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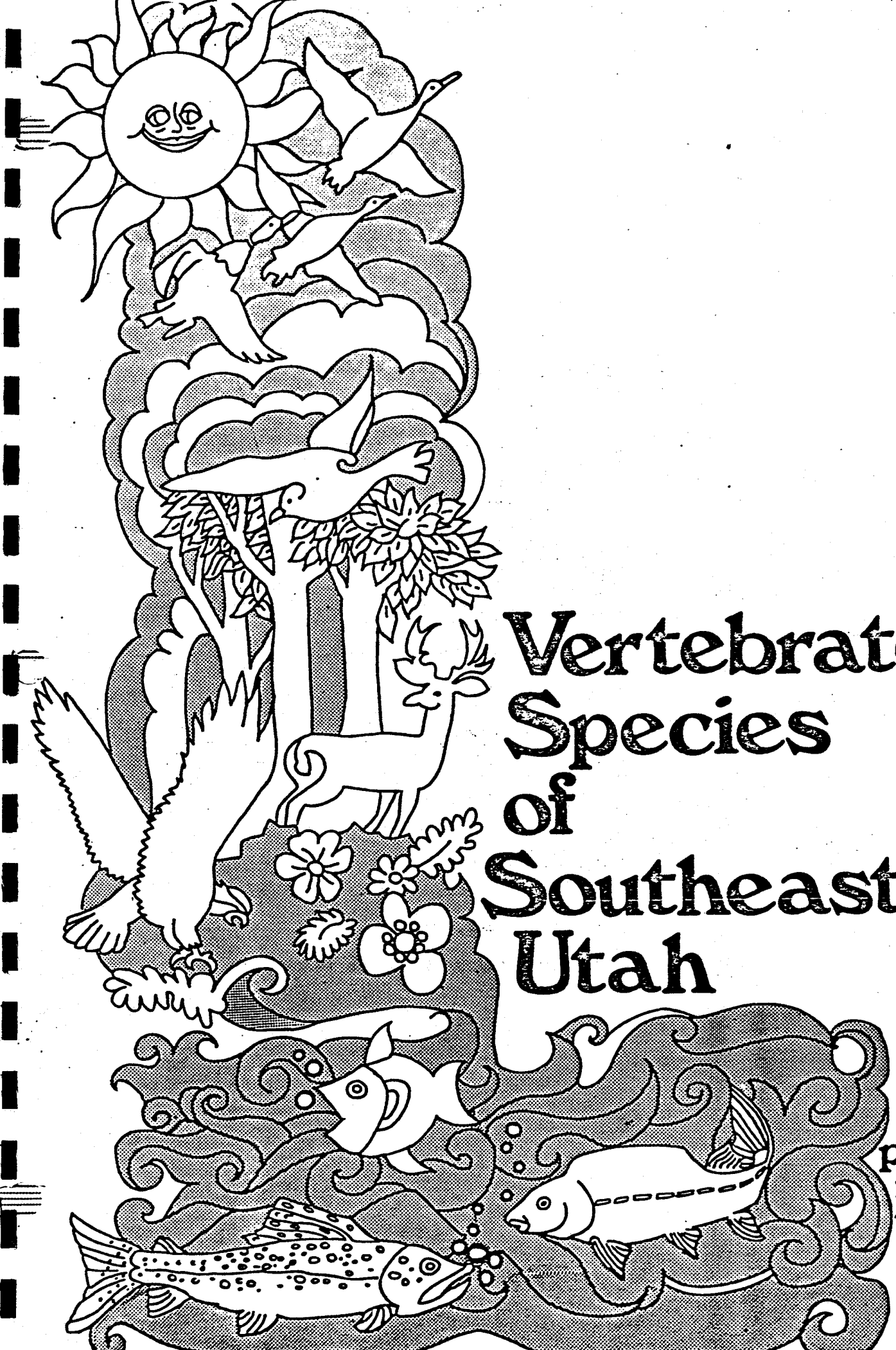

Vertebrate Species of Southeastern Utah

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SPECIES LIST OF VERTEBRATE WILDLIFE

THAT INHABIT SOUTHEASTERN UTAH

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Agencies and individuals that have contributed information on species distribution within the southeastern region are acknowledged. Bureau of Land Management and U.S. Forest Service biologists provided information concerning local sightings and distribution of wildlife species. Species lists obtained from Arches and Canyonlands National parks were also helpful. Within the Utah Division of Wildlife Resources, local conservation officers and wildlife biologists provided valuable information on species within their districts or areas of experience. Thanks go to other Division personnel who assisted with review of this document.

The status and population trend for individual species is a product of the experience of the authors and others who have professional experience with the wildlife resource in southeastern Utah.

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TABLE OF CONTENTS

Page

INTRODUCTION 1

SPECIES LIST 3
Fishes 3
Amphibians 6
Reptiles 8
Birds 14
Mammals 48

SUMMARY OF HIGH INTEREST SPECIES 68

LITERATURE CITED 69

LIST OF TABLES

Page

Table 1. List of Game Species and Region of Inhabitation within Utah 63
Big Game 63
Fishes 63
Furbearers 64
Migratory Game Birds 64
Small Game - Mammals 65
Small Game - Upland Birds 66

Table 2. Classification of the 466 Species of Vertebrate Wildlife. 67

SPECIES LIST OF VERTEBRATE WILDLIFE THAT INHABIT SOUTHEASTERN UTAH

Utah is believed to be inhabited by 734 species of vertebrate wildlife. Four hundred forty-five of these species are protected: 2 amphibians, 2 reptiles, 26 mammals, 58 fish and 357 birds. One hundred of the protected species are game species: 10 species of big game; 20, fish; 10, furbearers; 43, migratory game birds; 5, small game mammals; and 12, upland, small game birds. Table 1 provides a comparison of inhabitation by game species between Utah Division of Wildlife Resource's five regions.

Southeastern Utah is inhabited by 466 species of vertebrate wildlife in six biogeographic areas (Table 2). Three hundred forty-three of these species are protected: 2 amphibians, 26 mammals, 38 fish and 277 birds. Seventy-nine of the protected species that inhabit southeastern Utah are game species: 9 species of big game; 13, game fish; 9, furbearers, 35, migratory game birds; 4, small game mammals; and 9, upland, small game birds.

Southeastern Utah has been divided into six biogeographic areas. Each area allows an overlap of wildlife species that inhabit contiguous low and high elevation areas. This procedure was utilized to reduce any controversy that would normally arise from a "sharp line" drawn on a map.

A- Wasatch Plateau extending east from Skyline Drive to Highway 10 and bounded on the north by Highway 6 and on the south by Interstate 70.

B- West Tavaputs Plateau including all drainages into the Price River drainage from Soldier's Summit east along Reservation Ridge and including the drainages into Argyle, Nine Mile and Minnie Maud creeks; bounded on the east by the Green River and south and west by Highway 6.

C- East Tavaputs Plateau bounded on the east by the Colorado-Utah state line; on the south by Interstate 70; on the west by the Green River and on the north by Uintah-Ouray Indian Reservation and the Uintah-Grand county line.

D- San Rafael Swell and San Rafael Desert bounded by Highway 6 on the north; Highway 10 on the west; the Green River on the east and the Emery-Wayne county line on the south.

E- Henry Mountains and Burr Desert bounded on the north by Emery-Wayne county line; the Green and Colorado rivers on the east; Lake Powell on the south and Capitol Reef National Park and the Waterpocket Fold on the west.

F- Mountains and deserts of Grand and San Juan counties south of Interstate Highway 70 and north of the San Juan River bounded on the east by the Utah-Colorado border and on the west by the Green and Colorado rivers and Lake Powell.

Each species is listed by common name followed by the generic and specific nomenclature. The status for each species was determined by the authors after evaluation and consultation from several sources. The listing for mammals was developed from Sparks (1974), Burt and Grossenheider (1976) and Durrant (1952). The primary sources consulted in compiling the bird list were Behle and Perry (1975) and Hayward et al. (1976) although, Peterson (1969), Robbins et al. (1966) and Udvardy and Rayfield (1977) were also used.

Holden (1973), Bailey et al. (1970), Eddy (1969) and Sigler and Miller (1963) were consulted for preparation of the list of fishes.

The status of reptiles and amphibians was determined through discussion with local herpetologists. The phylogenetic listing is after Stebbins (1966). Tanner (1975) was consulted for species inhabiting Utah.

The following code letters are given for each species to describe its status.

K Status unknown - It is believed that these species are present, but little is known of their population dynamics.
C Common - These species are widespread and abundant.
U Uncommon - These species are widespread, but not abundant.
R Rare - These species are seldom identified during any one year.
O Occasional - These species are periodically identified during a long term period--10-50 years.
A Accidental - Distribution for these species does not normally include this area. Sightings are as far between as 50 to 100 years.
E Endangered - These species are endangered with extinction or extirpation from wildland in Utah.
T Threatened - These species are threatened with becoming endangered in Utah.
L Limited - These species are common but restricted to a particular use area or habitat type in Utah.
X Extirpated - These species have disappeared from wildland habitats in Utah.
P Protected - These species are protected by state or federal laws in Utah.
N Nonprotected - These species are not protected by any laws in Utah.

The following terminology is used to describe the seasonal status for avian species.

Transient - These species pass through southeastern Utah twice a year during their migratory travels.

Resident - These species occur yearlong in southeastern Utah.

Summer Resident - These species breed in southeastern Utah and migrate elsewhere for the winter.

Winter Resident - These species breed elsewhere but winter in southeastern Utah.

Note, the species marked with an asteric (*) are of high interest to the State and those marked with an exclamation mark(!) have potential to inhabit the environs of the project area.

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Fishes -- 38 species in southeastern Utah				
Family Clupeidae				
Threadfin Shad (*Dorosoma petenense*)	E,F	L-P	Stable	Lake-pelagic areas
Family Salmonidae				
* Cutthroat Trout (*Salmo clarki*)	A,B,D,F	C-P	Stable	Lakes-rocky shores, deep pelagic water; river-pools, riffles, and overhanging banks
* Rainbow Trout (*Salmo gairdneri*)	A,B,E,F,	C-P	Stable	Lake-littoral and pelagic areas rivers-pools, riffles, overhanging banks
* Brown Trout (*Salmo trutta*)	A,B,E,F	C-P	Stable	Lake-pelagic and littoral areas rivers-pools, riffles, and overhanging banks
* Brook Trout (*Salvelinus fontinalis*)	A,F	L-P	Stable	Lake-pelagic and littoral areas
Family Esocidae				
* Northern Pike (*Esox lucius*)	E,F	L-P	Unknown	Lake-littoral areas with submerged trees and brush
Family Cyprinidae				
Longfin Dace (*Agosia chrysogaster*)	E,F	K-P	Unknown	Unknown
Carp (*Cyprinus carpio*)	A,B,C,D,E,F	C-P	Stable	Lakes-littoral areas; quiet water areas in rivers, ponds, sloughs, creeks, and irrigation ditches
Utah Chub (*Gila atraria*)	A,B	L-P	Abundant	Irrigation ditches, ponds, sloughs, creeks, rivers, and lakes

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* Leatherside Chub (Gila copei)	A,E	C-P	Stable	Pool and riffle areas
* Humpback Chub (Gila cypha)	B	E-P	Decreasing	Eddies and backwaters
* Bonytail Chub Gila elegans)	B,C,F	E-P	Decreasing	Main channels of large rivers
Roundtail Chub (Gila robusta)	B,C,D,E,F	C-P	Stable	Riffles and stagnant backwaters
Red Shiner (Notropis lutrensis)	B,C,D,E,F	C-P	Increasing	Riffles, pools, backwaters, and eddies
San Shiner (Notropis stramineus)	F	C-P	Increasing	Riffles, pools, backwaters, and eddies
Fathead Minnow (Pimephales promelas)	B,C,D,E,F	C-P	Stable	Pools and backwaters
* Colorado Squawfish (Ptychocheilus lucius)	B,C,D,E,F	E-P	Decreasing	Slow waters, eddies, backwaters, and large pools
* Longnose Dace (Rhinichtys cataractae)	A	U-P	Unknown	Pools and riffles
! Speckled Dace (Rhinichtys osculus)	A,B,C,D,E,F	C-P	Stable	Pools and riffles
Redside Shiner (Richardsonius balteatus)	A,B,D	C-P	Stable	Lakes, creeks and rivers
Family Catostomidae				
White Sucker (Catostomus commersoni)	E,F	U-P	Unknown	Unknown
Bluehead Sucker (Catostomus discobolus)	A,B,C,D,E,F	C-P	Stable	Pools, riffles and lakes

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Flannelmouth Sucker (Catostomus latipinnis)	B,C,D,E,F	C-P	Stable	Pools and riffles
! Mountain Sucker (Catostomus platyrhynchus)	A	L-P	Stable	Pools and riffles
* Humpback Sucker (Xyrauchen texanus)	B,C,D,E,F	T-P	Decreasing	Large rivers with strong currents
Family Ictaluridae				
* Black Bullhead (Ictalurus melas)	B,C,D,E,F	C-P	Stable	Pools, quiet water and lakes
* Yellow Bullhead (Ictalurus natalis)	E,F	R-P	Stable	Quiet water areas and lakes
* Channel Catfish (Ictalurus punctatus)	B,C,D,E,F	C-P	Stable	Pools, riffles, quiet water areas and lakes
Family Cyprinodontidae				
Plains Killifish (Fundulus kansae)	F	R-P	Stable	Quiet water areas
Family Poeciliidae				
Mosquito fish (Gambusia affinis)	F	R-P	Stable	Quiet water areas
Family Cottidae				
* Mottled Sculpin (Cottus bairdi)	A	C-P	Stable	Rocky riffles and pool areas
Family Percichtyidae				
* Striped Bass (Morone saxatilis)	E,F	C-P	Increasing	Lake-pelagic areas
Family Centrarchidae				
Green Sunfish (Lepomis cyanellus)	B,C,D,E,F	C-P	Stable	Quiet backwaters and lakes
* Bluegill (Lepomis macrochirus)	E,F	C-P	Stable	Lakes-littoral areas with rocky shores and submerged brush

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* Largemouth Bass (Micropterus salmoides)	A,B,C,D,E,F	C-P	Stable	Rivers-quiet water areas; lakes-littoral rocky areas, with submerged brush
* Black Crappie (Pomoxis nigromaculatus)	E,F	C-P	Stable	Lake-littoral zone around submerged brush and trees, and pelagic areas
Family Percidae				
* Perch (Perca flavescens)	F	U-P	Unknown	Unknown
* Walleye (Stizostedion vitreum)	E,F	C-P	Stable	Lake-deep water around rocky bottoms
Amphibians -- 11 species in southeastern Utah				
Family Ambystomatidae				
! * Tiger Salamander (Ambystoma tigrinum)	A,B,C,D,E,F	C-P	Unknown	Quiet water of ponds, reservoirs, lakes, temporary rain pools and streams from arid sagebrush plains to rolling grasslands, mountain meadows and forests
Family Pelobatidae				
! Great Basin Spadefoot Toad (Scaphiopus intermontanus)	A,B,C,D,E,F	C-N	Unknown	Sagebrush flats, pinion-juniper woodlands to high elevations in spruce-fir communities

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Western Spadefoot Toad (*Scaphiopus hammondi*)	F	K-N	Unknown	Washes, alkali flats, foothills, mountain valleys, in open vegetation and shortgrass, where soil is sandy and/or gravelly
Family Bufonidae				
/ Western Toad (*Bufo boreas*)	A	K-N	Unknown	Desert streams, springs, grasslands, woodlands, and mountain meadows
Red Spotted Toad (*Bufo punctatus*)	D,E,F,	C-N	Unknown	Open grassland and rocky canyons
/ Woodhouse's Toad (*Bufo woodhousei*)	A,B,C,D,E,F	C-N	Unknown	Grassland, sagebrush flats, woods, desert streams, valleys, flood plains, farms, and city backyards
Great Plains Toad (*Bufo cognatus*)	C,D,E,F,	C-N	Unknown	Prairies, deserts, quiet water of streams, grasslands and sagebrush plains
Family Hylidae				
/ Chorus Frog (*Pseudacris triseriata*)	A,B,C,D,F	C-N	Unknown	Grassy pools, lakes, and marshes of prairies or mountains

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Canyon Tree Frog (Hyla arenicolor)	E,F	L-N	Unknown	Intermittant or permanent streams with rocky pools in canyons with cottonwoods or other trees
Family Ranidae				
* Bullfrog (Rana catesbeiana)	F	L-P	Unknown	Colorado River-usually quiet water where there is thick growth of aquatic vegetation
! Leopard Frog (Rana pipiens)	A,B,C,D,E,F	C-N	Unknown	Springs, creeks, rivers, ponds, canals, reservoirs and wet meadows
Reptiles -- 36 species in southeastern Utah				
Family Iguanidae				
* Chuckwalla (Sauromalus obesus)	E,F	L-N	Unknown	Rocky hillsides
Collared Lizard (Crotaphytus collaris)	A,B,C,D,E,F	C-N	Unknown	Canyons, rocky gullies, mountain slopes and boulder strewn alluvial fans where vegetation is sparse
Leopard Lizard (Crotaphytus wislizenii)	A,B,C,D,E,F	C-N	Unknown	Arid and semi-arid plains with bunchgrass, sagebrush or other low desert shrub communities; avoids dense vegetation
Lesser Earless Lizard (Holbrookia maculata)	F	K-N	Unknown	Washes, sandy stream banks and sand dunes on shortgrass prairi and farmlands

ecies	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! Eastern Fence Lizard (Sceloporus undulatus)	A,B,C,D,E,F	C-N	Unknown	Forest, woodlands, prairie, brushy flatlands, sand dunes, rocky hillsides and farmlands
Desert Spiny Lizard (Sceloporus magister)	D,E,F	C-N	Unknown	Shadscale deserts, pinion-juniper woodland, willows and cottonwoods.
! Sagebrush Lizard (Sceloporus graciosus)	A,B,C,D,E,F	C-N	Unknown	Variety of habitat types; sagebrush, pinion-juniper, low desert shrub and rocklands
! Tree Lizard (Urosaurus ornatus)	A,B,C,D,E,F	C-N	Unknown	Trees and rocks
! Side-blotched Lizard (Uta stansburiana)	A,B,C,D,E,F	C-N	Unknown	Inhabits a variety of habitat types; sandy washes with scattered rocks and low growing shrubs
Desert Horned Lizard (Phrynosoma platyrhinos)	E	K-N	Unknown	Along washes at the edge of dunes in saltbrush and sagebrush areas
! Short-horned Lizard (Phrynosoma douglassi)	A,B,C,D,E,F	C-N	Unknown	Desert grassland, sagebrush, pinion-juniper, pine-spruce and spruce-fir associations, extending from desert shrub to mountain habitats

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Family Xantusiidae				
* Utah Night Lizard (Xantusia vigilis)	E,F	L-N	Unknown	Dead clumps of yucca plants and woodrat middens
Family Teiidae				
Plateau Whiptail (Cnemidophorus velox)	F	K-N	Unknown	Mountains in pinion-juniper woodland and lower edges of ponderosa pine forests
Western Whiptail (Cnemidophorus tigris)	A,B,C,D,E,F	C-N	Unknown	Desert shrub communities where plants are sparse and there are open areas for running
Family Scincidae				
Many-lined Skink (Eumeces multivirgatus)	E,F	K-N	Unknown	Shortgrass prairie that extends into the mountains; often vacant lots, city dumps and backyards
Western Skink (Eumeces skiltonianus)	C	K-N	Unknown	Grasslands, woodlands and forests in rocky habitat near streams with abundant cover
Family Boidae				
Rubber Boa (Charina bottae)	A	C-N	Unknown	Grasslands, woodlands, and forests with rotting logs; often found under rocks and under the bark of fallen or standing dead trees

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Family Colubridae				
Smooth Green Snake (Opheodrys vernalis)	F	K-N	Unknown	Damp grassy environment
! Striped Whipsnake (Masticophis taeniatus)	A,B,C,D,E,F	C-N	Unknown	Brushlands, grasslands, sagebrush flats, pinion-juniper woodlands and open pine forests
Coachwhip (Masticophis flagellum)	E,F	K-N	Unknown	Utilizes a variety of habitats but avoids dense vegetation; rodent burrows, rocks and branches are used
! Racer (Coluber constrictor)	A,B,C,D,E,F	C-N	Unknown	Meadows, sparse brush and forest openings with semi-arid and moist areas; grassy places near rocks and logs are preferred
Corn Snake (Elaphe guttata)	F	K-N	Unknown	Stream and river bottoms, rocky wooded hillsides, coniferous forests, and farmland with rodent burrows, rocks and logs
! Ringneck Snake (Diadophis punctatus)	A	K-N	Unknown	Moist habitats usually in the mountains or along stream and river bottoms

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! Gopher Snake (Pituophis melanoleucus)	A,B,C,D,E,F	C-N	Unknown	Lowlands to high mountains including desert, coniferous forest and farmland types; grassland and open brushland are prescribed
! * Milk Snake (Lampropeltis triangulum)	A,B,C,F	K-N	Unknown	Variety of habitats from lowlands to mountains; rotten logs and stumps are preferred
Common Kingsnake (Lampropeltis getulus)	E,F	K-N	Unknown	Variety of habitats from lowlands to mountains with rock outcrops and clumps of vegetation under rotting logs or rocks
! * Sonora Mountain Kingsnake (Lampropeltis pyromelana)	A	K-N	Unknown	Mountains, pinion-juniper woodlands, mountain brush, coniferous forests with rocks, logs and dense clumps of vegetation
Long-nosed Snake (Rhinocheilus lecontei)	F	K-N	Unknown	Prairies, brushland and irrigated parts of deserts
! Western Terrestrial Garter Snake (Thamnophis elegans)	A,B,C,D,E,F	C-N	Unknown	Variety of terrestrial and aquatic habitats from lowlands to mountains
! Common Garter Snake (Thamnophis sirtalis)	A,F	K-N	Unknown	Variety of habitats, usually near water

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Black-necked Garter Snake (*Thamnophis cyrtopsis*)	F	K-N	Unknown	Desert and grasslands
Western Black-headed Snake (*Tantilla planiceps*)	E,F	K-N	Unknown	Grasslands, woodlands and deserts; often found under rocks and logs
! Night Snake (*Hypsiglena torquata*)	A,B,C,D,E,F	C-N	Unknown	Plains, sagebrush flats, desert and woodlands; often found under rocks and surface litter
Family Crotalidae				
Hopi Rattlesnake (*Crotalus viridis nuntius*)	E	U-N	Unknown	Prefers rock piles and rodent burrows on grasslands, brushlands, woodlands and forests; avoids sparsely vegetated deserts
Prairie Rattlesnake (*Crotalus viridis viridis*)	F	U-N	Unknown	Prefers rock piles and rodent burrows on grasslands, woodlands and forests; avoids sparsely vegetated deserts
! Midget Faded Rattlesnake (*Crotalus viridis concolor*)	A,B,C,D,E,F	C-N	Unknown	Prefers rock piles and rodent burrows on grasslands, brushlands, woodlands and forests; avoids sparsely vegetated deserts

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Birds -- 278 species in southeastern Utah				
Order Gaviiformes				
Family Gaviidae				
Common Loon (*Gavia immer*)	A,B,C,D,E,F	U-P transient and winter resident	Stable	Lakes of coniferous forests, open lakes, reservoirs and bays
Order Podicipediformes				
Family Podicipedidae				
Horned Grebe (*Podiceps auritus*) *	A,B,C,D,E,F	R-P transient and summer resident	Stable	Lakes, ponds and reservoirs
Eared Grebe (*Podiceps nigricollis*)	A,B,C,D,E,F	C-P summer resident	Stable	Lakes, bays and reservoirs
* Western Grebe (*Aechmophorus occidentalis*)	A,B,C,D,E,F	C-P summer resident	Stable	Sloughs, bays and reservoirs and lakes with emergent vegetation for nesting
Pied-billed Grebe (*Podilymbus podiceps*)	A,B,C,D,E,F	C-P summer resident	Stable	Ponds, lakes, streams and marshes
Order Pelecaniformes				
Family Pelecanidae				
* White Pelican (*Pelecanus erythrorhynchos*)	A,B,C,D,E,F	L-P transient and summer resident	Stable	Larger shallow bodies of water and large rivers
Family Phalacrocoracidae				
* Double-crested Cormorant (*Phalacrocorax auritus*)	A,B,C,D,E,F	U-P summer resident	Stable	Bays, lakes and rivers

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Order Ciconiiformes				
Family Ardeidae				
!*Great Blue Heron (Ardea herodias)	A,B,C,D,E,F	C-P resident	Stable	Marshes, shallow reservoirs, rivers, streams, shores and irrigation ditches
Green Heron (Butorides striatus)	B,E,F	R-P transient	Unknown	Marshes, wooded streams, rivers, small ponds and lake margins
Cattle Egret (Bubulcus ibis)	E,F	O-P transient	Unknown	Marshes, lake margins, and irrigated lands
! Snowy Egret (Egretta thula)	A,B,C,D,E,F	C-P summer resident	Stable	Marshes, ponds, lake margins and irrigated land
Black-crowned Night Heron (Nycticorax nycticorax)	A,B,C,D,E,F	C-P summer resident	Stable	Marshes, lake margins and shores
Least Bittern (Ixobrychus exilis)	D,E,F	U-P transient	Unknown	Densely vegetated marshes
American Bittern (Botaurus lentinginosus)	A,B,C,D,E,F	U-P summer resident	Stable	Densely vegetated marshe
Family Ciconiidae				
Wood Stork (Mycteria americana)	D,E,F	O-P transient	Unknown	Marshes, ponds and lake margins
Family Threskiornithidae				
*White-faced Ibis (Plegadis chihi)	A,B,C,D,E,F	C-P summer resident	Increasing	Marshes and irrigated land

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Order Anseriformes				
Family Anatidae				
* Whistling Swan (Olor columbianus)	A,B,C,D,E,F	O-P winter resident C-P transient	Stable	Lakes, large rivers and fields
* Trumpeter Swan (Olor buccinator)	B,C,D,E,F	R-P transient	Unknown	Lakes and large rivers
* Canada Goose (Branta canadensis)	A,B,C,D,E,F	C-P resident and transient	Increasing	Lakes, bays, marshes, rivers and grainfields
*White-fronted Goose (Anser albifrons)	A,B,C,D,E,F	R-P transient	Stable	Marshes, fields, lakes and bays
*Snow Goose (Chen caerulescens)	A,B,C,D,E,F	U-P transient	Stable	Marshes, grainfields, reservoir, ponds and bays
* Ross' Goose (Chen rossii)	A,B,C,D,E,F	O-P transient	Stable	Marshes, grainfields, prairies, ponds and bays
! * Mallard (Anas platyrhynchos)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes, irrigated land, grainfields, ponds, rive lakes, bays and reservoi extending from lowlands mountains
! *Gadwall (Anas strepera)	A,B,C,D,E,F	C-P resident and transient	Stable	Lakes, ponds, rivers and marshes
! * Pintail (Anas acuta)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes, grainfields, ponds, lakes and reservoirs

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
/ *Green-winged Teal (Anas crecca)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes, lakes, ponds, rivers and bays
*Blue-winged Teal (Anas discors)	A,B,C,D,E,F	U-P resident and transient	Stable	Ponds and marshes
/*Cinnamon Teal (Anas cyanoptera)	A,B,C,D,E,F	C-P resident and transient	Stable	Stock ponds, rivers, marshes and lakes
*American Widgeon (Anas americana)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes, irrigated land, ponds, lakes and bays
* Northern Shoveler (Anas clypeata)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes, ponds and sloughs
/*Wood Duck (Aix sponsa)	A,B,C,D,E,F	R-P transient	Stable	Wooded rivers and ponds
*Redhead (Aythya americana)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes with some deep water, lakes and reservoirs
*Ring-necked Duck (Aythya collaris)	A,B,C,D,E,F	U-P transient	Stable	Coniferous lakes, wooded ponds, marshes and reservoirs
*Canvasback (Aythya valisineria)	A,B,C,D,E,F	C-P transient R-P summer resident	Stable	Marshes, lakes and reservoirs

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
*Greater Scaup (Aythya marila)	A,B,C,D,E,F	U-P transient	Stable	Lakes, rivers and ponds
*Lesser Scaup (Aythya affinis)	A,B,C,D,E,F	C-P transient	Stable	Marshes, ponds and lakes
*Common Goldeneye (Bucephala clangula)	A,B,C,D,E,F	U-P transient	Stable	Lakes and rivers
*Bufflehead (Bucephala albeola)	A,B,C,D,E,F	U-P transient	Stable	Lakes, ponds and rivers
*White-winged Scoter (Melanitta deglandi)	D	O-P transient	Stable	Large lakes and reservoirs. Recorded occurrence at Desert Lake WMA
*Ruddy Duck (Oxyura jamaicensis)	A,B,C,D,E,F	C-P resident and transient	Stable	Marshes, ponds, rivers and reservoirs
*Hooded Merganser (Mergus cucullatus)	A,B,C,D,E,F	R-P transient	Stable	Wooded lakes, ponds, rivers and reservoirs
*Common Merganser (Mergus merganser)	A,B,C,D,E,F	C-P transient U-P winter resident	Stable	Wooded lakes and rivers in summer; in winter, open rivers, lakes and ponds
*Red-breasted Merganser (Mergus serrator)	A,B,C,D,E,F	C-P transient	Stable	Lakes, reservoirs and rivers

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Order Falconiformes				
Family Cathartidae				
/*Turkey Vulture (Cathartes aura)	A,B,C,D,E,F	C-P summer resident	Stable	Usually seen in sky or perched on dead trees, posts, carrion or on groun
California Condor (Gymnogyps californianus)	A,B,C,D,E,F	X-P	Extirpated	Usually seen in sky or perched on dead trees, posts, carrion or on groun
Family Accipitridae				
/*Goshawk (Accipiter gentilis)	A,B,C,D,E,F	U-P resident	Stable	Mountain woodlands
/ *Sharp-shinned Hawk (Accipiter striatus)	A,B,C,D,E,F	U-P resident and transient	Stable	Forests, thickets, scrubоak, desert riparian, mountain woodlands and aspen
/*Cooper's Hawk (Accipiter cooperii)	A,B,C,D,E,F	C-P summer resident and transient R-P winter resident	Stable	Broken woodlands, dry wooded canyons, riparian areas, pinion-juniper and conifers
/*Red-tailed Hawk (Buteo jamaicensis)	A,B,C,D,E,F	C-P resident	Stable	Open country, woodlands, mountains and deserts
*Red-shouldered Hawk (Buteo lineatus)	C,F	A-P transient	Unknown	Broken woodlands, primarily along lowland rivers and often close to cultivated fields
/* Swainson's Hawk (Buteo swainsoni)	A,B,C,D,E,F	U-P summer resident	Stable	Dry plains and rangeland with hills; open forest or alpine meadows with sparse trees

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* Rough-legged Hawk (Buteo lagopus)	A,B,C,D,E,F	C-P winter resident	Stable	Open country, woodlands, deserts and marshes
* Ferruginous Hawk (Buteo regalis)	A,B,C,D,E,F	U-P summer resident R-P winter resident	Stable	Open desert; infrequentl marshes and farmlands are utilized
1 * Golden Eagle (Aquila chrysaetos)	A,B,C,D,E,F	C-P resident	Stable	Open mountains, foot-hills, canyons and deser
*Bald Eagle (Haliaeetus leucocephalus)	A,B,C,D,E,F	E-P winter resident	Increasing	Lakes, rivers and marshe surrounded by open country with available perching sites
1 *Marsh Hawk (Circus cyaneus)	A,B,C,D,E,F	C-P resident	Stable	Marshes, fields and prairies
Family Pandionidae				
*Osprey (Pandion haliaetus)	A,B,C,D,E,F	U-P transient	Stable	Rivers, lakes and large bodies of water
Family Falconidae				
1 *Prairie Falcon (Falco mexicanus)	A,B,C,D,E,F	C-P resident	Stable	Canyons, open habitat in mountains, plains and deserts
*Peregrine Falcon (Falco peregrinus)	A,B,C,D,E,F	E-P resident	Unknown	Canyons, high cliffs, rivers, marshlands and deserts
*Merlin (Falco columbarius)	A,B,C,D,E,F	C-P winter resident	Unknown	Open country and foot-hills; often associated with flocking passerine

pecies	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! * American Kestrel (Falco sparverius)	A,B,C,D,E,F	C-P summer resident U-P winter resident	Stable	Open country, prairies, deserts, wooded streams, farmland and cities
Order Galliformes				
Family Tetraonidae				
! * Blue Grouse (Dendragapus obscurus)	A,B,C,D,E,F	C-P resident	Stable	Coniferous forests, aspen, mountain brush, open slash and burns
! * Ruffed Grouse (Bonasa umbellus)	A,B	C-P resident	Stable	Aspen and coniferous forests near stream courses
! *Sage Grouse (Centrocercus urophasianus)	A,B,C,F	C-P resident	Stable	Sagebrush plains associated with pasture lands; sagebrush parks associated with wet meadows
Family Phasianidae				
* California Quail (Lophortyx californicus)	A,B,D,E,F	C-P resident	Stable	Mountain brush, woodland edges and farmlands near river bottoms
* Gambels Quail (Lophortyx gambelii)	D,E,F	C-P resident	Stable	Desert thickets, usually near water
* Chukar (Alectoris chukar)	A,B,C,D,E,F	C-P resident	Stable	Rocky, grassy or brushy slopes in arid mountains and canyons
* Ring-necked Pheasant (Phasianus colchicus)	A,B,C,D,E,F	C-P resident	Decreasing	Irrigated cropland, pastureland, wetlands and desert wa

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* White-winged Pheasant (Phasianus colchicus)	E,F	L-P resident	Decreasing	Irrigated cropland, pastureland and wetlands near Hanksville and Bluff, Utah
Family Meleagrididae				
*Merriam's Turkey (Meleagris gallapavo)	F	L-P resident	Stable	Mountainous regions with Ponderosa pine, mixed conifer and aspen woodlands or mountain brush
Order Gruiformes				
Family Gruidae				
*Sandhill Crane (Grus canadensis)	A,B,C,D,E,F	R-P transient	Stable	In winter, prairies grainfields and marshes in summer, mountain meadows and marshes
Family Rallidae				
*Virginia Rail (Rallus limicola)	A,B,C,D,E,F	C-P resident	Stable	Marshes
*Sora Rail (Porzana carolina)	A,B,C,D,E,F	U-P resident	Stable	Marshes and wet meadows
*Common Gallinule (Gallinula chloropus)	A,D	R-P transient	Unknown	Marshes, wet meadows, lakes with bulrush or cattails and sedges
*American Coot (Fulica americana)	A,B,C,D,E,F	C-P resident and transient	Stable	Ponds, lakes, marshes, and agricultural lands adjacent to wetland habitats.
Order Charadriiformes				
Family Charadriidae				
Semipalmated Plover (Charadrius semipalmatus)	A,B,C,D,E,F	U-P transient	Stable	Shores of marshes, reservoirs and mudflats

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
*Snowy Plover (Charadrius alexandrinus)	A,B,C,D,E,F	U-P transient	Stable	Alkali and sand flats
! Killdeer (Charadrius vociferus)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Fields and pastures, lawns, riverbanks, irrigated land, shores, plowed fields, alkali flats and gravel roads
! Mountain Plover (Charadrius montanus)	A,B,C,F	R-P transient	Stable	Semi-arid grasslands, plains and plateaus
American Golden Plover (Pluvialis dominica)	A,B,C,D,E,F	U-P transient	Stable	Prairies, mudflats and shores
Black-bellied Plover (Pluvialis squatarola)	A,B,C,D,E,F	C-P transient	Stable	Mudflats, open marshes and shores
Family Scolopacidae				
* Common Snipe (Capella gallinago)	A,B,C,D,E,F	C-P resident	Stable	Marshes, irrigation ditches, stream sides, and wet meadows
* Long-billed Curlew (Numenius americanus)	A,B,C,D,E,F	U-P summer resident and transient	Declining	Meadows, pastures and wetlands
* Willet (Catoptrophorus semipalmatus)	A,B,C,D,E,F	U-P summer resident and transient	Stable	Marshes, wet meadows and muddy shores
! Spotted Sandpiper (Tringa macularia)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Pebbly lake shores, ponds and stream sides

Species	Biogeograph. Area Inhabited	Status	Population Trend	Habitat Use Area
Solitary Sandpiper (Tringa solitaria)	A,B,C,D,E,F	U-P transient	Stable	Stream sides, ponds and marshes
Greater Yellowlegs (Tringa melanoleuca)	A,B,C,D,E,F	U-P transient	Stable	Open marshes, mudflats, streams and ponds
Lesser Yellowlegs (Tringa flavipes)	A,B,C,D,E,F	C-P transient	Stable	Marshes, mudflats, shores and pond edges
Pectoral Sandpiper (Calidris melanotos)	A,B,C,D,E,F	U-P transient	Stable	Prairie pools and marshy shores
Baird's Sandpiper (Calidris bairdii)	A,B,C,D,E,F	U-P transient	Stable	Rainpools, pond margins mudflats and shores
Least Sandpiper (Calidris minutilla)	A,B,C,D,E,F	C-P transient	Stable	Grassy marshes, rain-pools, shores and alkal mudflats
Western Sandpiper (Calidris mauri)	A,B,C,D,E,F	C-P transient	Stable	Shores, beaches, mud-flats and open marshes
Sanderling (Calidris alba)	A,B,C,D,E,F	U-P transient	Stable	Lake shores
Short-billed Dowitcher (Limnodromus griseus)	A,B,C,D,E,F	U-P summer resident and transient	Stable	Mudflats, open marshes and ponds
Long-billed Dowitcher (Limnodromous scolopaceus)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Mudflats, shallow pools and wetlands

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Marbled Godwit (Limosa fedoa)	A,B,C,D,E,F	C-P transient	Stable	Grasslands and meadows near lakes and shallow lake margins
Family Recurvirostridae				
American Avocet (Recurvirostra americana)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Marshes, mudflats, alkaline lakes, shallow ponds and sloughs
Black-necked Stilt (Himantopus mexicanus)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Grassy marshes, alkali mudflats, pools and shallow lakes
Family Phalaropodidae				
Wilson's Phalarope (Phalaropus tricolor)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Shallow lakes, marshes, pools, shores and mudflats
Northern Phalarope (Phalaropus lobatus)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Lakes and ponds
Family Laridae				
Glaucous Gull (Larus hyperboreus)	D	R-P transient	Stable	Recorded using marshlands at Desert Lake WMA
Herring Gull (Larus argentatus)	A,B,C,D,E,F	U-P transient	Stable	Lakes, farmlands and dumps
! California Gull (Larus californicus)	A,B,C,D,E,F	C-P summer resident	Stable	Lakes, rivers, farmlands and dumps
! Ring-billed Gull (Larus delawarensis)	A,B,C,D,E,F	C-P winter resident	Stable	Lakes, rivers, refuse dumps, fields and cities

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Franklin's Gull (Larus pipixcan)	A,B,C,D,E,F	C-P summer resident	Stable	Prairies, marshes, lakes and plowed fields
! Bonaparte's Gull (Larus philidelphia)	A,B,C,D,E,F	U-P transient	Stable	Rivers, lakes and open marshes
Forsters Tern (Sterna forsteri)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Marshes, lakes and reservoirs
Common Tern (Sterna hirundo)	A,B,C,D,E,F	U-P transient	Stable	Lakes and reservoirs
Black Tern (Chlidonias niger)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Marshes, lakes and reservoirs
Caspian Tern (Hydroprogne caspia)	A,B,C,D,E,F	U-P transient	Stable	Large lakes and reservoirs
Order Columbiformes				
Family Columbidae				
! * Band-tailed pigeon (Columba fasciata)	A,E,F	U-P summer resident and transient	Stable	Forests, canyons and foothills near mountain brush (acorns) and agricultural lands
Rock Dove (Columba lavia)	A,B,C,D,E,F	C-N resident	Stable	Cities, farms and cliffs
! * Mourning Dove (Zenaida macroura)	A,B,C,D,E,F	C-P summer resident and transient	Stable	Farmlands, towns, open woods, grassland and deserts
White-winged Dove (Zenaidura asiatica)	E,F	A-P summer resident and transient	Unknown	Open woods and river bottoms

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Order Cuculiformes				
Family Cuculidae				
! * Yellow-billed Cuckoo (Coccyzus americanus)	A,B,C,D,E,F	K-P summer resident	Unknown	River thickets and willows
Order Strigiformes				
Family Tytonidae				
! * Barn Owl (Tyto alba)	A,B,C,D,E,F	K-P resident	Unknown	Woodlands, fields, farms, towns, canyons, cliffs and dirt banks
Family Strigidae				
! * Screech Owl (Otus asio)	A,B,C,D,E,F	U-P resident	Stable	Riparian communities and wooded canyons
! * Flammulated Owl (Otus flammeolus)	A,B,C,D,E,F	K-P summer resident	Unknown	Open pine and fir forests in mountains
! * Great Horned Owl (Bubo virginianus)	A,B,C,D,E,F	C-P resident	Stable	Ubiquitous
! * Pygmy Owl (Glaucidium gnoma)	A,B,C,D,E,F	K-P resident	Unknown	Wooded canyons in open coniferous, mixed woodlands and pinion-juniper forests
* Burrowing Owl (Speotyto cunicularia)	A,B,C,D,E,F	L-P resident	Declining	Open grassland, prairies, dikes, desert, farms and prairie dog colonies

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* Spotted Owl (Strix occidentalis)	C,E	K-P Unknown	Unknown	Wooded canyons with narrow side canyons in the desert
* Long-eared Owl (Asio otus)	A,B,C,D,E,F	C-P resident	Stable	River woodlands, pinion-juniper forests, willow thickets and Russian olive trees
* Short-eared Owl (Asio flammeus),	A,B,C,D,E,F	C-P resident	Stable	Marshes, prairies, irrigated land and open country with short vegetation
* Saw-whet Owl (Aegolius acadicus)	A,B,C,D,E,F	K-P resident	Stable	Forest, conifers and groves
Order Caprimulgiformes				
Family Caprimulgidae				
Common Nighthawk (Chordeiles minor)	A,B,C,D,E,F	C-P summer resident	Stable	Treeless plains to mountains with open pine woods; often seen in fli over country side or tov
Lesser Nighthawk (Chordeiles acutipennis)	E	R-P summer resident	Unknown	Arid open scrub, dry grasslands, pastures and desert washes
Poor-will (Phalaenoptilus nuttallii)	A,B,C,D,E,F	C-P summer resident	Stable	Arid uplands with open pinion-juniper and spars brush; riparian areas ar roadsides

pecies	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Order Apodiformes				
Family Apodidae				
/*Black Swift (Cypseloides niger)	A,B,C,D,E,F	U-P summer resident	Unknown	Open areas in mountain country
White-throated Swift (Aeronautes saxatalis)	A,B,C,D,F	C-P summer resident	Unknown	Open areas; wide ranging and breeds mainly in dry mountain canyons
Family Trochilidae				
/ Black-chinned Hummingbird (Archilochus alexandri)	A,B,C,D,E,F	C-P summer resident	Unknown	Semi-arid country near water; semi-wooded canyons and slopes, mountain brush and riparian woodlands
/ Broad-tailed Hummingbird (Selasphorus platycercus)	A,B,C,D,E,F	C-P summer resident	Unknown	Ubiquitous
/ Rufous Hummingbird (Selasphorus rufus)	A,B,C,D,E,F	C-P summer resident and transient	Unknown	Forest edges, thickets in coniferous and deciduous forests, mountain brush and alpine meadows
/ Calliope Hummingbird (Stellula calliope)	A,B,C,D,E,F	C-P summer resident	Unknown	High mountains, canyons and forest openings
/ Rivoli's Hummingbird (Eugenes fulgens)	E,F	U-P summer resident	Unknown	High mountain forest openings, pine-oak forests and canyons

Species	Geographic Area Inhabited	Status	Population Trend	Habitat Use Area
Order Caraciiformes				
Family Alcedinidae				
!* Belted Kingfisher (Megaceryle alcyon)	A,B,C,D,E,F	U-P resident	Stable	Rivers, ponds and lakes
Order Piciformes				
Family Picidae				
! Common Flicker (Colaptes auratus)	A,B,C,D,E,F	C-P resident	Stable	Deciduous or mixed woodlands, open forest, farms towns, canyons and semi-open country
* Pileated Woodpecker (Dryocopus pileatus)	F	R-P resident	Unknown	Mature coniferous and mixed forests with many snags
Red-headed Woodpecker (Melanerpes erythrocephalus)	B	R-P resident	Unknown	Groves, farm country, riparian areas, towns and scattered trees
! Yellow-bellied Sapsucker (Sphyrapicus varius)	A,B,C,D,E,F	C-P resident	Unknown	In summer woodlands and aspen groves; in winter orchards and other trees
* Williamson's Sapsucker (Sphyrapicus thyroideus)	F	U-P summer resident	Unknown	Higher coniferous forests and burns
*Lewis Woodpecker (Asyndesmus lewis)	F	K-P summer resident and transient	Unknown	Scattered or logged forests, burns, cottonwood groves and ponderosa pine
! Hairy Woodpecker (Dendrocopos villosus)	A,B,C,D,E,F	C-P resident	Unknown	Mountain forests, woodlands and river groves

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
/ Downy Woodpecker (Dendrocopos pubescens)	A,B,C,D,E,F	C-P resident	Unknown	Broken or mixed forest, willows, poplars, riparian woodlands, orchards and shade trees
/ Northern Three-toed Woodpecker (Picoides tridactylus)	A,B,C,E,F	U-P resident	Unknown	Coniferous forests
Order Passeriformes				
Family Tyrannidae				
Western Kingbird (Tyrannus verticalis)	A,B,C,D,E,F	C-P summer resident	Stable	Open country with scattered trees, farms and roadsides
/ Cassin's Kingbird (Tyrannus vociferans)	A,B,C,D,E,F	U-P summer resident	Unknown	Semi-open high country, scattered trees, pine-oak mountains and ranch groves
Eastern Kingbird (Tyrannus tyrannus)	A,B,C,D,E,F	C-P summer resident	Unknown	Wood edges, parklands, riparian areas, farms, shelter belts, orchards and roadsides
Ash-throated Flycatcher (Myiarchus cinerascens)	A,B,C,D,E,F	C-P summer resident	Stable	Semi-arid country, deserts, brush, pinion-juniper and open woods
Black Phoebe (Savornis nigricans)	F	C-P resident	Unknown	Streamside woodlands, farmyards and towns with cliffs near water
Says Phoebe (Savornis sava)	A,B,C,D,E,F	C-P resident	Unknown	Open arid country, deserts, bushy plains, prairie farms, canyon mouths and bu

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! Willow (Traill's) Flycatcher (Empidonax traillii)	A,B,C,D,E,F	C-P summer resident	Unknown	Breeds in willow thickets in low valleys, along canyons or in high mountain meadows
! Hammond's Flycatcher (Empidonax hammondii)	A,B,C,E,F	U-P summer resident	Unknown	High coniferous forests
! Dusky Flycatcher (Empidonax oberholseri)	A,B,C,D,E,F	C-P summer resident	Unknown	Breeds in mountain brush with a scattering of trees
Gray Flycatcher (Empidonax wrightii)	A,B,C,D,E,F	K-P summer resident	Unknown	Breeds in sagebrush and pinion-juniper woodlands
! Western Flycatcher (Empidonax difficilis)	A,B,C,D,E,F	C-P summer resident	Unknown	Moist woods, mixed or coniferous forests, canyons, groves; must have water and shade
! Western Wood Peewee (Contipus sordidulus)	A,B,C,D,E,F	C-P summer resident	Unknown	Woodlands, pine-oak forests, open conifers and river groves
! Olive-sided Flycatcher (Contopus borealis)	A,B,C,D,E,F	U-P summer resident	Unknown	Coniferous forests, burns and clearings; in migration habitats used are varied; usually seen on tip of dead tree or branch

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Family Alaudidae				
! Horned Lark (Eremophila alpestris)	A,B,C,D,E,F	C-P resident	Unknown	Plains, desert, prairies, fields, sparse sagebrush flats, dirt roads, shores, alpine meadows, alkali flats and areas of sparse vegetation
Family Hirundinidae				
! Violet-green Swallow (Tachycineta thalasssina)	A,B,C,D,E,F	C-P summer resident	Unknown	Widespread when foraging; when nesting, open forests foothill woods, mountains, canyons, cliffs and towns
! Tree Swallow (Iridoprocne bicolor)	A,B,C,D,E,F	C-P summer resident	Unknown	Open country near water, marshes, mountain meadows, streams, lakes and wires; when nesting requires dead trees and snags, preferabl near water
! Bank Swallow (Riparia riparia)	A,B,C,D,E,F	C-P summer resident	Unknown	Usually near water; over fields, marshes, streams and lakes
! Rough-winged Swallow (Stelgidopteryx ruficollis)	A,B,C,D,E,F	C-P summer resident	Unknown	Near streams, lakes and washes
! Barn Swallow (Hirundo rustica)	A,B,C,D,E,F	C-P summer resident	Unknown	Open or semi-wooded country, farms, ranches, fields, marshes and lakes; usually near man's habitation

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! Cliff Swallow (Petrochelidon pyrrhonota)	A,B,C,D,E,F	C-P summer resident	Unknown	Open to semi-wooded country, neat farms, cliffs, canyons, rivers or lakes
! * Purple Martin (Progne subis)	A,B,C,E,F	U-P summer resident	Unknown	Open forests of aspen and conifers
Family Corvidae				
! Steller's Jay (Cyanocitta stelleri)	A,B,C,D,E,F	C-P resident	Unknown	Conifers and pine-oak forests
! Gray Jay (Perisorius canadensis)	A,B,C,E,F	R-P resident	Unknown	Coniferous forests
Scrub Jay (Aphelocoma coerulescens)	A,B,C,D,E,F	C-P resident	Unknown	Foothills, oaks, mountain brush, river woods and pinion-juniper woodlands
! Black-billed Magpie (Pica pica)	A,B,C,D,E,F	C-P resident	Unknown	Foothills, ranches, sage-brush, river thickets, shelterbelts and prairie brush
! Common Raven (Corvus corax)	A,B,C,D,E,F	C-P resident	Unknown	Mountains, deserts, canyons and cliffs
! Common Crow (Corvus brachyrhynchos)	A,B,C,D,E,F	O-P transient	Unknown	Deciduous, mixed and open coniferous woodlands farmlands and river grove
Pinion Jay (Gymnorhinus cyanocephala)	A,B,C,D,E,F	C-P resident	Unknown	Pinion-juniper woodlands, but ranges into sagebrush
! Clark's Nutcracker (Nucifraga columbiana)	A,B,C,E,F	C-P resident	Unknown	High mountains in conifer near tree line

