0019

APPENDIX 7-D
REGIONAL AQUIFER AND GROUND WATER STUDY
BEAR CREEK PERMIT AREA
CO-OP MINE

Updated 12/18/84

Proposed Outline of Groundwater Hydrology Study for Coop Mine
by
R &M Consultants

Submitted to: Utah Division of Oil, Gas & Mining
Dated: September 11, 1984

A step by step plan for the proposed investigations into groundwater hydrology at the Bear Creek Coop Mine is outlined for review by DOGM. This outline is based on discussions with DOGM on September 10, 1984 and on a previous proposal submitted by R&M Consultants to Coop Mining Co. and reviewed by DOGM. This document is a supplement to the proposal previously presented. Objectives and elements of critical phases of the investigations are identified and a tentative time schedule is presented. Five major phases are identified. These are (1) Preliminary investigations; (2) Numerical Flow and Contaminant Transport Modeling; (3) Analysis of model results and development of groundwater monitoring plan; (4) Implementation of monitoring plan ; and (5) Documentation and preparation of final report.

Outline:

Note: Items representing continuing activities proceeding in parallel with other activities are marked by *.

I. Preliminary Investigations

Activity	Estimated Time (months)
1. Literature Review - Regional and adjacent area geology - Geologic controls on aquifer flow - Precipitation, Recharge & Spring/Stream Discharge - Basal Water Quality	2*
2. Drilling of Preliminary Monitoring Wells - 12 wells drilled from within the mine and from the surface (between the mine Bear Canyon Spring); - locations are approximately identified on maps attached selection criteria include accessibility, topography, proximity to water areas in the mine, coverage of either side of a fault zone; exact locations near these will be determined by conditions in the mine	1 - 1.5

- Drill holes through the roof will also be completed at locations 1,2,4-8 ; water samples will be collected, static head and flow rates will be measured and the conductivity of the composite aquifer system above the mine will be estimated if possible
- wells drilled to a max. depth of 100 to 200 ft. (higher elevation wells drilled deeper), in 20 to 30 ft. stages, with core samples & water samples collected and water levels recorded at each stage.
- well drilling is terminated (except near faults) if a thick (>20') impervious, dry bed is encountered.

3. Documentation of extent and nature of mine water 2-2.5*
   - locations within the mine with percolation or other mine water inflows will be precisely identified
   - water 'reservoirs' in the mine will be defined
   - the rate of total water inflow into the mine will be estimated
   - water quality variations in the mine area will be documented (data from drilling program, mine water, springs and roof percolation)
   - all data collected will be correlated to infer the mechanisms, directions and extent of flow and to estimate recharge through mass balance techniques

Comments: The intent of these investigations is to provide the framework for basal groundwater information. It is hoped that at the conclusion of this phase adequate information will have been obtained to provide at least a preliminary indication of the flow patterns, recharge, discharge, and flow controls and to project the geologic structure in the mine and adjacent areas. Preliminary indications are that spring flows are fault controlled. In the event that this observation is reinforced and drilling in a number of locations fails to indicate the presence of other mechanisms of groundwater flow, additional drilling may be necessitated to more precisely identify the flow mechanism and recharge to the fault zone. Locations for this drilling will be specified at this time. DOGM will be presented (informally) with the results from the drilling operations and from the correlation studies as they become available.

II. Numerical Flow and Contaminant Transport Modeling

Activity	Estimated Time (months)
1. Preliminaries - Selection of appropriate model - Projection of aquifer outcrops - necessary modifications of computer code	0.25-0.5
2. Estimation of model input parameters - aquifer thicknesses, lateral extent - flow boundaries - recharge (temporal and spatial distribution) - hydraulic conductivity, storage coefficients, dispersivity initial model runs will be based on values estimated from literature/experience for similar formations. These assumptions will be systematically varied to perform a sensitivity analysis of response	1-1.5
3. Model applications and calibration - the response of mine area aquifers will be simulated as described in the original proposal to DOGM - simulated water levels and spring discharges will be compared to observations and the values of model parameters will be adjusted as indicated - in case model results are highly sensitive to perturbations of model parameters or severe adjustments are neccessary to establish an agreement between model results and observations field tests will be initiated to verify the values of model parameters	2-3

Comments: Attention will primarily be focused on aquifers below the coal seam mined. Initial observations indicate that either the water in aquifers above the coal seam exists in perched conditions or that these aquifers are discontinuous. These aquifers are however important in the proximity of the fault zones. In case preliminary drilling activity strongly suggests a lack of significant water movement in the lower aquifers and a prominence of fault dominated drainage the analysis shall focus on identifying the flow mechanism of aquifer drainage to the fault zone. This will be attained through the use of both the applications of numerical models and of analytical solutions to the drainage flow problem (ref. Halek and Svec, 1981 and Bear, 1979). Both the upper and lower aquifers will be

modeled for the purpose. DOGM will be informed of the results of this analysis.

III. Analysis of modeling results and development of groundwater monitoring plan

Activity	Estimated Time (months)
1. Analysis of results - Simulated piezometric surfaces and water quality parameters (e.g. TDS) will be contoured in the mine area at a level of detail adequate to identify the temporal (within year) and spatial variations - flow patterns will be established from the simulations - impacts of mining on area aquifers will be assessed in terms of both water quantity and quality impacts	1-1.5*
2. Monitoring Plan - the location and depth of additional monitoring wells will be identified based on the previous analysis; the number and depths of piezometers in each well will be specified - the criteria will be the potential for impact, variability of the flow and contaminant transport patterns, representativeness and adequate coverage of the study area	1-1.5*

Comments: It is anticipated that a final set of 15 to 30 locations will be used for monitoring. The number will be dictated by the observed variablity/uniformity of the results and observations, the extent of water encountered and by the extent of impact indicated. These locations shall include both monitoring wells and area springs. The frequency of monitoring will be a function of the proximity of the site to flow control/recharge/discharge areas, indicated temporal variability, accessibility and the availability of prior data at the site. Monitoring locations may also be differentiated between sites used for water quantity, water quality or both quantity and quality measurements on a similar basis. DOGM will be informed of the sites selected and their justification prior to the implementation of the drilling plan.

IV. Implementation of Monitoring Plan

Activity	Estimated Time (months)
1. Completion of wells/piezometers	1-4
2. Collection of data at specified intervals	Monthly
3. Re-calibration of model - after mining has progressed and a data base established from the sites selected, the model will be re-calibrated to conform to the data obtained (concurrent precipitation, discharge and water level records)	Annually
4. Specification of additional monitoring sites as needed	At 1300'--Advance in any undeveloped reserve

Comments: Items 2-4 will proceed on a long-term time frame. Phase V (follows) will be completed prior to these items.

V. Documentation & Final Report Preparation

Activity	Estimated Time (months)
1. Preparation of final report - format of Chapter 7.1 (Guidelines) - Maps/Figures showing projected outcrops simulated and observed piezometric surface and water quality contours, stratigraphic sections fault, spring, mine water inflow and mine water locations - detailed output from simulations - addressing all issues raised by DOGM in meeting of 9/10/84 and at every stage of progress of the investigations, specifically addressing questions pertaining to flow mechanisms, faulting, extent of aquifers, recharge and discharge, and mining impact on water quantity and quality (including the effects of controlled subsidence) detailed presentation of all modeling and analysis assumptions and of model input parameters	1.5-2

Comments: Regional and site information will be addressed at appropriate levels of detail.

Note on Selection of Preliminary Monitoring Sites:

Sites 1, 2 and 8 are near areas where the coal seam is depressed and water percolates through the roof and collects on the floor. Sites 4-7 are intended to provide coverage on either side of the fault that feeds the Bear Canyon Spring. Sites 3 and 9 are used for completeness of a cross-section of water level and quality data. Sites 10-12 are outside the mine. Sites 11 and 12 are very near the spring on either side of the fault. Site 10 is between the mine and the spring. It is felt that this set will be fairly representative.

APPENDIX 7-D
REGIONAL AQUIFER AND GROUND WATER STUDY
BEAR CREEK PERMIT AREA
CO-OP MINE

Scope

Regional aquifer and ground water studies have been initiated by Co-op Mining Company and R&M Consultants, Inc. Preliminary drill hole data and interpretation are presented herein and an outline and schedule for continued studies is included.

Seven drill holes were drilled in early September, 1984 at the locations indicated in the attached Drill Hole Location Plan, Figures 1A through 1D. The drill holes were drilled both up and down from within the mine workings and extended where possible to 200 feet. Logs of the drill holes are included in Figure 2A through 2G.

On August 22, 1984, LaMonte G. Sorenson, Senior Engineering Geologist and Upmanu Lall, Ph.D., Ground Water Hydrologist, visited the Co-op Mine site for an inspection of underground workings and surface features. Ground water occurrences and seeps were examined and initial drill hole locations were selected. Mr. Sorenson and Dr. Lall proceeded to inspect outcrops around the general mine area, including the Bear Creek spring and the Birch Spring areas. The subsurface and ground inspections were supplemented with a low level aerial reconnaissance of the general permitt and surrounding areas. These subsurface, surface, and aerial inspections are the basis for this preliminary (initial) evaluation.

The methodologies outlined are designed to identify the following:

1. The depth below the surface and the horizontal extent of the water table and aquifers;

2. The lithology and thickness of the aquifers;

3. The uses of the water in the aquifers and water table;

4. The quality of subsurface water, if encountered; and

5. The recharge, storage, and discharge characteristics of aquifers and the quality and quantity of ground water, according to the parameters and in the detail required by the Division.

Initial conclusions and findings will be completed by January 1, 1985. However, due to the complexities of the region, an on-going study will be conducted through the life of mining operations with quarterly updates provided to the Division of Oil, Gas, and Mining.

If a situation were encountered which was significantly different than projected, all mining activity in that immediate area would cease.

The Division would be contacted, the situation evaluated, and a new course of action agreed on prior to resumption of mining in the area affected.

Co-op is committed to adherence of the time table submitted to the Division on September 11, 1984 by R&M Consultants, a copy of which is herein attached.

1.5-2 months

DRILL HOLE LOCATION PLAN

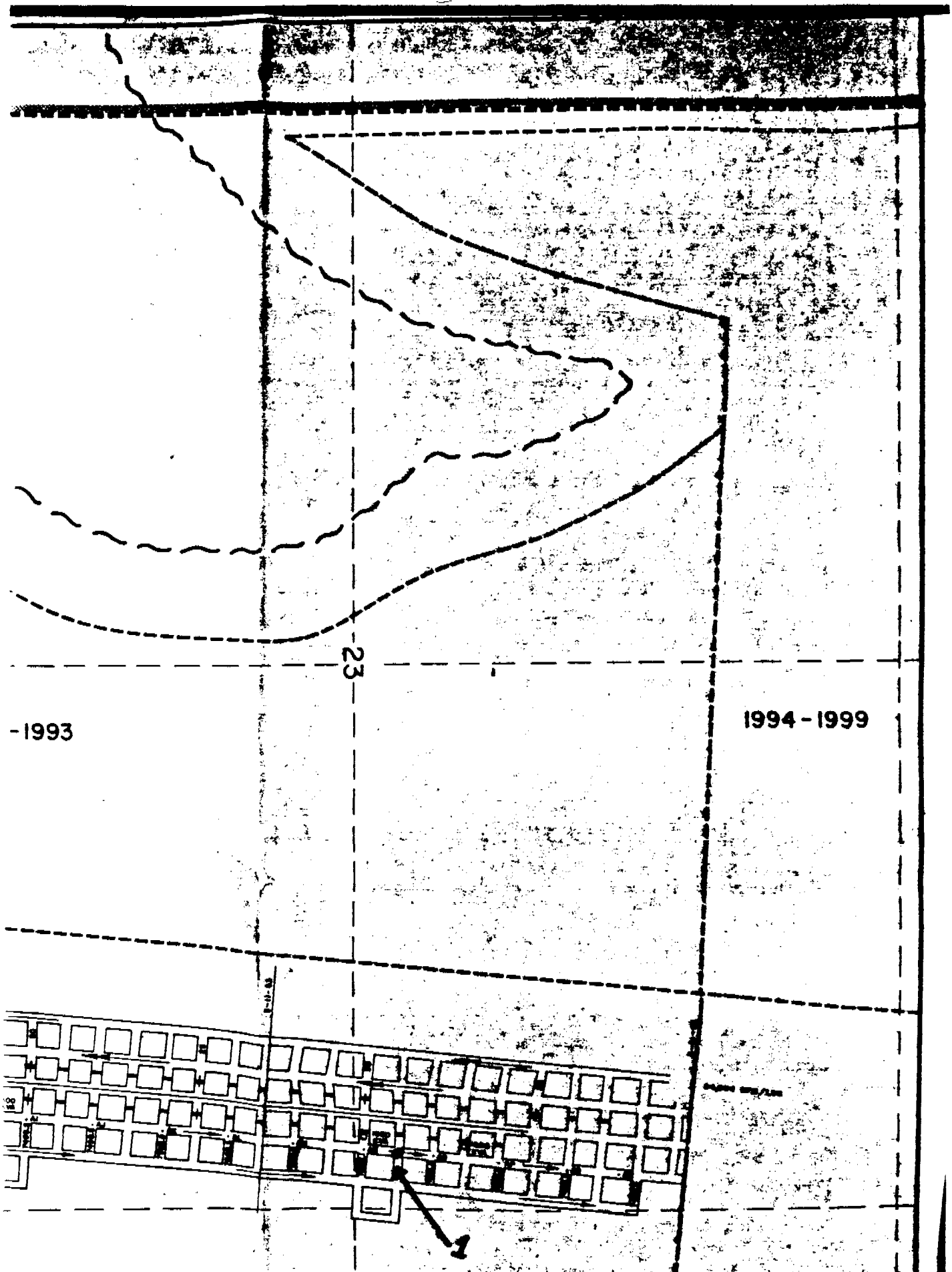


FIGURE 1A

DRILL HOLE LOCATION PLAN

2000 - 2015

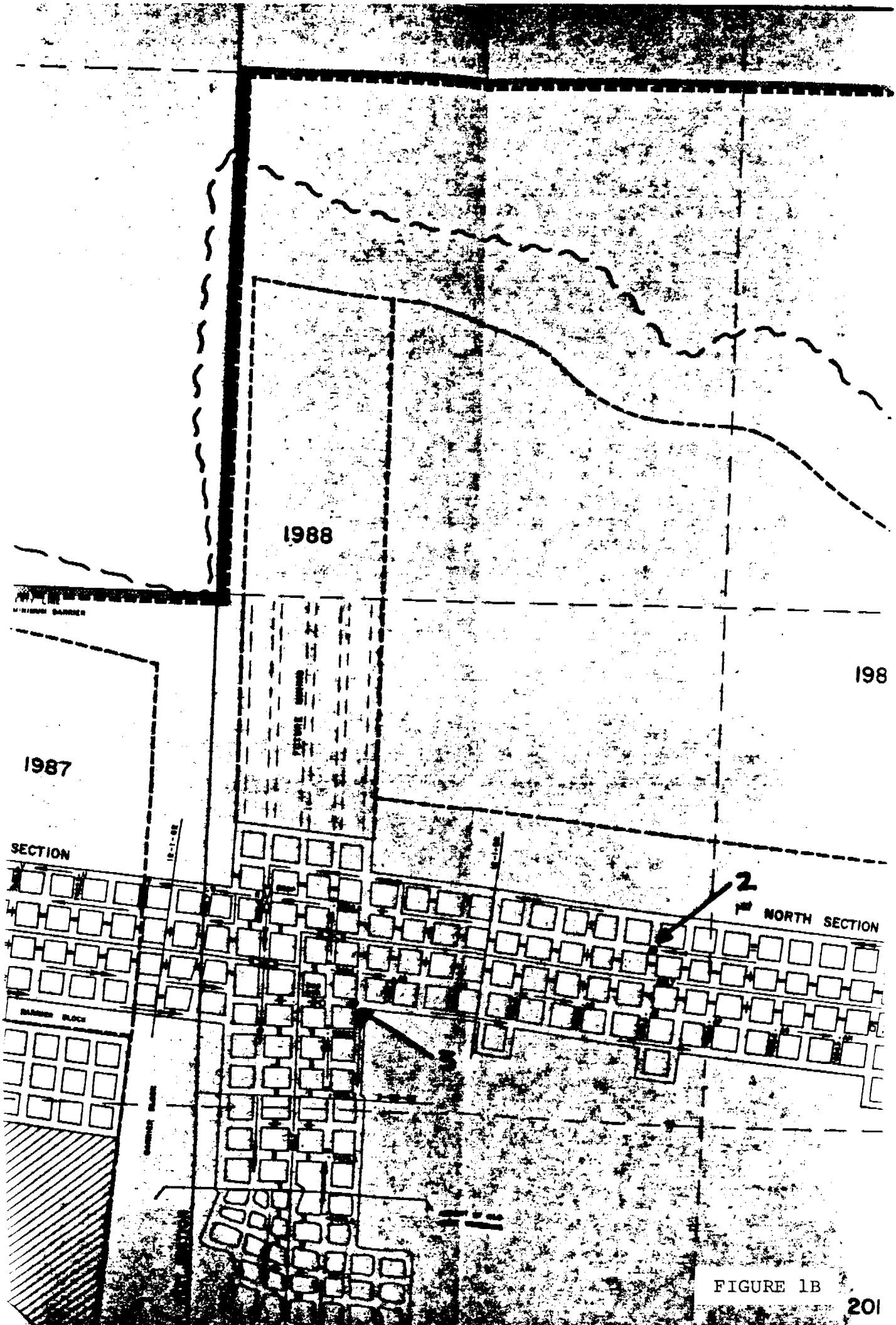


FIGURE 1B

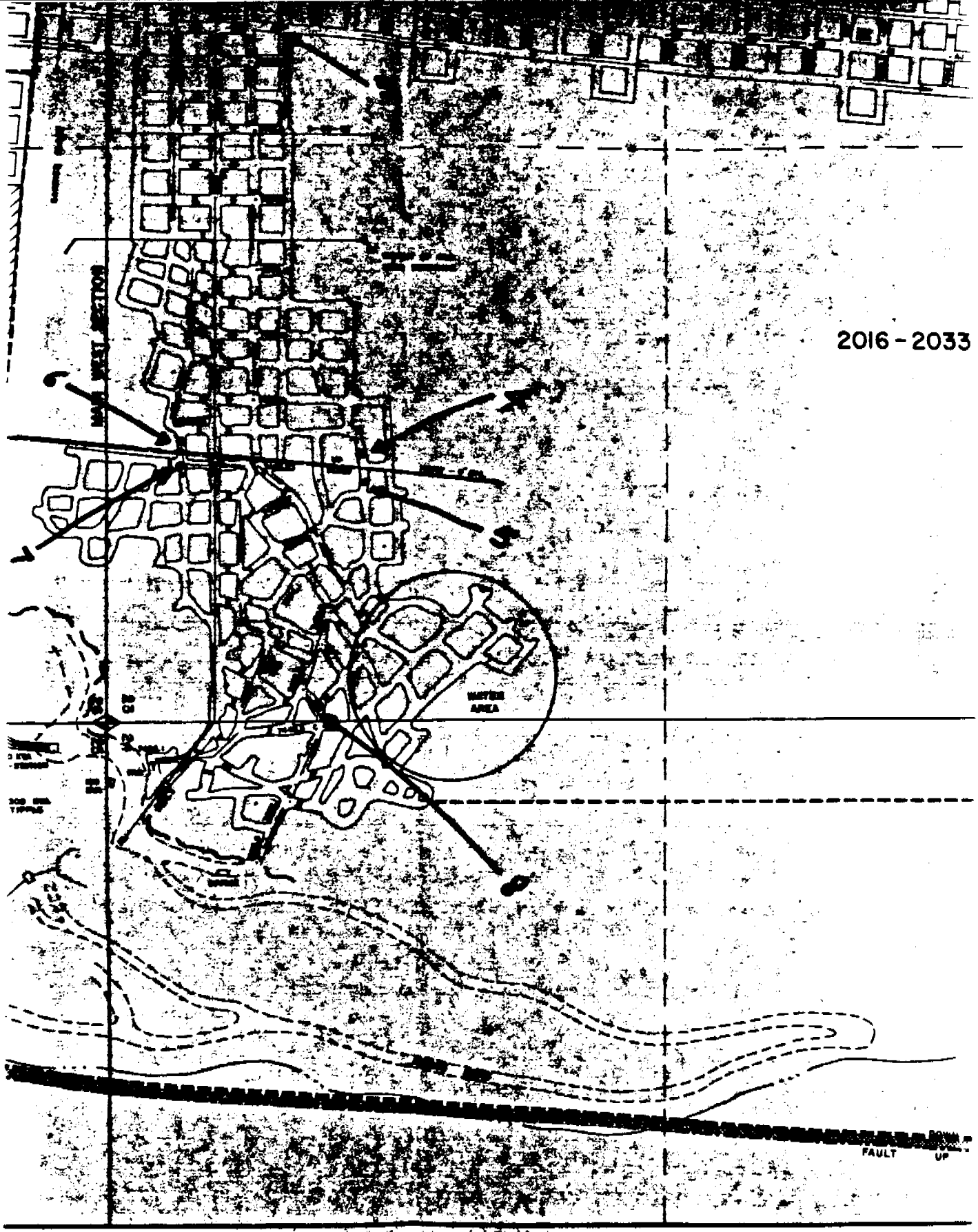

2016 - 2033
MAIN WEST SECTION
WATER AREA
FAULT
UP
LEGEND
MINE WORKINGS
SECTION LINE
PROJECTED MINING
FAULT LINE
OVERCAST
PROPERTY LINE
REGULATOR
COAL OUTCROP
SEALED AREA
PERMIT BOUNDARY

FIGURE 1C

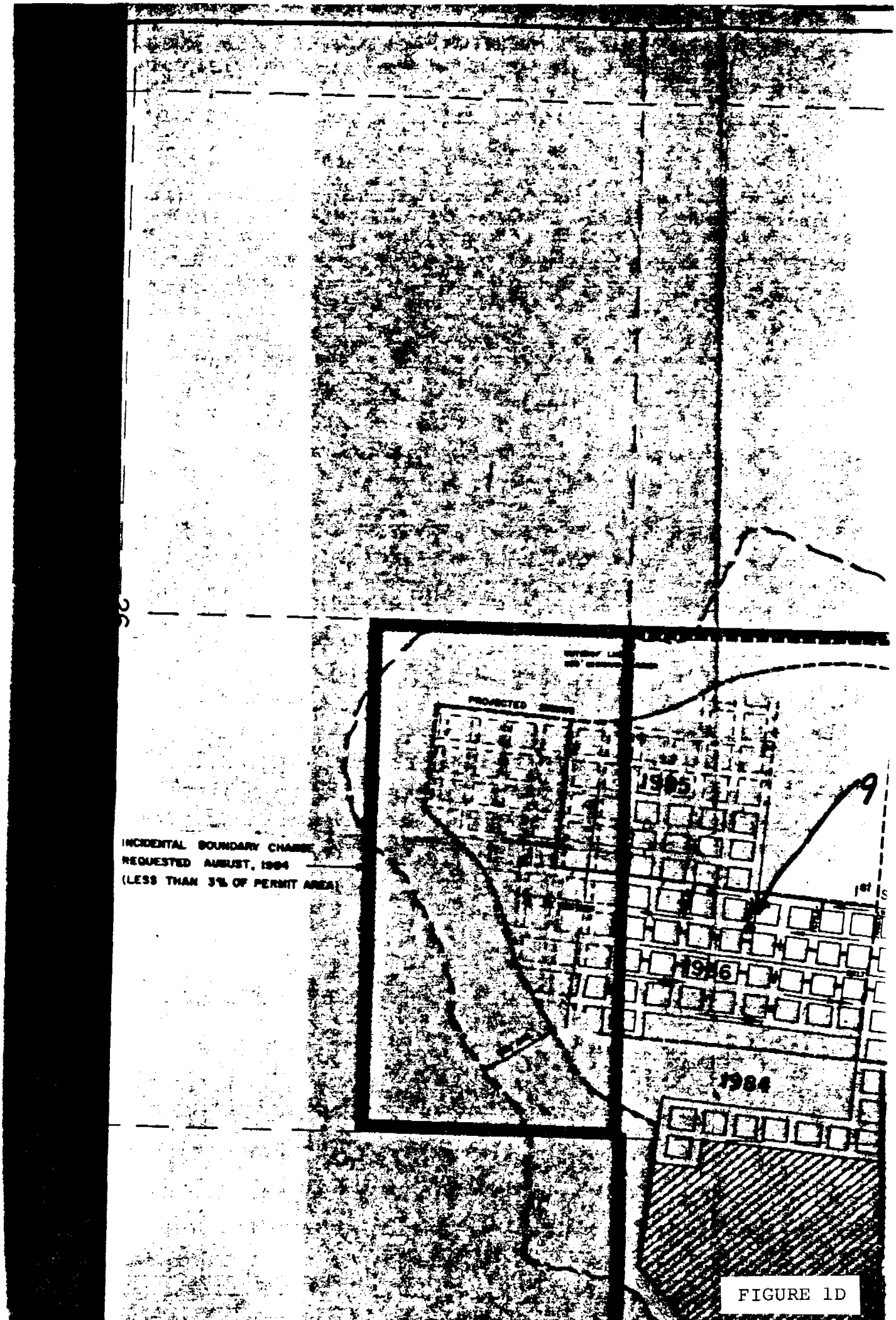
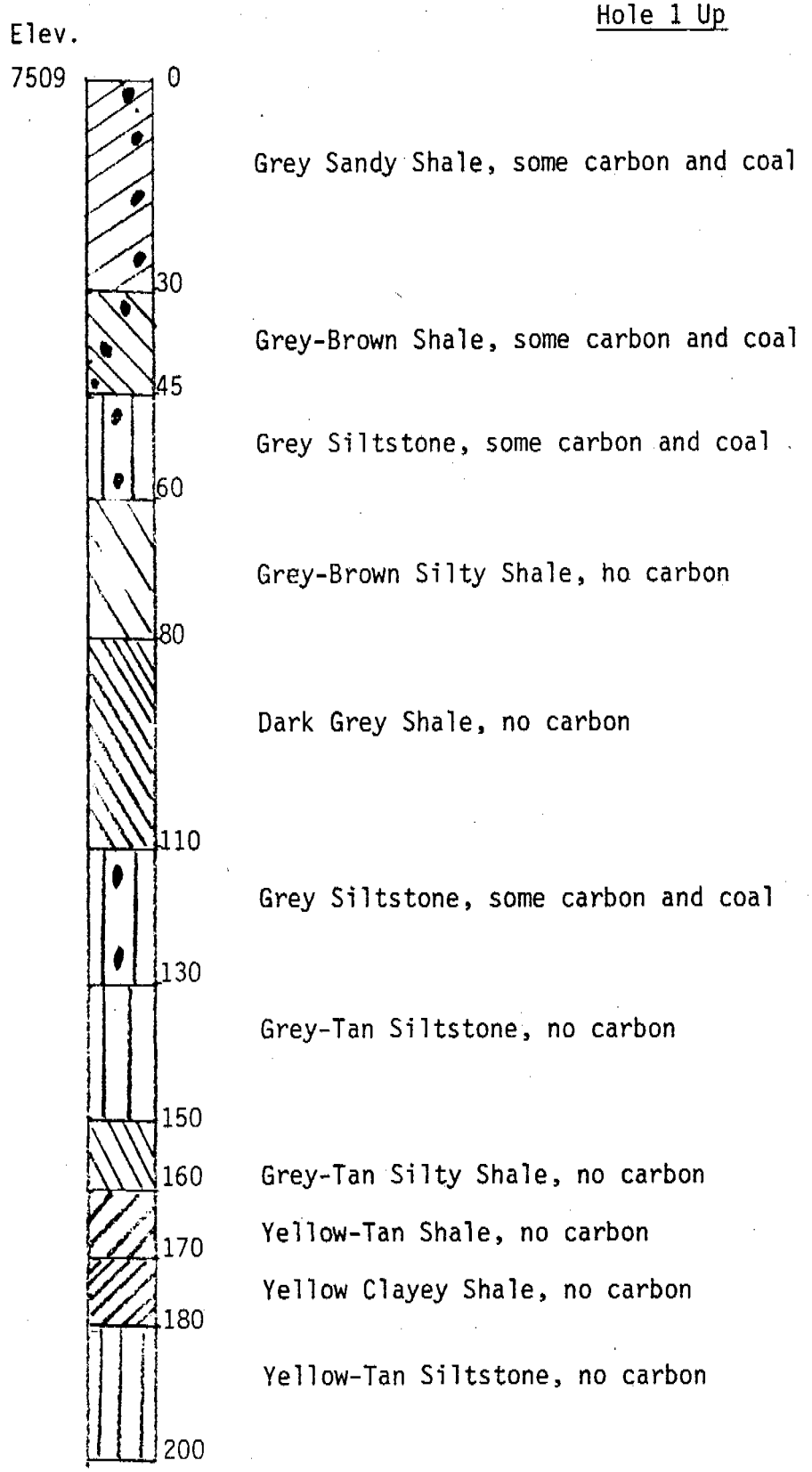

INCIDENTAL BOUNDARY CHANGE
REQUESTED AUGUST, 1984
(LESS THAN 3% OF PERMIT AREA)
PROJECTED
1985
1986
1984

FIGURE 1D

DRILL HOLE LOGS

Hole 1 Up

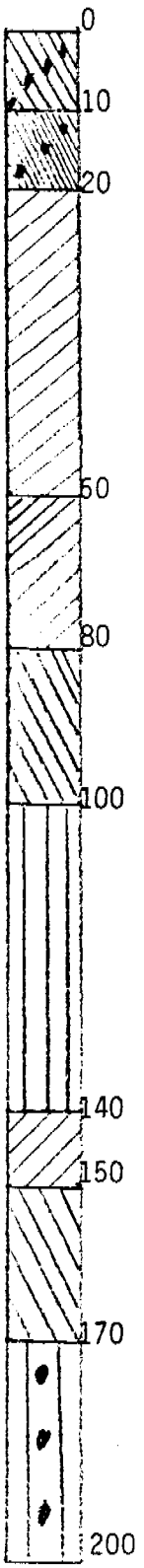


DRILL HOLE LOGS

FIGURE 2A

Hole 2 Up

Elev.
7492



Grey-Clayey Shale, some carbon and coal

Grey Clay, some carbon and coal

Yellow-Tan Silty Shale, no carbon

Yellow-Tan Shale, no carbon

Yellow-Tan Clayey Shale, no carbon

Tan Siltstone, no carbon

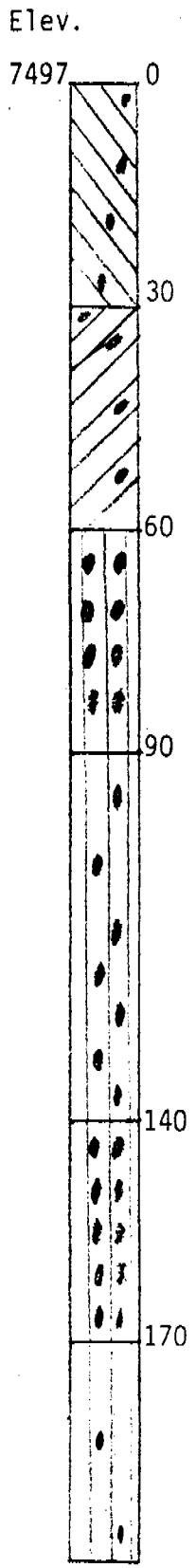
Tan-Grey Silty Shale, no carbon

Grey Shale, no carbon

Grey Siltstone, some carbon and coal

FIGURE 2B

Hole 1 Down



Grey Shale, some carbon and coal

Grey Sandy Shale, some carbon and coal

Grey Siltstone, much carbon and coal

Grey-Light Brown Siltstone, some carbon and coal

Grey-Light Brown Siltstone, much carbon

Grey Siltstone, very little carbon

FIGURE 2C

Hole 6 Down

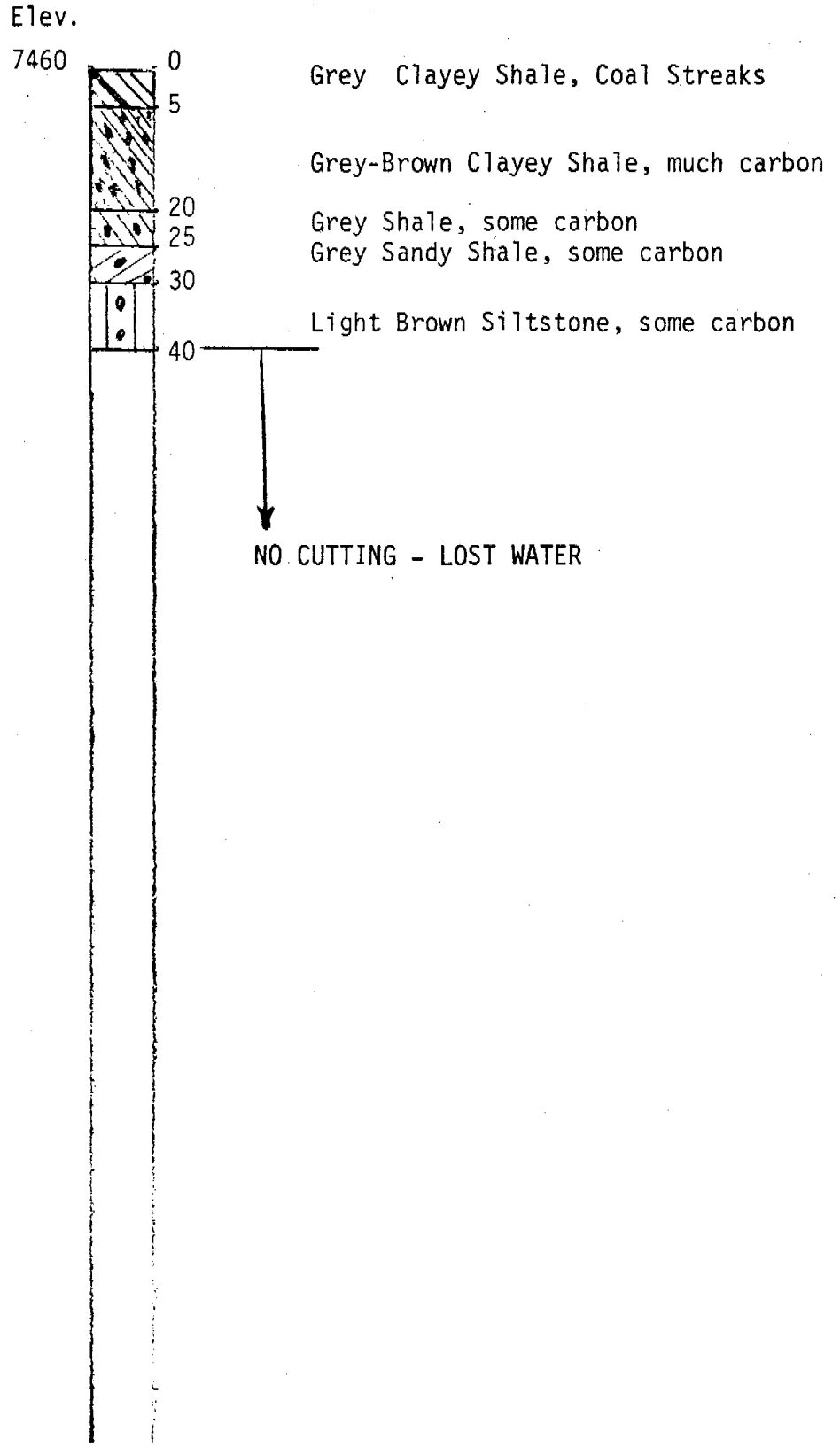
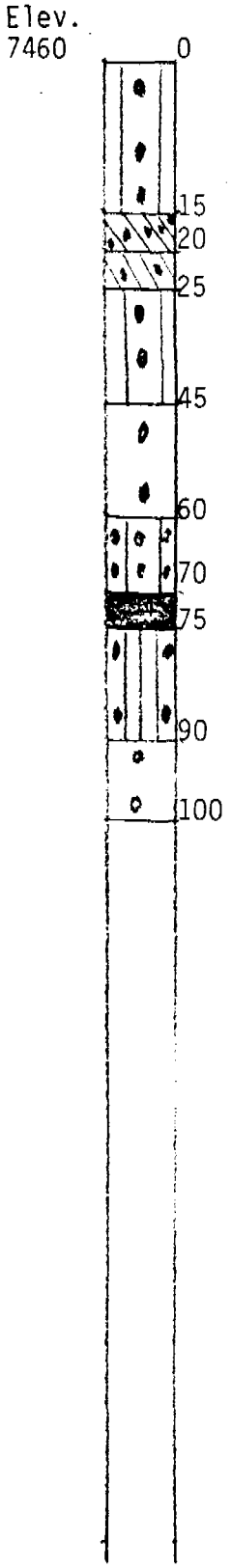


FIGURE 2D

Hole 7 Down



Light Brown Siltstone, some carbon

Light Brown Clayey Shale, much carbon

Light Brown-Grey Shale, some carbon

Light Brown Siltstone, some carbon

Light Brown Sandstone, some carbon

Light Brown Siltstone, much carbon and coal

Coal (95%), Light Brown Siltstone (5%)

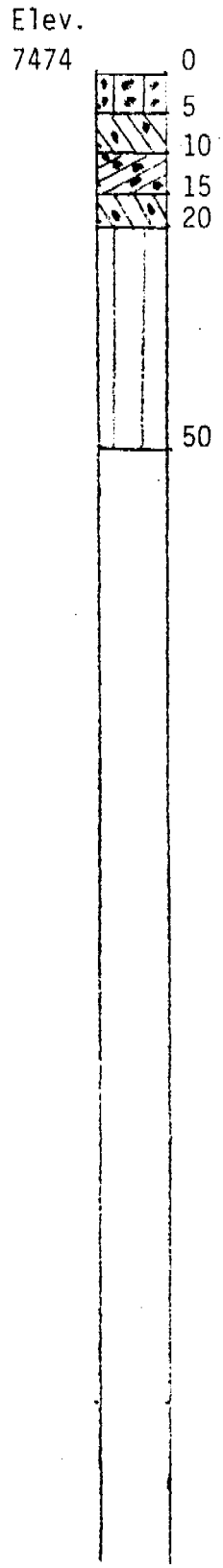
Brown Siltstone, some carbon

Brown Sandstone, some carbon

NO CUTTING - LOST WATER

FIGURE 2E

Hole 9 Down



Brown Siltstone, much carbon

Grey-Brown Shale, some carbon

Grey Clay Shale, much carbon

Light Brown-Grey Shale, some carbon

Light Brown Siltstone, no carbon

NO CUTTING - LOST WATER

FIGURE 2F

Hole 11 down

FRACTURES ENCOUNTERED SOON AFTER DRILLING

HOLE WAS THEN DRILLED AT AN ANGLE, TO PERMIT AN INCREASE IN THE DEPTH DRILLED. FURTHER FRACTURING WAS ENCOUNTERED SOON AFTER. NO WATER WAS ENCOUNTERED. DRILL LOGS AND HOLE LOCATION ARE NOT ATTACHED, BUT WILL BE MADE AVAILABLE SHORTLY.

FIGURE 2G

DRILL LOG INTERPRETATION

All holes (except No. 11) were drilled at approximately the locations indicated on the map submitted earlier. The location of Hole 11 was not accessible, and a suitable location (up canyon, west of fault) could not be easily determined.

No water was encountered in any of the holes drilled. The construction of a map delineating the piezometric surface in the area was thus not possible. The only statement that can be made in this regard is that no saturated water exists to the depths drilled above and below the coal seam mined (depths are indicated on the drill logs). As is evident from the drill logs the material above and below the seam is composed of interbedded shales, siltstones, clays and sandstone. The presence of some other coal seams is also indicated. By and large, the geologic materials identified have quite low permeabilities and would behave as aquifuges or aquicludes. The movement of water through these materials (if and when saturated) would occur at a very slow rate. On the other hand, the rapid loss of drilling water is some holes, particularly those drilled near the fault, indicated the presence of highly permeable zones such as fractures. This observation is consistent with intuitive prior beliefs that the spring discharge and regional ground water hydrology are controlled by faulting and fractures.

At this stage it appears that mining has not intercepted significant storage in the area's aquifers and that the impacts of mining on ground water movement and quality are minimal. There is a potential for impact of mining on ground water, if a water bearing fracture zone is encountered during mining. At present, this event cannot be forecast. Water has not been encountered in the vicinity of faults in significant quantities, in the area mined. Even above the coal seam mined, presence of water could not be detected (drill holes). Since the probability of encountering water bearing fissures seems to be small from available data, it is proposed that mining be allowed to proceed with periodic drilling of monitoring wells to assess the potential for encountering water. In case a zone with significant water is encountered, the need to maintain a mining barrier will be assessed.

The drilling program proposed earlier will be continued and efforts will be made to infer locations of potential water bearing strata. This task will be accomplished in one to two months and a formal report including

generalized stratigraphic sections and outcrop projections presented. Additional monitoring locations will be specified as mining progresses. Some of these locations will also be used to infer the aquifer properties of the Castlegate sandstone. The timetable for this additional monitoring will be a function of the rate of progress of mining. Monitoring locations will be added as the mine progresses through 1,000 to 2,000 feet. The drill holes for inferring the characteristics of the Castlegate sandstone will be completed within one year of approval of the permit application. Drill log data from surrounding areas will also be used to augment the information on the Castlegate sandstone and other potential recharge areas.

At present pillar removal is planned only for the southern extremity of the mine. Since no water bearing fissures have been indentified above the coal seam, in this area, the impact of resulting subsidence on ground water is expected to be minimal. The continuing in-mine drilling program may help identify any water-bearing strata as mining progresses. Pillars will not be removed in any such areas and no subsidence will be allowed. In other areas the potential for subsidence and its propogation will be assessed, along with possible impacts on identified water-bearing fissures.

A geologic map showing cross-sections, stratigraphy, outcrop projections and clearly identifying exposed geologic strata and recharge areas will also be prepared by October 7, 1984.

ADDITIONAL SOIL TEST DATA

INSERT

CHAPTER 8 - APPENDIX

8-A

Lab. No. Notes Below

Date Rec'd. 3-24-84

Date Sampled 3-24-84

Sampled By Yourselves

STANDARD LABORATORIES, INC.

Co-Op Mining Company
P.O. Box 1245
Huntington, Utah 84528

Sample ID: 43726 P1 Existing Topsoil Stockpile
43727 P2 Loadout Alternative Soil
43728 RF-3 Road Fill St 1,3 & 6

Lab No.	SAR (meq/l)	Saturation (%)	Conductivity	Sand (%)	Clay (%)	Silt (%)
43726	0.29	26.62	700 umhos/cm	62.04	10.24	27.72
43727	0.50	33.25	2200 umhos/cm	7.52	31.92	60.56
43728	1.68	30.38	2870 umhos/cm	50.36	13.00	36.64

EIVED

Respectfully Submitted,

SURVEY OF RENEWABLE RESOURCE LANDS
CO-OP BEAR CANYON PERMIT AREA AND
POTENTIAL IMPACTS OF SUBSIDENCE

On June 13, 1984, an aereal survey was conducted of the entire Bear Canyon Mine Permit Area as well as all surrounding areas which could feasibly be impacted by subsidence. The results of that survey are as follows:

(1) Hydrologic Balance: There are no seeps and/or springs above the area of the coal beds. No surface water was observed other than Bear Creek which lies beyond the potential area of subsidence. Additional site specific work was done Fall, 1984. See Appendix 7-D.

(2) Timber: There is no marketable timber within the area and the terrain is so steep as to preclude the establishment and/or harvest of such.

(3) Vegetation (Ref. grazing): The bulk of the area is high priority wildlife habitat. Potential impacts were evaluated in cooperation with UDWR Personnel. The results of that evaluation are discussed under Impacts.

The terrain is inhospitable to domestic grazing and is not utilized as such under present or future land use practices.

(4) Fish and Wildlife: The absence of water precludes the presence of fish. The entire area of influence is utilized by a wide variety of wildlife.

(5) Paleo-Archeo: There are no known sites within the area as documented by ground Paleo-Arch survey, Appendix 5-1.

Revised 9/28/84

6.5.4 Columns and Cross-Sections (Appendix 6-A)

6.5.5 Coal Reserves (See page 1-3)

6.5.5.2 Coal characteristics (App. 6-B)

6.5.6 Coal and rock sample sites (See Plate 2-2)

6.5.6.1 Rock characteristics (App. 6.C)

6.6.1 Mining hazards (See Appendix 3-B)

6.6.2 Surface hazards (See Sec. 3.5.8)

6.6.3 Impacts of mining (See Sec. 3.5) Appendix 7-D

Except where folded, the regional dip of rocks in the area generally is in a southerly direction at angles that rarely exceed 4 degrees (Danielson,'81). Most of the horizontal movement of groundwater of any significant distance is in the Star Point-Blackhawk aquifer. The Star Point formation seems to be the limit of vertical movement for local groundwater because of the impermeability and thickness of the underlying Mancos shale.

The rate of groundwater moves varies greatly throughout the area as pointed out below.

> "The rate at which water moves through the groundwater system depends largely on the permeability of the rock through which water flows. It may take only a few days for water to flow through solution cavities in the Flagstaff Limestone from recharge area to discharge point; it may take years for water to travel the same distance through the less permeable Blackhawk Formation. Six water samples from the Star Point-Blackhawk aquifer were collected in 1979 from seepage areas...and from springs... All six samples contained detectable concentration of tritium, indicating that at least some of the water had been recharged to the system within the past 10 to 30 years.
>
> Rapid movement of water through the groundwater system is indicated by the rapid response of spring discharge to changes in recharge. Generally, prior to construction of Electric Lake in 1972, most of the discharge of Huntington Creek during the fall of each year was derived from groundwater discharge. The magnitude of base flow at gaging station 09328000 during November correlates well with the water content of the previous April 1 snowpack; it reflects a rapid response in base flow to melting of the snow and resulting groundwater recharge." (Danielson,'81)

The relative imperviousness of most of the rock strata of the area inhibits groundwater movement, what rapid movement there is is along fault lines and through fractured rock. A more detailed discussion is attached under Appendix 7-D.

are of early Upper Cretaceous age. The major commercial coal seams occur in the Blackhawk Formation and are of Companion age.

