A STUDY OF CALIFORNIA DESERT SOILS

for the

Bureau of Land Management
Riverside District Office

by

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A Study of California Desert Soils Subjected to Recreational Vehicle Use in the C.D.C.A.

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DISCUSSIONS AND CONCLUSIONS

Physical Test Results:

From a *geologic* viewpoint, the physical effects of the off-road vehicle use on the desert is negligible. The percentage of present affected area is extremely small. The alluvial areas tested are subject to constant reworking and burial from desert thunderstorms, with resultant erosion or burial of vehicle tracks. The sand dunes are essentially in constant motion and vehicle tracks have a life expectance of only a few days. Rainfall is the controlling geologic factor for the expected duration of the vehicle tracks in alluvial areas. A very approximate estimate of the amount of rainfall necessary to erase the vehicle tracks could be derived from the soil characteristics and general slope angle. The random nature of limited rainfall in the desert prevents any meaningful time period estimate from being made.

The *geologic effect* of off-road vehicle use in the desert is apparently negligible. Natural processes of wind and water erosion have a more pronounced effect. In order of increasing resistance to vehicle effects the desert areas are: older alluvium and dissected terrace deposits, alluvial flats, alluvial fans, and sand dunes. No bedrock areas were tested, but these are probably on a par with other eroding terrains such as older alluvium and terrace deposits.

From a *soils engineering* standpoint, the poorly sorted sands of the dune areas showed the greatest resistance to off-road vehicles. The gravels were next in resistance to vehicle densification. Well graded sands, with a wide range of particle sizes, were the least resistant to vehicle densification. This is theoretically proper, since well graded particles provide a wider range of possible sizes to fill the native voids. This particle size relationship was matched by the tendency for characteristically more angular particles to densify more easily than rounded particles. The natural percolation capacity of the soils was significantly reduced in all but sand dune areas. The limited percentage of affected areas, coupled with the limited run-off-recharge potential of the generally minimal desert rainfall tend to reduce the significance of the percolation rate changes measured.

The measured *soils engineering effect* of current off-road vehicle use was a significant increase in density and soil strength, and a significant decrease in native porosity and percolation capacities in areas tested. The total area of affected soil was not measured. This can be best estimated from recent air photos. Erosional and depositional characteristics of the areas tested seem to be more significant to vehicle effects than does the actual soil type. However, these processes are generally characterized by definite soil types. Soil types listed by order of increasing resistance to vehicle effects are: SW, GM, GP and SP.

Plant Growth Relationships:

There are sufficient characteristics common to most sites to permit a general commentary which can be usefully applied to all.

We did not find any situation with pedological development. Since soil horizons were not present, we did not attempt regular profile descriptions. The materials are described as fluvial or aeolian deposits rather than soils. Where horizon like formations were found, they were considered as discontinuities rather than pedological horizons.

All sites, disturbed and undisturbed, are relatively coarse with high percentages of sand, gravel and/or stones. They have very low moisture holding capacities, very low cation exchange capacities and show low salinity levels (EC$\times 10^3$ 2 to 2.5 or lower). With the exception of calcium, they show low cation levels. Organic matter is also low. The pH range is from neutral at 7 to alkaline at 9 or more.

In evaluating for agricultural potential, these add up to the exp
tation that specialized irrigation practices would be required and t
fertility would be low. Suitable crops would have to be chosen.
toxicity problems from salinity or alkalinity are indicated. Proble
due to topography and stoniness are obvious in some areas.

A comparison of disturbed and undisturbed areas at each site w
regard to plant growth potential does not reveal any significant st
surface differences. At the surface, the lack of organic matter and
isting vegetative growth are apparent. However with one excepti
(Shadow Mountain), it appears to us that if recreational vehicle u
were to cease, the native cover could reestablish itself without t
much difficulty. The rate of such reestablishment would depend
presently unpredictable factors such as rainfall.

We do not know of any test which usefully predicts erosi
hazard, and it is obvious that in an actively eroding area, vegetatio
more difficult to establish. This, therefore, is also an unevalua
factor.

The Shadow Mountain exception mentioned above is due to t
fact that a dense surface is now exposed where it formerly w
covered with sand and vegetative cover. This presents a very differ
situation for revegetation and we would expect it to recover mu
more slowly than in the other cases.

INTRODUCTION

Ten desert test sites were selected by the Bureau of Land Manag
ment. These sites were subjected to standard soil and engineering te
procedures by Edward S. Babcock & Sons, Laboratories, and Gall
her and Bovey, Geotechnical Consultants, to determine the effects
recreational vehicle use.

This report presents the test results and an analysis of the relati
durability of the sites to recreational vehicle use.

FIELD DESCRIPTIONS OF SITES

Stoddard Valley, Site 1A & B

The site is a southwest sloping alluvial fan which flanks the Le
wood Anticline. The material is stratified recent alluvium rather tha
soil, since both sheet and gully erosion and/or deposition is occu
ring at a more rapid rate than are pedological processes. Rock typ
in the source area are continental fluvial sands and gravels.

Tests were made inside and alongside four wheel drive race cour
tracks. The density samples can be classified as poorly bedded an
poorly graded coarse sand. The disturbed area is characterized b
loss of vegetative cover and resultant organic litter in the Ao horizo
Plant roots were observed to a depth of about 18" in both disturbe
and undisturbed areas. No significant moisture was noted.

Shadow Mountain, Site 2A & B

The site is an easterly sloping alluvial flat which flanks the Shado
Mountains. Rock types in the source areas are probably metamor
phic quartzites and hypidiomorphic rocks.

Tests were made inside and adjacent to a cross country motorcycl
race pit area. The density samples can be classified as poorly sorte
fine sand. The undisturbed area test hole showed stratified alluviu
to a depth of at least 3' with the usual desert vegetative cover an
associated surface organic litter. The race pit area at one time wa
covered with at least several inches of sand and organic litter. I
presently consists of a red brown, weathered body of soil to a dept
of at least 3', which is very hard and tight. No roots were observed.
No significant moisture was noted.

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Chemehuevi Wash, Site 3A & B

The site is a broad alluvial valley, subject to sheet and gully erosion during the desert rainstorms. Rock types in the source area are principally volcanic flow rocks with some intermixed granitics. As with the other sites, the material under study is not properly a soil but rather a randomly stratified alluvium.

Tests were made within and adjacent to cross country motorcycle race tracts. Density samples were poorly graded coarse gravelly sands. The test holes showed loose material with no cohesion when dry but which held some shape when wet. Moisture and roots were noted below 3" and extending to a depth of at least 4'. The alluvial strata appear to be in small lenses 3 to 4 sq. ft. in area rather than covering larger areas.

Dumont Dunes, Site 4A & B

Tests were made within and adjacent to a recreational vehicle play area north of the Dumont sand dunes. The area is a partly dissected reworked southwest sloping alluvial flat, with significant quantities of surficial windblown sand. Density samples were a combination of subangular gravels mixed with subrounded fine windblown quartz sands. The gravel is composed of volcanic flow rocks, metasediments and granitics.

The disturbed sample site is almost denuded of vegetation and has a very stoney surface. Erosion forces are mainly aeolian rather than fluvial. The test hole revealed a rather uniform profile to at least 4'. The material is dry, loose and unconsolidated. No moisture or roots were noted.

The undisturbed site is some distance away on an elevated ridge. Desert vegetation and surface organic litter were noted. The profile consisted of one foot of loose sand and stones underlain by a very dense red brown, lime cemented unrelated layer which was very difficult to penetrate. The discontinuity is sharp. No moisture or roots were found in this subsurface horizon.

Baker, Site 5A & B

The area is an alluvial flat which drains to the west into Soda Lake. Tests were made within and adjacent to recreational vehicle tracks just east of Baker. Density samples are poorly graded fine to coarse grained gravelly sand. Gravel portions were composed of principally granitic particles with some metasediments.

Test pits and auger borings revealed stratified alluvium to a depth of at least 4'. Moisture and roots were found below 3", both of which provided the only cohesiveness noted in an otherwise loose material.

Dove Springs, Site 6A & B

The site is a deeply incised broad alluvial wash. Test holes indicate that the deposits are highly stratified, but in small lenses rather than in large sheets.

Tests were made within and adjacent to motorcycle tracks which were superimposed on a highly used recreational vehicle play area. The undisturbed tests were made within a patch of vegetation in this otherwise highly used area.

Density samples are poorly graded fine to coarse grained sands with minor gravel. Gravel particles are composed of quartz feldspar and mica and granitic aggregates.

Moisture was found below 2', roots were noted throughout the profile to at least 4'.

Teagle Wash, Site 7A & B

The site is a broad alluvial drainage with local exposures of older alluvial materials derived from limestone among others.

Tests were located in an exposure of older alluvium or terrace deposits. They were made within and adjacent to a cross country motorcycle race course. Density samples are poorly graded silty fine grained sands. Gravel sized particles were composed of well cemented quartz and feldspar sand grains.

Test holes reveal a highly stratified laminar structure but with no soil profile development as such. The platelets, both surface and subsurface, are lime cemented but easily broken. No moisture wa found. Roots were found to at least 4'.

Orocopia, Site 8A & B

The site is on a shallow northeast sloping alluvial fan adjacent t an existing surface drainage. The test sites were situated on a trac corner within and adjacent to a motorcycle play area. Densit samples were poorly sorted reworked sandy gravels. The grave particles are principally gneiss and schist, shed from the Orcopi Mountains.

The test holes are characteristic of a stream bed. Any structure i due to the assortment of sand, gravel and fines laid down by flowin water. Due to the stoney character, digging was difficult. The onl difference between the disturbed and undisturbed sites was th presence of vegetation and surface organic litter. No moisture wa found. Roots were noted to the depth excavated, about 2½'.

Glamis, Site 9A &B

The test site is located near the Glamis highway adjacent to an within a sand buggy trail. The site is within an extensive area of sand dunes. Density samples are composed of frosted blowsand. Sand particles are principally quartz.

The "profiles" are uniform sand to at least 4'. Moisture wa noted below 4" and an occasional root near existing vegetation coul be found. Obviously wind is the principle agent for erosion.

Yuha Desert, Site 10A & B

The site is a dissected older alluvial terrace deposit. Large concre tions as well as lime cementation of large stones abound. The surfac is a form of desert pavement.

