THE VISION TO CHANGE.
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Santa Ana College Central Heating & Cooling Plant

Project # 5807

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Central Plant Engineering Study

Executive Summary

This study looked at the feasibility of constructing a new central cooling plant for Santa Ana College (SAC). We concluded the campus will best be served by a plant with 1000-tons of chiller capacity and 8,700-ton-hours of thermal energy storage. The new plant will be located on campus. The plant will consist of a two story chiller & pump building and a cylindrical thermal energy storage tank. There also will be an underground chilled water distribution pipe system installed to connect the campus buildings to the central plant. The proposed central plant will reduce energy cost with better operating efficiency and reduced peak energy demand as compared to the existing systems.

We estimated the energy, operating, and construction costs for a central plant to connect to ten of the existing campus buildings and seven new buildings. We compared three different plant designs against the existing systems on campus. We determined that a plant designed with a thermal energy storage capacity sized to cover the peak electrical demand period to be an optimal design.

The available space on campus to locate a central plant is limited. We propose that a two level plant be built to reduce the footprint of the building. The central plant can have a footprint as small as 55ft x 35ft. The lower level will house two chillers and four chilled water pumps. The upper level will have the two cooling towers and two condenser water pumps. The upper level will not have a roof. The thermal energy storage tank will be 60ft in diameter and 45ft tall.

Most of the buildings are due for HVAC upgrades, because the equipment is at the end of its service life. Our buildings' report details what must be done at each building to convert it to central plant operations. The improvement to the buildings to central plant operations will reduce the maintenance efforts needed in each building and will better indoor space conditions. The amount of work needed in each building is reflected in our cost estimate.

We estimate the central plant will reduce the campus electrical bill by better than 50%; this is for the portion of the bill that pertains to cooling only. The electrical consumption of the campus will be reduced by 60% and demand will be reduced by 47%. We expect the emission of greenhouse gasses that result in the production of electricity to be reduced by the same amount as electrical consumption.

We estimated the construction cost to build a central plant with a campus distribution pipe network. We also estimated the cost to modify and connect the existing buildings to the central plant. For Santa Ana College the cost to modify and connect the existing buildings high as compared to the cost to build the central plant. This is due to the type and age of mechanical equipment on campus.

Grand Total - All Divisions	
Central Plant	$4,670,900
Building Connections/Conversions to Central Plant	$3,076,000
Grand Total	$7,746,900

Thermal Energy Storage Tank Details

Tank option	Ton-Hr	Delta T	Gal H2O	CF H2O	Height*	Diameter
High Peak	8,700	20	734,590	98,200	45	60

Note: * Height includes 5ft freeboard & 5ft spare space

Santa Ana College Central Plant Building List		
Building	**GSF**	**Central Plant Loads (Tons)**
Building "A" - Chavez Building	68,459	196
Building "D" - Dunlap Hall	53,682	179
Building "F" - Locker Rooms	24,745	99
Building "G" - Cook Gym	34,612	43
Building "I" - Classroom Building	23,000	77
Building "L" - Library	50,473	168
Building "M" - Planetarium	3,600	14
Building "S" - Administration	24,304	93
Building "U" - Johnson Center/Bookstore	54,364	155
Building "W" - Physical Education	21,600	33
Existing Totals	***358,839***	***1,058***
Vocational Technology	35,000	140
Middle College High School	30,000	120
Science Building	62,900	252
Allied Health	55,138	138
Fine Arts and Music	45,000	113
Performing Arts	40,000	100
Student Services	60,000	150
Future Totals	***328,038***	***1,012***
Total	**686,877**	**2,070**
Peak Load with 60% Diversity Factor Applied (Tons)		**1,242**
Peak Chilled Water Flow Rate (GPM)		**1,490**

Central Plant

The new central plant for Santa Ana College (SAC) will provide chilled water service to all major campus buildings for cooling purposes. We included ten existing buildings and seven future buildings in our central plant analysis. This totaled up to 686,900GSF on campus. The central plant will consist of two 500-ton electric centrifugal chillers, two cooling towers, two primary chilled water pumps, two secondary chilled water pumps and two condenser water pumps. The plant will have an 8,700-Ton·Hr chilled water thermal energy storage tank (TES). The TES will store enough chilled water to cool the campus during the high peak electrical period on the hottest days, from 12pm to 6pm. The chilled water will be distributed to the campus through a chilled water piping system. The entire plant will be designed with variable volume flow. The chillers will have variable speed drives (VDF). The two secondary chilled water pumps will be distribution pumps for the campus. The other two primary chilled water pumps will be used to move water through the chillers to the TES tank. All chilled water pumps will have VFD's. The three condenser water pumps are used to move water between the chillers and cooling towers.

Figure 1-2.1 Typical central plant chiller room with three York electric chillers

We do not recommend that the College build a centralized heating plant. Rather it is better that the heating of the buildings remain internal and dedicated to each building. There is no benefit to have a centralized heating system at SAC considering the heating loads of the campus. The recommended individual boilers for each building have very high efficiencies that match, or are better, of larger boilers. A central boiler plant would mean pumping heating hot water throughout campus. This would be an increase in energy consumption over individual boilers.

Another important consideration against centralized heating is the fact that underground hot water heating piping tends to be maintenance intensive and the life-cycle costs are undesirable. The energy cost savings will never match the installation and operational costs of a centralized heating plant for the SAC campus.

Some buildings have existing boilers that will remain in use, and other buildings will need new boilers or indirect gas duct heaters. This is discussed in the "Buildings Report" chapter.

SAC buys power from SCE and is on a time of use (TOU) rate schedule. The College pays different electrical consumption rates and demand charges depending on the time of day. The TOU schedule has three periods: high-peak, mid-peak, & off-peak. The rates are highest during high-peak, and lowest during off-peak. The biggest cooling loads are during high-peak. There are two seasons involved with TOU rates, high season and low season. We are only concerned with the high season rates because they impact the cost of cooling the campus the most. The College also buys electricity based on demand. If the College can shift 15% of demand to off-peak a better rate schedule is available. We believe the central plant will shift more than 15% of demand to off-peak, and they College will get the better rates for all electricity purchased.

The daily operation of the central plant will be to provide chilled water to the campus buildings to meet cooling demand. Chilled water will be produced at night, stored in the TES, and then distributed to the campus buildings during the high-peak electrical rate hours. Thus the College avoids buying electricity for cooling when it costs the most. During mid-peak the chillers will meet cooling loads. During off-peak the chillers will simultaneously meet campus loads and charge the TES tank. The entire plant design is variable flow and the chillers and water pumps utilize energy as required by the campus demand. Energy will be conserved through the variable volume design. The chillers will only operate during off-peak and mid-peak hours and preferably at night when the outside air temperature is the coolest and electrical rates are the lowest. The objective of the plant is to produce the chilled water with the least amount of energy and cost as possible, and to seamlessly meet the campus cooling loads. The cooling plant will have several benefits to SAC.

Improved AC Efficiency					
	GSF	Installed Capacity (Tons)	GSF/Ton	kW/Ton	Energy Usage on a GSF basis (Watts per GSF)
Existing Buildings	502,114	1,690	297	1.25	4.21
Planned Central Plant w/ existing and new buildings	686,877	1000	687	0.74	1.08

Figure 1-2.2 Table comparing the existing efficiency to the proposed central plant efficiency

The campus will need less chiller capacity as compared to the existing systems. The cooling energy for the hottest part of the day will be made at night and stored in the TES tank. This reduces the size of the chillers needed for the College. We have all night, 9-hours, to make enough cool water to cover the 6-hour high-peak period. The installed AC capacity on campus is currently 1,690-tons, and we a proposing two 500-ton chillers. This is a reduction of 690-tons on campus.

The energy efficiency of the chillers will be a big improvement over any existing AC equipment on campus. The current method of cooling the campus buildings is a combination of air-cooled package units and air-cooled chillers (plus one water cooled chiller in Russell Hall). The new machines will be water-cooled centrifugal chillers and will have much better energy efficiency. The energy required to provide cooling will be reduced from 1.25kW/ton to 0.74kW/ton with the installation of the new central plant. When looked at on a Watt per unit area basis the new central plant will improve the campus energy efficiency by 400%.

The central plant chillers will have a longer life span as compared to conventional building chillers. They will start and stop less often. This is because they only come on once per day to charge the TES tank and to meet campus demand. During the hotter months the chillers will operate every day the campus is open, but during the cooler months they will often only operate a couple of times per month. (The fully charged TES tank will last two weeks or more in the winter.) The greatest wear on a chiller is during start-up, and by reducing the number of "starts" the life of the chiller is extended.

The operation of a central plant with TES will reduce the campus electrical bills. The electrical demand &consumption charges will be lower for the following reasons:

1. The water-cooled chillers are smaller than the current campus AC equipment.
2. The water-cooled chillers are more efficient.
3. The chillers do not operate during high-peak electrical rates.
4. The chillers will operate at the coolest parts of the day reducing energy needed to produce chilled water.
5. Demand is shifted to off-peak and the College can get a better electrical rate from SCE.

The amount of maintenance work for the air conditioning systems of the campus will be reduced. The central plant will replace 134 separate refrigeration circuits with two. There will be a huge reduction in the number of refrigeration leaks and equipment failures. The types and amounts of refrigerants on campus will be reduced. Plus the new chillers will use an environmentally friendly gas such as R-123 or R-134a depending on the chillers selected.

Another benefit that is often overlooked is the reduction of noise on campus. The current systems are not very quiet and operate during the day. This adds to the background noise on campus. The proposed central plant will have the chillers located inside the plant, which will control the noise. The cooling towers are outside and could create a noise issue with neighbors, but we have recommended extremely quiet fans to keep the noise level low.

The chillers and pumps will have variable speed drives. They will ramp up to the speed that is needed at any time to match loads. This reduces the plant energy consumption considerably compared to constant speed equipment. Another benefit is that the speed controllers start the equipment slowly; they act as soft-starters. This reduces in-rush electrical current, which is 5-7 times running load amps for equipment that starts fully loaded. The equipment will have a longer life span due to the soft starts because the ramped starting is easier on the mechanical and electrical components.