Structurally, strata in the eastern Wasatch Plateau generally dip southerly (sometimes slightly southeast or southwest) at low angles of 1 to 3 degrees. Locally, near faults, the dip increases to about 20 degrees. Three major north-south trrending fault zones have been defined in the Wasatch Plateau Coal Field (see Fig. 6-1). Each zone is the product of a high angle block fault with extensive minor fracturing within the graben. The Joes Valley Fault is the largest zone. As shown in Fig. 6-1, the zone lies several miles west of the Co-Op permit area. The Pleasant Valley Fault Zone is approximately 3 to 5 miles wide. In most areas the fault planes of the Pleasant Valley Zone are vertical with between a few feet to 100 feet displacement (Doelling, 1972), although greater displacement occurs locally. The North Gordon Fault Zone, which occurs near the eastern boundary of the Wasatch Plateau field, is the least extensive of the zones. The trends of the faults have a complex pattern. Displacement is generally less than 800 feet (See Plate 2-1 for a larger scale view of faults within the permit area.) A site specific study was conducted Fall, 1984. That study is found in Appendix 7-D.

6.4 GEOLOGY OF THE PROJECT VICINITY

Plates 2-3, and 3-1 show the topography of the area. The permit area is generally rugged, with elevations varying from 7,000 to about 10,000 feet above sea level. Slopes within the permit area vary from more than 210% (65 degrees) east of Star Point to less than 4% (2 degrees) on Gentry Ridge.

6.4.1 Stratigraphy

All of the geologic formations exposed on or adjacent to the permit area are Cretaceous members of the Mesaverde group, with the exception of the North Horn Formation, which is Tertiary (See Table 6-1 & Figure 6-2). The minable coal seams are located in the Upper Cretaceous Blackhawk Formation.

Star Point Sandstone

The Star Point Sandstone, the basal formation of the Meseverde group (Doelling, 1972), is a light-colored, fairly well-sorted marine sandstone of medium to fine grain (Spieker, 1931). North of the Wattis

4) Water produced in the mine could be piped to the affected site.

5) Water shares presently owned could be transferred.

Alternative 4 may mean treating of poorer quality water and pumping to overcome elevation differences.

In the unlikely event that mining adversely affects a water source, the Co-op Mining Company will select an alternative after considering all possibilities of each site-specific circumstance.

3.5.3.3 Ground Water Monitoring Plan

An ongoing ground water monitoring program will be conducted. **(See Appendix 7-D)**

3.5.3.4 Projected Impacts of Mining on the Surface Water Hydrologic Balance

The occurrence and quality of water in any region is highly controlled by geology. The majority of the mine plan area is strong structurally and consists of the same geologic formations. It is presumed that mining activities will have little adverse impact on the area hydrologic system.

3.5.3.5 Control Measures to Mitigate Impacts - Surface Water

Runoff from all disturbed areas will be passed through sediment treatment facilities. Any discharge from facilities will be monitored in accordance with NPDES permit standards and state and federal regulations.

The effects of the mining operation on the surface water system will be analyzed through the surface water monitoring plan described in the next section. In the unlikely event that monitoring shows that the surface water system is being adversely

CHAPTER 8

SOILS

Chapter VIII

Soil Resources

Table of Contents

ents and Soil Amendments to be Used (817.25)

8.11 Mitigation and Control Plans

SCS Soil Survey_____Appendix 8-B

8.1 SCOPE

At the request of Wendell Owen, representing CO-OP Mining Company, and the San Rafael Soil Conservation District, the Soil Conservation Service performed a soil and vegetation survey on proposed mine property in Huntington Canyon. The surveys were designed to be comply with the March 1979 Permanent Regulatory Program Requirements to the Office of Surface Mining Reclamation and Enforcement, Department of Interior. (See Appendix 8-B SCS Report)

8.2 METHODOLOGY

The survey covers approximately 23 acres on Bear Creek in Huntington Canyon, Emery County, Section 25, T16S, R7E,SLBM. The soils are shown on the attached map. Each soil is identified with a three letter symbol, and the pattern and extent are shown by the soil boundary lines on the map. It should be noted that the entire survey area had been disturbed from previous mining activities. Therefore, the soil characteristics were projected from the surrounding areas. All areas having the same symbol are essentially the same kind of soils. There may be small areas of other soils included within the delineation that are slightly different. The soils are named but

have not been correlated. When the overall county survey is completed, small areas may become inclusions in other map units. Some names may change also. Included at the end of the report are the engineering uses and interpretations of the soils. The soil horizonation symbols, procedures, and nomenclature are as defined in the Soil Survey Manual (Ag. Handbook No. 18), National Soil Handbook of the Soil Conservation Service, and Soil Taxonomy.

SCS range conservationist, George Cook, visited each described soil in the survey area in November and recorded present vegetation and productivity according to ecological site analysis methods of the Soil Conservation Service. Present vegetation was recorded by percentage air dry weight. Estimates were made of annual production and range condition for the 1980 growing season. These findings are included in this report and the ecological sites identified on the soil map accompanying the soil report.

Most of the soils in the survey area are used as rangeland and wildlife habitat except where mine

disturbances have occurred. On areas that have similar climate and topography, the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between soils and vegetation and water. In this survey area the soils are grouped into ecological sites. An ecological site is an area or areas of rangeland or woodland uniform enough in climate, soils, drainage, exposures and topography that it supports a definite plant community that will produce a specific amount of vegetation. The kind of vegetation is generally the combination of plants that grew on the site before the range or woodland was affected by grazing, cultivation or otherwise altered and is called the potential vegetation. Normally the potential vegetation is the most productive combination of range or woodland plants that a site can support. Potential plant communities for the Bear Creek Canyon area obtained from clipping data, is not yet available from the Bureau of Land Management. As climate is a major factor in determining the potential plant community different climatic regime have been defined to facilitate the grouping of soils into ecological sites and the naming of sites. In this

survey area there are two climatic regimes used. These are defined generally as follows:

Upland Climatic Regime - The average annual precipitation is 12 to 16 inches. Approximately 35 to 40 percent comes during the summer months. The growing period usually begins about April 1 and lasts until the first of November until moisture is depleted or the plants mature. The freeze-free season is 100 to 130 days, and the mean annual temperature is 47° to 50° F.

Mountain Climatic Regime - The average annual precipitation is 12 to 16 inches. Approximately 35 percent comes during the summer months. The growing season begins in the later part of April and lasts until the middle of October or until moisture is depleted or the plants mature. The freeze-free season is 80 to 110 days and the mean annual temperature is 44° to 47° F.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is deter-

mined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site.

Such management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

More detailed information is available in the Price Field Office of the Soil Conservation Service.

8.3 SOIL INFORMATION

8.3.1 Soils Identification

SOIL LEGEND

SOIL SYMBOL	SOIL MAPPING UNIT NAME
D2E	Datino bouldery fine sandy loam, 5 to 20 percent slopes
DIG	Datino very stony fine sandy loam, 55 to 70 percent slopes

8.3.2 Soils Description

D2E Datino bouldery fine sandy loam, 5 to 20 percent slopes

This Datino soil is very deep and well drained. It occurs on moderately steep alluvial fans and some sloping flood plains at elevations of 7,100 to 7,140 feet (2,165 to 2,177 meters). This soil formed in alluvium and colluvium derived mainly from sandstone and shale. The average annual percipitation is 14 to 16 inches (36 to 41 centimeters). Mean annual air temperature

is 42 to 45 degrees F. (5 to 7 degrees C.), mean annual soil temperature is 44 to 47 degrees F. (6 to 8 degrees C.), and the average freeze-free season is about 80 to 110 days.

Slopes are 5 to 20 percent and mostly East facing. They are short and concave-convex.

Vegetation is dominantly pinyon, Utah juniper, salina wildrye, squirreltail, big sagebrush, Douglas-fir, and Rocky Mountain juniper.

Included in mapping are small areas of a similar soil except with 20 percent gravel and cobbles in the surface layer.

In a typical profile the surface layer is brown, bouldery fine sandy loam and cobbly loam about 10 inches (25 centimeters) thick. The subsoil is light brown very stony loam about 28 inches (71 centimeters) thick. The substratum is light reddish brown cobbly fine sandy loam to a depth of 60 inches (1.5 meters) or more.

Permeability is moderate. Available water capacity is 6 inches (15 centimeters) to a depth of 60 inches (1.5 meters). Organic matter content in the surface layer is 4 percent. Effective rooting depth is about 60 inches (1.5 meters). Surface runoff is medium and erosion hazard is moderate under potential native vegetation and high if vegetation is removed and the soil is left bare. Erodibility is low. This soil is used for range, wildlife habitat and mining operations.

Taxonomic classification is loamy-skeltal, mixed Typic Haploboralls.

A typical pedon of Datino bouldery fine sandy loam, 5 to 20 percent was described on the cut above 200 feet East and 1,100 feet South of the NW corner of Section 25, T16S, R7E.

A11 -- 0 to 2 inches (0 to 5 centimeters) brown (10YR 5/3) bouldery fine sandy loam, dark brown (10YR 3/3) when moist; moderate fine granular structure; loose, very friable, slightly sticky,

non-plastic; common very fine to medium, few coarse roots; 10 percent boulders, 10 percent stones, 5 percent cobbles, 10 percent gravel; slightly calcareous; moderately alkaline (8.0); abrupt smooth boundary.

A12 - - 2 to 10 inches (5 to 25 centimeters); brown (10 YR 5/3) cobbly loam, dark brown (10 YR 3/3 when moist; moderate medium granular structure; soft, friable, slightly sticky, slightly plastic; common very fine to medium, few coarse roots; 10 percent cobble and 10 percent gravel; moderately calcareous; moderately alkaline (ph 8.2); clear smooth boundary.

B2 - - 10 to 38 inches (25 to 96 centimeters); light brown 7.5YR 6/4) very stony loam, brown (7.5YR 4/4) when moist; weak medium subangular blocky structure; slightly hard, friable, slightly plastic; common very fine to medium roots; 1 percent boulders, 30 percent stone, 10 percent cobbles, 20 percent gravel; moderately calcareous; strongly alkaline (ph 8.5); abrupt wavy boundary.

C1 - - 38 to 60 inches (96 to 152 centimeters) light reddish brown (5YR 6/4) cobbly fine sandy loam, reddish brown (5YR 4/4) when moist; massive; soft, very friable, slightly sticky, non-plastic; few very fine and fine roots; 10 percent cobbles, 5 percent gravel; strongly calcareous; strongly alkaline (ph 8.6).

D1G Datino - Rock Outcrop Complex, 55 to 70 Percent Slopes

This map unit is on very steep canyon side-slopes. Slopes are short and concave-convex. Elevation is 7,140 to 7,600 feet (2,177 to 2,318 meters). The average annual precipitation is 14 to 16 inches (36 to 41 centimeters). Mean annual air temperature is 42 to 44 degrees F. (6 to 7 degree C.) and the average frost-freeze season is 80 to 110 degrees.

This unit is 75 percent Datino very stony fine sandy loam, 55 to 70 percent slopes in single and concave areas and 15 percent rock outcrop on ridges.

Included in this unit is about 6 to 15 inches in depth, associated with the rock outcrop.

The Datino soil is very deep and well drained. This soil formed in colluvium derived mainly from sandstone and shale. Slopes are 55 to 70 percent and East facing. They are short and concave-convex. Vegetation is dominantly pinyon, Utah juniper, Rocky Mountain juniper, salina wildrye, Douglas-fir, curlleaf mountain mahogany.

In a typical profile the surface layer is brown or yellowish brown, very stony fine sandy loam about 16 inches (41 centimeters) thick. The subsoil is very pale brown, very stony sandy clay loam about 20 inches (51 centimeters) thick. The substratum is very pale brown, very stony silty clay loam to a depth of more than 60 inches (152 centimeters).

Permeability is moderate to 36 inches (91 centimeters) and moderately slow below 36 inches. Available water capacity is 6.5 inches (16 centimeters) to a depth of 60 inches (1.5 meters). Organic matter content in the surface layer is

about 4 percent. Effective rooting depth is about 60 inches (1.5 meters). Surface runoff is rapid and erosion hazard is high under potential native vegetation and very high if vegetation is removed and the soil is left bare. Erodibility is low. This soil is used for range, wilflife habitat, and mining operation.

Taxonomic classification is loamy-skeletal, mixed Typic Haploboralls.

A typical pedon of Datino very stony fine loam, 55 to 70 percent slopes was described on the bank about 150 feet North of the old Mine portal about 300 feet North and 300 feet East of the SW corner of Section 24, T16S, R7E.

All - - 0 to 3 inches (0 to 8 centimeters); brown (10YR 5/3) very stony fine sandy loam, dark brown (10YR 3/3) when moist; moderate fine granular structure; soft, very friable, non-sticky, non-plastic; many very fine, few medium and coarse roots; moderately calcareous; moderately alkaline (ph 8.4); abrupt smooth boundary.

A12 - - 3 to 16 inches (8 to 41 centimeters); yellowish brown (10YR 5/4) stony fine sandy loam, dark brown (10YR 3/3) when moist; weak medium granular structure; soft, firable, non-sticky, non-plastic; many very fine and fine, few medium and coarse roots; 2 percent boulders, 10 percent stones, 10 percent cobbles, 10 percent gravel; moderately calcareous; moderately alkaline (ph 8.4); clear smooth boundary.

B2 - - 16 to 36 inches (41 to 91 centimeters) very pale brown (10YR 7/3) very stony sandy clay loam, pale brown (10YR 6/3) when moist; weak medium subangular blocky structure; slightly hard, firm, slightly sticky, plastic; common very fine and fine roots; many fine pores; 2 percent boulders, 15 percent stone, 15 percent cobbles, 10 percent gravel; moderately calcareous; strongly alkaline (ph 8.6); abrupt wavy boundary.

C1 - - 36 to 60 inches (91 to 152 centimeters) very pale brown (10 YR 8/4) stony silty clay loam, light yellowish brown (10YR 6/4) when moist; moderate medium and coarse subangular

blocky structure; hard, firm, sticky plastic; few very fine and fine roots, common fine pores; 2 percent boulders, 10 percent stones, 10 percent cobbles, 5 percent gravel; strongly calcareous; strongly alkaline (ph 8.9).

8.4 PRIME FARMLAND DETERMINATION

The entire permit area is deamned unsuitable for prime farmland based on:

1. There is no available water rights of an agricultural nature in conjunction with and of the land within the permit area.

2. The vast majority of the permit area is excessively steep to farm.

3. The nature of the soils (excessive rock) prohibit farming activities.

Based on all of the above the only conclusion possible is there are no Prime Farmlands within the permit area. See Appendix 8-C SCS Correspondance.

8.5 SOILS, PHYSICAL AND CHEMICAL PROPERTIES

Soil testing, ~~where~~ which conducted on those soils in the permit area, are attached (see Appendix 8-4). Co-op is presently testing additional soil which has been purchased to relieve the deficiencies in the present stockpile. The results of these tests will be provided to the division on their return.

No data

8.6 USE OF SELECTED OVERBURDEN MATERIALS OR SUBSTITUTES

Total estimate of topsoil stockpile in place as of 08/31/83, Co-Op Mine, Bear Canyon.

Tentative estimate of soil on hand is 2600 cubic yards. (See Plate 8-2). Additional material is not anticipated with the completion of the bathhouse and shop grading. Total estimate of material necessary to cover those areas with 6" of soil where there is no available growth media on site is 6.2 acres. The balance of the 10 acres [3.8] has the native material available and redistributed on interim reclaimed areas or it is available as down east material along the pre-law existing road.

At present the mine is deficient approximately 5,500 cubic yards. However, this material is available off-site. Co-Op has purchased in excess of 6,000 cubic yards from R.D. Campbell property in Carbon County, Utah. The preliminary tests indicate the soil is comparable or better than what was present prior to disturbance. Co-Op has a "Life of mine, paid in full" lease on approximately 2 acres of fee property within .5 miles of the mine along the Bear Canyon County road (See Plate 8-3). Historically, the area has been utilized for recreation. At present, there is a baseball field, picnic area, and concrete dance pavillion (See photo, Figure 8.6-1). The existing soils on this site are marginal and despite several attempts at revegetation, are virtually bare. Co-Op is committed to relocating 6,324 yds. of soil. The intent is to distribute this material at a uniform depth of 4" over

an area of 75,600 sq. ft. (app. 924 cu. yds.). This material will be of a permanant nature and will be left in place at the conclusion of mining. An additional 5,500 cubic yards will be distributed at a uniform depth on the ball field (See Fig. 8.6-2, cross section of substitute topsoil pile). This area will serve as a topsoil pile during the life of the mine, the field will have a clear water diversion ditch to prevent potential erosion and will be bermed until revegetation efforts preclude the potential of surface erosion.

A seed mix is designed for a rapid establishment of a turf suitable for recreational use as well as rapid establishment of a dense sod covering (See Table 8.6-1). A sprinkling system will be installed to insure both establishment and permanance. At the conclusion of the mining the surplus topsoil will be removed and redistributed on the mine property disturbance. The remaining 4" of soil will be revegetated utilizing the same methodology that the mine has committed to on the balance of their property to enhance both domestic and wildlife use.

The necessity for an alternative site off permit is justified by the following on-site conditions:

1. The Bear Canyon mine site is fully occupied with the existing structures.

2. There is no site within the permit boundary which could be utilized without massive additional disturbance.

3. Due to the critical winter range statute of the canyon bottom for Mule deer winter feed, any additional disturbance would be unwarranted.

4. The vegetation established at the alternative site would enhance wildlife feed.

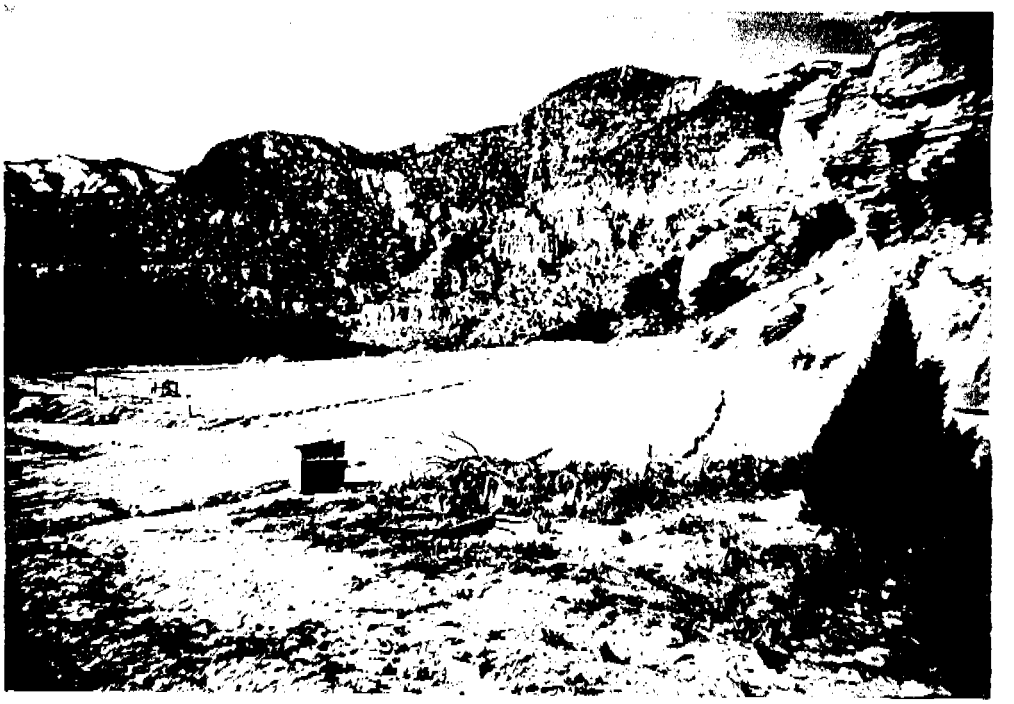
Table 8.6.-1

SEED LIST BALL PARK

Poa pratensis	50#/acre
Festuca dasycloda	50#/acre

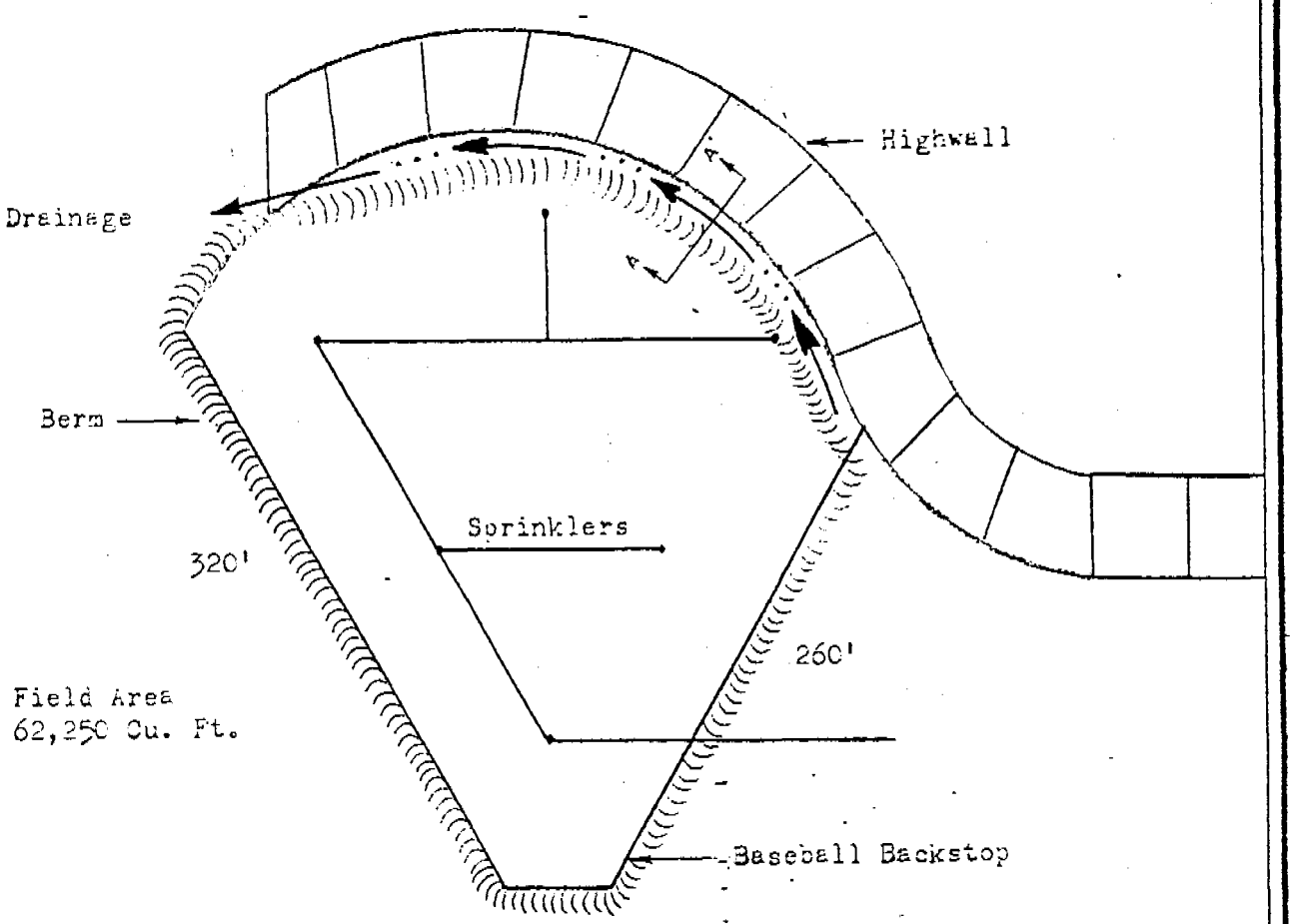
An incidental boundary change was submitted 2/8/85 in order to incorporate this area into the permit area. See attachment 8.6-1.

Figure 8.6.-1



PLAN VIEW

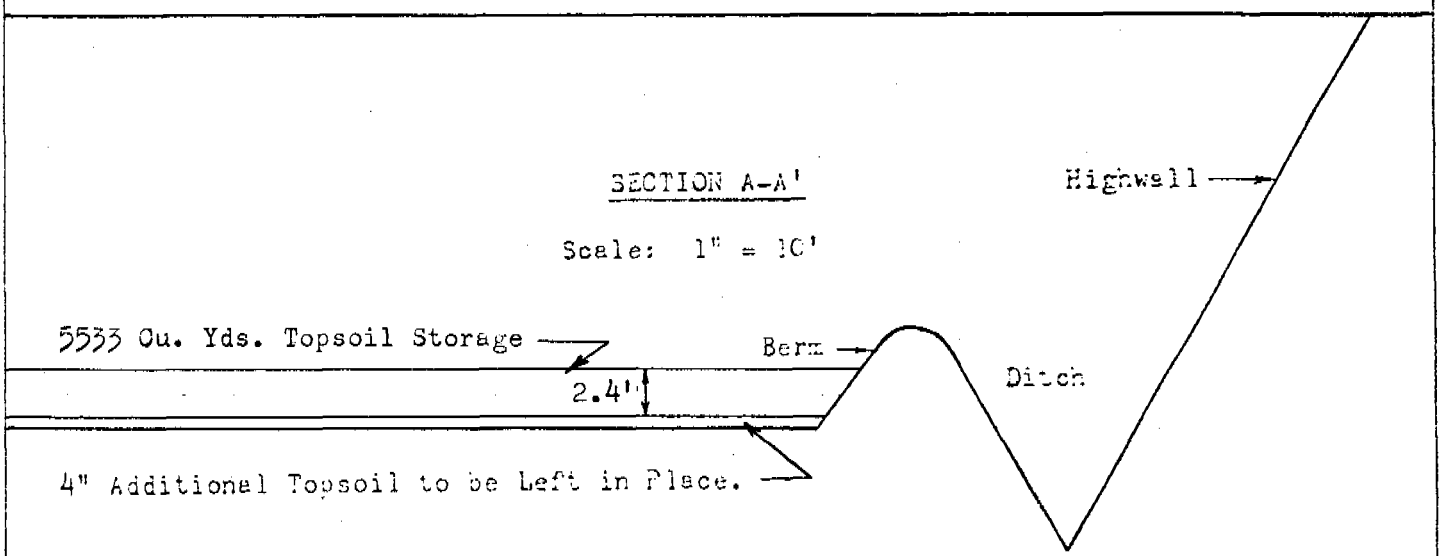
Scale: 1"=100'



PROPOSED TOPSOIL STORAGE AREA

SECTION A-A'

Scale: 1" = 10'



PROPOSED TOPSOIL STORAGE	BEAR CANYON	FIGURE NO. 8.6-2

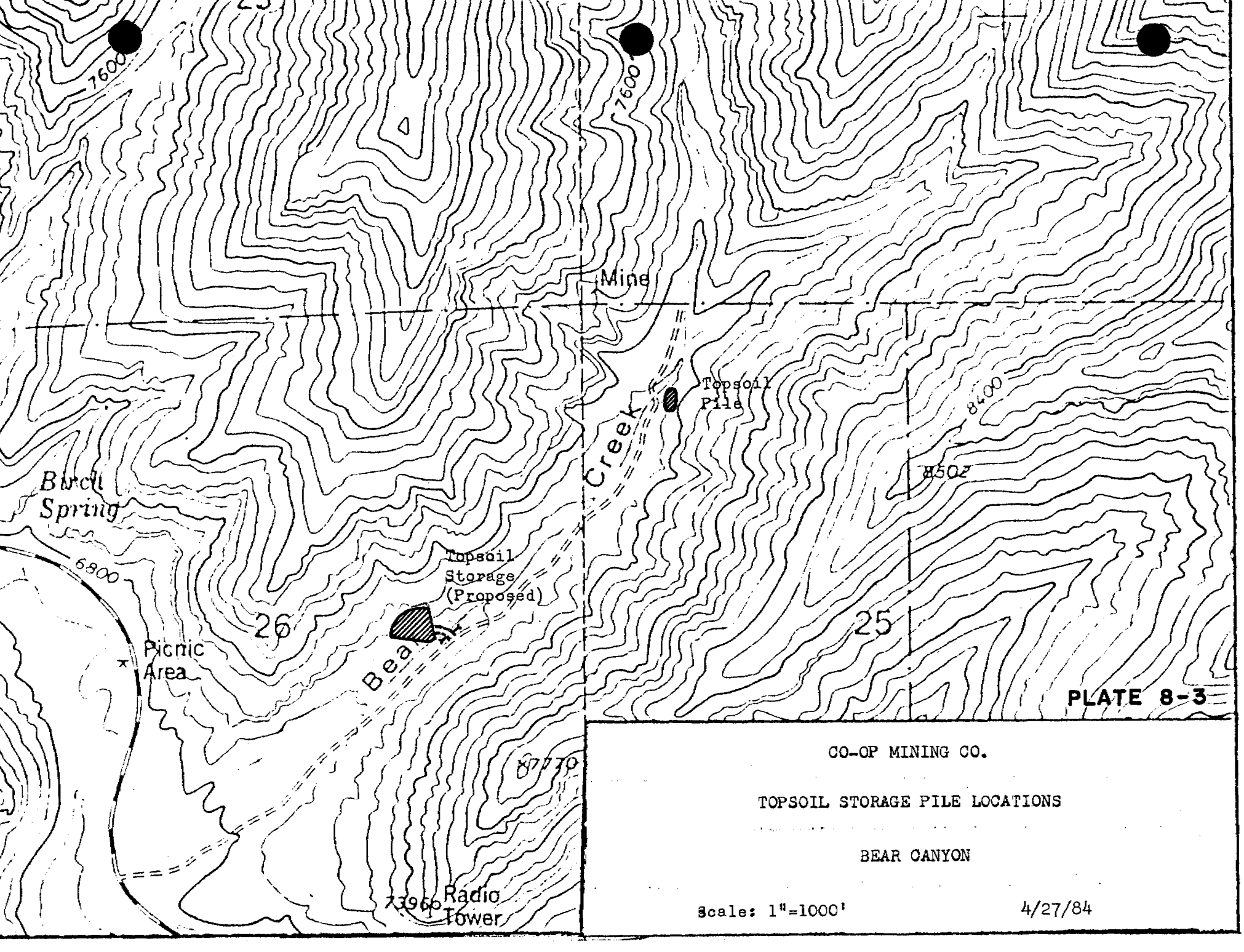


PLATE 8-3

CO-OP MINING CO.

TOPSOIL STORAGE PILE LOCATIONS

BEAR CANYON

Scale: 1"=1000'

4/27/84

8.7 PLANS FOR REMOVAL, STORAGE AND PROTECTION OF SOILS

SOILS, PHYSICAL AND CHEMICAL PROPERTIES OF SOILS; RESULTS OF ANALYSIS, TESTS, TRIALS AND INTERIM RECLAMATION PLAN.

The 1982 Co-op field investigations provided information on the physical and chemical properties of soils in the permit area. A Soils Legend will be included for each soil in a map unit (Plate 8-1). A rating for topsoil is included on this form as are some chemical properties. In studies during the 1982 field season an onsite sampling was analyzed for the required chemical properties in all horizons (see Appendix A).

SOIL REMOVAL, HANDLING, STORAGE, AND PROTECTION PLANS

To prevent suitable topsoil from being wasted or contaminated by waste materials, topsoil was removed from all new construction areas as a separate operation. The topsoil was stockpiled and will be consolidated and protected from wind and water erosion and contamination which might lessen its capability to support vegetation. The following subsections deal specifically with the varous phases of the top-

soil and subsoil handling plan.

Topsoil Removal

At the start of the construction phase, topsoil was collected from the area. Existing vegetation was removed and topsoil was collected prior to excavation or other surface disturbance operations within the affected areas.

The depth of topsoil removal in each case depends on the amount of A and B horizon material as defined in OSM Regulation 30 CFR 783.21 and 783.22. The topsoil removed in these areas consists of A horizon quality material and B horizon quality material with virtually no distinctive difference. The C horizon material was not removed since it was not sufficiently capable of supporting diverse vegetation due to the excessive rock.

The equipment used for topsoil removal consisted of bulldozers, front-end loaders, and dump trucks. The use of bulldozers requires pushing of the topsoil to a collection point for loading into dump trucks or other means of transportation to the de-

signated stockpile. Adequate supervisory personnel were present at the time of the topsoil removal to instruct the equipment operators in the proper techniques of topsoil removal and to ensure that required horizons were removed and stored.

Topsoil Stockpile

Topsoil is presently being stored within areas of the permit boundary (see Plate 2-2). It is the Co-op intent to consolidate Piles #3 with Pile #4; to utilize Pile #2 which is principally rock and unsuitable as a growth media as rip-rap where ever the need arises; and to relocate Pile #1 which is primarily rock to the site of Pile #4 to be used as a top dressing upon final reclamation.

The Piles have been consolidated (Appendix 3-D).

Plans involving topsoil storage can be labeled as "short term" or long term" depending on completion of activities in each area and the reclamation schedule presented. These piles should be considered "long term".

Short-Term Topsoil Storage Areas

Short-term stockpiles of topsoil will be for areas to be reclaimed almost immeadiately upon cutting and at final grade. Topsoil will be redistributed promptly to minimize natural degradation processes.

Long-Term Topsoil Storage Areas

During any new construction of areas that will be used for the duration of the mining operation within the permit area, topsoil will be collected and stockpiled. The topsoil will be used later for postmining reclamation of the abandonment areas.

Topsoil Protection

The short-term topsoil stockpile will be sprayed with water or temporarily vegetated to retard erosion. The long-term topsoil stockpile will be protected by the following operational steps:

A stable surface will be provided in an area outside the influence of active operations.

Short-term stockpiles of topsoil will be for areas to be reclaimed almost immeadiately upon cutting and at final grade. Topsoil will be redistributed promptly to minimize natural degradation processes. No short-term piles are anticipated at this time. If a need arises, a site-specific plan will be submitted prior to disturbance.

Long-Term Topsoil Storage Areas

During any new construction of areas that will be used for the duration of the mining operation within the permit area, topsoil will be collected and stockpiled. The topsoil will be used later for postmining reclamation of the abandonment areas.

Topsoil Protection

The short-term topsoil stockpile will be sprayed with water or temporarily vegetated to retard erosion. The long-term topsoil stockpile will be protected by the following operational steps:

A stable surface will be provided in an area outside the influence of active operations.

As a stockpile is completed, it will be left in a rough condition to minimize erosion.

Stockpiles will be situated out of drainages to prevent water erosion.

Storage piles will be vegetated with quick-growing, soil-stabilizing plants. Revegetation will involve the immediate seeding of stockpiles topsoil during the next planting season with the seed mixture recommended in a report on vegetation and plant community analysis (See Attachment 2A Seed List) in compliance with the requirements of the appropriate land management agency.

Signs will be posted to protect the stockpiles from accidental use as fill or from other inadvertent material contamination. The establishment of noxious plant species will be prevented.

The stockpiled topsoil will not be removed or otherwise disturbed until required for the redistribution operation on a prepared, regraded

disturbed area.

8.8 PLANS FOR REDISTRIBUTION OF SOILS

Prior to topsoil redistribution, regraded land will be scarified by a ripper-equipped tractor. The ground surface will be ripped to a suitable depth in order to reduce surface compaction, provide a roughened surface assuring topsoil adherence, and promote root penetration. Steep slope areas which must remain after abandonment will receive special ripping to create ledges, crevices, pockets, and screes. This will allow better soil retention and vegetation establishment.

Within a suitable time period prior to seeding, topsoil will be distributed on areas to be reclaimed. During this time, the topsoil will be allowed to settle and attain equilibrium with its natural environment. This procedure will be followed for areas in which facilities such as roadbeds, mine pads, and building sites are to be abandoned.

Topsoil redistribution procedures will ensure an approximate uniform thickness consistent with the pro-

disturbed area.

8.8 PLANS FOR REDISTRIBUTION OF SOILS

Prior to topsoil redistribution, regraded land will be scarified by a ripper-equipped tractor. The ground surface will be ripped to a depth of 14" in order to reduce surface compaction, provide a roughened surface assuring topsoil adherence, and promote root penetration. Steep slope areas which must remain after abandonment will receive special ripping to create ledges, crevices, pockets, and screes. This will allow better soil retention and vegetation establishment.

Within a ten day period prior to seeding, topsoil will be distributed on areas to be reclaimed. During this time, the topsoil will be allowed to settle and attain equilibrium with its natural environment. This procedure will be followed for areas in which facilities such as roadbeds, mine pads, and building sites are to be abandoned.

Topsoil redistribution procedures will ensure an approximate uniform thickness of 6 inches as stated in the

reclamation plan. Topsoil will be redistributed in the fall of the year (Oct.) suitable for establishment of permanent vegetation.

To minimize compaction of the topsoil following redistribution, travel on reclaimed areas will not be allowed. After topsoil has been applied, surface compaction will be reduced by using a D-6 Crawler tractor and harrowing to a 4" depth. This operation will also help prepare a proper seed bed and protect the redistributed topsoil from wind and water erosion.

Co-Op Mining will exercise care to guard against erosion during and after application of topsoil and will employ wood fiber mulch and tacifiers to ensure the stability of topsoil on graded slopes. The specific methods to be implemented will be defined in the attached Interim Plan. The soil stabilization methodology that will be used includes the placement of crushed and heavier material at the toe of roadfill slopes, and the random placement of large rocks and boulders on the surface. This procedure will enhance the microclimate as well as make the reclaimed area more aesthetically compatible with the undisturbed surroundings.

undisturbed surroundings.

8.9 NUTRIENTS AND SOIL AMENDMENTS

Phosphorus

Nitrogen

Soil ph and salinity

Soil texture

Chemical analysis for micronutrients will be conducted by testing soil extracts from the redistributed material. All necessary fertilization or neutralization, as determined by soil testing, will be done according to the final Reclamation Plan.

8.10 EFFECTS OF MINING OPERATIONS ON TOPSOILS, NUTRIENTS, AND SOIL AMENDMENTS

Since the Co-op Mine is an underground mine, the impact of mining on soils will be minor overall. The impacts of surface operations and mining facilities on soil resources consist of coverage of soil by landfills and refuse, disturbance of soils during construction activites, erosion created by removing vegetation, reduced forage growth due to nutrient degrada-

posed reclamation plan. Topsoil will be redistributed at a time of the year suitable for establishment of permanent vegetation.

To minimize compaction of the topsoil following redistribution, travel on reclaimed areas will be limited. After topsoil has been applied, surface compaction will be reduced by using appropriate equipment running at a suitable depth. This operation will also help prepare a proper seed bed and protect the redistributed topsoil from wind and water erosion.

Co-op Mining will exercise care to guard against erosion during and after application of topsoil and will employ the necessary measures to ensure the stability of topsoil on graded slopes. The specific methods to be implemented will be defined in the attached Interim Plan. An example of the soil stabilization methodology that might be used includes the placement of crushed and heavier material at the toe of roadfill slopes, and the random placement of large rocks and boulders on the surface. This procedure will enhance the microclimate as well as make the reclaimed area more asthetically compatible with the

tion, reduced livestock capacity, and particulate emissions to the air.

The areas in which soil has been disturbed to date within the permit area, includes the loadout area, future offices, shops and substations, roads, portal areas, and the topsoil storage areas. Additional acreage may be disturbed in the future if Co-op elects to proceed with certain projects it is considering.

8.11 MITIGATION AND CONTROL PLANS

Detailed Interim Reclamation Plans (Appendix 3-C) are attached and are part of the Bear Canyon Mine Reclamation Plan in regard to stockpiling and long and short term plans and goals for final reclamation.

Co-Op is committed to take whatever steps ace necessary to minimize loss of soil through erosion. Whenever rills or gullies become in evidence, Co-Op will fill, regrade, rip rap and reseed, tackify, and mulch. This work will commence prior to significant loss. (Rills and gullies, less than 9").

CO-OP MINING COMPANY

P.O. Box 1245
Huntington, Utah 84528

(801) 748-5238
Coal Sales (801) 748-5777

February 8, 1985

Utah Division of Oil, Gas & Mining
355 West North Temple
#3 Triad Center Suite 350
Salt Lake City, Utah 84180-1203

Attention: Dr. Dianne R. Nielson, Dir.

RE: 788.12,2,(d) Incedental
Boundary Revisions

Dear Dr. Nielson:

Co-Op Mining Company, Bear Canyon Mine ACT/015/025,#2, Emery County Utah, formally requests under UCA-40-10-1 et seq. UMC regulation 788.12,1,(d) an incidental boundary change Bear Canyon Mine permit area. The change is noted and delineated on attachment Figure 3-4A(1) and on Plate 3-4A. The incidental boundary change encompasses an area of 1.5 acres which is less than 1% of the existing permit area.

This area is necessary to stockpile topsoil and will preclude the unnecessary disturbance of additional land in Bear Canyon considering this area is presently disturbed.

Co-Op feels that the existing surity agreement is adequate to address this additional area. This assumption is based on the fact that there are no new structures, road, and/or facilities within the 1.5 acre area. Co-Op anticipates reclamation of the area, Fall of 1985. The

area was covered by the existing subsidence inventory and lies within the existing permit area of potential subsidence influence zone.

I have included a copy of the plan for your personal review.

I appreciate your consideration of this matter.

Sincerely,

Melvin A. Coonrod
Permitting and Compliance

njc/mc

APPENDIX 8-A

SOIL TEST REPORTS

SOIL TEST REPORT

NO. 7404.0

AGRICULTURAL CONSULTANTS, INC.

P.O. DRAWER 507 — 240 S. FIRST AVENUE
BRIGHTON, COLORADO 80601
303/659-2313

DATE RCVD 11-12-82

REPORTED 11-23-82

REPORT TO: CO-OP MINING COMPANY ATTN: MR. OWEN

BILL TO: SAME

GROWER: SAME

SAMPLE ID: BEAR UPPER PAD

TEXTURE si=silt, silty sn=sand, sandy lo=loam, loamy cl=clay	pH		CEC Meq /100g	SALT Mmhos /cm	Na Meq /100g	Lime %	OM %	Org N Lbs	AVAILABLE NUTRIENTS ppm (1)										
	H_2O	Buf							NO_3	P(2)	K(2)	Ca	Mg	S(2)	B	Zn	Fe	Mn	Cu
N LO	8.3	7.0	9.5	1.9	0.2	8.7	0.9	31.5	9	1	44	2700	250	58	0.2	0.4	1.5	1.1	0.3

CROP	YIELD GOAL	CROP RESIDUE T/A	MNR T/A	RECOMMENDATIONS POUNDS PER ACRE											
				N	P_2O_5	K_2O	Elem Sulfer	Lime	Mg	SO_4-S	Boron	Zinc	Iron	Mn	Cu
DL Native Grasses	Average	-	0	50	30	70	0	0	0	0	0	0	0	0	0

1.ppm=parts per million or lbs element per million lbs soil. ppm x 2 = lbs/acre 6-7" depth. ppm x 3.5 = lbs/acre fest. 2. P x 2.3 = P_2O_5 K x 1.2 = K_2O S x 3 =

Values reported but without specific remarks are considered to be within growth range of intended crop.

If poor moisture conditions reduce fertilization accordingly.

Supervised by Diana Lansing

ATTACHMENT 1-A

SOIL TEST REPORT

NO. 7405.0

AGRICULTURAL CONSULTANTS, INC.
P.O. DRAWER 507 — 240 S. FIRST AVENUE
BRIGHTON, COLORADO 80601
303/659-2313

DATE RCVD 11-12-82

REPORTED 11-23-82

REPORT TO: CO-OP MINING COMPANY ATTN: MR. OWEN

BILL TO: SAME

GROWER: SAME

SAMPLE ID: BEAR POWER POLE

TEXTURE si=silt, silty sn=sand, sandy lo=loam, loamy cl=clay	pH		CEC Meq /100g	SALT Mmhos /cm	Ns Meq /100g	Lime %	OM %	Org N Lbs	AVAILABLE NUTRIENTS ppm (1)										
	H_2O	Buf							NO_3	P(2)	K(2)	Ca	Mg	S(2)	B	Zn	Fe	Mn	Cu
	8.0	7.0	38.7	4.6	0.3	9.1	1.8	45.0	6	1	90	9900	510	204	0.6	0.4	4.6	1.4	0.4

CROP	YIELD GOAL	CROP RESIDUE T/A	MNR T/A	RECOMMENDATIONS POUNDS PER ACRE											
				N	P_2O_5	K_2O	Elem Sulfer	Lime	Mg	SO_4-S	Boron	Zinc	Iron	Mn	Cu
DL Native Grasses	Average	-	0	50	50	90	0	0	0	0	0	0	0	0	0

1.ppm=parts per million or lbs element per million lbs soil. ppm x 2 = lbs/acre 6-7" depth. ppm x 3.5 = lbs/acre feet. 2. P x 2.3 = P_2O_5 K x 1.2 = K_2O S x 3 =
Values reported but without specific remarks are considered to be within growth range of intended crop.

If poor moisture conditions reduce fertilization accordingly.

Supervised by Diana Lansing

ATTACHMENT 1-A

SOIL TEST REPORT

NO. 7406.0

AGRICULTURAL CONSULTANTS, INC.
P.O. DRAWER 507 — 240 S. FIRST AVENUE
BRIGHTON, COLORADO 80601
303/659-2313

DATE RCVD 11-12-82

REPORTED 11-23-82

REPORT TO: CO-OP MINING COMPANY ATTN: MR. OWEN

BILL TO: SAME

GROWER: SAME

SAMPLE ID: SCALES BEAR

TEXTURE (silt, silty; sand, sandy; loam, loamy; clay, clay)	pH		CEC Meq /100g	SALT Mmhos /cm	Na Meq /100g	Lime %	OM %	Org N Lbs	AVAILABLE NUTRIENTS ppm (1)											
	H_2O	Buf							NO_3	P(2)	K(2)	Ca	Mg	S(2)	B	Zn	Fe	Mn	Cu
LD	8.3	7.0	11.1	1.0	0.2	8.6	1.3	45.5	8	3	99	3400	210	31	0.6	0.6	3.8	2.0	0.3

CROP	YIELD GOAL	CROP RESIDUE T/A	MNR T/A	RECOMMENDATIONS POUNDS PER ACRE											
				N	P_2O_5	K_2O	Elem Sulfer	Lime	Mg	SO_4-S	Boron	Zinc	Iron	Mn	Cu
DL Native Grasses	Average	-	0	40	50	50	0	0	0	0	0	0	0	0	0

1.ppm=parts per million or lbs element per million lbs soil. ppm x 2 = lbs/acre 6-7" depth. ppm x 3.5 = lbs/acre feet. 2. P x 2.3 = P_2O_5 K x 1.2 = K_2O S x 3

Values reported but without specific remarks are considered to be within growth range of intended crop.

