# Appendix E
Geology and Soils Technical Memorandum

**MEMORANDUM**

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| **To:** | Kara Peterson; San Diego State University |
| **From:** | Perry Russell, Dudek |
| **Subject:** | SDSU Imperial Valley Off-Campus Center – Calexico, Affordable Student Housing Project – Geology and Soils Technical Memorandum |
| **Date:** | December 12, 2024 |
| **cc:** | Sarah Lozano, Mollie Brogdon; Dudek, Michael Haberkorn; Gatzke Dillon & Ballance |
| **Attachments:** | A – Figures<br>B – Geotechnical Report |

Dudek has conducted an evaluation pursuant to the requirements of the California Environmental Quality Act (CEQA), California Public Resources Code 21000 et seq., to analyze the potential impacts related to geology and soils associated with construction and operation of the proposed San Diego State University (SDSU) Calexico Affordable Student Housing Project (Project or proposed Project), to be located at the SDSU Imperial Valley Off-Campus Center, located in Calexico, California. This technical memorandum provides the results of the geology and soil analysis.

# 1 Project Overview and Background

In September 2003, the California State University (CSU) certified an environmental impact report for the SDSU Imperial Valley Master Plan Project (State Clearinghouse No. 2002051010) and approved a Campus Master Plan for the expansion and improvement of the SDSU Imperial Valley Off-Campus Center, which includes locations in Calexico and Brawley, both located in Imperial County (SDSU 2003). The Off-Campus Center is an extension of SDSU's main campus in San Diego and furthers the University's regional educational mission to provide additional educational opportunities to the outlying communities of Imperial County. The previously certified and approved Campus Master Plan and EIR provided the authorization necessary for enrollment of 850 full-time equivalent (FTE)[1] students at the Off-Campus Center, corresponding associated faculty and staff, and a framework for development of the facilities necessary to serve this projected enrollment and campus population.

The Off-Campus Center - Calexico is approximately 8.3 acres in size and is located in the City of Calexico (City). Most of the Calexico location is built out, consisting of several educational and support facilities. The environmental impacts associated with development of the Off-Campus Center – Calexico were evaluated at a program level of review in the 2003 EIR. In the CSU's continuing effort to build out the Imperial Valley Off-Campus Center and provide additional educational opportunities, SDSU presently proposes construction and operation of a four-building complex that would provide affordable student housing at the Calexico location for 80 students and a resident manager. Additional details regarding the proposed housing is provided below.

1 A full-time equivalent (FTE) student is one full-time student taking 15 course credits, or 3 part-time students each taking 5 course credits.

# 2 Project Location and Existing Conditions

The Off-Campus Center – Calexico is located at 720 Heber Avenue in downtown Calexico, approximately 0.5 miles north of the United States–Mexico border (see Figure 1, Regional Map). Regional access to the Off-Campus Center is provided via SR-111 and SR-98 to the north. The Calexico location is bordered by four streets: Heber Avenue to the west, Sherman Street to the north, Blair Avenue to the east, and 7th Street to the south. Residential uses bound the Calexico complex to the north, east, south, and west. Other surrounding uses include Calexico High School, located northeast, and Calexico City Hall, located immediately south. The Off-Campus Center - Calexico currently consists of 17 buildings and an associated surface parking lot (see Figure 2, Vicinity Map, and Figure 3A, Existing Campus Master Plan).

As a state entity, the CSU/SDSU is not subject to local government plans, regulations, and guidelines, such as those contained in the City's General Plan. The above notwithstanding, for information purposes, the Off-Campus Center -Calexico is zoned as Open Space and is designated as Public Facilities in the City's General Plan (City of Calexico 2015a).

The proposed Project site is approximately 0.58 acres in size (25,320 square feet) and is located at the southeast corner of the campus, at the northwest corner of East 7th Street and Blair Avenue (see Figure 2). The entirety of the Project site has previously been graded and is relatively flat in nature, with an average elevation of 3.5 feet above mean sea level. The Project site encompasses the locations identified in the Campus Master Plan as future Building 21 (see Figure 3A and Figure 3B, Proposed Campus Master Plan). The Project site consists of vacant and undeveloped land with two trees located along the northern boundary of the site. A chain-link fence separates the Project site from the recently removed temporary Campus Buildings 201, which were located immediately west of the Project site.

# 3 Project Description

## 3.1 Affordable Student Housing Complex

The proposed Project would involve the construction of a single-story, four-building complex approximately 12,840 square feet in size that would provide for affordable student housing. The complex would include three student housing buildings, including one smaller live-in unit building, and a community building. Two of the three proposed residential buildings would each be approximately 5,500 square feet in size and would include five four-bedroom, two-bathroom apartment units, totaling 40 student beds per building (two student beds per bedroom, 80 student beds in total). The third proposed residential building would be a live-in manager unit that would consist of a single two-bedroom, one-bathroom apartment. The proposed live-in unit would also include approximately 100 square feet of office space that is intended to provide a space for tenant meetings, social services, or counseling. All apartment units would also be equipped with a living area and kitchen. The proposed community building program would be approximately 840 square feet and include laundry, mail, restroom, electrical, and maintenance facilities. The mail room would be located outside, under the shaded amenity patio of the community building (see Table 1).

### Table 1. Affordable Student Housing Complex Area Calculations

| | Quantity | Area (Square Feet) | Beds |
|---|---|---|---|
| **Residential Buildings (3)** | | | |
| 4-Bedroom, 8-Bed Unit | 5 | 5,150 | 40 |
| 4-Bedroom, 8-Bed Unit | 5 | 5,150 | 40 |
| Live-In Unit | 1 | 1,000 | 2 |
| Office (Included in Live-In Unit) | N/A | N/A | N/A |
| *Subtotal* | *11* | *11,300* | *82* |
| **Community Building (1)** | | | |
| Laundry Room | 1 | 300 | N/A |
| Service Rooms | 4 | 450 | N/A |
| Restroom | 2 | 100 | N/A |
| Mail/Package (Outside) | 1 | 270 | N/A |
| *Subtotal* | *N/A* | *1,150* | *N/A* |
| **Other** | | | |
| Trash/Recycling Enclosure | 1 | 850 | N/A |
| Open Space | N/A | 2,300 | N/A |
| Landscaping/hardscaping | N/A | 12,500 | N/A |
| *Subtotal* | *N/A* | *13,650* | *N/A* |
| **Combined Total** | **N/A** | **26,100** | **82** |

**Note:** N/A = not applicable.
All square foot amounts presented in the table are approximate amounts only and may not add to the site plan area totals described in this document due to rounding.

Other on-site proposed amenities include a courtyard, bike racks, and a community waste enclosure. The courtyard would be approximately 1,600 square feet and would be centrally located in the proposed complex (see Figure 4, Site Plan). Approximately 15 bike racks would be provided throughout the Project site. A community waste enclosure at the northeast corner of the Project site would allow residents a convenient place to dispose of waste and recyclables.

### 3.1.1 Operation

The Off-Campus Center - Calexico, including the Project site, is owned and operated by the CSU/SDSU. The CSU Board of Trustees, on behalf of SDSU, is the lead agency responsible for certifying the adequacy and completeness of this document and approval of the proposed Project. SDSU and the IVCCD have received joint funding under the State of California Higher Education Student Housing Grant Program to construct the proposed Project.

To support basic housing needs for students in the Imperial Valley, SDSU and IVCCD have executed a 30-year master lease agreement that details operation of the Project. This agreement dictates that 40 of the 82 proposed student beds would be reserved for IVCCD students who attend the Imperial Valley College in Imperial. Likewise, 40 of the proposed 82 beds, would be reserved for SDSU Off-Campus Center - Calexico students. A 2-bedroom unit would also provide living space for on-site management. SDSU would be responsible for operating, managing, and maintaining the proposed Project once operational.

Student beds made available under the proposed Project would be leased/rented to eligible low-income students. Eligible low-income students are defined as having 30% of 50% of the Annual Median Income for Imperial County. In the event, after a good faith outreach effort, there is not sufficient demand from students meeting the eligibility requirements within 90 days of the start of the fall semester, unassigned beds may be leased at market rates to SDSU and IVCCD students not meeting the low-income eligibility requirements. In addition to meeting the low-income criteria, eligible students would be required to be enrolled students and take a minimum average of 12 degree-applicable units per semester term, or the quarterly equivalent (with exceptions permitted), to facilitate timely degree completion.

### 3.1.2 Other Project Elements

#### Building and Site Design

The proposed buildings have been designed to reflect the character and massing of the existing Off-Campus Center - Calexico, as well as the surrounding neighborhood. Building design is centered around a courtyard-style housing complex and would consist of smooth stucco walls with downspouts and rafters, punctuated by composite terra cotta–colored roof tile accents and windows. Maximum building heights would range from 14 feet to 18 feet.

#### Landscaping, Other Site Improvements, and Lighting

The Project would include approximately 16,000 square feet of on-site landscaping and hardscape improvements (i.e., pedestrian walkways). All proposed landscaping would consist of drought-tolerant, indigenous plants. The landscape scheme would include shrubs, hedges, and a variety of trees. A total of 39 trees would be added to the Project site including five fan palms, eight mesquite trees, six evergreen elms, and 20 yucca trees.

All exterior on-site lighting would be hooded or shielded, directed downward, and would be compliant with applicable standards for lighting control and light pollution reduction (i.e., Title 24, American National Standards Institute/Illuminating Engineering Society).

The proposed complex would be secured via an iron security fence that would measure 6 feet in height and run approximately 64 linear feet, connecting to the proposed buildings. Access to the complex would only be available to residents and their guests via two pedestrian gates located at the northwestern corner and southern portion of the proposed complex. The gates would be equipped with security card access for residents.

#### Utilities and Public Services

New points of connection for domestic water, fire supply water, sewer, storm drainage and electrical connections from existing utility lines would be required to serve the proposed Project. Potable water service, as well as sewer collection services at the Project site, would be provided by the City. The Project would connect to an existing sanitary sewer maintenance access line located in Blair Avenue via new 6-inch mains. Connections for water (including domestic, fire, and irrigation) would be from an existing water main located in Blair Avenue. Distribution water pipes would be extended underground to serve each proposed building. A new water meter would be located in the proposed maintenance room in the community building. Adequate water treatment capacity and supply and sewer treatment capacity exists within the City's water and sewer system to accommodate the Project; therefore, no capacity upgrades to infrastructure would be necessary.

Stormwater drainage includes two stormwater catch basins. One basin would be located on the eastern boundary of the Project site, and the second would be situated immediately east of the existing chain-link fence at the western boundary of the Project site. The proposed catch basins would function as both water quality and flood control features, by filtering out surface water contaminants and slowing stormwater runoff prior to stormwater discharge into the City's stormwater system via one new storm drain located in the southeast corner of the Project site.

Electrical services within the Project area are provided by Imperial Irrigation District, which provides electric power to over 158,000 customers in the Imperial Valley in addition to areas of Riverside and San Diego counties (IID 2024). New utility connections and infrastructure would be required to support electrical services on site. The Project would connect to on-site electrical power infrastructure via an existing 12kV, three phase, three wire, 60 Hertz overhead line routed along East 7th Street. No natural gas usage is proposed for the Project.

The Project would require a new point of connection for on-site telecommunications and would connect to the existing AT&T communications via the on-campus minimum point of entry.

#### Access, Circulation, and Parking

Regional access to the Project site is provided via SR-111 and SR-98 to the north. Local access is provided via Blair Avenue and East 7th Street. Parking to the Project site is available in the existing campus parking lot, immediately north of the Project site, which has sufficient capacity to serve the proposed Project. On-site circulation improvements would consist of additional paved pathway/pedestrian walkway features throughout the proposed complex and along the northern boundary of the Project site (see Figure 4). Emergency access would be provided directly adjacent to the Project site on East 7th Street and Blair Avenue.

### 3.1.3 Design Standards and Energy Efficiency

In May 2014, the CSU Board of Trustees broadened the application of sustainable practices to all areas of the university by adopting the first systemwide sustainability policy, which applies sustainable principles across all areas of university operations, including facility operations and utility management. In May 2024, the CSU Sustainability Policy was updated to expand on existing sustainability goals (CSU 2024a). The CSU Sustainability Policy seeks to integrate sustainability into all facets of the CSU, including academics, facility operations, the built environment, and student life (CSU 2018). Relatedly, the state has also strengthened energy-efficiency requirements in the California Green Building Standards Code (Title 24 of the California Code of Regulations).

As a result, all CSU new construction, remodeling, renovation, and repair projects, including the proposed Project, would be designed with consideration of optimum energy utilization, low life cycle operating costs, and compliance with all applicable state energy codes and regulations. Progress submittals during design are monitored for individual envelope, indoor lighting, and mechanical system performances. In compliance with these goals, the proposed Project would be equipped with solar ready design features that would facilitate and optimize the future installation of a solar photovoltaic (PV) system.

### 3.1.4 Off-Site Improvements

Off-site improvements would include the resurfacing of a portion of Blair Avenue adjacent to the eastern boundary of the Project site that would be disturbed as a result of trenching to make necessary connections to the existing water main and sanitary sewer maintenance access. Any area disturbed as a result of this connection within Blair Avenue would be resurfaced to existing conditions. All off-site improvements would occur within the Blair Avenue right-of-way.

### 3.1.5 Construction

Construction would be performed by qualified contractors. Plans and specifications would incorporate stipulations regarding standard CSU/SDSU requirements and acceptable construction practices, such as those set forth in the SDSU Stormwater Management Plan, CSU Seismic Policy, The CSU Office of the Chancellor Guidelines, and the CSU Sustainability Policy, regarding grading and demolition, safety measures, vehicle operation and maintenance, excavation stability, erosion control, drainage alteration, groundwater disposal, public safety, and dust control.

#### Construction Timeline

Construction of the proposed Project would take approximately 17 months to complete and is estimated to begin as early as January 2025 and be completed by May 2026, with occupancy planned for fall 2026. Construction activities would generally occur Monday through Friday between the hours of 8:00 a.m. and 5:00 p.m., with the potential for weekend construction on Saturday between 9:00 a.m. and 5:00 p.m. No construction would occur on Sundays or holidays or at night.

#### Construction Activities

A construction mobilization or staging area would be located immediately northeast of the proposed Project site and would occupy approximately 8,000 square feet. The area would be located east of existing Campus Building 6, west of Blair Avenue, and south of the existing parking lot (see Figure 2 and Figure 3A). To accommodate use of this area, four trees would be removed.

Construction would include site preparation, grading and excavation, utility installation/trenching, building foundation pouring, building construction, and landscaping. Excavation depths are anticipated to be 3 feet below grade. The majority of waste (i.e., excavated gravel/soil) generated during Project construction would be balanced/used within the site. Approximately 2,600 cubic yards of soil would be removed from the site and exported to Republic Services Allied Imperial Landfill, approximately 12 miles north. The entire Project site, including construction mobilization area (approximately 34,000 square feet in total) would be disturbed as a result of Project construction. Two trees would be removed from the Project site to accommodate the proposed Project.

Table 2 displays the construction equipment anticipated to be used during construction.

**Table 2. Anticipated Construction Equipment**

| | |
|---|---|
| Aerial Lifts | Pressure Washers |
| Air Compressors | Pumps |
| Cement and Mortar Mixers | Rollers |
| Concrete/Industrial Saws | Rough Terrain Forklifts |
| Dumpers/Tenders | Rubber-Tired Dozers |
| Excavators | Rubber-Tired Loaders |
| Forklifts | Scrapers |

**Table 2. Anticipated Construction Equipment**

| | |
|---|---|
| Generator Sets | Signal Boards |
| Graders | Skid Steer Loaders |
| Off-Highway Tractors | Surfacing Equipment |
| Off-Highway Trucks | Sweepers/Scrubbers |
| Other Construction Equipment | Tractors/Loaders/Backhoes |
| Other General Industrial Equipment | Trenchers |
| Other Material Handling Equipment | Welders |
| Plate Compactors | |

**Source:** Dorsey and Nielson Construction Inc, pers. comm., 2024

### Construction Waste

The Project would generate construction debris during on-site clearing activities. In accordance with Section 5.408 of the California Green Building Standards Code, the Project would implement a construction waste management plan for recycling and/or salvaging for reuse of at least 65% of nonhazardous construction/demolition debris. Additionally, the Project would be required to meet Leadership in Energy and Environmental Design v4 requirements for waste reduction during construction. Solid waste generated during construction would be hauled off site to the Republic Services Allied Imperial Landfill at 104 East Robinson Road in Imperial, California.

# 4 Analysis Methodology

The analysis presented here considers the potential geology and soil impacts of the proposed Project relative to existing conditions. Establishment of the Project site's existing geology and soil conditions has been prepared using information contained in the previously certified 2003 SDSU Imperial Valley Campus Master Plan Project EIR (SDSU 2003), combined with updated information, as applicable, from the California Geological Survey (CGS), Southern California Earthquake Data Center, U.S. Geological Survey (USGS), Imperial County General Plan (Seismic and Public Safety Element) (Imperial County Planning and Development Services 1997), and Imperial County General Plan EIR (Imperial County Planning and Development Services 1993). In addition, the results of an August 2022 Project-specific geotechnical report by Group Delta (Attachment B, Geotechnical Report) have been incorporated into the existing conditions section and impact analysis.

# 5 Geology and Soils

## 5.1 Existing Conditions

### Regional Geology

The SDSU Off-Campus Center - Calexico lies within the Salton Trough, the dominant landform within Imperial County. The Salton Trough encompasses the Coachella, Imperial, and Mexicali Valleys and extends north from the Gulf of California. The lowest part of the basin is the bed of the prehistoric Lake Cahuilla, with its ancient beach line at about 35 feet above mean sea level. The deepest portion is covered by the Salton Sea with a water surface level measured at 226 feet below mean sea level at its highest level in April 1986. The geologic structure of the trough is a result of an evolving "rift" in the earth's crustal plates. As the crust thins due to the "spreading" of the trough, magma rises closer to the surface, heating deep groundwater. Nonmarine and alluvium sediments cover large portions of the area. An unexposed succession of Tertiary- and Quaternary-age sedimentary rocks lies below the alluvial and lake bottom sediments, ranging in depth from 11,000 feet or greater at the margins to over 20,000 feet in the central portions of the Salton Trough. The valley is drained by an 8,360-square-mile watershed, which eventually empties into the Salton Sea (SDSU 2003).

## Soils

Surficial soils beneath the Project site consist of Imperial-Glenbar silty clay loams, on 0% to 2% slopes. The upper 60 inches of this soil type typically consist of silty clay loam and clay loam. These soils are moderately well-drained, have low runoff potential, and are not prone to flooding (USDA 2023). Underlying sediments in the Off-Campus Center - Calexico area consist of over 100 feet of late Pleistocene to Holocene lacustrine (i.e., lake) deposits associated with ancient Lake Cahuilla. These sediments are typically unconsolidated to poorly consolidated and porous, consisting generally of clay, silt, and occasional beds of medium dense silty sand. Clay and silt soils typically exhibit medium to high expansion potential and range in consistency from medium stiff to hard (SDSU 2003; Attachment B).

A Project-specific geotechnical report indicated that the upper 3 to 4 feet of soils consist of undocumented fill consisting of clay with varying amounts of sand and organic material. Laboratory tests of samples collected at the site indicate the near-surface soils have a moderate expansion potential, are medium stiff to hard in consistency, and are considered corrosive to severely corrosive. Geotechnical borings drilled on site encountered several 2- to 4-foot-thick beds of silty sand and nonplastic silt within the lacustrine deposits, at depths ranging between approximately 13 to 20 feet, 28 to 30 feet, and 48 to 50 feet below existing ground surface. These silty sand and silt layers consisted of loose to medium dense material, which are potentially liquefiable under a high seismic demand, as described in the Liquefaction and Lateral Spreading section below (Attachment B).

## Faulting and Seismicity

Surface fault rupture is the displacement of ground surface that occurs along a fault line during an earthquake event. Based on criteria established by CGS, faults are classified as either Holocene-active, pre-Holocene, or age-undetermined. Faults are considered active when they have shown evidence of movement within the past 11,700 years (i.e., Holocene epoch). Pre-Holocene faults, also known as potentially active faults, are those that have shown evidence of movement more than 11,700 years ago and generally before 1.6 million years (Quaternary age). Faults whose age of most recent movement is not known or is unconstrained by dating methods or by limitations in stratigraphic resolution are considered age-undetermined and inactive (CGS 2018).

The Alquist-Priolo Earthquake Fault Zoning Act (formerly known as the Alquist-Priolo Special Studies Zones Act) established state policy to identify active faults and determine a boundary zone on either side of a known fault trace, called the Alquist-Priolo Earthquake Fault Zone. The delineated width of an Alquist-Priolo Earthquake Fault is based on the location, precision, complexity, or regional significance of the fault and can be between 200 and 500 feet in width on either side of the fault trace. If a site lies within a designated Alquist-Priolo Earthquake Fault Zone, a geologic fault rupture investigation must be performed to demonstrate that a proposed building site is not threatened by surface displacement from the fault before development permits may be issued (CGS 2018).

The Imperial Valley area is subjected to frequent seismic events, with related concerns of ground shaking and liquefaction. The most noteworthy of the numerous faults traversing the Salton Trough is the Holocene-active Coachella section of the San Andreas Fault. Two other major northwest-trending Holocene-active fault zones bounding the Salton Trough include the San Jacinto Fault to the northwest and the Elsinore Fault to the southwest (see Figure 5, Regional Faulting). The potential for future large earthquakes on the San Andreas and San Jacinto Fault Zones is based on potential rupture scenarios associated with both fault zones, as movement on the San Jacinto Fault is dependent on movement of the southern San Andreas Fault Zone. Based on historic and pre-historic fault ruptures, the maximum worst-case earthquake on these two interrelated fault zones would be moment magnitude ($M_w$) 8.0. However, the probable maximum magnitude is $M_w$ 6.5 to $M_w$ 7.5 for the San Jacinto Fault and $M_w$ 6.8 to $M_w$ 8.0 for the San Andreas Fault (Sanders 1993; USGS 2002; Scharer and Yule 2020; SCEDC 2024).

The Holocene-active Imperial Fault is the closest fault to the Off-Campus Center - Calexico, located approximately 7 miles northeast of the Calexico Off-Campus Center (CGS 2024a) (see Figure 5). However, the Off-Campus Center - Calexico is not located in an Alquist-Priolo Earthquake Fault Zone associated with the Imperial Fault (CDMG 1990), and no known active faults are present in the immediate site vicinity (Attachment B). The Imperial Fault Zone is the principal element of the San Andreas Fault System within the Salton Trough. Ground surface rupture has occurred twice during historic times, including 1940 and 1979 (and possibly in 1915), as evidence by offset of historic alluvium, lacustrine deposits, and cultural features. The 1940 earthquake produced surface rupture offsets up to 23 feet near the United States–Mexico border. Data from these earthquake events suggest a slip rate of 15 to 20 millimeters per year for the Holocene epoch (past 11,700 years). As discussed below, slip is transferred north through the Brawley Seismic Zone, and some slip may be transferred to the San Jacinto Fault Zone. The recurrence interval is 30 to 40 years for a 1979-style earthquake event and 270 to 700 years for a 1940-style earthquake. Others have postulated recurrence intervals of 40 years, 137 years, and 37 years, respectively, for the northern, central, and southern segments of the fault. In addition, the maximum probable earthquake magnitude for the Imperial Fault is $M_w$ 6.5 to $M_w$ 7.0 (Treiman 1999; SCEDC 2024; USGS 2022).

The largest recorded earthquake in Imperial County occurred on the Imperial Fault in May 1940. This Richter magnitude 7.0 earthquake was centered on the international border, east of Calexico, and could be traced for approximately 50 miles, from the Volcano Lake in Mexico, north through the Imperial Valley, just north of Brawley. The newly completed All-American Canal was offset approximately 14 feet by movement on the fault, and nine people died from the earthquake. In addition, a magnitude 6.6 earthquake occurred along the Imperial Fault in October 1979. The epicenter was 7 miles east of Calexico. No lives were lost, but numerous structures and canals were damaged, including settlement of the All-American Canal up to 4 feet. Earthquake damage was estimated at $30 million. In addition, a magnitude 7.2 earthquake occurred near Calexico in April 2010 (CGS 2024b; Imperial County Planning and Development Services 1993; USGS and CGS 2011).

Other substantial earthquakes in Imperial County include those occurring in 1892 (M7.1), 1915 (M6.3 and 7.1), 1930 (M5.7), 1950 (M5.4), 1957 (M5.2), 1968 (M6.5), 1980 (M6.1), 1981 (M5.8), 1987 (M6.2 and 6.8), and 2010 (M7.2). In addition to the faults described above, other active faults in the region include the Superstition Hills, Superstition Mountain, Laguna Salada, and Cerro Prieto Faults. Currently, portions of Imperial County are affected by a minor earthquake with a magnitude of 4.5 or less every few months. Imperial County may experience an earthquake with a magnitude of 5.5 or greater every 5 years and dozens of micro-seismic events, with magnitudes of 2.0 or less, on a daily basis (CGS 2024b; Imperial County Planning and Development Services 1993; USGS and CGS 2011).

Fluid injection and geothermal energy extraction in the North Brawley Geothermal Field, located within the Brawley Seismic Zone, located approximately 17 miles north of the Off-Campus Center – Calexico (see Figure 5), have been linked to seismic hazards. After a few years of geothermal operations at the North Brawley Geothermal Field, located within the Brawley Seismic Zone, several magnitude 4 to 5 earthquakes occurred in 2012, followed by a long period of few earthquakes. Ground deformation was analyzed in the area, combining radar images, GPS, and leveling to reveal how the ground moved before, during, and after the 2012 events, with centimeter-scale accuracy. Another potential source of concern in geothermal fields is faults that slip without generating seismic waves. Silent slip, or fault creep, may play a role in controlling the location and duration of earthquake swarms. The processes behind silent or aseismic slip at geothermal fields are not well understood, largely because they are difficult to measure (Materna et al. 2022).

## Liquefaction and Lateral Spreading

Liquefaction involves a sudden loss in strength of saturated, cohesionless soils that are subject to ground shaking during an earthquake and results in temporary transformation of the soil to behave more like a fluid mass. For liquefaction to occur, three conditions are required: (1) ground shaking of sufficient magnitude and duration; (2) a groundwater level at or above the level of susceptible soils during the ground shaking (i.e., generally at depths less than 40 feet); and (3) soils that are susceptible to liquefaction.

The Off-Campus Center – Calexico has not been included in regional liquefaction analyses by CGS (2024c). However, the unconsolidated sediments of the Salton Trough, especially in saturated areas such as irrigated lands, are subject to failure during earthquakes as a result of liquefaction (Imperial County Planning and Development Services 1993). Liquefaction caused by the M7.2 El Mayor-Cucapah earthquake was widespread throughout the southern Imperial Valley. Ground motions of 0.3 g to 0.6 g (percent of gravity) were recorded in most liquefaction areas (USGS and CGS 2011).

As described above, geotechnical borings drilled on-site encountered several 2- to 4-foot-thick beds of silty sand and nonplastic silt, at depths ranging between approximately 13 to 20 feet, 28 to 30 feet, and 48 to 50 feet below existing ground surface. These silty sand and silt layers consisted of loose to medium dense material, which are potentially liquefiable under a high seismic demand. Groundwater was encountered at the Project site at a depth of approximately 28 feet below ground surface. Secondary effects of liquefaction include sand boils, settlement and instabilities within sloping ground that occur as lateral spreading, seismic deformation, and flow sliding. Lateral spreading is the horizontal deformation of gently sloping ground (slope less than 6%), and seismic deformation is the horizontal movement of more steeply sloping ground, both of which can occur during strong ground shaking. Flow sliding is an overall instability of more steeply sloping ground that can occur following or near the end of strong ground shaking, depending on its duration. Also associated with liquefaction is seismic compaction, which is the densification of loose to medium dense granular soils that are above groundwater. Of these, liquefaction-induced settlement and seismic compaction are considered more likely to occur at the Project site given the site surface and subsurface conditions (Attachment B).

Liquefaction-triggering calculations completed for the Project site indicated that liquefaction would likely occur as a result of a $M_W$ 7.1 earthquake, a peak ground acceleration of 0.59 g (percent of gravity), and a depth to groundwater of 20 feet. Based on the results of the triggering analyses, there are several potentially liquefiable zones within the subsurface profile. In general, the potentially liquefiable soils consist of thin beds that are generally less than 2 feet thick each, but some up to 4 feet thick locally. The estimated liquefaction-induced volumetric settlement is approximately 1 inch or less at each exploration location. The estimated liquefaction-induced differential settlement is approximately 0.5 inch or less over a horizontal distance of 30 feet. Since the site is essentially level, the potential for significant liquefaction-induced lateral displacement should be low (Attachment B).

### Subsidence

Subsidence is the permanent collapse of the pore space within a soil or rock and downward settling of the earth's surface relative to its surrounding area. Subsidence can result from the extraction of water, oil, or geothermal resources and the addition of water to the land surface—a condition called "hydrocompaction," or peat loss. The compaction of subsurface sediment caused by the withdrawal or addition of fluids can cause subsidence. Land subsidence can disrupt surface drainage; reduce aquifer storage; cause earth fissures; damage buildings and structures; and damage wells, roads, and utility infrastructure.

According to the U.S. Geological Survey Areas of Land Subsidence in California map, there have been no recorded instances of subsidence in the Off-Campus Center – Calexico area associated with groundwater pumping, peat loss, or oil extraction (USGS 2024). Natural subsidence has been occurring within the Salton Trough, averaging nearly 2 inches per year at the center of the Salton Sea but decreasing to zero near the Mexican border (Imperial County Planning and Development Services 1997).

In addition, subsidence in geothermal fields can occur when large fluid volume production leads to the decrease of pore pressure inside reservoirs. This decline disturbs the pressure stability, and overburden pressure compresses the pores, resulting in a drop in the ground surface. The decrease in ground surface elevation can not only result in damage to buildings, pipelines, and canals, but also may interrupt the balance in the nearby ecosystem (Sektiawan et al. 2016). Significant ground movement, in the form of ground subsidence and horizontal movement, may accompany geothermal development in the Imperial Valley. Regional and local survey nets are being monitored to detect and measure possible ground movement caused by future geothermal developments. Precise measurement of surface and subsurface changes is required to differentiate human-induced changes from natural processes (USGS 2013). Two geothermal facilities are located approximately 3.0 miles and 3.5 miles northwest of the Calexico SDSU Off-Campus Center – Calexico (Imperial County Planning and Development 2013).

Satellite radar interferometry (InSAR) was applied to detect surface deformation associated with geothermal development and concluded that distinct areas of subsidence are present in three geothermal fields in the Imperial Valley, including the Salton Sea, Heber, and East Mesa geothermal fields. In addition, ground uplift was observed at the Heber geothermal field (Eneva et al. 2012). These geothermal fields are located approximately 34 miles northwest, 3 miles northwest, and 15 miles northeast of the Off-Campus Center - Calexico, respectively (Imperial County Planning and Development 2013).

Land subsidence can be avoided by re-injecting all production water back into the aquifer it was withdrawn from so that pressure changes are minimized. Subsidence can be reduced through monitoring combined with aquifer management. Aquifers must be managed to balance groundwater recharge and groundwater discharge at both local and basin-wide scales. Management tools include: (1) ensuring all water used for geothermal heat extraction is pumped back into the aquifer, (2) replacing water lost from the aquifer by increasing groundwater recharge to the basin-fill aquifer through conjunctive management of groundwater and surface water resources and importation of water from other basins, (3) dispersing high-discharge wells to reduce localized land subsidence, and (4) reducing overall groundwater withdrawals in the basin (USGS 2012). In addition, well field programs covering production and injection plans in Imperial County are required by the Bureau of Land Management and California Geologic Energy Management Division (CalGEM) for each major geothermal project and are subject to review by CalGEM and Imperial County (Imperial County Planning and Development Services 1997).

### Slope Stability

The topography of the SDSU Off-Campus Center – Calexico is relatively flat to gently sloping, and no evidence of ancient landslides or slope stabilities are present (Attachment B).

# 6 Impact Analysis and Conclusions

## 6.1 Thresholds of Significance

The significance criteria used to evaluate the impacts of the proposed Project related to geology and soils are based on Appendix G of the CEQA Guidelines (14 CCR 15000 et seq.). A significant impact under CEQA would occur if the proposed Project would:

a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:
   i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault.
   ii. Strong seismic ground shaking.
   iii. Seismic-related ground failure, including liquefaction.
   iv. Landslides.
b) Result in substantial soil erosion or the loss of topsoil.
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
d) Be located on expansive soil, as defined in the 2022 California Building Code, creating substantial direct or indirect risks to life or property.
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

## 6.2 Impact Analysis

a) ***Would the project directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:***

i. ***Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault?***

Impacts related to rupture of a known earthquake fault were evaluated in Section 3.2, Geology/Soils, of the 2003 EIR, which concluded that the Off-Campus Center – Calexico is not within the limits of the Alquist-Priolo Special Studies Zones of the Imperial and Brawley Faults (SDSU 2003). Accordingly, the 2003 EIR did not provide an impact conclusion regarding potential rupture of a known earthquake fault.

