DRAFT REPORT – REVISION 1

GEOTECHNICAL EVALUATION
ACCESS ROADS AND STRUCTURE PADS
SUNRISE POWERLINK PROJECT
SAN DIEGO AND IMPERIAL COUNTIES,
CALIFORNIA

PREPARED FOR:

SAN DIEGO GAS & ELECTRIC COMPANY

URS PROJECT NO. 27669019.00002

REVISED OCTOBER 16, 2009 (REV. 1)

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Prepared for

San Diego Gas & Electric Company
8315 Century Park Court, CP21G
San Diego, CA 92123

URS Project No. 27669019.00002

Revised October 16, 2009 (Rev. 1)

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Revised October 16, 2009 (Rev. 1)

Ms. Molly Frisbie
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San Diego, CA 92123

Subject: Geotechnical Evaluation
Access Roads and Structure Pads
Sunrise Powerlink Project
San Diego and Imperial Counties, California
URS Project No. 27669019.00002

Dear Ms. Frisbie:

URS Corporation Americas (URS) is pleased to present this draft report of Geotechnical Evaluation for the Sunrise Powerlink project access roads and structure pads. Our work is intended to assist San Diego Gas & Electric Company (SDG&E) and their consultants with the planning, design and construction of the transmission line access roads and structure pads.

In our opinion, the proposed earthwork to develop access roads to the structures, structure pads and temporary pull site pads is geotechnically feasible provided that the recommendations presented in this report are incorporated into design and construction.

If you have any questions regarding this report, please contact us.

Sincerely,

URS CORPORATION

Charles Robin (Rob) Stroop, G.E. 2298
Senior Project Geotechnical Engineer

Michael E. Hatch, C.E.G. 1925
Principal Engineering Geologist

CRS/MEH:kl

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ASTM	American Society for Testing and Materials
BV	Bureau Veritas
Caltrans	California Department of Transportation
H:V	horizontal:vertical
kV	kilovolt
mm	millimeters
MSE	Mechanically Stabilized Earth
NCMA	National Concrete and Masonry Association
OSHA	Occupational Safety and Health Administration
pcf	pounds per cubic foot
PI	plasticity index
psf	pounds per square foot
SDG&E	San Diego Gas & Electric
URS	URS Corporation Americas

SECTION 1 INTRODUCTION

1.1 BACKGROUND

The Sunrise Powerlink Project is a proposed 230/500 kilovolt (kV) transmission line, approximately 110 miles in length that will extend from the San Diego Gas & Electric Company (SDG&E) Sycamore Canyon Substation in San Diego County eastward to the SDG&E Imperial Valley Substation in Imperial County. Figure 1 presents a vicinity map that shows the project alignment.

The western portion of the project will be a 230 kV transmission line beginning at Sycamore Canyon Substation and extending to the proposed Suncrest Substation located east of Alpine and south of Interstate 8 in the Bell Bluff area. From the Suncrest Substation, a 500 kV transmission line will extend eastward, crossing Interstate 8 twice between the Suncrest Substation and the Jacumba area, crossing it again in the Mountain Springs Grade area, and crossing again in the Plaster City area. The eastern terminus of the project is at the Imperial Valley Substation.

The overhead transmission line alignment has been divided into 13 sections for references purposes. The section designations provided to URS are from west to east; 4A, 5, 7, 8A, 8B, 8C, 8D, 8E, 9A, 9B, 9C, 10A, and 10B. Section 6 is a proposed underground alignment and is not a part of this study.

1.2 PROJECT DESCRIPTION

The proposed project will consist of earthwork to develop access roads to the transmission line structures, structure pads, and temporary pull site pads. These improvements will include construction of cut and fill slopes to form the structure pads, temporary cable pull site pads and access roads. In summary, masonry retaining walls and Mechanically Stabilized Earth (MSE) walls will be constructed to retain the cut and fill slopes, respectively. We understand earthwork activities are planned such that the materials generated will be balanced at each construction site and no significant imports or exports are anticipated. In addition, portions of existing roadways may be modified to improve access for project construction or future maintenance.

Cut slopes heights will be a maximum of 50 feet, sloped at inclinations ranging from 0.75:1 to 2:1 Horizontal:Vertical (H:V). Some of the cut slopes may be retained by cantilever type masonry retaining walls, ranging in height from 4 to 12 feet.

Fill slopes heights will be a maximum of 50 feet sloped at inclinations of 2:1H:V or 1.5H:V. Fill slopes at several locations will be retained by MSE walls formed with geogrid-reinforced fill. MSE walls will be typically 18 to 20 feet high, with a maximum height of 32 feet. Material generated from the cut activities on-site will be used as general fill and backfill for retaining walls.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this URS Corporation Americas (URS) evaluation is to assist SDG&E and their civil engineering subconsultant, Bureau Veritas (BV) with the geotechnical design of the access roads to the transmission line structures, the structure pads and the temporary pads for cable pull sites. The scope of the evaluation included:

- Desktop review of available aerial imagery, published geologic information and previous URS geotechnical investigations;
- Review of in-progress grading plans;
- Site reconnaissance of about 100 structure and access roads sites;
- Evaluating proposed cut and fill slope inclinations;
- Performing global stability analysis of retaining walls; and
- Preparation of this geotechnical evaluation report.

The results of the field reconnaissance and our review of available information were used to develop discussions, conclusions, and recommendations regarding:

- Generalized soil and groundwater conditions at the site;
- Recommendations for earthwork;
- Recommendations for cut and fill slopes; and
- Recommendations for retaining wall design.

The recommendations presented in this report include transmission line Section 4A to Section 9C. No recommendations were requested by BV or SDG&E for Sections 10A or 10B.

1.4 AVAILABLE INFORMATION

Available information was reviewed to perform the evaluation and to develop the discussions, conclusions and recommendations presented in this report. The information reviewed is listed in the references section of this report.

1.4.1 Grading Plans

As part of the desktop analyses and field reviews, URS has reviewed various versions of the site grading plans prepared by BV. The first sets of grading plans were prepared as part of the 50 percent construction documents and were provided to us between May 14 to June 5, 2009. Later versions have been provided as they became available.

1.4.2 URS Geotechnical Investigations

The site and geologic conditions along the transmission line alignment presented in this report are based on our review of the following URS geotechnical investigation reports:

- "DRAFT Preliminary Geologic Hazards Evaluation, Sunrise Powerlink, Southern Route, San Diego and Imperial Counties, California," dated February 3, 2009, URS Project No. 27668031.00020.

- "DRAFT Geotechnical and Geologic Hazards Investigation, Sunrise Powerlink Project, San Diego and Imperial Counties, California (Rev. 1)", dated August 28, 2009, URS Project No. 27668031.00040.

1.4.3 Geologic Maps and Aerial Imagery

Published geologic maps and aerial imagery were used for preliminary evaluation of the geologic conditions. Regional geologic mapping compiled by Kennedy and Tan (2005), and Todd (2004) and the geologic strip maps from the geotechnical and geological hazards investigation report (URS, 2009b) were used to assess the geologic conditions. Aerial imagery reviewed included historic stereographic aerial photographs and digital images and terrain modeling software from Google Earth Pro.

SECTION 2 GEOTECHNICAL EVALUATION

The geotechnical evaluation included field reconnaissance of about 100 sites from June 23 through October 1, 2009. The field reconnaissance was completed by engineering geologists from our firm at sites where BV requested recommendations for cut and fill slopes to be steeper than 2:1 horizontal:vertical (H:V) inclinations. Geologic conditions were interpreted from the observed surface exposures. Prior to the field reconnaissance, an engineering geologist completed a desktop terrain analysis of the sites based on available aerial imagery, geologic maps and the grading plans. URS also field evaluated several portions of the existing access roads for steeper slope recommendations, where requested by BV. No subsurface explorations were completed as part of this evaluation.

2.1 GEOLOGIC HAZARDS

The primary geologic hazards that may affect the sites are landslides, rockfalls and debris flows, some of which may be caused by strong ground motion from a seismic event. Detailed evaluations of other geologic hazards along the transmission line alignment, such as major faults crossings, seismic shaking, and liquefaction and seismic settlement are discussed in our Preliminary Geologic Hazards Evaluation for the Sunrise Powerlink project (URS, 2009a). The follow paragraphs briefly discuss landslides, rockfalls and debris flows.

The majority of the Sunrise Powerlink alignment is underlain by crystalline rocks with minor alluvial deposits and a minor occurrence of sedimentary and layered volcanic rocks in the Jacumba area. Landslides are possible, but relatively rare in the crystalline rock setting. Based on our field reviews and terrain analysis of the alignment, no active or recent landslides are present in or adjacent to the transmission line. There are possible ancient landslides mapped in the vicinity of Section 4A as shown on Figure 2A. Structure P20 is located on a possible ancient landslide. This feature is characterized by subdued geomorphology suggestive of an ancient feature. No movement has occurred in this area during the 16 year period since the Sycamore-Creelman transmission line was constructed, and a pole was constructed within the limits of the suspected landslide. This location will be drilled as part of the geotechnical investigation planned as one of the lead activities of the construction.

In addition to landslides, areas of intense erosion, debris flows and soil slips, and rock falls occur in areas of sloping terrain in San Diego and Imperial Counties. Areas of intense erosion or recent debris flows or soil slips are evidenced by fresh scarps and slopes barren of vegetation. The site selection process and specifically the field walkdown efforts sited structures so that areas of recent erosion or soil movement were avoided.

Rockfalls occur in areas with bold rock outcrops and steep natural slopes. Additionally, jointed rock may undergo rockfalls if construction slopes were to daylight unstable wedges or blocks. Steepened rock slopes may also slough material if subjected to seismic shaking. In general, the rock fall hazard is greatest in areas with slope inclinations in excess of 60 degrees from horizontal. Extensive boulder outcrops and steep slopes are encountered locally along the alignment in various locations. Rockfalls have occurred in some of these areas during the geologic past.

Based on our preliminary review of the structure sites, there are no structures located within zones characterized as having a high risk of rock fall hazard and no large, unstable boulders that pose a significant risk to the proposed structure sites have been identified. There are areas where the construction of access roads or pads will encounter surface boulders that could become dislodged during grading activities or whose stability may be reduced by the change in grade or by the grading process. In addition, the construction of cut slopes may impact embedded boulders in the cut or near the crest of the cuts in some areas. The areas of potential rock fall include the steep rocky slopes in Section 5 between structures P47-2 and P47A-1 and P54-1 and P55.

Methods to mitigate rockfall hazard include; evaluating the rocks upslope of the structure site and identifying which rocks need to be mitigated, safely dislodging loose rock to a downslope location, breaking down large rock into smaller fragments that can be safely moved, or stabilizing potentially loose rock in place.

Additionally, care must be taken in areas of proposed cut slopes to account for rocks near the upslope edge of the excavation and to dislodge them or stabilize them prior to excavating or blasting. After grading plans for structure sites and access roads are finalized and prior to start of grading, rock fall surveys should be performed upslope of these areas to evaluate the site specific rock fall hazard and provide guidance on which rocks need to be moved, broken up, or stabilized. Appendix A provides Guide Specifications for support and stabilization of potential rockfall areas.

2.2 SUBSURFACE CONDITIONS

URS geotechnical and geologic hazards evaluation report (URS, 2009b) discusses in detail the physiographic, geologic and tectonic setting and conditions along the transmission line alignment. Tables 1 through 9 of this report summarize the interpreted subsurface conditions based on observations from the field reconnaissance. The following sections provide discussions of the overall subsurface conditions that exist along the transmission line alignment where access road and transmission line structures will be formed. The surficial deposits and bedrock geologic units are described from youngest to oldest relative geologic age. The approximate aerial extent of the soil/rock zones are shown on the Site Plan and Generalized Geologic Maps (Figures 2a through 2u). A key to geologic maps is presented on Figure 3. The geologic units described in the following paragraphs are those encountered in Section 4A through Section 9C. A discussion of the subsurface conditions for Sections 10A and 10B are not included in this report.

2.2.1 Alluvium, Older Alluvium and Possible Ancient Landslides (Qal, Qt/f, and Qls?)

Alluvial deposits are present locally in drainages throughout the project alignment. However, the most significant deposits of unconsolidated Quaternary alluvium are found in the larger inter-montane valleys such as Jacumba Valley (Section 9C). The alluvium consists mostly of unconsolidated layers and lenses of porous silty sand, sandy clay, and clayey to sandy silt with gravels and cobbles.

Older alluvial deposits are also present along the alignment. The older alluvial deposits typically underlie the younger alluvial deposits within most alluvial valleys and may be encountered during grading. The older deposits are similar in composition to the younger alluvium but generally exhibit greater strength and may be slightly or even moderately cemented locally.

The composition and strength of these older alluvial materials are variable depending on the local parent sources, geologic age and mode of deposition. The older alluvium includes terrace, fan and talus deposits. The composition of the older alluvium or talus can vary greatly. Talus deposits typically contain granitic cobbles and boulders in a silty sand matrix. Clayey sand or sandy clay matrix material may be encountered locally, especially in areas where sources are mafic, volcanic, or metamorphic rocks. Coarse-grained alluvial fan deposits that contain very large clastic material may be encountered near the mountain fronts. These mountain front alluvial deposits are referred to as fanglomerates, and are generally indurated. Fanglomerates are encountered along the slopes of El Capitan Mountain, north of the San Diego River Valley in Section 5.

Possible ancient landslides are present along and near the alignment in Section 4A as discussed in Section 2.1. The proposed access road grading and pad grading in these areas is minor and does not impact the slope stability of these deposits.

Large boulders that result from exfoliation and differential weathering processes are also present at the ground surface throughout much of the area underlain by granitic terrain. Material from rocky outcrops in steep terrain is subject to some down slope movement; thus, some of the rock at the surface has been transported short distances by gravity.

2.2.2 Jacumba Volcanics (Tj)

In the Jacumba area, many of the mesas adjacent to the alignment are capped by Miocene basalt flows, and a number of small peaks represent relict volcanic vents or cones. Large outcrops of volcanic rock are mapped along Section 9C within the Jacumba area as part of the Jacumba Volcanics geologic unit. This unit contains basalt and andesite flows, breccias, and pyroclastic rocks.

2.2.3 Anza Formation (Ta)

This formation consists of Miocene nonmarine sandstone and coarse conglomerate. This is a minor unit relative to the transmission line geology and is present only in the eastern portion of the alignment (Section 9C). Locally, this unit is thin and capped by the Jacumba Volcanics.

2.2.4 Poway Group - Pomerado Conglomerate, Mission Valley Formation, and Stadium Conglomerate (Tp, Tmv, Tst)

Eocene sedimentary deposits of the Poway Group are present along the western end of the alignment. The Poway Group is comprised of conglomerate, nonmarine sandstone, and brackish water claystone and is subdivided into Pomerado Conglomerate (Tp), Mission Valley Formation (Tmv), and Stadium Conglomerate (Tst), from youngest to oldest, respectively. Pomerado and Stadium Conglomerate are prevalent along the alignment in Section 4A, and a relatively thick sequence overlies bedrock in the western portion of Section 5 from structures P35 to P42. These two units are very similar and are generally a massive cobble conglomerate with a, silty to clayey sandstone matrix. The gravels, cobbles and rare boulders consist predominantly of rounded weakly metamorphosed volcanic and volcaniclastic rocks with lesser quartzite and granitic rock. Localized layers or lens of sandstone are also present. These units are slightly to moderately cemented and typically support steep natural and man-made slopes.

2.2.5 Crystaline Rocks of the Peninsular Ranges Batholith of Southern California (Kgr, Ka, Klb, Kjv, Kcm, Kc, Kmgp, Kgm, Klp, Jcr, KJld, Kih)

A major portion of the transmission line alignment crosses the Peninsular Ranges of Southern California. The Peninsular Ranges are comprised of extensive granitic rock, where tonalite and granodiorite are the most abundant single rock types, although the composition ranges from gabbro to granite. The undivided granitic rock unit (Kgr) is a generalized map unit consisting of tonalite and granodiorite mapped along the alignment in Section 5. Several early Cretaceous rock units including tonalite of Alpine (Ka), tonalite of Las Bancas (Klb), the more resistant granitic rocks of the Corte Madera Monzogranite (Kcm), and localized large plutons and small bodies of gabbroic rocks (i.e. dark colored mafic and ultramafic rocks that have high contents of iron- and magnesium-bearing minerals) mapped as Cuyamaca Gabbro (Kc) are prevalent in Sections 5, 7, 8A, and 8B.

The Cuyamaca Gabbro weathers into more clayey soil and is generally more deeply weathered than the lighter colored granodiorites and tonalites. Areas underlain by Cuyamaca Gabbro generally develop a more gentle rolling topographic expression than the other granitic rock types.

Cretaceous granitic rocks of the Granite Mountain tonalite (Kgm) and the La Posta tonalite (Klp) dominate the geology along the alignment in Sections 8C through 9B, and east of Jacumba in Section 9C.

2.2.6 Metavolcanic Rocks (Kmv, Ksp)

The Cretaceous metavolcanic rocks unit (Kmv) is mapped along the mountain slopes of Highway 67, in the San Diego River Valley area (Section 5) and surrounding mountains and becomes more localized in the Alpine area and areas south of Japatul Valley. These rocks consist of metamorphosed volcanic rock of varied original rock type including tuffs, tuff-breccias and volcanic flow rocks. The Santiago Peak Volcanics (Ksp) are also Cretaceous metavolcanic rocks. This unit is common in western San Diego County but is only locally encountered along the Sunrise Powerlink alignment as mapped in the Moreno Valley area of Section 5.

2.2.7 Metamorphic Rocks (JTRm, KJvs, Jsp, MzPzm)

A series of metamorphic rocks assigned to four map units are present along the alignment between the proposed Suncrest Substation and Mountain Springs Grade. The mapped rock units include the Jurassic and Triassic metasedimentary and metavolcanic rocks (JTRm), and the Jurassic and Cretaceous metasedimentary and metavolcanic rocks (KJvs). Migmatic schist and gneiss of Stephenson Peak (Jsp) is mapped northwest of Jacumba in Section 9C. Smaller bodies and inclusions of metamorphic rocks are present locally near the margins within the La Posta plutonic rocks.

2.2.8 Groundwater Conditions

Groundwater is expected to exist at depths that should not typically influence construction of the access roads and structure pads. However, shallow perched ground may occur seasonally in drainages and seeps may occur along steep rocky slopes. Seepage could be encountered during access road or pad construction in cuts along steep rocky slopes.

SECTION 3 DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

In our opinion, the proposed earthwork to develop the access roads to the transmission line structures, the structure pads and the temporary cable pull site pads is geotechnically feasible provided the recommendations of this report are incorporated into design and construction. However, the recommendations are based on the findings from field reconnaissance and knowledge of the performance of similar types of low traffic volume unpaved access roads in the area. Therefore, substantial geotechnical oversight is recommended during construction to: 1) evaluate the adequacy of design based on the subsurface conditions exposed, and 2) provide revised recommendations that may be required when different subsurface conditions are encountered.

The following sections provide geotechnical recommendations based on the information provided to us, results of previous geotechnical investigations, site reconnaissance, engineering evaluations and analyses, and professional judgment. The recommendations consider the low traffic volume, the surrounding rural land use, the unpaved road surface and the temporary condition of grading for pull sites. There may be increased maintenance burden in the future for such items as removing debris from eroding slope surfaces, dislodged cobbles or boulders, or shallow slope failures.

3.1 EARTHWORK

Earthwork should incorporate the following measures that are typical to southern California practices:

- Removing unsuitable soils that do not possess sufficient strength and stability to support fill slopes and retaining structures. Removals should extend to competent materials observed by geotechnical professional supervised by a California-registered Geotechnical Engineer.
- Processing material obtained from excavation to achieve a maximum particle size and distribution that is suitable for conventional placement in engineered fills in accordance with American Society Testing and Materials (ASTM) Test Standard D1557.
- Placing fill in loose lifts that range from 8 to 12 inches and compacting each lift to 90 percent relative compaction, using the latest version of ASTM D1557 as the compaction standard.
- Constructing keyways and benching into competent material for fill slopes.
- Compacting the face of fill slopes.
- Controlled blasting near cut slope faces.

The following sections provide specific recommendations for earthwork.

3.1.1 Site Preparation

Vegetation and debris within areas to be graded should be cleared and properly disposed of offsite. Topsoil should be stripped in areas to be graded and should be disposed offsite or stockpiled for reuse. Topsoil is considered unsuitable fill material, but is a resource for vegetation and may be reused as topsoil in re-vegetated or landscaped areas. Existing infrastructure (if any) should be properly demolished and disposed at an appropriate facility offsite.

