VOLUME 4

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Archaeology

(with 1981 Supplement and Submittal)

Hydrology

SOUTHERN UTAH FUEL COMPANY

SUFCO COAL MINE

COASTAL STATES ENERGY COMPANY

1980

VOLUME 4

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ENGINEERING

INTENSIVE ARCHEOLOGICAL SURFACE EVALUATIONS AND SAMPLE SURVEY OF THE SOUTHERN UTAH FUEL COMPANY COAL MINE IN SEVIER COUNTY, UTAH

Mine Plan Applicant:
Coastal States Energy Company
of Salt Lake City, Utah

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ARCHEOLOGICAL-ENVIRONMENTAL
RESEARCH CORPORATION

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Salt Lake City, Utah

ABSTRACT

In the summer of 1980, the Archeological-Environmental Research Corporation conducted a sample unit survey for Coastal States Energy Company in the Convulsion Canyon/Little Duncan Mountain locality of Sevier County, Utah. A total of nine sample units was intensively evaluated for cultural resources. These non-randomly selected sample units included 180 acres for a ten percent sample of the total 1800 acres within the general project area.

A total of six cultural resource sites was recorded during the survey. Four previously recorded sites are also evaluated in this report. These sites include one modern monument and nine prehistoric sites, ranging from lithic scatters to temporary campsites. None of the ten sites are considered eligible for nomination to the National Register of Historic Places.

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Chapter I - INTRODUCTION

A. General Data on the Project

From July 24 to July 28, 1980, the Archeological-Environmental Research Corporation of Salt Lake City (AERC) conducted a sample survey cultural resource evaluation for Coastal States Energy Company (CSEC), which owns the Southern Utah Fuel Company Mine located in Convulsion Canyon/Little Duncan Mountain locality of Sevier County, Utah. Coastal States Energy Company, desirous of preparing a revised mine plan 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 on this Coastal States-Southern Utah Fuel Company development, please refer to the mine plan application.

AERC's field evaluations in this locality actually began in the summer of 1976 as consultant to Southern Utah Fuel Company to examine eight drill locations and 0.5 miles of access road. Later examinations of additional drill locations, seismic lines, and access roads have been conducted by AERC for Coastal States Energy Company in 1977, 1979, and 1980 in the Old Woman Plateau area south of Little Duncan Mountain. All AERC research in the mine plan permit area is demonstrated in Figures 1, 2, and 3. Figure 1 shows the mine plan permit area locality. Figure 2, consisting of Maps A, B, and C, shows the locations of all access roads, drill locations, and

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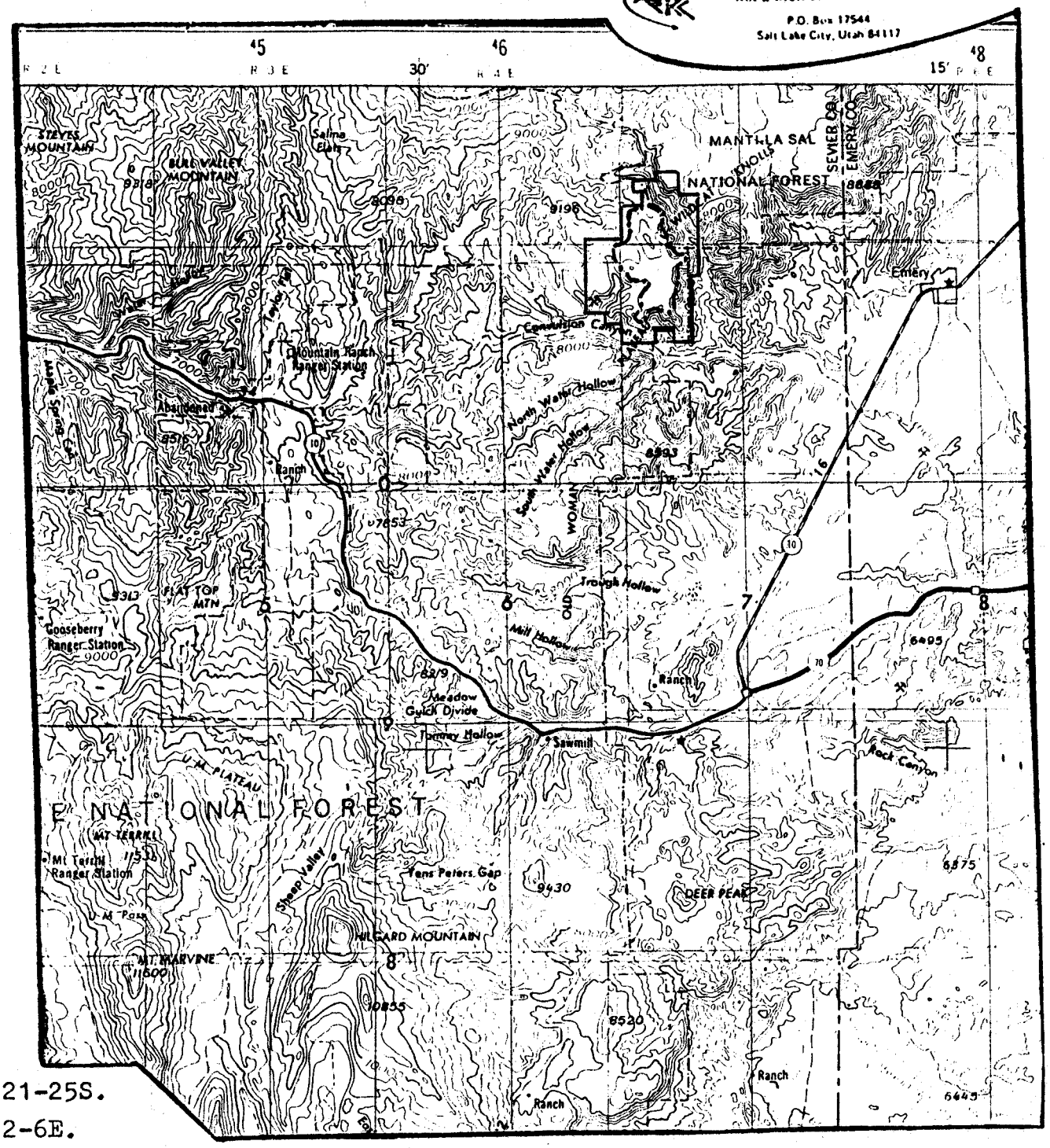

T. 21-25S.

R. 2-6E.

Meridian: Salt Lake B. & M.

Quad: Salina, Utah 1:250,000

Project: CSEC-80-1

Series: Central Utah

Date: 10-24-80

Figure 1

Mine Plan Area

Legend:

Mine Plan Boundary

Subsidence Survey Zone

1" = 4 miles

Scale

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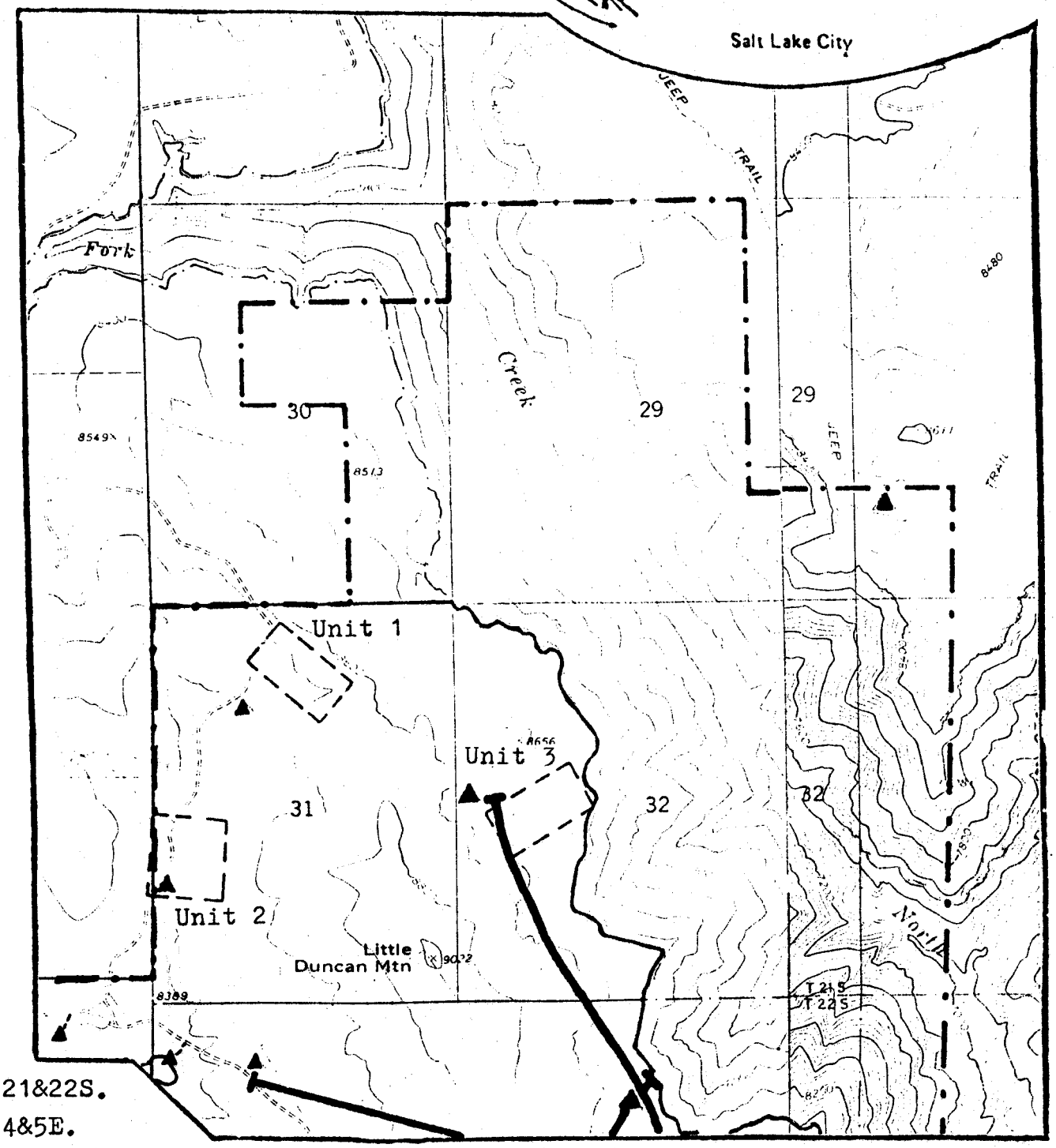

T. 21&22S.

R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1

Series: Central Utah

Date: 8-13-80

Figure 2a

Previous Archeological Investigations in the Mine Plan Area

Legend:

Subsidence Survey Zone

Sample Unit

Seismic Corridor

Drill Location

Access Route

0 .5 1

.5 0 .5 1 Km

Scale

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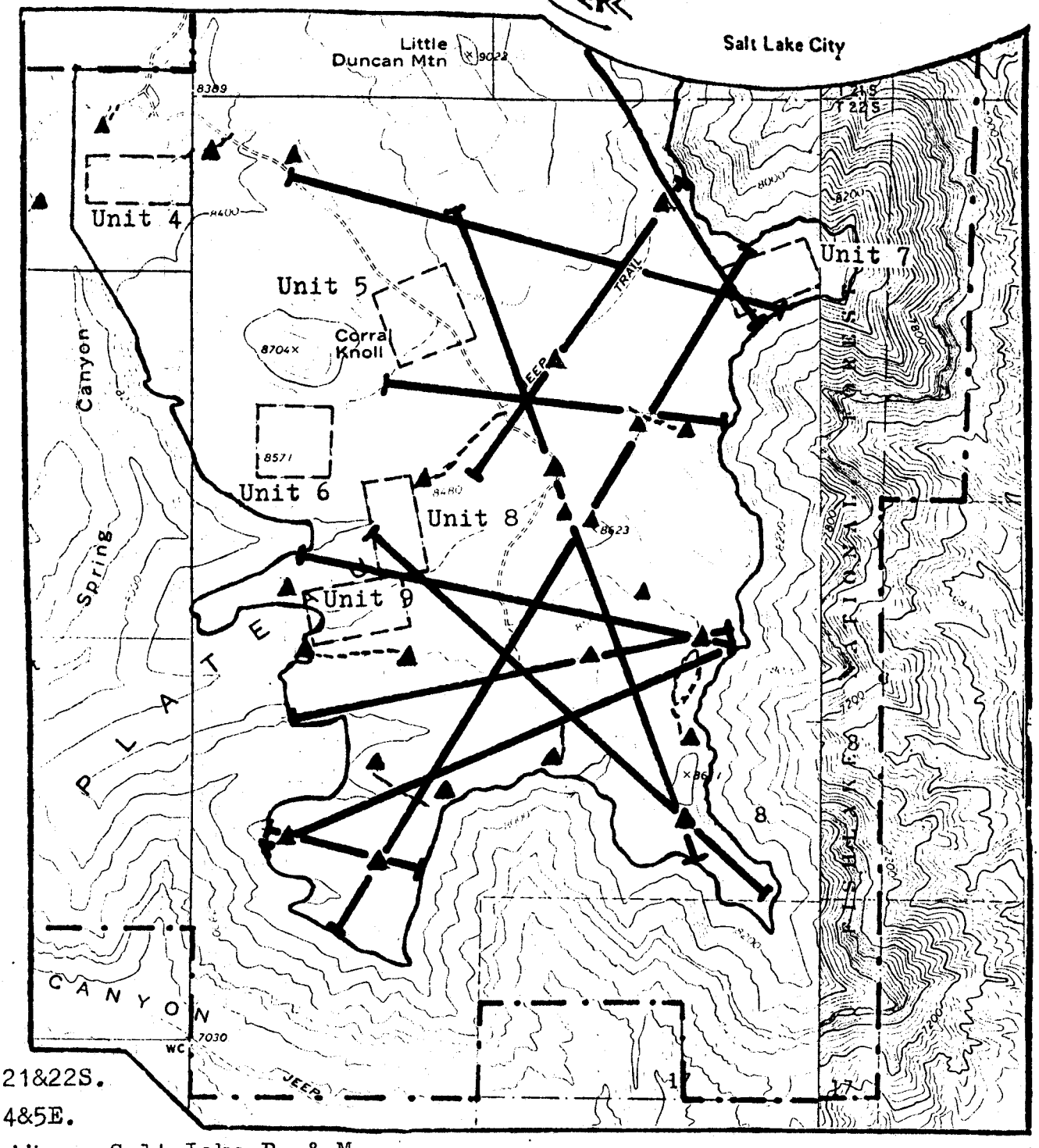

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Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1

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Figure 2b

Previous Archeological Investigations in the Mine Plan Area

Legend:

Subsidence Survey Zone

Sample Unit

Seismic Corridor

Drill Location

Access Route

0 .5 1

.5 0 .5 1 Km

Scale

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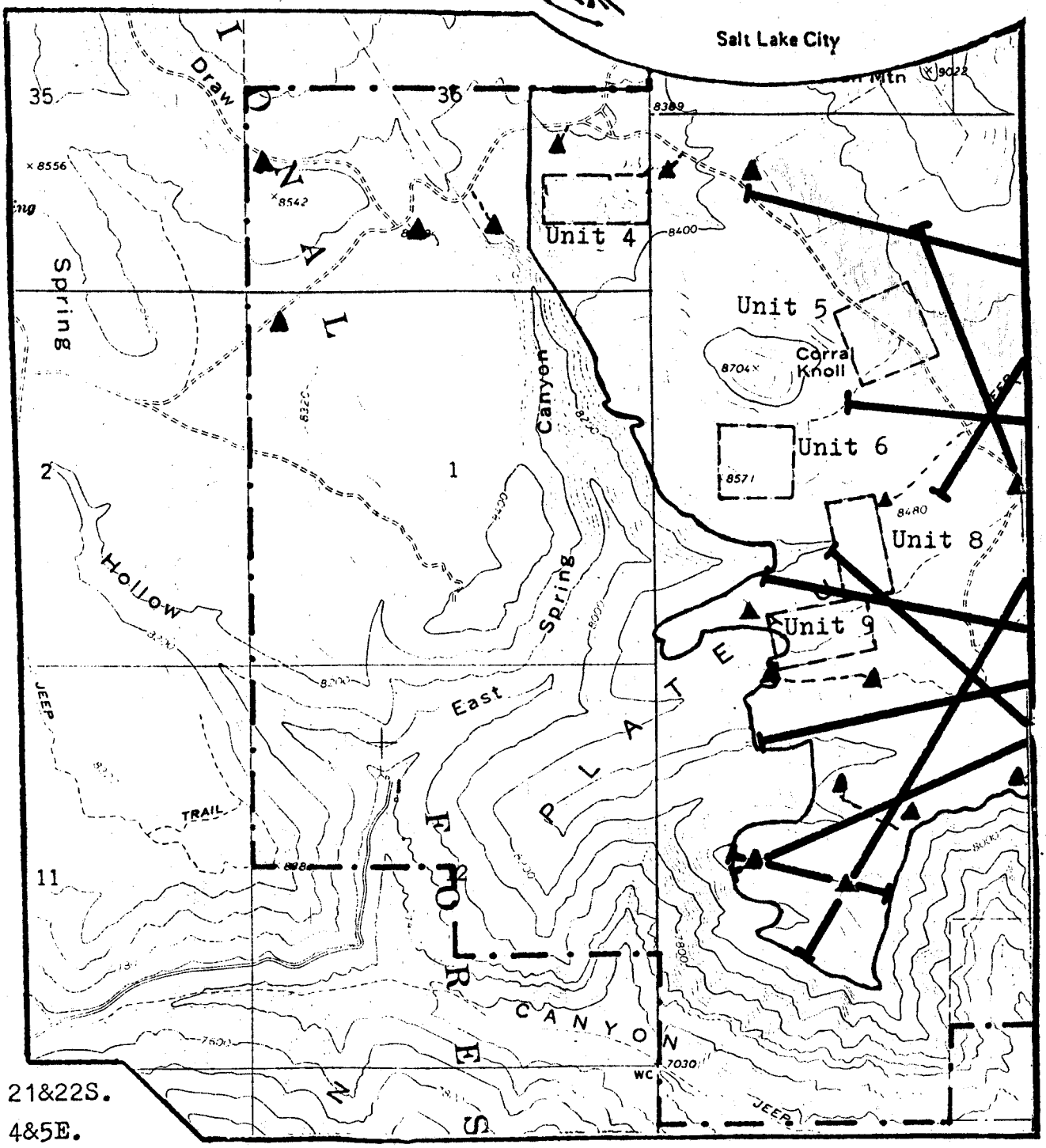

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Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1

Series: Central Utah

Date: 8-13-80

Figure 2c

Previous Archeological Investigations in the Mine Plan Area

Legend:

Subsidence Survey Zone

Sample Unit

Seismic Corridor

Drill Location

Access Route

0 .5 1

.5 0 .5 1 Km

Scale

seismic lines evaluated by AERC in the mine plan permit area from 1976 through the 1980 field season. Figure 3 (Maps A through C) shows all the cultural resources, the subsidence zone and the sample units situated within the mine plan permit area. Only significant isolates or actual cultural resource sites are shown on Figure 3.

AERC's field evaluations in the general project area include four sites recorded during the projects specified above and some six sites recorded during the sample survey initiated for this report. Recommendations concerning mitigational techniques relative to these ten sites and other cultural resource evaluations will be provided in this report.

AERC conducted field work under various U.S. Forest Service antiquities and special use permits.

The resource inventory included nine sample units of 20 acres each. This acreage comprised a ten percent sampling of the approximate 1800 acres situated in the mine plan area, which is a potential subsidence zone. Future mining operations in the coal seams beneath the Old Woman Plateau could result in surface subsidence. The purpose of this research, therefore, was to ascertain through non-random sample analysis, the probability for existence of historic and/or prehistoric cultural resource sites that would be highly susceptible to subsidence impact.

The surface areas surveyed and locations of cultural resources are shown on Figure 1, and are situated within Section 36 of Township 21 South, Range 4 East; Section 31 and 32 of Township 21 South, Range 5 East; Section 1 of Township 22 South, Range 4 East; and Sections 5, 6, and 7 of Township 22 South, Range 5 East of Sevier County, Utah. The project area is situated at the head of the East Spring Canyon fork of Convulsion Canyon, and around Little Duncan Mountain. The survey area is on an Acord Lakes

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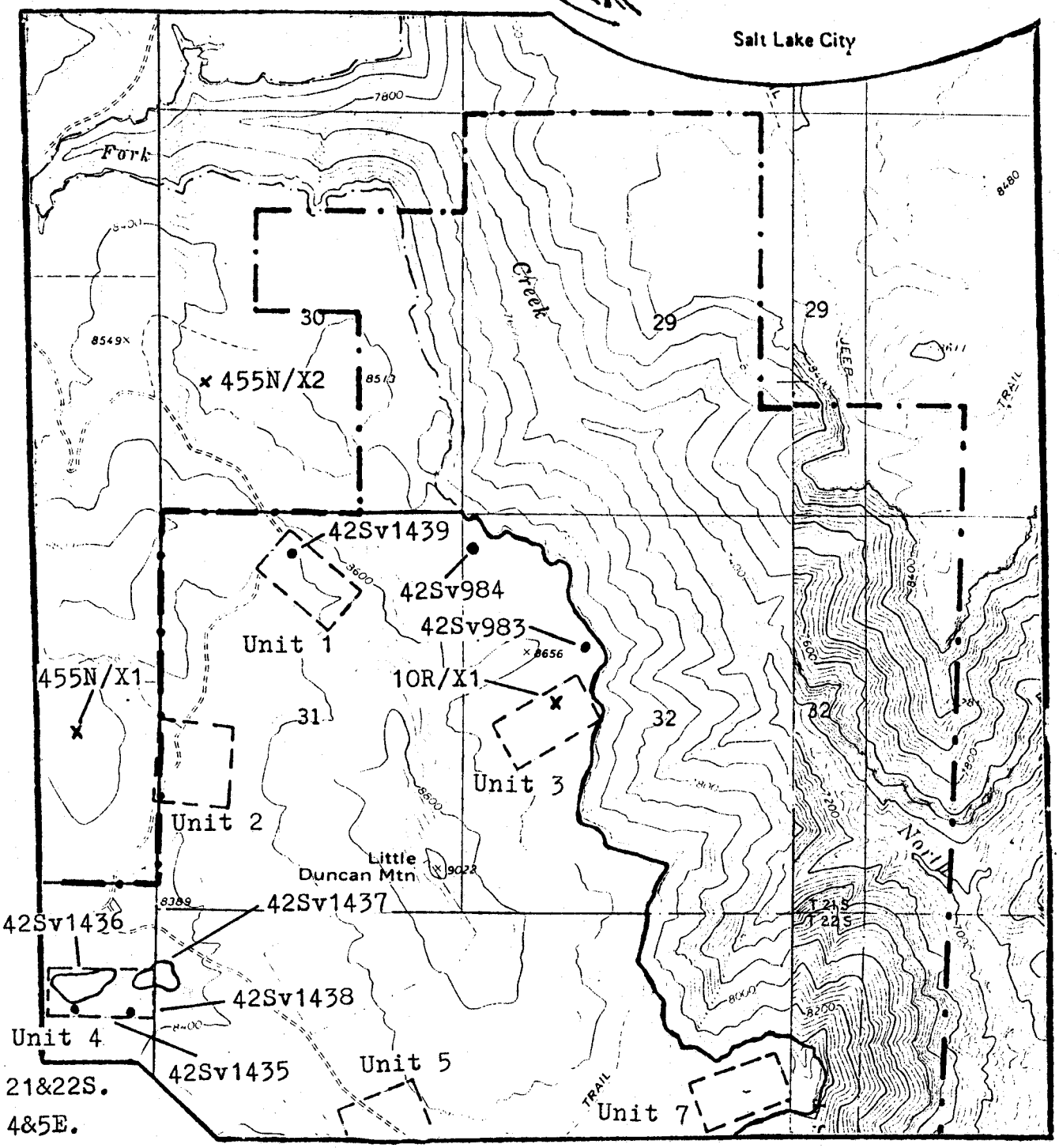

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1
Series: Central Utah
Date: 8-13-80

Figure 3a
Sample Survey Units and Cultural Resources in the Mine Plan Area

Legend:
Sample Unit
Archeological Site
Isolated Artifact

0 .5 1

.5 0 .5 1 Km

Scale

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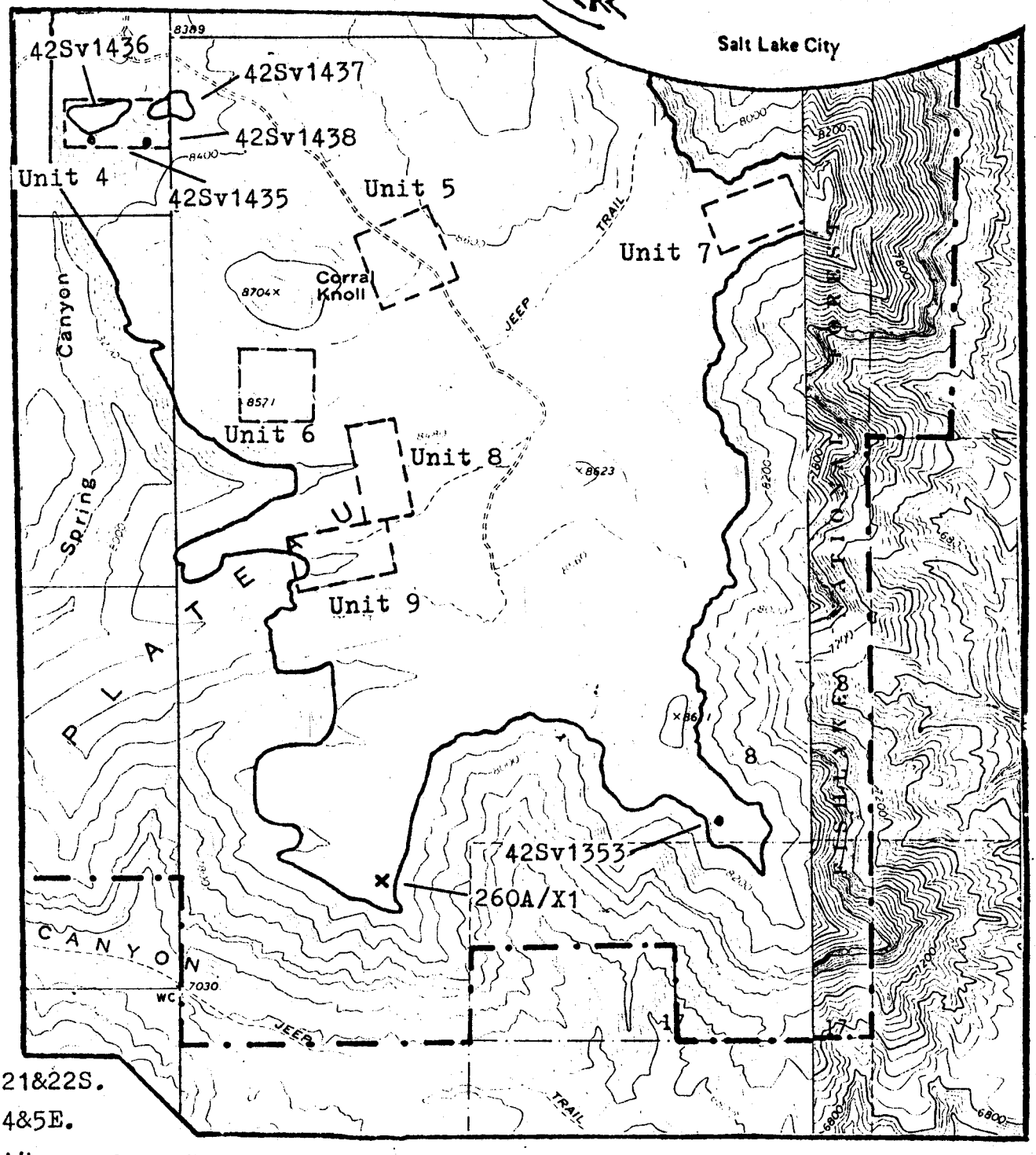

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R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC 80-1

Series: Central Utah

Date: 8-13-80

Figure 3b
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Legend:

Sample Unit

Archeological Site

Isolated Artifact

0 .5 1

.5 0 .5 1 Km

Scale

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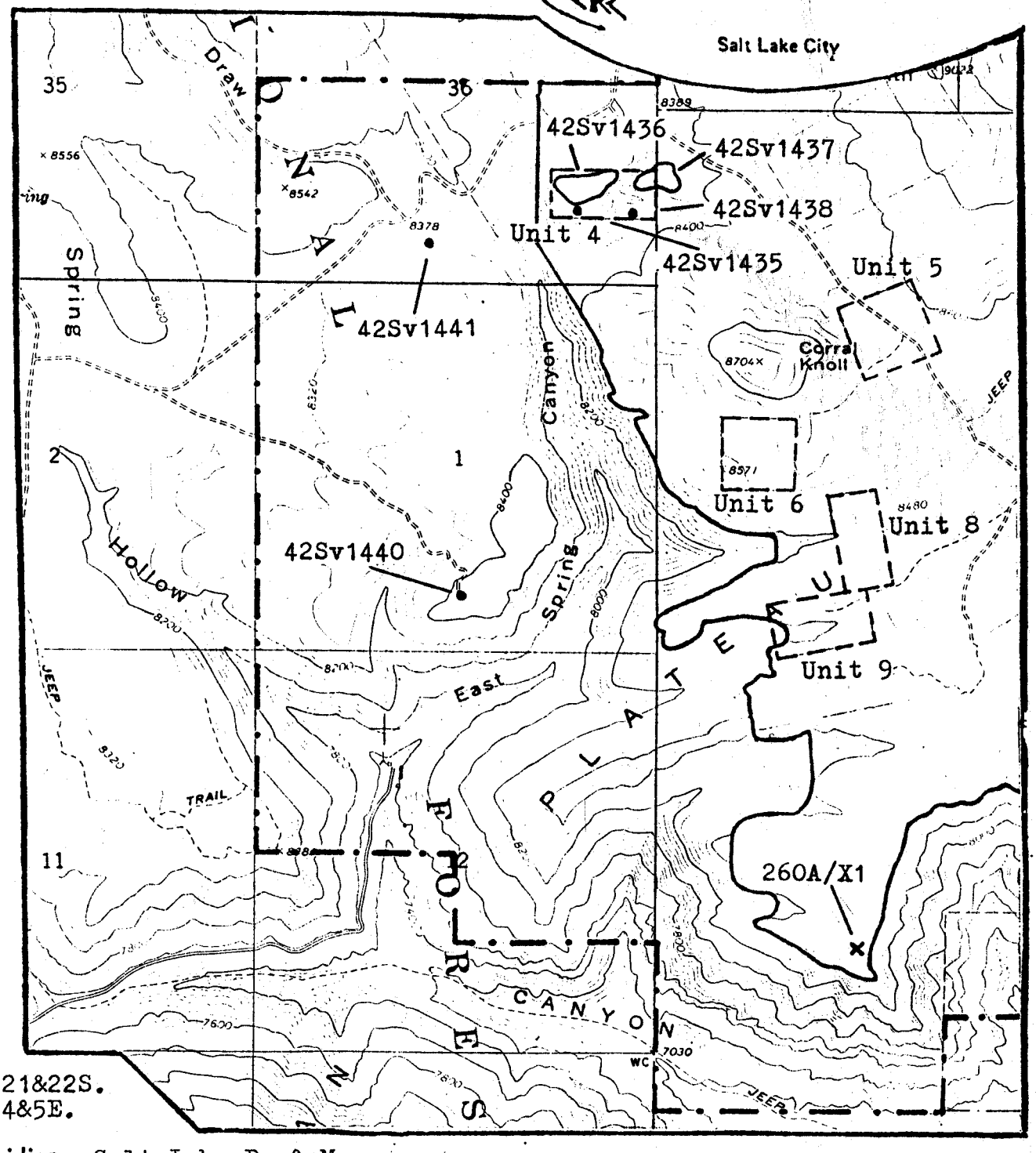


T. 21&22S.
R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah
7.5 Minute USGS

Project: CSEC 80-1
Series: Central Utah
Date: 8-13-80

Figure 3c
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Legend:
Sample Unit
Archeological Site
Isolated Artifact

0 .5 1
.5 0 .5 1 Km
Scale

7.5 minute USGS topographic quad and is on lands administered by the U.S. Forest Service.

All field notes and site data are filed at AERC headquarters in Bountiful, Utah. Site reports are being submitted to the State Historic Preservation Office as well as to all other relevant government agencies.

B. Environment and Locality

The project locality is situated on the northern portion of the Old Woman Plateau on the north side of Convulsion Canyon in Sevier County, Utah. The project locality is a high elevation plateau with a few large hills. All the area is surrounded on three sides by deep, steep-sided canyons. The elevation of the plateau varies between about 8400 feet and 9000 feet, but the majority of surface area on the plateau is around 8600 feet ASL. The plateau is bordered on the west by East Spring Canyon (elevation 7400 to 8000 feet), on the south by Convulsion Canyon (elevation 6600 to 7200 feet) through which the main fork of Quitchupah Creek flows, and on the east by the north fork of Quitchupah Creek (elevation 6600 to 7400 feet). To the north and northwest of the project locality, the plateau extends farther and increases slightly in altitude. The main and north forks of Quitchupah Creek, both perennial streams, meet near the southeastern corner of the project locality and then flow generally eastward into Ivie Creek, along the eastern flank of the Wasatch Plateau.

The high elevations in the project locality have a strong effect on the local climate. The annual precipitation is between 12 and 16 inches with half the amount falling between May and September (Utah Water and Power Board), although precipitation is generally much higher to the northwest and lower to the southeast. The project locality elevation also determines the freeze-free growing period which is between 60 and 100 days. As with the precipitation, the project locality is also on a steep gradient for the freeze-free period with much lower values to the northwest and much higher values to the southeast.

Table 1

Local Mammalian Species

Order Insectivora	
Shrew	*Sorex spp.*
Order Lagomorpha	
White-tailed jack rabbit	*Lepus townsendii*
Snowshoe rabbit	*Lepus americanus*
Black-tailed jack rabbit	*Lepus californicus*
Cottontail rabbit	*Sylvilagus nuttallii*
Order Chiroptera (Bats)	
	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.*
Tree squirrel	*Tamiasciurus hudsonicus*
Northern pocket gopher	*Thomomys talpoides*
Beaver	*Castor canadensis*
Western harvest mouse	*Reithrodontomys megalotis*
Mouse	*Peromyscus spp.*
Meadow mouse	*Microtus spp.*
Wood rat	*Neotama cinerea*
Big jumping mouse	*Zapus princeps*
Porcupine	*Erethizon dorsatum*
Marmot	*Marmota flaviventer*
Flying squirrel	*Glaucomys sabrinus*

Table 1 (cont'd.)

Order Carnivora		
Coyote	*Canis latrans*	
Wolf	*Canis lupus*	(no longer present)
Red fox	*Vulpes fulva*	
Gray fox	*Urocyon cinereoargenteus*	(no longer present)
Grizzly bear	*Ursus horribilis*	(no longer present)
Black bear	*Ursus americanus*	
Ring-tailed cat	*Bassaricus astutus*	
Mink	*Mustela vison*	
Ermine	*Mustela erminea*	
Long-tailed weasel	*Mustela frenata*	
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	*Ovis canadensis*	(no longer present)

The montane ecozone also supports a wide variety of avian species, some of which are summer migrants. Table 2 lists these species according to Hayward et al. (1976). 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.

Table 2

Local Avian Species

Coniferous Niche

Red-breasted nuthatch	Sitta canadensis	(summer)
Golden-crowned kinglet	Regulus satrapa	
Ruby-crowned kinglet	Regulus calendula	
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

C. The Prehistory and History of the Region

The prehistoric human activities in the Price River Basin-Book Cliffs region of east-central Utah is divided into four main phases, beginning with the Paleo-Indian culture phase which was characterized by a big game hunting subsistence base, augmented by gathering activities. This phase, which existed ca. 12,000 to 7000 Before Present (B.P.), has been sequentially divided into the Llano, Folsom, and Plano cultures based upon diagnostic projectile points recovered in the western United States. Clovis, Folsom, and Plano sites have been recorded in central and western Utah but no Paleo-Indian sites or materials have been discovered in the project area. Isolated artifacts from the Plano subphase (ca. 9000 to 7000 B.P.) occur in a higher frequency in the Price River and Muddy Creek regions than artifacts related to the previous subspheres. This indicates that population densities were probably increasing in central Utah during the Plano which roughly corresponds with the gradual drying trend of Antev's Anathermal phase.

The reduction of the great herds in the West, possibly affected by the aridity of the Altithermal phase and the increase in population gradually shifted the subsistence base from big game exploitation to an emphasized gathering economy which characterizes the Archaic cultural phase. The Archaic cultures of this general region have been examined in the Central Coal Project of Utah as reported by AERC in 1979. Pertinent information from that report can be noted:

> 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. in preparation) 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 four phases based on changes in both projectile point types and population densities (Schroedl 1976).

The Black Knoll subphase begins at approximately 8300 B.P. and continues until about 6200 B.P. 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 Black Knoll subphase of the Archaic was characterized by two types of dart points, the Pinto and the Northern Side-notch (Schroedl 1976).

The Castle Valley subphase of the Archaic began about 6200 B.P. and ended about 4500 B.P. Subsistence techniques and the utilization of caves were the same as the earlier Black Knoll subphase but dart point styles changed and also diversified. Dart points such as Rocker Base, Sudden Side-notch, and Hawken Side-notch appeared early in the Castle Valley subphase and continued to be utilized until the end. During the later part of the Castle Valley subphase, Humboldt dart points appeared and quickly became the dominant style (Schroedl 1976).

The Green River subphase of the Archaic began about 4500 B.P., ended about 3300 B.P., and has a western and eastern variant (Schroedl 1976). Both variants are characterized by subsistence techniques unchanged from earlier Archaic subphases. The two variants are distinguished by differences in dart points. Gypsum and San Rafael Side-notch dart points are associated with the eastern variant. The dart points of the eastern variant exhibit a Plains influence.

The Dirty Devil subphase of the Archaic began about 3300 B.P. and has been given an arbitrary termination date of 1500 B.P. (Schroedl 1976). Subsistence techniques were unchanged during the early portion of the subphase, but evidence of corn horticulture in the late Dirty Devil subphase 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). At all three locations, corn caches were found which dated generally between 1600 and 2000 B.P.

The dart point most characteristic of the Dirty Devil subphase is the Gypsum point which continued from the Green River subphase. The very late portion of the Dirty Devil subphase evidences the advent of the bow and arrow. At Cowboy Cave (Jennings et al. in preparation), Rose Springs arrowheads were recovered from the uppermost level and were dated between 1500 and 1600 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 Archaic phase. However, the advent of the bow and arrow around 1600 to 1500 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. in preparation).

The last centuries of the Archaic also witnessed the first evidence of corn horticulture (Hauck 1979:66-69).

The Fremont culture of Utah extended over the greater part of that state from the Salt Lake and Uintah Basins on the north to the Henry Mountains and the Virgin River headwaters on the south. The Fremont variants of the Uintah Basin and the San Rafael-Price River regions have been dated between 1500 and 700 B.P. This culture utilized an economic base including both a hunting-gathering subsistence and horticulture. In addition to their dependence on the bow and arrow, these people maintained village settlements and developed technologies in ceramics and stone architecture, undoubtedly influenced by the Anasazi cultures of southern Utah. Movement between the Uintah Basin and the Price River Basin was accomplished through Nine Mile Canyon where numerous Fremont sites have been recorded. Since Soldier Creek, which lies in the project area, leads east directly to the headwaters of Minnie Maud Creek in Nine Mile Canyon, there is a high probability of extensive Fremont activity along Soldier Creek.

The Shoshonean phase extended from ca. 650 B.P. into the Historic period. Their subsistence base was primarily oriented to seasonal hunting and gathering activities; however, there is ethnographic evidence of horticulture being practiced by Utes in the Fremont River valleys of southern Utah. Small Shoshonean familial bonds (Ute, Paiute and Shoshone peoples) utilized the bow and arrow for hunting and warfare, constructed brush surface shelters, and manufactured distinctive gray to tan ceramic

vessels. The Desert Side-notch point and thick, sand-tempered grayware are distinctive artifacts from the Shoshonean phase in central Utah.

The Historic period in east-central Utah is divided into three phases: Early Historic, Agricultural Settlement, and Mining Developments.

The Early Historic period is characterized by the introduction of Euro-American trading, exploration and fur trapping which affected the aboriginal populations in Utah beginning in the Seventeenth century. The Dominguez-Escalante Expedition of 1776-1777 brought the first known Spanish contact in central Utah; however, their expedition map is quite accurate concerning the Price River Basin, suggesting previous Spanish activity in the basin. By the early 1800s, and until 1840, the fur trade was active in Utah. Trappers, traders, and explorers included members of the Arza-Garcian expedition of 1813, Antoine Robidoux, Jedediah Smith, William Ashley and Peter Skeen Ogden. The fur trade began its decline after 1840 as a result of changes in European and eastern American fashions which caused a serious social-economic impact on the Ute Indian fur trading in Utah (Hauck 1979:78-80).

The settlement of Utah, beginning in 1847 by Mormon pioneers, gradually brought widespread agricultural development into Utah. Mormon settlement of the Price River Basin was not initially accomplished due to hostile Ute bands residing on the east of the Wasatch Range (O'Neill 1973). The establishment of military control over the Utes and their relocation to the Uintah Reservation in 1877 brought the first settlements in Castle Valley. By 1880, Emery County, which included all of present-day Carbon County, was created by the Territorial Legislature (Lever 1898:593). Present-day settlements in the general locality include the towns of Huntington, Ferron, Castledate, Emery, and Salina.

Coal mining in the project area was first begun in 1853 with the Gunnison Expedition's discovery of coal deposits situated three miles east of the modern town of Emery. The first attempt to exploit the coal resources of the general locality occurred in 1875 at Connellsville in Huntington Canyon on the east slopes of the Wasatch. Various mining activities were initiated along the Wasatch after that date, e.g., Pleasant Valley, Winter Quarters Canyon, and the Mud Creek Mine (from 1875 through 1882). By 1888, the Castle Gate Mine was operational and in 1899, a mine at Sunnyside had begun production (Hauck 1979:84-86).

D. Previous Investigations in the Project Area

Previous investigations within the mine plan permit area have been conducted by AERC archeologists between 1976 and the summer season of 1980. AERC began its research in the project area in June, 1976, when F. R. Hauck evaluated eight potential drill locations and one access road for cultural remains. In the report for this project, (SUFC-76-1) which was dated June 16, 1976, AERC reported the evaluation of cultural resource sites 42Sv983 and 984 (incorrectly labeled at that time as 42Sv761 and 762). In addition, a Cascade bipoint was recovered as an isolate artifact during the project (see Figure 4H). The locations evaluated during this and the subsequent projects are shown in Figure 2.

AERC staff archeologist, Dennis Weder, evaluated two drill locations and a short access road in the project area during the 1977 season. The AERC report (CSEC-77-3) which was prepared on May 9, 1977, stated that no cultural resources were observed or recorded during the project.

Two projects were conducted in the mine plan permit area by AERC in 1979. Report CSEC-79-1, which was prepared June 14, 1979, details the evaluation of fifteen drill locations, two access roads, and eleven proposed seismic lines. One single cultural resource site (AERC 268/1-42Sv1353) was recorded during this project. On September 4, 1979, a report for CSEC-79-4 was prepared which described a surface survey performed by Andrew J. McDonald of AERC. Mr. McDonald evaluated eight drill locations and four access roads for prehistoric and historic cultural resources. No cultural resource sites were found during this survey although scattered isolate lithic flakes were observed.

AERC's most recent research in the project area was reported on August 22, 1980, as project CSEC-80-3. V. Garth Norman, an AERC staff archeologist, conducted an evaluation of four drill locations and access routes in the mine plan permit area. Mr. Norman reported on prehistoric archeological site (AERC 474R/1-42Sv1441).