If poor moisture conditions reduce fertilization accordingly.

Supervised by Dian Lansing

ATTACHMENT 1-A

APPENDIX 8-B

SCS SOIL SURVEY

SOIL SURVEY AND INTERPRETATIONS
VEGETATION SURVEY
for
CO-OP MINING CO.
Huntington Canyon
March 1980

Earl Jensen, Soil Scientist, SCS
George Cook, Range Conservationist, SCS
Gary Moreau, District Conservationist, SCS

TABLE OF CONTENTS

SOIL SURVEY AND INTERPRETATIONS
VEGETATION SURVEY
for
CO-OP MINING CO.

At the request of Wendell Owen, representing CO-OP Mining Co., and the San Rafael Soil Conservation District, the Soil Conservation Service performed a soil and vegetation survey on proposed mine property in Huntington Canyon. The surveys were designed to comply with the March 1979 Permanent Regulatory Program Requirements of the office of Surface Mining Reclamation and Enforcement, Department of Interior.

The survey covers approximately 23 acres on Bear Creek in Huntington Canyon, Emery County, Section 25, T16S, R7E, SLBM. The soils are shown on the attached map. Each soil is identified with a three letter symbol, and the pattern and extent are shown by the soil boundary lines on the map. It should be noted that the entire survey area had been disturbed from previous mining activities. Therefore, the soil characteristics were projected from the surrounding areas. All areas having the same symbol are essentially the same kind of soils. There may be small areas of other soils included within the delineation that are slightly different. The soils are named but have not been correlated. When the overall county survey is completed, small areas may become inclusions in other map units. Some names may change also. Included at the end of the report are the engineering uses and interpretations of the soils. The soil horizonation symbols, procedures, and nomenclature are as defined in the Soil Survey Manual (Ag. Handbook No. 18), National Soil Handbook of the Soil Conservation Service, and Soil Taxonomy.

SCS range conservationist, George Cook, visited each described soil in the survey area in November and recorded present vegetation and productivity according to ecological site analysis methods of the Soil Conservation Service. Present vegetation was recorded by percentage air dry weight. Estimates were made of annual production and range condition for the 1980 growing season. These findings are included in this report and the ecological sites identified on the soil map accompanying the soil report.

Most of the soils in the survey area are used as rangeland and wildlife habitat except where mine disturbances have occurred. On areas that have similar climate and topography, the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between soils and vegetation and water.

In this survey area the soils are grouped into ecological sites. An ecological site is an area or areas of rangeland or woodland uniform enough in climate, soils, drainage, exposures and topography that it supports a definite plant community that will produce a specific amount of vegetation. The kind of vegetation is generally the combination of plants that grew on the site before the range or woodland was affected by grazing, cultivation or otherwise altered and is called the potential vegetation. Normally the potential vegetation is the most productive combination of range or woodland plants that a site can support. Potential plant communities for the Bear Creek Canyon area obtained from clipping data, is not yet available from the Bureau of Land Management. As climate is a major factor in determining the potential plant community different climatic regime have been defined to facilitate the grouping of soils into ecological sites and the naming of sites. In this survey area there are two climatic regimes used. These are defined generally as follows:

Upland Climatic Regime - The average annual precipitation is 12 to 16 inches. Approximately 35 to 40 percent comes during the summer months. The growing period usually begins about April 1 and lasts until the first of November until moisture is depleted or the plants mature. The freeze-free season is 100 to 130 days, and the mean annual temperature is 47^{o} to 50^{o} F.

Mountain Climatic Regime - The average annual precipitation is 16 to 20 inches. Approximately 35 percent comes during the summer months. The growing season begins in the later part of April and lasts until the middle of October or until moisture is depleted or the plants mature. The freeze-free season is 80 to 110 days and the mean annual temperature is 44^{o} to 47^{o} F.

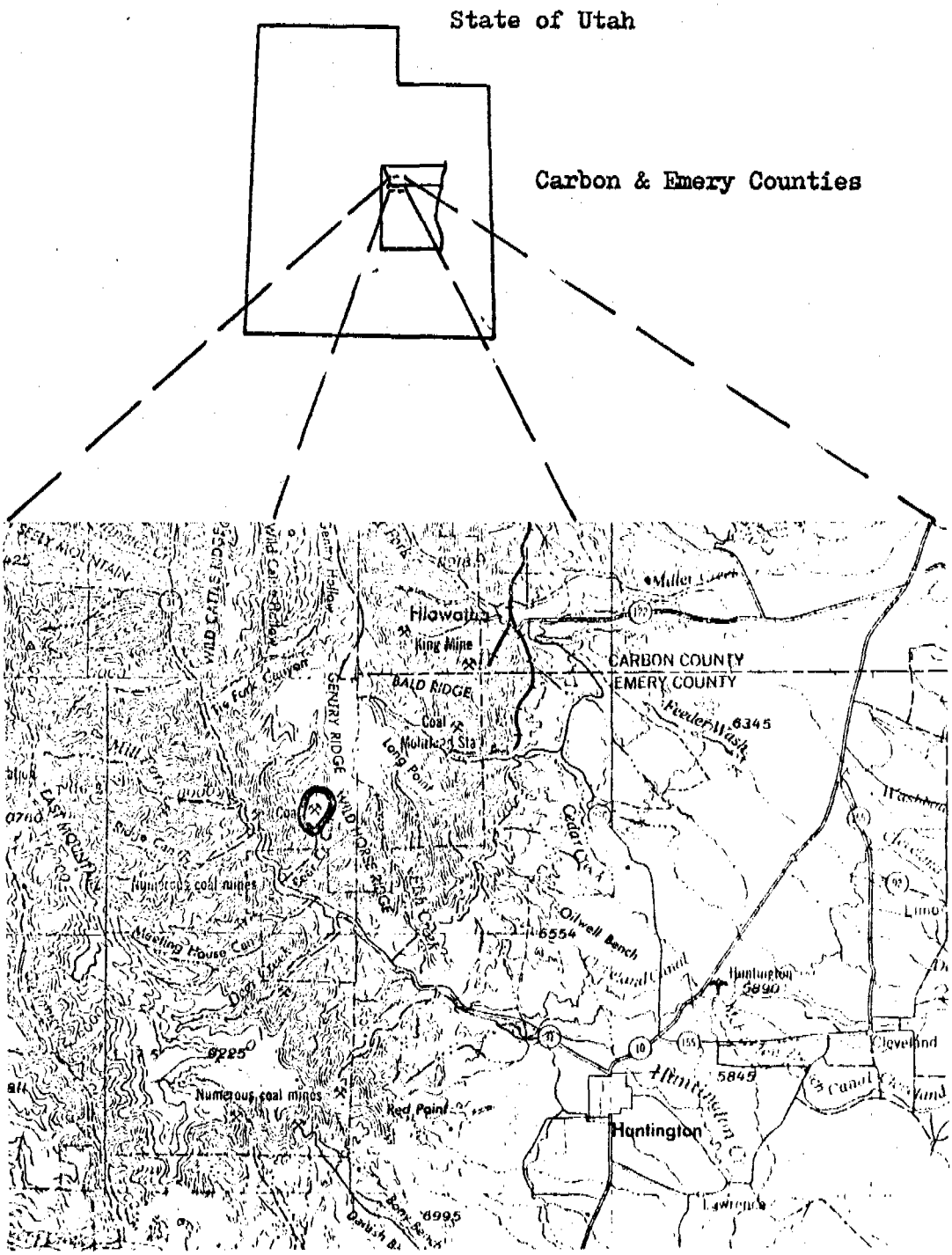
Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the exisitng community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site.

Such management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

More detailed information is available in the Price Field Office of the Soil Conservation Service.

LOCATION MAP
FOR
Soil Survey
of
CO-OP Mining Co.
Bear Canyon Area



Survey Area Circled

SOIL LEGEND

Soil Symbol	Soil Mapping Unit Name
D2E	Datino bouldery fine sandy loam, 5 to 20 percent slopes
D1G	Datino very stony fine sandy loam, 55 to 70 percent slopes

DESCRIPTION OF THE SOILS

D2E Datino bouldery fine sandy loam, 5 to 20 percent slopes.

This Datino soil is very deep and well drained. It occurs on moderately steep alluvial fans and some sloping flood plains at elevations of 7,100 to 7,140 feet (2,165 to 2,177 meters). This soil formed in alluvium and colluvium derived mainly from sandstone and shale. The average annual precipitation is 14 to 16 inches (36 to 41 centimeters). Mean annual air temperature is 42 to 45 degrees F. (5 to 7 degrees C.), mean annual soil temperature is 44 to 47 degrees F. (6 to 8 degrees C.), and the average freeze-free season is about 80 to 110 days.

Slopes are 5 to 20 percent and mostly east facing. They are short and concave-convex.

Vegetation is dominantly pinyon, Utah juniper, salina wildrye, squirreltail, big sagebrush, Douglas-fir, and Rocky Mountain juniper.

Included in mapping are small areas of a similar soil except with 20 percent gravel and cobbles in the surface layer.

In a typical profile the surface layer is brown, bouldery fine sandy loam and cobbly loam about 10 inches (25 centimeters) thick. The subsoil is light brown very stony loam about 28 inches (71 centimeters) thick. The substratum is light reddish brown cobbly fine sandy loam to a depth of 60 inches (1.5 meters) or more.

Permeability is moderate. Available water capacity is 6 inches (15 centimeters) to a depth of 60 inches (1.5 meters). Organic matter content in the surface layer is 4 percent. Effective rooting depth is about 60 inches (1.5 meters). Surface runoff is medium and erosion hazard is moderate under potential native vegetation and high if vegetation is removed and the soil is left bare. Erodibility is low. This soil is used for range, wildlife habitat, and mining operations.

Taxonomic classification is loamy-skeletal, mixed Typic Haploboralls.

A typical pedon of Datino bouldery fine sandy loam, 5 to 20 percent was described on the cut about 200 feet east and 1100 feet south of the NW corner of Section 25, T16S, R7E.

A11 -- 0 to 2 inches (0 to 5 centimeters) brown (10YR 5/3) bouldery fine sandy loam, dark brown (10YR 3/3) when moist; moderate fine granular structure; loose, very friable, slightly sticky, nonplastic; common very fine to medium, few coarse roots; 10 percent boulders, 10 percent stones, 5 percent cobbles, 10 percent gravel; slightly calcareous; moderately alkaline (8.0); abrupt smooth boundary.

A12 -- 2 to 10 inches (5 to 25 centimeters); brown (10YR 5/3) cobbly loam, dark brown (10YR 3/3) when moist; moderate medium granular structure; soft, friable, slightly sticky, slightly plastic; common very fine to medium, few coarse roots; 10 percent cobble and 10 percent gravel; moderately calcareous; moderately alkaline (ph 8.2); clear smooth boundary.

B2 -- 10 to 38 inches (25 to 96 centimeters); light brown 7.5YR 6/4) very stony loam, brown (7.5YR 4/4) when moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine to medium roots; 1 percent boulders, 30 percent stone, 10 percent cobbles, 20 percent gravel; moderately calcareous; strongly alkaline (ph 8.5); abrupt wavy boundary.

C1 -- 38 to 60 inches (96 to 152 centimeters) light reddish brown (5YR 6/4) cobbly fine sandy loam, reddish brown (5YR 4/4) when moist; massive; soft, very friable, slightly sticky, nonplastic; few very fine and fine roots; 10 percent cobbles, 5 percent gravel; strongly calcareous; strongly alkaline (ph 8.6).

AH3A

D1G Datino - Rock outcrop complex, 55 to 70 percent slopes.

This map unit is on very steep canyon sideslopes. Slopes are short and concave-convex, Elevation is 7,140 to 7,600 feet (2,177 to 2,318 meters). The average annual precipitation is 14 to 16 inches (36 to 41 centimeters). Mean annual air temperature is 42 to 44 degrees F. (6 to 7 degrees C.) and the average frost-freeze season is 80 to 110 degrees.

This unit is 75 percent Datino very stony fine sandy loam, 55 to 70 percent slopes in single and concave areas and 15 percent rock outcrop on ridges.

Included in this unit is about 10 percent of a shallow soil that is about 6 to 15 inches in depth, associated with the Rock outcrop.

The Datino soil is very deep and well drained. This soil formed in colluvium derived mainly from sandstone and shale. Slopes are 55 to 70 percent and east facing. They are short and concave-convex. Vegetation is dominantly pinyon, Utah juniper, Rocky Mountain juniper, salina wildrye, Douglas-fir, curlleaf mountainmahogany.

In a typical profile the surface layer is brown or yellowish brown, very stony fine sandy loam about 16 inches (41 centimeters) thick. The subsoil is very pale brown, very stony sandy clay loam about 20 inches (51 centimeters) thick. The substratum is very pale brown, very stony silty clay loam to a depth of more than 60 inches (152 centimeters).

Permeability is moderate to 36 inches (91 centimeters) and moderately slow below 36 inches. Available water capacity is 6.5 inches (16 centimeters) to a depth of 60 inches (1.5 meters). Organic matter content in the surface layer is about 4 percent. Effective rooting depth is about 60 inches (1.5 meters). Surface runoff is rapid and erosion hazard is high under potential native vegetation and very high if vegetation is removed and the soil is left bare. Erodibility is low. This soil is used for range, wildlife habitat, and mining operation.

Taxonomic classification is loamy-skeletal, mixed Typic Haploboralls.

A typical pedon of Datino very stony fine sandy loam, 55 to 70 percent slopes was described on the bank about 150 feet north of the old mine portal about 300 feet north and 300 feet east of the SW corner of Section 24, T16S, R7E.

A11 -- 0 to 3 inches (0 to 8 centimeters); brown (10YR 5/3) very stony fine sandy loam, dark brown (10YR 3/3) when moist; moderate fine granular structure; soft, very friable, nonsticky, nonplastic; many very fine, few medium and coarse roots; moderately calcareous; moderately alkaline (ph 8.4); abrupt smooth boundary.

A12 -- 3 to 16 inches (8 to 41 centimeters); yellowish brown (10YR 5/4) stony fine sandy loam, dark brown (10YR 3/3) when moist; weak medium granular structure; soft, friable, nonsticky, nonplastic; many very fine and fine, few medium and coarse roots; 2 percent boulders, 10 percent stones, 10 percent cobbles, 10 percent gravel; moderately calcareous; moderately alkaline (ph 8.4); clear smooth boundary.

B2 -- 16 to 36 inches (41 to 91 centimeters) very pale brown (10YR 7/3) very stony sandy clay loam, pale brown (10YR 6/3) when moist; weak medium subangular blocky structure; slightly hard, firm, slightly sticky, plastic; common very fine and fine roots; many fine pores; 2 percent boulders, 15 percent stones, 15 percent cobbles, 10 percent gravel; moderately calcareous; strongly alkaline (ph 8.6); abrupt wavy boundary.

C1 -- 36 to 60 inches (91 to 152 centimeters) very pale brown (10YR 8/4) stony silty clay loam, light yellowish brown (10YR 6/4) when moist; moderate medium and coarse subangular blocky structure; hard, firm, sticky plastic; few very fine and fine roots, common fine pores; 2 percent boulders, 10 percent stones, 10 percent cobbles, 5 percent gravel; strongly calcareous; strongly alkaline (ph 8.9).

DESCRIPTION OF PRESENT VEGETATION

Upland Stony Loam (Pinyon-Juniper) Ecological Site

Two inventories of the Upland stony loam (P-J) ecological sites in the Bear Canyon area recorded the following vegetation as a percentage of air dry weight:

1) Pit 1, SW¼, Sec. 24, T16S, R7E. This site relates to the D1G soil.

2) Pit 2, NW¼, Sec. 25. T16S, R7E. This site relates to the D2E soil.

	Percent	
Grass and Grass-like Plants	Pit 1	Pit 2
Indian ricegrass	5	5
Salina wildrye	25	10
Squirreltail		10
Sedge		2
Needleandthread		2
Muttongrass	T	1
Forbs		
Buckwheat	1	
Mustard	1	2
Aster	1	2
Other	2	2
Crytantha		2
Stickseed		2
Trees and Shrubs		
Rubber rabbitbrush		5
White fir	5	
Douglas fir	5	5
Pinyon pine	30	25
Juniper	10	10
Rocky Mountain juniper	10	5
Curlleaf mountainmahogany	5	
Big sagebrush		5
Elderberry		5
Total annual Production (estimated in pounds/acre)	900	1500
Ecological rating	Good	Good

Notes: Inventories were completed in November, 1980, making forb identification very difficult. The vicinity of Pit 2 appeared to have been burned in early 1900's. These sites were in a transition zone between upland and mountain climates.

April 24, 1985

Wendell Owen
Co-op Mining Company
P.O. Box 1245
Huntington, Utah 84528

Dear Mr. Owen:

Pursuant to your request, please be advised that C.O.P. Coal Development Company hereby grants permission to Co-op Mining Company to store top soil, as needed or requested by the State of Utah, on C.O.P. property in the ball park area at Bear Canyon.

C.O.P. COAL DEVELOPMENT CO.

BY Joseph O. Kimpton
Vice President

-Summary of Ditch Sizes-

All ditches are triangular "V ditch" with 1:1 side slopes. (See Plate 7.1 for typical.)

	Flow(cfs)	Vel.(fps)	Rip Rap Size**	Slope(%)	Depth Of Ditch	Depth Of Water
D-1R	10.2	6.8	6"	6.0	2'-0"	1'-6"
D-2R	12.1	6.8	6"	6.0	2'-0"	1'-6"
D-3R	10.4	6.8	6"	6.0	2'-0"	1'-6"
D-1U	1.5	3.5	N/R	4.0	1'-3"	0'-9"
D-2U	1.5	3.9	N/R	5.0	1'-3"	0'9"
D-3U	6.1	5.5	4"	5.0	1'-9"	1'-3"
D-4U	11.8	6.6	6"	5.0	2'-0"	1'-6"
D-5U	.9	3.5	N/R	7.0	1'-0"	0'-6"
D-6U	.9	3.5	N/R	7.0	1'-0"	0'-6"
D-7U	10.3	6.6	6"	5.0	2'-0"	1'-6"
D-8U	2.3	4.4	N/R	6.25	1'-3"	0'-9"
D-9U	1.8	5.0	4"	8.3	1'-3"	0'-9"
D-10U	1.5	5.7	6"	18.0	1'-0"	0'-6"
D-11U	7.6	7.9	9"	14.0	1'-6"	1'-0"
D-1D	.8	4.0	N/R	9.0	1'-0"	0'-6"
D-2D	1.5	5.5	4"	10.0	1'-3"	0'-9"
D-3D	1.0	5.2	4"	15.0	1'-0"	0'-6"
D-4D	4.8	5.3	4"	6.25	1'-6"	1'-0"
D-5D	7.2	6.2	6"	6.4	1'-9"	0'-9"
D-6D	1.2	4.4	N/R	6.25	1'-3"	0'-9"

*6" freeboard added to required flow depth.
** see Plate 7.1 for location of rip rap.
N/R - not required

-Summary of Culvert Sizes-

	Flow(cfs)	Vel.(fps)	Rip Rap	Slope(%)	Diameter	Required Headwater**
C-1R	10.2	9.5	12"	8.0	18"	27"
C-2R	12.1	9.5	12"	8.0	18"	36"
C-3R	16.4	9.5	12"	8.0	18"	27"
C-1U	8.8	12.3	24"+	15.0	30"	18"
C-2U	1.5	8.4	9"	15.0	15"	9"
C-3U	7.9++	5.7	6"	5.0	12"	36"*
C-4U	6.1++	5.1	6"	5.1	10"	36"*
C-5U	6.1++	5.0	N/R	4.8	10"	36"*
C-6U	.9	4.4	N/R	3.7	10"	12"
C-7U	10.3	9.7	12"	8.3	12"***(18")	27"
C-8U	8.8	13.0	24"+	15.0	18"	24"
C-9U	1.5	8.0	9"	7.3	15"	9"
C-1D	1.5	10.9	16"+	20.0	15"	9"
C-2D	4.8	9.6	12"	12.0	18"	15"
C-3D	1.2	5.2	6"	4.2	12"	9"
60" CMP	231.2	13.8	24"	3.4	60"	102"

*When capacity of culvert is exceeded flow continues down ditch to next culvert.

**From invert elevation.

***Existing 12" CMP to be replaced with 18" CMP at 8.3% slope.

+ Energy dissipating device could be used instead of rip rap.

++ A two foot high check dam of rip-rap is used to develop the headwater necessary for maximum flow through the culvert, excess flow continues down the ditch.

N/R - Not required

Design Parameters Determination Procedure

Listed below are the various parameters, along with and the procedures used to obtain them, which were supplied to the computer programs used in calculating the runoff hydrographs and routings and the ditch and culvert sizings.

The equations used in the Hydro Plus III - SCS hydrograph program are listed this section, 7.2.5.2 Diversion Structures. The parameters that were used are as follows:

Basin Area - the areas where calculated, using a planimeter, from those outlined on Plate 7-5.

Basin Curve Number - this SCS runoff curve number was estimated using "A Guide to Hydrologic Analysis Using SCS Methods", Section 5. This section is included in the reference section. The soil of the mine plan area is best described by soil group "C". For the undisturbed areas the land use description is "woods or forest land" and the hydrologic condition "fair". Using these description a curve number of "73" was obtained. For disturbed areas the curve number "82" was used.

24-Hour Precipitation - the precipitation amounts for the various storm frequencies came from E. Arlo Richardson's "Estimated Return Period for Short-Duration Precipitation in Utah", the Hiawatha area.

Average Basin Slope - the slopes of the various areas outlined on Plate 7-5 were derived by dividing the total change in elevation by the hydralic length.

Hydralic Length - this length, also from Plate 7-5, is the length from the area outlet or mouth to the divide or point of highest elevation.

Basin Lag - this value was computed by the computer program with the computer using a minimum of 15 minutes.

The hydrograph reservoir routing program used the appropriate runoff hydrograph routed through the appropriate sedimentation pond, "A" or "B". Pond capacity per elevation and spill way capacity were determined from the cross sections and criteria shown on Plates 7-2 and 7-3.

From the parameters listed above, the computer program was able to generate runoff hydrographs. From these hydrographs the peak or maximum flow was used in the sizing of the ditches. For sizing the ditches and culverts the parameters used are as follows:

Ditch Depth - various ditch depths were tried, in 3" increments, until a depth was found that would handle the the maximum flow.

Culvert Diameter - the diameters were obtained by field measurement, unless noted otherwise. If the flow was larger than could be handled by the culvert a check dam 2' high of rip-rap is used to develop headwater for maximum flow through the culvert, excess flow continues down the ditch.

Manning Coefficient - the coefficients came from Van Te Chow's "Open-Channel Hydralics," For corrugated metal pipes and flumes, n=.023; for natural channels-straight, full stage, no pools with weeds and stones, n=.035.

Slope - for ditches the total change in elevation was divided by the total length, both values were obtained from Plate 7-1. For culverts the slope was obtained from field measurements.

H/C
6-21-84

To determine the headwater necessary for maximum flow through the various culverts the orifice computer program was run for the different size culverts being used in the mine plan area. The equations used in the program are listed on the individual printouts. The parameters supplied the programs are as follows:

D - diameter of culvert size being considered.

C - the ooefficient of contraction for orifices was obtained from King and Brater's "Handbook of Hydralics".

RIPRAP REQUIREMENTS

RIPRAP

Where the velocity of flow exceeds 5 fps but is less than 15 fps riprap will be placed. The size of riprap used will be based on the following graph, by Peterka. For flows above 15 fps an energy dissipating device will be used.

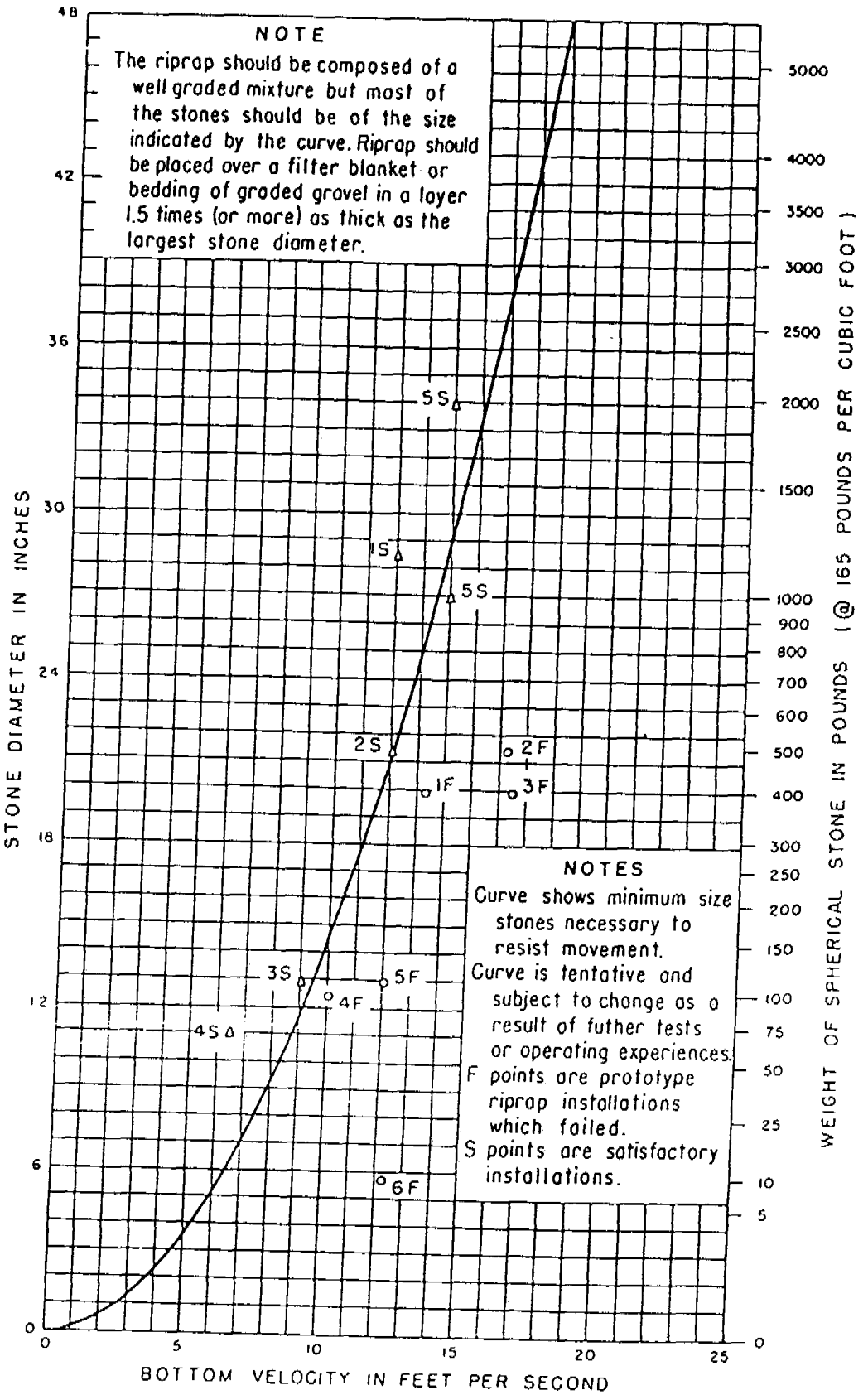


FIGURE 165.—*Curve to determine maximum stone size in riprap mixture.*

From: Peterka, A.J., "Hydraulic Design of Stilling Basins and Energy Dissipators", U.S. Bureau of Reclamation, Engineering Monograph No. 25.

Feb. 85

UPDATE APPENDIX 7-D

R&M CONSULTANTS, INC. • 5280 SOUTH 320 WEST, SUITE E-160 • MURRAY, UTAH 84107 • PHONE (801) 263-3419
ENGINEERS

January 3, 1985

Department of Natural Resources
Division of Oil, Gas, and Mining
355 West North Temple, Suite 350
Triad #3
Salt Lake City, Utah 84180-1203

Attention: Mary Boucek

SUBJECT: Interim Report on the Ground Water Hydrology Study for the Co-op Mine, Bear Creek Permit Area, Emery County, Utah.

Gentlemen:

The following interim report is presented for the purpose of summarizing the present status of the ground water study program outlined in our correspondence to your office, concerning Chapter 7 requirements and dated September 11, 1984 and October 25, 1984.

The following outline addresses UMC Section 783.15 and UMC Section 817.13. Following our discussion of the requirements of each of these paragraphs we include a brief outline of our future scope of work based on the results of our information gathered to date.

UMC 783.15

a.1 Ground water, perched or static, has not been encountered by our subsurface investigations to date. Two additional exploratory holes, WM-A and WM-B, have been drilled subsequent to those included with the October 25, correspondence. These holes have been drilled at the locations indicated in our most recent correspondence to you on this subject dated October 29, 1984. Neither of these exploratory holes encountered water.

a.2 These cannot be assessed to date for reasons given in paragraph a.1 above.

a.3 This item cannot be assesed at this time for reasons given in paragraph a.1 above.

a.4 To date 6 water samples have been analyzed for 13 parameters each for the purpose of obtaining water quality base-line data and for correlation purposes. Three have been obtained from subsurface sources (roof seeps and sumps) within the Bear Creek Mine and three have been obtained from

sources outside the mine and within the permit area. No water samples have been obtained from any of the nine drill holes drilled to date.

b. This paragraph cannot be addressed at this time due to the lack of encounter of ground water to date.

Section UMC 817.13

Exploration holes drilled for the intent of determining the ground water occurrences for the purpose of this study which encounter ground water shall be cased with two-inch diameter PVC pipe, slotted at the appropriate depth(s) and backfilled within the annular space with free-draining sand or gravel backfill to no more than three feet from the ground surface. The top three feet will have the annular space filled with cement grout to affect a permanent water-tight seal at the ground surface. The PVC casing will be fitted with a threaded coupling at its top, which will be glued on. The threaded coupling will allow use of a threaded cap for protection from surface contamination, between sampling intervals, of the ground water encountered. Drill holes treated as per the preceeding will be regarded as temporary ground water monitoring wells. On completion of their use for this purpose, the protruding PVC will be cut off flush with the ground surface and the inside of the casing backfilled with sand or gravel backfill up to three feet from the surface. The top three feet of the PVC will then be filled with cement grout to affect a permanent seal.

Ground water monitoring holes inclined above horizontal will be cased with slotted PVC at a diameter as near to the drill-hole size as feasible since granular backfill cannot be placed. Surface sealing of the annular space between the PVC and the drill-hole wall will be with a fast setting cement grout or resin to hold the PVC casing in place and to effect a surface water seal if required by site conditions.

SUMMARY OF INVESTIGATIONS COMPLETED AND MODIFICATIONS TO ORIGINAL PROPOSED SCOPE OF WORK:

Our initial hypothesis stated that: the ground water regime in the permit area is predominantly fault controlled and that the ground water table and/or major aquifers lie appreciably below or outside areas affected or which will be affected by present or future, planned mining activities.

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Radioactive isotype analyses of water obtained from several roof-seep areas are also being considered to determine the approximate duration of the underground containment of the ground water which is currently emerging as roof-seepage.

Enclosed also are seven copies of the revised geologic map of the Bear Creek permit area, labeled as Plate 3.4-1.

Please contact us if there are any questions or comments concerning the above.

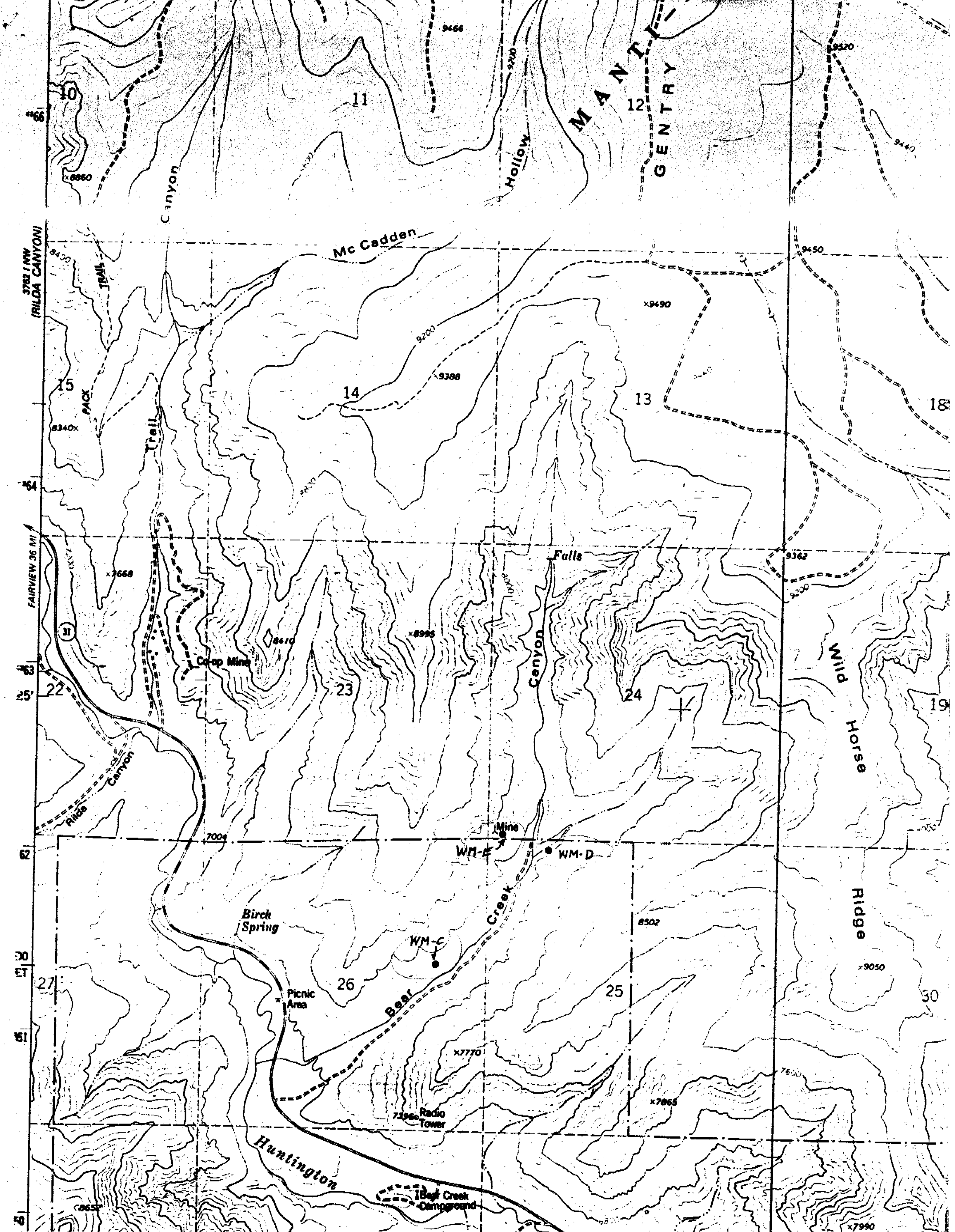
Sincerely Yours,

R&M CONSULTANTS, INC.

Lamonte Sorenson
Senior Engineering Geologist

LS/ljp

Att.



9466
MANTI
GENTRY
10
11
12
Hollow
Canyon
×8860
Mc Cadden
9200
×9490
9450
9520
9440
×9388
3762 I NW (RILDA CANYON)
PACK
TRAIL
Trail
15
14
13
18
8340×
FAIRVIEW 36 MI
31
×7668
8410
Co-op Mine
×8995
Falls
Canyon
9362
Wild
Horse
Ridge
22
23
24
19
Rilda
Canyon
7004
Mine
WM-E
WM-D
Birch
Spring
Creek
8502
WM-C
26
25
27
30
×9050
Picnic
Area
Bear
×7770
×7865
7296
Radio
Tower
Huntington
Bear Creek
Campground
×7990

APPENDIX 3-5-8A

SUBSIDENCE MONITORING PLAN

It is proposed to install two permanent subsidence monitoring points, one at each end of the property, to allow for an on-going evaluation of subsidence or other mining-related surface impacts. The stations shall be monitored at nominal 6-month intervals, for changes in elevation, tilt or rotation. In addition, a field investigation shall be made at least once per year, and any obvious subsidence or mine related surface effects will be noted and located on a map. A copy of the results of the subsidence survey and map will be available for inspection at the office, and a summary of the survey results will be sent to the Division within 60 days following the final survey for the year.

It is proposed to use the SMS, or Subsidence Monitoring System, described in detail in the following pages. This system is available commercially, and if approved by the Division, the program will be implemented in the Spring/Summer of 1985. The monitoring program will continue for a minimum of one year after mining ceases on the permit area. Location of monitoring stations are shown in Fig. 3-3A attached.

final release

During the operation , all owners of property within the area that could be impacted by subsidence shall be notified by mail six months prior to mining beneath their property and be informed of:

817.122 Pub Notice

1. Specific areas mining will take place
2. Dates of underground operations that could cause subsidence in the area.

3. Measures to be taken to prevent and or control adverse surface effects.

Co-Op Mining Co. furthur commits to the following course of action should subsidence cause any material damage or a reduction in value of structures or land. 817.124 Subs. owner protection

1. Restore, rehabilitate, or remove and replace, to the extent technologically and economically feasible, each meterially damaged structure, feature or value promptly after the material damage from subsidence is suffered, to the condition it would be in if no subsidence had occurred and restore, to the extent technologically and economically feasible, those surface lands that were reduced in reasonably foreseeable use as a result of such subsidence to a condition capable of supporting before subsidence; or

2. Purchase the damaged structure or feature (except structures or features owned by the person who conducted the underground coal mining activities) for its pre-subsidence fair market value. The person conducting the underground coal mining operation shall promptly, after the material damage or reduction in value or reasonably foreseeable use from subsidence occurs, to the extent technologically and economically feasible, restore the purchased structure or the structure owned by the person conducting the underground mining operations, restore those surface lands that were materially damaged or reduced in value or reasonable foreseeable use by such subsidence,

to a condition capable and approporate of supporting the structure, and any other foreseeable uses such surface lands were capable of supporting before mining. Nothing in the paragraph shall be deemed to grant or authorize an exercise of the power of condemnation or the right of eminent domain by any person engaged in underground coal mining activities; or

3. Compensate the owner of any surface structure in the full amount of the diminution in value resulting from subsidence, by purchase prior to mining of a noncancellable premium prepaid insurance policy or other means approved by the Division as assuring before mining begins that payments will occur; indemnify every person owning an interest in the surface for all damages suffered as a result of the subsidence; and, to the extent technologically and economically feasible, fully restore the land to a condition capable of maintaining reasonably foreseeable uses which it could support before subsidence.

SUBSIDENCE MONITORING SYSTEM

Introduction: The Subsidence Monitoring System (SMS) is a complete subsidence and surface effects monitoring system for underground coal mines. The system consists of a monitoring tower and graduated base plate, which, when properly installed, allows for easy measurement of elevation changes, as well as magnitude and direction of tilt and rotation of the station. The SMS stations can be purchased separately and owner-installed, or they can be purchased with installation included. Precise surveying is required for initial set-up, as with all monitoring stations.

Purpose: The SMS is designed to assist underground coal operators to comply with the requirements of the subsidence monitoring and protection portion of the Surface Mining Regulations administered under the Office of Surface Mining (and related State Agencies) and the 43 CFR 3246 regulations under the Bureau of Land Management.

This station offers complete "subsidence" or "surface effects" data for undermined areas, by facilitating the measurement of elevation change, degree and direction of tilt, as well as rotation. Most subsidence stations are nothing more than a survey point and provide only data on elevation changes, completely ignoring the other common surface effects of underground mining - ground tilt and rotation. By determining all applicable surface effects, and correlating such effects with known mining conditions, the operator has a much better chance of predicting potential surface effects of the operation, and supporting those predictions as required.

The question of subsidence has long been a "gray area", not only in the industry, but particularly in the regulations. Laws require prediction (and generally monitoring) of mine subsidence; however, until recently, no definite guidelines or criteria have been pushed by

the agencies. This is changing with the advent of the "Permanent Program Approvals" required by the surface mining agencies, and the gradual "maturing" of the agencies themselves. The SMS is designed to allow an operator to get into and remain in compliance with the regulations, and when properly implemented, this system is guaranteed to comply with the requirements of the law and provide adequate data to allow reasonable prediction of surface effects from underground mining.

The SMS stations are initially somewhat more costly and complicated than conventional subsidence monitoring "points", however, not only will they provide more complete and reliable data, they will also result in cost savings as the monitoring program continues. The following is a partial list of the positive attributes of this system:

(1) Permanent installation.

(2) Elevations can be shot directly from long distance, reducing manpower and field costs.

(3) Station monitoring (other than elevation) requires only a plumb-bob and 60' of string, reducing time and effort from packing survey instruments over the mountainous terrain.

(4) Station monitoring can be done in conjunction with required field inspections and/or aerial flagging visits.

(5) The system works extremely well with an aerial monitoring program, reducing survey time and costs.

(6) Provide measurement of elevation, as well

as magnitude and direction of ground tilt and/or rotation.

(7) Meets or exceeds agency guidelines.

(8) Assures continued compliance, even if requirements are more strictly enforced or made more stringent.

The SMS is proposed to the industry for two main reasons:

1. To provide for complete and reliable data on the actual surface effects of underground mining.

2. To provide data that will enable companies and agencies to better predict possible surface effects of underground mining under various cover and extractions conditions.

With reliable data, it is conceivable that this program could ultimately result in the ability to predict that no surface effects will occur under certain mining conditions, possibly eliminating the need for further monitoring in the future. Thus, the ultimate goal of the SMS may very well become the elimination of its need under certain circumstances.

Principle: The SMS is designed to serve as a permanent subsidence monitoring point. It can either be used in conjunction with a conventional elevation survey, or with elevations determined from an aerial survey. In addition to providing an elevation base, this station readily displays direction and magnitude of tilt and/or rotation. The following procedure should be followed each time the station is checked:

(1) An elevation should be determined at the center of the base plate This can be accomplished by:

(a) A conventional level survey from a known, undisturbed benchmark.

(b) Shooting the station from a distant, known benchmark and calculating the new elevation by use of the vertical angle;

(c) Performing an aerial survey to determine new elevations; Note that the SMS lends itself very well to (a) & (b) above, both of which require a minimum of manpower and time.

(2) An inspection of the surface around and between stations should be made, and any possible subsidence effects should be noted.

(3) A plumb-bob should than be hung from the hook inside the station cap, and allowed to swing freely about 1/8" above the base plate. If the point of the bob hangs directly over the center of the base plate, no tilt has occurred. If the plumb-bob point rests outside of the base plate center, the direction of tilt can be closely estimated from the compass on the base plate, and the degree of tilt can be read directly off the concentric rings on the plate. Record the results and;

(4) Remove the plumb-bob. Next, tie one end of the 50' - 60' string onto the south reference point and stretch the line through the station legs, tying it off on the north reference point. (The line should be free and taut between the points.) Now observe the location of the line in relation to the north-south line on the base plate. If the lines coincide, no rotation has occurred. If the line does not match the base plate north-south line, the degree and direction of rotation can be readily determined from the compass on the plate. It should be noted that the direction of rotation will be opposite to that shown on the compass. (Example: If the line matches the N 15 E bearing line on the plate, the degree of rotation is 15 , and the direction of

actual rotation is N 15 W.)

(5) Record all results and proceed to the next station.

A great deal of time and effort can be saved by locating several (or all) of the SMS stations in view of a single benchmark or reference station. In this manner, vertical angles can be shot to all visible stations from a minimum number of set-ups. The stations are made to allow for direct readings over a long distance, eliminating the need for a rodman to go to each station. This allows for completion of the elevation survey in a single step, eliminating the need to pack a transit or level to each of the stations. The only apparatus required for the rotation and tilt determinations is the plumb-bob and 60' of string.

The SMS system is even further simplified when used in conjunction with an aerial survey. Once initial elevations are determined, all that is required is a visit to each station to install (or check) the aerial flagging - of course, the tilt and rotation should be monitored at this time, with elevations to be determined during the aerial survey. In this situation, no transits or levels are needed at all, beyond the initial installation.

SUBSIDENCE MONITORING SYSTEM

SPECIFICATION SHEET

1 – 6' aluminum tower, graduated in 0.1' intervals, painted red and white with black numerals. Note: Tower is 8' long, allowing for 2' in ground.

1 – 6.28" diameter, aluminum baseplate, inscribed in 15° compass increments and $\frac{1}{2}$° tilt indicator.