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Family Paridae				
! Black-capped Chickadee (Parus atricapillus)	A,B,C,D,E,F	C-P resident	Unknown	In summer aspen-conifer, mixed woodlands and forest edges; in winter woodlands along valley streams and tree rows
! Mountain Chickadee (Parus gambeli)	A,B,C,D,E,F	C-P resident	Unknown	In summer mountain forests and conifers; in winter riparian woodlands at lower elevations
Plain Titmouse (Parus inornatus)	A,B,C,D,E,F	C-P resident	Unknown	Pinion-juniper woodlands
Bushtit (Psaltriparus minimus)	A,B,C,D,E,F	C-P resident	Unknown	Oak woodlands, mountain brush, broad-leafed and mixed woods and pinion-juniper forest
Family Sittidae				
! White-breasted Nuthatch (Sitta carolinensis)	A,B,C,D,E,F	C-P resident	Unknown	Coniferous forests, pinion-juniper woodlands, oak brush, and riparian woodlands
! Red-breasted Nuthatch (Sitta canadensis)	A,B,C,E,F	C-P resident	Unknown	Coniferous forests
! Pygmy Nuthatch (Sitta pusilla)	A,B,C,D,E,F	C-P resident	Unknown	Ponderosa pines and Douglas fir

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use
Family Certidae				
/ Brown Creeper (Certhia familiaris)	A,B,C,E,F	C-P resident	Unknown	In summer mature montane mixed and coniferous forests; lower elevations in winter
Family Cinclidae				
/ Dipper (Cinclus mexicanus)	A,B,C,D,E,F	C-P resident	Unknown	Fast-flowing streams in or near mountains; lower levels in winter
Family Troglodytidae				
/ House Wren (Troglodytes aedon)	A,B,C,D,E,F	C-P summer resident	Unknown	Woodlands of mountains and valleys
Rock Wren (Salpinctes obsoletus)	A,B,C,D,E,F	C-P resident	Unknown	Desert to high mountain areas with talus slopes and cliffs
Canyon Wren (Catherpes mexicanus)	A,B,C,D,E,F	C-P resident	Unknown	Rocky cliffs, crevices, and rock slides
Bewick's Wren (Thryomanes bewickii)	A,B,C,D,E,F	C-P resident	Unknown	Under brush and pinion-juniper woodlands
Long-billed Marsh Wren (Cistothorus palustris)	A,B,C,D,E,F	L-P resident	Unknown	Cattail marshes
Family Mimidae				
Mockingbird (Mimus polyglottos)	A,B,C,D,E,F	U-P transient and summer resident	Unknown	Towns, farms, ranches, roadsides, brush and desert streamsides
/ Gray Catbird (Dumetella carolinensis)	A,B,C,D,E,F	U-P summer resident	Unknown	Undergrowth, brush or thickets along valley streams

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Brown Thrasher (Toxostoma rufum)	D,E,F	R-P resident	Unknown	Brushy places and thorny thickets
Bendire's Thrasher (Toxostoma bendirei)	F	R-P resident	Unknown	Desert scrub and farmlands
! Sage Thrasher (Oreoscoptes montanus)	A,B,C,D,E,F	C-P resident	Unknown	Sagebrush, rabbit-brush, brushy slopes and mesas
Family Muscicapidae				
! American Robin (Turdus migratorius)	A,B,C,D,E,F	C-P resident	Unknown	In summer towns, lawns, farmland, open forests, streamsides and any wooded habitat; in winter berry-bearing trees
Varied Thrush (Ixoreus naevius)	E,F	O-P winter resident	Unknown	Deciduous and coniferous forests usually near water
! Hermit Thrush (Catharus guttatus)	A,B,C,D,E,F	C-P summer resident and transient	Unknown	In summer mixed woodlands and open coniferous forest in winter woods, thickets and parks
! Swainson's Thrush (Catharus ustulatus)	A,B,D	C-P summer resident	Unknown	Willow thickets, river woodlands, aspens, forest undergrowth and conifers
! Veery (Catharus fuscescens)	A,B	U-P summer resident	Unknown	Streamside woodlands

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* Western Bluebird (Sialia mexicana)	A,B,C,D,E,F	U-P summer resident	Unknown	Scattered trees, open conifers, forests and farms
* Mountain Bluebird (Sialia currucoides)	A,B,C,D,E,F	C-P resident	Unknown	In summer open areas where mountain meadows and pastures are interspersed with loose stands or single coniferous trees; in winter lower elevations, often open areas with available perching sites
Townsend's Solitaire (Myadestes townsendi)	A,B,C,D,E,F	C-P resident	Unknown	In summer open coniferous forests in the mountains; in winter canyons, brushy slopes and junipers
Family Sylviidae				
Blue-gray Gnatcatcher (Polioptila caerulea)	A,B,C,D,E,F	C-P summer resident	Unknown	Open mixed woods, streamside thickets, mountain brush and pinion-juniper woodlands
Golden-crowned Kinglet (Regulus satrapa)	A,B,C,D,E,F	U-P resident	Unknown	In summer coniferous forests; in winter pinion-juniper and brush in lower elevations
Ruby-crowned Kinglet (Regulus calendula)	A,B,C,D,E,F	C-P resident	Unknown	In summer coniferous forests; in winter other woodlands and thickets

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Family Motacillidae				
Water Pipet (Anthus spinoletta)	A,B,C,D,E,F	C-P resident	Unknown	In summer alpine zone; in migration and winter plains, bare fields, shores and irrigated field
Family Bombycillidae				
Bohemian Waxwing (Bombycilla garrulus)	A,B,C,D,E,F	U-P winter resident	Unknown	Widespread and feeds on berries
Cedar Waxwing (Bombycilla cedrorum)	A,B,C,D,E,F	C-P winter resident	Unknown	Open woodlands, Russian olive and other fruiting trees or orchards
Family Laniidae				
Northern Shrike (Lanius excubitor)	A,B,C,D,E,F	U-P winter resident	Unknown	Semi-open country or open country with look-out posts
Loggerhead Shrike (Lanius ludovicianus)	A,B,C,D,E,F	C-P resident	Unknown	Deserts and other open country with lookout posts, wires, scattered trees and low scrub
Family Sturnidae				
Starling (Stuirnus vulgaris)	A,B,C,D,E,F	C-P resident	Unknown	Cities, fields, orchards and woodlands
Family Vireonidae				
Gray Vireo (Vireo vicinior)	D,E,F	U-P summer resident	Unknown	Brushy mountain slopes, scrub oak and junipers
Solitary Vireo (Vireo solitarius)	A,B,C,D,E,F	U-P summer resident	Unknown	Streamside woodlands, pinion-juniper and Ponderosa pine forests

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Warbling Vireo (Vireo gilvus)	A,B,C,D,E,F	C-P summer resident	Unknown	Deciduous and mixed aspen woodlands near mountain and valley streams
Family Parulidae				
Orange-crowned Warbler (Vermivora celata)	A,B,C,D,E,F	C-P summer resident and transient	Unknown	Brushy woodland clearings, hillsides, aspens and mountain brush; in migration streamside woodlands
Nashville Warbler (Vermivora ruficapilla)	A,B,C,D,E,F	U-P transient	Unknown	Open mixed woods with undergrowth and at forest edges
Virginia's Warbler (Vermivora virginiae)	A,B,C,D,E,F	C-P summer resident	Unknown	Oak canyons, brushy slopes and pinion-juniper brushland
Lucy's Warbler (Vermivora luciae)	E,F	U-P summer resident	Unknown	Along desert streams in willows and cottonwoods
Yellow Warbler (Dendroica petechia)	A,B,C,D,E,F	C-P summer resident	Unknown	Willows, aspens, streamside trees and shrubs or town shade trees
* Grace's Warbler (Dendroica graciae)	E,F	U-P summer resident	Unknown	Ponderosa pine-oakbrush communities of the mountains
Magnolia Warbler (Dendroica magnolia)	A,B,C,D,E,F	U-P transient	Unknown	Coniferous forests

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Hermit Warbler (Dendroica occidentalis)	E,F	U-P summer resident and transient	Unknown	Coniferous forests; in migration other trees
Yellow-rumped Warbler (Dendroica coronata)	A,B,C,D,E,F	C-P summer resident	Unknown	In summer coniferous and mixed forests; in winter varied woods, river thickets, brush and gardens
Black-throated Gray Warbler (Dendroica nigrescens)	A,B,C,D,E,F	C-P summer resident	Unknown	In summer dry oak slopes, pinion-juniper woodlands, open mixed woods; in migration varied trees and brush
Townsend's Warbler (Dendroica townsendi)	A,B,C,D,E,F	U-P transient	Unknown	Coniferous forests
Northern Waterthrush (Seiurus noveboracensis)	B,C,D,E,F	U-P transient	Unknown	Swampy or wet woods, streamsides and lake-shores; in migration thickets
MacGillivray's Warbler (Oporornis tolmiei)	A,B,C,D,E,F	C-P summer resident	Unknown	Low dense undergrowth and shady, damp thickets
Yellowthroat (Geothylpis trichas)	A,B,C,D,E,F	L-P summer resident	Unknown	Cattail and bulrush marshes, willow thickets and streamsides
Yellow-breasted Chat (Icteria virens)	A,B,C,D,E,F	C-P summer resident	Unknown	Dense brush along water courses, willow thickets and [illegible]st canyons

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
/ Wilson's Warbler (Wilsonia pusilla)	A,B,C,D,E,F	C-P summer resident	Unknown	Deciduous shrubbery or thickets, streamside growth, willows and fir thickets in the mountains
/ American Redstart (Setophaga ruticilla)	A,B,C	U-P transient	Unknown	Open secondary deciduous woodlands and riparian woodlands
Family Ploceidae				
House Sparrow (Passer domesticus)	A,B,C,D,E,F	C-P resident	Unknown	Cities, farms and houses
Family Icteridae				
/ Western Meadowlark (Sturnella neglecta)	A,B,C,D,E,F	C-P resident	Unknown	Open fields, meadows and plains
Yellow-headed Blackbird (Xanthocephalus xanthocephalus)	A,B,C,D,E,F	C-P summer resident	Unknown	Marshes with cattail and bulrushes; forages in fields and open country
Red-winged Blackbird (Agelaius phoeniceus)	A,B,C,D,E,F	C-P resident	Unknown	Breeds in marshes with emergent aquatic vegetation, forages in cultivated land and at the edge of water
Northern Oriole (Icterus galbula)	A,B,C,D,E,F	C-P summer resident	Unknown	Open woodlands, cottonwoods or other shade trees and riparian areas

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
* Scotts Oriole (Icterus parisorum)	C,D,E,F	U-P summer resident	Unknown	Pinion-juniper woodlands of desert mountains. oak slopes and cottonwood trees in canyons
Rusty Blackbird (Euphagus carolinus)	A	O-P transient	Unknown	Wooded marshes and riparian woodlands
Brewer's Blackbird (Euphagus cyanocephalus)	A,B,C,D,E,F	C-P resident	Unknown	Varied open country, lakeshores, irrigated pastures, feed lots, parks and cities
Common Grackle (Quiscalus quiscula)	A,B,D	A-P transient	Unknown	Farms, fields, streamsides and wet woodlands
Brown-headed Cowbird (Molothrus ater)	A,B,C,D,E,F	C-P resident	Unknown	Farms, fields, barnyards wood edges and riparian woodlands
Family Thraupidae				
Western Tanager (Piranga ludoviciana)	A,B,C,D,E,F	C-P summer resident	Unknown	Open coniferous, aspen or mixed forests; widespread in migration
Family Embarizidae				
Rose-breasted Grosbeak (Pheucticus ludovicianus)	F	O-P summer resident	Unknown	Broadleaf riparian areas and aspens
Black-headed Grosbeak (Pheucticus melanocephalus)	A,B,C,D,E,F	C-P summer resident	Unknown	Edges of second growth deciduous woods, pinion, riparian areas, orchards and parks

Species	Biogeographic Area Inhabit	Status	Trend	Habitat Use Area
Blue Grosbeak (Guiraca caerulea)	B,C,D,E,F	C-P summer resident	Unknown	Brushy and weedy places, willows and river thicke and other riparian areas
Lapland Longspur (Calcarius lapponicus)	A,B,C,D,E,F	R-P winter resident	Unknown	Fields, grasslands, saline flats, desert shrub; often seen with horned larks
Indigo Bunting (Passerina cyanea)	A,B,D	R-P summer resident	Unknown	Brush, farm lands and streamsides
Lazuli Bunting (Passerina amoena)	A,B,C,D,E,F	C-P summer resident	Unknown	Mountain brush, stream-side shrubs and farmland tree rows
Green-tailed Towhee (Chlorura chlorura)	A,B,C,D,E,F	C-P summer resident	Unknown	Low mountain brush, greasewood and pinion-juniper woodlands
Rufous-sided Towhee (Pipilo erythrophthalmus)	A,B,C,D,E,F	C-P resident	Unknown	Mountain brush, forest edges and city shrubs
Lark Bunting (Calamospiza melanocorys)	A,B,C,D,E,F	O-P transient	Unknown	Plains, prairies, desert shrub and sagebrush
Savannah Sparrow (Passercules sandwichensis)	A,B,C,D,E,F	C-P summer resident	Unknown	Grasslands, fields, saltgrass meadows and open country
* Grasshopper Sparrow (Ammodramus savannarum)	A,B,C,D,E,F	R-P transient	Unknown	Dry grasslands
LeConte's Sparrow (Ammospiza leconteii)	F	A-P transient	Unknown	Tall grass, weedy meadows and marshes

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Vesper Sparrow (*Pooecetes gramineus*)	A,B,C,D,E,F	C-P summer resident	Unknown	Alfalfa and grain fields, meadows, sagebrush and desert shrub
Lark Sparrow (*Chondestes grammacus*)	A,B,C,D,E,F	C-P summer resident	Unknown	Open country in sagebrush and desert shrub with available perch sites
Sage Sparrow (*Amphispiza belli*)	A,B,C,D,E,F	U-P summer resident	Unknown	Sagebrush, greasewood and other desert shrubs
Dark-eyed Junco (*Junco hyemalis*)	A,B,C,D,E,F	C-P resident	Unknown	In summer openings and edges of coniferous and mixed woodlands; in winter greasewood and undergrowth
Gray-headed Junco (*Junco caniceps*)	A,B,C,D,E,F	C-P summer resident	Unknown	Coniferous, mixed forests and mountain brush
Tree Sparrow (*Spizella arborea*)	A,B,C,D,E,F	U-P winter resident	Unknown	Willow thickets and brushy areas
Chipping Sparrow (*Spizella passerina*)	A,B,C,D,E,F	C-P summer resident	Unknown	Mountain coniferous and deciduous woodlands, valley woodlands, farms, orchards, parks and brushlands
Brewer's Sparrow (*Spizella breweri*)	A,B,C,D,E,F	C-P summer resident	Unknown	Sagebrush, greasewood and other desert shrubs or brushy areas
Harris Sparrow (*Zonotrichia querula*)	A,B,C,D,E,F	U-P winter resident	Unknown	Brushy edges of open woodlands, Russian olives and willows

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use
White-crowned Sparrow (Zonotrichia leucophrys)	A,B,C,D,E,F	C-P resident	Unknown	In summer forest edges and clearings, low brush and mountain thickets; in winter widespread in the valleys, along fence rows, willows, brushy areas, corn and greasewood
White-throated Sparrow (Zonotricia albicollis)	E,F	R-P winter resident	Unknown	Coniferous and mixed woodlands, woodland undergrowth thickets and brush
Golden-crowned Sparrow (Zonotrichia atricapilla)	E,F	R-P winter resident	Unknown	Mountain brush and brushy areas in the lower valleys
Swamp Sparrow (Zonotrichia georgiana)	F	U-P winter resident	Unknown	Marshes; in migration weedy fields
Fox Sparrow (Zonotrichia iliaca)	A,B,C	K-P summer resident and transient	Unknown	Valley and mountain woodlands and brushy areas usually near water
Lincoln's Sparrow (Zonotrichia lincolnii)	A,B,C	U-P summer resident R-P winter resident	Unknown	In summer willow thickets, brushy bogs; in winter lowland thickets, tall weeds and bushes
Song Sparrow (Zonotrichia melodia)	A,B,C,D,E,F	C-P resident	Unknown	Woodland edges, grasslands, cattail marshes, thickets and brushy fence rows

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Black-throated Sparrow (Amphispiza bilineata)	A,B,C,D,E,F	U-P summer resident	Unknown	Pinion-juniper, mountain brush and sagebrush
Family Fringillidae				
Evening Grosbeak (Coccothraustes vespertinus)	A,B,C,D,E,F	C-P winter resident	Unknown	Boxelders, Russian olive trees and fruiting shrubs
Cassin's Finch (Carpodacus cassinii)	A,B,C,D,E,F	C-P summer resident U-P winter resident	Unknown	In summer, open conifer forests of high mountains in winter valleys
House Finch (Carpodacus mexicanus)	A,B,C,D,E,F	C-P resident	Unknown	Varied habitats; towns, ranches, open woods, mountain scrub, canyons, deserts and riparian area
Pine Grosbeak (Pinicola enucleator)	A,B,C,E,F	U-P resident	Unknown	In summer coniferous forests; in winter mixed woods and fruiting trees
Rosy Finch (Leucosticte arctoa)	A,B,C,D,E,F	C-P resident	Unknown	In summer alpine tundra, meadows and snowfields; winters in lowlands
Pine Siskin (Carduelis pinus)	A,B,C,D,E,F	C-P resident	Unknown	Coniferous forests, along edges of second growth deciduous forests; in migration seen in large flocks in the lower valle

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
American Goldfinch (*Carduelis tristis*)	A,B,C,D,E,F	C-P resident	Unknown	Riparian woodlands, willows, cottonwoods, orchards, roadsides and sunflowers
! Lesser Goldfinch (*Carduelis psaltria*)	A,B,C,D,E,F	C-P resident	Unknown	Open brushy country, open woods, wooded streams and gardens
! Red Crossbill (*Loxia curvirostra*)	A,B,C,E,F	U-P summer resident	Unknown	Coniferous forests
Mammals -- 103 species in southeastern Utah				
Order Insectivora				
Family Soricidae				
*Dwarf Shrew (*Sorex nanus*)	B,C,D,E,F	R-N	Unknown	Open grass-covered areas which may have scattered brush, marshes, coniferous forests and openings in woods
! North Water Shrew (*Sorex palustris*)	A,B,C,E,F	C-N	Unknown	Along nearly all permanent streams in mountainous areas
! Merriam Shrew (*Sorex merriami*)	A,B,C,D,E,F	U-N	Unknown	Arid sagebrush or grassland areas, mountain mahogany, coniferous forests, aspen and cottonwoods
! Vagrant Shrew (*Sorex vagrans*)	A,B,C,F	C-N	Unknown	Marshes, bogs, wet meadows and along streams in forests

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! Masked Shrew (Sorex cinereus)	A,B,D,E	C-N	Unknown	Moist sites in forests, open country and brushlan
! Dusky Shrew (Sorex obscurus)	A,B,C,F	C-N	Unknown	Marshes, coniferous forests and dry hillsides
* Gray (Desert) Shrew (Notiosorex crawfordi)	E,F	R-N	Unknown	Arid alluvial fans, brushy slopes, sagebrush and other low desert shrub communities
Order Chiroptera				
Family Vespertilionidae				
! Little Brown Myotis (Myotis lucifugus)	A,B,C,D,E,F	C-N	Unknown	Caves, mine tunnels, hollow trees or buildings usually near water
Fringed Myotis (Myotis thysanodes)	A,B,C,D,E,F	U-N	Unknown	Caves, old buildings, roc crevices, pinion-juniper and desert shrub
! Long-eared Myotis (Myotis evotis)	A,B,C,D,E,F	C-N	Unknown	Coniferous forests in hig mountains, around buildin or trees and occasionally caves
! Long-legged Myotis (Myotis volans)	A,B,C,D,E,F	C-N	Unknown	Buildings, small pockets, crevices in rock ledges and trees

Species	Geographic Area Inhabited	Status	Population Trend	Habitat Use A
Yuma Myotis (Myotis yumanensis)	A,B,C,D,E,F	U-N	Unknown	Caves, tunnels and buildings in arid areas
California Myotis (Myotis californicus)	A,B,C,D,E,F	C-N	Unknown	Mine tunnels, hollow trees, loose rocks, buildings, bridges; chiefly a crevice dweller (up to 6,000 feet in elevation)
Small-footed Myotis (Myotis leibii)	A,B,C,D,E,F	U-N	Unknown	Caves, mine tunnels, crevices in rocks and in buildings
Silver-haired Bat (Lasionycteris noctivagans)	A,B,C,D,E,F	C-N	Unknown	Forest areas, occasionall in caves or buildings
Western Pipistrelle (Pipistrellus hesperus)	A,B,C,D,E,F	C-N	Unknown	Caves, under loose rocks, crevices, in cliffs, buildings; arid areas nea water courses
Big Brown Bat (Eptesicus fuscus)	A,B,C,D,E,F	C-N	Unknown	Caves, tunnels, crevices, hollow trees, buildings and wooded areas
* Red Bat (Lasiurus borealis)	A,B,C,D,E,F	U-N	Unknown	Wooded areas; roosts in trees and occasionally enters caves
Hoary Bat (Lasiurus cinereus)	A,B,C,D,E,F	U-N	Unknown	Wooded areas
* Western Big-eared Bat (Plecotus townsendii)	A,B,C,D,E,F	C-N	Unknown	Caves, mine tunnels and buildings utilized for roosting; inhabits arid western desert shrub, pinion-juniper and pine forests

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Mexican Big-eared Bat (Plectus phyllotis)	F	R-N	Unknown	Caves in pine-oak forests between 5,000 to 8,500 feet elevation
*Spotted Bat (Euderma maculata)	Unknown	K-N	Unknown	Arid country; it occasionally enters buildings and caves
Pallid Bat (Antrozous pallidus)	A,B,C,D,E,F	C-N	Unknown	Caves, mine tunnels, crevices in rocks, buildings and trees are utilized for roosts; inhabits scattered desert shrub and pine-oak forests below 6,500 feet elevation
Family Molossidae				
Mexican Free-tailed Bat (Tadarida brasiliensis)	A,B,C,D,E,F	C-N	Unknown	Caves and buildings are utilized for roosts; inhabits lower and upper Sonoran Life Zones
Order Lagomorpha				
Family Ochotonidae				
Pika (Ochontona princeps)	A,B,C,E,F	C-N	Unknown	Talus slopes and rock-slides above 8,000 feet elevation
Family Leporidae				
/ White-tailed Jackrabbit (Lepus townsendii)	A,B,C,D	C-N	Stable	Open, grassy or sage-brush areas at medium elevation
/ *Snowshoe Hare (Lepus americanus)	A,B,C	C-P	Cyclic	Coniferous forests and aspen, riparian and brush types near conifers

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Black-tailed Jackrabbit (*Lepus californicus*)	A,B,C,D,E,F	C-N	Stable	Open grassland, sagebrush and desert shrub areas at low to medium elevations
*Mountain Cottontail (*Sylvilagus nuttallii*)	A,B,C,E,F	C-P	Stable	Thickets, sagebrush, loose rocks, cliffs and forests
*Desert Cottontail (*Sylvilagus audubonii*)	A,B,C,D,E,F	C-P	Stable	Open plains, foothills and low valleys with grass, sagebrush or scattered pinion-juniper
Order Rodentia				
Family Sciuridae				
Zuni Prairie Dog (*Cynomys gunnisoni*)	F	C-N	Stable	Mountain valleys, 5,000-12,000 feet elevation; open to slightly brushy country with scattered pinion-juniper
White-tailed Prairie Dog (*Cynomys leucurus*)	A,B,C,D,E,F	C-N	Stable	Valleys and flatlands where vegetation is sparse
*Abert Squirrel (*Sciurus aberti*)	F	L-P	Stable	Ponderosa pines
Red Squirrel (*Tamiasciurus hudsonicus*)	A,B,C,F	C-N	Stable	Coniferous forests in the mountains

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
*Spotted Ground Squirrel (Spermophilus spilosoma)	F	L-N	Unknown	Open forests, scattered brush and grassy areas with sandy soil is preferred
Rock Squirrel (Spermophilus variegatus)	A,B,C,D,E,F	C-N	Stable	Rocky canyons with boulder strewn slopes, riparian woodlands, and ditchbanks
Uintah Ground Squirrel (Spermophilus armatus)	A,B	C-N	Stable	Meadows and edges of fields near green vegetation up to 8,000 feet elevation
Golden-mantled Ground Squirrel (Spermophilus lateralis)	A,B,C	C-N	Stable	Mountain brush, open pine and spruce-fir forests to above timberline
Whitetail Antelope Squirrel (Ammospermophilus leucurus)	A,B,C,D,E,F	C-N	Stable	Arid areas of low desert and foothills with sparse vegetation
Yellow-billied Marmot (Marmota flaviventris)	A,B,C,E,F	C-N	Stable	Rocky sites or talus slopes along valleys or in foothills 5,000 to 9,000 feet elevation
*Northern Flying Squirrel (Glaucomys sabrinus)	A,B,C,F	C-N	Unknown	Coniferous and mixed forests in high mountains

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Least Chipmunk (Eutamius minimus)	A,B,C,D,E,F	C-N	Stable	Variety of habitat types including sagebrush, desert shrub, mountain bush, coniferous and mixed forest areas
Colorado Chipmunk (Eutamius quadrivittatus)	C,E,F	C-N	Stable	Coniferous forests, mountain brush areas, rocky slopes and ridges
Uintah Chipmunk (Eutamius umbrinus)	A,B,D,E,F	C-N	Stable	Coniferous forest and mountain brush areas up to timberline with rocky slopes
Cliff Chipmunk (Eutamius dorsalis)	A,B,C,D,E	U-N	Stable	Pinion-juniper slopes, riparian woodlands with rocky areas
Family Geomyidae				
Northern Pocket Gopher (Thomomys talpoides)	A,B,C,D,E,F	C-N	Unknown	Grassy prairies, alpine meadows, brush areas, open pine forests; generally restricted to the mountains
Valley or Botta Pocket Gopher (Thomomys bottae)	A,B,C,D,E,F	C-N	Unknown	Valleys and mountain meadows; prefers loam soil but may be found in sandy or rocky situations

ecies	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Ord Kangaroo Rat (Dipodomys ordii)	A,B,C,D,E,F	C-N	Unknown	Desert shrub, pinion-juniper and tamarisk communities; sandy soils preferred but found on hard soils
Baird Pocket Mouse (Perognathus flavus)	F	C-N	Unknown	Prefers short grass areas with sandy or rocky soils
Great Basin Pocket Mouse (Perognathus parvus)	A,D	C-N	Unknown	Sagebrush or greasewood and other desert shrub communities and pinion-juniper
Apache Pocket Mouse (Perognathus apache)	C,D,F	C-N	Unknown	Sparse brushlands and scattered pinion-juniper, usually 5,000-7,200 feet elevation
Family Castoridae				
* Beaver (Castor canadensis)	A,B,C,D,E,F	C-P	Increasing	Streams, lakes and irrigation systems with poplars, birch or willows on the bank
Family Cricetidae				
Western Harvest Mouse (Reithrodontomys megalotis)	A,B,C,D,E,F	C-N	Unknown	Grasslands, open desert, wetlands, irrigated farmland of dense vegetation near water
Canyon Mouse (Peromyscus crinitus)	A,B,C,D,E,F	C-N	Unknown	Rocky canyons and slopes with mountain brush

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Deer Mouse (Peromyscus manicalatus)	A,B,C,D,E,F	C-N	Unknown	All dry-land habitat and irrigated farmland within its range
Brush Mouse (Peromyscus boylei)	A,B,C,D,E,F	C-N	Unknown	Brushy areas of arid and semi-arid regions; prefers rocky sites
Pinion Mouse (Peromyscus truei)	A,B,C,D,E,F	C-N	Unknown	Rocky terrain in pinion-juniper areas
Northern Grasshopper Mouse (Onychomys leucogaster)	C,F	U-N	Unknown	Open country of grass, sagebrush or greasewood and sandy or gravelly soil
*White-throated Wood Rat (Neotoma albigula)	F	C-N	Unknown	Brushland with rocky cliffs and shallow caves
Desert Wood Rat (Neotoma lepida)	A,B,C,D,E	C-N	Unknown	Desert floors and rocky slopes with low desert vegetation or arid mountain brush
*Mexican Wood Rat (Neotoma mexicana)	F	C-N	Unknown	Rocks, cliffs and mountains
Bushy-tailed Wood Rat (Neotoma cinerea)	A,B,C,D,E,F	C-N	Unknown	High mountains with rimrock, rock slides and pines
Muskrat (Ondatra zibethicus)	A,B,C,D,E,F	C-N	Stable	Marshes, edge of ponds, lakes, streams and irrigation canals

ecies	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
/ Meadow Vole (Microtus pennsylvanious)	A,D	C-N	Unknown	Moist areas with dense growth of grasses
/ Mountain Vole (Microtus montanus)	A,B,D,E	C-N	Unknown	Dense vegetation in sagebrush-grass communities
/ Richardson's Vole (Microtus richardsoni)	A	C-N	Unknown	Creekbanks and marshes in mountains to above timberline
/ Longtail Vole (Microtus longicaudus)	A,B,C,D,E,F	C-N	Unknown	In summer streambanks, mountain meadows with dry sites; in winter brushy areas
Sagebrush Vole (Lagurus curtatus)	C,F	C-N	Unknown	Scattered sagebrush with loose soil and arid conditions
Family Muridae				
Black Rat (Rattus rattus)	A,B,C,D,E,F	C-N	Unknown	Buildings and dumps
Norway Rat (Rattus norvegicus)	A,B,C,D,E,F	C-N	Unknown	Burrows along building foundations and beneath rubbish piles
/ House Mouse (Mus musculus)	A,B,C,D,E,F	C-N	Unknown	Buildings and occasionally in fields

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
Family Zapodidae				
Western Jumping Mouse (Zapus princeps)	A	C-N	Unknown	Low meadows near streams with lush growth of grasses and forbs; found in various land habitats
Family Erethizontidae				
Porcupine (Erethizon dorsatum)	A,B,C,D,E,F	C-N	Stable	Forested areas, occasionally away from trees if brush is available
Order Carnivora				
Family Canidae				
Coyote (Canis latrans)	A,B,C,D,E,F	C-N	Stable	Ubiquitous
Red Fox (Vulpes fulva)	A,B,C,D,E,F	C-N	Stable	Forest and open country preferred
Kit Fox (Vulpes macrotis)	A,B,C,D,E,F	U-N	Stable	Open level, sandy ground preferred with low desert vegetation
Gray Fox (Urocyan cinereoargenteus)	A,B,C,D,E,F	C-N	Stable	Brush and open forests

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
*Gray Wolf (Canis lupus)	A,B,C,D,E,F	X-P	Extirpated	Wilderness forests
Family Ursidae				
*Black Bear (Ursus americanus)	A,B,C,E,F	C-P	Increasing	Mountainous areas
*Grizzly Bear (Ursus horribilis)	A,B,C,E,F	X-P	Extirpated	Remote mountainous regions
Family Procyonidae				
Ring-tailed Cat (Bassariscus astutus)	A,B,C,D,E,F	C-N	Stable	Near water on slopes with mountain brush, rocky ridges and cliffs
*Raccoon (Procyon lotor)	A,B,C,D,E,F	O-N	Increasing	Along streams, lake borders and near wooded areas or rock cliffs
Family Mustelidae				
*Short-tailed Weasel (Mustela erminea)	A,B,C,F	R-P	Stable	Brushy or wooded areas not far from water
*Long-tailed Weasel (Mustela frenata)	A,B,C,D,E,F	C-P	Stable	All land habitat types near water
*Mink (Mustela vison)	A,B,C,F	L-P	Unknown	Along streams and lakes
*Wolverine (Gulo luscus)	A,B	X-P	Extirpated	Remote mountain regions
*Black-footed Ferret (Mustela nigripes)	A,B,C,D,F	E-P	Unknown	Prairie dog towns
*Marten (Martes caurina)	A,B,C,F	R-P	Unknown	Coniferous forests at high elevations

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
! *Badger (Taxidea taxus)	A,B,C,D,E,F	C-P	Stable	Open grasslands, deserts and high mountain forests where prey is available
! *Striped Skunk (Mephitis mephitis)	A,B,C,D,E,F	C-P	Increasing	Semi-open country of prairie, brushlands or mixed woodlands within two miles of water
! *Spotted Skunk (Spilogale gracilis)	A,B,C,D,E,F	C-P	Stable	Prairies or grasslands with brushy or sparsely wooded areas along streams with boulders
*River Otter (Lutra canadensis)	A,B,C,D,E,F	R-P	Unknown	Along streams and lake borders
Family Felidae				
!*Bobcat (Lynx rufus)	A,B,C,D,E,F	C-P	Declining	Rimrock and mountain brush areas
*Canada Lynx (Lynx canadensis)	A,B,C,E,F	X-P	Extirpated	Forested areas in the mountains
! *Cougar (Felis concolor)	A,B,C,D,E,F	C-P	Stable	Rugged mountains with forests, cliffs and ledges
Order Artiodactyla				
Family Cervidae				
! *Mule Deer (Odocoileus hemionus)	A,B,C,D,E,F	C-P	Increasing	Coniferous forests, desert shrub, mountain brush, grassland with shrubs and other habitats where browse species are present

Species	Biogeographic Area Inhabited	Status	Population Trend	Habitat Use Area
/ *Moose (Alces alces)	A	L-P	Increasing	Mountainous areas, forests, mountain brush and willow bottoms
/ *Rocky Mountain Elk (Cervus canadensis)	A,B,C,E,F	C-P	Increasing	Semi-open forests, mountain meadows (in summer), foothills, plains and valleys
Family Antilocapridae				
* Pronghorn Antelope (Antilocapra americana)	B,C,D,E,F	L-P	Stable	Open prairies and sagebrush or desert shrub plains
Family Bovidae				
*Desert Bighorn Sheep (Ovis canadensis nelsoni)	D,E,F	L-P	Increasing	Precipitous terrain on mountain and canyon slopes and rims with sparse growth of trees
* Rocky Mountain Bighorn Sheep (Ovis canadensis canadensis)	B,C	L-P	Increasing	Precipitous terrain on mountain and canyon slopes and rims with sparse growth of trees
* Bison (Bison bison)	E	L-P	Stable	Desert shrub plains of the Burr Desert and mountain brush forest habitats associated with steep mountain slopes of the Henry Mountains

List of Game Species and Region of Inhabitation within Utah.

Game Species of Utah	REGION				
	Southeastern	Southern	Central	Northeastern	Northern
10 BIG GAME SPECIES					
Bison	x	x			
Black Bear	x	x	x	x	x
Cougar	x	x	x	x	x
Desert Bighorn Sheep	x	x			
Elk	x	x	x	x	x
Moose	x		x	x	x
Mountain Bighorn Sheep	x		x	x	x
Mountain Goat			x		
Mule Deer	x	x	x	x	x
Pronghorn Antelope	x	x	x	x	x
Subtotal	9	7	8	7	7
20 GAME FISH SPECIES					
Arctic Grayling		x		x	x
Black Bullhead	x	x	x	x	x
Black Crappie	x	x	x	x	x
Bluegill	x	x	x	x	x
Bonneville Cisco					x
Brook Trout	x	x	x	x	x
Brown Trout	x	x	x	x	x
Channel Catfish	x	x	x	x	x
Cutthroat Trout	x	x	x	x	x
Golden Trout			x	x	
Kokanee Salmon				x	x
Lake Trout		x	x	x	x
Largemouth Bass	x	x	x	x	x
Mountain Whitefish			x	x	x
Northern Pike	x	x			
Perch	x	x	x	x	x
Rainbow & Albino Trout	x	x	x	x	x
Smallmouth Bass			x	x	x
Striped Bass	x	x			
Walleye	x	x	x	x	x
White Bass		x	x		
Subtotal	13	16	16	17	17

Game Species of Utah	REGION				
	Southeastern	Southern	Central	Northeastern	Northern
9 FURBEARER SPECIES					
Badger	x	x	x	x	x
Beaver	x	x	x	x	x
Long-tailed Weasel	x	x	x	x	x
Marten	x	x	x	x	x
Mink	x	x	x	x	x
River Otter	x			x	x
Short-tailed weasel	x	x	x	x	x
Spotted Skunk	x	x	x	x	x
Striped Skunk	x	x	x	x	x
Subtotal	9	8	8	9	9
43 MIGRATORY GAME BIRD SPECIES					
American Widgeon	x	x	x	x	x
Band-tailed Pigeon	x	x	x		
Barrows Goldeneye	x	x	x	x	x
Black Brant		x			x
Black Duck		x	x		x
Blue-winged Teal	x	x	x	x	x
Bufflehead	x	x	x	x	x
Canada Goose	x	x	x	x	x
Canvasback	x	x	x	x	x
Cinnamon Teal	x	x	x	x	x
American Coot	x	x	x	x	x
Common Gallinule	x	x	x		x
Common Goldeneye	x	x	x	x	x
Common Merganser	x	x	x	x	x
Common Snipe	x	x	x	x	x
European Widgeon			x		x
Fulvous Tree Duck		x			x
Gadwall	x	x	x	x	x
Greater Scaup	x	x	x	x	x
Green-winged Teal	x	x	x	x	x
Harlequin Duck					x

Game Species of Utah	REGION Southeastern	Southern	Central	Northeastern	Northern
Hooded Merganser	x	x	x	x	x
Lesser Scaup	x	x	x	x	x
Mallard	x	x	x	x	x
Mourning Dove	x	x	x	x	x
Old Squaw		x	x		x
Pintail	x	x	x	x	x
Red-breasted Merganser	x	x	x	x	x
Redhead	x	x	x	x	x
Ring-necked Duck	x	x	x	x	x
Ross Goose	x	x			x
Ruddy Duck	x	x	x	x	x
Sandhill Crane	x	x	x	x	x
Shoveler	x	x	x	x	x
Snow Goose	x	x	x	x	x
Sora Rail	x	x	x	x	x
Surf Scoter			x		x
Trumpeter Swan		x	x		x
Virginia Rail	x	x	x	x	x
Whistling Swan	x	x	x	x	x
White-fronted Goose	x	x	x	x	x
White-winged Scoter	x	x	x		x
Wood Duck	x	x	x	x	x
Subtotal	35	40	39	31	42

5 SMALL GAME-MAMMAL SPECIES

Abert Squirrel	x				
Desert Cottontail	x	x	x	x	
Mountain cottontail	x	x	x	x	x
Pigmy Cottontail		x	x		x
Snowshoe Hare	x	x	x	x	x
Subtotal	4	4	4	3	3

Game Species of Utah	REGION				
	Southeastern	Southern	Central	Northeastern	Northern
12 SMALL GAME-UPLAND BIRD SPECIES					
Blue Grouse	x	x	x	x	x
California Quail	x	x	x	x	x
Chukar	x	x	x	x	x
Gambels Quail	x	x			
Hungarian Partridge			x		x
Merriam's Turkey	x	x			
Ring-necked Pheasant	x	x	x	x	x
Ruffed Grouse	x	x	x	x	x
Sage Grouse	x	x	x	x	x
Sharp-tailed Grouse					x
White-tailed Ptarmigan				x	x
White-winged Pheasant	x	x			
Subtotal	9	9	7	7	9
100 Total Game Species in Utah	78	83	81	73	86

Table 2. Classification of the 466 species of vertebrate wildlife that inhabit six biogeographic areas within Southeastern Utah.

	Biogeographic Areas[1]					
	A	B	C	D	E	F
FISH	14	20	15	15	24	31
Protected-Threatened	(0)	(1)	(1)	(1)	(1)	(1)
Protected-Endangered	(0)	(3)	(2)	(1)	(1)	(2)
Protected-Nongame	(10)	(11)	(9)	(10)	(12)	(16)
Protected-Game	(4)	(5)	(3)	(3)	(10)	(12)
AMPHIBIANS	6	5	6	7	7	10
Protected-Nongame	(1)	(1)	(1)	(1)	(1)	(2)
Unprotected-Nongame	(5)	(4)	(5)	(6)	(6)	(8)
REPTILES	18	14	15	14	21	28
Unprotected-Nongame	(18)	(14)	(15)	(14)	(21)	(28)
BIRDS	242	244	242	235	251	262
Protected-Extirpated	(1)	(1)	(1)	(1)	(1)	(1)
Protected-Threatened	(0)	(0)	(0)	(0)	(0)	(0)
Protected-Endangered	(2)	(2)	(2)	(2)	(2)	(2)
Protected-Nongame	(199)	(202)	(202)	(193)	(208)	(217)
Protected-Game	(39)	(38)	(36)	(38)	(39)	(41)
Unprotected-Nongame	(1)	(1)	(1)	(1)	(1)	(1)
MAMMALS	84	80	80	65	66	90
Protected-Threatened	(0)	(0)	(0)	(0)	(0)	(0)
Protected-Endangered	(1)	(1)	(1)	(1)	(0)	(1)
Protected-Extirpated	(2)	(2)	(2)	(0)	(2)	(2)
Protected-Game	(18)	(19)	(19)	(12)	(16)	(19)
Unprotected-Extirpated	(0)	(0)	(0)	(0)	(0)	(0)
Unprotected-Nongame	(63)	(58)	(58)	(52)	(53)	(62)
Total Protected Species	277	286	279	263	293	317
TOTAL:	364	363	358	336	369	421

[1] Biogeographic areas of southeastern Utah
A- Wasatch Plateau east of Skyline Drive
B- West Tavaputs Plateau
C- East Tavaputs Plateau
D- San Rafael Swell and Desert
E- Henry Mountains and Burr Desert
F- Mountains and Deserts south of I-70 in Grand and San Juan counties

VERTEBRATE SPECIES OF WILDLIFE HAVING HIGH INTEREST TO THE STATE OF UTAH

Class of Animal	Number of species		
	Statewide[1]	SER[2]	Valley Camp of Utah
Fish	33	20	2
Amphbians	3	2	1
Reptiles	10	4	2
Birds	104	95	23
Mammals	61	40	13
TOTAL	211	161	51

1. Utah Division of Wildlife Resources as the state of Utah's wildlife authority recognizes 211 species of vertebrate wildlife that inhabit the state as being of high interest. High interest wildlife represent all game species and all species having significant economic importance from either a comsumptive or nonconsumptive perspective or special asthetic, scientific or educational values. This list includes all federally listed threatened or endangered species of wildlife.

2. Evaluation of data presented in Utah Division of Wildlife Resources publication No.78-16, " Species List of Vertebrate Wildlife That Inhabit Southeastern Utah" shows that 161 of the 211 species of the states high interest wildlife inhabit the Southeastern Region (SER) of the state on occasion or during different seasons of the year.

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RESULTS OF VEGETATION SAMPLING AND MONITORING FOR THE UTAH AND BELINA REVEGETATION TEST PLOTS

1989

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Test Plot Results

INTRODUCTION

Following are second year results from vegetation monitoring of test plots for Valley Camp of Utah. The plots are located near Scofield, Utah. Quantitative data were also submitted in 1988 for the test plots.

The test plots were constructed in 1987 to test revegetation potential of available soil material on the mine area. The test plot design was developed by the State of Utah, Division of Oil, Gas & Mining (DOGM) and Valley Camp of Utah, Inc. Plot construction (layout and earthmoving work) was accomplished by (or under the direction of) Valley Camp of Utah. Seed, fertilizer and hydromulch by the specified design was applied by Mt. Nebo Scientific in October of 1987.

Two main areas were used as sites for the vegetation test plots. These areas were called the Utah Site and the Belina Site. The Utah Site is located south of the truck load-out pad and east of the railroad tracks on an old coal storage area. The Belina Site is on the slope south of the sediment pond.

Monitoring was initiated by sampling the vegetation on the two sites by Mt. Nebo Scientific in August of 1988 and 1989. An additional site that had been previously implemented by a different contractor was sampled and submitted to Valley Camp Co. and DOGM for comparisons in 1988. Results of the quantitative sampling are summarized in this report.

METHODS

Quantitative and qualitative data were taken on each of the two sites. Bi-directional random placement of sampling plots were designed to provide unbiased accuracy of the data compiled. A randomized block design was implemented to insure adequate representation of the entire plot. On the Utah site, three 12.5 meter transects were regularly placed on the plot to adequately cover the entire plot. Twenty sample points were then placed every 1.5 meters along these transects. A one meter buffer strip was placed around the entire plot where sample points were avoided to limit sample bias. There was only one treatment to be monitored on this plot.

The Belina Site, however, had four different treatments to be sampled. Therefore, a total of four areas or "subplots" were sampled. The subplots were labeled on the data summary tables by directional locations and treatments and are listed below:

1) NE Subplot, Light Soil A, Fertilized
2) NW Subplot, Light Soil A, Unfertilized
3) SE Subplot, Gray Soil B, Fertilized
4) SW Subplot, Gray Soil B, Unfertilized

Three transects were also placed on each of the subplots listed above. Eight sample locations were regularly placed on each treatment with a total of 40 samples for all treatments. A one meter buffer strip was also placed around each of the treatments where quadrat placement was avoided.

Cover estimates were made using ocular methods with meter square quadrats. Species cover, total cover, composition and relative

frequency were also assessed from the quadrats. Also recorded on data sheets were estimated precipitation, slope, exposure, grazing use, animal disturbance and other appropriate notes.

Sampling adequacy for cover on the Utah Site was achieved using formulas from Snedocor and Cochran (1980), insuring that 80% of the samples were within 10% of the true mean of the test plots. Sample number of the Belina Site was determined by L. Kunzler (DOGM). All sample means, standard deviations, and sample sizes were included in this report to enable the reviewers to apply further statistical tests if desired.

Plant species nomenclature follows Welsh et al. (A Utah Flora. 1987. Great Basin Naturalist Memoir No. 9). Sample design and methodologies were approved by a representative of the State of Utah, DOGM (L. Kunzler, Reclamation Biologist). Mr. Kunzler was present on site upon initiation of the test plot sampling in 1988.

RESULTS

Summary Tables

All results of the vegetation sampling for 1989 are shown on the summary tables (Tables 1 - 10). Included in these tables are:

1) percent cover and standard deviations (total living cover, mulch & litter, bare ground, & rock),
2) composition (% shrubs, forbs, & grasses),
3) cover and frequency by species,
4) sample sizes.

Nomenclature

Because the author decided to use the most recent nomenclature for plant species for the summary tables, and because some of the species on the original seed mix list have been changed, a list is provided below showing the old and new scientific names.

Old Name (on seed mix lists)	New Name (Welsh 1987)
Shrubs	
Amelanchier alnifolia	Amelanchier alnifolia
Artemisia tridentata var. vaseyana	Artemisia tridentata vaseyana
Chrysothamnus nauseosus albicaulis	C. nauseosus albicaulis
Rosa woodsii	Rosa woodsii
Sambucus coerulea	Sambucus coerulea
Symphoricarpos oreophilus	Symphoricarpos oreophilus
Forbs	
Achillea millefolium	Achillea millefolium
Artemisia ludoviciana	Artemisia ludoviciana
Linum lewisii	Linum perenne ssp. lewisii
Hedysarum boreale	Hedysarum boreale
Medicago sativa	Medicago sativa
Melilotus officinalis	Melilotus officinalis
Penstemon strictus	Penstemon strictus
Grasses	
Agropyron dasystachyum	Elymus lanceolatus
Agropyron smithii	Elymus smithii
Bromus marginatus	Bromus carinatus
Poa canbyi	Poa canbyi
Poa pratensis	Poa pratensis

The test plots will continue to be monitored according to the schedule accepted by the State of Utah, DOGM.

TABLE 1: 1989 SAMPLING RESULTS - BELINA PLOT
(NE Subplot, Light Soil A, Fertilized)

Total cover and composition for the revegetation test plots of Valley Camp of Utah. The table shows means, standard deviations and sample sizes.

COVER

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Total Living Cover	29.50	15.61	8
Mulch & Litter	11.63	6.87	8
Bareground	13.75	9.27	8
Rock	45.13	16.67	8

COMPOSITION

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Shrubs	1.91	3.51	8
Forbs	5.08	6.55	8
Grasses	93.02	9.63	8

*Sample size was determined by Division of Oil, Gas & Mining (see METHODS).

TABLE 2: **1989 SAMPLING RESULTS - BELINA PLOT**
(NE Subplot, Light Soil A, Fertilized)

Mean percent cover, standard deviation, sample size and relative frequency by species for the revegetation test plots of Valley Camp of Utah.

COVER BY SPECIES

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
SHRUBS				
Artemisia tridentata	0.13	0.33	8	12.50
Picea pungens	0.13	0.33	8	12.50
FORBS				
Circium sp.	0.75	1.64	8	25.00
Linum lewsii	0.38	0.48	8	37.50
Urtica dioica	0.13	0.33	8	12.50
GRASSES				
Bromus carinatus	6.50	5.15	8	62.50
Dactylus glomeratus	3.38	4.15	8	50.00
Elymus lanceolatus	13.88	9.91	8	87.50
Elymus smithii	2.13	2.32	8	50.00
Elymus spicatus	0.25	0.66	8	12.50
Poa pratensis	1.88	4.96	8	12.50

TABLE 3: 1989 SAMPLING RESULTS - BELINA PLOT
(NW Subplot, Light Soil A, Unfertilized)

Total cover and composition for the revegetation test plots of Valley Camp of Utah. The table shows means, standard deviations and sample sizes.

COVER

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Total Living Cover	31.25	5.99	8
Mulch & Litter	14.38	7.68	8
Bareground	12.50	2.50	8
Rock	41.88	8.99	8

COMPOSITION

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Shrubs	--	--	--
Forbs	7.08	13.58	8
Grasses	92.92	13.58	8

*Sample size was determined by Division of Oil, Gas & Mining (see METHODS).

TABLE 4: **1989 SAMPLING RESULTS - BELINA PLOT**
(NW Subplot, Light Soil A, Unfertilized)

Mean percent cover, standard deviation, sample size and relative frequency by species for the revegetation test plots of Valley Camp of Utah.

COVER BY SPECIES

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
SHRUBS	--	--	--	--
FORBS				
Circium sp.	0.25	0.66	8	12.50
Epilobium halleanum	0.63	1.65	8	12.50
Fragaria vesca	0.63	1.65	8	12.50
Urtica dioica	0.13	0.33	8	12.50
GRASSES				
Bromus carinatus	3.75	4.15	8	50.00
Dactylis glomerata	4.75	3.60	8	75.00
Elymus lanceolatus	15.50	8.99	8	100.00
Elymus smithii	1.25	2.17	8	25.00
Elymus spicatus	3.75	4.84	8	37.50
Elymus trachycaulus	0.63	1.65	8	12.50

TABLE 5: 1989 SAMPLING RESULTS - BELINA PLOT
(SE Subplot, Gray Soil B, Fertilized)

Total cover and composition for the revegetation test plots of Valley Camp of Utah. The table shows means, standard deviations and sample sizes.

COVER

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Total Living Cover	35.63	11.84	8
Mulch & Litter	8.13	3.48	8
Bareground	28.13	3.48	8
Rock	28.13	7.47	8

COMPOSITION

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Shrubs	--	--	8
Forbs	15.42	22.00	8
Grasses	84.58	22.00	8

*Sample size was determined by Division of Oil, Gas & Mining (see METHODS).

TABLE 6: **1989 SAMPLING RESULTS - BELINA PLOT**
(SE Subplot, Gray Soil B, Fertilized)

Mean percent cover, standard deviation, sample size and relative frequency by species for the revegetation test plots of Valley Camp of Utah.