We studied three different central plant models and compared them to the existing equipment to determine what the best solution is for SAC in terms of energy usage, operating costs and first costs. Our first option was a central plant with a TES tank large enough to cover the entire peak electrical period (8am to 11pm). The second choice was the same but with a smaller TES tank to cover the high peak period only. Lastly we looked at a central plant without a TES tank.

The plant with a full coverage TES system had three 500-ton chillers and 12,000-ton-hrs of storage. This plant had an overall electrical demand that was 59% of existing systems, and peak demand was only 6% of existing systems. The energy costs were only 43% of existing. The load shifting and efficiency improvements improved the outlook for the College.

The plant with a TES tank sized for high-peak coverage only had two 500-ton chillers and 8,700-ton-hrs of storage. This plant had an overall electrical demand that was only 48% of existing, and the peak demand was only 6% of the existing systems! The cooling energy costs were 30% of existing. The construction costs for this plant is lower than the full coverage plant above.

The central plant without any TES tank performed much better than the existing systems, with the peak demand at 59% of existing. This plant would be the least costly to build. However the College cannot get the better electrical rates due to the fact that no demand is shifted off-peak.

Central Plant Comparison								
Plant Type	Consumption (kWhr)	Percent of Existing	Demand (kW)	Percent of Existing	Peak Demand (kW)	Percent of Existing	Energy Costs	Percent of Existing
Existing Air Cooled Systems	18,759	100%	1,682	100%	1,682	100%	71,689	100%
Central Plant without TES	8,462	45%	1,050	62%	996	59%	42,407	59%
Central Plant with Full Peak TES	11,025	59%	996	59%	108	6%	26,684	37%
Central Plant with High Peak TES	10,036	54%	740	44%	108	6%	31,321	44%

Figure 1-2.3 Chart of plant performance. Consumption, Demand, and Energy Costs were calculated for a fully loaded plant, most of the year conditions will be less than full load, and these numbers are only for comparison of the different alternatives.

The best choice is the central plant with a TES tank sized for high peak loads only. The full storage plant will not use less energy than the high peak design, but will cost slightly less to operate under fully loaded conditions. Most of the year conditions are less than fully loaded and the full peak TES does not any costs advantages over the high peak TES plant. The smaller plant has one less chiller, cooling tower, and two less pumps than the larger plant. The TES tank is about 40% smaller. This plant will cost less to build and operate. It will be easier to place it on campus where space is always at a premium.

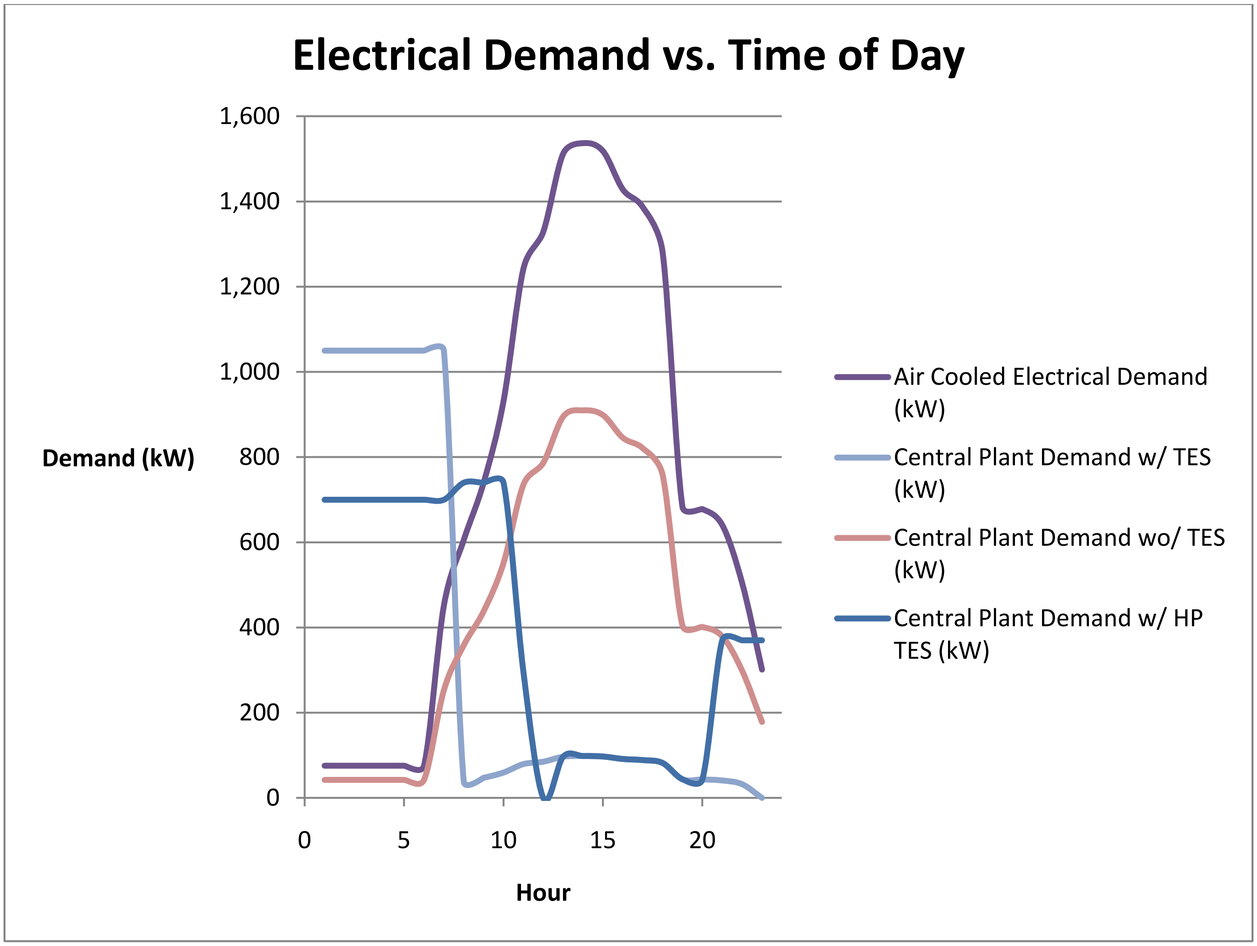

Figure 1-2.4 Graphical representation of the College's cooling load profile and energy demand. Note that the systems with TES reduced peak demand from over 1500kW to about 100kW.

We looked at SCE rates schedules and used a time of use demand rate schedule for large customers (over 0.5MW demand). We assumed SAC was on critical peak rate and that with the construction of the central plant with TES the campus could go onto Option "A" rate schedule. The requirement to get Option "A" is moving at least 15% of the electrical demand to off-peak periods. Our graph above shows a demand reduction of approximately 50%, so the College should be qualified for Option "A".

The better rate has an improved demand charge compared to Critical Peak rate ($11.70 per kW vs. $22.08 per kW). The lower demand rate will apply to all electrical loads on the campus, so that the costs savings will extend beyond the cooling systems. Our study only considered the electrical usage for cooling the College's buildings.

TES System

The proposed thermal energy storage system for SAC is a chilled water tank of the "thermalcline" type. Two types of construction are used for this kind of tank, steel or concrete. Either type will be a good fit for SAC, but steel tanks are more typical for this application. At the start of the central plant design an analysis could be done to determine which has the lowest cost.

The TES tank was sized at 8,700-Ton·Hrs, which results in tank with approximately 735,000-gals of water. The tank will be cylindrical constructed to AWWA standards. The tank's internal dimensions will be 45-ft high and 60-ft in diameter. The best location for the tank is next to the central plant building.

Internal to the tank is a chilled water distribution manifold to allow the proper flow of water in and out of the tank; it is not just a simple hollow tank. Above ground TES tanks have to contend with outside air temperatures of 90°F or greater in the summer. The tank must be well insulated so that energy lost to the environment is reduced.

Figure 1-3.1 Typical TES tank on a college campus, this particular one has 7,200-Ton-hrs and is 55ft in diameter and 45ft tall.

The TES tank stores water at 40°F and the return water temperature from the campus is set at 60°F. There is a sharply defined layer between the two different temperatures that natural develops because of the density difference between the two. This sharply defined transition is called the "thermalcline". The key to this system is the fact that there is no mixing in the tank. This is why there is a distribution manifold inside the tank. At any given time the stored cooling capacity of the TES tank is known by finding where the thermalcline is. It is also important to maintain the return water temperature close to 60°F to ensure all the capacity of the tank is utilized.

TES Operations

To reap all the benefits of a chilled water TES system the return water temperature from the buildings needs to be around 60°F. This will maximize the central plant's capacity. In order to get the campus chilled water return water temperature at 60°F, the cooling coils in the buildings must be sized for the proper temperature difference or rise; commonly called "Delta-T". We've determined that four buildings have chilled water systems in place, and the existing coils can handle the increased delta-T by modifying the control set points and flow rates through the coils. Many buildings do not have chilled water service at all and will receive new air handlers with chilled water coils as part of the connection to the central plant.

The flow scheme through every coil connected to the central plant will be variable flow with a two-way control valve. Control of all valves will be handled by the campus wide energy management system. (The EMS system will be upgraded with the installation of the new central plant.)

The TES tank is "charged" when the electrical rates are the lowest and preferably when it is the coolest outside. It will take 9-hours for the two chillers to completely cool the TES tank from 60°F to 40°F. Typically during a peak design-day the campus will be cooled from the tank alone between 12pm to 6pm. The chillers will begin to charge the tank after 6pm and run as long as needed to completely charge the tank. Between 6pm and when the campus closes the chillers will both supply water to the tank and the campus. As the campus demand drops, more of the chillers' capacity will be used to charge the tank (the level of the water in the tank does not change, but water is moving through the tank during this process).