1 – North Reference Point

1 – South Reference Point

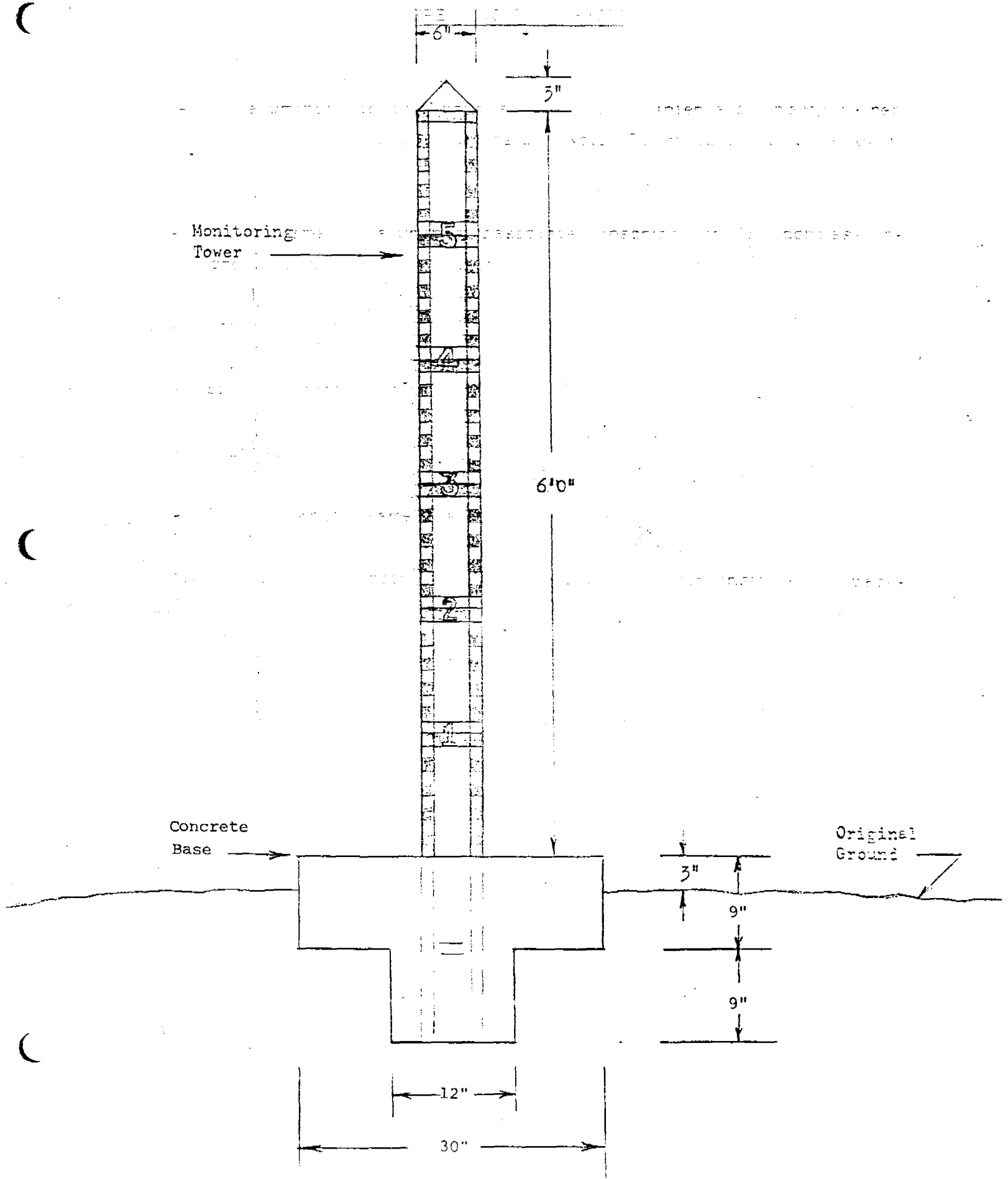
1 – Plumb-bob Hook

1 – 2" X 4" Brass Name Plate

6 ft.^{3} Concrete for Installation (Provided only with installation package).

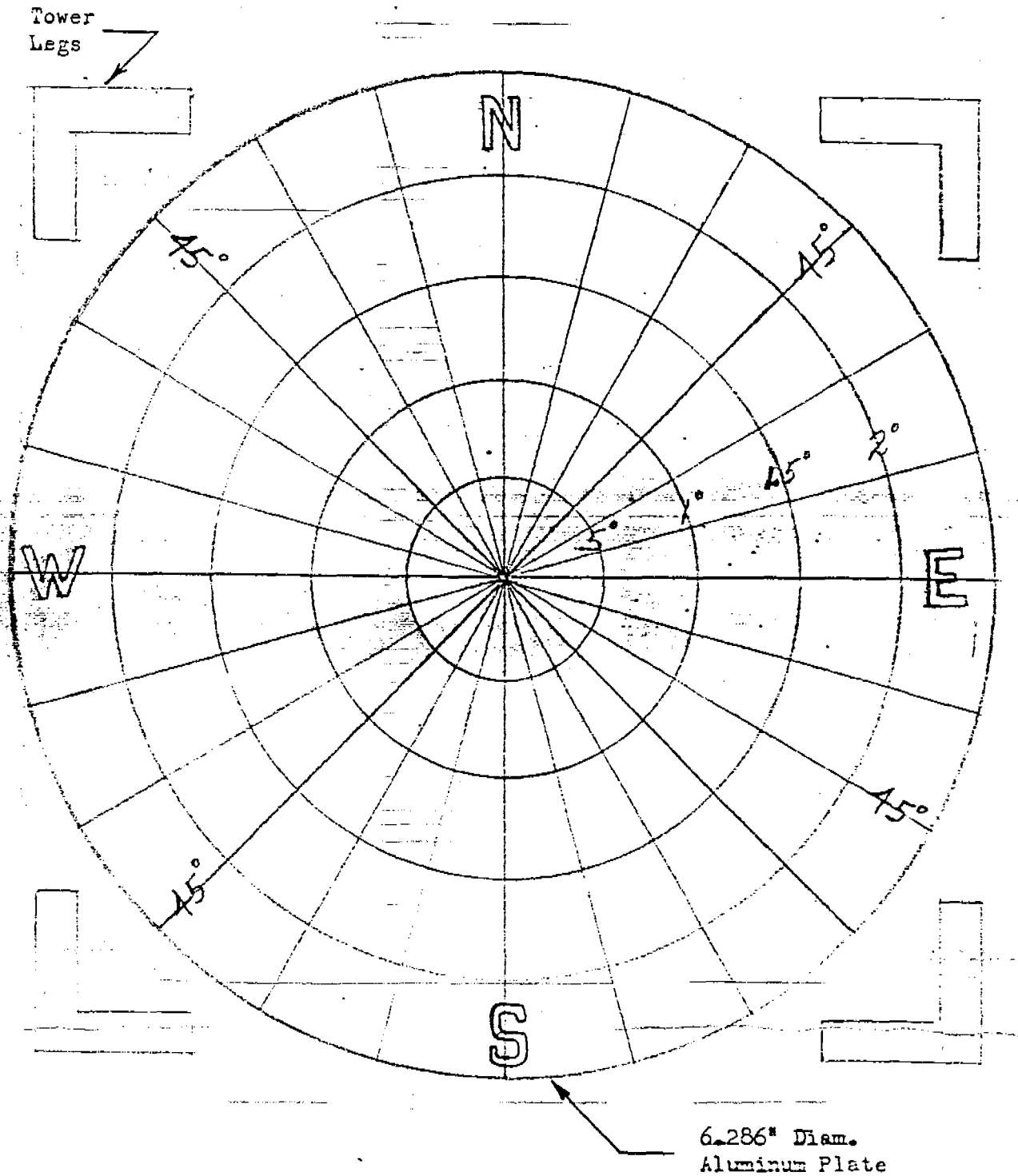
SMS MONITORING STATION

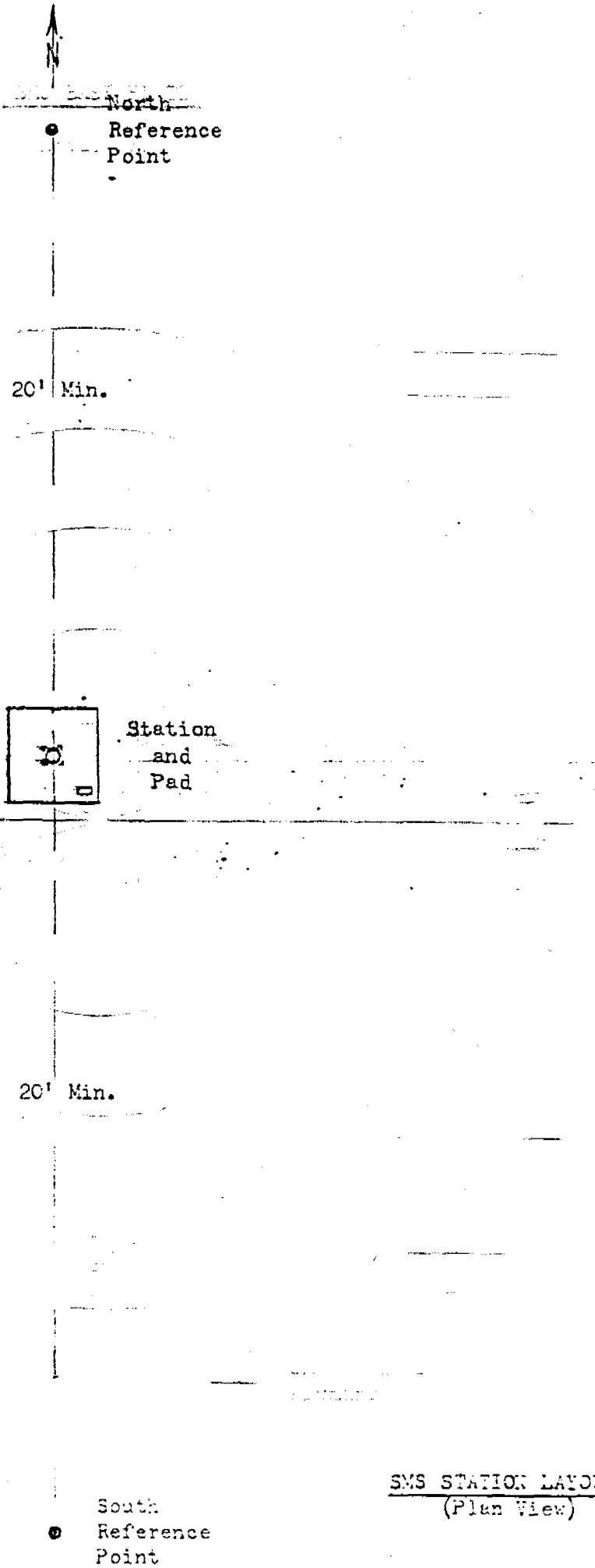
Scale: 1"=1'



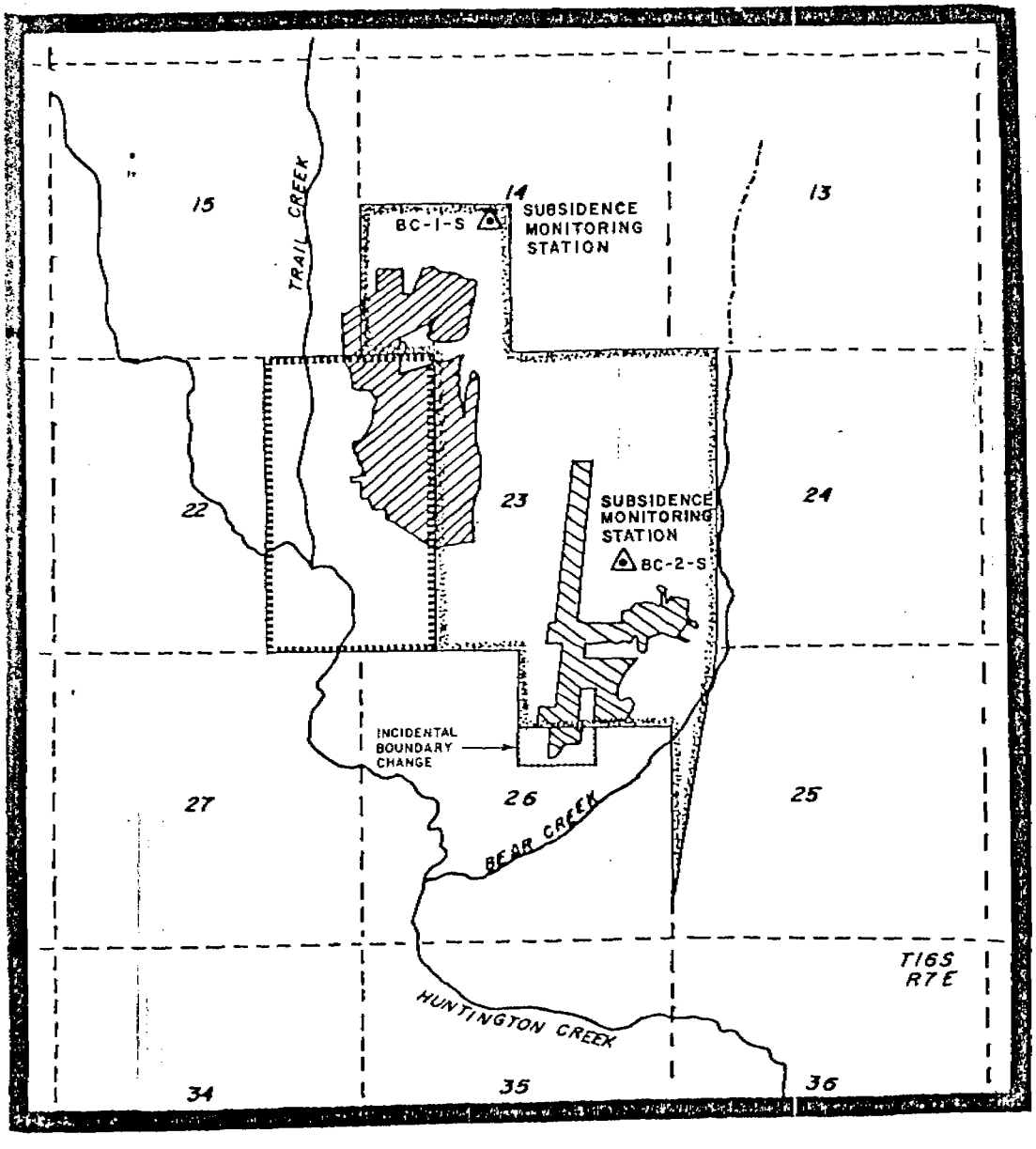
SMS BASE PLATE

(Actual Size)





SMS STATION LAYOUT
(Plan View)



KEY

BEAR CANYON MINE PERMIT AREA

TRAIL CANYON MINE PERMIT AREA

BEAR CANYON MINE WORKINGS

TRAIL CANYON MINE WORKINGS

SECTION BOUNDARIES

STREAMS

N

0 0.5 1.0 MI.

SCALE 1:24,000

TRAIL CANYON AND BEAR CANYON MINES:
PERMIT AREAS / MINE WORKINGS
SUBSIDENCE MONITORING POINTS

FIGURE 3-3a

UPDATE APPENDIX 7-D

sources outside the mine and within the permit area. No water samples have been obtained from any of the nine drill holes drilled to date.

b. This paragraph cannot be addressed at this time due to the lack of encounter of ground water to date.

Section UMC 817.13

Exploration holes drilled for the intent of determining the ground water occurrences for the purpose of this study which encounter ground water shall be cased with two-inch diameter PVC pipe, slotted at the appropriate depth(s) and backfilled within the annular space with free-draining sand or gravel backfill to no more than three feet from the ground surface. The top three feet will have the annular space filled with cement grout to affect a permanent water-tight seal at the ground surface. The PVC casing will be fitted with a threaded coupling at its top, which will be glued on. The threaded coupling will allow use of a threaded cap for protection from surface contamination, between sampling intervals, of the ground water encountered. Drill holes treated as per the preceeding will be regarded as temporary ground water monitoring wells. On completion of their use for this purpose, the protruding PVC will be cut off flush with the ground surface and the inside of the casing backfilled with sand or gravel backfill up to three feet from the surface. The top three feet of the PVC will then be filled with cement grout to affect a permanent seal.

Ground water monitoring holes inclined above horizontal will be cased with slotted PVC at a diameter as near to the drill-hole size as feasible since granular backfill cannot be placed. Surface sealing of the annular space between the PVC and the drill-hole wall will be with a fast setting cement grout or resin to hold the PVC casing in place and to effect a surface water seal if required by site conditions.

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Our initial hypothesis stated that: the ground water regime in the permit area is predominantly fault controlled and that the ground water table and/or major aquifers lie appreciably below or outside areas affected or which will be affected by present or future, planned mining activities.

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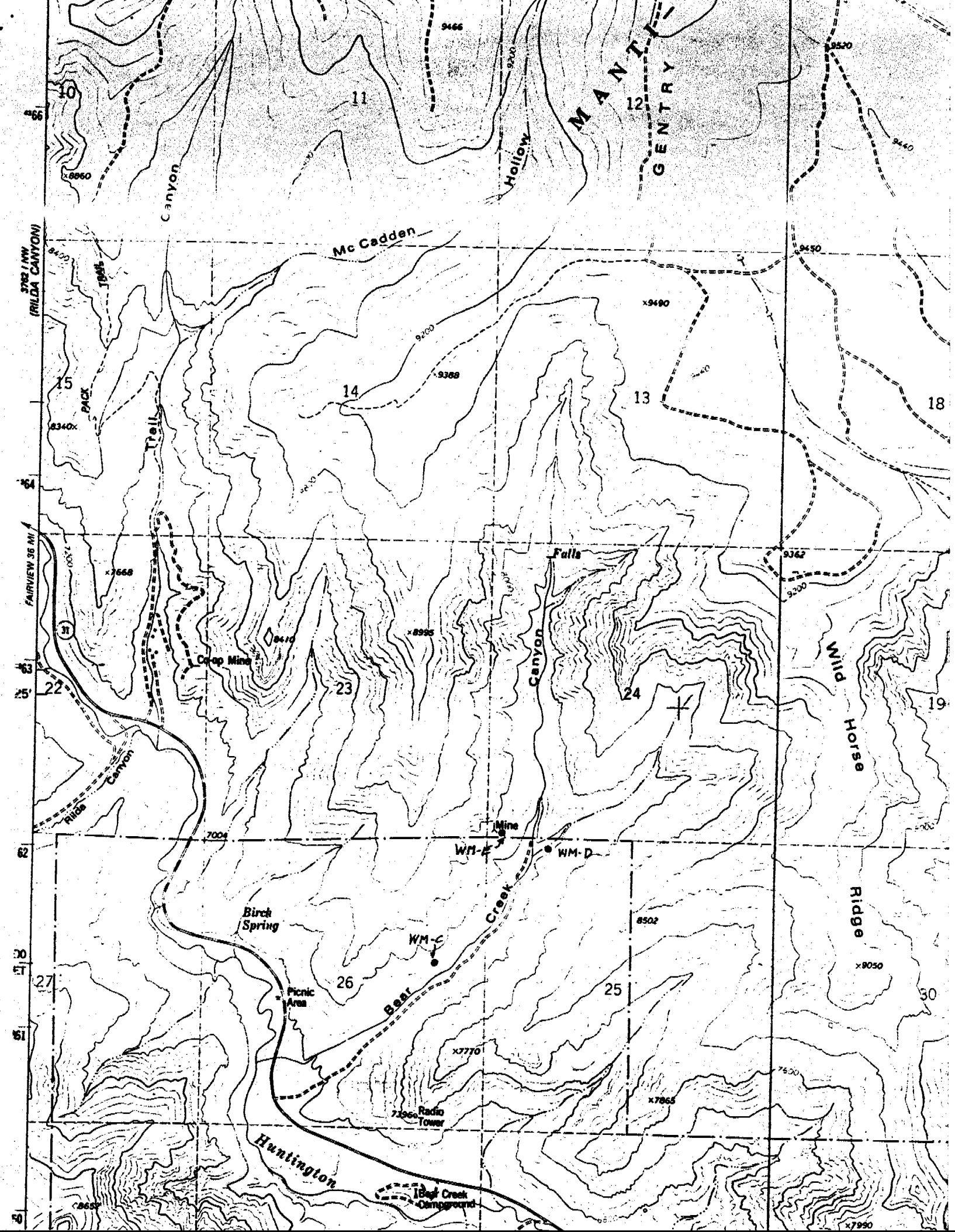
MANTI-
GENTRY
Hollow
Canyon
McCadden
Trail
PACK
Trail
Falls
Canyon
Wild Horse
Ridge
Coop Mine
Rilda Canyon
Mine
WM-C
WM-D
Birch Spring
Creek
Bear
Picnic Area
Radio Tower
Huntington
Bear Creek Campground
3762 / NW
(RILDA CANYON)
FAIRVIEW 36 MI
10
11
12
13
14
15
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22
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24
25
26
27
30
9466
9520
9440
9450
9490
9200
9388
9362
8340
8410
8995
7004
8502
9050
7770
7865
7990
8659

PLANS FOR REDISTRIBUTION OF SOILS

Prior to topsoil redistribution, regraded land will be scarified by a ripper-equipped tractor. The ground surface will be ripped to a 14" depth in order to reduce surface compaction, provide a roughened surface assuring topsoil adherence, and promote root penetration. Steep slope areas which must remain after abandonment will receive special ripping to create ledges, crevices, pockets, and screes. This will allow better soil retention and vegetation establishment.

Within a 10 day time period prior to seeding, topsoil will be distributed on areas to be reclaimed. During this time, the topsoil will be allowed to settle and attain equilibrium with its natural environment. This procedure will be followed for areas in which facilities such as roadbeds, mine pads, and building sites are to be abandoned.

Topsoil redistribution procedures will ensure an approximate uniform thickness consistent with the proposed reclamation plan. Topsoil will be redistributed at a time of the year suitable for establishment of permanent vegetation.

To minimize compaction of the topsoil following redistribution, travel on reclaimed areas will be limited. After topsoil has been applied, surface compaction will be reduced by using appropriate equipment running at a suitable depth. This operation will also help prepare a proper seed bed and protect the redistributed topsoil from wind and water erosion.

Co-op Mining will exercise care to guard against erosion during and after application toptopsoil and will employ the necessary measures to ensure the stability of topsoil on graded slopes. The specific methods to be implemented will be defined in the attached Interim Plan. An example of the soil stabilization methodology that might be used includes the placement of crushed and heavier material at the toe of roadfill slopes, and the random placement of large rocks and boulders on the surface. This procedure will

CHAPTER 7

HYDROLOGY

CHAPTER 7

Table of Contents

Chapter 7, Hydrology

Groundwater hydrology

7.1 Scope

Co-op Mining Company's Bear Canyon mine has no springs or seeps within the permit area. However, there is an old reservoir of contained water within the mine itself. This water has in the past discharged out of the mine in compliance with NPDS requirements. This underground water appears to be recharged on a local level directly proportional with the spring snow-melt or excessively heavy thunderstorms; this would indicate a local recharge through surface fractures.

7.1.1 Methodology

Co-op is committed to monitor any seeps which are encountered in the normal course of mining, however, in order to avoid small contained basions of water which have little or no ability to recharge in a reasonable time frame, only those seeps or springs which maintain a 25gpm flow for 48 hours will be monitored. In addition, Co-op has agreed to monitor a small intermittant spring adjacent to the Huntington City Spring (Bear Spring). It is believed this spring is a result of 'backed up' or contained water which the collection system in the Bear Spring will not accommodate. Monitoring is designed to determine flow in gpm, temperature, ph, t,d,s, iron, magnesium and

phosphates. Flow is determined by the actual measurment of the stream, depth times width times 2/3 velocity, or whenever feasible, a timed filling of a gallon container will be used as a more accurate determination. The other parameters will be determined by a certified laboratory.

CHAPTER VII

7.1 Groundwater Hydrology

7.1.2 Existing groundwater resources consists of a spring near the mouth of Bear Canyon (not within the Mine plan area) that is owned by the city of Huntington, the water from which is piped to that city; a small intermittant spring in the same proximity as the Huntington Spring; a spring just off from Huntington Canyon called Birch Spring; and two small springs in Trail Canyon (See Plate 7.1 for location of springs).

7.1.2.1 Regional Groundwater Hydrology (See Appendix 7-A)

7.1.2.2 Mine Plan Area Aquifers; (See Appendix 7-A)

7.1.3 Groundwater Development and mine dewatering

7.1.3.1

The small stream of water observed by the

Division (less than 5 gpm) was encountered by the applicants predecessor and continued to run from the abandoned mine during the interim period.

It originates in the old workings to the North of the present portal in the form of a general dripping from the roof. The quantity varies with the variations in the rainfall outside. The area is close to the surface as described in the following:
"-------in entering the mine that Co-op will be going into, it appears that the faults evident in that mine underground are tight, and the water is only near the canyon wells. In other words, near the entry, near the portal, not further in. There is no evidence of water further in. I don't believe that at that locality there is precipitation recharging the aquifer, so I am of the opinion that the mining operation will not affect the discharge of the spring."

Bruce Kaliser, State Hydrologist--1980

A map of the underground workings is included, and shows the area in which this water

originates. Plate 3-4 . Also Sec.7.1.3.2, 7.1.5, and 7.1.6.

7.1.3.2 Mine Dewatering

The water from the mine will be accumulated in an underground storage tank and utilized for dust control for roads and surface coal facilities (See Chapter XI), and for the mine bathhouse.

This will be periodically monitored for quality and quantity. Co-op Mining Company has water rights for this purpose at the Trail Canyon portal and currently has an application before the State Water Rights Division to change the point of diversion to the Bear Canyon portal. (Appendix 7-B)

7.1.4 Effects of Mining Operation on Groundwater

Relative to the subsurface waters, it is Co-op's contention that the mining activity will have no adverse impact on existing aquafers. This contention is supported in testimony by Bruce N. Kaliser, Utah State Hydrologist and leading

authority - 18th June, 1980 - Cause Number Act 015/025.

> "In brief, my conclusion is that it is highly unlikely that the mine plan as presented to me by the Co-op Company would interfer with the quantity or quality of any of those springs, particularly the one in question, the Bear Canyon Spring."*

In essence, the Co-op contention that the mine activity will have no adverse impact is based on the expert testimony of the state's foremost authority. However, if the state is in error in this matter, the Co-op has committed to and has indemnified the users of said springs that the Co-op will take whatever action is necessary to mitigate any foreseeable impacts.

*Transcript - June 18th, 1980 - hearing of the Board of Oil, Gas, and Mining, Page 62 - Cause Number ACT/015/025-Appendix 7-A

7.1.5 Mitigation and Control Plans

In the event that the quality of water at the Big Bear Creek Spring site decreases below the standards set by the Utah State Board of Health for culinary water, or in the event that the quantity of water at the Big Bear Spring decreases in flow 25% below the flow for the month immediately preceding, in any 30-day period; or 50 percent below the average flow for the preceding 180 days in any 180-day period and such decrease cannot reasonably be accounted for as being a result of a lack of precipitation or other causes unrelated to Co-op's Mining activities, then Co-op shall in accordance with this Agreement undertake such action as may be necessary to obtain water from some other source, and place said water into the culinary water system of City in such quantity and quality as would replenish the flow and quality that has been lost with the same quantity of water, the quality of which passes the standards of the Utah State Board of Health for culinary water. Co-op agrees to use all reasonable diligence to take the required action or make the required replacement of a permanent acceptable nature as rapidly as feasi-

ble, not to exceed one year, unless a greater time is required by law, and further agrees to maintain such temporary measures until permanent measures are completed, at Co-op's sole expense.
Excerpt; Huntington Spring Agreement (See Appendix 7-C).

Alternate water supply:

Co-op Mining Company presently owns 300 + shares in the Huntington-Cleveland Irrigation Company and will purchase additional shares if at some future time it becomes necessary to replace water rights.

Indemnity:

Co-op Mining Company carries liability insurance that includes water wells & springs. (See Appendix 2-C)

7.1.6 Groundwater Monitoring Plan

Co-op Mining Company does commit to monitor any

ground waters encountered during normal mining so long as the flow is in excess of one gal/ min. over a period of forty-eight hours. Flow of less than one gal/min. or flows which do not sustain themselves for over forty-eight hours are determined to be small isolated perched aquafers of no significance.

Co-op has provided data from the Castle Valley Special Service District on Huntington Spring. This spring is the property of the Service District and Co-op has indemnified the District of any disruption of this spring which is a result of mining activities.

The only other spring in the area is a small intermittent spring in the same proximity of the Huntington Spring. Co-op will monitor this spring when flows are present.

7.2 Surface Water Hydrology

COMPULATION WATER QUALITY DATA - BEAR CANYON MINE

DATE	FE	MAG.	SS	PH	FLOW	DATE	FE	MAG.	SS	PH	FLOW
1983											
Jan. 21	0	0	0	0	0	21	0	0	0	0	0
Feb. 22	0	0	0	0	0	22	0	0	0	0	0
Mar. 18	0	0	0	0	0	18	0	0	0	0	0
Apr. 25	.17	.36	20,000	7.5	425gpm	25	.15	.07	20,000	7.5	425g
May 24	43.10	5.00	15,880	7.7	2.5cfs	24	36.30	3.80	14,740	7.9	2.5c
June 16	7.63	.05	8,326	8.1	2.5cfs	16	6.50	.05	14,060	8.1	2.5c
July											
Aug.											
Sept.											
Oct.											
Nov.											
Dec.											
Jan.											

Table 7-1

UMMC 817.43 Hydrologic Balance: Diversions and Conveyance of Overland flow, Shallow Ground Water and Ephemeral Streams

Erosion protection measures for the undisturbed and disturbed drainages flowing off the upper pad, across from the fan and the portal area must be detailed to show that erosion will be avoided.

REPLY

An updated map shows the requested detail. (Plate 7-2)

The disposition of the undisturbed drainage above (uphill from(the portal area is unclear. Is there an undisturbed diversion planned or will undisturbed drainage be routed into the sediment pond?

REPLY

The drainage referred to above passes through the uppermost road culvert that is under both the top part of the ascending portal road and that part of the road that turns back to the intake portal, in the same manner that the undisturbed drainage to the North of the portal pass through the other road culverts. These culverts are identified as reference #11 on the hydrologic reference map.

The undisturbed diversion for theupper storage pad and substation area flows south and then west while the disturbed diversion for this same area appears to flow the opposite direction. Please clarify.

REPLY

The appearance is correct. They do flow in opposite directions. The purpose of this is to avoid having the disturbed area runoff flowing through the undisturbed hollow to the south, or the runoff from the undisturbed area flowing through the hollow below the fan that has been changed to a disturbed area. This can be accomplished by using the correct slopes and grade levels for the upper pad.

UMC 817.43 Hydrologic Balance: cont.

It is unclear where the drainage from the crusher facility access road goes; please clarify.

REPLY

It passes onto the main road that passes the truck loading area, and thence to the main sedimentation pond. Please refer to updated map (copy included).

Disturbed drainage from the south end of the crusher pad is routed via culvert to the bathhouse pad. At the point of the culvert on the bathhouse pad, no indication of how this drainage will be routed is shown. Please clarify.

REPLY

The entire bathhouse pad is disturbed area and will slope toward its entrance to the adjoining road and thence to the main sedimentation pond. The runoff from the downspout in particular, will flow along the side of the bathhouse entrance as shown on the updated map (copy included).

The outflow from the 18 inch culvert running under the coal stockpile pad where it intersects Bear Creek appears prone to obstruction from sediment deposits in the creek bed. How will this outflow be maintained and kept free of obstruction?

REPLY

This will be inspected monthly and after each major storm or other runoff event and cleaned as required.

7.2 Scope

Co-op Mining Company, in preparation of the Bear Canyon Facility, has consulted and contracted work from Vicking Engineers, Horrocks Engineering, as well as relied heavily on the expert testimony of Bruce Kaliser. The following preceding firms and individuals worked closely with the Division of Oil, Gas, and Mining to ensure the sizing, location of all Drainage and Sediment structures on Co-op Bear Canyon Mine properties to protect the integrity of all surface water which passes through the mine site.

In addition, Co-op Mining has worked out a comprehensive monitoring Plan with sample points both above and below the Mine operation so that any problems will be readily corrected.

7.2.1 Methodology

Co-op has committed to monitor surface water monthly in two locations on Bear Creek (see Plate 7-1? ← 3-7-84). The same methodology as indicated in 7.1.1 will be utilized. In addition to the Bear Creek Samples- Co-op is presently monitoring Trail Creek- above and

below that area which is disturbed due to mining activities.

7.2.2 Existing Surface Water Resources

7.2.2.1 Appendix 7-D Regional Hydrology

7.2.2.2 Mine Plan Area Hydrology See Appendixes 7-E, 7-F, 7-G, Plate 7-1

7.2.3 Surface Water Development, Control and Diversions Appendixes 7-F, 7-G Plates 7-1, 7-2, 7-3

7.2.3.1 Water supply See 7.1.3.2

7.2.3.2 Sedimentation control structures and diversions See Appendixes 7-F, 7-G Plates 7-1, 7-2, 7-3

7.2.4 Effects of mining on surface water

7.2.4.1 Hydrologic Balance

Co-op is committed to protecting the hydrologic balance as witnessed by the numerous diversion and sediment control structures on the property.

During any construction phase in a natural environment the potential of depredation of

surface waters is present and unfortunately does occur through the inadvertant erosion of exposed soil during periods of run-off. Again, Co-op has and is presently addressing this problem through straw berms, sediment catch basins and ponds and by diverting disturbed and undisturbed run-off.

In addition, Co-op has implemented an extensive interim revegetation program in October, 1983 wherein soil tackifiers and mulches were utilized to stabilize the soil until the vegetation is established.

7.2.4.2 Quality of Surface Water

The occurance and quality of water in the region is highly controlled by geology. The majority of the Mine Plan Area is strong structurally and consists of the same geologic formations. It is presumed that mining activities will have little adverse impact on the aerial hydrologic system. The only drainage which in the present permit are as Bear Creek. All surface facilities is located within the lower half of this drainage. All Disturbed area drainage will be directed through a sediment pond unless it is specifically excluded and permitted as such, small area exemptions etc. Unless unusual flows are encountered in the mine, it is not expected that any mine water will be directly discharged into the drainage. In this event the necessary NPDS permits would be obtained and the necessary parameters met.

The quality of water on the Top -(North) portion of the Permit area is excellent. However, when this water flows across the various Macos shale formations the quality desinagrates at an excellerated pace. Bear Creek heads on a massive mud slide at the head of the canyon and is a

vert poor to marginal quality, by the time it is consolidated into a stream.

7.2.5 Buffer Zone

Co-op is committed to maintain a minimum of a 50 foot Buffer Zone wherever possible. Unfortunatly the restrictions of the Canyon and the utilization of old existing disturbances; roads, Pile areas, etc. make a Buffer Zone unobtainable in many areas. Whenever the 50 foot Buffer Zone must be encroached, Co-op has contacted the Necessary Regulatory agencies to obtain permission. In addition, Co-op is committed to not only reclaiming disturbances along the creek, but to actually enhance the riparian Zone. (See attachment)

7.2.6 Surface Water Monitoring

Presently Co-op monitors Trail Creek above the mine complex at the site of Trail Canyon Weir and at the South end of the culvert which passes the water under Huntington Canyon Highway below the mine complex. In Bear Canyon, Bear Creek is monitored above the mine- below Bear Creek Falls and below the mine at Beaver Creek Weir W-4. The water is tested for iron, maganese, susupended solid and the flow, plt and temperature are recorded. During times of heavy snow and/or ice, a portion of the channel is exposed to determine if any flow is present. Standard flow determinations are used in the case of the weirs - the depth is correlated to the appropriate chart. Co-op will provide an annual summary sheet that will include surface water quality and quantity data in a consolidated, clear manner sufficient to identify seasonal variations and meet the requirements of UMC 783.16. (example is attached herein) (Table 7-1)

APPENDIX 7- A

UNDERGROUND HYDROLOGY

BEFORE THE BOARD OF OIL, GAS AND MINING

DEPARTMENT OF NATURAL RESOURCES

in and for the STATE OF UTAH

- - - - - - - - - - - - - - -

IN THE MATTER OF THE APPROVAL OF NOTICE OF INTENT AND RECLAMATION) PLAN SUBMITTED BY CO-OP MINING COMPANY.

CAUSE NO. ACT/015/025

- - - - -

BE IT REMEMBERED that on the 18th day of June, 1980, a hearing was held before the Board of Oil, Gas and Mining in the above-entitled matter and said hearing was taken before Athena Moore, a Certified Shorthand Reporter and Notary Public in and for the State of Utah, holding Utah C.S.R. License No. 88, commencing at the hour of 10:20 a.m. in the Wildlife Resources Auditorium, 1596 West North Temple, Salt Lake City, Utah.

Q Please give us your name and address and by whom you are employed?

A Bruce N. Kaliser, 2951 Nila Way, Salt Lake City. Employed by the State of Utah, Division of Utah Geological and Mineral Survey.

Q (By Mr. Feight) You have heard the testimony before the Board this morning and you have some comments to make relative to this and your own experience in the area?

A Yes. Briefly, my work consisted of examination of the literature, a field examination of the sites of the three springs; Bear Canyon, Little Bear Canyon, and Birch Spring in this vicinity in question.

Examination of the existing mine to which they will enter and expand and the geology in the vicinity of the field. This was done about a month ago at the request of Castle Valley Special Services District.

In brief, my conclusion is that it is highly unlikely that the mine plan as presented to me by the Co-op Company would interfere with the quantity or quality of any of those springs, particularly the one in question, the Bear Canyon

Spring.

Q What do you base this conclusion on?

A I base that on the hydrogeologic regime which I believe prevails in the vicinity. The source of the spring is the Star Point Sandstones. There is a very predominant northeast striking joint and fault system that they parallel. The water contributory to this spring exists in my opinion to the north of the mine in the area of the Gentry Mountain. I believe that faults are a guiding, a strong guiding influence to the migratory pattern of groundwater regime in this area. But in entering the mine that Co-op will be going into, it appears that the faults evident in that mine underground are tight, and water is only a distant near the canyon wells. In other words, near the entry, near the portal, not further in. There is no evidence of any water further in.

I don't believe that at that locality there is precipitation recharging the aquifer, and so I am of the opinion that the mining operation will not affect the discharge of the spring.

Now I do have other data. I've looked at the data. I believe what's been presented here

this morning I have not been given copies of what you have. I don't know for a fact that I have seen everything in identical fashion that you have been presented. But it's probably the same data that I have been provided by the improvement district and the mine.

Q Mr. Kaliser, if you look at Protestant's Exhibit No. 2, could you kind of draw a fault line for the Board and tell them where you think the faults are to the mining operation, and from what I understand, you are saying that the faults are so tight in the area of the mine that there is no migration of water through the fault system, am I correct?

A At the elevation of the mine, the fault gauge is sufficiently tight, and the relief, the runoff that would occur in the vicinity of the mine, I don't believe you would get a contribution at that point. I'm not saying that the faults--quite opposite--I'm not saying that the faults don't influence the groundwater pattern, but I'm saying that there is no evidence from what I see of the faults and in the mine that that is having any influence on the vertical migration of water down to the water table. There is no water table in

the mine.

Q Is the Star Point Formation which is I understand is the water formation in this area, is above or below the coal seam?

A Below the coal seam. The coal seam is in the Blackhawk, so the mine is in the Blackhawk. I do believe there is hydraulic connection there between most of those formations because of that very prominent joint pattern that exists in this part of the plateau. And, of course, this area, this vicinity that we are speaking of is right in the present valley fault zone, so there are individual fault strands. Some of which are identified on existing geologic maps and some of which are in the field. In other words, identified faults not heretofore mapped and some showing presently on maps.

Q Approximately how many faults are there in the vicinity of the mine?

A In the vicinity of the mine I would say there could be three.

MR. BOX: Could you put them on the exhibit?

THE WITNESS: This map is sufficiently small in scale. I could, with a little time, but

I don't know if you want me to take up that time.

This is the larger scale.

MR. McINTYRE: Are they running northeast?

THE WITNESS: They are about North 10 Degrees East. They are about vertical in attitude.

MR. McINTYRE: And what about displacement?

THE WITNESS: Displacement, we've measured in the mine displacements of two and a half feet, four feet two inches and one foot three inches in each case down to the east toward the canyon and the strikes that we measured varied from North 8 East to North 11 East. These were all taken in the mine underground.

The greatest fault appears to be at about 600 feet west of the mine portal, the existing mine portal.

Now if that fault maintains its strike, it would not strike into the spring and examination of the immediate vicinity of the spring reveals no trace of the fault, interestingly enough. It does show that the water is emerging from joints from this which are parallel to the fault, but I think interestingly enough, no fault is seen within the

immediate vicinity of the spring. You can see seepage being emitted from three distinct joints at the spring site. So it's quite an interesting situation.

I'm going to sketch on here some of the faults. I can do that, although the scale is such that you can't hold me to it. Birch Spring which is just around the corner, it's actually slightly northwest of Bear Canyon, but it is around the corner, cliffwise, and appears also to be emitted from a shear zone, a zone of closely shaped faults, but not distinct displacement. I can't observe any distinct fault displacements. It's an area that's highly deformed and has created this very prominent joint set, but you don't need displacement to create the channels, the secondary permeability roots.

MR. DANIELS: Can you hypothesize that this point produces the actual charge into the spring is from horizontal movement through the joint at or in the Star Point from areas to the north or to the west?

THE WITNESS: I think what happens to the north where principally the snow accumulates on Gentry Mountain, there is a recharge that is

vertical down to the water table through the Blackhawk, and there is a recharge also from those channels which are from those drainages which are lying along the joint and the fault bed. That vertical migration then reaches the Star Point and travels laterally along shear zones, prominent joints or faults and emerges where the topography disects the formation. I think all this is happening well below the mine.

MR. DANIELS: Essentially what you're saying is the water is dropping down to the next formation below and falling in under the mine?

THE WITNESS: Right.

MR. McINTYRE: In your opinion is it highly probable that additional activity underground in the mine could actually increase the flow of water to the spring in question?

THE WITNESS: Depending upon the use of the water in the mine and how they go about mining. It's possible. I think it would have a negligible effect at this site. It might have a greater effect should they go up to the north.

MR. DANIELS: Have you got an opinion on subsidence of the mine whether actual subsidence of the roof of the mine would affect the water flow

to the spring?

A I don't believe that subsidence would have an effect, because I think the runoff over the slopes above the mine--the rule is the greater the slope is -- and it is to the north, and I don't think it would make a difference.

There was one or two locations within the mine where there was roof collapse. No water was observed, however.

MR. DANIELS: Thank you.

MR. CHAIRMAN: Bruce, are you through?

THE WITNESS: Yes.

APPENDIX 7-B

WATER RIGHTS

FORM 108 Exchange Application No. .....

APPLICATION FOR THE RIGHT OF EXCHANGE OF WATER STATE OF UTAH

For the purpose of obtaining permission to make an exchange of water, application is hereby made to State Engineer, based upon the following showing of facts submitted in accordance with the requirements of Sec. 73-3-20, Utah Code Annotated, 1953.

1. The name of the applicant is Mrs. Charles W.(Lavenda) Kingston
2. The post office address of the applicant is 862 E.Garfield Ave.SLC, Ut. 84110
3. The right to be exchanged was acquired by Application No. 35836 (93-1067)
   (Give application No., certificate No., Decree, stock purchase, or other identification.)
4. The quantity of water is 0.25 second-feet, or ..... acre-feet.
5. The period of use from January 1 *(Month)* *(Day)* to December 31 *(Month)* *(Day)*, inc.
6. The period of storage from ..... *(Month)* *(Day)* to ..... *(Month)* *(Day)*, inc.
7. The direct source of supply is Tunnel tributary to .....
   ..... in Emery county.
8. The point of diversion is* N 210' & W 320' from E¼ Cor. Sec. 22, T16S, R7E, SLM
9. The water is, or was, to be used for the following purposes: .....
   Irrigation SE¼ ne¼ Sec. 22, T16S, R7E, SLM
   Mining
   ..... Total 10 acres.
   (Give place of use by legal subdivision of land)

THE FOLLOWING EXCHANGE IS PROPOSED

10. 0.25 second-feet or ..... acre-feet of water represented by the foregoing right will be delivered from January 1 *(Month)* *(Day)* to December 31 *(Month)* *(Day)* incl. of each year, to satisfy other rights, into ..... at a point* .....
    N79' & E75' from the SW cor. Sec. 24 T16 R7E SLM
11. In exchange for the water delivered and described in par. 10, there will be ..... second-feet or ..... acre-feet diverted from ..... *(Month)* *(Day)* to ..... *(Month)* *(Day)* incl., of each year from a well ..... *(diameter and depth)*
    or stream ....., at a point* .....
12. The water will be used for .....
    Irrigation
    Mining ....., Total 10 acres.

NOTE: *The point of diversion, point of return or point of delivery must be located by course and distance or by rectangular distances with reference to some United States land survey corner.*

Form 114
25M 4-63

IN THE ....SEVENTH.... JUDICIAL DISTRICT COURT, IN AND FOR THE COUNTY OF.....EMERY..... STATE OF UTAH

IN THE MATTER OF THE GENERAL DETERMINATION OF RIGHTS TO THE USE OF ALL WATER BOTH SURFACE AND UNDERGROUND WITHIN THE DRAINAGE AREA OF THE SAN RAFAEL RIVER IN SANPETE AND EMERY COUNTIES IN UTAH.

STATEMENT OF WATER USER'S CLAIM
CODE NO. 93 SERIAL NO. 1067
MAP NO. 21

NOTE: This blank is sent to you in accordance with Utah Law. The information called for herein will be used in connection with the adjudication of water rights on the above mentioned drainage area. All questions applicable to your claim must be answered fully, and one copy of this form must be filed with the Clerk of the District Court at .....Castle Dale....., Utah, within sixty (60) days from date of service of the attached Notice. A copy shall be filed with the State Engineer, State Capitol, Salt Lake City. Failure to file the attached Statement of the Water User's Claim with the Clerk of the District Court within the time stated will forever bar and estop you from asserting any right to the use of water from said drainage area.

1. Name of Claimant Charles W. Kingston
2. Address 862 East Garfield Avenue Interest Claimed Full
   Salt Lake City, Utah 484110
3. Name of particular spring, spring area, stream, well, tunnel or drain from which water is diverted is Underground Water (Mine Tunnel) in Emery County.
4. Priority date claimed January 20, 1964 Date when water was first used .....
   Date when work on diverting system was first begun ..... Date when diverting system was completed ..... Nature of work .....
5. Class of Right (Indicate by X):
   (a)..... Right to surface water initiated by beneficial use before 1903 Claim No. .....
   (b)..... Right to underground water initiated before 1935 Claim No. .....
   (c)..... Right decreed by court, cite title of case .....
   (d) X Application filed, State Engineer's Office No. 35836 Cert. of App. No. Election
   (e)..... Right acquired by adverse use prior to 1939 Chng. a-6330
6. Nature (Indicate by X), Amount, and Annual Period of Use (by month & day):
   (a) X Irrigation Sec. Ft. Inc. from April 1 to October 31 (both dates incl.)
   (b)..... Stockwatering Sec. Ft. ..... from ..... to ..... (both dates incl.)
   (c)..... Domestic Sec. Ft. ..... from ..... to ..... (both dates incl.)
   (d)..... Municipal Sec. Ft. ..... from ..... to ..... (both dates incl.)
   (e) X Mining Sec. Ft. 0.25 from January 1 to December 31 (both dates incl.)
7. Direct Flow Appropriation (must be described with reference to U. S. Government Survey Corner)
   (a) Point of diversion from ~~[illegible]~~, tunnel ~~[illegible]~~ N. 210 ft. & W. 320 ft. from E¼ Cor. Sec. 22, T16S, R7E, SLB&M.
   (b) Description of spring area .....
   (c) Point of rediversion or point of return to natural channel .....
   (d) If flow is intermittently diverted, list by number or description, all rights involved .....
8. Where water is used for irrigation purposes:
   (a) Area irrigated in legal subdivisions of land by 40-acre tract. (All sources of water for same land or lands must be described in each instance by name or claim number) CLAIMS USED FOR PURPOSE DESCRIBED: 93-1067 on: 0.5 acre in SE¼NE¼ Sec. 22, T16S, R7E, SLB&M.
   (b) Do you get water under a ditch owned by several users..... If so, give names of all users and divisions of interest .....
9. Where water is used for Stockwatering:
   (a) Number of each kind of stock watered .....
   (b) All sources of water for same stock. (Describe by name or claim number) .....
10. Where water is used for Domestic: .....
    (a) Number of families or their equivalent ..... All sources of water for same use. (Describe by name or claim number) .....