COVER BY SPECIES

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
SHRUBS	--	--	8	--
FORBS				
Epilobium halleanum	0.38	0.70	8	25.00
Hedysarum boreale	1.13	1.76	8	37.50
Machaeranthera canescens	0.63	1.65	8	12.50
Penstemon strictus	1.63	3.31	8	25.00
GRASSES				
Bromus carinatus	6.88	10.83	8	50.00
Dactylis glomerata	1.63	3.31	8	25.00
Elymus lanceolatus	8.75	8.91	8	62.50
Elymus smithii	9.63	5.57	8	87.50
Elymus spicatus	1.25	2.17	8	25.00
Poa pratensis	3.75	4.84	8	37.50

TABLE 7: 1989 SAMPLING RESULTS - BELINA PLOT
(SW Subplot, Gray Soil B, Unfertilized)

Total cover and composition for the revegetation test plots of Valley Camp of Utah. The table shows means, standard deviations and sample sizes.

COVER

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Total Living Cover	30.00	14.36	8
Mulch & Litter	5.00	0.00	8
Bareground	35.00	12.75	8
Rock	30.00	12.50	8

COMPOSITION

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Shrubs	--	--	8
Forbs	11.61	11.70	8
Grasses	88.39	11.70	8

*Sample size was determined by Division of Oil, Gas & Mining (see METHODS).

TABLE 8: **1989 SAMPLING RESULTS - BELINA PLOT**
(SW Subplot, Gray Soil B, Unfertilized)

Mean percent cover, standard deviation, sample size and relative frequency by species for the revegetation test plots of Valley Camp of Utah.

COVER BY SPECIES

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
SHRUBS	--	--	--	--
FORBS				
Epilobium halleanum	0.63	1.65	8	12.50
Penstemon strictus	1.88	2.42	8	37.50
Urtica dioica	0.38	0.99	8	12.50
GRASSES				
Bromus carinatus	5.38	3.67	8	75.00
Dactylis glomerata	3.38	4.15	8	50.00
Elymus lanceolatus	7.13	5.16	8	75.00
Elymus smithii	7.50	11.18	8	62.50
Elymus spicatus	1.88	2.42	8	37.50
Poa pratensis	1.88	4.96	8	12.50

TABLE 9: 1989 SAMPLING RESULTS - UTAH PLOT
(Single plot design)

Total cover and composition for the revegetation test plots of Valley Camp of Utah. The table shows means, standard deviations and sample sizes.

COVER

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Total Living Cover	33.20	9.14	20
Mulch & Litter	6.95	5.48	20
Bareground	50.50	17.69	20
Rock	9.35	9.91	20

COMPOSITION

	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE *
Shrubs	2.94	4.14	20
Forbs	59.57	14.92	20
Grasses	37.50	14.09	20

* Sample size insures 80% accuracy within 10% of the true mean.

TABLE 10: **1989 SAMPLING RESULTS - UTAH PLOT**
(Single Plot Design)

Mean percent cover, standard deviation, sample size and relative frequency by species for the revegetation test plots of Valley Camp of Utah.

COVER BY SPECIES

SPECIES	% MEAN COVER	STANDARD DEVIATION	SAMPLE SIZE	RELATIVE FREQUENCY
SHRUBS				
Artemisia tridentata	1.15	1.62	20	40.00
FORBS				
Artemisia ludoviciana	2.25	3.81	20	35.00
Chaenactis douglasii	0.30	1.10	20	10.00
Circium sp.	1.75	2.98	20	30.00
Eriogonum sp.	0.45	0.80	20	30.00
Gayophytum ramosissimum	0.10	0.44	20	5.00
Lappula occidentalis	1.00	2.00	20	35.00
Linum perenne ssp. lewisii	1.00	1.26	20	50.00
Melilotus officinalis	7.20	4.83	20	95.00
Penstemon strictus	0.10	0.44	20	5.00
Polygonum aviculare	0.60	0.86	20	35.00
Rumex cripus	0.30	0.56	20	25.00
Salsola iberica	2.15	2.20	20	60.00
Verbascum thapsus	2.20	2.16	20	55.00
GRASSES				
Bromus carinatus	1.65	2.15	20	40.00
Elymus lanceolatus	7.70	3.89	20	95.00
Elymus smithii	3.30	3.35	20	60.00

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE COLORADO—UTAH
1311 FEDERAL BUILDING
125 SOUTH STATE STREET
SALT LAKE CITY, UTAH 84138-1197

IN REPLY REFER TO:

November 10, 1982

FEB 27 1990

Cleon Feight, Director
Division of Oil, Gas and Mining
4241 State Office Building
Salt Lake City, Utah 84114

Dear Mr. Feight:

This letter is written to inform you of two field trips to examine potentially hazardous powerlines within the permit boundaries of the mines described in your letter dated August 18, 1982. Mr. Ron Joseph of my staff has completed a review of the distribution lines of the following mining companies. Overall, he found no eagle remains beneath the lines examined nor does he suspect any problems with the lines in question. The following is a brief summary of each site visited and a description of the configuration examined. When possible, he examined the lines with company personnel.

Valley Camp of Utah Inc.

Mr. Joseph met with E.B. Foust, Chief Engineer to survey the lines of Valley Camp's Belina Mines and Utah #2. The three phase Belina lines for the most part traverse high timbered mountainous terrain. Previous Fish and Wildlife Service (FWS) surveys have not shown a problem with powerlines in coniferous cover primarily because trees themselves offer much better perch sites than crossarms of power poles. As an added precaution, Mr. Foust pointed out to Mr. Joseph where Valley Camp has erected perch sites in areas where the Company believed a problem could exist within the Belina Mine complex. However, on close examination, the lines did not reveal any use by raptors.

Mr. Foust also toured Mr. Joseph through the Utah #2 Mine area across from its headquarters. Due to extensive mining near the facilities and associated human activity, it is unlikely that raptors would use the lines. Again, trees dominate the landscape and raptor perch use is undoubtedly confined to trees and ridges.

Utah Power and Light (UP&L); Des-Bee-Dove, Wilberg, Deer Creek Mines

Des-Bee-Dove

Ron Joseph met with Scott Rassmussen, UP&L District Manager in Castledale, Utah, to examine the forementioned mine sites. The Des-Bee-Dove mine lines consist predominantly of 69KV three phase powerlines. The configuration is safe since adequate conductor clearance exists on the 10-foot crossarms should an eagle attempt

to perch on the pole. Much of the line traverses habitat used by wintering golden eagles. In fact, an adult golden eagle was observed using one crossarm as a perch. Mr. Joseph walked segments of the 3-4 mile line passing through relatively flat, sparsely vegetated habitat and documented some use of the lines by raptors. However, no remains were found and more importantly the lines are constructed such that birds are not likely to be electrocuted when using the crossarms as perch sites.

Wilberg

Mr. Rassmussen also showed Mr. Joseph the Wilberg line. The three phase line is energized with 69KV and is constructed such that eagles and other raptors are not likely to be electrocuted. As with the Des-Bee-Dove line, the Wilberg line has adequate conductor clearance on the 8-foot crossarm and center pole. A minimum of 42 inches separates the conductor on the pole top and those on the crossarm. Approximately 1-2 miles of line traverses habitat used by jackrabbits and no remains of rabbits or eagles were evident beneath the crossarms. Therefore, we do not anticipate any electrocution problems with the Wilberg line.

Deer Creek

The Deer Creek Mine line is constructed without a crossarm. Raptors are unable to perch on the staggered conductors of the 12KV line thereby eliminating electrocution hazards.

Trail Mountain and Knight

Mr. Rassmussen accompanied Mr. Joseph in the field to examine the UP&L lines providing power to the Trail Mountain Mine, Natomas Coal Company. The 12KV lines parallel the road and are of an armless configuration; a design which is safe for raptors because it prevents perching. The Knight Mine is of the same configuration as the Trail Mountain Mine. No problems are expected with the lines to the Knight Mine.

Beaver Creek Coal Company, Castle Valley Spur

Dave Myers of Beaver Creek Coal Company met with Mr. Joseph at the C.V. Spur facility and both walked the length of the line. The armless configuration and close proximity of the line to the C.V. Spur accounts for the lack of raptor use of the powerlines.

In summary, Mr. Joseph examined the lines described in your August 18, 1982, letter and has not found any to be a threat to eagles or other raptors. Please feel free to contact us once again if we can be of additional assistance.

Sincerely,

Field Supervisor
Ecological Services

cc: OSM, Denver
DWR, SLC

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DIVISION OF
OIL, GAS & MINING

Valley Camp of Utah

Belina Haul Road Reclamation Plan

January 1987

KC HARRISON-KUNDSTEN
A MORRISON-KNUDSEN CO.

BELINA HAUL ROAD RECLAMATION PLAN

Prepared For

Valley Camp of Utah, Inc.
Helper, Utah

Prepared By

Morrison-Knudsen Engineers, Inc.
Boise, Idaho

January, 1987

0842h/1

ENGINEERING CERTIFICATION

I, J. Carl Dille, have reviewed Section 2 and 3 and the following Tables, Figures and Exhibits in the Belina Haul Road Reclamation Plan.

REGISTERED PROFESSIONAL ENGINEER
No. 5538
J. CARL DILLE
STATE OF UTAH

J. Carl Dille, P.E.

Figure 2-1 thru 2-8	Typical Cross Section of Unstable Fill
Figure 2-9	Slope Stability Analysis of Current
Figure 2-10	Slope Stability Analysis of Reclaimed Haul Road
Figure 3-1	Small Drainage Hydraulic Data
Figure 3-2	Bowl Crossing Hydraulic Data
Figure 3-3	Eccles Creek Channel Design
Figure 3-4	Typical Waterbar Detail
Table 2-1	Potentially Unstable Slopes
Table 3.2	Watershed Size and Flow Characteristics
Table 3.3	Riprap Design
Table 3.4	Riprap Filter Design
Table 3.5	Eccles Creek Channel Hydraulic Data

TABLE OF CONTENTS

1.0 INTRODUCTION
- 1.1 General
- 1.2 Objectives

2.0 GEOTECHNICAL INVESTIGATION
- 2.1 General
- 2.2 Natural Talus Evaluation
- 2.3 Critical Fill Areas
- 2.4 Methods and Results of the Slope Stability Analysis

3.0 HYDROLOGY/HYDRAULICS
- 3.1 General
- 3.2 Design Flow
- 3.3 Channel Design
  - 3.3.1 Small Drainages
  - 3.3.2 Bowl Crossing
- 3.4 Riprap design
  - 3.4.1 Small Drainages
  - 3.4.2 Bowl Crossing
- 3.5 Eccles Creek
- 3.6. Concrete Ditches
- 3.7 Water Control Bars

4.0 RECLAMATION PROCEDURES
- 4.1 Road Surface Removal
- 4.2 Corrugated Metal Pipe Removal
- 4.3 Recontouring
  - 4.3.1 Bowl Crossing
  - 4.3.2 Eccles Creek Crossing
  - 4.3.3 Unstable Fill Slopes
- 4.4 Topsoiling
- 4.5 Seed Bed Preparation
- 4.6 Seeding
- 4.7 Fertilizer
- 4.8 Mulching
- 4.9 Erosion Control and Maintenance
- 4.10 Revegetation
- 4.11 Reclamation Costs

LIST OF TABLES

TABLE 2.1 Potentially Unstable Slopes
TABLE 3.1 Precipitation Depths
TABLE 3.2 Watershed Size and Flow Characteristics
TABLE 3.3 Riprap Design
TABLE 3.4 Riprap Filter Design
TABLE 3.5 Eccles Creek Channel Hydraulics
TABLE 4.1 Soil Disposal Volumetrics
TABLE 4.2 Reclamation Cost Estimates

LIST OF FIGURES

FIGURE 1-1 Typical Haul Road Cross Section
FIGURE 2-1 - 2-8 Typical Cross Sections of Unstable Fill
FIGURE 2-9 Slope Stability Analysis of Current Haul Road
FIGURE 2-10 Slope Stability Analysis of Reclaimed Haul Road
FIGURE 3-1 Small Drainage Hydraulic Data
FIGURE 3-2 Bowl Crossing Hydraulic Data
FIGURE 3-3 Eccles Creek Channel Design
FIGURE 3-4 Typical Waterbar Details
FIGURE 4-1 Stable Fill, Final Contour Surface
FIGURE 4-2 Cross Section - Bowl Crossing
FIGURE 4-3 Unstable Fill - Final Contour Surface

LIST OF EXHIBITS

EXHIBIT 3-1 Watershed Map

SECTION 1.0 - INTRODUCTION

1.1 General

The following reclamation plan is for Valley Camp of Utah's Belina Haul Road which supports their coal mining operation located on Whiskey Creek in Carbon County, Central Utah.

The haul road is constructed on a cut/fill bench having a total road width of thirty-four feet with very steep natural slopes above and below the road. These two facts create several unique problems when considering reclamation of the road.

This reclamation plan addresses the removal of the road surface materials and associated structures and the recontouring of the area to facilitate the return of the disturbed lands to its pre-mining land use of limited rangeland and wildlife habitat.

1.2 Objectives

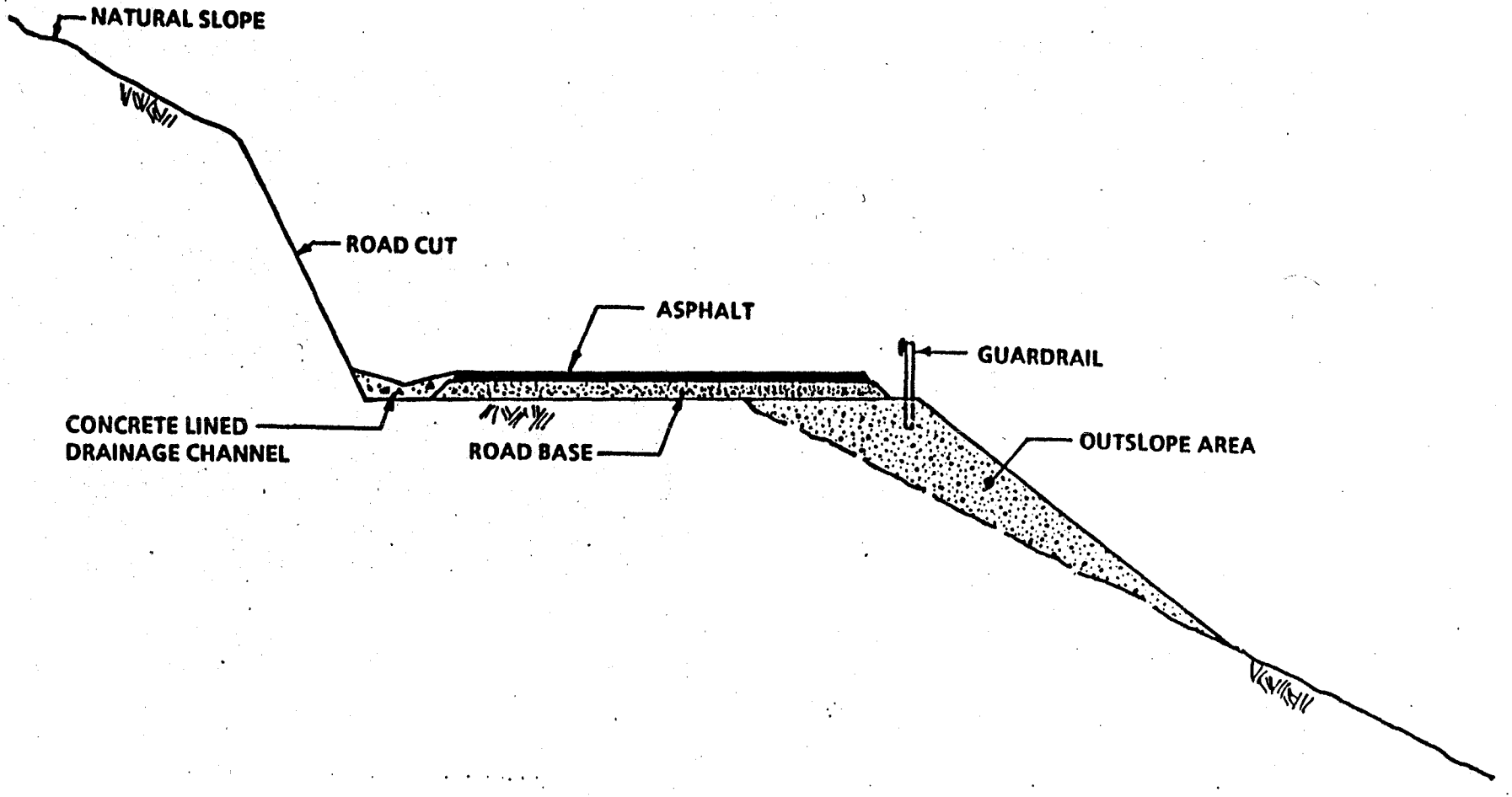
The objectives of this reclamation plan are to eliminate the permanent road surface and support structures and return the disturbed land to a condition capable of supporting the pre-mine land use of limited rangeland and wildlife habitat. These objectives will be obtained by recontouring the road surface to re-establish a drainage pattern comparable to pre-mining conditions; by replacing the soil medium and re-establishing an effective permanent vegetation cover.

The affective area consists of a strip of land approximately 100 feet wide and 1.5 miles long. Although the right-of-way (ROW) is approximately 100 feet wide, this reclamation plan will only address the road surface (34 feet wide); the outslope areas having

questionable slope stability and the area to be re-disturbed to re-establish the natural drainages. Figure 1-1 is a typical cross section illustrating the construction of the Belina Haul Road. Approximately ten acres will require recontouring and/or reclamation activities. The majority of the road outslope areas are considered stable as final reclamation, as discussed in Section 2.0, and therefore will not be disturbed. Determination of slope stability is discussed in detail in Section 2.0. The results of a limited geotechnical evaluation concerning the road outslopes and drainage fills are shown in Table 2.1. Only the potentially unstable slopes and their corresponding station location are shown on this table. These station locations were determined from plan and profile sheets showing the general road location and grade. Survey station locations were shown on the map beginning at the mine portal going towards the Eccles Canyon intersection and ending at Station 83+52.

Reclamation activities will be conducted in a manner that will minimize the potential adverse impacts to the air, water, vegetation, wildlife, and general aesthetics of the area. This proposed reclamation plan will establish a permanent, diversified vegetation cover capable of self-regeneration and soil stabilization that will support the post-mining land use of limited rangeland and wildlife habitat.

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
TYPICAL HAUL ROAD CROSS SECTION
Figure 1-1



SECTION 2 - GEOTECHNICAL INVESTIGATION

2.1 General

The geotechnical investigation for the Belina Haul Road was performed in three phases. Phase I was a site evaluation of the natural talus in the local region. Phase II identified the areas considered to be critical. Phase III was the slope stability analysis for typical sections of the road before and after reclamation. Conclusions were then based upon all three phases.

Soils in this region are considered young and primarily consist of weathered rock high in quartz. The Unified Soil Classification System would consider this material as SP since it is gravelly sand which is poorly graded and has very few fines. This type of soil has essentially no cohesion; therefore, it is considered a pure phi (Ø) soil which will control the type of slope failures and geometry of the natural talus slopes.

2.2 Natural Talus Evaluation

Natural talus slopes in the haul road area widely vary between 30 percent to over 100 percent. By considering the friction angling (Ø) of the soil to be constant across the region, the depth to bedrock will control the natural talus slope stability. Shallow soils are stable at greater slopes than deep soils. The length of run also plays a major role in the stability of the slopes. The natural talus in the region was self-stabilizing due to small failures creating a terracing effect across the hillside. The stabilizing of the natural talus slopes is still occurring and numerous natural slope failures

may be seen around the vicinity of the Belina Haul Road. The friction angle of the talus was derived from the geometry of a recent natural slope failure. This failure analysis produced a friction angle equal to 31°. This value is very typical for SP classified soils.

2.3 Critical Fill Areas

Critical fill areas are defined for this discussion as areas which have localized evidence of recent slope failures, slopes which exceed the friction angle of the soil, or slopes that have similar characteristics of recent failures in the region, such as deep soil horizons. These critical areas are listed in Table 2.1:

TABLE 2.1

POTENTIALLY UNSTABLE SLOPES*

AREA	Station Location	Linear Distance	Slope Pre-Construction	Slope Post-Construction
1	21+10 to 22+70	160'	63%	70%
2	24+06 to 29+34	520'	63%	72%
3	30+40 to 32+00	160'	55%	68%
4	37+18 to 44+00	682'	63%	70%
5	51+17 to 52+75	158'	65%	75%
6	61+00 to 64+12	312'	70%	80%
7	73+00 to 75+60	260'	84%	128%
8	77+18 to 82+46	528'	84%	143%

TOTAL = 2,780 Feet

*Typical Geometries for each one of these reaches are illustrated in Figures 2.1 to 2.8.

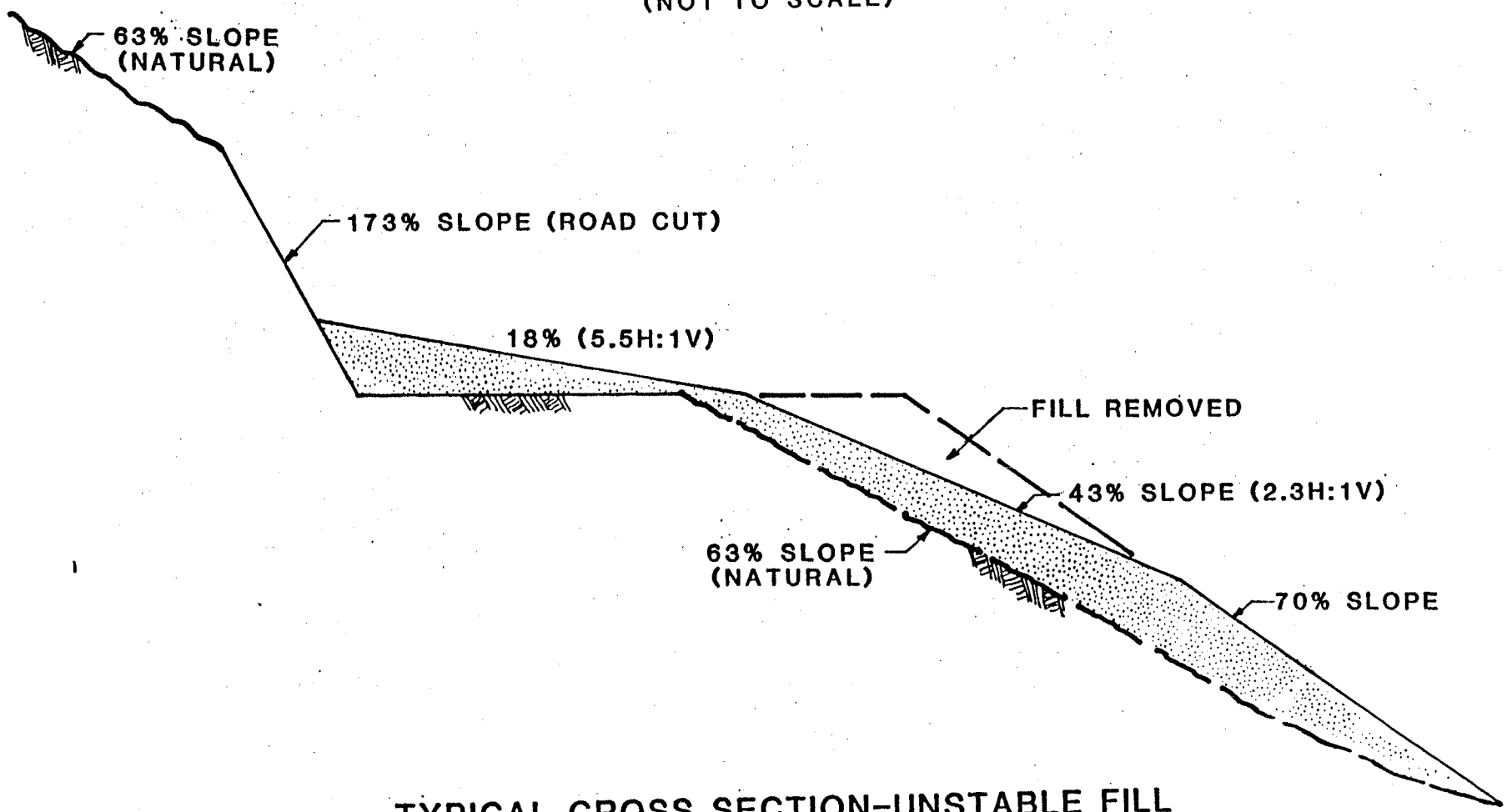
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-1

(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA 21 + 10 TO 22 + 70

AREA 1

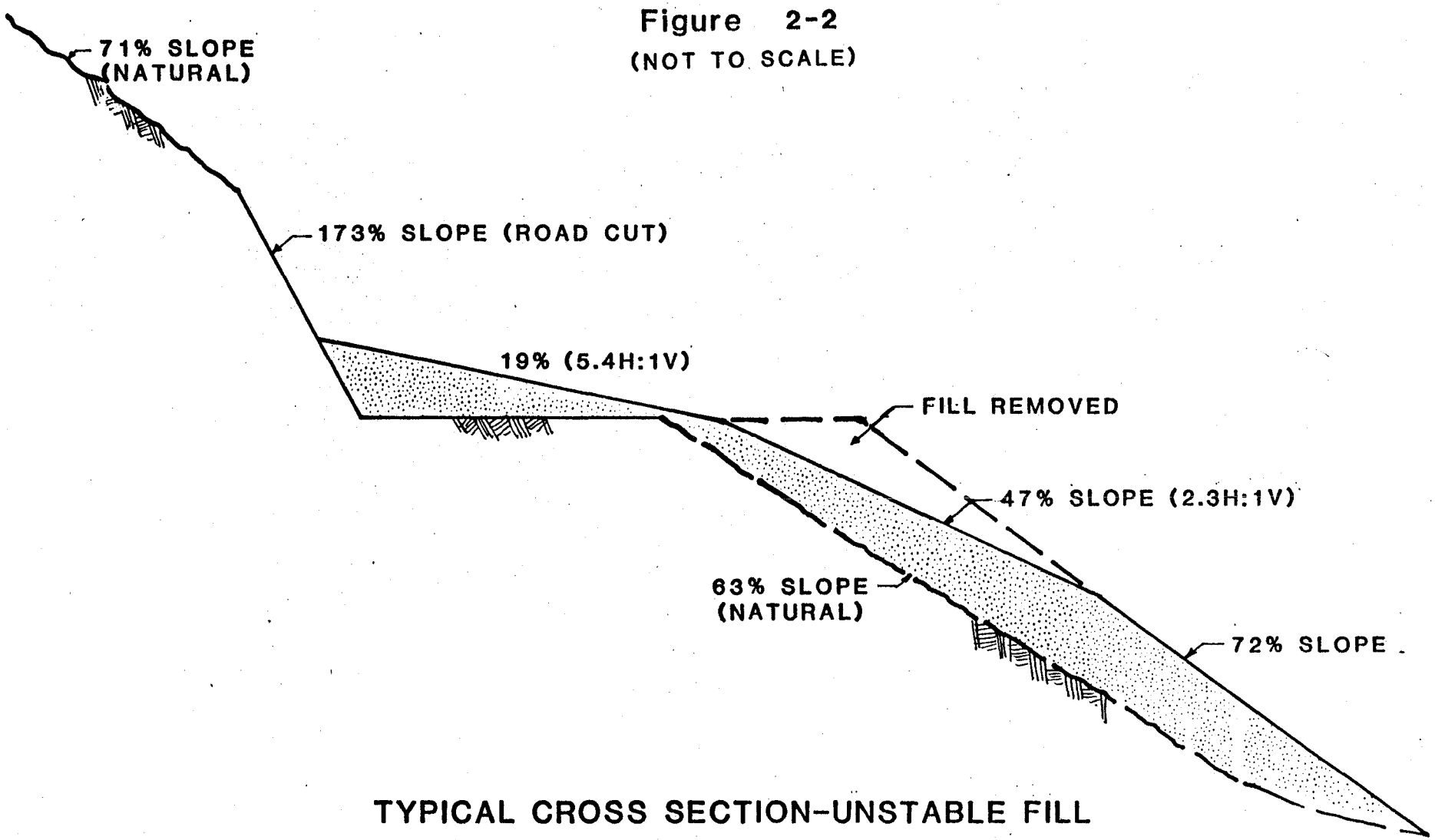
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-2

(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 24 + 06 TO 29 + 34

AREA 2

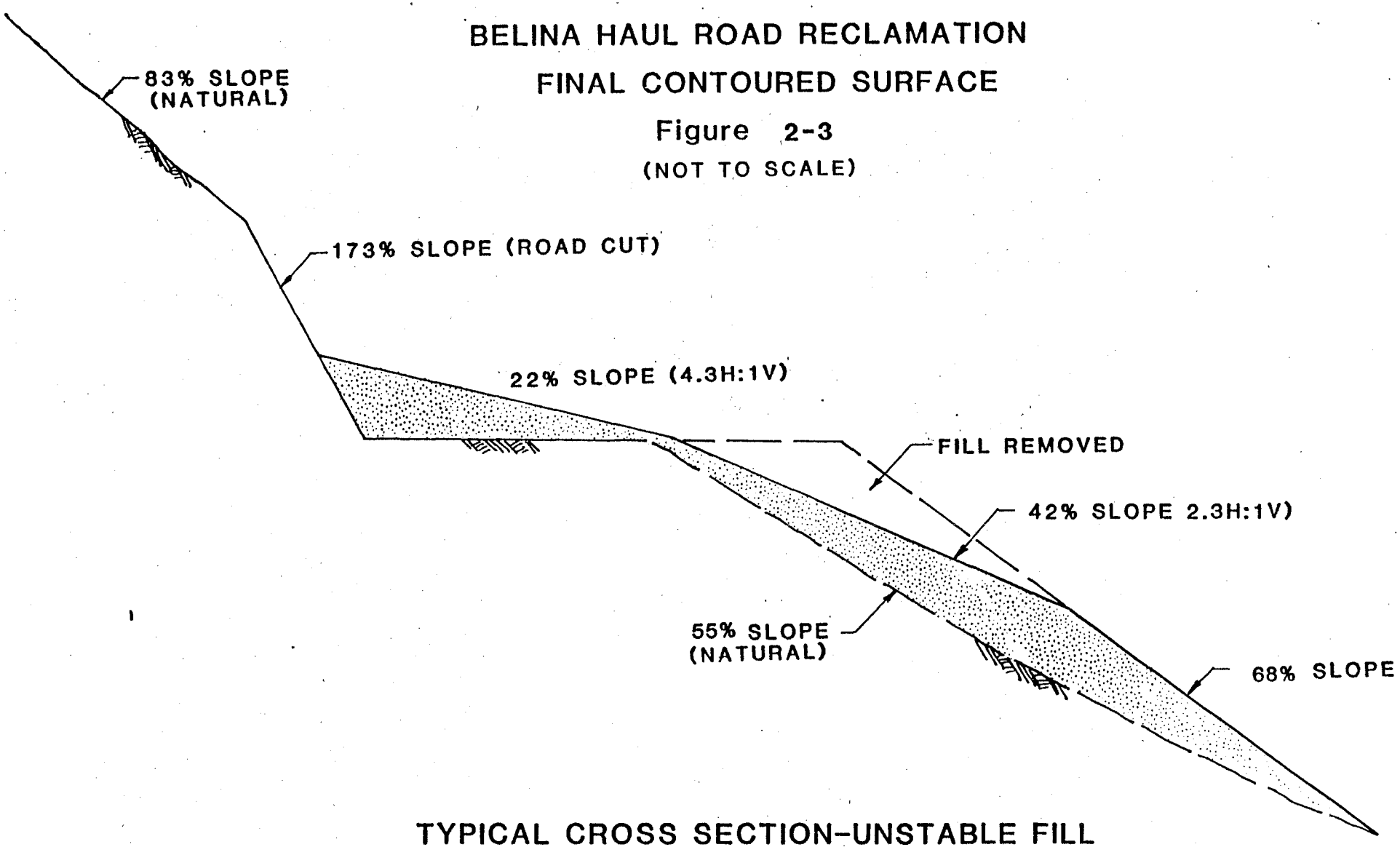
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-3

(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 30 + 40 TO 32 + 00

AREA 3

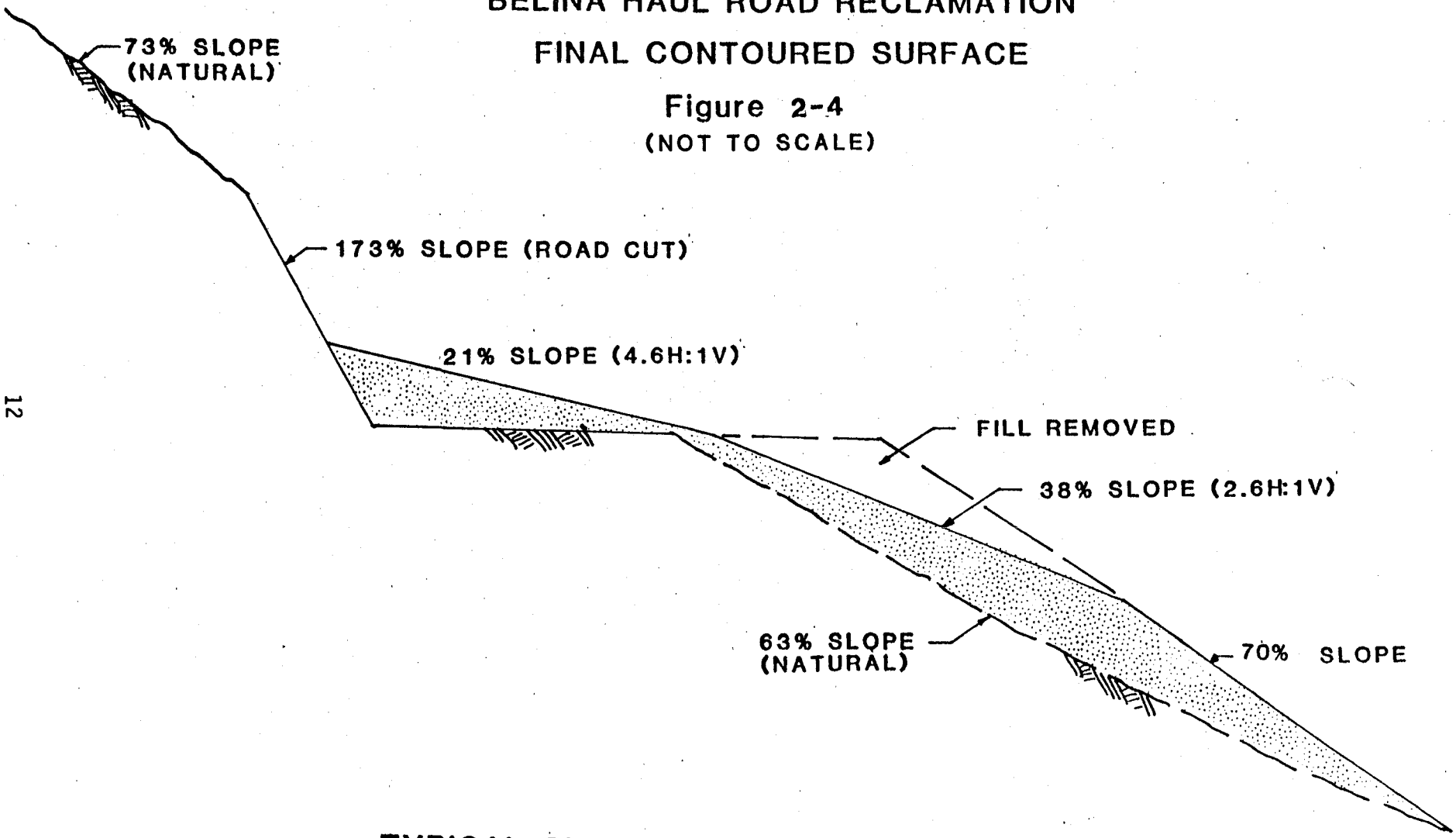
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-4

(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 37 + 18 TO 44 + 00

AREA 4

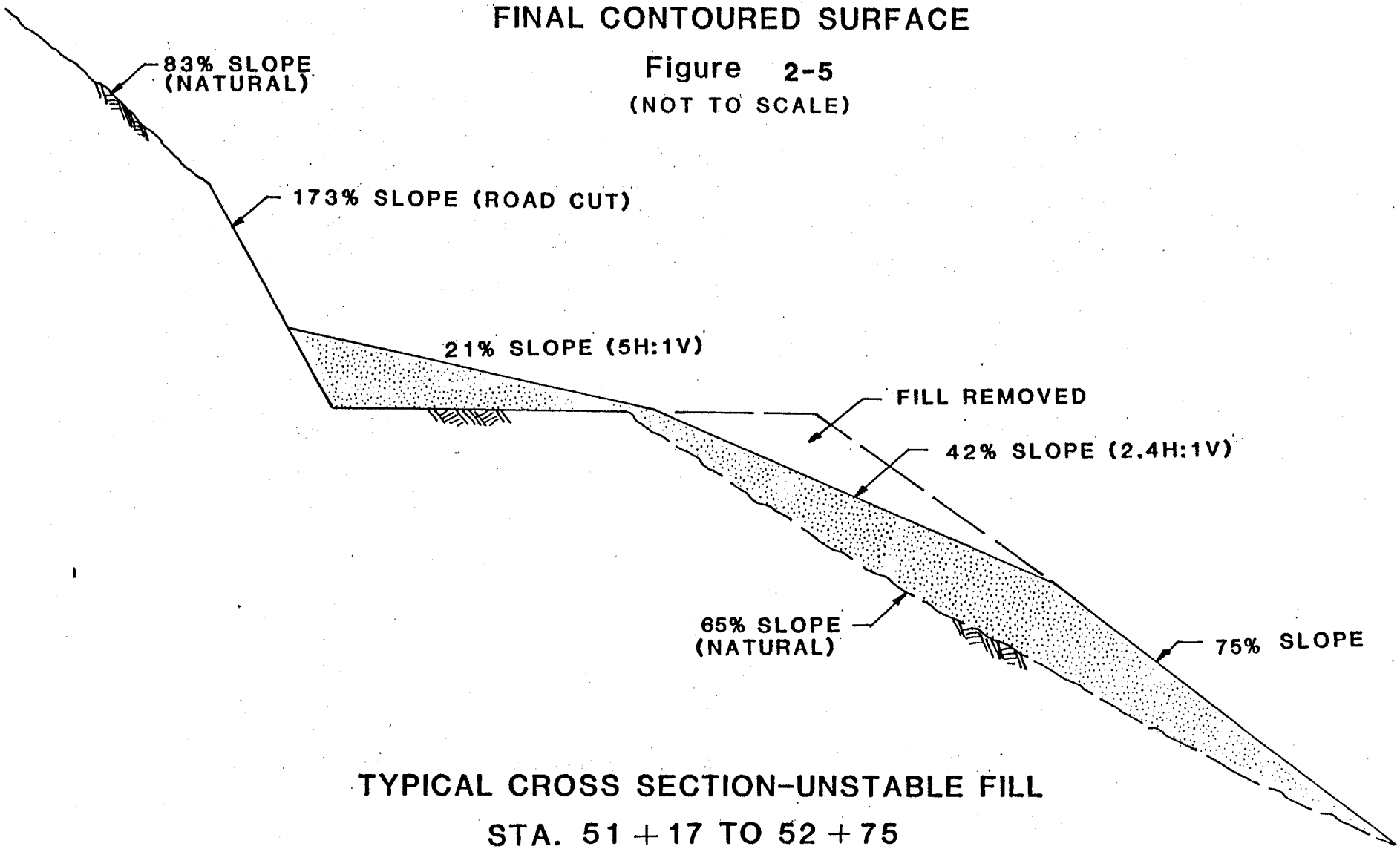
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-5

(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 51 + 17 TO 52 + 75

AREA 5

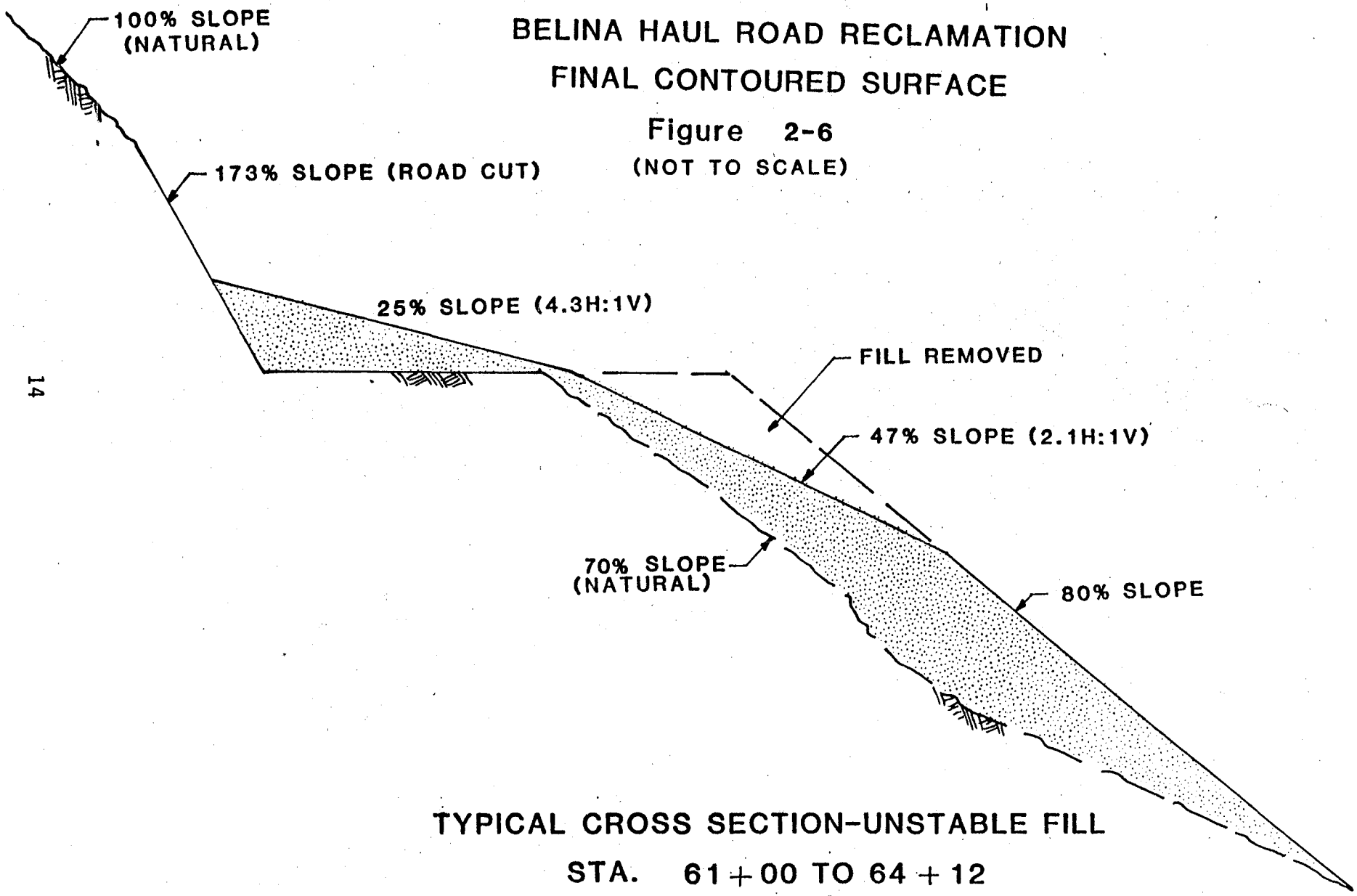
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-6

(NOT TO SCALE)



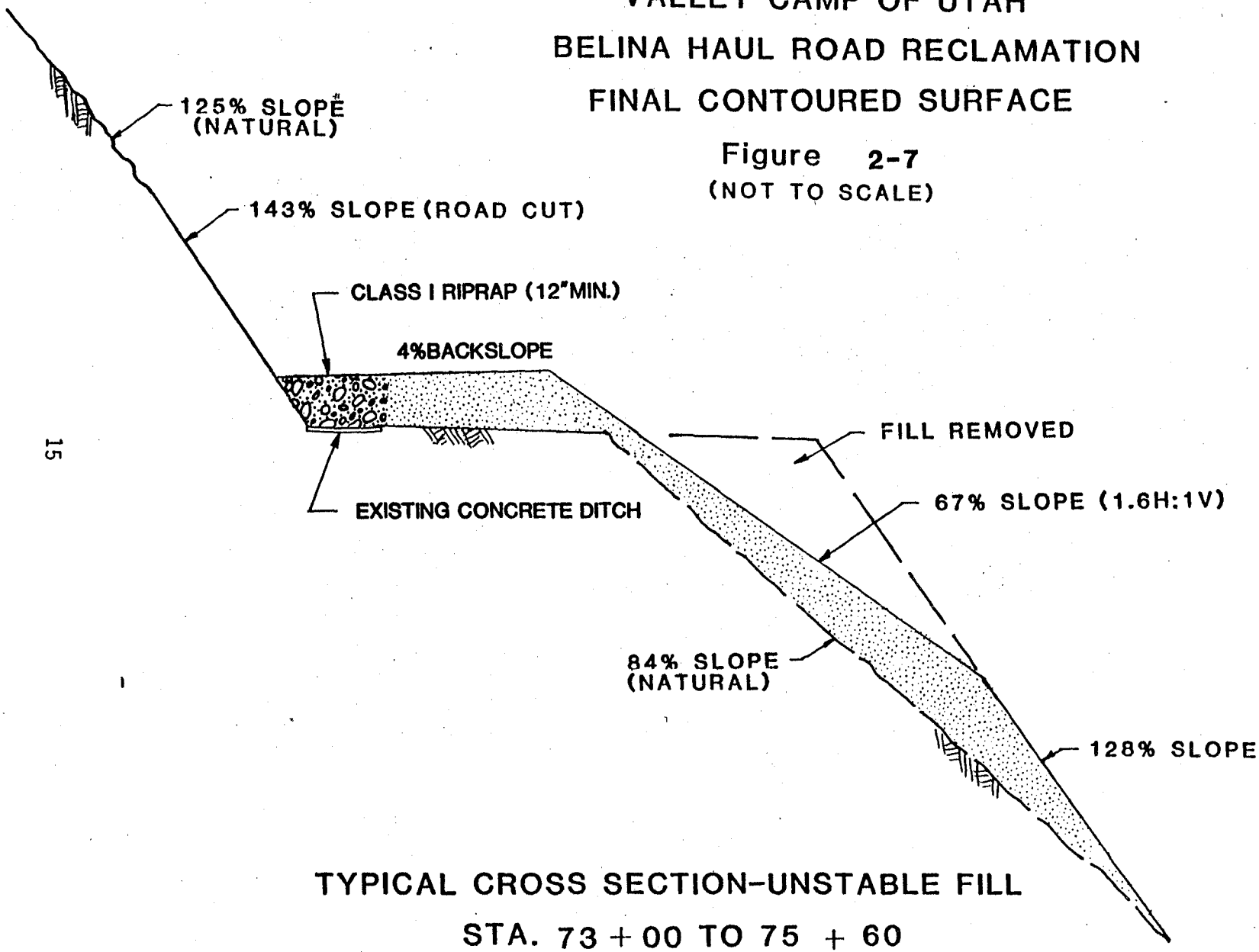
TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 61+00 TO 64+12

AREA 6

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
FINAL CONTOURED SURFACE

Figure 2-7
(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 73 + 00 TO 75 + 60

AREA 7

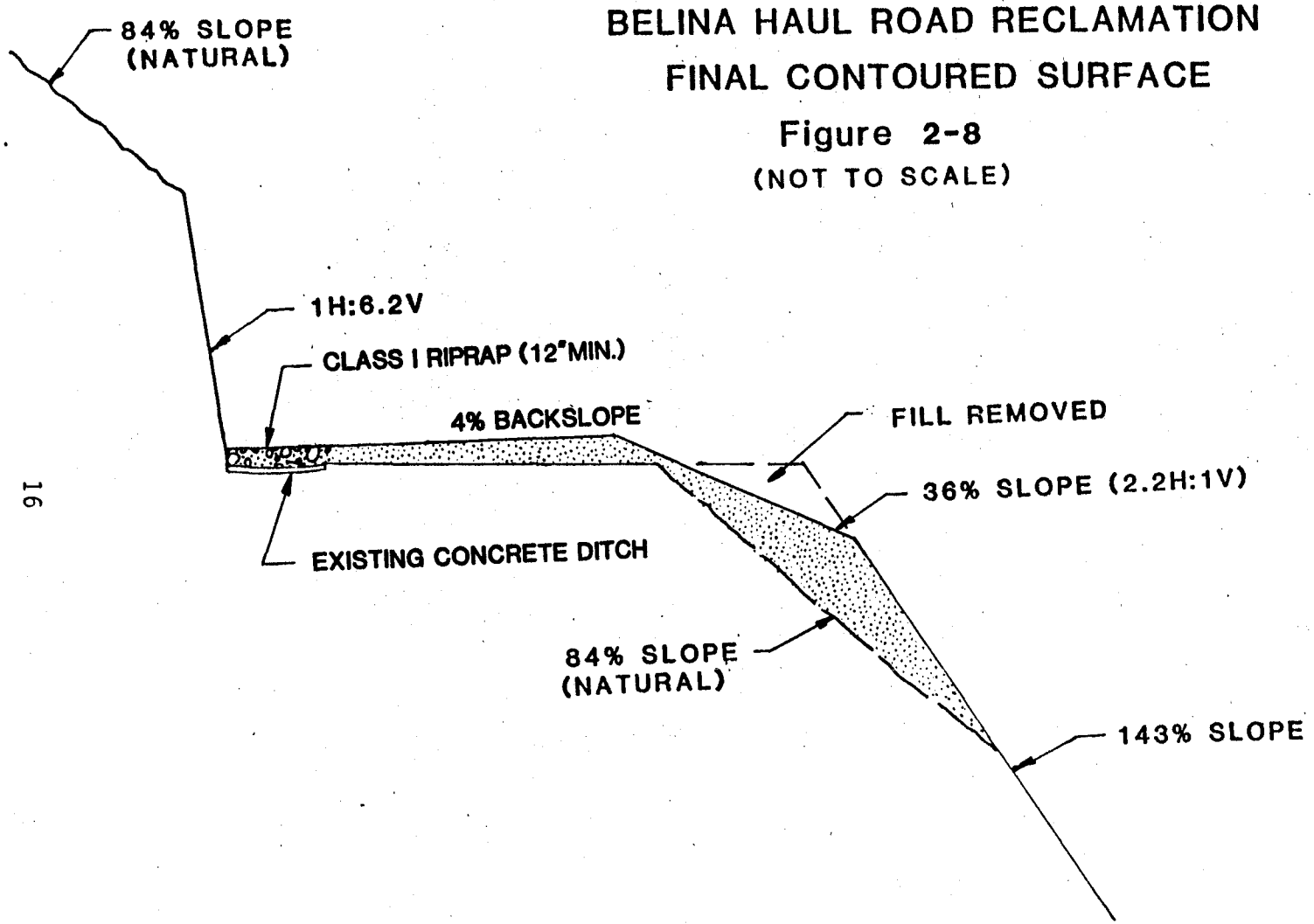
VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

FINAL CONTOURED SURFACE

Figure 2-8

(NOT TO SCALE)



TYPICAL CROSS SECTION-UNSTABLE FILL

STA. 77 + 18 TO 82 + 46

AREA 8

The Bowel Crossing has not been considered to be a critical fill area due to the reclamation plans in this reach. By removing the top portion of the fill, this region does not present a slope stability problem and should remain stable.

