0039

J.B. KING MINE
RECLAMATION PLAN REVISION

1994 APPENDIX TO
PERMIT ACT/015/002

February 1994

HANSEN
ALLEN
& LUCE INC
SALT LAKE CITY, UTAH

J.B. KING MINE
RECLAMATION PLAN REVISION

1994 APPENDIX TO PERMIT ACT/015/002

Submitted to:
WESTERN STATES MINERALS CORPORATION
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Reno, Nevada 89502

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February 18, 1994

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WESTERN STATES MINERALS CORPORATION

Ms. Pamela Grubaugh - Littig, Permit Coordinator
Utah Division of Oil, Gas and Mining
355 West North Temple
3 Triad Center, Suite 350
Salt Lake City, Utah 84180-1203

February 17, 1994

RE: J. B. King ACT/015/002 - Reclamation Plan Revision

FEB 18 1994

Dear Ms. Grubaugh - Littig:

This submittal is in response to the State of Utah Department of Natural Resources, Division of Oil, Gas and Mining's (Division) letter dated November 9, 1993. In this letter, the Division requested additional information to assess the technical adequacy of the J. B. King Reclamation - 1993 Proposed Work proposal dated September 30, 1993.

As stated in our previous submittal, Western States Minerals Corp. (WSMC) would like to reiterate that it believes that current reclamation performed at the J. B. King Site has been accomplished in good-faith and has produced excellent results with respect to revegetation success and erosional control. In addition, WSMC believes the site has reached an equivalent erosional stability with the surrounding area.

However, the Division has required WSMC to undertake abatement action that far exceed earlier reclamation standards. In addition, the Division has suggested that WSMC modify the channel design to approximate the configuration of adjacent natural channels.

We believe that the enclosed proposal goes far beyond the abatement action required and presents an opportunity for experimental design and practice which will advance reclamation technology. We think you will agree that WSMC has presented unique and innovative approaches to enhance vegetation success, redesign the existing drainages, and minimize erosion. To the extent that this proposal presents performance standards for which variances may be required, WSMC will submit a request pursuant to R-645-302-210. Because this proposal is in the form of an abatement action, and the Division continues to hold the Phase II Bond of $126,078.00, we assume there will be no increase in the reclamation bond for this presently proposed activity. Furthermore, these activities should not restart the bond clock.

Once the proposed sampling activity is completed and the data is analyzed, the final design can be completed. At that time, the project cost can be summarized; and the Detailed Schedule of Changes to the Permit will be submitted.

If you have any questions, please call me at your earliest convenience.

Sincerely,

E. M. (Buzz) Gerick
V.P. Operations

250 S. Rock Blvd., Ste. 130 • Reno, Nevada 89502 • (702) 856-3339 • FAX (702) 856-1818

Form DOGM - C1 (Last Revised 6/93) File Folder # 3

APPLICATION FOR PERMIT CHANGE

Title of Change:
J.B. King Mine - Reclamation Plan Revision

Permit Number: ACT /015 /002

Mine: J.B. King

Permittee:

Description, include reason for change and timing required to implement: Reconfiguration of reclaimed J.B. King Mine site to address remedial actions required by NOV #91-32-6-1; #93-25-3-1; and #93-25-5-1. Abatement will begin within 45 days of plan approval by DOGM.

☐ Yes	☒ No	1. Change in the size of the Permit Area? ______ acres ☐ increase ☐ decrease.
☐ Yes	☒ No	2. Change in the size of the Disturbed Area? ______ acres ☐ increase ☐ decrease.
☐ Yes	☒ No	3. Will permit change include operations outside the Cumulative Hydrologic Impact Area?
☐ Yes	☒ No	4. Will permit change include operations in hydrologic basins other than currently approved?
☐ Yes	☒ No	5. Does permit change result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes	☒ No	6. Does permit change require or include public notice publication?
☒ Yes	☐ No	7. Permit change as a result of a Violation? Violation #
☒ Yes	☐ No	8. Permit change as a result of a Division Order? D.O.#
☐ Yes	☒ No	9. Permit change as a result of other laws or regulations? Explain:
☒ Yes	☐ No	10. Does permit change require or include ownership, control, right-of-entry, or compliance information?
☐ Yes	☒ No	11. Does the permit change affect the surface landowner or change the post mining land use?
☒ Yes	☐ No	12. Does permit change require or include collection and reporting of any baseline information?
☐ Yes	☒ No	13. Could the permit change have any effect on wildlife or vegetation outside the current disturbed area?
☒ Yes	☐ No	14. Does permit change require or include soil removal, storage or placement?
☒ Yes	☐ No	15. Does permit change require or include vegetation monitoring, removal or revegetation activities?
☐ Yes	☒ No	16. Does permit change require or include construction, modification, or removal of surface facilities?
☒ Yes	☐ No	17. Does permit change require or include water monitoring, sediment or drainage control measures?
☒ Yes	☐ No	18. Does permit change require or include certified designs, maps, or calculations?
☐ Yes	☒ No	19. Does permit change require or include underground design or mine sequence and timing?
☐ Yes	☒ No	20. Does permit change require or include subsidence control or monitoring?
☐ Yes	☒ No	21. Have reclamation costs for bonding been provided or revised for any change in the reclamation plan?
☐ Yes	☒ No	22. Is permit change within 100 feet of a public road or perennial stream or 500 feet of an occupied dwelling?
☐ Yes	☒ No	23. Is this permit change coal exploration activity ☐ inside ☐ outside of the permit area?

☐ **Attach 3 complete copies of proposed permit change as it would be incorporated into the Mining and Reclamation Plan.**

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

E.M. Gerick (signature) Feb. 17, 1994

Signed - Name - Position - Date
E.M. Gerick - V.P. Operations

Subscribed and sworn to before me this 17th day of Feb, 1994

Paula B. Roberts (signature)
Notary Public

My Commission Expires: Aug. 11, 1995
Attest: STATE OF Utah
COUNTY OF Utah

OFFICIAL NOTARY SEAL
PAULA B. ROBERTS
Notary Public
STATE OF UTAH
My Comm. Exp. AUG 11, 1995
8186 BOYSENBERRY DR. SANDY UT 84093

RECEIVED
Received by Oil, Gas & Mining
FEB 18 1994

ASSIGNED PERMIT CHANGE NUMBER

LIST OF FIGURES

1.0 INTRODUCTION

This report presents additional reclamation procedures proposed by Western States Minerals Corporation (WSMC) at the reclaimed J.B. King Mine site. WSMC is proposing several activities at the reclaimed site that will disturb revegetated areas. The activities are in response to the Utah Division of Oil, Gas, and Mining (Division) requirements. WSMC is responding to correct conditions on the site that the Division contends do not meet the design or standards of the reclamation plan in drainage, erosion control, and revegetation. The specific areas of concern are: (1) the main and feeder drainage ditches configuration, (2) areas uncovered or having limited cover of soil on the top of the refuse pile, left for use as a revegetation test plot, (3) rate of erosion on the sides of the refuse pile, and (4) lack of revegetation success on small select areas of the site. These conditions were detailed in several Notices of Violation (NOVs) issued by Division as follows: NOV 91-32-6-1; NOV 93-25-3-1; and NOV 93-25-5-1.

The modifications proposed here will be the basis for changes to the approved Reclamation Plan (dated May 1, 1985 and subsequent additions through 1990). In this report, reference is made in each section, in parenthesis or by direct reference, to the appropriate Section in the approved Plan. When the modifications are approved and/or implemented, the appropriate sections will be formally submitted to the Division. It is also anticipated that at the completion of the proposed reclamation activities, an "as constructed" report will be filed.

The proposed additional reclamation facilities are shown on Drawing JBK-3. The main activity planned by WSMC is a reconfiguration of the drainage ditches by deepening the channels and changing alignment and gradient. Excavation of the channels will expose underlying soil or bedrock formations to form a plunge pool at the base of the rock face to dissipate energy in the water runoff.

Additional activities will involve the placement of the soil materials excavated from the reconfiguration operation. First, the soil will be used to cover the revegetation test plot on the top of the refuse pile maintained by the Division. Next, excess excavated soil material from channel construction will be distributed on the shaley area on the south side of the site. In addition, portions of sideslopes on the refuse pile will be selectively covered with rock mulch for additional erosion control.

This report is divided into eight sections: 1) Introduction, 2) Present Conditions, 3) Hydrology, 4) Channels, 5) Refuse Pile, 6) Testing, 7) Proposed Reclamation Procedures Cost, and 8) Proposed Standards. The purpose of this report is to gain Division approval for the proposed additional reclamation procedures and permission to proceed with the testing. The actual testing phase must be completed before details of plan will be known, and the project costs can be calculated.

2.0 PRESENT CONDITIONS

This section will summarize the revegetation status to date based on the 1989 through 1993 monitoring and surveying reports. Previous reclamation activities will be reviewed to provide an informational basis for the proposed additional reclamation procedures in this report.

2.1 **Previous Reclamation Activities** (Synopsis and update of UMC 784.13 - Reclamation Summary, July 1990)

Underground coal mining operations ceased in May 1981 at the J.B. King Mine site. In the spring and summer of 1985, the portals were permanently sealed and the facilities and equipment were removed for salvage. Surface disturbances were reclaimed in August through October of 1985. There was Phase I bond release following these activities.

The first phase of the reclamation consisted of removing six inches to four feet of contaminated surface material from the yard, coal stockpile area, and slurry/sedimentation ponds (UMC 817.22). This material was placed around the toe of the existing coarse refuse area (UMC 817.24). In conjunction with this work, the cement pads and foundations for the shop and mill were broken up and used as part of the portal backfill. The seven mine portals were backfilled by dozing two foot lifts of material from the portal bench area into and against the portals. Each lift was compacted prior to the placement of the next lift. Non-organic trash and debris were buried in a designated landfill at the southeast end of the mine site. All of the mine wells were plugged according to state requirements except WW #1 which was left intact at the request of Utah State Lands and Forestry.

The second phase of reclamation consisted of grading the refuse area to a rolling topography with a proposed maximum slope of 2H/1V, however the actual slope achieved was 4H/1V. This area was then dry compacted with a drum roller attached to a D-6 Dozer.

The third phase of reclamation consisted of the excavation, haulage, and placement of four feet of topsoil and substitute topsoil on the regraded refuse pile and the coal stockpile pad. Stockpiled topsoil was minimal due to the historic mining and the contamination of surface soils by fine coal dust and sediment (UMC 817.22). The topsoil stockpile and the existing sediment control berm were utilized to supply a small portion of the required soil material. The majority of the soil material used to cover the refuse pile was borrowed from the rest of the mine site; specifically from the main diversion channel and from the shaley slope on the southwest side of the site (UMC 817.24). Concurrently, a new sediment pond, sized to contain the 10 year, 24 hour storm event was constructed at the northwest end of the mine site (UMC 817.42, 817.45, and 817.56).

The fourth phase of reclamation consisted of 5 activities; (1) shaping the main channel, (2) installing check dams in the feeder ditch, (3) building a sedimentation control berm and ditch along the northern perimeter of the refuse area, (4) ripping the soil cover to a depth of 18 inches, and (5) seeding the entire 28 acre site. Approximately 5 acres of the site were drill seeded and the remainder was broadcast seeded at double the drill seed rate (UMC 817.112). The seeded area was also fertilized and mulched with straw (UMC 817.114). The seeding was completed during early October 1985 (UMC 817.113). A revegetation test plot (approximately one acre), located at the top of the reclaimed refuse area, was installed during reclamation at the request of the Division (UMC 817.111-.117 Revegetation supplement submitted July 1, 1985; Test Plot Area - Revegetation of Refuse Pile). This test plot incorporates varying depths of topsoil (0 to 4 feet), and three different fertilizer application rates. This test plot has been monitored by the Division, and it is slated to be covered with soil and revegetated during 1994 by WSMC.

The fifth and final phase of reclamation performed during the first week of April 1986 consisted of the planting of 5,000 seedlings (UMC 783.19 and 817.111-.117) and the construction of 2700 feet of perimeter fence (UMC 784.13).

Post reclamation monitoring was conducted on a monthly basis during the first year after reclamation was completed and quarterly thereafter. The sedimentation pond has never overflowed even during 1992 and 1993 when precipitation was above average. There has been no contribution of suspended solids to runoff outside of the reclaimed area. Post reclamation concerns have consisted primarily of erosion control and vegetative cover onsite. The site has been periodically monitored for revegetation cover, density, and general site conditions as required by the permit (UMC 784.13(b)(5)(vi)). In addition, during the summers of 1991 to 1993 the site was monitored for vegetation cover and density for trend analysis during years with no monitoring requirements.

Erosion (UMC 817.45 and 817.106)

The main diversion channel and the feeder ditch were originally designed to be unarmored with gently sloping revegetated banks. The design did not allow for the intensity of the rainfall events nor the relatively low vegetative cover common to this region. This resulted in excessive erosion of the feeder channel and the upper reaches of the main channel. In May 1987, rip rap was installed in the eroded channel areas. However, in late 1987 the rip rap also eroded due to intense storm activity that exceeded design criteria. In June 1988, the channels were again recontoured and the rip rap reinstalled. The check dams in the feeder ditch were also reinstalled. During severe storms in 1989, these installations failed and were repaired. They failed again in 1991. The Division issued NOV's subsequent to these failures, citing failure to meet design criteria.

A second area of erosional concern has been the west and southwest facing slopes of the refuse pile. Contour furrows in combination with straw bales and silt fences were initially used to control erosion. In late summer, 1986, the contour furrows filled with sediment and breached after the occurrence of several major storm events. This resulted in rilling along most of the slope area. The larger rills have been periodically filled with rock anchored straw, or controlled with additional silt fences. The rills and gullies do not interfere with the post-mining land use, and they appear to be stabilizing with natural rock armoring. The silt fences were removed during the summer of 1993, since their purpose for controlling sediment runoff during the early stages of revegetation was complete.

Revegetation (UMC 783.19)

Revegetation on the site has generally resulted in a vegetative cover and density that is comparable to the reference area, and other vegetation in the vicinity of the site. The west and southwest facing slopes of the reclaimed refuse area have been the most difficult area of the site to revegetate. This is due to a combination of the southern exposure, early unauthorized cattle grazing, poor soil conditions, and low precipitation from 1988-1990. In 1989, a grazing permit was secured from the state of Utah, and the perimeter fence was completely rebuilt, and sections added. A road was relocated outside of the reclaimed area in order to control vehicle entry and to prevent cattle trespass. The road on the site and some of the areas which were traversed by heavy equipment during channel rebuilding (comprising approximately two acres) were ripped, reseeded, and mulched in mid-October 1989.

2.2 **Present Revegetation Conditions and Trends** (UMC 783.19, 817.111, and 817.116)

The general condition and phenology of the vegetation on site has improved due to abundant precipitation during 1991 to 1993. Plant species cover has increased from 1989, and some shrubs and grasses have germinated to produce numerous seedlings. Grasses and shrubs have increased in size and cover. The plant cover on the reclaimed site is comparable to the region, and this year's (1993) increased growth was proportional to the reference area. The general trend in vegetation on the site has been a gradual increase in shrub density, also an increase of plant species of desirable forage quality with a simultaneous decrease in weedy species. There has also been a general increase in total plant cover of desirable plants (from 13% in 1989 to 25% in 1993). The reclaimed site does not have the same dominant species as the natural vegetation, but the species present provide good cover and quality habitat for animals. The reclaimed site has become a functional ecosystem with a diverse assemblage of plants and animals, and habitats in good condition. Due to the vegetation seeded and planted during reclamation, the J.B. King mine site contains more desirable vegetation for grazing than the surrounding areas, which has been heavily utilized as winter pasture for many years.

The perimeter fences surrounding the reclaimed site are in good condition and are being maintained on a continuous basis by a local contractor. The erosion control features including the catch pond, and rills filled with straw and rock are intact and operating. Erosion has not been excessive during the past two years of greater precipitation. Soil surfaces have stabilized through natural processes of armor plating with residual rock and compaction. The silt fences have been removed since their function of catching sediment during the early mine reclamation is no longer needed. The site is continuing to be monitored and maintained to promote revegetation and erosion control. Grazing rights to the site were obtained by WSMC through 1999 to exclude cattle. Vegetation and general site conditions were monitored during 1989, 1991, 1992, and 1993, and show a positive progressive trend in reclamation results.

Monitoring during 1993 showed that four-wing saltbush (*Atriplex canescens*) was the most abundant woody plant species measured in the sample plots at 45% of the total number of shrubs, and an average density of 1304 shrubs per acre. Shadscale (*Atriplex confertifolia*) was the second most abundant with a density of 22% of the total and 632 shrubs per acre. Winterfat (*Ceratoides lanata*) and greasewood (*Sarcobatus vermiculatus*) each were 11% of the total with 328 and 320 shrubs per acre respectively. Rubber rabbitbrush (*Chrysothamnus nauseosus*) was the last shrub species with a significant density at 9% of the total and 272 shrubs per acre.

During 1993, the average percent cover of all monitored plots for shrubs, grasses, and forbs was 17.2, 6.8 and 0.9 respectively, for an average desirable vegetative cover of 24.9%. Weeds (three species) had an average percent cover of 7.4. Bare ground comprised an average of 38.7% of the ground cover; litter, 17.4%; and rock, 11.6%.

Trends (UMC 817.113 to 817.117)

The trends of the shrub density and total vegetation cover at the reclaimed J.B. King site can be analyzed from the surveys and monitoring conducted during the past four years from 1989 to 1993. The changes are related to two major factors: (1) natural plant succession on disturbed substrates with gradual changes in species composition, cover, and density over a period of time; and (2) responses to climatic conditions and local weather patterns, particularly amounts and timing of precipitation. The natural trend in plant succession in this region is from a weedy annual forb to perennial shrubs and grasses. The planting of seeds and seedlings during early revegetation activities (1985 and 1986) partially shortcut the weedy seral stage of succession. However, the site has had various amounts of weedy cover depending on rainfall, the degree of soil and substrate disturbance, and the amount of desirable vegetative cover. In the local weather conditions, a three-year drought from 1988 to late 1991 has been followed with abundant snow and rain during the growing season in 1992 and 1993.

Shrub density increased from the three earlier surveys, but there was little apparent increase in total shrubs between 1992 and 1993. The previously noted change in shrub density and percentage composition has continued. The trend in shrub density was 1970 shrubs per acre in 1987, 2146 in 1989, 2430 in 1991, and 2,224 in 1992. The 2880 shrubs per acre calculated in 1993 was somewhat denser, probably as a result of a large number of seedlings, only some of which were large enough to be counted as shrubs in ground cover. The number of shrub species has stayed fairly constant, but the composition has been changing. Four-wing saltbush (*Atriplex canescens*) decreased in numbers and percentage of shrubs from 70% in 1987, to 47% in 1989, to 37% in 1991; then increased to 47% in 1992. The density and percentage was approximately the same in 1993 at 45%. The number of four-wing saltbush shrubs decreased during the earlier drought, and have been partially replaced as a result of new germination. Over the past two years, there were increases noted in winterfat (*Ceratoides lanata*) and shadscale (*Atriplex confertifolia*) as seedlings generally over the whole site, and in greasewood (*Sarcobatus vermiculatus*) in areas with clay or saline soils.

In summary, since the site was first revegetated, shrub density and percent composition has changed in the kinds and numbers of shrubs. The composition change has been the result of natural succession and replacement of shrubs, and as a result of the drought cycle followed by abundant moisture. The past two years has resulted in numerous shrub seedlings which were measured in the plant cover, but not in shrub density. Portions of the reclaimed areas had greater density, and some shrubs are germinating in specific soils. Greasewood was noted in the clay soils, and Gardner's saltbush in shaley slopes.

The average total plant cover including weeds was measured at approximately 21.0% (12.9% excluding weeds) in 1989, 14.8% (13.2% excluding weeds) in 1991, and 50.1% (22.0% excluding weeds) in 1992; and in the latest survey, the total plant cover measured in 1993 was averaged 32.3% (24.9% excluding weeds). This increase in vegetative cover the past two years was due to the high amount of precipitation the site received and the resultant increase in plant growth and germination. Variance in plant microcommunities was still high due to the differences in soils, moisture, and other ecological conditions. The dominant lifeform of the vegetative cover was shrubs although, during years of low moisture, grasses and forbs increase in amount of plant cover. Three species of plants were considered weeds and were excluded when calculating total desirable cover. Halogeton (*Halogeton glomeratus*) was the most abundant weed on the site, and is generally not considered desirable as forage and can be poisonous to sheep when constituting a large portion of their diet. However, in the fairly early successional stage present on the site, it promotes soil stability and its annual growth provides ground cover (litter) for the following year. Summer cypress (*Kochia scoparia*), and Russian thistle (*Salsola paulsenii*) were the other common weeds. As the vegetation on the site proceeds through natural succession, weeds will decrease as the disturbance factors decrease and soil surfaces change. A more natural vegetation will become established that resembles the surrounding plant community types, this trend can already be seen between 1989 and 1993.

