EASTERN WASHINGTON UNIVERSITY

Campus Infrastructure Renewal

CHILLED WATER SYSTEM EVALUATION

August 1, 2014

CAMPUS INFRASTRUCTURE RENEWAL
Project AE1368
<u>CHILLED WATER SYSTEM EVALUATION</u>

FOR

EASTERN WASHINGTON UNIVERSITY

Cheney, Washington

By

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July 2014
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Under Contract to NAC|Engineering

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INTRODUCTION

The following report summarizes the evaluation of the Eastern Washington University, EWU, Central Campus Chiller Plant and Campus Chilled Water Distribution piping system with regard to current configuration, condition, capacity, and opportunities for expansion to serve future facilities as envisioned under the 2013 Comprehensive Campus Master Plan.

The goal of this steam system evaluation is to identify deficiencies with the present campus wide infrastructure that should be corrected or upgraded, in order to support the ongoing and long term growth of the campus. This report contains recommendations (potential projects) for correcting the noted infrastructure deficiencies, along with corresponding rough order of magnitude cost estimates for these upgrades, in order to assist EWU in putting together their capital funding requests for the upcoming biennium.

- Replacement schedule based on system age.
- Modification/expansion required to accommodate master plan.
- Modification/renovation required to provide operational efficiencies.

EXISTING CAMPUS CHILLED WATER SYSTEM

Rozell Central Campus Chiller Plant

The Central Campus Chiller Plant is located in the Rozell facility at the north end of campus. The chiller plant furnishes chilled water at approximately 45 deg. F, to the majority of the campus building through a network of underground tunnels and shallow utilidors, to provide for the space cooling and air conditioning needs of the campus facilities.

There are five (5) water-cooled centrifugal chillers located in the lower level of the Rozell Central Plant. These chillers were installed in 1996 as part of a major plant upgrade. All chillers utilize environmentally friendly R-134a refrigerant.

Chillers

The Rozell Central Campus Chiller Plant consists of the following five, centrifugal type, single speed, water-cooled chillers:

Chiller # 1	Carrier Model 19 XL 50534 93CP Water-Cooled, Centrifugal, R-134a 500 Tons Built 1996
Chiller # 2	Carrier Model 19 XL 50534 93CP Water-Cooled, Centrifugal, R-134a 500 Tons Built 1996
Chiller # 3	Carrier Model 19 EX 3133-736DK621 S Water-Cooled, Centrifugal, R-134a 1,000 Tons Built 1996
Chiller # 4	Carrier Model 19 EX 3133-736DK621 S Water-Cooled, Centrifugal, R-134a 1,000 Tons Built 1996
Chiller # 5	Carrier Model 19 EX 3133-736DK621 S Water-Cooled, Centrifugal, R-134a 1,000 Tons Built 1996

Total Plant Capacity: <u>4,000 Tons</u>

Cooling Towers

Each chiller is coupled to a dedicated matching cooling tower. The plant cooling towers are located on the roof of the Rozell Central Plant. The two smallest towers are original, pre-1996 upgrade vintage, while the two of the other three larger towers are from the 1996 expansion, and one of the other larger towers was installed in about 2009.

The cooling towers for the central plant consist of two (2) original vintage, 500 ton capacity towers and three (3) newer, 1,000 ton capacity towers. All the cooling towers are open type design with induced draft, draw-through propeller fans. Fan motors are all 2-speed type for some capacity control.

Free Cooling Heat Exchangers

The chiller plant is equipped with two (2) plate & frame type heat exchangers that provide partial cooling capacity to the chilled water distribution piping system during shoulder seasons, before the chillers are energized. These heat exchangers are located in the lower level of the Rozell plant, near the pump gallery. Each free cooling heat exchanger is coupled to a cooling tower, in order to provide for indirect heat rejection from the campus chilled water loop, during mild weather, without having to operate the plant's compressorized chillers.

One heat exchanger has a nominal capacity of about 300 tons and was installed in about 1998. The other heat exchanger has a nominal capacity of about 200 tons and was installed in 2003. Each heat exchanger is designed with a 1 deg. F approach. Total free cooling capacity is 500 tons.

Chiller Plant Pumps

Pumps for the chillers and the cooling towers are located in the lower level of the Rozell Central Plant. Condenser water (tower loop) and primary chilled water (evaporator loop) piping for each chiller-tower pair is provided by dedicated single speed pumps. The condenser water pump motors are furnished with soft starters.

