

Report of Investigation No. 122
Utah Geological and Mineral Survey

PRELIMINARY GEOLOGIC RECONNAISSANCE
OF TWELVE PROPOSED COAL-FIRED
POWER PLANT SITES,
EASTERN UTAH COUNTY, UTAH

Prepared at the request of the Interagency Task Force
on Power Plant Siting, Utah Energy Office

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INTRODUCTION

On November 28, 1977 the Utah Geological and Mineral Survey was requested by the Utah Energy Office to provide a brief geologic evaluation of 12 proposed coal-fired power plant sites (figure 1) in the Uinta Basin near Bonanza, Utah. A two-day field trip was scheduled by the Energy Office for December 5-6, 1977 and included an aerial and ground reconnaissance of each site.

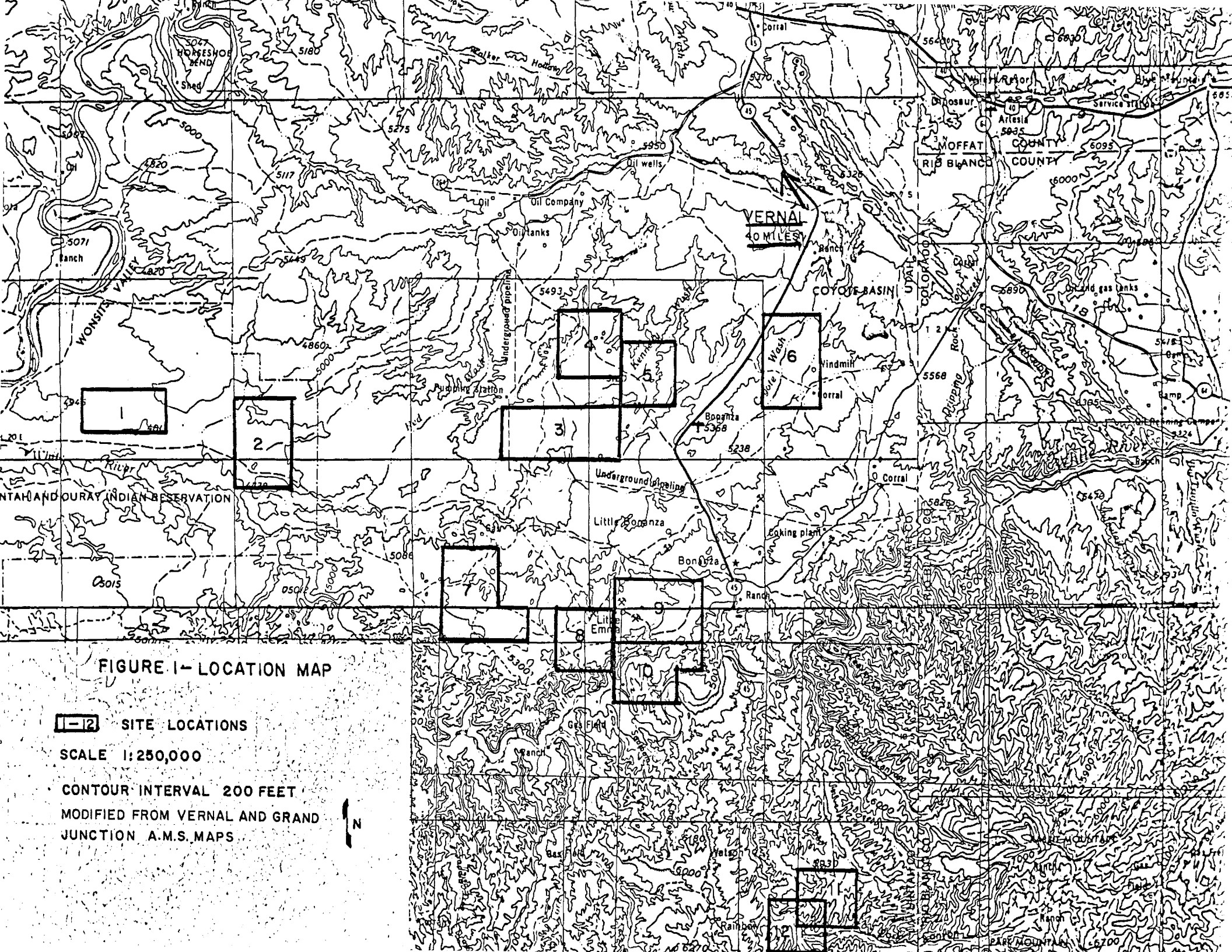
A proposed dam on the White River will furnish water to the generating facility, and coal is to be transported in a slurry pipeline from fields near Rangely, Colorado.

This report does not represent a detailed geologic investigation. It presents a very general review of local geology, petroleum hydrocarbon occurrences, and potential geologic hazards.

AREA OVERVIEW

Geology

The 12 proposed sites lie at the eastern edge of the Uinta Basin



physiographic subprovince of the Colorado Plateau. Kinney (1955) characterizes this area as a shallow-eroded, gently rising plain that extends eastward from the Green River to a low, curving hogback ridge of Mesa Verde sandstones, capped with the Wasatch Formation, near the Colorado state line. The area exposes in part upper Green River, Uinta, and Duchesne River Formations. Sites 1 through 10 are located on bedrock and soil derived from erosion of the Uinta Formation, and sites 11 and 12 are located on bedrock and soil derived from erosion of the Parachute Creek Member of the Green River Formation. Parts of the Parachute Creek Member are recognized as potential oil shale development resources.

Soils and Erosion

The Uinta Formation is composed of fluvial and lake deposits consisting of an interbedded sequence of silt, sand, clay, and minor amounts of gravel. Soils found in the area reflect this ancient environment. Soils located in sites 11 and 12 are primarily silts and clays reflecting the shale and siltstone deposits of the Green River Formation. Because of the semi-arid nature of the area, exposed soils consist primarily of wind eroded material from the parent bedrock with some reworking by water, minor amounts of mass wasting consisting of rock fall from cliffs, and gravity movement of loose rock and soil debris on slopes. Wind erosion of the soft, unconsolidated sediments has produced interesting sculpture throughout much of this area.

Soil erosion by water consists of sheetwash transporting surface material downslope and flashfloods from short duration summer storms

carrying soil and rock in suspension. Soil cover is shallow and supports sparse vegetation at all proposed site locations. Soil disturbed by construction activity will be easily eroded by wind and water, and extensive revegetation will be required during and after site construction.