11. Where water is used for Municipal Purposes:
(a) Name of city or town supplied ..... Population .....
Number of families ..... Quantity of water .....

12. Where water is used for a purpose not above enumerated:
(a) Nature of Use ....Mining..... Extent of Use .....
.....
.....
.....
.....
.....

13. Appropriation for Storage Purposes:
(a) Name of reservoir .....
(b) Location of reservoir by legal subdivisions described by 40-acre tracts .....
.....
(c) Maximum capacity of reservoir in acre feet ..... : Year construction commenced .....
Completed .....: Water first used ..... Is reservoir located on or off stream.....
(d) Period of Storage from ..... to ..... (both dates incl.). Period of use from .....
to..... (both dates incl.). Maximum area in acres inundated ..... Max. depth in feet.....
Average depth in feet..... Is reservoir drained each year..... Maximum number of fillings per year..... Is reservoir used for equalizing purposes..... If feeder canal is used, give maximum carrying capacity in sec. ft.....

14. Diverting Works:
(a) Surface water diverting dam: Material composed of .....
Max. length..... Max. height..... Max. width at bottom..... Max. width at top.....
(b) Underground water diverting works: Is well flowing or pump..... Depth of well.....
Diameter of well..... Length of drain..... Width of drain ..... Depth of drain.....
Diameter of drain..... Length of tunnel .....Width of tunnel..... Height of tunnel.....
Type of pump..... Capacity of pump.....
(c) Surface and underground water conveying works: Length of ditch to first place of use..... Width of ditch at top ..... Width of ditch at bottom..... Depth of water..... Grade of ditch per 1000 ft..... Material through which ditch passes..... Maximum length of pipe line to first place of use..... Diameter of pipe line ..... Grade of pipe line per 1000 feet.....

15. The undersigned hereby enters his appearance and waives service of summons or other process.

STATE OF UTAH
} SS. (To be used if claimant is an individual)
COUNTY OF SALT LAKE

CHARLES W. KINGSTON ..... being first duly sworn, upon oath deposes and says that he is the claimant whose name appears hereon, that he has read the foregoing statement of his claim and knows the contents thereof, that he has signed the same, and that the answers therein are true to his best knowledge and belief.

C. W. Kingston
..... Signature of Claimant

Subscribed and sworn to before me this 26TH day of MARCH 1975

Kenward H. McKinney
..... NOTARY PUBLIC

STATE OF UTAH
} SS. (To be used if claimant is a corporation or an estate)
COUNTY OF .....

....., being first duly sworn, upon oath deposes and says that he is the ..... of the above claimant, that he makes this certification on behalf of said claimant, that he has read the foregoing statement of claim and knows the contents thereof, and that he has signed the name of said claimant to said statement, that the answers set forth therein are true to his best knowledge and belief.

.....

Subscribed and sworn to before me this ..... day of ..... 19.....

.....
NOTARY PUBLIC

KENWARD H. MCKINNEY NOTARY PUBLIC Commission Expires Aug. 4, 1977 State of Utah

AGREEMENT

THIS AGREEMENT entered into this 27th day of January, 1982, by and between Co-op Mining Company, a Utah partnership, C.O.P., INC., a Utah corporation, hereinafter jointly referred to as "Co-op", and Huntington City, a municipal corporation, hereinafter called "City".

WITNESSETH:

THAT WHEREAS, Co-op is undertaking to develop and put into operation a coal mine in Big Bear Creek Canyon, in Emery County, Utah;

AND WHEREAS, City has received in the past and is now receiving a significant portion of its culinary water supply from a spring in Big Bear Creek Canyon in the general proximity of the proposed mining operation;

AND WHEREAS, the parties to this Agreement wish to cooperate with each other so as to assure that Co-op activities will not in any manner result in a loss or diminution of the water supply available to the City from the Spring, the parties do hereby AGREE and COVENANT between themselves as follows:

1. That, at the option of City, representatives of City and the Co-op will make inspections underground in the old Bear Canyon Mine and any other mine operated in Bear Canyon by Co-op, to check for water.

2. That the City will maintain a flow meter at the Spring site and shall take measurements from the meter on a continuing basis so that any interference with the water supply or diminution in the flow can be readily determined; and the flow figures as measured shall be made available to Co-op.

3. That in the event that the quality of water at the Big Bear Creek Spring site decreases below the standards set by the Utah State Board of Health for culinary water, or in the event that the quantity of water at the Big Bear Spring decreases in flow —25%— below the flow for the month immediately preceding, in any 30-day period; or 50 per cent below the average flow for the preceding 180 days in any 180-day period and such decrease cannot reasonably be accounted for as being a result of a lack of precipitation or other causes unrelated to Co-op's mining activities, then Co-op shall in accordance with this Agreement undertake such action as may be necessary to obtain water from some other source, and place said water into the culinary water system of City in such quantity and quality as would replenish the flow and quality that has been lost with the same quantity of water, the quality of which passes the standards of the

Utah State Board of Health for culinary water. Co-op agrees to use all reasonable diligence to take the required action or make the required replacement of a permanent acceptable nature as rapidly as feasible, not to exceed one year, unless a greater time is required by law, and further agrees to maintain such temporary measures until permanent measures are completed, at Co-op's sole expense. In the event that water treatment is required to bring the water obtained by Co-op up to Utah State standards for culinary water, Co-op further agrees to pay the proportionate share of the cost for treatment of said water as long as the interruption continues. In the event it is later determined that such decrease in the flow or quality of water is not a result of Co-op's mining activities, City agrees to reimburse Co-op for its reasonable and necessary expenses incurred pursuant to this paragraph. Co-op further agrees that if said mining operations diminish or interfere with the flow of or quality of water from the above Spring to the extent that mechanical water treatment plant is necessary, said Co-op shall pay a percentage of the plant cost related to said plant, proportional to the water needing treatment as a result of the diminution in quality or quantity of the Big Bear Springs, compared to the total water being treated by the City.

4. The parties further agree that the figures of 25% and 50 per cent relative to a decrease in flow of the Big Bear Creek Spring cited in paragraph 3 above as the trigger for Co-op's obligation to replace said diminution of flow may be altered from time to time by mutual agreement of the parties after a period of three years, after which time the parities will have sufficient spring flow data to more accurately establish that point at which the diminution of flow at the Spring site is likely to have been caused by the Co-op's mining operations.

5. In the event that there is a good faith dispute between the parties hereto whether or not Co-op's mining activities are the cause of a diminished flow or quality in Big Bear Creek Spring, the parties shall cooperate in taking immediate corrective measures reasonably necessary to restore said flow or quality of water. Each party shall bear one-half of the cost thereof, provided that if it can later be shown that said mining activities were not responsible for said diminution in flow or quality, City shall reimburse Co-op within a reasonable time from such showing for Co-op's costs already paid pursuant to this paragraph and Co-op shall not be obligated to pay any additional costs of the corrective measures not yet paid at the time of such showing. Further, if it can be later shown that said mining activities were responsible for said diminution in flow or quality, Co-op shall reimburse City within a reason-

able time for City's costs already paid pursuant to this Agreement.

6. In the event of good faith dispute between the parties as to the cause of any diminution in flow or quality of said Spring, the parties agree to appoint an arbitration committee and to be bound by the decision of said committee. This committee shall consist of five menbers: one Co-op representative, one City representative, and three representatives chosen by the other two members. The arbitration committee shall immediately meet and within 30 days make a preliminary decision as to the cause of any dininution in flow or quality of said Spring which preliminary decision shall bind the parties until the committee has had time to make a full investigation and reach a final decision. Nothing in this Agreement shall be construed as depriving either party of a right of action against any other non-parties including any insurance company issuing insurance pursuant to paragraph 9 hereof.

7. In the event any other mining operation or other activity of any other person or entity is proposed or planned in the area which may affect the flow of the Big Bear Creek Spring, City will require such person or entity to sign an agreement similar to this Agreement, binding such other person or entity to bear responsibility for any adverse effect such other person's or entity's activities may have upon the flow or quality of said Spring. In the event any diminution in the flow or quality of the Spring may be attributable to the activities of any person or entity other than Co-op, Co-op shall have the right to establish the same to City's reasonable satisfaction and thereby shall be entitled to reimbursement by City within a reasonable time from such establishment for reasonable costs incurred by Co-op for corrective action required under this Agreement to the extent it is established that such other person or entity is responsible for the diminished flow or quality. In that event City agrees to look to such other person or entity for such corrective action as it deems necessary.

8. This Agreement shall terminate and Co-op shall have no further obligation hereunder with respect to any diminution of flow of Big Bear Creek Spring, one year after the final termination of Co-op's or its successors in interests' mining activity in Bear Canyon.

9. In order to assure performance on its part of the covenants of this Agreement, Co-op agrees to insure the City in an amount not less than Three Hundred Thousand ($300,000) Dollars with a company acceptable to City which insurance policy may be the same policy as is required by Section 40-10-10(6) Utah Code Annotated.

10. In the event legal action is brought to enforce the terms of this Agreement, the losing party in such action agrees to pay all costs thereof, including the reasonable attorney's fees of the prevailing party.

11. This Agreement shall cover the proposed mining operation on the Six Hundred Eighty (680) acres covered by and described in Cause No. ACT - 015-025, before the Utah Board of Oil, Gas and Mining, Department of Natural Resources.

12. As a condition to entering into the foregoing Agreement, the City agrees that it will withdraw its protest in Cause No. ACT - 015-025 before the Board of Oil, Gas and Mining, Department of Natural Resources of the State of Utah, and also it agrees that it will not protest the proposed mining operation on the the Six Hundred Eighty (680) acres as heretofore filed as a mining plan with the Board of Oil, Gas and Mining, Department of Natural Resources of the State of Utah, or protest the issuance by Emery County of any necessary building permits or approvals for Co-op's mining operations in Bear Canyon.

13. The City hereby specifically reserves its rights to protest any and all other legal remedies on all other mining plans or proposals on land not included in the acreage covered by this Agreement.

14. Co-op agrees that the transfer or assignment of the premises affecting said Spring or this Agreement shall not release Co-op from any obligations in this Agreement unless Huntington City has in writing consented to said release, which consent shall not be unreasonably withheld.

15. The parties shall not assign their obligations or rights under this Agreement without the mutual consent of each other.

16. It is agreed by the parties that this Agreement applies to and binds the heirs, executors, administrators, successors and assigns of the respective parties hereto.

IN WITNESS WHEREOF, the said parties to this Agreement have here unto affixed their signatures, the day and year first above written.

CO-OP MINING COMPANY

By D J Peterson

ATTEST:

Luana Kingston
Secretary

C.O.P., INC.

By D J Peterson
Its President

ATTEST:

Toby D Thorpe
City Recorder

HUNTINGTON CITY

By
Its Mayor

APPENDIX 7-D

REGIONAL HYDROLOGY

Chart 2-12: HYDROLOGIC AREAS

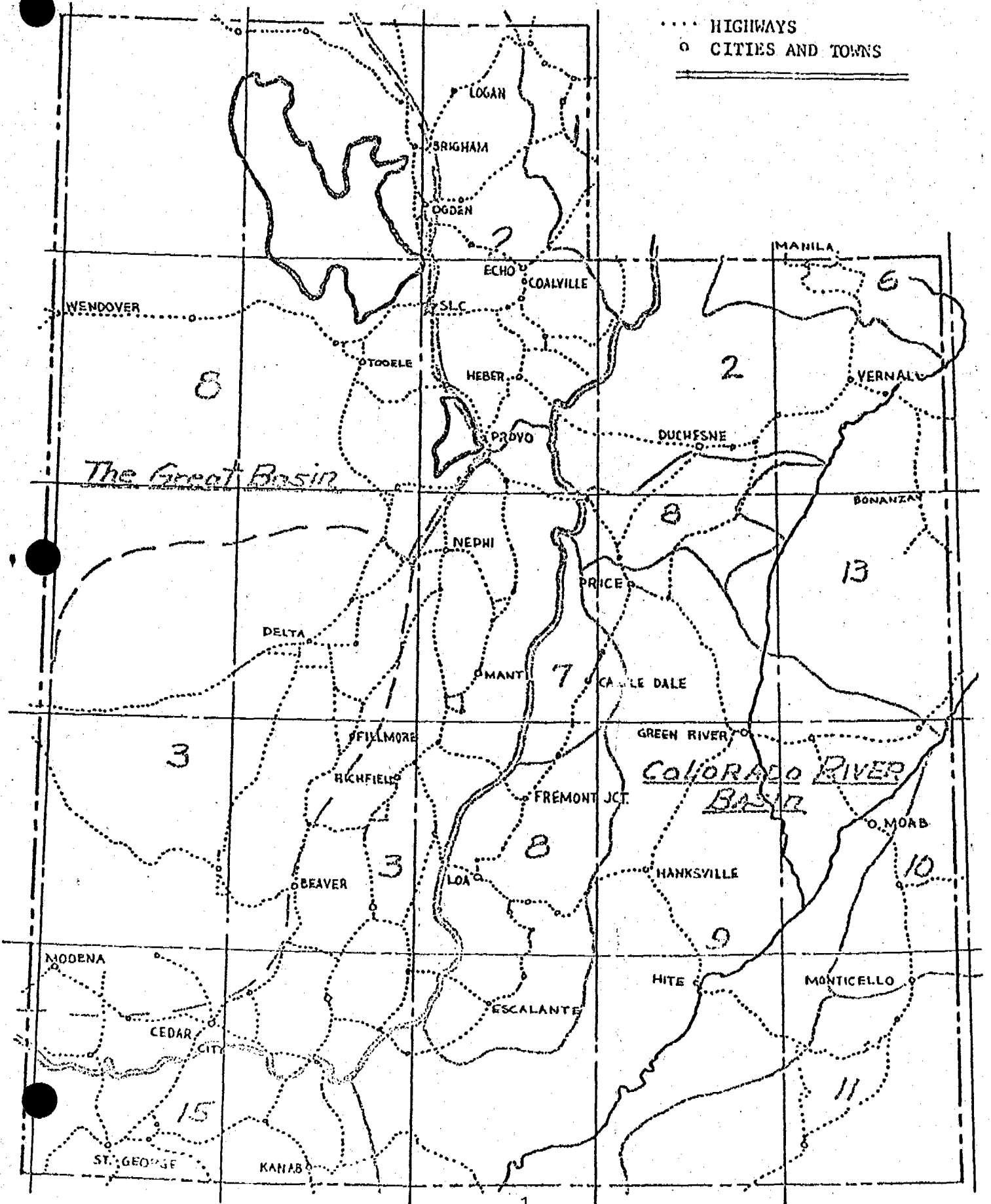


Chart 2-11: FLOOD REGIONS

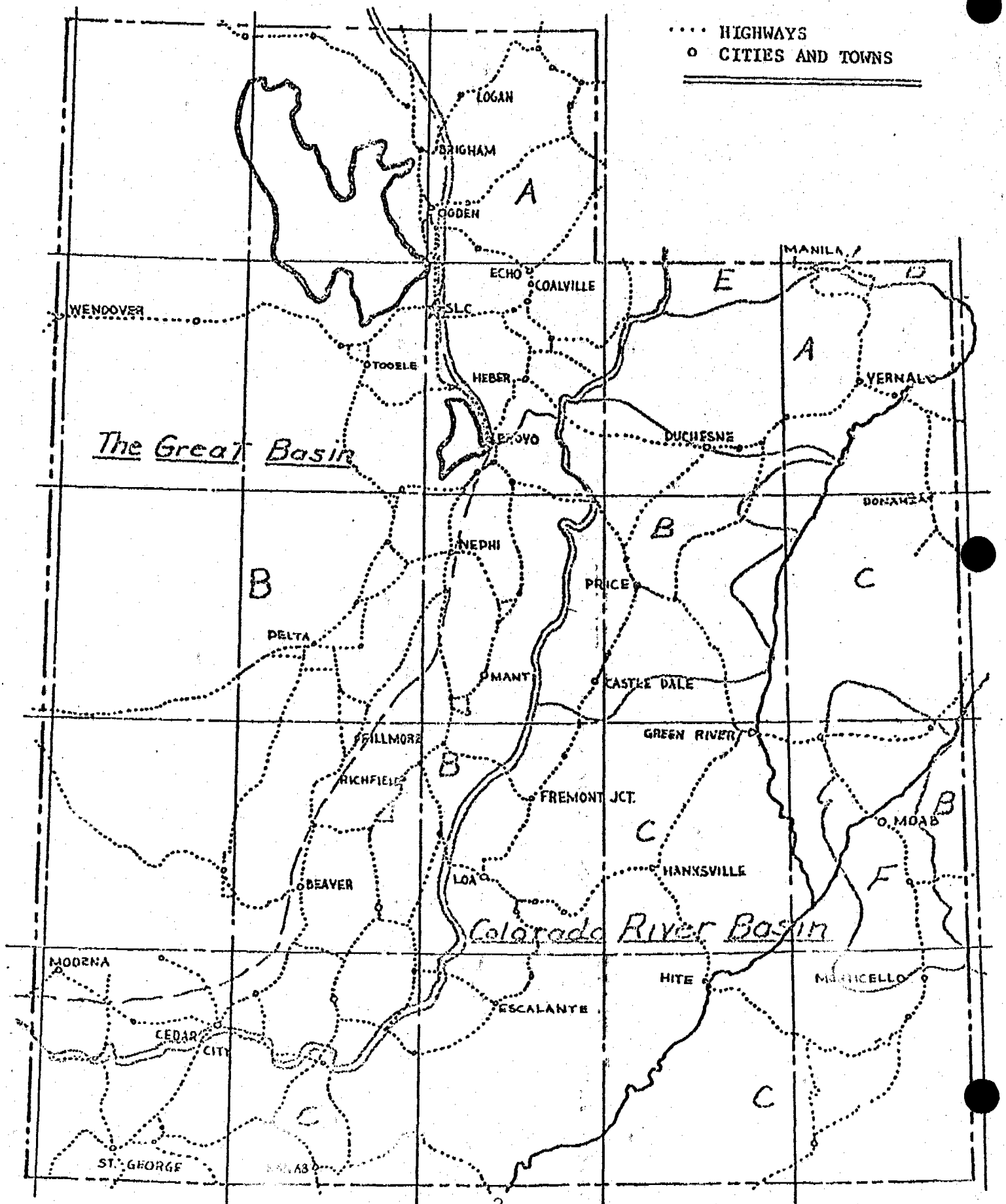


CHART 2-15: FLOOD FREQUENCY RELATIONS FOR HYDROLOGIC AREA 7
(COLORADO RIVER BASIN)

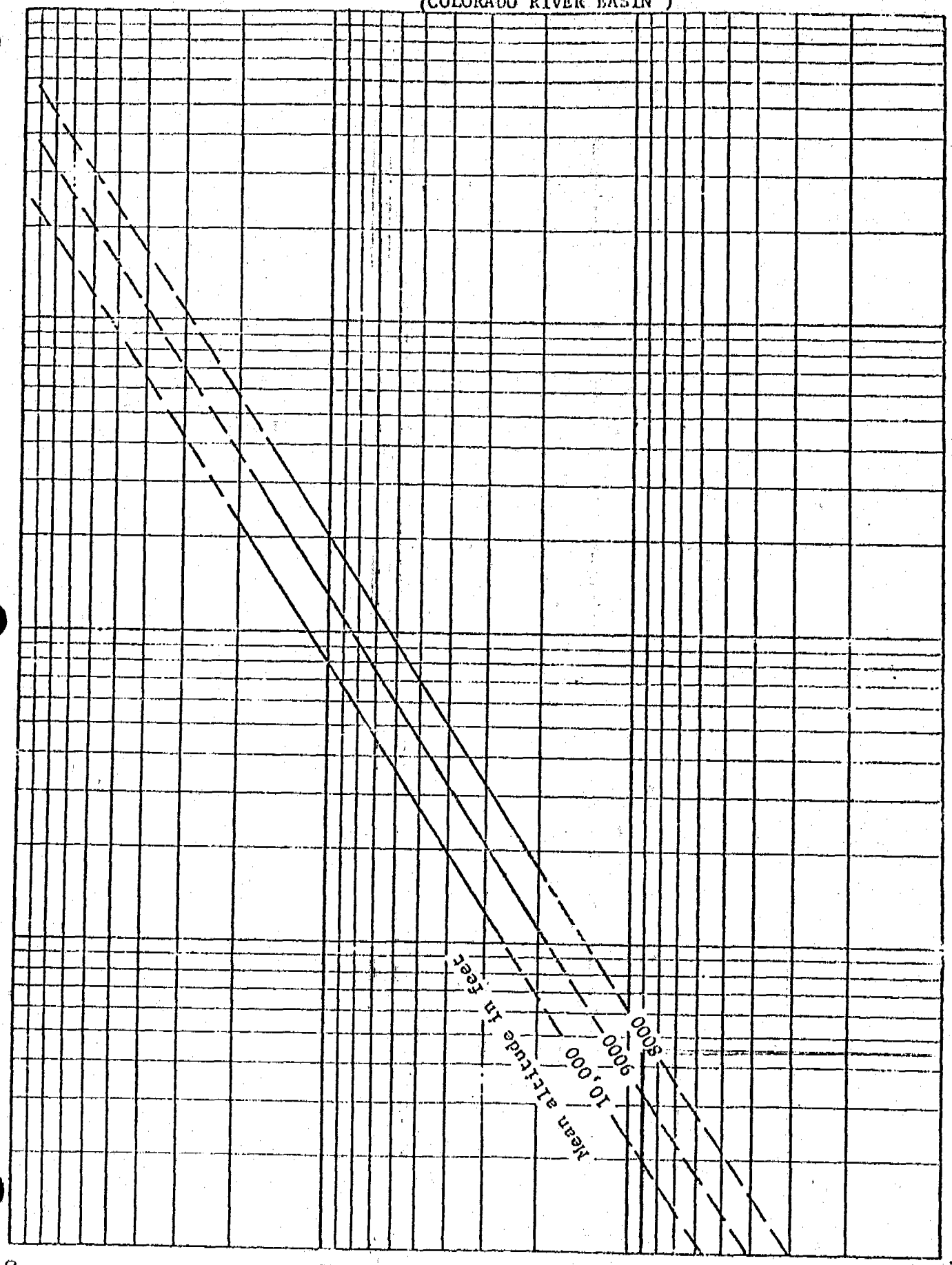


Table 2-08: LAND FACTORS FOR SMALL WATERSHEDS.

TYPICAL GEOGRAPHIC LOCATIONS	TYPICAL TERRAIN CHARACTERISTICS	LAND FACTORS
	ALLUVIAM	
	(CLEAN)	
Farmington Salt Lake Bench Lands	Fans from granitic uplifts Spits, bars, glacial till, etc.	0.3 → 0.8
	(DIRTY)	
Sevier Valley Echo Canyon Salt Lake Valley	Fans and pediment plains from shale areas, etc. Conglomerate Lake deposits - flood plain areas	1.0 → 1.5
	IGNEOUS	
	(RIOLITIC - POROUS)	
N.W. of St. George Fish Lake area Marysville Canyon	Cinder areas (Small areas) Basalt and lava flows Riolitic flows	0.5 → 1.5
	(SHISTOS OR GRANITIC)	
Bald Mountain - Uintahs Farmington Canyon Little Cottonwood Canyon Salt Lake City	Rubbled uplifts Metamorphic shales Batholitic uplifts - granitic	0.3 → 1.2
	LIMESTONE	
Logan Canyon	Hard, pure limestone or dolomite (breaks up in blocks; talus slopes may be present)	0.5 → 1.0
	SANDSTONE	
Brigham City Bryce Canyon	Massive (well-cemented) quartzite, etc. abundant talus slopes - rubble piles Friable (poorly-cemented) dirty sand dunes may be present	0.5 → 2.0
	SHALE	
San Rafael Swell Green River	Sandy shale - alternating clayey sand and shale members Clayey shale	1.5 → 2.5

ESTIMATED RETURN PERIODS FOR SHORT DURATION PRECIPITATION
(inches)

Station: Clear Creek Summit
Latitude: 39° 39'

Elevation: 9630
Longitude: 111° 12'

RETURN PERIOD (years)	DURATION									
	5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.10	.16	.20	.28	.35	.46	.57	.84	1.08	1.33
2	.12	.19	.25	.34	.43	.57	.70	1.04	1.34	1.65
5	.16	.24	.31	.43	.54	.72	.90	1.34	1.73	2.14
10	.19	.29	.37	.51	.65	.86	1.06	1.55	1.99	2.45
25	.24	.38	.48	.66	.84	1.08	1.31	1.88	2.39	2.92
50	.25	.38	.48	.67	.85	1.13	1.40	2.07	2.67	3.29
100	.27	.42	.53	.73	.93	1.24	1.54	2.29	2.96	3.65

ESTIMATED RETURN PERIODS FOR SHORT DURATION PRECIPITATION
(inches)

Station: Hiawatha
Latitude: 39° 29'

Elevation: 7230
Longitude: 111° 01'

RETURN PERIOD (years)	DURATION									
	5 Min	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	12 Hr	24 Hr
1	.03	.04	.05	.07	.09	.24	.39	.76	1.09	1.43
2	.07	.10	.13	.18	.23	.40	.55	.95	1.30	1.67
5	.13	.20	.25	.35	.44	.62	.79	1.22	1.60	2.00
10	.16	.25	.31	.43	.55	.75	.93	1.40	1.82	2.25
25	.23	.35	.44	.62	.78	.99	1.19	1.69	2.14	2.60
50	.26	.40	.50	.70	.88	1.11	1.33	1.89	2.38	2.90
100	.31	.48	.60	.84	1.06	1.30	1.54	2.12	2.64	3.18

CHART 2-22A: COMPOSITE FLOOD FREQUENCY CURVE FOR REGIONS A, B, & E
(COLORADO RIVER BASIN)

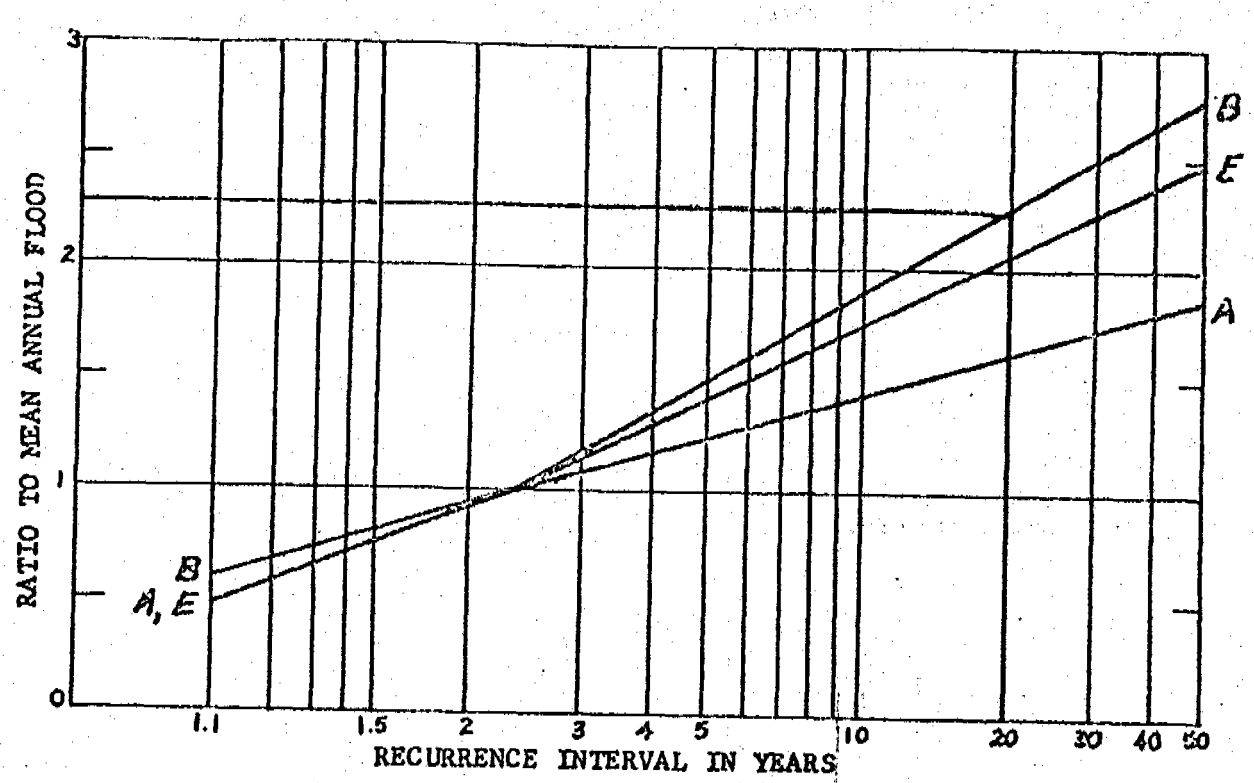
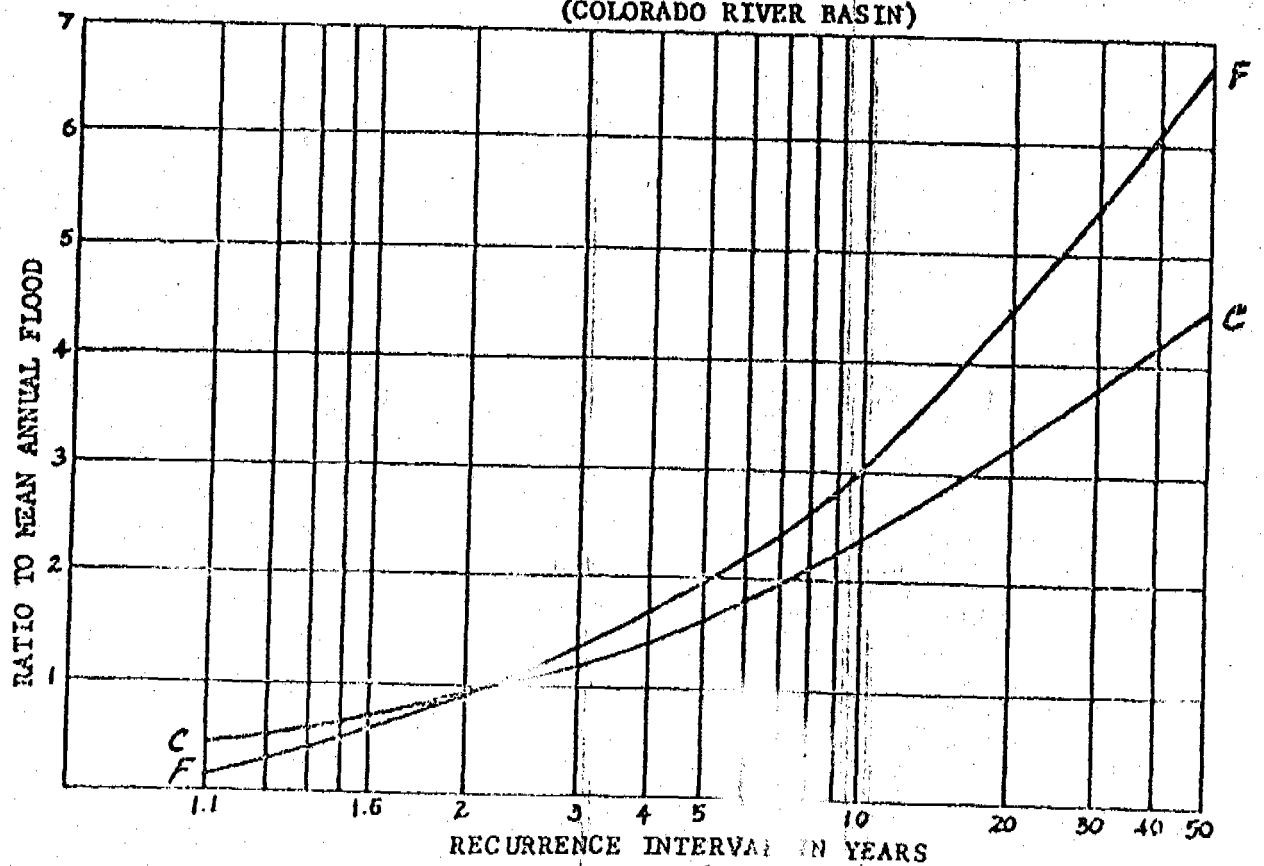


CHART 2-22B: COMPOSITE FLOOD FREQUENCY CURVES FOR REGIONS C & F
(COLORADO RIVER BASIN)



Precipitation; Hiawatha reporting station:

Annual precipitation	Normal	13.18 in.
	1980	18.62 in.

Evaporation:

Pan evaporation	May through Oct.	45.6

APPENDIX 7-E

MINE PLAN AREA HYDROLOGY

CLASS I ROAD HYDROLOGY

HORROCKS & CAROLLO ENGINEERS
A JOINT VENTURE
ONE WEST MAIN
P.O. BOX 377
AMERICAN FORK, UTAH 84003

August 5, 1983

Mr. Wendell Owen
Co-Op Mining Company
P.O. Box 1245
Huntington, Utah 84528

Subject: Bear Creek Canyon Mine Site
Access Roadway Culverts

Dear Mr. Owen:

I have reviewed the information which you verbally conveyed to me relative to my letter of August 3, 1983 regarding the 1800 feet of "private" road in Bear Creek Canyon which is the access road for your mine.

Based on my understanding of the regulations for road crossing culverts; I would recommend that two (2) additional 18-inch culverts be added to the subject access road at 1230 feet from the lower end and at 1800 feet from the lower end (i.e. At the upper end). These two (2) culverts would be in addition to the existing 18-inch culvert which is 650 feet from the lower end. The new 18-inch culverts should have at least 30-inches of headwater depth over the top of the pipes and should be laid at a 8% grade.

The drainage ditch to convey the water to the culverts should be a V-type ditch with one to one side slopes at least 1½ feet deep constructed to match the road grade where possible, but with at least a 6% grade. If the existing road grade is only 4%, a similar V-type drainage ditch would need to be 2 feet deep.

If you desire clarification, or need additional information-, please contact me.

Very truly yours,

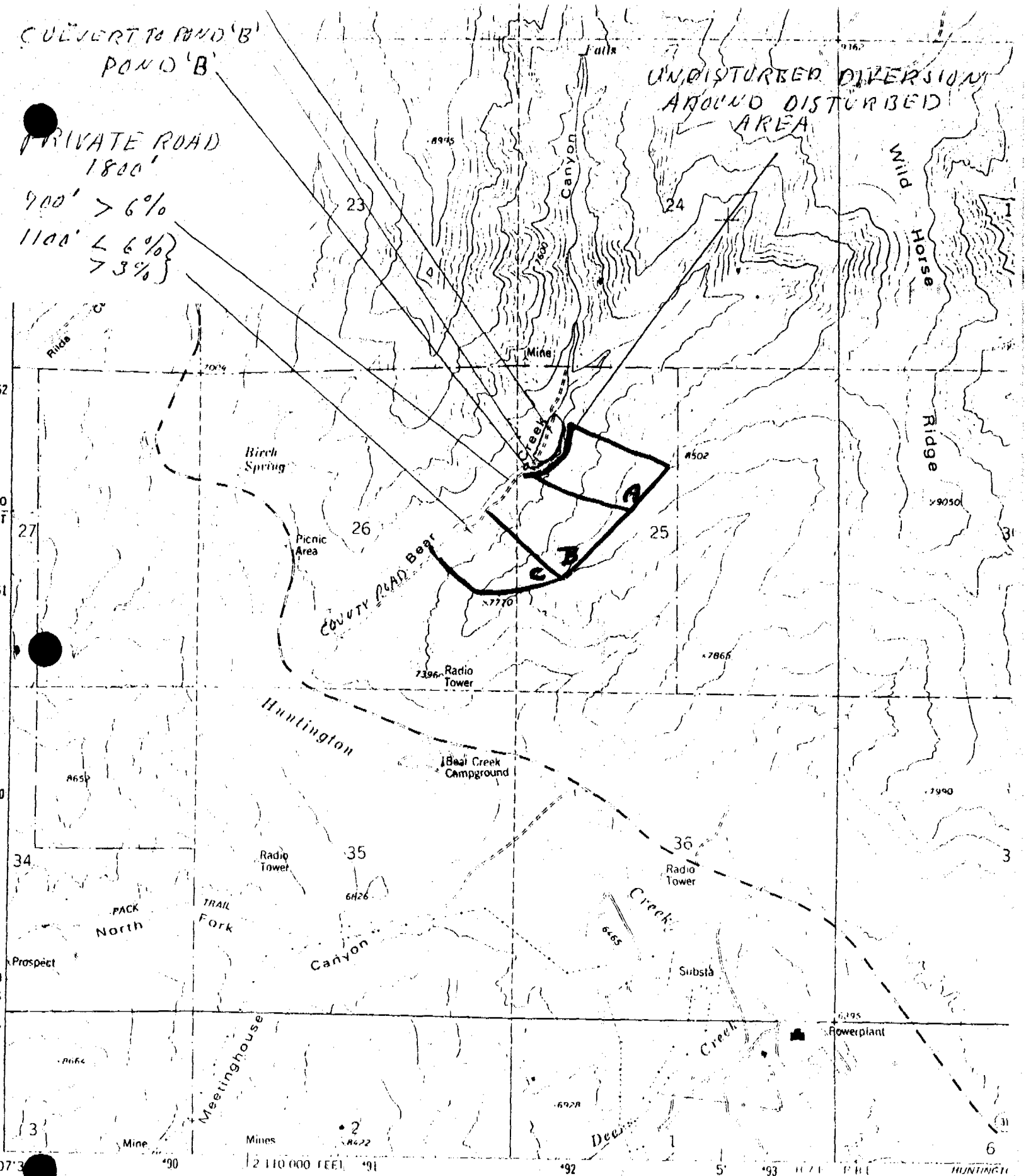
HORROCKS & CAROLLO ENGINEERS

H. Lee Wimmer

H. Lee Wimmer, P.E.
Hydrologist

HLW:hlw

cc: Co-Op Mining Company
53 West Angelo Avenue
Salt Lake City, Utah
84115



Mapped, edited, and published by the Geological Survey

Control by USGS, NOS/NOAA, and U.S. Forest Service

Topography by photogrammetric methods from aerial photographs taken 1970. Field checked 1974. Map edited 1978

Bear Canyon Side Flow

Culverts under access roadway

Design Data

Site elevation : 7150 feet (U.S.G.S.)
Runoff Areas : see map, A = 33.4 acres, B = 39.7 acres, C = 33.9 acres
Design charts : Utah Department of Transportation (UDOT) Roadway Drainage Manual
Frequency : 10 year return period
Precipitation Data : "Hiawatha" data by E. Arlo Richardson, State Climatologist

Determinations

Use UDOT small area runoff method, $Q = (Q_c)(LF)(FF)$

1 hour - 25 year rainfall = 0.78 in/hr.

From Table 2-05, K = 0.13

From chart 2-07, Q_c = 14.1 cfs for A
Q_c = 16.2 cfs for B
Q_c = 14.3 cfs for C

From Table 2-08, LF = 1.2

FF = Design/I_{25} = 2.25/2.60 = 0.87

$\Rightarrow Q = (14.1)(1.2)(0.87) = 14.7$ cfs for A
$Q = (16.2)(1.2)(0.87) = 16.9$ cfs for B
$Q = (14.3)(1.2)(0.87) = 14.9$ cfs for C

From computer printout
Use 18" CMP at 8% slope for each area.

Required headwater depth, UDOT chart 2-53
Hw = 43 inches or 30 inches over top of pipe

Check flows using Rational method
use runoff coefficient = 0.35
use 15 minutes for time of concentration flow
$\Rightarrow I_{15} = 1.24$ in/hr
$Q_A = (0.35)(1.24)(33.9) = 14.5$ cfs
$Q_B = (0.35)(1.24)(39.7) = 17.2$ cfs
$Q_C = (0.35)(1.24)(33.9) = 14.7$ cfs
} OK, close enough

Bear Canyon site Plan

culverts under access roadway (cont'd)

Find required ditch cross section:

use Manning equation, $Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$

for earth lined channel, $n = 0.035$

Try channel of 1:1 side slopes, 2' deep
Average slope of ditch = 6% ±

for slope shown, $P = 5\sqrt{2}$, $A = 4\ ft^2 \Rightarrow R = 0.71$

$Q = \frac{1.486}{0.035}(4)(0.71)^{2/3}(0.06)^{1/2} = 33.0$ cfs

Try channel of 1:1 side slopes, 1½ feet deep
$P = 3$, $A = 2.25\ ft^2 \Rightarrow R = 0.75$

$Q = \frac{1.486}{0.035}(2.25)(0.75)^{2/3}(0.06)^{1/2} = 19.3$ cfs, OK

$\Rightarrow$ use a ditch with 1:1 side slopes of least 1½ feet deep

Check size for 4% slope of ditch
Try 2 feet deep

$Q = \frac{1.486}{0.035}(4)(0.71)^{2/3}(0.04)^{1/2} = 27.0$ cfs, OK

STANDARD

475
965 (478.67)
1436

A

22
50 (25)
75

$\frac{478.67}{25} = \frac{640\ Ac}{X} = 33.43$ ACRES

B

27
58 (29.67)
89

$\frac{478.67}{29.67} = \frac{640\ Ac}{X} = 39.67$ ACRES

C

24
50 (25.33)
76

$\frac{478.67}{25.33} = \frac{640\ Ac}{X} = 33.87$ ACRES

UNIFORM FLOWS IN CIRCULAR CONDUITS PARTIALLY FULL HLW 8/5/83

DATA

n	SLOPE	Dia (in)	LIMIT
.023	.080000	18.0	.010000

DEPTH IS KNOWN; Velocity and flow are found

RESULTS

Q (cfs)	Q (gpm)	Q (MGD)	DEPTH (in)	VELOCITY (fps)	R	AREA sq in	ITER
16.84	7,558	10.88	18.0	9.53	0.3750	254	1

APPENDIX 7-F

MINE PLAN AREA HYDROLOGY

WATER AND SEDIMENT CONTROL STRUCTURES

CO-OP MINING CO.

P.O. Box 15809
Salt Lake City, Utah 84115
Phone (801) 467-4003

August 25, 1983

Dave Darby
Division of Oil Gas and Mining
4241 State Office Building
Salt Lake City, Utah 84114

RE: NOV N83-5-5-3, #2
NOV N83-5-5-2, #2
NOV N83-5-8-3, #3

Dear Mr. Darby;

As discussed in our meeting of Aug. 24, 1983, we have, with additional information furnished by Mr. Wimmer, prepared a map to reference the subject matter in the hydrologic calculations. Reference numbers have been assigned to the various existing and proposed hydrologic structures and areas referred to in the computations. These correspond to the numbers indicating the location on the map. We hope this will serve the purpose as requested.

All ditches will be constructed with a minimum of .3 foot freeboard in addition to the sizing recommended in Mr. Wimmers calculations. We are preparing a new corrected plate of the catch basin (pond B) indicating the rectangular shape and the minimum distance from the stream channel as we discussed in our meeting. This will be ready to send to you in a few days.

If you have any other questions concerning the hydrology, please call myself of call Mr. Wimmer direct.

Thank you;

Wendell Owen

Wendell Owen

HORROCKS & CAROLLO ENGINEERS
A JOINT VENTURE
ONE WEST MAIN
P. O. BOX 377
AMERICAN FORK, UTAH 84003

June 30, 1983

CO-OP MINING COMPANY

BEAR CREEK CANYON SITE PLAN

HYDROLOGICAL CERTIFICATION

I, Harold Lee Wimmer, do certify that I am a registered professional engineer, and that I hold certificate No. 3535 as prescribed under the laws of the State of Utah. I further certify that I have a Bachelor of Engineering Science Degree in Civil Engineering from Brigham Young University and a Master of Science Degree in Civil Engineering from the University of Southern California, with an emphasis on Hydrology. I further certify that by authority of the owners I have reviewed or performed the attached hydrology computations for the existing Bear Creek Canyon Site Plan and that said calculation and computations have been correctly performed in accordance with professional standards of practice relating to hydrology and that the conclusions contained herein are true and correct and represent use of current hydrologic and climatological information.

Harold Lee Wimmer

Harold Lee Wimmer, P.E.
Utah P.E. No. 3535

HORROCKS & CAROLLO ENGINEERS
A JOINT VENTURE
ONE WEST MAIN
P. O. BOX 377
AMERICAN FORK, UTAH 84003

July 8, 1983

Mr. Wendell Owen
Co-Op Mining Company
P.O. Box 1245
Huntington, Utah 84528

Subject: Bear Creek Canyon Mine Site
Hydrology Computations

Dear Mr. Owen:

As discussed with you in our meeting Monday, June 6, 1983, and subsequent discussions I have performed hydrologic calculations for sediment storage and runoff at the subject site and have the following results and conclusions:

1. The computed volume for sedimentation in Pond A (the larger pond) is 76,621 cubic feet. If the pond can be constructed 8' deep this would require a pond approximately 120 feet by 80 feet. If, however, the pond can only be constructed 6' deep it would require a pond of 140 feet by 91 feet. Pond B (the smaller pond) needs to have 9,309 cubic feet of storage and this pond could be 4' deep and approximately 50 feet by 50 feet.

2. Based on the calculations I would recommend that the downspout #1 (the upper downspout) be constructed to conform to the grade of the existing contours on the hillside and be constructed of 15" corragated metal pipe. Particular care should be paid to the construction of the inlet to this pipe as it will probably be subseptible to plugging from debris. The lower downspout should be constructed of 18" corragated metal pipe laid to conform to the existing ground contours.

3. The drainage berm or ditch to convey the water to the sediment pond for the "A" area could be constructed of a V-type ditch with one to one side slopes at least 1½ feet deep at a grade of 6%.

