PRELIMINARY GEOLOGICAL AND GEOTECHNICAL HAZARD EVALUATION REPORT

CITIZENS IMPERIAL SOLAR, LLC

NILAND, IMPERIAL COUNTY, CALIFORNIA

MAY 21, 2018

Prepared for:

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

It is our understanding that the proposed Project will consist of the design and construction of a 30-megawatt solar photovoltaic energy facility to provide a renewable and reliable source of electrical power. Project components will include generating facility, access driveways, and electrical interconnection. The proposed facility will be connected to the electric grid at the existing on site Midway Substation and the lifespan of the Project is expected to be 25 years. All proposed improvements will be located on approximately 222.8 acres of land, designated as Parcels ‘A’ and ‘B’, owned and administrated by Imperial Irrigation District.

1.2 SITE LOCATION AND DESCRIPTION

The proposed Citizens Imperial Solar, LLC Project (Project) is located approximately 30 miles northeast of El Centro and 5 miles southeast of Niland in Imperial County, California. The Project site consists of two parcels (Parcel ‘A’ and Parcel ‘B’) and is located at East Simpson Road (dirt road) just west of the intersection with East Highline Canal Road (dirt road).The site location is shown on Figure 1, Site Location Map in Appendix A. Both parcels appear to have been previously used for agriculture purposes. Agricultural fields surround the parcels to the west and south. The East Highline Canal Road sets the northeast boundary of each parcel. The East Highline Canal runs adjacent to the road immediately northeast of the Project site. Tributary canals run generally east to west along dirt roads north and south of each parcel. Generally, the surface was covered with dry vegetation. Since the site was previously used for farming, the top 6 to 12 inches of subgrade soils appear to be loose. There is an existing substation and yard at the southeast side of Parcel ‘A’. The substation and yard occupy approximately 4 and 0.25 acres, respectively. At Parcel ‘A’, transmission lines run along the southern boundary, crosses through the field at the southeastern corner to the substation and turns northeast along East Highline Canal Road. Transmission lines also run along the western and northern boundaries of Parcel ‘A’. Some of the area along the northwest quadrant of Parcel ‘A’ is currently being used for parking and storage of crates. Transmission lines run along the western and northwest-to-southeast boundary of Parcel ‘B’.

The topography of the Project site is relatively flat with elevations ranging from approximately -59 feet at the west to -38 feet at the east. The coordinates at the center of the Project site are approximately:

Latitude: 33.19107ºN Longitude: 115.43208ºW

1.3 PURPOSE AND SCOPE

The purpose of this preliminary geological and geotechnical study was to review existing geologic/geotechnical data and evaluate preliminary geological and geotechnical hazards for the proposed Project.

Our scope of services for this project included the following tasks:

Literature Review: Reviewed various readily available published and unpublished geologic and geotechnical documents pertinent to the Project site. A list of references used in preparation of this report is presented in Section 6.0.

Site Reconnaissance: Performed a brief site reconnaissance to visually observe the existing site conditions including existing on-site near-surface soils and potential geologic hazards. Selected photographs from our site reconnaissance are included in Appendix B, Site Photographs.

Preliminary Geologic and Geotechnical Hazards Evaluation: This evaluation included location of known and mapped nearby earthquake faults and seismic zones in relation to the Project site, intensity of ground shaking, potential for liquefaction, ground rupture, landslides, and flooding. Other potential hazards such as expansion, collapse, and corrosivity potentials of on-site soils were also evaluated. Our evaluations were performed based on literature review only. Field and laboratory testing program was not included as a part of our services.

Report Preparation: Relevant geotechnical and geological data were compiled in this report along with our findings and conclusions for the proposed Project.