Isopluvial contours of this area (compiled by Miller and others, 1973) (figures 2-5) show that a six-hour event would release approximately 0.5 to 0.7 inch in the area with a 50 percent probability. A 24-hour event would release approximately 1.9 to 2.0 inches with a 2 percent probability. A 2 percent probability is known as a "50" year statistical likelihood. Although these are relatively minimal amounts of rainfall, the amount of surface runoff and resulting flooding will be determined by not only precipitation, but also condition of the surface and existing soil moisture levels. A member of the siting team stated that approximately one week prior to our investigation several inches of water, caused by rapid snow melt, was located over much of the Kennedy Wash area. At the time of our investigation there was still standing water and evidence of recent water-induced erosion in Kennedy Wash.

Seismic

Seismic response of each site will be determined in part by epicenter location, duration of event, type and thickness of soil or bedrock, and depth to a regional or local water table. Detailed knowledge of foundation characteristics will be required of each site before seismic response can be determined. All 12 sites are located in earthquake zone 1 (Hoffman and vonHake, 1971). Expected levels of earthquake shaking hazards are shown

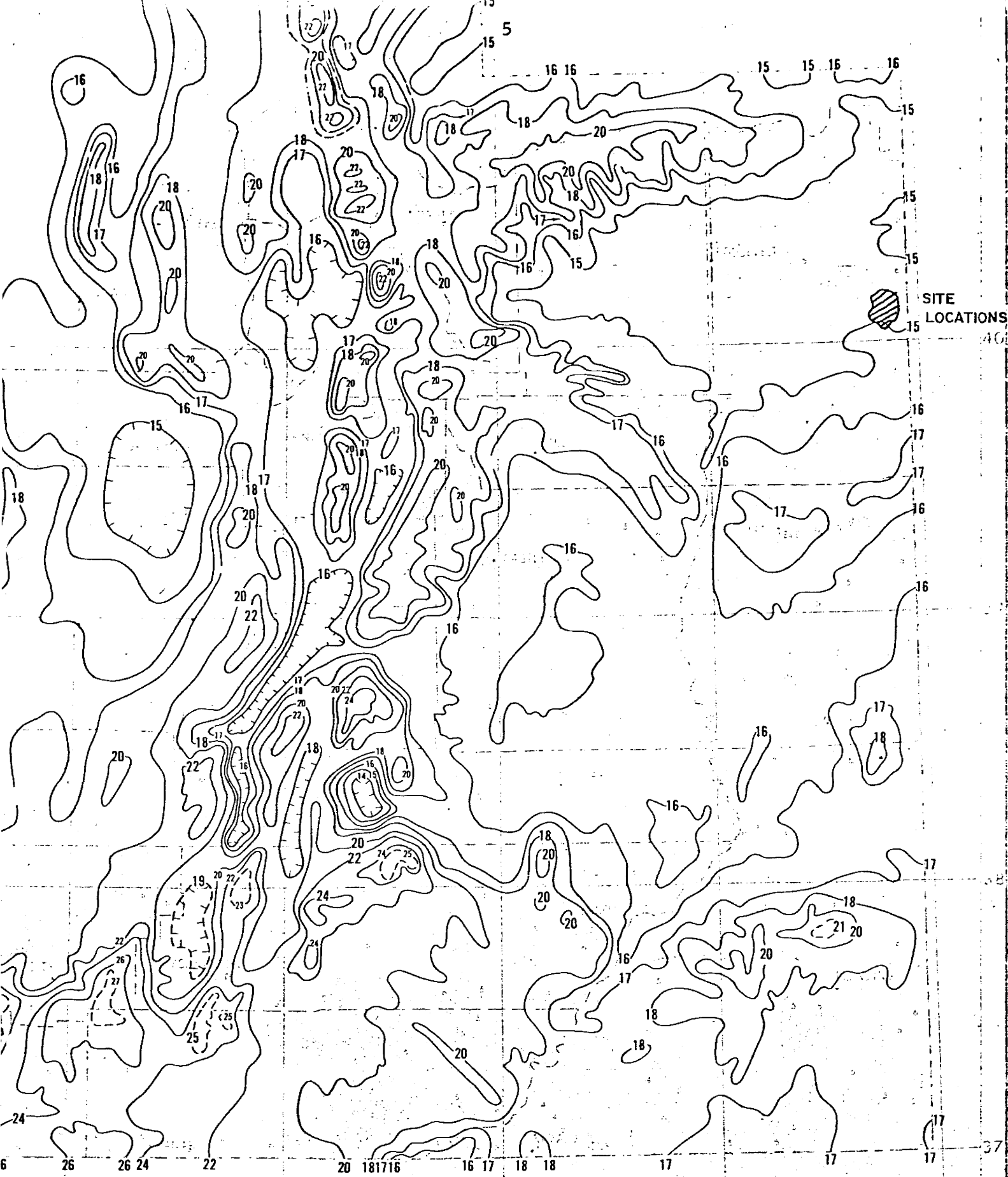


Figure 2

ISOPLUVIALS OF 0.02 PROBABILITY 6-HR PRE-
CIPITATION, MAY-OCTOBER IN TENTHS OF AN
INCH

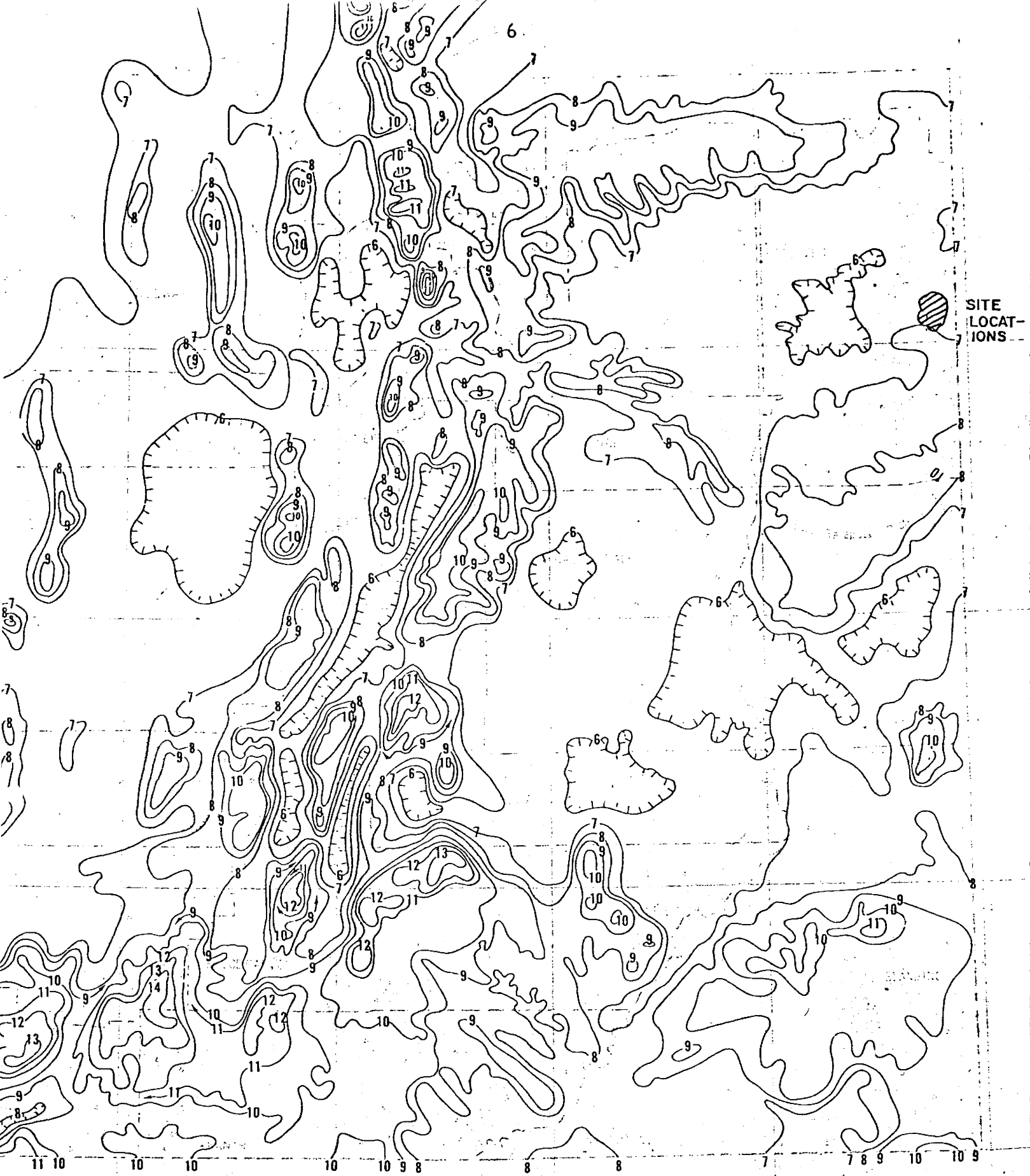


Figure 3

ISOPLUVIALS OF 0.50 PROBABILITY 6-HR PRE-
CIPITATION, MAY-OCTOBER IN TENTHS OF AN
INCH

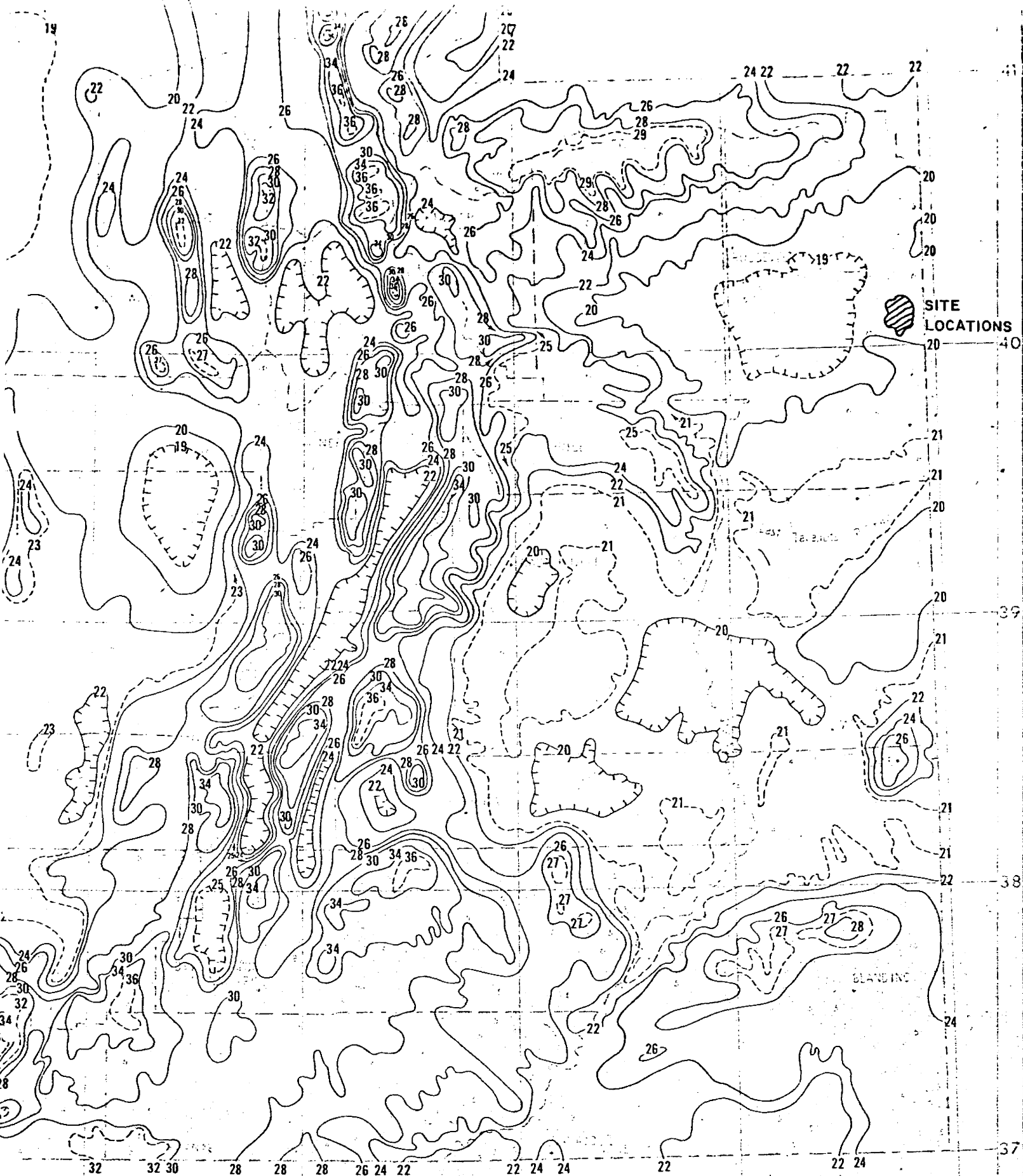


Figure 4

ISOPLUVIALS OF 0.02 PROBABILITY 24-HR PRE-
CIPITATION, MAY-OCTOBER IN TENTHS OF AN
INCH

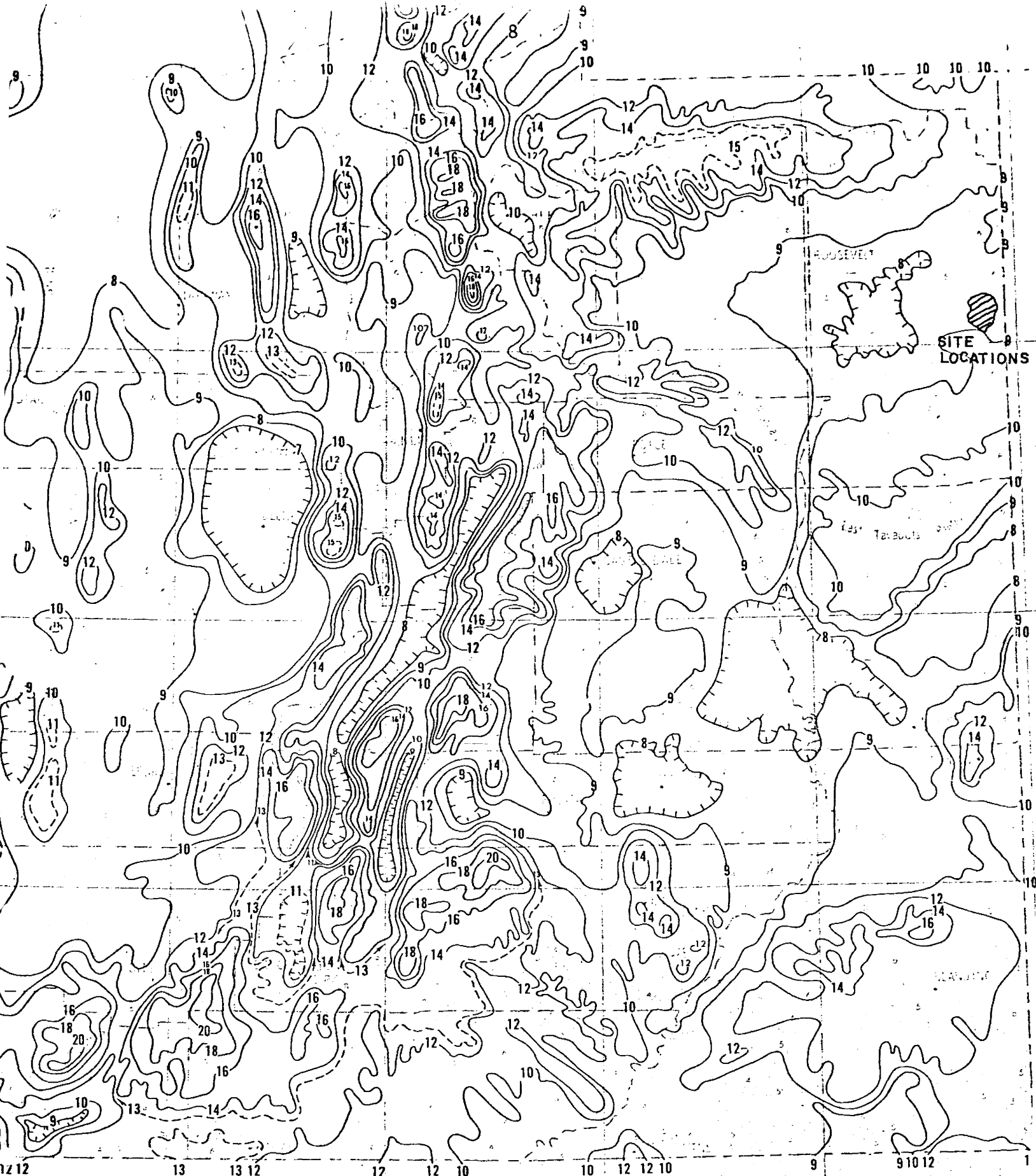


Figure 5

ISOPLUVIALS OF 0.50 PROBABILITY 24-HR PRE-
CIPITATION, MAY-OCTOBER IN TENTHS OF AN
INCH

UTAH

0 10 20 30 40
MILES

as less than 4 percent of gravity (figure 6). Hoffman and vonHake (1971) describe a zone 1 area equivalent to a Richter scale magnitude of 4.0 to 4.9 that would usually create ground shaking approximately 30 miles from the epicenter.

Groundwater Occurrences

Because of low-permeability bedrock formations that underlie the southern Uinta Basin, it is doubtful that wells capable of supporting large sustained withdrawals (more than 500 gallons/minute) could be located in the majority of the proposed sites. An exception may be those sites near the White River. Price and Miller (1975) state: "The best potential source for future large-scale development of groundwater in the southern Uinta Basin lies in the unconsolidated alluvial deposits along the Green, White, and Duchesne Rivers. These deposits, where saturated, generally are less than 50 feet thick and are of small extent."

Chemical analysis of groundwater collected by Price and Miller indicates that dissolved-solids concentration increases in depth and deep aquifers are likely to contain saline water. An exploratory drilling program to define quantities and chemical properties of potential groundwater sources should be given a high priority.

Significance of Petroleum Hydrocarbon Occurrence

The Uinta Basin is and will continue to be a major area of petroleum exploration and development in Utah. The relation of the various aspects of petroleum development to the proposed power plant sites is as follows:

