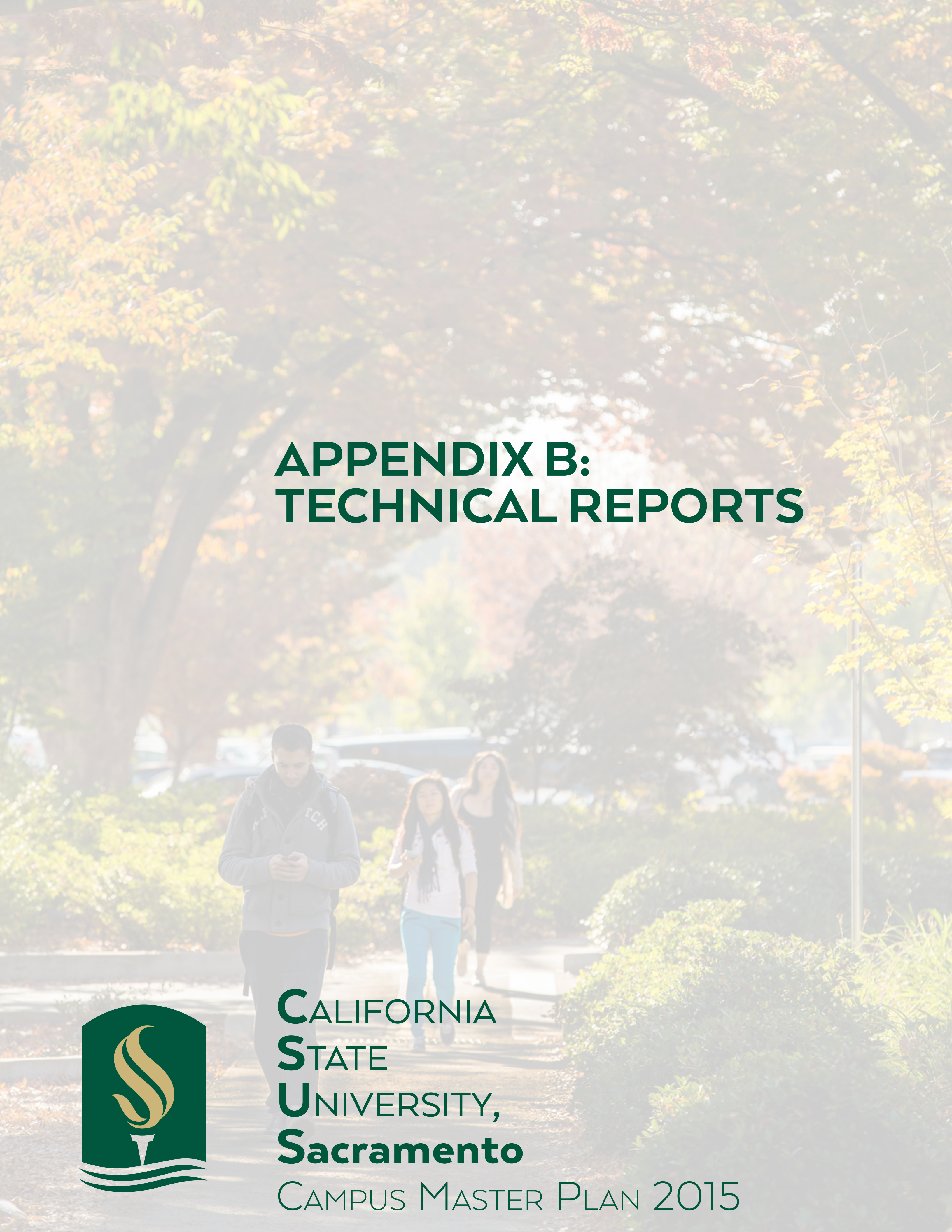

APPENDIX B: TECHNICAL REPORTS

California State University, Sacramento

Campus Master Plan 2015

APPENDIX B

UTILITIES AND INFRASTRUCTURE: TECHNICAL REPORTS

SACRAMENTO STATE

Appendix B: Technical Reports

Parallel to the Master Plan process, the campus infrastructure was evaluated by the engineering firm, P2S, as part of a larger project being conducted by the Chancellor's Office. This Appendix contains the reports and materials developed for the Master Plan that reflect those investigations and recommendations. The comprehensive report on the Sacramento State campus developed by P2S for the Chancellor's Office is available from the University.

B.1 P2S Existing Utilities

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Cal State University Sacramento

Central Plant and Distribution
Existing System Description

March 17, 2013

Prepared by:
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Central Plant/Chilled Water and Steam Distribution System

Majority of the cooling and heating needs of the campus are currently met by a central heating and cooling plant located near the center of campus at the corner of Moraga Way and Sinclair Road. Completed in 1959, the Central Plant (Bldg #32) provides chilled water (CHW) and steam to the majority of buildings on campus via an underground distribution piping network. The majority of the chilled water/steam and condensate return piping was replaced in 1994 and 2004 with pre-insulated PVC and Steel piping respectively. There is a small portion of original 1950's chilled water and steam/condensate piping currently serving the northwest end of campus from Lassen Hall (LSN) to the Athletic Center (ATH). The campus also has a TES system that assist the campus in generating and storing chilled water during the off peak periods and using the same to cool the facilities during the peak periods thus and helping the campus offset peak demand and reduce operating costsCurrently the central plant serves approximately,2200,000 sq-ft of building space.

The campus also has few facilities that have dedicated chillers/AC Package units and boilers that meet the cooling and heating demands of these facilities respectively.

The central plant has a Tridium energy management and control system (EMCS). There are multiple control manufacturers at the building level throughout campus; i.e. Johnson Controls, Siemens, etc. These buildings are integrated utilizing Tridium JACE into the Tridium ststem. A few buildings have pneumatic controls.

Based on the discussions had and data received from the campus, the campus has a maximum cooling load of approximately 3,400 tons or 20,000 ton-hours based on a 6-hour peak period and a heating demand of 55,000lb-steam per hour. This results in a cooling diversity factor of about 60%. The maximum connected steam demand to the campus is approximately 77,000 lb-steam per hour. This results in a heating diversity factor of about 65%.

CHW Generation

The chilled water generation at the plant is accomplished via three (3) 1,250-ton Trane chillers. The chillers are currently served by a 12kV-4160V, 3phase, system. All three chillers currently utilize R-123 refrigerant. All three chillers can operate at the same time, providing an instantaneous cooling capacity of 3,750 tons.

There is a three-cell Ceramic Unilite cooling tower (CT-1, CT-2, and CT-3) adjacent to the central plant building. The cooling tower has three (3) variable-speed fans; each fan is rated at 100-HP motor. The cooling towers were replaced in 1998, 2004 and are in good condition. The condenser water design Δ°T is 10°F. Its associated pumps are also located within the same structure.

There is a single above ground, insulated, welded-steel, thermally-stratified thermal energy storage tank (TES) located south adjacent to the central plant. Expanded in 2001, the tank is 62 feet in diameter and has a height of 72 feet. The tank has a volumetric storage capacity of 1,625,000 gallons. The TES system generates approximately 18,725 tons-hours of cooling with a 20°F temperature difference when fully charged, based on an assumed 83% TES efficiency.

The TES system is currently being charged by the chillers during off-peak periods. The TES then discharges and distributes to the entire campus during on-peak periods, thus reducing the peak demand charges incurred by the campus. The TES system assists the campus in generating and storing chilled water during the off peak periods and using the same to cool the facilities during the peak periods thus and helping the campus offset peak demand and reduce operating costsThe TES is configured so that either of the chillers can charge the tank. The tank charging period depends upon the load profile of the day.

CHW Pumping

The chilled water pumping system is designed as a primary/secondary pumping arrangement. There are three (3) Bell & Gosset primary CHW pumps (CHWCP-1, CHWCP-2, CHWCP-3). CHWCP-1 and CHWCP-2 are constant speed pumps, each is 20-HP rated at 1,825 gpm at 35 feet of head. CHWCP-3 is a 25-HP pump with a variable speed drive, rated for the same conditions.

In addition, there are two (2) variable-speed Bell & Gosset secondary CHW pumps (CHWLP-7, CHWLP-8). CHWLP-7 and CHWLP-8 have 125-HP motors. The secondary CHW pumps are cycled as a function of CHW demand.

There are two (2) variable-speed Johnston condenser (CW) pumps (CWP-5, CWP-6), each with 100-HP motors rated for 5,625 gpm at 60 feet of head. The CW pumps are cycled to maintain the required pressure differential across the condenser water header.

All of the expansion tanks and associated air separators are located on the same floor.

CHW Distribution

The chilled water is distributed through a combination of direct buried pre-insulated, PVC and steel piping. The central plant provides chilled water through two (2) main distribution networks. There is a 24" chilled water main at the central plant that splits into two (2) mains; one 16" main going north and the other 20" main going south.

North-Campus Distribution

The 16' chilled water main traverses north and follows the original 1952 campus distribution system. There are additional branches that connect to the newer buildings. Most of the north-campus chilled water piping was replaced in 1994 with pre-insulated piping. However, there is a small portion of original 1950's chilled water piping from Lassen Hall (LSN) and continues to the Athletic Center (ATH).

South-Campus Distribution

The 20" chilled water main splits into a 16" that continues toward the south-end of campus and a 12" that continues east adjacent to Sinclair Road towards Santa Clara Hall (SCL). The south-campus chilled water piping was replaced in 1994 with pre-insulated piping.

In speaking with the campus facilities staff, the following CHW distribution issues were discovered.

- The majority of the main campus chilled water lines are pre-insulated steel pipes, with most sections approximately 20 years old. Below is a summary of the older pipe sections.
    - Distribution CHW piping from Lassen Hall to the Athletics Office (formerly the Health Center), circa 1950's.
    - Distribution CHW mains within utility tunnel and direct-buried, circa 1994.
- The campus does have a preventative maintenance schedule to exercise the campus CHW isolation valves . There have been no reported issues with the chilled water piping.
- There is a lack of isolation valves on the CHW distribution.

Steam Generation

The steam generation is accomplished at the plant via three (3) natural gas-fired steam boilers and its associated condensate return equipment located at the north end of the central plant. Installed in 2007, the two (2) gas-fired, Nebraska steam boilers (B-1, B-2) are rated at 45,000 lb-steam/hr. Installed in 1997, the gas-fired Hurst steam boiler (B-3) is rated at 20,000 lb-steam/hr. The total steam capacity is 110,000 lb-steam/hr. The boiler system provides steam at 90 PSI and the condensate returns from the building at 212°F and arrives at the central plant at approximately 180°F. The boiler plant is in good condition.

Steam – Feed Water Pumping

There are two (2) 20-HP boiler feed water pumps that provide campus steam requirements; the pumps are fed from a de-aerator (DA) tank held at 220°F. There is also a stand-by turbine pump.

Most buildings have a steam-to-hot water heat exchanger. Some buildings have HHW pumps to circulate the HHW throughout the buildings in addition to coil booster pumps. Condensate pumps send condensate back to the central plant steam boilers.

Steam Distribution

The steam is distributed through two (2) main distribution networks. The north-campus is served by a 10" main and the south-campus is served by a 12" main.

North-Campus Distribution

The 10' steam main leaves the central plant and follows the original 1952 campus distribution system. There are additional branches that connect to the newer buildings. Most of the north-campus steam and condensate piping was replaced in 1994 with pre-insulated piping. However, there is a small portion of original 1950's steam/condensate piping which starts at steam vault #21 adjacent to Lassen Hall (LSN) and continues to the Athletic Center (ATH).

South-Campus Distribution

The 12" steam main leaves the central plant, traverses towards Tahoe Hall (TAH) and eventually ends at the capped steam vault #41 adjacent to the University Union (UU). There is an underground utility tunnel that starts from the Central Plant Building and runs South on Moraga Way. It continues past Sinclair Road, running parallel to Capistrano Hall (CPS) then heading diagonal in a Southeast direction between Amador Hall (AMD) and Library South (LIB). The tunnel then turns due East running between Library South and the AIRC building (ARC) and terminates at the University Union building. The underground tunnel is approximately 8' tall by 8' wide, 1,600 feet long with racking and cable tray to accommodate routing cable and steam pipes throughout the campus. There is also a 12" branch that goes east along Sinclair Road and terminates at vault #12 between Sequoia Hall (SQU) and Riverside Hall (RVR). The south-campus piping was replaced in 2004 with pre-insulated piping.

In speaking with the campus facilities staff, the following steam/condensate distribution issues were discovered.

- The majority of the main campus steam and condensate lines utilize a dual-shell piping system with pre-insulated steel pipes. Most sections are approximately 20 years old. Below is a summary of the older pipe sections.
    - Distribution steam piping from Lassen Hall to the Athletics Office (formerly the Health Center), circa 1950's.
    - Distribution steam/condensate mains within utility tunnel and direct-buried, circa 1994.
- There have been no reported issues with the steam and condensate piping.

Age and Reliability

Chillers CH-1 was installed in 2002, CH-2 was installed in 1998 and CH-3 was installed in 2004. All the chillers are in good condition. Per industry standards, chillers/boilers have a life expectancy of approximately 25 years with regular maintenance.

Discussions with campus personnel revealed that the campus provides routine equipment maintenance both internally and through service contracts with local providers. The two (2) gas-fired, Nebraska steam boilers (B-1, B-2) were installed in 2007. The gas-fired Hurst steam boiler (B-3) was installed in 1997. The boiler plant is in good condition.

Majority of the CHW and steam/condensate piping were replaced in 1994 and 2004 with pre-insulated PVC and Steel piping respectively and is in good condition. There is a small seqment of original 1950's piping serving the northwest end of campus from Lassen Hall to the Athletics Office (formerly the Health Center) that is aged and need to be replaced.

Redundancy

The existing chillers provide a total cooling capacity of 3,750 tons and are capable of charging the 18,275 ton-hours TES tank completely during the off peak periods. The TES tank system is however at capacity and its capacity will need to be augmented to meet the peak demand of the facilities planned as part of the master plan. Should one of the chillers fail, the other chiller can still charge the TES tank completely during off peak and mid peak periods and meet the peak cooling demands of the campus. The chilled water and condenser water pumps are piped in parallel with a common header respectively. Should one of the pumps fail, the remaining pumps can meet the flow requirements of the facilities and thus offer redundancy.

The existing steam boilers are capable of delivering a total of 110,000 lb-steam per hour andis adequately sized to meet the heating demands of the campus. Discussions with facilities staff revealed that the maximum steam demand varies between 50,000 lb-steam/hr-77,000 lb-steam/hour. Should one of the boilers fail, the remaining boilers can meet the peak heating demands of the facilities. In addition, should one of the heating hot water pumps fail, the remaining pumps can meet the flow requirements of the facilities and thus offer redundancy.

History of Outages / Disruption of Service

There have been no failures with the chilled water or steam systems in the last 5 years. The CHW / steam pipes also have not had any major failures.

Dedicated Building Systems

In addition to the Central Plant, a few of the facilities have dedicated chillers and boilers that meet the cooling and heating needs of these facilities. These systems are summarized below by each facility:

Broad Field House

Two (2) Carrier 30RAN air-cooled chillers (CH-1, CH-2) installed in 2007 meet the cooling demands of the facility. CH-1 is 10-tons and CH-2 is 20-tons. One (1) 250,000-input BTU Noritz N-0931 tankless boiler, also installed in 2007 meets the heating demands of the facility. . The chillers and boilers are in good condition.

El Dorado Hall - ELD

One (1) 40-ton Trane air-cooled chiller installed in 2004 meets the cooling demands of the facility. . One (1) 750,000-input Fulton Pulse hot-water boilers (B-1) installed in 1993 meets the heating demands of the facility. . The chiller/boiler provide CHW/HHW for this building. chillers and boilers are in good condition.

Green House

One (1) 970,000-input Parker T970 hot-water boiler installed in 2006 meets the heating demands of the facility. . The boiler provides HHW for this buildingThe boiler is in good condition.

Hornet Bookstore - BKS

Two (2) 2,000,000-input Aerco BMK 2.0 hot-water boilers (B-1, B-2) installed in 2006 meet the heating demands of the facility. . The boiler provides HHW for this building. This building is connected to the CHW loop, but not connected to the steam loop from the central plant. The boilers are in good condition.

Modoc Hall - MDC

One (1) 350-ton Trane water-cooled chiller and one (1) 2,970,000-input BTU Parker T297 HHW boiler, both installed in 2003 meet the cooling and heating demands of the facility. . The chiller/boiler is located in a satellite central plant adjacent to the building. The chiller and boiler provide CHW & HHW for this building. The equipment is in good condition.

Public Safety - PSB

One (1) 20-ton Trane air-cooled chiller (ACCH-1) installed in 1999 meets the cooling demands of the facility. . One (1) 675,000-input BTU Ajax hot-water boiler (B-1) meets the heating demands of the facility. . The chiller provides the CHW for cooling for the 1st floor of this building. The boiler provides HHW for the entire building. The equipment is in fair condition.

The Well - WEL

Two (2) 320-ton Trane water-cooled chillers (CH-1, CH-2) and two (2) 3,000,000-input BTU Aerco BMK 3.0 boilers (B-1, B-2); all installed in 2009 meet the cooling and heating demands of the facility. These chillers/boilers provide CHW / HHW for this building. The equipment is in good condition.

Yosemite Hall Pool - YSM

One (1) 970,000-input BTU AJAX WH boiler (B-1), installed in 2003 provides HHW for the pool use.. The boiler is in fair condition.

Mariposa Hall - MRP

One (1) 80-ton McQuay air-cooled chiller meets the cooling demands of the facility. . This chiller serves as standby and for off-hours application when CHW is not available from the central plant. This building is connected to the central plant. The chiller is in fair condition.

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Humbolt Hall - HMB

Two (2) 400,000-input BTUH Parker hot-water boilers (B-1, B-2) installed in 1999 meet the industrial HHW demands of the building for specific use. There is also a 2,000,000-input BTU Cleaver Brooks M4 hot-water boiler that was installed in 1985 and has been abandoned and left in place. This building is connected to the central plant. The boilers are in fair condition.

Kadema Hall - KDM

One (1) 550,000-input BTUH Rite Model 55 hot-water boiler installed in the 1960's meets the heating demands of the facility. . This boiler serves as standby and for off-hours application when HHW is not available from the central plant. This building is connected to the central plant. The boiler is in fair condition.

Placer Hall - PLR

One (1) 2,500,000-input BTUH Bryan AB hot-water boiler installed in 1996 meets the heating demands of the facility. . This boiler serves as standby and for off-hours application when HHW is not available from the central plant. This building is connected to the central plant. The boiler is in fair condition.

University Union - UU

One (1) 700-ton Trane water-cooled chiller installed in 1996 as part of the University Student Union expansion meets the cooling demands of the facility. . This chiller serves as the primary source for CHW for this building. This building is connected to the central plant, as back-up. The chiller is in good condition.

Residence Halls

The residence halls on campus also have satellite CHW / HHW equipment that meet the cooling and heating demands of the facility. . None of the residence halls are connected to the central plant. Their systems are summarized below:

American River Courtyard - AMC

Two (2) 180-ton SMARDT WA water-cooled chillers (CH-1, CH-2) installed in 2008 meet the cooling demands of the facility. . Two(2) 2,000,000-input BTU Aerco BMK 2.0 hot water boiler installed in 2008 meet the heating demands of the facility. . This building is not connected to the central plant. The equipment is in good condition.

Desmond Hall - DSM

One (1) 160-ton Carrier 30HR water-cooled chiller (CH-1) installed in 1990 meets the cooling demands of the facility. . One (1) 2,000,000-input BTU Ajax WGXH boiler installed in 1989 meets the heating demands of the facility. . This building is not connected to the central plant. The equipment is original to the building and is in fair condition.

Dining Commons - DC

There are two (2) chillers located in the Commons equipment room that meet the cooling demands of the facility. . One (1) 150-ton Trane RTHA water-cooled chiller (CH-1) installed in 1993. This chiller CH-1 serves the cooling requirements for the Commons. The other chiller (CH-2) is a 250-ton Trane RTHA water-cooled chiller. This chiller provides CHW for the adjacent residence halls; Sierra Hall (SRA) and Sutter Hall (STR). The chillers are in good condition.

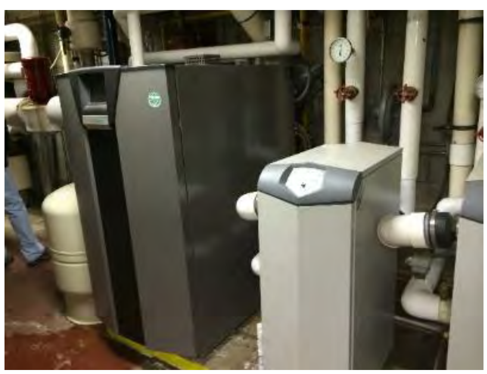
One (1) 2,000,000-input BTU Aerco BMK 2.0 boiler installed in 2009 meets the heating demands of the facility. . . The boiler is in good condition.

Draper Hall – DRP and Jenkins Hall – JNK

Each residence hall has one (1) 60-ton Trane CGWD water-cooled chiller (CH-1) installed in 1995 and one (1) 1,500,000-input BTU Ajax WGXH boiler installed in 1988 that meet the cooling and heating demands of the facility respectively. The equipment is in fair condition.

Sierra Hall – SRA and Sutter Hall – STR

Each residence has one (1) 1,000,000-input BTU Lochinvar boiler installed in 2008 that meets the heating demands of the facility. . The boilers are in good condition.



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Cal State University Sacramento

Electrical Distribution System
Existing System Description

March 17, 2013

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Electrical Service

California State University, Sacramento is currently served from a 69kV transmission service originating from an outdoor switchyard located on south west side of the campus. The campus derives its power from Sacramento Municipal Utility District 69kV system which provides redundancy through two circuits (Pocket Line 3 and Hurley Line 7). The SMUD service is metered at 69kV.

The 69kV service is transformed to a 12.47kV service with the help of a single 10/12.5/15 MVA 69-12.47kV transformer located in an outdoor switchyard located on the south west side of the campus. 69-12.47kV transformer was manufactured by Powercon Corp and was installed in 1998. The bus bars and overhear conductors connecting the transformers were found to be bare and not insulated. The secondary side of this transformer serves the main campus 15kV rated, 1200A switchgear located outside adjacent to the main switchyard in a NEMA 3R enclosure. The switchgear is equipped with a main 1200A breaker and three 600A feeder breakers. A capacitor bank located adjacent to the main switchgear and served from this main switchgear improves the overall power factor of the campus. Three circuits originate from this main 15kV switchgear, one circuit serves the main 15kV switchgear housed in a modular enclosure located adjacent to the existing central plant, a second circuit serves the Hornet Stadium and the third circuit serves a capacitor bank.. The campus operates and maintains the transformer and the 12kV switchgear. The switchgear and the transformer are approximately 15years old and are in good condition.

The main 15kV switchgear located in a modular enclosure adjacent to the existing central plant was also installed in 1998 and comprises of a two main 1200A breakers and eight 600A feeder breakers. This switchgear derives its service from two 12kV feeders, one originating from the main 15kV switchgear located in the switchyard on the south west side of the campus and the other from a selector switch located on the south side of the central plant near Sinclair Road. This selector switch is served from two SMUD circuits; one circuit is fed from State University Drive West and the other SMUD circuit traverses from State University Drive East along the pedestrian bridge to the campus. The main 15kV switchgear thus has the capability of being served either from the main 12kV circuit originating from the main 69-12.47kV switchyard or from one of the two SMUD circuits that terminate in the selector switch located along Sinclair Road. The SMUD meter for these circuits is located in the main 15kV switchgear located adjacent to the existing central plant. The main 12kV circuit originating from the main 69-12.47kV switchyard is routed overhead along State University Drive West, is close to an existing rail line and is routed amidst large trees that pose a danger to the existing lines and these lines are thus vulnerable to damage and short circuit.

The main 15kV switchgear located adjacent to the central plant is equipped with two main 15kV 1200A breakers, metering section and eight 1200A feeder breakers. The breakers and the switchgear are manufactured by General Electrical in 1998 and are in good condition. Each feeder is equipped with a vacuum breaker and SEL 751A relay for protection. The main and the feeder breakers are metered through these relays and are currently monitored at the central plant. The existing GE meters installed in each of the sections have been abandoned. Seven 15kV feeders originating from this switchgear form multiple loops through 15kV selector switches and serve power to various buildings and facilities on campus. The circuits are grouped in three pairs (1/2, 3/4 and 5/6) and traverse through manholes and duct banks to serve each of the facilities on campus. Feeders '1' and '2' serve the southern portion of the campus, feeders '3' and '4' serve the central part of the campus and feeders '5' and '6' serve the northern portion of the campus. Elastimold connectors installed in each of the manholes help route two circuits to each building 15kV substation on campus. Majority of the substations on campus are equipped with dual 15kV fused switches that help the campus provide a primary selective system and facilitate switching between feeders should a feeder fail or is taken down for maintenance. The main 12kV switchgear also serves the existing central plant (Circuit '8'). The central plant is equipped with a 12kV-4.16kV pad mount transformer that serves the 4160V chillers and two 1000kVA 12kV-480V substations that meet the power demands of the central plant pumps, boilers and cooling towers. Circuit 7 circuit breaker is currently a spare and is used as a back-up spare during maintenance. There are two spare conduits stubbed up at the concrete pad along the north side of the switchgear enclosure for future expansion.

A recent project undertaken by the campus added four selector switches at various locations on the campus that provide the ability to the campus to switch group of buildings between circuits and thus provide the campus with the flexibility of serving buildings from alternate circuits should a circuit fails or is taken down for maintenance. However, there are still limited selector switches to allow the campus to isolate individual circuits and switch between circuits.

The campus also has photovoltaic systems on their existing Library, the WELL and a small system at their Facilities Services Yard that offset a portion of the campus total energy consumption.

An electrical site plan showing locations of substations, manholes and routing of circuits throughout the campus is provided at the end of this section. All conduits are 4" and are encased in concrete. Table 1 below summarizes the installed capacities and approximate demand in kVA for each of the facility served by the campus 12kV distribution system. The University owns and maintains the 69kV-12kV transformers, 15kV substations, 15kV distribution network, and the substations located in each building. A single line diagram of the campus is also enclosed at the end of this section.

Electrical Distribution System

The primary overhead electrical conductors serving the main 12kV switchgear at the central plant comprise of two sets of 15kV, 500kcmil EPR conductors and provide approximately 15MVA of capacity. The campus main 15kV distribution system is made up of 15kV, '3' conductor 250MCM EPR cables installed in concrete encased duct banks that traverse through conduits and manholes to serve 15kV selector switches and dual 15kV fused switches in individual facilities located on campus. Radial feeders comprising of 15kV, 3#2 EPR cables originating from these selector switches serve each of the buildings substations. The campus distribution system was upgraded in 1998 and is in good condition. 15kV fused air switche/substations s in few of the buildings were found to be old, had experienced maintenance issues, spare parts to repair breakers and other components of the substations are difficult to find and need to be replaced. These include Library North and South, Amador Hall, Tahoe Hall, Eureka Hall, Placer Hall, Humboldt Hall, Brighten Annex and Shasta Hall. A fault on an older substation will result in the tripping of the main 15kV breaker since the substation breakers are old and are unable to trip on a fault. This will result in either a campus wide shut down or shuts down power to a group of buildings depending on the actual fault.

Table 1 provides the installed capacities and demand in kVA for each of the facilities on each of the 12kV feeders originating from the 12kV switchgears. Similarly, the existing emergency generators and the facilities they serve are shown in Table 5.

A review of the connected loads on each feeder revealed that the feeders '5' and '6' have minimum loads while feeders '1' and '2' and '3' and '4' were moderately loaded. The existing distribution system is adequately sized to meet the current demands of the campus and is in good condition.

Age and Reliability

The main 15kV switchgear and the associated medium voltage cables that form part of the distribution system were installed in 1998 and are in good condition. The existing system also provides a primary selective system which provides the campus with the ability to transfer to an alternate feeder should one of the feeder fails or is taken down for maintenance. The campus however does not have adequate selector switches that could provide the campus to isolate feeders and individual buildings shoud a fault occur on one of the feeders The reliability of the existing electrical system is thus compromised. 15kV fused air switches/substations s in few of the buildings were also found to be old, had experienced maintenance issues, spare parts to repair breakers and other components of the substations are difficult to find and need to be replaced. These include Library North and South, Amador Hall, Tahoe Hall, Eureka Hall, Placer Hall, Humboldt Hall, Brighten Annex and Shasta Hall. A fault on an older substation will result in the tripping of the main 15kV breaker since the substation breakers are old and are unable to trip on a fault. This will result in either a campus wide shut down or shuts down power to a group of buildings depending on the actual fault..

The campus also currently does not have arc flash labels on each of their equipment serving each of the buildings on campus. A short circuit and coordination study was however conducted by the campus in 2005.

History of Outages

The campus has experienced two outages in the last three years.

Redundancy

The campus currently has a primary selective system comprising of six 15kV feeders originating from the main switchgear and traversing through dual 15kV switches located in individual buildings to serve power to various buildings and facilities on campus. The circuits traverse through manholes and duct banks to serve each of the facilities on campus. A few of the 15kV dual switches however are old and at the end of their useful life and are at risk of providing the campus with the ability of switching over to an alternate feeder should a feeder fail or is taken down for maintenance. So although the campus has a primary selective system, the internal distribution system is at risk in these buildings of providing tredundancy should one of the feeders fails or is taken down for maintenance. There are also limited selector switches to transfer power to an alternate feeder should one of the feeders fail or is taken down for maintenance.

The campus has a dual feed from the utility company and has not experienced a campus wide outage over the past five years.

Current Campus Connected Load and Demand

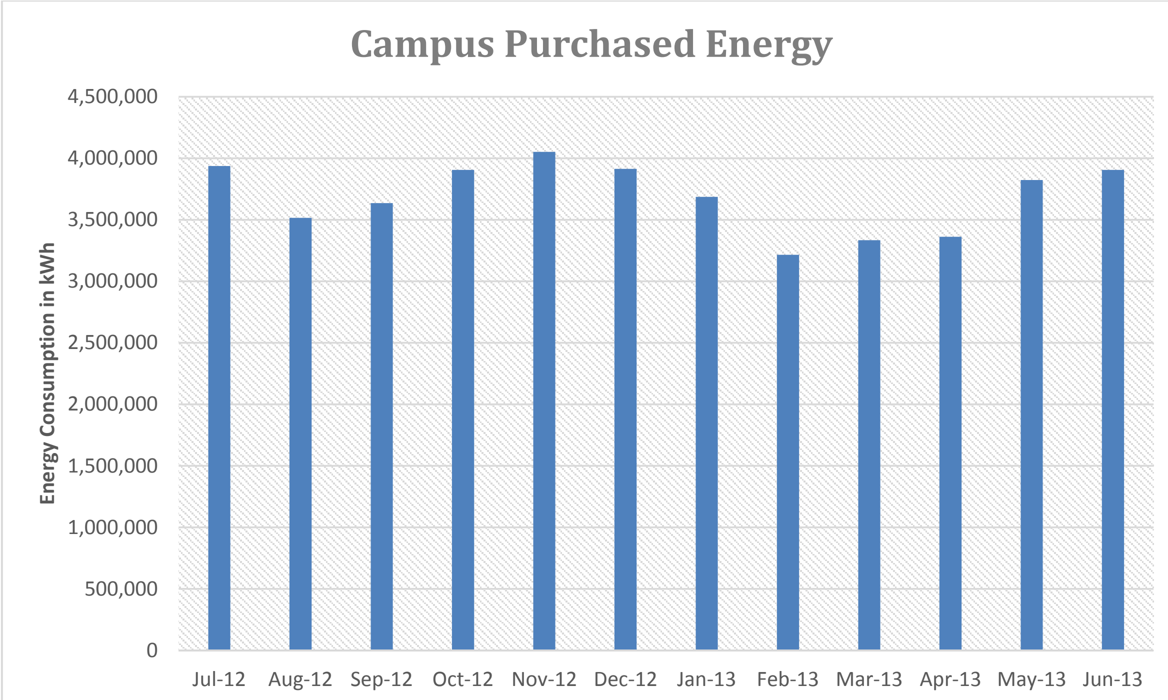
The current installed capacity of the campus is 48MVA and the maximum demand of the campus is approximately 8.75MVA which occurs during the months of September and October.

The total energy consumption of the campus per year is approximately 44.5million kWh.

Table 1 below provides the list of buildings and their associated installed capacity and demand. Table 2 provides the total maximum demand seen by each of the feeders. Feeders serving each of these associated facilities are also provided in the table. The campus currently has 4 electrical meters. Table 3 provides the numbers and the areas each meter serves on the campus.

The charts below provide the purchased kWh over the past year, main meter peaks and total electrical cost variation from June 2012 to May 2013.