SAC Buildings Report

Overall Report

There are ten building candidates to be connected to the proposed central plant. Of the these buildings only three have chilled water systems in place that can easily converted to central plant operations. The other seven buildings have refrigeration coils with direct expansion coils (DX). These coils are not suitable for chilled water applications. Of the thirteen, in all but one case we recommend replacing the existing equipment to convert to central plant. The one case, in Building "W", there is a new heat pump air handler that can have its coils replaced with chilled and hot water coils.

There will be a significant impact on the cost and scope of the central plant project due to the amount of new mechanical equipment needed in the buildings. But most of the existing equipment is at the point of needing replacement. In all cases the energy efficiency of the buildings will be greatly improved with new equipment on central plant operations. The campus will get a much longer service life with less maintenance efforts from centralized heating and cooling equipment than the equivalent in unitary air-cooled equipment.

Figure 1-4.0 Campus View

Building "A" Chavez Hall

Use/Occupancy: Faculty Offices, Classrooms, Computer Center

68,459GSF

Year Built: 1996

Year Remodeled: 2005

The Chavez Hall building HVAC system consists of rooftop air cooled chillers, air handlers, and heating hot water boilers. There are four chillers, two boilers, three computer room condensing units, and 8-air handlers. The building's air handlers have chilled water coils. The air distribution system is variable air volume with reheat coils at the terminal units. The computer room has three computer room air conditioners.

The air handler units are in good working order, and can be readily converted to central operations by connecting the chilled water from the central plant to the coils. The control system will need modified to match the central plant's operation. A larger temperature difference across the chilled water coils will be required. We believe this can be achieved by altering the control system parameters and new hardware will not be needed.

Figure 1-4.1 Roof-top AC equipment on Chavez Hall

Building “C” Fine Arts

Use/Occupancy: Teaching Classrooms, Art gallery, Art Studios Labs

22,537GSF

Year Built: 1972

This building is due to be replaced, but if that plan changes the following is necessary to convert it to central plant.

This building is served by three large multi-zone package units. The units have DX cooling and gas fired heating. The units are not suitable for central plant operations. They will require replacement with units that can connect to the central plant.

The replacement for the package units are air handler units with the same foot print. These machines will be custom made to fit this building exactly. The new air handler units are configured like a multi-zone unit and will connect to the existing ductwork and reduce the modifications needed to the building. They will set on the existing roof curb and this will reduce the disruption to the building operations.

The new units will have gas duct heaters built into them for heating and chilled water coils for cooling. The new units will be a tri-deck configuration that prevents simultaneous heating and cooling, yet allows for precise control of the space temperatures.

Building "D" Dunlap Hall

Use/ Occupancy: Teaching classrooms, faculty offices

53,682GSF

Year Built: 1973

HVAC Upgrades: 2005

The building mechanical systems consists of a single roof top air handler, two air cooled chillers, and two heating boilers.

The chillers are Trane RTAU screw compressors with an air cooled condenser section. The machines are new and in excellent condition.

The air handler is a HuntAir brand with a fan array. The air handler has chilled water coils, and is ready to connect to a central plant. The building air distribution system is a variable air volume design.

To connect this building to central plant chilled water lines would be routed to the roof top equipment and connected. The control system would be adjusted to ensure the temperature rise across the chilled water coils matches the needs of the central plant. The building heating system and boiler will remain in operation.

Figure 1-4.2 Dunlap Hall roof-top AC equipment

Building "E"

Use/Occupancy: Fitness Center

5,280GSF

Year Built: 1947

HVAC Upgrades: 2005

We understand this building will not be connected to the central plant, but if that plan changes the following is necessary:

The building HVAC system consists of three rooftop gas-electric package units. These machines cannot be converted to central plant operations.

To convert this building to central plant operations the package units will be replaced with air handling units. The air handlers will have chilled water coils and a gas-fired heater section. This conversion plan will reuse the existing air distribution ductwork. New DDC controls, valves, and temperature sensors will be added as part of the conversion process.

Figure 1-4.3 Building "E"

Building "F" Locker Room

Use/ Occupancy: Locker rooms and offices

24,745GSF

Year Built: 2005

The Building "F" has a roof mounted chiller, boiler, and fan coil units to serve the buildings HVAC needs. The building and equipment are newly constructed. This building is easily converted to central plant operations due to the fact it has a chiller and boiler in place.

There are 14-fan coil units on the roof. The units are connected to the air cooled chiller and boiler to provide heating and cooling to the spaces below. Each fan coil unit serves a single zone.

To convert this building to central plant operations the chilled water lines would be routed to the roof and connected to the existing lines. The operating controls will be adjusted to meet the requirements of the central plant and to optimize performance. The chiller will be removed from the building. The chilled water pump will also become redundant and can be permanently removed from the roof of the building. The existing boiler and hot water system will remain in operation.

Figure 1-4.4 Typical fan coil unit on the roof of building "F"

Building "G" Gym Building

Use/ Occupancy: Gym Building, Locker Room, Weight Room, Classrooms

34,612GSF

Year Built: 1954

HVAC Upgrades: 2005

The Gym building has ceiling suspended air handlers for the gym ventilation. There are gas-fired heaters suspended from the ceiling. The gym does not have air conditioning.

There is a weight room under the West side bleachers that has a new Alliance brand air handler. The air handler was installed as part of Building "F" construction project. The air handler has a heat pump condensing unit connected to it. The condensing unit is air cooled.

The East side of the building has a heat pump split system to heat and cool two classrooms. The condenser unit is located on the roof of the "W" building.

The West side air handler can be converted to central plant operations by replacing the coil section. The DX coils will be replaced with cooling coils. The condenser will become redundant and removed from the building. Heating from this system will either be from a gas-fired duct heater or a newly installed boiler. The east side split system can be replaced with two fan coil units; one for each classroom. The gym section HVAC should remain as built.

Figure 1-4.5 Cook Gym air handler

Building "H" Hammond Hall

Use/Occupancy: Classrooms, offices

15,720GSF

Year Built: 1954

HVAC Upgrades: 1981

This building is due to be replaced, but if that plan changes the following is necessary to convert it to central plant.

The mechanical systems consist of two roof-top heat pump condensing units and two air handlers. Each air handler serves a single floor of the two story building. The air handler systems are constant volume systems. The system is an obsolete design that cannot operate efficiently. The equipment is all beyond its useful life span and ready to be replaced.

To convert Hammond Hall to central plant operations the entire mechanical system will be replaced. The building air handlers will be removed, along with their associated condensers. The distribution ductwork would not be suitable for the new system and must be replaced. A new DDC control system for the building would be installed.

New ductwork with VAV boxes would be the preferred replacement system. This will easily meet current California Energy Code requirements and enhance the building's performance. The work to replace all the existing ductwork will be extensive and the building will have to be taken out of service during the construction period. But effort will give the College a new system that requires little maintenance to operate.

New air handlers will be added. They can be located on the roof, if the building's structure permits it. Or they can be fitted into the existing mechanical rooms.

Figure 1-4.6 Hammond Hall

Building "I" Classroom Building

Use/Occupancy: Classrooms

23,000GSF

Year Built: 2008

The HVAC system for this newly built building consists of 17-roof top package units. Each package unit handles one classroom. All package units are gas/electric heating and cooling.

Unfortunately the mechanical design of this new building is not efficient for central plant operations. A best practice design would mean a new ductwork system throughout the building. An alternative method that is the least intrusive to convert the building to central plant operations would be to replace each package unit with a fan coil unit. The ductwork above the roof would need modifications to connect to the fan coil units. The new system would be one fan coil per classroom to keep with the building's original design and to avoid a major ductwork re-fit project.

Heating for the building could be either a boiler system or gas-fired duct heaters.

The building will require a complete DDC control system to control and operate the fan coil units. The control valves and room temperature sensors will be connected to the DDC system.

Figure 1-4.7 Typical roof-top AC package units on classroom building

Building "L" Library

Use/Occupancy: Library, Classrooms, Offices

50,473GSF

Year Built: 1956

HVAC Upgrades: 1990

The HVAC system for the original part of the Library building consists of three multi-zone roof top units, three roof-top split systems, and a heating hot water boiler. All these pieces of equipment are over 20-years old and are due for replacement.

The Library addition has seven roof-top package units.

All the existing mechanical equipment is not readily connected to a central plant operating scheme. Conversion to central plant will mean replacement of the existing units. The three roof-top multi-zone package units would be replaced with air handlers that connect to the multi-zone ductwork. The split systems would be replaced with air handlers. The roof-top package units will be replaced with fan coil units. The split systems and package units will need some minor ductwork modifications to accept the new machines.

New DDC controls will be part of the conversion process. The control valves will be electronic, and the thermostats will be replaced with temperature sensors.

Figure 1-4.8 Split systems on roof of the library

Building "M" Planetarium

Use/Occupancy: Planetarium

3,600GSF

Year Built: 1967

HVAC Upgrades: 1986

The Planetarium HVAC system consists of two package units. They are gas/electric units. Conversion of this building would involve replacing the package units with air handler units. Chilled water lines will be extended to the building and connected to the new air handlers. The air handlers will have gas-fired heaters. New DDC controls will be part of the conversion process. The control valves will be electronic, and the thermostats will be replaced with temperature sensors.

Building "N" Music Building

Use/Occupancy: Classrooms, Offices

7,875GSF

Year Built: 1965

Year Remodeled: 1970

This building is due to be replaced, but if that plan changes the following is necessary to convert it to central plant.

The Music building has a single gas-electric package unit. Conversion to central plant operations would involve replacing this unit with a multi-zone unit with chilled water coils. The new unit will have a gas-fired duct heater built into it. The new units will be a tri-deck configuration that prevents simultaneous heating and cooling, yet allows for precise control of the space temperatures. New DDC controls will be part of the conversion process. The control valves will be electronic, and the thermostats will be replaced with temperature sensors.