As discussed above, the Holocene-active Imperial Fault is the closest fault to the SDSU Off-Campus Center - Calexico, located approximately 7 miles to the northeast. The Off-Campus Center - Calexico is not located in an Alquist-Priolo Earthquake Fault Zone, and no known active faults are present in the immediate site vicinity. No new information or substantial changes in circumstances have occurred requiring new or additional analysis regarding rupture of a known earthquake fault at the Project site. As a result, surface fault rupture is not anticipated at the Project site, and the Project would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving the rupture of a known earthquake fault. **No impact** would occur.

ii. ***Strong seismic ground shaking, or***

iii. ***Seismic-related ground failure, including liquefaction?***

Impacts related to seismic ground shaking, seismic-related ground failure, and liquefaction were evaluated in Section 3.2, Geology/Soils, of the 2003 EIR, which concluded that although no geotechnical conditions have been identified to preclude development of the Imperial Valley Campus Calexico projects as planned, geology and soil impacts would be significant because of the hazards from seismic activity if proper construction techniques are not observed at the detailed design and construction stages (SDSU 2003). Mitigation measures were provided that require SDSU to (1) avoid adverse discontinuities in strength between major structural elements, (2) prior to detailed site planning, conduct a subsurface geotechnical and soil study to ensure structural integrity, and (3) adhere to recommendations of the geotechnical and soil study in developing grading and construction plans (SDSU 2003, pp. 3.2-4, 3.2-5, and 11-1).[2] With implementation of the mitigation measures, impacts were determined to be less than significant.

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[2] **Section 3.2, Geology/Soils, Mitigation Measures 1 and 2**: (1) Adverse discontinuities in strength between major structural elements shall be avoided. (2) Prior to detailed site planning, a subsurface geotechnical and soils study shall be conducted to determine the shrink-swell potential and to develop design specific measures to ensure structural integrity. Grading and construction plans shall conform to recommendations of the study (SDSU 2003, pp. 3.2-4, 3.2-5, and 11-1).

Updated information since completion of the 2003 EIR related to seismicity, including liquefaction and fluid injection, are summarized below, as well as in Section 5.1, Existing Conditions. The Imperial Valley area is subjected to frequent seismic events, with related concerns of ground shaking and liquefaction. The most noteworthy of the numerous faults traversing the Salton Trough is the Holocene-active Coachella section of the San Andreas Fault. As described above in Section 5.1, two other major northwest-trending Holocene-active fault zones bounding the Salton Trough include the San Jacinto Fault to the northwest and the Elsinore Fault to the southwest (see Figure 5). In addition, the Holocene-active Imperial Fault is located 7 miles northeast of the Off-Campus Center - Calexico, and the Brawley Seismic Zone is located approximately 17 miles to the north. Fluid injection and geothermal energy extraction in the North Brawley Geothermal Field, located within the Brawley Seismic Zone, have been linked to seismic hazards.

Geotechnical borings drilled on site encountered several loose to medium dense, 2- to 4-foot-thick beds of silty sand and nonplastic silt, which are potentially liquefiable under a high seismic demand. Liquefaction-induced settlement and seismic compaction are considered likely to occur given the site surface and subsurface conditions. The estimated liquefaction-induced differential settlement is approximately 0.5 inches or less over a horizontal distance of 30 feet. Since the site is essentially level, the potential for significant liquefaction-induced lateral displacement should be low.

Since certification of the 2003 EIR, the CEQA significance criteria have been revised (per Appendix G of the 2022 CEQA Statute and Guidelines). Seismic impacts on any given project are no longer considered potentially significant. Rather, impacts would only be considered significant in the event the project directly or indirectly caused seismic impacts to occur. Because construction and operation of the proposed buildings would not induce seismicity, the Project would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking and **no impacts** would occur.

Regardless, the following is an updated discussion of protocol that would be followed with respect to seismic engineering of the proposed buildings. As required by the 2022 California Building Code (CBC), the proposed SDSU Off-Campus Center – Calexico buildings and associated infrastructure improvements would be constructed in accordance with the recommendations of the Project-specific geotechnical report (Attachment B), which includes recommendations for remedial grading and foundation design to address strong seismic ground shaking, liquefaction, differential settlement, and seismic densification. Accordingly, while referred to as “recommendations” in geotechnical reports, each recommendation is, in fact, required by law to be implemented. More specifically, the geotechnical report recommends the use of thickened and heavily reinforced conventional building foundations or post-tensioned slabs to reduce the potential for distress to the proposed buildings associated with post-liquefaction settlement. The geotechnical recommendations are consistent with CGS Note 48, Design and construction in accordance with these recommendations would provide, to the extent feasible, an acceptable level of earthquake safety for students, employees, and the public who occupy the buildings.

In addition, the Project would be designed in accordance with the CSU Seismic Requirements document (CSU 2024b), which includes specific requirements for the construction of new buildings, to ensure that all CSU buildings provide an acceptable level of earthquake safety for students, employees, and the public. The CSU Seismic Policy applies to all structures within the bounds of a CSU campus Master Plan. These seismic requirements set forth procedures to follow to manage current construction programs and limit future seismic risk to acceptable levels. The CSU has established campus-specific seismic ground motion parameters that supersede CBC values and implement a conservative evaluation on CBC Structural Risk Category assignments.

The CSU Seismic Requirements document (CSU 2024b) states that all building projects and all engineered structures, such as the proposed Project, are to be peer reviewed. This process starts at project inception and continues until construction completion. Peer review concurrence letters are typically issued at completion of the Schematic Preliminary Design and Construction Documents Phases, and during the course of construction on deferred submittals that have a seismic component. Resolution of outstanding Seismic Review Board peer review comments is required before start of construction, and resolution of Seismic Review Board construction phase submittals is required prior to occupancy. John A. Martin and Associates, Inc. maintains a Seismic Peer Review Master Enabling Agreement with the CSU, under which each campus and the administrative office of the CSU may engage them for peer review services (CSU 2024c). John A. Martin and Associates, Inc. would provide a conformance letter to the Seismic Review Board prior to start of construction.

In addition, the Project would be submitted to the CSU Architecture and Engineering, Building Code Plan Check Review process. All approved plans for construction would include a stamp that verifies the design would be completed in compliance with appropriate CSU Seismic Requirements. The stamp would also indicate that the Project has been reviewed consistent with Chapter 16 of the California Building Code and the State Earthquake Protection Law.

The proposed buildings and infrastructure improvements would be constructed under the supervision of a California Geotechnical Engineer and/or California Certified Engineering Geologist. In addition, construction and operation of proposed Project facilities would not increase the potential for earthquakes or seismically induced ground failure to occur. As a result, the Project would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking or seismic-related ground failure, including liquefaction. For these reasons, **no impacts** would occur.

*iv. Landslides?*

The initial study (IS) prepared for the 2003 EIR determined that no impact would occur with regard to landslides (SDSU 2003). The topography of the Off-Campus Center – Calexico and surrounding area is relatively flat to gently sloping, and no evidence of ancient landslides or slope instabilities are present. With implementation of the required recommendations provided in the Project-specific geotechnical report (Attachment B), as required by the CBC, grading and construction would not cause slope instability to occur. The geotechnical report recommends that temporary excavations be inclined no steeper than 1:1 for heights up to 5 feet. Vertical excavations should be shored. As a result, the Project would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides. As such, impacts would be **less than significant.**

***b) Would the project result in substantial soil erosion or the loss of topsoil?***

The 2003 EIR and IS prepared for the 2003 EIR did not specifically address soil erosion and loss of topsoil. Therefore, a discussion regarding the proposed Project's potential to result in substantial soil erosion or the loss of topsoil is provided below.

The proposed Project site is approximately 0.60 acres in size (approximately 25,400 square feet), and the construction laydown area would occupy approximately 8,200 square feet, immediately northeast of the Project site. The construction laydown area would be located east of existing Campus Building 6, west of Blair Avenue, and south of the existing parking lot (see Figure 2 and Figure 3a). The entirety of the Project site has previously been graded and is relatively flat. The Project would involve site preparation, grading, and excavation associated with Project construction. Excavation depths are anticipated to be 2 to 5 feet, followed by soil backfill and compaction. Approximately 2,600 cubic yards of soil would be removed from the site and trucked off-site.

Project grading and construction would temporarily expose on-site soils to wind and water erosion, which in turn could result in sedimentation of downstream drainages. However, stormwater best management practices (BMPs) would be installed during grading and construction to minimize the potential for soil erosion. BMPs would be consistent with construction site runoff controls detailed in the SDSU Stormwater Management Plan (SDSU 2022), including erosion controls, sediment controls, and run-on/runoff controls. Typical construction BMPs would include straw wattles, sediment basins, sediment fences, covering stockpiled soil, vehicle track-out controls at entrance/exit points, and limitations on work periods during storm events. Based on the SDSU Stormwater Management Plan, construction sites less than 1 acre (such as the Project site) would be inspected weekly by the Environmental Health and Safety staff for proper BMP implementation. If the Environmental Health and Safety staff deems a project is not in compliance with minimum BMPs set forth in the construction contract language, they would provide the contractor with a copy of their site inspection/audit report and include a list of actions required to bring the site into compliance. Staff would re-inspect the site within 72 hours after notifying the contractor of the deficiencies. After construction, the Project site would be developed with impermeable surfaces and approximately 16,000 square feet of on-site landscaping, thus eliminating the potential for soil erosion. As a result, the Project would not result in substantial soil erosion or the loss of topsoil, and impacts would be **less than significant.**

***c) Would the project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?***

The IS completed for the 2003 EIR concluded that no impacts would occur with respect to potentially unstable geologic units, including landslides, lateral spreading, subsidence, liquefaction, and collapse (SDSU 2003). Since certification of the 2003 EIR, the CEQA significance criteria have been revised (per Appendix G of the 2022 CEQA Statute and Guidelines). Geologic hazard impacts on any given project are no longer considered potentially significant. Rather, impacts would only be considered significant in the event the project directly or indirectly caused geologic hazard impacts to occur. Therefore, the following is an updated discussion of potential impacts related to geologic hazards, as well as an updated discussion of protocol that would be followed with respect to geotechnical engineering of the proposed buildings. In addition, updated information since completion of the 2003 EIR related to liquefaction and subsidence are summarized below. New information pertaining to liquefaction and subsidence is also presented in Section 5.1.

As described in the analysis of Thresholds a-ii and a-iii, although the Project would be susceptible to potentially strong seismically induced ground shaking and liquefaction, Project design and construction would be completed in compliance with the 2022 CBC, the recommendations of the Project-specific geotechnical report (Attachment B), and the CSU Seismic Requirements document (CSU 2024b). CSU Architecture and Engineering review would further assist to offset potential risks to structures and people associated with liquefaction and collapsible soils. In addition, constructing the proposed buildings within a liquefaction-prone area would not, in and of itself, increase liquefaction risks to surrounding uses. Although the Project site is potentially susceptible to liquefaction, no slopes are present on the site, thus eliminating the potential for lateral spreading to occur. As described in the analysis of Threshold a-iv, the Project would not be susceptible to landslides.

On-site clay rich soils are compressible and should experience some time-dependent consolidation settlement (i.e., long-term settlement). Silty sand and silt beds should also settle with initial fill and structural loading (i.e., short-term settlement). Provided minimal fill placement is needed at the site to achieve the proposed finish grades and foundation loading is limited to the bearing pressures provided in the recommendations of the geotechnical report (Attachment B), most of the long-term settlement should occur in a relatively short time following initial loading. Zones of thick clay could experience some time-dependent consolidation settlement if significant loading from fill or foundation loads are proposed for the Project. However, Project design and construction would be completed in accordance with the recommendations of the Project-specific geotechnical report, which include estimating the settlement magnitude and duration associated with the proposed fill placements and foundation loads. As a result, potential impacts related to compressible soils would be minimized.

Clayey surficial soils present a severe risk of sulfate attack and are also corrosive to very corrosive to buried metals. The geotechnical report (Attachment B) recommends placement of 2 to 5 feet of imported sand beneath sidewalks and building slabs-on-grade to reduce the potential for sulfate attack and corrosion. Sulfate-resistant Type V cement is also recommended for use on site. As a result, potential impacts related to sulfate attack and corrosive soils would be minimized.

Natural subsidence has been occurring within the Salton Trough, averaging nearly 2 inches per year at the center of the Salton Sea, and decreasing to zero near the Mexican border and the Project site. This natural subsidence is relatively uniform over large areas. In addition, subsidence in geothermal fields can result in damage to buildings and related infrastructure. Two geothermal facilities are located approximately 3.0 miles and 3.5 miles northwest of the SDSU Off-Campus Center - Calexico. Satellite radar interferometry (InSAR) was applied to detect surface deformation associated with geothermal development and concluded that distinct areas of subsidence are present in three geothermal fields in the Imperial Valley, including the Salton Sea, Heber, and East Mesa geothermal fields. In addition, ground uplift was observed at the Heber geothermal field. These geothermal fields are located approximately 34 miles northwest, 3 miles northwest, and 15 miles northeast of the Off-Campus Center - Calexico, respectively.

Therefore, subsidence as a result of geothermal activity does not appear to be occurring at the Project site. Well field programs covering production and injection plans in Imperial County are required by the Bureau of Land Management and CalGEM for each major geothermal project and are subject to review by CalGEM and Imperial County, thus minimizing the potential for subsidence to occur. In addition, construction and operation of the proposed SDSU Off-Campus Center - Calexico buildings would not result in substantial adverse impacts such that collapse would occur. As a result, the Project would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. Impacts would be **less than significant.**

*d)* ***Would the project be located on expansive soil, as defined in the 2022 California Building Code, creating substantial direct or indirect risks to life or property?***

Impacts related to expansive soils were evaluated in Section 3.2, Geology/Soils, of the 2003 EIR, which concluded that although no geotechnical conditions have been identified to preclude development of the Imperial Valley Campus Calexico projects as planned, geology and soil impacts are significant because of the hazards from expansive soils if proper construction techniques are not observed at the detailed design and construction stages (SDSU 2003). Mitigation measures were provided that would require SDSU to (1) prior to detailed site planning, conduct a subsurface geotechnical and soil study to determine the shrink-swell potential, and (2) adhere to recommendations of the geotechnical and soil study in developing grading and construction plans (SDSU 2003, pp. 3.2-4, 3.2-5, and 11-1).[3] With implementation of the mitigation measures, impacts were determined to be less than significant.

Soil sampling completed on site indicated that moderately expansive soils are present in near surface soils, to a depth of 5 feet. Project design and construction would occur in compliance with recommendations of the Project-specific geotechnical report (Attachment B) and the provisions of the 2022 CBC, which requires that grading, structural design, and construction be completed such that potentially expansive soils would not adversely affect foundations, piping, and related infrastructure. The geotechnical report recommends that the clay-rich, expansive soil excavated as part of the Project not be re-used as compacted fill. Fill should be imported to replace expansive soil materials underlying the proposed structures, flatwork, and pavements, to depths of 2 to 5 feet. Additional measures include thickened foundations and slabs or post-tensioned slab-on-grade to support the proposed buildings.

Project design would also be completed in accordance with the CSU Architecture and Engineering review process. As a result, construction of the Project on potentially expansive soils would not create substantial direct or indirect risks to life or property. Impacts would be **less than significant**, and no additional mitigation is required.

*e)* ***Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?***

The IS completed for the 2003 EIR concluded that no impacts would occur with respect to the use of septic tanks or alternative wastewater disposal systems (SDSU 2003). No new information is available regarding

[3] **Section 3.2, Geology/Soils, Mitigation Measures 1 and 2**: (1) Adverse discontinuities in strength between major structural elements shall be avoided. (2) Prior to detailed site planning, a subsurface geotechnical and soils study shall be conducted to determine the shrink-swell potential and to develop design specific measures to ensure structural integrity. Grading and construction plans shall conform to recommendations of the study (SDSU 2003, pp. 3.2-4, 3.2-5, and 11-1).

this environmental criteria. The proposed buildings would be connected to existing sewer infrastructure operated by the City. As a result, septic tanks or alternative wastewater disposal systems would not be used in association with the Project. **No impacts** would occur.

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# Attachment A

Figures


SOURCE: ESRI

DUDEK

0 4 8 Miles

FIGURE 1
Regional Map

Technical Memorandum for the SDSU Imperial Valley Off-Campus Center - Calexico Affordable Student Housing Project


SOURCE: AERIAL-ESRI MAPPING SERVICE 2023; DEVELOPMENT-SDSU 2024



FIGURE 2
Vicinity Map

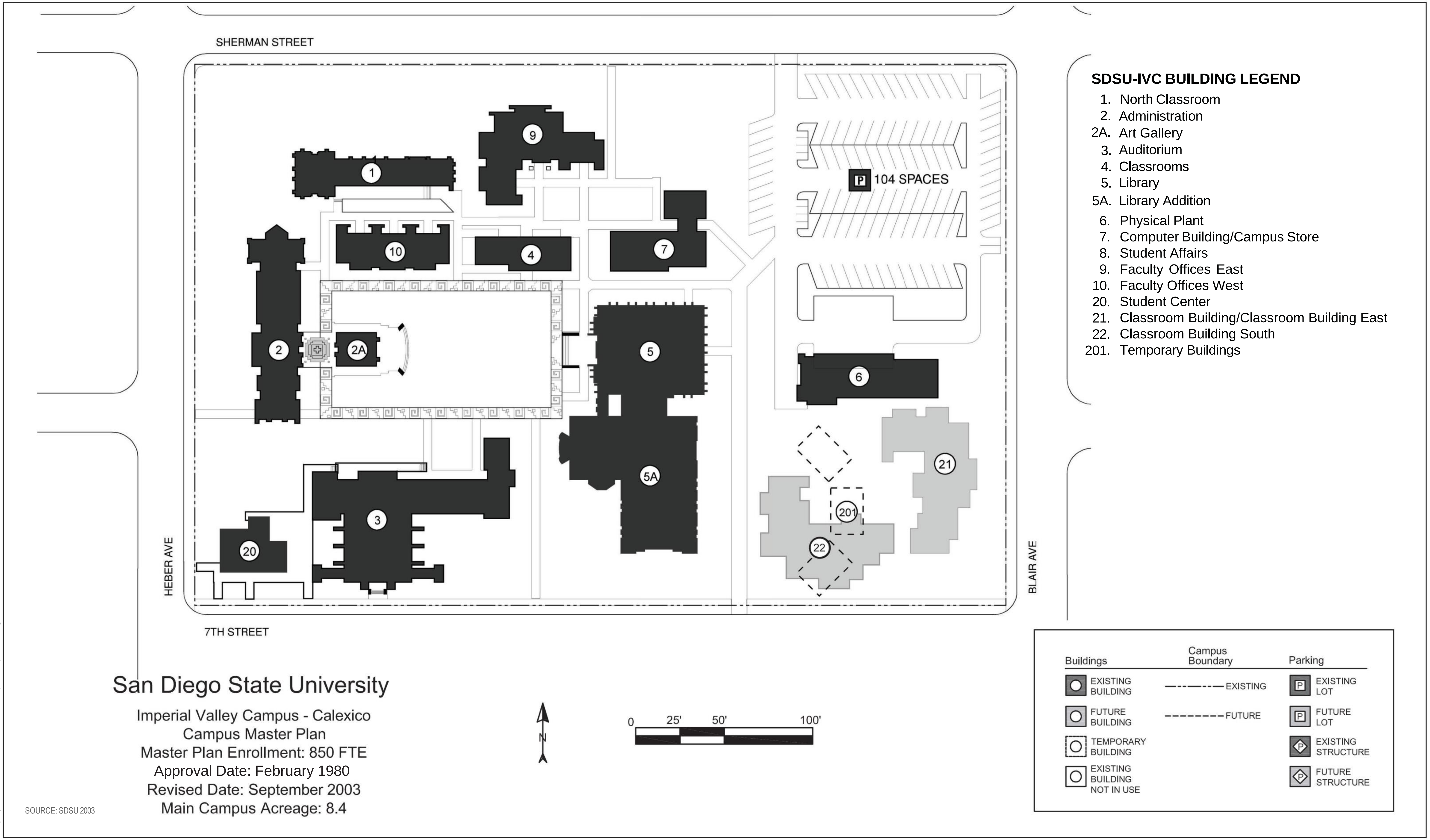



**FIGURE 3A**

Existing Campus Master Plan

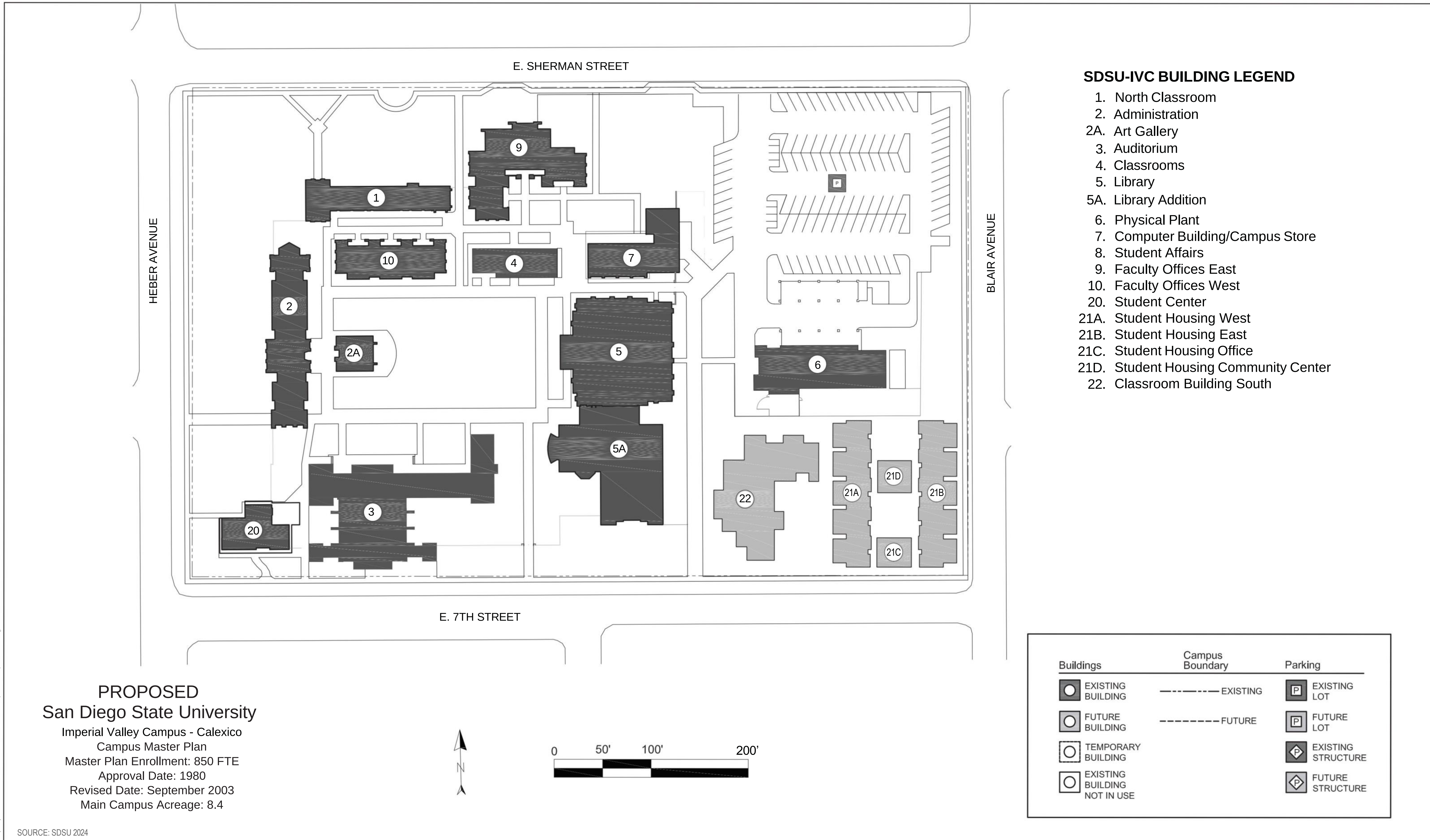



**FIGURE 3B**
Proposed Campus Master Plan

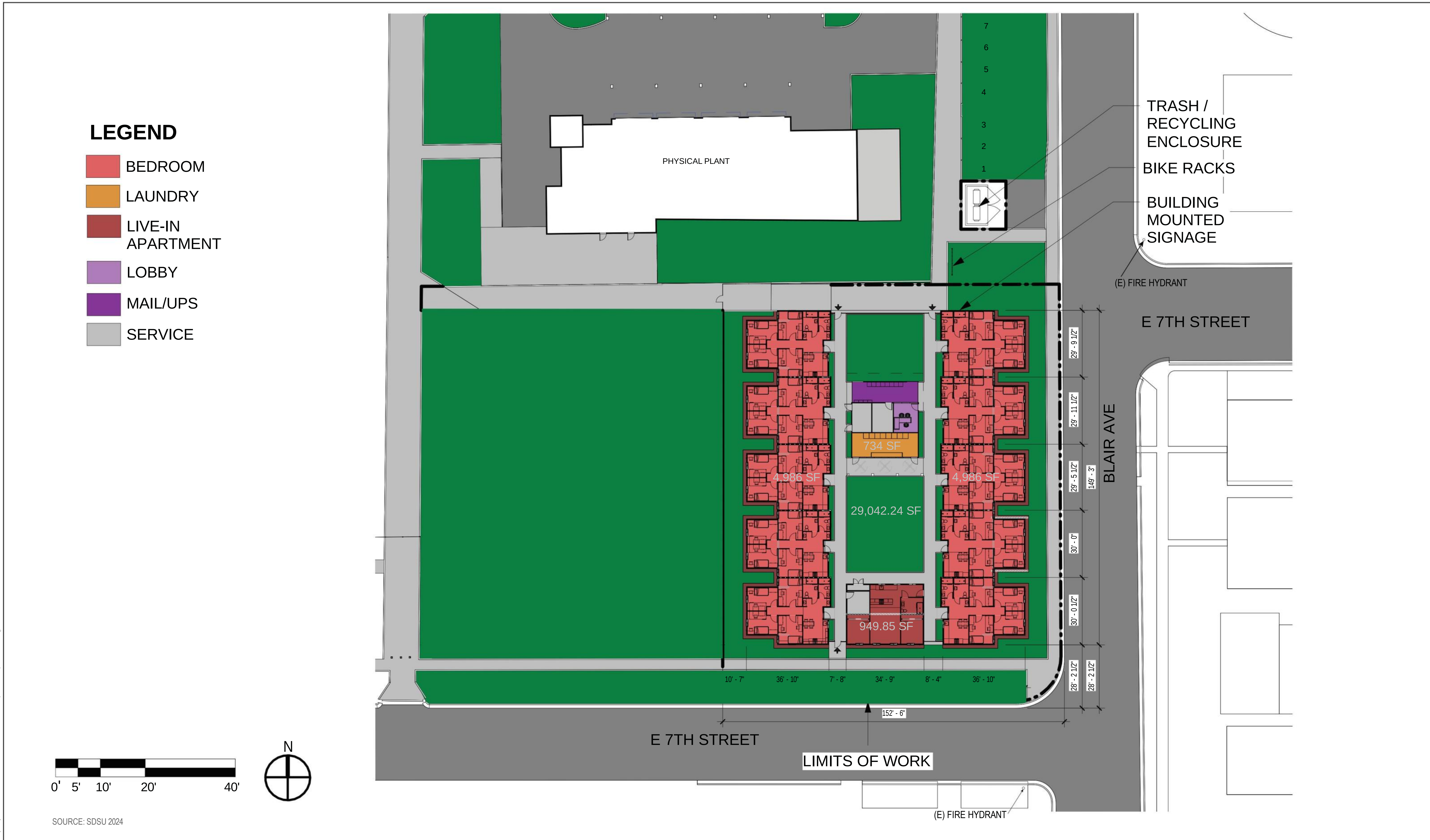
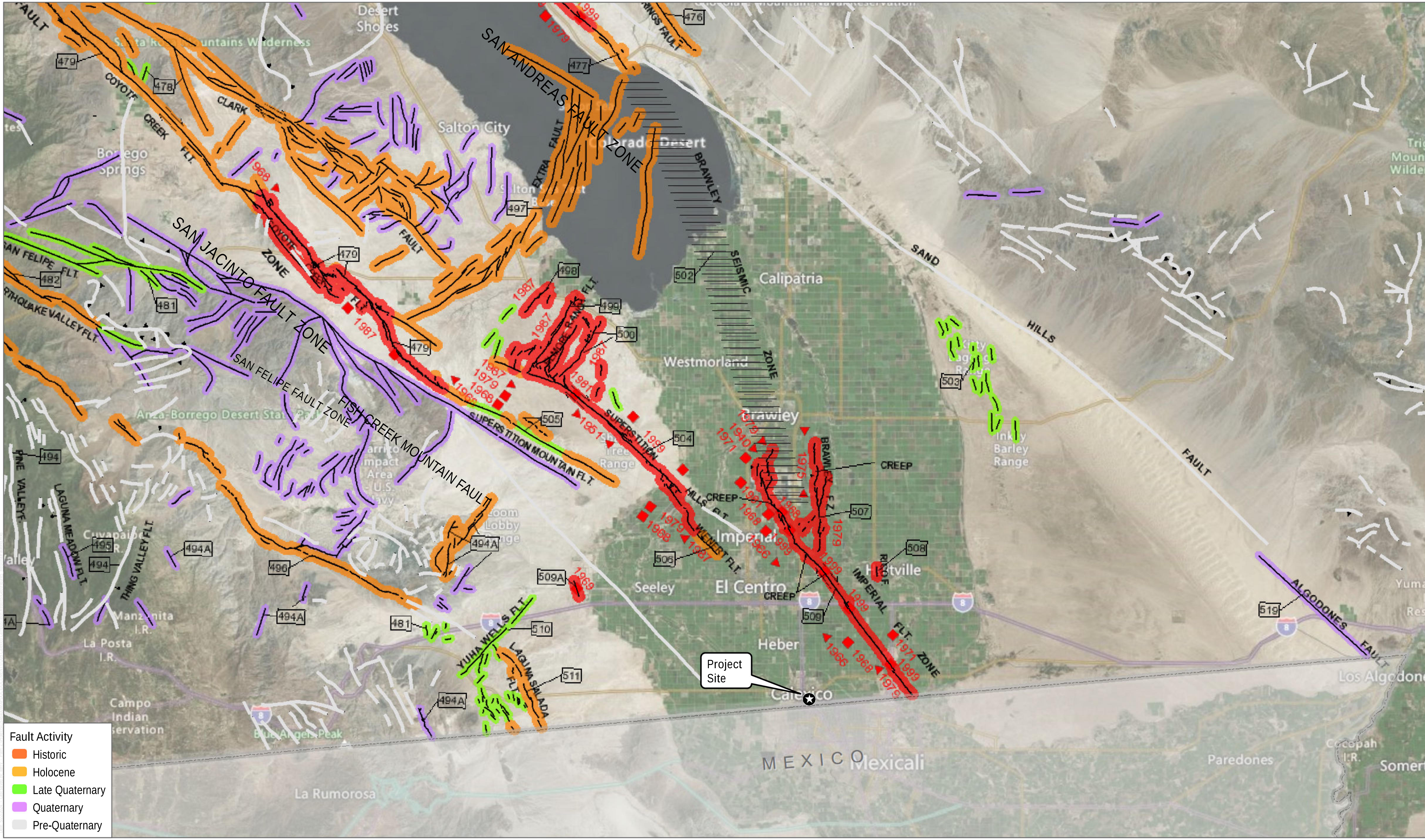



**FIGURE 4**

Site Plan




SOURCE: USGS 2022; CGS 2022; County of Imperial; Bing Maps

DUDEK

0 5 10 Miles

FIGURE 5

## Regional Faulting

Technical Memorandum for the SDSU Imperial Valley-Calexico Off-Campus Center Affordable Student Housing

# Attachment B
Geotechnical Report

# REPORT OF GEOTECHNICAL INVESTIGATION
# STUDENT RESIDENCE HALL
# SAN DIEGO STATE UNIVERSITY
# IMPERIAL VALLEY CAMPUS
# CALEXICO, CALIFORNIA

Prepared for

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Project No. SD732
August 3, 2022

San Diego State University
Facilities Planning, Design & Construction
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Project No. SD732
August 3, 2022

Attention: Ms. Amanda Scheidlinger, Director of Construction

**SUBJECT: REPORT OF GEOTECHNICAL INVESTIGATION**
**Student Residence Hall**
**San Diego State University – Imperial Valley Campus**
**Calexico, California**

Ms. Scheidlinger:

Group Delta Consultants, Inc. are pleased to submit this report of geotechnical investigation for the proposed Student Residence Hall building at the San Diego State University Imperial Valley Campus in Calexico, California. This report summarizes our conclusions regarding the geologic and geotechnical site constraints, and provides geotechnical recommendations for remedial grading, foundation, slab, utilities, and pavement section design.

We appreciate this opportunity to be of professional service. Please feel free to contact the office with any questions or comments, or if you need anything else.

**GROUP DELTA CONSULTANTS**

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Distribution: (1) Addressee, Ms. Amanda Scheidlinger (ascheidlinger@sdsu.edu)

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**FIGURES**



**APPENDICES**

## 1.0 INTRODUCTION

Group Delta Consultants, Inc. (Group Delta) are pleased to submit the following report of geotechnical investigation that provides geotechnical recommendations for the proposed Student Residence Hall building at the San Diego State University (SDSU) Imperial Valley Campus (IVC) in Calexico, California. The general location of the site is shown on Figure 1, Site Location, and the campus location is shown in more detail on Figure 2, Site Vicinity. The approximate locations of the subsurface explorations that were completed at the site are shown on Figure 3, Exploration Locations, along with the proposed Phase I and Phase II building addition approximate footprint limits (HED, 2022).

### 1.1 Scope of Services

Our geotechnical services were provided in general accordance with the provisions of the referenced proposal (Group Delta, 2022). The purpose of this work was to characterize the geologic and geotechnical constraints to site development, and to provide recommendations for grading and design of the new foundations, slabs, utilities, and pavements. The recommendations provided herein are based on subsurface investigation, the findings from laboratory tests, our engineering analyses, and our previous experience with similar geologic conditions in the site vicinity. In summary, we provided the following services for this project.

