Preliminary Geotechnical and GeoHazards Report

Iris Solar Farm
NEC Ferrell Road and Hwy 98
Calexico, California

Prepared for:

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May 2013

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May 28, 2013

Mr. Tom Buttgenbach
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5455 Wilshire Boulevard, Suite 200
Los Angeles, CA 90036

Preliminary Geological and Geotechnical Hazard Evaluation
Iris Solar Farm
NEC Ferrell and State Hwy 98
Calexico, California
LCI Project No. LE13090

Dear Mr. Buttgenbach:

This preliminary geotechnical report and geologic hazards study is provided for preliminary site evaluation and permitting of the photo-voltaic solar farm at the approximately 521-acre project area located at the northeast corner of Ferrell Road and State Hwy 98 approximately 4 miles west of Calexico, California.

Scope of Work

The scope of work consisted of a geologic and geotechnical hazards evaluation of the project site which addresses the following items:

1. Site location in relation to mapped earthquake faults and seismic zones.
2. Review of published geologic literature and maps.
3. Intensity of ground shaking at the site determined by probabilistic methods (10% probability of occurrence in 50 years).
4. Potential for liquefaction, ground failure, and landslides at the site.
5. Potential for expansive soil hazards at the site including methods for mitigation.
6. Potential for flooding at the site from man-made facilities (dams, canals, etc.) and from natural storms.
7. Ability of site soils to support individual or community sewage disposal system leach fields.

Site Description

The project site is located at the northeast corner of Ferrell Road and State Hwy 98. The project site consists of 521-acres comprised of seven agricultural fields currently in crop production. Dirt field roads bisect the site in north-south and east directions. The incised New River flood channel (about 35 feet deep) forms the northern boundary of the site. State Hwy 98, a paved two-lane highway, forms the southern boundary of the site. Weed Road, an unpaved rural road, abuts the eastern margin of the site and Ferrell Road, a paved rural road, forms the western property boundary. A rural residence and farm shop are located near the northeast corner of the site.

Agricultural fields are located around the perimeter of the project site. Dirt field roads are located along the margins and also cross the parcels. The adjacent properties are approximately the same elevation as the project sites, except along the northern property boundary, which abuts the incised New River flood channel.

Site Geological Conditions

Site Geology: The project site is located in the Imperial Valley portion of the Salton Trough physiographic province. The Salton Trough is a topographic and geologic structural depression resulting from large scale regional faulting. The trough is bounded on the northeast by the San Andreas Fault and Chocolate Mountains and the southwest by the Peninsular Range and faults of the San Jacinto Fault Zone. The Salton Trough represents the northward extension of the Gulf of California, containing both marine and non-marine sediments since the Miocene Epoch. Tectonic activity that formed the trough continues at a high rate as evidenced by deformed young sedimentary deposits and high levels of seismicity. Figure 1 shows the location of the site in relation to regional faults and physiographic features.

The Imperial Valley is directly underlain by lacustrine deposits, which consist of interbedded lenticular and tabular silt, sand, and clay. The Late Pleistocene to Holocene lake deposits are probably less than 100 feet thick and derived from periodic flooding of the Colorado River which intermittently formed a fresh water lake (Lake Cahuilla).

Older deposits consist of Miocene to Pleistocene non-marine and marine sediments deposited during intrusions of the Gulf of California. Basement rock consisting of Mesozoic granite and Paleozoic metamorphic rocks are estimated to exist at depths between 15,000 - 20,000 feet.

Source: California Geological Survey 2010 Fault Activity Map of California
http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html#

LANDMARK Geo-Engineers and Geologists Project No.: LE13090	Regional Fault Map	Figure 1

Based on Unified Soil Classification System, the permeability of these soils is expected to be low to very low.

Groundwater: The groundwater in the site area is brackish and typically encountered at a depth of between 5 to 10 feet below ground surface in the vicinity of the project site. There is uncertainty in the accuracy of short-term water level measurements, particularly in fine-grained soil. Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties, drainage, and site grading. The groundwater level noted should not be interpreted to represent an accurate or permanent condition.

Onsite Wastewater Disposal: The near surface soils at the project site generally consist of silty clays and clays having a very low to low infiltration rate. The near surface soils are considered poor in supporting onsite septic systems and leach fields for wastewater disposal. Site specific studies will be required to determine that State Health standards are met in regard to soil percolation rates and separation of leach fields from groundwater.

Geological Hazards

Landsliding: No ancient landslides are shown on geologic maps of the region and no indications of landslides were observed during our site investigation. The hazard of landsliding is unlikely due to the relatively planar topography of the project site.

Volcanic hazards: The site is not located proximal to any known volcanically active area and the risk of volcanic hazards is considered very low.

Tsunamis, seiches, and flooding: The site does not lie near any large bodies of water, so the threat of tsunami, seiches, or other seismically-induced flooding is considered unlikely.

Expansive soil: In general, much of the near surface soils within the project site consist of silty clays and clays having a high to very high expansion potential. The clay is expansive when wetted and can shrink with moisture loss (drying). Development of building foundations, concrete flatwork, and asphaltic concrete pavements should include provisions for mitigating potential swelling forces and reduction in soil strength, which can occur from saturation of the soil.

Liquefaction/Seismic Settlements: Liquefaction is a potential design consideration because of possible saturated sandy substrata underlying the site. Liquefaction occurs when granular soil below the water table is subjected to vibratory motions, such as produced by earthquakes. With strong ground shaking, an increase in pore water pressure develops as the soil tends to reduce in volume. If the increase in pore water pressure is sufficient to reduce the vertical effective stress (suspending the soil particles in water), the soil strength decreases and the soil behaves as a liquid (similar to quicksand). Liquefaction can produce excessive settlement, ground rupture, lateral spreading, or failure of shallow bearing foundations.

Four conditions are generally required for liquefaction to occur:

(1) the soil must be saturated (relatively shallow groundwater);
(2) the soil must be loosely packed (low to medium relative density);
(3) the soil must be relatively cohesionless (not clayey); and
(4) groundshaking of sufficient intensity must occur to function as a trigger mechanism.

All of these conditions may exist to some degree at this site. Liquefaction settlement and ground fissures have been noted in the incised flood channel areas after strong seismic events.

Seismic Hazards

The project site is located in the seismically active Imperial Valley of southern California and is considered likely to be subjected to moderate to strong ground motion from earthquakes in the region.