Previous investigations within the general area adjacent to the mine plan permit area have been conducted by Brigham Young University in 1977. Three sites (42Sv1065, 1066, and 1067) were recorded in the bottom of Quitchupah Canyon. Also in 1977, AERC conducted a sample survey inventory throughout central Utah and evaluated two quarter sections near Duncan Mountain. Sites 42Sv1029, 1030, and 1031 resulted from that expedition. In the early summer of 1980, a U.S. Forest Service archeologist recorded site 42Sv1386 near the head of Duncan Draw.

The Coastal States Energy Company mine plan permit area is within that portion of Fishlake National Forest which was designated as the "Forest South" planning unit during the 1977 cultural resources evaluation of central Utah conducted by AERC. Some 25 sample quarter sections were intensively evaluated, with a total of 41 sites recorded in this planning unit (see Hauck 1979:Table 5-50, Fig. 5-13).

The National Register of Historic Places has been consulted and no registered sites will be affected by this project. No registered sites are situated within the project area; the closest sites on the National Register are situated in Township 23 South, Range 4 East.

E. Research Design

AERC's research design, developed for the Convulsion Canyon project area, consists of the following:

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 utilization of the Little Duncan Mountain locality;
3. 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;
4. the determination of presence or absence of of early historic Euro-American habitation, trapping, trade or travel within the project area; and
5. the determination, on a regional level, of whether the sites in the project area contained any remains demonstrating local interaction between the Sevier and San Rafael vaiants of the Fremont culture.

AERC hypothesized that a high density of limited activity sites would cluster along the head of East Spring Canyon in association with supposed game trails and, accordingly, selected sample units to test the hypothesis. Prehistoric limited activity sites would include small lithic scatters, small surface quarries, hunting sites, and

kill-butchering sites. (The minimal definition of a limited activity site is an association of four or more flakes and/or lithic tools and/or ceramic sherds observed within the original context of deposition.)

Other prehistoric site types which could occur in the project area include rock art panels, temporary and extended campsites, rockshelters, and surface quarries. These sites were expected to have a low density in the project area because of the absence of any permanent water resources and because of the elevation and exposed nature of the plateau.

Historic period sites within the project locality are unknown except for a monument to Jack Addley who was struck by lightning in 1938.

Chapter II - METHODOLOGY

A. Field Research

During July, 1980, a cultural resource inventory of nine sample units was conducted by AERC for Coastal States Energy Company in the Convulsion Canyon project area around the Little Duncan Mountain locality of Sevier County, Utah.

V. Garth Norman of AERC was in charge of the field crew with F. R. Hauck as the principal investigator. Survey crew members consisted of Bunny Melendez, Monika Williams, and Brooks Britt.

The survey area is between the 8320 and 8800 foot ASL contours within the upland zone where future surface disturbance resulting from subsidence could occur. This potential for subsidence disruption was identified by Coastal States Energy Company personnel as lying within a 1785 acre area (see Figures 1 and 2). A ten percent surface survey involving 180 acres within nine selected units in this subsidence zone of about 1800 acres was intensively surveyed by an AERC crew in late July, 1980. The selection of these sample units was made by AERC based upon an analysis of the terrain involved and the potential within the different land-form features for containing significant cultural resource sites, historic as well as prehistoric, which would be susceptible to extensive damage from future subsidence. As is demonstrated in Figure 3a through c, some nine sample units of 20 acres each were selected utilizing this biased strategy.

Locations of the sample units and their land ownership and acreage are shown on Table 3 (see maps for specific locations):

Table 3

Sample Unit	Acreage	Location	Ownership
1	20	T21S., R5E., Sec. 31	U.S. Forest
2	20	T21S., R5E., Sec. 31	"
3	20	T21S., R5E., Sec. 32	"
4	20	T21S., R4E., Sec. 36	"
5	20	T22S., R5E., Sec. 6	"
6	20	T22S., R5E., Sec. 6	"
7	20	T22S., R5E., Sec. 5	"
8	20	T22S., R5E., Sec. 6, 7	"
9	20	T22S., R5E., Sec. 7	"

The extremely complex nature of the canyon slopes precluded these surface areas from being considered in this sample survey; a large portion of mineral lease area under study lies on steep terrain which is inaccessible. A large portion of the uplands is in montane ecozones around Duncan Mountain and Little Duncan Mountain where site potential is minimal. The remaining lower levels of uplands were sampled selectively in areas of moderate to high site potential. Sample unit 4 was selected at the head of East Spring Canyon because it is the major access between Convulsion Canyon and the uplands. Unit 1 is in a saddle at the extreme head of the upland drainage into this canyon. Unit 2 is on a gentle sloping drainage between units 1 and 4. Units 5, 6, 8, and 9 are in saddles and at the head of tributary drainages of East Spring Canyon. Units 3 and 7 are relatively flat areas on the east base of Little Duncan Mountain and on the rim of Convulsion Canyon.

All inventoried sample units were examined by performing parallel transects with the survey personnel spaced approximately 15 meters (50 feet) apart. Shorter intervals and zigzag transects were utilized for intensive examination of specific areas judged to be of high site potential.

A total of 16 archeological sites and one historic monument has been recorded in the general project area. Nine of the archeological sites and the historic monument are located in the permit area. Four of these sites (42Sv984, 42Sv985, 42Sv1353, and 42Sv1441) were recorded under separate consulting projects undertaken by AERC. The remaining six sites (42Sv1435 through 42Sv1440) were recorded during this sample survey.

All cultural resource sites were recorded on Bureau of Land Management site forms, photographed, sketched, and their locations marked on an Acord Lakes 7.5 minute USGS topographic map. Site reports for all relevant government agencies are included in an appendix to this report.

B. Laboratory Research

The analyses performed in the laboratory for this project concerned the evaluation of projectile points, miscellaneous lithics and ceramic fragments.

Projectile point analyses included identification of manufacturing techniques, e.g., heat treatment, blank and preform preparation, edge grinding, edge reworking and use wear analyses. Arrow and atlatl points were catalogued according to type.

The evaluation of miscellaneous lithics involved obsidian trace element analysis and the identification of various tool styles and manufacturing techniques.

Ceramics collected during the performance of the field survey were examined to determine manufacturing technique, paste and temper composition and surface preparation. Sherds were later catalogued according to type and variety.

A representative sample of diagnostic artifacts were collected during three separate survey programs in the permit area beginning in 1976. Sites which were involved include 42Sv1435 (six sherds), 42Sv1436 (one biface, three projectile points, and three obsidian flakes for trace element studies), 42Sv1437 (one point tip, one drill midsection, one sherd), 42Sv1438 (two points). A total of six isolate projectile points was also collected including 10R/X1, 260A/X1 and 2, 473N/X1, and 455N/X1 and 2.

These projects were conducted under various short term U.S. Forest Service special use permits and under Region 4 permits issued by the Regional Forester. These permits were not numbered as is the practice in the Department of Interior. Minimal collection of a representative sample of diagnostics was permitted.

C. Artifact Inventory and Analysis

Chronological evaluations of prehistoric sites were accomplished through artifact correlation with established types and varieties. The various projectile point types collected from the field were generally identifiable with similar Great Basin, Eastern Great Basin, Colorado Plateau, and Western Plains types. Ceramics were evaluated for type, and thus correlated with the types and varieties of local Utah wares.

Table 4 contains a listing of artifacts observed according to survey unit and site number, followed by sites recorded during other projects. Diagnostic isolates were assigned a field number and their locations were designated on Figure 3.

Table 4

Sample Survey Unit	AERC Site No.	Permanent Site No.	Artifacts
1	455N/5	42Sv1439	1 biface scraper 1 retouched flake primary & secondary flakes
	isolate		biface scraper
2	455N/X1 (isolate)		1 Humboldt point
	isolate		chert stone shatter
3	only isolates observed		various chert flakes turtleback scraper knife midsection chert stone shatter 2 retouched flakes 1 Cascade bipoint (AERC 10/X1)
4	455N/1	42Sv1435	Emery Gray ware Snake Valley B/w Snake Valley gray ware 1 mano chert & quartzite flakes bone awl

Table 4 (cont'd.)

Sample Survey Unit	AERC Site No.	Permanent Site No.	Artifacts
4	455N/2	42Sv1436	1 Bull Creek point 1 Sudden side-notch point 2 knife fragments obsidian, quartzite chert flakes
"	455N/3	42Sv1437	Emery Gray ware 1 point tip 1 point midsection 1 biface chert flakes
"	455N/4	42Sv1438	1 Elko side-notch 1 stemmed-tonged point chert flakes
5	isolate artifacts observed		1 biface 1 retouched flake core shatter chert flakes
6	no sites		
7	no sites		
8	no sites		
9	isolate artifact observed		chert flake
Outside Units			
"	455N/6	42Sv1440	historic monument
"	474R/1	42Sv1441	chert flakes
"	10R/1	42Sv983	chert flakes
"	10R/2	42Sv984	point midsection point squared base chert flakes
"	260A/1	42Sv1353	chert flakes

Table 4 (cont'd.)

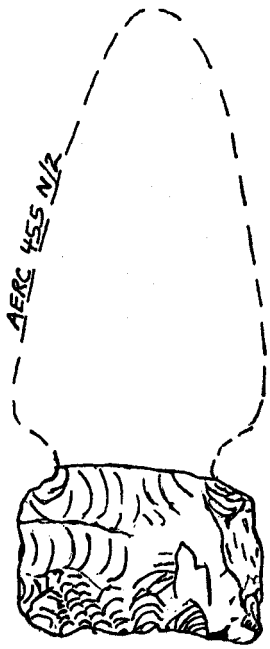
Sample Survey Unit	AERC Site No.	Permanent Site No.	Artifacts
Outside Units			
"	455N/X2	isolate observed	Elko side-notch
"	260A/X1	isolate observed	Elko corner-notch

Some 11 diagnostic artifacts inventoried in Table 4 were observed during the sample survey and other consulting projects in the study area. Culturally diagnostic remains were of prehistoric origin including ceramics of three types from two sites, three different diagnostic point types from two different sites, and three isolates. No Historic period artifacts were observed in the sample survey.

Figure 4 shows the diagnostic artifacts inventoried from the subsidence zone and the mine plan permit area.

ACTUAL SIZE

A



D

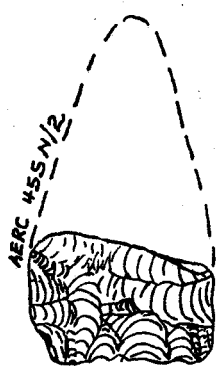
B

C

E

FIGURE 4

F



G

H

Chapter III - CULTURAL RESOURCE DESCRIPTIONS

A. Site Analyses

Six previously unrecorded cultural resource sites were located during the general inventory, all of which are situated at the head of the East Spring Canyon drainage, between Duncan Mountain and Little Duncan Mountain. A brief summary of the pertinent site characteristics is shown on Table 5. Included in Table 5 are four sites recorded by AERC within the survey area during other consulting projects.

Based on the definitions of cultural resource significance (see Chapter IV), two of the cultural resource sites listed in Tables 5 and 6 are considered eligible for nomination to the National Register of Historic Places (NRHP). The four prehistoric sites and one modern site (42Sv1440) classified as CRRS:S-3 are not candidates for nomination to the National Register of Historic Places. Site 455N/1 (42Sv1435) was being considered for recommendation to the National Register by the Richfield District Office of the U.S. Forest Service, but recent vandalism has destroyed over 80 percent of the site.

The remaining three sites were recorded as CRRS:S-4 status, i.e., having minimal scientific value (no temporally diagnostic remains or depth potential). Should additional historic and archeological research provide information showing that any site has greater cultural value than is presently assigned, the site rating will be adjusted accordingly.

Figure 3a-c are maps which locate the ten sites as well as the valuable isolated artifact finds. Additional

Table 5

Cultural Resource Site Summary

AERC Site No.	Permanent Site No.	Site Type	Culture
10R/1	42Sv983	Lithic scatter	Unknown
10R/2	42Sv984	Lithic scatter & temporary camp	Unknown
260A/1	42Sv1353	Lithic scatter	Unknown
455N/1	42Sv1435	Rock shelter	Fremont
455N/2	42Sv1436	Lithic scatter & quarry	Fremont to Early Archaic
455N/3	42Sv1437	Lithic-ceramic scatter/temporary camp	Fremont
455N/4	42Sv1438	Lithic-ceramic scatter	Fremont/Early to Late Archaic
455N/5	42Sv1439	Kill-butcher	Unknown
455N/6	42Sv1440	Modern monument	Euro-American
474R/1	42Sv1441	Lithic scatter & quarry	Unknown

information on these sites is contained in the site reports which are being proided to all relevant government agencies as an appendix to this report.

B. Comparative Resource Analysis

All ten sites situated in the subsidence zone of the mine plan permit area are prehistoric except for a modern monument (42Sv1440). Two of these sites (15%) are rockshelter sites; three others (23%) are lithic-ceramic scatters, two of which are also possible temporary campsites. An additional seven sites (54%) are lithic scatters; two of these show surface quarry activity and one is a kill-butcher site.

Cultural resource sites are found in three general areas. Site density is heaviest near the rim of Old Woman Plateau along the upper shallow drainages related to Convulsion Canyon. Some six sites (42Sv1435 through 42Sv1439 and 42Sv1441), or 46% of the 13 sites, are situated along the upper drainages at the head of East Spring Canyon. This area was sampled by four sample units and four earlier drill locations. In addition to these sites, other isolate tools and flakes were observed in Units 1, 2, and 5 (see Table 4).

The absence of cultural resources in Sample Units 6, 8, and 9 (only one isolate flake was observed in Unit 9) may be attributed to two factors: the drainages into East Spring Canyon are relatively steep, and residual surfaces are rare, dominated by a combination of extensive vegetation cover and eroded surface resulting from logging activity.

Cultural resources are also concentrated in a second general area along the rim of Quitchupah Canyon at the east base of Little Duncan Mountain. This area was sampled by Unit 3 and three earlier drill location evaluations conducted as separate projects. Various isolates in Sample unit 3 (see Table 4) and the two sites (42Sv983 and 42Sv984) along the rim northward, reveal that rather

extensive hunting activity occurred along the rim where game movement is somewhat restricted by terrain. Site 42Sv1353, a lithic scatter on a southeastern point of the plateau, is in a similarly restricted area.

Artifacts collected or observed by AERC personnel in various projects conducted from 1976 to 1980 in the mine plan permit area demonstrate a wide range of cultural activity. The Plano phase of the Paleo-Indian period may be represented in the possible Cascade bipoint collected in 1976 (see Figure 4H). The Early to Late Archaic cultural phases in east-central Utah are reflected in artifacts A, B, D, F, and G of Figure 4. These artifacts include a Humboldt point, one Sudden Side-notch, and two Elko Side-notch points. In addition, an Elko Eared point, which was not sketched in the field, was observed in 1979 in the project area.

Fremont activity in the mine plan permit area is demonstrated on three different sites, all located within Sample unit 4. These sites feature the San Rafael variant as determined by ceramics at 42Sv1435, a Bull Creek point (see Figure 4E) observed on site 42Sv1436, and some Emery Gray ware observed on site 42Sv1437. No Shoshonean activity in the mine plan permit area has been observed during the various archeological evaluations which have been conducted.

No historic sites, i.e. pre-1930, have been identified in the mine plan permit area. Isolated historic artifacts, however, have been observed in the Convulsion Canyon bottom and on slopes adjacent to the existing mine at the fork of Mud Spring Hollow and East Spring Canyon.

Chapter IV - EVALUATIONS AND RECOMMENDATIONS

A. Resource Significance Evaluations

An evaluation of site significance for the ten sites situated within the Convulsion Canyon mine plan permit area is presented in Table 6. Here the site quality indicators are presented with a statement on site condition. The field assessment of significance utilizing 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

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. Two sites were rated as CRRS:S-2 while five sites were of CRRS:S-3 value. The remaining three sites have been given a CRRS:S-4 rating.

The two sites (42Sv1435 and 42Sv984) have 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.

Table 6

Site Significance

Site	Quality *	Condition	CRRS Value Rating
42Sv1435	c, g	Poor	S-2
42Sv1436	g	Poor	S-3
42Sv1437	g	Poor	S-3
42Sv1438	g	Poor	S-3
42Sv1439	-	Poor	S-4
42Sv1440	-	Good	S-3 **
42Sv983	c, g	Poor	S-3
42Sv984	c, g	Good	S-2
42Sv1441	g	Poor	S-4
42Sv1353	-	Good	S-4

* AERC Quality indicators are:

a) size or layout is unique;

b) quantity and/or quality of artifacts is unique;

c) depth is indicated;

d) environmental location is unique;

e) unique artifacts, architecture, art or structure exist;

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.

** Jack Addley was killed on the location by lightning in 1938. He was a native of Emery, Utah and was in the area either guarding a herd of livestock or prospecting when killed. Local friends erected the monument after the body was recovered. Jack's horse, Star, is buried at the site.

B. National Register Criteria of Eligibility

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

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

b) none of the ten sites "are associated with the lives of persons significant in our past;" or

c) none of the ten sites "embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction."

The two CRRS:S-2 sites (42Sv984 and 42Sv1435) have both "yielded or may be likely to yield information important in the prehistory" of the region. Neither site, however, appears to be of such a high caliber of significance to presently warrant CRRS:S-1 status as eligible for nomination as a National Register site. This evaluation is based strictly upon site evaluation in the field.

C. Discussion of Impact Potential on Cultural Resource Sites

Direct impact potential of cultural resource sites is related to the possible subsidence of surface areas that could be affected in the future by the removal of coal seams within the project area on Old Woman Plateau (see Table 7).

Direct impact stemming from project development, e.g. bulldozing, portal development, etc., is not being considered in this report since direct impact to archeological sites due to these kinds of activities is being mitigated through avoidance procedures by AERC. Inasmuch as no historic or prehistoric site types which are susceptible to extensive disturbance from subsidence are known within the subsidence zone, the potential for direct impact of these types of sites is considered to be nil. The Addley monument (42Sv1440) could sustain some damage from subsidence but its historic value is minor, and its crude stone construction could be easily replaced.

Indirect impact is a greater threat to the archeological sites. This, however, would result primarily from non-project related hunting and camping activity by casual visitors and not from mining operations. Three sites (42Sv1435, 42Sv1436, and 42Sv1437) are the most vulnerable because of their extent and accessibility. They have already sustained considerable impact from vandalism.

Table 7

Cultural Resource Impact Potential

Site	CRRS Status	Possible Direct Impact*	Indirect Impact	Impact Agent	Figure Reference**
42Sv1435	S-2	Mining operations	High	Vandalism	3a, b, c
42Sv1436	S-3	Mining operations	High	Vandalism	3a, b, c
42Sv1437	S-3	Mining perations	High	Vandalism	3a, b, c
42Sv1438	S-3	Mining operations	Low	Vandalism	3a, b, c
42Sv1439	S-4	Mining operations	Low	Casual visitors	3a
42Sv1440	S-3	Mining operations	Low	Casual visitors	3c
42Sv983	S-3	Mining operations	Low	Casual visitors	3a
42Sv984	S-2	Mining operations	Low	Casual visitors	3a
42Sv1441	S-4	Mining operations	Low	Casual visitors	3c
42Sv1353	S-3	Mining operations	Low	Casual visitors	3b, c

* impact specifically limited to subsidence

** maps showing location

D. Recommendations

There are three basic kinds of adverse impact which can occur to both known and unknown cultural resource sites in the mine plan permit area.

The first of these is direct or project-related disturbance resulting from development activities. Ongoing archeological consultation with Coastal States Energy Company can preclude direct impact of any known or unknown sites during any phase of project development. AERC, therefore, recommends that the Coastal States Energy Company policy be continued involving archeological evaluations of surfaces prior to initiating exploration or developmental projects in the mine plan permit area.

The second aspect of adverse impact which may occur in the mine plan permit area relates to vandalism of sites. To curtail this activity, AERC suggests that the Coastal States Energy Company (and the Southern Utah Fuel Company) administrators acquaint all personnel with the federal antiquities laws concerning the preservation of cultural resource sites. AERC further recommends that all field personnel be made aware of the value of the resources and be watchful for visitors into the mine plan permit area who may be intent on destroying cultural resource sites. Site 42Sv1435 has been extensively vandalized during the summer of 1980. AERC recommends that basic testing of this rockshelter site in the mine plan permit area and, although extensively damaged, it still has value in aiding and understanding the prehistory of the project area. If vandalism within the project area continues, this site and others will lose all value for future research.

The third type of adverse impact which can occur in the mine plan permit area is disruption through

subsidence. With the future removal of coal seams under the Old Woman Plateau, the potential increases for future disturbance of the surface of the plateau. Extensive AERC surface evaluations conducted from 1976 through 1980 involving both sample survey, drill location evaluation, access road evaluation, and seismic line evaluation have demonstrated that no architectural cultural resources which would be highly susceptible to subsidence exist in the mine plan permit area or, more specifically, within the subsidence zone. The limited activity sites which are the most common within the project area involve prehistoric lithic scatters and hunting and camping sites. Depth potential on these types of sites is generally low in this area; hence, should subsidence occur in the future, only marginal or no disruption of these sites is anticipated. AERC, therefore, concludes that subsidence does not constitute a viable potential impact to any significant or susceptible cultural resource sites situated within the mine plan permit area.

The mitigative and avoidance comments presented herein are considered sufficient to provide a high level of protection to the cultural resource sites which are situated within the permit area. AERC recommends that Coastal States Energy Company be granted a cultural resource clearance based upon these recommendations to facilitate their future mine development and exploration.

BIBLIOGRAPHY

Aikens, C. Melvin
1967 Excavations at Snake Rock Village and the Bear River No. 2 Site. University of Utah Anthropological Papers, No. 87, Salt Lake City.
1970 Hogup Cave. University of Utah Anthropological Papers, No. 93, Salt Lake City.

Alexander, Thomas G.
1963 From Dearth to Deluge: Utah's Coal Industry. Utah Historical Quarterly, Vol. 31, No. 3, Salt Lake City.

Ashcroft, Gaylen L. and E. Arlo Richardson
Map of Freeze-Free Season, State of Utah. Utah Agricultural Experiment Station, Utah State University and Department of Commerce, ESSA, Environmental Data Services.

Beckwith, E. G.
1855 Report of Exploration for a Route for the Pacific Railroad by Captain J. W. Gunnison, Topographical Engineer, near the 38th and 39th Parallels of North Latitude. Reports of Explorations and Surveys, Vol. 2, Washington.

Berge, Dale L.
1973 "An Archeological Survey in the Castle Valley Area, Central Utah." Museum of Archeology & Ethnology, Brigham Young University, Provo. (Manuscript on file)
1974 An Archaeological Survey in the Castle Valley Area, Central Utah. Publications in Archaeology, Department of Anthropology and Archaeology, New Series No. 1, Brigham Young University Press, Provo.
1976 "Cultural Resource Evaluation of the Clear Creek Substation - Helper - Blackhawk 46 K.V. Transmission Line, Swisher Mine." Department of Archeology and Anthropology, Brigham Young University, Provo. (Manuscript submitted to the Utah Power & Light Co.)

1977b "Cultural Resource Evaluation of the Emery Substation - Dog Valley Mine Distribution Line." Department of Anthropology and Archeology, Brigham Young University, Provo. (Manuscript submitted to the Utah Power & Light Co.)

Berge, Dale L. and Michael P. Benson
1977 "A Cultural Resource Evaluation of the Emery Plant to Emery City Transmission Line." Department of Anthropology and Archeology, Brigham Young University, Provo. (Manuscript submitted to the Utah Power & Light Co.)

Berry, Michael S.
1974 The Evans Mound: Cultural Adaptation in S.W. Utah.
1975 Archeological, Historical and Paleontological Survey for Consolidation Coal Company and Kemmerer Coal Company in Emery County, Utah. A Special Report, Division of State History, Salt Lake City.

Carr, Stephen L.
1972 The Historical Guide to Utah Ghost Towns. Western Epics, Salt Lake City.

DeBloois, Evan
n.d. Joe's Valley Alcove. (Unpublished manuscript)

Doelling, H. H.
1972 Central Utah Coal Fields . . . . Monograph #3. Utah Geological and Minerological Survey , Salt Lake City.

Durrant, Stephen
1952 Mammals of Utah. University of Kansas Publications, Museum of Natural History, No. 6, Lawrence.

Dykman, James L. and Richard A. Thompson
1976 "The Dog Valley Strip Mine Survey." A Special Report by the Southern Utah State College, Cedar City.

Earle, B. J.
1975 "An Archaeological Summary of the Wasatch Plateau, Central Utah." Museum of Archeology and Ethnology, Brigham Young University, Provo. (Manuscript of file)

Fowler, D. D., D. B. Madsen, and E. M. Hattori
1973 Prehistory of Southeastern Nevada. Desert Research Institute Publications in the Social Sciences, No. 6, Reno.

Gillin, John
1941 Archeological Investigations in Central Utah. Papers of the Peabody Museum of American Archaeology and Ethnology, Vol. 17, No. 2, Cambridge.

Gillio, David A.
1975 "Archeological Survey of Trail Mountain Timber Sale." U. S. Forest Service, Richfield. (Manuscript on file)

Gunnerson, James H.
1956 A Fluted Point Site in Utah. American Antiquity, Vol. 21, No. 4, Salt Lake City.
1957 An Archeological Survey of the Fremont Area. University of Utah Anthropological Papers, No. 28, Salt Lake City.
1962a Unusual Artifacts from Castle Valley, Central Utah. Miscellaneous Collected Papers, University of Utah Anthropological Papers, No. 60, Salt Lake City.
1962b Plateau Shoshonean Prehistory: A Suggested Reconstruction. American Antiquity 28 (1):41-45, Salt Lake City.
1969 The Fremont Culture: A Study in Culture Dynamics on the Northern Anasazi Frontier. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 59, No. 2, Cambridge.

Hauck, F. R.
1976 "An Archeological Survey of Drill Locations and Access Roads in the Acord Lake Locality of Sevier County, Utah." Report prepared for the Southern Utah Fuel Company by the Archeological-Environmental Research Corporation of Salt Lake City.

1977 "Archeological Clearance of an Access Route and Two Drill Stations in Convulsion Canyon, Utah." Report prepared for the Coastal States Energy Company by the Archeological-Environmental Research Corporation of Salt Lake City.

1979 Cultural Resource Evaluation in Central Utah-1977. Cultural Resource Series, No. 3, Bureau of Land Management, Utah.

Hayward, C. Lynn, Clarence Cottam, Angus M. Woodbury and Herbert H. Frost
1976 Birds of Utah. Great Basin Naturalist Memoirs, No. 1. Brigham Young University Press, Provo.

Helm, Claudia
1974 "Preliminary Report of an Archaeological Survey in Sevier, Emery and Garfield Counties." Department of Anthropology, University of Utah, Salt Lake City. (Manuscript submitted to the U. S. Forest Service and the Bureau of Land Management and to the National Science Foundation.)

Holmer, Richard N.
1978 "A Mathematical Typology for Archaic Projectile Points of the Eastern Great Basin." Unpublished Ph.D. Dissertation, Department of Anthropology, University of Utah, Salt Lake City.

Holmer, R. N. and D. G. Weder
1980 Common Post-Archaic Projectile Points of the Fremont Area. Antiquities Section Selected Papers, Volume VII, No. 16, D. B. Madsen, Editor, Salt Lake City.

Hurst, C. T.
1948 The Cottonwood Expedition, 1947 - a Cave and a Pueblo Site. Southwestern Lore, Vol. 14, No. 1.

Jennings, J. D.
1957 Danger Cave. University of Utah Anthropological Papers, No. 27, Salt Lake City.
1974 Prehistory of North America. Second edition, McGraw-Hill, Inc., New York.

Jennings, Jesse D., Alan R. Schroedl and Richard N. Holmer
1980 Sudden Shelter. University of Utah Anthropological Papers, Salt Lake City.

Jennings, Jesse D., et al
n.d. Cowboy Cave. University of Utah Anthropological Papers, Salt Lake City (Manuscript in preparation)

Johnson, Carl M.
1970 Common Native Trees in Utah. Special Repor t 22, Agricultural Experiment Station, College of Natural Resources, Utah State University, Logan.

Kennette, S. D. and F. R. Hauck
1978 "Archeological Reconnaissance in the Scofield Locality of Carbon and Emery Counties, Utah." Report prepared for the Coastal States Energy Company by the Archeological-Environmental Research Corporation, Salt Lake City (CSEC-78-1).

Lamb, Sydney,M.
1958 Linguistic Prehistory in the Great Basin. International Journal of American Linguistics, Vol. 24.

Leach, Larry L.
1966 The Archeology of Boundary Village. University of Utah Anthropological Papers, No. 83, Miscellaneous Paper, No. 13, Salt Lake City.
1967 "Archeological Investigations at Deluge Shelter." Department of Anthropology, University of Utah, Salt Lake City. (Manuscript on file)

Lever, W. H.
1898 History of Sanpete and Emery Counties.

Lindsay, LaMar
1974 "Report of a Preliminary Archeological Survey of Coal Lease Lands (U-073039, U-073040 and U-073041), Sevier and Emery Counties, Utah. A Special Report prepared for the Bureau of Land Management, Salt Lake City.

Lindsay, LaMar W. and Christine K. Lund
1976 Pint Size Shelter. Antiquities Section Selected Papers, Vol. III, No. 10, Division of State History, Salt Lake City.

Lister, Robert H., and Florence C. Lister
1961 The Coombs Site, Part III: Summary and Conclusions. University of Utah Anthropological Papers, No. 41, Glen Canyon Series, No. 8, Salt Lake City.

Louthan, Bruce D. and Dale L. Berge
1975 "Archaeological Survey of the Huntington-Sigurd Transmission Line on Bureau of Land Management Lands." Department of Archeology and Anthropology, Brigham Young University. (Manuscript submitted to the Utah Power & Light Co.)

Lupton, C. T.
1916 Geology and Coal Resources of Castle Valley. U. S. Geological Survey Bulletin, No. 628, Washington, D. C.

Lyman, June and Norma Denver
1970 Ute People, An Historical Study. Uintah School District and the Western History Center, University of Utah, Salt Lake City.

Madsen, David B.
1975a Three Fremont Sites in Emery County, Utah. Antiquities Section Selected Papers, Vol. I, No. 1, Division of State History, Salt Lake City.
1975b Dating Paiute-Shoshoni Expansion in the Great Basin. American Antiquity, Vol. 40, No. 1, Washington, D. C.

Madsen, David B. and LaMar W. Lindsay
1977 Backhoe Village. Antiquities Section Selected Papers, Vol. IV, No. 12, Division of State History, Salt Lake City.

Madsen, Rex
1973 "Topography, Climate and Soil Types as Indicators of Fremont Regional." Paper presented at the Great Basin Anthrogpological Conference, University of Utah, Salt Lake City.
1977 Prehistoric Ceramics of the Fremont. Museum of Northern Arizona Ceramic Series, No. 6, Flagstaff.

Marwitt, John P.
1968 Pharo Village. University of Utah Anthropological Papers, No. 91, Salt Lake City.
1973 Median Village and Fremont Culture Regional Variation. University of Utah Anthropological Papers, No. 95, Salt Lake City.

Matheny, Ray T.
1971 "Archaeological Survey of Huntington Canyon Salvage Project, June 1971." Department of Anthropology and Archaeology, Brigham Young University, Provo. (Manuscript submitted to Utah Power & Light Co.)

McElprang, Stella, et al
1949 Castle Valley. Daughters of the Utah Pioneers, Emery County Chapter, Salt Lake City.

Miller, David E., compiler
1968 Utah History Atlas, Second Edition. Smith Printing Service, Salt Lake City.

Morss, Noel
1931 The Ancient Culture of the Fremont River in Utah. Papers of the Peabody Museum of American Archeology and Ethnology, Vol. 12, No. 3, Cambridge.
1954 Clay Figurines of the American Southwest. Papers of the Peabody Museum of American Archaeology and Ethnology, Vol. 49, No. 1, Cambridge.

National Archives of the United States
1973 Advisory Council on Historic Preservation, Part 800 - Procedures for the Protection of Historic and Cultural Properties. National Register, Vol. 39, No. 18, Washington, D. C.

Norman, V. G. and F. R. Hauck
1980a "Archeological Evaluations of Proposed Exploration Wells in the Convulsion Canyon Locality of Sevier County, Utah." Report prepared for the Coastal States Energy Company by the Archeological-Environmental Research Corporation of Salt Lake City.

1980b "Archeological Survey of a Proposed Collection Pond in the Convulsion Canyon Locality of Sevier County, Utah." Report prepared for the Coastal States Energy Company by the Archeological-Environmental Research Corporation of Salt Lake City.

O'Neill, Floyd A.
1973 "A History of the Ute Indians of Utah Until 1890." Doctoral dissertation submitted to the University of Utah, Salt Lake City.

Powell, Allan Kent
1976 A History of Labor Union Activity in the Eastern Utah Coal Fields: 1900-1934. University of Utah, Salt Lake City.

Ranch, Rebecca
1980 "A Cultural Resource Evaluation of the Soldier Creek Coal Mine Property in Emery County, Utah." A report prepared for the Soldier Creek Coal Company by the Archeological Center at the University of Utah, Salt Lake City.

Reagan, Albert B.
1935a An Archaeological Trip to Buck Horn Draw - Indians Worshipping the Sun. Utah Academy of Sciences, Arts, and Letters, Vol. XII, Salt Lake City.
1935b Trip to Bull Hollow Wash, May 3-4, 1935. Utah Academy of Sciences, Arts, and Letters, Vol. XII, Salt Lake City.

Reynolds, Thursey, J., et al
1948 Centennial Echoes from Carbon County. Daughters of the Utah Pioneers of Carbon County, Salt Lake City.

Sargent, Kay
1977 "Emery County: An Archeological Summary." Division of State History, Salt Lake City.

Schroedl, Alan R.
1976 "The Archaic of the Northern Colorado Plateau." Unpublished dissertation, Department of Anthropology, University of Utah, Salt Lake City.

Schroedl, Alan R. and Patrick F. Hogan
1975 Innocents Ridge and the San Rafael Fremont. Antiquities Section Selected Papers, Vol. I, No. 2, Division of State History, Salt Lake City.

Smith, T. M. and F. R. Hauck
1979a "An Intensive Inventory of Drill Sites and Access Roads in the East Mountain Locality of Emery County, Utah." Report prepared for the Utah Power and Light Company by the Archeological-Environmental Research Corporation, Salt Lake City (UPL-79-10).
1979b "An Intensive Inventory of the Proposed UPL Cottonwood Creek - Wilberg Mine Portal Area (UPL-79-5)." Report prepared for Utah Power and Light Company by the Archeological-Environmental Research Corporation, Salt Lake City.

Steward, Julian
1974 Ute Indians I. Aboriginal and Historical Groups of the Ute Indians of Utah. Garland Publishing Inc., New York and London.

Sutton, Wain, ed.
1949 Utah Centennial History, Vol. II. Lewis Historical Publishing Company, New York.

Taylor, Dee Calderwood
1957 Two Fremont Sites and Their Position in Southwestern Prehistory. University of Utah Anthropological Papers, No. 29, Salt Lake City.

Tripp, George
1966 A Clovis Point From Central Utah. American Antiquity, Vol. 27, No. 3.
1967 Bill Mobely does it again! Utah Archeology, Vol. 13, No. 1.

Utah Water and Power Board
Map of the Normal Annual Precipitation, 1931-1960, State of Utah.

Vienneau, Azor
1973 The Bottle Collector. Petheric Press, Halifax, Nova Scotia.

Walker, J. Terry
1977 "Archeological Investigations on Trough Springs Ridge and Near the Huntington Canyon-Electric Lake Dam." Department of Anthropology and Archaeology, Brigham Young University, Provo. (Manuscript on file)

Wilson, Curtis J. and Howard L. Smith
1976 Interstate Highway I-70 Salvage Archeology, Antiquities Section Selected Papers, Vol. II, No. 7, Division of State History, Salt Lake City.

Winter, Joseph C.
1973 The Distribution and Development of Fremont Maize Agriculture: Some Preliminary Interpretations. American Antiquity, Vol. 38, No. 4.

Winter, Joseph C. and Henry G. Wylie
1974 Paleoecology and Diet at Clyde's Cavern. American Antiquity, Vol. 39(2):303-315, Washington, D. C.

Wormington, H. M.
1955 A reappraisal of the Fremont Culture. Proceedings of the Denver Museum of Natural History, No. 1, Denver.
1964 Ancient Man in North America. The Denver Museum of Natural History, Popular Series, No. 4, Denver.

Wylie, Henry G.
1972 "Report of Excavations at Clyde's Cavern (42Em177) Emery County, Utah." Department of Anthropology, University of Utah, Salt Lake City. (Manuscript on file)

APPENDIX

Site Reports Under Separate Cover
Provided to Relevant Agencies

1981 SUPPLEMENT

FEDERAL COAL LEASE NO. U-47080

ABSTRACT

As an extension of the 1980 study for Southern Utah Fuel Company, Archeological Environmental Research Corporation (AERC) conducted a sample survey cultural resources evaluation of the U-47080 lease area in January of 1981. Through non-random sample analysis, nine sample units were inventoried totaling 120 acres, for a 10 percent sampling of the total 1,160 acres within the lease area.

During the survey, three archaeological sites were recorded. These sites are small, prehistoric lithic scatters in poor condition with unknown cultural affiliation. None of the three sites is considered eligible for nomination to the National Register of Historic Places. The following presents the AERC report for the U-47080 lease area.

ARCHEOLOGICAL - ENVIRONMENTAL RESEARCH CORPORATION

588 West 800 South Bountiful, Utah 84010
Tel: (801) 292-7061 or 292-9668

February 9, 1981

Subject: ADDENDUM - Emergency Lease Area Cultural Resources Evaluation in the Duncan Mountain Locality (Addendum to AERC Paper No. 20 entitled "Intensive Archeological Surface Evaluations and Sample Survey of the Southern Utah Fuel Company Coal Mine in Sevier County, Utah" dated October, 1980).

Project: Southern Utah Fuel Company - 1981 Permit Application

Project No.: SUFC-81-1

Permit: U.S. Forest Service Special Use Permit issued to AERC January 28, 1981

To: Coastal States Energy Company, ATTN: Mr. Keith Welch, 1354 E. 3300 South, Suite 303, Salt Lake City, Utah 84106

District Ranger, Fishlake National Forest, Richfield Ranger District, P.O. Box 646, Richfield, Utah 84701

Forest Supervisor, Fishlake National Forest, U.S. Forest Service, 170 North Main, Richfield, Utah 84701

Info: Mr. H. G. Wylie, Archeologist, Region 4, U.S. Forest Service, 324 - 25th Street, Ogden, Utah 84401

Dr. David B. Madsen, State Archeologist, Antiquities Section, State Historic Preservation Office, 300 Rio Grande, Salt Lake City, Utah 84101

GENERAL DATA ON THE PROJECT:

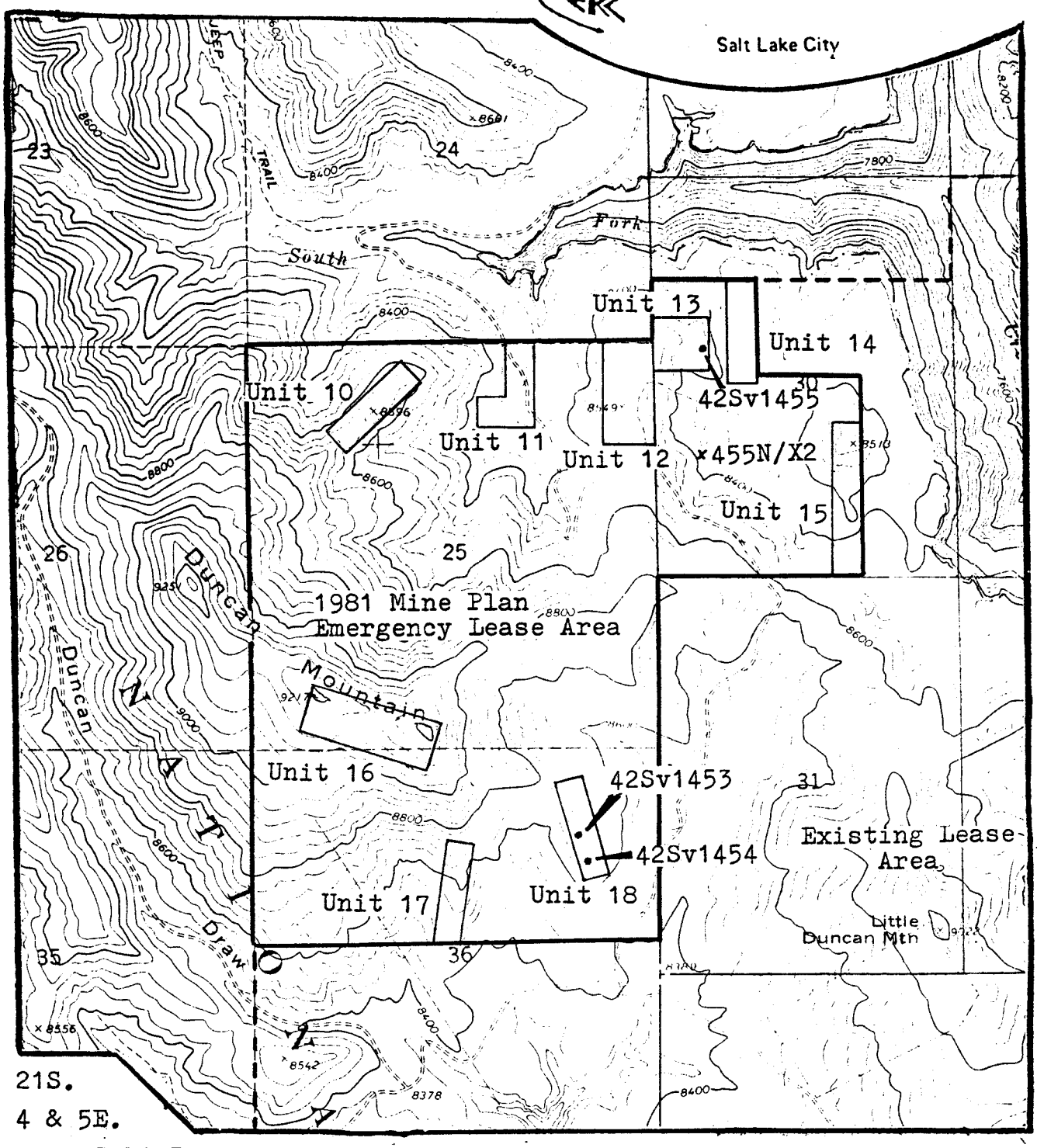
From January 28 to January 30, 1981, V. Garth Norman of the Archeological-Environmental Research Corporation conducted a sample survey cultural resources evaluation in the Duncan Mountain locality Emergency Lease Area for the Southern Utah Fuel Company (SUFC), a division of Coastal States Energy Company. This evaluation is an extension of the 1980 study, with this report as an addendum to AERC Paper No. 20 entitled Intensive Archeological Surface Evaluations and Sample Survey of the Southern Utah Fuel Company Coal Mine in Sevier County, Utah (see Hauck et al. 1980).

The resource inventory included nine sample units ranging from 10 to 25 acres each, totaling 120 acres, and are numbered in sequence from 10 to 18 in order to continue the sequence established in the 1980 study. This acreage comprised a ten percent sampling of about 1160 acres in the Emergency Lease area. As with the previous study, the purpose of this research was to ascertain, through non-random sample analysis, the probability for existence of significant historic and/or prehistoric cultural resource sites that could sustain adverse affect from subsidence occurring as a result of future underground mining operations.

The surface areas surveyed and locations of cultural resources are shown in Figure 1, and are situated within Sections 25 and 36 of Township 21 South, Range 4 East, and in Section 30 of Township 21 South, Range 5 East, in the Fishlake National Forest lands of Sevier County, Utah. The project area is situated on the northwest corner of the 1980 Mine Plan area, and is located between 8280 and 9200 foot ASL contours on Duncan Mountain and adjacent foothills to the south of the South Fork of Quitchupah Creek (see Figure 1).