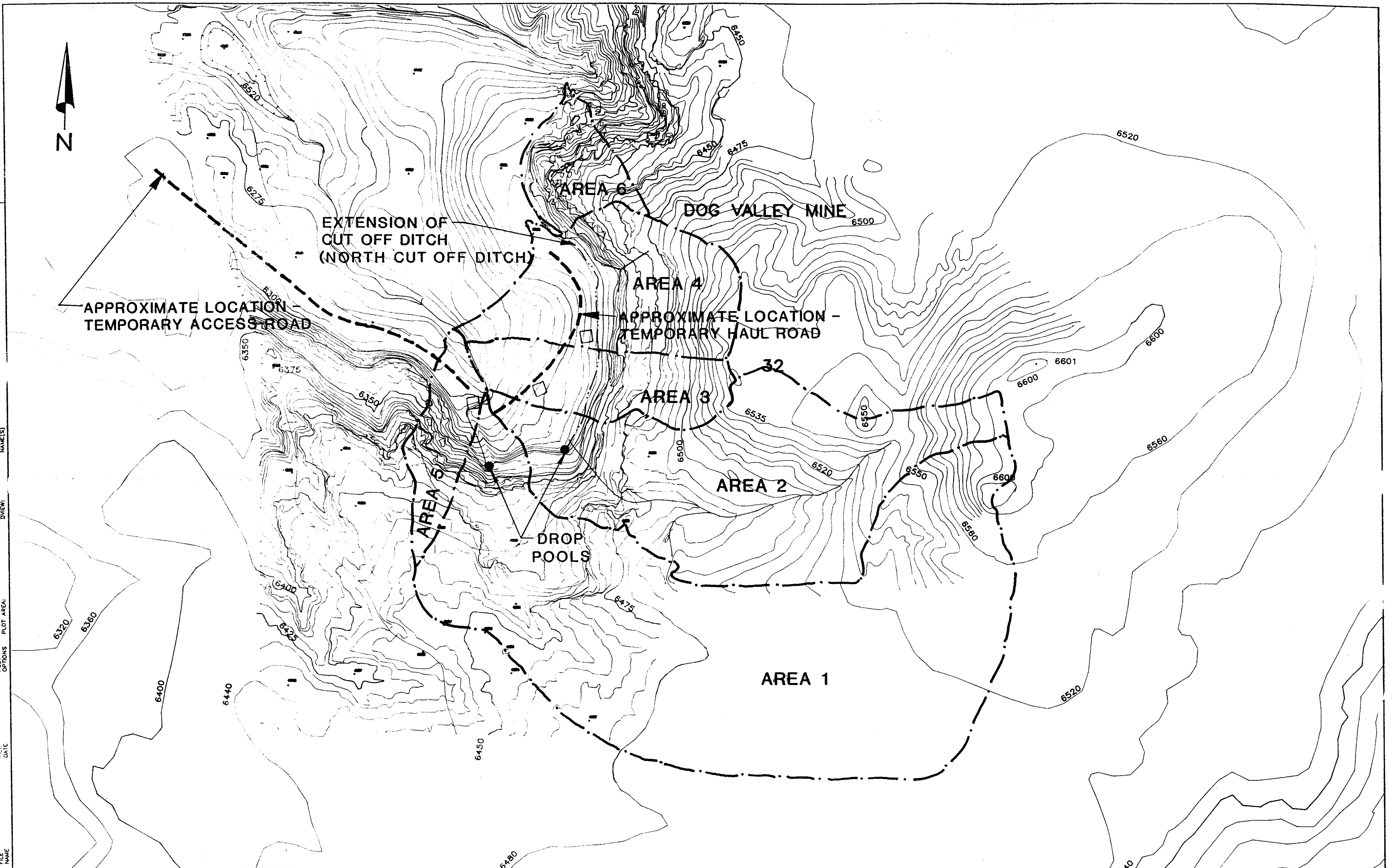
Although the grass percent cover did not increase greatly from the previous year, many young grass seedlings were observed in the past two years. Much of the grass was recorded as trace occurrences. Several grass species that are common in the natural communities near the mine site are becoming established onsite. Some of the grass species were in the original seed mixture, but are now becoming large enough to be observed in the plots. The grasses noted as increasing onsite were needle and thread (*Stipa comata*), galleta (*Hilaria jamesii*), and ricegrass (*Oryzopsis hymenoides*). Wheatgrasses (*Agropyron spp*) are common, but difficult to identify due to extensive hybridization. Hybrids were common throughout the site, and all hybrids of wheatgrasses were simply classified as one hybrid.

The other onsite condition undergoing change was the establishment of animal and invertebrate populations. Elk have overwintered on the site the past two years, and use by insects, birds, and small mammal burrows were observed. Ant hills were numerous on site, and are easily seen because ants denude vegetation surrounding their hills.

2.3 **Substrate and Topographic Considerations** (UMC 817.25)

The soil chemical and physical characteristics on the J.B. King mine have a large influence on revegetation plant cover, and affect the subsequent types of vegetation that persist on the site. The soil texture and chemical nutrient status is of particular importance for plant growth and species composition. Heavy, clay textured soils have very low plant growth in this part of the Colorado Plateau due to poor soil moisture conditions. Large concentrations of salts or alkali conditions in the soils can inhibit plant germination and growth. The sedimentary shale and sandstone around the coal beds typically are high in salts and some metals, and low in the plant nutrients of nitrogen, potassium, and phosphorus.

The majority of the soils observed on the reclaimed minesite are derived from a mixed substrate including large amounts of shale, some sandstone, and other miscellaneous soil materials. The soils tested on the site had a silt loam to silty clay texture, were basic, and had a high content of salts and alkali. In general, shaley bedrock soils were high in alkalinity. Nitrogen and phosphorus concentrations were low to medium, and potassium was average. Straw and other organic matter was observed in the top layers of soil but nitrogen was generally deficient. Other elements in excessive amounts in these soils were sulfur, boron, and iron; and either manganese or magnesium were also high. The onsite soil factors that are severely limiting for arid climate plant growth include the high content of clay, salt, alkali, and other minerals. The soil textures generally do not limit plant growth, but coupled with high salinity and alkalinity, they can contribute to the problem.



HANSEN ALLEN & LUCE INC. CONSULTANTS ENGINEERS Salt Lake City Utah	PROJECT ENGINEER	DESIGNED / DRAFTED / CHECKED / DATE SEPT. 1993	NO. 3 / 2 / 1 — DATE — REVISIONS — BY — APVD.	SCALE 1" = 600'	VERIFY SCALE: BAR IS ONE HALF INCH ON ORIGINAL DRAWING. IF NOT ONE HALF INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

WESTERN STATES MINERAL CORPORATION
J.B. KING MINE

DRAINAGE BASINS

FIGURE NO. JBK-4

Nutrients and fertilizer, as a soil amendment, are not effective for promoting plant growth if adequate soil moisture conditions are not present. This explains the poor growth and productivity of vegetation during drought years. During years of adequate moisture, plant cover and productivity will double when compared to dry seasons. The nature of the soils on the mine site and in this region requires plant species that are adapted to soils with poor textures, high salt content, and excess alkali and are drought tolerant. The soils analyzed all contained some excess salt and alkali, and require adequate soil moisture for good plant growth. The nutrient requirements for revegetation to native plants has not been established in this region.

3.0 **HYDROLOGY** (UMC 817.41 & 817.43)

R645 Coal Mining Rules indicate that the design capacity for an ephemeral channel should provide for *"combination of channel, bank and floodplain configuration ... adequate to pass safely the peak runoff of ... 10-year, 6-hour precipitation event for a permanent diversion" (742.333).* In consultation with Division and Western States Minerals Corporation (WSMC), it has been decided to utilize the 100-year 6-hour storm event, which is greater than that required in the regulations, for channel design.

Runoff flow rates have been computed by defining six drainage basins as shown on Figure JBK-4. Some of these six basins were then subdivided into two or three sub-areas as needed to more accurately determine peak flows which will be carried by each channel. The area and average slope were determined for each sub-area. Runoff was modeled using a computerized version of the SCS Curve Number Method for a 100 year 6 hour storm of 1.8 inches of precipitation. The results are summarized in the table below and the detailed calculations are shown in Appendix 1.

RUNOFF CALCULATION SUMMARY

DRAINAGE AREA	SUB-AREA	AREA (ACRES)	SLOPE (%)	PEAK RUNOFF (CFS)
1	Upper Area	30.8	10.1	24.9
	Middle Area	6.4	10.1	5.6
	Lower Area	0.6	14.0	0.6
2	Upper Area	10.7	18.9	9.3
	Middle Area	5.3	18.9	4.7
	Lower Area	1.0	14.0	0.9
3	Upper Area	2.1	29.9	1.9
	Lower Area	2.1	17.0	1.9
4	Upper Area	5.0	26.2	4.5
	Lower Area	2.9	25.0	2.6
5	N/A	3.2	23.0	3.0
6	N/A	2.5	41.5	2.3

4.0 CHANNELS (UMC 817.44)

State of Utah Coal Mining Rules state: *"A permanent diversion or a stream channel reclaimed after the removal of a temporary diversion will be designed and constructed so as to restore or approximate the premining characteristics of the original stream channel including the natural riparian vegetation to promote the recovery and the enhancement of the aquatic habitat"(742.313).*

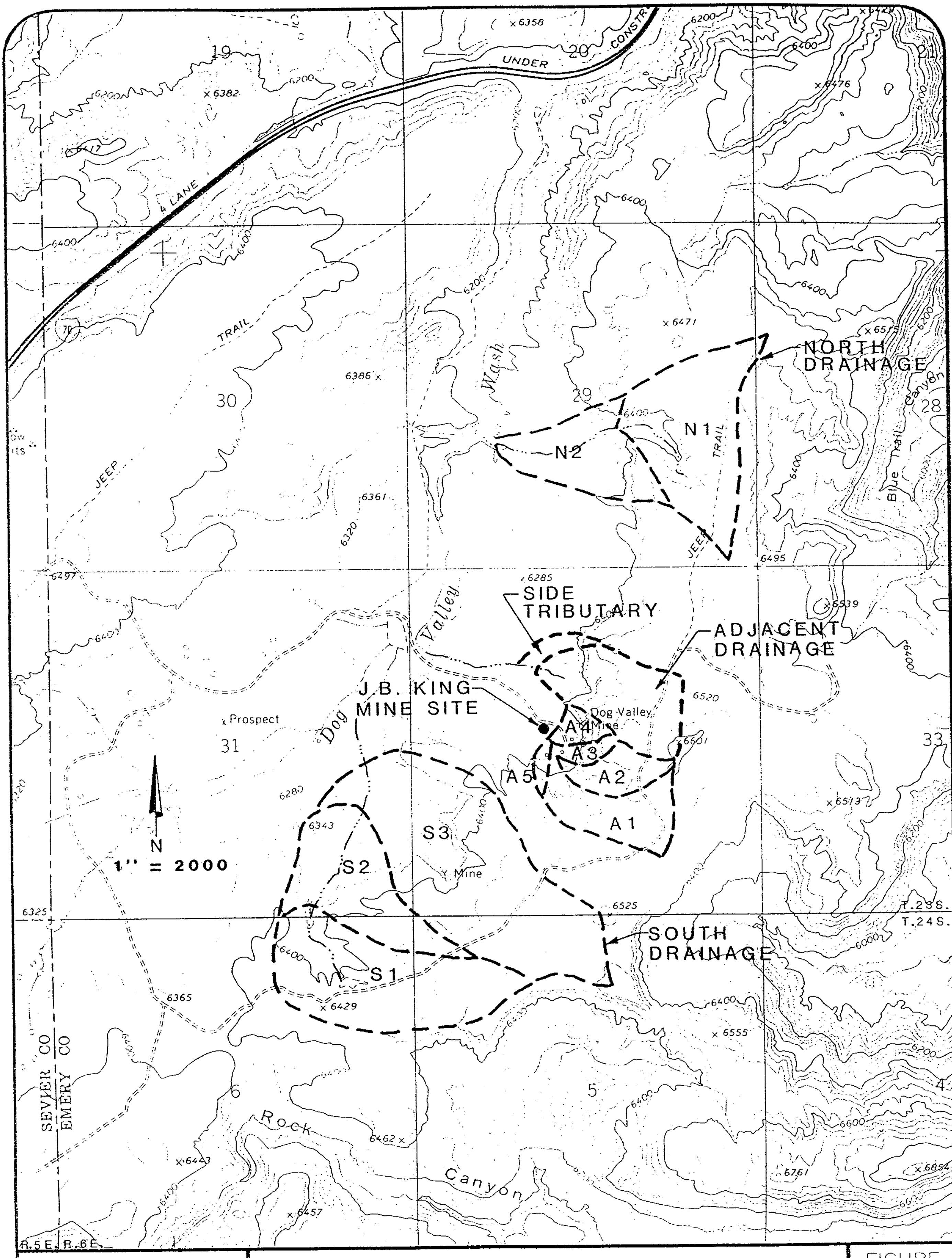
The premining characteristics of the J. B. King stream channels can be approximated through comparisons to the adjacent natural channels.

4.1 Characteristics of Adjacent Channels

Adjacent drainages to the J.B. King Mine site are shown on Figure JBK-5.

South Drainage: Located approximately 4000 feet southwest of the J. B. King site in Section 31.

The channel is highly incised just below the sandstone cliffs with channel depths of about 14 feet and near vertical side slopes. About 850 feet downstream from where sandstone ledge rock



HANSEN ALLEN & LUCE inc.	J.B. KING MINE & ADJACENT DRAINAGES	FIGURE JBK-5

dominates the channel, the channel disperses into an alluvial outwash area. Most of the channel below the sandstone ledges is eroded into past alluvial deposits. Cross section characteristics were examined at 12 locations starting at the downstream end of the channel (see the following table). Average channel characteristics for the four upper most cross sections (#'s 9, 10, 11, & 12) are: top width 21 feet, bottom width 19 feet, and channel depth 12 feet. Channel side slopes are near vertical (about 1 horizontal to 12 vertical). The maximum identified channel meander limit is 85 feet.

SOUTH DRAINAGE CHANNEL (SEC. 31)
CROSS SECTION DATA

X-SEC #	Bottom Width (ft)	Channel Depth (ft)	Channel Top Width (ft)	Width of Channel Meander (ft)	Comment
1	10	3.5	25	60	near downstream end of channel
2	25	2.4	34	60	channel side banks impacted by cattle
3	27	3.8	33	61	channel slope about 1.5%
4	16	5.9	24	85	
5	44	5.5	61	85	confluence with side channel, side channel length about 25'
6	19	6	32		
7	20	6.5	29		channel slope about 2.1%, confluence of side channel with side channel length of about 52'
8	21		22		straight channel reach
9	22	9	25		
10	12	11.8	15		
11	24	12	25		channel slope about 2.5%

X-SEC #	Bottom Width (ft)	Channel Depth (ft)	Channel Top Width (ft)	Width of Channel Meander (ft)	Comment
12	18	14.5	20	85	100' upstream from this section the channel becomes controlled by sandstone blocks which have fallen into channel.

North Drainage: Located about 4500 feet north of the J. B. King Mine site in Section 29. The Dog Valley channel upstream from the confluence is incised with steep vegetated banks. Sediment deposition has occurred at the confluence of the north drainage with Dog Valley channel. At the confluence the north drainage is about 8' deep and 11' wide with steep banks. Meander limit of the north drainage appears to be about 48'.

Adjacent Channel: Located just north of the J. B. King Mine site. This channel has an average channel slope of 5% which consists of reaches of about 2% slope interspersed with drops formed at sandstone ledges. This channel is likely the most similar to the premining channel through J. B. King Mine site. The drainage area is very similar to the total area tributary to the main J. B. King channel (less than 5% difference in tributary area). The measured channel width varied from about 2.5 feet wide in the upper reach to about 4 feet below the confluence with the side tributary (see Figure JBK-5). Channel depth varied from 2 feet in the upper reach to over 7 feet below the confluence with the side tributary. The channel side slopes varied from near vertical in the upper reach to about 0.7 horizontal to 1 vertical just below the confluence with the side tributary (top width varied from about 3 feet to about 14 feet).

Side Tributary Channel: This channel is tributary to the above described Adjacent Channel from the north (see Figure JBK-5). The Side Tributary Channel has a small tributary area (about 5 acres). The channel appears to be actively cutting just above the confluence with the Adjacent Channel. Channel slope varies from about 7% just above the confluence with the Adjacent Channel to 5% in upper reaches. The channel is very narrow and incised. Channel depth varies from the same as the Adjacent Channel at the confluence (about 7 feet) to less than a foot in upper reaches. Bottom width varies from about 0.8 feet to 1.2 feet with near vertical side slopes.

4.2 Proposed Channel Design and Analysis

The natural landscape is erosional, natural channels in the vicinity have the following characteristics: 1) concave slope, 2) lower channel reaches are depositional and channels tend to be less defined (characteristic of alluvial outwash plains), 3) channel depths generally increase and widths generally decrease as the upstream sandstone ledge rock is approached, 4) non-disturbed channels tend to have steep side slopes, and 5) upstream channel gradients are controlled by sandstone blocks and ledges. Natural channels in the vicinity are very poorly vegetated with a vegetation cover of less than 5%.

Bottom Width. A comparison of channel bottom width versus tributary area is presented on Figure JBK-6. Projecting a channel bottom width for the tributary area associated with the J. B. King Mine main channel on Figure JBK-6 indicates a bottom width of about **5 feet** would be appropriate.

Depth. Comparing channel depths of adjacent streams and the stream profiles of adjacent streams suggests that an appropriate channel depth is **about 10 feet.**

Top Width. Side slopes of adjacent undisturbed channels vary between nearly vertical to near 1 horizontal to 1 vertical with top widths just slightly larger than bottom widths. Channel side slopes through the J. B. King Mine site will be chosen to be stable from slope failure based upon soil strength characteristics determined from the test drilling.

Meander Width. The natural channels in adjacent drainages are free to wander and show evidence of active meandering. Through time the J. B. King reclaimed channels can also be expected to wander. Adjacent stream channels have measured meander widths of 85 feet and 48 feet (for the south and north drainages respectively). Many factors influence the meander width, however, if a meander width equal to the larger south drainage (about 85 feet) is provided, this should be adequate. A recommended meander limit of 100 feet (50 feet each side of the channel center line) is shown on Drawing JBK-7. The channel meander limits will be checked during the test drilling phase to assess the potential for exposing coal refuse. Materials found to be toxic or acid forming will be protected as described in Section 7.2.0.

4.3 Channel Hydraulics and Drawings (UMC 783.24)

Calculated runoff flows were used to design plunge pools and to check the capacity of proposed channels. Plunge pools were designed using the methodology described by V.T. Chow in "Open Channel Hydraulics." Details are contained in Appendix 2. It is proposed that two plunge pools be constructed, one at the head of the main channel and the other at the head of the feeder ditch as shown on Drawing JBK-7. Channels will be excavated to the approximate lines and grades shown on Drawing JBK-9. The final depths of the channel excavations will be based on actual conditions such as the presence of any rock ledges and the depth to shale. The designs shown herein are based on estimates and the "as built" channels may differ from these designs as required by field conditions. The channels will be constructed approximately to the alignments and profiles shown in the designs.

The south side feeder ditch (Ditch 1 - See Drawing JBK-7) has capacity well in excess of the design flow (30.5 cubic feet per second). The main feeder ditch (Ditch 2) has capacity well in excess of the design flow (15.9 cubic feet per second). A ditch (ditch 4) along the toe of the cliff which forms the south east boundary of the site will collect and divert runoff to the existing cutoff

TRIBUTARY AREA VS CHANNEL BOTTOM WIDTH

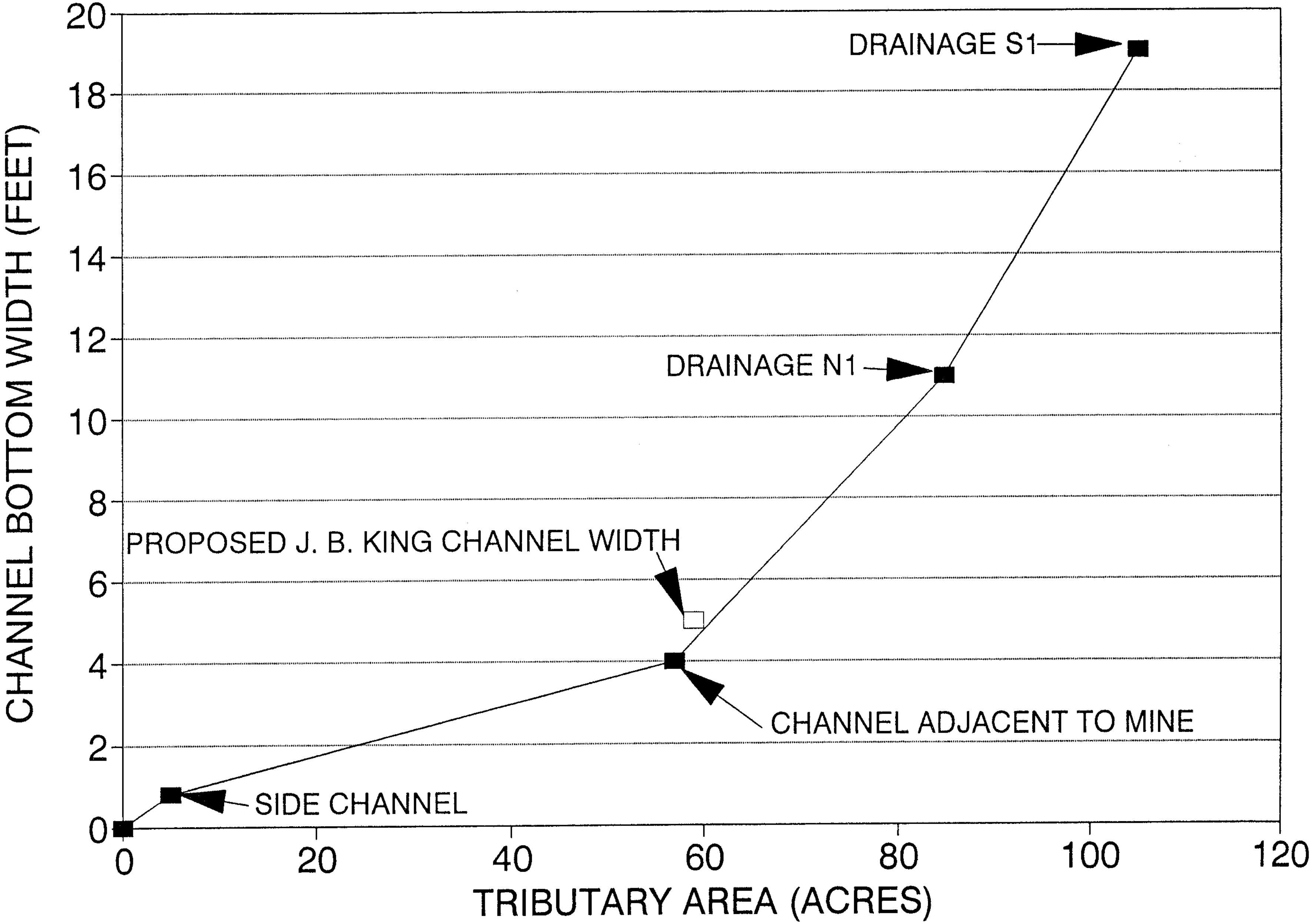
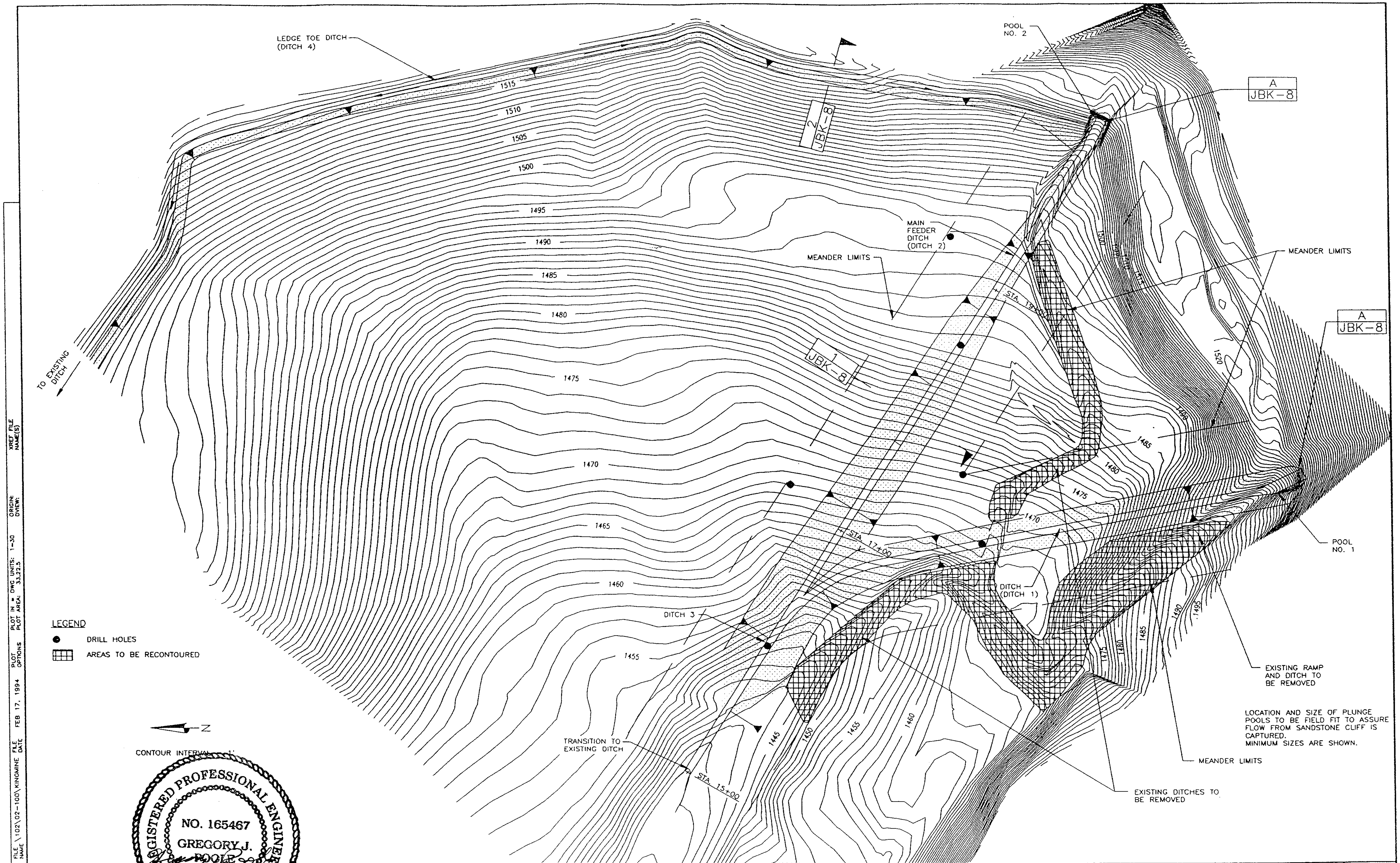


FIGURE JBK-6



HANSEN ALLEN & LUCE INC. CONSULTANTS ENGINEERS Salt Lake City Utah

DESIGNED	KCS	3				
DRAFTED	RSE	2				
CHECKED	GJP	1				
PROJECT ENGINEER	DATE FEB. 1994	NO.	DATE	REVISIONS	BY	APVD.