4. For the spillway needed on the sediment storage ponds, I would recommend an 18" riser pipe connected to an 18" CMP outlet pipe laid at a minimum of 6% slope.

Map reference numbers( ) *

Pond A (1)

Pond B (2)

Spout 1 (3)

Spout 2 (4)

(5)

(6)

* Map reference numbers are not part of the original work by Mr. Wimmer and have been added for clarification as required by the Division of O G M and with the consent of Mr. Wimmer. None of the text has been altered.

Reference #

5. The ditch to convey the water to the upper downspout could be constructed of a V-type ditch with one to one side slopes at least 1 foot deep at an average slope of 6%. A greater slope than 6% should be avoided to prevent errosion upstream of the downspout. If it is necessary to construct this channel at a greater slope, it should be riprapped or reinforced with Gabions to prevent errosion. (7)

The ditch to convey the water from the end of the upper downspout to the lower downspout can be constructed of V-type ditch with one to one side slopes at least 1½ feet deep. Again, this ditch will need to be riprapped if constructed at a greater slope than 6%. (8)

The area next to the 15" outlet from the 15" pipe will need to be riprapped to reduce the outlet velocity of 12.4 feet per second without creating errosion. This riprap should meet specifications for NCSA No. R-6 with an average partical size of 12", or by the use of Gabions. (9)

6. The capacity of the 10" culverts on the upper access road is 3.76 cubic feet per second when flowing full, which is adequate (10)

7. The capacity of the 12" culverts on the upper access road is 6.12 cubic feet per second when full, which is adequate. (11)

8. I have reviewed the calculations on the existing culverts which provided drainage for the undisturbed areas through the disturbed areas and find that the 18" culvert located near the middle of the plot plan on the north side of the stream is adequate to convey the flows with a minimum headwater over the top of pipe depth of 20". (12)

The existing 60" culvert in the mainstream channel is adequate to convey the flows with a minimum headwater depth of 84" over the top of the pipe. (13)

I have attatched to this letter my engineering calculations and backup reference data for your files.

If you desire clarification or have additional questions or need additional information please contact me.

Very truly yours,

HORROCKS ENGINEERS

H. Lee Wimmer

H. Lee Wimmer, P.E.
Hydrologist

HLW:map

Enclosures

Bear Canyon Site Plan

Sediment storage from disturbed area

For areas, 3 years COSMC regulations 817.46 (6)(c),
Soil ≈ 90 lbs/ft³

V_{A1} = (282.4)(2.24)(3)(2000/1)(1/90) = 42,172 ft³ *
V_{A2} = (69.4)(4.96)(3)(2000/1)(1/90) = 22,948 ft³
V_{A3} = (53.0)(3.51)(3)(2000/1)(1/90) = 12,402 ft³
V_{B} = (39.9)(1.79)(3)(2000/1)(1/90) = 4,761 ft³

* To high, this calculated figure is higher than will ever occur in practice because the soil type for this hillside would consist of large rocks and other particle sizes being larger also. I would recommend reducing this figure to the amount calculated for one (1) year, 14,057 ft³

⇒ For A1+A2+A3, sediment storage volume =
14,057 + 22,948 + 12,402 = 49,407 ft³ (1)

For B, sediment storage = 4,761 ft³ (2)

For Design Size Plan

Surface Runoff into Diversion around site

Design Data

Area : See previous table
Slope : " " "
Maximum Length : $L_1 = 450'$, $L_2 = 900'$, $L_3 = 1040'$, $L_4 = 320'$
Runoff Coefficient : 0.40
25Y-24hr Storm : Rainfall data by L. Arlo Richardson, State Climatologist

Determinations

Use Rational equation, $Q = CIA$
For Area A1 Use $T_c = 5$ min $\Rightarrow I_{max} = 2.76$ in/hr
For other Areas Use $T_c = 10$ min $\Rightarrow I_{max} = 2.10$ in/hr

$Q_{A1} = (0.40)(2.76)(2.24) = 2.47$ cfs

→ Use 15" CMP for downspout #2 — (3)

check Headwater depth - Use Chart 2-53
need H_w of 12 inches? OK

$Q_{A2} = (0.40)(2.10)(4.96) = 4.17$ cfs

Total Q @ downspout #2 = $Q_{A1} + Q_{A2} = 2.47 + 4.17 = 6.64$ cfs

→ Use 18" CMP for downspout #2 — (4)

$H_w = 20"$ or 2' with Top of pipe

$Q_{A3} = (0.40)(2.10)(\quad) = \quad$ cfs

Total Q for ditch = $Q_{A1} + Q_{A2} + Q_{A3} = 9.6$ cfs

Bear Canyon Site Plan

Ditch Size to convey runoff to downspouts

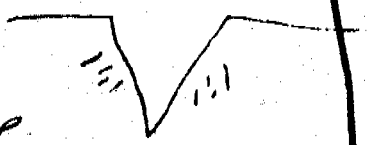
Design Data

As before, $Q_1 = 2.47$ cfs, $Q_2 = 6.64$ cfs

Calculations:

For ditch size to convey runoff to upper downspout use Manning Equation, $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

For earth lined channel, $n = 0.035$



Try channel of 1:1 side slopes, 1' deep
Try average slope of 6% ± (grades slope will probably cause erosion)

For slopes shown, $P = 2\sqrt{2}$, $A = 1.5 ft^2 \Rightarrow R = A/P = 0.35$

$Q = \frac{1.486}{0.035}(1)(0.35)^{2/3}(0.06)^{1/2} = 5.16$ cfs, ok

→ Use a ditch with 1:1 side slopes at least 1 foot deep with slope of 6% to channel runoff to upper downspout

(7)

Check need for riprap below downspout

(9)

(10)

outlet velocity = 12.9 ft/sec (see computer printout)

⇒ Need riprap NCSA No. R-6 (average particle size of 12 inches) or use Gabions

To convey runoff to lower downspout

→ Use a ditch with 1:1 side slopes at least 1½ feet deep with slope of 6%

(8)

Bear Canyon Site Flow

Surface runoff from undisturbed hillsides

Design Data:

Area : LA = 953 acres, LB = 21.4 acres
Average Elevation : (9,200 + 7,200)/2 = 8,200 feet (U.S.G.S.)
Design Charts : Utah Department of Transportation (UDOT) Roadway Drainage Manual
Flood Frequency : 20 year return period (Use 25)

Determinations:

Use UDOT Small area runoff method, $Q = (Q_c)(LF)(FF)$
1 hour - 25 year rainfall = 0.78 inches
From Table 2.05, K = 0.13
From chart 2.07, Q_c = 202 cfs for LA
Q_c = 10 cfs for LB
From table 2.08, LF = 1.2
FF = I_{design}/I_{25} = 1 for 25 year return period

$\Rightarrow Q = (202)(1.2)(1) = 242$ cfs for LA (60" CMP)
$Q = (10)(1.2)(1) = 12$ cfs for LB (18" CMP)

From computer print out
for 60" CMP full, Q_{max} = 261 cfs, OK

check headwater depth for 242 cfs (13)
UDOT chart 2.63
$\rightarrow$ Hw = 144 inches or 8'-0" over top of pipe

for 18" CMP full, Q_{max} = 22 cfs, OK (12)

check headwater depth for 12 cfs
$\rightarrow$ Hw = 38 inches or 20" over top of pipe

Lee Company Site Pond 1

Runoff Storage from disturbed area

Design Data
24 hour - 10 year storm : 2.25 inches

Determinations
CN = 30 ?, From Table 9.1, "SCS National Engineering Handbook", Section 4, "Hydrology"
Runoff from figure 10.1, in source as above = 0.7 inches

⇒ Volume of runoff in FT^3

(15) $V_{A1} = (2,24)(43,560)(0,7)(1/12) = 5,692\ FT^3$
(16) $V_{A2} = (4,96)(43,560)(0,7)(1/12) = 12,603\ FT^3$ } 27,214 FT
(17) $V_{A3} = (3,51)(43,560)(0,7)(1/12) = 8,919\ FT^3$
(18) $V_B = (1,79)(43,560)(0,7)(1/12) = 4,548\ FT^3$

⇒ Total Volume in ponds required for sediment and runoff:

Pond A = 49,407 + 27,219 = 76,621 FT^3 — (1)

Pond B = 4,761 + 4,548 = 9,309 FT^3 — (2)

Bear Canyon Site Plan

Sediment Storage from disturbed area

Design data

Size elevation : 7150 feet (U.S.G.S.)
Runoff Area : see 1"=50' map for individual areas
Average Slope length : see table below
Average slope gradient : " " "
6 hour - 10 year storm : 1.4 inches
Soil characteristics : 12% silt, 24% fine sand, 36% sand, 0% organic matter, course graded soil, moderate permeability

Table

Area #	Area* (acres)	Average slope length (feet)	Average slope gradient (%)
A1	2.24	420	36
A2	4.96	560	14
A3	3.51	640	11
B	1.79	520	10

(15) (16) (17) (18)

*B, Pine Tree

Determinations

Use Uniform Soil Loss Equation, $A = RKLSPC$

R: From Signal "Universal soil loss Equation", SCS Jan. 78
Use R = 40

K: From "A soil erodability nomograph ...", where silt plus % fine sand = 36%, % sand = 36%
K = 0.32

LS: From Table 1, "Universal soil loss Equation", SCS ... Use (See table above) For A1, LS = 22.06
A2, LS = 5.42
A3, LS = 4.14
B, LS = 3.12

C: Assume bare ground, use C = 1
P: Assume no erosion control, use P = 1

$\Rightarrow A_{A1} = (40)(0.32)(22.06)(1)(1) = 283.8$ tons/acre/year
$A_{A2} = (40)(0.32)(5.42)(1)(1) = 69.7$ " " "
$A_{A3} = (40)(0.32)(4.14)(1)(1) = 53.0$ " " "
$A_B = (40)(0.32)(3.12)(1)(1) = 39.9$ " " "

Bear Canyon Site Plan

Surface runoff into diversions around site (cont.)

For required ditch cross section area, use Manning equation, $Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

For earth lined channel, $n = 0.035$

Try channel of 1:1 side slopes, 2' deep
Average slope of ditch 6%+

For slope shown, $P = 2\sqrt{8}'$, $A = 4 ft^2 \Rightarrow R = 0.71$

$Q = \frac{1.486}{0.035}(4)(0.71)^{2/3}(0.06)^{1/2} = 33.0$ cfs

Try channel of 1:1 side slopes, 1½ feet deep, $P = 3$, $A = 2.25 ft^2$
$\Rightarrow R = 0.75$

$Q = \frac{1.486}{0.035}(2.25)(0.75)^{2/3}(0.06)^{1/2} = 19.3$ cfs, ok

→ Use a ditch with 1:1 side slopes at least 1½ feet deep (19)

- - - - -

For spillway on sediment storage pond,

Use an 18" riser and 18" CMP outlet pipe at 6% grade ±

$\Rightarrow Q = 13.97$ cfs ok (6)
(See computer printout)

The culvert crossing the road conveying the drainage from disturbed area B will need to carry a volume of 2 cfs. The existing 15" culvert is adequate.

Prepared under the direction of
Harold Wimmer, Professional Engineer
by Wendell Owen

Wendell Owen

Bear Canyon Site Plan

culverts under access roadway (A-B)

Find required ditch cross section:

use Manning equation, $Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$

for earth lined channel, $n = 0.035$

Try channel of 1:1 side slopes, 2' deep
Average slope of ditch = 6% ±

for slope shown, $P = 2\sqrt{8}$, $A = 4 ft^2 \Rightarrow R = 0.71$

$Q = \frac{1.486}{0.035}(4)(0.71)^{2/3}(0.06)^{1/2} = 33.0$ cfs

Try channel of 1:1 side slopes, 1½ feet deep
$P = 3$, $A = 2.25 ft^2 \Rightarrow R = 0.75$

$Q = \frac{1.486}{0.035}(2.25)(0.75)^{2/3}(0.06)^{1/2} = 19.3$ cfs, OK

$\Rightarrow$ use a ditch with 1:1 side slopes at least 1½ feet deep — (20)

check size for 4% slope of ditch
Try 2 feet deep

$Q = \frac{1.486}{0.035}(4)(0.71)^{2/3}(0.04)^{1/2} = 27.0$ cfs, OK

COOP MINE 7/6/33 KDB PLANIMETER AREAS OF RUNOFF

STANDARD:

463
945 469.67 PER SQ. MILE
1409

AREA A

692
1390 699.33 $\frac{699.33}{x} = \frac{469.67}{27,878,400 \text{ s.f.}}$ = 41,510,425.34 S.F. =
2098

952.95 ACRES

AREA B

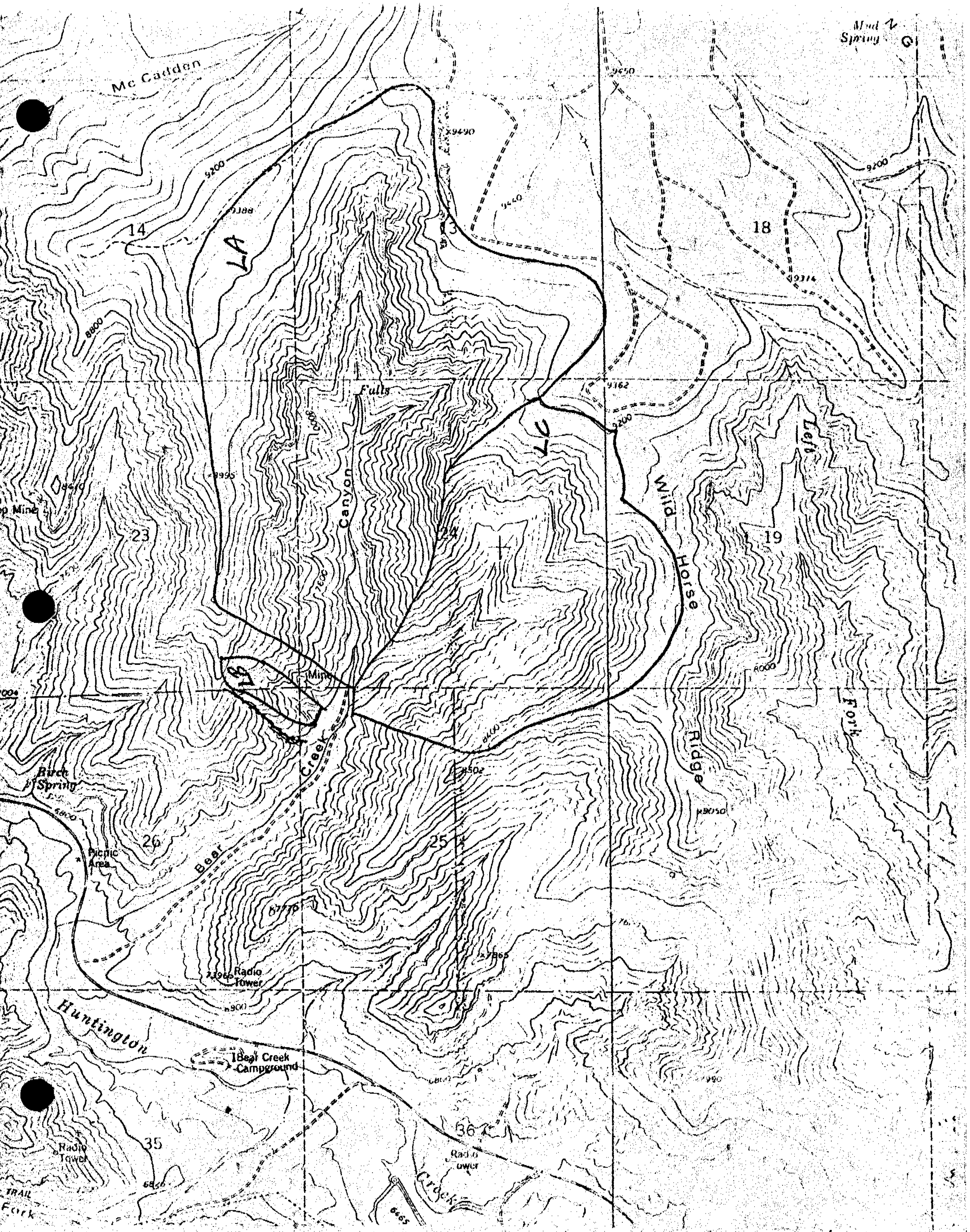
13
30 15.67 $\frac{15.67}{x} = \frac{469.67}{27,878,400 \text{ s.f.}}$ = 930,130.79 S.F. =
47

21.35 ACRES

AREA C

341
691 353.00 $\frac{353}{x} = \frac{469.67}{27,878,400 \text{ S.F.}}$ = 20,953,169.67 S.F. =
1059

481.02 ACRES


Mc Caddan
Mud Spring
14
13
18
LA
LC
LB
Falls
Canyon
Wild Horse Ridge
Left Fork
23
24
19
Mine
Birch Spring
Bear Creek
26
25
Picnic Area
Radio Tower
Huntington
Bear Creek Campground
35
36
Radio Tower
TRAIL
Fork
Creek
9200
8800
9490
9388
9440
9650
9162
9995
9374
9050
8600
8502
7865
7770
7966

```
10   IMAGE /,"UNIFORM FLOWS IN CIRCULAR CONDUITS PARTIALLY FULL          HLW  7/8
/83 ",2/
20   PRINTER IS 0
21   PRINT ""
30   PRINT USING 10
40   INPUT "PRINTER IS (0=Paper, 16=CRT)",Cd
50   PRINTER IS Cd
60   INPUT "DO YOU NEED INSTRUCTIONS? (1=YES)",W
70   IF W=1 THEN Teach
80   RAD
90   N=S=E=Dia=D=R=A=Q=0
100  INPUT "ENTER n",N,"ENTER SLOPE",S,"ENTER ERROR LIMIT",E
110  INPUT "ENTER DIAMETER (INCHES)",Dia
120  Ra=Dia/24
130  PRINT "      DATA"
140  IMAGE "       n      SLOPE     Dia (in)      LIMIT ",/,5X,.DDD,2X,D.D5
D,4X,DDD.D,6X,.6D,2/
150  PRINT USING 140;N,S,Dia,E
160  ON KEY #0,6 GOSUB Know_d
170  ON KEY #1,5 GOSUB Know_v
180  ON KEY #2,4 GOSUB Know_q
190  ON KEY #3,3 GOTO 90
200    DISP "ON KEY #0=known Depth; #1=known V; #2=known Q; #3=NEW DATA
IS WAITING"
210  K=1
220  GOTO 200
230  STOP
240 Know_d: WAIT 30
250  INPUT "ENTER DEPTH (inches)",D
260  IF D<=Dia THEN 310
270  DISP "         DEPTH > DIAMETER !!"
280  BEEP
290  WAIT 2000
300  GOTO 110
310  D=D/12
320  Theta=2*ACS(1-D/Ra)
330  REM                          Theta IS INTERIOR ANGLE
340  A=(Theta-SIN(Theta))*Ra^2/2
350  R=A/(Theta*Ra)
360  Q=1.49/N*A*R^(2/3)*S^.5
370  V=Q/A
380  Qgpm=Q*448.86
390  PRINT USING 400
400  IMAGE "      DEPTH IS KNOWN; Velocity and flow are found  ",/
410  IF V>10 THEN PRINT USING 500
420  GOTO 1230
430  STOP
440  REM                                  START TO FIND Max. DEPTH OF FLOW
450 Know_v:  K=1
460  INPUT "ENTER VELOCITY (fps)",V
470  PRINT USING 480
480  IMAGE "     VELOCITY IS KNOWN; Depth and flow are found",/
490  IF V>10 THEN PRINT USING 500
500  IMAGE "     VELOCITY EXCEEDS RANGE OF MANNING'S EQUATION"
510  Di=Dia/12
520  REM                                      Di = Diameter IN FEET
530  R=(V*N/(1.49*S^.5))^1.5
540  V1=1.10*1.49/N*(Ra/2)^(2/3)*S^.5
550  REM       (1.10) is factor to account for greater capacity at (0.9) depth
560  IF V>V1 THEN GOTO 690
570  Theta=2.2
580  IF R/Di-.25=0 THEN 770
590  K1=1/(4*(R/Di-.25))
600  GOSUB Fn_o
610  GOSUB Fn_1
620  T=Theta-Fo/Fo1
630  IF T<E^8 THEN 690
```

```
640   Er=ABS((Theta-T)/T)
650   IF (Er<E) OR (K>900) THEN GOTO 740
660   Theta=T
670   K=K+1
680   GOTO 600
690   PRINT USING 700
700   IMAGE /,"VELOCITY INPUT IS HIGHER THAN HYDRAULIC CAPACITY"
710   GOTO 460
720   REM                                  END ITERATIVE LOOP
730   REM                                    DISPLAY OUTPUT
740   A=(T-SIN(T))*Ra^2/2
750   Q=V*A
760   GOTO 1220
770   BEEP
780   DISP "DIVISION BY ZERO"
790   WAIT 500
800   V=V-.01
810   GOTO 530
820   REM                                  F (Theta)
830 Fn_o:  Fo=Theta+K1*SIN(Theta)
840   RETURN
850   REM                                  F' (Theta)
860 Fn_1:   Fo1=1+K1*COS(Theta)
870   RETURN
880   REM                                          START TO FIND DEPTH
890 Know_q:  K=1
900   INPUT "WHAT FLOW UNITS: 1=cfs  2=gpm  3=MGD",Fo
910   ON Fo GOTO 990,960,1010
920   GOTO 900
930   PRINT USING 940;Q
940   IMAGE /,5X,"Q INPUT,",4DZ.D,",IS GREATER THAN HYDRAULIC CAPACITY"
941   BEEP
942   WAIT 1500
950   GOTO 900
960   INPUT "ENTER Q (gpm)",Q
970   Q=Q/448.86
980   GOTO 1030
990   INPUT "ENTER Q (cfs)",Q
1000  GOTO 1030
1010  INPUT "ENTER Q (MGD)",Q
1020  Q=Q/.646317
1030  Theta=PI
1040  REM                                 START ITERATIVE LOOP
1050  T=SIN(Theta)+2*Theta^.4*(Q*N/(1.49*S^.5*Ra))^.6/Ra
1060  Er=ABS((Theta-T)/T)
1070  IF (Er<E) OR (K>900) THEN 1110
1080  Theta=T
1090  K=K+1
1100  GOTO 1050
1110  Q1=1.02*1.49/N*(Ra/2)^(2/3)*S^.5*PI*Ra^2
1120  REM      (1.02) is factor to account for greater capacity at (0.9) depth
1130  IF Q>Q1 THEN GOTO 930
1140  REM                                   END ITERATIVE LOOP
1150  REM                                       OUTPUT
1160  PRINT USING 1170
1170  IMAGE "      FLOW IS KNOWN; depth and velocity are found  ",
1180  A=(T-SIN(T))*Ra^2/2
1190  V=Q/A
1200  IF V>10 THEN PRINT USING 500
1210  R=(V*N/(1.49*S^.5))^1.5
1220  D=Ra*(1-COS(T/2))
1230 PRINT "     RESULTS                    DEPTH   VELOCITY          AREA"
1240 PRINT " Q (cfs)   Q (gpm)  Q (MGD)   (in)     (fps)     R
sq in ITER"
1250 PRINT USING 1260;Q,Q*448.86,Q*.646317,D*12,V,R,A*144,K
1260 IMAGE DDDDZ.DD,3X,3DC3D,X,4DZ.DD,2X,DDZ.D,5X,DDZ.DD,2X,Z.4D,3X,4D,4D,2/
1270 RETURN
1280 STOP
```

```
1290 Teach:  PRINT TAB(20),"INSTRUCTIONS "
1300   PRINT "MANNING'S EQUATION IS USED TO FIND UNIFORM FLOWS IN CIRCULAR"
1310   PRINT "CONDUITS WHERE THE WATER SURFACE MAY BE AT ANY DEPTH BETWEEN"
1320   PRINT "ZERO AND THE DIAMETER.  SPECIAL FUNCTION KEYS ARE USED TO,"
1330   PRINT "PROVIDE ADDED FLEXIBILITY IN USING THE THREE PROGRAMS AVAILABLE:"
1340   PRINT "      1. V  and  Q   ARE UNKNOWN"
1350   PRINT "      2. Depth and Q ARE UNKNOWN"
1360   PRINT "      3. Depth and V ARE UNKNOWN"
1370   PRINT
1380   PRINT "PROGRAMS REQUIRE KNOWN MANNING'S n, SLOPE, PIPE DIAMETER,"
1390   PRINT "AND AN ERROR LIMIT FOR USE IN ITERATIVE SOLUTIONS (typical"
1400   PRINT "value is 0.0001)."
1410   PRINT
1420   PRINT "THE PROGRAMS ALLOW DATA TO BE OUTPUT ON EITHER THE CATHODE "
1430   PRINT "RAY TUBE, THE INTERNAL PRINTER, OR OTHER PRINTER.  "
1440   PRINT "WHEN THE PROGRAM CALLS FOR DATA OR A DECISION, ENTER THE "
1450   PRINT "DESIRED NUMBER AND PRESS THE 'CONT' KEY.  WHEN 'ON KEY'"
1460   PRINT "IS DISPLAYED, THE USER MAY TRANSFER TO THE DESIRED AREA "
1470   PRINT "OF THE PROGRAM BY PRESSING SPECIAL FUNCTION KEY ko, k1, k2,"
1480   PRINT "OR k3.  "
1490   PRINT
1500   PRINT "THE FOLLOWING DATA IS OUTPUT IN ENGLISH UNITS:"
1510   PRINT "Q (flow), FLOW DEPTH, AVERAGE VELOCITY, HYDRAULIC RADIUS, "
1520   PRINT "AREA OF THE FLUID CROSS SECTION, AND NO. OF ITERATIONS "
1530   PRINT "PERFORMED IN SOLVING THE PROBLEM."
1540   PRINT
1550   PRINT "WHEN FINISHED, PRESS THE 'STOP' KEY, REWIND THE DATA CARTRIDGE"
1560   PRINT "BY PRESSING KEY k7, AND WHEN REWOUND, EJECT THE DATA CARTRIDGE "
1570   PRINT "BY PRESSING THE EJECT BAR."
1580   GOTO 80
1590   STOP
1600   END
```

HORROCKS & CAROLLO ENGINEERS
A JOINT VENTURE
ONE WEST MAIN
P. O. BOX 377
AMERICAN FORK, UTAH 84003

October 14, 1983

Mr. Wendell Owen
Co-op Mining Company
P.O. Box 1245
Huntington, Utah 84528

Subject: Bear Creek Mine Site
Sedimentation Ponds

Dear Mr. Owen:

Following the mine site visit with yourself on Thursday, September 29, 1983 and our measurements of the existing large sedimentation pond; I have reviewed previously performed hydrologic calculations for the sediment storage and runoff at the subject site and offer the following results and conclusions:

1. Previously I computed the required volume for sedimentation in pond A (the larger pond) to be 76,621 cubic feet (see letter of July 8, 1983). In discussing this matter with John Whitehead of DOGM, today's date, Mr. Whitehead informed me that his calculations would require the sedimentation pond to contain 84,158 cubic feet or approximately 9% more than I calculated. It probably requires less effort and expense to increase the pond size to accommodate the 84,158 cubic feet calculated by Mr. Whitehead, rather than try to convince DOGM that 76,621 cubic feet is an acceptable figure.

2. I have computed the capacity of the existing sedimentation pond to be 49,200 cubic feet (to the point of overflowing at the overflow spillway). This would be after the removal of 13,200 cubic feet of sediment now existing in the pond bottom.

3. To achieve a capacity of 84,158 cubic feet with the existing dike embankments would require that the embankments be raised to a uniform elevation nine feet above the bottom of the pond when the existing sediment is removed, in addition an additional foot of embankment should be placed to provide for "freeboard".

4. If constructing the dikes to this elevation is not feasible, additional capacity can be acquired by enlarging the basin to the west and the north, which is excavation in original ground. However, from my site visit, this area appears to contain large boulders and would probably be difficult to excavate.

5. Also required is raising the spillway elevation to correspond to the increased capacity. It would be my recommendation that the existing spillway be filled in and that a spillway consisting of a corregutated metal pipe drop structure and outlet pipe with an oil skimming device be installed to comply with DOGM regulations, and also requirements of the Utah State Department of Health, Bureau of Environmental Health.

6. An 18" riser pipe connected to an 18" CMP outlet laid at a minimum slope of 6% would be of adequate capacity for the outlet structure. If this option is chosen, I would recommend that a cutoff collar be installed on the pipe where the pipe would pass through the existing embankment.

7. The sedimentation pond dikes are constructed of native aluvial material, bulldozed into place and shaped in a somewhat irregular fashion. Although the dike sections contain larger rocks than would be normally recommended, the dikes have been in place for several years and are stable. The top width of the dikes varies from 12 to 18 feet.

8. If the dikes are raised to accommodate the additional capacity required; it is recommended that during construction the larger rock particles be worked to the outside of the dike; the material be moistened to optimum moisture content, and compacted to 95% of the lab density. In addition it is recommended that the slope of the east dike be flattened or that the toe of the east dike flow be buttressed as indicated on the attached sketch "A".

I have attached to this letter my engineering drawings on the sedimentation pond and other backup reference data for your files.

If you desire clarification, have additional questions, or need additional information, please contact me.

Very truly yours,

HORROCKS & CAROLLO ENGINEERS

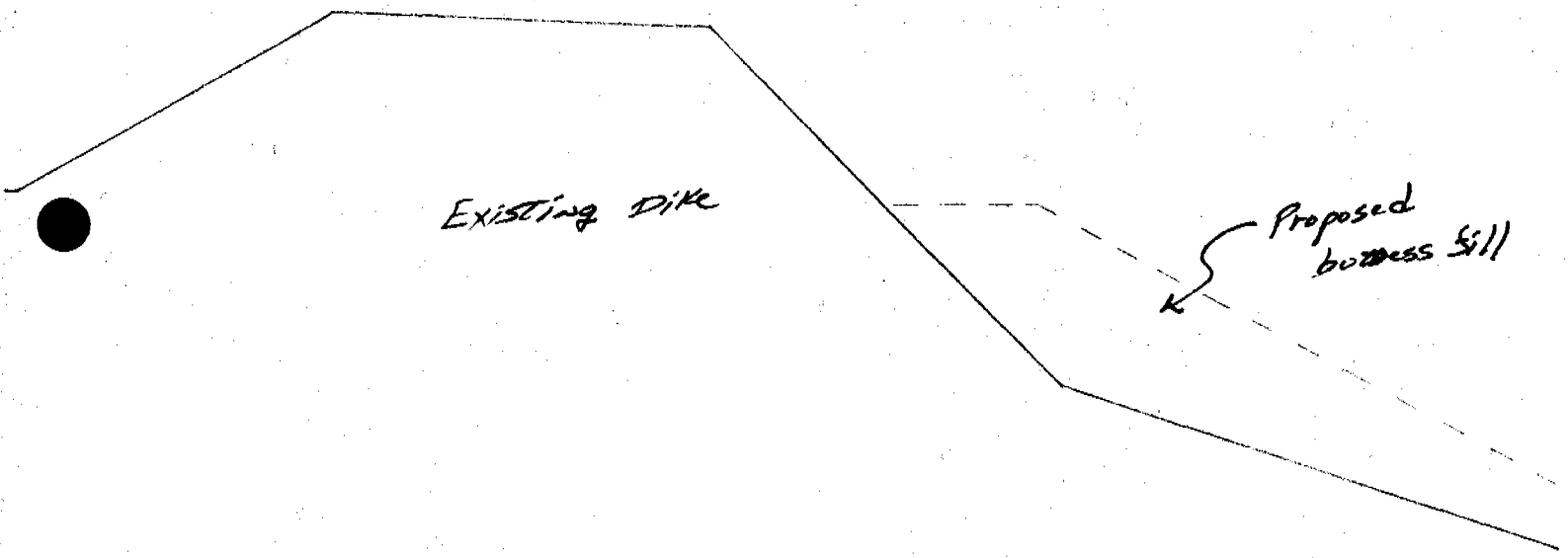
H. Lee Wimmer

H. Lee Wimmer, P.E.
Professional Engineer

REGISTERED PROFESSIONAL ENGINEER
No. 3535
HAROLD LEE WIMMER
STATE OF UTAH

lh
Enclosures

Figure 7-F '1' Pond "A"



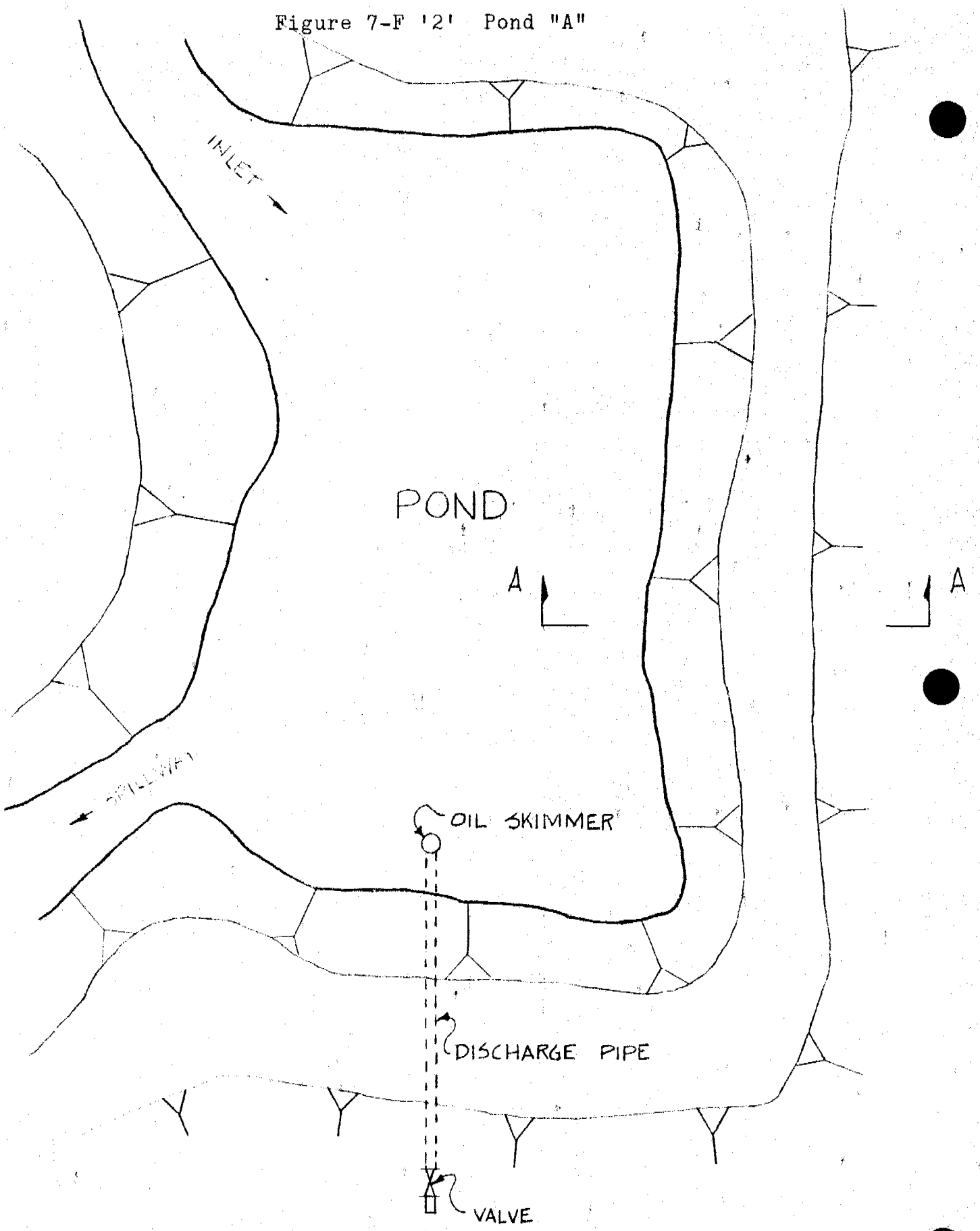
SCALE: 1" = 6'-0"

Section A-A

SKETCH "A"

CO-OP Mine

Figure 7-F '2' Pond "A"



Scale: 1"=20'

Co-Op Mine
Sedimentation Pond "A"

ENGINEERS

Project Name Loop Mine Date 10/6/83

Project No. Station or Pit Location

Sample No #1 (COAL PARTICLES) Requisted by HLW

2 sediment in pond

AS RECEIVED GRADATION

Screen Size	Weight (a)	Percent Retained	Percent Passing	SPECS.
3"				
2"				
1"	0	0	100%	
3/4"	63.0	0.8	99.2	
1/2"	914.7	1.2	98.1	
~~3/8"~~				
#4	319.8	3.9	94.1	
Wet Wt. ~~#4~~				
Dry Wt. #4	7654.4	94.1		
Total Wt Dry	8131.9			

WASHED GRADATION AFTER CRUSHING (2500 GM. DRY SAMPLE)

Screen Size	Weight Retained	Percent Retained	Percent Passing	Total % Passing	SPECS.
#8	126.3	8.5	91.5	18.3	
#10	37.6	2.5	89.0	16.8	
#16	121.7	8.2	80.8	16.3	
#20	79.7	5.4	75.5	14.8	
#30	60.4	4.1	71.4	13.8	
#40	67.1	4.5	66.9	13.1	
#50	95.8	6.4	60.5	12.3	
#100	328.3	22.0	38.4	11.1	
#200	113.2	7.6	30.8	7.0	
-#200	459.0	30.8	0		
Total Wt	1489.1				

Wt. before washing

Wt. after washing

MOISTURE DETERMINATION	-#4
Container & Wet Soil Weight (gm.)	
Container & Dry Soil Weight (gm.)	
H_2O Loss	
% Moisture	

A.A.S.H.O Classification

COPIES TO:

Tested by KIRK D. BEECHER

ENGINEERS

Project Name Coop Mine Date 10/6/83

Project No. _____ Station or Pit Location _____

Sample No #2 Requisted by: HOW

Native material, Pond dikes

AS RECEIVED GRADATION

Screen Size	Weight (g)	Percent Retained	Percent Passing	SPECS.
3"				
2"	0	0	100%	
1½"	1132.1	14.0	86.0	
3/4"	875.8	10.9	75.1	
1/2"	466.8	5.8	69.3	
3/8"				
#4	1112.1	13.8	55.6	
Wet Wt. -#4				
Dry Wt. -#4	4483.1	55.6		
Total Wt Dry	8069.9			

WASHED GRADATION AFTER CRUSHING (2500 GM. DRY SAMPLE)

Screen Size	Weight Retained	Percent Retained	Percent Passing	Total % Passing	SPECS.
#8	141.7	8.9	91.1	19.7	
#10	31.1	2.0	89.1	17.9	
#16	69.8	4.4	84.7	17.5	
#20	40.7	2.6	82.2	16.7	
#30	31.8	2.0	80.1	16.2	
#40	47.9	3.0	77.1	15.8	
#50	91.4	5.8	71.4	15.2	
#100	350.3	22.1	49.3	14.0	
#200	146.4	9.2	40.1	9.7	
-#200	635.7	40.1	0		
Total Wt.	15868				

Wt. before washing _____

Wt. after washing _____

MOISTURE DETERMINATION

	-#4
Container & Wet Soil Weight (gm.)	
Container & Dry Soil Weight (gm.)	
H_2O Loss	
% Moisture	

A.A.S.H.O Classification

COPIES TO:

Tested by KIRK D. BEECHER

CO OP MINING
BEAR CANYON
CATCH BASIN
NOT SCALED

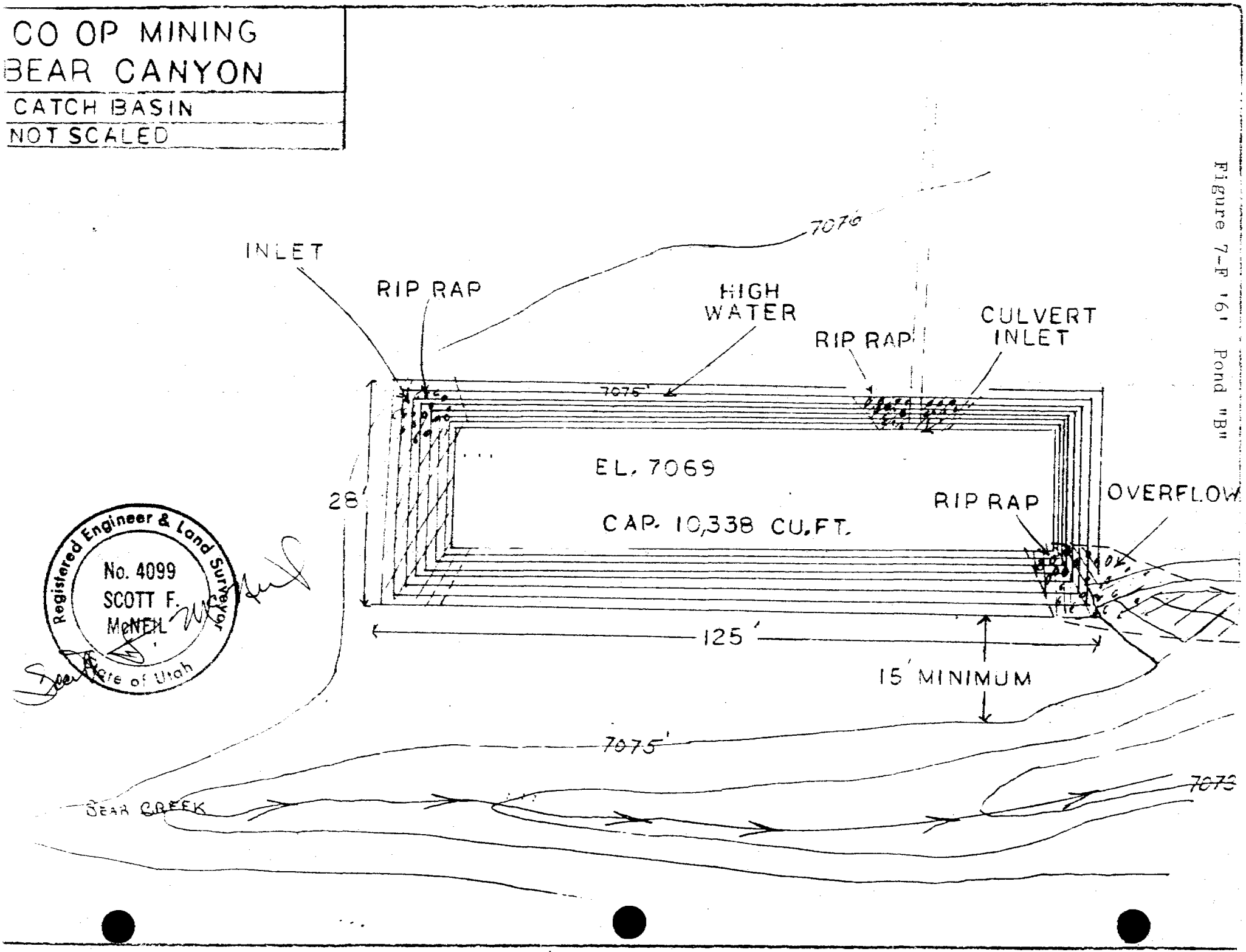


Figure 7-F '6' Pond "B"

APPENDIX 7-G

60" Culvert

UMC 817.43 Hydrologic Balance: Diversions and Conveyance of Overland Flow, Shallow Ground Water Flow and Ephemeral Streams

As mentioned in the May 5th letter, sizing calculations should be submitted for the small culvert crossing under the road for the disturbed drainage east of the catch basin.

(b) Conservative calculations performed by the Division show that the peak runoff of a 10-year, 24-hour event in Bear Creek Canyon would be 197 cubic feet per second (cfs). The transmission of a 60 inch concrete culvert with a headwall of one is 130 cfs. Co-op will be required to increase the headwall at the culvert entrance to 1½, i.e., the embankment above the top of the culvert should be at least 30 inches.

CO-OP REPLY:

(a) The firm of Horrocks & Carollo Engineers, have done a thorough review of the hydrology of the entire area. Their report is attached in appendix A Sizing calculations are attached.

(b) The Co-op is committed to 84 inches of fill

above the 60 inch culvert. Culvert location is shown on Plate 7-2. Complete hydrologic calculations Appendix 7-F.