Tests were located within and adjacent to a motorcycle race cours which runs across an otherwise heavily used area. Density sample were composed of sandy gravel. Gravel particles were composed o gneiss, granitics, quartzite, limestone, and volcanic flow rocks.

Due to the stones and cementations, excavation and auger boring were not possible. Subsurface samples were taken from an im mediately adjacent gully exposure. There is no soil profile develop ment. No observation of moisture or root penetration was made.

TEST METHODS

Soils Engineering:

Various soils tests were performed at the selected sites. These included the following:

- Density of Soil in Place by the Sand-Cone Method (ASTM Designation: D-1556-64)
- Infiltration equilibrium rate (empirical method)
- Soil strength determination (soil types precluded vane and impact apparatus)
- Void ratio determination (from measured dry density)
- Field classification of soils (ASTM D-2488-69)
- Topographic cross-section through tests (by tape and hand level, where significant)

Soil, Miscellaneous:

All tests were made in accordance with methods described in USDA Handbook 60 except where otherwise noted.

- pH—determined on saturated paste
- $EC \times 10^3$ and SAR—determined on the saturation extract
- Cation Exchange Capacity—Due to the large amount of lime present, it was necessary to leach the soils with dilute Hydrochloric Acid prior to making the tests. The determination was made by the Gypsum-Barium Triethanalamine Modification of the Method of the University of California Agricultural Extension Division.
- Soluble Cations—IN Neutral Ammonium Acetate extract. Results include both water soluble and exchangeable Cations expressed as Milliequivalents per 100 grams of soil.

- Organic Matter—Determined as loss on ignition and may include some carbonates.
- Particle Size Distribution—Determined by standard sieve and hydrometer methods.
- Moisture Holding Capacity—Expressed as the difference between the 1/3 bar moisture and the 15 bar moisture.

Comments

Dry Density is expressed in pounds per cubic feet. Void ratio is an expression of amount of open space between solid particles. Increase in density or decrease in voids is an indication of compaction.

Percolation rate is a measure of the rate at which water moves through the soil. It is dependant on compaction among other factors. It is expressed as the number of minutes required for one inch of water to move past the surface of the wet soil.

Geologic: Q—formed in Quaternary or recent geologic time
al—alluvium, deposited mainly by running water
s—sand
o & t—associated with cemented soils

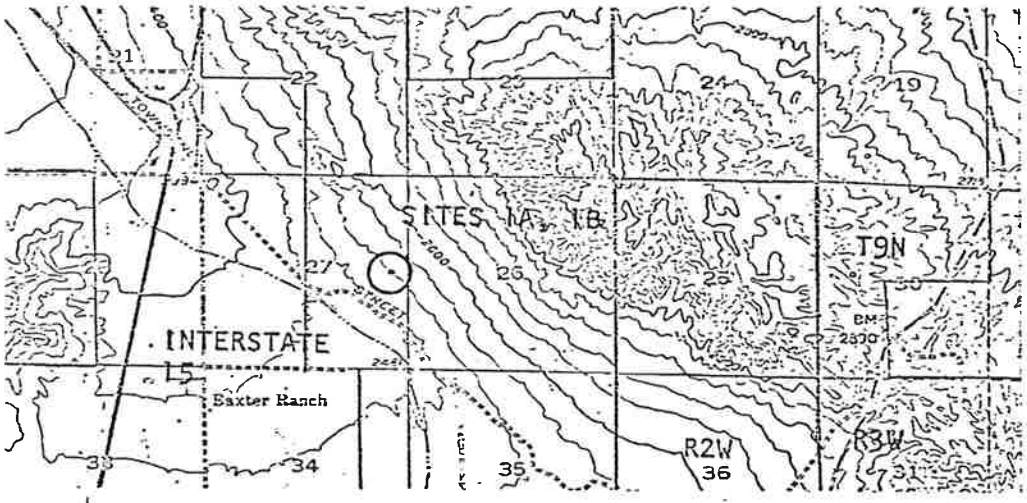
Soils: GW—well graded gravels
GP—poorly graded gravels
SW—well graded sands
SP—poorly graded sands
SM—poorly graded silty sands

Organic Matter—Determined as loss on ignition and may include some carbonates.

Particle Size Distribution—Determined by standard sieve and hydrometer methods.

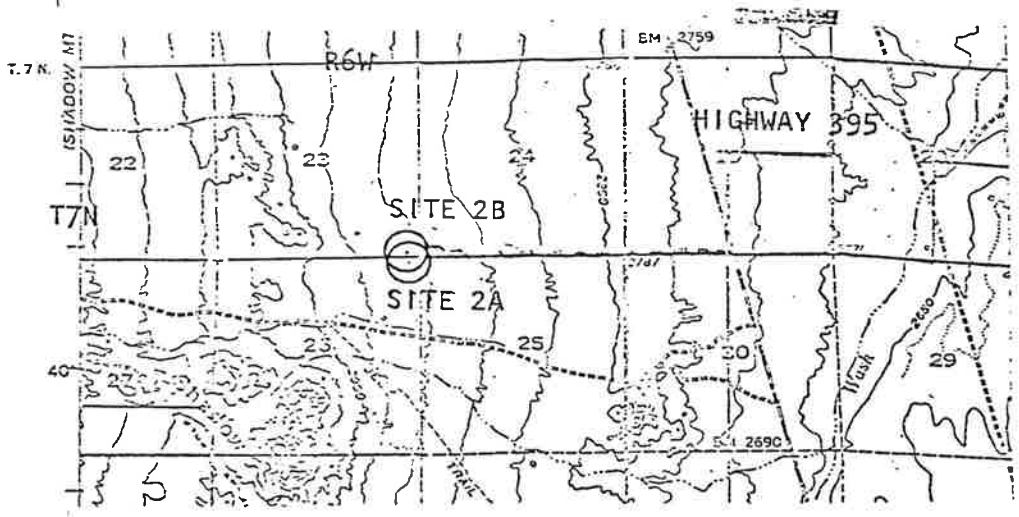
Moisture Holding Capacity—Expressed as the difference between the 1/3 bar moisture and the 15 bar moisture.

STODDARD VALLEY—SITE 1A, B



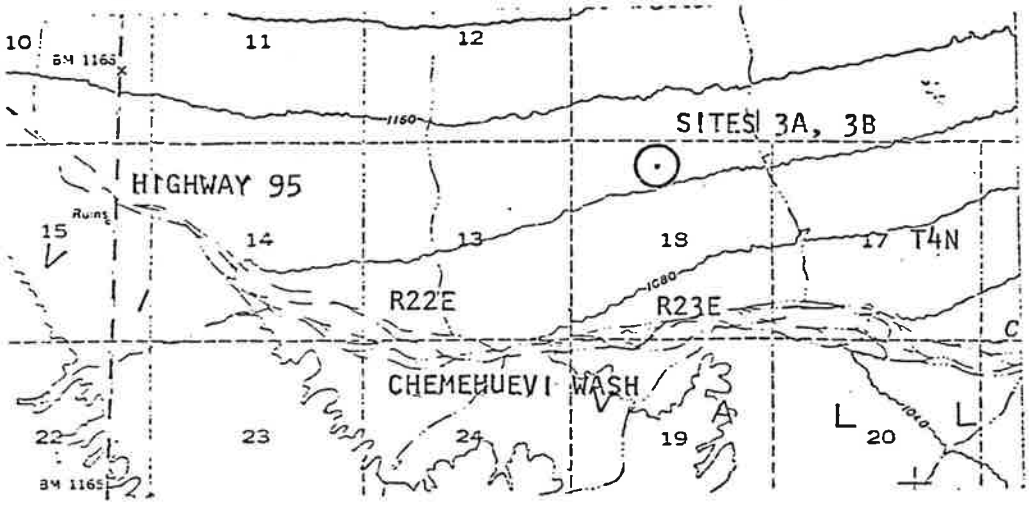
BASE MAP—BARSTOW QUADRANGLE, USGS, SCALE 1 " = 1 MILE

SHADOW MOUNTAIN—SITE 2A, B



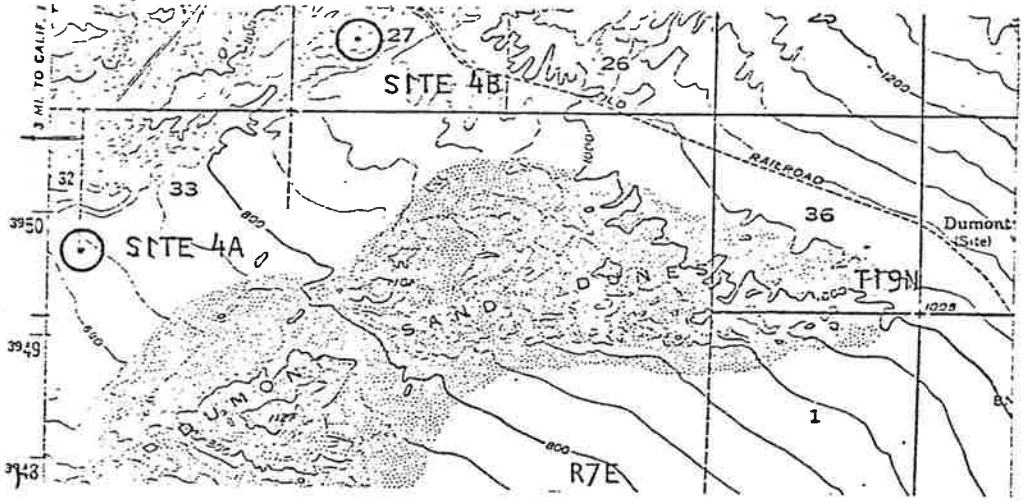
BASE MAP—VICTORVILLE QUADRANGLE, USGS, 1" = 1 MILE