- A visual reconnaissance of the surface characteristics of the site and surrounding areas, and a review of the relevant reports.
- A subsurface exploration of the site including five Cone Penetration Test (CPT) soundings along with three geotechnical borings. The exploratory geotechnical boring and CPT sounding locations are shown on Figure 3, Exploration Locations. The boring records and CPT sounding data are provided in Appendix A.
- Laboratory tests were conducted on soil samples collected from the explorations. Laboratory tests conducted included sieve and hydrometer analyses, percent passing the number 200 sieve, Atterberg limits, Expansion Index (EI), soil corrosivity, in-situ moisture content, undrained shear strength, consolidation, and one-dimensional swell tests. The laboratory test results are summarized in Appendix B.
- Engineering analysis of the field and laboratory data to develop geotechnical recommendations for site preparation, remedial earthwork, foundation and pavement design, soil reactivity, site drainage and moisture protection.
- Preparation of this report summarizing our findings, conclusions and geotechnical recommendations for the proposed Student Residence Hall building.

## 1.2 Site Description

SDSU IVC is located at 720 Heber Avenue in Calexico, California. The campus in situated near the international border with Mexico within the Imperial Valley. The site is located about 30 miles south of the Salton Sea, as shown on Figure 1, Site Location. The proposed project site is located in the southeast corner of the campus, near the intersection of East 7th Street and Blair Avenue. The site currently contains an empty grass lot, three modular buildings, chain-link fencing, and landscaping consisting of several trees. The site location is relatively flat-lying and located approximately 4 to 6 feet above mean sea level (Google Inc., 2022).

## 1.3 Proposed Development

Outside of conceptual drawings (HED, 2022), details of the proposed building additions are not yet available. Based on the conceptual drawings, we understand that the project will consist of two development phases, each adding a two-story structure at the approximate locations shown on Figure 3, Exploration Locations. The buildings will likely consist of a relatively light-weight wood-framed or steel structure supported on conventional shallow reinforced concrete foundations or a post-tensioned slab. Other new site improvements may include new sidewalks and pavement areas, as well as various new landscape areas and subsurface utilities. It is assumed that site grades will remain approximately consistent with the current elevations, and that fill placements above existing grades are not needed for the site development.

# 2.0 FIELD AND LABORATORY INVESTIGATION

Our field investigation included advancing five CPT soundings on May 31st, 2022, and three geotechnical borings on June 1st, 2022. The maximum depth explored was approximately 100 feet below grade. Soil samples were collected at selected intervals within each geotechnical boring for laboratory testing and geotechnical analysis. The exploration locations are shown on Figure 3, Exploration Locations. The boring records and CPT sounding data are provided in Appendix A. Shear wave velocity measurements were collected at CPT-1 at 5-foot depth intervals, and the measurements are also presented in Appendix A.

The laboratory testing program included sieve and hydrometer analyses, percent passing the number 200 sieve, and Atterberg limits to aid in material classification according to the Unified Soil Classification System (USCS). Additional tests were performed to evaluate the in-situ moisture content and dry density, soil expansion characteristics (i.e., EI), compressibility parameters, undrained shear strength, and corrosivity potential. The in-situ moisture content and dry density, sieve and hydrometer analyses, percent passing the number 200 sieve, Atterberg limits, expansion index and unconfined compressive strength results and presented on the boring records in Appendix A. The laboratory test results are also shown in Appendix B.

## 3.0 GEOLOGY AND SUBSURFACE CONDITIONS

The site is located within the Salton Trough of the Colorado Desert geomorphic province, a topographic and structural depression bound to the north by the Coachella Valley and to the south by the Sea of Cortez. The Salton Trough is a region of transition from the extensional tectonics of the East Pacific Rise to the transform tectonic environment of the San Andreas system. Late Cenozoic extension of the Sea of Cortez formed this deep topographic and structural depression.

The Salton Trough is an actively growing rift valley in which sedimentation has almost kept pace with tectonism (Elders, 1979). Periodically throughout its history, the Colorado River delta has diverted and filled the trough producing cycles of sedimentation from marine, to deltaic, to fluvial and lacustrine. Today, the Salton trough is dominated by the Salton Sea and the Mesozoic-age crystalline basement rocks are covered by about 15,000 feet of Cenozoic sedimentary accumulation (Van De Kamp, 1973).

The site is located in an area that has been covered by lakes during the Quaternary time. The most recent of the lakes that formed in the Salton Trough was known as Lake Cahuilla, which was formed by flooding of the Colorado River and existed until approximately 300 years ago (Elders, 1979). The old shoreline of Lake Cahuilla can be traced along the Santa Rosa Mountains north of the site, and averages about 40 feet above mean sea level. The site is underlain at depth by hundreds of feet of lacustrine deposits, overlain by shallow fill.

The approximate locations of the explorations conducted at the site are shown on Figure 3, Exploration Locations. The general geology in the site vicinity is shown on Figure 4, Regional Geology. Logs interpreting the subsurface conditions we encountered in the explorations are provided in Appendix A. The geologic materials at the site are described below.

### 3.1 Lacustrine Deposits

The entire site is underlain by deep lacustrine deposits associated with the ancestral Lake Cahuilla. The lacustrine sediments are estimated to be well over 100 feet thick (Kovach et al., 1962). The lake sediments are typically fine grained, and generally consist of interbedded clays (USCS classifications CL and CH), with thin lenses of silt (ML) and occasional beds of silty sand (SM). The granular soils within the lake deposits are typically medium dense in consistency. The clays range from medium to high plasticity, and range in consistency from medium stiff to hard.

Laboratory tests indicate that the surficial clays have a moderate expansion potential and would be considered corrosive to severely corrosive based on the results of our limited corrosion screening tests. The estimated undrained shear strength (Su) of the predominately clayey lacustrine deposits typically ranges from about 1 to greater than 4 kips per square foot (ksf), based on interpretations of pocket penetration (PP) tests, CPT data, and an undrained shear strength test, as shown in Appendices A and B. This indicates the clayey soils are medium stiff to hard in consistency. Shear wave velocity measurements performed at CPT-1 indicated an average shear wave velocity of about 690 feet per second (ft/s), or 210 meters per second (m/s). In our opinion, a 2019 California Building Code (CBC) Site Class D (Stiff Soil) would be most applicable to the general site conditions.

Several roughly 2-foot-thick beds, but some up to 4-feet thick locally, of silty sand (SM) and non-plastic silt (ML) were encountered in the explorations within the Lacustrine deposits at depths ranging between approximately 13 to 20, 28 to 30, and 48 to 50 feet below existing grade. The hammer energy corrected blow counts ($N_{60}$) within these layers ranged from approximately 11 to 29 and CPT tip resistance ranged from 75 to 175 tons per square foot (tsf), which is indicative of a loose to medium dense material. Our analyses indicate that these zones of material are potentially liquefiable under a high seismic demand, as described in the *Earthquake-Induced Ground Failure* section of this report.

### 3.2 Fill

Undocumented fill was encountered in all our explorations. The fill is "undocumented" because there are no known records of observation and in-place density testing of the fill placement and compaction by a Geotechnical Engineer. The fill was measured to be approximately three to four feet thick in our explorations. The surficial fill generally consists of lean clay (CL) with varying amounts of sand and organics. The fill soils have a medium potential for expansion (EI between 51 and 90) and are considered to be corrosive to severely corrosive.

### 3.3 Groundwater

Groundwater was measured at a depth of approximately 28 feet below ground surface (roughly elevation of -24 feet MSL) in boring B-1 after drilling. Note that groundwater levels fluctuate over time due to changes in groundwater extraction, irrigation, or rainfall. It should also be noted that changes in rainfall, irrigation practices, or site drainage may produce seepage or locally perched groundwater conditions at any depth within the fill or lacustrine deposits underlying the site.

## 4.0 GEOLOGIC HAZARDS

The site is located within the Salton Trough of the Colorado Desert geomorphic province, which is a seismically active area in southern California, as shown on Figure 5A, Regional Fault Locations. The Salton Trough is the zone of transition between the ocean floor spreading regime in the Sea of Cortez and the right-lateral, strike-slip regime of the San Andreas system. Geologic hazards at the site are related to the potential for strong ground shaking due to an earthquake on one of several nearby active faults, as well as the potential for associated soil liquefaction and dynamic settlement. Each of the potential geologic hazards is described in more detail below.

### 4.1 Strong Ground Motion

The site is in a seismically active area. There are several active faults in the site vicinity that have produced moderate to large earthquakes within the past 100 years. The Imperial Fault Zone ruptured with a magnitude 6.9 earthquake in 1940, and again with a magnitude 6.4 earthquake in 1979 (USGS, 1982). The trace of the ground rupture from the 1940 earthquake was located about 5 miles east of the site (see Figure 4 and Figure 5B for the approximate 1940 ground rupture location). Additionally, there are several other known active faults close to the site, including the Superstition Hills and Superstition Mountain fault zones to the northwest, and the Laguna Salada and Cerro Prieto fault zones to the south (see Figures 4 and 5A). The Superstition Hills fault experienced a magnitude 6.7 earthquake in 1987 (Magistrale, 1989). In 2010, a magnitude 7.2 earthquake occurred on the Laguna Salada fault zone south of the international border (Gonzalez-Ortega, 2014). These earthquakes caused damage to structures throughout Imperial Valley, including soil liquefaction, settlement, and surficial slumps along the Imperial Irrigation District canal and drains (USGS, 1982, Gonzalez-Ortega 2014, Holzer, 1989).

The new building will likely be subjected to numerous small to moderate magnitude earthquakes, as well as occasional larger magnitude earthquakes from nearby active faults over its expected life span. The resulting strong ground motions associated with this hazard may be managed by structural design per the governing edition of the CBC and California State University (CSU) Seismic Requirements (CSU, 2020). Seismic design parameters are provided in the *Recommendations* section of this report.

### 4.2 Ground Rupture

Ground rupture results from movement on an active fault reaching the ground surface. The site is not located within an Alquist-Priolo Active Fault Zone and no known active faults are present in the immediate site vicinity, as shown on Figure 5B, Local Faults. Potential for ground rupture should therefore be considered low.

### 4.3 Earthquake-Induced Ground Failure

Potentially liquefiable soils underlie the site. Figure 4, Regional Geology, illustrate that the site is mapped in an area underlain by Quaternary Lake Deposits (i.e., Lacustrine Deposits) that are known to be potentially susceptible to liquefaction and its secondary effects (e.g., earthquake-induced ground failure).

#### 4.3.1 Background

Liquefaction is the sudden loss of soil shear strength within saturated, loose to medium dense, sands and non-plastic silts. Liquefaction is caused by the build-up of pore water pressure during strong ground shaking from an earthquake. Secondary effects of liquefaction are sand boils, settlement and instabilities within sloping ground that occur as lateral spreading, seismic deformation and flow sliding. Lateral spreading is the horizontal deformation of gently sloping ground (slope less than 6 percent), and seismic deformation is the horizontal movement of more steeply sloping ground, both of which can occur during strong ground shaking. Flow sliding is an overall instability of more steeply sloping ground that can occur following or near the end of strong ground shaking, depending on its duration. Associated with liquefaction is seismic compaction, which is the densification of loose to medium dense granular soils that are above groundwater. Of these, liquefaction-induced settlement and seismic compaction are considered more likely to occur given the site surface and subsurface conditions, as discussed below.

### 4.3.2 Vertical Settlement Analyses

4.3.2.1 Volumetric Settlements

The computer program CLiq (Geologismiki, 2019) was used to perform liquefaction triggering calculations using several CPT-based methods, including those recommended by the NCEER Workshops (Youd et al., 2001) and Boulanger and Idriss (2014). CLiq also calculates the estimated free-field volumetric settlement (below groundwater) and seismic compaction (above groundwater). The analyses adopted the following input parameters:

Peak Ground Acceleration ($PGA_M$):..........................................0.59g
Earthquake Magnitude (Mw):..................................................... 7.1
Groundwater Level: .........................20 feet Below Ground Surface

The $PGA_M$ was evaluated using the maximum of the: 1) most recent version of the CSU Seismic Requirements (CSU, 2020), and; 2) maximum considered earthquake geometric mean ($MCE_G$) peak ground acceleration adjusted for Site Class effects obtained from the OSHPD Seismic Design Maps Tool (SEAOC/OSHPD, 2019) in accordance with the 2019 California Building Code (CBSC, 2019). The controlling magnitude used in the liquefaction evaluation was selected by reviewing deaggregation results obtained from the USGS Unified Hazard Tool (USGS, 2022). A design groundwater level of 20 feet below ground surface was adopted based on our interpretation of the soil saturation in in-situ soil samples and CPT data.

The analyses were performed using data collected from the CPTs performed at the site (CPT-1 through CPT-5). The correlated CPT parameters were compared to the results of our field and laboratory testing collected from Boring B-1. The CPT Soil Behavior Type (SBT) correlated from the CPT data was adjusted to best fit the observations, classifications and material properties of the soils within the borings.

In accordance with Special Publication 117A (CGS, 2008) and general geotechnical engineering practices, a factor of safety against liquefaction of 1.3 was adopted in the analyses, and the liquefaction analyses were limited to a depth of 50 feet.

The liquefaction settlement analyses include depth weighting proposed by Cetin et al. (2009), which consists of a simple linear weighting factor that weights the volumetric strain with depth. This reduces the impact of volumetric strains at large depths. The weighting starts at one at the ground surface and reduces to zero at the weighting limit depth, selected to be the depth of analysis for this project (i.e., 50 feet).

#### 4.3.3 Vertical Settlement Summary

Based on the results of the triggering analyses there are several potentially liquefiable zones within the subsurface profile. In general, the potentially liquefiable soils consist of occasional thin beds that are generally less than 2-foot-thick each, but some up to 4-feet thick locally. The estimated liquefaction-induced volumetric settlement is approximately 1-inch or less at each exploration location. The estimated liquefaction-induced differential settlement is approximately 0.5-inch or less over a horizontal distance of 30 feet.

#### 4.3.4 Instability of Sloping Ground

Since the site is essentially level and the buildings are not located immediately adjacent to sloping ground, the potential for significant liquefaction-induced lateral displacement should be low.

### 4.4 Landslides

Evidence of ancient landslides or slope instabilities was not observed during our literature review or site reconnaissance and the site is essentially level. Provided that our geotechnical recommendations are properly implemented during construction, it is our opinion that slope instability does not adversely impact the proposed development.

### 4.5 Tsunamis, Seiches, and Flooding

The distance between the subject site and the Sea of Cortez precludes damage due to seismically induced waves (tsunamis) or seiches within the Pacific Ocean or Sea of Cortez. The Salton Sea is located over 30 miles north of the site at more than 230 feet below mean sea level, which is more than 200 feet below the existing site elevations. The New River is located about three quarters of a mile west of the site, and the Alamo River is located about 7 miles east of the site. However, the normal water surface elevations in these rivers are roughly 20 to 40 feet below site grades. Further, the site is mapped in Federal Emergency Management Agency (FEMA) zone designated “Area of Minimal Flood Hazard” (FEMA, 2008). Consequently, the potential for earthquake induced or other flooding at the site is considered to be low. However, the flooding hazard at the site should be evaluated by the project civil engineer.

## 5.0 GEOTECHNICAL CONDITIONS

Fill and lacustrine deposits underly the site, as discussed in the *Geology and Subsurface Conditions* section of this report. Geotechnical conditions associated with these units are discussed below.

### 5.1 Expansive Soils

Laboratory tests indicate the surficial soils at the site should have a “Medium” Potential Expansion. The results of three Expansion Index (EI) tests conducted on bulk soils samples obtained from the ground surface to a depth of about 5 feet below existing grades ranged from 60 to 82, averaging 71 with a median of 70 (i.e., Medium Potential Expansion). Appendix B provides the test results.

### 5.1 Compressible Soils

Compressible soils underlie the site. Most of these soils are clay that should experience some time dependent consolidation settlement (i.e., long-term settlement). There are also beds of non-plastic silty sand and silt that should settle elastically with the initial fill and structure loading (i.e., short-term settlement). In general, the clay has a medium to high plasticity and we interpret it to be relatively stiff and slightly overconsolidated from consolidation testing, pocket penetrometer tests, undrained shear strength testing, CPT interpretations, and Plasticity Index data. The in-situ moisture contents are generally near the Plastic Limit and the Liquidity Indices are less than 0.7, which indicate relatively stiff and low compressibility soils.

Provided minimal fill placement is needed at the site to achieve the proposed finish grades and foundation loading is limited to the bearing pressures provided in the *Recommendations* section of this report, most of the long-term settlement should occur in a relatively short time following initial loading. However, there are zones of thick clay that could experience some time dependent consolidation settlement if significant loading from fill or foundation loads are proposed for the project. The estimated settlement magnitude and duration associated with the proposed fill placements and foundation loads should be evaluated during the design development phase of the project to evaluate the potential impact to the project.

### 5.2 Reuse of Onsite Soils

Soils from proposed onsite excavations at the site are anticipated to consist of lean and fat clay (CL and CH) and are generally not considered suitable for re-use as compacted fill without specific recommendations [see the *Post-Tensioned Slabs (Case B – Existing Clay)* section of this report]. Imported fill is anticipated to be needed to replace expansive materials underlying the proposed structures, flatwork, and pavements. Recommendations for imported fill are provided in the *Recommendations* section of this report.

## 6.0 CONCLUSIONS

The proposed Student Residence Hall building appears to be feasible from a geotechnical perspective, provided that appropriate measures are implemented during construction. Several geotechnical conditions exist on site that should be addressed.

- Laboratory tests indicate that the surficial soils at the site have a moderate potential for expansion (EI between 51 and 90). The use of thickened foundations and slabs underlain by imported non-expansive soil (EI<20) could reduce the potential for future distress to the building associated with soil expansion. Alternatively, a post-tensioned slab-on-grade could be used to support the new building. Alternative post-tension slab design parameters are provided for slabs bearing on either imported select soil or compacted on-site clay.

- The fill is not suitable for reuse as engineered fill without specific recommendations. Laboratory tests indicate the fill soils primarily consist of lean and fat clay (CL and CH) with a medium expansion potential. To reduce the potential for heave related distress, we recommend placing and compacting non-expansive soil (EI<20) beneath structures, pavements, flatwork and other heave-sensitive improvements.

- Groundwater was encountered at the site at a depth of about 28 feet below existing surface grades. The site is also located in an area of high seismic activity, and the potential does exist for relatively minor earthquake-induced liquefaction and settlement of the granular lacustrine deposits beneath the site. We estimate that the proposed building could experience post-liquefaction differential settlement on the order of 0.5-inch over a horizontal distance of 30 feet. In addition to helping reduce the potential for distress associated with expansive soils, the use of thickened and heavily reinforced conventional building foundations or post-tensioned could also help to reduce the potential for distress to the building associated with post-liquefaction settlement.

- The site is underlain by zones of thick clay that could experience some time dependent consolidation settlement if significant loading from fill or foundation loads are proposed for the project. The estimated settlement magnitude and duration associated with the proposed fill placements and foundation loads should be evaluated during the design development phase of the project to evaluate the potential impact to the project

- Laboratory tests indicate that the clayey surficial soils at the site present a *severe* risk of sulfate attack and are also *corrosive* to *very corrosive* to buried metals. The recommended placement of two to five feet of imported sand beneath the sidewalks and building slabs-on-grade could help to reduce the potential for sulfate attack and corrosion. However, sulfate resistant Type V cement is recommended for use at the site. Various corrosion control measures may also be needed for buried metal structures. A corrosion consultant may be contacted.

- Our previous experience indicates that the on-site clayey soils are not suitable for effective storm water infiltration measures. An infiltration rate of less than 0.05 inches per hour is estimated based on previous infiltration tests we have conducted on similar clay soils. The clays typically have a permeability of $10^{-7}$ to $10^{-9}$ centimeters per second (essentially impermeable). This suggests that the on-site soils are not suitable for full or partial infiltration measures.

- The potential for active faults or landslides to adversely impact the building is considered remote. However, the site is situated within a zone of high seismic activity. The strong ground shaking hazard may be mitigated by structural design in accordance with the applicable provisions of the governing CBC and minimum CSU Seismic Requirements.

## 7.0 RECOMMENDATIONS

The remainder of this report presents recommendations for earthwork construction and the design of the proposed improvements. These recommendations are based on empirical and analytical methods typical of the standards of practice in southern California. If these recommendations do not cover a specific feature of the project, please contact our office for revisions or amendments.

### 7.1 Plan Review

We recommend that grading and foundation plans be reviewed by Group Delta prior to finalization. We anticipate that substantial changes in the development may occur from the preliminary design concepts used for this investigation. Such changes may require additional geotechnical evaluation, which may result in substantial modifications to the remedial grading and foundation recommendations provided in this report.

### 7.2 Excavation and Grading Observation

Foundation and grading excavations should be observed by the project geotechnical consultant. During grading, the geotechnical engineer's representative should provide observation and testing services continuously. Such observations are considered essential to identify field conditions that differ from those anticipated by this investigation, to adjust designs to the actual field conditions, and to evaluate that the remedial grading is accomplished in general accordance with the recommendations in this report. The recommendations provided in this report are contingent upon Group Delta providing these services. Our personnel should perform sufficient testing of fill and backfill during grading and improvement operations to support our professional opinion as to compliance with the compaction recommendations.

### 7.3 Earthwork

Grading and earthwork should be conducted in general accordance with the requirements of the current CBC and the earthwork recommendations provided within this report. The following recommendations are provided regarding specific aspects of the proposed earthwork. These recommendations should be considered subject to revision based on the conditions observed by the geotechnical consultant during the grading operations.

#### 7.3.1 Site Preparation

General site preparation should begin with the removal of deleterious materials, including any existing structures, vegetation, turf, contaminated soil, trash, and demolition debris. Existing subsurface utilities or groundwater wells that underly the proposed improvements should be properly abandoned and relocated outside of the proposed building footprint. Excavations associated with abandonment operations should be backfilled and compacted as described in *Fill Compaction* Section of this report. Wells, if present, should be abandoned per local and State guidelines. Alternatively, abandoned utilities may be grouted with a two-sack sand-cement slurry under the observation of the project geotechnical consultant.

### 7.3.2 Improvement Areas

At least two feet of compacted fill with an Expansion Index of 20 or less is recommended beneath new concrete sidewalks and exterior flatwork areas. To accomplish this objective, the upper 24-inches of soil below slab subgrade (i.e., bottom of the slab) should be excavated and removed from the site. The over-excavation should include the soil within 2-feet of the sidewalk perimeter (measured horizontally). The resulting excavation surface should be scarified, brought to 3-percentage points or more above optimum moisture content and compacted to at least 90 percent of the maximum dry density per ASTM D1557. The excavation bottom should then be backfilled to the planned slab subgrade elevations using a non-expansive (EI<20) granular material and be compacted in accordance with the recommendations in the *Fill Compaction* section below. Subgrade compaction should be conducted immediately prior to placing concrete or base.

### 7.3.3 Building Areas

The clayey lacustrine deposits beneath the proposed building addition consist of expansive lean clay (CL) and fat clay (CH). We recommend that the upper 5 feet of clayey soil beneath the proposed building finish pad elevations be excavated and removed from the site. The remedial excavations should extend at least 5 feet horizontally beyond the perimeter of the proposed building, wherever possible. However, the excavations should not pass below a 1:1 plane extending down and out from the bottom outside edge of any existing foundations, in order to avoid undermining these footings and causing distress to existing structures. The resulting excavation surface should be scarified, brought to 3-percentage points or more above optimum moisture content and compacted to at least 90 percent of the maximum dry density at per ASTM D1557. The excavation bottom should then be backfilled to the planned slab subgrade elevations using a non-expansive (EI<20) granular material and be compacted in accordance with the recommendations in the Fill Compaction section below.

### 7.3.4 Fill Compaction

All fill and backfill should be placed and compacted at or slightly above optimum moisture content per ASTM D1557 using equipment capable of producing a uniformly compacted product. The loose lift thickness should be 8 inches, unless performance observed and testing during earthwork indicates a thinner loose lift is needed, or a thicker loose lift is possible, up to a loose lift thickness of 12 inches.

The minimum recommended relative compaction is 90 percent of the maximum dry density per ASTM D1557. Sufficient observation and testing should be performed by the project geotechnical consultant during grading so that an opinion can be rendered as to the compaction achieved. Rocks or concrete fragments greater than 6 inches in maximum dimension should not be used in compacted fill.

A two-sack sand and cement slurry may be used as an alternative to compacted fill soil. It has been our experience that slurry is often useful in confined areas which may be difficult to access with typical compaction equipment. A minimum 28-day compressive strength of 100 psi is recommended for the two-sack sand and cement slurry. Samples of the slurry should be fabricated and tested for compressive strength during construction.

#### 7.3.5 Import Soil

Imported fill sources should be observed and tested by the project geotechnical consultant prior to hauling onto the site to evaluate the suitability for use. In general, imported fill materials should consist of granular soil with more than 70 percent passing the ¾-inch sieve and less than 35 percent passing the No. 200 sieve based on ASTM C136, and an Expansion Index less than 20 based on ASTM D4829. Samples of the import should be tested by the geotechnical consultant in order to evaluate the suitability of these soils for their proposed use.

Additional testing per the guidelines provided by the Department of Toxic Substances Control (DTSC, 2001) is required by the Owner prior to accepting soil for import. Test results should meet most stringent State and Federal residential screening levels including the most up-to-date DTSC Modified Screening Levels (DTSC-SLs) and United States Environmental Protection Agency Regional Screening Level (RSL).

#### 7.3.6 Subgrade Stabilization

All excavation bottoms should be firm and unyielding prior to placing fill. In areas of saturated or "pumping" subgrade, a geogrid such as Tensar BX-1200 or Terragrid RX1200 may be placed directly on the excavation bottom, and then covered with at least 12 inches of minus ¾-inch aggregate base. Once the excavation is firm enough to attain the recommended compaction within the base, the remainder of the excavation may be backfilled using either compacted soil or aggregate base. If wet soil conditions are encountered where further excavations are needed, an additional 12-inches of free draining open graded material (such as minus ¾-inch crushed rock) should be placed between the stabilizing geogrid and the compacted well graded aggregate base. The open graded material should be completely enveloped in filter fabric (such as Mirafi 140N).

#### 7.3.7 Temporary Excavations

Temporary excavations may be needed to construct the planned improvements. Excavations should conform to Cal-OSHA guidelines (2018). In general, we recommended that temporary excavations be inclined no steeper than 1:1 for heights up to 5 feet. Vertical excavations should be shored. Any excavations that encounter groundwater seepage should be evaluated on a case-by-case basis.

The design, construction, maintenance, and monitoring of all temporary slopes is the responsibility of the contractor. The contractor should have a competent person evaluate the geologic conditions encountered during excavation to determine permissible temporary slope inclinations and other measures as required by Cal-OSHA. The below assessment of OSHA Soil Types for temporary slopes is based on preliminary engineering classifications of material encountered in widely spaced explorations.

Based on the findings of our subsurface investigation, the following OSHA Soil Types may be assumed for planning purposes.

**PRELIMINARY CAL/OSHA SOIL TYPES**

| Geologic Unit | Cal/OSHA Soil Type |
|---|---|
| Fill | Type B[1] |
| Lacustrine Deposits | Type B[1] |

1. This assumes that no groundwater seepage or caving is encountered in the excavations.

## 7.4 Surface Drainage

Foundation and slab performance depends greatly on how well surface runoff drains from the site. The ground surface should be graded so that water flows rapidly away from structures and top of slopes without ponding. The surface gradient needed to achieve this may depend on the prevailing landscaping. Planters should be designed and built so that water will not seep into the foundation, slab, pavement or other heave/settlement structure areas. If roof drains are used, the drainage should be channeled by pipe to the storm drain system, or discharge at least 10 feet from buildings. Irrigation should be limited to the minimum needed to sustain landscaping, and consideration should be given to utilizing drought tolerant landscape to further minimize water used for irrigation. Excessive irrigation, surface water, water line leaks, or rainfall may cause perched groundwater to develop within the underlying soil.

## 7.5 Storm Water Management

We anticipate that various bioretention basins, swales or pervious paver block pavements may be proposed to promote on-site infiltration for storm water Best Management Practice (BMP). In order to help evaluate the feasibility of on-site infiltration, the infiltration rate of the on-site soil may be estimated using borehole percolation or double ring infiltrometer tests conducted within the planned BMP areas. However, our experience indicates that infiltration testing in clay soils should result in a "No Infiltration" condition per the applicable BMP Design Manual. An infiltration rate of less than 0.05 inches per hour is estimated based on previous infiltration tests we have conducted in similar clay soils. The clays typically have a permeability of $10^{-7}$ to $10^{-9}$ cm/s (essentially impermeable).

## 7.6 Foundation Recommendations

The foundations for the new buildings should be designed by the project structural engineer using the following geotechnical parameters. These are only minimum criteria, and should not be considered a structural design, or to preclude more restrictive criteria of governing agencies or the structural engineer. The following recommendations should be considered preliminary, and subject to revision based on decisions made during design development and the conditions observed by the geotechnical consultant during grading.

### 7.6.1 Conventional Foundations

The following recommendations assume that remedial grading will be conducted for the building pad area as recommended in the *Earthwork* Section, and that the building pad grade will be underlain by at least 5-feet of granular non-expansive compacted fill (EI<20). Conventional shallow foundations would be considered appropriate for this condition, as shown in Figure 6.

| | |
|---|---|
| *Allowable Bearing:* | *2,000 psf (allow ⅓ increase for short-term wind or seismic loads)* |
| *Minimum Footing Width:* | *12 inches* |
| *Minimum Footing Depth:* | *24 inches below lowest adjacent soil grade* |
| *Minimum Reinforcement:* | *Two No. 5 bars at both top and bottom in continuous footings* |

### 7.6.2 Post-Tensioned Slabs

Two different post-tensioned slab foundation design conditions are summarized below. Case A provides recommendations assuming the building will be underlain by at least 5-feet of non-expansive compacted fill, and Case B assumes that a post-tension slab foundation may be designed to bear directly on recompacted expansive on-site clay. The following recommendations are provided using the Post-Tensioning Institute (PTI) Document *PTI DC10.5-19* (2019).

#### 7.6.2.1 Case A – Select Fill

For Case A, we have assumed that remedial grading will be conducted per our recommendations, and that the proposed building will be underlain by at least 5-feet of imported granular non-expansive compacted fill in accordance with the *Earthwork* Section of this report, overlying the existing expansive clay. The following post-tension slab foundation design parameters are considered applicable to buildings that will be underlain by such conditions. Note that these recommendations should be considered preliminary, and subject to revision based on the as-graded conditions observed by the geotechnical consultant during fine grading of the site.

*Post-Tension Slab Design Parameters (Case A):*

| | | |
|---|---|---|
| *Moisture Variation Distance, $e_m$:* | *Center Lift:* | *5.5 feet* |
| | *Edge Lift:* | *2.5 feet* |
| *Differential Soil Movement, $y_m$:* | *Center Lift:* | *0.5 inches* |
| | *Edge Lift:* | *1.0 inches* |
| *Allowable Bearing:* | *2,000 psf at slab subgrade* | |

7.6.2.2 Post-Tensioned Slabs (Case B – Existing Clay)

As an alternative to remedial grading to replace the highly expansive clays with imported sand as described in Case A above, a post-tension slab foundation may be designed to bear directly on the highly expansive on-site clay. For Case B, the undocumented fill soils underlying the proposed structure should be excavated and replaced as a uniformly compacted fill beneath the building (as a minimum). The undocumented fill depth is anticipated to extend approximately three to four feet below existing grades at the site. The clayey fill soil should be compacted to at least 90 percent relative compaction at 3-percentage points or more above optimum moisture content per ASTM D1557. The following post-tension slab foundation design parameters are considered appropriate for a building underlain by recompacted clayey fill soils.

*Post-Tension Slab Design Parameters (Case B):*

| | | |
|---|---|---|
| *Moisture Variation Distance, $e_m$:* | *Center Lift:* | *7.0 feet* |
| | *Edge Lift:* | *3.5 feet* |
| *Differential Soil Movement, $y_m$:* | *Center Lift:* | *1.5 inches* |
| | *Edge Lift:* | *2.5 inches* |
| *Allowable Bearing:* | *2,000 psf at slab subgrade* | |

### 7.6.3 Settlement

Total and differential settlements of the proposed structure due to the allowable bearing loads provided above are not expected to exceed 1.5 and 0.75 inches in 30 feet, respectively. In addition to static settlement, the site may experience post-liquefaction total and differential settlements on the order of approximately 1-inch and 0.5 inches in 30 feet, respectively, as discussed in *Earthquake Induced Ground Failure* Section.

### 7.6.4 Lateral Resistance

Lateral loads against the structure may be resisted by friction between the bottoms of footings and slabs and the underlying soil, as well as passive pressure from the portion of vertical foundation members embedded into compacted fill. A coefficient of friction of 0.25 and a passive pressure of 250 psf per foot of depth may be used for level ground conditions.

## 7.7 Seismic Design

Structures should be designed in general accordance with the governing seismic provisions of the 2019 CBC, as well as the minimum seismic design requirements of the California State University (CSU, 2020). Field testing consisting of shear wave measurements in CPT-1 resulted in average shear wave velocity in the upper 30 meters ($V_{S,30}$) of approximately 210 m/s. Based on these measurements, the Site Classification using Chapter 20 of ASCE 7-16 would be Site Class D. The following preliminary seismic design parameters are recommended by the California State University Seismic Requirements (CSU, 2020) for the site.

