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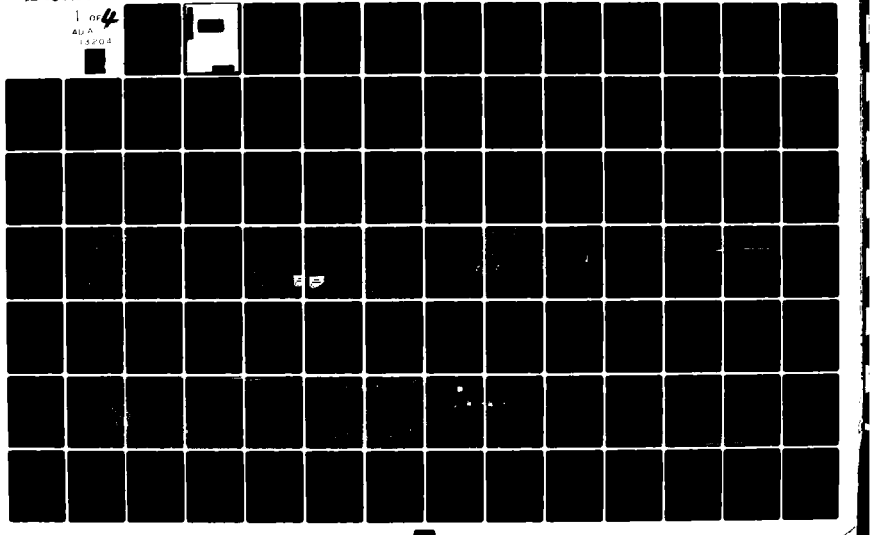

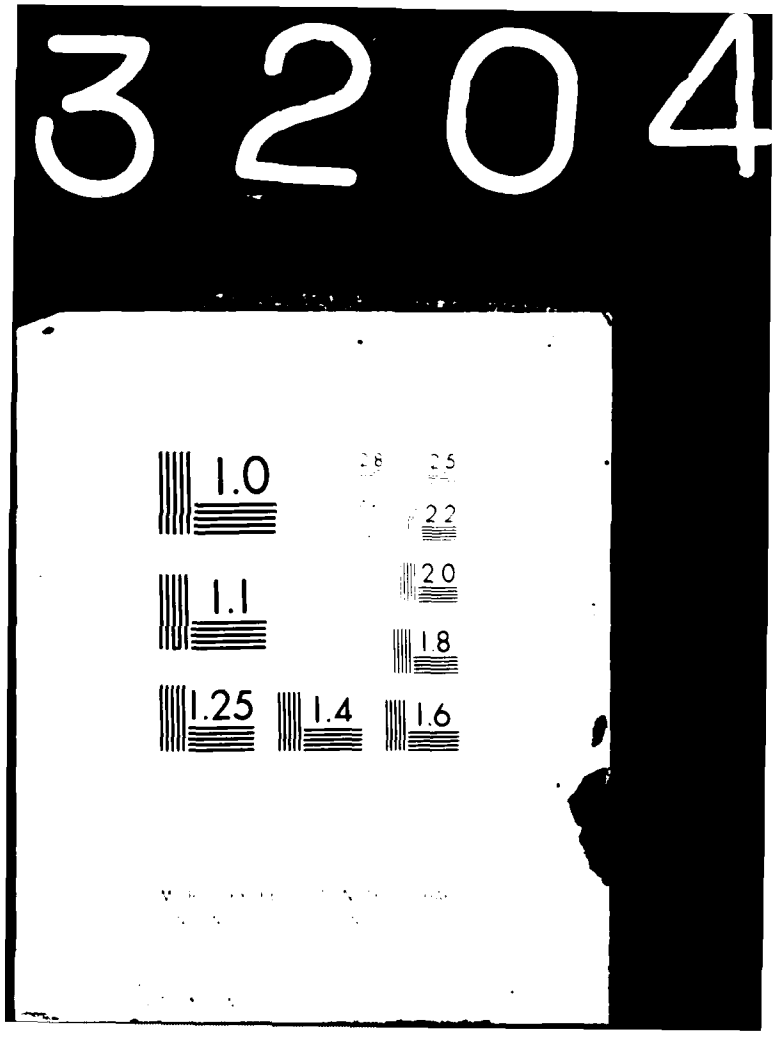
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AGGREGATE RESOURCES REPORT DEPARTMENT OF DEFENSE AND BUREAU OF LAND MANAGEMENT LANDS, SOUTHWESTERN UNITED STATES

Prepared for:

Space and Missile Systems Organization (SAMSO)
Norton Air Force Base, California

Prepared by:

Fugro National, Inc.
3777 Long Beach Boulevard
Long Beach, California 90807

10 February 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents results of Aggregate Resource Evaluation Investigation performed within D.O.D. + Bureau of Land Management M X Siting Regions ~~as defined by Fugro N.~~ in Texas, New Mexico, Arizona, and Nevada.

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FOREWORD

This report was prepared for the Department of Air Force Space and Missile Systems Organization (SAMSO) in compliance with conditions of Contract No. F04704-77-C-0010 and deals with potential concrete aggregate resources within and adjacent to selected lands under consideration for siting of the MX Land Mobile Advanced ICBM System.

This report was prepared for SAMSO under the direction of Kenneth L. Wilson, Project Director, and under the supervision of the following senior staff: Robert J. Lynn, Project Manager-Geology; Stanley H. Madsen, Project Manager-Engineering and C. Marshall Payne, Senior Geologist. Personnel responsible for conduct of the field work, data analysis, and report writing include William R. Lund, Michael R. Long, Eugene Y. Hsu, and James B. Thompson with final graphics preparation directed by Edd V. Joy and James A. Nenneman.

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1.0 INTRODUCTION

1.1 BACKGROUND AND LOCATION

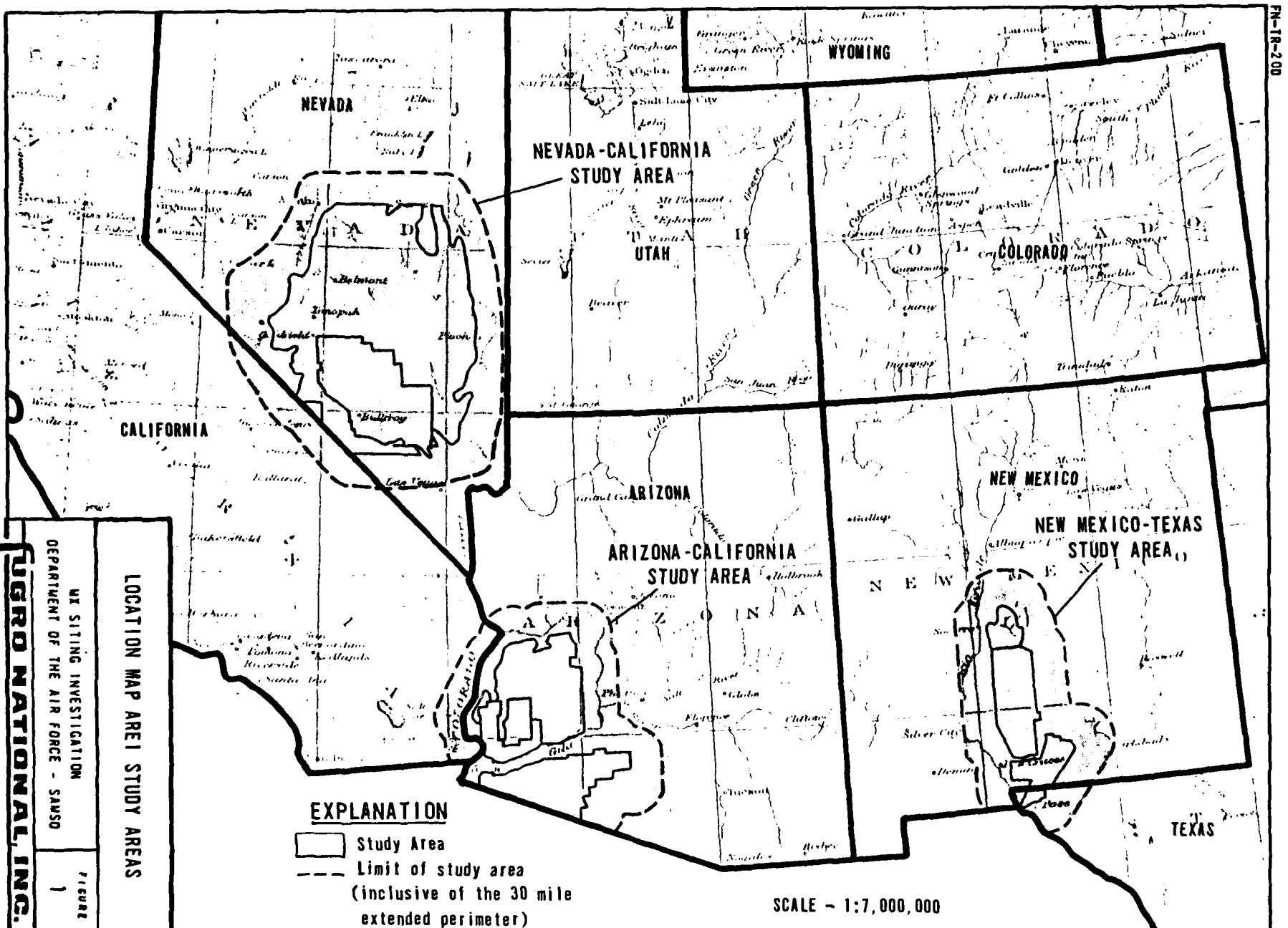
This report presents the results of the Aggregate Resource Evaluation Investigation (AREI) performed within the Department of Defense (DoD) and Bureau of Land Management (BLM) MX Siting Regions as defined by Fugro National in 1976 (FN-TR-15) and a 30-mile boundary extension around these lands (Figure 1). These siting regions are being considered by other contractors to SAMSO as part of an evaluation program of potential MX deployment areas. This evaluation program will yield data related to possible siting configurations of facilities, construction cost estimates, and other factors important to the development of the MX system. These regions are among many other potentially suitable siting areas in the western United States delineated during Intermediate Screening (FN-TR-17).

To maintain continuity with previous Fugro National MX studies and to facilitate the retrieval of information, the regions under consideration have been divided into the following study areas:

1. New Mexico-Texas Study Area (NM-TSA) (Figure 2); comprised of White Sands Missile Range (WSMR), Fort Bliss Military Reservation (FBMR), White Sands Missile Range Extension (WSMRE).

2. Arizona-California Study Area (A-CSA) (Figure 3); comprised of Yuma Proving Grounds (YPG), Luke-Williams Bombing and Gunnery Range (LBGR), the Gila Bend Group (GBG) of BLM land.

3. Nevada-California Study Area (N-CSA) (Figure 4); comprised of Nellis Bombing and Gunnery Range (NBGR), and the Nellis Group (NG) of BLM.



FN-TR-200

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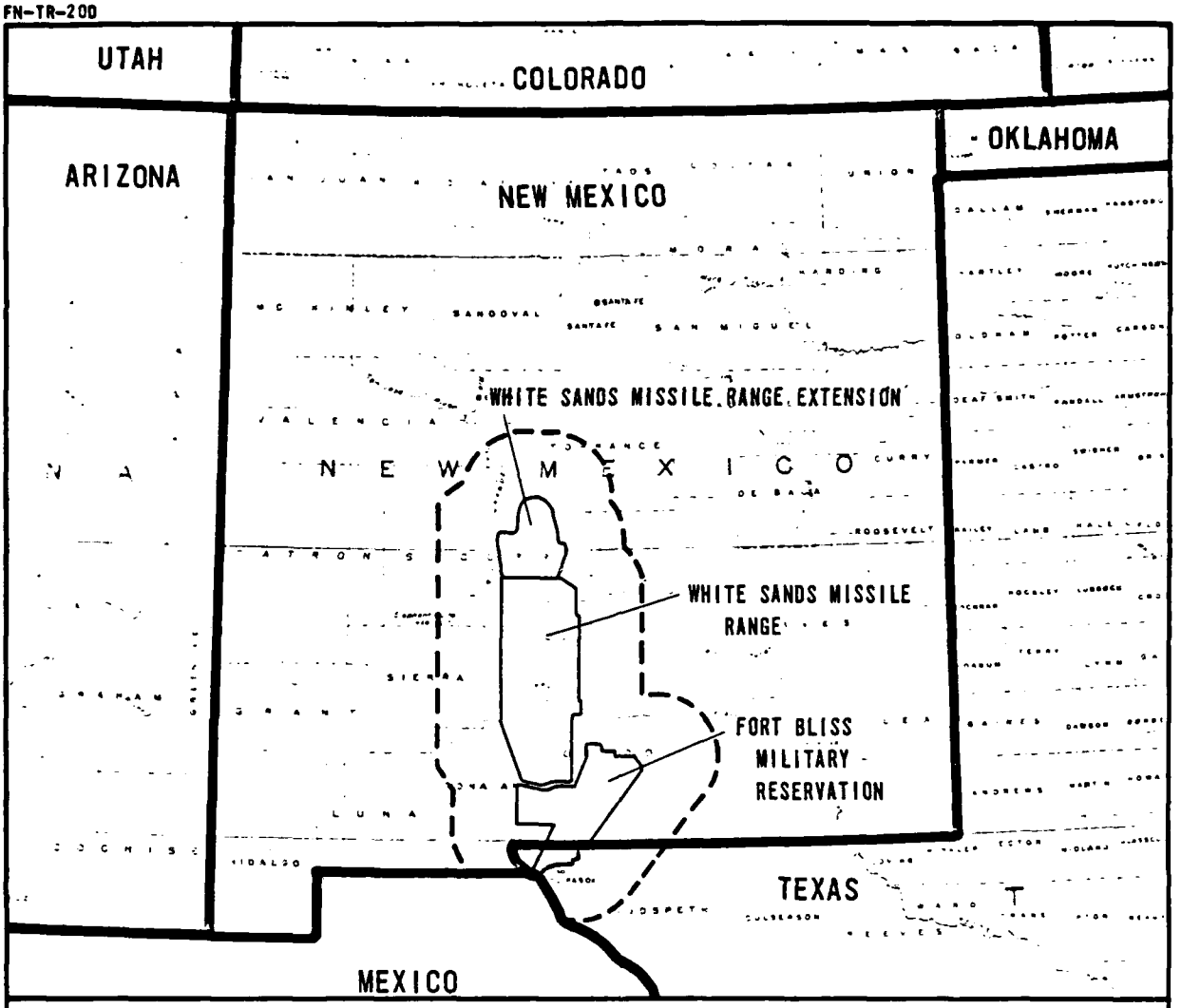
LOCATION MAP AREI STUDY AREAS

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 1

FN-TR-200



EXPLANATION

Limit of study area (inclusive of the 30 mile extended perimeter)

0 50 100 150
STATUTE MILES

0 50 100 150
NAUTICAL MILES

0 100 200
KILOMETERS

N

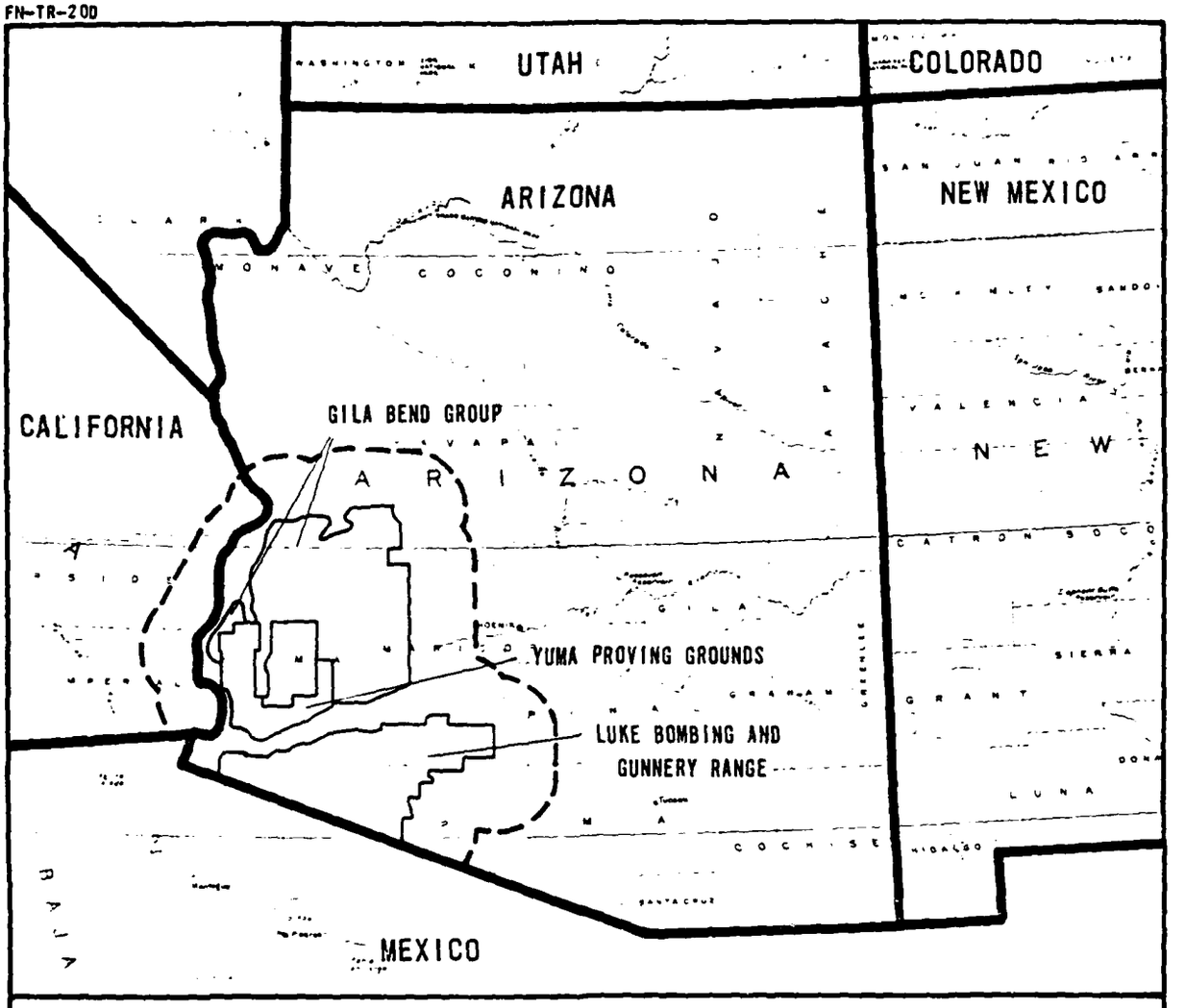
NEW MEXICO-TEXAS STUDY AREA
LOCATION MAP

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 2

FUGRO NATIONAL, INC.

FN-TR-200



EXPLANATION

Limit of study area (inclusive of the 30 mile extended perimeter)

0 50 100 150
STATUTE MILES

0 50 100 150
NAUTICAL MILES

0 100 200
KILOMETERS

N

ARIZONA-CALIFORNIA STUDY AREA
LOCATION MAP

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
3

FUGRO NATIONAL, INC.

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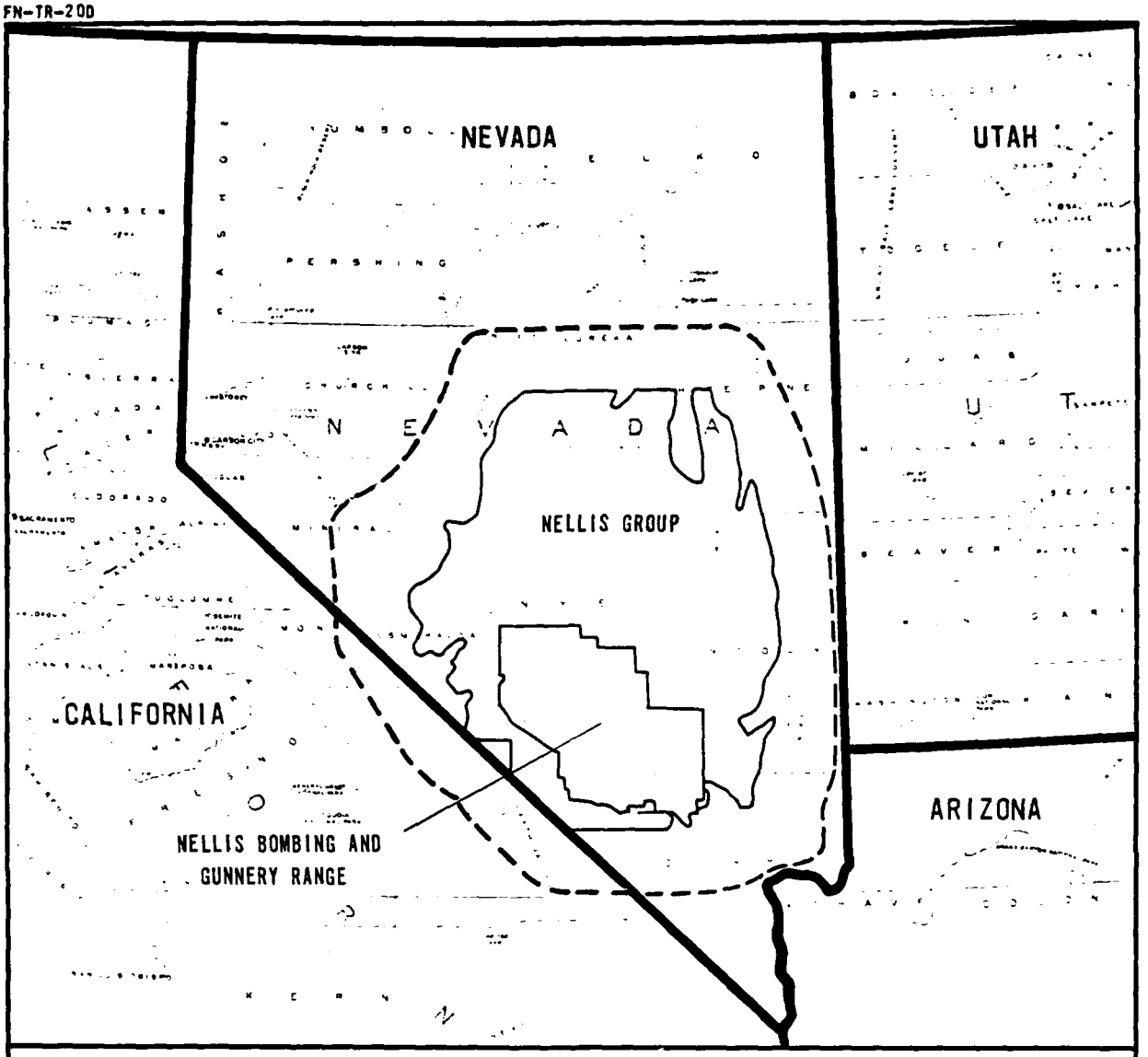


EXPLANATION

Limit of study area (inclusive of the 30 mile extended perimeter)

0 50 100 150
STATUTE MILES

0 50 100 150
NAUTICAL MILES

0 100 200
KILOMETERS

N

NEVADA-CALIFORNIA STUDY AREA
LOCATION MAP

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE 4

FUGRO NATIONAL, INC.

Included within each study area is a 30-mile wide peripheral corridor around the boundaries defined in FN-TR-15. Locally the limit of the 30-mile wide corridor deviates so that additional promising potential sources of concrete aggregate could be considered. Areas which were not available for field reconnaissance due to access restrictions are indicated on the accompanying aggregate resource maps.

1.2 PURPOSE AND SCOPE

The purpose of the AREI was to inventory and rank sources of sand and gravel according to their suitability for use as aggregate in 4 to 12 kips per square inch (ksi) compressive strength concrete to be used in construction of the MX trench system. The AREI study was designed to provide regional information on the general location, quality, and quantity of sand and gravel aggregate sources within the study areas in a useful and informative format for planning purposes. Providing detailed information of the type necessary for the actual location of proven available suitable aggregate sources and for design of an aggregate plant was outside the purposes of this study. Also there was no attempt to address water availability for concrete mixes to construct MX facilities.

Factors considered in order to make the inventory and rank the sources included:

1. Type of deposit; both hard-rock (quarry) and basin-fill (borrow pit) sources were investigated;
2. Quality of the material; American Society of Testing and Materials (ASTM) standards and Standard Specifications for Public Works Construction (SSPWC) were used to evaluate aggregate quality;

3. Quantity of material; 26 million cubic yards (yd^3) of coarse aggregate and 17.7 million yd^3 of sand are estimated to be required (Parsons, 1977) per deployment area (3000 nm of trench);

4. Size of boundary extension; the 30-mile boundary extension around the DoD and BLM MX siting regions was based on information from ongoing deployment area evaluation studies (Parsons, 1977) pertaining to the maximum practical construction haul distances anticipated for the MX system;

5. Availability of water for aggregate processing; review of existing data on ground and surface water within the study area; and

6. Accessibility; a brief review of major land transportation facilities within the study area.

The scope of this investigation required that both field reconnaissance and office studies be performed. The following steps were included in the analysis:

1. Collection of applicable data pertaining to a) the existence and quality of and potential sources of concrete aggregate, and b) the geology, soils, and related construction materials within the study area;

2. Analysis and evaluation of collected data with subsequent selection of area for field reconnaissance;

3. Aerial and ground field reconnaissance of representative borrow pits and quarries and potential sources of concrete aggregate with sampling of selected representative materials;

4. Limited laboratory testing to supplement available existing data and to provide sufficiently detailed information to assist in predicting suitability of potential aggregate resources over broad areas;

5. Development and applications of a concrete aggregate sources preliminary ranking system utilizing ASTM and SSPWC standards and specifications;

6. Cursory review of existing data on water availability and land transportation facilities within the study area; and

7. Depiction of data on large and small graphics and tables and preparation of the report.

1.3 STUDY APPROACH, METHODS, AND REPORT FORMAT

The study approach, as determined with SAMSO, was to 1) utilize to the maximum extent possible existing data on aggregate sources in each area, 2) obtain samples of representative potential aggregate source materials for laboratory testing and 3) assess critical physical/chemical properties and provide laboratory data to support the results of the inventory and ranking.

Collection of existing data from available sources was a primary factor controlling the study approach. Data were collected from many agencies, institutions, and individuals. Data collection activities included trips to Reno and Carson City, Nevada, Phoenix, Arizona, and Santa Fe, Albuquerque, and Socorro, New Mexico. Principal sources of data directly pertaining to concrete aggregate or related construction materials were the state highway departments of New Mexico, Arizona, and Nevada, and the United States Bureau of Reclamation. The majority of this information is related to the use of sand and gravel for asphaltic concrete or as select material or aggregate base course in road construction. Many of the acceptance tests for these types of construction materials are similar to those for concrete aggregate.

Engineering and geologic criteria were used to analyze and evaluate the existing data. Materials determined to be unsuitable for use as concrete aggregate were dismissed early from further consideration, and potentially suitable material sources were selected for further investigation.

A field reconnaissance of the study areas was made to collect additional necessary data and to verify conditions determined during the review of existing information. During this phase of the study, a number of existing quarries and borrow pits, as well as other potential sources of concrete aggregate, were examined. Data were collected from over 600 field stations; both hard rock and basin-fill materials were sampled. Representative samples of hard-rock sources were obtained from exposures of fresh or slightly weathered material whenever possible. Basin-fill materials were collected by channel sampling stream cuts or other natural or manmade exposures. Where cross sections of these materials were unavailable, samples were collected from shallow hand-dug pits. The size of both hard-rock and basin-fill samples collected for supplementary testing ranged between 30 and 100 pounds.

A limited number of representative samples were selected for laboratory testing and/or thin-section analysis. Testing was designed to supplement existing data and emphasis was placed on determining durability, soundness, and gradation. The plasticity index of the fines resulting from the Los Angeles abrasion test was determined for each limestone sample to detect the presence of argillaceous material. The principal tests performed were:

1. Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine (ASTM C131-69);
2. Soundness of Aggregates by Use of Magnesium Sulfate (ASTM C88-73);

3. Sieve or Screen Analysis of Fine and Coarse Aggregate (ASTM C136-71); and

4. Plastic Limit and Plastic Index of Soils (ASTM D424-59).

Identification of the AREI study are presented in text form on three 1:500,000 scale aggregate resource maps and as appendices. The aggregate resource maps (Drawing 1 through 3) show the location type and rank of all Class A and Class B aggregate sources (Section 1.4, Ranking System); Class C materials are only generally depicted. Geologic symbols utilized on the Drawings relate to locate stratigraphic and formation units where possible. A conversion table to relate these to symbol nomenclature from previous reports (e.g., FN-TR-18) is contained in Appendix G. In addition, these maps show the location of Fugro National field stations and the locations of representative aggregate sources for which test data were available. Appendices contain tables summarizing the basic data collected during the field investigations, the results of Fugro National's supplemental testing program, representative test data gathered from various outside sources, an explanation of caliche development, the Unified Soil Classification System, photographs of typical materials sources, and a map symbol conversion table.

All contacts which represent distinct boundaries between geologic material types (or classes of aggregate resources) are shown as solid lines. Where the depicted data were extrapolated beyond the limits of the source data, or where accuracy of the data may be questionable, the contacts are dashed. Locally,

small deposits of one class of material are found in close association with a larger deposit of a different class material. Due to scale limitations, these smaller deposits could not be shown on the aggregate resource maps and have been combined with the more prevalent material.

Several areas of restricted access exist within the study area boundaries and have been identified on the aggregate resource maps and in Sections 2.2, 3.2, and 4.2. Interpolation of data was made into these areas from the literature and from inferences arrived at by studying similar nearby deposits. National and state parks, monuments, recreation areas, and designated wildlife refuges were excluded from the study. No attempt was made to interpolate data into them.

1.4 PRELIMINARY AGGREGATE RANKING SYSTEM

After completing field activities and compiling all data, a system to preliminarily rank potentail concrete aggregate sources was developed in order to describe the relative merits of these potential sources. Consistent with available information, the ranking system divides potential aggregate sources into three classes: Class A, Class B, and Class C. This ranking system and the specifications for each class of material are presented in Table 1. The specifications for each class of material are based on: 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) a review of the literature applicable to concrete aggregates, 4) contacts with industrial

TABLE 1

PRELIMINARY AGGREGATE RANKING SYSTEM

AGGREGATE CHARACTERISTIC (1)	CLASS A	CLASS B	CLASS C
Abrasion Resistance (L.A. Abrasion Test) (2)	50% loss or less	50% loss or less	greater than 50% loss
Soundness (MgSO 4 Soundness Test) (3)	15% loss or less	15% loss or less	loss greater than 15%
Percent minus #200 sieve (4)	less than 5-10%	5-40%	more than 30-40%
Sum of clay lumps and soft, friable and lightweight particles (5)	less than 5%	5-40%	more than 30-40%
Sum of highly vesicular or porous material	less than 5%	5-25%	more than 20-25%
Sum of flat, platy or elongate particles	less than 5%	5-20%	more than 15-20%
Injurious organic material	none	0-10%	more than 10%
Other deleterious material or coatings (soluble sulfates, chlorides, alkali reactive aggregate, mica, caliche, coal, lignite, etc.) (6)	insignificant amount		prohibitive amount
Sum of minus #200 material, clay lumps soft or friable particles, organic material, or other unusable deleterious constituents where two or more are present in excessive amounts.	less than 5%	5-30%	more than 20-30%

1) Aggregate characteristic usually an estimated quantity; however, characteristic based on results of standard test noted, or equivalent, where available.
(2) ASTM C131 (500 revolutions)
(3) ASTM C 88 (5 cycles)
(4) ASTM C117
(5) ASTM C142, C123
(6) ASTM C227, C295, C586, etc.
(7) This class may be divided into subunits B_1(one or two poor characteristics) or B_2(more than two poor characteristics)

producers of concrete aggregate, 5) contacts with consultants in the field of concrete aggregates, and 6) sound engineering and geologic judgment.

Since the majority of deposits being evaluated either lack test data completely or were previously tested for their suitability for some other purpose, this preliminary ranking system relies heavily on qualitative evaluations based upon field observations. Field estimates of durability, soundness, gradation, percentage of material types present, and caliche development (Appendix D) were used extensively.

The general characteristics of Class A, Class B, and Class C aggregate sources follow.

Class A

Potential sources of high-quality concrete aggregate not requiring the use of special cements or admixtures. Only nominal processing should be necessary to meet known requirements for concrete aggregate. However, additional testing and case history studies will be needed to confirm adequacy and define exact characteristics.

Class B

Potential source of possible concrete aggregate exhibiting one or more undesirable characteristics which make it of poorer quality than Class A aggregate. Detailed investigations will be required to accurately determine aggregate suitability and probable concrete characteristics. Where possible, this class of

material was divided into subunits B_1 and B_2. Materials classified as B_1 are considered to be generally adequate for concrete aggregate having only one or two characteristics which cause them to be ranked as Class B material. Those materials ranked as B_2 are considered to be probably suitable but have several characteristics which may make them marginal for use as concrete aggregate. Where these distinctions could not be made with present information, the material is classified as Class B.

Class C

Material considered unsuitable for use as concrete aggregate.

1.5 CONCLUSIONS AND RECOMMENDATIONS

1.5.1 Conclusions

1. Sufficient volumes of material to satisfy the aggregate requirements of the MX system appear to be available from a variety of both basin-fill (borrow pit) and/or hard-rock (quarry) sources within each of the three areas considered by the AREI study (Figure 1). The materials suitable for use as concrete aggregate in the NM-TSA and the N-CSA are generally of a higher quality and are available in greater quantities than those in ACSA. This is due to the widespread occurrence in ACSA of highly weathered volcanic, granitic, and metamorphic rocks and a general lack of durable quartzite and carbonate units.

2. Depending upon the locations selected for the deployment areas, more than one source or type of source may be required to provide the volumes of both sand and gravel required by the MX system.

3. Utilization of aggregate in the quantities required by the MX system during construction would increase by several times the present level of aggregate production in each of the three AREI study areas and would require the development of deposits not presently being considered as materials sources by local producers of concrete aggregate.

4. Processing to improve the aggregate will be required in most instances. The nature and extent of processing necessary will depend on the individual characteristics of the source

selected to supply the material. At a minimum, it is expected that washing of the aggregate would be required.

5. Adequate supplies of surface water for washing aggregate are only locally available within the three AREI study areas. It is expected that the water necessary for aggregate plant operation will come, for the most part, from ground-water sources.

   a. Fresh ground-water supplies in the NM-TSA are generally confined to be the wedge-shaped, coarse-grained permeable zones in poorly consolidated basin-fill deposits along the flanks of mountain ranges. Beneath and extending basinward from the fresh-water supplies are extensive supplies of saline water. Depth to ground water in alluvium ranges from 0 to 342 feet in the Tularosa Basin and from 18 to 342 in Jornada del Muerto Basin.

   b. Fresh ground-water supplies within the A-CSA are found in both basin-fill and rock aquifers. Depth to ground water ranges from 50 to 100 feet below ground surface adjacent to major drainages in the study areas to as much as 1000 feet in some central basins.

   c. Fresh ground-water supplies within the N-CSA are stored in basin-fill and rock aquifers. Depths to water are highly variable but generally will be the shallowest in the central portions of valleys and will deepen toward the mountains. Ground water in rock aquifers is stored in both volcanic and sedimentary rocks. Artesian conditions exist locally.

1.5.2 Recommendations

1. Prior to final selection of deployment areas, a detailed study of aggregate sources to be utilized during construction should be made. Such a study would provide information on the relative economic aspects of the various sources and provide additional information on the physical characteristics of the deposits which could t en be used to develop plant designs, mining methods, and concrete mix designs. The nature and extent of such a study would depend upon the locations selected for deployment areas, anticipated construction methods, and any additional specifications established for the concrete.

2. Highly angular aggregate such as that produced by a quarrying operation requires more sand, cement, and water to achieve efficient concrete workability than does an aggregate with a majority of round or semiround particles. The percentage of crushed rock allowed in a mix design has a definite impact on the final cost of the concrete and should be evaluated prior to final selection of aggregate sources.

3. Prior to the beginning of construction, the materials to be encountered during trench excavation should be investigated to determine their suitability for use as a source of concrete aggregate.

2.0 NEW MEXICO-TEXAS STUDY AREA

2.1 SUMMARY OF AGGREGATE RESOURCES

This section presents a brief summary of the potential sources of concrete aggregate found in the NM-TSA. They have been grouped under their general type of deposit (basin fill or hardrock) and are listed in decreasing order of suitability.

It should be noted that the composite alluvial units listed were primarily established to accommodate map-scale limitations and frequently contain deposits which can supply significant quantities of high-quality material.

2.1.1 Basin-Fill Deposits

1. Stream-Channel Deposits

   - generally coarse grained, clean, suitably shaped, non-cemented, free of deleterious coatings;
   - best quality materials found along streams which drain quartzite or carbonate terrain; and
   - due to relatively small size may require more than one deposit to supply required volumes of material.

2. Santa Fe Formation

   - composite alluvial unit comprised of flood-plain, stream-channel, river-terrace, alluvial-fan, and pediment deposits located along the Rio Grande River and its tributaries;
   - most heavily utilized source of aggregate in the NM-TSA;
   - deposits are of various ages and origin and therefore exhibit a wide variation in quality of materials;
   - stream-channel deposits, younger river terraces, and younger alluvial fans represent the best potential sources of material; and
   - high percentage of alkali reactive material.

3. Alluvial Fans

   - widespread throughout the NM-TSA;
   - contain large quantities of material;

- best quality material found in deposit with quartzite or carbonate rock in their source area;
- older portions of alluvial fans frequently exhibit strong caliche cementation and clay development; and
- materials grade from coarse-grained near mountain fronts to finer-grained near valley centers.

4. Alluvial Deposits Undifferentiated

- composite alluvial unit comprised of alluvial fans, pediments, river terraces, and stream-channel deposits;
- shown in areas where contacts between deposits are gradational or too complex to show at map scale;
- best material sources are stream-channel deposits and younger alluvial fans;
- deposits are of different ages and origin and exhibit a wide variation in quality of material;
- best quality materials are found in deposits with quartzite or carbonate rocks in their source area; and
- older alluvial fan and pediment deposits frequently exhibit strong caliche cementation and clay development.

2.1.2 Rock Units

1. Quartzite

- hard, durable, clean, nonreactive; and
- limited area of exposure - South Manzano Mountain.

2. San Andres Formation, Madera Limestone, Hueco Formation

- widespread within study area;
- thick to massively bedded, hard, durable limestones and dolomites with localized horizons of sandstone, shale, and evaporite;
- contain chert and dolomite which may be alkali reactive; and
- rock unit selected depends on location of deployment areas.

3. Carbonate Rocks Undifferentiated

- widespread within study area;
- thick to massive-bedded limestones and dolomites interbedded with locally extensive sandstone and shale horizon; and
- contain chert and dolomite which may be alkali reactive.

4. Yeso Formation

   - basically a sandstone and shale unit with as much as 50 percent limestone interbeds in the southern portion of the study area;
   - limestone generally thin- to medium-bedded, argillaceous; and
   - contains chert and dolomite which may be alkali reactive.

5. Basalt

   - limited testing indicates that these materials are adequately durable and sound;
   - localized occurrences;
   - includes flows, flow remnants, dikes, and plugs;
   - generally vesicular, locally scoriaceous; and
   - interstitial volcanic glass common, potentially alkali reactive.

6. Granitic Rocks

   - nonreactive;
   - degree and depth of weathering highly variable; and
   - majority of material observed at surface not considered suitable for use as a source of crushed rock.

7. Volcanic Rock Undifferentiated

   - intermediate to acidic rocks occurring as flows, dikes, plugs, airfall tuffs, ash flows, and agglomerates;
   - not generally considered suitable for aggregate due to low durability and excess of low density, soft particles; and
   - locally, materials with adequate durability do occur, indicated on the aggregate resource map where recognized.

2.2 LOCATION AND DESCRIPTION

The NM-TSA is located in south-central New Mexico and extreme western Texas (Figure 2). It includes portions of Otero, Lincoln, Dona Ana, Sierra, Socorro, Torrance, Chaves, and Valencia counties, New Mexico, and El Paso and Hudspeth counties, Texas. The study area is roughly rectangular in shape and comprises approximately 16,600 square nautical miles (nm^2). Of this total, 2706 nm^2 are included in WSMR, 1325 nm^2 in FBMR, 1062 nm^2 in WSMRE, and the remaining approximately 11,500 nm^2

within the 30 miles boundary extension. Extending northerly from El Paso, Texas, the NM-TSA has maximum north-south and east-west dimensions of approximately 197 nm and 122 nm, respectively. Areas of restricted access into which data have been interpolated for this study include the FBMR and portions of the Mescalero Apache Indian Reservation. Areas of restricted access into which data have not been interpolated include White Sands National Monument, San Andres National Wildlife Refuge, Bosque Del Apache National Wildlife Refuge, and Jornada Experimental Range.

The NM-TSA lies within the Mexican Highland section of the Basin and Range Physiographic Province. Physiography is controlled by, and strongly reflects, the underlying geologic structures. This area is characterized by the eroded remnants of uplifted fault-block mountains separated by down-dropped basins. Typically, closed-basin conditions predominate with primary and secondary drainages terminating at playas in the central portions of the basins. Valleys within the NM-TSA include the Rio Grande River Valley, Jornada del Muerto, and Tularosa Basin in New Mexico and the Hueco Bolson area of Texas. Major mountain ranges in the study area include the San Andres, Oscura, Manzano, Sandia, Magdalena, Cabballo, and Sierra de las Uvas ranges in New Mexico; the Franklin Mountains and Sacramento Front of New Mexico and Texas, and the Hueco Mountains in Texas.

2.3 PRESENT PRODUCTION OF CONCRETE AGGREGATE

Current production of sand and gravel within the NM-TSA serves the needs of the local construction industry and state and

county highway department. The estimated yearly production by commercial suppliers of screened sand and gravel within the NM-TSA is less than 1.5 million cubic yards (yd^3) per year. The percentage of this total used as concrete aggregate is unknown. The principal-use centers are located at Socorro, Las Cruces, and Alamagordo, New Mexico, and El Paso, Texas.

Basin-fill deposits presently supply the bulk of all sand and gravel utilized within the NM-TSA. Quarried rock is being employed as a source of concrete aggregate only where suitable basin-fill deposits are absent, where basin-fill deposits are of such low quality that quarried rock becomes economically competitive, or to satisfy a particular construction specification. The following table (Table 2) presents representative costs of screened sand and gravel and transportation costs from various localities within the NM-TSA.

Table 2

REPRESENTATIVE COSTS OF AGGREGATE IN THE NMTSA

Location	Screened Gravel*	Concrete Sand	Transport
Socorro, N.M.	$5.00/yd.	$4.00/yd.	$.09/yard mile
Las Cruces, N.M.	4.65/yd.	4.00/yd.	.12/yard mile
Almagordo, N.M.	4.50/yd. (3/4")	4.00/yd.	By Contract
El Paso, Texas	4.50/ton (quarry)	3.10/ton	.06/ton mile

*Note 1" rock unless otherwise specified

2.4 POTENTIAL SOURCES OF CONCRETE AGGREGATE

The literature search and field reconnaissance of the NM-TSA have determined that numerous potential sources of concrete aggregate are located within this study area. Sufficient volumes of acceptable materials appear to be available from either basin-fill or hard-rock sources to satisfy the requirements of the MX system.

2.4.1 Basin-Fill Deposits

The principal basin-fill sources of potentially acceptable concrete aggregate within the NM-TSA includes stream-channel deposits, the basin-fill deposits comprising the Santa Fe Formation, undifferentiated alluvial deposits, and alluvial fans.

Central basin deposits in Jornada del Muerto, the Tularosa Basin-Hueco Bolson area, and other localities in the NM-TSA (Drawing 1) were ranked as Class C material due to the fine-grained nature of the soils, the abundance of soluble sulfates (gypsum) present, and the strong caliche development in these materials. Stream-channel deposits in these areas may produce limited quantities of fine- to medium-grained sand suitable for use as filler material.

2.4.1.1 Stream-Channel Deposits - Aa1

Stream-channel deposits are frequently utilized as a source of sand and gravel by commercial producers of concrete aggregate in the NM-TSA. The deposits vary from heterogeneous mixtures of sand, gravel, cobbles, and boulders near mountain fronts to fine-grained sands, silts, and clays near valley centers and

along major drainages such as the Rio Grande and Rio Puerco rivers (Drawing 1). The quality of the material found in stream-channel deposits reflects the properties of the rock types located in the stream's source area and along its course; the deposits have been ranked accordingly. Near mountain fronts, where stream gradients are high, stream-channel deposits are generally coarse-grained, noncemented, free of deleterious coatings, suitably shaped, contain a low percentage of silt and clay fines, and are relatively durable; the soft and friable materials having been removed by the natural abrasive action of stream transport (Appendix F). Further from the mountain fronts, suitable sources of sand may be located. Material deposited by streams near valley centers or on the flood plains of major drainages are generally too fine-grained to make acceptable aggregate. Many stream-channel deposits are self-renewing with a fresh supply of sand and gravel being carried downstream during periodic cloudbursts.

While these deposits contain sufficient quantities of material to meet the current needs of local users, the great majority of deposits are inadequate to supply the quantities of material required by the MX system. However, several such deposits located around a deployment area could supply the necessary volume of aggregate. Due to their relatively small size, most stream-channel deposits have been included within one of the larger composite map units categories shown on the aggregate resource map.

2.4.1.2 Sante Fe Formation - Asf

The alluvial deposits comprising the Santa Fe Formation are the most heavily utilized sources of sand and gravel in the NM-TSA. These units are found along the Rio Grande River and its tributaries and are therefore adjacent to several of the major use centers in the study area (Drawing 1). Commercial aggregate producers have located a number of borrow pits within this formation and, state and county road departments use it extensively as a source of aggregate base course and select material for road construction. Most commercial production of aggregate from the Santa Fe Formation comes from stream-channel deposits, younger river-terrace deposits, and alluvial fans consisting of reworked older Santa Fe materials. These deposits are usually coarse-grained, unconsolidated, contain a low percentage of silt and clay fines and lack the strong caliche cementation and coatings which are typical of the older deposits of the formation.

Included within the Santa Fe Formation are flood-plain, stream-channel, river-terrace, alluvial fan and pediment deposits which have been divided into two distinct members; an upper coarse-grained pediment, terrace, and alluvial fan sequence, and a lower finer-grained terrace and flood-plain deposit. The deposits comprising these two members are of different ages and have many different source areas; consequently, they exhibit a wide variation in degree of induration and quality of material. Where the Rio Grande River is a considerable distance from the mountain fronts, the materials within the Santa Fe Formation

consist of hard, durable, semiround to round particles of the more resistant rock types found upstream. A high percentage of potentially alkali reactive volcanic particles are found within these deposits. Where the river is closer to the mountain fronts, the materials reflect the rock types in the closest source area. Among these deposits, the most durable materials are found where carbonate rocks predominate in the source area. The degree of caliche development found in the Santa Fe Formation ranges from none to Stage IV (Appendix D) and usually increases with the age of the deposit and the proximity to a carbonate source area. Deposits bordering mountain ranges containing carbonate rocks commonly exhibit Stage III or Stage IV caliche development at relatively shallow depths below the ground surface.

Due to the widespread occurrence of potentially alkali reactive material and the variable nature of caliche development within individual deposits, the Santa Fe Formation has been ranked as Class B material.

2.4.1.3 Alluvial Fans - Aaf

Alluvial fans flanking mountain fronts are widespread throughout the NM-TSA, (Appendix F) and contain some of the best and most extensive reserves of sand and gravel in the study area. Numerous borrow pits have been located in these deposits to supply the needs of the local construction industry and to provide material for road maintenance.

Alluvial fan deposits are generally poorly sorted, heterogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt and clay. They exhibit steep to moderate slopes, become finer grained with decreased stream gradient, and are dissected by numerous braided streams and arroyos (Appendix F).

The quality of the material in this deposits depends on their parent rock, distance from their source areas, and their relative age. The older portions of fans commonly contain more decomposed clasts and have a high percentage of clay minerals produced by inplace weathering of the deposit. The best source areas within active alluvial fan deposits are near mountain fronts where stream gradients are high and coarse-grained clean materials are deposited. These areas also contain the youngest fan materials, so caliche development is at a minimum. Further from the mountain front, deposits of finer-grained material may be located. In the older portions of alluvial fans, and where source rocks are predominantly carbonates, strong caliche cementation was observed with Stage II to Stage IV caliche development occurring from 1 to 10 feet below the fan surface. At these depths, alluvial fan materials are well consolidated, contain excess carbonate as deletereous coatings, and are not considered suitable for use as concrete aggregate. However, the layer of poorly to noncemented material overlying the calichified zone may produce acceptable aggregate. The ranking assigned to the various alluvial fan units within the NM-TSA reflect the quality of surface or subsurface materials contained in the deposit and the extent of caliche development.

2.4.1.4 Alluvial Deposits Undifferentiated - Au

The best potential sources of concrete aggregate within this unit are to be found in stream-channel deposits and in the younger portions of alluvial fans near mountain fronts where materials are coarse grained, have a low percentage of silt and clay fines, and a minimum amount of caliche development. At present, the only significant production of sand and gravel from materials shown as alluvial deposit undifferentiated in the NM-TSA comes from small borrow pits which supply aggregate for road maintenance and construction.

The principal deposits comprising this map unit are pediments and alluvial fans with associated stream-channel deposits and local river terraces. These deposits have been grouped together as undifferentiated in areas where contacts are gradational or too complex to show at map scale. These deposits are of different ages and origin and exhibit a wide variation in quality of material. In general, the most durable materials are found where quartzite or carbonate rocks occur in the source area, or where other materials have been transported sufficiently far to remove the softer particles. Volcanic materials are dominant in deposits west of the Rio Grande River, while limestone and dolomite are the most prevalent east of the river. Pediments and the older portions of alluvial fans frequently exhibit Stage II to Stage IV caliche development at 1 to 10 feet below the ground surface.

The widespread occurrence of potentially alkali reactive material and the variable nature of caliche development found within individual deposits makes this unit Class B material.

2.4.2 Rock Units

The principal hard-rock (quarry) sources of potentially acceptable concrete aggregate within the NM-TSA (Drawing 1) include quartzite, the San Andres Limestone, the Madera Limestone, the Hueco Limestone, carbonate rocks undifferentiated, the Yeso Formation, basalt, granitic rocks, and undifferentiated volcanic rocks. Each of these units are briefly characterized in the following pages.

2.4.2.1 Quartzite - Qtz

The only significant deposits of quartzite found within the NM-TSA are located along the west side of the South Manzano Mountains. Deposits typically occur as long, narrow lenses or "reefs" varying from a few feet to over 1000 feet in width and as much as a mile or more in length. Typically, the quartzites are white to gray with local red, brown, and purple zones and are composed of 90 to 100 percent quartz grains with traces of muscovite, ciotite, and sericite. Where observed during the field reconnaissance, the quartzites are very hard, highly fractured, durable rocks. At present, there is no known significant production of aggregate from this unit; however, it should make an excellent source of nonreactive crushed rock and has been ranked as Class A material.

2.4.2.2 San Andres Formation - Psa

The San Andres Formation is the most widely distributed limestone unit in the NM-TSA. It represents an extensive potential source of high-quality, crushed rock. Los Angeles abrasion and soundness values reported by the New Mexico Highway Department (NMHD) for the San Andres Formation vary considerably, but they are usually well within ASTM and the SSPWC specification limits for concrete aggregate. Due to the low demand for aggregate in the NM-TSA and the isolate nature of most exposures, present production of crushed rock from the San Andres Formation is limited to small quarries providing material for road construction where basin-fill deposits are lacking or are of poor quality.

In the NM-TSA the San Andres Formations varies from a thick-bedded, pure crystalline limestone and dolomite, to thin-bedded, argillaceous, cherty lime with very thin shale partings, to massive bedded gypsum. In the Chupedera Mesa area (Drawing 1), this formation has been divided into a thick, lower limestone sequence, a thick, middle gypsum member, and a thin, upper limestone member. The areas in which gypsum has been recognized, roughly from Tularosa north, have been excluded as unsuitable for concrete aggregate. Care should be taken when selecting a site for crushed rock to avoid zones of contamination with shale, mudstone, chert, and gypsum.

Due to presence of potentially alkali reactive material, the San Andres Formation has been ranked as Class B material.

2.4.2.3 Madera Limestone - Pm

The Madera Limestone member of the Sandia Formation is a dark-gray, thick- to massively bedded, hard, cliff forming unit consisting of fossiliferous limestone, dolomite, and dolomitic limestone with thin interbeds of sandstone, shale, and chert. It is expressed as a prominent topographic feature along the Rio Grande River Valley in the northern portion of the study area (Drawing 1).

Due to the rugged nature of the mountains underlain by this unit, it has seen little use as a source of aggregate; however, if care is taken to avoid zones of shale, sandstone and chert, it should provide a good source of crushed rock. The presence of potentially alkali reactive material makes the Madera Limestone Class B material.

2.4.2.4 Hueco Formation - Ph

The Hueco Formation represents a large potential source of high-quality, crushed rock in the southeastern portion of the study area (Drawing 1). The bulk of present production from this unit occurs from quarries located in the Hueco Mountains. A number of other widely scattered small quarries in this unit provide material for road maintenance and construction.

The Hueco Formation consists of limestone with interbedded conglomerate and shale. The limestone is typically light gray, thinly bedded to massive, cherty and fossiliferous with minor dolomite horizons. In the south-east and central portions of the study area, the limestone member is a prominent unit and is

mapped separately but it thins to the north and west and there it is grouped within the undifferentiated carbonate unit.

Due to the presence of dolomite and opaline chert which may be alkali reactive, this unit has been ranked as Class B material.

2.4.2.5 Carbonate Rock Undifferentiated - Cau

The carbonate rocks undifferentiated unit is widespread throughout the NM-TSA, and represents an extensive potential source of crushed rock. The bulk of present production from this unit occurs in the El Paso, Texas, area where it is used as a source of coarse aggregate. Elsewhere in the NM-TSA production is limited to small quarries, usually established to provide materials for a specific job where basin fill sources were lacking.

The rock units grouped as carbonate rocks undifferentiated include thick sequences of limestones and dolomites interbedded with locally extensive sequences of shale and sandstone (Appendix F). The carbonate rocks are typically light- to dark-gray, thin- to massively bedded, cherty and fossiliferous. These rocks are generally hard, durable, and are the competent units that underlie many of the major topographic features in central New Mexico.

Quarries located to avoid zones of sandstone, shale, and other contaminants should be capable of producing large quantities of acceptable crushed rock. Due to the presence of potentially alkali reactive material and localized horizons of low durability sedimentary rocks, this unit has been ranked as Class B material.

2.4.2.6 Yeso Formation - Py

Present production of crushed rock from this unit is limited to small quarries which provide material for road construction and maintenance. The Yeso Formation consists of interbeds of limestone, sandstone, siltstone, shale, and gypsum. This formation outcrops throughout the study area but has only been shown as a potential aggregate source in the southern section (Drawing 1) where it may be as much as 50 percent limestone. In this area, the carbonate portions of the Yeso Formation consist of light- to dark-gray, thin- to medium-bedded, argillaceous limestone and dolomite with sandstone lenses and chert. Elsewhere within the NM-TSA, the Yeso Formation contains only occasional horizons of gray, thin-bedded, argillaceous limestones. These horizons, where tested by the NMHD, were usually durable enough for concrete aggregate but are of limited extent and may contain other impurities which would make siting a source area difficult.

The widespread occurrence of soft clastic sedimentary units and the presence of potentially alkali reactive materials make the Yeso Formation Class B or B_2 material.

2.4.2.7 Basalt - Vb

Due to the remote location of most exposures, basalt is not being extensively utilized as a source of crushed rock in the NM-TSA. Limited test results show the basalt to be adequately durable and sound with low to moderate material losses in the L.A. abrasion and $MgSO_4$ soundness tests. Basalts are frequently vesicular and may be scoriaceous (greater than 50 percent)

vesicles near the tops of flows. These materials would have to be avoided or removed before the deposit could be effectively quarried. Thin section analyses indicate that the basalt in the NM-TSA frequently contains interstitial glass and, as a result, may be alkali reactive.

Due to the vesiclar nature of most exposures and the presence of potentially alkali reactive material, basalts in the NM-TSA are ranked as Class B or B_2 material.

2.4.2.8 Granitic Rocks - gr

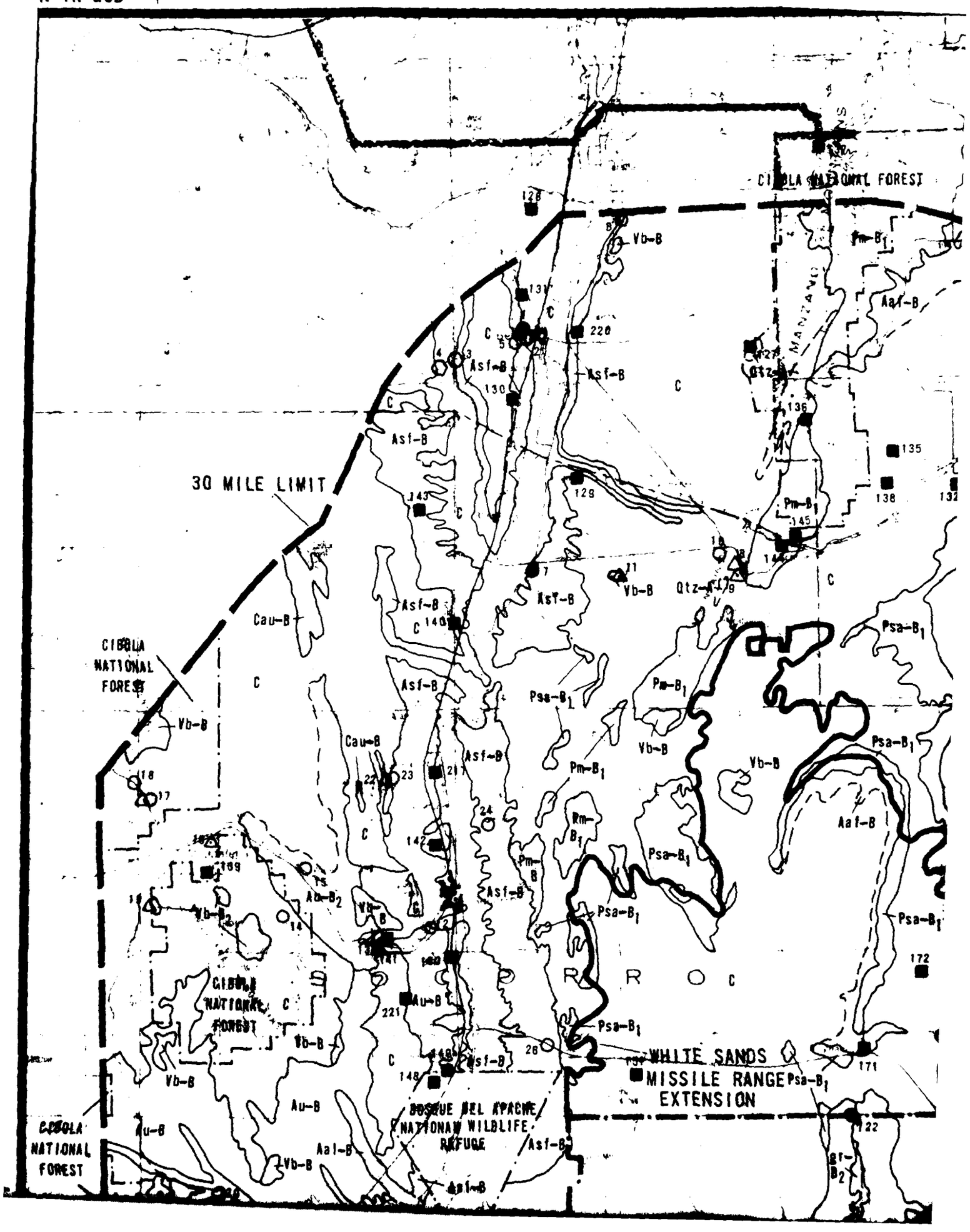
Granitic rocks found within the NM-TSA represent a potential source of nonreactive crushed rock; however, the extent to which they may be utilized as concrete aggregate is strongly dependent on the degree and depth to which they have been weathered. There is presently no known production of crushed rock from granitic sources in the study area.

