow individual access to either station without interference to the other.

3.2.2.4 Lubrication Building

Approximate Construction Date: Spring of 1983

This facility will be located near the fuel storage tanks and will house the various lubrication oils and greases.

3.2.3 Coal Handling, Processing, Prep and Storage

3.2.3.1 Hopper Pit

Approximate Construction Date: January, 1983

The hopper pit will be a concrete drive over structure with the coal haul trucks dumping coal through a grizzly and into a large metal hopper located inside this structure. Coal will then feed from the hopper through a feeder crusher where it is sized to 5" x 0". This crushed raw coal then discharges onto a conveyor and is conveyed and discharged into the raw coal storage pile by means of a fixed stacker tube. The concrete structure will be incised into the ground such that the grade elevation northwest of the hopper is essentially level with the top of the hopper structure. There will be raw coal stockpiling in the leveled area near the hopper in case of a mechanical problem with the crushing or materials handling system.

3.2.3.2 Raw Coal Reclaim Conveyor

Approximate Construction Date: Spring of 1983

The reclaim conveyor will be located under the 5" x 0" raw coal stockpile. This conveyor will reclaim coal by using reclaimers and feeders to take the coal by gravity feed from the above grade stockpile and feed it on a conveyor belt located below the stockpile. This conveyed 5" x 0" product will be elevated by the conveyor to the transfer building where it will be transfered by chutework to another above grade belt conveyor. This conveyor will feed the 5" x 0" coal into the raw coal preparation plant feed circuit.

3.2.4 Power System

3.2.4.1 Electrical Power Distribution System

Electrical power will be brought into the Surface Mine at 69 kilovolt (KV) level. This 69 KV powerline will tap into the existing 69 KV line that serves the Underground Mine. This tap point, the direction and length of the new 69 KV line is shown on Plate III-1.

This new 69 KV line will feed the main mine substation. Its location is also shown on Plate III-1. This substation will transform the 69 KV voltage to 7.2 KV. This substation will contain two (2) transformers. One transfomer will supply 7.2 KV, 3 phase, power to the fixed facilities. The other transformer will supply 7.2 KV, 3 phase, power to the surface mining equipment. Necessary electrical protection equipment will accompany each transformer. These transformers and the protection equipment will be skid-mounted. The immediate area inside the substation will be stripped of topsoil and gravel will be spread. Two (2) ground fields, composed of ground rods driven in a pattern into the ground, will be placed adjacent to the substation.

The 7.2 KV, 3 phase, power, for the fixed facilities, will be brought to the facilities via an overhead powerline. This power will enter a small substation at the facilities area. This substation area will be removed of topsoil and the area spread with gravel. A ground field, as described in the above paragraph, will be adjacent to the substation.

7.2 KV power from the main substation to the surface mining equipment will be brought to the equipment via a mining-duty power cable. This cable shall lay on top of the ground. One cable shall come out of the main substation and go to a point near the active mining operation. At that point, it branches into two (2) cables to establish a baseline power system. At periodic intervals, the individual pieces of machinery may tap into the baseline power system as their work progresses along the active pit. Similar power cables shall supply power from the baseline power system to each individual piece of machinery. Those machines will be a dragline, a loading shovel, and an overburden drill.

The overhead 69 KV and 7.2 KV powerlines shall be installed in such a manner to minimize surface disturbance to the earth and vegetation. Topsoil would be removed from each hole dug for a power pole and kept segregated from the lower material. Then when the pole is set into the hole, the lower earthen material would be placed down around the pole and tamped. Topsoil material then would be placed on top of that. Excess material would be gently sloped around the pole and seeded.

The poles would all have raptor protection in accordance with USDA, OGM, and OSM requirements per REA Bulletin 61-10.

There will be an access road required for access to the mine substation. It shall be for small vehicles and be no wider than a two lane road. It shall be designed and constructed as a class II road. Its location is shown on Plate III-1.

3.2.5 Water Supply System

Approximate Construction Date: Spring of 1983

Water from the existing well located near the underground bathhouse facility will supply raw water by a pump to an above ground metal storage tank located north of the existing well near the Surface Mine facilities. Water intended for potable use will be fed to a water treatment plant from the storage tank. Water quality will be treated as required to meet the quality specifications set forth by the Utah Public Health Department. The potable water will then be piped by underground pipeline to the various distribution points at the Shop facilities, Underground Mine facilities and Preparation Plant facilities. This pipe will be buried in a common trench to minimize excavation and disturbance. Raw water for fire protection and equipment wash water will also be piped from the raw water storage tank direct to the truck wash bay and to the fire protection system at the Surface Mine facility.

3.2.6 Sewer System

Approximate Construction Date: Spring of 1983

The Surface Mine facility will utilize a new septic tank/leach field to be located in the immediate vicinity of the office/shop/bathhouse/warehouse building. This system will be designed according to the State of Utah Public Health Department regulations governing waste disposal systems. Design of the system will be based on information developed during our geotechnical investigation of the area.

3.2.7 Transportation, Roads, Parking Areas

3.2.7.1 Access Road

Approximate Construction Date: Spring of 1983

Access to the site will be provided by a two lane class II graveled road beginning at the preparation plant site and traversing north-easterly to the Surface Mine parking lot. All access to the site will be by this access so as to separate this traffic from the coal hauler traffic.

3.2.7.2 Emery Surface Mine Haulroads

Approximate Construction Date: Spring, 1983

General

The main haulroad for the Emery Surface Mine will connect the coal loadout facility, office/shop facility, and the four main inclines of the surface mine area.

For the purpose of discussion, the haulroad will be broken into sections as follows: the loadout or dump loop (Sta. 7+80 to 31+00), the service loop (Sta. 0+00 to 11+00), and the main haulroad (Sta. 31+00 to 114+00). The inclines are named A, B, C, and D and start at their intersection with the main haulroad, continuing until they reach the mining boundary, at which point they are no longer considered Class I roads.

The layout for the main haulroad is shown on Plate III-1.

Haulroad Location

The main haulroad and the service and loadout loops have been located on stable ground so as to minimize erosion and promote drainage. All drainage crossings will be made using culverts.

Haulroad Design

Vertical Alignment

The vertical alignment of the haulroad, loops, and inclines can be seen on Plates XII-6 through 13.

The overall and maximum grades for the road sections are as follows:

Road Section	Overall Grade	Max. Grade
Loadout Loop	0.0%	2%
Service Loop	0.4%	3%
Main Haulroad	0.7%	4%
Incline A	4.6%	6%
Incline B	5.4%	6%
Incline C	5.2%	6%
Incline D	5.3%	6%

Road Cuts

With few exceptions, the haulroad will be constructed in sandstone, therefore the cut slopes will be 1v:0.25h and no special stabilizing measures will be necessary. All topsoil will be removed from the disturbance area prior to construction.

Road Fills

Prior to construction, all topsoil and vegetative material shall be removed from the site. This material will not be used as a road fill material. If the original terrain exceeds 20% slopes, the existing ground will also be plowed, stepped or keyed as to stabilize the fill.

After site preparation has been completed, fill material (whose volume of +6" material is less than 25%) shall be placed in uniform layers not exceeding 12 inches in depth. If the fill material contains rocks greater than 12 inches, the layer depth shall not exceed the approximate average size of the rocks, up to a maximum depth of 36 inches. Rock fill will be distributed by blading and dozing to ensure proper placement. Each lift will be leveled and compacted before the next lift is placed. Compactive effort will be sufficient to achieve 95% of the maximum dry density in accordance with ASTM D 698-78 (Standard Proctor Method). Only material within its acceptable moisture content will be used, so as to achieve the design compaction. This material shall also be reasonably free of organic material, coal or coal blossom, frozen material, or peat material.

The embankment side slopes will not exceed 1v:2h. The road surfaces will be crowned at a rate of one-quarter inch per foot of surface width.

The illustrations which follow show typical haulroad and incline cut and fill section, as well as a haulroad fill section adjacent to the southern diversion ditch.

Haulroad Drainage

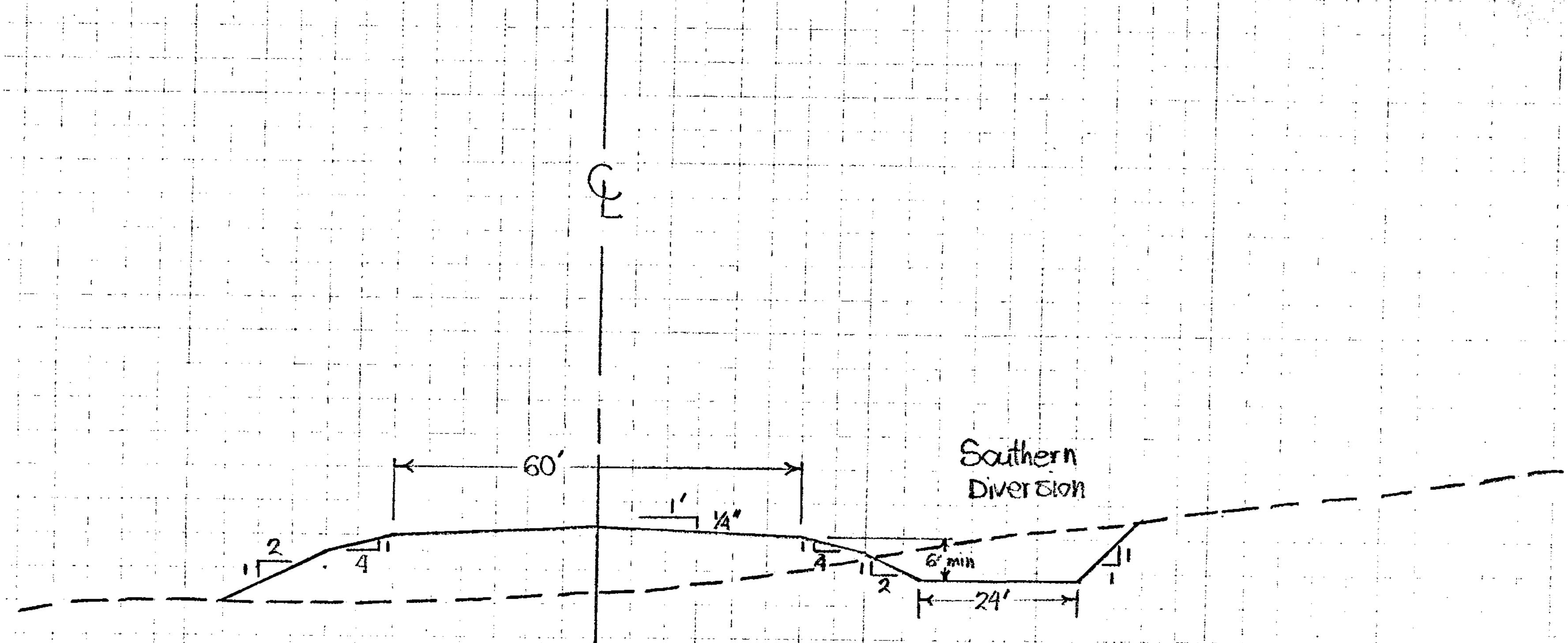
The drainage design for the haulroad system will be accomplished by standardizing the roadside ditches throughout the haulroad, as shown on the following page. Due to the horizontal placement and vertical alignment of the haulroad, the majority of the route does not intercept any overland water runoff, therefore the haulroad ditches need only the capacity to handle the water that will fall directly onto the road and the side slopes. On that portion of the haulroad that does intercept significant runoff, Diversion Ditch No. 2 will handle the larger flow.

Six culverts are to be placed under the haulroad system. Their locations and designs are in the surface water management section, 7.2.3.2.

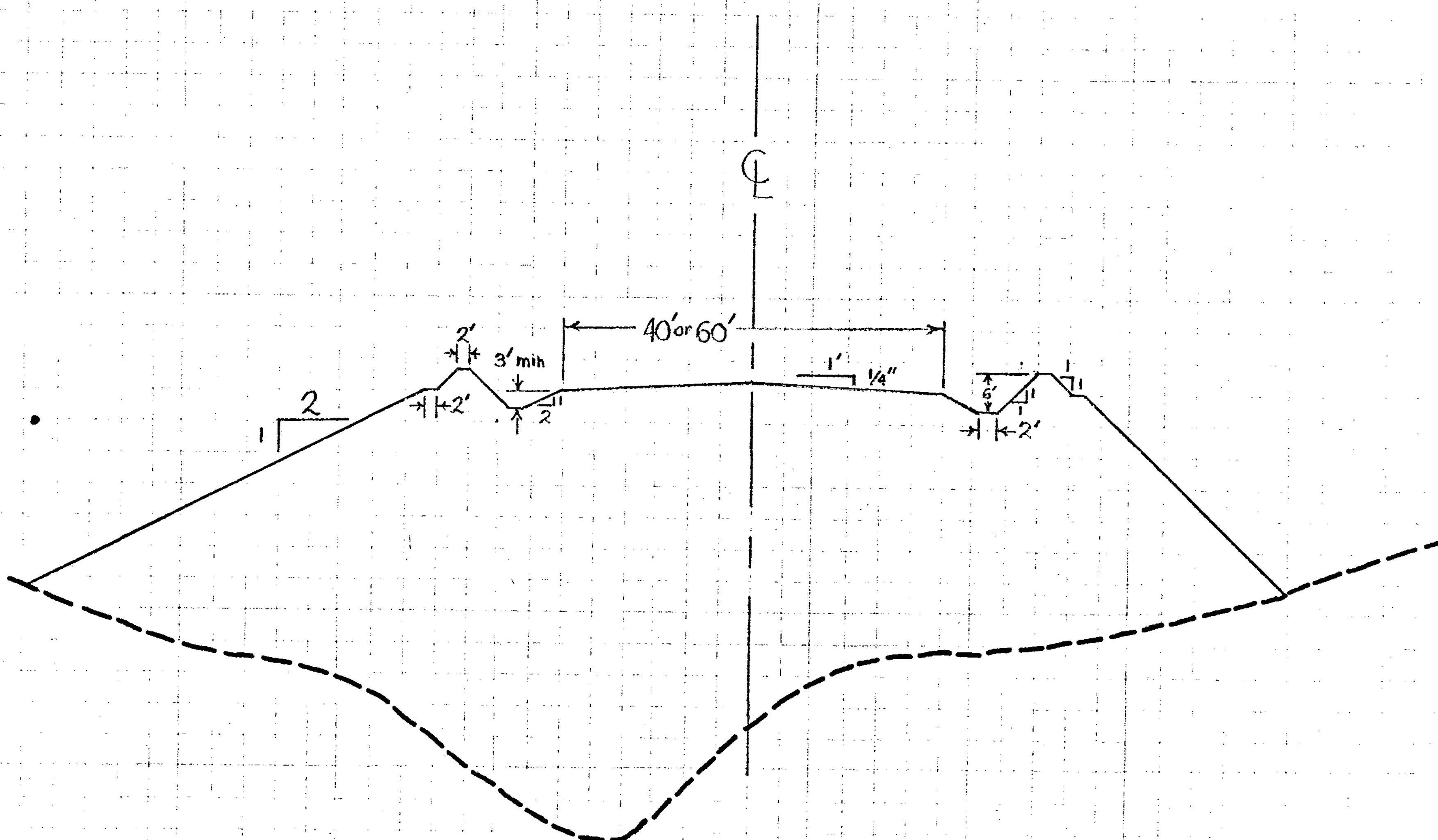
The incline ditches are designed to include surface runoff from the area between the main haulroad and the incline itself.

Haulroad Surfacing

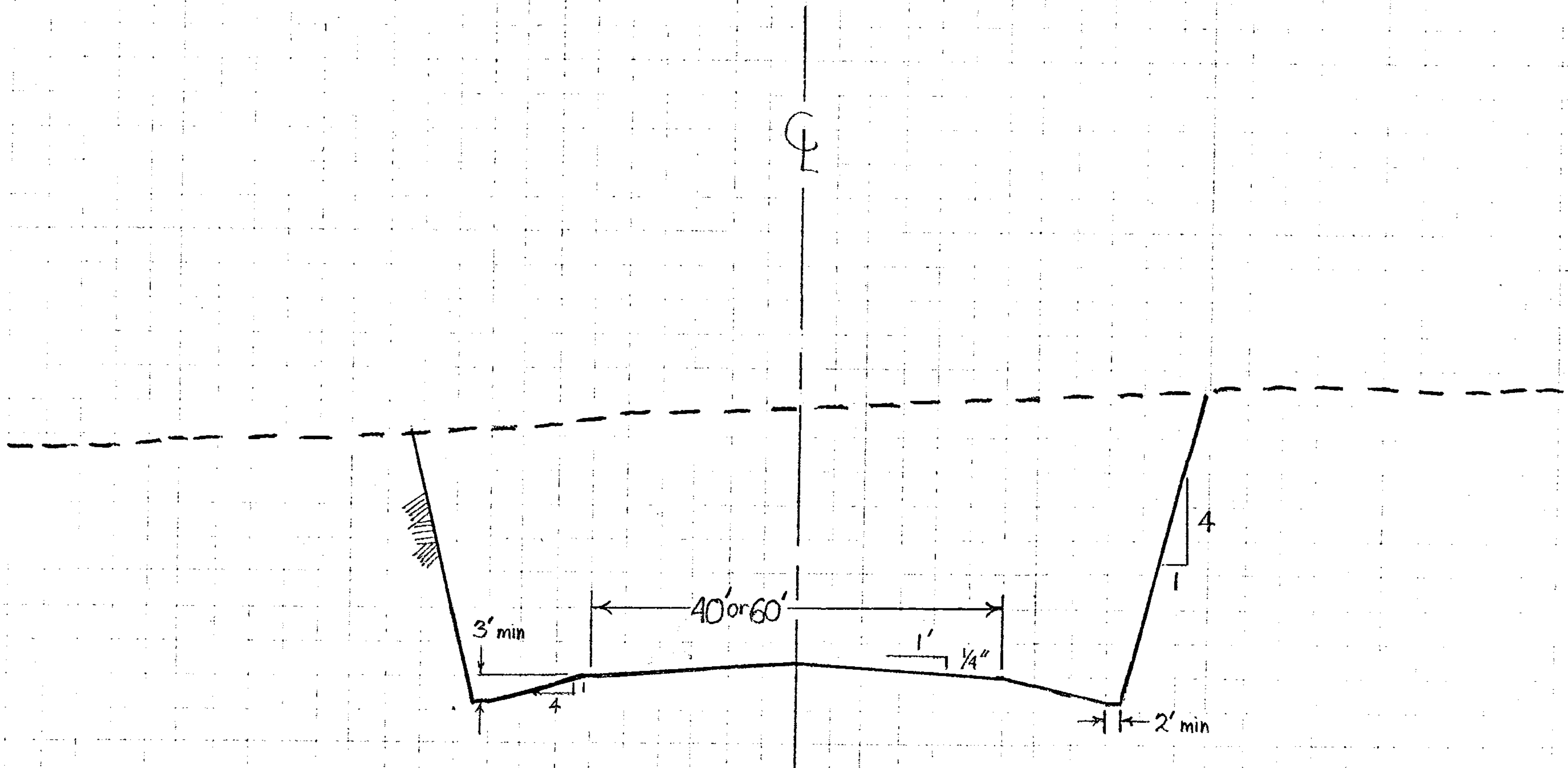
All portions of the haulroad will be surfaced with either crushed rock or gravel. No acid or toxic-forming substances shall be used in road surfacing.



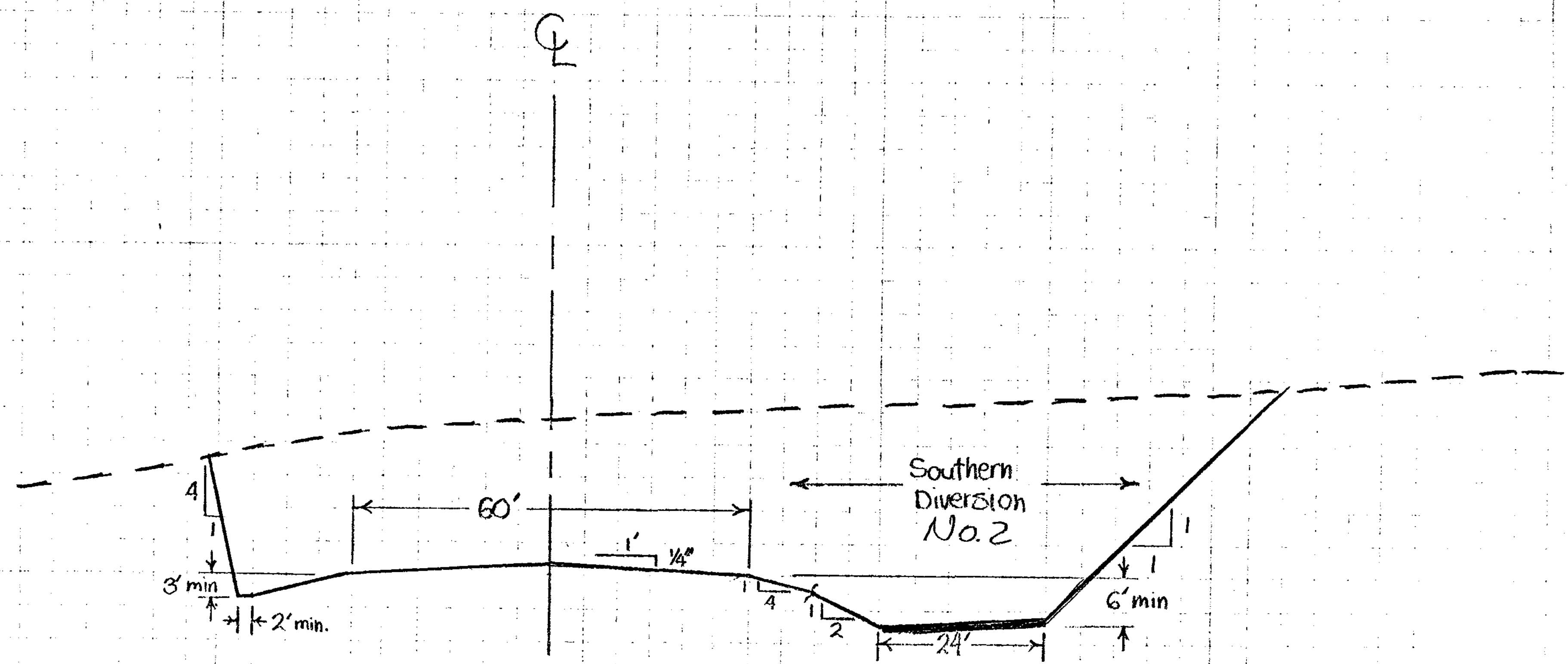
Typical Haulroad Fill Section with Southern Diversion



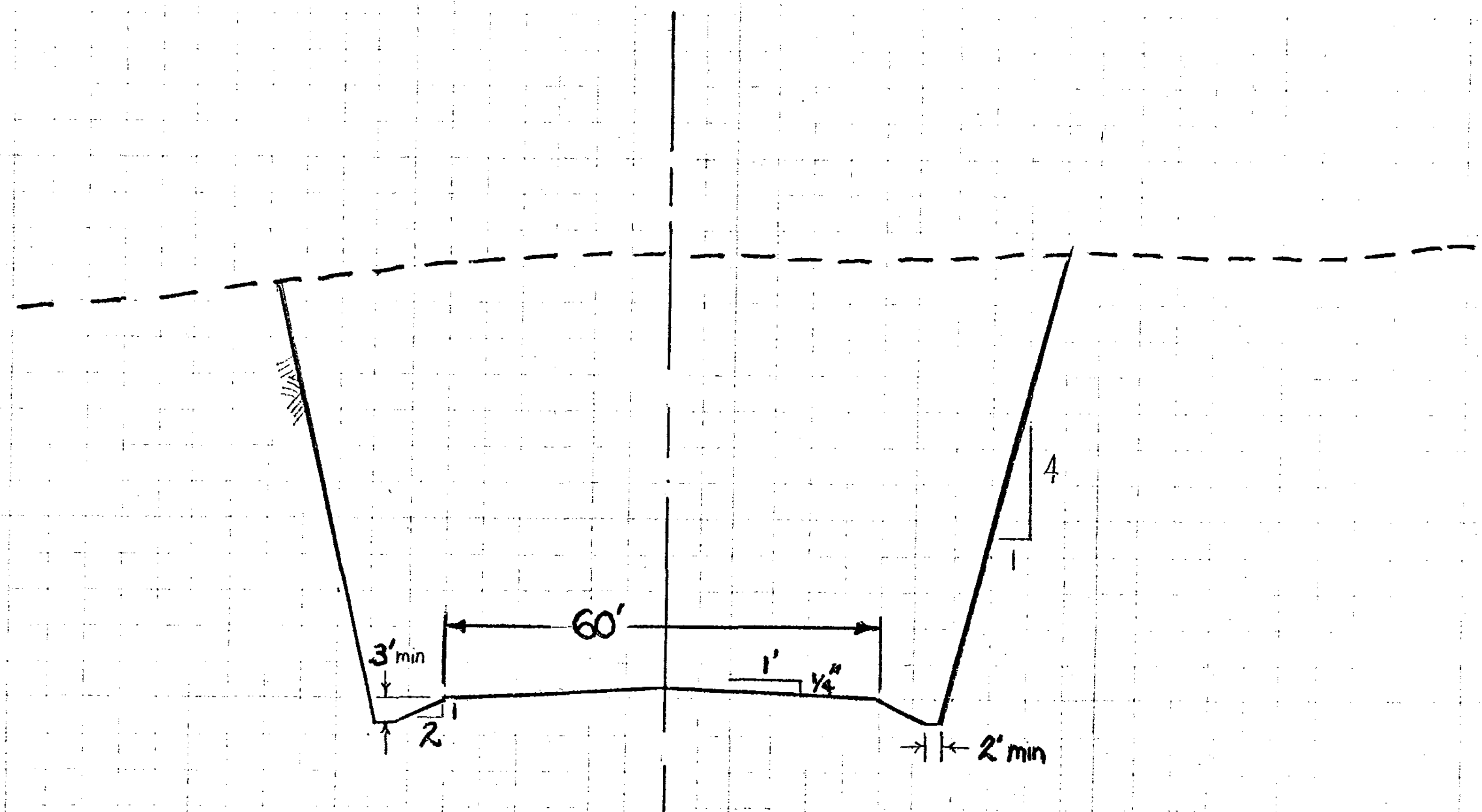
Typical Haulroad or Incline Fill Section



