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**San Francisco State University  
Campus Master Plan**

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**Chapter 10.  
Campus Infrastructure**

## 10. Campus Infrastructure

The master plan projects the infrastructure needs of the campus to the year 2020. The following discussion focuses on the campus utility infrastructure and central plant. The recommendations presented here are preliminary and further studies addressing specific siting and cost benefit analysis will be performed as individual components of the master plan are implemented. The master plan also recommends a campus-wide integrated strategic energy resource plan as a follow-on study.

### Utility Infrastructure

SF State has a complex system of utilities that provides services to the 25-plus buildings on campus. These services include sanitary sewer and storm drainage, domestic and fire suppression water supply, natural gas, heating hot water, electrical power, and telecom services. Most buildings are tied to campus systems; however there are a few with individual services. For instance, the Mary Ward and Mary Park residence halls have individual boilers for heating hot water and are not connected to the central plant.

The master plan development will necessitate changes to each utility system to some degree; however in general, there is capacity in the infrastructure to accommodate the planned growth of the campus. The two principal goals of the master plan with respect to utilities are to minimize impacts and promote sustainability wherever possible. With these goals in mind, the following sections review the opportunities for sustainability and the necessary changes to specific systems to allow for development.

### *Sustainability*

The master plan seeks to redevelop the SF State campus in a manner consistent with CSU sustainability goals. In essence, a sustainable approach tries to meet the needs of a campus or facility by using less energy than traditional methods, conserving water, and utilizing recycled materials or renewable resources as much as possible. A large component of sustainability is also taking into account the life-cycle cost of projects rather than only considering the initial cost. Because the University will operate the facilities over the long term, this approach can lead to substantial operational cost savings over time.

Many of the opportunities for sustainable practice occur within buildings or are related to building systems. Some examples include natural ventilation, multiple temperature zone controls, low-flow plumbing fixtures, waterless urinals, green roofs, photo-voltaic panels, high-efficiency lighting, occupancy sensors, selection of building materials, and many more. At the campus-wide infrastructure level, stormwater and the central plant present two significant opportunities for sustainable practice given the extent of redevelopment proposed for the SF State campus. The other primary opportunity is the use of reclaimed water for irrigation or fire suppression. Plans underway by the San Francisco Public Utilities Commission (SFPUC) to construct a recycled water treatment plant in the vicinity of the campus offer the University an opportunity to use recycled water for irrigation.

Options for renewable energy should be studied and evaluated for every new building or campus infrastructure project such as the use of solar hot water panels, photo-

voltaic cell panels, and wind turbines. For example, an optional use for some portion of the top deck of the parking garage might be a zone for photovoltaic panels. Any opportunity to generate some of its own renewable energy to offset fossil-fuel-based power supply will translate into operational cost savings to the University as well as being beneficial to the environment as a whole.

- **Stormwater Management**

Currently, stormwater runoff flows from the campus into the City's combined sewer main. The master plan introduces a set of project-specific, campus-regional, and campus-wide measures that decrease the rate and quantity of runoff and improve the quality, or cleanliness, of the water discharged from the site.

Each individual building site project will incorporate design elements, such as bioswales and rain gardens, to collect and clean rainwater. These elements will also afford an opportunity for water to percolate back into the ground, reducing the overall site runoff. At a campus-regional scale, the storm drainage system will collect the drainage from several adjoining project areas by means of vegetated channels or closed pipes to vegetated retention / infiltration zones. These campus-regional elements will be larger and further enhance the potential for stormwater to be reintroduced into the groundwater table. Where possible, these elements will be tied together and directed into the valley.

The valley running through the center of the SF State campus was formerly a streambed draining into Lake Merced. The master plan takes advantage of this natural resource by returning a portion of the valley back to its historic native riparian habitat and reconnecting it via an underpass beneath Lake Merced Boulevard directly to Lake Merced. The master plan not only enhances the connectivity of the site, but also provides a means to convey stormwater runoff into Lake Merced, thereby reducing the impact of the campus on the City of San Francisco sewer system and helping to maintain water levels in the lake. Due to the size of the campus and the topography, it may not be possible for all portions to be tied into the drainage system to the valley—particularly in the early stages of implementation when new stormwater improvements are isolated from other portions of the new network. For instance, the areas north of Buckingham and south of Holloway will need to be studied carefully in the detailed design stage to see which tie-ins are feasible and where direct connections to the city sewer may have to be made on an interim basis. However all projects at a minimum will include site-specific measures to improve stormwater quality.