The granitic rocks include intrusive and metamorphosed intrusive rocks (granite, quartz monzonite, granite gneiss) of several different ages. They are typically light-colored, fine- to coarse grained, silicious to intermediate in composition, and locally exhibit a gneissose or schistose structure near contacts and faults. Where observed in outcrops these rocks are moderately to highly weathered and are not considered to be a suitable source of crushed rock. Exposures seen in natural or manmade cuts at depths to 40 feet are moderately weathered to fresh and may be hard and durable. In general, the younger the rock unit the less weathered and more durable it is.

Due to the high degree of weathering observed at the surface, and the uncertain depths to which the weathering extends below the surface, the granitic rock in the NM-TSA has been ranked as Class B or B_2 material.

2.4.2.9 Volcanic Rocks Undifferentiated - Vu

Extensive exposures of intermediate to acidic extrusive and shallow intrusive rocks occurring as a series of flows, dikes, plugs, airfall tuffs, ash flows, and agglomerates are found within the NM-TSA. As a rule, these materials are not considered to be adequate as a source of crushed rock due to a lack of durability and a high percentage of low density, friable, and porous material. However, materials with adequate durability are present locally and have been indicated (Drawing 1) where identified. Due to the presence of potentially alkali reactive material and possible contamination by soft or friable particles, this unit has been ranked as Class B_2.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30 MILE LIMIT
CIBOLA NATIONAL FOREST
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WHITE SANDS MISSILE RANGE EXTENSION
MANZANO
R R O C
Vb-B
Asf-B
Cau-B
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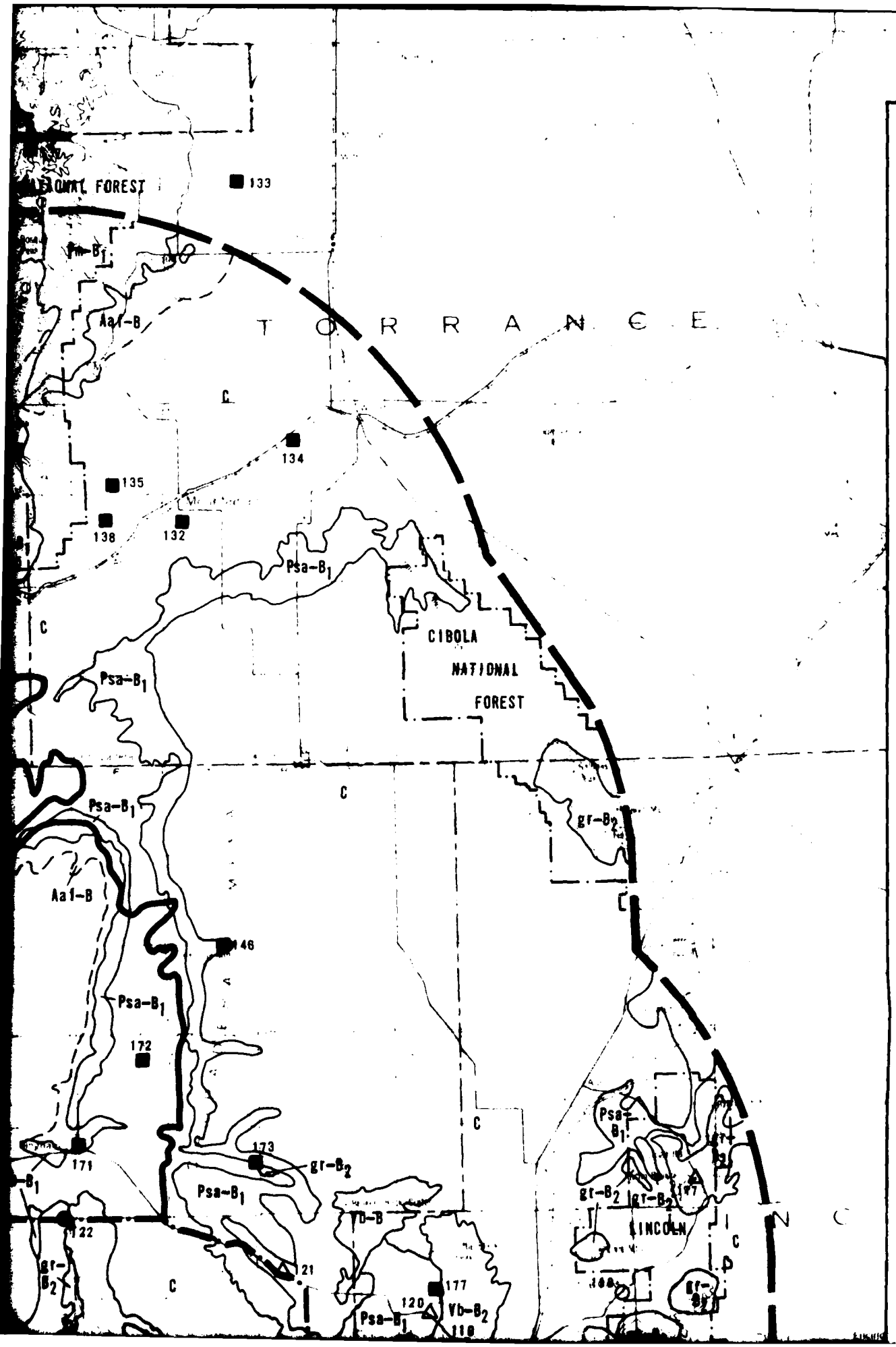

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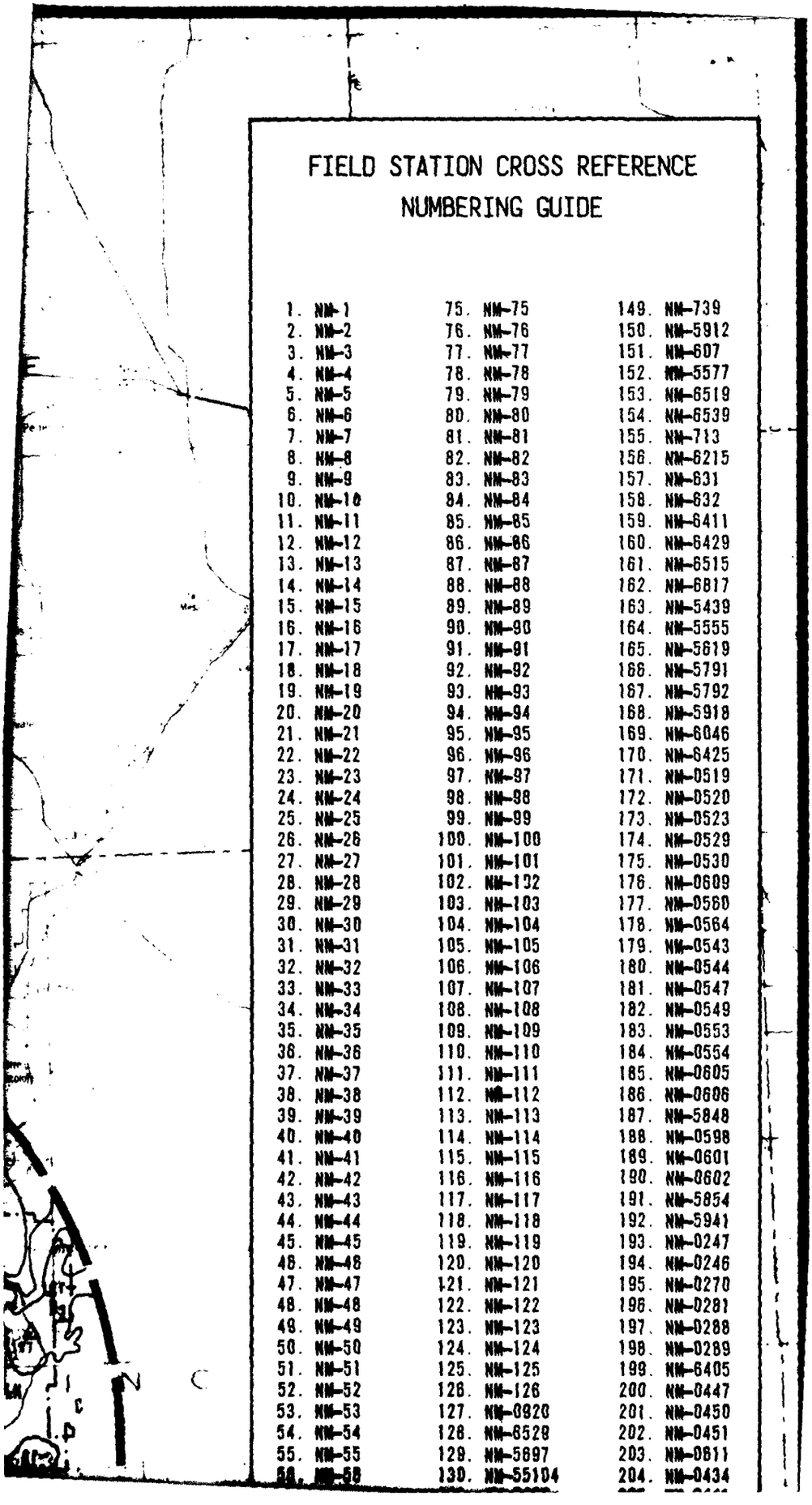

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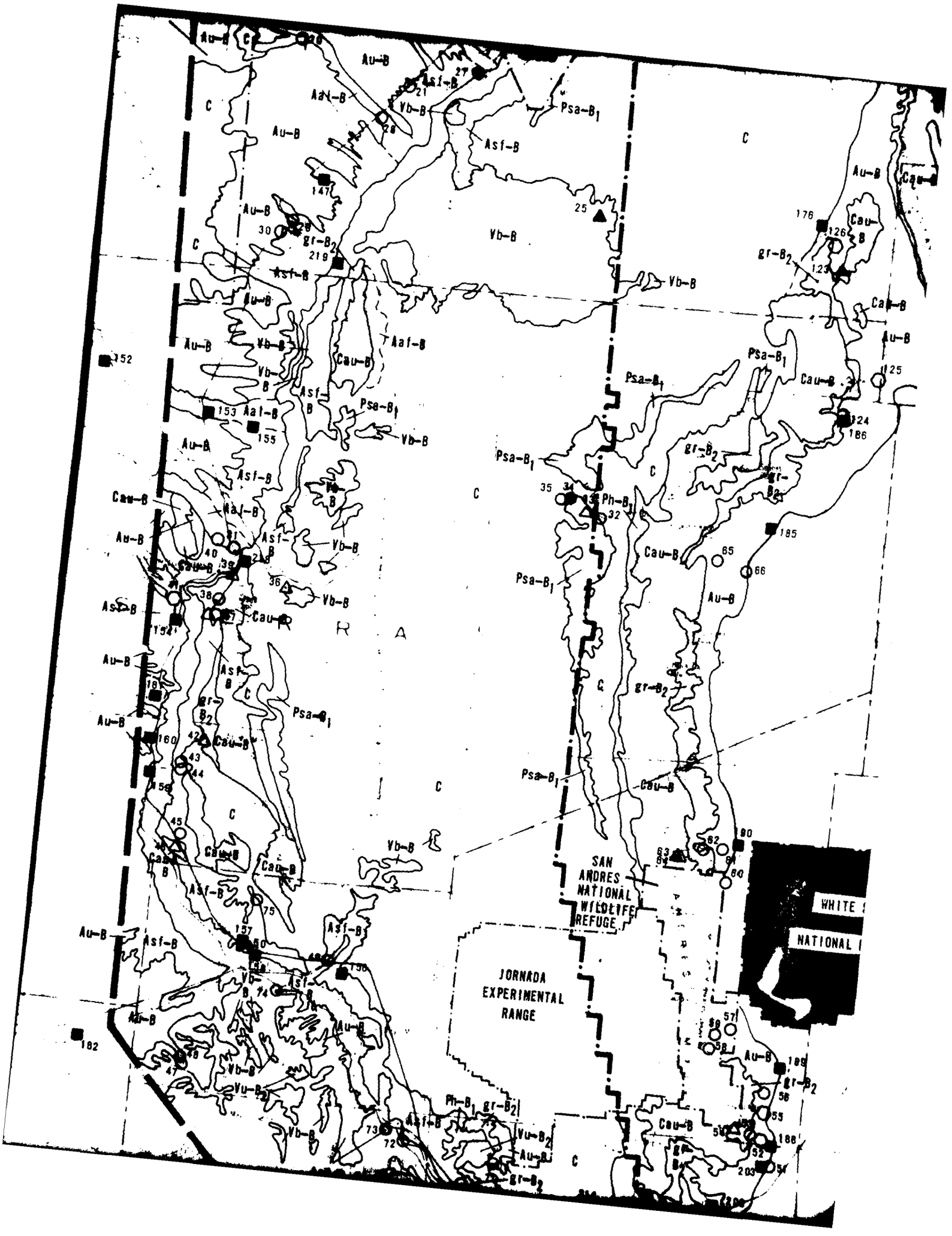
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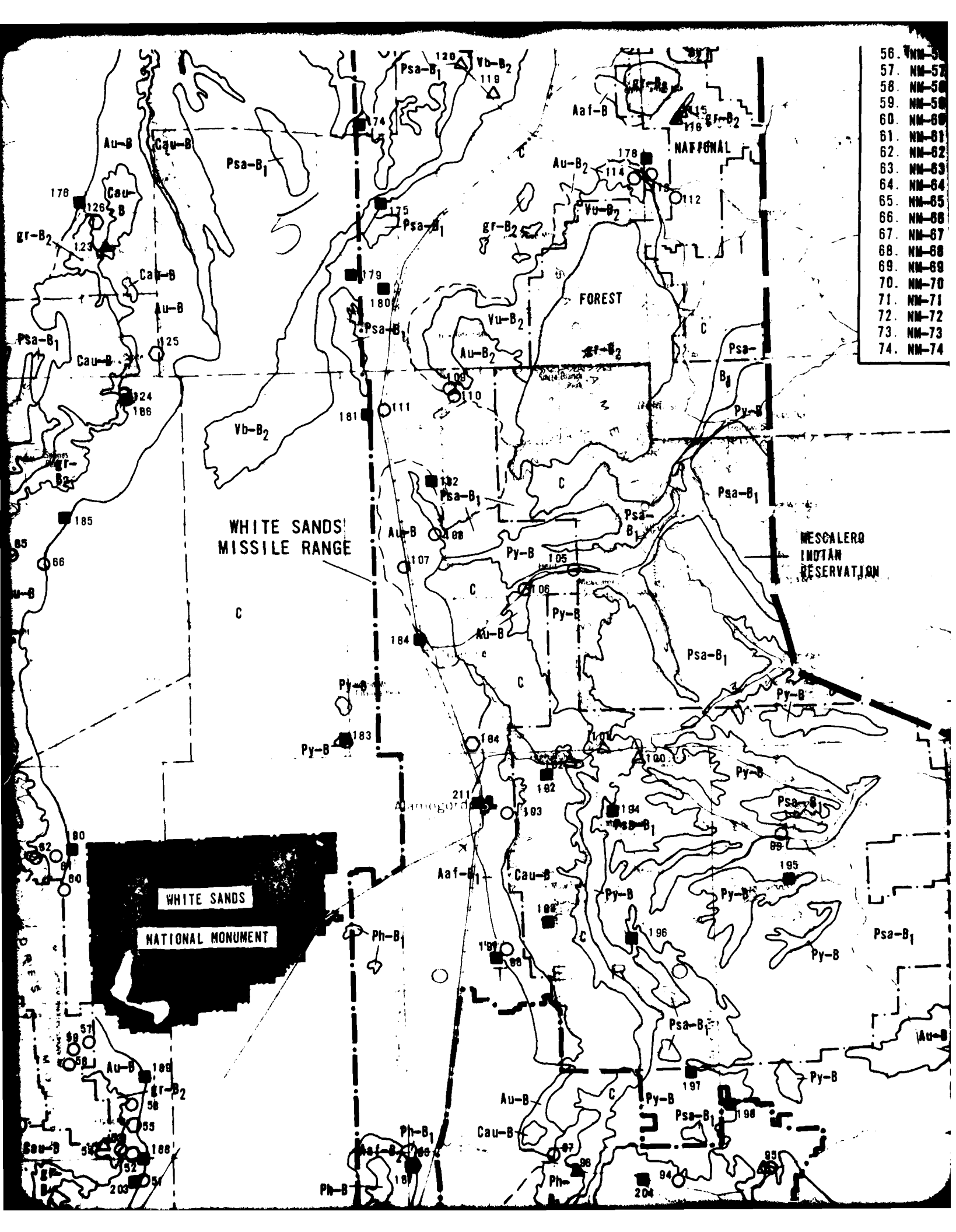
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MISSILE RANGE
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INDIAN
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FOREST
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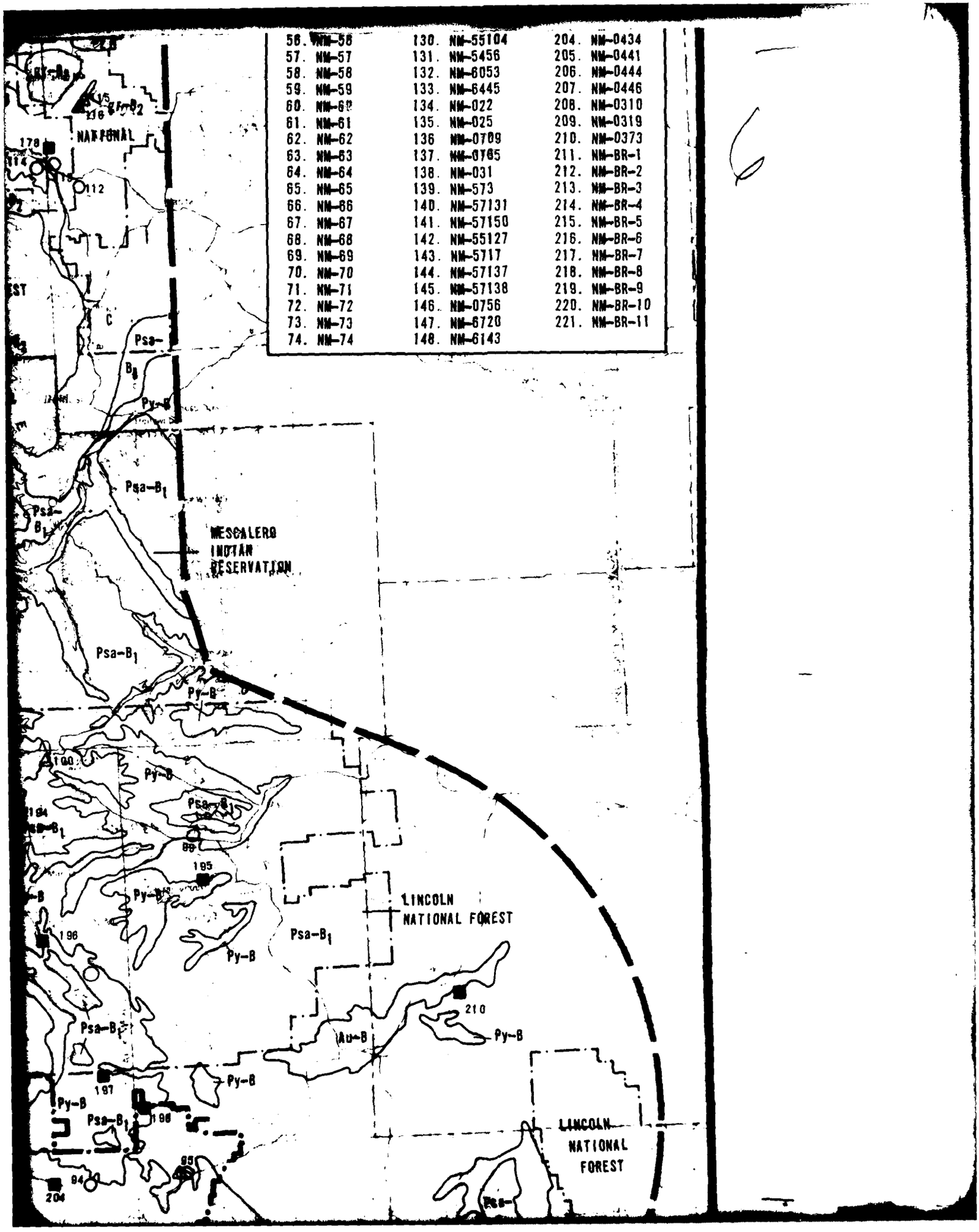
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MESCALERO INDIAN RESERVATION
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LINCOLN NATIONAL FOREST
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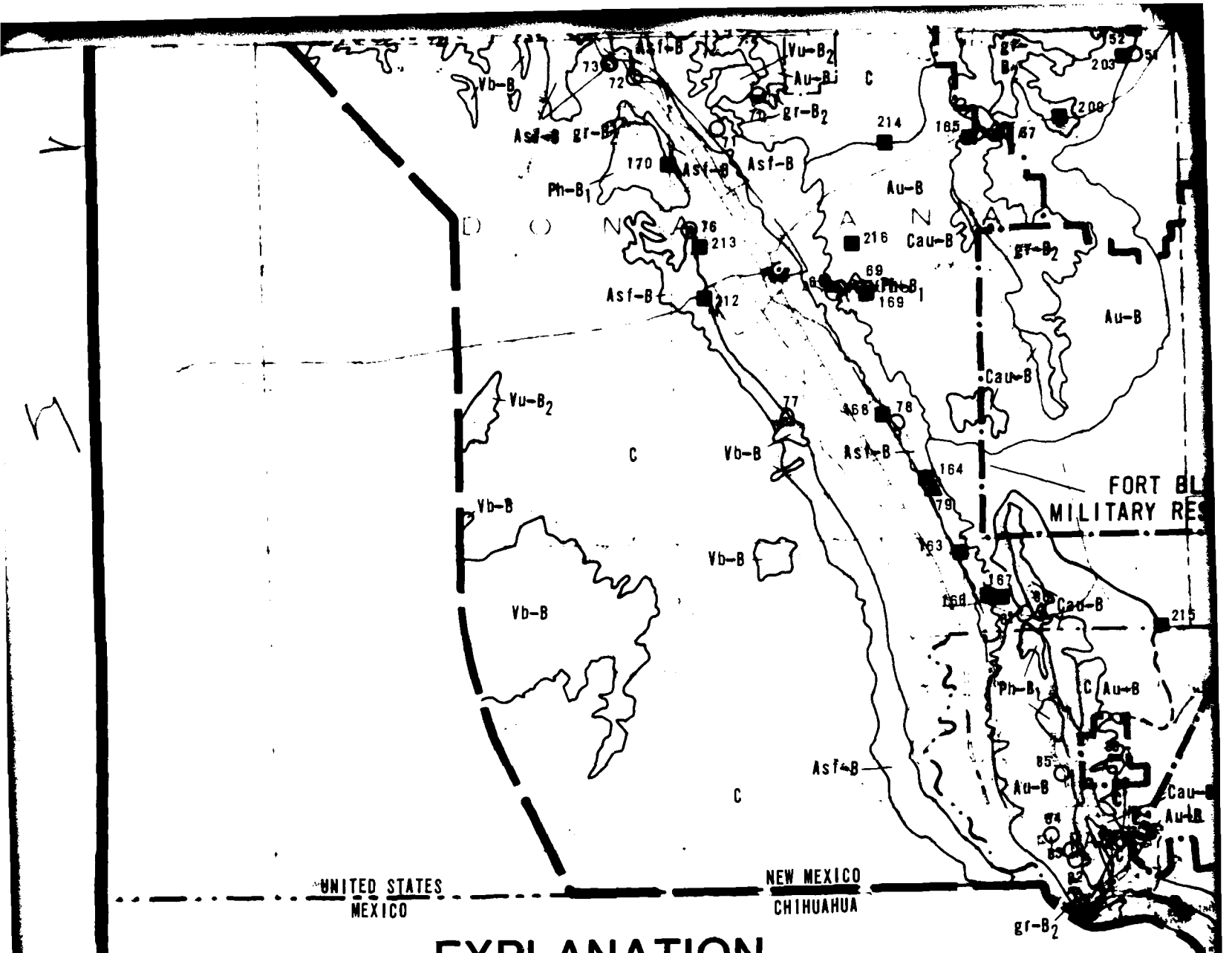


EXPLANATION

SOURCES OF POTENTIAL AGGREGATE

BASIN-FILL DEPOSITS

Aaf	Stream Channel Deposits (A1)*
Asf	Santa Fe Group (A)
Aaf	Alluvial Fan Deposits (A5)
Au	Alluvial Deposits Undifferentiated (A)

ROCK UNITS

Qtz	Quartzite (M)
Psa	San Andres Formation (S2)
Pm	Madera Limestone (S2)

SYMBOLS

FUGRO NATIONAL FIELD STATIONS

Basin-Fill Deposit

- ○ Data point, not sampled
- ◒ Sampled and not tested
- ● Sampled and tested

Rock Units

- △ Data point, not sampled
- ◬ Sampled and thin-sectioned
- ▲ Sampled and tested

Photo Stop

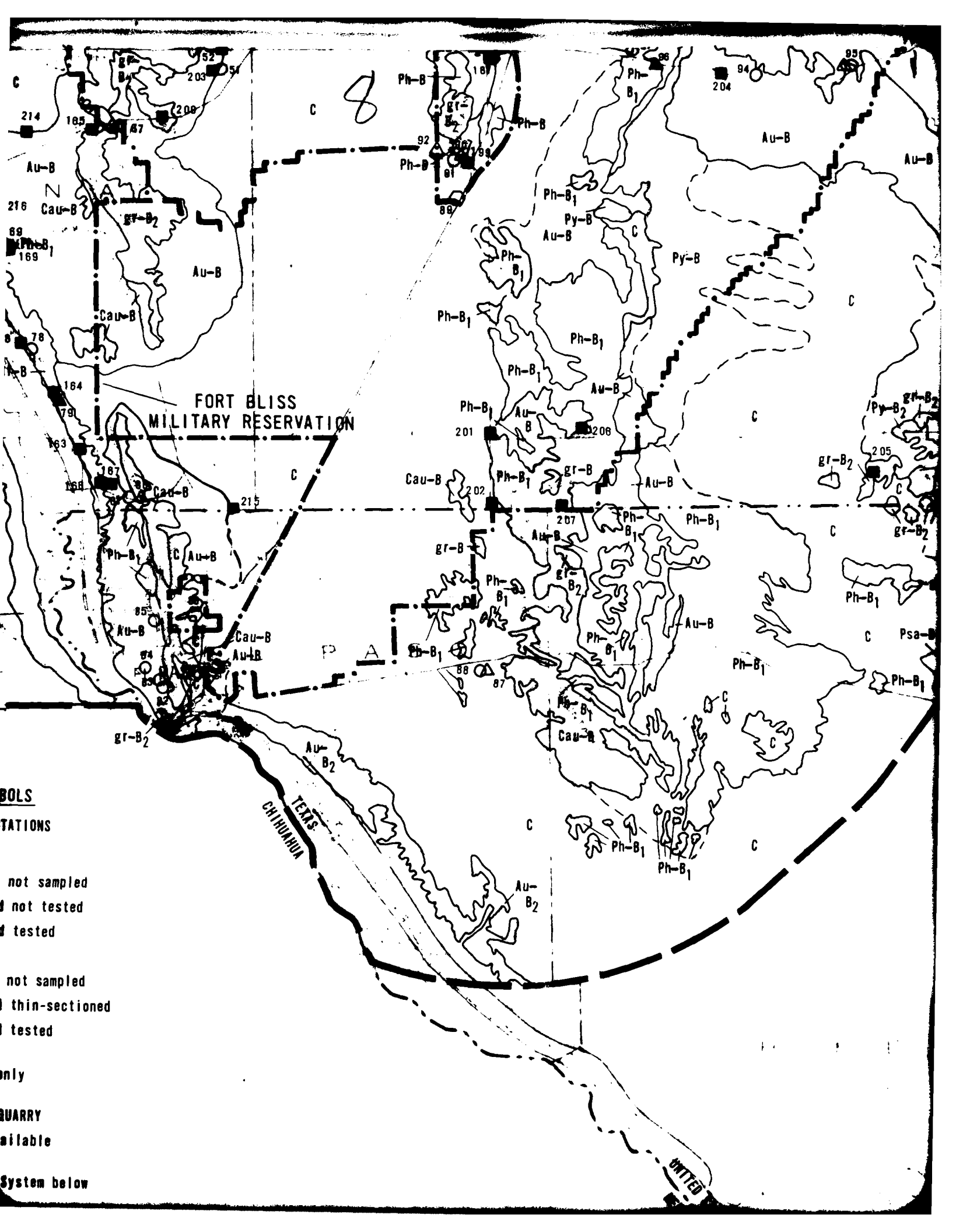
- ⬡ Photograph only

EXISTING BORROW PIT OR QUARRY

- ■ Test data available

MATERIAL TYPE - RANKING

Form B - See Ranking System Above



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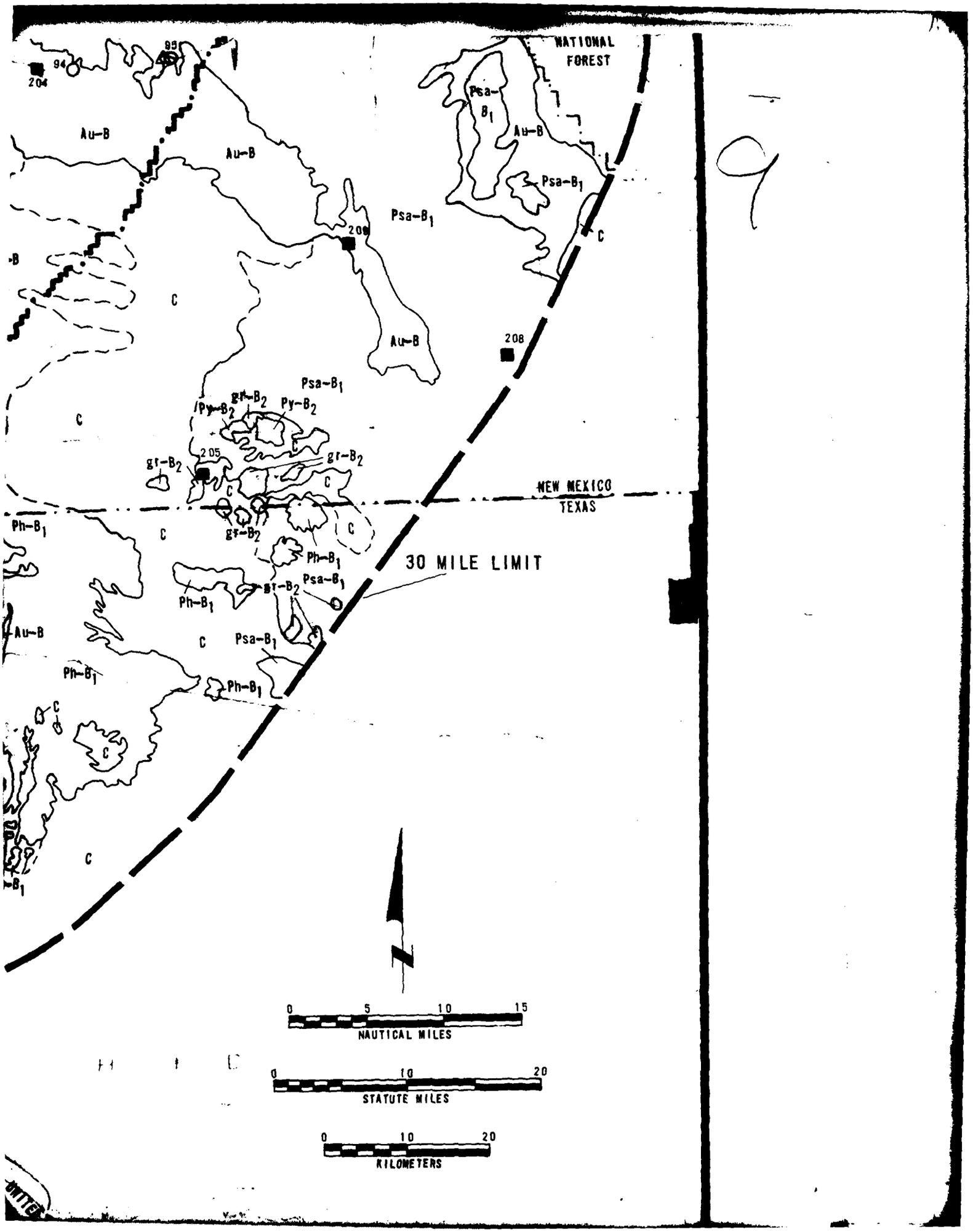
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NAUTICAL MILES
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STATUTE MILES
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KILOMETERS

Pm	Madera Limestone (S2)
Ph	Hueco Formation (S2)
Cau	Carbonate Rocks Undifferentiated (S2)
Py	Yeso Formation (S2)
Vb	Basalt (I2 and/or I3)
gr	Granitic Rocks (I2)
Vu	Volcanic Rock Undifferentiated (I)

*Reference Appendix G for symbol explanation and comparison.

MATERIAL TYPE - RANKING

Cau-B See Ranking System below

GEOLOGIC CONTACT

Dashed where approximate

RANKING SYSTEM

A CLASS A: Potential sources of high quality aggregat nominal processing necessary to meet know and case history studies needed to confir

B CLASS B: Potential sources of concrete aggregate ex of poorer quality than Class A aggregate. aggregate suitability and probable concret divided into subunits B_1 and B_2. Materials concrete aggregate. B_2 material is consid which may make it marginal for use as a co

C CLASS C: Material considered undesireable for use a

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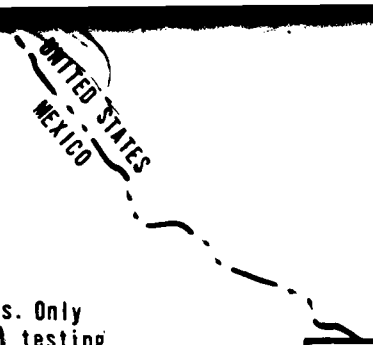

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NEW MEXICO-TEXAS AGGREGATE RESOURCE MAP

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

DRAWING
1

FUGRO NATIONAL, INC.

3.0 ARIZONA-CALIFORNIA STUDY AREA

3.1 SUMMARY OF AGGREGATE RESOURCES

This section presents a brief summary of the potential sources of concrete aggregate found in the A-CSA. They have been grouped under their general type of deposit (basin fill or hard rock) and are listed in order of decreasing suitability.

It should be noted that the composite alluvial units were primarily established to accommodate map-scale limitations and frequently contain deposits which can supply significant quantities of high-quality material.

3.1.1 Basin-Fill Deposits

1. Stream-Channel Deposits

   - generally coarse grained, clean, suitably shaped, non-cemented, and free of deleterious coatings;
   - through-going drainages and widespread volcanics in the A-CSA result in potentially alkali reactive material occurring in most large drainage; and
   - due to relatively small size, may require more than one deposit to supply the required volume of material.

2. River Terrace Deposits

   - located along major drainages in the A-CSA;
   - comprised of rounded clasts or the more durable rock types located upstream;
   - generally capped by a caliche horizon of variable thickness;
   - contain potentially alkali reactive materials; and
   - additional deposits of unknown extent may be covered by blow-sand along the Gila River.

3. Alluvial Fans

   - best material sources are near mountain fronts where materials are coarse-grained and non- to poorly cemented;
   - materials grade from coarse-grained near mount

- fans located along mountain fronts containing granitic or metamorphic rock are frequently poorly developed and contain low durability materials; and
- older alluvial fans commonly exhibit strong caliche cementation and clay development.

4. Alluvial Deposits Undifferentiated

- composite alluvial unit comprised of alluvial fans, pediments, river terraces, and stream-channel deposits;
- shown in areas where contacts between deposits are gradational or too complex to show at map scale;
- deposits are of different ages and origin and exhibit a wide variation in quality of material;
- older alluvial fans and pediment deposits frequently exhibit strong caliche cementation; and
- best material sources are stream-channel deposits and younger stream terraces or alluvial fans.

3.1.2. Rock Units

1. Basalt

- limited testing indicates rock may be sufficiently durable and sound;
- includes flows, flow remnants, dikes, and plugs;
- generally vesicular, locally scoriaceous and may have low specific gravity and/or be porous;
- volcanic glass and zeolites common, potentially alkali reaction; and
- may contain caliche coatings along joints which may be extensive.

2. Granitic Rock, Gneiss, and Associated Metamorphic Rocks

- nonreactive;
- degree and depth of weathering highly variable;
- most material exposed at surface is not considered to be a suitable source of crushed rock; and
- locally, gneiss exhibits well-developed, closely spaced foliation.

3. Sedimentary Rocks Undifferentiated

- isolated exposures of limited extent;
- predominantly highly fractured limestone;
- contains potentially alkali reactive material; and
- locally metamorphosed.

3.2 LOCATION AND DESCRIPTION

The A-CSA is located in southwestern Arizona and southeastern California (Figure 3). It includes portions of Yuma, Mohave, Pima, Pinal, Yavapai, and Maricopa counties, Arizona, and Imperial, Riverside, and San Bernardino counties, California. The study area is roughly square in shape and comprises approximately 20,100 nm^2. Of this total, 1900 nm^2 are included in the YPG, 3230 nm^2 in LBGR, 2900 nm^2 in GBG, and the remaining approximately 12,070 nm^2 within the 30-mile extension. Extending northerly from the United States-Mexican international boundary, the A-SCA has maximum north-south and east-west dimensions of approximately 168 nm and 169 nm, respectively. Areas of restricted access into which data have been interpolated for this study include YPG, San Cristobal Valley within LBGR, and the Papago, Maricopa, Gila River, Gila Bend, Colorado, and Yuma Indian Reservations. Areas of restricted access into which data have not been interpolated include the Kofa Game Range, Cibola National Wildlife Refuge, Imperial National Wildlife Refuge, Cabeza Prieta Game Range, Organ Pipe Cactus National Monument, Havasu National Wildlife Refuge, Lake Havasu State Park, White Tank Mountains, and Buckeye Cooperative Regional Parks.

The A-CSA lies mainly within the Sonoran Desert section of the Basin and Range Physiographic Province. The northernmost portion of the study area intrudes into the Mexican Highland section of the Basin and Range Physiographic Province, and a small portion in the vicinity of Yuma lies within the Salton Trough section. The physiography is controlled by, and strongly

reflects, the underlying geologic structure. The study area is characterized by the eroded remnants of uplifted fault-block maountains separated by down-dropped basins. The mountain ranges are rugged and exhibit predominantly north to northwest trends. However, the northernmost ranges of the study area align east to west and northeast. The valleys are generally broad and elongate with gently sloping surfaces grading toward the basin interiors. Major drainages within the A-CSA include the Colorado, Gila, Bill Williams, and Santa Maria Rivers.

3.3 PRESENT PRODUCTION OF CONCRETE AGGREGATES

Current production of sand and gravel within the A-CSA serves the needs of the local construction industry and state and county highway departments. The estimated yearly production by commercial suppliers of screened sand and gravel within the A-CSA is less 1.5 million yd^3 per year. The percentage of this total used as concrete aggregate is unknown. There are no large scale producers of sand and gravel within ACSA. The nearest large aggregate producers are located in the Phoenix, Arizona area east of the study area. Principal use centers are located at Yuma, Buckeye, and Gila Bend, Arizona and Blythe, California. During the field reconnaissance of ACSA most sand and gravel operations were observed to be using stream channel deposits, river terrace deposits, or alluvial fan deposits as material sources. Quarries were noted in the Aztec Hills near Dateland, Arizona and at a small isolated bedrock knob southwest of Winterhaven, California; both were inactive. The following table (Table 3) presents representative costs of screened sand

and gravel and transportation costs at various localities within the A-CSA.

TABLE 3

Representative Costs of Aggregate in the A-CSA

Location	Screened Gravel*	Concrete Sand	Transport
Yuma, AZ	$4.40/ton	$4.40/ton	$.08/ton mile
Gila Bend, AZ	5.58/yd.	7.10/yd.	By contract
Buckeye, AZ	4.15/ton	4.80/ton	$.09/ton mile
Blythe, CA	5.10/ton	5.10/ton	$.10/ton miles

* Note 1" rock unless otherwise specified

3.4 POTENTIAL SOURCES OF CONCRETE AGGREGATE

Potential sources of concrete aggregate exist within the A-CSA, however, they are neither as abundant nor of as high a quality as materials observed in the NM-TSA and the N-CSA. Sufficient volumes of acceptable material to supply the requirements of the MX system appear to be available in the study area, however, depending on the location of the deployment areas selected it may be necessary to haul aggregate further than in the NM-TSA and the N-CSA or to use a higher percentage of crushed rock.

3.4.1 Basin-Fill Deposits

Suitable basin-fill sources of concrete aggregate are of relatively limited extent within the A-CSA due to the high percentage of granitic and metamorphic source rocks found in the study area which break down quickly and produce weathered particles of low durability and clay minerals. With the exception of stream-channel deposits and younger alluvial fans, most basin-fill

deposits observed in the A-CSA exhibit a moderate to strong amount of caliche development at relatively shallow depths below the ground surface. A number of older alluvial deposits tested had $MgSO_4$ soundness losses in excess of 15 percent due to the presence of caliche coatings. Where it was felt that these test results might not be indicative of an entire deposit the material was classified as Class B_2 material and is shown as such on the aggregate resource map (Drawing 2).

Central basin deposits in the A-CSA were ranked as Class C material due to the fine-grained nature of the soil, the occurrence of various evaporative salts in the soil, and the frequent presence of extensive caliche deposits at shallow depths. Stream-channel deposits in these areas may produce limited quantities of fine- to medium-grained sand suitable for use as filler material.

3.4.1.1 Stream-Channel Deposits - Aa1

Stream-channel deposits are frequently utilized as a source of sand and gravel by aggregate producers in the A-CSA. These deposits vary from heterogeneous mixtures of sand, gravel, cobbles, and boulders near mountain fronts to fine-grained sands, silts, and clays near valley centers and along major drainages such as the Gila and Colorado Rivers (Drawing 2). The quality of the material found in stream-channel deposits reflects the properties of the rock types located in the stream's source area and along its course, and the deposits have been ranked accordingly. Due to the through-flowing nature of most drainages and

the widespread occurrence of intermediate and acidic volcanics in the A-CSA, the materials found along the larger stream channels in the study area should be considered potentially alkali reactive. Near mountain fronts where stream gradients are high, stream-channel deposits are generally coarse-grained, noncemented, free of deleterious coatings, suitably shaped, contain a low percentage of silt and clay fines, and are relatively durable (the soft and friable materials having been removed by the natural abrasive action of stream transport). Further from the mountain fronts, suitable sources of sand may be located. Material deposited by streams near valley centers or on the flood plains of major drainages are generally too fine-grained to make acceptable aggregate. Many stream-channel deposits are self-renewing with a fresh supply of sand and gravel being carried downstream during periodic cloudbursts.

The majority of stream-channel deposits in the A-CSA are not individually large enough to supply the quantity of material required by the MX system. However, several such deposits located around deployment area could supply the necessary volume of aggregate.

Due to their relatively small size, most stream-channel deposits have been included within one of the larger composite materials categories shown on the aggregate resource map (Drawing 2).

3.4.1.2 River Terrace Deposits - At

River-terrace deposits along the Gila and Hassayampa rivers represent a locally extensive source of potentially acceptable

concrete aggregate. A number of small borrow pits have been developed in these deposits. Most are inactive or used only periodically to supply the requirements of local construction projects. The materials within these deposits consist of hard, durable, semiround to round particles of the more resistant rock types found upstream. A high percentage of potentially alkali reactive volcanic particles are found throughout this unit. Usually at less than a 1-foot depth, there occurs a zone of Stage II to Stage IV caliche development. Locally, zones of heavy caliche cementation occur at various depths on stratified unconsolidated sand and gravel. $MgSO_4$ soundness tests run on these calichified surface materials show losses in excess of 15 percent due to the presence of caliche coatings. Therefore, surface materials and zones of strong caliche development are not considered suitable for use as concrete aggregate. However, it may be practical to strip off the overlying calichified material and use the underlying sand and gravel.

River-terrace deposits along the Gila River in the vicinity of Gila Bend and Dateland, Arizona, are overlain by a layer of loose blow-sand. Further investigation in these areas may uncover significant additional quantities of acceptable material.

Due to the widespread occurrence of potentially alkali reactive material and zones of strong caliche development, this unit has been ranked as Class B material.

3.4.1.3 Alluvial Fans - Aaf

Alluvial fans are found flanking many mountain fronts in the A-CSA. Acceptable aggregate can be produced from selected deposits in the study area, however, due to the marginal nature of much of this material, careful exploration and testing would be required to prove out adequate reserves of suitable aggregate.

These deposits are generally poorly sorted, heterogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, clay, and fines (Appendix E). They exhibit steep to moderate slopes, become finer grained with decreased stream gradients toward the valley center and are dissected by numerous braided streams and arroyos.

The quality of the material found in these deposits for use as concrete aggregates varies with the rock types in their source areas. The best source of materials within active alluvial fan deposits is near mountain fronts where stream gradients are high and coarse-grained, clean materials are deposited. These areas also contain the youngest fan materials, so caliche development is at a minimum. Due to the rapid decomposition of granite and granite gneiss rock units and the weathering of feldspars to clay, alluvial fans are poorly developed along mountain ranges composed of these rock types. Alluvial fans fronting mountain ranges containing schists or gneiss with strongly developed foliation or segregation banding commonly contain an excess of platy, elongate, or smooth particles, and the possible presence of chlorite minerals is considered to be high. The relative

age of the fan also affects material quality; older portions of fans commonly contain more decomposed clasts and have a higher percentage of clay materials.

In older alluvial fans, and where source rocks are predominantly carbonates, strong caliche cementation was observed with Stage II to Stage IV caliche development occurring from 3 to 10 feet below the fan surface. At these depths, alluvial fan materials are well-consolidated, contain excess carbonate as deleterious coatings, and are not considered suitable for use as concrete aggregate. However, the layer of poorly to noncemented material overlying the calichified zone may produce acceptable aggregate.

The rankings assigned to the various alluvial fan units in the N-CSA reflect the quality of the materials contained in the deposit and the extent of caliche development present.

3.4.1.4 Alluvial Deposits Undifferentiated - Au

The best potential sources of concrete aggregate within this composite alluvial unit are to be found in stream-channel deposits and in younger alluvial fans and river terraces. These materials are generally coarse-grained, have a low percentage of silt and clay fines, and have a minimum amount of caliche development. At present, the only known production of sand and gravel from this unit comes from small borrow pits which supply aggregate for road maintenance and construction.

The principal deposits comprising this map unit in the A-CSA are pediments, river terraces, and alluvial fans. These deposits have been grouped together as undifferentiated in areas where contacts are gradational or too complex to show at map scale. Pediments, older river terraces, and the older portion of alluvial fans, where observed, frequently exhibited Stage II to Stage IV caliche development from 3 to 10 feet below the ground surface. Locally, $MgSO_4$ soundness tests performed on these materials showed losses in excess of 15 percent resulting from the presence of caliche coatings. Due to the limited number of tests performed and the variable extent of caliche redevelopment at different localities in this unit, these test results are not considered to be representative of all the deposits in this group. However, they do indicate the need for a careful exploration and testing program to locate an acceptable source of concrete aggregate in this unit.

The widespread occurrence of potentially alkali reactive material and the variable nature of the caliche development found within individual deposits makes this unit Class B material.

3.4.2 Rock Units

The principal hardrock (quarry) sources of potentially acceptable concrete aggregate within the A-CSA (Drawing 2) include basalt, granitic rocks, gneiss and associated metamorphic rocks, and sedimentary rocks undifferentiated. Each of these units are briefly characterized in the following pages.

3.4.2.1 Basalt - Vb

Due to the remote location of exposures and the current low demand for aggregate, basalt is not presently being utilized as a source of crushed rock in the A-CSA. Limited test results show basalt to be adequately durable and sound with low to moderate material losses in the Los Angeles abrasion and $MgSO_4$ soundness tests. The basalts are frequently vesicular and may be scoriaceous (greater than 50 percent vesicles) especially near the tops of flows. This material would have to be avoided or removed before the deposit could be effectively quarried. Thin-section analyses indicate that basalts within the N-CSA frequently contain interstitial glass and, as a result, may be alkali reactive.

Two ages of basalt are recognized in the A-CSA, a younger group of flat-lying flows and an older sequence which is extensively eroded and block-faulted (Appendix F). Weathering of these units produces bouldery masses and talus slopes which mantle the sides of the so-called "Malpais Hills" within the study area.

The surfaces of many of these basic flow rocks (particularly the older tilted series) may be decomposed into a sticky, plastic clay. Road cuts through both the younger and older flows show these materials to be extensively fractured with considerable caliche coatings along joints. Locally the basalts contain interbeds of sedimentary material, tuff, or volcanic agglomerate.

Due to the presence of potentially alkali reactive volcanic glass and the vesicular nature of the rock, basalt in the A-CSA has been ranked as Class B or B_2 material.

Extensive exposures of intermediate to acidic extrusive and shallow intrusive rocks occuring as a sequence of flows, dikes, plugs, airfall tuffs, ashflows, and agglomerates are widespread in the A-CSA. These rocks are frequently highly altered, eroded, and fractured. As a rule, these materials are not considered to be adequate as a source of crushed rock due to a lack of durability and a high percentage of low density, friable, and porous material. However, isolate rock units within these volcanics may provide limited quantities of suitable material. Due to the isolated nature and very limited extent of these acceptable materials, they have not been indicated on the A-CSA aggregate resource map.

3.4.2.2 Granitic Rock - gr

The granitic rocks found within the A-CSA represent a potential source of nonreactive crushed rock, however, the extent to which they may be utilized as concrete aggregate is strongly dependent on the degree and depth to which they have been weathered. During the field reconnaissance, only one small quarry was observed in this material.

Granitic rocks include both intrusive and metamorphosed intrusive units such as granites, quartz monzonite, monzonite, and granite gneiss. They are typically light-colored, medium- to coarse-grained, and silicious to intermediate in composition.

The degree and depth of weathering of these rocks is extremely variable throughout the A-CSA.

Where observed in outcrops, the majority of granitic rocks were moderately to highly weathered and were not considered to be a suitable source of crushed rock (Appendix F). Exposures seen in road cuts and in the quarry were moderately weathered to fresh at depths ranging from 3 to 40 feet below the ground surface.

Due to the high degree of weathering observed at the surface and the uncertain depths to which the weathering extends below the surface, most granitic rock in the A-CSA have been ranked as Class B or B_2 material.

3.4.2.3 Gneiss and Associated Metamorphic Rocks - gn

Gneiss and associated metamorphic rocks represent a potential source of nonreactive crushed rock; the extent to which they may be utilized as a material source is strongly dependent on the depth and degree of weathering and the extent to which they are foliated. During field reconnaissance, one inactive quarry in this material was observed.

The rock included within this unit ranges from granite gneiss consisting of coarse, equidimensional quartz and feldspar grains with slight to moderate foliation to typically banded gneiss which exhibit both strong mineral segregation and foliation. Where observed in surface exposures,these rocks were moderately to very weathered and were not considered to be a suitable source of crushed rock. Several deep cuts in these materials

observed along U.S. Interstate 8 and in the quarry expose fresh to slightly weathered rock between 10 and 40 feet below ground surface.

Where foliation (e.g., banding) is poorly developed or widely spaced, fresh material from this unit can produce suitable crushed rock. When foliation is closely spaced or where the rock has become schistose or phyllitic in character, it is considered an unsuitable source of material and may be potentially alkali reactive. Localized, irregularly shaped bodies of mafic metamorphics associated with gneiss may contain chlorite minerals which, when placed in concrete, can be detrimental to structural steel.

Due to the high degree of weathering observed at the surface and the variable extent to which foliation may be present in this unit, the majority of gneissic rock in the A-CSA has been ranked as Class B or B_2 material.

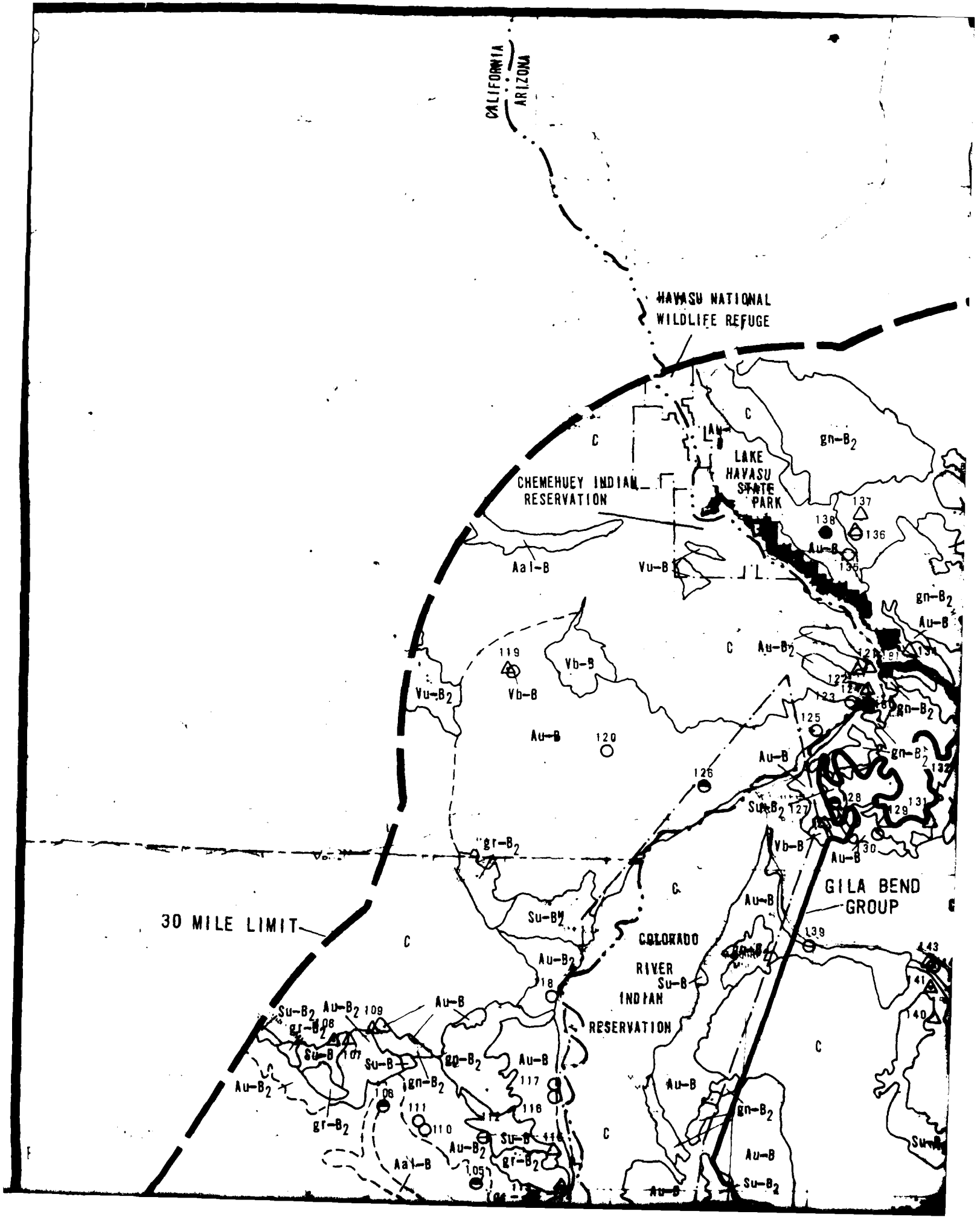
3.4.2.4 Sedimentary Rocks Undifferentiated - Su

The majority of the material in this unit is durable enough to make an acceptable source of crushed rock. However, due to the limited exposures of this unit and its isolated nature, it is not expected to provide large or continuous quantities of material.

Rock units grouped within this category are primarily limestones and dolomites with associated quartzites and interbedded shale,

sandstone, and conglomerate. The limestone is typically light- to dark-gray, thin- to massively bedded, cherty, and fossiliferous. Where present, the associated quartzites have been grouped with the limestones because individual outcrops are not extensive enough to be shown at map scale. The quartzites are commonly white to red-brown, medium- to thick-bedded, and of variable hardness. As a group these rocks have been faulted, tilted, and locally metamorphosed.