Typical Haulroad Cut Section

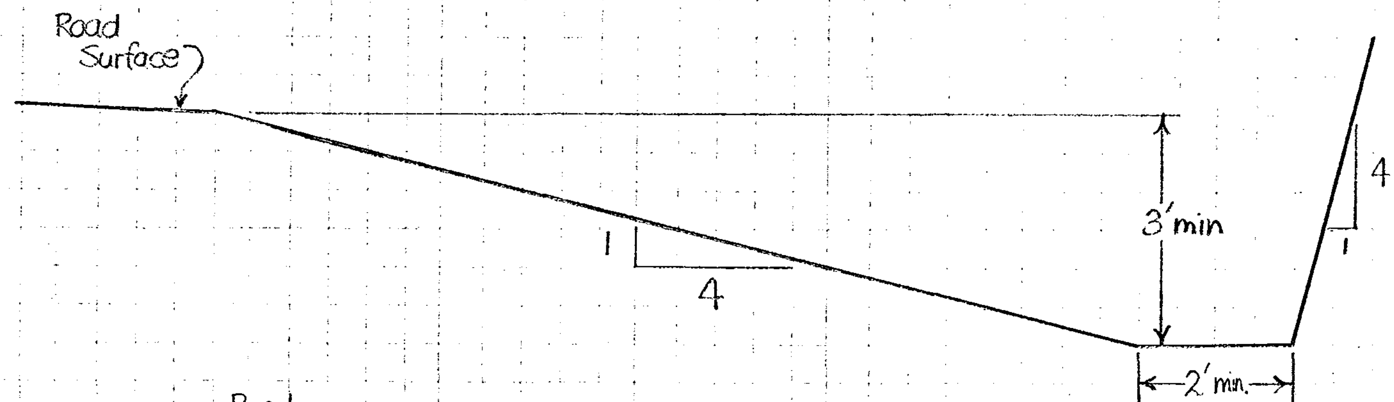


Typical Haulroad Cut Section with Southern Diversion (No. 2)



Typical Incline Cut Section

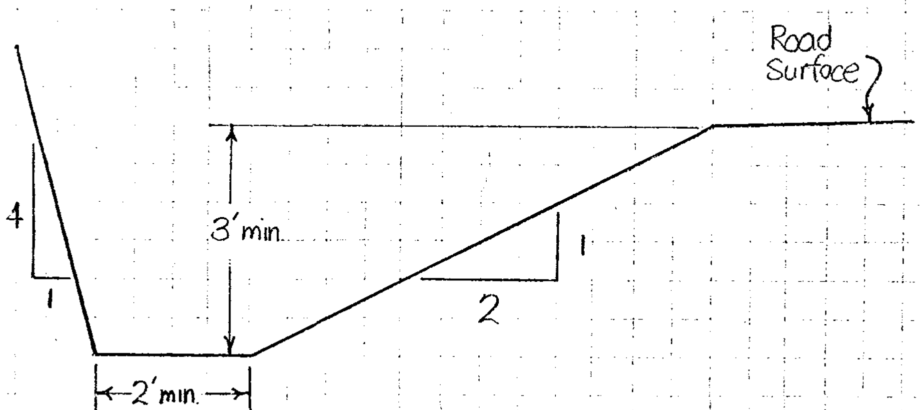
Typical Haulroad Ditch



Ditch Area $= (1/2)(12)'(3)' + (1/2)(2+2\tfrac{3}{4})'(3)' =$

$= 25.1\ \square'$

Typical Incline Ditch



Ditch area $= (1/2)(6)'(3)' + (1/2)(2+2\tfrac{3}{4})'(3)' = 16.1\ \square'$

INCLINE DITCH CALCULATIONS

GENERAL DATA

Design Storm = 10 year-24 hour

Antecedent Moisture Condition II

Design Precepitation = 1.5"

Curve Number = 90

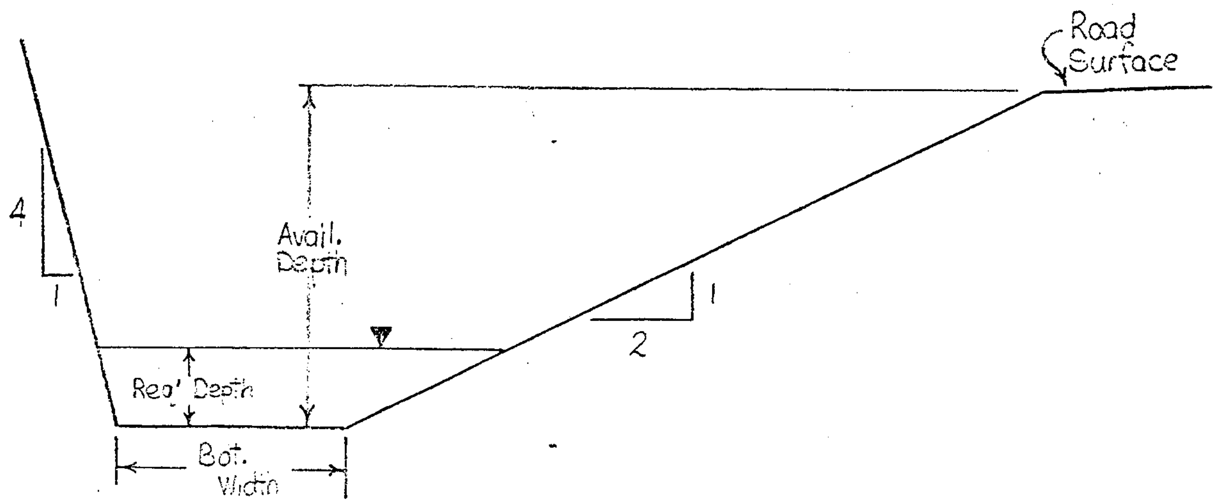
Watershed Slopes = Moderate

Soil Type = bedrock

Manning's n = 0.025

Longitudinal Slope = 6%

TYPICAL CROSS-SECTION



SITE SPECIFIC DATA

	Incline A	Incline B	Incline C	Incline D
Watershed Area (acres)	11.4	16.5	13.8	57.6
Required Peak Flosw (cfs)	10	15	11	39
Maximum Velocity (fps)	7.4	8.4	7.7	10.2
Design Bottom Width (ft.)	2	2	2	4
Required Flow Depth (ft.)	0.53	0.68	0.57	0.79
Available Flow Depth (ft.)	3	3	3	3

Haulroad Maintenance

All haulroads will be maintained so that design grades and drainage are kept for the life of the facility so as to insure its safe and efficient use. Maintenance will include blading, filling pot holes, replacement of gravel, re-stabilizing cut and fill slopes, brush removal, watering for dust control and minor reconstruction if necessary.

Should a roadway become structurally damaged by a catastropic event it will be reconstructed as soon as practical after the event.

Haulroad Restoration

The haulroad fills across the northern diversion and Christiansen Wash will be left in place and have been designed as permanent structures. The side slopes of these fills will be stabilized with rip-rap during their construction. After the roadway is no longer needed as a haulroad, the roadway and surrounding area will be graded and smoothed so as to form a 20' wide roadway. The 20' wide roadway will be better suited to the post-mining land use and will provide valuable access to the area east of Christiansen Wash. Following grading, topsoil will be respread on each side of the road and the area revegetated in the same manner as the adjacent areas.

3.2.7.3 Parking Areas

Approximate Construction Date: Spring of 1983

A graveled parking area for all employees and visitors to the site will be provided just northwest of the Surface Mine office/shop/bathhouse/warehouse building. The parking lot will have outside lighting provided.

3.2.8 Fire Protection Plan

The fire water for the Surface Mine will be provided from a dedicated storage in the raw water storage tank. This fire water will be piped to the Surface Mine facilities site by an underground buried line. This line will furnish fire water for the interior fire fighting system for the building and for the outside fire hydrants located on the outside perimeter of the building. Also, dry type fire extinguishers will be provided in the office, shop and warehouse areas. The fuel and lubrication storage will be located remote from the shop building and be protected with service from outside fire hydrant and dry type fire extinguishers located near the facilities.

3.3 Mine Plan

3.3.1 Mining Methods

3.3.1.1 Overburden Removal

The Emery Surface Mine will use two different mining methods in the permit area. During the prestripping stage and the first six months of operation, a truck-shovel method will be employed. After this initial mining, the truck-shovel operation will be replaced with a dragline operation.

The initial mining will begin in Christiansen Wash with a truck-shovel method of mining. The overburden will be blasted, loaded into trucks and transported to the haul road embankment across Christiansen Wash to be used as fill, to the spoil area east of the haulroad embankment, or to a previously mined area. Coal loading in this initial cut will begin at the southwestern end of the pit and progress in a northeasterly direction up the Wash.

Subsequent to the initial cut in Christiansen Wash, a dragline shall be used for the removal of overburden. The initial dragline boxcut shall be opened on the southern side of the permit mining area. This boxcut will be located at the edge of the burn line of the I-J coal seam. The dragline pits shall be oriented in a northeast to south-westerly direction approximately parallel to the strike of the coal seam. Mining shall advance to the northwest to an average maximum depth of 130 feet leaving a 500 foot standoff from the underground workings.

3.3.1.2 Coal Loading and Transportation

The exposed coal will be drilled and blasted with anfo. This procedure fractures the coal, thus facilitating loading operations. The coal shall be loaded with a hydraulic backhoe or front-end loader into trucks to be hauled out of the pit to the loadout or stockpile area. As each seam is removed, the parting or interburden between seams will be removed and placed in the bottom of the previously mined pit.

3.3.2 Pit Sequence

Refer to Plate III-1 for the mining sequence in the permit area.

3.3.3 Coal Conservation and Recovery

The I-J seam coal in the permit area shall be extracted subject to prudent mining practices. No coal within present economic and technological limits will be left unmined.

All coal will be mined:

1) Between the burn line of the I-J coal zone and the maximum depth limitation of the dragline.

2) With care to minimize out of seam dilution by non-carbonaceous materials.

3) With an appropriate standoff from physical barriers to allow sufficient working room without disturbing said barrier (i.e. active underground works, uncontrolled lands).

3.3.4 Equipment Selection

3.3.4.1 Overburden Removal

The overburden shall be drilled prior to blasting with an overburden drill.

During the prestripping and initial mining, a hydraulic shovel or front end loader will load coal into haul trucks. A dragline will be used subsequently to remove the overburden.

The surface of the coal as well as partings will be cleaned by dozers and front end loaders.

3.3.4.2 Coal Removal

In-place coal is drilled prior to blasting with a coal drill.

Coal will be loaded into haul trucks with a hydraulic backhoe or a front-end loader.

3.3.5 Operation Schedule

Stripping operations are planned on a 3 shift, 7 day a week schedule, while coal loading is planned on a 2 shift, 5 day a week schedule. A labor force of about 70 hourly and 20 salaried employees is anticipated for this operation. The annual production in clean tons from the Surface Mine is projected as follows:

Year	Clean Tons (000)
1983	600
1984	1000
1985	800
1986	1200
1987	1100

The clean tons indicated above are from the upper I and lower I Seams. Approximately, 150,000 tons of J Seam coal may mined each year. The J Seam coal is of poorer quality (high sulphur, low BTU) and will be blended with the Deep Mine and I Seam surface coal when possible to produce a saleable product meeting necessary quality specifications.

3.3.6 Explosives

Blasting at the Emery Surface Mine will be used to break-up the overburden so that it can be excavated by dragline methods. The coal will also be blasted to facilitate loading into haulage trucks.

Blasting Procedures

Overburden will be drilled with a rotary type drill producing holes of 7 7/8" to 9 7/8" diameter. Holes will be loaded with a blasting agent. The collar will be stemmed with drill cuttings to improve fragmentation and reduce noise and fly rock. Hole burden and spacing will be such as to provide an adequate powder factor. Each hole will be primed with commercial cast primers and detonating cord downlines to insure proper detonation. Holes will be interconnected on the surface using detonating cord and millisecond detonating relays. The blast will be initiated with a single electric blasting cap fired from a safe distance.

Coal to be blasted will be drilled with an auger type drill producing holes of 2 3/4" diameter. Holes will be loaded with blasting agent and stemmed with drill cuttings. Hole burden and spacing will be such as to provide an adequate powder factor. Each hole will be primed with one 1 x 6 primer and a detonating cord downline and interconnected on the surface with detonating cord trunklines. The blast will be initiated with a single electric blasting cap fired from a safe distance.

Safety Procedures

Prior to blasting, the area is cleared of personnel and equipment. It is then closed and guarded by blasting personnel. The warning for a blast is a signal from a siren. Following detonation, the "all clear" signal is sounded only after the blast area has been checked by a qualified person and determined safe to re-enter.

Warning signs identifying the blasting areas will be posted at the entrances to all such areas.

Certification of Personnel

All blasting operations will be conducted by persons certified to do so.

Monitoring and Pre-blasting Surveys

Blasts will be planned so that the amount of explosives detonated within any 8 millisecond period will be within a scaled distance of 60. Therefore, seismographic monitoring should not be necessary.

Because of the distance to any structures pre-blasting surveys are not planned. However, if requested, pre-blasting surveys that fall within the scope of SMC 816.62 will be conducted by company personnel.

Public Notice of Blasting Schedule

A schedule of blasting operations will be published according to the regulations. The schedule will follow the requirements of the regulations.

Blasting Records

Records will be kept of each blast on a standardized form that will address the information required in SMC 816.68. These records will be signed by the blasting supervisor and will be maintained at the mine office for a period of at least 3 years. These records will be available for inspection by the Division and the public on request during normal business hours.

Deviations from the Blasting Schedule

The blasting schedule will be adhered to except in instances which would result in unsafe operation. These may be the result of rain, lighting or other atmospheric conditions that would delay the firing of previously loaded holes. Delays might also be caused by equipment malfunction or problems in properly clearing the blasting area. Blasts which are delayed will be shot as soon as conditions become safe.

Explosive Storage

The explosives storage area for the surface mine will be comprised of two areas, each enclosed by an earthen bunker. With side slopes of 2:1, the bunkers will surround each storage area.

Prepackaged blasting agents will be stored, in the largest of the two sites, in drop-off trailers.

The second, smaller, bunkered area will contain a magazine for storage of primers and detonating cord. It will also contain a separate magazine for storage of detonators and detonating relays.

Siting, construction, and storage structures will comply with Federal law and regulations 27 CFR, Part 181, Subpart J - Storage.

The location of these storage areas is shown on Plate III-1.

3.4 Environmental Protection

3.4.1 Preservation of Land Use

The current land uses on the acreages to be disturbed within the permit area are made up of rangeland, pastureland, and wildlife habitat. These land uses were determined according to the soil uses in the permit area based on aerial photo-interpretation and USDA-SCS information.

Most of the pre-mine land use is rangeland grazed by livestock and utilized by wildlife.

Consol will make reasonable efforts to replace these land-use types after mining.

3.4.1.1 Projected Impacts of Mining on Current and Future Land Use

Land use of the affected area within the permit boundary will be affected, but only temporarily. The reclamation plan for this area proposes to replace the same land uses after mining. In the same respect, Consol proposes to reclaim any future surface disturbance areas to the same land use/uses that existed prior to disturbance.

3.4.1.2 Control Measures to Mitigate Impacts

The vegetation, soils, land use and wildlife inventories discussed in this application have documented the existing pre-mining resources in the permit area. The replacement of the same land uses that existed prior to mining will assure that long term land use impacts do not occur.

3.4.2 Protection of Human Values

3.4.2.1 Projected Impacts of Mining on Human Values - Historical and Cultural

Several cultural resource surveys have been conducted in the area of the proposed Emery Surface Mine. Among them are:

Report Author	Organization	Date
1. Michael S. Berry	Utah Division of State History	Mar., 1975
2. David B. Madsen	Utah Division of State History	Feb., 1976
3. F. R. Hauck	Archaeological-Environmental Research Corporation	Oct., 1980
4. F. R. Hauck	Archaeological-Environmental Research Corporation	July, 1981

Of the cultural resource sites identified during these surveys, three sites are located within the surface mine permit area. These three sites were identified in the Michael Berry survey in March of 1975. In February of 1976 Mr. David Madsen investigated these sites and on February 20, 1976 recommended that the area be approved for disturbance. Other identified sites in the general mine area are outside the permit boundary and will not be disturbed.

Copies of the four cultural resource reports are contained in Chapter V along with a compendium chart listing the known archaeological sites and possible impacts.

3.4.2.2 Control Measures to Mitigate Impacts

No known archaeological sites will be disturbed without prior approval of the Division of Oil, Gas, and Mining. Should Consol discover a possible archaeological site during the course of mining operations, Consol will stop work in the vicinity of the site and notify the Division of Oil, Gas, and Mining and not disturb the site until the site has been properly evaluated and approved for disturbance.

About 340 acres of the proposed permit area have not been surveyed for cultural resource sites. This area will be surveyed in the near future and the results will be submitted when received.

3.4.3 Protection of the Hydrologic Balance

Surface Water

The proposed surface coal mine is located along Christiansen Wash, approximately three-quarters of a mile upstream from its confluence with Quitchupah Creek. Streamflow within the vicinity of the proposed mine is sustained primarily by irrigation return flow (either as overland flow or ground-water seepage) of water originally diverted from Muddy Creek. Consequently, the quality of water varies with the season and can be highly variable within any season owing to man's influence. Generally, the water is of marginal quality by the time it reaches the proposed mine area due to increases in dissolved solids, primarily sodium and sulfate.

Ground Water

Within the mine plan area, three zones bear ground water. These include the upper Ferron aquifer, the Blue Gate Shale, and Quaternary deposits which include alluvium and terrace deposits.

The upper Ferron aquifer is of primary significance to the mining operation. Its saturated thickness over the surface mine area averages 60 feet. Recharge to the aquifer occurs as subsurface inflow from the Joe's Valley - Paradise fault zone located northwest of the proposed mine area. The Emery underground mine is and will continue to be, an intervening discharge point between the recharge source and the surface mine. The TDS of the ground water of the upper Ferron averaged 1,300 mg/l over the last two-year period. An appropriated spring is used for occasional stock watering just east of the proposed mine area. The source of this spring is probably the upper Ferron aquifer.

The Blue Gate Shale separates the upper Ferron aquifer from water within the Quaternary deposits over most of the general mine area. However, in the vicinity of the proposed mine area the Blue Gate pinches out and is weathered. Subsequently, hydraulic communication is possible between these two water-bearing zones. The Blue Gate shale contains brackish or saline water in an unconfined state above the upper Ferron aquifer over much of the rest of the permit area.

Terrace deposits occur above the Blue Gate Shale within the southwest portion of the permit area and contain water whose source is largely applied irrigation water. Many springs, of relatively good quality water, issue from the contact with the relatively impermeable Blue Gate Shale. These springs contribute to the flow of Christiansen Wash below the surface mine area and promote dissolved solids concentration reduction along Christiansen Wash between the central and southern portions of the permit area.

Alluvium occurs as a narrow band adjacent to Christiansen Wash and as a broader, gently sloping deposit in the northern portion of the surface mine area. Within this northern portion it contains water within a thin (on the order of 5 feet) pebble zone which exists on top of either Blue Gate Shale or Ferron Sandstone. Its source is largely seeped irrigation waters and is therefore, anticipated to be of poor quality.

3.4.3.1 Projected Impacts of Mining

Surface Water

Christiansen Wash will be permanently diverted around the mining operation. No impacts are anticipated as a result of this diversion.

Discharge to Christiansen Wash is expected to increase by less than 0.3 cfs on the average owing to the addition of pit inflow from the upper Ferron aquifer. A portion of this discharge will replace that which has ceased to flow naturally from the upper Ferron aquifer owing to underground mine inflow influences. During some periods of the year, the TDS concentration of water in Christiansen Wash will be increased.

Ground Water

Ground water will be removed from storage within the upper Ferron aquifer by potentiometric level lowering owing to pit development. Lines and Morrissey (1981) predicted inflow to average 0.3 cfs, and potentiometric levels to be lowered by about 60 feet in the vicinity of the mine and 5 feet at a distance of 2.5 miles. Actual amounts will be less than these predictions owing to lower, current potentiometric levels in the vicinity of the surface mine.

Ground water contained within alluvium which enters near the northeast corner of the surface mine area may inflow. This water and that of the upper Ferron could potentially come in contact with disturbed overburden, thereby leaching minerals and adding to its existing TDS content.

3.4.3.2 Control Measures to Mitigate Impacts

Surface Water

The diversion of Christiansen Wash, other surface runoff north of the mine area, and runoff south of the mine area are planned to minimize the effects of mining on surface waters. This will preclude contact of surface waters with the potentially leachable spoil.

A sediment pond will impound all waters accumulated within the mine area prior to their discharge to Christiansen Wash. Water will not be discharged from the pond until its quality meets the requirements of the NPDES discharge limitations.

Ground Water

Consol intends to control ground water inflow by pumping it to the sediment pond and storing and discharging it in compliance with all applicable laws.

3.4.3.3 Monitoring Plans

Surface Water

Consol plans no additional monitoring sites other than those already being monitored under our approved monitoring plan. However, discharge from the sediment pond will be in accordance with the requirements of our NPDES permit.

Ground Water

Consol intends to drill and complete five additional monitor wells in the vicinity of the proposed surface mine, four in alluvium and one in the upper Ferron aquifer upgradient of the highwall (Plate 7-1).

Aquifer tests will be conducted on the alluvial well to be completed upgradient of the surface mine area. Water levels in all wells will be measured bi-monthly and sampled for quality quarterly for at least a period of one year. Table 1 lists water-quality parameters that will be determined on collected water samples during the first year (Section 7.1.6). In addition, Consol intends to document appropriate information on the Christiansen spring and monitor it on the same frequency and for the same parameters as listed for the monitor wells.

3.4.4. Preservation of Soil Resources

Below are listed the soils which occur within the disturbance area within the permit boundary:

- Abbott Fine Sandy Clay Loam
- Alluvial Land
- Badland
- Castle Valley ESVFSL
- Castle Valley - Sh Series Complex
- Chipeta-Persayo Complex
- Disturbed Land
- Ferron Silt Loam
- Gullied Land
- Palisade Very Fine Sandy Loam
- Ravola Loam
- Rockland
- Sh Series - Palisade Complex
- GP Silt Loam
- Harding Variant-Haplargid
- Hunting Clay Loam
- Hunting Loam
- Ildefonso Sandy Clay Loam
- Ildefonso Sandy Clay Loam - Eroded
- Killpack Clay Loam
- Killpack Loam
- Libbings Clay Loam
- Persayo-Chipeta Complex
- Ravola Loam - Eroded
- Saltair Silty Clay Loam
- Woodrow Silty Clay Loam

These soils vary from 0" to 60" in depth of suitable plant growth materials (SPGM). The SPGM will be removed, stockpiled and stabilized to ensure protection until time for redistribution.

3.4.4.1 Projected Impacts of Mining on Soil Resources

Because of measures described above for preserving SPGM resources, impacts to these materials will be minimal and temporary. All SPGM will be respread after mining has been terminated.

3.4.4.2 Control Measures To Mitigate Impacts

Impacts to soil resources will be minimized through carefully removing SPGM materials, stockpiling them, and vegetatively stabilizing them. Great care will be taken to prevent contamination of these materials during removal, storage, and redistribution. Erosion will be minimized during storage and after redistribution.

3.4.5 Protection of Vegetative Resources

Consol will cooperate with all state and federal agencies in the protection of vegetative resouces on the mine permit area. This will include adequate restoration of habitat to be disturbed during the mining process and protection of undisturbed habitat from operational effects.

3.4.5.1 Projected Impacts of Mining on Vegetative Resources

Vegetative types to be affected during the mining process are listed below:

Riparian Meadow
Annual Forb Community
Mixed Desert Shrubland
Greasewood Shrubland
Pinyon/Juniper Woodland
Rock Outcrop/Talus
Disturbed Area
Agricultural Area

Reclamation after mining will insure the restoration of equal and similar vegetation types for replacing these impacted acreages. Therefore, the impact will only be temporary in nature.

3.4.5.2 Mitigating Measures to be Employed to Reduce Impacts on Vegetative Resources

The reclamation-revegetation plan to be implemented for all disturbed acreages will be developed to be compatiable with the surrounding area and will replace the temporarily lost acreages with equally valuable vegetative types. The species to be selected for planting will be useful for wildlife habitat restoration as well as domestic livestock grazing.

3.4.5.3 Vegetative Monitoring Procedures

The vegetation on the reclaimed sites will be monitored at intervals through the liability period to check revegetation progress. Data will be collected for cover, density, and possibly productivity. Methods and standards for demonstrating reclamation success and the use of reference areas will be discussed in detail in section 3.5.6 of the reclamation plan.

3.4.6 Protection of Fish and Wildlife

Consol will cooperate with all state and federal agencies in the protection of wildlife resources on the mine permit area.

3.4.6.1 Projected Impacts of Mining on Fish and Wildlife

There are approximately 837 acres of land to be disturbed within the permit area.

Generally, wildife populations using the site as permanent or seasonal residents or as migrants are subject to the following major disturbances.

1. Temporary habitat reduction through disturbance of the land surface.

2. Temporary reduction of available food and cover through direct vegetation removal and resulting increased competition for remaining resources.

3. Temporary reduction of raptor and predator hunting habitat through decreased numbers and habitat of small wildlife species.

4. Temporary reduction of habitat quality in surrounding areas resulting from increased competition as permit area species move into adjacent areas.

5. Temporary disruption of patterns of daily movement, feeding, resting, predator-prey relationships, and reproductive activities due to habitat elimination and increased human activity.

6. Temporary disruption of nesting areas for passerine birds, game birds, and raptors.

3.4.6.2 Recommended Mitigation Measures to be Used to Protect Fish and Wildlife

Mine and related activities will have limited impacts on wildlife populations in the area. Plant species used for revegetation will be selected on the basis of their compatibility with habitat restoration and grazing as well as erosion control and survival.