The master plan development will cause an approximate 2 percent increase in annual storm runoff from new building areas. Annual storm runoff was calculated using annual precipitation data for the San Francisco area. Due to the new swale and open channel system, the quantity of storm runoff directed to the City combined sewer main will be decreased by approximately 20 percent, for a net reduction of 18 percent from the runoff rate and quantity of the existing campus. The swale and open channel system will filter and percolate storm runoff through the campus using surface swales where possible and convey runoff to Lake Merced, thereby reducing the quantity of storm runoff that enters the public system for treatment. Any water flowing directly into Lake Merced will be filtered and cleansed to meet the highest applicable standards for water quality—most notably, the standards set by the San Francisco Public Utilities Commission (SFPUC). In areas of the campus with potential concentrations of pollutants, such as the corporation yard and loading docks, runoff will be directed to the City sewer system.

The net reduction in runoff entering the storm drain system has the additional benefit of offsetting the increase in sanitary sewer volume due to new buildings on campus; thus the master plan development will not increase the City's combined sewer wet weather flow at buildout. The related follow-on studies specified in Chapter 11 under "Further Studies" will seek, additionally, to determine how the master plan development specifically will meet a "net zero" increase in combined sewer wet-weather flows incrementally, as each individual phase is implemented. In particular, the Integrated Stormwater Management Master Plan, the Infrastructure Master Plan, and the Utility Capacity/Sizing Analysis will aid in making these determinations.

- **Central Plant**

Part of the CSU sustainability mandate is to reduce the requirement for energy from the electricity grid and promote energy independence using economically feasible alternatives where possible. Currently SF State maintains a central utility plant that produces a sizeable portion of its electrical demand and also provides centralized hot water from the "waste" heat generated. This is an ideal system to improve overall campus energy efficiency and reduce dependence on purchased power sources.

The dual goals of energy independence and sustainable building and operation practices come together on the SF State campus in the central utility plant, which includes the plant building itself, fuel sources, electric generation equipment, related electrical switch gear, electrical distribution system, and hot water distribution system. From an infrastructure standpoint, sustainability means the efficient use of energy and some degree of independence. Through the central plant, SF State is making the most of the energy produced (electricity) by using the waste heat generated for domestic heating purposes. This co-generation greatly increases the overall system efficiency. A more extensive discussion of the central plant follows later in this chapter.

### *Existing utility systems*

A separate Building and Site Infrastructure Conditions report was prepared in April 2006 that assessed existing utility systems performance standards, anecdotal information regarding actual system performance, and potential impacts from master plan development. The following excerpts from that report are included here to provide a brief overview of the existing utility infrastructure that serves the campus.

- **Sanitary Sewer**

The sanitary sewer system on the SF State campus is a mixture of gravity lines and pumped force mains. Since the campus is situated around a valley, there are two pump stations to lift sewage out of the low points. The first lift station is located in the western athletic fields between the tennis courts and the baseball field. It collects sewage from the western residential buildings to the south and the Lakeview Center and corporation yard facilities to the north. This is all pumped out via a 6-inch force main to a connection to the City system in Winston Drive. Most of the buildings around the academic core, the Towers, and the Village drain to the northeast corner of the Student Services Center. From here a 12-inch gravity line ties out to Font Boulevard where it connects to the City system. The second pump station is located in the upper athletic field. This pump station is much smaller and only collects the field house and restroom building serving Cox Stadium. The sewage is pumped up to the Student Services Center where it drains into the 12-inch main toward Font. There are

three other connections to the public system, all smaller in size and serving between one and four buildings.

- **Storm Drainage**

The valley is the remnant of a former canyon cut by a seasonal stream that discharged into Lake Merced. As the area was developed, the stream was placed underground by the City of San Francisco in large diameter concrete pipes that carry the water south now rather than toward Lake Merced. Although the valley now contains athletic fields and the parking garage, the overall drainage pattern remains unchanged. The surface runoff is now collected by a network of drains and pipes that tie to the large concrete pipes.

- **Water System**

The SF State campus water system is unusual in that while it has two different onsite water systems, one for fire and one for domestic and irrigation water, they are interconnected and served by the same connections to the public water supply. This onsite distribution system is made of 6- and 8-inch piping and forms several interconnecting loops with isolation valves so portions of the line can be shut down for repairs as needed. In 1997 a second loop of 8-inch piping dedicated to fire water was constructed around the academic core. All hydrants and fire services in this area were shifted to the new system. The remainder of campus is still served by the single system for both fire and domestic services.