Due to the presence of potentially alkali reactive material and the locally highly deformed nature of these rocks, this unit has been ranked as Class B or B_2 material.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RESERVATION
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RIVER
INDIAN
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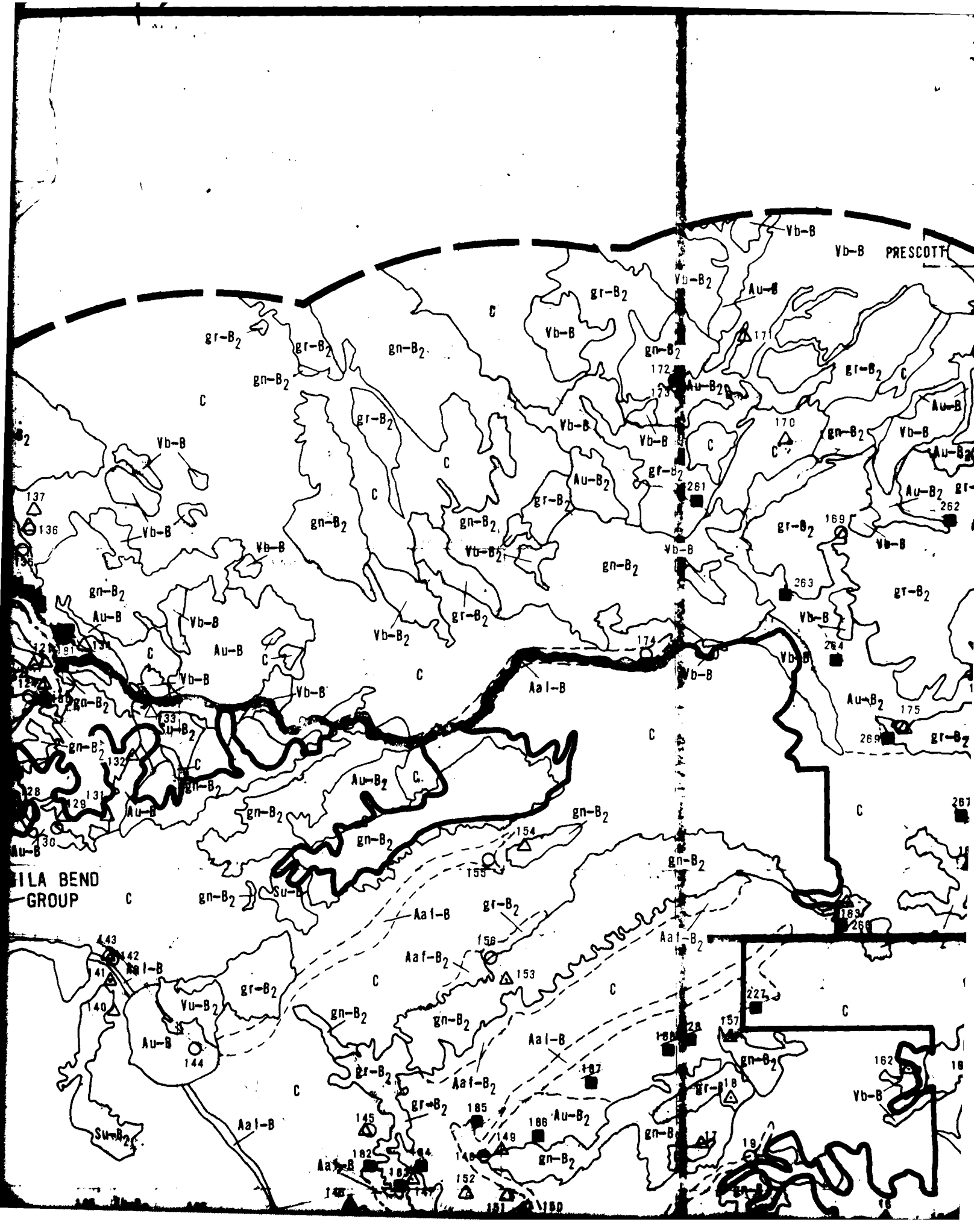
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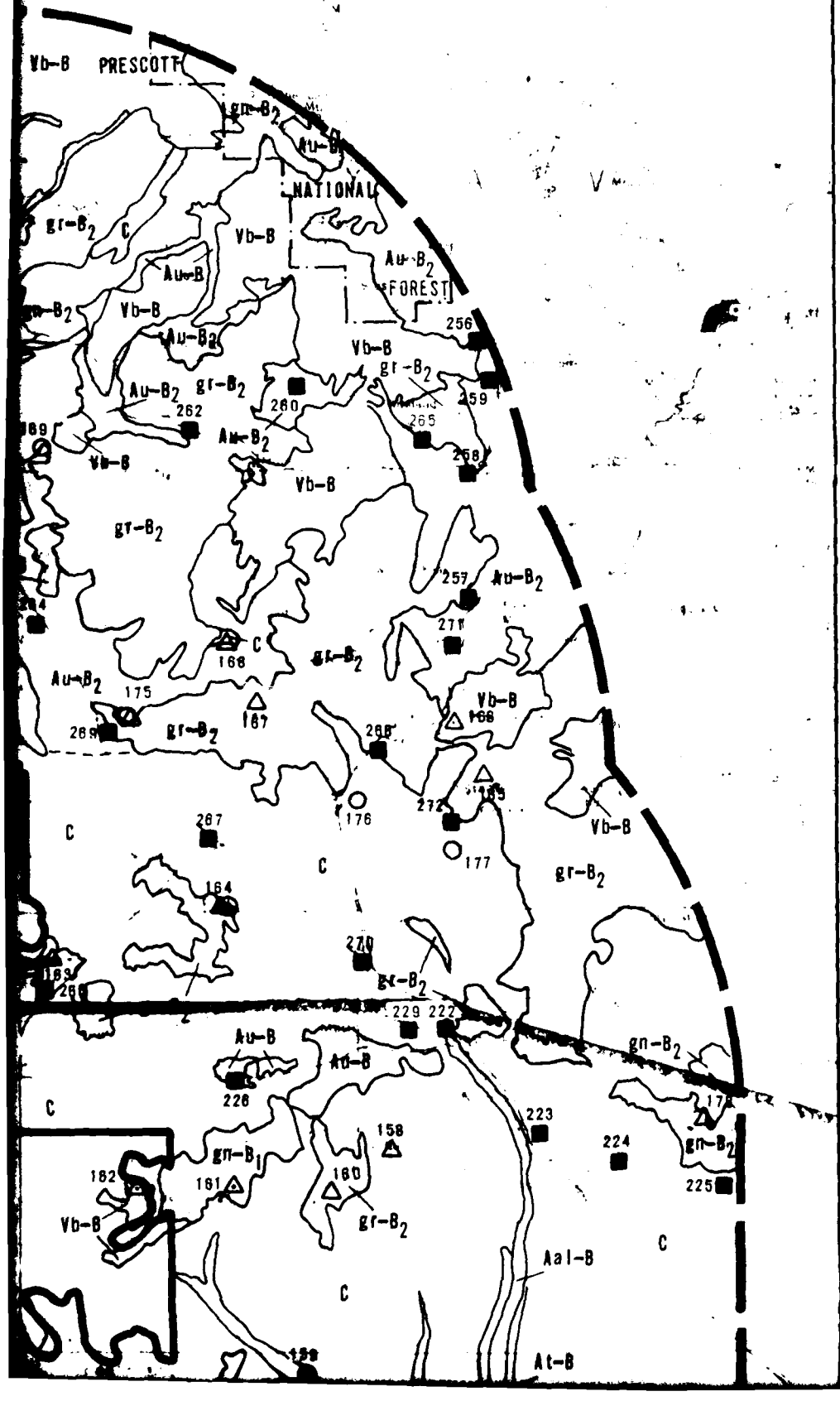

FIELD STATION CROSS REFERENCE

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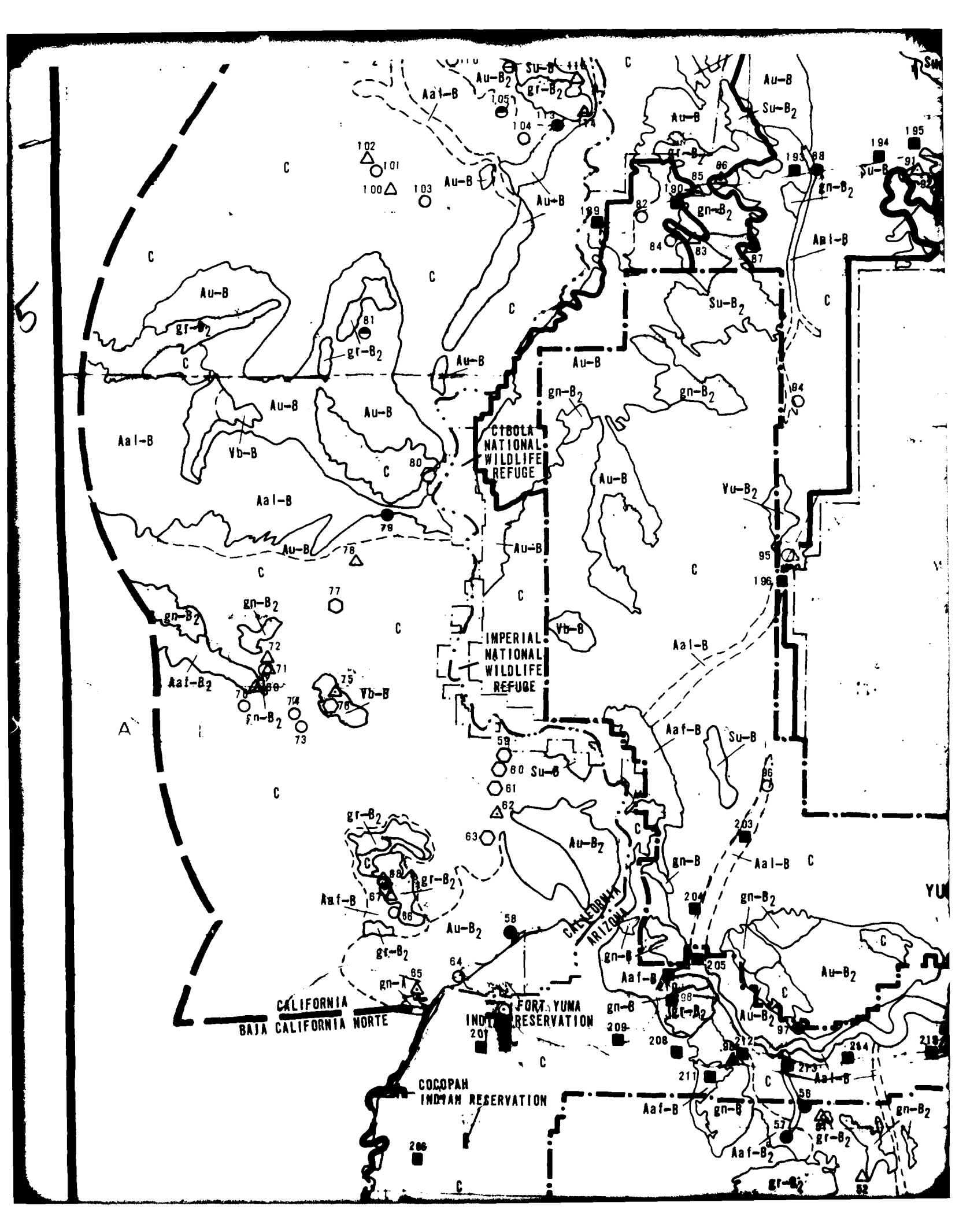
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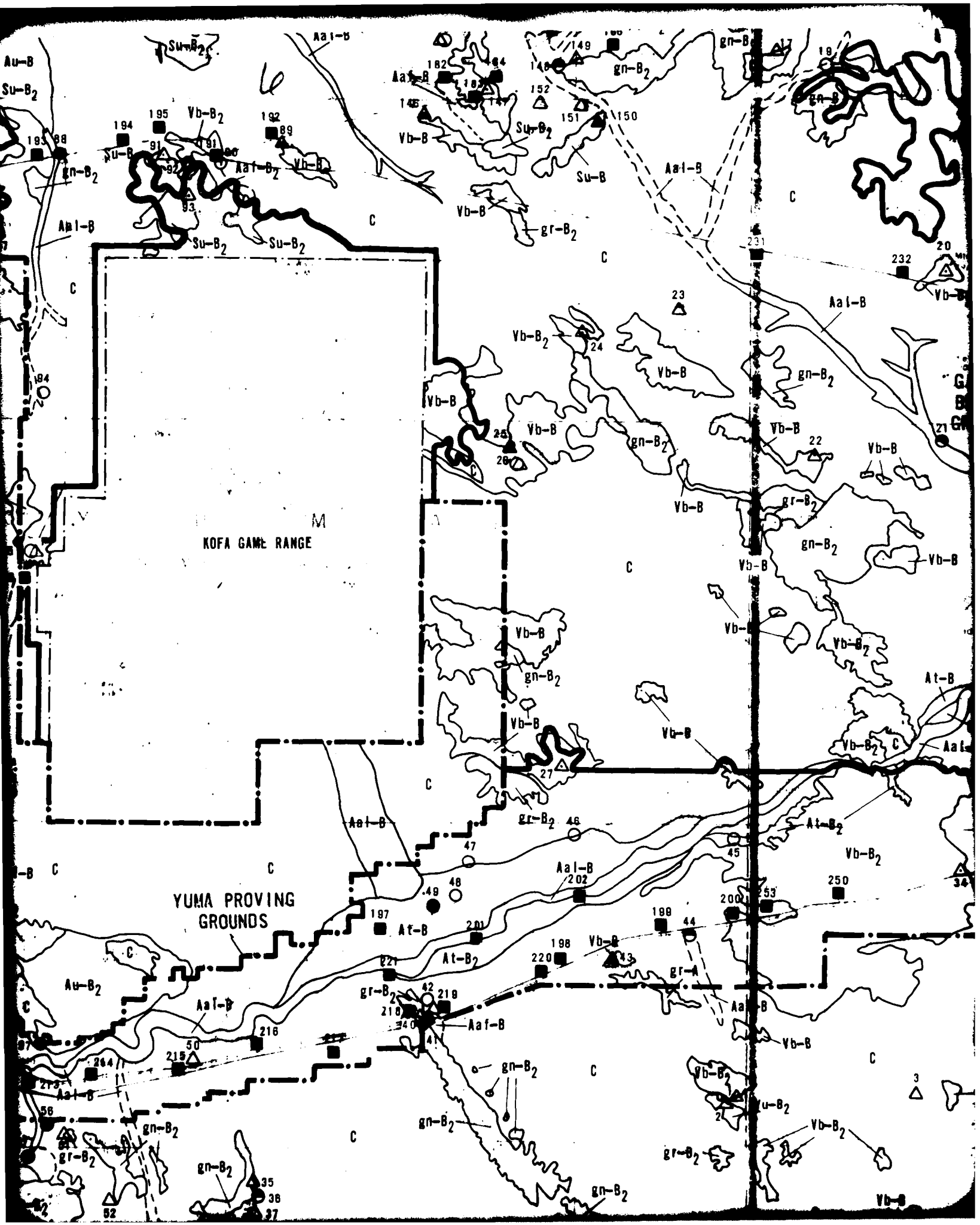
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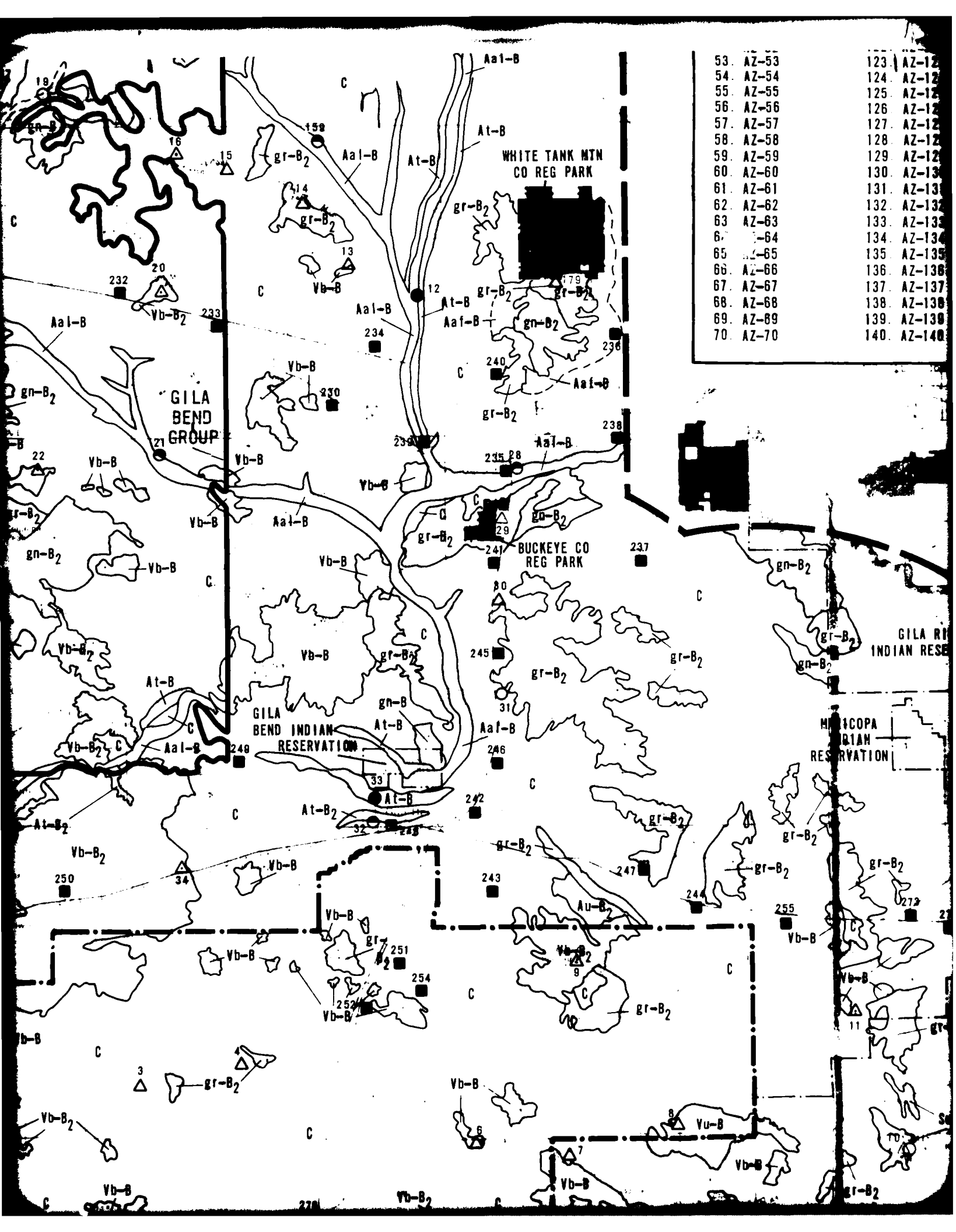
YUMA PROVING GROUNDS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67. AZ-67	137. AZ-137	207. AZ-447	277. AZ-1406
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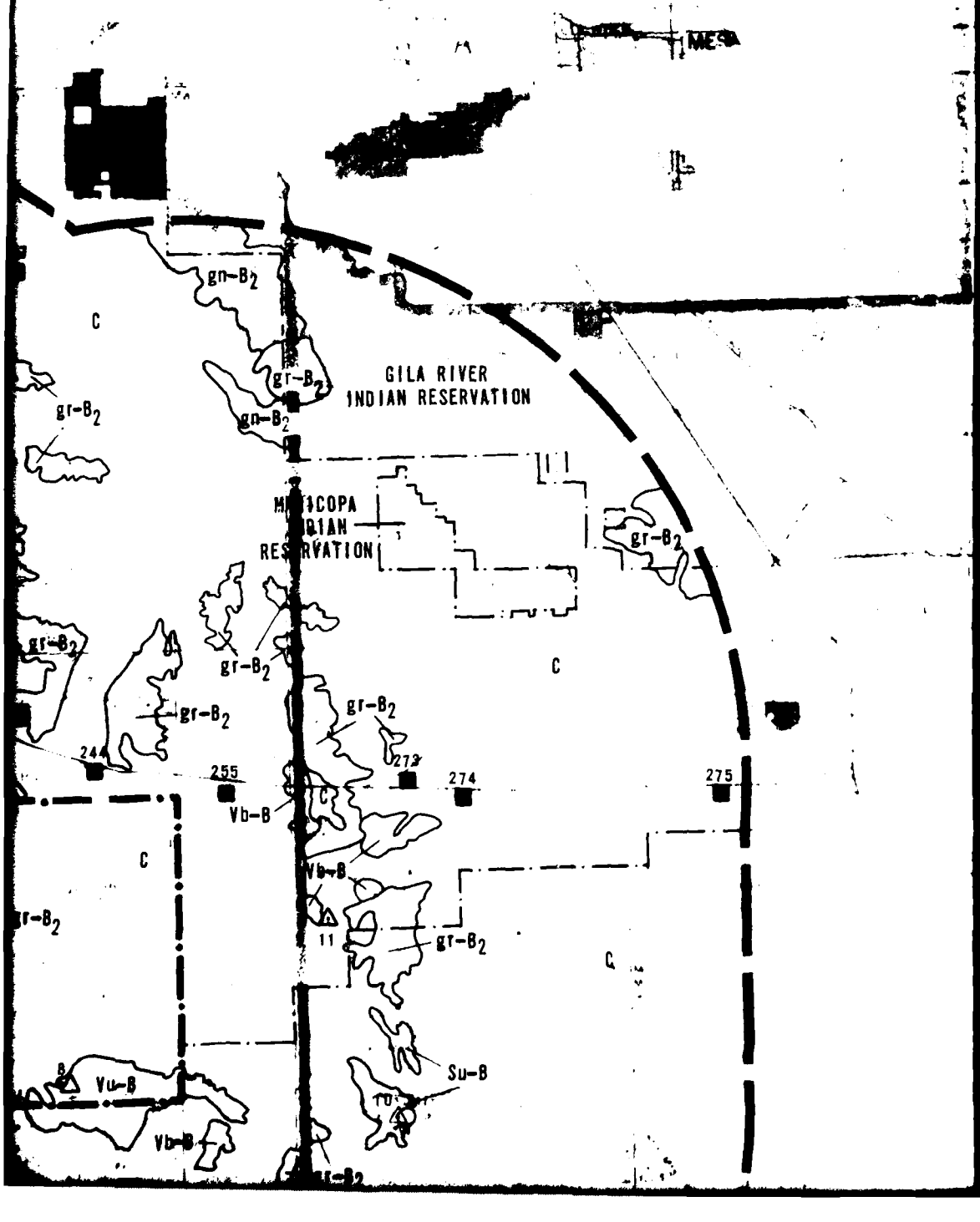
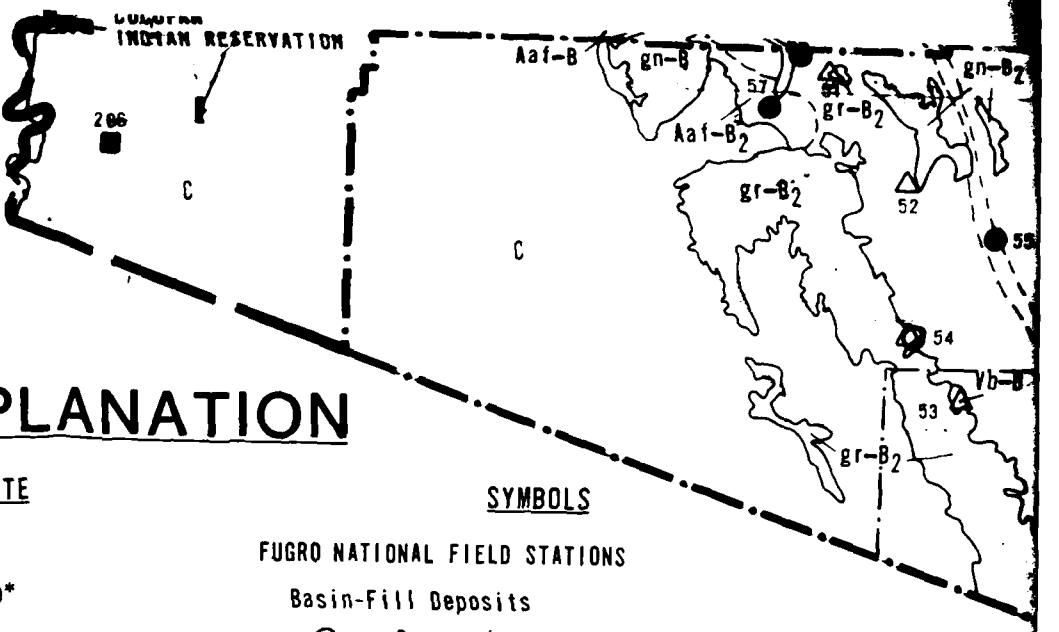




EXPLANATION

SOURCES OF POTENTIAL AGGREGATE

BASIN-FILL DEPOSITS

- Aal — Stream Channel Deposits (A1)*
- At — River Terrace Deposits (A2)
- Aaf — Alluvial Fan Deposits (A5)
- Au — Alluvial Deposits Undifferentiated (A)

ROCK UNITS

- Vb — Basalt (I2 and/or I3)
- gr — Granitic Rocks (I2)
- gn — Gneiss and Associated Metamorphic Rocks (M)
- Su — Sedimentary Rock Undifferentiated (S)

*Reference Appendix G for symbol explanation and comparison.

SYMBOLS

FUGRO NATIONAL FIELD STATIONS

Basin-Fill Deposits

- ○ Data point, not sampled
- ◒ Sampled and not tested
- ● Sampled and tested

Rock Units

- △ Data point, not sampled
- ◬ Sampled and thin-sectioned
- ▲ Sampled and tested

Photo Stop

- ⬡ Photograph only

EXISTING BORROW PIT OR QUARRY

- ■ Test data available

MATERIAL TYPE-RANKING

- $gr\text{-}B_2$ See Ranking System below

GEOLOGIC CONTACT

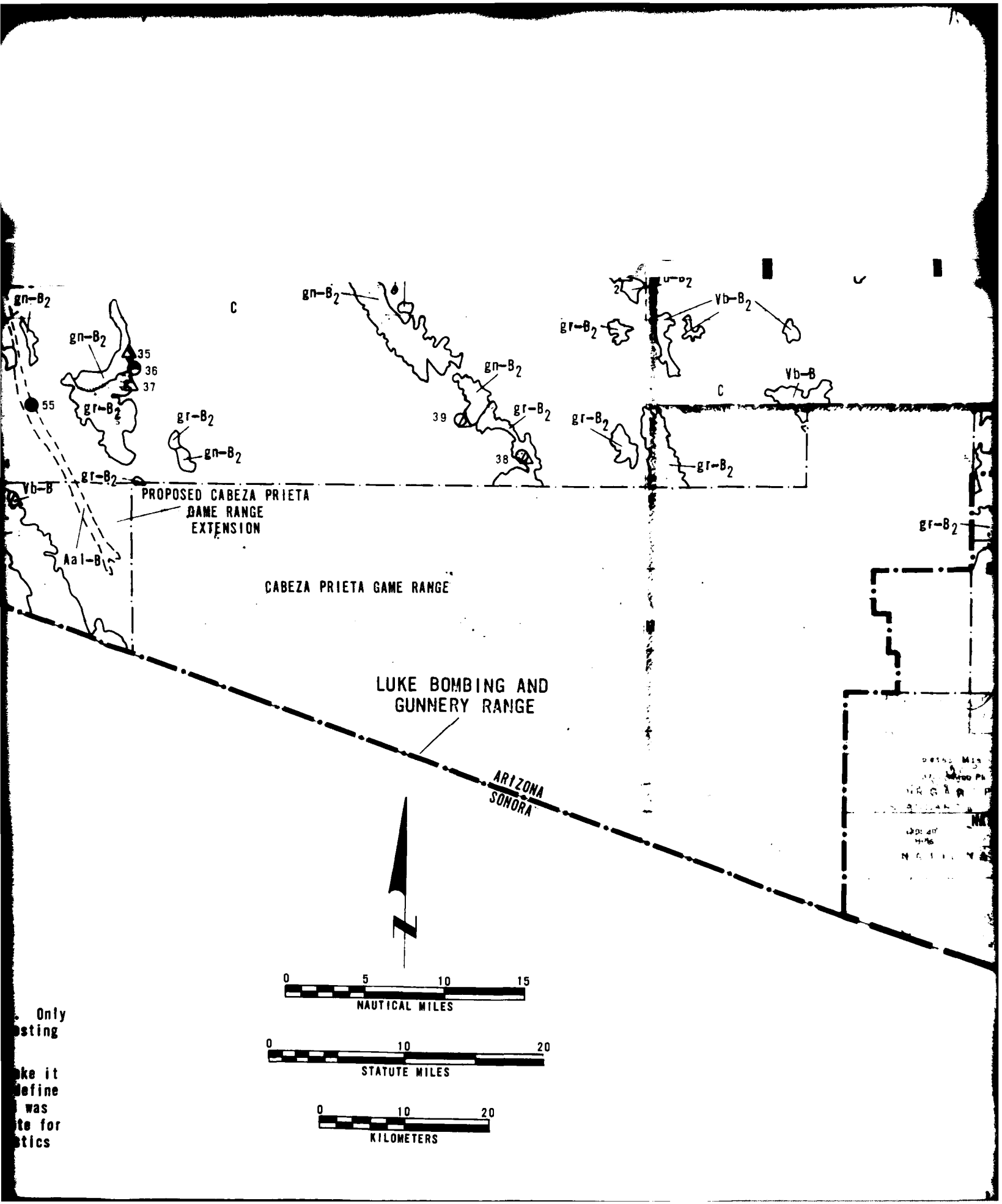
- ~-- Dashed where approximate

RANKING SYSTEM

A CLASS A: Potential sources of high quality aggregate not requiring the use of special cements or admixtures. Only nominal processing necessary to meet known requirements for concrete aggregate. Note: Additional testing and case history studies needed to confirm adequacy and define exact characteristics of material.

B CLASS B: Potential sources of concrete aggregate exhibiting one or more undesireable characteristics which make it of poorer quality than Class A aggregate. Detailed investigation would be required to accurately define aggregate suitability and probable concrete characteristics. Where possible this class of material was divided into subunits B_1 and B_2. Materials classified as B_1 are considered to be generally adequate for concrete aggregate. B_2 material is considered to be probably suitable but has several characteristics which may make it marginal for use as a concrete aggregate.

C CLASS C: Material considered undesireable for use as concrete aggregate.



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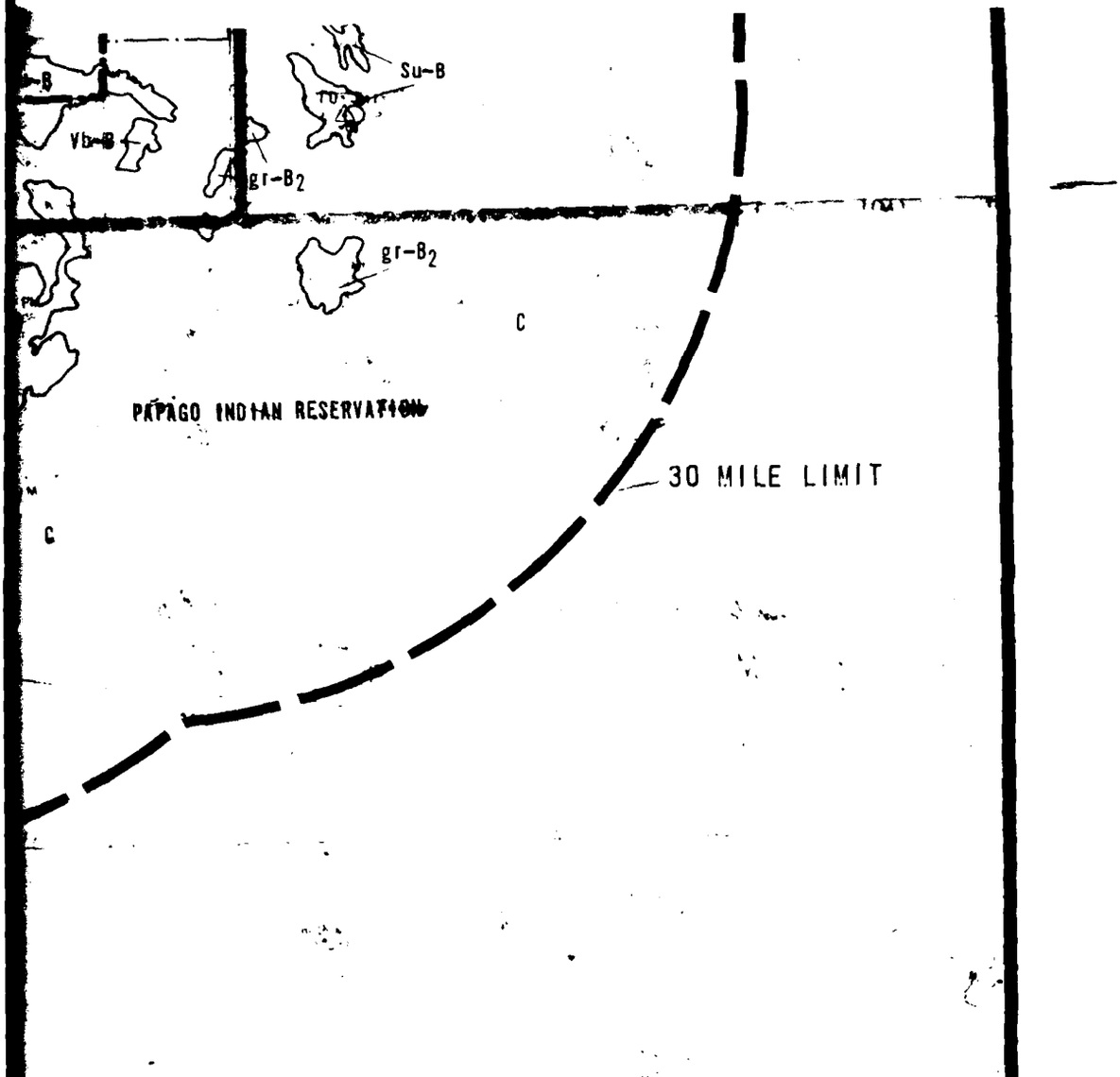

ARIZONA-CALIFORNIA AGGREGATE RESOURCE MAP

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

DRAWING
2

FUGRO NATIONAL, INC.

4.0 NEVADA-CALIFORNIA STUDY AREA

4.1 SUMMARY OF AGGREGATE RESOURCES

This section presents a brief summary of the potential sources of concrete aggregate found in the N-CSA. They have been grouped under their general type of deposit (basin fill or hard rock) and are listed in decreasing order of suitability.

It should be noted that the composite alluvial units listed were primarily established to accommodate map-scale limitations and frequently contain deposits which can supply significant quantities of high-quality material.

4.1.1 Basin-fill Deposits

1. Stream-Channel Deposits

   - generally coarse-grained, clean, suitably shaped, non-cemented, free of deletereous coatings; and
   - best quality materials found along streams which drain quartzite or carbonate terrain (due to their relatively small size more than one deposit may be required to supply the necessary volume of aggregate).

2. Alluvial Fans

   - widespread throughout the N-CSA;
   - contain large quantities of materials;
   - best quality material found in deposits with quartzite or carbonate rock in their source areas;
   - older portions of alluvial fans frequently exhibit strong caliche cementation and clay development; and
   - materials grade from coarse-grained near mountain fronts to finer-grained near valley centers.

3. Alluvial Deposits Undifferentiated

   - one of the most heavily utilized sources of aggregate in the N-CSA;
   - composite alluvial unit comprised of alluvial fans, pediments, river terraces, and stream-channel deposits;
   - shown in areas where contacts between deposits are gradational or too complex to show at map scale;
   - deposits are of different ages and origin and exhibit a wide variation in quality of material;

- best quality material found in deposits with quartzite or carbonate rock in their source area;
- older alluvial fan and pediment deposits frequently exhibit strong caliche cementation and clay development; and
- best material sources are stream-channel deposits and younger stream terraces or alluvial fans.

4.1.2 Rock Units

1. Quartzite

   - locally extensive reserves;
   - hard, durable, clean, nonreactive;
   - thick-bedded and massive in eastern portion of study area; and
   - interbedded with up to 50 percent sandstone, shale, and dolomite on west side of study area.

2. Limestone

   - locally extensive reserves;
   - thick- to massively bedded limestone with thin horizons of shale and siltstone; and
   - none to very low percentage of potentially reactive material.

3. Carbonate Rocks Undifferentiated

   - widespread within study area;
   - thick- to massively bedded limestones and dolomites interbedded with locally extensive sandstone and shale horizons; and
   - contain dolomite and opaline chert which may be alkali reactive.

4. Arcturus Formation

   - extensive outcrops in northern portion of study area;
   - lower limestone members considered suitable for crushed rock; and
   - contains dolomite and opaline chert which may be alkali reactive.

5. Basalt

   - limited testing indicates rock may be sufficiently durable and sound;
   - includes flows, flow remnants, dikes, and plugs;
   - generally vesicular, locally scoriaceous and may have low specific gravity or be porous;
   - interstitial volcanic glass possibly alkali reactive; and
   - interbedded sedimentary and volcanic agglomerate units.

6. Granitic Rock, Gneiss, and Associated Metamorphic Rock

   - nonreactive;
   - degree and depth of weathering highly variable;
   - most material exposed at surface is not considered to be a suitable source if crushed rock; and
   - locally, gneiss exhibits well-developed, closely spaced foliation.

7. Sedimentary Rocks Undifferentiated

   - located in the White and Inyo mountains of California;
   - include shale, argillite, limestone, dolomite, and quartzite;
   - structurally disturbed, locally metamorphosed; and
   - thin-bedded, highly variable deposit.

8. Volcanic Rock Undifferentiated

   - intermediate to acidic rock occurring as flows, dikes, plugs, airfall tuffs, ash flows, and agglomerates;
   - not generally considered suitable for aggregate due to low durability and excess of low density, soft particles; and
   - locally, flow units of suitable materials do occur (indicated on map where recognized).

4.2 LOCATION AND DESCRIPTION

The N-CSA is located in south-central Nevada and east-central California (Figure 4). It includes portions of Clark, Lincoln, White Pike, Eureka, Nye, Mineral, Esmeralda, and Lander counties, Nevada, and Mono and Inyo counties, California. Roughly rectangular to square in shape, the study area comprises approximately 40,400 nm^2. Of this total, 4529 nm^2 are within the NBGR, 9569 nm^2 within the Nellis Group of BLM lands (NG), and the remaining approximately 26,300 nm^2 is within the 30-mile extension. Extending northerly from near Las Vegas, Nevada, the N-CSA has maximum north-south and east-west dimensions of 238 nm^2 and 215 nm^2, respectively. Areas of restricted access into which data have been interpolated for this study area include

the NBGR, the Nevada Wildhorse Range, Desert National Wildlife Range, Yomba Indian Reservation, Duckwater Indian Reservation, Moapa Indian Reservation, Nevada Test Site, Tonopah Test Range, and several small areas which have been designated recreation lands or wildlife management areas. Areas into which data have not been interpolated include Death Valley National Monument, Lake Mead National Recreation Area, Valley of Fire State Park, Beaver Dam State Park, Cathedral Gorge State Park, and Pahranagat National Wildlife Refuge.

The N-CSA lies totally within the Great Basin section of the Basin and Range Physiographic Province. The physiography is controlled by, and strongly reflects, the underlying geologic structure. The study area is characterized by the eroded remnants of uplifted fault-block mountains separated by down-dropped basins. The ranges are rugged and exhibit predominantly north to northwest trends. The valleys are generally broad, elongate, gently sloping surfaces grading toward the basin's interior. Typically, closed-basin conditions predominate with primary and secondary drainages terminating at playas in the central portion of the basins.

The basins are characterized by alluvial fans flanking the mountains and coalescing around playa lakes in the central portions of the valleys. White River is the only major drainage system within the N-CSA.

4.3 PRESENT PRODUCTION OF CONCRETE AGGREGATE

Presently, sand and gravel are produced in the N-CSA for use by the local construction industry and state and county highway construction and maintenance. The estimated yearly production by commercial suppliers of screened sand and gravel within the N-CSA is less the 1 million yd^3 per year. The percentage of this total used as concrete aggregate is unknown. The only area within the N-CSA served by large-scale aggregate producers is Las Vegas, Nevada, and vicinity. All other areas are served by small independent producers. The principal use centers are Las Vegas and Ely, Nevada. During field reconnaissance of the N-CSA most of the sand and gravel operations observed were located in stream channel deposits, river-terrace deposits, or alluvial fan deposits. One quartzite quarry operation in was observed at the south end of the Arrow Canyon Range, and a cement plant quarry operation was noted in the Las Vegas Mountains northeast of Las Vegas, Nevada. The following table (Table 4) presents representative costs of screened sand and gravel and transportation costs at various localities within the N-CSA.

TABLE 4

Representative Costs of Aggregate in NCSA

Location	Screened Gravel*	Concrete Sand	Transport
Las Vegas	$4.65/yd (3/4")	$5.45/yd	$.30/yard mile
Ely	$7.00/yd	$8.00/yd	$.09/yard mile

* Note 1" rock unless otherwise specified

4.4 POTENTIAL SOURCES OF CONCRETE AGGREGATE

The literature search and field reconnaissance of the N-CSA have determined that numerous potential sources of concrete aggregate are located within the study area. Sufficient volumes of acceptable materials appear to be available from either basin-fill or hard-rock sources. Current production of sand and gravel is limited to basin-fill deposits; only one small quarry (abandoned) was observed during the field reconnaissance.

4.4.1 Basin-fill Deposits

The principal basin-fill sources of potentially acceptable concrete aggregate within the N-CSA (Drawing 3) includes stream-channel deposits, alluvial fans, and alluvial deposits undifferentiated. Due to the widespread occurrence of carbonate rock in the N-CSA, the degree of caliche development and cementation within the basin-fill deposits of this area was the strongest observed during the study. The older portions of most alluvial deposits are strongly cemented frequently exhibiting Stage III or Stage IV caliche development at shallow depths below the ground surface.

4.4.1.1 Stream-Channel Deposits - Aa1

Stream-channel deposits are the most heavily utilized source of sand and gravel by commercial producers of concrete aggregate in the N-CSA. While these deposits contain sufficient quantities of material to meet the needs of local users, the great majority are not individually large enough to supply the volume of material required by the MX system. However, several such

deposits located around a deployment area could supply the necessary aggregate.

Stream-channel deposits vary from heterogeneous mixtures of sand, gravel, cobbles, and boulders near mountain fronts to fine-grained sands, silts, and clays near valley centers. The quality of the material found in stream-channel deposits reflects the properties of the rock types found in the stream's source area and along its course, and the deposits have been ranked accordingly. The most durable materials are found along streams which drain areas of carbonate or quartzite terrain. The deposits along streams draining volcanic and metamorphic source areas are highly variable and may or may not contain acceptable materials. Near mountain fronts where stream gradients are high, stream-channel deposits are generally coarse-grained, noncemented, free of deleterious coatings, suitably shaped, contain a low percentage of silt and clay fines, and are relatively durable (the soft and friable materials having been removed by the natural abrasive action of stream transport). Further from the mountain fronts, suitable sources of sand may be located. Material deposited by streams near valley centers or on the flood plains of major drainages are generally too fine-grained to make acceptable aggregate. Many stream-channel deposits are self-renewing, with a fresh supply of sand and gravel being carried downstream during periodic cloudbursts.

In the N-CSA, most drainages are closed basins with few stream channels extending to near the central portions of the basin.

As a result, most stream-channel deposits are relatively small and for that reason, many have been grouped with alluvial fan deposits or as undifferentiated alluvial deposits along mountain fronts.

4.4.1.2 Alluvial Fan Deposits - Aaf

Alluvial fans flanking mountain fronts are widespread throughout the N-CSA and contain some of the best and most extensive reserves of sand and gravel in the study area. Numerous small borrow pits have been established by local aggregate producers in this unit, with the bulk of the material being utilized for road construction and maintenance.

Alluvial fan deposits are poorly sorted, heterogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay fines (Appendix F). They exhibit steep to moderate slopes, become finer grained with decreased stream gradient, and where coalesced, form bajadas. Generally, the alluvial fans in the N-CSA grade quickly to valley floors, are poorly dissected, and, in the northern portion of the study area, are moderately to heavily vegetated.

The quality of the material found in these deposits for use as concrete aggregates varies with the particular rock types in their source areas, and the deposits have been ranked accordingly. Fans with quartzites or carbonate rocks in their source area generally contain the highest quality materials. The relative age of the fan also affects the quality of the material. The older portions of fans commonly contain more decomposed

clasts and have a higher percentage of clay minerals. The best source areas within active alluvial fan deposits are near the mountain fronts where stream gradients are high and coarse-grained clean materials are deposited. These areas also contain the youngest fan materials, so caliche development is at a minimum. Further from the mountain fronts, deposits of finer grained material may be located.

The degree of caliche development and cementation in the older portions of many alluvial fans in the N-CSA was the strongest observed during this study. Stage II to Stage IV caliche development frequently occurs at depths of 1 to 10 feet below fan surfaces in areas where carbonate rocks are common. At these depths, alluvial fan materials may be consolidated, contain excess carbonate as deleterious coatings, and are not considered suitable for use as concrete aggregate. However, the 1 to 10 feet of poorly to noncemented material overlying the calichified zone may produce acceptable aggregate.

4.4.1.3 Alluvial Deposits Undifferentiated - Au

The materials within this unit are heavily utilized as a source of sand and gravel in the N-CSA. This is due to the fact that many small stream-channel deposits and younger alluvial fans included within this larger composite map unit because of map-scale limitations are a preferred source of materials by aggregate producers in the Las Vegas, Nevada, area.

The best potential sources of concrete aggregate within this unit are to be found in stream-channel deposits and in the

younger portions of alluvial fans near mountain fronts where materials are coarse-grained, have a low percentage of silt and clay fines, and a minimum amount of caliche development. The most durable materials are found in deposits which have quartzite or carbonate rocks in their source area, or where other materials have been transported sufficiently far to remove the softer particles. Pediments and the older portions of alluvial fans frequently exhibit Stage II to Stage IV caliche development from 1 to 10 feet below the ground surface.

The widespread occurrence of potentially alkali reactive material and the variable nature of caliche development found individual deposits makes this unit Class B material.

4.4.2 Rock Units

The principle hard-rock (quarry) sources of acceptable crushed rock within the N-CSA (Drawing 3) include quartzite, limestone, carbonate rock undifferentiated, the Arcturus Formation, granitic rocks, gneiss and associated metamorphic rocks, sedimentary rocks undifferentiated, and volcanic rocks undifferentiated.

4.4.2.1 Quartzie - Qtz

Extensive deposits of quartzite within the N-CSA are capable of producing large quantities of hard, durable, nonalkali reactive crushed rock for use as concrete aggregate. The present known production of crushed rock from this unit is extremely limited; one small abandoned quarry was observed during the field reconnaissance.

The quartzites within the N-CSA include both sedimentary and metasedimentary rocks. Typically, they are light-colored with local red-brown and purple zones and are composed of 90 to 100 percent quartz grains. The quartzite observed during the field reconnaissance ranged from a medium- to massive-bedded sequence of very durable quartzite with minor shale, sandstone, and siltstone interbeds in the eastern and southern portions of the study area to a western series of thin- to medium-bedded quartzites interbedded with as much as 50 percent shale and siltstone (Drawing 3).

Where quartzite was the predominant constituent of the deposit, it was ranked as Class A material. Where quartzites have been recognized in the field or noted in the literature as containing appreciable quantities of dolomite, siltstone, or shale, they were ranked as Class B or B_1 material.

4.4.2.2 Limestone - Ls

Carbonate rocks designated as limestone in the N-CSA represent a potential source of high-quality, nonalkali reactive crushed rock. There is no known present production of crushed rock from this unit. Typically, the limestone within this formation are light- to dark-gray, thick- to massively bedded, and fossiliferous with minor horizons of shale and siltstone. This unit is a hard, durable cliff former and appears to be essentially free of chert, dolomite, and other deleterious materials. This unit crops out in portions of the Snake, Egan, and Cherry Creek ranges (Drawing 3) and, where recognized, has been ranked as Class A material.

4.4.2.3 Carbonate Rock Undifferentiated - Cau

The rock units classified as carbonate rocks undifferentiated represent the most widespread source of high-quality, crushed rock within the N-CSA. There is no known significant production of material for use as concrete aggregate from this unit at the present time. However, a cement plant located northeast of Las Vegas, Nevada, uses the quarried material from this unit as its source of lime.

Materials classified as carbonate rocks undifferentiated include thick sequences of complexly faulted limestones and dolomites interbedded with locally extensive sandstone, shale, siltstone, and chert. The formations included within this unit are typically light- to dark-gray, thinly to massively bedded, cherty, and fossiliferous. Locally, quartzites have been included in this unit where individual outcrops were not extensive enough to be shown at map scale.

These rocks are generally hard, durable, cliff formers and are the competent units that form many of the major topographic features in eastern and southern Nevada. They have been ranked as Class B material due to the presence of soft shale and sandstone horizons and the presence of opaline cherts and dolomite which may make the deposits alkali reactive.

4.4.2.4 Arcturus Formation - Par

The Arcturus Formation outcrops over an extensive area in the northern portion of the N-CSA. It consists of two members, an upper sequence of calcareous sandstone and siltstone which is

not considered an acceptable source of crushed rock and a lower cherty limestone member which locally may supply significant quantities of suitable material. The limestone member was shown separately where recognized and combined with the sandstone member where contacts are unclear (Drawing 3).

Typically, the lower member consists of massive, light-olive-gray to white, resistant, fossiliferous, cherty limestone and dolomite with occasional softer horizons of sandy limestone and silty limestone. This unit has been ranked as Class B_2 due to the locally extensive exposures of sandstone found within this formation and the presence of dolomite and opaline chert which may make the material alkali reactive.

4.4.2.5 Baslat - Vb

Due to the current low demand for aggregate within the study area and the isolated nature of most exposures, basalt is not being utilized as a source of crushed rock in the N-CSA. Those basalts on which limited tests were run showed adequate durability with low to moderate material loss in L.A abrasion and $MgSO_4$ soundness tests. The basalts are frequently vesicular and may be scoriaceous (greater than 50 percent vesicles) especially near the tops of flows. This material would have to be avoided or removed before the deposit could be effectively quarried. Thin-section analyses indicate that the basalts in the N-CSA frequently contain interstitial glass and, as a result, may be alkali reactive. Locally, the basalts contain numerous interbeds of volcanic agglomerate and tuffaceous materials.

Due to the presence of potentially alkali reactive volcanic glass, the vesicular nature of the rock, and the interbedded soft materials, basalts in the N-CSA are ranked as Class B or B_2 material.

4.4.2.6 Granitic Rock - gr

Granitic rocks found within the N-CSA represent a potential source of nonreactive crushed rock, however, the extent to which they may be utilized as concrete aggregate is strongly dependent on the degree and depth to which they have been weathered. There is no known significant production of aggregate from granitic rocks in the N-CSA. Granitic rocks include intrusive and metamorphosed intrusive rocks such as granite, monozonite, granite gneiss, and diorite gneiss. These rocks are typically light-colored, medium- to coarse-grained, silicious to intermediate intrusives with local gneissic or schistose structure developed near contacts and major structures. Where observed in outcrops, the majority of these granitic rocks were moderately to highly weathered and were not considered to be a suitable source of crushed rock. Exposures in man-made cuts were moderately weathered to fresh at depths to 40 feet.

Due to high degree of weathering observed at the surface and the uncertain depth to which the weathering extends below the surface, most granitic rocks in the N-CSA have been ranked as Class B_2 material.

4.4.2.7 Gneiss and Associated Metamorphic Rock - gn

Gneiss and associated metamorphic rocks represent a potential source of nonreactive crushed rock; the extent to which they can be utilized as a materials source is strongly dependent on the depth and degree of weathering and extent to which they are foliated.

Gneissic rocks within the study area are, for the most part, Precambrian metamorphic complexes. These materials consist of quartzose and banded gneiss with occasional irregularly shaped bodies of mica schist. Locally, the quartzose layers become thick to massive and resemble quartzite. Where observed in outcrops, these gneissic rocks were moderately to highly weathered and considered a suitable source of crushed rock.

Where foliation is poorly developed or widely spaced, fresh material from this unit may produce acceptable crushed rock. When foliation is closely spaced or where the rock has become schistose or phyllitic in character, it is considered an unsuitable source of crushed rock and may be alkali reactive. Localized irregularly shaped bodies of mafic metamorphics associated with the gneisses may contain chlorite minerals which can be detrimental to steel placed in concrete containing such aggregate.

Due to the high degree of weathering observed at the surface and the variable extent to which foliation may be present in this unit, the majority of gneissic rock in the N-CSA has been ranked as Class B_2 material.

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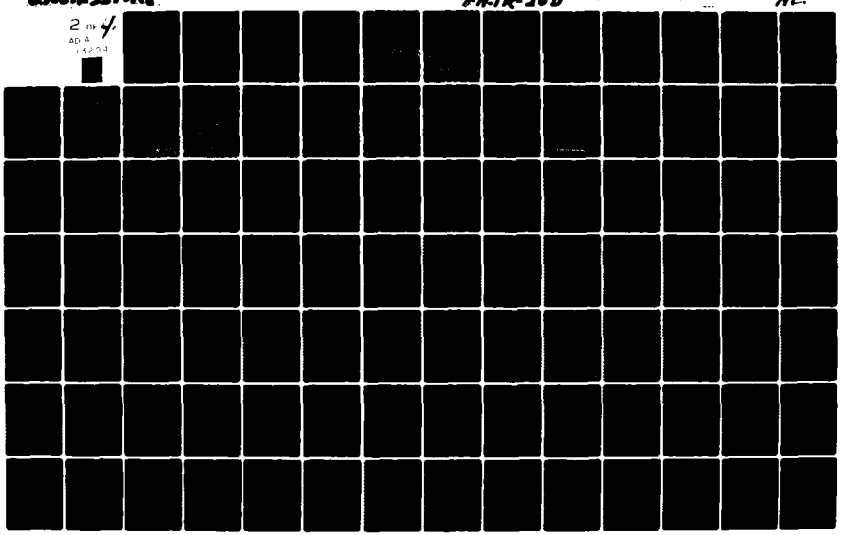
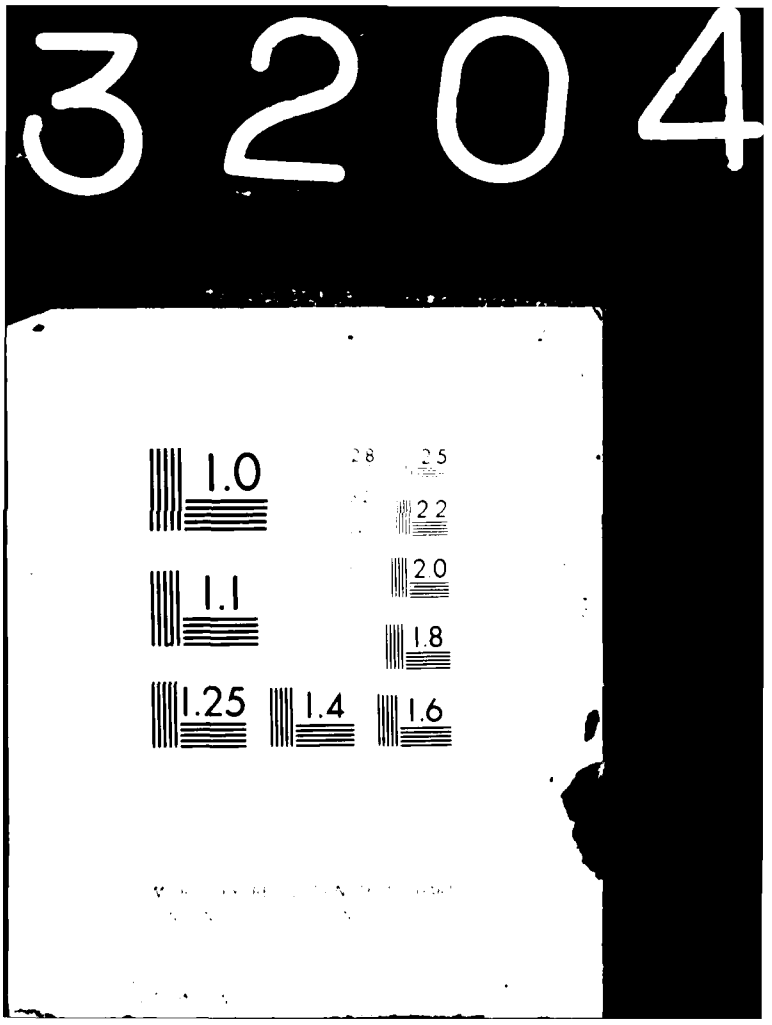
Unclassified FAIR-20D NL

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4.4.2.8 Sedimentary Rocks Undifferentiated - Su

This unit includes sedimentary and metasedimentary rocks cropping out predominantly in the White and Inyo mountains of eastern California. Rocks within this unit include interbedded sandstone, argillite, shale, dolomite, limestone, and quartzite. In many localities, these sediments have been metamorphosed to a hornfels or schist.

Locally, the limestone, dolomite, and quartzite represent potential aggregate sources, but due to the extreme variability of the material types, the presence of potentially alkali reactive material and the extent of metamorphism and structural disturbance, these materials have been ranked as Class B_2 materials.

4.4.2.9 Volcanic Rocks Undifferentiated - Vu

Extensive exposures of intermediate to acidic extrusive and shallow intrusive rocks occurring as a series of flows, dikes, plugs, airfall tuffs, ash flows, and agglomerates are found in the central and western portions of the N-CSA. As a rule, these materials are not considered to be an adequate source of crushed rock due to a lack of durability and a high percentage of low density, friable, and porous material (Appendix F). However, materials with adequate durability are present locally and have been indicated (Drawing 3) where identified.

Due to the presence of potentially alkali reactive material, the possible contamination by soft or friable particles, and the

isolated nature of their exposures, this unit has been ranked as Class B_2.

