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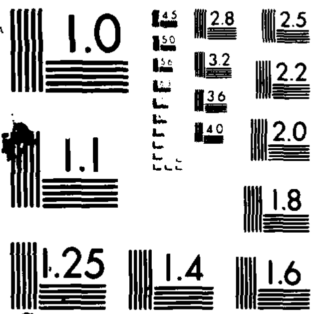

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MX SITING INVESTIGATION
GEOTECHNICAL EVALUATION

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AGGREGATE RESOURCES STUDY
LAKE VALLEY
NEVADA

PREPARED FOR
BALLISTIC MISSILE OFFICE (BMO)
NORTON AIR FORCE BASE, CALIFORNIA

FUGRO
NATIONAL, INC.
Consulting Engineers and Geologists

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This report contains the Valley-Specific Aggregate Resources Study for Lake Valley and surrounding areas in Nevada. It is the sixth in a series of reports that contain aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials on a valley specific basis. The findings presented are based on field reconnaissance and limited laboratory testing, existing data from the State of Nevada Department of Highways, and a previous regional aggregate investigation and Verification studies conducted by Fugro.

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AGGREGATE RESOURCES STUDY

LAKE VALLEY

NEVADA

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

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27 February 1981

FUGRO NATIONAL, INC.

FOREWORD

This report was prepared for the Department of the Air Force, Ballistic Missile Office (BMO), in compliance with Contract No. F04704-80-C-0006, CDRL Item No. 004A6. It presents the results of Valley-Specific Aggregate Resources studies within and adjacent to selected areas in Nevada that are under consideration for siting the MX system.

This volume contains the results of the aggregate resources study in Lake Valley. It is the sixth of several Valley-Specific Aggregate Resources investigations which will be prepared as separate volumes. Results of this report are presented as text, appendices, and two drawings.

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EXECUTIVE SUMMARY

This report contains the Valley-Specific Aggregate Resources Study (VSARS) for Lake Valley and surrounding areas in Nevada. It is the sixth in a series of reports that contain aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials on a valley-specific basis. The findings presented are based on field reconnaissance and limited laboratory testing, existing data from the State of Nevada Department of Highways, and a previous regional aggregate investigation and Verification studies conducted by Fugro.

A classification system based on aggregate type and potential use was developed to rank the suitability of all basin-fill and rock aggregate sources. Four aggregate types have been designated: coarse, fine, and coarse and fine (multiple) aggregates derived from basin-fill sources, and crushed rock aggregates derived from rock sources. Each aggregate type was then classified using the following definitions:

Class I — Potentially suitable concrete aggregate and road-base material source;

Class II — Possibly unsuitable concrete aggregate/potentially suitable road-base material source; and

Class III — Unsuitable concrete aggregate or road-base material source.

Decisions on assigning a particular aggregate source to one of the three classes were determined from existing and Fugro

National laboratory aggregate tests performed as part of this study (abrasion resistance, soundness, and alkali reactivity), and, to a lesser degree, from field visual observations.

Emphasis in this study is placed on the identification and delineation of Class I basin-fill coarse aggregate. These deposits are considered to be the primary sources of concrete and road-base construction materials. Results of the study are presented on a 1:125,000-scale aggregate resources map (Drawing 2) and are summarized as follows:

1. Coarse Aggregate - Major Class I coarse aggregate basin-fill sources are located in alluvial fan (Aafc, Aafg,) and older lacustrine shoreline (Aolg, Aols) deposits east of the Schell Creek Range. Additional Class I coarse aggregate sources whose boundaries generally could not be delineated are also located in alluvial fan (Aafg, Aafs, Aaf) deposits in the northeastern and southern portion of the study area.

   Potentially suitable Class II coarse aggregate sources are widespread and extensive in the study area. Although boundaries of specific deposits could not be delineated, they are typically located within alluvial fans (Aafg, Aaf, Aafs) flanking Class I and/or Class II rock sources and in older lacustrine (Aol, Aols) deposits.

2. Fine Aggregate - Most coarse aggregate basin-fill sources are also potential multiple sources (coarse and fine) that will supply varying quantities of fine aggregate either from the natural deposit or during processing. Specific Class I fine aggregate sources were identified and delimited in older lacustrine deposits (Aolg) located east of the Schell Creek Range.

   Potential Class II fine aggregate sources are widespread and extensive in the study area. Specific deposit boundaries could not be delineated but typically occur basinward of most Class I and Class II coarse aggregate deposits and/or rock exposures.

3. Crushed Rock - Prominent Class I crushed rock aggregate sources and their locations within the study area follow.

a. Undifferentiated carbonate rocks (Cau) composed primarily of limestone and dolomite from the Highland Peak and Guilmette formations and undifferentiated upper Cambrian deposits. Extensive deposits are located along the western margin (Schell Creek, Bristol, Highland, and Chief ranges, Dutch John and Grassy mountains at the north end of the Fairview Range, and the Pioche Hills) and southeastern portion (Wilson Creek Range and White Rock Mountains) of the study area;

b. Prospect Mountain Quartzite (QTz) exposed in the northwestern (Schell Creek Range) and southwestern (Pioche Hills and Chief Range) parts of the study area;

c. Unnamed Mississippian and Pennsylvanian limestones (Ls) primarily exposed in the northwestern part of the valley (Dutch John and Grassy mountains at the north end of the Fairview Range, and Schell Creek Range); and

d. Laketown, Sevy, and Simonson dolomites (Do) exposed primarily in the Schell Creek Range.

The useability of any of these rock units as crushed rock aggregate sources will depend on their location and accessibility within the study area and their minability.

Additional aggregate testing and field investigations will be required to further refine the lateral and vertical extents of classification boundaries and to define exact physical and chemical characteristics of a particular basin-fill or rock source within the valley area.

1.0 INTRODUCTION

1.1 STUDY AREA

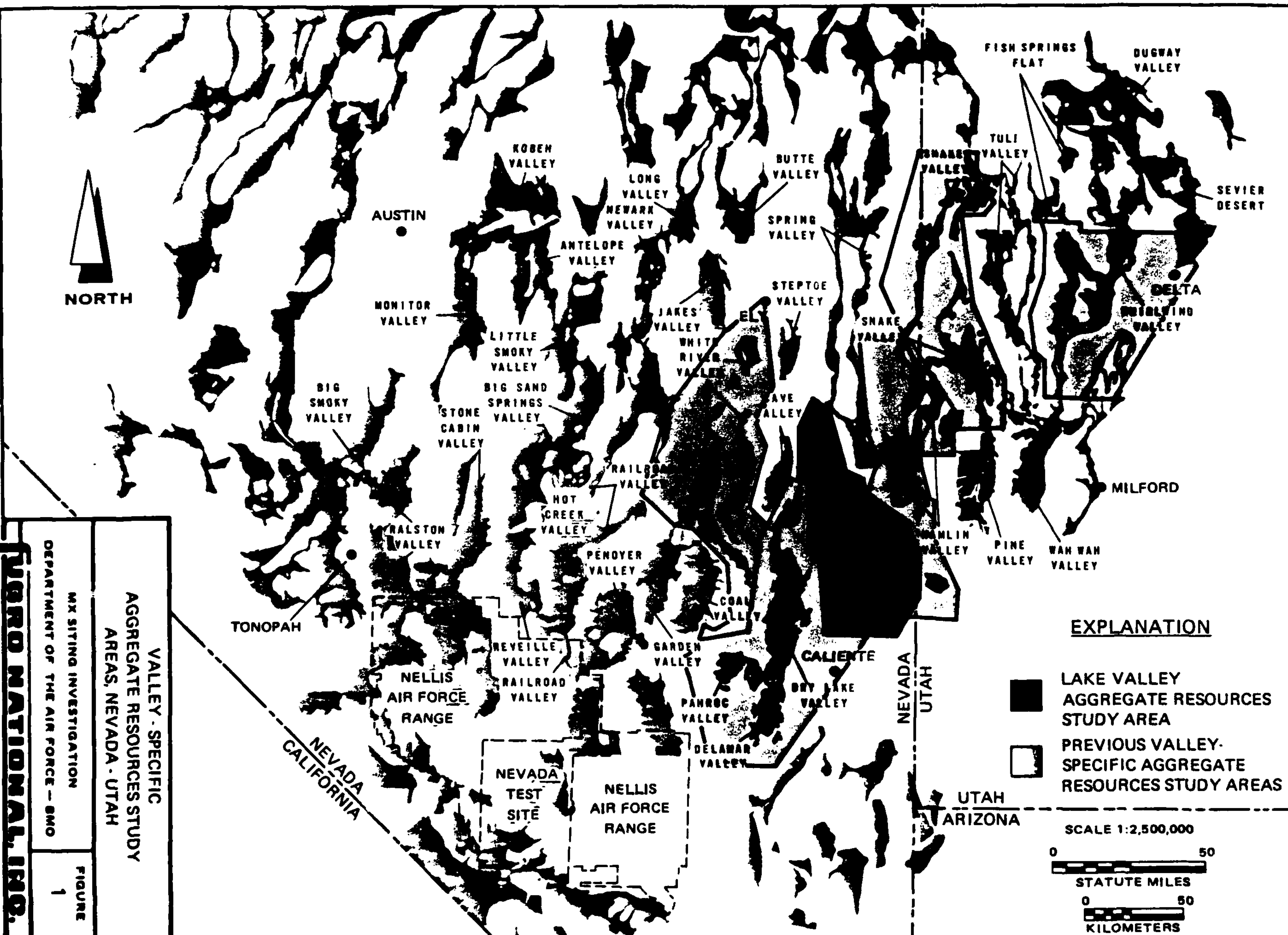
This report presents the results of the Valley-Specific Aggregate Resources Study (VSARS) completed for Lake Valley (Figure 1). Located in eastern Lincoln County, Nevada, the area contains a north-south trending alluvial basin flanked chiefly by carbonate and volcanic rock mountain ranges. The Schell Creek, Fairview, Bristol, Highland, and Chief ranges border the site on the west, and the Fortification and Wilson Creek ranges and the White Rock and Mahogany mountains mark the eastern boundary.

U.S. Highway 93 provides access to the western side of the study region, and State Highways 25 and 83 provide access to areas along the southern border. A network of unpaved roads and four-wheel drive trails crisscross the study area (Drawing 1).

The valley area is mainly comprised of undeveloped desert rangeland administered by the Bureau of Land Management (BLM). The towns of Pioche and Panaca, Nevada, lie just within the southwestern border of the valley-specific study area and are serviced by a spurline of the Union Pacific Railroad from Caliente, Nevada.

1.2 BACKGROUND

The MX aggregate program began in 1977 with the investigation of Department of Defense (DoD) and BLM lands in California, Nevada, Arizona, New Mexico, and Texas (FN-TR-20D). Refinement of the MX siting area added portions of Utah and Nevada that were not



VALLEY - SPECIFIC AGGREGATE RESOURCES STUDY AREAS, NEVADA - UTAH

MX SITING INVESTIGATION

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FIGURE 1

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studied in the initial Aggregate Resources Evaluation Investigation (AREI). This additional area (Figure 2), defined as the Utah Aggregate Resources Study Area (UARSA), was evaluated in the fall of 1979, and a second general aggregate resources report (FN-TR-34) was submitted on 3 March 1980. Both general aggregate investigations were designed to provide regional information of the general location, quality, and quantity of aggregates that could be used in the construction of the MX system.

Subsequent to the general studies, VSARS were developed in FY 79 and continued in FY 80 to provide more-detailed information on potential aggregate sources in specified valley areas (Figure 1).

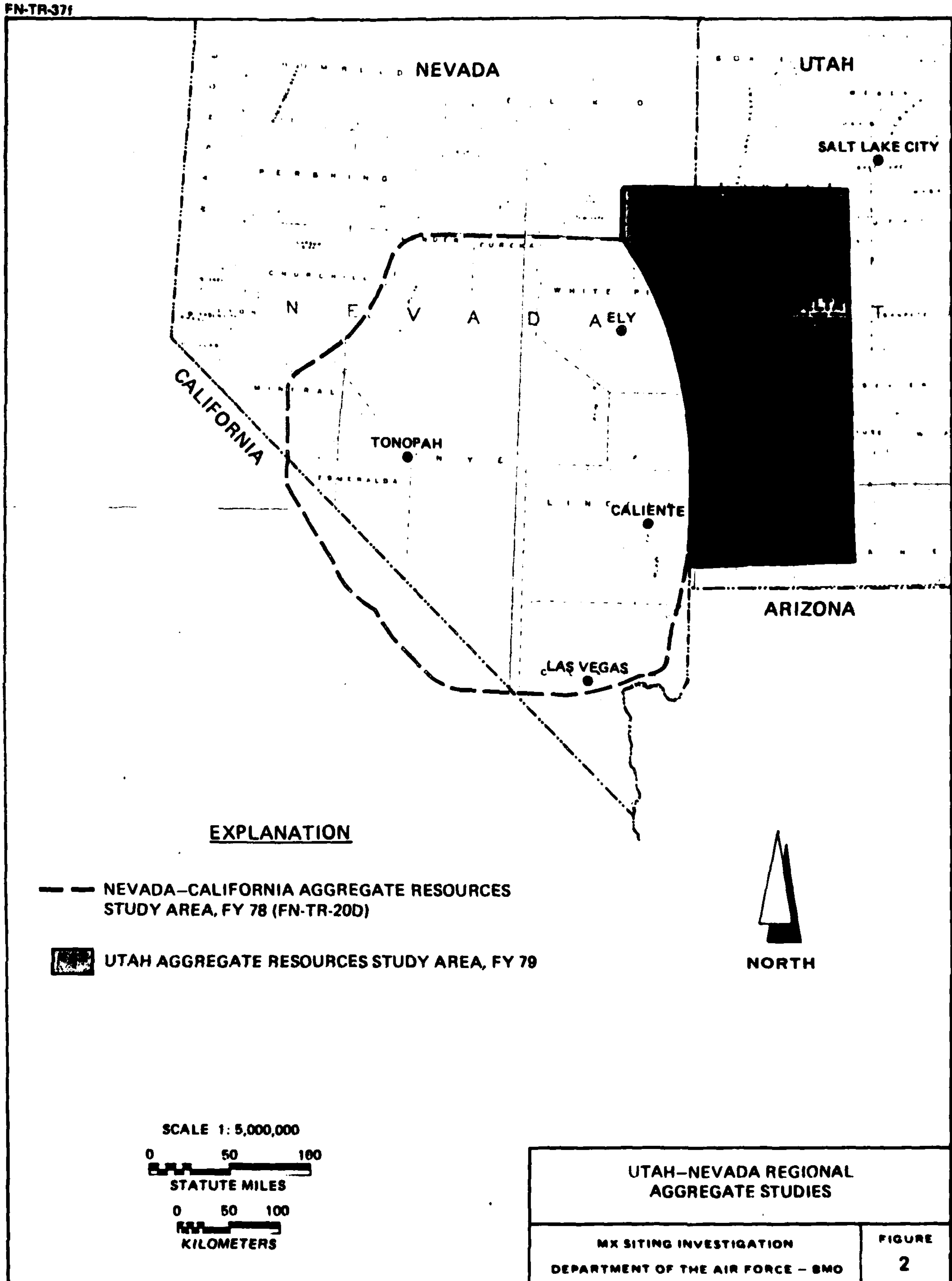
1.3 OBJECTIVES

The primary objective of the VSARS program is to classify, on a valley basis, basin-fill and rock deposits for suitability as concrete and road-base construction materials. The VSARS format is designed to select and present the locations of the most acceptable aggregate sources for preliminary construction planning and follow-on, detailed aggregate investigations.

1.4 SCOPE

The scope of this investigation required office and field investigations and included the following:

1. Collection and analysis of available existing data on the quality and quantity of potential concrete aggregate and road-base material sources. American Society of Testing and Materials (ASTM) standards and Standard Specifications for Public Works Construction (SSPWC) were used to evaluate quality.



UTAH–NEVADA REGIONAL AGGREGATE STUDIES

MX SITING INVESTIGATION

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FIGURE 2

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2. Aerial and ground reconnaissance of all identified potential aggregate sources in the valley area, with more detailed investigation and sample collection of likely basin-fill (coarse and fine aggregates) and rock- (crushed rock aggregates) construction material sources.

3. Laboratory testing to supplement available existing data and to provide detailed information to assist in determining the suitability of specific basin-fill or rock deposits as construction material sources within the valley area.

4. Development and application of an aggregate classification system (Section 2.5) that emphasizes aggregate type (coarse, fine, or crushed rock) and potential construction use (concrete and/or road base).

2.0 STUDY APPROACH

2.1 EXISTING DATA

Collection of existing test data from available sources was an important factor in the VSARS program. The principal source of existing data directly pertaining to aggregate construction materials was the State of Nevada Department of Highways (Appendix A). The majority of this information is related to the use of aggregate material for asphaltic concrete, base course in road construction, or ballast material. However, many of the suitability tests for these types of construction materials are similar to those for concrete and were applicable to this investigation (Appendix A).

2.2 SUPPLEMENTAL FUGRO NATIONAL DATA

Supplemental Fugro National data were obtained from: 1) field data and supplementary test data compiled during the general aggregate resources study (FN-TR-20D), 2) Lake Valley Verification study (in progress), and 3) the current Valley-Specific Aggregate Resources Study (Appendix A).

The primary objective of the initial general aggregate study was a regional evaluation and ranking of all potential aggregate sources. Twelve data points from the general aggregate study were located within the VSARS area (Drawing 1). These data stops supplied specific aggregate information which included two 150-pound samples collected for limited laboratory testing (Appendix A).

Verification geologic maps were an initial source of information on the type and extent of basin-fill units within specific valley areas. In addition, Verification study data included information from 11 trench locations distributed throughout the study area (Drawing 1). Depths of the selected trenches ranged from 5 to 14 feet (1.5 to 4.3 m). While the Verification studies are not specifically designed to generate aggregate data, the sampling techniques and testing procedures (Appendix A) are applicable to the aggregate evaluation.

The VSARS program required aerial and ground reconnaissance of the study area to collect additional information to verify conditions determined during the data review. Included in the 51 field station data stops was the collection of 27 samples for laboratory testing. Potential coarse and fine aggregate basin-fill samples were collected by channel sampling stream cuts or man-made exposures. Potential crushed rock aggregate samples were obtained from exposures of fresh or slightly weathered material whenever possible. The weight of all laboratory samples collected ranged between 100 and 150 pounds. Rock hand samples, which generally did not exceed five pounds in weight, were collected for office analyses.

Identification of basin-fill materials in all field studies followed ASTM D 2488-69, Description of Soils (Visual-Manual Procedure), and the Unified Soil Classification System (Appendix C). Rock identifications followed procedures described in the Quarterly of the Colorado School of Mines (1955) and

Standard Investigative Nomenclature of Constituents of Natural Mineral Aggregates (ASTM C 294-69).

2.3 DATA ANALYSIS

Geologic and engineering criteria were used in the evaluation of potential aggregate sources within the study area. This was supplemented by laboratory analysis of selected samples during the valley-specific aggregate testing program (Table 1). Coarse aggregate is defined as predominantly plus 0.185 inch (4.75 mm) fine gravel- to boulders-basin-fill material. Fine aggregate is defined as less than 0.375 inch (9.5 mm) and predominantly less than 0.185 inch (4.75 mm) and plus 0.0029 inch (0.074 mm) coarse to fine sand basin-fill material. While all laboratory tests supplied definitive information, the soundness, abrasion, and alkali reactivity results were considered the most critical in determining the use and acceptability of a potential aggregate source.

2.4 PRESENTATION OF RESULTS

Study results are presented in text, tables, two 1:125,000 scale maps, and appendices. Drawing 1 presents the location of the 76 existing test data and supplemental Fugro data sites within the study area. Drawing 2 presents the location of all Fugro National laboratory sample sites and all potential basin-fill and rock aggregate sources within the valley area. In addition, these potential aggregate sources are classified according to proposed aggregate use and type (Section 2.5).

ASTM TEST	SAMPLE TYPE AND NUMBER OF TESTS		
	COARSE	FINE	ROCK
ASTM C–88; SOUNDNESS BY USE OF MAGNESIUM SULFATE	14	16	11
ASTM C–131; RESISTANCE TO ABRASION BY USE OF THE LOS ANGELES MACHINE	14		11
ASTM C–136; SIEVE ANALYSIS	16	16	
ASTM C–289; POTENTIAL REACTIVITY OF AGGREGATE (CHEMICAL METHOD)	5	3	3
ASTM C–127 AND C–128; SPECIFIC GRAVITY AND ABSORPTION	7	5	4

AGGREGATE RESOURCES STUDY
AGGREGATE TESTS
LAKE VALLEY, NEVADA

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TABLE 1

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Geologic unit symbols utilized in Drawing 2 relate to standard geological nomenclature whenever possible. Undifferentiated basin-fill and rock units were established primarily to accommodate accuracy of data and map scale and may contain deposits which could supply significant quantities of high quality materials. A conversion table to relate these geologic symbols to the geologic unit nomenclature used in the Fugro National Verification studies is contained in Appendix E.

All contacts which represent distinct boundaries between geologic units are shown as solid lines in Drawing 2. The contacts are dashed where the depicted data were extrapolated beyond the limits of the source data or where accuracy of the data may be questionable. Local small deposits of one geologic unit may be found in close association with a larger deposit of a different geologic unit. Due to the reconnaissance level of the field investigation or scale limitations, these smaller deposits could not be depicted on the aggregate resources map and have been combined with the more prevalent material. Similarly, potential aggregate source classifications are preliminary and may contain lesser amounts of material of another use or type. Therefore, all classification lines are dashed and delimit the best aggregate evaluations possible at this level of investigation. In cases of highly variable rock or basin-fill units and limited aggregate tests, boundaries could not be drawn, and information is presented as point data in Drawing 2.

Appendices contain tables summarizing the basic data collected during Fugro National's supplemental field investigations, the results of Fugro National's supplemental testing programs, and existing test data gathered from various outside sources (Appendix A). Also included in appendices are an explanation of caliche development (Appendix B), the Unified Soil Classification System (Appendix C), photographs of typical aggregate sources within the study area (Appendix D), and a geologic unit cross reference table (Appendix E).

2.5 PRELIMINARY CLASSIFICATION OF POTENTIAL AGGREGATE SOURCES

A system was developed to preliminarily classify all potential aggregate sources in the study area. This classification is designed to present the best potential sources of coarse, fine, coarse and fine (multiple source), and crushed rock aggregate types within a valley-specific area (Drawing 2) based on potential aggregate use (Table 2). Concrete aggregate parameters are the principal consideration in this report since materials suitable for use as concrete aggregate are generally acceptable for use as road-base material. Therefore, the three classifications described below were based primarily on results of the abrasion, soundness, and alkali reactivity tests.

Class I — Potentially suitable concrete aggregate and road base material source. Coarse and crushed rock aggregates which either passed abrasion, soundness, and alkali reactivity tests or passed abrasion and soundness tests and were not tested for alkali reactivity; fine aggregates which either passed soundness and alkali reactivity tests or passed soundness tests and were not tested for alkali reactivity.

Class II — Possibly unsuitable concrete aggregate/potentially suitable road-base material source. Coarse, fine, and crushed rock aggregates which either failed the soundness and/or alkali reactivity tests or were classified only by field visual observations or other test data.

AGGREGATE CHARACTERISTIC[1]			AGGREGATE USE CLASSIFICATION		
			CLASS I	CLASS II	CLASS III
ABRASION RESISTANCE, PERCENT WEAR[2]			< 50	< 50	> 50
SOUNDNESS, PERCENT LOSS[3]	COARSE AGGREGATE	Na SO_4	< 12	> 12	> 12
		Mg SO_4	< 18	> 18	> 18
	FINE AGGREGATE	Na SO_4	< 10	> 10	> 10
		Mg SO_4	< 15	> 15	> 15
POTENTIAL ALKALI REACTIVITY[4]			INNOCUOUS TO POTENTIALLY DELETERIOUS	DELETERIOUS	DELETERIOUS

1. AGGREGATE CHARACTERISTIC BASED ON STANDARD TEST RESULTS
2. ASTM C131 (500 REVOLUTIONS)
3. ASTM C88 (5 CYCLES)
4. ASTM C289

PRELIMINARY AGGREGATE CLASSIFICATION SYSTEM, VALLEY–SPECIFIC AGGREGATE RESOURCES STUDY

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TABLE 2

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Class III <u>Unsuitable concrete aggregate or road base material source</u>. Coarse and crushed rock aggregates which failed the abrasion test and were excluded from further testing. Fine, and rarely coarse aggregates composed of significant amounts of clay- and silt-sized particles.

Sources not specifically identified as Class I, II, or III from the three critical test results or have high clay- and silt-sized particle (less than .0029 inch [.074 mm]) content are designated as Class II sources. All classifications are preliminary with additional field reconnaissance, testing, and case history studies needed to confirm adequacy, delimit areal boundaries, and define exact physical and chemical characteristics.

The following publications/sources were used in defining the three use classifications:

1. ASTM C33-74A Standard Specifications for Concrete Aggregate;
2. SSPWC Part II Construction Sections 200-1.1, 1.4, 1.5, and 1.7;
3. Literature applicable to concrete aggregates;
4. Industrial producers of concrete aggregates; and
5. Consultants in the field of concrete aggregates.

3.0 GEOLOGIC SETTING

3.1 PHYSIOGRAPHY

The study area lies entirely within the Basin and Range physiographic province. Primary physiographic features are controlled by block faulting which has produced the uplifted north-south trending mountains and intervening down-dropped, alluvial-filled basins.

Elevations within the valley range from more than 6600 feet (2012 m) near the northern end of Lake Valley to approximately 4700 feet (1433 m) near the town of Panaça in the extreme southern section of the study area.

Eight mountain ranges bound the study area. These ranges include the Highland, Bristol, Fairview, and Schell Creek ranges on the western side and the Mohogany and White Rock mountains and Fortification and Wilson Creek ranges on the eastern side of the study area (Drawing 2). The Pioche Hills form a partial topographic divide at the southern end of the study area between Lake and Meadow valleys. Topographic relief between mountain ridges and basins is generally greatest along the northwest valley margin where it averages approximately 3000 feet (914 m). Drainage is open in the main valley with surface water flowing south into Meadow Valley Wash which connects with the Muddy River near Moapa, Nevada.

3.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Rocks representing the Paleozoic, Mesozoic, and Cenozoic eras occur within and adjacent to the valley area. These rocks are of various igneous (intrusive and extrusive), metamorphic, and sedimentary lithologies (Drawing 2).

Paleozoic sedimentary rocks consist predominantly of thin- to very thick-bedded quartzites, limestones, and dolomites with interbedded sandstone, shale, and siltstone. They occur extensively in the western half of the study area within the Schell Creek, Bristol, and Highland ranges.

Unconformably overlying Paleozoic rocks within the study region are Mesozoic deposits consisting predominantly of undifferentiated volcanic rocks principally composed of flows, mud flows, breccias, and tuffs of rhyolitic to andesitic composition. These rocks occur most extensively in the White Rock and Mahogany mountains and the Wilson Creek Range on the eastern margin and in the Fairview Range along the west-central border of Lake Valley.