2.0 GEOLOGY, FAULTING AND SEISMICITY

2.1 REGIONAL GEOLOGIC SETTING

The Project site is located in the Imperial Valley, a part of the Salton Trough, located in the Colorado Desert physiographic province of California. With surface elevations as low as 275 feet below sea level, the Salton Trough formed as a structural depression resulting from tectonic boundary adjustment between the Pacific and the North American plates. The Salton Trough is bounded on the east and northeast by the San Andreas Fault and on the west by the San Jacinto Fault Zone. The structural trough is filled with more than 15,000 feet of Miocene and younger, marine and non-marine sediments capped by approximately 100 feet of Pleistocene and later lacustrine deposits that have been deposited by intermittent filling derived from periodic flooding of the Colorado River and Lake Cahuilla (Morton, 1977). Regional Geologic Map is shown on Figure 2 (Appendix A).

2.2 SURFACE SUBGRADE SOILS AND GROUNDWATER CONDITIONS

Based on a review of published data by the California Geological Survey (CGS, 2010), the Project site is generally underlain by stratified alluvial deposits, predominately consisting of interbedded layers of silt, sand and clay. According to the Soil Survey of Imperial County, California prepared by United States Department of Agriculture Soil Conservation Service (2018) the near-surface soils are predominantly comprised of fine sand, gravelly sand, and occasionally clay and silty clay. Figure 3 (Appendix A) shows a general soil map of the Project site.

The groundwater levels are anticipated at depths between 5 to 10 feet below the existing ground surface. Seasonal fluctuations of shallow groundwater should be expected during periods of rainfall, irrigation of adjacent properties, and site grading. The groundwater levels shown herein should not be interpreted to represent accurate current or permanent conditions.

2.3 FAULTING

Southern California straddles the boundary between two global tectonic plates known as the North American Plate (on the east) and the Pacific Plate (on the west). The main plate boundary is represented by the San Andreas Fault, which extends northwest from the Gulf of California in Mexico, through the desert region of the Imperial Valley, through the San Bernardino region, and into Northern California, where it eventually trends offshore, north of San Francisco (Jennings and Bryant, 2010).

In Southern California, the plate boundary is a complex system of numerous faults known as the San Andreas Fault System (SAFS) that span a 150-mile-wide zone from the main San Andreas fault in the Imperial Valley westward to offshore of San Diego (Powell et al., 1993 and Wallace, 1990). The major faults east of San Diego (from east to west) include the San Andreas Fault, the San Jacinto fault, and the Elsinore fault. The SAFS is a transform plate boundary dominated by right-lateral fault displacement with the Pacific Plate moving northwest relative to the North American Plate (Wallace, 1990 and Weldon and Sieh, 1985). The significance of this lateral faulting is that transform plate interactions typically generate much smaller maximum magnitude earthquakes than convergent or subduction plate boundaries. Thus, in Southern California the expected maximum moment magnitudes for most faults are typically in the M6.5 to M7.5 range, with only a few faults (San Andreas Fault, possibly some thrust faults of the Transverse Ranges) capable of generating earthquakes in the M8 range, such as the 1906 San Francisco and 1857 Fort Tejon earthquakes, on the San Andreas Fault itself.

Most of the seismic energy and associated fault displacement within the SAFS occurs along the fault structures closest to the plate boundary (i.e., on the Elsinore, San Jacinto, and San Andreas faults) (Powell et al. 1993). Approximately 1.9 inches/year (49 millimeters per year, [mm/yr.]) of overall lateral displacement have been measured geodetically and as fault slip across the plate boundary. Combined, the Elsinore, San Jacinto, and San Andreas faults account for up to 1.6 inches/year (41 mm/yr.), or 84 percent, of the total plate displacement. The remaining 16 percent is accommodated across the faults to the west (Bennett et al., 1996).

The Project site is located in the seismically active Southern California region, within the influence of several fault systems that are considered to be active or potentially active. Several active or potentially active faults are located in the vicinity of the Project site. The locations of these faults relative to the site are shown on Figure 4, Fault Map (Appendix A).