A single line diagram for the campus is enclosed at the end of the section for your reference.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Energy Consumption in kWh
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1,000,000
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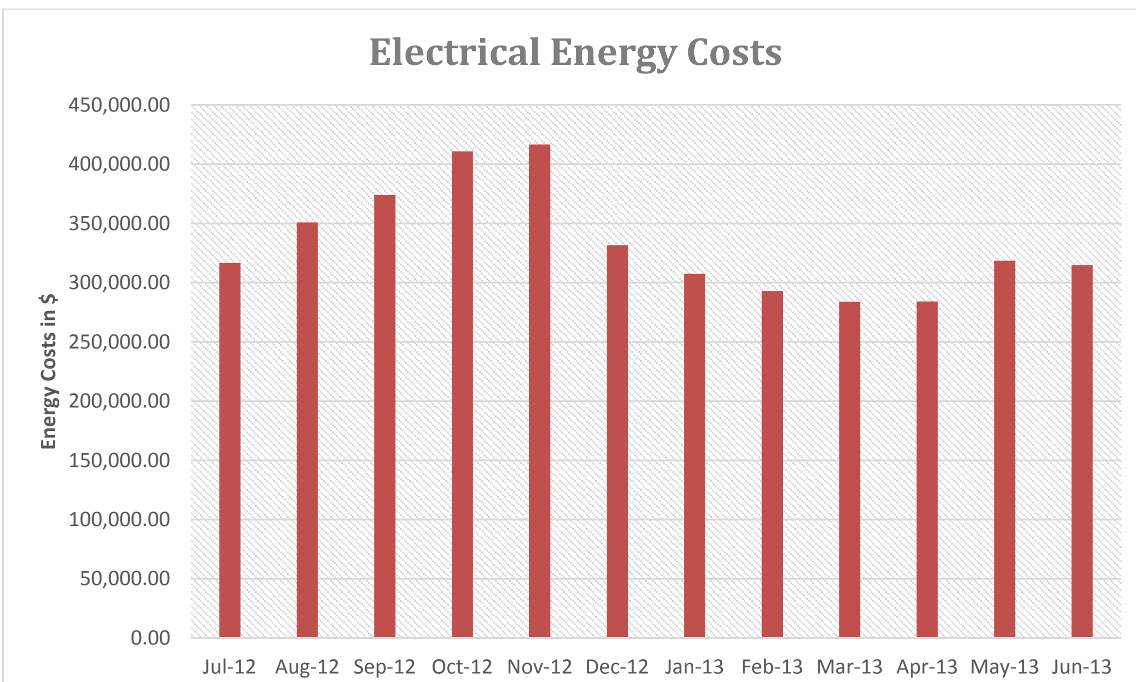
Jun-13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Energy Costs in $
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Jul-12
Aug-12
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Oct-12
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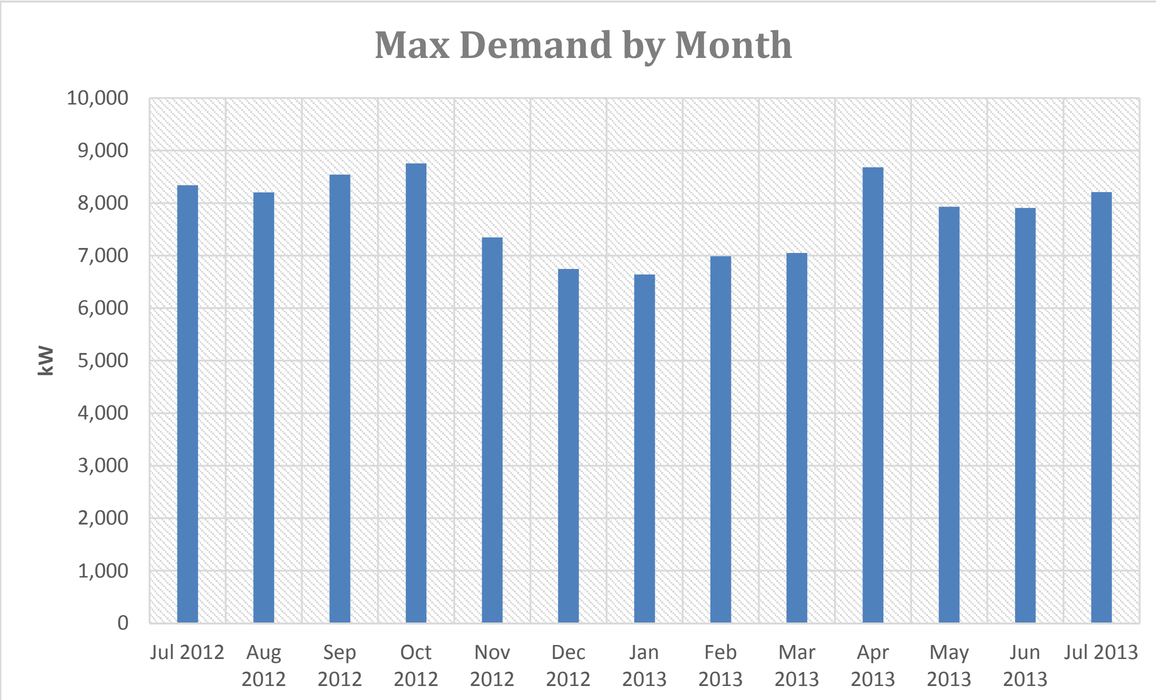
Feb-13
Mar-13
Apr-13
May-13
Jun-13



Electrical Installed Capacity and Demand in kVA – All Feeders

Bldg No.	Building Name	Bldg. TAG	Occupancy Type	Gross Area (Sq. Ft.)	Yr. Built	Installed Capacity in kVA	Approx. Demand	Feeders
1	Sacramento Hall	SAC	Adminstration	38,090	Jul-1959	500	150	Feeders '5' and '6'
2	River Front Center *	RFC	Food Sales	40,198	Sep-1959	825	248	Feeders '5' and '6'
4	Douglass Hall	DH	Classroom - General	22,700	Feb-1959	-	-	Feeders '3' and '4'
7	Kadema Hall	KDM	Art	46,184	Nov-1962	300	90	Feeders '3' and '4'
9	Shasta Hall	SHS	Theater Arts	62,667	May-1970	1250	375	Feeders '5' and '6'
10	Calaveras Hall	CLV	Classroom - General	21,630	Sep-1956	500	150	Feeders '3' and '4'
11	Alpine Hall	ALP	Social Science	30,550	Jun-1957	-	-	Feeders '3' and '4'
12	Brighton Hall	BRH	Business Administration	30,880	Jun-1966	800	240	Feeders '3' and '4'
13	Humboldt Hall	HMB	Science	24,908	Sep-1967	-	-	Feeders '3' and '4'
14	Santa Clara Hall	SCL	Engineering	66,391	Aug-1960	1000	300	Feeders '3' and '4'
15	Yosemite Hall	YSM	Physical Education	82,301	Oct-1981	1000	300	Main 12kV Switchgear
16	Draper Hall	DRP	Dormitories	38,212	Sep-1959	-	-	Feeders '5 and '6'

17	Jenkins Hall	JNK	Dormitories	38,212	Sep-1959	-	-	Feeders '5 and '6'
19	Recreation Facility		Dormitories	1,152	Dec-1976	-	-	Feeders '5 and '6'
20	Handball Courts		Physical Education	5,969	Dec-1959	-	-	Main 12kV Switchgear
22	Physical Plant Service Center		Corporate Yard	35,272	Dec-1959	300	90	Feeders '5' and '6'
23	Corporate Yard - Addition		Corporate Yard	1,250	Jan-1992	-	-	Feeders '1' and '2'
24	Non-Destructive Laboratory		Education	1,381	Jun-1961	-	-	Feeders '1' and '2'
25	American River Courtyard	AMC	Dormitories	209,050	Jul-2009	600	180	Feeders '5' and '6'
26	Lassen Hall	LSN	Student Services	110,000	Nov-1980	750	225	Feeders '5' and '6'
27	Outdoor Theater		Theater Arts	2,160	Feb-1953	-	-	
28	Greenhouse		Science	4,025	Feb-1953	-	-	
29	Geology Optical Lab		Science	1,263	Sep-1962	-	-	
31	Hornet Foundation Office		Auxilliary	6,000	Dec-1959	-	-	
32	Central Plant		Corporate Yard	13,569	Dec-1959	1225	368	Feeders '5' and '6'
33	Athletic Center ; formerly Student Health Center	ATH	Physical Education	27,313	May-1975	500	150	Feeders '5' and '6'
34	Tahoe Hall	TAH	Business Administration	64,764	May-1979	750	225	Feeders '1' and '2'
35	Capistrano Hall	CPS	Music	84,722	Sep-1967	750	225	Feeders '1' and '2'
36	Sequoia Hall	SQU	Science	191,137	Aug-1967	2250	675	Feeders '3' and '4'
37	Del Norte Hall	DLN	Classroom - Multi Purpose	54,000	Aug-1988	500	150	Feeders '5' and '6'
38	Eureka Hall	EUR	Education	59,488	Sep-1969	500	150	Feeders '3' and '4'
39	Amador Hall	AMD	Psychology	67,138	Oct-1981	1000	300	Feeders '1' and '2'
40	Library	LIB	Library	377,074	Feb-1991	4000	1200	Feeders '1' and '2'
41	PE Field House		Physical Education	9,300	Jun-1969	2500	750	Feeders '1' and '2'
42	Solano Hall	SLN	Classroom - General	67,710	Sep-1992	1000	300	Feeders '5' and '6'
43	Mendocino Hall	MND	Classroom - General	77,000	Dec-1990	1500	450	Feeders '3' and '4'
44	Sierra Hall	SRA	Dormitories	41,662	Apr-1974	1500	450	Feeders '5' and '6'
45	Sutter Hall	STR	Dormitories	40,102	Apr-1974	1500	450	Feeders '5 and '6'
46	Dining Commons **	DC	Cafeteria	22,747	Oct-1981	-	-	Feeders '5 and '6'

47	University Union *	UU	Union	162,268	Jun-1991	1000	300	Feeders '1' and '2'
48	Riverside Hall	RVR	Engineering	83,316	Sep-1989	1500	450	Feeders '3' and '4'
49	Food Service Outpost		Food Sales/Vendor	1,300	Sep-1983	-	-	
52	SAC City UFD School District		Auxilliary	720	Jan-2007	-	-	
53	Office of Education		Auxilliary	1,200	Jan-2007	-	-	
54	Eli & Edythe Broad Field House		Physical Education	26,013	Jan-2008	500	150	Feeders '1' and '2'
56	Placer Hall *	PLR	Science	67,101	Jan-1997	1000	300	Feeders '3' and '4'
57	Hornet Foundation Storage		Warehouse	7,800	Apr-1990	-	-	Feeders '1' and '2'
58	Public Service Bldg	PSB	Adminstration	11,892	Dec-1959	300	90	Feeders '1' and '2'
59	El Dorado Hall	ELD	Faculty Office	11,029	Dec-1959	-	-	Feeders '1' and '2'
60	Hornet Stadium		Other	254,465		2500	750	Feeders '1' and '2'
61	Child Development Center **	CDC	Other	13,704	Sep-1988	150	45	Feeders '1' and '2'
62	Benicia Hall	BNC	Faculty Office	7,203	Jun-2002	112.5	34	Feeders '1' and '2'
65	Folsom Hall	FLS	Classroom - Multi Purpose	198,692		-	-	
75	Receiving Warehouse		Warehouse	5,000	Sep-1984	-	-	
81	Modoc Hall **	MDC	Auxillary	85,402	Jan-2004	1500	450	Feeders '1' and '2'
82	Art Sculpture Lab	ASL	Art	12,040	Apr-1976	75	23	Feeders '1' and '2'
87	Roundhouse Vending Center		Other	707	Dec-1959	-	-	
88	Napa Hall **	NPA	Extended Education	33,932	Jun-2002	500	150	Feeders '1' and '2'
89	Parking Structure I	PSI	Parking Structure	494,208	Sep-1992	300	90	Feeders '1' and '2'
90	Desmond Hall	DSM	Dormitories	50,134	Aug-1990	500	150	Feeders '5' and '6'
91	Hornet Bookstore *	BKS	Bookstore	93,170	Jul-2007	1500	450	Feeders '1' and '2'
92	Mariposa Hall	MRP	Classroom - General	78,079	Aug-2000	1500	450	Feeders '3' and '4'
94	Parking Structure II	PSII	Parking Structure			300	90	Feeders '1' and '2'
95	Academic Information Resource Center	ARC	Classroom - General	97,923	Jan-2005	2500	750	Feeders '1' and '2'
99	Parking Structure III	PSIII	Parking Structure	983,620	Jan-2007	300	90	Feeders '1' and '2'
101	City Fire Station		Other	7,022		-	-	

104	Alumni Center **	AC	Auxillary	10,800	Jul-2000	300	90	Feeders '1' and '2'
106	Baseball Storage		Physical Education	1,430	Aug-1998	-	-	
108	Capital Public Radio **	CPR	Auxillary	19,838	Jan-2004	400	120	Feeders '1' and '2'
109	The WELL *	WEL	Auxillary	150,845	Sep-2010	2500	750	Feeders '1' and '2'
112	Sacramento Hall Annex	SNX	Adminstration	2,201	Oct-2001	-	-	
200	Temp		Adminstration	3,600	Sep-2001	-	-	
-	Well No 1		-	-	-	150	45	Feeders '1' and '2'
-	Parking Lot 8		-	-	-	112.5	34	Feeders '1' and '2'
-	South Booster Pumps		-	-	-	112.5	34	Feeders '1' and '2'
-	UTAPS and SAC Modulars		-	-	-	500	150	Feeders '1' and '2'
-	Pumping Plant		-	-	-	750	225	Feeders '1' and '2'
-	Arc Modulars		-	-	-	112.5	34	Feeders '5' and '6'
-	Storm Pumps at Well III		-	-	-	75	23	Feeders '5' and '6'
	TOTAL					**48350**	**14505**	

Electrical Installed Capacity and Demand in kVA – Feeders 1 and 2

Bldg No.	Building Name	Bldg. TAG	Occupancy Type	Gross Area (Sq. Ft.)	Yr. Built	Installed Capacity in kVA	Approx. Demand	Feeders
23	Corporate Yard - Addition		Corporate Yard	1,250	Jan-1992	-	-	Feeders '1' and '2'
24	Non-Destructive Laboratory		Education	1,381	Jun-1961	-	-	Feeders '1' and '2'
34	Tahoe Hall	TAH	Business Administration	64,764	May-1979	750	225	Feeders '1' and '2'
35	Capistrano Hall	CPS	Music	84,722	Sep-1967	750	225	Feeders '1' and '2'
39	Amador Hall	AMD	Psychology	67,138	Oct-1981	1000	300	Feeders '1' and '2'
40	Library	LIB	Library	377,074	Feb-1991	4000	1200	Feeders '1' and '2'
41	PE Field House		Physical Education	9,300	Jun-1969	2500	750	Feeders '1' and '2'
47	University Union *	UU	Union	162,268	Jun-1991	1000	300	Feeders '1' and '2'
54	Eli & Edythe Broad Field House		Physical Education	26,013	Jan-2008	500	150	Feeders '1' and '2'
57	Hornet Foundation Storage		Warehouse	7,800	Apr-1990	-	-	Feeders '1' and '2'
58	Public Service Bldg	PSB	Adminstration	11,892	Dec-1959	300	90	Feeders '1' and '2'
59	El Dorado Hall	ELD	Faculty Office	11,029	Dec-1959	-	-	Feeders '1' and '2'
60	Hornet Stadium		Other	254,465		2500	750	Feeders '1' and '2'
61	Child Development Center **	CDC	Other	13,704	Sep-1988	150	45	Feeders '1' and '2'
62	Benicia Hall	BNC	Faculty Office	7,203	Jun-2002	112.5	34	Feeders '1' and '2'
81	Modoc Hall **	MDC	Auxillary	85,402	Jan-2004	1500	450	Feeders '1' and '2'
82	Art Sculpture Lab	ASL	Art	12,040	Apr-1976	75	23	Feeders '1' and '2'
88	Napa Hall **	NPA	Extended Education	33,932	Jun-2002	500	150	Feeders '1' and '2'
89	Parking Structure I	PSI	Parking Structure	494,208	Sep-1992	300	90	Feeders '1' and '2'
91	Hornet Bookstore *	BKS	Bookstore	93,170	Jul-2007	1500	450	Feeders '1' and '2'
94	Parking Structure II	PSII	Parking Structure			300	90	Feeders '1' and '2'
95	Academic Information Resource Center	ARC	Classroom - General	97,923	Jan-2005	2500	750	Feeders '1' and '2'
99	Parking Structure III	PSIII	Parking Structure	983,620	Jan-2007	300	90	Feeders '1' and '2'
104	Alumni Center **	AC	Auxillary	10,800	Jul-2000	300	90	Feeders '1' and '2'

108	Capital Public Radio **	CPR	Auxillary	19,838	Jan-2004	400	120	Feeders '1' and '2'
109	The WELL *	WEL	Auxillary	150,845	Sep-2010	2500	750	Feeders '1' and '2'
-	Well No 1		-	-	-	150	45	Feeders '1' and '2'
-	Parking Lot 8		-	-	-	112.5	34	Feeders '1' and '2'
-	South Booster Pumps		-	-	-	112.5	34	Feeders '1' and '2'
-	UTAPS and SAC Modulars		-	-	-	500	150	Feeders '1' and '2'
-	Pumping Plant		-	-	-	750	225	Feeders '1' and '2'
	TOTAL					**25363**	**7609**	

Electrical Installed Capacity and Demand in kVA – Feeders 3 and 4

Bldg No.	Building Name	Bldg. TAG	Occupancy Type	Gross Area (Sq. Ft.)	Yr. Built	Installed Capacity in kVA	Approx. Demand	Feeders
4	Douglass Hall	DH	Classroom - General	22,700	Feb-1959	-	-	Feeders '3' and '4'
7	Kadema Hall	KDM	Art	46,184	Nov-1962	300	90	Feeders '3' and '4'
10	Calaveras Hall	CLV	Classroom - General	21,630	Sep-1956	500	150	Feeders '3' and '4'
11	Alpine Hall	ALP	Social Science	30,550	Jun-1957	-	-	Feeders '3' and '4'
12	Brighton Hall	BRH	Business Administration	30,880	Jun-1966	800	240	Feeders '3' and '4'
13	Humboldt Hall	HMB	Science	24,908	Sep-1967	-	-	Feeders '3' and '4'
14	Santa Clara Hall	SCL	Engineering	66,391	Aug-1960	1000	300	Feeders '3' and '4'
36	Sequoia Hall	SQU	Science	191,137	Aug-1967	2250	675	Feeders '3' and '4'
38	Eureka Hall	EUR	Education	59,488	Sep-1969	500	150	Feeders '3' and '4'
43	Mendocino Hall	MND	Classroom - General	77,000	Dec-1990	1500	450	Feeders '3' and '4'
48	Riverside Hall	RVR	Engineering	83,316	Sep-1989	1500	450	Feeders '3' and '4'
56	Placer Hall *	PLR	Science	67,101	Jan-1997	1000	300	Feeders '3' and '4'
92	Mariposa Hall	MRP	Classroom - General	78,079	Aug-2000	1500	450	Feeders '3' and '4'
	TOTAL					**10850**	**3255**	

Electrical Installed Capacity and Demand in kVA – Feeders 5 and 6

Bldg No.	Building Name	Bldg. TAG	Occupancy Type	Gross Area (Sq. Ft.)	Yr. Built	Installed Capacity in kVA	Approx. Demand	Feeders
1	Sacramento Hall	SAC	Adminstration	38,090	Jul-1959	500	150	Feeders '5' and '6'
2	River Front Center *	RFC	Food Sales	40,198	Sep-1959	825	248	Feeders '5' and '6'
9	Shasta Hall	SHS	Theater Arts	62,667	May-1970	1250	375	Feeders '5' and '6'
16	Draper Hall	DRP	Dormitories	38,212	Sep-1959	-	-	Feeders '5 and '6'
17	Jenkins Hall	JNK	Dormitories	38,212	Sep-1959	-	-	Feeders '5 and '6'
19	Recreation Facility		Dormitories	1,152	Dec-1976	-	-	Feeders '5 and '6'
22	Physical Plant Service Center		Corporate Yard	35,272	Dec-1959	300	90	Feeders '5' and '6'
25	American River Courtyard	AMC	Dormitories	209,050	Jul-2009	600	180	Feeders '5' and '6'
26	Lassen Hall	LSN	Student Services	110,000	Nov-1980	750	225	Feeders '5' and '6'
32	Central Plant		Corporate Yard	13,569	Dec-1959	1225	368	Feeders '5' and '6'
33	Athletic Center ; formerly Student Health Center	ATH	Physical Education	27,313	May-1975	500	150	Feeders '5' and '6'
37	Del Norte Hall	DLN	Classroom - Multi Purpose	54,000	Aug-1988	500	150	Feeders '5' and '6'
42	Solano Hall	SLN	Classroom - General	67,710	Sep-1992	1000	300	Feeders '5' and '6'
44	Sierra Hall	SRA	Dormitories	41,662	Apr-1974	1500	450	Feeders '5' and '6'
45	Sutter Hall	STR	Dormitories	40,102	Apr-1974	1500	450	Feeders '5 and '6'
46	Dining Commons **	DC	Cafeteria	22,747	Oct-1981	-	-	Feeders '5 and '6'
90	Desmond Hall	DSM	Dormitories	50,134	Aug-1990	500	150	Feeders '5' and '6'
-	Arc Modulars		-	-	-	112.5	34	Feeders '5' and '6'
-	Storm Pumps at Well III		-	-	-	75	23	Feeders '5' and '6'
	TOTAL					**11138**	**3341**	

Table 2

Substation	Feeders	Installed Capacity in KVA	Approx. Demand in KVA
Main 12.47kV Switchgear – at Central Plant	Feeder '1'	12680	3800
	Feeder '2'	12680	3800
	Feeder '3'	5425	1630
	Feeder '4'	5425	1630
	Feeder '5'	5570	1670
	Feeder '6'	5570	1670
	Feeder '7'	0	Spare
	Feeder '8'	0	Spare

TABLE 3

Location	Meter Number	Account Number	Tariff
Central Plant	615210	1785382615210	GUT-L
Central Plant	619559	1783665619559	GUP-L
Parking Lot Lighting	499753	430039499753	GSN
Parking Lot# 11 Lighting	581097	684352581097	GSN

TABLE 4 Existing Generators

Building/Area	Make and Model	Type	Year	Size
Athletic Facilities	Kohler - Spectrum	Diesel Generator	1999	350kW
Riverside /ECS	Onan	Diesel Generator	1986	30/45kW
Eureka	Onan	Natural Gas - Propane	-	20kW
State University Drive West	Caterpillar	Diesel Generator	1980	100kW
Library North	Generac	Natural Gas - Propane	1995	45kW
Library South	Onan	Natural Gas -Propane	2011	85kW
Mendocino Hall	Generac	Natural Gas - Propane	1995	60kW
Parking Garage I	Katolight	Natural Gas -Propane	1987	100kW
Placer Hall	Onan	Natural Gas -Propane	2006	100kW
Capistrano Portable	Onan	Diesel Generator	1992	100kW
Public Safety	Generac	Diesel Generator	1989	20kW
Amador Hall	Onan	Natural Gas -Propane	2004	20kW
Sequoia Hall	Generac	Natural Gas	1996	65kW
Shasta Hall	Onan	Propane	2005	20kW
Stadium	Onan	Diesel Generator	2012	125kW
Storm Drain Pumping Station	Generac	Diesel Generator	2010	175kW
Storm Drain Pumping Station	Caterpillar	Diesel Generator	1978	400kW
Mariposa	Olympian	Natural Gas -Propane	2000	100kW
Parking Garage II	Onan	Natural Gas -Propane	2002	55kW
Parking Garage III	Kohler	Natural Gas -Propane	2006	100kW
Napa Hall	Kohler	Natural Gas -Propane	2002	50kW
Central Plant	Olympian	Natural Gas -Propane	2002	100kW
AIRC	Kohler	Diesel Generator	2005	810kW
Modoc Hall	Onan	Natural Gas – Propane	2004	225kW

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Cal State University Sacramento

Gas Distribution System
Existing System Description

March 17, 2013

Prepared by:
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Table of Contents

Natural Gas System

Natural gas is supplied to the University by Pacific Gas & Electric (PG&E) through a long term transportation agreement with the Department of General Services (DGS). There are ten (10) utility-owned natural gas meters on campus.

The campus is currently served by an existing 6" high pressure gas (HPG) main from PG&E that is routed through the center of campus. The 6" HPG main provides natural gas at 240 PSI. There are a total of 9 existing gas connections to this 6" HPG line. The following report summarizes the various gas connections and meters at the campus.

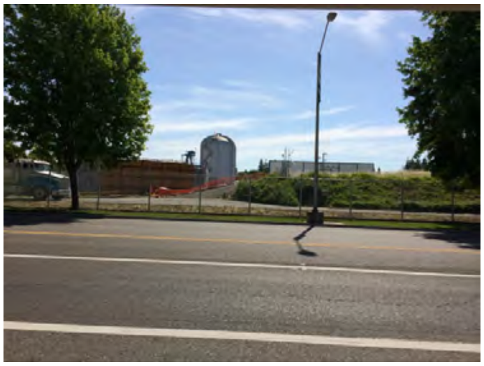
There is a large tap that occurs adjacent to the Central Plant in the middle of campus. This is a 4" HPG line that feeds the central campus utility gas meter that provides natural gas to the majority of the buildings in the middle of campus. This gas distribution operates at 5 PSI MPG. This central campus utility gas meter also supplies the gas requirements for the boilers in the Central Plant at an elevated pressure of 35 PSI.

1. There is a 1-1/2" HPG tap west of the Child Development Center (CDC). This PG&E gas meter serves the Child Development Center and the Parking Structure II (PSII).

2. There is an abandoned tap just south of tap #2 described above. This abandoned gas line runs toward The Well (WEL).
3. There is a 2" HPG tap west of the El Dorado Hall (ELD) that feeds a PG&E gas meter that serves this building.

4. There is a 3/4" HPG tap west of Public Safety (PSB) that feeds a PG&E gas meter that serves this building, as well as Art Sculpture Lab (ASL) and parts of El Dorado Hall.

5. There is a 2" HPG tap southwest of Public Safety that feeds the nearby Fairbairn Water Treatment Plant.



6. There is a 2" HPG tap just south of tap #6 described above that feeds a PG&E gas meter on the south side of Parking Structure III (PSIII).

7. There is 1/1/4" HPG tap that feeds a PG&E gas meter on the east side of the Alumni Center (AC).

8. There is another 4" HPG tap on the south-end of campus east of Napa Hall (NPA) and Modoc Hall (MDC). There are three (3) PG&E gas meters on this line. From the 4" HPG line, a 2" HPG line serves Napa Hall, a 2" HPG line services Modoc Hall, and a 1-1/4" line serves the Capital Public Radio Building (CPR).

In addition, there is a separate connection to the PG&E service that is off-campus, located off J Street. This connection has a PG&E gas meter and is used to serve the Student Housing Complex on the north side of campus. This gas distribution provides natural gas at 5 PSI.

The campus is currently served by an existing 6” high pressure gas (HPG) main from PG&E that is routed through the center of campus. The 6” HPG main provides natural gas at 240 PSI.

There are also campus-installed gas sub-meters and regulators, typically located at the buildings. These sub-meters and regulators operate at low pressure gas 5 PSI (LPG) and are used to measure gas consumption quantities for campus billing purposes. The low-pressure gas is then piped to serve hot water boilers and domestic water heaters that provide space heating in certain buildings and domestic hot water needs of the facilities respectively. Natural gas is also used for dedicated boilers at variouscampus buildings for generating steam and industrial hot water.

In speaking with the campus facilities staff, the following gas distribution issues were discovered.

- The main campus natural gas lines are steel pipes, with some sections are over 50 years old. Below is a summary of the older pipe sections.
  - o Distribution piping to Draper/Jenkins Halls (Bldg. 16/17) circa 1959.
  - o Distribution piping to Sierra/Sutter Halls (Bldg. 44/45) circa 1974
  - o Majority of the main campus distribution adjacent to Alpine Hall (Bldg. 11), circa 1960's.
- Polyethylene (PE) has been used as the pipe material for all gas line replacements and new installations.
  - o Distribution piping to American River Courtyard (Bldg. 25), circa 2009.
  - o Distribution piping to Broad Field House (Bldg. 54), circa 2008.
  - o Distribution piping adjacent to Douglas Hall.

A natural gas distribution plan providing pipe sizes and routing of gas lines is provided at the end of the section.

A model for the overall natural gas piping infrastructure system has been generated and was evaluated for the system capacity. From this model it was calculated that piping segments serving buildings consume approximately twentyfive (25%) percent capacity. The buildings that are included within this range are Capital Public Radio, Alumni Center, Child Development Center, El Dorado Hall, Public Safety, Napa Hall, Modoc Hall, Library, and Capistrano Hall.

The piping segments that are within the seventyfive (75%) percent of the piping capacity are the central campus supply and supply branches to buildings 27, 40, 47, 91, and 95.

Age and Reliability

Majority of the Campus gas infrastructure was installed about 20 years back and is in good standing condition. The distribution system throughout the campus has undergone extensions over the years to accommodate campus expansions and additions and comprises of a mixture of PE and steel lines. Discussions with the campus maintenance facilities staff revealed that gas mains downstream of the gas meters are black steel pipe ranging from 3/4 inch to 6-inches in diameter. A few of the sections still have the old steel lines, are experiencing leakages and are at the end of their useful life.

The facility maintenance staff performs leak surveys on the campus gas infrastructure. There have been a leaks discovered over the years on the older gas piping and repairs made at each leak.

There are limited isolation valves on the gas infrastructure. The absence of isolation valves results in shutting down majority of the gas infrastructure and associated facilities to isolate a portion of the gas line in event of a leakage. Provision of new isolation valves and replacement of existing valves will help the campus isolate a section of the piping in event of its leakage.

There are earthquake valves installed throughout campus; observed at the Hornet Bookstore, Field House, etc. However, several buildings do not have earthquake valves. . These buildings need to be provided with earthquake valves to meet current codes.

Currently, the campus does not have a maintenance schedule to exercise the gas isolation valves.

Redundancy

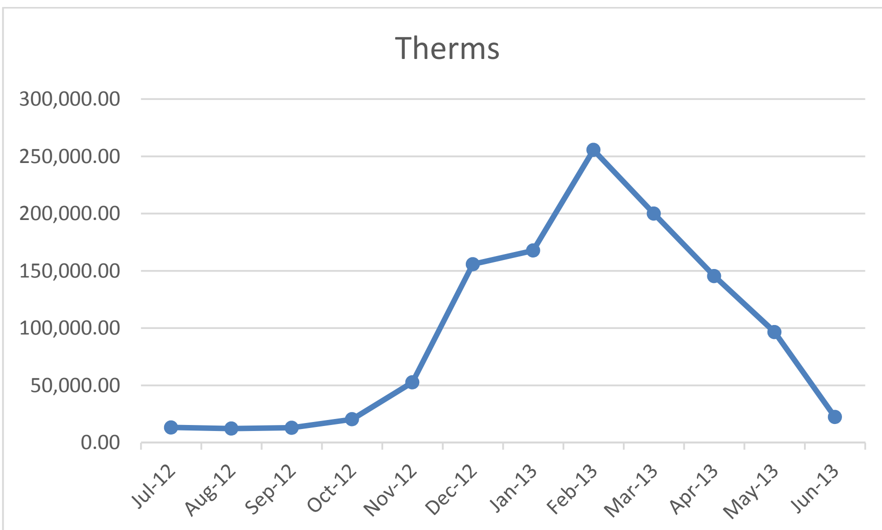
There is a single utility-owned gas meter that serve the majority of the buildings on campus; located at the central plant. In addition, there are several individual utility-owned gas meters that serve single buildings throughout the campus. The campus has no reported failures from PG&E side and thus the existing gas supply is considered a reliable service.

History of Outages / Disruption of Service

There have been no reported failures or disruption of service from PG&E for the last five years. However, the campus has had leaks on the older steel gas line distribution over the years due to its age and condition.

Existing Natural Gas Loads

Based on utility meter data from June 2012 through May 2013, the total gas usage was approximately 1,155,000 therms. The cost to the campus over the same period is approximately $852,000. See Table 1 for annual campus gas usage.



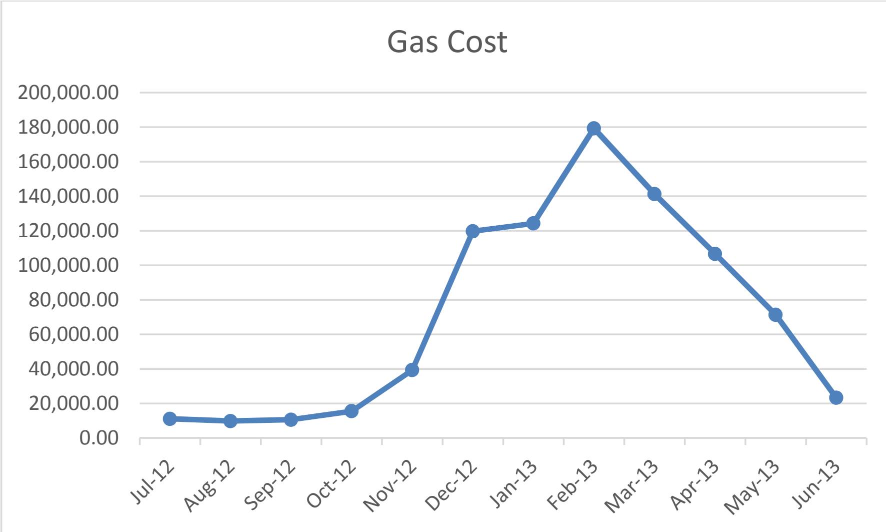

Gas Cost
200,000.00
180,000.00
160,000.00
140,000.00
120,000.00
100,000.00
80,000.00
60,000.00
40,000.00
20,000.00
0.00
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13
Jun-13

TABLE 1 – Utility Meter Loads

Utility Meter Name	Utility Meter No.	Total Load (Therms)
Central Plant	3363-5437	932,814
Alumni Center	5212-7834	2,235
Residence Halls; includes Dining Commons, Courtyard Market, Desmond, Draper, Jenkins, Sierra, Sutter, and American River Courtyard Halls	3046-603X	171,901
Child Development Center	5272-2978	1,954
Nursing	5238-3903	339
Public Safety	4269-6665	11,770
Napa Hall	5282-6345	6,097
Modoc Hall	2716-5534	26,735
Capital Public Radio	5459-4617	1,004
Parking III	3811-4329	37
Total	-	1,154,886

Table 2 provides a summary of building heating and domestic connected load demands. For non-metered buildings, the demand load is estimated based on building square footage and building usage type.