Following the clearing of vegetation and debris, and upon completion of removals, the surface within areas to receive fill should be scarified, moisture conditioned as necessary, and compacted prior to fill placement. Areas temporarily excavated during earthwork should be similarly scarified, moisture conditioned and reworked to the satisfaction of a geotechnical professional supervised by a California-registered Geotechnical Engineer before placing additional fill to avoid drying out and lamination along the fill interface.

3.1.2 Fill Materials

Except for organic materials at the surface, the surficial soil deposits and properly processed rock should be suitable for use as general fill to form access roads and structure pads. The characteristics of the material generated during excavation will depend upon the degree of weathering, fracturing and excavation method. Fill should have a maximum particle size of 12 inches with a matrix of fine gravel to relatively well-graded coarse to fine sand.

3.1.3 Fill Placement and Compaction

Fill material should be placed in loose lifts no thicker than the maximum particle size, moisture conditioned, and processed as necessary to achieve uniform moisture content above optimum. Fill material should be placed and processed to avoid "nesting" or concentrations of rock without sufficient fines for compaction. Each lift should be compacted to not less than 90 percent relative compaction, using the latest version of ASTM D1557 as the compaction standard. Placement of fill should be performed under the observation and testing services of a geotechnical professional supervised by a California-registered Geotechnical Engineer.

3.1.4 Import Materials

Import materials are not anticipated for the proposed project. However, if used, a Geotechnical Engineer should review and test all import sources prior to their use.

3.1.5 Fill Slopes

Fill slopes may be constructed at inclinations no steeper than 1.5:1 H:V. Fill slopes should be keyed and benched into competent material to the maximum extent practicable. Keying and benching should be observed by geotechnical professional supervised by a California-registered Geotechnical Engineer. Figure 4 presents a typical detail for keying and benching.

Compaction should occur to the edge of the fill slope to the maximum extent practicable. The face of fill slopes should be compacted by “trackwalking” with dozer at 5 foot increases in height as the slope is formed.

3.1.6 Cut Slopes

Permanent cut slopes can be designed to inclinations ranging from 1.5:1 to 0.75:1 H:V depending on the material type and degree of weathering. Tables 1 through 9 summarize the recommended cut slope inclinations based on the geologic conditions interpreted from field reconnaissance.

Most cut slope excavations for the project should expose variously weathered rock although there are some areas where older sedimentary deposits or alluvial deposits are present in areas of planned cuts. The ability to construct the proposed cut slope inclinations depends on the material, the degree of weathering and, within the fresh to slightly weathered rock, the presence, frequency and orientation of rock mass discontinuities (e.g., joints, fractures etc.). Discontinuities that remain in the weathered rock can also influence stability. Discontinuities oriented out-of-slope (dip angle parallel or shallower than the slope inclination) could result in deep-seated type failures (rock glides), or surface failures such as rockfalls, spalling or exfoliation.

Therefore, large cut slopes (in excess of 10 feet high) should be geologically reviewed as excavation proceeds downward to evaluate the character and orientation of discontinuities. Some form of stabilization is often needed following excavation of cut slopes formed in rock. It may be necessary to locally apply surface type rock stabilization measures, such as scaling, wire netting, rock dowels and rock bolts. Appendix A provides a guide specification for cut slope stabilization.

If blasting is performed near finished cut slope surfaces, it should be controlled to minimize the development of new cracks and/or expansion of existing discontinuities. Controlled blasting techniques, such as presplitting or smooth-wall blasting should be considered.

A boulder survey should be completed in the area above and below the planned crest of cut slopes to evaluate the rockfall potential. The slopes above all cuts should be cleared (scaled) of potentially unstable boulders that present a rockfall hazard. This scaling activity should precede any blasting or significant grading activities on the slopes. Boulders that could be dislodged by the grading process or that are potentially unstable should be safely removed or stabilized.

3.1.7 Surface Drainage

Surface drainage should be directed away from the top of slopes and road surfaces. Ponded water at the top of slope and sheet flow over slope surfaces should not be allowed.

3.2 CANTILEVER MASONRY RETAINING WALLS

Cantilever type masonry retaining walls will be used to retain cut slopes such that project grading remains within the project Right-of-Way. The maximum height of masonry wall will be about 12 feet. The walls will support sloping ground with inclinations ranging from 2:1 to 1.5:1 H:V.

3.2.1 Design Parameters

Continuous spread footings may be used to support the masonry retaining walls. The footings may be designed for an allowable bearing pressure of 3,000 pounds per square foot (psf). Footings should be embedded to the maximum extent practicable, a minimum of 18 inches within competent material observed by a geotechnical professional supervised by a California-registered Geotechnical Engineer. The recommended bearing capacity assumes there is level infinite ground in front of the wall.

The following table presents recommended equivalent fluid pressures for walls with ascending sloping ground behind the wall where the back of the wall is vertical and there is no surcharge or hydrostatic pressure.

Design Parameter	Value (pounds per cubic foot [pcf])	Condition
Active Equivalent Fluid Pressure	40	2:1 (H:V) ascending
	50	1.5:1 (H:V) ascending
Allowable Passive Resistance	300	Level ground

These lateral earth pressure values are applicable for coarse-grained, relatively free-draining, non-to low-expansive soils placed as properly compacted backfill. The values above assume that compaction within four feet of the wall will be performed with light hand-held equipment or equivalent equipment; the lateral pressures would be higher if heavy equipment is used for compaction next to the walls.

3.2.2 Subsurface Drainage

The retaining wall design should include subsurface drainage to reduce the potential for developing hydrostatic pressure behind the wall. Retaining walls should have free draining material immediately behind the back of the wall and a base drain. Except for the upper two feet, the backfill immediately adjacent to retaining walls (minimum horizontal distance of 12 inches measured perpendicular to the wall) should consist of ¾-inch crushed rock wrapped in filter fabric, such as Mirafi 140N, or approved equivalent. Pervious Backfill conforming to Standard Specifications for Public Works Construction or Permeable Material conforming to California Department of Transportation (Caltrans) Standard Specifications (Caltrans, 2006) may be used as an alternative to crushed rock and filter fabric. The free draining material should be placed in layers (no thicker than 6 inches) and lightly vibrated with four to five passes of a small, hand-operated vibratory compactor.

The base drain should be a minimum four-inch diameter perforated pipe (SDR 35) leading to a suitable permanent outlet. The pipe should be surrounded by at least one cubic feet, per foot of pipe, of free draining ¾-inch crushed rock wrapped with filter fabric, such as Mirafi 140N, or approved equivalent. Weep-holes may be used as an alternative to the perforated pipe base drain and outlet. Weep-holes should be at least 2 inches in diameter and spaced no greater than 8 feet. They should outlet immediately above finished grade at the bottom of wall.

Prefabricated drainage composites, such as MiraDrain 6000 or equivalent, may be used as an alternative to placing free draining material immediately behind the back of the wall. Manufacturer recommendations for the installation of these products should be followed, although a Geotechnical Engineer should review the recommendations in consideration of the specific application and interpreted subsurface and groundwater conditions. Drainage composites should be attached to the back of the retaining wall as opposed to the excavated face. A Geotechnical Engineer should review the proposed drainage composite, as well as the outlet detail.

3.3 MECHANICALLY STABILIZED EARTH RETAINING WALLS

Hilfiker® welded wire faced Mechanically Stabilized Earth (MSE) retaining walls are proposed to retain fill slopes. Geosynthetic-reinforced fill will be used to form these gravity retaining structures. The wall heights will typically be about 18 to 20 feet, with a maximum wall height of about 32 feet.

3.3.1 Design Parameters

Processed on-site materials placed as properly compacted fill should possess an internal friction angle of at least 35 degrees and a moist unit weight of 130 pcf. The processing of material should limit the maximum particle size to 4 inches. The National Concrete Masonry Association (NCMA, 2002) recommends the following physical characteristic for soils placed in the reinforced zone. It may be necessary to selectively screen, process and stockpile material to meet these physical characteristics.

Sieve Size	Recommended Gradation Percent Passing by Weight
100 mm (4 inch)	100 – 75
4.76 mm (No. 4)	20 – 100
0.425 mm (No. 40)	0 – 60
0.075 mm (No. 200)	0 – 35
Plasticity Index (PI) [a]	< 20

Notes:
a. A PI < 8 is recommended to minimize expansive potential and provide suitable drainage characteristics.
b. mm – millimeters.

Designers of MSE retaining walls should note the following site-specific conditions:

- Installation damage reduction factors should be used to assess the allowable strength of the geogrid reinforcement. NCMA recommends using installation damage reduction factors since the angular particles that ¾ inch, or larger in size are more likely to damage the geogrid reinforcement during the placement and compaction of fill in the reinforced zone. We expect that much of the material processed for fill in the reinforced zone will possess angular gravel that is greater than a ¾-inch particle size.
- Where there is a potential for conflict between structure foundations and geogrid reinforcement, the designer should consider additional reinforcement coverage to compensate for removal of the geogrid reinforcement required to install the foundations.
- Typically, seismic design for MSE retaining walls includes conventional pseudo-static loading during global stability analyses; internal seismic loading is not used in MSE design (Caltrans, 2009).
- MSE retaining walls should be founded on competent materials observed by a geotechnical professional supervised by a California-registered Geotechnical Engineer. Foundations should be setback from descending slopes a minimum distance of 7 feet measured horizontally from the outside bottom edge of the foundation to the slope face. The wall designer should provide the bearing pressure to URS to review where MSE retaining walls will be founded within descending slopes.

- Backfill material within the reinforced and retained zones should be compacted to a minimum of 90 percent of maximum dry density as determined by ASTM D1557. The rock fill within the facing zone should be compacted with relatively light vibratory roller or equivalent equipment.

3.3.2 Subsurface Drainage

Based on the anticipated backfill materials available on site, subsurface drainage should not be necessary for MSE retaining walls. However, the contract documents should include provisions that allow the Geotechnical Engineer to instruct the contractor to place additional subsurface drainage if geologic mapping of the wall backcut exposes seeps or other similar forms of groundwater that have the potential to exceed the capacity of standard wall drains. An inclined drainage system or chimney drain along the wall backcut should be considered in such circumstances. Figure 5 presents typical details for drain construction.

3.4 RETAINING WALL GLOBAL STABILITY ANALYSIS

Global (overall) stability was evaluated at selected cut and fill wall locations. Two-dimensional slope stability analyses were performed using the computer program SLOPE/W (version 7.0) developed by Geo-Slope International (2007). Analyses were performed at selected wall locations based on the proposed wall heights and site conditions identified on the wall cross-sections prepared by BV, and anticipated subsurface conditions. For each cross section analyzed, the program searches for the sliding surface that produces the lowest factor of safety. Stability factors of safety are defined as the ratio of the shear forces and moments resisting movement along a potential sliding surface to the forces or moments driving the instability. Minimum static and pseudo-static factors of safety of 1.5 and 1.1, respectively, generally indicate a stable slope condition. A seismic coefficient, equal to one-third of the horizontal peak ground acceleration (PGA), was used for pseudo-static analysis (Caltrans, 2009). The PGA was calculated using the U.S. Geological Survey developed ground motion program (USGS, 2009).

3.4.1 Cut Walls – Cantilever Masonry Retaining Walls

Stability analyses for the cut walls included foundation soil parameters based on our geotechnical and geologic hazards investigation report (URS, 2009b) and retained slope conditions identified in Section 3.2.1. Wall backfill material properties were developed assuming that the backfill is generated on-site and screened to meet the requirements of a coarse-grained, relatively free-draining, non-to-low-expansive material placed as compacted fill, presented in Section 3.2.1. Static and pseudo-static analyses performed at two critical wall cross-sections indicate the walls should be globally stable considering static and pseudo-static conditions.

3.4.2 Fill Walls – Hilfiker® MSE Walls

Stability analyses for Hilfiker® MSE fill walls incorporated the soil parameters required for the MSE backfill materials presented in Section 3.3.1 and anticipated foundation materials based on our geotechnical and geologic hazards investigation report (URS, 2009b). A uniform vertical surcharge pressure of 240 psf was applied to simulate construction loads on the graded structure pad. The potential slip surfaces were not permitted to go through the reinforcement.

Based on our analysis of preliminary wall geometries and locations, global stability may control the geogrid lengths. The geogrid lengths should be a minimum of 0.8 times the wall height. URS should review the finalized MSE wall designs to confirm that global stability is maintained. In addition, if new walls are designed from the date of this report, URS should be notified to evaluate the need for further analyses.

Internal and external stability of the MSE walls are responsibility of the wall designer. Internal stability design is dependent of the soil reinforcement extensibility and material type. Internal stability failure modes include soil reinforcement rupture, soil reinforcement pullout, and excessive elongation under the design load. External stability includes resistance to sliding, and overturning, maximum eccentricity, and bearing capacity.

3.5 TEMPORARY SLOPES

The design and excavation of temporary slopes as well as their maintenance during construction is the responsibility of the Contractor. The Contractor should have a geotechnical or geological professional evaluate the soil conditions encountered during excavation to determine permissible temporary slope inclinations and other measures as required by the California Occupational Safety and Health Administration OSHA (Cal/OSHA).

Based on the existing data the design of temporary slopes and benches for planning purposes may assume the conditions below.

Geological Unit	Cal/OSHA Soil Type
Surficial Deposits	Type C
Completely to highly weathered rock with no adverse geological defects	Type B
Moderately weathered rock with no adverse geologic defects	Stable Rock

The Contractor's geotechnical or geological professional may use the information provided in this report to assess the stability of temporary slopes, as well as any additional data they may need to acquire, to prepare a specific temporary slope analysis and design. Existing infrastructure that is within a 2:1 H:V line projected up from the bottom edge (toe) of temporary slopes should be monitored during construction.

The Contractor should note that the materials encountered in construction excavations may vary along the project alignment. The above assessment of soil type for temporary excavations is based on preliminary engineering classifications of material determined in our previous report (URS 2009b). The Contractor's geotechnical or geological professional should observe and map mass excavations and temporary slopes at regular intervals during excavation and assess the stability of temporary slopes, as necessary.

The tops of all excavations should be graded to prevent runoff from entering the excavation. Temporary slopes should not be allowed to become soaked with water or to dry out. Surcharge loads should not be permitted near the edge of excavations; they should be located a horizontal distance greater than the depth of the cut, measured horizontally from the top edge of the excavation, unless the cut is properly shored and designed to accommodate the surcharge.

SECTION 4 UNCERTAINTIES AND LIMITATIONS

The recommendations made herein are based on the assumption that subsurface conditions do not deviate appreciably from those found during our field reconnaissance and during the previous geotechnical investigations. We recommend that URS review the final grading plans to verify that the intent of the recommendations presented herein has been properly interpreted and incorporated into the contract documents. We further recommend that all foundation and slope excavation areas and fill and backfill placement be observed by a qualified engineer or geologist, to further evaluate if site conditions are as anticipated, to help identify and mitigate rock fall hazards, or to provide revised recommendations, if necessary.

Geotechnical engineering and the geologic sciences are characterized by uncertainty. Professional judgments presented herein are based partly on our understanding of the proposed construction, and partly on our general experience. Our engineering work and judgments rendered meet current professional standards; we do not guarantee the performance of the project in any respect.

Southern California is an area of high seismic risk. It is generally considered economically unfeasible to build a totally earthquake-resistant project; it is therefore possible that a large or nearby earthquake could cause damage at the site.

Final design details for the proposed project are not available at this time. The recommendations presented in this report are intended to assist SDG&E and their subconsultants in the project planning and design. The professional judgments and interpretations presented in this report are based on our current knowledge of the proposed project, our interpretations of the subsurface conditions in the project area, and our understanding of the geologic and tectonic setting of the project. This knowledge is based on the information provided to us, published literature, and our investigations referenced in this report and field reconnaissance.

SECTION 5 REFERENCES

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URS Corporation, 2009b. “DRAFT Geotechnical and Geologic Hazards Investigation, Sunrise Powerlink Project, San Diego and Imperial Counties, California,” dated August 28, 2009, URS Project No. 27668031.00040.

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Table 1
Section 4A Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P6-1	Massive cobble conglomerate(gravels, cobbles, rare boulders in a sandy matrix with variable cementation) -	1:1	Access road and pad
P7	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P8-2	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P10	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P11	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P13-2	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P14	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P15	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P23	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P24	Massive cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad

Table 2
Section 5 Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P34-2	Metamorphic and meta-granitic rock with localized colluvium and thin residual soils	1:1	Access road
		0.75:1	Pad
P35-2	Pad located at geologic contact between granitic rocks below and a capping deposit of cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P36-1	Cobble conglomerate (gravels, cobbles, rare boulders in a sandy matrix with variable cementation)	1:1	Access road and pad
P43-1	Granitic rock with abundant boulder outcrops, historic grading in immediate area has cuts ranging from 50 to 60 degrees	0.75:1	Access road and pad
P44-1	Granitic and metamorphic rock along ridge	1:1	Access road and pad
P45-1	Granitic rock with localized surficial deposits along access road	1:1	Access road and pad
P46-2	Granitic rock with rocky outcrops in pad area	1:1	Access road and pad
P47-2	Granitic rock with large boulder outcrops, steep slopes along access road/ Potential rock fall hazard during construction activities	0.75:1	Access road and pad
P47A-1	Granitic rock with localized large boulder outcrops, massive rock outcrop along proposed access road route to the east of P47A-1 pad / Potential rock fall hazard during construction	0.75:1	Access road and pad
P48-2	Granitic rock with localized large boulder outcrops,	0.75:1	Access road and pad
P49-1	Granitic rock with localized large boulder outcrops,	0.75:1	Access road and pad
P50-1	Mixed granitic rock types, fanglomerate in lower road area near larger drainage cross	0.75:1	Upper access road and pad
		1:1	Lower access road adjacent to drainage
P52	Granitic rock with boulder outcrops	0.75:1	Access road and pad

Table 2
Section 5 Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads
(Continued)

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P53-1	Granitic rock with localized boulder outcrops and locally steep slopes	0.75:1	Access road and pad
P54-1	Very steep slopes and granitic rock with large boulder outcrops / Potential rock fall hazard during construction	0.75:1	Access road and pad
P55	Steep and locally very steep slopes with large boulder outcrops/ potential rock fall hazard during construction activities	0.75:1	Access road and pad
P57	Metavolcanic rock and moderate terrain along ridge line	1:1	Access road and pad
P58	Metavolcanic rock and localized colluvium	1:1	Access road and pad
P59	Metavolcanic rock with exposures near pad, road has fanglomerate (localized boulders) over rock locally	0.75:1	Pad and upper half of access road
		1:1	Lower half of access road
P60	Granitic and metavolcanic rock	0.75 :1	Access road and pad
P61	Granitic and metavolcanic rock	0.75 :1	Access road and pad
P62	Colluvium over granitic rock	1:1	Access road and pad
P63	Granitic rock, dark, more deeply weathered	0.75:1	Pad
		1:1	Access road
P67-1	Granitic rock at pad and along upper end of access road, central and lower portion of access road underlain by boulder fanglomerate	0.75:1	Pad and uppermost portion of access road
		1:1	Central and lower portion of access road
P71	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad

Table 2
Section 5 Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads
(Continued)

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P72-2	Granitic rock with boulder outcrops and localized colluvium, drainage crossed by access road	0.75:1	Access road and pad
P73-2	Granitic rock with boulder outcrops and localized colluvium, drainage crossed by access road	0.75:1	Access road and pad
P74-2	Granitic rock with boulder outcrops and localized colluvium, two drainages crossed by access road	0.75:1	Access road and pad
P75-1	Granitic rock with boulder outcrops and localized colluvium, drainage crossed by access road	0.75:1	Access road and pad
P76-1	Granitic rock with boulder outcrops and localized colluvium, drainage crossed by access road	0.75:1	Access road and pad
P77	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad
P78-1	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad
P79-1	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad
P80-1	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad
P82-1	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad
P-83	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad
P-84	Granitic rock with boulder outcrops and localized colluvium	0.75:1	Access road and pad

Table 3
Section 7 Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P99-1	Granitic rock with localized rock/boulder outcrops, colluvium and thin residual soils	1:1	Access road and pad
P100-1	Granitic rock with localized rock/boulder outcrops, colluvium and thin residual soils	1:1	Access road
		0.75:1	Pad
P107	Metamorphic rock (migmatite, schists, and localized granitic rock) with localized colluvium and thin residual soils	1:1	Access road
		0.75:1	Pad
P108	Metamorphic rock (migmatite, schists, and localized granitic rock) with localized colluvium and thin residual soils	1:1	Access road
		0.75:1	Pad
P109-1	Metamorphic rock (migmatite, schists, and localized granitic rock) with localized colluvium and thin residual soils	1:1	Access road
		0.75:1	Pad