SCALE 1" = 60'

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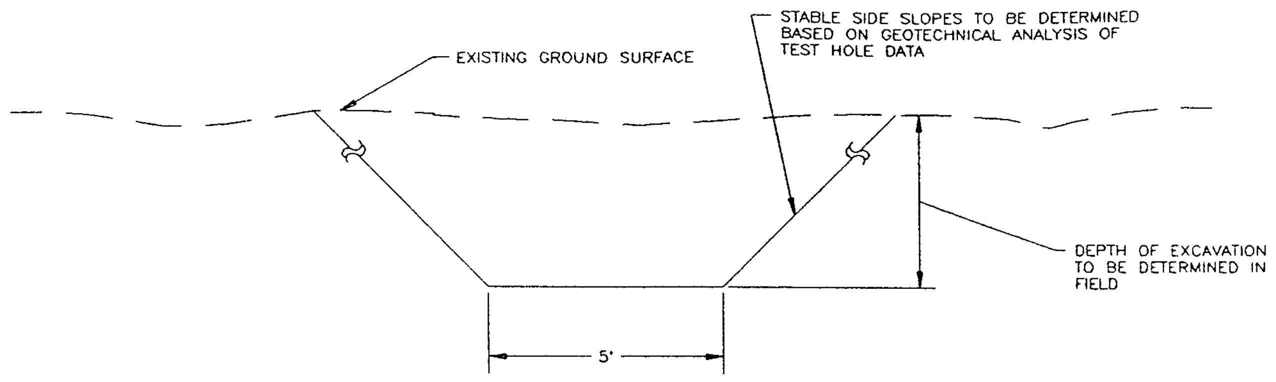
WESTERN STATES MINERAL CORPORATION
J.B. KING MINE

PROPOSED RECLAMATION CHANNEL RECONSTRUCTION
PLAN VIEW

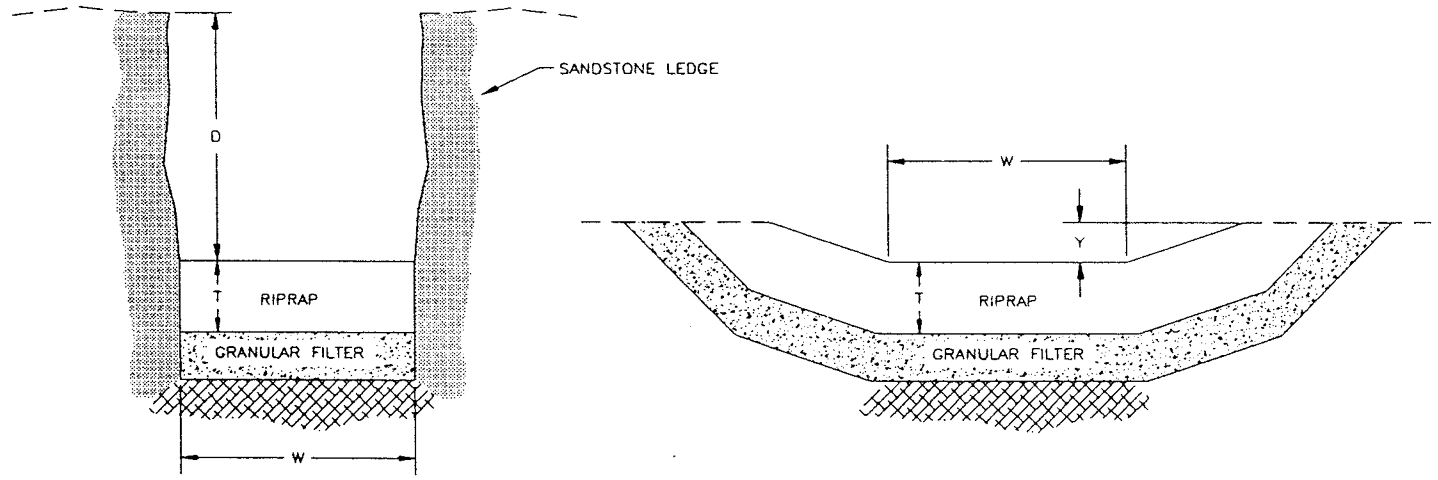
SHEET NO. JBK-7

1/93

	D (FT.)	W MIN. (FT.)	L MIN. (FT.)	Y MIN. (FT.)	MIN. RIPRAP D50 (IN.)	T MIN. (FT.)
DROP 1	10	8	25	3.5	12	3.0
	15	8	25	3.6	14	4.0
	20	8	25	3.8	14	5.1
DROP 2	10	7	20	2.8	12	2.9
	15	7	20	2.9	14	3.8
	20	7	20	3.0	14	4.2



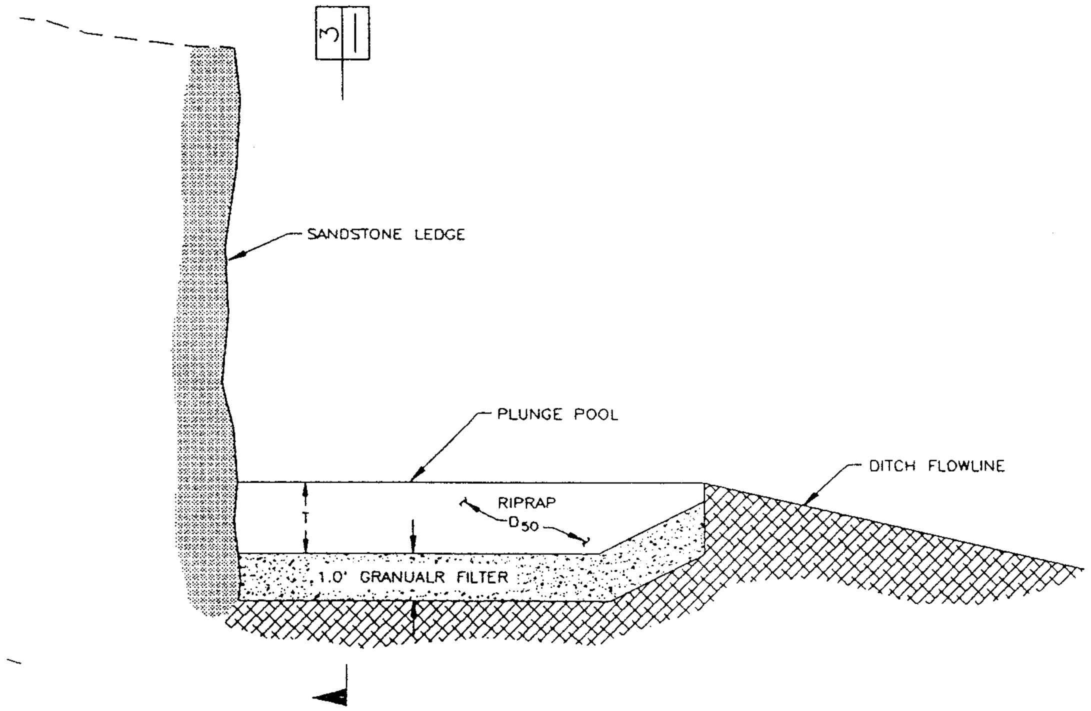
SECTION 1 / JBK-7



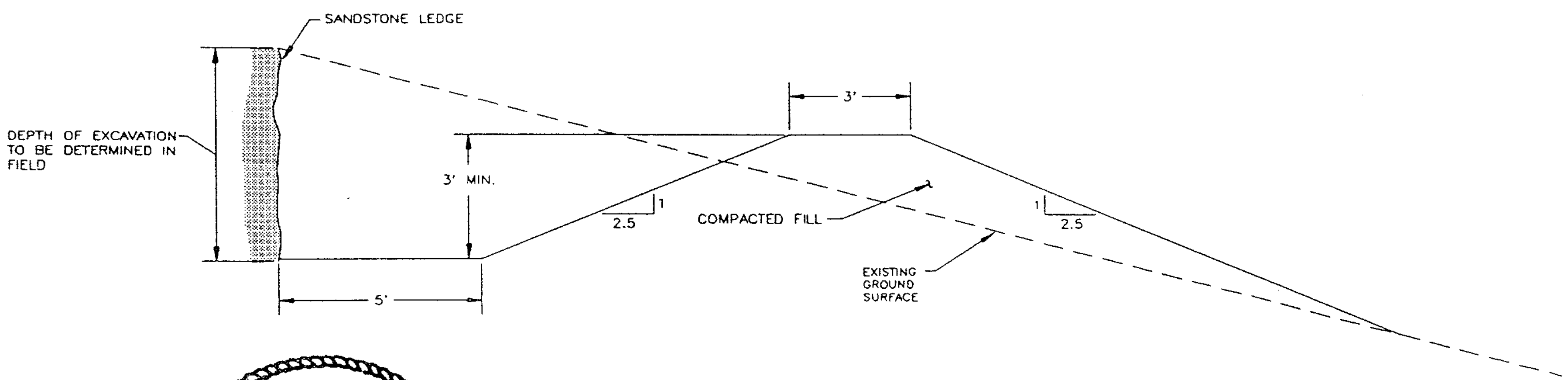
OPTION A

OPTION B

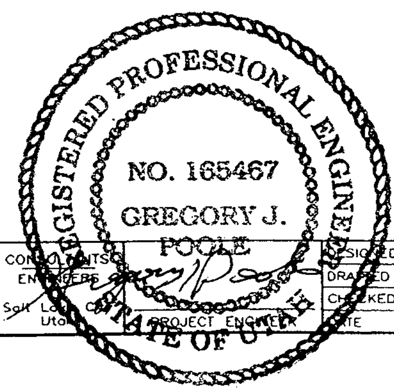
SECTION 3



DETAIL A / JBK-7



SECTION 2 / JBK-7



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Salt Lake City, Utah
1/93

DESIGNED	KCS	3	
DRAFTED	RSE	2	
CHECKED	GJP	1	
DATE	FEB. 1994	NO.	DATE
PROJECT ENGINEER		REVISIONS	BY / APVD.

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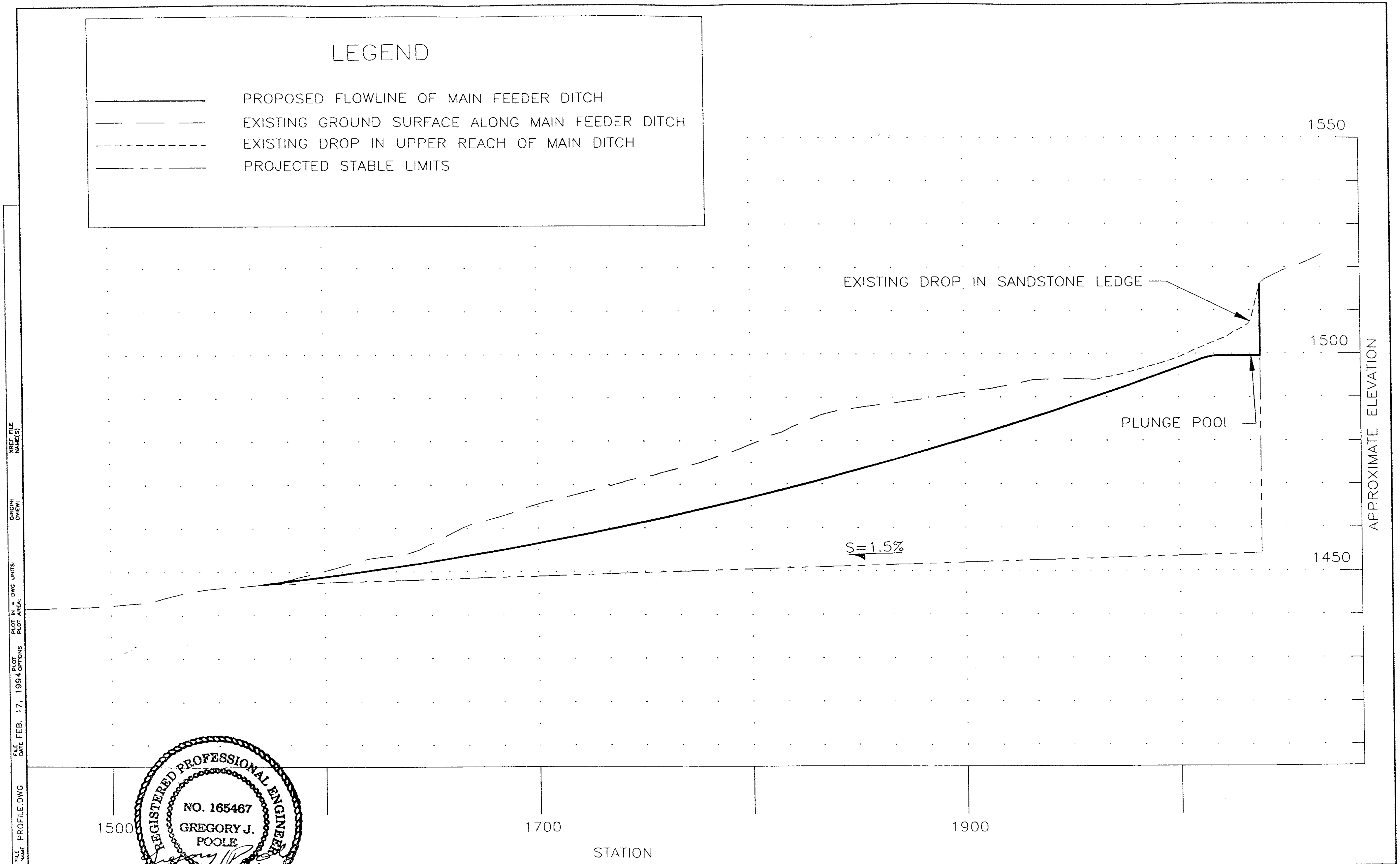
J.B. KING MINE

PROPOSED RECLAMATION CHANNEL RECONSTRUCTION
TYPICAL SECTIONS & DETAILS

SHEET NO. JBK-8



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Salt Lake City Utah

PROJECT ENGINEER

DESIGNED GJP
DRAFTED JSJ
CHECKED GJP
DATE FEB. 1994

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2				
1				

SCALE AS SHOWN

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J.B. KING MINE

PROPOSED RECLAMATION CHANNEL RECONSTRUCTION PROFILE

SHEET NO. JBK-9

1/93

ditch and to the plunge pool at the head of the main feeder ditch. This channel (Ditch 4) is designed to carry a flow of 1.9 cfs. Ditch 3 is formed by the confluence of ditches 1 and 2 and has capacity well in excess of the design flow (51.5 cubic feet per second). Calculations of channel capacities are based on Manning's Equation (see computations in Appendix 3) and details shown on Drawings JBK-7, JBK-8, and JBK-9.

4.4 Monitoring of Channel Performance

Channel peformance is defined as acceptable if channels keep within the meander limits shown on Drawing JBK-7 and within the stable profile limits shown on Drawing JBK-9.

5.0 REFUSE PILE (UMC 817.103)

The procedure for reclamation on the refuse pile are present in Section 7.0, proposed revegetation.

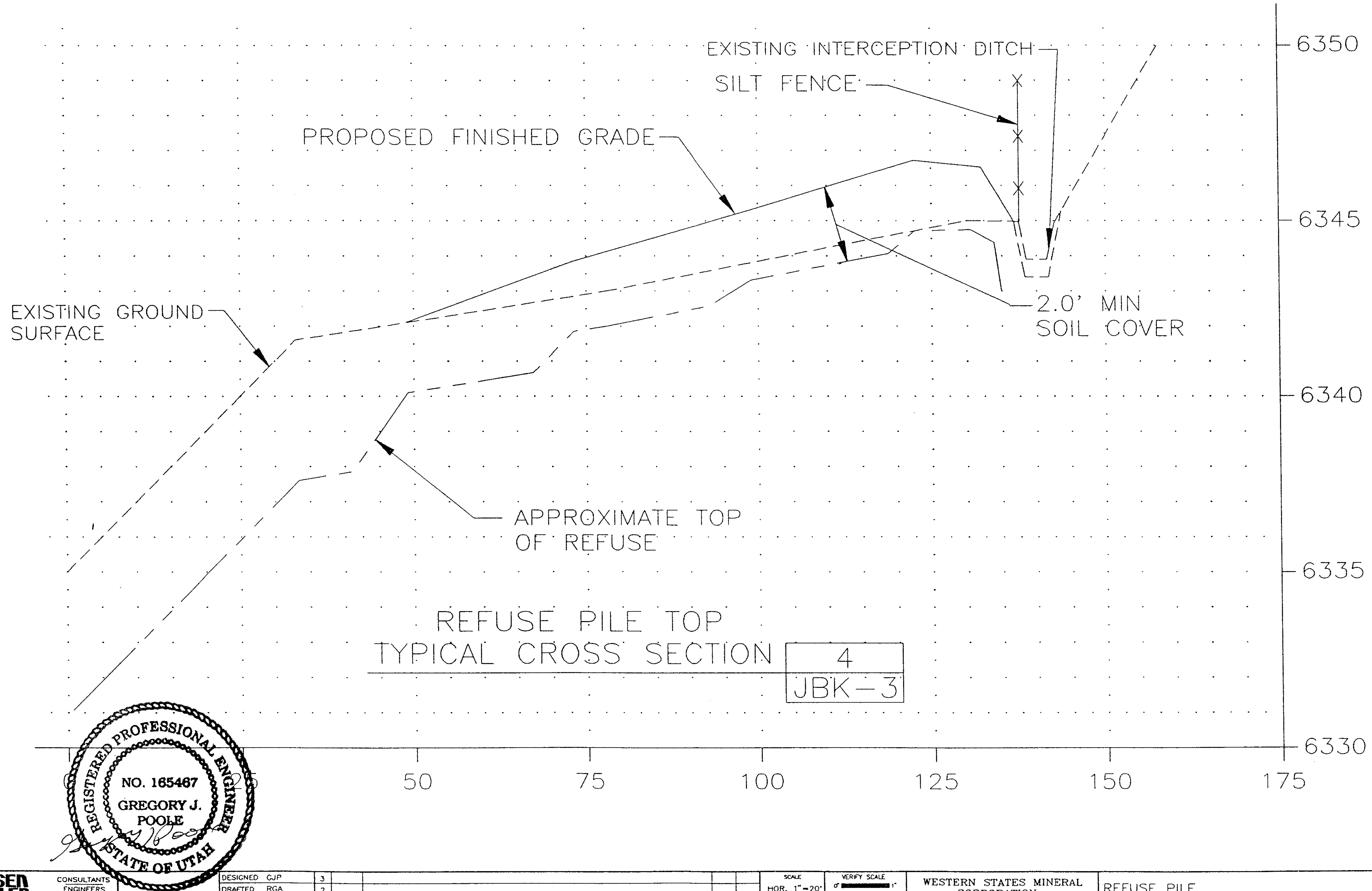
5.1 Top of Refuse Pile

The top of the refuse pile will receive material from the channel excavation to provide a minimum soil cover over refuse of two feet (see Figure JBK-10). Silt fence will be placed along the interception ditch between the ditch and the top of the refuse pile to treat storm runoff from disturbed areas of the top of the refuse pile which are tributary to the interception ditch during revegetation (UMC 817.45). After revegetation is satisfactory, the silt fence will be removed. The top of the Refuse Pile will be revegetated in accordance with Section 7.1.2.