Cenozoic rocks, where present, unconformably overlie older rocks. Tertiary volcanic rocks are comprised of welded and nonwelded tuffs and lava flows of basaltic to rhyolitic composition. These volcanics predominantly occur as isolated units in mountain ranges on the eastern side of the valley.

Unconformably overlying all older units are unconsolidated Cenozoic basin-fill deposits. The basin-fill units consist of alluvial fan, lacustrine, and stream-channel and terrace material. These deposits reach a combined thickness of many hundreds to thousands of feet in the valley axis.

Geologic deposits have been grouped into six rock and four basin-fill geologic units for use in discussing potential aggregate sources. The grouping of these units was based on similarities in physical and chemical characteristics and map-scale limitations. The resulting units simplify discussion and presentation without altering the conclusions of the study.

3.2.1 Rock Units

Geologic rock units were grouped into six categories (see Drawing 2): quartzite (Qtz), limestone (Ls), dolomite (Do), carbonate rocks undifferentiated (Cau), sedimentary rocks undifferentiated (Su), and volcanic rocks undifferentiated (Vu).

3.2.1.1 Quartzite - Qtz

The Prospect Mountain Quartzite, of Cambrian age, crops out in the Chief and Schell Creek ranges and within the Pioche Hills (Drawing 2). This formation consists of reddish-brown to white, thin- to thick-bedded, well-indurated, fine-grained quartzite containing up to 10 percent feldspar grains. It contains interbeds of less resistant quartzite, micaceous shale, pebble conglomerate, and arkosic sandstone layers. Diabase dikes and sills of basaltic appearance may locally intrude this formation.

The Eureka Quartzite crops out as a small unit in the northwest portion of the study area within the central Schell Creek Range and in the east-central part of Lake Valley within the Wilson Creek Range (Drawing 2). It is generally less than 500 feet (150 m) thick and is closely associated with and often mapped as dolomitic rock (Do). The formation is white or light-gray in appearance, vitreous, fine- to medium-grained, and massive orthoquartzite. Sandstone and dolomitic sandstone are exposed at the top and bottom of the formation.

3.2.1.2 Limestone - Ls

Limestone is a carbonate rock which is hard, durable, medium- to thick-bedded, and forms resistant outcrops within the study area. Mapped units represent upper Paleozoic sediments principally of Mississippian, Pennsylvanian, and Permian age. Units represented include the unnamed Mississippian, Pennsylvanian, and Permian limestones. The limestones are typically medium- to dark-gray, fine- to medium-grained, fossiliferous, and sparsely cherty with well-developed bedding and jointing. This unit is mapped chiefly in the northern portion of the study area with major deposits occurring in Grassy and Dutch John mountains in the northern Fairview Range and in the Schell Creek and Fortification ranges.

3.2.1.3 Dolomite - Do

Dolomite is a high magnesium content carbonate rock that is characteristically dark- to medium-gray in appearance, medium-grained, sparsely to moderately cherty, and hard with well-developed bedding and jointing. Principal formations that comprise the bulk of this unit are the lower Paleozoic Ely Springs, Laketown, Sevy, and Simonson dolomites. Small units are mapped in the Schell Creek Range at the northern end of the site area.

3.2.1.4 <u>Carbonate Rocks Undifferentiated - Cau</u>

Materials classified as undifferentiated carbonate rocks include thick, complex sequences of limestone and dolomite with thin interbeds of sandstone, shale, and siltstone. Individual units are not delineated separately due to map-scale limitations and the highly interbedded nature of these units. Principal formations in this unit include the Highland Peak, Guilmette, and undifferentiated upper Cambrian units. These cliff forming rocks are chiefly limestone and are typically light- to dark-gray in appearance, thinly to thickly bedded, hard, durable, cherty, and fossiliferous. Undifferentiated carbonate units are the most extensive of the mapped sedimentary rock units within the study area. The Bristol and Highland ranges along the southwestern margins of the site are almost entirely mapped as undifferentiated carbonate rocks. Major units also are located in the Pioche Hills and the Fairview and Schell Creek ranges and White Rock Mountains.

3.2.1.5 <u>Sedimentary Rocks Undifferentiated - Su</u>

Geologic formations mapped as undifferentiated sedimentary rocks include interbedded sandstone, shale, dolomite, limestone, and quartzite. These deposits are characterized by poorly indurated material with complex bedding. The highly interbedded nature of these units prevents separation into individual rock types. Principal geologic formations included within this unit are the Pioche Shale, Chainman Shale, and Arcturus Formation which principally crop out at the northern end of the site in the Schell Creek, Fairview, and Fortification ranges (Drawing 2).

3.2.1.6 Volcanic Rocks Undifferentiated - Vu

Undifferentiated volcanic rocks form the most extensive rock units in the study area and are principally located in the Mahogany and White Rock mountains and the Wilson Creek, Fairview, and Fortification ranges (Drawing 2). These rocks are Cretaceous to Pliocene and consist predominantly of welded and nonwelded pyroclastics (air falls, ash flows, ignimbrites) of andesitic to rhyolitic composition. Individual rock units have not been delineated separately because of map-scale limitations and complex composition.

3.2.2 Basin-Fill Units

Four basin-fill units are mapped within the study area (Drawing 2). These consist of older lacustrine (Aol), alluvial fan (Aaf), stream channel and terrace (Aal), and undifferentiated alluvial deposits (Au). Coarse (c) (primarily composed of cobble-sized material), gravel (g), and sand (s) grain-size designations (e.g., Aafg) have been assigned to basin-fill units in the Verification mapped areas. Fine-grained stream channel and older lake deposits (silts and clays) that have been mapped in the central portion of the basin and labeled as unsuitable aggregate sources will not be discussed in the text.

3.2.2.1 Older Lacustrine Deposits - Aol

Older lacustrine deposits were formed from late Pliocene to early Pleistocene time in response to a much wetter climate. These deposits are widely distributed throughout the study area and are usually interbedded with or overlain by alluvial fan deposits (Drawing 2). Observed size gradations range from coarse gravel to sand, silt, and clay. Older lacustrine shoreline deposits (sandbars, sand spits, deltas) of Pleistocene Lake Carpenter in northern Lake Valley typically consist of sand and gravel and are particularly well developed at elevations of approximately 5900 to 6000 feet (1798 to 1829 m) above mean sea level. Older lacustrine deposits at the southern end of the site area typically composed of sand and gravel units with high percentages of fine-grained material (silt and clay).

3.2.2.2 Alluvial Fan Deposits - Aaf

Alluvial fans bordering the mountain fronts and extending out into the valley basins are the most extensive potential basin-fill aggregate deposits mapped and labeled within the study area (Drawing 2). They are typically homogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay that grade from very coarse grained near the rock/alluvium contact to fine grained near the valley centers.

Individual fan units contain poorly to well-graded, angular to subangular particles that exhibit considerable lateral and vertical textural variation. Composition of the surrounding source rock strongly controls the textural properties of material formed in alluvial fan deposits. Fan units formed at the base of carbonate or quartzitic rocks are characteristically coarse grained, whereas fans developed from volcanic sources tend to be fine grained. Caliche development in soils (Appendix B), a natural process of soil development in arid climates, ranges from none in younger fans to Stage III in older units.

3.2.2.3 Stream Channel and Terrace Deposits - Aal

Stream-channel and terrace deposits within the study area are associated with primary and secondary ephemeral streams (Drawing 2). Secondary ephemeral streams commonly transect alluvial fan deposits and trend normal to the ranges toward the valley axis. Most are too small or indistinct to be depicted on Drawing 2 and have been grouped with adjacent, more prominent units (i.e., alluvial fan, undifferentiated alluvium). Secondary streams join the primary ephemeral drainage system in the central basin, which drains southward into Meadow Valley Wash. These deposits vary from homogeneous to poorly stratified mixtures of sand, gravel, cobbles, and boulders near mountain fronts to sand, silt, and clay near valley centers.

3.2.2.4 Alluvial Deposits Undifferentiated - Au

Undifferentiated alluvial deposits consist primarily of combinations of basin-fill units in areas that were not examined and mapped during the Verification program. Located predominantly in the southern portion of the study area, this group includes alluvial fan, older lacustrine, and stream-channel and terrace deposits. These alluvial deposits are unstratified to stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay derived from a wide range of rock types. Composition varies according to the characteristics of the individual units and the lithology of the source rock.

4.0 POTENTIAL AGGREGATE SOURCES

Based on the results of field visual observations and aggregate testing, potential basin-fill and rock sources were divided into three basic material types (i.e., coarse, fine, and crushed rock) and classified into one of the three use categories (Section 2.5). Basin-fill deposits tested in the study area may also be placed within a multiple-type category (coarse and fine aggregate source). Coarse aggregate (gravel to boulders) included material predominantly retained on the No. 4 sieve (greater than 0.185 inch [4.75 mm]). Fine aggregate (predominantly sand) includes material entirely passing the 3/8-inch sieve (less than 0.375 inch [9.5 mm]) and almost entirely passing the No. 4 sieve (0.185 inch; 4.75 mm) and retained on the No. 200 sieve (0.0029 inch [0.074 mm]).

Boundaries (Drawing 2) of basin-fill aggregate sources were generalized and will require additional studies to accurately define their location. Boundaries of identified crushed rock sources are based on the aerial map extent of the geologic formations tested (i.e., Prospect Mountain Quartzite, Fish Haven Dolomite) and not on the aggregate geologic unit (i.e., Qtz, Do) described in Section 3.2.1.

In the following discussion, the best potential coarse, fine, or crushed rock source within each Class I and Class II category is presented first, followed by sources with successively lower potential. This ranking of deposits is preliminary and based upon an analysis of Fugro National and existing data.

4.1 BASIN-FILL SOURCES

4.1.1 Coarse Aggregate

4.1.1.1 Potentially Suitable Concrete Aggregate and Road Base Mineral Sources - Class I

Extensive Class I coarse aggregate sources are located in the northern end of Lake Valley within alluvial fans (Aafc, Aafg, Aafs) deposits that border the Schell Creek and northern Fairview (Dutch John and Grassy mountains) and Fortification ranges (Drawing 2). Alluvial units consist predominantly of loose to medium dense, crudely stratified sand, gravel, and cobbles composed of subangular carbonate and quartzite clasts. Laboratory test data indicate these deposits have acceptable abrasion and soundness values for Class I coarse material (Table 2). An alkali reactivity test was performed on one sample with innocuous test results. Sieve analyses for these samples suggest that the fan deposits are moderately well graded and generally have sufficient material for crushing, especially the Aafc deposit east of the Schell Creek Range. Fine-aggregate material comprises as much as 42 percent of the tested deposits. Overburden averages 1.5 to 3 feet (0.5 to 1 m) thick and consists predominantly of slightly cemented gravel (Stage II).

Access to these deposits is provided by U.S. Highway 93 which traverses the area and by numerous unpaved roads. Minability is considered good to excellent in these sources. Additional field reconnaissance and testing will be necessary to accurately define the boundaries of these potential sources.

Class I coarse aggregate sources were also identified in alluvial fan (Aafg, Aafs, Aaf) deposits at the southern end of Lake Valley east of the Bristol and Highland ranges (Drawing 2). Field observations indicate that the deposits consist of loose to dense, poor to moderately well-graded, crudely stratified gravelly sand or sandy gravel. Gravel comprises as much as 75 percent of the examined units and consists predominantly of subangular to subrounded carbonate and volcanic clasts. The coarse fraction of these sources passed the soundness and abrasion tests for Class I coarse aggregate. Alkali reactivity tests were performed on three samples with innocuous to potentially deleterous test results. Fine aggregate material comprises 14 to 60 percent of these deposits. Overburden thickness ranges from 1.5 to 3 feet (1 to 2 m), consisting of slightly cemented gravel (Stage I to III). Boundaries of some of these sources are tentatively depicted and will require additional field investigations for accurate definition. The access and minability of these deposits are considered excellent.

Class I aggregate sources were identified in older lacustrine shoreline (Aolg, Aols) deposits east of the Schell Creek Range within the central valley basin (Drawing 2). Field observations indicate these deposits consist of poorly to moderately well-graded, crudely stratified to stratified, loose to medium dense gravelly sand or sandy gravel. Gravel comprises from 34 to 67 percent of these sources and consists primarily of subrounded carbonate, quartzite, sandstone, and volcanic clasts. These deposits passed abrasion and soundness requirement for a Class I source. Innocuous test results were obtained from the one alkali reactivity test performed. Overburden ranged from 1.5 to 3 feet (0.5 to 1 m) consisting of slightly cemented gravel (Stage II). Boundaries of these units are tentative where shown and will require additional field investigations to accurately define. The access and minability of these sources are considered excellent.

Field observations suggest that most alluvial fan units and older lacustrine shoreline units located basinward from the rock/alluvium contact of Class I and possibly Class II carbonate or quartizitic rocks may qualify as Class I coarse aggregate sources.

4.1.1.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

A Class II coarse aggregate source was identified in older lacustrine (Aol) deposits west of the White Rock Mountains at the southern end of the site (Drawing 2). This deposit consists of medium-dense, moderately well-graded, crudely stratified, gravelly sand. Gravels comprise 44 percent of the source and consist predominantly of subangular to subrounded volcanic clasts. The coarse aggregate passed the abrasion test but had unacceptable soundness losses. Overburden averages about 3 feet (1 m) in thickness, and the access and minability of this unit are considered to be very good.

Based on field observations, other Class II coarse sources are present in alluvial fan (Aaf, Aafs) deposits near the rock/alluvium contact of nearly all mountain ranges. The access and minability of these units will vary but should generally be good.

4.1.1.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No unsuitable coarse aggregate sources were identified in the Lake Valley valley-specific study area.

4.1.2 Fine Aggregate

4.1.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I

Class I fine aggregate sources were identified in older lacustrine shoreline deposits (Aolg) in northern Lake Valley (Drawing 2). These deposits consist of loose- to medium-dense, poorly to moderately well-graded, crudely stratified sandy gravel with gravels comprising from 52 to 67 percent of the material. Silt and clay comprise between two and 17 percent of these deposits. Abrasion, soundness, and alkalai reactivity tests for coarse and fine fractions are within Class I standards. The high percentage of acceptable gravel (Section 4.1.1.1) and sand makes these deposits potentially excellent multiple sources. Overburden consists of 3 feet (1 m) or less of slightly cemented soil. Good access to these deposits is provided by U.S. Highway 93 which parallels the shoreline deposits at the northern end of Lake Valley. Minability is considered excellent for these sources. Boundaries of Class I fine aggregate sources are tentative where shown and will require additional field investigations for accurate delimitation.

Based on field observations, other potential Class I fine aggregate sources may exist in alluvial fans adjacent to Class I and/or possibly Class II crushed rock sources and within older lacustrine shoreline deposits.

4.1.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Materials Sources - Class II

Class II fine aggregates were identified within alluvial fan (Aafc, Aafg, Aafs, Aaf) deposits bordering the central valley basin and in older lacustrine (Aolg, Aols, Aol) and stream channel (Aal) deposits throughout the study area (Drawing 2). Field observations indicate these deposits are poorly to moderately well-graded, crudely stratified to stratified, loose- to medium dense gravelly sand and sandy gravel. Gravel ranges from 15 to 75 percent of the tested units' multiple type source and generally consist of carbonate rock clasts with some intermediate volcanic, quartzite, and sandstone clasts. Where tested, the coarse fraction passed requirements for Class I coarse aggregate (Section 4.1.1.1). Soundness losses for the fine fractions were excessively high resulting in a Class II ranking. Samples tested for alkali reactivity proved innocuous to potentially deleterious for both the coarse and fine fractions. Due to the scope of this investigation, boundaries of the fine aggregate sources could not be delineated and will require further field studies for accurate definition.

Based on field observations, additional Class II fine aggregate sources may be available from most Class I and Class II basin-fill areas shown in Drawing 2.

4.1.2.3 Unsuitable Concrete Aggregate or Road-Bass Material Sources - Class III

Class III fine aggregate sources were not specifically identified during testing but generally coincide with the distribution of stream channel deposits of the Lake Valley drainage system and within older lacustrine (Aol) and alluvial fan (Aaf) deposits in the central valley basin (Drawing 2). These sediments are typically composed of interbedded and stratified to cross-bedded, loose to moderately dense fine sand and soft to moderately stiff silt and clay.

4.2 CRUSHED ROCK SOURCES

4.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I

Class I crushed rock sources are distributed predominantly in the western half of the study area within the Schell Creek, Fairview, Bristol, and Highland ranges, and the Pioche Hills. Smaller, isolated units occur in the White Rock Mountains and in the Wilson Creek Range. These sources consist of: undifferentiated carbonate rocks (Cau) from the Highland Peak Formation, undifferentiated upper Cambrian deposits, and the Guilmette Formation; Prospect Mountain Quartzite (Qtz), unnamed Mississippian and Pennsylvanian limestones (Ls), Simonson, Sevy, and Laketown dolomites (Do); and undifferentiated volcanic rocks (Vu).

The Highland Peak Formation (Cau) forms extensive rock units the Bristol, Highland, and Chief ranges and the Pioche Hills in the southwestern part of Lake Valley. This formation also provides Class I crushed rock aggregate material in the southern White Rock Mountains. Field observations indicate that splitting characteristics are favorable for crushing, and laboratory testing indicates abrasion and soundness losses are within Class I crushed rock standards (Table 2). Alkali reactivity tests have not been completed on this formation. Limestone from this rock unit has been previously quarried at the south end of the Highland Range and used in road construction.

Undifferentiated upper Cambrian rocks (limestones and dolomites), although not as extensive as the Highland Peak Formation, are also present as major deposits in the Highland and Bristol ranges and as a small isolated unit in the southern Wilson Creek Range. Limited field observations suggest that the limestones within this formation are hard and have good splitting characteristics. Test results show no undesirable aggregate characteristics for a Class I rock unit (Table 2), however, alkali reactivity has not been determined for this source.

The Guilmette Formation (Cau) crops out at Dutch John Mountain at the northern end of the Fairview Range and in the Schell Creek and northern Bristol ranges (Drawing 2). The formation consists primarily of moderately hard to hard, dark-gray to grayish-black limestone that is thin to thick-bedded and has favorable splitting characteristics for crushing. Although not tested during this investigation, laboratory tests performed in Dry Lake and Hamlin valleys (FN-TR-37-a, FN-TR-37-d) indicate that abrasion, soundness, and alkali reactivity tests are within Class I crushed rock aggregate requirements.

The Highland Peak Formation, undifferentiated upper Cambrian deposits, and the Guilmette Formation, because of their close proximity to major transportation arteries (U.S. Highway 93 and State Highway 83), would provide good to excellent accessible and minable sources of Class I crushed rock aggregate for the southern part of the study area.

The Prospect Mountain Quartzite (Qtz) was identified as a Class I crushed rock source within the Pioche Hills and Chief Range at the southern end of Lake Valley and in the Schell Creek Range at the northern end of the site. Field observations indicate that the quartzite is very hard, has slabby splitting characteristics, and no deleterious materials. Abrasion, soundness, and alkali reactivity tests are within Class I standards for crushed rock aggregate. Access to this source, at the southern end of Lake Valley, is excellent and is provided by U.S. Highway 93. Minability should be good to excellent.

Limited laboratory tests on unnamed Mississippian and Pennsylvanian limestones (Ls) located at the ·orthern end of the Fairview Range (Dutch John and Grassy mountains) and in the Schell Creek Range at the north end of the valley (Drawing 2) indicate that abrasion, soundness, and alkali reactivity are well within Class I standards (Table 2). Field observations indicate the limestones are typically very hard, fine-grained, thin- to thick-bedded and have favorable splitting characteristics for crushing. These units have very good to excellent access, which is provided by U.S. Highway 93 and unpaved roads. Minability is very good especially in those units exposed in the small hills located east of the Schell Creek Range near the valley basin.

Laketown, Simonson, and Sevy dolomites (Do) form isolated small rock units in the Schell Creek Range (Drawing 2). They consist primarily of dolomites with thin interbeds of sandstone and sedimentary breccia. Splitting characteristics of the dolomites are favorable for crushing, and both abrasion and soundness tests indicate these units are within Class I standards for crushed rock aggregate (Simonson and Sevy dolomites tested in Hamlin Valley, FN-TR-37-d). No alkali reactivity tests were performed on these units; however, potentially deleterious reactions may result from chert observed during field reconnaissance. The access and minability of the Laketown Dolomite is good to excellent especially in the small hills east of the Schell Creek Range.

Undifferentiated volcanic rock (Vu) was identified as a Class I crushed rock aggregate source in the Fortification and Wilson Creek ranges on the eastern side of the study area (Drawing 2). Boundaries could not be drawn due to lateral and vertical lithologic variations (see Section 4.2.2). Acceptable abrasion, soundness, and alkali reactivity test results indicate that volcanic rocks of andesitic and rhyodacitic composition could make potentially suitable crushed rock sources in areas where boundaries can be defined. Alkali reactivity tests proved potentially deleterious and further testing should be completed in these sources (Table 2). Field observations indicate splitting characteristics are generally favorable for crushing, and access and minability are good.

4.2.2 Possible Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

No Class II crushed rock aggregate sources were specifically identified from the laboratory testing program. Extensive rock units indicated on Drawing 2 as Class II crushed rock sources were classified only by field visual observations. The predominant types of rock in this category are undifferentiated volcanics (Vu) of highly variable lithologic composition, certain Paleozoic carbonates (Ls, Do), and undifferentiated sedimentary (Su) rocks.

4.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No Class III crushed rock aggregate sources were identified within the Lake Valley study area during this investigation.

5.0 CONCLUSIONS

Results of the valley-specific aggregate investigation indicate that potentially good to high quality (Classes I and II) basin-fill and crushed rock aggregate sources are present within the Lake Valley valley-specific area to meet construction requirements of the MX system (Drawing 2).

5.1 POTENTIAL BASIN-FILL AGGREGATE SOURCES

5.1.1 Coarse Aggregate

Major Class I coarse aggregate deposits listed in order of potential suitability, have been identified within the following areas:

1. Extensive alluvial fan deposits (Aafc, Aafg) east of the Schell Creek Range in the northern part of the study area; and
2. Older lacustrine shoreline deposits (Aolg, Aols) in the north central valley, east of the Schell Range.

Field observations and laboratory testing indicate additional sources of Class I coarse aggregate are available in alluvial fan deposits (Aafg, Aafs, Aaf) adjacent to Class I and/or Class II crushed rock sources in the northeastern and southern portions of the site.

Based on field observation and limited test results, potentially suitable Class II coarse aggregate sources are widespread and extensive in the study area. Although boundaries of specific deposits could not be delineated, they are typically located within older lacustrine deposits (Aol) or alluvial fans (Aaf, Aafs) flanking Class I and/or Class II rock sources.

5.1.2 Fine Aggregate

While most coarse aggregate sources will supply quantities of fine aggregate (multiple source) either from the natural deposits or during processing, several fine aggregate sources were sampled and tested. Class I fine aggregate sources were identified within older lacustrine deposits (Aolg) east of the Schell Creek Range in the northern portion of Lake Valley.

Further field reconnaissance will be required to identify and delineate additional Class I fine aggregate sources, however, based on field observations, potential sources may exist in alluvial fan units (Aafg, Aafs, Aaf) derived from Class I and/or Class II rock sources and in older lacustrine shoreline units (Aols, Aol).

Potential Class II fine aggregate sources are widespread and extensive throughout the study area. Specific boundaries could not be delineated but typically occur in alluvial fan (Aaf, Aafs, Aafg, Aafc) and older lacustrine (Aolg, Aols, Aol) deposits basinward of most Class I and Class II rock exposures.

5.2 POTENTIAL CRUSHED ROCK AGGREGATE SOURCES

Class I crushed rock sources exist in several sections of the study area. The most suitable deposits and their corresponding locations are as follows:

a. Prospect Mountain Quartzite (QTz), Guilmette Formation (Cau), Laketown, Sevy, and Simonson dolomites (Do), unnamed Mississippian and Pennsylvanian carbonates (Cau), and undifferentiated upper Cambrian carbonates (Cau). - Northern Lake Valley study area (Schell Creek Range, and the Dutch John and Grassy mountains at the north end of the Fairview Range).

b. Guilmette and Highland Peak formations (Cau), Prospect Mountain Quartzite (QTz), and undifferentiated upper Cambrian carbonates (Cau). - Southwestern Lake Valley study area (Bristol, Highland, and Chief ranges, and the Pioche Hills).

c. Highland Peak Formation and undifferentiated upper Cambrian carbonates (Cau). - Southeastern Lake Valley study area (White Rock Mountains and the Wilson Creek Range).

Quartzite (QTz) and carbonate (Cau, Do, Ls) Class I crushed rock sources, exposed within the Pioche Hills and small hills east of Schell Creek Range, could provide crushed rock material for much of the study area because of their close proximity to the valley basin and good to excellent minability.

Undifferentiated volcanic rocks (Vu), limestone (Ls), dolomite (Do), and undifferentiated carbonate (Cau) and sedimentary rocks (Su), which are widely distributed throughout the study area, compose most of the Class II crushed rock sources classified by field visual observations and delineated in Drawing 2.

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APPENDIX A

Fugro National Field Station and Supplementary Test Data and Existing Test Data Summary Tables - Lake Valley

EXPLANATION OF FUGRO NATIONAL FIELD STATION AND SUPPLEMENTARY TEST DATA

Fugro National field stations were established at locations throughout the valley-specific study area where detailed descriptions of potential basin-fill or rock aggregate sources were recorded (Drawing 1). All field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Data entries record conditions at specific field station locations that have been generalized in the text and Drawing 2. Detailed explanations for the column headings in Table A-1 are as follows:

Column Heading	Explanation
Map Number	This sequentially arranged numbering system was established to facilitate the labeling of Fugro National field station locations and existing data sites on Drawing 1 and to list the correlating information on Tables A-1 and A-2 in an orderly arrangement.
Field Station	Fugro National field station data are comprised of information collected during: o The Valley-Specific Aggregate Resources Study; sequentially numbered field stations were completed by two investigative teams (A and B); o The general aggregate investigation in Nevada (NV); R and H indicate ground and aerial reconnaissance stops, respectively; and o The Verification study in Lake Valley (LV); trench data (T) were restricted to information below the soil horizon (1 to 6 feet).
Location	Lists major physiographic or cultural feature in or near which field stations or existing data sites are situated.

Column Heading	Explanation
Geologic Unit	Generalized basin-fill or rock geologic units at field station or existing data locations. Thirteen classifications, emphasizing age and lithologic distinctions, were developed from existing geologic maps to accomodate map scale of Drawing 2.
Material Description	Except in cases where soil or rock samples were classified on laboratory results, the descriptions are based on field visual observations utilizing the Unified Soil Classification System (see Appendix C for detailed USCS information).
Field Observations	
Boulders and/or Cobbles, Percent	The estimated percentage of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an average diameter between 3 and 12 inches (8 and 30 cm); boulders have an average diameter of 12 inches (30 cm) or more.
Gravel	Particles that will pass a 3-inch (76-mm), and are retained on No. 4 (4.75 mm), sieve.
Sand	Particles passing No. 4 sieve and retained on No. 200 (0.075 mm) sieve.
Fines	Silt or clay soil particles passing No. 200 sieve.
Plasticity Index	Plasticity index (PI) is the range of water content, expressed as percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Field classification followed standard descriptions and their ranges are as follows: None - Nonplastic (NP) (PI, 0 - 4) Low - Slightly plastic (PI, 4 - 15) Medium - Medium plastic (PI, 15 - 30) High - Highly plastic (PI, > 31)
Hardness	A field test to identify materials that are soft or poorly bonded by estimating their resistance to impact with a rock hammer; classified as either soft, moderately hard, hard, or very hard.

