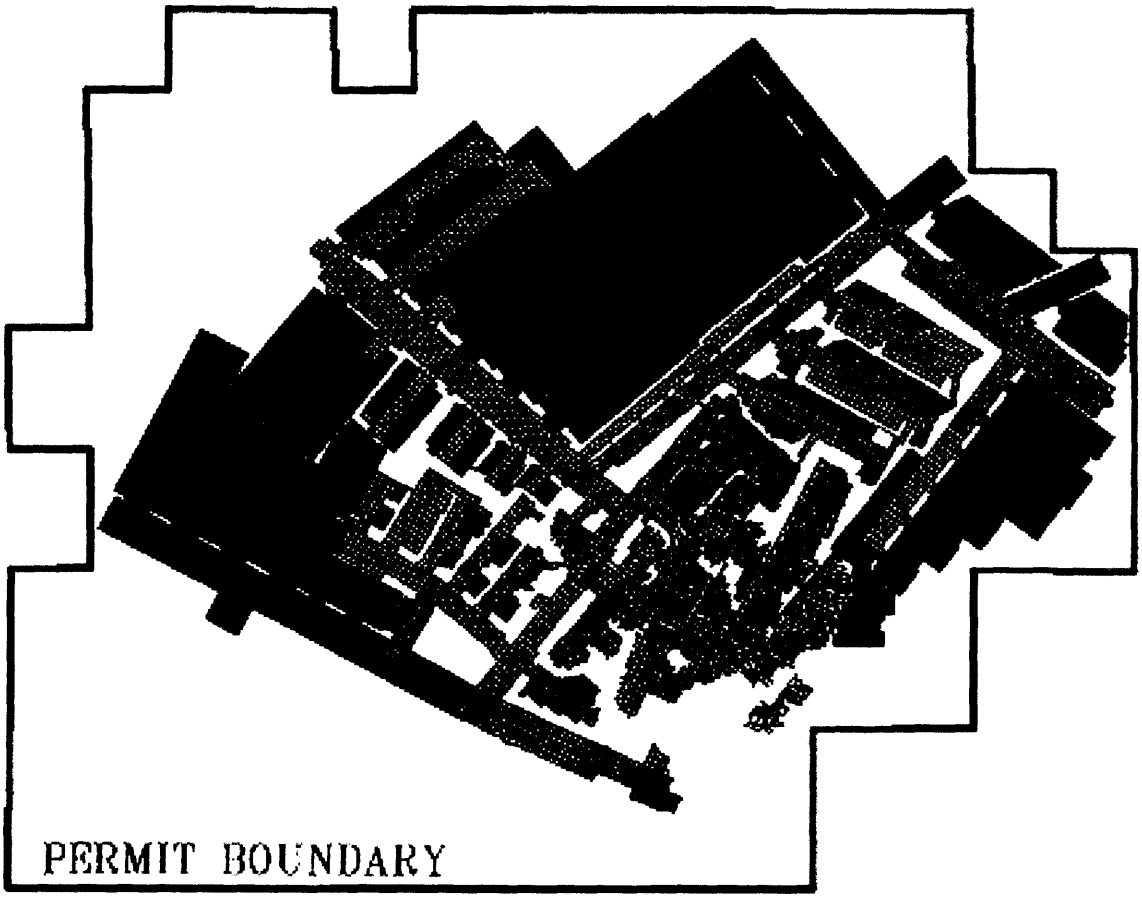
CONSOLIDATION COAL COMPANY
EMERY MINE

PERMIT ACT/015/015

CHAPTER XII

FIRST NORTH AREA
INCIDENTAL BOUNDARY CHANGE
APPLICATION



CHAPTER XII

EMERY MINE FIRST NORTH AREA INCIDENTAL BOUNDARY CHANGE APPLICATION

EMERY MINE
CONSOLIDATION COAL COMPANY
EMERY COUNTY, UTAH

SUBMITTED TO

UTAH DIVISION OF OIL, GAS AND MINING

PREPARED BY

CONSOLIDATION COAL COMPANY
P.O. BOX 566
SESSER, IL 62884-0566

APRIL 8, 2005

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CHAPTER XII

EMERY MINE FIRST NORTH AREA INCIDENTAL BOUNDARY CHANGE APPLICATION

XII.A INTRODUCTION

This application for an incidental boundary change ("IBC") is submitted to the Utah Division of Oil, Gas and Mining ("UDOGM") by Consolidation Coal Company ("Consol") for the Emery Mine in Emery County Utah (UDOGM Permit No. ACT/015/015). The IBC encompasses approximately 348 acres of private land and private coal adjacent to the existing Emery Mine permit area (see revised Plate III-9 of the approved MRP). The IBC falls within the area of an existing Cumulative Hydrologic Impact Assessment and is within a drainage basin already authorized in the approved mining and reclamation plan ("MRP").

Approval of this IBC request will allow Consol to develop additional coal reserves in the First North Area without the need for new surface disturbances. Coal will be extracted under this application from the IJ zone of the Ferron Sandstone using room and pillar methods without pillar extraction (i.e., first mining only).

XII.B GENERAL CONTENTS

XII.B.1 RIGHT OF ENTRY

Consol is the owner of all coal to be mined under this IBC application (see Plate III-9 of the approved MRP). Information regarding coal ownership within the IBC and adjacent areas is provided in Chapter I of the approved MRP.

All but approximately 19 acres of the First North Area IBC surface land is owned by Consol (see Plate III-9). The non-Consol portion of surface land is owned by Kenneth L. and Earlene Christiansen. Information regarding surface ownership within the IBC and adjacent areas is provided in Chapter I of the approved MRP. Consol knows of no pending litigation concerning their right to mine coal within the IBC area.

XII.B.2 LEGAL DESCRIPTION AND STATUS OF UNSUITABILITY CLAIMS

The area affected by this IBC application is located in T. 22 S., R. 6 E., SLBM as follows:

Section 22: NE¼, SE¼, and SE¼NW¼
Section 23: W½ SW¼
Section 27: NE¼

Consol knows of no portion of the First North Area IBC that is designated, or under study to be designated, as unsuitable for mining. Consol does not propose to conduct coal mining or reclamation operations in the IBC area within 300 feet of any occupied dwelling or within 100 feet of a public road.

XII.C ENVIRONMENTAL RESOURCE INFORMATION

XII.C.1 PERMIT AREA

The lands subject to coal mining operations within the IBC area are noted on Plate III-9. It is not anticipated that individual permits will be sought for subareas within the IBC area.

XII.C.2 SOIL RESOURCE INFORMATION

Soil resources in the IBC area are depicted in Figure XII-1. Descriptions of these soils are provided in Appendix XII-1. Soil series descriptions in the appendix were obtained from the U.S. Natural Resources Conservation Service (2005). Descriptions of individual map units were obtained from Swenson et al. (1970). Soils within the IBC area tend to be fine grained, ranging generally from loam to silty clay loam. If irrigated, the soil generally supports alfalfa or other irrigated crops. Otherwise, the soils mostly support the growth of rangeland plants such as shadscale, Indian ricegrass, greasewood, and/or saltgrass.

Additional information regarding soil resources in the IBC and adjacent areas is provided in Chapter VII of the approved MRP. Impacts to soil resources are not anticipated as a result of mining under this application since no new surface disturbances are planned.

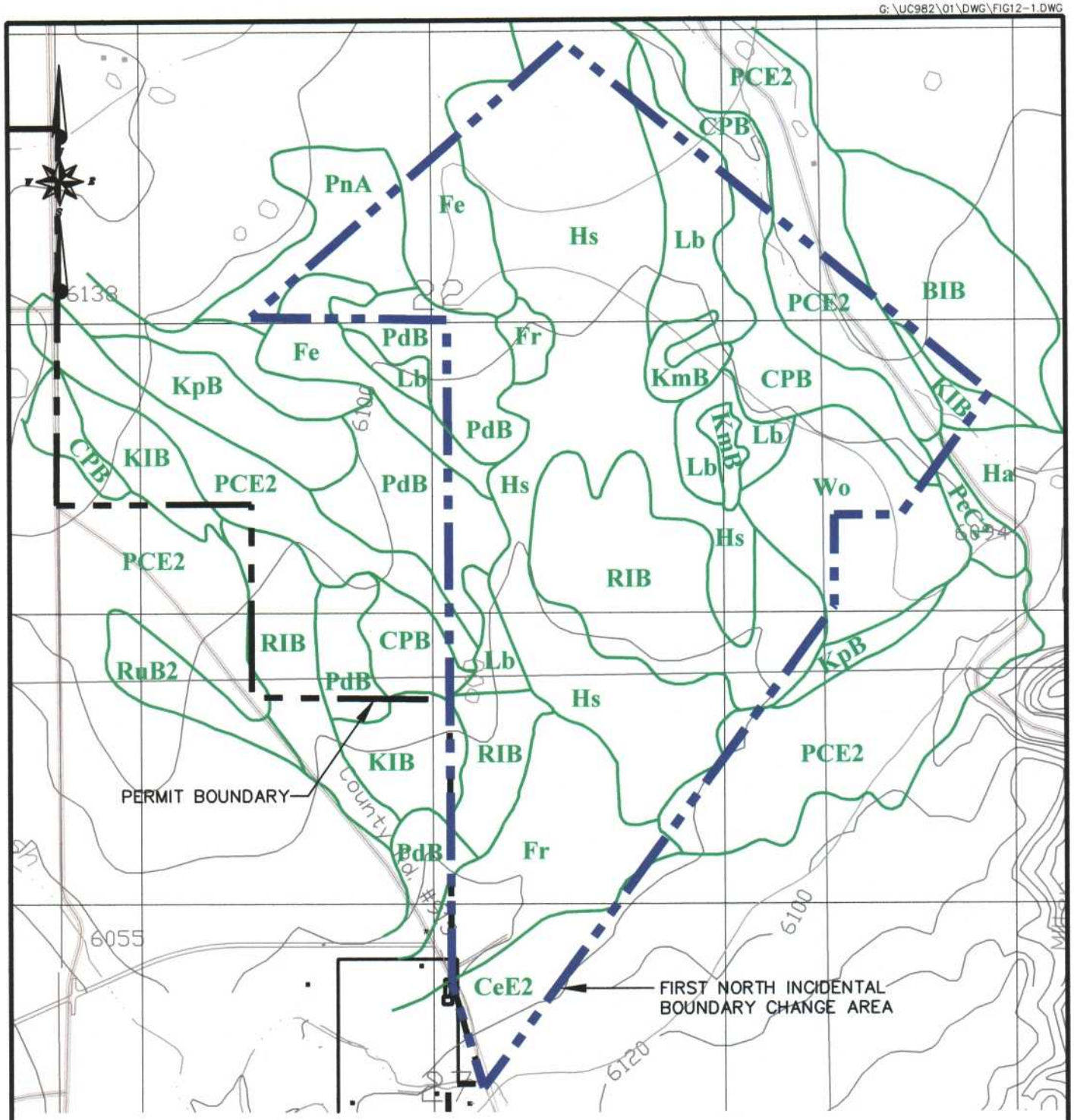
XII.C.3 VEGETATION RESOURCE INFORMATION

Information concerning vegetation resources within the IBC area is provided in Appendix XII-2. Three plant communities are present in the IBC area, namely shadscale, greasewood, and saltgrass. Portions of the area have been previously cultivated as pasture land, but cultivation activities do not appear to be current. Information presented in Appendix XII-2 indicates that federally-listed threatened or endangered plant species are not likely to exist in the IBC area. No impacts to vegetation are anticipated from mining in the IBC area due to the planned non-disturbance of the surface.

XII.C.4 FISH AND WILDLIFE RESOURCE INFORMATION

Information regarding fish and wildlife resources within the IBC and adjacent areas is provided in Chapter IX of the approved MRP. According to Appendix IX-1 of the approved MRP, wildlife habitat within the IBC and adjacent areas is classified as being of substantial year-long value to deer and of critical year-long value to ring-necked pheasants. No intermittent or perennial streams, and hence no fish habitat and no riparian habitat, occur within the IBC area.

G:\UC982\01\DWG\FIG12-1.DWG



BIB	BILLINGS SILTY CLAY LOAM, 1 TO 3 PERCENT SLOPES.
CeE2	HIDEOUT EXTREMELY ROCKY VERY FINE SANDY LOAM, 0 TO 20 PERCENT SLOPES, ERODED.
CPB	CHIPETA–PERSAYO ASSOCIATION, 1 TO 3 PERCENT SLOPES.
Fe	FERRON SILTY CLAY LOAM, HEAVY VARIANT.
Fr	FERRON SILT LOAM.
Ha	HARDING VERY FINE SANDY LOAM.
Hs	HUNTING LOAM, MODERATELY SALINE.
KIB	KILLPACK CLAY LOAM, 1 TO 3 PERCENT SLOPES.
KmB	KILLPACK CLAY LOAM, HIGH WATER TABLE VARIANT, 1 TO 3 PERCENT.
Lb	LIBBINGS SILTY CLAY LOAM.
PCE2	PERSAYO–CHIPETA ASSOCIATION, 1 TO 20 PERCENT SLOPES, ERODED.
PdB	PALISADE VERY FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES.
PeC2	PENOYER LOAM, 3 TO 6 PERCENT SLOPES, ERODED.
PnA	PENOYER LOAM, EXTENDED SEASON, 0 TO 1 PERCENT SLOPES.

0' 1000'

FIGURE XII–1. SOIL TYPES IN THE IBC AREA.

EarthFax

As indicated in Appendix IX-1 of the approved MRP, no evidence exists that rare or endangered wildlife species breed on, or make extensive use of, the IBC area. Golden eagles likely make occasional use of the area for hunting, but no nests exist within the IBC area. Furthermore, peregrine falcons may occasionally visit the area, but not to a substantial degree. Prairie dog colonies exist within the IBC area, but no evidence of black-footed ferrets has been observed in the area.

Additional information regarding fish and wildlife resources in the IBC and adjacent areas is provided in Chapter IX of the approved MRP. No impacts to fish and wildlife resources are anticipated due to coal mining in the IBC area.