Employees will be advised not to harass or illegally take any wildlife. It is especially important that wildlife not be harassed during winter, breeding, or early in the rearing process as these are critical periods. Hunting will be allowed on the permit area only when it will not create a danger to mine personnel or the sportsman. Consol will cooperate with the Utah Division of Wildlife Resources to reduce or eliminate the illegal or unwarranted killing of animals at the mine location.

Mine employees will be advised of the probabilities of vehicle-wildlife collisions in order that increased awareness will decrease these collisions. Employees will also be warned that stopping vehicles for viewing wildlife may disrupt the natural activities of these species.

3.4.6.3 Recommended Monitoring Procedures

Upon approval of the permit application, Consol will consult with the Utah Division of Oil, Gas, and Mining and the Utah Division of Wildlife Resources to determine to what extent fish and wildlife monitoring will be implemented.

3.4.7 Protection of Air Quality

The effects of mining operations on air quality were derived from an emissions inventory prepared by TRC Environmental Consultants. The inventory was submitted to the Utah Bureau of Air Quality as a part of an application for an air quality permit.

Fugitive dust (particulates) is considered the only potentially significant air pollutant to be generated by the mining operation, and therefore is the only pollutant addressed in this chapter.

Potential sources of fugitive dust from the mining operation include topsoil handling and stockpiling, overburden drilling, blasting, and removal, coal drilling blasting and removal, haul roads and access roads, and exposed areas. To reduce emissions from these sources, topsoil stockpiles will be revegetated as soon as possible after construction of the stockpile and the stockpiles will be located and oriented to minimize wind erosion, haul roads and access roads will be regularly sprayed with water to control dust, and the exposed areas of the mine will be minimized by stripping only enough area each year as is required for mining.

3.4.8 Waste Disposal Plans

Non-toxic waste materials such as trash, oil cans, and miscellaneous construction materials will be buried in the mining pit. Coal processing waste will be disposed of in the coal refuse area west of the coal preparation plant. A detailed discussion of the refuse area is contained in the Emery Underground Reapplication. Permit. Spoil from initial cuts will be stored temporarily between the main haulroad and the east edge of the mine area. This material will be placed in a controlled manner on slopes not exceeding 3:1 and will be removed during regrading operations. No areas will be used for soil placement until all topsoil and vegetation has been removed.

3.4.8.1 Projected Impacts of Disposal and Methods on the Environment

Since only non-toxic waste materials will be buried in the mine area and the volume of these materials will be very small, no adverse impacts are expected by using this disposal method. Coal processing wastes will be buried as described in the Emery Underground Reapplication Permit. The parent soils in the spoil placement areas consist of competant sandstone and shale. These materials will easily support the spoil until regrading occures.

3.4.8.2 Control Measures to Mitigate Impacts

All non-toxic wastes will be buried at least five feet above the groundwater level and at least two feet below the finished surface. Spoil will be regraded in accordance with the regrading plans contained in this application.

3.5 Reclamation Plan

3.5.1 Contemporaneous Reclamation

Sediment pond embankments, diversion ditches, and SPGM stockpiles will be seeded, mulched and stabilized to prevent soil erosion. The seed plan to be utilized is as follows:

Species	lbs. of PLS*/acre	PLS*/sq. ft.
crested wheatgrass	3.0	12
streambank wheatgrass	3.0	11
western wheatgrass	3.5	10
russian wildrye	3.0	12
yellow sweetclover	1.5	9
	14.0	54

*PLS - Pure live seed

3.5.2 Soil (SPGM) Removal and Storage

All SPGM will be mechanically removed and stockpiled prior to mining. These materials were previously inventoried and mapped. Please refer to a detailed discussion of the premine soils in Chapter VIII. Plate VIII-1 indicates the location of the individually mapped soil units.

There will be approximately 837 acres disturbed as a result of the mining process. From this acreage, approximately 1,601,000 yd^3 of Suitable Plant Growth Material will be recovered and stockpiled for later post-mining redistribution. Please refer to Table 3.5.2 for recovery depth details within the disturbance site.

Table 3.5.2

Pre-Disturbance Topsoils (SPGM) Data
Emery Strip Mine and Associated Facilities Area

Soil Type	Depth of SPGM (inches)	% of Map Unit	Acreage	Yd^3 to be Recovered
AB			2.9	21,264
Abbott	60	85	2.46	19,844
Ferron	36	7.5	.22	1,065
Rafael	12	7.5	.22	355
AW			10.6	0
Alluvial Land	0	100	10.6	0
BA			8.4	0
Badlands	0	100	8.4	0
CEE_2			209.5	215,477
Castle Valley	9	85	178.08	215,477
Rock Outcrop	0	7.5	15.71	0

Soil Type	Depth of SPGM (inches)	% of Map Unit	Acreage	Yd³ to be Recovered
Rockland	0	7.5	15.71	0
CEC-SH			28.4	18,900
Castle Valley	9	55	15.62	18,900
Sh series	0	40	11.36	0
extremely rocky phase	0	5	1.42	0
CRE_2			7.8	944
Chipeta	0	50	3.90	0
Badland	0	40	3.12	0
Persayo	18	5	.39	944
Shale outcrop	0	5	.39	0
CPB_2			31.6	19,118
Chipeta	0	60	18.96	0
Persayo	18	25	7.9	19,118
Shallow soils	0	15	4.74	0
DL			1.6	8,596
Disturbed land	40	100	1.6	8,596
FE			41.8	185,453
Ferron	30	90	37.62	151,734
Abbott	60	10	4.18	33,719
GU			12.1	0
Gullied land	0	100	12.1	0
GP			45.7	62,670
GP series	6	80	36.56	29,492
Sanpete	30	10	4.57	18,432
Ildefonso	24	10	4.57	14,746
HA			0.2	0
Harding variant	0	60	.12	0
Typic Haplargid	0	25	.05	0
Harding	0	15	.03	0
HN			21.7	109,565
Hunting	40	85	18.43	99,013
Billings	60	5	1.09	8,793
Rafael	12	5	1.09	1,759
Saline/alkaline soils	0	5	1.09	0
HS			41.8	213,338
Hunting-moderately saline phase	40	95	39.71	213,338
Strongly saline soils	0	5	2.09	0

Soil Type	Depth of SPGM (inches)	% of Map Unit	Acreage	Yd^3 to be Recovered
ILB			4.0	25,652
Ildefonso	54	85	3.40	24,684
Gypsiorthids	6	5	.2	161
Sanpete	30	5	.2	807
Haverson	0	5	.2	0
ILD$_2$			21.0	139,467
Ildefonso	54	85	17.85	129,591
Hunting	40	5	1.05	5,641
Sanpete	30	5	1.05	4,235
Harding	0	5	1.05	0
KLB			40.2	152,217
Killpack	28	90	36.18	136,003
Billings	60	5	2.01	16,214
Saline soils	0	5	2.01	0
KPB			5.0	18,796
Killpack	28	95	4.75	17,856
Killpack clay loam	28	5	.25	940
LB			6.4	29,427
Libbings	36	95	6.08	29,427
Deep and shallow clayey soils	0	5	.32	0
PDB			9.6	42,592
Palisade	30	80	7.68	30,976
Palisade-like	30	10	.96	3,872
Minchey cobbley loam	60	10	.96	7,744
PCE$_2$			91.2	88,282
Persayo	18	40	36.48	88,282
Chipeta	0	40	36.48	0
Badland	0	20	18.24	0
RLB			35.3	132,696
Ravola	30	80	28.24	113,901
Billings	60	6.6	2.33	18,795
Bunderson	0	6.6	2.33	0
Saline/alkali soils	0	6.6	2.33	0
RLB$_2$			4.8	19,360
Ravola	30	80	3.84	15,488
Bunderson	0	10	.48	0
Billings	60	10	.48	3,872
RY			86.8	0
Rockland	0	100	86.8	0

Soil Type	Depth of SPGM (inches)	% of Map Unit	Acreage	Yd^3 to be Recovered
SA			10.1	0
Saltair	0	100	10.1	0
SH-PDC			55.4	83,200
Sh series	0	50	27.70	0
Palisade	30	35	19.38	78,166
Castle Valley	9	7.5	4.16	5,034
Rock outcrop	0	7.5	4.16	0
WO			3.5	14,117
Woodrow silty clay loam	30	100	3.5	14,117
Totals			837.4	1,601,131

Note: Total SPGM to be respread will be approximately 14 inches in depth.

Before recovery and during redistribution, the soil depths will be staked and carefully supervised to ensure that the SPGM is not contaminated during either of these handling phases.

SPGM stockpiles will be labeled for identification, and mulched and seeded to ensure their stabilization. Any vegetative debris large enough to cause later stockpile stabilizing problems will be removed and disposed of prior to SPGM recovery.

3.5.3.1 Disposition of Dams, Ponds, and Diversions

The surface mine area surface water management includes two temporary collection ponds to be built upstream of the surface mine area sedimentation pond to provide runoff protection while that permanent pond is constructed. Since these two temporary ponds lie entirely within the mining area, their disposition will occur no later than when the surrounding topsoil is removed.

Other water management structures include both the north and south diversion ditches, which like sedimentation pond No. 1, have been designed as permanent structures. The culverts and spillway structures associated with these permanent facilities will also remain intact and functional.

3.5.3.2 Removal of Surface Structures

The surface structures at Consol's Emery Mine will be removed or razed upon either the completion of mining or after the useful life of these facilities has expired. The structures that are salvageable will either be sold or removed; all other structures will be razed and disposed of in an environmentally sound manner. Wherever possible, the inert and sound refuse will be utilized as backfill.

3.5.4 Backfilling and Grading Plans

The overburden material in the surface mine disturbance area consists primarily of sandstone, shale, and alluvium. Because it will be necessary to blast most of the overburden in the mine area prior to uncovering the coal, we anticipate that the overburden will occupy more volume than it does in its present state. However, roughly 20 feet of coal will be removed from the mine area. Therefore, it is possible to regrade the area to its approximate original topography with the exception of the extremely steep sloped areas adjacent to Christiansen Wash. In developing the post-mining topography plan, it was assumed that the overburden would "swell" to about 1.3 times its original volume. The estimated coal volume was then removed and the plan was developed to balance the overburden material and to provide adequate drainage for the area.

In order to facilitate the intended post-mining land use, the mine area will be graded to a gentle topography with the drainage to be located along the western edge of the mining area. The final pit will be backsloped to a maximum of about 20%. The disturbed areas, outside the mined area, will be regraded nearly identical to the present topography.

In order to represent the existing topography of the disturbance area, a pre-mining slope analysis was performed by outlining areas of similar slope and adding the acreages in each group. The following table shows the results of this analysis:

% Slope	Acres
Over 20	89.3
15 - 20	0
10 - 15	70.9
5 - 10	200.5
0 - 5	476.7
TOTAL	837.4

A similar analysis was performed on the post-mining topography map. The results of this analysis are shown below:

% Slope	Acres
Over 20	77.0
15 - 20	6.3
10 - 15	72.2
5 - 10	306.5
0 - 5	375.4
TOTAL	837.4

A comparison of the results of the pre- and post-mining slope analysis indicates an increase in the 5 - 10% slope range and a decrease in the 0 - 5% slope range. This is because the majority of the 5 - 10% slope range is about 6%. Overall the pre-and post-mining slopes are very close and the post-mining topography will be well suited to the post-mining land use.

The topography maps used in this analysis are included in Chapter XII along with a post-mining topography map and cross-sections showing pre- and post-mining profiles.

3.5.4.1 Recontouring

A Catapillar D-9 dozer or similar machine will be used to rough grade the mining area. This will consist of dozing the peaks off the spoil ridges and leveling out the spoil area. Rough grading will be performed between the inclines as mining progresses. Following completion of mining, the inclines and final pit will be rough graded with dozers. Following rough grading, the area will be finish graded as necessary with Catapillar 637 scrapers or similar machines. During finish grading operations, the soil will be spread in uniform layers and compacted as it is placed. Wherever possible, final grading will be done along the contour so as to minimize stability problems.

3.5.4.2 Removal or Reduction of Highwalls

Following rough grading of the spoil side of the final pit, the highwall will be backsloped by moving material from the highwall into the final pit using a dozer. Following rough grading the highwall will be finish graded as necessary with scrapers. Where possible finish grading will be done along the contour. Finish grading in the disturbance area will be done in accordance with the post-mining topography plan.

3.5.4.3 Variance From The 180 Day Backfilling and Grading Requirement

As shown on Plate III-1, mining operations will move from the southwest portion of the mining area to the northeast portion of the mine area in mid-1986. Mining operations will move back to the southeast portion of the mining area in mid-1987. This is necessary to balance the stripping ratio and ensure relatively uniform production from the surface mine to blend with the underground production. During the time mining operations are taking place, the inclines will remain open until the final pit has been mined.

This pit sequence will not result in reclamation delays in that the total length of open highwall would be the same if the area was mined in one long continuous pit. Therefore, a variance from the 180 day backfilling and grading requirement is requested.

Rough grading between the inclines will be kept as close to mining as possible and not further than four spoil ridges behind mining operations.

3.5.4. 4 Terracing and Erosion Control

Terracing and erosion control procedures are discussed under the following section and other later sections.

3.5.4. 5 SPGM Redistribution and Stabilization

There will be approximately 14 inches of SPGM redistributed over the entire 837 acre disturbance site. These soils will be respread carefully to ensure even distribution. The soils will be mulched and seeded at the earliest appropriate period to minimize soil erosion. Seeding and mulching will be discussed in later sections. If severe erosion problems develop before vegetation can be established, other control methods will be utilized, such as netting, chemical tackifiers, etc. Small ditches will be cut along the contour of the post-mine slopes to aid in controlling downslope erosion and to help catch moisture for vegetation establishment. The ditches will be simply constructed with a blade (grader) after the SPGM has been respread. Terrace or ditch spacing may be approximately every 100 feet. Please refer to Plate III-2 (Post-Mine Reclamation Map) for illustrations.

3.5.5 Revegetation Plan

There will be approximately 837 acres of the permit area disturbed as a result of mining, either by direct mining or by associated facilities. This acreage has eight vegetation types mapped for the area, those being: "riparian meadow," "annual forb community," "mixed desert shrubland," "greasewood shrubland," "pinyon/juniper woodland," "rock outcrop/talus," "previously disturbed area," and "agricultural lands." Of these types, the "mixed desert shrubland" makes up the overwhelmingly largest portion of the total acreage with 67.4%. The other types make up the additional acreage with the following percentages: riparian meadow - 9.6%, annual forb community - 5.7%, greasewood shrubland - 8.5%, pinyon/juniper woodland - 1.9%, rock outcrop/talus - 2.6%, the agricultural area - 3.9%, and the previously disturbed area - 0.06%. 96% of the total disturbance area is classified as rangeland.

The premine vegetation is clearly dominated by shrublands, thus the post-mine revegetation plan will be designed to put back the acreages to approximately 2/3 shrublands and 1/3 to grasslands. (The only exception to this will be the approximately 33 acres of pastureland that is to be reestablished.) These vegetation types will be established in alternating strips. The grassland strips will be approximately the width of a 12' seed drill and will be composed entirely of grass seed. The shrub strips will be about 24' wide and will be established by shrub seed and shrub transplants. This stripping method will aid in weed control and in reduction of moisture competition as well as being economical feasible.

Weeds can be controlled with 2-4D in the grass strips without harm to the plants. This should aid in overall control on the shrub strips also. We do not anticipate a severe weed problem because our SPGM should be relatively weed-free when redistributed any significant weed problems we do encounter will likely be from Kochia scoparius.

Another reason for using strips is more important, that being soil moisture competition between plants. It is a well documented fact that grasses will outcompete shrubs for moisture when the two plant groups are seeded together on new disburbance sites. During the establishment period. Once the shrubs become established, they hold their own well and actually are even better adapted than grasses once mature on extremely arid sites. However, as mentioned, the shrub seedlings will be outcompeted during the initial reclamation stage if planted with grasses and will never have a chance to become established. Thus, it is important to seed these types separately. The strips are a method of establishing both types at the same time. When the communities are established, intergration between communities can begin and continue through the successional development until climax is reached for the area as a whole. All components will be present for this to happen.

The strip-revegetation method will also aid in snow catchment for soil moisture retention. Strips will be designed along the slope contours for also aiding in erosion control.

To add more diversity to the revegetated acreages, the shrub strips will be of alternating types; i.e., Type 1 and Type 2. Although the seed plans will be identical, there will be totally different transplant plans for each of the two shrub strip types. The grass strips will be seeded all alike. Refer to Plate III-2, which is the post-mine revegetation map for illustrations of the strips.

3.5.5.1 Seedbed Preparation and Soil Amendments

A good firm seedbed is necessary for revegetation success. Our premine soils data indicate that the SPGM will probably be rather loamy, even sandy and thus will not need much cultivation. The scrapers doing the respreading may compact the surface soil slightly, if so, Consol will use a tractor-drawn cultivator or light disk to break up any compacted chunks if they are present. The diskings will also be needed to work fertilizer into the soil to a depth of about 3 to 6 inches. After disking, the surface should be uniform and ready to seed. The rate and type of fertilizer to be used will be: 150 lbs/acre of Diammonium phosphate (16-48-0). Note here that the reclamation sites will be irrigated during the first growing season. The additional water added will eliminate any concern for fertilizer burn on the plants.

3.5.5.2 Seeding and Transplanting

Rangeland

Once the SPGM has been worked into a good seedbed, seeding will begin in the strip fashion mentioned in Section 3.5.5. Transplanting of shrubs will come later. All seeding will be performed in the fall, more specifically, in late October or early November. Since many of the grass species to be used are native, their germination rate is usually higher after being out in the elements over winter. This is even more important to shrub seeds. Transplanting will be accomplished during early spring.

All seeding will be performed with a "rangeland drill" which is developed specifically for seeding native grass and shrub seeds, having agitators and a variety of seed boxes for different sized and weight seeds.

As mentioned before, the grasslands will be established in strips separate from the shrublands. Grasslands will be seeded over approximately 1/3 of the entire area. The seed plan for the grassland strips is as follows:

Grassland Seed Plan

Species	lbs of PLS*/Acre	PLS*/sq. ft.
crested wheatgrass (Agropyron desertorum)	3	12
Indian ricegrass (Oryzopois hymenoides)	1	4
alkali sacaton (Sporobolus airoides)	0.25	10
western wheatgrass (Agropyron smithii)	2.5	7
galleta (Hilaria jamesii)	1	4
bluegrama (Bouteloua gracilis)	0.5	8
pubescent wheatgrass (Agropyron trichophorum)	2	4
streambank wheatgrass (Agropyron riparium)	2.5	9
	12.75	58

*pure live seed

This seed plan was developed considering the arid conditions existing on the reclamation sites. These species will promote both quick and perennial establishment.

The shrublands will also be established in strips which will comprise approximately 2/3 of the total area to be revegetated. There will be two different transplant plans for the shrublands; i.e., a strip 1 plan and a strip 2 plan. However, the seed plan will be the same for both shrub strip types. The shrubland seed plan is as follows:

Shrubland Seed Plan

Species	lbs of PLS Per Acre	PLS/sq. ft.
antelope bitterbrush (Purshia tridentata)	10	3
four-wing saltbush (Atriplex canescens)	6	8
rubber rabbitbrush (Chrysothamnus nauseosus)	1	8
winterfat (Certoides lanata)	5	6
big sagebrush (Artemesia tridentata)	0.25	14
stansbury cliffrose (Cowania mexicana)	5	7
	27.25	46

All seeding will be performed prior to the application of mulch materials. Transplanting, however, will be done after mulching to prevent harm to the outplanted shrubs. Transplanting will be into the shrubland seeded areas. Two different shrub transplanting plans have been developed as later indicated. Illustrations of strip planting plans are shown on Plate ___. The transplants will be outplanted roughly on 9' x 9' centers, which comes to around 538 transplants/shrub strip acre. A slow release 21 gram fertilizer tablet with an analysis of 20-15-5 NPK will be dropped into each planting hole prior to outplanting the transplants. These tablets provide all the nitrogen, phosphorus, and potash needed by the shrublings for two years. Planting holes will be drilled with a power auger. Approximately one quart of water will be given to each transplant shortly after outplanting. The transplants will probably be inoculated with mycorrhizal fungi and will be weather hardened prior to outplanting.

The two shrub transplant strip will be established side-by-side and alternating with grassland strips. Refer to Plate III-2 for illustrations.

The shrubland transplant plans are listed below:

Strip No. 1 Transplant Plan

Species	No./Acre	% of Total
four-wing saltbush Atriplex canescens	135	25
rubber rabbitbrush Chrysothamnus nauseosus	135	25
greasewood Sarcobatus vermiculatus	110	20
big sagebrush Artemesia tridentata	55	10
oldman wormwood Artemesia abrotanum	24	5
oakbrush sumac Rhus trilobata	55	10
cliffrose Cowania mexicana	24	5
	538	100

Strip No. 2 Transplant Plan

Species	No./Acre	% of Total
winterfat *Ceratoides lanata*	81	15
shadscale *Atriplex confertifolia*	110	20
gardner saltbush *Atriplex gardneri*	81	15
Great Plains yucca *Yucca glauca*	24	5
saltbush *Atriplex corrugata*	81	15
prostrate kochia *Kochia prostrata*	56	10
Castle Valley clover *Atriplex cuneata*	81	15
green mormon tea *Ephedra viridis*	24	5
	538	100

These two plans differ in species and in general character to enhance diversity which creates differing habitats for small mammals and birds. Transplants must be in at least 13 cubic inches containers with corrugated sides to ensure correct root development before outplanting.

Of the 24 species to be utilized in revegetating the rangeland disturbance sites, only four are introduced species, those being: crested wheatgrass, pubescent wheatgrass, oldman wormwood, and prostrate kochia. None of these species are poisonous or noxious and are compatible with the plant and animal species of the region. These species are necessary to aid in achieving a quick and permanent stabilizing cover that enhances the control of soil erosion. All of these species have been studied in appropriate field trials and have demonstrated their ability at establishing effective cover capable of achieving the post-mining land use.

There are approximately 33.1 acres of pastureland that will be reestablished during the reclamation phase. This acreage will be seeded to sweet clover and crested wheatgrass.

3.5.5.3 Mulching

Straw or native hay mulch will be applied to the reclamation acreages after seeding has been completed and before transplanting of shrub materials. The mulch will be applied at a rate of 4,000 lbs./acre to all reclamation areas with potentially serious erosion problems. All other acreages will have mulch applied to them at a rate of 2,000 lbs./acre. The mulch will aid in controlling erosion, promoting germination of seeds, and increasing the moisture retention of the soil. After the mulch is blown onto the disturbed acreages, the mulch will be crimped in with a straight disk crimper. This process will secure the mulch to the soil.

3.5.5.4 Irrigation

Because of the extreme aridity of the disturbance area, irrigation will be necessary. Irrigation water will be applied to most of the reclamation acreages at a rate of 0.25 inches at one application per week. All irrigation will take place at night after the sun has gone down, preferably in early evening to minimize evaporation loses.

Irrigation water will only be applied for one growing season; i.e., during the establishment period only. The water will be applied in a manner that will maximize wetting depth in order to develop root systems that will be drought tolerant.

The irrigation system will likely be of sprinkler type that does not deliver large droplets that may erode the sandy topsoils. The small one or two tower center pivot irrigation systems would be well adapted to the conditions on these disturbance acreages.

The improved pastureland acreage will be irrigated for establishment and will be irrigated during the last two years of the liability period for comparisons to be made to USDA - SCS data

3.5.5.5 Weed Control

Kochia scoparia will probably be the weedy species that causes us the most difficulty. However, because our SPGM is weed-free now and will be kept that way, we should not have a major problem with weed infestations. Weed control will be chemical with 2-4D in the grassland strips only, which will also aid weed control on the area as a whole.

3.5.5.6 Management

The revegetated acreages will be carefully managed for two or three years after seeding and transplanting to control weeds, etc., and to ensure that the new vegetation is taking hold. Some grazing may be allowed under very careful control. In the advent that some small acreages fail to re-vegetate initially, Consol will reseed them.

3.5.5.7 Standards and Methods for Demonstrating Reclamation Success

Rangeland

The method to be utilized for demonstrating reclamation success on rangeland acreages, will be through the use of 4 vegetative reference areas already established. Please refer to Plate IX-1 for locations. Over 96% of the disturbance area is made up of native rangeland.

There are seven vegetative communities which make up this rangeland acreage. These communities will be represented in post-mine comparisons by the following reference areas:

1. "Mixed desert shrubland reference area" - will represent the "mixed desert shrubland community acreage (564.6 acres, 67.4% of disturbance area), the "annual forb community" (47.7 acres, 5.7% of disturbance area), the "rock outcrop/talus community" (21.7 acres, 2.5% of disturbance area), and the "previously disturbed area" (0.5

MD RA
MD
AF
R
D

acres, 0.06% of the disturbance area). The latter three communities were included into this reference areafor representation because the "mixed desert shrubland" reference area is the most similar to these sites in cover and productivity when compared to the other reference areas.

2. "Riparian meadow reference area" - will represent the "riparian meadow" community acreage (80.7 acres, 9.6% of the disturbance area).

3. "Greasewood shrubland reference area" - will represent the "greasewood shrubland" acreage (71.6 acres, 8.5% of the disturbance area).

4. "Pinyon/juniper reference area" - will represent the "pinyon/juniper woodland" community acreage (16.5 acres, 1.9% of the disturbance area).

The weighted mean for production and cover will be developed from data collected from these reference areas at the time for comparisons to the post-mine vegetation which will be the last two years of the liability period. The weighted mean will be developed based on the proportions of the premine disturbance area which was made up by the various vegetation types. Because the premine vegetation is classified as rangeland, production and cover will be the primary parameter standards used for demonstrating revegetation success levels.

Cover and production sampling will be performed on the grassland and shrubland acreages separately and then a weighted mean calculated for the revegetated area as a whole. These means will be compared to the reference area means with a statistical "T" test to varify equal-to or greater-than production and cover situations.

Data collected for cover and productivity will be done so at 90% confidence limits on both reclaimed and reference areas to ensure accuracy.