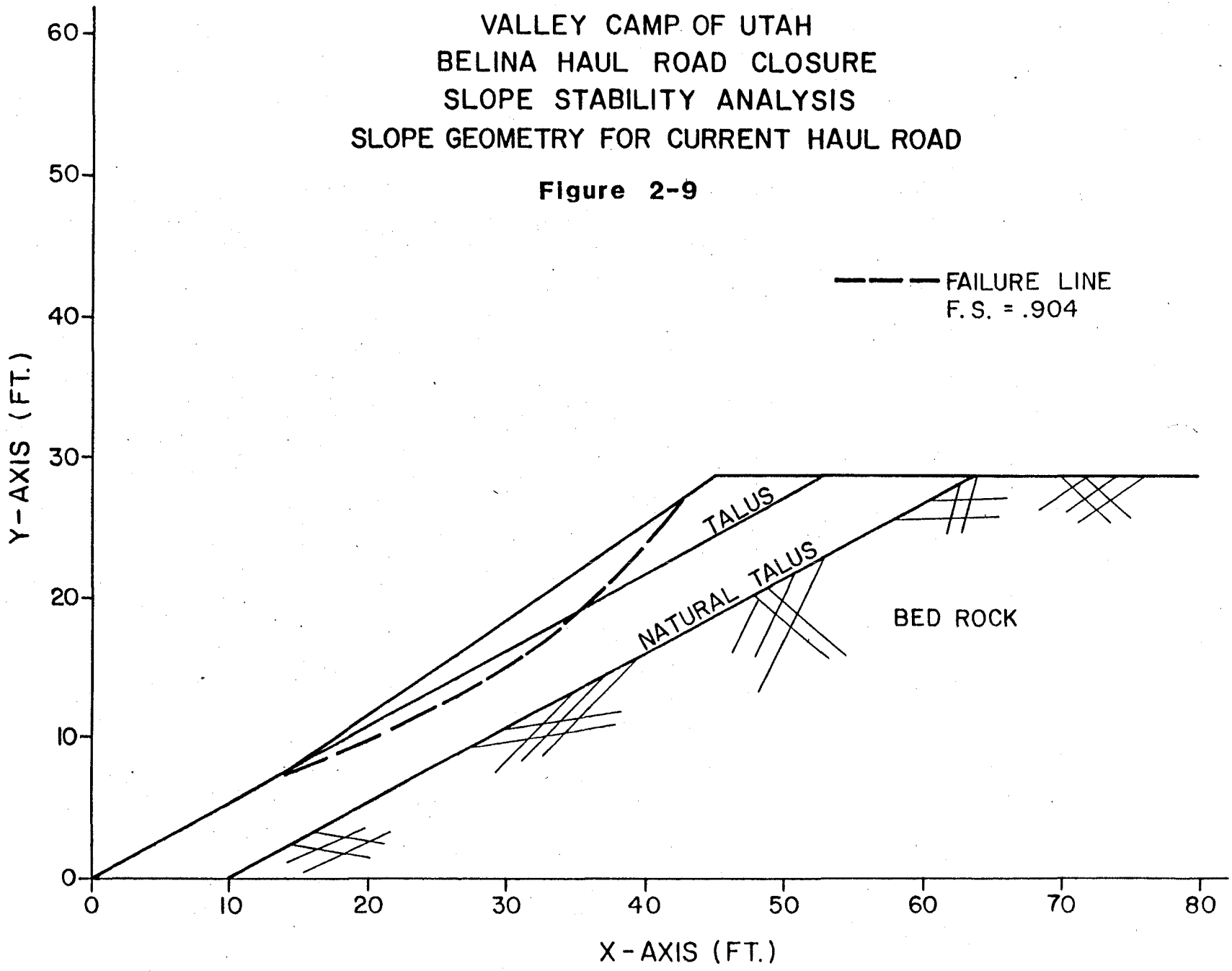
2.4 Methods and Results of the Slope Stability Analyses

The slope stability analysis was performed using the computer model STABL 5. Typical geometries before and after reclamation of the Belina Haul Road are illustrated in Figures 2.9 and 2.10. The natural talus slope used for model input was set equal to 53 percent and the talus slope to 68 percent. The reclamation slope was based upon the capability of a backhoe to reach downslope 25 feet. The soil density was assumed to be 100 pounds per cubic foot with a phi value of 31°.

The factor of safety for the talus on the current haul road was estimated to be .904, which is reasonable since the talus' phi value input is 31° and no adjustment was made for the irregular bedrock formation. The factor of safety after reclamation was estimated to be 1.08, which increases the factor of safety from the original haul road geometry by 19 percent. This increases the factor of safety to be greater than most of the natural talus since many of the natural slopes are unstable. Most natural talus slopes in the region have a factor of safety equal to 1.00 for their given geometry. Note that the failure plane configuration produced by the model shows shallow, circular failures which are predominant in this region. The very steep slopes noted in this study were made up of coarser sands and gravels which have considerably higher friction angles than the soil used for the typical section modeling. This non-homogeneity is common in young, shallow soils with some deviation in parent material and weathering exposure.

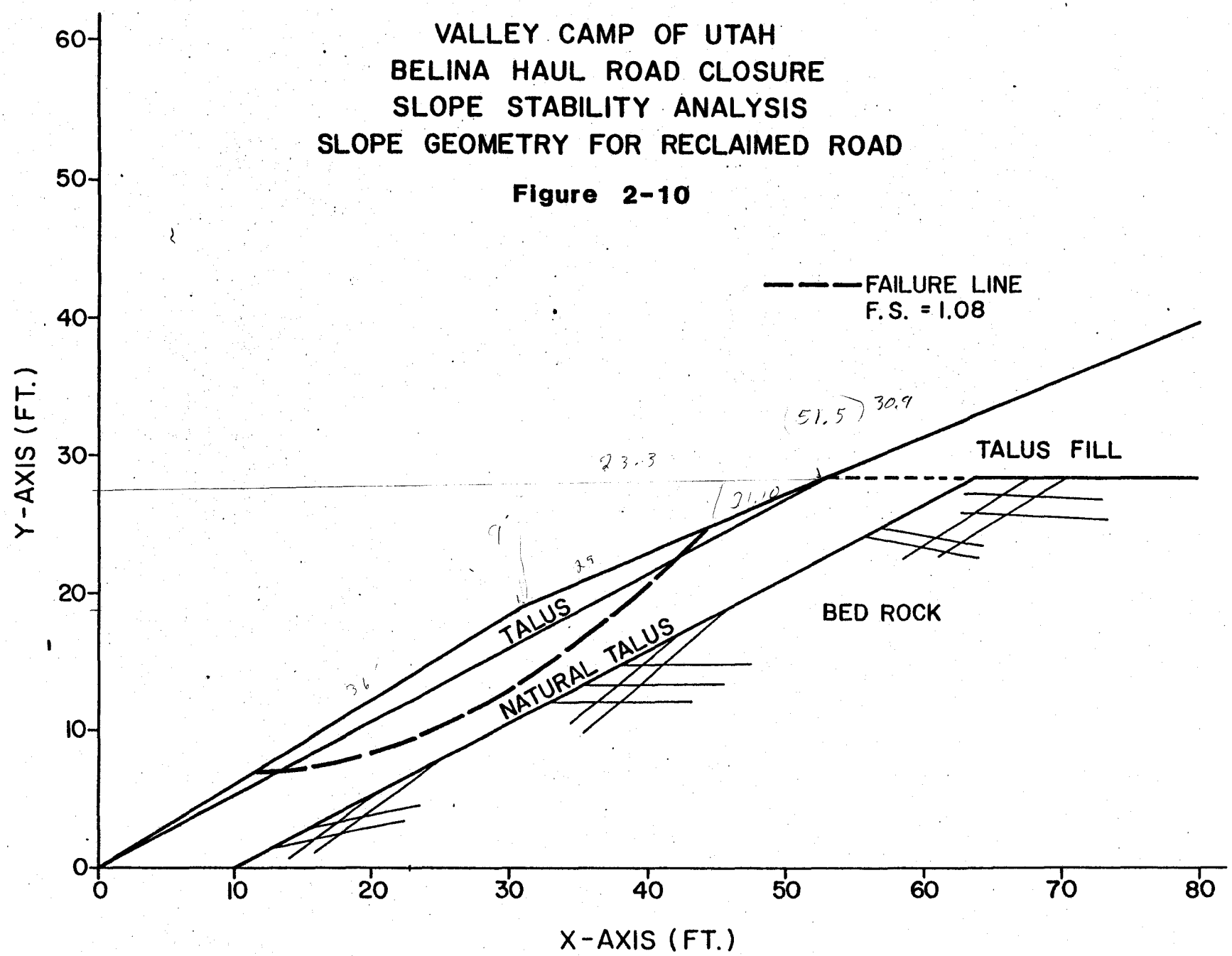
VALLEY CAMP OF UTAH
BELINA HAUL ROAD CLOSURE
SLOPE STABILITY ANALYSIS
SLOPE GEOMETRY FOR CURRENT HAUL ROAD

Figure 2-9



VALLEY CAMP OF UTAH
BELINA HAUL ROAD CLOSURE
SLOPE STABILITY ANALYSIS
SLOPE GEOMETRY FOR RECLAIMED ROAD

Figure 2-10



SECTION 3.0 SURFACE HYDROLOGY/HYDRAULICS

3.1 General

Surface water runoff was determined for the seven small drainages on the Belina Haul Road using the Soil Conservation Service (SCS) curve number method and the TR-20 Computer Program. Once flows were determined for each of the drainages, typical channels were developed and the velocity was determined so that the riprap sizing could be developed. Also included as part of the surface water design are the water bars to be constructed along the recontoured road.

3.2 Design Flows

The design storm for the seven drainages shown on Exhibit 3-1 was the 100 year, 24 hour, which has a rainfall amount of 3.65 inches. This is based on information developed for the Clear Creek Summit, Utah. Table 3-1 shows the precipitation depths versus return period for the Clear Creek Summit Site. The flows were developed based on a Type II rainfall distribution and are shown in Table 3-1.

The major parameters used in determining the runoff with the TR-20 model are the drainage area, time of concentration and CN. The time of concentration is defined as the time required for water to travel from the most hydraulic point of the watershed to the point of interest. It is computed by adding together the time for various segments of the conveyance system. For the mountainous drainage along the Belina Haul Road the time was estimated following the steps outlined in the SCS TR-55 publication and consist of three parts, sheet flow, shallow concentrated flow and open channel flow. The time of travel for each segment was computed and added together to determine the time of concentration for the drainage.

TABLE 3-1

Estimated precipitation depths for various return periods and durations at Clear Creek, Summit, Utah (from Richardson (1971).

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

Runoff curve number (CN) are based on hydrologic soil group, cover type, and antecedent moisten condition of the soil. The soils and vegetation maps from Valley Camps' approved mining permit application (UT-0013) were used to determine the CN value for each of the drainages. The USFS has recently completed classifying their lands and assigning CN values and was contacted to see how values compared. In general the values computed for the haul road agreed quite closely and were slightly higher giving a more conservative estimate of the flow and were judged to be reasonable for forest lands. Table 3-2 below shows the date used to compute the design flows for each of the drainages.

TABLE 3.2

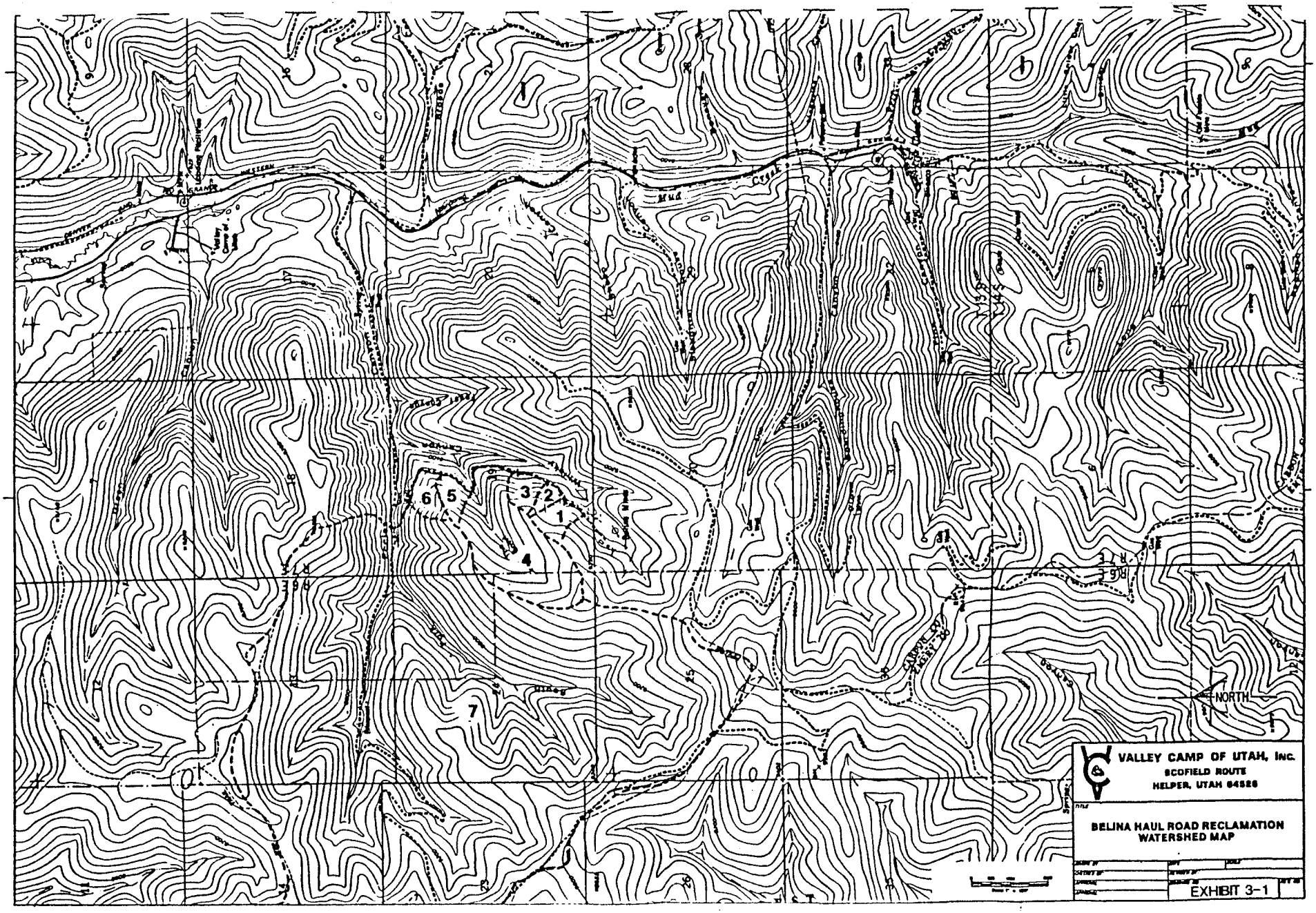
WATERSHED SIZE AND FLOW CHARACTERISTICS

Watershed #	CN	tc hrs.	Area, AC	Q cfs
1	60	.49	18.8	6.7
2	60	.35	9.6	4.3
3	60	.74	11.8	3.2
4 (Bowl Crossing)	60	.71	147.8	44.0
5	60	.71	14.2	4.0
6	60	.56	25.0	8.3
7 (Eccles Creek)	60	1.37	2087.0	378.

3.3 Channel Design

It is proposed in the reclamation plan that the existing culverts be removed and the ephemeral channels reestablished at their original slope and be protected with riprap. Figure 3.1 shows a typical section through the road after regrading and contouring and the various hydraulic data.

The slope will vary from about 15 percent across the road to a maximum of 65-70 percent along the slope face. To replace the culverts on five of the smallest drainages, a small "V" ditch will


1
2
3
4
5
6
7
NORTH
VALLEY CAMP OF UTAH, INC.
SCOFIELD ROUTE
HELPER, UTAH 84526
BELINA HAUL ROAD RECLAMATION
WATERSHED MAP
EXHIBIT 3-1

be constructed to carry the flow from each of the small drainages through the road sections. These small ditches will be protected with riprap and a typical section is shown on Figure 3-1.

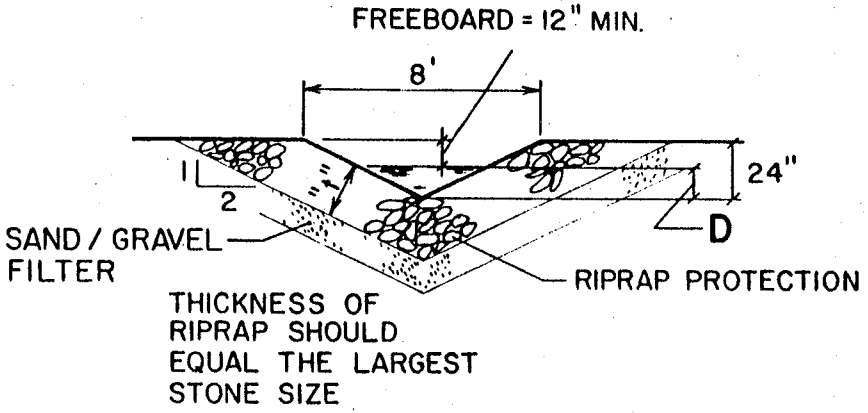
Velocities were computed using the Manning's equation. The channel roughness coefficient, n, was estimated based on values for small mountain streams where the depth of flow is small when compared to the size of bed material. In Open-Channel Hydraulics, Chow suggested n values range from .040 to .070 for small, steep mountain streams with cobbles and boulders. Values were also determined from the paper Two Approaches for Estimation of Manning's n in Mountain Streams, by Weache, et al. at the Wyoming Water Research Center. Based on their method, n is estimated to range from .065 to .085. A value of .06 was used in all of the computation. It was felt that the turbulence would be very high since the average depth of flow would range from .5 feet to 1.0 feet and the riprap size would range from 1.0 feet to 2.0 feet.

While this value is higher than those typically used, (.035 - .045), it is felt justified because the depth of flow is much greater than the stone size and this is not the case for the Belina Haul Road drainages.

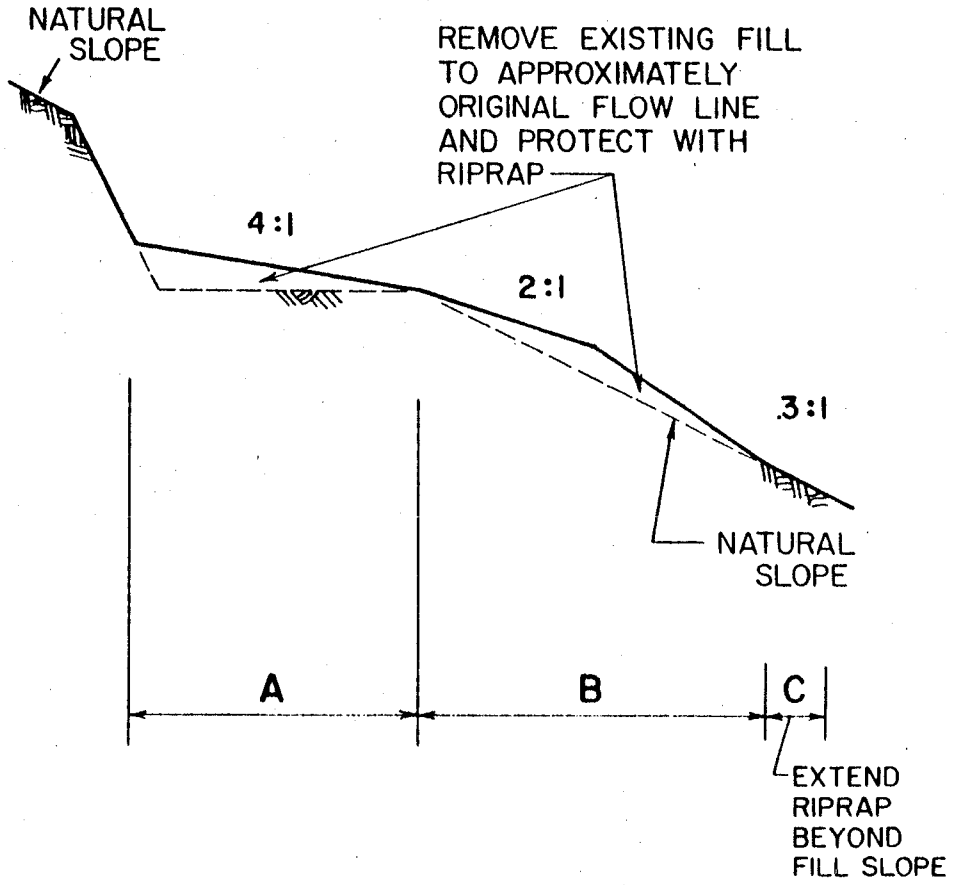
3.3.1 Small Drainages

Flows vary from 3.2 to 8.3 cfs for the five smallest drainages. The small "V" ditches were designed based on the maximum flow of 8.3 cfs. This will provide a conservative design and will standardize them making construction easier. The velocity will vary from about 4 feet per second for the 15 percent slope to about 10 ft/sec. on the steeper slope of 70 percent. Details for each of the crossings are shown on Figure 3-1.

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
SMALL DRAINAGE
HYDRAULIC DATA
Figure 3–1



TYPICAL "V" DITCH
FOR SMALL DRAINAGES



TYPICAL STREAM CROSSING
FOR SMALL DRAINAGES

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
SMALL DRAINAGE
HYDRAULIC DATA
Figure 3–1a

AREA	DRAINAGE	CHANNEL SLOPE	Q in cfs.	*D Depth Ft.	VELOCITY Ft./Sec.	RIPRAP CLASS
*A	1	15%	6.7	.85	5	I
	2	15%	4.3	.70	4	I
	3	15%	3.2	.65	4	I
	5	15%	4.0	.70	4	I
	6	15%	8.3	.90	5	I
*B	1	63%	6.7	.65	9	II
	2	63%	4.3	.55	8	II
	3	55%	3.2	.50	7	II
	5	70%	4.0	.50	8	II
	6	70%	8.3	.70	10	II
*C	ALL					II

*SEE FIGURE 3-1 FOR LOCATION

3.3.2 Bowl Crossing

Design of the channel for the Bowl Crossing drainage (Area 4) was done in a similar manner. The 100 year design flood is estimated at 44 cfs. It is proposed that a small overland flow channel be constructed through the rock fill after the soil fill has been removed, (See Section 4.3.1) which will have a bottom width of four feet. Figure 3-2 shows a typical section through the fill. The existing culvert will remain in place and will carry the smaller flows. The new overland flow channel will carry the flood flows for the more infrequent storms and also if the culvert should become clogged. The velocity in the new channel will vary from 8 ft/sec. across the rock fill where the slope is about 15 percent to 13 ft/sec. down the steeper natural slope. Details of the channel and hydraulic data are shown on Figure 3-2.

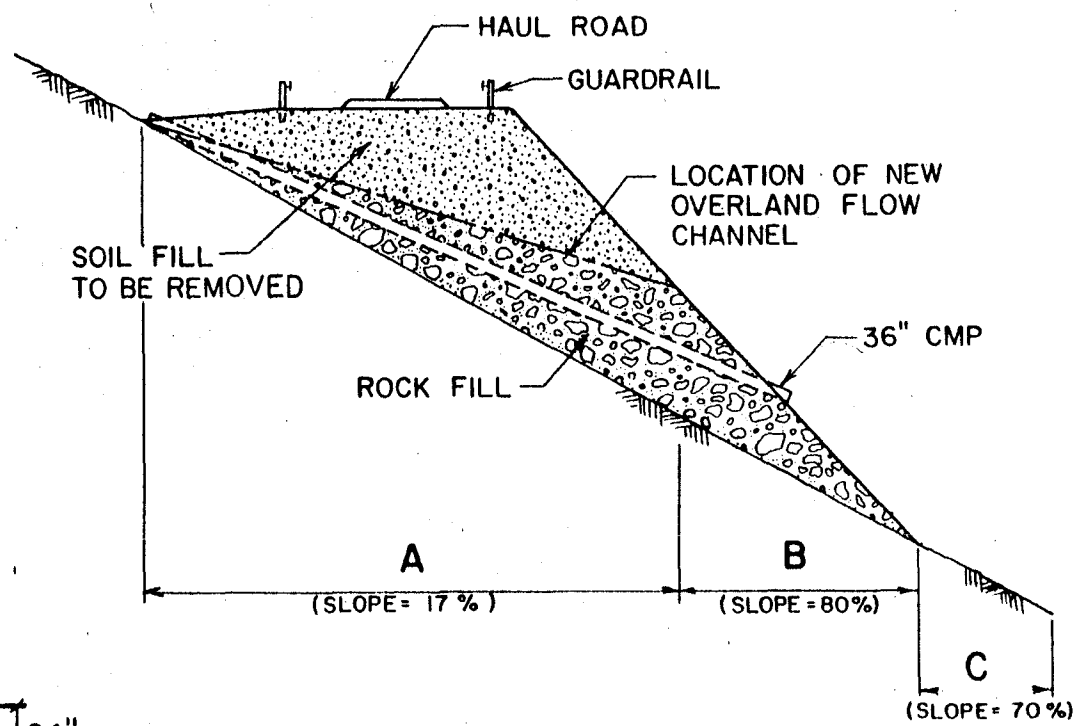
The design for Eccles Creek drainage is covered in Section 3.5.

3.4 Riprap Design

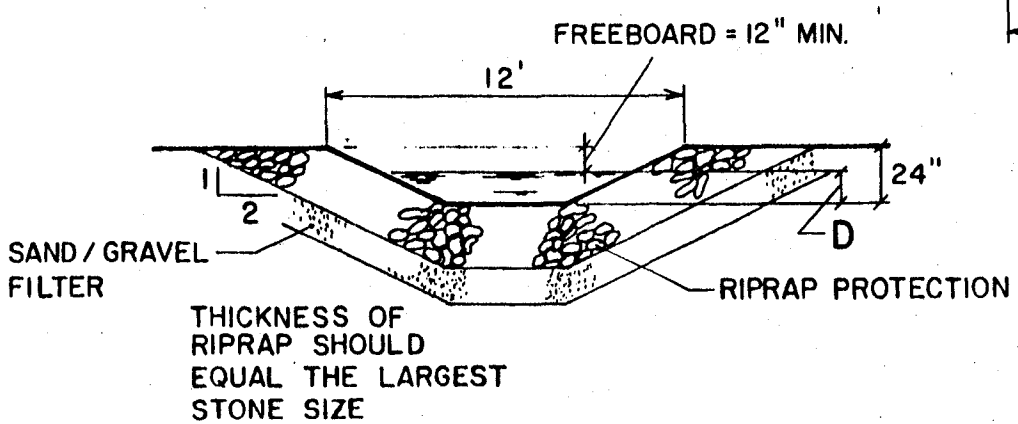
Rirrap sizing was selected based on the above velocities using USBR Engineering Monograph #25 and FHWA Hydraulic Engineering Circular #11. The d_{50} size is four inches on the flatter slopes (Class I) and is nine inches on the steeper slopes (Class II). Gradation for the different classes of riprap are shown in the Table 3.3.

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
BOWL CROSSING
HYDRAULIC DATA
Figure 3–2

AREA	D Depth Ft.	VELOCITY Ft./Sec.	RIPRAP CLASS
A	1.0	8	II
B	.70	13	II
C	.70	13	II



SECTION THRU BOWL CROSSING



TYPICAL DITCH
FOR BOWL CROSSING
DESIGN Q=44 cfs.

TABLE 3.3

RIPRAP DESIGN

Class	Max.	Size, In d_{50}	Min.
I	8	4	1 1/2
II	24	18	6
III	36	24	8

Riprap should be reasonably well graded from the maximum size down to the minimum. The concrete removed from the project will be used as part of the riprap protection and will be broken so as not to be larger than the d_{50} size and will not makeup more than 15 percent of the volume. The riprap will extend beyond the toe of the fill slopes a minimum of five feet to provide energy dissipation at the termination of the riprap channels, the energy dissipator will be small mounds of riprap approximately 18"-24" high to help spread the flows out and reduce erosion.

A filter blanket will be constructed and placed between the riprap and the native material. The filter will be constructed of a well-graded gravel with a minimum size of about 3/16" up to a maximum required by the riprap class and is shown below in Table 3.4.

TABLE 3.4

RIPRAP FILTER DESIGN

RIPRAP CLASS	MAX, in	MIN, in	THICKNESS, in
I	*		
II	4	3/16	9
III	6	3/16	9

*Not required; native material acceptable

3.4.1 Small Drainages

The existing native material appears to be sandy gravelly material based on field inspections. The gradation is estimated to be from 3 inches down to less than 1/8" with a d_{50} size of about 3/8". This material will meet the requirements for a filter material for the Class I riprap, since the d_{15} Riprap/d_{85} Base is less than 5.

3.4.2 Bowl Crossing

Based on field observations and discussions with the mining operation people, it appears that the blast rock in the Bowl crossing fill has a maximum size of 18 inches to 36 inches. This would provide adequate protection based on the above velocities. If, when the soil fill is removed and the channel is constructed, it is determined that the actual blast rock is not large enough, additional riprap protection (Class III) will be provided.

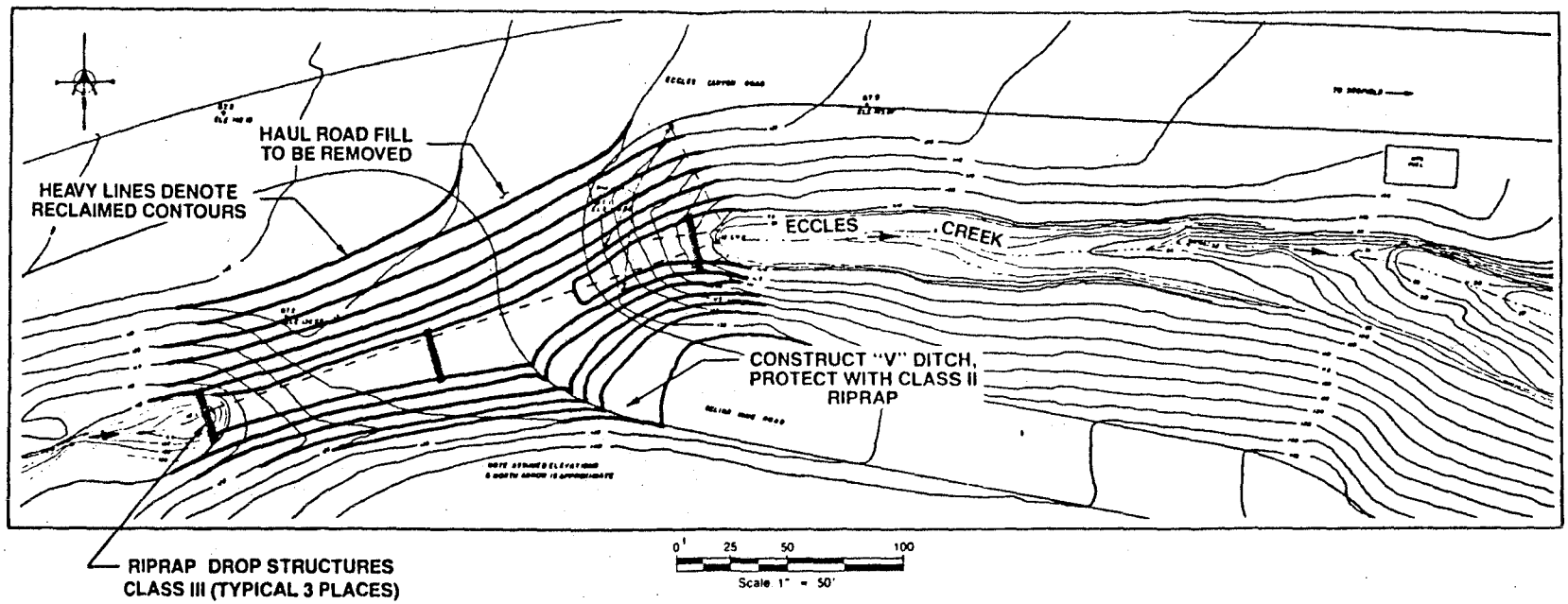
After excavating the soil fill at the Bowl Crossing the base material will be examined to determine if it meets the filter criteria. If it does not, a filter will be constructed meeting the gradation shown in Table 3-4.

3.5 Eccles Creek

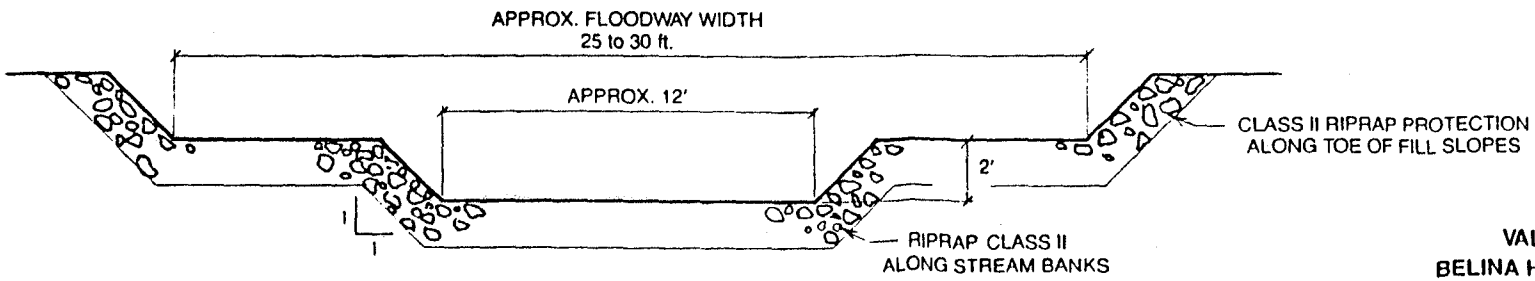
The drainage above the Belina Haul in Eccles Creek is the largest with an area of 2,047 acres. The 100 year 24 hour storm is estimated to be about 378 cfs. The channel slope in this area is estimated to be 2 - 2.5 percent. This channel will have a low flow section with a width of 12 feet. The velocity for the 100 year storm will be approximately 6.6 feet per second with depth varying from about 1.5 feet in the floodway to 3.5 feet in the main channel. A Manning's n of .060 was used in computing the flow depth and velocities for Eccles Creek. Based on this velocity and depth of flow, the Class II (24 inch)

riprap will be required. The channel will be constructed with similar geometry to the recently reconstructed channel below the Belina Haul Road turnout. A typical section through this channel is shown in Figure 3-3. The design of this channel will be similar to the recently completed channel reconstruction just downstream. This will maintain continuity in the channel design. The channel will include several drop structures to maintain a reasonable stream gradient of 2.5 percent or less. These drop structures will be constructed of large rock so that they will maintain a natural appearance. Figure 3-3 shows a plan view of the proposed new alignment after the fill is removed.

The velocity and depth were also computed for the average annual flow to evaluate the effects on fish passage, and are presented in Table 3.3. The average annual flow is estimated to be about 28 cfs. This flow was computed using the USGS report, "Methods for Estimating Peak Discharges and Flood Boundaries of Streams in Utah", WRI 83-4129. In addition to the average annual flow, depths and velocities were computed for several other flows.



ECCLES CREEK PLAN VIEW



TYPICAL SECTION THROUGH ECCLES CREEK

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
ECCLES CREEK CHANNEL DESIGN
PLAN AND SECTION
Figure 3-3

TABLE 3.3

ECCLES CREEK CHANNEL HYDRAULICS

Discharge, cfs	Depth,Ft.	Velocity, Ft./Sec.	Channel Slope %
15	.55	2.2	2.0
20	.65	2.5	2.0
28*	.80	2.8	2.0
30	.85	2.9	2.0

*Average annual flow

These are within the reported sustainable swimming speed for trout, which is two to six feet per second as reported in Fisheries Handbook, by Milo C. Bell, 1986. These velocities were not related to depth of flow in Milo C. Bell's report.

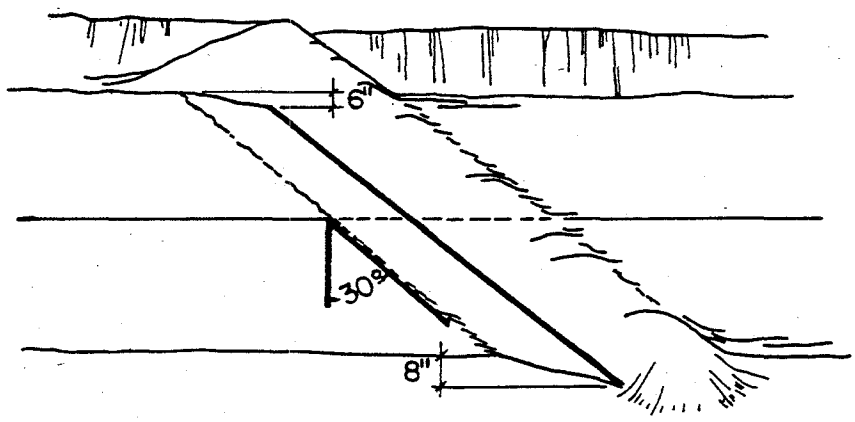
3.6 Concrete Ditch: Sta 71+00 to 82+00

A riprap ditch will be constructed at the base of the cut slope from about Sta. 71+00 to Sta. 82+00 where the haul road intersects Eccles Creek as shown on Figure 2-7 and Figure 2-8. Class I riprap will be placed over the existing concrete ditch with a minimum depth of about 12 inches. The reclaimed back slope of the road surface will contain the design flows. The last 100 feet of this ditch has a slope of about 35 percent where it drops down into Eccles Creek. This reach will be constructed similar to those in Figure 3-1. The ditch will have side slopes of 2H:1V and be protected with Class II riprap.

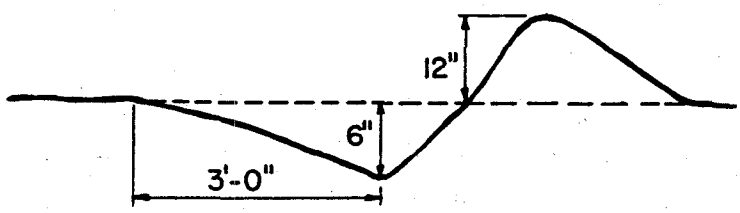
3.7 Water Control Bars

Water control bars will be constructed to reduce erosion of the recontoured haulroad. Figure 3-4 shows a typical waterbar. These structures will be spaced approximately 100 feet apart along the road. Waterbars will be placed more frequently if, during the final reclamation work it is determined they would be necessary to control runoff. Class I riprap protection will be included in the construction of the water control bars. The riprap will be placed at the point where the flow breaks over the edge of the old road bed.

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
TYPICAL WATERBAR
DETAILS
Figure 3–4



PLAN



SECTION

SECTION 4.0 - RECLAMATION PROCEDURES

4.1 Road Surface Removal

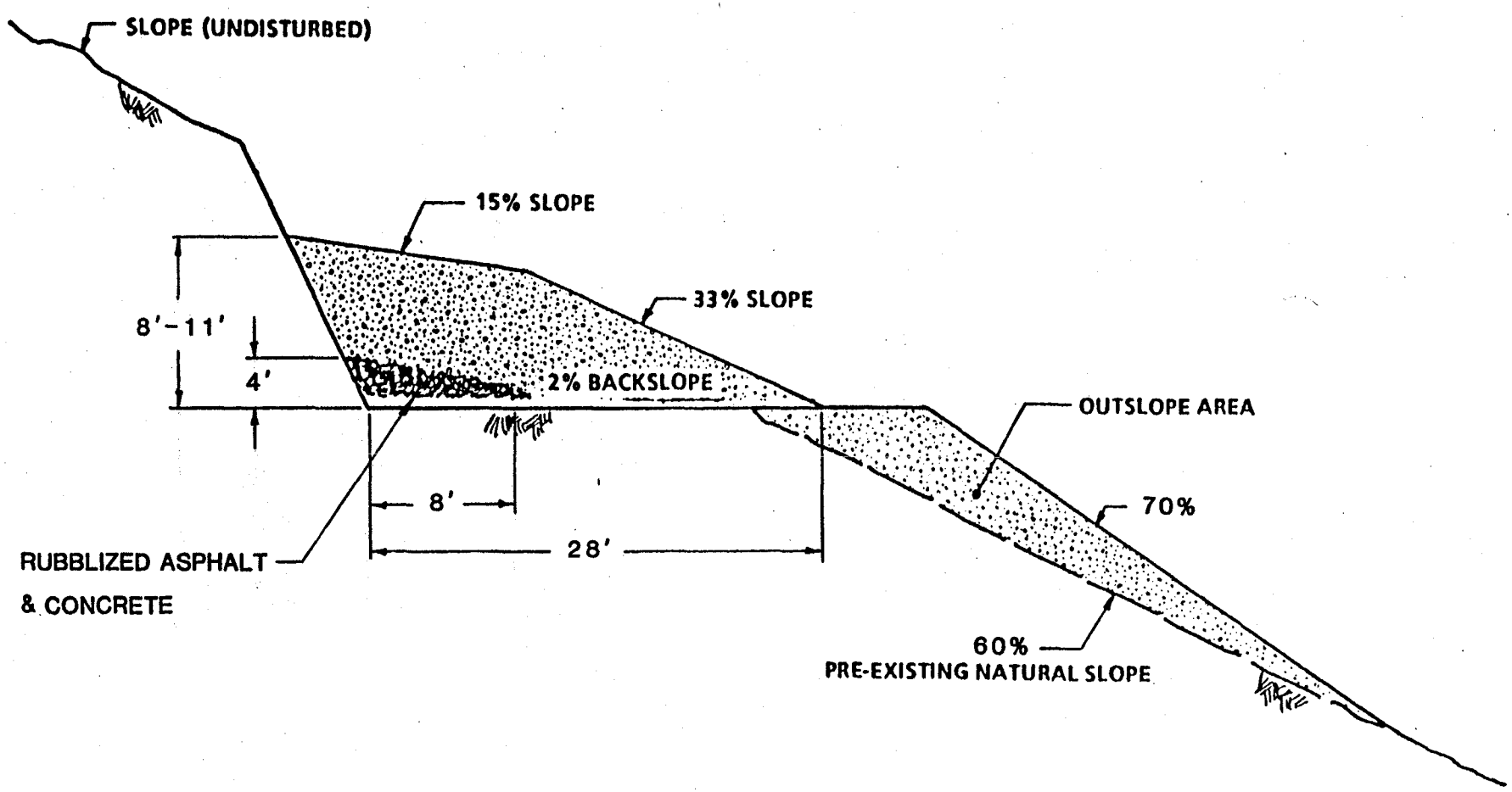
Reclamation of the road will begin with the removal of the asphaltic concrete road surface and the Portland cement concrete lining of the water control ditch which is located at the toe of the road cut slope. A portion of the cement concrete ditch (from station 71+00 to station 82+00) will be left in place and backfilled with riprap, as discussed in Section 3.6. After the road surface is reclaimed and the recontoured surface sloped back towards the hill at approximately four percent, this water control structure will convey water to Eccles Creek. Leaving this portion of the concrete ditch in place will minimize infiltration to the fractured rock hillside, thereby lessening the chance of slope failure. This water control structure will be monitored for bond release for the same period as the rest of the reclamation. The cement concrete lining will be rubblized to eliminate any slippage surface when it and the asphaltic concrete and fill material are placed for disposal. The larger pieces of cement concrete will be salvaged and used as riprap if they meet the specifications for riprap discussed in Section 3.4.

The asphaltic concrete will then be broken and will be placed against tne toe of the cut slope over the previously placed broken Portland cement concrete. The asphaltic concrete will be piled approximately four feet deep adjacent to the cut slope and graded to ground level seven to eight feet out from the toe of the slope (Figure 4-1). There are approximately 3,500 in place cubic yards of asphaltic concrete to dispose of. To insure a competent fill and prevent piping, the asphaltic concrete will be placed in an engineered manner and compacted. The asphalt will be broken by ripping it with the

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
TYPICAL CROSS SECTION - STABLE FILL
FINAL CONTOURED SURFACE

Figure 4-1

(NOT TO SCALE)



scarifiers on a motor grader or equivalent machine. The scarifiers are approximately 17-20 inches apart. It is expected, therefore, that their use will create pieces of asphalt less than two-feet square. If necessary a dozer will be walked over the ripped asphalt to further reduce the size. The rubblized asphalt will then be bladed to the toe of the cut slope by a motor grader or equivalent equipment. The asphalt will be compacted in one foot lifts. Once the asphaltic concrete surface has been removed, the gravel road base material will be ripped or disked to eliminate compaction and to promote water infiltration and root penetration.

After the asphalt is placed and compacted it will be covered with soil removed from the out slope fill portions of the road, to a sufficient depth to prevent it from being exposed to the atmosphere. The surface of the replaced soil will be contoured as shown in Figure 4-1 to reestablish a drainage pattern similar to that which was present prior to mining.

4.2 Corrugated Metal Pipe Removal

Seven of the eight corrugated metal pipe (CMP) culverts buried in the Belina haul road will be removed during reclamation. These channels, which include Eccles Creek, will be cleared of fill material, recontoured and riprapped as necessary to prevent excessive erosion. The riprap material will consist of large competent rock and/or broken pieces of cement concrete as discussed in Section 3.4 of this report. The removed CMP will be salvaged if possible, or disposed of in a section of the underground mine workings as detailed in Section 784.13 of Valley Camp's approved Mining and Reclamation Plan Permit Number UT0013.

The remaining CMP is the large culvert through the fill in the Bowl. As agreed to during a site visit with UDOGM personnel, this CMP will be left in place unplugged. The reconstruction of a channel through the fill will provide a significant overflow safety factor in the unlikely event that the CMP would become dammed or plugged.

4.3 Recontouring

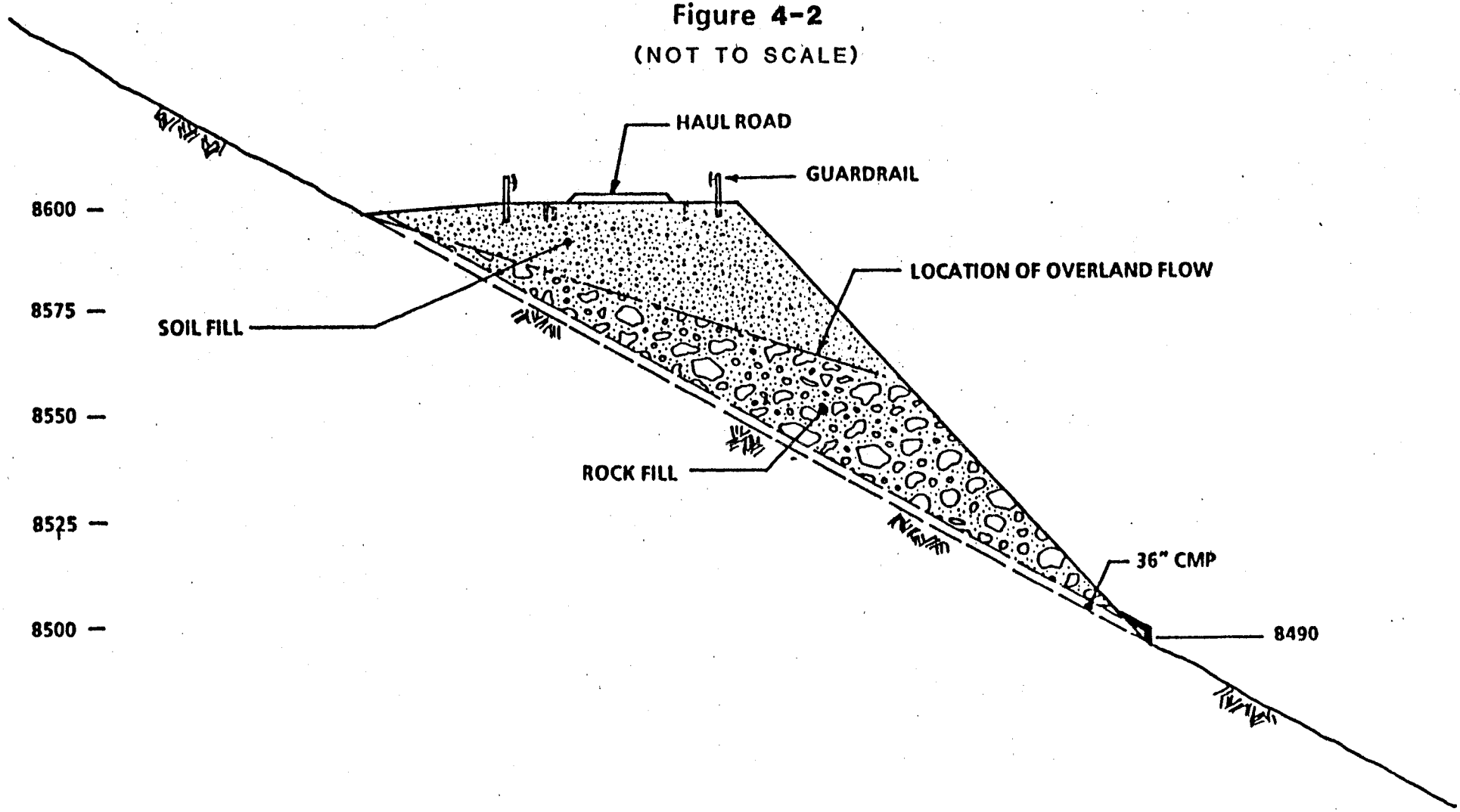
The recontoured areas will be developed by placing soil material excavated from two major fill areas (the Bowl crossing and the Eccles Creek crossing) on the "cut" portions of the road against the cut slopes as buttress fills. Additionally, portions of the road outslope fill areas are considered to be of questionable stability and will therefore also be excavated and placed in the buttress fills. Approximately 30,000 to 35,000 cubic yards of material will be excavated and placed during this recontouring effort. Drainage crossovers will be constructed across this recontoured surface to shorten the slope length and prevent excessive erosion (refer to Section 3.6 for details). These cutouts or crossovers will be riprapped to prevent the development of rills and gullies.

The reclaimed surface of the haul road will in most cases, slope to the outside. In some cases, however, it will slope back to the hill. Approximately the first 1,100 feet of the road, (from station 82+00 to station 71+00 on the CEI, 9/83 drawings) has a very steep outslope (approaching 120 percent) toward Eccles Creek. To keep water off of the face of this area and protect Eccles Creek the recontoured surface will pitch into the hill at approximately four percent (Figure 2.8). Runoff will be collected in a riprapped ditch constructed at the base of the road cut slope and will be conveyed down the hill and released to Eccles Creek approximately at the haul road/creek junction. The design of this ditch is addressed in Section 3.5 of this report.

4.3.1 Bowl Crossing

The largest fill is located near the midpoint of the haul road. It consists of blast rock on the bottom and soil on the top. The soil portion (approximately 15,000 yd^3) will be excavated and an overland channel will be developed through the remaining rock. The CMP will be left in place unplugged. This new drainage will be a permanent

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
THE BOWL CROSSING
Figure 4-2
(NOT TO SCALE)



structure constructed from competent rock which meets riprap specifications. In addition, energy dissipaters will be utilized, if necessary, to control the flow of water until it reaches the natural drainage channel. Figure 4.2 is a cross section showing the present road surface, fill slopes, and the projected location of the overland flow channel.

