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## CHAPTER FIVE

**R645-301-500 (GENERAL ENGINEERING)**

## R645-301-500 GENERAL ENGINEERING

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500 GENERAL ENGINEERING

510 INTRODUCTION

The refuse disposal area, previously created by the Sunnyside Coal Company (SCC), has been acquired by Sunnyside Cogeneration Associates (SCA) to serve as a long-term supply of waste fuel for its coal mine waste-to-energy facility, located adjacent to the SCA Permit Area. SCA's alternative energy project has been approved by the Federal Energy Regulatory Commission as a Qualifying Facility, based on the usage of coal mine waste as fuel in its fluidized-bed combustion boiler. SCA will use "active waste" from off-site processing plants/refuse piles, "accumulated waste" from refuse piles, and other alternate fuels as sources of waste fuel for the facility. SCA's fueling plan will require excavation of coal mine waste from the existing refuse pile, which began as early as January 1993.

Based on SCA's contract for the sale of electricity to Utah Power and Light, handling coal mine waste to serve as an alternative energy fuel will be a consistent and continuous process. Coal mine waste that continues to be generated by off-site preparation plants and other coal materials as discussed in Chapter Nine, will also be factored into SCA's fueling strategy, which can allow direct acceptance of coal mine waste at the facility, or temporary placement within the approved storage areas or the refuse disposal area prior to utilization.

SCA will excavate coal mine waste from the refuse disposal area based on sampling and analyses and a materials handling plan which will be periodically updated by SCA. Excavation of the coal mine waste will be considerate of material quality, pile and embankment stability, and mine operation. Over the life of SCA's facility, nearly all of the coal mine waste will be burned to generate electricity. Final reclamation of the refuse pile will be accomplished after all of the coal mine waste is either burned as a fuel, or repositioned within the refuse disposal area for final disposal, if determined to be unacceptable fuel material (i.e., ashes, rock, soil, etc.).

Currently, there are activities that occur outside the Sunnyside Cogeneration Associates Permit Boundary that have significant bearing on the operations of the SCA Cogeneration facility and the SCA Permit Area. These activities occur in conjunction with the SCA permit site.

In order for SCA to acquire the quality and quantity of fuel for the cogeneration facility, coarse or fine refuse materials may be accepted from off-site facilities as needed. The refuse is stockpiled in designated areas within the SCA permit site then mixed with existing refuse on the SCA permit site and transported to the cogeneration facility. These operations; acceptance of refuse from off-site facilities and the transporting of coarse refuse to the cogeneration facility, require access roads that extend beyond the limits of the SCA permit boundary.

In addition to the access roads mentioned above, there are access roads to the south of the SCA permit boundary that are utilized for the purposes of the SCA operations. These roads are utilized to access areas of the SCA permit site that are inaccessible from the north side of the permit area. They are used by authorized contractors of SCA for the purposes of such activities as: water quality monitoring, periodic inspections and site maintenance as needed.

Activities that occur outside the SCA Permit Area also include watersheds outside the permit area that drain into contained areas within the permit area. Chapter Seven of the Permit outlines these watersheds.
and the areas to which they drain. Also included are detailed maps and calculations showing the amount of water from each watershed and the capacity of the drainages and ponds that were constructed to contain them. In some instances, a drainage commencing within the SCA Permit Area may extend beyond the limits of the SCA permit boundary. An example of this is the outlet of the Pasture Sediment Pond. In such a case, SCA commits to maintaining this drainage and providing the necessary information to the Division to show its adequacy to handle the required storm event. In the event that this occurs elsewhere within the permit area, SCA will handle each instance on a case-by-case basis and notify the DOGM of any proposed changes to the Permit.

It should be noted that the SCA operations encompass a number of entities that do not necessarily lie or operate within the permitted area. The activities that occur outside of the permitted area are done so in a controlled manner under permits from other agencies, and have been incorporated into the entire design and plan of the SCA Cogeneration facility. SCA understands the implications of utilizing entities outside of the permitted area and commits to maintaining the applicable areas in accordance with DOGM requirements.

This chapter includes operation plans, reclamation plans, design criteria, and performance standards that are applicable to the SCA Permit Area. Design calculations are referenced in the appropriate sections along with maps, plans, and cross-sections. It should be noted that SCA has relied on data, maps, plans, and cross-sections from previous approved permits for the SCC mines in order to verify locations of geologic structures, sediment ponds, borrow areas, road culverts, creeks, etc. that lie within the SCA Permit Area. In this chapter where the "permit area" is referred to, the SCA Sunnyside Permit Area is to be assumed unless the larger overall area for the SCC is specifically referred to in the text as the "original SCC permit area."

512 CERTIFICATION

512.100 Cross Sections and Maps

The maps and cross sections, associated with this permit, have been prepared and certified by, or under the direction of, a qualified, registered professional engineer or land surveyor, with assistance from experts in related fields such as hydrology, geology and landscape architecture. These maps and cross sections will be updated as required by the Division of Oil, Gas and Mining (DOGM).

A list of plates that are applicable to the SCA Permit Area as required under R645-301-512.100 through R645-301-512.260 are included in the General Table of Contents.

512.110 Mine Workings

No underground mine workings exist within the SCA Permit Area. Plate 5-7 delineates the extent of surface areas previously disturbed by mining activities. Plate 5-8 shows the existing surface and subsurface facilities and features which have been associated with mining activities.
512.120 Surface Facilities and Operations

Plate 5-1 shows the location and size of existing areas of spoil, waste, coal development waste, and non-coal waste disposal, dams, embankments, other impoundments, and water treatment facilities within the SCA Permit Area. It also shows the facilities used for crushing and screening the coal refuse as well as the features associated with the adjacent cogeneration facility.

Plates 5-5 A - E show topsoil pile cross sections.

512.130 Surface Configurations

As required under sections 542.300 and 302-200, maps or cross sections detailing plans for soil stabilization, compacting and grading are referenced in the appropriate sections.

512.140 Hydrology

Maps required under R645-301-722 and R645-301-731.700 are included in Chapter Seven, Hydrology. Among these requirements are locations of subsurface water within or adjacent to the SCA Permit Area, intakes for current users, sedimentation ponds, coal processing waste banks, and embankments. Maps are provided only when the above mentioned locations fall within the SCA Permit Area or within an adjacent area that will potentially impact the SCA Permit Area.

512.150 Geologic Cross Sections and Maps

Chapter Six, section 622, includes information applicable to the SCA Permit Area such as: elevations and locations of test borings and core samples; nature, depth, and thickness of coal seams; and crop lines and strike and dip of the coal.

512.200 thru 512.260 Plans and Engineering Designs

Plate 5-1 outlines the locations of excess spoil, durable rock fills, coal mine waste, impoundments and other surface facilities within and adjacent to the SCA Permit Area. Plate 5-2 outlines the locations of primary roads. The design of the Excess Spoil Disposal Areas is found in Chapter Nine and Appendices 9-2, 9-5, and 9-7. Coal mine waste will also be placed in the Excess Spoil Disposal Areas.

513 COMPLIANCE WITH MSHA REGULATIONS AND MSHA APPROVALS

513.100 thru 513.800 Compliance with 30 CFR

Coal mine waste dams, embankments, impoundments, sedimentation ponds, refuse piles, the extinguishing of coal mine waste fires, and the nature and timing of reclamation activities will meet the
performance standards set forth by the MSHA. The embankments and impoundments that are regulated by the MSHA are shown in Plate 5-4, Slope Stability Criteria Map. Where applicable, SCA will comply with all MSHA Regulations and obtain all required MSHA Approvals.

A geotechnical report prepared in February 1987 and updated in June 1992 by Rollins, Brown and Gunnell (Appendix 5-5) shows that the former East Slurry Cell and the former West Slurry Cell Embankments meet the requirements of 30 CFR 77.214 and 77.215. The cross-sections for this report are shown in Plate 5-6.

Coal mine waste fires will be extinguished by placing two-feet of borrow material over the burning area. Only those persons authorized by the Operator, and who are familiar with the appropriate procedures will extinguish any coal mine waste fires. The source of borrow material may be any of the borrow areas within the Permit Area where excess material exists beyond that needed for reclamation, or from spoil material removed during the mining process, or from an acceptable off-site source. When an area is mined, the fire control materials will be placed in the Excess Spoil Disposal Area.

514 INSPECTIONS

514.100 thru 514.140 Excess Spoil Disposal Areas

A professional engineer or specialist experienced in the construction of earth and rock fills will periodically inspect the fill throughout the construction period (at least four times a year) as required by the DOGM. These inspections will be performed during critical construction periods such as: foundation preparation, installation of final surface drainage systems, and the final graded and revegetated fill. A schedule of periodic inspections is provided in Table 5-1.

A certified report will be provided by the professional engineer promptly after each inspection. The report will include any appearances of instability, structural weakness, and other hazardous conditions as well as the results of samples taken to determine the acid/toxic potential. The report on the drainage system and protector filters will also contain color photographs taken in compliance with section 514.130 thru 514.133 that are representative of the site. Photographs will accompany each certified report and will include physical features of the site in order to specifically and clearly identify the site.

A copy of each inspection report will be retained at the SCA cogeneration power plant site and at the office of the Engineer. A copy of the inspection report will be promptly sent by SCA to the Division, as required.

514.200 thru 514.250 Refuse Piles

A professional engineer or specialist experienced in the construction of earth and waste structures will inspect the refuse pile on a regular basis (at least four times a year) as required by the DOGM. These inspections will be performed during critical construction periods such as: foundation preparation, placement of underdrains and protective filter systems, installation of final surface drainage systems, and the final graded and revegetated facility. A schedule of periodic inspections is provided in Table 5-1.
A certified report will be provided by the professional engineer promptly after each inspection. The report will include any evidence of instability, structural weakness, and other hazardous conditions. The report will also contain color photographs taken in compliance with section 514.240 that are representative of the site. Photographs will accompany each certified report and will include physical features of the site in order to specifically and clearly identify the site.

A copy of each inspection report will be retained at the SCA cogeneration power plant site and at the office of the Engineer. A copy of the inspection report will be promptly sent by SCA to the Division, as required.

514.300 thru 514.330 Impoundments

A professional engineer, or other qualified person designated by SCA, will inspect the impoundments within the SCA Permit Area. Impoundments, subject to MSHA, 30 CFR 77.216, will be inspected in accordance with the MSHA Approved Program found in Appendix 5-8. Quarterly inspections will be conducted on impoundments NOT subject to MSHA, 30 CFR 77.216. The various impoundments and their classification are outlined in Plate 5-4. A schedule for periodic inspections is provided in Table 5-1.

After each inspection, the qualified registered professional engineer will provide a certified report that the impoundment has been constructed and maintained as designed in accordance with the R645-302 Rules. The report will include information necessary to satisfy regulations set forth under section 514.312. Such information will include discussion of instability, structural weakness or other hazardous conditions, depth and elevation of any impoundment waters, existing storage capacity, any existing or required monitoring procedures and instrumentation, and any other aspects of the structure affecting stability. A copy of the report will be retained at the SCA cogeneration power plant site and at the offices of the Engineer. A copy of the inspection report will be promptly sent by SCA to the Division, as required.

Appendix 5-1 presents the slope stability analyses for the Railcut, Pasture and Borrow Area Sediment Ponds. Appendix 5-3 presents slope stability analyses for the former Clear Water Pond and the former Slurry Ponds One and Two. Appendix 5-4 contains information on slope stability for the Coarse Refuse Toe and Old Coarse Refuse Road Sediment Ponds. The above mentioned impoundments have been determined to be stable under existing conditions.

515 REPORTING AND EMERGENCY PROCEDURES

515.100 Slides and Other Damage

At any time a slide occurs which may have an adverse effects on public property, health, safety, or the environment, SCA will notify DOGM by the fastest available means and comply with remedial measures required by DOGM.
515.200 Impoundment Hazards

At any time there is a potential impoundment hazard, SCA will notify DOGM by the best available means. DOGM will be informed of the emergency procedures formulated for public protection and remediation.

515.300 thru 315.322 Procedures for Temporary Cessation of Operations

Before temporary cessation of excavation of the refuse pile or reclamation activities for a period of 30 days or more, or as soon as it is known that a temporary cessation will extend beyond 30 days, SCA will submit to DOGM a notice of intention to cease or abandon operations. It is understood by SCA that temporary abandonment will not relieve a person of their obligation to comply with any provisions of the approved permit. Regular monitoring and inspections will continue. Maintenance will occur if needed.

All surface facilities will be effectively secured in areas in which there are no current operations, but in which operations are to be resumed under an approved permit.

In the event of a cessation, regulations 515.321 and 515.322 will be addressed. A statement of the exact number of surface acres and the horizontal and vertical extent of subsurface strata which have been affected in the SCA Permit Area prior to such temporary cessation or abandonment, the extent and kind of reclamation of surface area which will have been accomplished, and identification of the backfilling, regrading, revegetation, environmental monitoring, and water treatment activities that will continue during the temporary cessation.

516 SLIDE PREVENTION

There are no underground mining operations within the SCA Permit Area, nor are there any exposed coal seams. Therefore, barriers for the purpose of slide prevention near coal seams will not be used within the SCA Permit Area.

520 OPERATION PLAN

521 GENERAL

The following sections contain plans, appropriate maps, cross sections, narratives, descriptions, and calculations in accordance with the requirements relevant to this section. Practices will be limited to excavation and handling of coal mine waste to segregate non-combustibles, and redisposing such materials in accordance with 301-536. SCA's operating plan for its adjacent alternative energy power plant is designed to substantially reduce the final quantity of waste materials which will ultimately remain within the existing refuse disposal area. Reclamation essentially commenced with the first ton of waste removed and used as an alternative energy fuel. Reclamation will be a continuous process over the life of the mine, ultimately grading, covering and revegetating any remaining non-combustible materials. Descriptions of these operations are included in the following sections as well as Chapter Nine, Mining Plan.
521.100 thru 521.190 Cross Sections and Maps

See Section 512 for a list of plates that are pertinent to fulfilling the requirements of this section.

521.200 thru 521.270 Signs and Markers Specifications

The location and details for Permit boundary, historic sites, disturbed area and topsoil stockpiles are shown in Plate 3-1, Pre- and Post Law Disturbance. All required signs and markers are in place and maintained in compliance with R645-301-521.200.

1. The signs and markers will be posted, maintained, and removed by SCA;
2. They will be a uniform design (so that they can be easily seen), be made of a durable material, and conform to local laws and regulations;
3. They will be in-place and maintained during all operation and reclamation activities; and
4. They will be retained and maintained until after the release of all bonds.

For the purposes of the operation and reclamation activities, perimeter markers will be used in compliance with the following rules and regulations:

1. The perimeter of all areas affected by surface operations or facilities before beginning reclamation activities will be clearly marked; and
2. The perimeter of the SCA Permit Area will be clearly marked before the beginning of surface reclamation activities.

For the purposes of the operation and reclamation activities, buffer zone markers will be used in compliance with the following rules and regulations:

1. Signs will be erected to mark buffer zones as required under R645-301-731.600 and will be clearly marked to prevent disturbance by surface operations and facilities; and
2. Buffer zones will be marked along their boundaries as required under R645-301-731.600.

Topsoil markers have been erected to mark where topsoil or other vegetation-supporting material is physically segregated and stockpiled as required under R645-301-234.

522 COAL RECOVERY

SCA's activities will maximize the use and conservation of the coal resource by gleaning the very least amount of heating value originally extracted from the coal measures. SCA will utilize the best technology currently available to incinerate coal mine waste in a fluidized bed combustion boiler, which will supply steam to generate over 50 MW of electrical energy. Fluidized-bed combustion has been approved as the best technology to maintain environmental integrity during this waste utilization activity.
Abandoned coal refuse piles are often times reactivated, and reprocessed to recover a marketable coal product. On some occasions, piles are reworked several times, using various processing approaches. SCA's activities will assure that no reworking of this pile occurs in the future, as the small amount of remaining materials will have been determined to be non-combustible. SCA's use of coal mine waste to generate electricity is consistent with our national energy policy to conserve our domestic energy resources.

523 MINING METHODS

SCA's activities will include excavation and handling of coal mine waste and redisposal of non-combustible materials within the SCA Permit Area. Approximately 410,000 tons per year of coal mine waste will be consumed by SCA. The fueling plan for the coal waste fired generator will require excavation of accumulated waste from the existing pile areas, beginning as early as January 1993, and continuing for approximately thirty years. Based on SCA's contract for the sale of electricity to Utah Power and Light, handling coal mine waste to serve as an alternative energy fuel will be a consistent and continuous process. Coal mine waste that continues to be generated by offsite preparation plants will also be factored into SCA's fueling strategy, which can allow direct acceptance of waste at the facility, or temporary placement within the refuse disposal area prior to utilization.

Detailed plans on excavation activities can be found in Chapter Nine, Section 9.6.

SCA will use a standard mobile fleet of excavation equipment which may include all or some of the following: dozers, front-end loaders, end-dump trucks, scrapers, back-hoes, and support equipment (water truck, maintenance vehicles). Excavation will be carried out in lifts, to assure continued stability of the refuse pile, while providing ability to segregate non-combustible materials as they are encountered. An advancing benched face working area will provide access to fuel along a face on each working layer. Sampling and testing will be a continuous process to insure that materials provided to SCA's cogeneration facility meet minimum levels of combustibility. Materials will be segregated as they are excavated for handling in one of three ways: 1) direct hauling to the power plant site, 2) redisposal within the SCA excess spoil disposal areas, or 3) handled through a static grizzly on the refuse pile to separate non-combustibles (rocks, metal, timbers, etc.). Any materials separated through the grizzly will be temporarily stored in piles until loaded and transported to the combustor or the refuse disposal area. The grizzly staging area will be relocated from time to time as excavation activities warrant, and will minimize accumulations of separated materials.

523.100 thru 523.220 Surface Coal Mining and Reclamation Operations Relating to Underground Mines

No activities related to the SCA Permit Area will be conducted closer than 500 feet of an underground or abandoned underground mine. This is reinforced by the fact that there are no underground or abandoned underground mines within 500 feet of the SCA Permit Area boundary.

524 BLASTING AND EXPLOSIVES

There will be no blasting or explosives used within the SCA Permit Area. Thus, regulations 524 through 524.800 are not applicable to this Permit Application and consequently are not addressed.
525 SUBSIDENCE

No material damage or diminution within the Permit Area will be caused by subsidence because no underground coal resources are available within the Permit Area which would cause subsidence. No past or future underground coal mining operations have or are likely to occur within the SCA Permit Area.

526 MINE FACILITIES

The following sections contain narratives explaining the construction, modification, use and maintenance of facilities that lie within the SCA Permit Area and are designated in sections 526.100 through 526.300.

526.100 thru 526.116 Mine Structures and Facilities

Surface and subsurface facilities and features which existed prior to January 21, 1981 are shown on Plate 5-8 existing surface and subsurface facilities and features. Existing surface features are identified on Plate 5-1 Surface Facilities.

SLURRY HANDLING and STORAGE

The slurry ditch was constructed in the 1950's, for the purpose of transporting coal processing waste in slurry form from the Sunnyside Mine wash plant to the disposal sites within the current SCA permit area.

Typically, during operation of the Sunnyside coal wash plant, one slurry pond was in use while the other was in either the drying or cleaning stages. Occasionally when both slurry ponds were being serviced, flows were diverted to the East Slurry Cell. With the cessation of operations at the SCC Wash Plant, slurry is no longer being transported to the SCA Permit Area. The Excess Spoil Disposal Area #2 has been approved to fill the area of the slurry ponds and clear water pond. This includes additional maintenance to the slurry ditch (see Appendix 9-7). The ditch meets or exceeds the permanent program performance standards. It is of sufficient size to safely pass the design storm as calculated in Appendix 7-3.

The West Slurry Cell (formerly MSHA No. 1211-UT-09-02093-03) was located near the center of the permit area. The cell was constructed in the 1950's as a disposal site for fine coal refuse slurry. Wet slurry was last deposited in this cell in 1975 when the East Slurry Cell was put in operation. Since then, dry coal fines from other slurry cells as well as coarse refuse from the Sunnyside Mine have been placed in the cell. This area was actively mined by SCA during the first years of operations.

A dike was constructed of non-combustible earth materials across the existing wash to impound the slurry. This dike was subsequently covered with coarse refuse material to stabilize the west bank of the slurry cell in order to meet the permanent program performance standards under SMCRA. This dike material was excavated during the SCA operations. The West Slurry Cell has been excavated to the point where it no longer is considered an impoundment and has been decommissioned by MSHA. The area is now only referred to as the Refuse Pile.

The East Slurry Cell was located adjacent to and on the east side of the former West Slurry Cell. The
cell was constructed in 1974 primarily of coarse refuse material. The pond was constructed with a total capacity of 184 acre-feet. The East Slurry Cell was a temporary control structure with former MSHA No. 1211-UT-09-02093-02. The structure was a temporary impoundment as addressed in R645-301-733. The structure has been excavated to the point where it is no longer an impoundment and has been decommissioned by MSHA as such and the area is now considered part of the Refuse Pile.

The outer slopes of the east bank of the East Slurry Cell were reclaimed by the Sunnyside Coal Mine. SCA intends to excavate the suitable coarse refuse and the fine refuse from the cell in accordance with the mining plan outlined in Chapter Nine. Regular monitoring is conducted in accordance with the regulations for the Refuse Pile. These monitoring reports are available at the mine site. See Appendix 7-3 for hydrologic calculations. This cell meets or exceeds the permanent program performance standards.

**Slurry Ponds #1 and #2 and the Clear Water Pond** were located near the northeast corner of the permit area. They were constructed during the 1970's to de-water the slurry from the Sunnyside coal wash plant. Fine refuse slurry material arrived from the coal preparation wash plant by way of the open slurry ditch. The ponds were designed to be used for de-watering, settling and filtration of the coal fines.

The Excess Spoil Disposal Area #2 has filled the area of the slurry ponds and the Clearwater Pond (See Appendix 9-7). The Pasture Pond was enlarged in 2007 to receive storm water previously received by the Slurry Ponds and/or the Clear Water Pond.

Other impoundments within the SCA permit site are also discussed in Section 526.300 Water Pollution Control Facilities as well as in Chapter 7 and Appendix 7-3. Regular monitoring of all impoundments is conducted in accordance with R645-514. These monitoring reports are available at the mine site and are submitted to the Division as required. All impoundments meet or exceed the permanent program performance standards.

**COARSE REFUSE HANDLING and STORAGE**

Construction of the **REFUSE PILE (MSHA ID Number 1211-UT-09-02093-01)**, which SCA is excavating, began prior to 1969. The western toe of the pile was extended to the west in the 1970's to provide a stable embankment for the West Slurry Cell that existed at the time and meet the permanent program performance standards. Additional refuse material was added to the top surface of the refuse pile by the Sunnyside Coal Mine as recently as 1994.

Plate 9-4 identifies the location and extent of the coarse and fine refuse that has been deposited by the Sunnyside Coal Mine over the past decades and outlines the intended mining sequencing as SCA excavates the refuse usable as fuel for the adjacent power plant. The information used to create the mine sequencing plan comes from a study conducted by John T. Boyd Inc. and has been included in Appendix 9-1 of the permit as a reference.

**Temporary storage areas** are identified on Plate 5-1. These areas were approved by DOGM in 1993. They are adequately graded to provide surface drainage towards an approved diversion which flows to an approved sediment pond. These areas meet or exceed the permanent program performance standards.

**Refuse Haul Roads** are appropriately identified and classified on plates 5-2. They are graded and maintained to meet or exceed the permanent program performance standards. Transportation facilities are further discussed in Section 527. The south portion of the Old Coarse Refuse Haul Road, constructed by Sunnyside Mine in the 1970's, was reclaimed by SCA in 1994 (see Plates 10-2).
The **Crushing and Conveyance Structures** located at the north end of the permit area were constructed in 1992. The permit boundary was increased in 1994 to include these facilities. Plate 5-1 identifies the structures within the permit area as well as the adjacent cogeneration facility. A narrative description of the facilities is in Chapter Five. These facilities are maintained and operated to comply with the appropriate MSHA requirements and to meet or exceed the permanent program performance standards.

The **Excess Spoil Disposal Area #1** (MSHA # 1211-UT-09-02093-04) is currently under construction and will continue to be constructed throughout the life of the cogeneration facility. This area west of the Refuse Pile was identified in 1993, for permanent disposal of excess spoil and coal mine waste. The permanent disposal area will be constructed and maintained to meet the permanent program performance standards. Regular inspections will be conducted in accordance with R645-301-514.

Foundation studies conducted have determined that the area is appropriate for this permanent disposal facility within the constraints of its design. Surface water is diverted around the disposal area. This site is not a slurry cell and large quantities of wet waste are not disposed of in the pile. No existing seeps or water sources were identified, therefore, concerns about acid leachate were determined negligible. Under-drains were determined to be unnecessary. See Plates 9-1, Chapter nine, and Appendices 9-2, and 9-5 for design criteria.

The **Excess Spoil Disposal Area #2** is under construction in the northeast portion of the Permit Area. In essence, this small disposal area is designed to fill the two former slurry ponds and the Clearwater Pond with excess spoil and coal mine waste.

This permanent disposal area is proposed to be constructed and maintained to meet the permanent program performance standards. Regular inspections will be conducted in accordance with R645-301-514. See Plates 9-8, Chapter Nine and Appendix 9-7 for design criteria.

The temporary storage area west of the Pasture pond for **Non-Coal Waste** was identified in 1993. This area will be used as described in Chapter Nine for the temporary storage of non-coal waste until such time as the material can be disposed in an appropriate local landfill. The storage area will be maintained in accordance with the permanent program performance standards. The **Industrial Waste Dump**, utilized by the Sunnyside Mine since the 1970's, was closed and capped with 18 inches of clay material as described in Chapter nine. This former dump site is now used by SCA as Temporary Storage Area #2.

**Topsoil** was removed prior to all new surface disturbance and construction which commenced following enactment of laws requiring its protection. The topsoil is stored in stockpiles on the permit site. After the useful life of these areas from which the topsoil was removed, the topsoil will be used to reclaim the area in accordance with the reclamation plan. All topsoil piles on the SCA permit area are appropriately identified and protected. They have been revegetated for interim soil protection, and adequate berms are in place to contain eroded sediment from the piles as calculated in Appendix 7-7. They meet the permanent program performance standards. See plates 5-5 for cross-sections and volumes of the stockpiles.

The **Revegetation Test Plots** (Sacco Flats Test Plots), located in the north-east portion of the permit site, were constructed by the Sunnyside Mine in the Fall of 1985. The SCA permit boundary was enlarged in 1993 to include the entire plots. These test plots are maintained to meet the permanent program performance standards. Annual maintenance includes items such as fence repair and other items identified as necessary.
526.200 thru 526.222 Utility Installation and Support Facilities

The only utilities within the SCA Permit Area are power lines which are shown in Plate 5-1. These power lines are maintained by Utah Power and Light. All operations will be conducted in a manner which minimizes damage, destruction, or disruption of services provided by these UP&L electric lines.

Support facilities, of which there are currently none on-site, will be operated in accordance with a permit issued to SCA for the refuse disposal area. Plans and drawings for each support facility to be constructed, used, or maintained within the SCA Permit Area include a map, appropriate cross sections, design drawings, and specifications sufficient to demonstrate how each facility will comply with applicable performance standards. In addition to the other provisions of R645-301, support facilities will be located, maintained, and used in a manner that:

1. Prevents or controls erosion and siltation, water pollution, and damage to public or private property; and

2. To the extent possible using the best technology currently available - minimizes damage to fish, wildlife, and related environmental values; and minimizes additional contributions of suspended solids to stream flow or runoff outside the SCA Permit Area.

526.300 Water Pollution Control Facilities

The water pollution control facilities within the SCA Permit Area include sediment ponds and diversion ditches.

Sedimentation control ponds are used to store and/or treat water runoff from disturbed areas up to and including a 10-year, 24-hour event. Designs of the ponds and diversions are located in Appendix 7-3. Details (including design drawings and calculations) for all sediment control ponds and diversion ditches are included in Chapter Seven, Section 720.

All sediment ponds will be inspected as outlined for impoundments in Section 514.

Sediment removed from the ponds will be disposed of in the excess spoil area. If the material is to be used as a borrow material, the material will first be sampled and tested to verify its quality. Material to be reused as topsoil substitute must meet acceptable classifications according to the Table Two from the DOGM Guidelines for Management of Topsoil and Overburden and must comply with the Title V Coal Program Guideline for Disposal of Sedimentation Pond Waste, dated November 26, 1990. The operator will contact DOGM to receive approval of the location and the amount of material to be used. All impoundments meet or exceed the permanent program performance standards.

526.400 Air Pollution Control Facilities

SCA will continue its programs in the permit area to comply with the requirements of the Clean Air Act and other applicable air quality laws and regulations, as well as health and safety standards. A copy of the SCA Air Quality permit is included in Appendix 4-2.

Most of the region around the SCA Permit Area has been designated a Class II area for purposes of
determining any significant amounts of air quality deterioration. Deterioration of the air quality is not expected during the permit period with the exception of short high wind periods when sand and smaller grained particles are picked up outside of the SCA Permit Area and added to the air in the permit area.