Table 4
Section 8A - Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P10-1	Granitic rock with isolated/scattered boulder/rock outcrops and localized colluvium and thin residual soils	1:1	Access road and pad
P22-1	Gabbro (mafic rock) and localized granitic rock and colluvium and thin residual soils: Pad located near geologic contact between granitic rock and gabbroic rocks	1.5:1	Access road
		1:1	Pad
P23-2	Granitic rock with isolated/localized boulder/rock outcrops and localized thin residual soils with cobbles	1:1	Access road and pad
P24-1	Granitic rock with isolated/scattered boulder/rock outcrops and localized colluvium and thin residual soil cover	1:1	Access road and pad
P29-1	Granitic rock with isolated/scattered boulder/rock outcrops and localized colluvium and thin residual soils	1:1	Access road and pad
P35-1	Granitic rock with some large boulder/rock outcrops and localized colluvium and thin residual soils	1:1	Access road and pad
P37-2	Granitic rock with extensive rock surface exposures to the south and locally around pad areas	1:1	Access road and pad
P39-1	Granitic rock with localized large boulder rock outcrops	1:1	Access road and pad
P41	Granitic rock with localized large rock/boulder outcrops and thin colluvium and residual soils along access road; geologic contact. between granitic and gabbro rock near access road at ridgeline into pad area; pad in gabbro rock with thin colluvium and residual soils	1:1	Access road and pad
P42	Gabbro rock with localized boulder outcrops and granitic rock zones, with thin colluvium and residual soils along access road; gabbro rock in pad area with relatively thin residual soils and localized rock/boulder outcrops	1.5:1	Access road and pad

Table 5
Section 8C Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P47-2	Granitic rock with localized large rock/boulder outcrops, colluvium and relatively thin residual soils along access road; pad (west) located at toe of slope of massive granitic bedrock	0.75:1	Pad
		1:1	Access road
P53-2	Granitic rock with extensive rock outcrop along west side of pad, gabbroic rock along east side of pad and access road	0.75:1	Pad and large cut slope along upper road portion (to approx. Sta. 10+50)
		1:1	Remainder of access road
P56-3	Granitic rock near top of knoll with extensive rock outcrop	0.75:1	Pad and upper portion of access road
		1:1	Lower portion of access road
P57-1	Granitic rock with common rock outcrops	0.75:1	Pad area and access road from Sta. 0+00 to approx. 2+ 00
		1:1	Remainder of access road
P58-2	Grantic rock with common rock outcrops	1:1	Access road and pad
P62A-1	Granitic rock with extensive rock outcrops	0.75:1	Access road and pad
P63	Granitic rock with extensive rock outcrops	0.75 :1	Access road and pad
P-64	Granitic rock with extensive rock outcrops	0.75 :1	Access road and pad
P-65-1	Granitic rock with extensive rock outcrops	0.75 :1	Access road and pad

Table 6
Section 8D Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P69	Granitic rock with extensive rock outcrops	0.75 :1	Access road and pad
P70	Granitic rock with extensive rock outcrops	0.75 :1	Access road and pad
P75-1	Granitic rock with extensive rock outcrops	0.75 :1	Access road and pad
P76-1	Granitic rock with common outcrops	1:1	Access road and pad
P80	Granitic rock with localized rock/boulder outcrops (isolated massive bedrock), colluvium and relatively thin residual soils	1:1	Access road
		0.75:1	Pad
P83	Granitic rock with localized rock/boulder outcrops (isolated massive bedrock), colluvium and residual soils	1.5:1	Access road
		0.75:1	Pad
P86-1	Granitic rock with localized rock/boulder outcrops, colluvium and residual soils	1:1	Access road and western (lower) pad
		0.75:1	Eastern (upper) pad and upper access spur
P87-1	Granitic rock with localized rock/boulder outcrops, colluvium and residual soils	0.75:1	Pad area and access road from Sta. 28+50 to 29+50 and 31+00 to pad
		1:1	Remainder of access road
P88-1	Granitic rock with localized rock/boulder outcrops, colluvium and residual soils	0.75:1	Pad area and access road from Sta. 1+00 to 4+00
		1:1	Access road from Sta. 4+00 to 8+66

Table 7
Section 8E Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

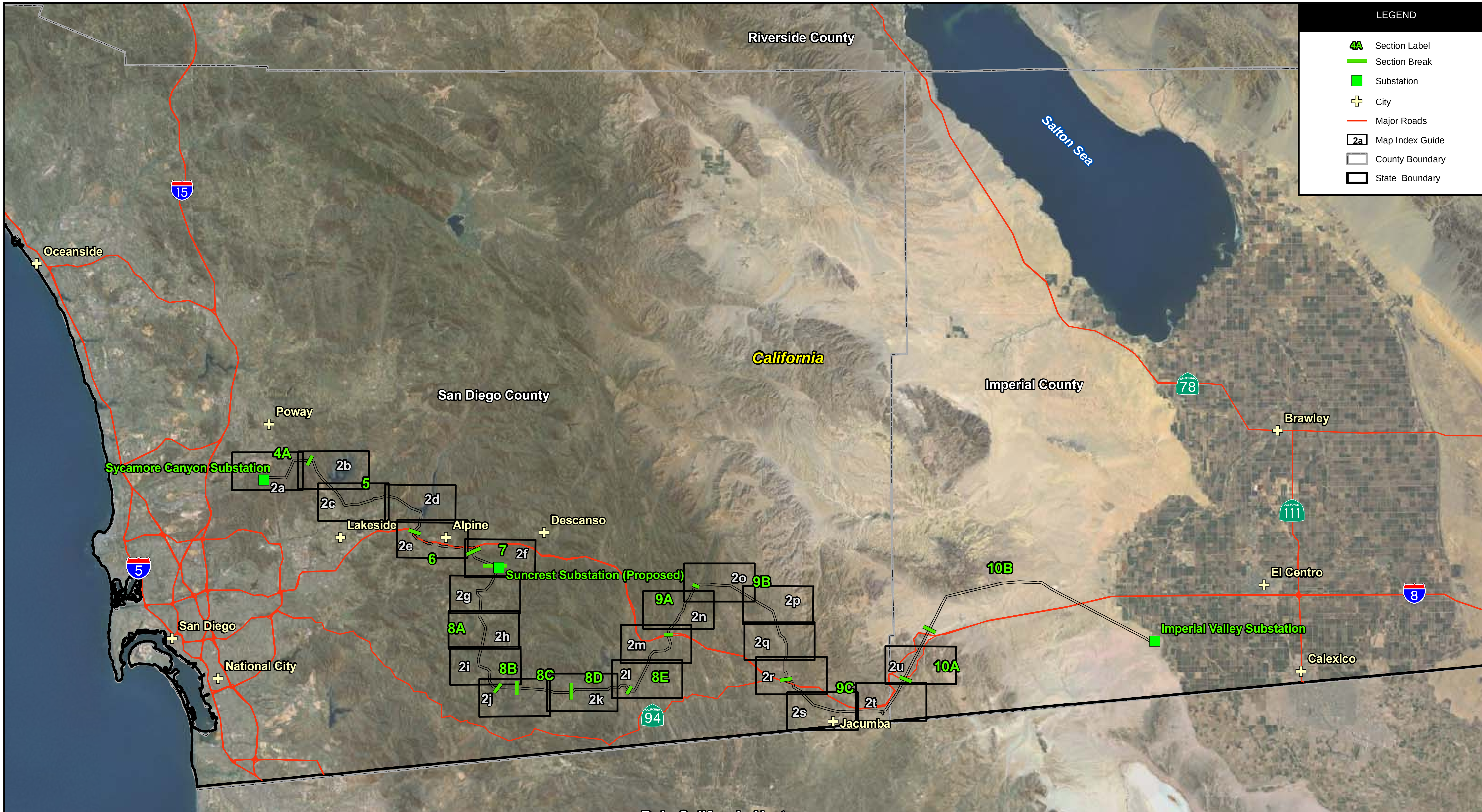
Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P89-1	Colluvium and residual soils over weathered granitic bedrock, fill east of structure site-recent grading in immediate area (platform)	1:1	Access road and pad
P106-3	Granitic rock with scattered boulder/rock outcrops and localized colluvium and thin residual soils. Massive bedrock existing near southwestern edge of pad.	1:1	Access road
		0.75:1	Pad
P119-2	Alluvium, colluvium and residual soils along access road (Valley), then granitic rock with localized colluvium and thin residual soils in hill slope access road to pad area	1.5:1	Access road in valley
		1:1	Pad and remainder of the access road

Table 8
Section 9A Cut Slope Recommendations
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Structure No.	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P120-3	Granitic rock, deeply weathered with localized rock outcrops	1:1	Access road and pad
P120A	Granitic rock, deeply weathered with localized rock outcrops	1:1	Access road and pad
P121A	Granitic rock, weathered with rock outcrops	1:1	Access road and pad
P122-2	Granitic rock with extensive rock outcrop locally.	0.75:1	Access road and pad
P123-1	Granitic rock with localized rock/boulder outcrops (isolated massive bedrock), colluvium and residual soils (increase along lower access road area	1.5:1	Along lower access road (first 150 feet)
		0.75:1	Upper access road and pad
P129	Granitic rock with increasing outcrops near crest of knoll	0.75:1	Pad
		1:1	Access road

Table 9
Cut Slope Recommendations for Proposed Pull Sites
SDG&E Sunrise Powerlink Project
Access Roads and Structure Pads

Pull Site	Section	Site and Geologic Conditions	Recommended Inclinations (H:V)	Slope Location
P120-3 - P120A	9A	Granitic rock, generally deeply weathered, some boulder outcrop. Permanent Wire Site	1.5 :1	Access road and pad
P141	9B	Alluvium/colluvium over deeply weathered granitic rock.	1.5:1	Pad
P170	9B	Weathered granitic rock, few outcrops	0.75:1	Access road and pad
P177-178	9B	Weathered granitic rock	0.75:1	Access road and pad
P187-2	9B	Weathered granitic rock with few large boulder outcrops	0.75:1	Access road and pad
P192-1	9B	Weathered granitic rock and surficial soils few outcrops	0.75:1	Access road and pad
P193-1	9B	Weathered granitic rock extensive boulder outcrops	0.5:1	Pad
P203-3 – P204-3	9B	Weathered granitic rock and surficial deposits	1.5:1	Access road and pad
P215	9C	Weathered granitic rock and surficial deposits	1:1	Access road and pad
P219-1	9C	Weathered granitic rock and surficial deposits	0.75:1	Access road and pad
P220-1	9C	Weathered granitic rock with common rock outcrops	0.75:1	Access road and pad
P225-1 - P226-1	9C	Weathered granitic and metamorphic rock in cut area	0.75:1	Access road and pad
P236-1 – P237-1	9C	Weathered granitic rock	1:1	Access road and pad
P243 – 244	9C	Sandy alluvium	1.5:1	Access road and pad
P255-1	9C	Alluvium and Older alluvium	1.5:1	Access road and pad



SOURCES:
ESRI (Cities, Major Roads, County and State Boudaries); SDGE (Sunrise Power Link Route 2009); USDA NAIP (Aerial 2005)

VICINITY MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

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SCALE: 1" = 8 Miles (1:506,880)
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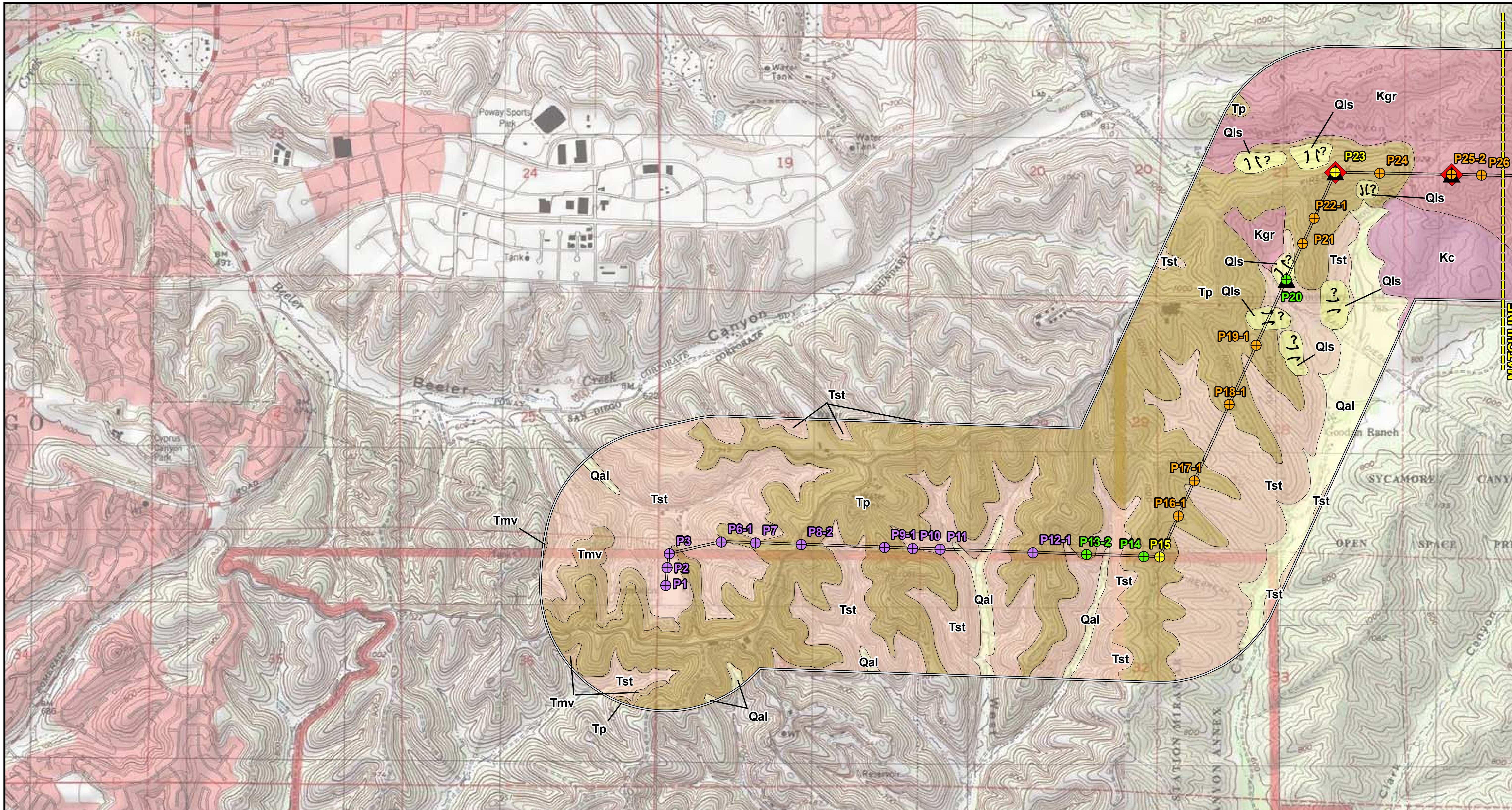

Proposed Centerline
- Overhead
- Underground
- Section Boundary

Structure Type
- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)
- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

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SCALE: 1" = 2000' (1:24,000)
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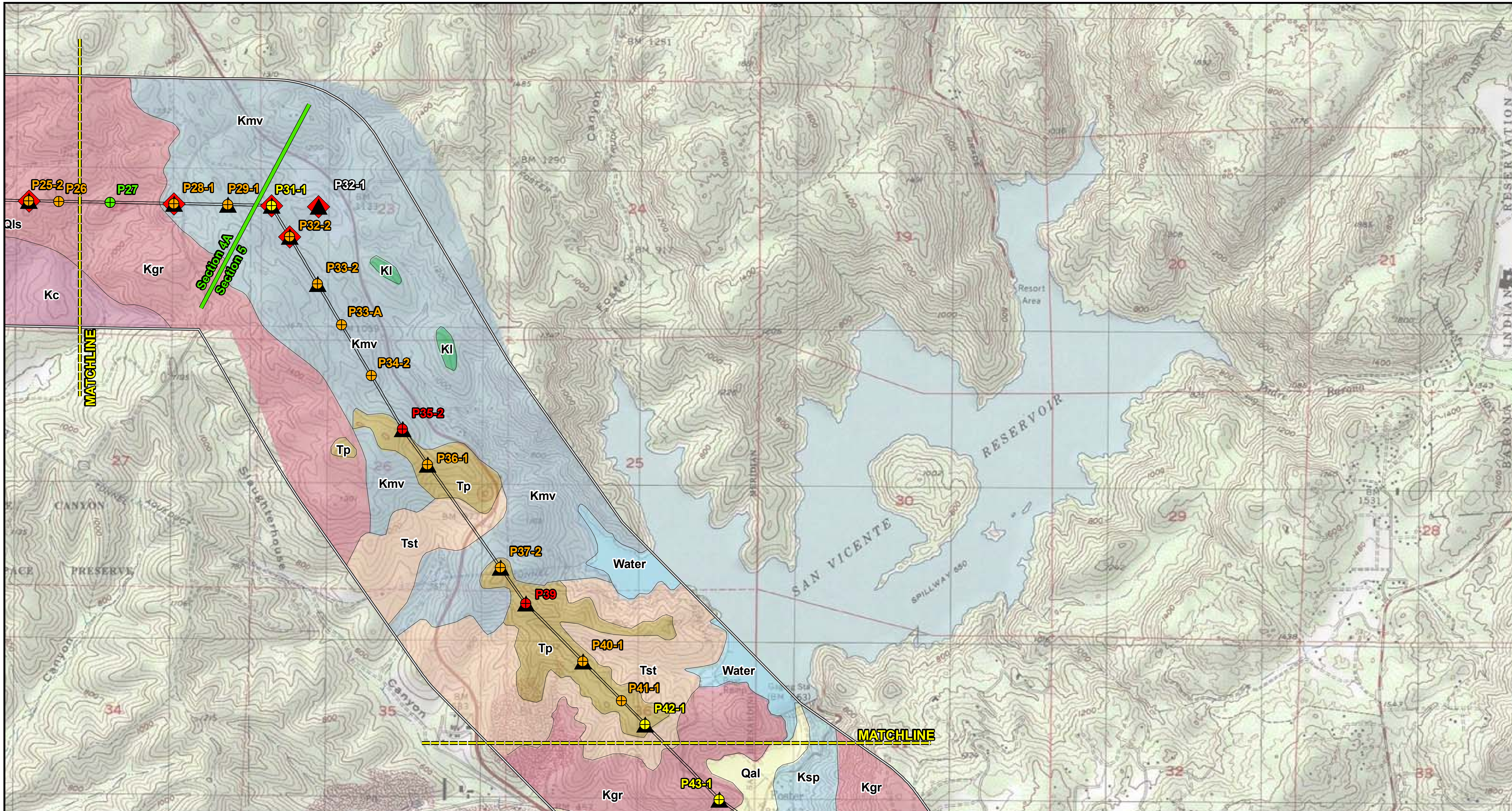

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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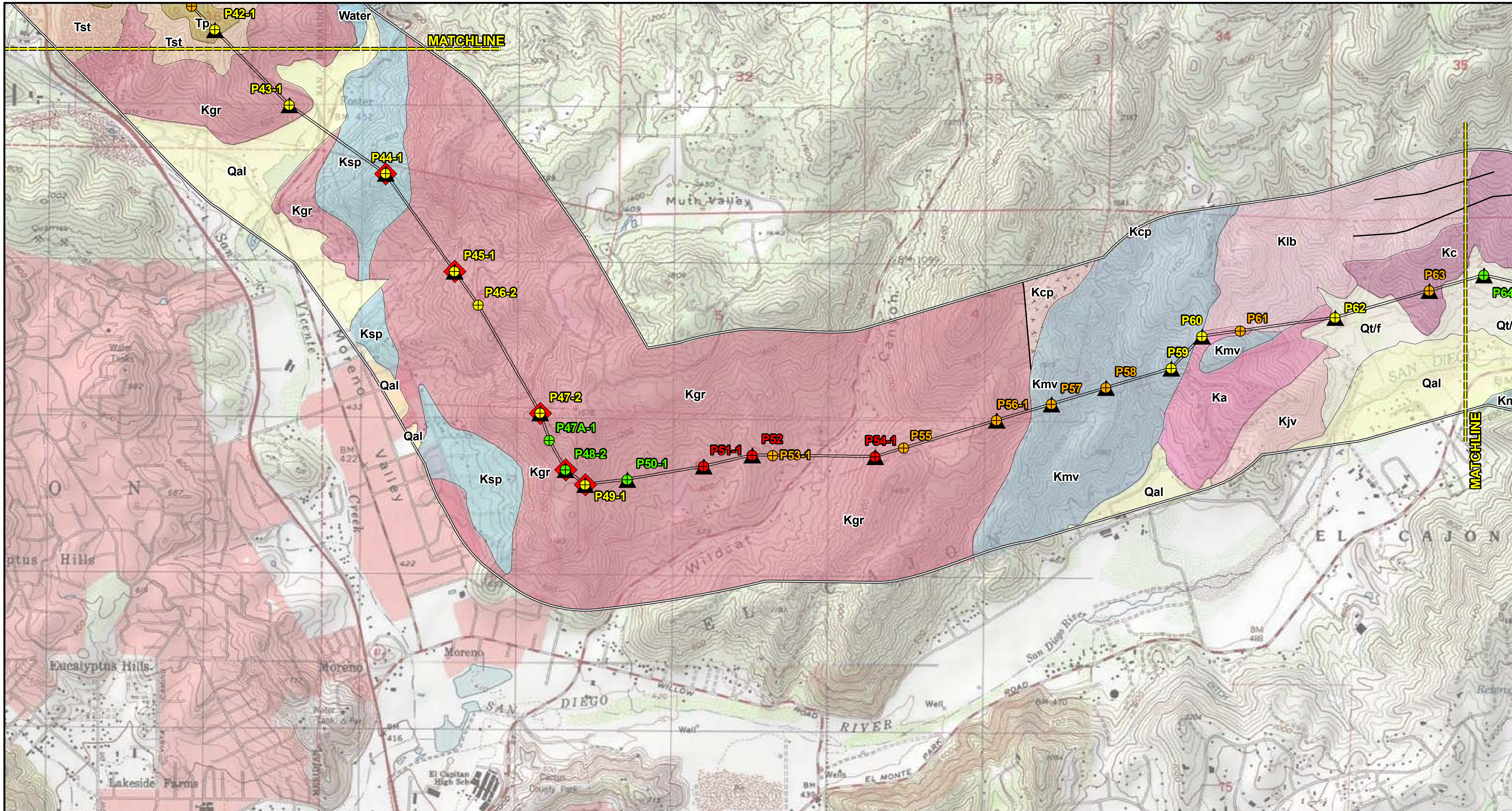