FIELD STATION CROSS REFERENCE NUMBERING GUIDE

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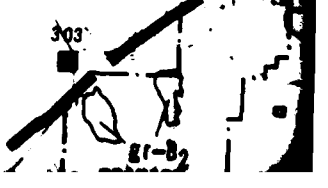

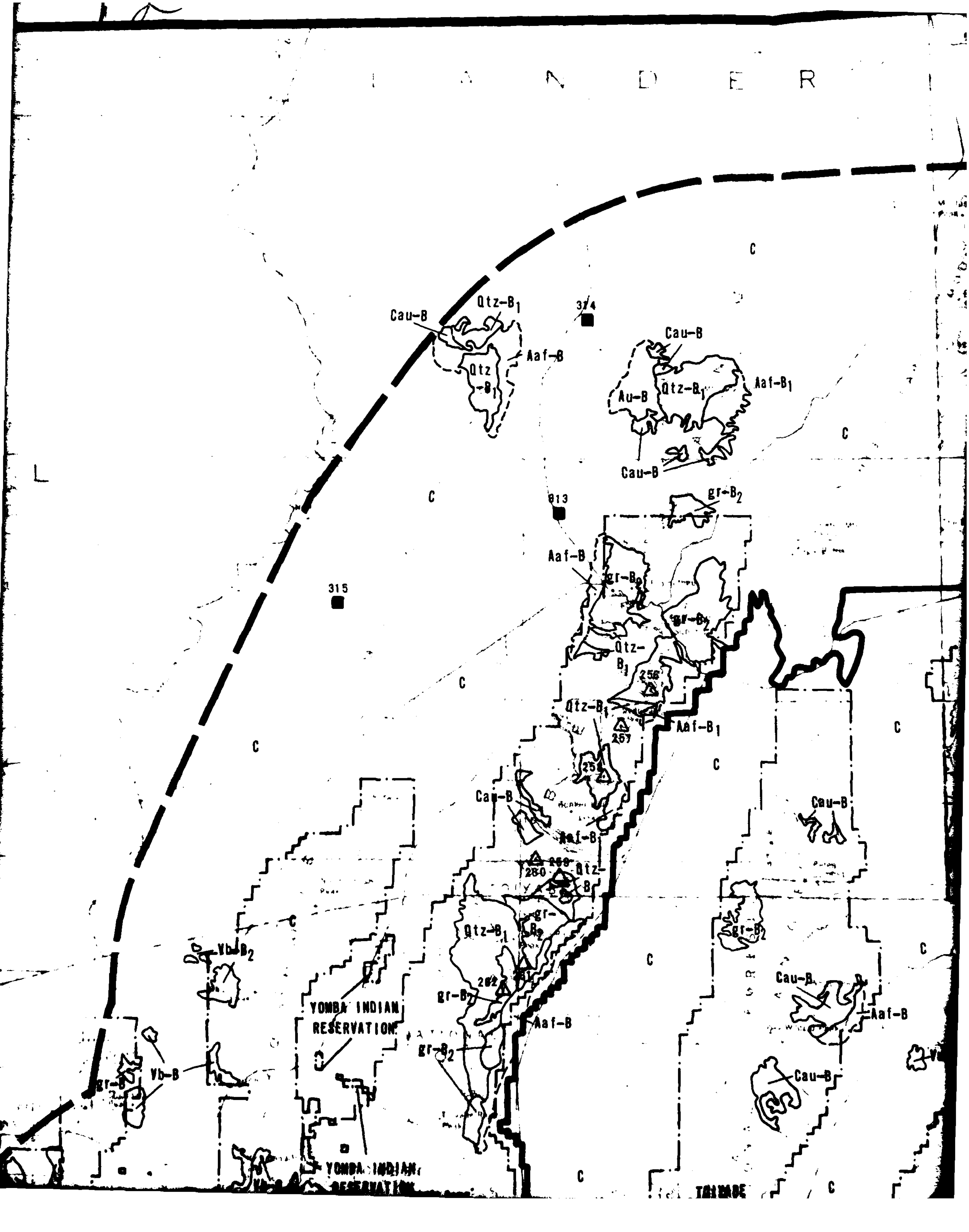
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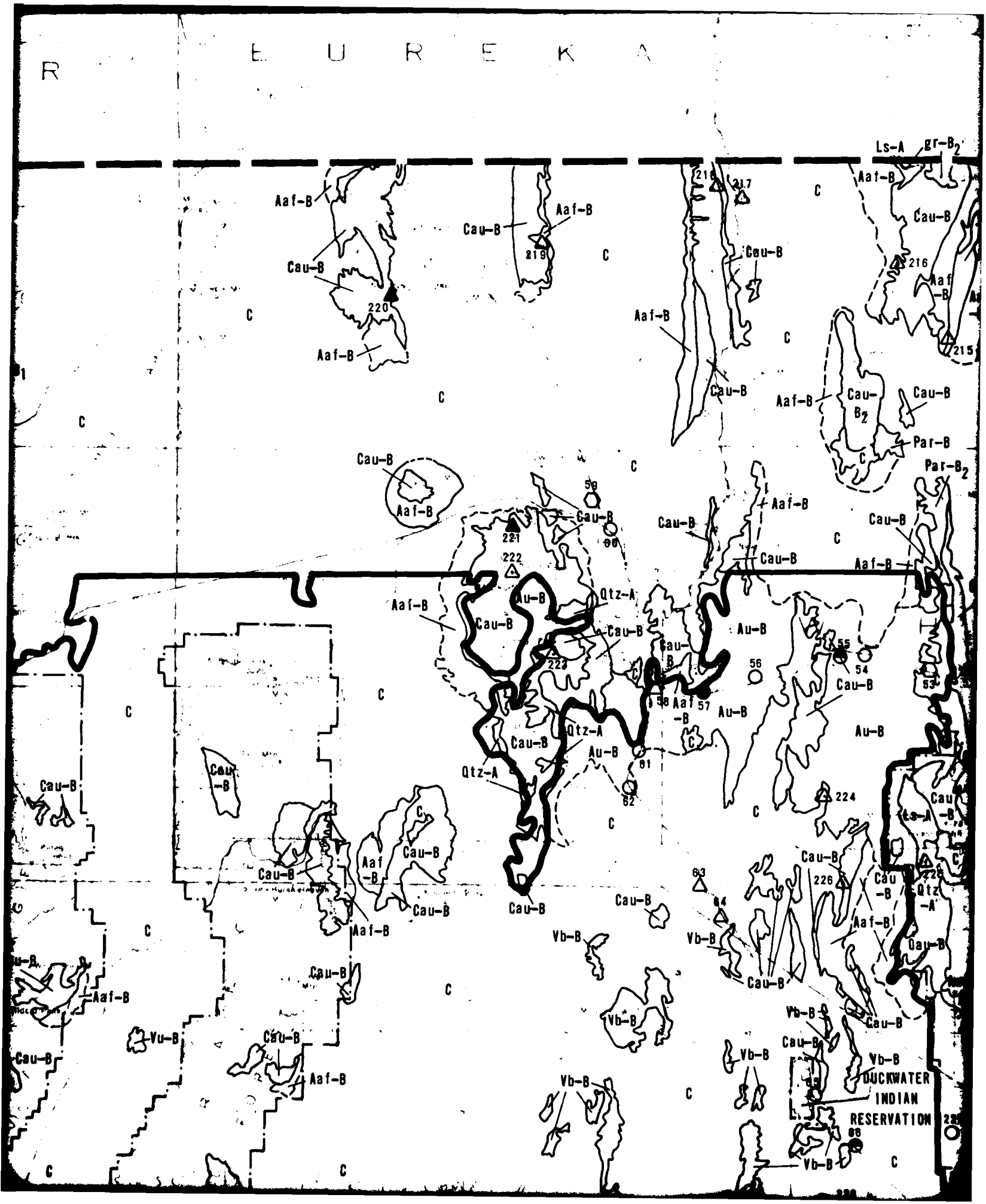
YOMBA INDIAN RESERVATION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RESERVATION
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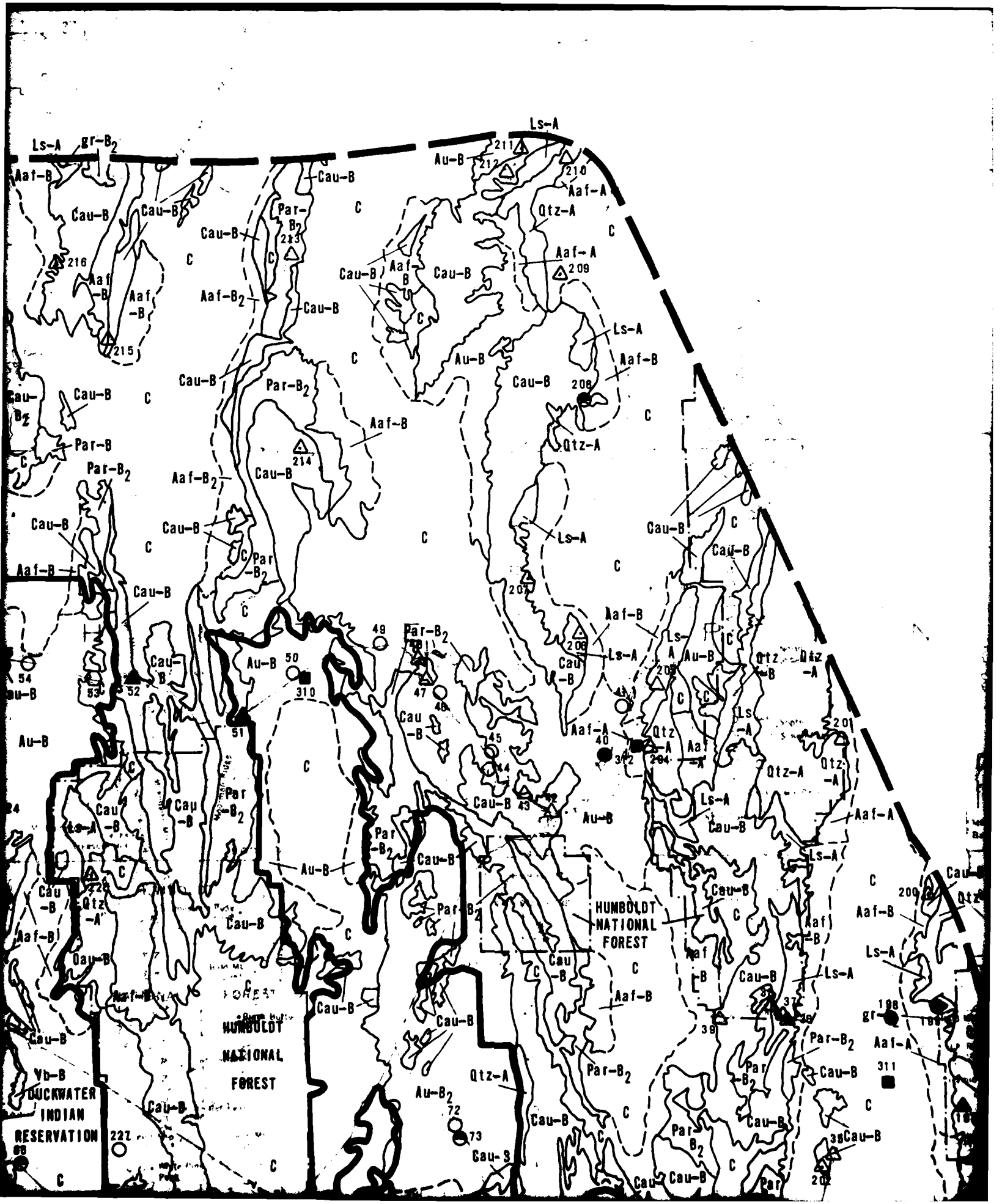
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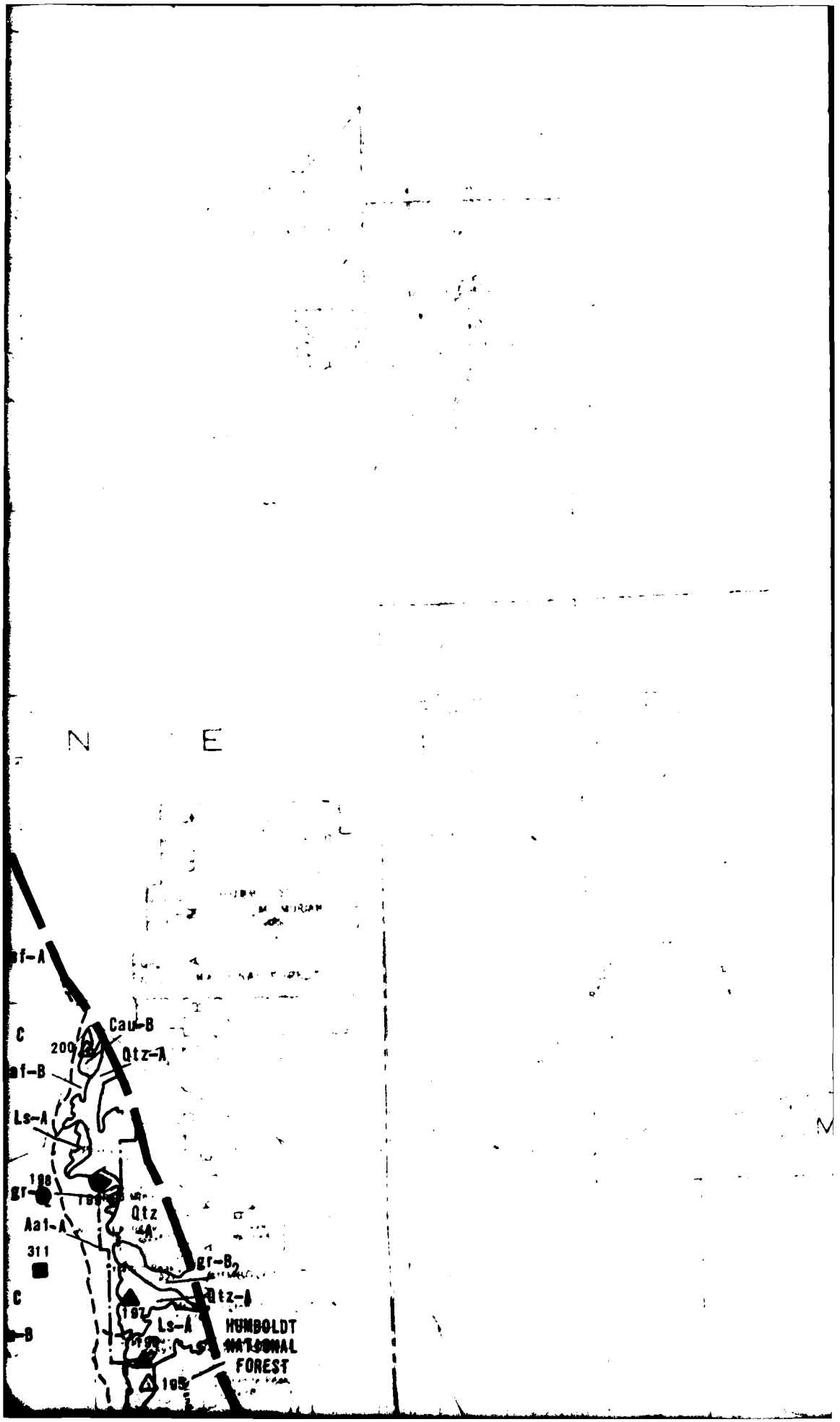
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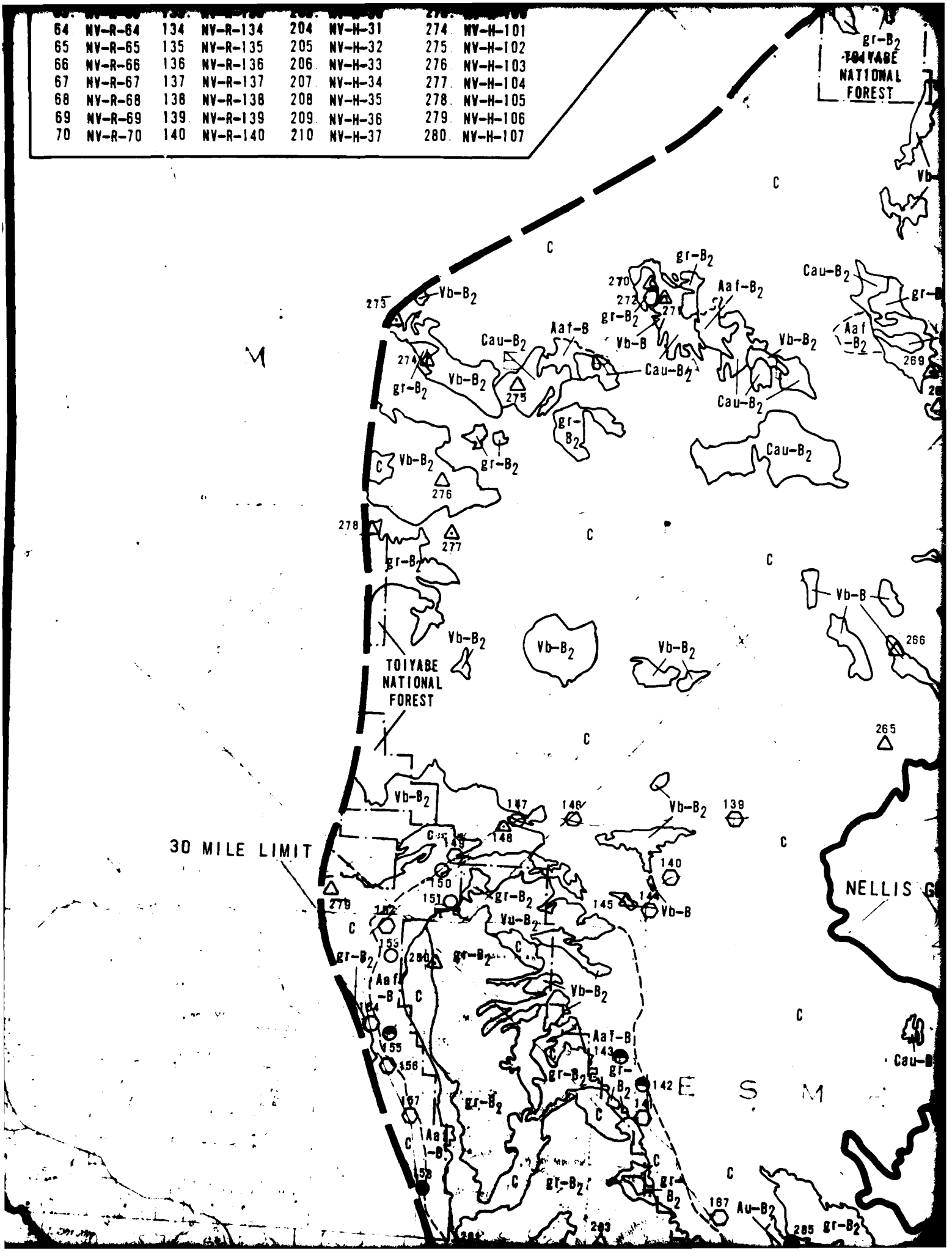
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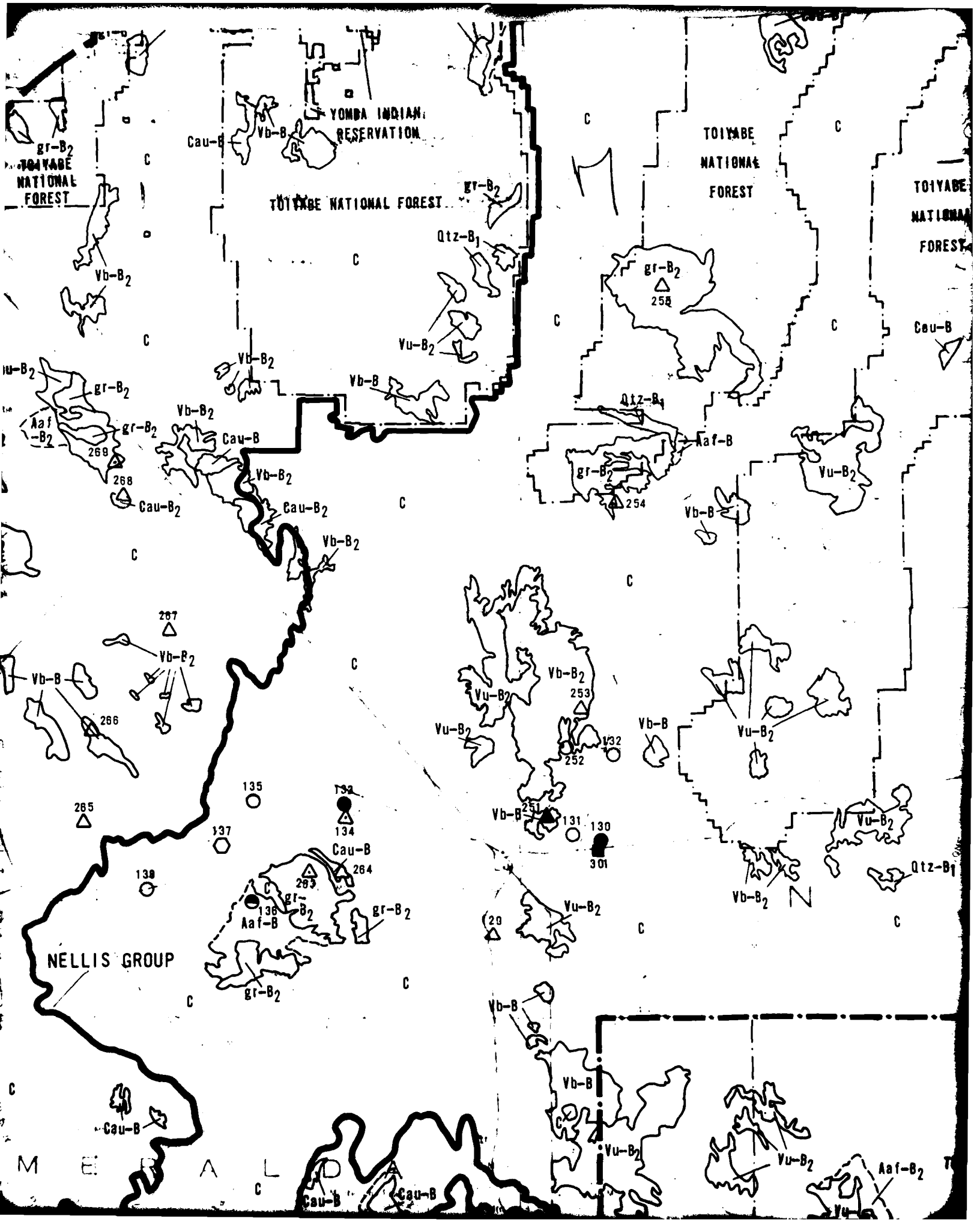
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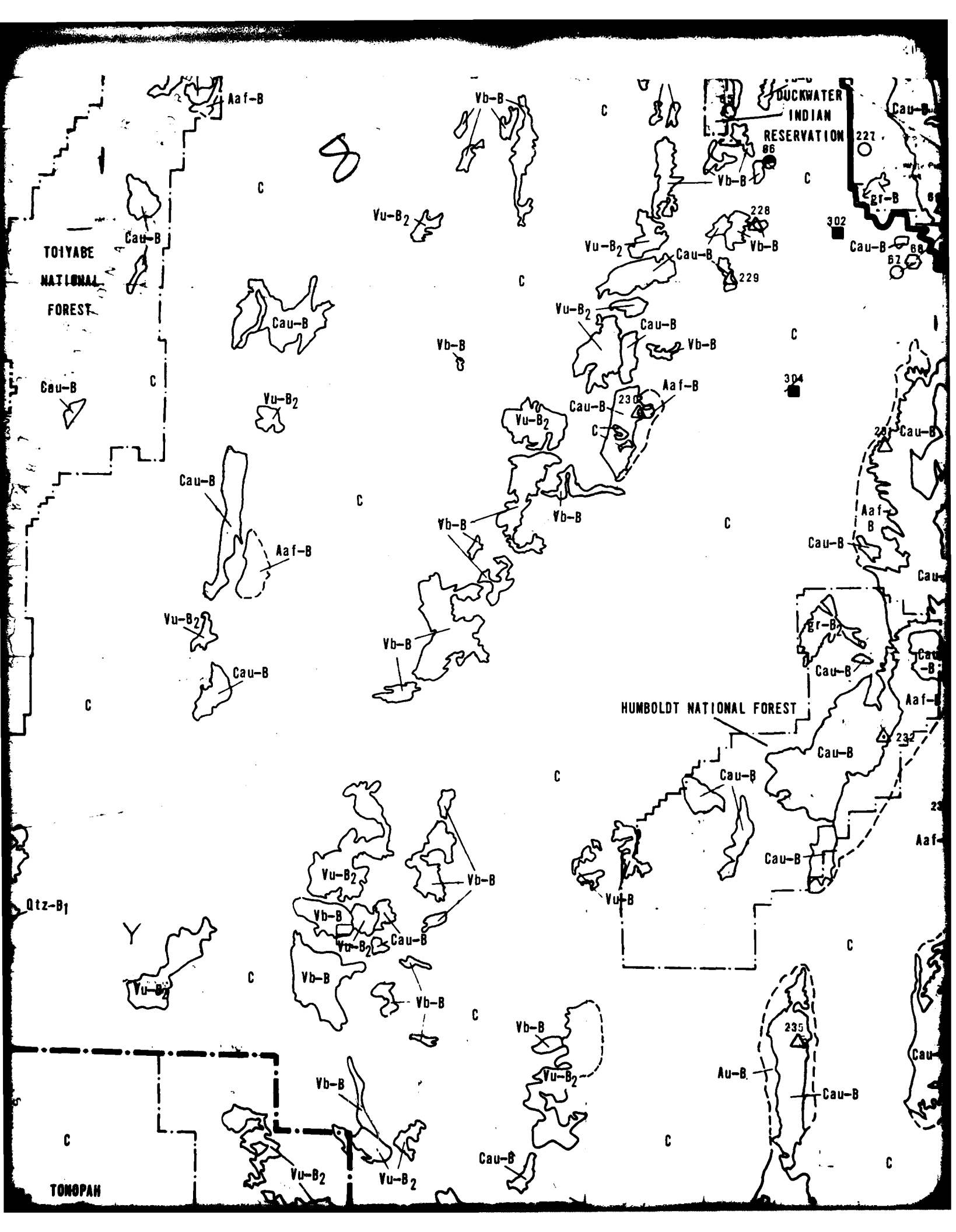
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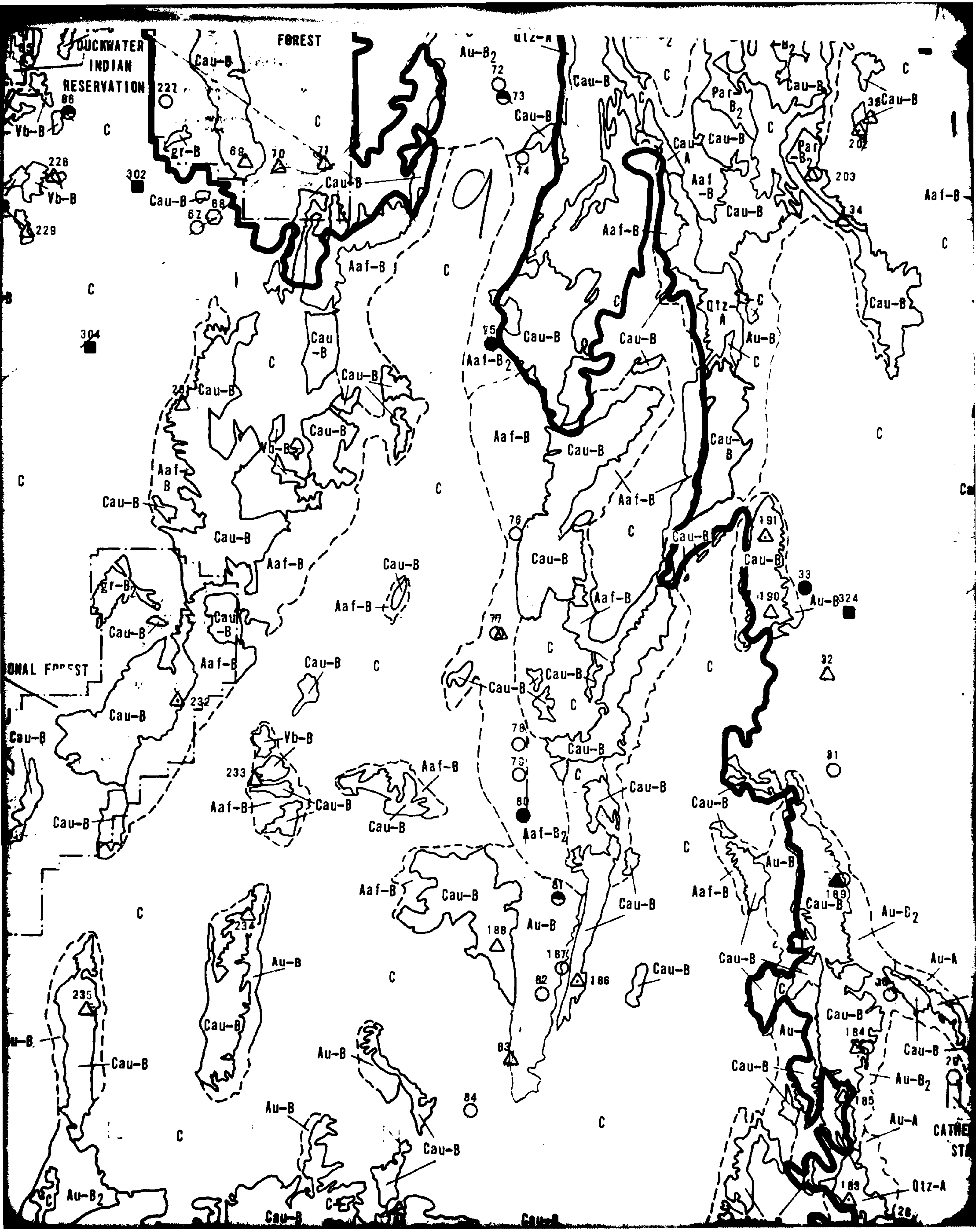

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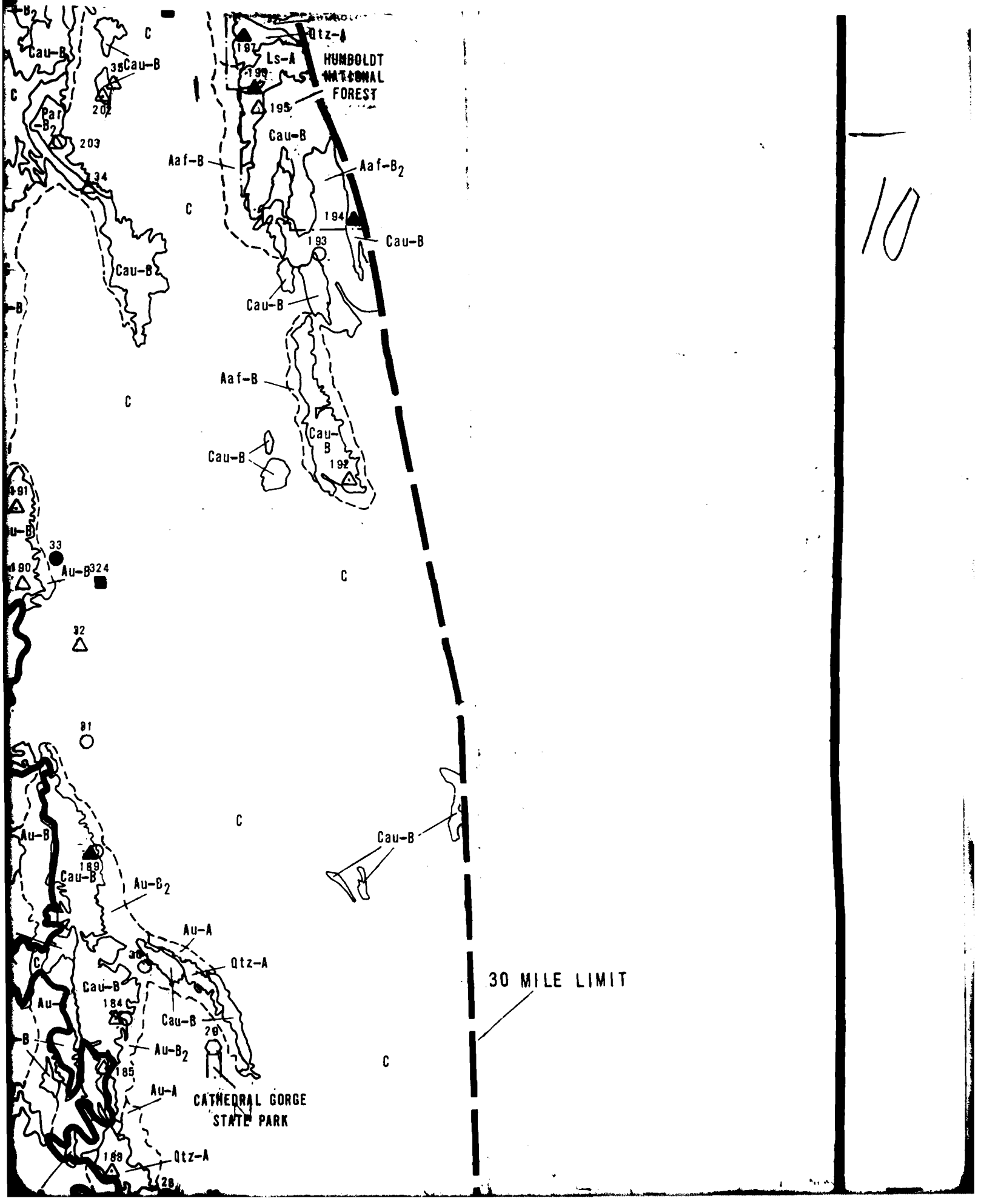
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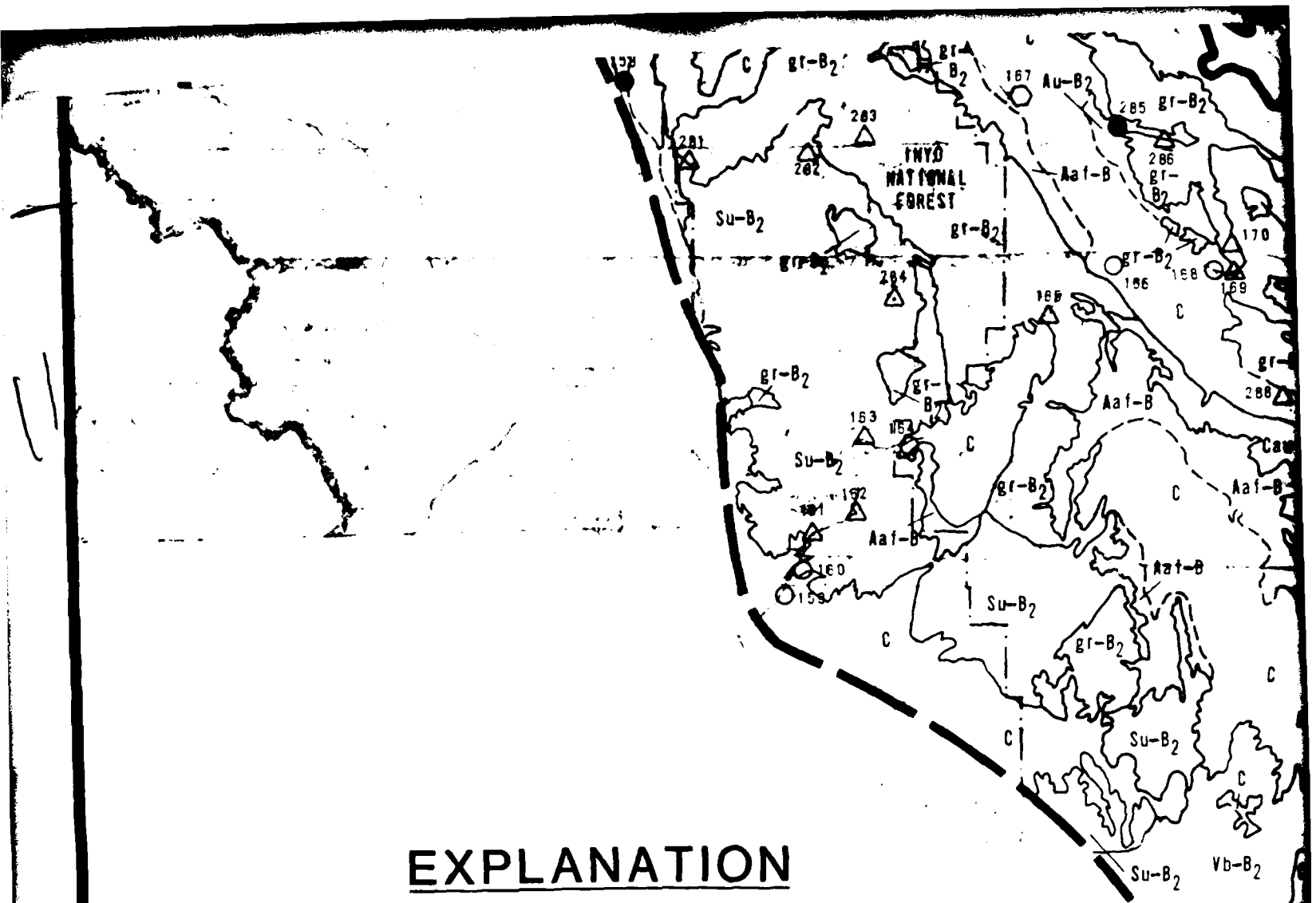


EXPLANATION

SOURCES OF POTENTIAL AGGREGATE

BASIN-FILL DEPOSITS

Aal	Stream Channel (A1)*
Aaf	Alluvial Fan deposits (A5)
Au	Alluvial deposits Undifferentiated (A)

ROCK UNITS

Qtz	Quartzite (S1)
Ls	Limestone (S2)
Cau	Carbonate Rocks Undifferentiated (S2)
Par	Arcturus Formation (S2)
Vb	Basalt (I2 and/or I3)
gr	Granite (I1)

SYMBOLS

FUGRO NATIONAL FIELD STATIONS

Basin-Fill Deposit

- ○ Data point, not sampled
- ◒ Sampled and not tested
- ● Sampled and tested

Rock Units

- △ Data point, not sampled
- ◬ Sampled and thin-sectioned
- ▲ Sampled and tested

Photo Stop

- ⬡ Photograph only

EXISTING BORROW PIT OR QUARRY

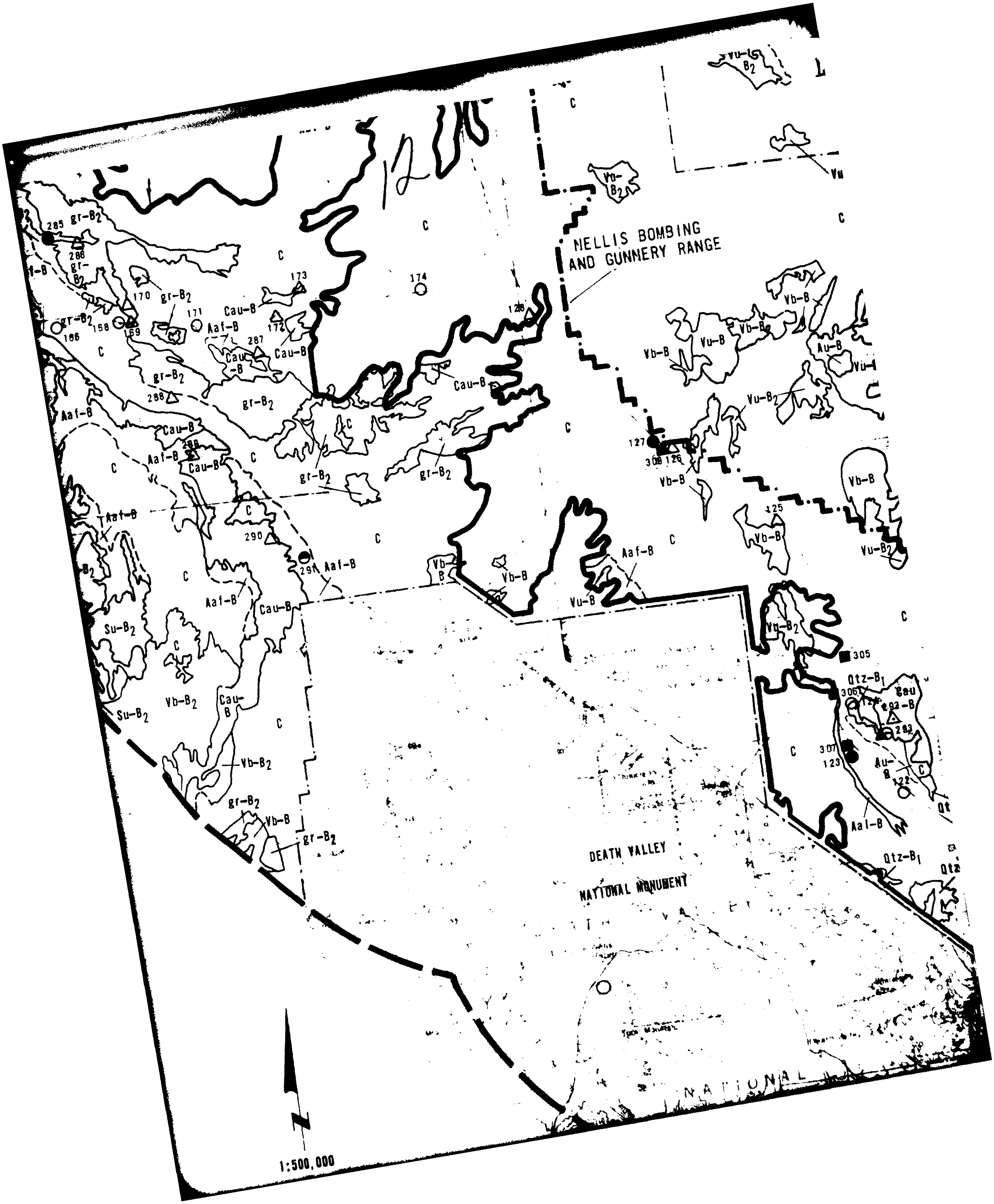
- ■ Test data available

MATERIAL TYPE-RANKING

Cau-B See Ranking System below

GEOLOGIC CONTACT

Dashed where approximate



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AND GUNNERY RANGE
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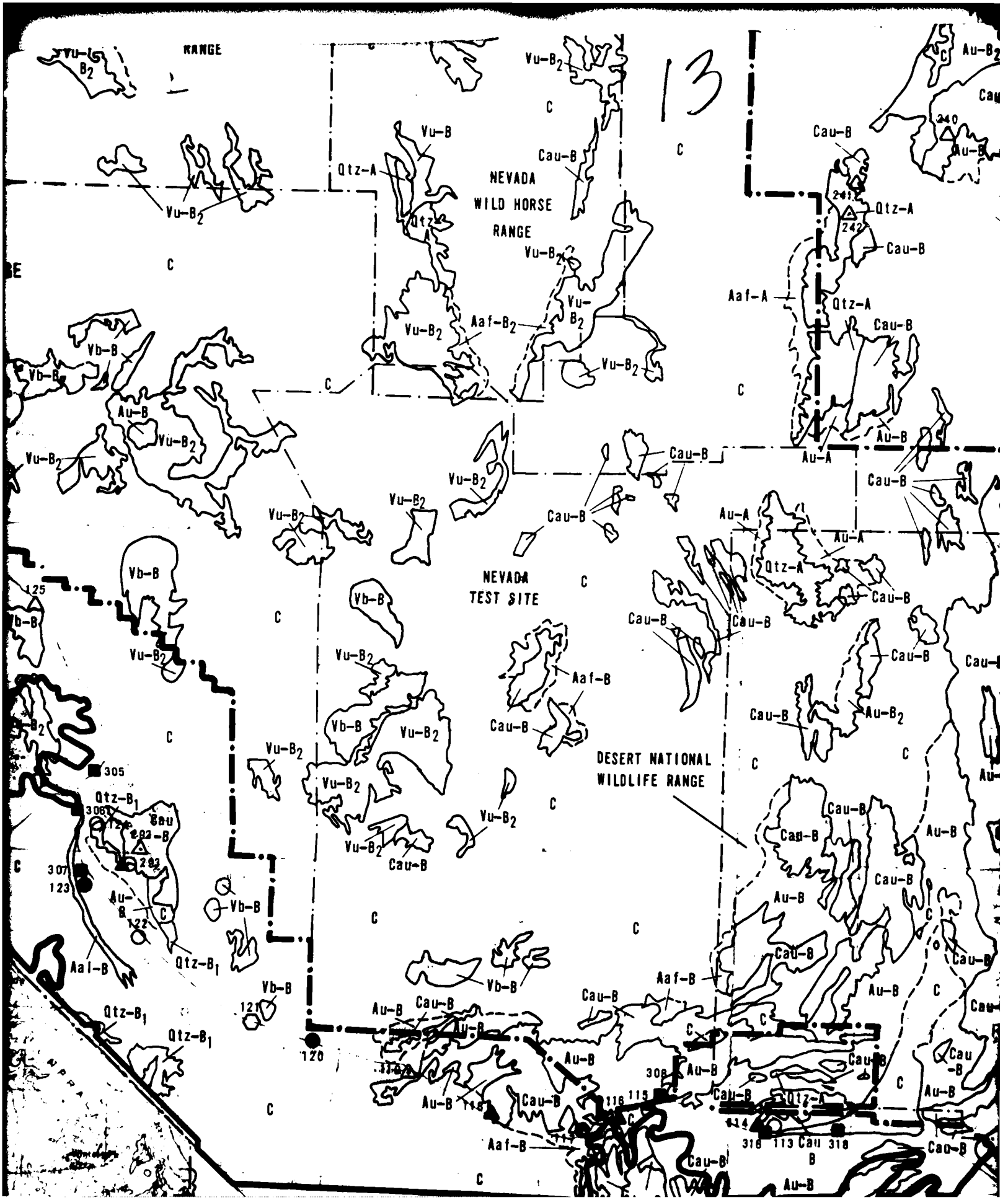
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RANGE
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WILDLIFE RANGE
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Cau-B
Qtz-A
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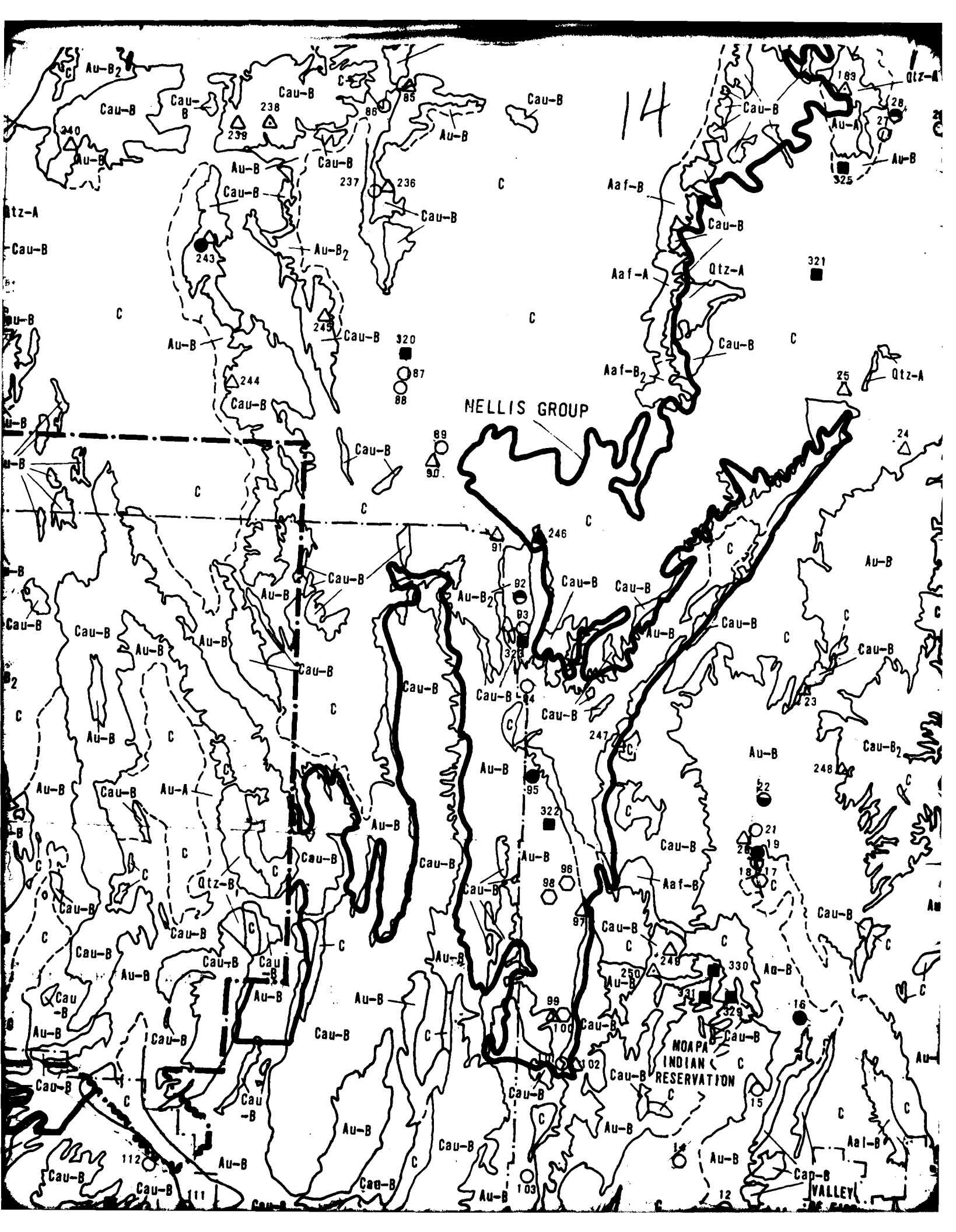
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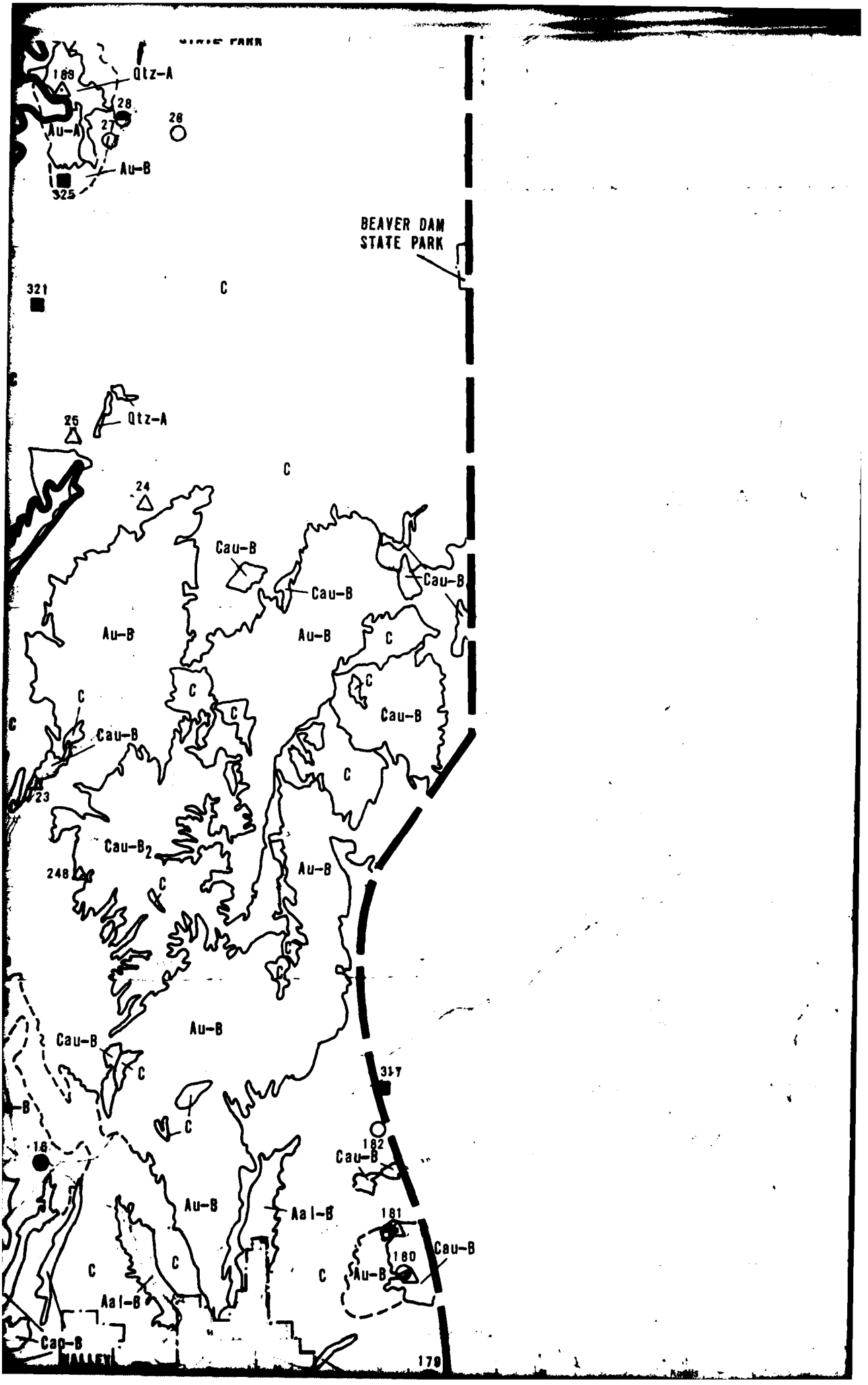
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STATE PARK
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Cau-B2
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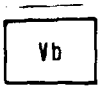
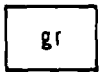
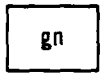
Cap-B
VALLEY



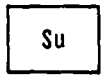
Basalt (I2 and or I3)



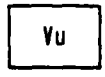
Granite (I1)



Gneiss and Associated Metamorphics (M)



Sedimentary Rocks Undifferentiated (S)



Volcanic Rocks Undifferentiated (I)

GEOLOGIC CONTACT

Dashed where approximate

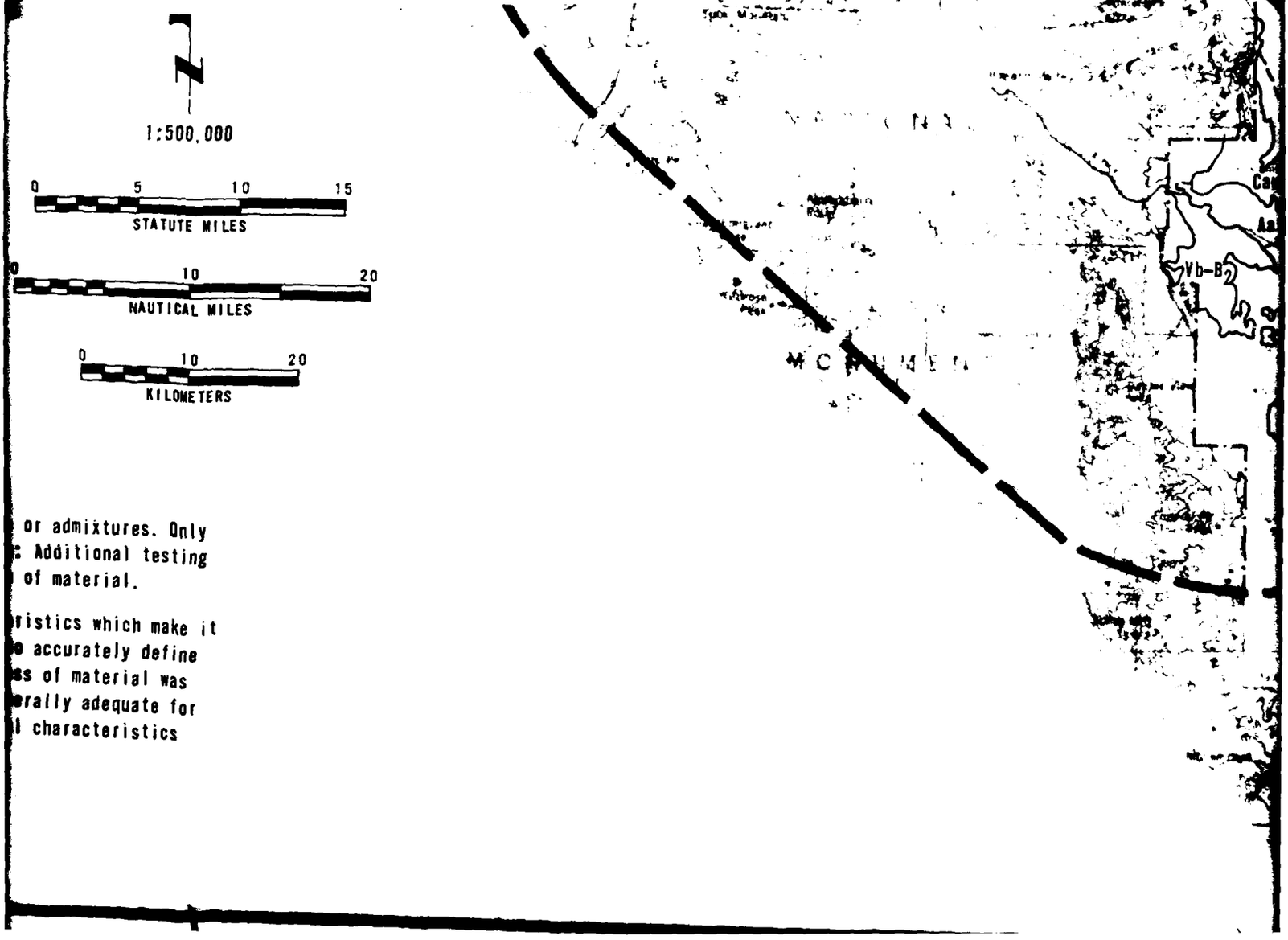
RANKING SYSTEM

A CLASS A: Potential sources of high quality aggregate not requiring the use of special cements or admixture nominal processing necessary to meet known requirements for concrete aggregate. Note: Additional and case history studies needed to confirm adequacy and define exact characteristics of material.

B CLASS B: Potential sources of concrete aggregate exhibiting one or more undesireable characteristics which of poorer quality than CLASS A aggregate. Detailed investigation would be required to accurately aggregate suitability and probable concrete characteristics. Where possible this class of materia divided into subunits B_1aand B_2. Materials classified as B_1 are considered to be generally adequa concrete aggregate. B_2 material is considered to be probably suitable but has several characteris which may make it marginal for use as a concrete aggregate.

C CLASS C: Material considered undesireable for use as concrete aggregate.

*Reference Appendix G for explanation and comparison.



or admixtures. Only
: Additional testing
of material.

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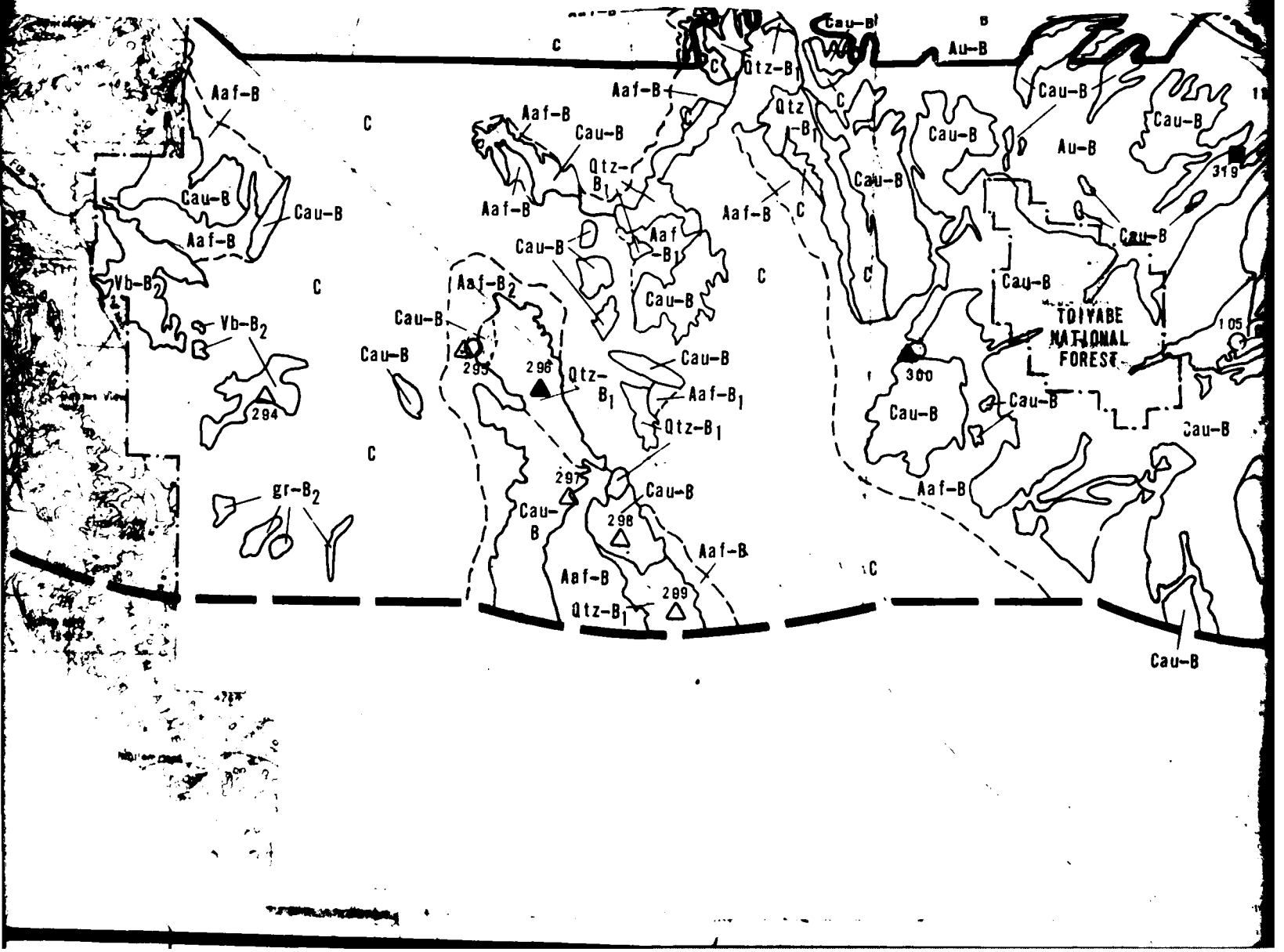
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Cau-B
Vb-B2
Vb-B2
294
gr-B2
C
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Qtz-B1
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Cau-B
Qtz-B1
Aaf-B
Cau-B
Aaf-B2
Cau-B
293
296
Qtz-B1
Aaf-B1
Qtz-B1
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Cau-B
Au-B
Qtz-B1
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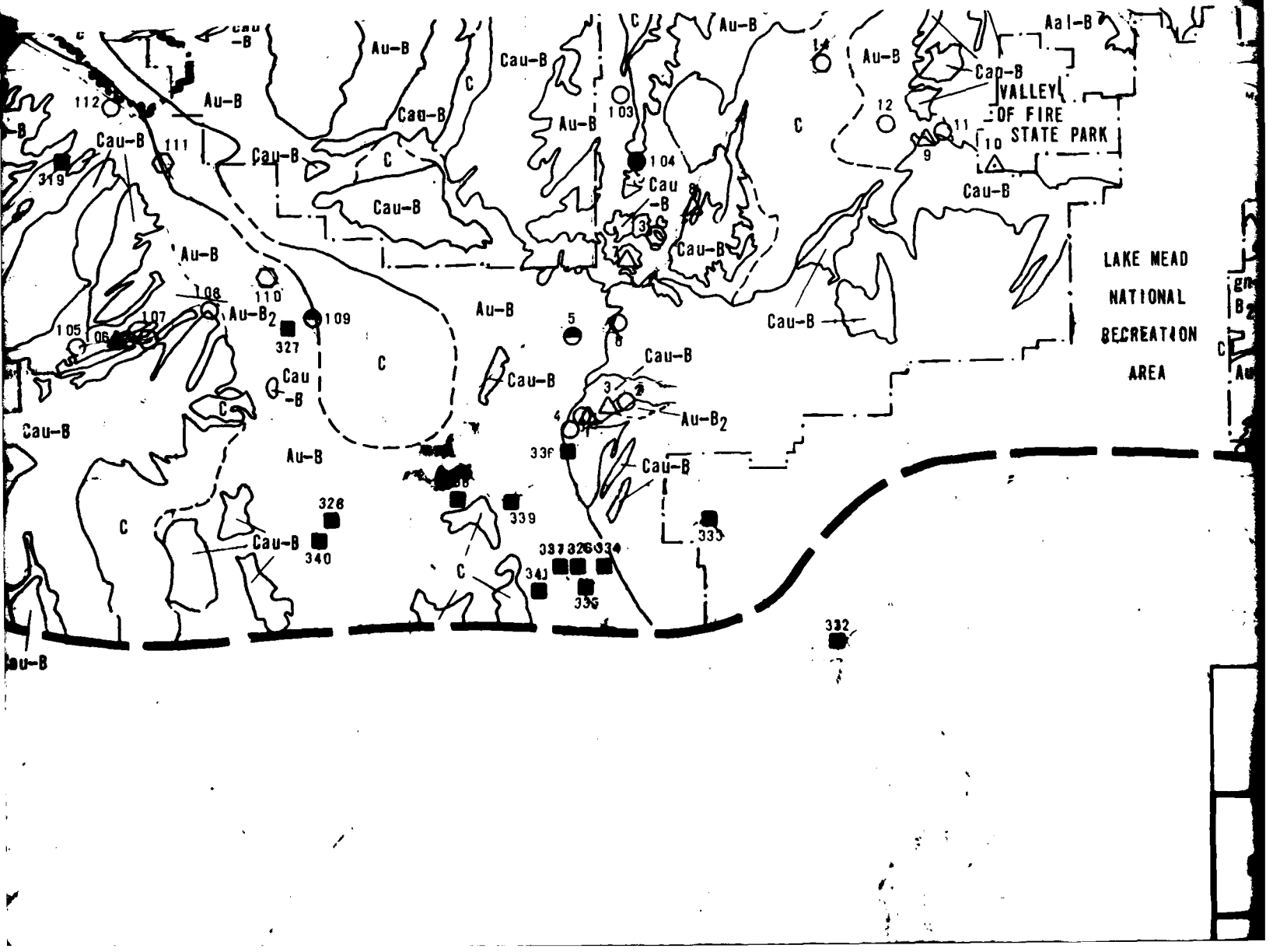
Au-B
Cau-B
C
Aal-B
VALLEY OF FIRE STATE PARK
LAKE MEAD NATIONAL RECREATION AREA
Au-B2
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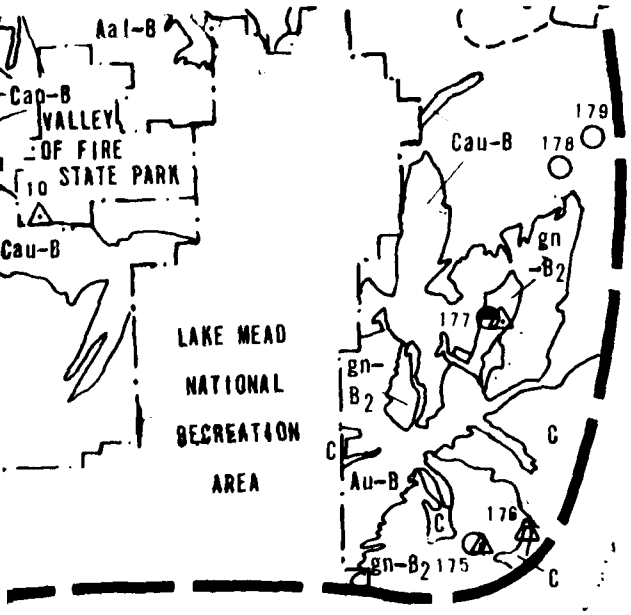


NEVADA-CALIFORNIA AGGREGATE RESOURCE MAP

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

DRAWING
3

FUGRO NATIONAL, INC.