The haul roads used by the refuse trucks are unpaved. To control fugitive dust, roads around the main complex which are being used by mobile equipment will be treated with calcium chloride, potassium chloride, or other acceptable biodegradable, organic wetting agents or sprayed with water as required during dry periods as required by SCA's Air Quality Permit.

NON-MINING RELATED ACTIVITIES

Terra-Tek, a drilling company, has been testing drill bits periodically since 1975 in an area in the western portion of the current SCA Permit Area. They generally drill to a maximum depth of about four feet. The area where drilling typically occurs is identified on Plate 5-1. Sunnyside Coal Company allowed Terra-Tek to conduct these non-mining related activities while the area was part of their permit. SCA will likely allow the drilling to continue until such time as it conflicts with the SCA operations. The Division was notified by letter dated March 17, 1993 of SCA's intentions regarding Terra-Tek.

527 TRANSPORTATION FACILITIES

The roads within the SCA Permit Area are shown on Plate 5-2. Also included on Plate 5-2 is a table showing widths, grades and lengths of each road within the SCA Permit Area. Plates 5-2 (C, D, G, H, J & K) AND 5-3 include typical cross-sections for the roads and plan and profiles of each road. All roads located within the Refuse Pile area are pit roads and will adjust as required throughout the operational period.

Roads within the SCA Permit Area will be maintained during the permit period. Maintenance will consist of basic custodial care to control erosion, repair of structures and drainage systems, removal of debris from culverts and ditches, and replacement of road surface material as needed. Additionally, all unpaved roads being used by mobile equipment and other unpaved operational areas will be water sprayed and/or chemically treated as necessary to reduce fugitive dust as required by SCA's Air Quality Permit.

In the event of a catastrophic event, roads will be repaired as soon as possible after the damage has occurred. Furthermore, there are no plans to alter any natural drainage way, or make alterations involving a steep cut slope.

Transportation facilities will be properly maintained and then restored at the end of the cogeneration plant life to prevent damage to fish, wildlife, and related environmental values, as well as to prevent additional contributions of suspended solids to stream flow or runoff outside the SCA Permit Area. Appendix 5-7 includes a description of each road and structural stability calculations for the roadway embankments. A few roads are identified in the reclamation plan to remain beyond reclamation to provide access through the permit area. Additional information on final reclamation of roads can be found in Chapter Ten. All transportation facilities meet or exceed the permanent program performance standards.

WASTE COAL HANDLING SYSTEM DESCRIPTION

The following sections discuss operations involving the use of the crushing facility. The crushing system utilizes the following units:
1. Waste coal receiving hopper (Truck Dump);
2. Transfer conveyors;
3. Primary and Secondary Crusher System;
4. Product Transfer/Stacking Conveyors/ Screen Station
5. Silo Storage/Transfer Conveyors; (Not in Permit Area)
6. Live-Storage Silos (Not in Permit Area).

The SCA Permit Area was enlarged to include the crushing units on May 16, 1994. The items 5 and 6 are not within the permit area. These facilities are associated only with the power plant operation and are not part of the mining process. The SCA crushing unit exists solely to appropriately size all material utilized in the SCA plant. This sizing is required regardless of the origination of the fuel. All material, whether it be run of mine ("ROM") coal or waste coal, will be run through the receiving hopper and crushed and sized accordingly.

It is anticipated that the SCA project may need to purchase six to seven thousand tons of ROM coal per year. This coal will typically be utilized when the waste fines have been frozen and are less accessible. There may be other circumstances when ROM coal will be utilized by the SCA facility.

Plate 5-1 shows the location of the crushing facility in relation to the SCA Permit Site. Material to be burned in the plant is run through the crushing and conveyor system and stored in the silos based on the B.T.U. values, etc. Then, material is fed from the silos through a conveyor system into the power plant and the boiler. The fluidized bed boiler requires material to be crushed to a certain specification. Therefore, it is important the SCA crushing unit size the material correctly.

The waste coal pile acquired in the early 1990’s represented approximately 23 years of fuel supply on the ground. Since the SCC mine ceased operations within a few years after SCA’s acquisition of the refuse area, SCA has obtained additional sources of material for its operation. This has included mixing ROM coal with its current waste coal supply and obtaining additional waste materials from other sites. All these materials must go through the crushing system that SCA has on site to meet boiler specifications for fuel.

It is important to know that no matter where material is obtained, whether it be from SCA’s DOGM permitted areas, ROM coal, or waste material from another site, this material is all directly fed into the waste coal receiving hopper and sized and crushed accordingly. SCA is not unique in this process. All coal fired power plants have crushing units on site to prepare fuel for boiler specifications.

The following paragraphs include a detailed description of the waste coal handling system for the SCA cogeneration facility.

The handling system provides for receiving Waste Coal from two independent sources, including screening the material according to size, with the oversize material being crushed to a 1/4" top size, and storage in segregated, enclosed silo systems, (1,800 tons total capacity), according to BTU content, (high or low), for reclamation in a proportioned blend by the plant operating system (provided by others).

The system also provides for: weighing incoming material as it is received, with printed record; removal of metals via electro-magnet, with backup metal detection of the final product; and, the ability to segregate crushed product into an open, dead-storage pile for emergency reclamation, if needed. Dust control features of the system include totally enclosed live-storage silos and transfer points, covered conveyor systems and a water-spray type dust suppression system at transfer points, as needed.
Waste Coal Receiving Hopper

Material from the Waste Coal piles will be received in an 100 ton capacity, ramped, drive-over Waste Coal Receiving Hopper designed with slope angles to ensure the flowability of wet, sticky coal.

The hopper slopes are lined with high molecular weight plastic sheeting ("slick sheet") to enhance flowability as well as to act as a replaceable wear surface. Air cannons are provided in the lower hopper walls to provide for flow activation for the fine pond material. The hopper is open, above grade, on one side to provide a "push-in slot" for receiving coal by dozer when needed.

Dust control is accomplished with a water-type suppression system to "fog" the hopper volume during unloading of dry gob materials.

Transfer Conveyors

Waste coal flows from the Waste Coal Receiving Hopper on a slow-speed, troughing conveyor (200 tph effective capacity) which feeds a transfer conveyor (250 tph effective capacity) that feeds the Primary Crusher. The Receiving Hopper conveyor belt is a heavy duty 3-ply belt to resist bruising and tears at this high impact point of loading.

A self-cleaning electro-magnet is mounted on the transfer conveyor to remove metals. A metal detector is mounted over the transfer conveyor downstream of the magnet as a protection element for the screening/crushing system. Additionally, a belt scale system (+ 1/4% accuracy) weighs all incoming material, with printed record.

Primary and Secondary Crushers

The Primary Crusher receives material from the transfer conveyor and sizes it to a nominal 1.5" size. Crushed material from the Primary Crusher is deposited on the next conveyor which then feeds the Secondary Crusher. Dust control for the Primary Crusher is a water-type suppression system.

The Secondary Crusher receives material from the Primary Crusher and sizes it to a nominal 1/4" size. A dust collection system is provided for the Secondary Crusher.

Product Transfer/Stacking Conveyors/Screen Station

Sized material from the Secondary Crusher flows onto a 36" Product Transfer conveyor (250 tph effective capacity) which transfers it to a 36" Radial Stacking Conveyor (250 tph effective capacity). The product is then conveyed either, to the Screen Station, to an open-pile for placement in dead storage, or to the Silo Storage Conveyor for transfer to the live-storage silos.

The single deck Screen Station separates the crushed product at 1/4". A 60" transfer conveyor takes the minus 1/4" product to the Transfer/Loader Hopper.

A 36" conveyor takes the plus 1/4" product from the screen to a temporary stockpile. This product is then transported to the Waste Coal Receiving Hopper (Truck Dump) to be reprocessed. A closed loop return conveyor transfers this material directly to be recrushed in the Secondary Crusher without the need for the temporary stockpile.

A 24" Transfer Conveyor and a 30" Radial Stacker transfer a portion of the screened product from the
Screen Station to an open pile for dead storage.

Dust Control for the Product Transfer and Stacking Conveyors and the Screen Station is a water-type suppression system and is applied as follows: immediately following the Secondary Crusher, at the transfer point between the 36" Product Transfer Conveyor and the 36" Radial Stacker, and at the outlet of the Screen Station.

The Transfer/Loader Hopper is mounted above the Silo Storage Conveyor. The Transfer/Loader Hopper is lined with slick sheet.

**Silo Storage/Transfer Conveyors**

The Silo Storage/Transfer Conveyors are located adjacent to the Permit Area and are associated with the power plant operation. The Silo Storage Conveyor is a stationary, troughing conveyor (250 tph effective capacity), which conveys product which has either been transferred directly from the Radial Stacking Conveyor, or reclaimed from the dead storage pile, to a transfer point on top of the first of three Live-Storage Silos.

Transfer points on top of each silo are semi-enclosed, with Y-gate chutes on the first two silos to direct the product into the silo, or onto the Silo Transfer Conveyors which connect to adjacent silos. The chute work is lined with slick sheet to enhance flowability.

**Live-Storage Silos**

The Live-Storage Silos are not located within the Permit Area. They are not associated with the mining operations. The three Live-Storage Silos are steel, totally enclosed cylindrical silos with cone hoppers (23,950 cubic feet total capacity each). Hopper angles are a minimum 60 degrees to ensure free flow of material during reclamation. A manually-operated, positive shut-off gate is included at the hopper outlet to provide for maintenance of adjacent mechanical equipment (to be provided by others).

Other silo features include bin level indicators and air-cannon flow activators. The silos are mounted with the outlets at the appropriate level, near grade, to provide for transfer of material by feeder systems onto the plant feed conveyor (to be provided by others).

528 HANDLING AND DISPOSAL OF COAL MINE WASTE

The applicability of Section 528 is related to handling of excess spoil and coal mine waste only. Details on the excavation of the coal mine waste can be found in Chapter Nine, Sections 9.6 through 9.7.

**Excess Spoil Disposal Areas**

Excess spoil will be placed in an Excess Spoil Disposal Area, designated on Plates 9-1A, 9-1B, 9-1C, and 9-1D or on Plates 9-8 A-D, in a controlled manner to ensure mass stability and prevent mass movement during and after construction. The disposal site will be designed and constructed to ensure that leachate and drainage from the area is controlled and does not degrade surface or underground water. Wastes will be routinely compacted and covered to prevent combustion and wind-borne waste. When the disposal is completed, a minimum of eighteen inches of soil cover will exist over the site and the site will be revegetated in accordance with the approved reclamation plan.
The Excess Spoil Disposal Areas will be inspected as required in Section 514.

Additional information concerning spoil disposal is outlined in Chapter Nine and Appendices 9-2, 9-5 and 9-7.

**Slurry Ponds**

Fine refuse from the SCC preparation plant was previously moved to dewatering or disposal areas by slurry transport in an open ditch. There were four slurry ponds within the SCA Permit Area: the West Slurry Cell, the East Slurry Cell, Slurry Pond One, and Slurry Pond Two. The East and West Slurry Cells were settling and evaporating impoundments that were constructed prior to or during 1974. Slurry Ponds One and Two were settling ponds. Presently, the SCC preparation plant is no longer in operation. Slurry Pond One and Slurry Pond Two have been filled in connection with Excess Spoil Area #2. The East Slurry Cell and the West Slurry Cell have been excavated to the point that they are no longer impoundments. The former slurry facilities have been incorporated within approved Excess Spoil Disposal Areas or Refuse Piles which are designed, maintained and inspected (addressing hydrology, structural stability and other operational conditions) in accordance with requirements for their current use (Appendix 5-2).

Subsidence will not affect the areas since the structures do not overlie the coal seam and are located several miles west of the nearest outcrop. Mud flows, rock debris falls or other landslides are not expected to be a problem because the embankments are located at or above the level of the surrounding topography. Possibility of failure downhill of the embankments is limited to a thin layer of colluvial material on bedrock. Failure of this material would not threaten the embankments.

**Coarse Refuse**

Detailed cross sections and grades for the Coarse Refuse Pile are shown in Plate 5-6. This plan shows the limits of the coarse refuse pile.

The coarse refuse disposal area is located on and is part of the west embankment of the former West and East Slurry Cells. The West Slurry Cell was constructed in the late 1950's to impound coal slurry from the Sunnyside mine's preparation plant. Coarse refuse material was added to the top and sides of the impoundment as the slurry level increased. The West Slurry Cell ceased being used as a settling pond in 1975 when the East Slurry Cell was built. Since that time, SCC continued to use the west embankment of the West Slurry Cell as the coarse refuse disposal area to stabilize the embankment and ultimately allow continued use of the West Slurry Cell.

The existing coarse refuse pile was built in lifts by leveling end dumped piles of material. The coarse refuse pile maintains a maximum 27 degree (2 horizontal:1 vertical) outslope and is terraced on 50-foot vertical increments. The terrace is a minimum 20-foot wide and is gently sloped to control surface water runoff and control erosion.

Geotechnical investigation of the West Slurry Cell embankments were conducted in 1984 and again in 1986. The 1984 work (Appendix 5-3) indicated that the West Slurry Cell embankment above the active coarse refuse disposal area was not stable with a static safety factor of 1.03. The study concluded that a safety factor of 1.46 would be obtained by maintaining maximum slopes of 2 (h) : 1 (v) and maintaining a moist compacted material density of 100 lbs per cubic foot. SCC continued stabilization of the west embankment by wheel compacting coarse refuse in lifts, maintaining 50-foot high benches at a maximum
2 (h) : 1 (v) slope, and establishing a minimum 20-foot terrace at every bench.

A 1986 report (Appendix 5-5) developed for a proposed coarse refuse pile expansion to the north of the existing coarse refuse pile, concluded a 2 (h) : 1 (v) slope between 50-foot high benches and terraces of 30-feet in width, while maintaining a moist compacted material density of 100 lbs per cubic foot provides an adequate factor of safety (greater than 1.5) under static conditions.

Cross-sections (shown in Plate 5-6) indicate the coarse refuse pile embankment maintained the slope and bench criteria established in the geotechnical investigations. Recent in-place density testing (Appendix 5-6) indicated moist compacted densities greater than 100 lbs per cubic foot as established in the geotechnical investigations.

The coarse refuse pile will be in a state of ongoing excavation throughout the permit period. A side view of the coal mine waste excavation is shown in Figure 5-1. Excess spoil material and coal mine waste not suitable as fuel will be separated from the combustible material going to the Cogeneration Plant; transported and placed in a controlled manner in horizontal lifts not exceeding four feet in thickness; concurrently compacted as necessary to ensure mass stability and to prevent mass movement during and after construction; graded so that surface and subsurface drainage is compatible with the natural surroundings; and covered with topsoil or substitute material if required. The Excess Spoil Disposal Areas are shown in Plates 9-1A, 9-1B, 9-1C, 9-1D, and 9-8 A-D.

All surface drainage from the area above the refuse pile will be diverted away from the fill into stabilized diversion channels designed to pass safely the runoff from a 100-year, 6-hour precipitation event. Calculations are found in Appendix 7-3.

The refuse pile will be inspected as outlined in Section 514.

Maintenance of the embankments will consist of filling and grading any erosion or other failure features discovered by the above inspections. Ditches on the terraces will be cleaned and graded as need warrants. Riprap in the drainage system will be repaired as needed.

Subsidence will not affect the refuse pile as the structure does not overlie the coal seam and is several miles west of the nearest outcrop. Mud flows, rock debris falls, or other landslides are not expected to be a problem. Possibility of failure near the sides and downhill of the refuse piles is limited to a thin layer of colluvial material on bedrock. Failure of this material would not threaten the refuse pile.

**Burning and Burned Waste Utilization**

Coal mine waste fires will be extinguished by covering the burning material with non-combustible material or by excavating burning or burned waste for surface extinguishing. Clean spoil available in the Excess Spoil Area or soil materials imported from off site may be used for fire suppression needs. Most areas of the refuse pile which are not within the active mining area have already been covered with non-combustible material to minimize the potential for coal mine waste fires. Therefore, it is not anticipated that significant quantities of materials will be needed for future fire suppression needs.

Only those persons authorized by the operator, and who have an understanding of the procedures to be used, will be involved in the extinguishing operations. No burning or burned coal mine waste will be removed from the permit disposal area without a removal plan approved by the Division. Consideration will be given to potential hazards to persons working or living in the vicinity of the structure.
Burned coal waste material encountered during excavation of the Coarse Refuse Pile will be disposed of in the Excess Spoil Pile.

**Industrial waste**

An industrial waste dump was located at the northeast end of the East Slurry Cell and the Refuse Pile in the refuse disposal area. The dump was constructed and used by excavating a trench, compacting the sides and bottom for a water barrier, and then covering the waste with a minimum of two feet of borrow material. It was closed as outlined in Chapter Nine.

**529 MANAGEMENT OF MINE OPENINGS**

**529.100 thru 529.400 Mine Openings**

There are presently no mine openings within the SCA Permit Area, nor are there expected to be in the future. Thus, the discussion of sealing or management of mine openings is not applicable and is not discussed in further detail.
530 OPERATIONAL DESIGN CRITERIA AND PLANS

531 GENERAL

The following sections include general plans for each sediment pond, water impoundment, coal processing waste bank, dam, and embankment within the SCA Permit Area. The SCA Permit Area is not threatened by subsidence of subsurface strata, therefore, the plans will not include discussions of this nature.

532 SEDIMENT CONTROL

The hydrologic design calculations for the sediment ponds are included in Appendix 7-3. These calculations outline the criteria, assumptions, and parameters used in order to design a structure that would be adequate to control sedimentation. Details are discussed in Chapter Seven, Hydrology, Section 740.

There is a system of collector ditches throughout the SCA Permit Area to collect runoff from roads and disturbed areas. These flow into sediment ponds that are located throughout the permit area. These ponds outfall into Icelander Creek tributaries, if they fill to their decant drains. The discharges are subject to the UPDES permit limitations discussed in Chapter Seven, Hydrology.

The permitted operations in the SCA Permit Area include excavations of the refuse piles, crushing the refuse and transportation of the refuse to the neighboring power plant site. The probable hydrologic impacts are expected to change very little with the inclusion of the excavation activities. The disturbance of the refuse piles caused by the excavation may increase sediment yield from these areas. The control of the extra sediment is discussed in Chapter Seven, Hydrology, Section 730.

533 IMPOUNDMENTS

See Sections 514 and 528.

534 ROADS

534.100 thru 534.340 Road Requirements

A maintenance plan for all unpaved roads is outlined below and is in accordance with requirements of both DOGM and the Division of Environmental Health. In the event that existing roads are retained under an approved post-mining land use, maintenance will continue as outlined in this section and section 527. The only post-mining land use plans for some existing roads within the SCA Permit Area are to allow occasional access to existing easements through the Permit area. These roads are identified on the Reclamation Plans.
All unpaved roads and other unpaved operational areas which are used by mobile equipment will be water sprayed and/or chemically treated to reduce fugitive dust as required by SCA's Air Quality Permit. A copy of SCA's Air Quality Permit is located in Appendix 4-2.

535 SPOIL

The disposal of spoil material is outlined in Chapter Nine.

536 COAL MINE WASTE

536.100 thru 536.900 Coal Mine Waste Disposal

See Section 528 and Chapter Nine, Sections 9.6 and 9.7.

540 RECLAMATION PLAN

541 GENERAL

See Chapter Nine, Mining Plan for details on contemporaneous reclamation. Chapter Ten, Reclamation Plan includes details on final reclamation. Reclamation cost estimates are detailed in Chapter Eight, Bonding.

542.400 Abandonment

Before abandonment of the SCA Permit Area or before seeking final bond release, SCA will ensure that all temporary structures were removed or reclaimed and that permanent structures have been maintained properly and meet the requirements of the reclamation plan.

542.500 Sediment Ponds and Ditches

All sediment ponds, mine water discharge ponds, and ditches no longer needed when the reclamation of the disturbed areas is completed will be re-contoured and revegetated.

542.600 Roads, Culverts, and Bridges

All roads not needed to provide access to the easements crossing the Permit Area, and associated structures will be reclaimed. The culverts will be dug up, removed, and disposed in an approved landfill or otherwise abandoned by filling the culvert to reduce the potential of piping. The roads and their ditches will be ripped, contoured and revegetated.
542.700 Final Abandonment of Disposal Area

Following the excavation of the coal mine waste the remaining material will be regraded to approximately re-establish the surface contours that existed before mining operation disturbances. Revegetation efforts will be initiated following the excavation and regrading activities. See Chapter Nine, Mining Plan for details on contemporaneous reclamation. Chapter Ten, Reclamation Plan includes details on final reclamation.

550 RECLAMATION DESIGN CRITERIA AND PLANS

Approximately 75 percent of the disturbed portions of the SCA Permit site was originally disturbed prior to the current reclamation laws. Plate 5-7 identifies the previously-mined areas.

See Chapter Nine for contemporaneous reclamation details. See Chapter Ten for final reclamation details.

560 PERFORMANCE STANDARDS

Coal mining operations will be conducted in accordance with this permit as approved and with the performance standards of the permanent program.

Primary Roads

- Graded to a minimum side slope of 2%.
- Minimum six-inch cut ditch to collect drainage.
- Dust control techniques actively applied on roads being used by mobile equipment as needed to meet the requirements of the approved Air Quality Permit issued by UDEQ.

Ancillary Roads

- Graded and maintained to adequately serve the purpose of providing access as needed.

Sediment Ponds

- Operated and maintained to protect against any discharge which exceeds the limits set by the approved UPDES Permit issued by UDEQ.
- Periodically monitored, and sampled if needed, as required by the UPDES Permit.
- Sediment level will not reach an elevation higher than the inlet to the decant drain pipe.
- Sized adequate to contain and/or treat the 10-year, 24-hour precipitation event.
- Side slopes not steeper than 2H:1V.
- Spillway adequately clean and clear from sediments or debris to allow safe discharge of the 25-year, 6-hour precipitation event.

Topsoil Storage
Adequate berm maintained to contain and/or treat runoff from the 10-year, 24-hour precipitation event.
- Cross-sectional storage area between the berm and the stockpile not less than the minimum required in Appendix 7-7.
- Rills and/or gullies deeper than 9-inches will be filled, graded, or otherwise stabilized.

Siltation Fences
- Filter fabric embedded into the ground at least 6-inches.
- Fence post embedded adequately to provide stability.
- Fencing material adequately attached to the filter fabric and to the fence posts to provide support to the fabric.

Straw Bales for Sediment Control
- Adequately installed and maintained to direct runoff through the bale rather than allowing flows around or under the bale.
- Deteriorated bales shall be replaced or supplemented with an additional bale if the area being treated still requires additional sediment control.

Diversions/Culverts
- Side slopes no steeper than 2H:1V.
- Of adequate cross-section to safely pass the design storm without overtopping the banks or floodplain.
- If extensive erosion or siltation occurs which inhibits the diversion or culvert from passing the design storm or which contributes excessive sediment to the receiving storm, maintenance will be provided. This maintenance may include excavating or shaping the diversion to line, grade and cross-section to meet the design criteria specified in Chapter 7.
FIGURE 5-1
SIDE VIEW OF COAL MINE WASTE EXCAVATION
Side View of Coal Mine Waste Excavation

Flagged Area From Fuel Plan

Working Faces

Boundary Cone

Layers From Fuel Plan

Eckhoff, Watson and Preator Engineering

Original Drawing By Salvage Construction
Redrawn By EWP Engineering, July 8, 1992
TABLE 5-1
INSPECTION SCHEDULE FOR THE EXCESS SPOIL DISPOSAL AREAS, REFUSE PILE AND ALL IMPOUNDMENTS
TABLE 5-1
INSPECTION SCHEDULE FOR THE EXCESS SPOIL DISPOSAL AREAS, REFUSE PILE AND ALL IMPOUNDMENTS

<table>
<thead>
<tr>
<th>AREA TO INSPECT</th>
<th>ACTION REQ'D</th>
<th>FREQUENCY</th>
<th>REGULATION #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Spoil Disposal Area #1</td>
<td>1</td>
<td>Quarterly</td>
<td>R645-301-514.110 30 CFR 77.216</td>
</tr>
<tr>
<td>(Noncombustible Waste Site)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess Spoil Disposal Area #2</td>
<td>1</td>
<td>Quarterly</td>
<td>R645-301-514.110</td>
</tr>
<tr>
<td>Refuse Pile</td>
<td>1</td>
<td>Quarterly</td>
<td>R645-301-514.220</td>
</tr>
<tr>
<td>Pasture Pond</td>
<td>2</td>
<td>Quarterly</td>
<td>R645-301-514.330</td>
</tr>
<tr>
<td>Coal Pile Sediment Pond</td>
<td>2</td>
<td>Quarterly</td>
<td>R645-301-514.330</td>
</tr>
<tr>
<td>Old Coarse Refuse Road Pond</td>
<td>2</td>
<td>Quarterly</td>
<td>R645-301-514.330</td>
</tr>
<tr>
<td>Coarse Refuse Toe Pond</td>
<td>2</td>
<td>Quarterly</td>
<td>R645-301-514.330</td>
</tr>
<tr>
<td>Rail Cut Pond</td>
<td>2</td>
<td>Quarterly</td>
<td>R645-301-514.330</td>
</tr>
<tr>
<td>Borrow Area Pond</td>
<td>2</td>
<td>Quarterly</td>
<td>R645-301-514.330</td>
</tr>
</tbody>
</table>

1. Inspect for appearance of instability, structural weakness, and other hazardous conditions.
   NOTE: These inspections will be performed during critical construction periods such as: foundation preparation, placement of underdrains and protective filter systems, installation of final surface drainage systems, and the final graded and revegetated facility.
2. Inspect for appearance of instability, structural weakness, and other hazardous conditions, depth and elevation of any impounded waters, existing storage capacity, any existing or required monitoring procedures and instrumentation and any other aspects of the structure affecting stability.
3. Describe any changes in the geometry of the impounding structure; instrumentation; average and maximum depths and elevations of the impounded water, sediment or slurry impounded; and any other aspect of the impounding structure affecting its stability.
4. Annual reports will be submitted to the MSHA district manager.
5. Impoundments meeting the criteria specified on 30 CFR 77.216 shall comply with the MSHA-Approved Program for Impoundment Inspections (PAP Appendix 5-8).
APPENDIX 5-1
SLOPE STABILITY ANALYSIS OF SEDIMENTATION PONDS
Appendix 5-1

Slope Stability Analysis of the Railcut, Pasture and Borrow Area Ponds

November 1992
Slope Stability Calculations

The purpose of this appendix is to show, with sample calculations, drawings, and existing data, that the stability of the existing ponds is adequate. The existing slope stability reports written by Rollins, Brown and Gunnel, Inc. (RBG) have been used to verify the stability of the slopes within the SCA Permit Area. EWP is using the data from these reports to verify slope stability for the Railcut, Pasture, and Borrow Area Ponds.

Within RBG's 1984 and 1985 slope stability reports, there are analyses of the East and West Slurry Cells, Slurry Pond #1, Slurry Pond #2, the Clear Water Pond, the Coarse Refuse Road Sediment Pond, and the Coarse Refuse Toe Sediment Pond. All of the above mentioned ponds have been determined to be stable under existing conditions.

The only ponds that were not previously analyzed are the Railcut, Pasture, and Borrow Area Ponds. Due to the lack of up-to-date information concerning the condition of these remaining ponds, EWP was forced to rely on past data to perform analyses of these ponds. In order to analyze these ponds, certain assumptions were made. These assumptions are as follows:

1. The soil within the Railcut Sediment Pond, Pasture Sediment Pond, and the Borrow Area Pond is the same soil type that exists within the Coarse Refuse Toe Pond. As stated in the August, 1985 report concerning the Coarse Refuse Toe Pond, "Standard penetration tests performed in the gravelly material in the lower portion of the soil profile at this site indicate that the gravelly material is in a medium-dense state. The granular material generally classifies as an SM or as a GM type material according to the Unified Soil Classification System." "...It will be noted that the subsurface materials within the embankment generally classify as a CL-1 or as a CL-2 material."

2. The soil that exists within the Railcut Sediment Pond, Pasture Sediment Pond and the Borrow Area Pond has the same cohesive strength as the soil within the Coarse Refuse Toe Pond. From RBG's 1985 report, a cohesive strength of 150 pounds per square foot was used for the Coarse Refuse Toe Pond.

3. The maximum dry density for the Railcut Sediment Pond, Pasture Sediment Pond, and the Borrow Area Pond is the same as the maximum dry density of the Coarse Refuse Toe Sediment Pond. The maximum dry density of the Coarse Refuse Toe Sediment Pond was found to be 109.0 pounds per cubic foot.

4. The friction angle of the ponds in question are the same as the friction angle of the Coarse Refuse Toe Sediment Pond. As stated in the 1986 Soil Stability Report by RBG, "...the friction angle of the material ranged from 27.9 to 32.6 degrees...". EWP has used a value of 29° to be conservative.