Column Heading	Explanation
Weathering	Changes in color, texture, strength, chemical composition or other properties of rock outcrops or rock particles due to the action of weather; field classified as either fresh, slight(ly), moderate(ly), or very weathered.
Deleterious Materials	Substances potentially detrimental to concrete performance that may be present in aggregate; includes organic impurities, low density material, (ash, vesicules, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche coatings, clay coatings, mica, gypsum, pyrite, chlorite, and friable materials, also, aggregate that may react chemically, or be affected chemically, by other external influences.
Laboratory Test Data	
Sieve Analysis (ASTM C 136)	The determination of the proportions of particles lying within certain size ranges in granular material by separation on sieves of different size openings; 3 inch, 1 1/2 inch, 3/4 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200.
No. 8, No. 50	Asterisked entries used No. 10 and No. 40 sieves, respectively.
Abrasion Test (ASTM C 131)	A method for testing abrasion resistance of an aggregate by placing a specified amount in a steel drum (the Los Angeles testing machine), rotating it 500 times, and determining the material worn away.
Soundness Test (ASTM C 88) CA, FA	CA = Coarse Aggregate FA = Fine Agregate The testing of aggregates to determine their resistance to disintegration by saturated solutions of magnesium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate information is not available from service records c. the material exposed to actual weathering conditions.

Column Heading	Explanation
Specific Gravity and Absorption (ASTM C 127 and 128)	Methods to determine the Bulk Specific Gravity, Bulk SSD Specific Gravity (Saturated - Surface Dry Basis), and Apparent Specific Grav[illegible] and Absorption as defined in ASTM E 12-[illegible] and ASTM C 125, respectively.
Alkali Reactivity (ASTM C 289)	This method covers chemical determination of the potential reactivity of an aggregate with alkalies in portland cement concrete as indicated by the amount of reaction during 24 hours at 80° C between 1 N sodium hydroxide solution and aggregate that has been *crushed and sieved to pass a No.* 50 (300-µm) sieve and be retained on a No. 100 (150-µm) sieve.
Aggregate Use	I = Class I; potentially suitable concrete aggregate and road-base material source. II = Class II; possibly unsuitable concrete aggregate/potentially suitable road-base material source. III = Class III; unsuitable concrete aggregate or road base material source. c = coarse aggregate f = fine aggregate f/c = fine and coarse aggregate cr = crushed rock All sources not specifically identified as Class I, II, or III from the abrasion, soundness, or alkali reactivity tests or the content of clay- and silt-sized particles, are designated as Class II sources.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUT[ION OF] MATERIAL [LESS] THAN COB[BLES,] PERCE[NT] GRAVEL	SAND
1	LV-A1	Lake Valley	Aals	Silty Gravelly Sand	SP-SM			
2	LV-A2	Lake Valley	Aaf	Silty Gravelly Sand	SP-SM	T	40	55
3	LV-A3	Wilson Creek Mountains	Vu	Rhyodacite				
4	LV-A4	Wilson Creek Mountains	Vu	Rhyodacite				
5	LV-A5	Lake Valley	Aafs	Sandy Gravel	GW			
6	LV-A6	Lake Valley	Vu	Rhyolite Tuff				
7	LV-A7	Lake Valley	Vu	Rhyolite				
8	LV-A8	Lake Valley	Aaf	Sandy Gravel	GP			
9	LV-A9	Rose Valley	Aal	Gravelly Sand	SW			
10	LV-A10	Eagle Valley Canyon	Aal	Silty Gravelly Sand	SP-SM	3	25	65
11	LV-A11	Eagle Valley	Ls	Limestone				
12	LV-A12	Little Spring Valley	Aol	Gravelly Sand	SP			

FIELD OBSERVATIONS							SIEVE ANALYSIS, PERCENT PASSING (AST							
DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS								
GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30
			None			Caliche Coatings, Volc. Ash		100	97.6	92.8	84.6	78.7	66.9	47.1
40	55	5	None			Caliche Coatings, Volc. Ash and Pumice								
				Hard	Slight to Moderate	Volc. Ash and Pumice								
				Mod.Hard	Moderate	Chalcedony, Volc. Ash, Pumice, glass and Vesicules								
			None			Volc. Ash and Glass, Silt Lenses	100	83.9	65.2	47.7	34.6	27.7	22.3	17.8
				Mod.Hard	Slight	Volc. Glass and Pumice								
				Mod.Hard	Slight to Moderate	Volc. Glass and Pumice								
			None			Volc. Glass and Pumice	97.1	88.2	73.0	57.8	46.4	38.8	30.6	19.4
			None			Volc. Glass and Pumice		100	98.9	95.9	84.2	72.2	52.6	31.4
25	65	10	None			Volc. Glass and Pumice								
				Hard	Slight	Chert, Friable Material								
			None			Caliche Coatings, Volc. Glass	100	93.0	81.0	68.1	55.7	42.6	29.8	17.8

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LABORATORY TEST DATA

ASSING (ASTM C 136)					ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								A REA (AST
								COARSE AGGREGATE				FINE AGGREGATE				
								SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA
66.9	47.1	20.3	8.8	5.1			29.3									
					27.7	2.6			2.41		1.1					Potentiall Deleteriou
22.3	17.8	12.0	6.7	3.4	29.0	10.5	20.5									
30.6	19.4	8.7	4.7	3.1	30.7	14.3	30.7		2.46		4.4					Potentiall Deleteriou
52.6	31.4	15.0	7.3	4.6			26.5									
					25.9	0.6			2.73		0.3					
29.8	17.8	9.1	5.1	3.3	30.7	20.1	38.1									

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TION					
GGREGATE			ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
GRAVITY		PERCENT ABSORPTION			
K	APPARENT		CA	FA	
					IIf
					IIf/c
					IIcr
			Potentially Deleterious		Icr
					Ic IIf
					IIcr
					IIcr
			Potentially Deleterious		Ic IIf
					IIf
					IIf/c
					Icr
					IIf/c

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
LAKE VALLEY, NEVADA

MX SITING INVESTIGATION
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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUT MATERIAL THAN CO PERC	
							GRAVEL	SAND
13	LV-A13	White Rock Mountains	Cau	Limestone				
14	LV-A14	Little Spring Valley	Aol	Silty Gravelly Sand	SP-SM	5	20	70
15	LV-A15	Meadow Valley	Aaf	Silty Sandy Gravel	GP-GM			
16	LV-A16	Lake Valley	Aafs	Silty Sandy Gravel	GP-GM	T	75	15
17	LV-A17	Grassy Mountain	Ls	Limestone				
18	LV-A18	Lake Valley	Aalg	Silty Sandy Gravel	GP-GM			
19	LV-A19	Lake Valley	Aafc	Silty Sandy Gravel	GW-GM			
20	LV-A20	Lake Valley	Aols	Gravelly Sand	SP	2	40	56
21	LV-A21	Lake Valley	Aafs	Silty Sandy Gravel	GM			
22	LV-A22	Lake Valley	Aalf	Sandy Silt	ML	0	10	40
23	LV-B1	Lake Valley	Cau	Limestone				
24	LV-B2	Lake Valley	Aafs	Silty Sandy Gravel	GW-GM			
25	LV-B3	Lake Valley	Aafs	Silty Sandy Gravel	GM			
26	LV-B4	Lake Valley	Aafs	Silty Sandy Gravel	GM	T	70	15
27	LV-B5	Fairview Range	Vu	Rhyolite Tuff				

	FIELD OBSERVATIONS														
	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (AST							
PERCENT	GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30
					Hard	Slight	Chert, Friable Material								
	20	70	10	None			Volc. Glass and Pumice								
				None			Caliche Coatings	97.6	84.4	52.5	34.1	25.0	20.1	17.8	16.2
	75	15	10	Low			Caliche Coatings								
					Hard	Slight	None								
				None			None	97.2	93.4	80.4	56.9	37.0	24.5	16.9	12.3
				Med.			Caliche coatings, Clay Coatings	95.0	88.1	60.2	38.2	25.8	18.9	15.0	13.0
	40	56	4	None			Caliche Coatings, Nodules								
				None			Caliche Coatings	100	97.7	66.7	46.3	34.7	27.3	22.9	21.0
	10	40	50	Med.			Volc. Glass, Ash and Pumice, Mica								
					Hard	Slight	None								
				None			Caliche Coatings, and Nodules	100	97.4	86.3	62.9	42.2	33.0	25.6	20.7
				Low			None		100	97.0	78.9	54.3	45.8	37.4	32.2
	70	15	15	Low			Clay Coatings								
					Mod. Hard	Mod.	Volc. Ash, Glass, and Pumice, Mica								

LABORATORY TEST DATA

SSING (ASTM C 136)					ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								AL REACT (ASTM
								COARSE AGGREGATE				FINE AGGREGATE				
								SPECIFIC GRAVITY				SPECIFIC GRAVITY				
						PERCENT LOSS										
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	CA	FA	BULK	BULK SSD	APPAR-ENT	PERCENT ABSORPTION	BULK	BULK SSD	APPAR-ENT	PERCENT ABSORPTION	CA
17.8	16.2	14.6	12.8	11.0	27.1	2.5	26.2		2.70		0.7		2.47		5.8	Innocuous
					27.4	1.2										
16.9	12.3	9.3	7.8	6.7	31.3	4.0	27.9									
15.0	13.0	11.7	10.6	8.9	28.7	1.8	22.5									
22.9	21.0	19.8	18.1	14.3	32.8	10.0	23.5									
					26.9	1.9										
25.6	20.7	15.2	9.7	6.2	29.9	5.5	32.9									
37.4	32.2	28.2	24.0	19.2	32.0	9.5	33.5		2.64		2.4					Innocuous

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RPTION)			ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
AGGREGATE					
GRAVITY		PERCENT ABSORPTION			
LK D	APPAR-ENT		CA	FA	
					IIcr
					IIcr
.47		5.8	Innocuous	Innocuous	Ic
					IIf
					IIc
					Icr
					Ic
					IIf
					Ic
					IIf
					IIf/c
					Ic
					IIf
					IIIf
					Icr
					Ic
					IIf
			Innocuous		Ic
					IIf
					IIc
					IIcr

FUGRO NATIONAL FIELD STATION
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LAKE VALLEY, NEVADA

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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRI MATERIA THAN C PER	
							GRAVEL	SAN
28	LV-B6	Lake Valley	Aafs	Gravelly Sand	SP	T	30	70
29	LV-B7	Lake Valley	Aafs	Silty Sandy Gravel	GP-GM	T	50	40
30	LV-B8	Lake Valley	Cau	Limestone				
31	LV-B9	Lake Valley	Aols	Gravelly Sand	SP	0	30	66
32	LV-B10	Lake Valley	Aols	Gravelly Sand	SP			
33	LV-B11	Schell Creek Range	Ls	Limestone				
34	LV-B12	Schell Creek Range	Ls	Limestone				
35	LV-B13	Lake Valley	Aolg	Silty Sandy Gravel	GP-GM			
36	LV-B14	Lake Valley	Aolg	Silty Sandy Gravel	GP-GM			
37	LV-B15	Schell Creek Range	Su	Limestone				
38	LV-B16	Lake Valley	Do	Dolomite				
39	LV-B17	Schell Creek Range	Ls	Limestone				
40	LV-B18	Schell Creek Range	Ls	Limestone				
41	LV-B19	Fortification Range	Ls	Limestone				

FIELD OBSERVATIONS								SIEVE ANALYSIS, PERCENT PASSING						
BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS							
	GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16
T	30	70	T				Caliche Coatings, Volc. Ash and Pumice							
T	50	40	10				None							
					Hard	Slight	Calcite Veins							
0	30	66	4	None			Volc. Glass and Pumice							
				None			Volc. Glass, Ash and Pumice		100	99.1	91.7	66.4	37.8	13.7
					Hard	Slight	Chert							
					Hard	Slight	None							
				None			Volc. Glass, Ash Pumice, Mica	100	91.6	78.6	66.9	47.6	36.3	19.7
				Low			Volc. Glass, Ash, Pumice, Mica		100	93.5	74.0	39.8	22.2	16.4
					Hard	Slight	None							
					Hard	Slight	None							
					Mod. Hard	Mod.	Chert							
					Hard	Slight	Chert							
					Mod. Hard	Moderate	Chert							

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LABORATORY TEST DATA

NT PASSING (ASTM C 136)						ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								R (A
									COARSE AGGREGATE				FINE AGGREGATE				
									SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
NO. 8	NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA
						24.8	0.4										
.8	13.7	5.0	3.8	3.0	2.6	27.2	13.9	28.3		2.63		1.8		2.48		2.9	
						28.7	0.7										
.3	19.7	11.6	8.0	6.2	5.2	23.5	2.2	11.0		2.63		1.2		2.61		2.0	Innocuo
.2	16.4	13.7	12.4	11.2	9.2	26.7	3.7	24.2									
						31.1	0.8										

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...RAVITY AND ABSORPTION (... C 127 AND C 128)					ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
...TE	FINE AGGREGATE						
	SPECIFIC GRAVITY						
PERCENT ABSORPTION	BULK	BULK SSD	APPAR-ENT	PERCENT ABSORPTION	CA	FA	
							IIf/c
							IIc/f
							Icr
							IIf/c
1.8		2.48		2.9			IIf Ic
							IIcr
							Icr
1.2		2.61		2.0	Innocuous	Innocuous	Ic/f
							Ic IIf
							IIcr
							Icr
							IIcr
							IIcr
							IIcr

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MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTI MATERIAL F THAN COBB PERCENT	
							GRAVEL	SAND
42	LV-B20	Lake Valley	Aolq	Sandy Gravel	GW			
43	LV-B21	Fortification Range	Vu	Rhyodacite				
44	LV-B22	Fortification Range	Vu	Andesite Tuff				
45	LV-B23	Pioche Hills	Qtz	Quartzite				
46	LV-B24	Meadow Valley	Au	Sandy Clay	CL	0	20	35
47	LV-B25	Meadow Valley	Aols	Gravelly Sand	SP	0	35	61
48	LV-B26	Pioche Hills	Cau	Limestone				
49	DL-A29	Highland Range	Cau	Limestone				
50	DL-A49	Dutch John Mountain	Aolq	Silty Sandy Gravel	GM			
51	DL-A50	Bristol Pass	Aafs	Gravelly Sand	SP	T	40	60
52	NV-H-10	Bristol Range	Cau	Limestone				
53	NV-H-10	Meadow Valley	Aaf	Silty Sandy Gravel	GM-SM		50	40
54	NV-H-11	Bristol Range	Cau	Limestone				
55	NV-H-15	Lake Valley	Aafs	Silty Gravelly Sand	SM		35	50

FIELD OBSERVATIONS													
TRIBUTION OF TERIAL FINER IAN COBBLES, PERCENT		PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (A							
SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	N 3
		None			Caliche Coatings, Volc. Ash	100	94.7	72.6	48.8	33.2	24.3	19.9	16
			Mod. Hard	Moderate	Volc. Ash and Vesicules,Mica								
			Hard	Slight	Volc. Glass and Ash								
			Very Hard	Slight	None								
35	45	High			Clay Coatings								
61	4	None			Caliche Coatings and Nodules								
			Hard	Slight	None								
			Hard	Slight	None								
		None			Caliche Coatings, 10% Chert		100	96.4	73.7	38.2	28.2	23.5	21
60	T	None			Chert, Pumice								
					None								
40	10	None			Caliche Coatings								
					None								
50	15	Low			Caliche Coatings, Chert								

LABORATORY TEST DATA

...SSING (ASTM C 136) NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	ABRASION TEST (ASTM C 131) PERCENT WEAR	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS CA	PERCENT LOSS FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	FINE AGGREGATE SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	ALK... REACT... (ASTM ... CA
19.9	16.9	13.4	5.1	2.0	22.2	1.0	11.0		2.63		0.7		2.58		2.0	Innocuous
					33.0	2.3										Potentially Deleterious
					29.7	0.3			2.64		0.4					Innocuous
					27.3	1.91										
23.5	21.1	20.3	19.6	17.6	25.6	5.10	8.00	2.63	2.67	2.75	1.56	2.56	2.61	2.68	1.79	
					27.5	5.30		2.60	2.65	2.73	1.84					

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SORPTION 128)			ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
INE AGGREGATE					
FIC GRAVITY		PERCENT ABSORPTION			
BULK SSD	APPARENT		CA	FA	
2.58		2.0	Innocuous	Innocuous	Ic/f
					IIcr
			Potentially Deleterious		Icr
			Innocuous		Icr
					IIIf
					IIf/c
					IIcr
					Icr
2.61	2.68	1.79			Ic/f
					Ic IIf IIcr
					IIc/f
					IIcr
					IIf/c

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							GRAVEL	SAND
56	NV-H-15	Bristol Range	Cau	Limestone				
57	NV-H-16	Grassy Mountains	Cau	Limestone				
58	NV-H-17	Dutch John Mountain	Cau	Limestone				
59	NV-R-30	Pioche Hills	Aaf	Sandy Gravel	GP-GM		60	35
60	NV-R-31	Lake Valley	Aafs	Clayey Sand	SC		5	60
61	NV-R-32	Lake Valley	Vu	Rhyolite Tuff				
62	NV-R-33	Grassy Mountain	Aafs	Silty Sandy Gravel	GP-GM			
63	NV-R-34	Lake Valley Summit	Ls	Limestone				
64	LV-T1	Lake Valley	Aolg	Sandy Gravel	GM		45	40
65	LV-T3	Lake Valley	Aafs	Silty Gravelly Sand	SM		25	60
66	LV-T4	Lake Valley	Aafs	Silty Sand	SM		15	56
67	LV-T5	Lake Valley	Aafs	Silty Sandy Gravel	GM		60	25
68	LV-T6	Lake Valley	Aafs	Gravelly Silty Sand	SM		10	75
69	LV-T7	Lake Valley	Aafs	Gravelly Silty Sand	SM		10	75
70	LV-T8	Lake Valley	Aafs	Gravelly Silty Sand	SM		10	70

PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			FIELD OBSERVATIONS				SIEVE ANALYSIS, PERCENT PASSING (AS							
	GRAVEL	SAND	FINES	PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 3
							Chert								
							1 to 2% Chert								
							1 to 2% Chert								
	60	35	5	Low			Chert, Caliche, Clay								
	5	60	35	Low			80% Volc. Glass								
							Volc. Glass								
							Chert, Caliche	100	92.7	80.5	62.3	49.2	42.0	37.3	30.
							5% Chert Nodules and Lenses								
	45	40	15	Low			Caliche Coatings, Clay								
	25	60	15	Low			Caliche Coatings								
	15	56	29	Low			Caliche Coatings								
	60	25	15	Low			Caliche Coatings and Nodules								
	10	75	15	Low			Caliche Coatings and Nodules								
	10	75	15	Low to Med.			Clay								
	10	70	20	Low											

LABORATORY TEST DATA

SING (ASTM C 136)					ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALK REACT (ASTM
								COARSE AGGREGATE				FINE AGGREGATE				
								SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA
					18.7	4.6										
7.3	30.5			6.8	26.0	5.3										

DEPA

3

PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
	CA	FA	
			Icr
			IIcr
			IIcr
			IIc/f
			IIf
			IIcr
			Ic IIf
			IIcr
			IIc/f
			IIf/c
			IIf
			IIc/f
			IIf
			IIf
			IIf

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
LAKE VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE
A-1

FUGRO NATIONAL, INC.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	[illegible]	
							GRAVEL	SAND
71	LV-T9	Lake Valley	Aafs	Silty Sand	SM		3	75
72	LV-T10	Lake Valley	Aols	Silty Sand	SM		3	50
73	LV-T11	Lake Valley	Aafs	Silty Sand	SM		5	55
74	LV-T14	Lake Valley	Aafs	Sand	SP		7	88

FIELD OBSERVATIONS						SIEVE ANALYSIS, PERCENT PASSING (ASTM C 13								
STRIBUTION OF TERIAL FINER THAN COBBLES, PERCENT		PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS									
SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50
75	22	Low			Caliche Coatings and Nodules									
50	47	Med.			Clay									
55	40	Low			Caliche Coatings and Nodules									
89	4	None			Caliche Coatings and Nodules									

LABORATORY TEST DATA

... C 136)			ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)	
						COARSE AGGREGATE				FINE AGGREGATE					
						SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION		
NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA

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3

PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	ALKALI REACTIVITY (ASTM C 289) FA	AGGREGATE USE
			IIf
			IIIf
			IIIf
			IIf

FUGRO NATIONAL FIELD STATION AND SUPPLEMENTARY TEST DATA
LAKE VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE A-1

FUGRO NATIONAL, INC.

EXPLANATION OF EXISTING DATA

Existing data pertaining to aggregates were extracted from the State of Nevada Department of Highways. These reports are compilations of available site data from existing files and records and are intended to accurately locate, investigate, and catalog materials needed for highway construction. Explanations for column headings which appear in Table A-2, that have not been previously discussed in Table A-1, are given below:

Column Heading	Explanation
Site Number	State of Nevada Department of Highways pit or site number. Locations correspond to map numbers listed on this table and placed on Drawing 1.

MAP NUMBER	SITE NUMBER	DATA SOURCE	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL			
							> 6"	3-6"	1½"
75	NV-LN6	NVHD	Lake Valley	Aols	Sandy Gravel				100
76	NV-LN08-1	NVHD	Lake Valley	Aafs	Gravelly Sand				

SIEVE ANALYSIS														ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		C
3-6"	1½"	1"	¾"	½"	¼"	⅜"	NO. 4	NO. 10	NO. 16	NO. 40	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	SPEC BULK
	100	97.7	95.4	88.0		80.3	53.7							24.0	7.39		
			90			75							5	24.5			

RAVITY AND ABSORPTION C 127 AND C 128)						PLASTICITY INDEX (ASTM D 423 AND D 424)	ALKALI REACTIVITY (ASTM C 289)	
E	FINE AGGREGATE							
	SPECIFIC GRAVITY							
PERCENT ABSORPTION	BULK	BULK SSD	APPAR-ENT	PERCENT ABSORPTION			CA	FA

EXISTING TEST DATA
LAKE VALLEY, NEVADA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE A-2
PAGE 1 OF 1

FUGRO NATIONAL, INC.

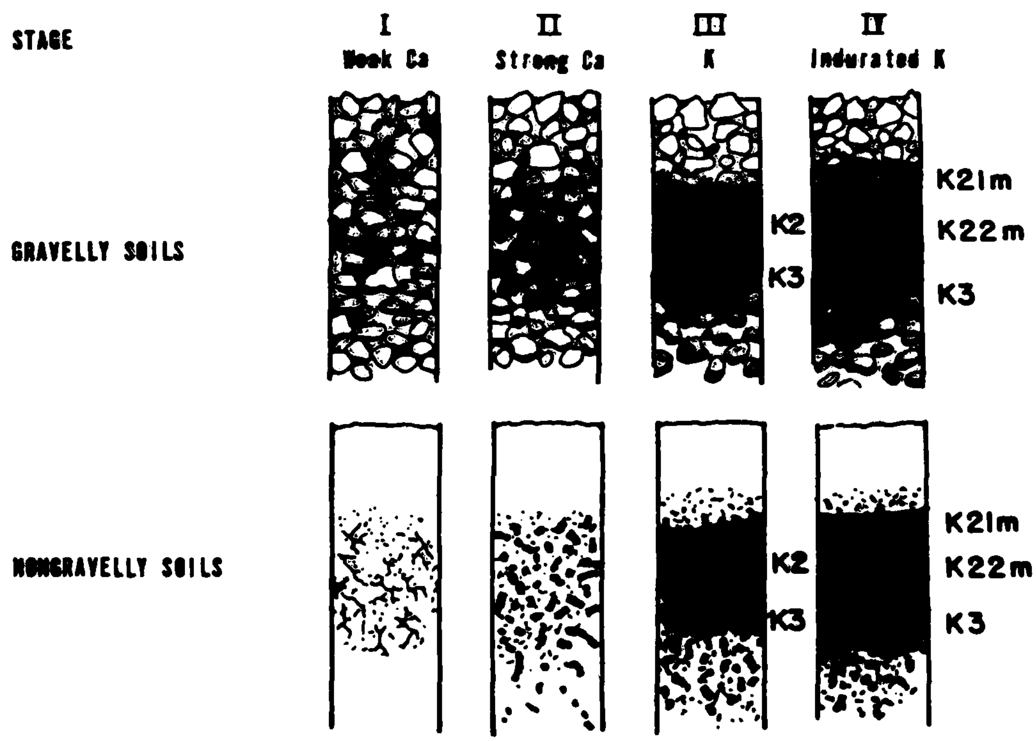
3

APPENDIX B

Summary of Caliche Development

DIAGNOSTIC CARBONATE MORPHOLOGY

STAGE	GRAVELLY SOILS	NONGRAVELLY SOILS
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Laminar horizon overlying plugged horizon



Stages of development of a caliche profile with time. Stage I represents incipient carbonate accumulation, followed by continuous build-up of carbonate until, in Stage IV, the soil is completely plugged.

Reference: Gile, L.H. Peterson, F.F., and Grossman, R.B., 1965, The K horizon: A master horizon of carbonate accumulation: Soil Science, v. 99, p. 74-82.

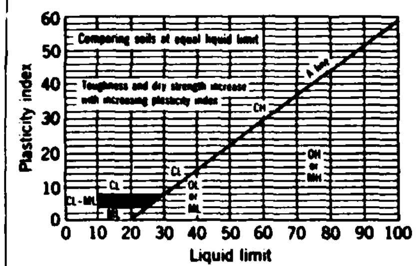
SUMMARY OF CALICHE DEVELOPMENT	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	FIGURE B-1

FUGRO NATIONAL, INC.

APPENDIX C

Unified Soil Classification System

Major divisions			Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)			Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils: More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is *larger* than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines			Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures			Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics		Atterberg limits above "A" line, with *PI* greater than 7
	Sands: More than half of coarse fraction is *smaller* than No. 4 sieve size	Clean sands (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines			Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures			Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures			Atterberg limits below "A" line with *PI* greater than 7
Fine-grained soils: More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Identification Procedures on Fraction Smaller than No. 40 Sieve Size		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				Use grain size curve in identifying the fractions as given under field identification	
	Silts and clays liquid limit less than 50		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses		
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions		
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity			
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils			



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications.* Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):
After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.
Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):
After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):
After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eight inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.
Highly organic clays have a very weak and spongy feel at the plastic limit.