CHEMEHUEVI WASH—SITE 3A B



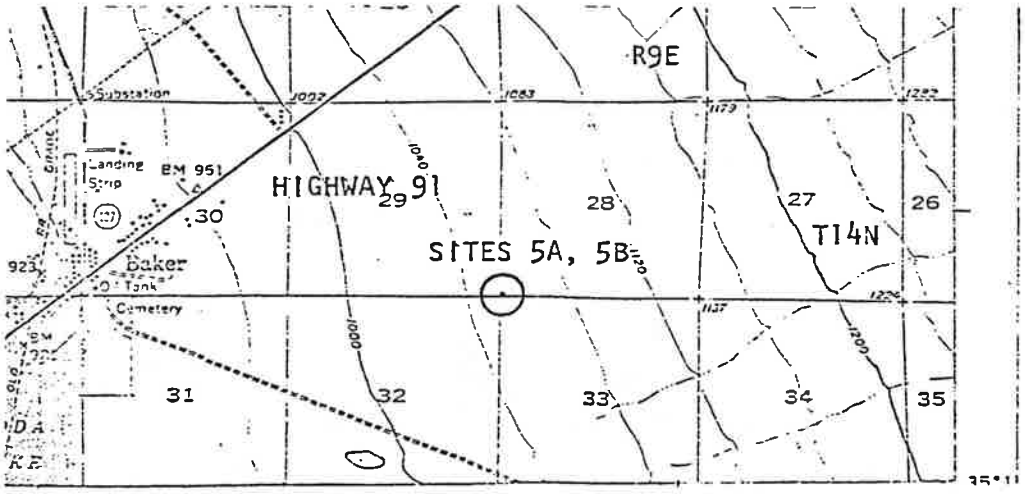
BASE MAP—SAUAHIA PEAK QUAD, USGS, 1″ = 1 MILE

DUMONT DUNES—SITE 4A, B



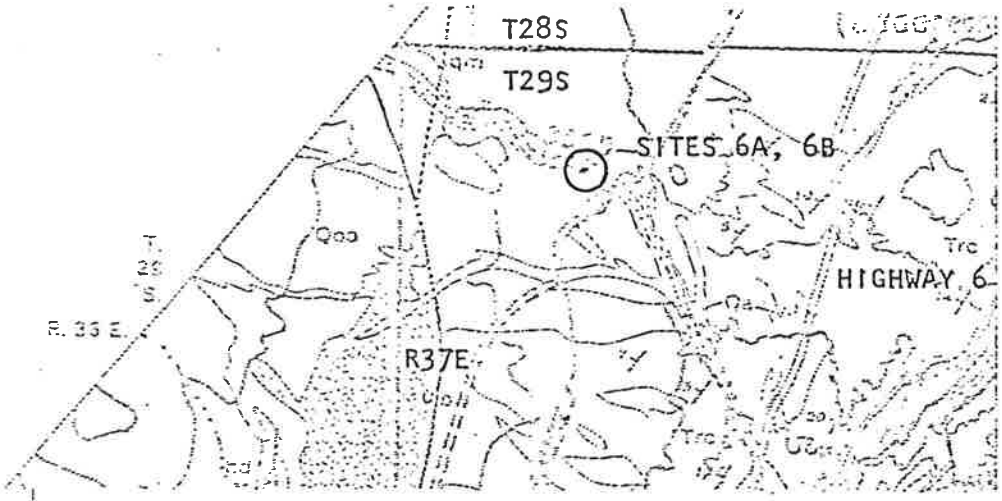
BASE MAP—SILURIAN HILLS QUAD, USGS, 1″ = 1 MILE

BAKER—SITE 5A, B



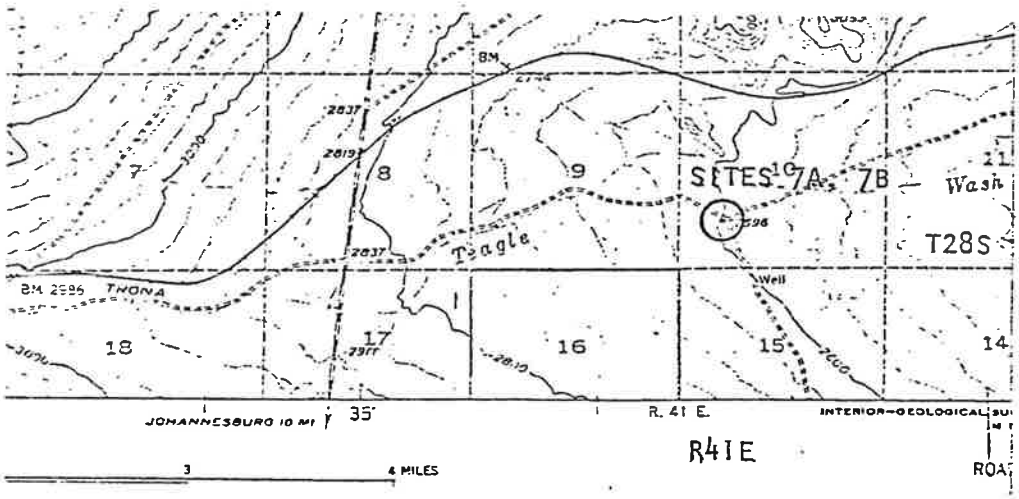
BASE MAP—BAKER QUAD, USGS, 1″ = 1 MILE

DOVE SPRINGS—SITE 6A, B



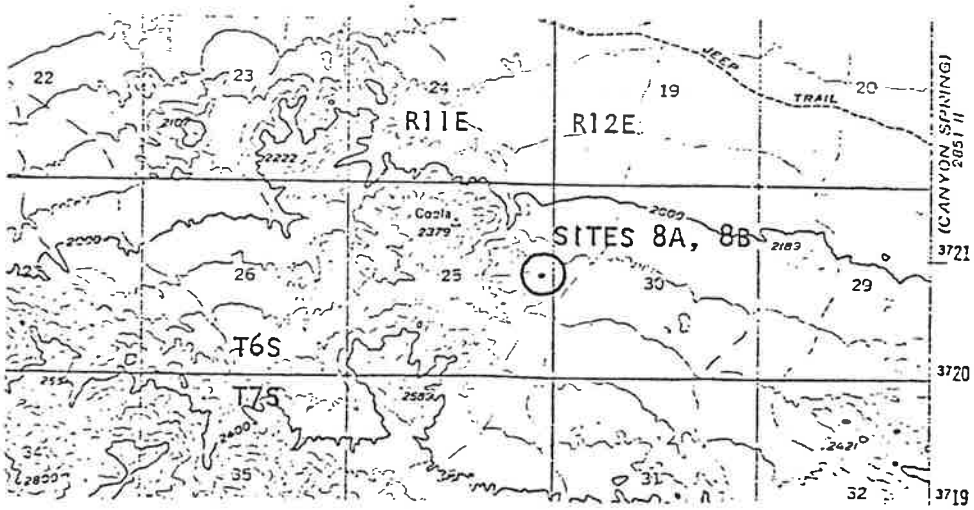
BASE MAP PLATE 1 OF PROFESSIONAL PAPER 522, USGS, 1967 SCALE, 1″ = 2 MILES

TEAGLE WASH—SITE 7A, B



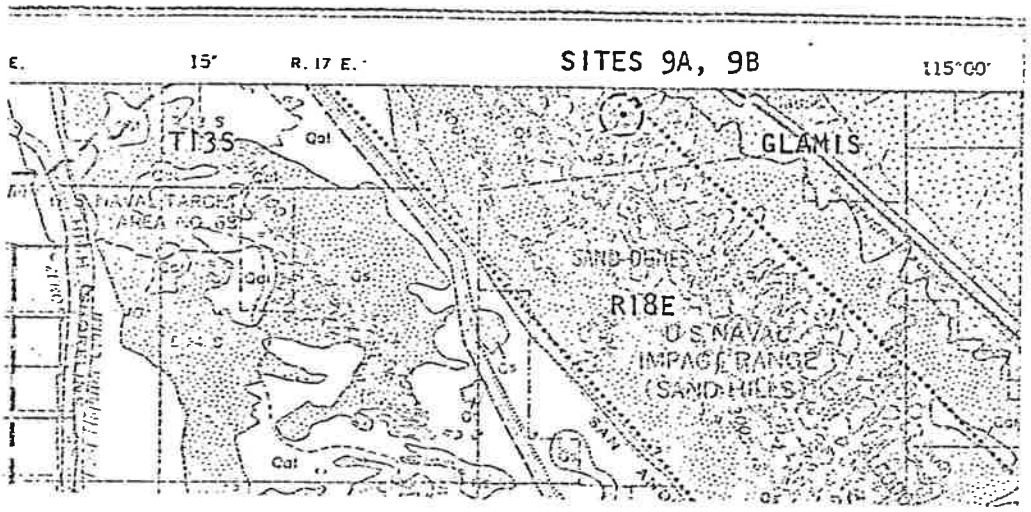
BASE MAP—RIDGECREST QUAD, USGS, 1″ = 1 MILE

OROCOPIA—SITE 8A, B



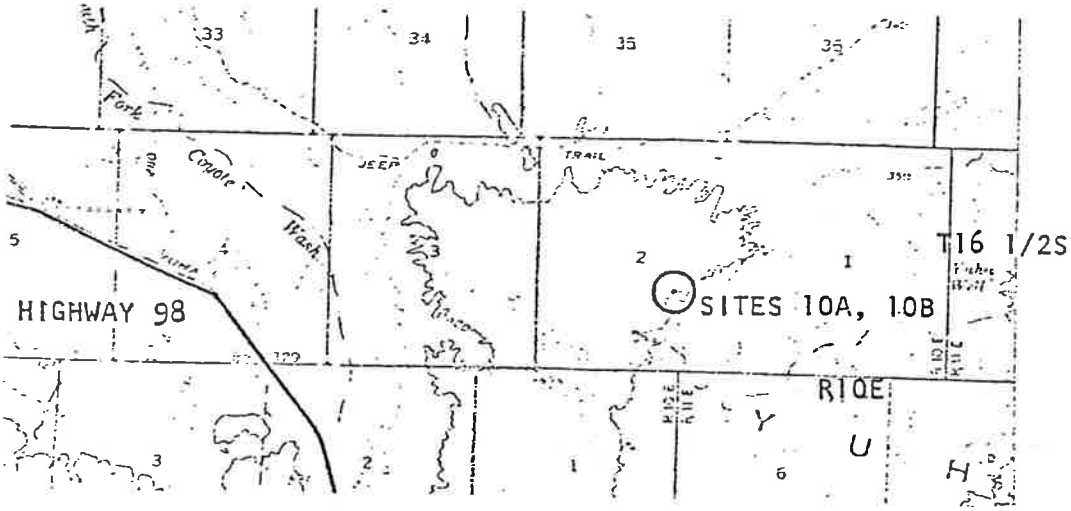
BASE MAP—COTTONWOOD SPRING QUAD, USGS, 1″ = 1 MILE