4.3.2 Eccles Creek Crossing

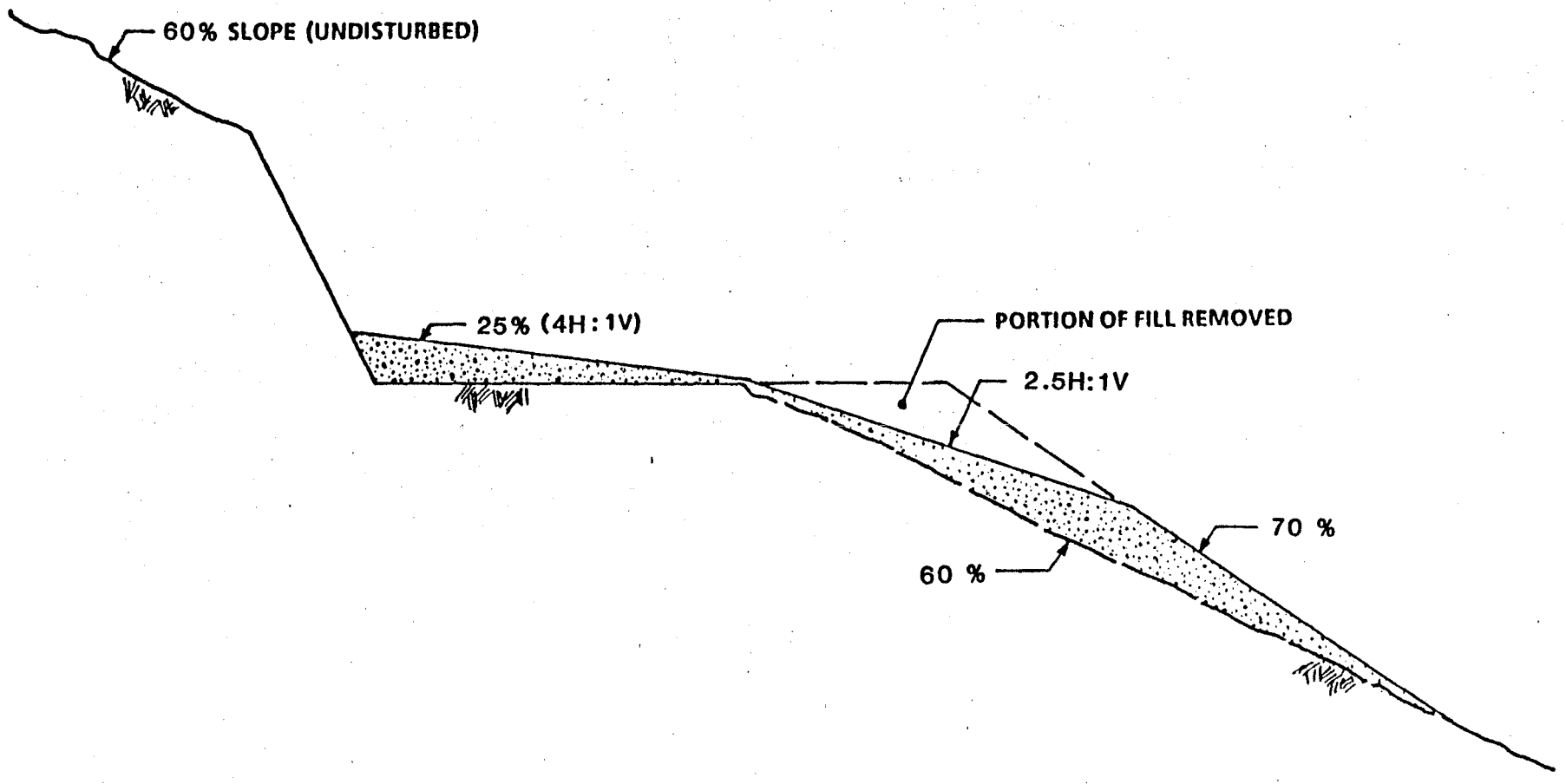
The second major fill is located at the intersection of the Belina Haul Road and the Eccles Canyon Road. This fill consists primarily of blast rock from the development of the first section of the haul road and is covered with soil. Again, only the soil portion will be removed. The remaining rock will be used as riprap for the rehabilitation of Eccles Creek, provided it meets riprap specifications. Any unused rock will be disposed of as discussed in Section 784.13 of Valley Camp's approved mining and reclamation plan (UT 0013). The corrugated metal pipe will be removed and disposed of similarily. These activities will allow Eccles Creek to return to its natural channel.

4.3.3 Unstable Fill Slopes

The third area from which backfill material will be obtained is from the portions of the outslope road fills that have been determined to be potentially unstable (Table 2.1). A sufficient quantity of fill will be removed from each of these fill slopes to reduce the potential of the slope failing. To initiate reclamation of these fill slopes, the guard rails will be removed and the support post and metal rails will be salvaged or disposed of.

The excavated material (Figure 4.3) will be removed using a backhoe or a similar machine to reach down the slope to retrieve material. As a result of this operation, the road edge will be cut back toward the

VALLEY CAMP OF UTAH
BELINA HAUL ROAD RECLAMATION
TYPICAL CROSS SECTION - UNSTABLE FILL
FINAL CONTOURED SURFACE
Figure 4-3
(NOT TO SCALE)



toe of the cut slope ten to fifteen feet. With the removal of this material the final surface will have an approximate slope of 2.5H:1V. The excavated material will be placed on the remaining road surface thereby creating an outslope of approximately 4H:1V.

The quantity of fill material estimated to be removed from the various sources and the estimate of the storage capacity that can be developed from utilizing the road surface is given in Table 4.1.

TABLE 4.1

VALLEY CAMP OF UTAH

BELINA HAUL ROAD RECLAMATION

SOIL DISPOSAL VOLUMETRICS

Fill Material To Remove:

o Eccles Creek Fill	4,000 $yd^3 \pm$
o The Bowl Crossing Fill	15,000 $yd^3 \pm$
o Haul Road Outslopes	6,000 $yd^3 \pm$
o Remaining CMP Removal	1,500 $yd^3 \pm$
o Asphaltic Concrete and Broken Cement Concrete	5,000 $yd^3 \pm$
GRAND TOTAL	31,500 $yd^3 +$

Storage Capacity:

o Haul Road with Stable Outslopes (3,470 feet)	25,000 $yd^3 \pm$
o Haul Road with Portion of Outslopes Removed (2,780 feet)	6,000 $yd^3 \pm$
o Backslope Section of Road (1,250 feet)	3,000 $yd^3 \pm$
GRAND TOTAL	34,000 $yd^3 +$

4.4 Topsoiling

During the construction of the haul road the overlaying topsoil and subsoils were excavated and stockpiled where possible, sidecast or used as fill. During the reclamation of the haul road some of the material which was sidecast and/or used for fill material will be excavated and used to recontour the road. The suitability of this material as a growth medium is evidenced by the vegetation currently growing on it and in fact very similar material has already been approved for use as topsoil at this mine by the Utah Division of Oil Gas and Mining. Prior to using this material as topsoil however, it will be analyzed for pH, texture, electrical conductivity, calcium, magnesium, sodium, organic matter, phosphorous and potassium. Because this material is a mixture of topsoil and subsoil and because no segregated topsoil stockpiles exist at this mine "topsoil" will not be placed on the regraded surface.

4.5 Seed Bed Preparation

The soil removed from the large fills will be replaced using dozers and scrapers. Soil removal from the potentially unstable outslopes will be accomplished using a backhoe or similar equipment. The soil replaced by scrapers and dozers will be scarified to a depth sufficient to allow root penetration whereas the soil placed by the backhoe will not require loosening since it will be subject only to limited packing. The final recontoured surface will then be disked or tracked on the contour prior to seeding.

4.6 Seeding

Seeding will follow the procedures and seed mixes outlined in Valley Camp's approved Mining and Reclamation plan, Permit Number UT 0013.

Areas of the haul road outslopes and cut slopes which will not be disturbed by reclamation activities will be subjected to a statistically valid vegetation survey at the time to determine the adequacy of the existing vegetation when compared to reference areas identified in Mining Permit Number UT-0013. If it is determined necessary, these undisturbed areas will be interseeded or interplanted with shrubs.

4.7 Fertilizing

A chemical analysis will be performed on samples of the soil which will indicate the nutrients and amounts necessary for proper plant growth. Fertilizer will be applied either just prior to or immediately following seeding.

4.8 Mulching

Mulch will be applied at approximately 2,000 pounds per acre, depending on the material of choice, and will follow application of the seed and fertilizer. The mulch will be straw or any of the other commonly used mulch materials. At the time of reclamation, where it is deemed necessary, a tackifying agent or some other means will be used to hold the mulch in place.

4.9 Erosion Control and Maintenance

During reclamation activities, interim erosion control measures such as filter fabric and straw bales will be used to control water flow. Once a drainage channel is established, these interim structures will be removed and the disturbed areas will be seeded, fertilized and mulched. At the conclusion of reclamation activities, runoff will be slowed by the proper placing of straw bales, filter fabric fences, riprap or mulch, in potential

problem areas. If runoff channels develop in excess of nine inches, the most applicable erosion control technique will be selected. For example, small erosion channels will be blocked with a filter fabric fence, a straw bale or some other material to slow the water and allow vegetation to establish.

4.10 Revegetation

The revegetated area will be monitored closely to ensure that a diverse, permanent vegetation cover capable of self-regeneration is developed. Revegetation success of the newly reclaimed haul road areas will be determined by following the techniques developed in Section 817.116 of Valley Camp's approved mining and reclamation plan, Permit Number UT-0013.

4.11 Reclamation Costs

Reclamation costs are summarized by task for the purpose of bonding costs. These cost estimates are made with the knowledge that the efficiency of workers and machinery may far exceed the normal rate because of the very limited work space, and the difficulty in scheduling of crews. The reclamation cost estimates are given in Table 4.2.

TABLE 4.2

RECLAMATION COST ESTIMATES

Remove Concrete and Asphaltic Concrete:			
Rip Portland Cement Concrete and Breakup Asphaltic Concrete			$ 3,500
Remove and Place Asphaltic Concrete (40 hrs. @ $87.50/hr.)			2,800
Compact Asphaltic Concrete			1,600
Break and Remove Concrete Ditch			6,500
Rip/Scarify Road Base Material (65 acres) (8 hrs. @ $75.00/hr.)			600
Remove corrugated Metal Pipes			8,000
Remove and Dispose Guard Rails, Posts, and Signs			5,800
Remove and Place Fill Material:			
20,000 yd^3 (Intersecting Drainage Fills)			50,000
7,000 yd^3 (Road Outslope Fills) (80 hrs. @ $100/hr.)			8,000
Recontour Road Surface:			
10.0 Acres ± (80 hrs. @ $100.00/hr.			8,000
Construct Riprap Drainage Channels:			
8 each (@ 200 feet each)			32,000
Redistribute Topsoil Substitute (10 Acres x 6" Deep):			
8,100 yd^3 ± (@$2.50/yd.)			20,000
Seedbed Preparation (Scarification, Disking, Harrowing)			1,000
Fertilizing, Seeding, and Mulching:			
Seed:	(10 acres @ 24.0 lbs/acre @ $15.00/P.L.S. lb.)	$3,600	
Fertilizer:	(10.0 acres @ $425.00/acre)	$4,250	
Mulching:	(10.0 acres @ $500.000/acre	$5,000	
Equipment and Labor:		$2,000	
Total			14,850
Monitoring			1,000
	TOTAL		$163,650
	10% Mobilization and Demobilization		16,365
	15% Profit and Administration		24,548
	Maintenance-10 Acres @ $100.00/ac/yr.		1,000
	TOTAL BONDING COST		$205,563

Technical Report

CONFIDENTIAL

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GROUND CONTROL STUDY FOR DOUBLE LIFT MINING PANELS

STABILITY ANALYSIS OF THICK SEAM
PILLARS BY FINITE ELEMENT SIMULATION TECHNIQUE

Belina No. 2 Mine
Valley Camp of Utah, Inc.
Scofield Route
Helper, Utah

AUGUST 1989

PROJECT NO. 2101
KENNETH C. KO & ASSOCIATES

CONFIDENTIAL

CONFIDENTIAL

KENNETH C. KO & ASSOCIATES, INC.
215 WEST LOUISIANA DENVER, COLORADO 80223 (303) 778-6748

August 1, 1989

Mr. Walter Wright, President
Valley Camp of Utah, Inc.
Scofield Route
Helper, Utah 84526

Dear Mr. Wright:

This report presents the results of the rock mechanics engineering study regarding the stability of small pillars and general operating areas in Belina No. 2 Mine to be mined by a new method of room and pillar mining. This proposed method of thick seam coal recovery is tentatively termed herein as the "double lift mining method". The objective of the study was to determine the applicability of this mining technique in the areas overlain by mined-out sections of upper seam, where the interburden is relatively shallow and the pillars in the proposed panels cannot be aligned to those in the upper panels.

The stability analysis was performed on two dimensional and three dimensional numerical models using one of the most advanced finite element codes that are applicable to underground mine structures. The site specific, physical and mechanical characteristics were used for the simulation models. The site specific geotechnical data at the Belina Mines have been

accumulated over the past ten years, and the reduced parameters from these data for the analyses are believed to closely represent the mine behavioral characteristics.

The results of analyses indicate that the proposed coal recovery by double lift method with small pillars in Belina No. 2 Mine is technically feasible in terms of mine stability based on the known and expected rock mechanics conditions in the site area. Mining near the fault zones and areas with overburden depth greater than 800' would require further engineering as the geologic conditions are uncovered. A minimum level of rock mechanics engineering program on a continual basis is recommended during the operation, to remedy for unexpected ground conditions.

Respectfully submitted,

KENNETH C. KO & ASSOCIATES, INC.

Kenneth C. Ko, President
Registered Professional Engineer
No. 3588
State of Utah

TABLE OF CONTENTS

CONCLUSIONS AND RECOMMENDATIONS 1

INTRODUCTION 4

SCOPE OF WORK 6

SITE CONDITIONS AND INITIAL STABILITY ESTIMATION 7

FINITE ELEMENT ANALYSIS 12

DESCRIPTION OF THE BMINES FINITE ELEMENT CODE 13

SINGLE PILLAR CLOSURE RESPONSE BEFORE AND AFTER FLOOR EXTRACTION 14

REGIONAL STUDY OF MINE STABILITY UNDER FLOOR EXTRACTION 21

MODELING THE RESISTANCE OF FAILED PILLAR 30

EFFECTS OF MINED OUT UPPER SEAM ON ACTIVE LOWER PANEL 33

EFFECTS OF ACTIVE LOWER PANEL ON UPPER MINE 41

REFERENCES 45

APPENDIX A: ROCK MECHANICS LABORATORY TESTING OF BELINA NO. 2 COAL SAMPLES

APPENDIX B: FINITE ELEMENT CODE DESCRIPTION

LIST OF FIGURES

FIGURE 1. PROJECTED MINE LAYOUT - BELINA NO. 2 MINE 5

2. OVERBURDEN AND INTERBURDEN CONTOURS 8

3. SAFETY FACTORS CALCULATED ASSUMING UNIFORM VERTICAL LOAD DISTRIBUTION 10

4. THREE DIMENSIONAL MODEL OF PILLAR BEFORE AND AFTER FLOOR REMOVAL 15

5. STRESS/STRAIN CHARACTERISTICS OF EQUIVALENT PILLAR/ENTRY SINGLE ELEMENT MODELS 20

6. THREE DIMENSIONAL REGIONAL MODEL OF THE FLOOR EXTRACTION STABILITY ANALYSIS 24

7. STRAIN DISTRIBUTION IN PILLARS AFTER FLOOR HAS BEEN REMOVED FROM ACTIVE PANEL 26

8. STRAIN CONTOURS IN THE PLAN SECTION OF THE ROOM AND PILLAR MINE 27

9. STRESS CONTOURS IN THE PLAN SECTION OF THE ROOM AND PILLAR MINE 28

10. BEHAVIOR OF THE 2-D MODELS FOR COAL PILLARS 32

11. TWO DIMENSIONAL DIAGRAM OF STAGGERED PILLARS BETWEEN THE UPPER AND LOWER COAL SEAMS 34

12. MEAN DISPLACEMENT OF SILTSTONE/SHALE INTERFACE VS. GROSS MEAN STRESS IN LOWER COAL PANEL 37

13. HORIZONTAL STRESS DISTRIBUTION IN SILTSTONE INTERBURDEN FOR 1000 PSI VERTICAL STRESS 39

14. STRESS CONTOURS IN THE UPPER COAL SEAM AS A RESULT OF DOUBLE LIFT MINING IN THE LOWER SEAM 42

LIST OF TABLES

TABLE 1. MATERIAL PARAMETERS USED IN FINITE ELEMENT MODELS FOR FLOOR EXTRACTION PROJECT 17

CONCLUSIONS AND RECOMMENDATIONS

The primary conclusion of the analyses presented herein is that the proposed method of removing the coal in the floor of the room and pillar panel would appear to be stable. It must be stated that this conclusion is contingent on the validity of a number of assumptions that were incorporated into the development of the model. Foremost among these is the decision to reduce the strength properties of coal by a factor of 25% from the laboratory properties. This was a highly subjective decision based on a combination of previous experience and the observation in the same areas of the mine over the last several years.

Properties were selected somewhat arbitrarily for the other materials above and below the active seam, and indeed the extent and position of these strata are not supported by extensive site investigation. Finally, the stability of the pillars involves far more complex phenomenology than the finite element model is capable of representing. While it is believed that conservatism was employed during the selection of a stability criterion, without in-mine verification, it would not be prudent to place much confidence in analysis alone. Documented case histories of similar instance of coal instability in the same mine, that have been accumulated during past years, were of great value in calibrating the stability criterion.

An additional conclusion is that three-dimensional analysis is an essential ingredient in addressing this problem. Indeed, in the final analysis of the stability issue, the 2-D and 3-D analyses came to different conclusions. The proximity of the region of virgin coal, which diverted a good portion of the overburden

pressure away from the active panel, thereby reducing the load to a level the pillars could support, could not be modeled in two dimensions. Earlier, in the development of the equivalent pillar/entry module, it was seen that the strength differences between the 2-D and 3-D analyses could not be accounted for by reduced coal area alone. It would have been difficult to prepare a convincing two-dimensional version of the pillar response model.

The roof over the active panel appears to have considerable rigidity, causing the gradients in strain in the active panel to take place over 100 or more feet. This corresponds to about two pillar and entry widths. This implies that the stability adjacent to a panel of virgin coal, or even a previously worked area of smaller extraction ratio, is greater within a pillar width of the panel than it is further away. With this in mind, it would seem possible to develop a sequence of floor removal that located critical facilities adjacent to structures of greatest stiffness. In this way, some degree of instability could be tolerated as long as the areas of instability did not intersect critical lifelines.

In terms of operating the double lift panels in the preselected areas, the following procedures, which have been incorporated in the Valley Camp's mining plan, should be adhered to:

1. The bottom coal in the rooms and entries adjacent to barriers or virgin coal, along the perimeter of a panel, should no be recovered.

2. Within the last few crosscuts in the 1st South Panel, (in the rooms parallel to the dike) a retreat plan should be made so that the second lift operation would

be made continuously without idle for two or three days. The coal pillars have a tendency to store the time dependent stress/strain energy. Particular care should be taken for potential bump conditions after such a period of idle near solid coal areas.

3. At least two entries next and parallel to the fault zone in the east main panels need to be left without bottom coal recovery. Additionally, the roof in these entries should be regularly inspected and reinforced as required during development.

4. The time factors in the stability is not well understood and need to be monitored during the operation. However, the effects of the double lift mining on the existing upper mine areas are estimated to be minimal. If and when re-mining a solid, presently unmined areas in the upper seam above the double-lift panels, more detailed analyses would be required.

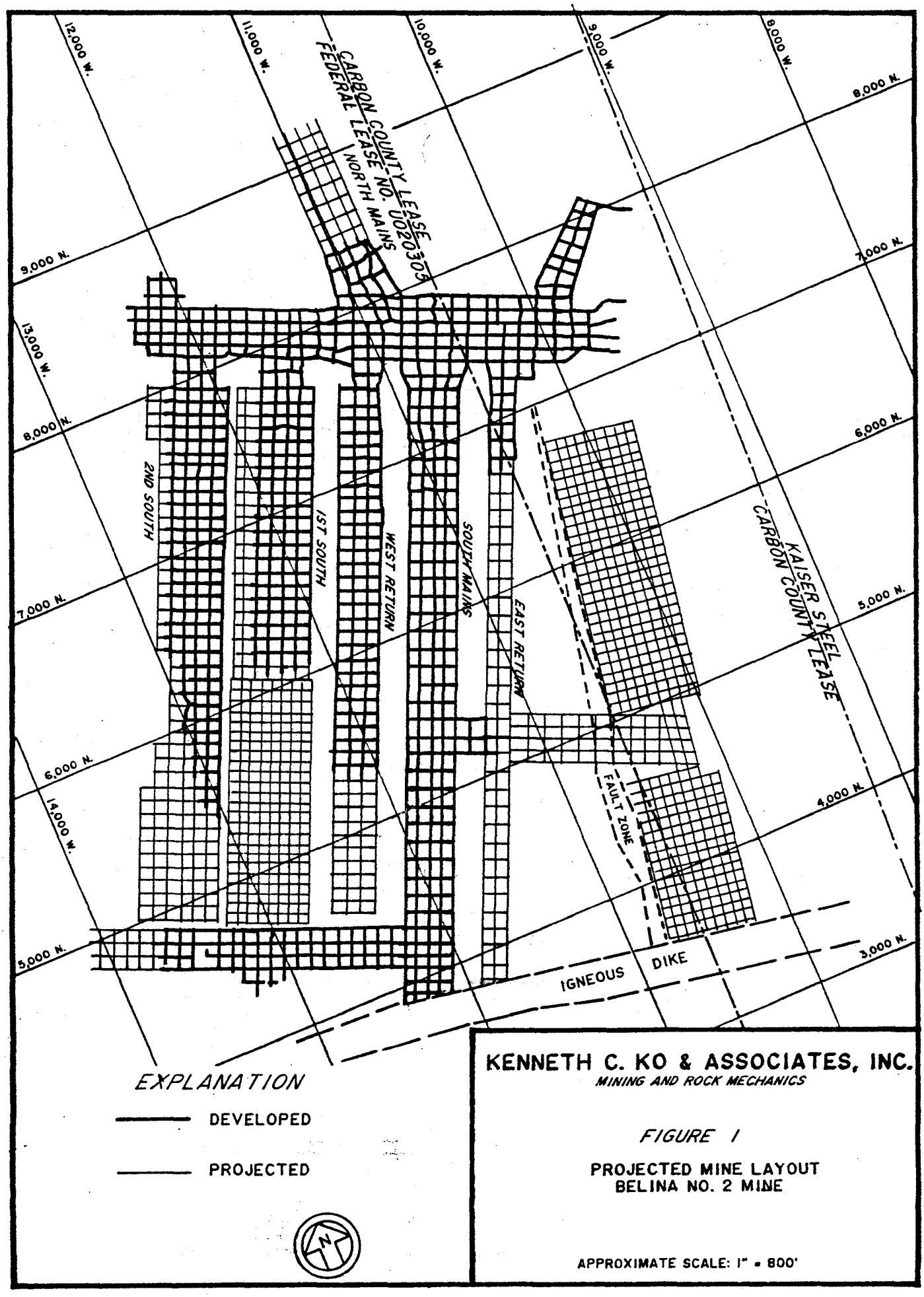
INTRODUCTION

This report presents the results of a rock mechanics engineering feasibility study regarding the proposed method of mining in the areas of the southern half of 1st South Panel and panels to be accessed by the 1st East Mains across a major fault zone of Belina No. 2 Mine. The approximate layout of Belina No. 2 Mine with existing and proposed developments is shown on Figure 1.

Valley Camp of Utah, Inc. (Valley Camp) has developed a new mining plan using a 40' remote continuous miner (Joy 12CM or an equivalent) to increase the face productivity as well as the overall coal recovery from the 20' thick seam. This new mining method entails developing panels with seven entries in development and three additional entries in retreat. The panel pillars will be 40' by 40', supporting the 20' wide rooms to be developed in the upper 10' of the coal seam. The lower portion of the coal seam, of up to 10' or so in thickness, will be recovered systematically in retreat. This mining technique is referred to as the "Double Lift" mining method in this report.

The double lift mining will leave 18' to 20' high pillars with cross-sectional dimensions of 40' by 40'. The proposed panels are overlain by mined out panels in the upper seam, Belina No. 1 Mine. Due to the differences in the coal recovery methods, the pillars and panels cannot not be "stacked". Furthermore, the interburden between the two mines is relatively shallow, ranging from 40' to 70' within the proposed panel areas.

Kenneth C. Ko & Associates, Inc. (KCKA) has worked on several projects regarding various rock mechanics aspects of room and pillar mining in both Belina No. 1 and No. 2 Mines since 1980.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CARBON COUNTY LEASE
FEDERAL LEASE NO. U020309
NORTH MAINS
2ND SOUTH
1ST SOUTH
WEST RETURN
SOUTH MAINS
EAST RETURN
KAISER STEEL
CARBON COUNTY LEASE
FAULT ZONE
IGNEOUS DIKE
EXPLANATION
DEVELOPED
PROJECTED
KENNETH C. KO & ASSOCIATES, INC.
MINING AND ROCK MECHANICS
FIGURE 1
PROJECTED MINE LAYOUT
BELINA NO. 2 MINE
APPROXIMATE SCALE: 1" = 800'

These projects were related to determining site specific geotechnical parameters for roof and pillar stability, subsidence potential, multiple seam interaction, and the like, through site inspection, laboratory testing, and in-situ testing, instrumentation, and monitoring. During 1983 and 1984, an extensive in-mine rock mechanics program was carried out to determine the feasibility of the thick seam retreat mining method with narrow pillars in Belina No. 1 Mine (KCKA, 1985). Documentation of the performance of this mining method and the ensuing program of monitoring the stability of the upper mine during the development of the lower mine (KCKA, 1988) have provided the basis for the evaluation of the new mining method in this report.

SCOPE OF WORK

The purpose of KCKA's rock mechanics services on this project was to investigate the potential for ground instability in the double lift panels during the production period. The study was to determine the adequacy of the panel pillar size for roof support and to evaluate the interaction between the double lift panel and the overlying mined out sections through the siltstone interbed.

Based upon the results of previous rock mechanics studies, the site characteristics have been reduced to rock mechanics parameters appropriate for numerical modeling of panel areas. A three dimensional finite element code was employed to analyze the changing ground stress conditions in the critical sections of the panel with respect to pillar and panel stability. The results of the investigation are described in this report.

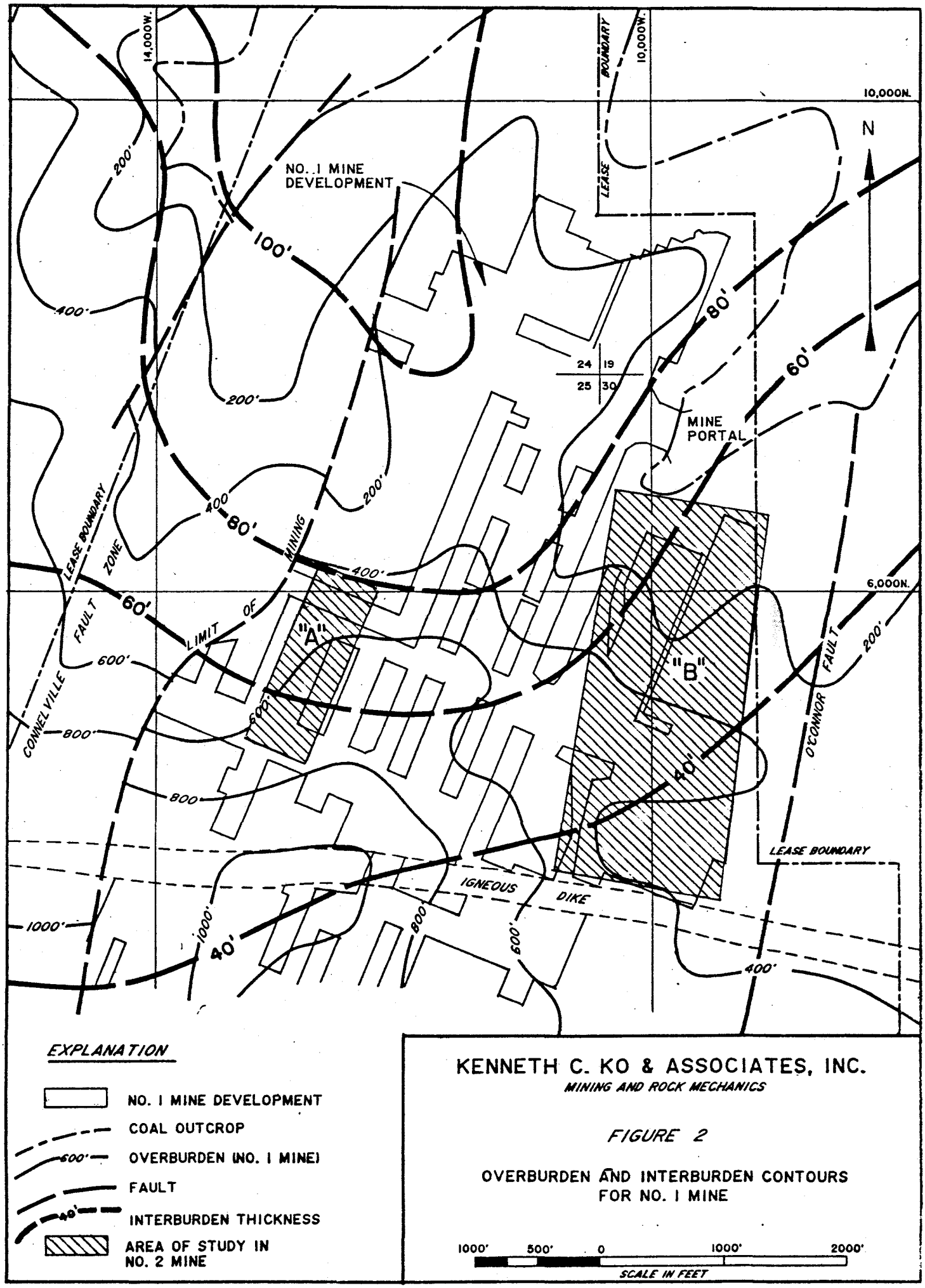
SITE CONDITIONS AND INITIAL STABILITY ESTIMATION

The Belina mine property is located between two regional faults: the Connelville Fault to the west and the O'Connor Fault to the east. These two faults generally trend to the north to NNE (Figure 2). A few local faults have been encountered in the mine. These faults are generally parallel to sub-parallel to the regional faults. The expression of these faults in underground has been relatively minor, and appeared to diminish in extent at the lower mine. Toward the mid section of the mine property is an east-west trending igneous dike which forms a boundary for the northern half of the mine operation.

The upper seam mine, Belina No. 1 Mine, had been developed through the igneous dike to the southern section of the property. The lower seam mine, Belina No. 2 Mine, is at present confined to the northern half of the property. The shaded areas marked "A" and "B" are where the new mining panels will be developed. The overburden depth to these panel areas can be obtained by adding the interburden thickness to the overburden depth to the No. 1 mine shown in Figure 2.

Area A will be developed as an extension of the existing development in the 1st South panel. The upper seam of this area was all mined out using 60' by 60' pillars having a height of 20' in the panel and 10' in the development. The interburden in this area ranges from 50' to 80', the interburden thickness decreasing with increasing overburden depth.

In Area B, two to six panels will be developed with the double lift method. The area is overlain by completely mined out sections in the No. 1 mine. Two panel sections had been mined out using the yielding pillar concept, leaving 20' by 60' pillars at



KENNETH C. KO & ASSOCIATES, INC.
MINING AND ROCK MECHANICS

FIGURE 2

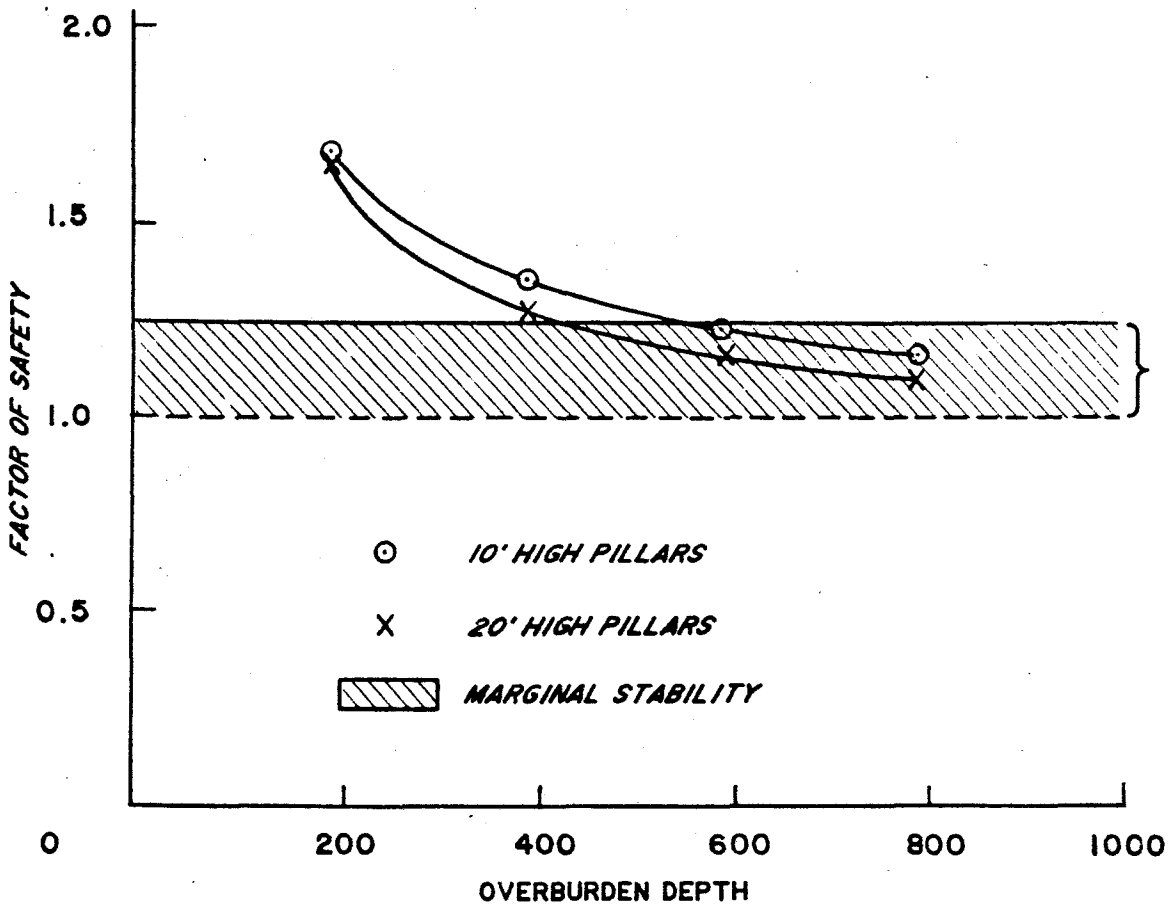
OVERBURDEN AND INTERBURDEN CONTOURS FOR NO. 1 MINE

20'in height. Other panel sections had been mined using a conventional pillar recovery method in the upper coal only, leaving various sizes of stumps. The interburden to the lower mine ranges between 40' and 60' in this area.

Detailed geologic sections are not available for the proposed panel areas. According to the geologic section maps of a neighboring mine, the overburden consists mostly of alternating shale and siltstone units interbedded with thin layers of sandstone. The interburden consists of a massive siltstone unit, indicated in a mine drilling program in 1985. The rock mechanics instrumentation and monitoring program in 1987 confirmed that the siltstone unit is generally intact. The floor of the lower seam mine is sandy siltstone to sandstone of unknown thickness.

The lower seam coal is generally stronger than the upper seam coal, as determined in KCKA's laboratory. The results of the laboratory tests are included in Appendix A of this report. The general strength characteristics of the lower seam coal are expected to vary from panel to panel, as was the case in the upper seam.

Based on these laboratory test results, the stability of 40' by 40' pillars in the lower seam panels was estimated using Wilson's method of calculation of safety factors. The results are plotted in **Figure 3**. The aforementioned method of calculation assumes that the overburden load is uniformly distributed over the entire mine area, and it does not take the general mine configuration into accounts. The two seam interaction, for example, is not accounted for. Nevertheless, the calculated factors of safety provide some indication as to the relative stability of the small pillars as a beginning point for a more analytical study. The results plotted in **Figure 3** indicate that the stability of the



SAFETY FACTORS CALCULATED ASSUMING UNIFORM VERTICAL LOAD DISTRIBUTION

FIGURE 3

pillars becomes marginal as the overburden depth becomes greater than 500'. This results imply that a systematic removal of coal at a continuous rate of retreat should be designed and adhered to.

A detailed analysis using a more comprehensive mathematical model is presented in the main text of this report. A finite element analytical study using the ESAP3 Code was made previously for the two seam condition in a two dimensional section model (KCKA, 1988). The geologic section used in that study was used also for the present study, incorporating a 50' interburden thickness.

FINITE ELEMENT ANALYSIS

Several finite element analyses were used to investigate the stability of the proposed double lift floor extraction plan for selected areas of Belina No. 2 Mine. These analyses were performed using a PC version of the BMINES finite element code, the capabilities of which are described herein, and some pertinent aspects are presented in Appendix B.

This investigation was carried out in three stages. The first involved the response of a single pillar to closure of the roof and floor both with and without the floor removed. The purpose of this phase of the analysis was to develop an equivalent pillar/entry module for use in assembling an economical version of the global stability model, and to develop criteria for identifying pillar failure. The second stage of investigation involved an analysis of the regional redistribution of stress and deformation brought about by the proposed floor removal in a single panel of the room and pillar mine. This was accomplished using a very large 3-D model of the region surrounding the entire panel, with the panel assembled using the synthetic pillar/entry modules developed in the first phase of analysis. The third stage of investigation involved a 2-D model of a two seam section to study the effects of the mined out sections in the upper seam on the stability of the lower seam within the immediate areas of the pillars.

The section concludes with a discussion of the results of these finite element analyses and the implications of these results regarding the stability of the proposed floor extraction plan.

DESCRIPTION OF THE BMINES FINITE ELEMENT CODE

The BMINES computer program provides for the static, two- or three-dimensional, linear or nonlinear analysis of structural and geologic systems. The code was specifically designed for application to mining problems involving the simulation of excavation and construction sequences. This program was originally developed for the US Bureau of Mines by Agbabian Associates (Van Dillen et al., 1981) and was recently modified, without government sponsorship, to run on the IBM PC (Appendix B).

The capabilities of the BMINES code that are of particular interest for the investigation considered herein include primarily its ability to handle very large three dimensional models. This is made possible by a non-core-resident equation solver that utilizes disk storage to accommodate stiffness matrices far too large to be contained in random access memory. The mesh generator is invaluable in assembling large three dimensional models in a reasonable length of time and with a minimum of error. The material library contains both linear and nonlinear material models, with a variety of plasticity laws and an ability to represent anisotropic, viscoelastic, and viscoplastic materials.

The load options include externally applied tractions and gravity self weight. Options available for other applications include joint or fault interface elements in both two and three dimensions, element activation and deactivation useful in modeling the sequence of excavation and installation of support systems, and a rockbolt element capable of modeling bolt rupture, bond failure, and dowel shearing across a joint interface. The program is limited to small deformation analyses.

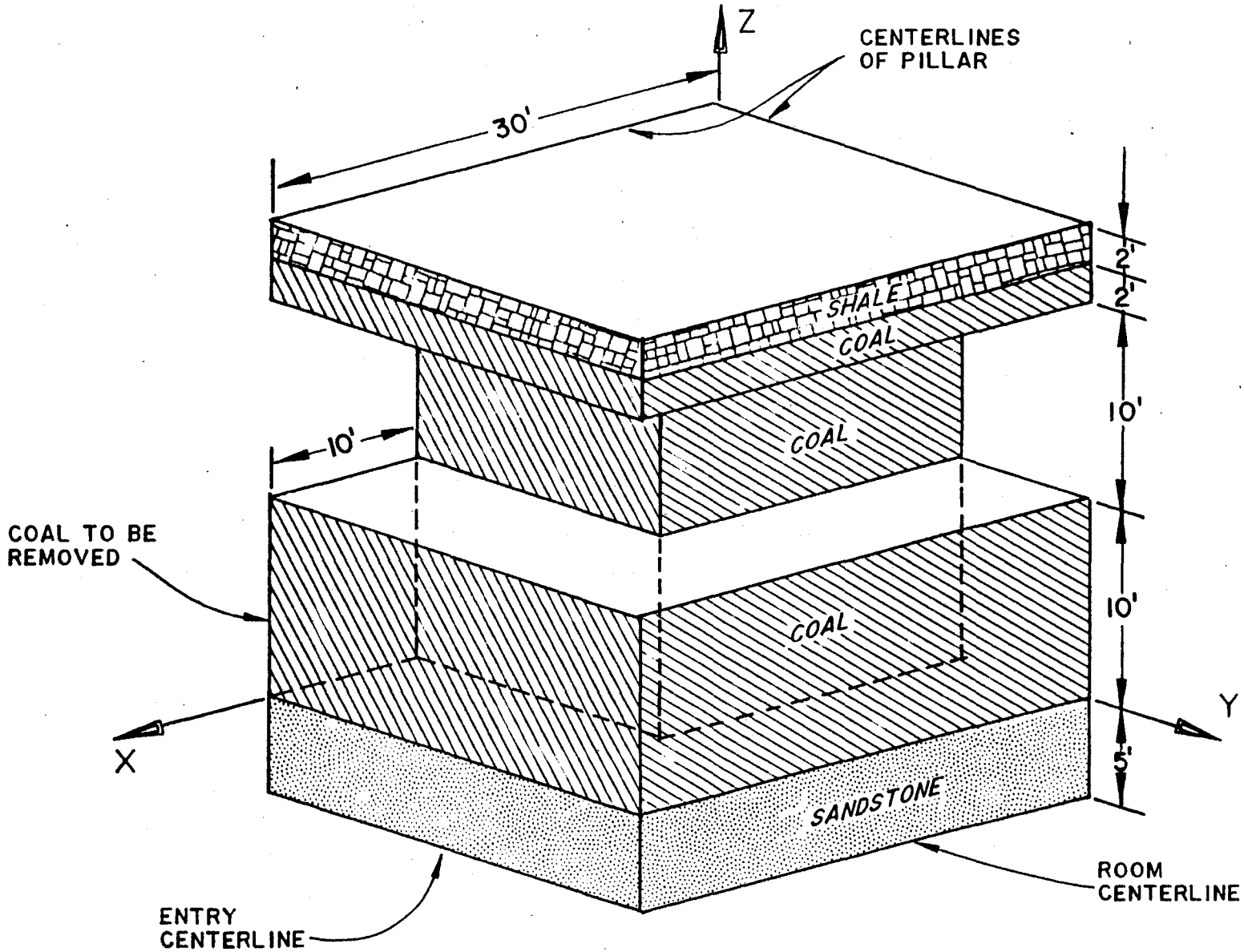
SINGLE PILLAR CLOSURE RESPONSE BEFORE AND AFTER FLOOR EXTRACTION

The room and pillar panel under consideration for floor removal consists of a uniform network of 40' by 40' pillars separated by 20' wide entries. A single pillar in this network contains planes of symmetry passing through the center of the pillar in both grid directions, and along the center lines of all entries. These planes of symmetry permit analysis using the three-dimensional model shown in **Figure 4**.

This model, containing only one quarter of a pillar, is bounded by four planes of symmetry. The top of the model corresponds to an interface between a soft shale member and a thick layer of competent siltstone. To simulate the effect of the relatively rigid overburden, the model shown is driven on the top surface by uniformly distributed displacements of prescribed magnitudes. The coal layer is underlain by a competent sandstone member, 5' of which has been included in the model in order to allow a natural transition of load between the pillar and the floor.

The question to be investigated by this model is how the removal of the coal indicated in the figure will affect the support capacity of the pillar.

Two finite element models were generated, one in which the coal to be removed is still in place, and the other in which it has been removed. Displacements ranging from 1" to 6" were then applied to both models. At each displacement level, the total resistance of the pillar was determined by multiplying the stress in each element in a horizontal plane of the pillar by the cross-sectional area of the element, and adding up the contribution from each element of the cross section. This resultant force in the pillar was then expressed as an equivalent stress for an



THREE - DIMENSIONAL MODEL OF PILLAR
BEFORE AND AFTER FLOOR REMOVAL

FIGURE 4

equivalent pillar/entry module by dividing it by the total plan area of the pillar and entry (30′ by 30′).

An equivalent strain in the pillar module can be determined by dividing the prescribed displacement by the height of the overall model, or 29′. The equivalent stress/strain curves of the pillar modules before and after floor removal can then be used in the construction of a regional model investigating the effects of floor removal over the entire panel.

Laboratory tests on coal samples from the mine have been performed by Kenneth C. Ko & Associates (Appendix A). Included in this data set are unconfined compression tests, triaxial tests, and Brazilian tension tests. Each of the unconfined and triaxial tests included instrumentation to measure the modulus of deformation.

The numerical representation of the coal material consists of linear elastic stiffness moduli with a quadratic representation of the failure envelope. It is well known that the mechanical response of the in-situ coal mass is diminished from the measured response of laboratory specimens due to the influence of joints and inhomogeneities. In accordance with previous experience in analyzing longwall coal mines (Van Dillen, 1978; Van Dillen and Fellner, 1981), the numerical model for in-situ coal was obtained by applying a reduction factor of 0.25 to each of the laboratory tests, and using a polynomial regression procedure to determine the coefficients of the yield envelope. Also in accordance with previous experience, the stiffness properties determined from the laboratory tests were used without reduction. The material parameters used to model the in-situ coal properties are provided in **Table 1**.

MATERIAL PARAMETERS USED IN FINITE ELEMENT MODELS FOR FLOOR EXTRACTION PROJECT

MATERIAL	YOUNG'S MODULUS (PSI)	POISSON'S RATIO	UNIT WEIGHT (PCF)	Y_{11} *	Y_{12} *	Y_{13} *	MAXIMUM VON MISES LIMITS (PSI)
COAL	2.5×10^5	0.25	78	73.5	-0.308	-1.76×10^{-5}	1425
SANDSTONE	2.0×10^6	0.25	160	94.0	-0.378	-1.04×10^{-5}	3537
SHALE	5.0×10^5	0.25	160	45.7	-0.373	-2.95×10^{-5}	1220

*FAILURE ENVELOPE IS DESCRIBED BY $\sqrt{J_2'} = Y_{11} + Y_{12} J_1 + Y_{13} J_1^2$ WHERE J_1 AND J_2' ARE THE FIRST STRESS INVARIANT AND THE SECOND INVARIANT OF THE DEVIATORIC STRESS STATE, RESPECTIVELY AND THE NEGATIVE VALUES OF NORMAL STRESS SIGNIFY COMPRESSION.

TABLE 1

The remaining rock units identified in Figure 4 include shale and sandstone. Laboratory test results for these materials were unavailable at the time the numerical model of the pillar was being constructed. Both the sandstone and the shale were judged to be of good rock quality in the sense of the rock mass characterizations tabulated by Hoek and Brown (1980). The text of this rock mass category description from Hoek and Brown is, "Good quality rock mass - fresh to slightly weathered rock, slightly disturbed with joints spaced at 1 meter to 3 meters."

A sandstone of a similar quality from another mine had been tested, resulting in an unconfined strength of 9000 psi. The sandstone in the mine under consideration was thought to be of similar strength, and so 9000 psi was used. Using the procedures of Hoek and Brown (1980) to adjust the laboratory strength parameters to in-situ field properties, the parameters tabulated in Table 1 were used. Similar reasoning was used to select the shale parameters also appearing in this table. These values correspond to an unconfined strength of 4600 psi.

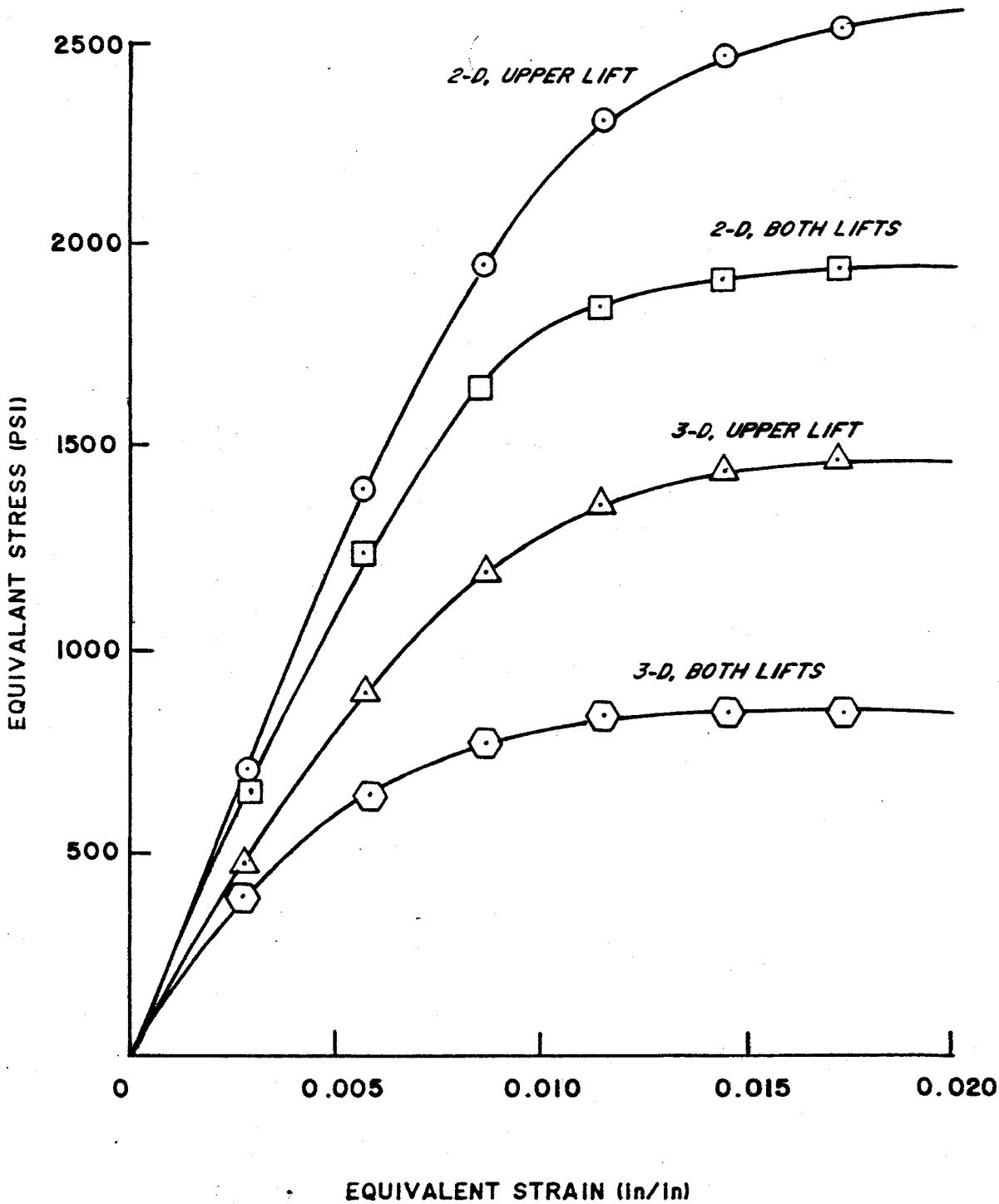
Four finite element models of the pillar shown in Figure 4 were created and executed, two in 2-dimensions and two in 3-dimensions. Both the 2-D and 3-D versions considered one case in which the floor had not been mined and a second case in which it had. All of these models were relatively small, the largest of them consisting of 123 elements, 216 nodes, 400 degrees of freedom, and a stiffness band width of 74. All were exposed to uniform displacements of the top surfaces of the models, and methods described earlier were used to determine the vertical stress/strain behavior of an equivalent, single-element, pillar/entry module.