BIBLIOGRAPHY

Albers, J. and Stewart, J., 1972, Geology and Mineral Deposits of Esmeralda County, Nevada: Nevada Bureau of Mines and Geology, Bulletin 78, 80 p.

American Concrete Institute Journal, 1961, Selection and Use of Aggregates for Concrete: NRMCA Publication, No. 101, 28 p.

American Public Works Association, 1970, Standard Specifications for Public Works Construction: Part 2 - Construction Materials, Sec 200 Rock Materials, pp. 62-70.

American Society for Testing and Materials, 1976, Annual Book of ASTM Standards, Part 14: Concrete and Mineral Aggregates, 706 p.

Archbold, N., 1966, Industrial Deposits of Mineral County, Nevada: Nevada Bureau of Mines, Report 14, 32 p.

Arizona Highway Dept., Materials Division, 1960, Aggregate Sources and Geology of Maricopa County, 55 p.

_____, 1960, Aggregate Sources and Geology of Yuma County, 55 p.

_____, 1972, A Materials Inventory of Yavapai County, 65 p.

_____, 1972, Aggregate Sources and Geology of Pinal County, 31 p.

_____, 1963, Aggregate Sources and Geology of Pima County, 63 p.

Babcock, H. and Kendall, K., 1948, Geology and Groundwater Resources of the Gila Bend Basin, Maricopa County, Arizona: U.S. Geological Survey Open File Report, 1948, 27 p.

Bachman, G. and Harbour, R., 1970, Geologic Map of the Northern Part of the San Andres Mountains, Central New Mexico: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-600.

Ball, S., 1907, A Geologic Reconnaissance in Southwestern Nevada and Eastern California: U.S. Geological Survey, Bulletin 308, 218 p.

Barnes, V., Geologic Atlas of Texas, Van Horn - El Paso Sheet: Bureau of Economic Geology, University of Texas at Austin.

Bateman, P., 1965, Geology and Tungsten Mineralization of the Bishop District, California: U.S. Geological Survey Professional Paper 470, 208 p.

BIBLIOGRAPHY (Cont.)

Beede, J., 1920, Correlation of the Upper Paleozoic Rocks of the Hueco Mountains Region: Texas Science, V. 51, 494 p.

Blanks, R., and Kennedy, H., 1955, The Technology of Cement and Concrete: V. 1, Concrete Materials, John Wiley & Sons, Inc., 422 p.

Brokaw, A. and Heidrick, T., 1960, Geologic Map and Sections of the Girou Wash Quadrangle, White Pine County, Nevada: U.S. Geological Survey Map, GQ-476.

Brokaw, A., 1967 Geologic Map and Sections of the Ely Quadrangle, White Pine County, Nevada: U.S. Geological Survey Map, GQ-697.

Brown, L., 1955, Some Observations on the Mechanics of Alkali-Aggregate Reaction: Portland Cement Association, Research Department Bulletin 54, 17 p.

_____, 1959, Petrography of Cement and Concrete: Portland Cement Research Department, Bulletin 111.

California Division of Mines and Geology, 1962, San Diego - El Centro Sheet.

Cambell, I., 1967, Geologic Map of California, Salton Sea Sheet: California Division of Mines and Geology.

Clemons, R. and Seager, W., 1973, Geology of Souse Springs Quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Bulletin 100, 31 p.

Colton, R. and Noble, D., 1967, Geologic Map of the Groom Mine SW Quadrangle, Nye and Lincoln Counties, Nevada: U.S. Geological Survey Map, GQ-719.

Cornwall, H., 1972, Geology and Mineral Deposits of Southern Nye County, Nevada: Nevada Bureau of Mines and Geology, Bulletin 77, 49 p.

Crowder, D., et al, 1972, Geologic Map of the Benton Quadrangle, Mono County, California and Esmeralda and Mineral Counties, Nevada: U.S. Geological Survey Map, GQ-1013.

Crowder, D. and Sheridan, M., 1972, Geologic Map of the White Mountain Peak Quadrangle, Mono County, California: U.S. Geological Survey Map, GQ-1012.

Davis, R., 1959, Sources of Concrete Aggregate on the Tonopah Test Range, Southeast of Tonopah, Nye County, Nevada: U.S. Geological Survey Memorandum Report 1002, 20 p.

BIBLIOGRAPHY (Cont.)

Drewes, H., 1963, Geology of the Funeral Peak Quadrangle, California, on the East Flank of Death Valley: U.S. Geological Survey Professional Paper 413, 78 p.

DuBois, F., 1977, Directory of Nevada Mine Operations Active During Calendar Year 1976: State of Nevada Industrial Commission, 15 p.

Erlin, B., 1966, Methods Used in Petrographic Studies of Concrete: Portland Cement Association, Research Department Bulletin 193, 17 p.

Ferguson, H. and Cathcart, S., 1975, Geology of the Round Mountain Quadrangle, Nevada: U.S. Geological Survey Map, GQ-40.

Forrester, J., 1962, Folio of Geologic and Mineral Maps of Arizona: Arizona Bureau of Mines, Bulletin 170.

Fugro, Inc., Sundesert Nuclear Plant, Preliminary Safety Analysis Report, V. 2: 2.5 - Geology and Seismology.

_____, Palo Verde Nuclear Generating Station, Environmental Report Construction Permit Stage, V. 2: 2.4 Geology.

Fugro National, Inc., 1975b, Geotechnical report, White Sands Missile Range/Fort Bliss Military Reservation: Cons. report for SAMSO, v. IIA, 113 p., data summary sheets, appendices and graphics volume.

_____, 1975c, Geotechnical report, Yuma Proving Grounds/Luke-Williams Bombing and Gunnery Range: Cons. report for SAMSO, v. IIB, 122 p., data summary sheets, appendices and graphics volume.

_____, 1975d, Geotechnical report, Nellis Bombing and Gunnery Range: Cons. report for SAMSO, v. IIC, 125 p., data summary sheets, appendices and graphics volume.

_____, 1975b, Geotechnical report, White Sands Missile Range Extension: Cons. report for SAMSO, v. IIA, 88 p., data summary sheets, appendices and graphics volume.

_____. 1976c, Geotechnical report, Gila Bend Group: Cons. report for SAMSO, v. IIB, 120 p., data summary sheets, appendices and graphics volume.

_____, Inc., 1976d, Geotechnical report, Nellis Group: Cons. report for SAMSO, v. IIC, 142 p., data summary sheets, appendices and graphics volume.

BIBLIOGRAPHY (Cont.)

Gile, L.H., 1961, A classification of Ca horizons in soils in a desert region, Dona Ana County, New Mexico: Soil Science Society America Proc., v. 25, no. ', p. 52-61.

Gile, L.H., Peterson, F.F., and Grossman, R.B., 1966, Morphologic and genetic sequences of carbonate accumulation in desert soils: Soil Sci., v. 101, p. 347-360.

Goldman, H. 1964, Sand and Gravel in California, an Inventory of Deposits: California Division of Mines and Geology, Bulletin 180, 80 p.

Griswold, G., 1959, Mineral Deposits of Lincoln County, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Bulletin 67, 117 p.

Hacker, L., 1977, Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico: U.S. Department of Agriculture, 101 p.

Hadley, D., 1968, Field and Laboratory Studies on the Reactivity of Sand-Gravel Aggregates: Portland Cement Association, Research Department, Bulletin 221, 33 p.

_____, 1964, Alkali Reactivity of Dolomite Carbonate Rocks: Portland Cement Association, Research Department, Bulletin 176, 19 p.

Hamilton, W., 1964, Geologic Map of the Big Maria Mountains NE Quadrangle, Riverside County, California and Yuma Counties, Arizona: U.S. Geological Survey Map, GQ-350.

Heindl, L. and Armstrong, L., 1963, Geology and Groundwater Conditions in the Gila Bend Indian Reservation, Maricopa County, Arizona: U.S. Geological Survey Water-Supply Paper 1647-A, 48 p.

Hinrichs, E., 1968, Geologic Map of the Camp Desert Rock Quadrangle, Nye County, Nevada: U.S. Geological Survey Map, GQ-726.

Hoffer, J., 1976, Geology of Potrillo Basalt Field, South-Central New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 149, 30 p.

_____, 1970, Petrology and Mineralogy of the Campus Andesite Pluton, El Paso, Texas: GSA Bulletin 81, pp. 2129-2135.

Hose, R., et al., 1976, Geology and Mineral Resources of White Pine County, Nevada: Nevada Bureau of Mines and Geology, Bulletin 85, 106 p.

BIBLIOGRAPHY (Cont.)

Jenkins, O., 1958, Geologic Map of California, Death Valley Sheet: State of California, Department of Natural Resources.

_____, 1967, Geologic Map of California, Mariposa Sheet: State of California, Division of Mines & Geology.

Jett, J., 1977, Directory of Active Mines in Arizona, (Including Sand and Gravel Producers): Arizona Department of Mineral Resources, 26 p.

Jicha, H., 1968, Geology and Mineral Resources of Mesa del Oro Quadrangle, Socorro and Valencia Counties, New Mexico: State Bureau of Mines and Mineral Resources, Bulletin 56, 67 p.

Jones, B. and Reaser, D., 1970, Geology of Southern Quitman Mountains, Hudspeth County, Texas: Bureau of Economic Geology, University of Texas at Austin, GQ Map No. 39.

King, P., 1948, Geology of the Southern Guadalupe Mountains, Texas: U.S. Geological Survey Professional Paper 215, 183 p.

Kleinhampl, F. and Ziony, J., 1967, Preliminary Geologic Map of Northern Nye County, Nevada: U.S. Geological Survey Open File Map.

Kottlowski, F., 1962, Reconnaissance of Commercial High-Calcium Limestones in New Mexico: New Mexico Institute of Mining and Technology, Circular 60, 77 p.

_____, 1956, Stratigraphic Studies of the San Andreas Mountains, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Memoir 1, 132 p.

_____, 1963, Paleozoic and Mesozoic Strata of Southwestern and South-Central New Mexico: New Mexico Institute of Mining and Mineral Resources, Bulletin 70, 100 p.

_____, 1957, High Purity Dolomite Deposits of South-Central New Mexico: New Mexico Institute of Mining and Technology, Circular 47, 43 p.

Krauskopf, K., 1971, Geologic Map of the Mt. Barcroft Quadrangle, California-Nevada: U.S. Geological Survey Map, GQ-960.

Krynine, O. and Judd, W., 1957, Principles of Engineering Geology and Geotechnics: McGraw-Hill Book Co., 450 p.

BIBLIOGRAPHY (Cont.)

Langman, L., et al, 1967, Soil Survey, Las Vegas and Eldorado Valleys Area, Nevada: U.S. Department of Agriculture, Series 1957, No. 23, 87 p.

Lattman, L., 1971, Geomorphology of the East Blank of the Spring Mountains, Nevada: U.S. Air Force AFCRL-71-0326, 10 p.

Lerch, W., 1956, Concrete Aggregate-Chemical Reaction: Portland Cement Association, Research Department Bulletin 74, 6 p.

_____, 1959, A Cement-Aggregate Reaction that occurs with Certain Sand-Gravel Aggregates: Portland Cement Research Department, Bulletin 122.

_____, 1956, Concrete Aggregates - Chemical Reactions: Portland Cement Research Department, Bulletin 74.

Longacre, J., 1977, Sixty-Fourth Annual Report by the State Inspector of Mines: Nevada State Inspector of Mines, 70 p.

Longwell, C. et al, 1936, Geology and Mineral Deposits of Clark County, Nevada: Nevada Bureau of Mines, Bulletin 62. Plates.

_____, 1965, Geology and Mineral Deposits of Clark County, Nevada: Nevada Bureau of Mines, Bull. 62, 218 p.

Lovelace, A., 1972, Geology and Aggregate Resources, District II: New Mexico State Highway Department.

McAllister, J., 1970, Geology of the Furnace Creek Borate Area, Death Valley, Inyo County, California: California Division of Mines & Geology Map Sheet 14.

_____, 1973, Geologic Map and Sections of the Amargosa Valley Borate Area - Southeast Continuation of the Furnace Creek Area, Inyo County, California: U.S. Geological Survey Map I-782.

McCutchan, B., 1976, Sixty-fifth Annual Report of the State Mine Inspector: State of Arizona.

McKee, E. and Nelson, C., 1967, Geologic Map of the Soldier Pass Quadrangle, California and Nevada: U.S. Geological Survey Map, GQ-654.

Metzger, D., 1957, Geology and Groundwater Resources of the Harquahala Plains Area, Maricopa and Yuma Counties, Arizona: U.S. Geological Survey Open File Report, 1957, 40 p.

BIBLIOGRAPHY (Cont.)

Metzgar, D., et al., 1973, Geohydrology of the Parker-Blythe-Cibola Area, Arizona and California: U.S. Geological Survey Professional Paper, 486-G, 130 p.

Metzgar, D., and Loeltz, O., 1973, Geohydrology of the Needles Area, Arizona, California and Nevada: U.S. Geological Survey Professional Paper, 486-J, 54 p.

Miller, F., 1970, Geologic Map of the Quartzite Quadrangle, Yuma County, Arizona: U.S. Geological Survey Map, GQ-841.

Morton, P., 1965, Geology of the Queen of Sheba Lead Mine, Death Valley, California: California Division of Mines and Geology, Special Report 88, 35 p.

National Sand & Gravel Association, 1977, Compilation of ASTM Standards Relating to Sand and Gravel and Concrete: NSGA Circular No. 113, NRMCA Publication No. 137.

Neher, R., 1976, Soil Survey of Mescalero-Apache Area, New Mexico, Northeastern Otero County: U.S. Department of Agriculture, Soil Conservation Service, 79 p.

Nelson, C., 1966, Geologic Map of the Blanco Mountain Quadrangle, Inyo and Mono Counties, California: U.S. Geological Survey Map, GQ-529.

_____, 1966, Geologic Map of the Wovcoloa Mountain Quadrangle, Inyo County, California: U.S. Geological Survey Map, GQ-528.

_____, 1940, Paleozoic Stratigraphy of Franklin Mountains, Texas, A.A.P.G Bulletin 24, pp 157-173.

Nevada Dept. of Highways, Materials and Research Laboratory Aggregate Test Data, Unpublished.

New Mexico State Highway Dept., Belen Quadrangle, No. 53, Unpublished.

_____, Manzano Mountains Quadrangle, No. 54, Unpublished.

_____, Laguna Del Perro Quadrangle, No. 55, Unpublished.

_____, Vaughn Quadrangle, No. 56, Unpublished.

_____, Jornada del Muerto Quadrangle, No. 89, Unpublished.

_____, Magdalena Quadrangle, No. 64, Unpublished.

_____, Socorro Quadrangle, No. 65, Unpublished.

BIBLIOGRAPHY (Cont.)

New Mexico State Highway Dept., San Antonio Quardrangle, No. 77, Unpublished.

_____, La Union Quadrangle, No. 125, Unpublished.

_____, Mt. Riley Quadrangle, No. 124, Unpublished.

_____, Cambray Quadrangle, No. 112, Unpublished.

_____, Las Cruces Quadrangle, No. 113, Unpublished.

_____, Hatch Quadrangle, No. 100, Unpublished.

_____, Elephant Butte Quadrangle, No. 88, Unpublished.

Nolan, T., et al., 1971, Geologic Map of the Eureka Quadrangle, Eureka and White Pine Counties, Nevada: U.S. Geologic Survey Map I-612.

Olmsted, F., 1972, Geologic Map of the Laguna Dam 7.5-Minute Quadrangle, Arizona and California: U.S. Geological Survey Map, GQ-1014.

Orkild, P., 1963, Geologic Map of the Tippipah Spring Quadrangle, Nye County, Nevada: U.S. Geological Survey Map, GQ-213.

Otte, C., 1959, Late Pennsylvania and Early Permian Stratigraphy of the Northern Sacramento Mountains, Otero County, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Bulletin 50, 111 p.

Papke, K., 1973, Industrial Mineral Deposits of Nevada: Nevada Bureau of Mines and Geology, Map 46.

Park, C. et al., 1958, Geologic Map and Sections of the Pioche Hills, Lincoln County, Nevada: U.S. Geological Survey Map, MF-136.

Parsons, 1977, Operation Construction Plan MX Buried Trench Construction and Test Project: Cons. report for SAMSO, v. I, p. 3-145.

_____, 1977, Operation Construction Estimate Cast-in-Place Concept for MX Buried Trench Construction and Test Project: Cons. report for SAMSO, p. 86.

Perhac, R., 1970, Geology and Mineral Deposits of the Gallinas Mountains, Lincoln and Torrance Counties, New Mexico: New Mexico State Bureau of Mines and Minerals Resources, Bulletin 95, 51 p.

BIBLIOGRAPHY (Cont.)

Pickett, G., 1956, Effect of Aggregate on Shrinkage of Concrete and Hypothesis Concerning Shrinkage: Portland Cement Association, Research Department, Bulletin 66, 5p.

Poole, F., 1965, Geologic Map of the Frenchman Flat Quadrangle, Nye, Lincoln, and Clarke Counties, Nevada: U.S. Geological Survey Map, GQ-456.

Portland, Cement Association, 1968, Design and Control of Concrete Mixtures, Engineering Bull. 11th Edition.

_____, 1975, Portland Cements.

Portland Cement Association, 1966, Fundamental Facts about Concrete.

_____, 1972, Aggregates for Concrete.

Roper, H., 1960, Volume Changes of Concrete Affected by Aggregate Type: Portland Cement Association, Research Deartment Bulletin 123, 4 p.

Ross, D., 1961, Geology and Mineral Deposits of Mineral County, Nevada: Nevada Bureau of Mines, Bulletin 58, 98 p.

Roswell Geologic Society, 1960, Guidebook for Field Trip Northern Franklin Mountains, Southern San Andres Mountains with Emphasis on Pennsylvanian Stratigraphy, 160 p.

Ruhe, R., 1967, Aggregate Resources and Soil Study, New Mexico Interstate Route 10: New Mexico State Highway Department.

Rutz, B., 1962, Aggregate Resources and Soil Study, New Mexico Interstate Route 10: New Mexico State Highway Department.

_____, 1964, Aggregate Resources and Soil Study, New Mexico Interstate Route 25: New Mexico State Highway Department.

Schmidt, P. and Craddock, C., 1964, The Geology of the Jarilla Mountains, Otero County, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Bulletin 82, 55 p.

Seager, W., et al, 1976, Geology of Dona Ana Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 147, 38 p.

_____, 1971, Geology of San Diego Mountain Area, Dona Ana County, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Bulletin 97, 38 p.

BIBLIOGRAPHY (Cont.)

Seager, W., and Hawley, J., 1973, Geology of Rincon Quadrangle, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Bulletin 101, 42 p.

Stark, J., 1956, Geology of the South Manzano Mountains, New Mexico: New Mexico State Bureau of Mines and Mineral Resources, Bulletin 34, 46 p.

Stewart, J. and Carlson, J., 1974, Preliminary Geologic Map of Nevada: U.S. Geological Survey Map, MF-609.

Stewart, J., et al, 1974, Geologic Map of the Piper Peak Quadrangle, Nevada - California: U.S. Geological Survey Map, GQ-1186.

Stewart, J., 1977, Geology and Mineral Deposits of Lander County, Nevada: Nevada Bureau of Mines and Geology, Bulletin 88, 106 p.

Troxel, B. and Wright, L., 1976, Geologic Features, Death Valley, California: California Division of Mines and Geology, Special Report 106, 72 p.

TRW, 1977, Warren Pfefferle, personal communication.

Tschanz, C., and Pampeyan, E., 1970, Geology and Mineral Deposits of Lincoln County, Nevada: Nevada Bureau of Mines, Bulletin 73, 188 p.

University of Nevada, Reno, Guidebook: Las Vegas to Death Valley and Return: Nevada Bureau of Mines and Geology, Report 26, 39 p.

University of Nevada, 1974, Guidebook to the Geology of Four Tertiary Volcanic Centers in Central Nevada: Nevada Bureau of Mines and Geology, Report 19, 72 p.

U.S. Army Material Command, 1972, The Master Plan of White Sands Missile Range, New Mexico: Basic Information Maps, 86 plates.

United States Department of the Interior, Bureau of Mines, 1974, The Mineral Industry of Arizona.

_____, 1974, The Mineral Industry of California.

_____, 1974, The Mineral Industry of Nevada.

United States Department of the Interior, Bureau of Reclamation, 1966, Concrete Manual: A Manual for the Control of Concrete Construction, 642 p.

BIBLIOGRAPHY (Cont.)

United States Department of the Interior, Bureau of Reclamation, Lower Colorado Regional Office, Nevada Aggregate Data, Unpublished.

_____, New Mexico Aggregate Data, Unpublished.

Vitaliano, C. and Callaghan, E., 1963, Geology of the Paradise Peak Quadrangle, Nevada: U.S. Geological Survey Map, GQ-250.

Waddell, J., 1976, Concrete Inspection Manual: International Conference of Building Officials, 332 p.

Wilhelms, D., 1963, Geology of Part of the Nopah and Resting Springs Ranges, Inyo County, California: PhD dissertation, University of California at Los Angeles, 224 p.

APPENDIX A

NEW MEXICO-TEXAS STUDY AREA DATA SHEETS

Explanation

The following notes are intended to serve as an aid in the use of Tables A1 and A2.

Table A1

Note 1 Multiple entries under a field station number indicate that data were collected on more than one potential source of concrete aggregate at that field station.

Note 2 Seive analyses reported for potential sources of crushed rock represent the size distribution of the sample following crushing to prepare the material for the L.A. abrasion test.

Note 3 Symbols used for designating the material type of basin-fill deposits are in accordance with the Unified Soil Classification System.

Note 4 Field stations at which only a photograph of representative materials was made are designated as photo stops in Appendix A1.

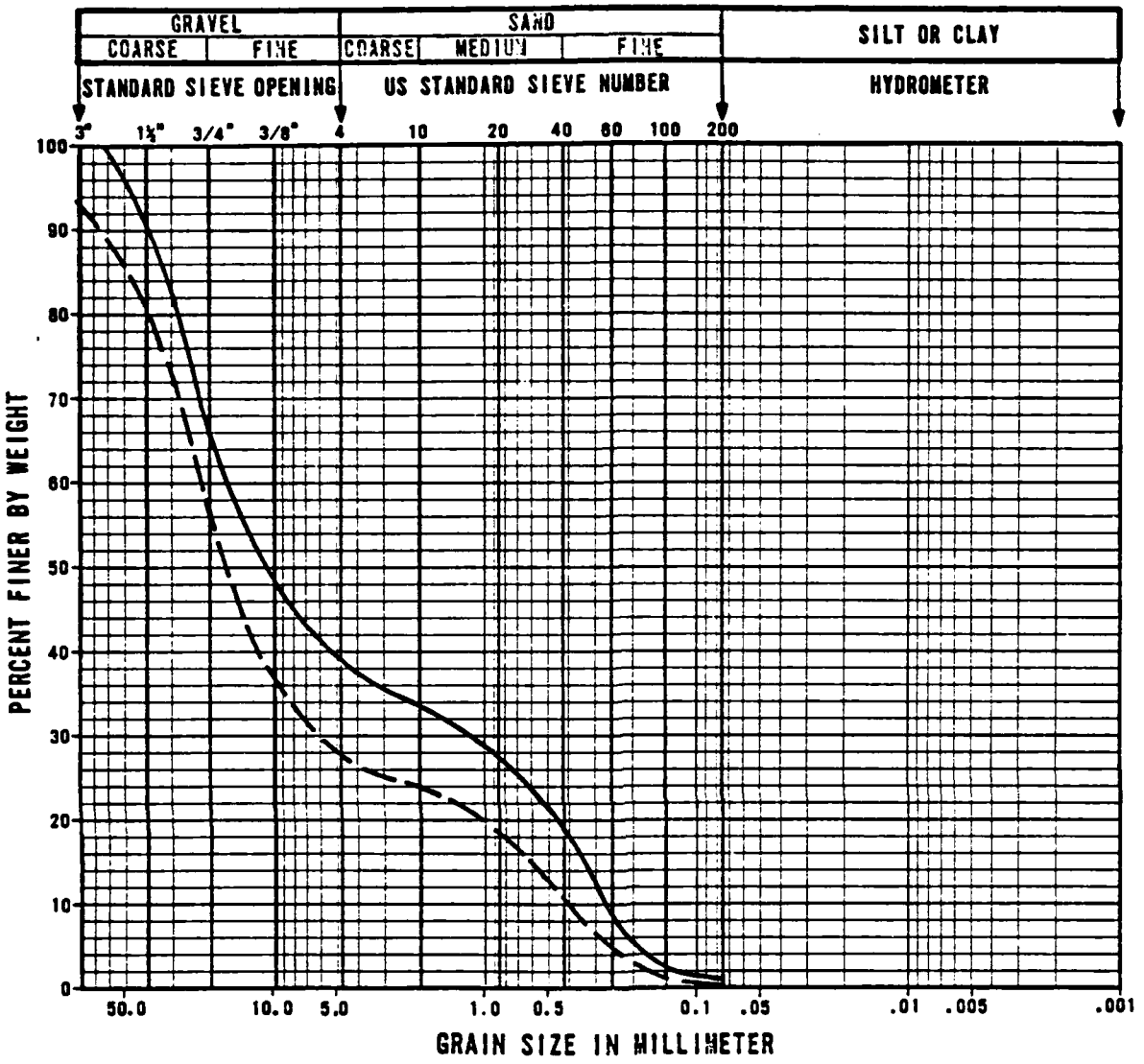
Table A2

Note 1 Much of the test data obtained from existing sources of information was not originally intended to determine the suitability of the material for use as concrete aggregate. Those test results which were applicable to concrete aggregate are shown.

Note 2 Test results from existing sources of information reported in Table A2 for the soundness loss of aggregate were determined using a sodium-sulfate saturated solution unless otherwise noted. Soundness loss determinations reported in Table A1 were obtained using a magnesium-sulfate saturated solution which provides a more-severe test.

Note 3 Where existing test data were reported separately for the coarse (+#4 sieve) and fine (-#4 sieve) fractions of a sample, a C for coarse of an F for fine precedes the appropriate data column.

Note 4 Limited quantities of suitable aggregate may be found locally within Class C basin-fill deposits. While these materials are not present in sufficiently large volumes to meet the needs of the MX system, they may prove adequate as a source of special purpose aggregate. Where available, representative test data for these deposits have been included in Table A2.



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NM-1	Asf	GP
— —	NM-7	Asf	GP

GRAIN SIZE CURVES
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATER TYP	LABORATORY TEST DATA SIEVE ANALYSIS % PASSING 1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
NM 1	Rio Grande Valley	Asf	SP	76	66	48	39	35	33	27	1	B
NM 2	Rio Grande Valley	Asf	SP-GP								3	B
NM 3	Rio Puerco Valley											
NM 4	Rio Puerco Valley											
NM 5	Rio Grande Valley	Asf	SP-GP/C									B
NM 6	Rio Grande Valley	Asf	GP-SP									A
NM 7	Rio Grande Valley	Asf	SP-GP	68	57	37	27	24	23	17.0	0	B
NM 8	Los Pinos Mtns		schist									C
NM 9	San Andres Mtns	Qtz	Quartzi									A
NM 10	Los Pinos Mtns	Au	SM									C
NM 11	Jornado Del Muerto	Vb	Basalt									B
NM 12	Arroyo de la Matanza	Au	SP & G									B
NM 13	Arroyo de la Matanza	Vu	Volcan: agglom									C
NM 14	Water Canyon	Au	SC									C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 1 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE A-1

UGRO NATIONAL, INC.

FN-TR-20

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 1	Rio Grande Valley	Asf	SP	Trace scoriacecus volcanics, soft seds, trace chert	1	high	yes	--
NM 2	Rio Grande Valley	Asf	SP-GP	River terrace west side Rio Grande River	-	--	--	--
NM 3	Rio Puerco Valley			Dissected terrace deposit (Photo stop)				
NM 4	Rio Puerco Valley			Flood plain deposit (Photo stop)				
NM 5	Rio Grande Valley	Asf	SP-GP/CL	Trace chert and soft sediments; interbedded clay lenses	1	high	yes	50
NM 6	Rio Grande Valley	Asf	GP-SP	None	1	high	no	4
NM 7	Rio Grande Valley	Asf	SP-GP	25% intermediate volcanics, trace mica and chert	1	high	yes	
NM 8	Los Pinos Mtns		schist	platy-soft material	-	low	no	
NM 9	San Andres Mtns	Qtz	Quartzite	clay-filling in fractures; caliche at surface	-	high	no	
NM 10	Los Pinos Mtns	Au	SM	abundant schist, soft platy particles	1-2	low	yes	
NM 11	Jornado Del Muerto	Vb	Basalt	scoriaceous and low density locally; caliche at surface	-	mod low	yes	
NM 12	Arroyo de la Matanza	Au	SP & GP	NMMD pit #57150, glassy volcanics, 20% lightweight particles	-	high mod	yes	
NM 13	Arroyo de la Matanza	Vu	Volcanic agglomerate	pumice, glassy, sof.	-	low	yes	
NM 14	Water Canyon	Au	SC	90% intermediate volcs. glassy	-	mod low	yes	

VALUES				LABORATORY TEST DATA												
POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
							2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
yes	--	--	NP low		7.4		100	91	76	66	48	39	35	33	27	1	B
--	--	--	--													3	B
yes	50 0	5 95	NP high														B
no	40	0	--														A
yes			NP	25.0	13.7		88	82	68	57	37	27	24	23	17.0	0	B
no	--	--	--														C
no	--	--	--														A
yes	25	10	NP low														C
yes	--	--	--														B
yes	--	--	--														B
yes	--	--	--														C
yes	20	35	low med														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 1 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE A-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 15	Shakespeare Canyon	Au	SC-SM GC-GM	50% intermediate volcanics, 15% agglomerate	1	high mod	yes	60
NM 16	Magdalena Mtns	Vu	Dacite	glassy; poorly bonded	-	mod	yes	--
NM 17	Bear Mtns	Au	SM & GM	soft coarse grained volcanics silicic volcanics and tuff	-	low mod	yes	35
NM 17	Bear Mtns	Vb	Basalt	caliche coatings at surface, very weathered in outcrop	-	low	no	--
NM 18	Bear Mtns	Au	GP	abundant silicic and intermediate volcanics, heavy caliche	3	mod low	yes	50
NM 19	Magdalena Mtns	Vu	Dacite	glassy, biotite	-	0 high	yes	--
NM 20	Mulligan Wash	Au	GP	abundant silicic volcanics, glassy	2	0 high	yes	65
NM 21	Rio Grande Valley	Asf	CL/ SM - GM	80% intermediate & silicic volcanics, clay, glassy	2	high	yes	10 50+
NM 22	Arroyo del Puertecito	gr	Granite Gneiss	v. weathered in outcrop; large biotite books	-	mod	no	--
NM 23	Arroyo del Puertectio	Au	SM	decomposed granite, trace clay, biotite	1	low	no	25
NM 24	Rio Grande Valley	Asf	SP-GP	15% intermediate volcanics, trace clay	1	high	yes	60
NM 25	Jornada del Muerto	Vb	Basalt	vesicular, glassy	-	high mod	yes	--
NM 26	Rio Grande Valley	Asf	SP & SM	30% intermediate volcanics 20% soft sediments	1	mod	yes	35
NM 27	Rio Grande Valley	Asf	GP	95% intermediate & silicic volcs glassy, moderate caliche coating	1	high	yes	--

TED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING 2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
high mod	yes	60	15	low														B2
mod	yes	--	--	--														C
low mod	yes	35	25	low med														C
low	no	--	--	--														C
mod low	yes	50	10	low														C
0 high	yes	--	--	--														B2
0 high	yes	65	trace	NP														B
high	yes	10 50+	10 50+	low med														B2
mod	no	--	--	--														C
low	no	25	10	low														C
high	yes	60	5	NP low														B
high mod	yes	--	--	--	25.0	3.0	NP	100	100	66	49	27	18					B
mod	yes	35	10	NP low														B
high	yes	--	--	NP	19.8	10.9		82	76	69	64	50	37	29	24	17	3.9	B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 2 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES			
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE
NM 28	Mulligan Gulch	Aal	SM-SP-GP	100% intermediate & silicic volcs., glassy, coatings	1	high	yes
NM 29	Nogal Canyon	Au	SM & SP	90% silicic & intermediate volcanics, trace chert		high	yes
NM 30	Nogal Canyon	Au	GP-GC	95% silicic & intermediate volcanics, tr. clay, glassy	1	high	yes
NM 31	Rio Grande Valley	Asf	GP-SP/SM	90% intermediate & silicic volcs caliche nodules, glassy	1	high	yes
NM 32	San Andres Mtns	Au	GP/ SC-CL	abundant caliche coatings, clay lenses limited quantity	2	high	no
NM 33	San Andres Mtns	Psa	Limestone	abundant caliche coating, dolomite	2	high	yes
NM 34	San Andres Mtns	Au	GP	caliche coatings, chert	1	high	yes
NM 35	San Andres Mtns	Au	GP-SP/SC	abundant caliche, chert	3	high	yes
NM 36	Jornado del Muerto	Vb	Basalt	vesicular, possibly glassy, caliche at surface		high	yes
NM 37	Turtle Mtns	Aal	GP-GM	10% soft sediments, trace chert	-	high	yes
NM 37	Turtle Mtns	Cau	Limestone	abundant chert, siltstone interbeds		high mod	yes
NM 38	Turtle Mtns	Asf	GP-SP	15% chert, caliche coatings	2	high	yes
NM 39	Turtle Mtns	Cau	Limestone-Dolomite	abundant chert, argillaceous		mod low	yes
NM 40	Negro Creek	Aal	SP-SM	75% intermediate and silicic volcanics, glassy	1	high	yes

ED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes	45	10	NP low														B
high	yes	45	10	NP														B
high	yes	60	10	low														B
high	yes	40	15	low NP														B
high	no	85	5	low														B
high	yes																	B_1
high	yes			NP	33.8	15.79		89	84	73	63	40	24	13	7	4	10	C
high	yes	60	10	NP														C
high	yes																	B
high	yes	50	10	NP														B
high od	yes																	B
high	yes	60	10	NP														B
od low	yes																	B
high	yes	25	15	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 3 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 41	Rio Grande Valley	Asf		View of Bluff in Santa Pe Formation (photo stop)	-	--	--	--
NM 42	Caballo Mtns	gr	Granite	weathered in outcrop	-	mod	no	--
NM 42	Caballo Mtns	Cau	Limestones	View of Madera and Sandia Formations (photo stop)				
NM 43	Caballo Mtns	Asf	GP-SP	10% chert, caliche coatings	1	high	yes	4(
NM 44	Apache Canyon	Asf	GP-GM	10% intermediate volcanics, tr. chert & caliche coatings	-	high	yes	5
NM 45	Green Canyon	Asf	GP-SP	25% soft sediments, trace chert	1	high	yes	4(
NM 46	Caballo Mtns	Cau	Limestone & Shale	abundant chert, platy particles, soft shale interbeds	-	high low	yes	-
NM 47	Sierra de las Uvas	Au	SP	10% silicic volcs., 10% soft sediments	1	high mod	yes	4
NM 48	Sierra de las Uvas	Au	SM-SC	10% silicic volcs, 10% soft sediments, caliche coatings	1	high mod	yes	3
NM 49	Rincon Arroyo	Asf	SP	40% silicic & intermediate volcs 10% soft seds, trace chert, clay	1	high mod	yes	3
NM 49	Rincon Arroyo	Asf	SP	15% silicic and intermediate volcanics, 10% chert	1	high	yes	
NM 50	Rio Grande Valley	Asf	GP-SP	35% intermediate-silicic volcanics, trace chert	1	high mod	yes	5
NM 51	Tularosa Valley	Au	GP-SP	caliche coatings, trace chert	1	high	yes	4(
NM 52	Tularosa Valley	Au		existing pit on WSMR (photo stop)				

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
--	--	--	--	--														
mod	no	--	--	--														B2
																		B
high	yes	40	10	NP low														B
high	yes	55	10	NP low														B
high	yes	40	5	NP														B
high low	yes	--	--	--														B
high mod	yes	45	5	NP														B
high mod	yes	35	15	NP low														B
high mod	yes	35	10	NP														B
high	yes	5	0	NP														B
high mod	yes	55	5	NP														B
high	yes	40	10	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 4 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 53	San Andres Mtns	Au	SP-SM	10% soft seds, abundant caliche, trace chert	2	high	yes	35
NM 53	San Andres Mtns	Au	SM	5% soft sediments, trace chert	1	high	yes	40
NM 54	San Andres Mtns	gr	Granite and diabase dike	soft diabasic material	-	high low	no	--
NM 55	San Andres Mtns	gr	Limestone Granite	View of contact exposed in mountain front (photo stop)				
NM 56	San Andres Mtns	Au	SM	soft particles	1	mod low	no	35
NM 56	San Andres Mtns	Au	SP-SW	20% soft particles, trace chert	-	mod low	no	35
NM 57	Tularosa Basin	Au	SP	10% soft seds, 5% chert 10% soft intrusives	-	high mod	yes	55
NM 58	San Andres Mtns	Au	GP	25% soft sediments, 5% chert, Fe oxides in sediments	2	high mod	yes	75
NM 59	San Andres Mtns	Au	SM	45% soft material, 5% chert, caliche coatings	1	mod high	yes	35
NM 60	San Andres Mtns	Au	SP-SM	10% soft particles, trace chert, abundant caliche locally	1 3	mod high	yes	45
NM 61	Deadman Canyon	Au	SP-SM	10% soft particles, trace chert, abundant caliche locally	1 3	mod high	yes	45
NM 62	Deadman Canyon	Au	SP	25% sedimentary particles, trace chert	-	high mod	yes	50
NM 63	Deadman Canyon	Cau	Metasediment	v. weathered in outcrop platy particles, chlorite	-	low mod	yes	--
NM 64	Deadman Canyon	Cau	Argillaceous Sandstone	soft, friable, high percent mica and platy minerals	-	low	no	--

ED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes	35	15	NP low														B
igh	yes	40	15	NP low														B
igh ow	no	--	--	--														B_2
od ow	no	35	15	low														B
od ow	no	35	5	NP														B
igh od	yes	55	5	NP low														B
igh od	yes	75	5	NP low														B
od igh	yes	35	15	low														B
od igh	yes	45	10	NP low														B
od igh	yes	45	10	NP low														B
igh od	yes	50	10	NP														B
ow od	yes	--	--	--														C
ow	no	--	--	--														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 5 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 65	Rhodes Canyon	Au	SP-SM	trace chert, 10% soft material	2	high mod	yes	40
NM 66	Rhodes Canyon	Au	SP	10% soft material, trace chert	-	high mod	yes	45
NM 67	Organ Mtns	gr	Quartz Monznonite	weathered in outcrop, biotite	-	mod	no	--
NM 68	Tortugas Arroyo	Asf	SP-GP SM-GM	75% intermediate-silicic volcanics, glassy, caliche	1	high	yes	45
NM 69	Rio Grande Valley	Ph	Limestone	caliche at surface, trace chert	-	high	yes	--
NM 70	Dona Ana Mtns	Au	SM	100% intermediate & silicic volcanics, glassy	-	high low	yes	20
NM 71	Dona Ana Mtns	Asf	GM	100% intermediate & silicic volcanics, caliche coatings	2	high	yes	60
NM 72	Rio Grande Valley	Asf	GP-SP	80% silicic volcanics, trace chert, soft particles	2	high mod	yes	45
NM 73	Rio Grande Valley	Asf	SP-GP	65% intermediate volcanics, caliche coatings	2	high	yes	35
NM 74	Rio Grande Valley	Asf	SM	20% intermediate volcanics, caliche coatings	1	high	yes	40
NM 75	Caballo Mtns	Asf	SM	caliche coatings, 15% chert	2	high	yes	30
NM 76	Rio Grande Valley	Asf	SP-GP	caliche coatings, trace silicic volcanics	2	high mod	yes	45
NM 77	Black Mesa	Vb	Basalt	caliche at surface, possible glass	-	high mod	no	--
NM 78	Rio Grande Valley	Asf	SP-SW	85% intermediate & silicic volcanics, chert	1	high	yes	30

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high mod	yes	40	10	NP														B
high mod	yes	45	10	NP														B
mod	no	--	--	--														B_2
high	yes	45	5	NP														B
high	yes	--	--	--														B_1
high low	yes	20	15	low														B
high	yes	60	15	low														B
high mod	yes	45	5	NP														B
high	yes	35	5	NP														B
high	yes	40	20	low														B
high	yes	30	30	NP														B
high mod	yes	45	10	NP low														B
high mod	no	--	--	--														B
high	yes	30	5	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 6 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE A-1

FN-YR-20

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 79	Rio Grande Valley	Vu	Andesite	possibly glassy, weathered feldspars; limited quantity	-	high mod	yes	--
NM 80	Franklin Mtns	Cau	Dolomite Limestone	abundant caliche at surface	-	high	yes	--
NM 81	Franklin Mtns	Au	GM-ML	45% argillaceous limestone, trace chert	2	mod high	yes	35
NM 81	Franklin Mtns	Au	SP-SM	10% chert, 5% soft sediments, caliche coatings	1	high mod	yes	45
NM 82	Franklin Mtns	Au	SP-SM/ CL-ML	10% soft sediments, trace chert, clay layers	2	high	yes	75
NM 83	Franklin Mtns	Au	GP & SM	5% soft sediments, trace chert	-	high	yes	60
NM 84	Rio Grande Valley	Au	GP-SP	70% silicic & intermediate volcs, 10% chert	1	high	yes	55
NM 85	Franklin Mtns	Au	SM	85% silicic volcanics, 5% soft sediments, glassy	1	high	yes	40
NM 86	Franklin Mtns			Metamorphics Exposed in Highway Cut (photo stop)				
NM 87	Hueco Mtns (Texas)	Ph	Limestone	caliche at surface, trace chert	-	high	yes	--
NM 88	Hueco Mtns (Texas)	Aaf	SM	abundant caliche, high % fines, trace chert	3	high	yes	40
NM 89	Jarilla Mtns	Ph		View of Jarilla Mtns. (photo stop)				
NM 90	Jarilla Mtns	Ph	Limestone	caliche at surface, chert	-	high	yes	--
NM 91	Jarilla Mtns	Au	SM	sulfides, platy & elongate particles, soft material	1	mod	yes	30

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high mod	yes	--	--	--	17.6	3.0												B_2
high	yes	--	--	--														B
mod high	yes	35	25	low														B
high mod	yes	45	10	NP														B
high	yes	75	5	NP low														B
high	yes	60	10	NP low														B
high	yes	55	5	NP														B
high	yes	40	10	NP														B
																		B
high	yes	--	--	--														B_1
high	yes	40	30	NP														C
high	yes	--	--	--														B_1
mod	yes	30	15	NP low														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 7 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 92	Jarilla Mtns	Cau	Limestone Siltstone	soft to med. hard particles, flaggy to shaley particles	-	mod low	no	--
NM 93	Jarilla Mtns	Cau	Limestone Quarry	Active quarry (photo stop)				
NM 94	Sacremento Mtns.	Au	GP-SP	5% soft seds, flat & elongate particles, caliche, dolomite	1	high	yes	50
NM 94	Sacremento Mtns	Au	GP-GM	10% soft sediments, dolomite caliche coatings	-	high	yes	55
NM 95	Sacremento Mtns	Au	GP-SP-SM	caliche coatings, lenses of fines, dolomite	1	high	yes	50
NM 95	Sacremento Mtns	Psa	Dolomite Limestone	Caliche at surface, dolomite	-	high	yes	--
NM 95	Sacremento Mtns	Au	GP-SP	Caliche coatings, dolomite	2	high	yes	55
NM 96	Sacremento Front	Ph	Dolomite Limestone	caliche at surface, dolomite	-	high	yes	--
NM 97	Tularosa Basin	Au	SP-SM	abundant caliche, dolomite	2	high	yes no	40
NM 98	Sacremento Mtns	Aaf	GP-GM	10% intermediate volcanics 5% soft seds., caliche coatings	-	high	yes	65
NM 99	Sacremento Mtns	Aal	GP & SM	10% soft sediments, dolomite layers of silt, limited quantity	1	high	yes no	70
NM 100	Sacremento Mtns	Psa	Dolomite Limestone	thin beds of argillaceous material - caliche at surface	-	high	yes no	--
NM 101	Sacremento Mtns	Py	Dolomite Limestone	caliche at surface, argillaceous material	-	mod high	yes no	--
NM 102	Sacremento Mtns	Cau	Limestone	trace chert, argillaceous zones, dolomite	-	high	yes	--

ATED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
mod low	no	--	--	--														C
high	yes	50	5	NP low														B
high	yes	55	10	NP														B
high	yes	50	5	NP														B
high	yes	--	--	--														B_1
high	yes	55	5	NP														B
high	yes	--	--	--	24.8	1.15	NP	100	100	71	51	26	14					B_1
high	yes no	40	10	NP low														B
high	yes	65	10	NP														B
high	yes no	70	15	NP														B
high	yes no	--	--	--														B_1
mod high	yes no	--	--	--														B
high	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 8 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE A-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 103	Tularosa Basin	Aaf	GP-SP	10% soft sediments, tr. chert, caliche coatings	1	high	yes	55
NM 104	Tularosa Basin	Aaf		(photo stop) active aggregate operation				
NM 105	Sacremento Mtns	Au	GP-GC/ SM-SC	clay, caliche coatings, dolomite	1	high	yes	60
NM 106	Sacremento Mtns	Au	GP-GM SP-SM/ML	20% soft sediments, clay, caliche coatings	1	high mod	no	20
NM 107	Tularosa Basin	Au	GP-SP	20% intermediate volcanics, glassy, 10% soft material	1	high mod	yes	60
NM 107	Tularosa Basin	Au	GP	15% intermediate volcs., glassy, 10% soft material, caliche	1	high mod	yes	80
NM 108	Tularosa Basin	Au	SP-SM	15% intermediate volcanics, 5% soft sediments	2	high mod	yes	35
NM 109	Sierra Blanca Mtns	Au	SP-SM	100% intermediate-silicic volcs, scoriaceous materials	-	mod	yes	40
NM 110	Sierra Blanca Mtns	Au	SM	20% intermediate volcanics, vesicular volcanics, glassy	1	mod	yes	20
NM 111	Tularosa Basin	Au	SM	50% intermediate volcanics, sand 80% gypsum	1	mod low	yes	40
NM 112	Sierra Blanca Mtns	Aal	SP	30% soft sediments, altered volcanics, soft	-	mod	yes	30
NM 112	Sierra Blanca Mtns	Au	CL-SC	60% soft seds, 40% intermediate volcanics, clay	-	mod low	yes	20
NM 113	Sierra Blanca Mtns	Au	SC-CL	80% soft seds., 20% intermediate volcanics, clay	1	mod low	yes	30
NM 113	Sierra Blanca Mtns	Au	SP-SW	80% soft seds., 20% intermediate volcanics	-	mod low	yes	40

ED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
igh	yes	55	5	NP														B
igh	yes	60	10	mod														B
igh od	no	20	40	NP low														C
igh od	yes	60	5	NP														B
igh od	yes	80	5	NP														B
igh od	yes	35	10	NP low														B
od	yes	40	10	NP														B_2
od	yes	20	10	NP low														B_2
od ow	yes	40	5	NP														C
od	yes	30	5	NP														C
od ow	yes	20	40	low mod														C
od ow	yes	30	40	mod														C
od ow	yes	40	tr	NP														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 9 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE A-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NM 114	Tularosa Basin	Au	SP - SW	35% soft sediments, altered intrusives	-	low mod	yes	35
NM 115	Carrizo Mtns	gr	Quartz Monzonite	weathered zones, soft to moderately hard	-	mod	no	--
NM 116	Carrizo Mtns	Vb	Basic Intrusive	intrusive dike, limited quantity	-	high	yes	--
NM 117	Ancho Mtns	gr	Dacite	moderately weathered. mod. hard-soft zones	-	mod	no	--
NM 118	Carrizo Mtns	Au	SM	85% intermediate volcanics, soft sediments	-	mod low	yes	40
NM 119	Malapais Lava Flow	Vb	Basalt	vesicular, possibly glassy, caliche surface	-	mod	yes	--
NM 120	Tularosa Basin	Psa	Dolomite Limestone	caliche at surface, gypsum	-	mod high	yes	--
NM 121	Tularosa Basin	Psag	Gypsum	100% evaporites	-	low	yes	
NM 122	Sierra Oscura Mtns	Au	SP-SM	chert, 5% soft sediments, caliche coatings	1	high	yes	40
NM 123	Mockingbird Gap	Cau	Limestone	caliche at surface, chert	-	high	yes	--
NM 124	San Andres Mtns	Au	SP & GP	10% soft seds & intermediate volcanics	1	high	yes	50
NM 125	San Andres Mtns	Au		View of basin fill deposits east side San Andres Mtns. (photo stop)				
NM 126	San Andres Mtns	Au		View of basin deposits and mountain front (photo stop)				

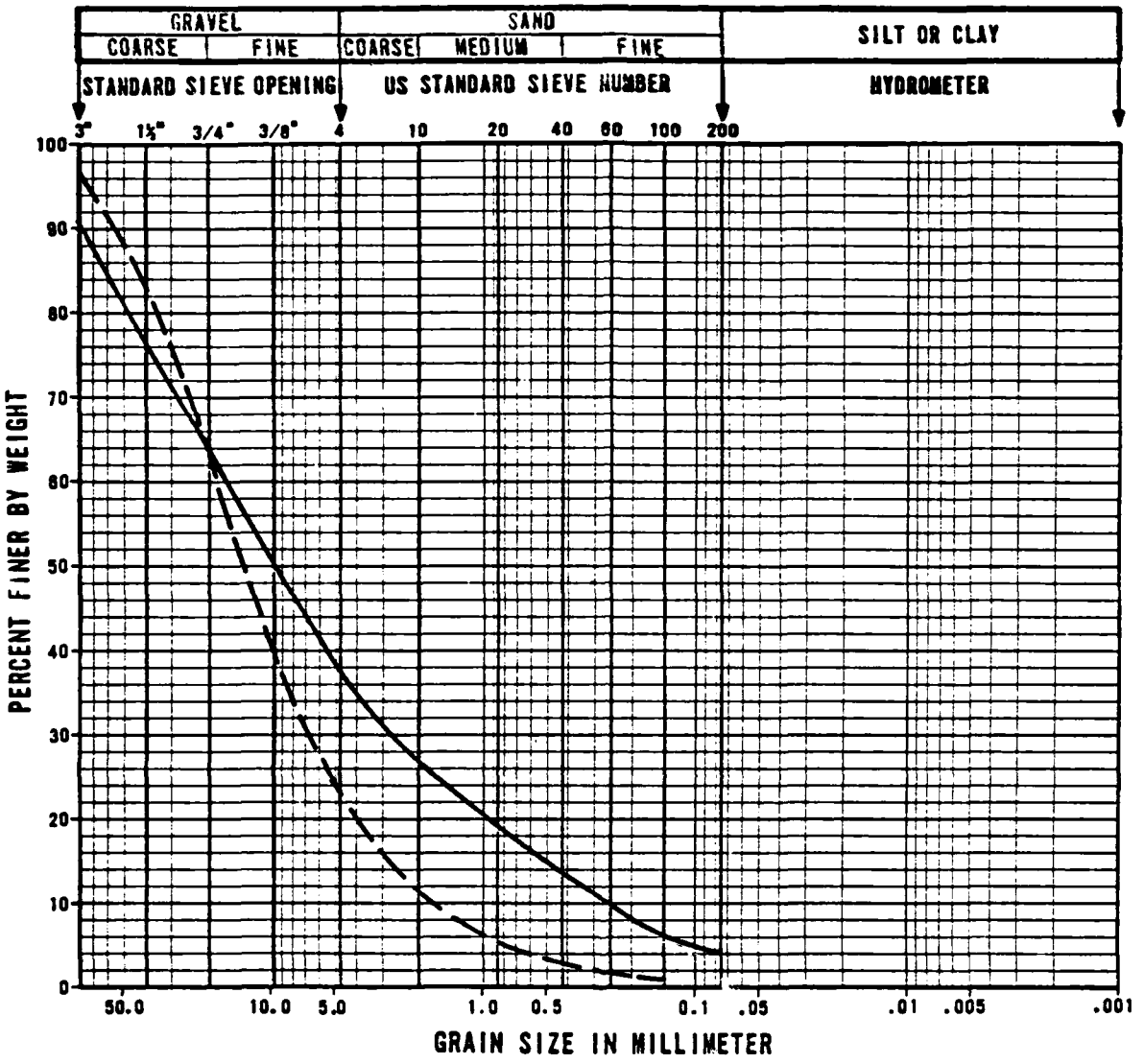
ESTIMATED VALUES					LABORATORY TEST DATA												
								SIEVE ANALYSIS % PASSING									
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
low mod	yes	35	5	NP														C
mod	no	--	--	--														B_2
high	yes	--	--	--														B
mod	no	--	--	--														B_2
mod low	yes	40	tr	NP														C
mod	yes	--	--	--														B_2
mod high	yes	--	--	--														B_1
low	yes																	C
high	yes	40	10	NP	26.6	2.23	13	100	100	73	54	26	13					B
high	yes	--	--	--	21.0	.43	NP	100	100	79	63	33	16					B
high	yes	50	10	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 10 OF 10
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE A-1

FN-TR-200



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NM-27	Asf	GW
— —	NM-34	Au	GW

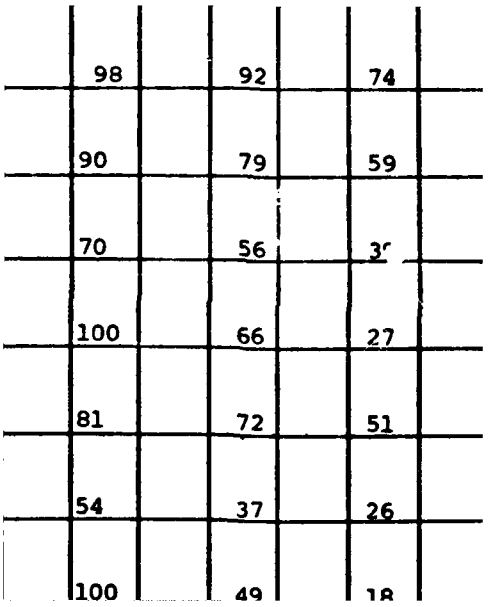
GRAIN SIZE CURVES
NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

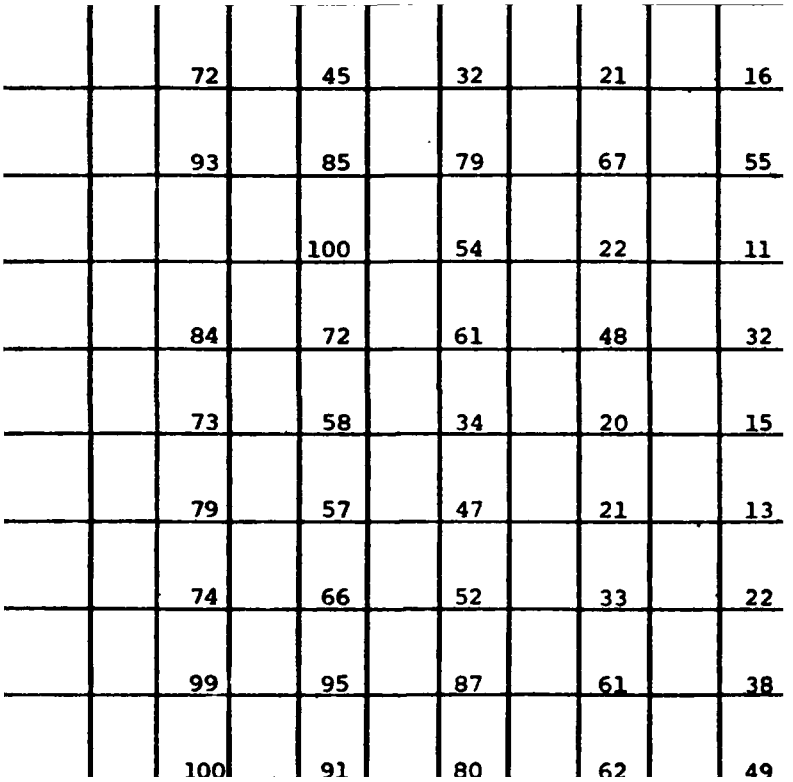
FIGURE
A-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY
NM 0920	NMHD	Manzano Mtns.	Qtz	quartzite	19.2	3.8	
NM 6529	NMHD	El Cerro de Los Lunas	Vu	dacite	21.2	7.4	
NM 5697	NMHD	Rio Grande Valley	Asf	sand, gravel	28.8	1.1	
NM 55104	NMHD	Rio Grande Valley	Asf	sand, gravel	26.0	15.0	
NM 5456	NMHD	Rio Grande Valley	Asf	sand, gravel	28.0	8.6	
NM 6053	NMHD	Estancia Valley	Aal	gravel, limited quantity	32.4	10.9	
NM 6445	NMHD	Arroyo Chinconte	Pm	limestone	30.0	1.16	
NM 022	NMHD	Tabet Draw	Aal	sand, gravel	28.8	4.8	
NM 025	NMHD	Manzano Mtns	Aal	sand, gravel	27.6	12.2	
NM 0709	NMHD	Priest Canyon	Qtz	quartzite	22.8	1.8	
NM 0705	NMHD	Manzano Mtns	Pm	limestone	22.3	7.1	
NM 031	NMHD	Manzano Mtns	Aal	gravel, limited quantity	28.4	2.5	
NM 573	NMHD	Magdalena Mtns	Au	limited quantity sand, gravel	24.0		
NM 57131	NMHD	Rio Grande Valley	Asf	sand, gravel	26.0		