GLAMIS—SITE 9A, B



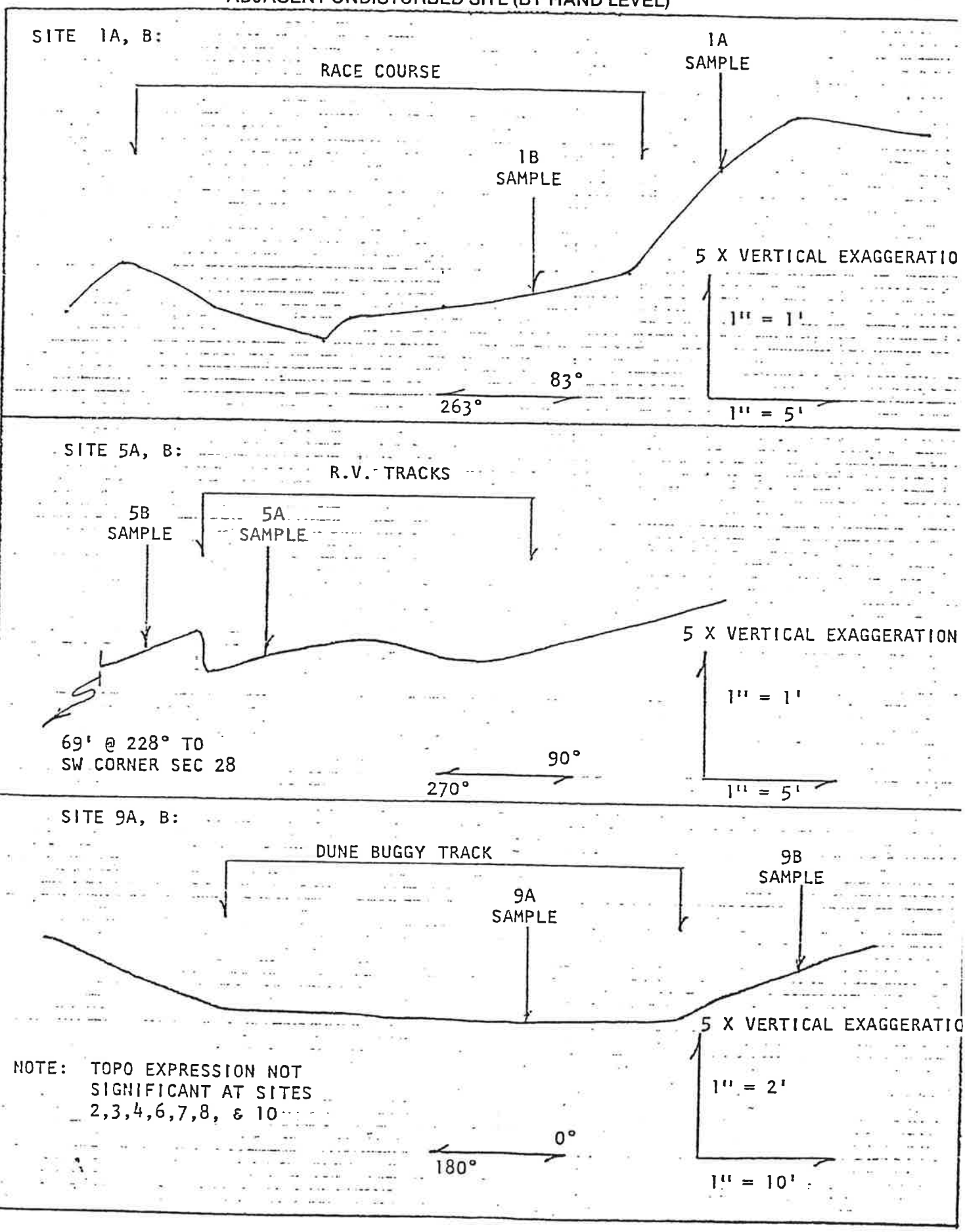
BASE MAP SAN DIEGO-EL CENTRO MAP SHEET
CALIFORNIA DIVISION OF MINES & GEOLOGY, 1962, 1″ = 4 MILES

YUHA DESERT—SITE 10A, B



BASE MAP B.L.M. YUHA DESERT TOPO MAP, 1″ = 1 MILE

TOPOGRAPHIC CROSS SECTIONS THRU TRACK AND ADJACENT UNDISTURBED SITE (BY HAND LEVEL)



ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 1A (undisturbed) STODDARD VALLEY

1. Typical Name: Sand with gravel and minor silt
2. Gradation: Well-graded coarse sand
3. Maximum Particle Size: 1"
4. Size Distribution: Gravel 5%, Sand 90%, Silt 5%
5. Grain Shape: Subangular
6. Mineralogy: Granitic gravel, with quartz, feldspar & mica particles in sand
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: Partly stratified
12. Cementation: No cementation
13. Local or Geologic Name: Alluvium
14. Group Symbol (U.S.C.): SW

Sample 1B (disturbed) STODDARD VALLEY

1. Typical Name: Sand with gravel
2. Gradation: Well-graded fine sand
3. Maximum Particle Size: To 1" ±
4. Size Distribution: Gravel 5%, Sand 90%, Silt 5%
5. Grain Shape: Subangular
6. Mineralogy: Granitic gravel, with quartz, feldspar & mica particles in sand
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Stratified
12. Cementation: No cementation
13. Local or Geologic Name: Alluvium
14. Group Symbol (U.S.C.): SW

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 2A (undisturbed) SHADOW MOUNTAIN

1. Typical Name: Gravelly fine sand
2. Gradation: Well-graded fine sand
3. Maximum Particle Size: 1" ±
4. Size Distribution: Gravel 2-4%, Sand 95%, Fines 1-3%
5. Grain Shape: Subangular to subrounded
6. Mineralogy: Gravel probably quartzite, with sand quartz and mica
7. Color: Brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: Poorly bedded (stratified)
12. Cementation: Not cemented
13. Local or Geologic Name: Qal
14. Group Symbol (U.S.C.): SW

Sample 2B (disturbed) SHADOW MOUNTAIN

1. Typical Name: Gravelly fine sand
2. Gradation: Well graded fine sand
3. Maximum Particle Size: 1¼" maximum
4. Size Distribution: Gravel 15%, Sand 80%, Fines 5%
5. Grain Shape: Angular-subangular
6. Mineralogy: Gravel probably quartzite, with sand quartz & mica
7. Color: Brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Stratified
12. Cementation: Not cemented
13. Local or Geologic Name: Qal
14. Group Symbol (U.S.C.): SW

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 3A (disturbed) CHEMEHUEVI WASH

1. Typical Name: Gravelly sand
2. Gradation: Well graded coarse sand
3. Maximum Particle Size: 1" maximum
4. Size Distribution: Gravel 25%, Sand 73%, Fines 2%
5. Grain Shape: Angular - subangular
6. Mineralogy: Gravel: granitics & meta sandstone, Sand: quartz & feldspar
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Poorly stratified
12. Cementation: Not cemented
13. Local or Geologic Name: Qal
14. Group Symbol (U.S.C.): SW

Sample 3B (undisturbed) CHEMEHUEVI WASH

1. Typical Name: Sandy gravel
2. Gradation: Poorly graded gravel
3. Maximum Particle Size: 2" maximum
4. Size Distribution: Gravel 75%, Sand 25%
5. Grain Shape: Angular - subangular
6. Mineralogy: Gravel: granitics & meta sandstone, Sand: quartz & feldspar
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: Poorly stratified
12. Cementation: Not cemented
13. Local or Geologic Name: Qal
14. Group Symbol (U.S.C.): GP

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 4A (disturbed) DUMONT DUNES

1. Typical Name: Gravelly fine sand
2. Gradation: Poorly graded windblown sand with gravel
3. Maximum Particle Size: To 1" maximum
4. Size Distribution: Gravel 5%, Sand 93%, Fines 2%
5. Grain Shape: Gravel is subangular, sand is subrounded
6. Mineralogy: 25% volcanic, 60% metaseds, 15% granitics Sand: quartz & minor feldspar
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Nonstratified
12. Cementation: Not cemented
13. Local or Geologic Name: Windblown sand and alluvial gravel (mixture)
14. Group Symbol (U.S.C.): SP

Sample 4B (undisturbed) DUMONT DUNES

1. Typical Name: Gravelly fine sand
2. Gradation: Poorly graded windblown sand with gravel
3. Maximum Particle Size: To 1" maximum
4. Size Distribution: Sand 95%, Gravel 3%, Fines 2%

5. Grain Shape: Gravel: subangular Sand: subrounded
6. Mineralogy: Gravel: 25% volcanic, 60% metaseds, 15% granitics Sand: quartz & minor feldspar
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Nonstratified
12. Cementation: Not cemented
13. Local or Geologic Name: Windblown sand and alluvial gravel (mixture)
14. Group Symbol (U.S.C.): SP

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 5A (disturbed) BAKER

1. Typical Name: Gravelly sand
2. Gradation: Well graded fine to coarse sand with gravel
3. Maximum Particle Size: 6" maximum < 1% cobbles
4. Size Distribution: Gravel 10-15%, Sand 80%, Fines 5-10%
5. Grain Shape: Subangular - subrounded
6. Mineralogy: Gravel: 80% granitics, 20% metaseds, Sand: quartz & feldspar
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Poorly stratified
12. Cementation: No cementation
13. Local or Geologic Name: Alluvium
14. Group Symbol (U.S.C.): SW

Sample 5B (undisturbed) BAKER

1. Typical Name: Gravelly sand
2. Gradation: Well graded fine to coarse sand with gravel
3. Maximum Particle Size: 6" maximum < 1% cobbles
4. Size Distribution: Gravel 10-15%, Sand 80%, Fines 5-10%
5. Grain Shape: Subangular - subrounded
6. Mineralogy: Gravel: 80% granitics, 20% metaseds, Sand: quartz & feldspar
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Poorly stratified
12. Cementation: No cementation
13. Local or Geologic Name: Alluvium
14. Group Symbol (U.S.C.): SW

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 6A (disturbed) DOVE SPRINGS