- **Natural Gas**

The natural gas system for the campus is relatively simple. The two main feeds are a 4-inch PG&E line from 19th Avenue to the north side of the gymnasium, and a 2-inch PG&E line from Lake Merced Boulevard to the central plant. From the gymnasium smaller campus-owned piping distributes the gas to the buildings in the vicinity that utilize natural gas. The central plant feed is also used to supply the steam boilers in both Business and the gymnasium. Other campus buildings that are not in the vicinity of the gymnasium have individual services from PG&E. Since the campus utilizes central heating hot water and domestic hot water, the need for gas is relatively minimal at most buildings.

### *Proposed changes*

The master plan will be implemented in two phases over the course of the planning horizon to 2020. As noted earlier, the utility systems in general have sufficient capacity to accommodate the campus growth. Most of the changes involve relocating conflicting utilities or extending services to the location of new building projects. Of notable exception will be the changes to the storm drainage system, as discussed previously, and the extension of heating hot water to all campus buildings. The addition of new buildings to the heating hot water system will require changes to the central plant system that are discussed in detail later in this chapter.

The following summarizes the specific changes to the utility infrastructure of campus within each phase of development—in particular, the additional infrastructure required to serve the new and redeveloped facilities. Also included here are several sidebars and illustrations that list the specific changes related to each building within the phase shown.

- Phase 1:

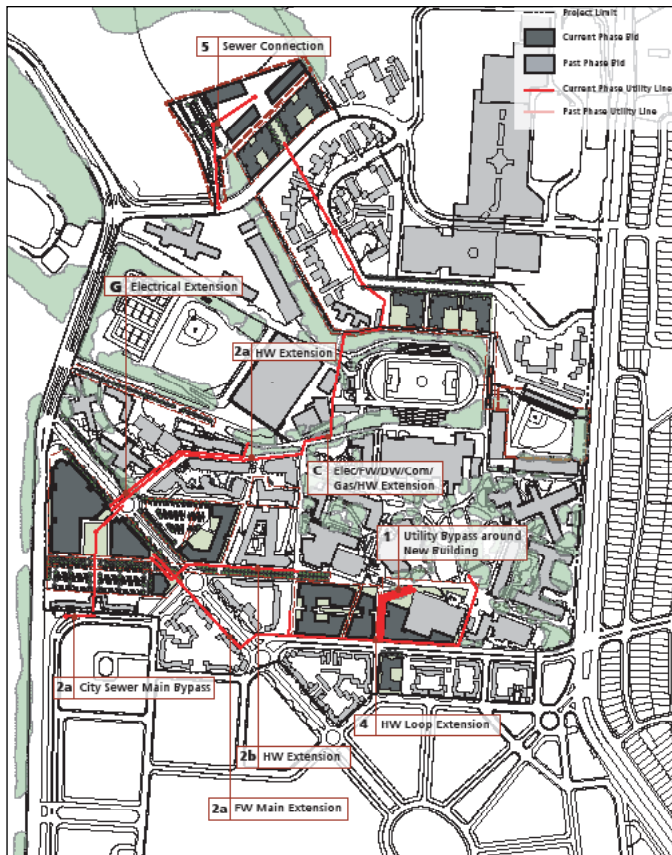
**Sanitary Sewer:** make direct connections to public mains in Holloway Avenue as required to serve the new BSS/HHS and library expansion and to mains in Font Boulevard as required to serve the new University Park South (UPS) housing and Clinical Sciences. Relocate approximately 700 feet of 24-inch City main to prepare the Creative Arts site. Construct approximately 700 feet of 8-inch sewer main to serve University Park North (UPN) housing and new Facilities/Maintenance.

**Storm Drainage:** make direct connections to public mains in Holloway Avenue as required to serve the new BSS/HHS and library expansion and to mains in Font Boulevard as required to serve the new UPS housing and Clinical Sciences. Make direct connection to public mains in Winston Drive as required to partially serve University Park North (UPN) housing and Facilities/Maintenance. See also Stormwater Quality below.

**Stormwater Quality:** new development such as the residential buildings in UPN and UPS, Creative Arts, BSS, and HHS should include localized stormwater treatment such as rain gardens and bioswales, and, where possible, connections into the new stormwater management network, thus reducing runoff quantities and size of storm drain piping.