Methods outlined in Hoek and Bray's, *Rock Slope Engineering*, are used for the analyses of the remaining ponds. The methodology relies on specific geometric and soil characteristics of the ponds. EWP is aware of the possibility of error and inaccuracy of relying on past data and broad assumptions, but at this time, it is impossible to obtain current information. It should be taken into...
consideration that the ponds being analyzed for the purposes of this report do not meet the criteria of 30 CFR 77.216-1 and 30 CFR 77.216-2. These ponds have been in place for many years and have not experienced any slope stability problems to-date.

The following data has been obtained based on the assumptions mentioned above. Cross sections for the Railcut Pond, Pasture Pond, and the Borrow Area Pond are shown on Plates 7-8b, 7-9 and 7-12a respectively. Ponds that have been analyzed previously are listed following the analyses and are referenced to existing slope stability analyses.

**Railcut Sediment Pond**

The Railcut Pond is located near the southwest corner of the SCA Permit Boundary. It is approximately 0.86 acres and has a capacity of 15.01 ac-ft. The factor of safety for the Railcut Pond was found using the assumptions listed above and geometry of the existing pond.

<table>
<thead>
<tr>
<th>RAILCUT SEDIMENT POND PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height</strong></td>
</tr>
<tr>
<td><strong>Slope Angle</strong></td>
</tr>
<tr>
<td><strong>Density</strong></td>
</tr>
<tr>
<td><strong>Cohesive Strength</strong></td>
</tr>
<tr>
<td><strong>Friction Angle</strong></td>
</tr>
</tbody>
</table>

The groundwater conditions around the Railcut Pond's upstream face indicate that Chart No.3 from Hoek and Bray's *Rock Slope Engineering* should be used for the analysis. Using the data from the table above, the following equation was calculated.

\[
EQ. (1) \quad \frac{c}{\gamma H \tan \phi} = \frac{150 \text{lb/ft}^2}{(109 \text{lb/ft}^3)(1 \text{ft})(\tan 29^\circ)} = 0.25
\]

where:  
\(c\) = cohesive strength  
\(H\) = Height  
\(\gamma\) = density  
\(\phi\) = friction angle

Once a value for this equation was determined, a factor of safety could be obtained. From Chart No. 3, the value for the following equation was determined.
where: $F = \text{factor of safety}$

$$EQ. \ (2) \quad \frac{Tan29^\circ}{F} = 0.26$$

The corresponding value of $F$ is 2.1. This factor of safety meets the requirements of DOGM and shows adequate slope stability.

**Pasture Sediment Pond**

The Pasture Sediment Pond is located just north of the West Slurry Cell. It is approximately 0.13 acres and has a capacity of 0.78 ac-ft. The factor of safety for the Pasture Sediment Pond was found using the assumptions listed above and geometry of the existing pond to determine the height and slope angle of the pond.

<table>
<thead>
<tr>
<th>PASTURE SEDIMENT POND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
</tr>
<tr>
<td>Slope Angle</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Cohesive Strength</td>
</tr>
<tr>
<td>Friction Angle</td>
</tr>
</tbody>
</table>

The groundwater conditions around the Pasture Pond indicate that Chart No. 2, from Hoek and Bray's *Rock Slope Engineering*, should be used for the analysis. This chart is included with this appendix as Chart No.2. Using the data from the table above, the following equation was calculated.

$$EQ. \ (1) \quad \frac{c}{\gamma HTan\phi} = \frac{150 \text{lb/ft}^2}{(109 \text{lb/ft}^2)(5 \text{feet})(Tan29^\circ)} = 0.50$$

where: $c = \text{cohesive strength}$  
$H = \text{Height}$  
$\gamma = \text{density}$  
$\phi = \text{friction angle}$

Using the value of 0.50 from above and a slope angle of 2°, a value for the following equation was determined from Chart No 2.

Thus, the corresponding safety factor for the Pasture Pond is 11.1. This factor of safety meets the
where: \( F = \text{factor of safety} \)

The corresponding factor of safety is 11 plus or minus, which meets the standards of DOGM and shows adequate slope stability.

**Borrow Area Pond**

The Borrow Area Pond is located near the southeast corner of the SCA Permit Boundary. It is approximately 0.87 acres and has a capacity of 4.59 ac-ft. The safety factor for the Borrow Area Pond was determined by using assumptions listed at the beginning of this report and by relying on design drawings supplied by Sunnyside Coal Company (SCC). The following table is an outline of the slope stability parameters that have been used for the purposes of this analysis.

<table>
<thead>
<tr>
<th>BORROW AREA POND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
</tr>
<tr>
<td>Slope Angle</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Cohesive Strength</td>
</tr>
<tr>
<td>Friction Angle</td>
</tr>
</tbody>
</table>

The groundwater conditions indicate that Chart No. 3 shall be used for determining the safety factor for the Borrow Area Pond. Using Chart No. 3 and the following equation, a safety factor could be determined.

\[
EQ. \ (1) \quad \frac{c}{\gamma HTan\phi} = \frac{150lb/ft^2}{(109lb/ft^3)(22.6feet)(Tan29°)} = 0.11
\]

Using the value of 0.11, a slope angle of 20°, and Chart No. 3, the factor of safety was obtained using the following equation:

\[
EQ. \ (2) \quad \frac{Tan29°}{F} = 0.36
\]

where: \( F = \text{factor of safety} \)

The factor of safety was found to be 1.54 which shows adequate slope stability.
As stated previously, the margin for error by using broad assumptions and past data can be large. EWP realizes this and as a result has used conservative quantities when analyzing the three ponds outlined above. Also, it is important to restate the fact that these ponds have been in place for many years and have not posed any slope stability problems to-date. The ponds not analyzed in this report have been analyzed previously and are referenced below. All of the ponds listed below have been determined to be stable, therefore, no additional analyses have been performed.

<table>
<thead>
<tr>
<th>PONDS</th>
<th>REFERENCE</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Refuse Road Sediment Pond</td>
<td>1985 Slope Stability Analysis by Rollins, Brown and Gunnell, Inc.</td>
<td>Appendix 5-4 Page 5-6</td>
</tr>
<tr>
<td>Slurry Pond #1</td>
<td>1984 Slope Stability Analysis by Rollins, Brown and Gunnell, Inc.</td>
<td>Appendix 5-3 Page 5</td>
</tr>
<tr>
<td>Slurry Pond #2</td>
<td>1984 Slope Stability Analysis by Rollins, Brown and Gunnell, Inc.</td>
<td>Appendix 5-3 Page 5</td>
</tr>
<tr>
<td>Clear Water Pond</td>
<td>1984 Slope Stability Analysis by Rollins, Brown and Gunnell, Inc.</td>
<td>Appendix 5-3 Page 5</td>
</tr>
<tr>
<td>East Slurry Cell</td>
<td>1984 Slope Stability Analysis by Rollins, Brown and Gunnell, Inc.</td>
<td>Appendix 5-3 Page 4</td>
</tr>
<tr>
<td>West Slurry Cell</td>
<td>1984 Slope Stability Analysis by Rollins, Brown and Gunnell, Inc.</td>
<td>Appendix 5-3 Page 4-5</td>
</tr>
</tbody>
</table>
Coal Pile Sediment Pond

The Coal Pile Sediment Pond is located at the north end of the permit area, west of the Access Road (see Plate 7-1A). It covers approximately 0.3 acres and has a capacity of approximately 1.5 acre-ft. The slope stability safety factor for the Coal Pile Sediment Pond was determined by using the same assumptions as were used for the Railcut, Pasture and Borrow Area Ponds. These assumptions are listed and explained at the beginning of Appendix 5-1. The following table is summarizes the slope stability parameters that have been used for the purposes of this analysis.

<table>
<thead>
<tr>
<th>COAL PILE SEDIMENT POND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (H)</td>
</tr>
<tr>
<td>Slope Angle</td>
</tr>
<tr>
<td>Density (γ)</td>
</tr>
<tr>
<td>Cohesive Strength (c)</td>
</tr>
<tr>
<td>Friction Angle (ϕ)</td>
</tr>
</tbody>
</table>

The groundwater conditions around the Coal Pile Sediment Pond indicate that Chart No. 3 shall be used for determining the safety factor for the Borrow Area Pond. Using Chart No. 3 and the following equation, a safety factor could be determined.

EQ. (1) \[
\frac{c}{\gamma HT \tan \phi} = \frac{150 \text{ lb/ft}^2}{(109 \text{ lbs/ft}^3)(14 \text{ ft})(\tan 32°)} = 0.16
\]

Using the value of 0.16, a slope angle of 32°, and Chart No. 3, the factor of safety (F) was obtained using the following equation:

EQ. (2) \[
\frac{\tan \phi}{F} = 0.37 \quad \text{The Factor of Safety (F) is therefore} \quad \frac{\tan 29°}{0.37} = 1.5
\]

A factor of safety of 1.5 meets the regulatory requirements for stability.
APPENDIX 5-2
GEOTECHNICAL INVESTIGATIONS OF SLURRY IMPOUNDMENTS
(DAMES AND MOORE)
REPORT OF MATERIAL AND STABILITY INVESTIGATION
COAL REFUSE DISPOSAL AREA
SUNNYSIDE, UTAH
FOR KAISER STEEL COMPANY

Dames & Moore Job No. 2074-010-06
REPORT OF MATERIAL AND STABILITY INVESTIGATION
COAL REFUSE DISPOSAL AREA
SUNNYSIDE, UTAH
FOR KAISER STEEL COMPANY

INTRODUCTION

This report presents the results of our slope stability studies performed on the existing coal slurry pond embankment at Kaiser Steel Company's Sunnyside Mine. The general location of the site with respect to nearby towns and roads is shown on Plate 1, Vicinity Map.

PURPOSE AND SCOPE

The purpose and scope of this study were developed through discussions between Mr. Harold Linke of Templeton-Linke & Alsup and Mr. George Toland of Dames & Moore. A detailed description of the purpose and scope of this study is outlined in our proposal dated January 30, 1973. The scope of work outlined in this proposal was later revised during subsequent discussions between the aforementioned men.

The purpose of these studies is to define the characteristics of the material in the disposal area, to evaluate the present stability of the embankment and to recommend modifications, if necessary, to the present system which would insure its continued stability. To accomplish this purpose, the following scope of work was performed:

1. Discussions with Kaiser Steel Company personnel familiar with the construction of the slurry pond embankment and the materials used for construction.
2. A field investigation program which included the drilling, logging and sampling of one boring to a depth of 121 feet and visual inspection of the slurry pond facility.

3. Laboratory testing to define the pertinent engineering characteristics of the waste material.

4. Engineering analyses to evaluate the stability of the present embankment and the necessity of remedial measures to improve the embankment stability.

5. Preparation of this written report, which includes a plot plan, description of the site conditions, summary of field explorations and laboratory test data, description of engineering analyses, and stability recommendations.

SITE CONDITIONS

SURFICIAL FEATURES:

The coal slurry pond is located at the head of a steep, narrow valley which is situated approximately one-half mile south of Sunnyside, Utah. Because of the steepness of this valley, the depth of waste material varies considerably across the pond. This depth ranges from a maximum of approximately 280 feet near the southwest portion of the pond to only a few tens of feet on the eastern and northern extremities of the pond.

In plan dimensions, the level portion of the pond contains about 25 acres. The pond is contained by 15- to 20-foot-high dikes which are constructed of broken coal. In the deepest portion the dike extends in a relatively smooth slope the entire 280 vertical feet. The inclination of the
dike at this location, which is the slope stability study area, is slightly over 37 degrees from horizontal.

In the vicinity of the high slope, Mr. John Beck of Templeton-Linke & Alsup supervised the construction of a ramp which extends approximately 200 feet into the pond. This ramp was constructed to provide access to the pond for drilling since the coal slurry materials would not support drilling equipment. The location of the ramp, exploration boring and high slope are shown on Plate 2, Plot Plan.

We understand that present planning calls for the development of a new waste disposal area in the immediate future. Therefore, little more waste will be discharged into the subject site.

**SUBSURFACE CONDITIONS:**

Because of the access ramp, we encountered four feet of loose, black, fine to coarse sand and gravel-sized coal waste material at the surface. This material is underlain by very soft, black, silt-sized coal tailings with sand and gravel-sized coal fragments in lenticular layers. These silt-sized coal tailings are similar to the material which covers all of the slurry pond with the exception of the perimeter dikes which are constructed from the same material as the ramp. At our boring location the silt-sized coal tailings are approximately 7-1/2 feet thick and are underlain by very loose, black, fine to medium, sand-sized coal tailings with occasional layers of silt-sized coal tailings. With depth, the silty layers grade less frequent. At a depth of 31 feet, loose, black, fine to coarse sand and gravel-sized coal waste material was encountered. This gravel-sized material continues to at least a depth of 121 feet, which is the maximum.
depth of our exploration boring. Based on discussions with Kaiser Steel Company personnel and our observations, we believe this same material extends to the canyon bottom. The characteristics of this material are very uniform except for occasional six-inch to two-foot-thick layers where sandstone gravel, cobbles and boulders were encountered. These sandstone materials probably came from borrow pits located near the site and were used to cover areas of the waste dump which began burning spontaneously. The sandstone material was encountered at depths of 38.5 to 40.5 feet, 48.0 to 49.0 feet, 68.0 to 69.0 feet, and 73.0 to 73.5 feet.

Two forms of deposition have been used in the waste disposal area. The silt and sand-sized materials encountered near the top of the boring have been placed hydraulically. In contrast, the gravel-sized material which forms the bulk of the waste dump was placed with dump trucks. Although both forms of deposition are currently being used at the site, the hydraulic transportation of silt and sand-sized materials has only been used recently, whereas the dump truck haulage has been used since the beginning of the coal waste dump. This accounts for the fact that only 30 feet, more or less, of slurry is located on the surface and the rest of the waste consists of sand and gravel-sized coal fragments.

GROUND WATER:

Except for the water which is located on the surface of the coal slurry pond and saturates the upper few feet of tailings, the rest of the coal waste dump is not saturated. The ground water level at the site probably corresponds closely to the contact between the waste coal and canyon bottom.
There is no evidence of seepage through the perimeter dikes or the high slope. The only visible seepage occurs where the toe of the high slope intersects the bottom of the canyon. At this location several gallons per minute of water was flowing during our field explorations. Most of this water undoubtedly comes from the coal slurry although some may be from natural drainage. Apparently, the slurry transport water percolates through the fine-grained tailings and runs through the sand and gravel-sized material without forming any type of water table due to the very high permeability of these latter materials.

**DISCUSSIONS AND RECOMMENDATIONS**

**GENERAL:**

The results of our stability analyses indicate that the coal slurry pond embankment is stable under the present conditions and that it should remain stable after the pond is no longer in use. These analyses were performed for both a static condition and dynamic loading condition which simulate earthquake forces. Detailed discussions regarding the seismicity of the locality, the method of slope stability analysis, the results of the slope stability analyses and recommendations based on the results of our study are discussed in detail in the following paragraphs.

**SEISMICITY OF LOCALITY:**

The Sunnyside area has had a history of earthquakes. Records of earthquakes go back as far as 1850 and from that date to the present, at least 12 seismic events of Richter Magnitude 4.0 to 4.9 have been recorded near Sunnyside. In addition to these moderate events, many smaller seismic events have also occurred and have been published through 1965 by the
Seismological Society of America. Earthquakes which have occurred since 1965 are published annually in the May issue of the "Quarterly Review" prepared by the Utah Geological and Mineralogical Survey.

It is commonly believed that most of the earthquakes recorded in and around Sunnyside, Utah are caused by rock bursts in the underground coal mines. This explanation would at least partially explain the concentration of earthquake epicenters in the immediate vicinity of Sunnyside, Utah. Because of this concentration, we have assumed in our analyses that the coal waste embankment could be subjected to an earthquake whose epicenter is at the dam site.

Based on correlation charts prepared by the U. S. Geological Survey and our past experience with similar seismic situations, we have estimated that the maximum probable ground acceleration at the embankment would be 0.05 times gravity. This factor was used in our stability analyses. However, to investigate the result of a more serious earthquake, we also evaluated the slope using an earthquake factor of 0.10 times gravity. The effects that these earthquake coefficients have on the stability calculations are discussed in a later paragraph.


METHOD OF SLOPE STABILITY ANALYSIS:

Because of the relatively homogeneous and soil-like characteristics of the gravel-sized broken coal fragments which constitute the coal slurry pond embankment, we analyzed the slope stability using the Fellenius Method of Slices. This is one of many limiting equilibrium methods of calculating the stability of a soil slope in which the failure surface is assumed to occur along a circular arc. The degree of stability is calculated by dividing the summation of resisting forces (cohesion and friction developed along the failure arc) by the summation of driving forces (total tangential components along the failure arc).

To aid in performing the stability calculations which are tedious and time-consuming, a Dames & Moore computer program and computer facilities were used. The computer program provides the flexibility of investigating the entire slope to determine the location of the most critical failure surface in the slope, that is, the failure surface with the lowest factor of safety. In addition, it provides the factor of safety calculation with a much higher degree of accuracy than would be feasible by hand calculation.

RESULTS OF STABILITY ANALYSES:

A graphical representation of the slope geometry and soil parameters used in our stability analyses is presented on Plate 3, Stability Analyses. This plate also shows the failure surface which was determined by the computer to have the lowest factor of safety of any in the slope. As shown on the right side of this plate, three minimum factor of safety were determined. These factor of safety each represent the same slope geometry and soil conditions; however, each one is for a different earthquake coefficient.
The data clearly shows, as would be expected, that the most stable slope condition is the static condition and the least stable slope condition is the situation which would occur with an earthquake induced acceleration equal to 10 percent of gravity. The stability data are summarized in the following table:

<table>
<thead>
<tr>
<th>Analysis No.</th>
<th>Earthquake Coefficient (In Percent Of Gravity)</th>
<th>Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1.622</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>1.479</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>1.353</td>
</tr>
</tbody>
</table>

For structures such as the coal slurry pond embankment which we are analyzing, a factor of safety of 1.25 for static conditions and of 1.0 for the worst probable earthquake condition is generally considered satisfactory. Therefore, the results of our stability analyses indicate that even with an earthquake greater than has ever been recorded in the vicinity of the site, the embankment is stable.

**RECOMMENDATIONS:**

Because of the apparent stability of the subject embankment as evidenced by both our stability calculations and the past performance of the embankment through several earthquakes, it is our opinion that no remedial measures are required to either insure or improve the stability of the embankment. Although present planning calls for discontinued use of this pond as a disposal area for the near future, we believe, based on our stability analyses, that it is not necessary to curtail further use of this area for stability reasons at this time.
The following plates and appendix are attached and complete this report:

Plate 1 - Vicinity Map
Plate 2 - Plot Plan
Plate 3 - Stability Analyses
Appendix - Field Explorations and Laboratory Tests.

Respectfully submitted,

DAMES & MOORE

George C. Toland
Consulting Partner
Professional Engineer No. 2311
State of Utah

GCT/REV: ab

Attachments
REFERENCE
PRINT TITLED, "KAISER STEEL CORP. —
COAL SLURRY POND — SUNNY SIDE, UTAH",
BY TEMPLETON, LINKE & ALSUP, CONSULTING
ENGINEERS, SALT LAKE CITY, UTAH.

PLOT PLAN

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APPENDIX

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS:

The subsurface soil and ground water conditions at the site were explored by drilling an exploration boring in the deeper portion of the waste dump. The boring was 121 feet in depth and was drilled with a truck-mounted rotary wash drilling rig. Relatively undisturbed samples of the soils encountered were obtained with a Dames & Moore soil sampler as shown on Plate A-3, Soil Sampler Type U.

The field exploration program was conducted and supervised by an experienced soils engineer from our staff. The materials encountered were classified by visual and textural examination in the field. These classifications were later supplemented by inspection and testing in our laboratory. A complete log was maintained in the field of the test boring. Graphical representation of the soils encountered in the test boring is shown on Plate A-1, Log of Boring. The nomenclature used to describe the soil types appears on Plate A-2, Unified Soil Classification System.

LABORATORY TESTING:

Two types of laboratory tests, moisture and density determinations and direct shear tests, were performed to determine the engineering parameters necessary to calculate the stability of the existing coal slurry pond embankment.

The moisture and density determinations were performed to aid in classifying the soils and to help correlate the direct shear test data. The moisture and density test data are presented on the left side of the boring log on Plate A-1.
The shear strength parameters of the waste materials were determined by performing direct shear tests on representative, relatively undisturbed samples. The tests were performed at in-situ moisture content and confining pressures which simulate the existing conditions in the embankment. The procedure used for testing is described on Plate A-4, Method of Performing Direct Shear and Friction Tests.

The results of the direct shear tests are shown in tabular form below:

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth In Feet</th>
<th>Soil Type</th>
<th>Confining Pressure In PSF</th>
<th>Peak Shearing Strength in PSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.5</td>
<td>SP</td>
<td>500</td>
<td>1,200</td>
</tr>
<tr>
<td>1</td>
<td>16.5</td>
<td>SP</td>
<td>3,000</td>
<td>2,975</td>
</tr>
<tr>
<td>1</td>
<td>20.0</td>
<td>SP</td>
<td>1,000</td>
<td>1,450</td>
</tr>
<tr>
<td>1</td>
<td>20.0</td>
<td>SP</td>
<td>4,000</td>
<td>2,800</td>
</tr>
<tr>
<td>1</td>
<td>25.5</td>
<td>SP</td>
<td>2,000</td>
<td>2,475</td>
</tr>
<tr>
<td>1</td>
<td>25.5</td>
<td>SP</td>
<td>5,000</td>
<td>4,400</td>
</tr>
<tr>
<td>1</td>
<td>45.5</td>
<td>GP</td>
<td>500</td>
<td>2,500</td>
</tr>
<tr>
<td>1</td>
<td>60.5</td>
<td>GP</td>
<td>1,000</td>
<td>4,575</td>
</tr>
<tr>
<td>1</td>
<td>70.5</td>
<td>GP</td>
<td>1,500</td>
<td>3,700</td>
</tr>
<tr>
<td>1</td>
<td>80.0</td>
<td>GP</td>
<td>2,000</td>
<td>6,000+</td>
</tr>
<tr>
<td>1</td>
<td>90.0</td>
<td>GP</td>
<td>2,500</td>
<td>4,500</td>
</tr>
<tr>
<td>1</td>
<td>100.0</td>
<td>GP</td>
<td>3,000</td>
<td>4,875</td>
</tr>
<tr>
<td>1</td>
<td>110.0</td>
<td>GP</td>
<td>4,000</td>
<td>6,000+</td>
</tr>
<tr>
<td>1</td>
<td>120.0</td>
<td>GP</td>
<td>5,000</td>
<td>6,000+</td>
</tr>
</tbody>
</table>

The following plates are attached and complete this appendix:

Plate A-1 - Log of Boring
Plate A-2 - Unified Soil Classification System
Plate A-3 - Soil Sampler Type U
Plate A-4 - Method of Performing Direct Shear and Friction Tests.
<table>
<thead>
<tr>
<th>Depth in Feet</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>BLACK FINE TO COARSE SANDY GRAVEL, FILL FOR ROAD, BROKEN COAL — LOOSE</td>
</tr>
<tr>
<td>6</td>
<td>BLACK SILT WITH SAND AND GRAVEL LAYERS, EQUIL. TAILINGS — VERY SOFT</td>
</tr>
<tr>
<td>10</td>
<td>CASING TO 8-1/2'</td>
</tr>
<tr>
<td>20</td>
<td>BLACK FINE TO MEDIUM SAND WITH OCCASIONAL FINE SANDY SILT LAYERS, (COAL TAILINGS) — VERY LOOSE</td>
</tr>
<tr>
<td>25</td>
<td>CASING TO 13-1/2'</td>
</tr>
<tr>
<td>35</td>
<td>GRADING FEWER SILT LAYERS</td>
</tr>
<tr>
<td>40</td>
<td>BLACK FINE TO COARSE SANDY GRAVEL, (BROKEN COAL) — LOOSE</td>
</tr>
<tr>
<td>45</td>
<td>LOSING SOME CIRCULATION AT 31' CASING TO 37'</td>
</tr>
<tr>
<td>50</td>
<td>GRAY SANDSTONE BOULDER FROM 38-1/2' TO 40-1/2'</td>
</tr>
<tr>
<td>55</td>
<td>CASING TO 43'</td>
</tr>
<tr>
<td>60</td>
<td>LOSING SOME CIRCULATION AT 41'</td>
</tr>
<tr>
<td>65</td>
<td>GRAY SANDSTONE COBBLES FROM 42' TO 49'</td>
</tr>
<tr>
<td>70</td>
<td>CASING TO 53'</td>
</tr>
</tbody>
</table>

KEY:
- A = FIELD MOISTURE EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL.
- B = DRY DENSITY EXPRESSED IN LBS. PER CUBIC FOOT.
- C = BLOWS PER FOOT OF PENETRATION USING A 140 LB HAMMER DROPPING 30 INCHES.
- D = DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED.
- E = DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED.

NOTES:
- THE DISCUSSION IN THIS TEXT UNDER THE SECTION TITLED, "SITE CONDITIONS, SUBSURFACE", IS NECESSARY TO A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS.
- ELEVATION DATA TAKEN FROM PRINT TITLED, "Kaiser Steel Corp. — Coal Slurry Pond — Sunnyside, Utah", BY TEMPLETON, Linkle & Alsip, Consulting Engineers, Salt Lake City, Utah.
<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>GRAPH SYMBOL</th>
<th>LETTER SYMBOL</th>
<th>TYPICAL DESCRIPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE GRANED SOILS</td>
<td></td>
<td></td>
<td>WELL-GRATED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GW</td>
<td>POORLY-GRATED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GP</td>
<td>Silty Gravels, Gravel-Sand-Silt Mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GM</td>
<td>Clayey Gravels, Gravel-Sand-Clay Mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GC</td>
<td></td>
</tr>
<tr>
<td>SAND AND SANDY SOILS</td>
<td></td>
<td></td>
<td>WELL-GRATED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SW</td>
<td>POORLY-GRATED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SP</td>
<td>Sily Sands, Sand-Silt Mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SM</td>
<td>Clayey Sands, Sand-Clay Mixtures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td></td>
</tr>
<tr>
<td>FINE GRANED SOILS</td>
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<td>ML</td>
<td>Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CL</td>
<td>Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Sily Clays, Lean Clays</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OL</td>
<td>Organic Silts and Organic Silty Clays of Low Plasticity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MH</td>
<td>Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Sily Soils</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH</td>
<td>Inorganic Clays of High Plasticity, Fat Clays</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OH</td>
<td>Organic Clays of Medium to High Plasticity, Organic Silts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT</td>
<td>Peat, Mins, Swamp Soils with High Organic Contents</td>
</tr>
</tbody>
</table>

**NOTE:** DUAL SYMBOLS ARE USED TO INDICATE BROADLINE SOIL CLASSIFICATIONS.

**SOIL CLASSIFICATION CHART**

**UNIFIED SOIL CLASSIFICATION SYSTEM**

**INCORPORATED**

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Direct shear tests are performed to determine the shearing strengths of soils. Friction tests are performed to determine the frictional resistances between soils and various other materials such as wood, steel, or concrete. The tests are performed in the laboratory to simulate anticipated field conditions.

Each sample is tested within three brass rings, two and one-half inches in diameter and one inch in length. Undisturbed samples of in-place soils are tested in rings taken from the sampling device in which the samples were obtained. Loose samples of soils to be used in constructing earth fills are compacted in rings to predetermined conditions and tested.

Direct Shear Tests
A three-inch length of the sample is tested in direct double shear. A constant pressure, appropriate to the conditions of the problem for which the test is being performed, is applied normal to the ends of the sample through porous stones. A shearing failure of the sample is caused by moving the center ring in a direction perpendicular to the axis of the sample. Transverse movement of the outer rings is prevented.

The shearing failure may be accomplished by applying to the center ring either a constant rate of load, a constant rate of deflection, or increments of load or deflection. In each case, the shearing load and the deflections in both the axial and transverse directions are recorded and plotted. The shearing strength of the soil is determined from the resulting load-deflection curves.

Friction Tests
In order to determine the frictional resistance between soil and the surfaces of various materials, the center ring of soil in the direct shear test is replaced by a disk of the material to be tested. The test is then performed in the same manner as the direct shear test by forcing the disk of material from the soil surfaces.

Method of Performing Direct Shear and Friction Tests
Direct Shear Tests
June 3, 1977

Kaiser Steel Corporation
Box D
Sunnyside, Utah 84539

Attention: Mr. J. T. Paluso,
Assistant Chief Mining Engineer

Gentlemen:

Refuse Pile & Slurry Pond Report
I. D. No. 1211-UT-9-0017
Sunnyside Mines Nos. 1, 2 & 3
I. D. Nos. 42-00093, 42-00094
& 42-00092

Gentlemen:

In compliance with your letter of May 24, 1977, our response to the technical review questions of the subject Refuse Pile and Slurry Pond is provided herewith. Our responses are directed to the stability analyses portion of the MESA letter and are as follows:

QUESTION 1 - At the time of our stability analyses, the present MESA regulations had not been developed. The test boring was selected at a location 200 feet in from the crest of the embankment in order to evaluate the most critical conditions anticipated in the pond for both the phreatic water surface condition and material strength condition.