1. Typical Name: Silty fine to coarse sand with minor gravel
2. Gradation: Well graded medium to fine sand
3. Maximum Particle Size: 1/2" maximum
4. Size Distribution: Silt 10%, Sand 85%, Gravel 5%
5. Grain Shape: Subrounded
6. Mineralogy: Quartz, granite & feldspar XL's in Gravel, Sand: quartz, feldspar & mica
7. Color: Brown
8. Odor: None
9. Moisture Content: Dry - Moist
10. Natural Density: Dense
11. Structure: Partly stratified
12. Cementation: Weakly cemented
13. Local or Geologic Name: Alluvium
14. Group Symbol (U.S.C.): SP

Sample 6B (undisturbed) DOVE SPRINGS

1. Typical Name: Silty fine to coarse sand with minor gravel
2. Gradation: Well graded medium to fine sand
3. Maximum Particle Size: 1/2" maximum
4. Size Distribution: Silt 10%, Sand 85%, Gravel 5%
5. Grain Shape: Subrounded
6. Mineralogy: Quartz, granite & feldspar XL's in Gravel, Sand: quartz, feldspar & mica
7. Color: Brown
8. Odor: None
9. Moisture Content: Dry - Moist
10. Natural Density: Dense
11. Structure: Partly stratified
12. Cementation: Weakly cemented
13. Local or Geologic Name: Alluvium
14. Group Symbol (U.S.C.): SP

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 7A (disturbed) TEAGLE WASH

1. Typical Name: Silty sand
2. Gradation: Well graded fine grained silty sand
3. Maximum Particle Size: Cemented clods to 6"
4. Size Distribution: 10% cemented > Gravel size, 75% fine sand, 15% silt
5. Grain Shape: Subangular - subrounded
6. Mineralogy: Quartz & feldspar grains
7. Color: Light tan
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: Nonstratified
12. Cementation: Partly cemented
13. Local or Geologic Name: Alluvial material, cemented (Qalo)
14. Group Symbol (U.S.C.): SM

Sample 7B (undisturbed) TEAGLE WASH

1. Typical Name: Silty sand
2. Gradation: Well graded fine grained silty sand
3. Maximum Particle Size: Cemented clods to 6"
4. Size Distribution: 10% cemented > Gravel size, 75% fine sand, 15% silt
5. Grain Shape: Subangular - subrounded
6. Mineralogy: Quartz & feldspar grains
7. Color: Light tan
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: Nonstratified
12. Cementation: Partly cemented
13. Local or Geologic Name: Alluvial material, cemented (Qalo)
14. Group Symbol (U.S.C.): SM

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 8A (disturbed) OROCOPIA

1. Typical Name: Sandy gravel (to 3")
2. Gradation: Well graded coarse sandy gravel
3. Maximum Particle Size: To 3" on gravel
4. Size Distribution: 75% gravel, 20% sand, 5% silt
5. Grain Shape: Angular grains
6. Mineralogy: 80% gneiss, 20% schist, Sand: quartz, feldspar, mica
7. Color: Grey brown
8. Odor: None
9. Moisture Content: Dry

10. Natural Density: Dense
11. Structure: Nonstratified (reworked)
12. Cementation: Not cemented
13. Local or Geologic Name: Qal
14. Group Symbol (U.S.C.): GW

Sample 8B (undisturbed) OROCOPIA

1. Typical Name: Sandy gravel (to 3")
2. Gradation: Well graded coarse sandy gravel
3. Maximum Particle Size: To 3" on gravel
4. Size Distribution: 75% gravel, 20% sand, 5% silt
5. Grain Shape: Angular grains
6. Mineralogy: 80% gneiss, 20% schist, Sand: quartz, feldspar, mica
7. Color: Grey brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: Partly stratified
12. Cementation: Not cemented
13. Local or Geologic Name: Qal
14. Group Symbol (U.S.C.): GW

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 9A (disturbed) GLAMIS

1. Typical Name: Fine sand
2. Gradation: Poorly graded uniform blowsand
3. Maximum Particle Size: Up to 3mm
4. Size Distribution: 100% fine sand
5. Grain Shape: Subangular to subrounded "frosted" grains
6. Mineralogy: Quartz, with minor feldspar & aphanitic volcanic grains
7. Color: Reddish tan
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: X-bedded, locally
12. Cementation: Not cemented
13. Local or Geologic Name: Blowsand (Qs)
14. Group Symbol (U.S.C.): SP

Sample 9B (undisturbed) GLAMIS

1. Typical Name: Fine sand
2. Gradation: Poorly graded uniform blowsand
3. Maximum Particle Size: Up to 3mm
4. Size Distribution: 100% fine sand
5. Grain Shape: Subangular to subrounded "frosted" grains
6. Mineralogy: Quartz, with minor feldspar & aphanitic volcanic grains
7. Color: Reddish tan
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Loose
11. Structure: X-bedded, locally
12. Cementation: Not cemented
13. Local or Geologic Name: Blowsand (Qs)
14. Group Symbol (U.S.C.): SP

ASTM-D2488
Checklist for Description of Coarse Grained Soils

Sample 10A (disturbed) YUHA DESERT

1. Typical Name: Coarse sandy gravel with minor silt
2. Gradation: Well graded sandy gravel
3. Maximum Particle Size: Particles to 1′ on surface
4. Size Distribution: Gravel 30%, Sand 60%, Silt 10%
5. Grain Shape: Angular
6. Mineralogy: Caliche cement locally, with gneiss/granitics 50%, volcanics 5%, limestone 20%, quartzite 25%, sand grains of quartz, feldspar & mica
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Partly stratified
12. Cementation: Partly cemented (calcareous)
13. Local or Geologic Name: Qalo/Qt
14. Group Symbol (U.S.C.): GM

Sample 10B (undisturbed) YUHA DESERT

1. Typical Name: Coarse sandy gravel with minor silt
2. Gradation: Well graded sandy gravel
3. Maximum Particle Size: Particles to 1′ on surface
4. Size Distribution: Gravel 30%, Sand 60%, Silt 10%
5. Grain Shape: Angular
6. Mineralogy: Caliche cement locally, with gneiss/granitics 50%, volcanics 5%, limestone 20%, quartzite 25%, sand grains of quartz, feldspar & mica
7. Color: Light brown
8. Odor: None
9. Moisture Content: Dry
10. Natural Density: Dense
11. Structure: Partly stratified
12. Cementation: Partly cemented (calcareous)
13. Local or Geologic Name: Qalo/Qt
14. Group Symbol (U.S.C.): GM

Laboratory Test Results

Site #1 STODDARD VALLEY

	Disturbed		Undisturbed	
Depth	0-4"	6-24"	0-6"	8-18
pH	7.7	7.7	7.8	7.5
ECx10^6	0.5	0.6	0.3	2.5
SAR	2.0	2.2	1.3	8.0
Cation Exchange Capacity, meq/100 gm	4.0	4.0	3.5	3.5
Extractable Cations, Ca, meq/100 gm	5.0	5.0	7.0	9.5
Extractable Cations, Mg, meq/100 gm	0.5	0.5	0.8	0.7
Extractable Cations, Na, meq/100 gm	0.2	0.3	0.2	0.9
Extractable Cations, K, meq/100 gm	0.1	0.1	0.3	0.3
1/3 Bar Moisture, %	2.56	2.86	4.19	3.5
15 Bar Moisture, %	2.29	2.27	3.04	2.4
Water Holding Capacity, %	0.27	0.59	1.15	1.1
Organic Matter, %	0.7	0.7	1.1	1.1
Particle Size Distribution, % Stones & Gravel, > 2mm	46.7	36.8	26.7	26.7
vcs 2 – 1 mm	11.0	13.8	9.7	8.7
cs 1 – 0.5 mm	13.4	15.2	11.4	11.6
ms 0.5 – 0.25 mm	10.9	13.4	14.0	13.9
fs 0.25 – 0.1 mm	5.4	5.5	10.8	10.7
vfs 0.1 – 0.05 mm	5.2	5.7	13.9	14.9
silt 0.05 – 0.002 mm	4.0	4.6	11.4	11.4
clay < 0.002 mm	2.7	4.3	1.0	1.0
Reaction to HCl (Effervescence)	faint	faint	faint	faint

Laboratory Test Results

Site #2 SHADOW MOUNTAIN

	Disturbed		Undisturbed	
Depth	0-4″	4-24″	0-4″	6-18″
pH	7.8	7.6	8.0	7.8
ECx10⁶	0.3	0.4	0.4	0.4
SAR	1.4	15.0	1.3	2.4
Cation Exchange Capacity, meq/100 gm	4.0	7.0	5.5	6.0
Extractable Cations, Ca, meq/100 gm	7.5	12.5	10.5	10.0
Extractable Cations, Mg, meq/100 gm	0.5	0.6	0.5	0.6
Extractable Cations, Na, meq/100 gm	0.2	1.1	0.2	0.3
Extractable Cations, K, meq/100 gm	0.2	0.1	0.4	0.4
1/3 Bar Moisture, %	5.18	6.26	5.94	5.90
15 Bar Moisture, %	3.77	4.75	3.62	3.58
Water Holding Capacity, %	1.41	1.51	2.32	2.42
Organic Matter, %	2.1	1.9	3.3	3.5
Particle Size Distribution, % Stones & Gravel, > 2mm	31.4	44.4	13.0	23.1
vcs 2 – 1 mm	11.6	10.6	7.8	8.8
cs 1 – 0.5 mm	12.5	10.3	8.5	8.9
ms 0.5 – 0.25 mm	14.7	8.7	11.6	11.6
fs 0.25 – 0.1 mm	7.8	3.4	13.2	11.7
vfs 0.1 – 0.05 mm	7.9	3.2	20.9	15.0
silt 0.05 – 0.002 mm	10.0	11.2	18.4	14.4
clay < 0.002 mm	2.0	6.3	3.3	3.0
Reaction to HCl (Effervescence)	faint	moderate	faint	moderate