5.2 Sides of Refuse Pile

The sides of the refuse pile will receive a minimum cover of 4 inches of rock mulch. Analysis with the Universal Soil Loss Equation predicts that the application of rock mulch will reduce erosion from the Refuse Pile side slopes by greater than a factor of 20. The predicted mean annual erosion rate with rock mulch is 0.5 tons per acre per year (see computations in Appendix 4). The predicted mean annual erosion rate with rock mulch is much less than the 2 tons per acre per year allowed by the Environmental Protection Agency for Hazardous Waste Landfill Cell side slopes (EPA, 1989).

The proposed source for the rock mulch is an existing pit leased by Utah Department of Transportation (see agreement for use in Appendix 4). The proposed rock mulch cover will contain some fines. The fines mixed with the rock will allow support of a reduced vegetative cover. Fines which are not protected by vegetation overtime may wash off the surface. As surface fines are washed away, the slope will become armored. The existing sediment pond will provide for runoff treatment during the armoring period. At the end of the reclamation period the surface of the rock mulch should be in balance with the erosion forces. This will provide for a more aesthetically pleasing side slope than if the cover were just rock. The side slopes of the refuse pile with be revegetated in accordance with Section 7.1.4.



REFUSE PILE TOP
TYPICAL CROSS SECTION 4 / JBK-3

FILE NAME PROTOP.DWG | FILE DATE FEB. 15, 1994 | PLOT OPTIONS | PLOT IN = DWG UNITS: 1=20 | PLOT AREA: | ORIGIN: | DVIEW: | XREF FILE NAME(S)

HANSEN ALLEN & LUCE INC. CONSULTANTS ENGINEERS Salt Lake City Utah	PROJECT ENGINEER	DESIGNED GJP / DRAFTED RGA / CHECKED GJP / DATE FEB. 1994	NO. 3 / 2 / 1 — DATE — REVISIONS — BY — APVD.	SCALE HOR. 1"=20' VERT. 1"=5'	VERIFY SCALE 0" 1" BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

WESTERN STATES MINERAL CORPORATION
J.B. KING MINE

REFUSE PILE CROSS SECTION

SHEET NO. JBK-10

6.0 SAMPLING AND TESTING WITHIN CHANNEL MEANDER LIMIT AND ON REFUSE PILE (UMC 817.15)

Upon approval from the Division a drilling program will be initiated to determine the presence of acid- or toxic-forming materials within the refuse pile and within the corridors delineated for the channels proposed herein. Approximate locations of proposed drill holes are shown on Drawing JBK-3 and Drawing JBK-7. Exact locations may be adjusted to accommodate field conditions.

Drilling will be accomplished with a balloon tired all-terrain drilling rig. This will eliminate the need to disturb the site for construction of roads and drill pads. The drilling method will consist of pounding a sampling tube five feet into the material to be drilled. The sampling tube will be withdrawn and the sample will be removed and labeled for identification. An auger drill will then be advanced five feet into the drill hole. The process is then repeated beginning with the pounding of the sampling tube five more feet into the material. Sampling will continue in each drill hole until consolidated material is encountered. This method allows samples to be taken of undisturbed material for more accurate logging of the drill holes.

No drilling fluids or mud will be used and no water will be encountered in the drill holes.

Samples collected within the proposed channel corridors, including any layers of coal fines, will be combined into ten foot composite samples beginning at the surface. One reason for doing this is that if a small layer of coal fines exists in the fill material in a location where it could be exposed by erosion of a channel there will also be exposed in the channel at least ten vertical feet of material above and/or below the layer of coal fines. All of the material exposed by the channel will erode together so the acid- and toxic-forming properties of the channel are more closely represented by composite samples. The other reason is to provide samples of the size recommended in the "Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining", April 1988, ("Guidelines") (two splits of two quarts each). If it is determined that any ten foot composite sample is acid- or toxic-forming because of the presence of coal fines, the subject coal fines will be handled as described in Section 7.2. (R645-301-553.300) (817.102f)

Samples of coal refuse material collected from drill holes located on the refuse pile area will be combined into ten foot composite samples of refuse material only. Samples of refuse material will not be combined with samples of the covering material or material from beneath the coal refuse. If the last increment of coal refuse sampled is less than ten feet then this increment will be composited with the previous composite sample. The primary reason for this procedure is to provide samples of the size recommended in the "Guidelines" of at least two quarts volume each for two splits.

Samples will be delivered to and analyzed by a certified laboratory for the parameters listed in the "Guidelines". See Section 7.2.2 for additional proposed testing. Also splits of the samples taken from the channel corridors will be subjected to geotechnical analyses to determine appropriate side slopes for the proposed channels.

Average acid- and toxic-forming properties for a drill hole on the refuse pile will be determined by calculating a weighted average of the parameters for each composite sample from the drill hole on a length weighted basis. The overall average acid- and toxic-forming properties of the refuse material will be determined by plotting the locations of the drill holes on the refuse pile, then connecting each plotted drill hole with the nearest drill hole/s with straight lines. Perpendicular bisectors will be constructed for each connecting line and the bisectors will be extended to the boundaries of the refuse pile. The area formed by the boundaries of the pile and the bisectors will be multiplied by the thickness of refuse measured in the drill hole located within that area to determine the weighting volume to be applied to the data derived from that drill hole. A volume weighted average will then be calculated for all of the parameters which will represent the average parameter values for the whole refuse pile. This method is similar to the Thiessen method described in "Hydrology for Engineers" by Ray K. Linsley, et.al., 1982, McGraw-Hill, pages 71 and 72. The parameters as determined by this method will then be evaluated against the standards presented in the "Guidelines". There are two reasons for using the volume weighted average parameters for the entire refuse material to determine acid- and toxic-forming properties. The first reason is that the "Guidelines" recommend a drill hole pattern of 16 holes per section, or about 1,742,000 square feet per drill hole, for phase two development characterization of overburden. Using four drill holes to characterize the refuse material results in a spacing of about 68,000 square feet per drill hole, or about 25 times more accurate than recommended by the "Guidelines". By using a single volume weighted average for each parameter to represent the entire refuse volume the sampling density is on the order of 272,000 square feet per sample. If the sampling density recommended by the "Guidelines" is considered sufficient by the Division, a sampling density six times the recommended density would be more than sufficient. See Section 7.2.2 for a discussion of soil testing for suitability for use in revegetation.

The second reason for using a single average for each parameter to represent the entire refuse volume is that if the refuse material erodes, the erosion will tend to take place over the entire refuse area, as well as over other surrounding areas. In other words the products of erosion will tend to be a random mixture of the refuse material itself, along with a mixture of other surrounding materials. This makes it impossible to predict the parameters of the products of erosion and over time the parameters of eroded refuse material will tend toward the average parameters for all of the refuse material. In other words, if the entire refuse pile is moved to another location and the refuse material is sampled in the new location the parameters of that sample will tend to match the average parameters of the refuse material before it was moved.

When drilling has been completed each drill hole will be backfilled with the drill cuttings. The top four feet of each drill hole located on the refuse pile will be backfilled with substitute topsoil material. It is expected that the areas disturbed will be limited to the actual drill holes because of the equipment proposed to be used so there should be no other grading or reclamation required. In any case the drill holes are to be located in areas which will be further disturbed during the construction of the channels and additional work performed on the refuse pile to reduce erosion. Because of this no further reclamation as a result of the drilling is proposed. (R645-301-551) (817.15)

7.0 PROPOSED REVEGETATION PROCEDURES

Revegetation activities on the J.B. King mine site have been influenced by local conditions of low annual precipitation (< 10 inches/year), a recent drought, and the generally poor plant growth conditions of the substrate and soil. The area has received precipitation as summer thundershowers which caused excess water runoff and decreased infiltration. The low plant growth in this region is frequently the results of two major factors; soil infertility or high salts, and low water availability. The proposed reclamation activities are designed to overcome these limitations through additional soil placement, roughening and rock mulching of erodible surfaces, and the addition of sewage sludge, if available, as a soil amendment to promote plant growth.

The reconfiguration of the ditches and transport of excavated material will require the use of heavy equipment, and a main access road and transport corridors across already revegetated areas. The freshly disturbed areas of the previous ditches, roads, covered revegetation test plots, slopes of the refuse pile, and excess soil on the south shaley area will require revegetation. A final activity will involve enhancement of select areas on the mine site which currently have low or no vegetative cover. Additional site specific information will be needed to determine these areas' exact extent and the best methods to increase the vegetative cover.

7.1 Additional Reclamation or Revegetation Activities on Disturbed Areas (UMC 817.111)

The areas on the site to be reclaimed or revegetated are principally those disturbed by the proposed reconfiguration of the drainage channel and the various soil or rock mulch placement activities. These areas of disturbance will be kept to a minimum size by confining equipment and reducing disturbance outside areas being worked. The areas that will need reclamation include: (1) portions of the regraded present ditches (that will no longer be used); (2) the main access corridor to the ditch, staging area, and transport routes to the refuse pile; (3) the revegetation test plots where soil will be placed; (4) the face of the refuse pile which will be covered with rock mulch, and the excess soils pile on the south shaley area. These areas of disturbance will essentially remove or cover the existing vegetation, and require either roughening or revegetation procedures, or both. In addition, some areas of sparse vegetative growth may need enhancement depending on the size and pattern of the vegetated areas. The procedures recommended for each area are described in the following sections.

7.1.1 Reconfigured Ditches and Banks (UMC 817.45)

The excavation of the drainage ditch will change the shape and gradient of the channels and produce excess soil materials. The sides and narrow bottoms of the ditches will be composed of either rock outcrop or naturally compacted material that will not be revegetated. Disturbed soil in the present ditches will be revegetated according to the standard procedures used on the rest of the site and those in this present proposal. Reclamation procedures will need to be reevaluated and altered after the results of the soil tests are known, and the final configuration of the ditch is planned and implemented. The purpose of the reclamation activities are to restore vegetation on those areas of the present ditches that will support plant growth.

The amounts of soil materials removed from the ditch and their placement on the site will be determined based on results of the soil sampling analysis. The purpose of this sampling is to collect geotechnical information in the vicinity of the ditch alignment, and to analyze for parameters important in determining their suitability for use in the revegetation program. This excavated material will be segregated and suitable soil substrate will be used to cover the revegetation test plots. See Section 7.2 for additional details on soil testing and handling.

Those areas around the drainage ditch to be revegetated will be roughened and seeded with the approved seed mix, augmented, if possible, with collections of native seed from the area. See Sections 7.4 and 7.5 for details on recommend-ed soil amendments and seed mix.

7.1.2 Revegetation Test Plot (UMC 817.111)

The revegetation test plot on top of the refuse pile has varying amounts of soil covering the coal refuse. See Permit Section 817.111 - Revegetation Supplement Dated July 1, 1985 - showing schematic of test plot in Figure on page 3. The test plot is approximately 100 feet wide and 435 feet long. The present area is mostly flat, with a slight slope to the west and north. The plot was segmented into four linear sections, each 25 feet wide by 435 feet long, with depths of soil cover at 0" (on the east, next to the perimeter ditch), 6", 12", and 24" (on the west, leading into the slope of the refuse pile). The purposes of the proposed alteration to the test plots are to cover exposed coal refuse, and to provide a suitable substrate for revegetation.

The proposed procedures for this test plot are:

1. Maintain the surface of the plot in its mostly flat topographic form to prevent runoff and erosion (See Figure JBK-10 for a cross section of the altered test plot).
2. Cover all segments of the test plot with a minimum of 24" of soil. That is, add the total 24" to the exposed coal refuse segment, add 18" additional soil to the current 6" depth, and add 12" additional soil to the current 12" depth. Suitable soil will be transported from the excavation of the newly proposed drainage ditches.
3. Grade the surface of the covered test plot into a roughened surface to enhance water availability for revegetation, and tie into the surface configuration of the western faces of the refuse pile (see Drawing No. JBK-3).
4. Amend the soil with sewage sludge and seed the area immediately with the recommended seed mix.

The excess soil placed on the south shaley area will be roughened and amended with organic matter mixed into the surface layer, before sowing with the recommended seed mix as described above. The surface will be either be protected with a straw mulch at a rate of approximately 3000 pounds per acre or the application of straw with cattle penning (see Section 7.4). If the soil from the excavated drainage ditches is not suitable, an alternative source of soil or cover material could be the rock mulch used on the slopes of the refuse pile.

7.1.3 Access Road and Transport Corridors (UMC 817.111)

These transport areas will generally be linear and no more that 10 feet wide. The compacted surface will be ripped and roughened prior to mulching and seeding. Roads susceptible to erosional rills will be protected by water bars. Straw mulch will be crimped into the loose soil surface.

7.1.4 Sloped Surfaces of the Refuse Pile (UMC 817.45, 817.105, and 817.111)

Slopes on the portions of the refuse pile are potentially erodible due to the low vegetative cover, and the placement of soil into smooth and compacted slopes. Vegetation on this slope will not control erosion given the arid climate, severe thunderstorms, and lack of mature drainage patterns. In order to control erosion, this surface will be roughened and covered with a rock mulch. The main purpose of these activities is slope stabilization and erosion control. The present vegetative cover, about 10%, will be destroyed by the roughening procedures and application of the rock mulch. See Section 4.0 for a discussion of vegetation performance standards for this section of the reclaimed site.

Details of the proposed activities on the slopes are as follows:

1. The slope of the refuse pile will be regraded to form a roughened surface (shown on Map JBK-3 for location). The roughened surface with elevation differences of approximately 12" will be formed along and across the slope in an irregular manner to simulate natural patterns. These will be field determined at the time of construction.
2. A minimum of 4" layer of rock mulch will be applied to the entire freshly disturbed surface. See Section 7.2.1 for a discussion of the source and nature of the rock mulch. The rock mulch will be mixed with sewage sludge, if available, to improve water holding capacity. The rock mulch surface will then be left roughened to insure water availability for vegetative growth.
3. The areas will be seeded immediately with the approved mix augmented with seed collected locally from native plants, if available. See Section 7.5 for a discussion of seed sources to be used. Penned and fed cattle <u>may</u> be used to fix straw into this surface, but stray application on the rock mulched side slopes is <u>not</u> required.

7.1.5 Staging Area and South Shaley Area (UMC 817.21, 817.24, and 817.25)

The proposed staging area and south shaley area (which was initially a substitute topsoil borrow area when the site was reclaimed in 1985) is located to the west of the proposed channel construction in the flat area below the southwest escarpment. This area will be disturbed by equipment staging, soil segregation and handling activities, and by placement of excess soil materials excavated during channel construction. At the end of these activities this area will need to be reclaimed.

Reclamation activities during construction will consist of segregation of the soils by: (1) placing soils determined to be unsuitable along the base of the escarpment (the former borrow area), (2) using suitable soils mixed with sludge to first cover the test plots on top of the refuse pile, and (3) then use the remainder to cover the unsuitable soils placed against the escarpment with a minimum of 2 feet. After construction activities cease, the surface of these areas will be contoured, roughened, and seeded. Straw mulch will be applied to enhance germination, or penned cattle may be used to fix straw mulch.

7.2 Substrate Handling Procedures (UMC 817.21)

The removal of substrate material from the reconfigured drainage channel will require excavation, handling, and placement a quantity of soil material estimated at between 5,000 and 8,000 cubic yards. The soil material removed will be used to cover the top of the refuse pile and the remainder will be placed on the staging and borrow area. This material will also require testing for quantity and suitability for use in reclamation. This section will describe the procedures to be used in handling these requirements.

7.2.1 Sources of Substrate (UMC 817.22)

Soil excavated during the reconfiguration of the drainage channels will be used to cover the revegetation test plot area on top of the refuse pile and to fill in the former borrow area below the southwest escarpment. This soil will be divided into either suitable or unsuitable soil for use in revegetation, as determined by testing. Portions of the soil will be handled twice by dumping first in the staging area, amended, and then transported again to the final destination. Other soil will be loaded and transported directly to the placement area. Soil transport and placement will depend on the efficient determination of suitability. Suitable soils may also be amended in place (see Section 7.4 for details).

Unsuitable soil, if present, will be placed along the base of the scraped escarpment (in the former borrow area) on the southwest side of the site. Approximately 2000 cubic yards of suitable soil will be needed to complete coverage of the top of the refuse pile. All remaining suitable soil will be used to cover the unsuitable soil below the southwest escarpment. If any of the excavated material is determined to be toxic or acid-forming, it will the first material be placed at the base of the escarpment, and later covered with at least two feet of suitable soil.

The source of rock mulch for plating the face of the refuse pile will be taken from a Sand & Gravel Lease (#37912) granted to the Utah Department of Transportation and used as a borrow area about one mile west of the site. This material will have a large percentage of rock. There are several pits in this borrow area that may be used. The material chosen will be tested for suitability for erosion control, and the fines portions tested for pH and electrical conductivity.

7.2.2 Proposed Testing of Substrate Sources (UMC 784.13)

Soils excavated from the reconfigured drainage channel will need to be tested for their suitability for use in revegetation. Six soil sample holes will be drilled into the area to be excavated for geotechnical analysis. Portions of the soil samples will first be tested for the percentage of coal refuse. If less than 10% coal refuse is present, then the samples from these cores will be tested for those parameters listed in Table 2, Overburden Evaluation for Vegetative Root Zone in the Division's Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining (UDOGM, April 1988). If the amount of coal refuse is greater than 10%, then the parameters listed in Table 6, Recommended Laboratory Methods (UDOGM, April 1988) for determination of toxic and acid forming materials will be tested. The results of these tests will give preliminary information on the soil to be excavated. See Section 6.0 for a discussion of sampling soil core procedures.

During implementation suitability of soil material will be first determined by visual inspection for texture, percentage of rock, and amounts of coal refuse. Obvious lenses of coal refuse will be segregated and placed first in the south shaley area, then covered. Other parameters of the soil will be tested with a field test kit for pH and electrical conductivity. Amounts of coal refuse in the soil will be tested with a quick method using an acid spray to reveal the coal particles. A field flotation method to separate the coal may be used, if practicable.

7.2.3 Implementation of Substrate Spreading and Distribution (UMC 817.24)

Soil substrate will be transported to and spread on that portion of the revegetation test plots with currently less than 24" of soil cover. The minimum depth of soil added will be 24" (on a 435' x 25' area) on bare spoils, 18" (on a 435' x 25' area) on the current 6" depth, and 12" (on a 435' x 25' area) on the current 12" depth in order to accommodate the soil surface roughening described in Section 7.3. The maximum amount of amended substrate needed would be approximately 2000 cubic yards. Roughening the surface will promote water availability for plant growth. This area will be reseeded immediately onto the fresh soil surface (see Section 7.5 for revegetation procedures).

Although not expected, if any toxic or acid-forming substrate material is found among the excavated material, it will be placed first in the former borrow area against the base of the southwest escarpment. It will be covered with a minimum of two feet of suitable cover material. All substrate material tested to be unsuitable for use in revegetation will also be placed in this area. This will be covered with the remainder of the suitable substrate after the revegetation test plot on the refuse pile is covered. This area will be contoured and revegetated by the same methods as the soil placed on the revegetation test plots.

7.3 Soil Surface Roughening (UMC 817.24)

The recommended pattern for the final grading on the revegetation test plot and soil placed on the south shaly area is to roughen the surface. The benefits from this are twofold: (1) this would minimize runoff and erosional gullying, and (2) the captured moisture will then remain available for onsite plant growth enhancement. The depth of the roughened depressions should be about initially be about 12", but will eventually decrease in depth the area is revegetated.

7.4 Soil Amendments (UMC 817.25 and 817.114)

The purpose of the recommended soil amendments is to overcome the effects of low nutrient status (provide a nitrogen and phosphorus source), to improve the soil tilth for plant water availability and use, and to retain nutrients. Soil conditions that limit water use ability by plants, due to high salt or alkali content, cannot be easily altered by soil amendments. These conditions can be partially offset by improving other general soil conditions for plant growth.

The best amendment for improving the nutrient status and moisture regime of the soil is heavy textured organic matter (such as sewage sludge). This will also improve tilth and water holding capacity. Hay and straw can be used to protect the reclaimed soil surface after seeding, but will not greatly improve the soil conditions or enhance plant growth. The organic sludge also contains large amounts of nitrogen that will slowly release over a period of years, having a persistent positive effect on the soil fertility. The use of sewage sludge will depend on finding a source close to the site and the ability to obtain a permit. Work on this is proceeding, and a potential source has been located from the city of Moab P.O.T.W. The rate of sludge application is being recommended in a range of 12 to 18 tons per acre.

Chemical fertilizer is not recommended for use as a soil amendment. The use of chemical fertilizer can promote weed growth that would compete with the native and desirable plants. Chemical fertilizer may increase salts in soils already high in salts. Also, the nutrient standards for the native vegetation is not known. An inappropriate nutrient addition will not help, and may even hinder, native plant germination and growth.

The procedures for using penned cattle for applying organic mulch is as follows:

1. Enclosed the area to be mulched with an electric fence.
2. Release cattle at the rate of about 15 to 25 per acre into the enclosure.
3. Provide excess feed hay (and water) evenly distributed on the ground.
4. Keep cattle on the area for about a week or until the ground is evenly covered with mulch.

This procedure has the advantage of evenly distributing a high quality mulch and creating pocket for seed germination.

7.5 Revegetation Activities (UMC 817.111 to UMC 817.117)

The revegetation activities include the proposed seed mix to be used, methods of acquiring seed and sources, and the application rates of seeding.

7.5.1 Seed Mix (UMC 817.100 and 817.112)

All reasonable attempts to use local native seeds for revegetation will be made. Local seed collection companies will be contacted for availability of native species for use in the seed mix. Also, WSMC will collect native seed along the Dog Valley escarpment of those plants which are desirable for revegetation on the site. Collection will depend on sufficient seed being set during the 1994 growing season.

The recommended seed mix has been adjusted based on the monitoring results of the past four years for growth of plant species in the original seed mixture. Some species that were planted did not germinate or grow, such as joint fir, blue grama and big bluestem, and these plants will not be seeded again. Table 7.1 gives the presently recommended seed mix. This mix may be adjusted depending on availability of seed from seed collection companies and from the Dog Valley native plant population seeds.