Proposed Centerline
- Overhead
- Underground
- Section Boundary

Structure Type
- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)
- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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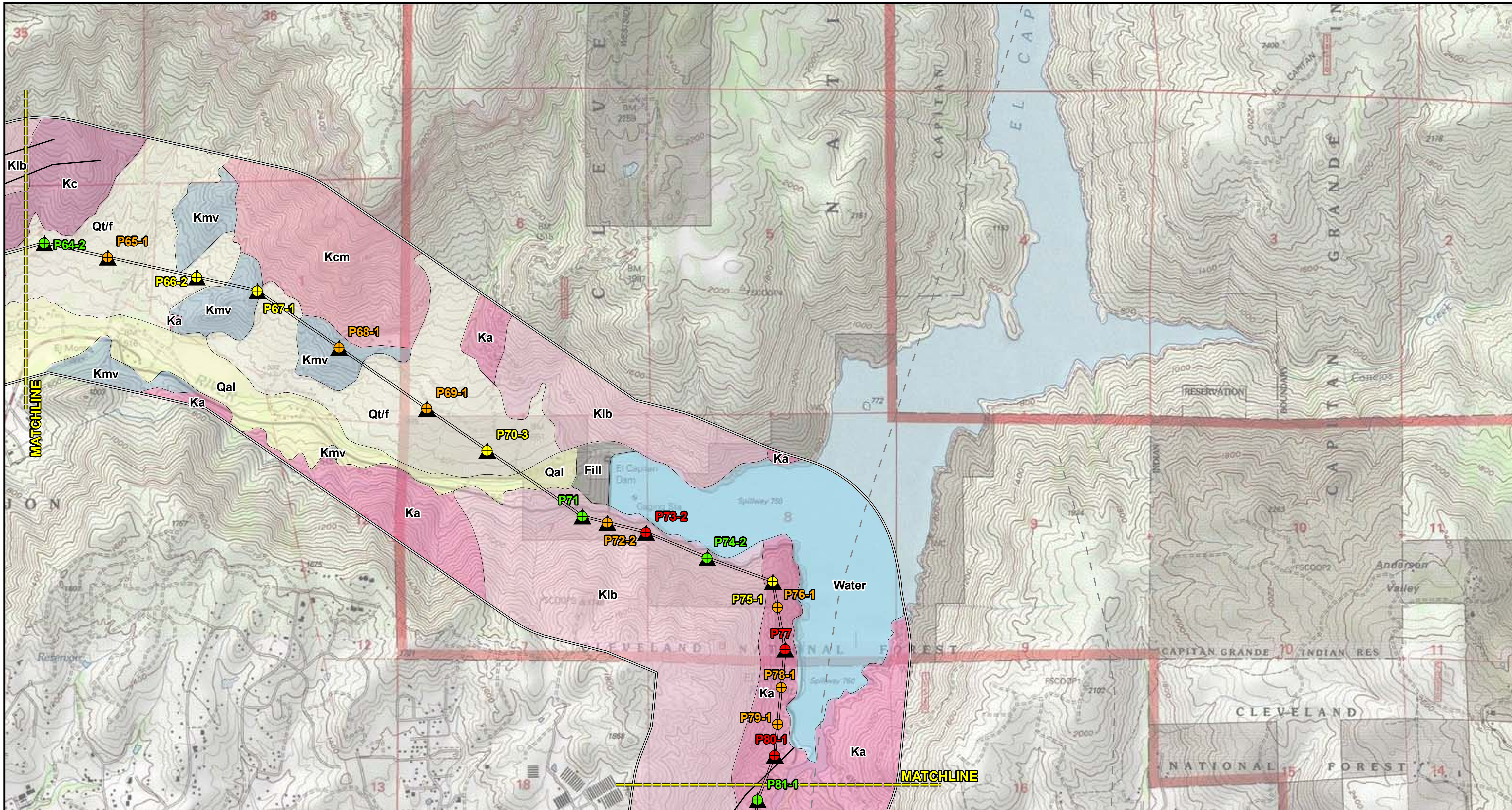

Proposed Centerline
- Overhead
- Underground
- Section Boundary

Structure Type
- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)
- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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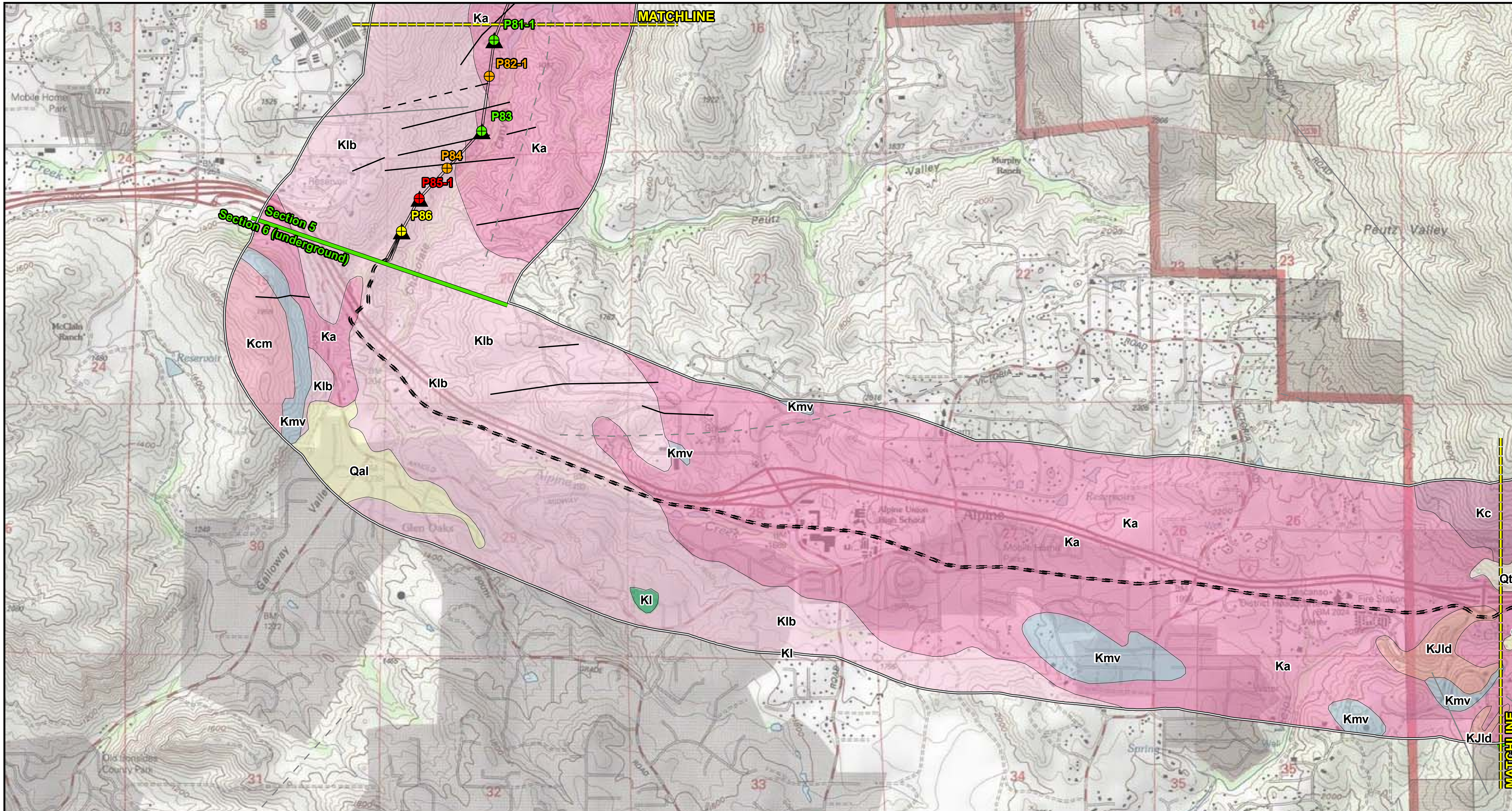

Proposed Centerline	Structure Type	On-Going URS Geotechnical Investigation (2009)	
Overhead	Angle	Seismic Refraction Location Coincident with Structure	Seismic Refraction Location at Previously Considered Structure Location
Underground	Dead End	Electrical Resistivity Location Coincident with Structure	Electrical Resistivity Location at Previously Considered Structure Location
Section Boundary	Strain		
	Tangent		
	Miscellaneous		

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

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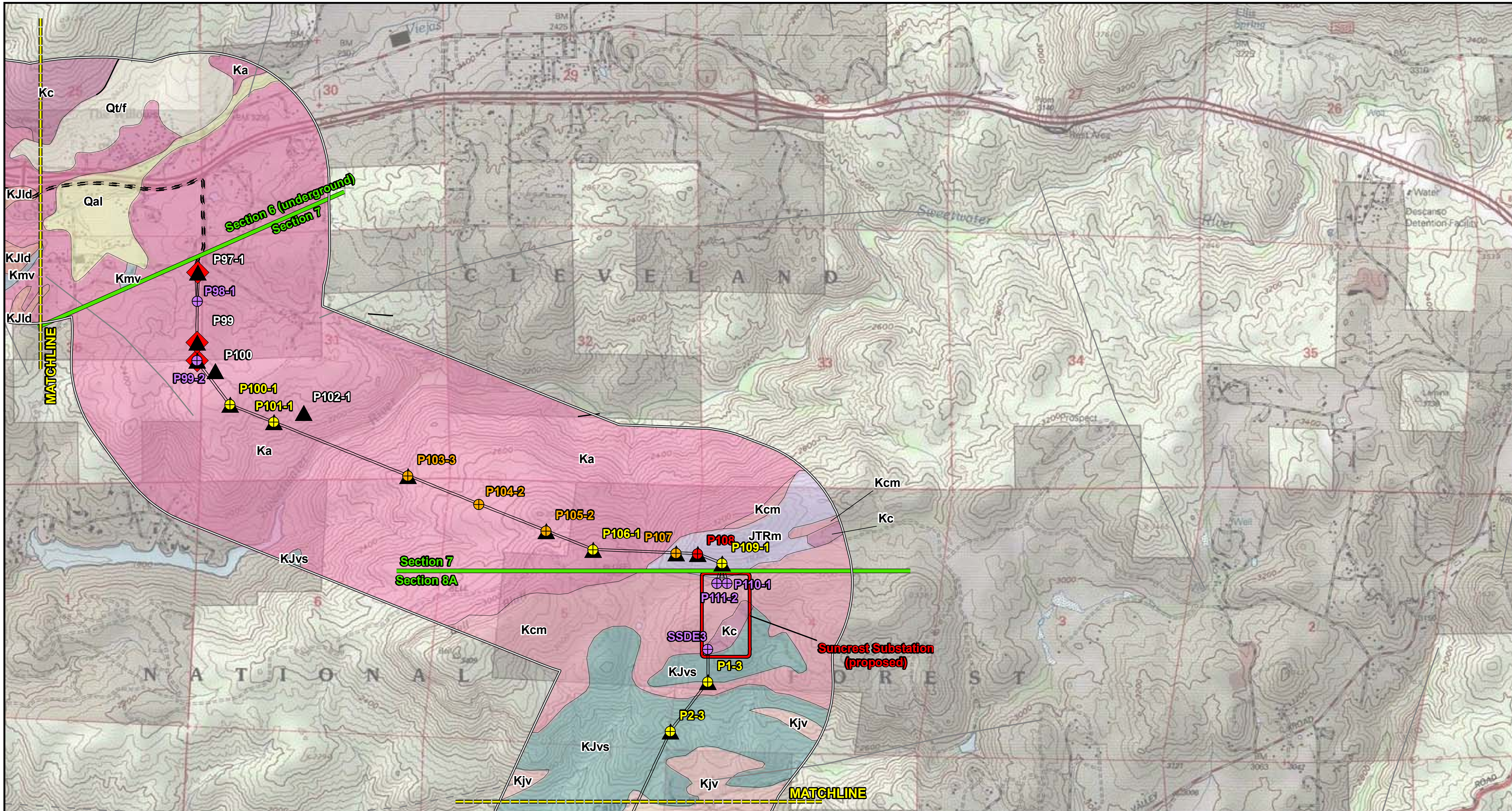

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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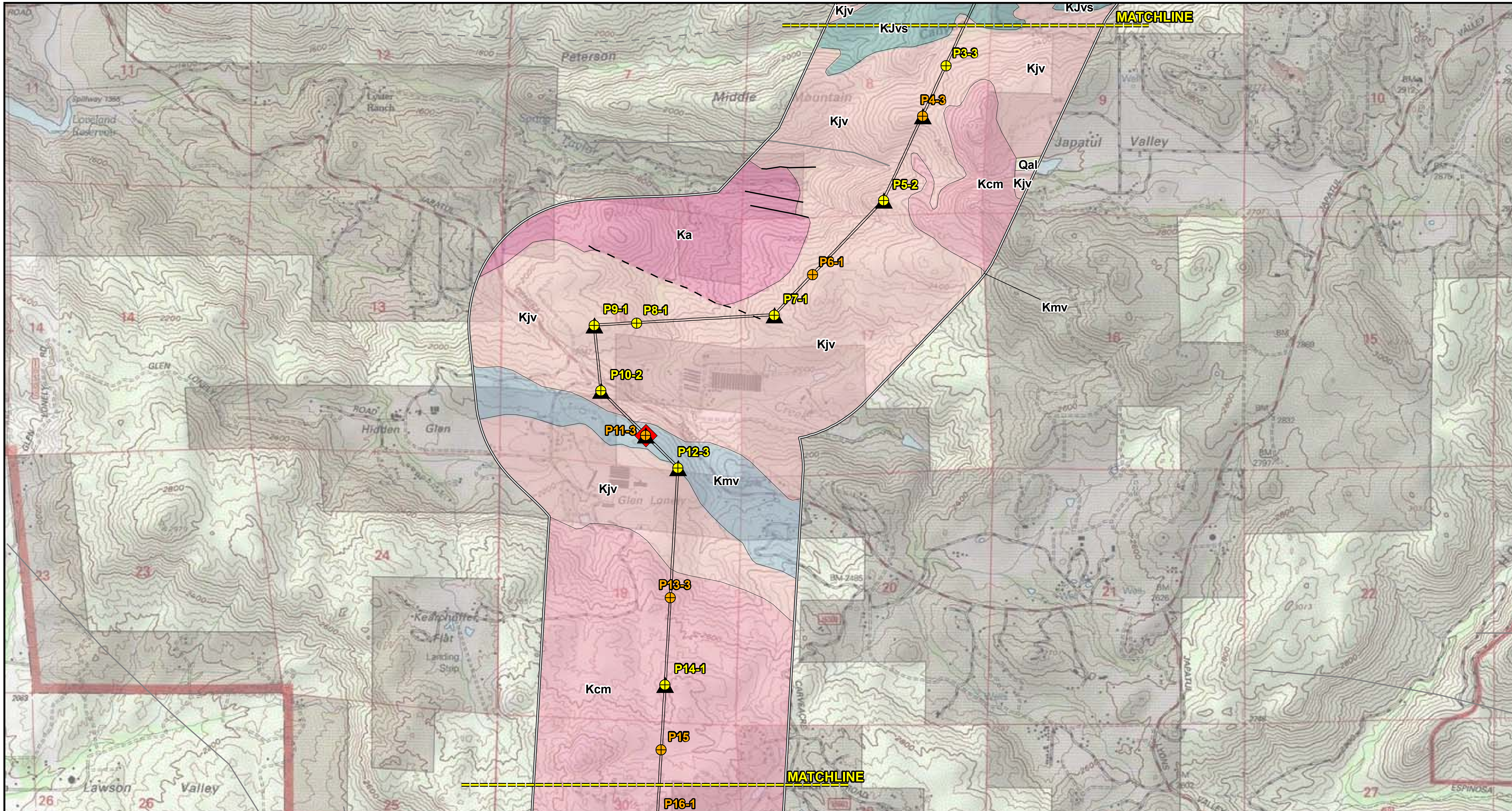

Proposed Centerline

Overhead

Underground

Section Boundary

Structure Type

Angle

Dead End

Strain

Tangent

Miscellaneous

On-Going URS Geotechnical Investigation (2009)

Seismic Refraction Location Coincident with Structure

Seismic Refraction Location at Previously Considered Structure Location

Electrical Resistivity Location Coincident with Structure

Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)

SCALE CORRECT WHEN PRINTED AT 11X17

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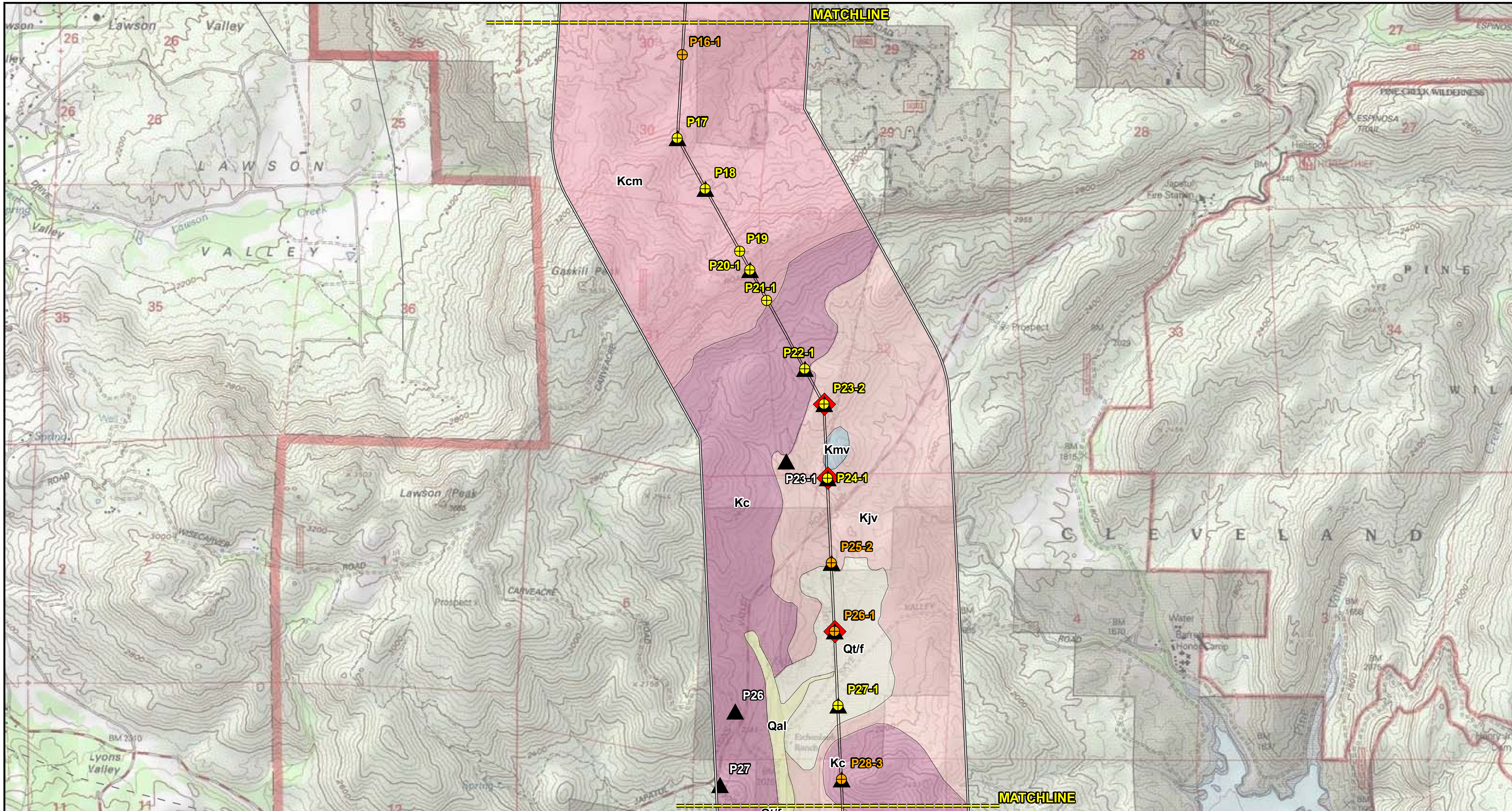