Groundshaking. Imperial Valley has numerous mapped faults of the San Andreas Fault System traversing the region. The San Andreas Fault System is comprised of the San Andreas, San Jacinto, and Elsinore Fault Zones in southern California.

The Imperial fault represents a transition from the more continuous San Andreas fault to a more nearly echelon pattern characteristic of the faults under the Gulf of California (USGS 1990). We have performed a computer-aided search of known faults or seismic zones that lie within a 62 mile (100 kilometer) radius of the project site (Table 1).

Table 1
Summary of Characteristics of Closest Known Active Faults

Fault Name	Approximate Distance (miles)	Approximate Distance (km)	Maximum Moment Magnitude (Mw)	Fault Length (km)	Slip Rate (mm/yr)
Unnamed 2*	5.9	9.5			
Superstition Hills	9.5	15.3	6.6	23 ± 2	4 ± 2
Imperial	9.8	15.7	7	62 ± 6	20 ± 5
Unnamed 1*	10.1	16.1			
Borrego (Mexico)*	10.2	16.3			
Yuha*	11.1	17.8			
Brawley *	11.5	18.4			
Laguna Salada	11.7	18.8	7	67 ± 7	3.5 ± 1.5
Rico *	12.9	20.6			
Cerro Prieto *	14.5	23.1			
Superstition Mountain	15.1	24.2	6.6	24 ± 2	5 ± 3
Pescadores (Mexico)*	15.3	24.4			
Shell Beds	15.4	24.7			
Yuha Well *	16.1	25.7			
Cucapah (Mexico)*	16.8	26.9			
Vista de Anza*	18.2	29.1			
Painted Gorge Wash*	22.6	36.2			
Ocotillo*	23.5	37.6			
Elsinore - Coyote Mountain	27.3	43.7	6.8	39 ± 4	4 ± 2
Elmore Ranch	28.5	45.6	6.6	29 ± 3	1 ± 0.5
San Jacinto - Borrego	33.1	53.0	6.6	29 ± 3	4 ± 2
Algodones *	38.3	61.3			

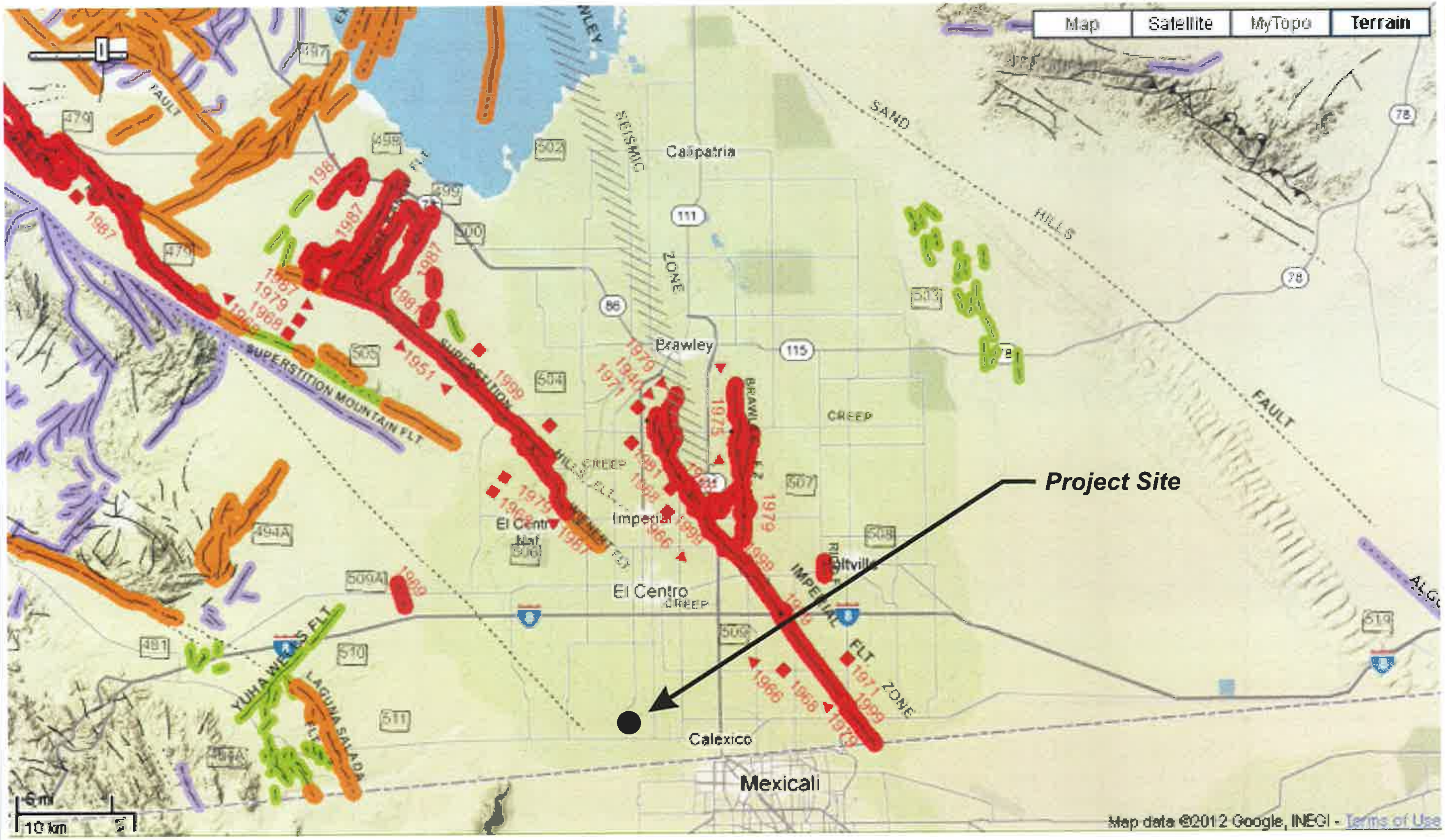
* Note: Faults not included in CGS database.

A fault map illustrating known active faults relative to the site is presented on Figure 1, *Regional Fault Map*. Figure 2 shows the project site in relation to local faults. The criterion for fault classification adopted by the California Geological Survey defines Earthquake Fault Zones along active or potentially active faults. An active fault is one that has ruptured during Holocene time (roughly within the last 11,000 years). A fault that has ruptured during the last 1.8 million years (Quaternary time), but has not been proven by direct evidence to have not moved within Holocene time is considered to be potentially active. A fault that has not moved during Quaternary time is considered to be inactive. Review of the current Alquist-Priolo Earthquake Fault Zone maps (CGS, 2000a) indicates that the nearest mapped Earthquake Fault Zone is an unnamed fault located approximately 5.9 miles west of the project site. The unnamed fault was recently identified and zoned after the April 4, 2010 magnitude 7.2M_w El Mayor-Cucapah earthquake.