UNIFIED SOIL CLASSIFICATION SYSTEM

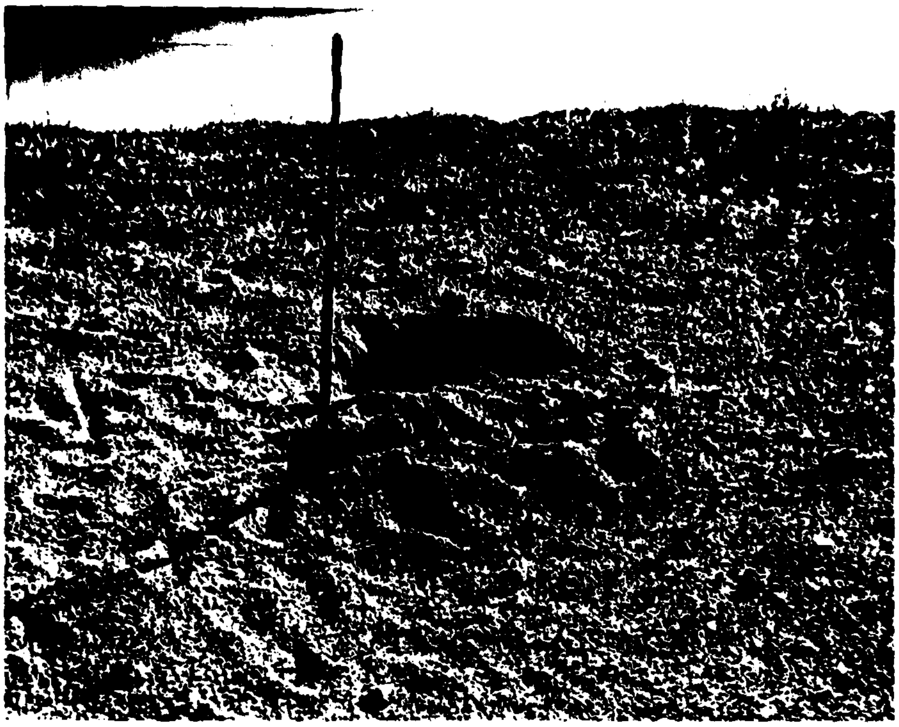
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE C-1

FUGRO NATIONAL, INC.

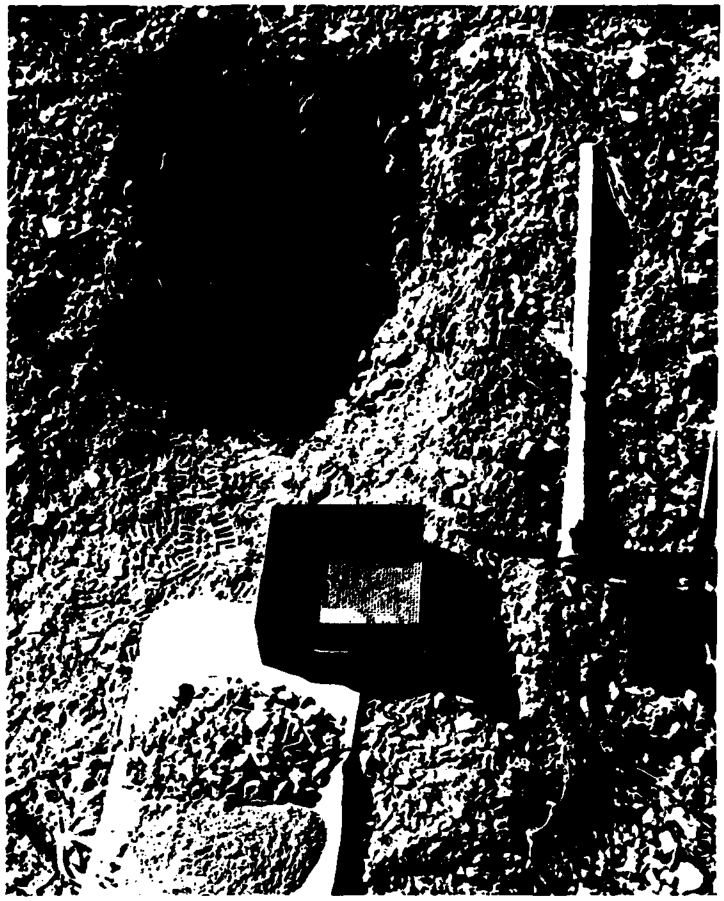
APPENDIX D

Lake Valley
Study Area Photographs



Older Lacustrine Shoreline Deposit (Aols), distributed within the central valley basin, northern Lake Valley; Class I, coarse aggregate source (Field Station 32)

LAKE VALLEY STUDY AREA PHOTOGRAPH	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE — BMO	FIGURE D-1
FUGRO NATIONAL, INC.	



Alluvial Fan Deposit (Aafs) exposed in northeastern Lake Valley;
Class I coarse aggregate source (Station 21)

LAKE VALLEY STUDY AREA PHOTOGRAPH	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE — BMO	FIGURE D-2

FUGRO NATIONAL, INC.

Prospect Mountain Quartzite (Qtz) exposed within the Pioche Hills; in the southwestern part of the study area; Class I crushed rock aggregate source (Station 45)

LAKE VALLEY STUDY AREA PHOTOGRAPH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE — BMO

FIGURE D-3

FUGRO NATIONAL, INC.

Laketown Dolomite (Do) exposed in low hills east of the Schell Creek Range in the northwestern part of the study area; Class I crushed rock aggregate source (Station 38).

LAKE VALLEY STUDY AREA PHOTOGRAPH

MX SITING INVESTIGATION

DEPARTMENT OF THE AIR FORCE — BMO

FIGURE D-4

FUGRO NATIONAL, INC.

APPENDIX E

Fugro National Geologic Unit Cross Reference

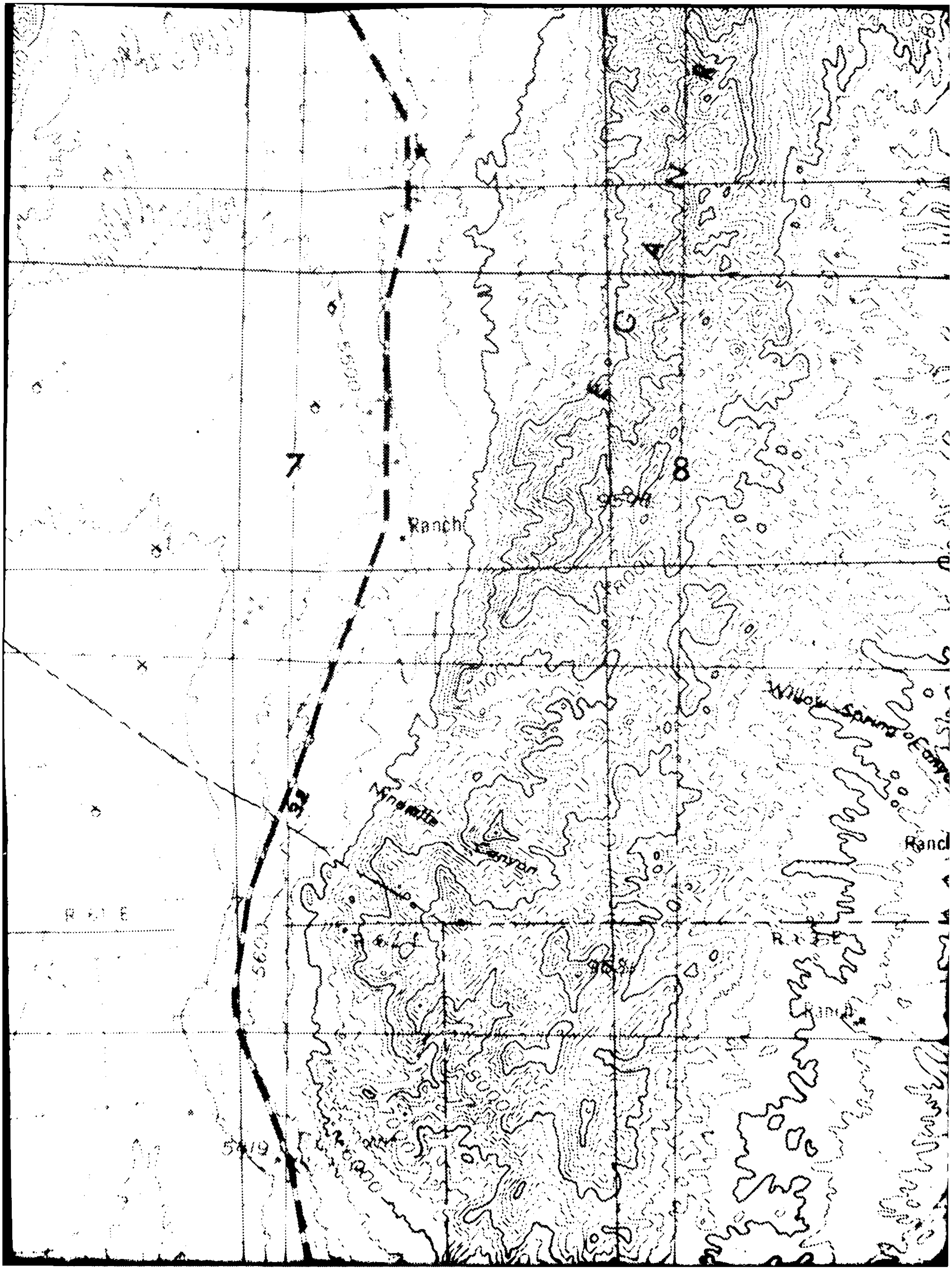
UARSA POTENTIAL AGGREGATE SOURCE SYMBOLS	FUGRO NATIONAL GENERAL GEOLOGIC UNIT EXPLANATION	
		ROCK
		Shown in regions where rock is exposed; the areally predominant (greater than 70 percent) rock type is indicated. In those areas where two rock types occur the predominant rock type is shown followed by the subordinate rock type (e.g. S_{2e}/I_{4}). Rock may be subdivided into bedrock (B).
	I	IGNEOUS (UNDIFFERENTIATED) Rocks formed by solidification of a molten or partially molten mass
GR	I_1	Intrusive Plutonic rocks formed by solidification of molten material beneath the surface (e.g. granite, granodiorite, diorite, gabbro)
Vu	I_2	Extrusive (intermediate and acidic) Volcanic rocks of intermediate and acidic composition formed by solidification of molten material at or near the surface (e.g. rhyolite, latite, dacite, andesite)
Vb	I_3	Extrusive (basic) Volcanic rocks of basic composition generally formed by solidification of molten materials at or near the surface (e.g. basalt).
Vu	I_4	Extrusive (pyroclastic) Rocks formed by accumulation of volcanic ejecta (e.g. ash, tuff, welded tuff, agglomerate)
Su	S	SEDIMENTARY (UNDIFFERENTIATED) Rocks formed by accumulation of clastic solids, organic solids and or chemically precipitated minerals
Su, Qtz	S_1	Arenaceous and or Siliceous Rocks Composed of sand size particles (e.g. sandstone, orthoquartzite) or of cryptocrystalline silica (e.g. opal, chert)
Ls, Do, Cau	S_2	Carbonate Rocks Composed predominantly of calcium carbonate detritus or chemical precipitates (e.g. limestone, dolomite, chalk)
	S_3	Argillaceous Rocks Composed of clay and silt-size particles (e.g. siltstone, shale, claystone)
	S_4	Evaporite Rocks Precipitated from solution as a result of evaporation (e.g. halite, gypsum, anhydrite, sylvite)
Su	S_5	Coarse Clastic Rocks Composed of gravel-sized or larger clasts (e.g. conglomerate, breccia)
Mu	M	METAMORPHIC (UNDIFFERENTIATED) Rocks formed through recrystallization in the solid state of preexisting rocks by heat and pressure
Mu	M_1	Coarse grained rocks formed by higher-grade regional metamorphism either banded or granular (e.g. gneiss, granulite, amphibolite)
Mu	M_2	Fine grained schistose rocks formed by lower grade regional metamorphism (e.g. schist, slate, phyllite)
Mu	M_3	Nonfoliated rocks formed chiefly by contact metamorphism (e.g. hornfels, marble)
Qtz	M_4	Metaquartzite rocks formed by metamorphism of highly siliceous rocks
		BASIN-FILL
	A	BASIN-FILL DEPOSITS Fine- to coarse-grained materials deposited principally by wind, water or gravity
Aal	A_1	Younger Fluvial Deposits Major modern stream channel and flood-plain deposits
Au, Aal	A_2	Older Fluvial Deposits Older incised stream channel and flood-plain deposits in elevated terraces bordering major modern drainages
Au	A_3	Eolian Deposits Wind-blown deposits of sand occurring as either thin sheets (A_{3s}) or dunes (A_{3d})
Aol	A_4	Playa and Lacustrine Deposits Deposits occurring in modern active playas (A_4) or in either inactive playas or older lake beds and abandoned shorelines associated with extinct lakes (A_{4o})
Aaf	A_5	Alluvial Fan Deposits Alluvial deposits consisting of debris flow and water-laid alluvium near mountain fronts grading into predominantly water-laid alluvium deposited in shifting distributary channels near the basin center. Younger (A_{5y}), intermediate (A_{5i}) and older (A_{5o}) alluvial fans are differentiated by surface soil development, terrain conditions and present depositional/erosional environment
Au	A_5/A_3	Mixed non-rock units. Most areally extensive unit is listed first
Aaf	A_{5y} (A_{5i})	Parenthetic unit underlies thin veneer of overlying mapped unit

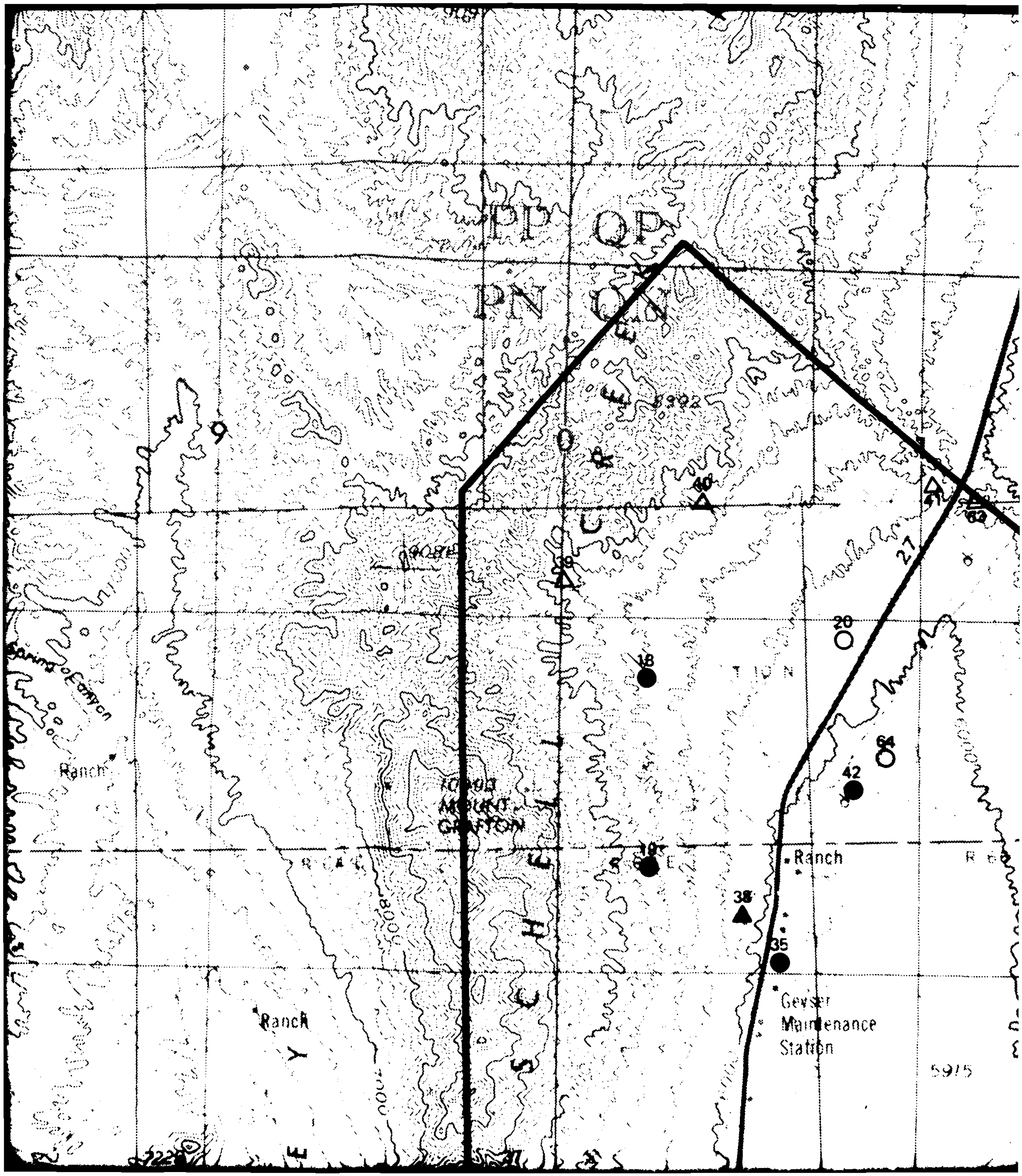
FUGRO NATIONAL GEOLOGIC UNIT CROSS REFERENCE

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - [redacted]

FIGURE E-1

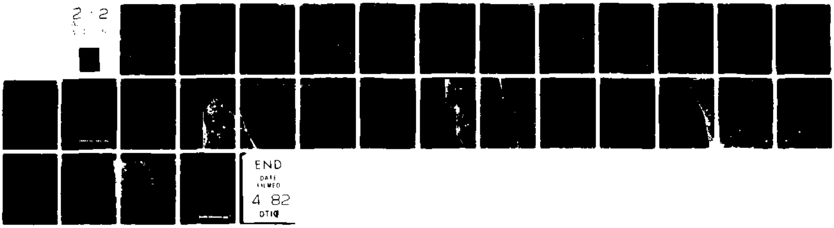
FUGRO NATIONAL, INC.


7
8
Ranch
Ranch
Willow Spring Canyon
Canyon
5600
5619
R.11E.


PP
QP
PN
QN
9
8992
40
41
62
27
39
20
18
64
42
Spring Canyon
Ranch
10903
MOUNT
GRAFTON
19
Ranch
38
35
Geyser
Maintenance
Station
Ranch
5975

AD-A112 705 FUGRO NATIONAL INC LONG BEACH CA F/G 8/7
MX SITING INVESTIGATION. GEOTECHNICAL EVALUATION. AGGREGATE RES--ETC(U)
FEB 81 F04704-80-C-0006
UNCLASSIFIED FN-TR-37-F NL

2 of 2



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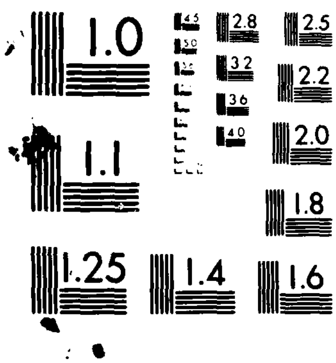
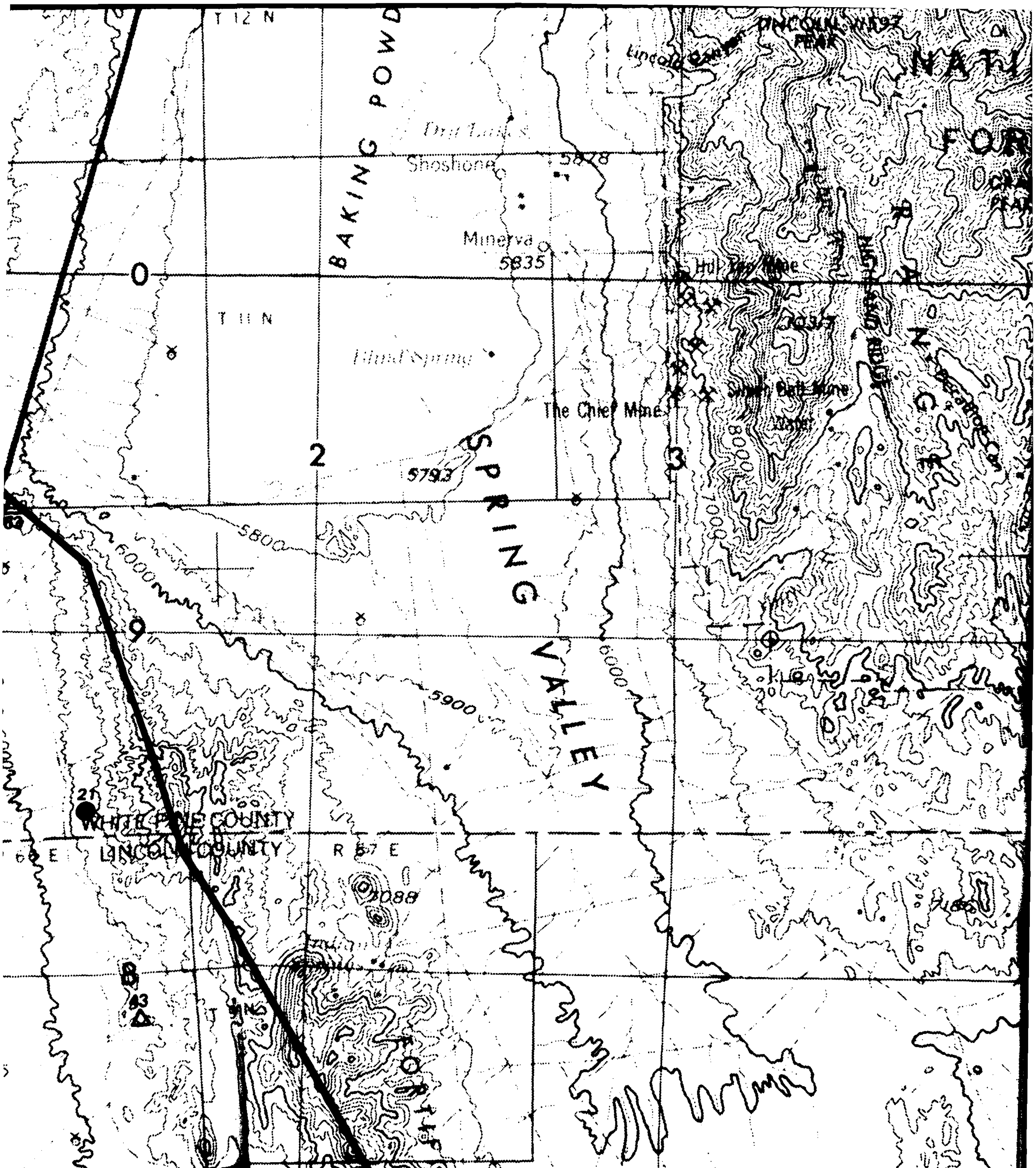
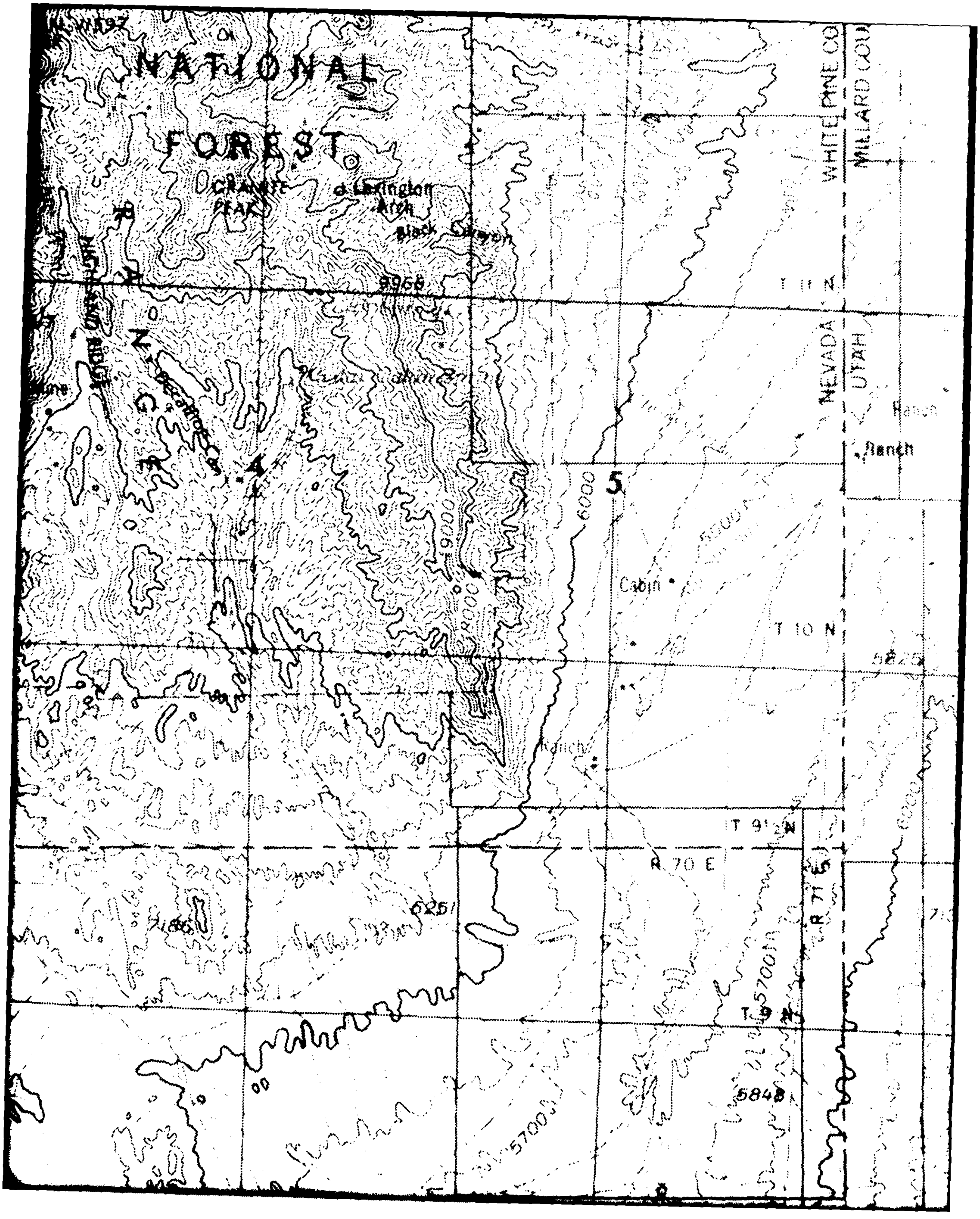