TABLE 2 – Building Heating and Domestic Connected Loads

Bldg No.	Building Name	Building Tag	Occupancy Type	Gross Area (Sq. Ft.)	Connected to Campus Steam (Y/N)	Heating Load Factor (BTUH/sq.ft.)	Estimated Heating Load (BTUH)	Estimated Domestic Load (BTUH)	Total Gas Load (BTUH)	Estimated Heating Load (CFH)	Estimated Domestic Load (CFH)	Total Gas Load (CFH)	Total Gas Load (Therm/Hr)	Hours per Year	Total Gas Load (Therm/Yr)
Central Plant - Main Campus															**932,814**
-	Academic Information Resource Center	ARC	Classroom - General	97,923	Y	15	1,468,845	220,327	1,689,172	1,469	220	1,689	16.9	2400	40,540
-	Alpine Hall	ALP	Social Science	30,550	Y	15	458,250	68,738	526,988	458	69	527	5.3	2400	12,648
-	Amador Hall	AMD	Psychology	67,138	Y	15	1,007,070	151,061	1,158,131	1,007	151	1,158	11.6	2400	27,795
-	Art Sculpture Lab	ASL	Art	12,040	N	30	361,200	54,180	415,380	361	54	415	4.2	2400	9,969
-	Athletic Center	ATH	Physical Education	27,313	Y	15	409,695	61,454	471,149	410	61	471	4.7	2400	11,308
-	Benicia Hall	BNC	Faculty Office	7,203	N	30	216,090	32,414	248,504	216	32	249	2.5	2400	5,964
-	Brighton Hall	BRH	Business Administration	30,880	Y	15	463,200	69,480	532,680	463	69	533	5.3	2400	12,784
-	Calaveras Hall	CLV	Classroom - General	21,630	Y	15	324,450	48,668	373,118	324	49	373	3.7	2400	8,955
-	Capistrano Hall	CPS	Music	84,767	Y	15	1,271,505	190,726	1,462,231	1,272	191	1,462	14.6	2400	35,094
-	Del Norte Hall	DLN	Classroom - Multi Purpose	54,000	Y	15	810,000	121,500	931,500	810	122	932	9.3	2400	22,356
-	Douglass Hall	DH	Classroom - General	22,700	Y	15	340,500	51,075	391,575	341	51	392	3.9	2400	9,398
-	Eureka Hall	EUR	Education	59,488	Y	15	892,320	133,848	1,026,168	892	134	1,026	10.3	2400	24,628
-	Facilities Services	FM			N	30	-	-	-	-	-	-	-	2400	-
-	Hornet Bookstore	BKS	Bookstore	93,170	N	30	2,795,100	419,265	3,214,365	2,795	419	3,214	32.1	2400	77,145
-	Humboldt Hall	HMB	Science	24,908	Y	15	373,620	56,043	429,663	374	56	430	4.3	2400	10,312
-	Kadema Hall	KDM	Art	46,184	Y	15	692,760	103,914	796,674	693	104	797	8.0	2400	19,120
-	Lassen Hall	LSN	Student Services	110,000	Y	15	1,650,000	247,500	1,897,500	1,650	248	1,898	19.0	2400	45,540
-	Library	LIB	Library	377,074	Y	15	5,656,110	848,417	6,504,527	5,656	848	6,505	65.0	2400	156,109
-	Mariposa Hall	MRP	Classroom - General	78,079	Y	15	1,171,185	175,678	1,346,863	1,171	176	1,347	13.5	2400	32,325
-	Mendocino Hall	MND	Classroom - General	77,000	Y	15	1,155,000	173,250	1,328,250	1,155	173	1,328	13.3	2400	31,878
-	Placer Hall	PLR	Science	67,101	Y	15								2400	27,780

							1,006,515	150,977	1,157,492	1,007	151	1,157	11.6		
-	River Front Center	RFC	Food Sales	40,198	Y	15	602,970	90,446	693,416	603	90	693	6.9	2400	16,642
-	Riverside Hall	RVR	Engineering	83,316	Y	15	1,249,740	187,461	1,437,201	1,250	187	1,437	14.4	2400	34,493
-	Santa Clara Hall	SCL	Engineering	66,391	Y	15	995,865	149,380	1,145,245	996	149	1,145	11.5	2400	27,486
-	Sequoia Hall	SQU	Science	191,137	Y	15	2,867,055	430,058	3,297,113	2,867	430	3,297	33.0	2400	79,131
-	Solano Hall	SLN	Classroom - General	67,710	Y	15	1,015,650	152,348	1,167,998	1,016	152	1,168	11.7	2400	28,032
-	Tahoe Hall	TAH	Business Administration	64,764	Y	15	971,460	145,719	1,117,179	971	146	1,117	11.2	2400	26,812
-	The WELL	WEL	Auxillary	150,845	N	30	4,525,350	678,803	5,204,153	4,525	679	5,204	52.0	2400	124,900
-	University Union	UU	Union	162,268	Y	15	2,434,020	365,103	2,799,123	2,434	365	2,799	28.0	2400	67,179
-	Yosemite Hall	YSM	Physical Education	82,301	Y	15	1,234,515	185,177	1,419,692	1,235	185	1,420	14.2	2400	34,073
							38,420,040	5,763,006	44,183,046	38,420	5,763	44,183	442	72,000	1,060,393
Alumni Center															**2,235**
-	Alumni Center	AC	Auxillary	10,800	N	15	162,000	16,200	178,200	162	16	178	1.8	2400	4,277
Residence Halls															**171,901**
-	Sutter Hall	STR	Dormitories	40,102	N	15	601,530	60,153	661,683	602	60	662	6.6	2400	15,880
-	Sierra Hall	SRA	Dormitories	41,662	N	15	624,930	62,493	687,423	625	62	687	6.9	2400	16,498
-	Draper Hall	DRP	Dormitories	38,212	N	15	573,180	57,318	630,498	573	57	630	6.3	2400	15,132
-	Jenkins Hall	JNK	Dormitories	38,212	N	15	573,180	57,318	630,498	573	57	630	6.3	2400	15,132
-	Desmond Hall	DSM	Dormitories	50,134	N	15	752,010	75,201	827,211	752	75	827	8.3	2400	19,853
-	Dining Commons	DC	Dormitories	22,747	N	15	341,205	34,121	375,326	341	34	375	3.8	2400	9,008
-	American River Courtyard	AMC	Dormitories	209,050	N	15	3,135,750	313,575	3,449,325	3,136	314	3,449	34.5	2400	82,784
							6,601,785	660,179	7,261,964	6,602	660	7,262	73	16,800	174,287
Child Development Center															**1,954**
-	Child Development Center	CDC	Other	13,704	N	15	205,560	20,556	226,116	206	21	226	2.3	2400	5,427
Nursing															**339**
-	El Dorado Hall	ELD	Faculty Office	11,029	N	15	165,435	16,544	181,979	165	17	182	1.8	2400	4,367

Public Safety															**11,770**
-	Public Safety	PSB	Adminstration	11,892	N	30	356,760	35,676	392,436	357	36	392	3.9	2400	9,418
Napa Hall															**6,097**
-	Napa Hall	NPA	Extended Education	33,932	N	15	508,980	50,898	559,878	509	51	560	5.6	2400	13,437
Modoc Hall															**26,735**
-	Modoc Hall	MDC	Auxillary	85,402	N	15	1,281,030	128,103	1,409,133	1,281	128	1,409	14.1	2400	33,819
Capital Public Radio															**1,004**
-	Capital Public Radio	CPR	Auxillary	19,838	N	15	297,570	29,757	327,327	298	30	327	3.3	2400	7,856
Parking III															**37**
-	Parking Structure III	PSIII	Parking	-	N	-	-	-	-	-	-	-	-	2400	-
Buildings Not Connected to Gas Utility															
-	Sacramento Hall	SAC	Adminstration	38,090	Y	15	571,350	57,135	628,485	571	57	628	6.3	2400	15,084
-	Sacramento Hall Annex	SNX	Adminstration	2,201	Y	15	33,015	3,302	36,317	33	3	36	0.4	2400	872
-	Shasta Hall	SHS	Theater Arts	62,667	Y	15	940,005	94,001	1,034,006	940	94	1,034	10.3	2400	24,816

No Gas Connection
Meter Locations

-	Folsom Hall (Off site)	FLS	Classroom - Multi Purpose	198,692	N	15	2,980,380	298,038	3,278,418	2,980	298	3,278	32.8	2400	78,682

B.2 P2S Analysis

Order	Label	Building Name	Bldg. TAG	Building Type	Floors	GSF	Yr Built
GROUP 1							
1.0	UE	University Union Expansion	UU	University Union		35,000	TBD
GROUP 2							
2.0		Well Expansion	WEL	Auxillary		22,500	TBD
GROUP 3							
3.0		Parking Structure 4, Arboretum Expansion and Transit Stop relocation	PS4	Parking		22,500	TBD
Demolition of Existing Buildings							
3.0b		Public Service Buidling	PSB	Administration		-11,892	Dec-1959
					Net Impact (tons) from New Parking St		
					Net Impact (tons) to CHW loop from		
GROUP 4							
New Science Building							
4.0	NS	New Science (Previous Master Plan) **	-	Science	6	204,000	TBD
Demolition of Existing Buildings							
4.1a		Humbodt Hall	HMB	Science		-22,414	Sep-1967

4.1a		Alpine Hall	ALP	Social Science		-30,336	Jun-1957
4.1a		Brighton Hall	BRH	Business Administration		-28,956	Jun-1966
				Net Impact (tons) to CHW loop from New Scie			
Remodel of Existing Buildings							
4.2		Sequoia Hall	SQU	Science		191,137	Aug-1967
4.2		Placer Hall *	PLR	Science		67,101	Jan-1997
Demolition of Existing Buildings:							
4.4		Calaveras Hall	CLV	Classroom - General		-18,820	Sep-1956
4.4		Douglas Hall	DH	Classroom - General		-18,796	Feb-1959
4.4		Santa Clara Hall	SCL	Engineering		-62,813	Aug-1960
New Engineering Building							
4.5	1	New Engineering Building	-	Academic	1	17,500	TBD
				Net Impact (tons) to CHW loop from New Enginee			
				Net Impact (tons) to CHW loop from			
GROUP 5							
5.0	LR	Library Renovation	LIB I	Library North		211,835	Sep-1974
5.0	LR	Library Renovation	LIB II	Library South		165,239	Feb-1991
GROUP 6							
New Performing Arts							
6.0	2	New Performing Arts **	-	Performing Arts	1	36,000	TBD
				Net Impact (tons) from New Perfor			
				Net Impact (tons) to CHW loop from			
GROUP 7							
New Gateway Building							
7.0	3	New Administration/Student Services Building **	-	Adminstration	2	43,340	TBD
Demolition of Existing Buildings							
7.1a		Sacremento Hall	SNX	Adminstration	2	-35,180	Jul-1959
				Net Impact (tons) to CHW loop from New Gate			
Remodel of Existing Buildings							

7.2		Lassen Hall	LSN	Student Services	3	110,000	Nov-1980
Demolition of Existing Buildings							
7.3a		Kademan Hall	KDM	Art	2	-40,483	Nov-1962
				Net Impact (tons) to CHW loop from			
				Net Impact (tons) to CHW loop from G			
GROUP 8							
North Campus Housing							
8.0	A / PS6	Student Housing & Parking	-	Dormitories/Parking		72,000	TBD
8.1	B / PS7	Student Housing & Parking	-	Dormitories/Parking		60,000	TBD
8.2	C / PS5	Student Housing & Parking	-	Dormitories/Parking		85,600	TBD
8.2b		Demolish Jenkins Hall	JNK	Dormitories		-32,863	Sep-1959
8.3	DE	Housing - Dining Expansion	DC	Cafeteria		TBD	TBD
8.4	D	Student Housing	-	Dormitories		100,000	TBD
8.4b		Demolish Desmond Hall	DSM	Dormitories		-48,871	Sep-1990
8.4b		Demolish Draper Hall	DRP	Dormitories		-32,072	Sep-1959
8.5	E	Student Housing	-	Dormitories		60,000	TBD
8.6	F	Student Housing	-	Dormitories		60,000	TBD
8.6b		Demolish Sierra Hall	SRA	Dormitories		-38,086	Apr-1974
8.7	G	Student Housing	-	Dormitories		60,000	TBD
8.7b		Demo - Sutter Hall	STR	Dormitories		-36,537	Apr-1974
8.8	H	Student Housing	-	Dormitories		30,000	TBD
8.9	I	Student Housing	-	Dormitories		60,000	TBD
				Net Impact (tons) from			
GROUP 9							
Children's Center and South Campus Housing							
9.0	9	Children's Center	-	Child Care		15,780	TBD
9.3	J	Faculty/Grad Apts	-	Dormitories		104,000	TBD
9.4	K / PS8	Faculty/Grad Apts & Parking	-	Dormitories/Parking		100,800	TBD
9.5	L	Faculty/Grad Apts	-	Dormitories		109,600	TBD

9.6	M	Faculty/Grad Apts	-	Dormitories	85,800	TBD
9.7	N	Student Housing	-	Dormitories	76,000	TBD
9.8	O	Student Housing	-	Dormitories	92,000	TBD
9.9	P / PS9	Student Housing & Parking	-	Dormitories/Parking	84,000	TBD
9.10	Q	Student Housing	-	Dormitories	87,000	TBD
				Net Impact (tons) from		
GROUP 10						
Event Center						
10.0	EC	Student Events Center	-	Student Activities	200,000	TBD
				Net Impact (tons) from (		
GROUP 11						
Stadium						
11.0		New Stadium	-	Student Activities	TBD	TBD
GROUP 12						
Parking Structure 10						
12.0		New Parking Structure 10	-	Parking	TBD	TBD
GROUP 13						
Ramona Extension						
13.0		Ramona Extenstion	-		TBD	TBD

* Note: Propose magnetic-type water-cooled chillers; i.e. SMARDT, Multi-stack chillers
Propose gas-fired, condensing-type, high-efficency hot-water boilers; i.e. AJAX, Aerco, etc
Consider combining several halls into single plant based on location
** Note: Propose to provide satellite boiler plants to eliminate underground STEAM piping

N/A Not Applicable
N/C Not Connected

Ton/SF	Tons	CP GPM @ 20F	CHW Pipe Size	Comments
300	117	140	(E) 6"	There is (1) 700-ton chiller serving this building. Current est. load is 540-tons. Proposed expansion (117-tons) should have no impact to chiller capacity. In addition, University Union is connected to campus CHW loop. Proposed expansion will increase CHW flow to approximately 788 GPM which although is close to maximum design flow on (E) 6" CHW line will be able to be accomodated.
300	75	90	N/C	The Well is not connected to campus CHW loop. (2) 320-ton chillers serve this building. Current estimated load is approximately 500 tons. Proposed expansion (75-tons) should have no impact to CHW capacity. However, proposed expansion will increase building load to approximately 92% of current chiller capacity
300	75	N/A	4"	Parking Services offices & Campus Police offices will require CHW extensions from proposed undergound CHW utilities. Another option would be to provide stand-alone system; ie split dx systems, etc
300	-40	N/A	N/C	
ructure 4 =	35			
GROUP 3 =	75			Minor impact to existing Central CHW services
300	680	816	8"	Extend CHW line from (e) 12" CHW at Hornet Bookstore; see proposed CHW routing
300	-75	-90	(E)6"	Cap line; see DEMO CHW routing as part of new central quad expansion

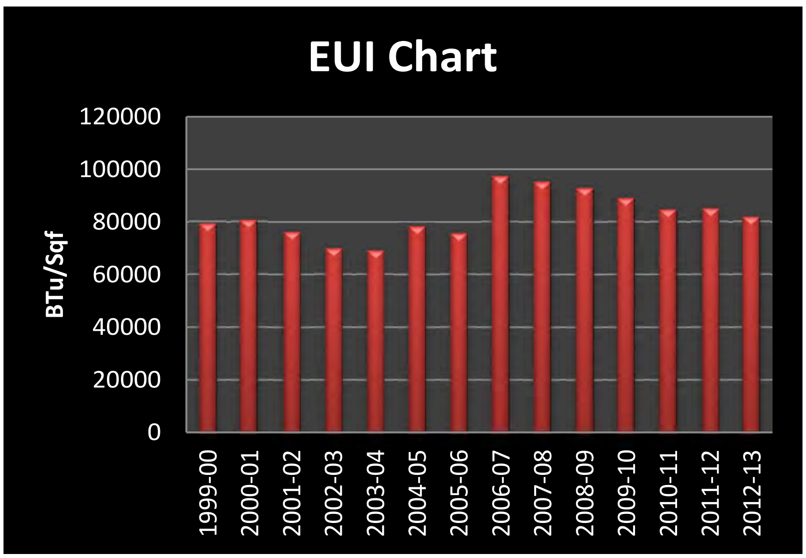
	300	-101	-121	(E)6"	Cap line; see DEMO CHW routing as part of new central quad expansion
	300	-97	-116	(E)6"	Cap line; see DEMO CHW routing as part of new central quad expansion
ence Bldg =		408			
	300	82	99	(E)8"	No change; existing CHW line has ample capacity
	300	118	142	(E)6"	No change; existing CHW line has ample capacity
	300	-63	-75	(E)4"	Cap line; see DEMO CHW routing as part of new central quad expansion
	300	-63	-75	(E)4"	Cap line; see DEMO CHW routing as part of new central quad expansion
	300	-209	-251	(E)2"	Provide new 4" CHW line from 12" CHW loop to serve new Engineering Bldg
	300	58	70	4"	Provide new 4" CHW line from 12" CHW loop; replaces load from Santa Clara Hall
ering Bldg =		-276			
GROUP 4 =		131			Minor impact to existing Central CHW services
	300	706	847	(E) 10"	No change; existing CHW line has ample capacity
	300	551	661	(E) 8"	No change; existing CHW line has ample capacity
	300	120	144	4"	Extend new CHW line from (E) 10"; recommend to create CHW loop. See proposed CHW routing
ning Arts =		120			
GROUP 4 =		120			Minor impact to existing Central CHW services
	300	144	173	6"	Extend new CHW line from (E) 10"; recommend to create CHW loop. See proposed CHW routing
	300	-117	-141	(E)4"	Cap line; see DEMO CHW routing as part of new Intramural/Activity area
way Bldg =		27			

300	367	440	2 - (E) lines; 6" & 8"	No change; existing CHW line has ample capacity
300	-135	-162	(E)4"	Cap line; see DEMO CHW routing as part of new central quad expansion
GROUP 7 =	-108			Reduces impact to existing Central CHW services
roup 1-7 =	**218**			**Minor impact to existing Central CHW services**
400	180	N/A	N/C	Satellite chillers with associate VFD pumps *
400	150	N/A	N/C	Satellite chillers with associate VFD pumps *
400	214	N/A	N/C	Satellite chillers with associate VFD pumps *
400	-82	N/A	N/C	DEMO
		N/A	N/C	
400	250	N/A	N/C	Satellite chillers with associate VFD pumps *
400	-122	N/A	N/C	DEMO
400	-80	N/A	N/C	DEMO
400	150	N/A	N/C	Satellite chillers with associate VFD pumps *
400	150	N/A	N/C	Satellite chillers with associate VFD pumps *
400	-95	N/A	N/C	DEMO
400	150	N/A	N/C	Satellite chillers with associate VFD pumps *
400	-91	N/A	N/C	DEMO
400	75	N/A	N/C	Satellite chillers with associate VFD pumps *
400	150	N/A	N/C	Satellite chillers with associate VFD pumps *
Group 8 =	**998**			**Consider mini-plants to serve multiple residence halls**
400	39	N/A	N/C	Satellite chillers with associate VFD pumps *
400	260	N/A	N/C	Satellite chillers with associate VFD pumps *
400	252	N/A	N/C	Satellite chillers with associate VFD pumps *
400	274	N/A	N/C	Satellite chillers with associate VFD pumps *

400	215	N/A	N/C	Satellite chillers with associate VFD pumps *
400	190	N/A	N/C	Satellite chillers with associate VFD pumps *
400	230	N/A	N/C	Satellite chillers with associate VFD pumps *
400	210	N/A	N/C	Satellite chillers with associate VFD pumps *
400	218	N/A	N/C	Satellite chillers with associate VFD pumps *
Group 9 =	**1887**			**Consider mini-plants to serve multiple residence halls**
400	500	N/A	N/C	Satellite chillers with associate VFD pumps *
Group 10 =	**500**			**Consider mini-plants to serve multiple residence halls**
400		N/A	N/C	Satellite chillers with associate VFD pumps *
		N/A	N/C	No impact
		N/A	N/C	No impact

	Building Name	Building #	Building Type	GSF	EUI (KBTU/SQFT-YR)
1	Academic Information Resource (	ARC	Classroom-General	97,923	61.3
2	Alumni Center **	AC	Auxillary	10,800	54.0
3	Alpine Hall	ALP	Social Science	30,550	61.3
4	Amador Hall	AMD	Psychology	67,138	61.3
5	American River Courtyard	AMC	Dormitories	209,050	61.3
6	Art Sculpture Lab	ASL	Art	12,040	61.3
7	Athletic Center	ATH	Physical Education	27,313	61.3
8	Benicia Hall	BNC	Faculty Office	7,203	60.2
9	Brighton Hall	BRH	Business Administration	30,880	60.2
10	Capital Public Radio **	CPR	Auxillary	19,838	46.7
11	Calaveras Hall	CLV	Classroom - General	21,630	61.3
12	Child Development Center **	CDC	Other	13,704	45.2
13	Capistrano Hall	CPS	Music	84,767	61.3
14	Central Plant		Corporate Yard	13,569	
15	Del Norte Hall	DLN	Classroom - Multi Purpose	54,000	61.3
16	Desmond Hall	DSM	Dormitories	50,134	61.3
17	Dining Commons **	DC	Cafeteria	22,747	375.2
18	Douglass Hall	DH	Classroom - General	22,700	61.3
19	Draper Hall	DRP	Dormitories	38,212	61.3
20	El Dorado Hall	ELD	Faculty Office	11,029	60.2
21	Eli & Edythe Broad Field House		Physical Education	26,013	61.3
22	Eureka Hall	EUR	Classroom/Faculty Office	59,488	61.3
23	Folsom Hall	FLS	Classroom - Multi Purpose	198,692	61.3
24	Hornet Bookstore *	BKS	Bookstore	93,170	56.9
25	Humboldt Hall	HMB	Science	24,908	121.3
26	Jenkins Hall	JNK	Dormitories	38,212	61.3
27	Kadema Hall	KDM	Art	46,184	61.3
28	Lassen Hall	LSN	Student Services	110,000	61.3
29	Library	LIB	Library	377,074	61.3
30	Mariposa Hall	MRP	Classroom - General	78,079	61.3
31	Mendocino Hall	MND	Classroom - General	77,000	61.3
32	Modoc Hall **	MDC	Auxillary	85,402	90.6
33	Napa Hall **	NPA	Extended Education	33,932	68.6
34	Placer Hall *	PLR	Science	67,101	121.3
35	Public Service Bldg	PSB	Adminstration	11,892	60.2
36	River Front Center *	RFC	Food Sales	40,198	296.2
37	Riverside Hall	RVR	Engineering	83,316	61.3
38	Sacramento Hall	SAC	Adminstration	38,090	60.2
39	Sacramento Hall Annex	SNX	Adminstration	2,201	60.2
40	Santa Clara Hall	SCL	Engineering	66,391	61.3

41	Sierra Hall	SRA	Dormitories	41,662	61.3
42	Sequoia Hall	SQU	Science	191,137	121.3
43	Shasta Hall	SHS	Theater Arts	62,667	61.3
46	Solano Hall	SLN	Classroom - General	67,710	61.3
47	Sutter Hall	STR	Adminstration	40,102	61.3
44	Tahoe Hall	TAH	Business Administration	64,764	60.2
45	The WELL *	WEL	Auxillary	150,845	58.0
48	University Union *	UU	Union	162,268	70.5
49	Yosemite Hall	YSM	Physical Education	82,301	61.3
				3,266,026	**76**



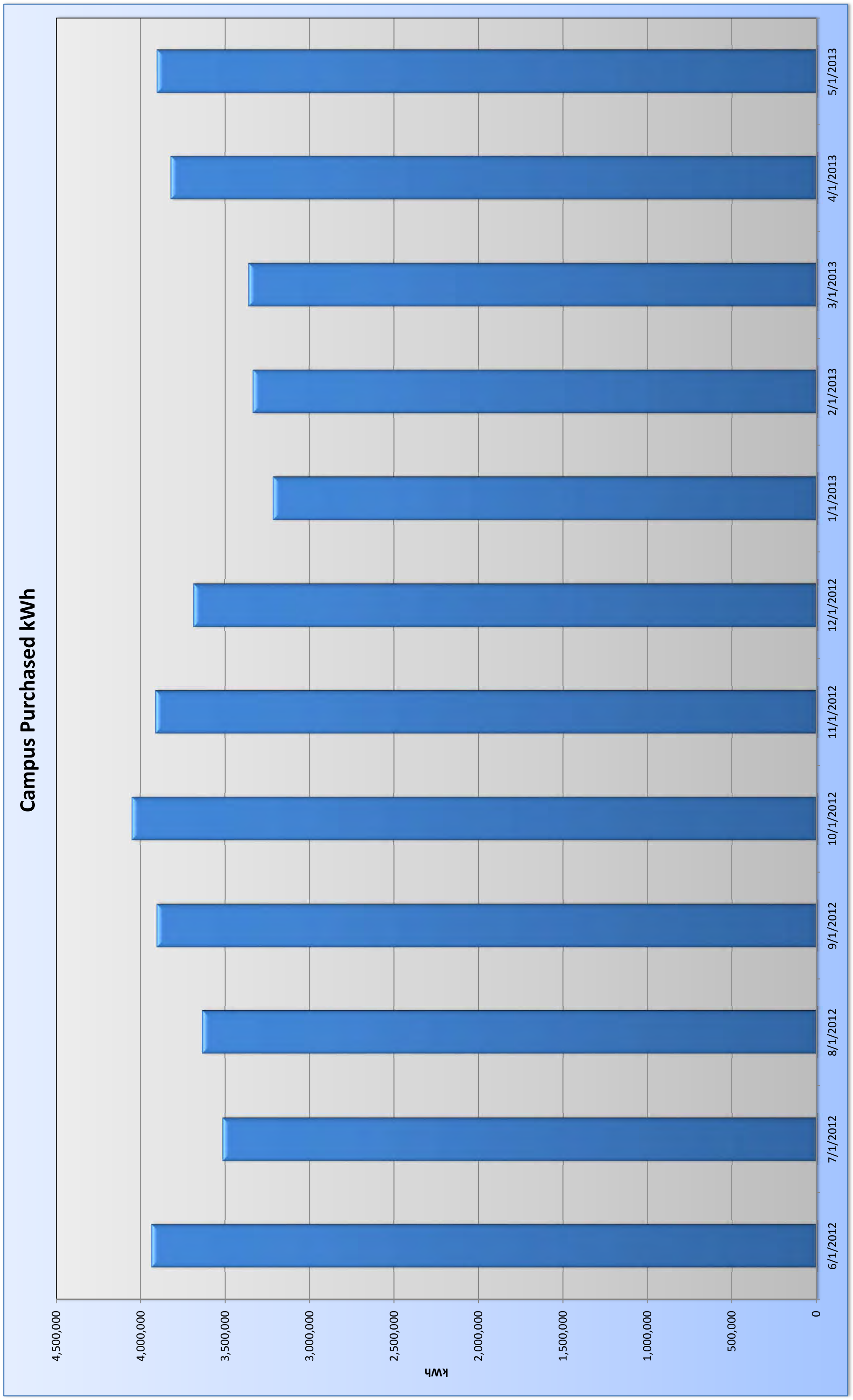
CSU Sacramento Master Plan Support for AC Martin (Based on Opt F @ 25,000 FTE CAP)

Label	Building Name	Bldg. TAG	Building Type	Floors	GSF	Yr Built	Heating Load Factor (BTUH/SF)	Total Heat Load (BTUH)	Lb-Steam Per Hour	Steam/Condensate Return Pipe Size	Comments
REMODEL OF EXISTING BUILDINGS											
	Lassen Hall	LSN	Student Services	3	110,000	Nov-1980	20	2,200,000	2,268	(E) 4" Steam (E) 1-1/2" CR	No change
	Sequoia Hall	SQU	Science	5	191,137	Aug-1967	20	3,822,740	3,940	(E) 4" Steam (E) 2-1/2" CR	No change
BUILDINGS TO BE DEMOLISHED											
	Alpine Hall	ALP	Social Science	2	-30,336	Jun-1957	20	(606,720)	(625)	(E) 4" Steam (E) 2" CR	Cap line; new central quad expansion
	Brighton Hall	BRH	Business Administration	2	-28,956	Jun-1966	20	(579,120)	(597)	(E) 4" Steam (E) 2" CR	Cap line; new central quad expansion
	Calaveras Hall	CLV	Classroom - General	1	-18,820	Sep-1956	20	(376,400)	(388)	(E) 4" Steam (E) 2" CR	Cap line; new central quad expansion
	Douglas Hall	DH	Classroom - General	2	-18,796	Feb-1959	20	(375,920)	(387)	(E) 4" Steam (E) 2" CR	Cap line; new central quad expansion
	Humbodt Hall	HMB	Science	2	-22,414	Sep-1967	20	(448,280)	(462)	(E) 3" Steam (E) 1-1/2" CR	Cap line; new central quad expansion
	Kademan Hall	KDM	Art	2	-40,483	Nov-1962	20	(809,660)	(835)	(E) 3" Steam (E) 1-1/2" CR	Cap line; new central quad expansion
	Sacremento Hall	SNX	Adminstration	2	-35,180	Jul-1959	20	(703,600)	(725)	(E) 2" Steam (E) 1-1/2" CR	Cap line; new Intramural/Activity area
	Santa Clara Hall	SCL	Engineering	1	-62,813	Aug-1960	20	(1,256,260)	(1,295)	(E) 3" Steam (E) 2" CR	Provide new 3" steam line from 10" steam loop to serve new Engineering Building
							sub-total of demo load =	(5,155,960)	(5,314)		
PROPOSED NEW BUILDINGS **											
1	New Engineering Building		Academic	1	17,500	TBD	20	350,000	361	2" Steam 1-1/2" CR	Provide new 3" steam line from 10" steam loop; replaces load from Santa Clara Hall
2	Performing Arts		Performing Arts	1	36,000	TBD	20	720,000	742	3" Steam 1-1/2" CR	Extend from 10"; possibe to connect "loop" with 10"
3	Admin/Student Services		Adminstration	2	43,340	TBD	20	866,800	893	3" Steam 1-1/2" CR	Extend from 10"; possibe to connect "loop" with 10"
NS	New Science (Previous MP)		Science	6	204,000	TBD	20	4,080,000	4,205	5" Steam 2" CR	Extend from 12" at Hornet Bookstore
UE	University Union Expansion	UU	University Union		35,000	TBD	20	700,000	721	(2) (E) steam lines: 3" Steam 1-1/2" CR; 4" Steam / 1-1/2" CR	Existing steam lines are sufficient to handle additional load
	Parking Structure 4, Arboretum Expansion and Transit Stop relocation	PS4	Parking / Police Station		22,500	TBD	20	450,000	464	2" Steam 1-1/2" CR	Parking Services offices & Campus Police offices will require Steam extensions from proposed undergound STM utilities. Another option would be to provide stand-alone system; ie split dx systems, etc
							sub-total of new load =	7,166,800	7,387		
							Net Impact (tons) to Steam loop =	**2,010,840**	**2,073**		**Minor impact to existing Central steam services**
PROPOSED RESIDENTIAL HALLS *											
A	Student Housing		Dormitories		72,000	TBD	20	1,440,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
B	Student Housing		Dormitories		60,000	TBD	20	1,200,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
C	Student Housing		Dormitories		85,600	TBD	20	1,712,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *

D	Student Housing	Dormitories	100,000	TBD	20	2,000,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
E	Student Housing	Dormitories	60,000	TBD	20	1,200,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
F	Student Housing	Dormitories	60,000	TBD	20	1,200,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
G	Student Housing	Dormitories	60,000	TBD	20	1,200,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
H	Student Housing	Dormitories	30,000	TBD	20	600,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
I	Student Housing	Dormitories	60,000	TBD	20	1,200,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
J	Faculty/Grad Apts	Dormitories	104,000	TBD	20	2,080,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
K	Faculty/Grad Apts	Dormitories	100,800	TBD	20	2,016,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
L	Faculty/Grad Apts	Dormitories	109,600	TBD	20	2,192,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
M	Faculty/Grad Apts	Dormitories	85,800	TBD	20	1,716,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
N	Student Housing	Dormitories	76,000	TBD	20	1,520,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
O	Student Housing	Dormitories	92,000	TBD	20	1,840,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
P	Student Housing	Dormitories	84,000	TBD	20	1,680,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *
Q	Student Housing	Dormitories	87,000	TBD	20	1,740,000	N/A	N/C	Satellite gas-fired HHW boilers with associate VFD pumps *

* Note: Propose magnetic-type water-cooled chillers; i.e. SMARDT, Multi-stack chillers
Propose gas-fired, condensing-type, high-efficency hot-water boilers; i.e. AJAX, Aerco, etc
Consider combining several halls into single plant based on location
** Note Propose to provide satellite boiler plants to eliminate underground STEAM piping

(E)2" Need to confirm existing 2" CHW line
N/A Not Applicable
N/C Not Connected


Campus Purchased kWh
kWh
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
6/1/2012
7/1/2012
8/1/2012
9/1/2012
10/1/2012
11/1/2012
12/1/2012
1/1/2013
2/1/2013
3/1/2013
4/1/2013
5/1/2013

B.3 P2S Recommendations

THE VISION TO CHANGE.
THE INTEGRITY TO SUSTAIN.

Cal State University Sacramento

Master Plan MEP Recommendations

March 17, 2013

DRAFT

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Table of Contents

CHILLED WATER (CHW) SYSTEM

An evaluation of the proposed facilities that will be added as part of the proposed master plan revealed that an estimated 1,076 tons will be added to the central plant CHW loop. The proposed demolition of buildings will remove an estimated 859 tons from the loop. The net impact thus to the central plant is approximately 217-tons or 1,300 ton-hours at peak periods.

The central plant currently has 3,750-tons of chiller capacity with an 18,725 ton-hour TES tank. The maximum cooling demand to the campus is approximately 3,300-tons during the summer. The additional 218-ton load will thus have no impact on chiller capacity.

However, this additional tonnage will impact the TES utilization. Based on the maximum cooling demand of 3,300 tons, this equates to about 20,000 ton-hours of required cooling (typically 6 hours; 2pm – 8pm). This exceeds the current TES capacity. Furthermore, data received from CSUS Facilities have confirmed that the TES tank cannot meet the cooling requirements during peak summer demand and one of the chillers need to be operated during the peak periods plant. The additional load from the proposed buildings will require one of the chillers to operate in conjunction with the TES to meet the cooling demands of the facilities. This will trigger utility demand charges and will increase the operating costs of the campus.

To meet the cooling demands of the proposed facilities, improve efficiency and minimize operating costs, P2S has the following recommendations:

- The Intent of the TES system is to reduce the peak demand charges and electrical costs incurred by the central plant equipment. The proposed master plan will add 218-tons or 1,300 ton-hours of cooling. It is recommended that a new thermal energy storage (TES) tank be installed, located adjacent to existing TES tank. Alternatively, the campus can undertake or implement campus wide energy conservation measures (ECM's) to improve building performance and lower overall building tonnage requirements. This would also include the commissioning of the existing central plant. An assumption of 10% reduction in the current tonnage can easily be achieved to reduce the overall tonnage demand at the campus. CSU Sacramento has the option to run the electrical chillers during peak demand periods to handle the additional load. However, there will be a financial demand charge from the utility company.

The existing chilled water distribution system is adequately sized to handle the cooling loads of the proposed facilities. We recommend the following to meet their cooling demands.

- Connect the proposed New Engineering Building to the CHW loop.

- Recommend extending underground CHW piping to the following proposed new buildings; see map.

1. a. Performing Arts Building (#2)
   b. Administration / Student Services Building (#3-Gateway)
   c. New Science Building (#NS)
   d. Optional: Police Station at Parking Structure 4

2. Note: Police Station can be stand-alone using DX split systems.

3. Recommend creating new underground CHW loops; see map.

4. e. New 10" CHW loop to serve Performing Arts and Admin/Student Services

   f. New 12" CHW loop to serve Science Buildings

STEAM SYSTEM

An evaluation of the loads of the proposed facilities revealed that will be added as part of the facilities master plan revealed that an estimated load of 7,386 lbs-steam/hour will be added to the central plant steam loop. The proposed demolition of buildings will remove an estimated 5,314 lbs-steam/hour from the central plant. The net impact thus would be approximately 2,072 lbs-steam/hour.

The central plant has a total steam capacity of 110,000 lbs-steam/hour. The typical maximum steam demand to the campus is approximately 50,000 lbs-steam/hour. There is thus no impact to central plant capacity with these proposed buildings.

To meet the heating demands of the proposed facilities, improve efficiency and minimize operating costs, P2S has the following recommendations:

5. Recommend to provide additional 450,000-input natural gas heating hot water boiler for the Well Expansion

6. Recommend to reconnect the New Engineering Building to central plant steam loop. Steam plant has ample capacity.

7. Campus preference is to eliminate steam generation and distribution. Provide satellite plant with gas-fired HHW boiler(s) for the following new buildings

8. - Performing Arts Building (#2)
   - Administration / Student Services Building (#3-Gateway)
   - New Science Building (#NS)
   - Police Station at Parking Structure 4

9. Alternate Option would be to extend the underground steam lines to the following new buildings:

10. - Performing Arts Building (#2)

    - Administration / Student Services Building (#3-Gateway)

    - New Science Building (#NS)

    - Police Station at Parking Structure 4

NATURAL GAS SYSTEM

- The proposed facilities will be served from a combination of 6" HPG PG&E line running along the central part of the campus and campus owned lines to meet the domestic hot water and labs demands of the facilities. A separate meter will be provided along with associated regulators and earthquake valves to serve the proposed facilities. Meter shall be able to connect to campus EMCS.

ELECTRICAL SYSTEM

- An evaluation of the facilities planned as part of the proposed master plan revealed that a net additional 300,000 square feet of state funded buildings and an additional 1,300,000 square feet of non-state funded buildings will be added to the existing campus. An analysis of the electrical demands of these future state and non-state buildings planned as part of this master plan revealed that the campus would approximately see an increase in its electrical demand by 1.7MW for Academic/Administration/Student Support buildings and approximately 4.5MW for Student Housing. These demands have been calculated based on the proposed square footages of the facilities planned as part of the master plan. A spreadsheet showing installed capacities and demand of the proposed facilities is enclosed herewith for reference.

- An analysis of the current 12.47kV distribution system was conducted to evaluate a) existing spare capacities available in each of the feeders b) the impact of the proposed facilities on the existing electrical distribution system and c) modifications required to support the future build out of the campus. The current electrical distribution was also analyzed for electrical duct-banks/manholes that will be in conflict with the proposed facilities and will require relocation. A campus site plan identifying electrical duct-banks/manholes that require demolition/relocation to support the planned facilities is enclosed herewith. A table providing the installed capacity/demand and feeders that will be used to serve each of the proposed facilities is provided for reference.

- PV systems are also recommended on proposed parking structures PS4 and PS10 and existing parking structure PS3 (approximately 1MW in total) to offset a portion of the peak electrical demand of the campus.

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Student Housing and Faculty/Grad Apartments (Bldgs. A-Q)

CHILLED WATER (CHW) SYSTEM

1. Provide satellite plant(s) with heat recoversy chiller(s), cooling tower and associate pumps; similar to existing residence halls.