98
92
74
90
79
59
70
56
100
66
27
81
72
51
54
37
26
100
49

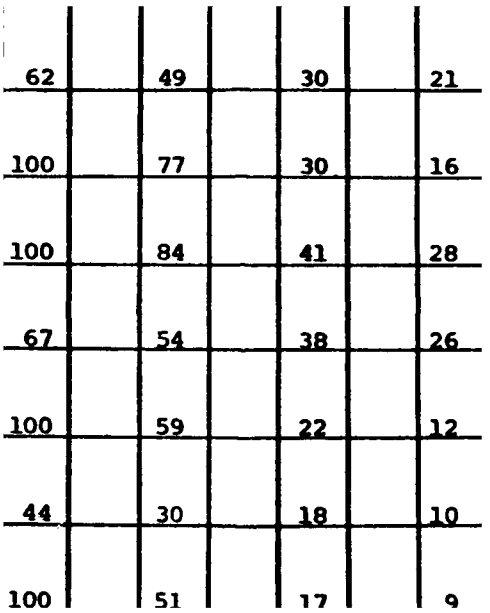
PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
NM 57150	NMHD	Six Mile Canyon	Asf	gravel	23.2	2.2		
NM 55127	NMHD	Rio Grande Valley	Asf	sand, gravel	22.8			
NM 5717	NMHD	Rio Grande Valley	Asf	sand, gravel	32.0			
NM 57137	NMHD	Abo Arroyo	Pm	limestone	19.4	1.7		
NM 57138	NMHD	Abo Arroyo	Au	soil, gravel	27.6			
NM 0756	NMHD	Chupadera Mesa	Aal	gravel	27.2			
NM 6720	NMHD	Rio Grande Valley	Asf	sand, gravel	22.0	9.0		
NM 6143	NMHD	Rio Grande Valley	Asf	sand, gravel	26.5	2.0		
NM 739	NMHD	Rio Grande Valley	Asf	sand, gravel	22.9	8.9		
NM 5912	NMHD	Rio Grande Valley	Asf	sand				
NM 607	NMHD	Jornado Del Muerto	Aal	sand, gravel, limited quantity	30.4	4.4		
NM 5577	NMHD	Roque Ramos Canyon	Asf	sand, gravel	24.0			
NM 6519	NMHD	Monticello Canyon	Aal	sand, gravel	18.4	3.8		
NM 6539	NMHD	Palomas Creek	Asf	sand, gravel	24.6	5.4		


72 45 32 21 16
93 85 79 67 55
100 54 22 11
84 72 61 48 32
73 58 34 20 15
79 57 47 21 13
74 66 52 33 22
99 95 87 61 38
100 91 80 62 49

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
NM 713	NMHD	Rio Grande Valley	Asf	sand, gravel	20.6	10.0		
NM 6215	NMHD	Rio Grande Valley	Asf	sand, gravel	19.2	5.9		
NM 631	NMHD	Rio Grande Valley	Asf	sand, gravel	17.6	3.1		
NM 632	NMHD	Rio Grande Valley	Asf	sand, gravel	16.0	2.4		
NM 6411	NMHD	Caballo Dam	Asf	sand, gravel	22.4	2.4		
NM 6429	NMHD	Rio Grande Valley	Asf	sand, gravel	18.8	8.5		
NM 6515	NMHD	Rio Grande Valley	Asf	sand, gravel	20.8	6.4		
NM 6817	NMHD	Sierra De Las Uvas	Au	sand, gravel	14.0	4.0		
NM 5439	NMHD	Rio Grande Valley	Asf	sand, gravel	18.4			
NM 5555	NMHD	Rio Grande Valley	Vu	andesite	21.6	0.6		
NM 5619	NMHD	San Augustine Pass	Au	gravel				
NM 5791	NMHD	Rio Grande Valley	Asf	sand, gravel	22.0	2.1		
NM 5792	NMHD	Rio Grande Valley	Asf	soil, gravel	22.4			
NM 5918	NMHD	Rio Grande Valley	Asf	gravel	20.0			

5.0	2.4		NP			78		66		49		30		24	
2.4	2.4		NP			85		77		66		56		46	
8.8	8.5		7			87		68		49		33		26	
0.8	6.4		NP			86		67		48		33		25	
4.0	4.0		NP			85		81		66		40		28	
8.4			NP							81		58		50	
1.6	0.6		NP			100		83		23		10		6	
2.0	2.1		NP			96		61		43		39		37	

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
NM 6046	NMHD	Tortugas Mtn.	Ph	limestone	18.0	0.5		NP
NM 6425	NMHD	Rio Grande Valley Mimbres River	Asf	sand, gravel	19.6	2.4		NP
NM 0519	NMHD	Jornado Del Muerto	Aaf	sand, gravel	20.4	4.7		NP
NM 0520	NMHD	Jornado Del Muerto	Py	limestone, limited quantity	25.0			NP
NM 0523	NMHD	Tularosa Valley	gr	intrusive metamorphics	63.2	24.7		NP
NM 0529	NMHD	Tularosa Valley	Aal	gravel	23.0			NP
NM 0530	NMHD	Tularosa Valley	Vb	basalt	15.2			NP
NM 0609	NMHD	Joranda Del Muerto	Au	cemented sand and gravel	22.5	26.9		9
NM 0560	NMHD	Tularosa Valley	Psa	limestone	20.4			NP
NM 0564	NMHD	Tularosa Valley	Au	gravel	23.2			NP
NM 0543	NMHD	Tularosa Valley	Aal	limited quantity gravel, sand	22.4	11.8		NP
NM 0544	NMHD	Tularosa Valley	Aal	sand, gravel,	18.4			NP
NM 0547	NMHD	Tularosa Valley	Au	gravelwith abundant gypsum	18.4	5.3		NP
NM 0549	NMHD	Tularosa Valley	Au	sand, gravel	22.0	2.3		NP


62
49
30
21
100
77
30
16
100
84
41
28
67
54
38
26
100
59
22
12
44
30
18
10
100
51
17
9

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
NM 0553	NMHD	Tularosa Valley	Py	limestone	22.4			
NM 0554	NMHD	Tularosa Valley	Au	gravel	24.0			
NM 0605	NMHD	San Andres Mtns.	Au	gravel, sand	23.0	6.4		
NM 0606	NMHD	San Andres Mtns	Au	sand, gravel	21.6	3.2		
NM 5848	NMHD	Tularosa Valley	Ph	limestone	23.2			
NM 0598	NMHD	San Andres Mtns.	Au	sand, gravel	20.4	2.0		
NM 0601	NMHD	Tularosa Valley	Au	silty sand, gravel	17.5			
NM 0602	NMHD	San Andres Mtns.	Au	gravel	26.4			
NM 5854	NMHD	Tularosa Valley	Aaf	gravel	24.8			
NM 5941	NMHD	Sacramento Mtns	Aaf	gravel	24.0	4.4		
NM 0247	NMHD	Sacramento Mtns	Cau	limestone	26.8			
NM 0246	NMHD	Sacramento Mtns	Psa	limestone	26.0			
NM 0270	NMHD	Sacramento Mtns.	Py	limestone	24.0			
NM 0281	NMHD	Sacramento Mtns.	Psa	limestone	25.2			

LABORATORY TEST DATA

500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
2.4								100		52		20		10					2
4.0								100		64		35		23					5
3.0	6.4		NP			76		55		37		24		18					4
1.6	3.2		NP			70		55		41		29		22					5
3.2			NP					100		48		18		10					1
0.4	2.0		NP			87		66		43		28		21					2
7.5			10			86		73		51		31		23					4
5.4			NP			63		41		27		17		13					2
1.8			NP			88		75		54		39		26					4
1.0	4.4		6			84		60		39		24		19					8
3.8			NP				100			60		22		11					3
5.0								100		87		3		22					9
3.0			8			69		42		18		10		9					6
5.2			NP					100		59		25		15					4

EXISTING TEST DATA
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NEW MEXICO-TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE
A-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX
NM 0288	NMHD	Sacramento Mtns	Py	limestone	41.0			NP
NM 0289	NMHD	Sacramento Mtns	Aal	gravel	27.4			NP
NM 6405	NMHD	Jarilla Mtns	Ph	limestone (altered)	17.2	5.3		NP
NM 0447	NMHD	San Andres Mtns.	gr	granite	32.0	2.9		NP
NM 0450	NMHD	Tularosa Valley	Au	gravel	20.0			4
NM 0451	NMHD	Hueco Mtns	Ph	limestone	21.2			NP
NM 0611	NMHD	Tularosa Valley	Au	gravel	22.6	19.6		NP
NM 0434	NMHD	Otero Mesa Tularosa Valley	Au	gravel	17.2			NP
NM 0441	NMHD	Flat Top Mtn	gr	diabase	15.2	0.3		NP
NM 0444	NMHD	Hueco Mtns	Ph	limestone	20.0			NP
NM 0446	NMHD	Hueco Mtns	Vu	rhyolite, limited quantity	35.2			NP
NM 0310	NMHD	Sierra Diablo Platform	Psa	limestone	32.8	1.0		NP
NM 0319	NMHD	Sierra Diablo Platform	Au	sand and gravel	24.4			
NM 0373	NMHD	Sierra Diablo Platform	Au	gravel	26.4			NP

LABORATORY TEST DATA

500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
1.0			NP					100		61		25		15					4
7.4			NP			52		36		24		16		13					7
7.2	5.3		NP					100		59		27		18					5
2.0	2.9		NP			100		85		32		16		8					1
0.0			4			74		59		35		20		13					5
1.2			NP			57		42		27		17		10					4
2.6	19.6		NP			69		56		40		27		19					4
7.2			NP			74		46		32		22		18					6
5.2	0.3		NP					100		54		20		9					2
0.0			NP					100		66		27		13					2
3.2			NP					100		77		30		15					2
2.8	1.0		NP			100		98		66		36		22					7
4.4						73		57		41		24		16					5
3.4			NP					100		72		23		17					5

EXISTING TEST DATA
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NEW MEXICO–TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE A-2

UGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION		ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY
NM BR-1	USBR	Alamogordo	Aaf	Sand and gravel	C	33.3	5.0	2.67
					F		4.3	2.65
NM BR-2	USBR	Rio Grande Valley	Asf	Sand and gravel		21.0	13.2	2.55
							5.4	2.56
NM BR-3	USBR	Rio Grande Valley	Asf	Sand and gravel	C	27.4	10.3	2.53
					F		5.3	2.62
NM BR-4	USBR	Jornada del Muerto	Au	Sand and gravel	C	25.9	16.2	2.51
					F		6.9	2.62
NM BR-5	USBR	Tularosa Valley	Au	Sand and gravel	F		6.8	2.62
NM BR-6	USBR	Rio Grande Valley	Au	Sand and gravel	C	16.2	2.1	2.60
					F		11.5	2.61
NM BR-7	USBR	Rio Grande Valley	Asf	Sand and gravel	C	26.0	6.7	2.61
					F		5.2	2.63
NM BR-8	USBR	Elephant Butte	Asf	Sand and gravel	C	26.3	11.7	2.58
					F		7.4	2.64
NM NM-9	USBR	Rio Grande Valley	Asf	andesite				1.72
NM BR-10	USBR	Rio Grande Valley	Asf	Sand and gravel	C	27.4	1.6	2.61
					F		4.7	2.61
NM BR-11	USBR	Rio Grande Valley	Au	Sand and gravel (mine tailings)	C F	22.8	7.9	2.49
							5.4	2.63

LABORATORY TEST DATA

500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
.3	5.0	2.67					100		57		12	1							
	4.3	2.65										100	82		62	40	18	5	3.7
.0	13.2	2.55																	
	5.4	2.56																	
.4	10.3	2.53					100		65		10	1							
	5.3	2.62										100	94		71		17	2	1.1
.9	16.2	2.51					100		87		26	30							
	6.9	2.62										98	89		75		18	3.0	2.0
	6.8	2.62										98	90		80		26	4.0	1.5
.2	2.1	2.60																	
	11.5	2.61										98	89		78		14	2.0	1.3
.0	6.7	2.61																	
	5.2	2.63																	
.3	11.7	2.58																	
	7.4	2.64					93.4		68.8		53.7	44.3	37.2		28.7	9	9.5	8.0	5.3
		1.72																	
.4	1.6	2.61																	
	4.7	2.61																	
.8	7.9	2.49																	
	5.4	2.63																	

EXISTING TEST DATA
PAGE 7 OF 7
NEW MEXICO–TEXAS STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE A–2

FUGRO NATIONAL, INC.

APPENDIX B

ARIZONA-CALIFORNIA STUDY AREA DATA SHEETS

Explanation

The following notes are intended to serve as an aid in the use of Tables B1 and B2.

Table B1

Note 1 Multiple entries under a field station number indicate that data were collected on more than one potential source of concrete aggregate at that field station.

Note 2 Seive analyses reported for potential sources of crushed rock represent the size distribution of the sample following crushing to prepare the material for the L.A. abrasion test.

Note 3 Symbols used for designating the material type of basin-fill deposits are in accordance with the Unified Soil Classification System.

Note 4 Field stations at which only a photograph of representative materials was made are designated as photo stops in Appendix B1.

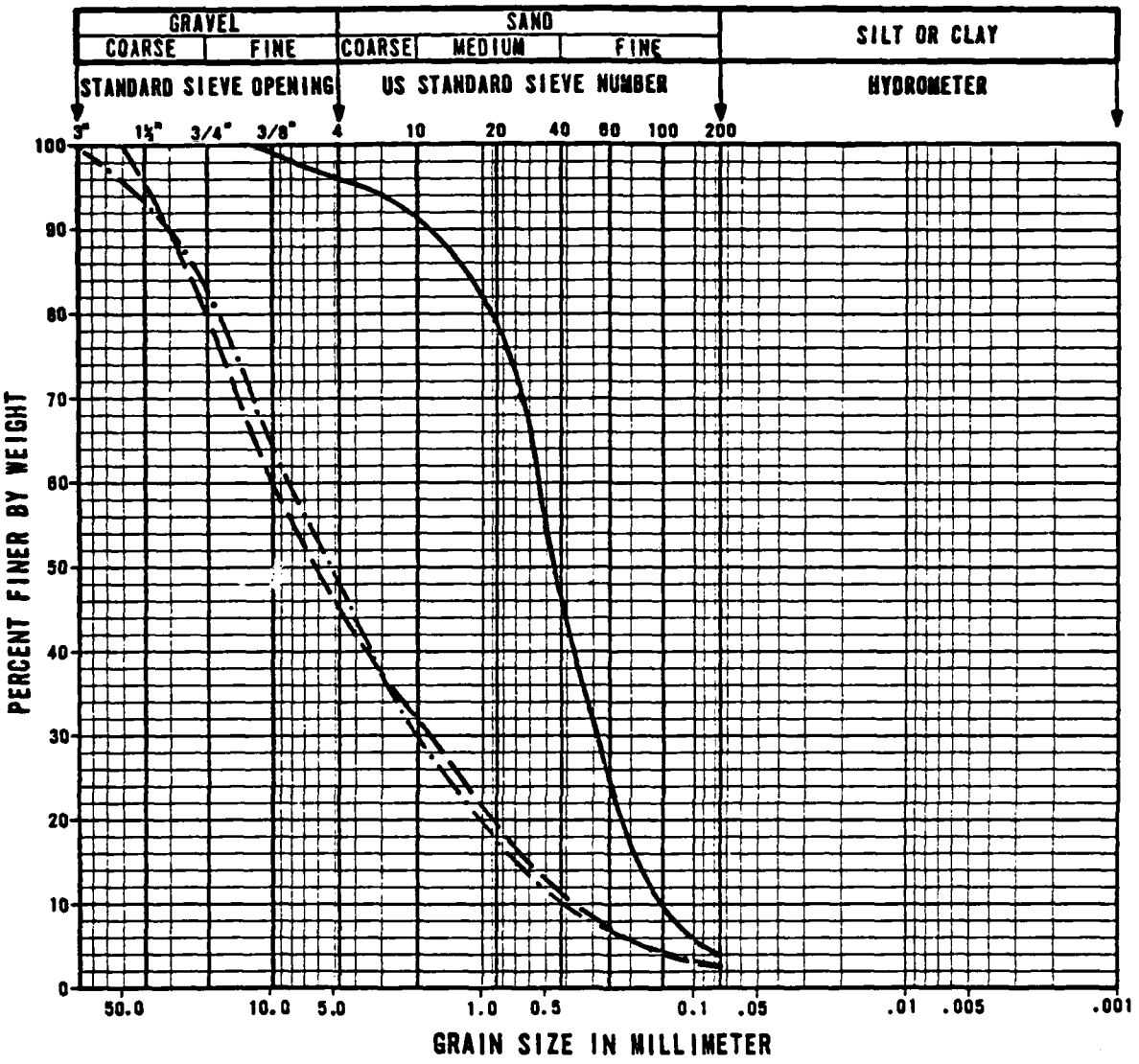
Table B2

Note 1 Much of the test data obtained from existing sources of information was not originally intended to determine the suitability of the material for use as concrete aggregate. Those test results which were applicable to concrete aggregate are shown.

Note 2 Test results from existing sources of information reported in Table B2 for the soundness loss of aggregate were determined using a sodium-sulfate saturated solution unless otherwise noted. Soundness loss determinations reported in Table B1 were obtained using a magnesium-sulfate saturated solution which provides a more-severe test.

Note 3 Where existing test data were reported separately for the coarse (+#4 sieve) and fine (-#4 sieve) fractions of a sample, a C for coarse of an F for fine precedes the appropriate data column.

Note 4 Limited quantities of suitable aggregate may be found locally within Class C basin-fill deposits. While these materials are not present in sufficiently large volumes to meet the needs of the MX system, they may prove adequate as a source of special purpose aggregate. Where available, representative test data for these deposits have been included in Table B2.



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	AZ-12	At	SP
— —	AZ-33	At	SP-GP
—·—	AZ-49	At	SP-GP

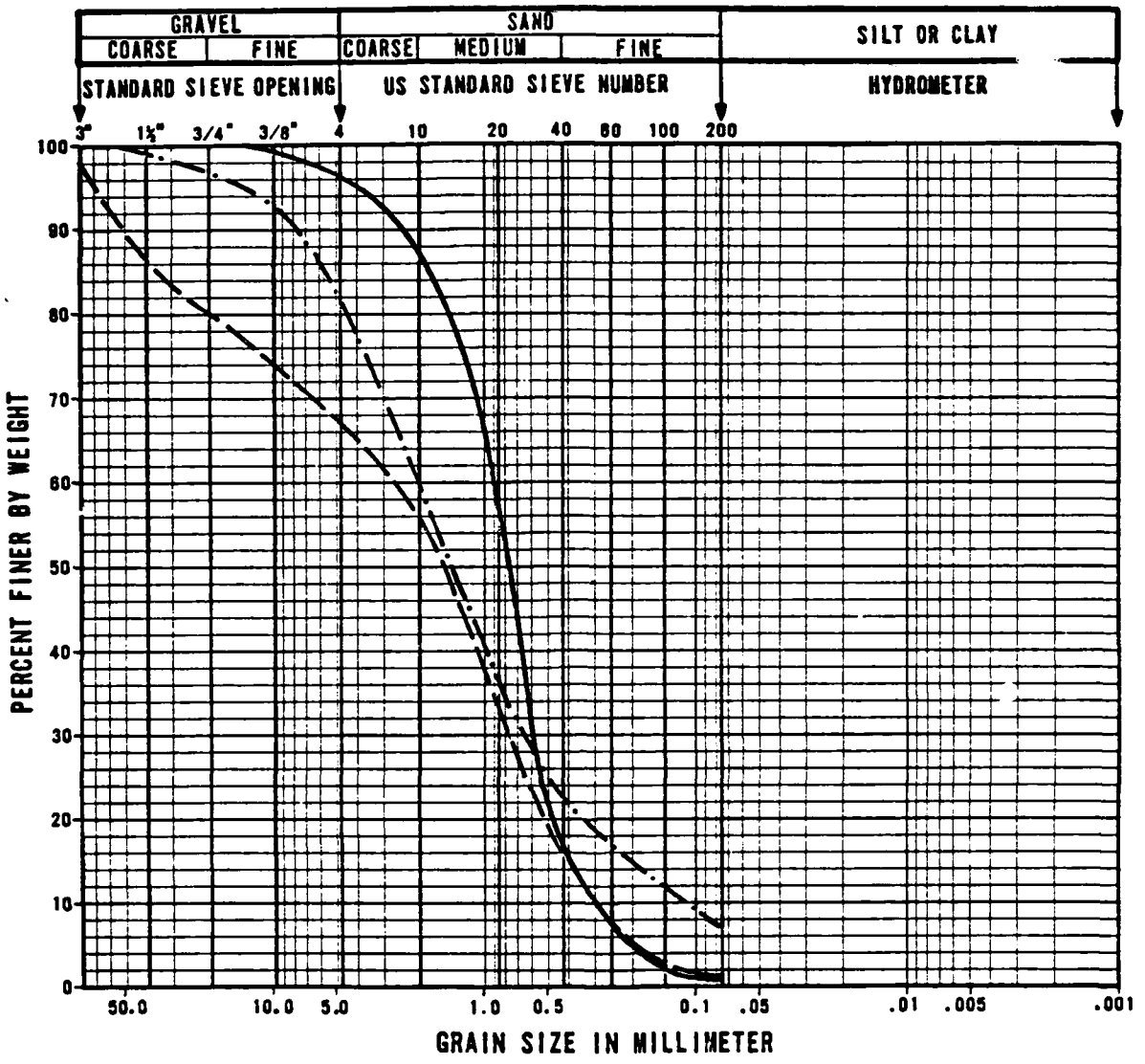
GRAIN SIZE CURVES
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
B-1

UGRO NATIONAL, INC.

FN-TR-200



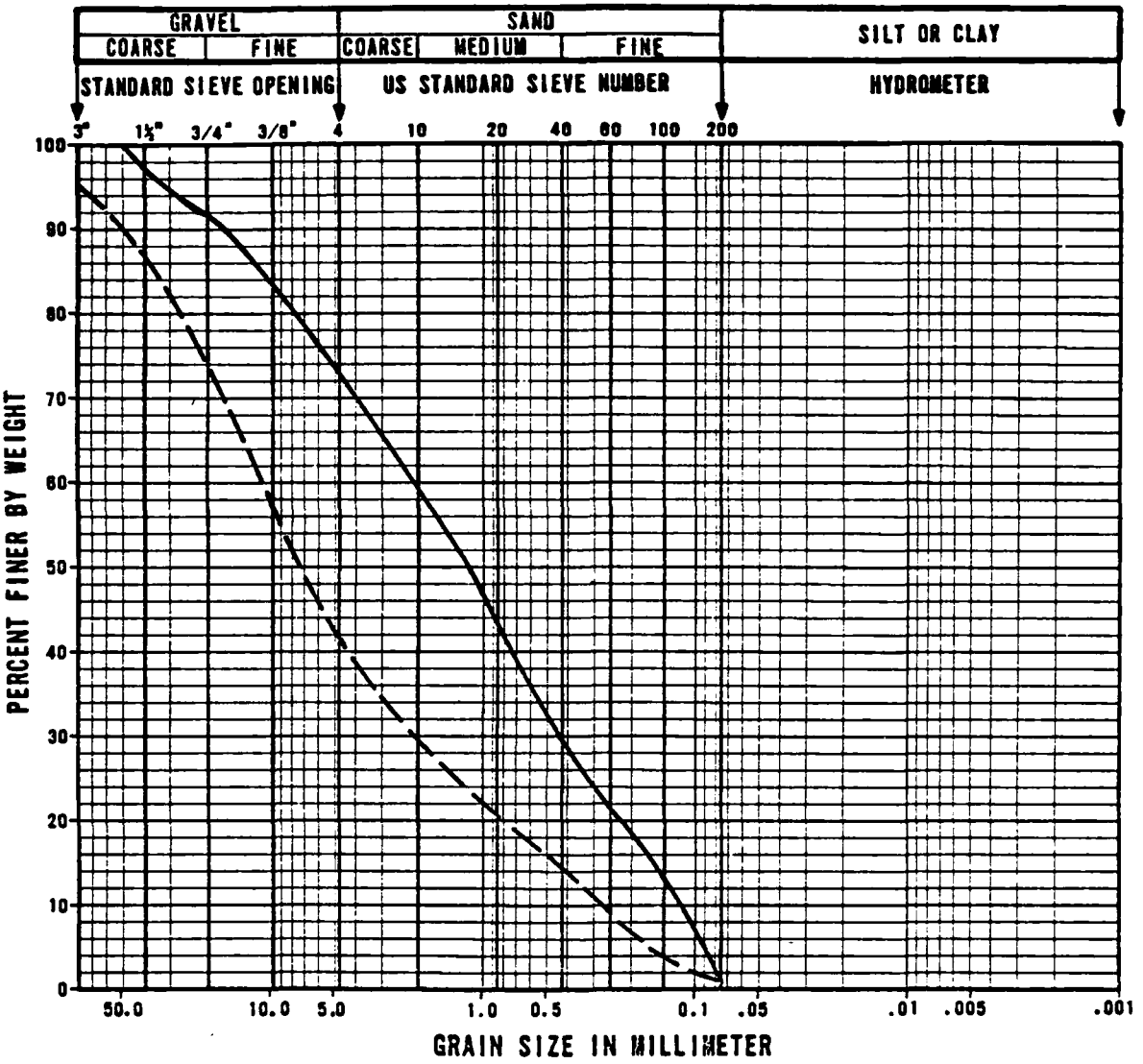
SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	AZ-55	Aal	SP
— — —	AZ-56	Aal	SW
—·—	AZ-58	Au	SW

GRAIN SIZE CURVES
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
B-2

UNIVERSITY RESEARCH NATIONAL, INC.

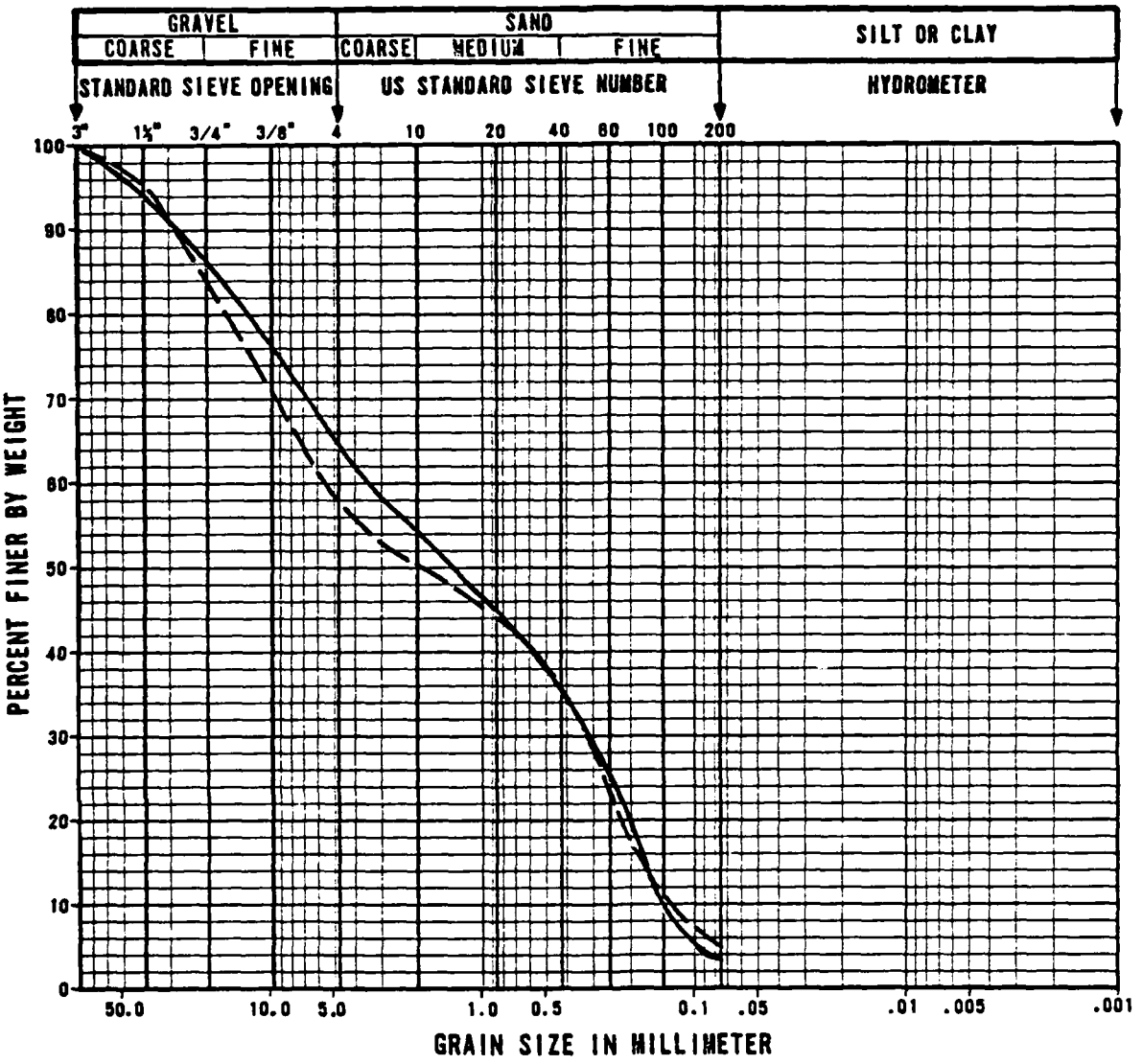


SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	AZ-79	Aal	SP
— — —	AZ-97	Au	GP

GRAIN SIZE CURVES
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
B-3



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	AZ-113	Au	SP
— —	AZ-138	Aal	SP

GRAIN SIZE CURVES
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
B-4

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 1	Aguilla Mtns	Vb	Basalt	40% vesicular, zeolites	-	high	yes	--
AZ 2	Aguilla Mtns	Vu	Andesite	glassy, caliche coatings at surfaces, limited quantities		mod	yes	--
AZ 3	Crater Range	Vb	Basalt	70% vesicular, zeolites, caliche coatings on talus	-	low mod	yes	--
AZ 4	Crater Range	Vb	Basalt & Andesite	Basalt - scoriaceous, zeolites; andesite - glassy	-	mod	yes	--
AZ 4	Crater Range	Talus	50% basalt 50% andesite	scoriaceous basalts weathered and soft, caliche coatings	-	low mod	yes	60
AZ 5	Batamote Mtns	Vb	Basalt	40% vesicular, zeolites, caliche coatings at surface	-	high	yes	--
AZ 6	Sauceda Mtns	Vb	Basalt	locally scoriaceous, zeolites, caliche coatings at surface	-	high mod	yes	--
AZ 7	Sauceda Mtns	Vu	Andesite	50% vesicular, zeolites, mod. hard, glassy, tuff interbeds	-	low mod	yes	--
AZ 8	Sauceda Mtns	Vu	Andesite	glassy, caliche at surface tuff interbeds, limited quantities	-	low high	yes	--
AZ 9	Sand Tank Mtns	Vb	Basalt	50% vesicular, zeolites, caliche at surface	-	mod	yes	--
AZ 10	Vekol Mtns	Aal	SP-SM	1-2% chert, remnant caliche coatings on gravel, limited quantity	-	high	yes	45
AZ 10	Vekol Mtns	Au	GM-GC	strong caliche cementation, soft particles, minor clay	3	high mod	yes	50
AZ 10	Vekol Mtns	Su	Limestone	1-2% chert, caliche at surface	-	high	yes	--
AZ 11	Table Top Mtns	Vb	Basalt	25% vesicular, zeolites, caliche coatings at surface	-	high	yes	--

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
high	yes	--	--	--														B_2
mod	yes	--	--	--														B_2
low mod	yes	--	--	--														C
mod	yes	--	--	--														C
low mod	yes	60	10	low														C
high	yes	--	--	--														B_2
high mod	yes	--	--	--														B
low mod	yes	--	--	--														C
low high	yes	--	--	--														B_2
mod	yes	--	--	--														B_2
high	yes	45	10	NP low														B
high mod	yes	50	5	low														C
high	yes	--	--	--														B
high	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 1 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE B-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	# CLASTS
AZ 12	Hassayampa River	A_t	SM-GM	weathered, soft, granitic & maric rocks	-	mod		--	-
AZ 12	Hassayampa River	Aal	SM-SP	40% intermediate & silicic volcs. 40% mod. hard to soft granitics	-	mod	yes	10	1
AZ 13	Flat Iron Mtn	Vb	Basalt	25% vesicular, zeolites	-	high	yes	--	-
AZ 14	Belmont Mtns	gr	Granite	very weathered in outcrop, coarse grained	-	low	no	--	-
AZ 15	Big Horn Mtns	Vu	Andesite Agglomerate	glassy, poorly lithified	-	low	yes	--	-
AZ 16	Big Horn Mtns	Vu	Andesite	glassy matrix	-	low mod	yes	--	-
AZ 17	Harguahala Mtn.	Su	Quartzite & Sandstone	thin quartzite lenses inter-bedded with sandstone and shale	-	low high	no	--	-
AZ 18	Harguahala Mtn.	gr	Granite	moderately weathered in outcrop, coarse grained	-	high mod	no	--	-
AZ 19	Tiger Wash	Aal	SP	Sand 50% silicic & intermed. volcanics or soft granitics	-	high mod	no	5	1
AZ 20	Burnt Mtn	Vb	Basalt	30% vesicular, zeolites, caliche coatings at surface	-	high	yes	--	-
AZ 21	Centennial Wash	Aal	SP	25% intermed. volcs., granitic gravel mod. hard to soft	-	mod	yes	5	
AZ 22	Eagletail Mtns	Vb	Basaltic Andesite	10-15% vesicular, zeolites	-	high	yes	--	-
AZ 23	Eagletail Mtns	Vu	Andesite Porphyry	soft, glassy	-	low	yes	--	-
AZ 23	Eagletail Mtns	Vu	Andesite Agglomerate	glassy, pumice, soft	-	low	yes	--	-

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
mod		--	--	--		8.2	NP				100	99	96	93	84	61	3.3	B
mod	yes	10	10	NP														B
high	yes	--	--	--														B
low	no	--	--	--														B_2
low	yes	--	--	--														C
low mod	yes	--	--	--														C
low high	no	--	--	--														C
high mod	no	--	--	--														B
high mod	no	5	15	NP														B
high	yes	--	--	--														B_2
mod	yes	5		NP														B
high	yes	--	--	--														B
low	yes	--	--	--														C
low	yes	--	--	--														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 2 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE B-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 24	Ranegras Plain	Vb	Basalt	30% vesicular, zeolite	-	high	yes	-
AZ 25	Little Horn Mtns.	Vb	Basalt	20% vesicular, caliche coating at surface	-	high	yes	-
AZ 26	Little Horn Mtns.	Vu	Rhyolite-Andesite	glassy, sulfide minerals, soft; limited quantity	-	low	yes	-
AZ 26	Little Horn Mtns.	Aal	GP	scoriaceous cobbles, glassy volcanics	-	high	yes	75
AZ 27	Palomas Mtns.	Vb	Basalt	10-15% vesicular, zeolites	-	high	yes	-
AZ 28	Gila River	Aal	SP-GP	25% intermed. volcs., granitics & sediments moderately hard	-	high	yes	50
AZ 29	Buckeye Hills	gr	Qtz. Monzonite	very weathered in outcrop, coarse grained	-	mod low	no	-
AZ 30	Maricopa Mtns	gr	Granite	very weathered in outcrop, coarse grained	-	high low	no	-
AZ 31	Gila River Valley	Au	SP-SM	Soft, decomposed granitics, abundant mica	-	low	no	20
AZ 31	Gila River Valley	Au	SM	soft, decomposed granitic gravel, abundant mica	1-2	low	no	30
AZ 32	Gila River Valley	At	SP-GP	caliche cap, 70% intermed. & basic volcanics	1-2	high	yes	60
AZ 33	Gila River Valley	At	SP-SM	55% basic and intermediate volcanics, caliche coatings	2-3	high	yes	
AZ 34	Sentinel Flow	Vb	Basalt	30% vesicular, zeolite caliche coatings on joints	-	high mod	yes	-
AZ 35	Mohawk Valley	Au	SM-GM	gravels very weathered and soft mica, elongate particles	1	low	no	40

* Only sample available from upper calichified surface.

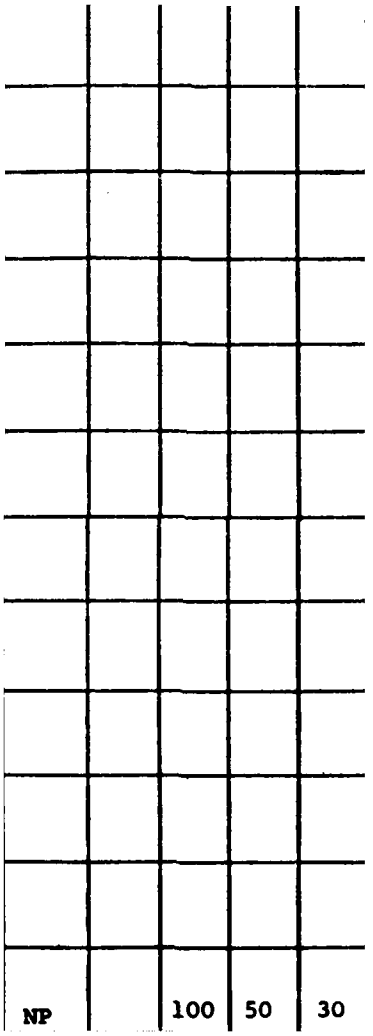
ESTIMATED VALUES					LABORATORY TEST DATA												
								SIEVE ANALYSIS % PASSING									
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
high	yes	-	-	-														B_2
high	yes	-	-	-	22.3	7.4	NP		100	57	38	19	12					B
low	yes	-	-	-														C
high	yes	75	5	NP														B_2
high	yes	-	-	-														B
high	yes	50	tr.	NP														B
mod low	no	-	-	-														B_2
high low	no	-	-	-														B_2
low	no	20	10	NP														C
low	no	30	20	low mod														C
high	yes	60	tr.	NP														B
high	yes				20.3	*17.6	NP	100	96	87	80	60	45	34	26	17	29	B_2
high mod	yes	-	-	-														B_2
low	no	40	20	NP low														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 3 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE B-1

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 35	Copper Mtns.	gn	Granite Gneiss	very weathered in outcrop, coarse grained	-	mod low	no	-
AZ 36	Mohawk Valley	Au	SM w/ GM	very weathered, decomposed granitics, caliche	2	low	no	35
AZ 36	Mohawk Valley	Aal	SP w/gravel	very weathered, decomposed granitic gravel	-	mod low	no	25
AZ 32	Copper Mtns	gn	Granite Gneiss	very weathered in outcrop, coarse grained	-	mod low	no	-
AZ 37	Copper Mtns	gr	Qtz. Monzonite	very weathered in outcrop, medium grained	-	mod low	no	-
AZ 38	Mohawk Mtns	gr	Qtz. Monzonite	very weathered in outcrop, coarse grained	-	mod low	no	-
AZ 38	Mohawk Valley	Au	SM w/gravel	very weathered, decomposed granitics	1-2	low	no	15
AZ 39	Mohawk Mtns	gn	Granitic Gneiss	veru weathered in outcrop, medium grained	-	mod low	no	-
AZ 39	Mohawk Valley	Au	SM-GM	very weathered decomposed granitics	1-2	low	no	40
AZ 40	Mohawk Mtns.	gn	Gneiss	moderately weathered in outcrop, fresh inroad cut, 20% platy	-	high mod	no	-
AZ 41	Mohawk Mtns.	gr	Granite	weathered in outcrop, coarse grained	-	high low	no	-
AZ 42	Mohawk Mtns.	Au	SM-CL	very weathered decomposed granitics, interbedded clay horizons	1	low		20
AZ 43	Aztec Hills	gr	Granite		-	high	no	-
AZ 44	Canyon Diablo Wash	Aal	SP-SW	20% basic and intermed. volcanics, decomposed granitics	-	mod	yes	10


NP
100
50
30

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% SIZE
AZ 45	Gila River Valley	At	GP	30% basic & intermediate volcs., weathered granitics, caliche	2-3	high mod	yes	50	
AZ 46	Gila River Valley	Aal	SP	limited quantity, 60% basic and intermediate volcanics	-	high	yes	10	t
AZ 47	Gila River Valley	At	SM	55% basic & intermed. volcanics trace chert, caliche	2-3	high	yes	40	2
AZ 48	Gila River Valley	Aal	SP	10% basic & intermed. volcanics mod. weathered granitics	1-2	mod,	yes	10	
AZ 49	Gila River Valley	At	SP	40% basic & intermed. volcanics	1-2	high mod	yes		
AZ 50	Wellton Mesa	Su	Sandstone	soft	-	low	no	-	
AZ 51	Lechuguilla Desert	gn	Granite Gneiss	very weathered in outcrop, coarse-grained	-	mod low	no	-	
AZ 52	Wellton Hills	gn	Granite Gneiss	very weathered in outcrop, medium-grained	-	mod low	no	-	
AZ 53	Raven's Butte	Vb	Basalt	10% vesicular, glassy	-	high	yes	-	
AZ 54	Lechuguilla Desert	Aaf	SM	very weathered, decomposed granitics	1-2	low	no	10	
AZ 54	Lechuguilla Desert	Aal	SP	very weathered, decomposed granitics	-	low	no	30	
AZ 54	Gila Mtns.	gr	Qt. Monzonite	very weathered in outcrop, medium grained	-	mod low	no	-	
AZ 55	Lechuguilla Desert	Aal	SP	very weathered, decomposed granitic gravel	-	mod low	no		
AZ 56	Sheep Mtn. Wash	Aal	SP	granitic & metamorphic gravel, moderately weathered	-	high mod			

BLUES				LABORATORY TEST DATA												
POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
							2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
yes	50	5	NP														B_2
yes	10	tr.	NP														B
yes	40	20	low														B
yes	10	5	NP														B
yes				18.6	8.6	NP	97	94	89	83	65	45	34	20	12	2.9	B
no	-	-	-														C
no	-	-	-														B_2
no	-	-	-														B_2
yes	-	-	-														B
no	10	20	NP low														C
no	30	tr.	NP														C
no	-	-	-														B_2
no					6.4					100		97	92	87	32	2.2	B_2
					9.2		58	86	83	80	74	67	59	44	23	0.7	B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 5 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 57	Lechuguilla Desert	Aaf	SP & GP	25% low durability material	2-3	high mod	yes	
AZ 58	Colorado River Valley	Au	SP	50% intermed. & silisic volcanics, soft particles	1	mod	yes	
AZ 59	Chocolate Mtns.	Vu	Volcanics	Tuffs, agglomerates, glassy volcanics, Photo Stop				
AZ 60	Chocolate Mtns.	Vu	Volcanics	Tuffs, agglomerates, glassy volcanics, Photo Stop				
AZ 61	Chocolate Mtns.	gn	Metamorphics	very weathered in outcrop, chlorite, Photo Stop				
AZ 62	Chocolate Mtns.	Vb	Basaltic Andesite	5% vesicular, limited quantity	-	high	yes	-
AZ 63	Picacho Wash	Au		Coarse grained horizon overlying fine grained horizons, Photo Stop				
AZ 64	Colorado River Valley	Au	GP & SP	30% basic & intermediate volcanics, 5% chert, caliche	2-3	high mod	yes	75
AZ 65	Colorado River Valley	gn	Augen Gneiss		-	high		-
AZ 66	Cargo Muchacho Mtns	Au	SM & GM	very weathered & decomposed granitics	-	mod low	no	-
AZ 67	Ogilby Hills	gr	Granite	weathered in outcrop, medium grained	-	mod	no	-
AZ 68	Cargo Muchacho Mtns	gn	Hornfels	limited quantity	-	high	no	-
AZ 68	Cargo Muchacho Mtns	Aal	SP & GP	50% very weathered, coarse grained granitics, 10% schist	-	mod		50
AZ 69	Chocolate Mtns.	gn	Granite Gneiss	moderately weathered, coarse grained	-	mod	no	-

*Heavy caliche this area, not considered typical of entire deposit.

D VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
igh od	yes				27.8	2.9	NP		100	60	38	18	11					B_2
od	yes					* 16.6	NP	100	99	99	96	93	81	65	44	29	7.2	C
gh	yes	-	-	-														B
gh d	yes	75	5	NP														B_2
gh		-	-	-														A
od ow	no	-	-	-														B_2
od	no	-	-	-														B_2
igh	no	-	-	-														B
od		50	tr.	NP														C
od	no	-	-	-														B_2

FIELD STATION AND SUPPLEMENTARY TEST DATA – PAGE 6 OF 15
ARIZONA–CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE B–1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES
AZ 70	Chocolate Mtns.	Au	GP & SP	60% schist and phyllite 30% basic & intermediate volcs.	1	mod	yes	50	t
AZ 71	Gables Wash	Aal	SP	60% schist and phyllite 10% volcanics	-	high mod	yes	60	t
AZ 71	Chocolate Mtns.	Vu	Rhyolite-Andesite	glassy, locally soft rubbely zones, limited quantity	-	high mod	yes	-	
AZ 72	Chocolate Mtns.		Mica Schist	soft, platy, mica	-	low		-	
AZ 73	Chocolate Mtns.	Au	SM & GM	very weathered metamorphics, platy & elongate particles, caliche	3	low		40	t
AZ 74	Chocolate Mtns.	Aal	GP & SP	30% schist and phyllite 30% intermediate volcanics	-	high mod	yes	40	t
AZ 75	Black Mtn.	Vb	Basalt	15% vesicular, zeolite	-	high	yes	-	
AZ 76	Chocolate Mtns.	Vu	Volcanics	Photo Stop					
AZ 77	Midway Mtns.	Vu	Volcanics	Photo Stop					
AZ 78	Midway Mtns.	gn	Gneiss	weathered in outcrop, coarse grained	-	low	no	-	
AZ 79	Milpitas Wash	Au	SP & SM	35% intermed. volcanics; occassional platy & elongate particles	1	mod	yes	40	
AZ 79	Milpitas Wash	Aal	SP	45% intermed. & silisic volcs. 55% weathered, mod. hard granitics & metamorphics	-	mod	yes		
AZ 80	Palo Verde Mtns.	Vu	Volcanics	Photo Stop					
AZ 81	Pebble Terrace	At	SP & GP	20% basic & intermediate volcanics; 2-3% chert	2-3	high	yes	50	

ED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
mod	yes	50	tr.	NP														C
high mod	yes	60	tr.	NP														C
high mod	yes	-	-	-														B_2
low		-	-	-														C
low		40	tr.	NP														C
high mod	yes	40	tr.	NP														C
high	yes	-	-	-														B
low	no	-	-	-														C
mod	yes	40	10	NP														B
mod	yes			NP		8.9		100	97	95	92	83	73	62	49	35	1.0	B
high	yes	50	10	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 7 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE B-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	
AZ 82	Colorado River Valley	Aal	SP	weathered granitics and metamorphics	-	mod		45	
AZ 82	Colorado River Valley	Au	SM & GM	occasional platy and elongate particles	1-2	mod	yes	30	
AZ 83	Dome Rock Mtns.	gn	Gneiss	weathered in outcrop	-	mod low		--	
AZ 84	Colorado River Valley	Au	GM - SM	platy and elongate particles	3	mod		50	
AZ 85	Dome Rock Mtns.	gn	Gneiss Schist	platy, mica, soft locally	-	mod low	no	--	
AZ 86	Dome Rock Mtns.	gr	Granite	weathered in outcrop	-	high mod	no	--	
AZ 87	Dome Rock Mtns.	Su	Quartzite & Shale	shale platy and soft	-	high low	no	--	
AZ 88	Tyson Wash	Aal	SP - GP	30% basic and intermediate volcanics ; limited quantity	-	high mod	yes	50	
AZ 89	Bear Hills	Vb	Basalt	15% vesicular, zeolites	-	high	yes	--	
AZ 90	Plamosa Mtns.	Aaf	SP & GP	40% intermediate and silisic volcs. 10% weathered granitic	2	mod	yes	50	
AZ 91	Plamosa Mtns.	Su	Metamorphic	sulfide minerals	-	high	yes	--	
AZ 92	Plamosa Mtns.	Vb	Basalt	65% vesicular, caliche coatings at surface	-	high mod	yes	--	
AZ 92	Poorman Wash	Aal	SP & GP	50% basic & intermediate volcs. platy & elongate particles	-	high	yes	60	
AZ 93	Plamosa Mtns.	Cau	Limestone & Shale	shale, soft and platy, limited quantity	-	high low	no	--	

TED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
mod		45	5	NP														B
mod	yes	30	15	low														B_2
mod low		--	--	--														B_2
mod		50	15	--														C
mod low	no	--	--	--														B_2
high mod	no	--	--	--														B_2
high low	no	--	--	--														B_2
high mod	yes	50	5	NP														B
high	yes	--	--	--														B
mod	yes	50	10	NP														B_2
high	yes	--	--	--														B_2
high mod	yes	--	--	--														C
high	yes	60	tr.	--														B
high low	no	--	--	--														B_2

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 8 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE B-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	
AZ 94	LaPosa Plain	Aal	SP & SM	80% intermediate and silisic volcanics	-	high	yes	
AZ 95	Chocolate Mtns. (Ariz.)	Vu	Andesite	glassy	-	mod	yes	
AZ 95	LaPosa Plain	Au	SM w/ GM	100% silisic and intermediate volcanics, many soft particles	1-2	low	yes	
AZ 96	Castle Dome Plain	Aal	SP	100% silicic and intermediate volcanics	-	high	yes	
AZ 97	Gila River Valley	Au	SP & GP	50% intermediate and silisic volcanics, weathered granitics	2	high	yes	
AZ 98	Gila River Valley	gn	Gneiss	weathered in outcrop, fresh at depths	-	high	yes	
AZ 99	Gila River Valley	Aaf	SM - SP	PVNGS aggregate supply Tanner Co. Pit	1-2	high	no	
AZ 100	McCoy Mtns.		Phyllite	soft, altered, platy	-	low	yes	
AZ 101	McCoy Wash	Aaf	SM & GM	90% schist and phyllite, platy & elongate particles	1	low	yes	
AZ 102	McCoy Mtns	gn	Augen Gneiss	soft, altered	-	low	yes	
AZ 103	Colorado River Valley	Au	GP & SP	30% basic and intermediate volcanic, 25% platy particles	1	high mod	yes	
AZ 104	Colorado River Valley	Au	ML	unit is a clayey silt	1	--	--	
AZ 105	McCoy Wash	Au	SP	moderately weathered granitics and metamorphics	1	mod high	yes	
AZ 106	McCoy Wash	Aal	SP - GP	occasional platy or soft particles	-	high	yes	

* Only available samples from calichified zone, not considered typical of entire deposit.

**Sodium Sulfate Soundness

ESTIMATED VALUES					LABORATORY TEST DATA													
								SIEVE ANALYSIS % PASSING										
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
high	yes	35	15	--														B
mod	yes	--	--	--														B_2
low	yes	45	15	--														C
high	yes	40	10	--														B
high	yes	55	5	--		*17.9												C
high	yes	--	--	NP	36	1.0												B
high	no	35	15	--	23.7	**3.4												A
low	yes	40	15	--														C
low	yes	--	--	--														C
low	yes	--	--	--														C
high mod	yes	30	10	--														C
--	--	0	60	mod														C
mod high	yes	35	5	NP														B
high	yes	55	5	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 9 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE B-1

FUGRO NATION/L, INC.

AD-A113 204 FUGRO NATIONAL INC LONG BEACH CA F/G 8/7
AGGREGATE RESOURCES REPORT DEPARTMENT OF DEFENSE AND BUREAU OF --ETC(U)
FEB 78 W R LUND, M R LONG, E Y HSU F04704-77-C-0010

unclassified

FH-TR-208

3 OF 4
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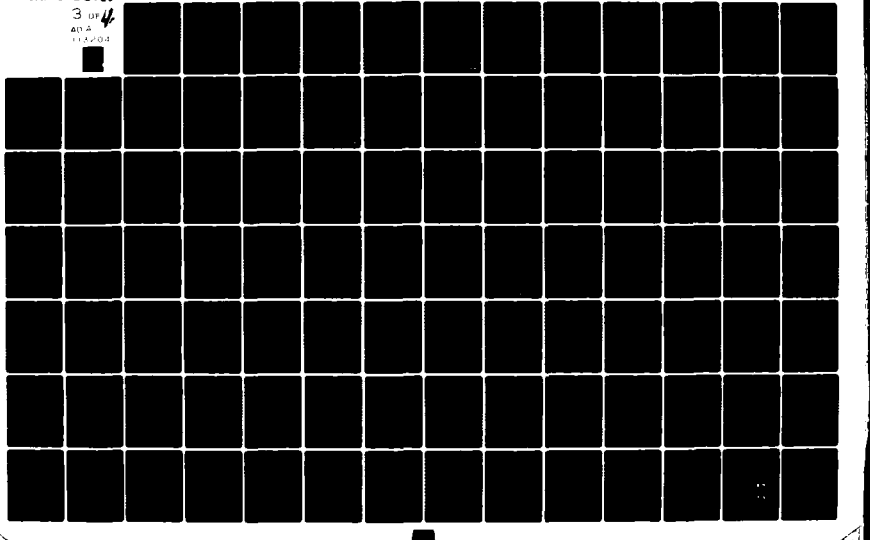
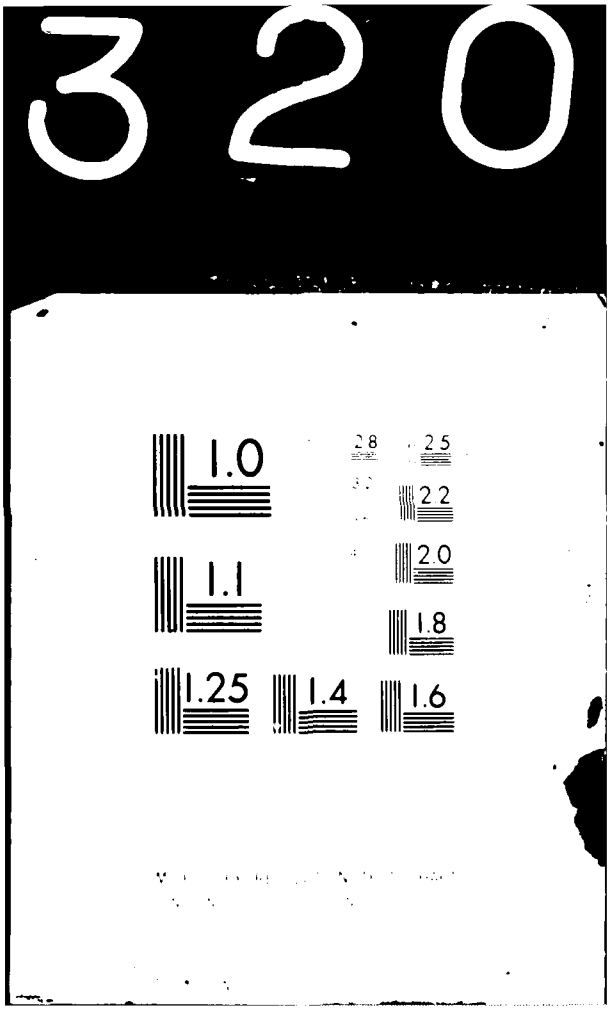
113204




320
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8

FM-TR-20

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	
AZ 107	Little Maria Mtns.		Schist-Phyllite	platy and elongate particles, soft	-	low-mod	yes	--	
AZ 108	Little Maria Mtns.	Su	Limestone	trace chert, highly fractured	-	high	yes	--	
AZ 109	Big Maria Mtns.	gn	Gneiss-Schist	platy and elongate particles, locally soft	-	high-mod		--	
AZ 110	McCoy Wash Valley	Au	SP & GP	mica, platy & elongate particles	-	high	no	55	
AZ 111	McCoy Wash Valley	Au	GM - SC	caliche cementation, clay coatings	2	mod low	no	35	
AZ 112	Big Maria Mtns.	Aal	GP	granitics moderately hard, 10% soft particles	-	high	no	70	
AZ 112	Big Maria Mtns.	Au	SM	Caliche cementation	2-3	mod		30	
AZ 113	Colorado River Valley	Au	SP	ocassional soft particles, 5% of intermediate volcanics	1	mod high	yes		
AZ 114	Big Maria Mtns.	gr	Granite	very weathered in outcrop, coarse-grained	-	mod low	no	--	
AZ 115	Big Maria Mtns.	Su	Limestone & Dolomite	thin bedded, locally platy	-	high	yes	--	
AZ 116	Colorado River Valley	Au	SM & GM	occasional soft, platy phyllite particles	1	high		50	
AZ 117	Colorado River Valley	Au	SP & GM	occasional platy particles, mica abundant	-	high		45	
AZ 118	Colorado River Valley	Au	SP & GM	phyllites, soft, platy particles	1	high	yes	35	
AZ -)	Whipple Mtns.	Vb	Basalt	15-20% vesicular, caliche coating at surface	-	high	yes	--	

ED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
low-mod	yes	--	--	--														C
high	yes	--	--	--														B
high-mod		--	--	--														B_2
high	no	55	5	NP														B_2
mod low	no	35	25	low mod														B_2
high	no	70	tr.	NP														B
mod		30	20	NP low														B_2
mod high	yes				31.8	5.9	NP	99	95	90	87	76	61	56	49	41	3.3	B
mod low	no	--	--	--														B_2
high	yes	--	--	--														B
high		50	10	NP														B
high		45	5	NP														B
high	yes	35	5	NP														B_2
high	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 10 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-1

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 120	Vidal Valley	Au	SM	50% intermed. & silisic volcs. strong caliche cementation occ. soft particles	2-3	mod.	yes	30
AZ 121	Whipple Mtns.		Sandstone	soft	-	low	no	--
AZ 122	Whipple Mtns.	gn	Gneiss	very weathered in outcrop, highly altered	-	low		--
AZ 123	Colorado River Valley	Au	SP & GP	limited quantities 40% basic and intermediate volcanics	1	high	yes	50
AZ 124	Whipple Mtns.	gn	Gneiss	very weathered in outcrop, highly altered	-	low	no	--
AZ 125	Colorado River Valley	Au	GP	70% basic and intermediate volcanics, caliche cementation	2	high	yes	65
AZ 126	Colorado River Valley	Au	SP & GP	15% basic and intermediate volcanics, occasional soft particles	-	high mod	yes	45
AZ 126	Colorado River Valley	Au	SM	25% basic and intermediate volcanics, 15% phyllite and schist	1	high mod	yes	35
AZ 127	Black Mtn.	Vb	Basalt	10% vesicular, caliche at surface	-	high	yes	--
AZ 128	Osborne Wash	Au	GP & SP	25% basic and intermediate volcanics, 15% phyllite and schist	1	high mod	yes	55
AZ 129	Buckskin Mtn.	Vu	Andesite	glassy, caliche at surface	-	high	yes	--
AZ 130	Osborne Wash	Au	SP & GP	20% basic volcanics occasional platy particles	2	high	yes	40
AZ 131	Buckskin Mtns		Metamorphic	very weathered in outcrop. highly altered, limited extent		mod low		--
AZ 132	Buckskin Mtns	gn	Gneiss	local zones of highly altered material; limited quantity	-	high		--

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
mod.	yes	30	20	low														B_2
low	no	--	--	--														C
low		--	--	--														C
high	yes	50	10	NP														B
low	no	--	--	--														C
high	yes	65	5	NP														B
high mod	yes	45	10	NP														B
high mod	yes	35	15	NP														B
high	yes	--	--	--														B
high mod	yes	55	5	NP														B
high	yes	--	--	--														B_2
high	yes	40	15	--														B
mod low		--	--	--														C
high		--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 11 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 133	Buckskin Mtns	Su	Quartzite	highly fractured, interbedded slates, limited quantity	-	mod high	no	--
AZ 133	Mineral Wash	Aal	SP	20% basic and intermediate volcanics	-	high	yes	40
AZ 134	Aubrey Hills	gn	Granitic Gneiss	very weathered in outcrop	-	mod	no	--
AZ 135	Colorado River Valley	Au	SM & GM	30% intermed. volcs., occasional soft particles, caliche	2	mod	yes	50
AZ 136	Colorado River Valley	Aal	SP - SM	70% intermediate volcanics; limited quantity	-	high	yes	25
AZ 136	Bill Williams Mtns.	Vu	Andesite	very weathered in outcrop	-	low	yes	--
AZ 137	Mohave Mtns.		Diorite	very weathered in outcrop and highly altered	-	low mod	yes	--
AZ 138	Colorado River Valley	Au	GP & SP	20% intermediate and silisic volcanics, caliche cementation	2	high mod	yes	45
AZ 139	Bouse Wash	Aal	SP	40% intermediate volcanics, occasional soft particles	-	high	yes	15
AZ 139	Bouse Wash	Au	SP/SM	occasional elongate particles, occasional soft particles	2	high mod	no	35
AZ 140	Plomosa Mtns.	gn	Gneiss	very weathered in outcrop, locally altered	-	mod low		--
AZ 141	Plomosa Mtns.	Su	Limestone	weathered in outcrop, dolomitic, caliche at surface	-	mod high	yes	--
AZ 142	Plomosa Mtns.	Au	SM	90% gneiss & schist, platy and elongate particles		high mod	no	30
AZ 143	Plomosa Mtns.	Su	Limestone Siltstone	soft, thin bedded - platy particles		low	no	