CBC Seismic Coefficients: The 2010 CBC general ground motion parameters are based on the Maximum Considered Earthquake for a ground motion with a 2% probability of occurrence in 50 years. The U.S. Geological Survey "Earthquake Ground Motion Tool", version 5.0.9a (USGS, 2009) was used to obtain the site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters shown in Table 2. The site soils have been classified as Site Class D (stiff soil profile). Design earthquake ground motions are defined as the earthquake ground motions that are two-thirds (2/3) of the corresponding MCE ground motions. Design earthquake ground motion data are provided in Table 2.

A peak ground acceleration (PGA) value of 0.40g was determined for liquefaction and seismic settlement analysis in accordance with 2010 CBC Section 1803.5.12 and CGS Note 48 (PGA = S_{DS}/2.5). The parameter S_{DS} is derived from the maximum considered earthquake spectral response acceleration for short periods (CBC Section 1613.5.4) and provided in Table 2 of this report.

Surface Rupture: The project site does not lie within a State of California, Alquist-Priolo Earthquake Fault Zone. Surface fault rupture at the project site is considered to be low. Ground failures (lateral spreading) were noted along the embankments of the New River after the April 4, 2010 magnitude 7.2M_w El Mayor-Cucapah earthquake.



Source: California Geological Survey 2010 Fault Activity Map of California
http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html#

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Map of Local Faults

Figure 2

EXPLANATION

Fault traces on land are indicated by solid lines where well located, by dashed lines where approximately located or inferred, and by dotted lines where concealed by younger rocks or by lakes or bays. Fault traces are queried where continuation or existence is uncertain. Concealed faults in the Great Valley are based on maps of selected subsurface horizons, so locations shown are approximate and may indicate structural trend only. All offshore faults based on seismic reflection profile records are shown as solid lines where well defined, dashed where inferred, queried where uncertain.

FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurred and is associated with one or more of the following:

(a) a recorded earthquake with surface rupture. (Also included are some well-defined surface breaks caused by ground shaking during earthquakes, e.g. extensive ground breakage, not on the White Wolf fault, caused by the Arvin-Tehachapi earthquake of 1952). The date of the associated earthquake is indicated. Where repeated surface ruptures on the same fault have occurred, only the date of the latest movement may be indicated, especially if earlier reports are not well documented as to location of ground breaks.

(b) fault creep slippage - slow ground displacement usually without accompanying earthquakes.

(c) displaced survey lines.

1906 ▶ ◀ 1906

1838 ▷ ◁ 1838

A triangle to the right or left of the date indicates termination point of observed surface displacement. Solid red triangle indicates known location of rupture termination point. Open black triangle indicates uncertain or estimated location of rupture termination point.

▶ 1951 ◀

Date bracketed by triangles indicates local fault break.

1992

No triangle by date indicates an intermediate point along fault break.

CREEP

Fault that exhibits fault creep slippage. Hachures indicate linear extent of fault creep. Annotation (creep with leader) indicates representative locations where fault creep has been observed and recorded.

1969

1968 ■ ■ 1968

Square on fault indicates where fault creep slippage has occured that has been triggered by an earthquake on some other fault. Date of causative earthquake indicated. Squares to right and left of date indicate terminal points between which triggered creep slippage has occurred (creep either continuous or intermittent between these end points).

Holocene fault displacement (during past 11,700 years) without historic record. Geomorphic evidence for Holocene faulting includes sag ponds, scarps showing little erosion, or the following features in Holocene age deposits: offset stream courses, linear scarps, shutter ridges, and triangular faceted spurs. Recency of faulting offshore is based on the interpreted age of the youngest strata displaced by faulting.

Late Quaternary fault displacement (during past 700,000 years). Geomorphic evidence similar to that described for Holocene faults except features are less distinct. Faulting may be younger, but lack of younger overlying deposits precludes more accurate age classification.

Quaternary fault (age undifferentiated). Most faults of this category show evidence of displacement sometime during the past 1.6 million years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age. Unnumbered Quaternary faults were based on Fault Map of California, 1975. See Bulletin 201, Appendix D for source data.

Pre-Quaternary fault (older that 1.6 million years) or fault without recognized Quaternary displacement. Some faults are shown in this category because the source of mapping used was of reconnaissnce nature, or was not done with the object of dating fault displacements. Faults in this category are not necessarily inactive.

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Fault Map Legend

Figure 3a

ADDITIONAL FAULT SYMBOLS

Bar and ball on downthrown side (relative or apparent).

Arrows along fault indicate relative or apparent direction of lateral movement.

Arrow on fault indicates direction of dip.

Low angle fault (barbs on upper plate). Fault surface generally dips less than 45° but locally may have been subsequently steepened. On offshore faults, barbs simply indicate a reverse fault regardless of steepness of dip.

OTHER SYMBOLS

Numbers refer to annotations listed in the appendices of the accompanying report. Annotations include fault name, age of fault displacement, and pertinent references including Earthquake Fault Zone maps where a fault has been zoned by the Alquist-Priolo Earthquake Fault Zoning Act. This Act requires the State Geologist to delineate zones to encompass faults with Holocene displacement.

Structural discontinuity (offshore) separating differing Neogene structural domains. May indicate discontinuities between basement rocks.

Brawley Seismic Zone, a linear zone of seismicity locally up to 10 km wide associated with the releasing step between the Imperial and San Andreas faults.

Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION: ON LAND	DESCRIPTION: OFFSHORE
Quaternary	Late Quaternary	Historic	200			Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
Quaternary	Late Quaternary	Holocene	11,700		? ? ?	Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
Quaternary	Late Quaternary	Pleistocene	700,000		? ?	Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
Quaternary	Early Quaternary	Pleistocene	1,600,000*		?	Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
Pre-Quaternary			4.5 billion (Age of Earth)			Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.

* Quaternary now recognized as extending to 2.6 Ma (Walker and Geissman, 2009). Quaternary faults in this map were established using the previous 1.6 Ma criterion.