**Domestic Water:** make direct connection to campus domestic water BSS/HHS and library expansion. Expand the 6-inch campus domestic water piping approximately 875 feet cross Font Boulevard to serve the new UPS housing, Clinical Sciences and Creative Arts. Make direct connections to Holloway Avenue to serve BSS/HHS and the library

Utility Phasing 1: Year 1 to 5



### Utility Connection

**Creative Arts:**

- HW: Extend mains; loop through building
- FW: Extend main
- Sewer: Bypass around Creative Arts & Font Blvd.
- DW: Connect to ex. campus main across Font Blvd.
- ELEC: Extend through ex. elec trench from manhole 6p-7p
- GAS: Connect to ex. campus main across Font Blvd.
- COM: Join trench with elec from manhole 6p-7p

**Library Expansion:**

- Bypass all ex. utilities around new footprint. Connect new utilities through ex. library or to adjacent ex. utilities.

**BSS/HSS:**

- Re-use connections from demolished Creative Arts building as necessary

**Clinical Sciences/UPS housing:**

- HW: Connect to extended mains for Creative Arts
- FW: Connect extended main across Font Blvd.
- SEWER: Connect to ex. City system in font blvd.
- DW: Connect to ex.

- campus main
- ELEC: Connect to elec
- GAS: Connect to ex. campus main
- COM: Joint trench with elec from man hole 6p/7p

**UPN Housing:**

- HW: Extend mains from central campus
- FW: Extend mains from central campus
- SEWER: Connect to ex. City system in Winston Dr.
- DW: Extend mains from central campus
- ELEC: Extend mains from central campus
- GAS: Extend mains from central campus
- COM: Extend mains from central campus

**Facilities / Maintenance:**

- FW: Extend mains from central campus
- SEWER: Connect to ex. City system in Winston Dr.
- DW: Extend mains from central campus
- ELEC: Extend mains from central campus
- GAS: Extend mains from central campus
- COM: Extend mains from central campus



expansion. Extend the 6-inch campus domestic water piping approximately 1,250 feet to serve UPN housing and Facilities/Maintenance.

Fire Water: make direct connection to campus domestic water BSS/HHS and library expansion. Expand the 8-inch campus fire water piping approximately 875 feet cross Font Boulevard to serve the new UPS housing, Clinical Sciences and Creative Arts. Make direct connections to the 8-inch campus fire water piping to serve BSS/HHS and the library expansion. Extend the 8-inch campus fire water piping approximately 2,200 feet to serve UPN housing and Facilities/Maintenance.

Natural Gas: there is no need for new or additional natural gas services for this phase.

Heating Hot Water: extend the 6-inch campus hot water piping approximately 1,400 feet along Holloway Avenue and make direct connection for the new BSS/HHS and library expansion. Extend the 6-inch campus hot water piping system approximately 875 feet along Tapia Drive and across Font Boulevard to provide heating hot water to the new UPS housing, Clinical Sciences and Creative Arts. Extend 6-inch campus hot water piping approximately 2,200 feet to serve UPN housing and Facilities/Maintenance.

Electrical: make direct connection to campus electric circuits for the new BSS/HHS and library expansion. Expand the campus electric circuit approximately 900 feet to the UPS housing, Clinical Sciences, and Creative Arts. Extend the campus electric circuits approximately 2,200 feet to serve UPN and Facilities/Maintenance

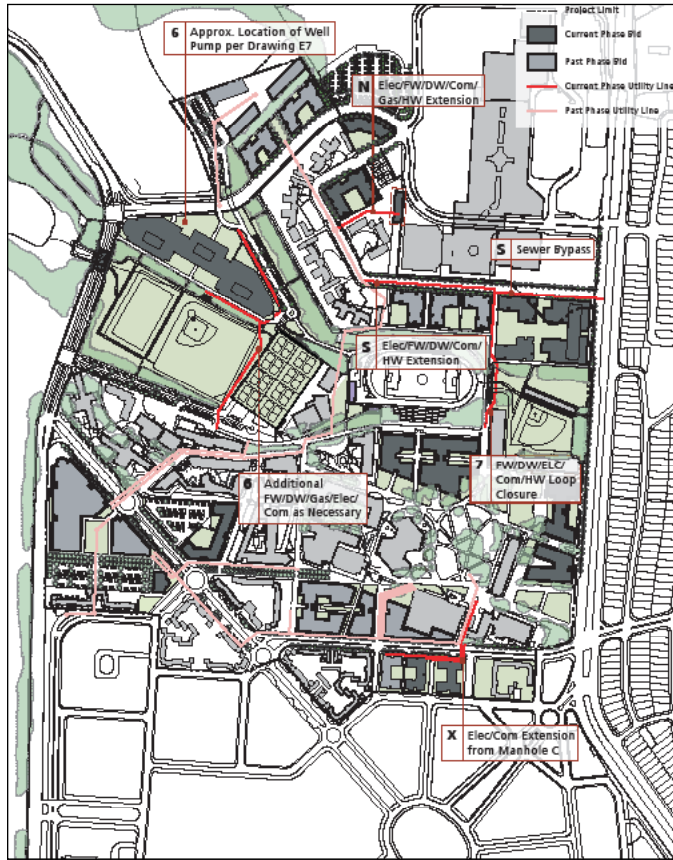
Telecom: make direct connection to campus telecom circuits for the new BSS/HHS and library expansion. Expand the campus telecom circuit approximately 900 feet to the UPS housing, Clinical Sciences, and Creative Arts. Extend the campus telecom circuits approximately 2,200 feet to serve UPN and Facilities/Maintenance.