XII.C.5 GEOLOGIC RESOURCE INFORMATION

Information regarding geologic resources within the IBC and adjacent areas is provided in Chapter V of the approved MRP. The Bluegate Shale member of the Mancos Shale outcrops over the entire surface of the IBC area. This unit is a saline, blue-gray silty mudstone and siltstone with rare, thin sandstone lenses. The Bluegate Shale abruptly overlies the Ferron Sandstone member of the Mancos Shale. The Ferron Sandstone consists of interbedded layers of sandstone, siltstone, shale, and coal, with the coal to be mined in the IBC area occurring in the upper portion of the Ferron Sandstone in a layer known as the IJ zone. The Tununk Shale member of the Mancos Shale underlies the Ferron Sandstone.

Based on data provided on Plate V-20 of the approved MRP, approximately 100 to 400 feet of overburden overlies the IJ zone within the IBC area. Roof and floor materials above and below the IJ zone within the IBC area are expected to be as indicated in Section V.A.4 of the approved MRP, consisting of interbedded sandstone and shale. Dark gray shale typically contacts the roof of the coal, with several feet of irregularly laminated, light gray, fine-grained quartz sandstone above the shale. The floor material is generally dark olive gray, coaly, silty shale interbedded with light gray, fine grained quartz sandstone.

According to Section V.A.4 of the approved MRP, the pH of the roof material ranges from about 5 to 9, with the pH of the floor materials tending to be slightly higher. The roof and floor materials tend to have low salinity (specific conductance less than 4.0 mmhos/cm), with moderate to high sodium adsorption ratios (1.8 to 28) and concentrations of heavy metals that are sufficiently low to not influence reclamation decisions.

The coal, overburden, and underburden in the IBC area are unlikely to have substantial acid-forming potential, as indicated by the pH of the rock and the slightly alkaline nature of water that has historically discharged from the Emery Mine (pH 7.1 to 8.5 – see Section V.A.5 of the approved MRP). Furthermore, as indicated in Section V.A.6 of the approved MRP, the sulfur content of the coal is generally low (typically 0.5 to 2.0 percent, with an average of about 0.7 percent), with variable proportions of the sulfur existing as pyrite. Concentrations of toxic constituents in the coal, overburden, and underburden are low (see Section V.A.4 of the approved MRP).

A comparison of Plates V-20 and VI-4 of the approved MRP indicates that the complete thickness of the Ferron Sandstone is probably saturated within the IBC area. Additional information regarding groundwater within the IBC and adjacent areas is provided below and in Chapter VI of the approved MRP.

XII.C.6 HYDROLOGIC RESOURCE INFORMATION

XII.C.6.1 Baseline Information

Mining within the IBC area will not involve the construction of additional surface facilities. Furthermore, as indicated in Section XII.A, coal will be mined under this application using room and pillar methods without pillar extraction (i.e., first mining only). Hence, no surface disturbance is planned.

Baseline hydrologic data have been collected from several surface and groundwater monitoring locations within the IBC and adjacent areas (see Plates VI-1 and VI-3 of the approved MRP). These data are discussed in Chapter VI of the approved MRP. Given the lack of surface disturbance planned for the IBC area and the close location of the IBC area relative to the existing permit area, the existing baseline data are considered adequate for the IBC area.

XII.C.6.2 Groundwater Information

As indicated in Chapter VI of the approved MRP, the complete thickness of the Ferron Sandstone is probably saturated within the IBC area, normally under confined conditions. Although the formation dips to the northwest (see, for instance Plate V-20), groundwater flows generally to the south or southeast (see Plates VI-5 and VI-9) except where influenced by mining in the area (Plate V-4). The hydrostatic pressure required to force groundwater up dip in the mine area is generally believed to originate from recharge along the Joe's Valley-Paradise fault zone located at higher elevations north and west of the mine area.

Although the Ferron Sandstone is completely saturated within the existing mine area, historic inflows to the mine have been predominantly from the roof rather than the floor. This suggests that the upper and lower portions of the Ferron Sandstone are hydraulically separated. This hydraulic separation is also indicated by a comparison of Plates VI-4 and VI-5 of the approved MRP, which indicates that past impacts of mining on the potentiometric surface of the area have occurred primarily in the upper Ferron Sandstone, with no noticeable potentiometric-surface impacts in the lower Ferron Sandstone.

Groundwater discharges from the Ferron Sandstone by wells, by dewatering of the Emery Mine, by seepage into Quitchupah Creek and Christiansen Wash, and by leakage into the Bluegate and Tununk Shales. Within the immediate vicinity of the IBC area, the largest anthropogenic discharge of groundwater from the Ferron Sandstone is dewatering of the Emery Mine that, according to Chapter VI of the approved MRP, accounts for approximately 0.6 to 1.2 cubic feet per second of water being removed from the Ferron Sandstone.

Natural groundwater quality in the *upper* Ferron Sandstone is moderately saline, with total dissolved solids concentrations in monitoring well and mine roof inflow samples averaging approximately 1000 to 1300 mg/l (see Table VI-9 of the approved MRP). The total dissolved solids concentration of groundwater in the *lower* Ferron Sandstone tends to be slightly lower, averaging approximately 800 mg/l (see the previously noted table). This difference in salinity further suggests a hydraulic separation between the upper and lower Ferron Sandstone. Sodium and sulfate are the dominant ions in groundwater occurring in both the upper and lower Ferron Sandstone.

XII.C.6.3 Surface Water Information

The IBC area lies within the drainage basin of Christiansen Wash, a perennial tributary to Quitchupah Creek. The only surface water courses within the IBC area are small ephemeral rills and irrigation ditches. No definitive stream channels exist within the IBC area. Three small stockwatering ponds exist in the IBC area, but these are fed by irrigation ditches and local overland flow rather than natural streams.

Information regarding surface water resources in the vicinity of the IBC area is provided in Section VI.A.3 of the approved MRP. As indicated in that section, streamflow in Christiansen Wash generally increases in the downstream direction, primarily due to irrigation return flow and inflow from a tributary south of the IBC area that carries spring water to the wash. Peak flows in Christiansen Wash typically occur in mid to late spring as a result of snowmelt runoff and then again in mid to late summer due to thunderstorms. Irrigation return flows contribute to Christiansen Wash during the summer months.

Data presented in Chapter VI of the approved MRP indicate that concentrations of dissolved constituents generally increase in the downstream direction along Christiansen Wash. This is attributed to irrigation return flow seeping into the steam. The total dissolved solids concentrations of Christiansen Wash tends to range from about 1,000 to 5,000 mg/l and are typically indirectly related to discharge rate. Calcium, sodium, and sulfate are the dominant ions. Total suspended solids concentrations vary widely in Christiansen Wash (from less than 100 to more than 3,000 mg/l) and tend to be directly related to discharge rate.

XII.C.6.4 Baseline Cumulative Impact Information

The First North IBC area lies within the cumulative impact area of the Emery Mine.

XII.C.6.5 Modeling

No surface or groundwater modeling was performed for this IBC application.

XII.C.6.6 Alternative Water Source Information

As indicated in Section VI.A.4 of the approved MRP, two private wells in the vicinity of the Emery Mine (the Bryant well and the Lewis well) have stopped flowing at the surface as a result of dewatering activities at the Emery Mine. Consol has furnished and installed pumps

and associated appurtenances to allow continued use of this water. Consol has also committed to drill new wells if needed to replace these water supplies.

It is doubtful that mining within the IBC area will substantially change the magnitude of past impacts to the hydrology of the Emery Mine area (see Section XII.C.6.7 of this application). However, the above commitment to provide alternative sources of water, if necessary, remains in effect for mining activities in the IBC area.

XII.C.6.7 Probable Hydrologic Consequences Determination

The probable hydrologic consequences of mining in the IBC area will be the same as noted in Section VI.A.7 of the approved MRP, namely:

- Changes to the potentiometric surface of the Ferron Sandstone (particularly the upper portion) due to mine dewatering activities and
- Changes in the quality and quantity of surface water in the area due to the discharge of intercepted mine water.

The *maximum* quantity of groundwater to be encountered in the IBC area was estimated based on the inflow per unit area to the existing portion of the Emery Mine. Data presented in Section VI.A.7 of the approved MRP indicate that inflow to the Emery Mine in 1989 and 1990 averaged approximately 1.0 cubic foot per second (i.e., 450 gallons per minute). Mine workings at that time occupied an underground area of approximately 1,440 acres (see, for instance, Plate VI-4 and several other plates that utilize the same base map). Mine workings in the IBC area will occupy an underground area of approximately 170 acres (see Plate XII-1). Assuming an equivalent inflow per unit area, mining in the IBC area may increase inflow to the Emery Mine by a *maximum* of about 12 percent.

Notwithstanding the above estimate, the IBC area is located up dip from the remainder of the Emery Mine, indicating that hydraulic pressures are naturally less in the IBC area than in the area of current mine workings further west. Furthermore, dewatering operations in the remainder of the Emery Mine have likely already dewatered a portion of the IBC area (see Plate VI-8 of the approved MRP). These factors indicate that groundwater inflow to the IBC workings will be less per unit area than in the remainder of the Emery Mine. Hence, total inflow to the IBC workings should be substantially less than 0.1 cubic foot per second (45 gallons per minute).

According to Section VI.A.7 of the approved MRP, mining of the IJ zone will not degrade groundwater quality in the Emery Mine permit and adjacent areas. A similar lack of groundwater quality impacts is anticipated from mining in the IBC area.

It is estimated from information contained in Section VI.A.7 of the approved MRP that approximately 0.1 cubic foot per second of groundwater that normally *would* seep into the Quitchupah Creek is intercepted in the Emery Mine and prevented from naturally discharging to the creek. However, this reduction in surface-water flow is offset by discharging to the creek approximately 1.0 cubic foot per second of groundwater intercepted in the mine. Hence, the

net impact of mining in the Emery Mine on the flow of Quitchupah Creek is a flow increase of approximately 0.9 cubic foot per second. Water intercepted in the IBC area may slightly increase this net effect.

Water in the Emery Mine comes into contact with rock dust, thereby increasing the total dissolved solids concentration of this water prior to being pumped to the surface into Quitchupah Creek. Similar impacts are anticipated from mining in the IBC area. According to Section VI.A.7 of the approved MRP, the salt load of Muddy Creek (into which Quitchupah Creek eventually discharges) is expected to increase 10 to 17 percent as a result of mining in the Emery Mine. The salt load of the Dirty Devil River (into which Muddy Creek discharges) has historically increased less than 1 percent due to mine-water discharges. Assuming the total dissolved solids concentration of water discharging from the IBC area is similar to that in the remainder of the Emery Mine, and assuming that mining in the IBC area results in an increase in the mine-water discharge to Quitchupah Creek of 5 percent, the total salt load of Muddy Creek will increase 1 to 2 percent due to mining in the IBC area. No water rights exist downstream of the mine discharge point on Quitchupah Creek or Ivie Creek (the receiving stream for Quitchupah Creek). Hence, no substantially increased impacts to water users are anticipated from salt loading due to mining in the IBC area.

No additional surface area will be disturbed under this application. Hence, additional sediment loads to local streams will not occur.

XII.D OPERATION PLAN

XII.D.1 MINING OPERATIONS AND FACILITIES

Coal will be extracted under this application using room and pillar methods without pillar extraction (i.e., first mining only). It is anticipated that 1,600,000 tons of coal will be mined from the IBC area at a rate of approximately 400,000 tons per year. Mining will occur using a continuous miner. General criteria for pillar design are provided in Section V.B.1 of the approved MRP.

No new surface facilities will be constructed under this application. Facilities associated with the Emery Mine that will be used during mining of the IBC area are discussed in Chapter II of the approved MRP.

The anticipated sequence of mining in the IBC area is indicated on Plate XII-1. This map also shows existing and anticipated underground workings within the current permit area and, for completeness only, potential mine workings outside of both the current permit area and the First North IBC area. Coal will not be extracted from areas outside the current permit area and the First North IBC area until those areas are properly permitted.

Although no subsidence is planned under this application, Plate XII-1 shows locations of proposed subsidence monitoring stations in the IBC and adjacent areas. These stations will be established as indicated in Figure V-8 of the approved MRP. These stations will be monitored as outlined in Section V.B.1 of the approved MRP.

XII.D.2 EXISTING STRUCTURES

No "existing structures", as defined in R645-100-200, exist in the IBC area. Structures located in other portions of the permit area that will be used during mining of the IBC area are discussed in Chapter II of the approved MRP. These structures will not be modified under this application.

XII.D.3 COAL RECOVERY

Coal will be recovered in a manner that maximizes utilization and recovery of the resource while maintaining environmental integrity. This plan will be modified if future designs call for extraction of the pillars.

XII.D.4 SUBSIDENCE CONTROL PLAN

No subsidence is planned for the IBC area.

XII.D.5 HYDROLOGIC INFORMATION

Information regarding surface and groundwater resources and probable hydrologic impacts of mining in the First North IBC and adjacent areas is provided in Section XII.C.6 of this application. A discussion of surface and groundwater monitoring programs associated with the Emery Mine is provided in Section VI.A.5 of the approved MRP. Information regarding the acid- and toxic-forming potential of the coal, overburden, and underburden is discussed in Section XII.C.5 of this application.

No surface disturbances are planned in the IBC area. Hence, no new diversions, stream buffer zones, sediment control structures, or other treatment facilities will be installed as a result of mining in the First North IBC area.

XII.E RECLAMATION PLAN

No new surface disturbances will occur as a result of mining in the First North IBC area. Hence, no additional land reclamation will be required as a result of this action. Information regarding reclamation of the Emery Mine surface facilities is provided in Chapter III of the approved MRP. This information includes a discussion of surface and groundwater monitoring programs, structure removal, backfilling and grading operations, drainage control, topsoil redistribution, site revegetation, etc.

XII.F CUMULATIVE HYDROLOGIC IMPACT ASSESSMENT

The First North IBC area lies within the existing cumulative hydrologic impact assessment ("CHIA") area associated with the Emery Mine. The CHIA that was previously prepared in conjunction with permitting the Emery Mine should be sufficient for evaluating the hydrologic impacts of the First North IBC area.