CROSS SECTION - NATURAL DRAINAGE

SITE OF 60" CULVERT BEFORE INSTALLATION

PRE-CULVERT INSTALLATION CROSS SECTION

BEAR CREEK

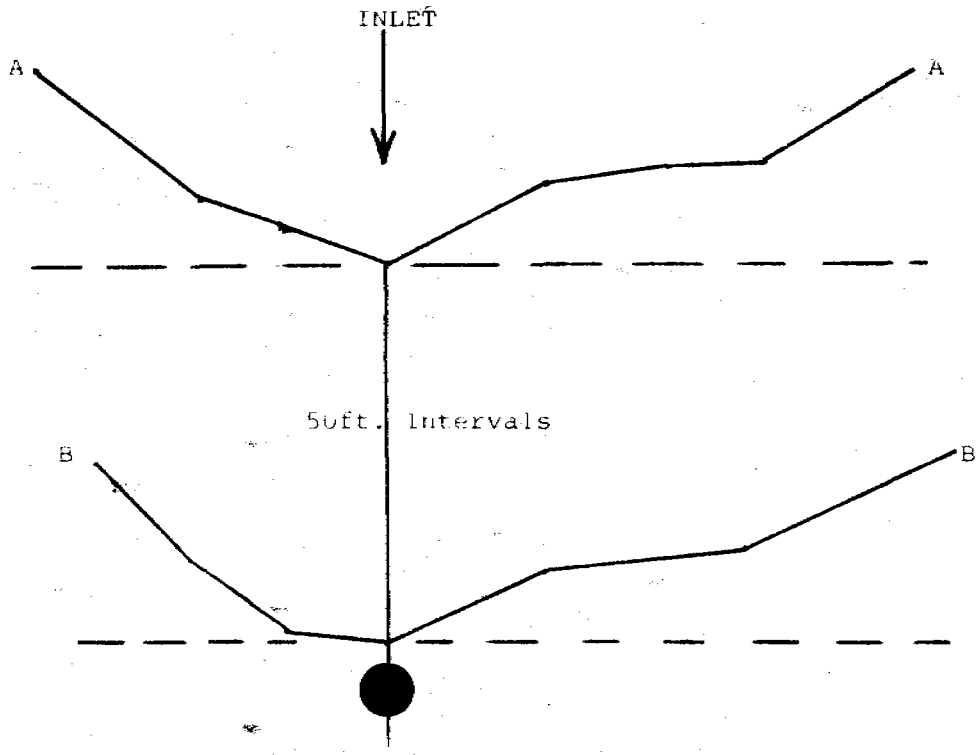
CO-OP MINING COMPANY

MAY 31,1983

N

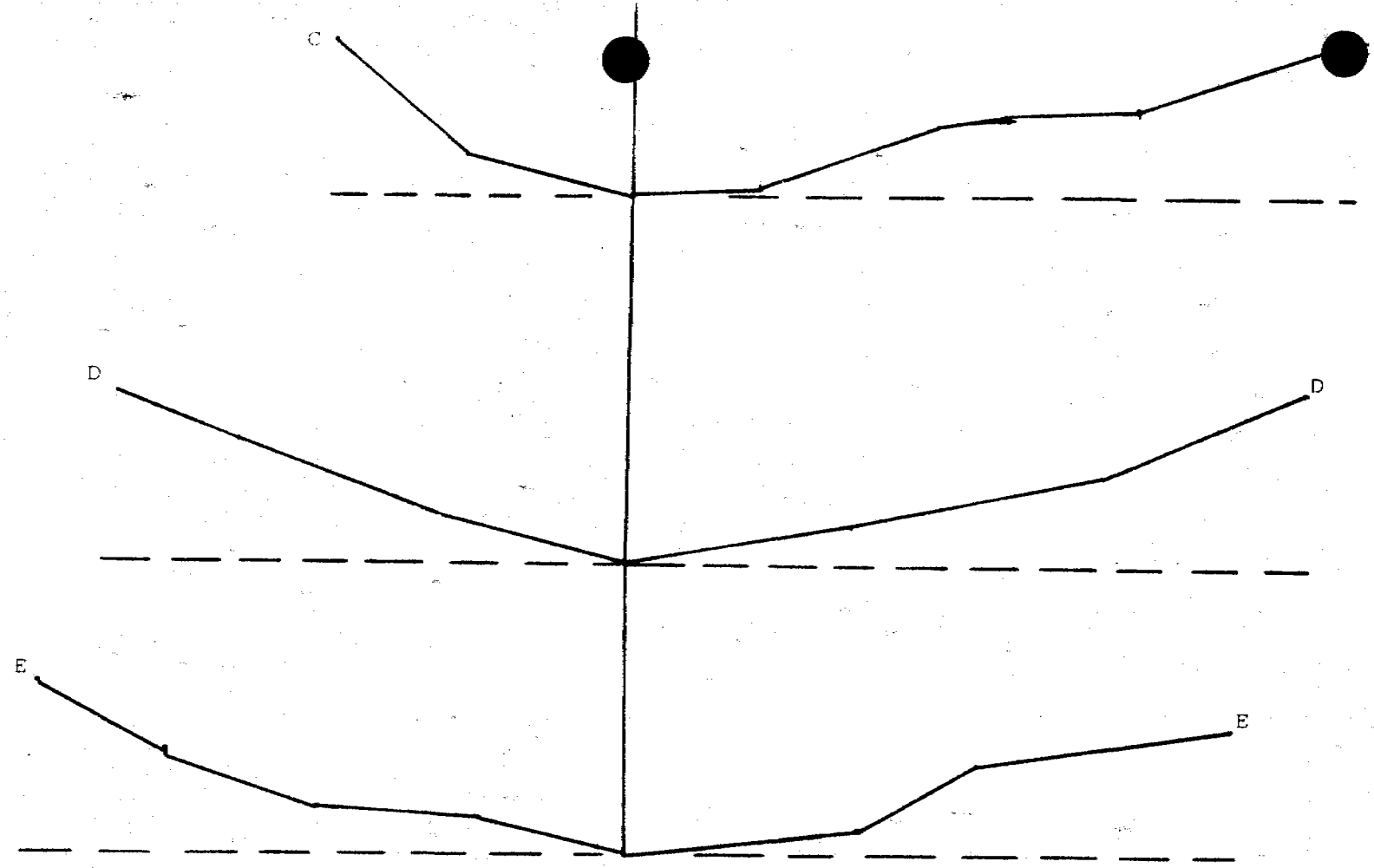
NORTH END ELEVATION (COMPARITIVE)

100.00 ft.



JOB NO. .....

CHKD. BY .....DATE .....

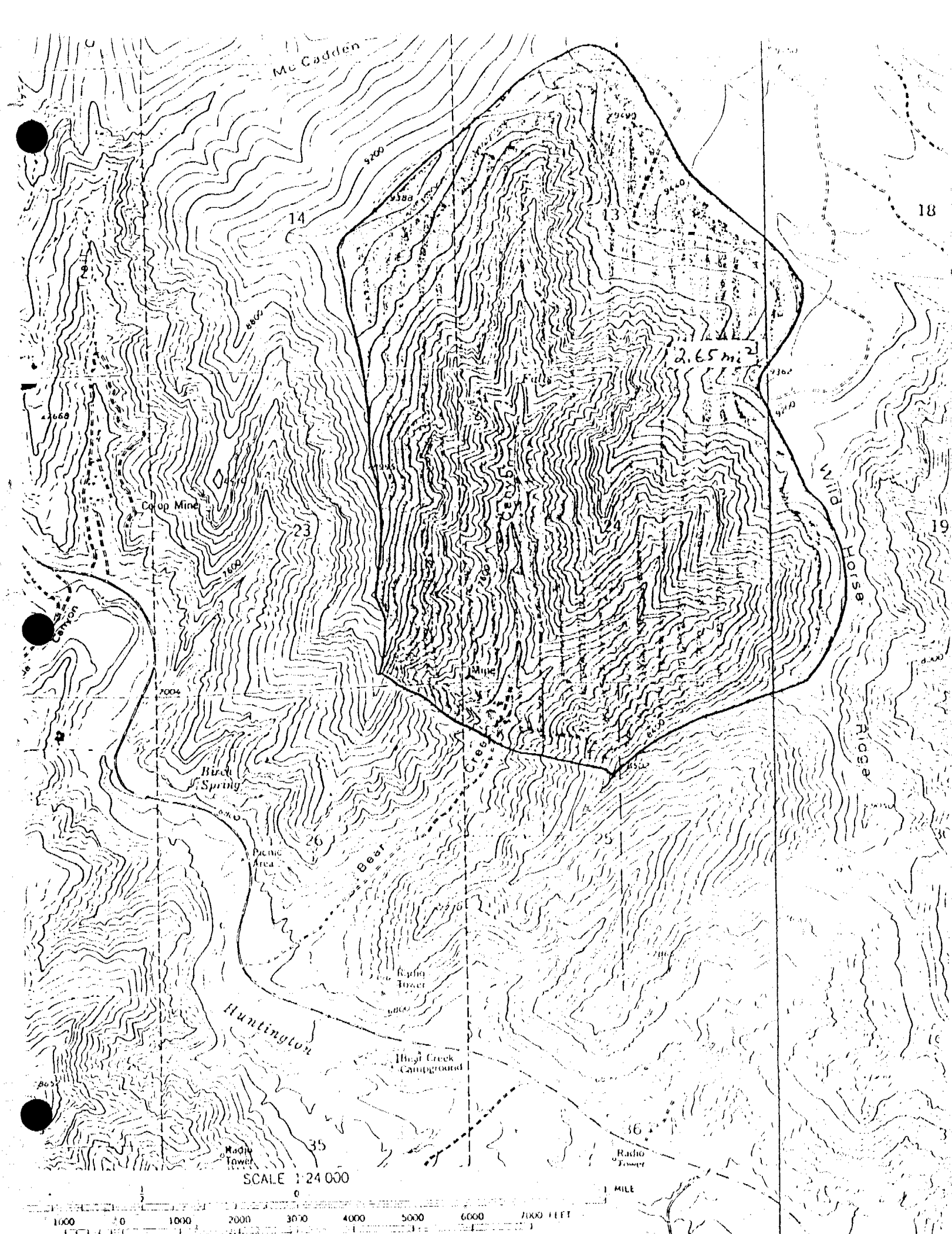


SOUTH END ELEVATION (COMPARATIVE)

93.09 ft.

3.4% DROP in 100 ft.

SCALE IN BOTH PLANES: 1in. to 10 f


McCadden
14
13
18
2.65 mi²
Wild Horse
Ridge
Coop Mine
23
24
19
Canyon
Mine
Creek
Bird
Spring
Picnic
Area
26
25
Bear
Radio
Tower
Huntington
High Creek
Campground
35
36
Radio
Tower
SCALE 1:24 000
MILE
1000
0
1000
2000
3000
4000
5000
6000
7000 FEET

UMC 817.44 Hydrolgic Balance: Stream Channel Diversions

The methodology which the Co-op Mining Co. contemplates implementing upon final abandonment and reclamation of that portion of Bear Creek in the vacinity of the Scale house are as follows:

1. To use a large track mounted excavator in conjunction with a small backhoe and crawler tractor to remove the 60' culvert and to regrade the opposing banks on approximately a 3 to 1 slope to facilitate revegetation and to enhance the establishment of a riparian zone. (Note fig. 1 for the present stream configuration and projected after reclamation).
2. To construct small holding ponds along the channel utilizing native materials. The actual methodology is to incorporate 2 logs approximately 10 to 14" in diameter, trench into the bank back approximately 10' on both sides of the creek channel, secure the logs together in a stacked manner with 36" anchor bolts, buried for approximately 10 feet with approximately 36" of fill material decreasing to 0" as the stream channel is

approached. An 18" wide by 5" deep notch cut along the top of the upper log in the center of the creek channel, to create a centralized spillway. Once the logs are secured into the channel, rock rip-rap should be laid on the up stream side to a height equal to the height of the log retainer and continued up stream for a distance of 36" decreasing in height so as to be level with the original rip-rapped channel. Then by utilizing a backhoe, a pit approximately 3' in diameter should be dug at the fall line of the spillway and lined with large rock 2' +. The log-pond configuration should be repeated at approximately 50' intervals along the course of the creek channel to create a stepped configuration along the area of disturbance.

The intent of the holding ponds created by the log-rock dam is to fill with sediment and minimize the down stream migration of this potentially detrimental sourse of silt and convert it into a potentially beneficial, enriched, growth media to facilitate the enlargement and establishment of riparian vegetation. Over a course of time the water holding capability of the ponded area will decrease as the ponds fill with

sediment, however, the small ponds at the base of the spillway should remain relatively free from sediment and due to the small surface areas and depth, they will hold water over an extended period during dry seasons. A diagram is attached for your review. (see Fig. 2) The methodology is one which has been successfully implemented by myself on various areas to facilitate both water holding and enhancement of riparian zones and has been proven successful.

UMC 817.44 Paragraph 2

A 93-R and a 404 permit have been applied for, a copy of the approvals will be forwarded to your office on our receival.

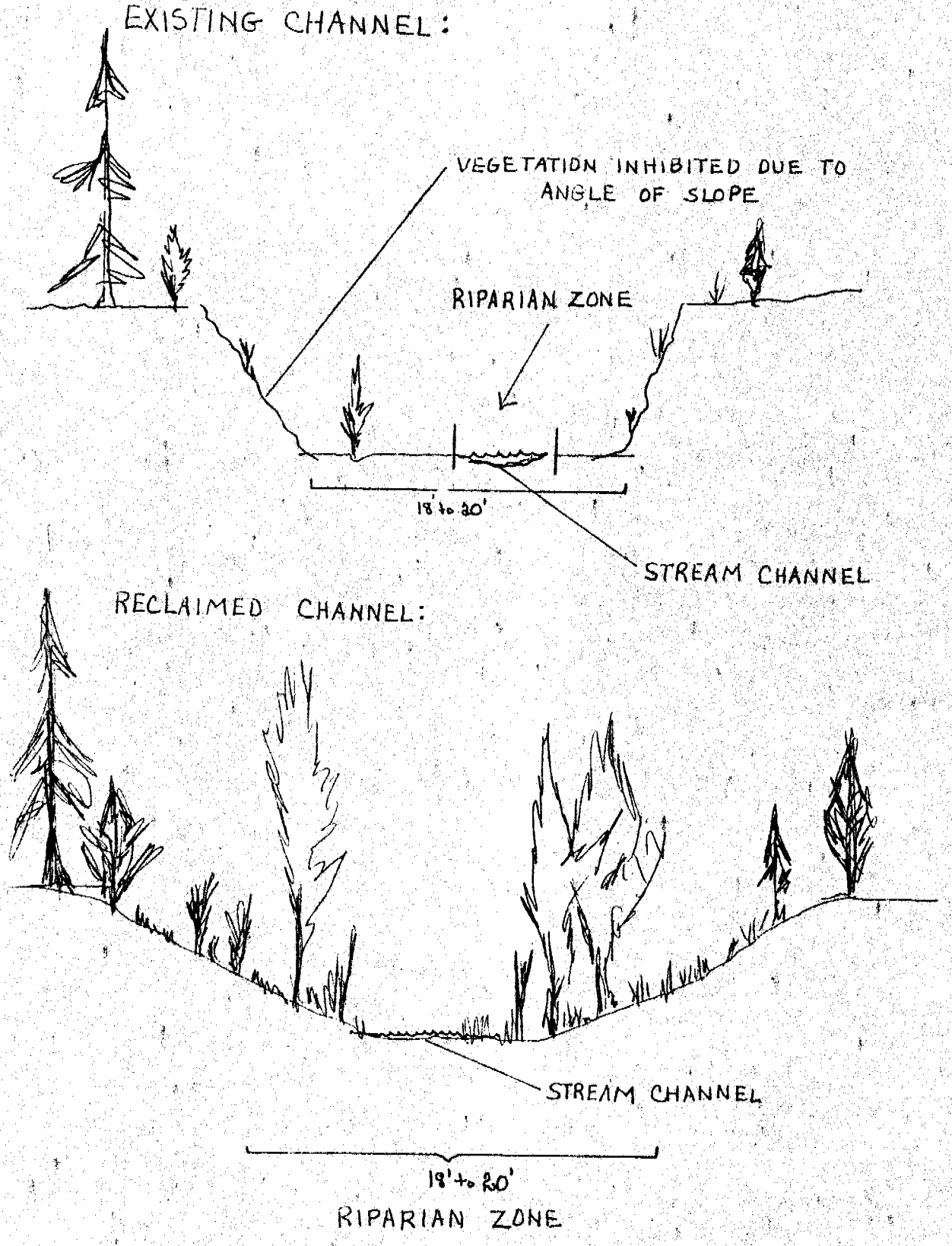
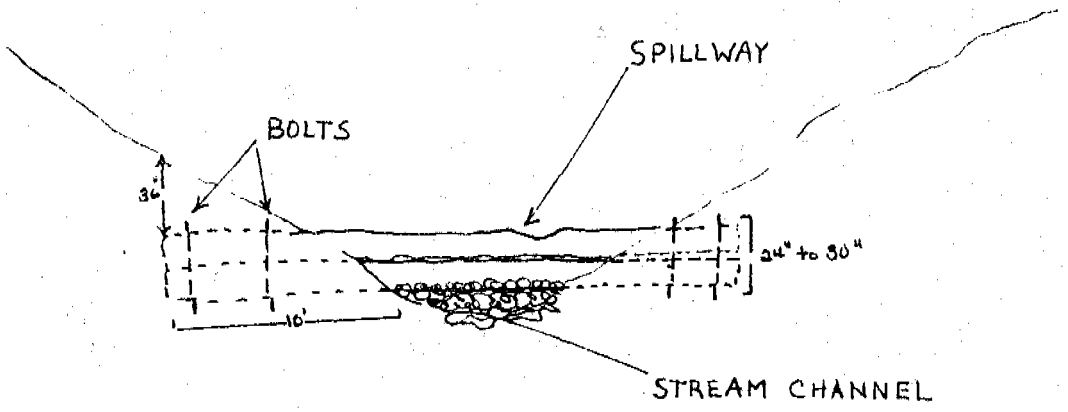
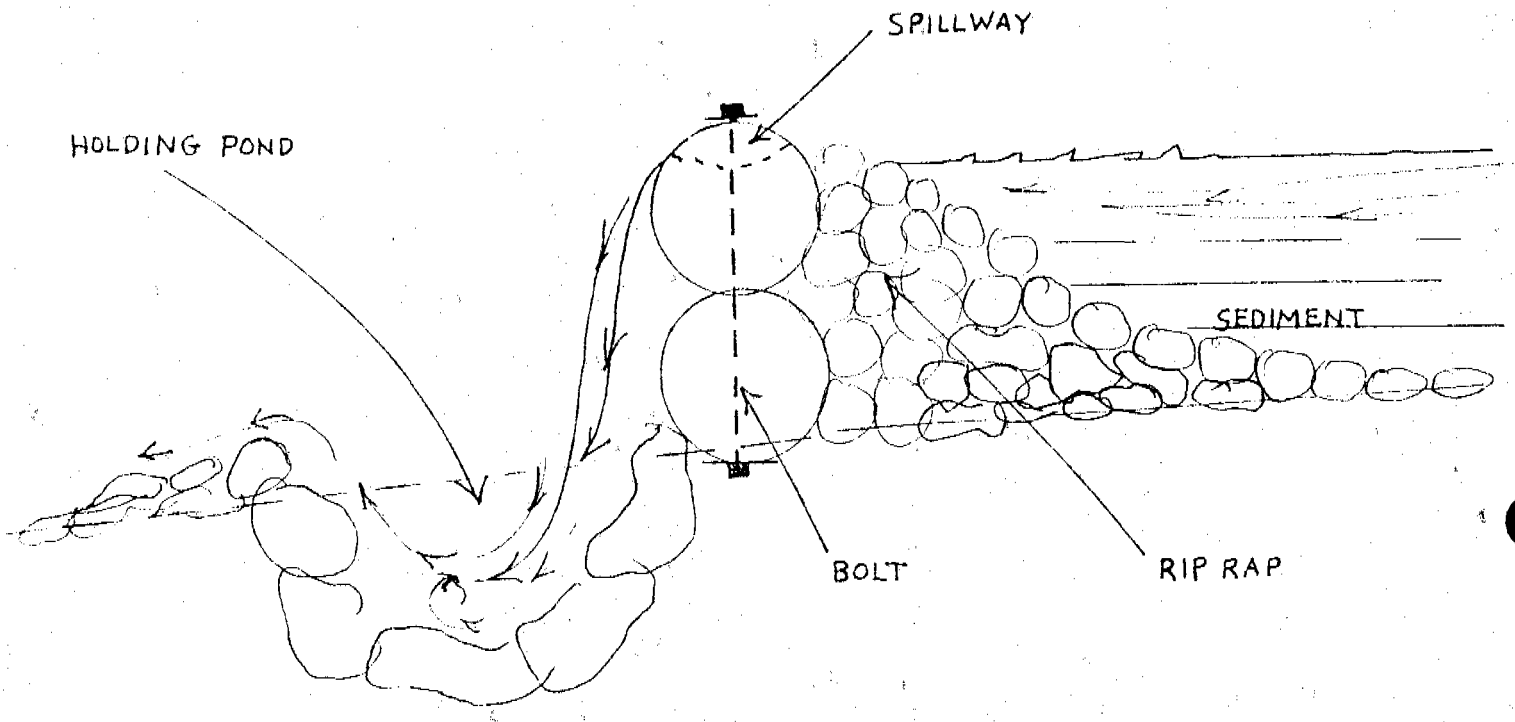

EXISTING CHANNEL:
VEGETATION INHIBITED DUE TO ANGLE OF SLOPE
RIPARIAN ZONE
18' to 30'
STREAM CHANNEL
RECLAIMED CHANNEL:
STREAM CHANNEL
18' to 30'
RIPARIAN ZONE

Fig. 1


SPILLWAY
BOLTS
36"
24" to 30"
10'
STREAM CHANNEL


SPILLWAY
HOLDING POND
SEDIMENT
BOLT
RIP RAP

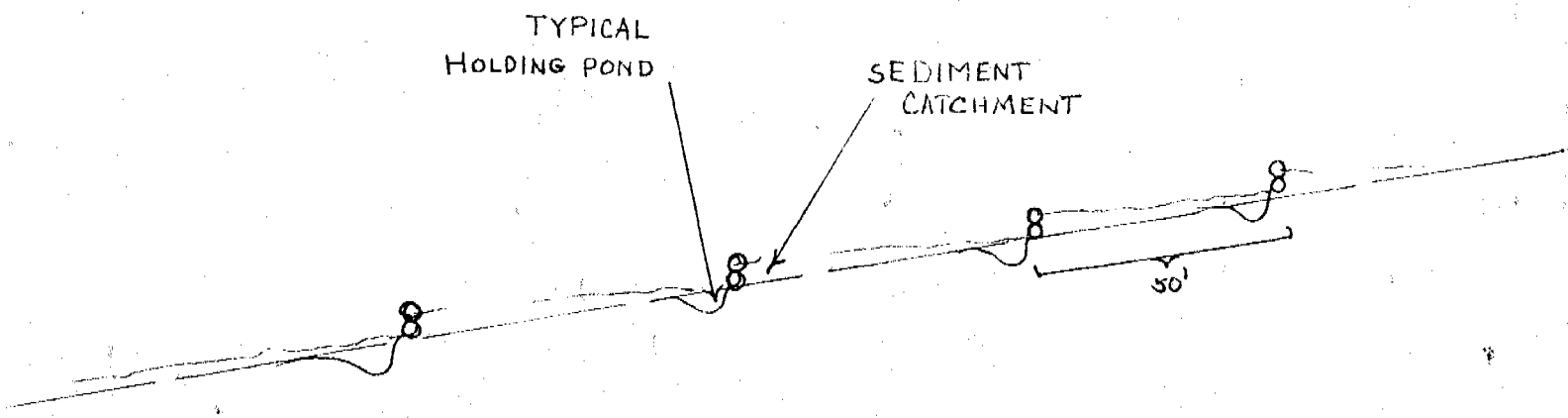
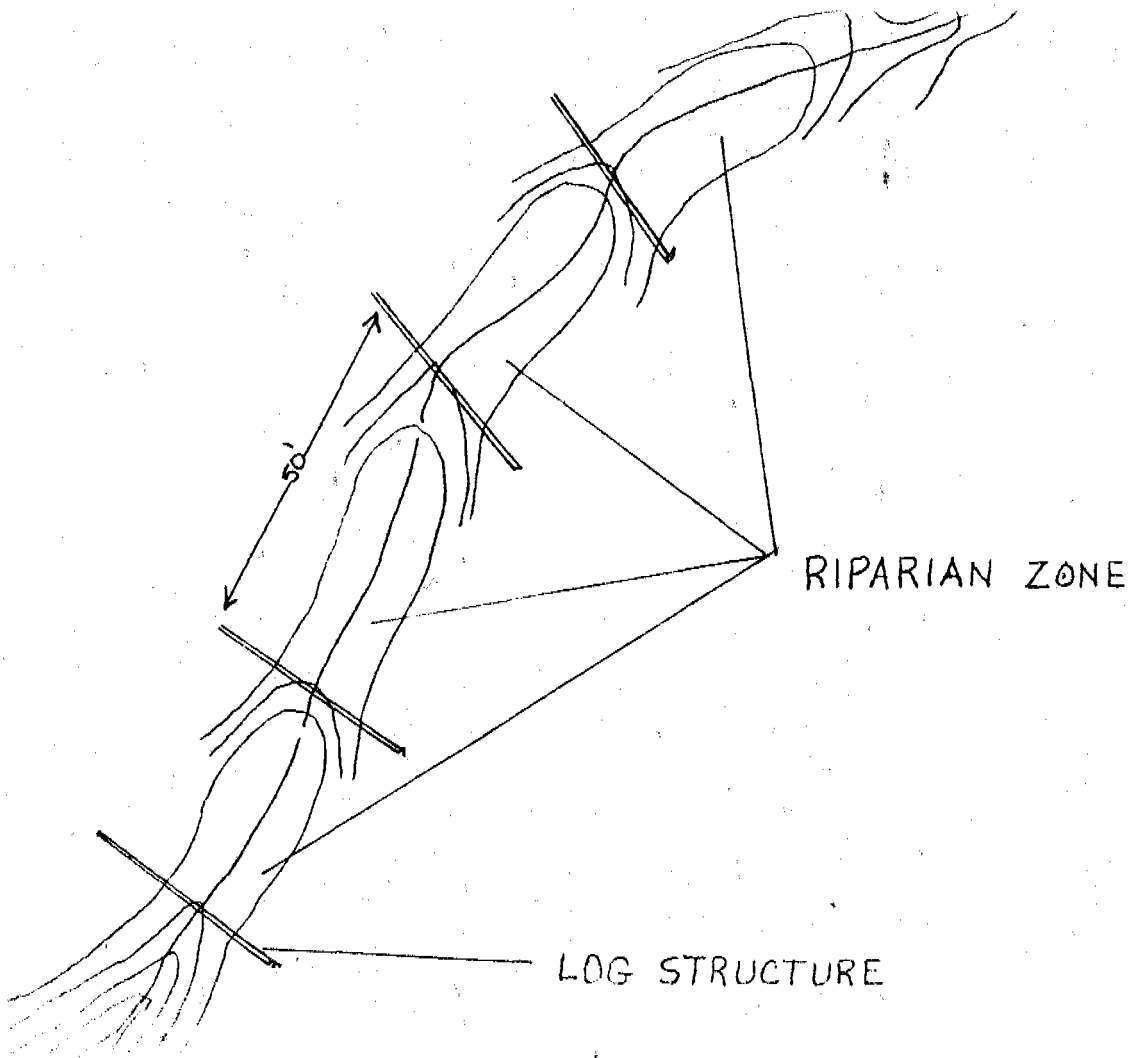

TYPICAL
HOLDING POND
SEDIMENT
CATCHMENT
50'

Fig. 2



ENHANCED STREAM CHANNEL

ATTACHMENT A

Melvin A. Coonrod
Co-Op Mining Company
P.O. Box 1245
Huntington, Utah 84528

August 27, 1983

Mr. Mark Page
State Engineer
Division of Water Rights
74 W. Main St.
Price, Utah 84501

REF: 93-R Permit Application
Bear Creek, Co-Op Mine

Dear Mark:

Attached is our 93-R permit application along with some additional data which I felt may be of value in determining the degree of impact of our proposed activity.

The Co-Op Mine has committed to U.D.O.G.&Mining to remove the culvert upon abandonment of the mine and to reclaim the stream channel in such a manner as to enhance the area. Presently, there is little or no riparian zone along this portion of the creek due to the eroded nature of the channel and the angle of the oppossing banks. Co-Op mine has committed to remove the culvert, decrease the angle of the side slopes and attempt to create a riparian zone along the creek. Also, establish a more stable vegetative cover on the banks.

Please contact me in the event that you have any questions or concerns relative to this activity. As usual, I appreciate your assistance in addressing this situation.

Sincerely,

Melvin A. Coonrod
Permitting & Compliance Director

MC/nc

cc: Army Corp Engineer - Robert Kramer
D.O.G.M. - James Smith

Melvin A. Coonrod
Co-Op Mining Company
P.O. Box 1245
Huntington, Utah 84528

August 27, 1983

Army Corp of Engineers
Robert Kramer
8402 Federal Building
125 South State Street
Salt Lake City, Utah 84114

REF: Phone conversation of Aug 24,1983
Co-Op Mine Bear Creek - 404 Permit Application

Dear Robert:

Attached is a copy of the Co-Op Mining Company Application to the State for a 93-R Permit. It appeared that the majority of the information we discussed was included here-in. The estimate of average stream flow of 1.5 cfs is mine, based on the last three months data. I would appreciate your estimate as to what is a realistic average on the creek based on the data I am sending.

The Utah Division of Oil, Gas, & Mining has indicated that we need a permit from the Utah Dept. of Health, however, in discussing what we are proposing, they indicated a 404 permit was the necessary document to allow them to "write off" on the culvert. After you have reviewed the data, would you please advise me if you require any additional material?

Needless to say, I appreciate your assistance in clearing up this situation. If I can be of any assistance, please call me at 801 653-2606.

Thank you,

Melvin A. Coonrod

MC/nc

Attachment

Form No. 93-R Application No. _____

APPLICATION TO ALTER NATURAL STREAM

Note: Information given in the following blanks should be free from explanatory matter, but when necessary, a complete supplementary statement should be made under the heading "Explanatory".

For the purpose of acquiring permission to alter a natural stream channel, application is hereby made to the State Engineer, based on the following facts, submitted in accordance with the requirements of the laws of the State of Utah, Section 73-3-29, Utah Code Annotated 1953, as amended.

1. Relocate ☐ Revetment Work ☒ Change ☐ Divert Stream Flow ☐

2. Name of applicant Co-Op Mining Company

3. Address of applicant P.O. Box 1245
Huntington, Utah 84528

4. The stream to be altered or relocated is Bear Creek

5. The channel to be altered is in the drainage area of Bear Creek Canyon, Huntington Canyon

6. The location of the channel to be altered is in Emery County. Located in SE¼, SW¼, Sec 25 Township 16 S Range 7E SBM

(Give location within 40-acre tract of section, township, and range.)

7. The nature of the proposed channel change is To install 200'linear feet of 60" culvert.

8. The alteration or relocation is made for the purpose of To protect the drainage from possible contamination by coal fines in the area of the Scale House.

9. The existing condition of the channel is Eroded to a near stable configuration.

10. The estimated streamflow is less than 1.5 second-feet.

11. The description of the proposed work involved is To install 200' of 60" culvert in the existing stream channel. (See attachment on location) to protect the drainage and facilitate surface drainage and handling of coal.

12. Is the land owned by the applicant? Yes ☒ No ☐ If the answer is "No", has written permission to proceed with the work been obtained?

Note: The approval of this application does not grant the applicant the right of egress or trespass. Such authorization must be accomplished in accordance with the standard legal procedures.

13. Channel Improvement Grouping (for federal agencies only) _____

Explanatory

The following additional facts are set forth in order to define more clearly the full purpose of the proposed application: The culvert is designed to allow the Co-Op Mining Co. to handle the weighing of coal trucks in such a manner and location to prevent surface waters which may contain coal fines to go through a sediment pond prior to reaching the creek. It will facilitate storage of materials, handling of coal, and future construction in the area. (See attachments for site specific information)

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
650 CAPITOL MALL
SACRAMENTO, CALIFORNIA 95814

REPLY TO
ATTENTION OF

September 6, 1983

Salt Lake City Regulatory Office (NWAH 236)

Mr. Melvin A. Coonrod
Co-op Mining Company
P. O. Box 1245
Huntington, Utah 84528

Dear Mr. Coonrod:

This is in reference to your letter dated August 27, 1983 concerning Department of the Army permit requirements associated with installing a 200 foot by 5 foot culvert in Bear Creek, within Section 25, Township 16 South, Range 7 East, Emery County, Utah.

A nationwide permit has been issued which authorizes the placement of dredged or fill material above the headwaters. The headwater is defined as the point of a stream above which the average annual flow is less than 5 cubic feet per second. The proposed work in Bear Creek would be above the headwaters and can be constructed under this authority provided the work meets the conditions listed on the enclosed information sheet.

Should you have any questions, please contact Mr. Robert Kramer of our Salt Lake City Regulatory Office, telephone (801) 524-6015.

Sincerely,

Tom Skordal
Chief, Salt Lake City
Regulatory Office

Enclosure

Copies Furnished:

Utah Bureau of Water Pollution Control
P.O. Box 2500, Salt Lake City UT 84110

U.S. Environmental Agency (8WM-SP)
1860 Lincoln Street, Denver CO 80295

U.S. Fish and Wildlife Service
125 South State Street, Room 1311
Salt Lake City UT 84138

NWAH

Information Sheet
Section 404 of the Clean Water Act
Nationwide General Permits for Work Above the Headwaters

Section 404 of the Clean Water Act requires Department of the Army approval prior to the discharge of dredged or fill material into waters of the United States or adjacent wetlands. This approval is granted in the form of a Department of the Army permit issued by the U.S. Corps of Engineers. Permits may be individual permits authorizing specified types of discharges in a specified waterway or group of waterways. Acting under this authority the Corps of Engineers has issued Nationwide General permits for the placing of dredged or fill material above the headwaters in non-tidal rivers, streams, and their impoundments, and in isolated lakes. The headwater is defined as a point on a non-tidal stream where the average annual flow is less than 5 cubic feet per second.

This nationwide general permit eliminates the need for processing individual permits for the discharge of dredged or fill material in these waters provided the following conditions are met:

a. The discharge will not be located in the proximity of a public water supply intake.

b. The discharge will not destroy a threatened or endangered species as identified under the Endangered Species Act, or destroy or modify the critical habitat of such species.

c. The discharge will consist of suitable material free from toxic pollutants, in other than trace quantities.

d. The fill created by the discharge will be properly maintained to prevent erosion and other non-point sources of pollution.

e. The discharge will not occur in a component of the National Wild and Scenic River System or in a component of a State Wild and Scenic River system.

The following management practices should also be followed, to the maximum extent practicable to minimize the adverse effects of the discharge on the aquatic environment:

a. Discharges of dredged or fill material into waters of the United States shall be avoided or minimized through the use of other practical alternatives.

b. Discharges in spawning areas during spawning season shall be avoided.

c. Discharges shall not restrict or impede the movement of aquatic species indigenous to the waters or the passage of normal or expected high flows or cause reloction of the waters (unless the primary purpose of the fill is to impound water).

d. If the discharge creates an impoundment water, adverse impacts on aquatic system caused by the accelerated passage of water and/or the restriction of its flow, shall be minimized.

e. Discharges in wetland areas shall be avoided.

f. Heavy equipment working in wetlands shall be placed on mats.

g. Discharges into breeding and nesting areas for migratory water fowl shall be avoided.

h. All temporary fills shall be removed in their entirety.

This nationwide general permit applies only to the authorization required under Section 404 of the Clean Water Act. THIS PERMIT DOES NOT OBVIATE THE REQUIREMENT TO OBTAIN ANY STATE, LOCAL, OR OTHER FEDERAL APPROVAL REQUIRED BY LAW.

If you have any questions or need additional information concerning the nationwide general permit, please contact our Regulatory Section, Room _____, or telephone (916) 440-_____.

STATE OF UTAH
NATURAL RESOURCES
Water Rights

1636 West North Temple • Salt Lake City, UT 84116 • 801-533-6071

Scott M. Matheson, Governor
Temple A. Reynolds, Executive Director
Dee C. Hansen, State Engineer

November 8, 1983

Co-Op Mining Company
P. O. Box 1245
Huntington
Utah 84528

RE: Stream Alteration 570

Dear Applicant:

Application to Alter Natural Stream Number 570 has been approved pursuant to the requirements of Statute 73-3-29, Utah Code Annotated, 1953, subject to the following:

1. Installation of sediment control measures to prevent siltation of Huntington Creek prior to start of your project.

A copy of the **approved** application is being returned to you for your records.

Sincerely yours,

Donald C. Norseth
for Dee C. Hansen, P.E.
State Engineer

DCH.DCN.pmh

cc: M.P. Page, Price Area Office
Darrell Nish, Wildlife Resources

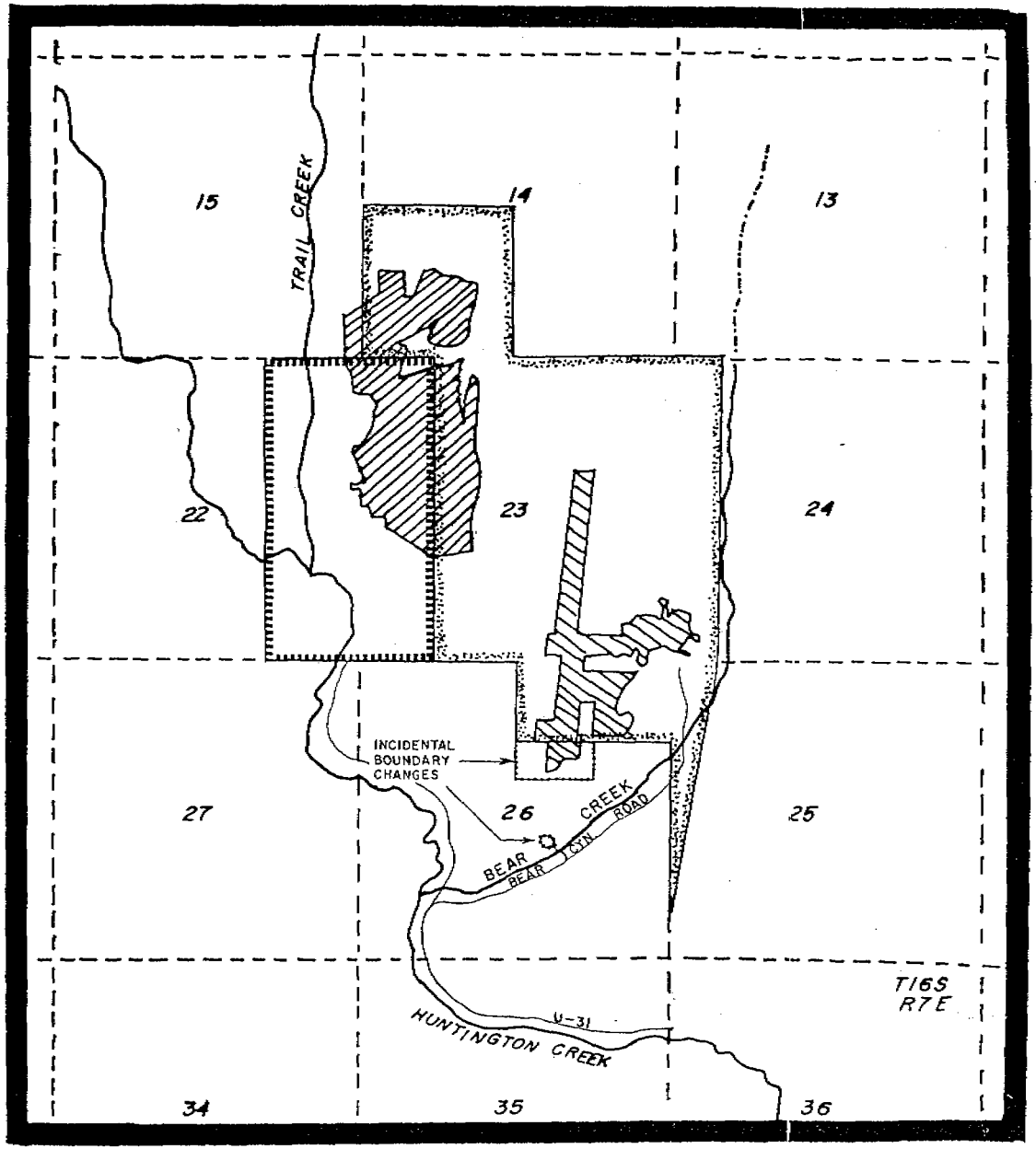
mining is shown on Plate 3-4 and the area where pillars will be removed is indicated.

This base map will be updated annually. Co-Op will notify adjacent property owners concerning subsidence potential prior to approaching their boudaries. Co-Op will conduct an annual survey to identify all evidence of subsidence. An annual field survey will be made to identify observable subsidence. Details are attached under Appendix 3-5-8A.

When subsidence is observed to adversely impact a surface structure or resource, the extent of the impact will be evaluated.

As pillars are pulled under the western portion of the mine plan area, impacts will be anticipated and hazards assessed on a site-specific basis. An overburden of approximately 1,000 feet or more in the western portion of the mine plan area should minimize surface impacts. Sandstone formations overlaying the Blackhawk coal bed should better distribute stresses and reduce the tendency for surface cracks and subsidence at the surface.

3.5.9 Waste Disposal Plans (Spoils, Coal Processing Wastes, Mine Development Wastes, Non-Coal Wastes, Removal, Handling and Storage



KEY

BEAR CANYON MINE PERMIT AREA

TRAIL CANYON MINE PERMIT AREA

BEAR CANYON MINE WORKINGS

TRAIL CANYON MINE WORKINGS

SECTION BOUNDARIES

STREAMS

N

0 0.5 1.0 MI.

SCALE 1:24,000

TRAIL CANYON AND BEAR CANYON MINES:
PERMIT AREAS / MINE WORKINGS

INCIDENTAL BOUNDARY CHANGES

FIGURE 3-4a

CHAPTER 9

VEGETATION

CHAPTER 9

TABLE OF CONTENTS

9.1 SCOPE

A reference area, approximately 1 or 2 acres in size was selected in July 1983 for the pinyon juniper grass and riparian vegetation types. The reference area was selected on the basis of similarity of species composition, cover, productivity, geology, soils, slope and aspect of the three vegetation types within the disturbed area defined at that time. This was done in conjunction with Mr. Lynn Kunzler of the Utah Division of Oil, Gas and Mining.

9.2 METHODOLOGY

A reconnaissance-type survey was conducted within the vegetation type that was disturbed, then correlated to reference areas in undisturbed areas. Surveys were conducted by a plant taxonomist during an initial sample period in August 1983. Additional species composition information was collected in conjunction with quantitative sampling in August 1983. Specific efforts were made to locate and identify species proposed or listed as threatened or endangered, noxious weeds and selenium indicators.

Sample Point Selection

Cover, shrub density and shrub height transects and tree density sampling points were located in pinyon juniper grass and riparian types on similar undisturbed areas using a random sampling technique. A random point was selected on the preliminary vegetation map

of the reference area for the first point. The direction and distance to subsequent points were randomly selected from the preceding point by using a random numbers tale. Each point was located in the field by pacing. Transect directions were randomly selected by compass bearings. The locations of sampling points were recorded and indicated on a site map.

Sample Adequacy Determination

Utah Division of Oil, Gas and Mining guidelines (1982) dictate the following sampling adequacy requirements for estimates of cover, shrub density and tree density:

grasslands - 90 percent confidence, 10 percent precision

shrublands and forests - 80 percent confidence, 10 percent precision

(Shrublands are defined as areas where shrubs contribute over 20 percent of the total cover.)

However, the guidelines require that a minimum number of samples be taken. The guidelines identify the maximum number if sampling adequacy is not met with fewer samples.

Vegetation Cover Estimation

Cover data was obtained at 50 points spaced at 1 meter intervals along a transect at each ranadomly selected sample point. A linear point-frequency frame (Mueller-Dombois and Ellenberg 1974) was used to accurately measure vertical hits on vegetation, litter-rock and bare ground. Crown or shoot cover was measured by counting only the first interception of the pin with a plant part. Overhead canopy cover was determined by recording the plant species hit when the vertical line of the pin was protected upward above the frame. Where crowns overlap in layered vegetation, the uppermost layer was considered the primary vegetation hit and subsequent hits on lower vegetation was recorded separately.

This technique provides frequency information for vegetative, litter-rock and bare ground components of total cover along a given transect. Frequency of individual plant species encountered along each transect was also determined to provide relative distribution information.

Shrub Density and Height Estimation

Shrub density and height were estimated along the same transects used for cover data. The height, number and species of shrubs whose stems rise within 50 centimeters on either side of the 50 meter transect was recorded. Shrub heights were measured and recorded by two classes: less than 1 foot and equal to or greater than 1 foot. All data was recorded on standard forms.

Tree Density and Basal Area Estimation

A total count of all trees within the reference area was done.

9.3 EXISTING RESOURCE

9.3.1 SCS Productivity Estimates

Productivity estimates and range condition for the reference were obtained from the local SCS Range Conservationist. (See Appendix 9-B.)

9.3.2 SAMPLING METHODOLOGY

Plant Cover: 38-50 meter transects; using a ten point frame at every 10 meter interval.

Shrub Density: 24 - 1 x 50 meter transects, counting all shrubs rooted within the sampling area.

Formula for Sample Adequacy:

$$\left(\frac{S\,t}{(0.1)\,(\bar{x})}\right)^2 = \frac{S^2\,t^2}{[(0.1)(\bar{x})]^2} = \text{number of samples needed (n)}$$

where:
t= 1.96 at 90% confidence (from t table)
s= standard deviation of sample
$\bar{x}$= mean of sample

For Cover: (numbers from cover summary sheet)

$$= \left[\frac{(8.60)(1.96)}{(0.1)(28.52)}\right]^2 = \left[\frac{16.856}{2.852}\right]^2 = 34.93$$

For Shrub Density: (numbers from Density Summary sheet)

$$= \left[\frac{(4.05)(1.96)}{(0.1)(19.13)}\right]^2 = \left[\frac{7.938}{1.913}\right]^2 = 17.22$$

Example calculation for deriving % vegetative composition:

Agsp $\frac{742}{38 \text{ transects}} = 19.5$ $\frac{19.5}{*\ 28.52} \times 100 = 68.37\%$ Agsp

all species' averages + bare ground + rock + litter = 100%
* All species averages totaled = 28.52

Example calculation for % shrub composition:

Chna $\frac{73}{24 \text{ transects}} = 3.04$ $\frac{3.04}{*\ 19.13} = 15.89\%$ composition

* 19.13 derived by adding all species averages.

9.3.3 Vegetation Types of the Co-Op Permit Area

Table 9-1 lists the vegetation types by total acres and acres of disturbance. Each type listed is described as follows:

Conifer Vegetation Types

The conifer vegetation type (Plate 9-1) occurs on steep north and west-facing slopes and on more moist areas of some south-facing slopes such as at the bottoms of the lower cliffs and between the riparian type and the lower fringes of the pinyon-juniper type. A mixture of conifer species such as Pinyon pine Pinus edulis, White fir Abies concolor, Douglas fir Pseudotsuga menziesii, and Utah juniper Juniperus osteosperma dominate the mature type. Primary understory species are Bluebunch wheatgrass Agropyron spicatum and Serviceberry Amelanchier alnifolia. Scattered Bristlecone pine Pinus longaeva occurs throughout the small valleys and along the edges of cliffs in the conifer type. Lightning and fire seared trees are scattered throughout this type. Browsing and grazing by native or domestic herbivores appears to be light in this type.