Laboratory Test Results

Site #3 CHEMEHUEVI WASH

	Disturbed		Undisturbed	
Depth	0-8″	12-24″	0-4″	6-24″
pH	8.4	7.7	7.9	7.8
ECx10⁶	0.3	0.3	0.4	0.3
SAR	5.5	5.9	4.9	3.9
Cation Exchange Capacity, meq/100 gm	3.0	3.5	4.5	4.5
Extractable Cations, Ca, meq/100 gm	12.0	11.0	11.5	12.0
Extractable Cations, Mg, meq/100 gm	0.6	0.7	0.8	0.9
Extractable Cations, Na, meq/100 gm	0.4	0.5	0.6	0.3
Extractable Cations, K, meq/100 gm	0.1	0.2	0.2	0.2
1/3 Bar Moisture, %	3.87	6.64	5.16	7.02
15 Bar Moisture, %	2.92	4.53	3.07	5.22
Water Holding Capacity, %	0.95	2.11	2.09	1.80
Organic Matter, %	2.4	3.9	2.7	3.7
Particle Size Distribution, % Stones & Gravel, > 2mm	32.1	29.2	50.0	21.7
vcs 2 – 1 mm	20.1	13.5	9.5	12.1
cs 1 – 0.5 mm	15.9	11.7	4.4	10.6
ms 0.5 – 0.25 mm	13.3	14.6	4.9	11.5
fs 0.25 – 0.1 mm	4.7	6.5	4.4	9.7
vfs 0.1 – 0.05 mm	4.1	7.6	7.4	11.2
silt 0.05 – 0.002 mm	5.8	10.6	15.4	15.4
clay < 0.002 mm	1.6	2.4	1.3	4.1
Reaction to HCl (Effervescence)	light	light	light	light

Laboratory Test Results

Site #4 DUMONT DUNES

	Disturbed		Undisturbed	
Depth	0-2″	6-18″	0-1″	12-1(
pH	8.2	9.1	8.4	8.1
ECx10⁶	0.4	1.9	0.3	1.(
SAR	1.2	75	0.5	27
Cation Exchange Capacity, meq/100 gm	0.5	0.5	0.5	1.(
Extractable Cations, Ca, meq/100 gm	21.5	37.5	26.5	43.5
Extractable Cations, Mg, meq/100 gm	1.2	1.2	1.2	1.9
Extractable Cations, Na, meq/100 gm	0.6	2.8	0.5	1.(
Extractable Cations, K, meq/100 gm	0.4	1.5	0.4	0.8
1/3 Bar Moisture, %	2.37	5.11	1.77	2.(
15 Bar Moisture, %	1.97	3.54	1.63	1.(
Water Holding Capacity, %	0.40	1.57	0.14	0.(
Organic Matter, %	2.4	3.1	1.8	9.1
Particle Size Distribution, % Stones & Gravel, > 2mm	16.4	15.0	8.7	43.1
vcs 2 – 1 mm	4.8	3.5	1.6	13.5
cs 1 – 0.5 mm	3.7	6.7	3.9	7.8
ms 0.5 – 0.25 mm	25.1	33.0	47.6	8.7
fs 0.25 – 0.1 mm	26.4	19.8	23.7	6.(
vfs 0.1 – 0.05 mm	17.2	11.9	8.7	6.(
silt 0.05 – 0.002 mm	4.0	7.0	4.0	5.2
clay < 0.002 mm	0.0	0.0	0.0	0.(
Reaction to HCl (Effervescence)	Strong	Strong	Strong	Strong

Laboratory Test Results

Site #5 BAKER

	Disturbed		Undisturbed	
Depth	0-3″	3-24″	0-3″	3-24′
pH	8.0	8.1	7.8	7.6
ECx10⁶	0.6	0.4	0.4	0.4
SAR	3.9	4.4	3.3	3.3
Cation Exchange Capacity, meq/100 gm	4.0	2.5	2.5	2.5
Extractable Cations, Ca, meq/100 gm	16.0	10.0	11.5	14.0
Extractable Cations, Mg, meq/100 gm	0.7	0.5	0.6	0.6
Extractable Cations, Na, meq/100 gm	0.4	0.4	0.3	0.3
Extractable Cations, K, meq/100 gm	0.3	0.2	0.2	0.2
1/3 Bar Moisture, %	3.60	2.38	3.37	2.63
15 Bar Moisture, %	3.08	1.90	2.04	1.55

Water Holding Capacity, %	0.52	0.48	1.33	1.08
Organic Matter, %	1.2	0.9	1.2	1.1
Particle Size Distribution, % Stones & Gravel, > 2mm	13.9	35.9	26.3	13.9
vcs 2 – 1 mm	9.4	10.7	6.4	15.9
cs 1 – 0.5 mm	9.8	17.0	7.1	20.2
ms 0.5 – 0.25 mm	25.2	13.4	15.6	19.5
fs 0.25 – 0.1 mm	22.9	8.9	19.0	13.7
vfs 0.1 – 0.05 mm	9.7	7.8	17.4	10.5
silt 0.05 – 0.002 mm	6.0	4.4	6.0	4.2
clay < 0.002 mm	1.9	1.0	1.0	1.0
Reaction to HCl (Effervescence)	Moderate	Faint	Moderate	Faint

Laboratory Test Results

Site #6 DOVE SPRINGS

	Disturbed		Undisturbed	
Depth	0-6″	6-36″	0-6″	6-36″
pH	7.5	7.3	7.2	7.3
ECx10⁶	0.4	0.4	1.9	2.3
SAR	4.4	4.9	3.1	6.8
Cation Exchange Capacity, meq/100 gm	3.0	4.0	3.0	3.0
Extractable Cations, Ca, meq/100 gm	2.5	4.5	2.5	4.0
Extractable Cations, Mg, meq/100 gm	0.6	0.9	0.7	1.0
Extractable Cations, Na, meq/100 gm	0.2	0.2	0.4	0.4
Extractable Cations, K, meq/100 gm	0.3	0.3	0.8	0.4
1/3 Bar Moisture, %	4.51	7.06	4.92	6.84
15 Bar Moisture, %	3.16	3.72	3.92	3.95
Water Holding Capacity, %	1.35	3.34	1.00	2.89
Organic Matter, %	1.3	0.9	1.6	1.3
Particle Size Distribution, % Stones & Gravel, > 2mm	21.4	22.9	9.4	15.2
vcs 2 – 1 mm	23.1	17.5	10.9	16.5
cs 1 – 0.5 mm	20.7	20.9	22.8	19.1
ms 0.5 – 0.25 mm	12.9	13.9	22.4	15.4
fs 0.25 – 0.1 mm	6.7	6.0	12.2	8.3
vfs 0.1 – 0.05 mm	5.5	4.3	10.8	8.1
silt 0.05 – 0.002 mm	7.0	11.6	8.9	15.1
clay < 0.002 mm	1.4	2.0	1.0	1.0
Reaction to HCl (Effervescence)	None	None	None	None

Laboratory Test Results

Site #7 TEAGLE WASH

	Disturbed		Undisturbed	
Depth	0-4″	4-24″	0-4″	4-24″
pH	7.5	8.1	7.9	7.9
ECx10⁶	0.4	1.2	0.5	2.0
SAR	3.0	4.8	4.3	8.9
Cation Exchange Capacity, meq/100 gm	6.5	3.0	7.0	8.0
Extractable Cations, Ca, meq/100 gm	29.0	36.5	37.5	47.0
Extractable Cations, Mg, meq/100 gm	1.5	2.1	1.6	2.3
Extractable Cations, Na, meq/100 gm	0.2	1.7	0.4	2.2
Extractable Cations, K, meq/100 gm	0.6	2.2	0.4	1.9
1/3 Bar Moisture, %	11.69	16.79	11.37	18.1
15 Bar Moisture, %	8.95	10.99	8.65	12.5
Water Holding Capacity, %	2.74	5.60	2.72	2.6
Organic Matter, %	4.4	7.2	4.7	6.9
Particle Size Distribution, % Stones & Gravel, > 2mm	11.8	9.7	22.2	12.5
vcs 2 – 1 mm	11.3	9.2	8.9	11.9
cs 1 – 0.5 mm	15.4	13.7	15.5	13.8
ms 0.5 – 0.25 mm	22.7	16.5	14.9	15.3
fs 0.25 – 0.1 mm	10.0	13.3	9.7	12.2
vfs 0.1 – 0.05 mm	8.9	12.4	9.7	11.0
silt 0.05 – 0.002 mm	11.4	18.0	11.4	12.4
clay < 0.002 mm	4.3	0.0	3.0	4.0
Reaction to HCl (Effervescence)	Strong	Strong	Strong	Strong

Laboratory Test Results

Site #8 OROCOPIA

	Disturbed		Undisturbed	
Depth	0-4″	6-24″	0-4″	6-24
pH	7.5	7.5	7.7	7.2
ECx10⁶	0.4	0.3	0.3	0.4
SAR	2.8	6.0	4.9	3.3
Cation Exchange Capacity, meq/100 gm	2.5	2.0	2.0	2.0
Extractable Cations, Ca, meq/100 gm	7.5	6.0	7.5	7.5
Extractable Cations, Mg, meq/100 gm	0.5	0.6	0.4	0.8
Extractable Cations, Na, meq/100 gm	0.2	0.3	0.2	0.1
Extractable Cations, K, meq/100 gm	0.3	0.3	0.3	0.3
1/3 Bar Moisture, %	4.23	3.39	5.28	4.2
15 Bar Moisture, %	2.43	2.29	3.20	2.9
Water Holding Capacity, %	1.80	1.05	2.08	1.2
Organic Matter, %	3.5	2.7	3.8	3.4
Particle Size Distribution, % Stones & Gravel, > 2mm	54.1	43.6	43.2	50.0
vcs 2 – 1 mm	13.0	20.9	12.8	13.1
cs 1 – 0.5 mm	9.3	17.8	13.4	13.1
ms 0.5 – 0.25 mm	4.9	6.6	6.2	7.1
fs 0.25 – 0.1 mm	3.9	1.8	2.9	2.3
vfs 0.1 – 0.05 mm	1.3	2.1	5.9	3.0
silt 0.05 – 0.002 mm	10.0	4.5	11.8	7.0
clay < 0.002 mm	0.0	0.0	0.0	1.0
Reaction to HCl (Effervescence)	Moderate	Moderate	Moderate	Moderate