XII.G REFERENCES

Swenson, J.L., D.T. Erickson, K.M. Donaldson, and J.J. Siozaki. 1970. Soil Survey of Carbon-Emery Area, Utah. U.S. Soil Conservation Service (now the U.S. Natural Resources Conservation Service). Salt Lake City, Utah.

U.S. Natural Resources Conservation Service. 2005. Official Soil Series Descriptions. Available online at http://soils.usda.gov/technical/classification/asd/index.html. Accessed 4 Apr 2005.

APPENDIX XII-1

Soil Descriptions

BILLINGS SERIES

The Billings series consists of very deep, well drained, moderately slowly or slowly permeable soils formed in alluvium derived from marine alkaline shales and mixed sedimentary rocks. Billings soils are on flood plains and valley floors. Slopes are 0 to 10 percent. The average annual precipitation is about 7 inches and the mean annual temperature is about 50 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, active, calcareous, mesic Typic Torrifluvents

TYPICAL PEDON: Billings silty clay loam - cultivated. (Colors are for air-dry soil unless otherwise noted.)

Ap1--0 to 3 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium granular structure; hard, firm, sticky and plastic; many medium roots; common medium pores; strongly calcareous, moderately alkaline (pH 7.9); clear smooth boundary. (1 to 6 inches thick)

Ap2--3 to 11 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine blocky and subangular blocky structure; hard, firm, sticky and plastic; many medium roots; common fine pores; strongly calcareous; moderately alkaline (pH 8.0); clear smooth boundary. (0 to 8 inches thick)

C1--11 to 18 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine blocky and subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine pores; strongly calcareous; mildly alkaline (pH 7.8); gradual wavy boundary. (6 to 15 inches thick)

C2--18 to 42 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine pores; strongly calcareous; mildly alkaline (pH 7.0); diffuse boundary. (10 to 24 inches thick)

Cy--42 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; few fine roots; few fine pores; few fine grayish brown (10YR 6/2) soft gypsum nodules; strongly calcareous; moderately alkaline (pH 8.0).

TYPE LOCATION: Emery County, Utah; 1.5 mile east of Huntington, 2,000 feet west and 600 feet north of the southeast corner of sec. 20, T. 17 S., R. 9 E.

RANGE IN CHARACTERISTICS: Mean annual soil temperature is 47 to 56 degrees F. The particle-size control section ranges from 27 to 35 percent clay and less than 15 percent sand coarser than very fine sand. Salinity and sodicity range from slight to very strong. Clay minerals

are mixed, but are dominantly illite and kaolinite. Calcium carbonate equivalent ranges from 5 to 25 percent. Reaction ranges from mildly alkaline to very strongly alkaline.

The A horizon has hues of 10YR to 5Y, value of 5 to 7 dry, and 4 to 6 moist, and chromas of 2 to 4.

The C and Cy horizons have hues of 10YR to 5Y, value of 5 to 7 dry, and 4 to 6 moist, and chromas of 2 to 4. Textures are silty clay loam, silt loam, clay loam, and very fine sandy loam. Gypsum is in crystals and nodules that amount to 0.5 to 10 percent of the horizon by volume.

GEOGRAPHIC SETTING: These soils are on valley floors, flood plains and a few narrow alluvial fans. Parent material is alluvium from alkaline marine shales and mixed sedimentary rocks containing gypsum. Slopes range from 0 to 10 percent. The climate is semiarid. Elevation ranges from 4000 to 6500 feet. Mean annual air temperature is 46 to 54 degrees F. and the freeze-free period ranges from 110 to 160 days. Mean annual precipitation ranges from 5 to 11 inches.

DRAINAGE AND PERMEABILITY: Well and moderately well drained; Runoff is medium to rapid; permeability is moderately slow to slow.

USE AND VEGETATION: Where irrigated and not too saline, alfalfa, small grains, sugar beets, and beans are grown. Potential vegetation is mainly shadscale, Indian ricegrass, galleta, and greasewood.

DISTRIBUTION AND EXTENT: The semiarid and arid parts of Montana, Wyoming, Colorado, and Utah. MLRA 34,35,28A. The series is extensive.

REMARKS: The pH values given are of soil paste.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from the surface of the soil to 11 inches (Ap1, Ap2 horizons)

Gypsum feature - the zone of gypsum accumulation from 42 to 60 inches (Cy horizon)

Particle-size control section - the zone from 10 to 40 inches.

BILLINGS SILTY CLAY LOAM, 1 TO 3 PERCENT SLOPES (B1B): This soil has the profile described as typical of the series. In some places the underlying material contains thin layers of loam or clay loam. Veins, crystals, or nodules of gypsum are common below a depth of 12 to 20 inches but occur erratically, depending on the source of sediment.

Included with this soil in mapping were spots, generally less than 2 acres in extent, that are strongly affected by salt and alkali. Also included were some loamy soils, small areas of clayey soils, and some places, especially below shaly colluvial slopes, where gravel is on the surface.

This Billings soil is well drained and is moderately susceptible to erosion. It retains about 11 inches of water, but only about 5 inches of water is readily available to plants. Runoff is medium, and permeability is slow. Roots penetrate deeply. The frost-free period is 110 to 130 days in 3 out of 4 years. Natural fertility is low, but fertility can be increase by applying manure and commercial fertilizer. This soil is fairly hard to work. The seedbed is more easily prepared if the soil is plowed in fall when it is moist, and is allowed to remain rough over winter, than when plowing is done in spring.

This soil is used for irrigated alfalfa, small grains, corn, pasture, and sugar beets. Alfalfa yields two crops and part of a third. Corn does not mature for grain and is used for ensilage or is pastured. Alfalfa generally responds to phosphate; small grains, corn, and pasture plants respond to a fertilizer containing nitrogen.

The soil generally needs to be leveled so that water can be distributed evenly. Leveling causes no damage if done when the soil is fairly dry. Many areas have already been leveled, and many areas of this soil are still in range. (Capability units IIIe-25, irrigated, and VIIs-D, nonirrigated; Desert Loam Bottom range site)

CHIPETA SERIES

The Chipeta series consists of very shallow and shallow, well drained, slowly permeable soils that formed in residuum and colluvium from shale. Chipeta soils are on upland pediments and hills and have slopes of 0 to 35 percent. The average annual precipitation is about 7 inches and the mean annual temperature is about 50 degrees F.

TAXONOMIC CLASS: Clayey, mixed, active, calcareous, mesic, shallow Typic Torriorthents

TYPICAL PEDON: Chipeta silty clay loam -cultivated. (Colors are for air-dry soil unless otherwise noted.)

Ap--0 to 5 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine discontinuous pores; violently effervescent; slightly alkaline (pH 7.7); clear smooth boundary. (1 to 5 inches thick)

C--5 to 13 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium and fine subangular blocky structure; hard, very firm, sticky and plastic; few fine and medium roots; few large continuous pores, few fine discontinuous pores; violently effervescent; slightly alkaline (pH 7.6); clear wavy boundary. (6 to 10 inches thick)

Cy--13 to 17 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak, moderately thick platy structure parting to weak medium blocky; hard, very firm, sticky and plastic; few fine and medium roots; many fine crystals and mycelia-like veins of gypsum; 20 percent unweathered shale fragments; violently effervescent; slightly alkaline (pH 7.4); gradual irregular boundary. (3 to 5 inches thick)

Cr--17 inches; weathered marine shale.

TYPE LOCATION: Emery County, Utah; 1 mile south and 1-1/2 miles east of Castle Dale, 1,000 feet south and 20 feet east of the northwest corner, sec. 11, T. 19 S., R. 8 E.

RANGE IN CHARACTERISTICS:
Soil moisture regime: Typic Aridic.
Soil temperature regime: Mesic.
Depth to shale: 5 to 20 inches.
Salinity: moderate to strong.
Particle-size control section: 35 to 50 percent clay.
Mean annual soil temperatures: 49 to 57 degrees F.
Reaction: slightly alkaline to strongly alkaline.

A horizon:
Hue: 10YR to 5Y

Value: 5 to 8 dry, 3 to 6 moist
Chroma: 2 to 4
Texture: loam or silty clay loam

C horizon:
Hue: 10YR to 5Y
Value: 4 to 6 dry, 3 to 5 moist
Chroma: 1 to 4
Textures: silty clay loam or silty clay
Gypsum: 0.5 to 10 percent and gypsum crystal ranges from few to many.

GEOGRAPHIC SETTING: These soils are on gently sloping to steep upland pediments and hills. Slopes are complex and range from 0 to 35 percent. These soils formed in residuum from alkaline marine shales containing gypsum. The climate is semiarid. The mean annual temperature is 45 to 55 degrees F. The freeze-free period ranges from 90 to 160 days. Mean annual precipitation ranges from 5 to 11 inches.

DRAINAGE AND PERMEABILITY: Well drained; medium to very high runoff; slow permeability.

USE AND VEGETATION: A few of the smoother areas of deeper soil are irrigated and used for growing grain and hay crops. Potential vegetation is mat saltbush and galleta.

DISTRIBUTION AND EXTENT: Western Colorado, Wyoming, eastern Utah, and New Mexico. LRR D, MLRA 34. The series is extensive.

REMARKS:
All pH values given are of soil paste.
Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon-the zone from the surface to 5 inches (Ap horizon)
Shallow feature-weathered shale at 17 inches (Cr horizon)

CHIPETA-PERSAYO ASSOCIATION, 1 TO 3 PERCENT SLOPES (CPB): This mapping unit consists of about 60 percent Chipeta silty clay loam, 1 to 3 percent slopes, and of about 40 percent Persayo loam, 1 to 3 percent slopes. These soils are intermingled and occur in no consistently identifiable pattern. Consequently, they were not separated in mapping. As a rule, the Chipeta soil is on ridges and has stronger slopes than the Persayo soil.

Included in the mapping were some areas of very shallow unnamed soils. Also included were other soils that are 20 to 40 inches thick over shale and small areas, generally less than 1 acre in extent, of strongly saline-alkali soils.

The profile of Chipeta silty clay loam, 1 to 3 percent slopes, is the one described as typical for the series. In most places this soil is 10 to 20 inches thick over shale. It has good drainage and is

slowly permeable. Runoff is medium, and the susceptibility to erosion is moderate. Roots penetrate to the shale and then spread horizontally. This Chipeta soil retains about 3 inches of available water. The soil is hard to work and to irrigate. Leveling is not practical, because this soil is too shallow.

The Persayo soil in this mapping unit has a profile like the one described for the Persayo series. Erosion has mainly caused the formation of rills and shallow gullies.

The dominant use of the soils in this mapping unit is spring and fall range. Alfalfa, grain, and pasture plants are grown in the irrigated areas, but the soils are poorly suited to those crops. Hay and pasture effectively reduce soil losses most of the time. (Both soils are in capability unit VIe-23, irrigated. The Chipeta soil is in capability unit VIIe-D3, nonirrigated; Desert Shale range site. The Persayo soil is in capability unit VIIe-D4, nonirrigated; Desert Loamy Shale range site)

FERRON SERIES

The Ferron series consists of very deep, poorly drained, moderately permeable soils that formed in alluvium on flood plains. Slopes are 0 to 3 percent. The average annual precipitation is about 8 inches and mean annual temperature is about 49 degrees F.

TAXONOMIC CLASS: Coarse-silty, mixed, active, calcareous, mesic Aeric Fluvaquents

TYPICAL PEDON: Ferron silt loam. (Colors are for air-dry soil unless otherwise noted.)

0i--1 inch to 0; undecomposed organic material, mainly grass roots; strongly calcareous, moderately alkaline (pH 8.3); abrupt smooth boundary. (0 to 3 inches thick)

Agy--0 to 3 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist, common fine prominent yellowish red (5YR 4/8) redoximorphic and common medium faint dark gray (4/0) redoximorphic depletions; weak thick platy structure parting to weak medium granular; slightly hard, friable, slightly sticky and slightly plastic; many fine and few medium roots; few medium and fine pores; moderately calcareous; moderately alkaline (pH 8.3); clear smooth boundary. (3 to 8 inches thick)

Cgy--3 to 15 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist, many medium distinct olive brown (2.5Y 5/6) redoximorphic concentrations; weak moderately thick platy structure parting to weak medium granular; soft, friable, slightly plastic; many medium and fine roots; common fine pores; many gypsum mycelia; moderately calcareous; mildly alkaline (pH 7.8); gradual wavy boundary. (6 to 12 inches thick)

Cg--15 to 60 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, brownish gray (2.5Y 5/2) moist, many medium and faint light olive brown (2.5Y 5/6) redoximorphic concentrations; massive; soft, friable; common medium and few fine roots; few fine pores; strongly calcareous; mildly alkaline (pH 7.7).

TYPE LOCATION: Emery County, Utah; 2 miles northwest of Huntington, 350 feet north and 20 feet west of the southeast corner of sec. 11, T. 17 S., R. 8 E.

RANGE IN CHARACTERISTICS: Mean annual soil temperatures range from 49 to 54 degrees F.

Ferron soils have mottles within 20 inches of the surface. The seasonal high water table ranges between the 6 and 30 inch depths. Calcium carbonate equivalent ranges from 10 to 25 percent. It ranges from slightly saline to strongly saline. Reaction ranges from mildly alkaline to strongly alkaline. The 10 to 40 inch contains less than 18 percent clay and less than 15 percent sand coarser than very fine sand, and it ranges in texture from very fine sandy loam to light silt loam, with the strata of fine sandy loams.

The A horizon has hues of 2.5Y through 5Y, values of 5 or 6 dry, 4 or 5 moist, and chromas of 1 or 2.

The C horizon has hues of 2.5Y through 5Y, values of 5 or 6 dry, and 4 or 5 moist, and chromas of 2. There is a subhorizon in the upper C horizon between 10 and 30 inches that has hue of 2.5Y, value 4 or 5 moist, and a chroma of 2.

GEOGRAPHIC SETTING: These soils are on flood plains and in the bottoms of narrow alluvial valleys. Slopes are 0 to 3 percent. Parent material is alluvium derived from marine shale and sandstone. The climate is semiarid. Mean annual temperatures is 47 to 52 degrees F. Mean annual precipitation ranges from 6 to 10 inches. The freeze-free period is from 100 to 140 days.