- **Phase 2:**

Sanitary Sewer: direct connection to public mains in Holloway Avenue to serve the new residential buildings in UPS and direct connection to campus mains for the new Science/Ethnic Studies and Psychology and Academic/Business buildings. Relocation of an existing sanitary lift station and 900 feet of 6-inch force main is required for the new gym-recreation/wellness center. Relocation of 1,225 feet of 8-inch public sewer main is required to clear the site for the University Conference Center.

Storm Drainage: direct connection to public mains in Holloway Avenue to serve the new residential buildings in UPS and direct connections to campus mains for the new Science/Ethnic Studies and Psychology and Academic/Business buildings. New construction in areas such as the gym-recreation/wellness center and University Conference Center should include storm drainage pipe as required to partially serve the demand. See also Stormwater Quality below.

Stormwater Quality: new development such as the residential buildings in UPS, gym-recreation/wellness center and University Conference Center should include localized stormwater treatment such as rain gardens and bioswales and, where possible, connections into the new stormwater management network, thus reducing runoff quantities and size of storm drain piping.



Utility Phasing 2: Year 6 to 10

**Utility Connection**

**Gymnasium:**

- Re-use ex. utility connections from demolished buildings if capacity allows. If not, extend from central campus.

**Satellite Power Plant:**

- HW: Connect to joint trench built in Phase 1
- FW: Connect to joint trench built in Phase 1
- SEWER: Connect to ex. main in Buckingham Way
- DW: Connect to joint trench built in Phase 1
- ELEC: Connect to joint trench built in Phase 1
- GAS: Connect to joint trench built in Phase 1
- COM: Connect to joint trench built in Phase 1

**UPN Housing / Conference Center:**

- HW: Connect Phase 1 joint trench / close loop
- FW: Connect Phase 1 joint trench / close loop
- SEWER: Connect to utility bypass
- DW: Connect Phase 1 joint trench / close loop
- ELEC: Connect to Phase 1 joint trench

- GAS: Connect Phase 1 joint trench / close loop
- COM: Connect Phase 1 joint trench

**Science / Ethnic Studies:**

- Re-use ex. utility connections from demolished buildings.

**Future Academic / Business:**

- Re-use ex. utility connections from demolished buildings.

**UPS housing:**

- HW: Connect to expanded loop from Phase 1 across Holloway Avenue.
- FW: Connect across Holloway Avenue.
- SEWER: Connect to ex. City system in Holloway Avenue.
- DW: Connect across Holloway Avenue.
- ELEC: Extend through ex. elec trench from manhole C
- GAS: Connect to Ex. PG&E main in Holloway Avenue.
- COM: Joint trench with elec from manhole C

Domestic Water: make direct connection to campus domestic water for new Science/Ethnic Studies and Psychology and Academic/Business buildings. Expand the 6-inch campus domestic water piping approximately 350 feet across Holloway Avenue to provide domestic water to the new residential buildings in UPS. Extend the 6-inch campus domestic water piping approximately 700 feet to serve the gym-recreation/wellness center and approximately 700 feet to serve the University Conference Center and UPN housing.

Fire Water: make direct connection to campus fire water for new Science/Ethnic Studies and Psychology and Academic/Business buildings. Expand the 8-inch campus fire water piping approximately 350 feet across Holloway Avenue to provide fire water to the new residential buildings in UPS. Extend the 8-inch campus fire water piping approximately 700 feet to serve the gym-recreation/wellness center and approximately 400 feet to serve the University Conference Center and UPN housing.