Laboratory Test Results

Site #9 GLAMIS SAND DUNES

	Disturbed		Undisturbed	
Depth	0-4″	6-24″	0-4″	6-24″
pH	7.5	7.5	7.5	7.5
ECx10^6	0.4	0.3	0.5	0.3
SAR	6.0	6.5	5.3	12.0
Cation Exchange Capacity, meq/100 gm	0	0	0	0
Extractable Cations, Ca, meq/100 gm	0.5	0.5	0.5	0.5
Extractable Cations, Mg, meq/100 gm	0.8	0.8	0.6	0.5
Extractable Cations, Na, meq/100 gm	0.2	0.2	0.2	0.2
Extractable Cations, K, meq/100 gm	0.2	0.2	0.3	0.3
1/3 Bar Moisture, %	1.22	1.61	1.47	1.43
15 Bar Moisture, %	1.19	1.58	1.42	1.40
Water Holding Capacity, %	0.03	0.03	0.03	0.03
Organic Matter, %	1.5	1.3	1.5	1.4
Particle Size Distribution, % Stones & Gravel, > 2mm	0.0	0.0	0.0	0.0
vcs 2 – 1 mm	0.0	0.0	0.0	0.0
cs 1 – 0.5 mm	11.5	0.9	1.6	5.8
ms 0.5 – 0.25 mm	56.2	53.1	51.7	56.8
fs 0.25 – 0.1 mm	22.8	33.6	35.1	27.7
vfs 0.1 – 0.05 mm	5.2	7.4	8.1	6.0
silt 0.05 – 0.002 mm	2.8	3.7	2.0	2.3
clay < 0.002 mm	0.0	0.0	0.0	0.0
Reaction to HCl (Effervescence)	None	None	None	None

Laboratory Test Results

Site #10 YUHA DESERT

	Disturbed	Undisturbed
Depth	0-2″	0-2″
pH	7.7	7.6
ECx10^6	0.5	0.5
SAR	4.3	3.1
Cation Exchange Capacity, meq/100 gm	1.5	1.5
Extractable Cations, Ca, meq/100 gm	10.0	11.5
Extractable Cations, Mg, meq/100 gm	1.1	1.3
Extractable Cations, Na, meq/100 gm	0.3	0.3
Extractable Cations, K, meq/100 gm	0.5	0.5
1/3 Bar Moisture, %	7.78	7.05
15 Bar Moisture, %	4.96	6.38
Water Holding Capacity, %	2.82	0.67
Organic Matter, %	2.3	3.0
Particle Size Distribution, % Stones & Gravel, > 2mm	23.1	31.0
vcs 2 – 1 mm	12.5	13.9
cs 1 – 0.5 mm	16.6	15.1
ms 0.5 – 0.25 mm	14.9	12.3
fs 0.25 – 0.1 mm	10.6	8.1
vfs 0.1 – 0.05 mm	6.9	4.0
silt 0.05 – 0.002 mm	10.1	9.6
clay < 0.002 mm	3.0	3.0
Reaction to HCl (Effervescence)	Strong	Strong St

PHYSICAL TESTS SUMMARY SHEET

Site (u) Undisturbed (d) Disturbed	Dry Density (P.C.F.)	% Change	Void Ratio	% Change	Moisture Content (% DryWt)	USC Soil Symbol ASTMD2487	Equilibrium Perc Rate Min/Inch	% Change	Geologic Unit Symbol	Location
Stoddard Valley										
1B (d)	113.1	10.5%	.462	25%	0.82	SW	5.0	250%	Qal	T9N, R2W
1A (u)	102.3		.616		0.66	SW	1.43		Qal	Sec 27
Shadow Mountain										
2B (d)	119.0	22%	.389	44%	2.3	SW	5.0	276%	Qal	T7N, R6W
2A (u)	97.6		.694		0.7	SW	1.33		Qal	Sec 23 & 26
Chemehuevi Wash										
3A (d)	124.1	17.4%	.332	41%	1.1	SW	3.33	166%	Qal	T4N, R23E
3B (u)	105.7		.564		0.4	GP	1.25		Qal	Sec 18
Dumont Dunes										
4A (d)	115.5	−1.%	.432	−5%	0.4	SP	1.54	0%	Qs&Qal	T19N, R7E
4B (u)	117.1		.412		0.4	SP	1.54		Qs&Qal	Sec 27 & 33
Baker										
5A (d)	118.2	13.5%	.399	32%	0.5	SW	3.64	10%	Qal	T14N, R9E
5B (u)	104.1		.588		0.6	SW	4.0		Qal	Sec 28
Dove Springs										
6A (d)	119.1	3%	.388	10%	1.9	SP	3.33	20%	Qal	T29S, R37E
6B (u)	115.6		.430		1.6	SP	4.0		Qal	Sec 9
Teagle Wash										
7A (d)	88.9	15%	.862	24%	2.0	SM	5.71	157%	Qal (o)	T28S, R41E
7B (u)	77.3		1.139		1.8	SM	2.22		Qal (o)	Sec 10
Orocopia										
8A (d)	132.9	17%	.244	46%	0.0	GW	0.7	65%	Qal	T6S, R11E
8B (u)	113.7		.454		0.0	GW	2.0		Qal	Sec 25
Glamis										
9A (d)	128.7	−3%	.285	−15%	0.0	SP	Not Measured		Qs	1.7 mi. E of Osborne Park near Hwy. 78
9B (u)	132.5		.248		0.02	SP			Qs	T13S, R18E
Yuha Desert										
10A (d)	116.5	10%	.419	26%	0.66	GM	4.6	58%	Qalo/Qt	T16 1/2S, R10E
10B (u)	105.7		.564		0.86	GM	2.9		Qalo/Qt	Sec 2

Editors Note: This report was prepared for the Bureau of Land Managements Desert District in June, 1973. It is one of the few comprehensive studies of the impact of recreational vehicles on the alluvial portions of the C.D.C.A. The 10 sites studied are widely scattered in different terrains and micro-climates. The study was performed by a professional geologist, soil engineer and soil scientist.

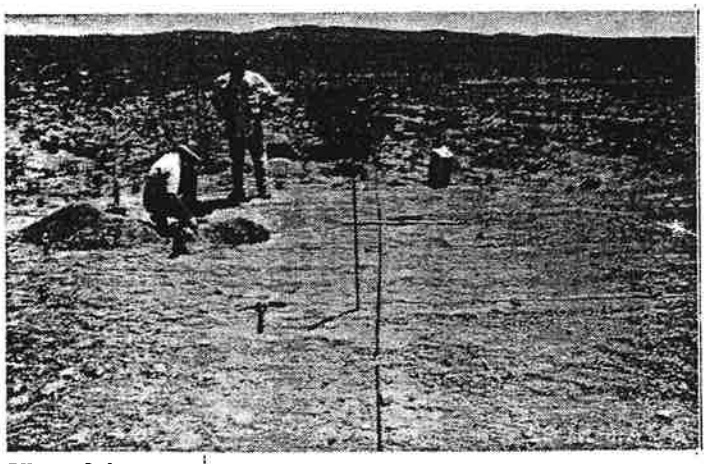
Photographic Supplement
to
A STUDY OF
CALIFORNIA DESERT SOILS
for the
Bureau of Land Management
Riverside District Office

by

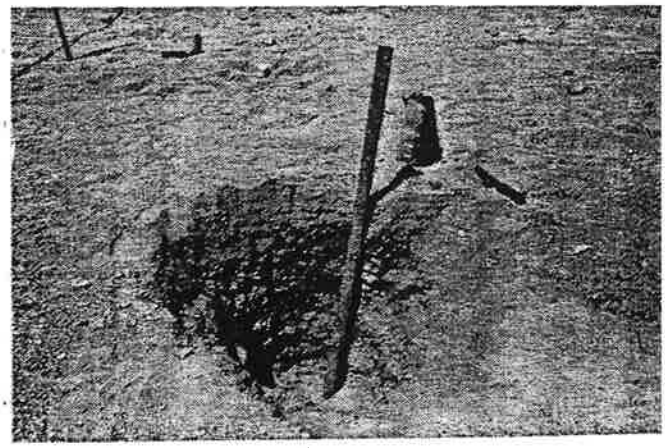
Edward S. Babcock & Sons
and
Gallaher & Bovey,
Geotechnical Consultants
Riverside, California