2. Provide 4-pipe fan coils/AHU to serve these buildings

HEATING HOT WATER (HHW) SYSTEM

1. Provide satellite plant(s) with gas-fired HHW boiler(s) and associated pumps; similar to existing residence halls.

2. Provide 4-pipe fan coils/AHU to serve these buildings

3. Consider Solar Thermal technology for the proposed facilities to offset natural gas demand.

NATURAL GAS SYSTEM

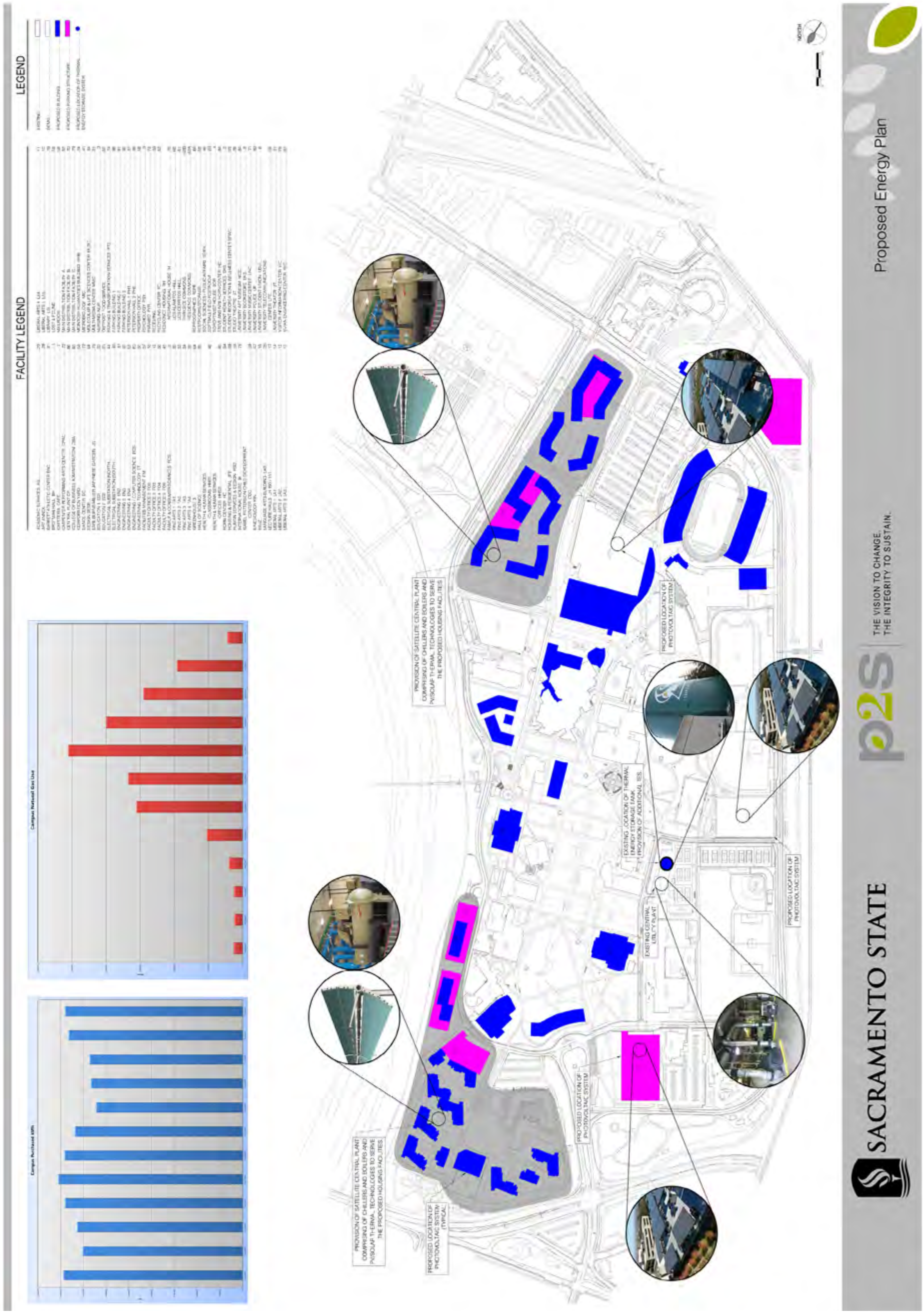
1. Provide a new gas line to serve the needs of the heating hot water and space heating loads. This gas line will be provided by PG&E from the north side of the proposed facilities and will be metered separately. Associated regulators and earthquake valves to serve the non-state residence halls shall be provided. Meter shall be able to connect to campus EMS system. Existing location of 6" HPG line owned by PG&E will need to be verified/relocated as it is currently in conflict with the proposed housing facilities('J'-'Q') on the south east side of the campus.

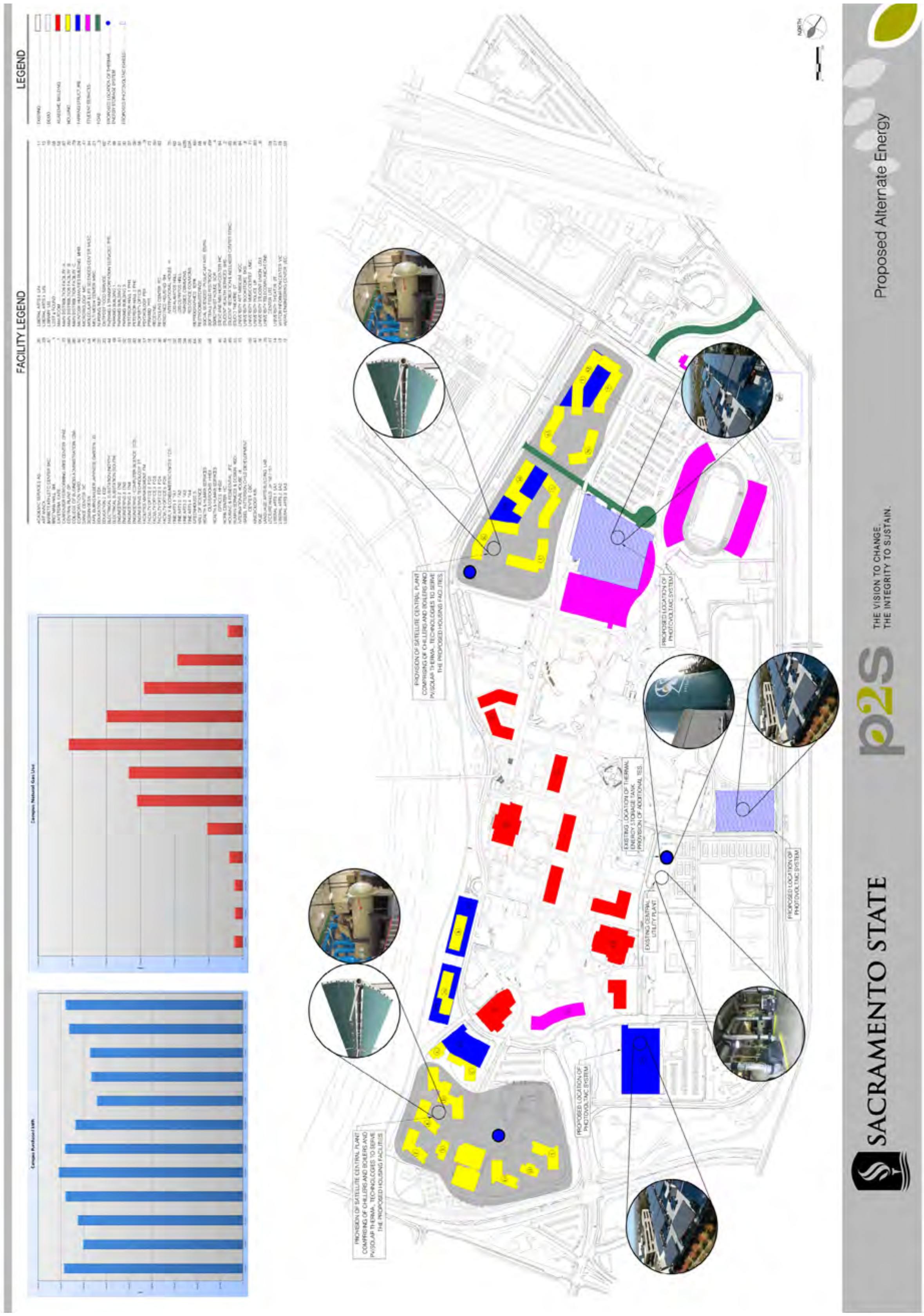
ELECTRICAL SYSTEM

1. Consider PV system for the proposed facilities to offset electrical demand.

2. Serve the proposed housing facilities (Facilities 'A'-'I') on the north east side of the campus with existing feeders '5' and '6'. Provide new 5"C duct banks with 15kV 3#250kcmil EPR conductors and extend to proposed building substations to meet their power requirements. Provide 15kV selector switches above grade to facilitate ease of isolation of facilities and transfer of service to an alternate feeder should the primary feeder fail or is taken down for maintenance.

3. Serve the proposed housing facilities (Facilities 'J'-'Q') on the south east side of the campus with a separate SMUD service. The electrical service will be metered at 480V and will serve the power needs of the proposed facilities.


Proposed Energy Plan
SACRAMENTO STATE
p2S
THE VISION TO CHANGE.
THE INTEGRITY TO SUSTAIN.
LEGEND
FACILITY LEGEND



LEGEND
FACILITY LEGEND
Proposed Alternate Energy
SACRAMENTO STATE
p2S
THE VISION TO CHANGE.
THE INTEGRITY TO SUSTAIN.

Order	Label	Building Name	Bldg. TAG	Building Type	Floors	GSF	Yr Built	Ton/SF	Tons	CP GPM @ 20F	CHW Pipe Size
GROUP 1											
1.0	UE	University Union Expansion	UU	University Union		35,000	TBD	300	117	140	(E) 6"
GROUP 2											
2.0		Well Expansion	WEL	Auxillary		22,500	TBD	300	75	90	N/C
GROUP 3											
3.0		Parking Structure 4, Arboretum Expansion and Transit Stop relocation	PS4	Parking		22,500	TBD	300	75	N/A	4"
Demolition of Existing Buildings											
3.0b		Public Service Buidling	PSB	Administration		-11,892	Dec-1959	300	-40	N/A	N/C
				Net Impact (tons) from New Parking Structure 4 =					35		
				Net Impact (tons) to CHW loop from GROUP 3 =					75		
GROUP 4											
New Science Building											
4.0	NS	New Science (Previous Master Plan) **	-	Science	6	204,000	TBD	300	680	816	8"
Demolition of Existing Buildings											
4.1a		Humbodt Hall	HMB	Science		-22,414	Sep-1967	300	-75	-90	(E)6"
4.1a		Alpine Hall	ALP	Social Science		-30,336	Jun-1957	300	-101	-121	(E)6"
4.1a		Brighton Hall	BRH	Business Administration		-28,956	Jun-1966	300	-97	-116	(E)6"
				Net Impact (tons) to CHW loop from New Science Bldg =					408		
Remodel of Existing Buildings											
4.2		Sequoia Hall	SQU	Science		191,137	Aug-1967	300	82	99	(E)8"
4.2		Placer Hall *	PLR	Science		67,101	Jan-1997	300	118	142	(E)6"
Demolition of Existing Buildings:											
4.4		Calaveras Hall	CLV	Classroom - General		-18,820	Sep-1956	300	-63	-75	(E)4"
4.4		Douglas Hall	DH	Classroom - General		-18,796	Feb-1959	300	-63	-75	(E)4"
4.4		Santa Clara Hall	SCL	Engineering		-62,813	Aug-1960	300	-209	-251	(E)2"
New Engineering Building											
4.5	1	New Engineering Building	-	Academic	1	17,500	TBD	300	58	70	4"
				Net Impact (tons) to CHW loop from New Engineering Bldg =					-276		
				Net Impact (tons) to CHW loop from GROUP 4 =					131		
GROUP 5											
5.0	LR	Library Renovation	LIB I	Library North		211,835	Sep-1974	300	706	847	(E) 10"
5.0	LR	Library Renovation	LIB II	Library South		165,239	Feb-1991	300	551	661	(E) 8"
GROUP 6											
New Performing Arts											
6.0	2	New Performing Arts **	-	Performing Arts	1	36,000	TBD	300	120	144	4"
				Net Impact (tons) from New Performing Arts =					120		
				Net Impact (tons) to CHW loop from GROUP 4 =					120		
GROUP 7											
New Gateway Building											
7.0	3	New Administration/Student Services Building **	-	Adminstration	2	43,340	TBD	300	144	173	6"
Demolition of Existing Buildings											
7.1a		Sacremento Hall	SNX	Adminstration	2	-35,180	Jul-1959	300	-117	-141	(E)4"
				Net Impact (tons) to CHW loop from New Gateway Bldg =					27		
Remodel of Existing Buildings											
7.2		Lassen Hall	LSN	Student Services	3	110,000	Nov-1980	300	367	440	2 - (E) lines; 6" & 8"
Demolition of Existing Buildings											
7.3a		Kademan Hall	KDM	Art	2	-40,483	Nov-1962	300	-135	-162	(E)4"
				Net Impact (tons) to CHW loop from GROUP 7 =					-108		
				Net Impact (tons) to CHW loop from Group 1-7 =					**218**		
GROUP 8											
North Campus Housing											
8.0	A / PS6	Student Housing & Parking	-	Dormitories/Parking		72,000	TBD	400	180	N/A	N/C
8.1	B / PS7	Student Housing & Parking	-	Dormitories/Parking		60,000	TBD	400	150	N/A	N/C
8.2	C / PS5	Student Housing & Parking	-	Dormitories/Parking		85,600	TBD	400	214	N/A	N/C
8.2b		Demolish Jenkins Hall	JNK	Dormitories		-32,863	Sep-1959	400	-82	N/A	N/C
8.3	DE	Housing - Dining Expansion	DC	Cafeteria		TBD	TBD			N/A	N/C
8.4	D	Student Housing	-	Dormitories		100,000	TBD	400	250	N/A	N/C
8.4b		Demolish Desmond Hall	DSM	Dormitories		-48,871	Sep-1990	400	-122	N/A	N/C
8.4b		Demolish Draper Hall	DRP	Dormitories		-32,072	Sep-1959	400	-80	N/A	N/C
8.5	E	Student Housing	-	Dormitories		60,000	TBD	400	150	N/A	N/C
8.6	F	Student Housing	-	Dormitories		60,000	TBD	400	150	N/A	N/C
8.6b		Demolish Sierra Hall	SRA	Dormitories		-38,086	Apr-1974	400	-95	N/A	N/C
8.7	G	Student Housing	-	Dormitories		60,000	TBD	400	150	N/A	N/C
8.7b		Demo - Sutter Hall	STR	Dormitories		-36,537	Apr-1974	400	-91	N/A	N/C
8.8	H	Student Housing	-	Dormitories		30,000	TBD	400	75	N/A	N/C
8.9	I	Student Housing	-	Dormitories		60,000	TBD	400	150	N/A	N/C
				Net Impact (tons) from Group 8 =					998		
GROUP 9											
Children's Center and South Campus Housing											
9.0	9	Children's Center	-	Child Care		15,780	TBD	400	39	N/A	N/C
9.3	J	Faculty/Grad Apts	-	Dormitories		104,000	TBD	400	260	N/A	N/C
9.4	K / PS8	Faculty/Grad Apts & Parking	-	Dormitories/Parking		100,800	TBD	400	252	N/A	N/C
9.5	L	Faculty/Grad Apts	-	Dormitories		109,600	TBD	400	274	N/A	N/C
9.6	M	Faculty/Grad Apts	-	Dormitories		85,800	TBD	400	215	N/A	N/C
9.7	N	Student Housing	-	Dormitories		76,000	TBD	400	190	N/A	N/C
9.8	O	Student Housing	-	Dormitories		92,000	TBD	400	230	N/A	N/C
9.9	P / PS9	Student Housing & Parking	-	Dormitories/Parking		84,000	TBD	400	210	N/A	N/C
9.10	Q	Student Housing	-	Dormitories		87,000	TBD	400	218	N/A	N/C
				Net Impact (tons) from Group 9 =					1887		
GROUP 10											
Event Center											
10.0	EC	Student Events Center	-	Student Activities		200,000	TBD	400	500	N/A	N/C
				Net Impact (tons) from Group 10 =					500		
GROUP 11											
Stadium											
11.0		New Stadium	-	Student Activities		TBD	TBD	400		N/A	N/C
GROUP 12											
Parking Structure 10											
12.0		New Parking Structure 10	-	Parking		TBD	TBD			N/A	N/C
GROUP 13											
Ramona Extension											
13.0		Ramona Extenstion	-			TBD	TBD			N/A	N/C

* Note: Propose magnetic-type water-cooled chillers; i.e. SMARDT, Multi-stack chillers
Propose gas-fired, condensing-type, high-efficency hot-water boilers; i.e. AJAX, Aerco, etc
Consider combining several halls into single plant based on location
** Note: Propose to provide satellite boiler plants to eliminate underground STEAM piping

N/A Not Applicable
N/C Not Connected

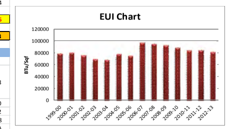
Order	Label	Building Name	Bldg. TAG	Building Type	Floors	GSF	Yr Built	Heating Load Factor (BTUH/SF)	Total Heat Load (BTUH)	Lb-Steam Per Hour	Steam/Condensate Return Pipe Size
GROUP 1											
1.0	UE	University Union Expansion	UU	University Union		35,000	TBD	20	700,000	721	(2) existing steam lines: 3" Steam 1-1/2" CR; 4" Steam / 1-1/2" CR
				Net Impact (BTUH) to steam loop from GROUP 1 =					700,000	721	
GROUP 2											
2.0		The Well	WEL	Auxillary		150,845	Sep-2010	20	3,016,900	N/A	N/C
2.0		Well Expansion	WEL	Auxillary		22,500	TBD	20	450,000	N/A	N/C
GROUP 3											
3.0		Parking Structure 4, Arboretum Expansion and Transit Stop relocation	PS4	Parking		22,500	TBD	20	450,000	464	2" Steam 1-1/2" CR
Demolition of Existing Buildings											
3.0b		Public Service Buidling	PSB	Administration		-11,892	Dec-1959	20	(237,840)	N/A	N/C
				Net Impact (BTUH) from New Parking Structure 4 =					212,160	464	
				Net Impact (BTUH) to steam loop from GROUP 3 =					450,000	464	
GROUP 4											
New Science Building											
4.0	NS	New Science (Previous Master Plan) **	-	Science	6	204,000	TBD	20	4,080,000	4,205	8"
Demolition of Existing Buildings											
4.1a		Humbodt Hall	HMB	Science		-22,414	Sep-1967	20	(448,280)	(462)	(E)6"
4.1a		Alpine Hall	ALP	Social Science		-30,336	Jun-1957	20	(606,720)	(625)	(E)6"
4.1a		Brighton Hall	BRH	Business Administration		-28,956	Jun-1966	20	(579,120)	(597)	(E)6"
				Net Impact (tons) to CHW loop from New Science Bldg =					2,445,880	2,521	
Remodel of Existing Buildings											
4.2		Sequoia Hall	SQU	Science		191,137	Aug-1967	20	3,822,740	3,940	(E)8"
4.2		Placer Hall *	PLR	Science		67,101	Jan-1997	20	1,342,020	1,383	(E)6"
Demolition of Existing Buildings:											
4.4		Calaveras Hall	CLV	Classroom - General		-18,820	Sep-1956	20	(376,400)	(388)	(E)4"
4.4		Douglas Hall	DH	Classroom - General		-18,796	Feb-1959	20	(375,920)	(387)	(E)4"
4.4		Santa Clara Hall	SCL	Engineering		-62,813	Aug-1960	20	(1,256,260)	(1,295)	(E)2"
New Engineering Building											
4.5	1	New Engineering Building	-	Academic	1	17,500	TBD	20	350,000	361	4"
				Net Impact (BTUH) to steam loop from New Engineering Bldg =					(1,658,580)	(1,710)	
				Net Impact (BTUH) to steam loop from GROUP 4 =					787,300	811	
GROUP 5											
5.0	LR	Library Renovation	LIB I	Library North		211,835	Sep-1974	20	4,236,700	4,367	(E) 10"
5.0	LR	Library Renovation	LIB II	Library South		165,239	Feb-1991	20	3,304,780	3,406	(E) 8"
GROUP 6											
New Performing Arts											
6.0	2	Performing Arts **	-	Performing Arts	1	36,000	TBD	20	720,000	742	4"
				Net Impact (BTUH) from New Performing Arts =					720,000	742	
				Net Impact (BTUH) to steam loop from GROUP 4 =					720,000	742	
GROUP 7											
New Gateway Building											
7.0	3	New Administration/Student Services Building **	-	Adminstration	2	43,340	TBD	20	866,800	893	6"
Demolition of Existing Buildings											
7.1a		Sacremento Hall	SNX	Adminstration	2	-35,180	Jul-1959	20	(703,600)	(725)	(E)4"
				Net Impact (BTUH) to steam loop from New Gateway Bldg =					163,200	168	
Remodel of Existing Buildings											
7.2		Lassen Hall	LSN	Student Services	3	110,000	Nov-1980	20	2,200,000	2,268	2 - (E) lines; 6" & 8"
Demolition of Existing Buildings											
7.3a		Kademan Hall	KDM	Art	2	-40,483	Nov-1962	20	(809,660)	(835)	(E)4"
				Net Impact (BTUH) to steam loop from GROUP 7 =					(646,460)	(666)	
				Net Impact (BTUH) to steam loop from Group 1-7 =					**1,310,840**	**2,073**	
GROUP 8											
North Campus Housing											
8.0	A / PS6	Student Housing & Parking	-	Dormitories/Parking		72,000	TBD	20	1,440,000	N/A	N/C
8.1	B / PS7	Student Housing & Parking	-	Dormitories/Parking		60,000	TBD	20	1,200,000	N/A	N/C
8.2	C / PS5	Student Housing & Parking	-	Dormitories/Parking		85,600	TBD	20	1,712,000	N/A	N/C
8.2b		Demolish Jenkins Hall	JNK	Dormitories		-32,863	Sep-1959	20	(657,260)	N/A	N/C
8.3	DE	Housing - Dining Expansion	DC	Cafeteria		TBD	TBD			N/A	N/C
8.4	D	Student Housing	-	Dormitories		100,000	TBD	20	2,000,000	N/A	N/C
8.4b		Demolish Desmond Hall	DSM	Dormitories		-48,871	Sep-1990	20	(977,420)	N/A	N/C
8.4b		Demolish Draper Hall	DRP	Dormitories		-32,072	Sep-1959	20	(641,440)	N/A	N/C
8.5	E	Student Housing	-	Dormitories		60,000	TBD	20	1,200,000	N/A	N/C
8.6	F	Student Housing	-	Dormitories		60,000	TBD	20	1,200,000	N/A	N/C
8.6b		Demolish Sierra Hall	SRA	Dormitories		-38,086	Apr-1974	20	(761,720)	N/A	N/C
8.7	G	Student Housing	-	Dormitories		60,000	TBD	20	1,200,000	N/A	N/C
8.7b		Demo - Sutter Hall	STR	Dormitories		-36,537	Apr-1974	20	(730,740)	N/A	N/C
8.8	H	Student Housing	-	Dormitories		30,000	TBD	20	600,000	N/A	N/C
8.9	I	Student Housing	-	Dormitories		60,000	TBD	20	1,200,000	N/A	N/C
				Net Impact (BTUH) from Group 8 =					7,983,420		
GROUP 9											
Children's Center and South Campus Housing											
9.0	9	Children's Center	-	Child Care		15,780	TBD	20	315,600	N/A	N/C
9.3	J	Faculty/Grad Apts	-	Dormitories		104,000	TBD	20	2,080,000	N/A	N/C
9.4	K / PS8	Faculty/Grad Apts & Parking	-	Dormitories/Parking		100,800	TBD	20	2,016,000	N/A	N/C
9.5	L	Faculty/Grad Apts	-	Dormitories		109,600	TBD	20	2,192,000	N/A	N/C
9.6	M	Faculty/Grad Apts	-	Dormitories		85,800	TBD	20	1,716,000	N/A	N/C
9.7	N	Student Housing	-	Dormitories		76,000	TBD	20	1,520,000	N/A	N/C
9.8	O	Student Housing	-	Dormitories		92,000	TBD	20	1,840,000	N/A	N/C
9.9	P / PS9	Student Housing & Parking	-	Dormitories/Parking		84,000	TBD	20	1,680,000	N/A	N/C
9.10	Q	Student Housing	-	Dormitories		87,000	TBD	20	1,740,000	N/A	N/C
				Net Impact (BTUH) from Group 9 =					15,099,600		
GROUP 10											
Event Center											
10.0	EC	Student Events Center	-	Student Activities		200,000	TBD	20	4,000,000	N/A	N/C
				Net Impact (BTUH) from Group 10 =					4,000,000		
GROUP 11											
Stadium											
11.0		New Stadium	-	Student Activities		TBD	TBD	20		N/A	N/C
GROUP 12											
Parking Structure 10											
12.0		New Parking Structure 10	-	Parking		TBD	TBD			N/A	N/C
GROUP 13											
Ramona Extension											
13.0		Ramona Extenstion	-			TBD	TBD			N/A	N/C

* Note: Propose magnetic-type water-cooled chillers; i.e. SMARDT, Multi-stack chillers
Propose gas-fired, condensing-type, high-efficency hot-water boilers; i.e. AJAX, Aerco, etc
Consider combining several halls into single plant based on location
** Note: Propose to provide satellite boiler plants to eliminate underground STEAM piping

N/A Not Applicable
N/C Not Connected

Building Type	Floors	GSF	Yr Built	W/Sqft	Required Capacity	kW Demand
University Union		35,000	TBD	15	525	210
Net Impact (kW) from New Parking Structure 4 =					525	210
Auxillary		22,500	TBD	15	338	135
Net Impact (kW) from New Parking Structure 4 =					863	345
Parking		22,500	TBD	8	180	72
Administration		-11,892	Dec-1959	10	-119	-48
Net Impact (kW) from New Parking Structure 4 =					61	24
Net Impact (kW) to Electrical Distribution System from GROUP 3 =					61	24
Science	6	204,000	TBD	15	3060	1224
Science		-22,414	Sep-1967	15	-336	-134
Social Science		-30,336	Jun-1957	15	-455	-182
Business Administration		-28,956	Jun-1966	15	-434	-174
Net Impact (kW) to Elect Distribution System from New Science Bldg =					1834	734
Science		191,137	Aug-1967	15	2867	1147
Science		67,101	Jan-1997	15	1007	403
Classroom - General		-18,820	Sep-1956	12	-226	-90
Classroom - General		-18,796	Feb-1959	12	-226	-90
Engineering		-62,813	Aug-1960	12	-754	-302
Academic	1	17,500	TBD	12	210	84
Net Impact (tons) to Elect Distribution System from New Engineering Bldg =					-995	-398
Net Impact (kW) to Elect Distribution System from GROUP 4 =					839	336
Library North		211,835	Sep-1974	12	2542	1017
Library South		165,239	Feb-1991	12	1983	793
Performing Arts	1	36,000	TBD	12	432	173
Net Impact (kW) to Elect Distribution System from New Performing Arts =					432	173
Net Impact (kW) to Elect Distribution System from GROUP 4 =					432	173
Adminstration	2	43,340	TBD	12	520	208
Adminstration	2	-35,180	Jul-1959	12	-422	-169
Net Impact (kW) to Elect Distribution System from New Gateway Bldg =					98	39
Student Services	3	110,000	Nov-1980	12	1320	528
Art	2	-40,483	Nov-1962	12	-486	-194
Net Impact (kW) to Elect Distribution System from GROUP 7 =					-388	-155
Net Impact (kW) to Elect Distribution System from Group 1-7 =					**2332**	**933**
Dormitories/Parking		72,000	TBD	10	720	288
Dormitories/Parking		60,000	TBD	10	600	240
Dormitories/Parking		85,600	TBD	10	856	342
Dormitories		-32,863	Sep-1959	12	-394	-158
Cafeteria		TBD	TBD			N/A
Dormitories		100,000	TBD	10	1000	400
Dormitories		-48,871	Sep-1990	12	-586	-235
Dormitories		-32,072	Sep-1959	12	-385	-154
Dormitories		60,000	TBD	10	600	240
Dormitories		60,000	TBD	10	600	240
Dormitories		-38,086	Apr-1974	12	-457	-183
Dormitories		60,000	TBD	10	600	240
Dormitories		-36,537	Apr-1974	12	-438	-175
Dormitories		30,000	TBD	10	300	120
Dormitories		60,000	TBD	10	600	240
Net Impact (kW) from Group 8 =					3615	1446
Child Care		15,780	TBD	10	158	63
Dormitories		104,000	TBD	10	1040	416
Dormitories/Parking		100,800	TBD	10	1008	403
Dormitories		109,600	TBD	10	1096	438
Dormitories		85,800	TBD	10	858	343
Dormitories		76,000	TBD	10	760	304
Dormitories		92,000	TBD	10	920	368
Dormitories/Parking		84,000	TBD	10	840	336
Dormitories		87,000	TBD	10	870	348
Net Impact (kW) from Group 9 =					7550	3020
Student Activities		200,000	TBD	10	2000	800
Net Impact (kW) from Group 10 =					2000	800
Student Activities		TBD	TBD	10		N/A
Parking		TBD	TBD	8		N/A
		TBD	TBD	10		N/A
Total Load Added in KW					15497	6199
Total Net Load Added in KW on Feeders 1 and 2						4327
Total Net Load Added in KW on Feeders 3 and 4						58
Total Net Load Added in KW on Feeders 5 and 6						1730

	Building Name	Building #	Building Type	GSF	EUI (KBTU/SQFT-YR)
1	Academic Information Resource Center	ARC	Classroom-General	97,923	61.3
2	Alumni Center **	AC	Auxillary	10,800	54.0
3	Alpine Hall	ALP	Social Science	30,550	61.3
4	Amador Hall	AMD	Psychology	67,138	61.3
5	American River Courtyard	AMC	Dormitories	209,050	61.3
6	Art Sculpture Lab	ASL	Art	12,040	61.3
7	Athletic Center	ATH	Physical Education	27,313	61.3
8	Benicia Hall	BNC	Faculty Office	7,203	60.2
9	Brighton Hall	BRH	Business Administration	30,880	60.2
10	Capital Public Radio **	CPR	Auxillary	19,838	46.7
11	Calaveras Hall	CLV	Classroom - General	21,630	61.3
12	Child Development Center **	CDC	Other	13,704	45.2
13	Capistrano Hall	CPS	Music	84,767	61.3
14	Central Plant		Corporate Yard	13,569	0.0
15	Del Norte Hall	DLN	Classroom - Multi Purpose	54,000	61.3
16	Desmond Hall	DSM	Dormitories	50,134	61.3
17	Dining Commons **	DC	Cafeteria	22,747	375.2
18	Douglass Hall	DH	Classroom - General	22,700	61.3
19	Draper Hall	DRP	Dormitories	38,212	61.3
20	El Dorado Hall	ELD	Faculty Office	11,029	60.2
21	Eli & Edythe Broad Field House		Physical Education	26,013	61.3
22	Eureka Hall	EUR	Classroom/Faculty Office	59,488	61.3
23	Folsom Hall	FLS	Classroom - Multi Purpose	198,692	61.3
24	Hornet Bookstore *	BKS	Bookstore	93,170	56.9
25	Humboldt Hall	HMB	Science	24,908	121.3
26	Jenkins Hall	JNK	Dormitories	38,212	61.3
27	Kadema Hall	KDM	Art	46,184	61.3
28	Lassen Hall	LSN	Student Services	110,000	61.3
29	Library	LIB	Library	377,074	61.3
30	Mariposa Hall	MRP	Classroom - General	78,079	61.3
31	Mendocino Hall	MND	Classroom - General	77,000	61.3
32	Modoc Hall **	MDC	Auxillary	85,402	90.6
33	Napa Hall **	NPA	Extended Education	33,932	68.6
34	Placer Hall *	PLR	Science	67,101	121.3
35	Public Service Bldg	PSB	Adminstration	11,892	60.2
36	River Front Center *	RFC	Food Sales	40,198	296.2
37	Riverside Hall	RVR	Engineering	83,316	61.3
38	Sacramento Hall	SAC	Adminstration	38,090	60.2
39	Sacramento Hall Annex	SNX	Adminstration	2,201	60.2
40	Santa Clara Hall	SCL	Engineering	66,391	61.3
41	Sierra Hall	SRA	Dormitories	41,662	61.3
42	Sequoia Hall	SQU	Science	191,137	121.3
43	Shasta Hall	SHS	Theater Arts	62,667	61.3
46	Solano Hall	SLN	Classroom - General	67,710	61.3
47	Sutter Hall	STR	Adminstration	40,102	61.3
44	Tahoe Hall	TAH	Business Administration	64,764	60.2
45	The WELL *	WEL	Auxillary	150,845	58.0
48	University Union *	UU	Union	162,268	70.5
49	Yosemite Hall	YSM	Physical Education	82,301	61.3
				3,266,026	76



SACRAMENTO STATE

p2s THE VISION TO CHANGE. THE INTEGRITY TO SUSTAIN.

Proposed Alternate Energy Data

SUSTAINABLE DESIGN APPROACH

We believe green/sustainable facility design is one that achieves high performance, over the full life cycle, in the following areas:

- Minimizing natural resource consumption through more efficient utilization of nonrenewable natural resources, land, water, and construction materials,
- Minimizing emissions that negatively impact our indoor environment and the atmosphere of our planet, especially those related to indoor air quality (IAQ), greenhouse gases, and global warming,
- Minimizing discharge of solid waste and liquid effluents,
- Minimal negative impacts on site ecosystems.
- Maximum quality of indoor environment, including air quality, thermal regime, illumination, acoustics/noise, and visual aspects to provide comfortable working environment.

The following methodology and approach will be adopted in bringing together engineering, innovation and sustainability to provide an overall sustainable design for the facilities planned at the campus as part of the proposed master plan.

- Orienting the buildings to minimize internal loads and maximize passive heating and cooling is key to making buildings efficient. The floor plans would be arranged in a way to block solar heat gain from the western sun and to maximize passive heating during the winter months. The buildings would use their building forms and orientation to take advantage of the sun to generate enough power to sustain them from an energy standpoint. Proper orientation for day lighting, ventilation and cooling will be the baseline approach to our design.

- Adopting an integrated approach for all the proposed facilities by working closely with the team to determine this optimum orientation and maximizing the efficiency of the envelope. Modeling energy performance and comparing various cost effective strategies available to achieve the optimum and most economical building envelope combinations will be pursued to maximizing energy efficiency and minimizing operating costs of the facilities.

- Generating daylighting models to determine the effect of daylight on the spaces and its use to minimize electric lighting will be pursued.

- The use of lightweight construction materials with low thermal mass is preferable, particularly on walls that are exposed to the sun. This is because lightweight construction materials such as timber, respond quickly to cooling breezes allowing the building to cool faster. These materials will be provided with insulation to prevent direct heat transfer and to improve the efficiency of mechanical cooling.

- Use of high thermal mass construction materials would also be evaluated. If high thermal mass materials are used, the building would be well shaded to avoid heat gain and insulated internally to reduce heat transfer. Recent research has shown that innovative, well-insulated and shaded thermal mass designs have been able to lower night time temperatures by 3 to 4°C with a low level of temperature fluctuation between day and night.

- Efficient mechanical and electrical systems will be identified and evaluated to serve the proposed facilities. Some of these strategies will include:

  - Use of indirect/direct evaporative cooling systems,
  - Use of radiant heating and cooling systems,
  - Use of earth tube to precondition outside air on VAV air handling system,
  - Use of phase change material on inside walls that will store 30 Btu/ft2 at 73°F phase change,
  - Use of air speed (ceiling fans) to expand thermal comfort ranges,
  - Use of effective control system integration strategies,
  - Use of energy efficient equipment to minimize energy consumption,
  - Use of energy efficient LED lighting coupled with effective occupancy and automatic daylight control strategies and demand control system,
  - Promoting task lighting in spaces to reduce overhead lighting power densities,

    - Promoting ‘occupancy control power strips to shut off monitors and other plug loads when not in use.
    - Evaluating DC distribution and providing the same in office areas.
    - Promoting cut off LED lighting outdoors
    - Promoting energy efficient distribution transformers to reduce no load and load losses.
    - Promoting metering with central display to monitor energy generation and consumption
    - Use of solar tubes to minimize electric lighting

- Options for providing renewable energy technologies utilizing solar will be evaluated to offset a portion of the overall facilities energy consumption and minimize greenhouse gas emissions. Following renewable systems will be pursued:

    - Use of Solar hot water to minimize use of natural gas consumption

    - Use of photovoltaic panels to offset a portion of the facilities electrical energy

- Water conservation strategies will be evaluated to maximize water efficiency with in each of the facility. Strategies like waterless/low gpf water fixtures, effective control/reduced use of water for irrigation, use of aerators in faucets, and the use of storm drain run off for irrigation will be evaluated and implemented.