**CSU – SDSU IMPERIAL CAMPUS SEISMIC DESIGN PARAMETERS**

| Hazard Level | Parameter | Site Class D |
|---|---|---|
| **BSE-1N** | $PGA_D$ | 0.40 |
| | $S_{D0}$ | 0.40 |
| | $S_{DS}$ | 1.00 |
| | $S_{D1}$ | 0.68 |
| **BSE-2N** | $PGA_M$ | 0.59 |
| | $S_{M0}$ | 0.60 |
| | $S_{MS}$ | 1.50 |
| | $S_{M1}$ | 1.02 |

## 7.8 On-Grade Slabs

The following recommendations assume that remedial grading will be conducted for the building pad area as recommended in the *Earthwork* Section, and that the building pad grade will be underlain by at least 5-feet of non-expansive compacted fill (EI<20). Conventional concrete building slabs should be at least 6 inches thick and should be reinforced with at least No. 3 bars on 12-inch centers, each way. Slab thickness, control joints, and reinforcement should be designed by the project structural engineer and should conform to the requirements of the current CBC.

### 7.8.1 Moisture Protection for Slabs

Moisture protection should comply with requirements of the current CBC, American Concrete Institute (ACI 302.1R-15) and the desired functionality of the interior ground level spaces. The project Architect typically specifies an appropriate level of moisture protection considering allowable moisture transmission rates for the flooring or other functionality considerations.

Moisture protection may be a “Vapor Retarder” or “Vapor Barrier” that use membranes with a thickness of 10 and 15 mil or more, respectively. The membrane may be placed between the concrete slab and the AB or finished subgrade immediately below the slab, provided it is protected from puncture and repaired per the manufacturer’s recommendations if damaged. Note that the CBC specifies that a capillary break such as 4 inches of clean sand be used beneath building slabs (as defined and installed per the California Green Building Standards), along with a Vapor Retarder.

## 7.9 Exterior Slabs

Exterior slabs and sidewalks subjected to pedestrian traffic and light vehicle loading (e.g., golf carts) should be at least 4 inches thick and underlain by 2-feet of granular non-expansive soil in accordance with the *Improvement Areas* section of this report. Control joints should be placed on a maximum spacing of 10-foot centers, each way, for slabs, and on 5-foot centers for sidewalks. The potential for differential movements across the control joints may be reduced by using steel reinforcement. Typical reinforcement would consist of 6x6 W2.9/W2.9 welded wire fabric placed securely at mid-height of the slab.

## 7.10 Preliminary Pavement Design

For all pavement areas, the upper 12 inches of clayey subgrade soil (below the pavement aggregate base section) should be removed. This removal should extend 2 feet or more beyond the outside edge of the pavement perimeter measured horizontally. The resulting excavation surface should be scarified immediately prior to constructing the pavements, brought to optimum moisture, and compacted to at least 90 percent of the maximum dry density at 3-percentage points or more above optimum moisture content per ASTM D1557. The excavation bottom should then be backfilled to the planned pavement subgrade (i.e., bottom of the aggregate base section) using a non-expansive (EI<20) granular material (i.e., subbase). Aggregate base and subbase should be compacted to 95 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Aggregate base should conform to the Standard Specifications for Public Works Construction (*SSPWC),* Sections 200-2.2, -2.4, or -2.5 (PWSI, 2018). Asphalt concrete should conform to Section 203-6 of the *SSPWC* and should be compacted to 91 and 97 percent of the Rice density per ASTM D2041 (PWSI, 2018).

### 7.10.1 Asphalt Concrete

Based on our previous experience, we anticipate that the clayey on-site soils have an R-Value of 5 or less. Preliminary asphalt concrete pavement design was conducted using the Caltrans Design Method (2018). We anticipate that a Traffic Index ranging from 5.0 to 6.0 may apply to new pavement areas. The project civil engineer should review the assumed Traffic Indices to determine if and where they may be applicable. Based on the minimum R-Value of 5 and the assumed range of Traffic Indices, the following pavement sections would apply.

**SUMMARY OF PRELIMINARY ASPHALT CONCRETE PAVEMENT SECTIONS**

| PAVEMENT TYPE | TRAFFIC INDEX | ASPHALT SECTION | BASE SECTION | SUBBASE SECTION[1] |
|---|---|---|---|---|
| Passenger Car Parking | 5.0 | 3 Inches | 10 Inches | 12 Inches |
| Light Truck Traffic Areas | 6.0 | 4 Inches | 12 Inches | 12 Inches |

***1) <u>NOTE</u>****: One foot of non-expansive subbase should be placed beneath the pavement section to reduce the potential for cracking due to soil heave/shrink behavior.*

### 7.10.2 Portland Cement Concrete

Concrete pavement design was conducted in general accordance with the simplified design procedure of the Portland Cement Association (1984). This methodology is based on a 20-year design life. For design, it was assumed that aggregate interlock would be used for load transfer across control joints. The concrete was assumed to have a minimum flexural strength of 600 psi. The flexural strength of the pavement concrete should be confirmed during construction using ASTM C78. For concrete pavement design, the subgrade materials were assumed to provide "low" support, based on our experience with similar materials. Using these assumptions and the same traffic indices presented previously, we recommend that the PCC pavement sections at the site consist of at least 6 inches of concrete placed over 6 inches of compacted aggregate base over 12 inches of compacted non-expansive subbase (i.e., EI < 20).

Crack control joints should be constructed for PCC pavements on a maximum spacing of 10 feet, each way. Concentrated truck traffic areas, such as trash truck aprons and loading docks, should be reinforced with number 4 bars on 18-inch centers, each way.

## 7.11 Pipelines

The planned addition may include various pipelines such as water, storm drain and sewer systems. Geotechnical aspects of pipeline design include lateral earth pressures for thrust blocks, modulus of soil reaction, and pipe bedding. Each of these parameters is discussed below.

### 7.11.1 Thrust Blocks

Lateral resistance for thrust blocks may be evaluated using a passive pressure value of 250 lbs/ft$^2$ per foot of embedment, assuming a triangular distribution and level ground conditions. This value may be used for thrust blocks embedded into compacted fill soils as well as the underlying lacustrine deposits, provided that these soils are located above the groundwater table.

### 7.11.2 Modulus of Soil Reaction

The modulus of soil reaction (E') is used to characterize the stiffness of soil backfill placed along the sides of buried flexible pipelines. For the purpose of evaluating deflection due to the load associated with trench backfill over the pipe, a value of 1,000 lbs/in$^2$ is recommended for the general conditions, assuming granular bedding material is placed around the pipe and the soils are located above the groundwater table.

### 7.11.3 Pipe Bedding

Typical pipe bedding as specified in the *Standard Specifications for Public Works Construction* may be used. As a minimum, we recommend that pipes be supported on at least 4 inches of granular bedding material such as minus ¾-inch crushed rock, disintegrated granite or granular materials with a Sand Equivalent of 20 or more. Where open graded material (e.g., ¾-inch minus crushed rock) is used as bedding and shading around and above the pipe, we recommend that open graded material should be completely enveloped in filter fabric (such as Mirafi 140N).

Where pipeline or trench excavations exceed a 15 percent gradient, we do not recommend that open graded rock be used for bedding or backfill because of the potential for piping and internal erosion. For sloping utilities, we recommend that coarse sand with a Sand Equivalent of 20 or more or sand-cement slurry be used for the bedding and pipe zone. The slurry should consist of a 2-sack mix having a slump no greater than 5 inches.

### 7.12 Reactive Soils

In order to assess the sulfate exposure of concrete in contact with the site soils, samples were tested for pH, resistivity, water-soluble sulfate and chloride content, as shown in Figure B-5. The sulfate test results indicate that the on-site soils present a *severe* potential for sulfate attack based on commonly accepted criteria (Bentivegna, et al., 2020). A *negligible* sulfate content is recommended for any imported soils and should be confirmed through laboratory testing prior to import.

The saturated resistivity and chloride content of the near surface soils are indicative of a *corrosive* to *very corrosive* soil with respect to buried metals based on commonly accepted criteria (Caltrans, 2021). Typical corrosion control measures should be incorporated into the project design, such as providing minimum clearances between reinforcing steel and soil, and sacrificial anodes for any buried metal structures. A corrosion consultant may be contacted for specific recommendations.

## 8.0 LIMITATIONS

This report was prepared using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in similar localities. No warranty, express or implied, is made as to the conclusions and professional opinions included in this report.

The findings of this report are valid as of the present date. However, changes in the condition of a property can occur with the passage of time, whether due to natural processes or the work of humans on this or adjacent properties. In addition, changes in applicable or appropriate standards of practice may occur from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and should not be relied upon after a period of three years.

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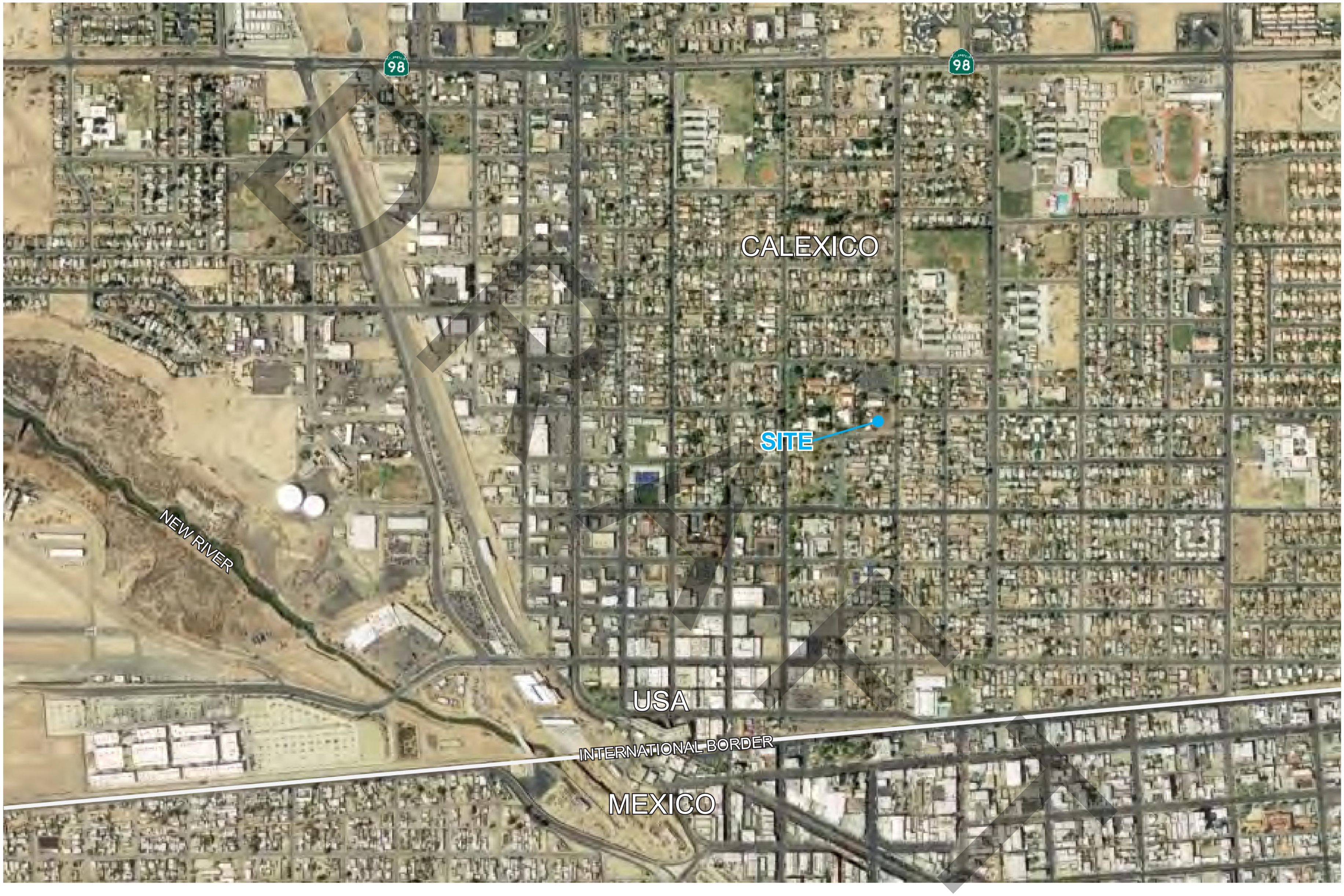



N

NO SCALE

| PROJECT NAME | FIGURE NAME | GROUP DELTA | |
|---|---|---|---|
| **SDSU IMPERIAL VALLEY CAMPUS**<br>**NEW RESIDENCE HALL**<br>**CALEXICO, CALIFORNIA** | **SITE LOCATION** | PROJECT NUMBER<br>SD732 | FIGURE NUMBER<br>**1** |

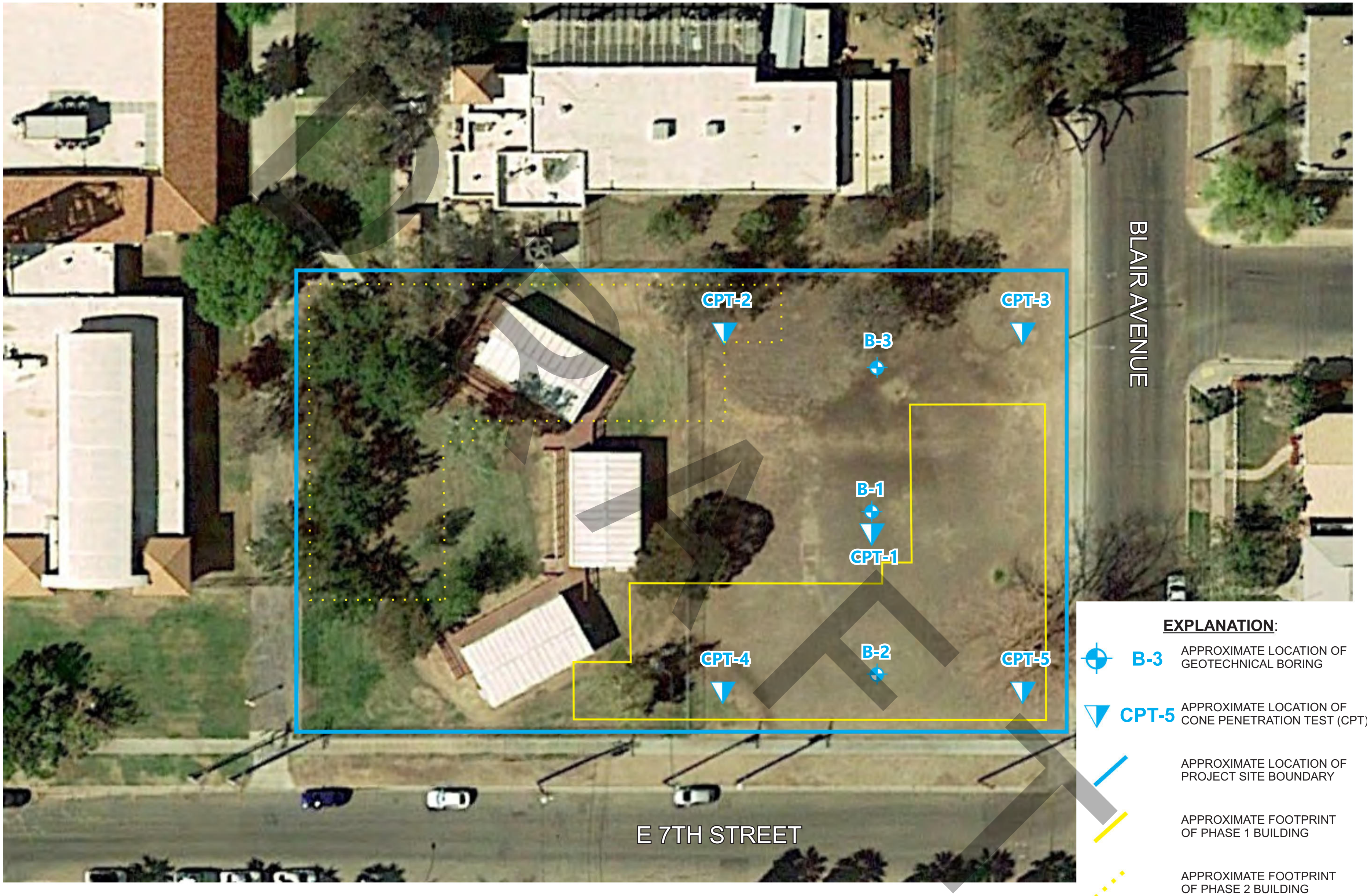
**REFERENCE**: GOOGLE EARTH PRO 7.3.4.8248. IMAGERY DATE APRIL 4, 2018.


N

NO SCALE

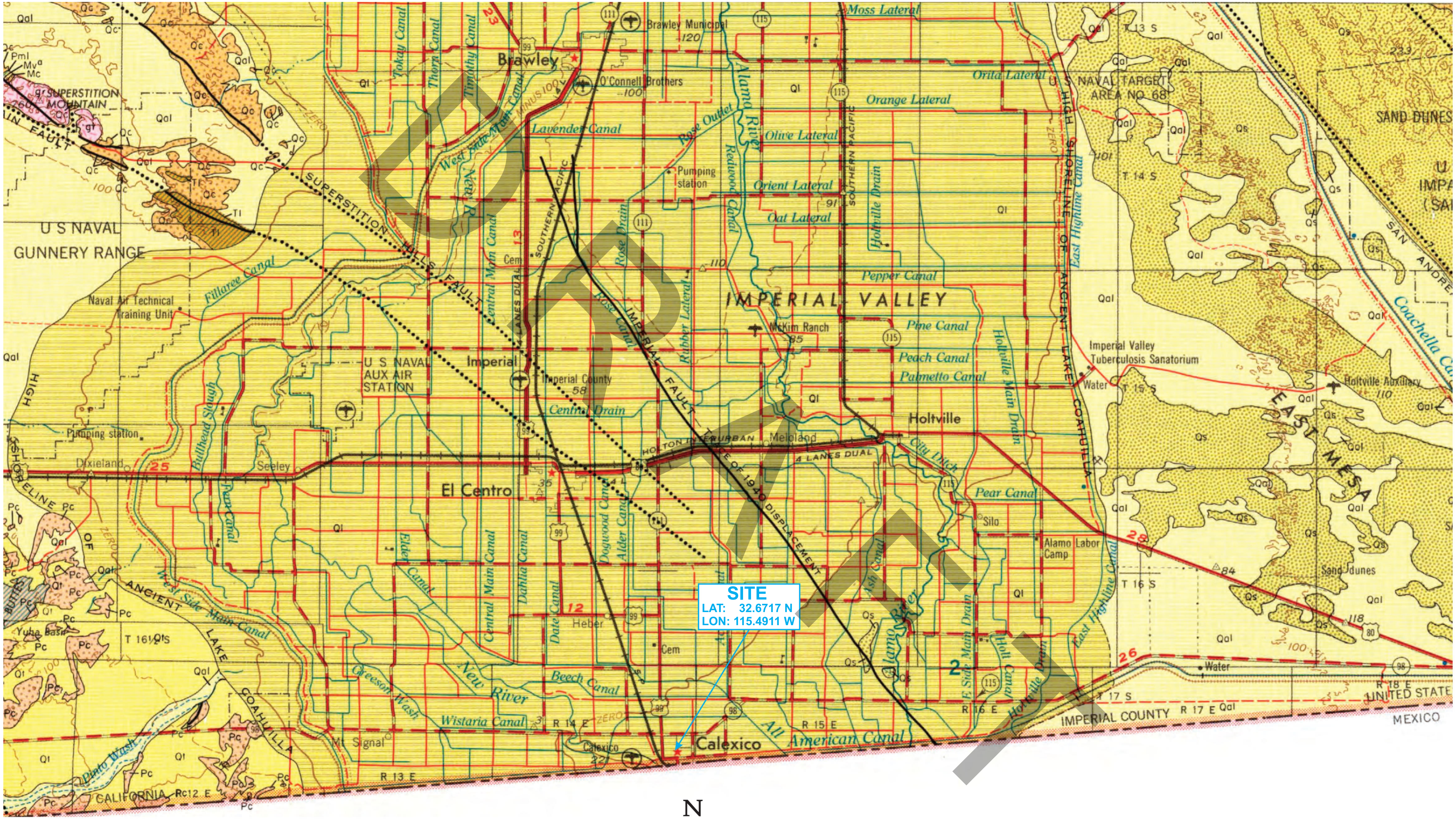
| PROJECT NAME | FIGURE NAME | GROUP DELTA | |
|---|---|---|---|
| **SDSU IMPERIAL VALLEY CAMPUS**<br>**NEW RESIDENCE HALL**<br>**CALEXICO, CALIFORNIA** | **SITE VICINITY** | PROJECT NUMBER<br>SD732 | FIGURE NUMBER<br>**2** |

**REFERENCE**: GOOGLE EARTH PRO 7.3.4.8248. IMAGERY DATE APRIL 4, 2018




| PROJECT NAME | FIGURE NAME | GROUP DELTA | |
|---|---|---|---|
| **SDSU IMPERIAL VALLEY CAMPUS<br>NEW RESIDENCE HALL<br>CALEXICO, CALIFORNIA** | **EXPLORATION LOCATIONS** | PROJECT NUMBER<br>SD732 | FIGURE NUMBER<br>**3** |

**REFERENCE**: GOOGLE EARTH PRO 7.3.4.8248. IMAGERY DATE AUGUST 1, 2021.




**EXPLANATION:**

| | |
|---|---|
| Ql | Quaternary lake deposits |
| Qal | Alluvium |
| Qs | Dune sand |
| Qt | Quaternary nonmarine terrace deposits |
| Qc | Pleistocene nonmarine |

N

NO SCALE

| PROJECT NAME | FIGURE NAME | GROUP DELTA |
|---|---|---|
| SDSU IMPERIAL VALLEY CAMPUS NEW RESIDENCE HALL CALEXICO, CALIFORNIA | REGIONAL GEOLOGY | PROJECT NUMBER: SD732; FIGURE NUMBER: 4 |

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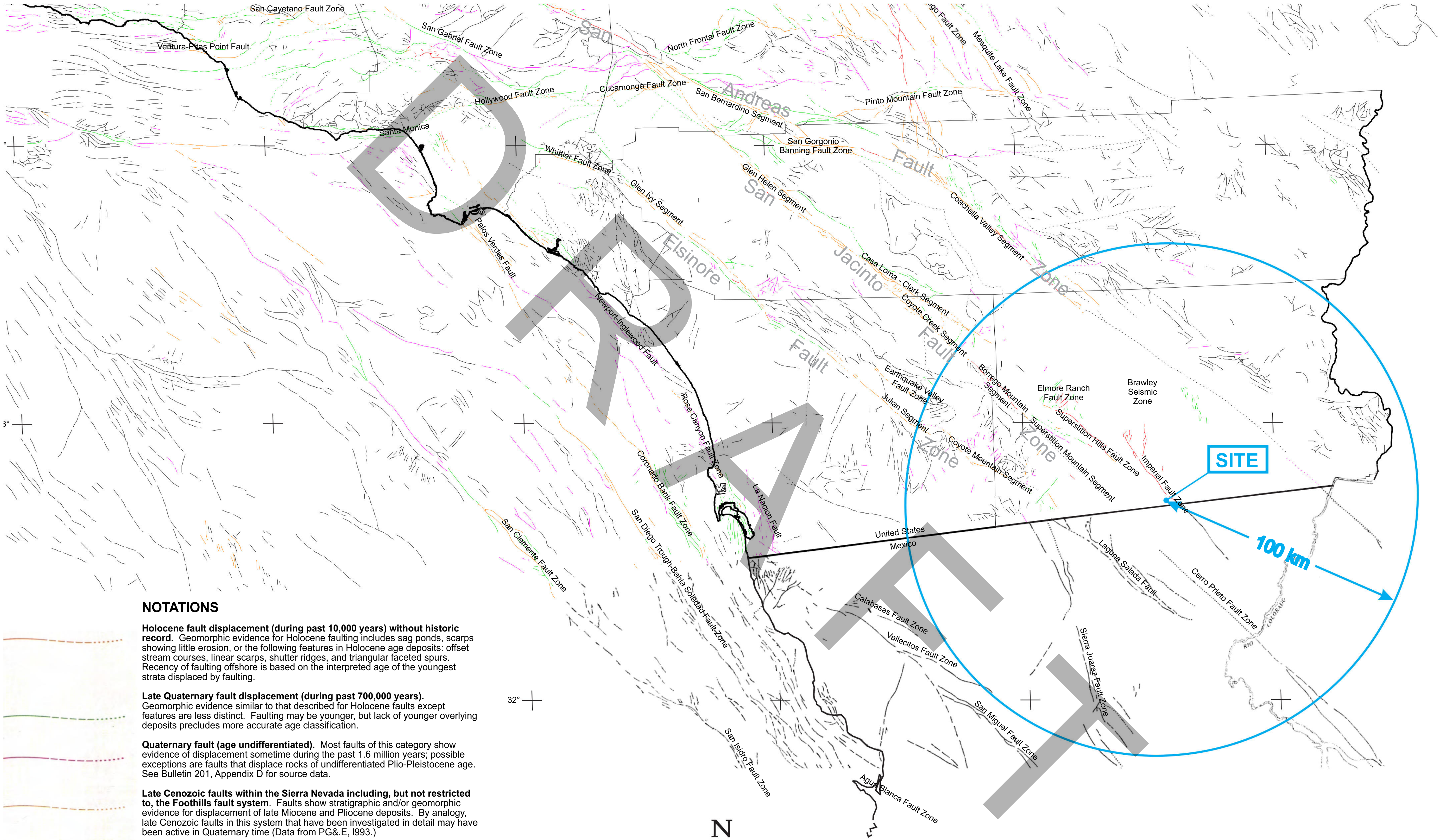


## NOTATIONS

**Holocene fault displacement (during past 10,000 years) without historic record.** Geomorphic evidence for Holocene faulting includes sag ponds, scarps showing little erosion, or the following features in Holocene age deposits: offset stream courses, linear scarps, shutter ridges, and triangular faceted spurs. Recency of faulting offshore is based on the interpreted age of the youngest strata displaced by faulting.

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

**Quaternary fault (age undifferentiated).** Most faults of this category show evidence of displacement sometime during the past 1.6 million years; possible exceptions are faults that displace rocks of undifferentiated Plio-Pleistocene age. See Bulletin 201, Appendix D for source data.

**Late Cenozoic faults within the Sierra Nevada including, but not restricted to, the Foothills fault system.** Faults show stratigraphic and/or geomorphic evidence for displacement of late Miocene and Pliocene deposits. By analogy, late Cenozoic faults in this system that have been investigated in detail may have been active in Quaternary time (Data from PG&E, I993.)

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

| PROJECT NAME | FIGURE NAME | GROUP DELTA | |
|---|---|---|---|
| **SDSU IMPERIAL VALLEY CAMPUS NEW RESIDENCE HALL CALEXICO, CALIFORNIA** | **REGIONAL FAULT LOCATIONS** | PROJECT NUMBER: SD732 | FIGURE NUMBER: 5A |

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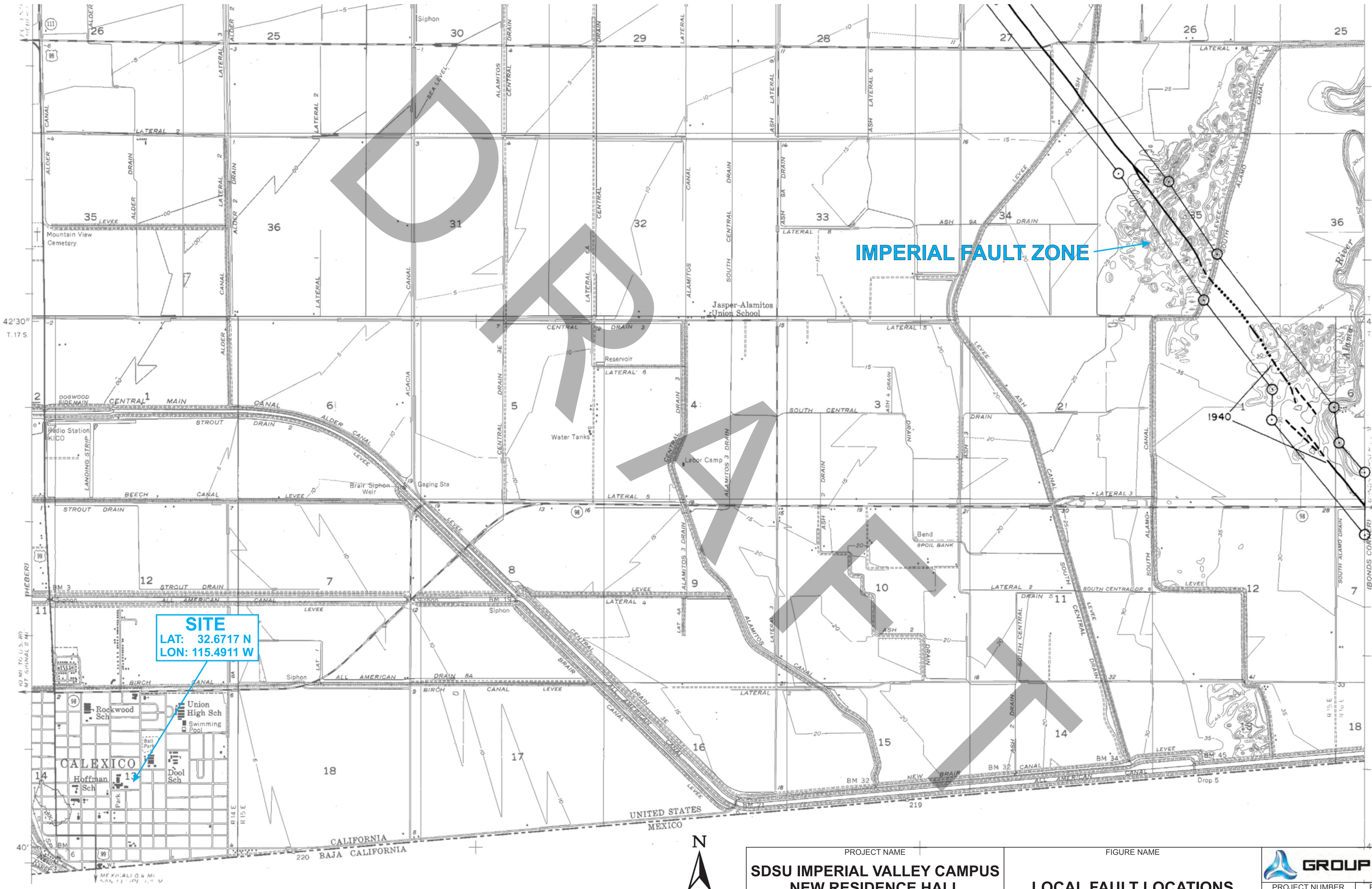
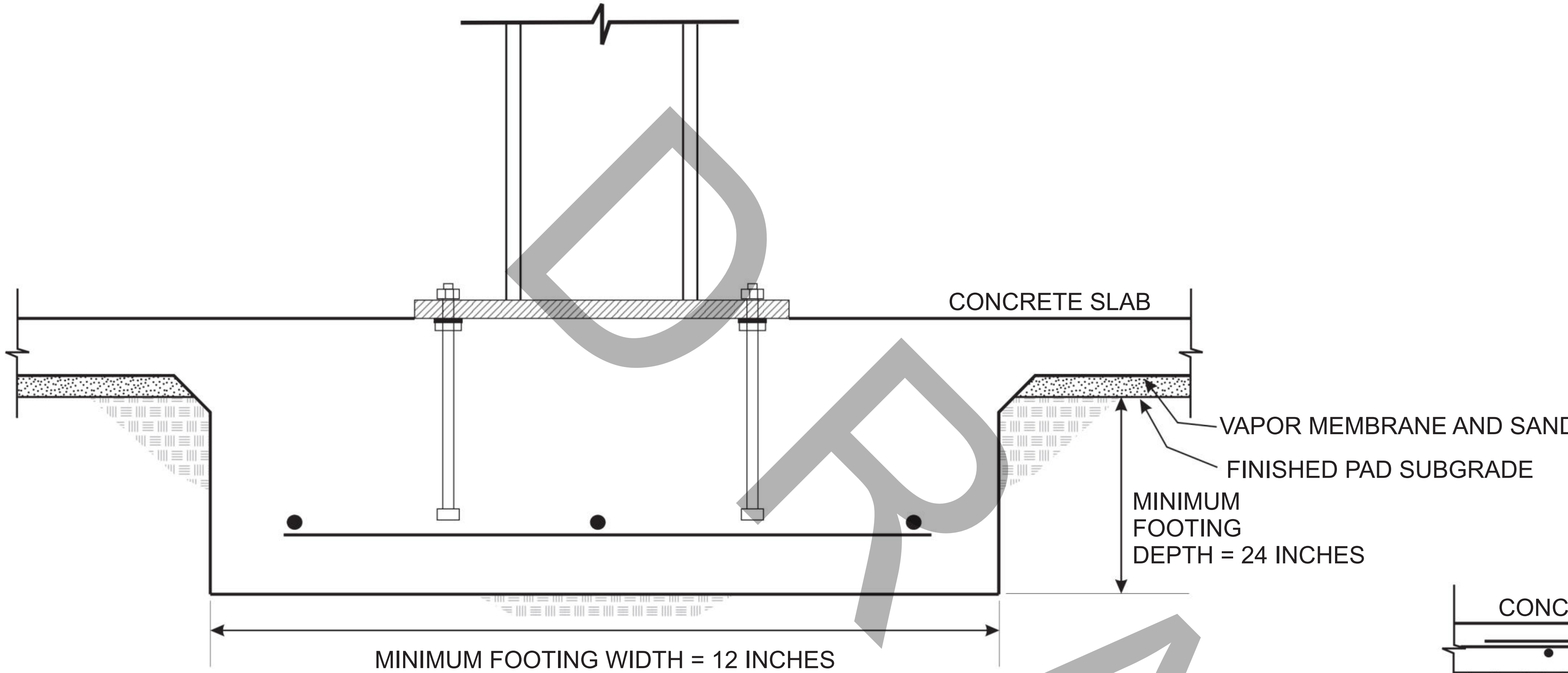
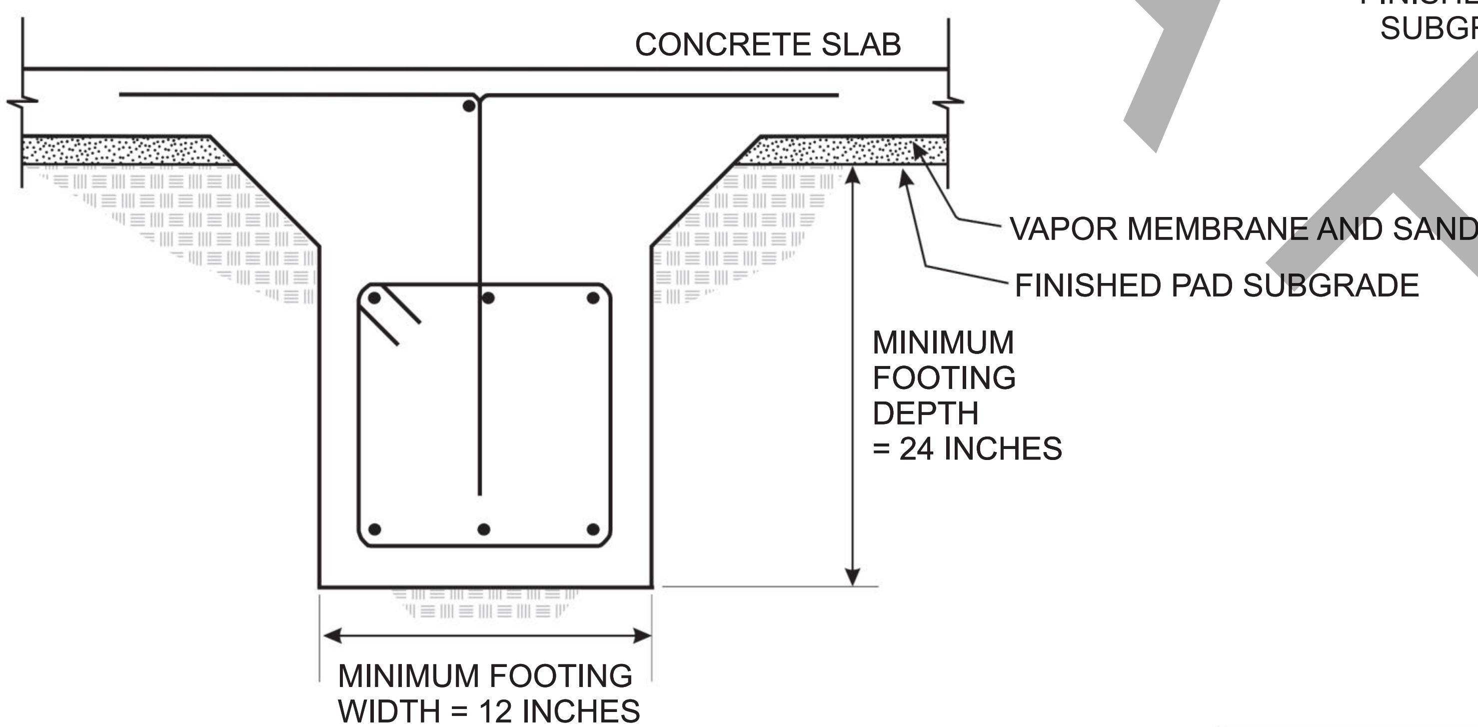



| PROJECT NAME | FIGURE NAME | GROUP DELTA | |
|---|---|---|---|
| SDSU IMPERIAL VALLEY CAMPUS<br>NEW RESIDENCE HALL<br>CALEXICO, CALIFORNIA | LOCAL FAULT LOCATIONS | PROJECT NUMBER<br>SD732 | FIGURE NUMBER<br>5B |