Building "P" Phillips Hall Theatre

Use/Occupancy: Theatre, Classrooms

14,985GSF

Year Built: 1955

HVAC Upgrades: 1973

This building is due to be replaced, but if that plan changes the following is necessary to convert it to central plant.

The theatre building has seven roof-top gas-electric package units serving its HVAC needs. The machines are from the original construction of the building.

In order to convert the building to central plant operations the package units will be replaced with air handlers and fan coils units. Chilled water will be routed to the building. The new units will have gas-fired duct heaters. New DDC controls will be part of the conversion process. The control valves will be electronic, and the thermostats will be replaced with temperature sensors.

Building "R" Russell Hall

Use/Occupancy: Science Building

58,666GSF

Year Built: 1967

HVAC Upgrades: 2005

This building is due to be replaced, but if that plan changes the following is necessary to convert it to central plant.

The science building has four air handlers, two chillers, and two boilers serving its HVAC needs. One of the chillers is water cooled and it has a cooling tower. The other chiller is air-cooled and is only used for back-up. The air handlers have heating and cooling coils. This building is readily converted to central plant operations.

To convert the building to central plant operations the air handlers will be connected to the chilled and hot water lines. The chillers and boilers will become redundant and can be removed. The central plant will provide sufficient pressure so that the chilled and hot water circulating pumps in the building are not needed.

Figure 1-4.9 York water chiller in penthouse mechanical room on Russell Hall

Building "S" Administration Building

Use/Occupancy: Offices

24,304GSF

Year Built: 1972

HVAC Upgrades: 1993

The mechanical systems for the Administration building consist of three roof-top multi-zone package units. The machines were replaced in 1993, but are due to their age they are ready to be replaced.

The simplest and most cost effective method to convert the building to central plant are specially built air handlers that fit onto the multi-zone mounting platform and connect directly to the existing ductwork. These types of units will be built with chilled water coils and gas-fired duct heaters. They have a third deck that is outside air so that they have a full economizer function and do not provide heating and cooling simultaneously. New DDC controls will be part of the conversion process. The control valves will be electronic, and the thermostats will be replaced with temperature sensors.

Figure 1-4.10 Screened mechanical equipment on the roof of building "S"

Building "T" Technical Arts

Use/Occupancy: Classrooms, Dry Labs

18,212GSF

Year Built: 1970

We understand that this building is due to be replaced, however if that plan changes the following is necessary:

This building has two roof-top multi-zone package units serving it. They have DX cooling and gas-fired heaters. They are at the end of their useful life and due to be replaced.

These machines are not readily converted to central plant operations and we recommend replacement units. The simplest and most cost effective method to convert the building to central plant are specially built air handlers These types of units will be built with chilled water coils and gas-fired duct heaters. They have a third deck that is outside air so that they have a full economizer function and do not provide heating and cooling simultaneously. New DDC controls will be part of the conversion process. The control valves will be electronic, and the thermostats will be replaced with temperature sensors.

Figure 1-4.11 Multi-zone AC package unit on the roof of Building "T"

Building "U" Johnson Center

Use/Occupancy: Bookstore, Cafeteria

54,364GSF

Year Built: 1968

HVAC Upgrades: 2000

This building was built in two phases. There are two separate and distinct mechanical systems in the building. The cafeteria section has 33-water source heat pumps. While the bookstore part has an air handler with DX coils.

The water source heat pumps are mounted above the ceiling throughout the building. There is a water loop routed above the ceiling to all the heat pumps. There is a cooling tower and boiler located in the mechanical yard outside of the building. The water source heat pumps are all connected to the boiler and cooling tower through the water piping. During the cooling season the cooling tower removes the heat from the building. And during the heating season the boiler is used to provide heat to the building. The cooling tower and boiler cannot operate at the same time.

The bookstore's air handler is located in the second floor mechanical room. The air handler has DX cooling coils and a gas–fired heating section. Its associated condenser unit is located in the same mechanical yard as the heat pump equipment. The air handler was recently replaced and is in good condition.

To convert the building to central plant operations two plans are needed. In the cafeteria section we recommend all the heat pumps be replaced with fan coil units. Placing the new fan coils in the same location as the heat pumps above the ceiling would be the most efficient method. The existing ductwork could be retained this way and construction costs will be reduced. New heating and cooling water lines would be needed for the fan coil units. They could be routed the same path as the condenser lines now in place. The cooling tower and boiler will become redundant and hence removed.

The bookstore conversion is simpler. The air handler would be rebuilt with new chilled and hot water coils section. The gas heater, DX coils, and condenser unit would be removed as they are no longer needed.

Building "W" Exercise Science

Use/Occupancy: Work out rooms, Classrooms

21,600GSF

Year Built: 1972

HVAC Upgrades: 1995

This building has three package units. Two are heating only. The others have condenser sections built into them. All of the equipment is ready to be replaced due to age.

To convert the building to central plant the package units would be replaced with fan coil units and air handlers. Central plant pipes would be routed over the roof of the building to the new machines. A new DDC control system will be installed to operate the equipment. The control system will include space temperature sensors, control valves, and be connected to the campus wide building automation system.

Figure 1-4.12 Roof top multi-zone AC unit on the roof of building "W"

Mechanical Program

The design of the Central Plant System for Santa Ana College (SAC) will address the overall objective of providing a system that meets the heating, ventilation, and cooling needs of the campus buildings, provides a safe environment, and accommodates any changes in the buildings' operations. The proposed central plant system will include a cooling towers, thermal energy storage tank (TES), chillers, pumps, hydronic systems, and chilled water distribution piping. Modifications to the existing buildings will encompass air handlers, pumps, controls, hydronic systems, and boilers.

The project contains major components that affect and influence the mechanical systems design and layout. The system will provide complete heating, ventilation, and air conditioning in conformance with applicable codes and specific requirements of the design criteria.

A. Design Criteria

Project Location:	Santa Ana, California
Latitude:	33°79'
Elevation:	115 feet
CEC Climate Zone:	8
LEED	No direct certification

B. Outside Design Conditions

Heat gains and losses to the exterior will be calculated using ASHRAE outdoor design conditions at frequency levels of 0.5% for summer dry bulb and wet bulb temperature and 0.2% for winter dry-bulb temperature.

	SUMMER	WINTER
Design Temperature	84°Fdb/67°Fwb	33°F

C. Basis of Calculation for Building Cooling Loads

The modeling of the existing buildings shall be developed using the Record Drawings provided by SAC. The actual construction, glazing, and R-values shall be entered into a computer simulation program (Trane Trace™) to determine the cooling loads of each building.

SAC provided the latest version of their campus master plan that includes several proposed buildings and their respective size. Use the following values to estimate the cooling loads of the proposed future buildings.

Walls -	Conditioned office will have insulated wall separating the conditioned office from the adjacent unconditioned spaces. Overall U= 0.153 or better.

Window -	New Exterior Windows 0.71 (center	U= 0.53 of glass)	Shading Coefficient=
	Unconditioned space Windows	¼” single pane glass.	

Roof -	R-19 Continuous board insulation over metal decking. Indoor Design Conditions

Spaces shall be designed in compliance with the 2007 California Mechanical Code.

D. Basis of Calculations for Site Piping

Site piping to the campus shall be calculated using a liquid velocity limited to 7 ft/sec max and 4ft of pressure drop per 100ft of run.

E. Applicable Codes

The codes and standards listed below are minimum requirements. Nothing is to prevent the architect, engineer, or consultant from exceeding the applicable requirements.

- California Building Standards Administrative Code (Title 24, Part 1), 2007
- California Building Code (Title 24, Part 2), 2007
- California Mechanical Code (Title 24, Part 4), 2007
- California Energy Code (Title 24, Part 6), 2005
- California Fire Code (Title 24, Part 9), 2007
- California Referenced Standards Code (Title 24, Part 12), 2007
- California Plumbing Code (Title 24, Part 5), 2007

F. Reference Standards and Guidelines

- ASHRAE Fundamentals Handbook 2005
- ASHRAE Applications Handbook 2007

G. Central Plant System

The central plant project will add chillers, cooling towers, pumps, a TES, and a chilled water distribution pipe network. The plant is anticipated to be built as a stand alone structure. The TES tank will be above grade or partly buried adjacent to the central plant building. The chilled water distribution pipes will route throughout campus underground and connect to the buildings. The heating systems for each building will be separate from the central plant and internal to the buildings.

The TES tank will store chilled water to provide the campus cooling need during SCE's high-peak electrical period. The TES will have 8,700ton-hrs capacity to meet the cooling demand of the campus between 12pm and 6pm. The tank is sized to handle the expected full build-out of the campus at 687,000GSF. The calculated peak load is 1,242-tons with a 60% diversity factor applied. The calculated peak chilled water flow rate is 2,000GPM.

The pumping and distribution are designed for providing a differential pressure of 15-20psi at each building. Any buildings added to the loop must be designed to provide at least 20°F of differential temperature. The design supply temperature is 40°F with a return water temperature of 60°F

The central plant project will also include modifying the existing building heating systems were required to meet additional loads and to meet South Coast Air Quality Management District's rules. Some buildings will require gas-fired duct heaters or boilers because of the equipment change-out to chilled water service.

Chillers

The central plant is sized for two 500-ton chillers. The size of the chillers will be enough to charge a fully depleted TES tank in 9-hrs and to handle campus peak loads with 60% diversity applied without the TES tank. The chillers will be variable speed centrifugal machines. Two chiller options are available: Trane CenTraVac™ CVHF models, that uses low pressure R-123 refrigerant, or York YK model using high pressure 134a refrigerant. These models are preferred because of their quiet and dependable service. The maximum energy consumption of these machines will be 0.55-kW/ton with an entering condenser water temperature of 80°F at full load, and at 70% loaded, 0.40-kW/ton with entering condenser water temperature of 71°F.