Table 7.1 Recommended Seed Mix for Revegetation

Common Name	Scientific Name	lbs/acre PLS*	% of total
Western wheatgrass	*Agropyron smithii*	4	21.9
Thickspike wheatgrass	*Agropyron lanceolatum*	2	11.0
Indian rice grass	*Oryzopsis hymenoides*	2	11.0
Galleta	*Hilaria jamesii*	2	11.0
Sand dropseed	*Sporobolus cryptandrus*	1	5.5
Winterfat	*Ceratoides lanata*	2	11.0
Four-wing saltbush	*Atriplex canescens*	1	5.5
Shadscale	*Atriplex confertifolia*	2	11.0
Gardner saltbush	*Atriplex gardneri*	1	5.5
Yellow sweet clover	*Melilotus officinalis*	0.5	2.7
Needle-n-thread	*Stipa comata*	0.5	2.7
Globemallow	*Sphaeralcea grossulariifolia*	0.5	2.7
Palmer penstemon	*Penstemon palmerii*	0.25	1.4

* PLS - pounds of pure live seed recommended for drilling per acre

7.5.2 Application Methods and Rates (UMC 817.113)

The general seed mix will be applied at 33 to 35 pounds per acre (twice the rate in Table 7.1) by the broadcast method. Seeds germinate best when applied immediately on freshly worked soil, therefore seeds will be applied as soon as (within 24 hours) a portion of the site is finished graded or roughened. Seed will be broadcast either by hand or using a hand-held mechanical spreader. Native seed collected from the Dog Valley area, if available, will be applied separately onto the most suitable sites based on substrate or topography. Available native seed with be hand spread as evenly as possible.

7.6 Undervegetated Areas (UMC 817.111 and UMC 817.116)

The Division is requesting the establishment of a better vegetative cover on the north side of the refuse area and drainage area (the area shown in green on Reclaimed Topography and Disturbed Area reclamation map dated 10-07-90, also titled JBK-1). This area has variable vegetative cover due to soil scraping and disruption during past mining and subsequent reclamation. Observations in the vicinity of the mine, however, showed that similar sparsely vegetated areas occur on natural, undisturbed soils due to natural heterogeneous soil and substrate conditions (see Section

4.0). There are outcrops of sandstone, shaley parent materials, alluvial flats, colluvial slopes, and coal seams that have similar sparse, low, or absent vegetative cover.

Twelve random samples were taken in the specific area north of the refuse pile during the 1993 site vegetation monitoring. The average desirable plant cover was 22.8% with 4 species of shrubs, 12 species of grasses, 3 species of forbs, and 3 species of weeds (not included in plant cover). This area as a whole does meet required revegetation standards and has cover similar to the site as a whole. However, localized areas of less than standard cover do exist. A composited soil sample from this particular area on the reclaimed site was analyzed for soil parameters and did not identify any specific soil problems. The soil was heterogeneous and similar to the rest of the site. The soil surface layers were probably removed during reclamation for borrow material since the soil surface lacks a organic surface layer, and the unweathered substrate materials were exposed at the surface in places.

The procedures given in Section 8.0 will establish criteria for what area needs increased vegetative cover based on natural conditions around the site for vegetative patterns and sizes of areas with little plant cover. The soil conditions can be observed onsite at the time of the corrective actions, and field determined as to the appropriate enhancements to use. The areas can be selectively enhanced using sewage sludge as a soil amendment to improve water holding capacity, and hand tools as described in Section 7.4. This is a long-term and better solution than attempting to selective rip and reseed small areas in an otherwise well revegetated area. This will be performed using accepted husbandry practices for the region.

8.0 PROPOSED ADDITIONAL METHODS FOR DETERMINING RECLAMATION STANDARDS (UMC 817.116)

The present reference area does not address two revegetation criteria raised as concerns by the Division at the JB King mine site. The present single reference area can be used for vegetative cover, shrub density, and productivity standards on the site. However, the first criteria not addressed is the pattern of vegetation and size allowance for bare versus vegetated areas. The topography and soils on the reclaimed site are complex and disturbed, and the vegetation established is not uniform. The second concern is the development of an appropriate revegetation standard for the slopes of the refuse pile which will be covered with rock mulch for erosion control. There will be a large percentage of rock on the surface to control rain splash and erosion, this will impact the vegetation that can be established. The amount of suitable soil surface for vegetation will be drastically reduced. There are no areas on the site or in the vicinity that will have this type of surface for use as a reference.

For the first additional criteria, WSMC is proposing to conduct a specific type of sampling for determining the relationship of vegetation patterns to soils and topography on undisturbed natural areas in the vicinity of the mine site. This method uses linear coupled transects, which are linear plots (typically 2 x 10 meters in size) laid end to end along a straight compass line and oriented parallel to the gradient. The transects will be run from the north edge of the site in a north direction along gradients at the same elevation as the site. This will be repeated running south from the southern edge of the site. The general areas to be surveyed will be the westerly facing escarpments and slopes of Dog Valley. Vegetative, topographic, erosional, and soil parameters will be recorded in each plot. The transects will be analyzed for the type of vegetation and size of bare areas as they relate to topography, soils, and erosional features.

The parameters in the transects to be measured for vegetation are: percent cover by species, numbers of shrubs by species, and length of the center line that is vegetated. Topographic features recorded will be slope and aspect; soils features will be types of substrate and percentage rock; and erosion features will be depths and width of drainages (gullies and rills), and depths of aggradation and degradation of surfaces. Transects will be permanently marked with 3' lengths of #3 rebar driven 2.5' into the ground.

The results of the transects will be analyzed for: (1) the vegetative types, percentage, and sizes of area with low vegetative cover; (2) the percentage and types of topographic slopes; (3) the percentage and types of soil; and (4) types and amounts of erosional features. The correlations between these four sets of parameters will be determined, and the results applied to conditions on the site with similar parameters. They will be applied as criteria for the allowable size and percentage of areas with low vegetative cover in relationship to topography and soils.

WSMC is proposing the following procedure for the revegetation standard to be used on the rock mulched slope of the refuse pile: (1) determine the percent cover of rock in 1995 after the surface has settled and weathered, (2) subtract the current percent cover of rock (about 11%) from this to determine the percentage of soil available for revegetation, and (3) this soil percentage of fines (potentially can be vegetated) will be multiplied by the present vegetative cover to derive a revised standard. For example, if rock cover in the rock mulched area is 75%, subtract 11% previous rock cover for a total of 64% rock cover. The soil surface cover would then be 36% (100% - 64%) times 10% vegetative cover, this would then equal 3.6% vegetative cover as the standard. This standard will apply only to that portion of the site covered with rock mulch.

WSMC is not proposing a vegetation standard for the coal refuse revegetation test plots covered with soil. This area is the responsibility of the Division, and the standard will be the same as the rest of the area (consistent with UMC 817.111-.117 Revegetation supplement submitted July 1, 1985; Test Plot Area - Revegetation of Refuse Pile, Paragraph 2).

REFERENCES

Utah Division of Oil, Gas, and Mining (UDOGM), April 1988, Guidelines for Management of Topsoil and Overburden for Underground and Surface Coal Mining.

U.S. Environmental Protection Agency, July 1989, Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments.

Israelsen, C. Earl, Joel E. Fletcher, Frank W. Haws, and Eugene K. Israelsen, 1984, Erosion and Sedimentation in Utah: A guide For Control, Utah Water Research laboratory, Utah State University, Logan, Utah.

Barfield, B.J., R.C. Warner, and C.T. Haan, 1985, Applied Hydrology and Sedimentology for Disturbed Areas.

Simons, Li & Associates, 1982, Engineering Analysis of Fluvial Systems

Appendix 1
Runoff Calculations

PROJECT : J.B. King Mine Area 1

AREA= 37.9 ACRES
AVERAGE BASIN SLOPE= 10.1 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 3000. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .1878 HOURS QPCFS= 152.62 CFS QPIN= 3.9934 INCHES
C3= 19.6837 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2212	.0000	.0000	.0	.00
1.43	.2286	.0000	.0000	7.7	.00
1.46	.2360	.0002	.0001	47.4	.00
1.50	.2438	.0004	.0002	101.3	.01
1.54	.2567	.0010	.0006	140.1	.03
1.58	.2695	.0019	.0009	152.6	.09
1.62	.2824	.0031	.0012	143.0	.17
1.65	.2952	.0045	.0014	120.7	.30
1.69	.3081	.0062	.0017	94.4	.47
1.73	.3209	.0080	.0019	69.6	.67
1.77	.3337	.0102	.0021	49.1	.89
1.80	.3466	.0125	.0023	33.3	1.11
1.84	.3594	.0151	.0026	22.0	1.35
1.88	.3723	.0179	.0028	14.1	1.59
1.92	.3851	.0208	.0030	8.8	1.82
1.95	.3980	.0240	.0032	5.5	2.06
1.99	.4108	.0274	.0034	3.3	2.28
2.03	.4516	.0393	.0119	2.0	2.57
2.07	.5017	.0562	.0169	1.2	3.22
2.10	.5517	.0754	.0192	.7	4.52
2.14	.6017	.0966	.0213	.4	6.49
2.18	.6518	.1198	.0231	.2	8.96
2.22	.7018	.1446	.0248	.1	11.66
2.25	.7518	.1709	.0264	.0	14.39
2.29	.8018	.1987	.0278	.0	17.00
2.33	.8519	.2278	.0290	.0	19.42
2.37	.9019	.2580	.0302	.0	21.63
2.40	.9519	.2893	.0313	.0	23.62
2.44	1.0020	.3215	.0323	.0	25.41
2.48	1.0520	.3547	.0332	.0	27.02
2.52	1.0860	.3778	.0230	.0	28.39
2.55	1.0995	.3870	.0093	.0	29.07
2.59	1.1130	.3964	.0093	.0	28.46
2.63	1.1265	.4057	.0094	.0	26.51
2.67	1.1400	.4152	.0094	.0	23.69

PROJECT : J.B. King Mine Area 1
(Continued)

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
2.70	1.1536	.4247	.0095	.0	20.63
2.74	1.1671	.4342	.0095	.0	17.80
2.78	1.1806	.4438	.0096	.0	15.45

HYDROGRAPH PEAK= 29.07 cfs
TIME TO PEAK= 2.55 Hours
RUNOFF VOLUME= 2.91 Acre-Feet

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CLIENT WSMC
PROJECT J.B. KING
FEATURE
PROJECT NO.

COMPUTED
CHECKED
DATE

AREA 2

CONTOUR LENGTH = 17 1/4" × 200 FT/IN = 3450

CONTOUR INTERVAL = 40 FT.

AREA = 16.8 ACRES = 731,808 SQUARE FT.

SLOPE = $\frac{3450 \times 40 \times 100}{731,808}$ = 18.9 %

HYDRAULIC LENGTH = 2,000 FT.

100 YEAR 6 HOUR STORM = 1.8"

CURVE NUMBER = 90

FROM "HYDRO" THE PEAK FLOW IS 14.19 CFS | USE 14.5 CFS |

SEE PAGES 5 & 6.

PROJECT : J.B. King Mine Area 2

AREA= 16.8 ACRES
AVERAGE BASIN SLOPE= 18.9 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 2000. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0993 HOURS QPCFS= 128.00 CFS QPIN= 7.5560 INCHES
C3= 37.2434 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2211	.0000	.0000	.0	.00
1.41	.2251	.0000	.0000	6.4	.00
1.43	.2290	.0000	.0000	39.8	.00
1.45	.2329	.0001	.0000	85.0	.00
1.47	.2369	.0002	.0000	117.5	.00
1.49	.2408	.0003	.0001	128.0	.01
1.51	.2460	.0005	.0002	119.9	.03
1.53	.2528	.0008	.0003	101.2	.04
1.55	.2595	.0012	.0004	79.2	.07
1.57	.2663	.0017	.0005	58.4	.10
1.59	.2731	.0022	.0005	41.2	.15
1.61	.2799	.0028	.0006	28.0	.20
1.63	.2867	.0035	.0007	18.4	.26
1.65	.2935	.0043	.0008	11.8	.32
1.67	.3003	.0051	.0008	7.4	.38
1.69	.3071	.0060	.0009	4.6	.44
1.71	.3139	.0070	.0010	2.8	.50
1.73	.3206	.0080	.0010	1.7	.56
1.75	.3274	.0091	.0011	1.0	.62
1.77	.3342	.0103	.0012	.6	.68
1.79	.3410	.0115	.0012	.3	.74
1.81	.3478	.0128	.0013	.2	.80
1.83	.3546	.0141	.0013	.1	.85
1.85	.3614	.0155	.0014	.0	.91
2.40	.9494	.2877	.0166	.0	12.67
2.42	.9759	.3046	.0169	.0	12.97
2.44	1.0023	.3218	.0172	.0	13.27
2.46	1.0288	.3392	.0174	.0	13.55
2.48	1.0552	.3569	.0177	.0	13.81
2.50	1.0804	.3740	.0171	.0	14.06
2.52	1.0876	.3789	.0049	.0	14.19
2.54	1.0947	.3838	.0049	.0	13.86
2.56	1.1019	.3887	.0049	.0	12.92
2.58	1.1090	.3936	.0049	.0	11.54

PROJECT : J.B. King Mine Area 2
(Continued)

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
2.60	1.1162	.3986	.0049	.0	10.01
2.62	1.1233	.4035	.0050	.0	8.56
2.64	1.1305	.4085	.0050	.0	7.33

HYDROGRAPH PEAK= 14.19 cfs
TIME TO PEAK= 2.52 Hours
RUNOFF VOLUME= 1.30 Acre-Feet

AREA 3

CONTOUR LENGTH = 7" x 200 FT./IN = 1400 FT.

CONTOUR INTERVAL = 40 FT.

AREA = 4.3 ACRES = 187,308 SQUARE FT.

$$\text{SLOPE} = \frac{1400 \times 40 \times 100}{187{,}308} = 29.9\%$$

HYDRAULIC LENGTH = 900 FEET

100 YEAR 6 HOUR STORM = 1.8 IN.

CURVE NUMBER = 90

FROM "HYDRO" THE PEAK FLOW IS 3.79 CFS | USE 4 CFS |

SEE PAGE 8

PROJECT : J.B. King Mine Area 3

AREA= 4.3 ACRES
AVERAGE BASIN SLOPE= 29.9 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 900. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0417 HOURS QPCFS= 78.06 CFS QPIN=18.0022 INCHES
C3= 88.7328 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	19.0	.00
1.42	.2281	.0000	.0000	65.3	.00
1.44	.2311	.0000	.0000	77.2	.00
1.45	.2341	.0001	.0000	59.1	.00
1.47	.2371	.0002	.0000	35.6	.00
1.48	.2400	.0003	.0000	18.5	.01
1.50	.2430	.0004	.0001	8.6	.02
1.51	.2481	.0006	.0002	3.7	.02
1.53	.2533	.0008	.0003	1.5	.04
1.54	.2584	.0011	.0003	.6	.05
1.56	.2635	.0015	.0003	.2	.06
1.57	.2686	.0019	.0004	.0	.08
2.40	.9468	.2860	.0126	.0	3.51
2.41	.9668	.2987	.0127	.0	3.56
2.43	.9868	.3116	.0129	.0	3.61
2.45	1.0067	.3247	.0130	.0	3.66
2.46	1.0267	.3379	.0132	.0	3.71
2.48	1.0467	.3512	.0133	.0	3.75
2.49	1.0667	.3647	.0135	.0	3.79
2.51	1.0818	.3749	.0103	.0	3.77
2.52	1.0872	.3786	.0037	.0	3.47
2.54	1.0926	.3823	.0037	.0	2.81
2.55	1.0980	.3860	.0037	.0	2.12
2.57	1.1034	.3897	.0037	.0	1.63
2.58	1.1088	.3935	.0037	.0	1.34

HYDROGRAPH PEAK= 3.79 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .33 Acre-Feet

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CLIENT WSMC
PROJECT J. B. KING
FEATURE
PROJECT NO.

COMPUTED
CHECKED
DATE

AREA 4

CONTOUR LENGTH = 15.25" x 200 FT/IN = 3050

CONTOUR INTERVAL = 40 FT.

AREA = 8.09 ACRES = 352,268 SQUARE FT.

SLOPE = $\frac{3050 \times 40 \times 100}{352,268}$ = 34.6

HYDRAULIC LENGTH = 5.25" x 200 FT/IN = 1050 FT.

100 YEAR 6 HOUR STORM = 1.8"

CURVE NUMBER = 90

FROM "HYDRO" THE PEAK FLOW IS 7.12 CFS. USE 7¼ CFS
SEE PAGE 10

PROJECT : J.B. King Mine Area 4

AREA= 8.1 ACRES
AVERAGE BASIN SLOPE= 34.6 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 1050. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0438 HOURS QPCFS= 139.65 CFS QPIN=17.1187 INCHES
C3= 84.3780 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	30.2	.00
1.42	.2281	.0000	.0000	110.5	.00
1.44	.2311	.0000	.0000	139.5	.00
1.45	.2341	.0001	.0000	113.9	.01
1.47	.2371	.0002	.0000	73.3	.02
1.48	.2400	.0003	.0000	40.6	.02
1.50	.2430	.0004	.0001	20.2	.03
1.51	.2481	.0006	.0002	9.3	.04
1.53	.2533	.0008	.0003	4.1	.06
1.54	.2584	.0011	.0003	1.7	.09
1.56	.2635	.0015	.0003	.7	.12
1.57	.2686	.0019	.0004	.3	.14
1.59	.2738	.0023	.0004	.1	.17
1.60	.2789	.0028	.0005	.0	.19
2.40	.9468	.2860	.0126	.0	6.59
2.41	.9668	.2987	.0127	.0	6.69
2.43	.9868	.3116	.0129	.0	6.78
2.45	1.0067	.3247	.0130	.0	6.87
2.46	1.0267	.3379	.0132	.0	6.96
2.48	1.0467	.3512	.0133	.0	7.04
2.49	1.0667	.3647	.0135	.0	7.12
2.51	1.0818	.3749	.0103	.0	7.10
2.52	1.0872	.3786	.0037	.0	6.60
2.54	1.0926	.3823	.0037	.0	5.47
2.55	1.0980	.3860	.0037	.0	4.21
2.57	1.1034	.3897	.0037	.0	3.24
2.58	1.1088	.3935	.0037	.0	2.64

HYDROGRAPH PEAK= 7.12 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .62 Acre-Feet

HANSEN ALLEN & LUCE inc

CLIENT WSMC
PROJECT J.B. KING
FEATURE
PROJECT NO.

COMPUTED
CHECKED
DATE

AREA 5

CONTOUR LENGTH = 4 IN. x 200 FT./IN = 800 FT.

CONTOUR INTERVAL = 40 FT.

AREA = 3.2 ACRES = 139,392 SQUARE FT.

SLOPE = $\frac{800 \times 40 \times 100}{139,392}$ = 23.0 %

HYDRAULIC LENGTH = 800 FT.

100 YEAR 6 HOUR STORM = 1.8"

CURVE NUMBER = 90

FROM "HYDRO" THE PEAK FLOW IS 2.82 CFS. USE 3 CFS
SEE PAGE 12.

PROJECT : J.B. King Mine Area 5

AREA= 3.2 ACRES
AVERAGE BASIN SLOPE= 23.0 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 800. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0432 HOURS QPCFS= 55.98 CFS QPIN=17.3491 INCHES
C3= 85.5135 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	12.5	.00
1.42	.2281	.0000	.0000	45.0	.00
1.44	.2311	.0000	.0000	55.8	.00
1.45	.2341	.0001	.0000	44.8	.00
1.47	.2371	.0002	.0000	28.4	.00
1.48	.2400	.0003	.0000	15.4	.00
1.50	.2430	.0004	.0001	7.6	.01
1.51	.2481	.0006	.0002	3.4	.02
1.53	.2533	.0008	.0003	1.5	.03
1.54	.2584	.0011	.0003	.6	.04
1.56	.2635	.0015	.0003	.2	.05
1.57	.2686	.0019	.0004	.0	.06
2.40	.9468	.2860	.0126	.0	2.61
2.41	.9668	.2987	.0127	.0	2.65
2.43	.9868	.3116	.0129	.0	2.68
2.45	1.0067	.3247	.0130	.0	2.72
2.46	1.0267	.3379	.0132	.0	2.75
2.48	1.0467	.3512	.0133	.0	2.79
2.49	1.0667	.3647	.0135	.0	2.82
2.51	1.0818	.3749	.0103	.0	2.81
2.52	1.0872	.3786	.0037	.0	2.60
2.54	1.0926	.3823	.0037	.0	2.14
2.55	1.0980	.3860	.0037	.0	1.64
2.57	1.1034	.3897	.0037	.0	1.26
2.58	1.1088	.3935	.0037	.0	1.03

HYDROGRAPH PEAK= 2.82 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .25 Acre-Feet

REVISED RUNOFF CALCULATIONS FOR ALTERNATIVE 3

ALTERNATIVE 3 INVOLVES DIVERTING FLOW FROM THE UPPER ENDS ON AREAS 1 AND 2. IN ORDER TO DETERMINE DITCH SIZES FOR THE DIVERSIONS AS WELL AS FOR THE RUNOFF WHICH WILL BE CONTROLLED ON SITE IT IS NECESSARY TO SUB-DIVIDE EACH AREA. AREAS 1 AND 2 HAVE BEEN DIVIDED INTO 3 SUBAREAS – THE UPPER AREA WHICH IS ABOVE THE OFF SITE DIVERSION DITCHES, THE "MIDDLE" WHICH IS AREA BELOW THE DIVERSION DITCHES AND ABOVE THE CLIFF, AND THE LOWER WHICH IS THE AREA BELOW THE CLIFF. AREAS 3 AND 4 HAVE BEEN DIVIDED INTO THE UPPER AREAS ABOVE THE CLIFF AND THE LOWER AREAS WHICH ARE BELOW THE CLIFF.