QUESTION 2 - Copies of the direct shear tests performed on samples of the materials encountered in the exploration boring are attached to this letter. As noted in the report, all samples were two and one-half inch in diameter and were tested as described in the report. The attached shear test summary shows...
the values selected for analyses. It is our opinion that the shear strength data presented are appropriate for shearing strength within the normal pressure range that would exist along the failure circle shown in the report.

QUESTION 3 - The statement on the phreatic surface was based on the results of the test boring which was drilled out in the pond area to reflect the phreatic surface in a critical location. Observations of the embankments indicated that water was flowing essentially vertical from the pond area and was not present at any location except at the bottom of the embankment.

QUESTION 4 - We would welcome a meeting at the site to discuss the 1973 investigation and to investigate current programs that might be undertaken.

We appreciate being asked to respond to these questions. Please contact us if you require additional information.

Yours very truly,

DAMES & MOORE

George C. Toland
Partner
Professional Engineer No. 2311
State of Utah

GCT/jw

Attachments
INCORPORATED

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<table>
<thead>
<tr>
<th>MOISTURE &amp; DENSITY</th>
<th>FIELD</th>
<th>TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT. SOIL &amp; RINGS</td>
<td>385.7</td>
<td></td>
</tr>
<tr>
<td>WT. RINGS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET WT. SOIL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WET DENSITY</td>
<td>70.3</td>
<td></td>
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<tr>
<td>LBS./CU./FT.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WT. DISH &amp; SOIL</td>
<td>157.4</td>
<td></td>
</tr>
<tr>
<td>DRY WT. SOIL</td>
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<td></td>
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<td>NET LOSS OF MOISTURE</td>
<td>237</td>
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<td>WT. DISH</td>
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<td>NET WT. OF DRY SOIL</td>
<td>158</td>
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<table>
<thead>
<tr>
<th>TEST SET-UP</th>
<th>LOAD</th>
<th>DEFLECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTINUOUS</td>
<td>V</td>
<td>INCREMENT</td>
</tr>
<tr>
<td>INCREASE</td>
<td>V</td>
<td>DECREASE</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>TEST SUMMARY</th>
<th>NORMAL PRESS.</th>
<th>YIELD STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 LBS./SQ. FT.</td>
<td>1550 LBS./SQ. FT.</td>
<td></td>
</tr>
<tr>
<td>DRY DENSITY</td>
<td>LBS./CU. FT.</td>
<td></td>
</tr>
<tr>
<td>14.7</td>
<td>LBS./SQ. FT.</td>
<td></td>
</tr>
<tr>
<td>FIELD MOISTURE</td>
<td>ULTIMATE STR.</td>
<td></td>
</tr>
<tr>
<td>19%</td>
<td>LBS./SQ. FT.</td>
<td></td>
</tr>
<tr>
<td>% OF DRY WT.</td>
<td>TEST MOISTURE</td>
<td></td>
</tr>
<tr>
<td>19%</td>
<td>LBS./SQ. FT.</td>
<td></td>
</tr>
<tr>
<td>% OF DRY WT.</td>
<td>FRICTION STR.</td>
<td></td>
</tr>
<tr>
<td>19%</td>
<td>LBS./SQ. FT.</td>
<td></td>
</tr>
</tbody>
</table>
## NOTES

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---

### MOISTURE & DENSITY

<table>
<thead>
<tr>
<th>FIELD</th>
<th>TEST</th>
<th>TEST SET-UP</th>
<th>TEST SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT. SOIL &amp;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RINGS</td>
<td>LOAD</td>
<td>DEFLECTION</td>
<td>NORMAL PRESS.</td>
</tr>
<tr>
<td>WT. RINGS</td>
<td>CONTINUOUS</td>
<td></td>
<td>4000</td>
</tr>
<tr>
<td>NET WT. SOIL</td>
<td>INCREASE</td>
<td></td>
<td>LBS./SQ. FT.</td>
</tr>
<tr>
<td>WT. DISH &amp; SOIL</td>
<td>DECREASE</td>
<td></td>
<td>LBS./CU. FT.</td>
</tr>
<tr>
<td>RY WT. SOIL DISH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NET LOSS OF MOISTURE</td>
<td>LOAD</td>
<td>INCREMENT</td>
<td>YIELD STRENGTH</td>
</tr>
<tr>
<td>WT. DISH</td>
<td>DEFLECTION</td>
<td></td>
<td>476</td>
</tr>
<tr>
<td>NET WT. OF DRY SOIL</td>
<td>LOADING SPEED</td>
<td></td>
<td>LBS./SQ. FT.</td>
</tr>
<tr>
<td>% OF DRY WT.</td>
<td>DEFLECTING SPEED</td>
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<td>ULTIMATE STR.</td>
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**FIELD LOADTEST SUMMARY**

<table>
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<th>DEFLECTION</th>
<th>INCREMENTS</th>
<th>% DECREASE</th>
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<tbody>
<tr>
<td>379.8</td>
<td>102.9</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

---

**NORMAL DEFORMATION IN INCHES**

**SHEAR STRESS IN LBS./SQ.FT.**

---

**DATA SHEET**

**LAB IDENT.**

---

**SAMPLED**

**SET-UP**

**TESTED**

---

**BORING**

**DEPTH**
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MOISTURE & DENSITY

FIELD TEST

TEST SET-UP

TEST SUMMARY

| WT. SOIL & RINGS | 39.9 | LOAD | DEFLECTION |
| WT. RINGS | | CONTINUOUS | INCREMENT |
| NET WT. SOIL | | INCREASE | DECREASE |
| WET DENSITY | 71.7 | INCREMENT INTERVAL | MIN. |
| WT. DISH = 0.7 | 105.7 | RECORDING INTERVAL | MIN. |
| DRY WT. SOIL DISH | 86.4 | LOAD | LBS./SQ. FT. |
| NET LOSS OF MOISTURE | 22.6 | DEFLECTION | INCHES |
| WT. DISH | 15.5 | LOADING SPEED | LBS./SQ.FT./MIN. |
| NET WT. OF DRY SOIL | 13.5 | DEFLECTING SPEED | INCHES/MIN. |

NORMAL PRESSURE

YIELD STRENGTH

DRY DENSITY

PEAK STRENGTH

FIELD MOISTURE

ULTIMATE STR.

% OF DRY WT.

TEST MOISTURE

FRICITION STR.

% OF DRY WT.
<table>
<thead>
<tr>
<th>MOISTURE &amp; DENSITY</th>
<th>FIELD</th>
<th>TEST</th>
<th>TEST SET-UP</th>
<th>TEST SUMMARY</th>
</tr>
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<td>LOAD</td>
<td></td>
</tr>
<tr>
<td>NET WT. SOIL</td>
<td></td>
<td></td>
<td>CONTINUOUS</td>
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<tr>
<td>WET DENSITY LBS./CU/FT.</td>
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<td>INCREMENT</td>
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<tr>
<td>WT. DISH &amp; SOIL</td>
<td>116.3</td>
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<td>RECORDING</td>
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<td>DRY WT. SOIL DISH</td>
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<td>INTERVAL</td>
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<tr>
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<td></td>
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</tr>
<tr>
<td>NET WT. OF DRY SOIL</td>
<td>137.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NORMAL DEFLECTION IN INCHES**

**SHEAR STRESS IN LBS./SQ.FT.**

**TEST SUMMARY**

- **NORMAL PRESS.** 5000 LBS./SQ. FT.
- **YIELD STRENGTH**
  - DRY DENSITY 50 LBS./CU. FT.
  - PEAK STRENGTH 4400 LBS./SQ. FT.
  - FIELD MOISTURE 30.1 % OF DRY WT.
  - TEST MOISTURE FRICITION STR.
  - % OF DRY WT. LBS./SQ. FT.
**Friction Test Data Sheet**

**Lab Ident.:** SM

**Set-Up:** / / Tested (Office)

---

**Notes:**

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### Normal Deflection in Inches

- Load: ✓ Deflection ✓ Increment ✓ Decrease

### Shear Stress in Lbs./Sq.Ft.

- Normal Press.: 1500 Lbs./Sq. Ft.
- Yield Strength: 3700 Lbs./Sq. Ft.
- Dry Density: 99.7 Lbs./Cu. Ft.
- Peak Strength: 9.6 Lbs./Sq. Ft.
- Field Moisture: 9.6 % of Dry Wt.
- Ultimate Str.: Lbs./Sq. Ft.
- Test Moisture: % of Dry Wt.
- Friction Str.: Lbs./Sq. Ft.

---

### Moisture & Density

<table>
<thead>
<tr>
<th>WT. Soil &amp; Rings</th>
<th>Field Test</th>
<th>Test Set-Up</th>
<th>Test Summary</th>
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<tr>
<td>WET DENSITY</td>
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<td>DECREASE</td>
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<td>WT. Dish</td>
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<tr>
<td>DRY WT. Soil</td>
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<td>INTERVAL</td>
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**INCORPORATED**

**FEB 04 2003**

**DIV OF OIL GAS & MINING**

---

**FRICITION TEST**  
**SL. TYPE** 60  
**DATA SHEET**  
**LAB IDENT.** 5/11/03  
**DURING**  
**IMPLED**  
**SET-UP**  
**TESTED**  
**OFFICE**

---

**NOTES**

---

**MOISTURE & DENSITY**  
**FIELD**  
**TEST**  
**TEST SET-UP**  
**TEST SUMMARY**

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<th>Field</th>
<th>Test</th>
<th>Test Set-Up</th>
<th>Test Summary</th>
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**NORMAL DEFLECTION IN INCHES**  
**SHEAR STRESS IN LBS./SQ.FT.**

---

**FRICTION TEST**  
**DATA SHEET**  
**SL. TYPE** 60  
**LAB IDENT.** 5/11/03  
**DURING**  
**IMPLED**  
**SET-UP**  
**TESTED**  
**OFFICE**
## INCORPORATED

**FEB 04 2003**

**DIV OF OIL GAS & MINING**

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### MOISTURE & DENSITY

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### TEST SET-UP

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<td><strong>LBS. /CU. FT.</strong></td>
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### TEST SUMMARY

- **Normal Press.**
- **Yield Strength**
- **Dry Density**
- **Peak Strength**
- **Field Moisture**
- **Ultimate Strength**
- **% of Dry WT.**
- **Test Moisture**
- **Friction Str.**

---

### NORMAL DEFLECTION IN INCHES

- **0.20**
- **0.10**
- **0.01**
- **0.00**

---

### SHEAR STRESS IN LBS./SQ.FT.

- **0.20**
- **0.10**
- **0.01**
- **0.00**

---

### GRAPHICS

- Graph showing **Normal Deflection in Inches**
- Graph showing **Shear Stress in LBS./SQ.FT.**

---

### ADDITIONAL NOTES

- **Notes**
- **Incoporated**
- **FEB 04 2003**
- **DIV OF OIL GAS & MINING**

---

### CONTACT INFORMATION

- **NAME**
- **TITLE**
- **COMPANY**
- **ADDRESS**
- **PHONE**
- **EMAIL**

---

### APPENDIX

- **APPENDIX**
- **APPENDIX**
- **APPENDIX**

---

**REMARKS**

**REMARKS**

**REMARKS**

**REMARKS**

**REMARKS**

**REMARKS**

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**Page Dimensions:** 624.4x801.7

**Image 0x0 to 624x802**

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**Note:** This document contains technical and scientific information related to soil testing, including normal deflection, shear stress, and various soil properties. It is likely a data sheet or test report used in engineering or geotechnical studies.
### NOTES

- **Sampled** / Set-Up / Tested
- **(Office)**

### Test Set-Up

- **Normal Deflection in Inches**
  - **Shear Deflection in LBS/SQ.FT.**

### Test Summary

<table>
<thead>
<tr>
<th>Moisture &amp; Density</th>
<th>Field Test</th>
<th>Test Set-Up</th>
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</thead>
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### Notes

#### INCORPORATED
FEB 04 2003
DIV OF OIL GAS & MINING

#### Shear Stress in Lbs./S ft.

#### Normal Deflection in Inches

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<tr>
<th>MOISTURE &amp; DENSITY</th>
<th>FIELD TEST</th>
<th>TEST SET-UP</th>
<th>TEST SUMMARY</th>
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<tr>
<td>WT. SOIL &amp; 1/4 RINGS</td>
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<td>LOAD ✔ DEFLECTION</td>
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<td>% OF DRY WT. LBS./SQ. FT.</td>
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May 24, 1977

Mr. George Toland  
Dames & Moore  
250 East Broadway  
Salt Lake City, Utah 84111

Re: Report on Material and Stability Investigation of Kaiser Steel's Coal Refuse Disposal Area

Dear Mr. Toland:

As per our telephone conversation last week, I am enclosing a letter from the Mining Enforcement and Safety Administration. The actual questions that need to be answered by your firm are circled.

I appreciate any help you can give us on this problem. If there will be any fees for your services please let me know.

Sincerely yours,

KAISER STEEL CORPORATION

J. T. Paluso  
Assistant Chief Engineer

JTP:dm  
Enclosure
All calculations were made using the reference "Design of Small Dams" by the Bureau of Reclamation.

Calculations:

A. From Figure 20, P. 53, the probable maximum thunderstorm 1-hour rainfall is 6.0 inches.

B. From Table A-5, P. 538, the runoff curve number is found to be 90.

C. From Figure A-4, P. 541, the direct runoff is found to be 4.85 inches.

D. The drainage area affecting the slurry pond is 138 acres. The total runoff will be $4.85'' \times 138 \text{ acres} = 669.3 \text{ acre-inches}$ or 55.78 acre-feet.
### FRICTION TEST DATA SHEET

**SL.** ____________  **TYPE** ____________  **BORING** ____________  **LAB IDENT.** ____________  **DEPTH** ____________

**TESTED** ____________  /  **SET-UP** ____________  /  **(_________ OFFICE)______________________________**

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**NOTES**

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**NORMAL DEFLECTION IN INCHES**

**SHEAR STRESS IN LBS./SQ.FT.**

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**M O I S T U R E & DENSITY **

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<td>DRY WT. SOIL</td>
<td>86.6</td>
<td>DEFLECTION INCREMENT</td>
<td>INCHES</td>
</tr>
<tr>
<td>DRY LOSS OF MOISTURE</td>
<td>33.1</td>
<td>LOADING SPEED</td>
<td>LBS./SQ.FT./MIN.</td>
</tr>
<tr>
<td>WT. DISCH</td>
<td>15.3</td>
<td>DEFLECTING SPEED</td>
<td>0.02 INCHES/MIN.</td>
</tr>
<tr>
<td>NET WT. OF DRY SOIL</td>
<td>71.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**NORMAL PRESS. 3000**  **LBS./SQ. FT.**

**D R Y DENSITY 29.75**  **LBS./SQ. FT.**

**FIELD MOISTURE 30.4**  **LBS./CU. FT.**

**% OF DRY WT.**  **LBS./SQ. FT.**

**TEST MOISTURE**  **LBS./SQ. FT.**

**FRICION STR.**  **LBS./SQ. FT.**

---

**INCORPORATED**

FEB 04 2003

DIV OF OIL GAS & MINING
APPENDIX 5-3
STABILITY ANALYSIS (ROLLINS, BROWN AND GUNNELL, INC.)
STABILITY ANALYSIS

KAISER STEEL DIKES
SUNNYSIDE, UTAH

March 1984

Rollins, Brown and Gunnell, Inc.
Professional Engineers
1435 West 820 North, P.O. Box 711
Provo, Utah 84603
March 23, 1984

Kaiser Steel Corporation
P.O. Box D
Sunnyside, UT 84539

Attn: Roger Kohlman

Gentlemen:

A stability analysis has been completed for various refuse dikes in the refuse disposal area for the Kaiser Steel Mine near Sunnyside, Utah. The purpose of this investigation was to determine the slope stability for the east side dikes, the west side dikes, and the coal slurry water sediment ponds. The investigation has been completed in accordance with a written contract between Kaiser Steel and our organization, and the results of the investigation are outlined in the following sections of this report.

The information presented in the report is discussed under the following headings: (1) Existing Site Conditions, (2) Subsurface Soil and Water Conditions, (3) Stability Analysis of the Dikes, and (4) The Results of Field and Laboratory Tests.

1. EXISTING SITE CONDITIONS

The refuse disposal area for the Kaiser Mine is located south of Sunnyside, Utah. The main disposal area is presented in Figure No. 1, and the location of the east and west side dikes are presented in this figure. The contours of the dike area are also shown in Figure No. 1. The slope at both the east and west side dike is apparent from the topography shown in these figures. Refuse from the Kaiser Mine is currently being disposed of at the west side dike. At the time this investigation was performed, the dike was being extended to the west and had only reached a portion of its final height. It is our understanding that some effort is being made to densify the refuse currently being disposed of in this fill. The east side dike is inactive, and no refuse material is being disposed of in this area.
The coal slurry water sediment control system is located north of the refuse disposal area, and the general layout of the system is presented in Figure No. 13. It will be noted that three slurry ponds exist throughout this site and that the slurry ponds have been formed by excavating into the natural materials throughout the site. At the time of our investigation, these ponds were empty and were relatively inactive.

2. SUBSURFACE SOIL AND WATER CONDITIONS

In order to define the characteristics of the coal refuse at the east and west side fills, two test holes were drilled in these areas at locations as shown in Figure No. 1. The logs for the two test holes are presented in Figures 2 and 3, and it will be noted that Test Hole No. 1, which was drilled at the east side dike, extended to a depth of approximately 80 feet below the surface of the fill. Test Hole No. 2 was drilled at the west side fill and extended to a depth of 132 feet. The natural ground surface was encountered at a depth of about 64 feet below the fill elevation in Test Hole No. 1 and at a depth of about 120 feet below the existing ground surface in Test Hole No. 2.

During the subsurface investigation at each of these dikes, sampling was performed at 5-foot intervals throughout the depth investigated. Samples were obtained by driving a 2-inch split-spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The number of blows to drive the sampling spoon through each 6 inches of penetration is defined as the standard penetration value. The standard penetration value provides a reasonable indication of the in-place density of sandy material, however considerable care must be exercised in evaluating the standard penetration value for gravelly-size material, particularly where the particle size exceeds the inside diameter of the sampling spoon. During the subsurface investigation for each of the test holes discussed above, recovery of the refuse material at each of the sampling locations was very good, indicating that the penetration value is a significant indicator of the density of the material in the profile at these two dikes. The results of the standard penetration tests performed at both dikes indicate that the coal refuse is in a medium-dense condition.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the material type according to this system is presented in Figure No. 5, and the meaning of the various symbols shown on the boring logs can be obtained from this figure.
The subsurface materials generally classify as GM-type materials, however some materials were encountered throughout the profile which classified as an SM-type material. It should be recognized that the soil classification designation has significance only insofar as the textural characteristics of the material is concerned. The natural material below the refuse in Test Hole No. 1 consisted predominantly of a brown, silty sand with some sandstone fragments. The natural material underlying the coal refuse in Test Hole No. 2 consisted of brown, silty, sandy gravel.

No groundwater was encountered in either of the test borings drilled at this site, however we understand that some groundwater seeps out of the bottom of the slope at the west dike. In order to obtain a better indication of the in-place unit weight of the refuse material throughout the area, one test pit was excavated in the vicinity of Test Hole No. 1, while two test pits were excavated in the vicinity of Test Hole No. 2. Logs for these three test holes are presented in Figures 6 and 7.

In-place density tests were performed at 3-foot intervals in these test pits, and the results of the in-place density tests are presented on the boring logs. It will be observed that the in-place density of the refuse material generally varied from about 70 pounds per cubic foot to 91 pounds per cubic foot. This information has been used qualitatively to determine the density characteristics of the material as determined by the standard penetration tests.

3. STABILITY ANALYSIS OF THE DIKES

In performing the stability computations, a computer model of Spencer's Method has been used. Spencer's Method satisfies both force and moment equilibrium and is considered to be a satisfactory method of solving limiting equilibrium problems. The shear strength parameters used in the stability analysis are based on the results of laboratory tests performed to define the strength characteristics of the refuse material. The results of the laboratory tests defining the shear strength parameters are discussed in a subsequent section of this report. Stability computations include the slope at the east side dike, the overall stability of the west side dike when the extension is complete, the lower slope of the existing west side fill, and the upper slope of the west side dike above the fill extension.

The stability associated with each of these slopes is discussed below as follows:
A. East Side Slope

A profile through the refuse material at the east side dike is presented in Figure No. 8. Shear strength parameters used in the stability analysis along with the in-place unit weight of the refuse material and the natural material is also presented in this figure. The critical failure surface for this slope is presented in Figure No. 8, and it will be noted that the factor of safety for this slope is 1.42. It will be observed that a friction angle of 35 degrees was used for the refuse material.

The results of the laboratory tests performed on the refuse material indicated a friction angle of between 36 and 37.8 degrees. Using a friction angle of 37 degrees for the refuse material, the factor of safety for the east side slope is slightly greater than 1.5, which in our opinion is satisfactory for this facility.

B. West Side Slope at the Ultimate Height

A cross-section through the west side dike when it reaches its ultimate height is presented in Figure No. 9, along with the shear strength parameters and the critical failure circle. It will be observed that a friction angle of 35 degrees and a cohesion of 200 pounds per cubic foot was used. It is recognized that the refuse material has no friction angle in a saturated condition, however in an unsaturated condition capillary pressures within the material can produce an 'apparent cohesion of at least this amount. Since there is essentially no opportunity for the refuse material to become completely saturated, it is our opinion that a cohesion of 200 pounds per square foot is a reasonable value. It will also be noted that a friction angle of 35 degrees was used, which is about 2 degrees less than the measured friction angle. It will be observed that using the shear strength parameters indicated above, a factor of safety of 2.31 was obtained, which is entirely satisfactory for the proposed slope.

C. Existing Slope at the West Side Dike Extension

The approximate elevation and profile of the existing west side dike extension is presented in Figure No. 10. The shear strength parameters of the refuse and the sandy gravel underlying the refuse is also presented in this figure. The stability analysis indicates a factor of safety of 2.39 for the critical failure surface for this slope. Since a factor of safety of 1.5 is generally considered...
satisfactory under limiting equilibrium conditions, the existing slope is satisfactory.

D. Existing Slope Above the West Side Dike Extension

As indicated earlier in this report, the west side dike extension is only partially complete. The profile of the refuse material above the west side extension is shown in Figure No. 11. A stability analysis has been performed for this slope using the shear strength parameters shown in Figure No. 11. The critical circle as shown in Figure No. 11 indicates a factor of safety of 1.03, which is unsatisfactory for this slope.

If the slope is cut back to the overall slope shown in Figure No. 12, a factor of safety of 1.46 is used using the shear strength parameters indicated. Since the slope will eventually be covered by the west side dike extension, it is our opinion that a factor of safety of 1.46 is satisfactory for this slope. If a friction angle of 37 degrees is used in the analysis, a factor of safety of 1.5 will be obtained.

E. Coal Slurry Water Sediment Control System

A plan view of the coal slurry water sediment control system is presented in Figure No. 13. As indicated earlier, the ponds at this location have been excavated into the existing ground. The contours showing the shape and topography are presented in Figure No. 1, along with sections through the slopes of each of the ponds. It will be observed that the side slopes vary from 2 horizontal to 1 vertical to 4.6 horizontal to 1 vertical. The depth of the ponds do not exceed 20 feet and an inspection of the area indicates that no slope stability problems exist for these facilities. Since the ponds are generally below ground, there is little or no possibility of a rupture which would release water from the ponds to adjacent areas. Any slope stability failure which would occur in the ponds would not result in any hazardous situation. It is our opinion that the slopes for these ponds are stable under the existing situation and that if any of the slopes failed, no serious problems could result.

4. THE RESULTS OF FIELD AND LABORATORY TESTS

Field and laboratory tests were limited to standard penetration tests, classification tests, and triaxial shear tests. The
standard penetration tests have been previously discussed, and the results of these tests are presented on the boring logs.

In order to obtain an indication of the shearing strength of the subsurface material, three consolidated drained triaxial shear tests were performed on representative samples from Test Hole No. 1, and three consolidated drained triaxial shear tests were performed on representative samples from Test Hole No. 2. The results of these tests are presented in the form of a Mohr envelope in Figures 14 and 15. It will be noted that the in-place dry unit weight of the samples shown in Figure No. 14 varied from about 78 to 80 pounds per cubic foot, while the in-place unit weight of the materials in Test Hole No. 2 varied from about 74 to 75 pounds per cubic foot. All samples for triaxial shear tests were performed at their in-site moisture content. These tests covered the range in the in-place density as determined by the field tests, and it is our opinion that they provide a reasonable indication of the shearing strength of both the east and the west side dikes in their in-place condition. It will be noted that the friction angle varied from 36 degrees for the material obtained from Test Hole No. 2 to 37.8 degrees for the material obtained from Test Hole No. 1.

Conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests which, in our opinion, define the characteristics of the material in the dikes in a reasonable manner. If there are any questions relative to the information contained herein, please advise us.

Yours truly,

ROLLINS, BROWN AND GUNNELL, INC.

Ralph L. Rollins

RLR/1ah
Enclosures
<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Group Symbols</th>
<th>Typical Names</th>
<th>Laboratory Classification Criteria</th>
</tr>
</thead>
</table>
| Gravels | GW | Well graded gravels, gravel-sand mixtures, little or no fines. | \( C_u = \frac{D_{85}}{D_1} \) Greater than 4
| | GP | Poorly graded gravels, gravel-sand mixtures, little or no fines. | \( C_u = \frac{D_{60}}{D_1} \) Between 1 and 3
| | GAT | Silty gravels, poorly graded gravel-sand-clay mixtures | Not meeting all gradation requirements for GW
| | GC | Clayey gravels, poorly graded gravel-sand-clay mixtures | Atterberg limits below "A" line, or PI less than 4
| | SW | Well graded sands, gravelly sands, little or no fines. | Atterberg limits above "A" line, or PI greater than 7
| | SP | Poorly graded sands, gravelly sands, little or no fines. | Above "A" line with PI between 4 and 7 and borderline cases requiring use of dual symbols
| | SAG | Silty sands, poorly graded sand-silt mixtures | Atterberg limits below "A" line, or PI less than 4
| | SC | Clayey sands, poorly graded sand-clay mixtures | Atterberg limits above "A" line, or PI greater than 7

<table>
<thead>
<tr>
<th>Fine Grained Soils</th>
<th>Group Symbols</th>
<th>Typical Names</th>
<th>Laboratory Classification Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt and Clays</td>
<td>ML</td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silt clays, lean clays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silts and organic silt-clays of low plasticity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MH</td>
<td>Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Inorganic clays of high plasticity, fat clays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO</td>
<td>Organic clays of medium to high plasticity; organic silts</td>
<td></td>
</tr>
<tr>
<td>Highly Organic Soils</td>
<td>Pt</td>
<td>Peat and other highly organic soils</td>
<td></td>
</tr>
</tbody>
</table>

- Divisions of GW and GM groups into subdivisions of sand and silt for roads and airfields only. Subdivision is based on Atterberg limits; subdivided when liquid limit is 28 or less and PI is 6 or less. The index is ignored when liquid limit is greater than 28.

- Bureau publication: these properties and characteristics of two groups are designated by combinations of group symbols. For example, GWGC, well graded gravel-sand mixture with clay binder.