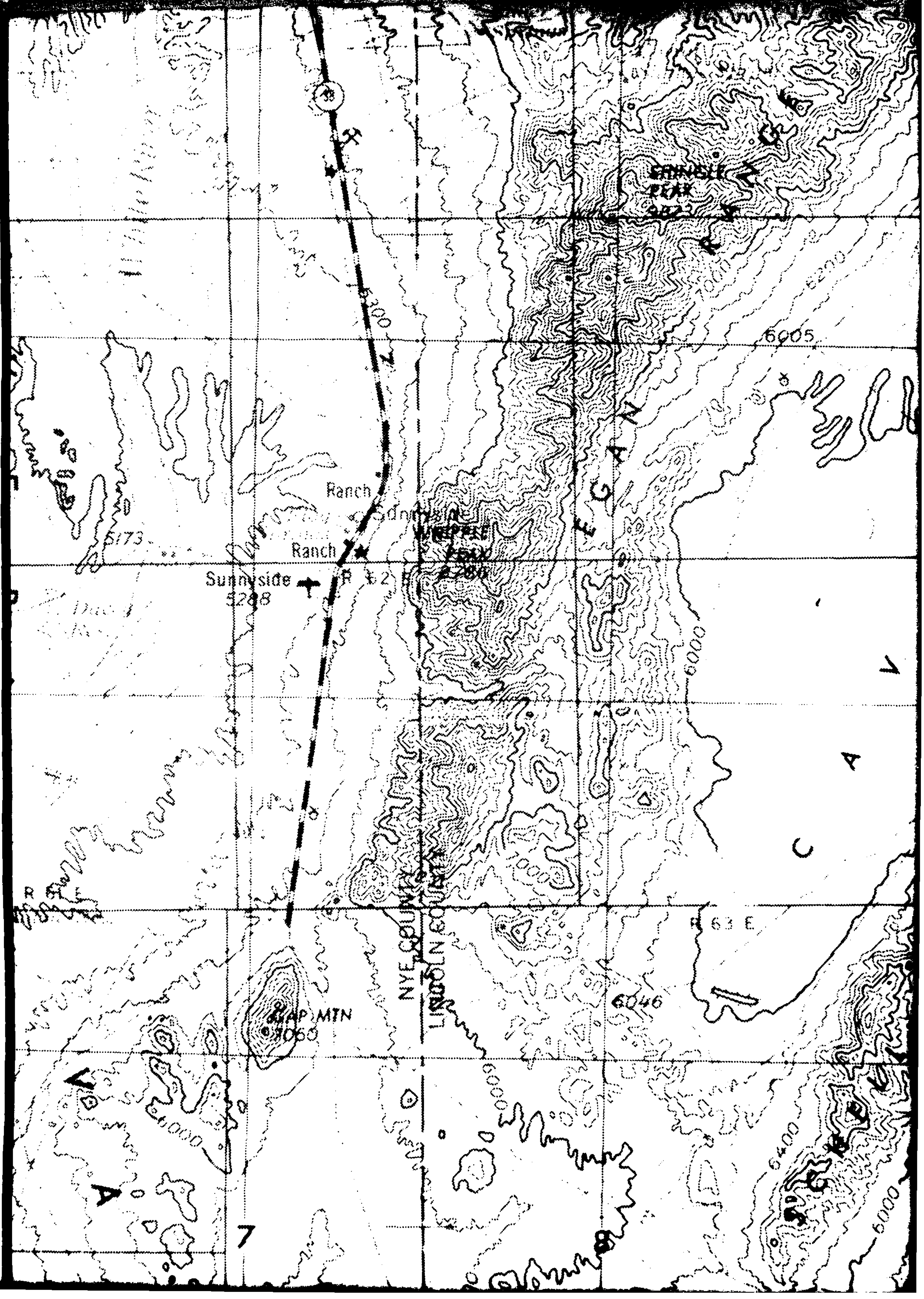
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A


T 12 N
BAKING POWD
Shoshone
Minerva
5835
0
T 11 N
The Chief Mine
2
5793
SPRING VALLEY
5800
6000
9
5900
3
8000
7000
NATI
FOR
21
WHITE PINE COUNTY
LINCOLN COUNTY
R 67 E
7088

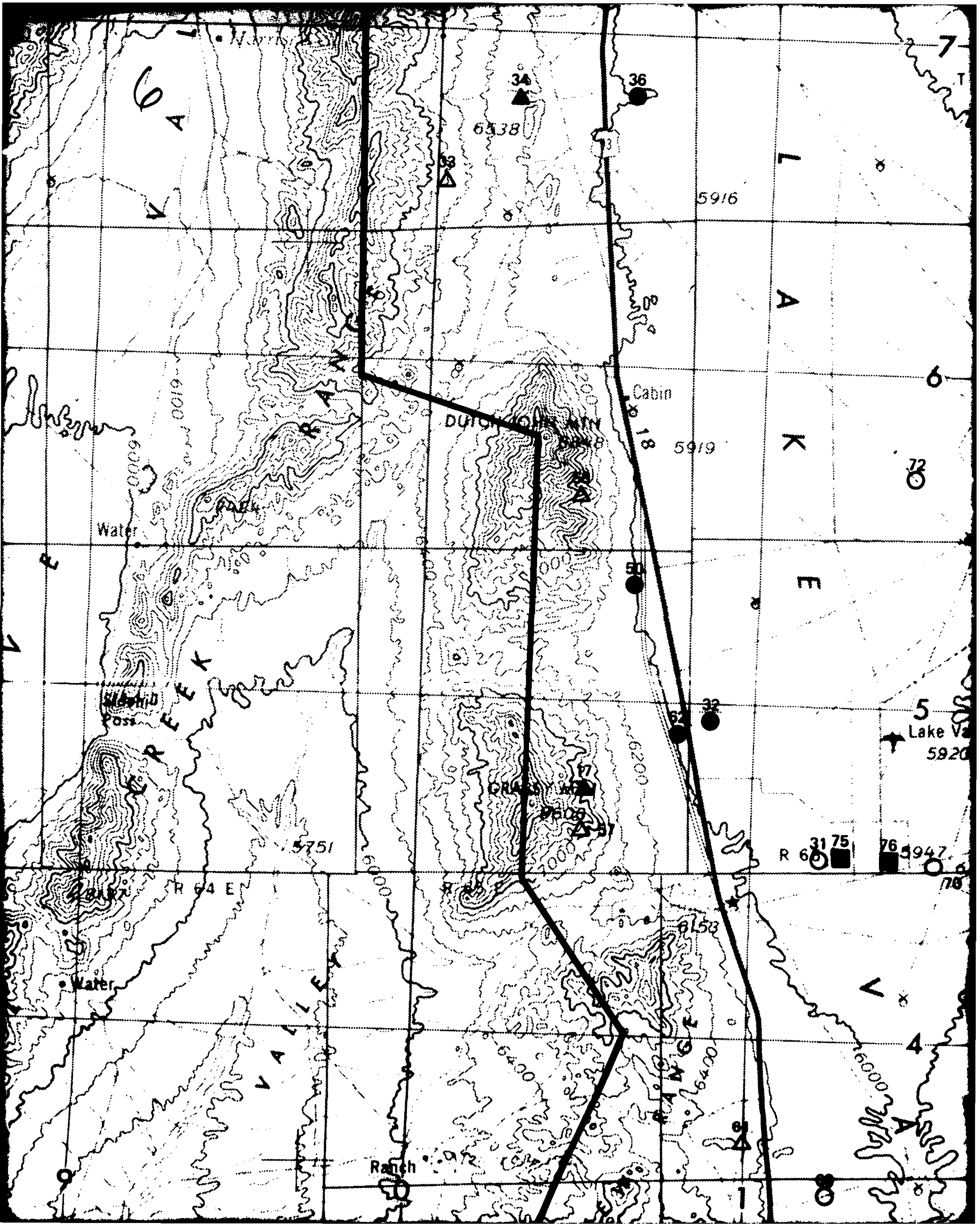


NATIONAL
FOREST
GRANITE PEAK
Lexington Arch
Black Canyon
9968
5
6000
9000
8000
Cabin
T 11 N
T 10 N
5825
Ranch
Ranch
Ranch
T 9½ N
R 70 E
R 71 E
6251
T 9 N
5700
5848
5700
6000
WHITE PINE CO
MILLARD COU
NEVADA
UTAH

5



38
Ranch
Ranch
Sunnyside
5288
R 62 E
R 61 E
R 63 E
5173
6005
6200
7000
6000
NYE COUNTY
LINCOLN COUNTY
GAP MTN
7060
6046
6400
7



DUTCH JOHN MTN
GRASS MTN
Cabin
Water
Water
Ranch
Pass
Lake Va
5920
6538
5916
5919
5751
5947
R 64 E
R 65
34
36
33
72
50
62
32
31
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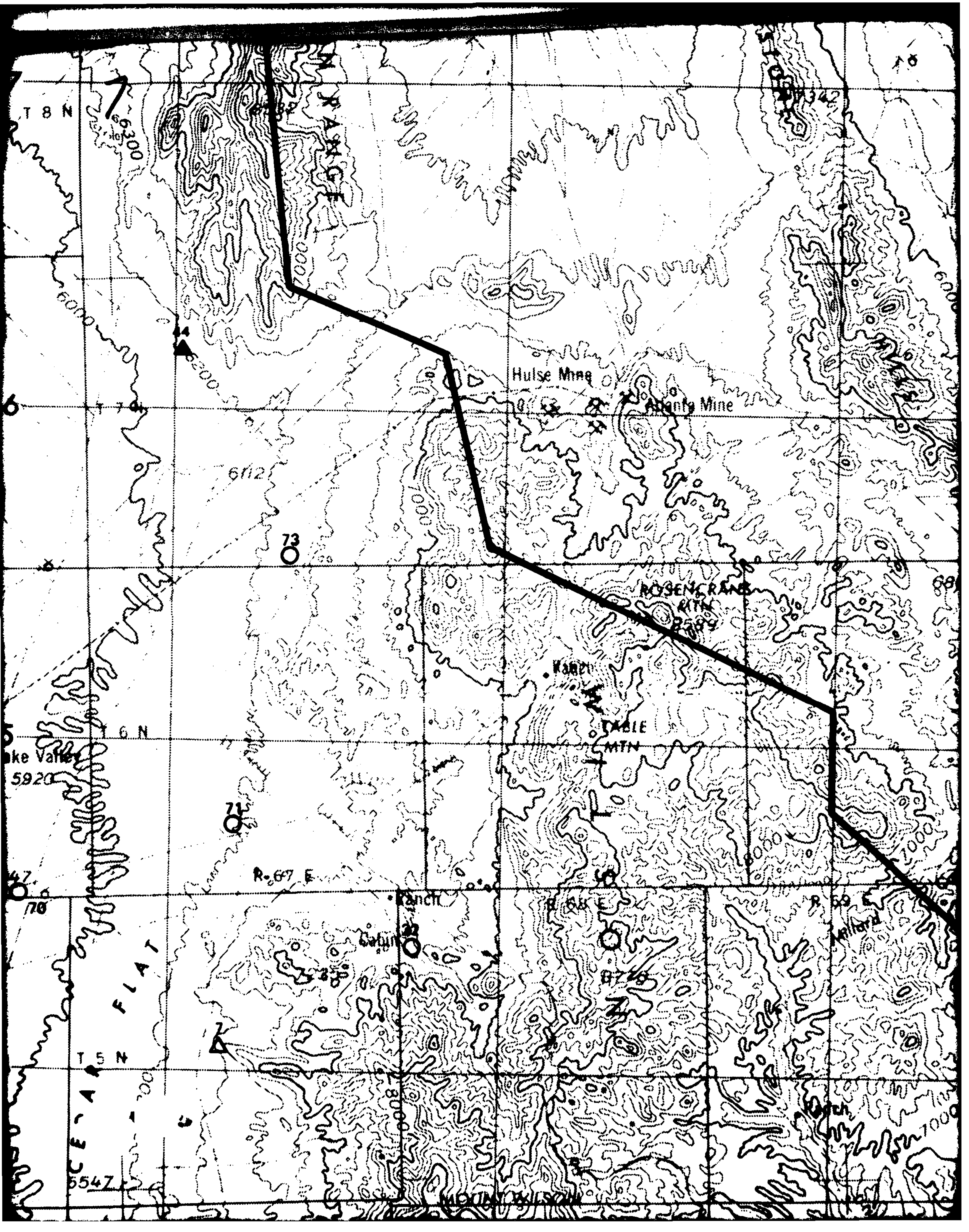
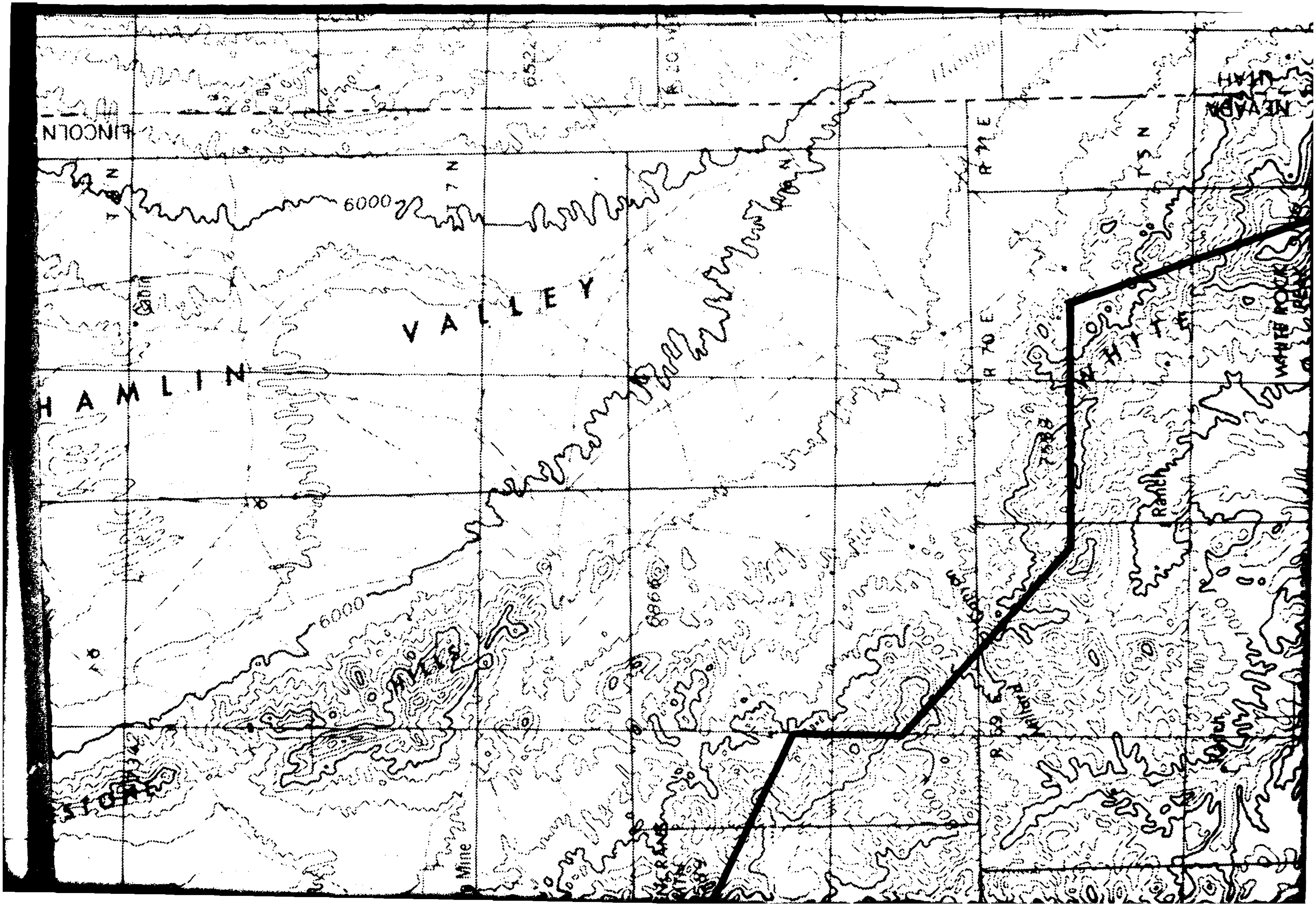
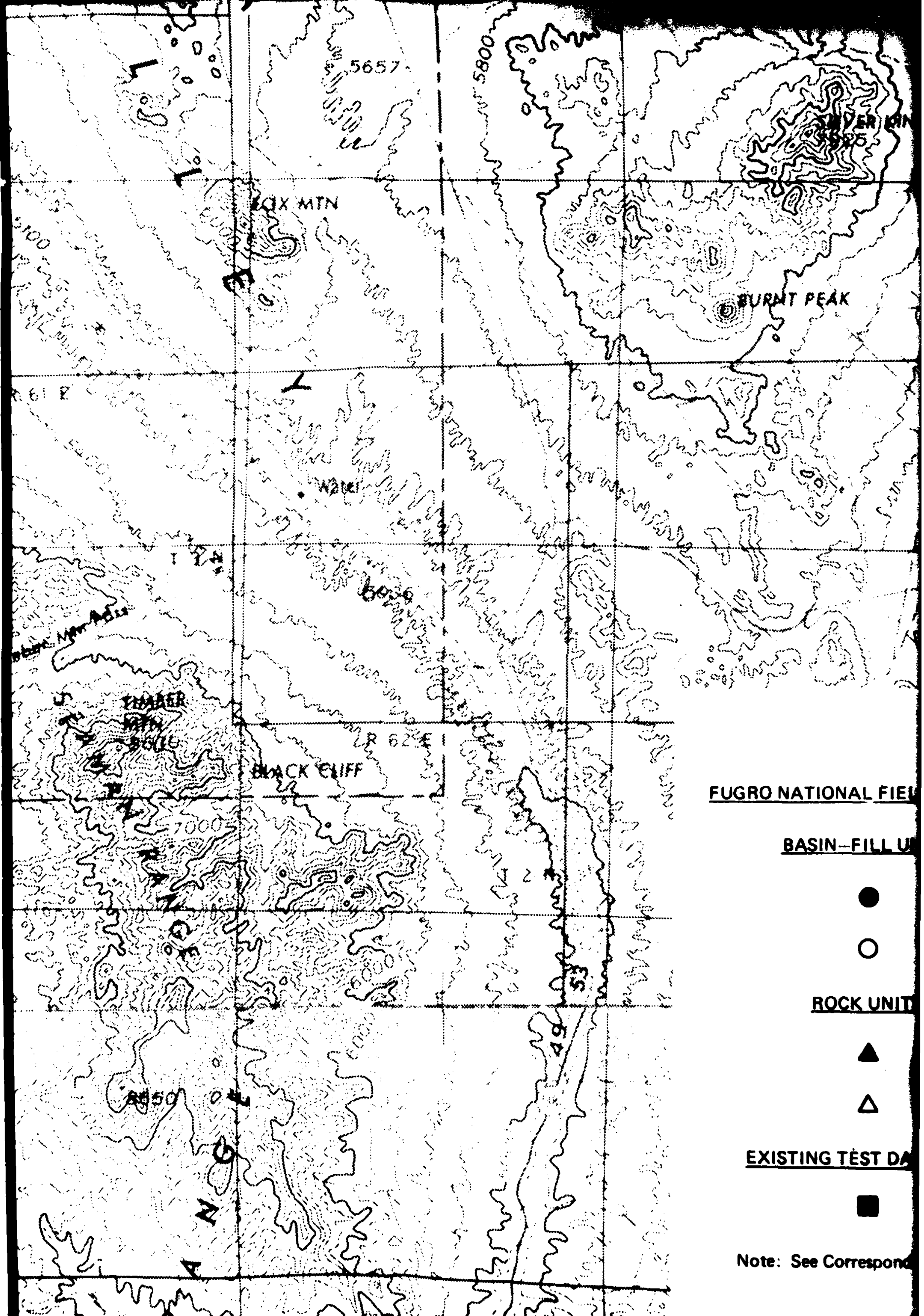
76
70
7
6
5
4
1

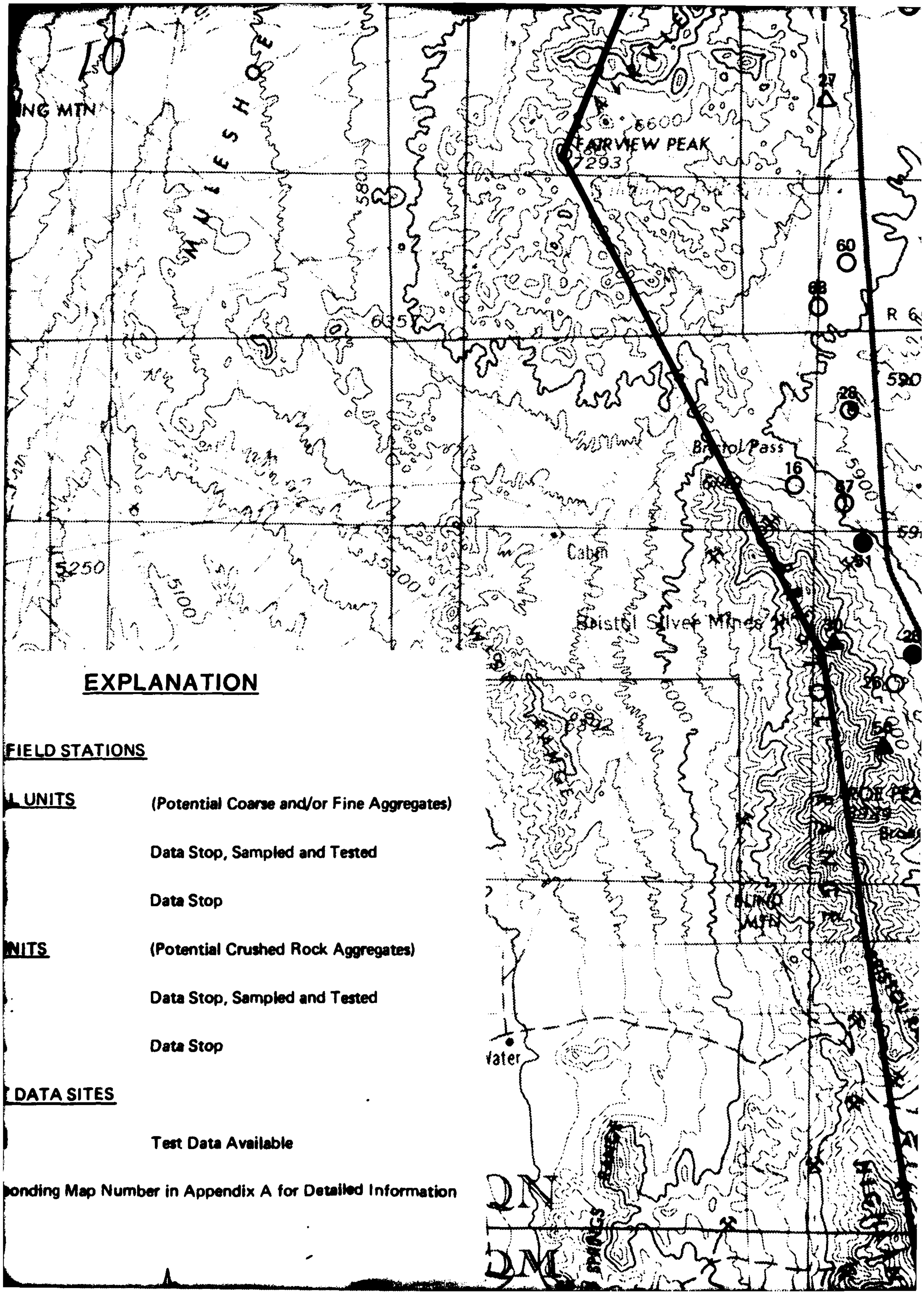


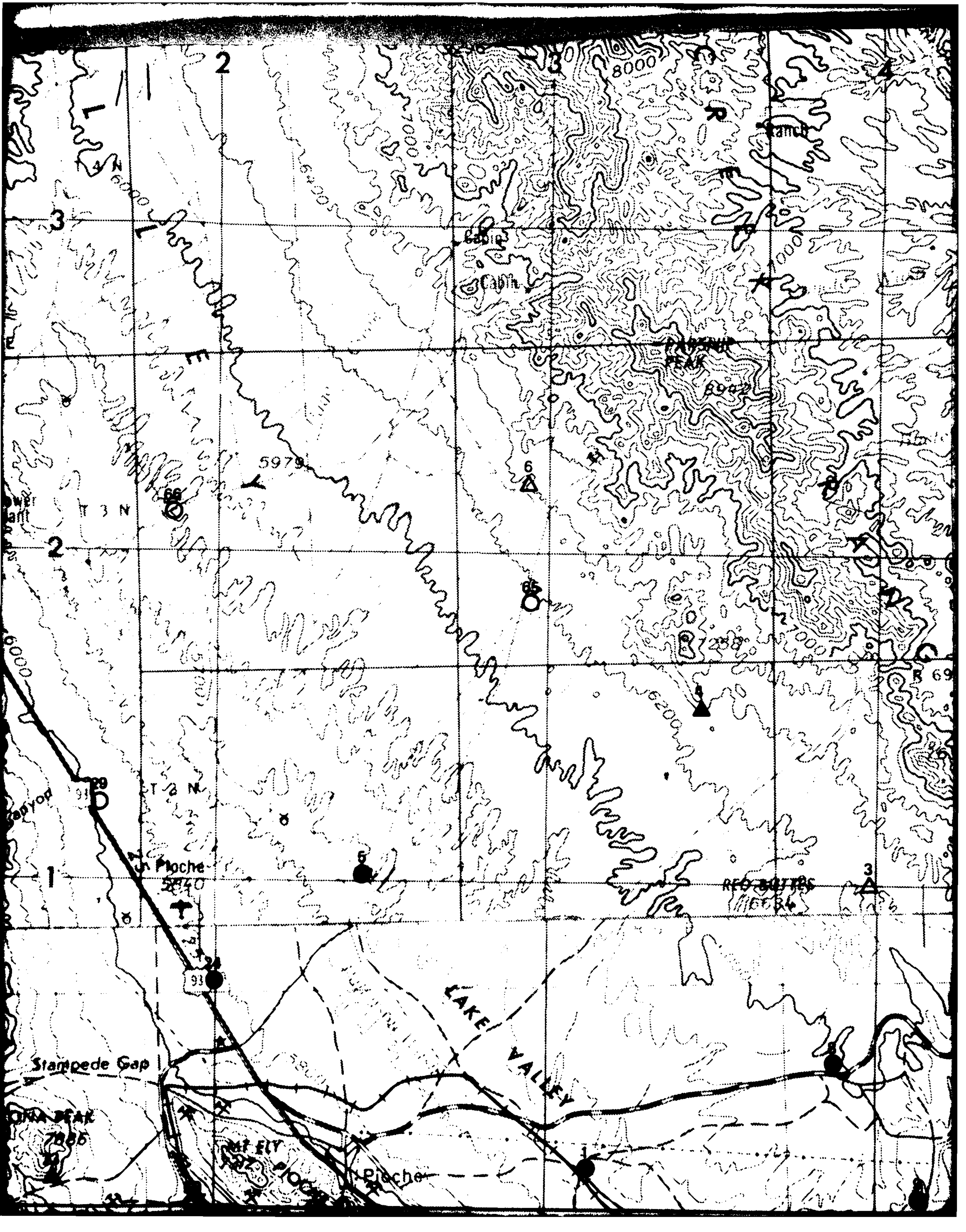
T 8 N
6300
RANGE
Hulse Mine
Atlanta Mine
T 7 N
6112
73
ROSENCRANS MTN
Ranch
TABLE MTN
T 6 N
Lake Valley
5920
71
R. 67 E
R. 68 E
R. 69 E
Ranch
Cabin
FLAT
T 5 N
5547
MOUNT WILSON