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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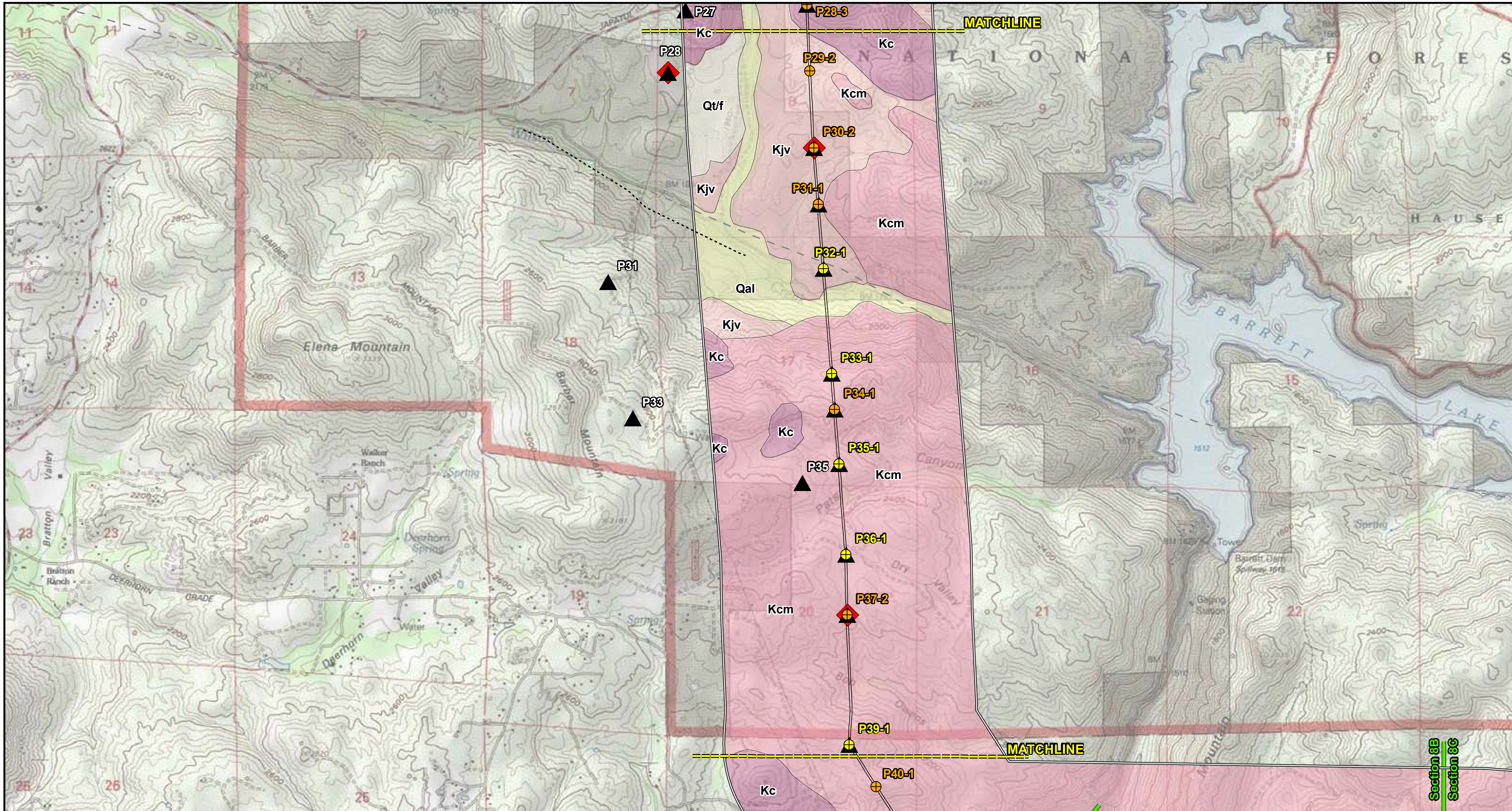

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
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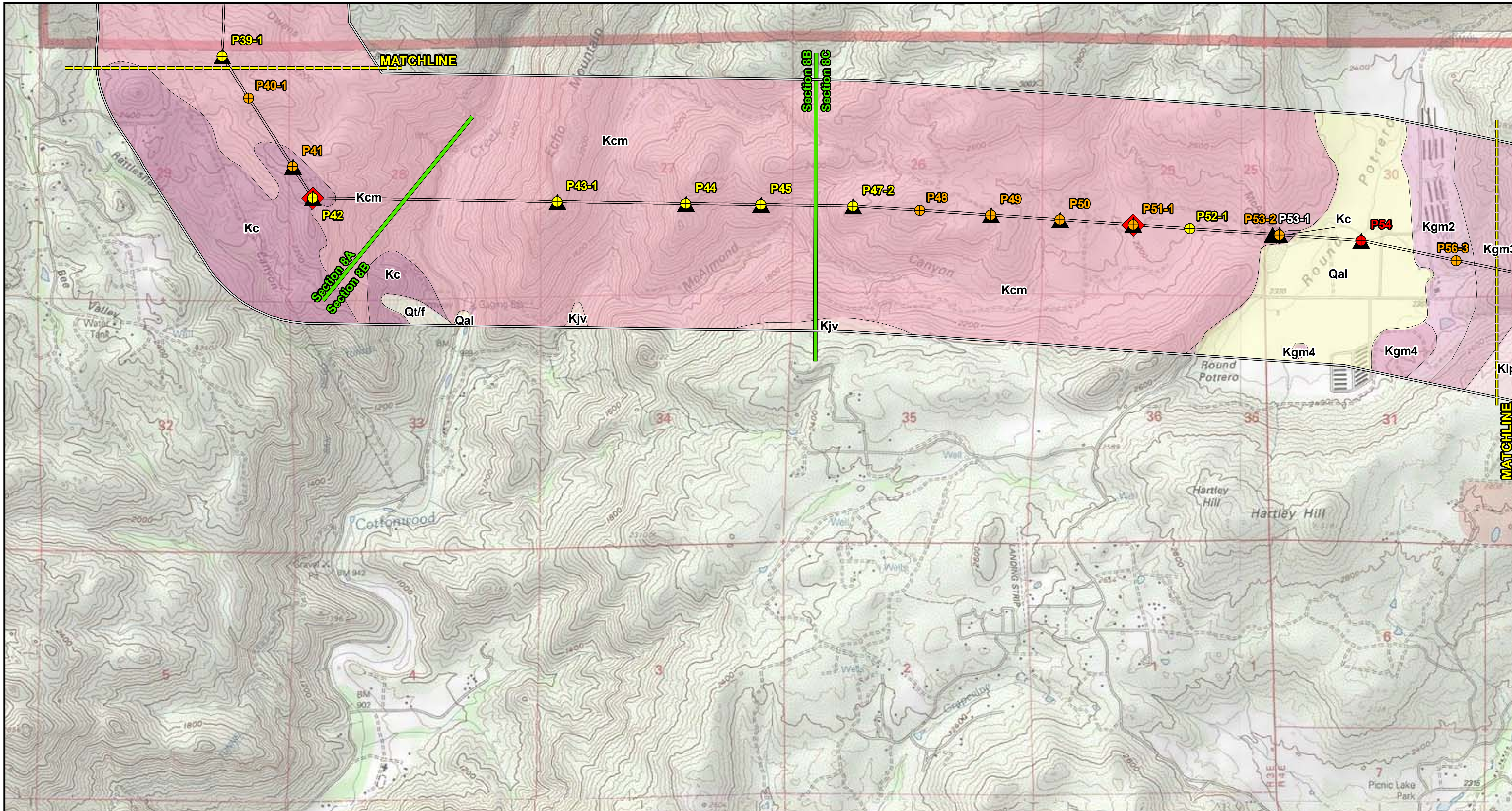

Proposed Centerline	Structure Type	On-Going URS Geotechnical Investigation (2009)	
Overhead	Angle	Seismic Refraction Location Coincident with Structure	Seismic Refraction Location at Previously Considered Structure Location
Underground	Dead End	Electrical Resistivity Location Coincident with Structure	Electrical Resistivity Location at Previously Considered Structure Location
Section Boundary	Strain		
	Tangent		
	Miscellaneous		

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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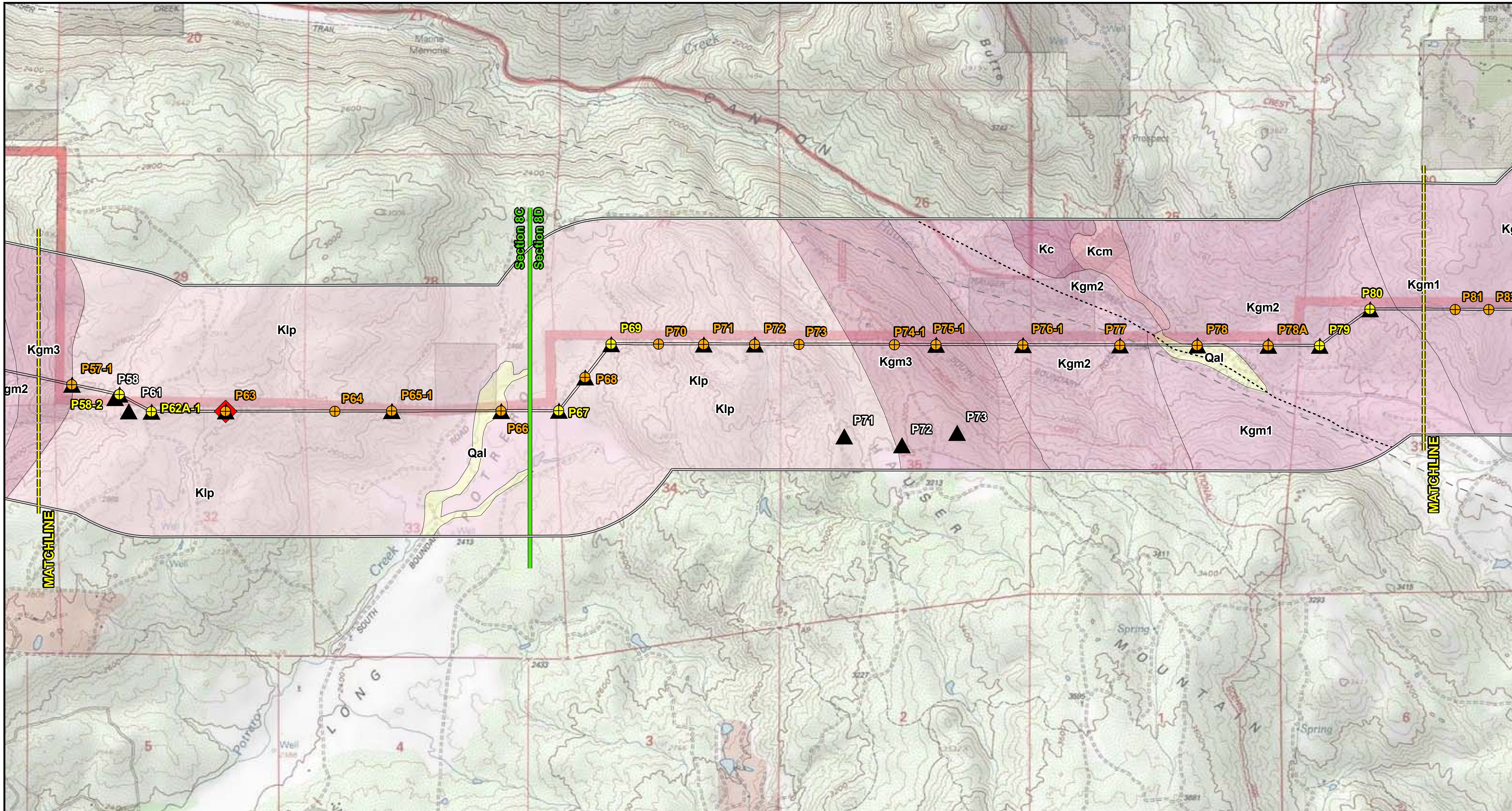

Proposed Centerline
- Overhead
- Underground
- Section Boundary

Structure Type
- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)
- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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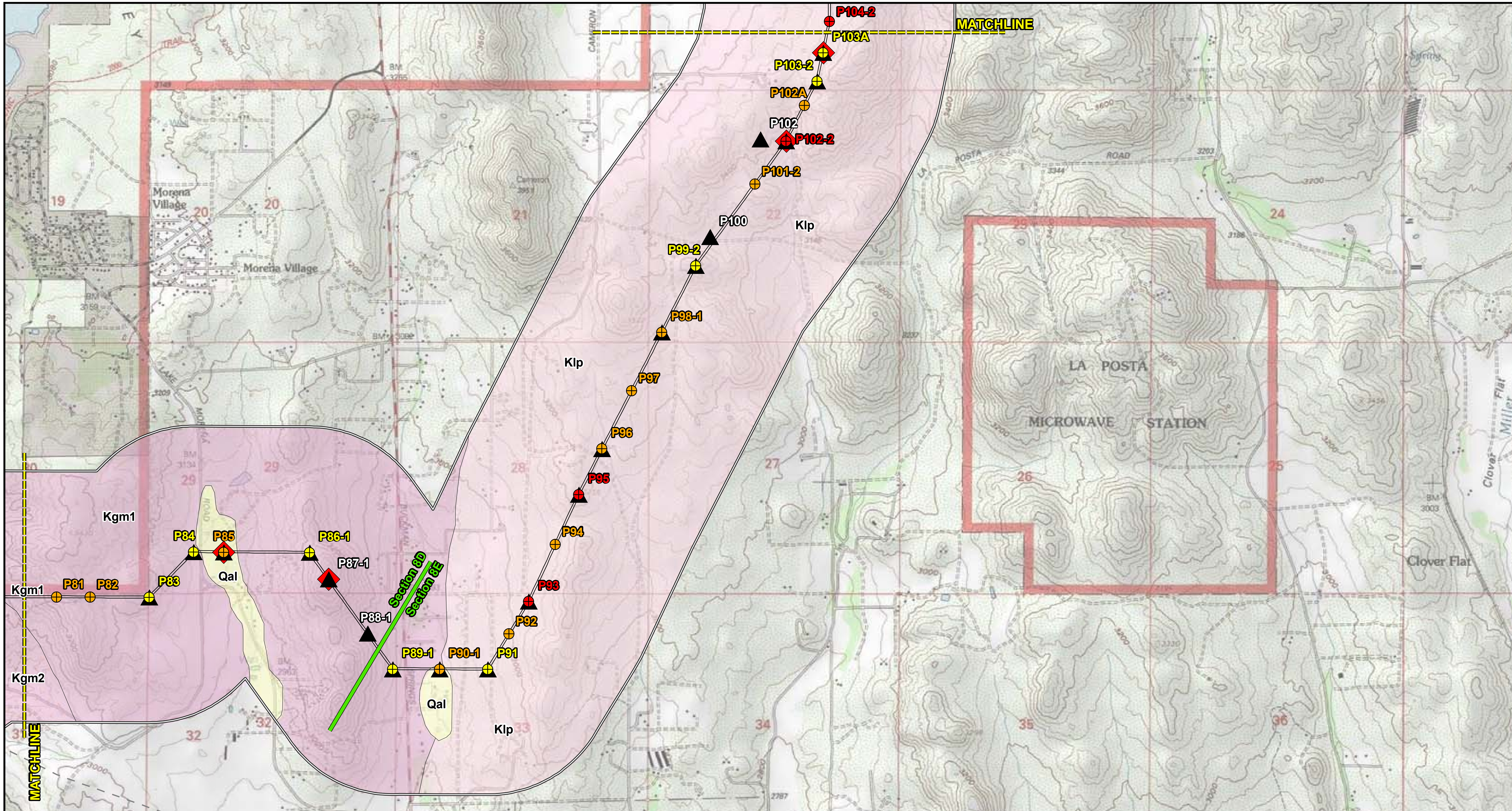

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)

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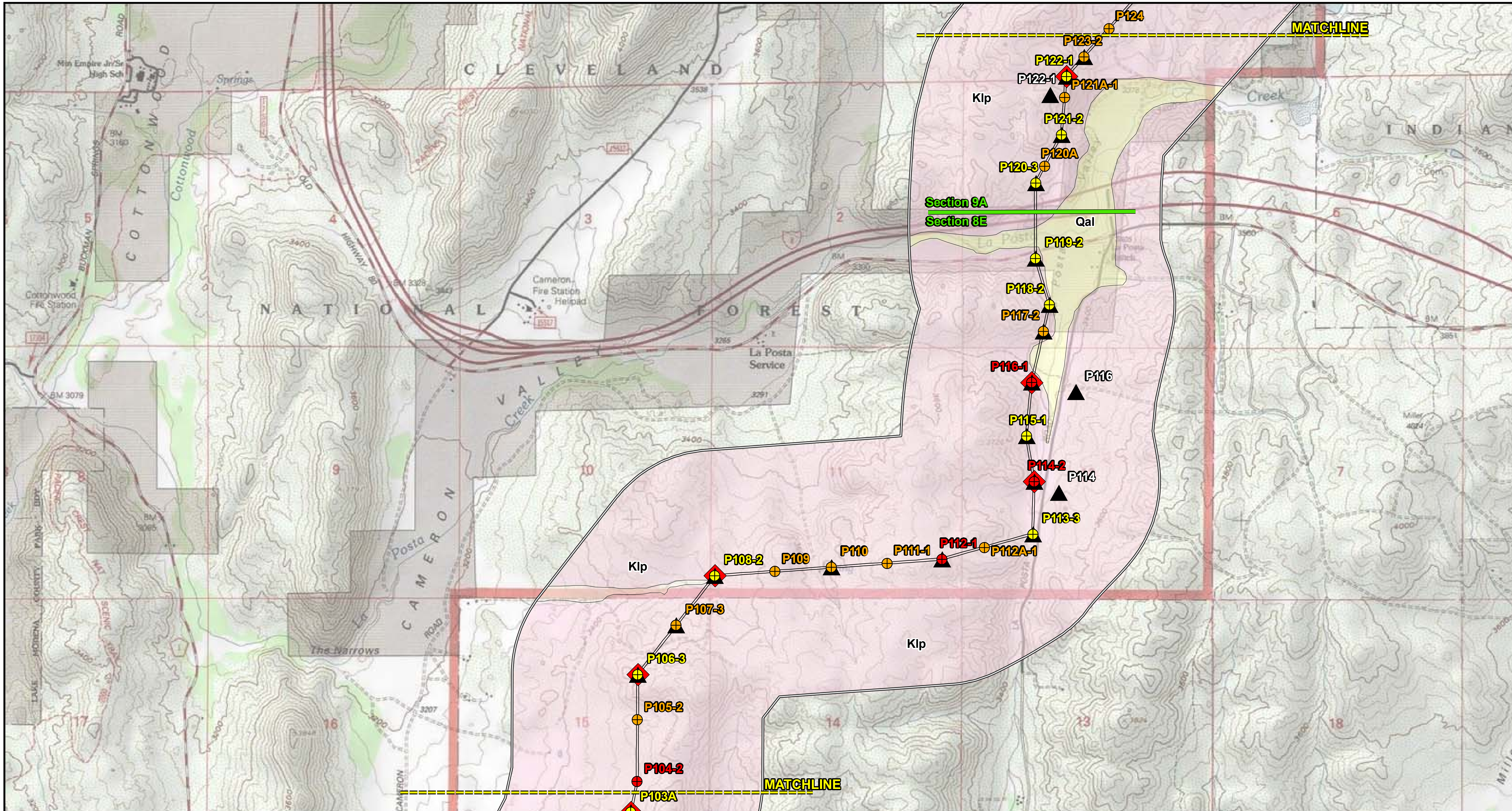