ATED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
mod high	no	--	--	--														B_2
high	yes	40	tr.	--														B
mod	no	--	--	--														B_2
mod	yes	50	15	NP														B
high	yes	25	15	NP														B
low	yes	--	--	--														C
low mod	yes	--	--	--														C
high mod	yes	45	10	NP		24.9		97	96	90	83	71	57	51	46	41	5.3	C
high	yes	15	5	NP														B
high mod	no	35	10	NP														B
mod low		--	--	--														C
mod high	yes	--	--	--														B_2
high mod	no	30	20	--														C
low	no																	C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 12 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-1

WOODWARD-CLYDE CONSULTANTS

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 144	Ranegras Plain	Au	SM	40% basic and intermediate volcanics, minor clay	1-2	high	yes	35
AZ 144	Ranegras Plain	Aal	SP	40% basic and intermediate volcanics	-	high mod	yes	20
AZ 145	Granite Wash Mtns.		Phyllite	weathered in outcrop, soft, platy & elongate particles	-	low	yes	--
AZ 145	Granite Wash Mtns.	Au	GM & SM	90% gneiss and schist; platy and elongate particles, caliche	2	high	yes	45
AZ 145	Granite Wash Mtns.	Aal	SP	100% metamorphic, platy elongate particles	-	mod	yes	50
AZ 146	Little Harquahala Mt	Vb	Basalt	weathering rind, caliche development at surface	-	high	yes	--
AZ 147	Granite Wash Mtns.	gr	Qtz. Monzonite	weathered at surface	-	mod high	no	--
AZ 148	Centennial Wash	Aal	SP	25% basic volcanics	-	high	yes	30
AZ 149	Harquahala Mtns.	gn	Granite Gneiss	weathered in outcrop, locally altered	-	mod low	no	--
AZ 150	Little Harquahala Mt.	Su	Limestone	thinly bedded; dolomitic	-	high mod	yes	--
AZ 151	Harquahala Mtns.	gn	Granite Gneiss	weathered in outcrop, soft	-	mod low	no	--
AZ 152	Little Harquahala Mt.		Gneiss & Schist	very weathered in outcrop, soft	-	low	no	--
AZ 153	Harcuvar Mtns.	gn	Gneiss	weathered in outcrop	-	mod low		--
AZ 154	Butler Valley	gr	Granite Gneiss	locally weathered in outcrop	-	mod high	no	--

ED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
igh	yes	35	15	low														B
igh od	yes	20	5	NP														B
ow	yes	--	--	--														C
igh	yes	45	15	low														C
od	yes	50	5	NP														C
igh	yes	--	--	--														B
od igh	no	--	--	--														B_2
igh	yes	30	tr.	--														B
od ow	no	--	--	--														B_2
igh od	yes	--	--	--	21.5	.4	NP			88	58	23	13					B
d w	no	--	--	--														C
w	no	--	--	--														C
d w		--	--	--														B_2
d igh	no	--	--	--														B_2

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 13 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-1

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 155	Butler Valley	Aal	SP	15% basic volcanics and mafic metamorphics	-	high	yes	40
AZ 156	Harcuvar Mtns.	Aaf	GP	10% ultramafic metamorphics, occasional soft particles	2	high	no	60
AZ 157	Harquahala Mtns.	gn	Granite Gneiss	weathered in outcrop, medium grained	-	mod	no	--
AZ 158	Vulture Mtns.	Vu	Rhyolite Tuff	soft, glassy	-	low	yes	--
AZ 159	Jackrabbit Wash	Aal	SP	40% intermediate and silisic volcanics	-	high	yes	20
AZ 160	Vulture Mtns.	gr	Granite	moderately weathered in outcrop	-	high mod	low	--
AZ 161	Vulture Mtns.	gn	Granite Gneiss	weathered	-	high	no	--
AZ 162	Black Butte	Vb	Basalt	10-15% vesicular		high	yes	--
AZ 163	Harcuvar Mtns.	gn	Gneiss	weathered in outcrop, coarse grained	-	mod	no	--
AZ 164	Congress Mtns.	gr	Granite	weathered in outcrop	-	low mod	no	--
AZ 164	Congress Mtns.	Aal	Sp	granitic gravel, moderately hard to soft, limited quantity	-	high mod	no	--
AZ 165	Weaver Mtns.	gr	Granite	moderately weathered in outcrop	-	mod high	no	--
AZ 166	Antelope Peak	Vb	Basalt	5% vesicular	-	high	yes	--
AZ 167	Date Creek Mtns.	gr	Granite	moderately weathered in outcrop, localized soft zones	-	high mod	no	--

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes	40	tr.	NP														B
high	no	60	10	--														B_2
mod	no	--	--	--														B_2
low	yes	--	--	--														C
high	yes	20	10	NP														B
high mod	low	--	--	--														B_2
high	no	--	--	--														B_1
high	yes	--	--	--														B
mod	no	--	--	--														B_2
low mod	no	--	--	--														B_2
high mod	no	--	--	--														B_2
mod high	no	--	--	--														B_2
high	yes	--	--	--														B
high mod	no	--	--	--														B_2

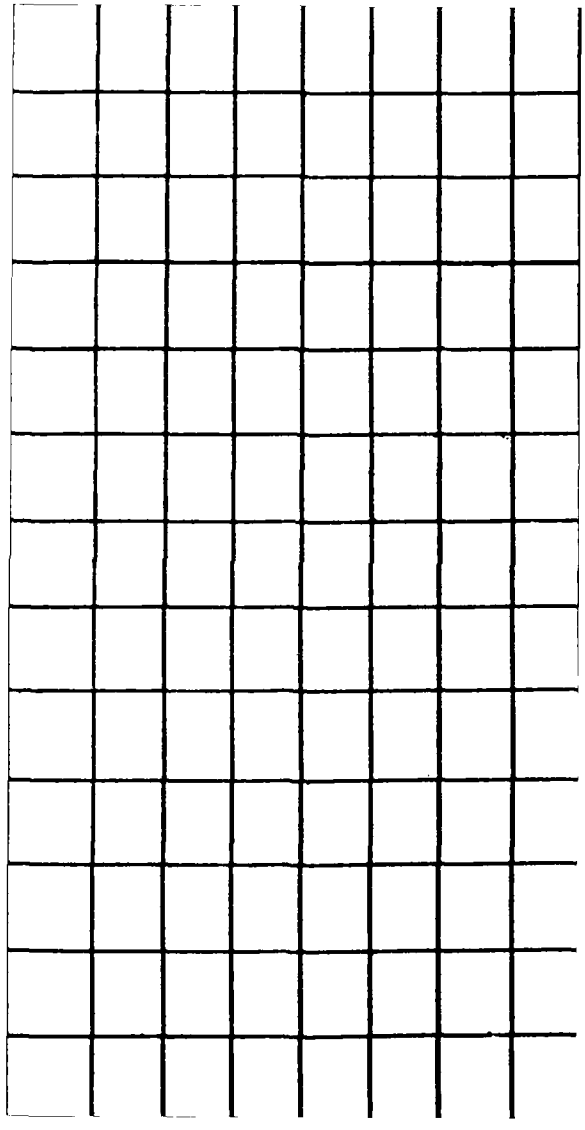
FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 14 OF 15
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION · ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
AZ 168	Sunflower Flat	Vb	Basalt	scoriaceous, brittle	-	mod	yes	
AZ 169	North Fork Santa Maria River	Aal	SP	50% basic volcanics, granitics moderately hard	-	high mod	yes	3
AZ 170	Miller Mountain		Schist	soft, shale partings	-	low		
AZ 171	Bozarth Mesa	Vb	Basalt	30%+ vesicular, glassy, ½" weathering rind	-	low mod	yes	
AZ 172	Burro Creek	Aal	SP	70% basic and intermediate volcanics	-	high	yes	4
AZ 173	Burro Creek	Au	Fanglomerate	70% basic and intermediate volcanics, strong caliche cementation, tuffaceous	3	mod	yes	2
AZ 174	Santa Maria River	Aal	SP	85% basic to silisic volcanics	-	mod high	yes	2
AZ 175	Date Creek	Aal	SP	30% basic and intermed. volcanics	-	high	yes	3
AZ 175	Date Creek Mtns.	Vu	Rhyolite Porphyry	glassy, low durability	-	low	yes	
AZ 176	[illegible] Creek Mtns.	Au	SC	clay, soft particles	1	low	no	
AZ 177	Weaver Mtns.	Aal	SP	70% basic and intermediate volcanics, soft granitics	-	mod high	yes	2
AZ 177	Weaver Mtns.	Au	SM/ML	85% basic and intermediate volcanics, thick silt horizon	2	mod	yes	2
AZ 178	Hieroglyphic Mtns.	gr	Granite	weathered in outcrop, coarse grained	-	mod	no	
AZ 179	White Tank Mtns.	gn	Gneiss	very weathered in outcrop, medium grained	-	mod low	no	



PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
AZ 6273	AZHD	Buckskin Mtns	Aaf	Silty clay, gravel				
AZ 6569	AZHD	Buckskin Mtns.	Aaf	Sand, silt, gravel				
AZ 5983	AZHD	Granite Wash Mtns.	Aaf	Silt, gravel, sand				
AZ 5352	AZHD	Little Harguahala Mtns.	Aaf	Sand, some clay				
AZ 5353	AZHD	Little Harguahala Mtns.	Aaf	Silt, sand				
AZ 5450	AZHD	McMullen Valley	Aal	Silty clay, sand				
AZ 5359	AZHD	Harquahala Mtns.	Au	Silt, sand, gravel				
AZ 6427	AZHD	McMullen Valley	Aal	Silt, sand, rock				
AZ 6545	AZHD	McMullen Valley	Aaf	Silt, clay, sand				
AZ 5899	AZHD	Colorado River Valley	Au	Silt, sand, gravel				
AZ 6168	AZHD	Dome Rock Mtns	Au	Silty clay, sand, gravel				
AZ 1196	AZHD	Plomosa Mtns	Aaf	Sand, gravel, boulder				
AZ 1179	AZHD	Bear Mtns.	Aal	Silt, sand, gravel				
AZ 6004	AZHD	Dome Rock Mtns.	Aal	Silt, sand, gravel, some clay				

LABORATORY TEST DATA

SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
				3"	2"	1½"	1"	¾"	½"	¼"	#4	#8	#10	#16	#40	#50	#100	#200
		3					87			49			36		19			6
		NP					88			65			51		27			1
		NP					81			55			36		12			3
		NP					99			91			62		19			6
		5					100						59		30			15
		3											93		65			36
		NP					75						31		12			4
		NP					74			55			38		16			6
		4											97		81			48
		NP					87			53			36		18			3
		NP					92			67			49		15			4
		NP					82						22		3			1
		NP					66						21		8			3
		3					79			46			28		9			4

EXISTING TEST DATA
PAGE 1 OF 8
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na $_2$SO$_4$ SOUNDNESS LOSS	SPECIFIC GRAVITY
AZ 5776	AZHD	La Posa Plain	Aal	Clay, caliche, gravel			
AZ 1198	AZHD	Plomosa Mtns	Aal	Silt, sand, gravel			
AZ 7121	AZHD	Chocolate Mtns.	Aal	Sand, gravel			
AZ 6915	AZHD	Gila River Valley	At	Silty clay, sand, gravel			
AZ 6625	AZHD	Gila River Valley	Aal	Blow sand, some silt, clay			
AZ 5931	AZHD	Gila River Valley	Aal	Silty sand, clay			
AZ 5936	AZHD	Gila River Valley	Au	Blow sand, silty sand, clay			
AZ 6618	AZHD	Gila River Valley	Aal	Silt, sand, some gravel			
AZ 6183	AZHD	Gila River Valley	Aal	Sand, gravel			
AZ 5459	AZHD	Castle Dome Plain	Aal	Clay, sand, gravel			
AZ 5455	AZHD	Castle Dome Plain	Aal	Blow sand, silt, sand			
AZ 1659	AZHD	Castle Dome Wash	Aal	Silt, sand, gravel			
AZ 497	AZHD	Colorado River Valley	Au	Silt, fine sand			
AZ 447	AZHD	Colorado River Valley	Au	Silty sand			

LABORATORY TEST DATA

Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
				3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
		14					74			36			20		11			8
		NP					94			-			35		14			3
		NP					-			40			28		10			3
		NP					88			56			44		19			9
		NP					-			-			100		35			25
		NP					84			71			63		47			16
		5					-			-			98		35			32
		NP					85			80			76		50			3
		NP					90			63			41		8			2
		NP					89			-			38		17			6
		NP					-			-			100		83			13
		NP					97			-			47		23			3
		NP					-			-			-		100			17
		NP					-			-			100		98			20

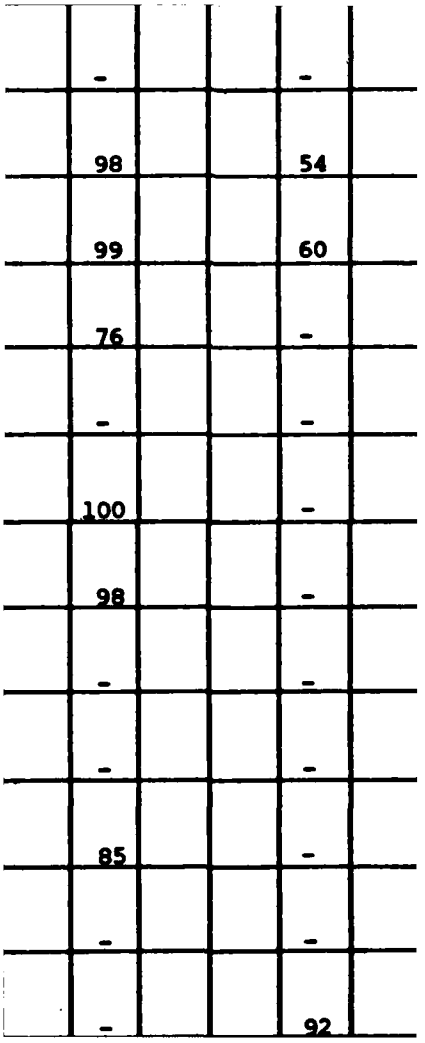
EXISTING TEST DATA
PAGE 2 OF 8
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na SO_4 SOUNDNESS LOSS	SPECIFIC GRAVITY
AZ 5007	AZHD	Fortuna Wash	Aal	Silt, sand, gravel			
AZ 5248	AZHD	Colorado River Valley	Au	Blow sand			
AZ 6641	AZHD	Gila River Valley	Aal	Silt, sand, some clay			
AZ 7161	AZHD	Gila Mtns	Aaf	Silt, sand, clay, gravel			
AZ 7165	AZHD	Gila Mtns.	Aaf	Silt, clay, sand, gravel			
AZ 222	AZHD	Gila River Valley	Aal	Sand, gravel			
AZ 226	AZHD	Gila River Valley	Au	Blow sand			
AZ 464	AZHD	Gila River Valley	Au	Blow sand, silt, sand			
AZ 2380	AZHD	Gila River Valley	Au	Blow sand, silt, sand, clay			
AZ 6939	AZHD	Gila River Valley	Au	Blow sand, sand, gravel			
AZ 2385	AZHD	Mohawk Mtns.	Aaf	Sand, gravel, clay			
AZ 478	AZHD	Mohawk Mtns.	Aaf	Silt, sand, gravel			
AZ 6623	AZHD	Gila River Valley	Au	Blow sand			
AZ 6879	AZHD	Gila River	Aal	Sand, gravel			


-
-
98
54
99
60
76
-
-
-
100
-
98
-
-
-
-
-
85
-
-
-
-
92

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY
AZ 5301	AZHD	Hasayampa River	Aal	Sand, gravel			
AZ 5608	AZHD	San Domigo Wash	Aal	Gravel			
AZ 6984	AZHD	Trilby Wash	Aal	Silt, sand, gravel			
AZ 7055	AZHD	Nada Wash	Aal	Silty sand, gravel			
AZ 1174	AZHD	Vulture Mtns.	Au	Clay, caliche			
AZ 5808	AZHD	Harquahala Mtns	Au	Silt, clay, gravel			
AZ 5714	AZHD	Harquahala Mtns.	Au	Silt, sand, clay			
AZ 7488	AZHD	Sols Wash	Aal	Silty sand, gravel			
AZ 5910	AZHD	Tonopah Desert	Au	Sand, clay, caliche			
AZ 7255	AZHD	Harquahala Valley	Au	Blow sand, silty clay, sand			
AZ 7322	AZHD	Harquahala Valley	Au	Silt, sand, gravel			
AZ 7327	AZHD	Winters Wash	Aal	Sand, gravel			
AZ 7414	AZHD	Tonopah Desert	Aal	Silty clay, sand			
AZ 5086	AZHD	Gila River	Aal	Gravel, sand	23		

LABORATORY TEST DATA

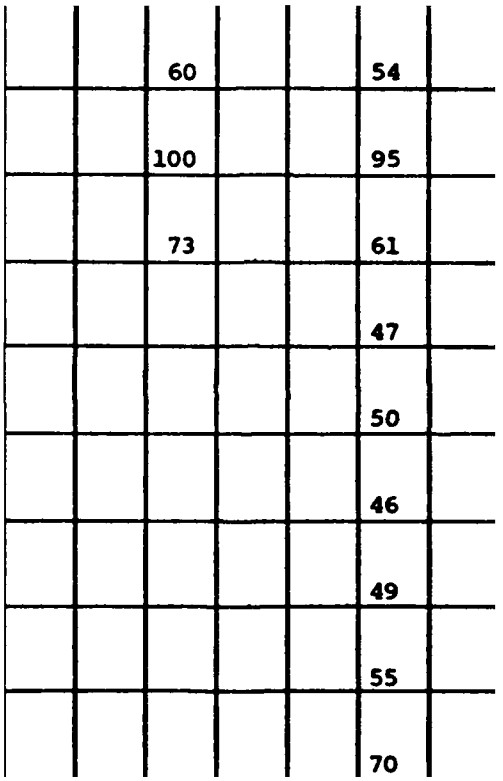
500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
			NP					99			91			68		13			4
			NP					94			55			44		25			3
			NP					80			59			50		28			6
			NP					91			59			35		15			3
			12					75						63		44			32
			18											95		81			66
			6											96		76			46
			NP					100			93			83		23			5
			14					99			90			75		50			35
			8								100			99		83			54
			14					97			80			71		60			42
			9					88			51			31		16			9
			15					94			73			58		24			9
23			NP					75			61			57		28			3

EXISTING TEST DATA
PAGE 4 OF 8
ARIZONA–CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B–2

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
AZ 1678	AZHD	White Tank Mtns.	Aaf	Gravel	38			
AZ 5014	AZHD	Rainbow Valley	Aal	Silt, sand				
AZ 5391	AZHD	Gila River	Aal	Bar gravel	16			
AZ 5787	AZHD	Hassayanpa River	Aal	Clay, sand, gravel				
AZ 7460	AZHD	White Tank Mtns.	Aaf	Silt, clay, sand				
AZ 1527	AZHD	Rainbow Valley	Aal	Sand, gravel	32			
AZ 1503	AZHD	Gila River Valley	Aal	Sand, gravel	29			
AZ 5637	AZHD	Sand Tank Wash	Aal	Sand, gravel	32			
AZ 5625	AZHD	Bender Wash	Aal	Sand, gravel	32			
AZ 1522	AZHD	Gila River Valley	Aal	Gravelly sand				
AZ 1510	AZHD	Gila River Valley	Aal	Gravelly sand				
AZ 5614	AZHD	Maricopa Mtns	Aal	Silt, sand, gravel	20			
AZ 5110	AZHD	Sauceda Wash	Af	Sand, gravel	23			
AZ 3002	AZHD	Painted Rock Dam	Aal	Gravel, sand	26			


60
54
100
95
73
61
47
50
46
49
55
70

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na $_2$SO$_4$ SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
AZ 6075	AZHD	Gila River Valley	Au	Blow sand, silt, sand, gravel				
AZ 5873	AZHD	Sauceda Mtns.	Aal	Gravel	23			
AZ 6078	AZHD	Sauceda Mtns.	Aal	Sand, gravel	26			
AZ 6066	AZHD	Sentenal Plain	Au	Blow sand, sand, silt				
AZ 5874	AZHD	Sauceda Wash	Aal	Gravel	25			
AZ 5559	AZHD	Vekol Wash	Aal	Sand, gravel	26			
AZ 63	AZHD	Woolsey Wash	Aal	Silt, clay, decomposed granite				
AZ 674	AZHD	Peeples Valley	Au	Clay, decomposed granite				
AZ 1650	AZHD	Skull Valley	Au	Clay, sand, gravel				
AZ 5742	AZHD	Skull Valley	Au	Silt, sand, decomposed granite				
AZ 51	AZHD	Thompsons Valley	Au	clay, sand, gravel, caliche				
AZ 441	AZHD	Gray Back Mtns	Aal	Clay, granite sand				
AZ 5168	AZHD	Gray Back Mtns	Au	Decomposed granite, clay				
AZ 5284	AZHD	Santa Maria River	Au	Silt, sand, gravel, boulders				

LABORATORY TEST DATA

SOUNDNESS LOSS	Na $_2$SO $_4$ SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
			8					100			98			88		41			8
			NP					86			51			78		19			8
			NP					93			66			54		29			11
			5								100			96		81			34
			NP					84			47			39		23			9
			NP					92			53			41		16			5
			9						99			80		44		16			7
			13						92			50		27		11			6
			28						90			77		60		25			7
			5						91			76		64		30			12
			22						88			70		52		29			18
			34						99			86		55		24			12
			18						93			58		25		9			6
			2						74			52		36		10			1

EXISTING TEST DATA
PAGE 6 OF 8
ARIZONA-CALIFORNIA STUDY AREA

[redacted] INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-2

FUGRO NATIONAL, INC.

12

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY
AZ 5702	AZHD	Hackberry Wash	Au	Clay, silt, sand, gravel			
AZ 7078	AZHD	Kirkland Valley	Au	Clay, sand, gravel			
AZ 9	AZHD	Harcouvar Mtns	Aal	Silt, sand, gravel			
AZ 5008	AZHD	Martin Creek	Aal	Silt, clay, sand, gravel			
AZ 5048	AZHD	Weaver Mtns.	Aal	Silty loam, caliche, decomposed granite			
AZ 5280	AZHD	Date Creek	Aal	Sand, gravel, decomposed volcanics	44		
AZ 6524	AZHD	Martinez Creek	Aal	Clay, silt, sand, gravel			
AZ 675	AZHD	Pebbles Valley	Au	Clay, sand, gravel			
AZ 7870	AZHD	Antelope Creek	Aal	Silt, sand,	19		
AZ 6474	AZHD	Table Top Mtns	Aal	Silty clay, gravel			
AZ 6145	AZHD	Table Top Mtns.	Au	Silt, sand, gravel			
AZ 6249	AZHD	Cruz Wash	Au	Blow sand, silty clay, sand			
AZ 3152	AZHD	Rio Cornez Wash	Aal	Sand, gravel			
AZ 1406	AZHD	Little Ajo Mtns	Aal	Sand, gravel	31		

LABORATORY TEST DATA

300 KV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
			27						98			82		67		26			5
			4						97			87		69		26			7
			9						100			64		52		29			12
			24						100			97		84		59			41
			14						89			77		59		31			15
4			29						99			90		67		12			2
			12						91			83		70		31			12
			37						87			68		47		18			9
9			3						54			37		27		12			3
			26					82				54		33		17			11
			NP					82				53		36		15			4
			7											99		74			25
			NP								65								7
1			NP					86			49			38		15			4

EXISTING TEST DATA
PAGE 7 OF 8
ARIZONA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE B-2

FUGRO NATIONAL, INC.

1 2

FM-TB-20

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION	ABRASION 500 RV	Na Mg SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
AZ 1320	AZHD	Pozo Redondo Mtns.	Aal	Sand, gravel				
AZ 1314	AZHD	Quijotoa Valley	Aal	Sand, gravel				

1"	¾"	½"	¼"	#4	#8	#10	#16
98			78			54	
92			66			49	

APPENDIX C

NEVADA-CALIFORNIA STUDY AREA DATA SHEETS

Explanation

The following notes are intended to serve as an aid in the use of Tables C1 and C2.

Table C1

Note 1 Multiple entries under a field station number indicate that data were collected on more than one potential source of concrete aggregate at that field station.

Note 2 Seive analyses reported for potential sources of crushed rock represent the size distribution of the sample following crushing to prepare the material for the L.A. abrasion test.

Note 3 Symbols used for designating the material type of basin-fill deposits are in accordance with the Unified Soil Classification System.

Note 4 Field stations at which only a photograph of representative materials was made are designated as photo stops in Appendix C1.

Note 5 Fugro National field station numbers preceded by an R were established during the ground reconnaissance of NCSA; those preceded by an H were established during the aerial reconnaissance.

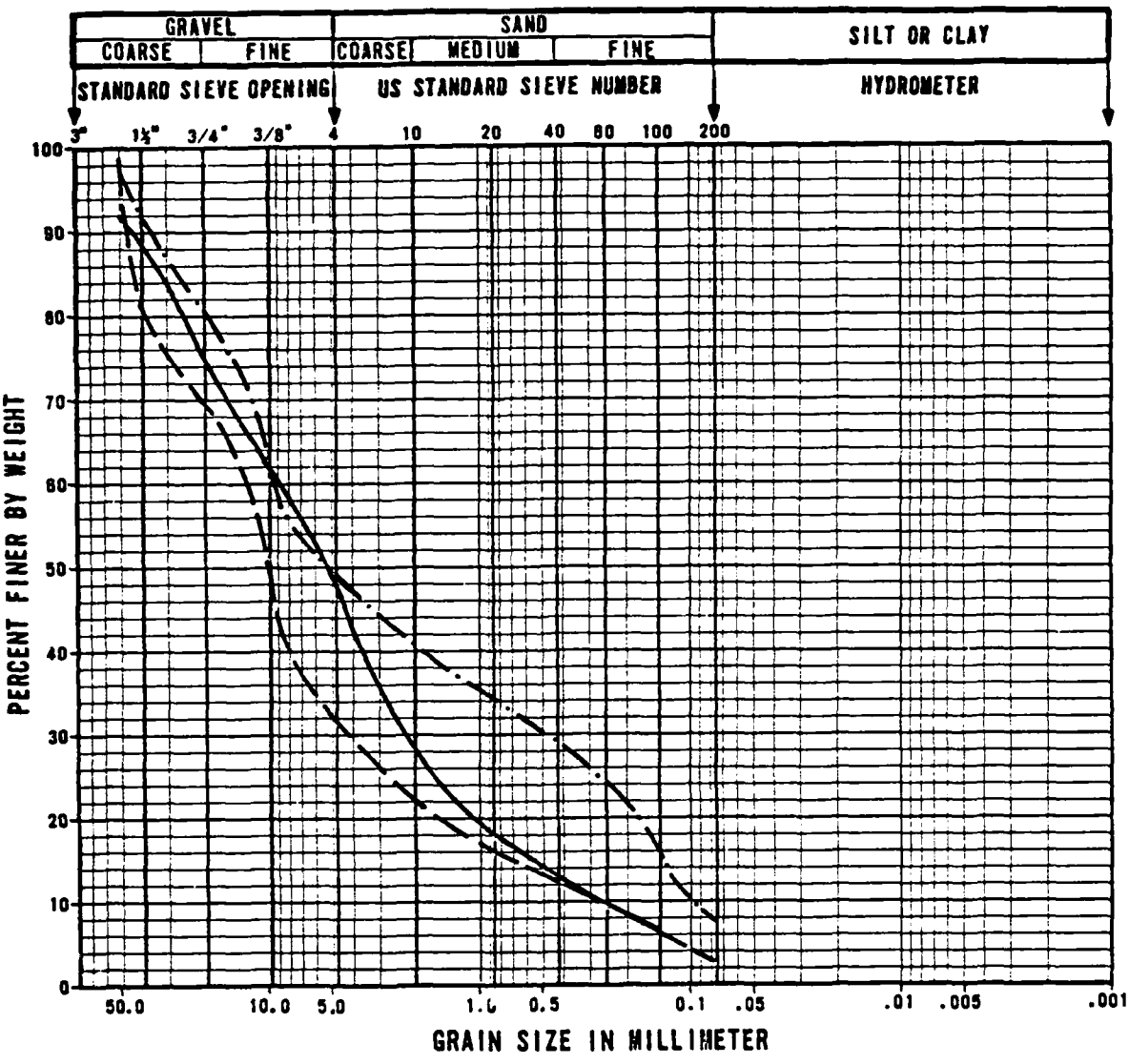
Table C2

Note 1 Much of the test data obtained from existing sources of information was not originally intended to determine the suitability of the material for use as concrete aggregate. Those test results which were applicable to concrete aggregate are shown.

Note 2 Test results from existing sources of information reported in Table B2 for the soundness loss of aggregate were determined using a sodium-sulfate saturated solution unless otherwise noted. Soundness loss determinations reported in Table C1 were obtained using a magnesium-sulfate saturated solution which provides a more-severe test.

Note 3 Where existing test data were reported separately for the coarse (+#4 sieve) and fine (-#4 sieve) fractions of a sample, a C for coarse of an F for fine precedes the appropriate data column.

Note 4 Limited quantities of suitable aggregate may be found locally within Class C basin-fill deposits. While these materials are not present in sufficiently large volumes to meet the needs of the MX system, they may prove adequate as a source of special purpose aggregate. Where available, representative test data for these deposits have been included in Table C2.



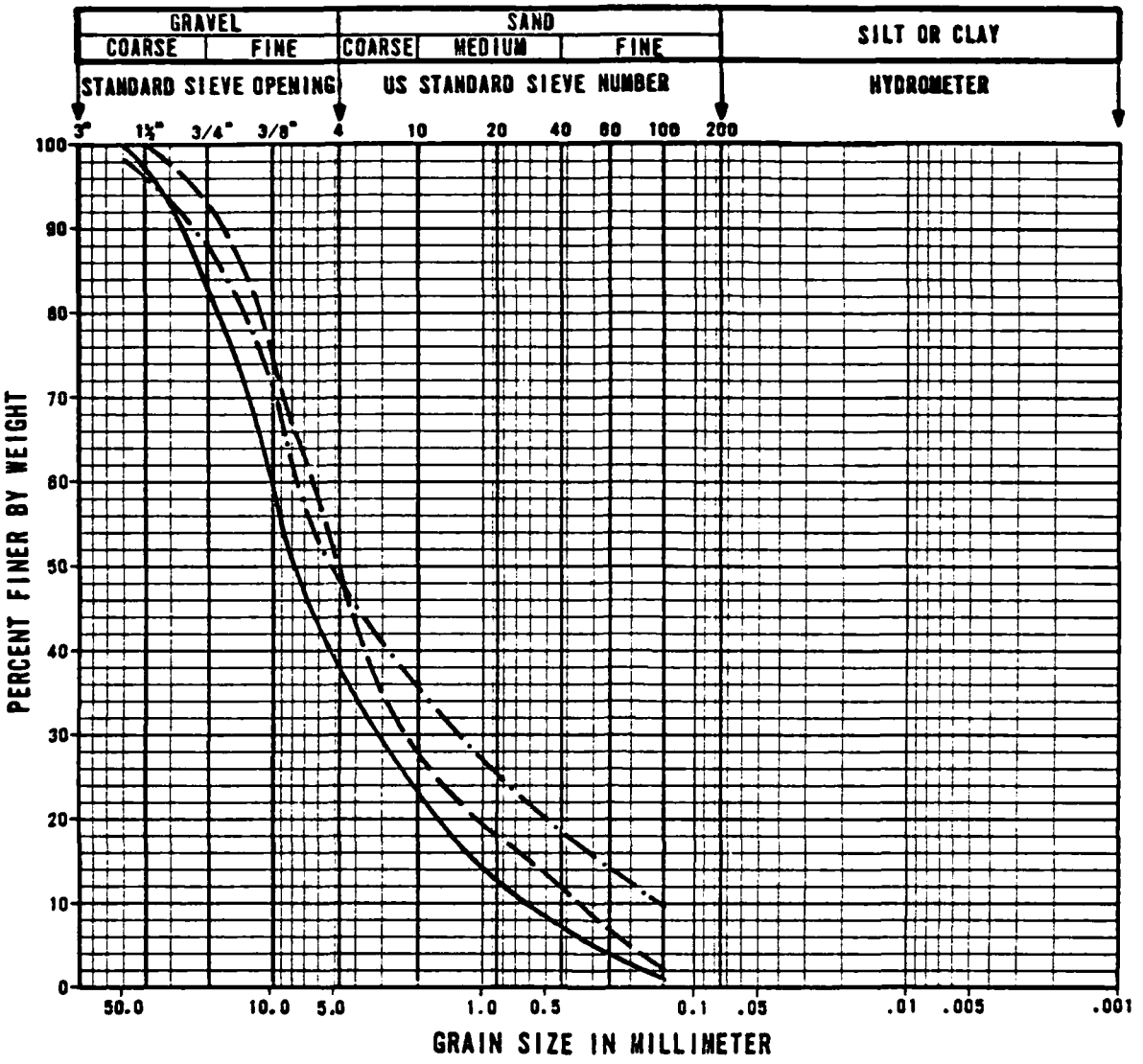
SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-R-16	Au	GW
— —	NV-R-19	Au	GP
—·—	NV-R-33	Au	GP-GM

GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-1

UGRO NATIONAL, INC.



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-R-40	Au	GW
— —	NV-R-57	Aaf	GW
—·—	NV-R-75	Aaf	GW

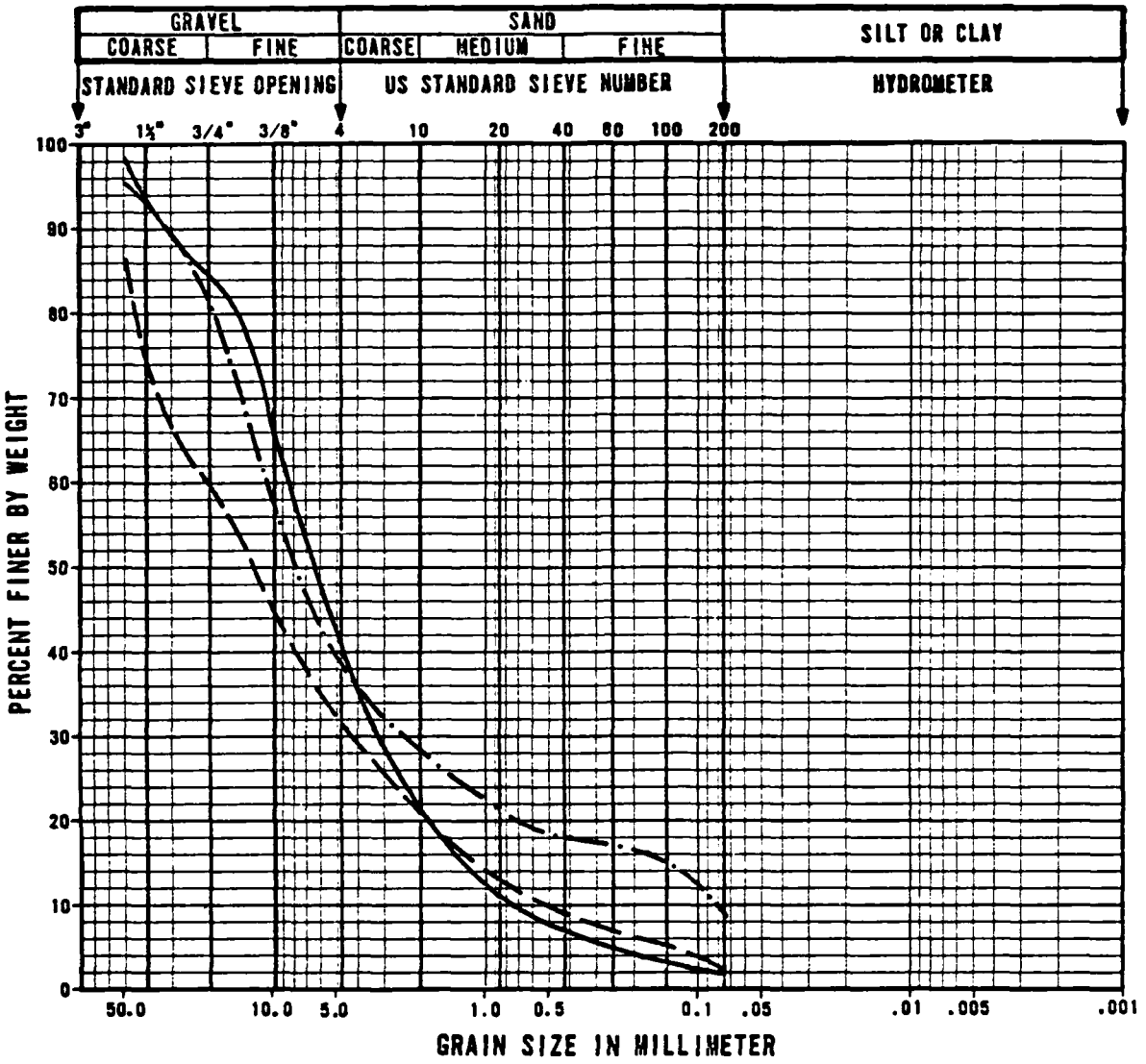
GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-2

UGRO NATIONAL, INC.

FN-TR-200

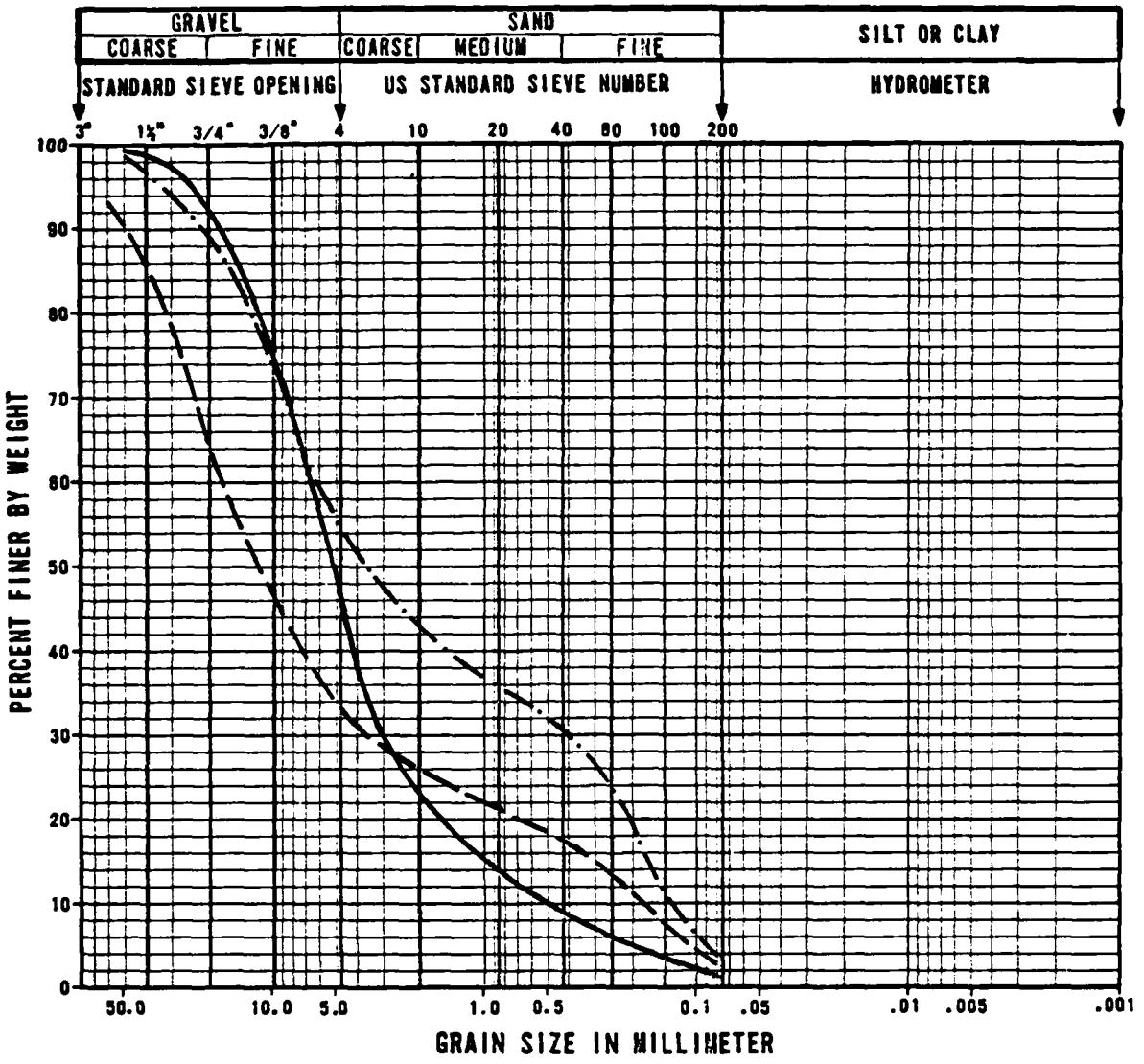


SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-R-80	Aaf	GW
— — —	NV-R-95	Au	GW
—·—	NV-R-104	Au	GP-GM

GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-3



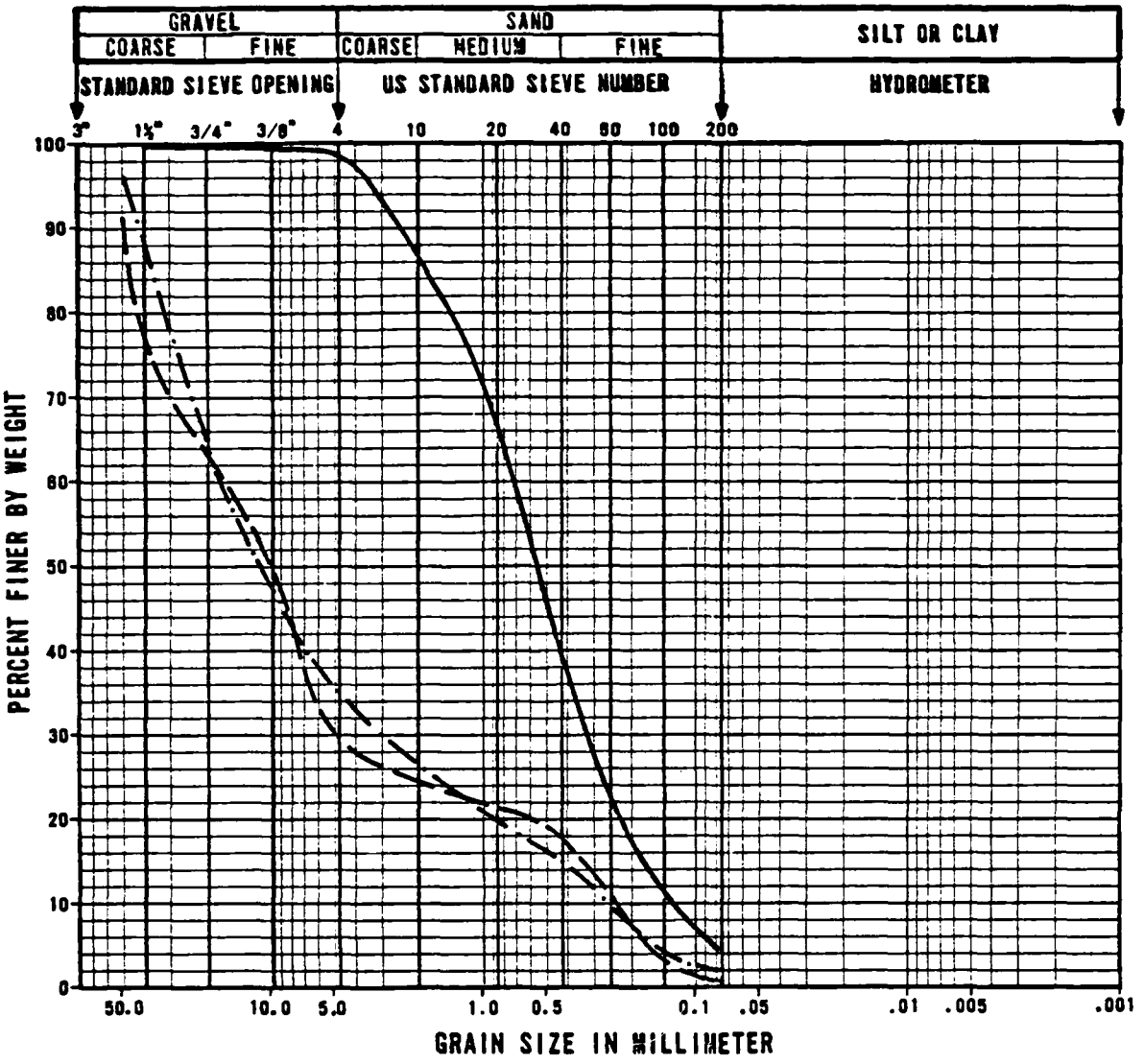
SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-R-120	Aal	GW
— —	NV-R-123	Aal	GP
—·—	NV-R-127	Au	SP-GP

GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-4

UGRO NATIONAL, INC.



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-R-130	Au	SP
— —	NV-R-133	Au	GP
—·—	NV-R-158	Aaf	GW

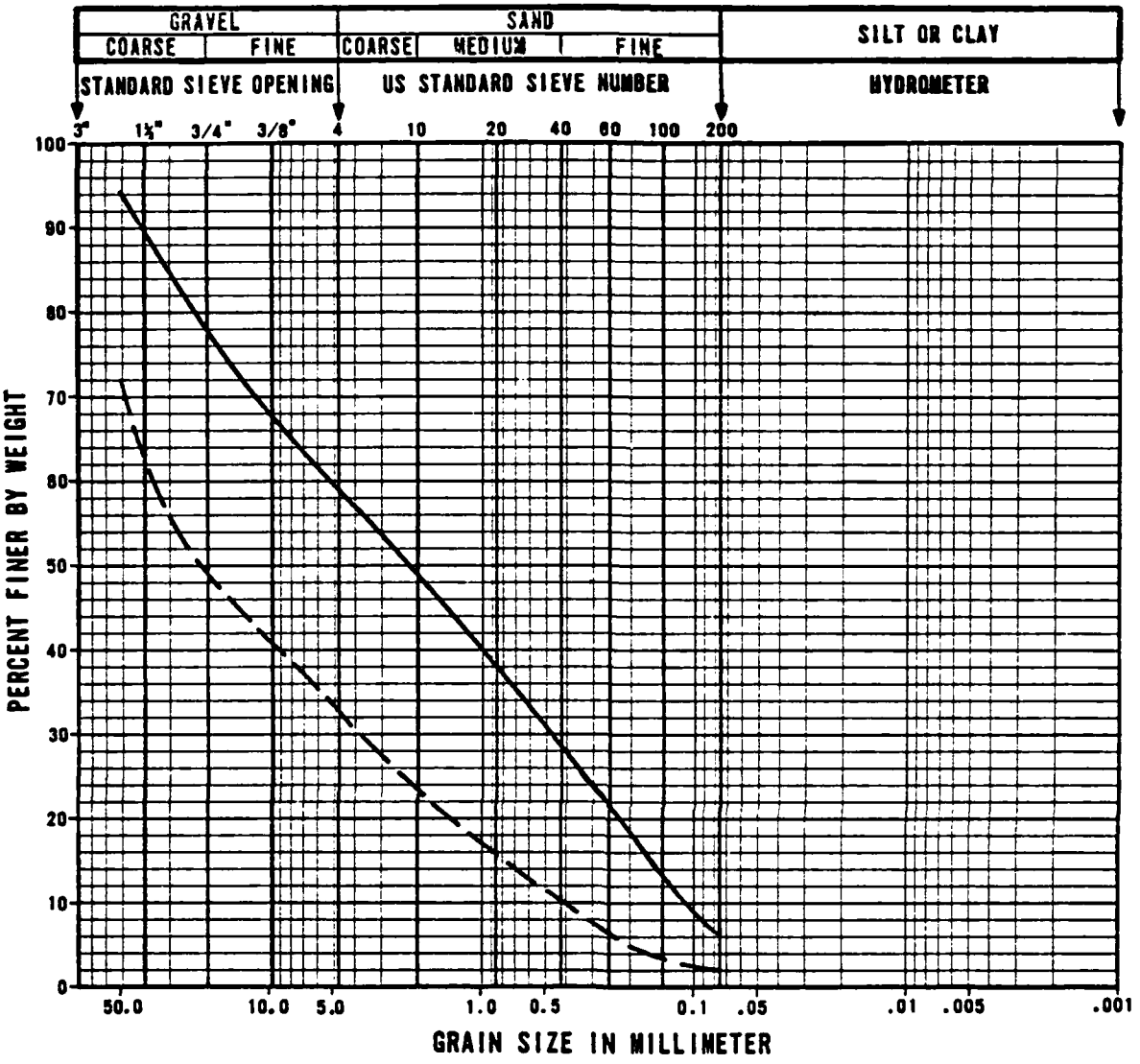
GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-5

UGRO NATIONAL, INC.

FN-TR-200



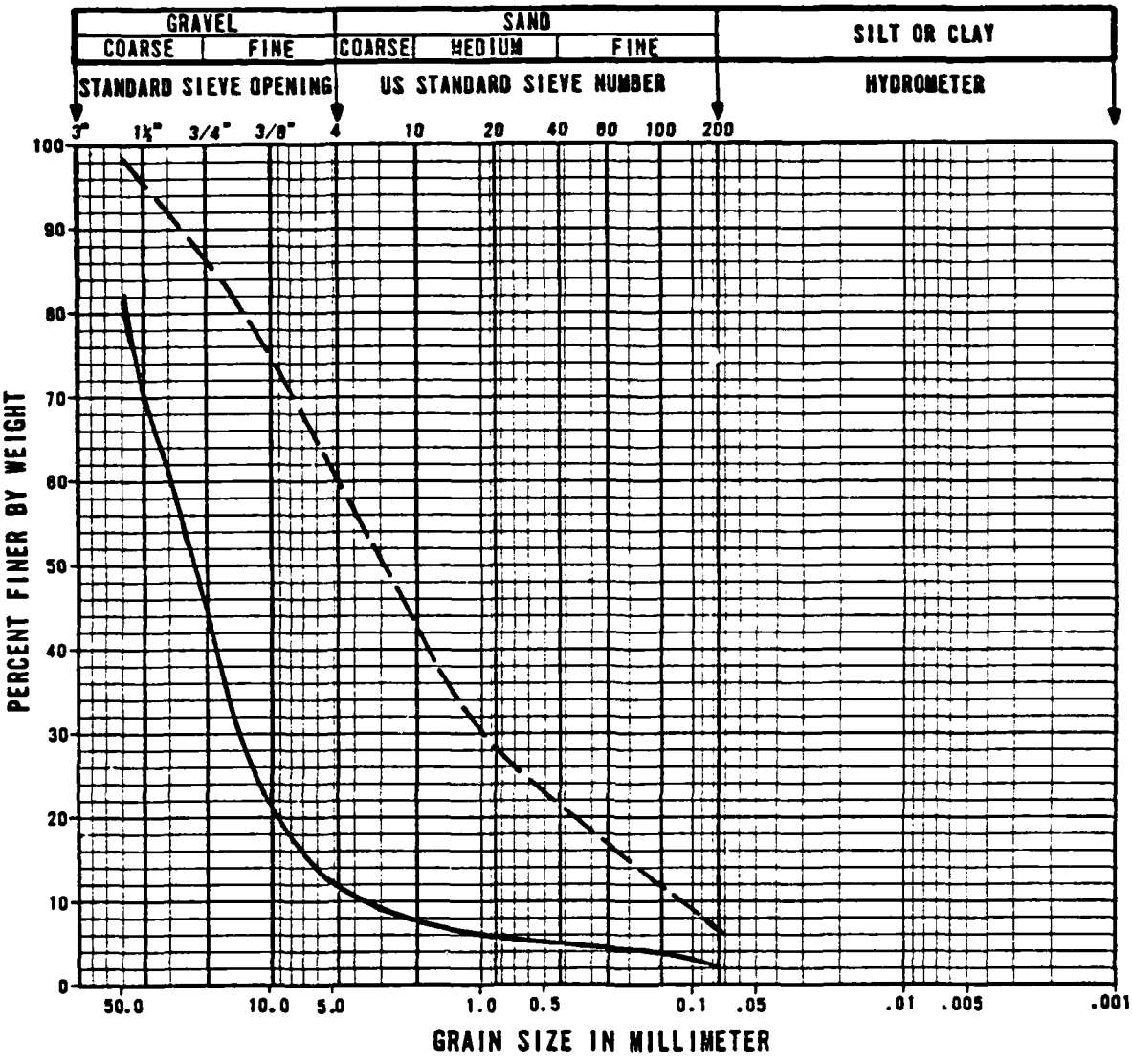
SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-H-24	Aaf	SP
— —	NV-H-25	Aaf	GP

GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-6

UGRO NATIONAL, INC.