All materials and systems designed will be evaluated based on life cycle costs to reduce maintenance and operation costs of the facilities in the future.

B.4 P2S Engineering Documents

p2S

California State University, Sacramento
MEP Master Plan Recommendations
March 21, 2014

Overview

- Existing Systems and Capacities
- Proposed Master Plan
- Proposed Loads and Capacity Requirements
- Recommendations

CSU SACRAMENTO MASTER PLAN RECOMMENDATIONS 2

Existing Systems and Capacities

- Central Plant with TES System
  - (3) 1250 Tons Electrical Chillers – Peak Capacity 3300tons
  - 18,725tonhour TES Tank – Peak ton hours – 20,000tonhours
  - Lack of TES capacity to meet peak demand
- 12kV Electrical Distribution System
  - 15MVA Transformer
  - Dual Feeds from SMUD
  - Six MV Feeders – Peak Demand – 8.7MW
  - Feeders '1' and '2' at capacity
  - Lack of Selector Switches to Isolate Feeders
- Natural Gas Distribution System
  - 6"HPG Line – Center of Campus
  - Medium Pressure Gas Distribution

Existing Systems and Capacities

- Sewer System
  - Combination of SDR 35 and VCP Piping
  - Majority of VCP lines lined
  - Sections of VCP lines along the central campus need to be lined.
  - Lift Stations in selected buildings
- Domestic Water System
  - Combination of C-900 and Transite Piping
  - Booster Pump Stations
  - Need replacement of section of old Transite Lines
- Storm Drain System
  - Storm Drain pumping stations
  - Selected areas near the center of campus get flooded
  - Receiver too small on the north side of campus

CSU SACRAMENTO MASTER PLAN RECOMMENDATIONS 4

Proposed Master Plan

Proposed Loads

- State Buildings – Approx. 300,000sqft Net Addition
  - Cooling Loads – 218tons
  - Heating Loads – 2073 lbs steam/hour
  - Electrical Loads – 1.7MVA
- Non State Buildings – Approx. 1,300,000sqft – Net Addition
  - Cooling Loads – 2500tons
  - Heating Loads – 26MMBH
  - Electrical Loads – 4.5MVA

Recommendations – State Facilities

- Augmentation of TES Capacity to offset peak demands
- Implementation of energy efficiency projects to lower tonnage requirements
- Extension of chilled water piping to serve new buildings and form loop system
- Extension of steam piping to serve new buildings
- Extension of existing MV feeders '3' and '4' and '5' and '6' to meet elect. load requirements
- Extension of existing Gas, Sewer and Water distribution to new buildings
- Provision of PV system on new buildings

CSU SACRAMENTO MASTER PLAN RECOMMENDATIONS 7

Recommendations – Non State Facilities

- Provision of satellite plant comprising of heat recovery chillers and boilers
- Provision of PV/Solar Thermal technologies to offset electrical and natural gas demands
- Extension of existing feeders '5' and '6' to serve NE Housing Facilities
- Provision of new SMUD electrical service to serve SE Housing Facilities
- Provision of PG&E gas service to serve the proposed housing facilities
- Provision of PV systems on Parking Structures

Proposed Master Plan

- PS5—up to 1,650 spaces, probable footprint impact shown in blue dashed line.
- Estimated 22,050 SF parking services/police satellite offices facility

CSU SACRAMENTO MASTER PLAN RECOMMENDATIONS 1

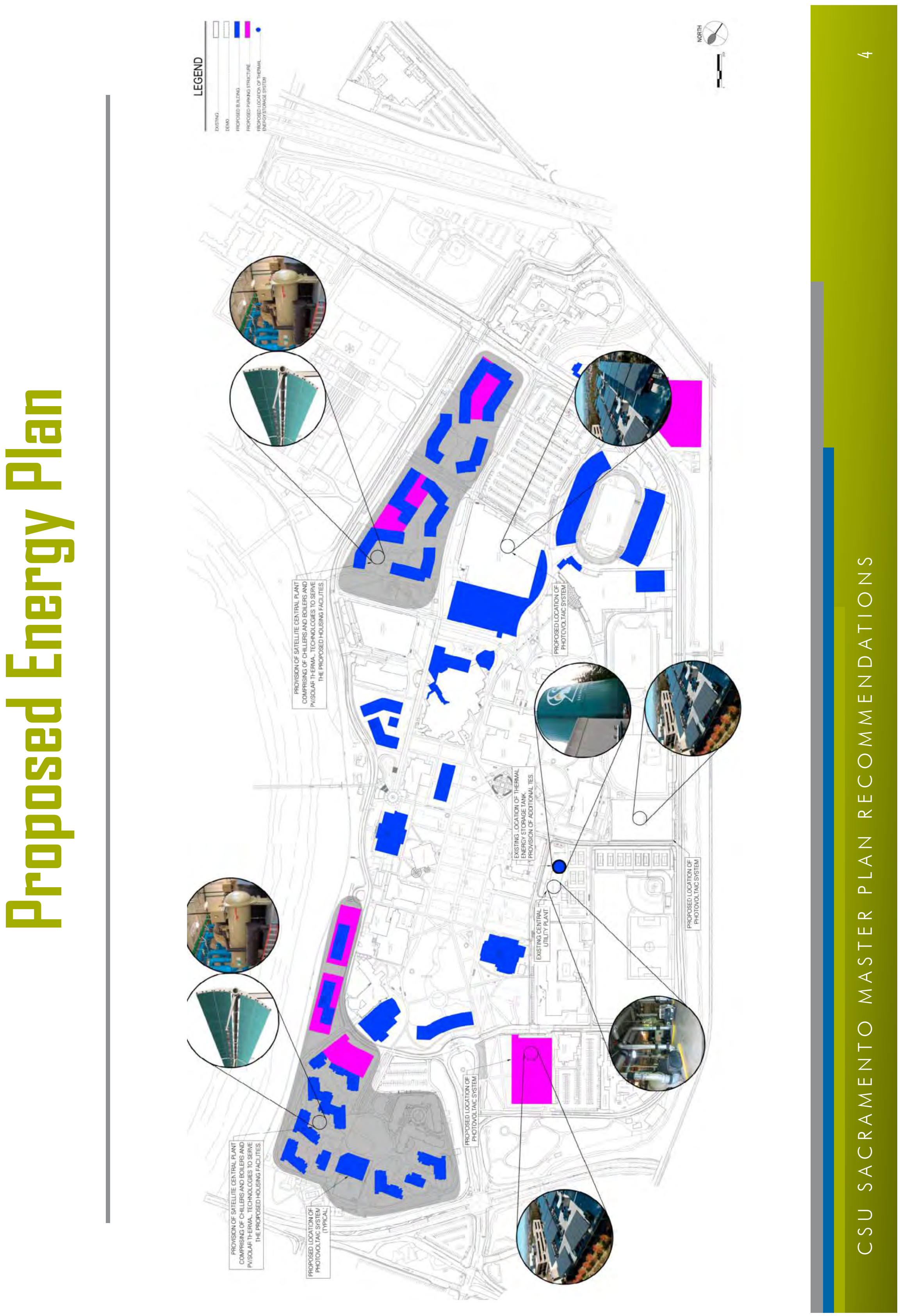
Sustainable Design Strategies

- Use of indirect/direct evaporative cooling systems,
- Use of radiant heating and cooling systems,
- Use of earth tube to precondition outside air on VAV air handling system,
- Use of phase change material on inside walls that will store 30 Btu/ft2 at 73°F phase change,
- Use of air speed (ceiling fans) to expand thermal comfort ranges,
- Use of effective control system integration strategies,
- Use of energy efficient equipment to minimize energy consumption,

CSU SACRAMENTO MASTER PLAN RECOMMENDATIONS 2

Sustainable Design Strategies

- Use of energy efficient LED lighting coupled with effective occupancy and automatic daylight control strategies and demand control system,
- Promoting task lighting in spaces to reduce overhead lighting power densities,
- Promoting 'occupancy control power strips to shut off monitors and other plug loads when not in use.
- Promoting cut off LED lighting outdoors
- Promoting energy efficient distribution transformers to reduce no load and load losses.
- Promoting metering with central display to monitor energy generation and consumption
- Use of solar tubes to minimize electric lighting


Proposed Energy Plan
LEGEND
NORTH
PROVISION OF SATELLITE CENTRAL PLANT COMPRISING OF CHILLERS AND BOILERS AND PV/SOLAR THERMAL TECHNOLOGIES TO SERVE THE PROPOSED HOUSING FACILITIES
PROPOSED LOCATION OF PHOTOVOLTAIC SYSTEM
EXISTING LOCATION OF THERMAL ENERGY STORAGE TANK PROVISION OF ADDITIONAL TES
EXISTING CENTRAL UTILITY PLANT
PROPOSED LOCATION OF PHOTOVOLTAIC SYSTEM (TYPICAL)
CSU SACRAMENTO MASTER PLAN RECOMMENDATIONS
4

B.5 Sustainability Analysis

BRIGHTWORKS SUSTAINABILITY

CSU Sacramento State Master Plan

Net Zero Energy Plan

Joshua Hatch

Christopher Forney

July 11th, 2014

Assumptions

Existing building with no planned renovations will have energy improvements of 30% by 2035

Existing buildings to be renovated do not see improvements until renovations

New buildings do not see continued improvements after they are built

Solar electricity production per kW of installed capacity 1550 *kWh/kW/yr*

Solar thermal on new housing will provide 50% of natural gas (assumed 45% of total

EUI TARGETS BY BUILDING TYPE

NEW	2015	2020	2025	2030	2035
Academic/Housing	40	30	20	20	20
Science	60	50	50	40	40
Food Service	200	175	150	125	100
Parking	15	15	10	10	10

RENOVATED	2015	2020	2025	2030	2035
Academic/Housing	60	55	50	45	40
Science	60	50	50	40	40
Food Service	n/a	n/a	n/a	n/a	n/a
Parking	n/a	n/a	n/a	n/a	n/a

EXISTING	2015	2020	2025	2030	2035
Percent Improvement, Cumulative	0%	15%	20%	25%	30%

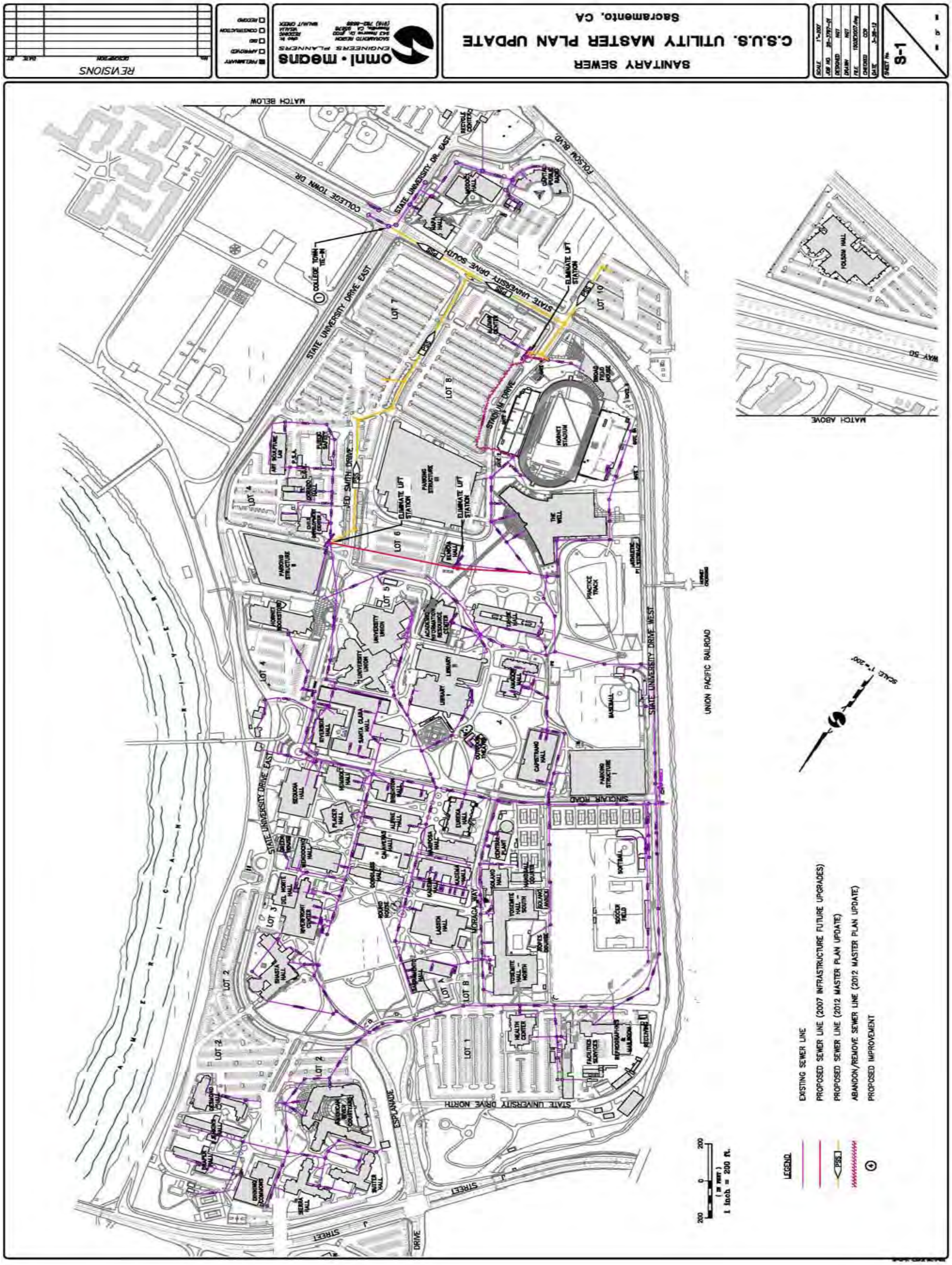
DEMOLISHED

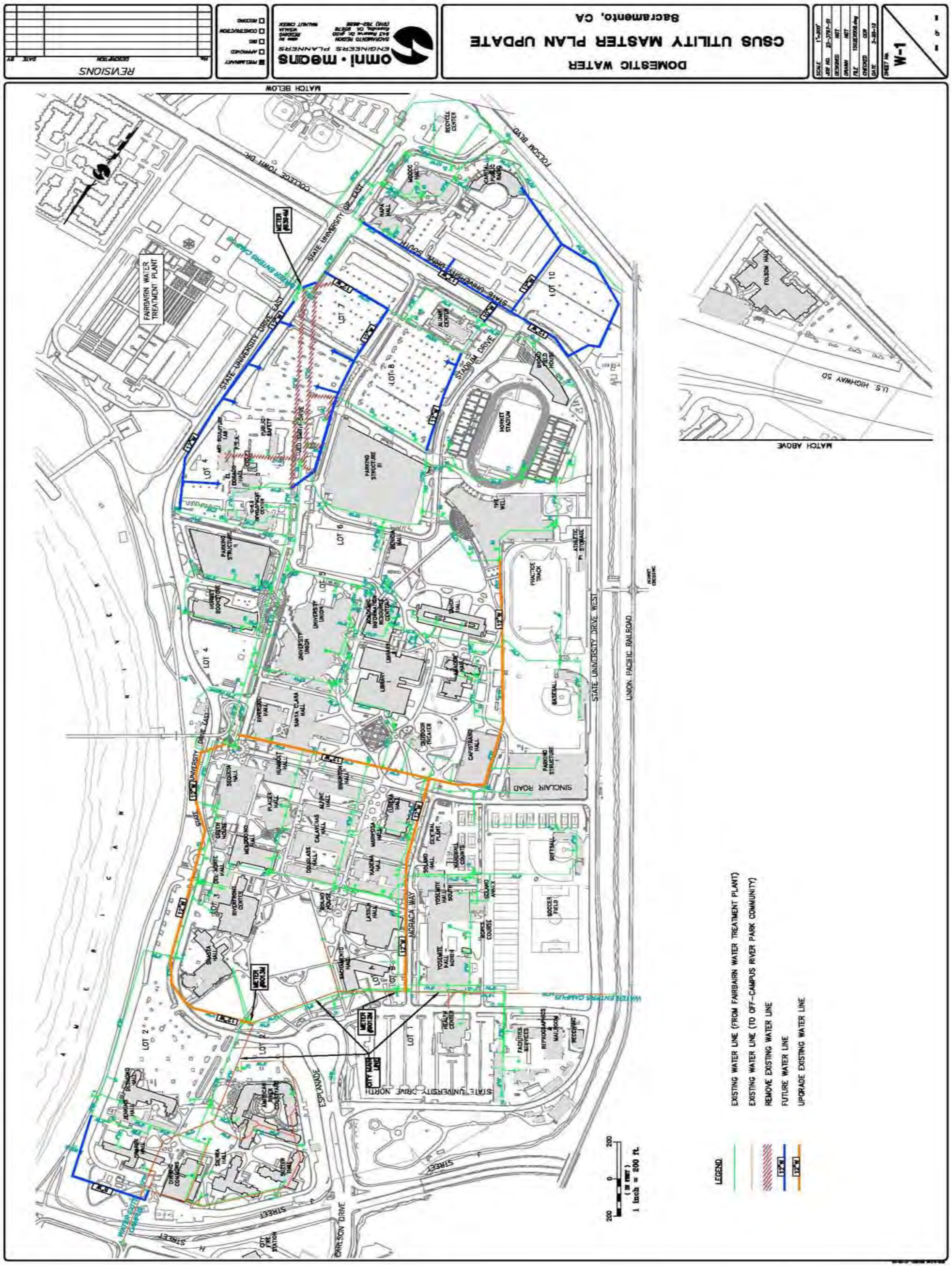
BUILDING SUMMARY					CHANGE SUMMARY			AREA SUMMARY (GSF)						ENERGY SUMMARY (KBTU/YR)				
Code	Building Name	GSF	EUI	Energy (kBTU/yr)	Group	Change - Building Type	GSF Change	Today	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
AH	University Union	162,268	70.5	11,439,894	Group 1	New - Student Actvs. Exp.	35,000		162,268	197,268	197,268	197,268	197,268	11,439,894	5,918,040	5,918,040	5,918,040	5,918,040
AH	Well	150,845	58.0	8,749,010	Group 2	New - Student Actvs. Exp.	22,500		150,845	173,345	173,345	173,345	173,345	8,749,010	5,200,350	5,200,350	5,200,350	5,200,350
AH	NEW			-	Group 3	New - Office Parking Srvs.	22,050			22,050	22,050	22,050	22,050		661,500	661,500	661,500	661,500
P	NEW			-	Group 3	New - Parking Structure 5	555,950			555,950	555,950	555,950	555,950		8,339,250	8,339,250	8,339,250	8,339,250
AH	Public Service Bldg	10,603	60.2	638,301	Group 3	Demo - Public Srvs. Bldg.	-10,603	10,603	10,603					638,301				
S	NEW			-	Group 4	New - Acad. Sci. Bldg.	204,000			204,000	204,000	204,000	204,000		10,200,000	10,200,000	10,200,000	10,200,000
S	Sequoia	191,137	61.3	11,716,698	Group 4	Renov - Lab into Office & Lab		191,137	191,137	191,137	191,137	191,137	191,137	11,716,698	11,716,698	9,556,850	9,556,850	9,556,850
S	Placer	67,101	121.3	8,139,351	Group 4	Renov - Lab into Office & Lab		67,101	67,101	67,101	67,101	67,101	67,101	8,139,351	8,139,351	3,355,050	3,355,050	3,355,050
S	Humbolt	24,908	61.3	1,526,860	Group 4	Demo - Acad. Sci.	-24,908	24,908	24,908					1,526,860				
S	Alpine	30,336	61.3	1,859,597	Group 4	Demo - Acad. Sci.	-30,336	30,336	30,336					1,859,597				
S	Brighton	28,956	60.2	1,743,151	Group 4	Demo - Acad. Sci. Bldg.	-28,956	28,956	28,956					1,743,151				
AH	Douglass	18,796	61.3	1,152,195	Group 4	Demo - Acad. Bldg.	-18,796	18,796	18,796	18,796				1,152,195	1,152,195			
AH	Calaveras	18,820	61.3	1,153,666	Group 4	Demo - Acad. Bldg.	-18,820	18,820	18,820	18,820				1,153,666	1,153,666			
AH	Santa Clara	62,813	61.3	3,850,437	Group 4	Demo - Acad. Bldg.	-62,813	62,813	62,813	62,813				3,850,437	3,850,437			
S	NEW			-	Group 4	New - Engineering Bldg.	17,500				17,500	17,500	17,500			875,000	875,000	875,000
AH	Library	377,074	61.3	23,114,636	Group 5	Renov - Library		377,074	377,074	377,074	377,074	377,074	377,074	23,114,636	23,114,636	18,853,700	18,853,700	18,853,700
AH	NEW			-	Group 6	New - Acad. Arts	36,000				36,000	36,000	36,000			720,000	720,000	720,000
AH	Shasta Hall	62,667	61.3	3,841,487	Group 6	Renovation - Acad.		62,667	62,667	62,667	62,667	62,667	62,667	3,841,487	3,841,487	3,841,487	2,820,015	2,820,015
AH	Capistrano Hall	84,722	61.3	5,193,459	Group 6	Renovation - Acad.		84,722	84,722	84,722	84,722	84,722	84,722	5,193,459	5,193,459	5,193,459	3,812,490	3,812,490
AH	NEW			-	Group 7	New - Acad. Student Srvs.	44,340					44,340	44,340				886,800	886,800
AH	Sacramento	35,180	60.2	2,117,836	Group 7	Demo - Acad. Bldg.	-35,180	35,180	35,180	35,180	35,180			2,117,836	2,117,836	2,117,836		
AH	Lassen	80,445	61.3	4,931,279	Group 7	Renov - Acad. Bldg.		80,445	80,445	80,445	80,445	80,445	80,445	4,931,279	4,931,279	4,931,279	4,931,279	3,217,800
AH	Kadema	40,483	61.3	2,481,608	Group 7	Demo - Acad. Bldg.	-40,483	40,483	40,483	40,483	40,483	40,483		2,481,608	2,481,608	2,481,608	2,481,608	
AH	Eureka Hall	59,488	61.3	3,646,614	Group 7	Renov - Acad. Bldg.		59,488	59,488	59,488	59,488	59,488	59,488	3,646,614	3,646,614	3,646,614	3,646,614	2,379,520
AH	Amador Hall	67,138	61.3	4,115,559	Group 7	Renov - Acad. Bldg.		67,138	67,138	67,138	67,138	67,138	67,138	4,115,559	4,115,559	4,115,559	4,115,559	2,685,520
AH	NEW			-	Group 8	New - Housing A	48,000			48,000	48,000	48,000	48,000		1,440,000	1,440,000	1,440,000	1,440,000
AH	NEW			-	Group 8	New - Housing B	60,000			60,000	60,000	60,000	60,000		1,800,000	1,800,000	1,800,000	1,800,000
AH	NEW			-	Group 8	New - Housing	100,000			100,000	100,000	100,000	100,000		3,000,000	3,000,000	3,000,000	3,000,000
AH	Sutter	36,537	61.3	2,239,718	Group 8	Demo - Housing	-36,537	36,537	36,537					2,239,718				
P	NEW			-	Group 8	New - Parking	188,000				188,000	188,000	188,000			1,880,000	1,880,000	1,880,000
F	NEW				Group 8	Renov - Dining Hall Expansion	20,000				20,000	20,000	20,000			3,000,000	3,000,000	3,000,000
AH	NEW			-	Group 8	New - Housing	60,000				60,000	60,000	60,000			1,200,000	1,200,000	1,200,000
AH	NEW			-	Group 8	New - Housing	30,000				30,000	30,000	30,000			600,000	600,000	600,000
AH	Desmond	48,871	61.3	2,995,792	Group 8	Demo - Housing	-48,871	48,871	48,871	48,871				2,995,792	2,995,792			
AH	NEW			-	Group 8	New - Housing	100,000					100,000	100,000				2,000,000	2,000,000
AH	Jenkins	38,212	61.3	2,342,396	Group 8	Demo - Housing	-38,212	38,212	38,212	38,212	38,212			2,342,396	2,342,396	2,342,396		
AH	NEW			-	Group 8	New - Housing	60,000					60,000	60,000				1,200,000	1,200,000
AH	Draper	32,072	61.3	1,966,014	Group 8	Demo - Housing	-32,072	32,072	32,072	32,072	32,072			1,966,014	1,966,014	1,966,014		
AH	NEW			-	Group 8	New - Housing	90,000						90,000					1,800,000
AH	Sierra	38,086	61.3	2,334,672	Group 8	Demo - Housing	-38,086	38,086	38,086	38,086	38,086	38,086		2,334,672	2,334,672	2,334,672	2,334,672	
AH	NEW			-	Group 8	New - Housing	60,000						60,000					1,200,000
AH	NEW			-	Group 9	New - Children's Center	15,780				15,780	15,780	15,780			315,600	315,600	315,600
AH	Children Center	11,054	45.2	499,641	Group 9	Demo - Children's Center	-11,054	11,054	11,054	11,054				499,641	499,641			
AH	El Dorado	11,898	60.2	716,260	Group 9	Demo - Housing	-11,898	11,898	11,898	11,898				716,260	716,260			
AH	Art Scupture Lab	15,132	61.3	927,592	Group 9	Demo - Art Lab	-15,132	15,132	15,132	15,132				927,592	927,592			
AH	NEW			-	Group 9	New - Housing	104,000					104,000	104,000				2,080,000	2,080,000
AH	NEW			-	Group 9	New - Housing	100,800					100,800	100,800				2,016,000	2,016,000
AH	NEW			-	Group 9	New - Housing	109,600					109,600	109,600				2,192,000	2,192,000
AH	NEW			-	Group 9	New - Housing	85,800					85,800	85,800				1,716,000	1,716,000
AH	NEW			-	Group 9	New - Housing	76,000						76,000					1,520,000
AH	NEW			-	Group 9	New - Housing	92,000						92,000					1,840,000
AH	NEW			-	Group 9	New - Housing	84,000						84,000					1,680,000
AH	NEW			-	Group 9	New - Housing	87,000						87,000					1,740,000
AH	Benicia Hall	6,684	60.2	402,377	Group 10	Demo - Benicia	-6,684	6,684	6,684	6,684				402,377	402,377			
AH	NEW			-	Group 10	New - Student Event Center	200,000				200,000	200,000	200,000			4,000,000	4,000,000	4,000,000
AH	NEW			-	Group 11	New - Stadium	?					?	?				?	?
P	NEW			-	Group 12	New - Parking Structure	600,000						600,000					6,000,000
TOTAL FOR NEW + RENOVATED + PRE-DEMOLISHED								**1,499,213**	**1,812,326**	**2,728,486**	**3,101,698**	**3,600,774**	**4,611,205**	**115,836,098**	**124,198,707**	**113,886,263**	**117,148,377**	**123,701,485**
														Percent Improvement of Existing Buildings (cumulative)				
														0%	15%	20%	25%	30%
AH	Acad. Info. Resource Ctr	97,923	61.3	6,002,680	Existing	Unchanged		97,923	97,923	97,923	97,923	97,923	97,923	6,002,680	5,102,278	4,081,822	3,061,367	2,142,957
AH	Alumni Center **	10,800	54.0	582,695	Existing	Unchanged		10,800	10,800	10,800	10,800	10,800	10,800	582,695	495,290	396,232	297,174	208,022
AH	American River Courtyard	209,050	61.3	12,818,622	Existing	Unchanged		209,050	209,050	209,050	209,050	209,050	209,050	12,818,622	10,895,829	8,716,663	6,537,497	4,576,248
AH	Athletic Center	27,313	61.3	1,674,287	Existing	Unchanged		27,313	27,313	27,313	27,313	27,313	27,313	1,674,287	1,423,144	1,138,515	853,886	597,720
AH	Capital Public Radio **	19,838	46.7	927,205	Existing	Unchanged		19,838	19,838	19,838	19,838	19,838	19,838	927,205	788,124	630,499	472,875	331,012
AH	Central Plant	13,569		-	Existing	Unchanged		13,569	13,569	13,569	13,569	13,569	13,569	-	-	-	-	-
AH	Del Norte Hall	54,000	61.3	3,310,200	Existing	Unchanged		54,000	54,000	54,000	54,000	54,000	54,000	3,310,200	2,813,670	2,250,936	1,688,202	1,181,741
F	Dining Commons **	22,747	375.2	8,534,294	Existing	Unchanged		22,747	22,747	22,747	22,747	22,747	22,747	8,534,294	7,254,150	5,803,320	4,352,490	3,046,743
AH	Eli & Edythe Field House	26,013	61.3	1,594,597	Existing	Unchanged		26,013	26,013	26,013	26,013	26,013	26,013	1,594,597	1,355,407	1,084,326	813,244	569,271
AH	Folsom Hall	198,692	61.3	12,179,820	Existing	Unchanged		198,692	198,692	198,692	198,692	198,692	198,692	12,179,820	10,352,847	8,282,277	6,211,708	4,348,196
AH	Hornet Bookstore *	93,170	56.9	5,296,844	Existing	Unchanged		93,170	93,170	93,170	93,170	93,170	93,170	5,296,844	4,502,317	3,601,854	2,701,390	1,890,973
AH	Mariposa Hall	78,079	61.3	4,786,243	Existing	Unchanged		78,079	78,079	78,079	78,079	78,079	78,079	4,786,243	4,068,306	3,254,645	2,440,984	1,708,689
AH	Mendocino Hall	77,000	61.3	4,720,100	Existing	Unchanged		77,000	77,000	77,000	77,000	77,000	77,000	4,720,100	4,012,085	3,209,668	2,407,251	1,685,076
AH	Modoc Hall **	85,402	90.6	7,740,747	Existing	Unchanged		85,402	85,402	85,402	85,402	85,402	85,402	7,740,747	6,579,635	5,263,708	3,947,781	2,763,447
AH	Napa Hall **	33,932	68.6	2,329,312	Existing	Unchanged		33,932	33,932	33,932	33,932	33,932	33,932	2,329,312	1,979,915	1,583,932	1,187,949	831,564
F	River Front Center *	40,198	296.2	11,908,051	Existing	Unchanged		40,198	40,198	40,198	40,198	40,198	40,198	11,908,051	10,121,843	8,097,475	6,073,106	4,251,174
AH	Riverside Hall	83,316	61.3	5,107,271	Existing	Unchanged		83,316	83,316	83,316	83,316	83,316	83,316	5,107,271	4,341,180	3,472,944	2,604,708	1,823,296
AH	Sacramento Hall Annex	2,201	60.2	132,500	Existing	Unchanged		2,201	2,201	2,201	2,201	2,201	2,201	132,500	112,625	90,100	67,575	47,303
AH	Solano Hall	67,710	61.3	4,150,623	Existing	Unchanged		67,710	67,710	67,710	67,710	67,710	67,710	4,150,623	3,528,030	2,822,424	2,116,818	1,481,772
AH	Tahoe Hall	64,764	60.2	3,898,793	Existing	Unchanged		64,764	64,764	64,764	64,764	64,764	64,764	3,898,793	3,313,974	2,651,179	1,988,384	1,391,869
AH	Yosemite Hall	82,301	61.3	5,045,051	Existing	Unchanged		82,301	82,301	82,301	82,301	82,301	82,301	5,045,051	4,288,294	3,430,635	2,572,976	1,801,083
TOTAL FOR EXISTING UNCHANGED		**1,388,018**		**102,739,934**				1,388,018	1,388,018	1,388,018	1,388,018	1,388,018	1,388,018	102,739,934	87,328,944	69,863,155	52,397,366	36,678,156
GRAND TOTAL		**1,388,018**		**218,576,032**				2,887,231	3,200,344	4,116,504	4,489,716	4,988,792	5,999,223	**218,576,032**	**211,527,651**	**183,749,418**	**169,545,743**	**160,379,641**

	Existing/Unchanged		Change by 2035	Today	2015	2020	2025	2030	2035	2015	2020	2025	2030	2035
ACADEMIC/HOUSING	1,325,073	ACADEMIC/HOUSING	1,297,629	2,481,848	2,794,961	3,035,371	3,183,083	3,682,159	4,092,590	173,148,029	155,756,358	132,642,473	121,913,997	109,875,574
SCIENCE	-	SCIENCE	137,300	342,438	342,438	462,238	479,738	479,738	479,738	24,985,658	30,056,049	23,986,900	23,986,900	23,986,900
FOOD SERVICE	62,945	FOOD SERVICE	20,000	62,945	62,945	62,945	82,945	82,945	82,945	20,442,345	17,375,993	16,900,795	13,425,596	10,297,917
GARAGE	-	GARAGE	1,343,950	0	0	555,950	743,950	743,950	1,343,950	0	8,339,250	10,219,250	10,219,250	16,219,250
	1,388,018		**2,798,879**	**2,887,231**	**3,200,344**	**4,116,504**	**4,489,716**	**4,988,792**	**5,999,223**	**218,576,032**	**211,527,651**	**183,749,418**	**169,545,743**	**160,379,641**
		TOTAL DEMOLISH	**-509,441**											

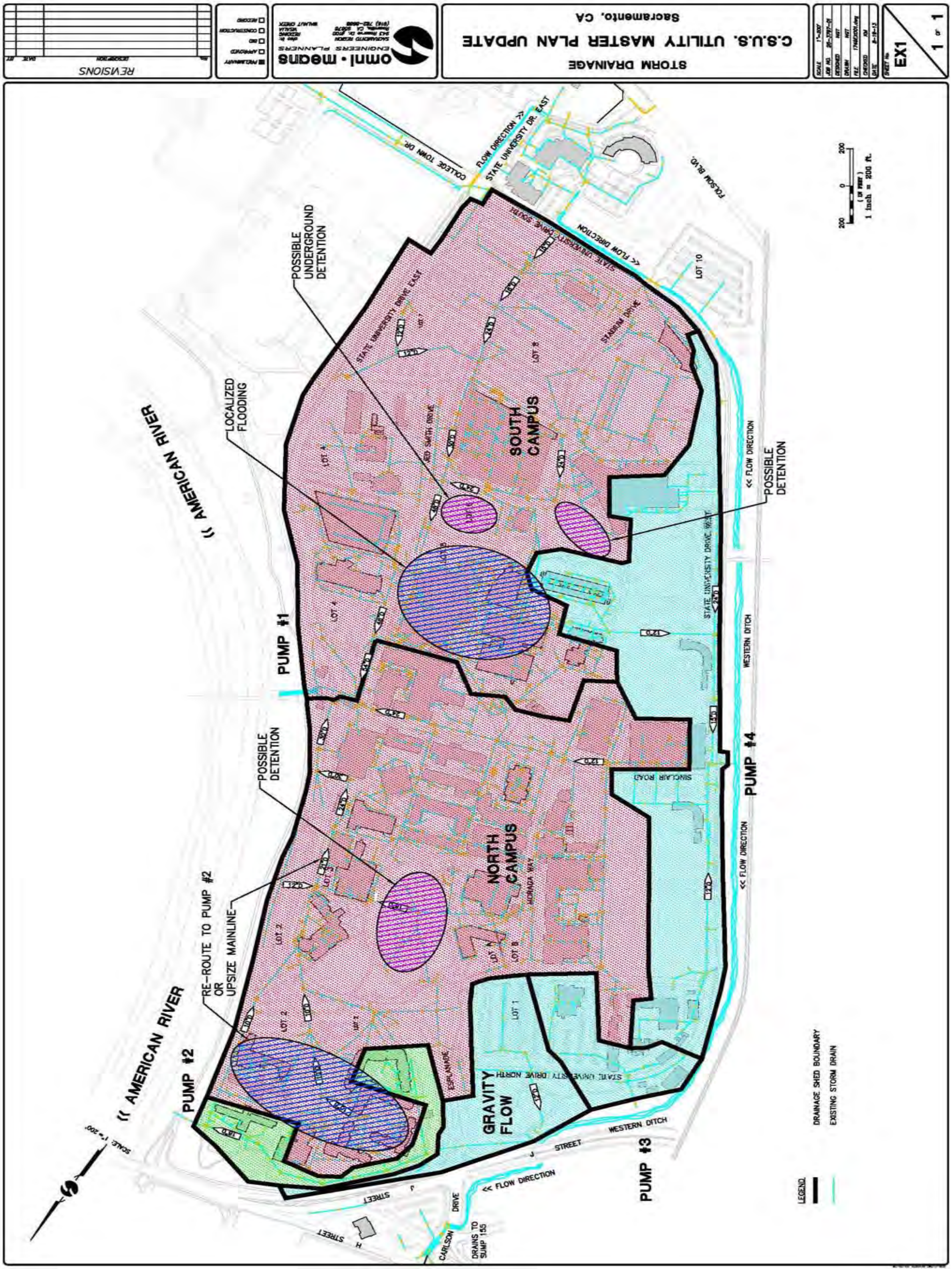
ENERGY USE SUMMARY	Today		SOLAR ENERGY INSTALLATION SUMMARY (kW) Today	2015	2020	2025	2030	2035	ENERGY USE SUMMARY (KBTU/YR) 2015	2020	2025	2030	2035
Natural Gas	45%								98,359,214	95,187,443	82,687,238	76,295,584	72,170,839
Electricity	55%								120,216,818	116,340,208	101,062,180	93,250,159	88,208,803
Solar Photovoltaic			500	2,144	3,787	5,431	7,074	8,718	11,336,643	20,028,986	28,721,329	37,413,672	46,106,015
Solar Thermal		50.0% Natural Gas Energy of New Housing							0	1,404,000	3,525,000	6,270,900	10,547,500
NET ENERGY USAGE (Zero = Net Zero!)									**207,239,389**	**191,498,665**	**155,028,089**	**132,132,071**	**114,273,627**