DRAINAGE AND PERMEABILITY: Poorly drained. Runoff slow; permeability moderate.

USE AND VEGETATION: Used for pasture. Potential vegetation is tufted hairgrass, redtop, native clover, and sedges.

DISTRIBUTION AND EXTENT: Mainly in eastern Utah. The series is inextensive. MLRA 34

REMARKS: Diagnostic horizons and features in this pedon include:

Ochric epipedon - the zone from 0 to 3 inches (Agy horizon).

Aquic feature - 2 chroma matrix and redoximorphic concentrations from 3 to 20 inches (Agy and upper Cgy horizons).

There is an irregular decrease in organic matter with depth.

All pH values given are of soil paste.

The classification was changed from Typic Fluvaquent to Aeric Fluvaquent in 9/94.

FERRON SILTY CLAY LOAM, HEAVY VARIANT, 0 TO 3 PERCENT SLOPES (FE): This soil occurs in small, low areas that receive seep water from higher lying canals and irrigated areas. Its profile is the one described for the heavy variant of the Ferron series.

Grazing is the only use of this soil. Some areas can be grazed only in winter when the soil is frozen. (Capability unit Vw-2W, nonirrigated; Wet Meadow range site)

FERRON SILT LOAM, 0 TO 3 PERCENT SLOPES (Fr): The profile of this soil is the one described for the series. This soil generally occurs in small, low areas that receive seepage water from canals or from irrigated areas higher on the slopes. It is typically mottled to the surface, but in places mottles occur at a depth below 20 inches. The surface layer is rich in organic matter and is moderately saline in places.

Included in the mapping were small areas of very strongly saline-alkali soils and small areas of soils in which the water table is at a moderate depth.

Drainage is poor, and permeability is moderate. Because of the high water table, most roots penetrate only to a depth of 30 inches or less. Runoff is slow, and the susceptibility to erosion is slight. The large amount of organic matter in the surface layer contributes to fertility, but this soil is low in natural fertility. Pastures that are dry enough for the application of fertilizer respond well to nitrogen and phosphorus.

This soil is used only for grazing. Livestock can graze some areas only in winter when the soil is frozen. (Capability unit Vw-2W, nonirrigated; Wet Meadow range site)

HARDING SERIES

The Harding series consists of very deep, well and moderately well drained soils that formed in alluvium and lacustrine deposits from sandstone, limestone and shale. The Harding soils are on lake plains, lake terraces, and flood plains. Slope ranges from 0 to 5 percent. The mean annual precipitation is about 10 inches and the mean annual temperature is 48 degrees F.

TAXONOMIC CLASS: Fine, mixed, active, mesic Xeric Natrargids

TYPICAL PEDON: Harding silt loam, rangeland. (Colors are for air dry soils unless otherwise noted.)

A--0 to 4 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; moderate thin platy structure; soft, friable, sticky and slightly plastic; common very fine roots; few very fine pores; moderately calcareous, disseminated carbonates; strongly alkaline (pH 8.8); abrupt smooth boundary.

Bw--4 to 10 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine pores; strongly calcareous disseminated carbonates; strongly alkaline (pH 8.6); clear smooth boundary.

Btn1--10 to 23 inches; very pale brown (10YR 7/3) silty clay; brown (10YR 5/3) moist; strong coarse prismatic structure that parts to strong fine angular blocky; very hard, extremely firm, very sticky and very plastic; few fine roots between peds; many moderately thick clay films on faces of peds; strongly calcareous, carbonates in soft rounded masses in peds mainly at the top of prisms; very strongly alkaline (pH 9.2); clear smooth boundary.

Btn2--23 to 30 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; moderate coarse prismatic structure that parts to strong fine angular blocky; hard, extremely firm, very sticky and very plastic; few very fine roots; common thick clay films on faces of peds; strongly calcareous, carbonates disseminated and in veins and rounded masses; very strongly alkaline (pH 9.6); gradual wavy boundary.

Bky--30 to 54 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; strong coarse angular blocky rock structure; very hard, extremely firm, very sticky and very plastic; common fine gypsum veins; strongly calcareous, disseminated carbonates; moderately alkaline (pH 8.4); clear smooth boundary.

C--54 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; platy rock structure; slightly hard, friable, slightly sticky and slightly plastic; moderately calcareous, disseminated carbonates; strongly alkaline (pH 9.0).

TYPE LOCATION: Juab County, Utah; about 2.5 miles west and 1 mile south of Mills; 1,300 feet west and 800 feet north of the southeast corner of sec. 33, T.15 S., R.2 W.

RANGE IN CHARACTERISTICS: The mean annual soil temperature is more than 47 degrees F.

The A horizon has hue of lOYR or 7.5YR, value of 6 or 7 dry, and 4 or 5 moist, and chromas of 2 or 3. Structure ranges from weak to moderate thin to thick platy.

The Bw horizon has hue of lOYR or 7.5YR, and value of 6 through 8 dry.

The Btn horizon has hue of lOYR or 7.5YR, values of 6 or 7 dry, and 4 or 5 moist, and chromas of 3 or 4. It contains more than 35 percent clay and textures are silty clay loam, stilty clay, or clay. Reaction ranges from strongly to very strongly alkaline. Organic staining is evident on the ped faces in most pedons. Structure ranges from moderate to strong prismatic or columnar and breaks to moderate or strong blocky. Calcium carbonate equivalent ranges from 15 to 40 percent.

The Bky horizon, when present, has value of 6 to 8 dry, and 5 to 7 moist, and chromas of 2 and 3. Gypsum content ranges from 1 to 10 percent.

GEOGRAPHIC SETTING: Harding soils are on nearly level to gently sloping lake terraces, lake plains, and flood plains at elevations of 4,200 to 5,600 feet. Slopes are O to 5 percent. These soils formed in alluvium and lacustrine deposits from sandstone, limestone, and shale. Mean annual temperature ranges from 45 to 52 degrees F., mean summer temperature is about 67 F. The freeze-free period is 110 to 140 days. The average annual precipitation is 8 to 12 inches.

DRAINAGE AND PERMEABILITY: Well and moderately well drained. Runoff is medium and high. Permeability is slow and very slow.

USE AND VEGETATION: Principally winter rangeland. Present vegetation is dominantly greasewood, bottlebrush squirreltail and shadscale.

DISTRIBUTION AND EXTENT: Central and western Utah, eastern Nevada, and southwestern Idaho. The soil is of moderate extent.

REMARKS: Diagnostic horizons and features in this pedon include:

Natric horizon - from a depth of 10 to 30 inches (Btn1 and Btn2 horizons).

The type location was changed to the Fairfield-Nephi Soil Survey in April 2003.

HARDING VERY FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES (Ha): The profile of this soil is the one described as typical of the series. Included in mapping was a small area about 4 miles east of Castle Dale in which the soil is only about 20 inches thick over shale. In this

included area, the surface layer and subsoil are similar to those in the typical Harding profile, but the gypsum layer is on top of the shale. Also included were soils not strongly affected by alkali.

Drainage is moderately good or good and permeability is slow. Roots generally penetrate no deeper than 30 inches. Where this soil is underlain by shale, roots penetrate only to the shale. Runoff is medium. This soil is moderately susceptible to erosion. It retains about 11 inches of water, but only about 5.5 inches of water is readily available to plants. Less than this amount is supplied by the limited precipitation.

This soil is suited to spring and fall grazing, and is used for that purpose. (Capability unit VIIs-S4, nonirrigated; Semi-Desert Limy Loam range site)

HIDEOUT SERIES

The Hideout series consists of very shallow and shallow, well drained soils that formed in eolian deposits and slope alluvium derived from sandstone. Hideout soils are on hillslopes and structural benches. Slopes range from 2 to 50 percent. Mean annual precipitation is about 10 inches and the mean annual temperature is about 47 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

TYPICAL PEDON: Hideout fine sandy loam, on a northwest-facing, linear, 18 percent slope in a Utah juniper rangeland at an elevation of 5,000 feet. (Colors are for dry soil unless otherwise noted.)

A--0 to 2 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine blocky structure parting to single grain; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine, few fine tubular and interstitial pores; very slightly effervescent, carbonates are disseminated; moderately alkaline (pH 8.2); abrupt smooth boundary. (1 to 3 inches thick)

C--2 to 10 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, few fine and medium roots; common very fine, few fine tubular and interstitial pores; very slightly effervescent, carbonates are disseminated; moderately alkaline (pH 8.4); abrupt smooth boundary. (6 to 18 inches thick)

R--10 inches; sandstone bedrock with fractures greater than 4 inches apart.

TYPE LOCATION: Uintah County, Utah; about 4.5 miles south of Split Mountain; located about 2,500 feet north and 1,500 feet west of the southeast corner of sec. 8, T. 5 S., R. 24 E., SLBM; Split Mountain, Utah USGS quad; lat. 40 degrees 23 minutes 57 seconds N. and long. 109 degrees 14 minutes 7 seconds W., NAD 27

RANGE IN CHARACTERISTICS:

Soil moisture: The soil moisture control section is affected by precipitation that has an even distribution through the year with a slight increase in late summer and early fall. Aridic moisture regime bordering on ustic.
Mean annual soil temperature: 47 to 50 degrees F.
Depth to lithic contact: 7 to 20 inches to sandstone bedrock

Particle-size control section: 5 to 18 percent clay

A horizon:
Hue: 7.5YR or 10YR
Value: 4 to 6 dry, 3 to 5 moist
Chroma: 3 to 6 dry or moist
Texture: fine sandy loam or sandy loam
Reaction: slightly alkaline or moderately alkaline

C horizon:
Hue: 7.5YR or 10YR
Value: 4 to 7 dry, 3 to 6 moist
Chroma: 3 to 6 dry or moist
Texture: fine sandy loam or sandy loam
Reaction: slightly alkaline or moderately alkaline

GEOGRAPHIC SETTING:
Parent material: eolian deposits and slope alluvium derived from sandstone
Landform: hillslopes and structural benches
Slopes: 2 to 50 percent
Elevation: 4,900 to 5,800 feet
Mean annual air temperature: 45 to 49 degrees F.
Mean annual precipitation: 8 to 12 inches
Frost-free period: 110 to 140 days

DRAINAGE AND PERMEABILITY: Well drained, low and medium runoff, moderately rapid permeability.

USE AND VEGETATION: The major uses are wildlife habitat, rangeland, and recreation. The potential native plant community is Utah juniper, black sagebrush, Indian ricegrass, galleta, and bluebunch wheatgrass. This soil has been correlated to Semidesert Shallow Loam (Utah Juniper-Pinyon) - 034XY233UT range site in Utah.

DISTRIBUTION AND EXTENT: Northeast Utah. LRR D, MLRA 34. This series is of small extent.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Particle-size control section: The zone from the surface to 10 inches. (A and C horizons)
Ochric epipedon: The zone from 0 to 2 inches. (A horizon)
Lithic contact: The contact with unweathered sandstone bedrock at 10 inches. (R layer)

The cation exchange activity class was inferred from laboratory data from similar soils in the Uintah Area Soil Survey.

HIDEOUT EXTREMELY ROCKY VERY FINE SANDY LOAM, 0 TO 20 PERCENT SLOPES, ERODED (CeE2): From 60 to 75 percent of this mapping unit is Hideout soil, and the rest is rock outcrop. The Hideout soil has the profile described as typical of the series. The texture of the surface layer is variable, however, because of deposition and removal of material by wind. In places, as much as half of the original surface layer is gone.

Included in mapping were areas of soils less than 10 inches thick over sandstone and other areas in which the soils are more than 20 inches thick.

Drainage is good, and permeability is moderately rapid. Roots penetrate to the sandstone and then spread horizontally. From 2 to 3 inches of available water is retained by this soil; the amount depends on the depth to sandstone. Runoff is slow to medium, but the amount of runoff is high because of the areas of bare rock. The susceptibility to further erosion from wind and water is slight to high. Many areas contain deep ravines.

This mapping unit is used for spring and fall range. Posts are cut from juniper in favorable sites. (Capability unit VIIs-S3, nonirrigated; Semi-Desert Stony Hills (Pinion-Juniper) range site)

HUNTING SERIES

The Hunting series consists of very deep, somewhat poorly drained, moderately permeable soils that formed in alluvium from shale and sandstone on alluvial fans and stream terraces. Slopes are 1 to 3 percent. The average annual precipitation is about 8 inches and the mean annual temperature is about 49 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, active, calcareous, mesic Aquic Torrifluvents

TYPICAL PEDON: Hunting loam--cultivated. (Colors are for air-dry soil unless otherwise noted.)

Ap--0 to 9 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few large and fine roots; few medium and fine pores; strongly calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (6 to 9 inches thick)

C1--9 to 27 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; few medium and fine pores; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary. (9 to 20 inches thick)

C2--27 to 30 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine roots; few fine pores; strongly effervescent; moderately alkaline (pH 7.9); gradual smooth boundary. (0 to 5 inches thick)

C3--30 to 60 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; with few medium distinct dark yellowish brown (10YR 4/5) redoximorphic concentrations; massive; slightly hard, friable; very few fine roots; few fine pores; strongly effervescent; moderately alkaline (pH 8.2).

TYPE LOCATION: Emery County, Utah; 950 feet west and 300 feet south of the NE corner of sec. 19, T. 19 S., R. 8 E. 2-1/2 miles northeast of Clawson.

RANGE IN CHARACTERISTICS: Soil temperatures are 49 to 54 degrees F. Hunting soils have distinct mottles at some depth between 20 and 40 inches, and have water tables between 20 and 40 inches in some seasons.

It ranges from very slightly saline to moderately saline. Carbonate content ranges from 10 to 25 percent. Gypsum veining occur in the lower C horizons below a depth of 12 inches. Texture of the particle-size control section is silt loam, very fine sandy loam, clay loam, or loam and averages 18 to 27 percent clay and less than 15 percent sand coarser than very fine sand.

The A and C horizons have hue of 2.5Y or 5Y, with dry color values of 5 or 6, moist values of 4 or 5, and chroma of 2.