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21S.

R. 4 & 5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: SUFC-81-1

Series: Central Utah

Date: 2/2/81

Figure 1
SAMPLE SURVEY UNITS AND CULTURAL RESOURCES IN THE EMERGENCY LEASE PROJECT AREA

Legend:

Sample Unit

Archeological Site •

Isolated Artifact x

0 .5 1

.5 0 .5 1 Km

All field notes and site data are filed at AERC headquarters in Bountiful, Utah. Site reports are being submitted to the State Historic Preservation Office as well as to all other relevant government agencies.

Please refer to the initial report (AERC Paper No. 20) for details of Prehistory, Environment, Previous Investigations, and Research Design.

FIELD RESEARCH:

A biased selection of sample units was made by AERC based upon an analysis of the terrain involved and the high relative potential of each sample unit for containing cultural resource sites. Saddles, ridges, alcoves, and sagebrush flats were all included in the surfaces sampled during this survey.

Locations of the sample units and their land ownership and acreage are shown on Table 1.

Table 1

Sample Unit Locations

Sample Unit	Acreage	Location				Ownership	
10	10	T.21S.,	R.4E.,	Sec.	25	U.S.	Forest
11	10	"	"	"	"	"	"
12	20	"	"	"	"	"	"
13	10	"	5E.,	"	30	"	"
14	10	"	"	"	"	"	"
15	15	"	"	"	"	"	"
16	25	"	4E.,	"	25 and 36	"	"
17	10	"	"	"	36	"	"
18	10	"	"	"	"	"	"

A large portion of the Emergency Lease area lies on Duncan Mountain's steep terrain which has a low site potential The AERC analysis indicated that potential for sites was greatest in level to moderately sloping ridge areas, in saddles, and at the head or mouth of draws. Sample units were located to examine these topographic features. Units 12, 15, and 16 are in ridge and saddle areas. Units 10, 17, and 18 are on ridge areas overlooking draws. Unit 11 is in a low ridge area

at the mouth of a major draw. Unit 13 is on a relatively flat ridge overlooking low knolls in Unit 14 and the adjacent flatlands.

All inventoried sample units were examined by performing parallel and zigzag transects at a 15 meter (50 feet) spacing between transects. Specific areas judged to be of high site potential were walked at an eight to ten meter spacing.

A total of three archeological sites was recorded in the Emergency Lease project area (see Figure 1). These sites, 42Sv1453, 42Sv1454, and 42Sv1455, were recorded, photographed, sketched, and their locations marked on an Acord Lakes 7.5 minute U.S.G.S. topographic map. Site reports for all relevant government agencies are included in an appendix to this report.

The three previously unrecorded cultural resource sites located during this inventory are small, prehistoric lithic scatters in poor condition. They are located on foothill ridge areas of Duncan Mountain. No cultural affiliation could be established for these sites (see Table 2).

Table 2

Cultural Resource Site Summary

AERC Site No.	Permanent Site No.	Site Type	Culture
539N/1	42Sv1453	Lithic scatter	Unknown
539N/2	42Sv1454	" "	"
539N/3	42Sv1455	" "	"

Sites 42Sv1453 and 42Sv1454 appear to be limited use hunting stations. They are located on relatively flat surfaces on the west rim of a ridge area, overlooking a draw to the southwest. Natural surface erosion could cover lithics

and artifact assoications on site 42Sv1453, but thin soils and rock exposure on site 42Sv1454 negate any potential for depth.

Site 42Sv1455 is located on a slightly raised residual point along a ridge line overlooking a draw and flatland to the east. The site is of limited usage and has limited depth potential. This site could have been previously collected since an old wagon trail extends along the ridge to the site locality.

In addition to the three sites, one isolated projectile point (455N/X2) was previously located in the survey area during the 1980 survey (see Figure 1). Another isolated point (455N/X1) was recovered near the center of sample unit 2 during the previous sample survey, but is mistakenly illustrated as being found in the area of unit 18 in Figure 3a of AERC Paper No. 20.

Two sites (42Sv1453 and 42Sv1455) have been given a CRRS:S-3 status, having limited depth potential and limited scientific value.

Site 42Sv1454 was recorded as CRRS:S-4 status, i.e., having minimal scientific value, lacking temporal diagnostic remains or depth potential (see AERC Paper No. 20 for definition of CRRS evaluation system). Should additional research reveal a greater value for any of these sites, the site value will be adjusted accordingly.

Table 3

Site Significance

Site	Quality	Condition	CRRS Value Rating
42Sv1453	c	Poor	S-3
42Sv1454	-	"	S-4
42Sv1455	c	"	S-3

AERC Quality Indicators are:

a) size or layout is unique;

b) quantity and/or quality of artifacts is unique;

c) depth is indicated;

d) environmental location is unique;

e) unique artifacts, architecture, are, or structure exist;

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.

IMPACT POTENTIAL ON CULTURAL RESOURCE SITES AND RECOMMENDATIONS:

Direct impact potential of cultural resource sites is related to the possible subsidence of surface areas that could be affected in the future by the removal of coal seams within the project area on Old Woman Plateau (see Table 4).

Direct impact stemming from project development, e.g., bulldozing, portal development, etc., is not being considered in this report since direct impact to archeological sites due to these kinds of activities is being mitigated through avoidance procedures by AERC. Inasmuch as no historic or prehistoric site types which are susceptible to extensive disturbance from subsidence are known within the subsidence zone, the potential for direct impact of these types of sites is considered to be nil.

Indirect impact is a greater threat to the archeological sites. This, however, would result primarily from non-project related hunting and camping activity by casual visitors and not from mining operations.

Sparse lithic remains on all three sites suggests that significant impact from vandalism has already occurred.

The low significance of all three cultural resource sites recorded in the Emergency Lease area does not warrant alteration of recommendations as provided in the report for the initial sample survey (see AERC Paper No. 20, pages 45 and 46).

NATIONAL REGISTER CRITERIA OF ELIGIBILITY:

Application of the National Register Criteria of Eligibility, defined under 36 CFR 60.6, to each of the three sites that are situated in the Emergency Lease project area provides the following information:

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

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

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

d) none of the three newly recorded sites (42Sv1453, 1454, and 1455) can be judged "likely to yield information important in the prehistory" of the region as a National Register site.

Based upon application of the criteria established in 36 CFR 60.6, none of the three sites evaluated in this report is eligible for nomination to the National Register of Historic Places.

Table 4

Cultural Resource Impact Potential

Site	CRRS Status	Possible Direct Impact	Indirect Impact	Impact Agent
42Sv1453	S-3	Mining operations	Low	Casual visitors
42Sv1454	S-4	" "	"	" "
42Sv1455	S-3	" "	"	" "

BIBLIOGRAPHY

Hauck, F. R., V. G. Norman and D. G. Weder
1980 Intensive Archeological Surface Evaluations and Sample Survey of the Southern Utah Fuel Company Coal Mine in Sevier County, Utah. Archeological-Environmental Research Corporation, Paper No. 20, Salt Lake City.

1981 SUBMITTAL

ARCHEOLOGICAL - ENVIRONMENTAL
RESEARCH CORPORATION

588 West 800 South Bountiful, Utah 84010
Tel: (801) 292-7061 or 292-9668

July 6, 1981

Mr. Keith Welch
Coastal States Energy Company
411 West 7200 South
Midvale, Utah 84047

Dear Keith:

I have just concluded a review of AERC Paper No. 20, Archeological Evaluations in the Convulsion Canyon Project Area, which was prepared for your firm in the fall of 1980 to be submitted with your mine plan for permitting. This review was requested based upon comments prepared by the Division of Oil, Gas and Mining and Office of Surface Mining and forwarded to Coastal States on June 5, 1981.

Comments given in the Apparent Completeness Review, Section 783.12, paragraphs 2 and 3, are addressed to problems which have been corrected in the report. Changes were made in pages 42 and 46 in February, 1981, and substitution pages mailed out on February 18, 1981, to Coastal States Energy Company, all U.S. Forest Service offices involved, the State Historic Preservation Office, and to Ms. Mary Ann Wright at Division of Oil, Gas and Mining. Evidently, both SHPO and DOGM failed to substitute the updated information for the original pages. I have made several additional minor changes on page 34 which should eliminate any question concerning our recommendations for site significance.

New site forms can be issued to correct the problem noted in paragraph 4. All site forms in our files are intact and the numbers are legible.

AERC can prepare a statement which will relate the survey results to our general research design as requested in paragraph 5. This statement will be developed as an addendum to the report, to be placed following the Appendices so that it will not disrupt the body of the report.

I should like to make comment on the deficiencies noted by the Office of Surface Mining in Section 784.17. Comments 1, 3, 7, 8, 9, 12, 13, 14 either have been corrected or are of questionable merit and should be dismissed. Comment 4 is appropriate and a statement should have been included in the report concerning variation in ground cover. Comment 5 is appropriate and will be corrected.

Comment 6: Site maps were not in use in 1976 when 42Sv983 and 984 were recorded. These small, limited activity lithic scatters would yield no additional information to a report review if they were sketched. Shadows on the photographs of 42Sv1440 do obscure the text of the monument; however, the complete text is given in the site report and this information is certainly sufficient for making an evaluation on the site. The site maps were prepared to facilitate in relocating the sites, not in presenting an ideal picture of the actual layout of each site.

Comment 10: This criticism is valid and appropriate changes in the report have been made (see attached page 29 which will replace the original).

Comment 11: The statement on page 38 has been changed to read "The Plano phase of the Paleo-Indian Period may be represented in the possible Cascade bipoint collected in 1976."

I hope that this information and the changes which we have made will be sufficient for your needs in repermitting this project. If you have any further needs or questions, please contact me.

Sincerely,

F. R. Hauck

F. R. Hauck, Ph.D.
President

FRH:dp

enc

Addendum to AERC Paper No. 20

Intensive Archeological Surface Evaluations and Sample Survey of the Southern Utah Fuel Company Coal Mine in Sevier County, Utah

Survey Results and Research Objectives

The basic research design utilized by AERC in the Convulsion Canyon project area is given on pages 24 and 25 of the report. The results of the surveys can be stated by separately addressing each objective.

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 is of importance in understanding settlement diversity in the region. AERC surveys in the project area have resulted in documenting a preponderance of Archaic sites with Fremont activity more scattered. No Paleo-Indian or Shoshonean sites have been found in the project area although Shoshonean sites are found in the region. One possible Paleo-Indian artifact has been found in the project area and a Clovis point has been recovered in the region (Tripp 1966).
2. The determination of presence or absence of cultural materials which demonstrate the utilization of the Little Duncan Mountain locality is of value in understanding land-use patterns and resource exploitation during prehistoric and historic periods of occupation. Artifacts and sites documented in the project area indicate prehistoric

activity was transitory and limited to small bands or familial groups which occupied the plateau on a seasonal basis. Of the 13 known sites (including the three reported in the Addendum of February 9, 1981), nine are limited activity lithic scatters. The three remaining prehistoric sites have evidence of short-term occupation, while the final site is of modern origin. No historic sites have been found in the project area. The Little Duncan Mountain locality was apparently infrequently utilized during the Fremont and Archaic phases as a hunting-gathering resource zone by small units which maintained more permanent residences elsewhere, probably down in the lower elevations.

3. The determination of which types of prehistoric cultural activity were conducted in the project area can be based upon patterns in artifact associations or predominance of particular types of sites. Research in the project area indicates the plateau around Little Duncan Mountain was utilized for hunting and possibly the collection of raw materials to be used in lithic tool maufacture. This hypothesis is based upon the large number of lithic scatters and the one kill-butchering site contrasted with the three sites containing occupational materials. In addition, the preponderance of sites at the immediate head of East Spring Canyon contrasted with the lack of sites on the Old Woman Plateau to the east of that canyon demonstrates the validity of the hypothesis that East Spring Canyon was an access corridor connecting the upper plateau with the open country to the east via Convulsion Canyon.

4. The determination of presence or absence of early historic Euro-American habitation, trapping, trade, or travel within the project area will be useful in documenting

the early historic period. To date, no historic activity of any type has been observed or recorded in the project area.

5. The determination of whether the sites in the project area contain any remains demonstrating local interaction between the Sevier and San Rafael variants of the Fremont culture is necessary in understanding Fremont regional patterns of trade and contact. All Fremont artifacts recovered from the project area are of the San Rafael variant. The project area is ten miles to the northeast of Salina Canyon which was the primary access corridor linking the Sevier and San Rafael variants. This distance and the intermediate barriers may preclude the project area from receiving an adequate distribution of artifacts which could reliably demonstrate interaction between these variants. Three obsidian flakes collected from 42Sv1436 could reflect the east-west interaction. Obsidian sources in Utah are situated in the Sevier River drainages and in the western region of the state. Trace element analyses of these fragments will possibly provide a tentative clue to interaction between the San Rafael and Sevier variants.

ARCHEOLOGICAL - ENVIRONMENTAL RESEARCH CORPORATION

588 West 800 South Bountiful, Utah 84010
Tel: (801) 292-7061 or 292-9668

August 5, 1981

Mr. Keith Welch
Coastal States Energy Company
411 West 7200 South
Midvale, Utah 84047

Dear Keith:

I am forwarding, as attachments to this letter, our comments in response to the list of deficiencies noted by OSM in their Completeness Review of the Southern Utah Fuel Company Convulsion Canyon Mine cultural resource report submitted by AERC (AERC Paper No. 20) in October, 1980.

Should you have any questions, please contact me at my office.

Sincerely,

F. R. Hauck, Ph.D.
President

FRH:dp
enc

Response to Statements Outlined in 784.17

1. The 5,230 acres in the mine plan includes the entire project area. Only 1,800 acres of the project area will be susceptible to subsidence from underground mining. Since the purpose of the 10% survey was to assess cultural resource potential in the subsidence zone, only those surfaces subject to subsidence were sampled.

2. Ventilation break-outs will be surveyed prior to construction if they are accessible. The break-outs are planned on vertical cliff faces which are not easily accessible and where the cultural resource potential is nil. No external access will be required.

3. The Principal Investigator selected nine 20-acre sample units for the following reasons: the relatively small sampling universe of 1,800 acres and the limited number of distinct localities which contained the topographic, geological, and vegetational factors which correlate with site presence and density in the Wasatch Plateau.

4. Ground visibility on the sample units varied from good to excellent. Units 1, 2, 3, and 4 are generally open with scattered timber and low shrubs. These surfaces were generally visible. The remaining units, 5 through 9, are in a Ponderosa Pine woodland and surface visibility is restricted below each pine but generally the surfaces are bare and exposed outside the needle drop zone.

5. Changes on the site forms have been made as suggested.

6. Site maps are not needed for sites 42Sv983 and 984. These small, limited activity, lithic scatters were recorded in 1976 prior to any requirements concerning site maps. If site maps were provided, they would not provide any further evidence of the sites' spatial contexts or sites' significance than are provided in the site reports. Shadows on the photographs of 42Sv1440 do obscure the text on the monument; however, the complete text is given in the site report and this information has been determined to be sufficient for making an evaluation that this site is not historic nor eligible for National Register status under any of the four criteria outlined in 36 CFR 60.6. Site maps have been prepared to facilitate in relocating each site, not in presenting an ideal picture of the actual layout on any given site.

7. See attached Addendum to Paper Number 20 for information on research goals and results.

8. Site 42Sv1435, a recently vandalized rock shelter, is susceptible to subsidence and is situated in the subsidence zone. Subsidence is not an immediate threat to this site, however, since vandalism will probably destroy this site long before the potential for subsidence can be considered a threat. For this reason, the U. S. Forest Service may wish to consider a test excavation of the site to obtain as much cultural information as is possible before its complete destruction by vandals. If subsidence does eventually pose an eminent threat

the remnants of the site, then archeologists could develop a new research strategy based upon a test excavation and the site's potential at that time for yielding new and valuable information on the prehistory of the locality and region.

9. National Register eligibility statements were clarified and substitution pages 42 and 46 provided to all review agencies in February, 1981. In addition, changes have been made on page 34 to further clarify site significance assessments.

10. See attached page 29 for clarification of this point. This page should be substituted for page 29 in the report. AERC has conducted a variety of projects in the locality since 1976 and has practiced artifact collection on some projects while refraining from collecting on other projects. The report, therefore, includes all artifacts observed or collected by AERC personnel from the general project area and is not strictly reflecting only the artifacts found during the sample survey project.

11. See substitute page 38 which is attached for clarification of this issue. This page should be placed within the body of the report.

12. This information is provided in the written report and on the site reports. Reference information on Fremont ceramics is provided in the bibliography (see Madsen, Rex 1977).

13. All previous investigations in, or adjacent to, the project area are referenced on pages 1, 22, 23, and are cited in the bibliography. These reports are on file at the appropriate state and federal offices and are not considered appendices to the present report, although the results of those surveys have aided understanding of the local history and prehistory.

14. The Addley monument (42Sv1440) was erected in 1938. The site report and the written report both establish the fact that this site is neither historic nor prehistoric. This site does not meet any of the criteria for potential inclusion as a National Register status site as established in 36 CFR 60.6. Since this site does not qualify, there is no need for conducting further field research or documentation.

ARCHEOLOGICAL - ENVIRONMENTAL RESEARCH CORPORATION

588 West 800 South Bountiful, Utah 84010
Tel: (801) 292-7061 or 292-9668

July 20, 1981

Mr. Keith Welch
Coastal States Energy Company
411 West 7200 South
Midvale, Utah 84047

Dear Keith:

Enclosed are copies of the site forms for AERC Paper No. 20 that you requested during our telephone conversation this date.

If you have any further questions, please contact me at my office.

Sincerely,

F. R. Hauck, Ph.D.
President

dp

encs

USDA - FOREST SERVICE

2363

ARCHEOLOGICAL SITE INVENTORY

Serial Number [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] (1–8)

Transaction Code [ ] (9)

Category No. (10–12)		Description (16 . . . 79)
050	04	Region
051	Name Fishlake No.	Forest
052	Name Richfield No.	District
053	Forest Land	F.S. Site number
054	Utah	State
055	Sevier	County
056	42Sv983 SUFC-76-1 AERC 10/1	Permanent State number
057		Site name (if any)
058	6/24/77	Date permanent number assig
059	On Register ___ Nominated ___ Potential X	National Register status
060	NW ¼ SE ¼ NW ¼ S 32 T 21S R 5E Meridian Salt Lake	Legal description
061	FS ___ USGS Acord Lakes 7.5	Map References
062	466600m E 4310700m N	UTM Grid
063	N.A.	Aerial Photo Data
064	June 15, 1976	Date of Survey
065	AERC	Reported By
067	F. R. Hauck	Recorded By
070	Mt. Mahagony	Type of Vegetation on Site list dominant tree, shrub, herbaceous species present
075	Alpine Formation ___ Southwestern Spruce-Fir Forest ___ Spruce-Fir, Douglas Fir Forest ___ Pine-Douglas Fir Forest ___ Juniper-Pinyon Woodland ___ Oak-Juniper Woodland X Mountain Shrub Formation ___ Mountain Grassland Formation ___ Prairie Formation ___ Plains Grassland Formation ___ Desert Grassland Formation ___ Great Basin Desertscrub Formation ___ Southwestern Desertscrub Formation ___	Type of Vegetation around site

Category No. 10 11 12 — 42 Sv 983 — Description 13 . . . 23

085	Colluvial ___ Alluvial ___ Aeolian ___ Residual X Glacial ___ Lacustrine ___	Origin of Soil around site
090	0-3 °	Ground slope of site
092	N__ S__ E__ W__ NE__ NW__ SE__ SW__ 360 °	Aspect of site
093	Site is on low, mahogany covered knoll on SW rim of Quitchupah Canyon and about ½ mi. NE of Little Duncan Mtn.	Location of site
094	8,450 ft.	Elevation of site
100	Stream___ Spring X Seep___ Other___	Water resources
101	Distance 150m. Direction SW	Distance & direction to nearest water
120	none observed	Type of architecture
122	Rooms___ Pithouses___ Kivas___ Other___	Numbers & kinds of structures
130	Limited activity X Habitation___ Rock Art___ Water control___ Storage___ Other___	Type of site
135	30m(E-W) x 20 m^2 or ___ ft^2	Size of site
140	Unknown-	Cultural classification
143	___ BP ___ AD/BC	Date of site
150	Lithic X Ceramic ___ Bone ___ Other(s) ___	Kinds of artifacts observed
160	Marginal surface on bedrock. Eroded X Pothunted ___ Undisturbed X Other ___	Condition of site
165	Color___ B/W___ Neg. No.(s) NONE	Photographs taken

180 01 No collection, site not endangered by drilling activities. — Remarks

13 14 02 Lithics are scattered but some indication of depth and cultural

03 materials may be buried. Site was not carefully inventoried

04 since no mitigation required.

05

06

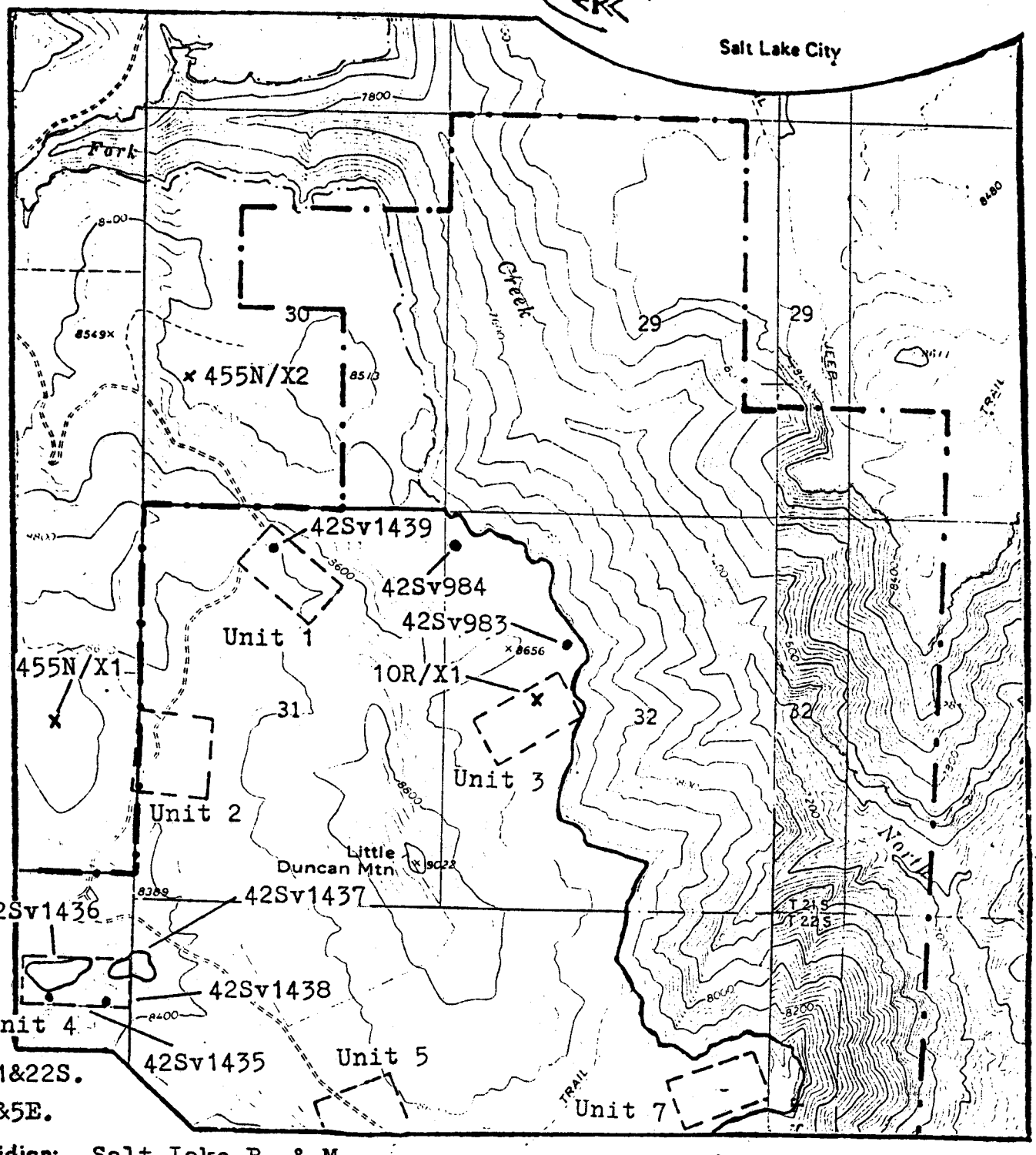
07

08

09

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21&22S.

R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1

Series: Central Utah

Date: 8-13-80

Figure 3a
Sample Survey Units and Cultural Resources in the Mine Plan Area

Legend:

Sample Unit

Archeological Site

Isolated Artifact

0 .5 1

.5 0 .5 1 Km

USDA - FOREST SERVICE

2363

ARCHEOLOGICAL SITE INVENTORY

Serial Number [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ] (1–8)

Transaction Code [ ] (9)

Category No. (10 11 12)

Description (16 . . . 79)

050	04	Region
051	Name Fishlake No.	Forest
052	Name Richfield No.	District
053	Forest Land	F.S. Site number
054	Utah	State
055	Sevier	County
056	42Sv984 SUFC-76-1 AERC 10/2	Permanent State number
057		Site name (if any)
058	6/24/77	Date permanent number assig
059	On Register ___ Nominated ___ Potential X	National Register status
060	NW ¼ NW ¼ NW ¼ S 32 T 21S R 5E Meridian Salt Lake	Legal description
061	FS ___ USGS Acord Lakes 7.5	Map References
062	466325m E 4311250m N	UTM Grid
063	N.A.	Aerial Photo Data
064	June 15, 1976	Date of Survey
065	AERC	Reported By
067	F. R. Hauck	Recorded By
070	Sagebrush	Type of Vegetation on Site list dominant tree, shrub, herbaceous species present
075		Type of Vegetation around site

Alpine Formation ___
Southwestern Spruce-Fir Forest ___
Spruce-Fir, Douglas Fir Forest ___
Pine-Douglas Fir Forest ___
Juniper-Pinyon Woodland ___
Oak-Juniper Woodland ___
Mountain Shrub Formation X
Mountain Grassland Formation X
Prairie Formation ___
Plains Grassland Formation ___
Desert Grassland Formation ___
Great Basin Desertscrub Formation ___
Southwestern Desertscrub Formation ___

} Peripheral

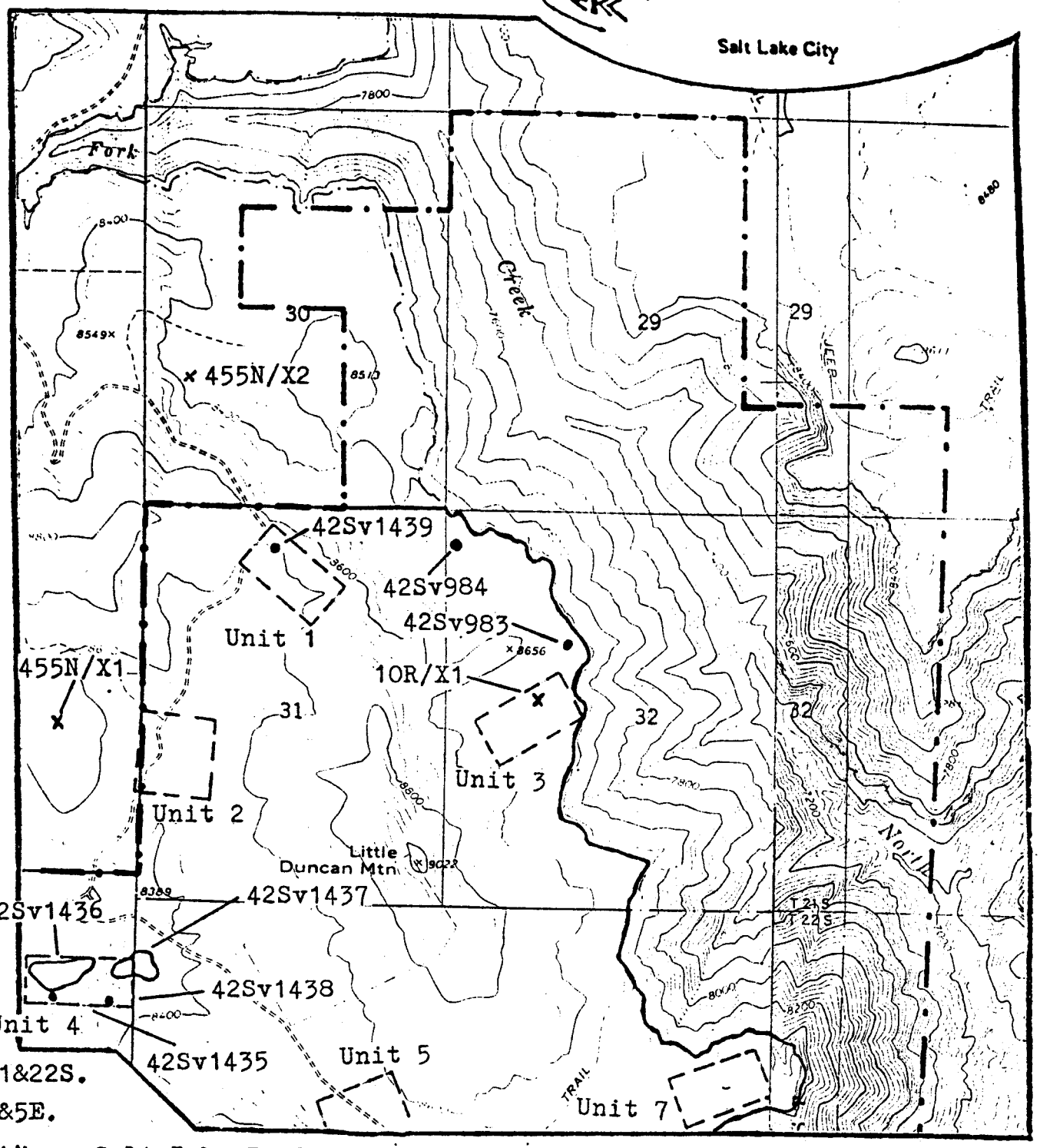
Category No. 42Sv984 Description

Category No.		Description
085	Colluvial ___ Alluvial X Aeolian ___ Residual X Glacial ___ Lacustrine ___	Origin of Soil around site
090	0-1 °	Ground slope of site
092	N S E W NE NW SE SW 360 °	Aspect of site
093	3/4 mi. NNE of Little Duncan Mtn. summit and ca. 100m. So. of Quitchupah rim.	Location of site
094	8,450 ft. old-on site to east	Elevation of site
100	Stream ___ Spring ___ Seep X Other ___	Water resources
101	Distance ___ Direction ___	Distance & direction to nearest water
120		Type of architecture
122	Rooms ___ Pithouses ___ Kivas ___ Other ___ lithic manuf. & possible camp site	Numbers & kinds of structures
130	Limited activity X Habitation ___ Rock Art ___ Water control ___ Storage ___ Other ___	Type of site
135	70m (E-W) x 30m m^2 or ___ ft^2	Size of site
140	Archaic	Cultural classification
143	___ BP ___ AD/BC	Date of site
150	Lithic X Ceramic ___ Bone ___ Other(s) ___ from drainage channel	Kinds of artifacts observed
160	Eroded X Pothunted ___ Undisturbed X Other ___	Condition of site
165	Color ___ B/W X Neg. No.(s) 5	Photographs taken

180 01 Site has Archaic style lithics-biface blade-percussion shaped Remarks
02 blades and points. No collection made but diagnostic artifacts
13 14
03 sketched on site. Site was originally location for a projected
04 coal drill pad-but pad moved ca. 80m. to SW into center of flat.
05 Site will not receive any impact from drilling activity. Site
06 has depth but no indication on surface of charcoal or structures.
07 Site is two components: A is NE of road and on western periphery
08 of a N-S drainage channel; Comp. B is 40m. SW of A & 5m. SW of road.
09 Both components are associated with low dirt hillocks covered
with larger than normal sagebrush.

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21&22S.

R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1

Series: Central Utah

Date: 8-13-80

Figure 3a
Sample Survey Units and Cultural Resources in the Mine Plan Area

Legend:

Sample Unit

Archeological Site

Isolated Artifact

0 .5 1

.5 0 .5 1 Km

N

1

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE

ANTIQUITIES SITE INVENTORY

1 AGENCY NO. 2 STATE NO. 42 5 1 4 5 3

3 PROJECT NAME CSEC-80-1 BLM REPORT ID# 11 14

5 PREHISTORIC X 8 RECORDED BY V. Garth Norman

6 HISTORIC 9 INSTITUTION AERC

7 PALEONTOLOGICAL 10 DATE 7/23/80

11 BLM DISTRICT NO. NA 21 12 BLM RESOURCE AREA NA 22 23

Salt Lake = 2 Cedar City = 4 Vernal = 8
Richfield = 5 Moab = 6

BO = Bonneville, WA = Wasatch, HR = House Range, WS = Warm Spring
SE = Sevier River, HM = Henry Mtns., BR = Beaver River, DX = Dixie
KA = Kanab, ES = Escalante, SJ = San Juan, GR = Grand, PR = Price
SR = San Rafael, DM = Diamond Mountain, BC = Book Cliffs.

13 COUNTY Sevier

14 UTM GRID: ZONE 12 24 25 Easting 464660 26 31 Northing 4395000 32 38

15 LEGAL DESCRIPTION: T. 21 S 39 42 R. 04 E 43 46 Sec. 36 47 48 (10 acre) Qu-Sec. NW 49 50 (40 acre) Qu-Sec. SE 51 52 (160 acre) Qu Sec.

Fill in spaces 43 or 46 only if: 42 Y = Vernal Meridian H = Half Township 46 H = Half Range

16 MAP NAME AND SCALE: Acord Lakes, 7.5 USGS

17 SURFACE OWNER: FS 55 56 LM = BLM FS = USFS ST = State PS = NPS PR = Private OT = Other OTHER:

18 NATIONAL REGISTER POTENTIAL: N 57 S=Significant, N=Nonsignificant Why: CRRS:S-2, Limited cultural remains.

19 MANAGEMENT VALUES: Interpretational Potential X Scientific

20 SITE CONDITION Poor % DESTROYED 80 58

21 AGENT CAUSING IMPACT VA 51 62, 63 64, 65 66
ER = Erosion
VA = Vandalization
PR = Project
OT = Other
NO = No Impact

22 PHOTO TAKEN: Y 67 Y=Yes N=No Color # B/W # 455N-1 (1)

23 RECOMMENDED PROTECTION Avoidance

24 SITE TYPE - CULTURAL RS 68 69, 70 71, 72 73 RA=Rock Art, LA=Limited Activity, ST=Struct RS=Rock Shelter, OT=Other

25 PALEONTOLOGICAL: Invertebrate Vertebrate Flora

26 CULTURAL FEATURES LS 74 75, CS 76 77, GS 78 79, HE 80 81, BS 82 83, SH 84 85, 86 87

LS = Lithic Scatter
CS = Ceramic Scatter
GS = Ground Stone Scatter
HE = Hearth
QU = Quarry
BS = Burned Stone
MD = Midden
DE = Depression
OT = Other

SH = Shelter
RA = Rock Alignment
RM = Rubble Mound
SC = Slab-lined cists
MG = Masonry Granary
MR = Masonry Rooms/Wall
TW = Tower
WC = Water Control
M7 = More than 7 of the above.

PI = Pictog
PE = Petrog
BU = Burial
HS = Historic
MN = Mines
CO = Corral
TR = Trail
GL = Glass

OT = Other

Description: Site consists of a rock shelter in a small alcove.

27 SITE DIMENSIONS: L. 25 EW Ft. w 15NS Ft. Depth

28 DEPTH OF FILL Y 88 Y=Yes N=No U=Undetermined

UT 8100-1 (4/72)

29 CULTURAL PERIOD/AFFILIATION |F|R| (89 90) | | (91 92) | | (93 94) | | (95 96)

PA = Paleo. Indian
AR = Archaic
FR = Fremont
BM = Basketmaker
OT = Other

PU = Pueblo/Anasazi
EA = Euro-American
UP = Ute-Paiute
NA = Navajo
UN = Unknown

OT=Other _____

30 SUB PERIOD = | | | | | | | | | | | | | | | | | | | (97 – 113)

31 ARTIFACTS OBSERVED: Lithic X Ceramic X Bone X Metal __ Charcoal X Glass __

DESCRIPTION Site contains Mano, Metate frag., Hammerstone, Arrow shaft polisher, stone axe sharpening marks, bone awl

32 SURFACE COLLECTED |Y| (114) Y=Yes, N=No,

33 DESCRIPTION OF ARTIFACTS COLLECTED: 3 ceramic sherds

34 CURATORIAL DISPOSITION BYU

35 AVERAGE ARTIFACT DENSITY: 10 Per m^2

36 ENVIRONMENTAL - TOPOGRAPHIC SITUATION

Level Terrain	X	Cave	__	Mesa Top	__	Talus	__
Broken Terrain	__	Slope	__	Cliff Edge	__	Other:	
Canyon Bottom	X	Ridge	__	Overhang	X		
Bench/Terrace	__	Ledge	__	Rim	__		

37 DIRECTION SITE FACES: south Flat X 38 GROUND SLOPE _____

39 ELEVATION OF SITE: |8|3|2|0| (115 – 119) 40 ORIGIN OF SOILS: Alluvial

41 WATER RESOURCES: Stream X Spring __ Seep __ Other __ None __ Perm. __ Inter. __

42 NAME OF WATER SOURCE East Spring Canyon Wash, 30 ft. south

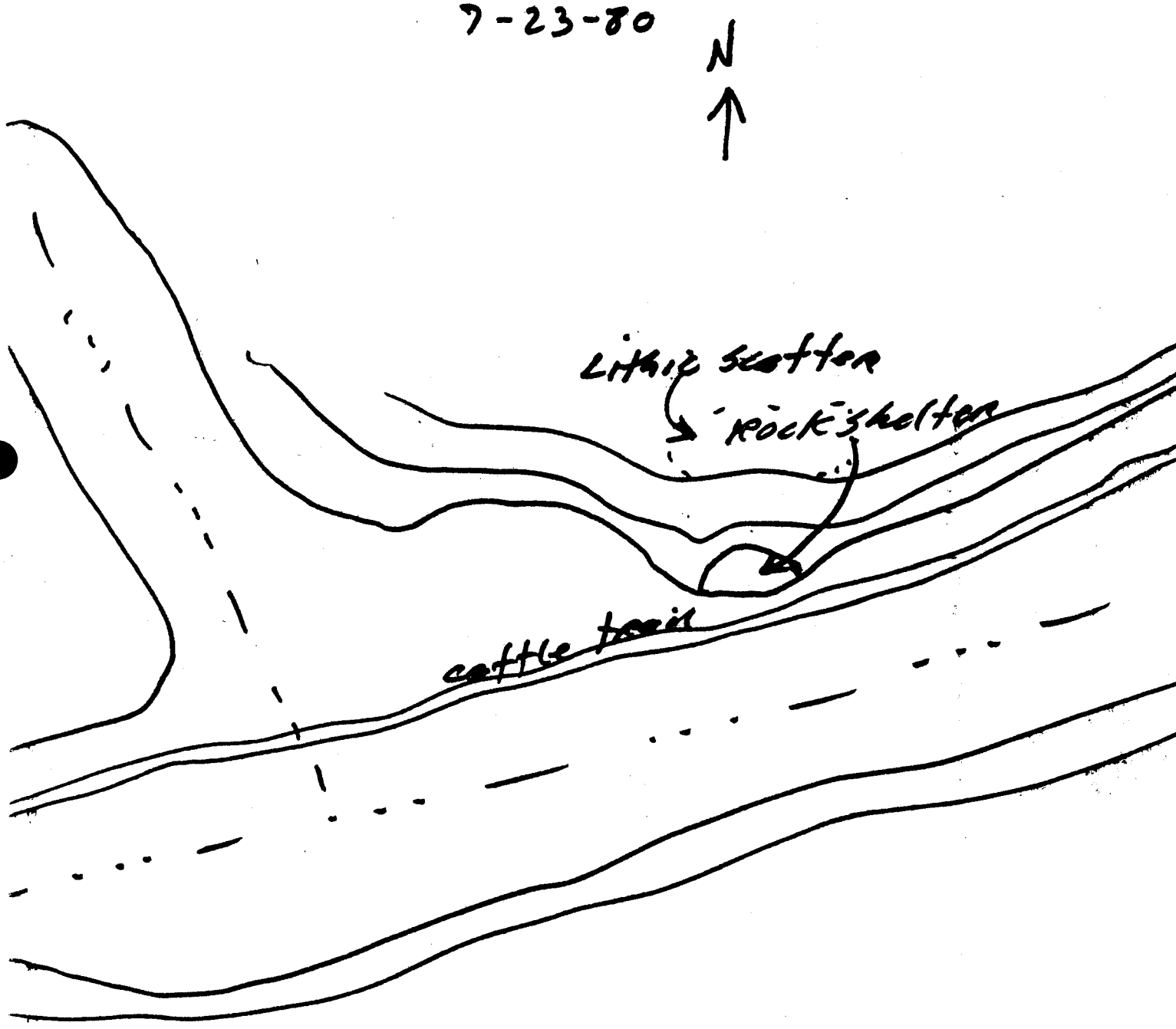
43 VEGETATION ON SITE: |S|m|a|l|l| |S|a|g|e| | (120 – 132) Quaken Aspen, Grasses

44 VEGETATION SURROUNDING SITE: Same, Pine

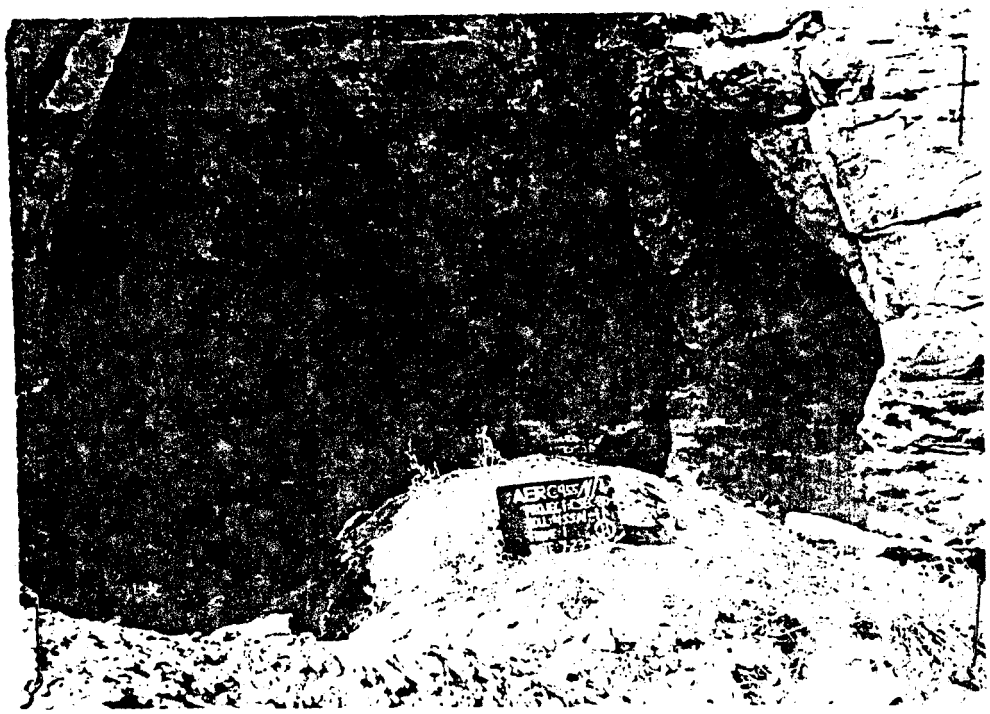
45 DESCRIPTION/REMARKS: The rock shelter is situated in a small alcove facin south. Extensive vandalism has removed soil from the eastern floor area to a depth of 1 to 2 feet. Two large pits 4'X5' and 8'X 5' have dug recently to a depth of 3 and 4 feet at the front of the cliff. No stratigraphy is present.