May - June, 1973

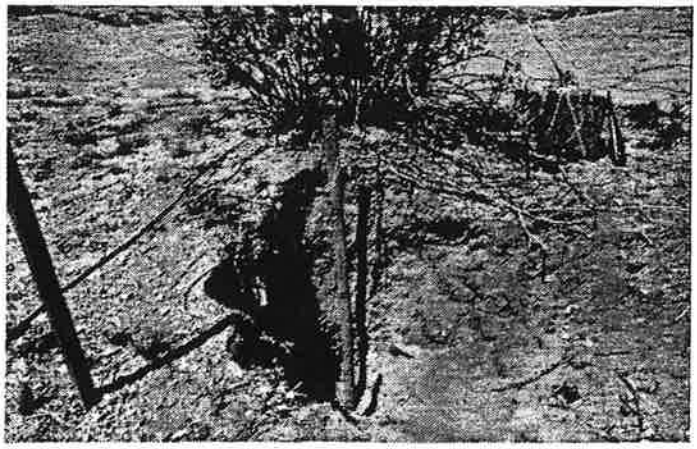
Site #1
Stoddard Valley



View of site

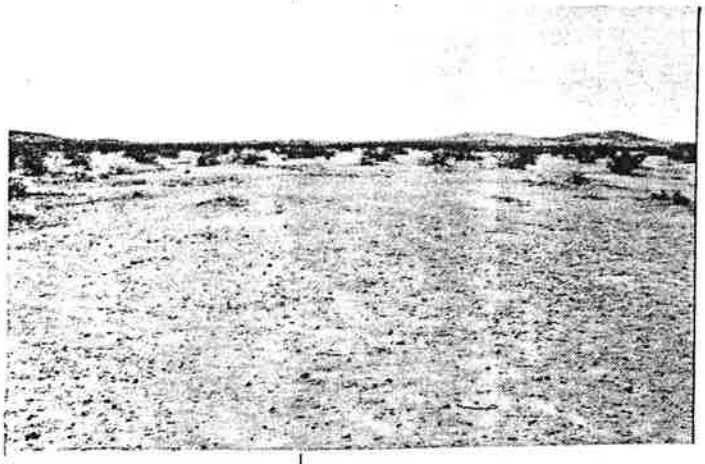


Disturbed area test hole

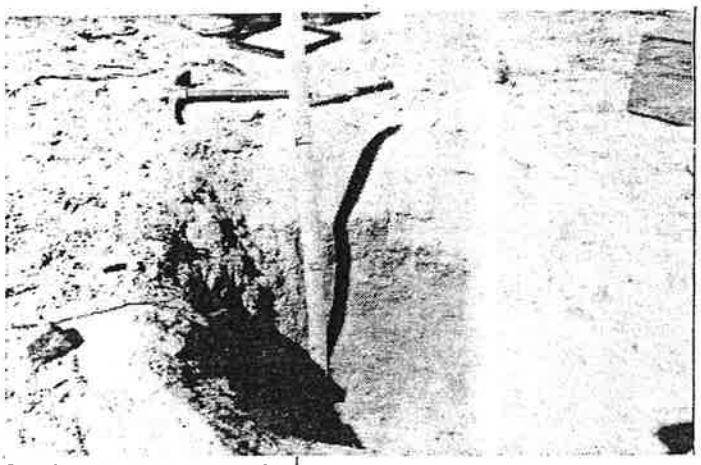


Undisturbed area test hole

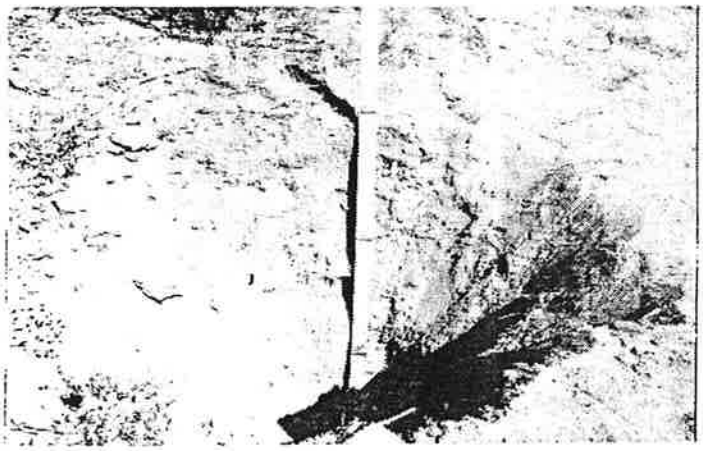
Site #2
Shadow Mountains



View of disturbed area



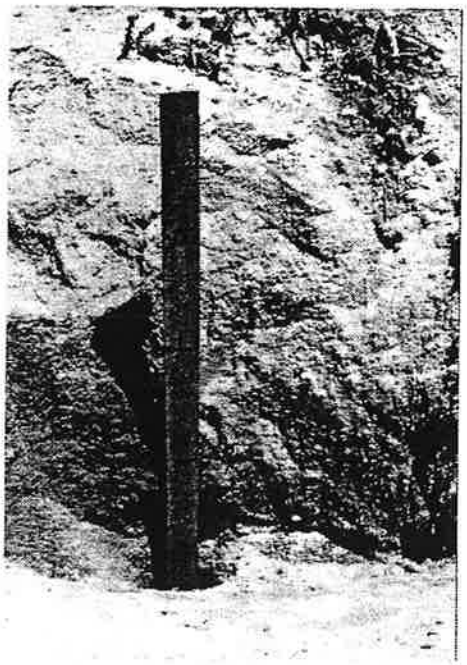
Undisturbed area test hole



Disturbed area test hole

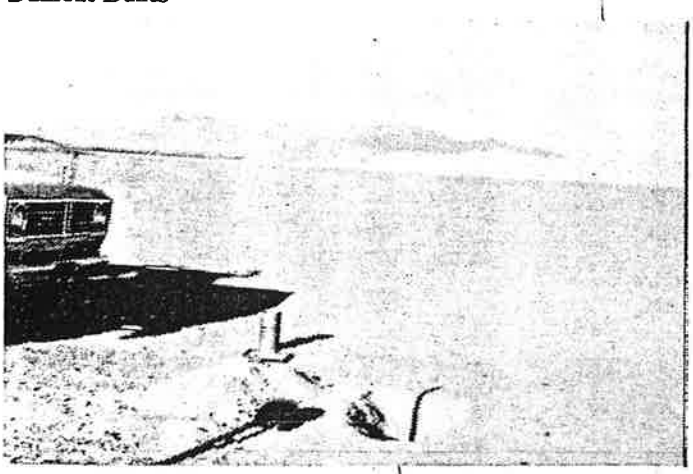
Site #3
Chemehuevi Wash

View of site



Profile typical of both disturbed and undisturbed areas (darker color in "subsoil" due to moisture)

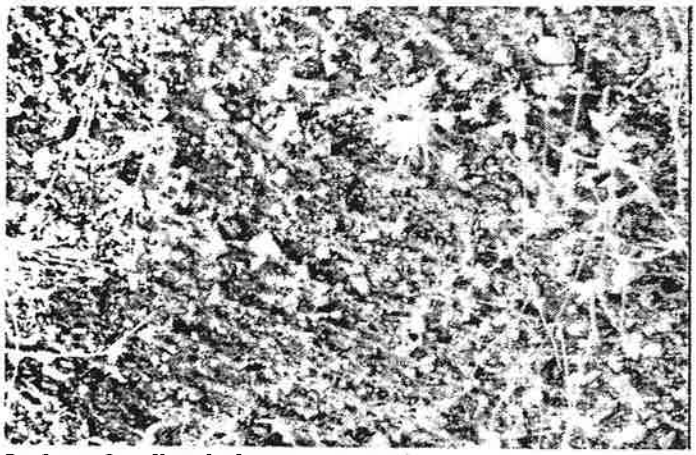
Site #4
Dumont Dunes



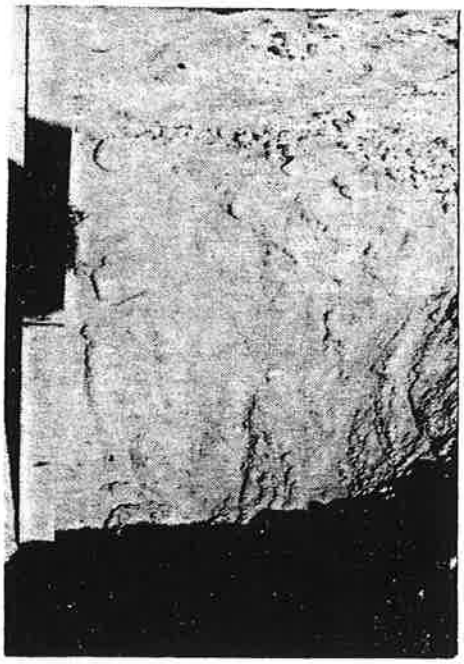
View of disturbed area

Site #5
Baker

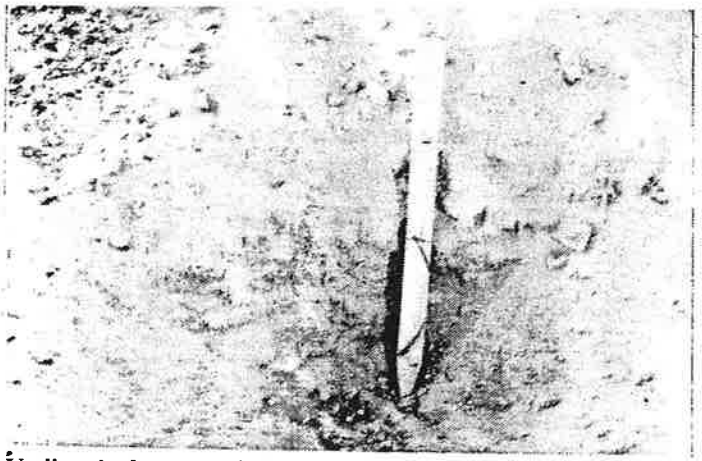
View of site



Surface of undisturbed area



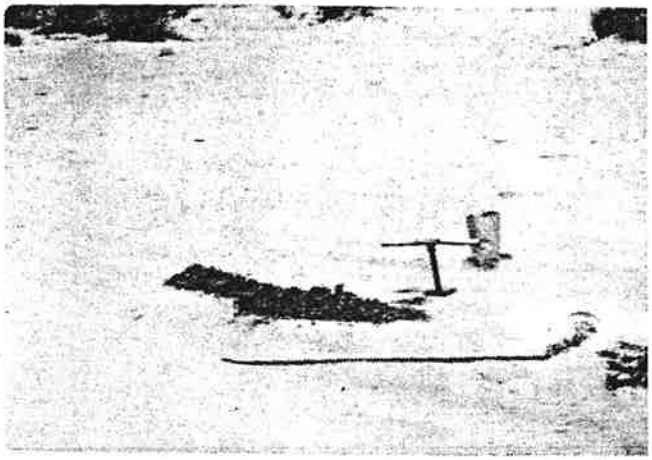
Profile typical of both disturbed and undisturbed areas



Undisturbed area test hole

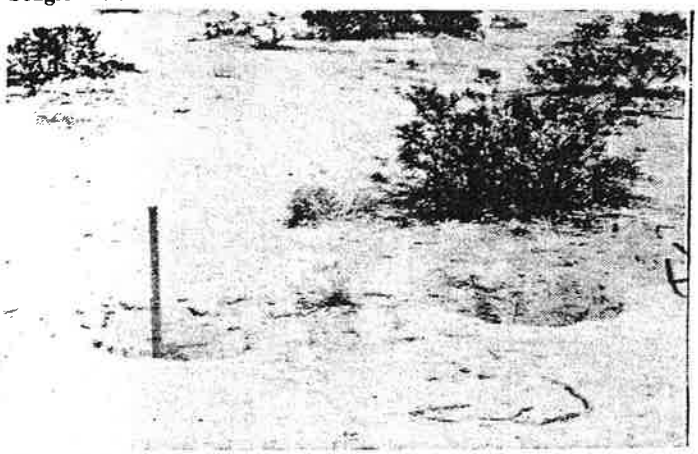
Site #6
Dove Springs

View of site



Auger coring. Dark color due to moisture

Site #7
Teagle Wash



View of site

Profile typical of both disturbed and undisturbed areas

Site #8
Orocopia Mountains

View of si..

Profile typical of both disturbed and undisturbed areas