Natural Gas: construct approximately 1,200 feet of 6-inch medium pressure gas main for connection to PG&E to serve a new satellite power plant.

Heating Hot Water: make direct connection to campus hot water system for new Science/Ethnic Studies and Psychology and Academic/Business buildings. Expand the 6-inch campus hot water piping approximately 300 feet across Holloway Avenue to provide domestic water to the new residential buildings in UPS. Extend the 6-inch campus hot water piping approximately 700 feet to serve the gym-recreation/wellness center and approximately 700 feet to serve the University Conference Center and UPN housing



Electrical: make direct connection to campus electrical circuits for the new Science/Ethnic Studies and Psychology and Academic/Business buildings. Expand the campus electric circuits approximately 350 feet across Holloway Avenue to serve the new residential buildings in UPS. Extend the campus electric circuits approximately 400 feet to serve the gym-recreation/wellness center and approximately 700 feet to serve the University Conference Center and UPN housing. Extend the campus electric circuits approximately 350 feet to serve the new satellite power plant.

Telecom: make direct connection to campus telecom circuits for the new Science/Ethnic Studies and Psychology and Academic/Business buildings. Expand the campus telecom circuits approximately 300 feet across Holloway Avenue to serve the new residential buildings in UPS. Extend the campus telecom circuits approximately 700 feet to serve the gym-recreation/wellness center and approximately 700 feet to serve the University Conference Center and UPN housing. Extend the campus telecom circuits approximately 350 feet to serve the new satellite power plant.

### ***Further studies***

Further studies are recommended to address the following:

- Stormwater Management Master Plan
- Infrastructure Master Plan
- Utility Capacity/Sizing Analysis
- Sanitary Sewer
- Domestic Water
- Fire Water
- Electric
- Telecom
- Hot Water
- Hydrology/Hydraulic Campus-Wide

## **Central Plant**

### ***Existing conditions***

The central plant at SF State is located at the approximate center of campus near the parking structure and waste management center. Constructed between 1997 and 1999, the plant fulfills two primary functions: it provides electrical power generation and heating hot water. As a secondary function the plant also supplies domestic hot water to the campus for sinks and showers. While space was originally allocated for chillers to provide building cooling water, the space has been used for other equipment and is no longer available. The need for a centralized cooling system is much less than the need for heating due to the cool climate of the area.

The existing building is approximately 12,500 square feet in size and houses the central plant equipment and provides some small office space. The current equipment allows the plant to provide approximately 36,000,000 btuh of heating energy and 2,175 kW of electricity. This is enough to meet the current heating loads with capacity to spare but is insufficient to meet the average power demands of campus.

- **Power Generation**

Two reciprocating engines, one (a Waukesha rated 725 kW) running on natural gas and the second (a Fairbanks Morse rated 1,400 kW) running on either natural gas or diesel fuel provide the power generation. The power is generated at 480 volts and the generator control / paralleling switchgear for each generator connects to the 480 volt double-ended switchgear that serves the central plant. The central plant switchgear is connected to the campus 12kV power distribution system through secondary substation transformers located outdoors on the north side of the central plant. The waste heat from the two engines is used to pre-heat the campus heating water; however it is not sufficient on its own to meet the heating requirements of the current campus. One of the existing natural gas boilers is used to satisfy heating hot water demand.

- **Heating Hot Water**

The high-temperature heating water system consists of two 600hp gas boilers and two 2,000 gpm pumps. The current campus load is satisfied by operating one boiler and one pump. The second boiler and pump are redundant equipment. The high-temperature heating water is pre-heated via engine-stack heat recovery from the two reciprocating engines. Prior to entering the heat recovery system, the high-temperature heating water is cooled by a waste heat radiator system (cooling towers on the roof) down to a maximum temperature of 146 degrees F and utilized to cool the engine lubrication system.

### *Assumptions for central plant*

The University will have to make some decisions with respect to what portion of the campus demands they wish to serve with the campus central plant. The primary decision is how much electrical generation capacity will be provided versus purchased power from the public utility provider. The final decision will be driven by a cost benefit analysis of the projected costs of electricity, the phasing of power plant and campus construction, and specific energy strategies of the University. For the purposes of the option presented in this report it has been assumed that the central plant will meet the following criteria:

- Provide for all of the heating needs of campus, including all campus-owned residential buildings.
- Provide adequate generation capacity to meet the average power demands of the campus including all campus-owned residential buildings.
- Ensure that part of the generation capacity is capable of operating during an emergency via an on-site fuel source.