Proposed Centerline
- Overhead
- Underground
- Section Boundary

Structure Type
- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)
- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)

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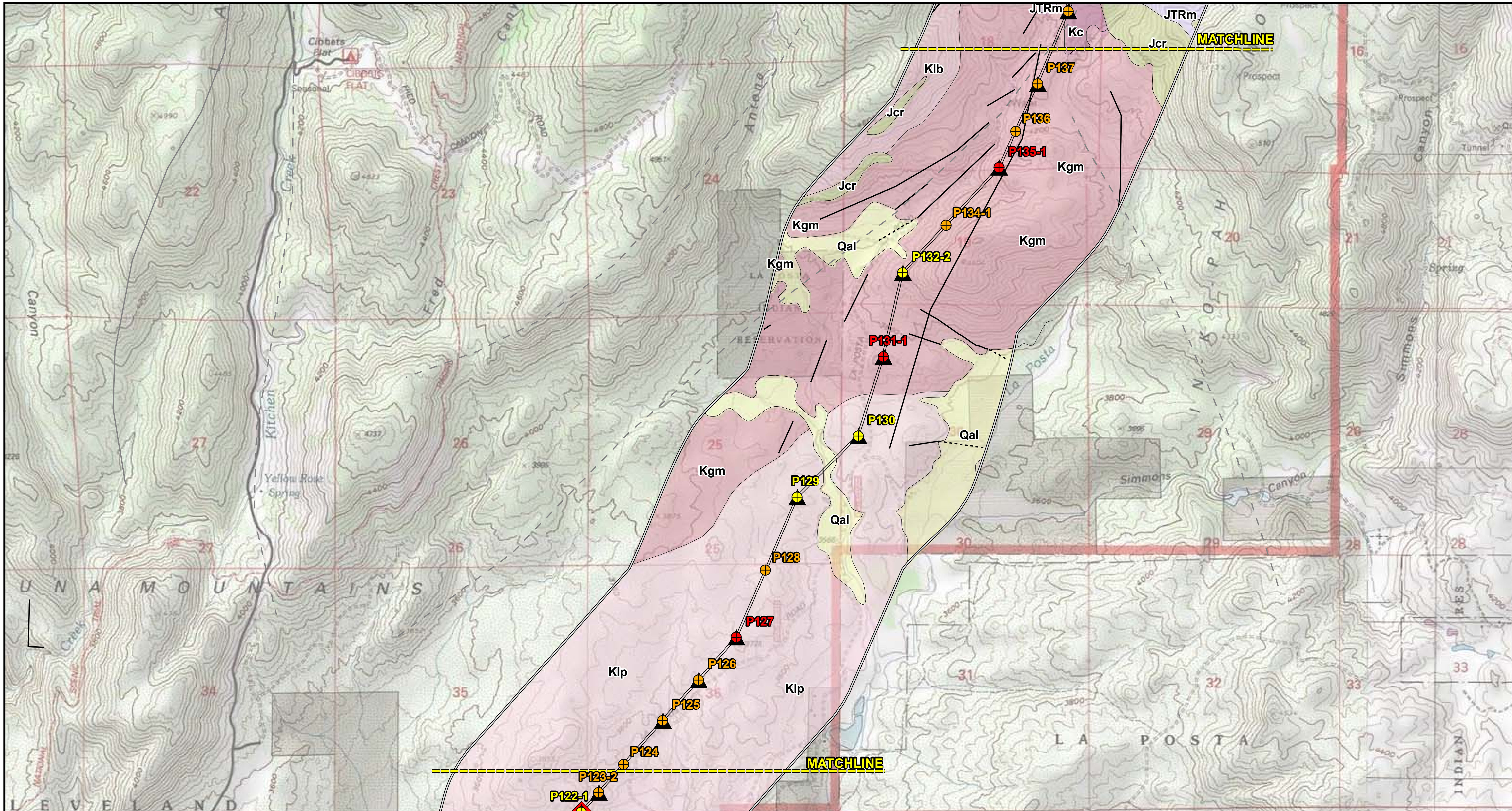

Proposed Centerline

Overhead

Underground

Section Boundary

Structure Type

Angle

Dead End

Strain

Tangent

Miscellaneous

On-Going URS Geotechnical Investigation (2009)

Seismic Refraction Location Coincident with Structure

Seismic Refraction Location at Previously Considered Structure Location

Electrical Resistivity Location Coincident with Structure

Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
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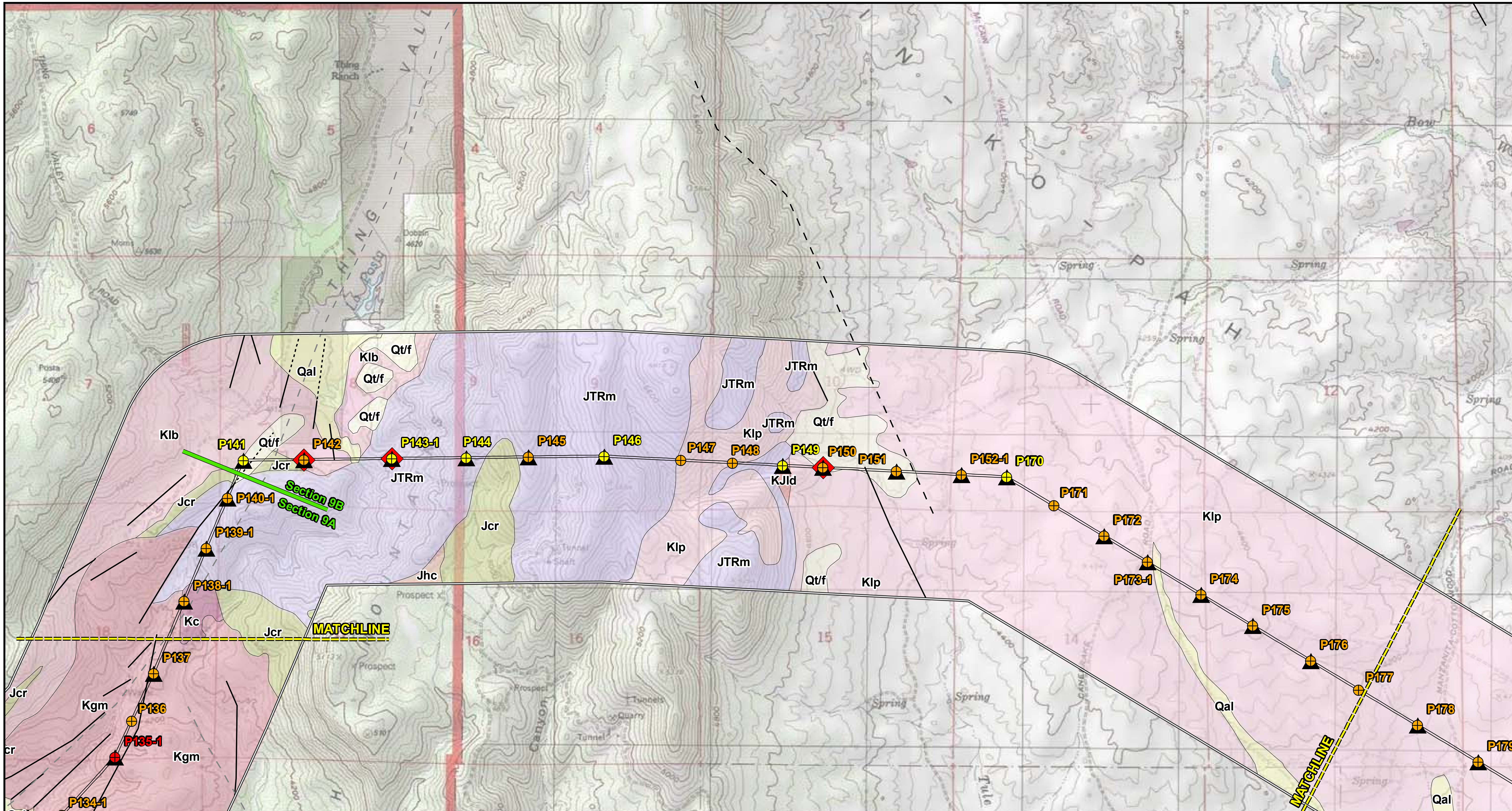

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)

SCALE CORRECT WHEN PRINTED AT 11X17

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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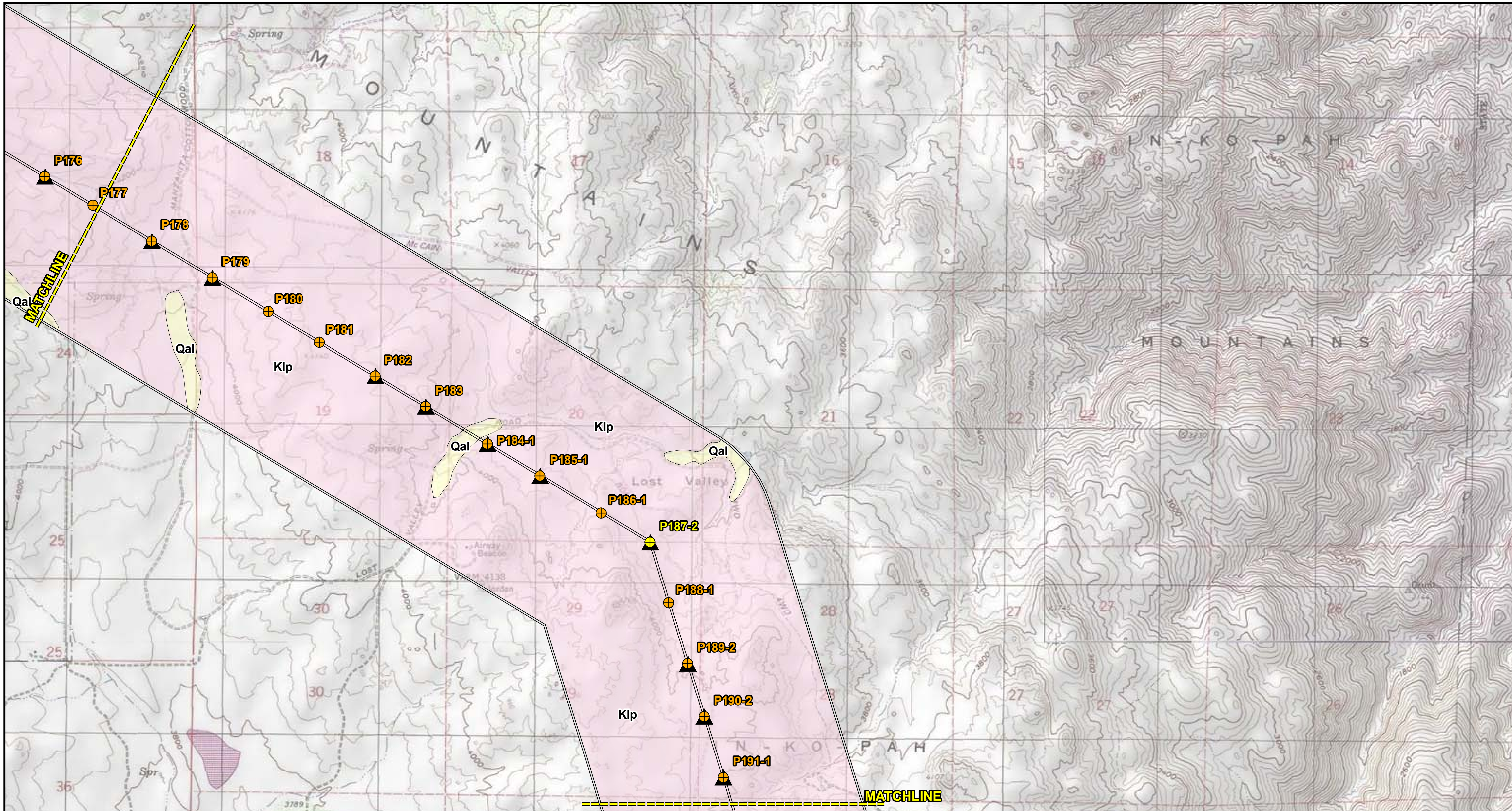

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
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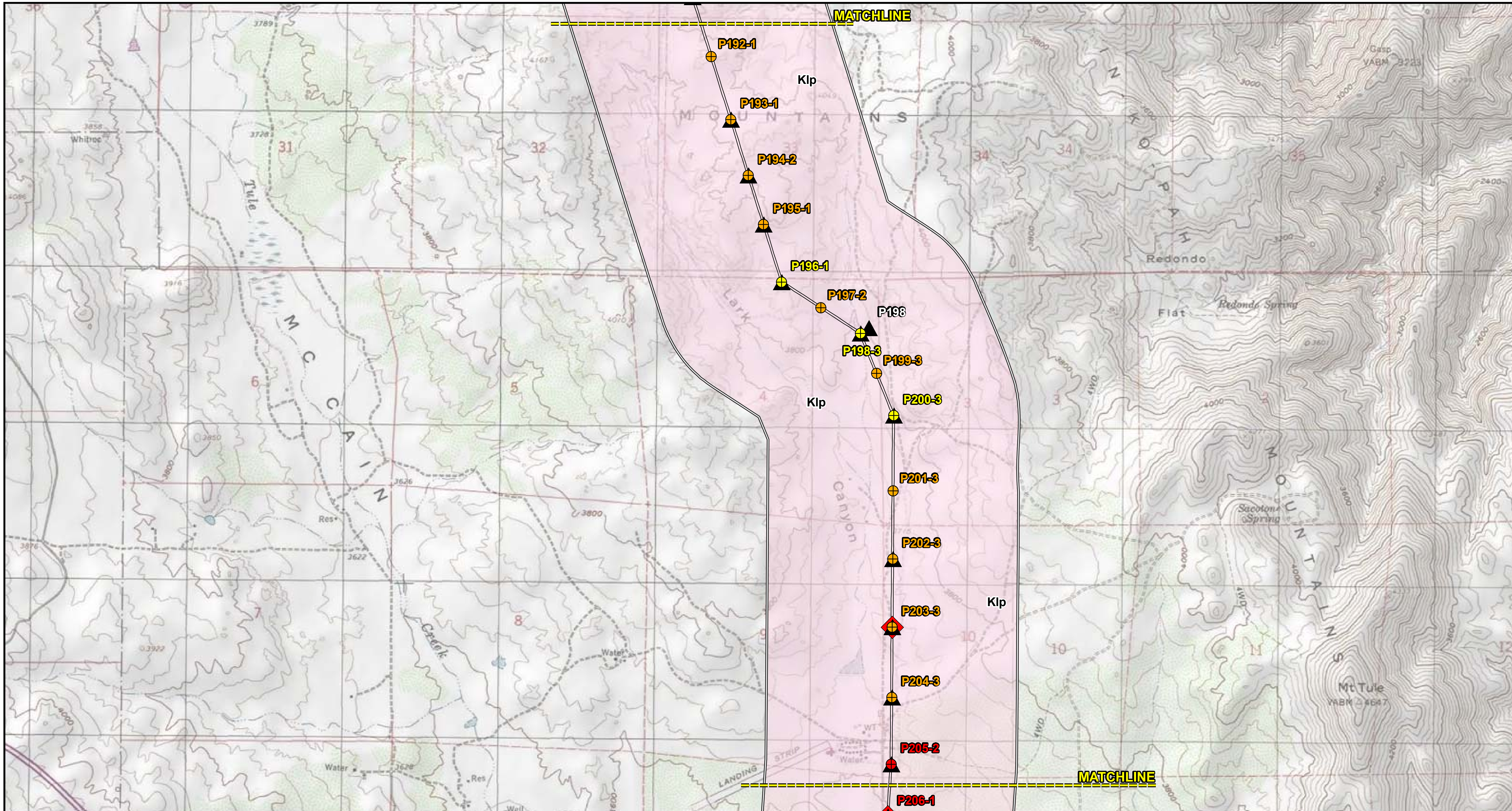

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)
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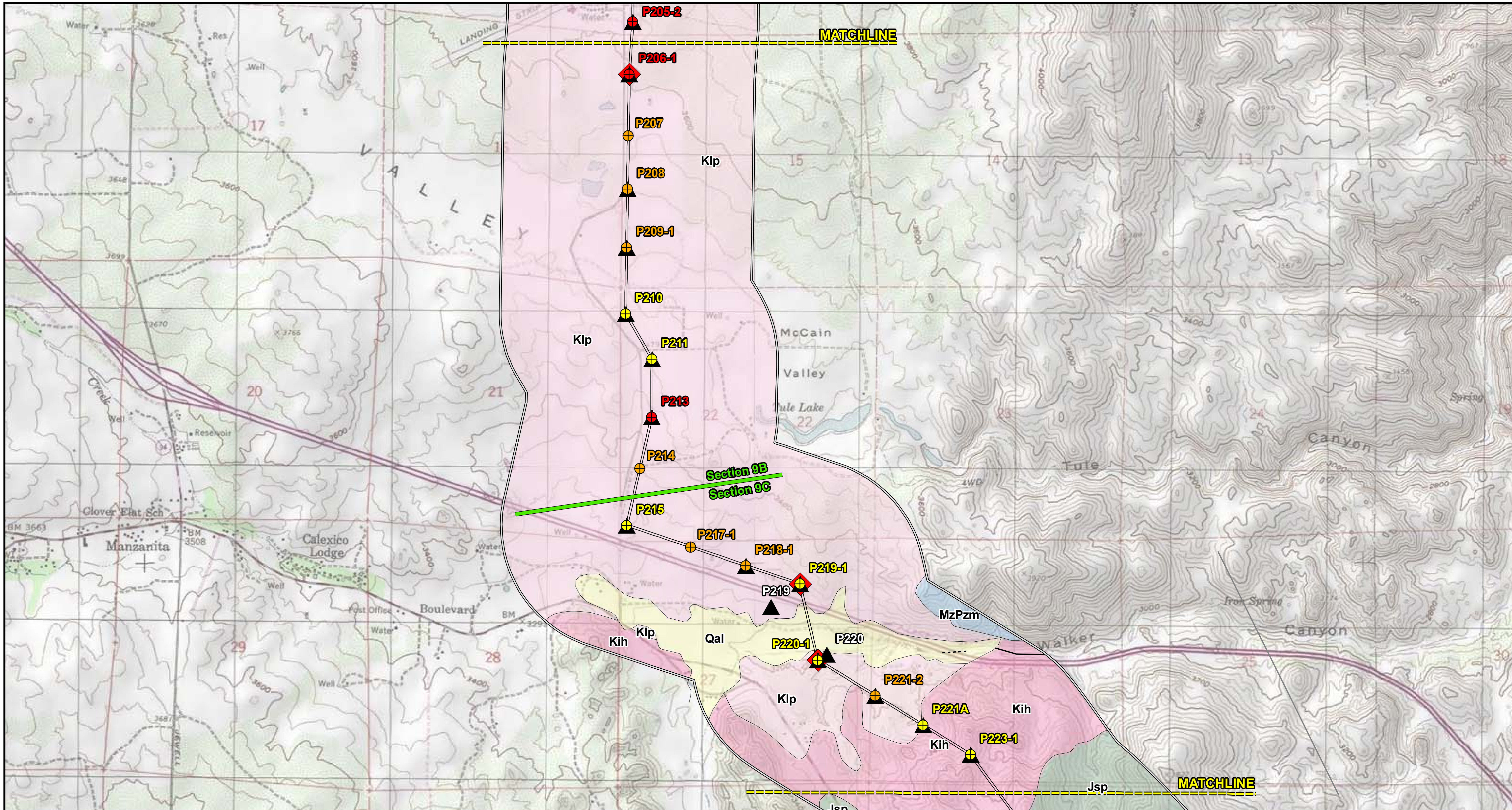