Agricultural Land (Improved Pastureland)

The pasturelands make up approximately 4% of the disturbance area. Reclamation success on reclaimed improved pastureland acreages will be demonstrated through the use of estimated hay yields expected on the premine agricultural soils that are present. These estimated yields were developed and published in the Soil Survey for the Carbon-Emery County Area by the USDA-SCS, THE USDI-BLM, and the Utah Agricultural Experiment Stations. Predicted yields are as follows:

Soil Types Found within the Agricultural Area
Estimated Yields - USDA-SCS

Soil Type	Acreage Within Disturbance Boundary	Estimated* Yield (lbs of hay/acre)	Total Yield Expected (lbs of hay)
Hunting loam	4.6	6,000	27,600
Ravola loam	12.4	6,000	74,400

Soil Type	Acreage Within Disturbance Boundary	Estimated* Yield (lbs of hay/acre)	Total Yield Expected (lbs of hay)
Killpack loam	5.1	4,000	20,400
Persayo chipeta	8.0	3,000	24,000
Woodrow silty clay loam	3.0	5,000	15,000
	33.1		161,400

*expected yields under common management

The post-mine reclaimed pastureland must produce 4,876* lbs of hay per acre for two consecutive years at the end of the liability period to demonstrate that bond release must be given. The yields are to be produced under irrigation.

Statistical "T" test comparisons will be made between pre- and post-mining means at the 90% confidence level.

* NOTE: As discussed in earlier sections, the soils that are shown to be present on the pastureland acreages were mapped by the generalized methods of the SCS and are of questionable accuracy for permit applications. Consol is currently conducting a site specific soil survey to more accurately describe the quantity and quality of the soils that are present. The site specific survey may significantly change the expected yields for this acreage. If so, the above data will be modified to reflect the true on-site expected yields before comparisons are made.

A further point to be made is that the above SCS yields are based on "common irrigation management" practices, where as our acreage would not be classified as being managed near that well in the pre-mine situation. Therefore the SCS yields are high as compared to what we have on-site and are consequently a bit unfair for comparison purposes.

3.5.6 Schedule of Reclamation

1983	Permanent stabilization of the northern diversion, southern diversion, the embankment across Christiansen Wash and the roadway embankment across the northern diversion. Temporary stabilization of the temporary road embankments and cut slopes, completed topsoil stockpiles, parking areas, explosive storage areas, access roads and temporary diversions.
1984	Rough grading in the 1984 boxcut area, complete remaining temporary and permanent stabilization of 1983 construction areas.
1985	Rough grading in the 1983 and 1984 mining areas.
1986	Rough grading in the 1985 mining area.
1987	Rough grading in the 1986 mining and boxcut area.
1988	Rough grading in the 1987 mining area. Finish grading in mine area southwest of Incline A.
1989	Rough grading in the 1988 mining area. Respread topsoil in the mine area southwest of Incline A.
1990	Rough grading in the 1989 mining area. Revegetate the area southwest of Incline A.
1991	Rough grading in the 1990 mining area.
1992	Rough grading the inclines, remove buildings, conveyors, and rough grade the final pit.
1993	Backslope final pit, finish grading between Inclines A and B, respread topsoil and revegetate parking and building areas.
1994	Finish grade between Inclines B and C, respread topsoil between Inclines A and B, revegetate between Inclines A and B.
1995	Finish grade remainder of mine area, finish grade temporary roads and diversions. Respread topsoil and revegetate between Inclines B and C.
1996	Respread topsoil on remainder of disturbance area. Revegetate between Inclines C and D.
1997 and 1998	Complete revegetation.

3.5.7 Cost Estimate for Reclamation

The Emery Surface Mine Permit Area has been divided into six categories of disturbance. Each of these six areas will be bonded at the total estimated cost of reclaiming the areas based on the requested disturbance for this permit term. The following is a description of each area and the method used to determine the bond amount.

Category A - This is the area between the disturbance area boundary and the permit boundary. Disturbance in this area will be very minor in nature and consist of power line construction and minor vehicle traffic.

Category B - This is the area intended for associated facilities such as areas for roads, diversions, parking facilities, explosive storage areas, coal stockpiles and buildings. The topsoil in these areas will be stripped and finish grading will be required during reclamation. Revegetation cost will be the same as in categories C, D, E, and F.

Category C - This area will be used for stockpiling topsoil from other areas. No grading will be required. The area will require revegetation only.

Category D - This area will not be mined until 1986. However, some disturbance will occur while mining the adjacent area. The bond for this area will be increased in 1985 to reflect the planned mining disturbance.

Category E - This area includes most of the extended mine plan area. Some disturbance in this area will occur while mining the adjacent areas. The bond in this area will be increased prior to receiving approval to mine this area.

Category F - This is the area that will most affected by mining and will be bonded at the highest rate.

3.5.7.1 Cost Estimate For Each Step Of Reclamation

Part I - Facility Removal

1. Removal of Shop, Office, Bathhouse, Warehouse Building

   A. Structure

120' x 125' x 26' = 390,000 C.F. = @ $0.14/C.F.	$ 54,600
63' x 33' x 10' x 20,790 C.F. = @ $0.14/C.F.	2,900

B. Foundation and Concrete Floors

Rip Floor Slab

$(120 \times 125 \times \frac{0.67}{27} + \frac{63}{27} \times 33 \times 0.33) \times \$75/C.Y. =$ 29,800

Bury Remaining Foundation Footings (Lot) = 5,000

2. Fuel Storage

(Includes Pumps) Remove 10,000 gal. Gas Tank (Lot) = 500

(Includes Pumps) Remove 50,000 gal. Diesel Tank @ 10¢/gal. = 5,000

Grade Area 250

3. Lube Building

Assume 40' x 20' x 10' = 8,000 C.F. @ $0.14/C.F. = 1,120

Concrete: $40 \times \frac{20}{27} \times 0.5 \times \$75/C.Y. =$ 1,100

4. Electrical Substation and Power Lines

(Lot) = 6,000

5. Water Storage Tank

130,000 gal. @ 10¢/gal. = 13,000

10,000 gal. (lot) = 500

6. Water Treatment Facility

Building 40' x 50' x 10' x $0.14/C.F. = 2,800

Remove Equipment (lot) = 1,800

Remove Concrete Floor $40 \times \frac{50}{27} \times 0.5 \times \$75/C.Y. =$ 2,700

7. Septic Tank

Excavate and Remove (Lot) = 1,000

8. Hopper Structure

Remove Equipment (Lot) = 2,500

Remove Concrete $40 \times \frac{40}{27} \times 5 \times \$75/C.Y.$ (Lot) = 3,000

Bury Footings (Lot) = 500

9. Raw Coal Conveyor and Stacking Tube

330' x 0.075 Ton/Ft. x $92/Ton = 2,300

10. Raw Coal Reclaim Conveyor

300' x 01075 T/L.F. x $92/Tn. = 2,100

11. Transfer Building

Remove Building - 21,000 C.F. x $0.14/C.F. = 2,900

Remove Concrete (Lot) = 1,500

12. Raw Coal Transfer Conveyor

300' x 0.075 T/F x $92/Tn.= 2,100

13. Sampler (Lot) = 2,000

14. Scale 500

SUBTOTAL - Facility Removal $147,470

Part II - Regrading

Based on historical costs from Consol's Western Region the estimated cost for mined acres = $1,870 per acre. For associated disturbance areas figure 50% of mine area cost or $935 per acre.

Part III - Topsoil Respreading

Based on respreading an average of 14 inches of topsoil, there will be about 1,882 cubic yards per acre available for respreading. 1882 cubic yards per acre x $1.25 per cubic yard = $2,353/acre

Part IV - Revegetation Cost

	Cost per Acre
Seedbed Preparation	$ 28.56
Seed and Transplant Materials	600.00
Mulching and Crimping	72.70
Erosion Control	37.63
Weed Control	27.64
Reseeding	33.14
Monitoring	108.23
TOTAL	$907.90

3.5.7.2 Forecast of Performance Bond Liability During Permit Term and Forecast of Liability for Life-of-Mine

1983 Bond Amount - The Perforamnce Bond to be furnished just prior to permit approval will be as follows:

Category A Areas: 119.0 acres @ $200 per acre = $23,800

Category B Areas: Facilities Removal = $147,440
Regrading = 190.5 acres @ $935 per acre = $178,118
Topsoil Respreading 190.5 acres @ $2,353 per acre = $448,247
Revegetation = 190.5 acres @ $907.90 per acre = $172,955

Category C Acres: Revegetation = 130.3 acres @ 907.90 per acre = $118,299

Category D Acres: 106.3 acres @ $400 per acre = $42,520

Category E Acres: 163.9 acres @ $400 per acre = $65,560

Category F Acres: Regrading = 258.7 acres @ $1,870 per acre = $483,769
Topsoil Respreading = 258.7 acres @ $2,353 = $608,721
Revegetation = 258.7 acres @ $908.90 = $234,874

TOTAL 1983 Bond Amount = $2,524,303

In 1985, the bond amount for the 106.3 acres in the Category D area will be increased to the bond amount for the mined area acres (Category F) from the $400/acre 1983 amount.

106.3 acres x ($5,130 - $400)	=	$ 502,895
1983 Bond Amount	=	$2,524,303
TOTAL 1985 Bond Amount	=	$3,027,198

In 1987 the remainder of the extended mine area will be permitted and the bond amount for the Category E area will be increased from the $400 per acre to the mined area amount.

163.9 acres x ($5,130 - $400)	=	$ 775,247
1985 Bond Amount	=	$3,027,198
TOTAL 1987 Bond Amount	=	$3,802,445

CHAPTER IV

LAND STATUS, LAND USE, POST-MINING LAND USE

CHAPTER IV

LAND STATUS, LAND USE, AND POST-MINING LAND USE

		Page No.
4.1	Scope	IV-1
4.2	Methodology	IV-1
4.3	Land Status	IV-1
4.3.1	Surface Land Ownership Within and Adjacent to the Permit Area	IV-1
4.3.1.1	Surface Managing Authorities	IV-3
4.3.1.2	Utility Corridors and Other Rights-of-Way	IV-4
4.3.2	Coal Ownership Within and Adjacent to the Permit Area	IV-4
4.4	Land Use	IV-6
4.4.1	Regional Land Use	IV-6
4.4.2	Land Use on the Permit Area	IV-6
4.4.3	Land Use During Operations	IV-8
4.4.3.1	Affect of Operations on Land Use	IV-8
4.4.3.2	Mitigation of Effects of Operations	IV-8
4.5	Post-Mining Land Use	IV-8
4.6	Socioeconomic Considerations	IV-9

LIST OF FIGURES

4.1	Land Use in Emery Mine Region	IV-7

DATA SUMMARY SHEET

VEGETATION TYPE: ______________________

	AFFECTED (Disturbance) AREA				REFERENCE AREA				
	$\overline{X}$	S	N	N_{min}	$\overline{X}$	S	N	N_{min}	t - value
Cover									
Density (plants/acre)									
Productivity									
Aspect									
Slope									
Soils									
Geology									

% Similarity: ______________________

$\overline{X}$ = Sample Mean

S = Sample Standard Deviation

N = Sample Size

N_{min} = Minimum Sample Size (for statistical adequacy)

4.0 LAND STATUS, LAND USE, AND POST-MINING LAND USE

4.1 Scope

Chapter 4.0 describes the status of lands in and adjacent to the permit area. Consol's right to mine is based on ownership or lease rights to the coal. Land use is discussed for the region and for the mine plan area. As discussed in Section 4.5, the post-mining land use will be the same as the pre-mining use.

4.2 Methodology

The section discussing land status was developed by reviewing Consol's land ownership information and right to mine documents. Title opinions were prepared for Consol which explained the status of coal and surface ownership. The discussion of land use is based on the present use of the soils in the area and a previous land use study prepared by the BLM.

4.3 Land Status

4.3.1 Surface Land Ownership Within and Adjacent to the Permit Area

The following information describes the surface land ownership within and adjacent to the permit area. Plate IV-2 shows surface land ownership in and adjacent to the permit area. P&M ownership derives from the parent company Gulf Oil Corp. which purchased Kemmerer Coal Company.

Township 22 South Range 6 East of SLM

Section 21	Portion NW¼	Robert Anderson Emery, Utah 84522 (801) 286-2369
	Portion NW¼ Portion SW¼	Lyle Anderson Box 523 Emery, Utah 84522 (801) 286-2295
	Portion SW¼	Wayne Staley Emery, Utah 84522 (801) 286-2213
	W½NE¼	Dermis Jensen Emery, Utah 84522 (801) 286-2355
	E½NE¼	Lloyd Jensen Emery, Utah 84522 (801) 286-2207

	Portion $SE\frac{1}{4}$	Earl Jensen Box 111 Emery, Utah 84522 (801) 286-2398
	Portion $SE\frac{1}{4}$	Morgan Jensen 1163 Wildflower Drive Cedar City, Utah 84728 (801) 586-6432
Section 22	$E\frac{1}{2}$ $SW\frac{1}{4}SW\frac{1}{4}$ $E\frac{1}{2}NW\frac{1}{4}$	P&M
	$SW\frac{1}{4}NW\frac{1}{4}$ $N\frac{1}{2}SW\frac{1}{4}$ $SE\frac{1}{4}SW\frac{1}{4}$	J. & L. Kingston 1998 South 9th East Salt Lake City, Utah 84103 Phone Unknown
	$NW\frac{1}{4}NW\frac{1}{4}$	Dewey Jensen Emery, Utah (801) 286-2355
Section 23	All except $SE\frac{1}{4}SE\frac{1}{4}$	P&M
	$SE\frac{1}{4}SE\frac{1}{4}$	USA
Section 26	$W\frac{1}{2}NE\frac{1}{4}$	P&M
	All except $W\frac{1}{2}NE\frac{1}{4}$	USA
Section 27	All	P&M
Section 28	Portion $NW\frac{1}{4}$	Cedar Ridge Land & Livestock Company Emery, Utah 84522 (801) 364-3339
	Portion $NW\frac{1}{4}$	Wayne Staley Emery, Utah 84522 (801) 286-2213
	Portion $NE\frac{1}{4}$	Morgan Jensen 1163 Wildflower Dr. Cedar City, Utah 84728 (801) 586-6432

	Portion NE¼	Jens O. Jensen 8760 Cranbrook Dr. Boise, Idaho 83704 (208) 376-1917
Section 29	S½ SW¼NW¼	P&M G. Olsen
	Portion NW¼SW¼	G. Olsen
	Portion NW¼SW¼ S½S½ NE¼SE¼ Portion NE¼NE¼	John Lewis 1163 E. 25th St. Idaho Falls, Idaho 83401 (208) 522-3646
	Portion NE¼NE¼	Cedar Ridge Land & Livestock Company Emery, Utah 84522 (801) 364-3339
	E½NW¼ W½NE¼ NW¼SE¼ NE¼SW¼	Earl Bryant Emery, Utah 84522 (801) 286-2227
	NW¼NW¼	L. Mangum Emery, Utah 84522
	SE¼NE¼	R. Jensen
Section 32	SW¼	Earl Bryant Emery, Utah 84522 (801) 286-2227
	N½ SE¼	P & M
Section 33	All	P & M
Section 34	N½	P & M
	S½	USA
Section 35	All	USA

4.3.1.1 Surface Managing Authorities

The following identifies the apparent surface managing agencies in and adjacent to the permit area.

Public Lands:	U.S. Department of Interior Bureau of Land Management Price, Utah 84501
State Lands:	Division of State Lands 231 E. 400 South Room 440 Salt Lake City, Utah 84111
Zoning:	Emery County Zoning Commission Castledale, Utah 84513
Irrigation:	Muddy Creek Irrigation District Clyde Mortenson, President Emery, Utah 84522

4.3.1.2 Utility Corridors and Other Rights-of-Way

Plate III1 shows the location of powerlines and road rights-of-way crossing the permit area.

4.3.2 Coal Ownership Within and Adjacent to the Permit Area

All the holdings described below that are shown as controlled by P&M or Consol are subject to a 50/50 lease agreement between Consol and Kemmer (now P & M) dated August 23, 1966 as amended 9/1/72 and 2/27/75, unless otherwise specified.

The lands listed pertain only to coal ownership. Plate IV-2 shows coal ownership in the permit area.

Township 22 South, Range 6 East of SLM

Section 21	All	P&M/Consol
Section 22	E½ NW¼NW¼ SW¼SW¼ SE¼NWP	P&M/Consol
	SW¼NW¼ N½SW¼ SE¼SW¼	USA
Section 23	N½SW¼ S½NW¼ NW¼NW¼ W½NE¼	P&M/Consol

	SE¼ S½SW¼ NE¼NW¼ E½NE¼	USA
Section 26	All	USA
Section 27	All	P&M/Consol
Section 28	All	P&M/Consol
Section 29	E½E½ SW¼SE¼ NE¼SW¼	P&M/Consol
	W½NE¼ E½NW¼ NW¼NW¼ NW¼SE¼	USA coal
	S½SW¼	State
	NW¼SE¼ SW¼NW¼	Olsen & Lewis (separate parcels) Olsen
Section 32	All	P&M/Consol
Section 33	All	P&M/Consol
Section 34	N½	P&M/Consol
	S½	USA
Section 35	All	USA

Leases in the permit area are shown in Plate IV-2 and are discussed in Section 2.4. There are no oil and gas wells nor any known oil and gas lease in the permit area.

4.4 Land Use

4.4.1 Regional Land Use

Regionally, land use in the vicinity of the Emery Mine includes five types. These are forestland, agriculture, pinyon-juniper rangeland, open rangeland, and urban areas. Figure 4-1 shows these land uses as they occur near the Emery Mine. The closest town is Emery which has a population of approximately 220 people, most of whom are involved in ranching, limited agriculture, or employed at the Emery Mine (BLM, 1979).

4.4.2 Land Use on the Permit Area

The permit area is made up of several land-use types, by far the major type being native rangeland. Of the types present, approximately 92.2% of the total permit area is rangeland, 3.4% is marginal pastureland, 3.4% is a native semi-woodland type, 0.1% is a man-made reservoir, and 0.05% is previously disturbed land. Please refer to Table 4.4.2 for acreage details.

The rangeland is utilized primarily for livestock grazing, and secondarily as wildlife habitat.

The pastureland acreage was apparently cultivated at one time, however, has only grasses on it now and seldom receives irrigation water. There is some question as to the soils that have been mapped for the pastureland acreages also, data was taked from SCS maps for this particular area. A detailed soils survey map is presently being developed to better qualify the soils type acreages. The detailed map will be sent in to the DOGM as soon as it is finished. The soils mapped from SCS data only are shown as screened on the premine soils map, Plate VIII-1.

The semi-woodland type consists primarily of small scattered juniper and pinyon pine trees growing within the native rangeland. This type

Table 4.4.2

Permit Area Land Use

Category	Acres in Proposed Disturbance Area	Acres in Permit Area	% of Total Permit Area
Previously disturbed lands	0.5	0.5	0.05
Pastureland	33.2	34.4	3.4
Rangeland	786.3	919.3	92.2
Rangeland semi-woodland	16.5	33.6	3.4
Reservoir	0.9	0.9	0.1
	837.4	988.7	100

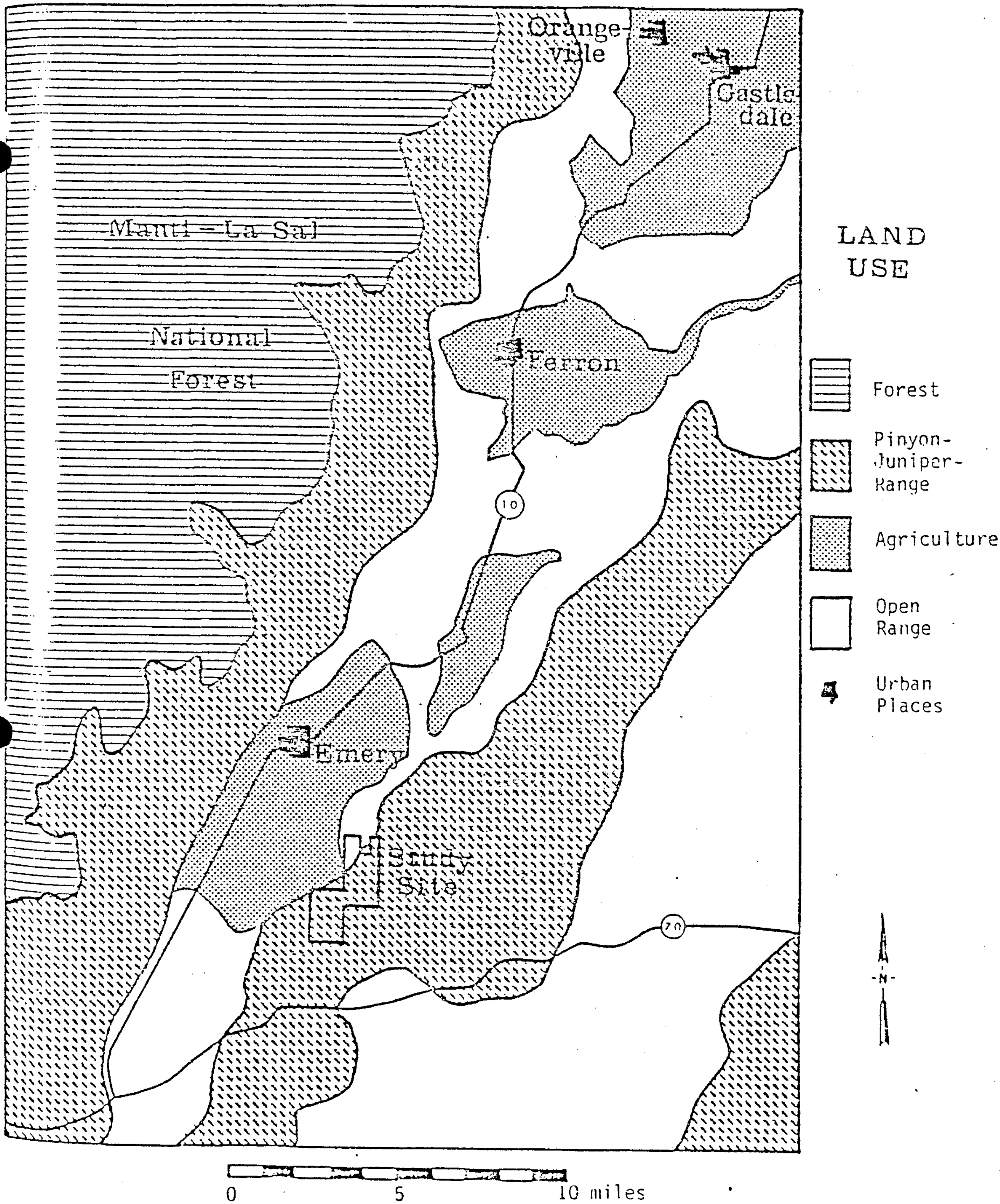


FIGURE 4-1
Land Use in Emery Mine Region

(Source: BLM, 1979)

benefits both livestock and wildlife as a cover against the elements. The other two types present are self-explanatory. Refer to the Permit Area Land-Use Map for illustrations, Plate IV-1.

4.4.3 Land Use during Operations

The land uses on approximately 84% of the permit area will be affected by mining operations. However, since the reclamation plan is designed to replace the premine land uses after mining, the affect will be temporary only.

4.4.3.1 Affect of Operations on Land Use

As stated earlier, land uses will be affected, but only temporarily. Care will be taken not to unnecessarily affect adjacent land uses during the operation process.

4.4.3.2 Mitigation of Effects of Operations

The reclamation plan discussed in Section 3.5 was developed to replace the same basic land uses that existed prior to mining. The replacement of these uses will make the land equally productive for livestock and wildlife. Certain environmental protection measures will be taken during mining to ensure that impacts will be minimized. These measures include: (1) sedimentation control, (2) protection of suitable plant growth materials, (3) minimizing disturbances, and (4) subsidence control.

4.5 Post-Mining Land Use

The affected acreages will be reclaimed to the same land uses as existed before mining. Refer to Table 4.4.2 for the categorization of the premine land uses.

4.6 Socioeconomic Considerations

Employment

As mentioned in Section 3.3.5, the Emery Surface Mine will employ about 90 people. About 70 of these poeple will be paid on an hourly basis and 20 will be paid on a monthly salary basis. It is anticipated that the hourly personnel will be hired locally and that the salaried personnel will be either hired locally or transferred from other locations.

The following table summarizes the population and employment statistics for the three counties to be most directly affected.

	Emery Co.	Sevier Co.	Carbon Co.
Population	12,100	15,200	23,200
Total Labor Force	6,690	7,050	10,110
Total Employment	6,430	6,660	9,600
Total Unemployed	260	390	510
Unemployment Rate	3.9%	5.5%	5.1%
Average Non-Farm Wage	$1,970/mo.	$1,073/mo.	$1,407/mo.
Average Household Size	3.5	3.2	3.0

(Source: Utah Department of Employment Security - 1981 Data)

CHAPTER V

HISTORICAL AND CULTURAL RESOURCES

5.0 HISTORICAL AND CULTURAL RESOURCES

5.1 Summary

As discussed in Section 3.4.2.1 four cultural resource surveys have been conducted in and around the surface mine area. About 340 acres of the area have not been surveyed. A compendium chart of cultural resource sites has been prepared listing the known sites in and around the surface mine area. A map showing the location of these sites has been prepared and a copy of the letter from Mr. David Madsen to Mr. Buddy Beach is also included.

Copies of the Michael Berry 1975 survey, the David Madsen 1976 survey and the F. R. Hauck 1980 and 1981 surveys and all site forms will be furnished if requested. The results of the spring 1982 survey will be furnished after it has been completed.