(Attach sketch map, photos, and xerox of topographic map with T., R., Scale, Quad. nam marked project & survey areas.)

42Sv1435
455 N/1
CSEC-80-1
7-23-80

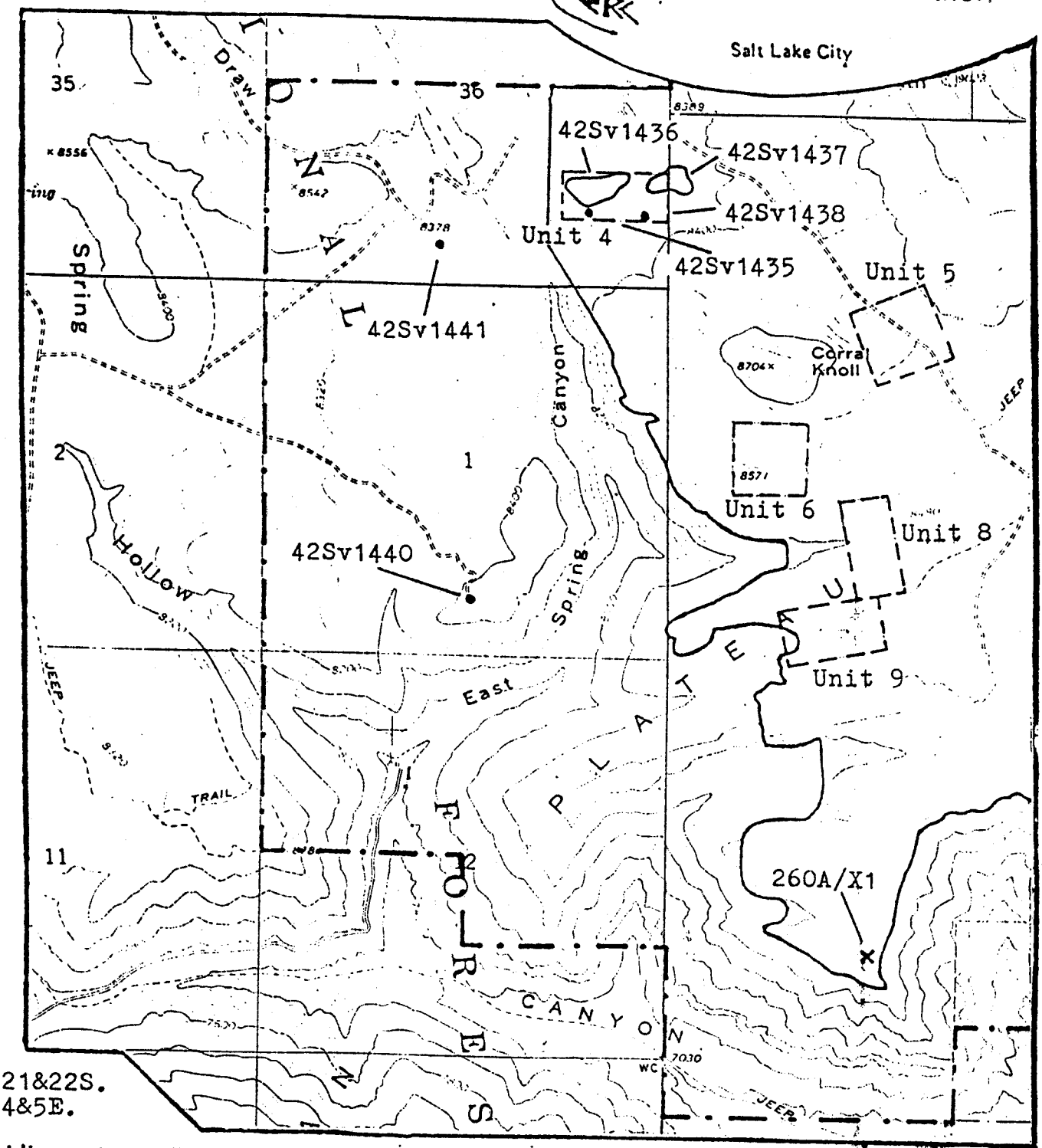


455N/1 42Sv1435
CSEC-80-1 7/23/80



ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21&22S.
R. 4&5E.

Meridian: Salt Lake B. & M.

Project: CSEC 80-1
Series: Central Utah
Date: 8-13-80

Figure 3c
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Quad:
Acord Lakes, Utah
7.5 Minute USGS

Legend:
Sample Unit
Archeological Site
Isolated Artifact

0 .5 1

.5 0 .5 1 Km

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE

ANTIQUITIES SITE INVENTORY

1 AGENCY NO. 455N/2 2 STATE NO. 42SV1436

3 PROJECT NAME CSEC-80-14 BLM REPORT ID# ___-___

5 PREHISTORIC X 8 RECORDED BY V. Garth Norman

6 HISTORIC __ 9 INSTITUTION AERC

7 PALEONTOLOGICAL __ 10 DATE 7/24/80

11 BLM DISTRICT NO. WA 12 BLM RESOURCE AREA WA

Salt Lake = 2 Cedar City = 4 Vernal = 8
Richfield = 5 Moab = 6

BO = Bonneville, WA = Wasatch, HR = House Range, WS = Warm Spring
SE = Sevier River, HM = Henry Mtns., BR = Beaver River, DX = Dixi
KA = Kanab, ES = Escalante, SJ = San Juan, GR = Grand, PR = Price
SR = San Rafael, DM = Diamond Mountain, BC = Book Cliffs.

13 COUNTY Sevier

14 UTM GRID: ZONE 12 Easting 464700 Northing 4309650

15 LEGAL DESCRIPTION: T 21S R 04E Sec. 36 (10 acre) W ½ (40 acre) E ½ (160 acre) Qu Sec.

Fill in spaces 43 or 46 only if: 42 V = Vernal Meridian, H = Half Township; 46 H = Half Range

16 MAP NAME AND SCALE: Acord Lakes, 7.5' USGS

17 SURFACE OWNER: FS LM = BLM, FS = USFS, ST = State, PS = NPS, PR = Private, OT = Other OTHER:

18 NATIONAL REGISTER POTENTIAL: N S=Significant, N=Nonsignificant Why: CRRS:S-3, Site consists of a lithic scatter.

19 MANAGEMENT VALUES: Interpretational Potential X Scientific __

20 SITE CONDITION Good % DESTROYED 50

21 AGENT CAUSING IMPACT VA, ___, ___
ER = Erosion, VA = Vandalization, PR = Project, OT = Other, NO = No Impact

22 PHOTO TAKEN: Y Y=Yes N=No Color # B/W # 455N-1 (2)

23 RECOMMENDED PROTECTION Avoidance

24 SITE TYPE - CULTURAL LA, ___, ___ RA=Rock Art, LA=Limited Activity, ST=Struct. RS=Rock Shelter, OT=Other

25 PALEONTOLOGICAL: Invertebrate __ Vertebrate __ Flora __

26 CULTURAL FEATURES LS, QU, ___, ___, ___, ___, ___

LS = Lithic Scatter, CS = Ceramic Scatter, GS = Ground Stone Scatter, HE = Hearth, QU = Quarry, BS = Burned Stone, MO = Midden, DE = Depression, OT = Other
SH = Shelter, RA = Rock Alignment, RM = Rubble Mound, SC = Slab-lined cists, MG = Masonry Granary, MR = Masonry Rooms/Wall, TW = Tower, WC = Water Control, M7 = More than 7 of the above.
PI = Pictog., PE = Petrog., BL = Burial, HS = Historical, MI = Mines, CO = Corral, TR = Trail, GL = Glass

OT = Other

Description: Site consists of lithics from hunting activity which are sparsely scattered over an extensive area.

27 SITE DIMENSIONS: L. 250 EW (M) Ft. W 100 NS (M) Ft. Depth

28 DEPTH OF FILL N Y=Yes N=No U=Undetermined

UT 8100-1 (4/79)

455N/2 STATE SITE NO. 42

29 CULTURAL PERIOD/AFFILIATION |F|R| (89 90) | | (91 92) | | (93 94) | | (95 96)

PA = Paleo. Indian
AR = Archaic
FR = Fremont
BM = Basketmaker
OT = Other

PU = Pueblo/Anasazi
EA = Euro-American
UP = Ute-Paiute
NA = Navajo
UN = Unknown

OT=Other _____

30 SUB PERIOD = | | | | | | | | | | | | | | | | | (97 – 113)

31 ARTIFACTS OBSERVED: Lithic X Ceramic __ Bone __ Metal __ Charcoal __ Glass

DESCRIPTION Site contains white, red and pink chert primary and seconda flakes, . Limited Quartzite and Mudstone flakes

32 SURFACE COLLECTED |Y| (114) Y=Yes, N=No,

33 DESCRIPTION OF ARTIFACTS COLLECTED: 1 Triangle point, 1 square base Sudden-side not 1 square base point, 3 obsidian flakes 34 CURATORIAL DISPOSITION BYU

35 AVERAGE ARTIFACT DENSITY: concentration of 10 Per m^2

36 ENVIRONMENTAL - TOPOGRAPHIC SITUATION

Level Terrain	X	Cave	__	Mesa Top	__	Talus	__
Broken Terrain	__	Slope	__	Cliff Edge	__	Other:	Plateau
Canyon Bottom	__	Ridge	__	Overhang	__		
Bench/Terrace	__	Ledge	__	Rim	__		

37 DIRECTION SITE FACES: _____ Flat X 38 GROUND SLOPE _____

39 ELEVATION OF SITE: |8|4|0|0| (115 – 119) 40 ORIGIN OF SOILS: Residual, Aeoli

41 WATER RESOURCES: Stream X Spring __ Seep __ Other __ None __ Perm. __ Inter.

42 NAME OF WATER SOURCE East Spring Canyon Wash

43 VEGETATION ON SITE: |S|m|a|l|l| |S|a|g|e| | (120 – 132) Grasses

44 VEGETATION SURROUNDING SITE: Pine, Aspen

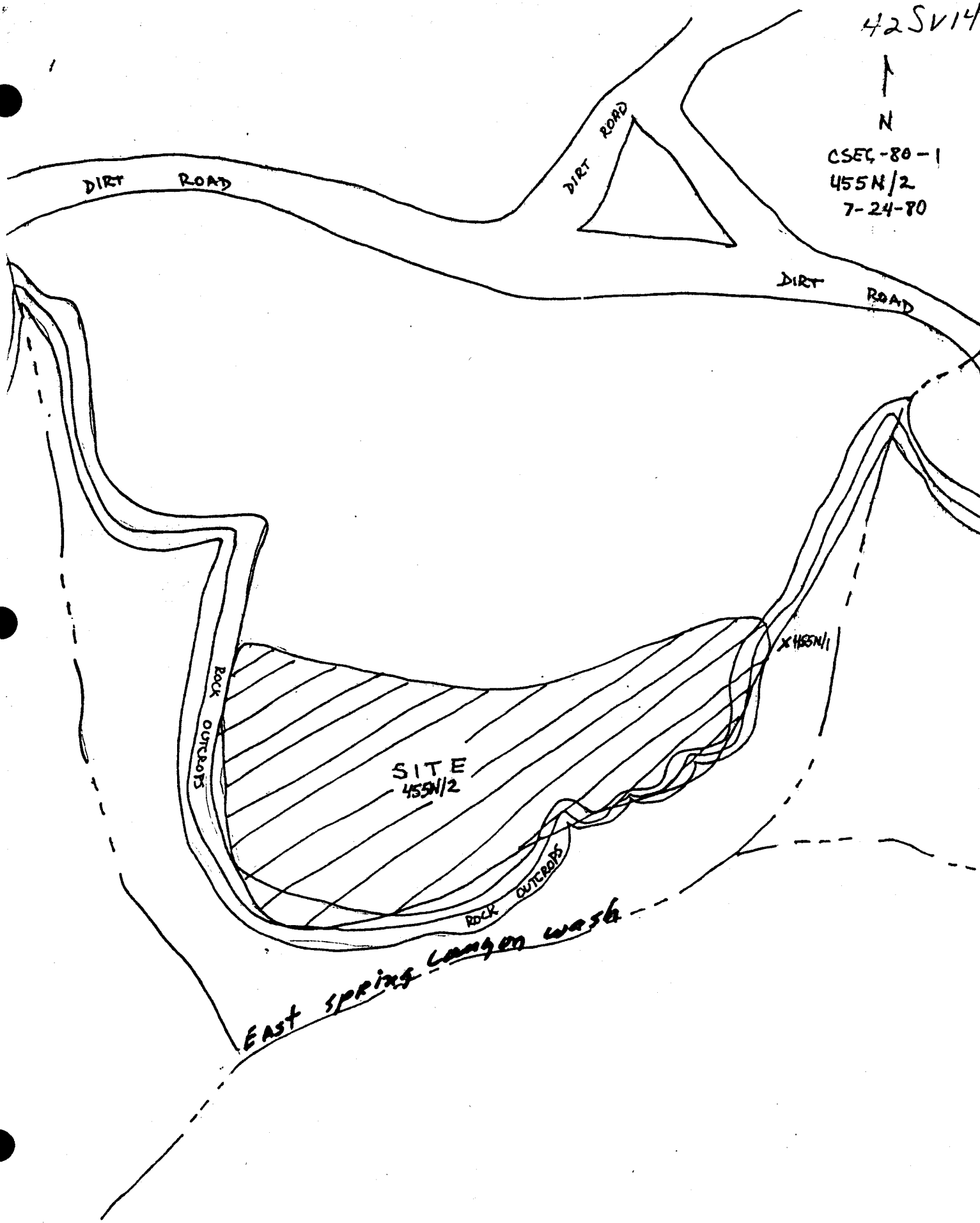
45 DESCRIPTION/REMARKS: The site has been extensively vandalized with piles 15 to 20 flakes of varied types discarded throughout the site area. The location served as a hunting station along a game trail through East Spring Canyon Wash, which terminates in this area. Chert stones are scattered along the slope directly north of the site and may have been collected and worked on the site.

(Attach sketch map, photos, and xerox of topographic map with T., R., Scale, Quad. nar marked project & survey areas.)

42SV14

N

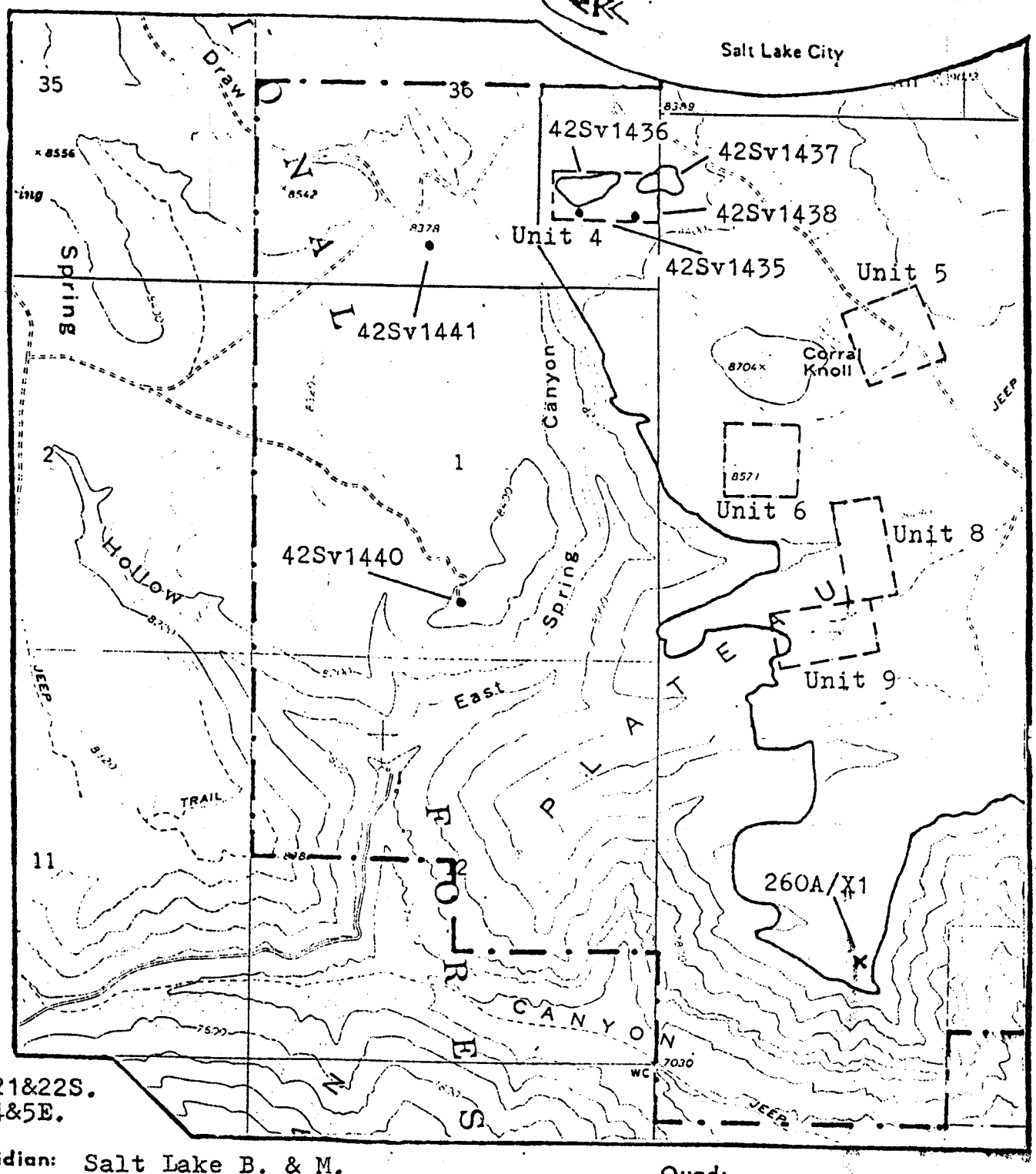
CSEC-80-1
455N/2
7-24-80



455N/2 42Sv1436

CSEC-80-1 7/24/80

ARCHEOLOGICAL-ENVIRONMENTAL
RESEARCH CORPORATION



T. 21&22S.
R. 4&5E.

Meridian: Salt Lake B. & M.

Project: CSEC 80-1
Series: Central Utah
Date: 8-13-80

Figure 3c
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Quad:
Acord Lakes, Utah
7.5 Minute USGS

Legend:
Sample Unit
Archeological Site
Isolated Artifact x

0 .5 1
.5 0 .5 1 Km

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE

ANTIQUITIES SITE INVENTORY

1 AGENCY NO. 455N/3 2 STATE NO. 42SW1437

3 PROJECT NAME CSEC-80-1 4 BLM REPORT ID# ___-___

5 PREHISTORIC X 8 RECORDED BY V. Garth Norman

6 HISTORIC __ 9 INSTITUTION AERC

7 PALEONTOLOGICAL __ 10 DATE 7/24/80

11 BLM DISTRICT NO. WA 12 BLM RESOURCE AREA NA

Salt Lake = 2 Cedar City = 4 Vernal = 8
Richfield = 5 Moab = 6

BO = Bonneville, WA = Wasatch, HR = House Range, WS = Warm Spring
SE = Sevier River, HM = Henry Mtns., BR = Beaver River, DX = Dixi
KA = Kanab, ES = Escalante, SJ = San Juan, GR = Grand, PR = Price
SR = San Rafael, DM = Diamond Mountain, BC = Book Cliffs.

13 COUNTY Sevier

14 UTM GRID: ZONE 12 Easting 464900 Northing 4309610

15 LEGAL DESCRIPTION: T 21 S R 04E Sec. 36 (10 acre) Qu-Sec. SE (40 acre) Qu-Sec. NE (160 acre) Qu Sec. S
Fill in spaces 43 or 46 only if: 42 V = Vernal Meridian, H = Half Township; 46 H = Half Range
and Township 22 South, Range 5 East, Sec. 6, SW, NW, SW

16 MAP NAME AND SCALE: Acord Lakes, 7.5' USGS

17 SURFACE OWNER: FS LM = BLM, FS = USFS, ST = State, PS = NPS, PR = Private, OT = Other OTHER:

18 NATIONAL REGISTER POTENTIAL: N S=Significant, N=Nonsignificant Why: CRRS:S-3, limited lithic and ceramic remains.

19 MANAGEMENT VALUES: Interpretational Potential __ Scientific X

20 SITE CONDITION Poor % DESTROYED 60

21 AGENT CAUSING IMPACT ER, VA, ? ER = Erosion, VA = Vandalization, PR = Project, OT = Other, NO = No Impact

22 PHOTO TAKEN: Y=Yes N=No Color # B/W # 455N-1 (3)

23 RECOMMENDED PROTECTION Avoidance

24 SITE TYPE - CULTURAL LA, ___, ___ RA=Rock Art, LA=Limited Activity, ST=Structure, RS=Rock Shelter, OT=Other

25 PALEONTOLOGICAL: Invertebrate __ Vertebrate __ Flora __

26 CULTURAL FEATURES LS, CS, ___, ___, ___, ___, ___

LS = Lithic Scatter, CS = Ceramic Scatter, GS = Ground Stone Scatter, HE = Hearth, QU = Quarry, BS = Burned Stone, MD = Midden, DE = Depression, OT = Other
SH = Shelter, RA = Rock Alignment, RM = Rubble Mound, SC = Slab-lined cists, MG = Masonry Granary, MR = Masonry Rooms/Wall, TW = Tower, WC = Water Control, M7 = More than 7 of the above.
PI = Pictograph, PE = Petroglyph, BU = Burial, HS = Historical, MN = Mines, CO = Corral, TR = Trail, GL = Glass

OT = Other

Description: Flakes are scattered across the level area of a ridge on a point overlooking two draws at the head of East Spring Canyon Wash.

27 SITE DIMENSIONS: L. 150 EW ~~Ft.~~ M W 50 NS ~~Ft.~~ M Depth

28 DEPTH OF FILL N Y=Yes N=No U=Undetermined

UT 8100-1 (4/77)

455N/3 STATE SITE NO. 42Sv14

29 CULTURAL PERIOD/AFFILIATION |F|R| | | | | | | (89 90, 91 92, 93 94, 95 96)

PA = Paleo. Indian, AR = Archaic, FR = Fremont, BM = Basketmaker, OT = Other, PU = Pueble/Anasazi, EA = Euro-American, UP = Ute-Paiute, NA = Navajo, UN = Unknown

OT=Other _____

30 SUB PERIOD = | | | | | | | | | | | | | | | | | (97 – 113)

31 ARTIFACTS OBSERVED: Lithic X Ceramic X Bone __ Metal __ Charcoal __ Glass

DESCRIPTION Site contains mostly white chert secondary and tertiary flake

32 SURFACE COLLECTED |Y| (114) Y=Yes, N=No,

33 DESCRIPTION OF ARTIFACTS COLLECTED: 3 sherds, 1 point tip, 1 point mid-sect

1 Gypsum point

34 CURATORIAL DISPOSITION BYU

35 AVERAGE ARTIFACT DENSITY: _____ 2 Per m2

36 ENVIRONMENTAL - TOPOGRAPHIC SITUATION

Level Terrain	X	Cave	__	Mesa Top	__	Talus	__
Broken Terrain	__	Slope	__	Cliff Edge	__	Other:	
Canyon Bottom	__	Ridge	X	Overhang	__		
Bench/Terrace	__	Ledge	__	Rim	__		

37 DIRECTION SITE FACES: _____ Flat X 38 GROUND SLOPE _____

39 ELEVATION OF SITE: |8|4|0|0| (115 – 119) 40 ORIGIN OF SOILS: Residual

41 WATER RESOURCES: Stream X Spring __ Seep __ Other __ None __ Perm. __ Inter.

42 NAME OF WATER SOURCE East Spring Canyon Wash

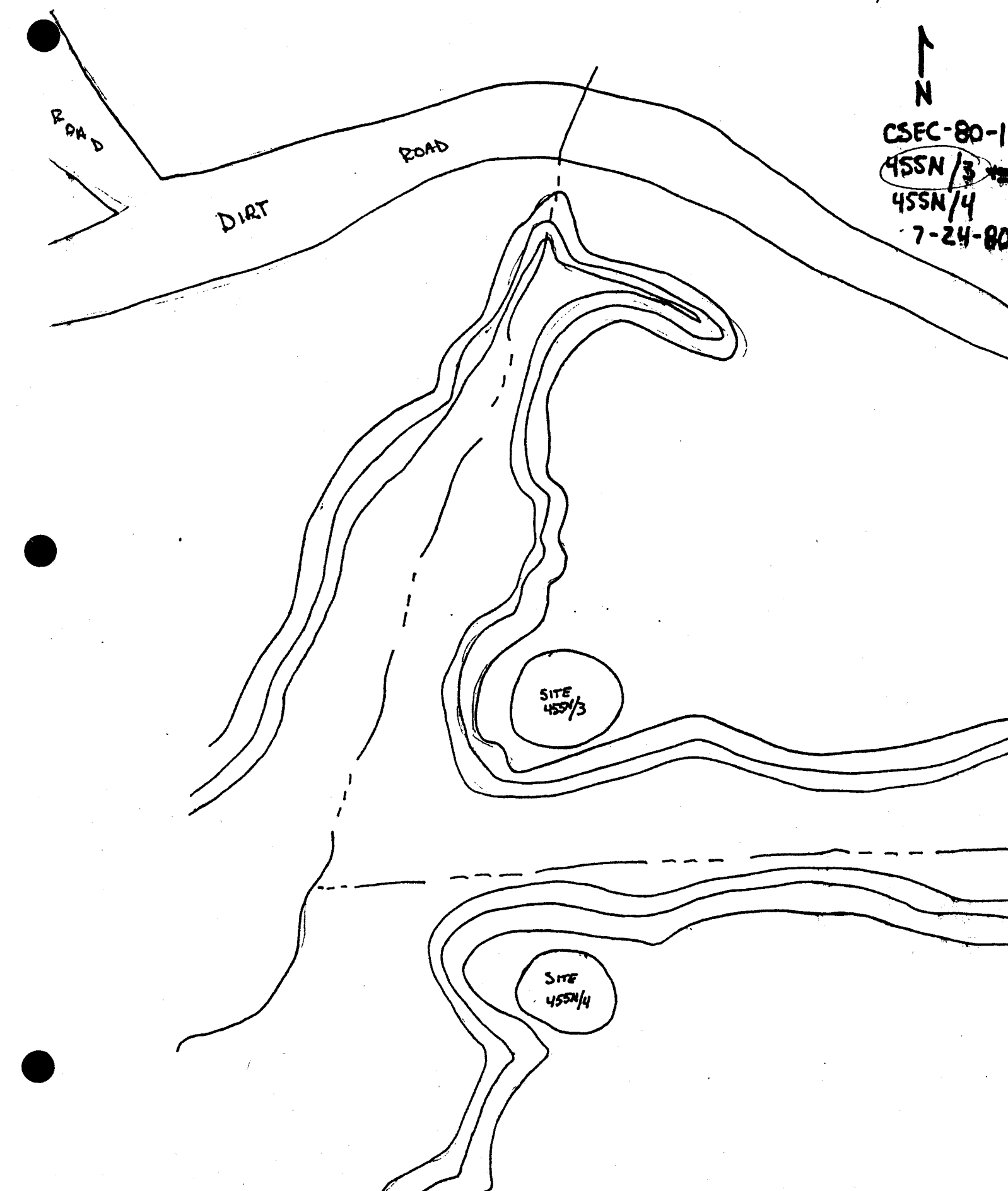
43 VEGETATION ON SITE: |S|m|a|l|l| |Sa|g|e| | | (120 – 132) Grasses

44 VEGETATION SURROUNDING SITE: Pine, Aspen

45 DESCRIPTION/REMARKS: The site may have been vandalized from modern camping activity in the area. The site was a hunting station, strategically located by game trails in adjacent washes, occasional ceramic sherds suggest the possibility of temporary camping as well.

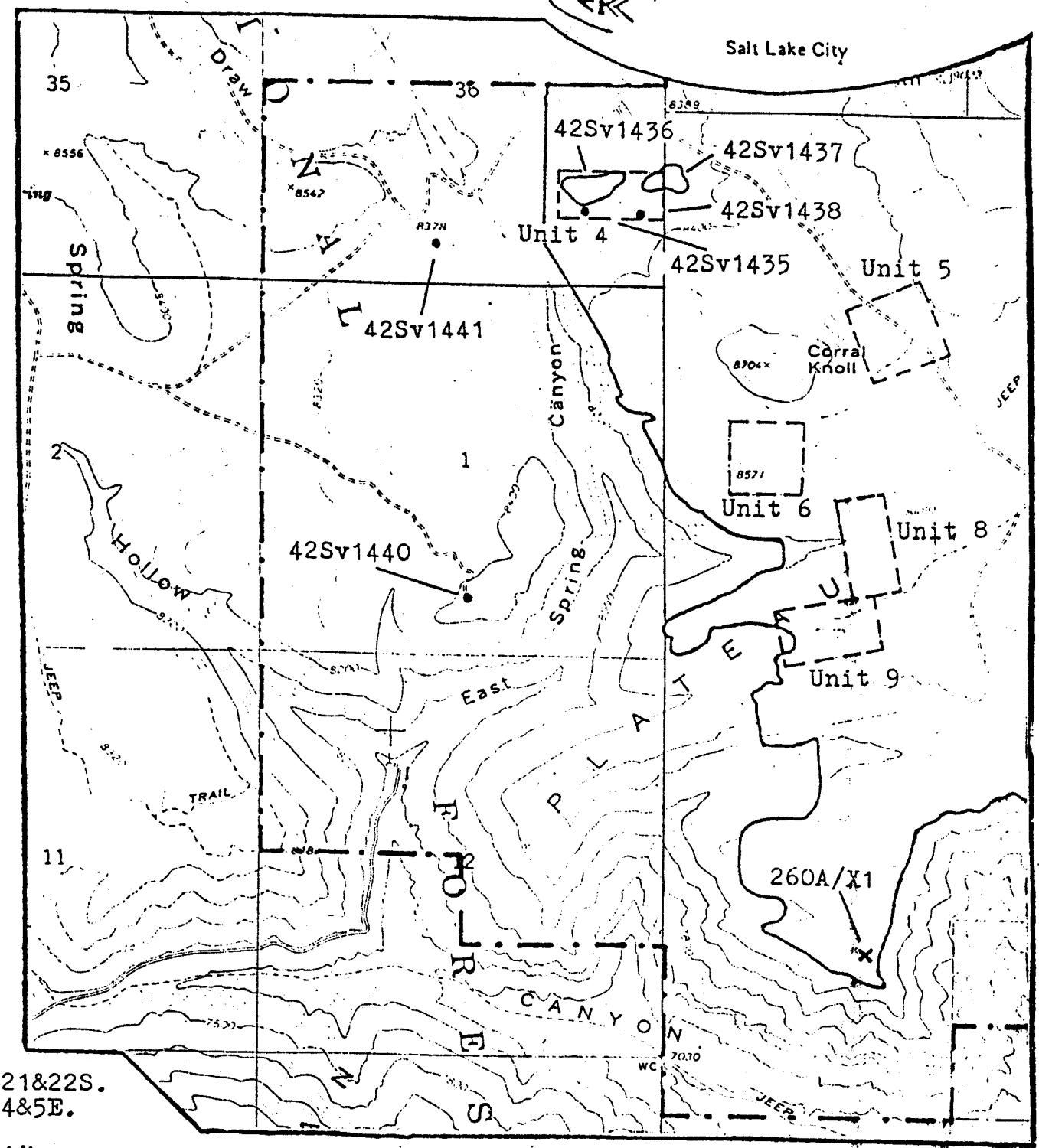
(Attach sketch map, photos, and xerox of topographic map with T., R., Scale, Quad. nar marked project & survey areas.)

42SV143


N
CSEC-80-1
455N/3
455N/4
7-24-80
ROAD
DIRT
ROAD
SITE 455N/3
SITE 455N/4

455N/3 42Sv1437
CSEC-80-1 7/24/80

ARCHEOLOGICAL-ENVIRONMENTAL
RESEARCH CORPORATION



T. 21&22S.
R. 4&5E.

Meridian: Salt Lake B. & M.

Project: CSEC 80-1
Series: Central Utah
Date: 8-13-80

Figure 3c
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Quad:
Acord Lakes, Utah
7.5 Minute USGS

Legend:
Sample Unit
Archeological Site
Isolated Artifact

0 .5 1
.5 0 .5 1 Km

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE

ANTIQUITIES SITE INVENTORY

1 AGENCY NO. 455N/4 2 STATE NO. 42SV1488

3 PROJECT NAME CSEC-80-1 4 BLM REPORT ID# (11–14)

5 PREHISTORIC X 8 RECORDED BY V. Garth Norman

6 HISTORIC __ 9 INSTITUTION AERC

7 PALEONTOLOGICAL __ 10 DATE 7/24/80

11 BLM DISTRICT NO. NA (21) 12 BLM RESOURCE AREA NA (22 23)

Salt Lake = 2 Cedar City = 4 Vernal = 8
Richfield = 5 Moab = 6

BO = Bonneville, WA = Wasatch, HR = House Range, WS = Warm Sprin
SE = Sevier River, HM = Henry Mtns., BR = Beaver River, DX = Dix
KA = Kanab, ES = Escalante, SJ = San Juan, GR = Grand, PR = Pric
SR = San Rafael, DM = Diamond Mountain, BC = Book Cliffs.

13 COUNTY Sevier

14 UTM GRID: ZONE 12 (24 25) Easting 464880 (26–31) Northing 4309470 (32–38)

15 LEGAL DESCRIPTION: T. 21S (39–42) R. 04E (43–46) Sec. 36 (47 48) (10 acre) Qu-Sec NE (49 50) (40 acre) Qu-Sec. SE (51 52) (160 acre Qu Sec.

Fill in spaces 43 or 46 only if: 42 Y = Vernal Meridian, X = Half Township; 45 H = Half Range

16 MAP NAME AND SCALE: Acord Lakes, 7.5' USGS

17 SURFACE OWNER: FS (55 56) LM = BLM, FS = USFS, ST = State, PS = NPS, PR = Private, OT = Other OTHER:

18 NATIONAL REGISTER POTENTIAL: N (57) S=Significant, N=Nonsignificant Why: CRRS:S-3, limited lithic and ceramic remains.

19 MANAGEMENT VALUES: Interpretational Potential __ Scientific X

20 SITE CONDITION Poor % DESTROYED 60 (58)

21 AGENT CAUSING IMPACT ER (51 62), VA (63 64), ? (65 66)
ER = Erosion, VA = Vandalization, PR = Project, OT = Other, NO = No Impact

22 PHOTO TAKEN: Y (67) Y=Yes N=No Color # B/W # 455N-1 (4)

23 RECOMMENDED PROTECTION Avoidance

24 SITE TYPE - CULTURAL LA (68 69), __ (70 71), __ (72 73) RA=Rock Art, LA=Limited Activity, ST=Struct RS=Rock Shelter, OT=Other

25 PALEONTOLOGICAL: Invertebrate __ Vertebrate __ Flora __

26 CULTURAL FEATURES LS (74 75), CS (76 77), __ (78 79), __ (80 81), __ (82 83), __ (84 85), __ (86 87)

LS = Lithic Scatter, CS = Ceramic Scatter, GS = Ground Stone Scatter, HE = Hearth, QU = Quarry, BS = Burned Stone, MO = Midden, DE = Depression, OT = Other
SH = Shelter, RA = Rock Alignment, RM = Rubble Mound, SC = Slab-lined cists, MG = Masonry Granary, MR = Masonry Rooms/Wall, TW = Tower, WC = Water Control, M7 = More than 7 of the above.
PI = Pictog, PE = Petrog, BU = Burial, HS = Historic, MM = Mines, CO = Corral, TR = Trail, GL = Glass

OT = Other

Description: Site consists of flakes scattered sparsely across the flat ridge top of a point.

27 SITE DIMENSIONS: L. 60 EW Ft. (M) W 20 NS Ft. (M) Depth

28 DEPTH OF FILL N (88) Y=Yes N=No U=Undetermined

UT 8100-1 (4/79)

455N/4 STATE SITE NO. 42Sv14

29 CULTURAL PERIOD/AFFILIATION |F|R| (89 90) | | (91 92) | | (93 94) | | (95 96)

PA = Paleo. Indian, AR = Archaic, FR = Fremont, BM = Basketmaker, OT = Other, PU = Pueblo/Anasazi, EA = Euro-American, UP = Ute-Paiute, NA = Navajo, UN = Unknown

OT=Other _____

30 SUB PERIOD = | | | | | | | | | | | | | | | | (97–113)

31 ARTIFACTS OBSERVED: Lithic X Ceramic X Bone __ Metal __ Charcoal __ Glass

DESCRIPTION Site contains mostly white chert secondary and tertiary flakes

32 SURFACE COLLECTED |Y| (114) Y=Yes, N=No,

33 DESCRIPTION OF ARTIFACTS COLLECTED: 2 points; one stemmed tonged; and one side notch.

34 CURATORIAL DISPOSITION BYU

35 AVERAGE ARTIFACT DENSITY: 1 Per m^2

36 ENVIRONMENTAL - TOPOGRAPHIC SITUATION

Level Terrain	X	Cave	__	Mesa Top	__	Talus	__
Broken Terrain	__	Slope	__	Cliff Edge	__	Other:	
Canyon Bottom	__	Ridge	X	Overhang	__		
Bench/Terrace	__	Ledge	__	Rim	__		

37 DIRECTION SITE FACES: West Flat __ 38 GROUND SLOPE _____

39 ELEVATION OF SITE: |8|4|b|b| (115–119) 40 ORIGIN OF SOILS: Residual

41 WATER RESOURCES: Stream X Spring __ Seep __ Other __ None __ Perm. __ Inter.

42 NAME OF WATER SOURCE East Spring Canyon Wash

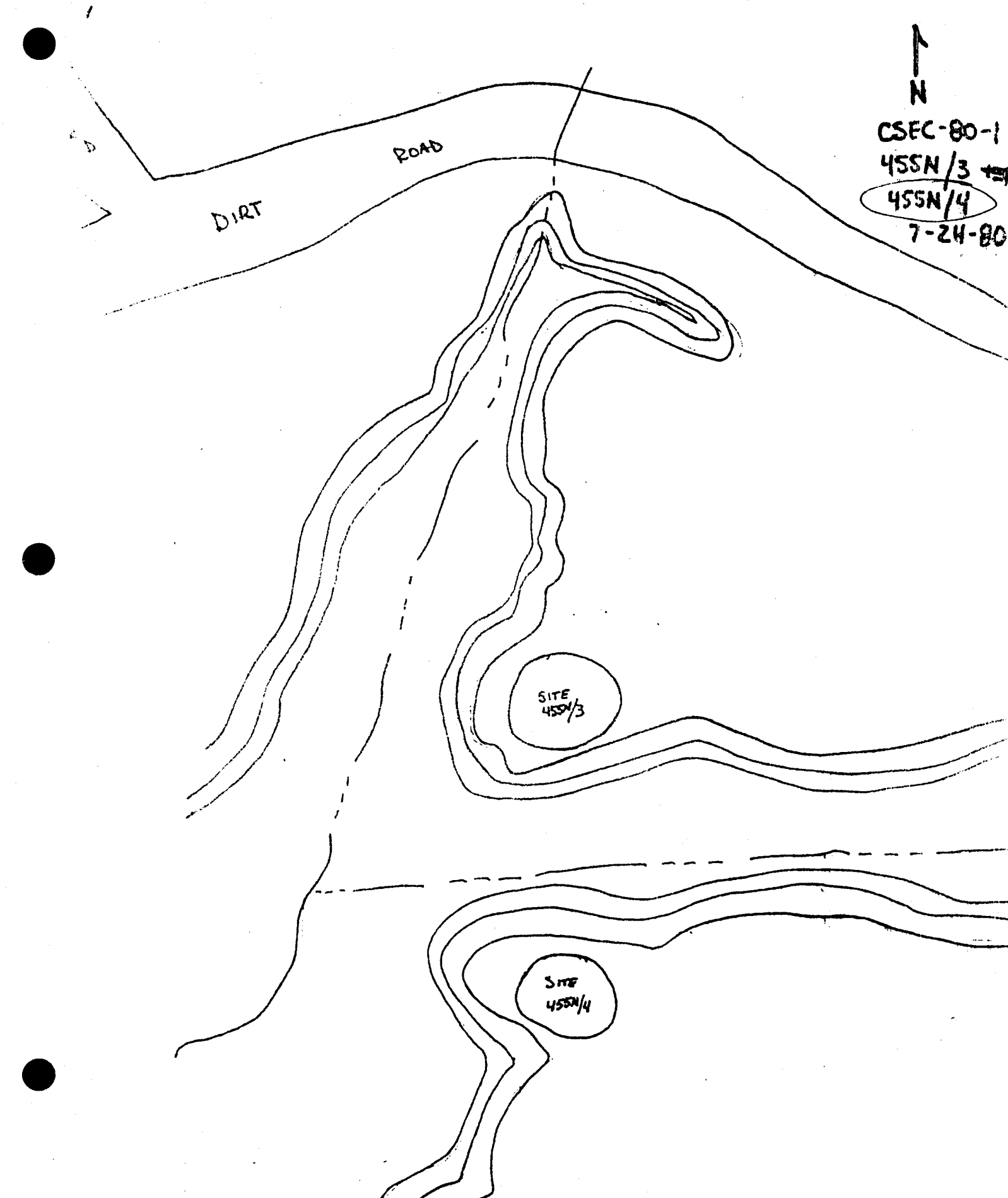
43 VEGETATION ON SITE: |S|m|all|l| |S|a|g|e| | | (120–132) Grasses

44 VEGETATION SURROUNDING SITE: Pine, Aspen

45 DESCRIPTION/REMARKS: The site functioned as a hunting station and is strategically located on a point overlooking washes that functioned as game trails.

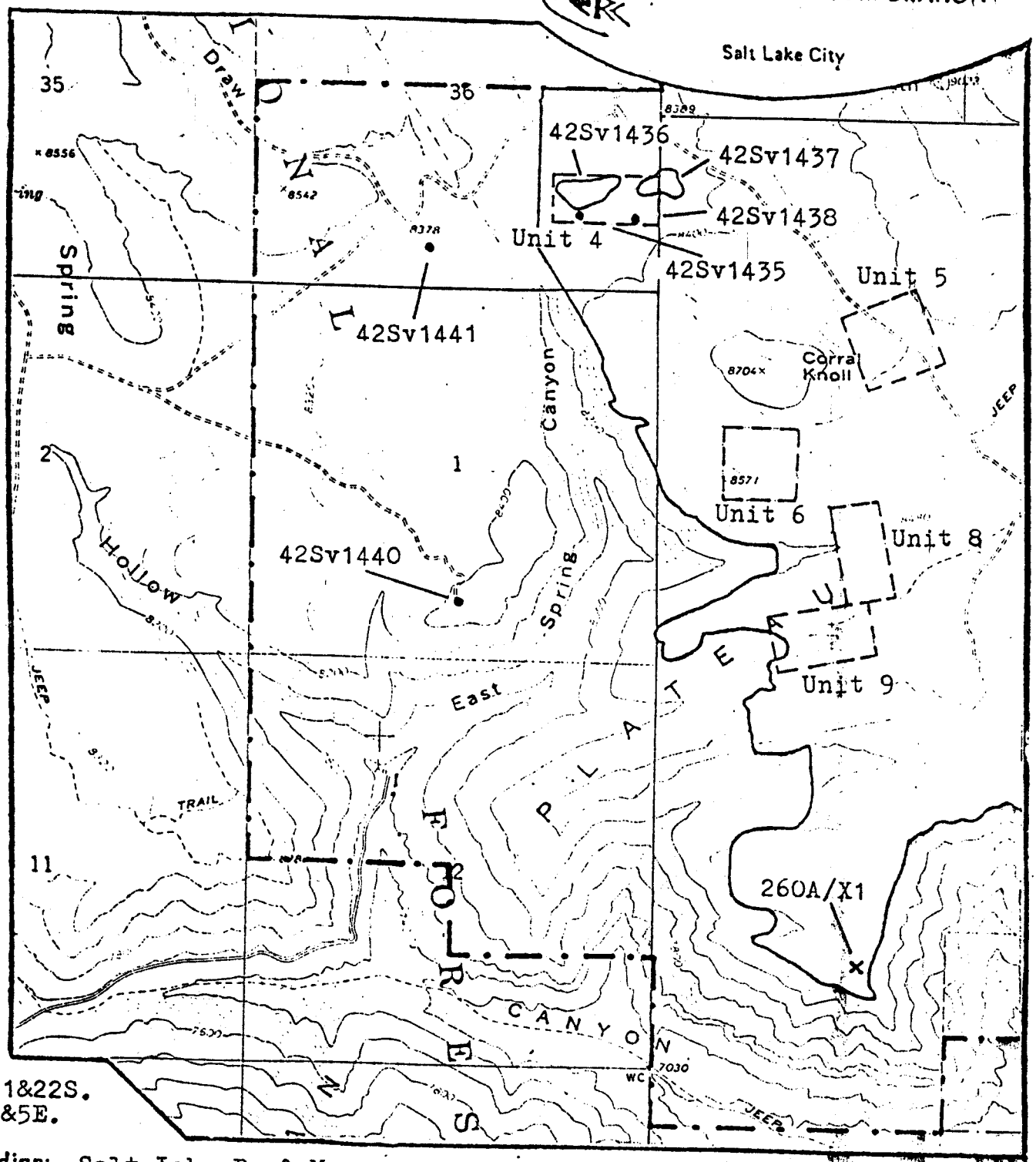
(Attach sketch map, photo
marked project & survey a

42SV1438



ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21&22S.
R. 4&5E.