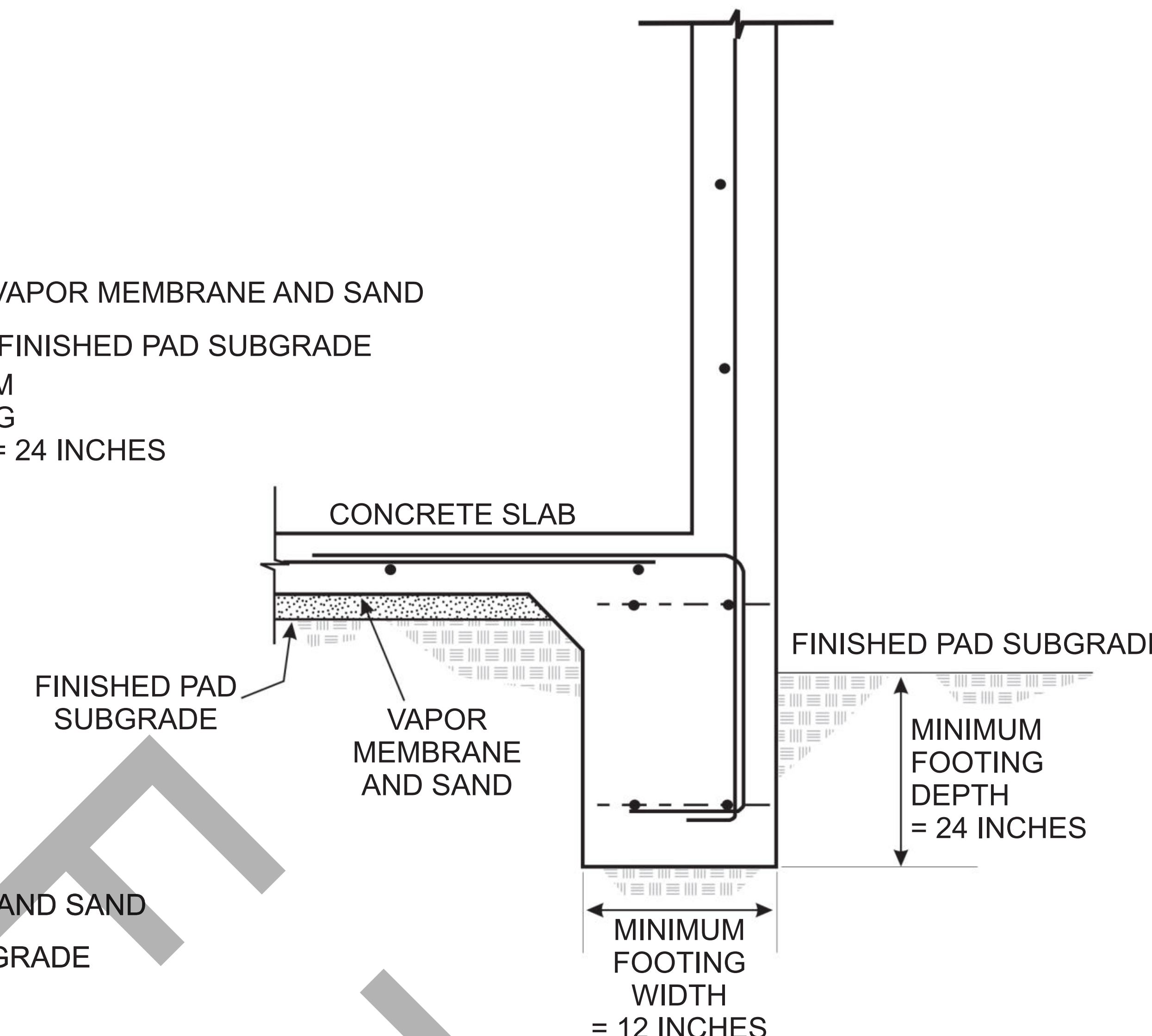
**Reference**: State of California (1990). *Alquist-Priolo Special Studies Zones, Calexico Quadrangle,* Revised Official Map, January 1.




**SQUARE FOOTING**




**INTERIOR CONTINUOUS FOOTING**




**EXTERIOR CONTINUOUS FOOTING**

| PROJECT NAME | FIGURE NAME | GROUP DELTA | |
|---|---|---|---|
| **SDSU IMPERIAL VALLEY CAMPUS<br>NEW RESIDENCE HALL<br>CALEXICO, CALIFORNIA** | **SHALLOW FOUNDATION DETAILS** | PROJECT NUMBER<br>SD732 | FIGURE NUMBER<br>6 |

***APPENDIX A***
***EXPLORATION RECORDS***

**APPENDIX A**

EXPLORATION RECORDS

Field exploration included a visual reconnaissance of the site, the drilling of three (3) hollow stem auger geotechnical borings, and the advancement of five (5) cone penetration tests (CPTs) between May 31st and June 1st, 2022. The maximum depth of exploration was approximately 100 feet below ground surface (bgs). The approximate exploration locations are shown on Figure 3. Logs of the explorations are provided in Figures A-1 through A-3, immediately after the Boring Record Legends.

***HOLLOW STEM BORINGS***

The hollow stem borings were advanced on June 1st, 2022, by Tri-County Drilling using a Diedrich D-120 truck mounted drill rig. Disturbed samples were collected from the borings using a 2-inch outside diameter unlined Standard Penetration Test (SPT) sampler and less disturbed samples were collected using a 3-inch outside diameter ring lined modified California sampler. Bulk samples of surficial soils were also collected from auger cuttings. The samples were sealed in plastic bags, labeled, and returned to the laboratory for testing.

The drive samples were collected from the exploratory borings using an automatic hammer with average Energy Transfer Ratio (ETR) of approximately 86 percent. For each sample, the 6-inch incremental blow-counts were recorded on the logs. The field blow counts (N) were normalized to approximate the standard 60 percent ETR, as shown on the logs ($N_{60}$). The modified California ring samples were also corrected for the 3-inch sampler diameter using Burmister's correction factor. The exploratory borings were logged using the Caltrans Soil and Rock Logging, Classification and Presentation Manual (2010) as a guideline.

***CONE PENETRATION TESTS***

The CPT soundings were advanced by Kehoe Testing and Engineering on May 31st, 2022, in general accordance with ASTM D5778. The CPT soundings were carried out using an integrated electronic cone system manufactured by Vertek. The CPTs were advanced using a 30-ton CPT rig. The cone used during the program was a 15 cm$^2$ cone and recorded the following parameters at approximately 2.5 cm depth intervals:

- Cone Resistance ($q_c$);
- Sleeve Friction ($f_s$);
- Dynamic Pore Pressure (u);
- Inclination; and
- Penetration Speed.

**APPENDIX A**

EXPLORATION RECORDS

At location CPT-1, shear wave velocity measurements were obtained at five foot intervals to a depth of approximately 100 feet. The shear wave was generated using an air-actuated hammer placed under the CPT rig at a specified offset distance from the rods. The cone was equipped with a triaxial geophone, which recorded the shear wave signal generated by the air hammer. The above parameters were recorded and viewed in real time using a laptop computer. A summary of the collected shear wave measurements is presented in Figure A-9.

The lines designating the interface between differing soil materials on the logs may be abrupt or gradational, and soil conditions at locations between the explorations may be substantially different from those at the specific locations we explored. It should be noted that the passage of time may also result in changes in the soil conditions reported in the logs.

The exploration locations were determined by taping or pacing distances from landmarks shown on Figure 3. The locations shown should not be considered more accurate than is implied by the method of measurement used and the scale of the figure. Approximate existing elevations at the boring locations were estimated using Google Earth Pro 2021.

# SOIL IDENTIFICATION AND DESCRIPTION SEQUENCE

| Sequence | Identification Components | Refer to Section: Field | Refer to Section: Lab | Required | Optional |
|---|---|---|---|---|---|
| 1 | Group Name | 2.5.2 | 3.2.2 | ● | |
| 2 | Group Symbol | 2.5.2 | 3.2.2 | ● | |
| | **Description Components** | | | | |
| 3 | Consistency of Cohesive Soil | 2.5.3 | 3.2.3 | ● | |
| 4 | Apparent Density of Cohesionless Soil | 2.5.4 | | ● | |
| 5 | Color | 2.5.5 | | ● | |
| 6 | Moisture | 2.5.6 | | ● | |
| 7 | Percent or Proportion of Soil | 2.5.7 | 3.2.4 | ● | ⬬ |
| | Particle Size | 2.5.8 | 2.5.8 | ● | ⬬ |
| | Particle Angularity | 2.5.9 | | | ○ |
| | Particle Shape | 2.5.10 | | | ○ |
| 8 | Plasticity (for fine-grained soil) | 2.5.11 | 3.2.5 | | ○ |
| 9 | Dry Strength (for fine-grained soil) | 2.5.12 | | | ○ |
| 10 | Dilatency (for fine-grained soil) | 2.5.13 | | | ○ |
| 11 | Toughness (for fine-grained soil) | 2.5.14 | | | ○ |
| 12 | Structure | 2.5.15 | | | ○ |
| 13 | Cementation | 2.5.16 | | ● | |
| 14 | Percent of Cobbles and Boulders | 2.5.17 | | ● | |
| | Description of Cobbles and Boulders | 2.5.18 | | ● | |
| 15 | Consistency Field Test Result | 2.5.3 | | ● | |
| 16 | Additional Comments | 2.5.19 | | | ○ |

## Describe the soil using descriptive terms in the order shown

**Minimum Required Sequence**:

USCS Group Name (Group Symbol); Consistency or Density; Color; Moisture; Percent or Proportion of Soil; Particle Size; Plasticity (optional).

⬬ = optional for non-Caltrans projects

**Where applicable**:

Cementation; % cobbles & boulders; Description of cobbles & boulders; Consistency field test result

**REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).**

# HOLE IDENTIFICATION

Holes are identified using the following convention:

*H – YY – NNN*

Where:

*H:* Hole Type Code

*YY:* 2-digit year

*NNN:* 3-digit number (001-999)

**Hole Type Code and Description**

| Hole Type Code | Description |
|---|---|
| A | Auger boring (hollow or solid stem, bucket) |
| R | Rotary drilled boring (conventional) |
| RC | Rotary core (self-cased wire-line, continuously-sampled) |
| RW | Rotary core (self-cased wire-line, not continuously sampled) |
| P | Rotary percussion boring (Air) |
| HD | Hand driven (1-inch soil tube) |
| HA | Hand auger |
| D | Driven (dynamic cone penetrometer) |
| CPT | Cone Penetration Test |
| O | Other (note on LOTB) |

**Description Sequence Examples:**

SANDY lean CLAY (CL); very stiff; yellowish brown; moist; mostly fines; some SAND, from fine to medium; few gravels; medium plasticity; PP=2.75.

Well-graded SAND with SILT and GRAVEL and COBBLES (SW-SM); dense; brown; moist; mostly SAND, from fine to coarse; some fine GRAVEL; few fines; weak cementation; 10% GRANITE COBBLES; 3 to 6 inches; hard; subrounded.

Clayey SAND (SC); medium dense, light brown; wet; mostly fine sand,; little fines; low plasticity.



GROUP DELTA

PROJECT NO. SD732

SDSU IVC NEW RESIDENCE HALL
CALEXICO, CALIFORNIA

**BORING RECORD LEGEND #1**

## GROUP SYMBOLS AND NAMES

| Graphic / Symbol | Group Names |
|---|---|
| GW | Well-graded GRAVEL<br>Well-graded GRAVEL with SAND |
| GP | Poorly graded GRAVEL<br>Poorly graded GRAVEL with SAND |
| GW-GM | Well-graded GRAVEL with SILT<br>Well-graded GRAVEL with SILT and SAND |
| GW-GC | Well-graded GRAVEL with CLAY (or SILTY CLAY)<br>Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND) |
| GP-GM | Poorly graded GRAVEL with SILT<br>Poorly graded GRAVEL with SILT and SAND |
| GP-GC | Poorly graded GRAVEL with CLAY (or SILTY CLAY)<br>Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND) |
| GM | SILTY GRAVEL<br>SILTY GRAVEL with SAND |
| GC | CLAYEY GRAVEL<br>CLAYEY GRAVEL with SAND |
| GC-GM | SILTY, CLAYEY GRAVEL<br>SILTY, CLAYEY GRAVEL with SAND |
| SW | Well-graded SAND<br>Well-graded SAND with GRAVEL |
| SP | Poorly graded SAND<br>Poorly graded SAND with GRAVEL |
| SW-SM | Well-graded SAND with SILT<br>Well-graded SAND with SILT and GRAVEL |
| SW-SC | Well-graded SAND with CLAY (or SILTY CLAY)<br>Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL) |
| SP-SM | Poorly graded SAND with SILT<br>Poorly graded SAND with SILT and GRAVEL |
| SP-SC | Poorly graded SAND with CLAY (or SILTY CLAY)<br>Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL) |
| SM | SILTY SAND<br>SILTY SAND with GRAVEL |
| SC | CLAYEY SAND<br>CLAYEY SAND with GRAVEL |
| SC-SM | SILTY, CLAYEY SAND<br>SILTY, CLAYEY SAND with GRAVEL |
| PT | PEAT |
| | COBBLES<br>COBBLES and BOULDERS<br>BOULDERS |

| Graphic / Symbol | Group Names |
|---|---|
| CL | Lean CLAY<br>Lean CLAY with SAND<br>Lean CLAY with GRAVEL<br>SANDY lean CLAY<br>SANDY lean CLAY with GRAVEL<br>GRAVELLY lean CLAY<br>GRAVELLY lean CLAY with SAND |
| CL-ML | SILTY CLAY<br>SILTY CLAY with SAND<br>SILTY CLAY with GRAVEL<br>SANDY SILTY CLAY<br>SANDY SILTY CLAY with GRAVEL<br>GRAVELLY SILTY CLAY<br>GRAVELLY SILTY CLAY with SAND |
| ML | SILT<br>SILT with SAND<br>SILT with GRAVEL<br>SANDY SILT<br>SANDY SILT with GRAVEL<br>GRAVELLY SILT<br>GRAVELLY SILT with SAND |
| OL | ORGANIC lean CLAY<br>ORGANIC lean CLAY with SAND<br>ORGANIC lean CLAY with GRAVEL<br>SANDY ORGANIC lean CLAY<br>SANDY ORGANIC lean CLAY with GRAVEL<br>GRAVELLY ORGANIC lean CLAY<br>GRAVELLY ORGANIC lean CLAY with SAND |
| OL | ORGANIC SILT<br>ORGANIC SILT with SAND<br>ORGANIC SILT with GRAVEL<br>SANDY ORGANIC SILT<br>SANDY ORGANIC SILT with GRAVEL<br>GRAVELLY ORGANIC SILT<br>GRAVELLY ORGANIC SILT with SAND |
| CH | Fat CLAY<br>Fat CLAY with SAND<br>Fat CLAY with GRAVEL<br>SANDY fat CLAY<br>SANDY fat CLAY with GRAVEL<br>GRAVELLY fat CLAY<br>GRAVELLY fat CLAY with SAND |
| MH | Elastic SILT<br>Elastic SILT with SAND<br>Elastic SILT with GRAVEL<br>SANDY elastic SILT<br>SANDY elastic SILT with GRAVEL<br>GRAVELLY elastic SILT<br>GRAVELLY elastic SILT with SAND |
| OH | ORGANIC fat CLAY<br>ORGANIC fat CLAY with SAND<br>ORGANIC fat CLAY with GRAVEL<br>SANDY ORGANIC fat CLAY<br>SANDY ORGANIC fat CLAY with GRAVEL<br>GRAVELLY ORGANIC fat CLAY<br>GRAVELLY ORGANIC fat CLAY with SAND |
| OH | ORGANIC elastic SILT<br>ORGANIC elastic SILT with SAND<br>ORGANIC elastic SILT with GRAVEL<br>SANDY elastic ELASTIC SILT<br>SANDY ORGANIC elastic SILT with GRAVEL<br>GRAVELLY ORGANIC elastic SILT<br>GRAVELLY ORGANIC elastic SILT with SAND |
| OL/OH | ORGANIC SOIL<br>ORGANIC SOIL with SAND<br>ORGANIC SOIL with GRAVEL<br>SANDY ORGANIC SOIL<br>SANDY ORGANIC SOIL with GRAVEL<br>GRAVELLY ORGANIC SOIL<br>GRAVELLY ORGANIC SOIL with SAND |

## FIELD AND LABORATORY TESTING

| | |
|---|---|
| C | Consolidation (ASTM D 2435) |
| CL | Collapse Potential (ASTM D 5333) |
| CP | Compaction Curve (CTM 216) |
| CR | Corrosion, Sulfates, Chlorides (CTM 643; CTM 417; CTM 422) |
| CU | Consolidated Undrained Triaxial (ASTM D 4767) |
| DS | Direct Shear (ASTM D 3080) |
| EI | Expansion Index (ASTM D 4829) |
| M | Moisture Content (ASTM D 2216) |
| OC | Organic Content (ASTM D 2974) |
| P | Permeability (CTM 220) |
| PA | Particle Size Analysis (ASTM D 422) |
| PI | Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89, AASHTO T 90) |
| PL | Point Load Index (ASTM D 5731) |
| PM | Pressure Meter |
| R | R-Value (CTM 301) |
| SE | Sand Equivalent (CTM 217) |
| SG | Specific Gravity (AASHTO T 100) |
| SL | Shrinkage Limit (ASTM D 427) |
| SW | Swell Potential (ASTM D 4546) |
| UC | Unconfined Compression - Soil (ASTM D 2166)<br>Unconfined Compression - Rock (ASTM D 2938) |
| UU | Unconsolidated Undrained Triaxial (ASTM D 2850) |
| UW | Unit Weight (ASTM D 2937) |
| WA | Percent passing the No. 200 Sieve (ASTM D 1140) |

## SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler (2.4" ID, 3" OD)
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

## DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

## WATER LEVEL SYMBOLS

- ▽ First Water Level Reading (during drilling)
- ▼ Static Water Level Reading (after drilling, date)

Definitions for Change in Material

| Term | Definition | Symbol |
|---|---|---|
| Material Change | Change in material is observed in the sample or core and the location of change can be accurately located. | ——— |
| Estimated Material Change | Change in material cannot be accurately located either because the change is gradational or because of limitations of the drilling and sampling methods. | – – – – |
| Soil / Rock Boundary | Material changes from soil characteristics to rock characteristics. | |

**REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).**

GROUP DELTA

PROJECT NO. SD732

SDSU IVC NEW RESIDENCE HALL
CALEXICO, CALIFORNIA

**BORING RECORD LEGEND #2**

| CONSISTENCY OF COHESIVE SOILS | | | | |
|---|---|---|---|---|
| Description | Shear Strength (tsf) | Pocket Penetrometer, PP Measurement (tsf) | Torvane, TV, Measurement (tsf) | Vane Shear, VS, Measurement (tsf) |
| Very Soft | Less than 0.12 | Less than 0.25 | Less than 0.12 | Less than 0.12 |
| Soft | 0.12 - 0.25 | 0.25 - 0.5 | 0.12 - 0.25 | 0.12 - 0.25 |
| Medium Stiff | 0.25 - 0.5 | 0.5 - 1 | 0.25 - 0.5 | 0.25 - 0.5 |
| Stiff | 0.5 - 1 | 1 - 2 | 0.5 - 1 | 0.5 - 1 |
| Very Stiff | 1 - 2 | 2 - 4 | 1 - 2 | 1 - 2 |
| Hard | Greater than 2 | Greater than 4 | Greater than 2 | Greater than 2 |

| APPARENT DENSITY OF COHESIONLESS SOILS | |
|---|---|
| Description | SPT $N_{60}$ (blows / 12 inches) |
| Very Loose | 0 - 5 |
| Loose | 5 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | Greater than 50 |

| MOISTURE | |
|---|---|
| Description | Criteria |
| Dry | No discernable moisture |
| Moist | Moisture present, but no free water |
| Wet | Visible free water |

| PERCENT OR PROPORTION OF SOILS | |
|---|---|
| Description | Criteria |
| Trace | Particles are present but estimated to be less than 5% |
| Few | 5 - 10% |
| Little | 15 - 25% |
| Some | 30 - 45% |
| Mostly | 50 - 100% |

| PARTICLE SIZE | | |
|---|---|---|
| Description | | Size (in) |
| Boulder | | Greater than 12 |
| Cobble | | 3 - 12 |
| Gravel | Coarse | 3/4 - 3 |
| | Fine | 1/5 - 3/4 |
| Sand | Coarse | 1/16 - 1/5 |
| | Medium | 1/64 - 1/16 |
| | Fine | 1/300 - 1/64 |
| Silt and Clay | | Less than 1/300 |

| CEMENTATION | |
|---|---|
| Description | Criteria |
| Weak | Crumbles or breaks with handling or little finger pressure. |
| Moderate | Crumbles or breaks with considerable finger pressure. |
| Strong | Will not crumble or break with finger pressure. |

**REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010), with the exception of consistency of cohesive soils vs. $N_{60}$.**

**Plasticity**

| Description | Criteria |
|---|---|
| Nonplastic | A 1/8-in. thread cannot be rolled at any water content. |
| Low | The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit. |
| Medium | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit. |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit. |

| CONSISTENCY OF COHESIVE SOILS | |
|---|---|
| Description | SPT $N_{60}$ (blows/12 inches) |
| Very Soft | 0 - 2 |
| Soft | 2 - 4 |
| Medium Stiff | 4 - 8 |
| Stiff | 8 - 15 |
| Very Stiff | 15 - 30 |
| Hard | Greater than 30 |

**Ref**: Peck, Hansen, and Thornburn, 1974, "Foundation Engineering," Second Edition.

**Note**: Only to be used (with caution) when pocket penetrometer or other data on undrained shear strength are unavailable. Not allowed by Caltrans Soil and Rock Logging and Classification Manual, 2010.



GROUP DELTA

PROJECT NO. SD732

SDSU IVC NEW RESIDENCE HALL
CALEXICO, CALIFORNIA

**BORING RECORD LEGEND #3**

# BORING RECORD

| PROJECT NAME | PROJECT NUMBER | BORING |
|---|---|---|
| SDSU IVC Student Residence Hall | SD732 | **B-1** |

| SITE LOCATION | START | FINISH | SHEET NO. |
|---|---|---|---|
| 720 Heber Avenue, Calexico, CA | 6/1/2022 | 6/1/2022 | 1 of 3 |

| DRILLING COMPANY | DRILLING METHOD | LOGGED BY | CHECKED BY |
|---|---|---|---|
| Tri-County Drilling Inc. | Hollow Stem Auger | C. Vonk | S. Narveson |

| DRILLING EQUIPMENT | BORING DIA. (in) | TOTAL DEPTH (ft) | GROUND ELEV (ft) | DEPTH/*ELEV.* GROUNDWATER (ft) |
|---|---|---|---|---|
| Diedrich D-120 | 8 | 51.5 | 4 | ▼ 28.0 / *-24.0* |

| SAMPLING METHOD | NOTES |
|---|---|
| Hammer: 140 lbs., Drop: 30 in. (Automatic) | ETR ~ 86%, $N_{60}$ ~ 1.43*$N_{SPT}$ ~ 0.96*$N_{MC}$ |

| DEPTH (feet) | ELEVATION (feet) | SAMPLE TYPE | SAMPLE NO. | PENETRATION RESISTANCE (BLOWS / 6 IN) | BLOW/FT "N" | $N_{60}$ | MOISTURE (%) | DRY DENSITY (pcf) | OTHER TESTS | DRILLING METHOD | GRAPHIC LOG | DESCRIPTION AND CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Grass and Organics |
| | | | B1 | | | | 21.7 | | EI PA PI | | | **FILL:** Lean CLAY (CL); brown; moist; mostly fines; few to little SAND; medium plasticity. 13% Sand, 87% Fines LL=46, PL=20, PI=26; EI = 70 |
| 5 | 0 | | S2 | 3 8 13 | 21 | 30 | | | PA PI | | | **LACUSTRINE DEPOSITS (Ql):** Fat CLAY (CH); brown; moist; mostly fines; trace SAND; high plasticity. 4% Sand, 96% Fines LL=65, PL=23, PI=42 Hard; minor caliche cementation; trace organics. PP>4.5 tsf |
| 10 | -5 | | R3-1 R3-2 | 8 19 24 | 43 | 41 | 16.1 | 108 | PA PI | | | No sand. 100% Fines LL=70, PL=25, PI=45 PP>4.5 tsf |
| | -10 | | | | | | | | | | | SILTY SAND (SM); medium dense; light grayish brown; moist; mostly fine SAND; some fines; non-plastic. 63% Sand, 37% Fines |
| 15 | | | S4-1 S4-2 | 3 2 7 | 9 | 13 | 6.0 | | PA | | | SILT with SAND (ML); medium dense; brown; moist; mostly fines; little fine SAND; low plasticity. |
| 20 | -15 | | R5 | 4 7 12 | 19 | 18 | 32.9 | 89 | C | | | Fat CLAY (CH); very stiff; brown; moist; mostly fines; trace fine SAND; high plasticity. PP=2.25 tsf |
| | -20 | | | | | | | | | | | |



**GROUP DELTA CONSULTANTS, INC.**
9245 Activity Road, Suite 103
San Diego, California 92126



FIGURE A-1 a

# BORING RECORD

| PROJECT NAME | PROJECT NUMBER | BORING |
|---|---|---|
| SDSU IVC Student Residence Hall | SD732 | **B-1** |

| SITE LOCATION | START | FINISH | SHEET NO. |
|---|---|---|---|
| 720 Heber Avenue, Calexico, CA | 6/1/2022 | 6/1/2022 | 2 of 3 |

| DRILLING COMPANY | DRILLING METHOD | LOGGED BY | CHECKED BY |
|---|---|---|---|
| Tri-County Drilling Inc. | Hollow Stem Auger | C. Vonk | S. Narveson |

| DRILLING EQUIPMENT | BORING DIA. (in) | TOTAL DEPTH (ft) | GROUND ELEV (ft) | DEPTH/*ELEV.* GROUNDWATER (ft) |
|---|---|---|---|---|
| Diedrich D-120 | 8 | 51.5 | 4 | ▼ 28.0 / *-24.0* |

| SAMPLING METHOD | NOTES |
|---|---|
| Hammer: 140 lbs., Drop: 30 in. (Automatic) | ETR ~ 86%, $N_{60}$ ~ 1.43*$N_{SPT}$ ~ 0.96*$N_{MC}$ |

| DEPTH (feet) | ELEVATION (feet) | SAMPLE TYPE | SAMPLE NO. | PENETRATION RESISTANCE (BLOWS / 6 IN) | BLOW/FT "N" | $N_{60}$ | MOISTURE (%) | DRY DENSITY (pcf) | OTHER TESTS | DRILLING METHOD | GRAPHIC LOG | DESCRIPTION AND CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S6-1<br>S6-2 | 2<br>3<br>5 | 8 | 11 | 28.7 | | PI<br>WA | | | **<u>LACUSTRINE DEPOSITS (Ql):</u> continued** Fat CLAY (CH) *(see previous page for full description):* Stiff to very stiff.<br>PP=1.0 tsf |
| | -25 | | | | | | | | | | | SILT (ML); loose to medium dense; brown; moist to wet; mostly fines; few fine SAND; non-plastic.<br>94% Fines.<br>LL=NP, PL=NP, PI=NP |
| 30 | | | R7-1<br>R7-2 | 3<br>5<br>8 | 13 | 12 | 31.6 | 92 | C<br>PI | | | Lean CLAY (CL); stiff; brown; moist; mostly fines; few fine SAND; medium plasticity.<br>LL=40, PL=21, PI=19<br>PP=1.5 tsf |
| | -30 | | | | | | | | | | | |
| 35 | | | R8-1<br>R8-2 | 6<br>16<br>23 | 39 | 37 | 27.9 | 97 | C<br>PI<br>WA | | | Fat CLAY (CH); hard; brown; moist; mostly fines; high plasticity.<br>100% Fines<br>LL=69, PL=22, PI=47<br>PP>4.5 tsf |
| | -35 | | | | | | | | | | | |
| 40 | | | S9 | 6<br>11<br>15 | 26 | 37 | 25.4 | | | | | PP>4.5 tsf |
| | -40 | | | | | | | | | | | |
| 45 | | | R10-1<br>R10-2 | 5<br>7<br>8 | 15 | 14 | 32.0 | 91 | | | | Very stiff.<br>PP=2.5 tsf |
| | -45 | | | | | | | | | | | |



**GROUP DELTA CONSULTANTS, INC.**
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FIGURE

A-1 b

# BORING RECORD

| PROJECT NAME | PROJECT NUMBER | BORING |
|---|---|---|
| SDSU IVC Student Residence Hall | SD732 | **B-1** |

| SITE LOCATION | START | FINISH | SHEET NO. |
|---|---|---|---|
| 720 Heber Avenue, Calexico, CA | 6/1/2022 | 6/1/2022 | 3 of 3 |

| DRILLING COMPANY | DRILLING METHOD | LOGGED BY | CHECKED BY |
|---|---|---|---|
| Tri-County Drilling Inc. | Hollow Stem Auger | C. Vonk | S. Narveson |

| DRILLING EQUIPMENT | BORING DIA. (in) | TOTAL DEPTH (ft) | GROUND ELEV (ft) | DEPTH/*ELEV.* GROUNDWATER (ft) |
|---|---|---|---|---|
| Diedrich D-120 | 8 | 51.5 | 4 | ▼ 28.0 / *-24.0* |

| SAMPLING METHOD | NOTES |
|---|---|
| Hammer: 140 lbs., Drop: 30 in. (Automatic) | ETR ~ 86%, $N_{60}$ ~ 1.43*$N_{SPT}$ ~ 0.96*$N_{MC}$ |

| DEPTH (feet) | ELEVATION (feet) | SAMPLE TYPE | SAMPLE NO. | PENETRATION RESISTANCE (BLOWS / 6 IN) | BLOW/FT "N" | $N_{60}$ | MOISTURE (%) | DRY DENSITY (pcf) | OTHER TESTS | DRILLING METHOD | GRAPHIC LOG | DESCRIPTION AND CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | S11 | 8<br>4<br>10 | 14 | 20 | 28.3 | | WA | | | **LACUSTRINE DEPOSITS (Ql): continued** SILT (ML); medium dense; brown; wet; mostly fines; few fine SAND; non-plastic; trace mica. 88% Fines |
| | -50 | | | | | | | | | | | Total Depth = 51.5 feet (target depth reached).<br>Groundwater measured at 28.0 feet after drilling.<br>Boring backfilled on 6/1/2022 shortly after drilling.<br>This Boring Record is part of a geotechnical report which must be considered in its entirety. |
| 55 | | | | | | | | | | | | |
| | -55 | | | | | | | | | | | |
| 60 | | | | | | | | | | | | |
| | -60 | | | | | | | | | | | |
| 65 | | | | | | | | | | | | |
| | -65 | | | | | | | | | | | |
| 70 | | | | | | | | | | | | |
| | -70 | | | | | | | | | | | |





**GROUP DELTA CONSULTANTS, INC.**
9245 Activity Road, Suite 103
San Diego, California 92126

# BORING RECORD

| PROJECT NAME | PROJECT NUMBER | BORING |
|---|---|---|
| SDSU IVC Student Residence Hall | SD732 | **B-2** |

| SITE LOCATION | START | FINISH | SHEET NO. |
|---|---|---|---|
| 720 Heber Avenue, Calexico, CA | 6/1/2022 | 6/1/2022 | 1 of 1 |

| DRILLING COMPANY | DRILLING METHOD | LOGGED BY | CHECKED BY |
|---|---|---|---|
| Tri-County Drilling Inc. | Hollow Stem Auger | C. Vonk | S. Narveson |

| DRILLING EQUIPMENT | BORING DIA. (in) | TOTAL DEPTH (ft) | GROUND ELEV (ft) | DEPTH/*ELEV.* GROUNDWATER (ft) |
|---|---|---|---|---|
| Diedrich D-120 | 8 | 21.5 | 5 | ▼ NE / *na* |

| SAMPLING METHOD | NOTES |
|---|---|
| Hammer: 140 lbs., Drop: 30 in. (Automatic) | ETR ~ 86%, $N_{60}$ ~ 1.43*$N_{SPT}$ ~ 0.96*$N_{MC}$ |

| DEPTH (feet) | ELEVATION (feet) | SAMPLE NO. | PENETRATION RESISTANCE (BLOWS / 6 IN) | BLOW/FT "N" | $N_{60}$ | MOISTURE (%) | DRY DENSITY (pcf) | OTHER TESTS | DESCRIPTION AND CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Grass and Organics |
| | | | | | | | | | **FILL:** Lean CLAY (CL); brown; moist; mostly fines; few fine SAND; medium plasticity; scattered organics (rootlets). EI = 60 |
| | | B1 | | | | 18.3 | | EI CR | **LACUSTRINE DEPOSITS (Ql):** Fat CLAY (CH); hard; brown; moist; mostly fines; few fine SAND; high plasticity; trace organics. PP>4.5 tsf |
| 5 | 0 | R2-1 R2-2 | 11 13 22 | 35 | 34 | 20.4 | 93 | | |
| 10 | -5 | R3 | 8 19 33 | 52 | 50 | 24.4 | 101 | SW | Brown to dark brown. PP>4.5 tsf |
| | | | | | | | | | Lean CLAY (CL); medium stiff; brown; moist; mostly fines; some fine SAND; medium plasticity. LL=31, PL=21, PI=10 |
| 15 | -10 | S4-1 S4-2 | 2 2 10 | 12 | 17 | 24.3 | | PI | |
| | | | | | | | | | Silty SAND (SM); medium dense; light grayish brown; moist; mostly fine SAND; little fines; non-plastic. |
| 20 | -15 | R5-1 R5-2 | 4 7 13 | 20 | 19 | 29.2 | 93 | PA UC | Fat CLAY (CH); stiff to very stiff; dark brown; moist; mostly fines; trace fine SAND; high plasticity 1% Sand, 99% Fines PP=2.0 tsf; UC = 2.5 ksf |

Total Depth = 21.5 feet (target depth reached).
Groundwater not encountered during drilling.
Boring backfilled on 6/1/2022 shortly after drilling.
This Boring Record is part of a geotechnical report which must be considered in its entirety.
Boring caved to 16.5 feet upon extracting augers.