PROPOSED EMERY SURFACE MINE
CULTURAL RESOURCE COMPENDIUM
(Updated April, 1982)***

Site No.	Site Type	NRHP Eligibility Criteria*	Impact Potential	
			Direct	Indirect
42Em611	Prehistoric Lithic Scatter	No	Moderate	Low
42Em625	Prehistoric Rock Shelter	No**	No**	No
42Em626	Prehistoric Rock Shelter	No**	No**	No
42Em627	Prehistoric Lithic Scatter	No**	No**	No
42Em1316	Prehistoric Rock Shelter	d	Low	Low
42Em1317	Prehistoric Lithic Scatter	No	Low	High
42Em1318	Prehistoric Rock Shelter	Unknown	Low	Moderate
42Em1319	Prehistoric Rock Shelter	Unknown	Low	High
42Em1385	Historic Farm Buildings	d	Low	Low
42Em1386	Prehistoric Lithic Scatter	No	Low	Low
488N/10	Historic Browning Mine Site	Unknown	Low	Moderate

*under 36 CFR 60.6

**see Madsen letter of Feb. 20, 1976, and LaMar Lindsay-C. K. Lund, 1976

***Does not include results of the spring of 1982 survey.

STATE OF UTAH
Calvin L. Rampton, Governor
DEPARTMENT OF
DEVELOPMENT SERVICES
Division of State History
Melvin T. Smith, Director
603 East South Temple
Salt Lake City, Utah 84102
Telephone: (801) 328-5755

February 20, 1976

Mr. Buddy A. Beach
Consolidation Coal Company
5889 So. Syracuse Circle
Plaza Colorado Building
Englewood, Colorado 80110

Dear Buddy,

Please find enclosed a report on the excavations we carried out on your property in Emery County, Utah. With the exception of the appendix on site geomorphology the report is complete. The delivery of the missing appendix has been promised us by February 27. I will forward it to you when we receive it.

I hope the format of the enclosed report is acceptable to you and sufficient for your present purposes. The report will be eventually published in our monograph series sometime this summer. When it appears I will forward however many copies you require, to your office.

The report is essentially a technical one and some of the terminology may be unclear to nonarcheologists. Depending on the distribution, you may wish us to forward you a glossary of terms. If so, please let me know.

With the completion and publication of this report, nothing further will be gained by continued excavations on your property. I feel therefore that it should be cleared for construction purposes.

I will forward a statement of costs to you along with the missing appendix. Unless there are changes you require, our contract should be fulfilled.

Sincerely,

David B. Madsen

DAVID B. MADSEN
State Archeologist

DBM:lg

Encl.

Figure 7 Archeological clearance

CHAPTER VI

GEOLOGY

6.0 GEOLOGY

TABLE OF CONTENTS

		Page No.
6.1	Scope	VI-1
6.2	Methodology	VI-1
6.3	Geology of the General Mine Area	VI-1
6.3.1	Structure	VI-1
6.3.2	Stratigraphy	VI-1
6.3.2.1	Tununk Shale	VI-3
6.3.2.2	Ferron Sandstone	VI-3
6.3.2.3	Blue Gate Shale	VI-3
6.3.2.4	Alluvium	VI-5
6.3.2.5	Terrace Deposits	VI-5
6.4	Geology of the Permit Area	VI-5
6.4.1	Stratigraphy	VI-5
6.4.2	Physical Properties of Overburden Strata	VI-8
6.4.3	Geochemistry of Major Strata	VI-10
6.4.3.1	General	VI-10
6.4.3.2	Acid-Forming Potential	VI-12
6.4.3.3	Alkalinity-Producing Potential	VI-12
6.4.3.4	Toxic-Forming Potential	VI-12
6.4.4	Subsurface Water	VI-13
6.5	Geologic Effects of Mining	VI-13
6.5.1	Mining Hazards	VI-13
6.5.2	Impacts of Mining	VI-13
6.6	Bibliography	VI-13
Appendix 6-1	Lithological Descriptions of Cuttings and Core	
Appendix 6-2	Stratigraphic Descriptions of Drill Holes	
Appendix 6-3	Methods and Results of Chemical Analysis	
Plates		

LIST OF TABLES

		Page No.
6-1	Coal Quality	VI-7
6-2	Summary of Physical Property Test Results	VI-9
6-3	Interpretation of Strip Area Geochemistry - General Parameters	VI-11

LIST OF FIGURES

6-1	Dominant structural features and stratigraphic sequences in and adjacent to the Emery Coal Field	VI-2
6-2	Basic Stratigraphic framework of the Ferron Sandstone in the vicinity of the Emery Coal Field	VI-4

6.0 GEOLOGY

6.1 Scope

This chapter contains a general geologic description of the general mine area and a detailed discussion of the geology and geochemistry of the permit area. Included are chemical analyses and physical property information on strata near the mineable seams.

6.2 Methodology

Geologic information contained within this chapter was obtained largely from exploration drilling, published geologic literature, and private studies. In addition, Consol conducted test borings to collect core and cuttings for chemical characterization, physical property determination, and to indicate the locations of subsurface water.

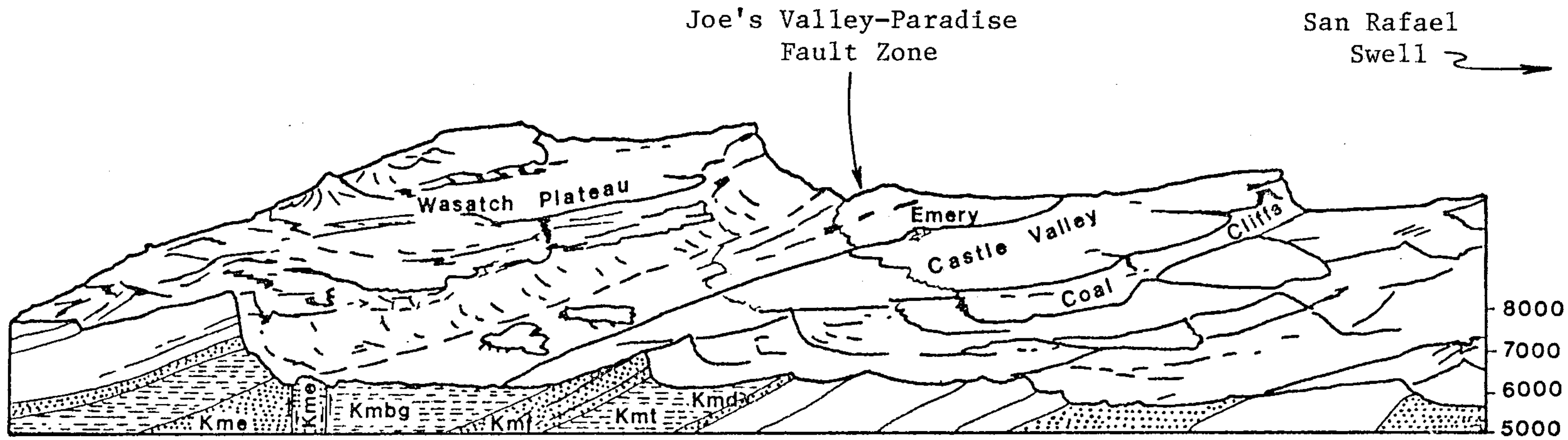
6.3 Geology of the General Mine Area

6.3.1 Structure

The Emery Coal Field is situated at the southern end of the Castle Valley, lying between the Wasatch Plateau to the west and the San Rafael Swell to the east. The San Rafael Swell is an elongated anticline which occurs in east-central Utah whose western flank produces inclinations through the Castle Valley of up to 10 degrees, but, more commonly between 2 and 5 degrees. The Joe's Valley Paradise fault graben parallels the plateau front on the western edge of the Castle Valley, ¼ mile to ½ mile west of Utah Highway 10. Displacement along this fault zone near the town of Emery is at least 1,000 feet (Doelling, 1972). No other folds or faults are significant in the general mine area. However, numerous vertical and conjugate joint systems are present and are easily visible in sandstone rocks. Figure 6-1 shows the dominant structural features and stratigraphic sequences of the Emery Coal Field and the surrounding area.

6.3.2 Stratigraphy

The sedimentary rock units of primary significance within the general mine area are, from oldest to youngest, the Tununk Shale, the Ferron Sandstone, and the Blue Gate Shale, all of which are members of the Upper Cretaceous Mancos Shale Formation. Quaternary rocks comprise streamlaid and fan alluvial deposits and terrace deposits. Plate 6-1 depicts the types of rocks exposed on and adjacent to the general mine area.



Kme	EMERY SANDSTONE
Kmbg	BLUE GATE SHALE
Kmf	FERRON SANDSTONE
Kmt	TUNUNK SHALE
Kmd	DAKOTA SANDSTONE

Figure 6-1. Dominant structural features and stratigraphic sequences of the Emery Coal Field and surrounding areas (adapted from BLM, 1979).

6.3.2.1 Tununk Shale

The Tununk Shale was deposited by westward transgressing waters of the Interior Cretaceous sea. It crops at the base of the Coal Cliffs which are adjacent to Muddy Creek (Figure 6-1). The Tununk Shale is blue-gray to black in color and offers very little resistance to erosion. Regional thickness ranges from 500 to 800 feet.

6.3.2.2 Ferron Sandstone

The Ferron Sandstone is the coal-bearing unit of the Emery Coal Field and also, the most resistant rock unit within Castle Valley. The Ferron Sandstone consists of two parts which are distinguishable on the basis of depositional history and, to a lesser degree, on lithology.

The northern part is a slightly older, stratigraphically lower silty sandstone unit that was deposited by a southwestward prograding delta system (Ryer, 1981). It extends within the Castle Valley from near Moore, northeast to around Wellington and averages about 100 feet thick. This northern unit is not significant to either coal or ground water resources within the Emery Coal Field.

The southern part of the Ferron Sandstone was deposited by successive processes of sedimentation from a northeastward prograding deltaic system. These deposits occur from the southernmost Ferron exposure northward to the vicinity of the settlement of Clawson, a distance of about 45 miles. The thickness of this portion of the Ferron generally increases southward from about 300 feet near Moore to about 850 feet near the southern end of Castle Valley (Lines and Morrissey, 1981). Within this area the Ferron consists of massive beds of very fine to medium-grained, delta-front sandstone, prodelta mudstones, and a wide variety of delta-plain rock types (mainly carbonaceous shale, coal, mudstone, siltstone, and thin-bedded, rippled, very fine grained sandstone) (Lines and Morrissey, 1981). Figure 6-2 shows the basic stratigraphic framework of the Ferron in the vicinity of the Emery Coal Field. Numbers refer to delta-front sandstone units of Ryer (1981).

6.3.2.3 Blue Gate Shale

The Blue Gate Shale also was deposited by a transgression of the western shoreline of the Interior Cretaceous sea. It is a saline, bluish gray mudstone and siltstone unit with a few thin layers of sandstone. The Blue Gate Shale thickens from its contact with the Ferron to greater than 1,200 feet just east of the Joe's Valley-Paradise fault zone.

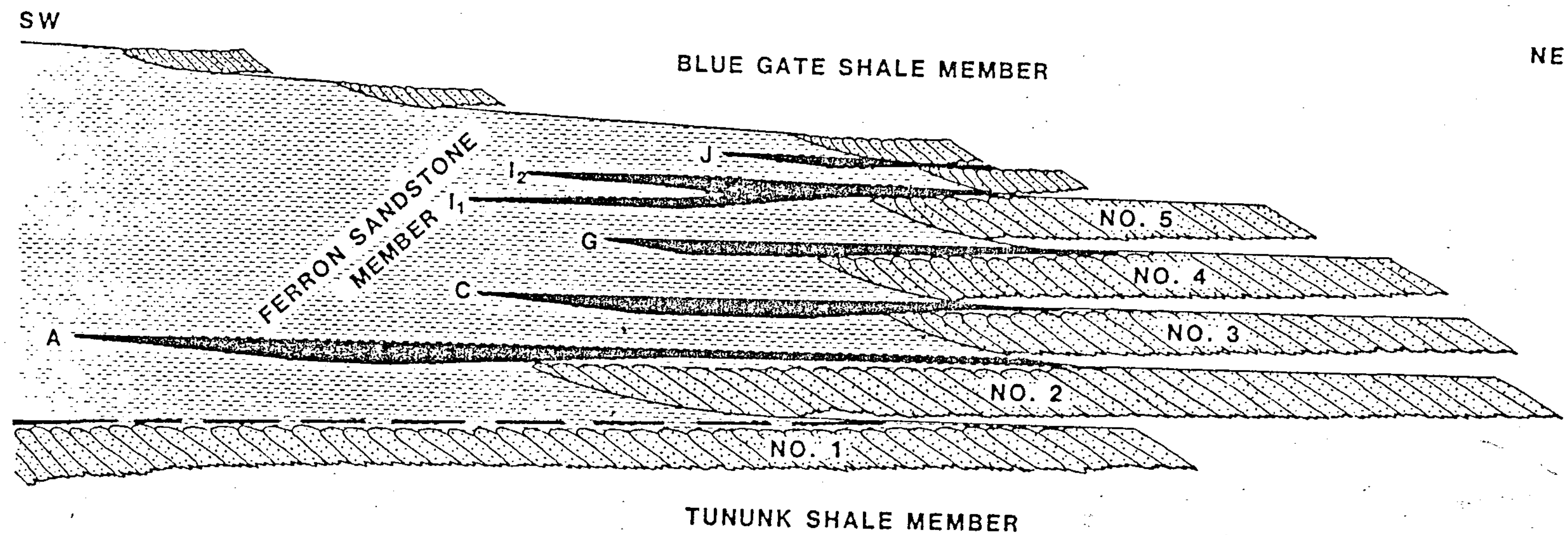


Figure 6-2. Basic stratigraphic framework of the Ferron Sandstone in the vicinity of the Emery Coal Field (Ryer, 1981).

6.3.2.4 Alluvium

Alluvium occurs as unconsolidated deposits of partly stratified silt, sand, gravel, and to a lesser extent clay, in and adjacent to the active stream channels of Quitchupah Creek, Christiansen Wash, and Muddy Creek. In addition, alluvium has been deposited as slope wash and fan material within drainages that are tributary to these active stream courses. These tributaries do not contain identifiable stream channels, however. Alluvium thickness along Quitchupah Creek may be as much as 75 feet. However, along Christiansen Wash and tributary drainages, alluvium thickness likely ranges from a few feet to about 25 feet.

6.3.2.5 Terrace Deposits

Sand and gravel deposits are present on terraces northeast of Quitchupah Creek. These deposits are thick (greater than 10 feet) in the S½ of Section 20, T22S, R6E, and thin towards the southeast along the terrace (Plate 6-1).

6.4 Geology of the Permit Area

6.4.1 Stratigraphy

The general geology of the permit area, down to and including the first 25 feet of strata below the IJ coal zone is shown in figures and described in lithologic descriptions. Plate 6-2 shows the drill hole and cross-section locations mentioned and discussed in this section. Appendices 6-1 and 6-2 contain lithologic and stratigraphic descriptions, respectively, of drill holes used to construct the cross-sections.

The major strata within the permit area are Quaternary alluvium (Qal), Blue Gate Shale (Kmbg), Ferron Sandstone above the IJ coal zone, the IJ coal zone, and the floor strata (Ferron Sandstone below the J coal zone). Complete lithologic descriptions are contained in Apprendix 6-1.

The alluvium (Qal) is crudely stratified, poorly sorted, calcareous, gypsiferous muds, sand, and gravels. The gravels are primarily dusty yellow, fine-grained limonitic sandstone fragments. A maximum alluvium thickness of 22 feet was encountered in drill hole FC703 (Appendix 6-2 and Plate 6-2).

The Blue Gate Shale (Kmbg) varies from 0 to 70 feet thick in the permit area, and is weathered, saline, alkaline, olive gray and medium blackish gray silty shale and siltstone with thin sandstone beds and abundant gypsum crystals. Partings and fracture surfaces are commonly coated with iron oxide.

The Ferron Sandstone above the IJ coal zone averages 55 feet thick in the outcrop area. Where overlain by Blue Gate Shale, its thickness averages 60 feet, and thins from soutwest to northeast across the permit area from about 80 feet to about 50 feet. It is a gray, yellow gray to orange gray, very fine to medium-grained, porous, massive, cross-bedded, feldspathic sandstone with thin beds of carbonaceous shales and coal, and coal fragments. In outcrop, the pyrite grains are oxidized and feldspars are altering to clays. The carbonaceous shales are fissile, and parting and fracture surfaces commonly have limonite, gypsum, or fine-grained pyrite.

The IJ coal zone is the targeted commercial horizon for this permit application and is the lowest interval to be mined. It ranges from 17 to 25 thick across the planned strip area (Plate 6-6). Depth of overburden ranges from 20 to 140 feet (Plate 6-6). In the proposed surface mine area, the zone consists, from base upwards, of a 13-15 foot layer of coal (Lower I), a 0-2 foot shale parting, a 4-6 foot layer of coal (Upper I), a 1-2 foot shale parting, and lastly a 3-5 foot layer of coal (J). Northwest of the permit area the Lower I is split by a clay parting, and in this case the splits are referred to, from top to bottom, as the LI1 and LI5. Table 6-1 lists coal quality data for the IJ zone.

The floor of the mine is comprised of interbedded carbonaceous shale, medium dark gray mudstone, olive green siltstone and light gray convoluted sandstone. The strata are generally dense and relatively impermeable.

As previously noted, Plate 6-1 shows the geology of the general mine area including that of the permit area. Alluvium occurs in the center of the permit area in stream channels and in a gently sloping, marshy area. The Blue Gate shale occurs on the northwest side of the permit area and forms rounded hills with 10 to 20 feet of relief. The Ferron outcrops along the southeast side of the permit area and is a dip slope former.

Cross-section A-A' (Plate 6-3) is a dip cross-section showing the northwesterly dip of the strata. Cross-section B-B' (Plate 6-4) is a strike cross-section along the northwest boundary of the surface mine area. The strata strike northeast-southwest, and the long axis of the pit is parallel to strike. Blue Gate Shale is deeply weathered, dissected, and gullied at the southwest end of the area. A saturated gravel bed is present in holes FC703 and FC706 at the base of the alluvium. Cross-section C-C' is another strike cross-section but near the southwest boundary of the surface mine area. Ferron occurs at the surface where it is weathered, limonitic, and fractured. In the subsurface, it is gray, reduced, and there is fresh pyrite.

TABLE 6-1

COAL QUALITY

EMERY SURFACE MINE AREA NO. 1

	As-Received Quality (6% Moisture)		
Seam	Btu	% Ash	% Sulfur
J	9,434	25.2	3.54
UI	11,093	15.2	2.01
LI0	11,862	11.1	1.17
LI1	10,852	16.8	1.65
LI5	12,089	9.7	0.95

- Data reflect the weighted average for each seam of the permit area.

6.4.2 Physical Properties of Overburden Strata

Five simple engineering tests: uniaxial (unconfined) compression, split cylinder, direct shear, sieve analysis, and slake durability were conducted on rock core or crushed rock core from holes FC167A, FC362, and FC365 under the direction of Dr. Ko, University of Colorado, Department of Civil Engineering. Unconfined compression and split cylinder tests were used to describe the strength of rock, hardness, ripability, and crushing strength. Slake durability was used to describe spoil weathering characteristic. Direct shear test was used to describe slope stability in spoil piles and reclaimed surfaces. Sieve analysis was used to describe the material tested in the direct shear test and describe potential spoil erodibility, permeability, compressibility, and workability.

Unconfined compressive strengths for rocks of the surface mine area are typical values for coal measure rocks (Barbour, Atkinson and Ko, 1979) (Table 6-2). Unconfined compressive strengths for the Blue Gate Shale are probably low; not enough intact core was available to test. The highest strength belonged to two samples (FC365-3 and FC167-7) described as shale. Because these two samples have such high strengths and high slake durability indices, they may be clasic siltstones. A sandy shale in the Ferron Sandstone (365-5) was also too fractured to test. The sandstones of the Ferron have moderate compressive strengths between 3912 and 8842 psi.

Tensile strengths of overburden samples are generally low, ranging from 238 to 1,059 psi (Table 6-2). Two samples of Blue Gate Shale could not be tested. The remaining two samples of Blue Gate had tensile strengths of 417 and 706 psi. The sandstones in the Ferron have tensile strengths of 238 to 689 psi. A shaley sandstone in the Ferron had a tensile strength of 869 psi. The highest tensile strength (1059 psi) was obtained from a shale (or clastic siltstone) from the Ferron (FC167-7). The generally low tensile strength of the overburden material will facilitate blasting and ripping.

Slake durability indices for the strata of the surface mine area range from high values to low values (Table 6-2). High values (97.6 percent and 91.7 percent) were obtained for FC167-7 and FC365-3 which are the shales or clastic siltstones of high compressive and tensile strengths of the Ferron Sandstone. The sandstones of the Ferron were also high and had values ranging from 90 to 97 percent. All the low values of the index were obtained from Blue Gate Shale samples (45, 60, and 72 percent). One Blue Gate Shale sample (362-3) did have a value of 95 percent.

Friction angles for the twenty specimens are generally high, ranging from 36.4° to 48.7° (Table 6-2), the range for gravels and pebbles (Lambe and Whitman, 1969). The high friction angles of the rock fragments tested imply a stable steep angle of the waste piles is possible, however, this indication should be tempered by the low slake indice of the shale material.

TABLE 6-2. Summary of Physical Property Test Results

Core	Sample	Rock Type	Unconfined Compressive Strength, psi	Tensile Strength, psi	Slake Durability Index, %	Friction Angle, Degrees	Gradation of Direct Shear Test Sample, % Finer Than Particle Size, inches					
							0.375	0.187	0.094	0.047	0.023	0.0117
365	1	sandstone	6,395	238	93.4	41.8	81.6	49.4	39.4	34.8	31.0	21.8
365	2	sandstone	5,688	305	92.3	41.6	87.8	60.5	49.3	43.5	36.7	18.3
365	3	shale**	18,767	654	91.7	45.1	75.9	28.5	14.0	7.7	4.9	3.6
365	4-8	sandstone	7,889	550	95.9	44.5	80.6	44.8	33.3	27.5	21.9	16.2
365	9	sandy shale	N.A.*	359	88.6	48.7	81.3	40.4	27.3	21.2	17.3	13.9
167	1	shale	N.A.	417	60.5	37.8	92.7	61.7	41.4	27.9	18.6	12.1
167	2	sandstone	7,036	391	92.5	37.7	89.7	52.2	36.5	29.0	24.2	17.8
167	3	sandstone	6,681	652	95.9	36.4	93.9	60.4	47.6	42.2	38.3	31.1
167	4	sandstone	8,842	684	95.8	43.3	84.5	52.0	42.4	38.4	35.7	27.8
167	5	shaley s.s.	6,331	869	97.1	39.8	73.5	36.5	26.8	23.1	21.0	17.8
167	6	sandstone	8,223	652	95.3	38.7	90.6	54.2	40.0	35.1	32.2	29.1
167	7	shale**	9,333	1,054	97.6	40.9	82.7	42.0	26.9	21.0	18.1	16.4
362	1	shale	N.A.	N.A.	45.3	43.9	83.4	34.0	19.1	10.4	5.7	3.3
362	2	shale	N.A.	N.A.	72.0	46.7	81.5	35.8	19.1	11.2	6.9	4.7
362	3	shale	N.A.	706	95.4	41.1	82.5	31.9	15.8	8.4	5.1	3.2
362	4	sandstone	5,298	346	90.1	41.3	84.0	53.2	42.7	36.8	31.3	21.5
362	5	sandstone	4,539	490	91.2	40.4	77.0	43.4	32.7	28.2	24.6	19.5
362	6	sandstone	3,912	448	92.3	43.2	77.3	39.8	28.3	23.6	20.8	17.9
362	7	sandstone	7,683	509	97.4	39.9	75.1	41.7	32.6	28.8	25.7	18.5
362	8	sandstone	7,891	494	93.0	42.6	81.6	53.5	44.6	40.7	37.6	31.9

*N.A. = data not available due to lack of usable specimen.
**classification is questionable.

Sieve analysis indicates the spoil material will be in unified classes GW and GP. The spoil will have good workability and good compaction characteristics.

6.4.3 Geochemistry of Major Strata

6.4.3.1 General

The results of the geochemical analysis of 72 samples for 32 parameters (2,304 values) are reported in Appendix 6-3. Table 6-3 shows volume-weighted averages for the major strata general parameters.

The pH of the tested samples is generally neutral, 6.5 to 7.5. A few strata (3) in the upper Ferron were moderately to strongly acid, 4.3 to 6.0. The mine floor strata are commonly moderately to strongly alkaline, 8.4 to 9.0. The pH of the overburden to be spoiled is buffered with large quantities of lime.

The strata are generally moderately saline. EC for the entire overburden averages 7.01, ranging from non-saline (0-4 mmhos/cm), to moderately saline (8-16 mmhos/cm). Only one sample exceeds 16 (16.6 mmhos/cm).

Saturation percent (SAT%) varies with texture. All but one sample are between 25 and 80 percent. These saturation percentages represent acceptable water holding capacities for spoiled overburden.

SAR values are commonly less than 3. Only one overburden stratum exceeds 10. Six floor strata exceed 10, with a maximum value of 15.7. A previous study indicated that the Blue Gate Shale is more sodic than indicated by these results (Walsh & Associates Inc., 1981). The Blue Gate Shale samples from holes FC700 - FC 706 were weathered and dissected or buried under alluvium and are probably not as sodic as unweathered Blue Gate Shale. For this reason it is expected that where the thickest strata of Blue Gate occur in the overburden, SAR's will be between 10 and 20.

Samples textures (% Sn, Si, Cl) were analysed. The upper Ferron is very sandy, with sand content up to 90 percent. Spoil derived from Ferron will be somewhat droughty and erodible. The Blue Gate and the alluvium are fairly clayey. Values are commonly greater than 40 percent.

The mine strata are generally calcareous as reflected in values for lime. The reported values are generally less than 5 percent. A large amount of calcareous material is available as a buffer for acid-producing strata.