Meridian: Salt Lake B. & M.

Project: CSEC 80-1
Series: Central Utah
Date: 8-13-80

Figure 3c
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Quad:
Acord Lakes, Utah
7.5 Minute USGS

Legend:
Sample Unit
Archeological Site
Isolated Artifact

0 .5 1

.5 0 .5 1 Km

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE

ANTIQUITIES SITE INVENTORY

1 AGENCY NO. 455N/5 2 STATE NO. 42SW1439

3 PROJECT NAME SEC-80-14 BLM REPORT ID# (11–14)

5 PREHISTORIC X 8 RECORDED BY V. Garth Norman

6 HISTORIC __ 9 INSTITUTION AERC

7 PALEONTOLOGICAL __ 10 DATE 7/24/80

11 BLM DISTRICT NO. NA (21) 12 BLM RESOURCE AREA NA (22 23)

Salt Lake = 2 Cedar City = 4 Vernal = 8
Richfield = 5 Moab = 6

BO = Bonneville, WA = Wasatch, HR = House Range, WS = Warm Spring
SE = Sevier River, HM = Henry Mtns., BR = Beaver River, DX = Dixi
KA = Kanab, ES = Escalante, SJ = San Juan, GR = Grand, PR = Pric
SR = San Rafael, DM = Diamond Mountain, BC = Book Cliffs.

13 COUNTY Sevier

14 UTM GRID: ZONE 12 (24 25) Easting 465650 (26–31) Northing 4311300 (32–38)

15 LEGAL DESCRIPTION: T 21 S (39–42) R 05E (43–46) Sec. 31 (47 48) (10 acre) Qu-Sec. NW (49 50) (40 acre) Qu-Sec. NW (51 52) (160 acre) Qu Sec. center

Fill in spaces 43 or 46 only if: 42 Y = Vernal Meridian, H = Half Township; 46 H = Half Range

16 MAP NAME AND SCALE: Acord Lakes, 7.5' USGS

17 SURFACE OWNER: FS (55 56) LM = BLM, FS = USFS, ST = State, PS = NPS, PR = Private, OT = Other OTHER:

18 NATIONAL REGISTER POTENTIAL: N (57) S=Significant, N=Nonsignificant Why: CRRS:S-4, non-diagnostic lithics

19 MANAGEMENT VALUES: Interpretational Potential X Scientific __

20 SITE CONDITION Poor % DESTROYED 50 (58)

21 AGENT CAUSING IMPACT ER (51 62), __ (63 64), __ (65 66)
ER = Erosion, VA = Vandalization, PR = Project, OT = Other, NO = No Impact

22 PHOTO TAKEN: Y (67) Y=Yes N=No Color # B/W # 455N-1(5)

23 RECOMMENDED PROTECTION Avoidance

24 SITE TYPE - CULTURAL LA (68 69), __ (70 71), __ (72 73) RA=Rock Art, LA=Limited Activity, ST=Struct RS=Rock Shelter, OT=Other

25 PALEONTOLOGICAL: Invertebrate __ Vertebrate __ Flora __

26 CULTURAL FEATURES LS (74 75), __ (76 77), __ (78 79), __ (80 81), __ (82 83), __ (84 85), __ (86 87)

LS = Lithic Scatter, CS = Ceramic Scatter, GS = Ground Stone Scatter, HE = Hearth, QU = Quarry, BS = Burned Stone, MD = Midden, DE = Depression, OT = Other
SH = Shelter, RA = Rock Alignment, RM = Rubble Mound, SC = Slab-lined cists, MG = Masonry Granary, MR = Masonry Rooms/Wall, TW = Tower, WC = Water Control, M7 = More than 7 of the above.
PI = Pictog, PE = Petrog, BU = Burial, HS = Historic, MN = Mines, CO = Corral, TR = Trail, GL = Glass

OT = Other

Description: Lithics are located on a saddle between Duncan Mountain, and Little Duncan Mountain.

27 SITE DIMENSIONS: L. 10 NS M Ft. W 6 EW M Ft. Depth

28 DEPTH OF FILL N (88) Y=Yes N=No U=Undetermined

UT 8100-1 (4/79)

29 CULTURAL PERIOD/AFFILIATION |U|N| (89 90) | | (91 92) | | (93 94) | | (95 96)

PA = Paleo. Indian
AR = Archaic
FR = Fremont
BM = Basketmaker
OT = Other
PU = Pueblo/Anasazi
EA = Euro-American
UP = Ute-Paiute
NA = Navajo
UN = Unknown

OT=Other _____

30 SUB PERIOD = | | | | | | | | | | | | | | | | | (97–113)

31 ARTIFACTS OBSERVED: Lithic X Ceramic __ Bone __ Metal __ Charcoal __ Glass

DESCRIPTION Site contains 1 biface scraper, and 1 retouched primary flake scraper, chert and quartzite secondary flakes.

32 SURFACE COLLECTED |N| (114) Y=Yes, N=No,

33 DESCRIPTION OF ARTIFACTS COLLECTED: NA

34 CURATORIAL DISPOSITION NA

35 AVERAGE ARTIFACT DENSITY: 2 to 5 Per $2m^2$

36 ENVIRONMENTAL - TOPOGRAPHIC SITUATION

Level Terrain	__	Cave	__	Mesa Top	__	Talus	__
Broken Terrain	__	Slope	X	Cliff Edge	__	Other:	
Canyon Bottom	__	Ridge	__	Overhang	__		
Bench/Terrace	X	Ledge	__	Rim	__		

37 DIRECTION SITE FACES: south Flat __ 38 GROUND SLOPE 15°

39 ELEVATION OF SITE: |8|6|0|0| (115–119) 40 ORIGIN OF SOILS: Aeolian

41 WATER RESOURCES: Stream __ Spring __ Seep __ Other __ None __ Perm. __ Inter.

42 NAME OF WATER SOURCE Unnamed

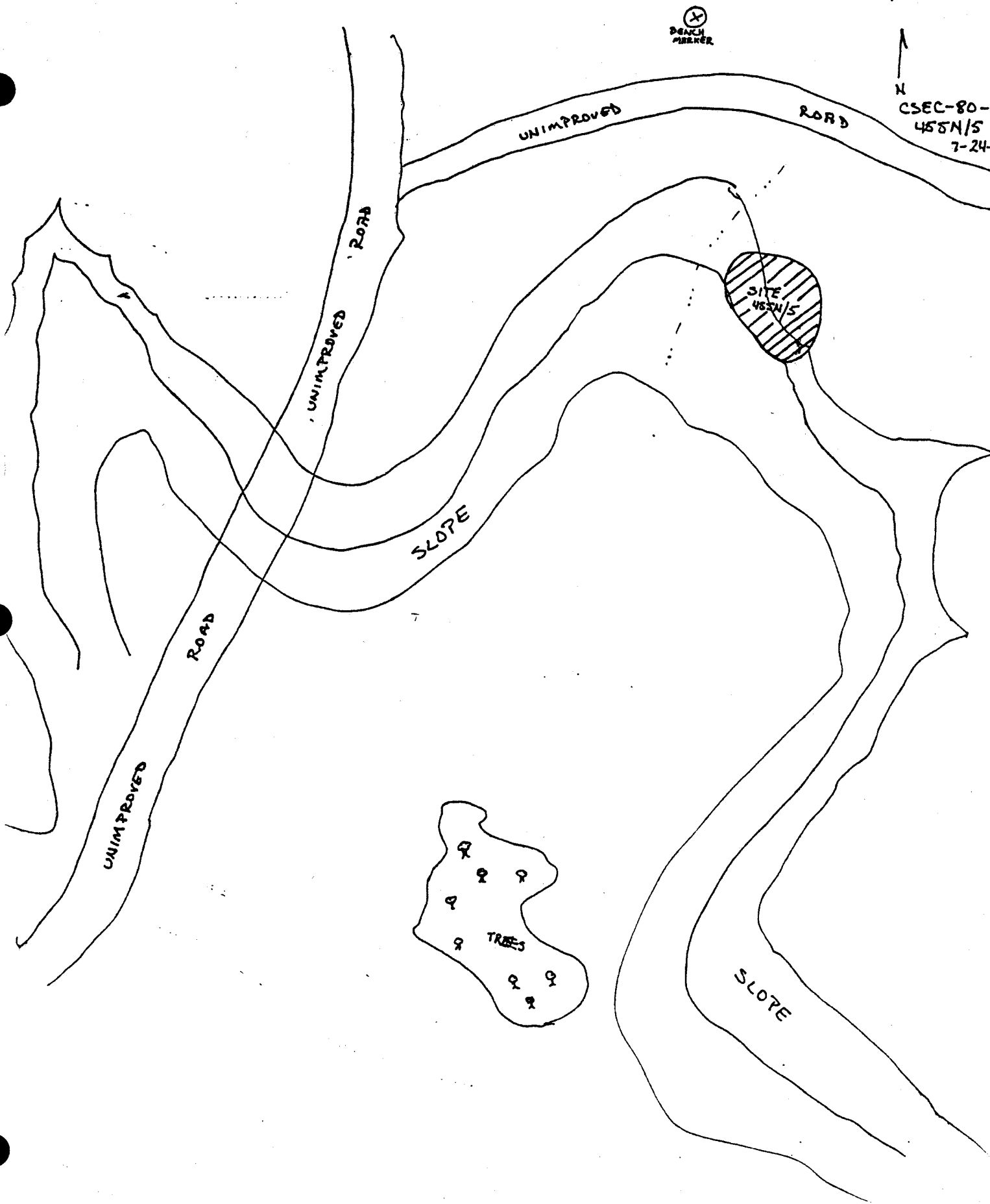
43 VEGETATION ON SITE: |S|m|a|l|l| |S|age| | | | (120–132) Grasses

44 VEGETATION SURROUNDING SITE: Same

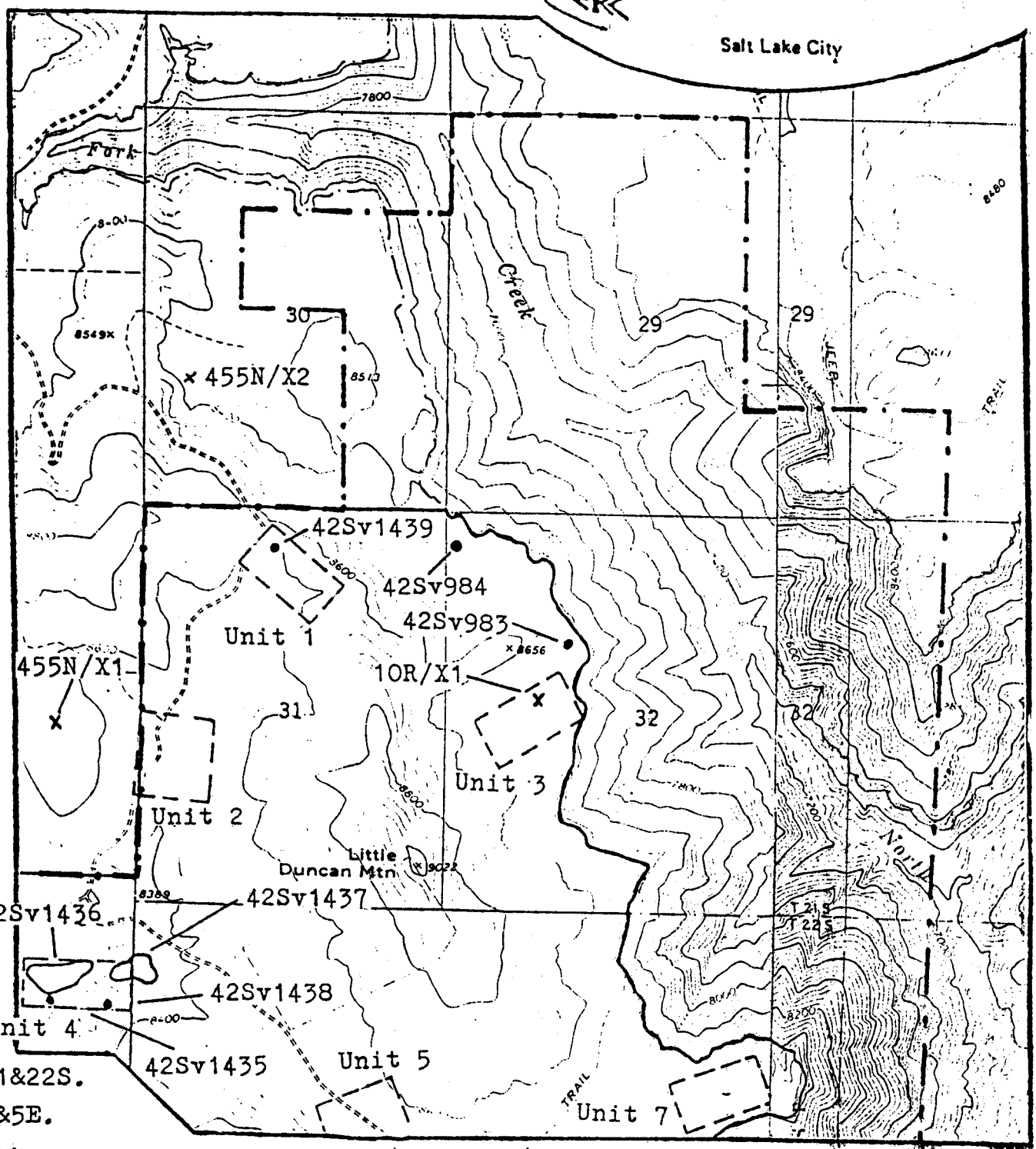
45 DESCRIPTION/REMARKS: The site is evidently a kill-butcher site. The lithics are in a shallow wash. Erosion could cover other lithics. The location is at the head of the upper tributary of Spring Canyon.

(Attach sketch map, ... quad. nam
marked project & su...

42SV14


BENCH MARKER
N
CSEC-80-
455N/5
7-24-
UNIMPROVED
ROAD
UNIMPROVED
ROAD
SITE
455N/5
SLOPE
UNIMPROVED
ROAD
TREES
SLOPE

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION



T. 21&22S.

R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: CSEC-80-1

Series: Central Utah

Date: 8-13-80

Figure 3a
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Legend:

Sample Unit

Archeological Site

Isolated Artifact

0 .5 1

.5 0 .5 1 Km

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
UTAH STATE OFFICE

ANTIQUITIES SITE INVENTORY

1 AGENCY NO. 455N/6 2 STATE NO. 1

3 PROJECT NAME CSEC-80-1 BLM REPORT ID# 11 14

5 PREHISTORIC __ 8 RECORDED BY F.R. Hauck

6 HISTORIC X 9 INSTITUTION AERC

7 PALEONTOLOGICAL __ 10 DATE 8/6/80

11 BLM DISTRICT NO. NA 21 12 BLM RESOURCE AREA NA 22 23

Salt Lake = 2 Cedar City = 4 Vernal = 8
Richfield = 5 Moab = 6

BO = Bonneville, WA = Wasatch, HR = House Range, WS = Warm Springs
SE = Sevier River, HM = Henry Mtns., BR = Beaver River, DI = Dixie
KA = Kanab, ES = Escalante, SJ = San Juan, GR = Grand, PR = Price
SR = San Rafael, DM = Diamond Mountain, BC = Book Cliffs,

13 COUNTY Sevier

14 UTM GRID: ZONE 12 24 25 Easting 464200 26 31 Northing 4308000 32 38

15 LEGAL DESCRIPTION: T 22 S 39 42 R 04E 43 46 Sec. 01 47 48 (10 acre) Qu-Sec. NW 49 50 (40 acre) Qu-Sec. SW 51 52 (160 acre) Qu Sec. 53
Fill in spaces 43 or 46 only if: 42 V = Vernal Meridian, H = Half Township; 46 H = Half Range

16 MAP NAME AND SCALE: Acord Lakes, Utah 7.5' USGS

17 SURFACE OWNER: FS 55 56 LM = BLM FS = USFS ST = State PS = NPS PR = Private OT = Other OTHER: ____

18 NATIONAL REGISTER POTENTIAL: S 57 S=Significant, N=Nonsignificant Why: Site is one of a kind; Has depth potential.

19 MANAGEMENT VALUES: Interpretational Potential __ Scientific X

20 SITE CONDITION Good % DESTROYED 0 58

21 AGENT CAUSING IMPACT NO 51 62, __ 63 64, __ 65 66
ER = Erosion
VA = Vandalization
PR = Project
OT = Other
NO = No Impact

22 PHOTO TAKEN: Y 67 Y=Yes N=No Color # ____ B/W # 455N-1 (6 & 7

23 RECOMMENDED PROTECTION Avoidance

24 SITE TYPE - CULTURAL ST 68 69, __ 70 71, __ 72 73 RA=Rock Art, LA=Limited Activity, ST=Structure, RS=Rock Shelter, OT=Other

25 PALEONTOLOGICAL: Invertebrate __ Vertebrate __ Flora __

26 CULTURAL FEATURES BU 74 75, HS 76 77, TW 78 79, RA 80 81, RM 82 83, __ 84 85, __ 86 87

LS = Lithic Scatter
CS = Ceramic Scatter
GS = Ground Stone Scatter
HE = Hearth
QU = Quarry
BS = Burned Stone
MD = Midden
DE = Depression
OT = Other

SH = Shelter
RA = Rock Alignment
RM = Rubble Mound
SC = Slab-lined cists
MG = Masonry Granary
MR = Masonry Rooms/Wall
TW = Tower
WC = Water Control
M7 = More than 7 of the above.

PI = Pictograph
PE = Petroglyph
BU = Burial
HS = Historical
MN = Mines
CO = Corral
TR = Trail
GL = Glass

OT = Other ____

Description: Site is a recent (1938) historic monument at the spot where Jack Addley was killed by light ning.

27 SITE DIMENSIONS: L. 10 ~~Ft.~~ M W 10 ~~Ft.~~ M Depth ____

28 DEPTH OF FILL Y 88 Y=Yes N=No U=Undetermined

UT 8100-1 (4/79)

42SN76 STATE SITE N. 42SV0144

30 CULTURAL PERIOD/AFFILIATION [E A] (89 90) [ ] (91 92) [ ] (93 94) [ ] (95 96)

OT=Other ______

PA = Paleo. Indian, AR = Archaic, FR = Fremont, BM = Basketmaker, OT = Other, PU = Pueblo An., EA = Euro-American, UP = Ute-Piute, NA = Navajo, UN = Unknown

30 SUB PERIOD = [ ] (97–113)

31 ARTIFACTS OBSERVED: Lithic __ Ceramic __ Bone __ Metal __ Charcoal __ Glass

DESCRIPTION Stone monuments to Jack and his horse"Old Star" which was buried on the spot where he (the horse) fell.

32 SURFACE COLLECTED [N] (114) Y=Yes, N=No,

33 DESCRIPTION OF ARTIFACTS COLLECTED: NA

34 CURATORIAL DISPOSITION NA

35 AVERAGE ARTIFACT DENSITY: NA Per ______

36 ENVIRONMENTAL - TOPOGRAPHIC SITUATION

Level Terrain	__	Cave	__	Mesa Top	__	Talus	__
Broken Terrain	__	Slope	X	Cliff Edge	__	Other:	______
Canyon Bottom	__	Ridge	__	Overhang	__		
Bench/Terrace	__	Ledge	__	Rim	__		

37 DIRECTION SITE FACES: North Flat __ 38 GROUND SLOPE $0^{o}-4^{o}$

39 ELEVATION OF SITE: [8 4 0 0 '] (115–119) 40 ORIGIN OF SOILS: Alluvial

41 WATER RESOURCES: Stream __ Spring __ Seep __ Other __ None X Perm. __ Inter.

42 NAME OF WATER SOURCE NA

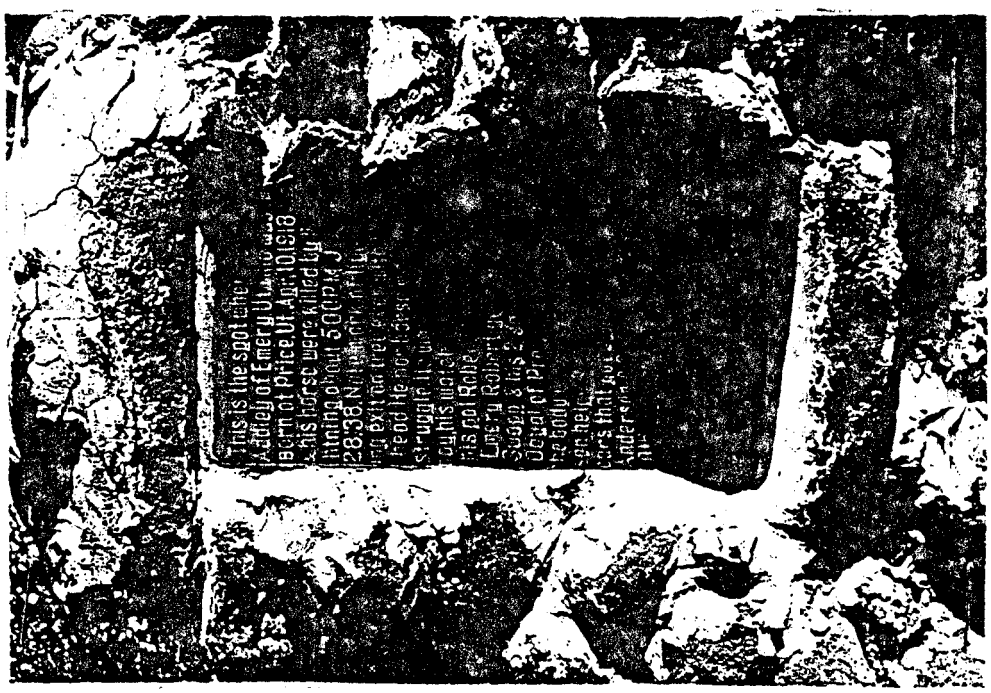
43 VEGETATION ON SITE: [A s pe n, Mth. M a h] (120–132) ogany, Ponderosa Pine

44 VEGETATION SURROUNDING SITE: Aspen - Mt. Mahogany Woodland

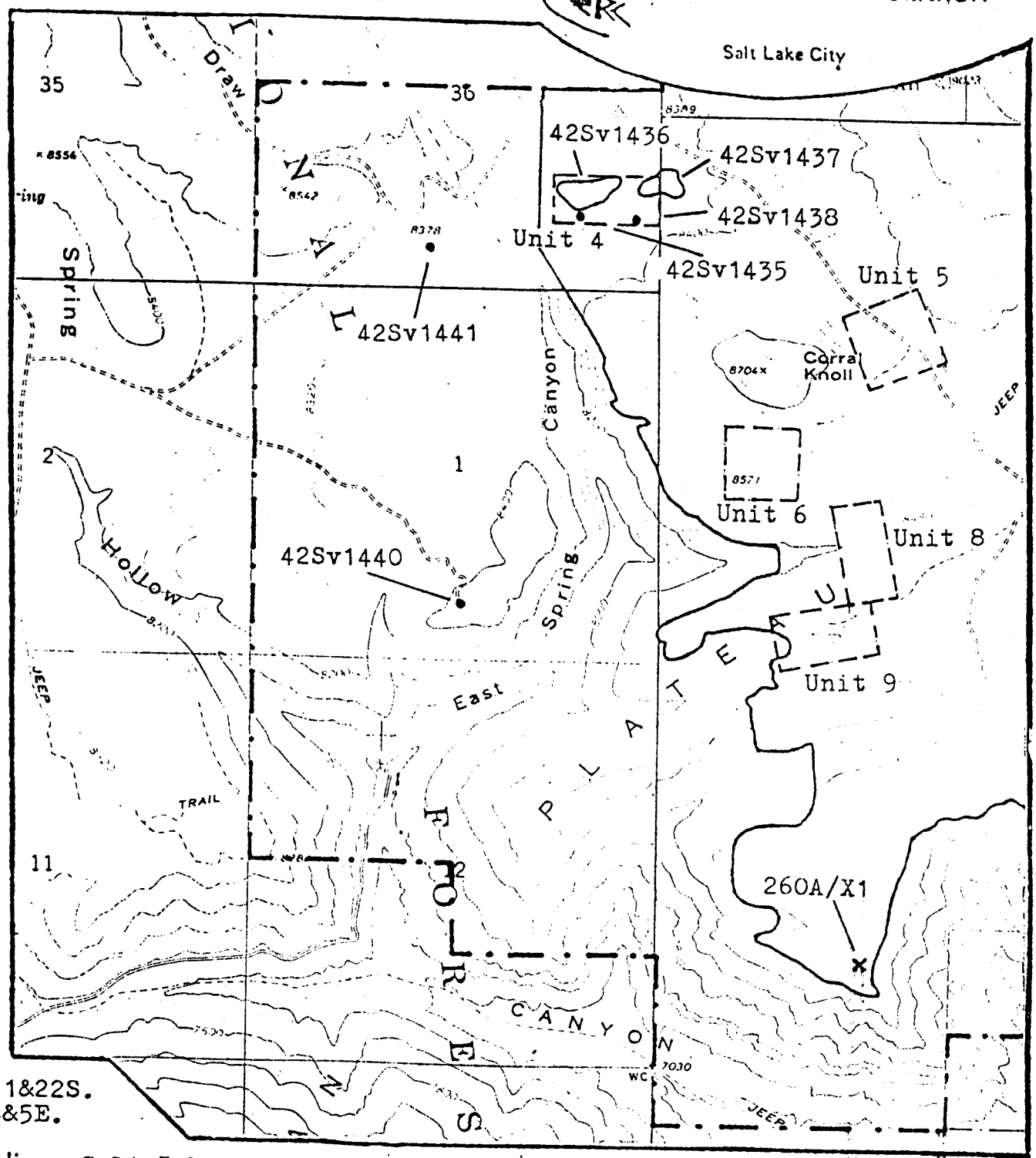
45 DESCRIPTION/REMARKS: Monument states the following: " This is the spot where Jack Addley of Emery, Utah who was born at Price, Ut. April 10, 1918 and his horse were killed by light ning about 5 PM June 28, 1938 Note mark of lightening exit on tree even with his head. He nor hors made a struggle. He was found next day, his watch still running by his pal Robert Anderson of Emery, Robert got Preston Swapp and his so Reed & Doyal of Provo, Ut. to guard the body with Pete and Jack Niels helping later. Drivers of 3 cars that got body George and Clint Ande and Clyde Mortenson. Other helping were Robert Anderson, Royal Niel Oliver Larson, Ken Peterson, La Mar Olsen, and E. Addley, his father, Forest granted special permit.

(Attach sketch map, photos, and xerox of topographic map with T., R., Scale, Quad. nam marked project & survey areas.)

42Sv1440 455N/6
CSEC-80-2 8/6/80



ARCHEOLOGICAL-ENVIRONMENTAL
RESEARCH CORPORATION



T. 21&22S.
R. 4&5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah
7.5 Minute USGS

Project: CSEC 80-1
Series: Central Utah
Date: 8-13-80

Figure 3c
Sample Survey Units
and
Cultural Resources
in the
Mine Plan Area

Legend:
Sample Unit
Archeological Site
Isolated Artifact

0 .5 1
.5 0 .5 1 Km

developed by cooperative agreement by:
Bureau of Land Management
Division of State History
University of Utah Archeological Center

1. Site No.(I/1-10) 42Sv1453
2. County Sevier
3. Temp. No. 539N/1

4. Class: x Prehistoric ___Historic ___Paleontologic
5. Cultural Site Type (interpreted function): Lithic scatter
6. Paleontological Site Type: __Invertebrate; __Vertebrate; __Flora
7. Elevation (I/11-15) 8720 ft. X .3048= 2657 m
   elevation source: USGS topographic map
8. UTM Grid: (I/16-30) zone 12 ; 464650 mE.; 4310480 m
9. (II/I-16) SW of NE of NE of Section 36 T. 21S., R. 4E.
10. Map Reference: Acord Lakes, Utah Series: 7.5' Date: 1968
11. Aerial Photo Data: NA
12. Site Location: The site is located on the SE ridge of Duncan Mountain

13. Land Owner (II/17-18): U.S. Forest Service
    BLM District/Forest (II/19): Fishlake National Forest
14. Site Name/Previous Designations: NA
15. Description of Site: The site is a sparse lithic scatter located on the west rim of a ridge, overlooking a draw to the SW. Alluvi soils may mask some lithics or artifacts; however, site has only limited depth potential.

16. Artifacts: Artifacts should be described/drawn on a continuation sheet and their locations plotted on the site map.

CLASS	QUANTITY
Debitage(II/30)	8
Bifaces (III/1-9)	
Scrapers(III/1-9)	
Utilized Flakes	

CLASS	TYPE	QUANT
Ceramics(III/10-21)		
Proj Pnt(III/1-9)		
Gnd Stn(II/22-29)		
Glass (II/22-29)		
Metal (II/22-29)		
Nails (II/22-29)		
Cans (II/22-29)		
Wood (II/22-29)		
Other (II/22-29)		

Description: 4 chert cores of dark brown, gray, and pink. 4 gr chert primary flakes.

17. Non-Structural Features: (describe and locate on site map)(III/2

_hearth/firepit(HE)	_rubble mound(RM)	_earthen mound(EM)	_trail/road(TR)
_midden(MD)	_stone circle(SC)	_burial(BU)	_RR grade(RG)
_depression(DE)	_rock alignment(RA)	_pictograph(PI)	_tram way/road(TW)
_water control(WC)	_mine tailings(MT)	_petroglyph(PE)	_other(OT)

Description: NA

Site No. 42Sv1453 (539N/1)

CLASS	MATERIAL	QUANTITY	CLASS	MATERIAL	QUANTITY
Single rm			Tower		
Multiple rm			Cairn		
Granary			Corral		
Cist			Dugout		
Pithouse			Kiln		
Kiva			Monument		
Well			Mine		

Description: NA

19. Cultural Affiliation (IV/7-14) Unknown

How Determined?

20. Site Dimensions: 5 m.X 8 m; Area(IV/17-21) 40 sq

21. Were surface artifacts collected? ___ Yes x No; (IV/22) If yes, attach a continuation sheet describing sampling method used.

22. Estimated depth of fill (IV/23): 0-10 cm.

Subsurface test? ___ Yes; x No (Include location of test on sit

Description:

23. Site Condition (IV/25): ___ Excellent; ___ Good; ___ Fair; x Poor

Agent of Impact: Erosion

24. Nat.Register Potential(V/1): ___ Significant(C); x Non-Significan

Justification: Sparse non-diagnostic lithics and limited depth potential.

25. Research Potential: Lithic analysis, hunting station

26. Recommended Mitigation: Avoidance

27. Direction/Distance to Permanent Water (V/5-10): East / 2.7

Type/Name of Water Source (V/11): Quitchupah Creek

Distance to nearest other Water Source (V/2-4): 400 m.

Type of other Water Source: Wash

Distance to Cultivatable Soil (V/12-14): Unknown

28. Topographic Location (check one under each heading) (V/15-18)

PRIMARY LANDFORM
_mountain spine(A)
_hill/butte(B)
_tableland/mesa(C)
X ridge(D)
_valley(E)
_plain(F)
_canyon(G)

POSITION ON LANDFORM
_top/crest/peak(A)
X edge(B)
_slope(C)
_toe/foot/bottom(D)
_saddle/pass(E)
_bench/ledge(F)
_rimrock(G)
_interior(H)

DEPOSITIONAL ENVIRONMENT
_fan(A)
_talus(B)
_dune(C)
_stream terrace(D)
_playa(E)
shore feature
_extinct lake(F)
_extant lake(G)
_alluvial plain(H)
_colluvium(I)
_moraine(J)
_flood plain(K)
_marsh(L)
_landslide/slump(M)
_delta(N)
_island(O)
_cliff(P)
_outcrop(Q)
_stream bed(R)

SECONDARY POSITI
_top/crest/ridge
_edge(B)
X slope(C)
_toe/foot(D)
_cutbank(E)
_detached monoli
_interior(G)
_step(H)
_riser(I)
_port.geo.featur
_spring mound/bo
_cave(L)
_alcove/shelter(
_patterned groun

Description: See #15

30. Vegetation COMMUNITY and association (V/24-25):

_ALPINE GRASSLAND(AA)

_SPRUCE FIR(BZ)
_krumholz(BA)
_white fir-spruce(BB)
_ASPEN DOUGLAS FIR(CZ)
_limber pine(CA)
_douglas fir(CB)
_lodgepole pine(CC)
_bristlecone pine(CD)
_aspen(CE)
_streamside(CF)
_meadow grassland(CG)

_YELLOW PINE-OAK(DZ)
_ponderosa pine(DA)
_oakbrush(DB)
_mountain brush(DC)
_maple(DD)
_streamside(DE)

_PLAINS/PRAIRIE(EZ)
_grasslands(EA)
_pinyon-juniper(EB)
_streamside(EC)

_COLD DESERT SHRUB(FZ)
_sagebrush(FA)
X small sagebrush(FB)
_little rabbitbrush(FC)
_shadscale(FD)
_horsebrush(FE)
_winter-fat(FF)
_hop-sage/blkbrsh(FG)
_bud sagebrush(FH)
_mat saltbrush(FI)
_gray molly(FJ)
_streamside(FK)

_SALT DESERT SHRUB(GZ)
_greasewood(GA)
_greasewood-shadscl(GB)
_seepweed(GC)
_picklewd/samphire(GD)
_saltgrass(GE)
_alkali sacaton(GF)
_rabbitbrush(GG)

_WARM DESERT SH
_desert saltbru
_creosote bush(
_creosote/bursa
_joshua tree(HD
_MARSH COMMUNIT

_ALKALI FLATS/M
FLATS/DRY LAKE/
WASTELAND(XZ)

_CULTIVATED LAN

Site No. 42SV1422 539N

Description: Small sage and grasses are along the slope and an oakbrush stand is to the southeast.

31. Next nearest plant association/distance: Alpine/400 m.

32. Photograph Numbers (V/26): 539N-1 (1)

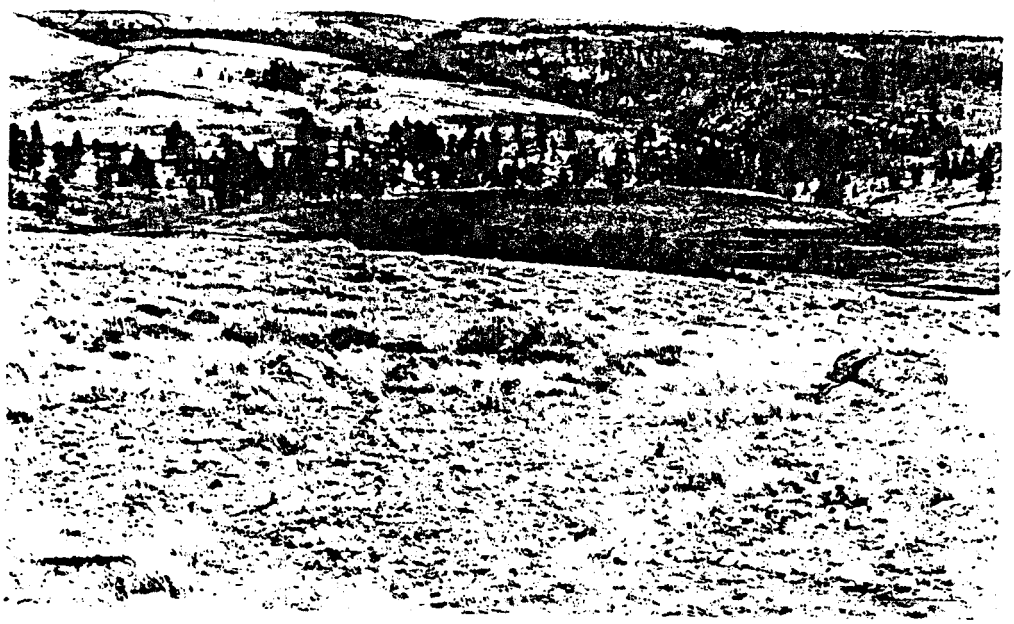
33. Recorded by: V. Garth Norman

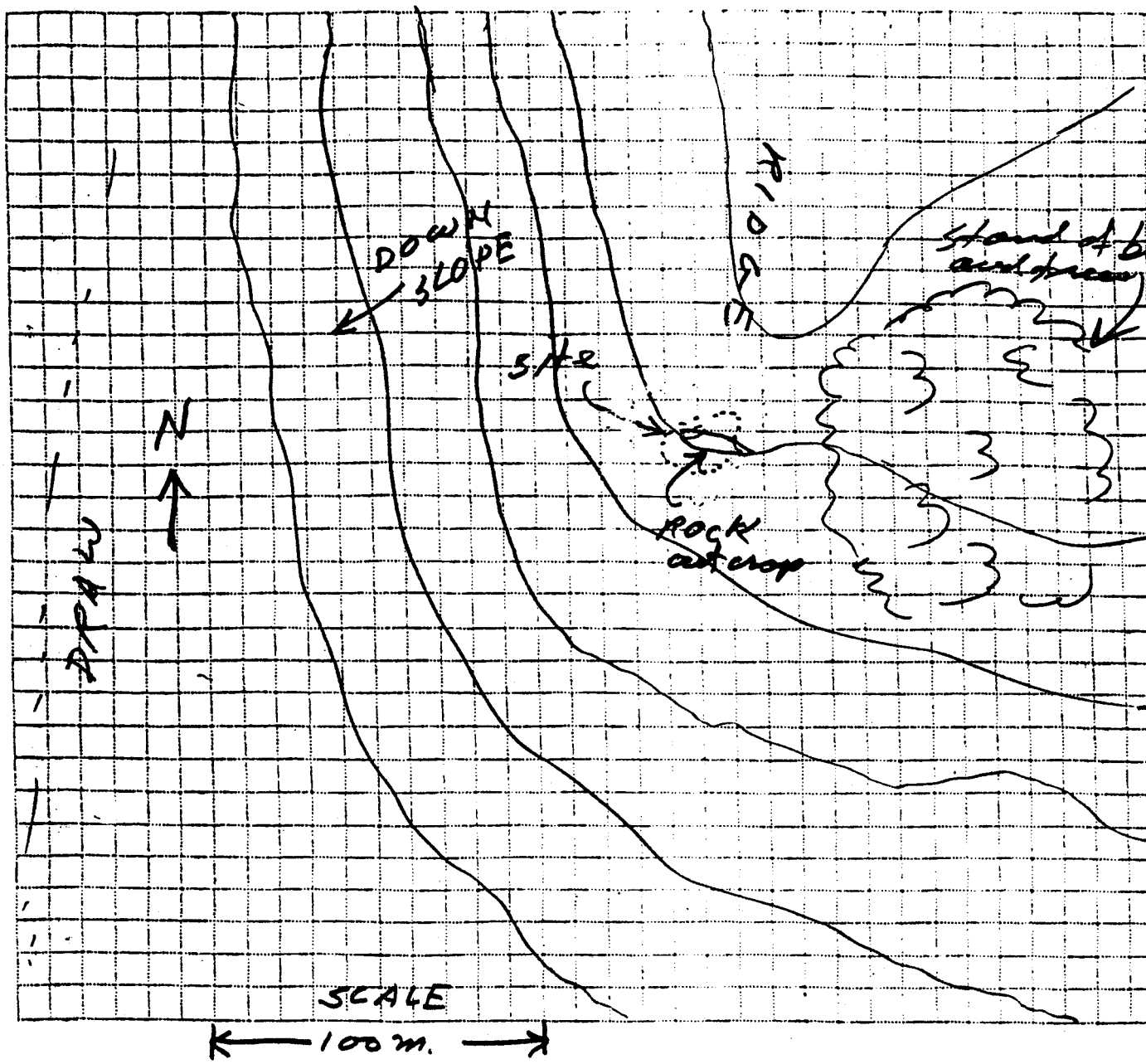
Survey Org. (V/27-28): AERC Date: 1/28/81

Assisting Crew Members: NA

34. Sponsoring Agency: Southern Utah Fuel Company (SUFC-81-1)

Contract No. NA





35. Encoding Form: (all entries are right justified)

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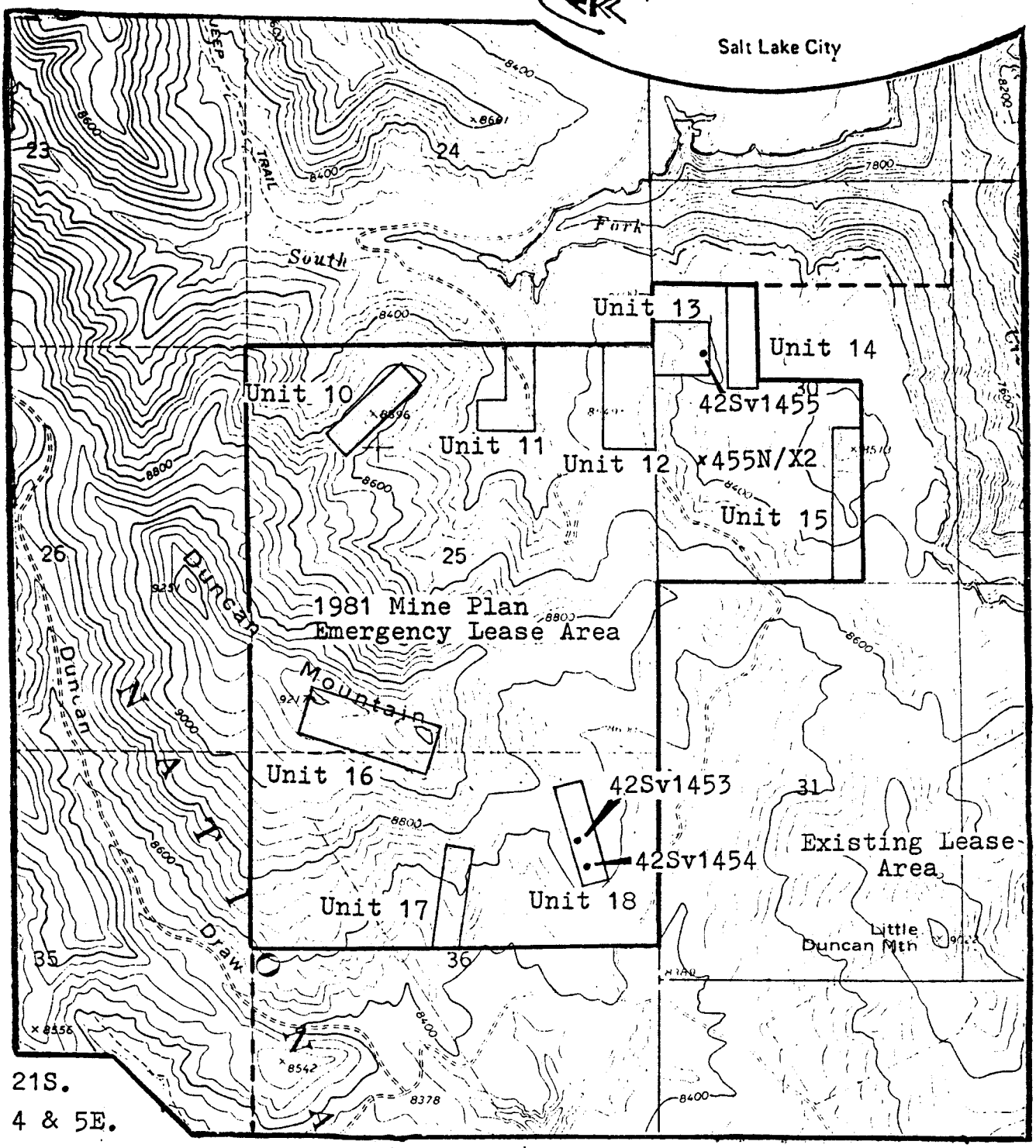
III																															
IV							Z	Z												4	0	Z	B	C	D	E	R				
V	D			4		9	0		2	7	B	9	9	9	D	B	-	C						F	B	B	A	E			
VI																															

Form must be accompanied by a site map; photocopy of U.S.G.S. t
map with T., R., scale, and quad name; photographs of the site;
artifact sketches (if applicable).