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**DIV OF OIL GAS & MINING**

**Figure No. 7**

---

**FEB 04 2003**
Test Pit No. 3

<table>
<thead>
<tr>
<th>Depth</th>
<th>Material</th>
<th>GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>84.2.4.7%</td>
<td>coal</td>
<td></td>
</tr>
<tr>
<td>77.7.5.6%</td>
<td>refuse</td>
<td></td>
</tr>
<tr>
<td>83.8.5.3%</td>
<td>coal</td>
<td></td>
</tr>
<tr>
<td>81.2.5.6%</td>
<td>refuse</td>
<td></td>
</tr>
</tbody>
</table>

**LEGEND**

- Sample location
- Torvane value
- Undisturbed sample
- No. of blows per 6" with std. spoon
- Groundwater elevation

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**FEB 04 2003**

**DIV OF OIL GAS & MINING**

**ROLLINS, BROWN AND GUNNELL, INC.**

**PROFESSIONAL ENGINEERS**

Log of Borings for:

Kaiser Steel Dike Stability

Sunnyside, Utah

Figure No. 6
Test Hole No. 2 (Cont.)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Sample</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>14,15,15</td>
<td>GM</td>
</tr>
<tr>
<td>105</td>
<td>13,14,15</td>
<td>GM</td>
</tr>
<tr>
<td>110</td>
<td>14,17,22</td>
<td>SM</td>
</tr>
<tr>
<td>115</td>
<td>13,18,15</td>
<td>SM</td>
</tr>
<tr>
<td>120</td>
<td>14,14,24</td>
<td>GM</td>
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<tr>
<td>125</td>
<td>23,13,16</td>
<td>GM</td>
</tr>
<tr>
<td>130</td>
<td>23,48</td>
<td>GM</td>
</tr>
</tbody>
</table>

LEGEND

- Sample location
- X.0.30 - Vane value
- Undisturbed sample
- 5.6.6 - No. of blows per ft wth std. spoon
- Groundwater elevation

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Kaiser Steel Dike Stability
Sunnyside, Utah

Figure No. 4

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**Test Hole No. 1**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Dr. silty sand w/sandstone</td>
</tr>
<tr>
<td>5</td>
<td>14,14,17 GH</td>
</tr>
<tr>
<td>10</td>
<td>14,23,23 GH</td>
</tr>
<tr>
<td>15</td>
<td>15,19,23 GM</td>
</tr>
<tr>
<td>20</td>
<td>17,23,19 GH</td>
</tr>
<tr>
<td>25</td>
<td>16,20,27 GH</td>
</tr>
<tr>
<td>30</td>
<td>10,21,29 GM</td>
</tr>
<tr>
<td>35</td>
<td>14,18,23 SM</td>
</tr>
<tr>
<td>40</td>
<td>22,19,16 GH</td>
</tr>
<tr>
<td>45</td>
<td>19,21,24 SM</td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
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</table>

**Test Hole No. 1 (Cont.)**

<table>
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<tr>
<th>Depth</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>

**LEGEND**

- Sample location
- A.D. 30 = Torvane value
- Undisturbed sample
- 5.6.6 = no. of blows per 6" with std. spoon
- Groundwater elevation

**INTEGRATED DIV OF OIL GAS & MINING**

**Fig. No. 2**

**Log of borings for:**
Kaiser Steel Dike Stability Sunnyside, Utah

**Fig. No. 2**
<table>
<thead>
<tr>
<th>Zone</th>
<th>Material</th>
<th>c, psf</th>
<th>θ, deg</th>
<th>γ', pcf</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Coal Refuse</td>
<td>0</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>II</td>
<td>Silty Sand, Sandy Silt</td>
<td>0</td>
<td>36</td>
<td>105</td>
</tr>
<tr>
<td>Zone</td>
<td>Material</td>
<td>c. psf</td>
<td>θ. deg</td>
<td>V. nc²</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
<td>--------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>Coal Refuse</td>
<td>0</td>
<td>35</td>
<td>80</td>
</tr>
</tbody>
</table>

F.S. = 1.03

Coal Refuse Zone I

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ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

KAISER STEEL DIKE STABILITY
Stability Analysis--Existing West Upper Slope
Sunnyside, Utah
### TRIAXIAL SHEAR TEST

**Project**: Kaiser Steel Dike
**Location**: Sunnyside, Utah

<table>
<thead>
<tr>
<th>Test no.</th>
<th>Sample data</th>
<th>Degree of saturation</th>
<th>Confining pressure</th>
<th>Maximum deviator stress</th>
<th>Strength values at failure</th>
<th>Sample size</th>
<th>Strain rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry density (pcf)</td>
<td>Moisture content (%)</td>
<td>(psi)</td>
<td>(psi)</td>
<td>Friction angle $\phi$ (degrees)</td>
<td>Cohesion ($c$/psi)</td>
<td>$L/D$ (inches)</td>
</tr>
<tr>
<td>○</td>
<td>77.9</td>
<td>8.3</td>
<td>0</td>
<td>20</td>
<td>37.8</td>
<td>0</td>
<td>2.87</td>
</tr>
<tr>
<td>□</td>
<td>80.2</td>
<td>8.3</td>
<td>0</td>
<td>32</td>
<td>37.8</td>
<td>0</td>
<td>2.87</td>
</tr>
<tr>
<td>△</td>
<td>78.9</td>
<td>8.3</td>
<td>0</td>
<td>40</td>
<td>37.8</td>
<td>0</td>
<td>2.87</td>
</tr>
</tbody>
</table>
TRIAXIAL SHEAR TEST

Project: Kaiser Steel Dike
Sunnyside, Utah

HOLE NO. 2
DEPTH: 3-6'
FIGURE NO. 15
March 30, 1984

Kaiser Steel Corporation
P.O. Box D
Sunnyside, UT 84539

Attn: Doug Pierce

Gentlemen:

This letter will supplement our report relative to the stability analysis of the Kaiser Steel dikes. In our report, submitted to you dated March 23, 1984, no consideration was given to the seismic stability of the existing dikes.

In the past, the earthquake stability of embankments have been assessed by applying a lateral force corresponding to some fraction of the gravitational acceleration. This procedure has been designated as a pseudo-static analysis, and the present state of the art in seismic stability analysis does not consider this procedure an acceptable method to determine the performance of an embankment under seismic conditions.

It is well known that loose, saturated sands and sensitive-type clays exhibit a substantial loss in strength when these materials are subjected to vibratory action; and massive failure usually accompanies seismic activity where such soils exist. The loss in strength in loose, saturated sands is due to the high pore pressures which develop in these materials under vibratory action and is termed liquefaction.

It should be noted that no groundwater was encountered in test holes drilled at either of the dikes during our investigations. Since the materials within the dikes are not saturated, the possibility of liquefaction of the subsurface materials is not possible. Furthermore, no sensitive-type clays were encountered in either of the test holes drilled in the dikes. As a consequence of this situation, the likelihood of a massive failure due to seismic activity is relatively remote for the existing dikes.

To further evaluate the seismic stability of the existing dikes, the comparison method developed by the Division of Water
Resources of the State of California has also been applied to the existing dikes. Figure No. 1, attached hereto, defines the basic criteria relative to the behavior of embankments according to the California method. It will be noted that the basic criteria includes the state of compaction, the peak ground acceleration, and the type of soils.

Based upon the results of the standard penetration tests performed in the refuse material in the two test holes drilled at this site, the existing materials appear to be in at least a medium-dense condition. In the area where the dikes are located, the U.S. Geological Survey has established that the acceleration, having a 90 percent probability of not being exceeded in 250 years is 0.2g. The material existing within the dikes would generally fall into Soil Group I according to the California Method. It is apparent from the table shown in Figure No. 1, that a medium-dense material having a peak acceleration equal to or less than 0.2g falls into Zone 7, which indicates that no stability problems will exist for the existing facilities under seismic activity.

Based upon the above considerations, it is our opinion that the potential for seismic instability is very low for the refuse dikes in this area. If there are any questions relative to the information contained above, please advise us.

Yours truly,

ROLLINS, BROWN AND GUNNELL, INC.

Ralph L. Rollins

RLR/lah

Enclosure
FIGURE NO. 1

<table>
<thead>
<tr>
<th>Relative Compaction (ASTM 1557)</th>
<th>Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Dense</td>
<td>100-95.0</td>
</tr>
<tr>
<td>Dense</td>
<td>91.3-94.9</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>88.7-91.2</td>
</tr>
<tr>
<td>Loose</td>
<td>88.6 or less</td>
</tr>
</tbody>
</table>

In many cases, the relative compaction testing was done using a standard other than ASTM 1557. However, Safety of Dams routinely faces this problem so conversion curves for various soils were included in the procedure.

In many cases the relative compaction testing was done using a standard other than ASTM 1557. However, Safety of Dams routinely faces this problem so conversion curves for various soils were included in the procedure.

Classify the level of acceleration.

**Peak Ground Acceleration**

- **Low** 0.2g or less
- **Medium** 0.21 to 0.39g
- **High** 0.40g or greater

It is noted that the duration of shaking was not used but should be in deciding borderline cases particularly for loose soils.

<table>
<thead>
<tr>
<th>Zones 1, 3, 4, 6</th>
<th>Borderline Zones - Cases that fall in these zones may or may not present a problem. A small investigative program is desirable to determine if there is a problem. Group III soils (clayey) might experience 0-5 percent settlement. There is some possibility for liquefaction of Groups I and II soils.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zones 2, 4, 5</td>
<td>Problem Zones - Cases that fall in these zones will usually present some type of problem. An investigative program would be very desirable. Settlement for Group II soils might range from 5-10 percent. Liquefaction for Groups I and II is very possible.</td>
</tr>
<tr>
<td>Zone 4</td>
<td>Real Problem Zone - An investigative program should be initiated immediately. Settlement for Group III soils might range from 10-20 percent. Probability of liquefaction for soil Groups I and II is very high.</td>
</tr>
<tr>
<td>Zone 7</td>
<td>No Problem - Cases that fall in this zone will normally not present any problems.</td>
</tr>
</tbody>
</table>

Predict behavior using the following chart.

<table>
<thead>
<tr>
<th>Acceleration</th>
<th>Low 0-0.2</th>
<th>Medium 0.21-0.39</th>
<th>High 0.40+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Dense</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Dense</td>
<td></td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

Classify the level of acceleration.

**Peak Ground Acceleration**

- **Low** 0.2g or less
- **Medium** 0.21 to 0.39g
- **High** 0.40g or greater

It is noted that the duration of shaking was not used but should be in deciding borderline cases particularly for loose soils.
February 18, 1985

Kaiser Steel Corporation
P.O. Box D
Sunnyside, UT 84539

ATTN: Roger Kohlman

Gentlemen:

As you have requested, we have performed a stability analysis for the exterior slope of East Slurry Cell for the Kaiser Steel Mine Near Sunnyside, Utah.

In performing the stability computations, a computer model of Spencer's Method has been used. Spencer's Method satisfies both force and moment equilibrium and is considered to be a satisfactory method of solving limiting equilibrium problems. The shear strength parameters used in the stability analysis are based on the results of laboratory tests performed for the report submitted to your office on March 25, 1984.

As requested, we have performed this analysis with the slope under saturated conditions. The analysis indicates that the slope under saturated conditions has a factor of safety of only 0.49, which is obviously insufficient for a stable slope. The results of the analysis along with the failure surface are presented on Figure No. 1.

If we can be of any further assistance, please notify us.

Sincerely,

ROLLINS, BROWN AND GUNNELL, INC.

Ralph L. Rollins

SLS: jbf
ENC
<table>
<thead>
<tr>
<th>ZONE</th>
<th>MATERIAL</th>
<th>C, pcf</th>
<th>$\phi$, degrees</th>
<th>Y, pcf</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Coal Refuse</td>
<td>0</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>II</td>
<td>Silty Sand, Silt-rich Silt</td>
<td>0</td>
<td>30</td>
<td>105</td>
</tr>
</tbody>
</table>

*Failure Surface - Saturated Condition*

F.S. = 0.49
APPENDIX 5-4
STABILITY ANALYSIS (ROLLINS, BROWN AND GUNNELL, INC.)
August 26, 1985

Kaiser Steel Corporation
P.O. Box D
Sunnyside, UT 84539

Attn: Roger Kohlman

Gentlemen:

It is our understanding that several small refuse pond dikes exist throughout the Kaiser Coal Operation where the sum of the upstream and downstream slopes are less than 5 horizontal to 1 vertical as required by the Utah Oil, Gas and Mining Division. We also understand that the Oil, Gas and Mining Division will approve the existing refuse ponds if the slopes have a factor of safety of 1.5 under operating conditions. The refuse ponds under consideration are known as the Coarse Refuse Toe Pond, the Old Coarse Refuse Pond, the Lower No. 2 Canyon Pond, the Pasture Canyon Pond and the Twin Shafts Pond. The location of the ponds is shown on a vicinity map in Figure No. 1

The purpose of this investigation was to determine the stability of the side slopes of the existing ponds under operating conditions. In performing the stability computations, a computer model of Bishop's Modified Method has been used for the analysis. Bishop's Method has been shown to be a satisfactory procedure for evaluating slope stability problems. Shear strength parameters characteristic of the materials existing within the embankment and the foundation have been used in the stability computations for each refuse pond. A description of the procedures used in performing the stability analysis for each of the ponds indicated above along with the results obtained is outlined in the following sections of this report:
1. COARSE REFUSE TOE POND

A typical cross section through the maximum section of the Coarse Refuse Toe Pond is presented in Figure No. 2. In order to evaluate the characteristics of the subsurface material within the existing dike, one test boring was drilled through the center of the dike to a depth of 20 feet below the crest of the dike. The log for this test hole is presented in Figure No. 3. It will be observed that the profile at this location consists of a low-plasticity clay to a depth of approximately 13.5 feet followed by a gravelly silty sand which extended to a depth of about 17.5 feet. Weathered shale was encountered immediately beneath the gravelly silty sand.

During the subsurface investigation sampling was performed at 5-foot intervals throughout the depth investigated. Undisturbed samples of the silty clay were obtained at the ground surface at a depth of 5 feet and at a depth of 10 feet below the crest of the dam. The in-place unit weight and the natural moisture content were determined for samples at 5 and 10 feet below the crest of the structure and the results of these tests are presented on the boring logs. It will be noted that in-place unit weights of 118.7 and 125.1 were obtained at this structure. The placement moisture content varied from 7.5 to 8.1 percent. Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. A description of the Unified Soil Classification System is presented in Figure No. 4 and the meaning of the various symbols shown on the boring logs can be obtained from this figure. It will be noted that the subsurface materials within the embankment generally classify as a CL-1 or as a CL-2 material.

Standard penetration tests performed in the gravelly material in the lower portion of the soil profile at this site indicate that the gravelly material is in a medium-dense state. The granular material generally classifies as an SM or a GM-type material according to the Unified Soil Classification System. Laboratory tests performed on the embankment material at this site to define its physical characteristics included classification tests, moisture density tests and direct shear tests. The results of the classification tests performed on samples of the embankment material are presented in Table No. 1, Summary of Test Data. It will be noted that the maximum plasticity index of the cohesive material in the embankment was 17.5 which indicates that the materials within the embankment are not highly plastic materials. The results of the moisture density tests performed on samples of the subsurface material from Drill Hole No. 1 are
presented in Figure No. 5 and it will be observed that the maximum dry density for this material was 109.0 pounds per square foot.

In order to obtain an indication of the shearing strength of this material, consolidated drained direct shear tests were performed on samples obtained at 5 feet and 10 feet below the crest of the embankment. Three direct shear tests were performed at each of the depths indicated above. The results of these tests are presented in the form of a Mohr envelope in Figure Nos. 6 and 7. It will be observed that the friction angle of the material ranged from 27.9 to 32.6 degrees while the cohesion varied from 5 to 6 psi. In performing the consolidated drained direct shear tests, each sample was saturated by back pressure techniques prior to performing the tests in order to obtain an indication of the shearing strength under operating conditions.

A stability analysis was performed for the Toe Pond embankment assuming steady state flow conditions for the downstream face and sudden drawdown conditions for the upstream face. The results of the stability analysis performed for the downstream face, assuming a friction angle of 29 degrees and a cohesion of 150 pounds per square foot, indicates a factor of safety of 1.01. The piezometric surface assumed for this case is presented in Figure No. 2. Since this cross section does not meet the requirements of the Oil, Gas and Mining Division, the downstream slope was modified by placing a berm along the downstream toe as indicated in Figure No. 2. Assuming that the berm on the downstream toe was granular type material, the results of the stability computation for this section indicated a factor of safety of approximately 1.5. It is our recommendation that the downstream face of the structure be modified by placing a berm along the toe as shown in Figure No. 2.

In performing the stability analysis for the upstream slope under sudden drawdown conditions, a friction angle of 29 degrees and a cohesion of 150 pounds per square foot was used in the analysis. The results of the stability computations indicate a factor of safety of 1.73. It is generally recognized that a factor of safety of 1.3 is satisfactory for the upstream face under sudden drawdown conditions. It is apparent, therefore, that the existing upstream face will be stable for the conditions indicated.
2. **TWIN SHAFTS REFUSE POND**

A typical cross section for the Twin Shafts Refuse Pond dike is presented in Figure No. 8. It will be observed that this dike is only 10 feet high. The characteristics of the subsurface material within the embankment and the foundation were defined by excavating the test pits through the embankment and 10 feet into the foundation. The test pit logs for these two holes are presented in Figure No. 9. It will be noted that the subsurface material throughout the profile for this facility consists of brown gravelly sandy silt in the upper 15 feet of the soil profile and a brown silty gravel in the lower portion of the foundation zone.

Sampling was performed at 3-foot intervals throughout the depth investigated in each of these test pits. The in-place unit weight and the in-place moisture content were determined at each sampling location and the results of these tests are shown on the test pit logs. It will be noted that the in-place unit weight of the embankment material was approximately 108 pounds per cubic foot while the in-place unit weight of the sandy silt in the foundation was about 91 pounds per cubic foot. The in-place unit weight of the silty gravel in the lower portion of the foundation varied from 126 to 128 pounds per cubic foot.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating "the soil type according to this system is presented on the test pit logs and it will be observed that the fine-grained material generally classified as an SM or a CL-ML type material, while the silty gravel generally classified as a GM or a GP type soil. Classification tests were performed on several samples from Test Pit Nos. 1 and 2 and the results of these tests are presented in Table No. 1.

In order to obtain an indication of the shearing strength of the subsurface material, consolidated drained direct shear tests were performed on the embankment material at a depth of 6 feet below the crest and on the foundation material at a depth of 3 feet below the bottom of the embankment. All direct shear test samples were saturated by back pressure techniques prior to performing the tests. The results of these tests expressed in the form of Mohr envelopes are presented in Figure Nos. 10 and 11. It will be observed that the embankment material had a friction angle of 34.6 degrees and a cohesion of 3 psi, while the foundation material had a friction angle of 32.4 degrees and a cohesion of 3 psi. All of the samples for the direct shear tests...
performed for this facility were densified to an in-place unit weight corresponding to the in-place densities determined during the field investigations.

A stability analysis was performed for the downstream slope assuming steady state flow conditions and for the upstream slope assuming sudden drawdown. The piezometric surface assumed for each of these conditions is presented in Figure No. 8. The results of the stability analysis indicates a factor of safety of 1.53 for the downstream slope assuming a friction angle of 32 degrees and a cohesion of 50 psf. Since the shear strength parameters used in the analysis is well below those determined in the direct shear tests, it is our opinion that the downstream slope for this facility has a factor of safety of greater than 1.5 under steady state flow conditions.

The results of the stability analysis for the upstream slope indicates a factor of safety of 1.44 assuming a friction angle of 32 degrees and a cohesion of 50 pounds per square foot. Since the factor of safety for the upstream slope is greater than 1.3, it is our opinion that this facility is stable for the case of sudden drawdown.

3. OLD COARSE REFUSE POND

The cross section for the Old Coarse Refuse Pond is presented in Figure No. 12. The characteristics of the subsurface material in the foundation area for this structure are defined by Test Pit No. 3, while the characteristics of the subsurface material throughout the embankment is defined by Test Pit No. 5. The logs for these test pits are shown in Figure No. 13. It will be noted that the subsurface material generally consists of broken shale particles intermixed with sandy silt.

During the subsurface investigation sampling was performed at 3-foot intervals in both the embankment pit and the foundation pit. The in-place unit weight and the in-place moisture content were determined at each sampling location and the results of these tests are shown on the test pit log. It will be noted that the embankment material generally varied from 118.5 pounds per cubic foot to 105 pounds per cubic foot, while the foundation material varied from 112 pounds per cubic foot to 126 pounds per cubic foot.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system is presented on the test pit logs.
Soil Classification System is presented in Figure No. 4 and the meaning of the various symbols shown on the test pit logs can be obtained from this figure. It will be noted that the subsurface material in the upper portion of the embankment generally classifies as a CL-ML type material, while the subsurface material in the lower portion of the embankment and in the foundation classifies as a CL-1 type soil. This means that all of the subsurface material for this facility have low-plasticity characteristics.

Laboratory tests performed to define the characteristics of the embankment and the foundation material at this site included classification tests, moisture density relationships and direct shear tests. Results of the classification tests are presented in Table No. 1, Summary of Test Data. It will be observed that the plastic index of the material within the embankment and the foundation is generally less than 12 percent which indicates that these materials have low-plasticity characteristics.

A moisture density test was performed on a representative sample of the existing embankment material and the results of this test are presented in Figure No. 14. It will be noted that the maximum density is approximately 123 pounds per cubic foot and that the optimum moisture content is about 10.4 percent.

In order to obtain an indication of the shearing strength of the embankment and the foundation material for this facility, several consolidated drained direct shear tests were performed on representative samples of the embankment and the foundation materials. The samples used in the test were densified to an in-place unit weight approximately equal to the density observed in the field. The samples were then saturated by back pressure techniques prior to performing the tests. The results of the tests for both the embankment and the foundation material expressed in the form of a Mohr envelope are presented in Figure Nos. 15 and 16. It will be observed that a friction angle of 32.4 degrees and a cohesion of 4 psi was obtained for the embankment material, and a friction angle of 33 degrees and a cohesion of 4 psi was obtained for the foundation material.

A stability analysis was performed for the downstream slope under steady state flow conditions and for the upstream slope for sudden drawdown conditions. The results of the analysis indicate a factor of safety of 1.5 for the downstream slope using a friction angle of 32 degrees and a cohesion of 125 pounds per square foot. A factor of safety of 1.46 was obtained for the upstream slope under sudden drawdown conditions assuming the same shear strength parameters indicated above for the downstream
slope. The piezometric surfaces used in the analysis are shown in Figure No. 12. Based upon these calculations, it is our opinion that both the upstream and the downstream slope will be stable under operating conditions.

4. LOWER NO. 2 CANYON POND

The cross section for the Lower No. 2 Canyon Pond dike is presented in Figure No. 17. In order to define the characteristics of the subsurface materials at this location two test pits were excavated. The logs for these test pits are presented Figure No. 18. Test Pit No. 6 was excavated at the crest of the embankment to a depth of 10 feet. The material types in the embankment are generally silty sandy gravel or silty sand. Test Pit No. 9 was excavated in the foundation materials at the toe of the embankment. It will be observed that the materials in the foundation generally consist of silty sands with some gravel.

During the subsurface investigation sampling was performed at 3-foot intervals in both the embankment test pit and foundation test pit. The in-place unit weight and the natural moisture content were determined at each sampling location and the results of these tests are presented on the test pit logs. It will be noted that the embankment materials had an in-place unit weight varying from 91.1 to 107.6 pounds per cubic foot, while the moisture content ranged from 8.2 to 17.7 percent. The in-place unit weight of the silty sands in the foundation varied from 91.9 to 99 pounds per cubic foot, while the moisture content was generally between 13 and 16 percent.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system is shown on the test pit log. A description of the Unified Soil Classification System is presented in Figure No. 4 and the meaning of the various symbols shown on the log can be obtained from this figure. It will be noted that the subsurface materials in the embankment classify either as GM or SM type materials, while the foundation soils had an SM classification.

Field and laboratory tests performed to define the characteristics of the embankment and the foundation materials at this site included classification tests, moisture density relationships and direct shear tests. Results of the classification tests are presented in Table No. 1, Summary of Test Data. It will be observed that the embankment materials contain between 19 and 27 percent in the silt and clay size range. Moisture density relationships were determined on representative samples.
from Test Pit Nos. 6 and No. 9 in order to obtain an indication of a degree of compaction of materials in the embankment and the foundation. Results of these tests are presented in Figure Nos. 19 and 20. It will be observed that the existing embankment materials obtained from Test Pit No. 6 had a maximum dry density of 114 pounds per cubic foot with an optimum moisture content of 12 percent. The foundation materials obtained from Test Pit No. 9 had a maximum dry density of 115.4 pounds per cubic foot with an optimum moisture content of 10.2 percent.

In order to obtain an indication of the shearing strength of the embankment materials for this structure, three consolidated drained direct shear tests were performed on representative samples of the embankment material obtained from Test Pit No. 6 at a depth of 3 feet. The samples used in the test were densified to an in-place unit weight approximately equal to the density measured in the field. The samples were then saturated by back pressure techniques prior to performing the tests. The results of the tests performed on the embankment are presented in the form of a Mohr envelope in Figure No. 21. This test indicates that the embankment materials have a friction angle of 34.6 degrees with a cohesion intercept of 2 psi.

A stability analysis was performed for the downstream slope under steady state seepage conditions and for the upstream slope under sudden drawdown conditions. Results of the analysis indicate a factor of safety of 1.5 for the downstream slope using a friction angle of 32 degrees and a cohesion value of 75 pounds per square foot. A factor of safety of 2.04 was obtained for the upstream slope under sudden drawdown conditions assuming the same shear strength parameters as indicated for the downstream slope. Based upon this analysis, it is our opinion that both the upstream and downstream slope will be stable under operating conditions.

5. PASTURE CANYON ROAD

The cross section for the Pasture Canyon Pond is presented in Figure No. 22. The characteristics of the subsurface materials were defined by excavating two test pits. Test Pit No. 7 was excavated at the crest of the embankment to a depth of 10 feet, and Test Pit No. 8 was excavated in the foundation materials at the toe of the embankment. The logs for the two test pits are shown in Figure No. 23. It will be observed that the subsurface materials generally consist of silty sands both in the embankment and the foundation.
During the subsurface investigation sampling was performed at 3-foot intervals in both the embankment test pit and the foundation test pit. In-place unit weight and natural moisture content were determined for each of the samples obtained during the investigation. The in-place unit weight of the embankment materials varied between 86.3 and 101.2 pounds per cubic foot while the moisture content varied between 6.7 and 15.1 percent. The in-place unit weight of the foundation materials varied from 94.5 to 102.6 pounds per cubic foot, while the moisture content was between 12 to 14 percent.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system is presented on the test pit logs. A description of the Unified Soil Classification System is presented in Figure No. 4 and the meaning of the symbols shown on the test pit logs can be obtained from this figure. It will be noted that the subsurface materials in the embankment and the foundation all classified as either SM or ML type soils indicating that the sands have greater than 15 percent in the silt and clay size range.

Laboratory tests performed to define the characteristics of the embankment and foundation materials at this site included classification tests, moisture density relationships and direct shear tests. Results of the classification tests are presented in Table No. 1, Summary of Test Data. It will be observed that the percentage of the sample in the silt and clay size range varied from 18.4 and 40.6 percent. A moisture density test was performed on a representative sample of the existing embankment material obtained from Test Hole No. 7 and the results of this test are presented in Figure No. 24. It will be noted that the maximum density is approximately 117 pounds per cubic foot with an optimum moisture content of 12.2 percent. This test was performed according to ASTM D 698 specifications and the maximum density is significantly higher than that of the embankment materials.

In order to obtain an indication of the shearing strength of the embankment and the foundation materials for this earth structure, consolidated drained direct shear tests were performed on representative samples obtained from Test Hole Nos. 7 and 8. Samples used in the test were densified to an in-place unit weight approximately equal to the density observed in the field. Samples were then saturated by back pressure techniques to simulate the conditions under which they will exist under operating conditions. The results of the tests for both the embankment and foundation materials are expressed in the form of...
Kaiser Steel Corporation  
Page 10  
August 26, 1985  

A Mohr strength envelope and are presented in Figure Nos. 25 and 26. For the embankment materials from Test Pit No. 7, the direct shear test indicates a friction angle of 33 degrees with a cohesion of 3 psi, while for the foundation materials from Test Pit No. 8, the direct shear test indicates a friction angle of 32 degrees with a cohesion of 2 psi.

A stability analysis was performed for the downstream slope under steady state seepage conditions and for the upstream slope under sudden drawdown conditions. The results of the analysis indicate a factor of safety of 1.53 for the downstream slope using a friction angle of 32 degree and a cohesion of 75 psf. A factor of safety of 1.33 was obtained for the upstream slope under sudden drawdown conditions. The piezometric surface under steady state and sudden drawdown conditions is shown in Figure No. 22. Based upon the slope stability calculations, it is concluded that both the upstream and downstream slope will be stable under operating conditions without any modification of the existing cross section.

The conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests which in our opinion define the characteristics of the subsurface materials in a reasonable manner. Should you have any questions regarding the investigation or analysis procedures, please feel free to call.

Yours truly,

ROLLINS, BROWN AND GUNNELL, INC.