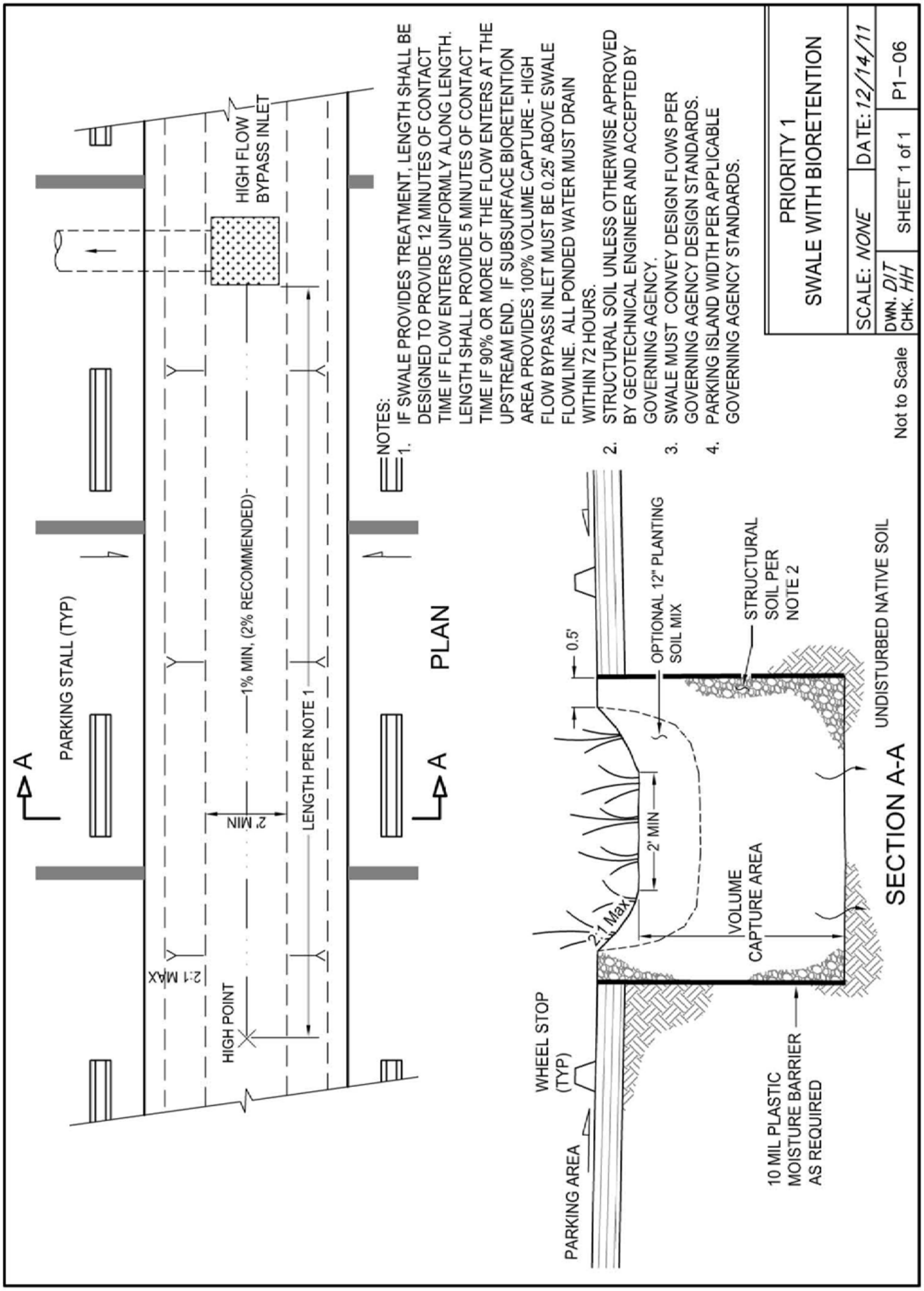
B.6 Civil Engineer Reports

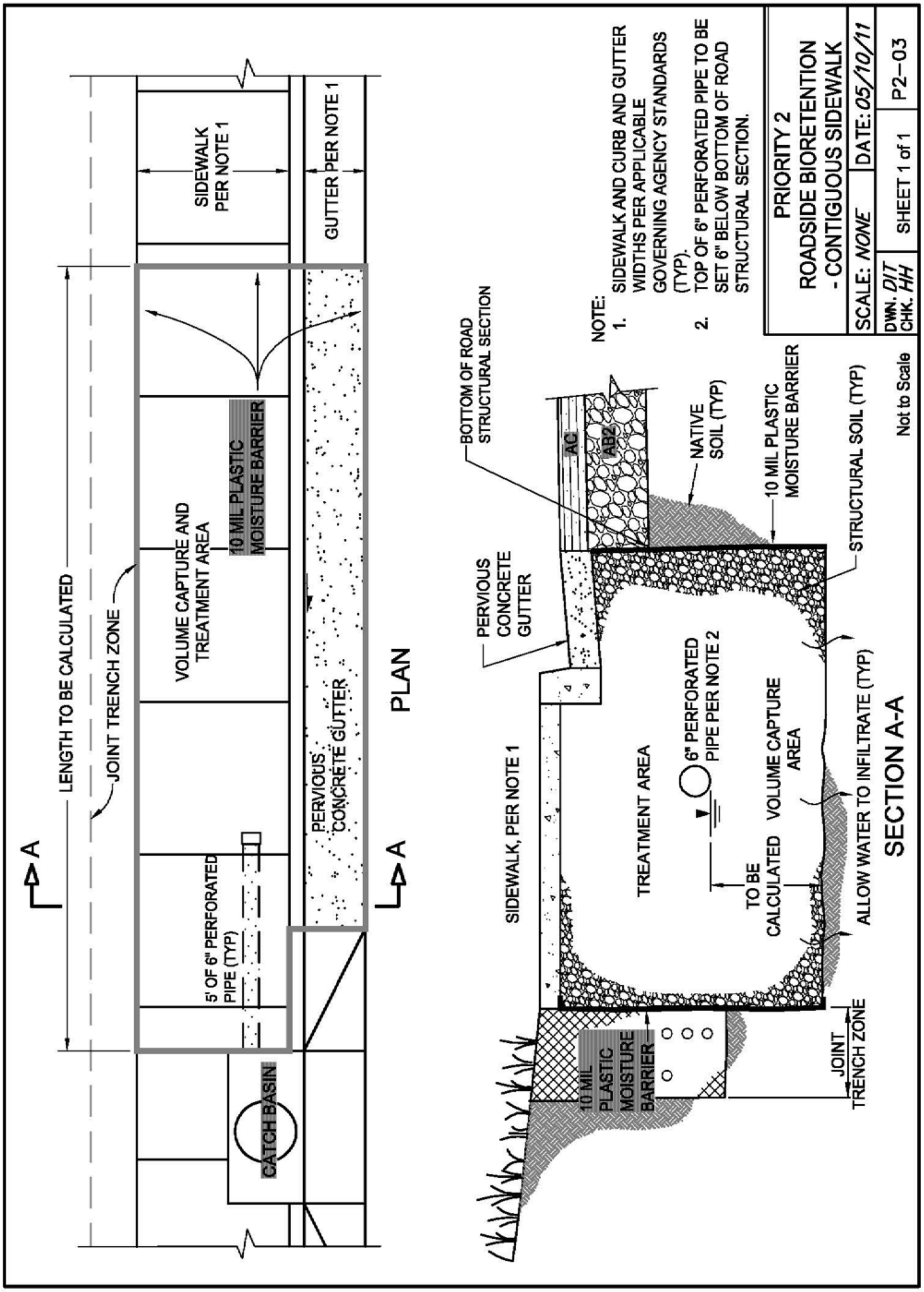

SANITARY SEWER
C.S.U.S. UTILITY MASTER PLAN UPDATE
Sacramento, CA
omni · means
REVISIONS
S-1
LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE (2007 INFRASTRUCTURE FUTURE UPGRADES)
PROPOSED SEWER LINE (2012 MASTER PLAN UPDATE)
ABANDON/REMOVE SEWER LINE (2012 MASTER PLAN UPDATE)
PROPOSED IMPROVEMENT
1 inch = 200 ft.
UNION PACIFIC RAILROAD
STATE UNIVERSITY DRIVE WEST
STATE UNIVERSITY DRIVE EAST
STATE UNIVERSITY DRIVE NORTH
MATCH BELOW
MATCH ABOVE

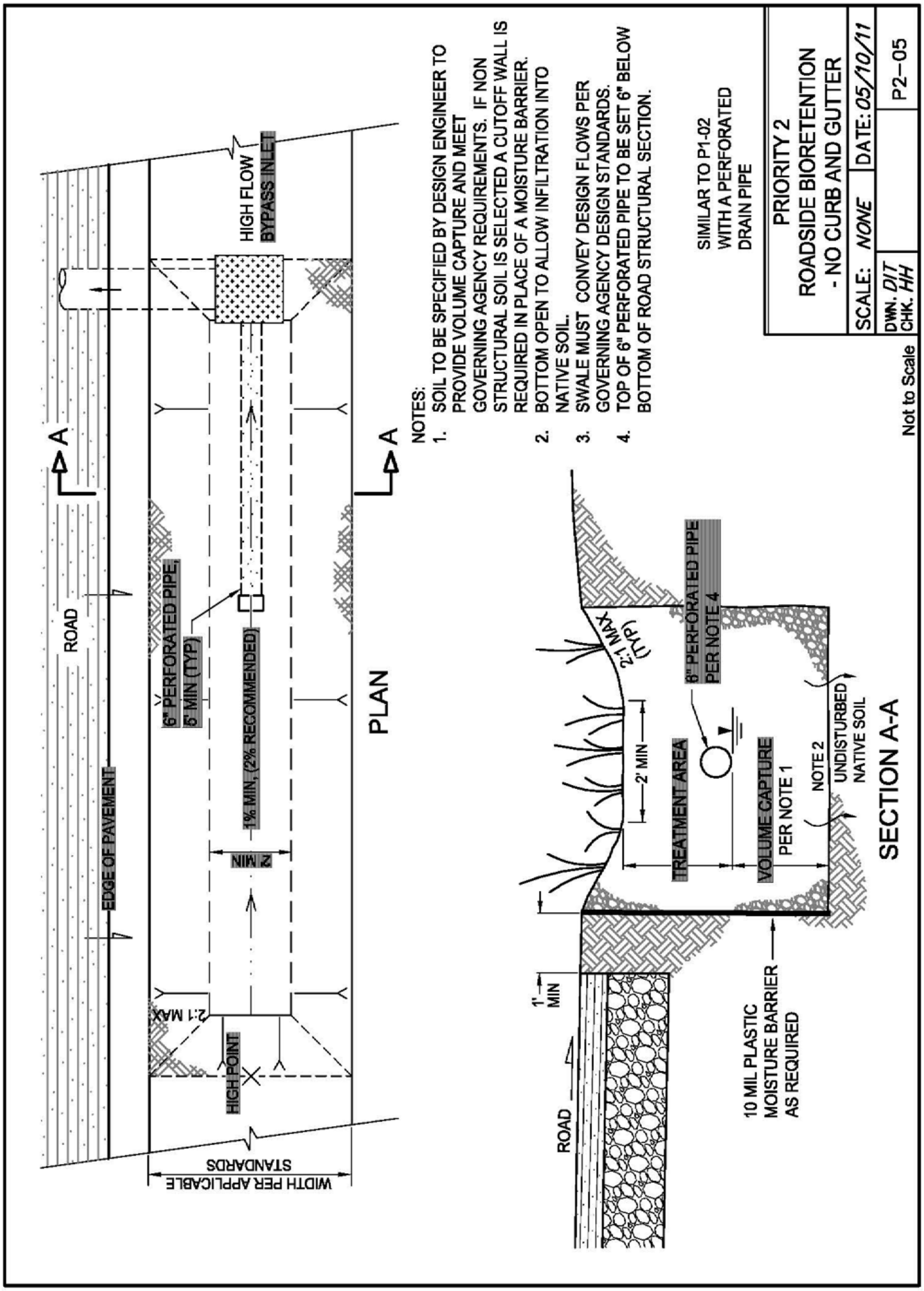


CSUS UTILITY MASTER PLAN UPDATE
DOMESTIC WATER
Sacramento, CA
W-1
omni • means
REVISIONS
LEGEND
EXISTING WATER LINE (FROM FAIRBAIRN WATER TREATMENT PLANT)
EXISTING WATER LINE (TO OFF-CAMPUS RIVER PARK COMMUNITY)
REMOVE EXISTING WATER LINE
FUTURE WATER LINE
UPGRADE EXISTING WATER LINE
1 inch = 200 ft.


REVISIONS
omni • means
ENGINEERS PLANNERS
C.S.U.S. UTILITY MASTER PLAN UPDATE
STORM DRAINAGE
Sacramento, CA
EX1
1 of 1
COLLEGE TOWN DR.
FLOW DIRECTION
STATE UNIVERSITY DR. EAST
FOLSOM BLVD.
LOT 10
1 inch = 200 ft.
POSSIBLE UNDERGROUND DETENTION
LOCALIZED FLOODING
AMERICAN RIVER
SOUTH CAMPUS
POSSIBLE DETENTION
STATE UNIVERSITY DRIVE WEST
WESTERN DITCH
PUMP #1
PUMP #4
SINCLAIR ROAD
NORTH CAMPUS
RE-ROUTE TO PUMP #2 OR UPSIZE MAINLINE
AMERICAN RIVER
PUMP #2
GRAVITY FLOW
STATE UNIVERSITY DRIVE NORTH
J STREET
PUMP #3
H STREET
CARLSON DRIVE
DRAINS TO SUMP 155
LEGEND
DRAINAGE SHED BOUNDARY
EXISTING STORM DRAIN

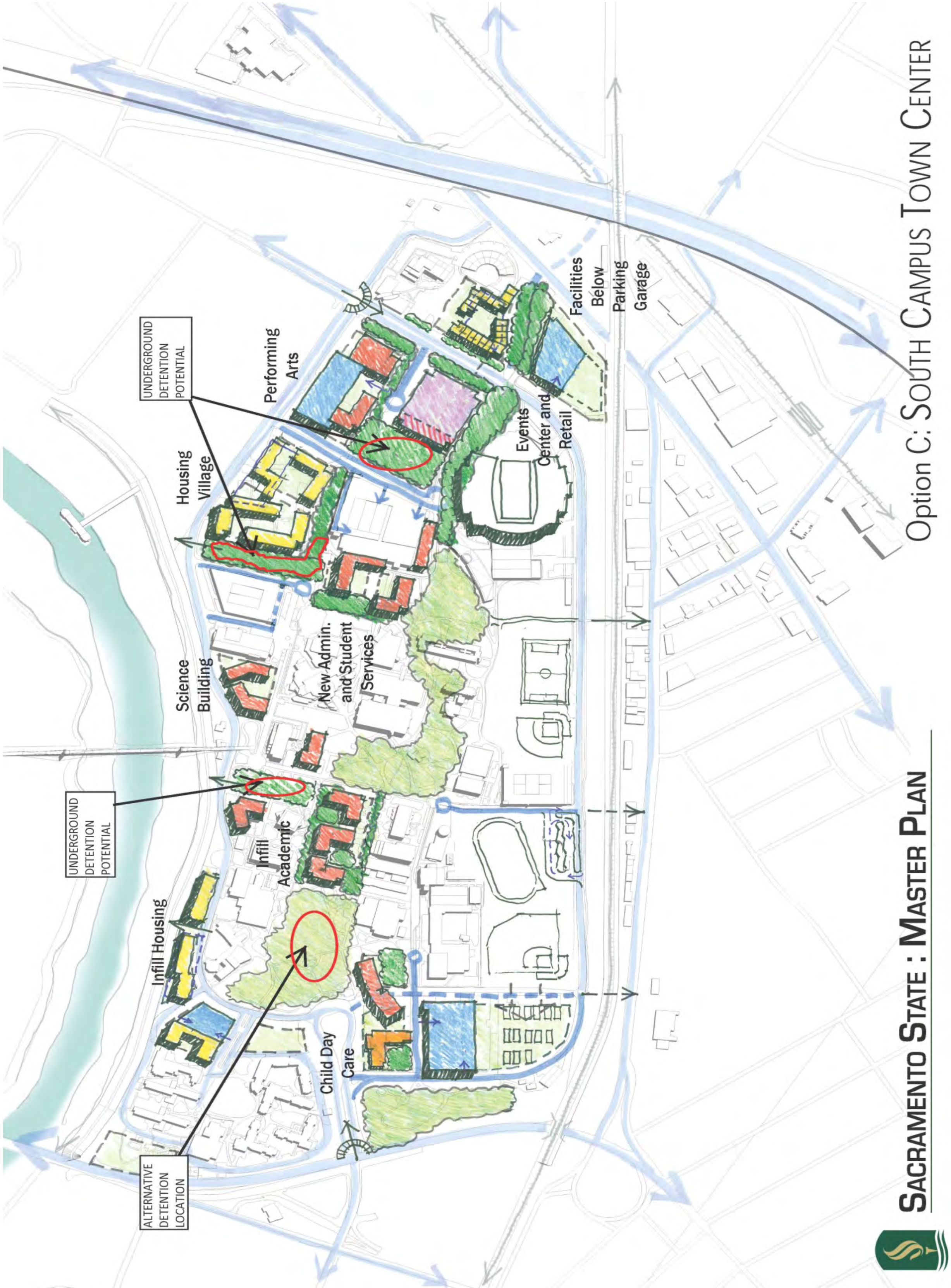

PARKING STALL (TYP)
A
A
HIGH FLOW BYPASS INLET
HIGH POINT
2:1 MAX
2' MIN
1% MIN, (2% RECOMMENDED)
LENGTH PER NOTE 1
PLAN
NOTES:
1. IF SWALE PROVIDES TREATMENT, LENGTH SHALL BE DESIGNED TO PROVIDE 12 MINUTES OF CONTACT TIME IF FLOW ENTERS UNIFORMLY ALONG LENGTH. LENGTH SHALL PROVIDE 5 MINUTES OF CONTACT TIME IF 90% OR MORE OF THE FLOW ENTERS AT THE UPSTREAM END. IF SUBSURFACE BIORETENTION AREA PROVIDES 100% VOLUME CAPTURE - HIGH FLOW BYPASS INLET MUST BE 0.25' ABOVE SWALE FLOWLINE. ALL PONDED WATER MUST DRAIN WITHIN 72 HOURS.
2. STRUCTURAL SOIL UNLESS OTHERWISE APPROVED BY GEOTECHNICAL ENGINEER AND ACCEPTED BY GOVERNING AGENCY.
3. SWALE MUST CONVEY DESIGN FLOWS PER GOVERNING AGENCY DESIGN STANDARDS.
4. PARKING ISLAND WIDTH PER APPLICABLE GOVERNING AGENCY STANDARDS.
PARKING AREA
WHEEL STOP (TYP)
10 MIL PLASTIC MOISTURE BARRIER AS REQUIRED
2:1 Max
2' MIN
0.5'
OPTIONAL 12" PLANTING SOIL MIX
STRUCTURAL SOIL PER NOTE 2
VOLUME CAPTURE AREA
UNDISTURBED NATIVE SOIL
SECTION A-A
PRIORITY 1
SWALE WITH BIORETENTION
SCALE: NONE
DATE: 12/14/11
DWN. D/T
CHK. HH
SHEET 1 of 1
P1–06
Not to Scale


LENGTH TO BE CALCULATED
JOINT TRENCH ZONE
SIDEWALK PER NOTE 1
GUTTER PER NOTE 1
VOLUME CAPTURE AND TREATMENT AREA
10 MIL PLASTIC MOISTURE BARRIER
5' OF 6" PERFORATED PIPE (TYP)
CATCH BASIN
PERVIOUS CONCRETE GUTTER
A
A
PLAN
BOTTOM OF ROAD STRUCTURAL SECTION
AC
AB2
NATIVE SOIL (TYP)
10 MIL PLASTIC MOISTURE BARRIER
STRUCTURAL SOIL (TYP)
PERVIOUS CONCRETE GUTTER
SIDEWALK, PER NOTE 1
TREATMENT AREA
6" PERFORATED PIPE PER NOTE 2
VOLUME CAPTURE AREA
TO BE CALCULATED
ALLOW WATER TO INFILTRATE (TYP)
10 MIL PLASTIC MOISTURE BARRIER
JOINT TRENCH ZONE
SECTION A-A
Not to Scale
NOTE:
1. SIDEWALK AND CURB AND GUTTER WIDTHS PER APPLICABLE GOVERNING AGENCY STANDARDS (TYP).
2. TOP OF 6" PERFORATED PIPE TO BE SET 6" BELOW BOTTOM OF ROAD STRUCTURAL SECTION.
PRIORITY 2
ROADSIDE BIORETENTION - CONTIGUOUS SIDEWALK
SCALE: NONE
DATE: 05/10/11
DWN. DIT
CHK. HH
SHEET 1 of 1
P2-03


ROAD
EDGE OF PAVEMENT
6" PERFORATED PIPE,
5' MIN (TYP)
1% MIN, (2% RECOMMENDED)
2' MIN
2:1 MAX
HIGH POINT
HIGH FLOW
BYPASS INLET
WIDTH PER APPLICABLE STANDARDS
A
A
PLAN
NOTES:
1. SOIL TO BE SPECIFIED BY DESIGN ENGINEER TO PROVIDE VOLUME CAPTURE AND MEET GOVERNING AGENCY REQUIREMENTS. IF NON STRUCTURAL SOIL IS SELECTED A CUTOFF WALL IS REQUIRED IN PLACE OF A MOISTURE BARRIER.
2. BOTTOM OPEN TO ALLOW INFILTRATION INTO NATIVE SOIL.
3. SWALE MUST CONVEY DESIGN FLOWS PER GOVERNING AGENCY DESIGN STANDARDS.
4. TOP OF 6" PERFORATED PIPE TO BE SET 6" BELOW BOTTOM OF ROAD STRUCTURAL SECTION.
SIMILAR TO P1-02
WITH A PERFORATED
DRAIN PIPE
PRIORITY 2
ROADSIDE BIORETENTION
- NO CURB AND GUTTER
SCALE: NONE
DATE: 05/10/11
DWN. DJT
CHK. HH
P2-05
Not to Scale
ROAD
1' MIN
10 MIL PLASTIC
MOISTURE BARRIER
AS REQUIRED
2:1 MAX (TYP)
6" PERFORATED PIPE
PER NOTE 4
2' MIN
TREATMENT AREA
VOLUME CAPTURE
PER NOTE 1
NOTE 2
UNDISTURBED
NATIVE SOIL
SECTION A-A


Option A: Arboretum Village
Child Day Care
Events Center and Retail
Facilities Shops & Yard
UNDERGROUND DETENTION POTENTIAL
Housing Village
Science Building
UNDERGROUND DETENTION POTENTIAL
Performing Arts
Infill Academic
Infill Housing
New Admin. and Student Services
Housing and Parking
ALTERNATIVE DETENTION LOCATION


Option B: Grand Park
UNDERGROUND DETENTION POTENTIAL
UNDERGROUND DETENTION POTENTIAL
ALTERNATIVE DETENTION LOCATION
Housing Village
Academic Village
Science Building
Events Center and Retail
Infill Housing
Performing Arts
New Admin. and Student Services
Housing and Parking & Day Care
Facilities Shops & Yard


Option C: South Campus Town Center
Sacramento State : Master Plan
Underground Detention Potential
Performing Arts
Housing Village
Events Center and Retail
Facilities Below Parking Garage
Science Building
New Admin. and Student Services
Underground Detention Potential
Infill Academic
Infill Housing
Child Day Care
Alternative Detention Location

2014 Storm Drainage Master Plan Update

Prepared for:

California State University Sacramento

Prepared by:

Omni-Means
ENGINEERS · PLANNERS

2014 STORM DRAINAGE MASTER PLAN UPDATE FOR CSUS

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EXECUTIVE SUMMARY

The CSUS campus drainage studies performed in 1966, 1989 and 2007 provide valuable information with respect to the historic drainage issues on campus. Omni-Means reviewed these drainage studies, extracted relevant historical data, and summarized key points in the 2012 Storm Drainage Master Plan for CSUS. This Storm Drainage Master Plan is a continuation of the 2012 Master Plan. This Storm Drainage Master Plan incorporates the proposed Stormwater Management facilities proposed with the 2014 campus Master Plan. The proposed Stormwater Management facilities in the 2014 Campus Master Plan are Bio-Swale (Campus Greenway "Hornet Creek", Rain Gardens, etc.), Infiltration Turf, and Permeable Pavement. The Stormwater Management facilities filtrate the storm runoff and perform the duties of Detention Basins. This report focuses on the detention / retention capabilities of these facilities.

Omni-Means used the Sac Calc computer program, which utilizes Sacramento County precipitation data and the Army Corps of Engineers' HEC-HMS (Hydrologic Modeling Software), to develop peak flows at various control points.

The Sac Calc program was then run with the proposed Detention Basins. The Detention Basins for each individual shed were combined to determine the total detention volume for each shed. The Detention Basins proposed for the 2014 Campus Master Plan significantly reduced the campus wide average peak flows of the 10 year event by 44% and the 100 year event by 41%.

This report also reviewed the amount of storm runoff the proposed Detention Basins would infiltrate throughout the campus. As part of the drainage study, infiltration testing was performed by ENGEO, Inc. The eastern portion of the campus will provide the greatest opportunities for infiltration. The report "Infiltration Opportunities" by ENGOE is included in the appendix of this report. The increase of infiltration would result in a volume reduction in the amount of storm runoff pumped from the campus into the American River. The storm runoff volume reduction for the entire campus was 22% based upon two 10 year 24 hour storm events.

This report analyzed the Hydrology of the existing system with the proposed Detention Basins. In order to determine the effects of the proposed Detention Basins on the existing storm drain systems, a follow up analysis study using XPSTORM computer model (or equivalent) will need to be performed. This will provide a comprehensive analysis of the entire campus' storm drainage system. Pump capacities, pipe systems, and ground elevations will be sync'ed together to provide a two-dimensional representation of how runoff moves through the campus during select storm events. A XPSTORM model will provide greater accuracy for surcharged pipes, as well as for when and where flooding occurs. BMPs can be added to the model as well to test effectiveness. A XPSTORM model is highly recommended and will serve to move the campus storm drain master plan beyond the one-dimensional analyses that has taken place in the past.

INTRODUCTION

The CSUS campus has an extensive storm drain system that portions of date back to the 1950s. The campus has little to no detention facilities and the storm runoff drains directly to area drains and catch basins. The area drains and catch basins are connected to storm drain pipes that allow storm runoff to drain directly to the American River or Western Ditch through pump stations. This report provides an overall analysis of the CSUS campus with regard to the existing storm drainage system and the reductions to the peak 10 year and 100 year event flows with implementation of the proposed detention facilities outlined in the 2014 Campus Master Plan. This report also takes into account the potential future developments and demolitions as outlined in the 2014 Campus Master Plans. Previous studies have been used for reference and comparison purposes. These studies have aided to establish a thorough understanding of the existing conditions. Based on this knowledge, the proposed detention facilities will not only solve the existing storm drain deficiencies, but also provide capacity for future development.

PREVIOUS STUDIES

Since moving to its permanent location in 1953, there have been several studies done with regards to storm drainage. In 1966 Kennedy Engineers developed a Utility Master Plan of the entire campus. In 1989 Boyle Engineering Corporation provided an updated Utility Master Plan. In 2007, Carter and Burgess developed a South Campus Drainage Report.

1966 UTILITIES MASTER PLAN (KENNEDY ENGINEERS)

Background information provided in the "Description of Site" section is helpful in understanding natural drainage patterns and potential drainage issues. The report states that the campus is the natural ponding area of the Sutter Slough, with a tributary area of approximately 7,000 acres. The City of Sacramento also uses the ditch adjacent to the railroad to convey flows from City Sump 31. At the date of the report (1966), the maximum discharge into the ditch was 60 cfs.

Kennedy Engineers also highlighted that the entire campus is reliant on pumps for effective drainage of the property. Also notable is that the then proposed library was being built on a natural low point. Consequently, the report describes "a recommended fill area centering about the location of the proposed library building. This nominal land fill area appears to be essential, not only in order to effect an efficient drainage pattern, but also to avoid a vulnerable low area near the center of campus activity" (Kennedy, 26). Evidently these words have proved prophetic, as localized flooding around the South Library, Academic Information Resource Center and University Union has been especially problematic in recent years.

In 1966, the only pump station was the original one built in 1952 near the east end of Sinclair Road, discharging directly into the American River. Kennedy Engineers recommended two (2) alternatives: 1) Re-route a portion of the west edge of campus to the ditch along the railroad levee via a new pump. 2) Continue to route all flows to the original pump. The former alternative was selected.

The report states, "Normally, storm water pumping facilities for drainage of an area solely dependent on pumped drainage would be recommended to meet the needs of a 25-year storm" (Kennedy, 27). However, the pumping facilities were designed to accommodate less than a 25-year storm for the following reasons. First, the proposed pump at the west end of campus was designed to accommodate a 5-year storm because the "turfed" areas could sustain ponding without damage (Kennedy, 9). Similarly, the "existing and enlarged" pump station on the east end of campus was sized only for a 10-year storm event, because the pipe network of Hornet Stadium was designed to provide detention.

Reinforced concrete pipe was recommended for all proposed storm drains: 12-inch minimum for mainlines and 10-inch minimum for laterals (Kennedy, 30). Additional capacity was recommended for the original pump station to accommodate the proposed improvements on the south side of campus. A recommendation was also made to contact the City of Sacramento to clarify the College's right to discharge into the west perimeter ditch (Kennedy, 29).

1989 UTILITY MASTER PLAN UPDATE (BOYLE ENGINEERING CORP.)

Citing the 1956 Agreement and Grant of Easement between the State of California and the City of Sacramento, Boyle Engineering writes, "CSUS has a storm drainage discharge agreement with the City of Sacramento for the on-site drainage channel. The City must accept any amount of storm drainage flow developed on campus into the on-site storm drainage channel." In other words, any amount of drainage generated on the CSUS campus can be re-routed into the ditch. The agreement has been discussed for

many years between CSUS and the City of Sacramento. OMNI-MEANS has been informed that until both CSUS and the City of Sacramento can come to terms with the 1956 agreement, no increase in the flow to the Western Ditch will be undertaken by CSUS.
In February of 1986, Sacramento experienced the equivalent of a 100-year storm event, with 2.63 in of rainfall in 24 hours, and 7.85 inches in seven days. The campus experienced no major flooding problems, but the water surface elevation of the American River was near the top of the levee.

At the time this Master Plan Update was completed (1989), there were 3 pumping stations. Listed by the university's current naming system, these are Storm Lift Stations 1, 3, and 4. Storm Lift Station 2 was built shortly after this Master Plan Update was completed.

Boyle Engineering Corp. estimated that a 10% increase in permeable land was expected through the removal of buildings and parking lots. This would have reduced the amount of peak runoff entering the storm drain system (Boyle, 4-5). The report references the "future campus master plan," but the precise location of these new permeable lands was not specified.

2007 South Campus Drainage Report (Carter and Burgess)

This study encompasses the area bound by Tahoe Hall to the north, State University Drive South, State University Drive East, and State University Drive West. Using StormCAD (Haestad Methods Inc.) and the Sacramento City and County Drainage Manual, Carter and Burgess analyzed the existing storm drainage system at 9 different phases of development. At the time of the report, Phase 2 was underway with the construction of the Bookstore. With the completion of the Recreation/Wellness Center (The Well), the campus is currently (2011) at the end of Phase 4. At each phase, the major existing storm drain facilities were determined to be either adequate or inadequate with regard to conveying various storm events.

On the whole, Carter and Burgess found many of the existing facilities to be inadequately sized and/or sloped. The report states, "The cause of the problems with the system is fairly simple. In short, the piping is too flat in slope and not big enough" (Carter and Burgess, 4). Pipe capacity for the 2-year, 5-year, 10-year and 100-year storm events was documented as "OK" for sufficient or "EX" for exceeded. See "Summary Table – End of Phase 4" (Carter and Burgess, 11). The report identifies areas of deficiency but did not offer solutions.

Synopsis of Previous Studies

As a whole, the campus storm drainage system has been historically undersized and generally inadequate. This is partly due to updates in published precipitation data. In recent years, the Army Corps of Engineers has increased storm event intensities to match the most current rainfall data. The campus' location at the natural outfall of Sutter Slough has posed problems for both onsite and offsite drainage. Offsite drainage must either be re-routed around the campus or through the campus. Drainage routed around the campus is conveyed through the Western Ditch, and through the campus via the Sump 31 pipelines constructed in 2001. Some on-site drainage naturally collects at the current location of the library. Pumps can redirect this drainage, but problems may arise with the lack of an overland release path for larger storms, as well as with power outages and other forms of pump failure. A series of modifications and adjustments will be necessary to solve the campus' current drainage problems.

SUMMARY OF EXISTING CONDITIONS

As reported by CSUS campus maintenance, on-site flooding has occurred on the lower levels of the Library II South and the Academic Information Resources Center. An interim solution has been implemented that redirects roof runoff from the Library II South via dual 12" storm drains to the storm drainage system between Benicia Hall and Parking Structure III.

The loading dock of the University Union (Lot 5) has also experienced substantial flooding. This drainage system ties directly into the mainline for the south campus that runs from south to north along Jed Smith Drive. As the mainline backs up, the University Union drainage system also backs up.

Although not as detrimental to University property, the athletic fields along State University Drive West have also reported localized flooding. This, however, is consistent with the original design recommendation by Kennedy Engineers in 1966. Because this area is "mostly turfed," it "would sustain only limited damage if subjected to ponding for periods of reasonable duration." (Kennedy, 29)

HYDROLOGY

Existing Drainage Sheds were defined based on CSUS Storm Drain CAD files and site reconnaissance. The CAD files are based on the North American Datum 1983 (NAD83) coordinate system. Peak flows were modeled using the Sac Calc computer program, which applies Sacramento County rainfall data to the Army Corp of Engineers' HEC-HMS software. Sac Calc calculates design flows using Sacramento County Hydrology Standards. Sac Calc is the de facto standard in the City and County of Sacramento, and has the ability to route runoff hydrographs and simulate detention storage. For this study the kinematic wave method was used for hydrograph routing. See Appendix for Drainage Shed Maps.