Under the current understanding of regional seismology and tectonics, the largest maximum earthquake to impact the project may be generated by the San Andreas Fault (Coachella Section) having an estimated maximum magnitude of M7.9. A list of nearby faults at the Project site are presented in Table 2-1 below, along with pertinent data such as fault type, distance to fault, and maximum magnitude.

Table 2-1. Nearby Faults

Fault Name	Distance (km)[1]	Site Location (Latitude and Longitude)	Maximum Magnitude	Fault Type[2]
Unnamed Faults East of Coachella Canal	15.8	33.19107ºN 115.43208ºW	6.4	SS
Brawley (Seismic Zone)	18.0		6.5	SS
Elmore Ranch	21.4		6.6	SS
San Andreas (Coachella)	32.3		7.9	SS
San Jacinto (Superstition Mtn.)	42.8		7.7	SS

Notes:
[1] Closest distance between site and fault rupture based on Caltrans Online v2.3.09 (Caltrans, 2017b).
[2] SS= Strike Slip Fault

2.4 HISTORICAL SEISMICITY

The Project site and vicinity are located in an area characterized by high seismicity.

The seismicity of the region surrounding the project site was evaluated using the earthquake database from USGS website (https://earthquake.usgs.gov/earthquakes/search/). Based on the review of the available data, 155 earthquake events with magnitudes equal or greater than 4.5 have occurred within a radius of 60 miles of the site in the last 100 years. Selected location of the earthquake epicenter, year of occurrence, and earthquake magnitude are summarized in Table 2-2.

Table 2-2. List of Selected Historic Earthquakes

Earthquake Location	Date of Earthquake	Earthquake Magnitude
5 km NNE of Brawley, CA	08-27-2012	4.9
4 km NNW of Brawley, CA	08-26-2012	5.4
8 km SSE of Ocotillo, CA	06-15-2010	5.7
12 km SW of Delta, B.C., MX	04-04-2010	7.2
22 km W of Westmorland, CA	11-24-1987	6.6
5 km NNE of Ocotillo, CA	04-09-1968	6.6
4 km N of Holtville, CA	05-19-1940	6.9
16 km WSW of Oasis, CA	03-25-1937	6.0

3.0 ASSESSMENT OF POTENTIAL GEOLOGIC AND GEOTECHNICAL HAZARDS

3.1 SEISMIC SHAKING

There is a high potential for moderate to severe seismic shaking during the design life of the proposed Project. The project site is located in the highly seismic Southern California region within the influence of several fault systems that are considered to be active or potentially active. A list of known faults considered capable of producing potentially damaging seismic shaking at the site is presented in Table 2-1. It is anticipated that the Project site will periodically experience ground accelerations and shaking as the result of small to moderate magnitude earthquakes occurring along these faults and other faults within the Southern California region.

The results of our seismic hazard analyses indicated that the estimated horizontal peak ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years and corresponding to the statistical return period of approximately 2,475 years, which is defined as the Maximum Considered Earthquake (MCE), is on the order of 0.55g.

3.2 FAULT-RUPTURE HAZARD

Surface rupture usually occurs along traces of known active or potentially active faults. However, many historic seismic events, including the 1994 Northridge Earthquake, have occurred on faults without surface expression (blind faults) that were not previously known to exist or to be active.

The California Geologic Survey (CGS) established criteria for faults as active, potentially active, and inactive. Active faults are those that show evidence of surface displacement within the last 11,000 years (Holocene age). Potentially active faults are those that demonstrate displacement within the past 1.6 million years (Quaternary age). Faults showing no evidence of displacement within the last 1.6 million years may be, in general, considered inactive for most structures, except for critical structures. In 1972 the Alquist-Priolo Special Studies Earthquake Hazards Act (APEHA) was passed, which required fault studies within 500 feet of active or potentially active faults. The APEHA designates “active” and “potentially active” faults utilizing the same age criteria as that used by the CGS. The site is not located within a currently-delineated State of California Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007 and CGS, 1999) and therefore the likelihood of fault rupture at the Project site is considered low. Location of known Alquist Priolo Earthquake Fault Zones in the general vicinity of the Project Site is shown on Figure 5, Seismic Hazard Map (Appendix A).