HAMLIN VALLEY
6000
6000
LINCOLN
NEVADA
UTAH
T 7 N
T 5 N
R 70 E
R 71 E
6522
6866
7588
Mine
Ranch
WHITE ROCK PEAK

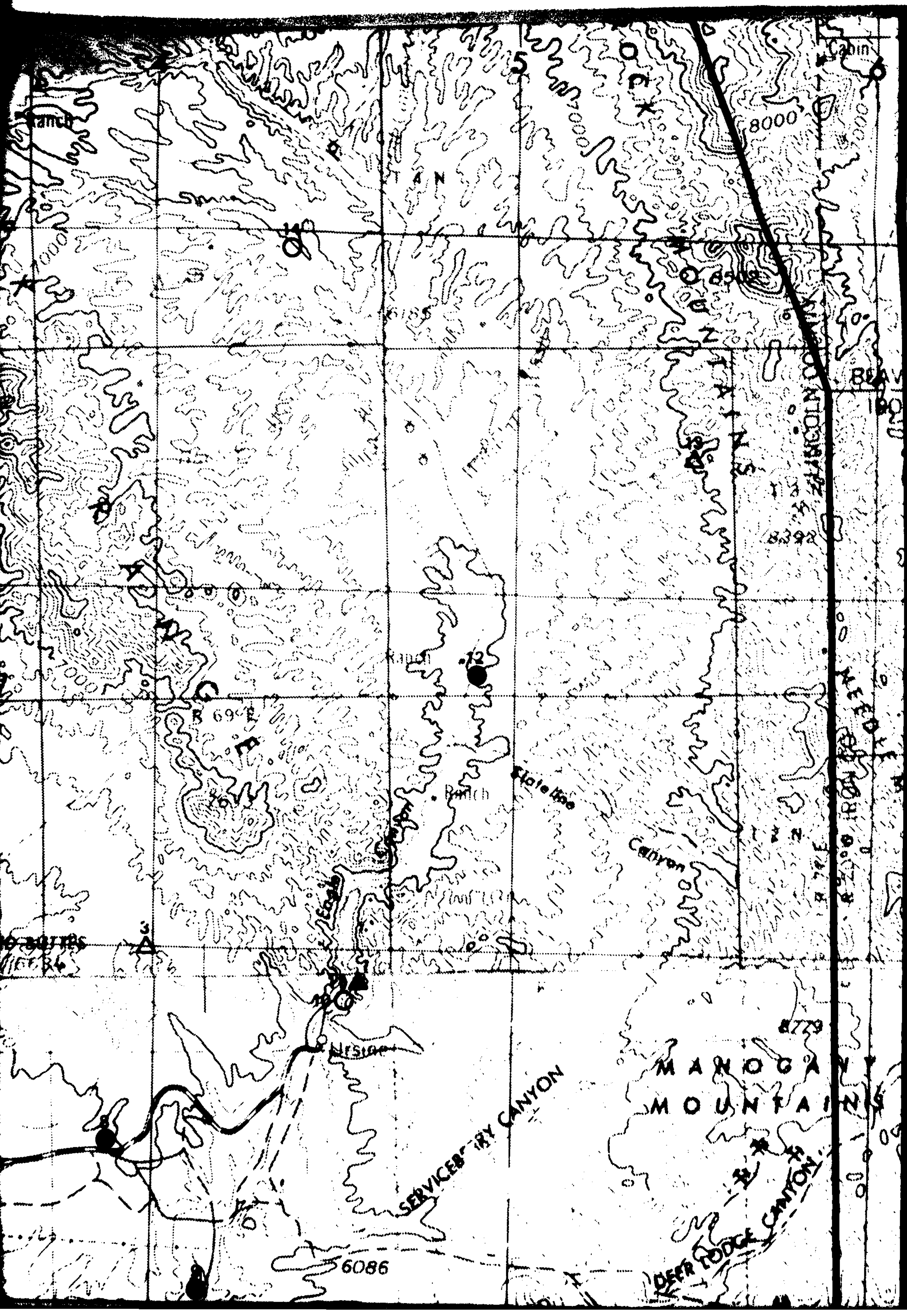
9


5657
5800
FOX MTN
BURNT PEAK
R 61 E
Water
R 62 E
BLACK CLIFF
7000
6000
53
49
FUGRO NATIONAL FIE
BASIN–FILL U
ROCK UNIT
EXISTING TEST DA
Note: See Correspond


10
ING MTN
MULESHOE
6600
FAIRVIEW PEAK
7293
6357
27
60
68
R 6
5900
28
Bristol Pass
16
67
Cabin
5250
5100
5300
Bristol Silver Mines
30
26
56
6000
Water
SPRINGS
EXPLANATION
FIELD STATIONS
L UNITS (Potential Coarse and/or Fine Aggregates)
Data Stop, Sampled and Tested
Data Stop
NITS (Potential Crushed Rock Aggregates)
Data Stop, Sampled and Tested
Data Stop
DATA SITES
Test Data Available
onding Map Number in Appendix A for Detailed Information



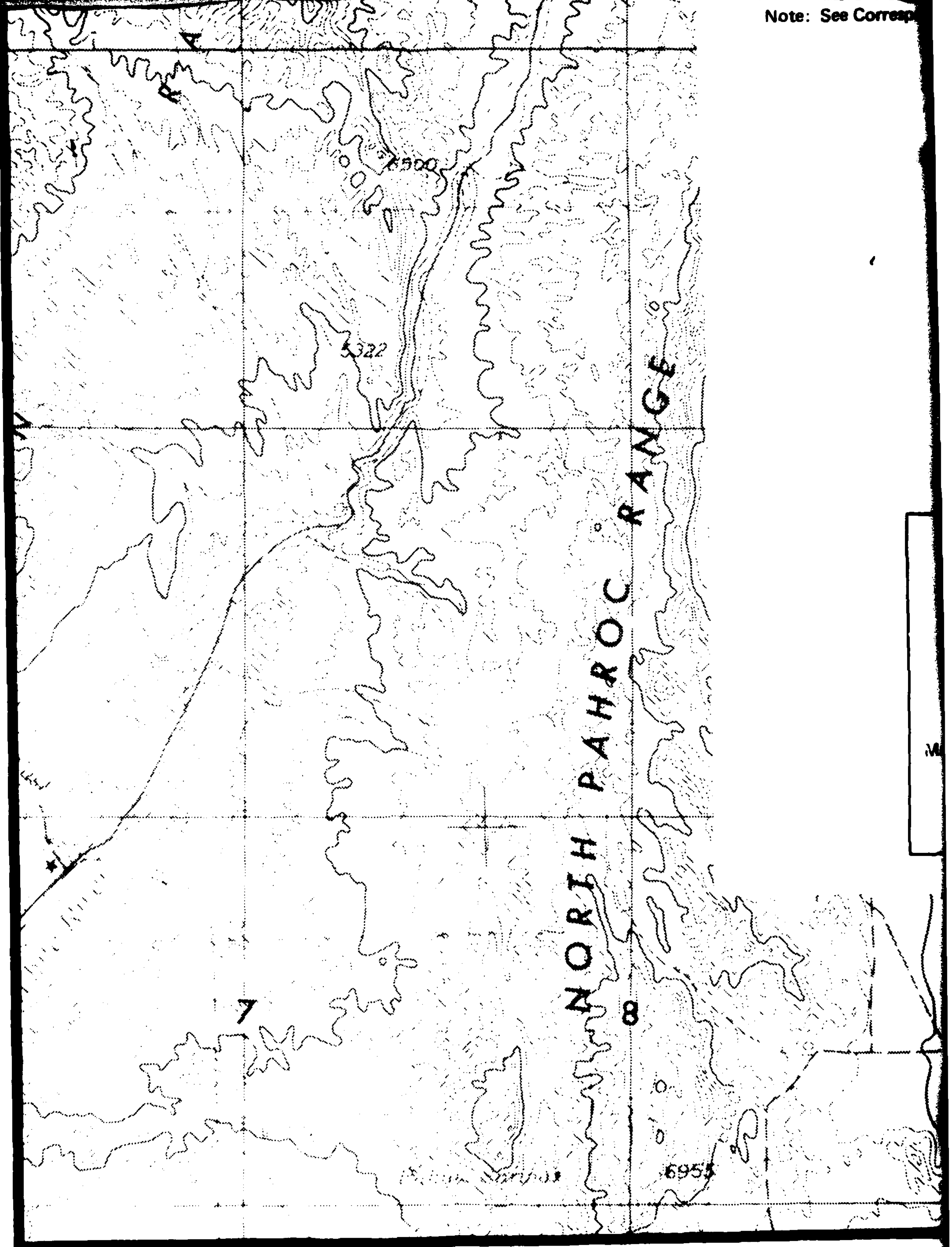
2
3
4
8000
Ranch
7000
6400
6000
Cabin
Cabin
PARSNIP
PEAK
8962
5979
T 3 N
6
66
65
7288
7000
6200
R 69
T 3 N
Pioche
5840
5
3
RED BUTTES
93
Stampede Gap
LAKE VALLEY
MT ELY
Pioche
7886


Cabin
8000
Ranch
6185
8509
LINCOLN CO
8392
Ranch
R 69 E
Ranch
Canyon
Ursine
8729
MAHOGANY
MOUNTAINS
SERVICEBERRY CANYON
DEER LODGE CANYON
6086

1

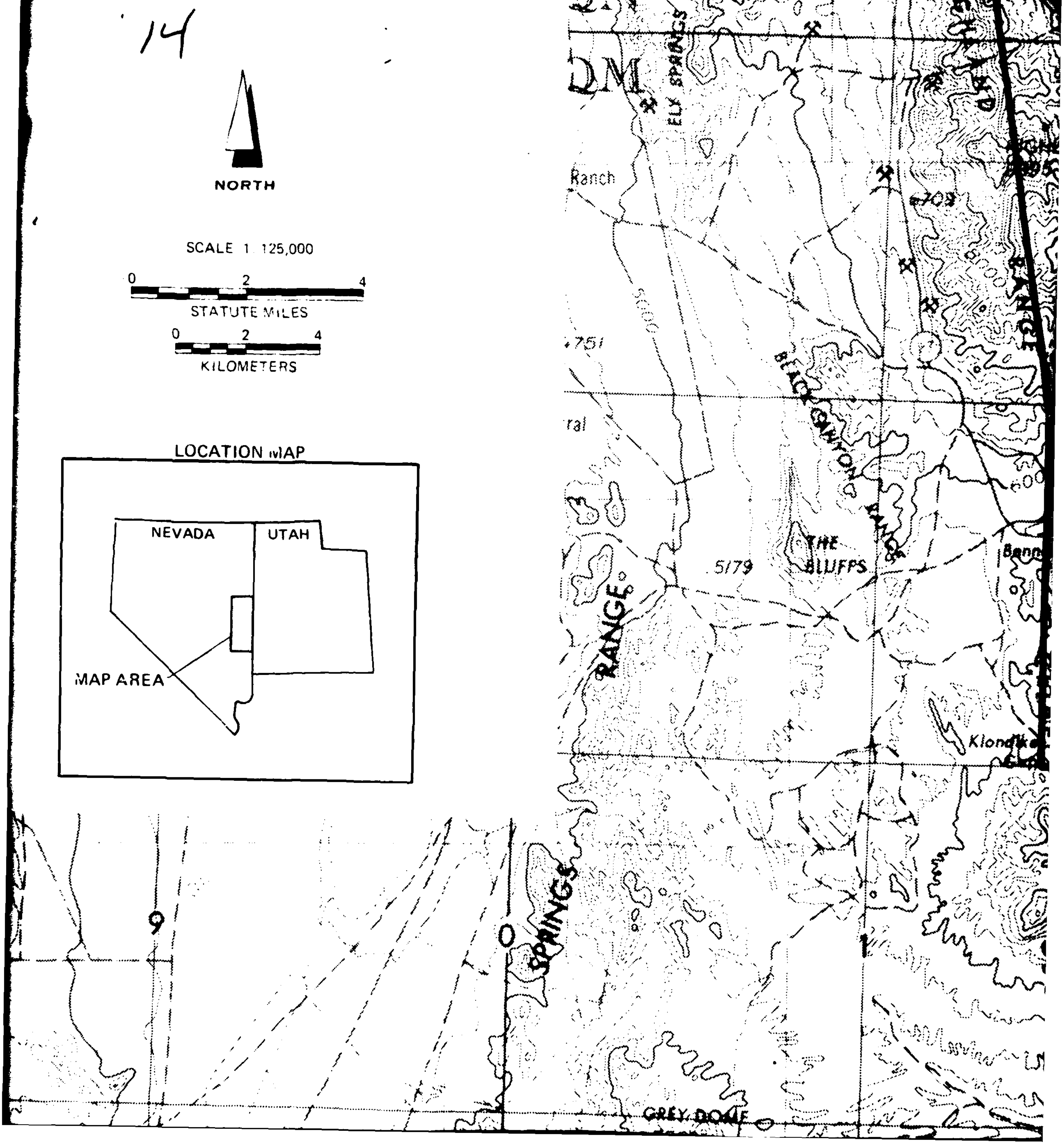
13

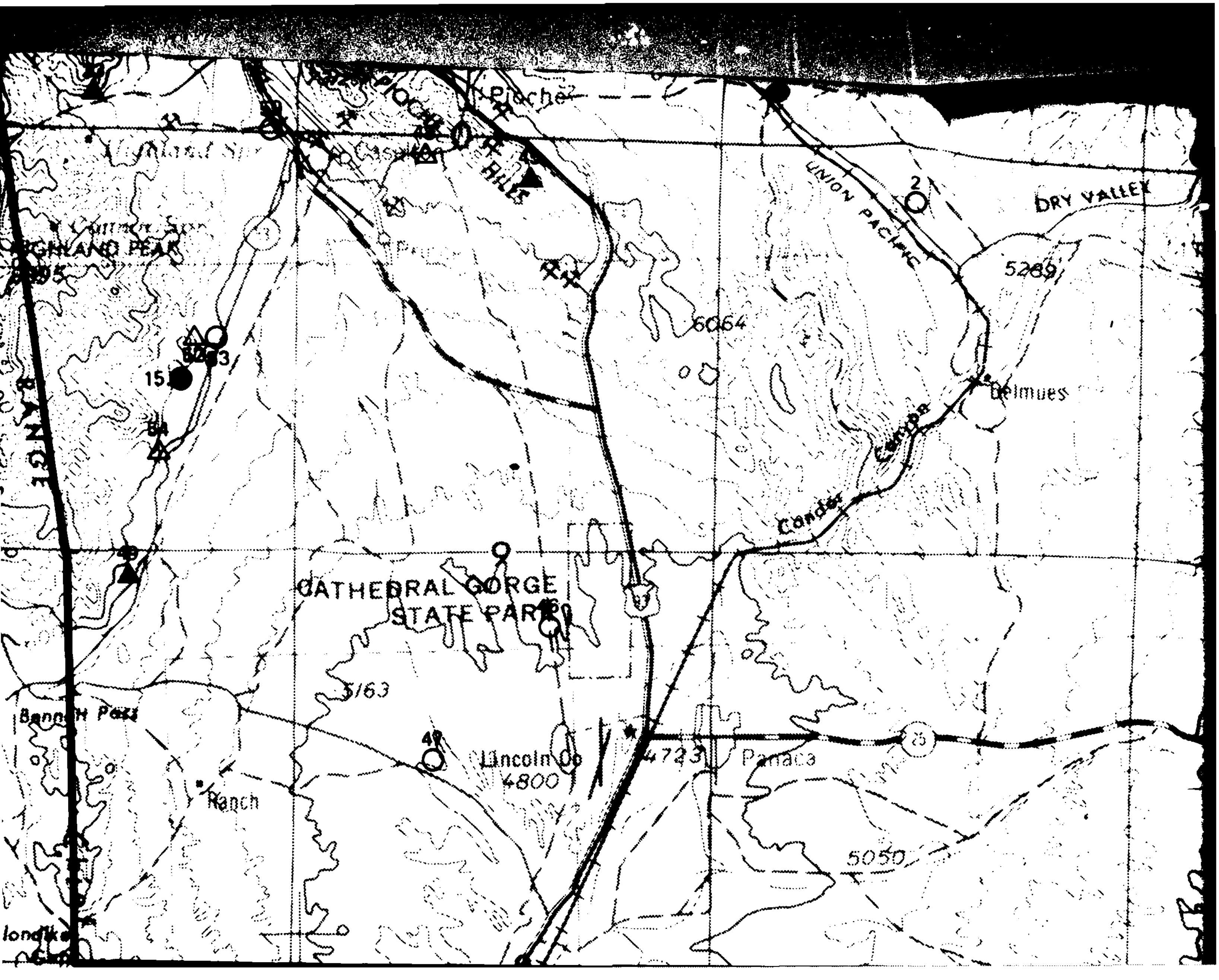
Note: See Corresp



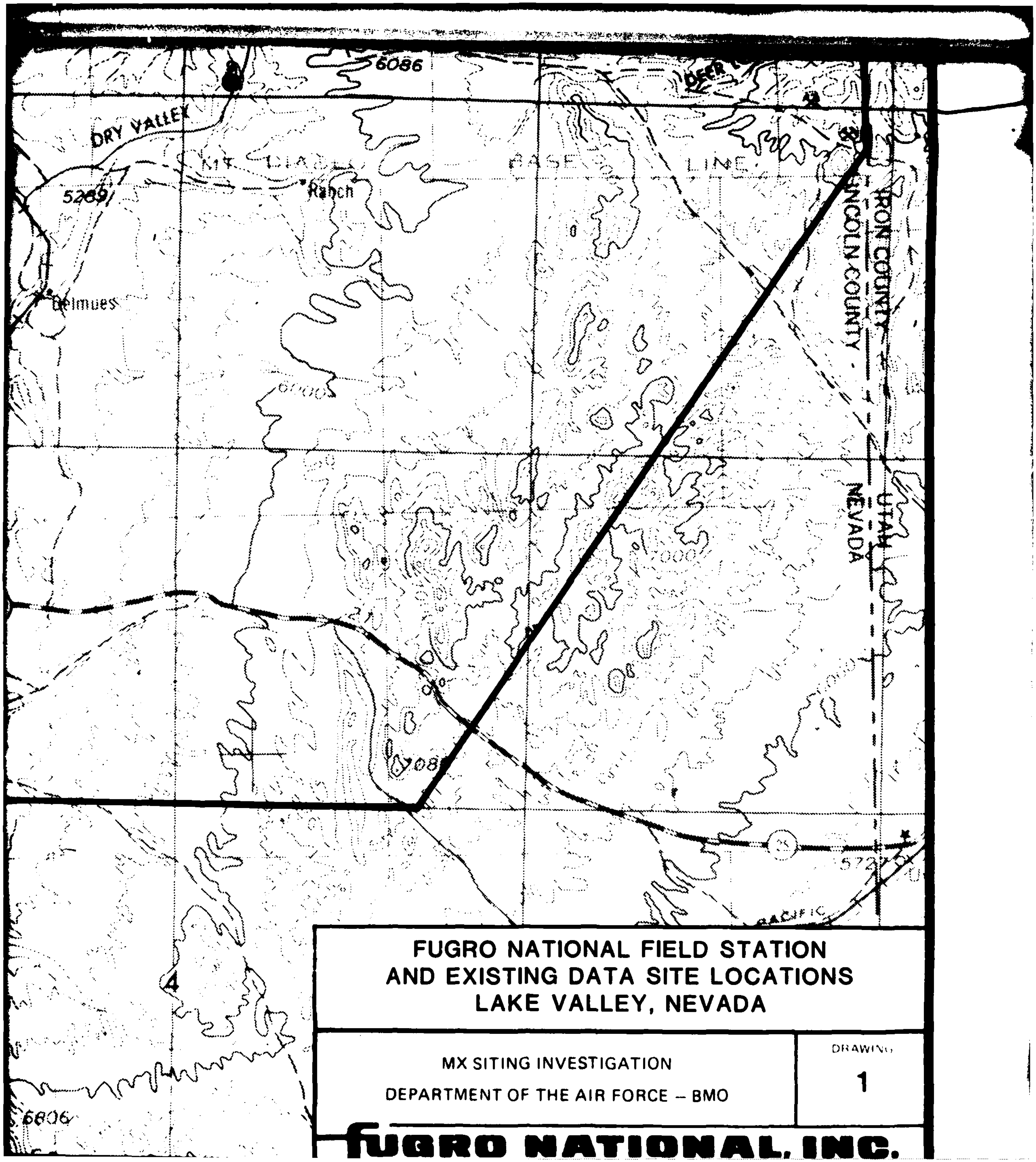
27 FEB 81

Corresponding Map Number in Appendix A for Detailed Information





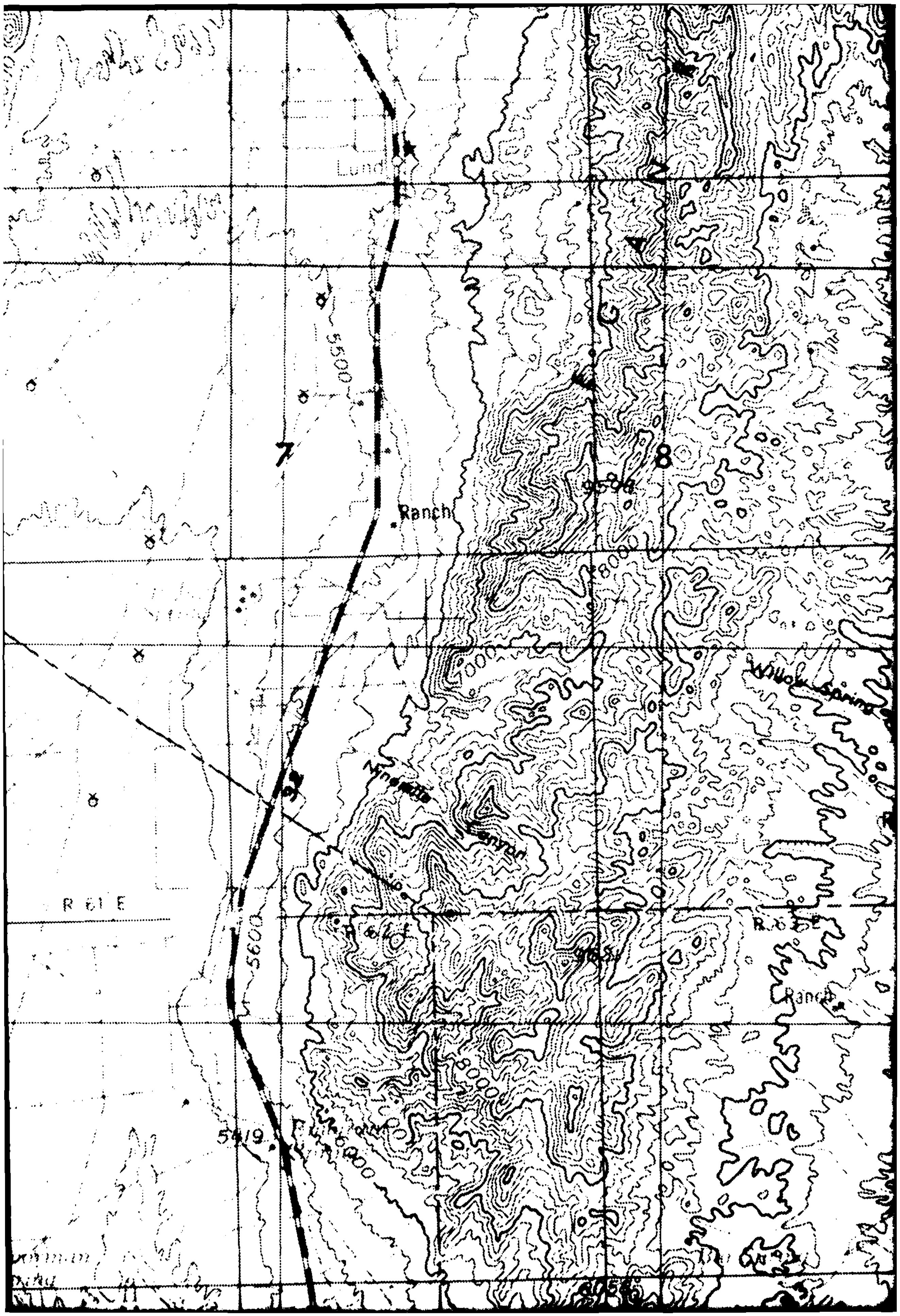
Pioche
DRY VALLEY
UNION PACIFIC
HIGHLAND PEAK
RANGE
6064
5269
Delmues
Condor Canyon
CATHEDRAL GORGE
STATE PARK
5163
Bannock Pass
Lincoln Co
4800
4723
Panaca
Ranch
5050