**GROUP DELTA CONSULTANTS, INC.**
9245 Activity Road, Suite 103
San Diego, California 92126

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

FIGURE A-2

# BORING RECORD

| PROJECT NAME | PROJECT NUMBER | BORING |
|---|---|---|
| SDSU IVC Student Residence Hall | SD732 | **B-3** |

| SITE LOCATION | START | FINISH | SHEET NO. |
|---|---|---|---|
| 720 Heber Avenue, Calexico, CA | 6/1/2022 | 6/1/2022 | 1 of 1 |

| DRILLING COMPANY | DRILLING METHOD | LOGGED BY | CHECKED BY |
|---|---|---|---|
| Tri-County Drilling Inc. | Hollow Stem Auger | C. Vonk | S. Narveson |

| DRILLING EQUIPMENT | BORING DIA. (in) | TOTAL DEPTH (ft) | GROUND ELEV (ft) | DEPTH/*ELEV.* GROUNDWATER (ft) |
|---|---|---|---|---|
| Diedrich D-120 | 8 | 21.5 | 5 | ▼ NE / *na* |

| SAMPLING METHOD | NOTES |
|---|---|
| Hammer: 140 lbs., Drop: 30 in. (Automatic) | ETR ~ 86%, $N_{60}$ ~ 1.43*$N_{SPT}$ ~ 0.96*$N_{MC}$ |

| DEPTH (feet) | ELEVATION (feet) | SAMPLE NO. | PENETRATION RESISTANCE (BLOWS / 6 IN) | BLOW/FT "N" | $N_{60}$ | MOISTURE (%) | DRY DENSITY (pcf) | OTHER TESTS | DESCRIPTION AND CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 5 | | | | | | | | Grass and Organcis |
| | | B1 | | | | 21.5 | | CR EI PA | **FILL:** Lean CLAY (CL); brown; moist; mostly fines; few fine SAND; low to medium plasticity. 7% Sand, 93% Fines EI = 82 |
| 5 | 0 | R2-1 R2-2 | 7 17 25 | 42 | 40 | 20.9 | 96 | C SW | **LACUSTRINE DEPOSITS (Ql):** Fat CLAY (CH); brown; moist; mostly fines; few fine SAND; high plasticity. Hard. PP>4.5 tsf |
| 10 | -5 | S3 | 6 14 20 | 34 | 49 | 19.8 | | | PP>4.5 tsf |
| | | | | | | | | | SANDY SILT (ML); medium dense; brown; moist to wet; mostly fines; some fine SAND; low plasticity to non-plastic. |
| 15 | -10 | R4-1 R4-2 | 3 11 19 | 30 | 29 | 11.7 | 99 | | Silty SAND (SM); medium dense; light grayish brown; moist; mostly fine SAND; little fines; non-plastic. |
| 20 | -15 | S5 | 4 6 9 | 15 | 21 | | | PI | Fat CLAY (CH); very stiff; brown; moist; mostly fines; trace fine SAND; high plasticity. LL=68, PL=23, PI=45 PP=2.5 tsf |

Total Depth = 21.5 feet (target depth reached).
Groundwater not encountered during drilling.
Boring backfilled on 6/1/2022 shortly after drilling.
This Boring Record is part of a geotechnical report which must be considered in its entirety.

**GROUP DELTA CONSULTANTS, INC.**
9245 Activity Road, Suite 103
San Diego, California 92126

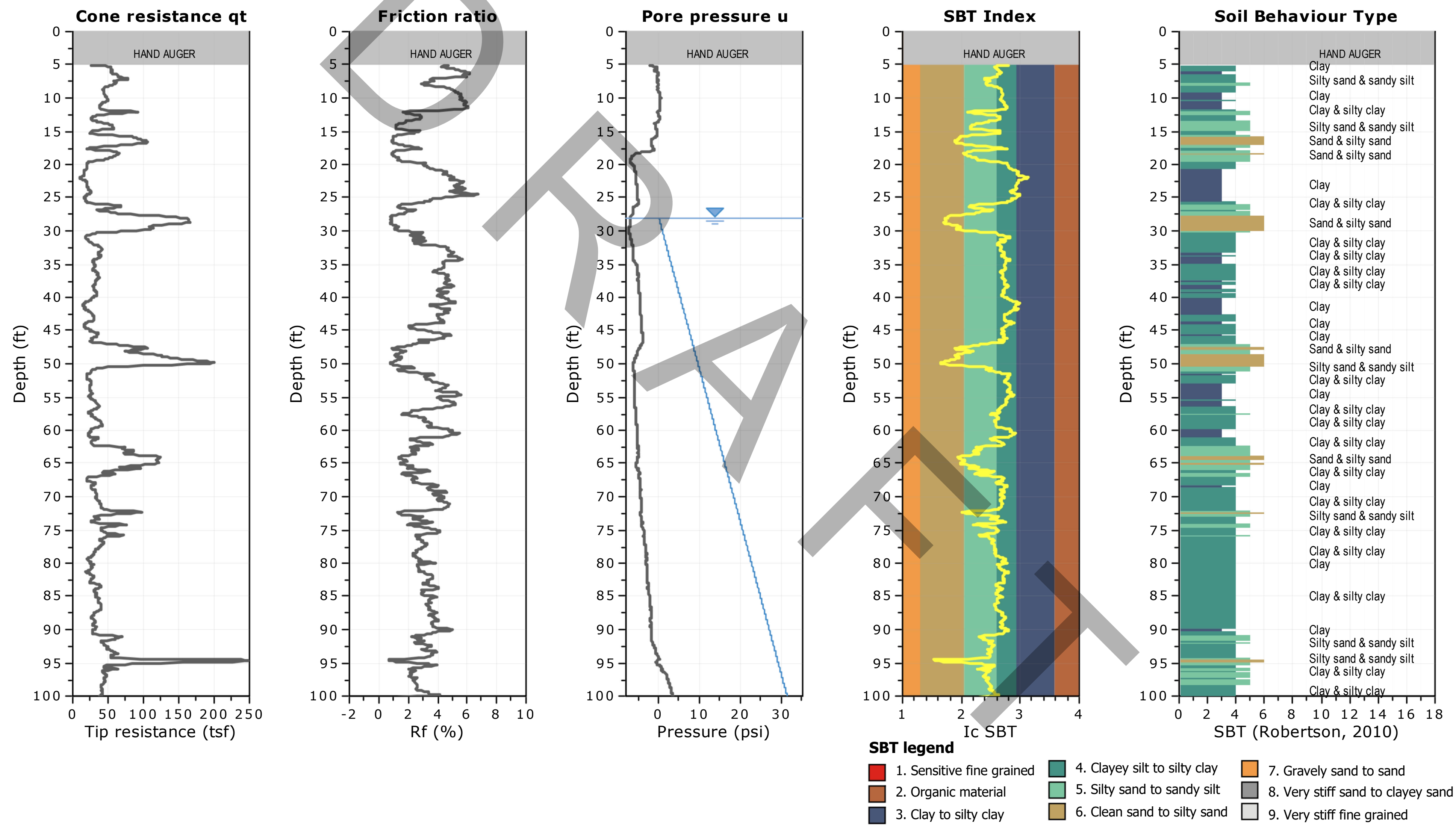
THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED.

FIGURE A-3

**Group Delta Consultants, Inc.**
9245 Activity Road, Suite 103
San Diego, CA
http://www.groupdelta.com

**CPT: CPT-1**
Total depth: 100.47 ft, Date: 5/31/2022
Surface Elevation: 4.00 ft

**Project:** **SD732 SDSU IVC New Residence Hall**
**Location:** **720 Heber Ave, Calexico, CA**



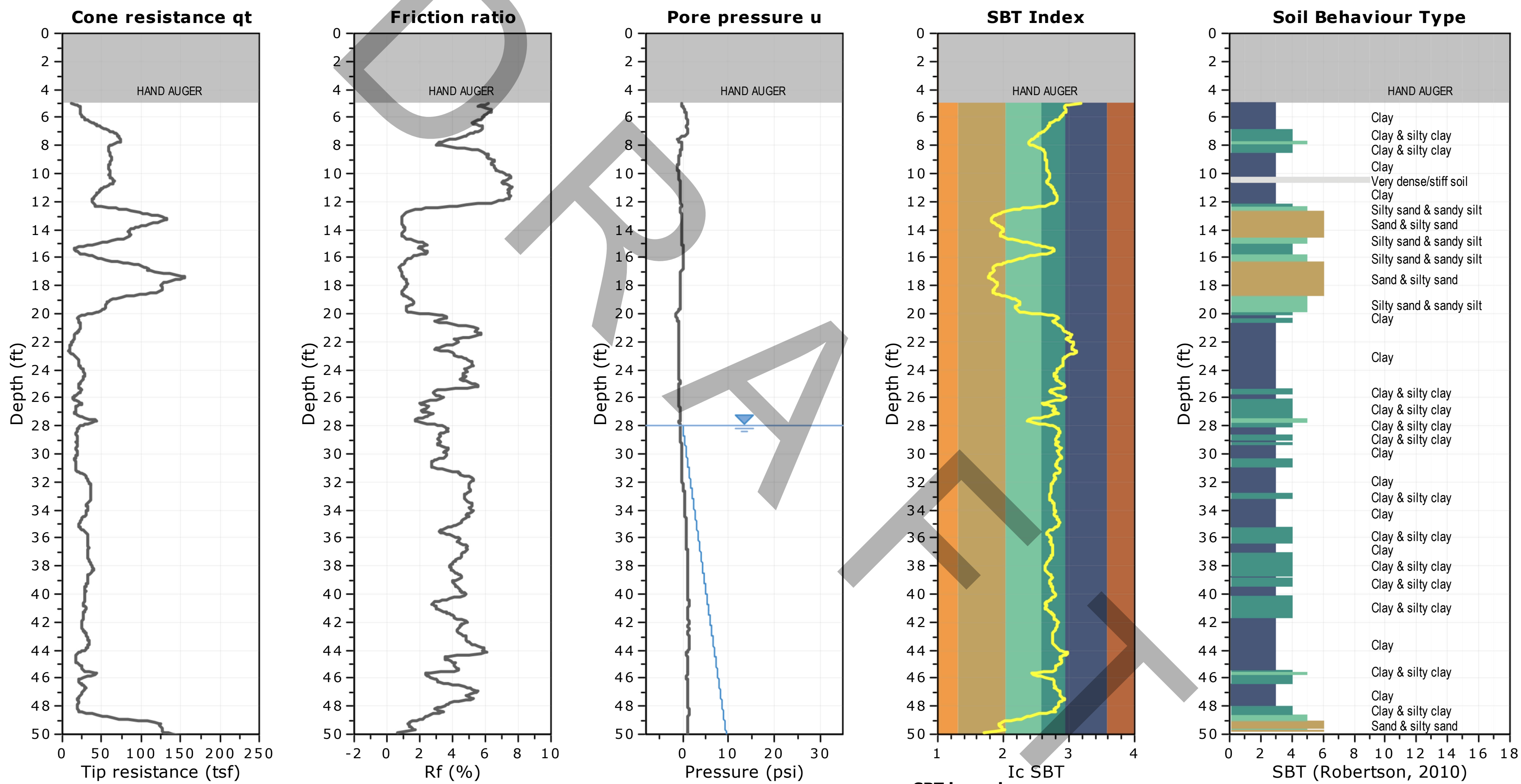

CPeT-IT v.3.5.2.2 - CPTU data presentation & interpretation software - Report created on: 6/10/2022, 10:40:43 AM
Project file: \\192.168.10.4\Files$\Projects\SD\SD700\SD732 SDSU Calexico Campus New Residence Hall\7. Calcs\CPeT-IT\SD732-CPeT-IT.cpt

**FIGURE A-4**

**Group Delta Consultants, Inc.**
9245 Activity Road, Suite 103
San Diego, CA
http://www.groupdelta.com

**CPT: CPT-2**
Total depth: 50.14 ft, Date: 5/31/2022
Surface Elevation: 6.00 ft

**Project:** **SD732 SDSU IVC New Residence Hall**
**Location:** **720 Heber Ave, Calexico, CA**




**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

CPeT-IT v.3.5.2.2 - CPTU data presentation & interpretation software - Report created on: 6/10/2022, 10:41:58 AM
Project file: \\192.168.10.4\Files$\Projects\SD\SD700\SD732 SDSU Calexico Campus New Residence Hall\7. Calcs\CPeT-IT\SD732-CPeT-IT.cpt

**FIGURE A-5**

**Group Delta Consultants, Inc.**
9245 Activity Road, Suite 103
San Diego, CA
http://www.groupdelta.com

**CPT: CPT-3**
Total depth: 50.13 ft, Date: 5/31/2022
Surface Elevation: 6.00 ft

**Project:** **SD732 SDSU IVC New Residence Hall**
**Location:** **720 Heber Ave, Calexico, CA**

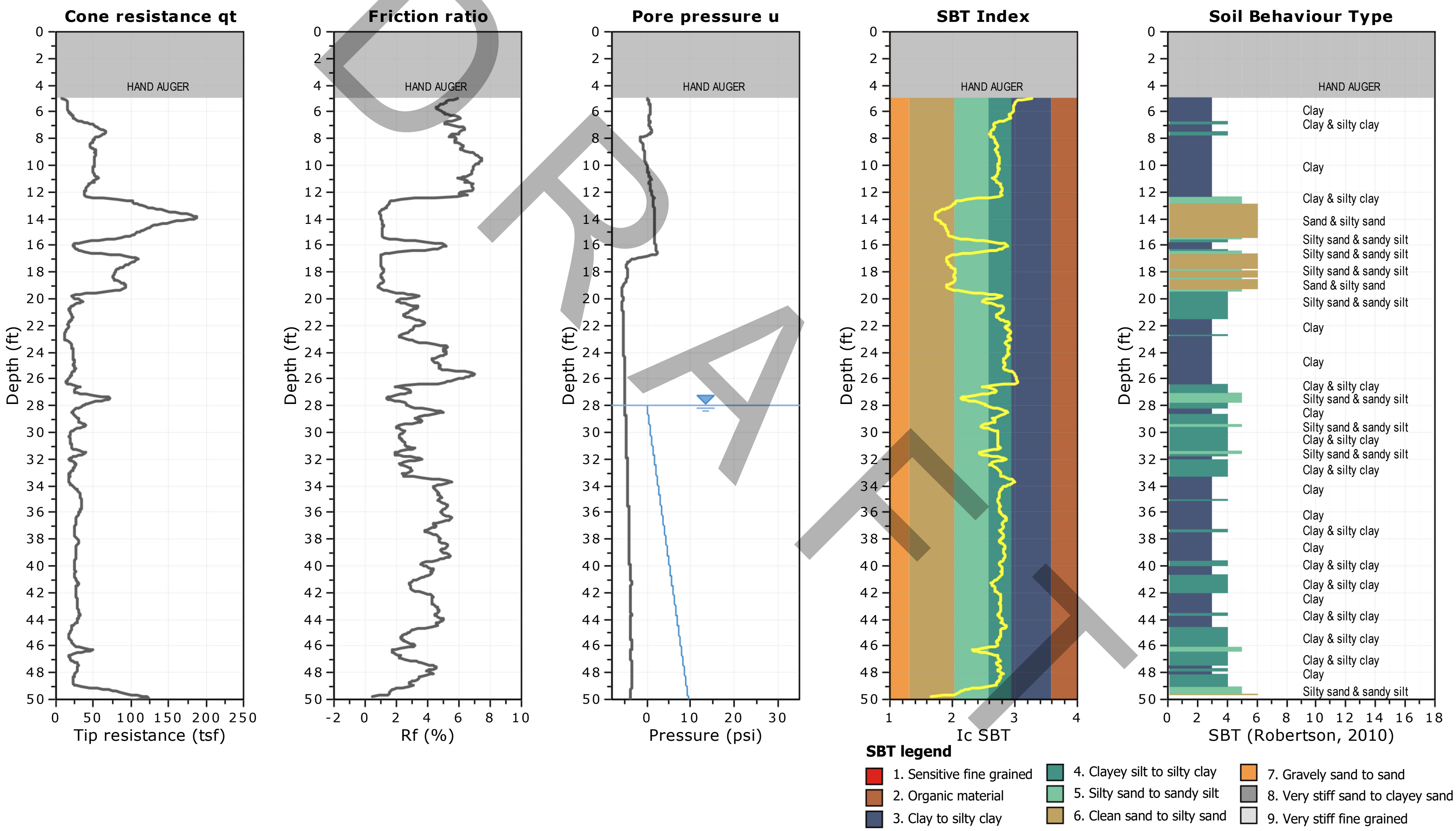




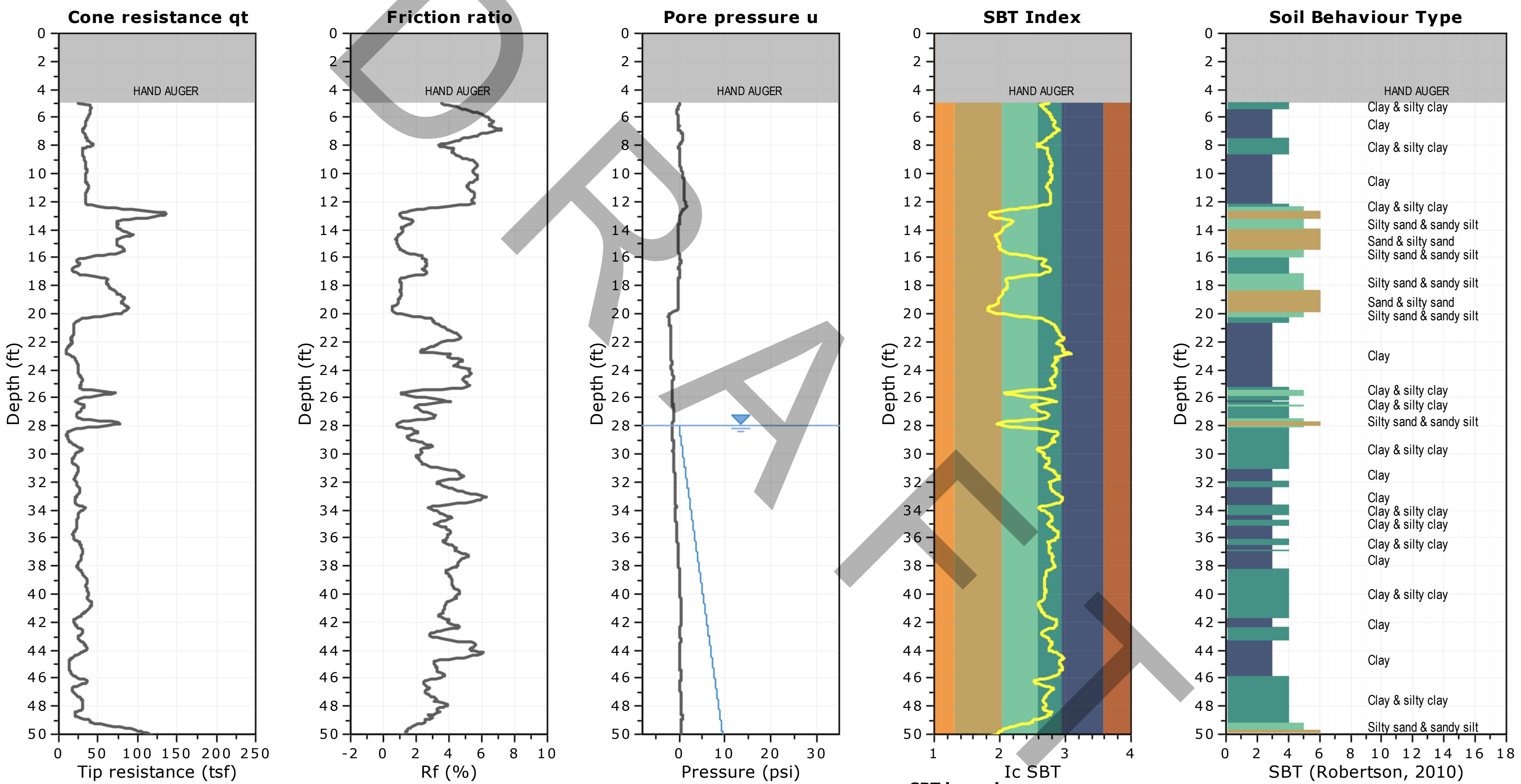



**FIGURE A-6**

Group Delta Consultants, Inc.
9245 Activity Road, Suite 103
San Diego, CA
http://www.groupdelta.com

**CPT: CPT-4**
Total depth: 50.47 ft, Date: 5/31/2022
Surface Elevation: 5.00 ft

**Project:** SD732 SDSU IVC New Residence Hall
**Location:** 720 Heber Ave, Calexico, CA




**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

CPeT-IT v.3.5.2.2 - CPTU data presentation & interpretation software - Report created on: 6/10/2022, 10:45:10 AM
Project file: \\192.168.10.4\Files$\Projects\SD\SD700\SD732 SDSU Calexico Campus New Residence Hall\7. Calcs\CPeT-IT\SD732-CPeT-IT.cpt

**FIGURE A-7**

Group Delta Consultants, Inc.
9245 Activity Road, Suite 103
San Diego, CA
http://www.groupdelta.com

**CPT: CPT-5**
Total depth: 50.09 ft, Date: 5/31/2022
Surface Elevation: 5.00 ft

**Project:** SD732 SDSU IVC New Residence Hall
**Location:** 720 Heber Ave, Calexico, CA

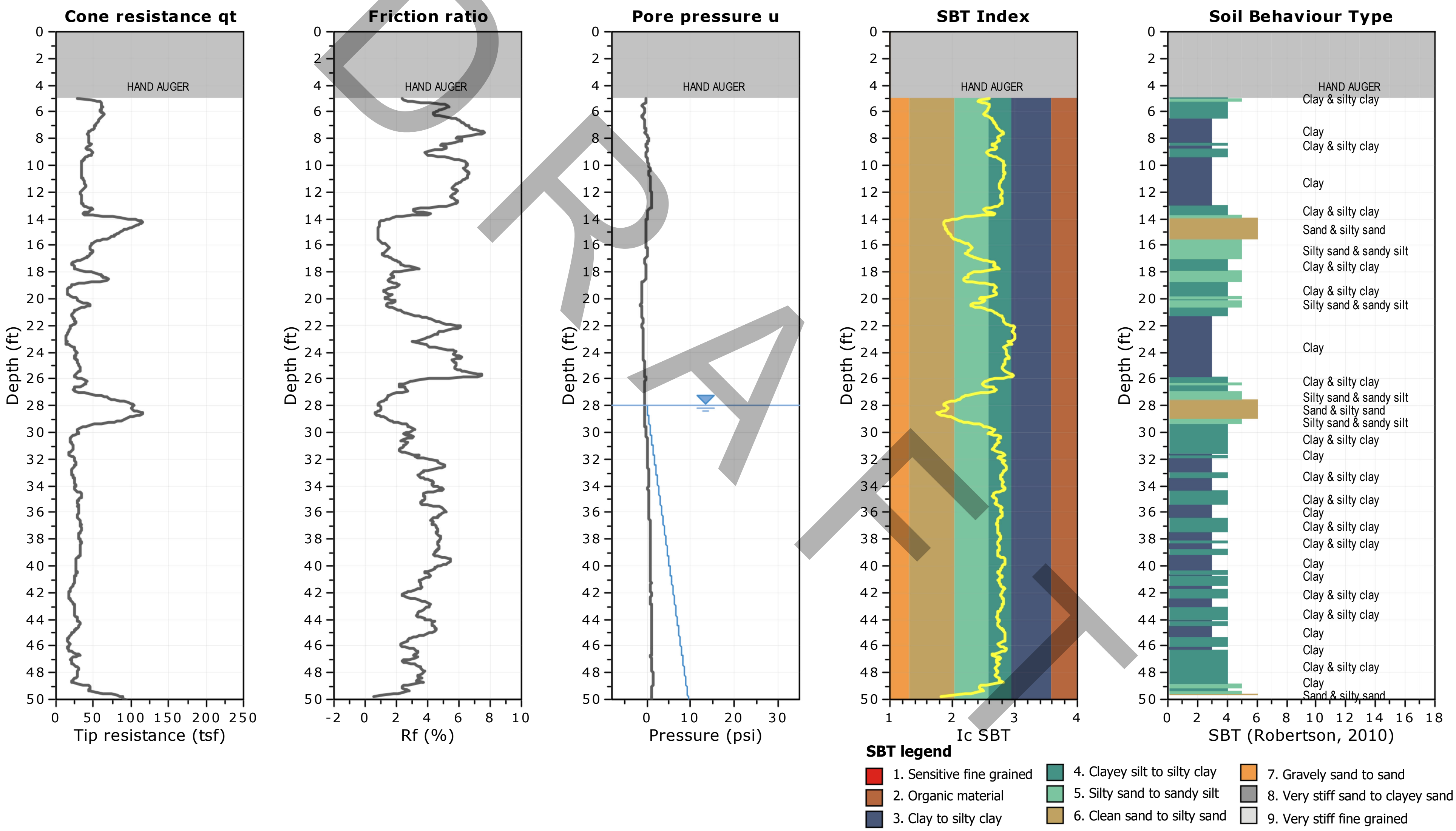





**FIGURE A-8**

Group Delta Consultants, Inc.
Project No. SD732

SDSU IVC Student Residence Hall
720 Heber Ave
Calexico, CA

CPT Shear Wave Measurements

| Location | Tip Depth (ft) | Geophone Depth (ft) | Travel Distance (ft) | S-Wave Arrival (msec) | S-Wave Velocity from Surface (ft/sec) | Interval S-Wave Velocity (ft/sec) |
|---|---|---|---|---|---|---|
| CPT-1 | 5.02 | 4.02 | 4.49 | 9.40 | 478 | |
| | 10.04 | 9.04 | 9.26 | 21.62 | 428 | 390 |
| | 15.06 | 14.06 | 14.20 | 31.16 | 456 | 518 |
| | 20.08 | 19.08 | 19.18 | 38.32 | 501 | 696 |
| | 25.03 | 24.03 | 24.11 | 46.68 | 517 | 590 |
| | 30.02 | 29.02 | 29.09 | 52.78 | 551 | 816 |
| | 35.04 | 34.04 | 34.10 | 58.76 | 580 | 838 |
| | 40.06 | 39.06 | 39.11 | 67.42 | 580 | 579 |
| | 45.08 | 44.08 | 44.13 | 75.14 | 587 | 650 |
| | 50.03 | 49.03 | 49.07 | 81.44 | 603 | 785 |
| | 55.18 | 54.18 | 54.22 | 89.08 | 609 | 674 |
| | 60.10 | 59.10 | 59.13 | 95.92 | 616 | 719 |
| | 65.06 | 64.06 | 64.09 | 102.36 | 626 | 770 |
| | 70.01 | 69.01 | 69.04 | 109.00 | 633 | 745 |
| | 75.10 | 74.10 | 74.13 | 115.20 | 643 | 821 |
| | 80.05 | 79.05 | 79.08 | 122.38 | 646 | 689 |
| | 85.07 | 84.07 | 84.09 | 128.04 | 657 | 887 |
| | 90.03 | 89.03 | 89.05 | 134.48 | 662 | 770 |
| | 95.01 | 94.01 | 94.03 | 140.04 | 671 | 895 |
| | 100.03 | 99.03 | 99.05 | 145.16 | 682 | 980 |

Shear Wave Source Offset - 2 ft

S-Wave Velocity from Surface = Travel Distance/S-Wave Arrival
Interval S-Wave Velocity = (Travel Dist2-Travel Dist1)/(Time2-Time1)



**FIGURE A-9**

*APPENDIX B*

*LABORATORY TESTING*

**APPENDIX B**

LABORATORY TESTING

Laboratory testing was conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions and in the same locality. No warranty, express or implied, is made as to the correctness or serviceability of the test results, or the conclusions derived from these tests. Where a specific laboratory test method has been referenced, such as ASTM or Caltrans, the reference only applies to the specified laboratory test method, which has been used only as a guidance document for the general performance of the test and not as a "Test Standard". A brief description of the tests follows.

**Classification:** Soils were visually classified according to the Unified Soil Classification System as established by the American Society of Civil Engineers per ASTM D2487. The soil classifications are shown on the Boring Records in Appendix A.

**Particle Size Analysis**: Particle size analyses were performed in general accordance with ASTM D6913, D7928 and D1140, and were used to supplement visual classifications. The test results are summarized on the Boring Records in Appendix A and are presented in detail in Figures B-1.1 through B-1.6 and B-2.

**Atterberg Limits**: ASTM D4318 was used to determine the liquid and plastic limits, and plasticity index of selected soil samples. The test results are presented with the associated gradation analyses in Figures B-1.1 through B-1.3 and are also summarized in Figure B-3.