Cooling Towers

The cooling towers are induced draft models with water filtration and tower cleaning capability. Tower fan speed is controlled by VFD's. The cooling tower fans will be Whisper Quiet™ models that create very little ambient noise. The cooling tower will be fitted with a Dolphin WaterCare™, or a Plusepure™ type water treatment system that will prevent the accumulation of scale and corrosion and also act as a biocide. The system will be chemical-free and environmental friendly. The towers will also have a sand filtration system similar to a swimming pool filter to keep the towers clean and reduce the amount of maintenance hours spent on the towers.

The cooling towers, and sand filtration system will be located in a mechanical yard next to the central plant building. This reduces the footprint of the plant and does not reduce the usable space on campus.

TES Tank

The proposed TES tank is a "thermalcline" style made from either pre-stressed concrete or steel. The steel tank shall constructed to the latest AWWA D100 standard and pre-stressed concrete tanks shall be constructed to the latest AWWA D110 standard. The chilled water is stored at 39°F and returned to the tank at 60°F. The water exits at the bottom of the tank and is returned at the top. The colder water is naturally heavier and stabilizes at the bottom of the tank. Separation between the two is maintained by creating a sharply defined transition layer known as a "thermalcline". Internal to the tank is a network of diffuser pipes that allow the flow of water into and out of the tank without stirring it up or causing mixing between the layers.

During the discharge mode the water is drawn from the bottom of the tank, circulated throughout the campus and then returned to the top of the tank. During the re-generation cycle the colder water is pumped into the bottom of the tank and the warmer water is drawn of the top. It is possible to operate the chillers to simultaneously cool the campus and re-generate the tank with any excessive capacity.

The nature of this type of TES requires that the chilled water return temperature remains close to optimum (58-60°F). If the return temperature is reduced efficiency of the tank is diminished because the tonnage is not being fully realized. We recommend change existing chilled water coils where necessary to expand their temperature rise from 10°F to 20°F. The Building "D" chilled water coils will create the correct temperature rise by changing the chilled water flow rate through them.

If a partially buried tank is selected the following considerations shall be taken. Buried tanks must withstand the weight of the soil covering as well as the load imposed any additional uses planned for above the tank. The tank must also be able to withstand soil loadings on the tank walls, as well as the hydrostatic pressure from groundwater, that may occur if the water in the tank is removed. The tank must be designed and built to have zero leakage. If a leak is detected during acceptance test it must be repaired at no additional cost to SCC. The concrete tank shall be designed by a structural engineer who specializes in water tank construction. Design and construction should confirm to the American Concrete Institute *Standards* 318-83 (ACI 1986) and 350R-83 (ACI 1983).

The need for commissioning for a TES system is particularly important because this type of system does not have excessive capacity that a non-TES system typical does. It is critical that the system performs as designed so that the long term cooling of the campus is met. The commissioning process should include the following phases.

1. Pre-design
2. Design
3. Construction
4. Startup
5. Operating training
6. Performance testing
7. System operation and optimization.

The commissioning agent is best if they are a third party hired directly by the campus and not attached to the construction contractor. The commissioning agent must have experience in commission TES central plants. The following performance test should be carried out:

1. Total discharge capacity
2. Discharge rate and discharge temperatures
3. Charging capacity
4. Scheduling and control sequences
5. Evaluation of peak demand and energy efficiency

Heating Hot Water

Smaller boilers in multiples are being used to increase the part load efficiency of the heating system, and to reduce the SCAQMD compliance costs for the campus. The boilers selected are non-condensing with a 40°F design delta T. Hot water heat was specified as it is the lowest operating cost alternative for heating the buildings.

H. Piping Materials

Chilled water and heating hot water piping within the central plant 3" and larger, shall be Schedule 40 black weld steel pipe ASTM A53, with thermal insulation to minimize heat gain or loss and prevent condensation.

Chilled water and heating hot water piping within the building that is 2 1/2" and smaller shall be Type "L", hard drawn copper tube. Insulation will be the same as the larger piping systems.

Outdoor and buried piping shall be C900 for the chilled water. Condenser piping will be internal to the central plant and will be schedule-40 black iron. Chilled water piping (below grade) shall be pre-insulated PVC pipe (AWWA C900) with high density polyethylene (HDPE) jacket and restrained joints. Insulation shall be factory applied 2" thick void free polyurethane foam.

I. Controls

The Central Plant automation/energy management system shall interface with the campus buildings controls and shall monitor and trend each buildings flow temperatures, pressures and thermal energy consumption. The central plant shall have a front-end computer and software for monitoring and controlling the central plant. The controls shall be preprogrammed to allow unattended operation of the central plant and monitoring and trending energy use. The system will be able to integrate multiple building functions, including equipment supervision and control, alarm management, energy management, and historical data management and archiving,.

All control panels will be stand-alone in memory, networking, and control operations. The design of the controls will be in a modular format, permitting future expansion capabilities. The system will monitor and control equipment according to the sequence of operation, as well as additional input and output points.

Each new air handler will have at a minimum these control points:

a. Start-Stop
b. Supply air temperature
c. Return air temperature
d. CHWS/R temperature
e. HHWS/R temperature (where applicable)
f. VFD speed control
g. Static pressure
h. CHW valve control
i. HHW valve control (where applicable)

Every air handler that is retrofitted to central plant service will receive additional controls to make it compatible with the new central plant control system. The start-stop function of any back up chillers (remaining existing units) will be modified to be part of the central plant control system.

J. Pumps

The central plant will have six main pumps: two primary chilled water pumps used for charging the TES Tank, two campus chilled water circulating pumps, and two condenser water pumps. All pumps shall be horizontal split-case double-end suction style. All chilled water pumps shall be variable volume, and have variable speed drives (VFD). Variable speed drives are not required on the condenser water pumps, but may be added for the soft-start feature which limits in-rush electrical current.

Electrical Program

The design of the electrical system for the Central Plant will encompass service to the new building, power for the proposed HVAC system interior and exterior lighting, fire alarm system and power distribution system. All these systems will be designed to provide the user with maximum flexibility and all equipment that forms part of these systems will be selected for durability and ease of maintenance that are consistent with the current campus standards.

A. Applicable Codes

- California Building Standards Administrative Code (Title 24, Part 1), 2007
- California Building Code (Title 24, Part 2), 2007
- California Electrical Code (Title 24, Part 3), 2007
- California Energy Code (Title 24, Part 6), 2005
- California Fire Code (Title 24, Part 9), 2007
- California Referenced Standards Code (Title 24, Part 12), 2007

B. Reference Standards and Guidelines

- NFPA 72: National Fire Alarm Code
- 1999 Edition of the Illuminating Engineering Society of North America Handbook

C. Design Criteria

Following are design voltages and load calculation criteria for the proposed building.

D. Design Voltages

1. Primary voltage:
   4160V, 3-phase, 3-wire

2. Secondary voltages:
   480Y/277V, 3-phase, 4-wire
   208Y/120V, 3-phase, 4-wire

E. High Voltage Switchgear

A new breaker with associate relays will be added to existing outdoor switchgear. A space is available.

F. High Voltage Transformer

Transformer shall be copper wound indoor dry-type transformer.

G. Lighting

Light fixtures and systems will be selected for efficiency, durability, maintenance ease, and to accentuate the area architecture. Indoor lighting will be tailored to building's needs.

The illumination levels will conform to the latest edition of Illuminating Engineering Society (IES) guidelines, and will be as follows:

Area	Average Foot Candles
Offices	30-50 FC
Restrooms	15-25 FC
Electrical/Mechanical Rooms	20-30 FC

H. Switchboard

The switchboard will be rated to handle the full connected load as required by code. It will located next to the transformer. It will include an underground pull section, college meter, main breaker with ground fault protection and feeder breakers for the service to the non-central part of the new physical education building. The central plan will have feeders for the chillers, pumps, cooling tower fans and other auxiliary control and lighting loads.

I. Metering

The metering will include a main kWh and kW meter on the main of the switchboard. This is a college meter. The chillers, pumps and fans will be metered via the Energy Management System and the VFD interface.

J. Equipment Servicing Disconnects

These will be provided either by the VFD's disconnect or we will provide a disconnect switch. All disconnects will be lockable.

K. Utility Coordination

This project will require coordination with the utility SCE.

Plumbing Program

Plumbing and Fire Protection Systems for the renovation will incorporate the objective of providing a system that complies with the occupant needs and provide a more efficient and safer environment. The scope of Plumbing and Fire Protection will include new plumbing fixtures, domestic water heating equipment, and water piping distribution systems. The central plant shall have fire sprinklers.

A. Applicable Codes

- California Building Standards Administrative Code (Title 24, Part I), 2007
- California Building Code (Title 24, Part 2), 2001
- California Plumbing Code (Title 24, Part 5), 2001
- California Energy Code (Title 24, Part 6), 2005
- California Fire Code (Title 24, Part 9), 2001
- California Reference Standards Code (Title 24, Part 12), 2001

B. Domestic Water Systems

Potable cold water service line and backflow prevention devices will be provided as required to account for all domestic cold water demands as well as industrial cold water needs. A central backflow prevention device will separate the domestic and industrial services.

C. Sanitary Sewer, Waste and Vent Systems

Soil/waste drainage piping will be provided to each domestic plumbing fixture. Sanitary drainage ventilation piping will be provided to each domestic plumbing fixture or trap and will terminate at various locations on the roof. Traps on each Cosmetology class sink will be provided with hair interceptors. The building drain sanitary soil/waste piping will be connected to the site sewer system of the building.

HVAC condensate drainage piping will be provided to each HVAC unit. Such piping will drain to an indirect waste connection to the sanitary soil/waste system via either tailpiece connection at the nearest lavatory or sink, or a fixed air gap mounted within a stainless steel panel in a wall. The roof air handler unit shall drain to roof mounted floor sinks adjacent to the unit. Floor sinks shall have elevated rims above roof level to prevent drainage of rainwater.

D. Domestic Systems Piping Materials

HW, CW: Copper tube, Type L, with wrought copper fittings and brazed or soldered joints.