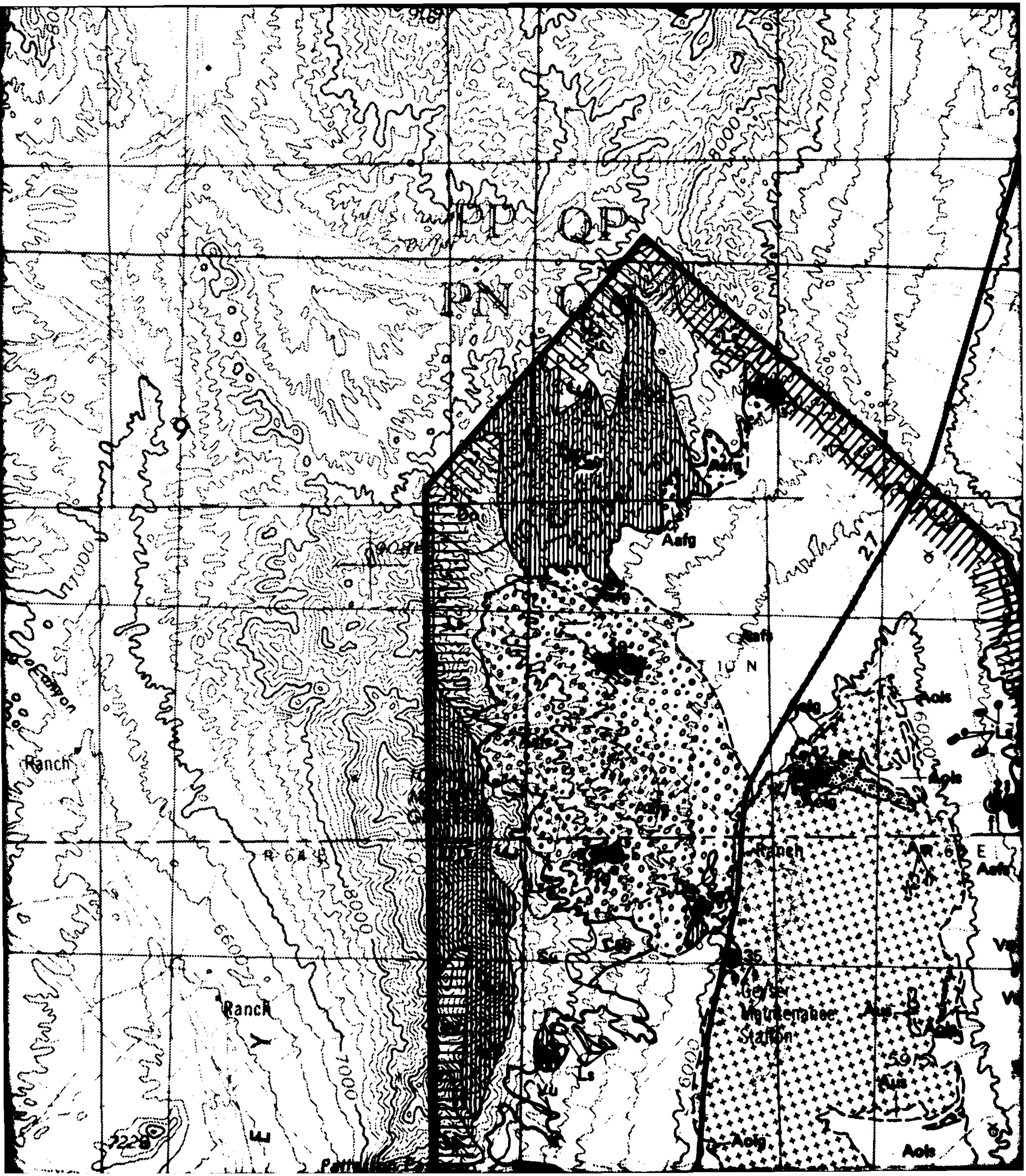


FUGRO NATIONAL FIELD STATION AND EXISTING DATA SITE LOCATIONS LAKE VALLEY, NEVADA

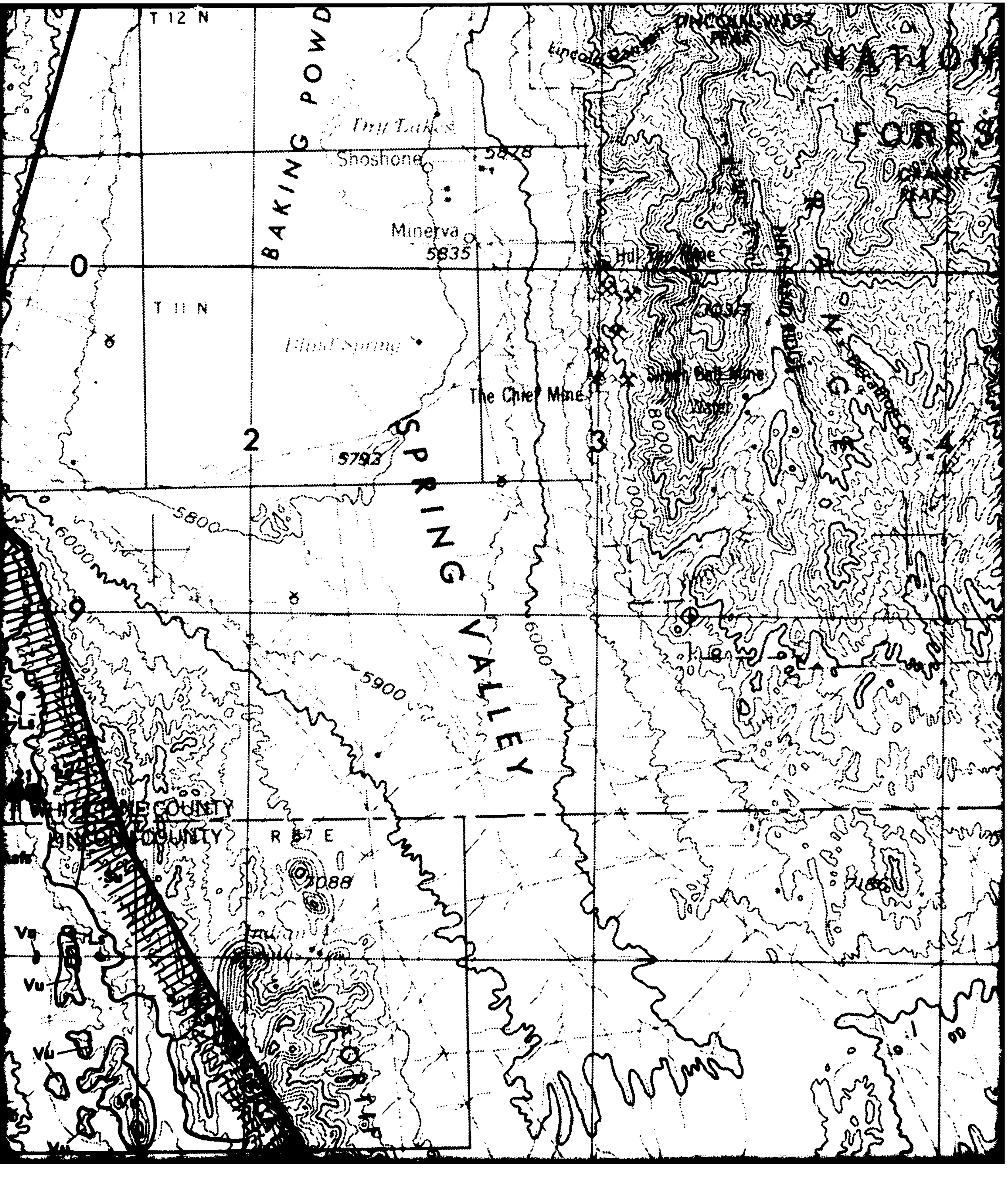
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE – BMO	DRAWING 1

FUGRO NATIONAL, INC.

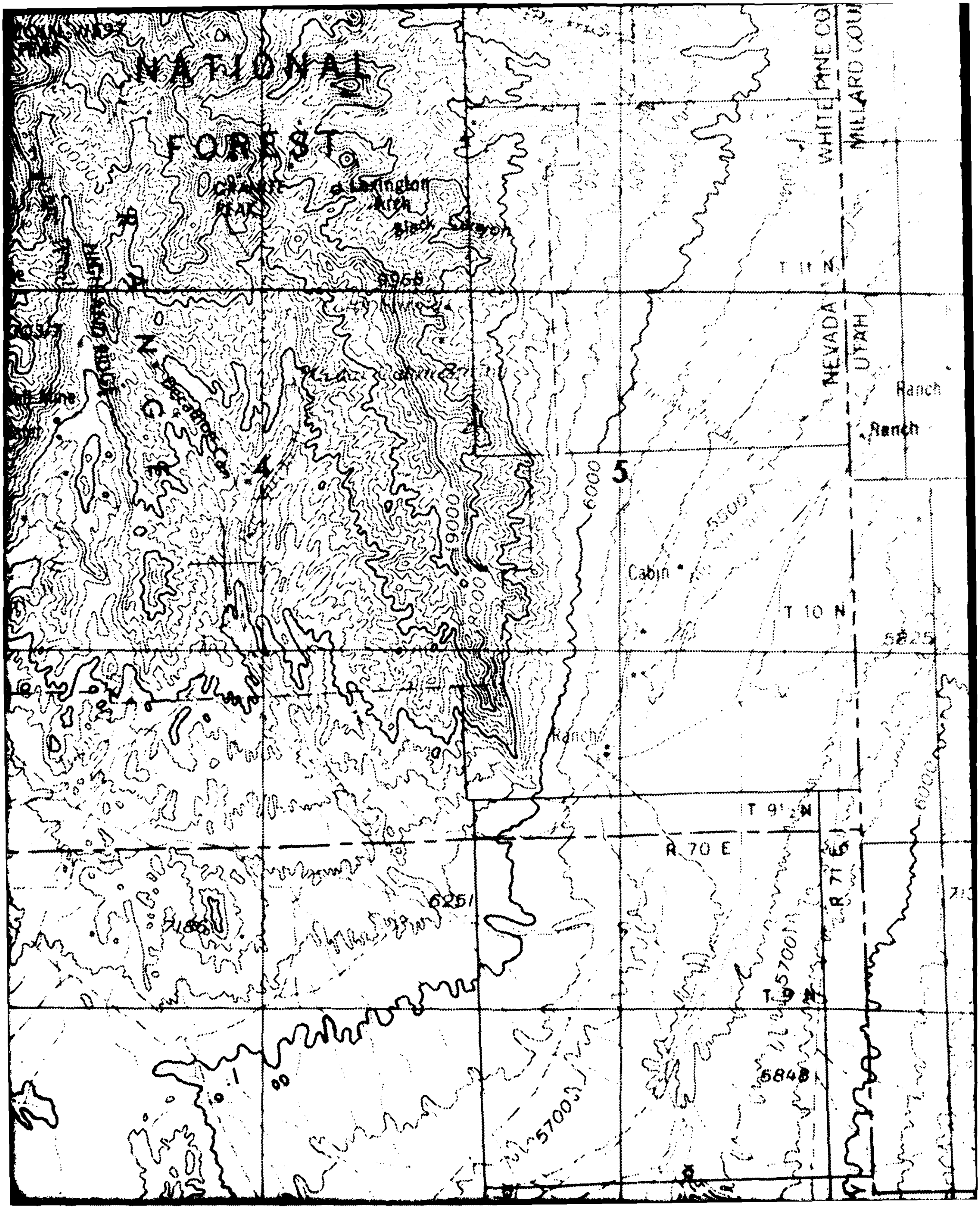

Lund
5500
7
8
Ranch
Willow Spring
Ninemile
Canyon
R 61 E
R 62 E
R 63 E
5600
Ranch
5419



PP
QP
PN
Aafg
T 10 N
Aols
Aolg
Ranch
R 64 E
Geyser
Station
Aus
Ranch
Canyon
Ranch
7000
8000
6600
27
35

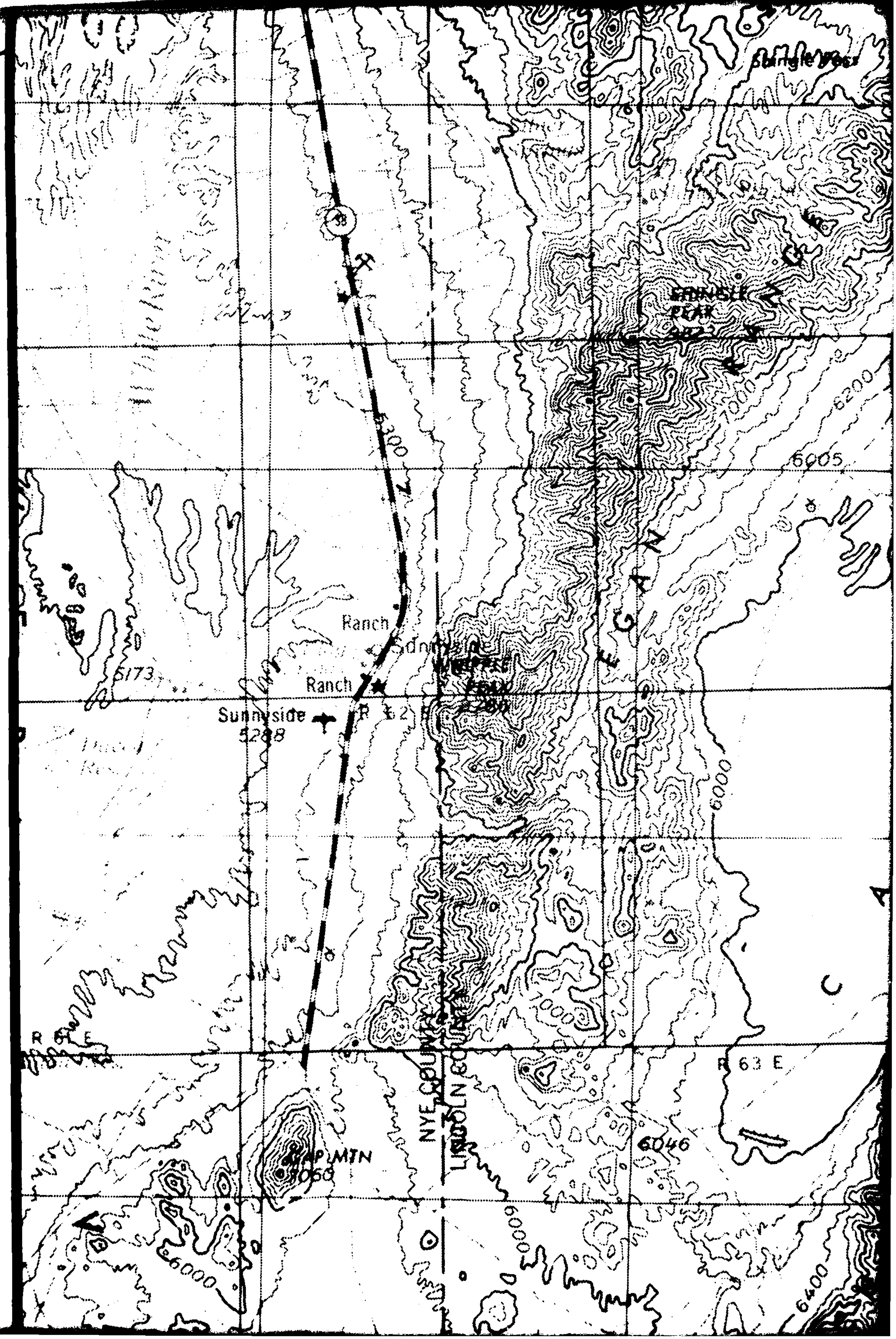


T 12 N
BAKING POWD
Dry Lakes
Shoshone
5828
Minerva
5835
T 11 N
The Chief Mine
SPRING VALLEY
5793
5800
6000
5900
NATION
FORES
WHITE PINE COUNTY
LINCOLN COUNTY
R 67 E
7088
Vu

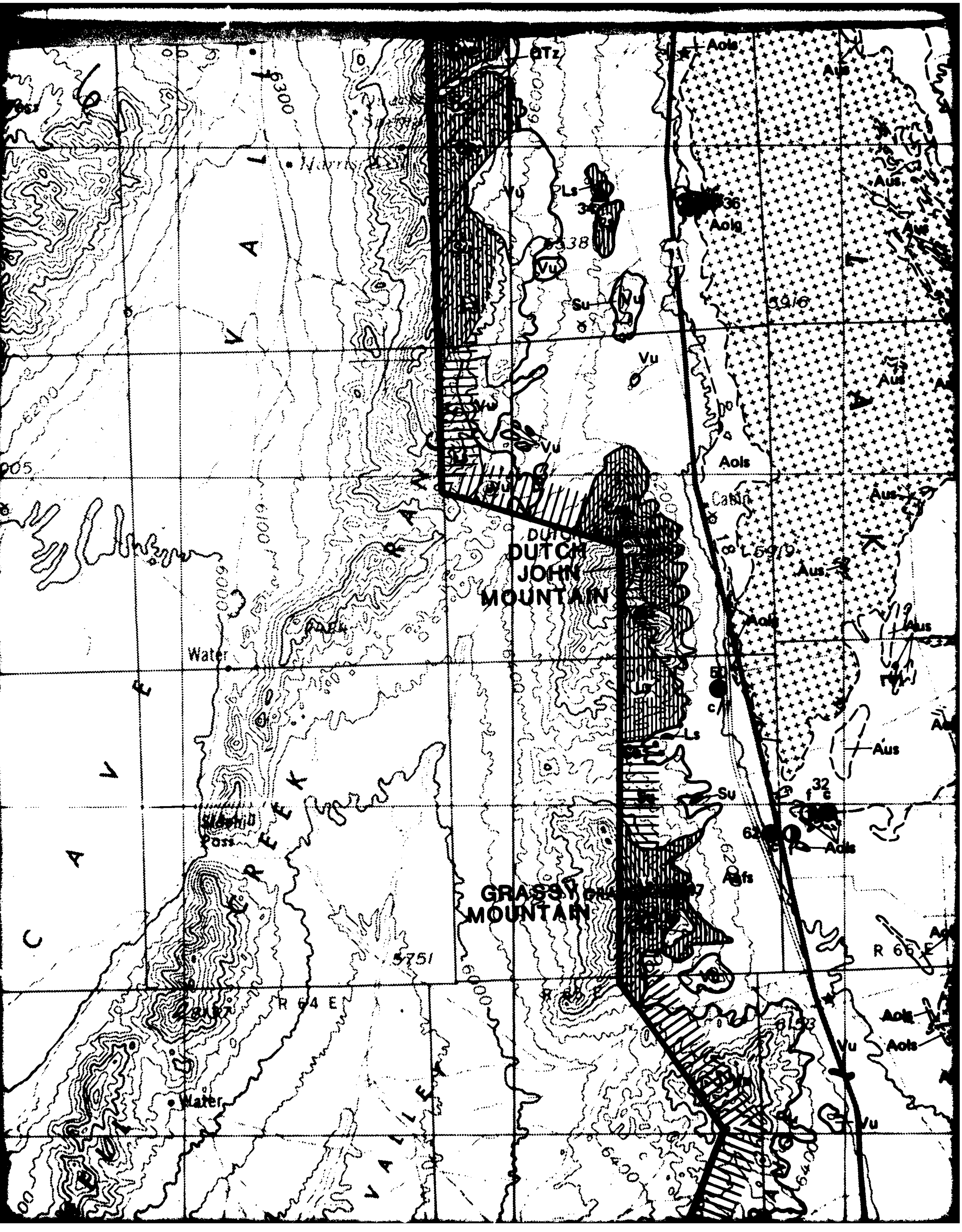


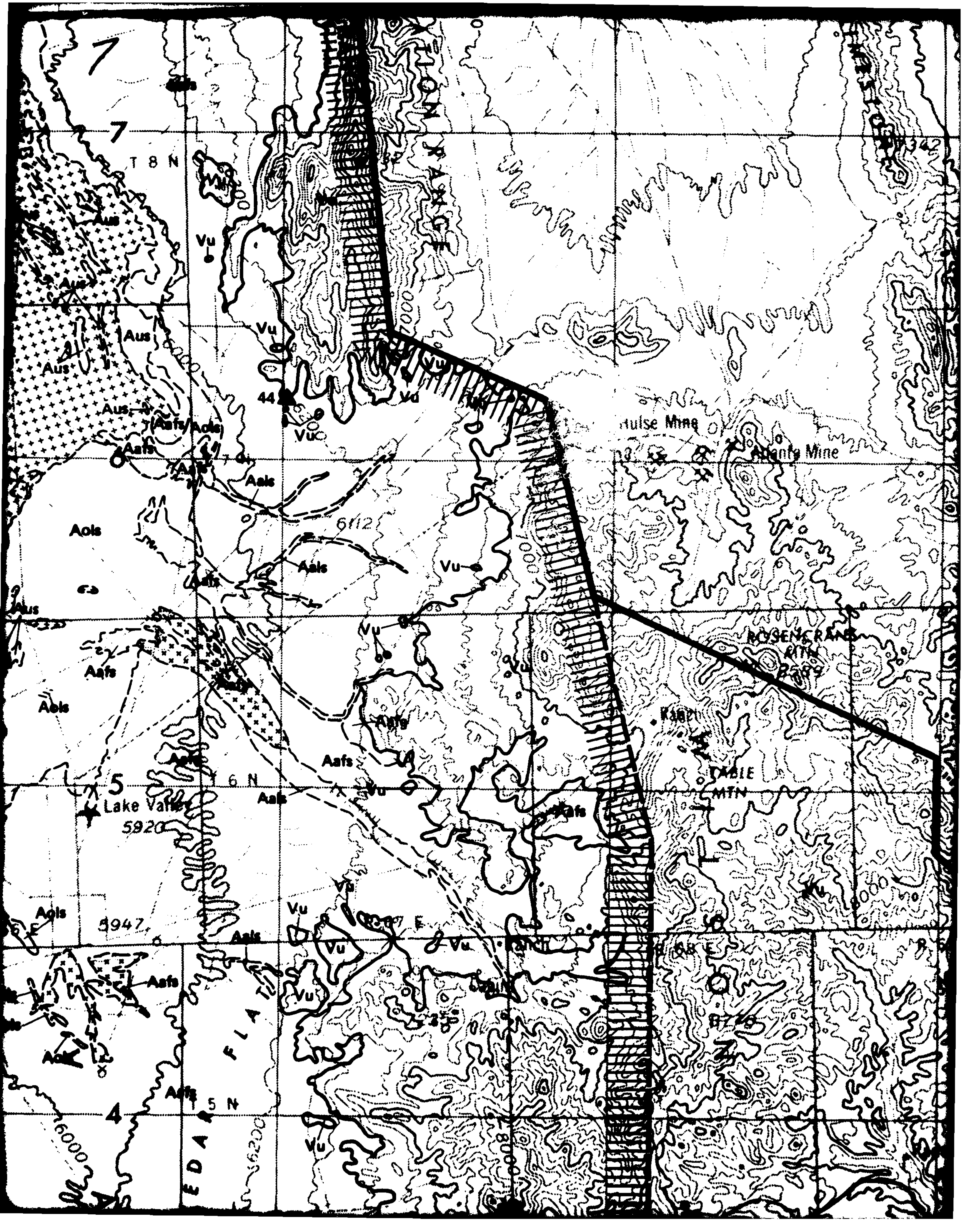
NATIONAL
FOREST
Lexington Arch
Black Canyon
8968
WHITE PINE CO
MILLARD COU
T 11 N
NEVADA
UTAH
Ranch
Ranch
5
6000
9000
8000
5500
Cabin
T 10 N
5825
Ranch
T 9½ N
R 70 E
R 71 E
6251
7186
5700
6000
T 9 N
5848
5700

5

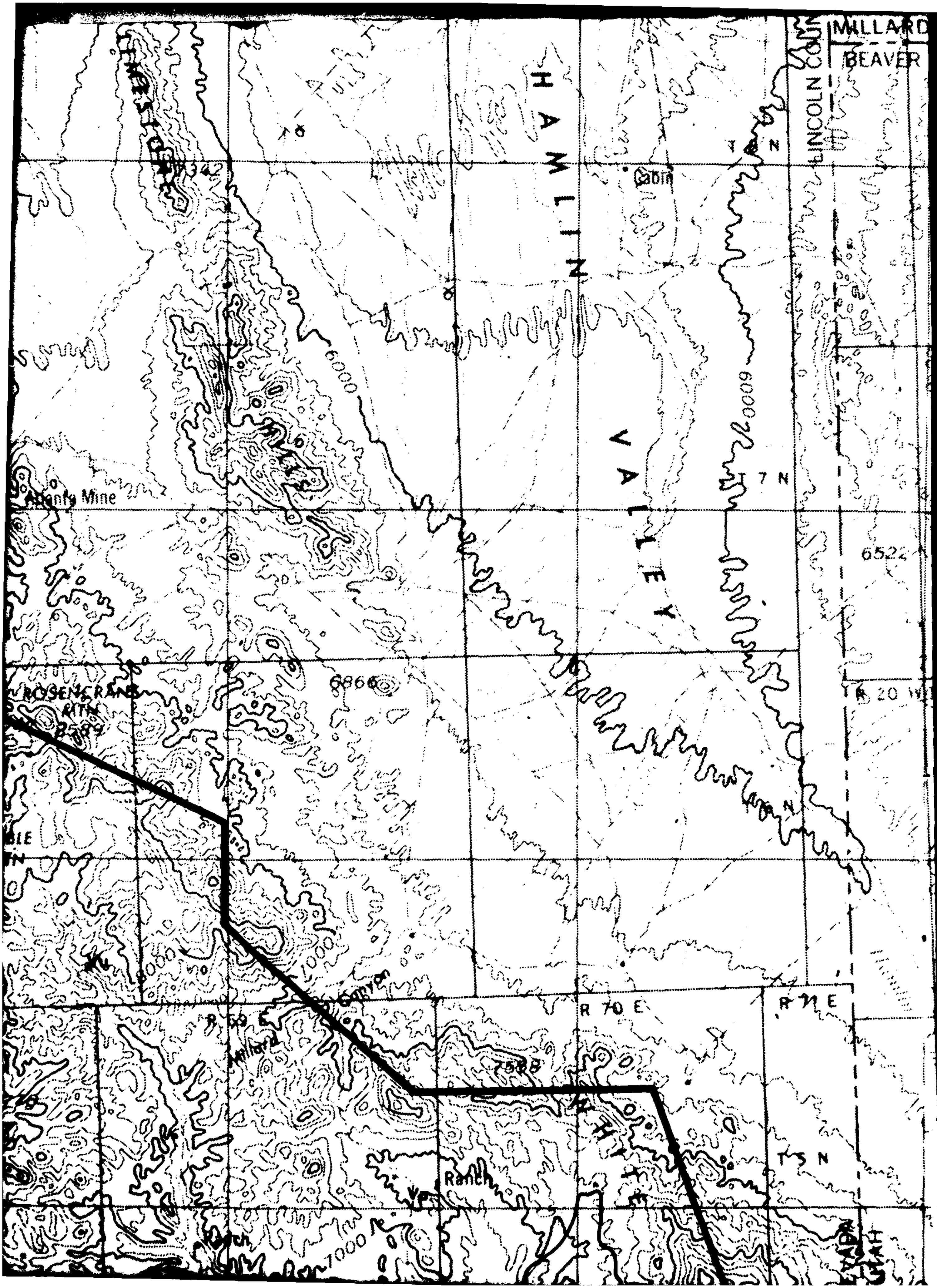


Shingle Pass
38
5300
7000
6200
6005
Ranch
Ranch
5173
Sunnyside
5288
R 62 E
R 61 E
R 63 E
NYE COUNTY
LINCOLN COUNTY
GAP MTN
7060
6046
6000
6400


DUTCH
JOHN
MOUNTAIN
GRASSY
MOUNTAIN
Water
Water
R 64 E
R 65 E
Cabin
Aols
Aus
Aolg
Vu
Su
Ls
Aofs
5751

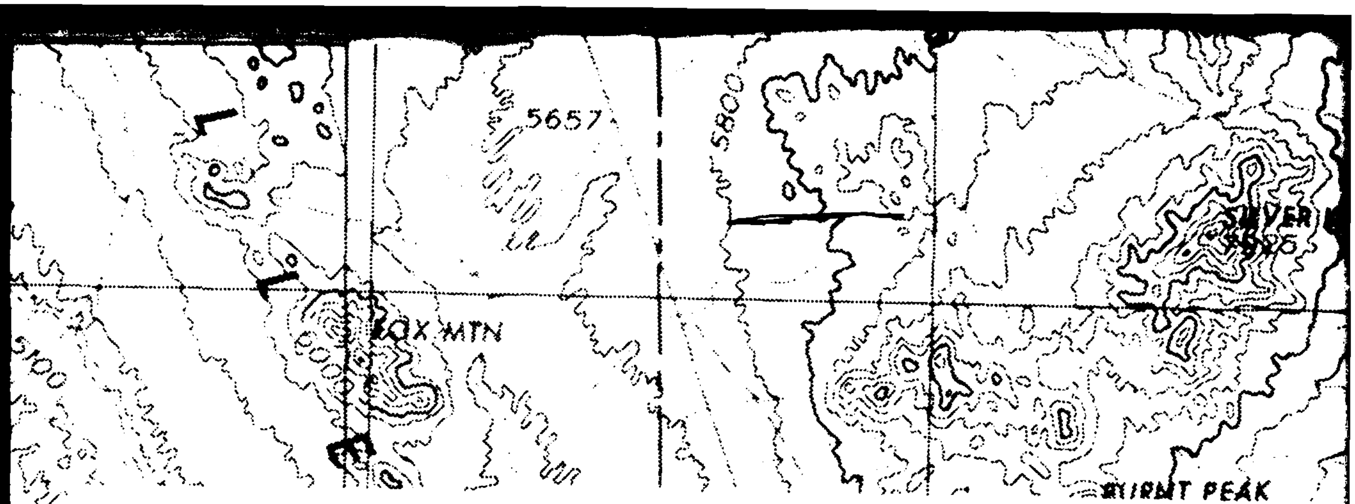


7
T 8 N
Aus
Vu
Aafs
Aols
Aals
Aafs/Aols
6112
Hulse Mine
Atlanta Mine
ROSENCRANS MTN
TABLE MTN
T 6 N
5
Lake Valley
5920
5947
T 5 N
4
FLAT
R 8 E



