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SOILS ENGINEERING REPORT

Prepared for

ARCATA ASSOCIATES

On

ATF-2 ANTENNA
EDWARDS AFB, KERN COUNTY
CALIFORNIA

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1.0 INTRODUCTION

This report presents the results of the soil investigation services performed relative to the ATF-2 antenna located within Edwards Air Force Base, Kern County, California.

The purpose of our services includes the review of site conditions as well as comments and recommendations relative to:

- Site grading
- Estimates of settlement
- Foundation support
- Support of slab-on-grade

No plans have been submitted to this office at the writing of this report. The development for this site includes a continuous footing for an ATF antenna. Site grading is expected to be minimal to moderate.

1.1 Site Description

The subject site is located within Edwards Air Force Base. It is anticipated that the continuous footing will be located on the hillside, south of Building 4720. At the time of our investigation, the site contained native desert flora.

2.0 FIELD EXPLORATION

2.1 Subsurface Exploration

The field exploration program consisted of one (1) exploratory boring, drilled to a maximum depth of approximately thirty (30) feet below existing ground surface. The test holes were drilled on June 3, 2008, utilizing a Mobile B-61 drill rig.

Bulk disturbed samples of the near-surface soils were obtained during boring of the test hole for classification purposes and represent a mixture of soils within the noted depths.

Relatively undisturbed samples were obtained to test for:

- Hydroconsolidation potential
- Shear strength
- *In situ* moisture and density determination
- Expansion characteristics of the natural soils

A Test Location Map (Appendix A) was prepared to illustrate the approximate location of the test hole on the site. The approximate location of the test hole was determined by Tom Barlow with NASA.

The Boring Log (Appendix B) represents the strata encountered by our field technician. Samples of the material were brought to our laboratory for identification and further testing.

2.2 Laboratory Testing

Subsequent to visual classification in the field, samples were delivered to our laboratory. Samples were reviewed along with field logs to assess which would be analyzed further. Samples considered as representative of soils which would be exposed and/or used in grading and those deemed within structural influence were chosen for further analysis.

Classifications were evaluated in accordance with the Unified Soil Classification System and a testing program was established. The following tests were performed (see Appendix C for test results):

Laboratory Test	Test Method
▪ Moisture Content and Unit Weight	ASTM D 2937
▪ Direct Shear	ASTM D 1140-92
▪ Consolidation	ASTM D 2435
▪ Expansion Index	ASTM D 4829
▪ Maximum Density-Optimum Moisture	ASTM D 1557
▪ Sand Equivalent Value	ASTM D 2419

2.3 Groundwater

Free groundwater was not encountered at the time of drilling. Fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature and other factors. Water well data indicates the static water table in this area to be over 100 feet from the site surface elevation.

3.0 CONCLUSIONS

Based on the field exploration, laboratory analysis and literature review, the proposed construction is considered feasible from a geotechnical standpoint provided that the recommendations provided herein are followed. The local building authority should be contacted prior to start of construction to assure the project is properly permitted and inspected during construction.

Field observations and testing during rough grading operations should be provided by the Soils Engineer so that a decision can be formed regarding the adequacy of the site preparation, the acceptability of fill materials, and the extent to which the earthwork construction and the degree of compaction comply with the project geotechnical specifications. Any work related to grading performed without the full knowledge of, and under the supervision of Arrow Engineering, may render the recommendations of this report invalid.

All grading and foundation plans should be reviewed by Arrow Engineering, hereinafter described as the Soils Engineer, prior to contract bidding. This review should be performed to determine whether the recommendations contained in this report are incorporated into the project plans and specifications.

The following conclusions are based on the data collected and represent professional opinions.

- Soils conditions at the site consist of multi-colored weathered bedrock (BR). Soils encountered were dense and slightly moist.

- Consolidation test results reveal that the upper layers of soil have a negligible tendency to hydroconsolidate. Refer to Section 4.1.3 for procedures to mitigate the potential for differential settlement.