Currently, there are five (5) main outfalls for the entire campus. All but one of these outfalls is located at a pump station. Storm Lift Station #1 is located at the East end of campus by the Guy West Bridge. This is the main outfall for the campus. The majority of the North side of campus drains to the original 3 pumps, which were constructed in 1952. The majority of the South campus drains to the 3 new pumps constructed in 1970. Storm Lift Station #2 is located at the Northeast corner of campus. It consists of 2 pumps constructed in 1989 and collects drainage from the student housing facilities. Storm Lift Station #3 has 1 pump constructed in 1984, and collects drainage from the Student Health Center, custodial buildings and a portion of Lot 1. Lift Station #4 has 2 pumps also constructed in 1984, and collects drainage from the athletic fields, Tahoe Hall, and a portion of the WELL building. The drainage shed labeled "Direct Outfall" collects drainage from Lot 1 and the botanical gardens on the north side of campus, just south of Esplanade. This drainage shed directly outfalls into the City maintained Western Ditch, where it changes course to a northerly alignment, away from the campus via culverts underneath "J "Street.

Figure 1 Lift Station #1 Discharge into American River

Figure 2 Lift Station #3 Controls

PROPOSED STORMWATER MANAGEMENT FACILITIES

The 2014 Campus Master Plan includes a section of landscaping that depicts the existing lawn and parking area to be retrofitted with stormwater management facilities. The exhibit "Schematic Landscape Plan" prepared by Quadriga Inc. depicts these distinct stormwater management features proposed for the campus. The storm water management features include: Bio-Swale (Greenway "Hornet Creek", Rain Garden) Turf Infiltration, and Permeable Pavement.

- **Bio Swale**
  Bio Swales are post-construction storm water treatment best management practice (BMP) that treat storm water vertically through an engineered soil filter media to detain or retain runoff on site. Bio-Swales include campus Greenway and Rain Gardens. A typical Bio-Swale will have one foot of freeboard from the ground to the area grate (to pond water) and 2' of engineered soil. The engineered soil will have 40% voids to retain storm runoff. The total volume of the Bio-Swales is 1.8 cubic feet per square foot of surface area (1.0 cf ponded water above the Bio Swale, plus 40% x 2' = 0.8 cf of water in the soil).

- **Turf Infiltration**
  Turf Infiltration is also a post-construction storm water treatment BMP that treats storm water vertically through an engineered soil filtration media to detain or retain runoff on-site. The Turf Infiltration areas will replace existing turf with 3' of engineered soil and quick draining turf. The engineered soil will have 40% voids to retain storm runoff. The total volume of the Turf Infiltration area is 1.2 cubic foot per square foot of surface area (40% x 3' = 1.2 cf of water in the soil).

- **Permeable Pavement**
  Permeable Pavement is a post-construction storm water treatment BMP that treats storm water vertically through porous pavement and open-graded bedding and base course rock. The porous pavement can be porous asphalt concrete, porous portland cement concrete or permeable pavers.

square foot of surface area (0.4 x 3' = 1.2 cf of water in the rock).

All three storm water management facilities listed above will be constructed by an existing area drain or a new area drain connected to the existing storm drain system. A perforated pipe located at the bottom of the storm water management facilities will be installed if infiltration is not expected due to site conditions.

It should be note that the potential solutions recommended in the 2012 Storm Drainage Master Plan are no longer necessary due to the proposed storm water management facilities mentioned in this report. The total area and depth of each storm water management facility will need to be determined on a case by case basis due to storm drain depth and infiltration rate.

The proposed stormwater management facilities consisting of the Bio-swales (Greenway "Hornet Creek", rain gardens), turf infiltration, and permeable pavement represent a dramatic change in the surface retention, detention, infiltration and stormwater biotreatment potential of the campus. The overall estimated change in the character of the surface area of the campus having a positive impact on stormwater management is summarized in Table 1.

Table 1

Estimated Change in Campus Surface Area			
Category	**Current Campus Area, Percent**	**Master Plan Current Campus Area, Percent**	**Net Change**
Pervious Area, Retention and Detention	30%	35%	5%
Area Receiving Primary Biotreatment	0%	14%	14%

The implementation of the storm water management facilities will have a significant reduction in both the peak flows within the storm drain system and the volume of the storm runoff pumped from the campus into the American River. The estimated peak flow and volume reduction for each outfall is summarized in Table 2.

Table 2

Summary of Strom Water Landscape Mitigations			
Outfall	**Q10 Peak Flow Reduction (%)**	**Q100 Peak Flow Reduction (%)**	**Volume Reduction* (%)**
Pump #1 (North)	54%	48%	42%
Pump #1 (South)	41%	39%	16%
Pump # 1 (North & South comb.)	47%	43%	29%
Pump #2	31%	28%	39%
Pump #3	0%	0%	0%
Pump #4	59%	59%	0%
Direct Outfall	28%	27%	42%
Shed 5	41%	40%	0%
Shed 6	0%	0%	0%
Total Campus	41%	38%	22%

*Volume Reduction is based on 2 consecutive 10 year, 24 Hour Storm Events.

Peak Flow: a rate of volume per time at an instantaneous point in time of a design storm, measured in cubic feet per second (cfs)
Volume: the total amount of rainfall associated with a particular storm, measured in cubic feet (ft3)

Peak Flow (cfs) and Volume (ft3) are two completely independent figures, based on two completely independent calculations in order to meet two completely independent criteria. The volume reduction is based upon the soil type for each shed. The infiltration rates are per the report prepared by ENGEO, Inc., titled "Infiltration Opportunities" and is included in the appendix. The flow summaries for the Peak Q10 and Q100 are included in the appendix. The volume reduction spreadsheet is also included in the appendix.

SUSTAINABLE DESIGN STRATEGIES

As portions of the campus are reconstructed or newly designed, sustainable practices are expected to be appropriately applied. The idea behind low impact design with regard to storm drainage is to mimic the natural patterns of the water cycle as closely as possible. This involves design practices that maximize evapo-transpiration, infiltration and natural processes of water quality treatment. General sustainable design strategies are found in the CSUS *Sustainable Design and Operations Strategies Report* (HOK, Draft 7-21-08). The following are recommended practices for the CSUS campus.

- **Bio-Swale & Turf Infiltrations:** As addressed in previous sections of this report, Bio-Swales and Turf Infiltration will be a major factor in sustainable Design Strategies. Bio-Swales, when properly designed, add to the aesthetic value of the landscaping while providing a functional purpose.
- **Pervious paving:** Porous asphalt, pervious concrete, or permeable pavers should be considered for parking lots or pedestrian sidewalks. Pervious paving reduces the runoff to storm drain systems, while recharging the groundwater table. Because the campus irrigation system is supplied entirely by wells, design practices that recharge the groundwater table serve to sustain campus landscaping.
- **Disconnect impervious pavement areas:** Where ever possible, impervious surfaces should be broken up to decrease the accumulation of sheet flow and concentrated flow. This can be implemented in parking lots and sidewalks.
- **Green roofs:** A major source of runoff volume on the CSUS campus is the building roofs. Currently, the building roofs are all impervious surfaces, contributing significantly to the storm drain peak flows. Various systems of roof vegetation can be implemented on both existing and new buildings. Roof vegetation retains up to 70% of precipitation through evapo-transpiration. Green roofs mimic the natural role of the tree canopy, where water is stored in leaves, branches and bark until it evaporates.
- **Disconnect roof drains:** Where ever possible, existing buildings with roof drains connected to the storm drain system should be disconnected and redirected to the proposed rain gardens. This will allow the storm runoff to be treated and detained in the rain garden.
- **Roof Cisterns:** Runoff from rooftops can also be stored in above ground and below ground cisterns. These roof cisterns can be used for irrigation and landscaping purposes, decreasing the amount of energy and groundwater resources currently being used.

FURTHER ACTION ITEMS

The next steps in the process of building a more robust storm drainage system are described below.

XPSTORM Model

The SacCalc hydrologic model provides only the peak flows for individual drainage sheds and control points, while incorporating detention and routing. XPSTORM, or equivalent modeling software, takes this analysis to the next level. XPSTORM connects every pipe network together along with the ground surface elevation. This provides a 2-dimensional model of where and when flooding occurs. An XPSTORM model will also provide a better understanding of the effect of backwater on each pipe network, as well a more accurate analysis of how time intervals affect localized flooding. As future development occurs, the model can be updated and reassessed to insure that the entire campus drainage system functions effectively.

Pump Station Evaluation

Flow capacity for each of the pump stations needs to be assessed by a contractor specializing in pump station evaluation. Because pumping efficiencies diminish over time, a thorough evaluation is needed to determine the actual performance capabilities of the pumps. This information is critical for ensuring the accuracy of the XPSTORM Computer Model.

Interim Projects

All interim storm drain improvement projects will require further study to determine its effects on the overall storm drain system. An XPSTORM Model would be especially helpful in both determining and analyzing these effects.

Topographic Survey

Storm drain systems are generally designed to meet 10-year storm requirements. Runoff from larger storm events is conveyed via overland release paths. Due to the unique situation of the campus, many of the overland release paths are inadequate or non-existent. The result is localized flooding and property damage. In order to effectively critique and re-design overland release paths, a topographic survey is necessary.

FLOW SUMMARIES
INFILTRATION OPPORTUNITIES

EXHIBITS:

X1 - EXISTING DRAINAGE SHEDS W/ DETENTION

FLOW SUMMARY

10-Year Peak Flow Mitigation - Landscape Detention

	Sac-Calc					Actual Effects of Landscape Detention				
XSUB-SHEDS	A (sf)	A (ac)	Q_{10} (cfs)	Q_{10} with Detention (cfs)	Q_{10} Reduction* (cfs)	Actual Tributary Area (sf)	Actual Tributary Area (%)	Actual Q_{10} Reduction (cfs)	Actual Q_{10} with Detention (cfs)	Actual Q_{10} Reduction (%)
X-PUMP 1	**7,486,363**	**171.9**	**168.0**	**43.0**	**125.0**	**4,709,455**	**63%**	**78.6**	**89.4**	**47%**
XN-OUT	**3,727,510**	**85.6**	**74.0**	**11.0**	**63.0**	**2,374,002**	**64%**	**40.1**	**33.9**	**54%**
XN-1	181,527	4.2	3.7	1.3	2.4	52,067	29%	0.7	3.0	19%
XN-2	1,739,953	39.9	34.0	2.4	31.6	1,043,972	60%	19.0	15.0	56%
XN-3	639,489	14.7	12.0	2.6	9.4	525,800	82%	7.7	4.3	64%
XN-4	456,221	10.5	11.0	0.5	10.5	361,153	79%	8.3	2.7	76%
XN-5	710,320	16.3	17.0	6.7	10.3	391,010	55%	5.7	11.3	33%
XS-OUT	**3,758,853**	**86.3**	**94.0**	**32.0**	**62.0**	**2,335,453**	**62%**	**38.5**	**55.5**	**41%**
XS-1	141,058	3.2	4.7	3.2	1.5	27,637	20%	0.3	4.4	6%
XS-2	426,739	9.8	10.0	4.0	6.0	151,425	35%	2.1	7.9	21%
XS-3	237,852	5.5	7.9	0.4	7.5	237,852	100%	7.5	0.4	95%
XS-4	201,890	4.6	5.9	5.9	0.0	6,030	3%	0.0	5.9	0%
XS-5	319,917	7.3	12.0	0.7	11.3	319,917	100%	11.3	0.7	94%
XS-6	264,258	6.1	12.0	0.3	11.7	203,252	77%	9.0	3.0	75%
XS-7	971,207	22.3	25.0	17.0	8.0	756,129	78%	6.2	18.8	25%
XS-8	120,579	2.8	3.4	3.4	0.0	0	0%	0.0	3.4	0%
XS-9	596,532	13.7	16.0	1.9	14.1	325,591	55%	7.7	8.3	48%
XS-10	327,287	7.5	10.0	0.6	9.4	261,830	80%	7.5	2.5	75%
XS-11	151,535	3.5	3.6	1.2	2.4	45,790	30%	0.7	2.9	20%
X-PUMP 2	**323,584**	**7.4**	**6.0**	**1.3**	**4.7**	**127,303**	**39%**	**1.8**	**4.2**	**31%**
X-PUMP 3	**284,112**	**6.5**	**7.0**	**7.0**	**0.0**	**0**	**0%**	**0.0**	**7.0**	**0%**
X-PUMP 4	**1,514,210**	**34.8**	**27.0**	**0.2**	**26.8**	**900,376**	**59%**	**15.9**	**11.1**	**59%**
X-DIRECT OUTFALL	**456,181**	**10.5**	**10.0**	**3.3**	**6.7**	**189,892**	**42%**	**2.8**	**7.2**	**28%**
X-SHED 5	**911,998**	**20.9**	**27.0**	**3.5**	**23.5**	**430,267**	**47%**	**11.1**	**15.9**	**41%**
X-SHED 6	**380,939**	**8.7**	**11.0**	**11.0**	**0.0**	**0**	**0%**	**0.0**	**11.0**	**0%**
TOTAL CAMPUS	**11,357,388**	**260.7**	**256.0**	**69.3**	**186.7**	**6,357,293**	**56%**	**104.5**	**151.5**	**41%**

*The peak flow mitigation modeled through Sac-Calc assumes that the entire drainage shed is routed through the sum of the landscape detention areas.
**For a more accurate model of the effects of the landscape detention areas, only a fraction of the Q10 reduction is counted. This fraction is the percentage of the drainage shed that actually contributes to the landscape detention areas.

Abbreviations:

X: Existing
P: Proposed
N: North
S: South
OUT: Outfall

FLOW SUMMARY

100-Year Peak Flow Mitigation - Landscape Detention

Sac-Calc						Actual Effects of Landscape Detention				
XSUB-SHEDS	A (sf)	A (ac)	Q_{100} (cfs)	Q_{100} with Detention (cfs)	Q_{100} Reduction* (cfs)	Actual Tributary Area (sf)	Actual Tributary Area (%)	Actual Q_{100} Reduction (cfs)	Actual Q_{100} with Detention (cfs)	
X-PUMP 1	**7,486,363**	**171.9**	**301.0**	**95.0**	**206.0**	**4,709,455**	**63%**	**129.6**	**171.4**	**43%**
XN-OUT	**3,727,510**	**85.6**	**132.0**	**33.0**	**99.0**	**2,374,002**	**64%**	**63.1**	**68.9**	**48%**
XN-1	181,527	4.2	7.1	3.3	3.8	52,067	29%	1.1	6.0	15%
XN-2	1,739,953	39.9	59.0	12.0	47.0	1,043,972	60%	28.2	30.8	48%
XN-3	639,489	14.7	24.0	7.0	17.0	525,800	82%	14.0	10.0	58%
XN-4	456,221	10.5	20.0	2.5	17.5	361,153	79%	13.9	6.1	69%
XN-5	710,320	16.3	32.0	13.0	19.0	391,010	55%	10.5	21.5	33%
XS-OUT	**3,758,853**	**86.3**	**169.0**	**62.0**	**107.0**	**2,335,453**	**62%**	**66.5**	**102.5**	**39%**
XS-1	141,058	3.2	8.6	5.5	3.1	27,637	20%	0.6	8.0	7%
XS-2	426,739	9.8	18.0	8.2	9.8	151,425	35%	3.5	14.5	19%
XS-3	237,852	5.5	13.0	13.0	0.0	237,852	100%	0.0	13.0	0%
XS-4	201,890	4.6	11.0	11.0	0.0	6,030	3%	0.0	11.0	0%
XS-5	319,917	7.3	19.0	3.2	15.8	319,917	100%	15.8	3.2	83%
XS-6	264,258	6.1	21.0	0.4	20.6	203,252	77%	15.8	5.2	75%
XS-7	971,207	22.3	43.0	28.0	15.0	756,129	78%	11.7	31.3	27%
XS-8	120,579	2.8	6.2	6.2	0.0	0	0%	0.0	6.2	0%
XS-9	596,532	13.7	27.0	6.7	20.3	325,591	55%	11.1	15.9	41%
XS-10	327,287	7.5	19.0	2.6	16.4	261,830	80%	13.1	5.9	69%
XS-11	151,535	3.5	6.5	2.8	3.7	45,790	30%	1.1	5.4	17%
X-PUMP 2	**323,584**	**7.4**	**11.0**	**3.1**	**7.9**	**127,303**	**39%**	**3.1**	**7.9**	**28%**
X-PUMP 3	**284,112**	**6.5**	**13.0**	**13.0**	**0.0**	**0**	**0%**	**0.0**	**13.0**	**0%**
X-PUMP 4	**1,514,210**	**34.8**	**52.0**	**0.3**	**51.7**	**900,376**	**59%**	**30.7**	**21.3**	**59%**
X-DIRECT OUTFALL	**456,181**	**10.5**	**20.0**	**7.2**	**12.8**	**189,892**	**42%**	**5.3**	**14.7**	**27%**
X-SHED 5	**911,998**	**20.9**	**50.0**	**7.5**	**42.5**	**430,267**	**47%**	**20.1**	**29.9**	**40%**
X-SHED 6	**380,939**	**8.7**	**21.0**	**21.0**	**0.0**	**0**	**0%**	**0.0**	**21.0**	**0%**
TOTAL CAMPUS	**11,357,388**	**260.7**	**468.0**	**147.1**	**320.9**	**6,357,293**	**56%**	**179.6**	**288.4**	**38%**

*The peak flow mitigation modeled through Sac-Calc assumes that the entire drainage shed is routed through the sum of the landscape detention areas.
**For a more accurate model of the effects of the landscape detention areas, only a fraction of the Q100 reduction is counted. This fraction is the percentage of the drainage shed that actually contributes to the landscape detention areas.

Abbreviations:

X: Existing

P: Proposed

N: North

S: South

OUT: Outfall

FLOW SUMMARY

Infiltration	**Volumes**		**Landscape Retention**						
Shed	**Infiltration Area (sf)**	**HSG[1]**	**Infiltration Rate (in/hr)**	**Volume Infiltrated[2] (ft3)**	**Total Shed Area (ft2)**	**Total Volume[3] (ft3)**	**Actual Tributary Area[4] (ft2)**	**Actual Tributary Area Volume (ft3)**	**% of Total Volume Infiltrated**
PUMP 1	**982,841**			**1,645,122**	**7,486,363**	**4,167,409**	**4,424,677**	**2,463,070**	**39%**
XN-OUT	**507,439**			**1,226,045**	**3,727,510**	**2,074,981**	**2,374,002**	**1,321,528**	**59%**
XN-1	10,004	B	1.00	28,984	181,527	101,050	52,067	28,984	29%
XN-2	312,726	B/D	0.50	581,144	1,739,953	968,574	1,043,972	581,144	60%
XN-3	49,303	B	1.00	197,212	639,489	355,982	525,800	292,695	55%
XN-4	80,537	B	1.00	201,042	456,221	253,963	361,153	201,042	79%
XN-5	54,868	B	1.00	217,662	710,320	395,411	391,010	217,662	55%
XS-OUT	**475,402**			**419,078**	**3,758,853**	**2,092,428**	**2,050,675**	**1,141,542**	**20%**
XS-1	5,782	B	1.00	15,385	141,058	78,522	27,637	15,385	20%
XS-2	31,852	C/D	0.10	12,741	426,739	237,551	151,425	84,293	5%
XS-3	59,005	A	1.50	132,404	237,852	132,404	237,852	132,404	100%
XS-4	3,200	C/D	0.10	1,280	201,890	112,385	6,030	3,357	1%
XS-5	53,808	A	1.50	19,560	319,917	178,087	35,138	19,560	11%
XS-6	98,776	B	1.00	113,144	264,258	147,103	203,252	113,144	77%
XS-7	50,488	D	0.00	0	971,207	540,639	756,129	420,912	0%
XS-8	0			0	120,579	67,122	0	0	0%
XS-9	103,803	C	0.30	124,564	596,532	332,070	325,591	181,246	38%
XS-10	60,013	D	0.00	0	327,287	182,190	261,830	145,752	0%
XS-11	8,674	D	0.00	0	151,535	84,354	45,790	25,490	0%
PUMP 2	25,613	B	1.00	70,865	323,584	180,129	127,303	70,865	39%
PUMP 3	0	B	1.00	0	284,112	158,156	0	0	0%
PUMP 4	467,130	D	0.00	0	1,514,210	842,910	900,376	501,209	0%
DIRECT OUTFALL	34,901	B	1.00	105,707	456,181	253,941	189,892	105,707	42%
SHED 5	105,103	D	0.00	0	911,998	507,679	0	0	0%
SHED 6	0	D	0.00	0	380,939	212,056	0	0	0%
TOTAL CAMPUS	**1,615,588**			**1,821,694**	**11,357,388**	**6,322,279**	**5,642,247**	**3,140,851**	**29%**

[1]Hydrologic Soil Group (HSG) infiltration rates are defined as follows:

A	1.50	in/hr
B	1.00	in/hr
C	0.30	in/hr
D	0.00	in/hr

[2]Volume Infiltrated is based on infiltration rate of soil over a 48 hour duration; cannot exceed Actual Tributary Area Volume

[3]Total Volume is the total amount of rainfall generated by 2 consecutive 10-year, 24 hour storms (6.68 inches)

[4]Actual Tributary Area is the portion of the drainage shed that is able to physically drain to the Infiltration Area.

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Project No.
10945.000.000

March 21, 2014

Keith Mullnix
Associate Principal
OMNI-MEANS, Ltd.
943 Reserve Drive, Suite 100
Roseville, CA 95678

Subject: California State University Sacramento
Sacramento, California

INFILTRATION OPPORTUNITIES

Dear Mr. Mullnix:

We are pleased to provide our infiltration test results and interpreted infiltration opportunities at California State University Sacramento (CSUS) campus, California. We performed infiltration testing and consultation in accordance with our signed agreement dated February 20, 2014. The purpose of our services was to assist the design team with information pertinent to the design and implementation of post-construction stormwater management features.

REVIEW OF EXISTING SUBSURFACE DATA

We reviewed the USDA Soil Survey map of the campus, regional geologic maps and DWR Water Data Library depth to groundwater information. The DWR library, and subsequent review of borings, identified the depth to groundwater was generally greater than 20 feet below the ground surface. We reviewed this information to assist in identifying appropriate locations for the infiltration tests.

USDA Soil Maps

We reviewed published soil data compiled by the United States Department of Agriculture (USDA) National Resource Conservation Service for background information on mapped soil conditions (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). Each survey maps soil units and includes a summary of general characteristics and recommended guidance. The USDA assigns soils to four general groups, A, B, C and D, which includes infiltration potential. The site-specific USDA Soil Resource report maps the western portion of the CSUS campus as Group D and the rest of the campus as Group A soils. Table 1 shows the site appropriate USDA generalized criteria for assigning hydrologic soil groups based on infiltration rates.

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TABLE 1
USDA Hydrologic Soil Groups*

Soil Property	Unit A	Unit B	Unit C	Unit D
Saturated hydraulic conductivity of the least transmissive layer	>1.42 in/hr	≤1.42 to >0.57 in/hr	≤0.57 to >0.06 in/hr	≤ 0.06 in/hr
Depth to water impermeable layer	>40 in	>40 in	>40 in	>40 in
Depth to high water table	>40 in	>40 in	>40 in	>40 in

*From Table 7-2, USDA National Engineering Handbook, Part 630 (210-VI-NEH), Chapter 7, May 2007

Published Geology Maps

The geology maps, consistent with the USDA map, identify the CSUS campus as being underlain by soils ranging from very dense cemented soil to loose silty sands closer to the river. These soil types generally span a wide range of infiltration rates due to the Pleistocene and Holocene-aged alluvial deposits. Table 2 includes a brief description of each of these geologic formations and our assessment of the relevant USDA hydrologic soil group based on our experience. Refer to Figure 1, the Infiltration Opportunities Site Plan, for the geologic contacts.

TABLE 2
Geologic Formations Underlying CSUS Campus with Associated Infiltration Opportunity

Geologic Formation	Description	Infiltration Opportunity	Corresponding USDA Hydrologic Soil Group
Riverbank (Qrl) - Pleistocene	Consists of red semi-consolidated gravel, sand and silt that results in very dense and hard cemented soil.	Very Limited	D
Modesto (Qmu) - Pleistocene	Consists of unconsolidated, unweathered gravel, sand, silt and clay from the Pleistocene era.	Very Limited	D
Alluvium (Qa) – Holocene	Consists of unweathered gravel, sand and silt deposited by present day streams and rivers. On the campus, this formation consists of loose to medium dense silty sands and sands and soft to very stiff silts and sandy silts.	Medium to High	A, B, C

INFILTRATION TESTING

Following our review of existing subsurface data and geology, we assisted in selection of the four infiltration test locations. Test locations were selected near previous soil borings. On March 12 and 13, 2014, we observed excavation of four test pits to depths of 3 feet below the existing ground surface (bgs) at the locations indicated on Figure 1. The test pits were logged by an ENGEO engineer to classify the soils encountered. The subsurface conditions for each location are described below. We obtained representative soil samples from each test location at a depth of 3 feet below existing grade and performed laboratory moisture content and gradation tests; the results are attached to this letter and also summarized with the infiltration test results. The test pits were excavated using a CAT KA6W37 backhoe and backfilled and compacted using a sheepsfoot compaction wheel.

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California State University
INFILTRATION OPPORTUNITIES

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TABLE 3
Subsurface Conditions at Test Pit Locations

Test Pit No.: DR-1 (Qmu)	
	0-1’ AGGREGATE BASE 1-3’ Silty CLAY with Sand (CL), reddish brown to red, hard, moist, low plasticity, fine-grained sand
Test Pit No.: DR-2 (Qrl)	
	0-1’ TOPSOIL 1-3’ Silty CLAY with Sand (CL-ML), brown, stiff to very stiff, moist, fine-grained sand
Test Pit No.: DR-3 (Qa)	
	0-1¾’ Silty SAND (SM), brown, loose, moist, poorly graded, fine-grained 1¾-2’ Poorly Graded SAND (SP), light brown, loose, moist, fine- to medium grained sand 2-3’ Silty SAND (SM), brown, loose to medium dense, moist

TABLE 3
Subsurface Conditions at Test Pit Locations (Continued)

Test Pit No.: DR-4 (Qa)	
	0-½' TOPSOIL ½-1½' FILL, gravelly, silty sand with asphalt fragments 1½-2' CONCRETE and ASPHALT (Old Road Fragments) 2-3' Silty SAND (SM), brown, loose, moist, fine-grained sand, poorly graded

We conducted infiltration testing using "Double-Ring" infiltrometer equipment (ASTM D3385-09 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer). The infiltration test locations are shown on Figure 1. We recorded the field data and calculated the infiltration rate for the inner ring of the Double Ring Infiltrometer using the following equation from ASTM D3385-94:

$$V_{IR} = \Delta V_{IR} / (A_{IR} * \Delta t)$$

Where:

V_{IR} = inner ring incremental infiltration velocity, in/hr
ΔV_{IR} = volume of liquid used during time interval to maintain constant head in the inner ring, cm^3
A_{IR} = internal area of inner ring, cm^2
Δt = time interval, h

Double-Ring Infiltrometer Photo

The depth of the test, soil type, percent passing the No. 200 sieve, in-situ moisture content and calculated stabilized infiltration rate at each test location are summarized in the following table:

TABLE 4
Double Ring Infiltrometer Test Results

Double Ring Infiltrometer ID	USCS Soil Classification at 3 feet	Measured Infiltration Rate (in/hr)	% Fines (Passing #200 sieve)	In-Situ Moisture Content at 3 Feet (%)	USDA Hydrologic Group Based on Tables 1 and 2
DR-1	CL - Silty Lean Clay with Sand	0.4	79	15.4	D
DR-2	CL- Silty Lean Clay with Sand	<0.1*	80	17.6	D
DR-3	SM - Silty Sand	6	39	6.4	A
DR-4	SM - Silty Sand	1.5	44	11.1	A

*Measured infiltration rate was negligible so it is reported as less than 0.1 inches per hour

These stabilized field infiltration rates are based solely on the change in water level measured at the locations tested. No conversion factors have been applied. The infiltration tests indicate a decrease in infiltration rates with an increase in in-situ moisture content and fines content, which was anticipated.

INFILTRATION OPPORTUNITIES

Following our infiltration testing, we reviewed existing geotechnical soil borings from the previous projects at the CSUS campus. We tabulated the soil types and consistency for the upper 20 feet encountered in the majority of the soil borings. Our goal was to develop a methodology for correlating USDA hydrologic soil groups with the soil data in the borings. For this correlation, we considered the following primary factors:

- Consider only the upper 10 feet of the soil profile since this is the zone of significant influence for infiltration; since 3 feet was to be removed for any infiltration feature, we ignored the upper 3 feet as well.

- Check the USCS soil classification and soil density/consistency.

- Assign USDA Hydrologic Group to each boring based on the least transmissive layer in the upper 10 feet.

We then developed a classification system for assigning a corresponding USDA hydrologic soil group to the tabulated boring data, similar to what has been used by others (MPCA, 2005) for recommended design infiltration rates based on soil type. We modified the classification system to incorporate the density/consistency of the borings as this can affect the actual infiltration; looser soils typically have higher porosity and subsequently higher infiltration potential. Using this classification system, we applied the general USDA hydrologic soil groups to the tabulated boring data, as shown in the attached table, Soil Boring Infiltration Opportunities. Tables 2 and 3 illustrate our interpretation of the soil consistency using reported SPT blow count information for coarse-grained and fine-grained soil.

TABLE 5
Interpretation of Standard Penetration Test Results

Soil Type	# of SPT Blow Counts (N-Value)	Density/ Consistency
Coarse Grained	0-4	Very Loose
	5-10	Loose
	11-29	Medium Dense
	30-49	Dense
	>50	Very Dense

Soil Type	# of SPT Blow Counts (N-Value)	Density/ Consistency
Fine Grained	0-2	Very Soft
	3-4	Soft
	5-8	Medium Stiff
	9-15	Stiff
	16-30	Very Stiff
	>30	Hard

Table 6 summarizes the our methodology for assigning hydrologic soil groups to specific soil layers. The assigned hydrologic groups for each boring reviewed are indicated on Figure 1.

TABLE 6
Methodology Used to Assign USDA Hydrologic Soil Group to Existing Subsurface Data

USDA Hydrologic Group	Design Infiltration Rate (in/hr)	USDA Soil Textures	USCS Soil Classification	Consistenty		Geologic Unit
				N-value	Density/Stiffness	
A	0.8 to 1.6+	Gravel, sandy gravel, silty gravels, sand, loamy sand and sandy loam	(SM) - Silty Sand	N < 30	Very Loose - Medium Dense	Qha
			(GM) - Silty Gravel	N < 30	Very Loose - Medium Dense	Qha
			(GP/GW) - Well/Poorly Graded Gravel	N < 30	Very Loose - Medium Dense	Qha
			(SW/SP) - Well/Poorly Graded Sand	N < 30	Very Loose - Medium Dense	Qha
B	0.3 to 0.6	Silt loam, loam, sandy clay loam	(SM) - Silty Sand	N ³ 30	Dense	Qha
			(GP/GW) - Well/Poorly Graded Gravel	N ³ 30	Dense	Qha
			(SW/SP) - Well/Poorly Graded Sand	N ³ 30	Dense	Qha
			(ML) - Sandy Silts	N ≤ 15	Very Soft - Stiff	Qha
C	0.2	Sandy clay loam	(ML) - SILTS	N ≤ 15	Very Soft - Stiff	Qha
D	<0.2	Clay loam, silty clay, loam, sandy clay, silty clay or clay	(GC) - Clayey Gravels, clayey sandy gravels	All	NA	Qrl/Qmu
			(SC) - Clayey SAND, gravelly SAND	All	NA	Qrl/Qmu
			(CL) - Low plasticity clays, sandy or silty clays	All	NA	Qrl/Qmu
			(ML) - SILTS, Clayey SILTS, Sandy SILTS	N > 15	Very Stiff - Hard	Qrl/Qmu

Our review of existing subsurface data indicated a wide range of soil types and geologic units across the campus, which leads to a wide range of infiltration opportunities for stormwater management features. The infiltration opportunities identified for each soil boring are generally consistent with the mapped geology, anticipated soil types within these areas and the measured infiltration rates. The infiltration test results confirm the anticipated variability across the site and identify areas of high and low infiltration opportunities, while the assigned hydrologic groups indicate a wide range of variability even within the Holocene alluvium. Based on the classification of the individual borings and the geology, we outlined approximate boundaries between Group A, B and C versus Group D soils. These boundaries are only estimations and variations are expected. Figure 1 can be used for preliminary evaluation of infiltration opportunities for general planning of stormwater management features.

CLOSURE

The intent of our scope of work was to provide infiltration test data and a qualitative assessment of the existing subsurface data to assist in the design of future stormwater management features. The assigned USDA hydrologic groups on Figure 1 are for planning purposes and should be confirmed prior to the design of these features. In our experience with stormwater management features, it is very valuable to have someone confirm the soil in contact with these features during construction to assist in producing effective results. ENGEO can provide these services as projects arise.

If you have any questions or comments regarding this letter, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

REGISTERED PROFESSIONAL ENGINEER NICHOLAS BROUSSARD No. 81322 Exp. 9/30/2015 CIVIL STATE OF CALIFORNIA

Nick Broussard, PE

REGISTERED PROFESSIONAL ENGINEER MARK M. GILBERT No. 2191 Exp. 3/31/2016 GEOTECHNICAL STATE OF CALIFORNIA

Mark Gilbert, GE

Attachments: References
Figure 1 – Infiltration Opportunities Site Plan
Table - Soil Boring Infiltration Opportunities
Laboratory Test Results (4 pages)

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REFERENCES

1. CSUS, Campus Geotechnical Testing Locations Figure, January 10, 2012.

2. Helley, Edward and Harwood, David; Geologic Map of the Late Cenozoic Deposits of the Sacramento Valley and Northern Sierran Foothills, California; 1985.