3.3 FLOOD HAZARD AND TSUNAMIS

Flooding can occur as a result of several factors in developed areas. These factors include: rainfall rates that exceed an area’s ability to absorb or control the runoff; impounded water retained behind a flood control structure (upstream-inundation), failure of a flood control structure (downstream-inundation), seiches, and tsunami.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Number 06025C0750C (2008), the Project site is considered a Zone X site, which is an area that is determined to be outside the 0.2% annual chance of flooding (500-year recurrence period). Therefore, the risk related to natural flooding is low.

Due to the site's inland location and the lack of any local impounded bodies of water, tsunami, and seiches do not represent potential hazards to the site.

3.4 Landsliding

Landslides and other forms of mass wasting, including mud flows, debris flows, and soil slips occur as soil moves downslope under the influence of gravity. Landslides are frequently triggered by intense rainfall or seismic shaking. Because the site is located in a relatively flat area, we do not consider landslides or other forms of natural slope instability to represent a significant hazard to the project.

3.5 Liquefaction/Seismic Settlement

The term liquefaction describes a phenomenon in which saturated, cohesionless soils temporarily lose shear strength (liquefy) when subjected to cyclic ground motions. Cyclic loading of saturated soils leads to the build-up of pore water pressure as a result of soil particles being rearranged with a tendency toward closer packing. Under undrained conditions, shaking of loose non-cohesive soils may result in loads being transferred from the soil skeleton to the pore water with consequent reduction in the soil strength and stiffness. Structures founded on or above potentially liquefiable soils may experience bearing capacity failures due to the temporary loss of foundation support, vertical settlements (both total and differential), and/or undergo lateral spreading. The factors known to influence liquefaction potential include soil type, relative density, grain size distribution, confining pressure, depth to groundwater, and the intensity and duration of the seismic ground shaking. Liquefaction is most prevalent in loose- to medium-dense, silty, sandy, and gravelly soils below the groundwater table.

Due to the anticipated relatively shallow depth to groundwater and the soil types present, the potential for liquefaction at the Project site exists. The liquefaction potential should be further evaluated during the design phase of the Project, using site-specific information collected from future site-specific exploratory boreholes.

3.6 Lateral spreading

Liquefaction-induced lateral spreading is defined as the lateral displacement of ground as a result of pore pressure build-up or liquefaction in shallow underlying soils during an earthquake. Lateral spreading can occur on sloping ground or where nearby slopes are present. The factors known to influence the magnitude of lateral spreading include earthquake magnitude, peak ground acceleration, distance between the site and the seismic event, the slope height and gradient, thickness of the liquefied layer, fines content, soil particle gradation, and residual strength of the liquefied soil.

Based on available soil and groundwater data, the risk for lateral spreading may exist at the subject site, particularly near the existing canals. To assess the actual risk, a site-specific geotechnical investigation should be performed and mitigation measures, if necessary, should be developed to reduce the magnitude of lateral displacement due to lateral spreading.

3.7 Land Subsidence

Subsidence is the sinking of the ground surface caused by the compression of earth materials or the loss of subsurface soil due to underground mining, tunneling, or erosion. The major causes of subsidence include fluid withdrawal from the ground, decomposing organics, underground mining or tunneling, and placing large fills over compressible earth materials. The effective stress on underlying soils is increased resulting in consolidation and settlement. Subsidence may also be caused by tectonic processes. The Project site is not located in an area of known ground subsidence or within any delineated zones of subsidence due to groundwater pumping or oil extraction (USGS, 2017). Accordingly, the potential for subsidence to occur at the site is considered to be low.