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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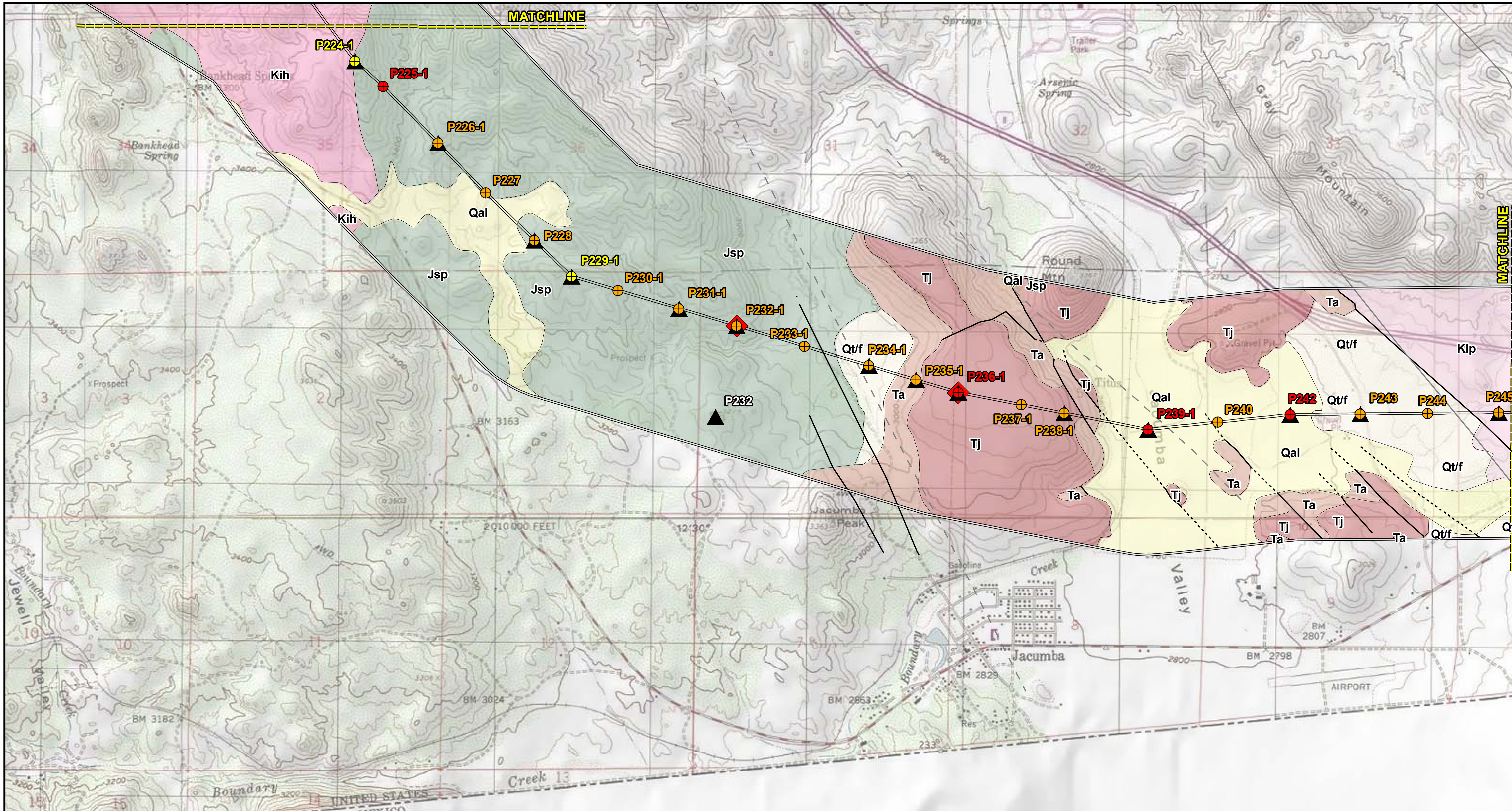

Proposed Centerline	Structure Type	On-Going URS Geotechnical Investigation (2009)	
Overhead	Angle	Seismic Refraction Location Coincident with Structure	Seismic Refraction Location at Previously Considered Structure Location
Underground	Dead End	Electrical Resistivity Location Coincident with Structure	Electrical Resistivity Location at Previously Considered Structure Location
Section Boundary	Strain		
	Tangent		
	Miscellaneous		

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet
SCALE: 1" = 2000' (1:24,000)
SCALE CORRECT WHEN PRINTED AT 11X17

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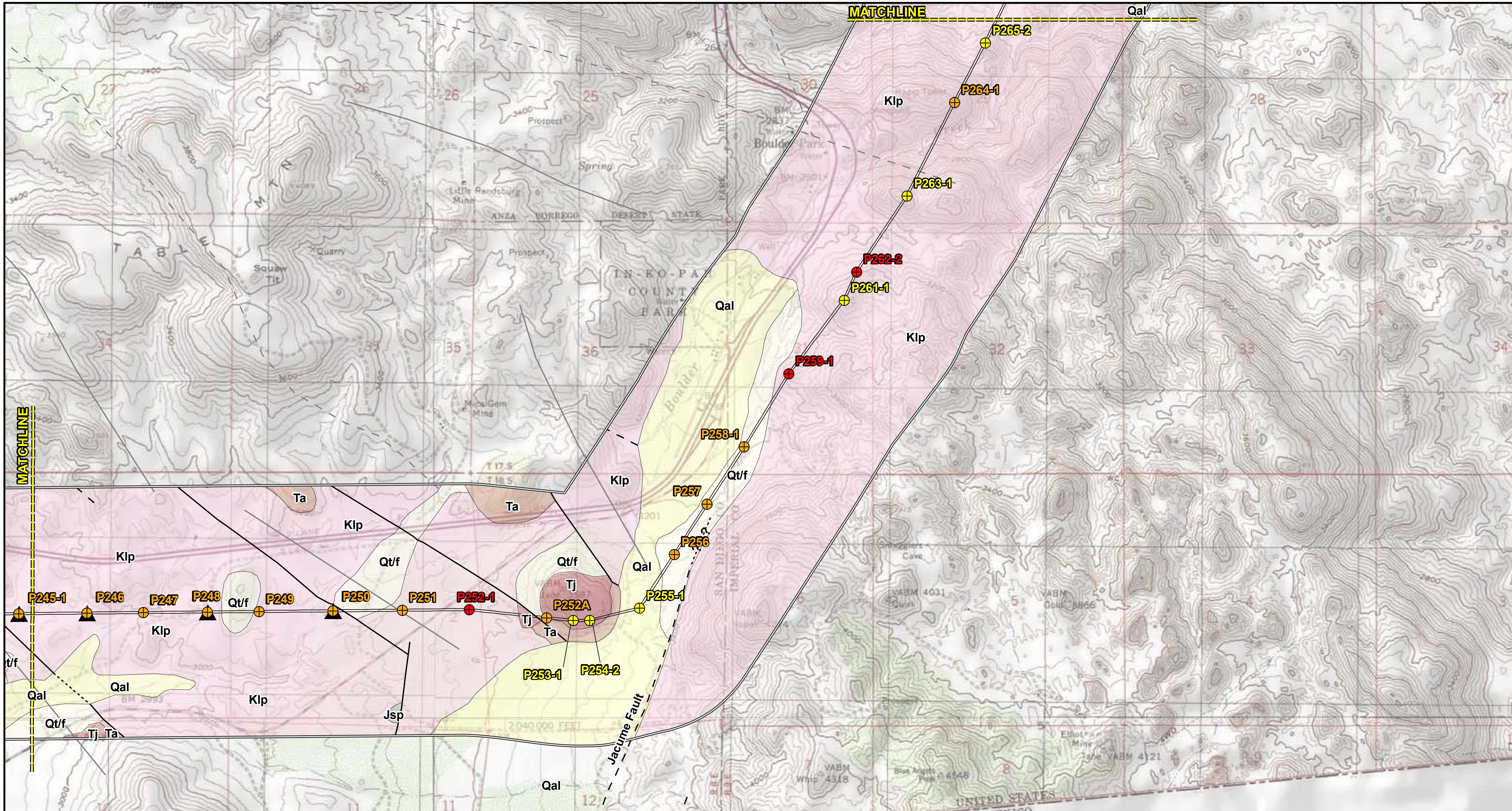

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

DRAFT

SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)

SCALE CORRECT WHEN PRINTED AT 11X17

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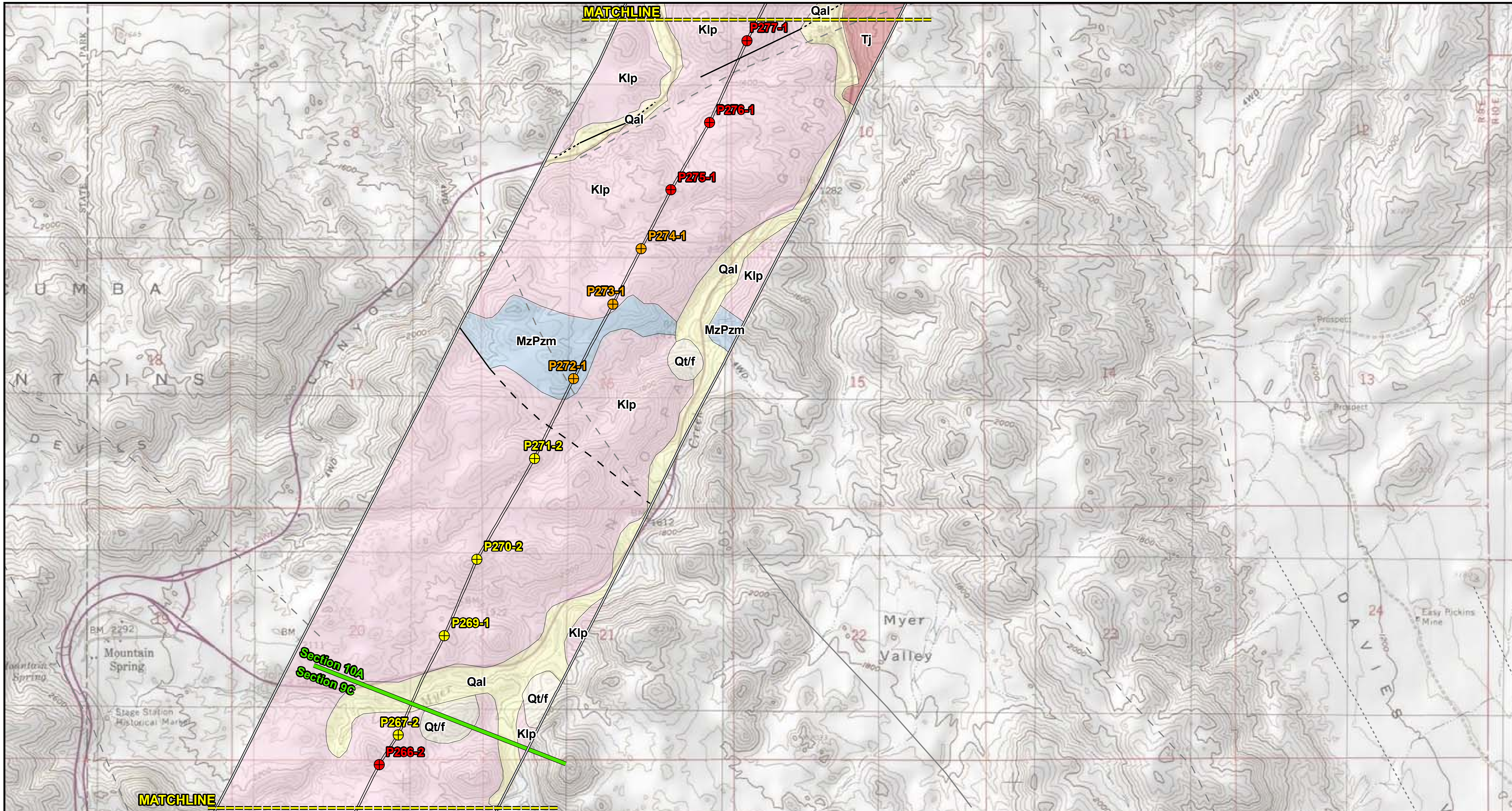

Proposed Centerline

- Overhead
- Underground
- Section Boundary

Structure Type

- Angle
- Dead End
- Strain
- Tangent
- Miscellaneous

On-Going URS Geotechnical Investigation (2009)

- Seismic Refraction Location Coincident with Structure
- Seismic Refraction Location at Previously Considered Structure Location
- Electrical Resistivity Location Coincident with Structure
- Electrical Resistivity Location at Previously Considered Structure Location

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SOURCES:
See Figure 3

For Geologic Symbol Index See Fig 3

1000 0 1000 2000 Feet

SCALE: 1" = 2000' (1:24,000)

SCALE CORRECT WHEN PRINTED AT 11X17

URS

SITE PLAN AND GENERALIZED GEOLOGIC MAP
SUNRISE POWERLINK PROJECT - ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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Fill

Ql, Sediments of ancient Lake Cahuilla

Qal, Alluvium

Qls, Possible Ancient Landslide Deposits

Qt/f, Older alluvial deposits, including terraces and alluvial fans

QTps, Palm Spring Formation

QTpsa, Palm Spring Formation overlain by alluvium

QTpsp, Palm Spring Formation overlain by pediment gravels

Ti, Imperial Formation

Tip, Imperial Formation overlain by pediment gravels

Tsm, Split Mountain Formation

Tal, Alverson Andesite

Tj, Jacumba Volcanics

Ta, Anza Formation

Tp, Pomerado Conglomerate

Tst, Stadium Conglomerate

Kl, Lusardi Formation

Kih, Indian Hill granodiorite of Parrish and others

Klp, Tonalite of La Posta

Klb, Tonalite of Las Bancas

Kc, Cuyamaca Gabbro

Kgm, Tonalite of Granite Mountain

Kgm4, Tonalite of Granite Mountain, Unit 4

Kgm3, Tonalite of Granite Mountain, Unit 3

Kgm2, Tonalite of Granite Mountain, Unit 2

Kgm1, Tonalite of Granite Mountain, Unit 1

Kmgp, Monzogranite of Mother Grundy Peak

Kcm, Corte Madera Monzogranite

Kcp, Chiquito Peak Monzogranite

Kjv, Japatul Valley Tonalite

Ka, Tonalite of Alpine

Kgr, Granitoid rocks

Ksp, Santiago Peak Volcanics

Kmv, Metavolcanic rocks and metagranitic rocks

KJld, Leucocratic dikes

KJvs, Metavolcanic and metasedimentary rocks

Jcr, Granodiorite of Cuyamaca Reservoir

Jsp, Migmatitic schist and gneiss of Stephenson Peak

JTRm, Metasedimentary and metavolcanic rocks

MzPzm, Rocks of Jacumba Mountains

Alquist Priolo (Earthquake Fault Zone) Faults

Accurately Located Fault Trace

Approximately Located Fault Trace

Inferred Fault Trace

Concealed Fault Trace

Quaternary Faults

Accurately Located Fault Trace

Approximately Located Fault Trace

Concealed Fault Trace

Pre-Quaternary Faults

Accurately Located Fault Trace

Approximately Located Fault Trace

Concealed Fault Trace

Geologic Contact

Approximately Located Geologic Contact

?

Approximate location of possible ancient landslide
Arrows denote direction of possible movement

Sources:

1) Modified from *Geologic Map of the San Diego 30x60 Quadrangle, California.* Michael P. Kennedy and Siang S. Tan. California Department of Conservation, California Geologic Survey. 2005.
2) Modified from *Preliminary Geologic Map of the El Cajon 30x60 Quadrangle, Southern, California.* V.R Todd. U.S Geologic Survey, OFR 2004-1361.
3) Modified from *Preliminary Geologic Map of the Imperial County , California. Paul K. Morton. 1966*
4) Alquist Priolo (EFZ) faults- Modified from California Geological Survey CD-ROM 2001-05 (2002), Official Map of Alquist-Priolo Earthquake Fault Zones. Various quads, various dates.
5) Quaternary/Pre-Quaternary Fault Data - *Digital Database of Fault from the Fault Activity Map of California and Adjacent Areas.* Charles W. Jennings. California Department of Conservation, California Geologic Survey. 2000.
6) Existing Structures- Located off Digital Globe Aerial . URS Corporation. 2008.
7) Proposed Structures - SDG&E. September 30, October 8, 12 and 15, 2009.
8) Freeways/Interstates – ESRI.

GEOLOGIC LEGEND AND SOURCES
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO & IMPERIAL COUNTIES, CALIFORNIA

URS	CREATED BY: CL	DATE: 10-16-09	FIG. NO:
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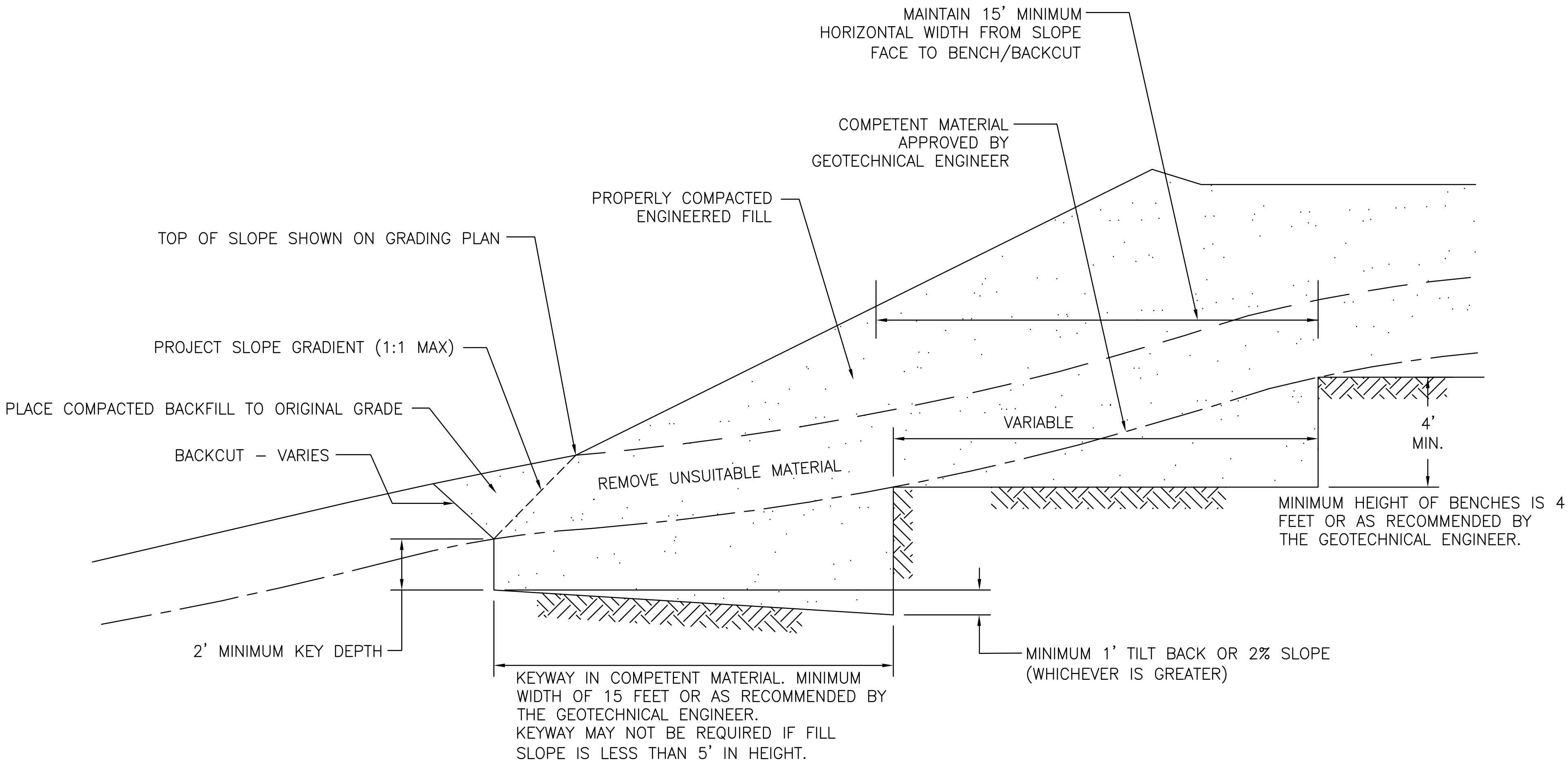

NOTES:

1. BENCHING SHALL BE REQUIRED WHEN NATURAL SLOPES ARE EQUAL TO OR STEEPER THAN 5:1 OR WHEN RECOMMENDED BY THE GEOTECHNICAL ENGINEER.