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21S.

R. 4 & 5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: SUFC-81-1

Series: Central Utah

Date: 2/2/81

Figure 1
SAMPLE SURVEY UNITS AND CULTURAL RESOURCES IN THE EMERGENCY LEASE PROJECT AREA

Legend:

Sample Unit

Archeological Site •

Isolated Artifact x

0 .5 1

.5 0 .5 1 Km

developed by cooperative agreement by:
Bureau of Land Management
Division of State History
University of Utah Archeological Center

1. Site No.(I/1-10) 42Sv1454
2. County Sevier
3. Temp. No. 539N/2
4. Class: x Prehistoric ___Historic ___Paleontologic
5. Cultural Site Type (interpreted function): Lithic scatter
6. Paleontological Site Type: __Invertebrate; __Vertebrate; __Flora
7. Elevation (I/11-15) 8680 ft. X .3048= 2645.7
   elevation source: USGS topographic map
8. UTM Grid: (I/16-30) zone 12 ; 464680 mE.; 4310365
9. (II/I-16) NW of SE of NE of Section 36 T. 21S. , R. 4E.
10. Map Reference: Acord Lakes, Utah Series: 7.5' Date: 1968
11. Aerial Photo Data: NA
12. Site Location: The site is on the SE ridge of Duncan Mountain.

13. Land Owner (II/17-18): U.S. Forest Service
    BLM District/Forest (II/19): Fishlake National Forest
14. Site Name/Previous Designations: NA
15. Description of Site: The site is a sparse lithic scatter which is located on the west rim of a ridge, on and near a rock outcropping, which provides a flat area overlooking a draw to the southwest.

16. Artifacts: Artifacts should be described/drawn on a continuation sheet and their locations plotted on the site map.

CLASS	QUANTITY
Debitage(II/30)	6
Bifaces (III/1-9)	
Scrapers(III/1-9)	
Utilized Flakes	

CLASS	TYPE	QUANT
Ceramics(III/10-21)		
Proj Pnt(III/1-9)		
Gnd Stn(II/22-29)		
Glass (II/22-29)		
Metal (II/22-29)		
Nails (II/22-29)		
Cans (II/22-29)		
Wood (II/22-29)		
Other (II/22-29)		

Description: 4 white/gray chert core and 2 primary flakes

17. Non-Structural Features: (describe and locate on site map)(III/2

_hearth/firepit(HE)	_rubble mound(RM)	_earthen mound(EM)	_trail/road(TR)
_midden(MD)	_stone circle(SC)	_burial(BU)	_RR grade(RG)
_depression(DE)	_rock alignment(RA)	_pictograph(PI)	_tram way/road(TW)
_water control(WC)	_mine tailings(MT)	_petroglyph(PE)	_other(OT)

Description: NA

Site No. 42Sv1454 (539N/2)

CLASS	MATERIAL	QUANTITY	CLASS	MATERIAL	QUANTITY
Single rm			Tower		
Multiple rm			Cairn		
Granary			Corral		
Cist			Dugout		
Pithouse			Kiln		
Kiva			Monument		
Well			Mine		

Description: NA

19. Cultural Affiliation (IV/7-14) Unknown

How Determined?

20. Site Dimensions: 5 m.X 5 m; Area(IV/17-21) 25 sq

21. Were surface artifacts collected? ___ Yes x No; (IV/22) If yes, attach a continuation sheet describing sampling method used.

22. Estimated depth of fill (IV/23): none

Subsurface test? ___ Yes; x No (Include location of test on sit

Description:

23. Site Condition (IV/25): ___ Excellent; ___ Good; ___ Fair; x Poor

Agent of Impact: Erosion

24. Nat.Register Potential(V/1): ___ Significant(C); x Non-Significan

Justification: Sparse lithic scatter without diagnostic remains.

25. Research Potential: Lithic analysis, hunting station

26. Recommended Mitigation: Avoidance

27. Direction/Distance to Permanent Water (V/5-10): East / 2.7 k

Type/Name of Water Source (V/11): Quitchupah Creek

Distance to nearest other Water Source (V/2-4): 400 m.

Type of other Water Source: Wash

Distance to Cultivatable Soil (V/12-14): Unknown

28. Topographic Location (check one under each heading) (V/15-18)

PRIMARY LANDFORM	POSITION ON LANDFORM	DEPOSITIONAL ENVIRONMENT		SECONDARY POSITI
_mountain spine(A)	_top/crest/peak(A)	_fan(A)	_marsh(L)	_top/crest/ridge(
_hill/butte(B)	X edge(B)	_talus(B)	_landslide/slump(M)	_edge(B)
_tableland/mesa(C)	_slope(C)	_dune(C)	_delta(N)	X slope(C)
X ridge(D)	_toe/foot/bottom(D)	_stream terrace(D)	_island(O)	_toe/foot(D)
_valley(E)	_saddle/pass(E)	_playa(E)	_cliff(P)	_cutbank(E)
_plain(F)	_bench/ledge(F)	shore feature	_outcrop(Q)	_detached monoli
_canyon(G)	_rimrock(G)	_extinct lake(F)	_stream bed(R)	_interior(G)
	_interior(H)	_extant lake(G)		_step(H)
		_alluvial plain(H)		_riser(I)
		_colluvium(I)		_port.geo.featur
		_moraine(J)		_spring mound/bo
		_flood plain(K)		_cave(L)
				_alcove/shelter(
				_patterned groun

Description: See #15

29. Degree/Aspect of slope (V/19-23): 3°/225°

30. Vegetation COMMUNITY and association (V/24-25):

_ALPINE GRASSLAND(AA)
_SPRUCE FIR(BX)
_krumholz(BA)
_white fir-spruce(BB)
_ASPEN DOUGLAS FIR(CX)
_limber pine(CA)
_douglas fir(CB)
_lodgepole pine(CC)
_bristlecone pine(CD)
_aspen(CZ)
_streamside(CD)
_meadow grassland(CC)

_YELLOW PINE-OAK(DX)
_ponderosa pine(DA)
_oakbrush(DB)
_mountain brush(DC)
_maple(DD)
_streamside(DZ)

_PLAINS/PRAIRIE(EX)
_grasslands(EA)
_pinyon-juniper(EB)
_streamside(EC)

_COLD DESERT SHRUB(FX)
_sagebrush(FA)
X small sagebrush(FB)
_little rabbitbrsh(FC)
_shadscale(FD)
_horsebrush(FE)
_winter-fat(FF)
_hop-sage/blkbrsh(FG)
_bud sagebrush(FH)
_mat saltbrush(FI)
_gray molly(FJ)
_streamside(FK)

_SALT DESERT SHRUB(GX)
_greasewood(GA)
_greasewood-shadscl(GB)
_seepweed(GC)
_pickleweed/samphire(GD)
_saltgrass(GE)
_alkali sacaton(GF)
_rabbitbrush(GG)

_WARM DESERT SH
_desert saltbru
_creosote bush(
_creosote/burs
_joshua tree(HD
_MARSH COMMUNIT

_ALKALI FLATS/M
FLATS/DRY LAKE
WASTELAND(XX)

_CULTIVATED LAN

Site No. 42Sv1454 (539N)

Description: Small sage and grasses are on the slope around the site. A stand of mountain brush lies adjacent to the east of the site.

31. Next nearest plant association/distance: Alpine/400 m.

32. Photograph Numbers (V/26): 539N-1 (2)

33. Recorded by: V. Garth Norman

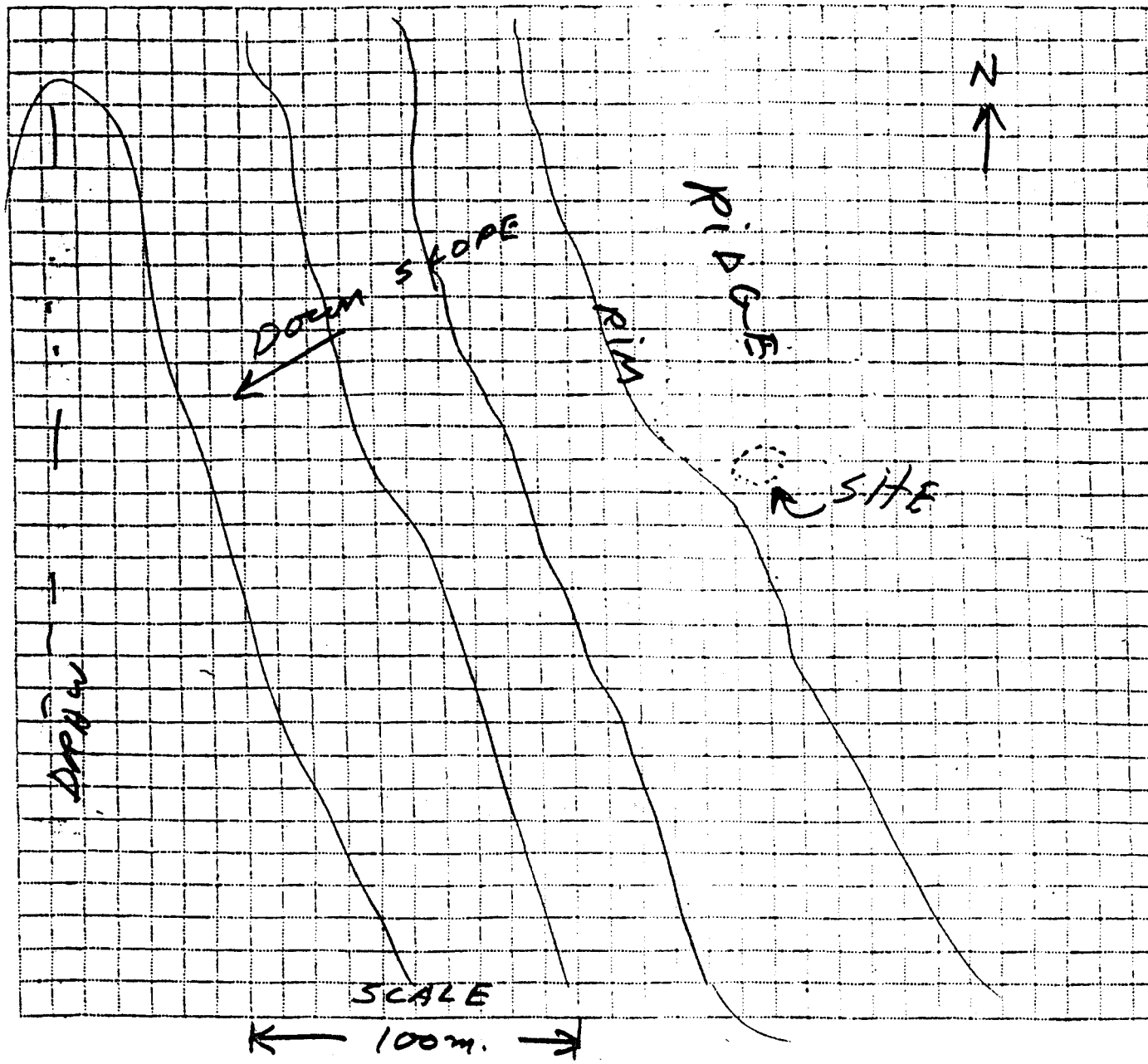
Survey Org. (V/27-28): AERC Date: 1/28/81

Assisting Crew Members: NA

34. Sponsoring Agency: Southern Utah Fuel Company (SUFC-81-1)

Contract No. NA

SITE NO. [illegible]



35. Encoding Form: (all entries are right justified)

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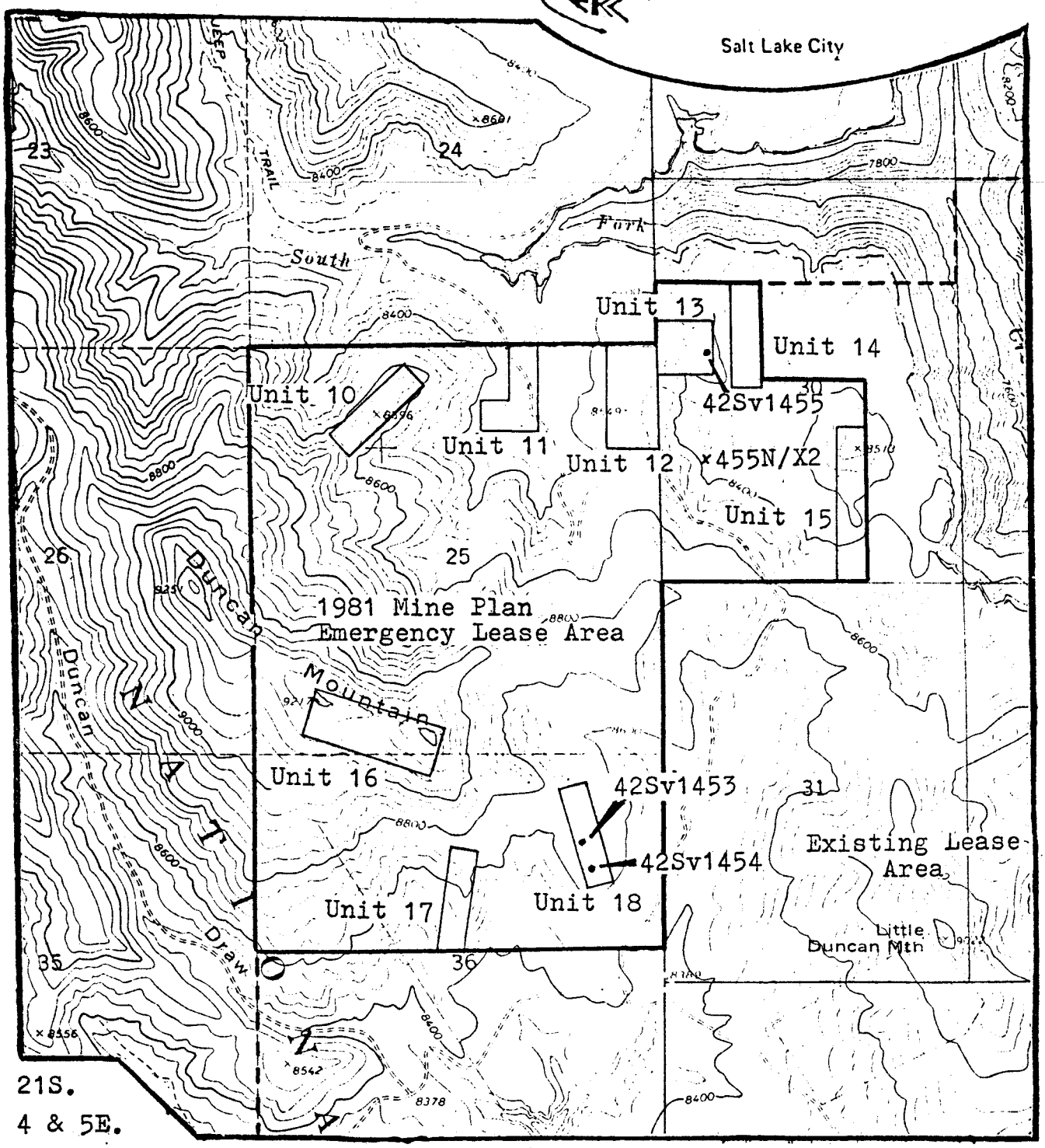
II	N	W	S	E	N	E	3	6	2	1		S		4		E	F	S	5	B	A	L	S							B	
III																															
IV							2	2												2	5	2	A	C	D	E	R				
V	D		4		9	0		2	7	B	9	9	9	P	B	-	C							F	B	B	A	E			
VI																															

Form must be accompanied by a site map; photocopy of U.S.G.S. t
map with T., R., scale, and quad name; photographs of the site;
artifact sketches (if applicable).

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21S.

R. 4 & 5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: SUFC-81-1

Series: Central Utah

Date: 2/2/81

Figure 1
SAMPLE SURVEY UNITS
AND
CULTURAL RESOURCES
IN THE
EMERGENCY LEASE
PROJECT AREA

Legend:

Sample Unit

Archeological Site •

Isolated Artifact x

0 .5 1

.5 0 .5 1 Km

N

developed by cooperative agreement by:
Bureau of Land Management
Division of State History
University of Utah Archeological Center

1. Site No.(I/1-10) 42Sv1455
2. County Sevier
3. Temp. No. 539N/3

4. Class: x Prehistoric ___Historic ___Paleontologic
5. Cultural Site Type (interpreted function): Lithic scatter
6. Paleontological Site Type: __Invertebrate; __Vertebrate; __Flora
7. Elevation (I/11-15) 8440 ft. X .3048= 2573 m
elevation source: USGS topographic map
8. UTM Grid: (I/16-30) zone 12 ; 465200 mE.; 4312400 m
9. (II/I-16) SE of SE of NW of Section 30 T. 21S., R. 5E.
10. Map Reference: Acord Lakes, Utah Series: 7.5' Date: 1968
11. Aerial Photo Data: NA
12. Site Location: The site is located on the NE ridge of Duncan Mountain.

13. Land Owner (II/17-18): U.S. Forest Service
BLM District/Forest (II/19): Fishlake National Forest
14. Site Name/Previous Designations: NA
15. Description of Site: The site is a sparse lithic scatter which is located on a slight rise of a point centered on the flat ridge on the eastern rim.

16. Artifacts: Artifacts should be described/drawn on a continuation sheet and their locations plotted on the site map.

CLASS	QUANTITY
Debitage(II/30)	6
Bifaces (III/1-9)	
Scrapers(III/1-9)	
Utilized Flakes	

CLASS	TYPE	QUANT
Ceramics(III/10-21)		
Proj Pnt(III/1-9)		
Gnd Stn(II/22-29)		
Glass (II/22-29)		
Metal (II/22-29)		
Nails (II/22-29)		
Cans (II/22-29)		
Wood (II/22-29)		
Other (II/22-29)		

Description: 1 primary flake and 5 tertiary flakes of dense gray mudstone.

17. Non-Structural Features: (describe and locate on site map)(III/2

_hearth/firepit(HE)	_rubble mound(RM)	_earthen mound(EM)	_trail/road(TR)
_midden(MD)	_stone circle(SC)	_burial(BU)	_RR grade(RG)
_depression(DE)	_rock alignment(RA)	_pictograph(PI)	_tram way/road(TW)
_water control(WC)	_mine tailings(MT)	_petroglyph(PE)	_other(OT)

Description: NA

Site No. 42Sv1455 (539N/3)

CLASS	MATERIAL	QUANTITY	CLASS	MATERIAL	QUANTITY
Single rm			Tower		
Multiple rm			Cairn		
Granary			Corral		
Cist			Dugout		
Pithouse			Kiln		
Kiva			Monument		
Well			Mine		

Description: NA

19. Cultural Affiliation (IV/7-14) Unknown

How Determined?

20. Site Dimensions: 3 m.X 3 m; Area(IV/17-21) 9 sq

21. Were surface artifacts collected? ___Yes x No; (IV/22) If yes, attach a continuation sheet describing sampling method used.

22. Estimated depth of fill (IV/23): 0-10-cm.

Subsurface test? ___Yes; x No (Include location of test on site

Description:

23. Site Condition (IV/25): ___Excellent; ___Good; ___Fair; x Poor

Agent of Impact: Erosion, and possible vandalism

24. Nat,Register Potential(V/1): ___Significant(C); x Non-Significant

Justification: Sparse non-diagnostic lithics and limited depth potential.

25. Research Potential: Lithic analysis, hunting station

26. Recommended Mitigation: Avoidance

27. Direction/Distance to Permanent Water (V/5-10): ___/ 600

Type/Name of Water Source (V/11): Stream/Quitchupah Creek (south fork

Distance to nearest other Water Source (V/2-4): 300 m.

Type of other Water Source: Wash

Distance to Cultivatable Soil (V/12-14): Unknown

28. Topographic Location (check one under each heading) (V/15-18)

PRIMARY LANDFORM
- _mountain spine(A)
- _hill/butte(B)
- _tableland/mesa(C)
- X ridge(D)
- _valley(E)
- _plain(F)
- _canyon(G)

POSITION ON LANDFORM
- _top/crest/peak(A)
- X edge(B)
- _slope(C)
- _toe/foot/bottom(D)
- _saddle/pass(E)
- _bench/ledge(F)
- _rimrock(G)
- _interior(H)

DEPOSITIONAL ENVIRONMENT
- _fan(A)
- _talus(B)
- _dune(C)
- _stream terrace(D)
- _playa(E)
- shore feature
  - _extinct lake(F)
  - _extant lake(G)
- _alluvial plain(H)
- _colluvium(I)
- _moraine(J)
- _flood plain(K)
- _marsh(L)
- _landslide/slump(M)
- _delta(N)
- _island(O)
- _cliff(P)
- _outcrop(Q)
- _stream bed(R)

SECONDARY POSITIO
- _top/crest/ridge(
- _edge(B)
- X slope(C)
- _toe/foot(D)
- _cutbank(E)
- _detached monolit
- _interior(G)
- _step(H)
- _riser(I)
- _port.geo.feature
- _spring mound/bo
- _cave(L)
- _alcove/shelter(
- _patterned ground

Description: See #15.

Site No. 42Sv1455 (539N)

29. Degree/Aspect of slope (V/19-23): Flat

30. Vegetation COMMUNITY and association (V/24-25):

_ALPINE GRASSLAND(AA)
_SPRUCE FIR(BZ)
X aspen(BA)
_white fir-spruce(BB)
_ASPEN DOUGLAS FIR(CZ)
_limber pine(CA)
_douglas fir(CB)
_lodgepole pine(CC)
_bristlecone pine(CD)
_aspen(CZ)
_streamside(CD)
_meadow grassland(CE)

_YELLOW PINE-OAK(DZ)
_ponderosa pine(DA)
X oakbrush(DB)
_mountain brush(DC)
_maple(DD)
_streamside(DE)

_PLAINS/PRAIRIE(EZ)
_grasslands(EA)
_pinyon-juniper(EB)
_streamside(EC)

_COLD DESERT SHRUB(FZ)
_sagebrush(FA)
X small sagebrush(FB)
_little rabbitbrush(FC)
_shadscale(FD)
_horsebrush(FE)
_winter-fat(FF)
_hop-sage/blkbrsh(FG)
_bud sagebrush(FH)
_mat saltbrush(FI)
_gray molly(FJ)
_streamside(FK)

_SALT DESERT SHRUB(GZ)
_greasewood(GA)
_greasewood-shadscl(GB)
_seepweed(GC)
_picklewd/samphire(GD)
_saltgrass(GE)
_alkali sacaton(GF)
_rabbitbrush(GG)

_WARM DESERT SHR
_desert saltbrus
_creosote bush(H
_creosote/bursag
_joshua tree(HD)
_MARSH COMMUNITI

_ALKALI FLATS/MU
FLATS/DRY LAKE/
WASTELAND(IZ)

_CULTIVATED LAND

Description: Small sage and grasses lie along the slope on, and around, the site. A stand of mountain brush, including maple, lies to the west and east of the site.

31. Next nearest plant association/distance: Small sage/100 m.

32. Photograph Numbers (V/26): 539N-1 (3)

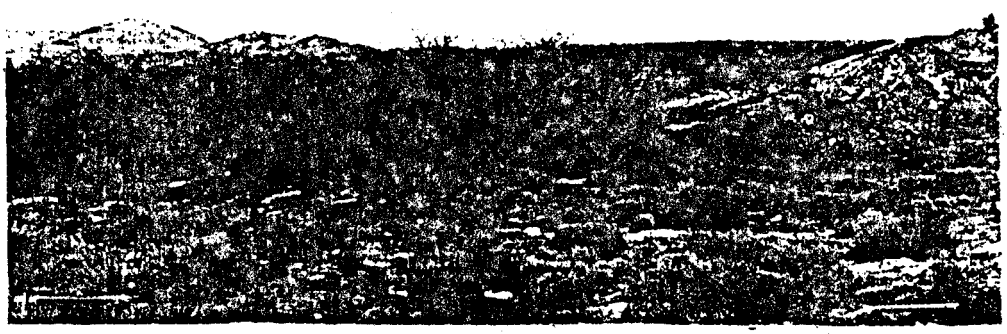
33. Recorded by: V. Garth Norman

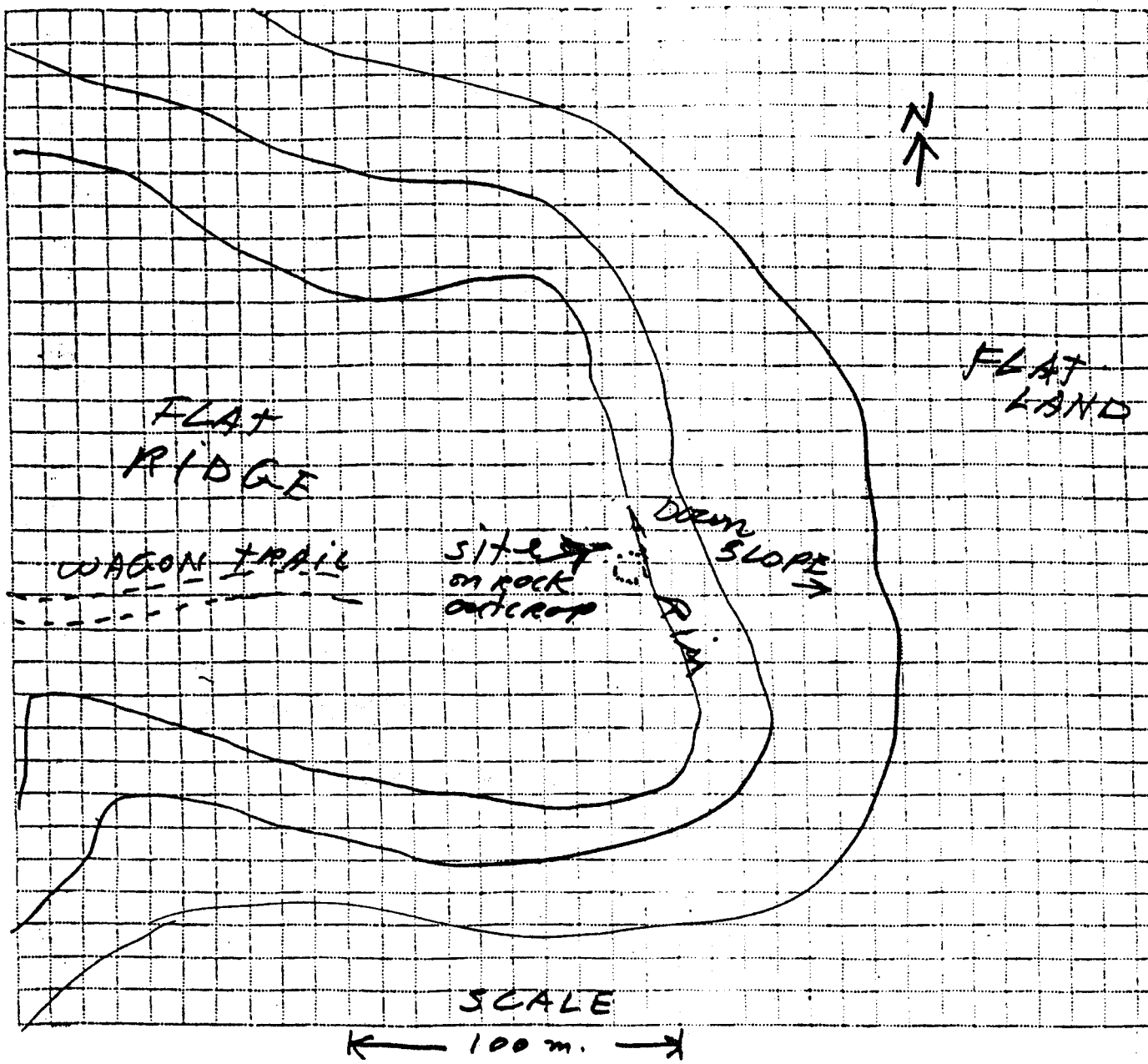
Survey Org. (V/27-28): AERC Date: 1/28/81

Assisting Crew Members: NA

34. Sponsoring Agency: Southern Utah Fuel Company (SUFC-81-1)

Contract No. NA





35. Encoding Form: (all entries are right justified)

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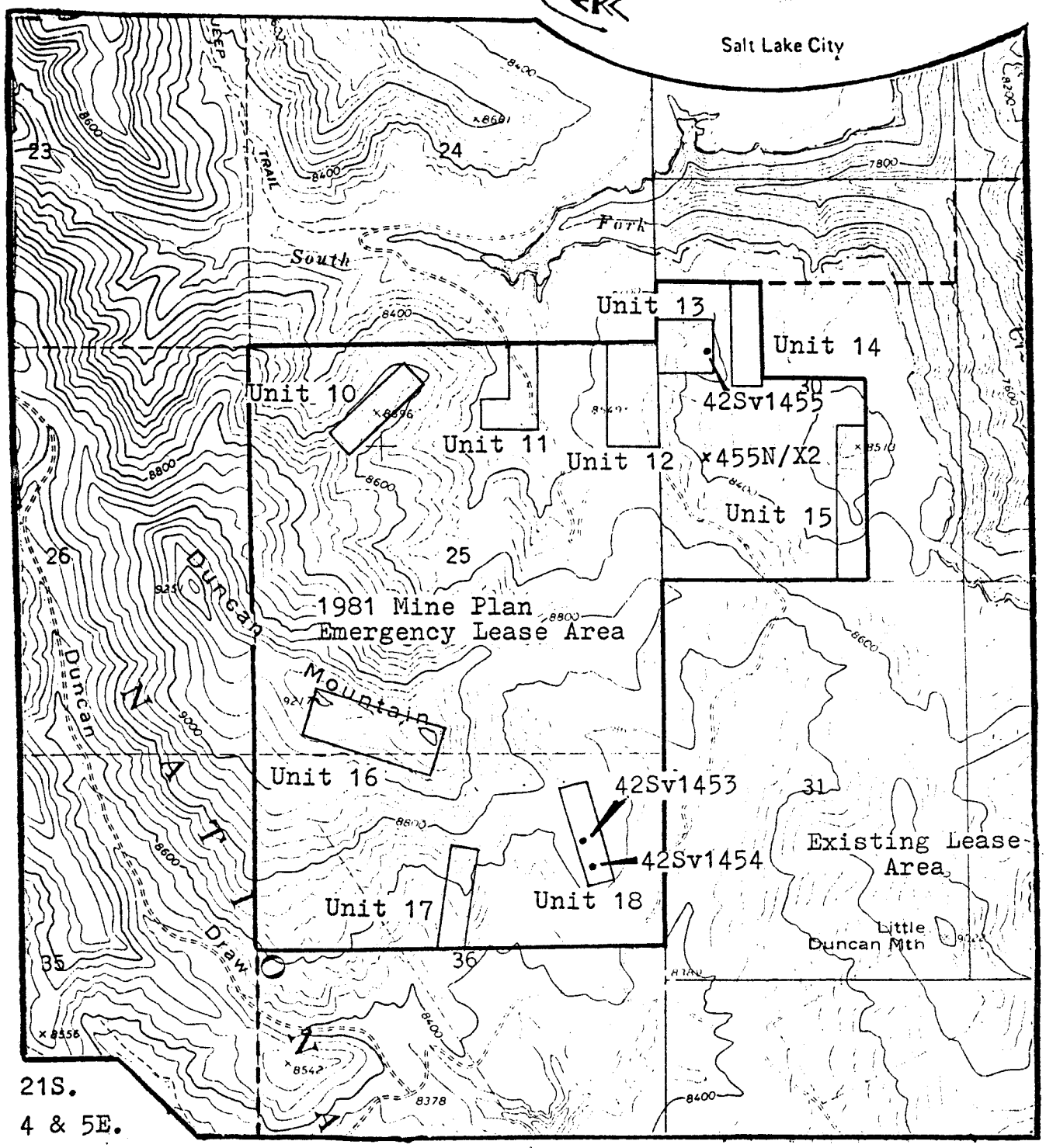
II	S	E	S	E	N	W	3	0	2	1		9		5		E	F	S	5	B	A	L	S								B
III																															
IV							2	2														9	2	B	C	D	E	R	V	A	
V	D			0			6			3	B	9	9	9	D	B	-	C						F	B	B	A	E			
VI																															

Form must be accompanied by a site map; photocopy of U.S.G.S. t
map with T., R., scale, and quad name; photographs of the site
artifact sketches (if applicable).

ARCHEOLOGICAL-ENVIRONMENTAL RESEARCH CORPORATION

Salt Lake City



T. 21S.

R. 4 & 5E.

Meridian: Salt Lake B. & M.

Quad: Acord Lakes, Utah 7.5 Minute USGS

Project: SUFC-81-1

Series: Central Utah

Date: 2/2/81

Figure 1
SAMPLE SURVEY UNITS AND CULTURAL RESOURCES IN THE EMERGENCY LEASE PROJECT AREA

Legend:

Sample Unit

Archeological Site

Isolated Artifact

0 .5 1

.5 0 .5 1 Km

Scale

TABLE H-1 CHARACTERISTICS OF OBSERVATION WELLS

Obs. Well No.	Location*	Total Hole Depth (ft)	Total Depth Cased (ft)	Casing I.D. (in.)	Perfor-ations (ft)	Elevation Casing Top	Formation Monitored	State Plane Coordinates E	State Plane Coordinates N
US-77-7	21S05E31ABC	294	-	1¼	-	-	-	-	-
US-77-8	22S05E6BB	160	160	1¼	110	8262.2	Castlegate	2,029,925	220,450
US-77-9	21S04E36DBB	400	100	1¼	75	8279.3	Upper Blackhawk/ Lower Castlegate	2,028,200	220,550
US-79-9	22S05E8BB	1140	860	2	20	7665.4	U-Hia Coal	2,031,540	214,460
US-79-10	22S05E8AC	870	880	2	20	7671.6	U-Hia Coal	2,033,870	214,590
US-79-12	22S05E5CAD	893	860	2	20	7624.3	U-Hia Coal	2,033,540	216,110
US-79-13	22S05E5CB	715	705	2	20	7811.3	Sandstone in Blackhawk	2,032,000	217,320

	June 3, 1978		October 5, 1979		June 20, 1980	
Observation Well No.	Depth to SWL** (ft)	Elev. of SWL (ft)	Depth to SWL** (ft)	Elev. of SWL (ft)	Depth to SWL** (ft)	Elev. of SWL (ft)
US-77-7	260.3	-	Dry	-	Dry	-
US-77-8	143.1	8396.90	140.4	8399.6	142.67	8397.33
US-77-9	>300	-	273.6	8121.4	269.83	8125.17
US-79-9	-	-	858.5	7681.5	Dry	-
US-79-10	-	-	878.1	7676.9	Dry	-
US-79-12	-	-	-	-	Dry	-
US-79-13	-	-	705.3	7829.7	Dry	-

* See Plate H-II for locations.

** Static Water Level (SWL) is measured from ground surface.

SOURCE: Coastal States Energy Company

TABLE H-1 CHARACTERISTICS OF OBSERVATION WELLS

Obs. Well No.	Location*	Total Hole Depth (ft)	Total Depth Cased (ft)	Casing I.D. (in.)	Perfor-ations (ft)	Elevation Casing Top	Formation Monitored	State Plane Coordinates E	State Plane Coordinates N
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US-77-8	22S05E6BB	160	160	1¼	110	8262.2	Castlegate	2,029,925	220,450
US-77-9	21S04E36DBB	400	100	1¼	75	8279.3	Upper Blackhawk/ Lower Castlegate	2,028,200	220,550
US-79-9	22S05E8BB	1140	860	2	20	7665.4	U-Hia Coal	2,031,540	214,460
US-79-10	22S05E8AC	870	880	2	20	7671.6	U-Hia Coal	2,033,870	214,590
US-79-12	22S05E5CAD	893	860	2	20	7624.3	U-Hia Coal	2,033,540	216,110
US-79-13	22S05E5CB	715	705	2	20	7811.3	Sandstone in Blackhawk	2,032,000	217,320

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US-77-8	143.1	8396.90	140.4	8399.6	142.67	8397.33
US-77-9	>300	-	273.6	8121.4	269.83	8125.17
US-79-9	-	-	858.5	7681.5	Dry	-
US-79-10	-	-	878.1	7676.9	Dry	-
US-79-12	-	-	-	-	Dry	-
US-79-13	-	-	705.3	7829.7	Dry	-

* See Plate H-II for locations.

** Static Water Level (SWL) is measured from ground surface.

SOURCE: Coastal States Energy Company

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
MINE PERMIT AREA									
001	21S04E36DCD	9-17-77	1.7	Time/Volume	Spring developed for stock watering by U.S. Forest Service	8230	Stock Watering	Castlegate Sandstone	Yes
		6-04-78	2	Time/Volume					
		9-26-78	2.2	Time/Volume					
		7-79	2.4	Time/Volume					
		10-79	2.1	Time/Volume					
		6-80	2.9	Time/Volume					
005	22S04E01DDA	9-13-77	1	Estimated	Spring historically developed for stock-watering. Facilities not maintained	7935	Stock Watering	Blackhawk Formation	Yes
		6-04-78	1	Estimated					
		9-26-78	-	Not Meas.					
		7-79	-	Not Meas.					
		10-79	-	Not Meas.					
		6-80	1	Estimated					
013	21S05E29BB	9-77	-	Not Meas.		7600		Blackhawk Formation	
		6-78	-	Not Meas.					
		6-80	Drips		Turbidity ≤ 2				
013-A	21S05E29BC	6-80	Seep		Eminating from black shale	7560			
013-B	21S05E29CBA	9-77	Seep	Not Meas.	Seep on both sides of creek	7510		Colluvium	
		6-80							

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA - Continued

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
013-C	21S05E29CBD	9-77 6-80	Seep Dry	Not Meas.		7480		Blackhawk Formation	
015-A	21S05E29CDA	9-77		Not Meas.	Fractured, flaggy, friable sandstone	7390		Starpoint Sandstone	
015-B	21S05E32ABB	9-77 6-80	 Very Small	Not Meas.	Fractured, flaggy, friable sandstone	7290		Starpoint Sandstone	
033	22S05E07BDB	9-17-77 6-04-78	Dry 0.8	Time/Volume	Two possible spring sites at base of Kc hillslope	8270		Castlegate Sandstone	Yes
058	21S05E32AC	6-80	0.5	Estimated	Water submerges before reaching creek	7280			
ADJACENT AREA									
007-A	21S04E13DAD	9-17-77	Pond		Water in catchment pond; only pond holding water at this time of year, may indicate a spring or seep	8260	Stock Watering	Alluvium, Hillwash Material (Near Price River Formation/Castlegate Sandstone Member Contact)	
008	21S05E19ADC	9-77 6-80	Seep 0.2	Not Meas. Estimated		7880		Castlegate/Blackhawk Contact	

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA - Continued

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
009	21S05E19DA	6-04-78	11.8	Time/Volume		7760			Yes
		6-80	3-4	Estimated	Turbidity~2				
010	21S05E19DAD	9-77	Seep	Not Meas.	Highly fractured coal and carbonaceous shale	7760		Blackhawk Formation	
		6-80	0.10	Estimated	Turbidity 6-8				
019-A	22S05E09DB	9-77		Not Meas.	Evaporative salt deposits on Kc sandstone outcrop	6680			
		6-80	Dry						
019-B	22S05E08DA	9-77		Not Meas.	Evaporative salt deposits on Ksp sandstone outcrop	6640			
023	22S04E16ACB	9-16-77	0.9	Time/Volume	Developed spring protected from livestock; base of Kc cliff	8000		Castlegate Sandstone Member (Base)	
024	22S04E16DCD	9-16-77	0.05	Time/Volume	Developed spring with watering trough; at base of ridge in draw	8055		Castlegate Sandstone Member/Price River Formation	
026	22S04E24BAC	9-16-77	0.1	Time/Volume	Developed spring with cistern and watering trough; at base of ridge in draw	8355		Castlegate Sandstone Member	

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA - Continued

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
027	21S04E34BCC LIZONBEE SPG	9-17-77	0.8	Time/Volume	Developed spring for livestock watering; hillside source is piped to watering area (pond)	8135		Price River Formation	
028	21S04E27BCC	9-17-77	(Dry) Seep Area		Evidence of previous moisture (vegetation). Source is colluvial slope	8230		Price River Formation	
030	21S04E22BDB	9-17-77	None		Unable to locate spring as noted on USGS topographic maps; observed several areas of previous moisture on a bench at the base of a slope (may be associated with a slump or fault).	8935		Price River Formation	
		6-78	Dry						
		9-78	Dry						
		7-79	10						
		10-79	2	Estimated					
030A	21S04E15DCC	9-17-77	Seep	Not Meas.	Moisture, vegetation indicate seep area	8760		North Horn Formation/ Price River Formation	
030B	21S04E15DCC	9-17-77	5	Estimated	Spring in dry stream channel; source is a fractured sandstone unit	8705		North Horn Formation/ Price River Formation Contact	

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA - Continued

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
031	21S04E21DBD	9-17-77	Moist	Not Meas.	Spring is dry at this time; source is in colluvium on a hillside	8360		Price River Formation	
032	21S04E35CDB on topo map	9-17-77 6-80	(Dry) Seep Area 5-10		Evidence of previous moisture (vegetation). Source is colluvial slope	8300		Price River Formation	
034	21S05E20BCD	9-17-77	Not Known	No Access	Appears to be a spring along fracture zone at canyon bottom	8040		Castlegate Sandstone Member (Base)	
035	21S05E26BBA GW-5	9-17-77	0.2	Time/Volume	Developed spring	8440	Stock Watering	Castlegate Sandstone Member (Base)	
036	21S05E26BCC ?	9-17-77	5	Estimated	Poor access prevented flow measurement; flow mainly from a caved mine adit; all flows appear to have source in a coal bed overlying a massive sandstone unit	7715		Blackhawk Formation	
047	22S04E12CDA	9-77	52		Pumphouse effluent. Pumphouse and water collection system in canyon bottom; spring area in alluvium (at Ksp/Kum contact)	7205	Industrial	Alluvium	Yes

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA - Continued

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
047		6-78	60						
		9-78	49						
		7-79	0						
		10-79	29.3						
048	22S04E16AAD				Developed spring used for domestic purposes and road wetting	7860	Domestic	Blackhawk Formation	
059	22S05E09BD	6-80	<0.1		2' Diameter pool in alluvium below spring	6680		Alluvium	
059-A	22S05E09BD	6-80	Seep		Eminating from dark shale	6705			
GENERAL AREA									
050(1)	22S04E29CAA				At base of cliff in draw	7800		Castlegate Sandstone Member (Base)	
051(2)	22S04E26CBD				In draw below plateau	8200		Castlegate Sandstone Member	
052(2)	22S04E32DBB				Hillslope	8445		Price River Formation	
053(2)	22S04E04DDC				On cliff slope below plateau	8205		Castlegate Sandstone Member	

TABLE H-2 SPRING AND SEEP INVENTORY FOR THE SUFCO PROPERTY AND SURROUNDING AREA - Continued

Site(1) No.	Location	Date Examined	Flow (gpm)	Method of Measurement	Remarks	Altitude (feet)	Water Use	Aquifer	Water Analysis
054(2)	23S04E02CCD				On hillslope below plateau	8280		Castlegate Sandstone Member	
055(2)	23S04E16BAB				In draw below plateau	8125		Castlegate Sandstone Member	
056(2)	21S04E17CBB				On open hillslope	9335		Price River Formation	

(1) See Plates H-I and H-II.
(2) These spring data were interpreted from USGS topographic maps (Scale 1:24,000).