The results of these four analyses are shown in Figure 5. The load capacity of the 2-D cases exceeds that of the 3-D cases because the results are being expressed in terms of equivalent stress of the pillar/entry module. In the 3-D case, coal occupies only 44% of the cross section of this module, whereas in the 2-D case coal occupies 67%. On this basis it would be expected that the load capacity of the 2-D cases would exceed those of the 3-D cases by a factor of 50%.

The results of Figure 5 indicate that the capacity of the 2-D pillar modules exceed those of the 3-D modules by more than this factor, or put another way, the strength reduction of coal pillars due to three-dimensionality exceeds that which would be expected on the basis of reduction of cross section alone. This additional reduction of capacity comes about due to a loss in confining stress in the 3-D case, which reduces the maximum vertical stress that can be achieved in the coal.

In each pair of cases, the capacity of the coal pillar is seen to decrease after removal of the floor, even though the coal cross section is not reduced. This effect can also be attributed to a loss of confinement in that the coal at midheight of the pillar is further from the ends of the pillar after the floor has been mined out. This effect is analogous to the sensitivity of unconfined compression tests of rock and concrete on specimen length.

The response shown in Figure 5, particularly for those cases in which the floor has been mined out, shows attainment of maximum capacity in the sense of classical plasticity, in that additional strain can be imposed on the pillar without an increase in stress. This behavior is not typical of coal pillars in that the attainment of ultimate load generally is accompanied by spalling



STRESS / STRAIN CHARACTERISTICS OF EQUIVALENT PILLAR / ENTRY
SINGLE - ELEMENT MODULES

FIGURE 5

of rib materials away from the coal face, thereby reducing both the coal area and the confinement of the interior of the pillar.

As a result of this spalling phenomenology, the capacity of the pillar begins to decrease shortly after the attainment of ultimate load. Such behavior cannot be modeled in the finite element code used for this study, nor in any codes of which the authors are aware. Since the real load capacity drops off after ultimate load, the load level in the pillars as computed by the finite element model is not a good indicator of pillar failure.

A much more sensitive measure of pillar capacity is the amount of equivalent strain in the pillar. It can be seen that for the three dimensional pillar with both levels mined out, ultimate load occurs when the equivalent strain reaches a value of about 1%. For this case then, strains in the pillar/entry modules of less than 1% will be considered stable, while strains in excess of 1% will be considered unstable.

REGIONAL STUDY OF MINE STABILITY UNDER FLOOR EXTRACTION

The primary issue in assessing the stability of the mine under the proposed process of floor extraction is the extent to which the weight of the overburden is transferred from the pillars in the active panel to the adjacent areas of virgin coal and/or panels of single layer mining. This issue is addressed by considering the mechanical response of the overlying rock, with the coal in the active panel and the adjacent panels serving only as a deformable foundation for these overlying members.

To provide the correct modulus of this foundation under varying conditions of loading, it is not necessary to model the pillars

and entries in detail. It is equally correct to replace these structures with simple modules that have the same relationships between equivalent stress and equivalent strain. Thus a single solid element having the load/deflection behavior shown in **Figure 5** can be used to replace the much more complex structure of the actual pillars and entries. This substitution is the basis for the use of the term "equivalent pillar/entry module" in the previous section.

It is also not necessary for one module to represent exactly one pillar, due to the regularity of the pillar pattern within the panel. The number of pillars actually represented by a pillar/entry module can be determined by dividing the horizontal area of the element by 3600 square feet.

The pillars in the active panel will actually be replaced by a pair of pillar/entry modules, the first representing the load/deflection properties of the pillar with the floor mined out, and the second representing the difference in load capacity between the pillar with only one layer mined out and the pillar with both layers mined out. These two modules occupy the same space in the finite element model, and are connected to exactly the same nodes.

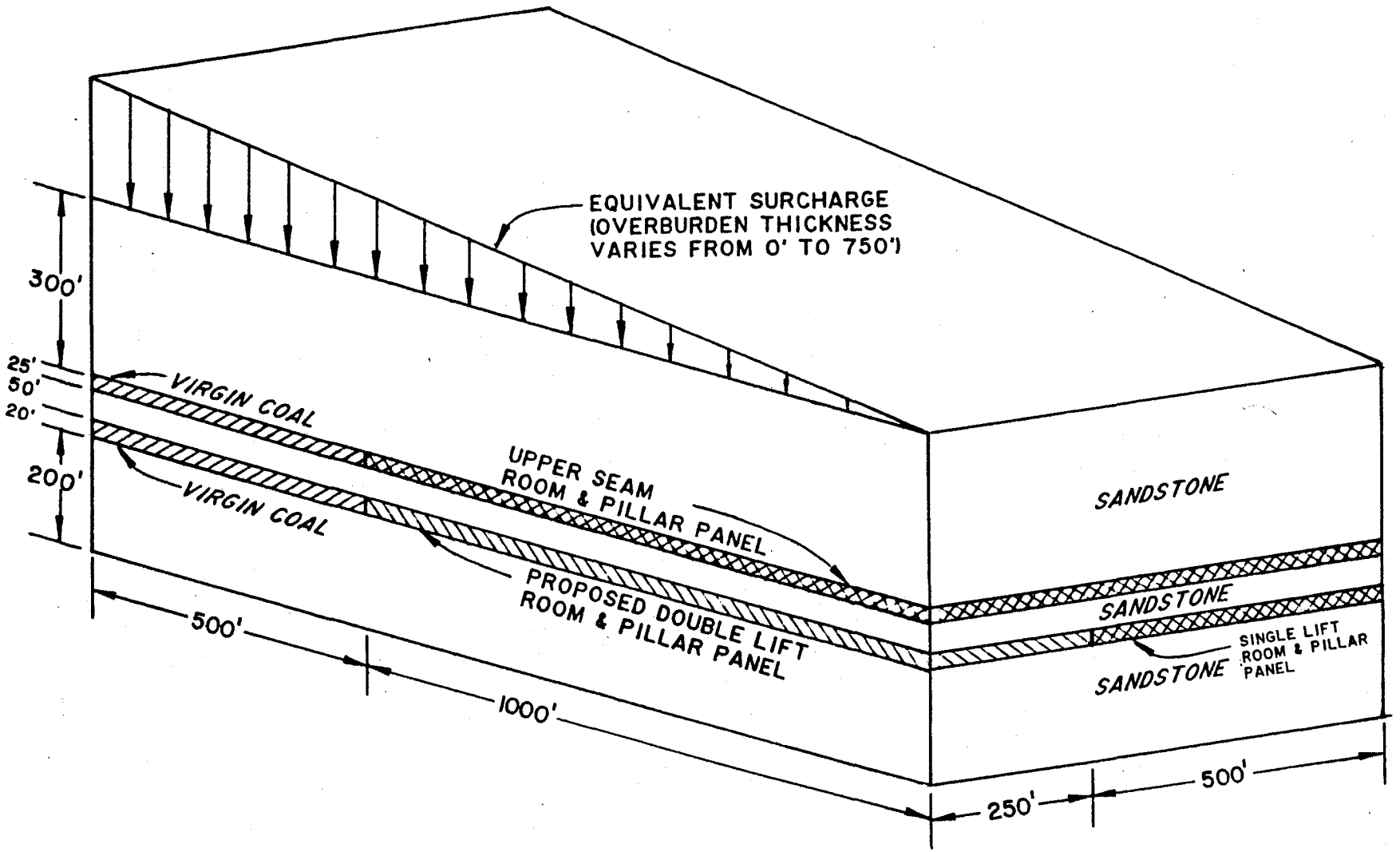
While both modules are active, the strain state in the two elements must necessarily be identical, and the resultant load is the sum of the individual loads. This situation represents the subgrade reaction of the pillars with only the upper level mined out. At a prescribed load step of the calculation, the second of these pillar/entry modules is forced to go inactive, leaving only the first in operation. This situation simulates the subgrade reaction of the pillar with both layers mined out.

A three-dimensional version of the regional stability model is shown in **Figure 6**. The model covers 1000 feet of length along the room and pillar panel, and an additional 500 feet of virgin coal at the far end. The near face of the model is along the center line of the active panel, and is represented, therefore, as a plane of symmetry. The active panel extends 250 feet into the model in the transverse direction, and an additional 500 feet of the mine is included in this dimension. This portion of the mine consists of a room and pillar panel previously mined in the top level only, and has material properties equivalent to the sum of the two pillar/entry modules described above.

Vertically, the model consists of a 50' thick layer of siltstone above the active pillar. This unit is overlain by another coal seam of 25' thickness, which has been mined in one level at an extraction ratio of about 50%. This would suggest that its stiffness properties would correspond to the sum of the two pillar/entry modules. Above the upper coal seam is a thick sandstone unit which is assumed to continue up to the ground surface. The model includes 300' of this layer. The cover above the 300' level varies from 0' at the near end of the model to 750' at the far end, resulting in a depth of cover of 500' above the farthest extent of the active panel.

Two finite element models have been constructed to analyze the configuration shown in **Figure 6**.

The first of these is a two-dimensional model in the transverse direction, with an assumed worst case depth of cover of 500' above the top of the model. This model consists of 196 elements and 210 nodes. There are 377 degrees of freedom and the stiffness band width is 31. The distribution of strain in the pillars after removal of the floor for this analysis is shown in



THREE - DIMENSIONAL REGIONAL MODEL OF THE
FLOOR - EXTRACTION STABILITY ANALYSIS

FIGURE 6

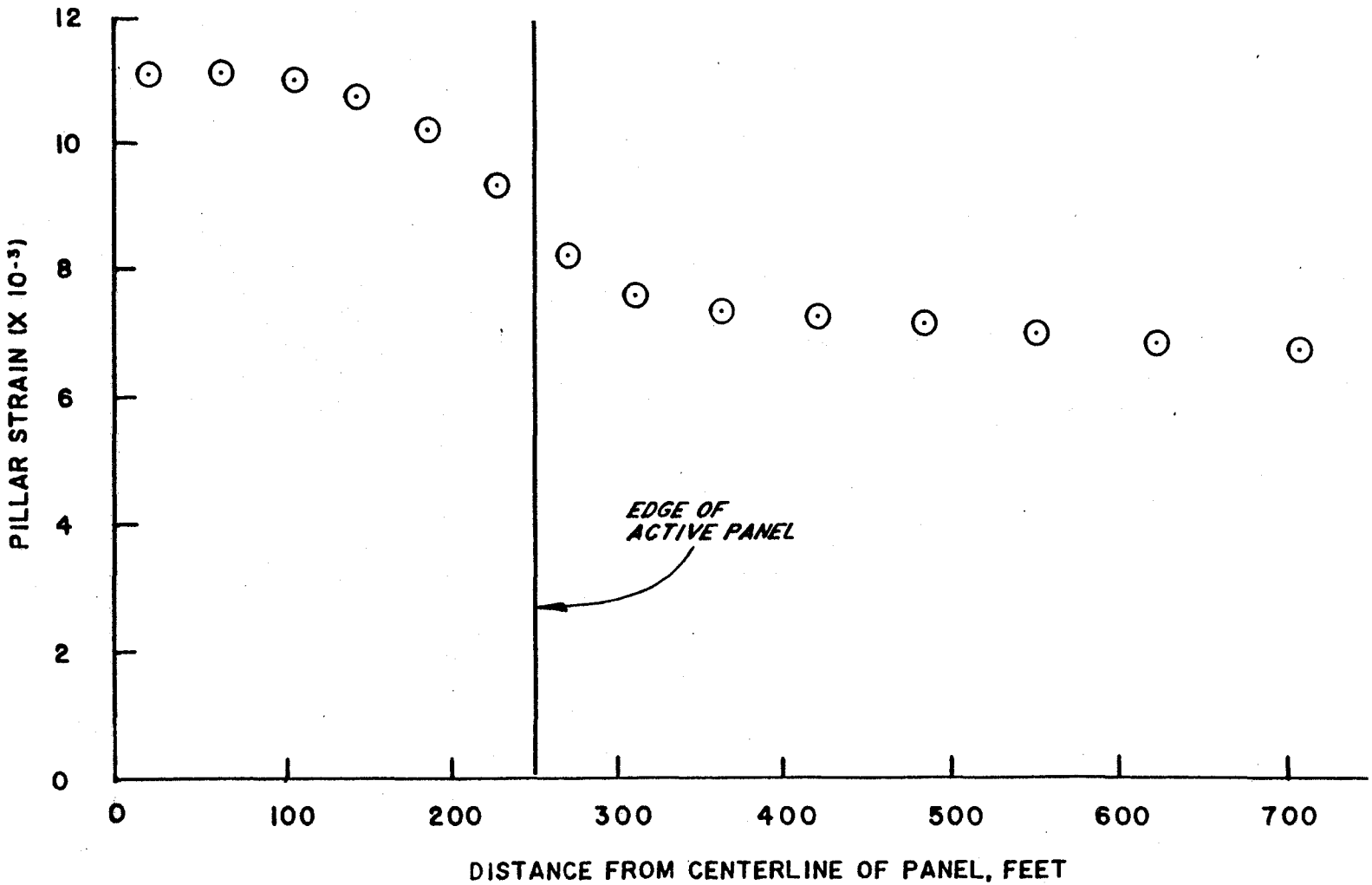
Figure 7. It is seen from this figure that the strains in the pillars attain a maximum value of about 1.1%, which is above the stability criterion set earlier at 1% strain. However, the two-dimensional analysis fails to take account of the proximity of the virgin coal at the location of maximum overburden.

The second model is three-dimensional, and consists of 780 elements, 1040 nodes, 2596 degrees of freedom, and a stiffness band width of 240. The strain levels in the mine plan section resulting from this analysis are shown in Figure 8. Note that the active panel is shown in the lower right portion of the figure. The upper right portion of the figure consists of an old room and pillar panel in which the top level only has been mined. The left portion of the figure is an area of virgin coal. The virgin coal is considerably stiffer than the previously mined area, which in turn is stiffer than the active panel, in which two levels are to be mined.

The stiffer areas tend to redistribute the load of the overburden away from areas of lesser stiffness, and so the pillars at the left edge of the active panel, where the depth of overburden is greatest, benefit from the nearby support of the virgin coal, and therefore exhibit less strain than was previously estimated on the basis of the two dimensional analysis.

The strain levels indicated in Figure 8 are within the stability limits established on the basis of Figure 5, and therefore lend support to the proposal to proceed with the project.

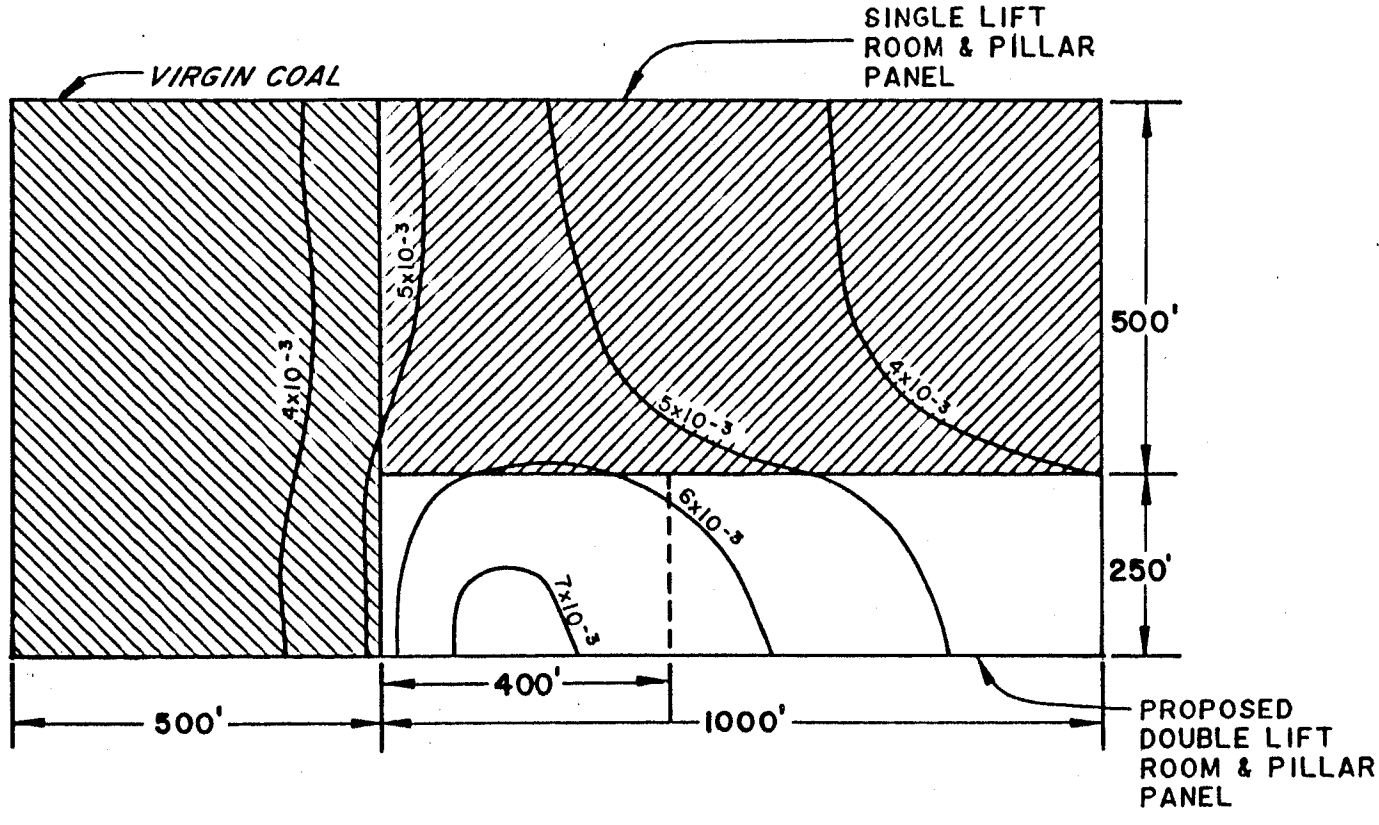
The differing results provided by the 2-D and 3-D analyses can be more fully understood by considering the stress distribution in the lower coal seam after extraction of the floor in the active panel. This stress distribution is shown in Figure 9 in the form



STRAIN DISTRIBUTION IN PILLARS AFTER FLOOR HAS BEEN REMOVED FROM ACTIVE PANEL

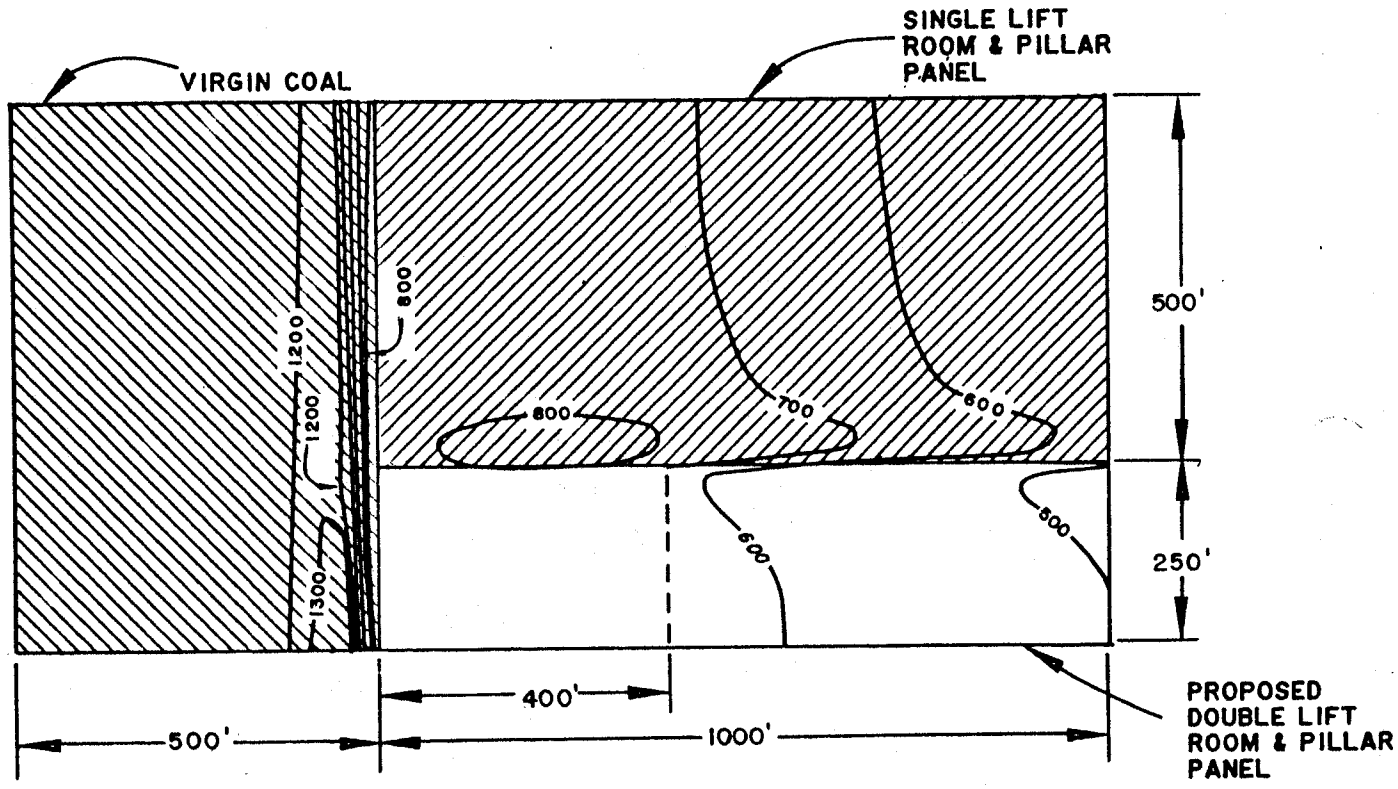
(2-D CASE)

FIGURE 7



STRAIN CONTOURS IN THE PLAN SECTION OF THE ROOM AND PILLAR MINE
(3-D CASE)

FIGURE 8



STRESS CONTOURS IN THE PLAN SECTION OF THE ROOM & PILLAR MINE
AFTER FLOOR REMOVAL
(3D CASE)

FIGURE 9

of contour plot. Note the large stress abutment in the section of virgin coal at the left of the region shown. The virgin coal, due to its much higher stiffness than the mined out panels, attracts a good portion of the weight of the rock overlying the active panel as well as the previously mined adjacent panel.

The effective load on the active panel is reduced due to the proximity of this virgin coal, resulting in a decreased amount of strain from that determined using two dimensional analysis. It is the stress concentration in the virgin coal that explains the differing conclusions of the 2-D and 3-D analyses.

There is also a much slighter difference in stiffness between the active panel and the adjacent, previously mined panel at the upper right of the figure. While this stiffness difference is not great, it is enough to produce a minor stress abutment in the adjacent panel, further relieving the state of stress in the active panel.

An important inference to be drawn from this figure is that the floor mining plan has been shown to be stable as long as the neighboring sections of the coal seam remain as they are. Further mining in the previously mined panel could add more load to the pillars in the currently active panel, and mining of panels in the virgin coal will certainly increase the load. Under these conditions, instability of the pillars in the currently active panel might be induced. Any further development of the adjacent coal panels should be investigated, using numerical analysis, for impacts on neighboring areas as well as instability within the proposed development.

MODELING THE RESISTANCE OF FAILED PILLAR

Above a thin layer of shale, the main member supporting the rooms in the lower coal seam is a 50' thick layer of siltstone. Above this member is a 20' thick upper seam of coal, which has been mined using a room and pillar method. The thickness of coal removed from this upper layer is 10'. It is expected that the pillars from this previous mining activity are intact, in that the overburden is not very thick. However, the possibility that some of these pillars may have failed should be considered. Due to the need for fine zoning in an analysis of this type, this question will be considered in two dimensions.

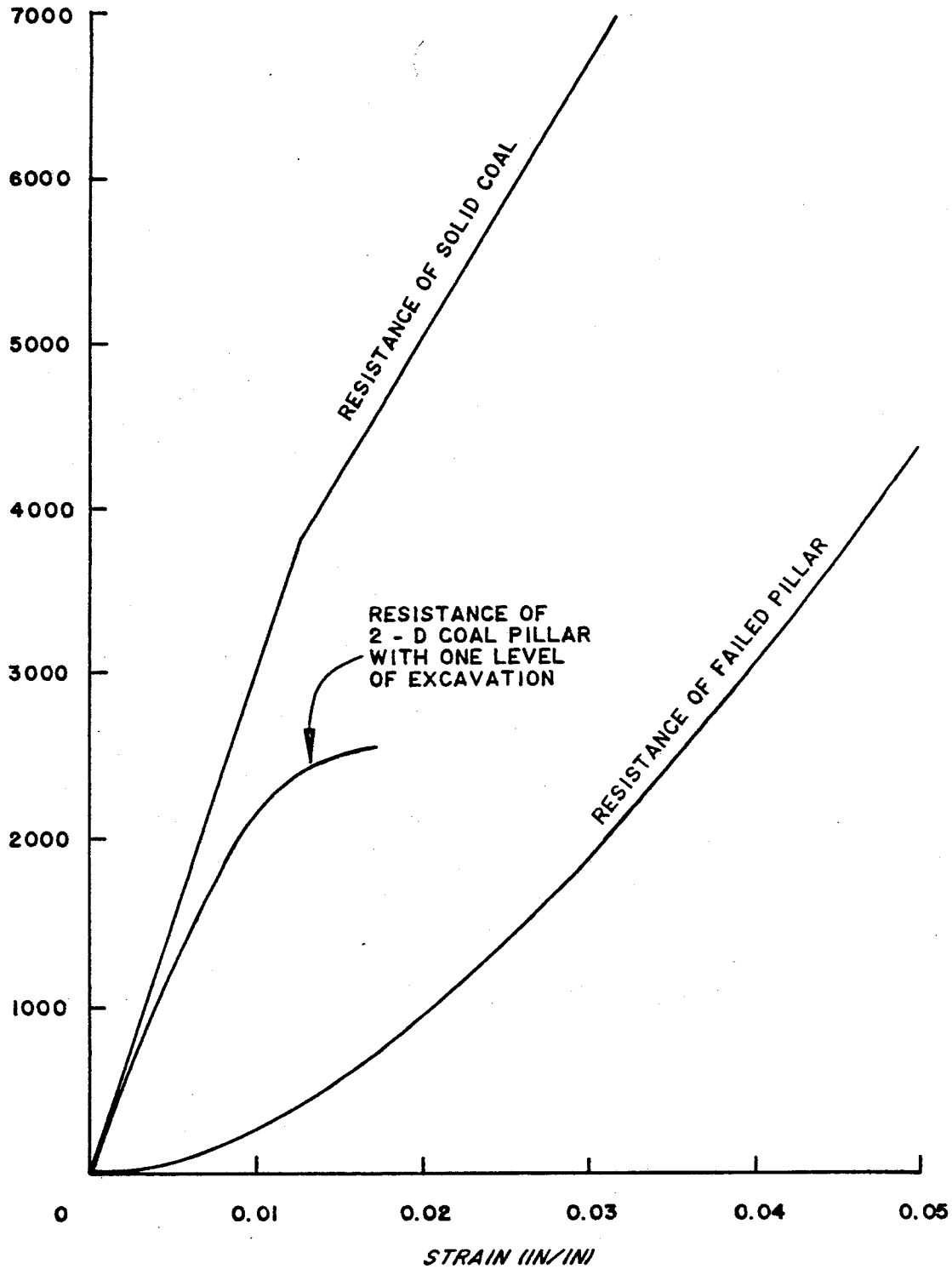
In order to investigate the effects of having failed pillars in the upper coal seam, a mechanical model for failed pillars must be developed. It would seem at first that the space formerly occupied by the pillar that is now assumed to have failed can be treated as if nothing were there. The consequences of such an assumption would be that the overburden formerly carried by the failed pillar would now have to be supported by those pillars still assumed to be intact. This may cause the remaining pillars to become overloaded, resulting in a large amount of deformation in these pillars.

Note from **Figure 5** that above a certain level of stress in the pillars, additional strain occurs with very little increase in stress. For two- dimensional pillars with one level of mining, **Figure 5** shows that stress level to be about 2500 psi. With the surviving pillars assuming the load formerly carried by the failed pillars, it is quite possible that the load will exceed the capacity of remaining pillars. In reality, such a situation will merely result in a general failure of all of the pillars in the upper level, which will tend to bring the stress field in the

lower seam back to a more uniform distribution.

As the surviving pillars fail, the deformation increases, and the rubble occupying the former positions of the failed pillars will become compressed. As the compressive strain increases, the resistance of the coal rubble will stiffen, eventually approaching the stiffness of solid coal once the void space has been crushed out. As this happens, the failed pillars begin to reclaim their original share of the overburden, thereby relieving the stress in the neighboring pillars and causing the deformation of these latter pillars to stop. Thus the model of the failed pillars must increase in stiffness with volumetric strain, approaching the stiffness of solid coal as the strain approaches the void fraction imposed by mining activity.

A variable modulus material model has been selected from the BMINES material library to accomplish the goals described above. The resistance offered by this model to uniaxial strain is shown in Figure 10, along with the resistance of solid coal and of a 2-D pillar module with one level of coal mined. Note that for small strain values, the stress in the failed pillar is negligible compared to the stresses in both the solid coal and the 2-D pillar. This remains true up to the strain level of 1.7%, which is the limit to which the 2-D pillar has been examined. Beyond this strain level, the stiffness of the failed pillar gradually increases, eventually approaching the stiffness of the solid coal. This model provides the ability to consider the effects of failed pillars in the upper seam on the distribution of stress in the lower seam and interburden. Such an analysis is provided in the next section.



BEHAVIOR, IN UNIAXIAL STRAIN, OF THE 2 - D MODELS FOR SOLID COAL, A PILLAR WITH ONE LEVEL OF COAL REMOVED, AND A FAILED PILLAR

FIGURE 10

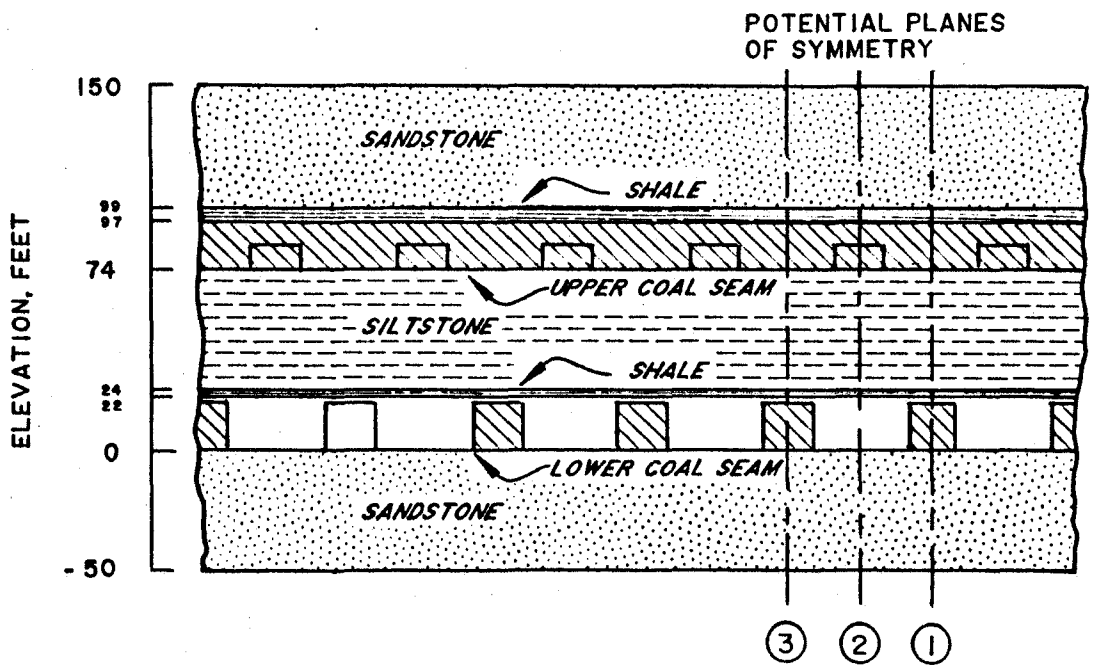
EFFECTS OF MINED-OUT UPPER SEAM ON ACTIVE LOWER PANEL

An auxiliary study has been undertaken to determine whether or not the replacement of the individual pillars and rooms in the upper coal panel with homogeneous pillar modules is an acceptable approximation for the purpose of investigating floor extraction in the lower seam.

Some of the concern arises from the fact that it has not been possible in all cases to stack the pillars in the lower seam directly below the existing pillars in the upper seam. The stress path through the upper seam is channeled through the surviving pillars, creating concentrations of stress in the siltstone interburden at these locations. When these stress concentrations occur between pillars in the lower seam, conditions somewhat less favorable than those imposed by uniform pillar modules may result.

To investigate this situation, a two-dimensional idealization of the interburden was considered. Although the stress magnitudes in two dimensions will be different than those resulting from a three-dimensional analysis, the phenomenology is very similar. If the use of equivalent pillar modules in the upper seam is acceptable in two dimensions, it follows that this procedure is likely to be acceptable in three dimensions. Most importantly, the use of a two-dimensional model allows us to zone the interburden with a very fine element grid to enable us to observe the effects of individual pillars as opposed to uniform pillar modules.

A diagram of the worst case pillar arrangement is shown in Figure 11. In this figure, the pillars in the upper seam are directly over the entries in the lower seam, and it is assumed that the



TWO - DIMENSIONAL DIAGRAM OF STAGGERED PILLARS BETWEEN THE UPPER AND LOWER COAL SEAMS

FIGURE 11

coal in the upper seam has been taken from the very bottom of the stratum. This places the minimum amount of material between the two mining panels.

Note that if all the pillars in the upper seam are intact, the center of every pillar and the center of every entry is a plane of symmetry. In such a case, planes 1, 2, and 3 in **Figure 11** would all be planes of symmetry, and only the material between any two of them would need to be included in the model. If every alternate pillar in the upper seam were intact, then the center lines of the pillars in the upper seam would be planes of symmetry, but the center lines of the entries would not be. In such a case, planes 1 and 3 of **Figure 11** would be planes of symmetry, but plane 2 would not be. These planes of symmetry have been utilized in the models considered below.

Three cases have been considered. The first utilizes uniform pillar modules in the upper coal seam, and only the region between a pillar center line and the nearest entry center line has been included in the model. Within this 30' wide column of rock, the siltstone interburden has been zoned using a grid of 5' by 5' elements, allowing excellent resolution of the distribution of stresses. The second model consists of the same planes of symmetry and the same zoning, but the pillar in the upper seam is modeled individually. In the third model, it is assumed that every alternate pillar in the upper seam has failed, shifting the weight that would have been carried by these pillars to the surviving pillars. This condition adds to the severity of the stress concentration problem described above. In all of these cases, the pillars of the lower coal seam were modeled individually in order to isolate differences arising from the method used to model the pillars in the upper seam.

All of the analyses described above were loaded using prescribed displacements on the top surfaces of the models. This was done to ensure that the models would not be exposed to loads higher than they are capable of resisting, thereby causing the calculations to go unstable. The actual load being resisted in each load step was determined by adding up the forces in each element of a single layer of the model. Since the material of the upper layer is different in each case, corresponding load steps of different analyses do not necessarily correspond to the same load levels.

Figure 12 shows the displacement of the bottom interface of the siltstone layer as a function of vertical stress for each of the three models. The stress values shown in this figure are obtained by determining the total force in the pillars of the lower coal seam, and dividing this force by the gross area of the panel, including entry area. The displacement values are the average downward displacement of the lower interface of the siltstone at each of these load levels.

It is very evident from these results that differences in the means of modeling the pillars of the top coal seam do not affect the deformation of the layers below, even when portions of the upper mine consist of failed pillars. This is an important finding for the purpose of investigating the stability of floor removal because the interaction between the pillars with the siltstone interburden determines the loading on each pillar during the mining of the floor. These results support the contention that this interaction has been modeled faithfully in the global panel model described elsewhere in this report.

Additional insight on the effects of different modeling techniques for the pillars in the upper seam can be gleaned from

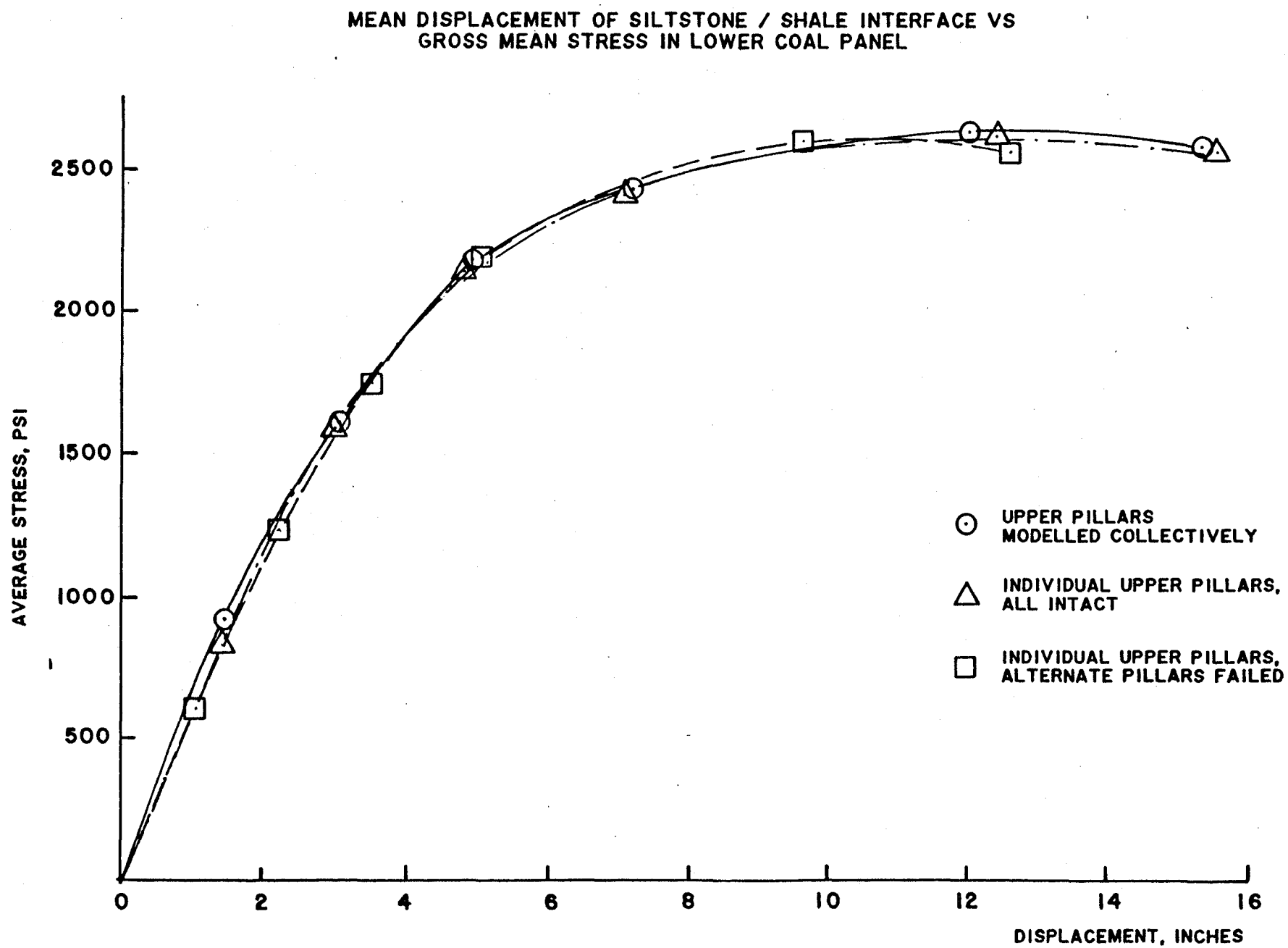

MEAN DISPLACEMENT OF SILTSTONE / SHALE INTERFACE VS
GROSS MEAN STRESS IN LOWER COAL PANEL
AVERAGE STRESS, PSI
2500
2000
1500
1000
500
0
2
4
6
8
10
12
14
16
DISPLACEMENT, INCHES
UPPER PILLARS
MODELLED COLLECTIVELY
INDIVIDUAL UPPER PILLARS,
ALL INTACT
INDIVIDUAL UPPER PILLARS,
ALTERNATE PILLARS FAILED

FIGURE 12

Figure 13. This figure shows a profile of the siltstone interburden layer at a position below the center line of an intact pillar of the upper coal seam. This places the profile directly over an entry of the lower seam.

The various symbols on this plot show the distribution of horizontal stress through the thickness of the stratum. Note the uniformity of the horizontal stress distribution indicated by the circles, which represent the calculation using the uniform pillar modules. There is some nonuniformity of this stress distribution only as it approaches the bottom of the stratum. This is because the pillars of the lower coal seam have been modeled explicitly, thereby introducing some genuine nonuniformity into this calculation near the bottom of the stratum. In particular, since this section is directly over an entry, the horizontal stress decreases at the bottom of the layer in response to the sag of the entry roof.

The case in which the pillars of the upper coal seam are modeled individually, and all of these pillars are intact, is represented by the triangles in **Figure 13**. Since the pillars in the upper seam are modeled explicitly in this analysis, and since the section is directly below a pillar, the state of stress is increased toward the top of the layer with respect to the first case.

Note also, however, that as one descends the siltstone layer, the triangles and the circles in **Figure 13** converge toward each other. This suggests that the significance of including the individual pillars in the upper coal seam is appreciable only near the top of the siltstone layer. It would imply that virtually nothing is lost from the interaction phenomenology of the pillars of the lower seam and the interburden, thereby

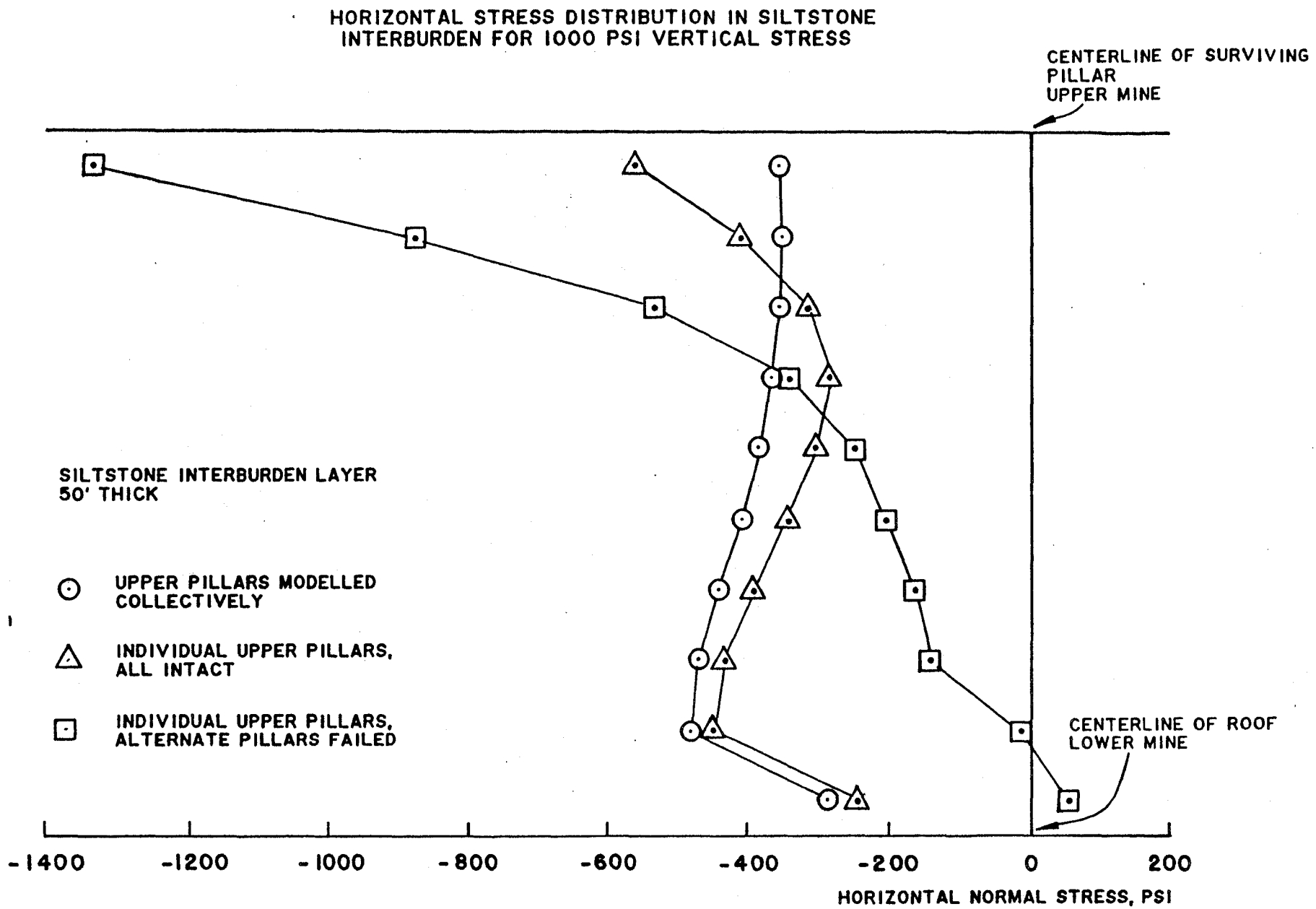

HORIZONTAL STRESS DISTRIBUTION IN SILTSTONE
INTERBURDEN FOR 1000 PSI VERTICAL STRESS
CENTERLINE OF SURVIVING
PILLAR
UPPER MINE
SILTSTONE INTERBURDEN LAYER
50' THICK
UPPER PILLARS MODELLED
COLLECTIVELY
INDIVIDUAL UPPER PILLARS,
ALL INTACT
INDIVIDUAL UPPER PILLARS,
ALTERNATE PILLARS FAILED
CENTERLINE OF ROOF
LOWER MINE
-1400
-1200
-1000
-800
-600
-400
-200
0
200
HORIZONTAL NORMAL STRESS, PSI

FIGURE 13

validating the modeling techniques used in the global panel model.

The effects of losing some of the pillars of the upper seam are illustrated by the square symbols of Figure 13. Note that due to the loss of the adjacent pillars on both sides of the pillar above the section shown, the state of stress is very concentrated toward the top of the siltstone layer. Some bending is evidently introduced, and a small amount of tension appears at the bottom of the layer. The siltstone has failed in the tension zone, and some roof problems in the entry of the lower seam should be expected. However, this is the same roof that existed in this location when the upper level of the lower coal seam was mined, and so this roof problem should already have been encountered.

The result of removing the floor of the lower coal seam will be to reduce the stiffness of the adjacent pillars, possibly producing additional sag in the siltstone stratum, and possibly making the roof stability problem in this location slightly more acute than it was. It should be noted that the zone of tension does not extend very far into the siltstone layer, so one should not expect anything more severe than a tendency toward local overbreak in these locations. Care should be exercised in removing the floor in areas that had roof control problems during mining of the upper level of the lower seam.

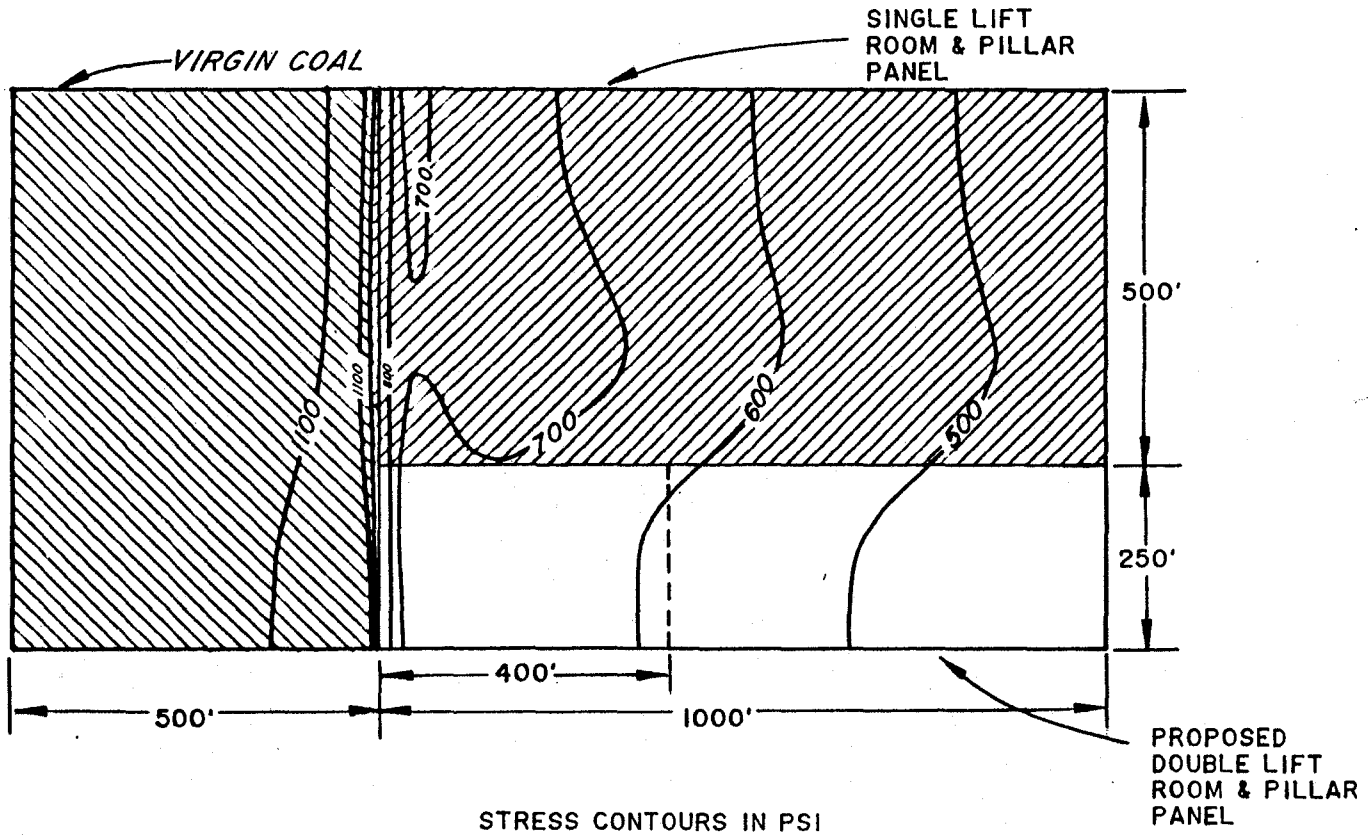
In summary, the global modal for the analysis of the stability of floor removal is only sensitive to phenomena occurring on a global scale. The most important issue to be addressed is whether the loss of stiffness for the pillar adjacent to the floor mining activity will allow it to unload its burden to stiffer structures nearby, or whether its reduced strength will be exceeded by its share of the overburden. These questions are

heavily dependent on the stiffness of the overlying rock, in particular the siltstone layer between the two coal seams. The analyses considered herein have verified that the siltsone pillar interaction is not compromised by the use of equivalent uniform pillar modules in the upper coal seam. A similar study could have been utilized to show that the use of such modules is also allowable in the lower coal seam. It is possible that local roof control problems may be made worse by mining the floor, but such problems are beyond the scope of this model. The global model addresses only the question of whether pillars will be crushed due to the loss of strength and stiffness resulting from removal of the floor, or whether the load is transferred to other structures. The model has been shown capable of addressing this question.