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Fault Map Legend

Figure 3b

Table 2
2010 California Building Code (CBC) and ASCE 7-5 Seismic Parameters

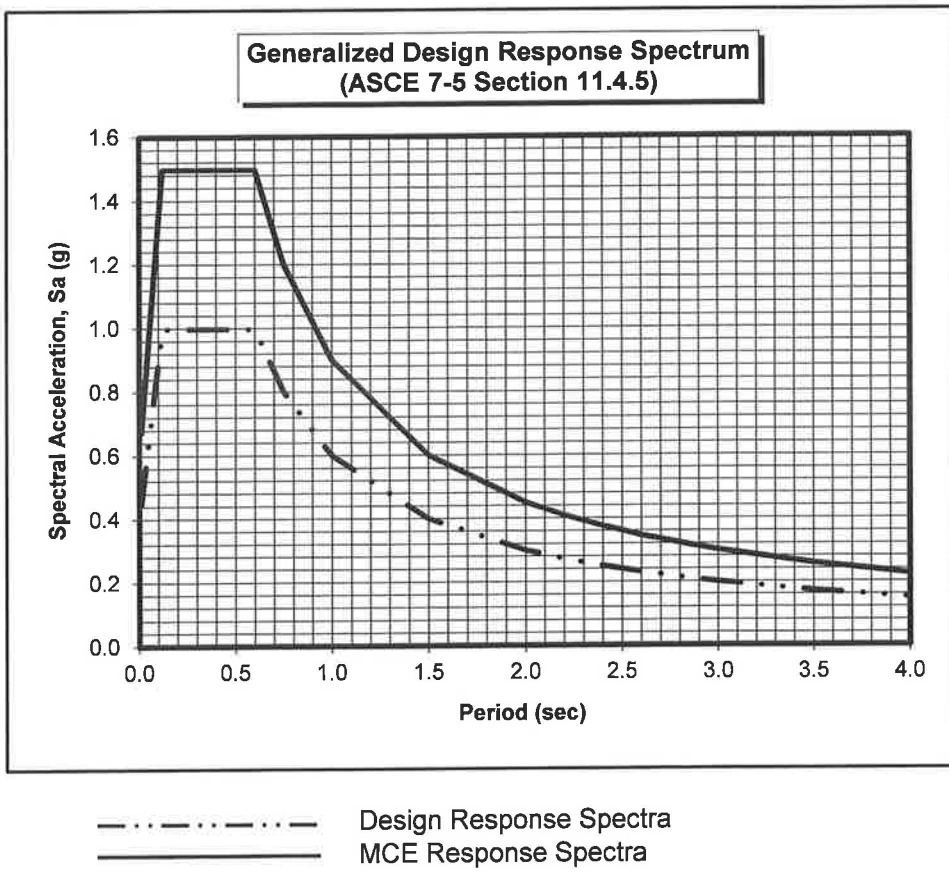
		CBC Reference
Site Class:	D	Table 1613.5.2
Latitude:	32.6867 N	
Longitude:	-115.5768 W	

Maximum Considered Earthquake (MCE) Ground Motion

Short Period Spectral Response	S_s	1.50 g	Figure 1613.5(3)	
1 second Spectral Response	S_1	0.60 g	Figure 1613.5(4)	
Site Coefficient	F_a	1.00	Table 1613.5.3 (1)	
Site Coefficient	F_v	1.50	Table 1613.5.3 (2)	
Adjusted Short Period Spectral Response	S_{MS}	1.50 g	$= F_a * S_s$	Equation 16-36
Adjusted 1 second Spectral Response	S_{M1}	0.90 g	$= F_v * S_1$	Equation 16-37

Design Earthquake Ground Motion

Short Period Spectral Response	S_{DS}	1.00 g	$= 2/3*S_{MS}$	Equation 16-38
1 second Spectral Response	S_{D1}	0.60 g	$= 2/3*S_{M1}$	Equation 16-39
	To	0.12 sec	$=0.2*S_{D1}/S_{DS}$	
	Ts	0.60 sec	$=S_{D1}/S_{DS}$	



2010 CBC

Period T (sec)	Sa (g)	MCE Sa (g)	80% Sa (g)
0.01	0.45	0.67	0.36
0.03	0.55	0.82	0.44
0.10	0.90	1.35	0.72
0.12	1.00	1.50	0.80
0.15	1.00	1.50	0.80
0.20	1.00	1.50	0.80
0.30	1.00	1.50	0.80
0.40	1.00	1.50	0.80
0.50	1.00	1.50	0.80
0.60	1.00	1.50	0.80
0.75	0.80	1.20	0.64
1.00	0.60	0.90	0.48
1.50	0.40	0.60	0.32
2.00	0.30	0.45	0.24
2.20	0.27	0.41	0.22
2.40	0.25	0.38	0.20
2.60	0.23	0.35	0.18
2.80	0.21	0.32	0.17
3.00	0.20	0.30	0.16
3.50	0.17	0.26	0.14
4.00	0.15	0.23	0.12

Other Hazards

Hazardous Materials: The site is not located in proximity to any known hazardous materials (methane gas, tar seeps, hydrogen sulfide gas), and the risk of hazardous materials is considered very low.

Radon 222 Gas: Radon gas is not believed to be a potential hazard at the site. A report titled "California Statewide Radon Survey-Screening Results", dated November 1990 and published by the California State Department of Health Services, notes that Southern California showed a low risk of elevated radon levels, based on 2-day tests conducted from January through April 1990. Some of the reported testing was performed in Imperial County; however, no data was observed as being at or near the project site.

Naturally occurring asbestos: The site is not located in proximity to any known naturally occurring asbestos, and the risk of naturally occurring asbestos is considered very low.

Hydrocollapse: The site is dominantly underlain by clays that are not expected to collapse with the addition of water to the site. The risk of hydrocollapse is considered very low.

Regional Subsidence: Regional subsidence has not been documented in the area west of the New River; therefore, the risk of regional subsidence is considered low.

Conclusion

This preliminary report was prepared according to the generally accepted *geotechnical engineering standards of practice* that existed in Imperial County at the time the report was prepared. No express or implied warranties are made in connection with our services.

Our research did not reveal conditions that would preclude implementation of the proposed project provided site specific geotechnical investigations are conducted prior to site development to provide geotechnical criteria for the design and construction of this project.

We appreciate the opportunity to provide our findings and professional opinions regarding geologic and geotechnical hazards at the site. If you have any questions or comments regarding our findings, please call our office at (760) 370-3000.

Sincerely Yours;
Landmark Consultants, Inc.