W, V: Heavy duty cast iron. No hub, minimum 1/4" per foot slope.

CD: Type "L" copper, insulated, minimum 1/4" per foot slope

CH – CHILLERS

MARK	MANUFACTURER & MODEL	LOCATION	TYPE	SERVICE	CAPACITY TONS	REFRIGERANT TYPE	REFRIGERANT CHARGE LBS	COMPRESSOR VOLTAGE	COMPRESSOR PHASE	COMPRESSOR HERTZ	COMPRESSOR INPUT KW	COMPRESSOR KW/TON	COMPRESSOR NPLV KW/TON	COMPRESSOR RLA/MCA/MOCP	EVAPORATOR GPM	EVAPORATOR EWT °F	EVAPORATOR LWT °F	EVAPORATOR PASS	EVAPORATOR PD FT	EVAPORATOR FOULING FACTOR	CONDENSOR GPM	CONDENSOR EWT °F	CONDENSOR LWT °F	CONDENSOR PASS	CONDENSOR PD FT	CONDENSOR FOULING FACTOR	SHIPPING WEIGHT LBS	OPERATING WEIGHT LBS	REMARKS
CH–1 & 2	TRANE CVHF	CENTRAL PLANT	VARIABLE SPEED WATER COOLED	CAMPUS	500	R–123	800	480	3	60	267.4	0.535	0.397	388.9/496/800	569	60	39	2	14	.00010	1500	80	90	2	22	.00025	21,654	24,309	OPTION 1 – TRANE CHILLERS
CH–1 & 2	YORK YKFSF	CENTRAL PLANT	VARIABLE SPEED WATER COOLED	CAMPUS	500	R–134A	2080	480	3	60	280	0.56	0.38	387/484/800	514	62	39	3	11	.00010	1350	80	90	2	12	.00025	24,426	27,450	OPTION 2 – YORK CHILLERS

CHWP – CHILLED WATER PUMPS

MARK	MANUFACTURER & MODEL	LOCATION	TYPE	SERVICE	PUMP DESIGN POINT FLOW GPM	HEAD FT	MAX BHP	EFF %	SPEED RPM	NPSHR FT.	PUMP MOTOR V/PH	HERTZ	HP	SPEED RPM	ENCLOSURE	OPERATING WEIGHT LBS.	REMARKS
CHWP–1 & 2	PACO 4015–7/8 KP	CENTRAL PLANT	HORIZONTAL SPLIT CASE	CAMPUS LOOP	800	175	44.18	79.9	1780	11.9	480/3	60	60	1780	TEFC	–	OPTION 1 – PACO PUMPS
CHWP–1 & 2	BELL & GOSSETT 1510–5G	CENTRAL PLANT	BASE–MOUNTED END–SUCTION	CAMPUS LOOP	800	175	45.17	79.1	1750	6.25	480/3	60	75	1750	TEFC	–	OPTION 2 – BELL & GOSSETT PUMPS
CHWP–3 & 4	PACO 6015–1/2 KP	CENTRAL PLANT	HORIZONTAL SPLIT CASE	CHILLER PLANT	570	90	15.8	81.7	1775	14.9	480/3	60	40	1775	TEFC	–	OPTION 1 – PACO PUMPS
CHWP–3 & 4	BELL & GOSSETT 1510–4E	CENTRAL PLANT	BASE–MOUNTED END–SUCTION	CHILLER PLANT	570	90	18.99	80.4	1750	8.21	480/3	60	40	1750	TEFC	–	OPTION 2 – BELL & GOSSETT PUMPS

CWP – CONDENSER WATER PUMPS

MARK	MANUFACTURER & MODEL	LOCATION	TYPE	SERVICE	PUMP DESIGN POINT FLOW GPM	HEAD FT	MAX BHP	EFF %	SPEED RPM	NPSH R	PUMP MOTOR V/PH	HERTZ	HP	SPEED RPM	ENCLOSURE	OPERATING WEIGHT LBS	REMARKS
CWP–1 & 2	PACO 6012–3/4 KP	COOLING TOWER YARD	HORIZONTAL SPLIT CASE	COOLING TOWER	1500	50	21.23	89.05	1187	6.2	480/3	60	25	1187	TEFC	–	OPTION 1 – PACO PUMPS
CWP–1 & 2	BELL & GOSSETT 1510–6BC	COOLING TOWER YARD	BASE–MOUNTED END–SUCTION	COOLING TOWER	1500	50	24.35	79.35	1770	11.6	480/3	60	30	1770	TEFC	–	OPTION 2 – BELL & GOSSETT PUMPS

CT – COOLING TOWERS

MARK	MANUFACTURER & MODEL	LOCATION	TYPE	SERVICE	AMBIENT AIR °FWB	COOLING TOWER FAN TYPE	AIRFLOW CFM	DIAMETER FT	SPEED RPM	CONDENSER WATER EWT °F	LWT °F	FLOW GPM	STATIC LIFT (FT)	COOLING TOWER MOTOR VOLTAGE	PHASE	HERTZ	HP	SPEED RPM	SHIPPING WEIGHT LBS	OPERATING WEIGHT LBS	REMARKS
CT–1 & 2	BAC 3552C	CENTRAL PLANT	FORCED DRAFT	CHILLERS	72	WHISPER QUIET	–	–	–	80	90	1500	5	480	3	60	30	–	11,510	25,150	OPTION 1 BAC COOLING TOWERS
CT–1	EVAPCO UT–224–118	CENTRAL PLANT	FORCED DRAFT	CHILLERS	72	SUPER LOW SOUND FAN	–	–	–	80	90	3000	2.4	480	3	60	30	–	23680	42220	OPTION 2 – EVAPCO TOWER

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Consultant

Project Title

UTILITY INFRASTRUCTURE MASTER PLAN

SANTA ANA COLLEGE
1530 WEST 17TH STREET
SANTA ANA, CALIFORNIA 92706

REGISTERED PROFESSIONAL ENGINEER
STATE OF CALIFORNIA

Revisions

Number	Description	Date
△	–	–

Designed J. VALIENSI
Drawn F. OTIZ
Checked J. VALIENSI
Approved –

Date –

Submittal –

Scale NONE

Sheet Title

EQUIPMENT SCHEDULES

Sheet Number

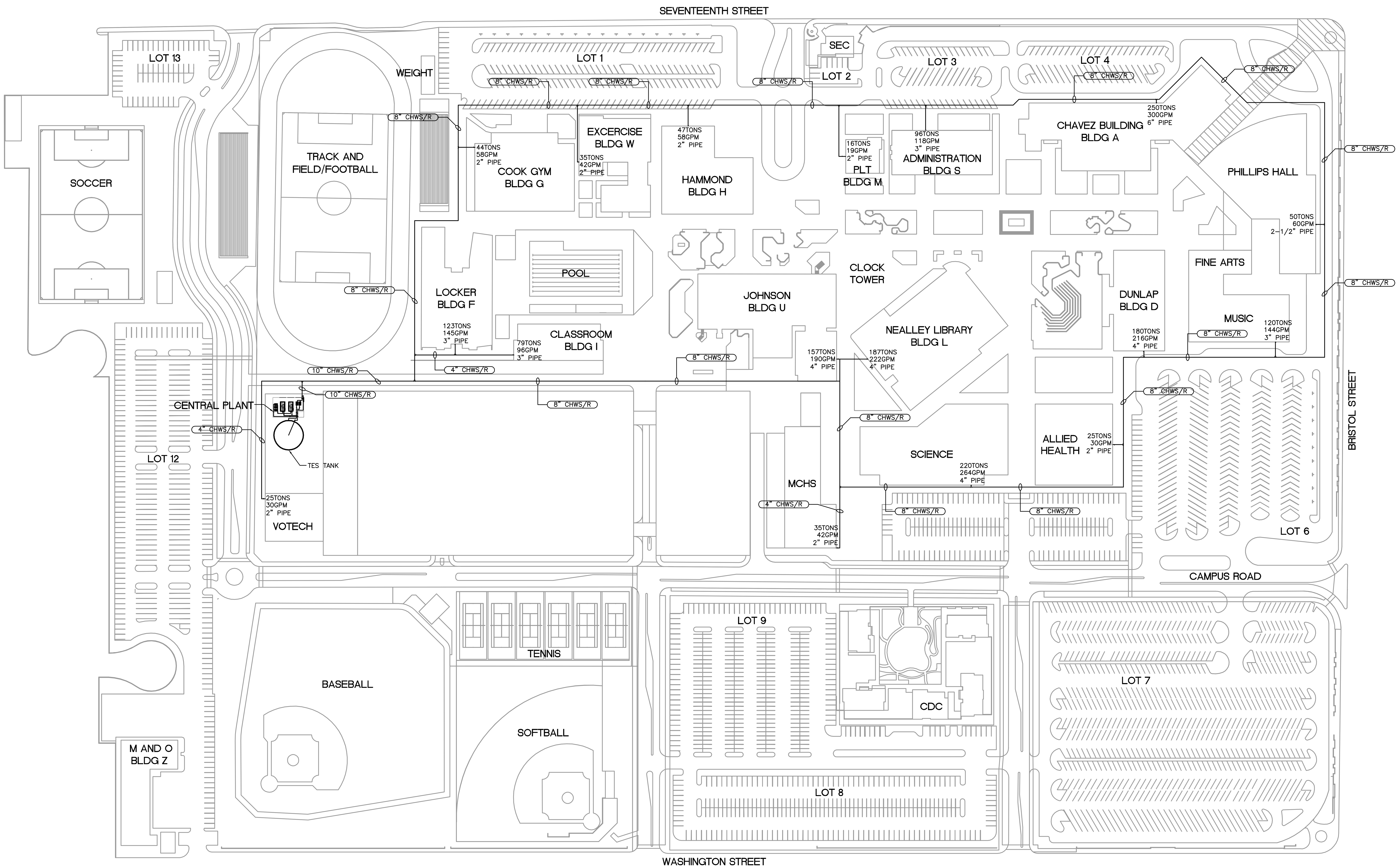
M0.2

of

J5807

NOTES

1. UNDERGROUND CHW PIPE IS C900 PVC
2. SERVICE VALVES ARE DIRECT BURIED BUTTERFLY VALVES
3. BUILDING CONNECTION AND SERVICE VALVES WITHIN 5FT OF EACH BUILDING