To develop a system that can meet the first two criteria, a projection of the future electrical and heating demands for the campus is needed. Table 1 shows the demands of the existing campus buildings and the existing housing complexes that the University presently owns.

The master plan calls for the removal of a number of the existing campus facilities and replacing them with new buildings. This will impact both the electrical and heating demands of the campus. Table 2 shows the approximate changes to campus for the planning horizon.

	Heat Load (btuh)(1)	Electrical Demands	
		Average Power (kW)	Peak Power (kW)
Existing Campus			
Academic Core	16,000,000	2,888	7,220
Housing Buildings			
University Park North (UPN)	20,000,000(2)	419	1,397
University Park South (UPS)		123	409
<b>Total Existing Campus and UPN &amp; UPS</b>	<b>36,000,000</b>	<b>3,430(3)</b>	<b>8,664(3)</b>

Table1  
Existing Campus Loads

- Notes:** (1) Heat loads based on historical data and existing boiler sizes.  
 (2) Heating load includes UPN, UPS, and all housing buildings, excluding Centennial Village.  
 (3) Total projected load is not a sum of the individual loads due to differences in usage patterns.

Building Use	Master Plan Changes		
	Removed	Added	Total Change
Academic	550,899 gsf	1,131,700 gsf	580,801 gsf
Student Services		80,000 gsf	80,000 gsf
Facilities & Maintenance	114,769 gsf	141,000 gsf	26,231 gsf
Gym/Rec Facilities	157,011 gsf	250,000 gsf	92,989 gsf
Library	30,000 gsf	95,400 gsf	65,400 gsf
Residential	496,000 gsf	1,200,000 gsf	704,000 gsf
Conference Center (Conference Space/Retail)		65,000 gsf	65,000 gsf
Conference Center (Guestroom)		35,400 gsf	35,400 gsf
Conference Center (Apartment)		53,000 gsf	53,000 gsf
<b>Total</b>	<b>1,348,679 gsf</b>	<b>3,051,500 gsf</b>	<b>1,702,821 gsf</b>
<b>Total Ex. Campus</b>			<b>4,544,812 gsf</b>
<b>Total Campus 2020</b>			<b>6,247,633 gsf</b>

Table 2  
Campus Changes By Year 2020

Based on these projected changes to the campus the following projected loads were determined:

	Total Campus	Area North of the Valley
Heating Demand	47,000,000 btuh	27,700,000 btuh
Electrical Demand	10,297 kW Peak	4,478 kW Peak
	4,119 kW Average	1,791 kW Average

Campus Demands at Year 2020

**Central plant - meeting future demand (2020)**

The existing central plant will remain in service and a satellite plant will be developed at the north end of campus to accommodate the growth in demand. Generally, the northern plant will house equipment to meet the demands of the area of campus north of the valley, and the existing central plant will be utilized to meet increased demands to the south. The two plants will tie to the same electrical distribution system making it possible to share loads, if needed, and provide additional redundancy to the system.

Satellite Plant Location Map



- **Power Generation**

*Existing central plant*

The existing Generator #1 is 9 years old and has remaining service life of 21 years. The existing Generator #2 is 18 years old and has remaining service life of 12 years. Replacement of Generator #2 should be planned within the time period for the master plan.

Based on the new average electrical demand load, the total generation capacity should be sized in the range of 4,000 to 5,000 kW. The existing central plant can accommodate only two generator units. A unit up to 1,500 kW can be installed within the existing space now occupied by Generator #2. A unit up to 2,500 kW can be installed within the existing space now occupied by Generator #1. The option presented here assumes no physical expansion of the existing central plant footprint. Additional generator capacity will be provided at the north satellite plant and through generator unit replacement in the existing central plant.

Replacement of the central plant substation to accommodate the increases in generation capacity will require outdoor space of 18' x 38' including front, rear, and side clearances.