Steven K. Williams, PG, CEG
Senior Engineering Geologist

Jeffrey O. Lyon, PE
President

APPENDIX A

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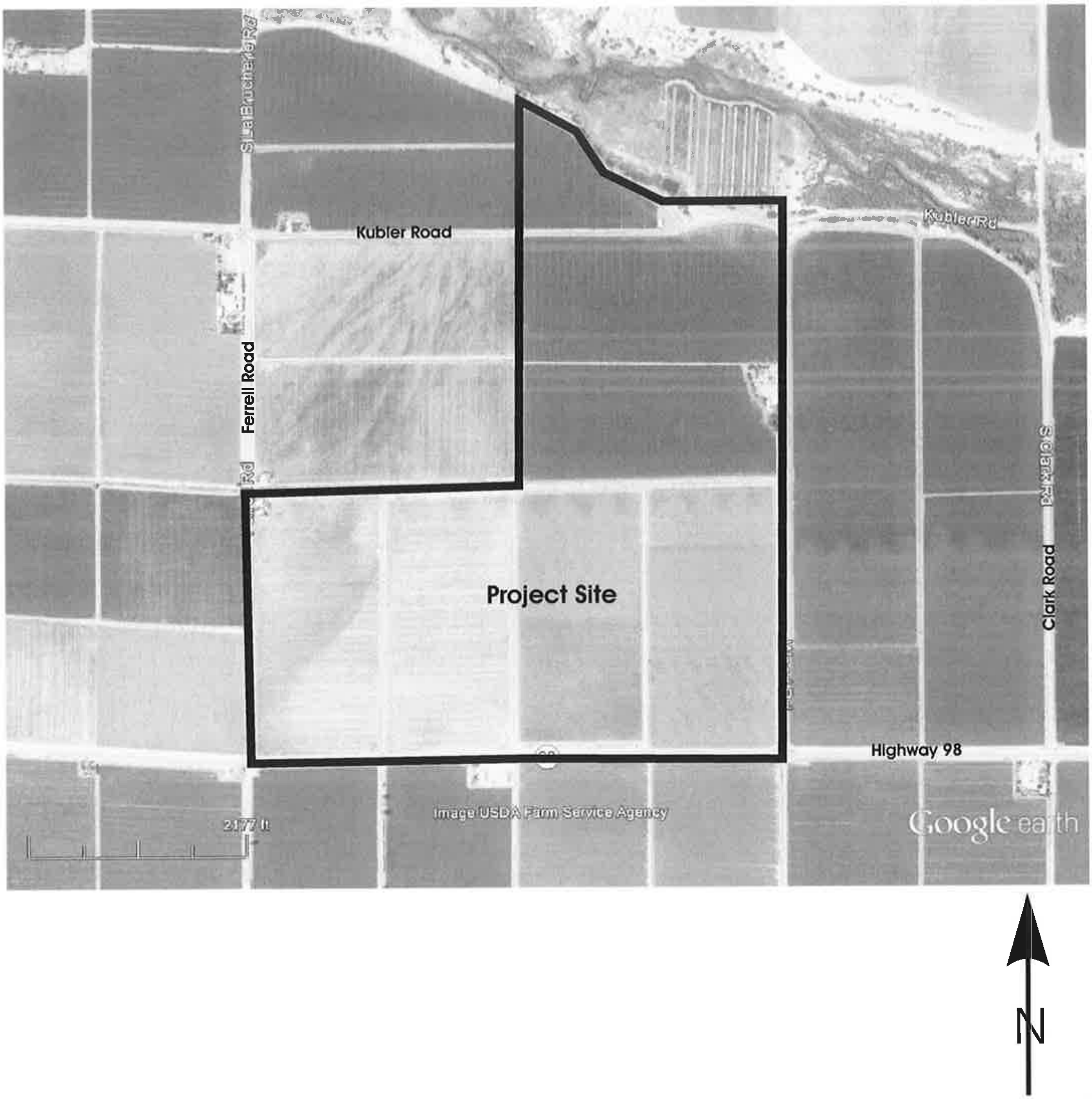
Vicinity Map

Plate A-1



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Site Map

Plate A-2

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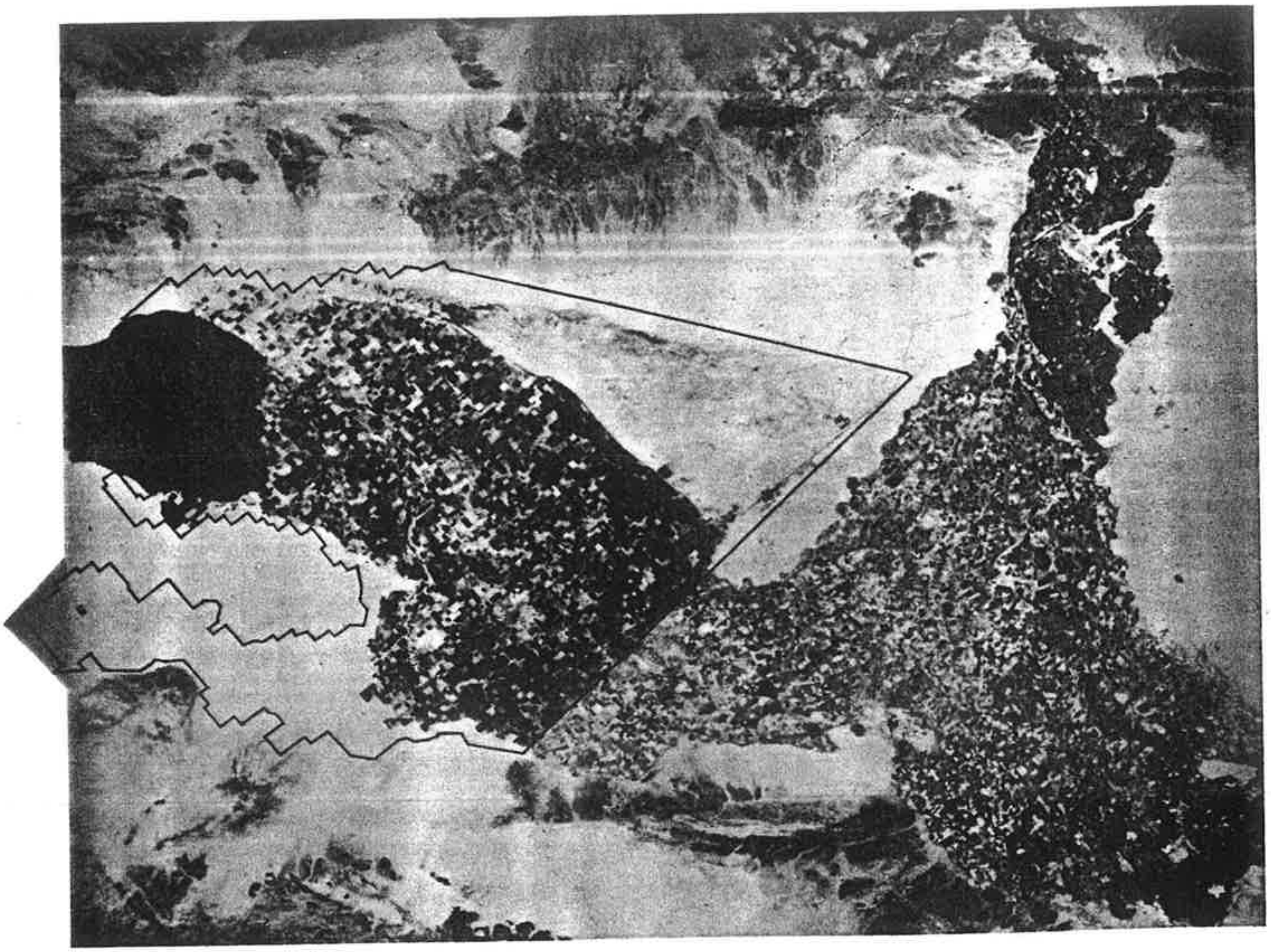
Soil Survey Map