GEOGRAPHIC SETTING: These soils are on alluvial fans and stream terraces on narrow valley floors. They are developed in alluvium from marine shale and sandstone. The climate is arid, with mean annual temperatures of 47 to 52 degrees F. Mean annual precipitation ranges from 6 to 10 inches. Freeze-free period is from 110 to 160 days.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained; medium to slow runoff; moderate permeability.

USE AND VEGETATION: Cultivated irrigated areas produce alfalfa, grain and pasture. Potential vegetation is alkali sacaton, Indian ricegrass, and galleta grass.

DISTRIBUTION AND EXTENT: Eastern Utah and western Colorado. This series is moderately extensive. MLRA 34.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric Epipedon - the layer from surface to 9 inches (Ap horizons)

The classification was changed from Aquic Udifluvent to Aquic Torrifluvents in 9/94. The placement is tentative because the profile lacks redox depletions of chroma 2 or less above 100 centimeters. However, there are redoxiomorphic concentrations and the inference that aquic conditions exist above 100 centimeters. Additional field work is needed.

HUNTING LOAM, MODERATELY SALINE, 1 TO 3 PERCENT SLOPES (Hs): The profile of this soil is similar to the one described as typical for the series, except that it is moderately saline.

Included in mapping were nearly level areas near Green River and areas in which the surface layer is silty clay loam 8 to 14 inches thick. Also included were spots, generally less than 1 acre in extent, of strongly saline soils.

Soil limitations caused by the water table and accumulations of salts are more severe in areas that receive seepage from irrigation ditches and canals. In some places overirrigation contributes to wetness. Salinity has reduced the amount of water readily available to plants to about 3 inches. Preventing losses of water through overirrigation and through seepage from ditches and canals improves soil drainage and helps in reclaiming this soil.

The main use of this soil is for irrigated pasture. Crops should be selected for their tolerance to salt. Alfalfa and small grains are grown, but this soil is not well suited to these crops. (Capability unit IVs-28, irrigated; not rated for other uses)

KILLPACK SERIES

The Killpack series consists of moderately deep, well drained, slowly permeable soils that formed in alluvium and residuum from saline marine shale. Killpack soils are on sideslopes and toeslopes of rolling shale hills. Slopes are 1 to 25 percent. Average annual precipitation is about 7 inches and mean annual temperature is about 52 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, active, calcareous, mesic Typic Torriorthents

TYPICAL PEDON: Killpack clay loam, cropland. (Colors are for air-dry soil unless otherwise noted.)

Ap--0 to 9 inches; brownish gray (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium and fine granular structure; hard, firm, slightly sticky and slightly plastic; common fine roots; common fine pores; strongly calcareous; mildly alkaline (pH 7.8); clear smooth boundary. (6 to 9 inches thick)
C--9 to 23 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate coarse subangular blocky parting to weak fine subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few fine pores; strongly calcareous; mildly alkaline (pH 7.7); gradual wavy boundary. (8 to 21 inches thick)

Cy--23 to 29 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, very firm, sticky and plastic; few fine roots; strongly calcareous; mildly alkaline (pH 7.7); many gypsum crystals 5 to 15mm in diameter; gradual wavy boundary. (6 to 10 inches thick)

Cr--29 inches; light brownish gray weathered shale.

TYPE LOCATION: Emery County, Utah; 2 miles northwest of Elmo, northeast of the Elmo road and the Cleveland-Price road; 2,450 feet north and 300 feet east of the SW corner of sec. 30, T. 16 S., R. 10 E.

RANGE IN CHARACTERISTICS: Soil temperatures are more than 47 degrees F. Depth to shale bedrock ranges from 20 to 40 inches. There is a few to common gypsum crystals accumulated immediately above the shale. Clay minerals are mixed but dominantly illite and kaolinite. The particle-size control section ranges from silty clay loam to silt loam with 18 to 35 percent clay.
The A horizon has hue of 10YR through 5Y, dry value of 5 or 6, moist value of 4 or 5, and chroma of 2 through 4.

The C horizon has hue of 10YR through 5Y, value of 5 through 7 dry, 3 through 7 moist, and chroma of 2 through 4.

The Cy horizon has the same color as the C horizon and contains 5 to 15 percent shale channers.

GEOGRAPHIC SETTING: These soils are on the gentle sideslopes of rolling shale hills. Slope gradients range from 1 to 25 percent. Killpack soils formed in alluvium and residuum from saline marine shale. The climate is semiarid with mean annual temperature of 47 to 55 degrees F. Mean annual precipitation ranges from 5 to 11 inches.

DRAINAGE AND PERMEABILITY: Well drained; medium to rapid runoff; slow permeability.

USE AND VEGETATION: Cultivated areas are used for grain, alfalfa hay, and irrigated pasture. The remaining areas are used for rangeland. Potential vegetation is shadscale, greasewood, galleta grass, and gardner saltbush.

DISTRIBUTION AND EXTENT: Eastern Utah and western Colorado. The series is moderately extensive.

REMARKS: The pH values were determined of soil paste.

KILLPACK CLAY LOAM, 1 TO 3 PERCENT SLOPES (K1B): The profile of this soil is the one described as typical of the series. Included in mapping were small areas in which the soil is thicker than 40 inches and places where it is less than 20 inches thick over shale. Also included were small areas of strongly and very strongly saline soils, and a small area south and west of Moore in which the soil is brown above a depth of 24 inches.

Drainage is good, and permeability is slow. Runoff is medium, and the susceptibility to erosion is moderate. Roots penetrate to the shale, and then they spread horizontally. About 4 to 5 inches of water is retained by this soil, but only about 2 to 2.5 inches, the amount depending on the depth to shale, is readily available to plants. This soil is hard to work, and generally it is hard to irrigate. The seedbed is more easily prepared if this soil is plowed in fall when it is barely moist, and is allowed to remain rough over winter, than when it is plowed in spring.

This soil is used for spring and fall range, for irrigated pasture, and for irrigated alfalfa and small grains. The growing season is only long enough for two full crops of alfalfa and for a part of a third to mature. (Capability units IVe-25, irrigated, and VIIs-D, nonirrigated; Desert Loam Bottom range site)

KILLPACK CLAY LOAM, HIGH WATERTABLE VARIANT, 1 TO 3 PERCENT SLOPES (KmB): This soil is the only variant of the Killpack series mapped in this survey area. Its profile is the one described as typical of the high water table variant of the Killpack series.

This soil generally occurs in small, low areas that receive seep water from canals or irrigation ditches higher on the slope. It has a water table at a depth between 20 and 36 inches, generally above the shale. Mottles are typically at a depth between 20 and 30 inches, but in places they are only 6 inches from the surface. Salinity is strongest near the surface, and it ranges from moderate to strong.

Drainage is poor, and permeability is slow. Runoff is slow, and the susceptibility to erosion is slight. Roots penetrate only to the shale, and then they spread horizontally. This soil is not extensive, nor is it important for farming. It is suited to and is used for grazing. (Capability unit VIw-2, nonirrigated; Wet Meadow range site)

LIBBINGS SERIES

The Libbings series consists of moderately deep, poorly drained, slowly permeable soils that formed in alluvium and residuum from shale. Libbings soils occur on low rolling hills and have slopes of 0 to 3 percent. The average annual precipitation is about 7 inches and the mean annual temperature is about 47 degrees F.

TAXONOMIC CLASS: Fine, mixed, active, mesic Gypsic Aquisalids

TYPICAL PEDON: Libbings silty clay loam. (Colors are for air-dry soil unless otherwise noted.)

A1z--0-1/2 inch; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate thick platy parting to moderate fine granular structure; hard, friable, sticky and plastic; many very fine vesicular pores; strongly calcareous; very strongly saline; thin salt crust on surface; strongly alkaline (pH 8.5); abrupt smooth boundary; (1/2 to 1 inch thick)

A2z--1/2 to 2 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate fine granular structure; soft, firm, sticky and plastic; few very fine roots; many very fine vesicular pores; strongly calcareous; very strongly saline; very fine salt grains; strongly alkaline (pH 8.9); abrupt smooth boundary. (1 to 3 inches thick)

Cz--2 to 9 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; very hard, very firm, sticky and very plastic; few fine and very fine roots; few fine and very fine discontinuous pores; strongly calcareous; very strongly saline; effloresced salt on some peds and in pores; strongly alkaline (pH 8.6); clear smooth boundary. (6 to 10 inches thick)

Czy1--9 to 25 inches; gray (2.5Y 6/1) silty clay, dark gray (2.5Y 4/1) moist; massive; very hard, very firm, sticky and very plastic; few medium and fine roots; few very fine discontinuous pores; strongly calcareous; very strongly saline; many salt and gypsum nodules; strongly alkaline (pH 8.6); gradual smooth boundary. (5 to 16 inches thick)

Czy2--25 to 34 inches; gray (2.5Y 6/1) silty clay, dark gray (2.5Y 4/1) moist; massive; very hard, very firm, sticky and plastic; few very fine roots; few very fine discontinuous pores; strongly calcareous; numerous soft gypsum nodules 5 to 15 mm in diameter; 5 to 10 percent shale fragments; strongly saline; strongly alkaline (pH 8.7); clear smooth boundary. (7 to 10 inches thick)
Cr--34 inches; soft platy shale. Roots and water concentrated between shale plates.

TYPE LOCATION: Emery County, Utah; 330 feet south and 160 feet east of the northwest corner of sec. 8, T. 17 S., R. 10 E.; about 2 miles south of Elmo, 1/4 mile west of Elmo-Cleveland Road.

RANGE IN CHARACTERISTICS: Depth to bedrock ranges from 20 to 40 inches. Depth to high water tables ranges from 10 to 30 inches. Salt content above 20 inches ranges from 2 to 5 percent. Exchangeable sodium is highest near the surface, 50 to 65 percent, and decreases with depth below 20 inches. Reaction is strongly alkaline to very strongly alkaline. The particle-size control section (10 to 40 inch depth) is dominantly silty clay, but ranges from heavy silty clay loam to clay more than 35 percent clay. Mean annual soil temperatures ranges from 49 to 53 degrees F.

The A horizon has hue of 10YR through 5Y with dry values of 5 or 6, moist values of 4 or 5, and chroma of 2.

The C horizon has hue of 1Y through 5Y, with dry values of 5 or 6, moist values of 4 or 5, and chromas of 1 or 2. Gypsum accumulation ranges from few to many, but there is typically 2 to 7 percent more gypsum in this horizon than in the underlying shale.

GEOGRAPHICAL SETTING: Libbings soils are on the footslopes of low rolling hills. Elevation is 5,400 to 5,500 feet. Slopes range from 0 to 3 percent. They are developed in residuum and alluvium from saline marine shale in areas where irrigation water or seepage from canals has caused salts to accumulate. The climate is semiarid, with mean annual temperature of 47 to 49 degrees. Mean annual precipitation ranges from 6 to 11 inches. Freeze-free period ranges from 110 to 140 days. GEOGRAPHICALLY ASSOCIATED SOILS: These are the Killpack, Chipeta, Persayo, Billings, and the competing Cache and Saltair soils. Killpack soils lack very strong salt horizons above 20 inches. Chipeta and Persayo are less than 20 inches deep over shale and lack very strong salt horizons. Billings soils are very deep and lack very strong salt horizons.

DRAINAGE AND PERMEABILITY: Poorly drained; runoff is medium; slow permeability. USE AND VEGETATION: Native range is the only use of this soil. The potential vegetation is alkali sacaton, alkali bluegrass, saltgrass, pickleweed and greasewood.

DISTRIBUTION AND EXTENT: Eastern Utah. Libbings soils are extensive.

REMARKS: All pH values were determined of soil paste. The name is coined.

LIBBINGS SILTY CLAY LOAM, 0 TO 3 PERCENT SLOPES (Lb): The profile of this soil is the one described as typical of the series. The surface layer is only ¼ to ½ inch thick. It has a platy structure but typically breaks to granules containing numerous crystals of salt. The layer over the shale contains numerous crystals of gypsum or salt, but in some places these crystals are not present.

Included in mapping were minor areas in which shale is at a depth of more than 40 inches, and some areas in which the shale is at a depth of less than 20 inches. Also included were some areas of saline soils that contain less than 2 percent salt.

Drainage is poor, and permeability is slow above the shale. Runoff is medium, and this soil is moderately susceptible to erosion. The water table is 10 to 30 inches below the surface, and is highest early in summer. Mottles occur in some places. Water spread horizontally to top of the shale and penetrates to a depth of only a few inches. In some places, water moves freely between the plates of shale. Roots penetrate to the shale, and then they spread horizontally.

This soil is used for grazing. (Capability unit VIIw-28, nonirrigated; Salt Meadow range site)

PALISADE SERIES

The Palisade series consists of very deep, well drained soils that formed in lake sediments derived from limestone and sandstone. The Palisade soils are on lake terraces. Slope ranges from 1 to 10 percent. The mean annual temperature is 48 degrees F., and the mean annual precipitation is about 10 inches.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, mesic Xeric Haplocalcids

TYPICAL PEDON: Palisade loam. (Colors are for dry soil unless otherwise noted).

A--0 to 6 inches; pale brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) moist; weak, thin, platey structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine roots; many fine and medium pores; moderately calcareous, lime is disseminated; moderately alkaline (pH 8.4); clear smooth boundary. (3 to 7 inches thick.)

Bw--6 to 12 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; weak, medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine roots; common very fine vesicular pores; moderately calcareous, lime is disseminated; strongly alkaline (pH 8.5); clear smooth boundary. (6 to 9 inches thick.)

Bk1--12 to 19 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; weak, medium and coarse, subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few very fine roots; many very fine vesicular pores; strongly calcareous, lime is disseminated; strongly alkaline (pH 8.7); gradual wavy boundary. (5 to 8 inches thick.)

Bk2--19 to 30 inches; light gray (10YR 7/2) loam, brown (10YR 5/3) moist; weak, medium and coarse, subangular blocky structure; very hard, friable, nonsticky, nonplastic; few very fine roots; many very fine vesicular pores; strongly calcareous, lime is disseminated; very strongly alkaline (pH 9.4); gradual smooth boundary. (10 to 16 inches thick.)