SYMBOL	FIELD STATION NO.	UNIT	SOIL TYPE
———	NV-H-70	Au-Aa1	GW
— —	NV-H-112	Au	SW

GRAIN SIZE CURVES
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

FIGURE
C-7

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-1	Frenchman Mtn	Aal	GP-SP	2% chert, occasional soft particles	0-1	high	Yes	60
NV R-1	Frenchman Mtn	gn	gneiss	mica in gneissic bandings	-	mod	No	--
NV R-2	Frenchman Mtn	Au	SM-GM	10% chert and soft particles	1-2	high	Yes	30
NV R-3	Frenchman Mtn	Cau	Limestone	5-30% chert	-	high	Yes	--
NV R-4	Frenchman Mtn	Au	SM	3% chert, some soft particles; caliche coating	2-3	high	Yes	35
NV R-5	Las Vegas Valley	Au	GP-SP	1% chert; heavy caliche coating and cementation	2	high	Yes	60
NV R-6	Las Vegas Valley	Au	GP-SP	3% chert; caliche coating	1-2	high	Yes	50
NV R-6	Las Vegas Valley	Aal	SP-GP	3-5% chert; caliche coating	-	high	Yes	45
NV R-7	Arrow Canyon Range	Cau	Limestone	5-10% chert	-	high	Yes	--
NV R-8	Dry Lake Range	Cau	Limestone	10-20% chert	-	high	Yes	--
NV R-9	Muddy Mtn	Cau	Limestone	10-20% chert lenses and interbeds	-	high	Yes	--
NV R-10	Muddy Mtn	Cau	Limestone	abundant chert at intervals	-	high	Yes	--
NV R-11	Muddy Mtn	Au	SM-GM	3% chert, caliche coating; abundant fines	2-3	high	Yes	40
NV R-12	Muddy Mtn	Au	SP-GP	1% chert; 2% soft particles, some caliche coating	1	high	Yes	30

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	Yes	60	5	NP														B
mod	No	--	-	--														B_2
high	Yes	30	20	NP														B_2
high	Yes	--	--	--														B
high	Yes	35	15	NP														B 2
high	Yes	60	10	NP														B_2
high	Yes	50	10	NP														B
high	Yes	45	10	NP														B
high	Yes	--	--	--														B
high	Yes	--	--	--														B
high	Yes	--	--	--														B
high	Yes	--	--	--														B
high	Yes	40	20	NP-low														B_2
high	Yes	30	20	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 1 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-13	Dry Lake Valley			Cement plant photo				
NV R-14	California Wash	Au	ML-CL	heavy caliche coating and cementation; 80% fines	3	soft	No	0
NV R-15	California Wash	Aal	SP-SM	10% chert	-	high-mod	Yes	40
NV R-15	California Wash	Au	SP	trace chert; caliche coatings	1-2	high	Yes	15
NV R-16	Moapa Valley	Au	SP	85% glassy volcanics	1	mod	Yes	
NV R-17	Meadow Valley Wash	Au	GP-SP	70% glassy volcanics	1-2	mod	Yes	50
NV R-18	Meadow Valley Wash			View of older alluvium (photo)				
NV R-19	Meadow Valley Wash	Au	GP	10% glassy volcanics; caliche coating	1-2	mod	Yes	
NV R-20	Meadow Valley Mtn	Vu	Rhyolite	Glassy, limited quantity	-	high	Yes	--
NV R-21	Meadow Valley Wash	Au	SP-GP	90% glassy volcanics	1-2	mod	Yes	35
NV R-22	Meadow Valley Wash	Au	SP-GP	55% glassy volcanics and 5% decomposed granite	-	high	Yes	40
NV R-23	Meadow Valley Range	Cau	Dolomite Limestone	chert; argillaceous	-	high mod	Yes	--
NV R-24	Clover Mtn	Vb	Basalt	glassy, limited quantity	-	high	Yes	--
NV R-25	Clover Mtn	Vu	Rhyolite	glassy	-	low-mod	Yes	--

ILUES				LABORATORY TEST DATA												
POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
							2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
No	0	80	med-low														C
Yes	40	10	med-low														B
Yes	15	5	NP														B
Yes			NP				92.0	89.4		75.0	61.8	48.2	38.2	28.0	14.9	0	B
Yes	50	0	NP														B
Yes			NP	12.8	3.9		98.8	80.7		70.4	48.9	31.4	23.2	18.7	13.9	2.8	B
Yes	--	--	--														B_2
Yes	35	15	low														B
Yes	40	5	NP														B
Yes	--	--	--														B
Yes	--	--	--														B
Yes	--	--	--														C

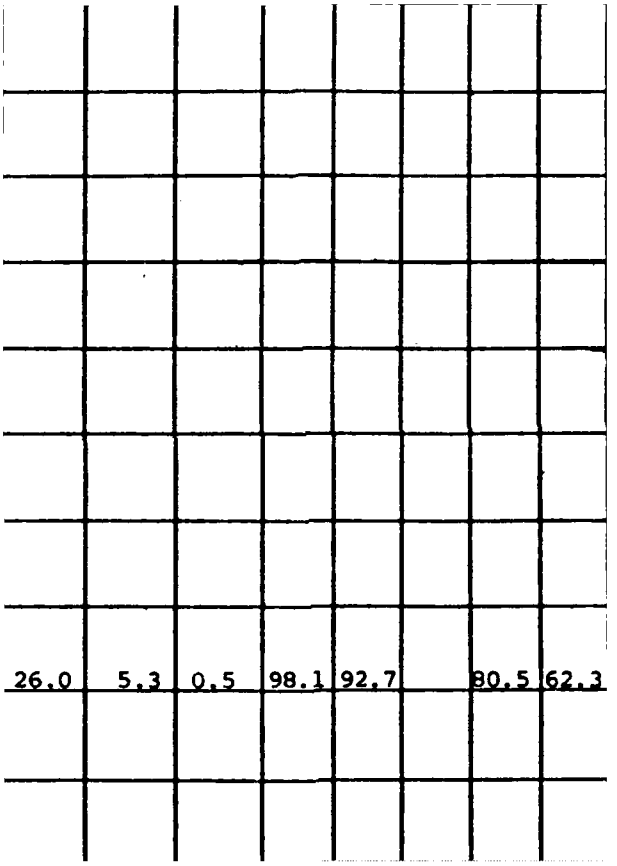
FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 2 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-26	Lake Valley	Au		70% fines	2	low	Yes	0
NV R-27	Chief Range	Au	SM-SP	95% glassy volcanics	1	mod	Yes	5
NV R-28	Chief Range	Au	SP	40% glassy volcanics	1	high	Yes	35
NV R-29	Cathedral Gorge			View of older lake deposits (photo)				
NV R-30	Pioche Hills	Au	GP-GC	rare chert; strong caliche cementation; clay	2	high	Yes	60
NV R-31	Lake Valley	Au	SC-SM	80% glassy volcanics	2-3	mod	Yes	5
NV R-32	Lake Valley	Vu	Rhyolite	glassy	-	low mod	yes	-
NV R-33	Grassy Mtn	Au	GP-SP	trace chert and dolomite 35% strong caliche; cementation	2	high mod	Yes	
NV R-34	Lake Valley Summit	Cau	Limestone	5% chert nodules and lenses	-	high	Yes	-
NV R-35	Baking Powder Flat	Cau	Limestone	minor chert, dolomite	-	high	Yes	-
NV R-36	Shell Creek Range	Ls	Limestone	argillaceous limestone interbeds	-	high	No	-
NV R-37	Shell Creek Range	Cau	Shale	soft, fissile rocks	-	low	No	-
NV R-38	Shell Creek Range	Par	Limestone	iron-oxide stains, soft siltstone interbeds, chert	-	low-mod	Yes	-
NV R-39	Shell Creek Range	Cau	Limestone	dolomite interbeds	-	high	Yes	-


26.0
5.3
0.5
98.1
92.7
80.5
62.3

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	
NV R-40	Steptoe Valley	Au	SP-GP	10% glassy volcanics; rare chert	1-2	mod high	Yes	
NV R-41	Steptoe Valley	Au	GP	15% glassy volcanics	1-2	mod high	Yes	4
NV R-42	Robinson Canyon	Cau	Limestone	chert and dolomite	-	high	Yes	-
NV R-43	Robinson Canyon	Cau	Limestone	Rare chert	-	high	Yes	-
NV R-44	Robinson Canyon	Au	SC	100% highly weathered shale	-	low	No	-
NV R-45	Robinson Canyon	Au	CL-SC	over 40% fines and abundant soft particles	1	low	No	2
NV R-46	Robinson Canyon	Au	SP	40% glassy volcanics and 25% soft particles	1	low mod	Yes	4
NV R-47	Egan Range	Par	Limestone	probably argillaceous dolomite	-	mod	Yes	-
NV R-48	Egan Range	Vu	Andesite & Agglomerate	glassy and soft	-	low	Yes	-
NV R-49	Egan Range	Au	SC-CL	100% glassy volcanics	1	mod low	Yes	2
NV R-50	Jakes Valley	Au	SP	80% glassy volcanics	-	high mod	Yes	3
NV R-51	Butte Mtns	Par	Limestone	dolomite, locally argillacoues	-	high	Yes	-
NV R-52	White Pine Range	Cau	Limestone	alternating chert, siltstone and sandstone thin beds	-	high	Yes	.
NV R-53	Newark Valley			View of older sediments (photo)				

TED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
mod high	Yes			NP				100	96.6		81.7	57.9	37.1	24.9	17.3	8.7		B
mod high	Yes	45	10	NP														B
high	Yes	--	--	--														B
high	Yes	--	--	--														B
low	No	--	--	--														C
low	No	20	40	low-mod														C
low mod	Yes	45	10	low														C
mod	Yes	--	--	--														B_2
low	Yes	--	--	--														C
mod low	Yes	20	40	mod-high														C
high od	Yes	30	5	NP														B
igh	Yes	--	--	--	11.9	1.8		100	86.2		33.1	15.2	8.0					B_2
igh	Yes	--	--	--	9.3	4.9		100	80.2		24.6	9.4	3.8					B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 4 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-54	Newark Valley	Au	SP-SM	50% glassy volcanics and trace chert; heavy caliche	2	high mod	Yes	35
NV R-55	Pancake Mtns	Au	SM	40% glassy volcanics	2	high	Yes	35
NV R-56	Newark Valley	Au	SP	40% glassy volcanics; 10% chert; some soft particles	2	high mod	Yes	50
NV R-57	Diamond Mtns	Au	GP-SP	5% glassy volcanics and chert	1-2	high	Yes	
NV R-58	Diamond Mtns	Cau	Limestone	dolomite	-	high mod	Yes	--
NV R-59	Diamond Valley			View of borrow pits (photo)				
NV R-60	Diamond Valley	Aaf	SP	20% soft siltstone and sand-stone; 40% glassy volcanics	2-3	low high	Yes	35
NV R-61	Little Smoky Valley	Au	SM	5% glassy volcanics and chert caliche coating some particles	1	high	Yes	20
NV R-62	Little Smoky Valley	Au	SP-GP	90% glassy volcanics	1-2	high	Yes	30
NV R-63	Pancake Range	Su	Sandstone	friable when weathered	-	low	No	--
NV R-64	Pancake Range	Vu	Rhyolite	glassy, chalcedony, limited quantity	-	high	Yes	--
NV R-65	Railroad Valley	Aaf	SP-GP	100% glassy volcanics	1-2	mod	Yes	4
NV R-66	Railroad Valley	Aal	SP	20% glassy volcanics, trace chert; limited quantity	1	high	Yes	4
NV R-67	Railroad Valley	Aaf	SP	40% glassy volcanics trace chert, limited quantity	1-2	high	Yes	4

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high mod	Yes	35	5	NP														B
high	Yes	35	15	NP low														B
high mod	Yes	50	0	NP														B
high	Yes			NP				100	100		92.6	74.2	48.6	30.5	21.9	14.2	0	B
high mod	Yes	--	--	--														B
low high	Yes	35	5	NP														C
high	Yes	20	15	NP low														B
high	Yes	30	5	NP														B
low	No	--	--	--														C
high	Yes	--	--	--														B
mod	Yes	40	5	NP														B_2
high	Yes	40	5	NP														B_2
high	Yes	40	10	NP														B_2

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 5 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-68	Grant Range			View of red beds in fault contract with limestones (photo)				
NV R-69	White Pine Range	Cau	Limestone	alternating argillaceous limestone beds, trace chert	-	high mod	Yes	--
NV R-70	White Pine Range	Vu	Rhyolite	glassy	-	low mod	Yes	--
NV R-71	White Pine Range	Vu	Rhyolite	glassy ; limited quantity	-	high	Yes	--
NV R-72	White River Valley	Au	SM	30% glassy volcanics, 1% chert	2-3	mod-high	Yes	20
NV R-73	White River Valley	Au	GP	20% glassy volcanics and 25% soft particles	2	low mod	Yes	60
NV R-74	White River Valley	Aaf	GP-GM	10% glassy volcanics, heavy caliche coatings	2-3	high	Yes	60
NV R-75	White River Valley	Aaf	GP	heavy caliche coatings and cementation	2-3	high	No	
NV R-76	White River Valley	Aaf	SM-ML	rare chert	1-2	high	Yes	20
NV R-77	Gap Mtn	Aaf	SP	35% glassy volcanics	1	high	Yes	35
NV R-77	Gap Mtn	Cau	Limestone	abundant chert nodules	-	high	Yes	--
NV R-78	White River Valley	Aaf	SP-SM	75% glassy volcanics; heavy caliche cementation	2-3	mod	Yes	25
NV R-79	White River Valley	Aaf	SP	75% glassy volcanics	-	high	Yes	15
NV R-80	White River Valley	Aaf	GP	1% glassy volcanics and chert caliche coatings	1-2	mod high	Yes	

ESTIMATED VALUES					LABORATORY TEST DATA												
								SIEVE ANALYSIS % PASSING									
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
high mod	Yes	--	--	--														B
low mod	Yes	--	--	--														C
high	Yes	--	--	--														B
mod-high	Yes	20	15	NP-low														B_2
low mod	Yes	60	5	NP														B_2
high	Yes	60	10	NP														B_2
high	No			NP				97.9	97.0		88.3	71.0	47.7	34.0	26.9	21.1	0	B_2
high	Yes	20	20 45	low														B
high	Yes	35	5	NP														B
high	Yes	--	--	--														B
mod	Yes	25	10	NP														B_2
high	Yes	15	5	NP														B
mod high	Yes			NP	27.0	4.6		97.6	93.4		84.3	64.6	41.1	23.4	13.5	7.6	1.5	B

FIELD STATION AND SUPPLEMENTARY TEST DATA – PAGE 6 OF 24
NEVADA–CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE · SAMSO

TABLE C–1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-81	White River Valley	Au	SP	35% glassy volcanics	1	high mod	Yes	35
NV R-82	White River Valley	Au	SP-SM	moderate caliche cementation; 40% glassy volcanics	2	high mod	Yes	35
NV R-83	White River Valley	Vu	Basalt and rhyolitic tuff	glassy, soft	-	low mod	Yes	--
NV R-84	White River Valley	Aaf	SP-SM	100% glassy volcanics	1	low mod	Yes	20
NV R-85	Hiko Range	Cau	Limestone	Dolomite, trace chert probably argillaceous	-	mod high	Yes	--
NV R-86	Pahranagat Valley	Au	SM-GM	5% glassy volcanics and moderate caliche coatings	2	high	Yes	20
NV R-87	Pahranagat Valley	Aaf	SP-SM	95% glassy volcanics	1	mod	Yes	25
NV R-88	Pahranagat Valley	Au	SP-SW	Limited extent 85% glassy volcanics	1	high	Yes	5
NV R-89	Pahranagat Valley	Au	SM	100% glassy volcanics	1	mod low	Yes	10
NV R-90	Pahranagat Valley	Vu	Silicic tuff	glassy	-	low	Yes	--
NV R-91	Pahranagat Valley	Vu	Rhyolite	glassy	-	low	Yes	--
NV R-92	Delamar Mtns	Au	SM	3% glassy volcanics & chert; caliche coatings	2-3	high	Yes	25
NV R-93	Delamar Mtns	Au	GP-SP	40% glassy volcanics; 10% chert	1-2	high mod	Yes	50
NV R-94	Delamar Mtns	Au	GP-SP	70% glassy volcanics and chert	1-2	mod	Yes	40

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high mod	Yes	35	10	NP														B
high mod	Yes	35	15	NP														B
low mod	Yes	--	--	--														C
low mod	Yes	20	15	NP														C
mod high	Yes	--	--	--														B
high	Yes	20	15	NP														B
mod	Yes	25	15	NP														C
high	Yes	5	5	NP														B_2
mod low	Yes	10	10	NP														C
low	Yes	--	--	--														C
low	Yes	--	--	--														C
high	Yes	25	15	NP														B_2
high mod	Yes	50	10	NP														B_2
mod	Yes	40	5	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 7 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FN-TR-20

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-95	Pahranagat Valley	Au	GP	rare chert; some caliche coating	1	high	Yes	
NV R-95	Pahranagat Valley	Au	SP-GP	2% chert; heavy caliche coating	2-3	high	Yes	70
NV R-96	Pahranagat Valley			(photo) View of older lake deposits				
NV R-97	Arrow Canyon Range	Cau	Limestone	50% + chert	-	high	Yes	--
NV R-98	Pahranagat Valley			View of stockpile screened gravels (photo)				
NV R-99	Las Vegas Range	Cau	Limestones	Trace chert and dolomite	--	High	Yes	--
NV R-100	Arrow Canyon Range			View of limestones and alluvial fans of Arrow Canyon Range (photo)				
NV R101	Hidden Valley	Au	GM-GP	rare chert	1-2	high	Yes	60
NV R102	Arrow Canyon Range	Otz	Quartzite	None ; limited quantity	-	high	No	--
NV R103	Hidden Valley	Au	GP-GM	caliche coating; 20% fines	2	high	Yes	55
NV R104	Dry Lake Valley	Au	GM-GP	trace chert 10% soft particles	1-2	high	Yes	65
NV R105	Kyle Canyon	Au	GP	heavy caliche cementation and coating, trace chert	3	high	Yes	65
NV R106	Kyle Canyon	Au	GP-SP	Trace chert minor caliche coating	-	high	Yes	60
NV R106	Kyle Canyon	Cau	Limestone	2-3% chert	-	high	Yes	--

high	Yes	--	--	--								
High	Yes	--	--	--								
high	Yes	60	10	NP								
high	No	--	--	--								
high	Yes	55	20	NP								
high	Yes	65		NP	14.7	1.1		95.2	92.7		80.5	57.1
high	Yes	65	5	NP								
High	Yes	60	2	NP								

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	[illegible]
NV R107	Kyle Canyon	View	of Kyle Canyon	showing stream channel deposits,	stream terrace, o			lde
NV R108	Kyle Canyon	Au	GP	heavy caliche cementation and coating, soft particles	2-3	high mod	Yes	6(
NV R109	Las Vegas Valley	Au	GM	trace chert moderate amount of soft particles	1	high	Yes	4(
NV R110	Las Vegas Valley			View of fans Las Vegas Valley (photo)				
NV R111	Las Vegas Valley			View of lake deposits in Las Vegas Valley (photo)				
NV R112	Las Vegas Valley	Au	GM	5% chert; 15% soft particles	1	high mod	Yes	4
NV R113	Indian Spring Valley	Au	SP-GP	5% chert; heavy caliche coating	1-2	high	Yes	4(
NV R114	Indian Spring Valley	Cau	Limestone	2-3% chert iron oxides on fracture surfaces	-	high	Yes	-
NV R115	Mercury Valley	Au	SP-GP	10% soft particles; caliche coatings, dolomite	1-2	high	Yes	4(
NV R116	Spring Mtn	Cau	Limestone	Dolomitic	-	high	Yes	-
NV R117	Spectar Range	Qtz	Quartzite	None	-	high	No	-
NV R117	Spectar Range	Aaf	SM	5% soft particles; caliche coatings on limestone gravel; limited quantity	1-2	high	Yes	3(
NV R118	Spectar Range	Cau	Limestone	Dolomitic	-	high	Yes	-
NV R119	Skeleton Hills	Cau	Limestone	argillaceous; brecciated	-	Mod	Yes	-

ED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
terrace, older fans (photo)																		
igh od	Yes	60	10	NP														B_2
igh	Yes	40	5	NP														B
igh od	Yes	4	15	NP														B
high	Yes	40	10	NP														B
high	Yes	--	--	--	11.0	12.0	NP	100	96.2		27.4	12.2	5.4					B
igh	Yes	40	10	NP														B
high	Yes	--	--	--	13.9	3.22	N.P.	98.5	82.3		27.4	11.2	3.8					B
high	No	--	--	--														A
igh	Yes	30	15	NP														B
igh	Yes	--	--	--	12.9	1.8	NP	98.2	76.9		26.6	10.9	4.7					B
Mod	Yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 9 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	# FINES
NV R120	Amargosa Desert	Aal	GP-SP	90% glassy volcanics and chert; limited quantity	--	high	yes		
NV R121	Amargosa Desert			View of gravel pit and cinder cone (photo)					
NV R122	Amargosa Desert	Aaf	SM-GM	85% glassy volcanics and light-weight tuffaceous particles	2-3	low	yes	40	1
NV R123	Amargosa Desert	Aaf	SM-GM	rare chert, caliche coatings	1-2	high	yes		
NV R124	Amargosa Desert	Aaf	SP-GP	85% glassy volcanics and soft tuffaceous particles	0	low	yes	40	
NV R125	Sacrobatus Flat	Vb	Basalt	20-35% vesicular	-	high	yes	--	
NV R126	Sacrobatus Flat	Vu	Rhyolite	glassy, limited extent	-	high	yes	--	
NV R127	Sacrobatus Flat	Au	SP	abundant low density particles 100% glassy volcanics	1	low mod	yes		
NV R128	Sacrobatus Flat	Vu	Rhyolite	glassy	-	mod	yes	--	
NV R129	San Antonio Mtns	Vu	Rhyolite	glassy	-	low mod	yes	--	
NV R130	Ralston Valley	Au	SP-GP	80% glassy volcanics; 20% soft particles, limited extent	1-2	mod	yes		
NV R131	Ralston Valley	Au	SM	100% glassy volcanics and soft particles	2	low	yes	30	
NV R132	Ralston Valley	Au	GM-SM	100% glassy volcanics and soft particles	1	low	yes	40	
NV R133	Big Smoky Valley	Au	GP	abundant soft particles 70% glassy volcanics	1	low mod	yes	30	

ATED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes			NP	14.4	2.9		99.3	99.2		92.9	75.8	46.4	32.8	19.6	10.3	1.1	B
low	yes	40	15	NP														C
high	yes			NP				92.5	85.8		68.8	45.9	32.7	26.2	22.1	19.2	2.3	B
low	yes	40	5	NP														C
high	yes	--	--	--														B
high	yes	--	--	--														B_2
low mod	yes			NP				98.5	96.8		88.5	72.9	54.0	45.6	38.7	32.7	2.8	C
mod	yes	--	--	--														C
low mod	yes	--	--	--														C
mod	yes			NP				100	100		99.9	99.5	98.6	90.1	62.8	50.5	3.5	B_2
low	yes	30	20	low-NP														C
low	yes	40	10	NP														C
low mod	yes	30	10	NP				90.8	77.1		64.4	50.1	29.2	27.5	24.6	20.1	0.4	C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 10 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R134	Lone Mtn	Vu	Rhyolite	glassy	--	low	yes	--
NV R135	Big Smoky Valley	Aaf	SM	100% glassy volcanics	2-3	mod	yes	30
NV R136	Lone Mtn.	Aaf	GP-SP	occasional soft particles 15% volcanic particles	1	high	yes	65
NV R137	Monte Cristo Range			View of tuffaceous volcanics photo				
NV R138	Big Smoky Valley	Aaf	SM	100% glassy volcanics; clinkry	1	low	yes	15
NV R139	Volcanic Hills			General view of Monte Cristo Mtn. and Silver Peak Range(photo				
NV R140	Volcanic Hills			General view of Volcanic Hills (photo)				
NV R141	Fish Lake Valley			View of alluvial fans from White Mtns (photo)				
NV R142	Fish Lake Valley	Aaf	GP-SM	possible chlorite	1-2	high	yes	4
NV R143	Fish Lake Valley	Aaf	GP-SP	possible chlorite	-	high	yes	7
NV R144	Fish Lake Valley			View of alluvial fans fans from White Mtns (photo)				
NV R145	Volcanic Hills	Vb	Basalt	10-50% vesicular; glassy	-	high	yes	--
NV R146	Candelaria Hills			View of basalt and potash-producing mine (photo)				
NV R147	White Mtns			View of volcanic ash and cinter (photo)				

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
low	yes	--	--	--														C
mod	yes	30	15	low														C
high	yes	65	5	NP														B
low	yes	15	10	NP														C
high	yes	45	15	low-NP														B
high	yes	70	5	NP														B
high	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 11 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
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TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R148	White Mtns	Vb	Basalt	glassy and vesicular	-	low-mod	yes	--
NV R149	White Mtns			View of basalt and volcanic ash (photo)				
NV R150	Queen Valley	Aaf	SM	50% glassy volcanics	1	mod	yes	40
NV R151	White Mtns	Aaf	GP-GM	30% glassy volcanics, chlorite possibly	1-2	mod	yes	40
NV R152	Queen Valley			View of alluvial fans from White Mtns (photo)				
NV R153	White Mtns	Aaf	SM	5% chloritic mafic volcanics and soft particles	1	mod	yes	15
NV R154	Benton Valley			View of alluvial fans fans from White Mtns (photo)				
NV R155	Hammil Valley	Aaf	SM	decomposed granite, possibly chloritic	1	mod	no	35
NV R156	White Mtns			Alluvial fans from White Mtns. (photo)				
NV R157	Hammil Valley			Alluvial fans from White Mtns. (photo)				
NV R158	Chalfant Valley	Aaf	GP	10% mafic volcanics	1-2	high	yes	
NV R159	Owens Valley	Aaf	GM-SM	80% platy & soft particles	1	low	no	40
NV R160	White Mtns	Aal	GP-GM	90% platy and soft particles	1	high mod	no	65
NV R161	Black Mtn	Su	metamorphic rocks	abundant chloritic and soft particles	-	low	no	--

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
low-mod	yes	--	--	--														B_2
mod	yes	40	15	low-NP														B
mod	yes	40	15	low-NP														B
mod	yes	15	15	low-NP														B
mod	no	35	15	NP														B
high	yes			NP	19.5	3.8		95.7	87.9		65.5	46.6	35.1	28.9	23.5	17.3	1.9	B
low	no	40	15	NP														C
high mod	no	65	10	NP low														C
low	no	--	--	--														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 12 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
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TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV R-162	White Mtns	Su	Limestone	abundant soft interbeds	-	high	no	--
NV R-163	White Mtns	Su	Argillite	platy particles	-	high	no	--
NV R-164	Deep Spring Valley	Aaf	GP-SP	moderate caliche coatings	1-2	high	no	70
NV R-165	White Mtns	Vb	Basalt	glassy, limited quantity	-	high	yes	--
NV R-165	White Mtns	gr	Granite	strongly weathered	-	mod	no	--
NV R-166	Fish Lake Valley	Aaf	SM	3% mica in sand; decomposed granite	-	low	no	5
NV R-167	White Mtns			Mafic volcanics along White Mountains(photo)				
NV R-168	Silver Peak Range	Aaf	SP-SM	60% platy particles, 5% chert	1-2	mod	yes	45
NV R-169	Silver Peak Range	Su	Marble	dolomitic, limited quantity	-	high	no	--
NV R170	Silver Peak Range	gr	Granite	coarse grained; poorly bonded	-	low mod	no	--
NV R171	Palmetto Mtns	Aaf	GP-SP	50% + soft particles 10% chert	1	low	yes	65
NV R172	Palmetto Mtns	Vu	tuff	glassy	-	low	yes	--
NV R173	Palmetto Mtns	Cau	Limestone	dolomite lenses	-	high	yes	--
NV R174	Mount Jackson Ridge	Aaf	SP-SM	glassy volcanics and platy metamorphics; 10% chalcedony	1	high mod	yes	30

ID VALUES					LABORATORY TEST DATA												
								SIEVE ANALYSIS % PASSING									
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
igh	no	--	--	--														B_2
igh	no	--	--	--														B_2
igh	no	70	10	NP														B
igh	yes	--	--	--														B
pd	no	--	--	--														B_2
pw	no	5	10	NP														C
pd	yes	45	10	NP														C
igh	no	--	--	--														B
ow pd	no	--	--	--														B_2
pw	yes	65	10	NP														C
pw	yes	--	--	--														C
igh	yes	--	--	--														B
igh pd	yes	30	25	low-NP														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 13 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

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FIELD STATION NUMBER	LOCATION	UN	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES					
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% SAND
NV H-1	Rattlesnake Wash	Aal	SP-SM	10% mica sand, occasional soft particles	-	mod	no	40	
NV H-1	Jumbo Peak	gn	Granite Gneiss	moderately weathered coarse grained	-	high mod	no	--	
NV H-2	Jumbo Peak	gr	Granite	weathered in outcrop, coarse grained	-	low	no	--	
NV H-3	Tramp Ridge	Cau	Limestone	trace chert, occasional thin argillaceous horizons	-	high mod	yes	--	
NV H-3	Tramp Ridge	gn	Granite Gneiss	weathered in outcrop coarse to medium-grained	-	med low	no	--	
NV H-3	Tramp Ridge	Aal	GP-SP	trace chert, 5% soft sedimentary particles	-	high	yes	35	
NV H-4	Grand Wash	Aal	SM	chert; abundant soft sedimentary particles	-	low	yes	20	
NV H-5	Virgin Mtns	Au	SM-SC	30% soft sedimentary particles, caliche coatings, clay	2-3	low mod	yes	35	
NV H-6	Virgin Mtns	Au	SP	trace chert	-	high	yes	40	
NV H-6	Virgin Mtns	Cau	Limestone	argillaceous horizons, trace chert	-	high mod	yes	--	
NV H-7	Virgin Mtns	Cau	Limestone	argillaceous, cherty	-	med	yes	--	
NV H-7	Virgin Mtns	Au	SP	1-2% chert	-	high	yes	15	
NV H-8	Virgin Mtns	Au	GP w/ SP	soft granitics and mafic metamorphics, abundant mica, schist & phyllite	2-3	mod soft	yes	60	
NV H-8	Virgin Mtns	Aal	SP	soft granitics and metamorphics, abundant mica	-	mod soft	yes	10	

VALUES					LABORATORY TEST DATA												
	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
d	no	40	10	NP													B_2
gh d	no	--	--	--													B_2
w	no	--	--	--													C
gh d	yes	--	--	--													B
d w	no	--	--	--													B_2
gh	yes	35	10	NP													B
w	yes	20	20	NP													C
w d	yes	35	25	low mod													C
gh	yes	40	10	NP													B
gh d	yes	--	--	--													B
d	yes	--	--	--													B
gh	yes	15	10	NP													B
d ft	yes	60	5	NP													C
d ft	yes	10	10	NP													C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 14 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
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TABLE C-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-9	Chief Mtns	Qtz	Quartzite		-	high	no	
NV H-10	Bristol Range	Au	SM-GM	1-2% chert, 10% limey shale particles	2-3	high	yes	5
NV H-10	Bristol Range	Cau	Limestone	dolomitic	-	high	yes	
NV H-11	Bristol Range	Cau	Limestone	dolomitic, moderately weathered in outcrop	-	mod high	yes	
NV H-12	North Pahroc Range	Cau	Limestone	abundant chert locally	-	high	yes	
NV H-13	North Pahroc Range	Au	Sm & GP	60% basic to silicic volcanics occasional soft partciles	2	high mod	yes	
NV H-13	North Pahroc Range	Au	SP	60% basic to silicic volcanics vesicular volcanics	-	mod	yes	
NV H-14	Seaman Range	Cau	Limestone	dolomitic	-	high	yes	
NV H-15	Bristol Range	Au	SM	Trace chert caliche cementation, minor clay	2-3	high	yes	
NV H-15	Bristol Range	Cau	Limestone	Trace chert interbedded mod-hard horizons	-	high	yes	
NV H-16	Grassy Mtn	Cau	Limestone	1-2% chert nodules	-	high	yes	
NV H-17	Dutch John Mtn	Cau	Limestone	1-2% chert	-	high	yes	
NV H-18	Limestone Hills	Cau	Limestone	very thin bedded, trace chert	-	high mod	yes	
NV H-19	Snake Range	Aaf	SM	strong caliche cementation and coatings, dolomite	2-3	high mod	yes	

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING 2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	RANKING
high	no	--	--	--														A
high	yes	50	10	NP														B_2
high	yes	--	--	--														B
mod high	yes	--	--	--														B
high	yes	--	--	--														B
high mod	yes	40	15	NP														B_2
mod	yes	15	5	NP														B_2
high	yes	--	--	--														B
high	yes	35	15	low														B_2
high	yes	--	--	--	18.7	4.6	NP	100	89.4		36.6	19.8	10.9					B
high	yes	--	--	--														B
high	yes	--	--	--														B
high mod	yes	--	--	--														B
high mod	yes	35	15	low														B_2

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 15 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-20	Snake Range	Cau	Limestone	dolomitic	-	high	yes	-
NV H-21	Snake Range	Ls	Limestone		-	high	no	-
NV H-22	Snake Range	Ls	Limestone		-	high	no	-
NV H-23	Snake Range	Qtz	Quartzite		-	high	no	-
NV H-24	Spring Valley	Aaf	SM & ML w/GP	caliche cementation	-	high	no	
NV H-25	Snake Range	Aaf	SP-GP	trace soft granite particles	1	high	no	
NV H-26	Snake Range	Cau	Limestone	abundant chert lenses and nodules	-	high	yes	-
NV H-27	Schell Creek Range	Qtz	Quartzite		-	high	no	-
NV H-28	Schell Creek Range	Cau	Limestone	2-3% chert, argillaceous	-	mod high	yes	-
NV H-30	Schell Creek Range	Au	SM	30% soft argillaceous limestone, caliche cementation	2-3	mod low	no	3
NV H-30	Fortification Range	Par	Limestone	very weathered in outcrop 2-3% chert	-	low mod	yes	-
NV H-31	Duck Creek Range	Qtz	Quartzite		-	high	no	-
NV H-32	Duck Creek Range	Ls	Limestone	occasional large 10-20 cm calcite crystals	-	high mod	no	-
NV H-33	Egan Range	Ls	Limestone	occasional large 10-20 cm calcite crystals	-	high	no	-

ATED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes	--	--	--	16.4	5.9	NP	100	88.4		34.3	17.1	89					B
high	no	--	--	--														A
high	no	--	--	--	24.9	2.5		100	92		38.7	17.7	9.0					A
high	no	--	--	--	5.6	3.1		100	75.5		26.4	13.2	7.5					A
high	no			low	36	65.0		94	88.8		78.3	67.7	58.8	49.7	42.1	33	6.1	C
high	no			NP	11.3	5.4		71.9	62.5		48.9	40.5	32.7	24.9	18.2	11.6	1.5	A
high	yes	--	--	--														B
high	no	--	--	--														A
od high	yes	--	--	--														B
od low	no	35	10	low														C
ow od	yes	--	--	--														B_2
igh	no	--	--	--														A
igh od	no	--	--	--														A
igh	no	--	--	--														A

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 16 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
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TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	
NV H-34	Egan Range	Qtz	Quartzite	weathered along joints	-	high	no	
NV H-34	Egan Range	Cau	Dolomite		-	high	yes	
NV H-34	Egan Range	Cau	Limestone	3-5% chert	-	high	yes	
NV H-35	Egan Range	Aal	GP	Trace chert; 15% moderately hard to soft sedimentary particles; limited quantity	-	high	yes	
NV H-36	Egan Range	gr	Qtz. Monzonite	very weathered in outcrop, coarse grained	-	low	no	
NV H-37	Cherry Creek Mtns	Qtz	Quartzite		-	high	no	
NV H-38	Cherry Creek Mtns	Cau	Limestone	trace chert, secondary calcite veinlets, weathered	-	high mod	yes	
NV H-39	Cherry Creek Mtns	Cau	Dolomite		-	high	yes	
NV H-40	Butte Mtns	Par	Limestone & shale	argillaceous limestone and shale predominate 2-3% chert	-	mod low	yes	
NV H-41	Butte Mtns	Cau	Limestone	1-2% chert, argillaceous	-	mod	yes	
NV H-42	Maverick Springs Range	Cau	Limestone	dolomitic weathered in outcrop, occ. large 15-20 cm crystal of calcite	-	high mod	yes	
NV H-43	Big Bald Mtn.	Cau	Dolomite	weathered in outcrop	-	mod	yes	
NV H-44	Diamond Range	Su	Sandstone & Conglomerate	low durability, friable horizons	-	mod low	no	
NV H-45	Diamond Range	Su	Quartzite & Shale	interbedded hard and soft horizons	-	high low	no	

TED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	no	--	--	--														A
high	yes	--	--	--														B
high	yes	--	--	--														B
high	yes	60	5	--														B
low	no	--	--	--														C
high	no	--	--	--														A
high mod	yes	--	--	--														B
high	yes	--	--	--														B
mod low	yes	--	--	--														B_2
mod	yes	--	--	--														B
high mod	yes	--	--	--														B
mod	yes	--	--	--														B
mod low	no	--	--	--														C
high low	no	--	--	--														C

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 17 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
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TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-46	Sulpher Springs Range	Cau	Dolomite	weathered in outcrop, fractured	-	high mod	yes	-
NV H-47	Roberts Mtns	Cau	Dolomite & Limestone	weathered in outcrop, fractured	-	high mod	yes	-
NV H-48	Mahogany Mtns	Cau	Limestone	thin shalely lenses, weathered, dolomitic	-	high mod	yes	-
NV H-49	Mahogany Mtns	Cau	Limestone	very weathered in outcrop, highly fractured, dolomitic	-	high mod	yes	-
NV H-50	McCulloughs Butte	Qtz	Quartzite		-	high	no	-
NV H-51	Pancake Mtns	Su	Interbedded Sediments	soft, strong Fe staining	-	low	no	-
NV H-52	Mt. Hamilton	Qtz	Quartzite		-	high	no	-
NV H-53	Pancake Range	Cau	Limestone	dolomitic	-	high	yes	-
NV H-54	White Pine Mtns	Aaf	Fanglomerate	40% soft sedimentary particles, caliche cementation	3	mod low		7
NV H-55	Pancake Mtns	Vb	Basalt	35% vesicular, glassy, brittle	-	mod	yes	-
NV H-56	Pancake Mtns	Cau	Limestone	calcite veinlets, dolomitic	-	high	yes	-
NV H-57	Pancake Mtns	Aaf	GP-SP	20% argillaceous limestone or limey mudstone, trace chert	-	high mod	yes	7
NV H-57	Pancake Mtns	Cau	Dolomite Limestone	trace chert	-	high	yes	-
NV H-58	Grant Mtns	Cau	Dolomite	very weathered in outcrop	-	mod	yes	-

ATED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high mod	yes	--	--	--														B
high mod	yes	--	--	--	12.7	3.8		100	95.1		29.5	19.1	9.3					B
high mod	yes	--	--	--	30.8	5.3		100	80.7		44.2	19.4	8.9					B
high mod	yes	--	--	--														B
high	no	--	--	--														A
low	no	--	--	--														C
high	no	--	--	--														A
high	yes	--	--	--														B
mod low		70	10	low														C
mod	yes	--	--	--														B
high	yes	--	--	--														B
high mod	yes	70	tr	NP														B
high	yes	--	--	--														B
mod	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 18 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-59	Quinn Canyon Range	Cau	Limestone	3-5% chert, locally very weathered	--	high	yes	--
NV H-60	Golden Gate Range	Cau	Limestone	dolomotic weathered in outcrop, occ. large 15-25 cm calcite crystals	--	high mod	yes	--
NV H-61	Golden Gate Range	Cau	Limestone	2-3% chert, weathered in outcrop	--	mod high	yes	--
NV H-62	Worthington Range	Cau	Dolomite		--	high	yes	--
NV H-63	Hiko Range	Cau	Limestone	dolomitic occ. thin argillaceous zones	--	high mod	yes	--
NV H-64	Hiko Range	Au	Fanglomerate	5% soft sediments, strong caliche cementation & coatings	2 3	high	yes	65
NV H-65	Irish Mountain	Cau	Limestone	weathered in outcrop, dolomitic	-	high	yes	--
NV H-66	Timpahute Range	Cau	Limestone	highly fractured and weathered this locality, dolomitic	-	mod low	yes	--
NV H-67	Timpahute Range	Cau	Limestone	dolomitic occasional large 15-25 cm calcite crystals	-	high	yes	--
NV H-68	Groom Range	Cau	Limestone	locally high fractured,dolomitic	-	high mod	yes	--
NV H-69	Groom Range	Qtz	Quartzite	occ. thin Fe rich sandstone horizons	-	high	no	--
NV H-70	Pahrangat Range	Aal	GP-SP	trace chert ; limited quantity	-	high	yes	
NV H-70	Pahrangat Range	Qtz	Quartzite	grainy along joints where weathered; limited quantity	-	high	no	--
NV H-71	Pahrangat Range	Cau	Limestone	5-10% chert	-	high	yes	--

ATED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes	--	--	--														B
high mod	yes	--	--	--														B
mod high	yes	--	--	--														B
high	yes	--	--	--														B
high mod	yes	--	--	--														B
high	yes	65	10	low														B_2
high	yes	--	--	--														B
mod low	yes	--	--	--														B
high	yes	--	--	--														B
high mod	yes	--	--	--														B
high	no	--	--	--														A
high	yes			NP	15.2	7.5		81.6	69.5		43.5	21.0	10.5	7.1	5.9	5.2	2.4	B
high	no	--	--	--														A
high	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 19 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-72	East Pahrangat Range	Cau	Limestone	1-2% chert; locally argillaceous	-	high	yes	--
NV H-73	Delmar Mtns	Cau	Limestone	weathered in outcrop, dolomitic	-	high	yes	--
NV H-74	Meadow Valley Mtns	Cau	Limestone	weathered in outcrop, dolomite, local argillaceous horizons	-	high mod	yes	--
NV H-75	Mormon Mtn.	Cau	Limestone	10% to locally 50% plus chert	-	high	yes	--
NV H-76	Meadow Valley Mtns	Cau	Limestone	5-10% chert	-	high	yes	--
NV H-77	Meadow Valley Mtns	Cau	Limestone	abundant chert; locally 50%+	-	high	yes	--
NV H-78	San Antonio Mtns	Vb	Basalt	less than 5% vesicular	-	high	yes	--
NV H-79	San Antonio Mtns	Aal	GP-SP	50% intermed. & silicious volcanics; glassy, soft	-	mod low	yes	45
NV H-80	San Antonio Mtns	Vb	Basalt	50% vesicular, glassy, brittle	-	high mod	yes	--
NV H-81	Toquima Range	gr	Qtz. Monzonite	very weathered in outcrop, coarse grained	-	mod low	no	--
NV H-82	Toquima Range	gr	Granite	very weathered in outcrop, coarse grained	-	mod low	no	--
NV H-83	Toiyabe Range	gr	Granite	very weathered in outcrop, coarse grained	-	mod low	no	--
NV H-84	Toiyabe Range	Cau	Limestone	highly fractured, locally a phyllite	-	mod	yes	--
NV H-85	Toiyabe Range	Qtz	Quartzite	locally sandstone, highly fractured and deformed	-	high mod	no	--

ESTIMATED VALUES						LABORATORY TEST DATA													
CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
									2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
-	high	yes	--	--	--														B
-	high	yes	--	--	--	8.8	1.0		100	83		31.6	14.3	7.5					B
-	high mod	yes	--	--	--														B
-	high	yes	--	--	--														B_2
-	high	yes	--	--	--														B
-	high	yes	--	--	--														B
-	high	yes	--	--	--	10.2	0.90	N.P.	100	74.5		37.3	13.7	7.3					B
-	mod low	yes	45	10	NP														C
-	high mod	yes	--	--	--														B_2
-	mod low	no	--	--	--														B_2
-	mod low	no	--	--	--														B_2
-	mod low	no	--	--	--														B_2
-	mod	yes	--	--	--														C
-	high mod	no	--	--	--														B_1

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 20 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-86	Toiyabe Range	Qtz	Quartzite	locally sandstone, highly fractured and deformed	-	high	no	--
NV H-87	Toiyabe Range	Cau	Limestone	highly deformed, fissile, locally a phyllite	-	mod	yes	--
NV H-88	Toiyabe Range	Qtz	Quartzite	locally a sandstone, highly fractured and deformed	-	high mod	no	--
NV H-89	Toiyabe Range	gr	Granite	very weathered in outcrop, coarse grained	-	mod low	no	--
NV H-90	Lone Mountain	gr	Granite	weathered in outcrop, medium grained	-	mod	no	--
NV H-91	Lone Mountain	Cau	Dolomite Limestone	locally metamorphosed	-	high	yes	--
NV H-91	Lone Mountain	Cau	Dolomite	locally metamorphosed and altered	-	high mod	yes	--
NV H-92	Monte Cristo Mtns.	Vu	Andesite	very weathered in outcrop, soft, glassy	-	low	yes	--
NV H-93	Monte Cristo Mtns	Vb	Basalt	20% vesicular	-	high	yes	--
NV H-94	Cedar Mtns	Vu	Andesite Tuff	soft, glassy	-	low	yes	--
NV H-95	Cedar Mtns	Cau	Limestone Dolomite	shale interbeds, intensely fractured, silicious	-	high	yes	--
NV H-96	Cedar Mtns	Cau	Limestone	weathered in outcrop, angular, sharp, dolomitic	-	high	yes	--
NV H-97	Gabbs Valley Range	gr	Granite	weathered in outcrop	-	mod high	no	--
NV H-98	Gabbs Valley Range	Vb	Basalt	5-10% vesicular	-	high	yes	--

ED VALUES					LABORATORY TEST DATA													
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING										RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	=30	#200	
high	no	--	--	--														B_1
mod	yes	--	--	--														C
high mod	no	--	--	--														B_1
mod low	no	--	--	--														B_2
mod	no	--	--	--														B_2
high	yes	--	--	--														B
high mod	yes	--	--	--														B
low	yes	--	--	--														C
high	yes	--	--	--														B
low	yes	--	--	--														C
high	yes	--	--	--														B_2
high	yes	--	--	--														B_2
mod high	no	--	--	--														B_2
high	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 21 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-99	Gabbs Valley Range		Limestone	photo stop				
NV H-100	Garfield Mtns	Vb	Basalt	40% vesicular, zeolites	-	high	yes	--
NV H-101	Garfield Mtns	gr	Granite	very weathered in outcrop, coarse grained	-	mod low	no	--
NV H-102	Garfield Mtns	Cau	Metamorphosed Limestone	very sharp, angular, platy metamorphic minerals	-	high	yes	--
NV H-103	Excelsior Mtns	Vb	Basalt	35% scoriaceous, glassy	-	high	yes	--
NV H-104	Excelsior Mtns	Su	Metamorphics	abundant metamorphic minerals, platy particles	-	mod high	yes	--
NV H-105	Excelsior Mtns	gr	Granite	very weathered in outcrop	-	mod high	no	--
NV H-106	North Benton Mtns	Vb	Basalt	very vesicular to scoriaceous, glassy	-	high	yes	--
NV H-107	White Mtns	gr	Granite Granite Gneiss	abundant biotite mica, locally moderately hard to soft	-	high low	no	--
NV H-108	White Mtns	Su	Shale, limestone and dolomite	platy particles, soft materials	-	mod low	yes	--
NV H-109	White Mtns	Su	Shale and Limestone	platy particles, soft material argillaceous limestone, dolomitic	-	mod low	yes	--
NV H-110	White Mtns	Vb	Basalt	limited extent, 35% vesicular, glassy	-	high mod	yes	--
NV H-111	White Mtns	Su	Quartzite, Argillite	very sharp, angular, brittle	-	mod high	no	--
NV H-112	Silver Peak Range	Au	SM	10% intermediate volcanics, moderately hard to soft materials	-	mod low	yes	--

TED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
high	yes	--	--	--														B_2
mod low	no	--	--	--														B_2
high	yes	--	--	--														B_2
high	yes	--	--	--														B_2
mod high	yes	--	--	--														C
mod high	no	--	--	--														B_2
high	yes	--	--	--														C
high low	no	--	--	--														B_2
mod low	yes	--	--	--														B_2
mod low	yes	--	--	--														B_2
high mod	yes	--	--	--														B_2
mod high	no	--	--	--														B_2
mod low	yes	--	--	--				99.2	96		85.9	74.4	59.7	43.1	31.6	22.8	6.1	B_2

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 22 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-113	Silver Peak Range	gr	Granite	very weathered in outcrop	-	low	no	--
NV H-114	Magruder Mtns	Cau	Limestone Dolomite	weathered in outcrop, moderately hard shale beds	-	mod	yes	--
NV H-115	Sylvania Mtns	gr	Quartz Monzonite	soft - very weathered in outcrop	-	low	no	--
NV H-116	Last Chance Mtns	Cau	Limestone	interbeds of soft sediments, platy particles, dolomitic	-	high low	yes	--
NV H-117	Last Chance Mtns	Cau	Limestone & Quartzite	abundant chert, limestone is moderately hard	-	high mod	yes	--
NV H-118	Last Chance Mtns	Aal & Aaf	GP	trace chert 5% soft sediments	1	high	yes	65
NV H-119	Bare Mtns	Cau	Dolomite, Limestone & shale	soft sediments, highly fractured	-	mod	yes	--
NV H-120	Bare Mtns	Au	GP-SP	5% soft sediments, dolomite	1	high	yes	50
NV H-120	Bare Mtns	Qtz	Quartzite	locally moderately hard, friable	-	high	no	--
NV H-121	Greenwater Mtns	Vb	Basalt	30-50% vesicular, brittle, glassy, zeolites in vesicles	-	mod	yes	--
NV H-122	Resting Springs Mtns	Aaf	GM-SM	abundant caliche, very weathered soft dolomite particles		mod	no	60
NV H-122	Resting Springs Mtns	Cau	Limestone & Quartzite	limestone soft;trace chert	-	high mod	yes	--
NV H-123	Resting Springs Mtns	Qtz	Quartzite	locally moderately hard, friable	-	high	no	--
NV H-124	Resting Springs Mtns	Cau	Limestone Dolomite	moderately hard, weathered trace chert	-	mod high	yes	--

D VALUES					LABORATORY TEST DATA													
								SIEVE ANALYSIS % PASSING										RANKING
BILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
w	no	--	--	--														B_2
d	yes	--	--	--														B
w	no	--	--	--														C
gh w	yes	--	--	--														B
gh d	yes	--	--	--														B
gh	yes	65	5	NP														B
d	yes	--	--	--														B
gh	yes	50	5	NP														B
gh	no	--	--	--	25.3	1.9		100	80.4		30.2	13.5	6.8					B_1
d	yes	--	--	--														B_2
d	no	60	10	NP low														B_2
gh d	yes	--	--	--														B
gh	no	--	--	--	13.7	3.2		94.7	81.1		25.3	11.4	6.0					B_1
d gh	yes	--	--	--														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 23 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

UGRO NATIONAL, INC.

FIELD STATION NUMBER	LOCATION	UNIT	MATERIAL TYPE	FIELD OBSERVATION - ESTIMATED VALUES				
				DELETERIOUS MATERIAL	CALICHE DEVELOPMENT	DURABILITY	POTENTIALLY REACTIVE	% GRAVEL
NV H-125	Nopah Mtns	Cau	Limestone Dolomite	abundant chert, argillaceous lenses, moderately hard	-	mod	yes	
NV H-126	Nopah Mtns	Otz	Quartzite	locally moderately hard, friable	-	high mod	no	
NV H-127	Spring Mtns	Cau	Limestone Dolomite	possibly argillaceous	-	high	yes	
NV H-127	Spring Mtns	Aaf	GP-SP	5% soft sediments dolomitic, caliche coating	-	high	yes	

TED VALUES					LABORATORY TEST DATA												
DURABILITY	POTENTIALLY REACTIVE	% GRAVEL	% FINES	PLASTICITY	ABRASION (500 RV)	Mg SOUNDNESS LOSS	PLASTICITY INDEX	SIEVE ANALYSIS % PASSING									RANKING
								2"	1½"	1"	¾"	⅜"	#4	#8	#16	#30	#200	
mod	yes	--	--	--														B
high mod	no	--	--	--														B_1
high	yes	--	--	--	16.5	2.7	N.P.	100	88.0		39.4	19.1	10.1					B
high	yes	60	5	NP														B

FIELD STATION AND SUPPLEMENTARY TEST DATA - PAGE 24 OF 24
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE SAMSO

TABLE C-1

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION		ABRASION 500 RV	Na SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX
NV N-1	NVHD	Ralston Valley	Au	Gravelly Sand	F		7.2	2.5	
					C		14.8	2.4	
NV N-1	NVHD	Ralston Valley	Au	Sandy Gravel	F		5.2	2.5	
					C		12.1	2.4	
NV N-2	NVHD	Railroad Valley	Aal	Sandy gravel		27.2	3.6	2.7	
NV N-3	NVHD	Gabbs Valley	Aal	Sandy Gravel		24.8	1.5	2.6	
NV N-4	NVHD	Railroad Valley	Aal	Gravelly Sand			4.2	2.5	
NV N-5	NVHD	Oasis Valley	Aal	Sandy Gravel	C	16.4		2.3	
					F		3.2	2.5	
NV N-6	NVHD	Amargosa Desert	Aal	Sandy Gravel	C	17.8		2.6	
					F				
NV N-7	NVHD	Amargosa Desert	Aal	Gravelly Sand					
NV N-8	NVHD	Indian Spring Valley	Au	Sandy Gravel		19.6	1.7	2.6	
NV N-9	NVHD	Sarcobatus Flat	Aal	Sandy Gravel	C	20.8	4.7	2.5	
					F		5.5	2.5	
NV W-1	NVHD	Jakes Valley	Au	Sand Gravel	F		2.8	2.5	
					C	23.2	6.7	2.6	
NV W-2	NVHD	Spring Valley	Au	Gravelly Sand; Stage three caliche				2.60	
NV W-2	NVHD	Spring Valley	Au	Gravelly Sand				2.58	
NV W-4	NVHD	Duck Creek Range	Aaf	Sandy Gravel		20.8	5.2	2.59	

LABORATORY TEST DATA

SOIL NO.	Na SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
	7.2	2.5																	
	14.8	2.4				100	97.6	93.7	86.6	78.5	71.4	52	37.8	30.9	24.4	10.0	6.7	3.6	2.1
	5.2	2.5																	
	12.1	2.4				100	92.6	83.5	76.2	63.8	57.2	41.4	33.7	29.7	25.5	8.8	5.1	1.5	0.9
.2	3.6	2.7				94.8	89.4	80.7	68.5	57.8	56.0	37.4							
.8	1.5	2.6				93.7	87.4	75.1	65.8	52.5	45.2	30.0							
	4.2	2.5										84.7	74.7	71.4	53.9	15.6	8.3	2.0	0.8
.4		2.3			100	75.6	65.7	56.6	51 2	45.8	41.9	33.7							
	3.2	2.5										68.0	52.2	45.0	38.0	19.6	14.5	6.8	2.9
.8		2.6			100	91.8	91.8	79.9	68.6	58.3	53.7	47							
												78.2	60.2	49.5	38.3	13.9	9.8	5.1	2.1
												62.5	55.3	49.7	41.9	16.2	10.3	4.7	2.0
.6	1.7	2.6				97.4	94.0	81.7	71.9	59.1	47.5	28.4							
.8	4.7	2.5																	
	5.5	2.5				100	94.3	87.2	81.2	71.1	64.0	43.8	33.4	30.3	21.7	10.0	7.1	3.4	1.8
	2.8	2.5																	
.2	6.7	2.6			100	94.3	83.6	63.0	50.5	35.4	27.4	13.8	12.2	11.3	8.7	2.9	1.7	0.6	0.2
		2.60										100	90.9		59.3		21.9	6.1	
		2.58										95.2	89.4	79.7	65.2	36.6	17.2	3.2	1.0
.8	5.2	2.59	NP			93.9	86.1	69.9	51.4	51.8	47.1	37.8							

EXISTING TEST DATA
PAGE 1 OF 4
NEVADA-CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE C-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION		ABRASION 500 RV	Na SOUNDNESS LOSS	SPECIFIC GRAVITY
NV LAN-1	NVHD	Reese River Valley	Aal	Sandy gravel		18.0	9.68	2.44
NV LAN-2	NVHD	Reese River Valley	Aal				5.16	2.60
NV LAN-3	NVHD	Smith Creek Valley	Aaf	Sandy gravel		25.2	1.2	2.42
NV C10	NVHD	Indian Spring Valley	Au	Sandy gravel		16.4	0.62	2.66
					C	26.6	2.23	2.73
NV C1	NVHD	Virgin Mtns.	Au	Gravelly sand	F		1.05	2.62
NV C3	NVHD	Indian Spring Valley	Au	Sandy gravel		16.1	0.6	2.67
NV C7	NVHD	Las Vegas Valley	Au	Sandy gravel		22.4	3.44	2.70
					F		6.38	2.53
NV LN1	NVHD	Paharanagat Valley	Aal	Gravelly sand	C	22.0	6.42	2.43
NV LN1	NVHD	Paharanagat Valley	Aal	Sandy gravel		23.0	2.97	2.81
					C	34.8	33.7	2.25
NV LN2	NVHD	Delamar Mtns	Au	Sandy gravel	F		12.7	2.40
NV LN4	NVHD	Sheep Range	Au	Sandy gravel		21.2	1.11	2.8
NV LN5	NVHD	Delamar Mtns	Au	Sandy gravel		24.4	2.16	2.62
NV LN6	NVHD	Lake Valley	Aal	Sandy gravel		24.0	7.39	2.50
NV LN7	NVHD	Delamar Mtns.	Au	Sandy gravel		19.6	2.41	2.70

LABORATORY TEST DATA

Na SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
				3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
9.68	2.44			100	82.4	71.5	58	46.8	36.1	25.9	?							
5.16	2.60										73.8	66.0	61.3	56.3	25.9	19.0	3.9	2.1
1.2	2.42			100	89.7	89	73.0	66.6	55.7	48.6	35.8							
0.62	2.66				100	93.7	81.2	68.7	53.5	45.1	30.5							
2.23	2.73																	
1.05	2.62					96.4	89.7	83.4	74.3	67.5	51.7	41.5	39.0	30.8	16.1	11.8	5.7	2.8
0.6	2.67				80.5	76.7	64.7	55	43	36.2	25							
3.44	2.70				98.2	91.2	77.4	66.2	52.1	44.3	26.8							
6.38	2.53																	
6.42	2.43				99.2	96.9	93.9	91.2	85.5	80.2	62	45.8	42.1	30.4	12.4	9.3	5.6	3.7
2.97	2.81			100	91.8	87.0	73.4	64.6	58	46.2	32							
33.7	2.25																	
12.7	2.40																	
1.11	2.8	NP			93.4	84.4	67.2	57.3	46.1	39.7	28.3							
2.16	2.62	NP			94.8	89.1	76.5	67.5	56.0	49.9	37.4							
7.39	2.50					100	97.7	95.4	88.0	80.3	53.7							
2.41	2.70	NP			100	99.1	96.5	89.2	74.0	63.1	45.5	35.4	32.2	22.7	6.2	2.5	1.1	0.7

EXISTING TEST DATA
PAGE 2 OF 4
NEVADA–CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE C-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION		ABRASION 500 RV	Na SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY
NV C26	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	23.9	2.0	2.54	
					F		6.0	2.60	
NV C27	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	37.3	5.1	2.66	
					F		2.5	2.64	
NV C28	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	27.5	1.9	2.74	
					F		2.5	2.71	
NV C13	Bureau of Reclamation	Moapa Valley	Au	Sand and gravel	C	25.2	15.4	2.60	
					F		8.4	2.53	
NV C14	Bureau of Reclamation	Moapa Valley	Au	Sand and gravel	C	24.8	7.1		
					F		5.5	2.50	
NV C15	Bureau of Reclamation	Moapa Valley	Cau	Limestone		28.3	15.8	2.64	
NV C16	Bureau of Reclamation	Black Mtns.	Au	Sand and gravel ; Hoover Dam	C	26.4	16.1	2.56	
					F		11.7	2.61	
NV C17	Bureau of Reclamation	Las Vegas Wash	Aal	Sand and gravel	C	22.6	8.8	2.57	
					F		6.6	2.51	
NV C18	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	27.1	7.7	2.49	
					F		8.2	2.48	
NV C19	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	21.7	1.7		
					F		9.2	2.65	
NV C20	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	27.4	4.1	2.68	
					F		4.2	2.53	
NV C21	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	24.7	5.8	2.50	
					F		7.4	2.64	
NV C22	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	25.0	5.7		
					F			2.68	
NV C23	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C	25.8	3.0		
					F		4.7	2.61	

LABORATORY TEST DATA

	Na SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
	2.0	2.54																	
	6.0	2.60		0.127															2.4
	5.1	2.66																	
	2.5	2.64																	5.4
	1.9	2.74																	
	2.5	2.71																	12.0
	15.4	2.60		0.016															
	8.4	2.53		0.006			90.8		71.3		58.3	49.6	46.7		41.1		33.0	25	19.4
	7.1			0.292															
	5.5	2.50		0.254	92.6		80.6		14.4		51.2	41.1	34.4		27.8		13.1	8.5	6.1
	15.8	2.64							66		27								
	16.1	2.56																	
	11.7	2.61					99		83.8		61.3	39.7	24		15.2		5.9	3.3	2.6
	8.8	2.57		0.287															
	6.6	2.51		0.159			88.9		84.2			60.6	50.1		39.7		20	10.1	2.6
	7.7	2.49																	
	8.2	2.48																	
	1.7																		
	9.2	2.65																	
	4.1	2.68																	
	4.2	2.53					90.5		66.6		49.6	37	31.9		28.0		21.0	15.4	9.0
	5.8	2.50		0.259															
	7.4	2.64		0.284					69		54.9	54.5	46.5		35		15.5	9.0	4.5
	5.7			0.023															
		2.68		0.025															
	3.0			0.232															
	4.7	2.61		0.422															

EXISTING TEST DATA
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NEVADA–CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE C-2

FUGRO NATIONAL, INC.

PIT NUMBER	DATA SOURCE	LOCATION	UNIT	MATERIAL DESCRIPTION		ABRASION 500 RV	Na SOUNDNESS LOSS	SPECIFIC GRAVITY
NV C24	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C		1.1	2.68
					F	26.6	3.1	2.68
NV C24	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C		6.0	2.72
					F	39.6	2.6	2.70
NV C24	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C		3.8	2.71
					F	40.5	3.2	2.69
NV C25	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C		5.7	2.56
					F	25.4	8.3	2.61
NV C25	Bureau of Reclamation	Las Vegas Valley	Au	Sand and gravel	C		2.9	2.54
					F	35.4	6.2	2.58

LABORATORY TEST DATA

500 RV	Na SOUNDNESS LOSS	SPECIFIC GRAVITY	PLASTICITY INDEX	REACTIVITY	SIEVE ANALYSIS % PASSING														
					3"	2"	1½"	1"	¾"	½"	⅜"	#4	#8	#10	#16	#40	#50	#100	#200
	1.1	2.68																	
.6	3.1	2.68																	
	6.0	2.72																	
.6	2.6	2.70																	
	3.8	2.71																	
.5	3.2	2.69																	
	5.7	2.56																	
.4	8.3	2.61																	
	2.9	2.54																	
.4	6.2	2.58																	

EXISTING TEST DATA
PAGE 4 OF 4
NEVADA–CALIFORNIA STUDY AREA

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE C–2

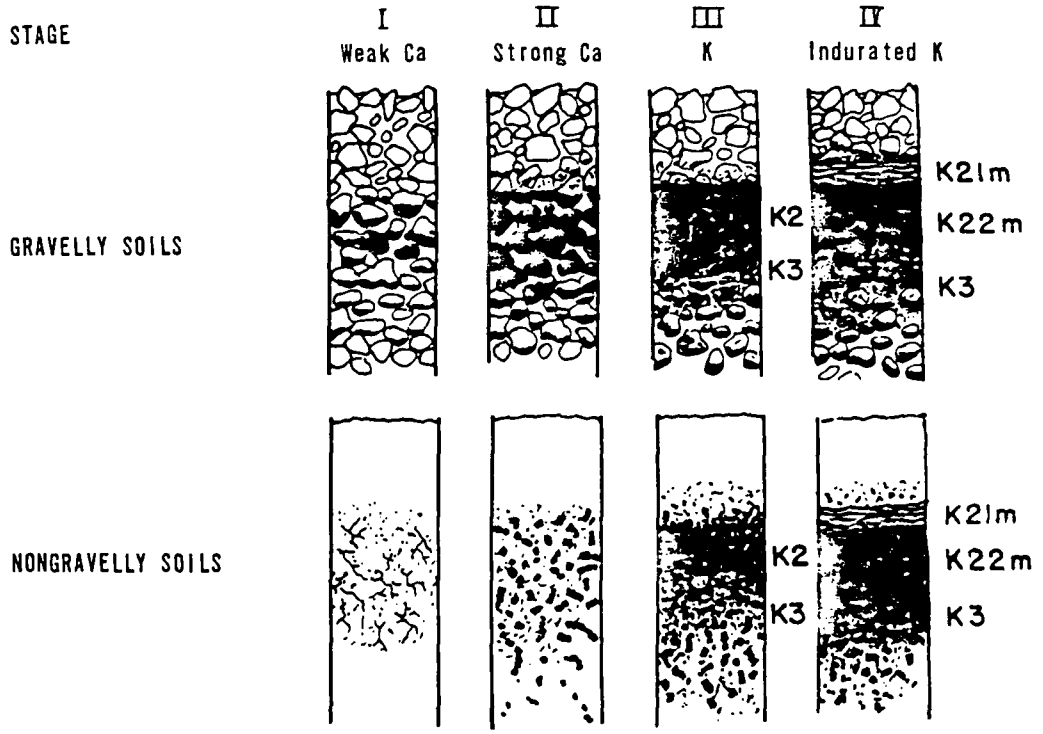
FUGRO NATIONAL, INC.

APPENDIX D

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.

SUMMARY OF CALICHE DEVELOPMENT

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - SAMSO

TABLE
D-1

APPENDIX E

UNIFIED SOIL CLASSIFICATION SYSTEM

AD-A113 204 FUGRO NATIONAL INC LONG BEACH CA F/G 8/7
AGGREGATE RESOURCES REPORT DEPARTMENT OF DEFENSE AND BUREAU OF --ETC(U)
FEB 78 W R LUND, M R LONG, E Y HSU FNTR-200 F04704-77-C-0010 NL
UNCLASSIFIED

END
DATE FILMED
06-82
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