Plate A-3

Soil Survey of

IMPERIAL COUNTY CALIFORNIA IMPERIAL VALLEY AREA



United States Department of Agriculture Soil Conservation Service
in cooperation with
University of California Agricultural Experiment Station
and
Imperial Irrigation District

TABLE 11.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
100----------------- Antho	0-13	Loamy fine sand	SM	A-2	0	100	100	75-85	10-30	---	NP
	13-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0	90-100	75-95	50-60	15-40	---	NP
101*:											
Antho--------------	0-8	Loamy fine sand	SM	A-2	0	100	100	75-85	10-30	---	NP
	8-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0	90-100	75-95	50-60	15-40	---	NP
Superstition------	0-6	Fine sand-------	SM	A-2	0	100	95-100	70-85	15-25	---	NP
	6-60	Loamy fine sand, fine sand, sand.	SM	A-2	0	100	95-100	70-85	15-25	---	NP
102*. Badland											
103----------------- Carsitas	0-10	Gravelly sand---	SP, SP-SM	A-1, A-2	0-5	60-90	50-85	30-55	0-10	---	NP
	10-60	Gravelly sand, gravelly coarse sand, sand.	SP, SP-SM	A-1	0-5	60-90	50-85	25-50	0-10	---	NP
104* Fluvaquents											
105----------------- Glenbar	0-13	Clay loam-------	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
	13-60	Clay loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
106----------------- Glenbar	0-13	Clay loam-------	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	13-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
107*---------------- Glenbar	0-13	Loam------------	ML, CL-ML, CL	A-4	0	100	100	100	70-80	20-30	NP-10
	13-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	35-45	15-30
108----------------- Holtville	0-14	Loam------------	ML	A-4	0	100	100	85-100	55-95	25-35	NP-10
	14-22	Clay, silty clay	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	22-60	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
109----------------- Holtville	0-17	Silty clay------	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	17-24	Clay, silty clay	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	24-35	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
	35-60	Loamy very fine sand, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	75-100	20-55	---	NP
110----------------- Holtville	0-17	Silty clay------	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-35
	17-24	Clay, silty clay	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-35
	24-35	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	55-85	25-35	NP-10
	35-60	Loamy very fine sand, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	75-100	20-55	---	NP

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
111*:											
Holtville	0-10	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	10-22	Clay, silty clay	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	22-60	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
Imperial	0-12	Silty clay loam	CL	A-7	0	100	100	100	85-95	40-50	10-20
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
112 Imperial	0-12	Silty clay	CH	A-7	0	100	100	100	85-95	50-70	25-45
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
113 Imperial	0-12	Silty clay	CH	A-7	0	100	100	100	85-95	50-70	25-45
	12-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	100	85-95	50-70	25-45
114 Imperial	0-12	Silty clay	CH	A-7	0	100	100	100	85-95	50-70	25-45
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
115*:											
Imperial	0-12	Silty clay loam	CL	A-7	0	100	100	100	85-95	40-50	10-20
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
Glenbar	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	13-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
116*:											
Imperial	0-13	Silty clay loam	CL	A-7	0	100	100	100	85-95	40-50	10-20
	13-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
Glenbar	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	13-60	Clay loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
117, 118 Indio	0-12	Loam	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	12-72	Stratified loamy very fine sand to silt loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
119*:											
Indio	0-12	Loam	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	12-72	Stratified loamy very fine sand to silt loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
Vint	0-10	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	25-35	---	NP
	10-60	Loamy sand, loamy fine sand.	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
120* Laveen	0-12	Loam	ML, CL-ML	A-4	0	100	95-100	75-85	55-65	20-30	NP-10
	12-60	Loam, very fine sandy loam.	ML, CL-ML	A-4	0	95-100	85-95	70-80	55-65	15-25	NP-10