[Signature]
Ralph L. Rollins

RLR/jbt
CR. TOE POND
DRILL HOLE #1

X, 109.5, 6.3
CL-1
Gray Silty Clay

X, 118.7, 7.5
CL-2
Gray Silty Clay

X, 125.1, 8.1
CL-2

15

24,11,13
2003
GM
17,20,24
SM

Gravelly Silty Sand
Weathered Shale
Possible Bedrock

KEY

sample location

X .030
torvane value
undisturbed sample

5,5,5 no. of blows per 6" with std. spoon

groundwater elevation
## Unified Soil Classification System

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Group Symbols</th>
<th>Typical Names</th>
<th>Laboratory Classification Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse Grained Soils</td>
<td>GW</td>
<td>Well graded gravel, gravel-sand mixtures, little or no fines.</td>
<td>[ C_u = \frac{D_{max}}{D_{min}} ] Greater than 4</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly graded gravel, gravel-sand mixtures, little or no fines.</td>
<td>[ C_e = \frac{(D_{min})^2}{D_{max} \times D_{min}} ] Between 1 and 3</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty gravel, poorly graded gravel-sand-clay mixtures</td>
<td>Not meeting all gradation requirements for GW</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey gravel, poorly graded gravel-sand-clay mixtures</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>SW</td>
<td>Well graded sands, gravelly sands, little or no fines.</td>
<td>Atterberg limits below &quot;A&quot; line, or Pl less than 4</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>Poorly graded sands, gravelly sands, little or no fines.</td>
<td>Atterberg limits above &quot;A&quot; line, or Pl greater than 7</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td>Silty sands, poorly graded sand-silt mixtures</td>
<td>[ C_u = \frac{D_{max}}{D_{min}} ] Greater than 6</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>Clayey sands, poorly graded sand-clay mixtures</td>
<td>[ C_e = \frac{(D_{min})^2}{D_{max} \times D_{min}} ] Between 1 and 3</td>
</tr>
<tr>
<td>Fine Grained Soils</td>
<td>ML</td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity</td>
<td>Not meeting all gradation requirements for SW</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays</td>
<td>Atterberg limits below &quot;A&quot; line, or Pl less than 4</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silts and organic silt-clays of low plasticity</td>
<td>Atterberg limits above &quot;A&quot; line, or Pl greater than 7</td>
</tr>
<tr>
<td></td>
<td>MH</td>
<td>Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Inorganic clays of high plasticity, fat clays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OH</td>
<td>Organic clays of medium to high plasticity; organic silts</td>
<td></td>
</tr>
<tr>
<td>Highly Organic Soils</td>
<td>P1</td>
<td>Peat and other highly organic soils</td>
<td></td>
</tr>
</tbody>
</table>

*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is greater than 28% and the PI is 6 or less; the suffix u used when liquid limit is greater than 28% and the PI is 8 or less.*

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

---

**Figure No. 4**

**Laboratory Classification Criteria**

- **Clay Index (CI):**
  - CI = (Plasticity Index - Liquid Limit) / 2

**Plasticity Chart**

For laboratory classification of fine-grained soils.
SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698
Maximum Density 109.0 lbs. per cubic foot
Optimum Moisture 12.4 %
### Direct Shear Test

**Project:** CR. TOE POND<br>CR COAL<br>**Hole No:** Drill Hole No. 1<br>**Depth:** 5' - 6'

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>2</td>
<td>118.7</td>
<td>7.5</td>
<td>100</td>
<td>26.5</td>
<td>19.8</td>
<td>0.0047</td>
</tr>
<tr>
<td>□</td>
<td>2</td>
<td>118.7</td>
<td>7.5</td>
<td>100</td>
<td>53.4</td>
<td>32.3</td>
<td>0.0047</td>
</tr>
<tr>
<td>△</td>
<td>2</td>
<td>118.7</td>
<td>7.5</td>
<td>100</td>
<td>78.4</td>
<td>46.7</td>
<td>0.0047</td>
</tr>
</tbody>
</table>

- **Normal stress** $\sigma_n$ (psi)
- **Degree of saturation** (%)
- **Sample data**
- **Horizontal displacement** $\delta_h$ (in x 10^-2)
- **Shear stress** $\tau$ (ps)
- **Friction angle** $\phi$ (degrees)
- **Cohesion** (c / psi)

---

**Note:** The diagrams illustrate the relationship between shear stress and normal stress, along with other parameters derived from the test results.

**Graphs:**
- Left: Shear stress vs. Horizontal displacement $\delta_h$ (in x 10^-2)
- Right: Shear stress $\tau$ vs. Normal stress $\sigma_n$ (psi)

**Units:**
- Horizontal displacement: $\delta_h$ (in x 10^-2)
- Shear stress: $\tau$ (psi)
- Normal stress: $\sigma_n$ (psi)

**Data Table:**

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>2</td>
<td>118.7</td>
<td>7.5</td>
<td>100</td>
<td>26.5</td>
<td>19.8</td>
<td>0.0047</td>
</tr>
<tr>
<td>□</td>
<td>2</td>
<td>118.7</td>
<td>7.5</td>
<td>100</td>
<td>53.4</td>
<td>32.3</td>
<td>0.0047</td>
</tr>
<tr>
<td>△</td>
<td>2</td>
<td>118.7</td>
<td>7.5</td>
<td>100</td>
<td>78.4</td>
<td>46.7</td>
<td>0.0047</td>
</tr>
</tbody>
</table>

**Parameters:**
- Friction angle $\phi$ (degrees)
- Cohesion (c / psi)

**Figure No. 6**
Horizontal displacement, $\delta_h$ (in. x 10^-2)

Normal stress, $\sigma_n$ (psi)

Shear stress, $\tau$ (psi)

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>125.1</td>
<td>8.1</td>
<td>100</td>
<td>25.5</td>
<td>22.7</td>
<td>0.0047</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>125.1</td>
<td>8.1</td>
<td>100</td>
<td>52.9</td>
<td>40.1</td>
<td>0.0047</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>125.1</td>
<td>8.1</td>
<td>100</td>
<td>78.0</td>
<td>56.6</td>
<td>0.0047</td>
</tr>
</tbody>
</table>

Friction angle $\phi$ (degrees) | Cohesion (c/psi) | 32.6 | 6.0

$\phi = 32.6^\circ$
Steady State Piesometric Surface

Sudden Drawdown Piesometric Surface

Gravely Sandy Silt

Critical Failure Surface
Steady State Case
F.S. = 1.53

Critical Failure Surface
Sudden Drawdown Case
F.S. = 1.28

Silty Gravel

1" = 5'
**DIRECT SHEAR TEST**

**Sample data**
- **Sample size (inches)**: 2
- **Dry density (pcf)**: 108.1
- **Moisture content (%):** 11.4
- **Degree of saturation (%):** 100
- **Normal stress \( \sigma_{n} \) (psi):** 26.5
- **Shear stress \( \tau \) (psi):** 21.5
- **Maximum shear stress \( \tau \) (psi):** 52.9
- **Strain rate (inches/minute):** 38.6
- **Friction angle \( \phi \) (degrees):** 34.6
- **Cohesion (c/psi):** 3.0

**Graphs**
- Normal stress vs. shear stress
- Horizontal displacement vs. shear stress

**Figure No. 1**

**Project:** TWIN SHAFTS REFUSE POND KAI COAL

**Hole No.:** EMBANKMENT (TP.1)

**Depth:** 6'
### Test Sample Parameters

<table>
<thead>
<tr>
<th>Test no.</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>90.8</td>
<td>18.8</td>
<td>100</td>
<td>26.4</td>
<td>19.3</td>
<td>0.0047</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>90.8</td>
<td>18.8</td>
<td>100</td>
<td>53.1</td>
<td>36.4</td>
<td>0.0047</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>90.8</td>
<td>18.8</td>
<td>100</td>
<td>28.2</td>
<td>52.6</td>
<td>0.0047</td>
</tr>
</tbody>
</table>

Friction angle $\phi$ (degrees): 32.4

Cohesion ($c$/psi): 3.0

---

**Figure**

**Horizontal displacement, $\delta_h$ (in. x 10^-2)**

**Vertical displacement, $\delta_v$ (in. x 10^-2)**

**Shear stress, $\tau$ (psi)**

**Normal stress, $\sigma_n$ (psi)**

**Phases**

- Rollins, Brown and Gunnell, Inc.
- Professional Engineers

**Project**

- Twin Shafts Refuse Pond
- Kaiser Coal

**Hole No.**

- Foundation (TP 2)

**Depth**

- 3'
Depth

OLD COARSE REFUSE POND FOUNDATION (TP.3)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>talus and weathered broken shale</td>
</tr>
<tr>
<td>126.3,9.1</td>
<td>CL-1</td>
</tr>
<tr>
<td>5</td>
<td>bedrock broken shale</td>
</tr>
<tr>
<td>112.3,8.4</td>
<td>CL-1</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>110.5,5.6</td>
<td></td>
</tr>
</tbody>
</table>

OLD COARSE REFUSE POND EMBANKMENT (TP.5)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>brown broken shale mixed with sand and silt</td>
</tr>
<tr>
<td>118.5,8.9</td>
<td>CL-ML</td>
</tr>
<tr>
<td>105.5,9.7</td>
<td>CL-ML</td>
</tr>
<tr>
<td>106.6,8.9</td>
<td>CL-1</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

KEY

- Sample location
- Torvane value
- Undisturbed sample
- No. of blows per 6" with std. spoon
- Groundwater elevation

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FEB 04 2003
DIV OF OIL GAS & MINING

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS
SOIL MOISTURE DENSITY RELATIONSHIP

ASTM D-698

Maximum Density 123.2 lbs. per cubic foot

Optimum Moisture 10.5 %

Dry Unit Weight in lbs. per cubic foot

Moisture in Percent

Rollins, Brown and Gunnell, Inc.
Professional Engineers

Project: Old Coarse Refuse Pond
Kaiser Coal
Location: 

Figure No. 14

FEB 04 2003
DIV OF OIL GAS & MINING

Incorporated
**Direct Shear Test**

**Project:** OLD COURSE REFUSE POND

**Kaiser Coal**

**HOLE NO:** EMBANKMENT (TP5)

**DEPTH:** 6 ft

**Figures:**

1. **Horizontal displacement, \( \delta_n \) (in. \( \times 10^{-2} \))
2. **Shear stress, \( \tau \) (psi)
3. **Normal stress, \( \sigma_n \) (psi)

**Table:**

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress ( \sigma_n ) (psi)</th>
<th>Maximum shear stress ( \tau ) (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bullet )</td>
<td>2</td>
<td>106.0</td>
<td>9.7</td>
<td>100</td>
<td>26.5</td>
<td>20.9</td>
<td>0.0047</td>
</tr>
<tr>
<td>( \square )</td>
<td>2</td>
<td>106.0</td>
<td>9.7</td>
<td>100</td>
<td>53.1</td>
<td>37.8</td>
<td>0.0047</td>
</tr>
<tr>
<td>( \triangle )</td>
<td>2</td>
<td>106.0</td>
<td>9.7</td>
<td>100</td>
<td>78.2</td>
<td>53.9</td>
<td>0.0047</td>
</tr>
</tbody>
</table>

Friction angle \( \phi \) (degrees): 32.4

Cohesion (c/psi): 4.0
The image contains a graph showing the relationship between normal stress and shear stress for different test numbers. The data for each test is listed in a table below the graph. The graph is titled "Direct Shear Test" and the data includes test numbers, symbol, sample size, dry density, moisture content, degree of saturation, normal stress, maximum shear stress, strain rate, and shear strength parameters.

Table:

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Friction angle $\phi$ (degrees)</th>
<th>Cohesion (c/psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\circ$</td>
<td>2</td>
<td>112.3</td>
<td>8.4</td>
<td>100</td>
<td>24.2</td>
<td>20.1</td>
<td>0.0047</td>
<td>33.0</td>
</tr>
<tr>
<td>$\square$</td>
<td>2</td>
<td>112.3</td>
<td>8.4</td>
<td>100</td>
<td>52.4</td>
<td>38.0</td>
<td>0.0047</td>
<td>33.0</td>
</tr>
<tr>
<td>$\triangle$</td>
<td>2</td>
<td>112.3</td>
<td>8.4</td>
<td>100</td>
<td>78.2</td>
<td>55.4</td>
<td>0.0047</td>
<td>4.0</td>
</tr>
</tbody>
</table>

The graph also includes a key point $\phi = 33.0^\circ$.
Steady State Piezometric Surface

Sudden Drawdown Piezometric Surface

Critical Failure Surface
Steady State Seepage
F.S. = 1.51

Silty Sand with Gravel and Coal

Critical Failure Surface
Sudden Drawdown Case
F.S. = 2.04

Silty Sand

FIGURE

NO 17

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

KAISER COAL REFUSE POND STABILITY STUDY
LOWER NO. 2 CANYON POND
**LOWER NO. 2 CANYON POND FOUNDATION (TP.9)**

**LOWER NO. 2 CANYON POND EMBANKMENT (TP.6)**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Sample Location</th>
<th>Sample Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>99.0,16.2</td>
<td>SM</td>
<td>dark brown silty sand with very little gravel</td>
</tr>
<tr>
<td>5</td>
<td>93.9,14.1</td>
<td>SM</td>
<td>light brown silty gravelly sand (loose)</td>
</tr>
<tr>
<td>10</td>
<td>91.9,13.6</td>
<td>SM</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>107.6,8.2</td>
<td>GM</td>
<td>silty sand and gravel</td>
</tr>
<tr>
<td>5</td>
<td>96.1,14.8</td>
<td>SM</td>
<td>brown silty sand with some gravel</td>
</tr>
<tr>
<td>10</td>
<td>91.1,15.2</td>
<td>GM</td>
<td>some coal as gravel</td>
</tr>
<tr>
<td>15</td>
<td>98.1,17.7</td>
<td>SM</td>
<td></td>
</tr>
</tbody>
</table>

**KEY**

- Sample location
- Torvane value
- Undisturbed sample
- 5,6,6 no. of blows per 6" with std. spoon
- Groundwater elevation

---

**ROLLINS, BROWN AND GUNNELL, INC.**  
PROFESSIONAL ENGINEERS

Log of Boring for:  
LOWER NO. 2 CANYON POND  
KAISER COAL

Figure No. 18
SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698
Maximum Density 114.0 lbs. per cubic foot
Optimum Moisture 12.0 %

DRY UNIT WEIGHT IN LBS. PER CUBIC FOOT

MOISTURE IN PERCENT

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

Project:
LOWER NO. 2 CANYON POND
KAISER COAL
Location:

Figure No. 19
SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D698
Maximum Density 115.5 lbs. per cubic foot
Optimum Moisture 10.6 %

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

Project:
LOWER NO 2 CANYON POND
KAISER COAL
Location:
Figure No. 20
### Shear Stress vs. Normal Stress

#### Graph Description:
- **Shear stress (τ)** vs. **Normal stress (σ)**
- A linear relationship is observed, with a slope indicating the angle of internal friction (φ).
- The graph shows data points and a trend line.
- The angle of internal friction (φ) is marked as 34.6°.

### Sample Data Table

<table>
<thead>
<tr>
<th>Test No. or Symbol</th>
<th>Sample Size (inches)</th>
<th>Sample Data</th>
<th>Degree of Saturation (%)</th>
<th>Normal Stress σ_n (psi)</th>
<th>Maximum Shear Stress τ (psi)</th>
<th>Strain Rate (inches/minute)</th>
<th>Shear Strength Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>o</td>
<td>2</td>
<td>96.1</td>
<td>14.8</td>
<td>100</td>
<td>26.5</td>
<td>20.3</td>
<td>0.0071</td>
</tr>
<tr>
<td>□</td>
<td>2</td>
<td>96.1</td>
<td>14.8</td>
<td>100</td>
<td>52.8</td>
<td>38.6</td>
<td>0.0071</td>
</tr>
<tr>
<td>△</td>
<td>2</td>
<td>96.1</td>
<td>14.8</td>
<td>100</td>
<td>78.9</td>
<td>56.3</td>
<td>0.0071</td>
</tr>
</tbody>
</table>

---

**Note:** The table includes key parameters for each test sample, providing a comprehensive view of the shear strength analysis results.
<table>
<thead>
<tr>
<th>Depth</th>
<th>PASTURE CANYON POND EMBANKMENT (TP7)</th>
<th>PASTURE CANYON POND FOUNDATION (TP8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>99.5, 6.7 ML</td>
<td>94.5, 13.2 SM</td>
</tr>
<tr>
<td></td>
<td>tan gravelly silty sand</td>
<td>tan silty sand with some gravel</td>
</tr>
<tr>
<td>5</td>
<td>101.2, 10.6 SM</td>
<td>some gravel as coal</td>
</tr>
<tr>
<td></td>
<td>some coal</td>
<td>97.4, 12.1 SM</td>
</tr>
<tr>
<td></td>
<td>some gravel as gravel</td>
<td>102.6, 13.8 SM</td>
</tr>
<tr>
<td>10</td>
<td>86.3, 12.1 SM</td>
<td>100.2, 15.1 SM</td>
</tr>
<tr>
<td></td>
<td>some coal</td>
<td>SH SM</td>
</tr>
<tr>
<td>15</td>
<td>102.2, 15.1 SM</td>
<td>100.2, 15.1 SM</td>
</tr>
<tr>
<td>20</td>
<td>85.3, 12.1 SM</td>
<td>100.2, 15.1 SM</td>
</tr>
</tbody>
</table>

**KEY**
- sample location
- X, Y = torvane value
- undisturbed sample
- 5.6.6 = no. of blows per 6" with std. spoon
- groundwater elevation

**INTEGRATED**

**FEB 04 2003**

**DIV OF OIL GAS & MINING**

**ROLLINS, BROWN AND GUNNELL, INC.**

**PROFESSIONAL ENGINEERS**

Log of Boring Inc:
- PASTURE CANYON POND
- KAISER COAL

**Figure No. 23**
SOIL MOISTURE DENSITY RELATIONSHIP
ASTM D-698
Maximum Density 117.0 lbs. per cubic foot
Optimum Moisture 12.2 %

DRE UNIT WEIGHT IN LBS. PER CUBIC FOOT

108 110 112 114 116 118

MOISTURE IN PERCENT

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

Project: DIV OF OIL, GAS & MINING
PASTURE CANYON POND
KAISER COAL

Location: FEB 04 2003
Figure No. 24

INTEGRATED
**Figure 25**

**Direct Shear Test**

- **Project:** Pasture Canyon Pond
- **Hole No.:** Embankment (TP7)
- **Depth:** 6'

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress σn (psi)</th>
<th>Maximum shear stress τ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>2</td>
<td>86.3</td>
<td>12.1</td>
<td>100</td>
<td>26.6</td>
<td>20.8</td>
<td>0.0071</td>
</tr>
<tr>
<td>△</td>
<td>2</td>
<td>86.3</td>
<td>12.1</td>
<td>100</td>
<td>52.6</td>
<td>37.3</td>
<td>0.0071</td>
</tr>
<tr>
<td>□</td>
<td>2</td>
<td>86.3</td>
<td>12.1</td>
<td>100</td>
<td>78.2</td>
<td>55.1</td>
<td>0.0071</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Friction angle φ (degrees)</th>
<th>Cohesion (c/psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.4</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Graph 1:**
- Horizontal displacement, δh (in. x 10^-2)

**Graph 2:**
- Normal stress, σn (psi)
- Shear stress, τ (psi)

**Graph 3:**
- Dry density (pcf)
- Moisture content (%)

**Legend:**
- ○
- □
- △
<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample size (inches)</td>
<td>Dry density (pcf)</td>
<td>Moisture content (%)</td>
<td></td>
<td></td>
<td>Friction angle $\phi$ (degrees)</td>
</tr>
<tr>
<td>○</td>
<td>2</td>
<td>97.4</td>
<td>12.1</td>
<td>100</td>
<td>26.5</td>
<td>20.4</td>
</tr>
<tr>
<td>□</td>
<td>2</td>
<td>97.4</td>
<td>12.1</td>
<td>100</td>
<td>53.1</td>
<td>36.6</td>
</tr>
<tr>
<td>△</td>
<td>2</td>
<td>97.4</td>
<td>12.1</td>
<td>100</td>
<td>79.1</td>
<td>55.5</td>
</tr>
</tbody>
</table>

Horizontal displacement, $\delta_n$ (in x 10^{-2})

Normal stress, $\sigma_n$ (psi)

Shear stress, $\tau$ (psi)

Direct shear test

Pasture Canyon Pond Coal

Hole No. Foundation (TPB) Depth: 6'

Figure No. 26
Table No. 1  SUMMARY OF TEST DATA

KAISER COAL REFUSE PONDS

<table>
<thead>
<tr>
<th>HOLE NO</th>
<th>DEPTH BELOW GROUND SURFACE</th>
<th>STANDARD PENETRATION BLOWS PER FOOT</th>
<th>IN-PLACE</th>
<th>UNCONFINED COMPRRESSIVE STRENGTH (lb/ft²)</th>
<th>FRICTION ANGLE (°)</th>
<th>CONSISTENCY LIMITS</th>
<th>MECHANICAL ANALYSIS</th>
<th>UNIFIED SOIL CLASSIFICATION SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unit Weight (lb/ft³)</td>
<td>Moisture (%)</td>
<td>Void Ratio</td>
<td>LL (%)</td>
<td>PL (%)</td>
<td>PI (%)</td>
<td>% Gravel</td>
</tr>
<tr>
<td>DH-1</td>
<td>1.0'-2.0'</td>
<td>109.5</td>
<td>6.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.0'-6.5'</td>
<td>118.7</td>
<td>7.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.0'-11.5'</td>
<td>125.1</td>
<td>8.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0'-16.5'</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
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Project: KAISER COAL REFUSE PONDS  
Feature:  
Location:  

Dwight Oil Gas & Mining  
FEB 04 2003
### Table No. 1 SUMMARY OF TEST DATA

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**Feature:**  
**Location:**

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APPENDIX 5-5
COAL REFUSE PILE GEOTECHNICAL REPORT
Geotechnical Report
Kaiser Coal Refuse Pile

July 1986
February 1987

A report by
Rollins, Brown, and Gunnell, Inc.
AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Min.

INTEGRATED
FEB 04 2003
DIV OF OIL, GAS & MINING

ROLLINS, BROWN AND GUNNELL, INC.
1435 WEST 820 NORTH • P.O. BOX 711 • PROVO, UTAH 84603 • (801) 374-5771

Professional Engineers

jk 92E 7-14-92
Geotechnical Report

Kaiser Coal Refuse Pile

AMENDMENT TO
APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

July 1986
February 12, 1987

Kaiser Steel Corporation
P.O. Box D
Sunnyside, Utah 84539

Attn: Carl W. Winters

Gentlemen:

Attached hereto is the Geotechnical Report for the Kaiser Coal Pile Refuse in Sunnyside, Utah.

If there are any questions regarding this report, please contact our office.

Yours truly,

ROLLINS, BROWN AND GUNNELL, INC.

Ralph L. Rollins
RLR/sle
Attachment
I. INTRODUCTION

The coal refuse disposal area for the Kaiser Mine is located south of Sunnyside, Utah. The refuse from the Kaiser Mine is currently being disposed of in the vicinity of the west slurry cell (west side dike) of the old refuse slurry pond. In order to dispose of refuse from future mining operations, an expanded coal pile disposal area is contemplated west and north of the present refuse pile. The Kaiser Coal Company is in the process of obtaining new permitting for disposal of the coal refuse in the new coal pile area.

A plan view of the proposed coal pile superimposed upon the existing topography is presented in Figure No. 1. It will be noted that the southeasterly boundary of the new coal pile coincides with the edge of the west slurry cell and that the refuse pile extends down the existing canyon to a point near the Carbon County Railroad. It will also be observed that the refuse pile laps over on the bench land north of the existing canyon. Profiles through the proposed refuse pile along lines AA and BB are also presented in Figure No. 1. Section AA shows the original ground surface in an east-west direction, the surface of the permitted refuse pile and the surface of the proposed refuse pile. The profile along Line BB shows the refuse pile where it encroaches upon the old slurry pond as well as its extension into the bench land north of the present disposal area. It will be observed from the plan view as well as the profile that the proposed refuse pile will be benched at periodic intervals as the refuse pile is constructed. Some effort is being expended at the present time to densify the refuse material as it is placed in the disposal area and it is anticipated that the same effort will be used to densify the material placed in the refuse pile.

In March of 1984, a stability analysis was performed for the existing west side dike and during this investigation, three test pits were excavated into the refuse material to obtain an indication of the in-place density of the refuse material. The results of these tests are presented in Figure Nos. 2 and 3. It will be observed that the in-place density of the refuse material varied from about 71 pounds per cubic foot to about 91 pounds per cubic foot with the natural moisture content varying from about 5 percent to as high as 11 percent. It will be observed, however, that the in-place dry density for most of the samples was in excess of 80pcf. The information obtained from these three test pits has been used in the current investigation as an estimate of the in-place density of the refuse material. Several triaxial shear tests were performed on the refuse material during that investigation and this information has also been used in arriving at appropriate shear strength parameters for stability calculations during this investigation.

AMENDMENT TO

APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

JK 92E 7-14-92
The information contained in this report includes (1) The General Geology of the Area, (2) The Results of a Subsurface Investigation Performed Throughout the Site, (3) The Results of Field and Laboratory Tests, (4) Drainage Considerations Including Both Surface Drainage and Internal Drainage and (5) Slope Stability Considerations.

II. GENERAL GEOLOGY OF THE AREA

The proposed site is located in the Colorado Plateau Province. Most of the geologic activity that occurred in this region took place during the Cretaceous Period. The most predominant and underlying formation is the Mancos Shale. This marine shale can be traced for hundreds of miles in all directions. Intertongued throughout the Mancos in this area is the Blackhawk Formation which is subdivided into six members. This intertonguing was caused by subsidence of marine basins and changing depositional environments.

Overlying these two formations is the Price River Formation which is separated from underlying sediments by an unconformity. It is a sediment that was a piedmont deposit and is approximately 1200 feet thick.

Sitting on top of those formations are the North Horn, Flagstaff Limestone, Coltan Formation and the Green River Formation. These formations vary widely in thickness and lateral extent. They were all formed in lacustrine and flood plain areas.

2. Stratigraphy of Sunnyside Area

A. Mancos Shale

The upper part of the Mancos Shale is a drab, bluish-gray marine shale with a few lenses of limestone and calcareous sandstone. It is exposed almost everywhere along the base of the cliffs. Concretionary beds are present in some areas and have numerous fossils. The Mancos grades upward into, and interfingers westward with, littoral marine sandstones of the Mesaverde Group. Though the Mancos ranges in thickness from 4000 to 5000 feet in this region, the portion exposed rarely exceeds 1000 feet.

B. Blackhawk Formation

The Blackhawk Formation is about 1100 feet of sandstone, carbonaceous shale and coal. It thins eastward by intertonguing with the Mancos Shale.
The Blackhawk is subdivided into six members. These members -- which are, from the base upward, the Spring Canyon, Aberdeen, Kenilworth, Sunnyside, Grassy and Desert -- are not all present in any one area.

The Spring Canyon Member consists of 60 to 100 feet of coals, carbonaceous shales and lenticular sandstones of lagoonal origin resting directly upon the massive, basal, littoral marine sandstone.

The Aberdeen Member consists of a massive, white-capped, littoral marine sandstone and the coal-bearing rocks and associated barrier-beach deposits between it and the next higher massive sandstone at the base of the Kenilworth. The basal Aberdeen reaches a maximum thickness of about 90 feet, it thins eastward and disappears in the Mancos. Four mineable coals are present in this member. Most important is the Castlegate "A" which rests directly on the basal sandstone. It has a maximum thickness of 19 feet.

The Kenilworth member consists of a massive cliff-forming basal sandstone, an overlying sequence of about 160 feet of coal-bearing rocks and barrier beach sandstones behind which they were deposited. The basal white-capped sandstone first appears near Castlegate, thickens to 86 feet, then thins eastward. The most important coal in this member is the Castlegate "D" which is about 19 feet thick.

The Sunnyside Member is composed of basal sandstone tongue and the overlying 26 feet of coal-bearing rocks which are replaced between Sunnyside and Desert by a series of six barrier beach sandstones. The white-capped basal sandstone appears near Kenilworth, reaches a thickness of 60 feet and then disappears south of Sunnyside. The barrier beach sandstones disappear into the Mancos. One important coal bed is found in this member, the Sunnyside Coal. It is more than 20 feet thick northwest of Sunnyside but is split eastward into two or three smaller beds. At Sunnyside, the lower bed is called Lower Sunnyside and the next higher and thicker one is the Upper Sunnyside. Still farther south the Upper Sunnyside splits into three lesser beds, each associated with a barrier-beach sandstone.

The Grassy Member consists of basal, littoral marine sandstone with a maximum thickness of 50 feet. This sandstone fades into the Mancos northeast of Green River.

Subdivision of the Blackhawk is completed near Desert with the appearance of the last of the more extensive sandstone tongues. This tongue together with the coal-bearing rocks and barrier sandstones that separate it from the overlying Castlegate
Member of the Price River Formation, disappears north of the Cisco. The basal sandstone reaches a maximum of about 70 feet and disappears into the Mancos.

C. Price River Formation

This formation consists of massive, basal, organic sandstone and an overlying series of carbonaceous shales, sandy shales and lenticular sandstone.

Throughout the western half of the Book Cliffs, where the basal Castlegate Member rests on Blackhawk rocks, the base of the formation is marked by an unconformity, with as much as 70 feet of relief.

The thickness of Price River includes 1,350 near Castlegate; 600 feet near Sunnyside; and about 2,500 feet near Palisade. Variations in thickness are due to intertonguing with the Mancos, local warping during deposition and pre-tertiary erosion.

The Castlegate Member consists entirely of massive, white to pine, cross-bedded sandstone which changes from coarse to fine-grained as you move eastward. In the western cliffs it is an organic sandstone up to 500 feet thick. Because it was deposited on a flood plain it is considered as Farrer Facies.

3. Seismic Activity

Since the seismic monitoring network was placed in operation in 1963, more than 50,000 tremors have been recorded in the district. Richter scale magnitudes of these tremors are as great as 4.0 and the calculated depths indicate that many occur within a few hundred feet of mine level. This means large amounts of energy are being released close to the mine level. The tremors are probably manmade earthquakes caused by release during stress redistribution around mine openings and around the overall mine cavity from which large amounts of coal were removed.