SOUTHERN UTAH FUEL COMPANY's HYDROLOGICAL RESPONSE TO OSM'S APPARENT COMPLETENESS REVIEW

for

Mr. Kevin Yocum
Coastal States Energy Corporation
Coastal Towers
Nine Greenway Plaza
Houston, Texas 77046

by

HYDROMETRICS, INC.
1300 Cedar Street
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406/443-4150

November 1, 1980

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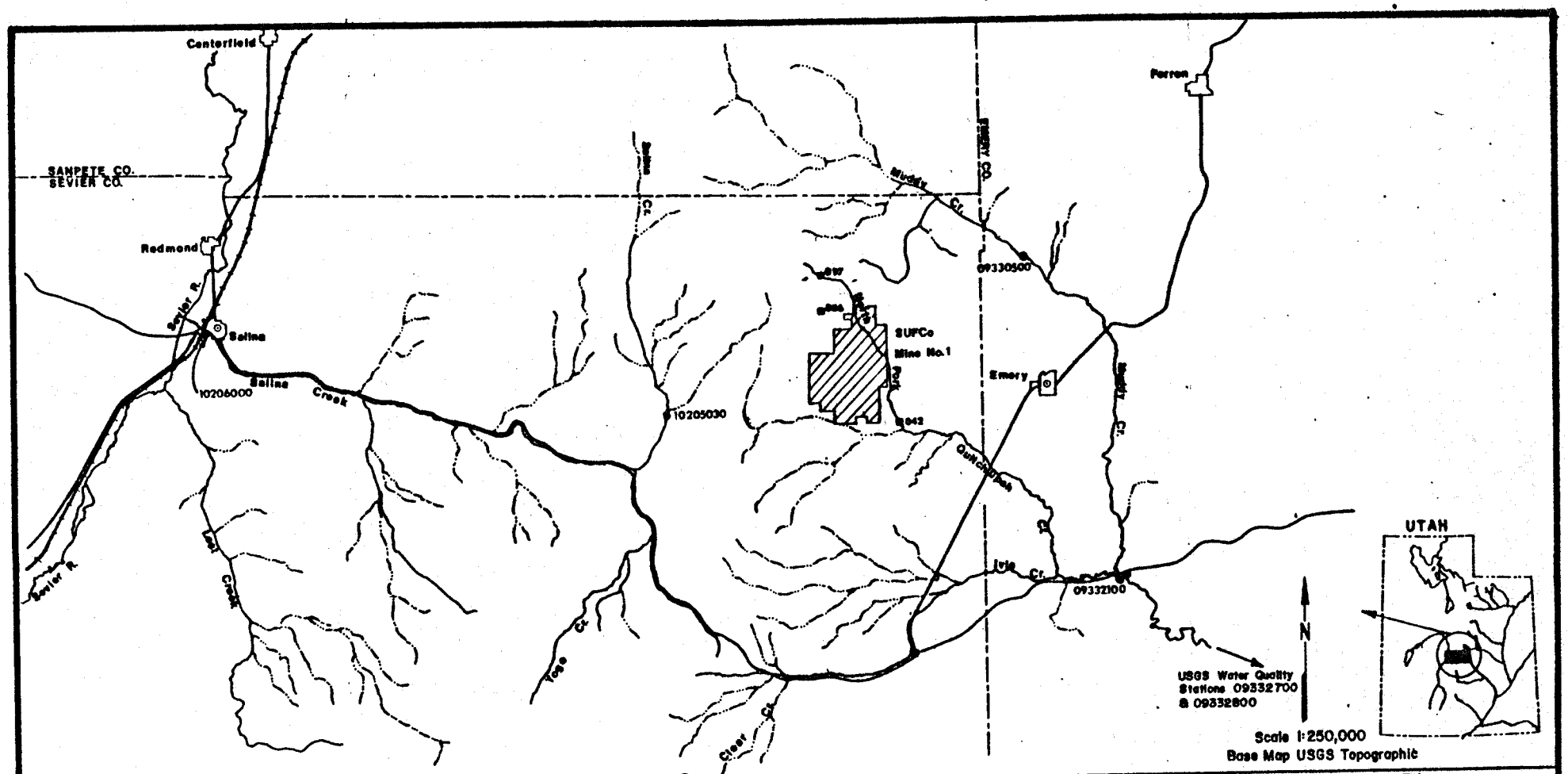
783.13 Statement to Clarify Areas

The "mine permit area" is that area enclosed by the mine permit boundary (Plate H-II). The "mine plan area" and the "affected area" are considered to have the same boundaries as the mine permit area. The "adjacent area" (Plate H-II) boundary varies from about 0.2 mile to 1.5 miles outside the mine permit boundary and includes most water quality monitoring sites. These definitions are consistent with Section 701.5 of the OSM Permanent Regulatory Program-Surface Coal Mining and Reclamation Operations.

The term "general area" is not defined in Section 701.5. Therefore, the following definition obtained from Montana's Permanent Program-Strip and Underground Mine Reclamation Act is used:

> General area means with respect to hydrology, the topographic and groundwater basin surrounding a mine plan area which is of sufficient size, including areal extent and depth, to include one or more watersheds containing perennial streams and groundwater systems and to allow assessment of the probable cumulative impacts on the quantity and quality of surface and groundwater systems in the basin.

The "general area" is shown on Plate H-II. Figure H-1 is a sketch map of the surface water drainage system in the SUFCo Mine No. 1 area near Salina, Utah.



LEGEND

- USGS Gaging Station
- SUFCo Gaging Station
- NOAA Met. Station
- Mine Plan Area
- USGS Water Quality Station

Prepared by
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PROFESSIONAL SEAL

SOUTHERN UTAH FUEL Co.
A SUBSIDIARY OF
COASTAL STATES ENERGY Co.

SURFACE WATER DRAINAGE SYSTEM
IN THE
SUFCo MINE No.1 AREA
NEAR SALINA, UTAH

JOB No.		FIGURE or EXHIBIT H-1
DWG No.	REVISIONS	

783.14(a) Provide Information (GMO-1)

A discussion of aquifers below the lowest coal seam to be mined is described in detail in Section 783.15.

783.14(a)(1)(i) Description of Subsurface Water

Areas where subsurface water is and will be exposed at face-up areas in the SUFCo No. 1 Mine are related to both geological and hydrological characteristics of overlying formations. Fractures, joints, and faults appear to be the most important conduits for movement of groundwater from strata overlying the coal seam. In the past few years observations by underground mine personnel show that most mine water is produced at working faces. As the workings are advanced, flows decrease rapidly and often completely dry up. There appears to be no way to positively predict when fractures and faults encountered in the mine will produce water. In some areas, fractures and faults are dry, whereas in other areas they contain water and drain into the mine. Underground personnel have also noted some seasonal variation in the quantity of water entering the mine. Generally the period of maximum inflow into the mine is in February and March and inflow decreases in the summer and fall months. There have been no quantitative measurements of of this annual change in flow, however there is enough seasonal difference to be noticeable.

Controlling mechanisms responsible for water entering the mine probably involve blocks of strata having interconnected fracture systems that drain and yield water to the mine. In some parts of the mine however, these fracture systems are not sufficiently permeable or are not interconnected enough to yield significant quantities of water. The nature of flow into the mine strongly suggests the main conduit for water movement is not flow in the porous media, but rather flow through zones of secondary permeability, i.e. faults and fractures. This is a common characteristic of many underground mines.

A recent map of the underground workings of the SUFCo No. 1 Mine, together with areas of mine inflow, are shown in Plate H-III.

Also shown on Plate H-III is the piping and pumping system for the mine. Pipes and pumps used to remove underground water from the mine are moved and changed as needed. For the past several years, the pumpage of water from the mine has varied from 200 to about 400 gallons per minute. The amount of water produced seems to be related to the number of headings being advanced in the mine.

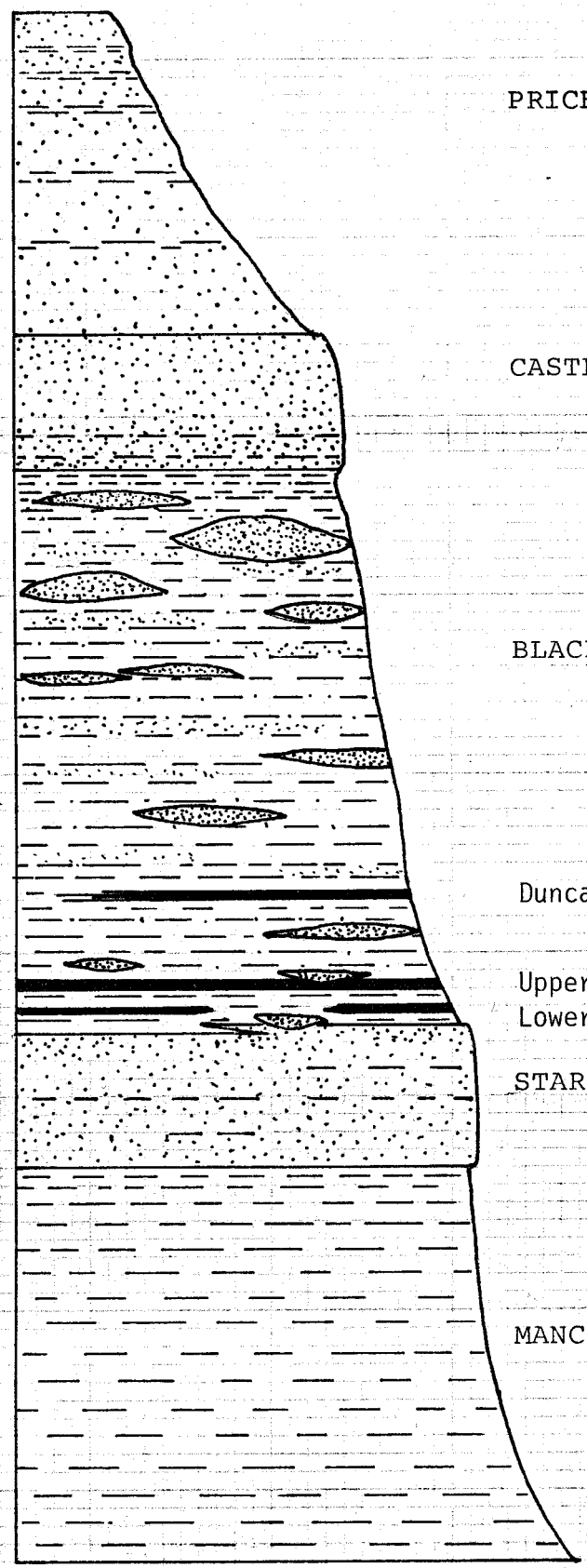
In the past few years, several large underground blocks of coal have been mined out and have subsided. In accordance with underground mining practices, these subsided blocks are sealed off and are monitored to determine water production. These large blocks are producing very little groundwater (less than 10 gpm), which again indicates that once the aquifer system is drained, there is little continued inflow of water into the mine. The coal seam itself produced very little water from the face or ribs and it probably should not be considered an aquifer.

783.15 Groundwater Information

Geology in the mine permit area is described in detail in Section 783.14. Stratigraphy of the area, in descending order, consists of the Price River formation, Blackhawk formation, Star Point sandstone and the Mancos shale. (Figure H-2). A large number of exploration holes have been drilled on the property to determine the area stratigraphy and the depth, thickness, and areal extent of the coal seam. A total of seven exploration holes were cased with perforated pipe. All holes were backfilled with cement to the desired elevation. The perforated casing was inserted and fine gravel packed around the pipes. Pipes were 1¼ inch or 2 inch black steel and perforations were either small drilled holes or thin torch-cut slots. After backfilling around the perforated section, a thin layer of drill cuttings was placed in the hole and the hole was backfilled to the ground surface with cement.

The Price River formation consists of about 450 feet of interbedded sandstone and claystone and is present on topographically high portions of the mine permit area. This formation has not been identified as an aquifer in the mine permit area and is not known to contain groundwater or to furnish water to springs in the area. No groundwater observation wells have been completed in this formation.

The Castlegate sandstone consists of an estimated 120 to 260 feet of medium to coarse-grained sandstone with a few thin interbedded mudstones or shales near the base. The sandstone is conglomeritic, forms prominent cliffs, and is well cemented with calcareous cement. Based on about 40 exploration drill holes in the mine permit area, the Castlegate sandstone contains small quantities of groundwater with faults and fractures being the major groundwater conduits. No significant quantities of groundwater (more than 2 gpm) were encountered in any exploration hole and no groundwater was detected in most holes. The drilling technique used (air with foam injection) makes it difficult to detect very small quantities of groundwater. A total



SOUTHERN UTAH FUEL Co.
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Figure H-2
STRATIGRAPHY of the SUFCO
NO. I MINE PERMIT AREA

of three observation wells were installed in the Castlegate sandstone. Characteristics of these wells are shown on Table H-1. There are three springs in or adjacent to the permit area that probably are derived from the Castlegate sandstone contact with the underlying Blackhawk formation (Table H-2 and locations on Plate H-II). Flow from these springs is small, but Spring 001 is important for livestock watering.

Based on available geological and hydrological data, the Castlegate sandstone is considered an aquifer. However there are only small quantities of groundwater in the formation. This groundwater probably is associated with fractures and faults and the sandstone probably transmits little water. If water is flowing in the sandstone, and it is acting as a porous media, then moist areas should be present at outcrops. The area was carefully examined for moist outcrops and none were found. Downdip?

As shown on the surficial geological map, the Castlegate sandstone is present over much of the mine permit area. It outcrops in deep canyons and forms steep cliffs. Depth of the Castlegate below the ground surface varies from zero at outcrops to over 400 feet beneath the high plateau areas. The only known use of water from the Castlegate sandstone is for livestock watering at springs.

Groundwater recharge to the Castlegate sandstone is from precipitation and snowmelt, and it discharges to springs and possibly transmits some water by vertical movement to underlying strata. Available evidence indicates annual recharge and discharge of groundwater are small. In the summer of 1980, two or three additional observation wells will be drilled into the Castlegate sandstone near Spring 001. The objective of these monitoring wells is to determine mining impacts in the Spring 001 area.

The Blackhawk formation underlies the Castlegate sandstone and consists

of about 710 to 833 feet of interbedded sandstone, siltstone, shale, and coal. The Blackhawk is exposed in canyons, but is over 600 feet beneath the high plateaus and hills on the mine permit area.

The Upper Hiawatha coal seam being mined by SUFCo is located near the base of the Blackhawk formation. During drilling of over 40 exploration holes, no significant quantities of groundwater were encountered in the Blackhawk. The Blackhawk formation is the source for a few seeps identified in the mine permit area (Table H-2). At the SUFCo Mine, groundwater has entered the underground workings at the rate of 200 to 400 gpm during the past few years. Underground workings are extensive in size and underlie an area of several square miles. As described in Section 783.14(a)(1)(i), underground water is encountered primarily at working faces and is associated with faults and fractures. These zones yield water readily into new headings, but inflow rates normally rapidly decline as mining progresses and inflow commonly ceases after a few months.

Both drilling and underground observations indicate the groundwater flow in the Blackhawk formation primarily is in faults and fractures. Very few springs and no "wet faces" are present in Blackhawk sandstone outcrop areas. This suggests that general flow through the pores in the sandstone is not significant.

A total of four observation wells have been completed in the Blackhawk formation (Table H-1). Measurements of static water levels in these wells in June, 1980, using an electric probe, showed these four wells to be dry. The presence of dry monitoring wells was somewhat surprising considering the 200 to 400 gpm groundwater inflow into the SUFCo underground workings. There are several possible explanations for this contradiction. It is possible that the observation wells have not encountered any fractures or faults and the primary permeability of the Blackhawk formation is insufficient to supply water to the wells. It also is possible that the

wells are plugged and are not hydraulically connected to the formation. It seems unlikely that four wells would fail to respond to water levels. The area could be drained by mining and the water levels have been lowered. This seems impossible in that new headings continue to encounter groundwater and groundwater continually enters the underground workings.

To obtain a better understanding of groundwater conditions, the four observation wells will be tested by water injection in the fall of 1980. This will show the extent of hydraulic connection with the Blackhawk formation. Recharge sources for the Blackhawk formation are not well known, however precipitation and periodic streamflow on outcrop areas and vertical percolation from the overlying Castlegate sandstone are probable sources of recharge. Discharge is to seeps and underground mine workings and probably to the underlying Star Point sandstone.

The Star Point formation is fine to medium grained in texture with grain size increasing upwards. The Star Point forms a well defined cliff between the slopes of Mancos shale and the overlying Blackhawk formation. Except where eroded or exposed in deep canyons, the Star Point sandstone underlies the entire mine permit area. The Star Point is over 1000 feet deep beneath the high plateaus and hill areas.

Few springs or seeps originate in the Star Point formation. The mine water supply system located in Convulsion Canyon may receive water from the Star Point. Exploration drilling generally has not extended far into the Star Point. Those holes drilled into the Starpoint formation have not encountered significant quantities of groundwater.

Recharge and discharge characteristics of this formation are not well known. Recharge may occur in some outcrop areas and by vertical movement from the overlying Blackhawk formation.

Underlying the entire mine permit area and exposed in deep canyons is the Mancos shale. This dark, slope-forming, marine shale is essentially impermeable and contains no groundwater.

783.15(a)(1) Depth and Extent of Water Table and Aquifers (Quantitatively)

Information on observation well logs are in Section 783.15 and well locations are shown on Plate H-II.

783.15(a)(4) Discussion of Data, Method of Collection, etc.

Discussion of quality of subsurface water is in Section 783.15, including methods of collection, preservation and analysis. ? This Volume? Where is it?

783.15(a)(4) Quality of Sub-Surface Waters

Quality of sub-surface waters can be determined by sampling observation wells, or springs, seeps, and discharges from underground mine workings. Observation wells in this area are deep and drilling of such wells requires use of drilling additives such as bentonite mud, foam, water, and cement. Use of these materials in wells makes it difficult to obtain a sample of the groundwater that has not been affected by well drilling and construction. This is particularly true in areas where aquifers supply small quantities of water as there is insufficient water to thoroughly clean the holes or to pump the holes prior to sampling. Water quality samples from most observation wells are significantly influenced by drilling and construction techniques and many holes provide water samples that do not represent formation water. Sampling of seeps, springs, and other natural points of discharge and underground workings provides a relatively unaffected water sample that is representative of groundwater in the formation.

In the SUFCo mine area, it was decided to not utilize observation wells as groundwater quality sampling points. Instead, the East Spring (Site 001), the mine discharge (Site 021), pumphouse effluent (Site 047), and selected sites within the underground workings (Plate H-III) will be used as water quality sampling points. These sites should accurately represent groundwater above, below, and within the coal. Tabulation of water quality at these sites is in Appendix H-A.

East Spring (Site 001) was developed by the U. S. Forest Service for livestock and has its source in the Castlegate sandstone. Flow from this spring has remained quite uniform since semi-annual sampling began in September, 1977, and has varied from 2 to 3 gpm (Appendix H-A). The quality of water from East Spring can be characterized as a very hard (more than 180 mg/l as $CaCO_3$), calcium-

bicarbonate water with moderate nitrogen and phosphorous concentrations, and with moderate quantities of dissolved solids and low concentrations of trace metals (Appendix H-A). This spring is heavily used for stock watering and easily meets the criteria for Utah's Class C water (Table H-3). The spring waters also are suitable as a public supply source and meet National Primary Interim Drinking Water Standards (Table H-4).

As described in this section, the SUFCo underground mining operation has a significant inflow of groundwater which is considered to be related to fracturing and faulting in the area. Water discharge from the mine is pumped into a culvert at Site 021 (Plates H-I and H-II). Flow from the mine is estimated by measurement of the time the pump is operated, less consumptive use in the mine for dust control. Flows in the mine typically have occurred in new headings and the overall trend in the mine has been an increase in the amount of water discharged as the number of headings increases. In 1977, flow from the mine ranged from 0 to 250 gpm with a total pumpage of 46,000 to 140,000 gallons per day (Coastal States Energy Corporation, 1977). By June, 1980, total volume discharged from the mine had increased to 433,500 gallons per day or about 425 gpm. (Craig Hilton, SUFCo Mine, pers. comm., June 20, 1980).

The quality of waters pumped from the mine in 1975 and 1976 (WESTECH, 1978) were of a similar quality to East Spring (Site 001). An examination of water quality data for both sites in 1978, 1979, and 1980 (Appendix H-A) indicates this conclusion is still generally true. However, the concentrations of sulfate and magnesium in the mine discharge increased significantly between 1975 and 1978. The quality of water discharged from the mine from 1978 through 1980 has remained essentially unchanged.

Site 047 (Pumphouse effluent) is the point of discharge for the water cistern that supplies water to the mine. The source of this

Table H-3 Utah Division Of Health Numerical Standards For Water In The State

Constitutent	CLASSES										
	Domestic Source			Recreation & Aesthetics		Aquatic Wildlife				Agri-culture	Indus-try	Special
	1A	1B	1C	2A	2B	3A	3B	3C	3D	4	5	6
Bacteriological (No./100 ml)												
(30-day Geometric Mean) Maximum Total Coliforms	1	50	5,000	1,000	5,000	*	*		*	*		
Maximum Fecal Coliforms	*	*	2,000	200	2,000	*	*		*	*		
Physical												
Total Dissolved Gasses	*	*	*	*	*	(b)	(b)		*	*		
Minimum DO (mg/l) (a)	*	*	5.5	5.5	5.5	6.0	5.5		5.5	*		
Maximum Temperature	*	*	*	*	*	20°C	27°C		*	*		
Maximum Temp. Change	*	*	*	*	*	2°C	4°C		*	*		
pH	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0		6.5-9.0	6.5-9.0		
Turbidity increase (c)	*	*	*	10 NTU	10 NTU	10 NTU	10 NTU		15 NTU	*		
Chemical (Maximum mg/l)												
Arsenic, dissolved	.05	.05	.05	*	*	*	*	STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS (SEE APPENDIX D)	*	.1	STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS	STANDARDS WILL BE DETERMINED ON A CASE-BY-CASE BASIS
Barium, dissolved	1	1	1	*	*	*	*		*	*		
Cadmium, dissolved	.010	.010	.010	*	*	.0004(d)	.004(d)		*	.01		
Chromium, dissolved	.05	.05	.05	*	*	.10	.10		.10	.10		
Copper, dissolved	*	*	*	*	*	.01	.01		*	.2		
Cyanide	*	*	*	*	*	.005	.005		*	*		
Iron, dissolved	*	*	*	*	*	1.0	1.0		1.0	*		
Lead, dissolved	.05	.05	.05	*	*	.05	.05		*	.1		
Mercury, total	.002	.002	.002	*	*	.00005	.00005		.00005	*		
Phenol	*	*	*	*	*	.01	.01		*	*		
Selenium, dissolved	.01	.01	.01	*	*	.05	.05		*	.05		
Silver, dissolved	.05	.05	.05	*	*	.01	.01		*	*		
Zinc, dissolved	*	*	*	*	*	.05	.05		*	*		
NH_3 as N (un-ionized)	*	*	*	*	*	.02	.02		*	*		
Chlorine	*	*	*	*	*	.002	.01		*	*		
Fluoride, dissolved (e)	1.4-2.4	1.4-2.4	1.4-2.4	*	*	*	*		*	*		
NO_3 as N	10	10	10									
Boron, dissolved	*	*	*	*	*	*	*		*	.75		
H_2S	*	*	*	*	*	.002	.002		*	*		
TDS (f)	*	*	*	*	*	*	*		*	1200		
Radiological (Maximum pCi/l)												
Gross Alpha	15	15	15	*	*	15(g)	15(g)		15(g)	15(g)		
Radium 226, 228 combined	5	5	5	*	*	*	*		*	*		
Strontium 90	8	8	8	*	*	*	*		*	*		
Tritium	20,000	20,000	20,000	*	*	*	*		*	*		
Pesticides (Maximum ug/l)												
Endrin	.2	.2	.2	*	*	.004	.004		.004	*		
Lindane	4	4	4	*	*	.01	.01		.01	*		
Methoxychlor	100	100	100	*	*	.03	.03		.03	*		
Toxaphene	5	5	5	*	*	.005	.005		.005	*		
2, 4-D	100	100	100	*	*	*	*		*	*		
2, 4, 5-TP	10	10	10	*	*	*	*		*	*		
Pollution Indicators (g)												
Gross Beta (pCi/l)	50	50	50	*	*	50	50		50	50		
BOD (mg/l)	*	*	5	5	5	5	5		5	5		
NO_3 as N (mg/l)				4	4	4	4		*	*		
PO_4 as P (mg/l)(h)	*	*	*	.05	.05	.05	.05		*	*		

* Insufficient evidence to warrant the establishment of numerical standard. Limits assigned on case-by-case basis.

(a) These limits are not applicable to lower water levels in deep impoundments.

(b) Not to exceed 110% of saturation.

(c) For Classes 2A, 2B, 3A, and 3B at background levels of 100 NTUs or greater, a 10% increase limit will be used instead of the numeric values listed. For Class 3D at background levels of 150 NTUs or greater, a 10% increase limit will be used instead of the numeric value listed. Short term variances may be considered on a case-by-case basis.

(d) Limit shall be increased threefold if $CaCO_3$ hardness in water exceeds 150 mg/l.

(e) Maximum concentration varies according to the daily maximum mean air temperature.

Temp. °C	mg/l
12.0 and below	2.4
12.1 to 14.6	2.2
14.7 to 17.6	2.0
17.7 to 21.4	1.8
21.5 to 26.2	1.6
26.3 to 32.5	1.4

(f) Total dissolved solids (TDS) limit may be adjusted on a case-by-case basis.

(g) Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

(h) PO_4 as P(mg/l) limit for lakes and reservoirs shall be

Table H-4
Federal Drinking Water Standards
for Public Water Supplies

Parameter	Maximum Contaminant Levels for Inorganic Chemicals (mg/l)
Primary Standards (1)	
Arsenic	0.05
Barium	1
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate as N	10.
Selenium	0.01
Silver	0.05
Fluoride	1.4 - 2.4 (2)

Secondary Standards (3)	Recommended Maximum Contaminant Levels (mg/l)
Chloride	250
Color	15 (color units)
Copper	1.0
Corrosivity	Non-corrosive
Iron	0.3
Manganese	0.05
Odor	Threshold odor number c
pH	6.5 - 8.5 Standards Uni
Sulfate	250
Zinc	5.0
Total Dissolved Solids	500
Foaming agents	0.5

(1) 40 CFR Part 141 (Federal Register, Vol. 40, No. 248, December 24, 1975)

(2) Maximum allowable concentration depends on annual average of maximum daily air temperatures at site of supply.

(3) 40 CFR Part 143 (Federal Register, Vol. 44, No. 140, July 19, 1979)

supply is an area of shallow groundwater which has been developed by use of a collection system consisting of 300 feet of perforated 4-inch PVC pipe buried upstream from the pumphouse. The source of groundwater in this area is probably from the alluvium and possibly from the Star Point/Upper Mancos contact in the canyon bottom. Measured flows at Site 047 have been relatively constant for the period of baseline water quality data collection (1978 through 1980). This water is a very hard, calcium-bicarbonate type with moderate concentrations of other major ions; manganese concentrations which typically exceed the recommended limit of 0.05 mg/l and low concentrations of other trace metals. Concentrations of most major ions (calcium, magnesium, sodium, potassium, sulfate, and bicarbonate, plus manganese) are greater in the pumphouse effluent than concentrations of the same ions in the mine effluent (Site 021). Dissolution of soluble minerals in the Star Point formation and possibly in the Upper Mancos formation is the probable cause for the increased ion concentration.

Water quality samples were also obtained from four sampling sites in underground workings of the SUFCo No. 1 Mine. These water quality data are tabulated in Appendix H-A. Locations of mine sampling points are shown on Plate H-III. Groundwater entering the mine is a very hard, alkaline, calcium magnesium-bicarbonate type with low concentrations of nutrients and metals, and low to moderate concentrations of total dissolved solids. Except for high concentrations of manganese and iron at Site 062, the waters meet all primary and secondary Federal Drinking Water Standards for public water supplies.

783.16(a) Map All Surface Water Bodies; Discuss Seasonal Variations in Water Quality

Water from the SUFCo Mine and associated surface facilities is discharged to the Quitchupah Creek watershed. The mine plan area, the adjacent area, and the general area are totally within the Quitchupah Creek watershed. The location of all surface water bodies, such as streams, ponds, and springs, and the location of the mining discharge are shown on Plate H-II. There are no lakes in the mine plan area or the adjacent area. Acord Lakes are in the general area.

Nine sites on or adjacent to the SUFCo property were selected for collection of baseline surface water quality (Table H-5 and Plate H-II). Eight of these sites were chosen to obtain data for streams above or below potential mine related disturbances or points of inflow to or outflow from the mine plan area. One site was chosen to obtain data on an important stock watering spring which may be adversely affected by subsidence. All samples were grab samples. Sample collection began in 1978, with samples collected during snowmelt runoff and the early fall low-flow season. Much of the Quitchupah Creek drainage upstream of the mine is inaccessible in winter and early spring due to snowpack accumulation. Therefore, sampling during snowmelt runoff was timed to occur as soon as possible after sites became accessible. A limited number of water quality samples were collected at other selected sites. Analyses of water at these sites typically was limited to flow, temperature, specific conductance, and turbidity (estimated).

The mine portal area is located at the confluence of Mud Spring Hollow and East Spring Canyon. During all sampling periods these drainages were dry at the mine portal area and had little or no streamflow anywhere in the drainage. Considerable effort will be made to obtain water samples from these drainages during the 1981 spring runoff. Samples will be collected at least once per month

TABLE H-5 SUFCo PROPERTY AND SURROUNDING AREA PRIMARY WATER QUALITY STATIONS AND PARAMETERS

Site No.	Location	Site Description	Field Measurements	Laboratory Measurements
001	21S04E36DCD	Spring in Duncan Draw (East Spring)	Discharge	Specific Conductance pH Calcium Magnesium Sodium Potassium Carbonate Bicarbonate Sulfate Chloride Total dissolved solids Total suspended solids Fluoride Nitrate as N Total Kjeldahl Orthophosphate as P Silica Total Iron Total Manganese Total Arsenic Total Cadmium Total Selenium
006	21S04E24CAC	S. Fork Quitchupah Creek	Specific Conductance Temperature (water) Turbidity (estimated)	
007	21S04E13ADC	N. Fork Quitchupah Creek		
021	22S04E12BAD	Mine Effluent		
041	22S05E16DDA	Quitchupah Creek above N. Fork		
042	22S05E16DAD	N. Fork Quitchupah above mouth		
046	22S04E12CDB	Convulsion Canyon above pumphouse		
047	22S04E12CDA	Pumphouse Effluent		
047A	22S04E12CDA	E. Spring Canyon above Convulsion Canyon		

during this time and peak runoff will be estimated from crest gage data or maximum depth of water in culverts.

Published information on water quality data for the mine plan and nearby area is limited. These data (Appendix H-A) consist of a single analysis of two springs near the mine, a single analysis of the mine sump and effluent, a single analysis for three sites on Quitchupah Creek, and three analyses for Muddy River (Creek) at the I-70 bridge. The U. S. Geological Survey (USGS) has no water quality stations in the Quitchupah Creek drainage, but has three stations on Muddy Creek (Figure H-I). Stations 09332700 (Muddy Creek at Delta Mine, near Hanksville, Utah) and 09332800 (Muddy Creek at Mouth near Hanksville, Utah) were established in 1975, and are stations at which chemical and physical quality data are regularly collected. However, these stations are many miles downstream of the SUFCo property. Limited water quality data (temperature and specific conductance) are collected at partial record station 09332100 (Muddy Creek below Interstate Highway I-90 near Emery, Utah). Water quality data have not been collected by the USGS in the Salina Creek drainage.

Baseline water quality samples collected by Hydrometrics were analyzed according to the analytical schedule in Table H-5. Samples collected for laboratory examination were collected, preserved, and stored in accordance with EPA recommended techniques and were analyzed in an EPA approved laboratory using techniques in 40 CFR 136 or equivalent techniques. Field analyses were completed on site immediately after collection. Results of chemical analyses of surface water samples collected in the mine plan area, adjacent area, and general area during the baseline period are tabulated in Appendix H-A.

Based on an examination of baseline period data (data for 1978 through 1980) plus published data, the following conclusions are made:

1) Water in the general area is generally of fair to good quality, is a calcium magnesium-bicarbonate type, is alkaline, and has low concentrations of nutrients and metals.

2) For parameters measured, waters sampled at baseline stations usually met federal primary and secondary drinking water standards (Table H-4). However, in five of seventeen samples collected in 1979, total dissolved solids exceeded secondary drinking water standards.

3) Downstream waters of Quitchupah Creek become progressively poorer with increasing total dissolved solids, particularly a substantial increase in sodium sulfate. This probably reflects dissolution of soluble salts from geological formations in the area. These waters change from a fair quality near the SUFCo Mine to poor quality at the Browning Mine. Waters from the Browning Mine exceed recommended standards for total dissolved solids, iron, and sulfate. The general picture of water quality which emerges is that of high quality water within the mine plan area and the adjacent area. These waters become degraded in quality by interaction with sodium-sulfate and other soluble minerals in geological units, particularly marine shales downstream from the mine area.

4) Total iron and manganese concentrations occasionally exceed federal secondary drinking water standards (Table H-4).

5) For parameters measured, waters sampled typically were better than required by Utah Water Quality Standards (Table H-3) for domestic use and aquatic wildlife.

However, orthophosphate concentrations in samples collected in 1979 and 1980, often exceeded Utah standards, while orthophosphate concentrations in samples collected in 1978 usually did not. Reasons for the apparent increase are unknown. However, area soils probably are the primary source of phosphorous.

possible contaminated samples?? bottles (recycled bottles?)

6) None of the water sampled exceeded recommended limits for livestock use (Table H-6).

7) Seasonal fluctuations in water quality of springs, effluent discharged from the mine, and general area streams were relatively small (Figure H-3, H-4 and H-5). In the streams however, quality usually was slightly poorer (higher concentrations of dissolved substances) in the fall than during spring runoff, when dissolved substances were somewhat lower. As expected, suspended solids concentrations were greater in the spring, during high flow, than in the fall. Suspended solids concentrations were typically less than 15 mg/l in the fall (Appendix H-A). Therefore, semi-annual sampling of streams is sufficient to define seasonal variations in water quality.

2 times a yr. for baseline determination is questionable?

8) No significant adverse mining related impacts to water quality of the mine plan area and adjacent area have been observed. However, the decrease in total dissolved solids in Quitchupah Creek above the North Fork (Site 041) is probably due to the dilution effect of the mine discharge. Total dissolved solids in the mine discharge (Site 021) are significantly lower than that in Convulsion Canyon above the pumphouse (Figure H-3). Oil and grease concentrations discharged from the mine have exceeded NPDES wastewater discharge permit effluent limitations because sheens have occasionally been observed at Site 047A.

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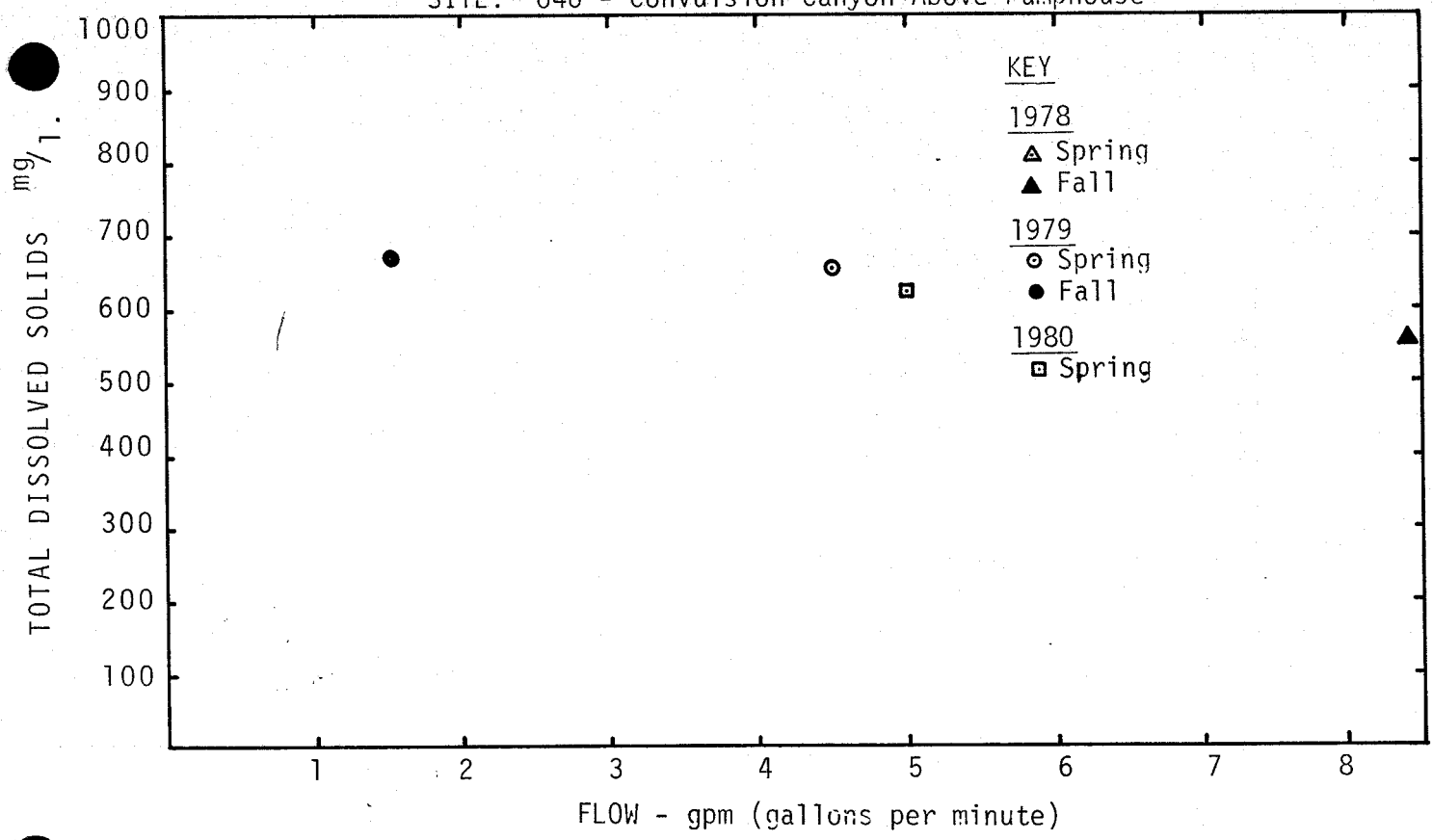
TABLE H-6 RECOMMENDED LIMITS FOR LIVESTOCK WATER

Parameter	Concentration - mg/l
$NO_3 + NO_2$ as N	100
Total Dissolved Solids	3000-5000
Boron	5
Aluminum	5
Cadmium	0.05
Copper	0.5
Fluoride	2.0
Iron	No Recommendation
Lead	0.1
Mercury	0.010
Selenium	0.05
Vanadium	0.1
Zinc	25

Source: U.S. Environmental Protection Agency, 1973. Water Quality Criteria 1972. EPA-R-73-023.