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

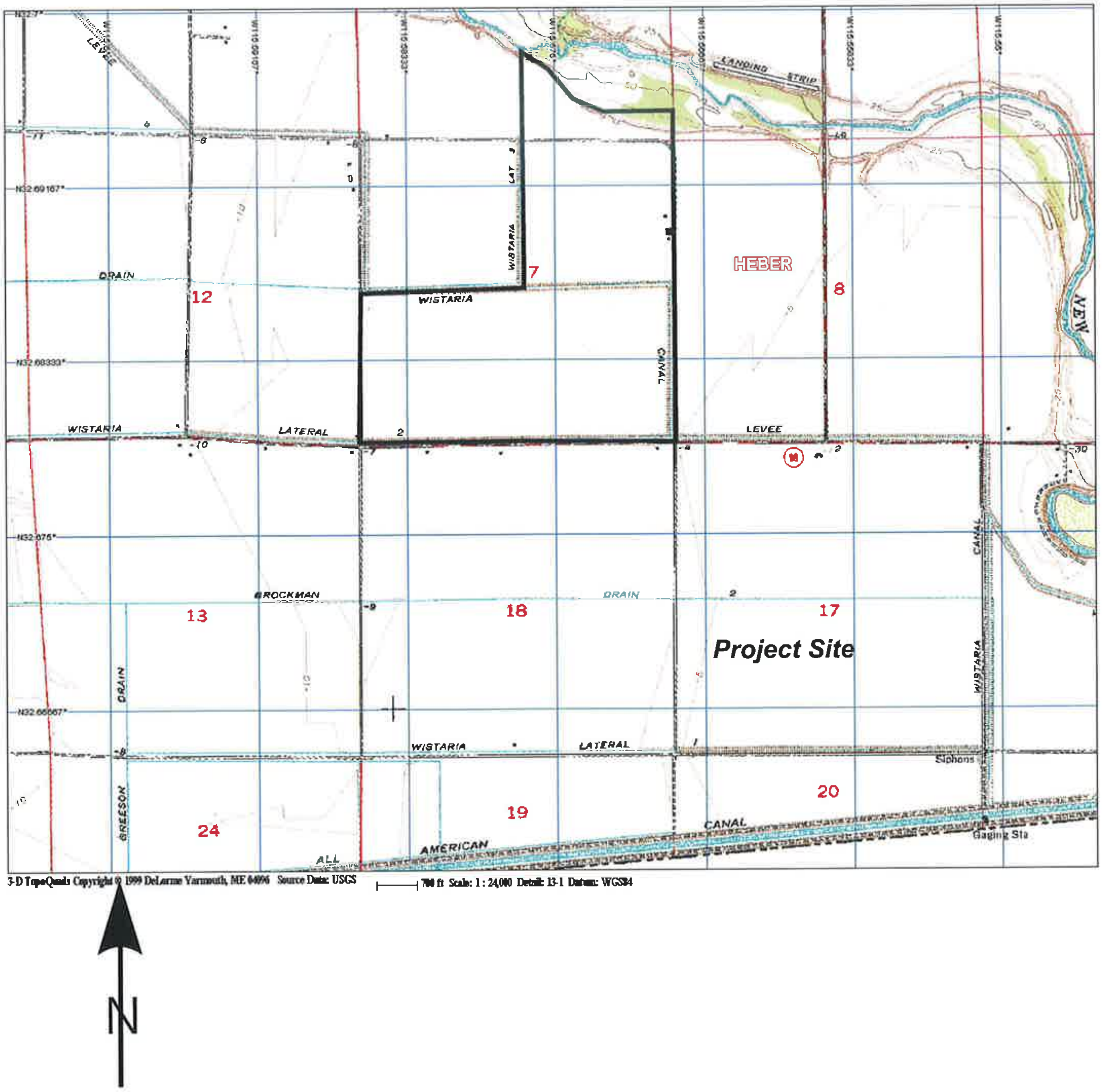
Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
121----------------- Meloland	0-12	Fine sand--------	SM, SP-SM	A-2, A-3	0	95-100	90-100	75-100	5-30	---	NP
	12-26	Stratified loamy fine sand to silt loam.	ML	A-4	0	100	100	90-100	50-65	25-35	NP-10
	26-71	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-40
122----------------- Meloland	0-12	Very fine sandy loam.	ML	A-4	0	95-100	95-100	95-100	55-85	25-35	NP-10
	12-26	Stratified loamy fine sand to silt loam.	ML	A-4	0	100	100	90-100	50-70	25-35	NP-10
	26-71	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-40
123*: Meloland----------	0-12	Loam-------------	ML	A-4	0	95-100	95-100	95-100	55-85	25-35	NP-10
	12-26	Stratified loamy fine sand to silt loam.	ML	A-4	0	100	100	90-100	50-70	25-35	NP-10
	26-38	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-40
	38-60	Stratified silt loam to loamy fine sand.	SM, ML	A-4	0	100	100	75-100	35-55	25-35	NP-10
Holtville---------	0-12	Loam-------------	ML	A-4	0	100	100	85-100	55-95	25-35	NP-10
	12-24	Clay, silty clay	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-35
	24-36	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	55-85	25-35	NP-10
	36-60	Loamy very fine sand, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	75-100	20-55	---	NP
124, 125----------- Niland	0-23	Gravelly sand---	SM, SP-SM	A-2, A-3	0	90-100	70-95	50-65	5-25	---	NP
	23-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	100	100	85-100	80-95	40-65	20-40
126----------------- Niland	0-23	Fine sand--------	SM, SP-SM	A-2, A-3	0	90-100	90-100	50-65	5-25	---	NP
	23-60	Silty clay-------	CL, CH	A-7	0	100	100	85-100	80-95	40-65	20-40
127----------------- Niland	0-23	Loamy fine sand	SM	A-2	0	90-100	90-100	50-65	15-30	---	NP
	23-60	Silty clay-------	CL, CH	A-7	0	100	100	85-100	80-95	40-65	20-40
128*: Niland------------	0-23	Gravelly sand---	SM, SP-SM	A-2, A-3	0	90-100	70-95	50-65	5-25	---	NP
	23-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	100	100	85-100	80-100	40-65	20-40
Imperial----------	0-12	Silty clay-------	CH	A-7	0	100	100	100	85-95	50-70	25-45
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
129*: Pits											
130, 131----------- Rositas	0-27	Sand-------------	SP-SM	A-3, A-1, A-2	0	100	80-100	40-70	5-15	---	NP
	27-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
132, 133, 134, 135-- Rositas	0-9	Fine sand-------	SM	A-3, A-2	0	100	80-100	50-80	10-25	---	NP
	9-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
136--------------- Rositas	0-4	Loamy fine sand	SM	A-1, A-2	0	100	80-100	40-85	10-35	---	NP
	4-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
137--------------- Rositas	0-12	Silt loam-------	ML	A-4	0	100	100	90-100	70-90	20-30	NP-5
	12-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
138*:											
Rositas-----------	0-4	Loamy fine sand	SM	A-1, A-2	0	100	80-100	40-85	10-35	---	NP
	4-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
Superstition------	0-6	Loamy fine sand	SM	A-2	0	100	95-100	70-85	15-25	---	NP
	6-60	Loamy fine sand, fine sand, sand.	SM	A-2	0	100	95-100	70-85	15-25	---	NP
139--------------- Superstition	0-6	Loamy fine sand	SM	A-2	0	100	95-100	70-85	15-25	---	NP
	6-60	Loamy fine sand, fine sand, sand.	SM	A-2	0	100	95-100	70-85	15-25	---	NP
140*:											
Torriorthents											
Rock outcrop											
141*:											
Torriorthents											
Orthids											
142--------------- Vint	0-10	Loamy very fine sand.	SM, ML	A-4	0	100	100	85-95	40-65	15-25	NP-5
	10-60	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
143--------------- Vint	0-12	Fine sandy loam	ML, CL-ML, SM, SM-SC	A-4	0	100	100	75-85	45-55	15-25	NP-5
	12-60	Loamy sand, loamy fine sand.	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
144*:											
Vint--------------	0-10	Very fine sandy loam.	SM, ML	A-4	0	100	100	85-95	40-65	15-25	NP-5
	10-40	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
	40-60	Silty clay------	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
Indio-------------	0-12	Very fine sandy loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	12-40	Stratified loamy very fine sand to silt loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	40-72	Silty clay------	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35

* See description of the map unit for composition and behavior characteristics of the map unit.