The chilled water distribution system is configured at the central plant level as a Primary-Secondary pumping system. The primary chilled water pumps produce flow through the individual chiller evaporator barrels. The secondary chilled water pumps produce flow to the campus chilled water piping network that serves individual buildings. There are three (3) secondary chilled water pumps that supply the campus loop. Two of these pumps have 2-speed motors and the third pump has a VFD drive for capacity control.

The various campus buildings generally utilize tertiary chilled water pumps to supply the cooling coils and other cooling loads at the building level. In some cases the buildings are decoupled from the campus loop with a plate & frame heat exchanger.

Chiller Plant Auxiliaries

Water Treatment Equipment: The chemical water treatment equipment for the open cooling towers plant is located in the lower level of the Rozell plant. Dosing pumps and monitoring devices provide chemical feed of corrosion inhibitors, biodides and PH maintenance. Make-up water is pre-treated through an ion exchange water softener plant. The campus chilled water distribution loop utilizes plain water, rather than a glycol-water anti-freeze solution, which therefore requires that the building system HVAC air coils be drained in the winter. The chilled water distribution system is also chemically treated with corrosion inhibitors and PH controllers.

Chiller Plant Operation

The several chillers, and their corresponding cooling towers and pumps, are manually staged on and off by the plant operators depending on weather conditions and campus cooling load. The chillers are rotated in service based on run times.

Chilled water is generally produced and delivered to the campus at about 45 deg. F. Chilled water return water temperatures vary with load and flow rates, but at times are as warm as about 64 deg. F (a 19 deg. delta T for the campus).

The cooling season generally runs from May through mid October. During the shoulder seasons, when cooling loads are light and the weather is mild, the free cooling heat exchangers are utilized to provide campus loop cooling, before the chillers are energized. Mechanical cooling (chillers) is generally needed whenever the outdoor air temperatures climb above 60 deg. F or so.

Chilled water is delivered to the campus using any number of the three (3) secondary chilled water pumps, depending upon load demands. The largest pumps is rated at about 2800 gpm and is run with a VFD drive at a variable speed/flow to maintain a differential pressure between the campus supply main and the campus return main of about 15 psig (34 ft hd). The other two secondary chilled water pumps are each 2-speed pumps, rated at a nominal 1100/700 gpm. These pumps are staged on as the campus demand increases and are run in conjunction with the VFD drive pump to maintain the differential pressure in the campus loop.

During the winter months, the campus chilled water distribution system is still circulated, but at a greatly reduced flow rate, in order to help keep the distribution piping and valves free from corrosion using the inherent chemistry protection provided by the treated chilled water flow. There are several valved bypasses located at the ends of the tunnel distribution system, that are opened in the winter to help maintain total network circuit flow paths.

Campus Chilled Water Tunnel Distribution System

General:

The chilled water is delivered to the campus through a piping network that is located mostly within an accessible (walkable) underground concrete utility tunnel, that provides a loop around the campus to serve all the major academic & some hall buildings.
Chilled water supply and return piping systems distribute out from the Rozell central plant, through the tunnel network and into the building mechanical spaces. In certain limited cases, the connections from the main tunnel to the buildings, is through shallow, non-accessible, concrete utility trenches, referred to as utilidors. These utilidors generally follow surface sidewalks, and pipes can be accessed by removing the lids of the utilidors if necessary. There are a few instances of direct-buried piping connections from the tunnel to a few of the older buildings.

Chilled water supply to each building is generally routed to the various HVAC system air handling unit and other cooling system coils that are distributed throughout the building. Most air handling unit coils are provided with dedicate tertiary pumps, that provide a boost to the chilled water flow from the plant and help to maintain good heat transfer through the coils. Control valves at each coil regulate the amount of cold, 45 deg. F, chilled water from the central plant, that is consumed by the coil. Warmer return chilled water then exits the building where it returns to the plant via the same utility tunnel network. Depending upon the weather conditions and the type of HVAC system control strategy employed, the coil tertiary pumps are not energized until hot weather, and instead the cooling coils derived their flow from the central plant pumps.

Pipe Materials & Installation:

It is understood that the chilled water supply and return distribution piping system lines, are constructed of Sched. 40 steel piping. Piping smaller than 2" size is generally threaded, while all piping larger than 2" is welded. Valves are installed with flanges while expansion joints are welded in the pipeline.

The chilled water piping is generally mounted on support stands off the tunnel floor, with supply and return lines run on opposite sides. In some cases the piping is installed on steel framing, in common with the steam piping, with roller supports, spider alignment guides and inline expansion joints where necessary. Anchors are generally tied directly in to the concrete walls. All the chilled water piping is insulated, mostly with fiberglass insulation, with jacketing that varies from coated paper ASJ type, to PVC to corrugated metal, depending upon location, age and service locations.