MILLARD
BEAVER
LINCOLN CO
HAMLIN
VALLEY
Cabin
6000
T 7 N
Mine
6522
6866
R 20 W
R 70 E
Canyon
Ranch
T 5 N

9



EXPLANATION

Potential Aggregate Sources

BASIN-FILL UNITS*

Aal	Stream Channel Deposits	(A1)
Aaf	Alluvial Fan Deposits	(A5)
Aol	Older Lacustrine Deposits	(A4o)
Au	Alluvial Deposits Undifferentiated	

ROCK UNITS*

Vu	Volcanic Rocks Undifferentiated	(I2 and/or I4)
Qtz	Quartzite	(M4 and/or S1)
Ls	Limestone	(S2)
Do	Dolomite	(S2)
Cau	Carbonate Rocks Undifferentiated	(S2)
Su	Sedimentary Rocks Undifferentiated	(S)

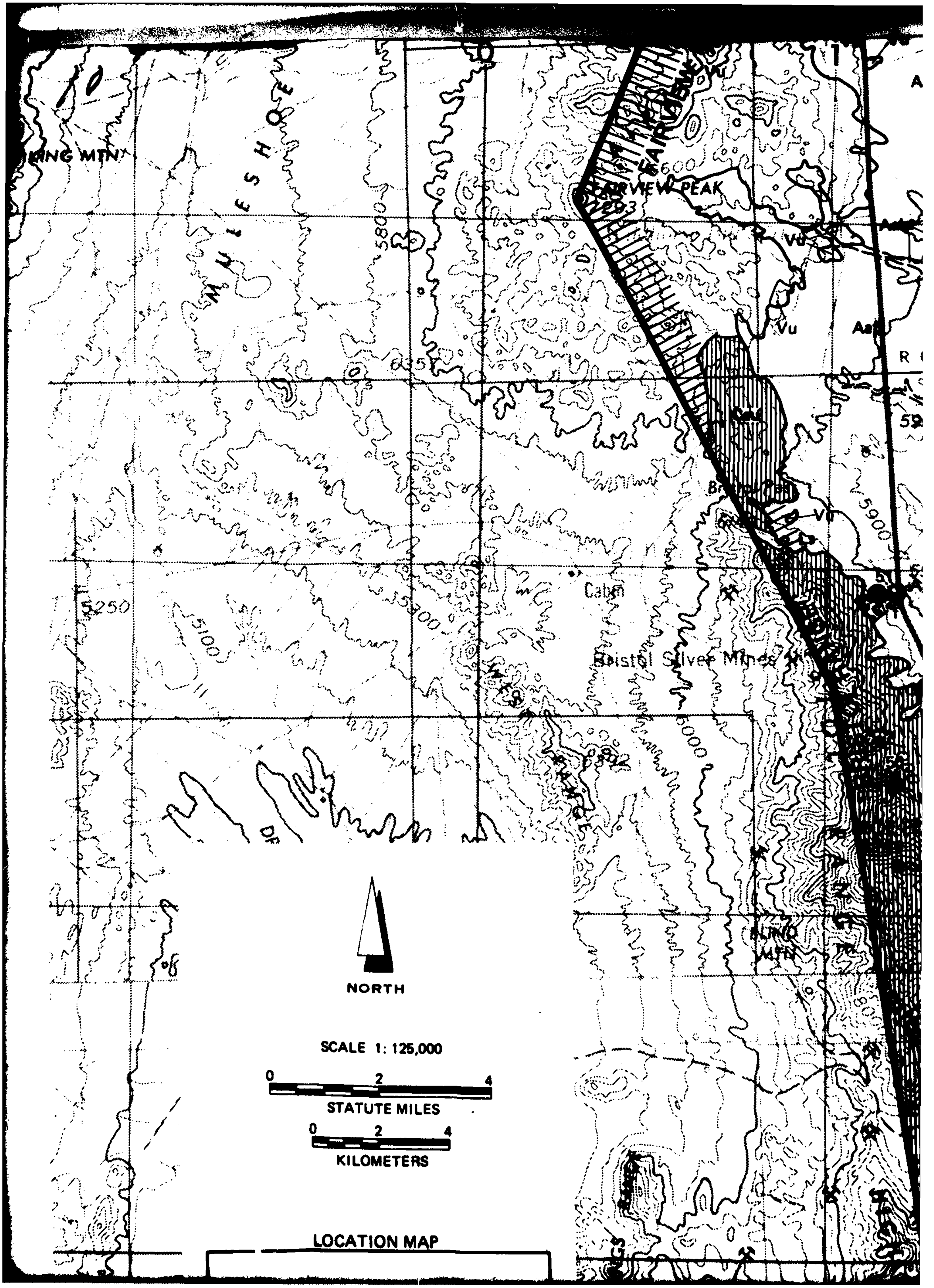
*Reference Appendix E for Symbol Explanation and Comparison

Symbols

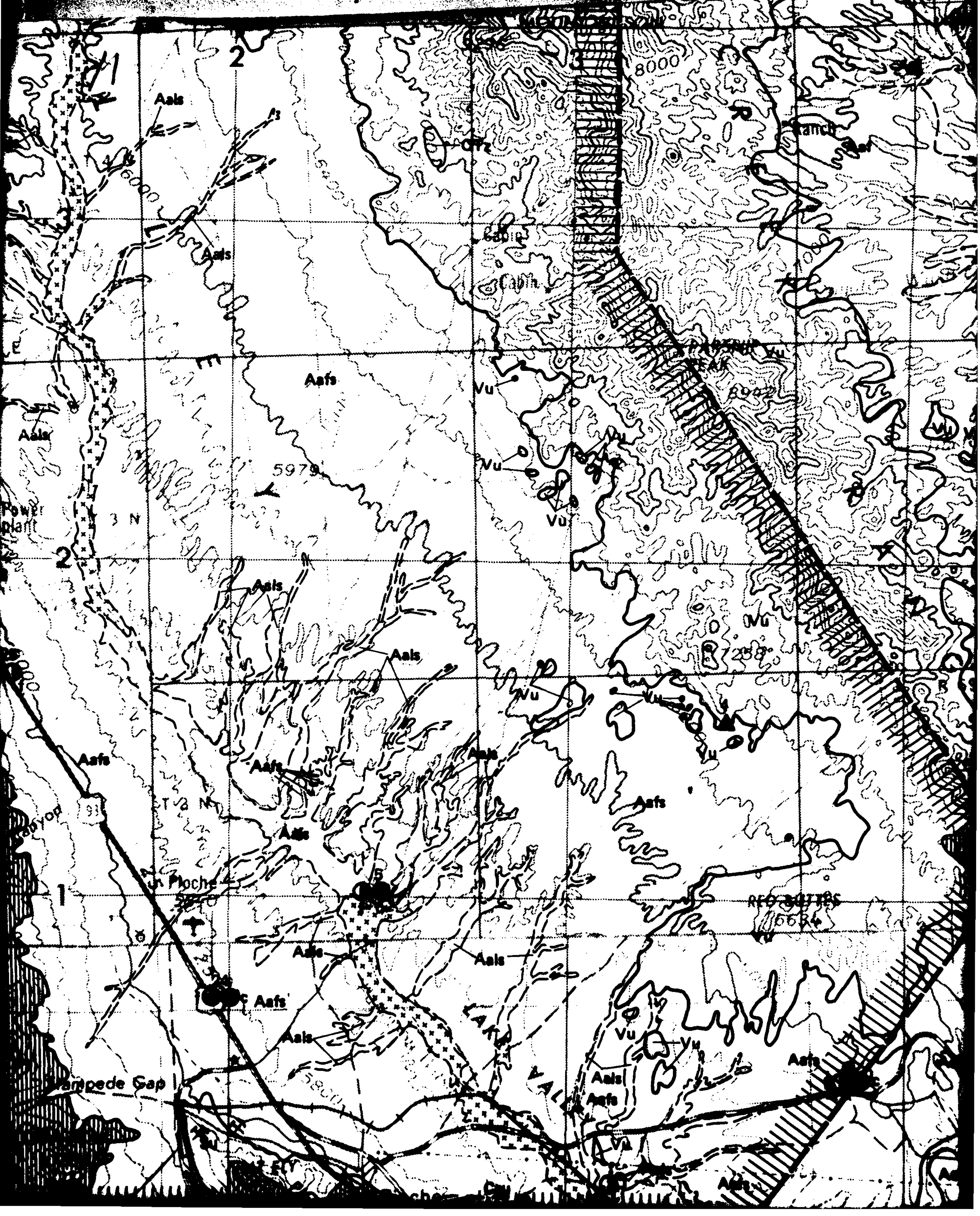
Aafg — Material type (Aaf) and Grain Size Designation (g). Grain size designations are coarse (c) gravel (g) and sand (s) and are assigned only in Verification Study Areas

Geologic Contact, Dashed Where Approximate

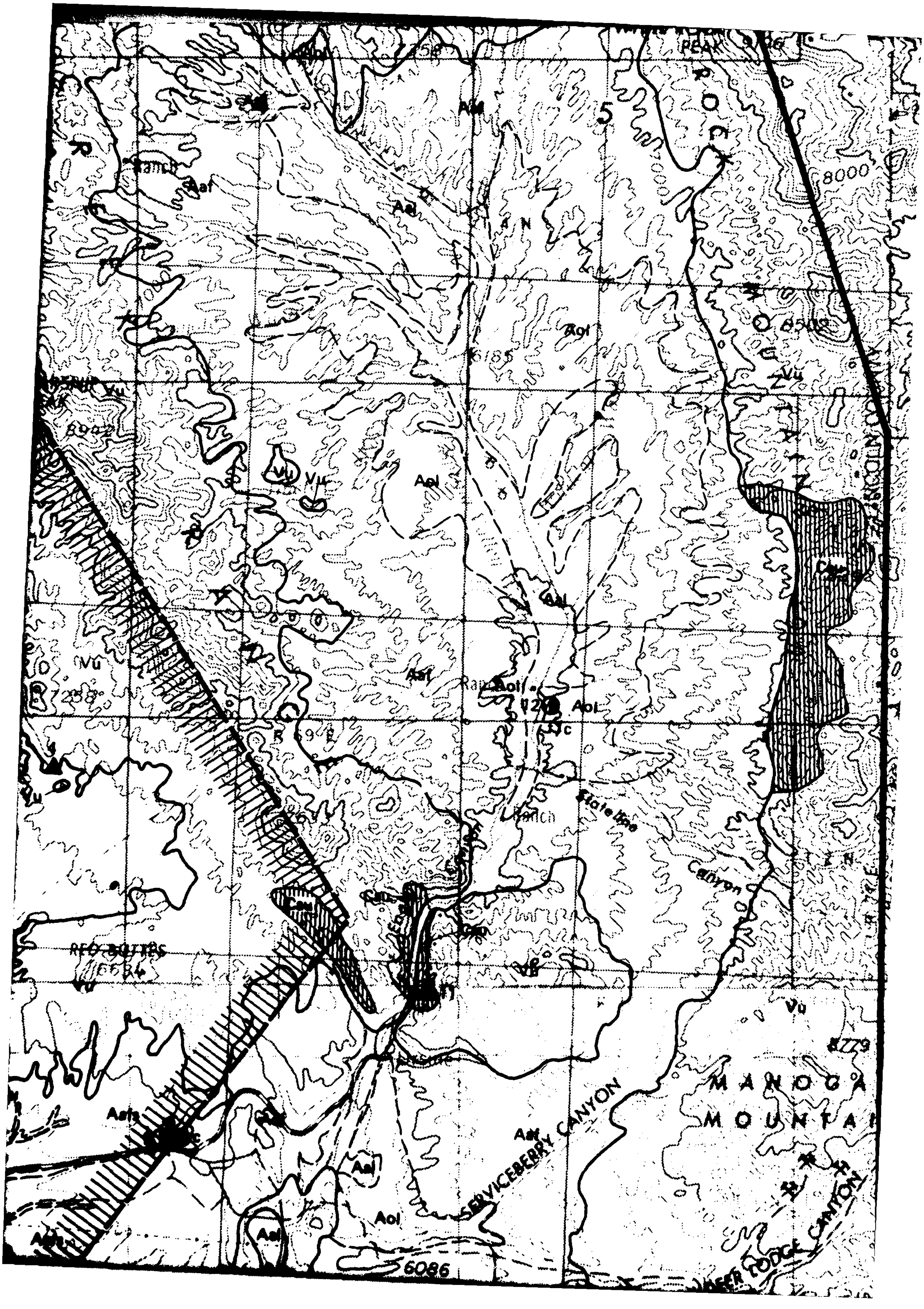
Approximate-Concrete Aggregate and/or Road-Base Materials Source Boundary



10
KING MTN
MULESHOE
FAIRVIEW PEAK
5800
6351
5900
5250
5100
5300
Cabin
Bristol Silver Mines
6000
6892
BLIND MTN
NORTH
SCALE 1: 125,000
0 2 4
STATUTE MILES
0 2 4
KILOMETERS
LOCATION MAP



Aals
Aafs
Vu
8000
Ranch
Cabin
5979
Power plant
T 3 N
T 2 N
Pioche
Red Buttes
6634
Stampede Gap
93


PEAK
8000
Aal
Aol
Vu
Ranch
Aaf
Cau
RED BUTTES
Stateline Canyon
SERVICEBERRY CANYON
M A N O G A
M O U N T A I
DEER LODGE CANYON
6086
8279

Verification Study Area

FUGRO NATIONAL VALLEY - SPECIFIC AGGREGATE RESOURCES SAMPLED AND TESTED FIELD STATIONS

BASIN-FILL AGGREGATE SAMPLE COARSE (c) AND FINE (f)	CRUSHED ROCK SAMPLE	CLASSIFICATION
●	▲	CLASS I
◐	▲	CLASS II
○	△	CLASS III

NOTE: SEE CORRESPONDING MAP NUMBER IN APPENDIX A FOR DETAILED INFORMATION

CLASSIFICATION SYSTEM

BASIN-FILL SOURCES

Class I – Potentially Suitable Coarse, Concrete Aggregate and Road-Base Material Source

Class I Potential Suitable Concrete Aggregate and Road Base Material Source

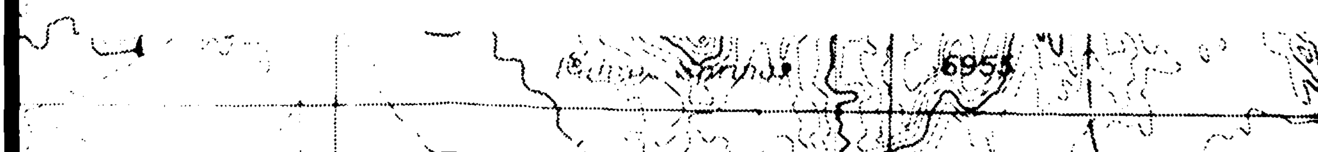
ROCK SOURCES

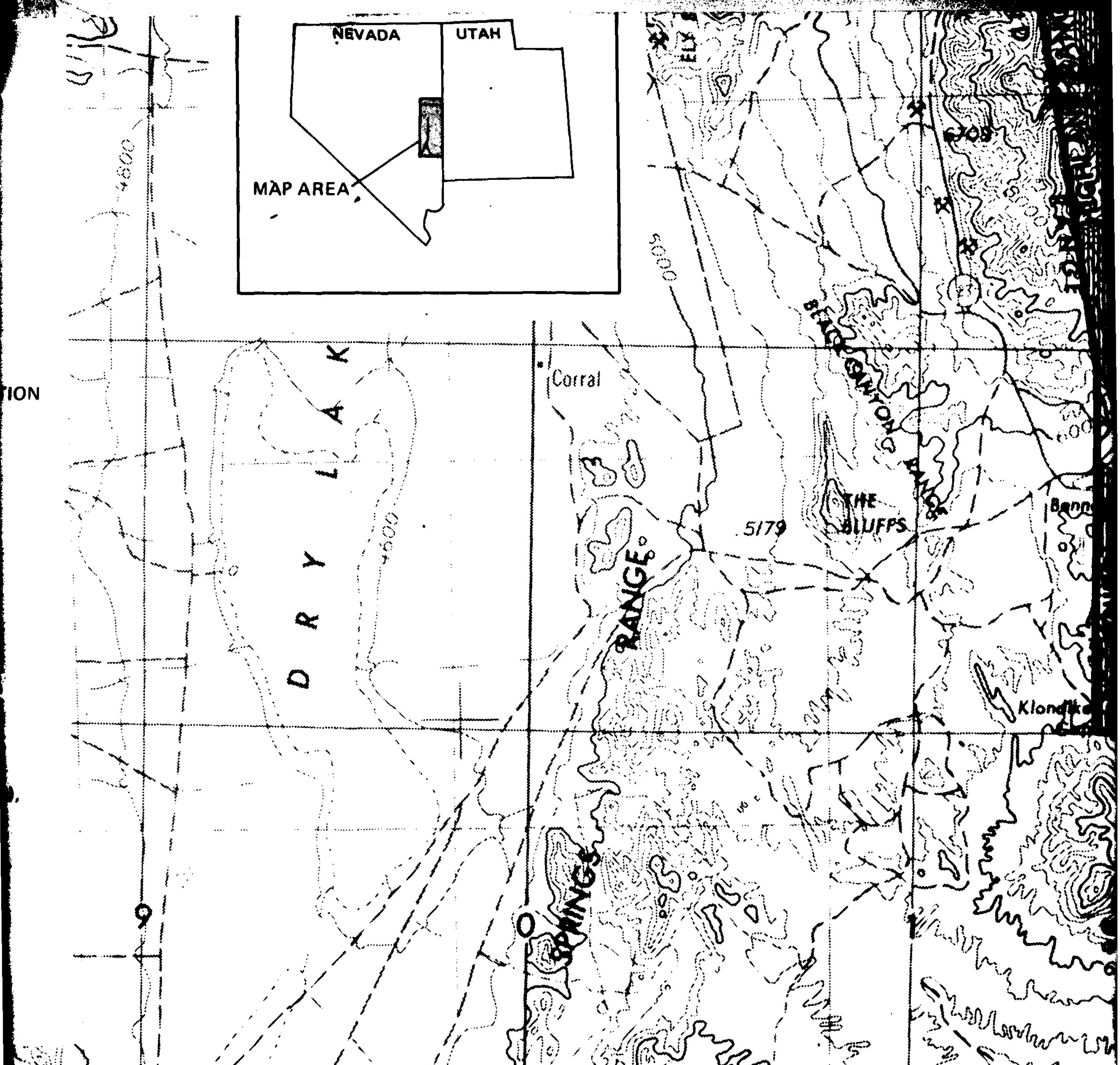
Class I Potentially Suitable Crushed Rock, Coarse and Fine (Multiple Type Sourse), Concrete Aggregate and Road-Base Materials Source

BASIN-FILL AND ROCK SOURCES

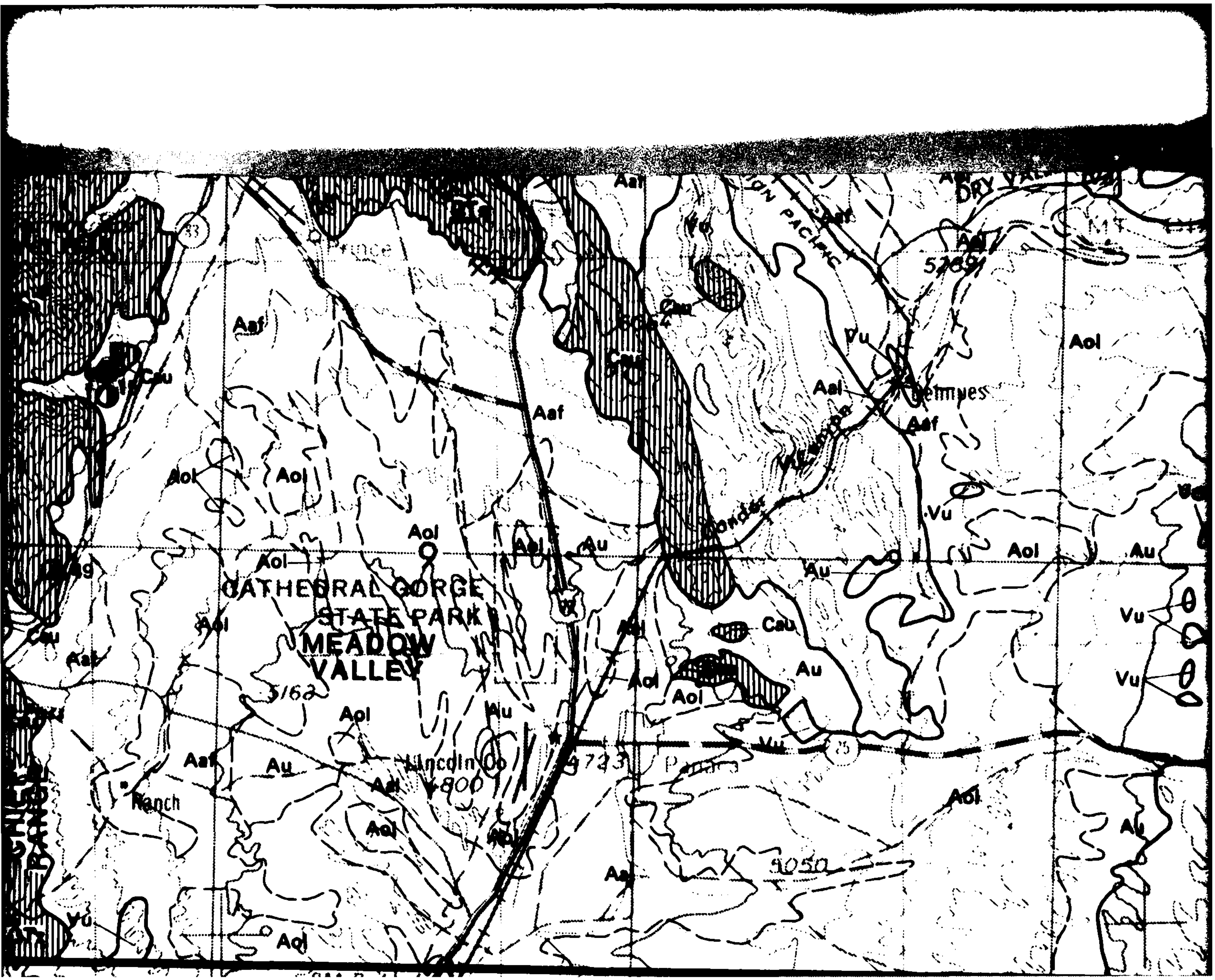
Class II Possibly Unsuitable Coarse, Fine and/or Crushed Rock Concrete Aggregate Potentially Suitable Road-Base Material Source

Class III Unsuitable Coarse, Fine and /or Crushed Rock Concrete Aggregate or Road-Base Material Source

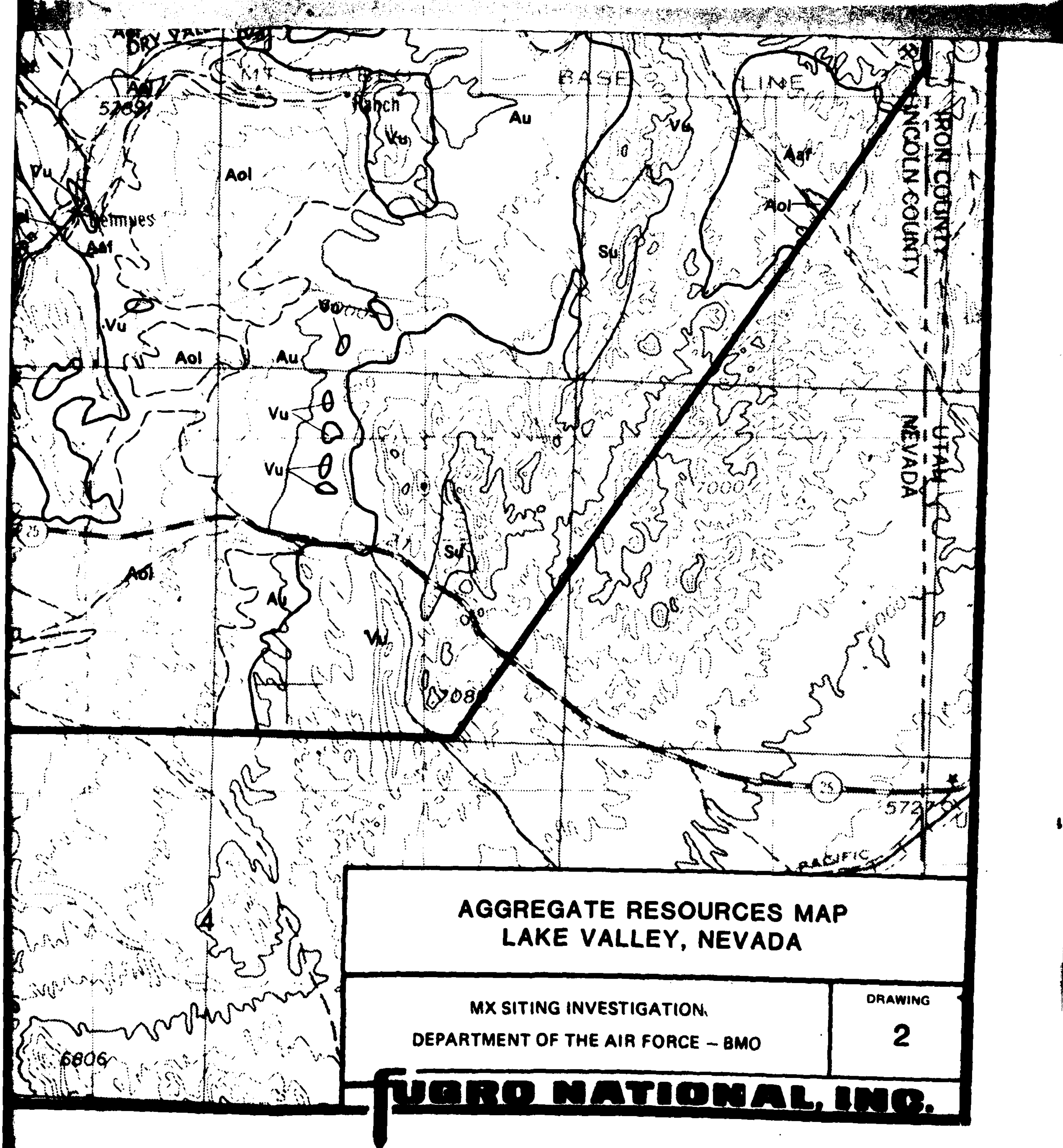




NEVADA
UTAH
MAP AREA
Corral
DRY LAKE
RANGE
SPRINGS
THE BLUFFS
5179
Klondike
GREY DOME



CATHEDRAL GORGE
STATE PARK
MEADOW
VALLEY
Lincoln Co
Ranch
ON PACIFIC
Aaf
Aol
Au
Vu
Cau
Aal
5162
4723
9050



BASE LINE
Ranch
Au
Vu
Aol
Agf
Su
IRON COUNTY
LINCOLN COUNTY
UTAH
NEVADA
7000
7080
25
5727
PACIFIC
6806
AGGREGATE RESOURCES MAP
LAKE VALLEY, NEVADA
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE – BMO
DRAWING
2
FUGRO NATIONAL, INC.

DATE
FILMED
8