Current Central Plant Generation (Based on Installed Capacity)	2,125 kW 2,656 kVA @ 80% power factor 123 Amps @ 12.47 kV 3-phase
Current Central Plant Substation Capacity	2,968 kVA 137 Amps @ 12.47 kV 3-phase
Current 12kV Distribution Feeder Capacity	5,616 kVA 260 Amps @ 12.47 kV 3-phase

*Existing Central Plant Electrical Generation and Central Plant Distribution Capacity*

New Central Plant Generation (Replace Gen #2 with 1,500 kW)	2,900 kW 3,625 kVA @ 80% power factor 168 Amps @ 12.47 kV 3-phase
New Central Plant Sub Capacity	4,000 kVA 186 Amps @ 12.47 kV 3-phase
Current 12kV Distribution Feeder Capacity (Current Feeder Capacity is Adequate)	5616 kVA 260 Amps @ 12.47 kV 3-phase

*Proposed Changes under the Master Plan*

#### *North Satellite Plant*

A new satellite plant north of the valley will include one new generating unit of up to 2,500 kW. A gas turbine generator with waste heat boiler is recommended as the projected heat load for buildings north of the valley is closely matched with the heat recovery from a gas turbine. A complete new unit substation will be required for the new satellite plant. A double-ended arrangement is recommended with a total transformer capacity of 5,000 kVA. Complete new generation control and paralleling equipment will be provided for the gas turbine generator. A new distribution system will be provided to serve all mechanical loads within the central plant. The 12kV campus distribution system will be extended to the new satellite power plant.

It is recommended that a new satellite plant also include space for a new electrical main substation. The existing substation is obsolete and deteriorated and in need of replacement. Providing the new substation in or adjacent to the new satellite plant would concentrate major elements of both the electrical and mechanical utility systems for the campus at the satellite plant as well as the existing central plant and would eliminate the existing stand-alone main electrical substation. Electrical service duct banks would be extended to the new satellite power plant location along with the campus distribution feeder duct banks.

The new satellite plant will require space for the gas turbine generator and related control and paralleling equipment, the building substation, and building distribution equipment. Additional space will be required for the relocation of the campus main electrical substation. Space requirements are as follows:



Gas Turbine Generator and Related Controls	25' x 45' (indoors)
Central Plant Electrical Distribution Equipment	20' x 25' (indoors)
Central Plant Unit Substation	18' x 38' (indoors or outdoors)
Campus Main Electrical Substation	25' x 35' (indoors or outdoors)

- **Heating**

The total projected heating demand of the campus is approximately 47,000,000 btuh and the existing capacity of the central plant is approximately 36,000,000 btuh. Much of the expected load will be on the northern side of the campus with the redevelopment of some of the UPN apartments and development of the conference center. The existing central plant has a theoretical capacity of 36,000,000 btuh; the actual capacity is 16,000,000 btuh, allowing for redundancy in the equipment.

*Existing Central Plant*

The existing central plant will require utilizing one of the existing boilers rated at 16,000,000 btuh, and the addition of one 10,000,000 btuh output boiler to achieve a total capacity of 26,000,000 btuh. The existing redundant boiler will remain for boiler redundancy. The existing expansion tank requires upsizing and the gas service increased. The existing 12-inch piping mains will be adequate for the increased load. The new boiler can fit within the existing building footprint. When the reciprocating engines are operated to generate electricity, they also generate 4,000,000 btuh of waste heat. The two active boilers will be throttled down to maintain 26,000,000 btuh during co-generation.

New Boiler: Cleaver Brooks Model 4WI 300 Boiler HP

*North Satellite Plant*

The new north satellite plant will require space to house one (1) 10,000,000-btuh output boiler with a second 10,000,000-btuh output redundant boiler, pumps, expansion tank, domestic hot water heat exchanger, and controls. Waste heat recovery from the gas turbine generator will provide approximately 18,000,000 btuh of heat via a waste heat boiler. New site heating and domestic hot water piping distribution and in-coming gas and domestic water services are required. The north campus satellite plant capacity will be 28,000,000 btuh, for a combined capacity with the central plant of 54,000,000 btuh

Boilers: Cleaver Brooks Model 4WI 300 Boiler HP.

Gas Turbine: Solar Turbines Model Centaur 40

The space for the new North Central Plant (Heating) is approximately 45' x 60'.

The Campus-Wide Integrated Strategic Energy Resource Plan will re-examine the above recommendations and modify as needed to achieve the sustainable goals of that study.

*Further studies*

Further studies are recommended to address the following:

- Campus-Wide Integrated Strategic Energy Resource Plan
- Electric Substation Capacity/Expansion
- Electric Feeder Capacity/Expansion
- Distribution Piping
- Boiler and Gen Set Emission Impacts
- Cost/Benefit Analysis for Power Generation vs. Power Purchase