EFFECTS OF ACTIVE LOWER PANEL ON UPPER MINE

The fact that the presence of failed pillars in the upper coal seam can accentuate local roof stability problems in the rooms and entries of the lower seam raises the question of whether or not additional pillar failure in the upper seam might be induced by double lift mining in the lower seam. While the 3-D global stability model described earlier was designed primarily for the purpose of analyzing the response in the lower seam, a re-examination of the results of this analysis is useful in assessing the magnitude of the effects on the upper seam.

Figure 14 shows contours of vertical stress in the upper seam of the global stability model after the completion of double lift mining in the indicated panel of the lower seam. The assumption was made in constructing this model that the upper seam was identical to the lower seam prior to the start of double lift



STRESS CONTOURS IN THE UPPER COAL SEAM AS A RESULT OF DOUBLE LIFT MINING IN THE LOWER SEAM

FIGURE 14

mining. Thus the left portion of the seam as shown in Figure 14 consists of solid coal, as does the lower seam, and the remainder of the seam consists of a uniform grid of 40' by 40' pillars, 10' high, separated by 20' wide rooms and entries. While the actual condition of the upper seam as described earlier in this report is somewhat different than assumed in the model, the results of the analysis indicate that double lift mining in the lower seam has only a slight effect on the distribution of stress in the upper seam, and this finding should be valid no matter what the actual condition of the upper seam may be.

Prior to the start of double lift mining in the lower seam, the variation of stress in the upper seam is uniform in the direction transverse to the panel axis. A major stress abutment exists in the solid coal at the edge of the mined out area, and the overburden increases from right to left as viewed in Figure 14, so the initial stress state is not uniform in the axial direction. Figure 14 shows that as a result of the mining activity in the lower seam, there is a slight shift of stress intensity away from the area overlying the active panel and into the area overlying the single layer room and pillar panel indicated in the figure.

A comparison of Figure 14 with Figure 9 indicates that the redistribution of stress induced in the upper seam is considerably less abrupt than the redistribution of stress in the lower seam. It appears that in the upper seam, the state of average stress in any area of the room and pillar panel does not increase by more than about 50 psi as a result of the further development of the lower seam. If the pillars in the upper seam are stable prior to the start of double lift mining in the lower seam, it is doubtful that this small amount of additional stress would cause a significant number of them to fail during the

double lift mining. Even if the condition of the upper seam is different from that assumed in the model, the magnitude of the stress changes brought about by the proposed double lift mining should be small, and the stability condition of the upper seam should be degraded only slightly from its condition prior to the start of double lift mining.

This stability assessment for the upper seam does not cover the potential development of the solid coal portion of the lower seam. Mining of this region would result in major redistribution of stress in both the upper and lower coal seams, and the effects on the stability of either cannot be inferred without a detailed numerical analysis of the specific configuration to be considered.

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APPENDIX A

ROCK MECHANICS LABORATORY TESTING OF BELINA NO.2 COAL SAMPLES

August 11, 1987

Valley Camp of Utah, Inc.
Scofield Route
Helper, Utah 84526

Attn: Mr. Walter Wright
Re: ROCK MECHANICS LABORATORY TESTING OF COAL SAMPLES

Gentlemen:

This letter report presents the results of our laboratory testing on the coal samples from Belina No. 2 Mine.

Six large blocks of coal were transported to KCKA's laboratory on June 19, 1986. These blocks were cut with a diamond saw into about five-inch sections. Two-inch diameter core samples were obtained from these cut blocks. The coring was made perpendicular to the coal bedding. The core samples were prepared and subjected to various laboratory tests to obtain the rock mechanics parameters for the coal material.

The test results are tabulated in Table I. Pertinent findings are discussed in the following:

Tensile Strength: The tensile strength of the coal samples was determined by an indirect tension test (Brazilian tensile test). The average tensile strength from eight tests was found to be 123 psi.

Uniaxial Compressive Strength: The uniaxial compression tests were performed on three samples. The failure strength ranged from 1780 to 2040 psi with an average of 1947 psi. This strength level is high when compared to the design strength of coal samples from Belina No. 1 seam (1431 psi).

Triaxial Compressive Strength: Seven core samples were tested under triaxial loading conditions for confining pressures ranging from 500 to 2000 psi. The results of these tests are graphically presented in Figure 1. The failure strength increases rapidly with the increase in confining pressures at a lower range, but the rate of increase is reduced at higher confining pressures. This implies that the triaxial strength of coal is non-linear and that different pillar design parameters should be used for different depths of the mine. As indicated by the Mohr's failure envelope in Figure 1, the

triaxial strength parameters may be presented as follows:

	Confining Pressure	
	0 -2000 psi	2000-4000 psi
Cohesion	150 psi	750 psi
Friction Angle	53 degrees	41 degrees

Dry Unit Weight: Dry unit weight (dry bulk density) of all tested samples was calculated and listed in Table 1. The average dry unit weight of the coal samples is about 79 pounds per cubic foot. This is equivalent to a bulk specific gravity of 1.27.

Young's Modulus: The Young modulus or the deformational modulus of most compressional test samples was measured and tabulated in Table 1. The modulus is shown to be sensitive to the confining pressure as summarized below:

Confining Pressure Psi	Young's Modulus Psi
500	217,647
1000	378,030
2000	390,223

The relationship between the confining pressure and the deformation modulus can be expressed as follows (See Figure 2):

$$E(S3) = 120014\ (S3)^{0.477}$$

where E(S3) = Young's modulus at confining pressure=S3
S3 = Confining pressure.

The "modulus coefficient" of 0.477 is very large for coal material, indicating that the stability of mine openings would be history-dependent; i.e., the stability of a pillar, room, or panel in such a coal deposit would depend greatly on the sequence of mining. (Note : the modulus at the uniaxial condition is not considered). Also, the coal with such a high coefficient should have a high level of bump potential. Additional testing, as the mine progresses, is recommended to further refine these triaxial strength data.

SUMMARY ANALYSIS

The material properties of the coal samples tested show the following characteristics:

1. The uniaxial strength of samples from the No. 2 mine is higher than

the general range of the strength of coal material from the No. 1 mine.

2. The pillar strength would rapidly increase with pillar width to a mine depth of about 2000 feet. Below this depth, the pillar strength will increase at a lower rate, and the coal face will be less bump-prone than in the shallower depths.

3. The stability of individual pillar, room or panel within the coal seam will vary significantly depending on the local excavation sequence.

The design of a given entry and panel layout should consider the above characteristics, provided that the coal samples tested are representative of the area. The opinions expressed herein are not conclusive but limited to the tested samples. Additional samples collected systematically from various mine locations should be evaluated to further refine the results to date.

Respectfully submitted,

KENNETH C. KO & ASSOCIATES, INC.

Kenneth C. Ko
President

KCK/rs

Enc.

TABLE I. LABORATORY TEST RESULTS

Sample Number	Confining Pressure psi	Strength psi	Young's Modulus psi	Dry Unit Weight, pcf
		Triaxial Tests		
1	500	4297	235,300	79.2
2	500	6127	200,000	82.6
3	1000	10663	372,700	78.5
4	1000	9199	383,300	78.4
5	2000	10823	392,300	79.2
6	2000	12923	438,500	77.0
7	2000	11300	340,000	78.4
		Uniaxial Tests		
8		2021		79.5
9		1783		77.7
10		2037		79.5
		Brazilian Tests		
11		101		
12		96		
13		76		
14		196		
15		165		
16		133		
17		114		
18		106		

SUMMARY

Average Uniaxial Strength	1947 psi
Average Dry Unit Weight	79 pcf
Average Tensile Strength	123 psi

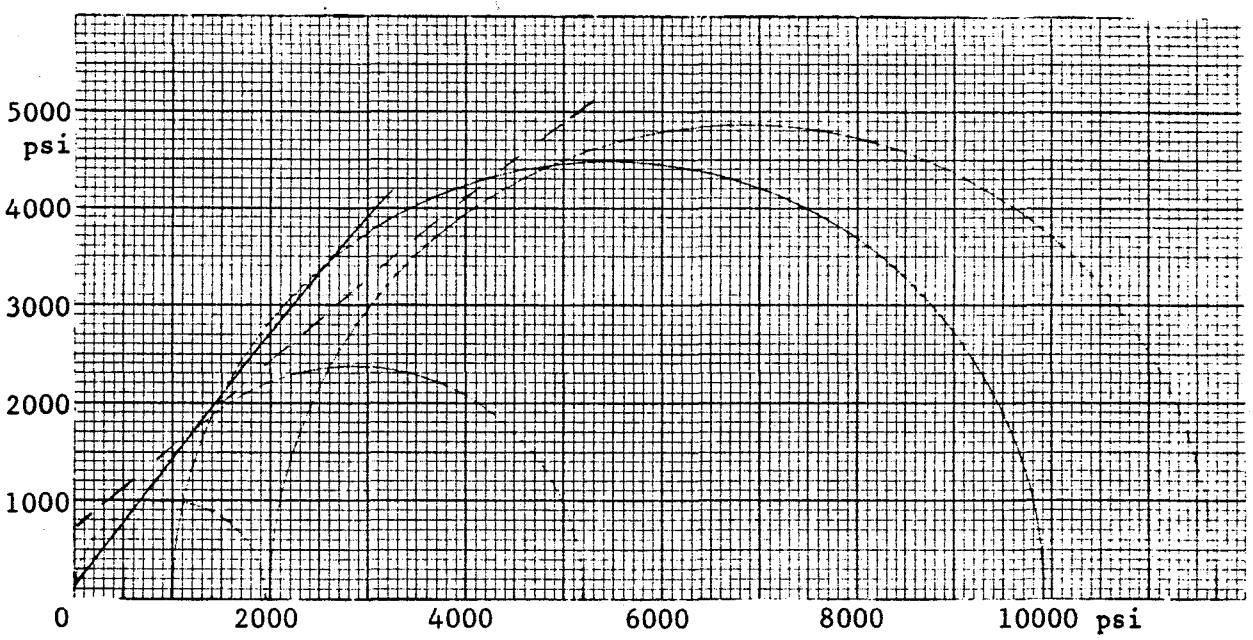

FIGURE 1. TRIAXIAL TEST SUMMARY

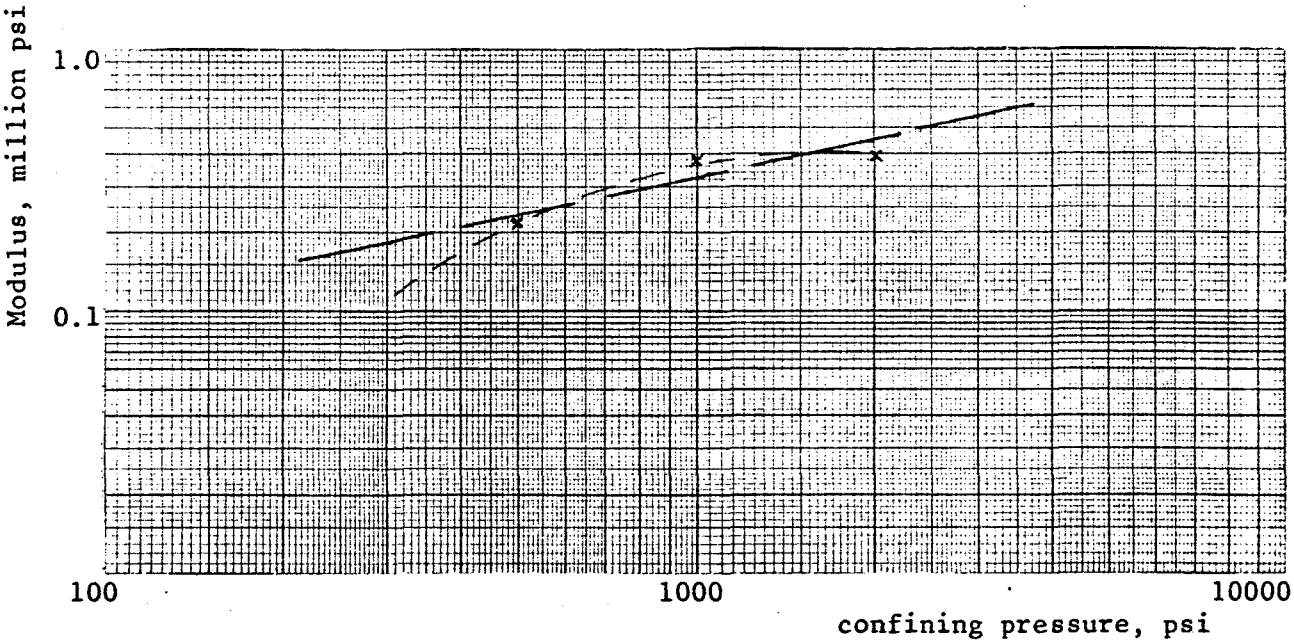

FIGURE 2. MODULUS VS. CONFINING PRESSURE

APPENDIX B

FINITE ELEMENT CODE DESCRIPTION

FINITE ELEMENT CODE DESCRIPTION

A three dimensional, static, finite element code has been developed specifically for the analysis of stress and deformation in the rock surrounding an underground excavation. The code was developed in the 1970's and early 1980's by Agbabian Associates under contract to the USBM. The code has been adapted to run on a personal computer using the hard disk for storage data for problems too large to be solved in RAM. While further development of the code is continuing, a usable version with full three dimensional and nonlinear material capabilities is running and checked out at this time.

The element library consists of four to eight node quadrilateral elements for plane stress, plane strain, and axisymmetric analysis, eight to 20 node three dimensional continuum elements, two and three dimensional joint or interface elements for the modeling of discontinuities in the rock, one dimensional bar elements useful in the representation of support structures such as cribbing and hydraulic supports, beam elements, and rockbolt elements.

The material models for all element types except beam elements include a wide range of inelastic, viscous, or anisotropic constitutive relations. The plasticity laws include Mohr-Coulomb, Drucker-Prager, a modified Drucker-Prager with a third order dependence on mean pressure, and the cap model. The constitutive relations for joint elements include peak and residual shear strengths that depend on normal pressure, and a dilatation law that depends on cumulative plastic strain. The rockbolt elements can simulate either mechanical anchor bolts or fully grouted resin bolts. The bolt itself is elasto-plastic with the ability to rupture if its ultimate strain is exceeded. It also has the capability of pullout if the bond strength between the rock and the bolt is exceeded. Finally, it provides dowel resistance across interfaces in the rock and will fail in shear if the slip along the joint exceeds a prescribed amount. The beam elements are restricted to linear elastic properties only.

The loading options include prescribed stresses along portions of the boundary, gravity loading, the specification of in-situ stress states, and the prestressing of structural elements. The simulation of mining is accomplished through element activity. The elements of rock that are scheduled for removal by a particular stage of excavation are set to go inactive on that load step. Structural elements, such as cribs or rockbolts, that are installed once the excavation achieves a prescribed stage of progress are specified to become active on a given load step. These elements can be activated with any desired state of initial stress. Through a sequence of load steps in which a progression of mine geometries can be specified through element activity, the evolution of stress and deformation in the mine at various stages of mine development can be studied.

Copy to Mary An

SCOTT M. MATHESON
GOVERNOR

STATE OF UTAH
DEPARTMENT OF COMMUNITY AND
ECONOMIC DEVELOPMENT

Division of
State History
(UTAH STATE HISTORICAL SOCIETY)

MELVIN T. SMITH, DIRECTOR
307 WEST 2ND SOUTH
SALT LAKE CITY, UTAH 84101
TELEPHONE 801/533-5755

DIVISION OF
OIL, GAS & MINING

January 7, 1981

James W. Smith
Division of Oil, Gas and Mining
Department of Natural Resources
1588 West North Temple
Salt Lake City, Utah 84116

RE: Skyline Mine - Coastal State's Energy Company, Carbon County, Utah

Dear Mr. Smith:

The staff of the Utah State Historic Preservation Officer has received your letter of October 24, 1980. The staff, having reviewed the submitted report by Archeological Environmental Research Corporation, entitled "Archeological Surface Evaluations in the Skyline Project in Carbon and Emery Counties," has determined that the report is adequate to determine mitigation of impacts of the proposed operations on historic and cultural resources. Because of the limited number of resources and the described no adverse effect upon them in the Skyline Mine project, it is felt that this report could satisfactorily be submitted as part of a mining program as outlined by the Memorandum of Agreement between the Division of State History and the Division of Oil, Gas and Mining.

The Preservation Office is aware of the December 22, 1980 letter submitted to Coastal States Energy by the Office of Surface Mining concerning the adequacy of the report for submission. Our office agrees that there are many technical errors in the report. However, since the cultural resources are not eligible and there is no adverse effect, the mine plan should be approved.

The Office of Surface Mining has pointed out some serious problems with this report and others. The Preservation Office of Utah would like to suggest to Oil Gas & Mining and the Office of Surface Mining that a meeting be set up to determine some specific guidelines that can be dealt with on a systems basis rather than individual cases.

State History Board Milton C. Abrams Chairman • Theron H. Luke • Ted J. Warner • Elizabeth Montague • Thomas G. Alexander
Dee G. Dayton • Walter K. Hinton • Helen Z. Papanikolas • David S. Monson • Elizabeth Griffith • William D. Owens

Should you need assistance or clarification, please call or write James L. Dykman, Cultural Resource Advisor, or Wilson G. Martin, Preservation Development Coordinator, Utah State Historical Society, Preservation Development, 300 Rio Grande, Salt Lake City, Utah 84101.

Sincerely,

Melvin T. Smith

Melvin T. Smith
Director and
State Historic Preservation Officer

JLD:jr:C942CB

cc: Office of Surface Mining, Attn: Bill Killiam, Brooks Towers, 1020 15th Street, Denver, Colorado 80202

INTENSIVE ARCHEOLOGICAL SURFACE EVALUATIONS IN THE PROPOSED WHISKEY CREEK CANYON-PLEASANT VALLEY PROJECT IN CARBON COUNTY, UTAH

Mine Plan Applicant:
Valley Camp of Utah, Inc.
(Coal Mine and General Service Facilities
Relative to Belina #1 and #2 and Utah #12 Mines)

F. R. Hauck, Ph.D., Principal Investigator

Report Prepared by:
F. R. Hauck, and D. G. Weder
ARCHEOLOGICAL-ENVIRONMENTAL
RESEARCH CORPORATION

PAPER NO. 21
September, 1980

Salt Lake City, Utah

ABSTRACT

In the summer of 1980, the Archeological-Environmental Research Corporation conducted an intensive cultural resource evaluation for Valley Camp Coal Company of Utah in the Pleasant Valley-Eccles Canyon locality south of Scofield, Utah. The survey consisted of a corridor evaluation extending from the proposed mine facilities in Whiskey Canyon to the Utah No. 2 Mine location.

A total of seven historic cultural resource sites is situated within, or adjacent to, the project area. These sites include four mine portal service areas, one sawmill site, and two cabin foundations. One of the seven sites is considered to meet the minimal criteria of eligibility under 36 CFR 60.6.

Table of Contents

	Page
Abstract	ii
Table of Contents	iii
List of Figures	iv
List of Tables	v
Chapter I - Introduction	1
A. General Data	1
B. Environment and Locality	5
C. Prehistory and History of the Region	10
D. Previous Investigations	31
E. Research Design	34
Chapter II - Methodology	36
A. Field Research	36
B. Laboratory Research	39
C. Artifact Inventory and Analyses	39
Chapter III - Cultural Resource Descriptions	42
A. Site Analyses	42
B. Comparative Analyses	44
Chapter IV - Evaluations and Recommendations	46
A. Resource Significance Evaluations	46
B. National Register Criteria of Eligibility	48
C. Discussion of Impact Potential on Cultural Resource Sites	49
D. Recommendations	51
Bibliography	52
Appendix	62
Site Reports	

List of Figures

		Page
1.	General Map of Project Area.	3
2.	General Map of Survey Area and Land Ownership in Project Area	4
3.	Map of Historic Sites in Project Area	37
4.	Artifact Sketches.	40

List of Tables

		Page
1.	Cultural Resource Site Summary.	43
2.	Cultural Resource Site Significance	47
3.	Cultural Resource Impact Potential.	50

Chapter I - INTRODUCTION

A. General Data on the Project

In the spring of 1980, the Archeological-Environmental Research Corporation (AERC) of Salt Lake City was contacted by Vaughn Hansen Associates, a Salt Lake City consulting firm, on behalf of Valley Camp of Utah, Inc. and contracted to perform an intensive cultural resource evaluation of mine portal areas, transportation corridors and service areas relative to the development of mine facilities in the Whiskey Canyon-Eccles Canyon-Pleasant Valley locality of Carbon County, Utah. Mine permits involved in this locality include Belina #1 and #2 and Utah #2. Vaughn Hansen Associates (VH) in conjunction with Valley Camp of Utah, Inc., desirous of preparing a mine plan application for submission to federal and state authorities, requested that cultural resource evaluations be conducted within the potential subsidence zone which would comply with pertinent government legislation, i.e., Executive Order 11593 "Protection and Enhancement of Cultural Environment" (Federal Register, Vol. 36, No. 95, May 15, 1971), and "The Archeological and Historical Data Conservation Act of 1974", which is an amendment of "The Reservoir Salvage Act of 1960" (74 Stat. 220). For additional information, please refer to the mine plan application prepared by Vaughn Hansen Associates.

AERC's field evaluations within this project area commenced in the summer of 1975 when F. R. Hauck began conducting proposed drill location evaluations for Valley Camp but in association with Sanders Associates, a consulting firm with offices in Kaysville, Utah. AERC's consulting for Sanders Associates (see report for June 13, July 17, October 13, November 28, 1975 and July 17 and August 23, 1976) featured

specific evaluations made within the general Scofield locality although no evaluations were actually conducted within the present project area.

Beginning in September, 1978, AERC began consulting for Coastal States Energy Company upon the Skyline Project which is situated on the west and adjacent to the Valley Camp project area (see Figure 1). Reports on AERC investigations in the Coastal States project area were furnished as CSEC-78-1 (10/2/78), CSEC-79-2 (7/23/79), CSEC-79-3 (8/10/79), CSEC-79-5 (9/18/79). In 1979, AERC conducted an intensive surface evaluation of the floor of Eccles Canyon extending from the mouth of that canyon on the west into the National Forest lands (see CSEC-79-2). That survey includes the entire floor of Eccles Canyon which will be included in the present mine plan permit application. During these preliminary cultural resource evaluations, only three cultural resource sites were recorded in the general locality. These sites included two historic campsites, AERC 270U/1 and 2, and one historic mine portal, service area, AERC 270N/1. All three sites are situated in Eccles Canyon; however, only the first two sites, 270U/1 and 2, need be considered in this report. Site 270N/1 is adjacent to the National Forest boundary up the canyon from the Valley Camp project area. No other cultural resources in the Eccles Canyon-Whiskey Creek locality had been recorded prior to AERC's surface evaluations being reported in this document.

From July 22-25, 1980, AERC personnel conducted intensive evaluations of the Whiskey Creek corridor and an extension of the Eccles Canyon corridor running north from the mouth of Eccles Canyon along the west bench of Pleasant Creek to the existing service area at the mouth of Green Canyon. Some four historic sites were recorded during this recent survey. Thus, a total of six historic cultural resource sites are situated within the Valley Camp mine plan permit area.

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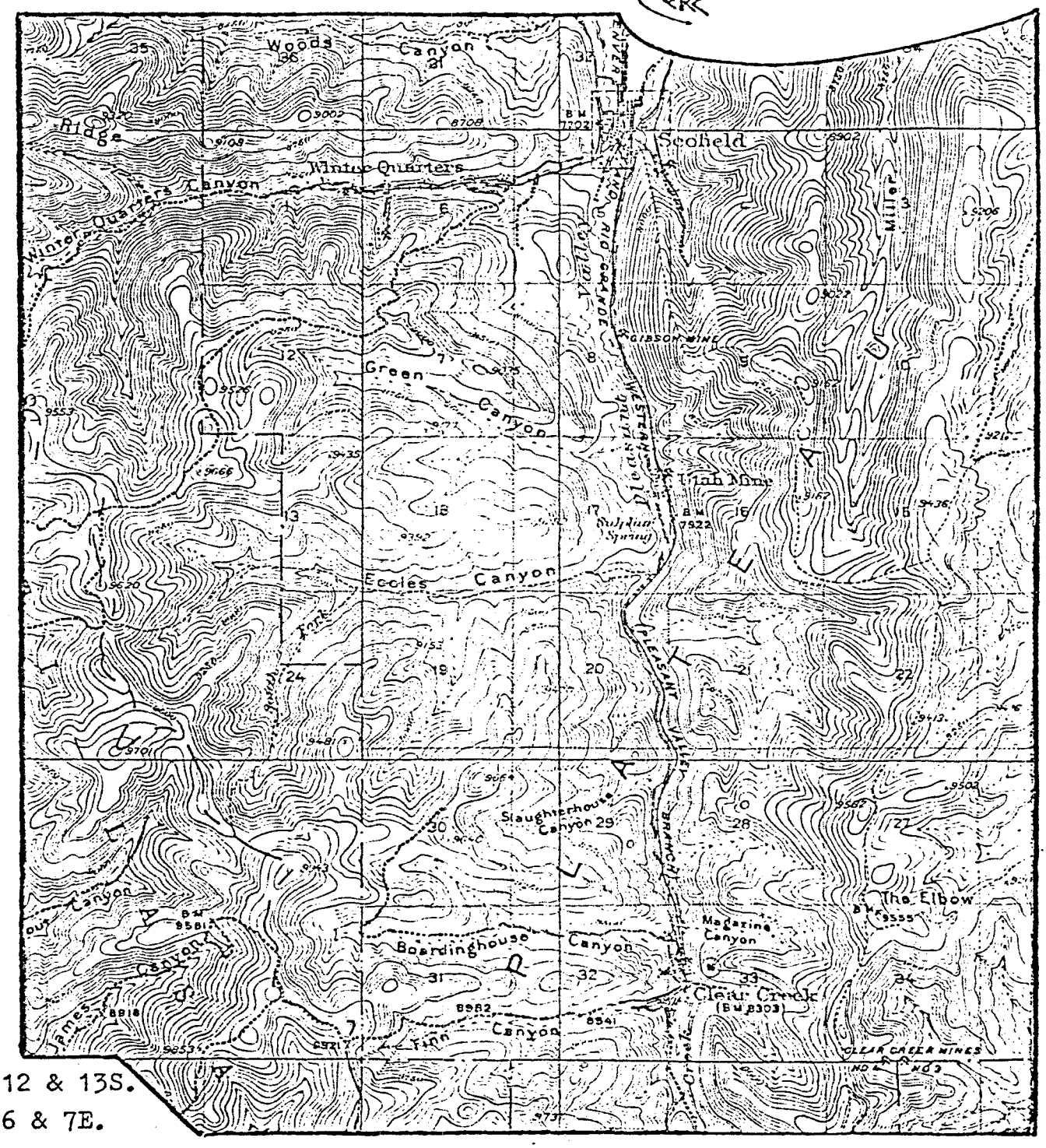

T. 12 & 13S.

R. 6 & 7E.

Meridian: Salt Lake B. & M.

Quad: Scofield, Utah 15 Minute USGS

Project: VH-80-1

Series: Central Utah

Date: 9-17-80

Figure 1

GENERAL MAP OF THE PROJECT AREA IN THE SCOFIELD LOCALITY OF CARBON COUNTY, UTAH

Legend:

N

1 0 1 2 M.

0 1 2 K.

Scale

Revised 2-26-82

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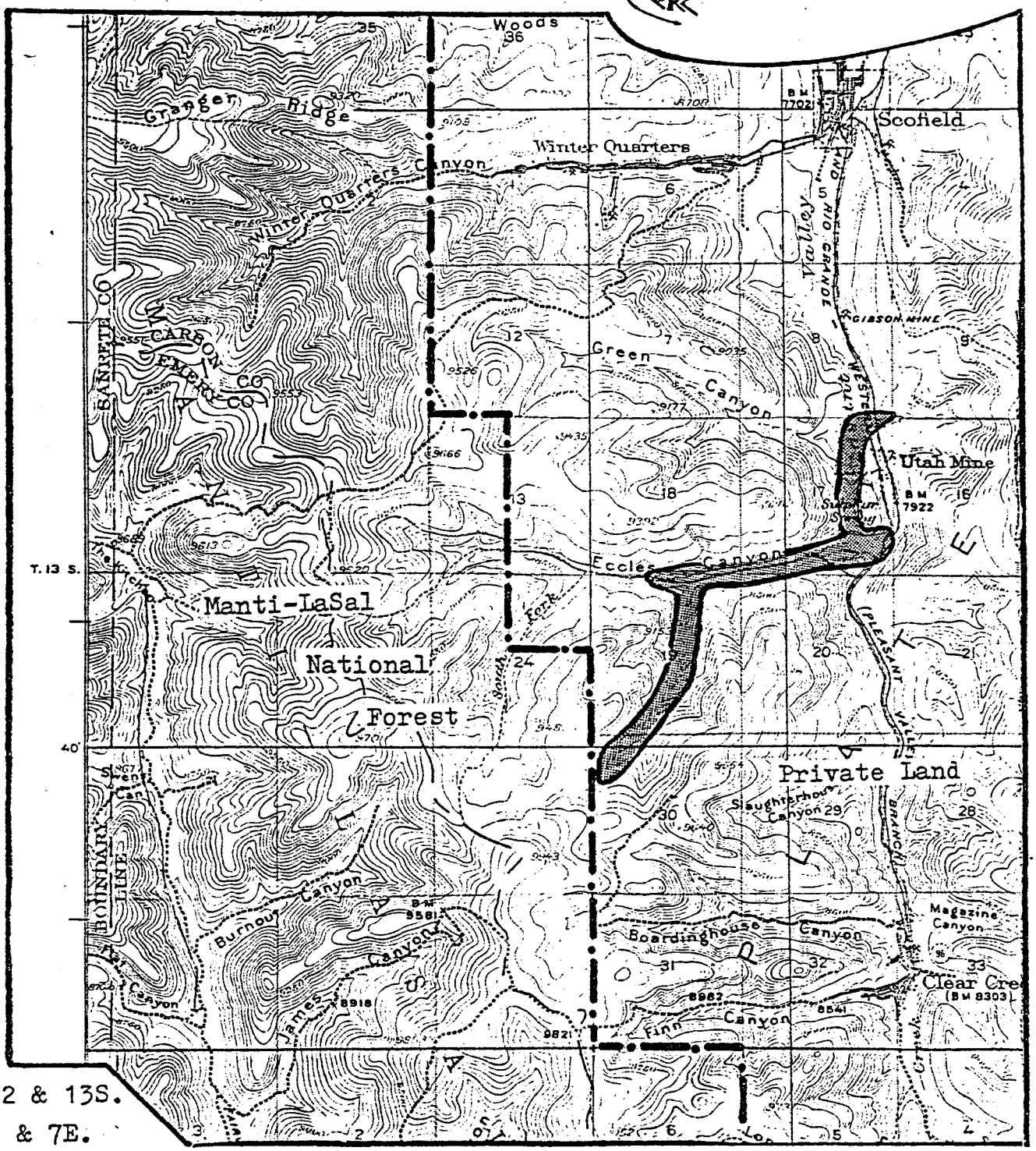

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Meridian: Salt Lake B. & M.

Quad: Scofield, Utah 15 Minute USGS

Project: VH-80-1

Series: Central Utah

Date: 9-17-80

Figure 2

SURVEY AREA AND LAND OWNERSHIP IN THE PROJECT AREA

Legend:

Survey Corridor

N

1 0 1 2 M.

1 0 1 2K.

Scale

Recommendations concerning site significance and mitigational techniques relative to those six sites are provided in this report.

All surveyed areas relative to the present mine plan permit are situated on privately owned lands and no federal antiquities permits have been procured to conduct the 1980 research.

The resource inventory area for the 1980 research involves about three miles of transmission corridor of 60 meters in width extending from the northwest quarter of Section 30 in Whiskey Creek north through the center of Section 19 into the bottom of Eccles Canyon and then east through Section 18 into Pleasant Valley and north in Section 17 to Section 8 and then east to the Utah No. 2 Mine location in the northeast quarter of Section 17, Township 13 South, Range 7 East, Salt Lake Base and Meridian. At special request from Valley Camp, AERC personnel also examined the Nicolitus Mine, the Green Canyon sawmill site and the Gibson Mine, all located in Pleasant Valley but outside the transmission corridor. This project area is situated about two miles south of Scofield, Utah, with the eastern corridor paralleling Utah State Highway No. 96 in Pleasant Valley. The Scofield, Utah, U.S.G.S. 15 Minute topographic map shows the project area.

All field notes and site data are filed at AERC headquarters in Bountiful, Utah. Site reports are being submitted to all relevant state and federal agencies as an appendix to this report. Artifacts collected during the survey are being curated at the Museum of Peoples and Cultures at Brigham Young University in Provo, Utah.

B. Environment and Locality

The project locality is situated in several narrow canyons which drain northwards into Scofield Reservoir via

Eccles Canyon Creek and Pleasant Valley Creek. The general elevation of the project area ranges between about 7750 feet at the Gibson Mine to about 9200 feet at the head of Whiskey Canyon.

The high elevations in the project area have a strong effect on the local climate. The precipitation amounts to about 30 inches annually, but most of this precipitation falls in the form of snow since the May to September precipitation is only eight inches (Utah Water and Power Board). Elevation and exposure also determine the freeze free growing period which is as low as 20 days per year at the highest elevation, but not greater than 60 days at the lowest elevations.

The surface geology of the project locality is relatively simple. The majority of the canyon's lower surfaces consists of an exposure of the Cretaceous age Star Point Sandstone, a formation of marine, deltaic and beach deposits of interbedded sandstone and shales. Above the Star Point is exposed the Black Hawk Group, a Cretaceous age deposit which consists of sandstone, mudstone, shale and coal.

The high elevation places the project locality within the Montane floral ecozone, but topographic factors create a mosaic of different plant communities. In the Montane ecozone, the following arboreal species are typically present in the project area (Johnson 1970):

Common Arboreal Species

Limber pine	*Pinus flexilis*
Engelmann spruce	*Picea engelmannii*
Blue spruce	*Picea pungens*
Subalpine fir	*Abies lasiocarpa*
White fir	*Abies concolor*
Douglas fir	*Pseudotsuga menziesii*
Rocky Mountain juniper	*Juniperus scopulorum*

Common juniper	Juniperus communis
Mountain mahogany	Cercocarpus ledifolius
Aspen	Populus tremuloides
Serviceberry	Amelanchier spp.

Due to topographic factors, the east-facing side and bottom of Whiskey Canyon are predominately aspen whereas the west-facing side is a mixture of evergreen species.

The floral community along the Pleasant Valley Creek bottom include mixtures of willow Salix spp., sagebrush Artemisia tridentata, rabbit brush Chrysothamnus nauseosus and grasslands grading into mountain shrub communities.

The project locality is situated in the Northern High Plateau Subcenter of the Middle Rocky Mountain Faunal area and is characterized by a wide variety of species. The mammal species known to exist in the general project area according to Durrant (1952) include the following:

Order Insectivora	
Shrews	Sorex spp.
Order Lagomorpha	
Pika	Ochotona princeps
White-tailed jack rabbit	Lepus townsendii
Snowshoe rabbit	Lepus americanus
Cottontail rabbit	Sylvilagus nuttallii
Order Chiroptera	
	Myotis spp.
Silvery-haired bat	Lasionycteris spp.
Big brown bat	Eptesicus spp.
Red bat	Lasiurus spp.
Long-eared bat	Corynorhinus spp.
Big free-tailed bat	Tadarida spp.
Order Rodentia	
Squirrels	Citellus spp.
Chipmunks	Eutamius spp.

Northern pocket gopher	Thomomys talpoides
Beaver	Castor canadensis
Western harvest mouse	Reithrodontomys megalotis
Mouse	Peromyscus
Meadow mouse	Microtus spp.
Wood rat	Neotama cinerea
Big jumping mouse	Zapus princeps
Porcupine	Erethizon dorsatum
Marmot	Marmota flaviventer
Order Carnivora	
Coyote	Canis latrans
Wolf (formerly in area)	Canis lupus
Red fox	Vulpes fulva
Gray fox	Urocyon cinereoargenteus
Grizzly bear (formerly in area)	Ursus horribilis
Black bear	Ursus americanus
Ring-tailed cat	Bassaricus astutus
Ermine	Mustela erminea
Long-tailed weasel	Mustela frenata
Marten	Martes caurina
Badger	Taxidea taxus
Striped skunk	Mephitis mephitis
Spotted skunk	Spilogale gracilis
Canada lynx	Lynx canadensis
Bobcat	Lynx rufus
Mountain lion	Felis concolor
Order Artiodactyla	
Elk	Cervus canadensis
Mule deer	Odocoileus hemionus
Mountain sheep (formerly in area)	Ovis canadensis

The montane ecozone also supports a wide variety of avian species, some of which are summer migrants. Some of these species, according to Hayward et al (1976) include the following:

Local Avian Species

Coniferous Niche		
	Red-breasted nuthatch	Sitta canadensis (summer)
	Golden-crowned kinglet	Regulus satrapa
	Ruby-crowned kinglet	Regulus calendua
	Yellow-rumped warbler	Dendroica coronata (summer)
	Western tanager	Piranga ludoviciana (summer)
Aspen Niche (Hole nesting)		
	Tree swallow	Tachycineata bicolor
	Violet green swallow	Tachycineata thalassina (summer)
	House wren	Troglodytes aedon (summer)
	Black-capped chickadee	Parus atricapillus
	Yellow-bellied sapsucker	Sphyrapicus varius
	Downy woodpecker	Picoides pubescens
	Common flicker	Colaptes auratus
	Chipping sparrow	Spizella passerina (summer)
	Cassin's finch	Carpodacus cassinii (summer)
	Black-headed grosbeak	Pheucticus melanocephalus (summer)
	Western wood pewee	Contopus sordidulus (summer)
	Mountain bluebird	Sialia currucoides (summer)
	Hermit thrush	Catharus gultatus
Predators		
	Goshawk	Accipiter gentilis
	Cooper's hawk	Accipiter cooperii
	Red-tailed hawk	Buteo jamaicensis
	Golden eagle	Aquila chrysaetos
	Great horned owl	Bubo virginianus

Those species which migrate into the area from out of the state are indicated as summer residents. The other species are present during the entire year but generally migrate to somewhat lower elevations during the winter months.

C. Prehistory and History of the Region

The variety of human cultures which have inhabited the project region can be examined from several perspectives. The temporal continuum extending over a range of 12,000 years involves such diverse groups as the early prehistoric big game hunters, the archaic hunter-gatherers, the semi-horticultural Fremont, the Shoshonean bands, the early historic explorers and fur trappers, the Mormon colonists, the coal and cattle barons, the final influx of farmers, small town settlers, and merchants. Man's social and technological variations mirror the complexity of economic means used to exploit the necessary resources of his changing ecological system.

The Prehistoric Period

The prehistoric period within the project region can be subdivided into four main temporal phases: Paleo Indian, Archaic, Fremont and Shoshonean.

PALEO INDIAN PHASE

The Paleo Indian phase began at approximately 12,000 B.P. and terminated by about 7000 B.P., and is generally divided into three subphases which are known as the Llano, Folsom and Plano cultures (Jennings 1974:81).

The Llano culture was characterized by the hunting of mammoth during a time period between 12,000 B.P. and 10,000 B.P. Since the Llano culture has been defined primarily from the excavation of mammoth kill sites, very little is known about the overall subsistence activities of this culture.

Evidence of the Llano culture has been found over a widespread area in the Intermountain West and Southwest.

The Clovis point, a large, lanceolate, fluted spear point, is the only artifact which can be used confidently to infer the presence of the Llano hunters. Clovis points, in association with mammoth remains, have been found in New Mexico, Oklahoma, Colorado, Arizona and Wyoming.

Based on these sites, which are characterized by mammoth-Clovis point association, the core area of the Llano culture is limited to eastern Colorado, most of New Mexico and eastern Arizona. However, the Clovis point by itself has a much larger distribution. Clovis points, or very similar fluted points, have been found throughout the entire United States.

Within the project region of Utah, no characteristic Llano sites have been found, although several isolated Clovis points and one fluted point site have been reported. An isolated Clovis point was reported from Sevier County, Utah (Tripp 1966). Gunnerson (1956) performed a test excavation on a small rockshelter in Emery County (42Em8) from which a local collector had obtained a Clovis point. The test excavation did not, however, recover any additional Clovis points. An unusual fluted point very closely resembling the Cumberland fluted points commonly found east of the Mississippi River was found by an amateur collector in the San Rafael Swell and reported by Hauck in 1979 (42Em677).

The Folsom culture (ca. 11,000 B.P. to 9000 B.P.) immediately followed the Llano culture, but several differences in subsistence and artifacts allow a clear distinction to be drawn. Although the primary evidence of the Folsom culture is also from kill sites, the fauna hunted and the projectile points used are different from the Llano culture. The Folsom point is a lanceolate, fluted and usually eared projectile point generally smaller and thinner than the Clovis point. In addition, the Folsom point is associated at kill sites with the extinct Bison antiquus.

Folsom kill sites occur predominantly within the same region as the Llano core area but isolated Folsom points are not as widely distributed as Clovis points. Isolated Folsom points are almost entirely limited to the High Plains immediately east of the Rocky Mountains. A total of 11 Folsom points has been found in Utah but only one of these, found by an amateur collector somewhere in the San Rafael Swell, is known from the project region (Tripp 1967).

The Plano subphase of the Paleo Indian phase extends from ca. 9000 B.P. to 7000 B.P. The Plano culture, like the Llano and Folsom cultures before it, was economically partially dependent on large game, bison in particular. However, the Plano culture is characterized by a great diversity of projectile point types. Plano culture projectile points are typically lanceolate, precisely flaked and non-fluted.

A new hunting technique also became widespread during the Plano subphase, the jump-kill. The jump-kill hunting technique entailed the driving of a herd of bison over the edge of a cliff or arroyo in order to injure or kill the bison.

Evidence of Plano culture inhabitation is predominately limited to the High Plains east of the Rocky Mountains. The presence of Plano culture hunters in Utah is not widely acknowledged.

The presence of Paleo Indian cultures within Utah was minimal even during the Llano subphase and tended to decrease with time. The slight Paleo Indian utilization of Utah can possibly be tied to the relative scarcity of the large game species in Utah compared to the Great Plains east of the Rocky Mountains than on the eastern side and, as a result, the large herbivorous animals utilized by the Paleo Indian cultures were present on the Great Plains in considerably greater numbers.

ARCHAIC PHASE

Because of the relatively arid conditions of Utah and the Great Basin, large mammal hunting was not a viable subsistence technique in that area. The Great Basin and adjacent Colorado Plateau of eastern Utah were occupied at an early date by Indian groups who were engaged in a subsistence pattern dependent on smaller game animals and the gathering of wild plant foods.

The utilization of caves and rockshelters by Archaic cultures in Utah has resulted in good temporal sequences for the entire Archaic phase. Radiocarbon dates from Danger Cave (Jennings 1957) verify human inhabitation of the Great Basin as early as 10,000 B.P., but the artifacts retrieved from the lowest levels of Danger Cave are not diagnostic of any recognized culture group.

In addition to Danger Cave, Hogup Cave (Aikens 1970) in the Great Basin, Sudden Shelter (Jennings, Schroedl, Holmer 1980) in the southern Wasatch Mountains and Cowboy Cave (Jennings et al n.d.) in southeastern Utah, have all supplied important data pertinent to the development of a cultural sequence for the Archaic inhabitants of Utah. The Archaic has been divided into three phases based on changes in projectile point types.

The Early Archaic Period begins at approximately 8500 B.P. and continues until about 6000 B.P. Subsistence during this period was based on generalized gathering and hunting techniques. A large variety of plant, animal and insect resources was utilized. Hunting was primarily limited to deer and mountain sheep although antelope and bison were also utilized. The trapping of rabbits and small rodents was also an important source of protein.

The prevalent utilization of caves and rockshelters as habitations in conjunction with the aridity of the area has resulted in conditions suited to the preservation of normally perishable materials. Due to the excellent preservation, it

is known that the spear thrower (atlatl) was the implement used for hunting. The atlatl was used with a two or three component shaft and stone dart point throughout the Archaic phase. The Early Archaic Period was characterized by four types of dart points, the Pinto, Humboldt, Elko and the Northern Side Notch (Holmer 1978). During this time period, the Elko point type had a limited areal extent confined primarily to the northeastern Great Basin and the northern Colorado Plateau. The Pinto and Humboldt points, generally found in close association in archeological contexts, had the same distribution as the Elko points, but are also found in sites in southern and central Idaho at this time period. The Northern Side notch point had a very wide distribution during the Early Archaic period encompassing the northern Great Basin, Columbia Plateau, Northern Colorado Plateau and Great Plains.

The Middle Archaic Period began about 6000 B.P. and ended about 4500 B.P. Subsistence techniques and the utilization of caves were the same as during the Early Archaic but dart point styles changed and also diversified. Dart points such as the Rocker Side-notched, Sudden Side-notched, McKean Lanceolate and San Rafael Side-notched were characteristic of this period (Holmer 1978). The Elko point continued to be used during this period in the same areas as it had been during the Early Archaic period. Although the Rocker Side-notched and Sudden Side-notched points were limited in their distribution to central Utah, the McKean Lanceolate and San Rafael Side-notched styles had wider distributions including the Great Plains at this time. Another point style made its appearance during the Middle Archaic, the Gypsum point (Holmer 1978). This point style was very common in the southern Great Basin and northern Colorado Plateau and continued to be utilized through the end of the Late Archaic period.

The Late Archaic period began about 4500 B.P. and ended at roughly 1700 B.P. Subsistence techniques were essentially unchanged from the earlier Archaic periods and the utilization of the Elko and Gypsum points styles was continued although the latter style is generally limited in its occurrence to the southern half of Utah. At the end of the Late Archaic period, two new technological developments occurred which mark a significant change in prehistoric subsistence patterns: the introduction of corn and the bow and arrow.

Evidence of corn horticulture in the latter part of the Late Archaic period has been found at several locations: Cowboy Cave (Jennings et al in preparation), Cottonwood Cave in western Colorado (Hurst 1948) and Clyde's Cavern in central Utah (Winter 1973, Winter and Wylie 1974). At all three locations, corn caches were found which dated generally between 1600 B.P. and 2000 B.P. The very late portion of the Late Archaic period also witnessed the advent of the bow and arrow. At Cowboy Cave (Jennings et al n.d.b), Rose Springs arrowheads were recovered from the uppermost level and were dated about 1700 B.P.

The entire Archaic phase is characterized by a gathering and hunting subsistence mode and a sequence of dart point styles which have been defined through the analysis of excavated cave and rockshelter sites. Transient habitation of these caves during the annual migratory round is the most widely accepted interpretation of the Archaic subsistence pattern.

The atlatl was the universal Archaic hunting implement until the very last centuries of the Late Archaic period. However, the advent of the bow and arrow around 1700 B.P. does not seem to have eliminated the utilization of the atlatl during the late Archaic. Gypsum dart points continued to be manufactured even after the appearance of Rose Spring arrowheads at Cowboy Cave (Holmer in Jennings et al n.d.).

addition, Anasazi tradewares are considerably more prevalent in the Fremont culture sites than in the Sevier culture sites.

The unnamed plains-derived culture of northern and northeastern Utah existed from about 1300 to 650 B.P. (Madsen and Lindsay 1977). This culture was dependent upon hunting of bison and the collecting of wild plants. The dwellings are normally shallow basin structures without any clear evidence of the type of superstructure utilized. Unlike the coiled pottery of the Sevier, Fremont and Anasazi cultures, the unnamed culture produced pottery by the paddle and anvil techniques. It is important to note that there is a considerable spatial overlap of the unnamed culture and the Fremont culture traits in the northern portion of the latter's distribution. There is insufficient data at the present to determine whether the spatial trait overlap is due to alternate occupation, simultaneous occupation by the two cultures or a combination of these two possibilities.

Hunting activities among the Sevier, Fremont and unnamed cultures are evident from the many varieties of small arrowheads which have been recovered from excavations. Small stemmed corner notched (Rose Spring) arrow points are present in the earlier phases of all three cultures, but after about 1100 B.P., numerous regional variants developed. Side notch arrow point styles (Bear River Side-notched and Uinta Side-notched) were common in the northern part of Utah while Parowan Basal-notched and Bull Creek arrow point styles were common in the southwestern and south central portions of Utah respectively. The Bull Creek points are of particular interest because they are found in high frequencies at both Kayenta Anasazi sites in southern Utah and Fremont sites along the east side of the Wasatch Mountains (Coombs Village, Bull Creek sites, Snake Rock Village, Old Woman and Poplar Knob) and probably indicate the reciprocal exchange of males for matrimonial purposes (Holmer and Weder 1980).

Dart points, the Elko series and Gypsum, in particular, are also found in association with Fremont sites. This association has been used by Schroedl (1976) to verify the indigenous development of the Fremont culture from Archaic antecedents. Dart points, during the Archaic, were used as both projectile points and knives (Weder in Jennings et al n.d.) but their function in the Fremont context has not yet been evaluated.

In reference to Utah, the Mesa Verde and Kayenta variants of the Anasazi culture are of particular importance. The San Juan Anasazi culture was centered around the Four Corners area where Colorado, New Mexico, Arizona and Utah meet. The Kayenta Anasazi inhabited the extreme southern periphery of Utah from the San Juan River west to central Utah. As has already been noted, Kayenta influence is particularly evident in a narrow band of sites running from Coombs Village northwards past the Henry Mountains to the Snake Rock Village site adjacent to Interstate 70 on the east side of the Wasatch Plateau.

SHOSHONEAN PHASE

The Shoshonean populations, who were the sole inhabitants of Utah at the time of Euro-American contact, have been in the northeastern Great Basin region since approximately 650 B.P. Their origin has been the subject of considerable controversy, however. Several hypotheses have been expressed.