- Soluble sulfate tests indicate that the upper soil layers have an 11 mg/kg of sulfate content and 0.9 mg/kg of chloride content. Refer to Section 4.4 for concrete design recommendations.

- A soil sample was tested in accordance with CTM 643. Results indicate pH levels of 7.7 S.U. and resistivity results indicate 8,800 ohms-cm of the native soil. No special considerations are necessary for protection of underground iron or steel pipe against corrosion.

- A soil sample was tested for ammonium and nitrate content. Results indicate non-detectable levels of ammonium and 1.5 mg/kg of nitrates of the native soil. No special considerations against corrosion by nitrates for copper underground utilities are necessary.

- Expansion index tests (ASTM D 4829) indicate that the upper soil layers have a "very low" expansion potential. Refer to Section 4.5 for foundation design recommendations.

- Provided the recommendations from this report are incorporated into the site grading and development, it is our opinion that the proposed grading on this property will not be subject to hazards from landslides, settlement, or slippage, and the grading will not adversely affect the stability of the site or adjacent properties. Test findings and statements of professional opinion do not constitute a guarantee or warranty, expressed or implied.

4.0 RECOMMENDATIONS

Based on the field reconnaissance, borings and other data collected, the following recommendations are provided for structure support:

4.1 Site Preparation

The grading requirements necessary to prepare the site for the proposed construction are outlined in the following paragraphs. Site grading should be in compliance with existing city, county and state building codes and as recommended in Section 4.1.3. An Arrow Engineering soils technician should observe rough site grading to ensure that field conditions are as expected and to provide additional recommendations if required.

4.1.1 Clearing and Grubbing

Prior to site grading, any existing stumps, roots, foundations, pavements, fill, trash piles and abandoned underground utilities should be removed from the proposed building and paving areas. The top surface should be stripped of any asphalt pavement and other debris and removed to an area outside of the proposed grading.

4.1.2 Preparation of Areas to Receive Fill

In order to help minimize potential settlement problems associated with structures supported on a non-uniform thickness of compacted fill, an Arrow Engineering soils technician should be consulted for site grading recommendations relative to backfilling large and/or deep depressions resulting from any removal referred to in Section 4.1.1. In general, all proposed construction should be supported by a uniform thickness of compacted soil.

4.1.3 Preparation of Building and Pavement Areas

To provide a more uniform bearing soil for the structural foundations and slab-on-grade, we recommend the following:

- **Building pads** - the proposed foundation shall be excavated entirely into competent bedrock. Verification of the proposed foundation elevations in all areas is required to satisfy this requirement.

  NOTE: The bottoms of all over-excavated areas shall be a level plane. Approval by Arrow Engineering of all removals is required prior to placement of fill.

- Soil beneath any proposed flexible and rigid paving areas should be scarified twelve (12) inches.

- The scarified soil should be moisture conditioned or aerated to optimum moisture content, placed in eight (8) inch maximum uncompacted lifts and uniformly compacted with **vibratory** compaction equipment to 90% of the maximum dry density as determined by ASTM D 1557-91 test procedure. **Compaction should be verified by Arrow Engineering through testing**.

- Soil shall not contain organic material, rocks, concrete, or asphalt larger than six (6) inches. Anything larger than six (6) inches shall be removed from the site.

- Site grade should be visually checked by Arrow Engineering or their representative prior to placement of fill.

Any import soils used to raise site grades should be equal to, or better than on-site soils in strength, expansion, and compressibility characteristics. Import soils will not be pre-qualified by the Soils Engineer. Acceptance of any import will be given after the material is on the project, either in place or in stockpiles of adequate quantity to complete the project. The Soils Engineer shall be notified of the source of import soils prior to delivery to the project, for preliminary testing.

Suitable fill soils should be moisture conditioned to optimum moisture content and mechanically compacted to 90% of the maximum dry density as determined by the ASTM D 1557 test procedure.