3.8 EXPANSIVE SOILS

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors and may result in unacceptable settlement or heave of structures. Based on available data, the onsite near-surface soil deposits primarily consist of sand, gravelly sand and clay/silty clay. Generally, sands are considered not expansive soils and clays may exhibit moderate to high expansion potential due to variation in moisture content. A site-specific geotechnical investigation should be performed to evaluate soil expansiveness and potential impact, if any, of expansive soil on the Project.

3.9 COLLAPSIBLE SOILS

Collapsible soil is generally defined as soil that will undergo a sudden decrease in volume and its internal support is lost under applied loads when water is introduced into the soil. The internal support is considered to be a temporary strength and is derived from a number of sources including capillary tension, cementing agents, e.g. iron oxide and calcium carbonate, clay-welding of grains, silt bonds, clay bonds and clay bridges. Soils found to be most susceptible to collapse include loess (fine grained wind-deposited soils), valley alluvium deposited within a semi-arid to arid climate, and residual soil deposits. At this time, it is unknown whether collapsible soils are present at the site. A site-specific geotechnical investigation should be performed to assess the presence of collapsible soils and evaluate potential impact, if any, of collapsible soils on the proposed improvements.

3.10 SOIL CORROSION

The on-site soils, particularly clay/silty clay, are known to be corrosive. Typical remediation for the corrosive soil conditions consists of using concrete mix with higher cement contents (Type V Portland Cement) and appropriate steel corrosion protection. Because fine grained soils are expected to be encountered at the subject site, corrosion potential should be further evaluated during the design phase of this Project. A site-specific corrosion study should be performed and mitigation measures should be recommended if the soils are found to be corrosive to concrete or steel.

3.11 OTHER GEOLOGIC HAZARDS

Volcanic Eruption: The Project site is not located in an area of a recent volcanism. Therefore, the potential for volcanic activity is very low.

Radon Gas: Radon gas is a radioactive product of uranium which can reach high levels depending on the local geology and building construction. According to Environmental Protection Agency (EPA) Map of Radon Zones, the Project site, as the entire Imperial County, is located in Zone 3 with predicted average indoor radon screening levels less than 2 picocuries per liter (pCi/L). Since the site is not located within an area of high potential for indoor radon levels (above 4 pCi/L), the potential for radon gas accumulation is considered low.

Naturally Occurring Asbestos: The site is not located in an area of known naturally occurring asbestos (CGS, 2011). Therefore, the potential for occurring asbestos is considered low.

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

4.0 PRELIMINARY SEISMIC DESIGN RECOMMENDATIONS

To reduce the effects of ground shaking produced by regional seismic events, seismic design should be performed in accordance with the applicable building codes. The data in Table 4-1 should be considered for the preliminary seismic analysis of the proposed structural improvements of the proposed Project based on the California Building Code (CBC, 2016).

Table 4-1. Preliminary Seismic Design Parameters – CBC, 2016

Category	Recommended Value
Site Class	D
Latitude	33.19107ºN
Longitude	115.43208ºW
Mapped (5% damped) spectral response acceleration parameter at short period (0.2 sec), S_S	1.416
Mapped (5% damped) spectral response acceleration parameter at long period (1.0 sec), S_1	0.494
Short period (0.2 sec) site coefficient, F_a	1.0
Long period (1.0 sec) site coefficient, F_v	1.806
Spectral response acceleration parameter at short period (0.2 sec), S_{MS}	1.416
Spectral response acceleration parameter at long period (1.0 sec), S_{M1}	0.892
Design (5% damped) spectral response acceleration parameter at short period (0.2 sec), S_{DS}	0.944
Design (5% damped) spectral response acceleration parameter at long period (1.0 sec) S_{D1}	0.595
Peak Ground Acceleration (PGA) (g)	0.50
Site -adjusted PGA (PGA_M) (g)	0.55
Design Magnitude(1) Mw	6.6

(1) Design magnitude based on USGS Probabilistic Deaggregation with 2% chance of exceedance in 50 years (2,475 year return interval) (USGS, 2008).