Grass Vegetation Type

The grass vegetation type (Plate 9-1) occurs on the small

Table 9-1

VEGETATION TYPES WITHIN THE BEAR CANYON PERMIT AREA
AND POTENTIAL DISTURBED AREA

	Permit Area		Disturbed Area	
Vegetation Type	Acres	Disturbed	Drill Seeded	Hydro-Seeded
Conifer	139.06	-0-	-0-	-0-
Grass	62.73	-0-	-0-	-0-
Riparian	7.46	.67	.37	.30
Pinyon-Juniper	654.96	9.64	6.04	3.60
Sagebrush	4.3	-0-	-0-	-0-
Reclaimed	.65	-0-	-0-	.65
Bare	19.30	-0-	-0-	-0-
TOTAL	904.27	10.31	6.41	4.55

knolls and benches of the upper slopes in the potential disturbed area as well as on ridgetops within the permit area. This type is dominated by Salina wildrye Elymus salinus mixed with Bluebunch wheatgrass Agropyron spicatum and Wild buchwheat Eriogonum corymbosum. Trees or shrubs common in the surrounding conifer type occasionally occur within the grass type but the overall appearance of the area is one dominated by grass species.

Riparian Vegetation Type

The riparian vegetation type (Plate 9-1) occurs as a narrow band in the moist bottoms of canyons in the mine plan area. Although riparian species such as Narrowleaf cottonwood Populus angustifolia and River birch Betula occidentalis occur in the type, species such as White fir Abies concolor and Douglas fir Pseudotsuga menziesii, which are common in the surrounding conifer type, also dominate the riparian type. In some areas it is primarily the presence of the stream bottom and relatively robust growth from of the species that separate the riparian bottom from the surrounding conifer vegetation. Most of the vegetation cover in this type is provided by the trees. The understory in the riparian type consists of scattered shrubs such as Rocky Mountain juniper Juniperus scopulorum and Woods rose Rosa woodsii as well as a sparse cover of grasses and forbes. Use of the riparian type by native and domestic herbivores appeared to be light.

Pinyon-Juniper Type

"PJ" habitats, prevalent on south-facing slopes with rocky substratas of blocky sandstone, were extensive in the permit area (see the Vegetation Map, Plate 9-1). Most Pinyon/ Juniper areas were dominated by open stands of Pinyon Pine Pinus Edulis, Rocky Mountain Juniper Juniperus scopulorum, and Utah Juniper Juniperus osteosperma, with large Curl-leaf Mountain Mahogany Cercocarpus ledifolius. In a few places, the conifers were essentially lacking, resulting in a Mountin Mahogany "woodland." Many of the Mountain Mahogany more closely resembled small trees than shrubs being over 3 m high and having a single large trunk near the ground. Scattered Ponderosa Pine Pinus ponderosa and Douglas-fir Pseudotsuga menziesii were conspicuous in more mesic sites, especially valley bottoms, and Serviceberry Amelanchier sp. was occasionally present in significant numbers.

Prominent PJ understory species included Big Sagebrush Artemisia tridentata, Fringed Sage Artemisia frigida, Broom Snakeweed Xanthocephalum sarothrae, Salina Wildrye Elymus salinus, Indian Ricegrass Oryzopsis hymenoides, Skyrocket Gilia Gilia aggregata, and Gumweed Machaeranthera grindelioides.

Sagebrush

The sparse distribution of the sagebrush habitat type appears to be controlled by exposure and moisture availability. The largest stands of sagebrush occur in the flat lower drainages of Bear Creek Canyon. This habitat type merges on both sides of the canyon bottom, with the Pinyon/Juniper (See Vegetation Map, Plate 9-1).

Dominant vegetation species include Big Sagebrush Artemisia tridentata, Rubber Rabbitbrush Chrysothamnus nauseosus, Fringed Sage Artemisia frigida, Thistle Cirsium sp., Skyrocket Gilia Gilia aggregata, Plains Pricklypear Opuntia polyacantha, Cheatgrass Bromus tectorum, and Bluebunch Wheatgrass Agropyron spicatum.

Bare Cliffs and Talus

Vegetation is nonexistent or sparse and consists of a few grasses and forbs. Cliffs separate the Grassland vegetation type of the plateau from the more vegetated areas of the canyon bottoms.

9.4 Threatened and Endangered Species

No plant species listed as threatened or endangered (U.S. Fish and Wildlife Service, 1982) or proposed for threatened or endangered status

(Welsh and Thorne, 1979) was observed on the study area. No plants listed as threatened or endangered are known to occur in the Co-Op permit area (Thompson, personal communication, 1983).

9.5 RECLAMATION PLAN

Bear Canyon, Trail Canyon and associated disturbance

The following procedures are designed to revegetate and control erosion. They should, to a large degree, satisfy the commitments made by Co-Op Mining Company in their permit while also satisfying DOGM regulations as pertaining to interim reclamation and final reclamation for those areas which will be utilized after mining operations are concluded.

The areas in question are along and adjacent to the Bear Canyon Mine and Trail Canyon Mine access road and will be of a permanent nature.

The actual ground involved comprises approximately 10 acres of disturbed land primarily road and deck areas. The actual procedures involve a four phase program; [1] earthwork, [2] hydromulch the entire area to supplement revegetation and control run-off until stabilization is complete, [3] prepare a site which will be stable enough for a period of time to allow vegetation to become established, and [4] to plant seedlings to further stabilize the soil and to provide necessary wildlife, hydrological and aesthetic commitments as detailed in mine reclamation permit.

PHASE 1 - Earthwork - Original Contour

The roads and pads will be brought back to a reasonable configuration by implementation of a large backhoe unit in conjunction with a crawler tractor (JD450). The actual method will involve the pulling of material from approximately ten feet below the road cut up onto the road surface and spreading and compacting this material with the crawler tractor, at the same time pulling the leading edge of the high wall down to lessen the degree and angle of the high wall. All work done, both above and below the road, will take into consideration existing vegetation and all effort will be made to minimize disturbance where possible. When there is no alternative other than disturbance, an effort will be made to relocate earth and maintain existing vegetation in place; attempting to relocate the vegetation in the proximity of the road disturbance. (See Attachment 2). The material redistributed to regain original contour will be compacted to approximately 95% of the original or adjacent undisturbed soil. Upon completion of this step of spreading and compacting, the unconsolidated native material will approach the original configuration of the site prior to disturbance. The native topsoil which was removed from the area will be redistributed to a depth of 6 inches, as indicated by Soil Survey - March 1980. Upon redistribution of the A horizon soil, all associated compaction resulting from spreading will be alleviated by ripping the entire area to a depth of 20 centimeters to enhance the revegetation effort.

PHASE 2 - Seeding and Mulching

The entire area of disturbance will be drilled and hydroseeded during the first Fall following the complete abandonment and earth work. (September through November). Spring seeding was considered too speculative to be implemented based on the variation in Spring moisture regimes.

The largest portion of the recontoured site will facilitate drill seeding In order to lessen compaction, a rangeland drill seeder pulled behind a small crawler tractor will be utilized. A tentative estimate of the area to drill seed is approximately 6.5 acres. The balance of the area would then be hydroseeded. The seed mix and rate of application is attached.

In combination with the seed, the following rates of tackifyer will be utilized:

[Rates of Tac were developed with respect to velocity and erosive power of water which is proportional to the square root of the slope.] An emperical factor was determined from laboratory and field studies to arrive at the minimum Tac fiber ratio. Thus, 60 pounds of Tac per ton of fiber is about minimum for slopes up to 20% and the emperical factor is determined as $60 \div 20\% = 12$. A 25% slope is about maximum for the minimum amount of Tac. For a 100% slope [1:1 or 45°] the ratio of Tac to fiber is calculated as:

[100%] [12] = 120 pounds.

SUGGESTED RATIOS OF TAC TO FIBER FOR HYDROSEEDING AND HYDROMULCHING TO SERVE AS MULCH OR SOIL BINDER

SLOPE ANGLE	SLOPE RATIO rise:run	PERCENT SLOPE	LBS. TAC PER TON FIBER	RATIO TAC TO FIBER
14°	1 : 4	25%	60[minimum]*	1 : 30
26°	1 : 2	50%	80	1 : 25
33°	1 : 1½	66%	100	1 : 20
45°	1 : 1	100%	120	1 : 16
57°	1½ : 1	150%	140	1 : 14
64°	2 : 1	200%	160[minimum]	1 : 12

* 60 pounds is suggested as a minimum to insure excellent stabilization; however, in many conditions 40 pounds of Tac per acre has given excellent results on a 1:4 or less slope.

The minimum specifications for both Tac and mulch are included under Attachment 5.

Following the seeding effort the entire area of disturbance will be hydromulched and fertilized. The rate of application of the wood fiber mulch is:

1,200 to 1,500 lbs/acre on 1:1 slopes

2,000 to 2,500 lbs/acre on 3:1 slopes

The mulch will also be fortified with Tac as previously indicated according to slope. Incorporated in the mulch slurry the following rate of fertilizer will be applied per acre:

80 lbs. N/acre

100 lbs. P_2 0_5/acre

100 lbs. K_2 0_5/acre

Approximately 50% of the above application will be incorporated in the mulch and the balance be added as an over-spray the following Fall. Recommendation on fertilizer requirements is based on soils test.

PHASE 3 - Site Preparation

Site stability will be largely accomplished through the grading, compacting and the utilization of a tackifying agent. However, on those areas with slopes of more than 2:1, the following procedures will add an additional parameter of stability and enhance the revegetation efforts.

Site preparation is both general and specific in procedures. The sites and methods provide a multitude of purposes and to a large degree are residual for several years. First and foremost, they effectively decrease the angle of repose of the slope in question. In accomplishing this you effectively modify the site and change those conditions which preclude vegetation from becoming established. Second, you change the severity of erosion and, in facat, use those surface waters which heretofore were destructive in nature. This is accomplished by creating basins wherein the water has time to soak in and thus can be utilized by vegetation.

By utilizing a small crawler tractor (JD450) terraces can be contoured on all slopes in excess of 2:1. The resulting terrace creates a bench effect and are spaced at 12" intervals down the slope. A terrace of 8' toed toward the hill is thus created. Planting is then instigated at approximately 2' distance from the cut face to minimize the detrimental effect of potential sluffing. On a small portion of the disturbed area it may be necessary to utilize hand labor to construct small terraces, approximately 18" benches on a contour of 4' intervals. These terraces are constructed utilizing a "Region 6" hand tool and would only be implemented in areas deamed hazardous for equipment and or in sensitive areas such as along Bear Creek where down east material could adversely effect the drainage. This, in turn, decreases the impact on adjacent watersheds and improves quality of surface waters. Those areas which are terraced provide a more favorable ecosystem than that of an equivalent slope. It facilitates better

utilization of grasses and forage for grazing animals; to some degree it modifies climate in that severity of wind and weather is somewhat diminished. Also, the cut face acts in much the same as a snow drift fence does in trapping and causing small areas of snow retention

PHASE 4 - Planting

The planting of seedlings will be done within 2 years of the seeding effort in order to evaluate the number and species of seedlings necessary to insure both composition and stocking of woody species to maximize utilization by wildlife and domestic grazing.

The species and numbers of individual plants are correlated to the reference area which was established during July of 1983. Stocking is discussed on page 3-99 and listed in Section 9.5.1.1 end of seed list.

Planting Procedure

Planting will be done utilizing a powered auger with a capability of drilling a 3 inch plus diameter hole to a depth of 16 inches. The roots of the sedling will be arranged in as near natural position as possible paying special attention not to "J" the root tips. (Fig. 9-1).

By holding the seedling at the root crown, soil will be compacted back around the roots being careful to leave no air pockets or loose dirt (which would constitute settling). The tree will be firm when

light pressure is exerted on the needles and standing in an errect position. Only hands shall be used to pack soil around the tree - the use of a stick or foot is strictly forbidden.

At all times the trees will be protected from direct sun light and special care will be exhibited when lifting the seedling from the planting bag to the prepared hole. The spacing of planted shrubs and trees will be to obtain the desired density and diversity while providing small clumps of cover for wildlife on approximately 100' intervals throughout the areas of disturbance that are in excess of 2 acres in size.

Field Storage

Field storage facilities are illustrated in Fig. 9-2. In the event snow is not available, a similar cache can be constructed using wet burlap and damp straw.

The mine will have to maintain a sorting, packaging and storing tent at the cache site. A sorting table will need to be set up in one tent. Each seedling must be examined and all that do not have a 2 to 1 crown to root relationship or are damaged must be discarded. The seedlings then need to be dipped in a vermiculite slurry and then rolled in wet burlap and placed in canvas planting bags.

The trees can only be left in the bags for twenty-four hour periods and then must be repacked following the same procedures.

The field handling of packed trees requires the crowns be kept moist and the bags covered with insulated tarps and stored in shaded areas.

During breaks, lunch, etc., the crews planting bags must be placed in shaded areas. At the end of each operational day all bags must be unpacked and the trees redipped in vermiculite and rerolled in wet burlap and repackaged to be used first the succeeding day.

Upon completion, the reclaimed area will be monitored to determine when bond release parameters are achieved. If the monitoring indicates inadequacies, the area will be supplemented with additional efforts.

The monitoring procedures will be the same sampling methodologies which will be incorporated in establishment of reference areas.

9.5.1 RECOMMENDED SEED MIX

BEAR CANYON MINE - CO-OP MINING COMPANY

RIPARIAN - CREEK BOTTOM

GRASSES	LBS/ACRE P.L.S.
Phalaris arundinacea	1
Oryzopsis hymenoides	3
Stipa viridula	2
Bromus marginatus	6
Argrapyron dasystachyum	5

FORBS	
Clematis lagusticifolia	2
Arnica cordifolia	1
Arlemisia ludovicina	.25
Vesia americana	3.5
Achillea milefolium lanulosa	.25
Trifolium melilotusofficinalis	3

SHRUBS	
Rosa woodsii	4
Rhus trilobata	3
Chrysothamnus nauseosus var. albicaulis	.5
Sambucus cerulea (raw-uncleaned)	5
	39.5 lbs/acre

Rates are designed for hydroseeding

Drill seeded area would be $\frac{1}{2}$ the listed application rate.

Species to be planted:

SPECIES	LINEAR FOOT SPACING	NUMBER PER ACRE
Populus angustifolia	5'	1,072.
Rosa woodsii	8 X 8'	680.

9.5.1.1 RECOMMENDED SEED MIX

BEAR CREEK MINE - CO-OP MINING COMPANY

PINYON JUNIPER GRASS

SPECIES	P.L.S. LBS./ACRE	APP. NO. SEEDS/FT^2
GRASSES		
Agropyron dasystachyum Thickspike wheatgrass	3	12
A. spicatum Bluebunch wheatgrass	8	22
Elymus salina Salina wildrye	1.5	15
Oryzopsis hymenoides Indian ricegrass	3	12
Poa secunda Sandberg bluegrass	1	21
FORBS		
Achillea millifolium Western Yarrow	.15	10
Aster chilensis Pacific aster	.15	9
Hedysarum boreale Northern sweetvetch	9	7
Lupinus sericeus Silky sweetvetch	20	6
Penstemon palmeri Palmer penstemon or P. strictus Rocky Mountain penstemon	.5	7

SHRUBS		
Amelanchier Utahensis Utah serviceberry	4	4
Artemisia tridentata ssp. vaseyana Big sagebrush	.15	9
Cercocarpus ledifolius Curlleaf Mountain mahogany	6	7
Chrysothamnus nauseosus var. albicaulus Whitestem rubber rabbitbrush	.5	5
Sambucus cerulea Blue elderberry	.8	4
For hydroseeding	59.75	159
$\frac{1}{2}$ application for drill seeded areas	30.00	

After 2 years the seeding effort will be evaluated and planting will be instigated in the event it appears necessary to bring the density and diversity of woody species up to the confidence levels of the corresponding reference area. The same species will be planted as listed above under shrubs. In addition, the following tree species will be planted:

SPECIES	NUMBER PER ACRE	SPACING WITHIN CLUMPS*
Pinus edules	15	5'
Acer glabrum torr.	15	5'
Prunus virginiana	5	25'

* Clumps spaces at 30 yd. intervals for wildlife cover

9.5.1.2 REVEGETATION

ESTIMATE OF RECLAMATION COSTS ON BEAR CANYON AND TRAIL CANYON MINE DISTURBANCE

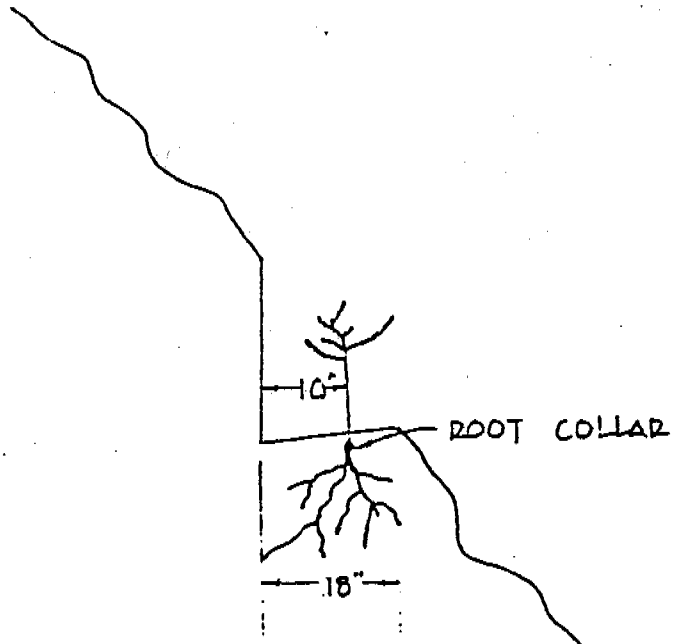
All costs are based on known costs - contract amount on work either in progress or completed in the preceding 12 months.

TYPE OF ACTIVITY	COST PER ACRE
Hydromulching and Seeding:	
Application of seed and tackifyer; equipment and labor only	$ 175.00/acre
Application of mulch, fertilizer and tac; equipment and labor only	275.00/acre
Mobilization [Utah Area]	Job 500.00
Mulch	380.00/acre
Tac @ $1.60/# 140#/acre	224.00/acre
Fertilizer @ $23.00/100#	23.00/acre
Drill Seeding	240.00/acre
JD 450 Crawler @ $45.00/hour estimating 8 hours/acre	360.00/acre
Case 580 Backhoe @ $35.00/hour estimating 24 hours/acre	840.00/acre
Seed	
Variable - current quote	165.00/acre
Planting and Site Preparation	93.00/acre
Nursery Stock	.50/each

CORRECT PLANTING PROCEDURES

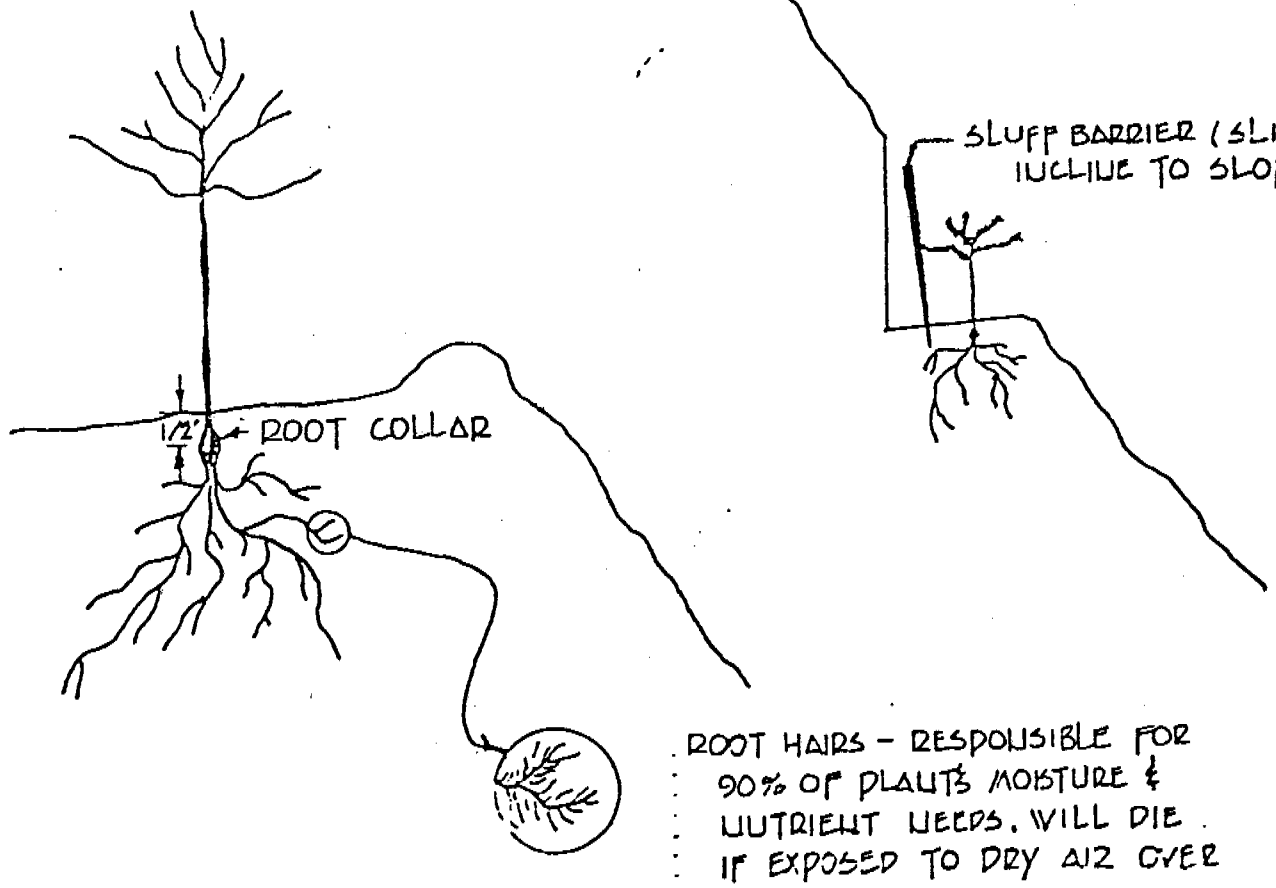
(PREPARED SLOPES)

Fig. 9-1



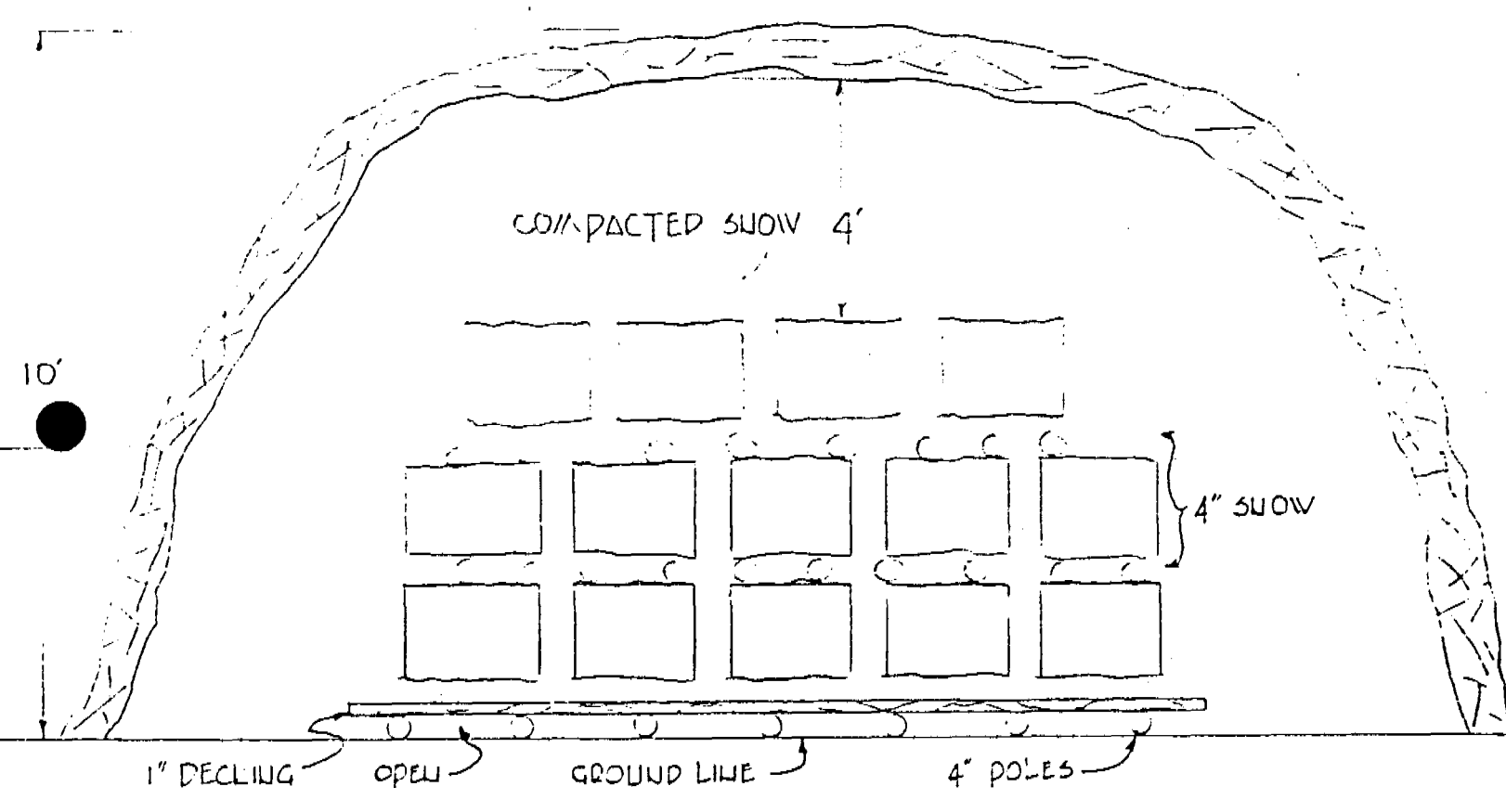
NOTES:

1. STEM PLANTED IN VERTICAL POSITION
2. PLANT STEM 10" FROM VERTICAL CUT OF SCALP
3. ROOTS ARE STRAIGHT AND SPREAD IN A NATURAL PATTERN
4. SOIL IS FIRMLY PACKED SO NO AIR POCKETS EXIST
5. ROOT COLLAR IS COVERED BY AT LEAST ½" OF SOIL
6. ROOTS PROTECTED FROM DRYING



ROOT HAIRS - RESPONSIBLE FOR 90% OF PLANTS MOISTURE & NUTRIENT NEEDS. WILL DIE IF EXPOSED TO DRY AIR OVER

Seedling Storage



SNOW CACHE WILL MAINTAIN SEEDLINGS AT 32°F. AND REALATIVE HUMIDITY OF 100%. SEEDLINGS SHOULD BE PLACED IN A COOL SHADED AREA 24 HOURS PRIOR TO PLANTING.

Fig 9-2

Appendix 9-A

VEGETATION ANALYSIS - REFERENCE AREA

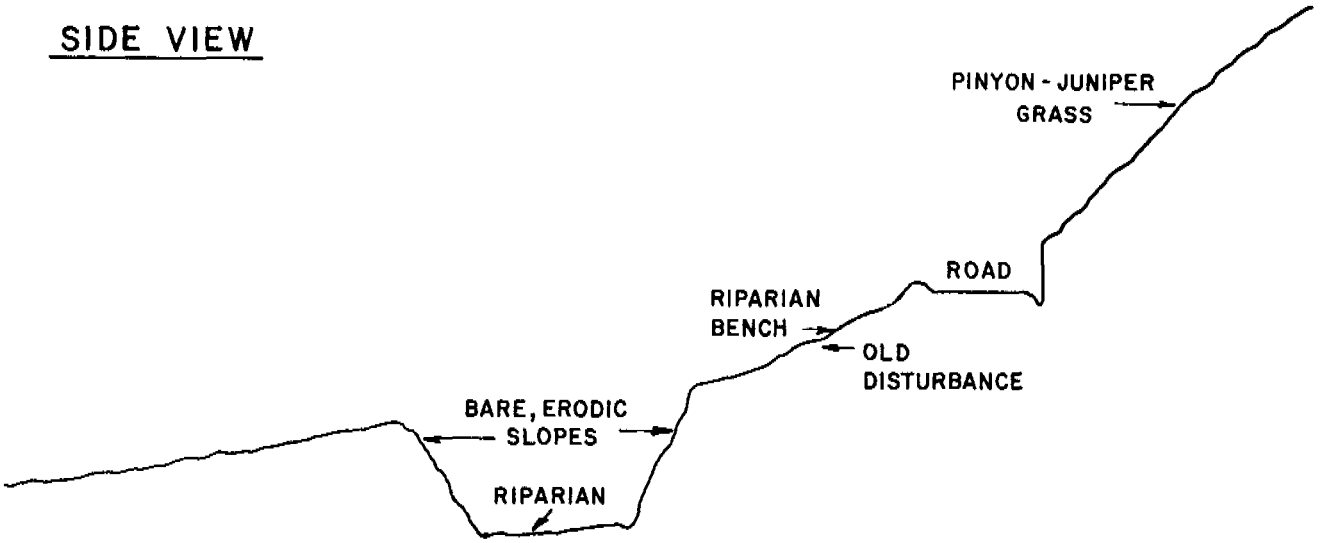
REFERENCE AREA
CRITERIA, RATIONALE, AND METHODOLOGY

Co-Op Bear Canyon Mine was established on a site which was previously disturbed in the early 1920's - 1940's, thus an accurate determination of the predisturbed vegetation cover was subjective. This, plus the fact the mine lies in a narrow canyon within an elevation span of 6,970 feet to 7,675 feet and centered in a vegetation zone considered as transitional. It was the opinion of UDOGM staff and Co-Op, that a reference area be selected that would accurately depict the area that was disturbed.

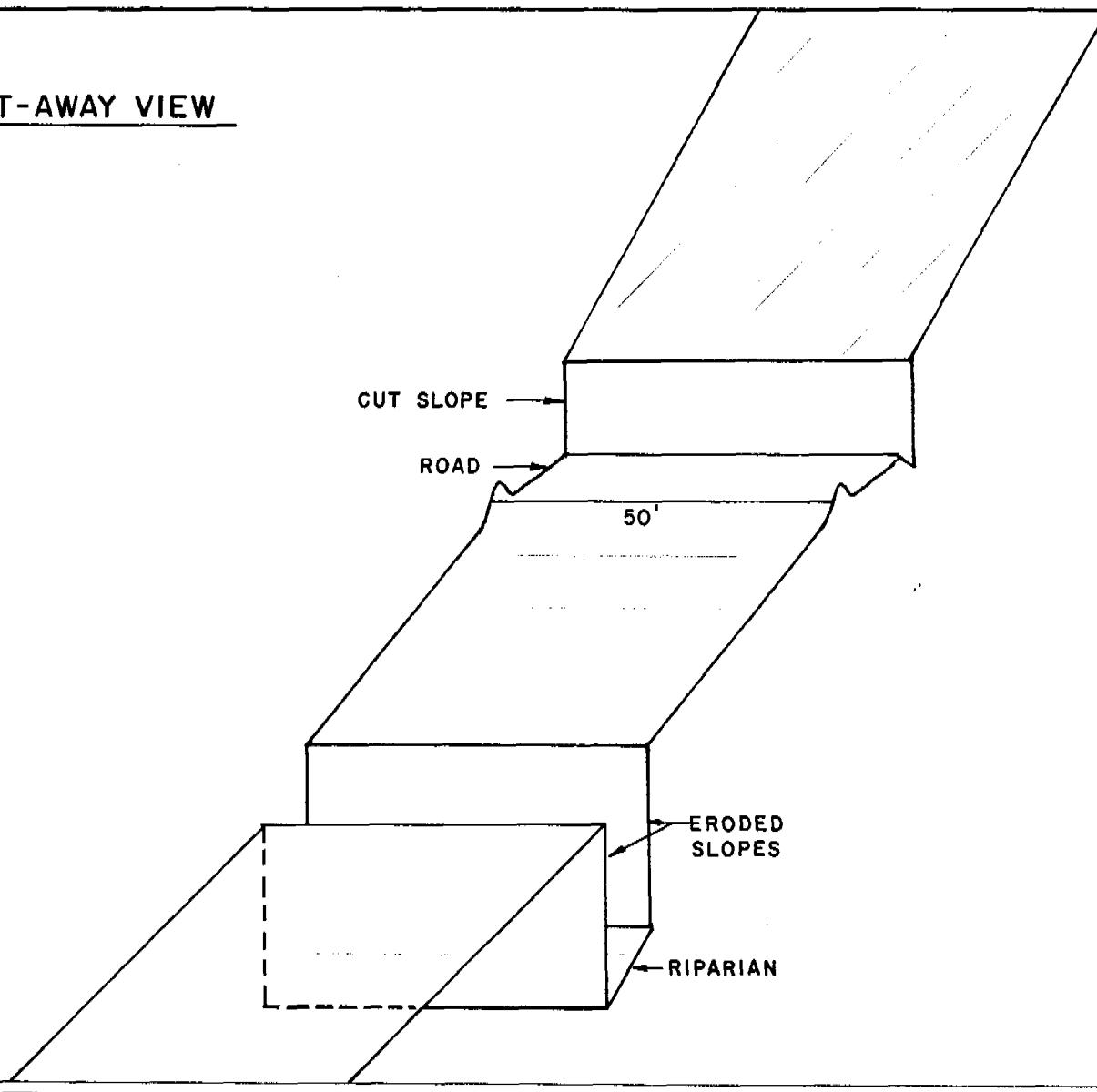
A reference area was selected off site, but within the fee property of the mine's parent company. (See Appendix 9-C Reference Area Protection). The reference area is marked on site with metal 5'5" posts on each corner. The area is comprised of a PJ grass association which is representative of the transition on the Bear Canyon site; a riparian bench which was selected on the basis of a desired riparian area which would be more representative of the channel enhancement configuration of post mining and a riparian creek zone which is what likely existed prior to disturbance. (See Fig. A for graphic representation showing transect location, numbers, and direction.)

The "B" reference area off-site was then compared to an undisturbed reference area (B) on-site within the permit area. It was selected

SIDE VIEW



CUT-AWAY VIEW



SLOPE VEGETATION ZONES

FIGURE NO. A

due to its proximity to the disturbed area and of similar elevation and aspect of the major portion of disturbance. This area "B" was designed as an alternative reference area in the event the "A" area was compromised. It was sampled only to show the degree of similarity to the PJ grass area as requested by the Division.

Melvin A. Coonrod
Co-Op Mining Company
P.O. Box 1245
Huntington, Utah 84528

August 20, 1983

Utah Division of Oil, Gas & Mining
Mr. James Smith
4241 State Office Building
Salt Lake City, Utah 84114

REF: ACR Committment July 29th 1983
Vegetation Analysis-Reference Area
Co-Op Mining Co. Bear & Trail Canyon

Dear Jim:

Please find attached: The data, work sheets and Summation on the Vegetation Reference Area. The area was selected in cooperation with Mr. Lynn Kunzler of the Division, and myself. The work was completed during August 6-7, 1983, and appears to be very representative of those areas which were disturbed in conection with mining activities in both Trail and Bear canyons.

The commitment to do this work was referenced in the Bear Canyon Scale modification, Bear Canyon Pad modification, and the Bear Canyon Apparant Completeness submittal. It was also referenced in the various reclamation plans I have submitted relative to the Co-Op's activities.

In view of this, I have attached eight copies. I would appreciate your assistance in diseminating this data.

I would again wish to express the Co-Op's appreciation for the Divisions' assistance in helping establish these areas.

Sincerely,

Melvin A. Coonrod
Permitting & Compliance Director
Co-Op Mining Company

Attachments: dup 8

CO-OP REFERENCE AREA - SUMMATION
PINYON-JUNIPER GRASS

AVERAGE COVER	% of VEGETATIVE COMPOSITION	GRASSES	SPECIES	COMMON NAME
19.5	68.37	Agsp	Agropyron spicatum	blue bunch wheat grass
		Orhy	Oryzopsis hymenoides	indian rice grass
		FORBS		
.05	.18	Hyri	Hymenozys spp.	
.05	.18	Stpi	Stanleya pinnata	prince's plume
.3	1.05	Arlu	Artemisia ludoviciana	louisiana sagewort
		Astra	Astrogalus spp.	milkvetch
		Chdo	Chaenactis douglosii	false yarrow
		Erige	Erigeron spp.	fleabane
.05	.18	Haplo	Happlopappus spp.	goldenweed
.05	.18	Saka	Salsola kali	russian thistle
		SHRUBS		
.11	.39	Artr	Artemisia tridentata	big sagebrush
.5	1.75	Epvi	Ephedra viridis	mormon tea
5.4	18.93	Eriog	Eriogonum spp.	buckwheat
.9	3.16	Gusa	Gutierrezia spp.	snakeweed
1.4	4.91	Chna	Chrysothamnus nauseogus	rubber rabbit brush
.2	.71	Opun	Opuntia spp.	prickly pear
28.52	100			

NUMBER ON SITE GREATER THAN 5 FEET TALL	TREES		
7	Juos	Juniperus osteosperma	Utah juniper
2	Jusc	Juniperus scopulorum	rocky mountain juniper
7	Pied	Pinus edulis	pinyon pine
0	Pipu	Picea purguns	blue spruce
0	Cemo	Cercocarpus montanus	true mountain mahogany

28.52	Total Vegetation	Size of PJ grass area:
13.8	Bare ground	78 X 210'
46	Rock	
11.7	Litter	
100.%		

RIPARIAN BENCH - CO-OP REFERENCE AREA

% Of Total Cover

FORBS		SHRUBS	
Arnica cordifolia	1	Chrysothamnus nauseosus	5
Clematis columbiana	5	Astragalus spp.	2
Tragopogon dubius	< 1	Artemisia frigida	1
Ipomopsis aggregata	< 1	Gutierrezia spp.	1
Castilleja spp.	< 1	Purshia tridentata	10
Circium spp.	< 1	Ephedra vividis	< 1
Hackelia floribunda	< 1	Chrysothamnus viscidiflorus	1
Artemisia dracuncalus	2	Opuntia spp.	< 1
		Symph spp.	< 1
	10%		20%

GRASSES

Poa pratensis	3
Oryzopsis hymenoides	2
Stipa comata	15
Bromus tectorum	5
	25%

Total size of area - 50' X 78'

Total vegetation	55%
Bare ground	10%
Rock	20%
Litter	15%

* RIPARIAN "STRIP" - CO-OP REFERENCE AREA

(Very narrow, steep slopes)

% Of Total Cover

FORBS

Circium spp.	2
Equisetem spp.	25
Clematis columbiana	5
Lathyrus spp.	2
Taraxacum officinale	< 1
Smiliacena spp.	1
Apocynum androsfemifolum	8
	43%

GRASSES

Juncus spp.	1
Bromus marginatus	< 1
Agrostic spp.	1
Poa spp.	< 1
	2%

SHRUBS

Rosa woodsii	14
Rhus trilobata	1
	15%

Vegetative total	60%
Bare ground	5%
Litter	20%
Rock	15%

*The riparian zone is so small that an adequacy was impossible to obtain.

SHRUB DENSITY

$$/ha = \frac{N}{24} \text{ transects } X\ 200$$

SHRUBS	NUMBER OF	% of SHRUB COMPOSITION
Artemisia tridentata	16	.42
Chrysothamnus nauseosus	608	15.89
Ephedra viridis	566	14.79
Eriogonum spp.	2108	55.10
Guaiacum sanctum	350	9.15
*Juniperus osteosperma	16	.42
*Juniperus scopulorum	8	.21
Opuntia spp.	8	.21
*Pinus edulis	75	1.96
*Pinus monophylla	16	.42
Rosa woodsii	25	.78
Purshia tridentata	16	.42
Tamarix pentandra	8	.21
	Total shrubs /ha 3820	99.98%

All shrubs rooted within the sample area.

*Tree species included due to their shrub-like nature less than 5' in height.

TREE DENSITY

A total count of all trees within the reference area was made indicating a density of:

		# Per Acre
Juniperus osteosperma	7	14
Juniperus scopulorum	2	5
Pinus edulis	7	14

BEAR CANYON SITE - SIMILARITY COMPARISON

GRASSES

Agropyron spicatum
Oryzopsos hymenoides

SHRUBS

Artemisia ludoviciana
Artemisia tridentata
Chrysothamnus nauseosus
Ephedra viridis
Salsola kali
Chrysothamnus douglasi
Opuntia spp.

TREES

Juniperus osteosperma
Juniperus scopulorum
Pinus edulis
Cercocarpus montanus

Bare ground
Rock (slightly more)
Litter

This area is very similar in coverage to the sampled reference area. The only difference is there is slightly more Artr and rock on this area.

All data and calculations were collected and compiled by Larry Germain, Paige Waldvogel in cooperation with Mel Coonrod.

Table
PLANT SPECIES IDENTIFIED ON OR ADJACENT TO
THE PERMIT AREA (7/82)

PLANT SYMBOL	SCIENTIFIC NAME	COMMON NAME
GRASSES		
Agsm	Agropyron smithii	western wheatgrass
Agtr	Agropyron trachycaulum	slender wheatgrass
Agin	Agropyron intermedium	intermediate wheatgrass
Agex	Agrostis exarata	red top
Avba	Avena barbata	wild oats
Bogr	Bouteloua gracilis	blue grama
Brma	Bromus marginatus	mountain brome
Brte	Bromus tectorum	cheat grass
Calam	Calamagrostis spp.	reed grass
Dagl	Dactylis glomerata	orchard grass
Elci	Elymus cinereus	basin wildrye
Elsa	Elymus salina	salina wildrye
Elgl	Elymus glaucus	blue wildrye
Hoju	Hordeum jubatum	foxtail
Hovu	Hordeum vulgare	barley
Kocr	Koeleria cristata	June grass
Orhy	Oryzopsis hymenoides	Indian ricegrass
Poa	Poa spp.	blue grass
Sihy	Sitanion hystrix	squirreltail
Stco	Stipa comata	needle and thread
GRASS LIKE		
Carex	Carex spp.	sedge
Scirp	Scirpus maritimus	bulrush
FORBS		
Anten	Antennaria spp.	pussy toes
Arco	Arnica cordifolia	heartleaf arnica
Ascle	Asclepias spp.	milkweed
Astra	Astragalus spp.	locoweed
Asco	Astragalus convallarius	narrowleaf vetch
Casti	Castilleja spp.	Indian paint brush
Ceras	Cerastium spp.	chickweed
Chdo	Chaenactis douglasii	false yarrow
Cirs	Cirsium spp.	thistle
Clco	Clematis columbiana	clematis
Coar	Convolvulus arvense	bindweed
Cora	Cordylanthus ramosus	bird's beak
Erum	Eriogonum umbellatum	buckwheat
Erysi	Erysimum spp.	wallflower
Fraga	Fragaria spp.	strawberry
Galiu	Galium spp.	bedstraw
Grsq	Grindelia squarrosa	gumweed
Hafl	Hackelia floribunda	false forget-me-not

FORBS CON'T

Hebo	Hedysarum boreale	sweet vetch
Heuch	Heuchera spp.	alum root
Hepa	Heuchera parvifolia	alum root
Ipag	Ipomopsis aggregata	scarlet gilia
Kosc	Kochia scoparia	summer cypress
Lala	Lathyrus lanzwertii	peavine
Lathy	Lathyrus spp.	peavine
Lygr	Lygodesmia grandiflora	skeleton weed
Meci	Mertensia ciliata	bluebells
Meof	Melilotus officinalis	sweet clover
Orfa	Orobanche fasciculata	broomrape
Osoc	Osmorhiza occidentalis	sweetanice
Oxytr	Oxytropis spp.	locoweed
Oxla	Oxytropis lambertii	locoweed
Penst	Penstemon spp.	penstemon
Peea	Penstemon eatonii	firecracker penstemon
Phace	Phacelia spp.	scorpion weed
Phid	Phacelia idahoensis	scorpion weed
Phau	Physaria australis	bladderpod
Saib	Salsola iberica	Russian thistle
Sedum	Sedum spp.	stonecrop
Sela	Sedum lanceolatum	stonecrop
Senec	Senecio spp.	oldman
Smst	Smilacina stellata	false soloman seal
Spco	Sphaeralcea coccinea	mallow
Stpi	Stanleya pinnata	prince's plume
Taof	Taraxacum officinale	dandelion
Thfe	Thalictrum fendleri	meadow rue
Trdu	Tragopogon dubius	oster plant
Vicia	Vicia spp.	vetch
Viola	Viola spp.	violet
Yucca	Yucca spp.	Yucca
Yuha	Yucca harrimaniae	Yucca

HALF-SHRUBS

Arfr	Artemisia frigida	fringe sagebrush
Atcu	Atriplex cuneata	mat saltbrush
Bere	Berberis repens	Oregon grape
Xasa	Xanthocephalum sarothrae (Gutierrezia sarothrae)	snake weed

SHRUBS

Amut	Amelanchier utahensis	service berry
Amal	Amelanchier alnifolia	serivce berry
Artr	Artemisia tridentata	sagebrush
Atco	Atriplex confertifolia	shadscale
Atcu	Atriplex cuneata	mat saltbush
Cela	Ceratoides lanata	winterfat
Chna	Chrysothamnus nauseosus	rubber rabbitbrush
Chvi	Chrysothamnus viscidiflorus	green rabbitbrush

SHRUBS CON'T

Epvi	Ephedra viridis	green mormon tea
Eriog	Eriogonum spp.	buckwheat
Opunt	Opuntia spp.	prickly pear
Phmo	Physocarpus monogynus	nine bark
Putr	Purshia tridentata	bitterbrush
Rimo	Ribes montegeum	currant
Rowo	Rosa woodsii	wild rose
Sambu	Sambucus spp.	elderberry
Same	Sambucus melanocarpa	elderberry
Save	Sarcobatus vermiculatus	greasewood
Syva	Symphoricarpos vaccinoides	snowberry
Syal	Symphoricarpos albus	snowberry
Tape	Tamarix pentandra	tamarix

TREES

Acgr	Acer grandidentatum	maple
Abla	Abies lasiocarpa	subapline fir
Cele	Cercocarpus ledifolius	curlleaf mountain mahogany
Cemo	Cercocarpus montanus	true mountain mahogan
Jusc	Juniperus scopulorum	rocky mountain juniper
Juos	Juniperus osteosperma	Utah juniper
Pied	Pinus edulis	pinyon pine
Pofr	Populus fremontii	cottonwood
Potr	Populus tremuloides	aspen
Psme	Pseudotsuga menziesii	Douglas fir
Salix	Salix spp.	willow
Tape	Tamarix pentandra	tamarix

The preceeding species list was complied by the SCS in June of 1982 and was submitted in its entirety. The list was compiled by Mr. George Cook and Associates "SCS report submitted".