A shrinkage factor of approximately three to eight (3-8) percent will occur when using the onsite material as compacted fill. Operation of grading equipment will also cause subsidence of the surface material,

which is estimated to be approximately 0.10 foot in graded areas. These losses do not consider stripping of vegetation from the site or differences between actual and mapped elevations.

Final site grade should be adequate to divert all water away from structures and not allow ponding on paving sections or near structures.

All roof-draining systems for the proposed buildings should be designed to divert run-off water away from structures.

Positive drainage devices should be constructed to divert tributary drainage from buildings.

An Arrow Engineering soils technician should be retained to provide geotechnical services during construction of the grading, excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that conditions change from those anticipated prior to the start of construction.

4.2 Utility Trenches

Backfill of public utilities within road right-of-ways or on the subject site should be placed in strict conformance with the requirements of the governing agency.

The provisions of this report relative to minimum compaction standards should govern utility trench backfill within the project boundary. In general, service lines extending inside the site should be backfilled with native soil and uniformly compacted to a minimum of 90% of maximum density as determined by the ASTM D 1557 test procedure. Jetting will not be allowed. **Compaction shall be verified by testing.**

Backfill operations should be observed and tested by an Arrow Engineering soils technician to monitor compliance with these recommendations.

4.3 Slope Stability and Grading

Slope stability calculations were not performed due to the anticipated height of less than three (3) feet for cut and fill slopes.

Slopes should not exceed a steepness of two horizontal to one vertical (2:1) unless soil test data and engineering calculations substantiate the stability of the slope and slope surface. Fill slopes should be overfilled and trimmed back to firm material.

4.4 Slab-on-Grade

Interior concrete slab-on-grade should be supported by compacted soil prepared as recommended in Section 4.1.3.

Exterior concrete (sidewalk, porches, etc.) immediately adjacent to structures should be poured independent of buildings (free-floating) and be supported by at least twelve (12) inches of compacted soil.

Reinforcement of slab-on-grade is contingent upon the structural engineer's recommendations and the expansion index of the supporting soil. Since the mixing of import soil with native soils could change the expansion index, additional tests should be conducted during rough grading to determine the expansion index of the subgrade soil. **Reinforcement should be placed at the slab mid-height.**

In areas which will be covered with flooring (carpet, tile, etc.), an appropriate vapor barrier (6 mil polyethylene or equal) should be installed in order to minimize vapor transmission from the sub-grade soil to the slab. The membrane should be covered with two (2) inches of sand to help protect it during construction. The sand should be lightly moistened just prior to placing the concrete.

4.5 Settlement Considerations

Maximum anticipated post construction settlement, based on footings founded on compacted soils as specified, should be less than one half inch. Differential settlement between exterior and interior load bearing members should be less than one-quarter inch. Most settlement should occur during construction.

4.6 Foundations

It is recommended that any buildings or structures constructed on this site be designed to at least the minimum code standards of the latest edition of the 2007 California Building Code. The following table and values are a summary of the seismic design parameters required for structural design per the 2007 CBC Section 1613.5.4 “Design Spectral Response Acceleration Parameters”.

Seismic Design Parameters	
Longitude	-117.912
Latitude	34.958
Site Class	D
Description	stiff soil profile
Site Coefficients	
F_a	1.149
F_v	1.592
Spectral Accelerations	
S_{DS}	0.671
S_{D1}	0.433

Continuous foundations should be supported by compacted soil prepared as delineated in Section 4.1.3.

Continuous foundations may be proportioned for the following values:

Design Values:
2,000 psf net capacity for dead and sustained live loads. This load may be increased 1/3 for total loads including wind or seismic forces.

The allowable bearing capacity should not exceed 2,500 psf for continuous foundations to keep estimated settlements within allowable limits.

Foundations should be embedded as required by the structural engineer. Actual depth and reinforcement requirements will be dependent on the expansion index of bearing soil (Section 4.7), applicable sections of the governing building code, and requirements of the structural engineer.

To mitigate potential major cracking in foundations caused by differential settlement, footings should be reinforced at top and bottom and as required by the structural engineer.