**Expansion Index**: The expansion potential of selected soil samples was estimated in general accordance with ASTM D4829. The test results are summarized in Figure B-4, along with a summary of previous expansion index tests we conducted at the site. Figure B-4 also presents common criteria for evaluating the expansion potential based on the expansion index.

**pH and Resistivity**: To assess the potential for reactivity with buried metals, selected soil samples were tested for pH and minimum resistivity using Caltrans test method 643. The corrosivity test results are summarized in Figure B-5, along with previous corrosion tests we conducted on site.

**Sulfate Content**: To assess the potential for reactivity with concrete, selected soil samples were tested for water soluble sulfate. The sulfate was extracted from the soil under vacuum using a 10:1 (water to dry soil) dilution ratio. The extracted solution was tested for water soluble sulfate in general accordance with ASTM D516. The test results are also presented in Figure B-5, along with common criteria for evaluating soluble sulfate content.

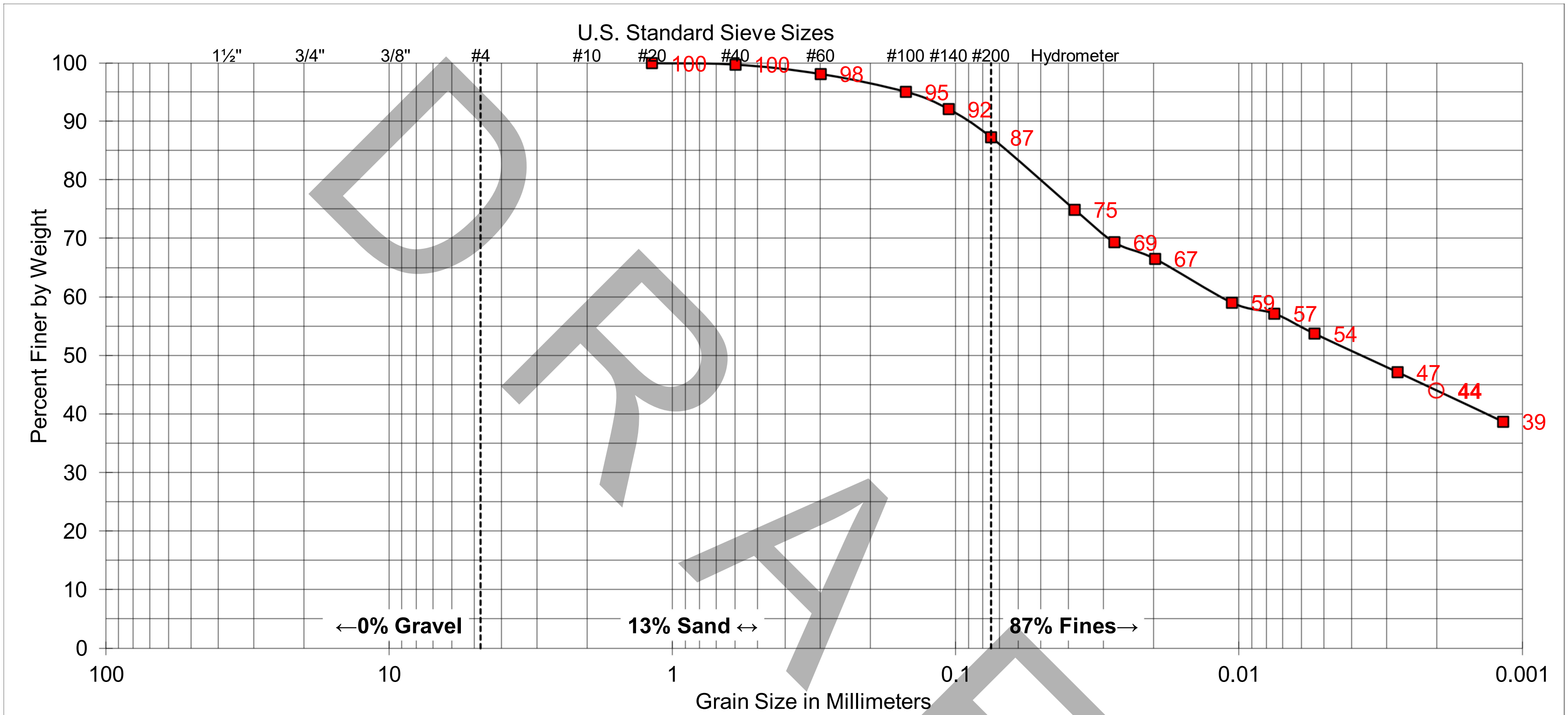
**Chloride Content:** Soil samples were also tested for water soluble chloride. The chloride was extracted from the soil under vacuum using a 10:1 (water to dry soil) dilution ratio. The extracted solution was then tested for water soluble chloride using a calibrated ion specific electronic probe in general accordance with ASTM D512. The test results are also shown in Figure B-5.

## APPENDIX B

LABORATORY TESTING (Continued)

**Unconfined Compressive Strength:** The undrained shear strength of a selected soil sample was assessed using unconfined compression testing performed in general accordance with ASTM D2166. The test results are presented in Figure B-6. The Pocket Penetration tests conducted on clayey samples during the field investigation are shown in the Boring Records in Appendix A.

**Consolidation:** The one-dimensional consolidation properties of selected soil samples were evaluated in general accordance with ASTM D2435. With the exception of the sample R-2-2 collected from Boring B-3 from depths of 6 to 6.5 feet as shown on Figure B-7.5, the samples were inundated with water under a nominal seating load, allowed to swell, and then subjected to controlled stress increments while restrained laterally and drained axially. Sample R-2-2 collected from Boring B-3 from depths of 6 to 6.5 feet as shown on Figure B-7.5 was not inundated with water during testing to evaluate the samples strain behavior to the controlled stress increments in an unsaturated state. The test results are presented in Figure B-7.1 through B-7.6.




| COARSE | FINE | COARSE | MEDIUM | FINE | SILT AND |
|---|---|---|---|---|---|
| GRAVEL | | SAND | | | CLAY |

| SAMPLE | |
|---|---|
| EXPLORATION ID: | B-1 |
| SAMPLE DEPTH: | 0.5' - 5' |

**UNIFIED SOIL CLASSIFICATION:** CL

**DESCRIPTION:** LEAN CLAY

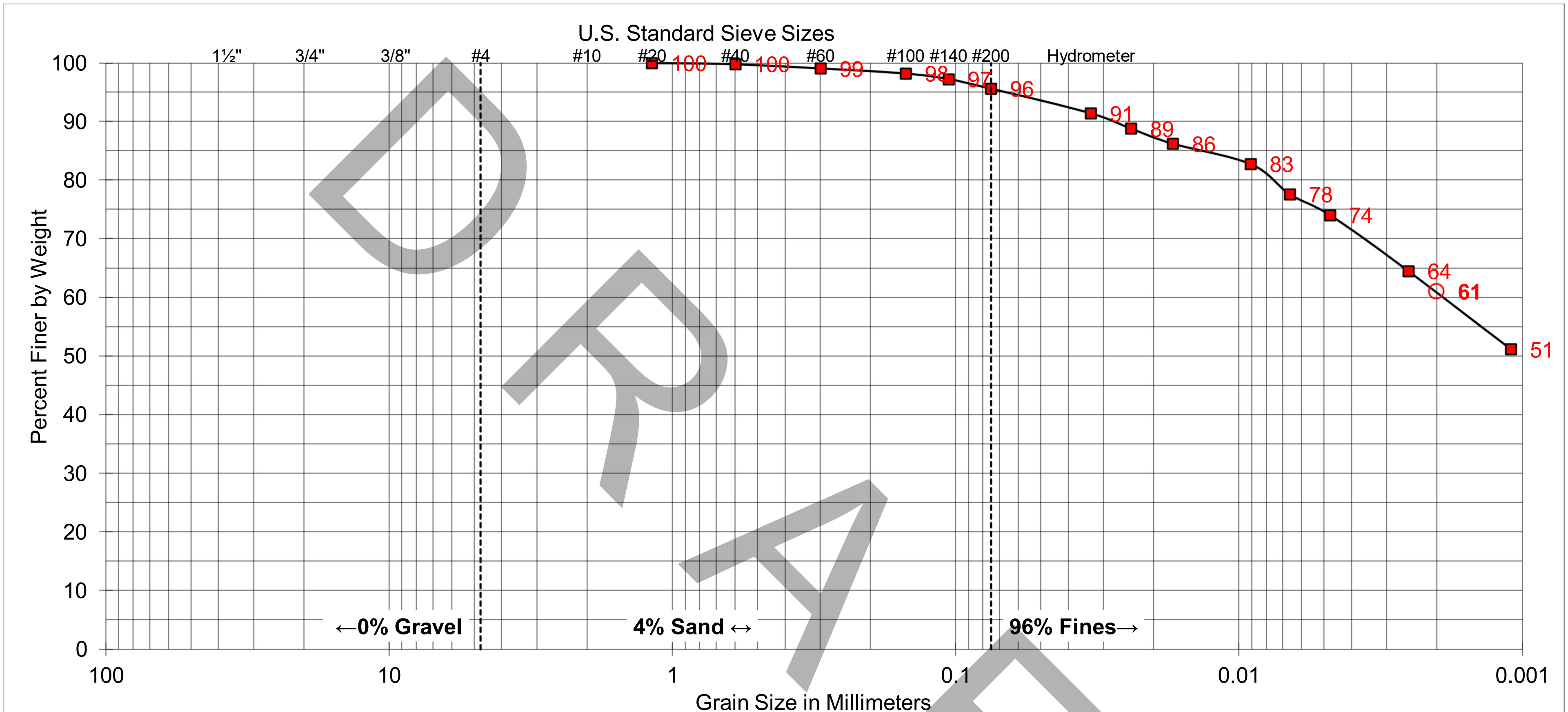
| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT: | 46 |
| PLASTIC LIMIT: | 20 |
| PLASTICITY INDEX: | 26 |

GROUP DELTA

**SOIL CLASSIFICATION**

Project No. SD732

**FIGURE B-1.1**




| COARSE | FINE | COARSE | MEDIUM | FINE | SILT AND |
|---|---|---|---|---|---|
| GRAVEL | | SAND | | | CLAY |

| SAMPLE | |
|---|---|
| EXPLORATION ID: | B-1 |
| SAMPLE DEPTH: | 5' - 6.5' |

**UNIFIED SOIL CLASSIFICATION:** CH

**DESCRIPTION:** FAT CLAY

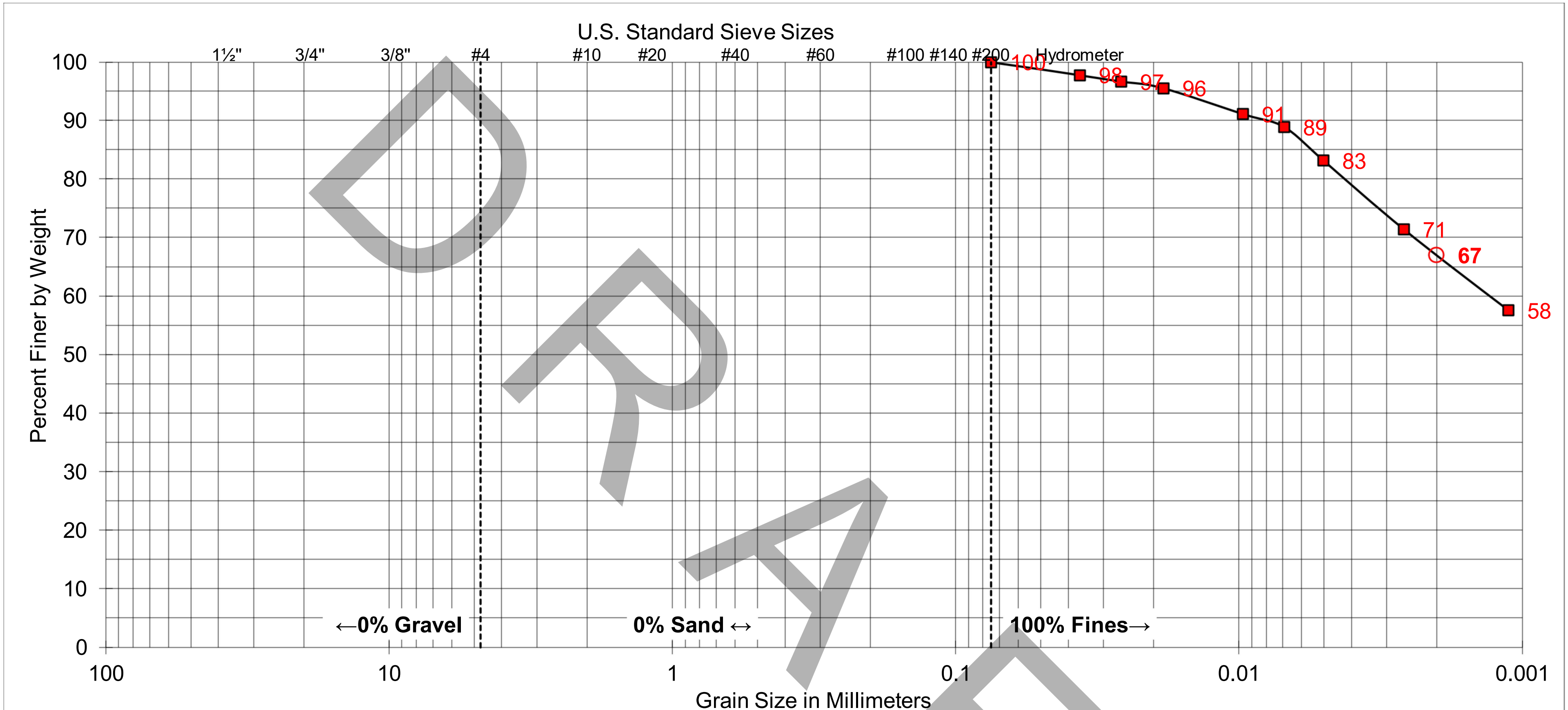
| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT: | 65 |
| PLASTIC LIMIT: | 23 |
| PLASTICITY INDEX: | 42 |

GROUP DELTA

**SOIL CLASSIFICATION**

Project No. SD732

**FIGURE B-1.2**




| COARSE | FINE | COARSE | MEDIUM | FINE | SILT AND |
|---|---|---|---|---|---|
| GRAVEL | | SAND | | | CLAY |

| SAMPLE | |
|---|---|
| EXPLORATION ID: | B-1 |
| SAMPLE DEPTH: | 10.5' - 11' |

**UNIFIED SOIL CLASSIFICATION:** CH

**DESCRIPTION:** FAT CLAY

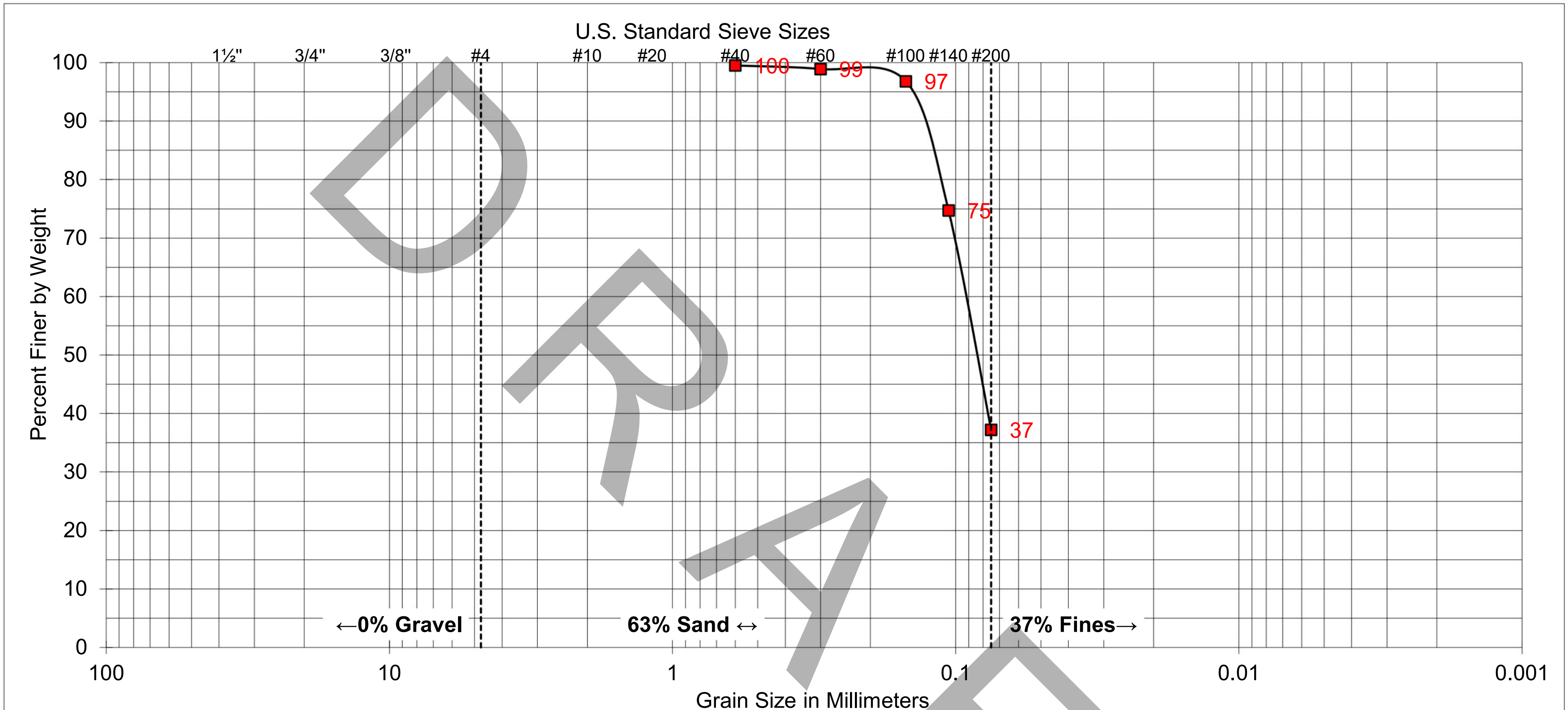
| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT: | 70 |
| PLASTIC LIMIT: | 25 |
| PLASTICITY INDEX: | 45 |

GROUP DELTA

**SOIL CLASSIFICATION**

Project No. SD732

**FIGURE B-1.3**




| COARSE | FINE | COARSE | MEDIUM | FINE | SILT AND |
|---|---|---|---|---|---|
| GRAVEL | | SAND | | | CLAY |

| SAMPLE | |
|---|---|
| EXPLORATION ID: | B-1 |
| SAMPLE DEPTH: | 15' - 15.5' |

**UNIFIED SOIL CLASSIFICATION:** SM

**DESCRIPTION:** SILTY SAND

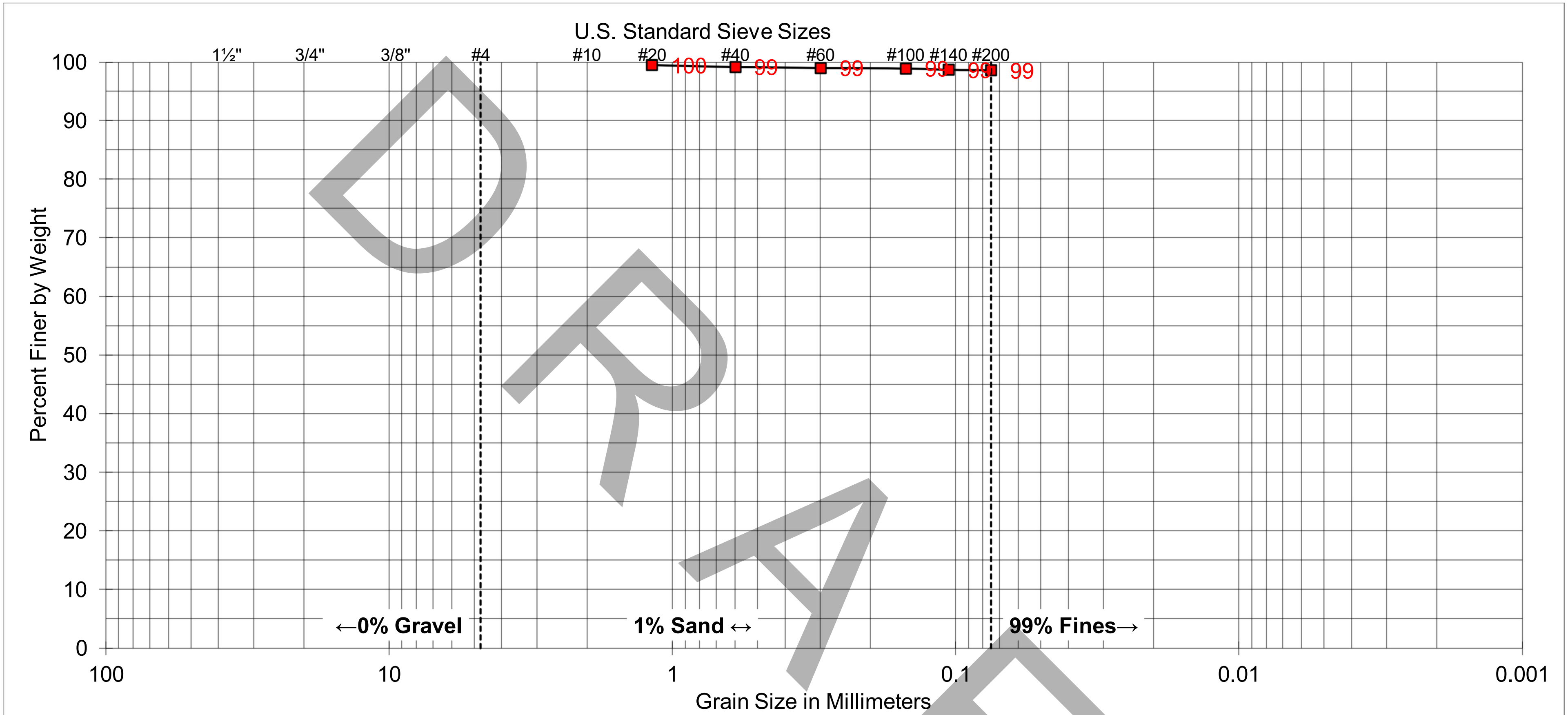
| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT: | -- |
| PLASTIC LIMIT: | -- |
| PLASTICITY INDEX: | -- |

GROUP DELTA

**SOIL CLASSIFICATION**

Project No. SD732

**FIGURE B-1.4**




| GRAVEL | | SAND | | | SILT AND CLAY |
|---|---|---|---|---|---|
| COARSE | FINE | COARSE | MEDIUM | FINE | |

| SAMPLE | |
|---|---|
| EXPLORATION ID: | B-2 |
| SAMPLE DEPTH: | 20.5' - 21' |

**UNIFIED SOIL CLASSIFICATION:** CH

**DESCRIPTION:** FAT CLAY

| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT: | -- |
| PLASTIC LIMIT: | -- |
| PLASTICITY INDEX: | -- |

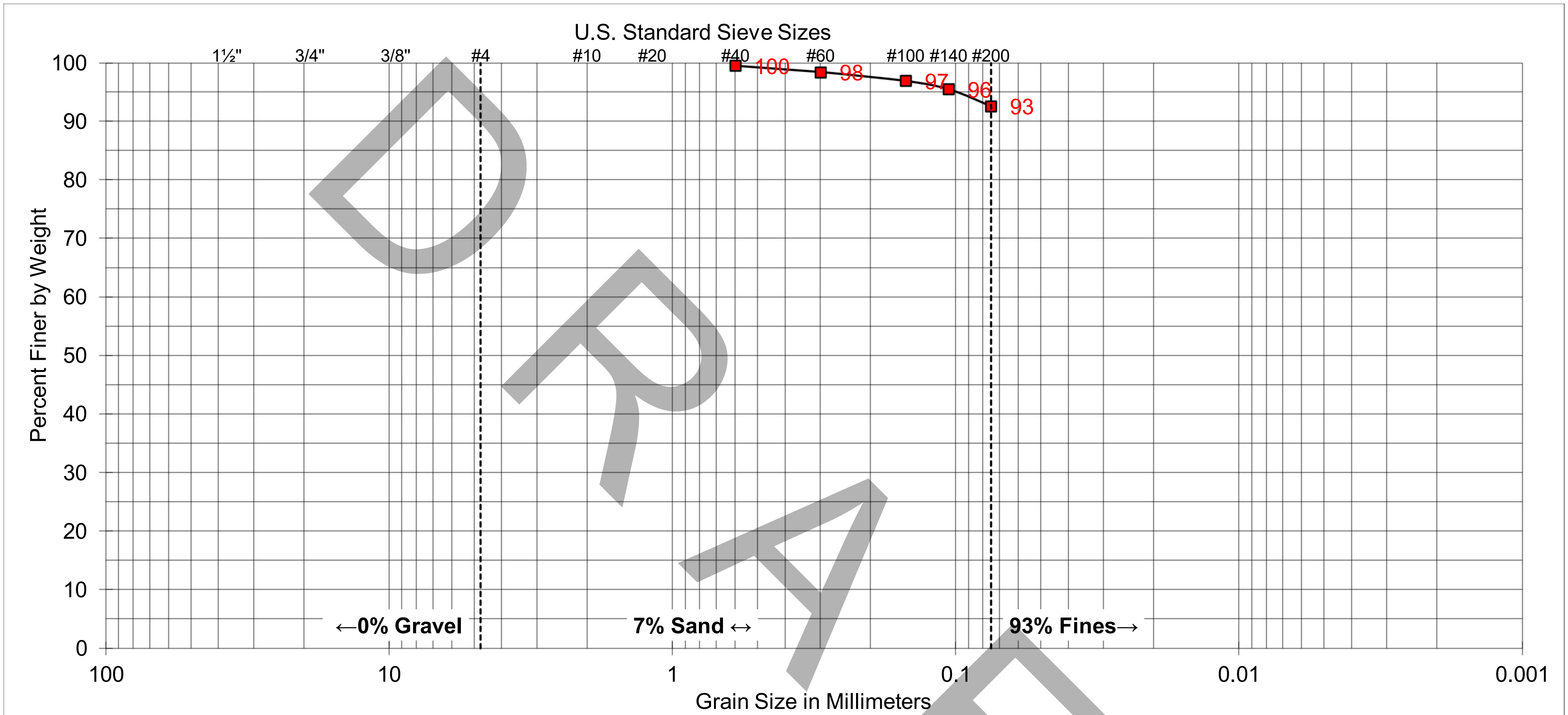


GROUP DELTA

**SOIL CLASSIFICATION**

Project No. SD732

**FIGURE B-1.5**




| COARSE | FINE | COARSE | MEDIUM | FINE | SILT AND |
|---|---|---|---|---|---|
| GRAVEL | | SAND | | | CLAY |

| SAMPLE | |
|---|---|
| EXPLORATION ID: | B-3 |
| SAMPLE DEPTH: | 0.5' - 5' |

**UNIFIED SOIL CLASSIFICATION:** CL

**DESCRIPTION:** LEAN CLAY

| ATTERBERG LIMITS | |
|---|---|
| LIQUID LIMIT: | -- |
| PLASTIC LIMIT: | -- |
| PLASTICITY INDEX: | -- |

GROUP DELTA

**SOIL CLASSIFICATION**

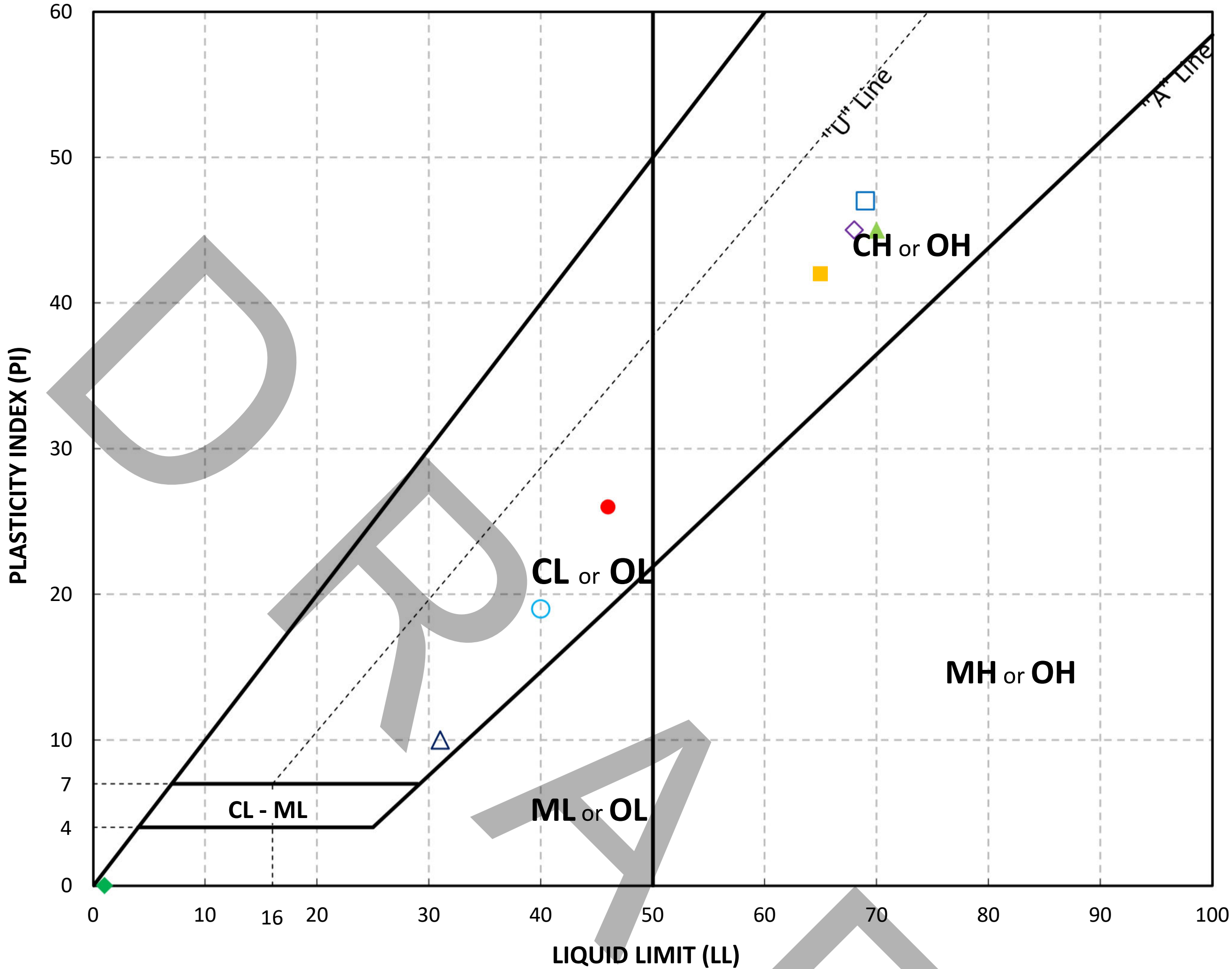
Project No. SD732

**FIGURE B-1.6**

**PERCENT PASSING THE NO. 200 SIEVE TEST RESULTS**
(ASTM D1140)

| SAMPLE | DESCRIPTION | PERCENT PASSING THE NO. 200 SIEVE |
|---|---|---|
| B-1 @ 26' – 26.5' | SILT (ML) | 94 |
| B-1 @ 35.5' – 36' | Fat CLAY (CL) | 100 |
| B-1 @ 50' – 51.5' | SILT (ML) | 88 |

## ATTERBERG LIMITS
(ASTM D4318)




| SYMBOL | BORING NO. | SAMPLE NO. | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | SOIL DESCRIPTION (USCS) |
|---|---|---|---|---|---|---|
| ● | B-1 | B-1 @ 0.5' - 5' | 46 | 20 | 26 | Lean CLAY (CL) |
| ■ | B-1 | B-1 @ 5' - 6.5' | 65 | 23 | 42 | Fat CLAY (CH) |
| ▲ | B-1 | B-1 @ 10.5' - 11' | 70 | 25 | 45 | Fat CLAY (CH) |
| ◆ | B-1 | B-1 @ 26' - 26.5' | NP | NP | NP | SILT (ML) |
| ○ | B-1 | B-1 @ 30.5' - 31' | 40 | 21 | 19 | Lean CLAY (CL) |
| □ | B-1 | B-1 @ 35.5' - 36' | 69 | 22 | 47 | Fat CLAY (CH) |
| △ | B-2 | B-2 @ 15' - 16' | 31 | 21 | 10 | Lean CLAY (CL) |
| ◇ | B-3 | B-3 @ 20' - 21.5' | 68 | 23 | 45 | Fat CLAY (CH) |

**Notes:** (1) Unified Soil Classification System (USCS) per ASTM D2487
(2) NP = Non-Plastic per ASTM D4318

**EXPANSION TEST RESULTS**
(ASTM D4829)

| SAMPLE | DESCRIPTION | EXPANSION INDEX |
|---|---|---|
| B-1 @ 0.5' – 5' | Lean CLAY (CL) | 70 |
| B-2 @ 0.5' – 5' | Lean CLAY (CL) | 60 |
| B-3 @ 0.5' – 5' | Lean CLAY (CL) | 82 |

| EXPANSION INDEX | POTENTIAL EXPANSION |
|---|---|
| 0 to 20 | Very low |
| 21 to 50 | Low |
| 51 to 90 | Medium |
| 91 to 130 | High |
| Above 130 | Very High |