REVISED RUNOFF CALCULATIONS - ALTERNATIVES 2 & 3

AREA - 1

UPPER	11.00 ×	3.0473 × 40,000	=	30.8 ACRES
MIDDLE	2.29		=	6.4
LOWER	0.22		=	0.6

AREA - 2

UPPER	3.82	=	10.7
MIDDLE	1.89	=	5.3
LOWER	0.34	=	1.0

AREA 3

UPPER	0.74	=	2.1
LOWER	0.75	=	2.1

AREA 4

UPPER	1.78	=	5.0
LOWER	1.05	=	2.9

REVISED RUNOFF FROM AREA 1

UPPER: AREA 30.8 ACRES
SLOPE 10.1 %
HYDRAULIC LENGTH 2,050 FT.
100 YR. 6 HR STORM 1.8"
CURVE NUMBER 90

FROM "HYDRO" PEAK RUN OFF FLOW IS 24.9 CFS

MIDDLE: AREA 6.4 ACRES
SLOPE 10.1 %
HYDRAULIC LENGTH 700 FT.
100 YR. 6 HR. STORM 1.8"
CURVE NUMBER 90

FROM "HYDRO" PEAK RUNOFF FLOW IS 5.6 CFS

LOWER: AREA 0.6 ACRES
SLOPE 14 %
HYDRAULIC LENGTH 200 FT.
100 YR. 6HR STORM 1.8"
CURVE NUMBER 90

FROM "HYDRO" PEAK RUNOFF FLOW IS: 0.6 CFS

PROJECT : J.B. King Revised Area 1 Top (UPPER)

AREA= 30.8 ACRES
AVERAGE BASIN SLOPE= 10.1 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 2050. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .1385 HOURS QPCFS= 168.19 CFS QPIN= 5.4155 INCHES
C3= 26.6932 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.38	.2202	.0000	.0000	.0	.00
1.41	.2257	.0000	.0000	8.4	.00
1.44	.2312	.0000	.0000	52.2	.00
1.47	.2367	.0002	.0001	111.7	.00
1.50	.2421	.0004	.0002	154.4	.02
1.52	.2510	.0007	.0004	168.2	.04
1.55	.2605	.0013	.0005	157.6	.07
1.58	.2699	.0020	.0007	133.0	.13
1.61	.2794	.0028	.0008	104.0	.22
1.63	.2889	.0038	.0010	76.8	.32
1.66	.2983	.0049	.0011	54.1	.45
1.69	.3078	.0061	.0012	36.7	.59
1.72	.3173	.0075	.0014	24.2	.73
1.74	.3268	.0090	.0015	15.5	.88
1.77	.3362	.0106	.0016	9.8	1.03
1.80	.3457	.0124	.0017	6.0	1.18
1.83	.3552	.0142	.0019	3.6	1.33
1.86	.3647	.0162	.0020	2.2	1.47
1.88	.3741	.0183	.0021	1.3	1.62
1.91	.3836	.0205	.0022	.7	1.76
1.94	.3931	.0228	.0023	.4	1.89
1.97	.4025	.0252	.0024	.2	2.02
1.99	.4120	.0277	.0025	.1	2.16
2.02	.4432	.0366	.0090	.0	2.34
2.35	.8859	.2482	.0221	.0	19.89
2.38	.9228	.2709	.0227	.0	20.93
2.41	.9596	.2942	.0233	.0	21.88
2.44	.9965	.3180	.0238	.0	22.76
2.47	1.0334	.3423	.0243	.0	23.58
2.49	1.0703	.3671	.0248	.0	24.34
2.52	1.0874	.3787	.0116	.0	24.93
2.55	1.0973	.3856	.0068	.0	24.84
2.58	1.1073	.3924	.0069	.0	23.67
2.60	1.1173	.3993	.0069	.0	21.55

PROJECT : J.B. King Revised Area 1 Top
(Continued)

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
2.63	1.1272	.4063	.0069	.0	18.95
2.66	1.1372	.4132	.0070	.0	16.33
2.69	1.1472	.4202	.0070	.0	14.02

HYDROGRAPH PEAK= 24.93 cfs
TIME TO PEAK= 2.52 Hours
RUNOFF VOLUME= 2.37 Acre-Feet

PROJECT : J.B. King Revised Area 1 Middle

AREA= 6.4 ACRES
AVERAGE BASIN SLOPE= 10.1 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 700. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0586 HOURS QPCFS= 82.56 CFS QPIN=12.7928 INCHES
C3= 63.0558 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	8.4	.00
1.42	.2281	.0000	.0000	42.2	.00
1.44	.2311	.0000	.0000	73.3	.00
1.45	.2341	.0001	.0000	82.5	.00
1.47	.2371	.0002	.0000	73.1	.00
1.48	.2400	.0003	.0000	55.7	.01
1.50	.2430	.0004	.0001	38.2	.02
1.51	.2481	.0006	.0002	24.3	.03
1.53	.2533	.0008	.0003	14.6	.04
1.54	.2584	.0011	.0003	8.4	.05
1.56	.2635	.0015	.0003	4.6	.07
1.57	.2686	.0019	.0004	2.5	.09
1.59	.2738	.0023	.0004	1.3	.11
1.60	.2789	.0028	.0005	.7	.13
1.62	.2840	.0033	.0005	.3	.15
1.63	.2892	.0038	.0005	.2	.16
1.65	.2943	.0044	.0006	.0	.18
2.41	.9668	.2987	.0127	.0	5.19
2.43	.9868	.3116	.0129	.0	5.26
2.45	1.0067	.3247	.0130	.0	5.34
2.46	1.0267	.3379	.0132	.0	5.41
2.48	1.0467	.3512	.0133	.0	5.48
2.49	1.0667	.3647	.0135	.0	5.54
2.51	1.0818	.3749	.0103	.0	5.58
2.52	1.0872	.3786	.0037	.0	5.45
2.54	1.0926	.3823	.0037	.0	4.98
2.55	1.0980	.3860	.0037	.0	4.27
2.57	1.1034	.3897	.0037	.0	3.51
2.58	1.1088	.3935	.0037	.0	2.87
2.60	1.1142	.3972	.0037	.0	2.39

HYDROGRAPH PEAK= 5.58 cfs
TIME TO PEAK= 2.50 Hours
RUNOFF VOLUME= .49 Acre-Feet

PROJECT : J.B. King Revised Area 1 Bottom (LOWER)

AREA= .6 ACRES
AVERAGE BASIN SLOPE= 14.0 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 200. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0183 HOURS QPCFS= 24.83 CFS QPIN=41.0321 INCHES
C3=202.2473 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	23.2	.00
1.42	.2281	.0000	.0000	14.5	.00
1.44	.2311	.0000	.0000	3.1	.00
1.45	.2341	.0001	.0000	.4	.00
1.47	.2371	.0002	.0000	.0	.00
2.40	.9468	.2860	.0126	.0	.52
2.41	.9668	.2987	.0127	.0	.52
2.43	.9868	.3116	.0129	.0	.53
2.45	1.0067	.3247	.0130	.0	.54
2.46	1.0267	.3379	.0132	.0	.54
2.48	1.0467	.3512	.0133	.0	.55
2.49	1.0667	.3647	.0135	.0	.55
2.51	1.0818	.3749	.0103	.0	.48
2.52	1.0872	.3786	.0037	.0	.28
2.54	1.0926	.3823	.0037	.0	.18
2.55	1.0980	.3860	.0037	.0	.16
2.57	1.1034	.3897	.0037	.0	.15
2.58	1.1088	.3935	.0037	.0	.15

HYDROGRAPH PEAK= .55 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .05 Acre-Feet

REVISED RUNOFF FROM AREA 2

UPPER: AREA 10.7 ACRES
SLOPE 18.9 %
HYDRAULIC LENGTH 1000 FT.
100 YR. 6 HR. STORM 1.8"
CURVE NUMBER 90

FROM "HYDRO" PEAK RUNOFF FLOW IS 9.3 CFS

MIDDLE: AREA 5.3 ACRES
SLOPE 18.9%
HYDRAULIC LENGTH 600 FT.
100 YR. 6 HR STORM 1.8"
CURVE NUMBER 90

FROM "HYDRO" PEAK RUNOFF FLOW IS 4.7 CFS

LOWER: AREA 1.0 ACRES
SLOPE 14 %
HYDRAULIC LENGTH 350 FT.
100 YR. 6 HR STORM 1.8"
CURVE NUMBER 90

FROM "HYDRO" PEAK RUNOFF FLOW IS 0.9 CFS

PROJECT : J.B. King Revised Area 2 Top (UPPER)

AREA= 10.7 ACRES
AVERAGE BASIN SLOPE= 18.9 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 1000. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0570 HOURS QPCFS= 141.94 CFS QPIN=13.1557 INCHES
C3= 64.8446 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	15.5	.00
1.42	.2281	.0000	.0000	76.2	.00
1.44	.2311	.0000	.0000	129.0	.00
1.45	.2341	.0001	.0000	141.2	.00
1.47	.2371	.0002	.0000	121.8	.01
1.48	.2400	.0003	.0000	90.4	.02
1.50	.2430	.0004	.0001	60.4	.03
1.51	.2481	.0006	.0002	37.4	.04
1.53	.2533	.0008	.0003	21.9	.06
1.54	.2584	.0011	.0003	12.2	.09
1.56	.2635	.0015	.0003	6.6	.12
1.57	.2686	.0019	.0004	3.4	.15
1.59	.2738	.0023	.0004	1.7	.18
1.60	.2789	.0028	.0005	.9	.22
1.62	.2840	.0033	.0005	.4	.25
1.63	.2892	.0038	.0005	.2	.28
1.65	.2943	.0044	.0006	.0	.31
2.41	.9668	.2987	.0127	.0	8.69
2.43	.9868	.3116	.0129	.0	8.82
2.45	1.0067	.3247	.0130	.0	8.94
2.46	1.0267	.3379	.0132	.0	9.06
2.48	1.0467	.3512	.0133	.0	9.18
2.49	1.0667	.3647	.0135	.0	9.29
2.51	1.0818	.3749	.0103	.0	9.34
2.52	1.0872	.3786	.0037	.0	9.09
2.54	1.0926	.3823	.0037	.0	8.25
2.55	1.0980	.3860	.0037	.0	7.00
2.57	1.1034	.3897	.0037	.0	5.72
2.58	1.1088	.3935	.0037	.0	4.65
2.60	1.1142	.3972	.0037	.0	3.88

HYDROGRAPH PEAK= 9.34 cfs
TIME TO PEAK= 2.50 Hours
RUNOFF VOLUME= .83 Acre-Feet

PROJECT : J.B. King Revised Area 2 Middle

AREA= 5.3 ACRES
AVERAGE BASIN SLOPE= 18.9 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 600. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0379 HOURS QPCFS= 105.80 CFS QPIN=19.7968 INCHES
C3= 97.5782 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	32.1	.00
1.42	.2281	.0000	.0000	96.4	.00
1.44	.2311	.0000	.0000	99.8	.00
1.45	.2341	.0001	.0000	66.9	.00
1.47	.2371	.0002	.0000	35.3	.01
1.48	.2400	.0003	.0000	16.0	.02
1.50	.2430	.0004	.0001	6.6	.02
1.51	.2481	.0006	.0002	2.5	.03
1.53	.2533	.0008	.0003	.9	.05
1.54	.2584	.0011	.0003	.3	.07
1.56	.2635	.0015	.0003	.0	.08
2.40	.9468	.2860	.0126	.0	4.36
2.41	.9668	.2987	.0127	.0	4.42
2.43	.9868	.3116	.0129	.0	4.48
2.45	1.0067	.3247	.0130	.0	4.53
2.46	1.0267	.3379	.0132	.0	4.59
2.48	1.0467	.3512	.0133	.0	4.64
2.49	1.0667	.3647	.0135	.0	4.70
2.51	1.0818	.3749	.0103	.0	4.64
2.52	1.0872	.3786	.0037	.0	4.15
2.54	1.0926	.3823	.0037	.0	3.22
2.55	1.0980	.3860	.0037	.0	2.36
2.57	1.1034	.3897	.0037	.0	1.81
2.58	1.1088	.3935	.0037	.0	1.53

HYDROGRAPH PEAK= 4.70 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .41 Acre-Feet

PROJECT : J.B. King Revised Area 2 Bottom (LOWER)

AREA= 1.0 ACRES
AVERAGE BASIN SLOPE= 14.0 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 350. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0286 HOURS QPCFS= 26.44 CFS QPIN=26.2237 INCHES
C3=129.2565 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	14.1	.00
1.42	.2281	.0000	.0000	26.3	.00
1.44	.2311	.0000	.0000	17.0	.00
1.45	.2341	.0001	.0000	7.1	.00
1.47	.2371	.0002	.0000	2.3	.00
1.48	.2400	.0003	.0000	.7	.00
1.50	.2430	.0004	.0001	.2	.00
1.51	.2481	.0006	.0002	.0	.00
2.40	.9468	.2860	.0126	.0	.83
2.41	.9668	.2987	.0127	.0	.85
2.43	.9868	.3116	.0129	.0	.86
2.45	1.0067	.3247	.0130	.0	.87
2.46	1.0267	.3379	.0132	.0	.88
2.48	1.0467	.3512	.0133	.0	.89
2.49	1.0667	.3647	.0135	.0	.90
2.51	1.0818	.3749	.0103	.0	.86
2.52	1.0872	.3786	.0037	.0	.69
2.54	1.0926	.3823	.0037	.0	.46
2.55	1.0980	.3860	.0037	.0	.33
2.57	1.1034	.3897	.0037	.0	.27
2.58	1.1088	.3935	.0037	.0	.26

HYDROGRAPH PEAK= .90 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .08 Acre-Feet

REVISED RUNOFF AREA 3

UPPER: AREA 2.1 ACRES
SLOPE 29.9%
HYDRAULIC LENGTH 450'
CURVE NUMBER 90
100 YR. 6HR. STORM 1.8"

FROM "HYDRO" PEAK RUNOFF FLOW IS 1.9 CFS

LOWER: AREA 2.1 ACRES
SLOPE 17%
HYDRAULIC LENGTH 500'
CURVE NUMBER 90
100 YR. 6 HR. STORM 1.8"

FROM "HYDRO" PEAK RUNOFF FLOW IS 1.9 CFS

PROJECT : J.B. King Revised Area 3 Top (UPPER)

AREA= 2.1 ACRES
AVERAGE BASIN SLOPE= 29.9 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 450. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0239 HOURS QPCFS= 66.37 CFS QPIN=31.3437 INCHES
C3=154.4928 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	46.9	.00
1.42	.2281	.0000	.0000	59.9	.00
1.44	.2311	.0000	.0000	26.4	.00
1.45	.2341	.0001	.0000	7.5	.00
1.47	.2371	.0002	.0000	1.7	.00
1.48	.2400	.0003	.0000	.3	.00
1.50	.2430	.0004	.0001	.0	.01
2.40	.9468	.2860	.0126	.0	1.77
2.41	.9668	.2987	.0127	.0	1.80
2.43	.9868	.3116	.0129	.0	1.82
2.45	1.0067	.3247	.0130	.0	1.84
2.46	1.0267	.3379	.0132	.0	1.86
2.48	1.0467	.3512	.0133	.0	1.88
2.49	1.0667	.3647	.0135	.0	1.90
2.51	1.0818	.3749	.0103	.0	1.77
2.52	1.0872	.3786	.0037	.0	1.27
2.54	1.0926	.3823	.0037	.0	.80
2.55	1.0980	.3860	.0037	.0	.60
2.57	1.1034	.3897	.0037	.0	.54
2.58	1.1088	.3935	.0037	.0	.53

HYDROGRAPH PEAK= 1.90 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .16 Acre-Feet

PROJECT : J.B. King Revised Area 3 Bottom (LOWER)

AREA= 2.1 ACRES
AVERAGE BASIN SLOPE= 17.0 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 500. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0345 HOURS QPCFS= 46.00 CFS QPIN=21.7236 INCHES
C3=107.0758 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	17.1	.00
1.42	.2281	.0000	.0000	44.4	.00
1.44	.2311	.0000	.0000	39.9	.00
1.45	.2341	.0001	.0000	23.2	.00
1.47	.2371	.0002	.0000	10.6	.00
1.48	.2400	.0003	.0000	4.2	.00
1.50	.2430	.0004	.0001	1.5	.01
1.51	.2481	.0006	.0002	.5	.01
1.53	.2533	.0008	.0003	.2	.02
1.54	.2584	.0011	.0003	.0	.03
2.40	.9468	.2860	.0126	.0	1.73
2.41	.9668	.2987	.0127	.0	1.76
2.43	.9868	.3116	.0129	.0	1.78
2.45	1.0067	.3247	.0130	.0	1.80
2.46	1.0267	.3379	.0132	.0	1.83
2.48	1.0467	.3512	.0133	.0	1.85
2.49	1.0667	.3647	.0135	.0	1.87
2.51	1.0818	.3749	.0103	.0	1.83
2.52	1.0872	.3786	.0037	.0	1.59
2.54	1.0926	.3823	.0037	.0	1.17
2.55	1.0980	.3860	.0037	.0	.84
2.57	1.1034	.3897	.0037	.0	.66
2.58	1.1088	.3935	.0037	.0	.57

HYDROGRAPH PEAK= 1.87 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .16 Acre-Feet

REVISED RUNOFF AREA 4

UPPER: AREA 5.0 ACRES
SLOPE 26.2%
HYDRAULIC LENGTH 450'
CURVE NUMBER 90
100 YR. 6HR. STORM 1.8"

FROM "HYDRO" PEAK RUNOFF FLOW IS 4.5 CFS

LOWER: AREA 2.9 ACRES
SLOPE 25%
HYDRAULIC LENGTH 550 FT.
CURVE NUMBER 90
100 YR. 6HR. STORM 1.8"

FROM "HYDRO" PEAK RUNOFF FLOW IS 2.6 CFS

PROJECT : J.B. King Revised Area 4 Top (UPPER)

AREA= 5.0 ACRES
AVERAGE BASIN SLOPE= 26.2 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 450. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0256 HOURS QPCFS= 147.93 CFS QPIN=29.3403 INCHES
C3=144.6184 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	95.0	.00
1.42	.2281	.0000	.0000	140.7	.00
1.44	.2311	.0000	.0000	72.0	.00
1.45	.2341	.0001	.0000	23.8	.01
1.47	.2371	.0002	.0000	6.2	.02
1.48	.2400	.0003	.0000	1.4	.02
1.50	.2430	.0004	.0001	.3	.03
1.51	.2481	.0006	.0002	.0	.04
2.40	.9468	.2860	.0126	.0	4.20
2.41	.9668	.2987	.0127	.0	4.26
2.43	.9868	.3116	.0129	.0	4.31
2.45	1.0067	.3247	.0130	.0	4.37
2.46	1.0267	.3379	.0132	.0	4.42
2.48	1.0467	.3512	.0133	.0	4.47
2.49	1.0667	.3647	.0135	.0	4.52
2.51	1.0818	.3749	.0103	.0	4.25
2.52	1.0872	.3786	.0037	.0	3.19
2.54	1.0926	.3823	.0037	.0	2.04
2.55	1.0980	.3860	.0037	.0	1.49
2.57	1.1034	.3897	.0037	.0	1.32
2.58	1.1088	.3935	.0037	.0	1.27

HYDROGRAPH PEAK= 4.52 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .39 Acre-Feet

PROJECT : J.B. King Revised Area 4 Bottom (LOWER)

AREA= 2.9 ACRES
AVERAGE BASIN SLOPE= 25.0 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 550. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

TP= .0307 HOURS QPCFS= 71.38 CFS QPIN=24.4098 INCHES
C3=120.3158 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	33.4	.00
1.42	.2281	.0000	.0000	71.3	.00
1.44	.2311	.0000	.0000	52.5	.00
1.45	.2341	.0001	.0000	25.0	.00
1.47	.2371	.0002	.0000	9.4	.00
1.48	.2400	.0003	.0000	3.0	.01
1.50	.2430	.0004	.0001	.9	.01
1.51	.2481	.0006	.0002	.2	.02
1.53	.2533	.0008	.0003	.0	.03
2.40	.9468	.2860	.0126	.0	2.41
2.41	.9668	.2987	.0127	.0	2.44
2.43	.9868	.3116	.0129	.0	2.48
2.45	1.0067	.3247	.0130	.0	2.51
2.46	1.0267	.3379	.0132	.0	2.54
2.48	1.0467	.3512	.0133	.0	2.57
2.49	1.0667	.3647	.0135	.0	2.59
2.51	1.0818	.3749	.0103	.0	2.51
2.52	1.0872	.3786	.0037	.0	2.08
2.54	1.0926	.3823	.0037	.0	1.44
2.55	1.0980	.3860	.0037	.0	1.02
2.57	1.1034	.3897	.0037	.0	.83
2.58	1.1088	.3935	.0037	.0	.76

HYDROGRAPH PEAK= 2.59 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .22 Acre-Feet

CALCULATION OF FLOW INTO EXISTING CUT-OFF DITCH

AREA 6

0.88 PLANIMETER READING
× 3.0473

2.68 SQ. IN. @ 1" = 200' ⟹ 2.5 ACRES.

CONTOUR LENGTH = 1130 FT.

CONTOUR INTERVAL = 40 FT.

$$\text{SLOPE} = \frac{1130 \times 40 \times 100}{2.5 \times 43560} = 41.5\%$$

HYDRAULIC LENGTH = 500 FT.

100 YR. 6 HR. STORM = 1.8"

CURVE NUMBER = 90

FROM "HYDRO" THE PEAK FLOW IS 2.3 CFS.

PROJECT : J.B. King Area 6

AREA= 2.5 ACRES
AVERAGE BASIN SLOPE= 41.5 PERCENT
CURVE NUMBER= 90.0
DESIGN STORM= 1.80 INCHES
STORM DURATION= 6.0 HOURS
HYDRAULIC LENGTH= 500. FEET
MINIMUM INFILTRATION RATE= .00 IN/HR

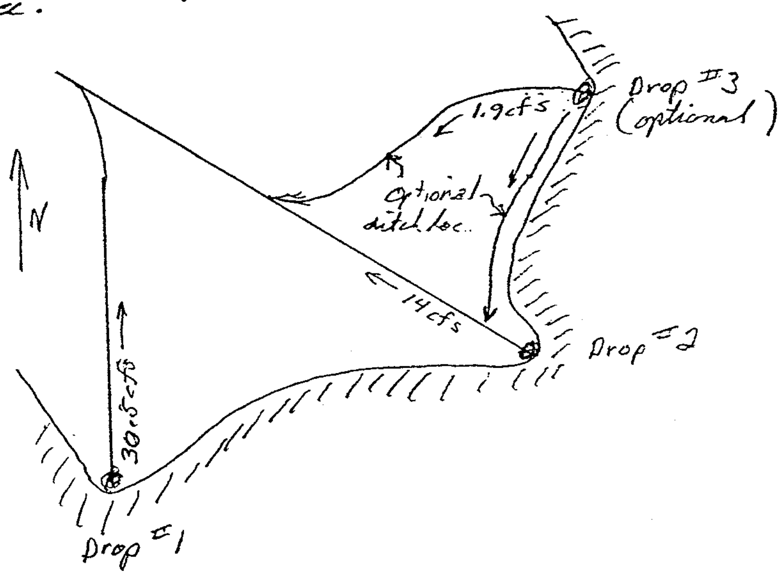
TP= .0221 HOURS QPCFS= 85.56 CFS QPIN=33.9416 INCHES
CS=167.2980 ITERATIONS= 8 SCS 6-hour

TIME HOURS	ACCUMULATED RAINFALL INCHES	RUNOFF INCHES	RAINFALL EXCESS INCHES	UNIT HYDROGRAPH CFS	OUTFLOW HYDROGRAPH CFS
1.39	.2222	.0000	.0000	.0	.00
1.41	.2252	.0000	.0000	67.0	.00
1.42	.2281	.0000	.0000	70.6	.00
1.44	.2311	.0000	.0000	25.7	.00
1.45	.2341	.0001	.0000	6.1	.00
1.47	.2371	.0002	.0000	1.1	.00
1.48	.2400	.0003	.0000	.2	.01
1.50	.2430	.0004	.0001	.0	.01
2.40	.9468	.2860	.0126	.0	2.12
2.41	.9668	.2987	.0127	.0	2.15
2.43	.9868	.3116	.0129	.0	2.18
2.45	1.0067	.3247	.0130	.0	2.20
2.46	1.0267	.3379	.0132	.0	2.23
2.48	1.0467	.3512	.0133	.0	2.25
2.49	1.0667	.3647	.0135	.0	2.28
2.51	1.0818	.3749	.0103	.0	2.08
2.52	1.0872	.3786	.0037	.0	1.42
2.54	1.0926	.3823	.0037	.0	.87
2.55	1.0980	.3860	.0037	.0	.68
2.57	1.1034	.3897	.0037	.0	.64
2.58	1.1088	.3935	.0037	.0	.64

HYDROGRAPH PEAK= 2.28 cfs
TIME TO PEAK= 2.49 Hours
RUNOFF VOLUME= .19 Acre-Feet

Appendix 2
Plunge Pool Design

Three possible plunge pools need to be analyzed for the three channels receiving concentrated flows from the sandstone ledges. The height of the ledges will depend on the conditions found as excavation of the channels takes place.