2. WHERE THE NATURAL SLOPE APPROACHES OR EXCEEDS THE DESIGN SLOPE RATIO, SPECIAL RECOMMENDATIONS WILL BE PROVIDED BY THE GEOTECHNICAL ENGINEER

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KEYWAY AND BENCHING DETAILS
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO AND IMPERIAL COUNTIES, CALIFORNIA

URS	SCALE: NOT TO SCALE	CHECKED BY: PB	DATE: 10–16–09	FIG. NO: 4
		PM: MEH	PROJ. NO: 27669019.00002	

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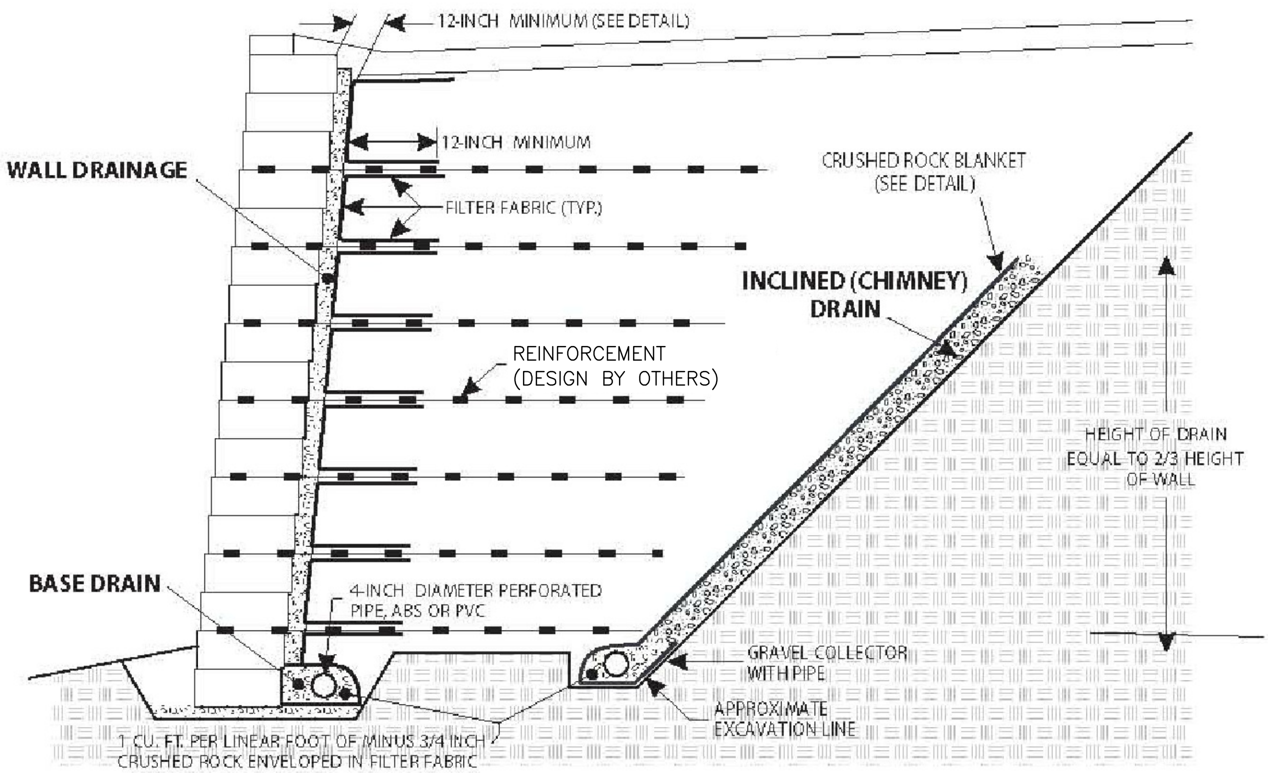
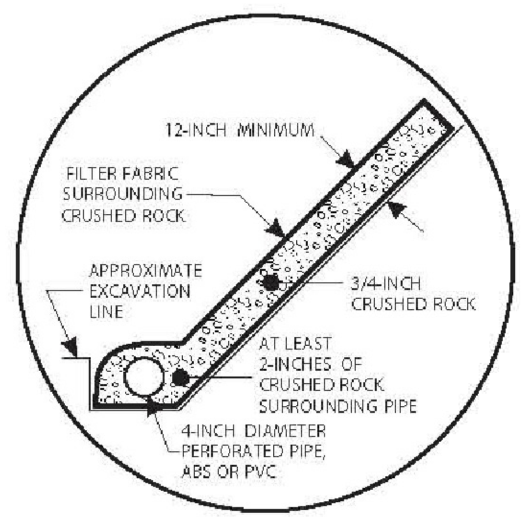
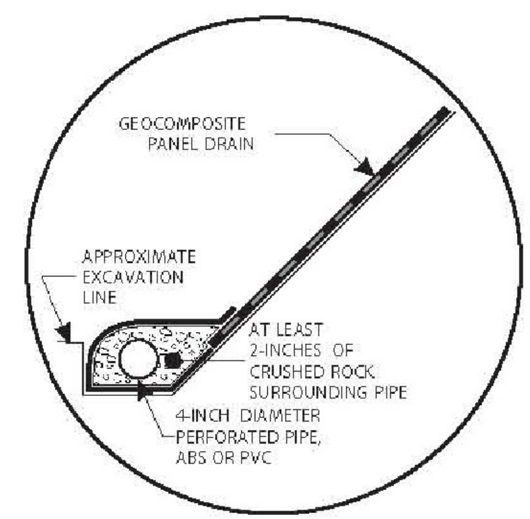


NOTES:

1. PERFORATED PIPE SHOULD OUTLET THROUGH A SOLID PIPE TO A FREE GRAVITY OUTFALL. PERFORATED PIPE AND OUTLET PIPE SHOULD HAVE A FALL OF AT LEAST 1%.
2. FILTER FABRIC SHOULD CONSIST OF MIRAFI140N, OR SIMILAR APPROVED PRODUCT. FILTER FABRIC SHOULD BE OVERLAPPED PER MANUFACTURERS INSTRUCTIONS.
3. DRAIN INSTALLATION SHOULD BE OBSERVED BY THE GEOTECHNICAL ENGINEER PRIOR TO BACKFLLLING.
4. IF IT IS DESIRED TO AVOID USING FILTER FABRIC, DRAINAGE MATERIAL IMMEDIATELY BEHIND THE WALL SHOULD CONFORM TO CALTRANS CLASS II PERMEABLE AGGREGATE, WHICH DOES NOT REQUIRE ENCLOSURE WITH FILTER FABRIC.
5. SUBSURFACE DRAINAGE MAY BE REDUCED OR ELIMINATED IF THE SOILS USED IN THE REINFORCED AND RETAINED ZONES ARE RELATIVELY "FREE DRAINING" AS APPROVED BY GEOTECHNICAL ENGINEER.



ROCK BLANKET ALTERNATIVE



GEOCOMPOSITE PANEL ALTERNATIVE

SUBSURFACE DRAINAGE DETAILS
SUNRISE POWERLINK PROJECT -
ACCESS ROADS AND STRUCTURE PADS
SAN DIEGO AND IMPERIAL COUNTIES, CALIFORNIA

URS	SCALE: NOT TO SCALE	CHECKED BY: PB	DATE: 10-16-09	FIG. NO.
		PM: MEH	PROJ. NO: 27669019.00002	5

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GUIDE SPECIFICATIONS
ROCK SLOPE SUPPORT AND STABILIZATION

TABLE OF CONTENTS

1.0 GENERAL

1.1 Scope of Work:

The Work includes all labor, material, equipment, transportation and services necessary for selecting, furnishing, installing, testing, and maintaining support stabilization systems for permanent cut slopes in rock. The locations and extent of the support will be as directed by the Engineer based on the actual conditions encountered during the slope excavation. Information on the nature of the materials encountered on site can be found in the Geotechnical Report for the Project.

2.0 PRODUCTS

2.1 Rock Slope Treatment:

2.1.1 Scaling and trimming of rock slopes: Scaling and trimming of rock slopes shall be carried out in such a manner that soil and rock is removed from the slope face without affecting the stability and integrity of the slope. Measures shall be taken to prevent uncontrolled falls of debris arising from scaling and trimming works. Scaling and trimming of rock slopes shall be carried out using hand-held tools. All material removed or excavated by scaling and trimming and loose fragments of soil and rock shall be removed from the slope. Rock faces shall be cleaned after scaling and trimming is complete.

2.1.2 Rock splitting: Rock splitting shall be carried out using percussive hammers, drills, hydraulic splitters, chemical expanding agents, hand-tools or other methods agreed by the Engineer.

2.1.3 Removal of boulders: Boulders which are to be removed from slopes shall be broken down by means of line drilling, expansive grouts, rock breakers or other methods agreed by the Engineer.

2.1.2 Stabilizing boulders: Stabilizing boulders in place by buttressing, strut or tie beams, anchorages, nets or lashing.

2.1.4 Sealing and infilling of rock joints: Joints in rock faces shall be sealed with concrete, cement mortar or masonry as approved by the Engineer.

2.2 Rock Bolts:

2.2.1 Untensioned Rock Bolts: Rock reinforcement element consisting of an untensioned steel bar with associated hardware recommended by the manufacturer. Untensioned Rock Bolts shall be bonded over their entire length to the rock mass using cement grout or resin or polyester epoxy. Untensioned

Rock Bolts may be used to contain fractured rock masses or to stabilize small, local sliding blocks/wedges by installation of the bolt perpendicular to the potential failure plane. The Engineer shall provide the design load, length, and spacing.

2.2.2 Tensioned Rock Bolt: Rock reinforcement element consisting of a tensioned steel bar with associated hardware recommended by the manufacturer. Tensioned Rock Bolts shall be bonded to sound rock with cement grout (in the anchorage zone) with an unbonded zone in which tension is developed. Polyester or epoxy resin or mechanical anchorages may be used, if approved by the Engineer. Tensioned Rock Bolts may stabilize sliding block/wedges by applying an additional force on a failure plane by transfer of load through tension on the bolt and compression on the face bearing plate. They may be applied as a single bolt, a small group of bolts, or a regular pattern to reinforce large areas. The Engineer shall provide the design load, length, and spacing.

2.2.3 Rock Bolt Materials

2.2.3.1 Rock bolts shall be commercially available products that comply with the requirements specified herein.

2.2.3.2 Rock bolts shall be either deformed bar, partially threaded or all-thread bar, and shall conform to ASTM A722 with 150 ksi minimum yield. The minimum size of the bolt will be No. 8 rebar and the maximum size will be No. 11 rebar.

2.2.3.3 Rock bolts shall be continuous over the entire design length without couplers.

2.2.3.4 The annular space between tensioned rock bolts and the sheathing in the unbonded length shall be grouted with noncorrosive grout over its full length prior to installation.

2.2.4 Hardware for Rock Bolts:

2.2.4.1 Centralizers/spacers shall be fabricated from material not detrimental to the rock bolts and shall permit grout to freely move throughout the drill hole.

2.1.4.2 Rock bolt assembly shall include bar, bearing plate, beveled washers, and nut. Washers shall be hardened steel washers, flat or beveled, as required. Hex nuts shall be heavy duty steel nuts. All rock bolt and bolt accessories shall comply with ASTM F 432.

2.2.4.3 If the rock face is not perpendicular to the axis of the bolt, or the rock under the bearing plate is not sound, a bearing pad approved by the Engineer shall be constructed so that the bolt is not bent when the tension is applied. When the rock surface is generally weak or weathered, extra large bearing plates shall be used to distribute the load over a larger surface.

2.1.4.4 Grout injection and vent tubes shall be provided as required for cement grouting.

2.2.5 Cement Grout for Rock Bolts:

2.2.5.1 Cement grout shall be non-shrink grout conforming to ASTM C1107 Grade B Dry-Package Hydraulic Cement Grout with a required compressive strength of 6,000 psi at 28 days.

2.2.5.2 Mix design shall have flowability adequate for proper injection, consolidation and encapsulation.

2.2.5.3 Water for mixing grout shall not contain substances deleterious to the grout.

2.2.6 Resin Grout for Rock Bolts:

2.2.6.1 Resin shall be proven non-shrink epoxy and polyester resin for rock bolts capable of permanently developing the bond and internal strength between the rock bolt and rock. Compressive strength of the mixed and cured resin shall a minimum of 14,000 psi when tested according to ASTM C39.

2.2.6.2 Gel time of the cartridges shall be as recommended by the manufacturer for each specific length and type of rock reinforcement.

2.2.6.3 Cartridge diameter shall be selected according to the recommendations of the manufacturer to ensure complete encapsulation of the rock reinforcing dowel and satisfactory in-hole mixing.

2.2.6.4 Epoxy or polyester resin to be incorporated into the rock reinforcing dowel installation shall be within the shelf-life period stated by the manufacturer.

2.2.6.5 Samples of the epoxy or polyester resins shall be provided for testing upon request of the Engineer.

2.2.7 Mechanical Anchors:

2.2.7.1 Mechanical anchor assemblies shall be at the end of the bolt and capable of exceeding the ultimate tensile strength of the bolt.

2.2.7.2 The anchor assembly shall be designed to prestress the bolt rod prior to grouting.

2.3 Wire Mesh Slope Protection:

2.3.1 Free Hanging Mat: Steel wire mesh draped over the slope face to direct dislodged rock to a road ditch for removal.

2.3.2. Slope Containment: Steel wire mesh affixed to the slope face to prevent rocks from passing through the system.

2.3.3. Wire Mesh Slope Protection Materials: The Contractor may use one of the following manufacturers or an alternate system may be submitted for review by the Engineer:

GEOBRUGG
551 Cordova Road, PMB 730
Santa Fe, NM 87505
(505) 438 6161

Chama Valley Productions, LLC
287 Maple Street
PO Box 280
Chama, New Mexico 87520
(505) 756 1032

3.0 EXECUTION

3.1 Preparation:

3.1.1 Potentially unstable boulders that represent a rockfall hazard above the slopes of all cuts shall be stabilized or cleared. This activity shall precede any blasting or significant grading activities on the slopes.

3.1.2 The final excavation surfaces shall be scaled of all loose or hanging rock fragments during or upon completion of the excavation in each lift. Excavation of the next lift shall not be allowed until the Engineer has approved the scaling. After scaling of the final rock excavation surface, the Engineer shall determine if permanent support of the cut slope is required.

3.1.3 Seal rock surface and install untensioned rock bolts, tensioned rock bolts, wire mesh slope protection as directed by the Engineer. Excavation of the next lift shall not be allowed until the Engineer has approved installation of the cut slope support

3.1.4 Ensure that an adequate supply of materials are stored on site and available in the amounts needed to install cut slope support of the type required, and to provide safe working conditions as soon as practicable during the excavation cycle.

3.1.5 Inspect all support elements immediately prior to their use to verify their ability to serve their intended function, including steel shapes, bars, fasteners, and accessories. Ensure that all metal objects are free of scale, rust, mud, oil, grease, concrete and other objectionable materials and of true shape.

3.2 <u>Installation</u>:

3.2.1 <u>General:</u>

3.2.1.1 The procedures and methods adopted for installation of the rock bolts, including equipment necessary to drill the holes and inject cement grout, shall conform to the manufacturer's recommendations, and shall be confirmed as acceptable during rock bolt trials.

3.2.1.2 Drill each hole at the diameter and to the depth recommended by the manufacturer for installation of the rock bolt, as approved by the Engineer. Drill each hole to a uniform diameter over the entire length.

3.2.1.3 Drill holes normal to the theoretical excavation surface unless otherwise directed to support specific blocks.

3.2.1.4 Upon completion of drilling, the collar of the drill hole shall be prepared and scaled of all broken or loose material, and the rock bolt shall be placed in the hole. Clean hole of all drill cuttings, sludge, and debris before the rock bolt is inserted into the hole using water or air at moderate pressures or other suitable methods recommended by the rock bolt manufacturer.

3.2.1.5 Tensioned Rock Bolts shall be fully grouted after stressing.

3.2.1.6 Each Tensioned Rock Bolt shall be tensioned to the specified design load. Tension shall be done with approved calibrated hydraulic jacks or as approved by the Engineer.

3.2.1.7 Each Untensioned Rock Bolt shall be torqued to a nominal 100 foot-pounds to ensure proper seating against the rock surface, or as recommended by the manufacturer.

3.2.2 <u>Cement-Grouted Rock Bolts:</u>

3.2.2.1 Install each bar using centralizers to achieve a uniform annulus around the bar.

3.2.2.2 Fill the annulus along its entire length with grout at a pressure no greater than that required to inject the hole with grout. Place grout in the drill hole to ensure the filling of the entire space between the bolt and sides of the drill hole, and the full encapsulation of the bolt. Pump the grout to the far end of the drill hole and continue pumping until grout is forced out of the de-airing tube at the face of the hole. The quantity of the grout and the grout pressures shall be recorded.

3.2.2.3. Do not use grout that has begun to set at the time of injection, or that was batched more than 90 minutes prior to injection.

3.2.2.4 Rock bolts with a grouted anchorage shall not be stressed until the design compressive strength has been attained.

3.2.4 <u>Resin-Grouted Rock Bolts:</u>

3.2.4.1 The diameter of drill holes for resin bolts shall be in accordance with the manufacturer's recommendations. The diameter shall be verified and maintained.

3.2.4.2 Use fast and slow set resin cartridges as required and in accordance with manufacturer's recommendations for each installation.

3.2.4.3 Rock bolts with a resin grouted anchorage shall be stressed according to the manufacturer's instructions.

3.2.5 <u>Mechanical Anchorage Rock Bolts:</u>

3.2.5.1. The anchor shall be expanded by rotation in accordance with the manufacturer's recommendations.

3.2.5.2. The torque for setting the anchor assembly shall be in accordance with the manufacturer's recommendations

3.2.5.3 Each mechanical rock bolt shall be tensioned to the specified load prior to grouting.

3.2.6 Wire Mesh Fabric:

3.2.6.1 For containment, the wire mesh fabric shall be secured horizontally and vertically. For free hanging wire mesh fabric, the fabric shall not be tensioned in any direction, but must remain loose to increase its dampening effect on rolling rocks. The bottom of the fabric shall rest on the slope, such that material dislodged under the fabric can fall freely from the bottom, yet will not fall or bounce onto the roadway.

3.2.6.2 Wire Mesh Fabric shall be installed in accordance with the requirements of the manufacturer, and as directed by the Engineer.

4.0 TESTING AND INSPECTION

4.1. General:

4.1.1 Provide personnel and equipment to set-up and operate the test equipment and provide access to test locations.

4.1.2 The load test equipment shall be placed over the rock bolts in such a manner that the jack or torque wrench, face plates, load cells, and anchorage are axially aligned and centered within the equipment.

4.1.3. Provide and maintain in good working condition the equipment to be used for performing pull tests. Keep in stock, or have ready access to, spare parts for the testing equipment.

4.1.4 Test rock bolts following approved test procedures.

4.1.5 The first five (5) Tensioned Rock Bolts and the first five (5) Untensioned Rock Bolts shall be considered rock bolt trials and shall be installed in the presence of the Engineer.

4.1.6 Ten (10) percent of the Tensioned Rock Bolts and ten (10) percent of the Untensioned Rock Bolts shall be tested as selected by the Engineer. All tests shall be performed in the presence of the Engineer. The purpose of these tests is to verify adequate bond.

4.2. Tensioned Rock Bolts:

4.2.1. Tension each production tensioned bolt installed to 120% of the design load using a calibrated hollow ram hydraulic jack. Hold that tension for a minimum of 10 minutes.

4.2.2. The test shall be conducted by the Contractor and the Engineer shall interpret the results and determine whether the rock reinforcing bolt is acceptable.

4.2.3. If no loss of load occurs in this time period, the rock reinforcing bolt is accepted. If a rock reinforcing bolt fails this test, the rock reinforcing bolt will be rejected and a replacement bolt installed in a separate hole adjacent to the failed bolt. Test the new rock reinforcing bolt.

4.2.4 The Engineer may require additional proof testing if any rock reinforcing bolts fail. No additional payment will be made for failed rock reinforcing bolts or for additional proof testing.

4.2.5. After tensioning and testing, lock off at 100% of the design load and grout the unbonded length of the bolt. Carry out grouting within 3 days of tensioning the rock bolt to provide corrosion protection and lock the tension stress permanently into the system.

4.3. Untensioned Rock Bolts:

4.3.1 Tension the rock reinforcing dowel to 100% of the design load with a calibrated hollow ram hydraulic jack. Hold the load for 10 minutes with no loss of load.

4.3.2 An Untensioned Rock Bolt will be considered to have failed if any movement of the bolt occurs. The Engineer may require additional testing beyond the 5% if any bolts fail. Replace failed bolts with a separate rock bolt installed in a separate hole. No additional payment will be made for failed bolts or for additional testing.

5.0 SCHEDULE OF DRAWINGS/DATA TO BE SUBMITTED BY CONTRACTOR

5.1 Rock Slope Support and Stabilization:

5.1.1 Steel wire mesh, details such as material specifications, details of steel wire mesh, anchorage and fasteners and installation procedures.

5.1.2 Rock bolts details, such as type and size of bolt, centralizers, spacers, bearing plates, grout type and mix details, washers, and nuts and other hardware and corrosion protection for each type of installation.

5.1.3 Methods for cleaning holes, tensioning, grouting, and testing.

5.1.4 Details of equipment for testing rock bolts, including test and calibration certificates.

5.1.5 Diameter and depth of hole to be drilled for rock bolts. Identify the amount of resin or cement grout and type of resin cartridge required based on the hole size drilled.