5.0 CONCLUSIONS AND LIMITATIONS

Our review of available geological and geotechnical literature did not reveal conditions that would preclude development of the proposed Project provided, as mentioned above, a site-specific geotechnical investigation is conducted prior to the site development. The proposed project is considered feasible for development from a geotechnical perspective.

This preliminary geological and geotechnical hazard evaluation report has been prepared for the use of HDR and the Citizens Energy Corporation for the proposed Citizens Imperial Solar, LLC Project. The report may not be used by others without the written consent of our client and our firm. The findings, conclusions, and preliminary recommendations presented in this report were prepared in a manner consistent with the standard of care and skill ordinarily exercised by members of its profession, practicing under similar conditions in the geographic vicinity, and at the time the services were performed. No other warranty is either expressed or implied.

Our findings, conclusions and preliminary recommendations presented in this report may be used for preliminary consideration of the feasibility and cost of site development purposes only. They are not intended for the design of the project. Additionally, a site-specific geotechnical investigation should be performed during the planning process for the proposed Project, in order to develop recommendations for the specific foundation designs and earthwork construction being considered for this project.

We appreciate the opportunity to provide our services on this Project. Please do not hesitate to contact undersigned if you have questions, comments, or need additional information.

Respectfully submitted,

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Senior Project Manager-Geotechnical

6.0 REFERENCES

The following references were used in preparation of this report:

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Appendix A

Figures

SITE LOCATION MAP
CITIZEN IMPERIAL SOLAR, LLC
NILAND, IMPERIAL COUNTY, CALIFORNIA

Figure 1

Reference: CGS, 2010, Geologic Map of California, Original compilation by Charles W. Jennings, Updated version by Carlos Gutierrez, William Bryant, George Saucedo, and Chris Wills.