3. Minnesota Pollution Control Agency, 2005. Minnesota Stormwater Manual, Version 2.

4. USDA, Part 630 Hydrology National Engineering Handbook – Chapter 7 Hydrologic Soil Groups; May 2007.

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FIGURE 1

Infiltration Opportunities Site Plan

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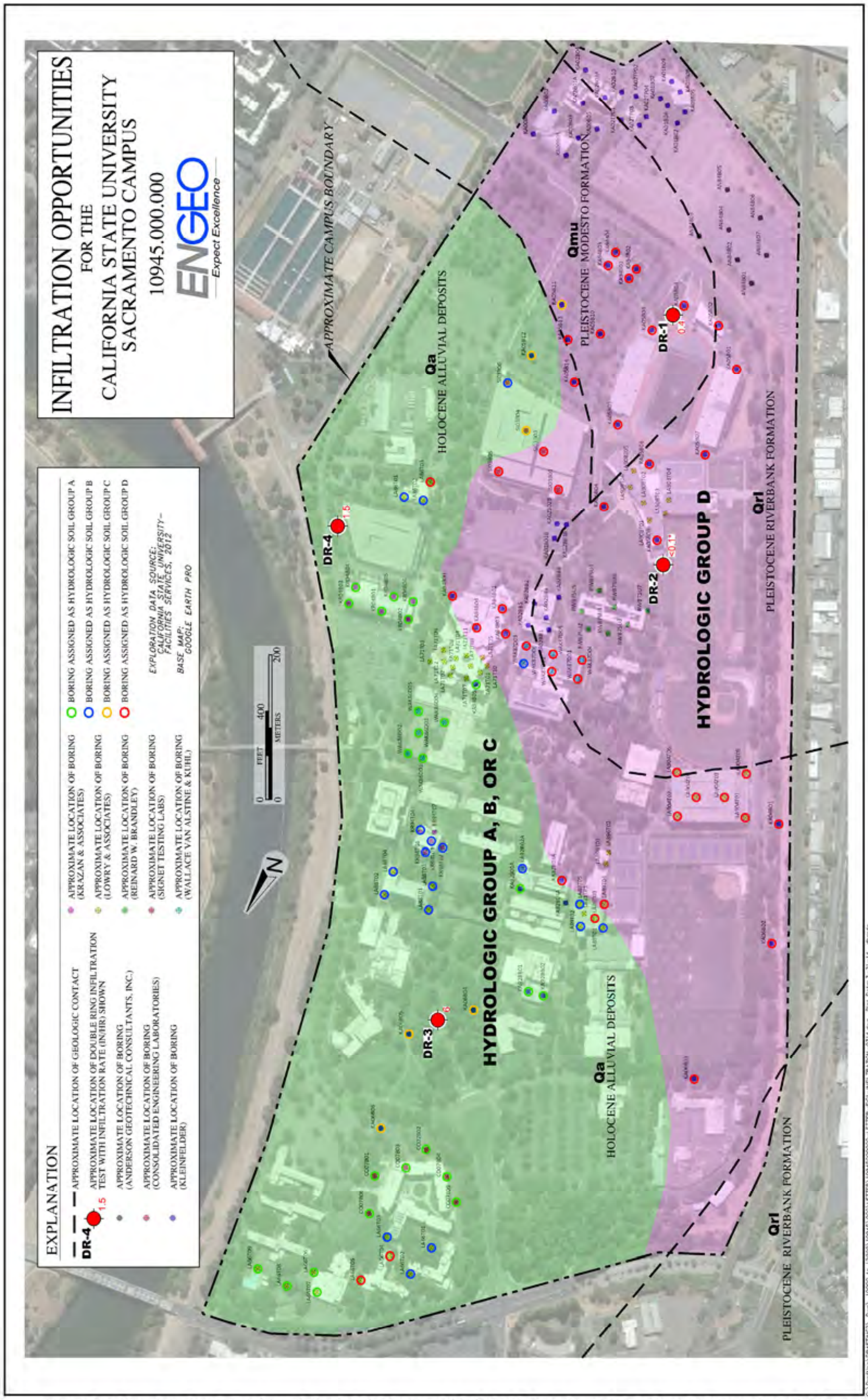
INFILTRATION OPPORTUNITIES
FOR THE
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SACRAMENTO CAMPUS
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EXPLANATION
APPROXIMATE CAMPUS BOUNDARY
HYDROLOGIC GROUP D
HYDROLOGIC GROUP A, B, OR C
Qa
HOLOCENE ALLUVIAL DEPOSITS
Qmu
PLEISTOCENE MODESTO FORMATION
Qrl
PLEISTOCENE RIVERBANK FORMATION
DR-1
DR-2
DR-3
DR-4

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TABLE

Soil Boring Infiltration Opportunities

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March 21, 2014

CALIFORNIA STATE UNIVERSITY SACRAMENTO

SOIL BORING INFILTRATION OPPORTUNITIES

Project	Boring ID	USDA Hydrologic Soil Group	Top Depth	USCS Classification	USCS Used	T Blow Cou	% Passing #200
New Residential Hall	C007B01	A	0.5	SM - Silty SAND	SM	8 to 11	
			25	SP - SAND	SP	11	
	C007B02	A	0.5	SM - Silty SAND	SM	11 to 13	
			25	CL	CL	3	
	C007B03	A	0.5	SM - Silty SAND	SM	10 to 16	
	C007B04	A	0.5	SM - Silty SAND	SM	7	
	C007B05	A	0.5	SM - Silty SAND	SM	9	
	C007B06	A	0	SM - Silty SAND	SM	7 to 10	
Proposed Phase II Expansion - University Union	KA94B01	A	1	SM - Silty SAND	SM	22	36
		D	5.25	ML - Sandy SILT	ML	22 to 31	
			13.5	SP-SM	SM	24	14
			19	GP- Sandy GRAVEL	GP		
	KA94B02	A	0.5	SM - Silty SAND	SM	6 to 10	
		D	7.5	ML - Clayey SILT	CL	6	
			15	ML - Clayey SILT	CL	20	
			20	GP- Sandy GRAVEL	GP	90/11"	
	KA94B03	A	0	SM - Silty SAND	SM	8 to 16	
		D	7	ML - Clayey SILT	CL	8	
			11	SM - Silty SAND	SM	30 to 31	
			22.5	GP - Sandy GRAVEL	GP		
	KA94B04	D	0	ML - Sandy SILT	ML	9 to 21	
			12	GP - Sandy GRAVEL	GP	73+	
	KA94B05	A	0	SM - Silty SAND	SM	6 to 10	
			13	CL - Silty CLAY	CL	41	
			17	GP - Sandy GRAVEL	GP		
Proposed Recreation, Wellness & Events Center Geotechnical Investigation Report	KA05B01	D	0.5	ML - Sandy SILT	ML	69 to 100+	
			11.5	SM - Silty SAND	SM	29 to 31	33
	KA05B02	D	1	ML - Sandy SILT	ML	100+	
			14	SM - Silty SAND	SM	19	
	KA05B03	D	0	ML - Sandy SILT	ML	21 to 44	
			13.5	SM - Silty SAND	SM	48	
	KA05B04	D	0	ML - Sandy SILT	ML	20	
		D	4	CL - Sandy Lean CLAY	CL	4 to 31	
	KA05B05	B	0	ML - Sandy SILT	ML	8 to 13	
		D	10	CL - Sandy Lean	CL	38 to 59	
			17	SC - Clayey SAND	SC	28	
	KA05B06	D	0	ML - Sandy SILT	ML	37 to 44	
		A	8.5	SM - Silty SAND	SM	15	
		A	12	SP - Poorly Graded SAND	SP	22	3
	KA05B07	D	0	ML - Sandy SILT	ML	20 to 36	
		A	5.5	SM - Silty SAND	SM	9 to 16	
	KA05B08	A	0	SM - Silty SAND	SM	8	26
		D	4.5	ML - Sandy SILT	ML	46	
		D	7	CL - Sandy Lean CLAY	CL	29	
			14	SM - Silty SAND	SM	14 to 32	
	KA05B09	D	0	ML - SILT	ML	22 to 48	
		A	4.5	SM - Silty SAND	SM	22	48
		D	7	ML - SILT	ML	18 to 37	
			15	SM - Silty SAND	SM	18	
			19	SM - Silty SAND	SM	80+	
	KA05B10	D	1	CL - Sandy Lean CLAY	CL	46	
		A	2.5	SM - Silty SAND	SM		
		D	4	CL - Gravelly CLAY	CL	7	
		A	5	SM - Silty SAND	SM	7	
		D	9	ML - SILT	ML	22 to 100+	
			18	SM - Silty SAND	SM	21	
	KA05B11	C	0.5	ML - SILT	ML	12 to 14	75
			12.5	SM - Silty SAND	SM	18 to 30	
	KA05B12	B	1	ML - Sandy SILT	ML	6	
		C	2.5	ML - Silt	ML	9 to 15	
			13	SM - Silty SAND	SM	34 to 21	

LEGEND
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SOIL BORING INFILTRATION OPPORTUNITIES

Project	Boring ID	USDA Hydrologic Soil Group	Top Depth	USCS Classification	USCS Used	T Blow Cou	% Passing #200
	KA05B13	D	0.5	ML - SILT	ML	11 to 17	
		A	8	SM - Silty SAND	SM	11 to 28	
	KA05B14		0.5	ML - SILT	ML	8 to 35	
			14.5	SM - Silty SAND	SM	19 to 53	
Alumni House	KA94B01	A	0.2	GP-GM - Sandy GRAVEL	GM		
		D	0.5	ML - Sandy SILT	ML	19 to 70	
			11	SM - Silty SAND	SM	89	
			18	GP-GM - Sandy GRAVEL	GP	50/3"	
	KA94B02		0.2	GP-GM - Sandy GRAVEL	GM		
		D	0.5	ML - Sandy SILT	ML	21 to 100+	71
			15.5	SM - Silty SAND	SM	78	
			18	GP-GM - Sandy GRAVEL	GM	50/4"	
	KA94B03		0.2	GP-GM - Sandy GRAVEL	GM		
		D	0.5	ML - Sandy SILT	ML	16 to 95	
			12	SM - Silty SAND	SM	90+	
			16	GP-GM - Sandy GRAVEL	GM		
	KA94B04		0.2	GP-GM - Sandy GRAVEL	GM		
		D	0.5	SM - Silty SAND	SM	52	44
		D	4	ML - Sandy SILT	ML	81+	
			15.5	SM - Silty SAND	SM		
Student Service Center Building Addition	KA92BB01		0	ML - Sandy SILT	ML	24	
			2	ML - Sandy SILT	ML	5 to 8	
			12.5	GM - Sandy Gravel	GM	40	
			16.5	SP-SM - Gravelly SAND	SM		
	KA92BB02	A	0	ML-SM - Sandy SILT	SM	6 to 8	47
			11	SP-SM - Gravelly SAND	SM	21 to 70	
Classroom Building II	KA92B01A		0	ML - Sandy SILT	ML	16	
		A	2	ML - Sandy SILT	ML	7 to 12	60
			15	SP-SM - Gravelly SAND	SM	78	
	KA92B02A		0	ML - Sandy SILT	ML	11 to 13	
		B	15	ML - Sandy SILT	ML	19	
			17	SP-SM - Gravelly SAND	SM		
	KA92B03A	D	0	ML - Sandy SILT	ML	21	
		B	2.5	SM - Silty SAND	SM	21	
		D	4	ML - Sandy SILT	ML	20 to 35	
			13.5	SP-SM - Gravelly SAND	SM		
	KA92B04A		0	ML - Sandy SILT	ML	None	
			17.5	SP-SM - Gravelly SAND	SM	None	
Utility Infrastructure Project Phase 2A	KA06B01	C	0	ML - SILT	ML	14	
		D	3	ML - Sandy SILT	ML	57	
			7	SP-SM - SAND with Silt	SM	40/6"	
			10	GP-GM - GRAVEL with silt and sand	GM	60/6"	
	KA06B02	D	0	ML - SILT	ML	16 to 62	
			15	SM - Silty SAND	SM		
	KA06B03	D	0	ML - SILT	ML	11 to 37	
			18.5	SM - Silty SAND	SM		
	KA06B04	C	0	ML - SILT	ML	9 to 14	
			15	GP - GRAVEL	GP		
			16.5	ML - SILT	ML		
	KA06B05	C	0	ML - SILT	ML	5 to 13	
	KA06B06	C	0.5	ML- SILT	ML	12	
			19	ML- SILT	ML	20	
			16	GP-GM - Sandy GRAVEL	GM	80+	
Science II	KR94T01	B	0	ML - Sandy SILT	ML	8 to 15	
			15	ML - Sandy SILT	ML	22	
			22	GM - Sandy Gravel	GM		
	KR94T02	B	0	ML - Sandy SILT	ML	5 to 15	

LEGEND
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SOIL BORING INFILTRATION OPPORTUNITIES

Project	Boring ID	USDA Hydrologic Soil Group	Top Depth	USCS Classification	USCS Used	T Blow Cou	% Passing #200
			18	GM - Sandy Gravel	GM	25 to 70	
	KR94T03	B	0	ML - Sandy SILT	ML	5 to 7	
			18	GM - Sandy Gravel	GM	74	
	KR94T04	B	0	ML - Sandy SILT	ML	4 to 11	
			17	GM - Sandy Gravel	GM	37 to 100+	
	KR94T05	B	0	ML - Sandy SILT	ML	5 to 9	
			18	GM - Sandy Gravel	GM	49 to 141	
Bookstore Building	KR04B01	A	0.5	SM - Silty SAND	SM	6 to 14	
			13	SC - Clayey SAND	SC	16	
			16.5	GP - Sandy GRAVEL	GP	72	
	KR04B02	A	0.5	SM - Silty SAND	SM	11	
		A	4	SM-ML - Silty SAND	SM	10 to 14	
			15	SM-ML - Silty SAND	SM	36	
	KR04B03	A	0.5	SM - Silty SAND	SM	5	
		A	3	SM-ML - Silty SAND	SM	5 to 9	
	KR04B04	A	1	SM - Silty SAND	SM	7	
		A	3.5	SM-ML - Silty SAND	SM	10	
		A	7.5	SM - Silty SAND	SM	6	
	KR04B05		15.5	GM - Sandy Gravel	GM	24	
	KR04B06	A	1	SM - Silty SAND	SM	7	
		A	4	SM-ML - Silty SAND	SM	10 to 11	
			14.5	GM - Sandy Gravel	GM	23	
Parking Structure	LA90AT01	D	0.5	ML - Sandy SILT	ML	21 to 27	
		B	6	SM - Silty SAND	SM	20 to 30	
			12	SM-GM - Sandy GRAVEL	GM	100+	
	LA90AT02	D	0.5	ML - Sandy SILT	ML	11 to 24	
		A	7	SM - Silty SAND	SM	7	
		A	9	SM-GM - Sandy GRAVEL	GM		
	LA90AT03	D	0.5	ML - Sandy SILT	ML	31 to 40	
		B	4.5	SM - Silty SAND	SM	31	
		B	9	SP - SAND	SP	33 to 60	
			14	SM-GM - Sandy GRAVEL	GM		
	LA90AT04	D	0.5	ML - Sandy SILT	ML	51	
		D	7	SM - Silty SAND	SM	45	
			11	SM-GM - Sandy GRAVEL	GM	100+	
	LA90AT05	D	0.5	ML - Clayey SILT	CL	51	
		A	8	SM - Silty SAND	SM	27	
			13	SM-GM - Sandy GRAVEL	GM	45 to 82	
	LA90AT06	D	0.5	ML - Clayey SILT	CL	36 to 76	
			12	SM - Silty SAND	SM	45 to 66	
			19	SM-GM - Sandy GRAVEL	GM		
Classroom Building	LA88T01	B	0	ML - Sandy SILT	ML	10	
		A	3	SM-SP - Silty SAND	SM	8	
		B	6	ML - Sandy SILT	ML	7 to 11	
		D	14	ML - Sandy SILT	ML	21	
	LA88T02	A	0	SM - Silty SAND	SM	16	
		B	3	ML - Sandy SILT	ML	10	
		A	5	SM - Silty SAND	SM	8	
		B	7.5	ML - Sandy SILT	ML	9 to 12	
			15	GM - Sandy Gravel	GM	85	
	LA88T03	A	0	SM - Silty SAND	SM	12	
		A	2	SP - SAND	SP		
		B	3.5	ML - Sandy SILT	ML	10	
		A	6	SM - Silty SAND	SM	10	
		B	7	ML - Sandy SILT	ML	11 to 14	
			18	ML - Sandy SILT	ML	20 to 28	
	LA88T04	B	2	ML - Sandy SILT	ML	5 to 6	
		A	5.5	SM - Silty SAND	SM	4 to 6	
		B	9	ML - Sandy SILT	ML	6 to 13	
Solano Hall	LA89T01	B	0	ML - Sandy SILT	ML	7	
		A	1	SM - Silty SAND	SM	23	

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SOIL BORING INFILTRATION OPPORTUNITIES

Project	Boring ID	USDA Hydrologic Soil Group	Top Depth	USCS Classification	USCS Used	T Blow Cou	% Passing #200
		B	3	ML - Sandy SILT	ML	8 to 14	
			16	GM - Sandy Gravel	GM	43 to 100+	
	LA89T02	B	0	ML - Sandy SILT	ML	8	
		A	1.5	SP - SAND	SP	6 to 9	
		B	4	ML - Sandy SILT	ML	13 to 16	
			15	GM - Sandy Gravel	GM	100+	
	LA89T03	D	0	ML - Sandy SILT	ML	31	
		A	2.5	SM - Silty SAND	SM	13	
		D	4	ML - Sandy SILT	ML	13 to 24	
			16	GM - Sandy Gravel	GM	100+	
	LA89T04		0	ML - Sandy SILT	ML	16 to 62	
		A	2.5	SP - SAND	SP	17	
		D	5	ML - Sandy SILT	ML	23 to 46	
			13.5	GM - Sandy Gravel	GM	100+	
	LA89T05		0	ML - Sandy SILT	ML	22	
		A	1.5	SP - SAND	SP	8	
		B	3	ML - Sandy SILT	ML	6 to 9	
			15.5	GM - Sandy Gravel	GM	52 to 100+	
Child Development Center	LA86T01		0	ML - Sandy SILT	ML	28	
		B	3	ML - Sandy SILT	ML	7 to 11	
			10	ML - Sandy SILT	ML	21	
	LA86T02		0	ML - Sandy SILT	ML	19	
		B	3	ML - Sandy SILT	ML	10 to 14	
			10	ML - Sandy SILT	ML	19	
	LA86T03		0	ML - Sandy SILT	ML	6 to 7	
		D	3	ML - Sandy SILT	ML	16 to 24	
			10	ML - Sandy SILT	ML	18	
Residence Halls	LA66T01		0	SM - Silty SAND	SM	7	
		B	8	ML - Sandy SILT	ML	9 to 13	
			18	SM - Silty SAND	SM	18	
	LA66T02	A	0	SM - Silty SAND	SM	11 to 15	
		B	6	ML - Sandy SILT	ML	14 to 15	
			13	SM - Silty SAND	SM	15 to 21	
	LA66T03	A	0	SM - Silty SAND	SM	12	
		B	7	ML - Sandy SILT	ML	14	
			18	ML-SM - Sandy SILT	ML-SM	17	
	LA66T04	A	0	ML-SM - Sandy SILT	ML-SM	14	
		D	4	ML-SM - Sandy SILT	ML-SM	17 to 25	
	LA66T05	A	0	SM - Silty SAND	SM	14	
		D	6	ML - Sandy SILT	ML	20	
			12	SM - Silty SAND	SM	20 to 3	
	LA66T06	A	0	SM - Silty SAND	SM	8 to 13	
			18	SM - Silty SAND	SM	17	
	LA66T07	A	0	SM - Silty SAND	SM	10 to 14	
			18	SM - Silty SAND	SM	17	
	LA66T08	A	0	SM - Silty SAND	SM	13 to 16	
			12	ML - Sandy SILT	ML	23	
			16	SM - Silty SAND	SM	27	
	LA66T09	A	0	SM - Silty SAND	SM	13 to 26	
CSU Sacramento Library II	WAK87D01		0	ML - Sandy SILT	ML		
		D	3	SM - Silty SAND	SM	37 to 45	
			17	GW - Sandy gravel	GW		
	WAK87D02	D	0	SM - Silty SAND	SM	42 to 54	
			16	GW - Sandy gravel	GW	300+	
	WAK87D03		0	ML - Sandy SILT	ML		
		A	3	SM - Silty SAND	SM	7	
		B	6.5	ML - Sandy SILT	ML		
		A	9	SM - Silty SAND	SM	7 to 14	
			13	SM - Silty SAND	SM		
			16	SP - SAND	SP	31	
	WAK87D04	D	0	SM - Clayey Silty SAND	SC	33	
			7	SP - SAND	SP	25	

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SOIL BORING INFILTRATION OPPORTUNITIES

Project	Boring ID	USDA Hydrologic Soil Group	Top Depth	USCS Classification	USCS Used	T Blow Cou	% Passing #200
			12	SM - Silty SAND	SM	77	
			19	GW - Sandy gravel	GW	51/1"	
	WAK87D05	D	0	ML- Clayey Sandy Silt	CL		
		D	3	SM - Silty SAND	SM	11 to 47	
		B	11	SP - SAND	SP	25	
			17	GW - Sandy gravel	GW		
	WAK87D06	B	0	SP - SAND	SP	34	
		D	6	ML - Sandy SILT	ML	7 to 50/5"	
			16	SP - SAND	SP	38	
Engineering/Computer Science Building	WAK86D01	A	0.5	SM - Silty SAND	SM	13 to 18	
			16	SP - SAND	SP		
			17.5	GW - Sandy gravel	GW	100+	
	WAK86D02	A	0.5	SM - Silty SAND	SM	13 to 18	
			12	ML - Sandy SILT	ML	66	
			19	GW - Sandy gravel	GW	100+	
	WAK86D03	A	0.5	SM - Silty SAND	SM	20 to 22	
		B	15	SM - Silty SAND	SM	33	
			17	SP - SAND	SP	42/0"	
			19	GW - Sandy gravel	GW		
	WAK86D04	A	0.5	SM - Silty SAND	SM	8 to 16	
			17	SP - SAND	SP	29	
	WAK86D05	A	0	SM - Silty SAND	SM	13 to 51	
			16.5	SP - SAND	SP	17	
Parking Structure III	SI03B01	D	0	ML	ML	66 to 100+	80+
	SI03B03	D	0	ML - Sandy SILT	ML	13 to 55	47+
	SI03B04	C	0	ML - SILT	ML	9	
			18	CL - Sandy SILT with Clay	CL	37	
	SI03B05	D	0	ML - Sandy SILT	ML	21	
	SI03B06	B	0	ML - Sandy SILT	ML	7	
		A	3	SP - SAND	SP	7	
		B	6	ML - Sandy SILT	ML	12	
			11	ML - Sandy SILT	ML	100+	

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LABORATORY TEST RESULTS

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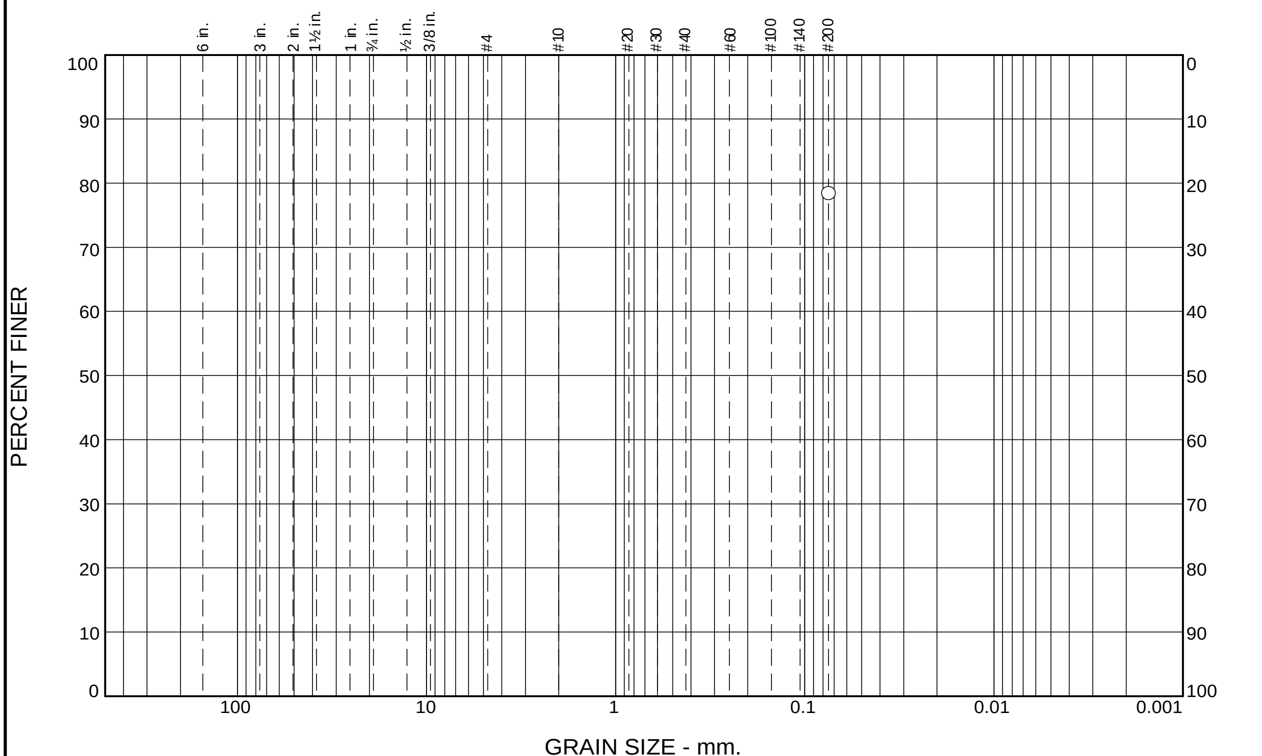
March 21, 2014

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						78.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	78.5		

* (no specification provided)

Soil Description

Dark yellowish brown silty lean CLAY with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: GEX
Sample Number: DR-1

Date: 03-14-2014

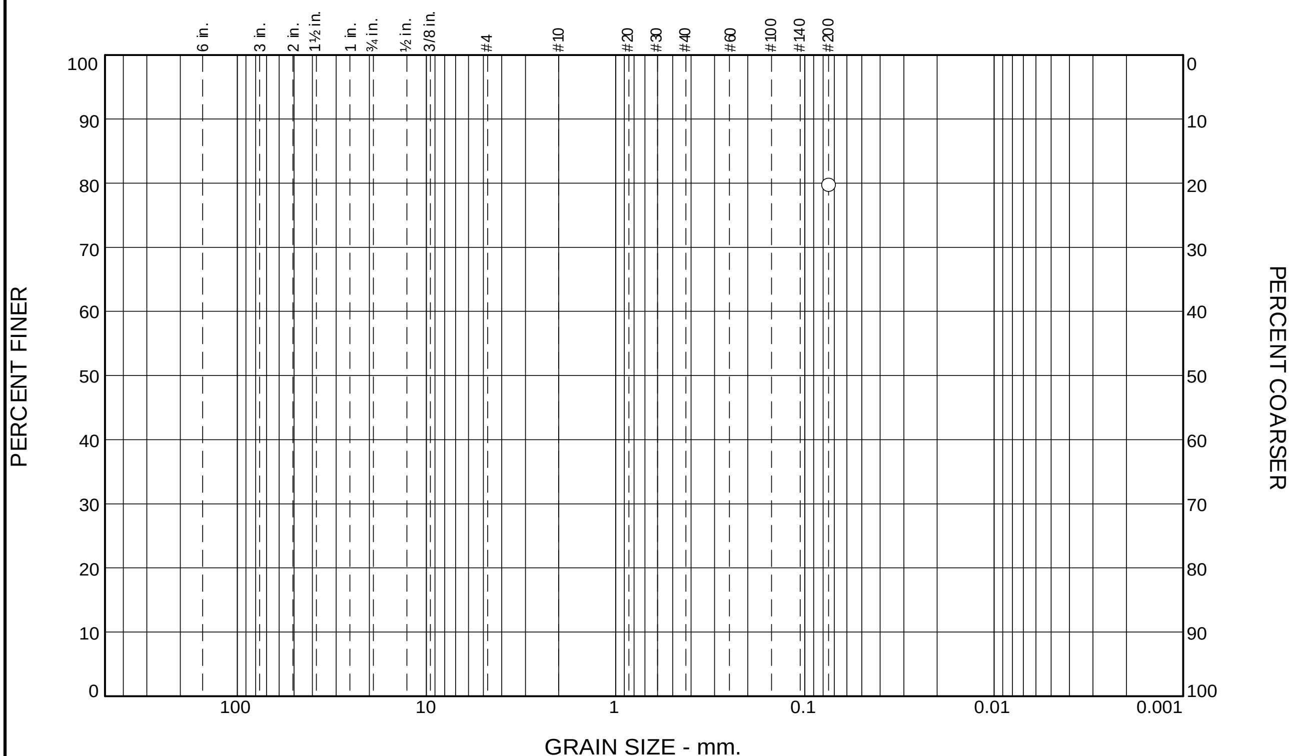
ENGEO INCORPORATED

Client: Omni Means, Ltd
Project: California State University Sacramento

Project No: 10945.000.000 PH001 **Figure**

Tested By: RAM **Checked By:** NB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						79.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	79.8		

* (no specification provided)

Soil Description

Dark yellowish brown silty lean CLAY with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: GEX
Sample Number: DR-2

Date: 03-14-2014

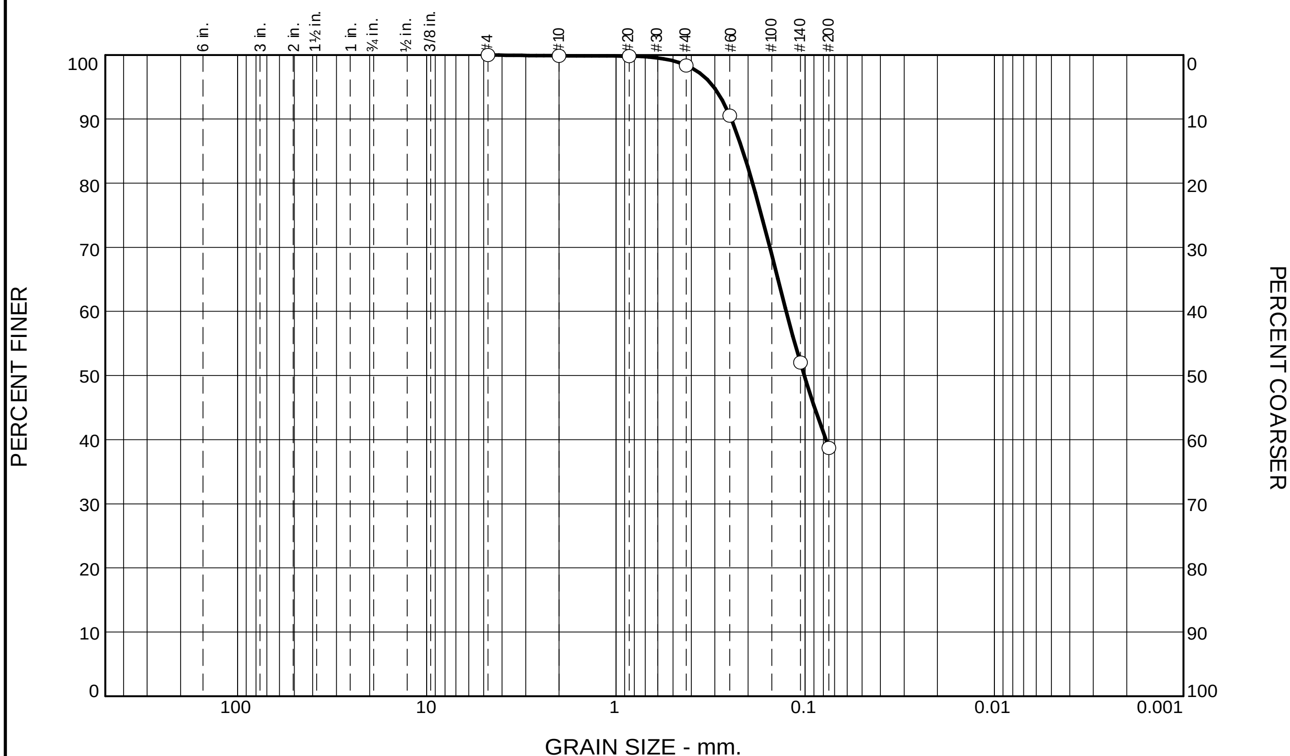
ENGEO INCORPORATED

Client: Omni Means, Ltd
Project: California State University Sacramento

Project No: 10945.000.000 PH001 **Figure**

Tested By: RAM **Checked By:** NB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.5	59.7	38.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	98.4		
#60	90.5		
#140	52.0		
#200	38.7		

* (no specification provided)

Soil Description

Dark brown silty SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2456 D_{85}= 0.2133 D_{60}= 0.1259
D_{50}= 0.1011 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: GEX
Sample Number: DR-3

Date: 03-14-2014

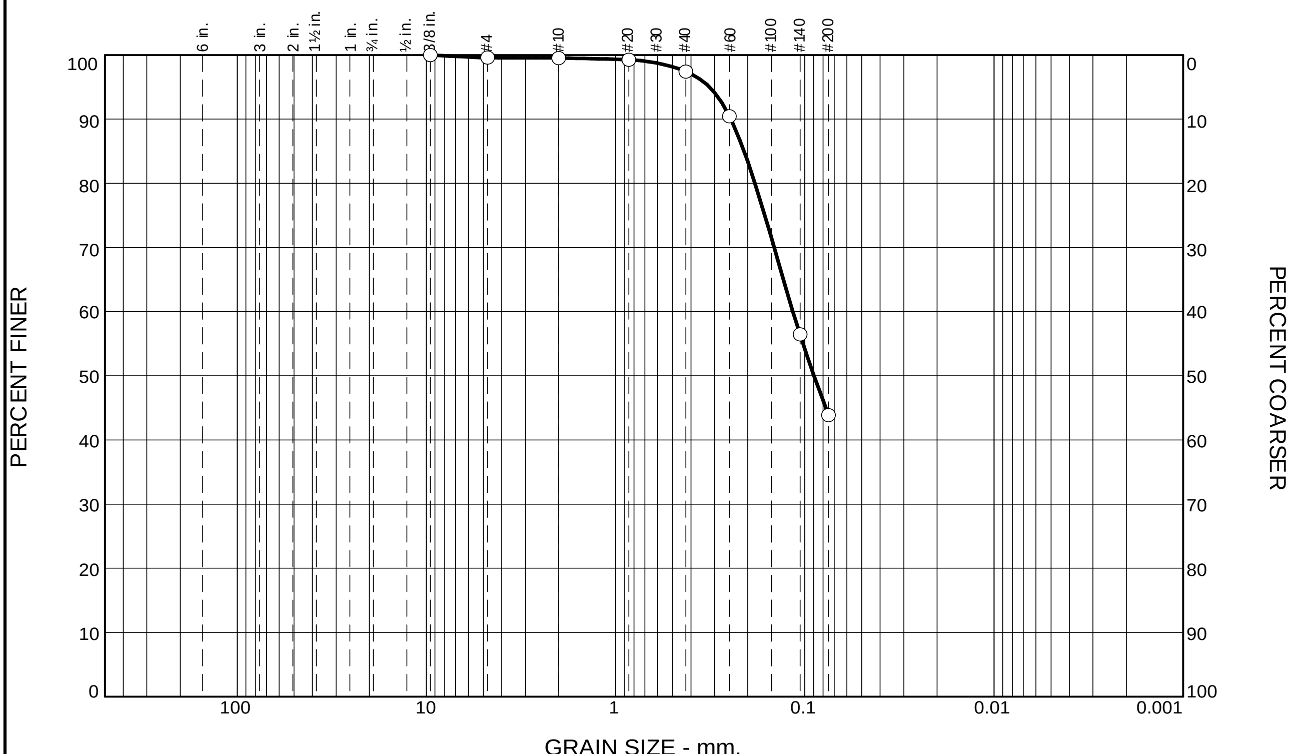
ENGEO INCORPORATED

Client: Omni Means, Ltd
Project: California State University Sacramento

Project No: 10945.000.000 PH001 **Figure**

Tested By: RAM **Checked By:** NB

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	0.1	2.1	53.5	43.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.6		
#10	99.5		
#20	99.3		
#40	97.4		
#60	90.5		
#140	56.4		
#200	43.9		

* (no specification provided)

Soil Description

Dark brown silty SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.2457 D_{85}= 0.2094 D_{60}= 0.1156
D_{50}= 0.0894 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Source of Sample: GEX
Sample Number: DR-4
Date: 03-14-2014

ENGEO INCORPORATED

Client: Omni Means, Ltd
Project: California State University Sacramento
Project No: 10945.000.000 PH001 **Figure**

Tested By: RAM **Checked By:** NB

EXISTING DRAINAGE SHEDS
WITH LANDSCAPE DETENTION AREAS
C.S.U.S. STORM DRAIN MASTER PLAN
Sacramento, CA
omni • means
ENGINEERS PLANNERS
REVISIONS
X1
XS-1
XS-2
XS-3
XS-4
XS-5
XS-6
XS-7
XS-8
XS-9
XS-10
XS-11
XN-1
XN-2
XN-3
XN-4
XN-5
X-SHED 5
X-SHED 6
X-PUMP #1
X-PUMP #2
X-PUMP #3
X-PUMP #4
X-DIRECT OUTFALL
FLOW DIRECTION
FOLSOM BLVD
HIGHWAY 50
MATCH BELOW
MATCH ABOVE
SUMP 31
1 inch = 200 ft.
LEGEND
DRAINAGE SHED BOUNDARY
DRAINAGE SUB-SHED NAME (SEE ABBREVIATIONS TO RIGHT)
DRAINAGE SHED WITH PUMPED OUTFALL
FUTURE BUILDING
PROPOSED BIO-SWALE (CAMPUS GREENWAY, RAIN GARDENS, ETC)
PROPOSED INFILTRATION TURF
PROPOSED PERMEABLE PAVEMENT
PUMP STATION LOCATION
ABBREVIATIONS
X EXISTING
P PROPOSED
N NORTH
S SOUTH