Sulfur values (PS, OS, SO4S, and TS) are low throughout the tested strata. Pyritic sulfur, a potential acid former, is less than reporting minimums (0.01 percent) for all samples tested. Acid Base Potential

Table 6-3 Interpretation of Surface Mine Area Geochemistry - General Parameters

CHEMICAL PARAMETER	Alluvium		Blue Gate Shale		Ferron Overburden		Ferron Floor	
	Range[1]	Mean[2]	Range[3]	Mean[2]	Range[4]	Mean[2]	Range[5]	Mean[2]
pH	7.1-7.7	7.3	7.0-7.2	7.1	4.3-7.8	6.8	6.9-9.0	7.7
Lime % ($CaCO_3$ equivalent)	8.5-21.8	16.0	0.0-20.3	10.7	0.0-7.2	2.6	0.0-2.7	0.8
Acid-Base Potential	84-217	159	0-200	106	-1 to 71	25	0-26	7
Electrical Conductivity	4.5-16.6	8.4	6.8-11.5	7.8	1.2-13.9	6.7	0.8-4.2	2.55
Sodium Absorption Ration	1.6-11.8	4.7	1.2-4.1	2.2	0.3-5.5	1.84	1.7-15.7	6.3
Saturation Percentage	47-75	66	62-75	70	27-38	33	28-88	52
Texture: % Sand	13-42	25	3-45	31	46-90	70	11-81	52
% Clay	35-54	45	39-48	44	3-19	8	6-77	32

1. 9 intervals, 3 holes
2. Volume-weighted average for stratigraphic unit unit for entire project area
3. 4 intervals, 3 holes
4. 40 intervals, 7 holes
5. 19 intervals, 7 holes

(ABP) can be calculated on ore values for pyritic sulfur and LM contents (see Table 6-3) range from 1 ton/1,000 tons spoil acid potential to about 200 tons/1,000 tons spoil base potential with an average ABP of about 49 tons/1,000 tons spoil base potential.

6.4.3.2 Acid-Forming Potential

Some of the Ferron overburden strata tested have acidic pH values. The pH values range from 7.8 down to 4.3. Organic acids may be responsible for the pH values; organic sulfur was 0.02 and 0.05 percent in strata with 5.6 and 4.3 pH. Pyritic sulfur is present in very low concentrations (0.01 percent), so the acid-producing potential is quite small. Moreover, the overburden strata contains large quantities of lime and the potential of the overburden as a whole is alkaline. Acid production is not anticipated to be a problem within the proposed mining area.

6.4.3.3 Alkalinity-Producing Potential

High pH and/or high SAR can cause piping, surface crusting, soil structure problems, and plant toxicities. The only samples with alkaline pH (8.1-9.0) all occurred below the coal in the floor strata. Likewise, floor strata were distinctly more sodic than the overburden with a mean SAR of 6.3 and 6 samples with SAR greater than 10. In that these floor strata will not be disturbed by mining, alkaline material production from them is not anticipated.

Results of this coring and analysis program have indicated. SAR's from 3 samples of the Blue Gate Shale were about 20 (18.1, 20.8, and 21.2). When mixed with the other less sodic types of spoil, however, the SAR is expected to lower on a volume basis.

6.4.3.4 Toxic-Forming Potential

Boron is essential for plant growth, but the amount required is small, and if exceeded, boron can be phytotoxic. Published suitability criteria for potential root zone material (Wyoming DEQ, 1981; Dollhopf, 1979) list boron concentration as suspect in the level of 5 to 8 ppm. No overburden sample exceeded 5 ppm. A few strata of floor material did exceed 5 ppm but all were less than 8 ppm. Because these strata will not be spoiled, they are not a problem.

Salinity in soil can restrict the growth of many plant species, however, the response of plants to salinity is highly variable, and the species that occur in the surface mine area are highly tolerant. The overburden strata tested are slightly to moderately saline and a few strata are at or slightly above suspect levels. The levels of salinity in the overburden are not high enough to be considered toxic to adapted species.

No other general parameters or trace elements tested are potential toxicity formers in the mine strata.

6.4.4 Subsurface Water

Subsurface water was encountered in the following holes within the following geologic units in the course of Consol's test boring program: FC703 - alluvium and Ferron Sandstone above IJ coal zone; FC704 - alluvium and Ferron Sandstone above IJ coal zone; and FC706 - alluvium and Ferron Sandstone above IJ coal zone. Section 7.1, Groundwater Hydrology, provides a detailed discussion of subsurface waters within the permit area.

6.5 Geologic Effects of Mining

6.5.1 Mining Hazards

Mining within the southwestern portion of the permit area will occur along a steep canyon which has been cut by Christiansen Wash. Minor problems with rock falls have occurred in the past, especially in the spring. Potentially dangerous material has been removed from the canyon walls in the past so that they do not pose a hazard. Consol does not anticipate any other hazards owing to the geology of the permit area.

6.5.2 Impacts of Mining

Consol does not predict any significant impacts on the geology of the permit area.

6.6 Bibliography

Bureau of Land Management, 1979, Reclaimability Analysis of the Emery Coal Field, Emery County, Utah. EMRIA Report No. 16, 413 p.

Doelling, H. H., 1972, Central Utah Coal Fields: Sevier-Sanpete, Wasatch Plateau, Book Cliffs and Emery Monograph, Series No. 3, Utah Geological and Mineralogical Survey, Salt Lake City, Utah.

Dollhopf, D. J., J. D. Goering, C. J. Levine, B. J. Bauman, D. W. Hedberg, and R. L. Hodder, 1979, Selective placement of coal strip mine overburden in Montana: I. Data Base. Mont. Agric. Exp. Stn. Res. Rpt. 135a, 109 P.

Lambe, T. W., and R. V. Whitman, 1969, Soil Mechanics, John Wiley & Sons, Chapters 3 to 11.

Ryer, T. A., 1979, Deltaic Coals of Ferron Sandstone Member of Mancos Shale: Predictive Model for Cretaceous Coal-Bearing Strata of Western Interior, American Assoc. of Petroleum Geologists Bull., V.65, No. 11, Nov. 1981, p. 2323-2340.

Lines, G. C., and Morrissey, D. J., 1981, Hydrology of the Ferron Sandstone Aquifer and Effect of Proposed Surface Coal Mining in Castle Valley, Utah, U. S. Geol. Survey Open-File Report 81-535, 109 p.

Walsh and Associates, 1981, Geologic Descriptions for Surface and Underground Mine Permit Applications - Emery Mine, Boulder, Colorado, 58 p.

Wyoming Department of Environmental Quality, Land Quality Division, 1981, Topsoil and Overburden Guide No. 1.

APPENDIX 6-1

LITHOLOGICAL DESCRIPTIONS OF CUTTINGS AND CORE

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6040' TD = 155', CORED FROM 20' - 155'

Depth (feet)	Description
0 - 5	Pale olive (10Y 6/2) to light olive gray (5Y 6/2) calcareous silty SHALE, abundant gypsum, moderately hard.
5 - 6.5	Light olive gray (5Y 6/2) calcareous silty SHALE, with medium bluish gray (5B 5/1) hard calcareous concretions.
6.5 - 17	Pale olive (5-10Y 6/2) and light olive gray (5Y 5/2) calcareous silty SHALE: from 8-10', abundant gypsum; from 8-12', hard chips; from 12-17', more sandy; from 15 to 17', yellowish brown (10YR 5/2).
17 - 20	Light gray (N7) subangular, fine- to medium-grained, slightly calcareous SANDSTONE.
20 - 38.7	Medium and light gray (N5 & N7) massive (some faint low-angle cross-bedding), coarse- to medium-grained, feldspathic SANDSTONE: moderate hardness; burrows and thin shale breaks at 21.4', 22.7', 24.2', 29.4', 34.8'; trace clay fragments; log at 38.4'; moderate amounts of fine-grained authigenic pyrite.
38.7 - 42	Medium and light gray (N5 & N7), faintly cross-bedded, angular, coarse-grained feldspathic SANDSTONE: hard; from 41.5' to 42.0', thin pyritic micaceous clay breaks.
42 - 51.4	Medium light gray and light gray (N6 & N7), lowangle cross-bedded, subangular, medium- to fine-grained feldspathic SANDSTONE: moderate hardness; trace muscovite; thin carbonaceous pyritic clay lamina; some graded beds (coarse to fine).
51.4 - 71.5	Light gray (N7) massive, coarse- to medium-grained, poorly sorted feldspathic SANDSTONE: minor clay fragments; moderate amounts of fine-grained pyrite; trace muscovite; carbonaceous shale partings; woody coal fragments at 53.0'.

71.5 - 77.5	Medium light gray (N6), cross-bedded, from coarse- to fine-grained (at 74.7') feldspathic SANDSTONE: hard; trace pyrite; very large carbonaceous clay fragments (>1 cm).
77.5 - 80.2	Very light gray (N8) and light olive gray (5Y 5-6/1) interbedded sandy (fine-grained) SILTSTONES and MUDSTONES; undulating lamination.
80.2 - 92	Light gray to medium light gray (N7 to N6), horizontal- and low-angle cross-laminated, fine- to medium-grained, feldspathic SANDSTONE: hard; thin carbonaceous and clayey lamina; trace muscovite; trace pyrite.
92 - 93.6	Medium dark gray (N4) and light gray (N7), burrowed carbonaceous, fine-grained SANDSTONE.
93.6 - 118.9	COAL INTERVAL.
118.9 - 119.7	Medium brownish gray (5YR 5/1) silty carbonaceous SHALE (coal floor).
119.7 - 124.7	Light gray (N7) and light olive gray (5Y 6-7/1), convolute bedding (slumping), subround, very fine to fine-grained SANDSTONE: hard; trace muscovite.
124.7 - 130.5	Medium dark gray (N4) and olive black (5Y 2/1) and light olive gray (5Y 6/1) SHALES: fissile; silty shale from 128.6 - 129.3.
130.5 - 135.4	Olive gray (5Y 4-5/1) SILTSTONE: hard; minor carbonaceous fragments; from 133.4 - 134.7, light gray (N7) very fine grained, hard, SANDSTONE.
135.4 - 140.6	Medium dark gray (N4) and olive black (5Y 2/1) SHALES.
140.6 - 143.2	Medium dark gray (N4) SILTSTONE.
143.2 - 155	Light gray (N7) and very light gray (N8), very fine to fine-grained, and coarse SANDSTONES, and medium dark gray (N4) and light olive gray (5Y 6/1) MUDSTONES: bedding surfaces between sands and muds are very irregular but distinct; some burrowing; trace muscovite; proportion of mudstones increases downward.

FC 701

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6080'   TD = 120', CORED FROM 50 - 99

Depth (feet)	Description
0 - 5	Pale yellowish brown (10YR 6/2) to light brown (5YR 7/4), subround, fine- to medium-grained, calcareous SANDSTONE: moderate limonite staining.
5 - 10	Light grayish orange (10YR 8/4) fine-grained (fine- to medium-grained from 10-20'), subround, slightly calcareous SANDSTONE.
20 - 25	Moderate yellowish brown (10YR 5/4), subround, fine- to medium-grained, noncalcareous SANDSTONE.
25 - 30	Light grayish orange (10YR 7-8/4), subround, fine-grained, slightly calcareous SANDSTONE.
30 - 35	Grayish orange, subround, very fine to medium-grained, SANDSTONE and dark gray lignitic fragments.
35 - 50	Moderate yellowish brown (10YR 5-6/4), subround, fine- to medium-grained, SANDSTONE: from 40-45, sand damp; moderate limonite staining.
50 - 60	Grayish orange (10Yr 7/4-6) and pale reddish brown (10R 6/4) (trace hematite), massive, fractured, fine- to medium-grained feldspathic SANDSTONE.
60 - 66.8	Grayish yellow (5Y 7-8/4) and yellowish gray (5Y 8/1) and very light gray (N8), subangular, fine-grained, feldspathic SANDSTONE: trace limonitic staining.
66.8 - 67	Olive gray (5Y 4/1), burrowed, very fine to fine-grained SANDSTONE.
67 - 93.6	COAL INTERVAL.
93.6 - 94.2	Medium olive gray (5Y 5/1) carbonaceous silty SHALE.
94.2 - 99	Light gray (N7) to medium light gray (N6) dense, hard, SILTSTONE and very fine grained SANDSTONE and silty SHALE.
99 - 110	Dark gray (N3) and medium olive gray (5Y 5/1) carbonaceous CLAY and clayey SHALE: low hardness.
110 - 120	Light olive gray SHALE and SILTY SHALE.

FC 702

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6070'

TD = 108, CORED FROM 0-108

Depth (feet)	Description
0 - 2	Moderate yellowish brown (10YR 4-5/4) fine-grained weathered SANDSTONE: moderately calcareous; abundant limonite; trace muscovite.
2 - 4.6	Grayish orange (10YR 7/2-4), massive, subangular, fine-grained SANDSTONE: moderate hardness; slightly calcareous; trace muscovite; minor coal clasts; some dark greenish gray clay fragments.
4.6 - 5.8	Light brown (5YR 6/4) and pale reddish brown (10R 5/4), massive, subangular, fine-grained, limonitic (stain and cement) SANDSTONE: hard; large (1/2" x 1/4") dark gray clay clasts.
5.8 - 21.3	Dark yellowish orange (10YR 6/6) to grayish orange (10YR 7/4), low-angle cross-bedded, angular, fine- to medium-grained, limonitic (stain and cement) SANDSTONE: hard; slightly calcareous from 10-12'; some bands of pale red (5R 6/2) and light brown (5YR 5/6); carbonaceous fragments concentrated in thin layers.
21.3 - 22.5	Dark greenish gray (5GY 4/1) CLAY and grayish yellow (5Y 8/4), medium- to fine-grained, subround, limonitic SANDSTONE: woody coal fragments.
22.5 - 24.7	Yellowish orange (10YR 7/6) horizontal bedded, subround, fine-grained, limonitic SANDSTONE: thin carbonaceous lamina.
24.7 - 29.5	Grayish orange (10YR 7-8/4), massive, fine-grained, feldspathic SANDSTONE: slightly calcareous; minor limonitic staining.
29.5 - 30.2	Dark brown to black and yellowish brown (10YR 6/2-4) subround, fine- to medium-grained SANDSTONE: thin carbonaceous lamina; minor limonitic staining.
30.2 - 33.9	Pale yellowish brown (10YR 6/2), crossbedded, subangular, fine-grained, feldspathic SANDSTONE: slightly calcareous; limonitic staining and cement; well-compacted.

33.9 - 34.3	Black sooty COAL.
34.3 - 38	Grayish yellow (5Y 8/4) and yellowish gray (5Y 7/2), subround, fine- to medium-grained, feldspathic SANDSTONE: trace limonitic staining; some feldspar grains altering to clay.
38 - 42.8	Medium dark gray (N4) and light gray (N7), burrowed, subangular, fine-grained, silty SANDSTONE: hard; abundant thin carbonaceous shale seams; some spots of light olive gray (5Y 6/1).
42.8 - 44	Yellowish gray (5Y 7/2-4), massive, fine- to very fine grained SANDSTONE: slightly calcareous; minor limonitic staining.
44 - 44.6	Black and light yellowish gray (5Y 8/2), burrowed, fine-grained, feldspathic SANDSTONE, abundant thin carbonaceous clay seams.
44.6 - 55.2	Medium yellowish gray (5Y 7/4) and minor grayish orange pink (5YR 7/2), fine-grained SANDSTONE: subtle horizontal lamination; dark carbonaceous fragments.
55.2 - 56.1	Medium dark gray (N4) and light gray (N7); burrowed, fine-grained, carbonaceous feldspathic SANDSTONE.
56.1 - 79.2	COAL INTERVAL.
79.2 - 79.5	Dusky yellowish brown (10YR 2/2) carbonaceous SILTSTONE.
79.5 - 83.4	Medium light gray (N6) hard SILTSTONE.
83.4 - 91.7	Medium olive gray (5Y 5/1) and very light gray (N8) interbedded mudstones and siltstones and very fine-grained sandstones: irregular bedding contacts; slumping; some crossbeds in sandstone.
91.7 - 93.1	Medium dark gray (N4) shaley lignite.
93.1 - 94	Medium light gray (N6) clayey SHALE.
94 - 94.8	Medium gray (N5) and light gray (N7) irregularly interbedded mudstones and siltstones.
94.8 - 96.4	Medium olive gray (5Y 5/1) sandy SILTSTONE: abundant carbonaceous clasts.
96.4 - 97.7	Medium light gray (N6) silty SHALE.

FC 702

98 - 100.6	Light gray (N7-8) very fine-grained SANDSTONE: slump structures.
100.6 - 108	Light gray (N7) and light olive gray (5Y 6/1) crossbedded, subround, medium-grained feldspathic SANDSTONE: at 106, coarse-grained, medium brownish gray (5YR 5/1), abundant medium-grained heavy mineral clasts.

FC 703

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6058'   TD = 116', CORED FROM 84-116'

Depth (feet)	Description
0 - 5	Light olive gray (5Y 5/2) calcareous mud.
5 - 10	Light olive gray (5Y 6/2) calcareous silty mud.
10 - 20	Dark dusky yellow (5Y 5/4) calcareous silty alluvium; moderate amounts of gypsum.
20 - 35	Medium bluish gray (5B 5/1) SHALE, and pebbles of light dusky yellow (5Y 7/4), fine-grained, limonitic SANDSTONE, and dark olive gray (5Y 4/2) MUD.
35 - 50	Light olive gray (5Y 5/2), fine- to medium-grained, subround, moderately calcareous SANDSTONE: mud and pebble contamination.
50 - 65	Dusky yellow (5Y 6/4), fine- to medium-grained, subround, moderately calcareous SANDSTONE: pebble contamination.
65 - 70	Light olive gray (5Y 5/2), fine-grained, coaly shaley silt and SANDSTONE: trace rusty pyrite; trace limonite; slightly calcareous.
70 - 84	Yellowish gray (5Y 6-7/2), fine- to medium-grained, subround, slightly calcareous SANDSTONE.
84 - 110.5	COAL INTERVAL.
110.5 - 112	0.4' of moderate yellowish brown (10YR 5/4), coal-stained SILTSTONE; olive gray (5Y 4/1) very fine-grained SANDSTONE: hard.
112 - 116	Light olive gray (5Y 6/1), hard, SILTSTONE: sandy toward 116.

FC 704

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6065'   TD = 140', CORED FROM 90-117'

Depth (feet)	Description
0 - 5	Light olive gray (5Y 5/2), clayey, calcareous alluvium (wet).
5 - 10	Light olive gray (5Y 5-6/2), clayey, calcareous alluvium (damp).
10 - 20	Dusky yellow (5Y 6/4), silty, sandy (fine-grained) alluvium: moderate limonite, minor gypsum, slightly calcareous.
20 - 35	Light olive gray (5Y 5/2) alluvium (damp), and medium bluish gray (5B 5/1) SHALE: moderate gypsum; slightly calcareous; sandy toward 35'; dry from 30-35'.
35 - 55	5' of yellowish gray (5Y 7/2), fine- to medium-grained SANDSTONE (dry); and medium light gray (N6) to light olive gray (5Y 6/1), fine- to medium-grained, subround, slightly calcareous SANDSTONE.
55 - 90	Medium light gray (N6) to light olive gray (5Y 6/1), fine-grained, subround, slightly calcareous SANDSTONE: trace limonite.
90 - 114	COAL INTERVAL.
114 - 117	Olive gray (5Y 4/1) to light olive gray (5Y 6/1), hard SILTSTONE: slightly carbonaceous at 114'.
117 - 140	Medium light gray (N6) to light olive gray (5Y 6/1) slightly calcareous SILTSTONE.

FC 705

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6085'   TD = 85', CORED FROM 42-68.5'

Depth (feet)	Description
0 - 5	Pale yellowish orange (10YR 8/6), fine- to very fine grained, subangular, feldspathic SANDSTONE: noncalcareous, moderate limonite.
5 - 20	Very pale orange (10YR 8/2), very fine to fine-grained SANDSTONE: trace limonite.
20 - 30	Yellowish gray (5Y 8/1), fine-grained SANDSTONE.
30 - 42	Yellowish gray (5Y 7/2), fine-grained, subangular SANDSTONE grading at 35' to yellowish brown (10YR 5/2) carbonaceous SANDSTONE.
42 - 63.4	COAL INTERVAL.
63.4 - 68.5	Dark yellowish brown (10YR 4/2), silty, carbonaceous SHALE and (at 63.9) medium greenish gray (5GY 5/1) mudstone.
68.5 - 75	Light gray (N7) hard SILTSTONE.
75 - 85	Medium gray (N5-6) sandy SILTSTONE: moderate hardness.

FC 706

LITHOLOGIC DESCRIPTION

APPROX. ELEV. = 6043' TD = 120', CORED FROM 66-95'

Depth (feet)	Description
0 - 10	Dark yellowish brown (10YR 4/2) to light olive gray (5Y 5/2) calcareous silty sand (dry).
10 - 20	Light olive gray (5Y 6/2) mud and pebbles of light dusky yellow (5Y 7/4), fine-grained, limonitic SANDSTONE: moderately calcareous; less mud at 15'; chips of medium bluish gray (5B 5/1) SHALE at 17'.
20 - 35	Light grayish orange (10YR 7/2-4), fine-grained, subround, slightly calcareous (to 30') silty SANDSTONE: trace limonite.
35 - 50	Yellowish gray 5Y 7/2 (5Y 7/4 at 45') fine- to very fine-grained subround SANDSTONE: trace limonite.
50 - 66	Medium light gray (N6) and light olive gray (5Y 7/2) burrowed (?), fine-grained, subround, carbonaceous SANDSTONE.
66 - 88.8	COAL INTERVAL.
88.8 - 89.6	Medium olive gray (5Y 5-6/1) hard carbonaceous SILTSTONE.
89.6 - 92	Olive gray (5Y 6/2) SILTSTONE and (at 90.6) light gray (N7) and dark olive gray (5Y 4-5/1) cross-bedded and slumped, very fine grained SANDSTONE and SHALE.
92 - 100	Medium gray (N5) to medium olive gray (5Y 5/1) carbonaceous siltstone and (at 92.5) light olive gray (5Y 6/1) cross-bedded, very fine grained, silty SANDSTONE: thin dark olive gray (5Y 4/1) clay breaks.
100 - 120	Medium light gray (N6-7), fine-grained, subround SANDSTONE.

APPENDIX 6-2

STRATIGRAPHIC DESCRIPTIONS OF DRILL HOLES

FC 700

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6040'   TD = 155', CORED FROM 20' - 155'

Formation	Depth (feet)	Lithologic Description
Blue Gate Shale	0 - 17	Pale olive (5-10Y 6/2) and light olive gray (5Y 5/2) gypsiferous, calcareous silty SHALE: with medium bluish gray (5B 5/1) hard calcareous concretions.
Top of Ferron Sandstone	17 - 77.5	Medium and light gray (N5 & N7), massive to faint low-angle cross-bedding, coarse- to medium-grained, feldspathic SANDSTONE: moderate hardness; burrows and thin shale breaks at 21.4', 22.7', 24.2', 29.4', 34.8'; trace clay fragments; log at 38.4'; moderate amounts of fine-grained authigenic pyrite; from 41.5' to 42.0', thin pyritic and carbonaceous micaceous clay breaks. Woody coal fragments at 53.0'; from 71.5 to 77.5, very large (>1cm) carbonaceous clay fragments.
	77.5 - 92	Light gray to medium light gray (N7 to N6), horizontal- and low-angle cross-laminated, fine- to medium-grained, feldspathic SANDSTONE: hard; thin carbonaceous and clayey lamina; trace muscovite; trace pyrite.
	92 - 93.6	Medium dark gray (N4) and light gray (N7), burrowed, carbonaceous, fine-grained SANDSTONE.
	93.6 - 118.9	J & I COAL SEAMS.
	118.9 - 119.7	Medium brownish gray (5YR 5/1) silty carbonaceous SHALE (coal floor).
	119.7 - 124	Light gray (N7) and light olive gray (5Y 6-7/1), convolute bedding (slumping), subround, very fine to fine-grained SANDSTONE: hard; trace muscovite.

FC 700

Formation	Depth (feet)	Lithologic Description
	124 - 130.5	Medium dark gray (N4) and olive black (5Y 2/1) and light olive gray (5Y 6/1) SHALES: fissile; silty shale from 128.6 - 129.3.
	130.5 - 135.4	Olive gray (5Y 4-5/1) SILTSTONE: hard; minor carbonaceous fragments; from 133.4 - 134.7, light gray (N7) very fine grained, hard, SANDSTONE.
	135.4 - 140.6	Medium dark gray (N4) and olive black (5Y 2/1) SHALES.
	140.6 - 143.2	Medium dark gray (N4) SILTSTONE.
	143.2 - 155	Light gray (N7) and very light gray (N8), very fine to fine-grained, and coarse SANDSTONES, and medium dark gray (N4) and light olive gray (5Y 6/1) MUDSTONES: bedding surfaces between sands and muds are very irregular but distinct; some burrowing; trace muscovite; proportion of mudstones increases downward.

FC 701

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6080'   TD = 120', CORED FROM 50' - 99'

Formation	Depth (feet)	Lithologic Description
Ferron Sandstone	0 - 5	Pale yellowish brown (10YR 6/2) to light brown (5YR 7/4), subround, fine- to medium-grained, calcareous SANDSTONE: moderate limonite staining.
	5 - 50	Light grayish orange (10YR 8/4) fine- to medium-grained, subround, slightly calcareous SANDSTONE; from 30' to 35' dark gray lignitic fragments; from 40-45', sand damp.
	50 - 60	Grayish orange (10YR 7/4-6) and pale reddish brown (10R 6/4) (trace hematite), massive, fractured, fine- to medium-grained feldspathic SANDSTONE.
	60 - 66.8	Grayish yellow (5Y 7-8/4) and yellowish gray (5Y 8/1) and very light gray (N8), subangular, fine-grained, feldspathic SANDSTONE: trace limonitic staining.
	66.8 - 67	Olive gray (5Y 4/1), burrowed, very fine to fine-grained SANDSTONE.
	67 - 93.6	J & I COAL SEAMS.
	93.6 - 94.2	Medium olive gray (5Y 5/1) carbonaceous silty SHALE.
	94.2 - 100	Light gray (N7) to medium light gray (N6) dense, hard, SILTSTONE and very fine grained SANDSTONE and silty SHALE.
	100 - 109	Dark gray (N3) and medium olive gray (5Y 5/1) carbonaceous CLAY and clayey SHALE: low hardness.
	109 - 120	Light olive gray SHALE and SILTY SHALE.