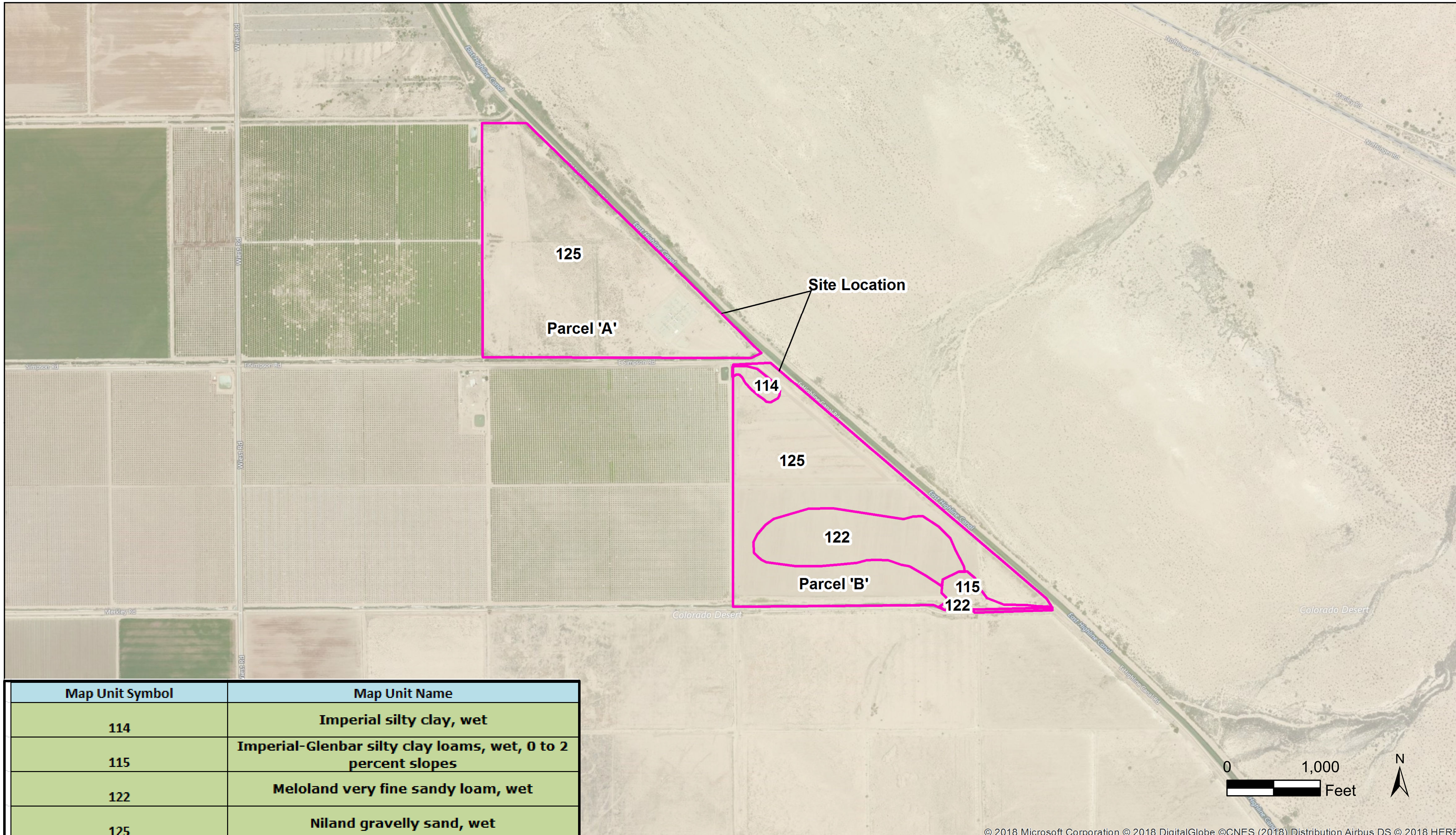
Q - Alluvium, lake, laya, and terrace deposits; unconsolidated and semi-consolidated. Mostly nonmarine, but includes marine deposits near the coast.

Qoa - Older alluvium, lake, playa, and terrace deposits.

REGIONAL GEOLOGIC MAP
CITIZEN IMPERIAL SOLAR, LLC
NILAND, IMPERIAL COUNTY, CALIFORNIA

HDR

Figure 2



Map Unit Symbol	Map Unit Name
114	Imperial silty clay, wet
115	Imperial-Glenbar silty clay loams, wet, 0 to 2 percent slopes
122	Meloland very fine sandy loam, wet
125	Niland gravelly sand, wet