Design of the plunge pool size is based on procedures in "Open Channel Hydraulics," by Ven T. Chow, 1959. The procedures assume a flowrate per unit width across the drop to establish a drop number, D. The drop number is then used to determine the plunge pool hydraulics.

Hydrologic calculations for the flowrates provided were obtained from "J.B. King Mine Proposed Erosion Control Plan," June 1992, prepared by Hansen, Allen & Luce, Inc.

Assume the following:

Drop #1
Q = 30.5 cfs
drop width = 6 feet
flowrate per unit width = 5.08 cfs/ft

Drop #2
Q = 14 cfs
drop width = 5 feet
flowrate per unit width = 2.8 cfs/ft

Drop #3 (Optional)
Q = 2 cfs
drop width = 3 feet
flowrate per unit width = 0.67 cfs/ft

HANSEN ALLEN & LUCE INC

CLIENT Western States Minerals SHEET 2 OF 8
PROJECT JB King Mine COMPUTED KCS
FEATURE Plunge Pool Design CHECKED
PROJECT NO. 109.02.100 DATE 9-3-93

The following presents the equations for the plunge pool hydraulics (from "Open Channel Hydraulics").

15-15. The Straight Drop Spillway. The aerated free-falling nappe in a straight drop spillway (Fig. 15-18) will reverse its curvature and turn smoothly into supercritical flow on the apron. Consequently, a hydraulic jump may be formed downstream. Based on his own experimental data

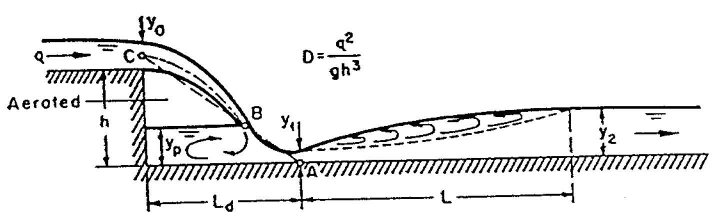


FIG. 15-18. Flow geometry of a straight drop spillway.

and those of Moore [40] and Bakhmeteff and Feodoroff [65], Rand [66] found that the flow geometry at straight drop spillways can be described by functions of the *drop number*, which is defined as

$$D = \frac{q^2}{gh^3} \tag{15-9}$$

where q is the discharge per unit width of the crest of overfall, g is the acceleration of gravity, and h is the height of the drop. The functions are

$$\frac{L_d}{h} = 4.30D^{0.27} \tag{15-10}$$

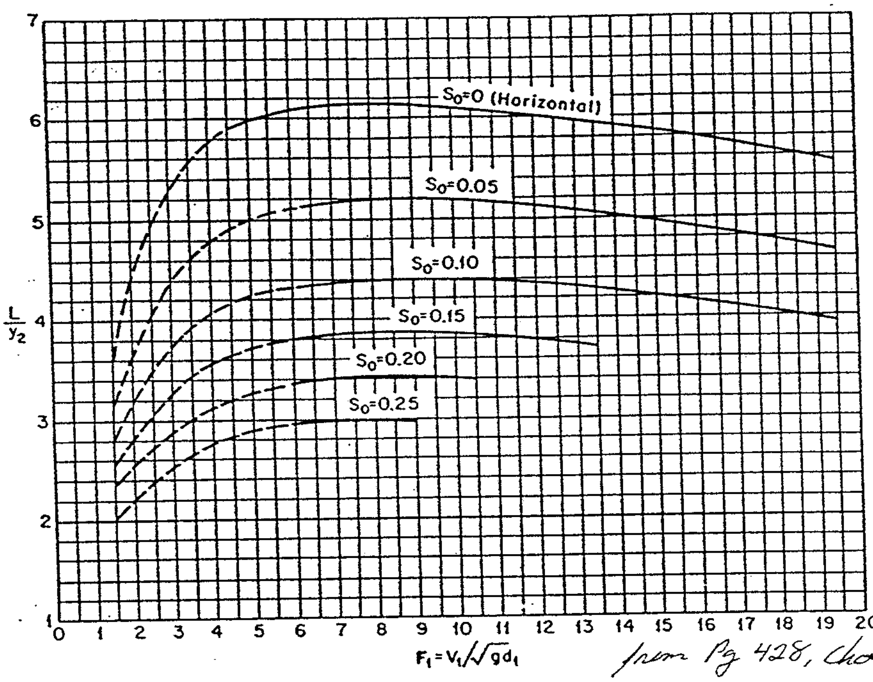
$$\frac{y_p}{h} = 1.00D^{0.22} \tag{15-11}$$

$$\frac{y_1}{h} = 0.54D^{0.425} \tag{15-12}$$

$$\frac{y_2}{h} = 1.66D^{0.27} \tag{15-13}$$

where L_d is the drop length, that is, the distance from the drop wall to the position of the depth y_1; y_p is the pool depth under the nappe; y_1 is the depth at the toe of the nappe or the beginning of the hydraulic jump; and y_2 is the tailwater depth sequent to y_1. The position of the depth y_1 can be approximately determined by the straight line ABC which joins the point A on the apron at the position of y_1, the point B on the axis of the nappe at the height of pool depth, and the point C on the axis of the nappe at the crest of the fall. The fact that these three points lie on a straight line was also verified by experiment.

For a given height h and discharge q per unit width of the fall crest, the sequent depth y_2 and the drop length L_d can be computed by Eqs. (15-10) and (15-13). On the one hand, if the tailwater depth is less than



from Pg 428, Chow

After sizing the plunge pool using the procedures in "Open Channel Hydraulics," the riprap is designed using procedures in "Evaluation of and Design Recommendations for Drop Structures in the Denver Metropolitan Area," Prepared for: Urban Drainage and Flood Control District, Dec. 1986.

The publication referenced above contains several graphs based on drop height (D) to riprap mean diameter (D_{50}).

or D/D_{50} for a ratio of 6, 12 & 24

Several curves are presented on each graph representing the sequent depth (y_2) to drop height ratio.

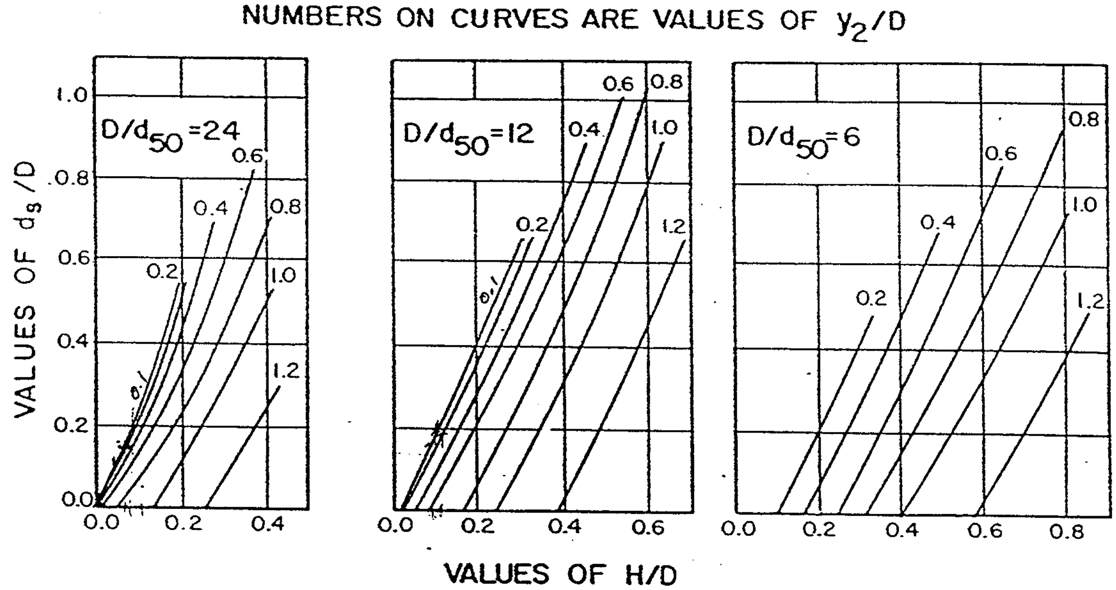
or y_2/D

To use the graphs, calculate ratio of upstream flow depth, H (which was assumed) to drop height

or H/D to locate a position on the horizontal axis.

Project a vertical line to the curve represented by y_2/D and from the intersection of the line H/D and the curve y_2/D, project a horizontal line to the vertical axis for a d_s/D value where d_s is the scour depth. Using a safety factor of 1.5 the riprap thickness in the plunge pool

Figure XII-2



The attached computer printouts present the plunge pool design results for each of the plunge pools based on the procedures presented herein.

Note that the computer printouts present variable plunge pool dimensions based on the height of the drop. The riprap thickness is also presented as a variable dependant upon the height of the drop and the D_{50} size of the riprap. An exact design for the plunge pool and riprap will be determined after the exploration phase of construction when the drop height is determined.

Options for design details for the plunge pool begin on sheet 8 of these calculations.

CLIENT: Western States Minerals
PROJECT: JB King Mine
FEATURE: Plunge Pool #1 Design
PROJ. #: 102.02.100
DATE: 09/03/93

POOL SIZE DESIGN - Based on "Open-Channel Hydraulics", Ven T. Chow, 1959

Flowrate: 30.5 cfs
Channel Width
upstream: 6 feet
downstream: 6 feet
Flowrate per foot
upstream: 5.08333 cfs/f

Drop Height D (ft)	Drop Number	Drop Length Ld (ft)	Pool Depth Yp (ft)	Toe Depth Y1 (ft)	Sequent Depth Y2 (ft)	Toe Vel. (fps)	Froude Number F1	L/Y2 From Chow Pg. 428	Pool Length L (ft)	Total Length (ft)
10	8.02E-04	6.276	2.08	0.261	2.423	19.5	6.715	6.10	14.8	21.1
12	4.64E-04	6.497	2.22	0.248	2.508	20.5	7.240	6.15	15.4	21.9
14	2.92E-04	6.690	2.34	0.238	2.583	21.4	7.715	6.15	15.9	22.6
16	1.96E-04	6.862	2.45	0.229	2.649	22.2	8.152	6.15	16.3	23.2
18	1.38E-04	7.017	2.55	0.222	2.709	22.9	8.558	6.15	16.7	23.7
20	1.00E-04	7.159	2.64	0.216	2.764	23.6	8.938	6.15	17.0	24.2
22	7.54E-05	7.290	2.73	0.210	2.814	24.2	9.296	6.10	17.2	24.5
24	5.81E-05	7.412	2.81	0.205	2.861	24.8	9.636	6.10	17.5	24.9
26	4.57E-05	7.525	2.88	0.201	2.905	25.3	9.959	6.07	17.6	25.2
28	3.66E-05	7.632	2.96	0.197	2.946	25.8	10.268	6.05	17.8	25.5
30	2.97E-05	7.733	3.03	0.193	2.985	26.3	10.565	6.03	18.0	25.7

RIPRAP DESIGN - Based on "Evaluation of and Design Recommendations for Drop Structures in the Denver Metropolitan Area", Urban Drainage and Flood Control District, 1986

Channel Width: 6 feet
Upstream Depth H: 1.5 feet
Riprap Density: 150 pcf
H2O Density: 62.4 pcf
H2O Mass Dens.: 1.936 lb-s2/f4
Sideslopes: 3 ?H:1V
Safety Factor: 1.5

Drop Height D (ft)	Riprap D50 (in)	Y2/D	D/D50	H/D	ds/D From Graphs Fig. XII-2	Scour Depth ds (ft)	Riprap Thick. (ft)
10	12	0.24	10.00	0.15	0.20	2.00	3.00
12	12	0.21	12.00	0.13	0.19	2.28	3.42
14	14	0.18	12.00	0.11	0.18	2.52	3.78
16	14	0.17	13.71	0.09	0.18	2.88	4.32
18	14	0.15	15.43	0.08	0.18	3.24	4.86
20	14	0.14	17.14	0.08	0.17	3.40	5.10
22	14	0.13	18.86	0.07	0.17	3.74	5.61
24	14	0.12	20.57	0.06	0.16	3.84	5.76
26	14	0.11	22.29	0.06	0.16	4.16	6.24
28	14	0.11	24.00	0.05	0.15	4.20	6.30
30	16	0.10	22.50	0.05	0.15	4.50	6.75

6/8

CLIENT: Western States Minerals
PROJECT: JB King Mine
FEATURE: Plunge Pool #2 Design
PROJ. #: 102.02.100
DATE: 09/03/93

POOL SIZE DESIGN - Based on "Open-Channel Hydraulics", Ven T. Chow, 1959

Flowrate: 14 cfs
Channel Width
upstream: 5 feet
downstream: 5 feet
Flowrate per foot
upstream: 2.8 cfs/f

Drop Height D (ft)	Drop Number	Drop Length Ld (ft)	Pool Depth Yp (ft)	Toe Depth Y1 (ft)	Sequent Depth Y2 (ft)	Toe Vel. (fps)	Froude Number F1	L/Y2 From Chow Pg. 428	Pool Length L (ft)	Total Length (ft)
10	2.43E-04	4.548	1.60	0.157	1.756	17.8	7.912	6.10	10.7	15.3
12	1.41E-04	4.708	1.71	0.150	1.818	18.7	8.530	6.13	11.1	15.9
14	8.87E-05	4.848	1.80	0.143	1.872	19.5	9.090	6.15	11.5	16.4
16	5.94E-05	4.973	1.88	0.138	1.920	20.3	9.604	6.15	11.8	16.8
18	4.17E-05	5.085	1.96	0.134	1.963	20.9	10.083	6.15	12.1	17.2
20	3.04E-05	5.188	2.03	0.130	2.003	21.5	10.530	6.15	12.3	17.5
22	2.29E-05	5.283	2.10	0.127	2.039	22.1	10.953	6.15	12.5	17.8
24	1.76E-05	5.371	2.16	0.124	2.073	22.7	11.353	6.15	12.8	18.1
26	1.39E-05	5.453	2.22	0.121	2.105	23.2	11.734	6.13	12.9	18.4
28	1.11E-05	5.531	2.28	0.118	2.135	23.6	12.098	6.13	13.1	18.6
30	9.02E-06	5.604	2.33	0.116	2.163	24.1	12.448	6.10	13.2	18.8

RIPRAP DESIGN - Based on "Evaluation of and Design Recommendations for Drop Structures in the Denver Metropolitan Area", Urban Drainage and Flood Control District, 1986

Channel Width: 5 feet
Upstream Depth H: 1 feet
Riprap Density: 150 pcf
H2O Density: 62.4 pcf
H2O Mass Dens.: 1.936 lb-s2/f4
Sideslopes: 3 ?H:1V
Safety Factor: 1.5

Drop Height D (ft)	Riprap D50 (in)	Y2/D	D/D50	H/D	ds/D From Graphs Fig. XII-2	Scour Depth ds (ft)	Riprap Thick. (ft)
10	12	0.18	10.00	0.10	0.19	1.90	2.85
12	12	0.15	12.00	0.08	0.19	2.28	3.42
14	14	0.13	12.00	0.07	0.18	2.52	3.78
16	14	0.12	13.71	0.06	0.16	2.56	3.84
18	14	0.11	15.43	0.06	0.16	2.88	4.32
20	14	0.10	17.14	0.05	0.14	2.80	4.20
22	14	0.09	18.86	0.05	0.14	3.08	4.62
24	14	0.09	20.57	0.04	0.13	3.12	4.68
26	14	0.08	22.29	0.04	0.13	3.38	5.07
28	14	0.08	24.00	0.04	0.13	3.64	5.46
30	16	0.07	22.50	0.03	0.12	3.60	5.40

7/8

CLIENT: Western States Minerals
PROJECT: JB King Mine
FEATURE: Plunge Pool #3 Design (optional)
PROJ. #: 102.02.100
DATE: 09/03/93

POOL SIZE DESIGN - Based on "Open-Channel Hydraulics", Ven T. Chow, 1959

Flowrate: 2 cfs
Channel Width
upstream: 3 feet
downstream: 3 feet
Flowrate per foot
upstream: 0.66667 cfs/f

Drop Height D (ft)	Drop Number	Drop Length Ld (ft)	Pool Depth Yp (ft)	Toe Depth Y1 (ft)	Sequent Depth Y2 (ft)	Toe Vel. (fps)	Froude Number F1	L/Y2 From Chow Pg. 428	Pool Length L (ft)	Total Length (ft)
10	1.38E-05	2.095	0.85	0.046	0.809	14.4	11.740	6.02	4.9	7.0
12	7.99E-06	2.169	0.91	0.044	0.837	15.1	12.657	6.00	5.0	7.2
14	5.03E-06	2.234	0.96	0.042	0.862	15.7	13.488	5.95	5.1	7.4
16	3.37E-06	2.291	1.00	0.041	0.884	16.3	14.252	5.90	5.2	7.5
18	2.37E-06	2.343	1.04	0.040	0.904	16.9	14.961	5.85	5.3	7.6
20	1.73E-06	2.390	1.08	0.038	0.923	17.4	15.626	5.82	5.4	7.8
22	1.30E-06	2.434	1.11	0.037	0.940	17.8	16.252	5.80	5.4	7.9
24	9.98E-07	2.475	1.15	0.037	0.955	18.3	16.846	5.75	5.5	8.0
26	7.85E-07	2.512	1.18	0.036	0.970	18.7	17.412	5.70	5.5	8.0
28	6.29E-07	2.548	1.21	0.035	0.984	19.1	17.952	5.65	5.6	8.1
30	5.11E-07	2.582	1.24	0.034	0.997	19.4	18.470	5.60	5.6	8.2

RIPRAP DESIGN - Based on "Evaluation of and Design Recommendations for Drop Structures in the Denver Metropolitan Area", Urban Drainage and Flood Control District, 1986

Channel Width: 6 feet
Upstream Depth H: 1.5 feet
Riprap Density: 150 pcf
H2O Density: 62.4 pcf
H2O Mass Dens.: 1.936 lb-s2/f4
Sideslopes: 3 ?H:1V
Safety Factor: 1.5

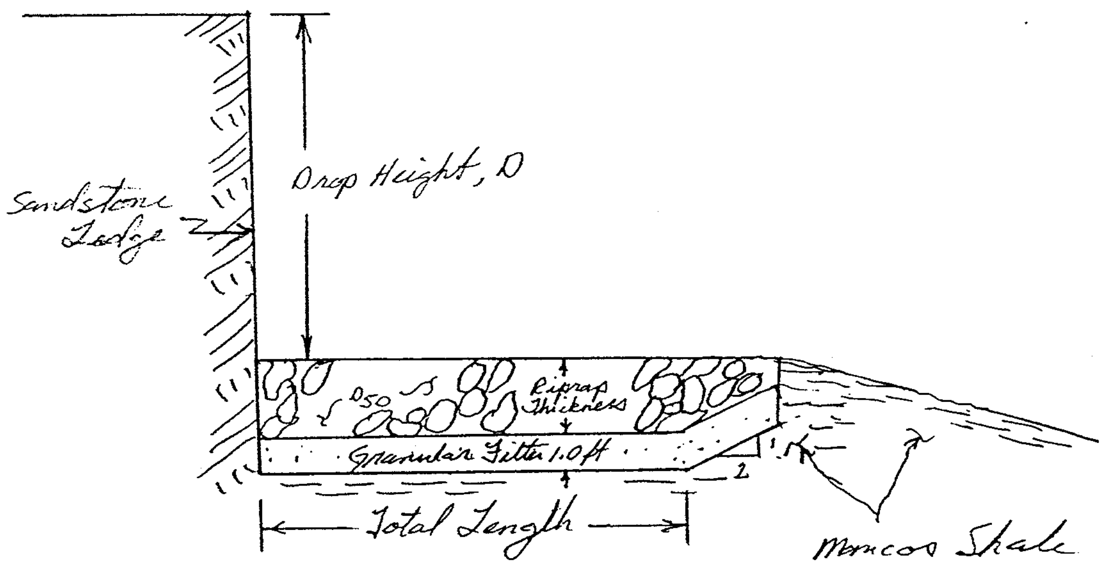
Drop Height D (ft)	Riprap D50 (in)	Y2/D	D/D50	H/D	ds/D From Graphs Fig. XII-2	Scour Depth ds (ft)	Riprap Thick. (ft)
10	12	0.08	10.00	0.15	0.18	1.80	2.70
12	12	0.07	12.00	0.13	0.19	2.28	3.42
14	14	0.06	12.00	0.11	0.18	2.52	3.78
16	14	0.06	13.71	0.09	0.16	2.56	3.84
18	14	0.05	15.43	0.08	0.16	2.88	4.32
20	14	0.05	17.14	0.08	0.14	2.80	4.20
22	14	0.04	18.86	0.07	0.14	3.08	4.62
24	14	0.04	20.57	0.06	0.13	3.12	4.68
26	14	0.04	22.29	0.06	0.13	3.38	5.07
28	14	0.04	24.00	0.05	0.13	3.64	5.46
30	16	0.03	22.50	0.05	0.12	3.60	5.40