## CORROSIVITY TEST RESULTS

(ASTM D512, ASTM D516, CTM 643)

| SAMPLE | pH | RESISTIVITY [OHM-CM] | SULFATE CONTENT [%] | CHLORIDE CONTENT [%] |
|---|---|---|---|---|
| B-2 @ 0.5’ – 5’ | 7.67 | 482 | 1.08 | 0.05 |
| B-3 @ 0.5’ – 5’ | 7.88 | 268 | 1.08 | 0.06 |

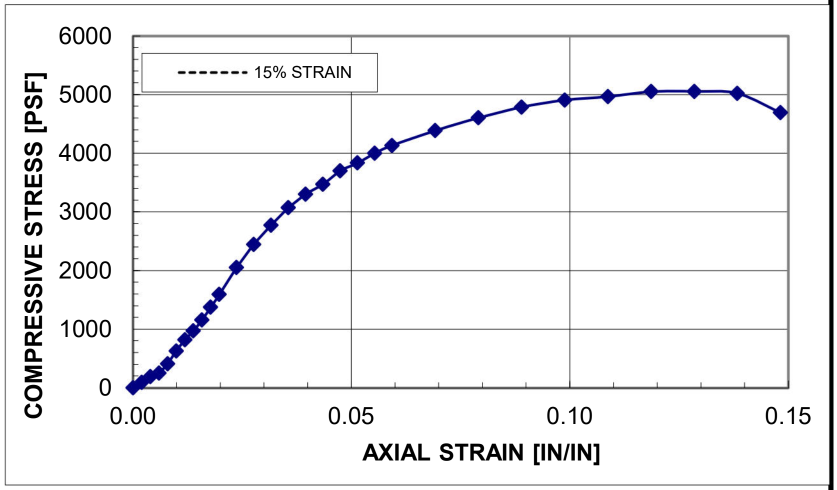
| SULFATE CONTENT [%] | SULFATE EXPOSURE | CEMENT TYPE |
|---|---|---|
| 0.00 to 0.10 | Negligible | - |
| 0.10 to 0.20 | Moderate | II, IP(MS), IS(MS) |
| 0.20 to 2.00 | Severe | V |
| Above 2.00 | Very Severe | V plus pozzolan |

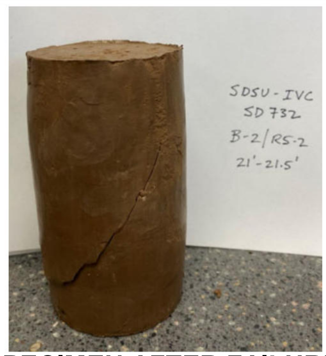
| SOIL RESISTIVITY [OHM-CM] | GENERAL DEGREE OF CORROSIVITY TO FERROUS METALS |
|---|---|
| 0 to 1,000 | Very Corrosive |
| 1,000 to 2,000 | Corrosive |
| 2,000 to 5,000 | Moderately Corrosive |
| 5,000 to 10,000 | Mildly Corrosive |
| Above 10,000 | Slightly Corrosive |

| CHLORIDE (Cl) CONTENT [%] | GENERAL DEGREE OF CORROSIVITY TO METALS |
|---|---|
| 0.00 to 0.03 | Negligible |
| 0.03 to 0.15 | Corrosive |
| Above 0.15 | Severely Corrosive |

| | | | |
|---|---|---|---|
| PROJECT: | **SDSU IVC Student Residence Hall** | TEST METHOD: | **ASTM D2166** |
| SAMPLE I.D.: | **B-2 @ 21' - 21.5'** | TESTED BY: | **J. Krehbiel** |
| DESCRIPTION: | **Fat CLAY (CH)** | DATE: | **6/17/22** |

| | | |
|---|---|---|
| TYPE OF SAMPLE | CAL | |
| WET WT. OF SAMPLE | 725.26 | [g] |
| INITIAL DIAM. | 2.4 | [in] |
| INITIAL HEIGHT | 5.060 | [in] |
| INITIAL AREA | 4.524 | [$in^2$] |
| INITIAL VOLUME | 22.89 | [$in^3$] |
| WET DENSITY | 120.7 | [pcf] |
| DRY WT. OF SAMPLE | 561.16 | [g] |
| WEIGHT OF WATER | 164.1 | [g] |
| INITIAL TOTAL MOISTURE | 29.2 | [%] |
| DRY DENSITY | 93.4 | [pcf] |
| L-D RATIO | 2.1:1 | |
| STRAIN RATE | 1.21 | [%/min] |
| STRAIN AT FAILURE | 12.85 | [%] |
| STRAIN AT FAILURE | 0.650 | [in] |
| 15% STRAIN | 0.759 | [in] |
| FAILURE CRITERIA: | Yield | |
| COMP. STRENGTH: | 5054 | [psf] |
| SHEAR STRENGTH: | 2527 | [psf] |
| SPEC. GRAVITY (Assumed) | 2.85 | |
| SATURATION: | 92 | [%] |
| FAILURE MODE: | Plastic | |



SPECIMEN AFTER FAILURE

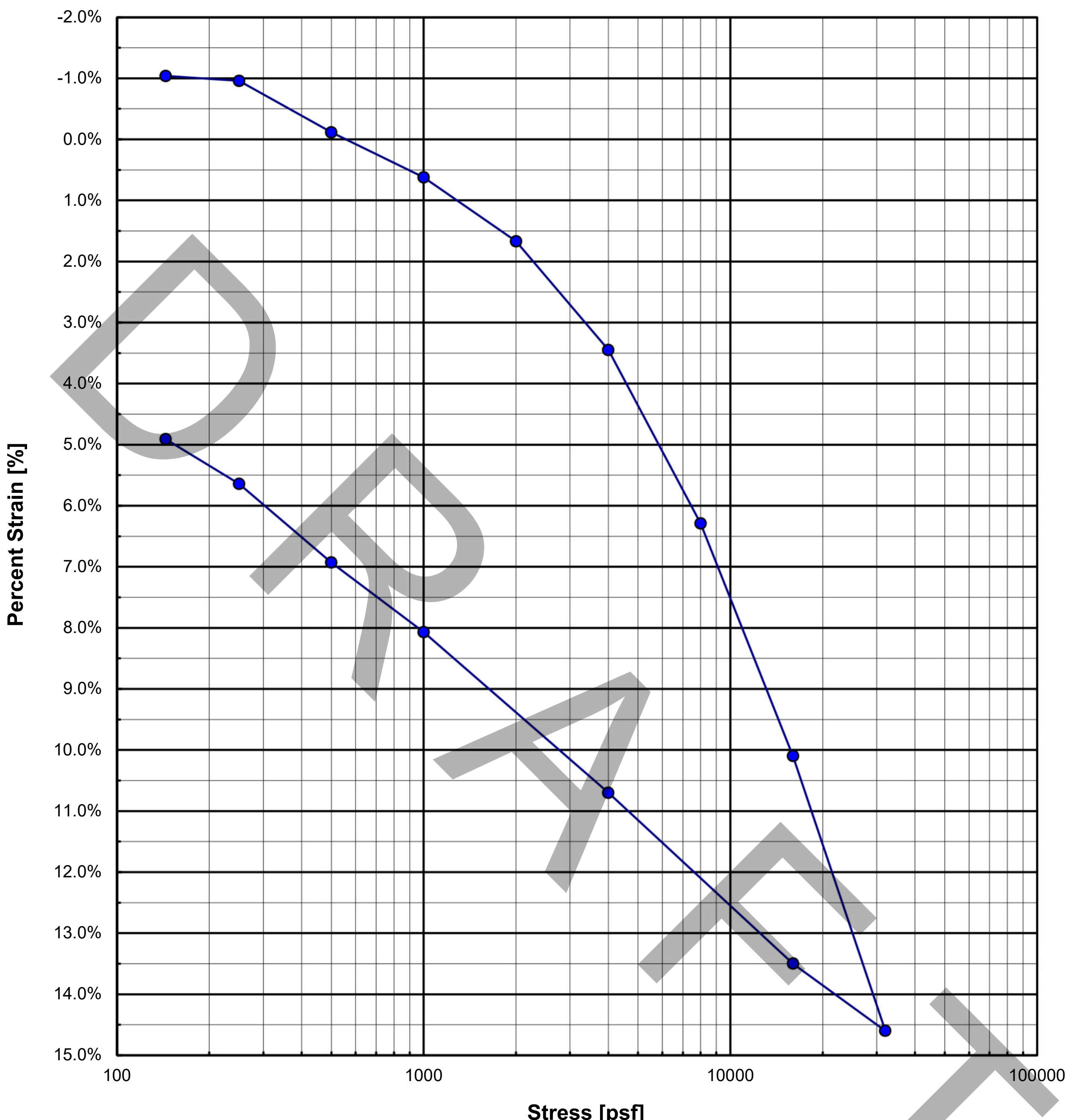
| Elapsed Time [min] | Axial Load [lb] | Strain Dial [in] | Total Deformation [in] | Axial Strain [in/in] | Corrected Area [$in^2$] | Stress [psf] |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 1.000 | 0.000 | 0.000 | 4.52 | 0.0 |
| 0.2 | 3.0 | 0.990 | 0.010 | 0.002 | 4.53 | 95.3 |
| 0.3 | 6.0 | 0.980 | 0.020 | 0.004 | 4.54 | 190.2 |
| 0.6 | 13.0 | 0.960 | 0.040 | 0.008 | 4.56 | 410.5 |
| 0.8 | 20.0 | 0.950 | 0.050 | 0.010 | 4.57 | 630.3 |
| 1.0 | 26.0 | 0.940 | 0.060 | 0.012 | 4.58 | 817.8 |
| 1.5 | 44.0 | 0.910 | 0.090 | 0.018 | 4.61 | 1375.7 |
| 1.6 | 51.0 | 0.900 | 0.100 | 0.020 | 4.62 | 1591.3 |
| 1.9 | 66.0 | 0.880 | 0.120 | 0.024 | 4.63 | 2051.0 |
| 2.3 | 79.0 | 0.860 | 0.140 | 0.028 | 4.65 | 2445.1 |
| 2.6 | 90.0 | 0.840 | 0.160 | 0.032 | 4.67 | 2774.2 |
| 2.9 | 100.0 | 0.820 | 0.180 | 0.036 | 4.69 | 3069.9 |
| 3.3 | 108.0 | 0.800 | 0.200 | 0.040 | 4.71 | 3301.9 |
| 3.6 | 114.0 | 0.780 | 0.220 | 0.043 | 4.73 | 3471.0 |
| 3.9 | 122.0 | 0.760 | 0.240 | 0.047 | 4.75 | 3699.2 |
| 4.2 | 127.0 | 0.740 | 0.260 | 0.051 | 4.77 | 3834.8 |
| 4.6 | 133.0 | 0.720 | 0.280 | 0.055 | 4.79 | 3999.3 |
| 4.9 | 138.0 | 0.700 | 0.300 | 0.059 | 4.81 | 4132.2 |
| 5.7 | 148.0 | 0.650 | 0.350 | 0.069 | 4.86 | 4385.1 |
| 6.5 | 157.0 | 0.600 | 0.400 | 0.079 | 4.91 | 4602.4 |



GROUP DELTA

**UNCONFINED COMPRESSIVE STRENGTH**

Project No. SD732
**FIGURE B-6**




**B-1, R-5 @ 21 - 21.5'**

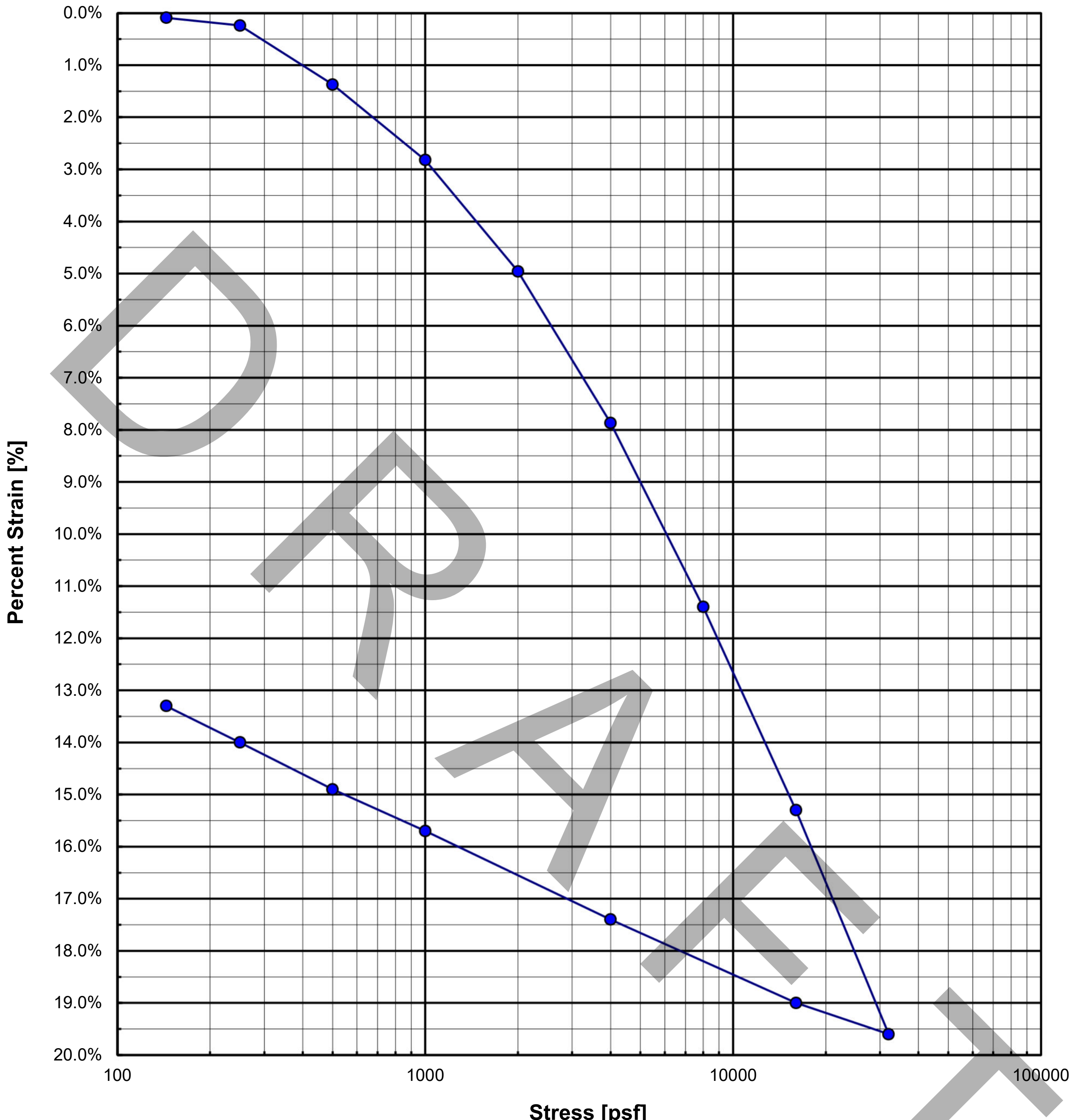
| INITIAL | FINAL | |
|---|---|---|
| 1.0000 | 0.9509 | SAMPLE HEIGHT [IN] |
| 89.0 | 93.6 | DRY DENSITY [PCF] |
| 2.79 | 2.79 | SPECIFIC GRAVITY (ASSUMED) |
| 0.97 | 0.86 | VOID RATIO (e) |
| 32.9 | 30.8 | WATER CONTENT [%] |
| 94.2 | 100.0 | DEGREE OF SATURATION [%] |

GROUP DELTA

**CONSOLIDATION RESULTS**

Project No. SD732

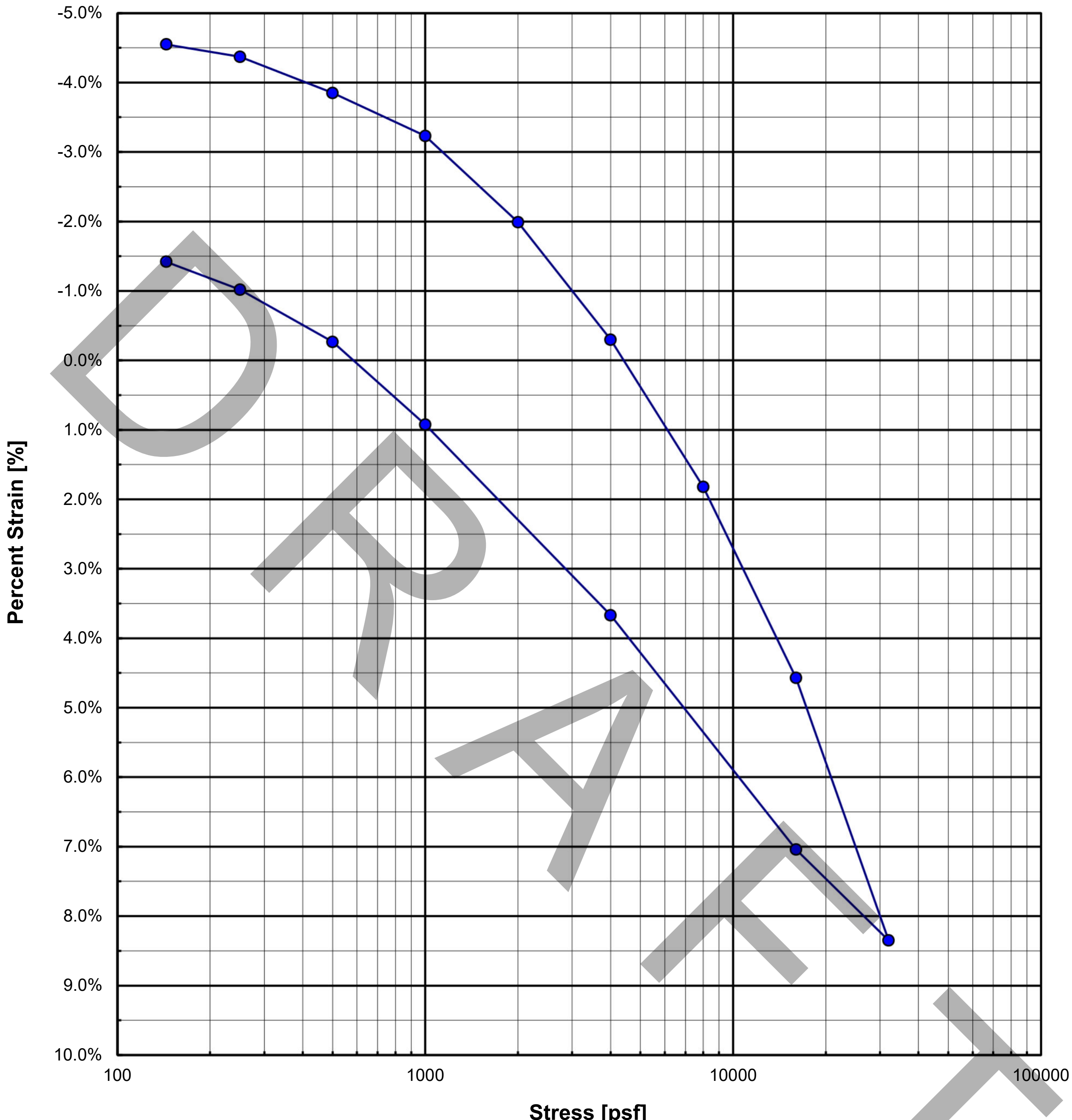
**FIGURE B-7.1**






**B-1, R-7-2 @ 31' - 31.5'**

| INITIAL | FINAL | |
|---|---|---|
| 1.0000 | 0.8670 | SAMPLE HEIGHT [IN] |
| 91.8 | 105.8 | DRY DENSITY [PCF] |
| 2.77 | 2.77 | SPECIFIC GRAVITY (ASSUMED) |
| 0.88 | 0.63 | VOID RATIO (e) |
| 31.6 | 22.9 | WATER CONTENT [%] |
| 99.0 | 100.0 | DEGREE OF SATURATION [%] |




**B-1, R-8-2 @ 36 - 36.5'**

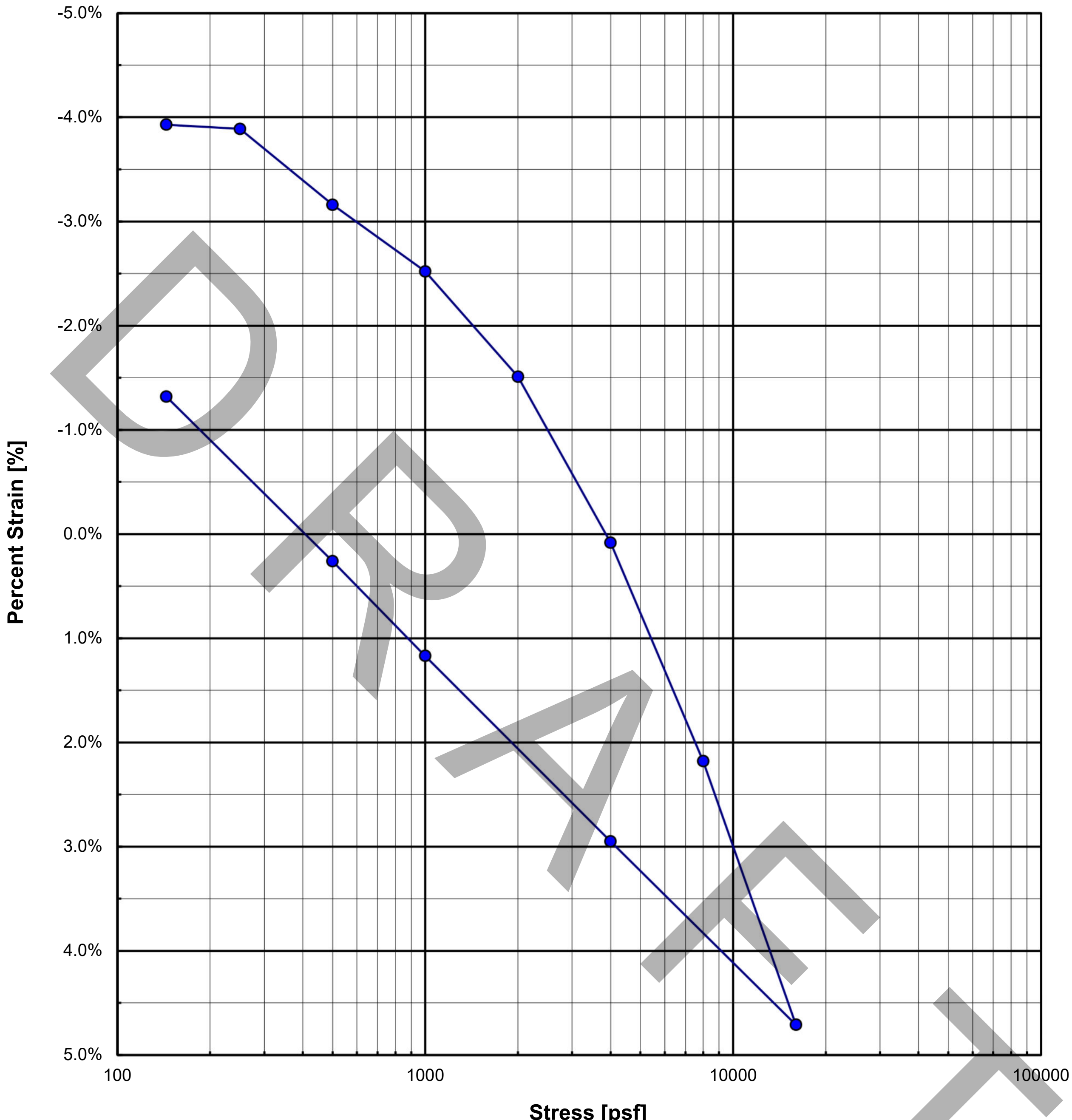
| INITIAL | FINAL | |
|---|---|---|
| 1.0000 | 1.0142 | SAMPLE HEIGHT [IN] |
| 96.8 | 95.4 | DRY DENSITY [PCF] |
| 2.83 | 2.83 | SPECIFIC GRAVITY (ASSUMED) |
| 0.91 | 0.85 | VOID RATIO (e) |
| 27.9 | 30.1 | WATER CONTENT [%] |
| 86.7 | 100.0 | DEGREE OF SATURATION [%] |

GROUP DELTA

**CONSOLIDATION RESULTS**

Project No. SD732

**FIGURE B-7.3**




**B-2, R-3 @ 11 - 11.5'**

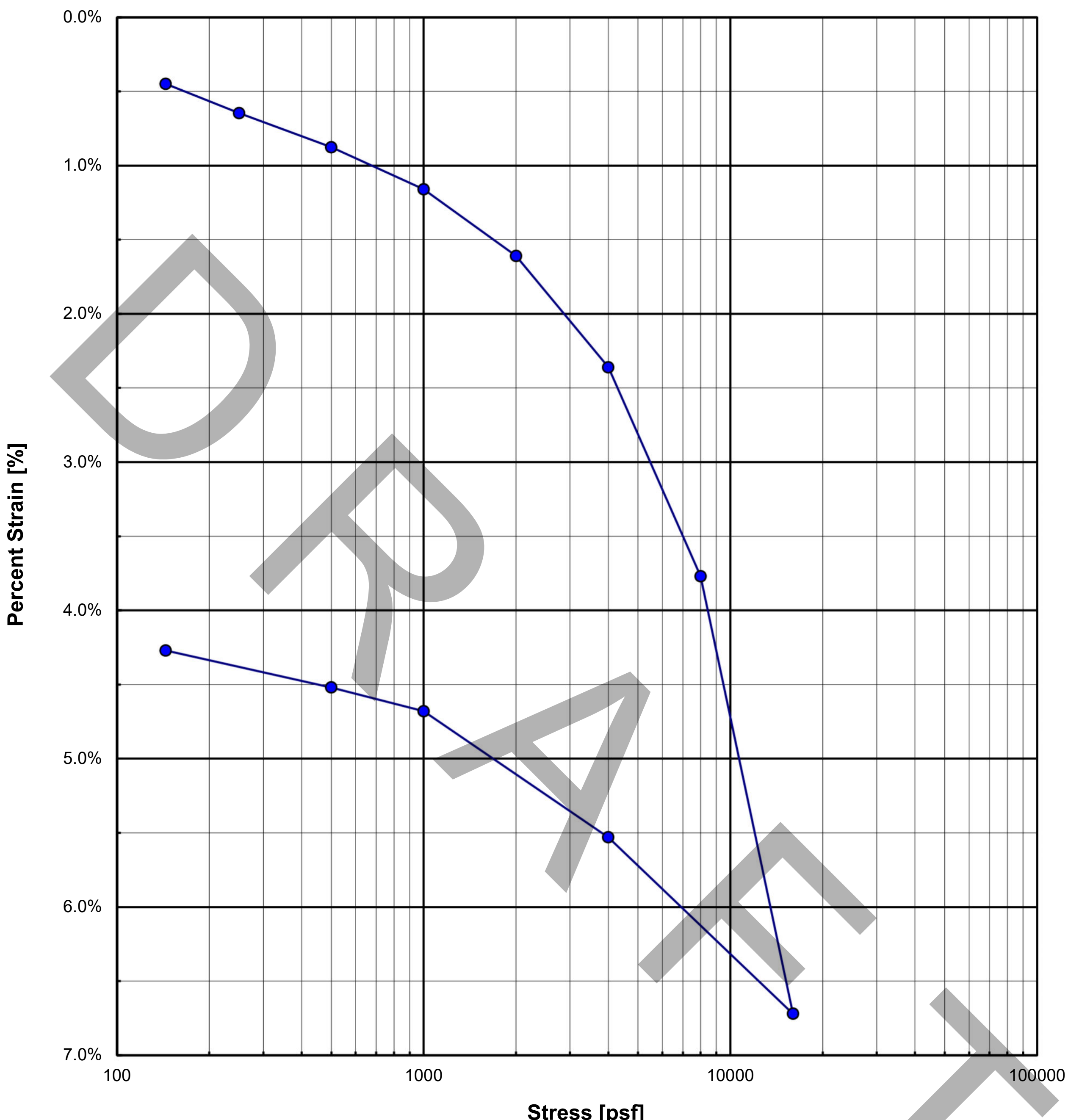
| INITIAL | FINAL | |
|---|---|---|
| 1.0000 | 1.0132 | SAMPLE HEIGHT [IN] |
| 101.0 | 99.7 | DRY DENSITY [PCF] |
| 2.84 | 2.84 | SPECIFIC GRAVITY (ASSUMED) |
| 0.83 | 0.78 | VOID RATIO (e) |
| 24.4 | 27.5 | WATER CONTENT [%] |
| 83.7 | 100.0 | DEGREE OF SATURATION [%] |

GROUP DELTA

**CONSOLIDATION RESULTS**

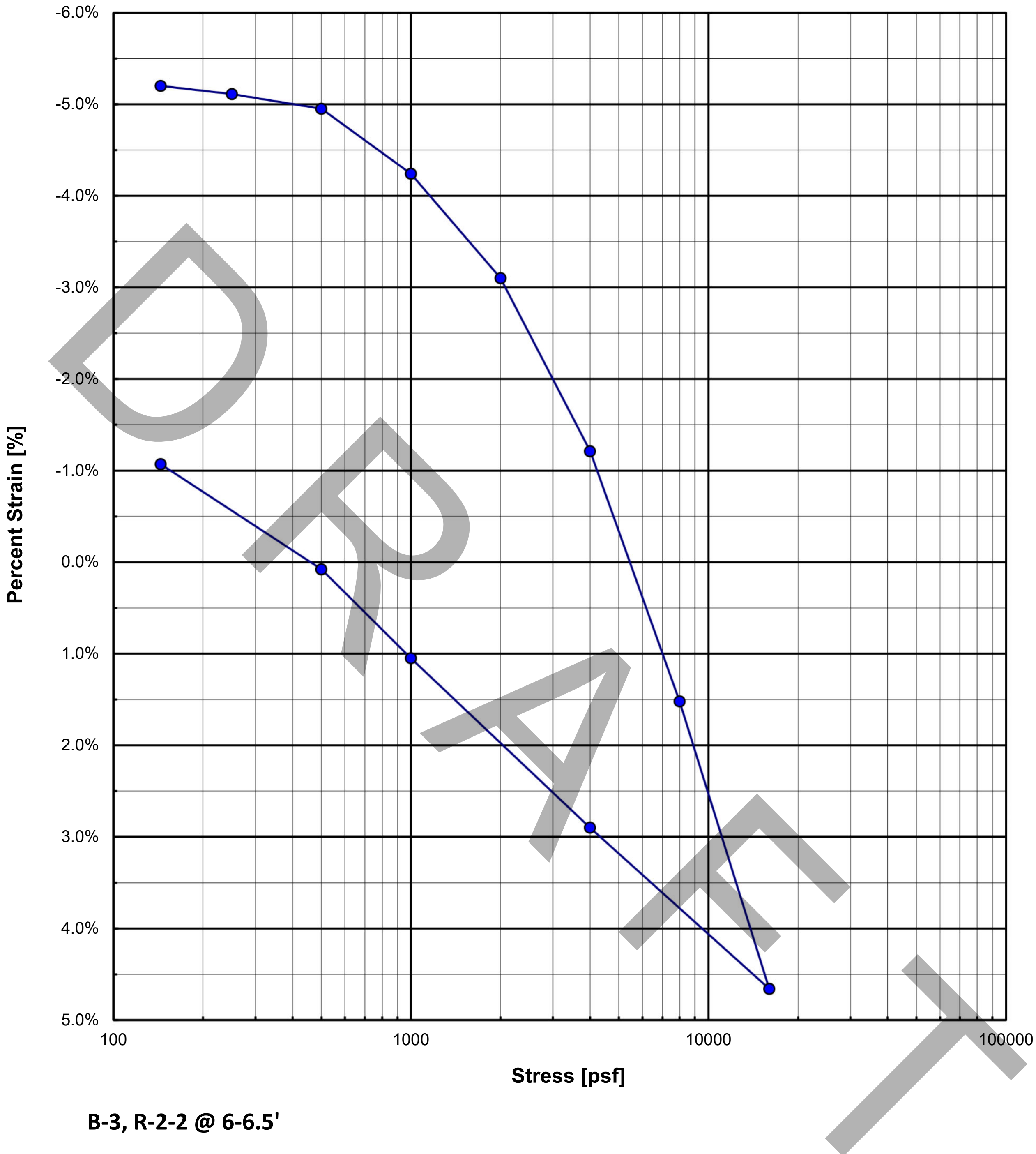
Project No. SD732

**FIGURE B-7.4**




**B-3, R-2-2 @ 6-6.5'**

| INITIAL | FINAL | |
|---|---|---|
| 1.0000 | 0.9573 | SAMPLE HEIGHT [IN] |
| 95.6 | 99.8 | DRY DENSITY [PCF] |
| 2.80 | 2.80 | SPECIFIC GRAVITY (ASSUMED) |
| 0.82 | 0.75 | VOID RATIO (e) |
| 19.8 | 18.9 | WATER CONTENT [%] |
| 67.5 | 70.6 | DEGREE OF SATURATION [%] |




**B-3, R-2-2 @ 6-6.5'**

| INITIAL | FINAL | |
|---|---|---|
| 1.0000 | 1.0107 | SAMPLE HEIGHT [IN] |
| 95.8 | 94.8 | DRY DENSITY [PCF] |
| 2.63 | 2.63 | SPECIFIC GRAVITY (ASSUMED) |
| 0.81 | 0.73 | VOID RATIO (e) |
| 20.9 | 27.9 | WATER CONTENT [%] |
| 68.5 | 100.0 | DEGREE OF SATURATION [%] |

GROUP DELTA

**CONSOLIDATION RESULTS**

Project No. SD732

**FIGURE B-7.6**