One hypothesis maintains that the Shoshoneans came from the southwest of the Great Basin at about the time of the dispersal of the Sevier, Fremont and Anasazi agriculturalists (Madsen 1975b and Lamb 1958). Gunnerson's hypothesis (1962) states that the Fremont, Sevier and Virgin cultures were Shoshonean peoples who had taken up horticultural and ceramic techniques diffused from the Anasazi but later reverted to an Archaic subsistence style after a climatic change which made agricultural subsistence techniques unproductive.

Regardless of which hypothesis is correct, Shoshonean groups (Ute, Paiute, Shoshone and Bannock) were inhabiting the Great Basin into eastern Utah at ca. A.D. 1300 roughly coincident with the disappearance of the Fremont and Sevier cultures.

The Shoshonean subsistence pattern was quite similar to the Archaic adaptation. Small familial bands were engaged in a gathering and hunting subsistence utilizing a wide variety of nondomesticated plant, mammal, and insect species.

Very little archeological evidence is available for this time period. Two characteristic artifact types can generally be associated with the Shoshonean occupation of Utah. The bow and arrow was utilized for hunting and a type of arrowhead, the Desert Side Notch point, has been correlated with the Shoshonean occupation (Holmer and Weder 1980). The Shoshoneans also utilized ceramics to a small degree. Shoshonean ceramics are easily distinguished from Sevier, Fremont and Anasazi wares by the former's relative crudeness. Shoshonean ceramics are typically thick walled, have large temper particles, are poorly smoothed, exhibit little decoration and have been fired in an uncontrolled or oxidizing atmosphere.

The Protohistoric Period

The prehistoric Shoshonean occupation of the Intermountain West continued up to and through the period of Euro-American contact. The Indian groups inhabiting the area of eastern Utah within which the project locality is situated came to be called the Utes.

PRECONTACT

The Utes are a group belonging to the Shoshonean (Uto-Aztecan) linguistic family of which there are three branches: Ute-Chemehuevi, Shoshoni and Mono-Paviotso. The Ute-Chemehuevi branch includes those groups which came to be

known as the Utes, Southern Paiutes and Chemehuevi. Although there is little archeological evidence, the Utes probably were characterized by a social organization and subsistence mode quite similar to all of the other aboriginal groups in the Great Basin and Colorado Plateau. The Utes were pedestrian gatherers and hunters who utilized a relatively large area of western Colorado and eastern Utah (Steward 1974).

The Utes were grouped into loosely organized bands consisting of extended families. Leadership was present only for subsistence task groups. The Utes could be reliably distinguished from the other contemporary aboriginal groups only in terms of linguistic differences.

Group territoriality was developed only in a statistical sense. A particular Ute band might consider a certain area as a home, but the seasonal round of each band was highly variable from year to year. The area with which any band was most familiar was not exlusively utilized by that band. Intermarriage among the various Ute bands tended to maintain linguistic unity but blur the definition of territorial homeland for any particular band. Except for those Utes who were utilizing the aquatic resources around Utah Lake, local populations were small and mobile (Steward 1974).

EARLY CONTACT

The presence of the Spanish colony at Santa Fe by 1598 resulted in the first contact between the Utes and Euro-American groups. The relationship which developed between the Utes and the Spaniards was consistently friendly and resulted in the spread of the horse among the Ute bands. When the Utes obtained the horse, a change in their subsistence occurred. The equestrian Ute was able to travel more widely and more effectively and concentrate on bison hunting (O'Neill 1973).

The utility of the horse was strongly mitigated by environmental factors, however. The maintenance of a large

horse herd required substantial supplies of grass which generally limited the advantage of the horse to those areas where grass was plentiful such as western Colorado, the Uintah Basin and along the western slopes of the Wasatch Mountains. The supply of grass also determined the distribution of the bison. The horse was, therefore, not equally valuable to all of the Ute bands. The bands in Colorado were able to support their horses whereas those bands in Utah, eastern Utah in particular, were unable to utilized the horse effectively and were more likely to eat a horse than ride it.

Considerable trading activity with the Utes was occurring during the 17th and 18th Centuries. Of particular importance was slave trade (O'Neill 1973). The Utes were able to conduct slave raids on neighboring tribes (especially the Navajo) because of their equestrian status. They then exchanged their slaves for horses and other Spanish goods. Whether the slaves were exchanged with traders travelling into Ute territory or were driven by the Utes to Spanish settlements is unknown because of the lack of documented evidence. Until the 1770s, there was little official Spanish interest in the territory of the Utes. However, at that time, King Charles III of Spain decided that an exploration of the areas north of Santa Fe would be beneficial to Spanish control. His developing interest was a reaction to the growing influence and explorations by the British and French in the West. Charles III felt that it was important to ensure control of trade by the Spaniards since he considered the British and French traders as a threat to Spanish rule (O'Neill 1973).

The first documented Spanish exploration of the area north of Santa Fe was the Dominguez-Escalante Expedition of 1776-1777. This expedition was also the first officially

sponsored exploration, the purpose of which was to find a route between Santa Fe and the Spanish settlements in California. Although the expedition was unsuccessful in reaching its goal, it did extensively explore the territory occupied by the Utes who, in all recorded instances, welcomed the Spaniards.

A trail was eventually established between Santa Fe and California which came to be known as the Spanish Trail. The origins of the Spanish Trail are obscure; however, this trail was probably utilized in prehistoric times as evidenced by its association with archeological sites.

LATE CONTACT

Beginning in the early 1800s, the fur trade became active in Utah. The Arze-Garcia expedition traded for furs with the Utes at Utah Lake in 1813 and soon thereafter trappers began to actively exploit the area. Etienne Provost was a member of the Choteau-DeMun exploration of 1815 to 1817 and subsequently founded his own trapping company which operated primarily within Ute territory. He was subsequently killed by the Utes near the site of the city which now bears his name, Provo (O'Neill 1973).

During this time, more detailed information on the Shoshonean peoples of the area was recorded. In particular, specific Ute bands are mentioned with reference to their respective territories. Within the project region, the Weeminuche band conducted its yearly rounds (O'Neill 1973).

The Adams-Onis treaty of 1819, which gave Mexico its independence, resulted in an influx of Americans to Santa Fe. Most of the Americans came to engage in trapping. The newly arrived trappers caused a considerable increase in traffic along the Spanish Trail and an increase in competition for the available fur resources. This competition was not welcomed by the Utes, who were no longer consistently friendly with the Euro-Americans.

Although there were a large number of independent trappers operating in Utah, their activities have not been well documented. Antoine Robidoux was an important trapper who by 1824 was operating primarily in the Uintah Mountains. William Ashley and Peter Skene Ogden were trapping in the northern Ute territory during the summer of 1824 and, at about the same time, Jedediah Smith was exploring eastern Ute territories to evaluate their trapping potential (O'Neill 1973).

The growing traffic along the Spanish Trail had an important effect on the local Ute bands. Wakara, a Tumpanuwache leader, became quite powerful in the 1820s by conducting horse raids in southern California and returning to Utah by way of the Spanish Trail (Lyman and Denver 1970). He enhanced his power and wealth by exacting tribute from travelers along the trail and by the trading of stolen horses and Pahvant and Paiute slaves (O'Neill 1973). In addition, Wakara and his band actively engaged in fur trapping.

By the late 1830s, there was considerable competition for the fur resources of Utah and western Colorado. Robidoux established a permanent fort and trading center in 1837 near Whiterocks in the Uintah Basin to capitalize on the beaver-laden streams of the Uintah Mountains.

The prosperity of the fur trade was not destined to last very long, however. The fierce competition over trapping areas led to widespread disruptive conflicts and, most importantly, the demand for furs used to make the beaver skin hats which were fashionable in Europe and the eastern United States declined rapidly about 1840 as the fashions changed. Fort Robidoux was burned in 1844 by the Utes who apparently blamed the trappers for the declining value of their furs (O'Neill 1973; Lyman and Denver 1970).

The decline of the fur trade had a serious impact on the Ute bands of Utah. The entire economic base of the

Utes began to disintegrate after 1840. The trading activities with Santa Fe began to dwindle with the decline in the horse and slave trade. The termination of Mexican control of the area in 1846 and the subsequent loss of contact for slave trade into Mexico (Lyman and Denver 1970) were very disruptive to the relationships existing between Utah and Santa Fe.

During the declining years of the fur trade, the largest invasion of Ute territory occurred. Beginning in 1847, Mormon pioneers began to move into Utah and rapidly swelled their numbers through immigration. At first, there was little conflict with the Utes because the major Mormon settlement, Salt Lake City, was on the periphery of the Ute territory and the earliest Mormon expansion was to the north. In 1849, Fort Utah (later to become the town of Provo) was founded near Utah Lake on the traditional campsite of the Tumpanuwache band. Since the Tumpanuwache band, still under the leadersip of Wakara, had been forced to revert to their earlier mode of subsistence due to the decline of the fur trade, their utilization of the resources around Utah Lake became of vital importance. The conflicting interests in the Utah Lake vicinity escalated into a series of raids and counterraids during the 1850s which became known as the Walker War. In the end, the Utes were forced to leave the valley and moved east across the Wasatch Mountains (O'Neill 1973).

The next few years were difficult for the Utes, who were being gradually forced to split up into small bands and resume a subsistence mode similar to the precontact period. Some of the bands, however, chose to raid Mormon settlements and farms to obtain cattle so that they could avoid starvation. These raids became more prevalent during the 1860s. Raids were conducted on the Mormon settlers west of the Wasatch and the Utes returned to the unsettled areas east of the Wasatch with the stolen cattle (O'Neill 1973).

Although several bands were responsible for these raids, one man by the name of Black Hawk became the focus of the blame for all the raiding.

The areas east of the Wasatch Mountains remained under Ute domination for several years. A Mormon attempt to colonize at Moab was undertaken in 1855 but the Mormon settlers were harassed by the Utes and forced to return to Salt Lake City. It was not until 1877, by which time the Utes had been removed to the Uintah Reservation, that Mormon colonists were able to safely settle east of the Wasatch Mountains (O'Neill 1973).

The Historic Period

The history of the east-central coal areas of Utah begins with the exploration and colonization efforts of the Spanish during the last quarter of the 18th Century. East-central Utah was first explored and mapped by the Dominguez-Escalante Expedition of the 1776-1777 in its efforts to establish a line of communication between the Spanish settlements of New Mexico and Monterey, California (Miller 1968).

Though the Dominguez-Escalante Expedition failed to achieve this end, subsequent attempts from the New Mexico settlements and the travelings of Spanish and American fur trappers, traders and frontiersmen resulted in a connecting route known as the Old Spanish Trail (Miller 1968:Map 20). Along this route, which came up from Santa Fe through the San Juan country, across the Colorado River at Moab, over the Green River at the present site of Green River, across the San Rafael Desert into Castle Valley, then south through Salina Canyon to southwestern Utah and southern California, passed thousands of horses and numerous trading, trapping and Indian slave trade expeditions (Miller 1968).

By the 1830s, the trail was well established, portions of its route being followed in 1853 by explorer, John C. Fremont and government surveyor, John W. Gunnison, who reported several sets of well-worn tracks near Green River where Interstate 70 presently runs. Other sections of the trail still remain near the Big Hole Wash in Emery County. The primary route of the Old Spanish Trail, plus divergent trails to Utah Lake, Fort Robidoux and Fort Kit Carson, brought the first extended contact into the project area (Miller 1968: Map 20).

Though forts and trading posts were scattered sparsely through southern and central Utah, the first attempts at organized settlement were undertaken by the Mormon Church. In 1855, the Elk Mountain Mission passed southward through Castle Valley to the area of Moab intending to establish a permanent settlement, but Indian hostility forced a quick retreat. The combination of hostile Indians, the desolate appearance of the region, the hardships involved in securing sufficient water for irrigation and doubts about the quality of the soil caused further attempts at colonization of the eastern area of what was then Sanpete County to be dropped for over 20 years (McElprang et al 1949:16).

At a priesthood meeting at Mt. Pleasant on September 22, 1877, encouragement was given to settle Castle Valley; soon after 75 men from Sanpete Stake were called with Christian G. Larsen as leader. Very few responded, however, because of the aforementioned reasons. Orange Seely was subsequently given the responsibility of superintending the founding of settlements and another call for colonizers was issued by the Church in the fall of 1878. Some of the earliest settlers of the area who dwelt in dugouts in hills or washes until log houses could be erected were Elias and John Cox, Ben Jones, William Avery and Anthony Humbel. By the fall of 1878, the crops were sufficient and the situation stable

enough for the families of these men to join them, a sure sign of an intent to remain (McElprang et al 1949).

Work progressed on the agricultural settlements of Castle Valley and roads were built through the Wasatch Mountains to the more stable areas of western Sanpete County. Additionally, in the fall of 1878, the "Star-Mail Route" was opened between Salina and Ouray, Colorado; it followed the paths of the Old Spanish Trail and the "Gunnison" Trail of years before (McElprang et al 1949:19-21). In just three years the towns of Castle Dale, Wilsonville, Ferron, Greenriver (Blake), Huntington, Lawrence, Molen and Orangewill had been established and the Legislative Assembly in February, 1880, created Emery Coutny, which embraced all of present-day Carbon, Emery and Grand Counties (Lever 1898:593).

Though the project region was settled for its agricultural and grazing possibilities, it was the area that inspired active settlement and set the mining-dominated industrial base that central and eastern Utah retains to the present.

The first recorded discovery of coal in eastern Utah was by the Gunnison Expedition of 1853 (Powell 1976:13) when they located deposits of coal approximately three miles east of present-day Emery. The isolated location of the Gunnison find, coupled with the hope that the deposits already discovered at Coalville and Wales would prove sufficient for the territory's needs, caused Gunnison's discovery to be forgotten. The subsequent failure of the efforts at Wales to produce good coking coal, and the Union Pacific Railroad's monopolization and price-fixing on the deposits at Coalville, caused a re-evaluation of the potential coal producing areas east of the Sanpete settlements (Powell 1976:13).

As a result, the first effort to exploit the newly found eastern coal deposits was undertaken in 1875 at Connellsville in the upper reaches of Huntington Canyon. The

Fairview Coal Mining and Coke Company was organized by men from New York, Salt Lake City and Fairview. Eleven coke ovens were constructed and the coke was hauled by wagon into Springville. The expense involved with the hauling and the questionable quality of the coke produced caused the failure and abandonment of Connellsville by 1878 after only three years of operation (Powell 1976:13).

The next development of coal resources was begun in the Pleasant Valley area, also in 1875. The Pleasant Valley Coal Company, headed by Milan O. Packard, constructed a wagon road from Springville up Spanish Fork Canyon to Pleasant Valley coal lands in 1876; 1877 saw the opening of the Number 1 Mine in Winter Quarters Canyon (Powell 1976:14). A narrow gauge rail line was completed from Springville through Spanish Fork Canyon in October of 1879 by the Pleasant Valley Railroad Company as the haul to Springville by the wagon road occupied four days in good weather while in winter the road was impassable. This Pleasant Valley area proved to be extremely productive. The first three large scale mines in eastern Utah were established in this area when the Mud Creek Mine was reopened in 1882 followed by the 1884 opening of the Union Pacific Mine at Scofield just east of Winter Quarters (Powell 1976:15).

From the earliest times, the railroads sought to control the supply of coal in the territory, e.g., the Coalville resources and Union Pacific Railroad's control over that source. During the early 1880s, the Denver and Rio Grande Railroad was extending its lines from Colorado through Utah. Though originally graded through Castle Valley and Salina Canyon, the route of the railroad was altered, going through Price and Spanish Fork Canyon and thus taking in the rich coal areas of what was to become Carbon County (McElprang et al 1949:22).

Further expressing its interest in eastern Utah coal, the Denver and Rio Grande Western (Denver and Rio Grande's Utah

holdings) purchased the independently owned Pleasant Valley Railroad Company and Pleasant Valley Coal Company in 1882. Shortly thereafter, Union Pacific Railroad Company (UPRR) penetrated the Pleasant Valley area in order to protect its threatened monopoly on Utah coal (Powell 1976:16). The UPRR formed the Utah Central Coal Company in 1882 and opened the Union Pacific Mine near Scofield in 1884. With the Denver and Rio Grande's Pleasant Valley Coal development (1882), the establishment of Utah Fuel Company in 1887 and the creation of Utah Central Coal of Union Pacific, the railroad companies almost totally dominated the ownership and production of the Utah mines until the early 1900s (Reynolds et al 1948:195).

In 1888, a mine was opened at Castle Gate on the Price River near the mouth of Price Canyon. In about 1899, a new mine began operations at Sunnyside just 24 miles east of present-day Price at the base of the Book Cliffs. The Sunnyside Number 2 Mine also began its production in 1899 with the coal obtained there, and also at Castle Gate, being utilized for coking purposes (Powell 1976:17-18).

In 1906, the first of the coal operations which would remain free from railroad control began production at Kenilworth, three miles east of Helper. This enterprise was financially backed by James Wade and F. A. Sweet and was called the Independent Coal and Coke Company because of its unique ownership status. Sweet, one of Utah's most prominent coal authorities, also opened a mine on the middle fork of Miller Creek in 1908 and named the camp Hiawatha (Reynolds et al 1948:213). This locality at the foot of Gentry Mountain, about 18 miles southeast of Price, was the scene of further coal mining development in 1911 when Black Hawk mine was opened by Brown and Eccles. Just a few miles to the south in northern Emery County, a small wagon mine was purchased by the Castle Valley Fuel Company and the town, Mohrland, named from the initials of the company's four major figures--Mays, Orem, Heiner

and Rice--was begun. Mr. W. H. Wattis undertook the last development in this area in 1916 at Wattis, several miles north of Hiawatha on the flank of Castle Valley Mountain.

The decade from 1911-1920 saw an increase in activity in the coal regions of east-central Utah with many new mines being opened in hitherto undeveloped areas within the Utah coal producing regions. In 1911, Frank Cameron prospected the region around Panther Canyon on the Price River, and in 1914, the first coal was shipped out by the Utah Fuel Company which had leased the properties to Cameron for development. Cameron also developed and opened a small camp at the base of Castle Rock, about five miles northwest of Helper. Located directly on the main line of the Denver and Rio Grande Western Railroad, the camp's name was changed many times as was its ownership. Originally known as Bear Canyon, it soon was called Cameron, for its developer, then Rolapp, and finally, Royal (Reynolds et al 1948:244).

In 1912, Jesse Knight, one of the most prominent men in Utah mining history, bought 1600 acres of coal land west of Helper to provide coal for his smelting operations in the Tintic District. His mine, at what eventually became known as Spring Canyon, began production in 1913 and was the first of many mines in the Spring Canyon District, one of the most prolific coal producing areas in eastern Utah. Soon after the establishment of Storrs (Spring Canyon), F. A. Sweet opened another mine in Spring Canyon at Standardville, so called because it was considered to be the standard for the development of future mining camps. The year 1914 saw the opening of the Latuda Mine and camp by Liberty Fuel Company while mines were opened in 1916 at Peerless and Rains. The last mining development undertaken in the Spring Canyon District was Mutual Coal Company's Mutual and Little Standard operations, begun in 1921 and 1925, respectively.

The final major coal producing area to be opened in east-central Utah was the Gordon Creek District. This region had first been prospected in 1908, but was really brought to prominence in 1920 by A. E. Gibson, the superintendent of the Spring Canyon Mine. Mines were developed in this area up until 1925 by Consumers Mutual Coal Company, National Coal Company and Sweet Coal Company. The operations of all three companies ceased by 1950 (Carr 1972:81).

After the development of the Gordon Creek area, further work on the coal regions was undertaken in areas that had been opened previously. In 1922, Columbia Steel Company opened a mine at Columbia near the location of Sunnyside in order to further exploit the excellent coking coal obtainable from that region. One very late development of the same coal veins that supported the Columbia operation was initiated in Horse Canyon in 1942 by the United States government to aid steel production at its Geneva plant (Reynolds et al 1948:252). Both mine and steel plant were taken over by U.S. Steel after WWII and continue in operation to the present.

Most of the mines in east-central Utah continued production through the heavy demand years of WWI and the years of prosperity that followed but a combination of overdevelopment, the increased use of other natural fuels, rising costs associated with expensive underground haulage and the Depression of the late 1920s and early 1930s caused several camps to be abandoned. Among the first mines to succumb were the long exploited Pleasant Valley mines. Winter Quarters, near Scofield, was closed down in 1928 while Scofield and Clearcreek experienced reductions of operations during the early 1920s and 1930s, respectively. Rains was also forced to cut back on operations in 1930. Despite these setbacks, as of

1929, there were 22 coal mines operating in Carbon, Emery and Grand counties, the production of these mines providing 98% of the state's output (Sutton 1949:852).

Economic and production difficulties continued to plague Utah's coal industry during the decade of the 1930s, forcing the closure of the Mutual and Mohrland mines in 1938. World War II brought a temporary respite to the general downward trend with many mines achieving their highest production levels during the war years and immediately thereafter.

The decade of the 1950s signalled the end for a great number of the eastern Utah coal mining operations as the adaptation of coal for new uses was insufficient to keep pace with this fuel's replacement in many of its traditional roles. The increasing use of natural gas for heating homes and heavy industry use and the railroad's switch to diesel power were among the developments which severely hurt the coal industry. This bleak picture has drastically changed with the advent of America's "energy shortage", and new technologies for coal use in the future have caused an upswing in coal production in east-central Utah. Mines which were closed, or kept running with skeleton crews, have begun to increase operations during the last decade and the possibility of a new sustained burst of coal mining activity definitely exists (Alexander 1963:244-247).

D. Previous Investigations in the Region

Archeological research in the Castle Valley locality began with the Claflin Emerson Expedition. In 1929, Noel Morss and Henry Roberts conducted explorations and limited test excavations under the auspices of this expedition along the Fremont River and as far north as the Muddy River in Emery County. Morss' work resulted in the original definition of the

Fremont cultural entity (Morss 1931, Gunnerson 1969). Morss' description of Fremont sites north of the Colorado River was an important contribution to the understanding of the prehistoric horticultural adaptation in the American Southwest.

With the exception of Reagan's description of the large petroglyph panel in Buckhorn Draw (Reagan 1935), there were no archeological investigations in the Castle Valley region for the next 15 years. Between 1952 and 1957, the University of Utah conducted a series of surveys in order to better define the nature of the Fremont occupation in Utah. A large number of Fremont sites was located along the east side of the Wasatch Plateau and several of the sites were subjected to limited test excavations, including 42Em5, the Emery Site (42Em47) and Snake Rock Village (42Sv5). Each of these three sites were Fremont habitations (Gunnerson 1957). In addition to these Fremont sites, Gunnerson also tested a shallow rock shelter on Silverhorn Wash (42Em8) as a result of a local collector's report that a fluted projectile point resembling the Clovis style had been found eroding from the shelter deposits. Little additional information was obtained by the excavation, however (Gunnerson 1956).

In the 1970s, there was a significant upsurge in archeological activity in the Castle Valley region. In 1970, three sites endangered by vandalism were excavated by the University of Utah. These sites, Windy Ridge Village (42Em73), Crescent Ridge (42Em74) and Power Pole Knoll (42Em75) all proved to be Fremont habitation sites (Madsen 1975a) dating between about 980 B.P. and 1260 B.P.

During the following year, the University of Utah conducted excavations at Clyde's Cavern (42Em177). Clyde's cavern was a locus of summer plant gathering activities during the Late Archaic period, but the majority of the cultural deposits was shown to be the result of summer maize cultivation and wild plant harvesting activities during the subsequent Fremont period (Wylie 1972, Winter and Wylie 1974).

The next site to be excavated in the study area was Joe's Valley Alcove (42Em693). During the summer of 1974, the United States Forest Service excavated this site which had cultural strata, dated by both radiocarbon and typological means, from the Early Archaic, Late Archaic and Fremont Periods (E. DeBloois, personal communication). That same summer, a University of Utah field school excavated the Innocents Ridge site, which proved to be yet another Fremont habitation locus (Schroedl and Hogan 1975).

During the early fall of 1975, the Antiquities Section, Division of State History (Utah) conducted an excavation of a small rockshelter as a part of the cultural resource mitigation program for Consolidation Coal Company of Denver, Colorado. This site, known as Pint Size Shelter (42Em625), had two main cultural strata, one dated to the Late Archaic and the other dated to the early Fremont Period. Both of these occupations were evidently the result of wild plant procurement activities (Lindsay and Lund 1976).

Other Fremont habitation sites, located farther to the south, have been excavated. These sites include Snake Rock Village (Aikens 1967), Old Woman and Poplar Knob (Taylor 1957) and the Old Road Site and Ivie Ridge Site (Wilson and Smith 1976). These five sites were all Fremont period habitations although Kayenta and Mesa Verde Anasazi ceramics were recovered at low frequencies indicating that there was contact with other cultural groups located further south.

In addition to these Fremont sites, a deeply stratified rockshelter (Sudden Shelter, 42Sv6) was found to contain occupational strata spanning the entire Archaic Period, ca. 8000 B.P. to 3000 B.P. (Jennings et al 1980). The original site report indicated that Fremont diagnostics were present on the site when it was originally documented, but these artifacts were no longer present when the excavations were begun. The

Sudden Shelter site is of particular importance to the local prehistory and the prehistory of the eastern Great Basin and northern Colorado Plateau because of its numerous well-defined occupational strata which has allowed a fine-grain correlation between certain diagnostic projectile point types and the temporal phases of the Archaic period.

A test excavation of two heavily vandalized rockshelter sites (42Em959 and 42Em960) in Cottonwood Canyon conducted by AERC in 1979 seem to mirror the results of the excavations at the nearby Joe's Valley Alcove. Radiocarbon analyses have not yet been completed, but projectile point correlations indicate that these two sites were occupied during the Early Archaic period, Late Archaic and, most heavily, during the Fremont period (Weder and Hauck, n.d.).

Since 1970, the level of survey intensity has increased drastically. The various cultural resource inventories conducted during the 1970s have generally been the result of natural resource development programs and are too numerous to summarize in the present context. Summaries of these inventories performed before 1978 can be found in Sargent (1977) and Hauck (1979). The combined inventory results as of 1977 indicate that the majority of the culturally identifiable sites in the general area are Fremont although Archaic sites are also well represented. Protohistoric Numic sites are present but rare (Hauck 1979a:110).

E. Research Design

AERC's research design which has been developed to aid in project planning and resource evaluation for the east slopes of the Wasatch Mountain Range in central Utah include the following factors:

1. The determination of presence or absence of a continual sequence of Paleo-Indian, Archaic,

Fremont and Shoshonean utilization of the project area and the local manifestations of these cultural phases when present;

2. the determination of presence or absence of cultural materials which demonstrate the prehistoric utilization of drainages as access routes across the mountain range;

3. the determination of whether any specific ecozone contained a preponderance of prehistoric cultural resource sites, thus demonstrating any diversity of preference for different ecozones;

4. the determination of which types of prehistoric cultural activity were conducted in the project area based upon patterns in artifact associations or predominance of particular types of sites;

5. the determination of presence or absence of early historic Euro-American habitation, trapping, trade or travel within the project area; and

6. the determination, on a regional level, of whether the sites in the project area contained any remains, demonstrating local interaction between the San Rafael and Sevier variants of the Fremont Culture.

Since all research conducted in the Eccles Canyon locality has been oriented to identifying, recording and analyzing the historic and prehistoric remains within the project locality, only marginal artifact collection and subsurface testing has been carried out. No floral, faunal, radiocarbon, pollen or flotation specimens have been obtained for laboratory analyses. Collections have involved only the retrieval of diagnostic historic artifacts from the vicinity of the Utah Mine.

Chapter II - METHODOLOGY

A. Field Research

During late July, 1980, an intensive cultural resource inventory of a transmission corridor was conducted by AERC for Valley Camp of Utah and the Vaughn Hansen Associates consulting firm of Salt Lake City, Utah. This corridor is associated with the Pleasant Valley-Whiskey Creek project area located near Scofield, Utah.

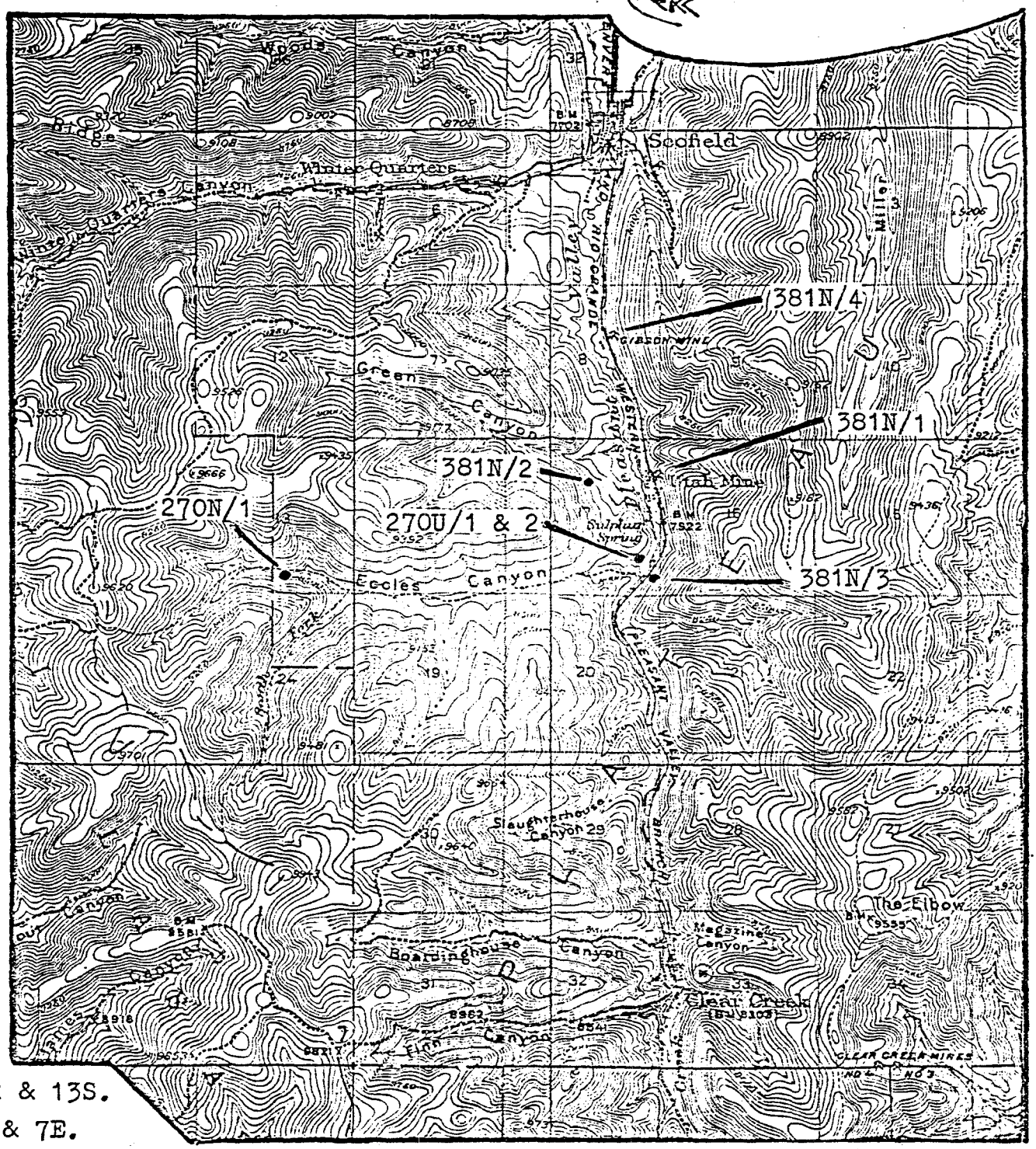
V. Garth Norman, a staff archeologist with AERC, was in charge of the field crew which included Monika Williams and Bunny Melendez. F. R. Hauck, president of AERC was principal investigator.

The survey area lies between the 7750 and 9200 foot elevations ASL within several narrow canyons where surface disturbance relative to transportation corridor development is planned. Location of the potential construction zones and the survey area is shown on Figure 3.

The purpose of the survey was twofold. An intensive evaluation of the Whiskey Canyon and Pleasant Valley corridor segments was conducted to assess the presence and significance of cultural resource sites which could be adversely affected by the development. These two corridors are linked by the eastern segment of the Eccles Canyon corridor which was evaluated by AERC in 1979 under contract to Coastal States Energy Company relative to that company's Skyline Project Mine Plan Permit application.

The second part of the survey was a surface examination and recording of three historic sites, all situated in Pleasant Valley. Although two sites, the Nicolitus Mine portals (AERC 381N/3), and the Gibson Mine (AERC 381 N/4), were evaluated by the AERC crew, they do not lie within the transmission corridor and no project-related adverse affect is planned for these sites.

ARCHEOLOGICAL - ENVIRONMENTAL RESEARCH CORPORATION



T. 12 & 13S.

R. 6 & 7E.

Meridian: Salt Lake B. & M.

Quad: Scofield, Utah 15 Minute USGS

Project: VH-80-1

Series: Central Utah

Date: 9-17-80

Figure 3

HISTORIC SITES IN THE PROJECT AREA

Legend:

Archeological Site or Historic Site •

N

1 0 1 2 M.

1 0 1 2K.

Scale

Their evaluation was considered important in providing a complete statement on the presence of important cultural resources situated adjacent to the present project permit area.

All inventoried surfaces in Whiskey Canyon, Eccles Canyon and on the west bank of Pleasant Valley were examined by team members performing parallel transects with personnel spacing ranging between 15 and 25 meters. In this manner, a three mile long corridor of about 60 meters width was intensively evaluated. Shorter intervals and zigzag transects were utilized on specific locations judged to be of high site potential.

A total of four historic sites has been recorded in the corridor zone. These sites (AERC 270U/1 and 2) include two historic cabin foundations situated at the mouth of Eccles Canyon which were recorded by AERC in 1979 (see report for CSEC-79-2 dated 7/23/79). Site AERC 381N/1 is the historic Utah No. 1 Mine site which is situated at the northern end of the corridor zone. The Green Canyon Sawmill site (AERC 381N/2) is located near the mouth of Green Canyon.

Three other historic sites are situated in the general area but lie outside the construction corridor zone. These sites include the Eccles Canyon Coal Mine (AERC 270N/1) which is situated in the southeast quarter of Section 13, Township 13 South, Range 6 East; the Gibson Mine (AERC 381N/4) which is situated in the northeast quarter of Section 8, Township 13 South, Range 7 East; and the Nicolitus Mine portals (AERC 381N/3) which are situated in Pleasant Valley in the southeast quarter of Section 17, Township 13 South, Range 7 East. One mine portal on the Nicolitus site is situated on the west bank of Pleasant Creek and, therefore, lies within the corridor zone. The remainder of this

site is situated on the east slope of Pleasant Valley and is outside the potential construction zone.

All cultural resource sites were recorded, evaluated, photographed, sketched and their locations marked on a Scofield, Utah, 15 Minute U.S.G.S. topographic map. Site reports will be provided to all relevant agencies as an appendix to this report.

B. Laboratory Research

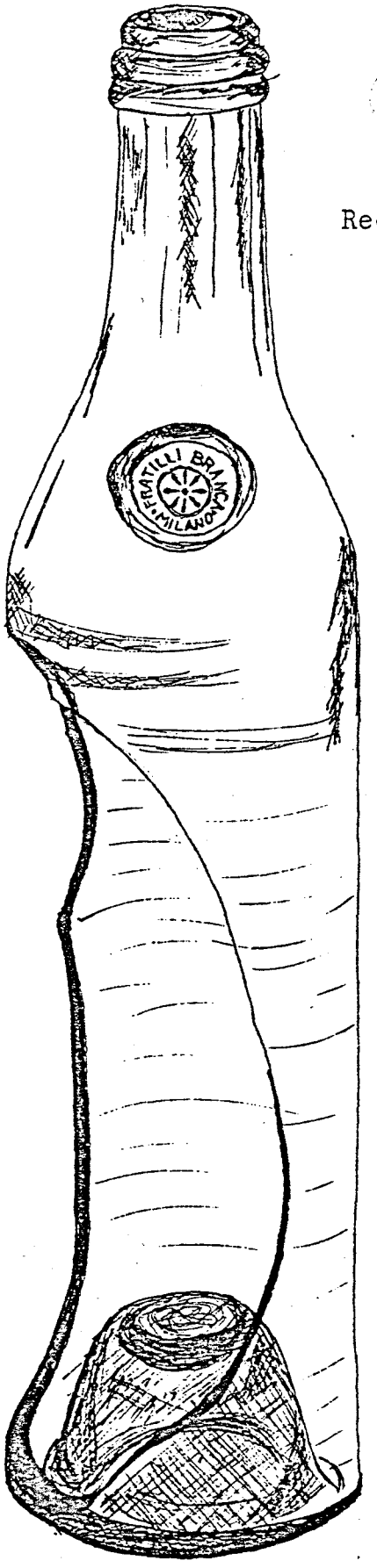
Laboratory analysis of artifacts was minimal since historic artifacts were minimally collected from only one site (381N/1). No other artifact or ecofact collections were made during the survey or during the 1979 survey when the Eccles Canyon segment of the corridor was evaluated.

C. Artifact Inventory and Analysis

The following historic artifacts were collected at the Utah No. 1 Mine site (AERC 381N/1):

1. One green wine bottle manufactured in Milan, Italy, by the Fratilli Branca Company. This bottle was manufactured using a three piece mold, a technique used in the United States between 1809 and 1885 A.D. The striations on the body of the bottle indicate a turn mold was used for that portion. Twin molds were in use in the United States between 1880 and 1900 A.D. These factors indicate that this bottle was probably constructed between 1880 and 1915 (c.f. Vienneau 1973:45-46).
2. Two pieces of a historic ceramic were collected in which the trademark show D. MEAKIN Ltd., -----, (E)ngland.

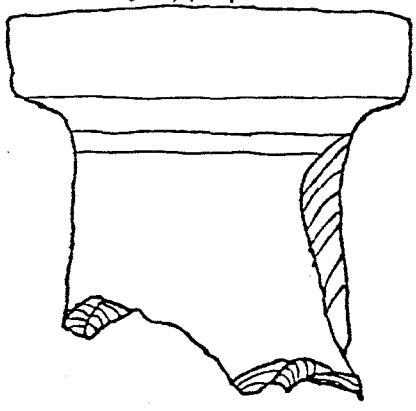
381 N/1



Reduced by 30%

Figure 4

381 N/1



Actual Size

3. One fragment of a purple, square bottle was collected which carries the trademark --POLEON, Olive Oil.

4. One blue glass insulator was collected which shows the trademark -ingray-42.

5. One brass, portable gas lantern top was collected which has the trademark --OY'S DROPPER, Pat. 5.26.14, 1916.

6. One brown bottle rim was collected.

7. One steel spoon was collected.

8. One square bottle fragment was collected. This fragment contains the trademark --FIC SYRUP CO., __FIC, (PR)ODUCTS (INC.), --(O)R.

9. One wooden mount for an insulator was collected.

Sketches of the wine bottle and the brown bottle rim are shown on Figure 4.

Chapter III - CULTURAL RESOURCE DESCRIPTIONS

A. Site Analyses

A total of seven historic cultural resource sites is situated in the general project area. Five of these sites are either in the potential construction corridor (AERC 270U/1 and 2) or are partially within the corridor (AERC 381N/1, 2, and 3). These five endangered sites are indicated on Table 1.

Based upon the definitions of cultural resource significance (see Chapter IV), none of the seven historic sites listed in Table 1 are considered eligible for nomination to the National Register of Historic Places (NRHP) based upon an archeological evaluation. The significance of these sites is provided on Table 2. Site 381N/1, the Utah No. 1 Mine is a potential candidate for nomination to the NRHP, based upon the available historic information on the Mine. This site has been given a CRRS:S-2 rating (see Chapter IV). The other three sites are not considered as having NRHP potential. The Nicolitus Mine has been rated a CRRS:S-3 while the two cabin foundations were originally rated at the equivalent of CRRS:S-4. Should additional historic data upon these four sites provide information indicating that any site has a greater cultural value than presently assigned, the site rating will be adjusted accordingly.

Site locations are shown on Figure 3. This map can be coordinated with Figure 2 to demonstrate the spatial relationship of these sites to the corridor zone. Additional information on these sites is provided in the site reports which are being provided to all relevant government agencies as an appendix to this report.

Table 1

Cultural Resource Site Summary

AERC Site No.	Permanent Site No.	Site Type	Culture	Land Ownership
270N/1	----	Mine	Euro-American	Private
270U/1*	----	Cabin, Stone foundation	Euro-American	Private
270U/2*	----	Cabin, Stone foundation	Euro-American	Private
381N/1	----	Mine	Euro-American	Private
381N/2	----	Saw mill, corral	Euro-American	Private
381N/3	----	Mine	Euro-American	Private
381N/4	----	Mine	Euro-American	Private

*Sites situated in the corridor zone which could be directly affected by transportation corridor development.

B. Comparative Resource Analysis

Of the five sites situated in the transmission corridor zone, and therefore susceptible to adverse affect during the construction period, site 381N/1, the Utah No. 1 Mine, is the most important. The Utah No. 1 Mine was originally begun between 1875 and 1880 when it was known as the Mud Creek Mine. This mine "opened on the Castlegate 'A' coal bed. The south of the mine is at tipple height above the railroad, and in 1923 the coal, which was then being mined for railroad use, was dumped from the mine cars without screening into railroad cars. This mine was idle for many years after it was opened and the workings are less extensive than those of the other old mines of the district" (Spieker 1931:96). Extensive surface modification in the site area conducted during the past 100 years has altered much of the historic nature of the site. Some historic foundation rubble and depressions are presently discernable as are limited trash and rubble accumulations situated between the railroad track and the paved highway.

The Green Canyon Sawmill site (AERC 381N/2) includes a cement foundation and wooden rails for the log track. A corral and an abandoned roadbed are associated with this site which lies behind the Valley Camp of Utah offices.

The Nicolitus Mine site (381N/3) includes two portals situated on both the east and west slopes of Pleasant Valley. This site is situated at the mouth of Eccles Canyon and is visible from the highway. The mine portals were opened in the early 1920s by John Nicolitus and were worked for about five years. Joe Williams obtained the lease from Nicolitus and worked the portals in 1931 and 1932 but without success. Williams subsequently sold the lease to John Stone for $1100,

who unsuccessfully solicited John Staley and Joe Podbevsek to reopen the mine. The mine was never again worked because the veins were too thin to be profitable. No coal was ever sold from the mine (personal interviews conducted with Tom Biggs and John Staley in Scofield on August 29, 1980 by V. Garth Norman).

Sites AERC 270U/1 and 2 include two historic cabin foundations situated on the north ridge at the mouth of Eccles Canyon. These sites were originally recorded in 1979 by AERC while consulting for Coastal States Energy Company (CSEC-79-2). Both sites are limited, consisting of stone alignments and minimal construction materials. No trash area was discernible. Both sites may have been temporary campsites utilized during the construction of the west portal of the Nicolitus Mine (381N/3).

No prehistoric cultural resource sites or isolated artifacts have been observed or recorded in the general project locality.

Chapter IV - EVALUATIONS AND RECOMMENDATIONS

A. Resource Significance Evaluations:

An evaluation of site significance for the four sites situated within the mine plan permit area is presented in Table 2. Here the site quality indicators are presented with a statement on site condition. The field assessment of significance utilizing the CRRS system is provided in the fourth column. The CRRS system is best explained by quoting from the BLM definition sheet:

> Cultural Resource Rating System
>
> The following criteria are established as guidelines. The Bureau recognizes that the assignment of a particular rating is a professional judgment; however, the rationale of these judgments will be explicitly documented as part of the evaluation process.
>
> Assign an evaluation rating (S1, S2, S3, S4) to each site according to the following guidelines and record on the BLM form 6400-3:
>
> S1. S1 sites are those sites which are worthy of preservation *in situ*. In general, they are sites in relatively good condition with integrity (both internal and external); and are unique or representative; and/or have associations with important events or personages; and/or have yielded, or have a clear potential for yielding, highly significant scientific or educational information.
>
> S2. S2 sites are those sites which contain important scientific or educational data but yet are not worthy of preservation *in situ*. They are generally not particularly unique, representative, nor do they have important associations. Many contemporary sites may be S2 sites because, although they cannot be clearly and immediately assessed as such, they may become highly significant when evaluated from a future historical perspective.
>
> S3. S3 sites are those sites whose main worth are their potential for contributing data in regards to solving larger problems, such as reconstruction of

Table 2

Site Significance

Site	Quality	Condition	CRRS Value Rating
270N/1	a, g	Poor	3
270U/1*	----	Poor	4
270U/2*	----	Poor	4
381N/1 (First mine in area)	a, c, g, h	Poor	2
381N/2 (Saw mill for 381N/1)	g, h	Poor	3
381N/3	g	Poor	3
381N/4	g	Poor	3

*Sites situated in the corridor zone which could be directly affected by transporation corridor development.

AERC Quality indicators are:

a) size or layout is unique;
b) quantity and/or quality of artifacts is unique;
c) indication of depth;
d) environmental location is unique;
e) existence of unique artifacts, architecture, art or structure;
f) condition is excellent for preservation of materials or data;
g) site contains specific cultural data revelant to temporal and spatial identifications;
h) site is scene of an important event; and
i) site is associated with an important person.

paleo-environments and human use patterns. These kinds of sites generally show little concentration of artifacts, few features, no important associations, and little or no uniqueness or representativeness.

S4. S4 sites are those sites which have minimal information retrieval possibilities, or which have no integrity, uniqueness, representativeness, or no important associations.

No sites were accorded CRRS:S-1 significance.

Only one site is rated as CRRS:S-2 while one site is of CRRS:S-3 value. The remaining two sites have been given a CRRS:S-4 rating.

The site (AERC 381N/1) has been given an S-2 value based on the potential for additional information through archeological excavation. Should future research on any one of these sites provide new data relative to significance, the CRRS rating will be appropriately upgraded.

B. National Register Criteria of Eligibility:

Application of the National Register Criteria of Eligibility, defined under 36 CFR 60.6, to each of the four sites that are situated in the mine plan permit area provides the following information:

a) None of the four sites is associated with events that have made a significant contribution to the broad patterns of our history; or

b) none of the four sites is associated with the lives of persons significant in our past; or

c) none of the four sites embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components may lack individual distinction; and,

d) site 381N/1 could yield information of value to the history of the region. Extensive surface modification of this site, however, precludes the Utah mine from consideration as an important and

intact historic site. Any information of value to the history of the region would have to be obtained through oral history research and through archeological excavation. This site should, therefore, be considered as meeting the standards of criteria "d" of 36 CFR 60.6. The other three sites (270U/1, 2, and 381N/3) are not eligible under the criteria outlined above.

C. Discussion of Impact Potential on Cultural Resource Sites

Direct impact, i.e., project-related disturbance of the four cultural resource sites located adjacent to the potential disturbance zone could result during surface modification for road and conveyor belt line development. The cabin foundations (270U/1 and 2), the Utah No. 1 Mine site (381N/1), and the sawmill site (381N/2) can be easily avoided during the construction period. The endangered west portal of the Nicolitus Mine (381N/3) is of marginal historic value and disturbance could occur without causing a loss of valuable information or historic materials.

Indirect impact of these four sites through vandalism can be considered a minimal threat to their historic value. Any valuable or useful lumber or construction materials which provide an identity to these sites has already been removed, discarded or destroyed on site.

Table 3 provides a summary of the basic adverse affect potential for all seven historic sites situated in the general project area.

Table 3

Cultural Resource Impact Potential

Site	CRRS Status	Direct Impact	Indirect Impact	Impact Agent	Figure Reference
270N/1	3	No	No	-----	2
270U/1*	4	Not probable	Possible	Vandalism	2
270U/2*	4	Not probable	Possible	Vandalism	2
381N/1	2	Not probable	No	Coal Mine Development	2
381N/2	3	No	Possible	Vandalism	2
381N/3	3	Not probable	Possible	Transmission Corridor Development & Vandalism	2
381N/4	3	No	No	Vandalism	2

*sites situated in the corridor zone

D. Recommendations

AERC recommends that whenever possible, site avoidance procedures be implemented as a means of preserving the historic resources of the general area (see Table 3). Should total destruction of any one of these sites become necessary, a complete photographic documentation of the site should be conducted prior to disturbance.

AERC would also recommend that an archeologist be present to monitor the disturbance of any large trash areas or midden accumulations since such localities could contain historically diagnostic artifacts.

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Scott M. Matheson
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DIVISIONS
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STATE OF UTAH
DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH
150 West North Temple, P.O. Box 2500, Salt Lake City, Utah 84110

Alvin E. Rickers, Director
Room 426 801-533-6121

533-6108
August 17, 1981

RECEIVED
AUG 21 1981
By

Trevor G. Whiteside
Valley Camp of Utah, Inc.
Scofield Route
Helper, UT 84526

RE: Air Quality Approval Order for Increase of Coal Production

Dear Mr. Whiteside:

On April 30, 1981, the Executive Secretary published a notice of intent to approve your increase in coal production from 1.2×10^6 tons/year to 2.25×10^6 tons/year. The 30-day public comment period expired on May 30, 1981 and no comments were received.

This air quality approval order authorizes the increase in production as proposed in your notice of intent dated March 26, 1981 with the following conditions:

1. The conveyor hood sections shall be securely positioned when transporting coal and be maintained in good operating condition.

2. The conveyor head chutes, reclaim tunnel feeder chutes and vibrator feeder discharge chutes shall be totally enclosed and maintained in good operating condition.

3. The conveyor skirtboards shall be properly positioned when transporting coal and be replaced as needed.

4. Stacker tube dust flaps shall be replaced as needed.

5. The 2.2 miles of haul road shared with other companies shall be paved no later than September 1, 1982. In the interim, the road shall be chemically stabilized to minimize fugitive emissions. A record/log of all treatments including date, amount and location shall be kept and made available to the Executive Secretary upon request.

6. The unpaved sections of haul roads not covered in condition #5 shall be chemically stabilized as necessary with dust suppressive material. A record/log of all treatments including date, amount and location shall be kept and made available to the Executive Secretary upon request.

7. All conveyor transfer points shall be equipped with water sprays.

8. The opacity of the crushing plant baghouse shall not exceed 20%. The baghouse shall be maintained in good operating condition.

9. No visible emissions, except from internal combustion engines, shall exceed 20% opacity as per Section 4.1.2, Utah Air Conservation Regulations (UACR). Visible emissions from diesel engines shall not exceed 20% opacity except for starting motion no farther than 100 yards or for stationary operation not exceeding three minutes in any hour according to Section 4.1.4, UACR.

10. All surge bins for loading of trucks or railroad cars shall be equipped with a telescoping chute to minimize the fall distance of the coal.

11. Total annual production of coal from the two mines and crushing plant throughput shall not exceed 2.25×10^6 tons without prior approval from the Executive Secretary according to Section 3.1, UACR.

12. The Executive Secretary shall be notified when monthly production reaches full capacity as a compliance inspection is required.

You are considered a minor source for purposes of the PSD regulations and will not require a permit from EPA/Region VIII. However, for State purposes you are a major source.

According to Section 3.9, UACR, a fee for the cost associated with processing this permit is required to be paid to the State of Utah upon receipt of this approval order. The final costs are attached.

Sincerely,

Brent C. Bradford
Executive Secretary
Utah Air Conservation Committee

DR:jw
cc: Southeastern District Health Dept.
EPA Region VIII (D. Kircher)
enclosure