Isolated pad (column) foundations may be proportioned for the following values:

Design Values:
2,000 psf net capacity for dead and sustained live loads. This load may be increased 1/3 for total loads including wind or seismic forces.

The allowable bearing capacity should not exceed 2,500 psf for isolated foundations to keep estimated settlements within allowable limits.

Foundations should be embedded as recommended by the structural engineer. Actual depth will be dependent on applicable sections of the governing building code and requirements of the structural engineer.

Reinforcement shall be as required by the structural engineer.

4.7 Expansion

The design of foundations should be based on the weighted expansion index (ASTM D 4829) of the soil. As stated previously, the preliminary expansion index of the on-site soil is in the "very low" classification. However, if the soil is thoroughly mixed during site preparation, the expansion index may change. Therefore, the expansion index should be evaluated after the site preparation has been completed, and the final foundation design adjusted accordingly.

Reinforcement should be as required by the structural engineer. Reinforcement shall be verified when building plans are available.

The following recommendations for foundations are provided as guidelines for foundation design:

Classification of "very low" (0-20)

No special considerations necessary for expansion

Classification of "low" (21-50)

Continuous foundations shall be excavated entirely into competent bedrock. **Reinforcement should be as required by the structural engineer based upon site specific conditions such as foundation loading and engineering characteristics of the subgrade soils.** As a minimum, we recommend two #4 on top and two #4 at bottom of continuous foundations. This minimum shall be verified for industrial buildings, when building plans are available.

Slab-on-grade reinforcement shall be as required by the structural engineer. All slabs shall be designed for any specific loading conditions by the structural engineer. Soil should be moistened to above optimum moisture to a depth of six (6) inches prior to placing concrete.

5.0 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and inspections will be made during construction to verify compliance with these recommendations. Such tests and inspections should include, but not necessarily be limited to the following:

- Observation and testing during site preparation, grading and placement of fill
- Inspection of footing excavations
- Consultation as may be required during construction
- Special inspection of concrete, masonry, or welding

The cost of these services is not included in our present fee arrangements. Budgets, which are dependent on design and construction schedules, can be provided when requested.

6.0 LIMITATIONS

The recommendations contained in this report are based on our field exploration, laboratory testing, and our understanding of the proposed construction. Conditions revealed by excavation may be at variance with the preliminary findings of this surficial investigation. Therefore, if any soil conditions are encountered at this site which are different from those assumed in the preparation of this report, our firm should be notified immediately so that we may review the situation and make supplementary recommendations, if needed. Our firm should also be notified if the scope of the proposed construction, including the proposed loading or structure locations, changes from that described in this report.

This report was prepared in accordance with generally accepted standards of practice in the southern California area at the time the report was written. No other warranty, express or implied, is made or intended.

It is the responsibility of the owner or of his representative, to ensure that the information and recommendations contained herein are brought to the attention of all parties to the project.

The findings of this report are valid as of the present date. However, changes in the conditions of the property can occur with the passage of time, whether they are due to natural processes or the works of man on this or adjacent properties.

This report has been prepared for the exclusive use of Arcata Associates and their agents for specific application to the proposed development.

APPENDIX A

BORING LOCATION MAP

APPENDIX B

SOILS CLASSIFICATION KEY
BORING LOGS

APPENDIX C

SUMMARY OF LABORATORY TESTS

SUMMARY OF LABORATORY TESTS

MAXIMUM-DENSITY-OPTIMUM MOISTURE (ASTM D 1557)

Boring #	Depth	Optimum Moisture	Maximum Density	Classification	Description
1	0-5'	8.0	133.0	SM	Moderate yellowish brown silty fine to coarse sand with #4 gravel

EXPANSION INDEX (ASTM D 4829)

Sample I.D.	Expansion	Expansion Potential
B1 @ 0-5’	0	Very low

SAND EQUIVALENT (ASTM D 2419)

Sample I.D.	Sand Equivalent
B1 @ 0-5’	46