HANSEN ALLEN & LUCE INC

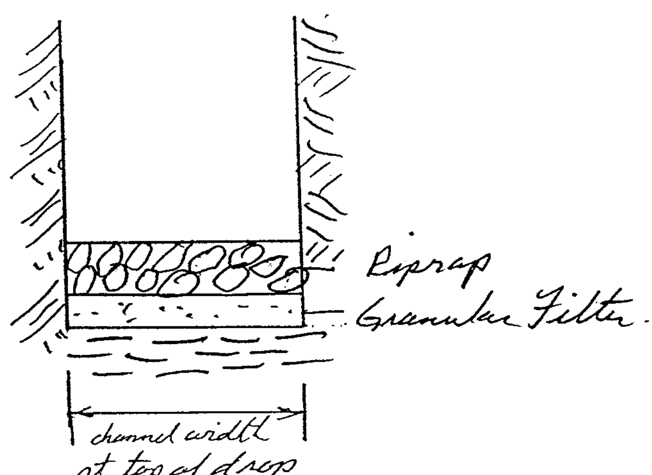
CLIENT Western States Minerals
PROJECT J B King Mine
FEATURE Plunge Pool Design
PROJECT NO. 102.02.100

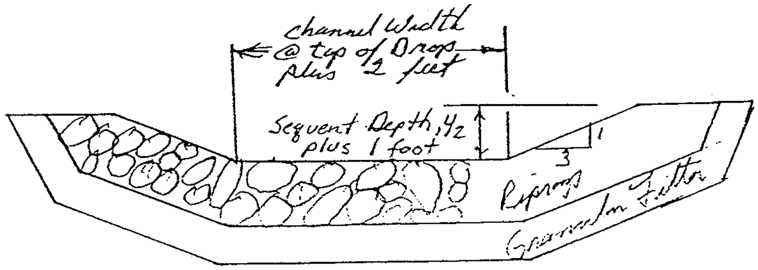
SHEET 8 OF 8
COMPUTED KLS
CHECKED
DATE 9-8-93

Plunge Pool Design Details
See computer printout pages for dimensions



section where drop is cut back into the sandstone ledge





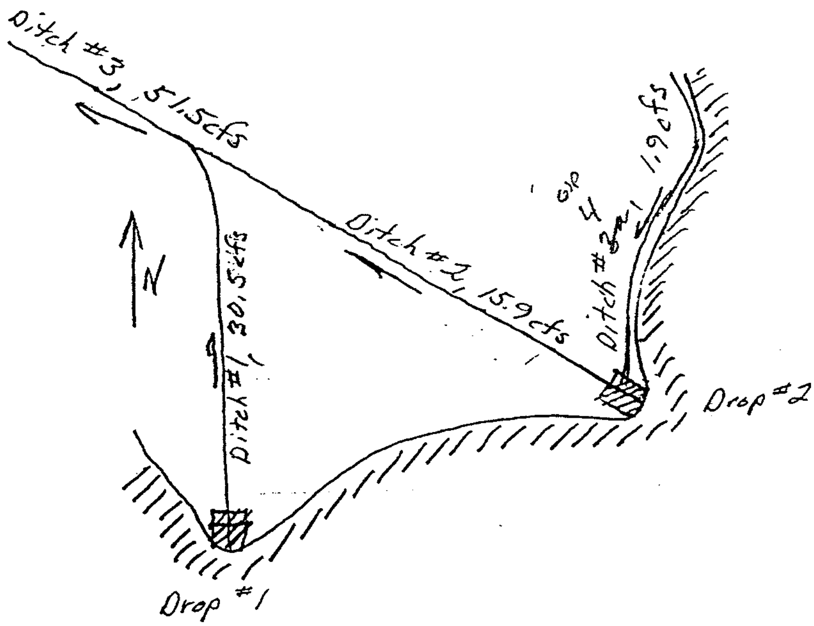
Appendix 3
Ditch Design

HANSEN ALLEN & LUCE inc

CLIENT Western States Minerals
PROJECT JB King Mine
FEATURE Ditch Hydraulics
PROJECT NO. 102.02.100

SHEET 1 OF 3
COMPUTED KCS
CHECKED
DATE 9-8-93

Determine the ditch dimensions downstream of the plunge pools required to carry the determined flowrates from the 100 yr 6 hr precipitation event. The flowrates used in these calculations were obtained from "JB King Mine Proposed Erosion Control Plan," June 1992.



Assume ditches 1, 2 & 3 are to be excavated into the underlying mancos shale material which will provide natural erosion control similar to the other natural and undisturbed channels in the area. The controlling design criteria will be the channel dimensions along the flattest slopes of the ditches. The steeper reaches of the ditches, in profile, will not exceed the steepness of other natural drainage channels in the area. Assume the channels to be naturally erodibly comparable to the other natural drainage channels in the area.

Assume for Mannings equation $n = 0.03$

Ditch No. 1: $Q = 30.5$ cfs
$S = 5\%$ approx. min.

Ditch No. 2: $Q = 15.9$ cfs
$S = 5\%$ approx. min.

Ditch No. 3a (4 c/p): $Q = 1.9$ cfs
find S and the req'd ditch dimensions

HANSEN ALLEN & LUCE inc

CLIENT: Western States Minerals
PROJECT: J B King Mine
FEATURE: Ditch Hydraulics
PROJECT NO. 102.02.100

SHEET 2 OF 3
COMPUTED KCS
CHECKED
DATE 9-9-93

CLIENT: Western States Minerals
PROJECT: J B King Mine
FEATURE: Ditch Hydraulics
PROJECT#: 102.02.100
DATE: 08-Sep-93

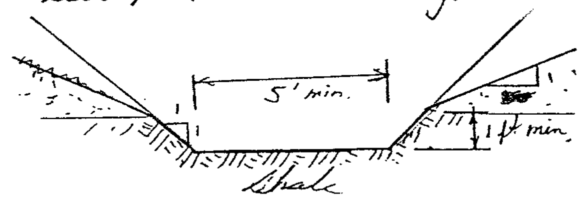
FIND: Ditch No. 1 Dimensions

Manning Equation Solution for Normal Flow Depth
(Trapezoidal Channel)

Flow (Q)	=	30.5 cfs
Manning n (n)	=	0.03
Bottom Width (b)	=	5 feet
Sideslope 1 (z1)	=	1 ?H:1V
Sideslope 2 (z2)	=	1 ?H:1V
Slope (So)	=	0.05
Normal Depth (y)	=	0.700 feet
Flow x-section area (A)	=	3.988 sq. ft.
Flow Top Width (T)	=	6.399 feet
Perimeter (P)	=	6.979 feet
Flow Velocity (V)	=	7.648 ft/sec.
Froude Number	=	1.707
Solve Equation	=	0.000

Ditch No. 1

excavate to a minimum depth of 1 ft into the shale. Ditch sideslopes in the shale may be 1H:1V.



Sideslopes above the shale should be 2.5:1 or flatter from the top of the shale to the existing ground surface. Freeboard is provided in the ditch by 0.3' in the shale and the rest (0.7' min) above the shale.

CLIENT: Western States Minerals
PROJECT: J B King Mine
FEATURE: Ditch Hydraulics
PROJECT#: 102.02.100
DATE: 08-Sep-93

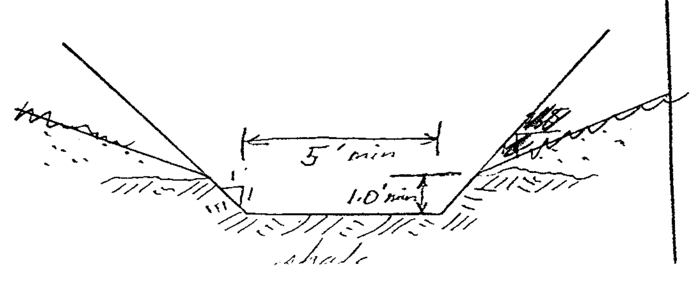
FIND: Ditch No. 2 Dimensions

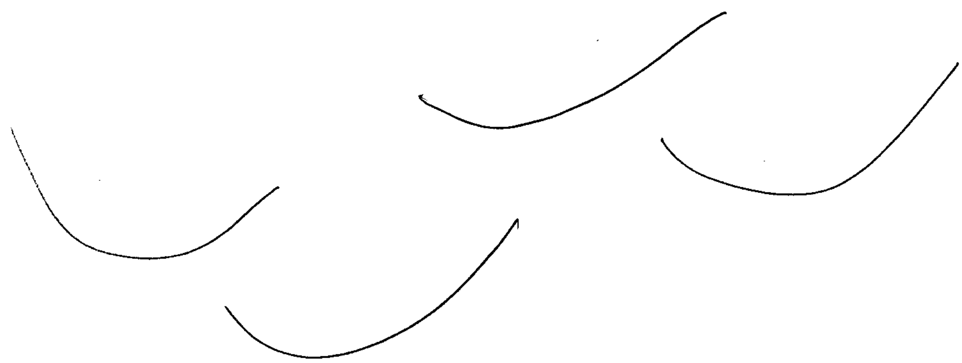
Manning Equation Solution for Normal Flow Depth
(Trapezoidal Channel)

Flow (Q)	=	15.9 cfs
Manning n (n)	=	0.03
Bottom Width (b)	=	5 feet
Sideslope 1 (z1)	=	1 ?H:1V
Sideslope 2 (z2)	=	1 ?H:1V
Slope (So)	=	0.05
Normal Depth (y)	=	0.474 feet
Flow x-section area (A)	=	2.596 sq. ft.
Flow Top Width (T)	=	5.949 feet
Perimeter (P)	=	6.342 feet
Flow Velocity (V)	=	6.124 ft/sec.
Froude Number	=	1.633

Ditch No. 2

Excavate to a minimum depth of 1 ft. into the shale. Ditch sideslopes in the shale may be 1H:1V. Excavated sideslopes above the shale should be 2.5 H:1V or flatter from the top of the shale to the existing ground surface. Freeboard is provided by 0.5 ft in the shale and the rest (0.5' min.) in the excavation above the shale.





CLIENT: Western States Minerals
PROJECT: J B King Mine
FEATURE: Ditch Hydraulics
PROJECT#: 102.02.100
DATE: 08-Sep-93

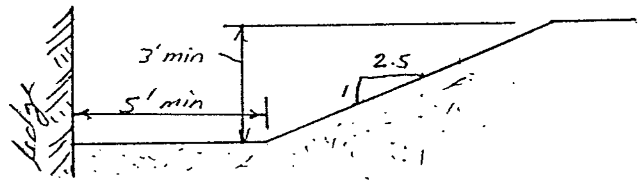
FIND: Ditch No. 3a Dimensions

Manning Equation Solution for Normal Flow Depth
(Trapezoidal Channel)

Flow (Q)	=	1.9 cfs	1.9 cfs
Manning n (n)	=	0.03	0.03
Bottom Width (b)	=	0 feet	5 feet
Sideslope 1 (z1)	=	0 ?H:1V	0 ?H:1V
Sideslope 2 (z2)	=	2.5 ?H:1V	2.5 ?H:1V
Slope (So)	=	0.09	0.09
Normal Depth (y)	=	0.557 feet	0.111 feet
Flow x-section area (A)	=	0.388 sq. ft.	0.571 sq. ft.
Flow Top Width (T)	=	1.392 feet	5.278 feet
Perimeter (P)	=	2.057 feet	5.410 feet
Flow Velocity (V)	=	4.899 ft/sec.	3.328 ft/sec.
Froude Number	=	1.636	1.783
Solve Equation	=	0.000	0.000

Ditch No. ~~3~~ 4 GR

To be excavated at the base of the sand stone ledge to receive runoff from above the ledge and direct the runoff to ditch no. 2. Construct the ditch with 5' min. bottom width, 3' min depth, vertical side against the ledge, 2.5H:1V or flatter sideslopes otherwise, Max. ditch slope is 9% to reduce erosion potential. This will also reduce erosion potential from concentrated flows in the 5' wide channel. The ditch is constructed larger to reduce effects of spalling material from the ledge filling the ditch.



CLIENT: Western States Minerals
PROJECT: J B King Mine
FEATURE: Ditch Hydraulics
PROJECT#: 102.02.100
DATE: 08-Sep-93

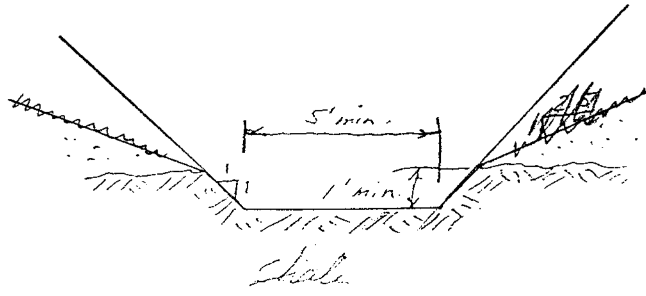
FIND: Ditch No. 3 Dimensions

Manning Equation Solution for Normal Flow Depth
(Trapezoidal Channel)

Flow (Q)	=	51.5 cfs
Manning n (n)	=	0.03
Bottom Width (b)	=	5 feet
Sideslope 1 (z1)	=	1 ?H:1V
Sideslope 2 (z2)	=	1 ?H:1V
Slope (So)	=	0.05
Normal Depth (y)	=	0.954 feet
Flow x-section area (A)	=	5.679 sq. ft.
Flow Top Width (T)	=	6.908 feet
Perimeter (P)	=	7.698 feet
Flow Velocity (V)	=	9.068 ft/sec.
Froude Number	=	1.762

Ditch No. 3

Excavate to a minimum depth of 1 ft. into the shale. Ditch sideslopes in the shale may be 1H:1V. Excavated sideslopes above the shale should be 2.5H:1V or flatter from the top of the shale to the existing ground surface. Freeboard is provided by 1.0' minimum in the excavation above the shale.



Predict Mean Annual Erosion from Refuse Pile side slopes for existing conditions.

Uniform Soil Loss Equation

reference: "Erosion and Sedimentation in Utah", Feb 1984

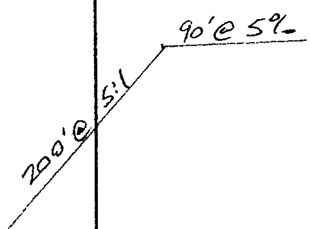
$A = R\,K\,LS\,Vm$

A = mean annual soil loss (tons/ac/yr)

R = rainfall factor
Salina map ⇒ $R = 8$ to 11 use $\underline{11}$

K = soil erodibility factor
Utah map ⇒ $K = 0.41$ to 0.50
use $K = \underline{0.46}$

LS = Length Slope factor
multiple slope



$$(LS)_n = \frac{(L\lambda_n\, S_{s_n})\,\lambda_n - (L\lambda_{n-1}\, S_{s_n})\,\lambda_{n-1}}{\lambda_n}$$

Top of Pile 90' @ 5% slopes to outside
side of Pile 200' @ 5:1

$$LS_{side} = \frac{7.6\,(90+200) - 3.87\,(90)}{200} = \underline{9.3}$$

Vm = vegetation and management factor
reference: "Applied Hydrology and Sedimentology For Disturbed Areas" Barfield et al, 1985

EXISTING: 20% veg. cover, no canopy
Exist. $Vm = \underline{0.24}$

Rock Mulch $Vm = \underline{0.01}$
(see attached figure)

EXISTING $A = (11)(.46)(9.3)(.24) = $ **11.3 t/ac/yr**

W/ROCK MULCH $A = (11)(.46)(9.3)(.01) = $ **0.5 t/ac/yr**

State of Utah

UTAH DEPARTMENT OF TRANSPORTATION

Michael O. Leavitt
Governor
W. Craig Zwick
Executive Director
Howard H. Richardson, P.E.
Assistant Director
Dan F. Nelson
Southern Region Director

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Richfield, Utah 84701
(801) 896-9501
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Jan. 24, 1994

State of Utah
Division of State Land and Forestry
3 Triad Center, Suite 400
355 West North Temple
Salt Lake City Utah 84180-1204
Attn: Gary Bagley

Dear Gary:

As per request of Mr. Buzz Gerick representing Western States Mineral Corporation. 250 South, Rock Boulevard, Suite 130, Reno. Nevada. has requested permission to remove 5,000 cu. yds. of pit-run material from a Sand and Gravel Lease #37912 (amended), granted to the Utah Dept. of Transportation. Permission is hereby granted to remove the material from the following area:T.23S, R5E, SLB&M Sec.36:S2NE4NE4,S2NW4NE4,SW4NE4,NE4NW4,SE4NW4,SW4NW4,NW4NW4, containing 280 acres more or less.

This letter is to correct the area of removal that was stated in a letter dated Jan 24, 1994. The letter of that date should have stated, that would be the area of placement instead of removal.

Payment to be made to the U.D.O.T. at the rate of $0.45 per cu. yd., and will be forwarded to the State Land Board upon inventory, and completion of the removal operation.

Mr. Al Spensko will be the contact person to designate the removal area and see that the rehabilitation is done as per lease agreement.

If we can be of further help or assistance, please be in contact with us.

Sincerely,

Paul L. Larsen
Mat'ls Eng'r Ass't

RECEIVED FEB - 7 1994

United States
Environmental Protection
Agency

Office of Solid Waste and
Emergency Response
Washington DC 20460

EPA/530-SW-89-047
July 1989

EPA

Technical Guidance Document:

Final Covers on Hazardous Waste Landfills and Surface Impoundments

Table 1-5. Cover Design

Vegetative Cover

- Thickness ≥ 2 ft
- Minimal erosion and maintenance (e.g., fertilization, irrigation)
- Vegetative root growth not to extend below 2 ft
- Final top slope between 3 and 5% after settlement or subsidence. Slopes greater than 5% not to exceed 2.0 tons/acre erosion (USDA Universal Soil Loss Equation)
- Surface drainage system capable of conducting run-off across cap without rills and gullies

Drainage Layer Design

- Thickness ≥ 1 ft
- Saturated hydraulic conductivity ≥ 10^{-3} cm/sec
- Bottom slope ≥ 2% (after settlement/subsidence)
- Overlain by graded granular or synthetic filter to prevent clogging
- Allow lateral flow and discharge of liquids

Low Permeability Liner Design

FML Component:

- Thickness ≥ 20 mil
- Final upper slope ≥ 2% (after settlement)
- Located wholly below the average depth of frost penetration in the area

Soil Component:

- Thickness ≥ 2 ft
- Saturated hydraulic conductivity ≤ 1 x 10^{-7} cm/sec
- Installed in 6-in lifts

- Summary of CQA activities for each landfill component.

This report must be signed by a registered professional engineer or the equivalent, the CQA officer, the design engineer, and the owner/operator to ensure that all parties are satisfied with the design and construction of the landfill. EPA will review selected CQA reports.

The CQA plan covers all components of landfill construction, including foundations, liners, dikes, leachate collection and removal systems, and final cover. According to the proposed rule (May 1987), EPA also may require field permeability testing of soils on a test fill constructed prior to construction of the landfill to verify that the final soil liner will meet the permeability standards of 10^{-7} cm/sec. This requirement, however, will not preclude the use of laboratory permeability tests and other tests (correlated to the field permeability tests) to verify that the soil liner will, as installed, have a permeability of 10^{-7} cm/sec.

Summary of Minimum Technology Requirements

EPA's minimum technology guidance and regulations for new hazardous waste land disposal facilities emphasize the importance of proper design and construction in the performance of the facility. The current trend in the regulatory programs is to develop standards and recommend designs based on the current state-of-the-art technology. Innovations in technology are, therefore, welcomed by EPA and are taken into account when developing these regulations and guidance.

References

1. EMCON Associates. 1988. Draft background document on the final double liner and leachate collection system rule. Prepared for Office of Solid Waste, U.S. EPA. NUS Contract No. 68-01-7310, Work Assignment No. 66.

2. U.S. EPA. 1987a. Liners and leak detection for hazardous waste land disposal units: notice of proposed rulemaking. Fed. Reg. Vol 52, No. 103, 20218-20311. May 29.

3. U.S. EPA. 1987b. Hazardous waste management systems: minimum technology requirements: notice of availability of information and request for comments. Fed. Reg. Vol. 52, No. 74, 12566-12575. April 17.

4. U.S. EPA. 1987c. Background document on proposed liner and leak detection rule. EPA/530-SW-87-015.

5. U.S. EPA. 1986a. Technical guidance document: construction quality assurance for hazardous waste land disposal facilities. EPA/530-SW-86-031.

6. U.S. EPA. 1986b. Hazardous waste management systems: proposed codification rule. Fed. Reg. Vol. 51, No. 60, 10706-10723. March 28.

7. U.S. EPA. 1985a. Hazardous waste management systems: proposed codification rule. Fed. Reg. Vol. 50, No. 135, 28702-28755. July 15.

8. U.S. EPA. 1985b. Draft minimum technology guidance on double liner systems for landfills and surface impoundments - design, construction, and operation. EPA/530-SW-84-014. May 24.

9. U.S. EPA. 1982. Handbook for remedial action at waste disposal sites. EPA-625/6-82-006. Cincinnati, OH: U.S. EPA.

- capable of remaining in place and minimizing erosion of itself and the underlying soil component during extreme weather events of rainfall and/or wind;

- capable of accommodating settlement of the underlying material without compromising the purpose of the component;

- surface slope approximately the same as the underlying soil (at least 3 percent slope); and

- capable of controlling the rate of soil erosion from the cover to no more than 2 tons/acre/year (5.5 MT/ha/yr), calculated by using the USDA Universal Soil Loss Equation.

Agency-recommended specifications for the lower soil component of the top layer include the following:

- for vegetation support, a minimum thickness of 60 cm (24 in.) including at least 15 cm (6 in.) of topsoil (soil of lower quality may be used beneath an armored surface); greater total thickness where required, e.g., where maximum frost penetration exceeds this depth, or where greater plant-available water storage is necessary or desirable;

- medium texture to facilitate seed germination and plant root development;

- final top slope, after allowance for settling and subsidence, of at least 3 percent, but no greater than 5 percent, to facilitate runoff while minimizing erosion; and

- minimum compaction to facilitate root development and sufficient infiltration to maintain growth through drier periods.

The owner or operator of the landfill should prepare a separate section specific to monitoring construction of the top layer to be included in the construction quality assurance (CQA) plan.

2.2 DISCUSSION

2.2.1 <u>Upper Component of Top Layer</u>

As noted in the design recommendations above, the upper component of the top layer may be vegetation (Agency-preferred where possible) or other erosion-impeding materials. These are discussed separately below.