FC 702

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6070' TD = 108', CORED FROM 0'-108'

Formation	Depth (feet)	Lithologic Description
Ferron Sandstone	0 - 5.8	Grayish orange (10YR 7/2-4), massive, subangular, fine-grained, limonitic SANDSTONE: moderate hardness; slightly calcareous; trace muscovite; minor coal clasts; some dark greenish gray clay fragments.
	5.8 - 21.3	Dark yellowish orange (10YR 6/6) to grayish orange (10YR 7/4), low-angle cross-bedded, angular, fine- to medium-grained, limonitic (stain and cement) SANDSTONE: hard; slightly calcareous from 10-12'; some bands of pale red (5R 6/2) and light brown (5YR 5/6); carbonaceous fragments concentrated in thin layers.
	21.3 - 22.5	Dark greenish gray (5GY 4/1) CLAY and grayish yellow (5Y 8/4), medium- to fine-grained, subround, limonitic SANDSTONE: woody coal fragments.
	22.5 - 29.5	Yellowish orange (10YR 7/6) horizontal bedded, subround, fine-grained, limonitic, feldspathic SANDSTONE: thin carbonaceous lamina.
	29.5 - 30.2	Dark brown to black and yellowish brown (10YR 6/2-4) subround, fine- to medium-grained SANDSTONE: thin carbonaceous lamina; minor limonitic staining.
	30.2 - 33.9	Pale yellowish brown (10YR 6/2), crossbedded, subangular, fine-grained, feldspathic SANDSTONE: slightly calcareous; limonitic staining and cement; well-compacted.
	33.9 - 34.3	Black sooty COAL.

FC 702

Formation	Depth (feet)	Lithologic Description
	34.3 - 55.2	Interbedded (a) grayish yellow (5Y 8/4) and yellowish gray (5Y 7/2), massive, subround, fine- to medium-grained, feldspathic SANDSTONE: trace limonitic staining; some feldspar grains altering to clay, and (b) medium dark gray (N4), light gray (N7), and light yellowish gray (5Y 8/2), burrowed, subangular, fine-grained, silty, feldspathic SANDSTONE: hard; abundant thin carbonaceous shale seams; some spots of light olive gray (5Y 6/1).
	55.2 - 57	Medium dark gray (N4) and light gray (N7); burrowed, fine-grained, carbonaceous feldspathic SANDSTONE.
	57 - 80	J & I COAL SEAMS.
	80 - 80.5	Dusky yellowish brown (10YR 2/2) carbonaceous SILTSTONE.
	80.5 - 91.7	Medium olive gray (5Y 5/1) and very light gray (N8) interbedded mudstones and siltstones and very fine-grained sandstones: irregular bedding contacts; slumping; some crossbeds in sandstone.
	91.7 - 94	Medium gray (N5) shaley lignite and clayey shale.
	94 - 97.7	Medium gray (N5) and light gray (N7) irregularly interbedded mudstones and siltstones, and silty shales; abundant carbonaceous clasts.
	98 - 100.6	Light gray (N7-8) very fine-grained SANDSTONE: slump structures.
	100.6 - 108	Light gray (N7) and light olive gray (5Y 6/1) crossbedded, subround, medium-grained feldspathic SANDSTONE: at 106, coarse-grained, medium brownish gray (5YR 5/1), abundant medium-grained heavy mineral clasts.

FC 703

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6058' TD = 116', CORED FROM 84'-116'

Formation	Depth (feet)	Lithologic Description
Alluvium (wet)	0 - 12	Light olive gray (5Y 5/2) calcareous silty mud.
(dry)	12 - 19	Dark dusky yellow (5Y 5/4) calcareous silty alluvium; moderate amounts of gypsum.
(wet)	19 - 22	Pebbles of light dusky yellow (5Y 7/4), fine-grained, limonitic SANDSTONE.
Blue Gate Shale	22 - 32	Medium bluish gray (5B 5/1) SHALE, and dark olive gray (5Y 4/2) MUD.
Top of Ferron Sandstone	32 - 65	Light olive gray (5Y 5/2), and dusky yellow (5Y 6/4), fine- to medium-grained, subround, moderately calcareous SANDSTONE: grain size mode coarsens at 60'.
	65 - 70	Light olive gray (5Y 5/2), fine-grained, coaly shaley silt and SANDSTONE: trace rusty pyrite; trace limonite; slightly calcareous.
	70 - 84	Yellowish gray (5Y 6-7/2), fine- to medium-grained, subround, slightly calcareous SANDSTONE.
	84 - 110.5	J & I COAL SEAMS.
	110.5 - 116	0.4' of moderate yellowish brown (10YR 5/4), coal-stained SILTSTONE; olive gray (5Y 4/1) very fine-grained SANDSTONE and SILTSTONE: hard.

FC 704

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6065'   TD = 140', CORED FROM 90'-117'

Formation	Depth (feet)	Lithologic Description
Alluvium (wet)	0 - 5	Light olive gray (5Y 5/2), clayey, calcareous sand.
(damp)	5 - 10	Light olive gray (5Y 5-6/2), clayey, calcareous sand.
(dry)	10 - 21	Dusky yellow (5Y 6/4), to light olive gray (5Y 5/2), silty, sand (fine-grained): moderate limonite, minor gypsum, slightly calcareous.
Blue Gate Shale	21 - 37	Medium bluish gray (5B 5/1) SHALE: moderate gypsum; slightly calcareous; sandy toward 37'; dry from 30-35'.
Top of Ferron Sandstone	37 - 55	5' of yellowish gray (5Y 7/2), fine- to medium-grained SANDSTONE (dry); and medium light gray (N6) to light olive gray (5Y 6/1), fine- to medium-grained, subround, slightly calcareous SANDSTONE: clean sand begins at 48'.
	55 - 89	Medium light gray (N6) to light olive gray (5Y 6/1), fine-grained, subround, slightly calcareous SANDSTONE: trace limonite.
	89 - 114	J & I COAL SEAMS.
	114 - 117	Olive gray (5Y 4/1) to light olive gray (5Y 6/1), hard SILTSTONE: slightly carbonaceous at 114'.
	117 - 140	Medium light gray (N6) to light olive gray (5Y 6/1) slightly calcareous SILTSTONE.

FC 705

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6085' TD = 85', CORED FROM 42'-68.5'

Formation	Depth (feet)	Lithologic Description
Ferron Sandstone	0 - 20	Pale yellowish orange (10YR 8/6) to very pale orange (10YR 8/2) fine- to very fine grained, subangular, feldspathic SANDSTONE: noncalcareous, moderate to trace limonite.
	20 - 42	Yellowish gray (5Y 7/2), fine-grained, subangular SANDSTONE grading at 35' to yellowish brown (10YR 5/2) carbonaceous SANDSTONE.
	42 - 63.4	J & I COAL SEAMS.
	63.4 - 68.5	Dark yellowish brown (10YR 4/2), silty, carbonaceous SHALE and (at 63.9) medium greenish gray (5GY 5/1) mudstone.
	68.5 - 85	Light gray (N7) to medium gray (N6) hard sandy SILTSTONE.

FC 706

STRATIGRAPHIC DESCRIPTION

APPROX. ELEV. = 6043'   TD = 120', CORED FROM 66'-95'

Formation	Depth (feet)	Lithologic Description
Alluvium	0 - 10	Dark yellowish brown (10YR 4/2) to light olive gray (5Y 5/2) calcareous silty sand (dry).
	10 - 13	Light olive gray (5Y 6/2) mud.
	13 - 17	Pebbles of light dusky yellow (5Y 7/4), fine-grained, limonitic SANDSTONE: moderately calcareous.
Blue Gate Shale	17 - 20	Medium bluish gray (5B 5/1) SHALE.
Top of Ferron Sandstone	20 - 52	Light grayish orange (10YR 7/2-4), to yellowish gray 5Y 7/2 (5Y 7/4 at 45') fine- to very fine-grained, subround, silty SANDSTONE: trace limonite. Slightly calcareous (to 30').
	52 - 66	Medium light gray (N6) and light olive gray (5Y 7/2) burrowed (?), fine-grained, subround, carbonaceous SANDSTONE.
	66 - 88.8	J & I COAL SEAMS.
	88.8 - 89.6	Medium olive gray (5Y 5-6/1) hard carbonaceous SILTSTONE.
	89.6 - 92	Olive gray (5Y 6/2) SILTSTONE and (at 90.6) light gray (N7) and dark olive gray (5Y 4-5/1) cross-bedded and slumped, very fine grained SANDSTONE and SHALE.
	92 - 100	Medium gray (N5) to medium olive gray (5Y 5/1) carbonaceous siltstone and (at 92.5) light olive gray (5Y 6/1) cross-bedded, very fine grained, silty SANDSTONE: thin dark olive gray (5Y 4/1) clay breaks.

FC 706

Formation	Depth (feet)	Lithologic Description
	100 - 120	Medium light gray (N6-7), fine-grained, subround SANDSTONE.

THICK FEET	DESCRIPTION	ELEVATION PARTING	SAMPLE	PERCENT MOIS	ASH	S	BTU	COMPOSITE MOI	ASH	LF	WGHT
		6089.67									
44.75	SS										
		6044.92									
0.75	SH										
		6044.17									
1.83	DC	J									
		6042.34									
0.75	SH										
		6041.59									
8.52	CO	UI									
		6033.07									
0.03	SH										
		6033.04									
1.23	CO	LI									
		6031.80									
0.03	SH	LI									
		6031.78									
12.20	CO	LI									
		6019.58									
9.91	SS										
		6009.67									

REQUESTED ANAL NOT AVAILABLE

DESCRIPTION EMERY STRIP
DRILL HOLE FC 165
COORD NORTH 198359.00
COORD EAST 2078406.00
SURF. ELEV. 6089.67
TOP OF SEAM 5089.67
SEAM THK. FT -929.91
BOTT OF SEAM 6019.58
TYPE ANAL. H2O FREE
SEAM ID: J
TYPE LOG: DRILLER

THICK FEET	CROSSECTION	ELEVATION PARTING	SAMPLE	MOIS	ASH	SULF	BTU	COMPOSITE MOIS	ASH	SULF	BTU
		6051.28									
19.00	XXXXX SM XXXXXX										
		6032.28									
5.30	SH										
		6026.98									
4.30	XXXXX ND XXXXXX										
		6022.68									
3.56	SH										
		6019.12									
5.70	SS										
		6013.41									
0.70	SH										
		6012.71									
48.61	SS										
		5964.11									
2.20	DC		J								
		5961.91									
0.60	SH										
		5961.30									
0.50	CO										
		5960.80									
1.10	SH										
		5959.71									
4.63	CO		UI								
		5955.07									
0.07	SH										
		5955.00									
3.93	CO		LI								
		5951.07									
0.06	SH		LI								
		5951.02									
4.48	CO		LI								
		5946.54									
0.02	SH		LI								
		5946.52									
5.41	CO		LI								
		5941.11									
10.00	SH										
		5931.11									

REQUESTED ANAL NOT AVAILABLE

DESCRIPTION EMERY STRIP 1
DRILL HOLE FC 167A
COORD NORTH 197757.00
COORD EAST 2075294.00
SURF. ELEV. 6051.28
TOP OF SEAM 5051.28
SEAM THK. FT -889.83
BOTT OF SEAM 5941.11
TYPE ANAL. H2O FREE
SEAM ID: J
TYPE LOG: DRILLER

THI FEET	CROSSFCTION	ELEVATION PARTING	ELEVATION SAMPLE	PERCENT MOIS	PERCENT ASH	PERCENT SULF	PERCENT BTU	COMPOSITE MOIS	COMPOSITE ASH	COMPOSITE SULF	COMPOSITE BTU
		- 6074.09									
20.00	SH										
		- 6054.09									
51.00	SS										
		- 6003.09									
3.50	CO	J									
		- 5999.59									
0.90	SH										
		- 5998.69									
9.30	CO	UI									
		- 5989.39									
0.30	SH										
		- 5989.09									
11.00	CO	LI									
		- 5978.09									
1.00	SH										
		- 5977.09									
9.00	SS										
		- 5968.09									

REQUESTED ANAL NOT AVAILABLE

DESCRIPTION	EMERY STRIP	1
DRILL HOLE	FC 169	
COORD NORTH	199005.00	
COORD EAST	2078251.00	
SURF. ELEV.	6074.09	
TOP OF SEAM	5074.09	
SEAM THK. FT	-904.00	
BOTT OF SEAM	5978.09	
TYPE ANAL.	H2O FREE	
SEAM ID:	J	
TYPE LOG:	DRILLER	

```
I  THICK  I  CROSSECTION    I  ----ELEVATION---    ---------PERCENT---------    -------COMPOSITE------I
I  FEET   I                 I  PARTING   SAMPLE    MOIS    ASH   SULF   BTU    MOIS    ASH   SULF   BTUI
--------------------------------------------------------------------------------------------------------I
!         !---------------!- 6028.27                                                                   !
!         !---------------!                                                                            !
!         !---------------!                                                                            !
!  29.50  !----- SH ------!                                                                            !
!         !---------------!                                                                            !
!         !---------------!                                                                            !
!         !---------------!                                                                            !
!         !---------------!- 5998.77                                                                   !
!         !...............!                                                                            !
!         !...............!                                                                            !
!         !...............!                                                                            !
!         !...............!                                                                            !
!  60.30  !..... SS ......!                                                                            !
!         !...............!                                                                            !
!         !...............!                                                                            !
!         !...............!                                                                            !
!         !...............!                                                                            !
!         !...............!                                                                            !
!         !---------------!- 5938.46                                                                   !
!   0.0   !..... SS ......! TF                                                                         !
!         !...............!                                                                            !
!         !---------------!- 5938.46                                                                   !
!   0.20  !----- SH ------!                                                                            !
!         !---------------!                                                                            !
!         !---------------!- 5938.27          REQUESTED ANAL NOT AVAILABLE                             !
!   0.50  !..... SS ......!                                                                            !
!         !---------------!- 5937.77                                                                   !
!   8.80  !----- SH ------!                                                                            !
!         !---------------!                                                                            !
!         !---------------!- 5928.96                                                                   !
!   3.40  !      CO       !  J                                                                         !
!         !---------------!- 5925.56                                                                   !
!   1.50  !----- SH ------!                                                                            !
!         !---------------!- 5924.06                                                                   !
!   5.30  !      CO       ! UI                                                                         !
!         !               !                                                                            !
!         !---------------!- 5918.77                                                                   !
!   3.50  !----- SH ------!                                                                            !
!         !---------------!- 5915.27                                                                   !
!         !               !                                                                            !
!  12.00  !      CO       ! LI                                                                         !
!         !               !                                                                            !
!         !---------------!- 5903.27                                                                   !
!   0.80  !----- SH ------!                                                                            !
!         !---------------!- 5902.46                                                                   !
!   3.60  !..... SS ......!                                                                            !
!         !...............!                                                                            !
!         !---------------!- 5898.86                                                                   !
!   5.60  !----- SH ------!                                                                            !
!         !---------------!                                                                            !
!---------!---------------!- 5893.27 ------------------------------------------------------------------!
```

```
DESCRIPTION EMERY STRIP    1
DRILL HOLE  FC 270B
COORD NORTH  194488.00
COORD EAST  2071684.00
SURF. ELEV.     6028.27
TOP OF SEAM     5028.27
SEAM THK. FT    -875.00
BOTT OF SEAM    5903.27
TYPE ANAL.  H2O FREE
SEAM ID:      J
TYPE LOG:   DRILLER
```

```
I THICK    CROSSECTION    I ----ELEVATION---  --------PERCENT--------  -------COMPOSITE------I
I FEET                    I PARTING   SAMPLE  MOIS  ASH  SULF   BTU    MOIS  ASH  SULF   BTUI
-------------------------------------------------------------------------------------------I
!         !---------------!- 6053.16                                                       !  DESCRIPTION EMERY STRIP   1
!         !---------------!                                                                !  DRILL HOLE  FC 362
! 13.70   !----- SH ------!                                                                !  COORD NORTH  197370.00
!         !---------------!                                                                !  COORD EAST  2074274.00
!         !---------------!- 6039.46                                                       !  SURF. ELEV.     6053.16
!         !XXXXXXXXXXXXXXX!                                                                !  TOP OF SEAM     5053.16
!  6.30   !XXXXX ND XXXXXX!                                                                !  SEAM THK. FT    -841.60
!         !XXXXXXXXXXXXXXX!                                                                !  BOTT OF SEAM    5894.76
!         !---------------!- 6033.16                                                       !  TYPE ANAL.  H2O FREE
!         !---------------!                                                                !  SEAM ID:     J
!  5.90   !----- SH ------!                                                                !  TYPE LOG:   DRILLER
!         !---------------!                                                                !
!         !---------------!- 6027.26                                                       !
!  4.10   !XXXXX ND XXXXXX!                                                                !
!         !XXXXXXXXXXXXXXX!                                                                !
!         !---------------!- 6023.16                                                       !
!         !---------------!                                                                !
! 35.30   !----- SH ------!                                                                !
!         !---------------!                                                                !
!         !---------------!                                                                !
!         !---------------!- 5987.86                                                       !
!  4.70   !..... SS ......! TF                                                             !
!         !---------------!- 5983.16                                                       !
!         !...............!                                                                !
!         !...............!            REQUESTED ANAL NOT AVAILABLE                        !
!         !...............!                                                                !
! 63.60   !..... SS ......!                                                                !
!         !...............!                                                                !
!         !...............!                                                                !
!         !...............!                                                                !
!         !---------------!- 5919.56                                                       !
!  3.65   !      CO       !  J                                                             !
!         !---------------!- 5915.91                                                       !
!  0.75   !----- SH ------!                                                                !
!         !---------------!- 5915.16                                                       !
!  0.30   !===== CL ======!                                                                !
!         !---------------!- 5914.86                                                       !
!  0.30   !----- SH ------!                                                                !
!         !---------------!- 5914.56                                                       !
!  1.30   !      CO       ! UI                                                             !
!         !---------------!- 5913.26                                                       !
!  0.50   !----- SH ------! UI                                                             !
!         !---------------!- 5912.76                                                       !
!         !               !                                                                !
! 18.00   !      CO       ! UI                                                             !
!         !               !                                                                !
!         !---------------!- 5894.76                                                       !
!  0.95   !----- SH ------!                                                                !
!         !---------------!- 5893.81                                                       !
!  0.65   !XXXXX ST XXXXXX!                                                                !
!---------!---------------!- 5893.16 ------------------------------------------------------!
```

```
I  THICK  I  CROSSECTION  I  ----ELEVATION---   --------PERCENT--------   -------COMPOSITE------I
I  FEET   I               I  PARTING   SAMPLE   MOIS   ASH  SULF   BTU    MOIS   ASH  SULF   BTUI
-------------------------------------------------------------------------------------------------I
!         !---------------!- 6043.99                                                             !
!         !---------------!                                                                      !
!  20.00  !----- SH ------!                                                                      !
!         !---------------!                                                                      !
!         !---------------!                                                                      !
!         !---------------!- 6023.99                                                             !
!   2.10  !===== CL ======!                                                                      !
!         !===============!                                                                      !
!         !---------------!- 6021.89                                                             !
!   4.50  !..... SS ......!                                                                      !
!         !...............!                                                                      !
!         !---------------!- 6017.39                                                             !
!   3.40  !XXXXX ND XXXXXX!                                                                      !
!         !XXXXXXXXXXXXXXX!                                                                      !
!         !---------------!- 6013.99                                                             !
!         !...............!                                                                      !
!         !...............!                                                                      !
!         !...............!                                                                      !
!         !...............!                                                                      !
!  71.30  !..... SS ......!                                                                      !
!         !...............!                                                                      !
!         !...............!                                                                      !
!         !...............!                                                                      !
!         !...............!                                                                      !
!         !---------------!- 5942.69          REQUESTED ANAL NOT AVAILABLE                       !
!   3.80  !      DC       ! J                                                                    !
!         !---------------!- 5938.89                                                             !
!   0.70  !===== CL ======!                                                                      !
!         !---------------!- 5938.19                                                             !
!   0.35  !----- SH ------!                                                                      !
!         !---------------!- 5937.84                                                             !
!   1.60  !      CO       ! UI                                                                   !
!         !---------------!- 5936.24                                                             !
!   0.40  !----- SH ------! UI                                                                   !
!         !---------------!- 5935.84                                                             !
!   4.35  !      CO       ! UI                                                                   !
!         !---------------!- 5931.49                                                             !
!   0.30  !XXXXX CA XXXXXX!                                                                      !
!         !---------------!- 5931.19                                                             !
!  13.80  !      CO       ! LI                                                                   !
!         !               !                                                                      !
!         !---------------!- 5917.39                                                             !
!   0.30  !----- SH ------!                                                                      !
!         !---------------!- 5917.09                                                             !
!   0.60  !===== CL ======!                                                                      !
!         !---------------!- 5916.49                                                             !
!   5.50  !----- SH ------!                                                                      !
!         !---------------!                                                                      !
!         !---------------!- 5910.99                                                             !
!   3.60  !..... SS ......!                                                                      !
!---------!---------------!- 5907.39 ---------------------------------------------------------!
```

```
DESCRIPTION EMERY STRIP    1
DRILL HOLE  FC 363
COORD NORTH  196400.00
COORD EAST  2074166.00
SURF. ELEV.     6043.99
TOP OF SEAM     5043.99
SEAM THK. FT    -873.40
BOTT OF SEAM    5917.39
TYPE ANAL.  H20 FREE
SEAM ID:      J
TYPE LOG:   DRILLER
```

THICK FEET	CROSSECTION	ELEVATION PARTING	ELEVATION SAMPLE	PERCENT MOIS	PERCENT ASH	PERCENT SULF	PERCENT BTU	COMPOSITE MOIS	COMPOSITE ASH	COMPOSITE SULF	COMPOSITE BTU
		6064.50									
58.60	SS										
		6005.90									
13.10	SH										
		5992.80									
38.30	SS										
		5954.50									
0.30	SH										
		5954.20									
3.70	CO	J									
		5950.50									
0.95	CL										
		5949.55									
0.30	SH										
		5949.25									
20.55	CO	UI									
		5928.70									
4.50	SH										
		5924.20									

REQUESTED ANAL NOT AVAILABLE

DESCRIPTION EMERY STRIP 1
DRILL HOLE FC 365
COORD NORTH 193279.00
COORD EAST 2071590.00
SURF. ELEV. 6064.50
TOP OF SEAM 5064.50
SEAM THK. FT -864.20
BOTT OF SEAM 5928.70
TYPE ANAL. H2O FREE
SEAM ID: J
TYPE LOG: DRILLER

APPENDIX 6-3

METHODS AND RESULTS OF CHEMICAL ANALYSES

AGRICULTURAL CONSULTANTS INC
240 SOUTH FIRST AVE
PO DRAWER 507
BRIGHTON, COLORADO 80601
(303)-659-2313

DATE: MARCH 2, 1982

REPORT TO: JIM WALSH / DON WASSEN

COMPANY: JAMES P. WALSH AND ASSOCIATES

PROJECT ID: CONSLIDATION II / OVERBURDEN

DESCRIPTION OF ABBREVIATIONS USED FOR SOIL TEST REPORT COLUMN HEADINGS

PH- PASTE PH, USDA HANDBOOK 60, METHOD (21A), PAGE 102

EC- ELECTRIC CONDUCTIVITY, MMHOS/CC, USDA HANDBOOK 60 CONDUCTIVITY ELECTRODE/WHEATSTONE BRIDGE METHOD 3(A) & 4(B)

SAT%- WATER HOLDING CAPACITY AT SATURATION, USDA HANDBOOK 60 METHOD (27A & B), PAGE 107

CA- CALCIUM, MEQ/L, USDA HANDBOOK 60 CHAPT 6/QUANITATION BY AAS METHOD (3A), PAGE 84.

MG- MAGNESIUM, MEQ/L, USDA HANDBOOK 60 CHAPT 6/QUANTITATION BY AAS METHOD (3A),PAGE 84.

NA- SODIUM, MEQ/L, USDA HANDBOOK 60 CHAPT 6/QUANTITATION BY AAS METHOD (3A),PAGE 84.

SAR- SODIUM ADSORPTION RATIO, USDA HANDBOOK 60/QUANTITATION BY AAS PAGE 26.

HCO3- BICARBONATE PPM USDA HANDBOOK 60

SN- SANDY OR SAND (%), A.S.A. MONO. NO.9 PART I, METHOD 43-5, PAGES 562-566.

SI- SILTY OR SILT (%), A.S.A. MONO. NO.9 PART I, METHOD 43-5, PAGES 562-566.

CL- CLAY (%), A.S.A.MONO. NO.9 PART I, METHOD 43-5, PAGES 562-566.

N- NITRATE NITROGEN, PPM, EXTRACTION BY A.S.A. MONO. NO.9 PART 2 METHOD 84-5.3.3, PAGE 1216.

OM- ORGANIC MATTER (HUMUS), % AMER SOC OF AGR #9 PT. 2 METHOD 90.3 PAGE 1372-1376

P- PHOSPHORUS (AVAILABLE PHOSPHORUS, PPM, AMER SOC OF AGR #9 NAHCO3 EXT)

AK- AVAILABLE POTASSIUM, PPM, AMER SOC OF AGR #9

LM- LIME, % , USDA HANDBOOK 60 CHAPT 6 (23B) CACO3 EQV

B- BORON (SOLUBLE), PPM.EXTRACTION BY A.S.A. MONO. NO.9 PART 2 METHOD 75-4, PAGE 1062. CURCUMIN METHOD.

SE- SELENIUM (SOLUBLE), PPM.EXTRACTION BY A.S.A. MONO. NO.9 PART 2 PAGE 1122 DAN-FLOUROMETRIC METHOD.

PB- LEAD, PPM DTPA EXT/AAS QUANTITATION (FOLLET AND LINDSAY, 1971).

MO- MOLYBDENUM, PPM.(NH4)2CO3 EXTRACTABLE (VLEK, 1975).

ZN- ZINC, PPM, DTPA EXT/AAS QUANTITATION

FE- IRON, PPM, DTPA EXT/AAS QUANTITATION

CU- COPPER, PPM, DTPA EXT/AAS QUANTITATION (FOLLET AND LINDSAY, 1981).

MN- MANGANESE, PPM, DTPA EXT/AAS QUANTITATION

CD- CADMIUM, PPM, DTPA EXT/AAS QUANTITATION

NI- NICKEL, PPM, DTPA EXT/AAS QUANTITATION

HG- MERCURY, PPM, ACID EXT/COLD VAPOR AAS, EPA SEDIMENTS 245.5

AS- ARSENIC, PPM, ACID EXT/FLAMELESS AAS (NELSON ET AL. 1953).