C1--30 to 43 inches; pale brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) moist; massive; soft, friable, nonsticky, nonplastic; strongly calcareous, lime is disseminated; very strongly alkaline (pH 9.1); gradual wavy boundary.

C2--43 to 60 inches; pale brown (10YR6/3) very fine sandy loam, dark brown (10YR4/3) moist; massive; soft, friable, nonsticky, nonplastic; strongly calcareous, lime is disseminated; very strongly alkaline (pH 9.2).

TYPE LOCATION: Box Elder County, Utah; located about 400 feet north and 700 feet east of the southwest corner of sec. 11, T.9N., R.7W.; about 7 miles southwest of Golden Spike Monument.

RANGE IN CHARACTERISTICS: Soil temperatures are 48 to 54 degrees F.

The control section contains 8 to 18 percent clay and more than 15 percent coarser than very fine sand. Textures include very fine sandy loam, silt loam, and loam. In some places, the lower one-third of the control section contains gravel fragments and cobbles not exceeding 50 percent by volume.

The A horizon has hue of 10YR, values of 5 or 6 dry, and 4 or 5 moist, and chromas of 2 to 5.

The B and C horizons have hues of 7.5YR or 10YR, values of 5 to 7 dry, and 4 to 6 moist, and chromas of 2 to 4. Calcium carbonate content of the calcic horizons ranges from 20 to 40 percent.

GEOGRAPHIC SETTING: These soils are on lake terraces. Slope ranges from 1 to 10 percent. Parent material is lake sediments derived from limestone and sandstone. Mean annual air temperature is 46 to 52 degrees F. and the freeze free period ranges from 90 to 130 days. The mean annual precipitation ranges from 8 to 12 inches.

DRAINAGE AND PERMEABILITY: Well drained. Runoff is medium; permeability is moderate.

USE AND VEGETATION: Irrigated areas are used for growing alfalfa, small grains, and corn for silage. Present vegetation on unirrigated areas is dominantly shadscale and rabbitbrush. Potential vegetation under excellent management would be Indian ricegrass, needle-and-thread, squirreltail, and bud sage.

DISTRIBUTION AND EXTENT: Southern and eastern Utah, and possibly Colorado. The series is extensive.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - from the surface to 6 inches (A horizon).

Calcic horizon - from 12 to 30 inches (Bk1 and Bk2 horizons).

The classification is based on the "Keys to Soil Taxonomy, Eighth Edition, 1998". This Palisade series was last reviewed in the field in 1965. The type location was moved to Box Elder county with the 1998 update of the series.

PALISADE VERY FINE SANDY LOAM, 1 TO 3 PERCENT SLOPES (PdB): The profile of this soil is the one described as typical of the series. Where this soil has been cultivated, the surface layer is mixed with material from the subsoil and can no longer be recognized. Gravel and cobblestones are between depths of 2 and 5 feet in places.

Included in the mapping were areas of Minchey loam, and places where gravel and cobblestones are at a depth of less than 20 inches. Also included was a small acreage near the Carbon County

Airport of a soil that contains a lime-cemented hardpan. Another inclusion, on the Porphyry Bench west of Price, consists of a small acreage of soils in which the surface layer and the subsoil are not calcareous.

Drainage is good, and permeability is moderate. Root penetration is deep. About 9 inches of water is retained by this soil, but only 4.5 to 5.5 inches is readily available to plants. Runoff is medium, and the susceptibility to erosion is moderate. This soil is easy to work and to irrigate. Leveling is needed in many areas, however, to help obtain the uniform distribution of irrigation water. The frost-free season is 110 to 130 days in 3 out of 4 years.

This soil is used for spring and fall range, and for irrigated alfalfa, small grains, corn, and pasture. Because of the short growing season, alfalfa produces only two full crops and part of a third. Corn does not mature for grain and is used for ensilage. Alfalfa needs a large amount of phosphorus. (Capability units IIe-24, irrigated and VIIc-S, nonirrigated; Semi-Desert Loam Bench range site)

PENOYER SERIES

The Penoyer series consists of very deep, well drained soils that formed in silty alluvium from limestone, volcanic rocks and lacustrine sediments. Penoyer soils are on inset fans, fan skirts, alluvial flats, flood plains, lake plains and alluvial fans. Slopes are 0 to 2 percent. The mean annual precipitation is about 7 inches and the mean annual temperature is about 54 degrees F.

TAXONOMIC CLASS: Coarse-silty, mixed, superactive, calcareous, mesic Typic Torriorthents

TYPICAL PEDON: Penoyer silt loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 4 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; moderate thick platy structure; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; strongly effervescent; strongly alkaline (pH 8.8); clear smooth boundary. (3 to 10 inches thick)

C1--4 to 17 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; common fine and medium vesicular pores, few fine tubular pores; strongly effervescent; strongly alkaline (pH 8.8); gradual smooth boundary. (4 to 20 inches thick)

C2--17 to 41 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky, and slightly plastic; few fine and medium roots; common fine and medium vesicular pores; strongly effervescent; strongly alkaline (pH 8.8); clear smooth boundary. (5 to 40 inches thick)

C3--41 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak thick platy structure that approaches massive in places; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine and very fine tubular pores; strongly effervescent; strongly alkaline (pH 8.8).

TYPE LOCATION: Lincoln County, Nevada; about 20 miles west of Caliente; 3.1 miles west of junction of Delamar road and U.S. Highway 93, and 0.2 mile north of U.S. Highway 93; about 700 feet south and 200 feet east of the northwest corner of section 8, T. 4 S., R. 64 E.; 37 degrees, 37 minutes, 14 seconds north latitude, 114 degrees, 50 minutes, 28 seconds west longitude.

RANGE IN CHARACTERISTICS:

Soil moisture - Usually dry, moist in some part for short periods during winter and early spring months for 10 to 20 days cumulative between July and October due to convection storms.

Soil temperature - 53 to 59 degrees F. Control section - Clay content: Averages 10 to 18 percent.

A horizon - Hue: 7.5YR or 10YR. Valve: 6 or 7 dry, 3 through 5 moist. Chroma: 2 through 4.

C horizon - Hue: 7.5YR or 10YR. Value: 6 or 7 dry, 3 through 5 moist. Chroma: 2 through 4.

Structure: Subangular blocky platy or massive. Consistence: Soft to hard, very friable or friable, slightly sticky to sticky and slightly plastic to plastic. Texture: Silt loam, but strata of very fine sandy loam, loam or silty clay loam are in some pedons. Effervescence: Strongly effervescent or violently effervescent. Reaction: Moderately alkaline to very strongly alkaline.

GEOGRAPHIC SETTING: Penoyer soils are on inset fans, fan skirts, alluvial flats, flood plains, lake plains, and alluvial fans. Slopes are 0 to 2 percent but are generally less than 1 percent. Elevations are 3,500 to 7,000 feet. They are crossed by a few shallow drainage channels. In places, wind deposited sandy hummocks, 2 to 4 inches high, are around the base of shrubs. Penoyer soils formed in silty alluvium derived from limestone, andesite, volcanic ash, basalt, tuff, sandstone and lacustrine sediments. The annual precipitation is 6 to 9 inches, the mean annual temperature is 51 to 56 degree F., and the frost-free season is 130 to 170 days.

DRAINAGE AND PERMEABILITY: Well drained; very slow runoff; moderate permeability.

USE AND VEGETATION: Most areas are used for rangeland. A few are irrigated and are used for growing alfalfa, small grain, potatoes and sugar beets. Dominant native plants are winterfat and some Indian ricegrass and galleta. Saltbush and greasewood are on saline or saline-alkali areas. Most of the surface area is bare.

DISTRIBUTION AND EXTENT: Central Nevada and southwestern Utah. The soil is of moderate extent. MLRA 29.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - The zone from the surface to 7 inches.

Particle-size control section - The zone from 10 to 40 inches.

Torriorthent features - Calcareous in all parts from 10 to 20 inches.

PENOYER LOAM, 3 TO 6 PERCENT SLOPES, ERODED (PeC2): This soil is similar to the one for which a profile is described as typical of the series, except that it has stronger slopes and is eroded. Included in mapping were minor areas of gravelly soils and of soils similar to the Penoyer, except that they have an olive or brownish-gray color.

Runoff is medium, and the susceptibility to erosion is high. Sheet erosion is moderately active. Many areas contain rills and shallow gullies.

This soil is used for irrigated pasture, alfalfa, and small grains. Many areas are used for spring and fall range. (Capability units IIIe-2, irrigated, and VIIe-D, nonirrigated; Desert Loam Bottom range site).

PENOYER LOAM, EXTENDED SEASON, 0 TO 1 PERCENT SLOPES (PnA): This soil is similar to the one for which a profile is described as typical of the series, except that it is nearly level and is near Green River, where the growing season is 140 to 160 days.

Included in mapping were soils that have slopes of 1 to 2 percent and some soils that have slopes of 3 to 6 percent. Included also were minor areas of soils that have a silty clay loam surface layer and a sandy loam subsoil.

Land leveling has been done in many fields, but it is still needed in some areas to improve the distribution of irrigation water. Runoff is slow, and the susceptibility to erosion is slight.

This soil is used for irrigated pasture, alfalfa, small grains, corn, melons, and sugar beets. Alfalfa produces three full cuttings a year, and corn matures for grain. (Capability unit I-1, irrigated; not rated for other uses)

PERSAYO SERIES

The Persayo series consists of shallow, well drained soils on hills, terraces, and ridges. These soils formed in thin sediments weathered from underlying soft sedimentary bedrock. Slopes are 1 to 45 percent. The mean annual precipitation is about 9 inches and the mean annual temperature is about 51 degrees F.

TAXONOMIC CLASS: Loamy, mixed, active, calcareous, mesic, shallow Typic Torriorthents

TYPICAL PEDON: Persayo silty clay loam - grassland. (Colors are for dry soil unless otherwise noted.)

A--0 to 4 inches; light yellowish brown (2.5Y 6/3) silty clay loam, light olive brown (2.5Y 5/3) moist; moderate fine granular structure, weak platy in the upper 1/2 inch; soft, very friable; calcareous; moderately alkaline (pH 8.2); gradual smooth boundary. (3 to 7 inches thick)

C--4 to 14 inches; light yellowish brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) moist; weak medium subangular blocky structure parting to moderate fine granules; hard, very friable; few small calcium sulfate crystals; calcareous; moderately alkaline (pH 8.2) gradual smooth boundary. (7 to 14 inches thick)

Cr--14 inches; calcareous; gray and yellow shale and siltstone.

TYPE LOCATION: Montrose County, Colorado; 0.1 mile north of the southeast corner of Sec. 22, T. 51 N., R. 10 W.

RANGE IN CHARACTERISTICS:

These soils are dry in all parts of the moisture control section for more than three-fourths of the time that the soil temperature is above 41 degrees F. Moisture regime is Typic Aridic. Mean annual soil temperature: 47 to 58 degrees F. Mean summer soil temperature: 60 to 75 degrees F. Depth to paralithic contact: 4 to 20 inches. Organic carbon: approximately .4 percent. The sand/clay ratio: less than 1 to about 3. Exchangeable sodium: typically less than 3 percent, but tends to increase as depth increases and differs among pedons. Calcium carbonate equivalent: 5 to 14 percent. Calcium sulfate: less than 1 to about 10 percent.

Particle-size control section (weighted average): Texture: silt loam, loam, clay loam, or silty clay loam
Clay content: 18 to 35 percent
Silt content: 30 to 65 percent
Sand content: 5 to 45 percent
Coarse fragments: usually less than 5 percent and range from 0 to 15 percent.

A horizon
Hue: 10YR to 5Y
Value: 5 to 7 dry, 4 to 6 moist
Chroma: 2 through 4
Reaction: slightly to strongly alkaline
Consistence: soft to slightly hard.

C horizon
Hue: 10YR through 5Y
Value: 5 or 6 dry, 4 or 5 moist
Chroma: 2 to 4
Reaction: slightly alkaline to strongly alkaline
It contains some visible calcium carbonate and gypsum which are not concentrated into a definite horizon of secondary accumulation and are considered to be characteristics of the parent sediments rather than pedogenic.

GEOGRAPHIC SETTING: These soils are on upland hills, terraces, and ridges. Slopes range from 1 to 45 percent. The soil formed in thin sediments weathered from underlying soft sedimentary bedrock. Elevation ranges from 5,000 to 6,800 feet. At the type location mean annual precipitation is 7 to 11 inches with peak periods of precipitation occurring during the late summer. Mean annual temperature ranges from 47 to 53 degrees F., and mean summer temperature is about 66 to 70 degrees F. Frost-free period ranges from 95 to 150 days. In Utah this soil has a mean annual precipitation of 6 to 8 inches, mean annual temperature of 48 to 50 degrees, and a frost-free season of 115 to 140 days at an elevation of 5,300 to 6,200 feet.

DRAINAGE AND PERMEABILITY: Well drained; medium to rapid runoff; moderate or moderately slow permeability.

USE AND VEGETATION: These soils are used almost exclusively for native pastureland. Native vegetation is salt sage, greasewood, shadscale, and scattered grasses.

DISTRIBUTION AND EXTENT: Western Colorado and Wyoming, northwestern New Mexico, and eastern Utah. The series is of large extent. MLRA 35.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Paralithic contact - at about 14 inches.

PERSAYO-CHIPETA ASSOCIATION, 1 TO 20 PERCENT SLOPES, ERODED (PCE2): About 60 percent of this mapping unit is Persayo loam, 1 to 20 percent slopes, eroded, and 40 percent is Chipeta silty clay loam, 3 to 20 percent slopes, eroded. These soils are intermingled and occur in no identifiable pattern. The chipeta soil generally is on ridges and has stronger slopes than the Persayo soil.

Included in the mapping were areas of 1 to 5 acres made up of a very strongly saline soil and of areas of a moderately deep soil. Also included was an area of about 200 acres, 5 miles east of Castle Dale, of a brown soil that is similar to the Persayo component mapped in this unit.