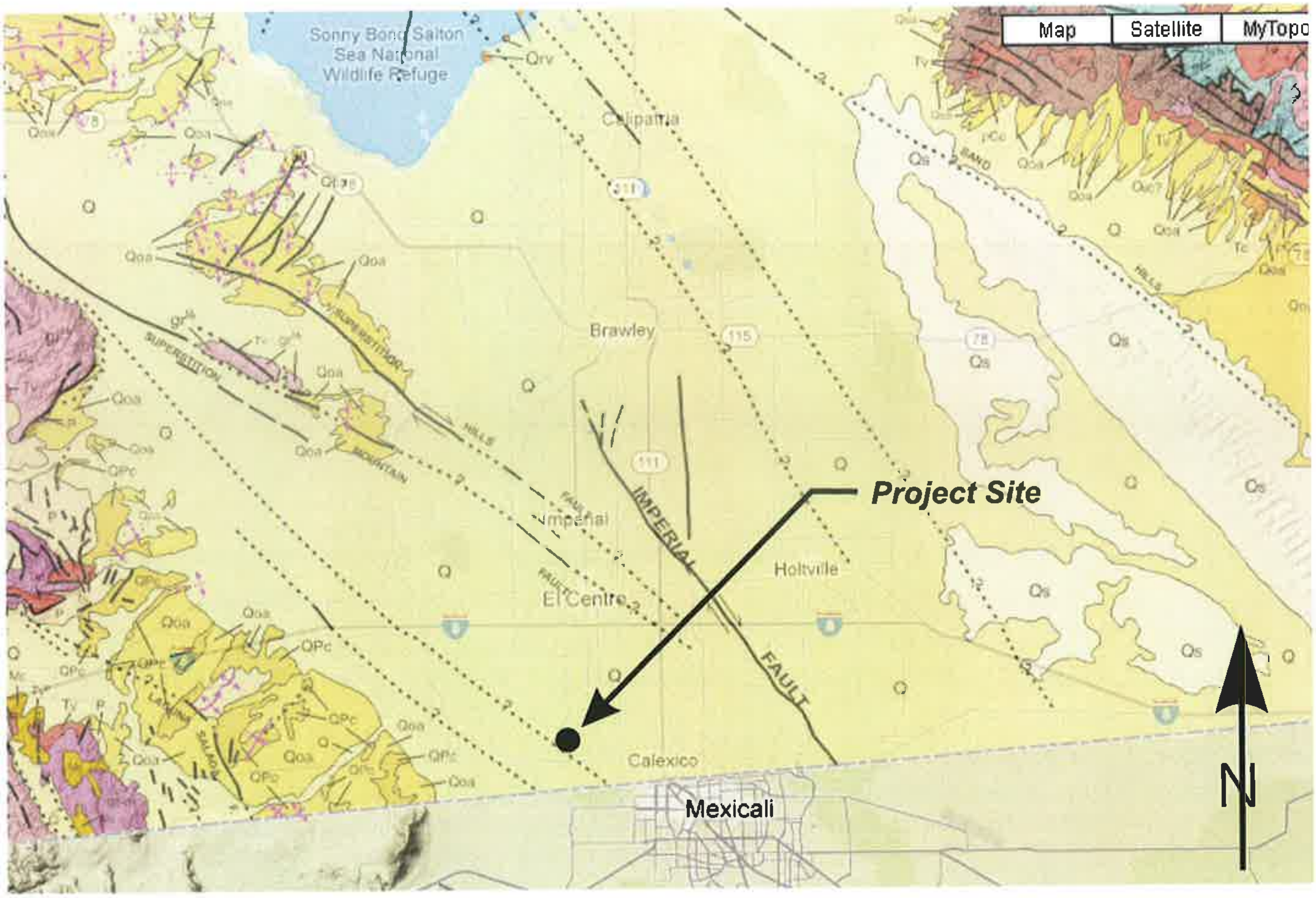


LANDMARK
Geo-Engineers and Geologists

Project No.: LE11083

Topographic Map

Plate A-4



GEOLOGIC LEGEND

Quaternary Deposits: Qs, Q, Qls, Qg, Qoa, QPc

Quaternary Volcanic Rocks: Qrv, Qrv, Qv, Qv

Tertiary Sedimentary Rocks: Tc, P, M, Mc, Oc, Ec, E, Ec, Ep

Tertiary Volcanic Rocks: Tv, Tv

Tertiary Plutonic Rocks: gr

Mesozoic Sedimentary and Metasedimentary Rocks: TK, K, Ku, Kl, KJf, KJf, KJf, J, Tr, sch, ls

Mesozoic Mixed Rocks: grm

Mesozoic Metavolcanic Rocks: Mzv, mv

Mesozoic Plutonic Rocks: gr, um, gb, gr

Paleozoic Sedimentary and Metasedimentary Rocks: Pz, Pm, C, D, SO, C

Paleozoic Mixed Rocks: m

Paleozoic Metavolcanic Rocks: Pzv

Paleozoic Plutonic Rocks: gr

Pre-Cambrian Rocks: pC, pCc, gr

SYMBOLS

Geologic boundary

Fault traces - solid where well located, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain. Ball and bar on downthrown side (relative or apparent). Arrows indicate direction of lateral movement (relative or apparent).

Thrust fault (barbs on upper plate)

Regional strike and dip of stratified rocks

Regional strike and dip of stratified rocks (overturned)

Anticlinal fold

Synclinal fold

Monoclinal fold

Site Location
Lat N32.7477 Long: W-115.5642

LANDMARK Geo-Engineers and Geologists **Project No.: LE13090**	**Regional Geologic Map**	**Plate A-5**