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Project Title

UTILITY INFRASTRUCTURE MASTER PLAN

SANTA ANA COLLEGE

1530 WEST 17TH STREET
SANTA ANA, CALIFORNIA 92706

Revisions

Number	Description	Date
△	–	–

Designed	J. VALIENSI
Drawn	F. OTIZ
Checked	J. VALIENSI
Approved	-
Date	-
Submittal	-
Scale	1"=80'

Sheet Title

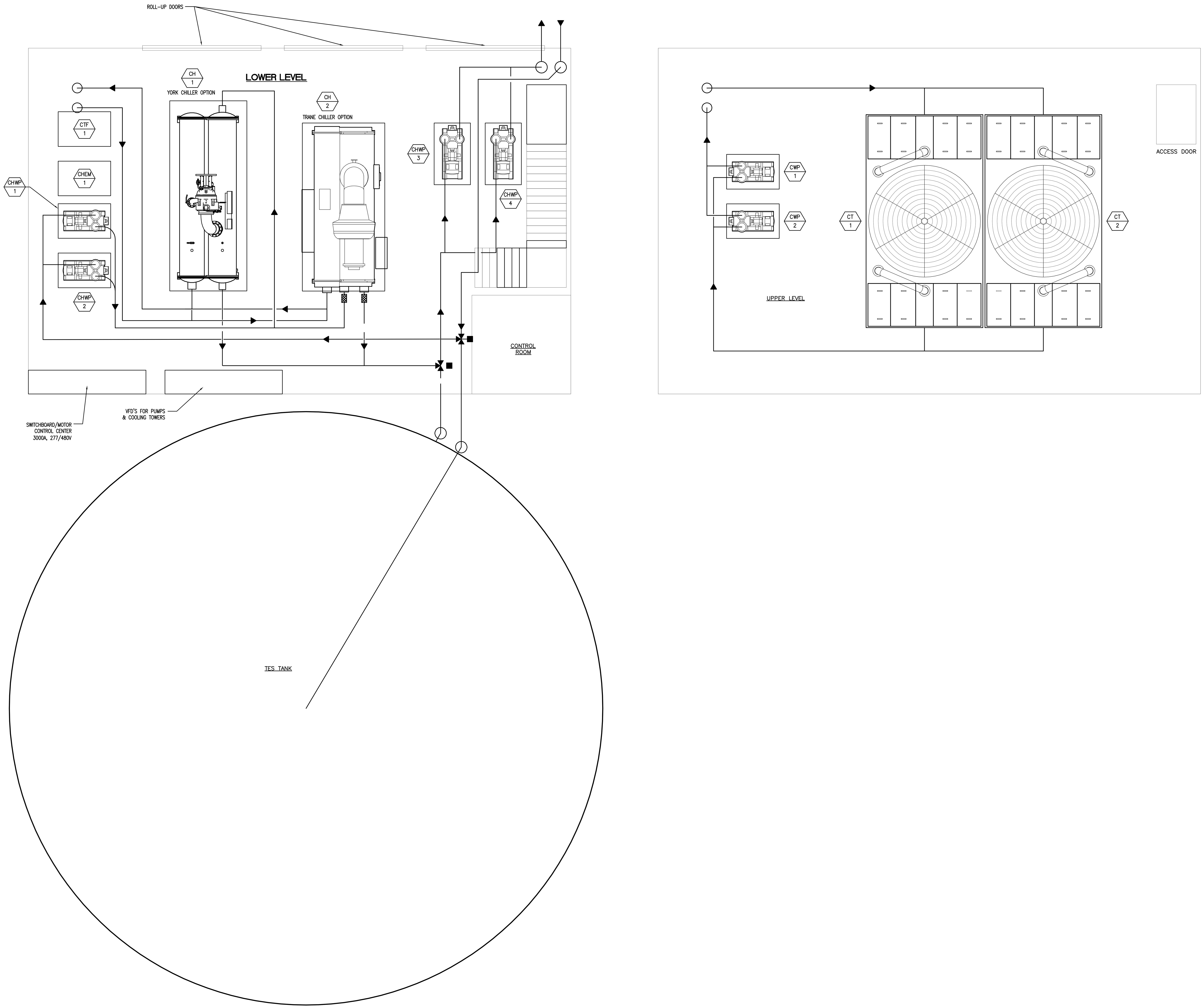
MECHANICAL SITE PLAN

Sheet Number

M1.1

of

J5807



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Revisions

Number	Description	Date
△	–	–

Designed	J. VALIENSI
Drawn	F. OTIZ
Checked	J. VALIENSI
Approved	-
Date	-
Submittal	-
Scale	1/4"=1'-0"