The Persayo soil has the profile described as typical of the series. It is well drained and has moderate permeability. Roots penetrate to the shale, and then they spread horizontally. This soil holds 1 to 3 inches of available water, the amount depending on the depth to bedrock. Runoff is medium, and the susceptibility to erosion is moderate.

The Chipeta soil has a profile similar to the one described as typical for the Chipeta series, except that the slopes are stronger and it is eroded. Rill and gully erosion are active.

The soils in this mapping unit are used mainly for spring and fall range, but in places they are used for irrigated pasture. Sheet erosion is active, and in many places shallow gullies have cut into the shale bedrock. (The Persayo soil is in capability unit VIIe-D4, nonirrigated; Desert Loamy Shale range site. The Chipeta soil is in capability unit VIIe-D3, nonirrigated; Desert Shale range site)

RAVOLA SERIES

The Ravola series consists of very deep, well drained soils that formed in alluvium derived from shale, siltstone, and sandstone. Ravola soils are on alluvial fans and flood plains. Slopes range from 0 to 10 percent. Mean annual precipitation is about 7 inches and the mean annual temperature is about 50 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, active, calcareous, mesic Typic Torrifluvents

TYPICAL PEDON: Ravola loam under cultivation. (Colors are for dry soil unless otherwise noted.)

Ap1--0 to 6 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure parting to weak fine subangular blocky; slightly hard, friable, slightly plastic; many fine roots, few coarse roots; common fine and medium pores; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary. (2 to 6 inches thick)

Ap2--6 to 9 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; strongly compacted plowpan layer; weak coarse subangular blocky structure parting to weak coarse granular; hard, friable, slightly sticky and slightly plastic; many fine roots; common fine pores; few medium pores; strongly effervescent; slightly alkaline (pH 7.7); clear smooth boundary. (0 to 3 inches thick).

C1--9 to 18 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak thin platy structure parting to weak very thin platy; hard, friable, slightly sticky and slightly plastic; few coarse and many fine roots; many medium and common fine pores, strongly effervescent; slightly alkaline (pH 7.7); gradual wavy boundary. (9 to 24 inches thick)

C2--18 to 45 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure parting to weak medium granular; slightly hard, friable, slightly sticky and slightly plastic; few medium and many fine roots; common medium pores; strongly effervescent; moderately alkaline (pH 7.9); gradual irregular boundary. (6 to 30 inches thick)

C3--45 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable; few fine roots; few fine pores; strongly effervescent; moderately alkaline (pH 7.9).

TYPE LOCATION: Emery County, Utah; about 1 1/2 miles south and 1/2 mile east of Huntington; located about 2,000 feet west and 600 feet north of the southeast corner of sec. 31, T. 17 S., R. 9 E.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature: 49 to 56 degrees F

Particle-size control section: 18 to 27 percent clay and less than 15 percent sand coarser than very fine sand

A horizon:
Hue: 10YR to 5Y
Value: 5 to 7 dry, 4 or 5 moist
Chroma: 2 or 4 dry or moist
Texture: loam, clay loam, very fine sandy loam, or silt loam
Calcium carbonate equivalent: 5 to 25 percent
Reaction: slightly to strongly alkaline

C horizon:
Hue: 10YR to 5Y
Value: 5 to 7 dry, 4 or 5 moist
Chroma: 2 to 4 dry or moist
Texture: stratified loamy sand to clay loam
Calcium carbonate equivalent: 5 to 25 percent
Reaction: slightly to strongly alkaline

GEOGRAPHIC SETTING:
Parent material: alluvium derived from shale, siltstone, and sandstone
Landform: alluvial fans and flood plains
Slopes: 0 to 10 percent
Elevation: 4,500 to 6,000 feet
Mean annual temperature: 47 to 56 degrees F
Mean annual precipitation: 5 to 11 inches
Frost-free period: 110 to 160 days

DRAINAGE AND PERMEABILITY: well drained, negligible to medium runoff, moderate or moderately slow permeability. These soils are subject to occasional brief flooding following high intensity summer thunderstorms.

USE AND VEGETATION: Irrigated areas are used for growing small grains, corn, sugar beets, alfalfa, and pasture. Potential vegetation is shadscale, greasewood, Indian ricegrass, and galleta.

DISTRIBUTION AND EXTENT: Eastern Utah, northwest New Mexico and western Colorado. LRR D, MLRA 28A, 34, 35, 37. This series is of large extent.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon: The zone from 0 to 9 inches. (Ap1 and Ap2)

RAVOLA LOAM, 1 TO 3 PERCENT SLOPES (R1B): In most places the profile of this soil is like the one described as typical of the series. In some places, however, the texture between depths of 10 and 40 inches is silt loam to very fine sandy loam and the texture below 40 inches is

sandy loam to silty clay loam. Salinity generally is slight to moderate. Alkalinity ranges from none to moderate. Veins of gypsum are common below a depth of 20 to 30 inches. The frost-free season is 110 to 130 days in 3 out of 4 years.

Included in mapping were areas of Billings silty clay loam, and other areas ½ acre to 1 acre in extent, of poorly drained, strongly or very strongly saline-alkali soils. Also included were areas of a soil that is brown or light olive in color, and areas of Ravola loam in which the slopes are slightly less than 1 percent.

Drainage is good, and permeability is moderate. Runoff is medium, and the susceptibility to erosion is moderate. Roots penetrate to a depth of 5 feet or more. This soil retains about 10.5 inches of water, but only about 6 inches of water is readily available to plants. Natural fertility is low, but the fertility in many fields is high because fertilizer has been applied. This soil is easy to work and to irrigate. The uniform distribution of irrigation water is needed. Land leveling can be done with little or no damage to the soil.

This soil is used for spring and fall range and for irrigated pasture, alfalfa, small grains, corn, and sugar beets. The growing season is long enough for alfalfa to produce two full cuttings and part of a third. Corn does not mature for grain and is used for ensilage. (Capability units IIe-2, irrigated and VIIc-D, nonirrigated; Desert Loam Bottom range site)

WOODROW SERIES

The Woodrow series consists of very deep, well drained soils formed in alluvium and lacustrine sediments derived from sedimentary rocks. Woodrow soils are on lake terraces, alluvial fans, floodplains and in narrow alluvial valleys. Slopes are 0 to 5 percent. The mean annual precipitation is about 9 inches and the mean annual air temperature is about 49 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, calcareous, mesic Xeric Torrifluvents

TYPICAL PEDON: Woodrow silty clay loam - rangeland. (Colors are for dry soil unless otherwise stated.)

A1--0 to 3 inches; pale brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) moist; thin platy structure; soft, friable, slightly sticky, plastic; few fine and medium roots; few fine pores; strongly effervescent, carbonates are disseminated; moderately alkaline (pH 8.3); clear smooth boundary. (1 to 4 inches thick)

A2--3 to 13 inches; pale brown (10YR 6/3) stratified silty clay loam and clay loam, brown (10YR 4/3) moist; weak fine and medium subangular blocky structure; hard, firm, slightly sticky, plastic; few fine roots; few fine pores; strongly effervescent, carbonates are disseminated; moderately alkaline (pH 8.3); clear wavy boundary. (3 to 10 inches thick)

C1--13 to 27 inches; light gray (10YR 7/2) stratified silty clay loam and clay loam, pale brown (10YR 6/3) moist; massive; hard, firm, sticky, plastic; few fine roots; few fine pores; strongly effervescent, carbonates are mostly disseminated; moderately alkaline (pH 8.4) diffuse irregular boundary. (10 to 26 inches thick)

C2--27 to 72 inches; light gray (10YR 7/2) silty clay loam laminated with thin lenses of clay loam or silt loam, light brownish gray (10YR 6/2) moist; massive; hard, firm, sticky, plastic; strongly effervescent, carbonates are mostly disseminated but some segregations as fine flakes or mottles; strongly alkaline (pH 8.5)

TYPE LOCATION: Millard County, Utah; about 1 mile west of Flowell. 150 feet east and 2000 feet north of the southwest corner of section 11, T. 15 S., R. 4 W.; lat. 39 degrees 32 minutes 39.29 seconds N. and long. 112 degrees 39 minutes 43.06 seconds W., NAD 83.; lat. 39 degrees 32 minutes 39.29 seconds N. and long. 112 degrees 39 minutes 43.06 seconds W., NAD 83.

RANGE IN CHARACTERISTICS: Fine stratification generally occurs throughout the profile. The particle-size control section is dominantly silty clay loam but thin lenses of silt loam, clay loam, or clay are common in most pedons and sandy loam lenses occur in some. This section averages about 28 to 35 percent clay and less than 15 percent is coarser than very fine sand. Calcium carbonate equivalent in the A and C horizons ranges from about 10 to 40 percent but is most commonly 15 to 25 percent. Slight accumulations of carbonates occur in some pedons. The

soils are usually dry but are continually moist in some part of the moisture control section for 25 to 35 percent of the time the soil temperature is above 41 degrees F. The mean annual soil temperature ranges from 47 to 54 degrees F. The soil moisture regime is aridic bordering on xeric.

The A horizon has hue of 10YR or 7.5YR, value of 5 through 7 dry, 4 through 6 moist, and chroma of 2 or 3. It is mildly to strongly alkaline.

The C horizon has hue of 10YR or 7.5YR, value of 6 through 8 dry, 4 through 7 moist, and chroma of 2 through 4. It is moderately to very strongly alkaline and contains O to 40 percent exchangeable sodium. Some pedons are moderately to strongly saline.

GEOGRAPHIC SETTING: These soils are on lake terraces, alluvial fans, flood plains, and in narrow alluvial valleys. Slopes range from 0 to 5 percent. They formed in alluvium and reworked lake sediments from sedimentary rocks. Elevation ranges from 4,600 to 6,000 feet. The climate is semiarid. The mean annual air temperature ranges from 45 to 52 degrees F. and the mean summer temperature ranges from 65 to 73 degrees F. The frost free period ranges from 100 to 160 days. The average annual precipitation ranges from 8 to 12 inches.

DRAINAGE AND PERMEABILITY: Well-drained; slow to medium runoff; slow permeability.

USE AND VEGETATION: Used for irrigated crops and range. Crops are mainly alfalfa, small grains, corn, and pasture. Vegetation in the non-cultivated areas is big sagebrush, rabbitbrush, shadscale, snakeweed, and some greasewood.

DISTRIBUTION AND EXTENT: West-central Utah and parts of Nevada. MLRA 28A, and 29. This series is moderately extensive.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from the soil surface to 12 inches (A1, A2 horizons)

Particle-size control section - the zone from 10 to 40 inches.

WOODROW SILTY CLAY LOAM, 1 TO 3 PERCENT SLOPES (Wo): A profile of this soil is the one described as typical of the series. In places, however, the texture of the surface layer is loam. Below a depth of 40 inches the texture ranges from sandy loam to silty clay loam.

Included in the mapping were a few areas of soils that have slopes of less than 1 percent. Also included were small, strongly saline spots, less than one-half acre in extent, and areas of Penoyer loam and of Billings silty clay loam.

Drainage is good, but permeability is slow. Runoff is medium, and the susceptibility to erosion is moderate. Roots penetrate to a depth of 5 feet or more. This soil retains about 11 inches of water, but only about 5 inches of water is readily available to plants. The soil is fairly easy to work and to irrigate. The seedbed is more easily prepared if the soil is plowed in fall when barely moist, and is allowed to reaming rough over winter, than when it is plowed in spring. Land leveling is needed in some areas so that water can be applied evenly over the soil.

This soil is used for irrigated pasture, alfalfa, small grains, corn, and sugar beets. The growing season is only long enough for alfalfa to produce two full crops and part of a third in a year. Corn does not mature for grain and is used for ensilage. A small acreage of this soil at Green River is nearly level. In this area the growing season is longer than in other places where the soil occurs, alfalfa produces three full crops a year, and corn matures for grain. Areas of this soil not in cultivation are used for spring and fall range. (Capability units IIe-2, irrigated, and VIIs-D, nonirrigated; Desert Loam Bottom range site)

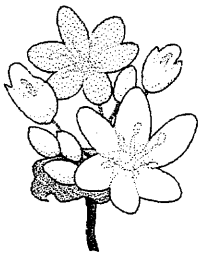
APPENDIX XII-2

Vegetation Report

PLANT COMMUNITIES
of the
1ST NORTH IBC AREA

at the
EMERY MINE SITE

for
CONSOLIDATION COAL COMPANY



Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
Springville, Utah 84663
(801) 489-6937

Patrick D. Collins, Ph.D.

for

CONSOLIDATION COAL COMPANY
P.O. Box 527
Emery, Utah 84522

April 2005

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PLANT COMMUNITIES OF THE 1ST NORTH IBC AREA
EMERY MINE

INTRODUCTION

Consolidation Coal Company (Consol) has applied for an Incidental Boundary Change (IBC) to their permit area because they are planning to mine coal underground in a new area. This new area is called 1st North. The 1st North IBC Area is approximately 300 acres in size and is located northeast and very near to the 4th East Portal site.

No surface disturbance has been planned for the new area. Moreover, subsidence caused by underground mining is also not anticipated during this phase of the mining operations. Therefore, there should be no change to the ground surface or the existing plant communities in the 1st North Area as a result of the proposed mining activities.

The major plant communities of the 1st North Area have been mapped (see attached *Vegetation Map of the 1st North IBC Area*). These communities are also briefly described below. A discussion on the potential for the occurrence of threatened or endangered plant species has also been included in this document.

METHODS

The vegetation of the 1st North Area was mapped in the field by walking the area and by using 2004 aerial photography that was obtained from the State Geographic Information Database (SGID). The field work was conducted on two different occasions, February 17, 2005 and March 26, 2005.

RESULTS

There were 3 major plant community types in the 1st North IBC Area including: Shadscale, Greasewood and Saltgrass. These communities are shown on the vegetation map included with this report. A brief description of each of these communities follows below; color photographs of each community type have also been included in this report.

Shadscale

The Shadscale community occupies the least amount of total acreage in the 1st North Area when compared to the other communities. This community is located on the south and southeast portions of the study area.