Oil Shale: Estimates vary as to when shale oil will become a viable

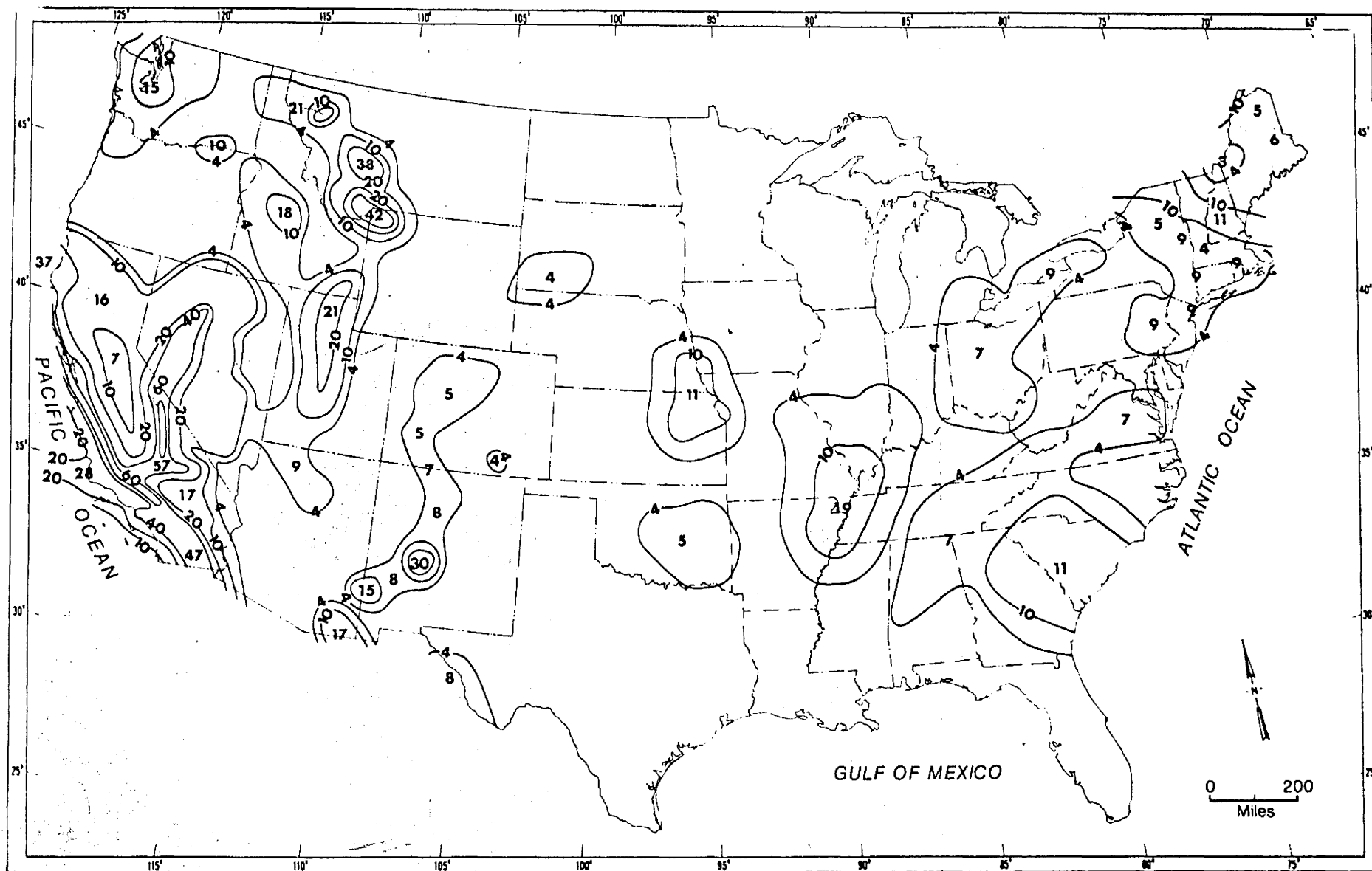


FIGURE 6

Map shows expectable levels of earthquake shaking hazards. Levels of ground shaking for different regions are shown by contour lines which express in percentages of the force of gravity the maximum amount of shaking likely to occur at least once in a 50-year period.

economic product, but there is little doubt that commercial development will occur. Oil shale varies in thickness and grade in nature, but it has become common to think of "rich" oil shale as that which will yield at least 25 gallons of crude shale per ton of rock (figure 7). Table 1 summarizes the thickness of rich oil shale and the depth from the surface to the Mahogany bed (the major oil shale unit). The Mahogany bed occurs at the surface at sites 11 and 12 (Cashion, 1973) where oil shale has the potential to be mined in open cuts (figure 7).

State sections in the entire area encompassed by the 12 possible sites are under lease for oil shale. Federal lands cannot currently be leased (U-a and U-b excepted), but that is expected to change with modification of the Mineral Leasing Act now under study by the U.S. Congress. Furthermore, litigation through which the State of Utah would acquire most of that federal land is in progress. If the courts award these lands to the state, it would allow their immediate leasing and possible encourage more rapid development of oil shale.

Oil and Gas: Several oil and gas fields occur within the general area of the 12 proposed sites (figure 8). The current development activities which involve expanding geographic boundaries are principally in the Natural Buttes gas field. Development is currently encroaching on sites 2 and 7. Most significant with regard to petroleum is that much of the central Uinta Basin, from south-central Duchesne County to the Colorado state line, has the potential for development of natural gas from low-permeability sandstone bodies. It is not known what parts of the area will have greater or lesser