SEASONAL FLUCTUATIONS IN WATER QUALITY

SITE: 046 - Convulsion Canyon Above Pumphouse



SEASONAL FLUCTUATIONS IN WATER QUALITY

SITE: 021 - Mine Effluent

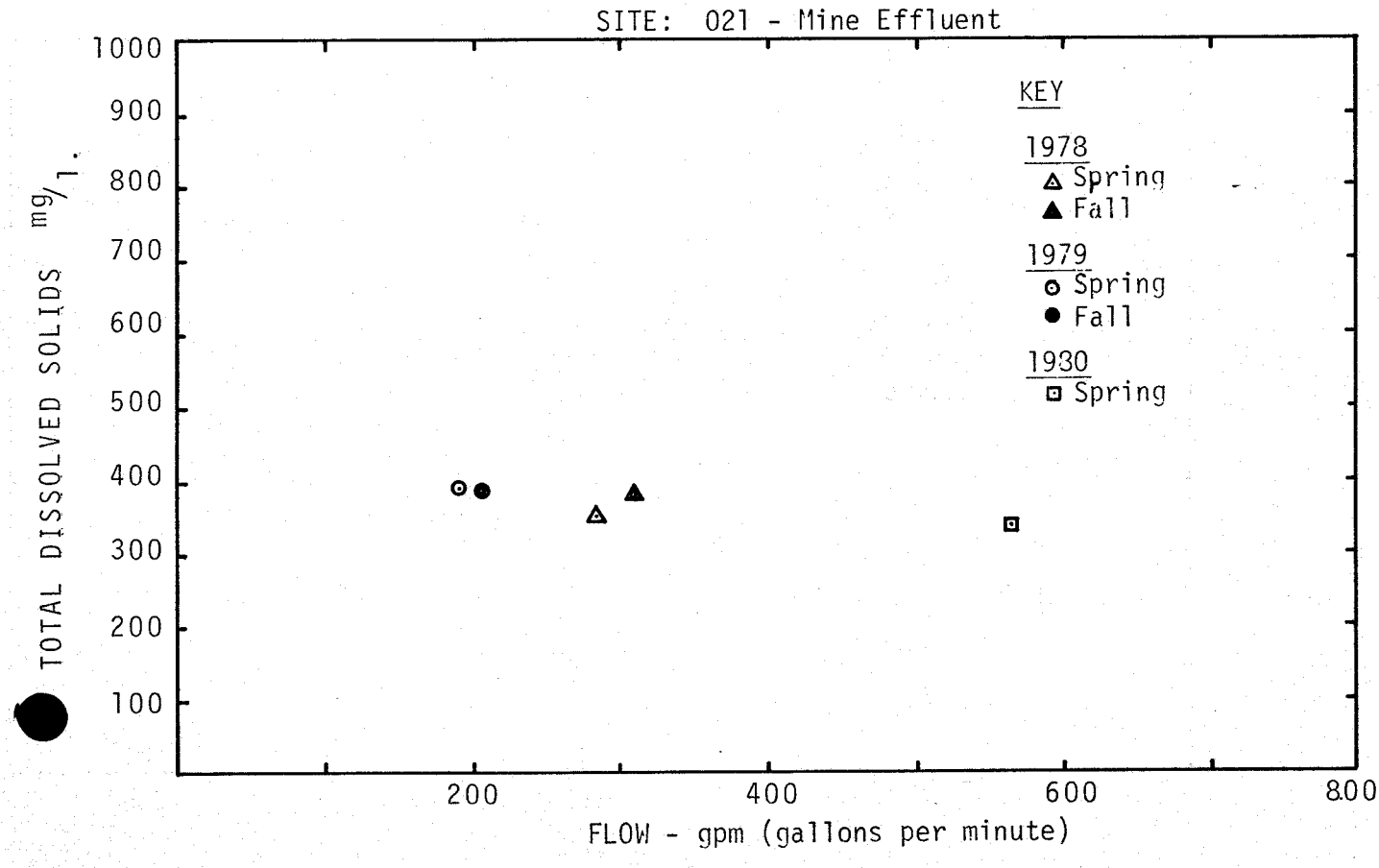
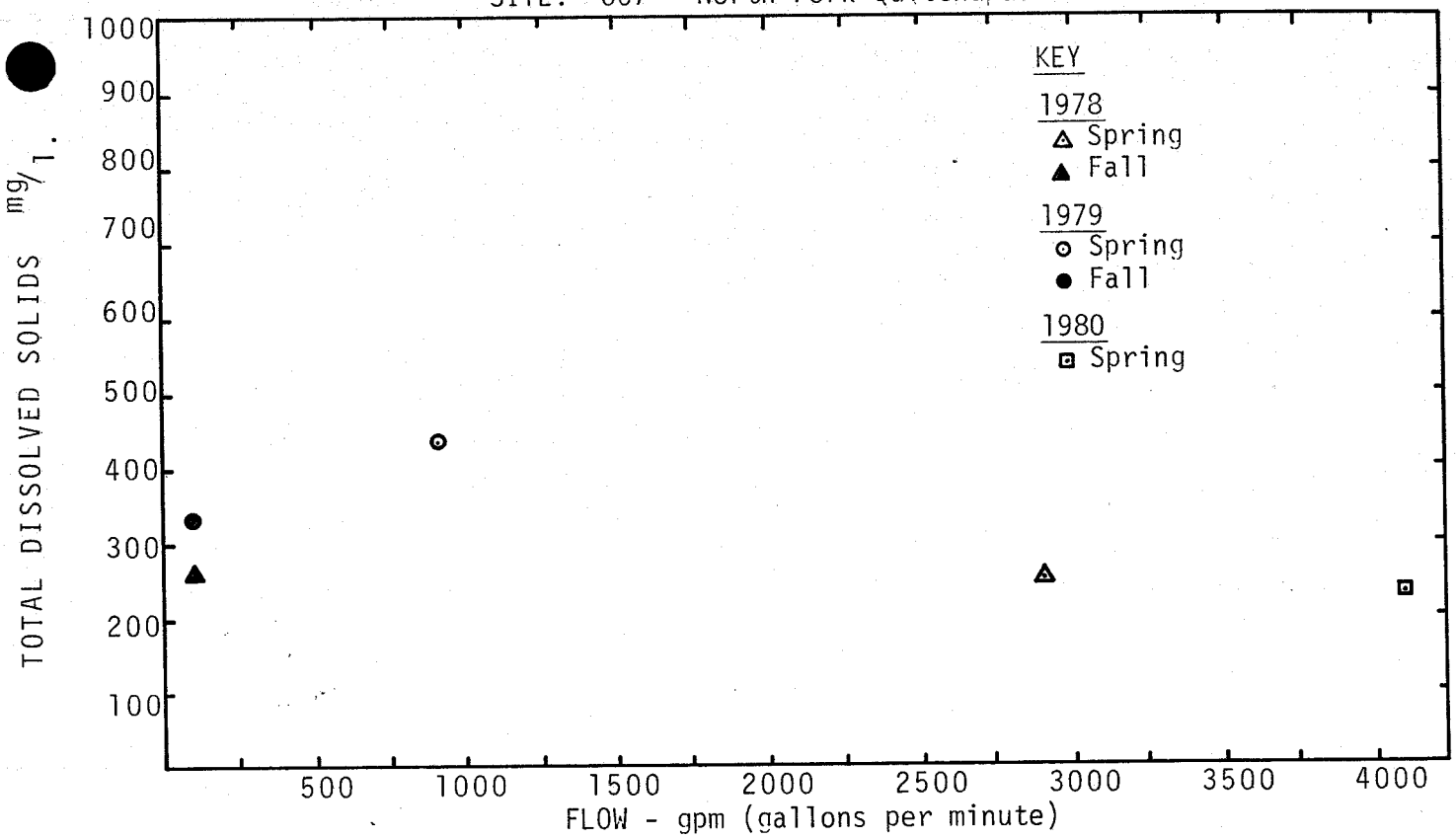


FIGURE H-3

SEASONAL FLUCTUATIONS IN WATER QUALITY

SITE: 007 - North Fork Quitchupah Creek



SEASONAL FLUCTUATIONS IN WATER QUALITY

SITE: 042 - North Fork Quitchupah Creek above Mouth

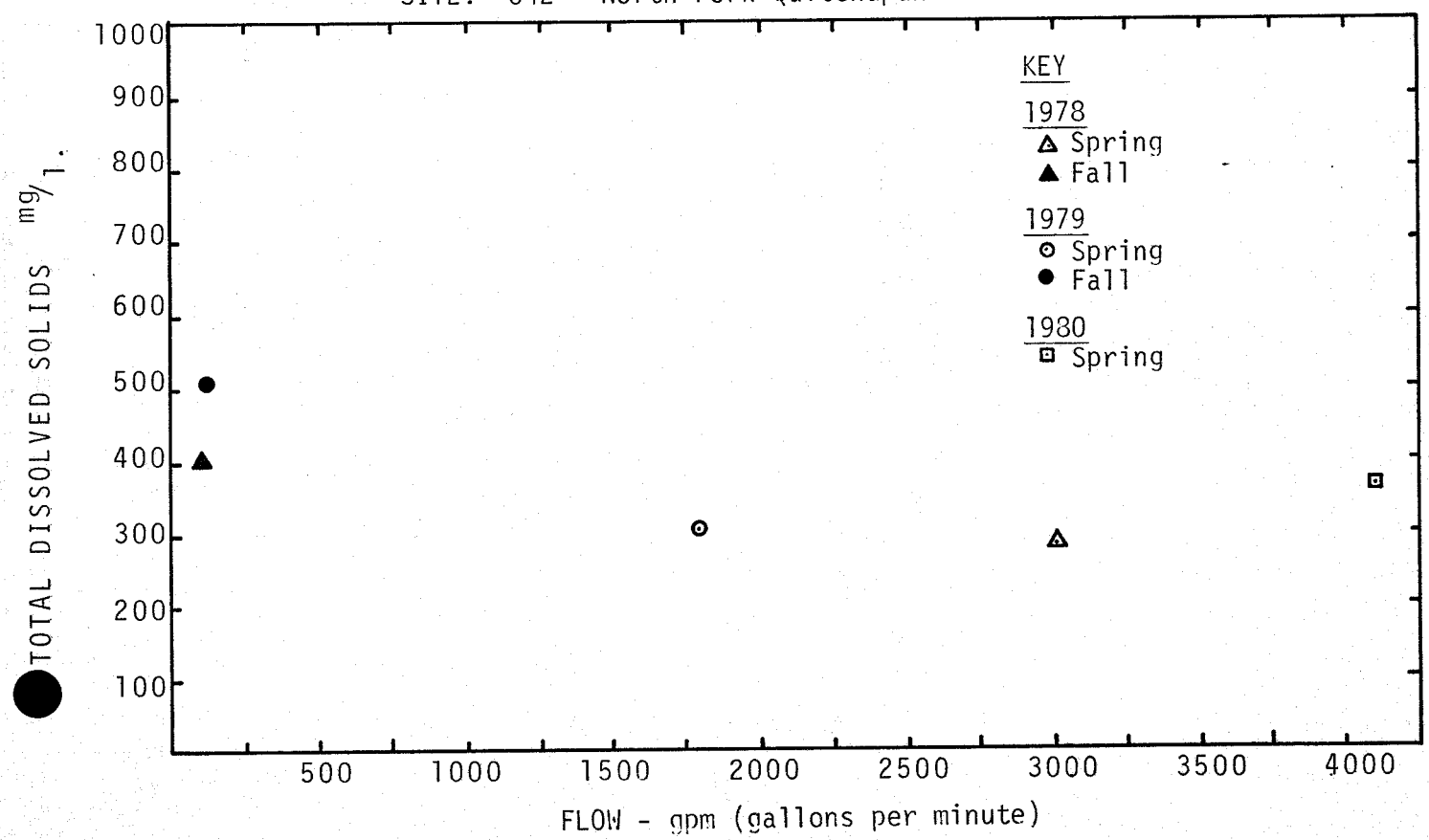
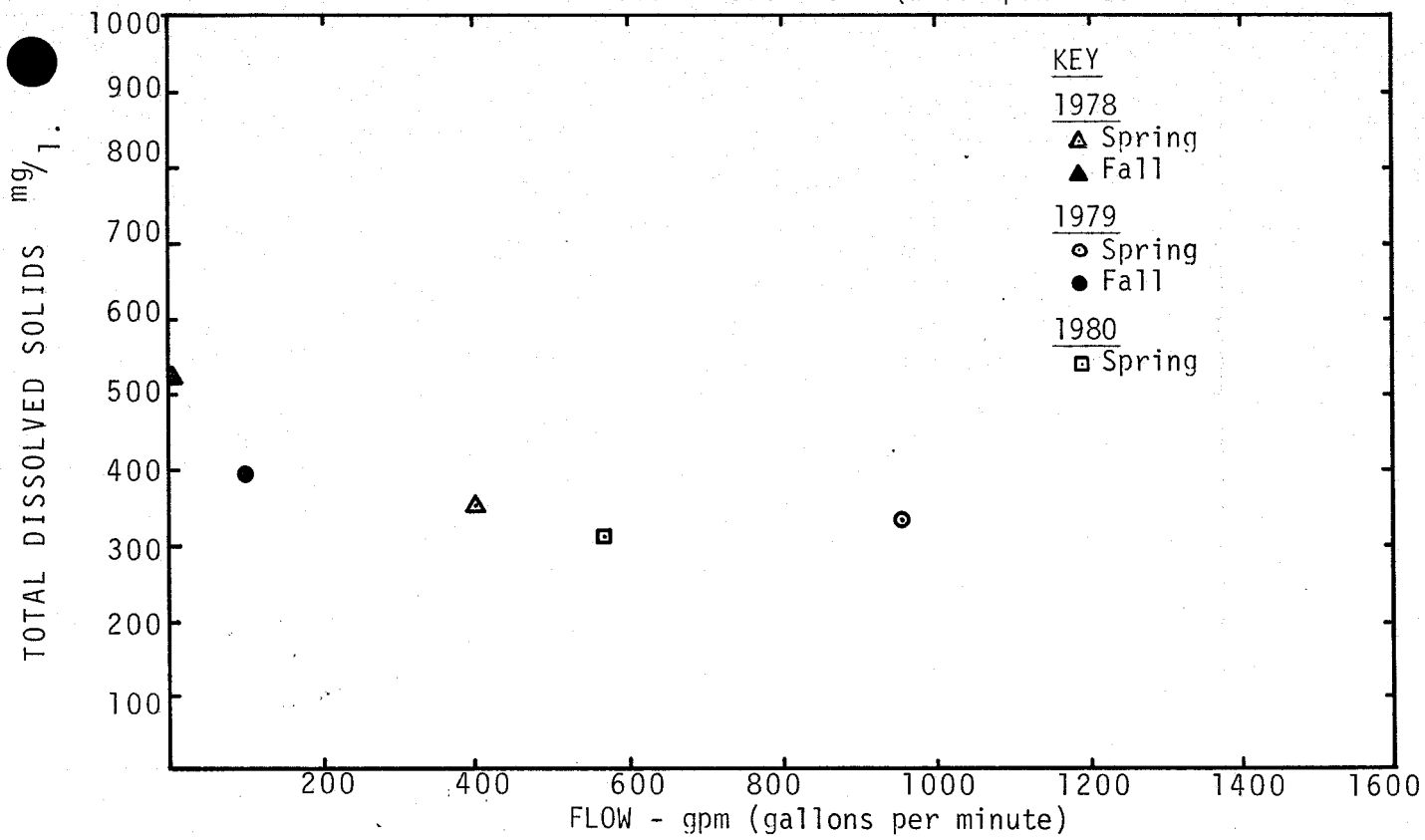


FIGURE H-4

SEASONAL FLUCTUATIONS IN WATER QUALITY

SITE: 006 - South Fork Quitchupah Creek



SEASONAL FLUCTUATIONS IN WATER QUALITY

SITE: 041 - Quitchupah Creek North Fork

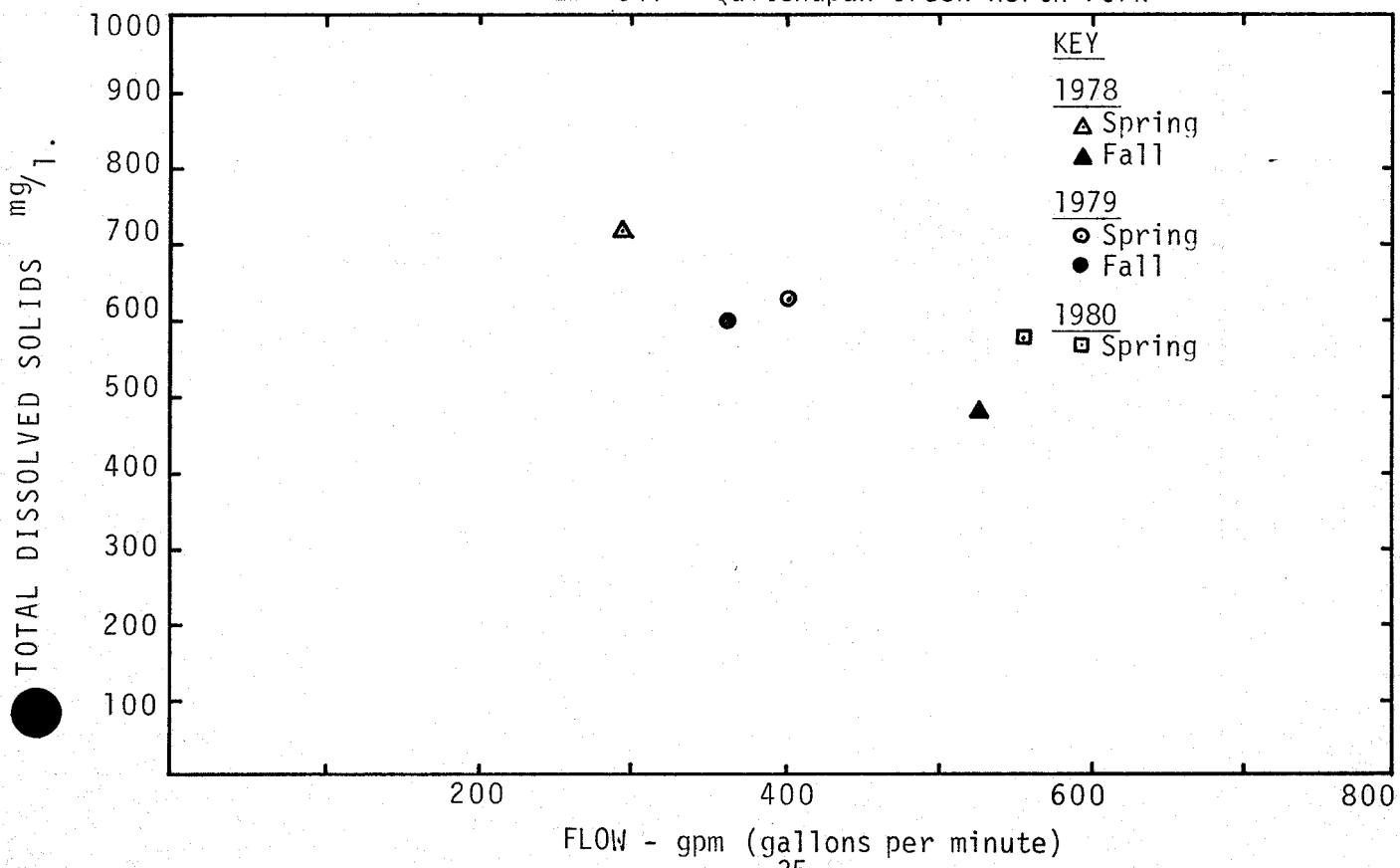


FIGURE H-5

Modifications were made to floor drains at shop facilities to correct this problem. Total suspended solids from the mine and surface facilities have exceeded NPDES wastewater discharge permit effluent limitations resulting in the deposition of coal fines in the lower reaches of East Spring Canyon (Site 047A), and in Convulsion Canyon downstream of the East Spring Canyon confluence. Improved operation and maintenance of existing facilities, and construction of proposed sedimentation ponds will correct this problem.

What about oil from mine?

What about fines from mine discharge?

9) Acidity measurements were not made because waters sampled are alkaline, highly buffered, and had pH values consistently greater than neutral (7.0). All pH values recorded were greater than 7.1 and less than 8.0.

10) Dissolved iron concentrations have not been measured. Total iron concentrations were usually less than maximum concentrations in federal secondary drinking water standards (Table H-4). The maximum total iron concentration measured was 1.23 mg/l and occurred during spring runoff. Since total iron concentrations during low flow periods are often low (commonly less than 0.1 mg/l) and coincide with low suspended solids concentrations, most of the iron apparently is associated with suspended sediment carried during spring runoff.

11) There appears to be no distinct correlation between streamflow and total manganese concentrations. The greatest total manganese concentration measured was 0.181 mg/l at Site 047 (Convulsion Canyon above pumphouse) during spring runoff. A similar value (0.101 mg/l) was obtained at the same site during low flow. Total manganese concentrations at other stream sites typically were

Is there a culvert associated with drainage here?

much less (usually less than 0.05 mg/l) during spring runoff and during fall low flow periods.

783.16(b)(1) Basin Discharges

Maximum, average, and minimum water yields for streams draining the mining area can be estimated by use of existing flow data and empirical formulas. The North Fork Quitchupah Creek (Site 042) has an area of 23.7 square miles and drains the northeastern part of the mine plan area. Quitchupah Creek above the North Fork (Site 041) has an area of 42.9 square miles and drains the remainder of the mine plan area (Plate H-II).

Peak Flows

There is insufficient historical streamflow data for a statistical analysis of maximum flows on either Quitchupah Creek or North Fork Quitchupah Creek. To estimate peak flows for these streams, a comparison was made with two nearby basins that have long-term streamflow records reported by the U.S. Geological Survey. Thirty-five years of data are available for the Muddy Creek Station (09330500), which is east of the SUFCo property and has a drainage area of 105 square miles above the gaging site. The other basin used for comparison is the upper Salina Creek. This basin is just west of the mine plan area and has a 51.8 square mile drainage area above the USGS gaging station (#10205030). A total of fifteen years of gaging data are available for the Salina Creek station. A statistical analysis of peak flows per unit area for the Muddy Creek and the Salina Creek sites were used to estimate peak flows for Quitchupah Creek and North Fork Quitchupah Creek.

Annual maximum peak flows for both Muddy Creek and Salina Creek were used for a flood frequency analysis as described by Zelenhasic (1970). Using this technique, peak flows were arrayed in descending order of magnitude, and flow probabilities were determined as shown in Tables H-7 and H-8. Data were plotted on log-probability paper (Figures H-6 and H-7). From these curves, flood magnitudes for given return intervals were determined (Table H-9). Both the North

TABLE H-7 PROBABILITY AND RECURRENCE INTERVAL CALCUALTED FROM 35-YEAR ANNUAL MAXIMUM SERIES FOR MUDDY CREEK NEAR EMERY, UTAH

Runoff Peak (c.f.s.)	Order Number ~~M~~ m (?)	Probability* $\frac{m}{n+1}$ per cent	Recurrence Interval $\frac{n+1}{m}$ years
3340	1	3.0	36.00
2290	2	6.0	18.00
2120	3	8.0	12.00
1640	4	11.0	9.00
1560	5	14.0	7.20
1560	6	17.0	6.00
1410	7	19.0	5.14
1320	8	22.0	4.50
1120	9	25.0	4.00
1080	10	28.0	3.60
969	11	31.0	3.27
850	12	33.0	3.00
816	13	36.0	2.76
752	14	39.0	2.57
698	15	42.0	2.40
660	16	44.0	2.25
544	17	47.0	2.12
535	18	50.0	2.00
504	19	53.0	1.89
446	20	56.0	1.80
404	21	58.0	1.71
403	22	61.0	1.63
360	23	64.0	1.56
356	24	67.0	1.50
322	25	69.0	1.44
303	26	72.0	1.38
299	27	77.0	1.33
295	28	78.0	1.28
290	29	81.0	1.24
282	30	83.0	1.20
270	31	86.0	1.16
268	32	89.0	1.12
257	33	92.0	1.09
91	34	94.0	1.05
72	35	98.0	1.02

* Where n is number of years of record and m is rank in the array.

TABLE H-8 PROBABILITY AND RECURRENCE INTERVAL CALCULATED FROM A 15-YEAR ANNUAL MAXIMUM SERIES FOR SALINA CREEK NEAR EMERY, UTAH

Runoff Peak (c.f.s.)	Order Number m	Probability* $\frac{m}{n+1}$ per cent	Recurrence Interval $\frac{n+1}{m}$ years
519	1	6.0	16.67
480	2	13.0	7.69
463	3	19.0	5.26
282	4	25.0	4.00
195	5	31.0	3.23
191	6	38.0	2.63
176	7	44.0	2.27
166	8	50.0	2.00
155	9	56.0	1.79
118	10	63.0	1.59
110	11	69.0	1.45
94	12	75.0	1.33
45	13	81.0	1.23
34	14	88.0	1.14
16	15	93.0	1.07

* Where n is the number of years of record and m is the rank of the item in the array.

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FIGURE H-6 LOG PROBABILITY GRAPH OF PEAK FLOWS OF MUDDY CREEK NEAR EMERY, UTAH

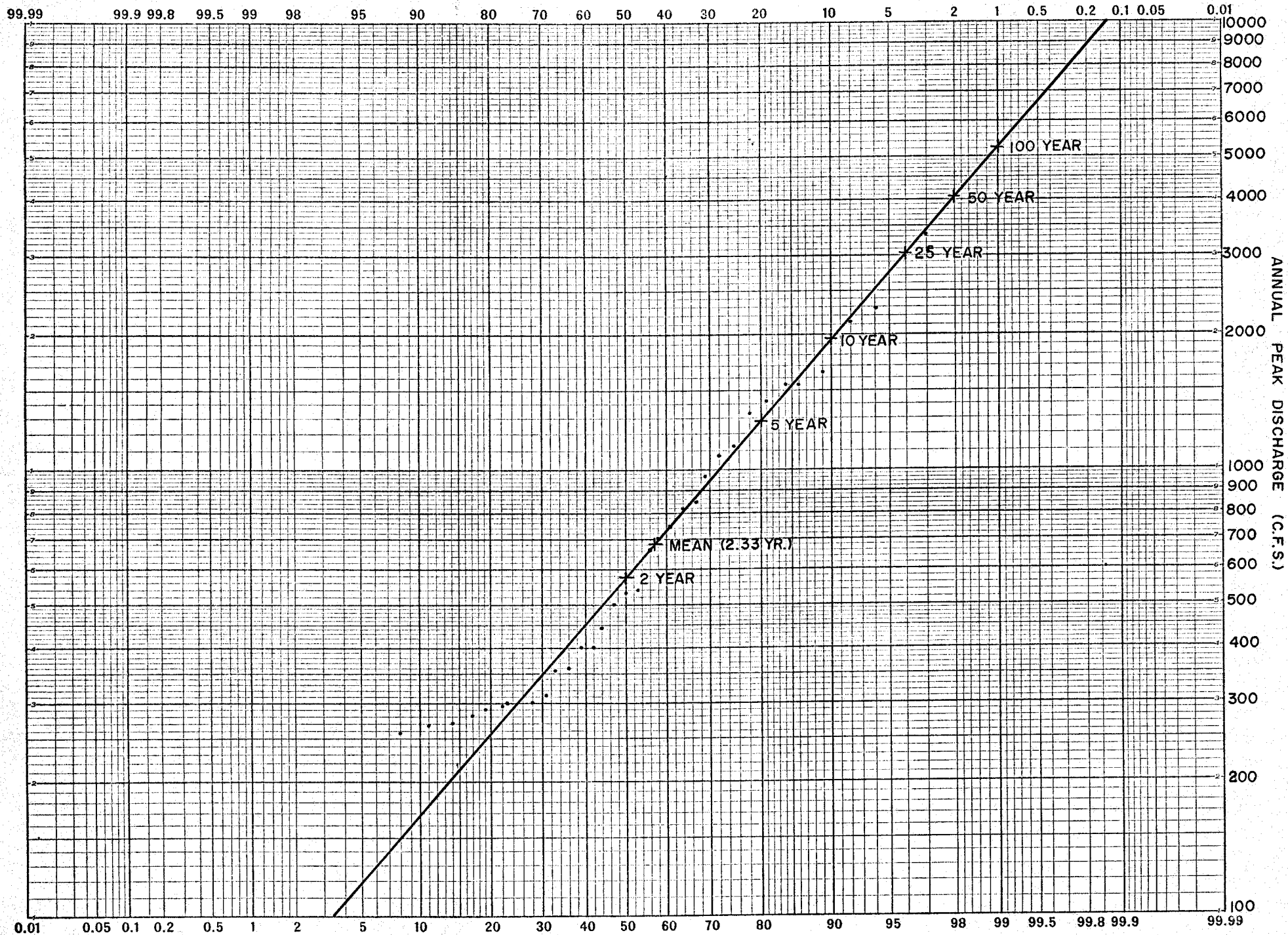

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FIGURE H-7 LOG PROBABILITY GRAPH OF PEAK FLOWS OF SALINA CREEK NEAR EMERY, UTAH

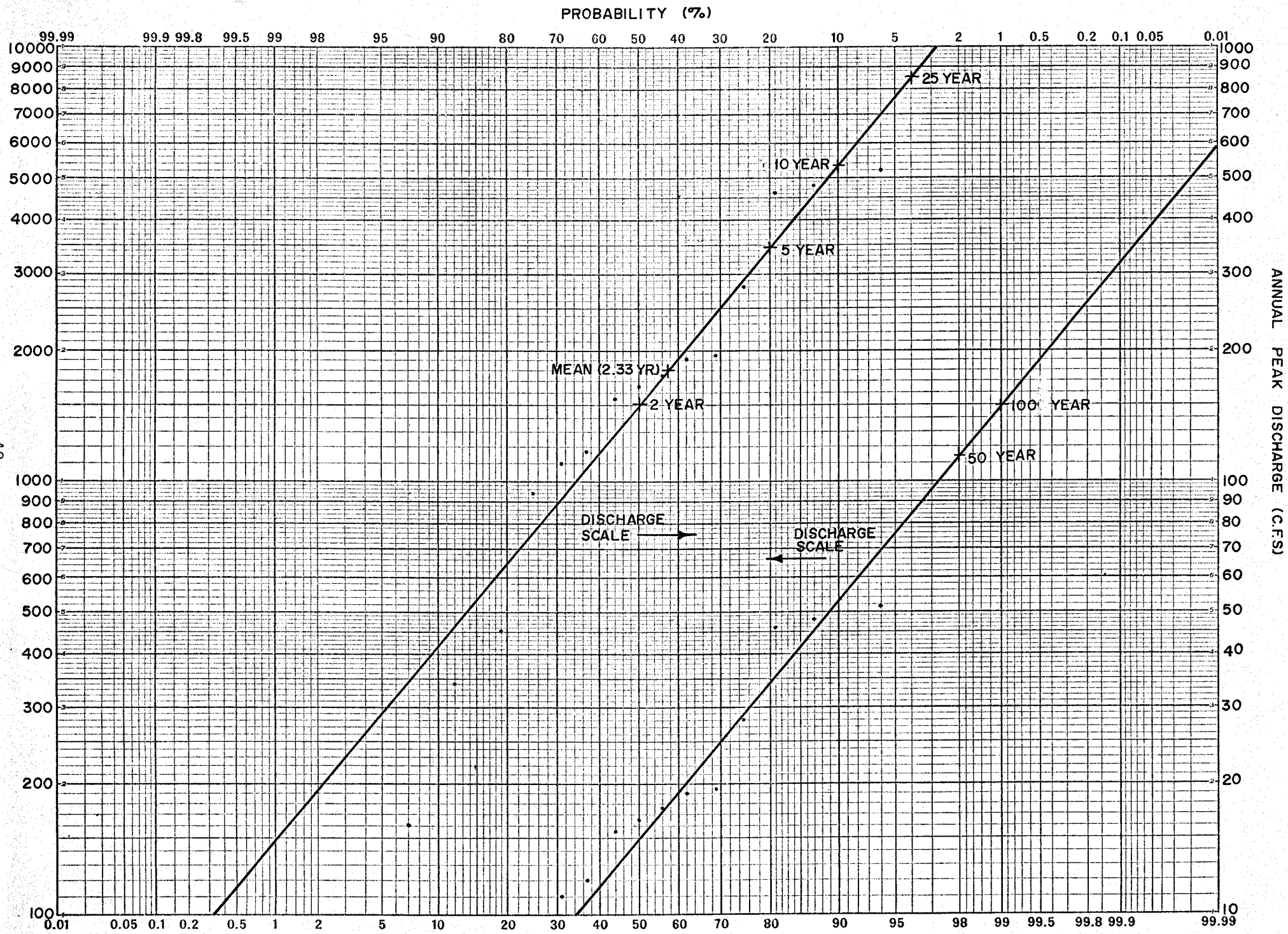

TABLE H-9 FLOOD FREQUENCY AND ESTIMATED MAXIMUM FLOW FOR MUDDY CREEK AND SALINA CREEK NEAR EMERY, UTAH

Muddy Creek (Drainage area: 105 sq. mi.)

Recurrence Interval (years)	Estimated Flow (cfs)	Flow Per Unit Area (cfs/mi.^{2})
100	5200	49.52
50	4050	38.57
25	3025	28.81
10	1950	18.57
5	1280	12.19
2	575	5.48
Mean annual flood (2.33)	680	6.48

Salina Creek (Drainage area: 51.8 sq. mi.)

Recurrence Interval (years)	Estimated Flow (cfs)	Flow Per Unit Area (cfs/mi.^{2})
100	1500	28.96
50	1140	22.01
25	850	16.41
10	535	10.33
5	345	6.66
2	150	2.90
Mean annual flood (2.33)	176	3.40

Fork Quitchupah Creek and Quitchupah Creek above the North Fork are similar physiographically and climatologically to the Muddy Creek and Salina Creek drainages. Estimated flood peaks for selected return intervals for Quitchupah Creek and the North Fork Quitchupah Creek are in Table H-10. Estimation of flood discharges for ungaged drainages are based on data from adjacent gaged streams for given recurrence intervals. This method is subject to several potential errors. These are:

Supportive Data? Veg + soils?

1) Local climatological factors vary greatly between drainages in the mountainous terrain of central Utah, giving potential errant results when extrapolating data one drainage to another. (A. Richardson, Utah State Climatologist, Personal communciation, July, 1980).

2) Snowmelt runoff is an important element in the determination of peak annual discharges. Snow accumulation and snowmelt can be significantly affected by topography, cornice development, and wind patterns.

3) Land use in adjacent drainages differs to some extent causing variations in discharge form individual streams in the area; e.g., irrigation practices, stream diversions, and ponding.

Yes! Have these been taken into account?

Average Flow

Grunsky's formula as modified by Sellers (1965), Ol'deKop's formula (Sellers, 1965 and Linsley, 1967), and comparison with average annual flow in adjacent basins were used to estimate average annual water yield from Quitchupah Creek above the North Fork (041) and North Fork Quitchupah Creek (042).

Estimates of annual precipitation and temperature used in these equations were obtained from data collected at the nearby Hiawatha

TABLE H-10 FLOOD FREQUENCY AND ESTIMATED MAXIMUM FLOW FOR NORTH FORK QUITCHUPAH CREEK AND QUITCHUPAH CREEK NEAR EMERY, UTAH

Recurrence Interval (years)	Estimated Flow (c.f.s.)	
	North Fork Quitchupah Creek (Site) 042	Quitchupah Creek (Site) 041
100	928	1683
50	716	1299
25	535	970
10	342	620
5	223	404
2	99	180
Mean annual flood (2.33)	117	212

Mine $111^{o}1'$ longitude, $39^{o}29'$ latitude). Meteorological characteristics at the SUFCo mine were considered to be similar to meteorological characteristics at the Hiawatha Mine (Arnold Richardson, personal communication, July 29, 1980).

Grunsky's formula:

$$Q = \alpha P^2 \quad (\text{for } P \leq 1/(2\alpha))$$

where Q is the long-term average annual runoff in inches; P is the long-term average annual precipitation in inches; and α is a runoff coefficient per inch. Based on guidelines developed by Hawkins (1976), a runoff coefficient value of 0.006 was assumed for the SUFCo mine property (Personal communication, Dr. Richard Hawkins, July 29, 1980).

Calculated average annual basin runoff using this equation is 1.04 inches and average annual runoff yields for each drainage are shown in Table H-11.

The second method used to determine average annual water yield from the area was Ol'deKop's formula. According to this method,

$$Q = P - E_o \tanh \frac{P}{Eo}$$

where Q and P are as previously defined, E_o is the potential evapotranspiration, and tanh is the hyperbolic tangent. Using precipitation data for the Hiawatha Mine, long-term average annual precipitation (P) at the SUFCo property is estimated to be 13.18 inches. Potential evapotranspiration (E_o) was computed using a formula developed by Thornthwaite (1948) which states:

$$E_o = 1.6\ b\ \ (10t/I)^a$$

where E_o is the monthly potential evapotranspiration in centimeters; t is mean monthly temperature (C^o); b is a factor to correct for unequal day length; I represents the summation of 12 monthly heat indexes to produce an annual heat index; and a is a cubic function of I. Solving for the monthly E_o, summing the 12 values, and converting metric to English units, produced an average annual evapotranspiration value of 22.5 inches. Substituting this value together with long-term average annual precipitation (P) into Ol'deKop's formula results in a calculated average annual water yield for the basin of 1.28 inches. Estimates of average annual water yield for each drainage are shown in Table 11.

TABLE H-11 ESTIMATED AVERAGE ANNUAL FLOW

	CALCULATED FLOW (IN CFS)		
Basin	Grunsky's Formula	Ol'deKop's Formula	Comparison with Adjacent Areas
Quitchupah Creek (041)	3.3	4.1	14.6
North Fork Quitchupah Creek (042)	1.8	2.2	8.0

The third method used to determine average annual water yield from the area was a comparison of average annual flow from adjacent areas. Recorded average flow for the Muddy Creek basin (32 years) and the upper Salina Creek (15 years) were divided by the basins' respective area. These unit flows were then averaged and multiplied by the area of the North Fork Quitchupah Creek and Quitchupah Creek basins to determine basinwide flows. Results of this method of calculation are in Table H-11.

Average annual water yield values obtained using these equations are not exact. The methodology and assumptions used may not apply to conditions at the SUFCo Mine and vicinity. Specifically, meteorological parameters used were derived from a geographically similar area but, local climatology in mountainous areas could produce a different

climatic regime for the SUFCo property, and data from the Hiawatha Mine may not be representative. Second, several importana parameters were not included in derivation of these formulas. These include geology, vegetation, and soil characteristics.

On-going streamflow monitoring in the SUFCo Mine area includes three flumes with continuous recorders installed in June, 1980. These sites are:

1) A Parshall flume and continuous recorder on the North Fork of Quitchupah Creek (T22S, R5E, Section 16, Tract DDA)

2) A cutthroat flume and continuous recorder on the North Fork of Quitchupah Creek (T21S, R4E, Section 24, Tract CBD)

3) A Parshall flume and continuous recorder on the South Fork of the North Fork of Quitchupah Creek (T21S, R4E, Section 4, Tract CAC)

With continued yearly monitoring of these sites, a better understanding of long-term water yield for the SUFCo Mine area will be obtained.

Minimum Flows

Evaluating duration, magnitude, and probability of occurrence of low flows has been a subject of much less hydrological effort than has peak flows. Therefore, predictive technology is poor. Low flows are environmentally important since they can be significant in terms of wildlife and livestock watering. Magnitude of these flows are particularly susceptible to influences from area geology, topography, and vegetation. Generally, low flow conditions exist during the late summer, fall, and winter. Data for low flows and drainages in the SUFCo Mine area is limited. Fall low flow data for streams in the

SUFCo Mine area are tabulated in Table H-12. Streamflow is very low in these drainages during dry seasons of the year and many, if not all, streams are dry during some portions of some years.

TABLE H-12 SUMMARY OF SELECTED LOW FLOW VALUES IN THE VICINITY OF THE SUFCO NO. 1 MINE NEAR SALINA, UTAH

Site No.*	Site Description	Flows (g.p.m.) 9-77	9-78	10-79
006	S. Fk. Quitchupah Cr.	34	2	99
007	N. Fk. Quitchupah Cr. above canyon	22.3	100	91
007B	Tributary to N. Fk. Quitchupah Cr. above canyon	Dry	Dry	Dry
041	Quitchupah Cr. above N. Fk.	247	525	359
042	N. Fk. Quitchupah Cr. near mouth	2.5	90	103
046	Convulsion Canyon (above pumphouse)	3.8	8.4	1.5
047A	East Spring Canyon above Convulsion Canyon	Not Measured	359	202
021	East Spring Canyon above mine	Dry	Dry	Dry
022	Mud Spring Hollow above mine	Dry	Dry	Dry

*See Plate H-II for location.

Base flow in Quitchupah Creek is significantly influenced by discharge from the SUFCo #1 Mine. Since 1977, the mine has discharged an average of approximately 200 to as much as 400 gallons per minute to the lower segment of East Spring Canyon. East Spring Canyon is a tributary to Convulsion Canyon, which in turn provides a significant base flow to Quitchupah Creek.

There are three continuous recording streamflow gaging stations in operation in the SUFCo Mine area. These are located at Sites 006, 007, and 042 (Plate H-II). Low flow measurements in these streams are significantly affected by severe snow and cold weather, which causes icing and damming of streamflow. This makes continuous recording of low flows in winter months difficult and inaccurate. In addition to recording stations, streamflows are measured semi-annually in all drainages and are adjacent to the mine permit area. This fall low flow data will continue to be collected and will be of significant value in determining stream low flow characteristics.

783.16(b)(2) Depict Seasonal Variations in Water Quality

Seasonal variations in water quality are discussed in Section 783.16(a).

783.17 Describe Alternative Water Supply

Based on an inventory of springs, it appears that one water supply source may be adversely affected by subsidence due to mining. Spring 001 located in East Spring Canyon (Plate H-II) probably originates in the lower portion of the Castlegate sandstone. Due to subsidence from planned underground mining, the spring potentially may have its flow interrupted or diminished. It is possible that underground mining will have no effect on this spring due to the healing or swelling effect that shales in this area may have. Often, shales will "flow" and seal fractures in a short time period. This could limit the vertical movement of water from the Castlegate sandstone into underlying strata. Subsidence from mining has occurred within about 1000 feet of this spring and, to date, no impacts have been observed. This spring is used for stock watering and has a consistent flow of about 1.5 to 2.5 gpm. There are several options to provide an alternate water supply if this spring is damaged by mining. These are:

1) Drilling of a water well into strata underlying the Castlegate sandstone. The Star Point sandstone underlies the Blackhawk formation and this sandstone contains some groundwater. The Star Point formation, however, furnishes water to very few springs, and groundwater encountered during exploration drilling has not been present in significant quantities. This sandstone appears to have a low permeability with limited potential to yield water to wells. Beneath the Star Point sandstone is the Mancos shale, which is a dark, marine shale, with essentially no potential for yielding water to wells.

   Drilling of a deep stock well into strata beneath the Blackhawk formation would be expensive, and would not have a good potential for success.

2) Drilling of a water well into abandoned mine workings. After mining ceases, a stock well could be successfully completed in underground workings of the SUFCo Mine. These underground workings, where subsidence has occurred, however, yield very little water and would be a difficult drilling target. Although the underground workings probably would yield adequate water to supply livestock, location of a drilling site to assure encountering underground water would be difficult. There would be a risk that the well would not encounter water or would not continuously produce adequate water. In addition, this alternative would require a mechanical pump which, due to lack of power in the area, would pose a problem.

3) Construction of surface water impoundment. Development of an impoundment in drainages north of Spring 001 is possible as an alternative water supply. This alternative, however, has several problems. Drainages in this area are ephemeral, and produce water only in response to snowmelt and heavy precipitation. This raises the possibility of an undependable water source during dry years. Also, runoff in the area is seasonal, with major runoff occurring in the spring. Water from the pond would need to be piped to the Spring 001 area. Due to natural variation in precipitation and possibly dry years, this alternative water supply would not be as dependable as the existing water supply and would require considerable construction.

4) Development of groundwater from upper Duncan Draw. Stock ponds in the upper end of Duncan Draw contain water during much of the year. A spring, present in Section 26, supplies three stock water ponds in Duncan Draw located downstream from this spring on a year-round basis. In consultation with U.S. Forest Service personnel at the Fishlake National

Forest in 1978, it was concluded that a plastic pipeline connecting upper Duncan Draw to the Spring 001 area would be a feasible alternative water supply. Water quality is good in upper Duncan Draw and it appears that production of one to two gallons per minute, on a year-round basis, would be possible and would not adversely impact upper Duncan Draw. If sufficient water is developed, this alternative also would allow development of several points along the pipeline to supply water for livestock and wildlife. The pipeline would be gravity fed and would probably offer a good alternative water supply to Spring 001. Winter operation would require consideration of frost protection during design.

783.24(b),(g) Provide Maps at Adequate Scale Showing Boundaries of Land, Public Roads

Maps have been prepared showing hydrologic features at required scales of the mine plan area (Plate H-I) and mine plan adjacent area (Plate H-II).

There are no water supply intakes within the general area. However, there is one diversion for irrigation of land adjacent to Quitchupah Creek within the general area (Plate H-II).

The mine discharges to East Spring Canyon (Site 021) approximately 0.5 mile upstream from its confluence with Convulsion Canyon (Plate I). No other discharges are contemplated from affected areas in the proposed mine plan area. What about sed pond?

783.25(f) Provide Maps, Cross-Sections that Require Scale of Aerial and Vertical Distribution of Aquifers (Seasonal Variations)

A detailed discussion of subsurface water in the mine permit area is given in section 783.15, including the areal and vertical distribution of aquifers. Cross-sections and structural maps of geologic units in the mine permit area are described in the geology Section (783.14).

783.25(g) Statement Regarding Irrigation Ditches

Other than for stock watering, the only identified agricultural use of water in the general area is the irrigation of a small strip of riparian land (about 110 acres) between the North Fork Quitchupah Creek and the Highway 20 bridge near Emery (Plate H-II). The irrigation diversion for this land is about 0.4 mile below the mouth of North Fork Quitchupah Creek. An additional 25 acres of riparian land, contiguous to and immediately upstream, appears irrigible and may have been irrigated in the past from this same diversion.

783.25(j) Locations of Gas, Oil and Water Wells

Extensive annual surveys of hydrologic features in the mine plan area, adjacent area, and general area (Plate H-I) were begun in September, 1977. No gas or oil wells have been identified within the proposed permit area from these annual surveys, or by the Utah Division of Oil, Gas, and Mining (Janice Tabish, Records Clerk, personal communication, August, 1980). In addition, no water wells are known to exist in the mine plan area and adjacent areas (WESTECH, 1978). One known water well exists in the general area (T22S, R4E, Section 15). One or more water wells may be associated with the abandoned homestead in T22S, R5E, Section 15. No other water wells are known or presumed to exist in the general area.

784.14(a)(1) Description of Changes in Surface and Groundwater Quality

The quality of surface water in the mine plan area and the adjacent area will not be adversely affected by underground mining. The only area in which changes in surface water quality may occur is in the mine portal and coal loading area. In this area, an impoundment and treatment system for surface water was installed to ensure that all surface waters discharged from the mine area meet NPDES (National Pollutant Discharge Elimination System) permit discharge effluent limitations. Water quality requirements of this permit ensures protection of surface waters downstream from the mine portal area.

Groundwater quality will not be affected in the mine plan area or the adjacent area, except where groundwater enters underground workings and is discharged from these workings. In this area, groundwater is impounded in sumps inside the mine and then is discharged at the portal to East Spring Canyon. Groundwater discharged at this point meets requirements of the NPDES discharge permit. Questionable!

After mining, there should be no adverse impacts on groundwater or surface water quality. There will be no surface disturbance in the mine portal area that will alter surface water quality in the mine plan area, adjacent area, or the general area. All underground mining openings will be sealed at the completion of mining; consequently, there should be no adverse post-mining impacts on groundwater quality.