Configuration:

The chilled water distribution piping is configured in a looped manner around the majority of the campus buildings. The west-side loop (known as the HPE loop), exits from Rozell and travels south, parallel to Washington Street, along the edge of the Woodward Field parking lot. The east-side loop (known as the Rozell loop), exits from Rozell, travels east along Cedar Street, turns south to the PUB, bends to the SE to Tawanka, turns to the SW and continues through the central plaza to the Art Complex. Just north of the Communications Building, the east and west loops join together.

There are several notable sub-branches that come off of the looped main:

- HPE Complex Branch
- CEB & Cheney Hall Branch
- WSP & Archives Branch
- Huston & Sutton Branch
- Senior & Kingston Hall Branch

The looped configuration of the chilled water main piping allows the chilled water system to be back-fed from either direction, in the case of maintenance or repair work on any section of the piping. Most pipe branch take-offs have isolation valves on both sides of the branch piping, which allows feed or isolation to occur on either side of the take-off. This provides great flexibility and allows most of the campus to be supplied with chilled water during service shut-downs on limited sections. Without a looped system, everything downstream from the shut-off point would otherwise be without service.

Access:

Access to the utility tunnel is provided in a number of locations. The main entrance, and the beginning of the tunnel, starts in the lower level of the Rozell Plant. Most other major buildings that are connected to the full size tunnel have basement or lower level mechanical rooms with doors that access the tunnel. At a few points along the tunnel route, there are stairway, with doors and surface structures for access or exiting. The original tunnel system also had some manholes with ladders, and a few ventilation turrets with access lids. Most of the manhole lids are sealed or rusted closed.

Age:

The utility tunnel, as well as most of the chilled water (and steam) distribution piping, was constructed in the early 1970s, along with the construction of the new Rozell Central Plant. This plant, and the utility tunnels, replaced the original steam plant (now the PLU bulding) and older direct buried steam distribution system. The tunnel has been expanded over the years to connect new buildings or sections of the campus as growth occurred. Most of the piping in the tunnel is therefore over 40 years old.

Condition:

Despite being over 40 years old, most of the steam supply and condensate return piping systems are in very good condition and have been well maintained. An end-to-end survey of the utility tunnel was conducted and all main branches, tees and major features were photographed for documentation as part of this report.

Most of the main and branch chilled water shut-off valves are butterfly valves with worm gear operators, which give excellent performance and help to extend the life expectancy of the system. Chilled water leaks at valves and fittings are virtually non-existent within the tunnel.

Insulation jacketing on the piping and valves was mostly intact and in good condition. Damage due to maintenance or water intrusion appeared minimal.

Capacity:

As part of this analysis, at chilled water system flow model was created for the entire campus chilled water distribution system (see analysis below). This model used information about the existing connected chilled water (air handling unit cooling coil loads in each building) and existing chilled water pipe sizing information, to develop a dynamic tool to help understand chilled water flow paths through the looped system, and to determine pressure losses from the Rozell Plant to the remote ends of the distribution system.