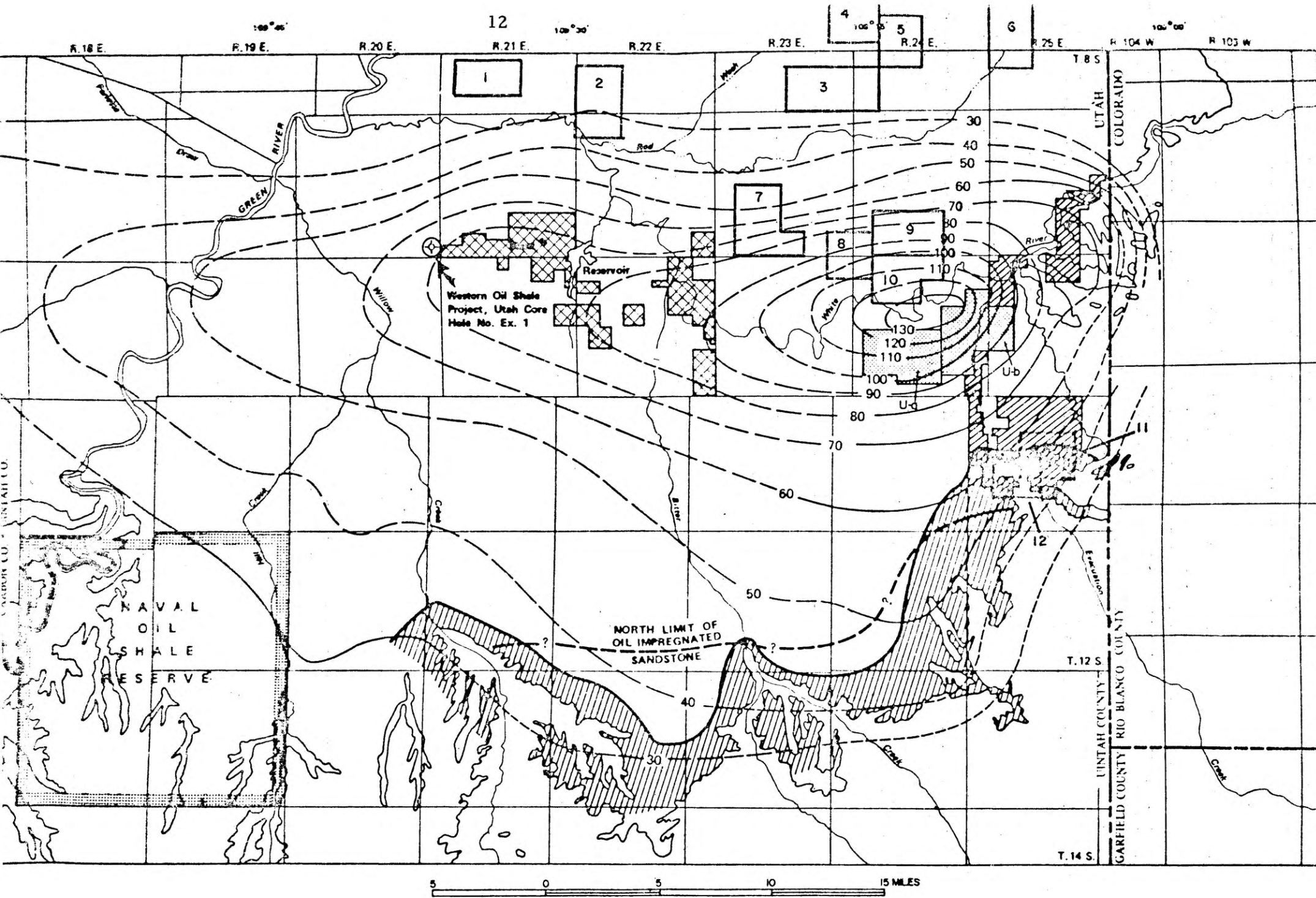


FIGURE 7

EXPLANATION



Tracts U-a and U-b, 10,240 acres.
Federal Prototype Oil Shale
Leasing Program.

U-a leased to Phillips and Sun
\$75,596,800.

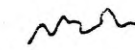
U-b leased to White River Shale
Oil (Sohio, Phillips and
Sun) \$45,107,200.



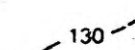
16,150 acres owned by Skyline Oil
and subject to mining leases A
and B (White River Shale, Oil).



14,688 (approx.) acres, Tosco
Sand Wash Project.



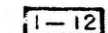
Outcrop of Mahogany oil shale.



Line showing thickness, in feet, of a
continuous sequence of oil shale
beds that will yield an average of
25 gallons of shale oil per ton.
Solid where based on oil-yield
data from cores; long dashed
where based on oil-yield data
from outcrop or cuttings from
exploratory walls; short dashed
where Mahogany oil-shale bed is
eroded.



Area suitable for stripping or
open cut mining.



SITE LOCATIONS



Site of experimental core hole
proposed as site for nuclear
explosion, to create chimney
for use as retort.
(project abandoned)

Corrected and revised 10-2-74
H.R. Ritzma

Active Oil Shale Lease Block, Eastern Uinta Basin, Utah

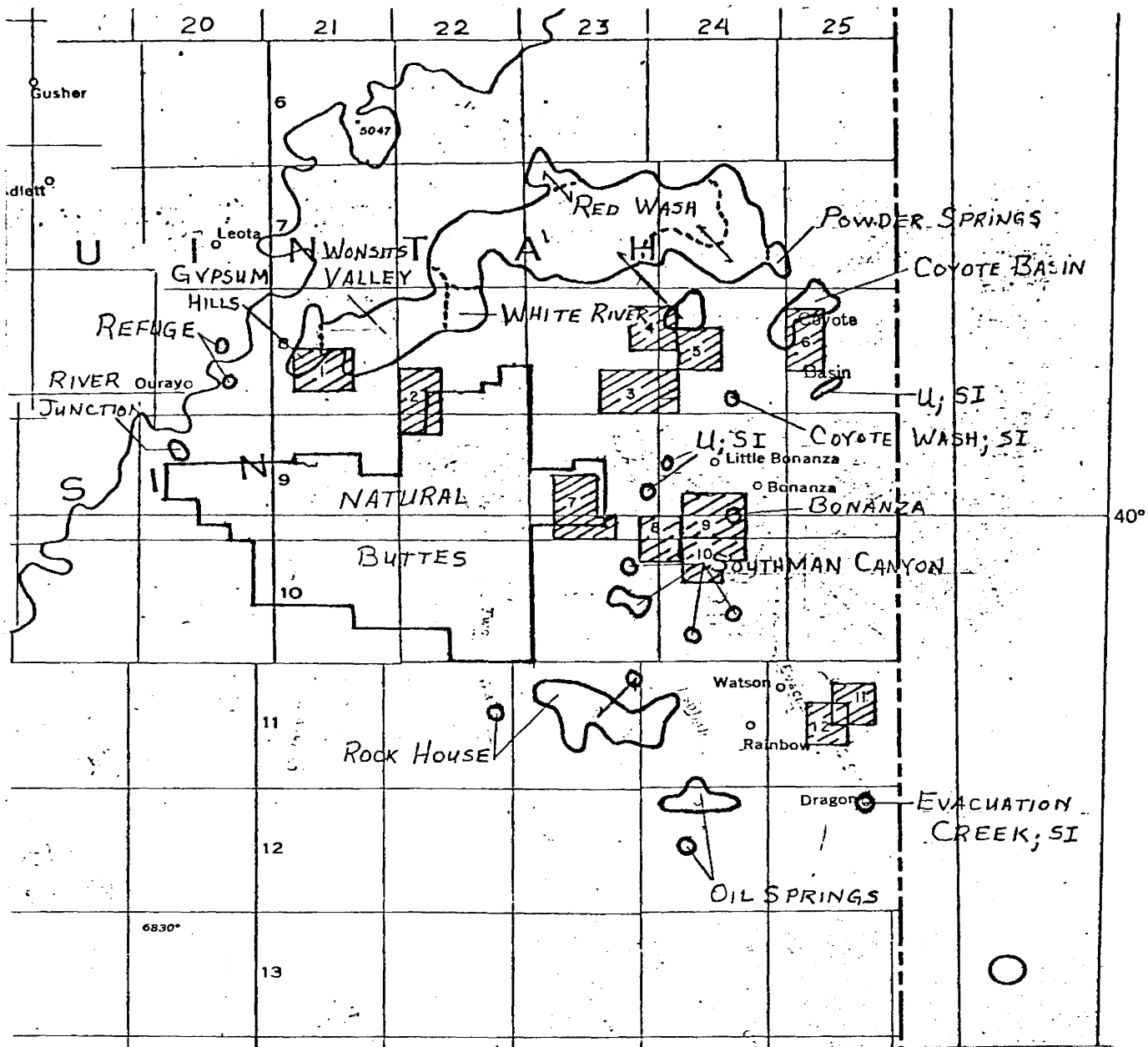


Figure 8. Location of oil and gas fields in the vicinity of proposed power plant sites. (Modified from "Utah," 1:500,000, 1959)