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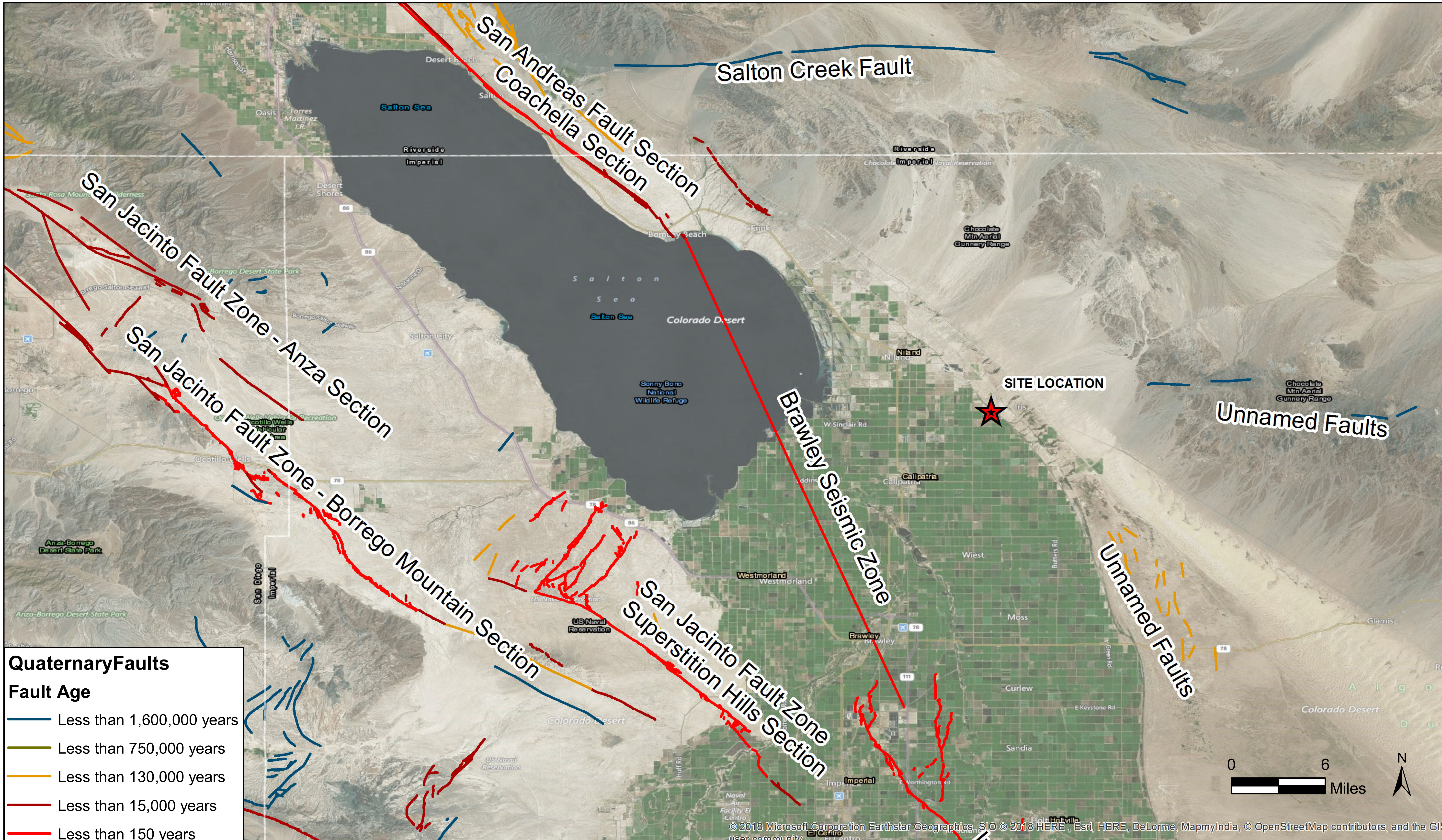
Reference: USDA, 2018, Web Soil Survey

SOIL SURVEY MAP
CITIZEN IMPERIAL SOLAR, LLC
NILAND, IMPERIAL COUNTY, CALIFORNIA

Figure 3



* Fault Age classifications are based on geologic evidence to determine the youngest faulted unit and the oldest unfaulted unit along each fault or fault section (Jennings, C.W., and Bryant, W.A., 2010)

Reference: USGS and CGS, 2006, Quaternary Fault and Fold Database for the United States

REGIONAL FAULT MAP
CITIZEN IMPERIAL SOLAR, LLC
NILAND, IMPERIAL COUNTY, CALIFORNIA

Figure 4

Reference: CDMG, 1990a, 1990b, 1990c, 1990d, and 1998

SEISMIC HAZARD MAP
CITIZEN IMPERIAL SOLAR, LLC
NILAND, IMPERIAL COUNTY, CALIFORNIA

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Figure 5

Appendix B

Site Photographs

Parcel 'A' – view to southeast

Parcel 'A' – view to northeast

Parcel ‘B’ – view to north

Parcel ‘B’ – view to south

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