Many tremors originate close to faults that transect parts of the mines. These are thought to be caused by energy released during local slippage along the faults, as a result of natural stresses, or mine induced stresses, or a combination of both. Stress redistribution accompanying slippage could cause areas which are already highly stressed to fail. Also different patterns of large-amplitude tremor occurrence in the northern and southern areas of the mining district seem to be related to different patterns of faults and to different methods of mining.
4. On-Site Geology

The beds in this area are nearly all horizontal, with the dips being from 2 degrees to 4 degrees to the southeast. These beds can be traced for many miles in almost every direction.

The bottom most formation that was encountered during the subsurface investigation was the Mancos Shale, which is a fine grained gray shale. There are numerous places in the area where outcrops can be distinctly identified. On both sides of the valley these weathered outcrops can be traced. Overlying the Mancos shale on the abutments where Drill Hole No. 4 was located is about 50 feet of alluvial overburden. This was washed out of the surrounding mountains and has been transported for some distance as shown by the graded and rounded nature of the rocks.

At the toe of the existing coal refuse pile, there is a constantly flowing stream. At the time of the drilling activity, stream flow was measured to be approximately 125 to 150 gallons per minute. Springs have been observed flowing out of the hillside on the right side of the refuse pile between the toe of the slope and the Carbon County Railroad. Springs also exist along the hillside downstream from the Railroad. The springs existing in this area most likely originate in Whitmore Canyon. The Grassy Trail Creek Reservoir is located in the canyon and some seepage is known to occur from the reservoir. The hillside north of the refuse pile consists of nearly 75 feet of granular overburden underlain with shale. Water from Whitmore Canyon is free to flow onttop of the shale to the area where the springs are observed.

III. SUBSURFACE INVESTIGATION AT THE SITE

The characteristics of the subsurface material in the area where the new coal pile will be located were defined by drilling six test borings to depths varying from 28 feet to 165 feet at locations as shown in Figure No. 1. It will be observed that Test Hole Nos. 1 through 3 generally define the characteristics of the subsurface material along the profile through Line AA, while Test Hole Nos. 4 through 6 define the characteristics of the material in the benchland north of the existing disposal area. Test Hole Nos. 1 and 2 extended through the existing refuse material into the natural earth materials underlying the existing refuse area. Test Hole No. 3, which was drilled downstream from the existing refuse area, defines the nature of the natural materials in the vicinity of the toe of the proposed coal pile. Test Hole Nos. 4, 5 and 6 were drilled to determine the characteristics of the subsurface material in the benchland and to obtain an indication of the bedrock material underlying the overburden throughout the bench. The boring logs for each of the test holes are presented in Figure Nos. 4 through 8.
be observed from Figure No. 4 that the depth of the refuse material in the vicinity of Test Hole No. 1 was 155 feet and that the material underlyng the refuse material was a stiff gray clay grading to shale. In Test Hole No. 2, the refuse extended to a depth of approximately 40 feet where the shale was encountered. The upper 26 feet of the natural materials is a weathered shale and grades to relatively hard shale at a depth of about 28 feet. In Test Hole No. 3, weathered shale extended to a depth of about 6 feet where relatively hard shale was encountered. Test Hole Nos. 4, 5 and 6, drilled in the benchland area north of the existing disposal area, consisted of a relatively dense clayey gravel in the upper portion of the soil profile followed by a sandy gravel with cobbles and boulders. Test Hole No. 4 was extended to the shale bedrock in the vicinity of 75 feet below the existing ground surface.

During the subsurface investigation, sampling was performed at 5-foot intervals throughout the depth investigated. Samples were obtained by driving a 2-inch split-spoon sampling tube through a distance of 18 inches using a 140 pound weight dropped from a distance of 30 inches. The number of blows to drive the sampling spoon through each 6 inches of penetration are presented on the boring logs. It should be observed, however, that in Test Hole Nos. 4, 5 and 6 it was not possible to drive the sampling spoon through the full 18 inches for most of the samples obtained in this area since the size of the granular particles was sufficiently large that penetration of the subsurface material was not possible. The number of blows to drive the sample through a given penetration distance is shown on the boring logs however. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value provides a reasonable indication of the in-place density of sandy-type materials and in sands and gravels where the sampling spoon can be driven through the subsurface material for the full 18 inches with a reasonable core recovery.

Undisturbed samples were obtained in the weathered shale material using a 2.5-inch inside diameter sampling tube equipped with brass liners. Where the sampling tube could not be driven into the shale, the hole was extended by coring operations.

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system is shown on the boring logs. A description of the Unified Soil Classification System is presented in Figure No. 8 and the meaning of the various symbols shown on the boring logs can be obtained from this figure. It should be noted that the classification associated with the refuse material only has meaning from a textural point of view. It should also be noted that...
The ground water level in Test Hole Nos. 1 through 3 was generally encountered at the interface between the refuse material and the underlying shales. Some ground water was observed in Test Hole No. 1 at a depth of 80 feet where a clayey shale layer was encountered. This water level represents a perched water condition and should not be construed as the natural ground water level. No ground water was encountered in Test Hole Nos. 4 through 6.

IV. FIELD AND LABORATORY TESTS

1. Introduction

Field and laboratory tests performed during this investigation were primarily limited to standard penetration tests, Atterberg limits, mechanical analysis, direct shear tests and triaxial shear tests. In-place density tests performed in test pits in a previous investigation are also included in this report. The standard penetration tests performed during the field investigations have been discussed in a previous section of this report and the results of these tests are shown on the boring logs. The results of these tests indicate that the coal refuse material is in a medium dense condition and that the granular material on the benchland area north of the existing refuse area is also in a relatively dense condition. Standard penetration tests performed in the natural material underlying the coal refuse indicate that the weathered shale is in a relatively stiff state and that the underlying shale is relatively hard.

2. Classification Tests

Atterberg limits performed on the Mancos Shale underlying the coal refuse material indicate that the plastic index for these materials does not exceed about 14 percent and that all of the materials classify as a CL-1-type material. Based upon these tests, it is concluded that most of the Mancos Shales underlying the proposed coal pile will be low plasticity type materials.

As indicated earlier in this report, the soil profile for the benchland north of the existing refuse pile consisted of granular-type materials. Satisfactory samples could only be obtained in the upper portion of the test holes drilled in this area. Mechanical analysis performed on samples obtained in the upper 25 feet of the material in this area are shown on Table No. 1, Summary of Test Data and it will be observed that the materials are relatively well graded and that the range of
material in the silt and clay size range generally varies from about 18 to 27 percent. A full grain size distribution curve was determined for the refuse material at depths of 20 to 40 feet and 100 to 140 feet in Test Hole No. 1. It should be noted that the sample obtained at a depth of 20 to 40 feet is characteristic of the main portion of the refuse material. The sample obtained from 100 to 140 feet, however, consisted of oxidized refuse which has a red brown color.

3. Consolidated Drained Direct Shear Tests

All direction shear tests were performed on undisturbed samples saturated by back pressure techniques. Drainage was permitted during the shearing process for all samples.

The shearing strength of the oxidized coal refuse in the lower portion of Test Hole No. 1 was defined by performing a 3-point Mohr envelope for representative samples of this material. The Mohr envelope for this test is presented in Figure No. 10 and it will be observed that a friction angle of 27.8 degrees and a cohesion of 34.4 psi was obtained for this material. It should be noted that the tests were performed on undisturbed samples which were partially cemented which accounts for the high cohesion obtained in these materials. The strength characteristics of a gravelly clay layer encountered at a depth of between 80 and 90 feet in Test Hole No. 1 were also defined by performing a 3-point Mohr envelope on an undisturbed sample of this material. The Mohr envelope for this material is presented in Figure No. 11 and it will be observed that a friction angle of 35.4 and a cohesion of 13.2 psi was obtained for this soil. A 3-point consolidated drained Mohr envelope was performed on saturated undisturbed samples of the shale material obtained at a depth of 160 to 161.5 feet in Test Hole No. 1. The Mohr envelope for this material is presented in Figure No. 12 and it will be observed that a friction angle of 24.3 degrees and a cohesion of 31.6 psi was obtained for this material.

The strength characteristics of the shale material in the vicinity of the contact between the refuse material and the shale in Test Hole No. 2 were determined from three, 3-point consolidated drained Mohr envelopes on samples obtained at depths of 40, 42, and 45 feet below the existing ground surface in Test Hole No. 2. The results of these tests are presented in Figure Nos. 13 through 15 and it will be observed that the friction angle of this material varied from 41.2 degrees to 46 degrees, while the cohesion varied from 0 to 5 psi.

4. Consolidated Drained Triaxial Shear Tests on Remolded Samples

The shearing strength characteristics of the refuse material were performed on modeled samples having a maximum size of 1/2

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by
inch. Three-circle Mohr envelopes were obtained for samples obtained at depths of between 20 and 41.5 feet in Test Hole No. 1 and at depths of between 10 and 36.5 feet in Test Hole No. 2. The samples used in this test were densified to an in-place dry density of approximately 84 pounds per cubic foot which generally conforms to the average dry density of the refuse material. Each sample tested was saturated by back pressure techniques prior to performing the test. The triaxial shear tests were performed under drained conditions. The results of the triaxial shear tests on the refuse material are presented in Figure Nos. 16 and 17 and it will be observed that friction angles varying from 33 degrees to 36 degrees and cohesion varying from 0 to 8 degrees were obtained for these materials.

The shearing strength parameters determined for the refuse material during this investigation compare favorably with the friction angle determined for refuse materials in previous investigations.

V. DRAINAGE CONSIDERATIONS

1. Surface Drainage

In order to determine the most feasible and economical surface drainage system for the proposed coal refuse pile, an indication of the quantity of water that would need to be controlled had to be obtained. Using procedures developed by the National Oceanic and Atmospheric Administration (NOAA), the 100-year, 6 hour rainfall was determined to be about 1.5 inches. The computer program HEC-I was then used to develop an inflow hydrograph for each of the four slopes that are in a triangular shape on Figure No. 1. These areas are designated as Area Nos. I, II, III, and IV and each includes the respective slope and terrace. The hydrographs for these areas are presented in Figure Nos. 20 through 23. An SCS Curve Number of 85 was assumed to generate the hydrographs.

From the hydrographs, a volume of water that will run off of the slopes onto the terraces was calculated. The volume for each hydrograph is shown on the respective figure. It will be noted that the largest quantity that is required to be controlled is 0.55 acre feet in Area No. 3.

We believe that the most economical means to dispose of the storm water is to grade the terraces into the embankment a sufficient amount to allow complete storage of the water until a sufficient amount of time has passed to allow it to percolate.
into the subsurface material. Figure No. 1 indicates a typical terrace dimension and the slopes required to store the runoff of a 100-year, 6 hour storm. It will be noted from Figure No. 1 that terraces 30 feet wide with a fall of 1.5 feet will be required to store the storm water.

2. Internal Drainage

Requirements for internal drains for valley fills consisting of coal refuse material are defined in "VMS 817.72 Disposal of the Underground Development Waste and Excess Spoil Paragraph (b) (4)". Inasmuch as seepage will occur through the refuse pile if the surface waters are disposed of as indicated above, we believe that some modifications to the drainage system specified in the above regulation is warranted.

As indicated earlier in the geological report, water is currently draining from the toe of the existing refuse pile. Measurements performed during the geological investigation indicated that the flow from the refuse pile was in the vicinity of 150 gallons per minute. If all of the surface drainage is stored on the terraces as indicated above, it can be expected that the surface runoff will eventually seep through the tailings material until it intersects the relatively impervious shale zone underlying the proposed refuse pile. The amount of water flowing out of the base of the refuse pile will be increased by the amount of seepage occurring through the proposed refuse pile. An underdrain has been designed to collect all water flowing through the refuse pile and to direct it outside of the proposed facility. The drain system consists of an 8-inch diameter perforated PVC pipe surrounded by a gravel filter which is in turn, enveloped by a larger diameter rock zone. It is our opinion that a system such as this is required to transmit the anticipated water as well as provide protection against piping of the embankment soils. The gradation of the filter material should conform to the gradation shown on Figure No. 1.

Typical cross sections through the drainage blanket are also shown in Figure No. 1. It is our opinion that if the filter drain is designed and placed in accordance with the recommendations outlined herein, drainage will occur from the refuse pile in such a manner that the coal pile will remain in an unsaturated condition.
VI. STABILITY CONSIDERATIONS

1. Static Stability

Typical Sections through the refuse pile are shown along AA and BB of Figure No. 1. It should be observed that the refuse material along AA will be essentially in contact with the shale while the section along BB will be located on the silty sands and gravels. A stability analysis has been performed for each of these conditions. In performing the stability computation, it has been assumed that all of the material within the refuse pile will exist in a moist condition and that the total unit weight will be at least 100 pounds per cubic foot. A stability analysis has been performed for each of the sections indicated above using a computer model of Spencer's Method. Spencer's Method satisfies both force and moment equilibrium and is considered to be a satisfactory method of performing limiting equilibrium problems. The shear strength parameters used in performing the stability analysis assumes that the refuse material will have a friction angle of 35 degrees with 0 cohesion. The total unit weight for the refuse has been assumed in the computation. A friction angle of 32 degrees and a cohesion of 200 psf have been used in the stability analysis for the shale underlying the refuse. The shearing strength parameters for the granular material in the foundation on the bench land north of the existing disposal area have been assumed to have a friction angle of 36 degrees and a cohesion of 0 with an in-place unit weight of 125 pounds per cubic foot.

The results of the stability analysis performed for a cross section through Line AA are presented in Figure No. 24 and the factor of safety obtained for this condition was 1.83. The critical failure surface for this slope is also shown in Figure No. 24. It will be observed that the critical failure surface occurs near the toe of the proposed facility. Since the shale has a shearing strength greater than the refuse material, all failure surfaces having a factor of safety near the critical value will also pass through the refuse material.

The results of the stability analysis performed for a profile along Line BB is presented in Figure No. 25. It will be observed for Test Hole Nos, 4, 5 and 6 that the subsurface material becomes quite dense at a depth greater than about 27 feet below the existing ground surface. The rock line, however, is assumed to occur at a depth of approximately 75 feet below the existing ground surface. The shear strength parameters indicated above have been used for this analysis and it will be noted from Figure No. 25 that the factor of safety for this slope is 1.93. The critical failure surface for this slope is also presented in Figure No. 25 and it will be observed that the critical failure circle passes through the refuse material.

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by (Signature) Date 7-14-92
Based upon the information provided above, it is our opinion that the proposed coal refuse pile will be stable with an adequate factor of safety under static conditions.

2. Seismic Conditions

In the past, the earthquake stability of embankments have been assessed by applying a lateral force corresponding to some fraction of the gravitational acceleration. This procedure has been designated as a pseudo-static analysis, and the present state of the art in seismic stability analysis does not consider this procedure an acceptable method to determine the performance of an embankment under seismic conditions.

It is well known that loose, saturated sands and sensitive-type clays exhibit a substantial loss in strength when these materials are subjected to vibratory action; and massive failure usually accompanies seismic activity where such soils exist. The loss in strength in loose, saturated sands is due to the high pore pressures which develop in these materials under vibratory action and is termed liquefaction.

It would be noted that no groundwater was encountered within the coal refuse during our investigations. Since the materials within the dikes are not likely to become saturated, the possibility of liquefaction of the subsurface materials is not possible. As a consequence of this situation, the likelihood of a massive failure due to seismic activity is relatively remote for the existing dikes.

To further evaluate the seismic stability of the proposed embankment, the comparison method developed by the Division of Water Resources of the State of California has also been applied. Figure No. 26, defines the basic criteria relative to the behavior of embankments according to the California method. It will be noted that the basic criteria includes the state of compaction, the peak ground acceleration, and the type of soils.

Based upon the results of the standard penetration tests performed in the refuse material in the two test holes drilled at this site, the existing materials appear to be in at least a medium-dense condition. In this area, the U.S. Geological Survey has established that the acceleration, having a 90 percent probability of not being exceeded in 250 years is 0.2g. The material existing within the dikes would generally fall into Soil Group I according to the California Method. It is apparent from the table shown in Figure No. 26, that a medium-dense material having a peak acceleration equal to or less than 0.2g falls into Zone 7, which indicates that no stability problems will exist for the existing facilities under seismic activity.
**Test Pit No. 1**

- Depth: 0 ft
  - 110.2, 7.2%
  - brown silty sandy gravel
- Depth: 1 ft
- Depth: 2 ft
- Depth: 3 ft
  - 70.9, 8.5%
  - GM
- Depth: 4 ft
- Depth: 5 ft
- Depth: 6 ft
  - 89.4, 11.4%
  - GM
- Depth: 7 ft
- Depth: 8 ft
- Depth: 9 ft
  - 86.1, 8.3%
  - GM
- Depth: 10 ft

**Test Pit No. 2**

- Depth: 0 ft
  - 83.3, 4.7%
  - GM
- Depth: 1 ft
- Depth: 2 ft
- Depth: 3 ft
  - 80.9, 5.9%
  - GM
- Depth: 4 ft
- Depth: 5 ft
- Depth: 6 ft
  - 84.0, 6%
  - GM
- Depth: 7 ft
- Depth: 8 ft
- Depth: 9 ft
  - 91.3, 5.8%
  - GM
- Depth: 10 ft

**LEGEND**

- Sample location
- Torvane value
- Undisturbed sample
- No. of blows per 6" with std. spoon
- Groundwater elevation

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Approved, Division of Oil, Gas & Mining

**JK 92E**

Log of borings for:
Kaiser Steel Dike Stability
Sunnyside, Utah

**ROLINS, BROWN AND GUNNELL, INC.**
**PROFESSIONAL ENGINEERS**

Figure No. 2
Test Hole No. 1 (cont)

15,14,21
17,22,33
23,35,51
13,14,25
12,13,15
12,13,20
20,22,23
31,30,28
19,21,21
20,21,27

LEGEND

sample location
X, 0.30 torvane value
undisturbed sample
5, 6, 6 no. of blows per 6" with std. spoon

groundwater elevation

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PROFESSIONAL ENGINEERS

Log of Borings for:
Kaiser Coal Company
Coal Refuse Pile

Figure No. 4a
Test Hole No. 4

6.21,22 brown sand  
br.silty gr.clay

24,22,24  
light brown silty gravelly clay

49,56  
brown sandy clayey gravel

30,23,33  
brown silty gravelly clay

27,28,26  
sandy gravel w/ cobbles & boulders

46/2"  
46/5"

36,23,23  
46/0"

46/2"  
46/0"

46/4"  
weathered gray shale

Core  
gray shale

LEGEND

sample location  
undisturbed sample  
torvane value  
5,6,6 no. of blows per 6" with std. spoon  
groundwater elevation

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PROFESSIONAL ENGINEERS

Log of Boring for:  
Kaiser Coal Company  
Coal Refuse Pile

Figure No. 6
## Unified Soil Classification System

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Group Symbols</th>
<th>Typical Names</th>
<th>Laboratory Classification Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$C_u = \frac{D_u}{D_w}$ \quad\text{Greater than 6} \quad (GW)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$C_c = \frac{(D_u)^2}{D_x \times D_w}$ \quad\text{Between 1 and 3} \quad (GW)</td>
</tr>
</tbody>
</table>

### Not meeting all gradation requirements for GW

- Atterberg limits below "A" line, or PI less than 4

\[ \text{Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols} \]

- Atterberg limits above "A" line, or PI greater than 7

\[ \text{Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols} \]

---

### Plasticity Chart

**Laboratory Classification Criteria**

- Determine percentage of gravel and sand from grain size curve:
  - More than 5% of gravel
  - More than 12% of sand
- GW, CP, SW, SP, SM, GC, GM, OL, GL, LL, ML, CL, CM, CH, OH, Pt

**Soil Types**

- GW: Well graded gravels, gravel-sand mixtures, little or no fines.
- GM: Silty gravels, poorly graded gravel-sand-clay mixtures.
- GC: Clayey gravels, poorly graded gravel-sand-clay mixtures.
- SP: Poorly graded sands, gravelly sands, little or no fines.
- SM: Silty sands, poorly graded sand-silt mixtures.
- SC: Clayey sands, poorly graded sand-clay mixtures.
- ML: Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
- OL: Organic silts and organic silt-clays of low plasticity.
- MH: Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
- CH: Inorganic clays of high plasticity, fat clays.
- OH: Organic clays of medium to high plasticity, organic silts.
- Pt: Peat and other highly organic soils.

---

*Division of CM and SM groups into subdivisions of d and u for roads and airfields only. Subdivisions based on Atterberg limits: suffix d used when liquid limit is 26 or less and the PI is 6 or less, the suffix u used when liquid limit is greater than 26.

**Borderline classification: Soils possessing characteristics of two groups are assigned the lower number symbol. For example GW-GC, well graded gravel-sand mixture with clay binder.
### Grain Size Distribution Curve

<table>
<thead>
<tr>
<th>GRAVEL</th>
<th>SAND</th>
<th>SILT OR CLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE</td>
<td>MEDIUM</td>
<td>FINE</td>
</tr>
<tr>
<td>FINE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Standard Sieve Sizes

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Percent by Weight</th>
</tr>
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<tbody>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
</tr>
<tr>
<td>60</td>
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<td>40</td>
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</tr>
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<td>20</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
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<td>4</td>
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</tr>
<tr>
<td>2</td>
<td></td>
</tr>
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<td>1</td>
<td></td>
</tr>
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<td>1/2</td>
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</tr>
<tr>
<td>1/16</td>
<td></td>
</tr>
<tr>
<td>1/32</td>
<td></td>
</tr>
</tbody>
</table>

**Rollins, Brown and Gunnell, Inc.**

**Project:** Kaiser Coal Company

**Location:** Coal Refuse File

**Hole No. 1**

- 1 @ 30'
- 1 @ 140'

**Figure No. 9**
### Test Data Summary

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>Undisturbed</td>
<td>100</td>
<td>101.8</td>
<td>83.5</td>
<td>$2.36 \times 10^3$</td>
<td>Friction angle $\phi$ (degrees)</td>
</tr>
<tr>
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<td>1</td>
<td>Undisturbed</td>
<td>100</td>
<td>214.3</td>
<td>156.9</td>
<td>$2.36 \times 10^3$</td>
<td>Cohesion (c/psi)</td>
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<tr>
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<td>1</td>
<td>Undisturbed</td>
<td>100</td>
<td>320.2</td>
<td>198.4</td>
<td>$2.36 \times 10^3$</td>
<td></td>
</tr>
</tbody>
</table>

* All samples were saturated using back pressure techniques

---

**Figure 10**

- **Project:** Consolidated Drained Direct Shear Test
- **Kaiser Coal Company Coal Refuse Pile**
- **Hole No.: 1 (oxidized refuse)**
- **Depth:** 100'-141.5'
All samples were saturated by back pressure techniques.
**CONSOLIDATED DRAINED DIRECT SHEAR TEST**

**Project:** Kaiser Coal Company

**Coal Refuse Pile**

**HOLE NO. 1 (Shale)**

**DEPTH:** 160'-161.5'

**FIGURE NO. 12**

---

### Test Sample Data

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress σ_n (psi)</th>
<th>Maximum shear stress τ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Undisturbed</td>
<td>100</td>
<td>101.9</td>
<td>80.1</td>
<td>6.3x10^{-4}</td>
<td>24.3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Undisturbed</td>
<td>100</td>
<td>210.0</td>
<td>121.5</td>
<td>6.3x10^{-4}</td>
<td>24.3</td>
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<td>100</td>
<td>321.1</td>
<td>179.0</td>
<td>6.3x10^{-4}</td>
<td>24.3</td>
</tr>
</tbody>
</table>

* All samples saturated by back pressure techniques

---

**Shear Stress, τ (psig)**

**Normal Stress, σ_n (psi)**

- **Friction Angle φ (degrees):**
  - 24.3°

- **Cohesion c (psi):**
  - 31.6

---

**Horizontal displacement, δ_h (in. x 10^{-2})**

**Vertical displacement, δ_v (in. x 10^{-2})**

---

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**ROLLINS, BROWN AND GUNNELL, INC.**

**PROFESSIONAL ENGINEERS**
* All samples were saturated by back pressure techniques.

**Test**

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress $\sigma_n$ (psi)</th>
<th>Maximum shear stress $\tau$ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>1</td>
<td>Undisturbed</td>
<td>100</td>
<td>53.3</td>
<td>49.8</td>
<td>9.45x10^-5</td>
<td>41.2°</td>
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<td>97.1</td>
<td>88.0</td>
<td>9.45x10^-5</td>
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</table>

**Table notes:**
- All samples were saturated by back pressure techniques.
CONSOLIDATED DRAINED DIRECT SHEAR TEST

Project: Kaiser Coal Company
Coal Refuse Pile

HOLE NO. 2 (Shale)
DEPTH: 42'

Figure No. 14

*All samples saturated by back pressure techniques
**Shear strength parameters**

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Sample size (inches)</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Normal stress σ₀ (psi)</th>
<th>Maximum shear stress τ (psi)</th>
<th>Strain rate (inches/minute)</th>
<th>Shear strength parameters</th>
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<td>44</td>
</tr>
<tr>
<td>□</td>
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<td>Undisturbed</td>
<td>100</td>
<td>83.9</td>
<td>86.1 x 10⁴⁻⁴</td>
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<td>44</td>
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<tr>
<td>△</td>
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<td>100</td>
<td>172.9</td>
<td>173 x 10⁴⁻⁴</td>
<td></td>
<td>44</td>
</tr>
</tbody>
</table>

* All samples were saturated by back pressure techniques

**Figure 15**
### CONSOLIDATED DRAINED TRIAXIAL SHEAR TEST

**Project:** Kaiser Coal Company Refuse Pile

**HOLE NO.** 1 (refuse)

**DEPTH:** 20-41.5'

**FIGURE NO.** 16

1. Samples saturated by back pressure techniques

---

<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Boring no. or depth</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Confining pressure (psi)</th>
<th>Maximum deviator stress (psi)</th>
<th>Strength values at failure</th>
<th>Sample size, L/D (inches)</th>
<th>Strain rate (inches/minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>1</td>
<td>83.2</td>
<td>5.76</td>
<td>100</td>
<td>20</td>
<td>79.9</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>□</td>
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<td>84.6</td>
<td>8.47</td>
<td>100</td>
<td>40</td>
<td>125.8</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>△</td>
<td>1</td>
<td>85.1</td>
<td>5.76</td>
<td>100</td>
<td>60</td>
<td>172.2</td>
<td>33</td>
<td>8</td>
</tr>
</tbody>
</table>

---

**Sample Strain size.**

*Date 3-2-03*

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PROFESSIONAL ENGINEERS

---

**Shear stress at maximum deviator stress (psi)**

**Normal stress (psi)**

---

**Axial strain (%)**
### Table: CONSOLIDATED DRAINED TRIAXIAL SHEAR TEST

<table>
<thead>
<tr>
<th>Test no.</th>
<th>Depth (ft)</th>
<th>Deviator stress, ( \sigma_d ) (psi)</th>
<th>Sample size (inches)</th>
<th>Drying density (pcf)</th>
<th>Moisture content (% o.w.)</th>
<th>Degree of saturation (%)*</th>
<th>Boring sample size (inches)</th>
<th>Shear stress at maximum deviator stress (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>35.5</td>
<td>51.9</td>
<td>36</td>
<td>40</td>
<td>100</td>
<td>100</td>
<td>36</td>
<td>125.3</td>
</tr>
<tr>
<td>84</td>
<td>84</td>
<td>25.5</td>
<td>84</td>
<td>5.83</td>
<td>100</td>
<td>100</td>
<td>26.5</td>
<td>84</td>
</tr>
<tr>
<td>8.30</td>
<td>100</td>
<td>60</td>
<td>36</td>
<td>123.5</td>
<td>40</td>
<td>20</td>
<td>5.83</td>
<td>25.5</td>
</tr>
<tr>
<td>62.9</td>
<td>62.9</td>
<td>36</td>
<td>36</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>36</td>
<td>179.2</td>
</tr>
<tr>
<td>400</td>
<td>84</td>
<td>36</td>
<td>36</td>
<td>40</td>
<td>100</td>
<td>100</td>
<td>36</td>
<td>52.5</td>
</tr>
<tr>
<td>200</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0.003</td>
<td>0</td>
<td>0</td>
<td>0.003</td>
<td>0.003</td>
</tr>
</tbody>
</table>

* All samples were saturated by back pressure techniques.