Although changes in elevation are minor, they are enough to influence the plant community types

of the area. The Shadscale community is located in some of the higher areas topographically. The dominant plant species in this community is shadscale (*Atriplex confertifolia*) with other important species present such as blue grama (*Bouteloua gracilis*), prickly pear cacti (*Opuntia* spp.), galleta (*Hilaria jamesii*), and broom snakeweed (*Gutierrezia sarothrae*).

Greasewood

Greasewood becomes more prevalent in lower elevations, or areas located closer to the natural drainages. This community occupies a major portion of the study area. It has less species diversity than the community mentioned above. The dominant plant species in this community are greasewood (*Sarcobatus vermiculatus*) and Torrey's seepweed (*Suaeda torreyana*).

Portions of this native plant community have been disturbed by previous cultivation and conversion to pasture or crop land. These crop species were not present in any significant amount when the vegetation mapping was conducted, but greasewood plants and "weedy" annuals were re-invading these areas.

Saltgrass

The lowest areas in the 1st North study area were comprised of Saltgrass communities. These communities are also a major component in the study area and are located within the bottom land or drainage areas. The water that flows within these areas is probably derived from natural

groundwater and surface water as well as runoff from irrigated pasture lands upslope. The dominant species in these communities was almost exclusively saltgrass (*Distichlis spicatus*).

Portions of the native Saltgrass plant communities may have also been disturbed by previous cultivation and conversion to crop or pasture lands. Consequently, some of the areas are presently dominated by "weedy" exotics, probably a result of abandonment of the crop and/or pasture lands and the irrigation operations that may have existed at that time. Also, some of the weedy areas seemed to have resulted from less flow of surface runoff from the pastures located up-gradient. This may be due to the drought conditions that have been so common in Utah for the past several years . A comparison of aerial photography dated several years prior revealed the presence of more Saltgrass communities than what seemed to have been present in the 2004 photographs.

Threatened and Endangered Species

There are several federally listed plant species that have the potential of occurring in the vicinity of the study area (Table 1). However, there is almost no chance of these species occurring directly in the study area for two

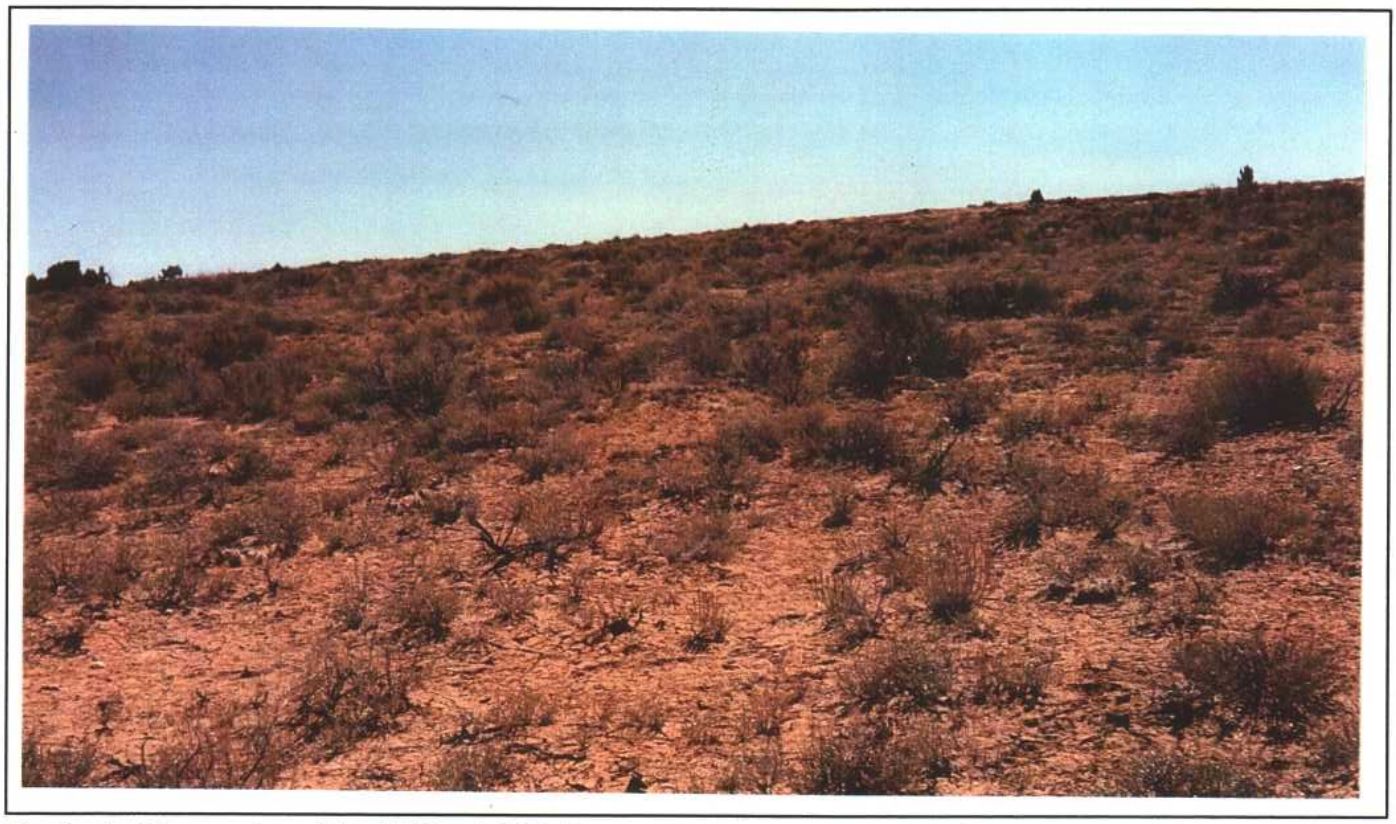
Table 1: Potential Threatened or Endangered Plant Species of the 1st North IBC Area at the Emery Mine

Scientific Name	Common Name	Status
Pediocactus winkleri	Winkler Footcactus	T
Pediocactus despainii	Despain Footcactus	E
Schoencrambe barnebyi	Barneby's schoencrambe	E
Sclerocactus wrightiae	Wright Fishhook Cactus	E
Townsendia aprica	Last Chance Townsendia	T

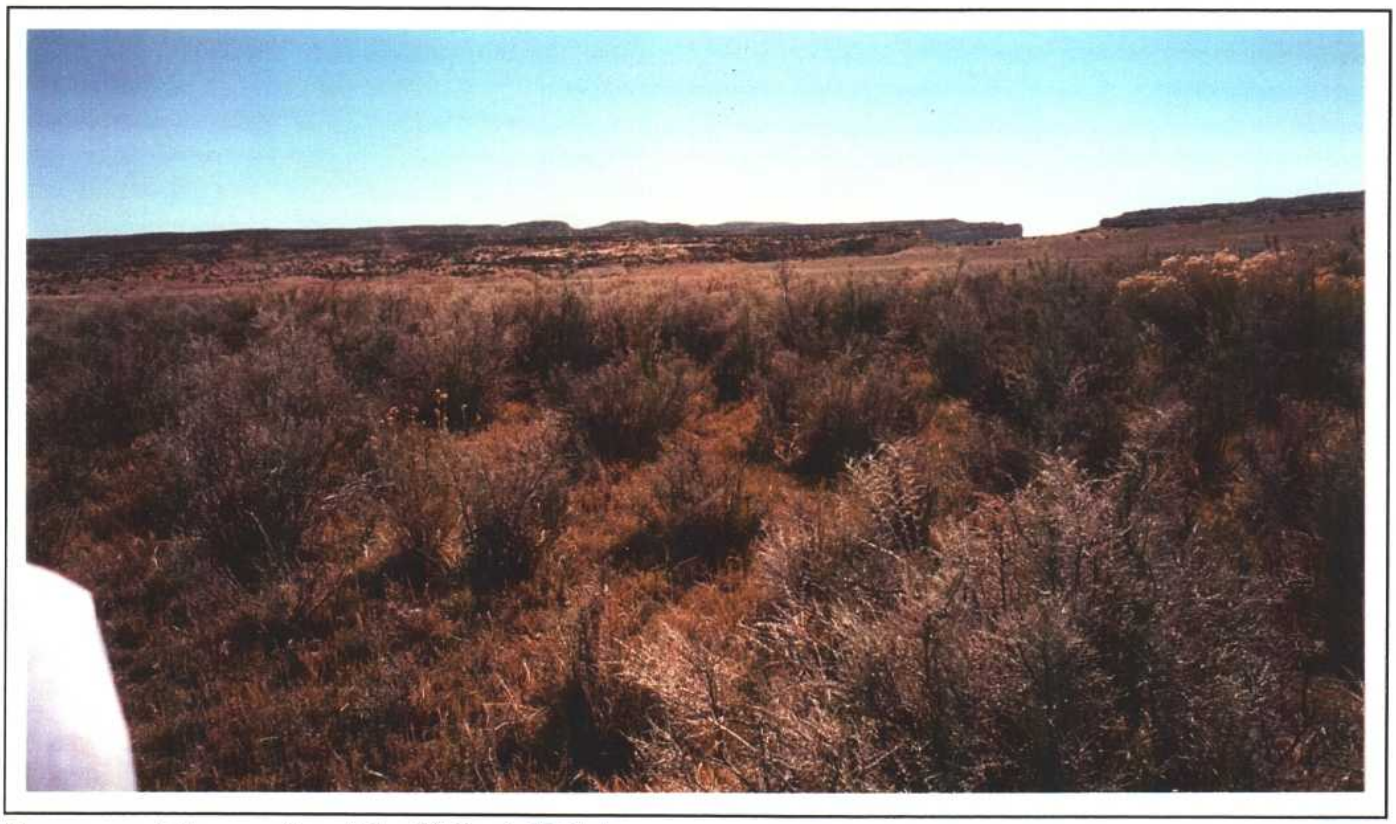
E = Federal Protection, Endangered
T = Federal Protection, Threatened

reasons. First, with the exception of the Shadscale community that occupies such a small portion of the study area, the T&E species are not found in the plant communities that exist there. Second, the Shadscale communities in the direct vicinity have been previously surveyed for these same T&E plant species by *Mt. Nebo Scientific, Inc.* in 2002 and 2003 when the 4th East Portal and its expansions were planned. No T&E or sensitive plant species were found in those surveys. Finally, as mentioned previously, no surface disturbance or subsidence caused by mining activities have been planned for the 1st North IBC Area.

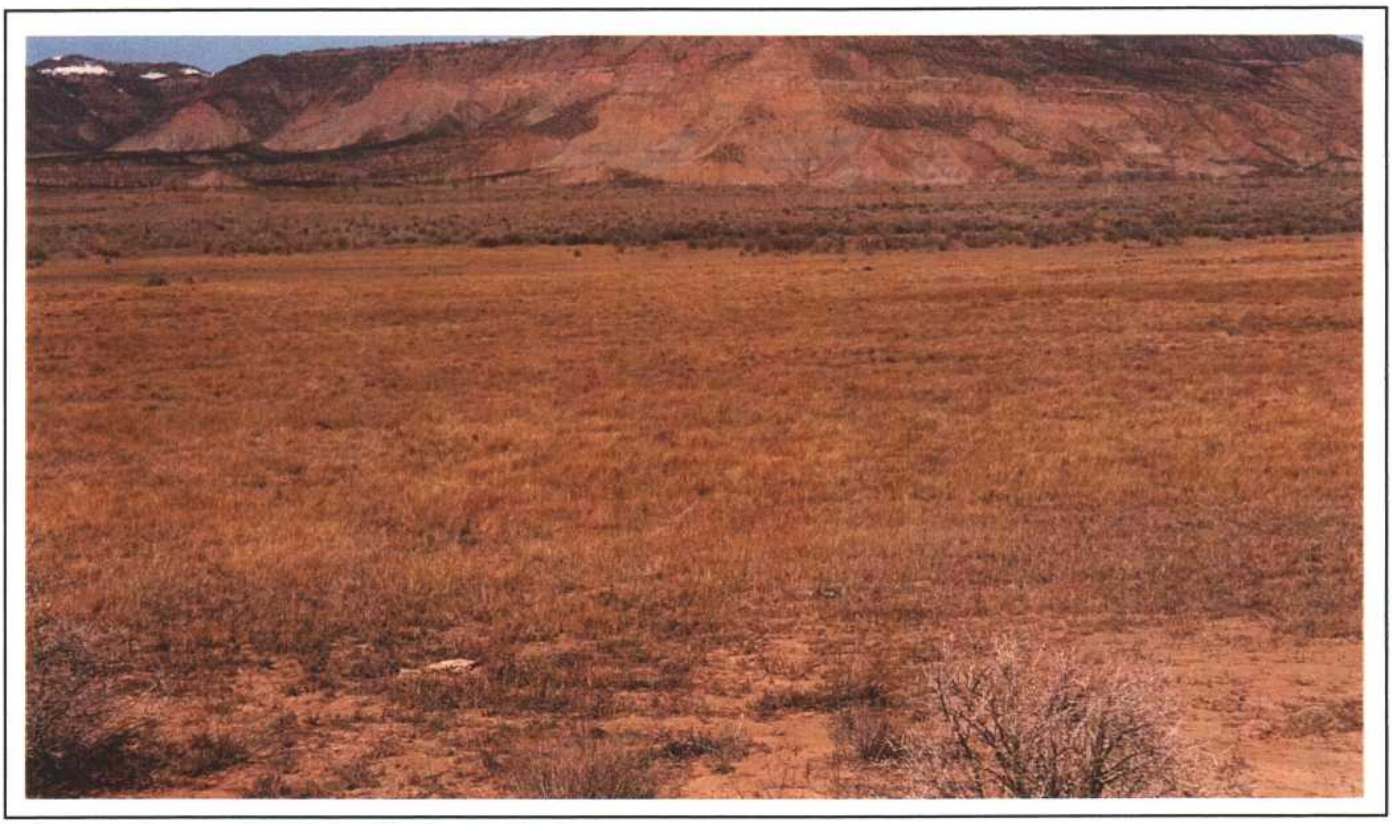
COLOR PHOTOGRAPHS
of the
PLANT COMMUNITIES



Shadscale Community of the 1st North IBC Area



Greasewood Community of the 1st North IBC Area



Saltgrass Community of the 1st North IBC Area