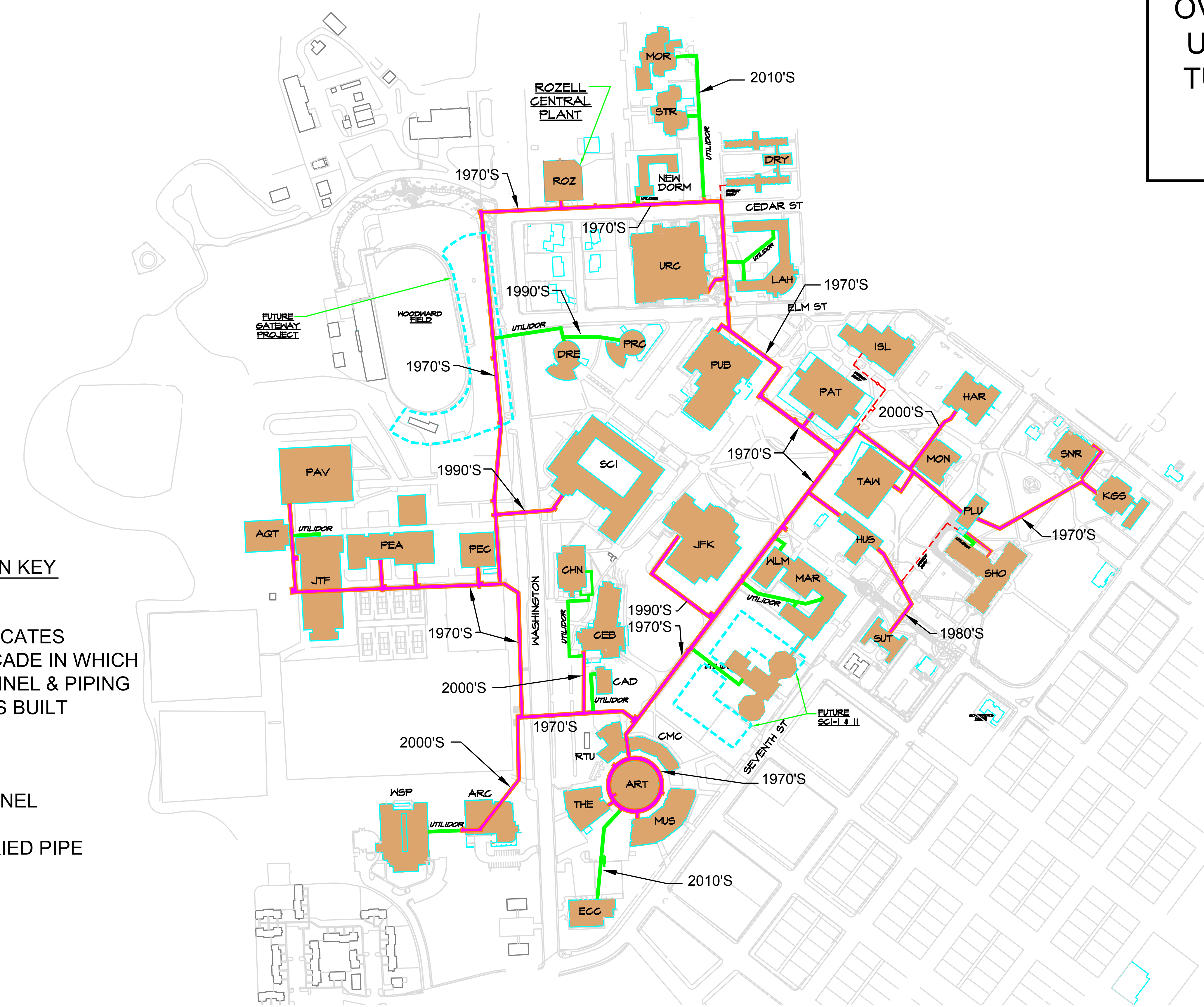
The main chilled water supply and return line exit from Rozell as 16” pipes. At the main junction just south of the plant the west (HPE) loop reduces to 12” size continues all the way down t the junction at the Art complex, where it reduces to a 10” pipe up to the east branch tee near Patterson Hall. The east (Rozell) loop stays at a 16” pipe and continues to a point just past the PUB branch, where it reduces to 12” pipe up to tee junction past Patterson. At this point the 10” pipe runs south to JFK Library and to the north and east to the PLU building.

See the discussions and analysis in the flow modeling section for recommendations relative to pipe size and capacity.

Life Expectancy:

Based on the observations of the tunnel-wide survey conducted for this report, it appears that the chilled water supply and return piping is in good condition, and without evidence of failures or major leaks. Reports from the EWU maintenance staff indicate that when the piping has been opened for new branch tie-ins or valve work, that the interior of the piping does not show undue corrosion or pitting. Although the majority of the main loop piping is over 40 years, it is reasonable to expect another 15 to 25 years of service life, assuming the same level of care and maintenance in to the future.

OVERALL UTILITY TUNNEL PLAN



TUNNEL CONSTRUCTION KEY

1970'S INDICATES DECADE IN WHICH TUNNEL & PIPING WAS BUILT

TUNNEL LEGEND

UTILITY TUNNEL
UTILIDOR
DIRECT BURIED PIPE

EWU - OVERALL UTILITY TUNNEL PLAN

N

Scale: 1" = 400'

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M-1

EXISTING CENTRAL CHILLER PLANT CAPCITY

CHILLER #1	-	500 TONS
CHILLER #2	-	500 TONS
CHILLER #3	-	1000 TONS
CHILLER #4	-	1000 TONS
CHILLER #5	-	1000 TONS
TOTAL	-	4000 TONS

CHILLED WATER PIPE SIZE KEY

12 ← CHILLED WATER SUPPLY & RETURN PIPE SIZE (INCHES)