**FIGURE 17**: CONSOLIDATED DRAINED TRIAXIAL SHEAR TEST

- **Kaiser Coal Company**
- **Coal Refuse Pile**
- **HOLE NO. 2 (refuse)**
- **DEPTH: 10-36.5'**

---

### Diagram: Shear stress at maximum deviator stress (psi)

- **Shear stress at maximum deviator stress**: 
  - **Normal stress (psi)**: 0, 40, 80, 120, 160, 200, 240
  - **Shear stress (psi)**: 0, 40, 80, 120, 160, 200, 240
  - **Angle \( \phi \)**: 35°

---

### Diagram: Deviator stress, \( \sigma_1 - \sigma_3 \) (psi)

- **Axial strain (%)**: 0, 4, 8, 12, 16, 18, 20
- **Axial strain (%)**: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

### Diagram: Axial strain (%)

- **Axial strain (%)**: 0, 10, 20, 30, 40
- **Axial strain (%)**: 0, 20, 40, 60, 80, 100
<table>
<thead>
<tr>
<th>Test no. or symbol</th>
<th>Boring no. or depth</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Confining pressure (psi)</th>
<th>Maximum deviator stress (psi)</th>
<th>Strength values at failure</th>
<th>Sample size L/D inches</th>
<th>Strain rate (inches/minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ 10'-11.5'</td>
<td>84</td>
<td>100</td>
<td>20</td>
<td>62.9</td>
<td>36</td>
<td>0</td>
<td>5/2.5</td>
<td>0.003</td>
</tr>
<tr>
<td>□ 25'-26.5'</td>
<td>84</td>
<td>5.83</td>
<td>100</td>
<td>125.3</td>
<td>36</td>
<td>0</td>
<td>5/2.5</td>
<td>0.003</td>
</tr>
<tr>
<td>△ 35'-36.5'</td>
<td>84</td>
<td>8.30</td>
<td>100</td>
<td>179.2</td>
<td>36</td>
<td>0</td>
<td>5/2.5</td>
<td>0.003</td>
</tr>
</tbody>
</table>

**Test:** CONCENTRATED DRAINED TRIAXIAL SHEAR TEST

**Project:** Kaiser Company

**Hole No.:** 2 (refuse)

**Depth:** 10-36.5'

**Figure:** 17
**Test no. or symbol** | **Boring no.** | **Sample data** | **Degree of saturation (%)** | **Confining pressure (psi)** | **Maximum deviator stress (psi)** | **Friction angle \( \phi \) (degrees)** | **Cohesion \( c \) (fps)** | **Sample size, \( L/D \) (inches)** | **Strain rate (inches/minute)**
---|---|---|---|---|---|---|---|---|---
\( \bigcirc \) | 4 | 120.4 | 9.4 | 100 | 30 | 91.5 | 38 | 0 | 5/2.5 | 1.34x10^7
\( \bigcirc \) | 4 | 121.3 | 9.4 | 100 | 50 | 139.6 | 5/2.5 | " | "
\( \bigtriangleup \) | 4 | 120.1 | 9.4 | 100 | 75 | 222.8 | 5/2.5 | " | "

* All samples were saturated by back pressure techniques.
### CONSOLIDATED DRAINED TRIAXIAL SHEAR TEST

**Project:** Kaiser Coal Company Coal Refuse Pile  
**Hole No. 6** (granular soil)  
**Depth:** 5-20'

**Table:**

<table>
<thead>
<tr>
<th>Test no.</th>
<th>Boring no.</th>
<th>Sample data</th>
<th>Degree of saturation (%)</th>
<th>Confining pressure (psi)</th>
<th>Maximum deviator stress (psi)</th>
<th>Strength values at failure</th>
<th>Sample size, L/D (inches)</th>
<th>Strain rate (inches/minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>6</td>
<td>119.6</td>
<td>10.3</td>
<td>100</td>
<td>30</td>
<td>135.4</td>
<td>39°</td>
<td>5/2.5</td>
</tr>
<tr>
<td>□</td>
<td>6</td>
<td>121.1</td>
<td>10.3</td>
<td>100</td>
<td>45</td>
<td>174.6</td>
<td>1</td>
<td>&quot;</td>
</tr>
<tr>
<td>△</td>
<td>6</td>
<td>120.0</td>
<td>10.3</td>
<td>100</td>
<td>60</td>
<td>251.4</td>
<td>1</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

*All samples were saturated by back pressure techniques*
Volume = 0.22 acre feet
Volume = 0.55 acre feet

Kaiser Coal Company - Coal Refuse Pile
Area III
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by JK 92E date 7-14-92

ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS
Figure NO. 23

Q = cfs

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ROLLINS, BROWN AND GUNNELL, INC.

Kaiser Coal Company
Coal Refuse Pile
Area IV

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Volume = 0.45 acre feet

Q = cfs
ZONE DESCRIPTION

I  Coal refuse
II Gray Shale

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by __________________________

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---

**STABILITY ANALYSIS - Section AA**

Proposed Refuse Pile Change - Kaiser Steel

---

### Table

<table>
<thead>
<tr>
<th>C (psf)</th>
<th>( \Phi ) (degrees)</th>
<th>( \delta ) (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35</td>
<td>100</td>
</tr>
<tr>
<td>200</td>
<td>32</td>
<td>120</td>
</tr>
</tbody>
</table>

---

**Critical Failure Surface**

- \( X = 2840 \)
- \( Y = 7620 \)
- \( R = 1460 \)

---

INTEGRATED
Critical Failure Surface F.S. = 1.97

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<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>C,psf</th>
<th>Φ degrees</th>
<th>ɸ psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Refuse</td>
<td>0</td>
<td>35</td>
<td>100</td>
</tr>
<tr>
<td>Sands &amp; Gravels</td>
<td>0</td>
<td>35</td>
<td>125</td>
</tr>
</tbody>
</table>

STABILITY ANALYSIS - Section BB
Proposed Refuse Pile Enlargement - Kaiser Steel

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CRITERIA USED IN THE CALIFORNIA METHOD OF SEISMIC STABILITY

1. Determine the Relative Density or Compaction State of the Materials Within the Dam

<table>
<thead>
<tr>
<th>Relative Compaction (ASTM 1557)</th>
<th>Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Dense</td>
<td>100-95.0</td>
</tr>
<tr>
<td>Dense</td>
<td>91.3-94.9</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>88.7-91.2</td>
</tr>
<tr>
<td>Loose</td>
<td>88.6 or less</td>
</tr>
</tbody>
</table>

2. Classify the Level of Acceleration

<table>
<thead>
<tr>
<th>Peak Ground Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>High</td>
</tr>
</tbody>
</table>

Note that the duration of shaking is not included but should be in deciding borderline cases particularly for loose soils.

3. Determine the Soil Group and Possible Behavior

<table>
<thead>
<tr>
<th>Soil Group</th>
<th>Classification</th>
<th>Behavior</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>GW, GP, GH, SW, SP</td>
<td>Liquefaction</td>
<td>1, 3, 6</td>
</tr>
<tr>
<td>II</td>
<td>SM, ML</td>
<td>Liquefaction and/or settlement-slip circle</td>
<td>2, 5</td>
</tr>
<tr>
<td>III</td>
<td>GC, SC, CL, OL, MH, CH, OH</td>
<td>Settlement-slip circle</td>
<td></td>
</tr>
</tbody>
</table>

Borderline Zones - Cases that fall in these zones may or may not present a problem. A small investigative program is desirable to determine if there is a problem. Group III soils (clayey) might experience 0-5 percent settlement. There is some possibility for liquefaction of Groups I and II soils.

Problem Zones - Cases that fall in these zones will usually present some type of problem. An investigative program would be very desirable. Settlement for Group II soils might range from 5-10 percent. Liquefaction for Groups I and II is very possible.

Real Problem Zone - An investigative program should be initiated immediately. Settlement for Group III soils might range from 10-20 percent. Probability of liquefaction for soil Groups I and II is very high.

Zone 7 - No Problem - Cases that fall in this zone will normally not present any problems.

4. Predict Behavior Using the Following Chart

<table>
<thead>
<tr>
<th>Acceleration</th>
<th>Low 0.0</th>
<th>Medium 0.21-0.39</th>
<th>High 0.40+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Dense</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Dense</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOLE NO</td>
<td>DEPTH BELOW GROUND SURFACE</td>
<td>STANDARD PENETRATION BLOWS PER FOOT</td>
<td>IN-PLACE</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------</td>
<td>------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>1</td>
<td>85-86.5'</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moisture (%) Void Ratio</td>
</tr>
<tr>
<td></td>
<td>157-158'</td>
<td>46/6&quot; 46/1&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>158.5-160'</td>
<td>46/1 ½&quot;</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>45-46.5'</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0-1.5'</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5-6.5'</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10-11'</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15-16.5'</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25-26.5'</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35-36.5'</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40-41.5'</td>
<td>46/5&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>75-76.5'</td>
<td>-6/4½&quot;</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.1.0'</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9-9.5'</td>
<td>46/5&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-20.5'</td>
<td>46/5&quot;</td>
<td></td>
</tr>
</tbody>
</table>

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by JK 92E date 7-14-92
Table No. 1 SUMMARY OF TEST DATA (continued)

Project KAI SER COAL CO. - COAL REFUSE PILE Feature Location SUNNYSIDE, TUAH

<table>
<thead>
<tr>
<th>HOLE NO</th>
<th>DEPTH BELOW GROUND SURFACE</th>
<th>STANDARD PENETRATION BLOWS PER FOOT</th>
<th>IN-PLACE</th>
<th>UNCONFINED COMPR ESSIVE STRENGTH</th>
<th>FRICTION ANGLE</th>
<th>CONSISTENCY LIMITS</th>
<th>MECHANICAL ANALYSIS</th>
<th>UNIFIED SOIL CLASSIFICATION SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>UNIT WEIGHT (lb/ft$^3$)</td>
<td>MOISTURE (%)</td>
<td>VOID RATIO</td>
<td>L.L. (%)</td>
<td>P.L. (%)</td>
<td>P.I. (%)</td>
<td>% Gravel</td>
</tr>
<tr>
<td>6</td>
<td>5 - 6.5'</td>
<td>33/6&quot; 56/4&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>41.5</td>
</tr>
<tr>
<td></td>
<td>15 - 16.5'</td>
<td>52/6&quot; 60/2&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>59.4</td>
</tr>
</tbody>
</table>
APPENDIX 5-6
IN-PLACE DENSITY DETERMINATION FOR
THE COARSE REFUSE PILE

INCORPORATED
FEB 04 2003
DIV OF OIL GAS & MINING
December 11, 1991

SOUTHWEST TESTING LABORATORIES

P.O. Box 59
Sunnyside, Utah 84539

RE: In Place Density Determination

Dear Mr. Gray,

Pursuant to your request, we are pleased to submit the following test results performed on the refuse pile at your Sunnyside facility.

<table>
<thead>
<tr>
<th>Total Unit Weight (pcf)</th>
<th>Moisture Content (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1·</td>
<td>104.0</td>
</tr>
<tr>
<td>2·</td>
<td>100.2</td>
</tr>
</tbody>
</table>

The in place density of the refuse pile material was checked at two randomly selected sites. The approximate location of these sites is indicated on the attached map. The test method we selected to obtain these results was ASTM D 2922 Method B (Density Of Soil And Soil-Aggregates In Place By Nuclear Methods).

Based on the test data, it can be assumed that the refuse material has been compacted to densities above the minimum required. This minimum density requirement was obtained from the Rollins, Brown and Gunnell, Geotechnical Report, dated February, 1987, which was supplied by your office. The referenced minimum density requirement was obtained under section VI STABILITY CONSIDERATIONS, of Paragraph one.

It is our pleasure to be of service. Should you have any questions, please contact our office.

Respectfully submitted,

Kim L. Phillips
Project Manager

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Approved, Division of Oil, Gas & Mining

EXHIBIT 1 by JK 82E date 7-14-92
SOUTHWEST TESTING LABORATORIES 475 EAST TABERNACLE ST. GEORGE, UTAH 84770 (801) 673-6850
February 17, 1992

SUNNYSIDE COAL CO.
P.O. Box 99
Sunnyside Utah 84539

Sample identification by SUNNYSIDE COAL CO.

Kind of sample Soil
reported to us

Sample taken at Sunnyside

Sample taken by Sunnyside

Date sampled January 28, 1992

Date received January 29, 1992

Analysis report no. 59-142616

SOIL ANALYSIS

pH 6.8 units
Conductivity 5.9 mmhos/cm

Nitrate-nitrogen 0.01 mg/kg
Total Available Selenium <0.01 mg/kg
Total Available Boron 2.00 mg/kg

SOLUBLE CATIONS

Calcium 20.16 meq/l
Magnesium 7.03 meq/l
Sodium 1.34 meq/l

Sodium Adsorption Ratio 0.36

ACID BASE POTENTIAL

Maximum Acid Potential 22.5 tons CaCO₃ / 1000 tons
Neutralization Potential 50.0 tons CaCO₃ / 1000 tons
Acid-Base Potential 27.5 tons CaCO₃ / 1000 tons

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Manager, Huntington Laboratory

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APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Manager, Huntington Laboratory
February 17, 1992

SUNNYSIDE COAL CO.
P.O. Box 99
Sunmyside Utah 84539

Sample identification by
SUNNYSIDE COAL CO.

Kind of sample Soil
reported to us

Sample taken at Sunnyside
Sample taken by Sunnyside
Date sampled January 28, 1992
Date received January 29, 1992

Analysis report no. 59-142617

<table>
<thead>
<tr>
<th>SOIL ANALYSIS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.8 units</td>
</tr>
<tr>
<td>Conductivity</td>
<td>3.3 mmhos/cm</td>
</tr>
<tr>
<td>Nitrate-nitrogen</td>
<td>0.01 mg/kg</td>
</tr>
<tr>
<td>Total Available Selenium</td>
<td>&lt;.01 mg/kg</td>
</tr>
<tr>
<td>Total Available Boron</td>
<td>1.68 mg/kg</td>
</tr>
<tr>
<td>SOLUBLE CATIONS</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>16.28 meq/l</td>
</tr>
<tr>
<td>Magnesium</td>
<td>13.50 meq/l</td>
</tr>
<tr>
<td>Sodium</td>
<td>2.54 meq/l</td>
</tr>
<tr>
<td>Sodium Adsorption Ratio</td>
<td>0.66</td>
</tr>
</tbody>
</table>

ACID BASE POTENTIAL

Maximum Acid Potential 25.0 tons CaCO₃ / 1000 tons
Neutralization Potential 46.2 tons CaCO₃ / 1000 tons
Acid-Base Potential 21.2 tons CaCO₃ / 1000 tons

AMENDMENT TO

APPROVED Mining & Reclamation Plan
Approved, Division of Oil, Gas & Mining

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Manager, Huntington Laboratory

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FEB 04 2003
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ROAD DESCRIPTIONS

TRANSPORTATION FACILITIES

The roads within the SCA Permit Area are used for a variety of purposes. These include hauling of refuse material, general access around the site, and various non-mining uses.

Presently, there are various roads within the permit area which connect to roads outside the permit area and provide a continuity of those outside uses. The discussion in this appendix related to roads within the permit area pertains only to mine uses within the permit. No additional information is included related to outside uses.

The following section includes descriptions of the transportation facilities within the SCA Permit Area, including the general location and most common uses of each road. All of the roads have a letter name (A, B, C, etc.) and a traditional name acquired throughout the past decades of operation. Road names match the designations shown on Plate 5-2.

A. Tonka Road is located in the north east portion of the permit area and provides access to/from properties east of the SCA Permit Area.
B. Upper Old Coarse Refuse Road is located in the south east portion of the permit area and provides access for inspection and monitoring.
C. Lower Haul Road is located in the central portion of the permit area and runs generally along the northerly edge of the Coarse Refuse Pile. This road provides access for haul trucks to the refuse pile. The eastern portion of this road also provides access for other haul traffic that needs to cross through the permit area to offsite facilities.
D. Railroad Access Road is located in the northeast portion of the permit area and provides access to this portion of the permit area.
E. Excess Spoil Disposal Area #2 Road is located in the northeast portion of the permit area and provides access to the Excess Spoil Disposal Area #2.
F. New Haul Access Road is located in the north central portion of the permit area and is heavily used for the haul trucks to deliver refuse to the processing area.
G. Borrow Area Pond South Access Road is located in the southeast portion of the permit area and provides access to/from properties to the south and east of the SCA Permit Area.
H. Coarse Refuse Seep Access Road is located in the west portion of the permit area. It provides access for inspection and monitoring.
I. Coarse Refuse Toe Pond Access Road is located in the west portion of the permit area. It provides access for inspection and monitoring.
J. Rail Cut Pond West Access Road is located in the south west portion of the permit area. It provides access for inspection and monitoring.
K. Old Coarse Refuse Road Sediment Pond Access Road is located in the south east portion of the permit area. It provides access for inspection and monitoring.
L. Lower Old Coarse Refuse Road is located in the west portion of the permit area. It provides access for inspection and monitoring.
S. West Pasture Access Road is located in the north central portion of the permit area and provides access to/from adjacent facilities north of the permit area. This road is used regularly for trucks crossing through the permit area to reach facilities on the other side of the permit area.

U. North Pasture Pond Access Road is located adjacent to the Pasture Pond on the north and west sides. It is used for access to and maintenance of the pond.

W. East Access Road is located in the southeast portion of the permit area and provides access for other haul traffic that needs to cross through the permit area to/from offsite facilities to the east of the SCA Permit Area. Use of this road is limited to SCA authorized users only. This road is temporary and will be removed and reclaimed when the soil under the road is needed for reclamation borrow material.

Plate 5-2 provides a description of the physical properties of each road. Please refer to Plate 5-2 for the following information pertaining to each individual road: Name, Type of Use, Road Plan & Profile drawing reference, Maximum Grade, Average Width, and Approximate Length.

STRUCTURAL STABILITY OF EMBANKMENTS

The structural stability of roads within the SCA Permit Area is largely determined by the stability of the roadside embankments. This section provides calculations to determine the stability of these embankments and their factor of safety. Calculations are based on methods presented in Hoek and Bray’s Rock Slope Engineering.

Most of the roads within the permit area fall within a common ranges of characteristics and embankment slopes. For simplification, these stability calculations will focus on the worst case scenario within the range and group all roads within the range together.

Soils

Information concerning soil types is included in the permit in Appendix 2-9 (the ACZ Soil Borrow Material Report); the SCS Soils Survey of Carbon Area; and Plate 2-1 (Soil Identification Map). The soils in the area are a Strych soil type ranging from very stony loam to a Gerst-Strych-Badland complex. These soil units are described in detail in the SCS Soil Survey for the Carbon Area. The soil type for each area was used to determine the cohesion strength, friction angle, and the density of the material. It should be recognized that values for cohesion strength were estimated based on existing information for the soil type in the designated area. In areas where the soil type was not apparent, a mixture of Strych dry stony loam and Gerst-Strych-Badland soil was assumed and an average value for the quantities listed below was employed for the purposes of determining structural stability.

Assumptions and Method

The “Circular Failure Method” from Rock Slope Engineering was used to determine the factor of safety for the road embankments. Using this method, the following assumptions were made:
- Soil type ranges from SM-SC to GM-GC
- Friction Angle \( F \) ranges from 31\(^\circ\) for SM-SC to > 31\(^\circ\) and >34\(^\circ\) for GM and GC soils.
- Density \( g \) values range between 90 to 100 pcf.
- Groundwater conditions are generally fully drained, but to be conservative, we will use Chart 2 representing a surface water source at a distance of 8x the slope height.
- The soil is \textit{may} not be compacted. Values for cohesion strength were estimated based on upper and lower limits for each soil type. Generally cohesion strength is between 450 and 600 lb/sqft for soils and estimated at 300 lb/sqft for refuse.

Most of the roads and embankments in the permit area are such that they have very minor slopes. For simplicity in calculations, we have grouped all roads at or less than the following characteristics into a single classification.

Typical Characteristics:
- Embankment Height \( H = 30 \text{ feet} \)
- Embankment Slope \( 2H : V = Q = 26.5^\circ \)
- Friction Angle \( F = 31^\circ \)
- Density \( g = 100 \text{ pcf} \)
- Groundwater Chart 2 at 8x slope distance or more away
- Cohesion strength \( c = 450 \text{ lb/sqft} \)

For these typical roads, the calculation values indicate the following:

\[
\frac{c}{(gH \tan F)} = \frac{450}{100 \times 30 \times \tan 31} = 0.26
\]

Chart 2 indicates for a 26.5\(^\circ\) slope that the \((\tan F / F)\) value = 0.27
This gives a \textbf{Factor of Safety} \( F = 2.2 \)

Roads with smaller or gentler embankment slopes have a higher factor of safety.

Other roads with steeper or higher embankments are calculated separately below.

Road K – Height \( H = 50 \text{ ft}, \) Slope\( Q = 45^\circ, \) Cohesion \( c = 450, \) Factor of Safety = 1.3
Road F – Height \( H = 16 \text{ ft}, \) Slope\( Q = 33^\circ, \) Cohesion \( c = 300, \) Factor of Safety = 2.2

Road embankments within the permit area appear to have an adequate Factor of Safety against circular failure.
APPENDIX 5-8

MSHA APPROVAL OF THE PROGRAM FOR IMPOUNDMENT INSPECTIONS
Randy J. Scott
Plant Manager
Sunnyside Cogeneration Associates
One Power Plant Road
Sunnyside, UT 84539

RE: Sunnyside Waste Coal Site
Mine ID No. 42-02093
East Slurry Cell
ID #1211-UT-09-02093-02
Impoundment Inspection Interval

Dear Mr. Scott:

Your request, in a letter dated August 29, 2001, concerning authorization to change the referenced impounding structure's mandatory inspection interval is approved in accordance with 30 CFR 77.216-3(a)(1). This approval is site-specific to the above referenced impoundment structure for the subject mine and will terminate when the site is abandoned or when you are notified of termination by the District Manager.

If you have any questions regarding this approval letter, please contact Billy Owens or Alice Perry of this office at 303-231-5463 extensions 145 and 139, respectively, or 303-231-5458.

Sincerely,

John A. Kuzar
District Manager
Enclosure
August 29, 2001

Mine Safety & Health Administration
District Manager
John A. Kuzar
P.O. Box 25367 D.F.C.
Denver, Co. 80225
Phone (303) 231-5458

Re: Sunnyside Coal Waste Site, 42-02093
   East Slurry Impoundment, 1211-UT-09-02093-02
   Coal Refuse Pile, 1211-UT-09-02093-01

Dear Mr. Kuzar

Sunnyside Cogeneration Associates (SCA) is requesting your approval to change our inspection frequency on the above referenced impoundment's and coal refuse pile. At the present we are inspecting the structures once every seven days (weekly), and are requesting that the inspection be made every 30 days (monthly).

The East Slurry Pond has not been used for its designed purpose, to contain slurry discharge, since 1995. At present, only storm water events report to the pond, with plenty of free board space.

The Coal Refuse Pile is currently being mined and has been since 1993. In 1995, the Sunnyside Coal Company stopped placing refuse material on the pile.

The following are steps and precautions that SCA would take upon this request being approved.

1. If a seismic activity occurs in the vicinity of the impoundment/refuse pile, an on-site inspection shall commence immediately.

2. If someone reports an unusual condition that may affect the safety/stability of the impoundment/refuse pile, an on-site inspection shall commence immediately.

3. If a significant runoff/precipitation event occurs, an on-site inspection will follow.

APPROVED

FEB 04 2003
DIV OF OIL GAS & MINING
4. The impoundment/refuse pile will be inspected at an interval not to exceed 30 days.

5. A daily monitoring record of the measurable rainfall shall be kept. All records about the impoundment/refuse pile shall be made available to MSHA personnel upon request.

The inspection frequency requirements will not preclude additional safety measures that an on site MSHA representative may require.

Should you have any questions, please contact Rusty Netz at (435) 888-4476.

Sincerely,

Agent For
Sunnyside Cogeneration Associates

Randy J. Scott
Plant Manager

c.c. Ted E. Farmer/Supervisory CMS&H Inspector-Price
Gene Ray/Supervisory CMS&H Inspector-Price
Plant File
Randy J. Scott  
Plant Manager 
Sunnyside Cogeneration Associates 
One Power Plant Road 
Sunnyside, UT 84539

Dear Mr. Scott:

MSHA personnel have reviewed and concur with the certification that the referenced site was abandoned in a manner to preclude the probability of future impoundment of water, sediment, or slurry. The above referenced impoundment is approved for abandonment and will be removed from the mine files.

The referenced impoundment identification number will be removed from the mine file. MSHA inspection and reporting requirements no longer apply to the referenced structure.

If you have any questions regarding this approval, please contact Billy Owens at 303-231-5463 extension 145 or 303-231-5458.

Sincerely,

John A. Kuzar
District Manager
August 29, 2001

Mine Safety & Health Administration
District Manager
John A. Kuzar
P.O. Box 25367 D.F.C.
Denver, Co. 80225
Phone (303)231-5458

Re: Sunnyside Coal Waste Site, 42-02093
East Slurry Impoundment, 1211-UT-09-02093-02
Coal Refuse Pile, 1211-UT-09-02093-01

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The following are steps and precautions that SCA would take upon this request being approved.

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2. If someone reports an unusual condition that may affect the safety/stability of the impoundment/refuse pile, an on-site inspection shall commence immediately.

3. If a significant runoff/precipitation event occurs, an on-site inspection will follow.
4. The impoundment/refuse pile will be inspected at an interval not to exceed 30 days.

5. A daily monitoring record of the measurable rainfall shall be kept. All records about the impoundment/refuse pile shall be made available to MSHA personnel upon request.

The inspection frequency requirements will not preclude additional safety measures that an on site MSHA representative may require.

Should you have any questions, please contact Rusty Netz at (435)888-4476.

Sincerely,

Agent For
Sunnyside Cogeneration Associates

Randy J. Scott
Plant Manager

c.c. Ted E. Farmer/Supervisory CMS&H Inspector-Price
Gene Ray/Supervisory CMS&H Inspector-Price
Plant File
Dear Mr. Pearce:

This is in response to Sunnyside Cogeneration Associates' letter dated October 14, 1994, concerning the Program for Impoundment Inspections for the subject mine. Your plan has been reviewed by MSHA personnel, and is acceptable. The plan, as submitted, will be made a part of the mine file.

Sincerely,

[Signature]

for

James K. Oakes
Acting District Manager
October 14, 1994

James K. Oakes  
Acting District Manager  
Coal Mine Safety and Health - District 9  
PO. Box 25367  
Denver, Colorado 80225-0367  
Phone: (303) 231-5462

RE: Sunnyside Cogeneration Associates, Program for Impoundment Inspections

Dear Mr. Oakes,

Your letter dated September 19, 1994 to Gray Norman of Savage Industries, Inc. requested a program for inspection of impoundments subject to 30 CFR 77.216. A conversation with Michael Stanton of your office indicated that the emergency procedures to be followed for notification in the event that potentially hazardous conditions develop were not found in the records for the facility.

Sunnyside Cogeneration Associates (SCA), the operator or controller of the permit area, hereby submits the Program for Impoundment Inspections within the SCA permit area.

Please direct any further correspondence to:  

Sincerely,

David R. Pearce  
Authorized Member, Management Committee

Alane E. Boyd, PE  
Senior Engineer,  
Eckhoff, Watson & Preator Engineering

cc: Brian Burnett, Callister, Nebeker, & McCullough  
Gray Norman, Savage Industries Inc.
Sunnyside Cogeneration Associates
Program for Impoundment Inspections
30 CFR 77.216-3 (e)

The nature of the Sunnyside Cogeneration Associates (SCA) operations is the surface excavation and removal of coal mine waste deposited over several decades by the operators of the Sunnyside Coal Mine. During operations of the Sunnyside Coal Mine Wash Plant, slurry flowed onto the area currently permitted by SCA. Historically the slurry was deposited in the impoundment currently designated as the West Slurry Cell.

In the 1970's, the East Slurry Cell was constructed as were Slurry Pond One and Slurry Pond Two, two small impoundments which do not meet the requirements of 30 CFR 77.216(a). These three impoundments were used to deposit slurry until 1994 when the Sunnyside Coal Company discontinued operation of the Wash Plant. In the event that the Wash Plant resumes operations, the slurry may again be deposited in these impoundments within the SCA permit area.

SCA's current excavation of coal mine waste is occurring in the area of the West Slurry Cell.

In accordance with 30 CFR 77.216-3(e), SCA will follow the program outlined below for impoundment inspections:

1) All water, sediment, or slurry impoundments, within the SCA Permit Area, which meet the requirements of 30 CFR 77.216(a), (currently the West Slurry Cell and the East Slurry Cell) shall be examined by a qualified person who is trained to recognize specific signs of structural instability and other hazardous conditions by visual observation. This qualified person will be designated by SCA and examination for appearances of structural weakness and other hazardous conditions will occur at intervals not exceeding seven days.

2) During time periods when slurry is being deposited in the impoundment, an existing piezometer in the embankment shall be monitored, at intervals not exceeding seven days, by a qualified person designated by SCA.

3) If a potentially hazardous condition develops, SCA shall immediately:
   a) Take action to eliminate the potentially hazardous condition. The specific procedures necessary to eliminate the potential hazardous condition will be dependant on the type of conditions occurring and may include activities such as de-watering, excavating, filling, etc.
   b) Notify the District 9 Manager, Denver, Colorado, (303) 231-5462
   c) Notify and prepare to evacuate, if necessary, all workers from mine property which may be affected by the potentially hazardous conditions. No underground mine workings exist within the SCA Permit area. Workers will be required to evacuate from the area surrounding or directly downhill from the hazardous conditions or from any other area which may be affected. No permanently occupied facilities exist directly downhill from these impoundments.
   d) Direct a qualified person to monitor all necessary instruments and examine the structure at least once every eight hours, or more often as required by an authorized representative of the Secretary.

4) Records from each inspection shall be maintained on the mine site and shall be available for inspection by an authorized MSHA representative.