EXPLANATION

- 1-12 Proposed power plant site locations
-  Oil or gas field, productive limit (with name)
-  Natural Buttes gas field, administrative limit
- U Unnamed gas discovery
- SI Shut in gas well or field

Table 1

Relation of Oil-Shale to Proposed
Power Plant Sites, Eastern Uintah County, Utah

OIL SHALE

Site	Thickness of 25 g. p. t. or richer (range)	Depth from surface to Mahogany oil-shale bed (approx.)
1	less than 30 feet	over 3,000 feet
2	up to 35 feet	2,700 to over 3,000 feet
3	less than 30 feet	2,250 to 3,000 feet
4	less than 30 feet	3,000 feet
5	less than 30 feet	2,500 feet
6	less than 30 feet	1,700 to over 2,000 feet
7	45 to 85 feet	2,100 to 2,400 feet
8	80 to 110 feet	1,500 to 2,100 feet
9	70 to 105 feet	1,000 to 2,000 feet
10	100 to 130 feet	less than 1,000 to 1,600 feet
11	0 to 60 feet	0 to less than 500 feet
12	0 to 60 feet	0 to less than 500 feet

Note: Overburden at tract U-a is about 1,000 feet; that at tract U-b is from less than 500 to 1,000 feet.

Source: Cashion, W. B., 1968.

economic potential, but the U. S. Geological Survey, Branch of Oil and Gas Resources, Denver, Colorado has undertaken a study of low-permeability gas sands which includes the subject area.

Normally, gas wells are drilled on 320- or 640-acre spacing. Ideally, other industrial development in an area should conform so that the established pattern of well spacing can be maintained. The additional expense that might be incurred by the necessity of directional drilling could be significant because of the marginal economic nature of extracting gas from low-permeability rocks.

Gilsonite: Gilsonite (or Uintahite) is an unusual petroleum hydrocarbon which was first mined in the area about 1888. Relatively little is known publicly of the production, reserves, and economics of the commodity, but Cashion (1964, p. 65) estimated that only one-tenth of the original reserves had been mined up to that time. Gilsonite occurs mainly as vertical, northwest-trending veins which crop out at the surface. Additional (undiscovered) gilsonite resources may occur below the Mahogany bed, slightly offset from the trace of the veins which crop out at the surface (Cashion, 1976, oral communication). The Black Dragon vein is of this type and is, in this manner, the deeper counterpart of the Rainbow vein (Cashion, 1967, p. 35). There are no known wide counterparts of the Independent and Cowboy veins farther north (Cashion, 1967, p. 33). It is not known whether the Little Emma and Wagonhound veins in the vicinity of proposed sites 8, 9, and 10 have wider counterparts at depth.

Oil-Impregnated Rocks: Oil-impregnated rocks or "tar sands" do not occur in any significant quantity within any of the identified possible power plant sites. Figure 7 shows the north limit of the most important oil-impregnated rocks, the P.R. Spring deposit.

DESCRIPTION AND ANALYSES OF SITES

Site No. 1
T. 8 S., R. 21 E., secs. 20-22 and 27-29
Ouray SE quadrangle

This site is located within the Uintah and Ouray Indian Reservation in Uintah County, approximately 1.5 miles north of the White River.

Small, intermittent streams flow through the north half of the site and empty onto the floodplains of the Green River. These streams are dry most of the year and will carry water during the early spring and after summer storms.

Foundation materials appear to be deep unconsolidated valley fill that would require detailed analysis to determine engineering properties. Surface materials consist of silt, clay, sand, and thin scattered veneers of gravel.

Flashflood potential is very low over the entire site; and except for the possibility of adverse soil conditions, this area would be suitable for a power plant location. Rerouting of some oil or gas pipelines may be necessary. Depth to groundwater is unknown.

Site No. 2
T. 8 S., R. 22 E., secs. 29-32
T. 9 S., R. 22 E., secs. 5-6
Red Wash SW quadrangle

Site No. 2 is also located within the Uintah and Ouray Indian Reservation near the Chapita Wells gas field. The White River passes through a small area (southwest corner) of the site. Several small intermittent streams flow through the site, discharging onto the floodplain.

of the White River. These streams are dry most of the year and during a storm would carry small amounts of water. Surface runoff is probably in the form of sheetwash, and the possibility of flashfloods is remote. Coyote and Red Wash, the only significant drainages in the immediate area, discharge into the White River south of the proposed site and would not endanger structures located within the proposed plant boundaries.

Foundation materials appear to be unconsolidated valley fill, probably reworked by water near the present channel of the White River. Potential deposits of sand and gravel may exist near the river channel. Surface materials consist of silt, sand, and clay covered by thin scattered veneers of gravel. A detailed soil analysis is needed to determine the engineering properties of the soils. Depth to water is not known, but it would be quite shallow near the White River. As in Site No. 1, this area would be suitable for a power plant location if oil or gas pipelines passing through the site can be rerouted.

Site No. 3

T. 8 S., R. 23 E., secs. 25-27 and 35-36

T. 8 S., R. 24 E., secs. 30-31

Bonanza and Red Wash SE quadrangles

The majority of suitable construction areas within this site are occupied by Kennedy Wash, a very active drainage system. At the time this inspection was made, standing water occupied many low areas. All drainages within Kennedy Wash are mapped as intermittent by U.S. Geological Survey 7 1/2 minute topographic coverage of this area, but very recent erosion channels and road washouts suggest that this drainage has the

capacity to generate flashfloods.

Foundation materials appear to be valley fill reworked by seasonal water flow. Although bedrock is exposed along the margin of Kennedy Wash, it is covered by a thick sequence of sediments in the wash and would require very deep excavation to expose it.

Potential for occurrences of poor soil (clay and silt) and flashfloods makes this site questionable as to suitability and is not recommended.

Site No. 4

T. 8 S., R. 23 E., secs. 12-13

T. 8 S., R. 24 E., secs. 7, 18

Bonanza, Dinosaur NW, Red Wash, and Red Wash SE
quadrangles

Kennedy Wash also occupies a significant part of this proposed location, although drainages do not appear as active as those in Site No. 3. During the inspection deep erosion channels and standing water was also observed. Flashflood hazards exist, although probably not as severe as in Site No. 3. Soil and foundation characteristics are similar to Site No. 3. Although somewhat better for development than Site No. 3, this location is not recommended.