F- FLUORIDE, PPM.SPECIFIC ION ELECTRODE

PS- PYRITIC SULFUR, %, SMITH R.M. ET AL (1974) AND ASTM D2492-68

SO4S- SULFATE SULFUR, %, SMITH R.M. ET AL (1974) AND ASTM D2492-68

OS- ORGANIC SULFUR, %, SMITH R.M. ET AL (1974) AND ASTM D2492-68

TS- TOTAL SULFUR, %, ASTM D2492-68

MINUS SIGN INDICATES LESS THAN REPORTING MINIMUMS.

B.

CONSOLIDATION OB / HOLE: FC-700

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 5.0	7.1	11.5	66.4	26.18	25.97	57.20	4.1	25	31	44	0.3	20.3	-.01	0.10	-.01	0.10	853	8	1	810
5.0 TO 17.0	7.2	8.4	74.0	7.05	19.10	50.42	1.2	3	49	48	0.4	8.6	-.01	0.09	-.01	0.09	678	8	1	840
17.0 TO 38.8	7.0	5.3	36.6	5.89	24.20	23.69	1.2	61	28	11	0.2	2.2	-.01	0.05	-.01	0.05	296	1	1	350
38.8 TO 42.0	7.0	4.0	27.2	6.89	14.68	12.23	1.9	85	8	7	0.3	2.1	-.01	0.01	-.01	0.01	120			
42.0 TO 51.3	7.2	2.7	32.4	5.04	9.86	7.81	1.7	77	16	7	0.4	3.8	-.01	0.01	-.01	0.01	129			
51.3 TO 71.4	7.3	2.7	29.7	5.86	10.78	6.51	2.0	83	14	3	0.4	2.5	-.01	0.01	-.01	0.01	75			
71.4 TO 77.5	7.4	3.0	28.7	5.69	12.54	7.43	1.8	84	11	5	0.3	4.3	-.01	0.01	-.01	0.01	81			
77.5 TO 80.3	7.8	2.7	37.6	6.28	7.44	8.33	2.2	73	10	17	0.3	6.1	-.01	0.02	-.01	0.02	93			
80.3 TO 92.0	7.7	2.4	32.3	4.64	9.92	6.41	1.6	80	15	5	0.2	4.7	-.01	0.01	-.01	0.01	104			
92.0 TO 93.6	6.8	8.5	28.4	5.52	23.18	44.67	0.9	79	18	3	3.6	6.8	-.01	0.03	-.01	0.03	286			
118.9 TO 119.7	8.9	2.9	49.9	14.63	4.18	5.42	6.7	16	54	30	0.4	0.3	-.01	0.00	-.01	0.00	243			
119.7 TO 124.7	8.7	1.9	35.0	13.93	1.49	0.95	12.6	50	44	6	0.2	0.3	-.01	0.00	-.01	0.00	107			
124.7 TO 130.5	8.9	2.7	87.8	16.24	2.91	2.20	10.2	11	12	77	2.9	1.6	-.01	0.03	-.01	0.03	337			

CONSOLIDATION OB / HOLE: FC-701

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 5.0	7.1	6.0	31.8	14.22	26.09	13.21	3.2	70	27	3	0.1	4.7	-.01	0.05	-.01	0.05	185	2	1	200
5.0 TO 10.0	7.3	10.5	32.4	21.47	35.98	43.20	3.4	63	31	6	0.1	2.9	-.01	0.09	-.01	0.09	468	2	1	200

10.0 TO 30.0	7.1	9.0	35.3	10.82	34.70	41.50	1.8	68	26	6	0.2	1.5	-.01	0.09	-.01	0.09	422	2	1	260
30.0 TO 50.0	7.0	12.6	32.4	4.18	38.99	63.71	0.6	63	19	18	0.1	3.5	-.01	0.09	-.01	0.09	334			
50.0 TO 67.0	6.3	10.4	29.6	5.65	39.43	45.09	0.9	77	16	7	0.2	1.8	-.01	0.09	-.01	0.09	363			
93.6 TO 95.0	8.7	2.9	32.6	17.08	5.07	2.90	8.6	64	29	7	1.4	0.2	-.01	0.00	-.01	0.00	151			
95.0 TO 100.0	8.6	2.0	35.3	15.77	2.49	1.32	11.4	70	21	9	0.1	2.7	-.01	0.00	-.01	0.00	100			
100.0 TO 110.0	8.6	3.4	67.7	24.65	2.83	2.07	15.7	40	14	46	2.3	1.0	-.01	0.01	-.01	0.01	423			

CONSOLIDATION OB / HOLE: FC-702

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 4.6	7.2	13.0	36.1	36.61	25.27	62.79	5.5	66	28	6	0.3	3.0	-.01	0.09	-.01	0.09	604	2	1	230
4.6 TO 10.0	7.0	13.9	34.5	29.27	36.33	58.03	4.3	69	19	12	0.2	2.9	-.01	0.10	-.01	0.10	466	2	1	190
10.0 TO 21.3	7.0	7.4	31.6	9.25	39.83	25.32	1.6	47	47	6	0.2	2.9	-.01	0.07	-.01	0.07	264	2	1	140
21.3 TO 22.5	6.6	8.1	27.9	9.98	43.50	28.68	1.7	81	16	3	0.1	0.3	-.01	0.08	-.01	0.08	288			
22.5 TO 29.5	6.8	5.8	28.3	6.64	41.69	11.31	1.3	78	17	5	0.1	2.5	-.01	0.07	-.01	0.07	265			
29.5 TO 30.2	6.2	9.8	29.5	6.71	41.53	36.12	1.1	86	9	5	0.2	0.8	-.01	0.08	-.01	0.08	229			
30.2 TO 33.9	6.4	5.6	31.1	4.48	41.49	10.29	0.9	78	15	7	0.1	3.5	-.01	0.07	-.01	0.07	229			
33.9 TO 34.3	5.2	7.9	27.5	10.61	42.84	26.63	1.8	89	5	6	6.6	0.0	-.01	0.08	0.03	0.11	65			
34.3 TO 38.0	5.7	2.4	28.7	5.45	14.60	3.48	1.8	90	4	6	0.2	0.0	-.01	0.01	-.01	0.01	85			
38.0 TO 42.8	5.8	3.3	29.7	5.38	15.34	7.18	1.6	90	7	3	2.8	0.0	-.01	0.02	-.01	0.02	33			
42.8 TO 55.2	6.4	6.5	32.7	4.57	37.28	12.63	0.9	88	8	4	0.1	2.5	-.01	0.07	-.01	0.07	199			
55.2 TO 56.1	6.5	4.1	33.0	5.17	23.32	13.14	1.2	86	11	3	3.2	0.2	-.01	0.04	-.01	0.04	142			
79.2 TO 79.5	8.1	1.5	31.9	8.51	3.51	1.46	5.4	81	12	7	1.6	0.1	-.01	0.00	-.01	0.00	86			

79.5 TO 83.4	8.3	1.1	60.6	8.61	1.32	0.99	8.0	48	12	40	0.3	0.2	-.01	0.01	-.01	0.01	110			
83.4 TO 91.7	8.3	1.7	27.9	12.45	2.72	0.95	9.2	79	15	6	3.7	0.5	-.01	0.00	-.01	0.00	79			

CONSOLIDATION OB / HOLE: FC-703

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 5.0	7.4	16.6	75.0	69.54	18.54	50.65	11.8	42	16	42	0.4	16.8	-.01	0.12	-.01	0.12	1662	8	1	840
5.0 TO 10.0	7.4	12.3	74.9	55.73	20.41	43.61	9.8	18	31	51	0.3	16.2	-.01	0.11	-.01	0.11	1328	12	4	850
10.0 TO 20.0	7.1	7.6	63.4	15.36	25.94	35.76	2.8	13	40	47	0.4	17.1	-.01	0.08	-.01	0.08	760	9	1	960
20.0 TO 35.0	7.0	7.1	61.9	12.93	24.44	30.16	2.5	45	16	39	0.2	0.0	-.01	0.08	-.01	0.08	97			
35.0 TO 50.0	6.9	9.6	35.1	14.86	36.56	37.98	2.4	46	49	5	0.3	7.2	-.01	0.08	-.01	0.08	492			
50.0 TO 65.0	7.0	9.5	32.0	14.15	37.12	29.20	2.5	68	16	16	0.2	3.6	-.01	0.08	-.01	0.08	272			
65.0 TO 70.0	6.9	7.0	35.2	11.85	31.92	22.71	-2.3	63	34	3	0.2	3.2	-.01	0.08	-.01	0.08	298			
70.0 TO 84.0	7.0	9.2	32.2	16.23	34.07	26.95	2.9	62	25	13	0.1	3.5	-.01	0.08	-.01	0.08	405			
84.0 TO 85.7	5.6	3.6	27.3	6.89	14.66	11.24	1.9	76	21	3	3.5	0.0	-.01	0.01	0.02	0.03	55			
110.2 TO 112.0	8.1	3.2	34.6	24.10	4.62	1.54	13.7	54	32	14	6.4	0.6	-.01	0.01	-.01	0.01	206			
112.0 TO 116.0	7.6	1.2	49.1	7.08	3.26	0.95	4.9	61	14	25	0.4	0.0	-.01	0.01	-.01	0.01	94			

CONSOLIDATION OB / HOLE: FC-704

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 5.0	7.3	4.5	66.0	15.82	14.60	14.15	4.2	39	21	40	0.5	15.7	-.01	0.07	-.01	0.07	426	8	1	790
5.0 TO 10.0	7.1	11.1	64.8	42.91	23.16	30.84	8.3	18	33	49	0.6	18.0	-.01	0.10	-.01	0.10	693	7	1	910
10.0 TO 20.0	7.1	6.8	74.0	14.11	23.20	30.65	2.7	36	16	48	0.5	21.8	-.01	0.08	-.01	0.08	839	10	1	910

20.0 TO 35.0	7.1	6.8	75.3	10.62	16.28	29.21	2.2	40	13	47	0.6	19.8	-.01	0.07	-.01	0.07	590
35.0 TO 50.0	6.9	6.9	34.4	13.13	33.46	23.23	2.5	64	31	5	0.1	3.2	-.01	0.07	-.01	0.07	292
50.0 TO 70.0	7.0	6.1	35.4	12.76	25.23	20.69	2.7	71	10	19	0.2	1.8	-.01	0.07	-.01	0.07	293
70.0 TO 90.0	6.9	5.3	36.4	1.43	22.79	21.98	0.3	76	16	8	0.1	1.1	-.01	0.07	-.01	0.07	190
114.0 TO 117.0	8.4	1.4	49.1	6.80	2.85	1.77	4.5	61	9	30	0.3	0.3	-.01	0.00	-.01	0.00	111
117.0 TO 125.0	7.1	4.2	56.8	8.58	15.76	16.44	2.1	46	6	48	0.4	2.6	-.01	0.07	-.01	0.07	331

CONSOLIDATION OB / HOLE: FC-705

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 5.0	7.5	1.9	34.2	4.77	10.40	3.50	1.8	54	43	3	0.3	0.0	-.01	0.00	-.01	0.00	24	2	1	220
5.0 TO 10.0	7.6	1.2	34.9	3.49	4.70	1.91	1.9	58	38	4	0.1	0.1	-.01	0.00	-.01	0.00	48	2	1	300
10.0 TO 30.0	5.2	1.3	35.8	3.89	5.48	1.49	2.1	55	32	13	3.2	0.0	-.01	0.00	0.02	0.02	62	2	1	320
30.0 TO 42.0	4.3	1.7	38.1	4.02	5.88	3.50	1.9	52	30	18	6.2	0.0	-.01	0.00	0.05	0.05	8			
63.4 TO 64.5	6.9	1.4	54.5	7.66	2.20	2.08	5.2	47	4	49	1.1	0.2	-.01	0.00	-.01	0.00	94			
64.5 TO 68.5	8.0	0.8	64.9	2.57	2.03	1.33	2.0	49	8	43	0.6	0.0	-.01	-.00	-.01	0.00	82			
68.5 TO 75.0	7.0	2.3	62.2	4.81	8.39	8.36	1.7	57	4	39	0.5	0.1	-.01	0.01	-.01	0.01	76			

CONSOLIDATION OB / HOLE: FC-706

DEPTH IN	PH	EC	SAT%	NA	CA	MG	SAR	SN	SI	CL	OM	LM	PS	SO4S	OS	TS	HCO3	N	P	AK
0.0 TO 5.0	7.5	9.0	65.9	17.94	23.81	40.46	3.2	19	40	41	0.7	14.7	-.01	0.08	-.01	0.08	752	7	3	880
5.0 TO 10.0	7.2	5.8	73.8	7.54	16.25	29.80	1.6	14	32	54	0.5	15.5	-.01	0.08	-.01	0.08	539	11	4	940
10.0 TO 20.0	7.7	6.3	47.1	14.04	28.18	21.24	2.8	27	38	35	0.2	8.5	-.01	0.08	-.01	0.08	472	6	1	350

20.0 TO 35.0	7.1	7.6	29.7	1.76	38.57	26.94	0.3	81	12	7	0.1	3.1	-.01	0.07	-.01	0.07	216
35.0 TO 50.0	7.0	10.4	28.7	19.40	36.62	32.53	3.3	82	14	4	0.1	3.1	-.01	0.07	-.01	0.07	359
50.0 TO 66.0	7.0	8.7	30.8	24.84	25.64	32.46	4.6	75	21	4	0.1	2.7	-.01	0.02	-.01	0.02	317
88.8 TO 89.6	9.0	1.2	63.7	7.65	3.96	1.70	4.5	46	6	48	1.9	0.2	-.01	0.00	-.01	0.00	158
89.6 TO 92.0	8.2	1.6	31.7	10.63	3.03	1.05	7.4	59	29	12	0.2	0.0	-.01	-.00	-.01	0.00	67
92.0 TO 100.0	8.1	1.7	34.9	11.97	1.72	0.76	10.7	70	15	15	2.9	0.1	-.01	0.00	-.01	0.00	89

B.

CONSOLIDATION OB / HOLE: FC-700

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 5.0	1.7	-0.1	-0.10	2.6	-0.1	1.9	0.02	13.3	-0.1	0.4	1.05	2.7	85
5.0 TO 17.0	-0.1	-0.1	-0.10	1.6	-0.1	1.3	0.02	1.8	-0.1	0.7	0.63	3.3	-10
17.0 TO 38.8	-0.1	-0.1	-0.10	1.6	-0.1	0.8	0.03	7.2	-0.1	1.2	0.25	3.8	-10
38.8 TO 42.0	-0.1	-0.1	-0.10	1.7	-0.1	0.7	0.03	1.7	-0.1	0.1	0.07	10.0	735
42.0 TO 51.3	-0.1	-0.1	-0.10	1.1	-0.1	0.4	0.01	0.8	-0.1	-0.1	0.09	7.9	909
51.3 TO 71.4	-0.1	-0.1	-0.10	1.8	-0.1	0.4	0.03	2.9	-0.1	0.1	0.09	4.7	210
71.4 TO 77.5	-0.1	-0.1	-0.10	1.2	-0.1	0.7	0.02	1.5	-0.1	-0.1	0.05	9.4	990
77.5 TO 80.3	-0.1	-0.1	-0.10	0.9	-0.1	1.4	0.03	10.4	-0.1	-0.1	0.07	13.0	1072
80.3 TO 92.0	-0.1	-0.1	-0.10	0.9	-0.1	0.7	0.02	1.5	-0.1	-0.1	0.08	14.0	1221
92.0 TO 93.6	-0.1	-0.1	-0.10	0.9	-0.1	0.2	0.03	0.5	-0.1	-0.1	0.07	18.0	872
118.9 TO 119.7	-0.1	-0.1	-0.10	0.7	-0.1	7.6	0.03	2.3	-0.1	0.5	0.05	10.0	850
119.7 TO 124.7	-0.1	-0.1	-0.10	0.7	-0.1	1.3	0.01	1.6	-0.1	0.3	0.06	6.0	468
124.7 TO 130.5	-0.1	-0.1	-0.10	5.0	-0.1	6.9	0.03	4.9	-0.1	0.9	0.06	8.2	415

CONSOLIDATION OB / HOLE: FC-701

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 5.0	-0.1	-0.1	-0.10	3.0	-0.1	1.1	0.02	8.5	-0.1	0.3	0.17	6.1	-10
5.0 TO 10.0	0.5	-0.1	-0.10	1.8	-0.1	0.4	0.01	11.4	-0.1	0.2	0.22	3.8	-10
10.0 TO 30.0	-0.1	-0.1	-0.10	1.6	-0.1	0.4	0.03	7.9	-0.1	0.4	0.15	2.8	-10
30.0 TO 50.0	0.5	-0.1	-0.10	1.5	-0.1	0.3	0.02	6.1	-0.1	0.2	0.18	0.9	-10
50.0 TO 67.0	0.3	-0.1	-0.10	1.4	-0.1	0.6	0.01	3.8	-0.1	0.3	0.07	5.6	555

93.6 TO 95.0	-0.1	-0.1	-0.10	1.5	-0.1	5.1	0.03	2.7	-0.1	0.5	0.08	4.7	513
95.0 TO 100.0	-0.1	-0.1	-0.10	0.8	-0.1	2.3	0.03	2.5	-0.1	-0.1	0.07	11.0	579
100.0 TO 110.0	-0.1	-0.1	-0.10	2.7	-0.1	4.7	0.02	5.1	-0.1	1.2	0.05	0.5	-10

CONSOLIDATION OB / HOLE: FC-702

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 4.6	0.8	-0.1	-0.10	1.5	-0.1	1.3	0.02	14.0	-0.1	0.5	0.73	38.0	698
4.6 TO 10.0	0.5	-0.1	-0.10	0.8	-0.1	0.7	0.02	7.1	-0.1	0.4	0.60	20.0	556
10.0 TO 21.3	-0.1	-0.1	-0.10	1.9	-0.1	0.4	0.02	11.0	-0.1	0.4	0.35	29.0	311
21.3 TO 29.5	-0.1	-0.1	-0.10	1.1	-0.1	0.7	0.01	2.3	-0.1	0.6	0.09	39.0	499
22.5 TO 29.5	-0.1	-0.1	-0.10	1.1	-0.1	1.2	0.02	1.2	-0.1	0.4	0.08	37.0	145
29.5 TO 30.2	-0.1	-0.1	-0.10	1.0	-0.1	0.9	0.01	1.3	-0.1	0.5	0.08	5.9	371
30.2 TO 33.9	-0.1	-0.1	-0.10	1.4	-0.1	0.4	0.01	1.1	-0.1	0.6	0.06	9.0	530
33.9 TO 34.3	-0.1	-0.1	-0.10	1.2	-0.1	0.4	0.02	2.6	-0.1	4.0	0.08	9.9	821
34.3 TO 38.0	-0.1	-0.1	-0.10	0.5	-0.1	0.4	0.02	2.3	-0.1	0.7	0.06	3.9	355
38.0 TO 42.8	-0.1	-0.1	-0.10	0.6	-0.1	0.6	0.03	2.8	-0.1	0.3	0.09	11.0	624
42.8 TO 55.2	-0.1	-0.1	-0.10	1.2	-0.1	0.8	0.03	1.2	-0.1	0.7	0.06	17.0	152
55.2 TO 56.1	-0.1	-0.1	-0.10	0.8	-0.1	1.0	0.03	1.1	-0.1	-0.1	0.07	12.0	926
79.2 TO 79.5	-0.1	-0.1	-0.10	0.7	-0.1	4.1	0.01	2.0	-0.1	0.2	0.08	9.7	1037
79.5 TO 83.4	-0.1	-0.1	-0.10	0.9	-0.1	5.0	0.02	1.6	-0.1	0.8	0.08	6.5	361
83.4 TO 91.7	-0.1	-0.1	-0.10	0.9	-0.1	2.8	0.01	2.2	-0.1	0.1	0.06	8.3	819

CONSOLIDATION OB / HOLE: FC-703

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 5.0	1.6	-0.1	-0.10	1.9	-0.1	3.0	0.02	2.9	-0.1	1.0	4.80	16.0	70

5.0 TO 10.0	1.2	-0.1	-0.10	1.8	-0.1	3.4	0.02	2.2	-0.1	0.8	3.64	15.0	127
10.0 TO 20.0	-0.1	-0.1	-0.10	1.4	-0.1	2.3	0.02	1.3	-0.1	0.6	0.80	6.3	-10
20.0 TO 35.0	-0.1	-0.1	-0.10	1.2	-0.1	1.3	0.01	1.7	-0.1	1.0	0.63	14.0	-10
35.0 TO 50.0	-0.1	-0.1	-0.10	1.6	-0.1	0.3	0.02	1.5	-0.1	0.7	0.20	11.0	-10
50.0 TO 65.0	-0.1	-0.1	-0.10	1.5	-0.1	0.2	0.02	1.0	-0.1	0.2	0.07	2.9	-10
65.0 TO 70.0	-0.1	-0.1	-0.10	0.9	-0.1	0.2	0.02	0.4	-0.1	0.2	0.07	2.8	-10
70.0 TO 84.0	-0.1	-0.1	-0.10	1.5	-0.1	0.5	0.01	6.2	-0.1	0.2	0.09	3.0	-10
84.0 TO 85.7	-0.1	-0.1	-0.10	0.3	-0.1	0.1	0.01	1.1	-0.1	-0.1	0.05	11.0	699
110.2 TO 112.0	-0.1	-0.1	-0.10	0.8	-0.1	0.6	0.01	7.1	-0.1	-0.1	0.05	16.0	631
112.0 TO 116.0	-0.1	-0.1	-0.10	0.8	-0.1	0.3	0.02	3.7	-0.1	0.2	0.07	9.4	812

CONSOLIDATION OB / HOLE: FC-704

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 5.0	-0.1	-0.1	-0.10	2.4	-0.1	0.8	0.01	9.6	-0.1	0.8	3.17	20.0	-10
5.0 TO 10.0	1.2	-0.1	-0.10	1.8	-0.1	0.6	0.02	1.3	-0.1	0.7	5.02	3.5	-10
10.0 TO 20.0	-0.1	-0.1	-0.10	1.3	-0.1	1.6	0.02	0.7	-0.1	0.5	2.52	5.3	-10
20.0 TO 35.0	-0.1	-0.1	-0.10	1.5	-0.1	1.9	0.01	5.7	-0.1	0.6	0.32	4.6	-10
35.0 TO 50.0	-0.1	-0.1	-0.10	1.5	-0.1	0.3	0.02	7.3	-0.1	0.2	0.06	2.4	-10
50.0 TO 70.0	-0.1	-0.1	-0.10	1.0	-0.1	0.2	0.02	2.5	-0.1	0.2	0.05	1.9	-10
70.0 TO 90.0	-0.1	-0.1	-0.10	0.7	-0.1	0.2	0.01	1.0	-0.1	0.1	0.07	2.2	-10
114.0 TO 117.0	-0.1	-0.1	-0.10	1.0	-0.1	1.1	0.02	8.2	-0.1	-0.1	0.07	9.4	712
117.0 TO 125.0	-0.1	-0.1	-0.10	4.1	-0.1	0.8	0.02	14.0	-0.1	0.5	0.06	3.7	-10

CONSOLIDATION OB / HOLE: FC-705

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 5.0	-0.1	-0.1	-0.10	1.3	-0.1	0.2	0.02	8.9	-0.1	0.1	0.08	0.4	-10

5.0 TO 10.0	-0.1	-0.1	-0.10	1.1	-0.1	0.2	0.01	6.6	-0.1	0.1	0.09	0.2	-10
10.0 TO 30.0	-0.1	-0.1	-0.10	0.7	-0.1	0.2	0.03	5.1	-0.1	0.1	0.08	0.7	-10
30.0 TO 42.0	-0.1	-0.1	-0.10	0.6	-0.1	0.1	0.02	1.9	-0.1	0.4	0.08	1.4	127
63.4 TO 64.5	-0.1	-0.1	-0.10	0.4	-0.1	1.9	0.02	2.9	-0.1	0.4	0.09	13.0	523
64.5 TO 68.5	-0.1	-0.1	-0.10	0.4	-0.1	0.7	0.03	4.1	-0.1	0.1	0.08	6.0	563
68.5 TO 75.0	-0.1	-0.1	-0.10	1.7	-0.1	0.8	0.01	4.7	-0.1	0.3	0.07	1.9	83

CONSOLIDATION OB / HOLE: FC-706

DEPTH IN	AS	CD	HG	PB	MO	B	SE	ZN	NI	CU	F	MN	FE
0.0 TO 5.0	-0.1	-0.1	-0.10	1.6	-0.1	0.9	0.01	0.9	-0.1	0.4	0.06	4.8	-10
5.0 TO 10.0	-0.1	-0.1	-0.10	2.3	-0.1	1.6	0.02	3.3	-0.1	1.3	0.07	9.6	-10
10.0 TO 20.0	-0.1	-0.1	-0.10	1.6	-0.1	0.2	0.03	2.5	-0.1	0.5	0.06	14.0	-10
20.0 TO 35.0	-0.1	-0.1	-0.10	1.4	-0.1	-0.1	0.03	9.2	-0.1	0.2	0.05	2.6	-10
35.0 TO 50.0	0.4	-0.1	-0.10	1.4	-0.1	-0.1	0.02	8.6	-0.1	0.4	0.44	3.1	-10
50.0 TO 66.0	-0.1	-0.1	-0.10	1.3	-0.1	-0.1	0.03	7.1	-0.1	0.1	0.07	2.3	-10
88.8 TO 89.6	-0.1	-0.1	-0.10	0.8	-0.1	1.3	0.02	1.1	-0.1	0.1	0.06	7.7	883
89.6 TO 92.0	-0.1	-0.1	-0.10	1.7	-0.1	0.6	0.01	0.9	-0.1	0.3	0.05	4.3	358
92.0 TO 100.0	-0.1	-0.1	-0.10	0.9	-0.1	1.2	0.02	3.6	-0.1	0.1	0.08	7.5	590

B.

PLATES

MAPS AND ILLUSTRATIONS FOR CHAPTER VI

VI-1 Geology of the General Mine Area

VI-2 Drill Hole and Cross-Section Location Map

VI-3 Cross-Section A-A'

VI-4 Cross-Section B-B'

VI-5 Cross-Section C-C'

VI-6 Coal Geology