Sheet Title

CENTRAL PLANT ENLARGED PLAN

Sheet Number

M2.1

of

J5807

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Division 15 - Mechanical				
TES Tank				
8700-Ton-Hr Above Ground TES Tank with internal piping	1	LS	835,200	835,200
Foundation for TES tank	1	LS	150,000	150,000
Central Plant Shell				
Concrete & Steel Structure	2000	SF	220	440,000
Site Preperation	4000	SF	25	100,000
Central Plant Equipment				
500-ton centrifugal chiller	2	EA	500,000	1,000,000
Site CHW pumps, 1000GPM w/ VFD	2	EA	35,000	70,000
CHW Regeneration pumps, 1,200GPM w/ VFD	2	EA	35,000	70,000
Condenser water pumps, 1,500GPM w/ VFD	2	EA	36,000	72,000
Cooling Tower, 500-Tons w/ VFD	2	EA	120,000	240,000
Sand filter for cooling towers	1	EA	30,000	30,000
Air separator for CHW	1	EA	10,000	10,000
Pump and Cooling Tower VFD	8	EA	7,500	60,000
Central Plant Chilled Water Piping, Fittings, and Supports				
14" Pipe A.G. blk. Stl. Pipe	140	LF	200	28,000
12" Pipe A.G. blk. Stl. Pipe	200	LF	168	33,600
10" Pipe A.G. blk. Stl. Pipe	100	LF	148	14,800
Valves and Specialties	1	LS	5,000	5,000
Pipe insulation for CHW pipe				
12" Pipe A.G. blk. Stl. Pipe	200	LF	18	3,600
10" Pipe A.G. blk. Stl. Pipe	100	LF	16	1,600
Chilled Water Distribution Lines				
Potholing	1	LS	10,000	10,000
Surveying	1	LS	7,500	7,500
Complete w/ trenching, backfill, connections, and pre-insulated pipe.	1	LS	180,000	180,000
Restore landscaping and hardscaping	1	LS	250,000	250,000
10" Pre-insulated CHWS/R Pipe	100	LF	171	17,106
8" Pre-insulated CHWS/R Pipe	10000	LF	120	1,204,444
6" Pre-insulated CHWS/R Pipe	500	LF	106	53,216
4" Pre-insulated CHWS/R Pipe	500	LF	96	48,000
3" Pre-insulated CHWS/R Pipe	400	LF	92	36,800
2-1/2" Pre-insulated CHWS/R Pipe	50	LF	90	4,500
2" Pre-insulated CHWS/R Pipe	1700	LF	89	151,300
Building Connections				
2" Service Valves	14	EA	800	11,200
2-1/2" Service Valves	2	EA	1000	2,000
3" Service Valves	8	EA	1100	8,800
4" Service Valves	8	EA	1200	9,600
6" Service Valves	1	EA	1500	1,500
10" Loop Valves	2	EA	1500	3,000
8" Loop Valves	60	EA	1400	84,000
6" Loop Valves	2	EA	1300	2,600
Flow Meter	16	EA	6500	104,000
Temperature Sensors	32	EA	650	20,800
Central Plant Total				***$5,374,166***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "A"				
Demolition				
Chillers	4	EA	5,500	22,000
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	200	LF	60	12,000
3" A.G. Blk. Stl. Pipe	80	LF	43	3,440
2" A.G. Blk.Stl. Pipe	0	LF	21	0
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	200	LF	14	2,800
3" A.G. Blk. Stl. Pipe	80	LF	10	800
2" A.G. Blk.Stl. Pipe	0	LF	8	0
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	8	EA	2,500	20,000
Balance & Test	6	HR	75	450
Building "A"Total				***$61,490***
Building "C"				
Demolition				
Packaged Units	3	EA	2,500	7,500
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	0	LF	60	0
3" A.G. Blk. Stl. Pipe	150	LF	43	6,450
2" A.G. Blk.Stl. Pipe	150	LF	21	3,150
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	0	LF	14	0
3" A.G. Blk. Stl. Pipe	150	LF	10	1,500
2" A.G. Blk.Stl. Pipe	150	LF	8	1,200
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	3	EA	2,500	7,500
New Air Handlers				
Air Handlers	3	EA	80,000	240,000
Control valves	4	EA	2,500	10,000
Controls	30	PT	650	19,500
Balance & Test	12	HR	75	900
Building "C"Total (Building not included in final estimate)				***$297,700***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "D" - Dunlap Hall				
Demolition				
Chillers	2	LS	2,500	5,000
Condensers	2	LS	2,500	5,000
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	150	LF	60	9,000
3" A.G. Blk. Stl. Pipe	0	LF	43	0
2" A.G. Blk.Stl. Pipe	150	LF	21	3,150
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	150	LF	14	2,100
3" A.G. Blk. Stl. Pipe	0	LF	10	0
2" A.G. Blk.Stl. Pipe	150	LF	8	1,200
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	2	EA	2,500	5,000
Controls	3	PT	650	1,950
Balance & Test	10	HR	75	750
Building "D" - Dunlap Hall				***$33,150***
Building "E"				
Demolition				
Package Units	3	EA	1,000	3,000
Chilled water pipe, fittings, and supports				0
4" A.G. Blk. Stl. Pipe	0	LF	60	0
2" A.G. Blk.Stl. Pipe	60	LF	21	1,260
2" A.G. Type L Copper Pipe	60	LF	28	1,680
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	0	LF	14	0
2" A.G. Blk.Stl. Pipe	60	LF	8	480
2" A.G. Type L Copper Pipe	60	LF	8	480
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	3	EA	2,500	7,500
New Fan Coil Unit & Coils				
Control valves	4	EA	2,500	10,000
Controls	30	PT	650	19,500
Fan Coil Units	3	EA	10,000	30,000
Balance & Test	12	HR	75	900
Fan Coils	2	EA	5,000	10,000
Building "E" Total (Building not included in final estimate)				***$84,800***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "F"				
Demolition				
Chiller & Pump	1	LS	4,000	4,000
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	0	LF	60	0
3" A.G. Blk. Stl. Pipe	120	LF	43	5,160
2" A.G. Blk.Stl. Pipe	0	LF	21	0
2" A.G. Type L Copper Pipe	60	LF	28	1,680
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	0	LF	14	0
3" A.G. Blk. Stl. Pipe	120	LF	10	1,200
2" A.G. Blk.Stl. Pipe	0	LF	8	0
2" A.G. Type L Copper Pipe	60	LF	8	480
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	2	EA	2,500	5,000
Controls	3	PT	650	1,950
Balance & Test	24	HR	75	1,800
Building "F" Total				***$21,270***
Building "G" - Cook Gym				
Demolition				
Heat Pump Condenser	1	LS	2,500	2,500
Split Systems	2	LS	2,500	5,000
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	0	LF	60	0
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	0	LF	14	0
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	3	EA	2,500	7,500
New Fan Coil Unit & Coils				
Control valves	4	EA	2,500	10,000
Controls	30	PT	650	19,500
Fan Coil Units	2	EA	10,000	20,000
Balance & Test	12	HR	75	900
Coils	1	EA	21,000	21,000
Balance & Test	24	HR	75	1,800
Building "G" Total				***$98,300***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "H" - Hammond Hall				
Demolition				
Heat Pump Condenser	2	LS	2,500	5,000
Air Handler	2	LS	5,000	10,000
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	0	LF	60	0
3" A.G. Blk. Stl. Pipe	120	LF	43	5,160
2" A.G. Blk.Stl. Pipe	0	LF	21	0
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	0	LF	14	0
3" A.G. Blk. Stl. Pipe	120	LF	10	1,200
2" A.G. Blk.Stl. Pipe	0	LF	8	0
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	2	EA	2,500	5,000
New Air Handlers				
Control valves	3	EA	2,500	7,500
Controls	30	PT	650	19,500
New VAV system & ductwork	15700	SF	22	345,400
Balance & Test	120	HR	75	9,000
New Air Handlers	2	EA	56,000	112,000
Building "H" Total (Building not included in final estimate)				***$526,960***
Building "I"				
Demolition				
Package Unit	17	LS	900	15,300
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	0	LF	60	0
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	0	LF	14	0
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	17	EA	2,500	42,500
New Fan Coil Unit & Coils				
Control valves	18	EA	2,500	45,000
Controls	204	PT	650	132,600
Fan Coil Units	17	EA	10,000	170,000
Balance & Test	68	HR	75	5,100
Building "I" Total				***$420,600***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "L" - Library				
Demolition				
Air Handlers	3	EA	2500	7,500
Split Systems	3	EA	2300	6,900
Package Units	7	EA	500	3,500
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	120	LF	60	7,200
3" A.G. Blk. Stl. Pipe	120	LF	43	5,160
2" A.G. Blk.Stl. Pipe	0	LF	21	0
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	120	LF	14	1,680
3" A.G. Blk. Stl. Pipe	120	LF	10	1,200
2" A.G. Blk.Stl. Pipe	0	LF	8	0
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	13	EA	2,500	32,500
Control valves	14	EA	2,500	35,000
Controls	27	PT	650	17,550
Balance & Test	24	HR	75	1,800
Air Handlers				
Air handlers	1	LS	576,000	576,000
Controls	390	EA	650	253,500
Boiler	1	EA	12,500	12,500
Building "L" Total				***$969,190***
Building "M" Planetarium				
Demolition				
Package Units	2	EA	1,500	3,000
Chilled water pipe, fittings, and supports				
2" A.G. Blk.Stl. Pipe	0	LF	21	0
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
2" A.G. Blk.Stl. Pipe	0	LF	8	0
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	2	EA	2,500	5,000
Control valves	3	EA	2,500	7,500
Controls	27	PT	650	17,550
Balance & Test	24	HR	75	1,800
Air Handlers				
Air handlers	1	LS	48,000	48,000
Controls	20	EA	650	13,000
Building "M" Total				***$103,050***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "N" Music				
Demolition				
Air Handler	1	EA	3,000	3,000
Chilled water pipe, fittings, and supports				
2" A.G. Blk.Stl. Pipe	0	LF	21	0
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
2" A.G. Blk.Stl. Pipe	0	LF	8	0
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	1	EA	2,500	2,500
Control valves	2	EA	2,500	5,000
Controls	2	PT	650	1,300
Balance & Test	12	HR	75	900
Air Handlers				
Air handlers	1	LS	160,000	160,000
Controls	12	EA	650	7,800
Building "N" Total (Building not included in final estimate)				***$187,700***
Building "P" Phillips Hall				
Demolition				
Packaged Units	6	EA	900	5,400
Air Handler	1	EA	3,000	3,000
Chilled water pipe, fittings, and supports				
3" A.G. Blk. Stl. Pipe	200	LF	43	8,600
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
3" A.G. Blk. Stl. Pipe	200	LF	10	2,000
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	7	EA	2,500	17,500
Control valves	8	EA	2,500	20,000
Controls	2	PT	650	1,300
Balance & Test	24	HR	75	1,800
Air Handlers				
Air handlers	1	LS	160,000	160,000
Controls	84	EA	650	54,600
Building "P" Total (Building not included in final estimate)				***$284,300***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "R" Russell Hall				
Demolition				
Chillers	2	EA	4500	9,000
Cooling Tower	1	EA	3,000	3,000
Chilled water pipe, fittings, and supports				
4" A.G. Blk. Stl. Pipe	120	LF	60	7,200
3" A.G. Blk. Stl. Pipe	200	LF	43	8,600
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
4" A.G. Blk. Stl. Pipe	120	LF	14	1,680
3" A.G. Blk. Stl. Pipe	200	LF	10	2,000
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	4	EA	2,500	10,000
Control valves	5	EA	2,500	12,500
Controls	16	PT	650	10,400
Balance & Test	36	HR	75	2,700
Building "R" Total (Building not included in final estimate)				***$77,180***
Building "S"				
Demolition				
Air Handler	3	EA	3000	9,000
Chilled water pipe, fittings, and supports				
3" A.G. Blk. Stl. Pipe	200	LF	43	8,600
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
3" A.G. Blk. Stl. Pipe	200	LF	10	2,000
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	3	EA	2,500	7,500
Control valves	4	EA	2,500	10,000
Controls	2	PT	650	1,300
Balance & Test	24	HR	75	1,800
Air Handlers				
Air handlers	1	LS	240,000	240,000
Controls	36	EA	650	23,400
Building "S" Total				***$313,700***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "T"				
Demolition				
Air Handler	2	EA	3000	6,000
Chilled water pipe, fittings, and supports				
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	2	EA	2,500	5,000
Control valves	3	EA	2,500	7,500
Controls	6	PT	650	3,900
Balance & Test	24	HR	75	1,800
Air Handlers				
Air handlers	1	LS	320,000	320,000
Controls	24	EA	650	15,600
Building "T" Total (Building not included in final estimate)				***$369,900***
Building "U"				
Demolition				
Heat Pumps	33	EA	1200	39,600
Condenser Unit	1	EA	2,500	2,500
Cooling Tower	1	EA	2,500	2,500
Boiler	1	EA	1,000	1,000
Chilled water pipe, fittings, and supports				
2" A.G. Blk.Stl. Pipe	250	LF	21	5,250
2" A.G. Type L Copper Pipe	1000	LF	28	28,000
Pipe insulation for CHW pipe				
2" A.G. Blk.Stl. Pipe	250	LF	8	2,000
2" A.G. Type L Copper Pipe	1000	LF	8	8,000
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	34	EA	2,500	85,000
Control valves	35	EA	2,500	87,500
Controls	340	PT	650	221,000
Balance & Test	136	HR	75	10,200
Fan Coil Units				
FCU	33	EA	5000	165,000
Air handler Coil	1	LS	15,000	15,000
Building "U" Total				***$672,550***

CSI Divisions	Quan.	Unit	Unit Cost $	Amount $
Building "W"				
Demolition				
Air Handler	3	EA	3000	9,000
Chilled water pipe, fittings, and supports				
2" A.G. Blk.Stl. Pipe	100	LF	21	2,100
2" A.G. Type L Copper Pipe	200	LF	28	5,600
Pipe insulation for CHW pipe				
2" A.G. Blk.Stl. Pipe	100	LF	8	800
2" A.G. Type L Copper Pipe	200	LF	8	1,600
Piping connections to equipment to include pipe fittings, valves, hangers & specialties	3	EA	2,500	7,500
Control valves	4	EA	2,500	10,000
Controls	6	PT	650	3,900
Balance & Test	24	HR	75	1,800
Air Handlers				
Air handlers	1	LS	120,000	120,000
Controls	36	EA	650	23,400
Building "W" Total				***$185,700***

Grand Total - All Divisions	
Central Plant	**$5,682,364**
Building Connections/Conversions to Central Plant	**$3,076,000**
Grand Total	**$8,758,364**