Site No. 5

T. 8 S., R. 24 E., secs. 16-17 and 20-21

Bonanza and Dinosaur NW quadrangles

Much of the area suitable for power plant locations lies within Kennedy Wash. Standing water and very recent evidence of flood-generated erosion was found throughout the proposed site. Wind erosion has created picturesque rock formations in the southeast corner of the area (Devils Playground).

Foundation materials probably consist of an interbedded sequence of sand, silt, clay, gravel, and various mixtures of sediments reworked by seasonal floods. A detailed soil analysis will be needed to determine engineering properties of foundation material.

This site is very similar to Site Nos. 3 and 4. It is not recommended for a power plant location.

Site No. 6

T. 8 S., R. 25 E., secs. 7-8 and 17-20

Bonanza, Dinosaur, Dinosaur NW, and Walsh Knolls
quadrangles

Access to this site is provided by a paved, all weather road (Utah Highway 45), providing access from Vernal to various oil, gas, and gilsonite producing areas near Bonanza.

Coyote Basin oil field is located in the northwest corner of the site and presently produces small quantities of oil. Three dry holes located within the proposed site boundaries were drilled between 1955 and 1966 and would indicate that oil production from the Green River Formation is unlikely at the site location. However, the production of gas from low-permeability sandstone reservoirs is possible throughout the site area.

Suitable construction sites are primarily located within Coyote Basin, with drainage to the southwest by way of Coyote Wash. Although drainages are similar to Kennedy Wash and may be subject to flashfloods, there are areas in sections 8, 17, and 18 that will be relatively safe from flood hazards. Other sections within the proposed site boundaries may require extensive grading and/or may be subject to flashfloods.

Foundation materials appear to be unconsolidated valley fill deposited

by wind and water. They will probably consist of an interbedded sequence of sand, silt, clay, and minor amounts of gravel. Extensive exposures of bedrock are located in section 7, and minor amounts are exposed in other nearby sections. A detailed exploration program will be required to determine engineering properties of the soil and depth to bedrock. This site would be suitable for location of a power plant.

Site No. 7

T. 9 S., R. 23 E., secs. 20-21, 28-29, and 32-34
Asphalt Wash and Red Wash SE

The majority of this site is located within the Chapita Wells gas field and has several wells and aboveground pipelines located within the proposed boundaries.

There are a few active drainages, and these will only carry water in the spring or after summer storms. Flashflooding should not be a hazard in this area.

Bedrock is exposed over much of the site and will probably provide fair to good bearing for structural foundations. Most sections within this site would require extensive grading operations. However, there are small areas within each section that could be developed. In general, this location would be suitable for a power plant location.

Site No. 8

T. 9 S., R. 23 E., sec. 36
T. 9 S., R. 24 E., sec. 31
T. 10 S., R. 23 E., sec. 1
T. 10 S., R. 24 E., sec. 6
Asphalt Wash and Southam Canyon quadrangles

This site is approximately 2 miles north of the White River, near

Southman Canyon gas field. Although exploration drilling for gas or oil may have been done in the past, there are no producing wells within the proposed site boundaries at this time. There are, however, several areas where gilsonite has been mined on a small scale operation, and additional reserves may be located within the site area.

Bedrock consisting of interbedded layers of silt, clay, and sand is exposed throughout much of the site and should provide for fair to good foundation material.

Sections 1 and 6 are located near cliffs bordering the White River. Any proposed site in these two sections should be provided with adequate setback from the edge of the cliff.

Drainages within the site are not active and should present no problems for structures or construction activity.

This site would be suitable for location of a power plant.

Site No. 9
T. 9 S., R. 24 E., secs. 27-29 and 32-34
Bonanza and Southam Canyon quadrangles

Site No. 9 is located approximately 2 miles southwest of Bonanza. Extensive gilsonite veins are located throughout the proposed site and have been commercially produced. Minor production is currently in progress throughout the area.

Exposed bedrock throughout the site appears to be mudstone and siltstone and will probably provide poor to fair foundation material. Very detailed exploration and laboratory analysis should be made to determine engineering properties of the rock and soil at the proposed site location.

Drainages are not active, and most runoff will be in the form of sheetwash.

Although the site would probably be suitable for a power plant, the occurrence of significant amounts of gilsonite and potentially adverse soils (silt and clay) or bedrock would make this a low priority site location. It is not recommended.

Site No. 10
T. 11 S., R. 24 E., secs. 3-5 and 8-9
Southam Canyon quadrangle

Very few areas within the proposed site boundaries would be suitable for a power plant location, and parts of sections 8 and 9 are located within the reservoir of the proposed White River dam. Extensive grading would be required in many of the sections proposed. An area in the southeast corner of section 5 is probably the most suitable, but has a gas well located at the proposed site location. Although not producing at the time of investigation, it appears it will be tied into existing pipelines in the very near future, and possibly other gas wells may be located in the immediate area.

Exposed bedrock consists of sand, silt, and clay that would be poor to fair as foundation material. Extensive exploration and laboratory testing would be required to determine engineering properties of rock and soil.

This location is not highly recommended.

Site No. 11
T. 11 S., R. 25 E., secs. 10-11 and 14-15
Dragon and Weaver Ridge quadrangles

Site No. 12
T. 11 S., R. 25 E., secs. 15-16 and 21-22
Dragon and Rainbow quadrangles

These two sites are within close proximity of each other, and both share section 15 as potential construction sites. They are similar to each other in all respects.

Bedrock is exposed throughout the sites and consists of shale. Foundation properties would be quite poor and will require extensive drilling and laboratory analysis to determine engineering properties. Generally, shale, or soil derived from the weathering products of shale, makes poor foundation material for heavy structures.

Drainage is active in the southern and eastern parts of the proposed sites and may represent some flashflood hazards if sites were located in this area. The problem would be primarily encountered in sections 11, 14, south half of section 15, and sections 21-22. Drainages within section 10, north half of section 15, and section 16 are not active, with runoff probably in the form of sheetwash.

Both sites are within an area of known oil shale reserves (figure 7, p. 12) and will be subject to future development of oil shale. Oil-bearing shale is probably located very close to or at the surface in both sites (table 1, p. 14).

Adverse soil and rock combined with potential oil shale development would make development of these sites extremely difficult. They are not recommended for development.

RANKING OF SITES

Sites are ranked based on the preceding discussions. Sites grouped together are essentially the same, with no particular preference made.

Number I is the most suitable and Number VI the least suitable.

- I. Site Nos. 1 and 2
- II. Site No. 6
- III. Site Nos. 7 and 8
- IV. Site Nos. 9 and 10
- V. Site Nos. 3, 4, and 5
- VI. Site Nos. 11 and 12

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