NO CHILLED WATER SERVICE TO THIS BRANCH

TUNNEL LEGEND

UTILITY TUNNEL

UTILIDOR

DIRECT BURIED PIPE

N

EWU - CHILLED WATER DISTRIBUTION PLAN

Scale: 1" = 400'

CHILLED WATER DISTRIBUTION PLAN

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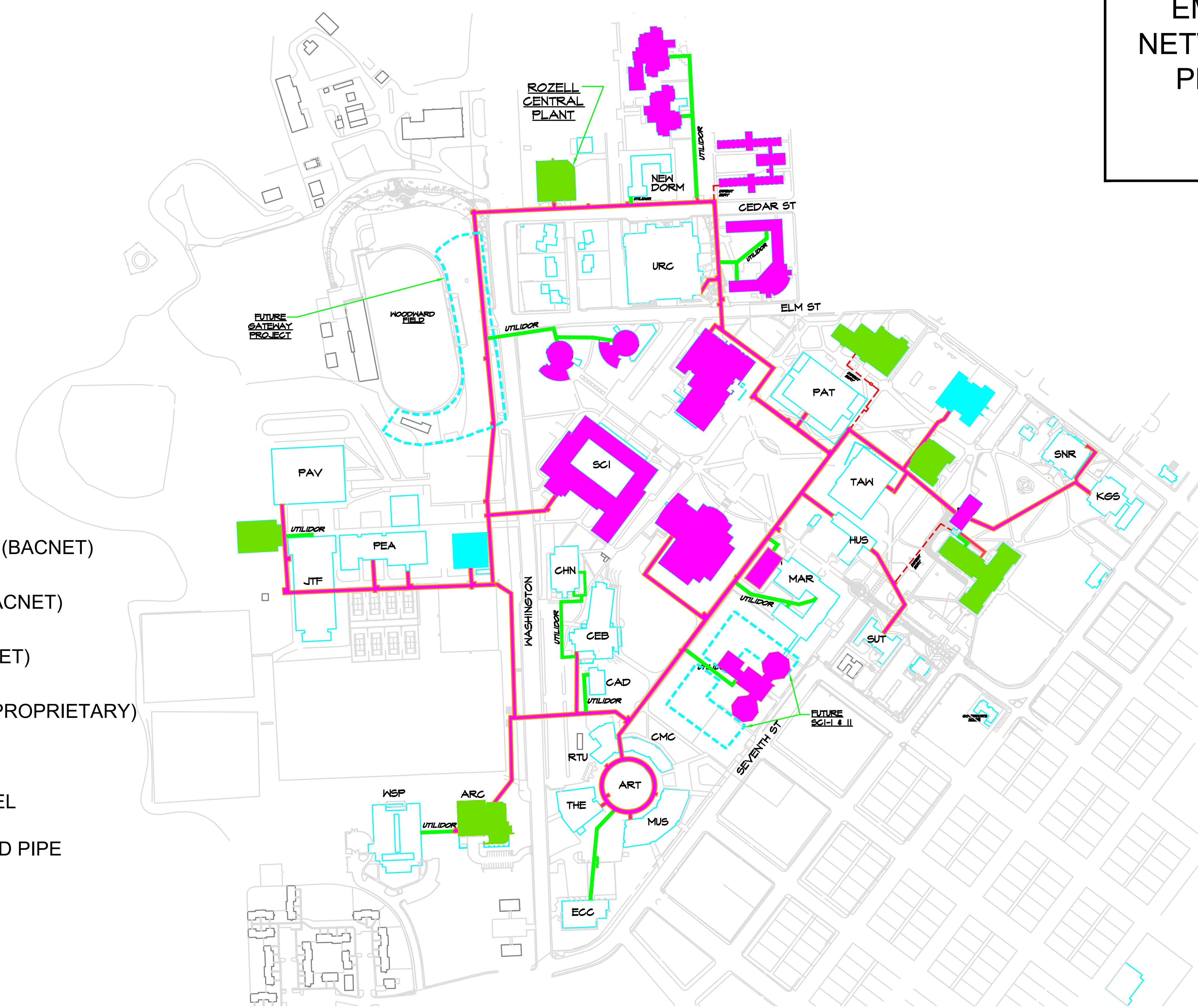
M-4

EMCS NETWORK PLAN



EMCS KEY

= ALERTON (BACNET)

= DELTA (BACNET)

= JCI (BACNET)

= STAEFA (PROPRIETARY)

TUNNEL LEGEND

UTILITY TUNNEL

UTILIDOR

DIRECT BURIED PIPE

EWU - EMCS NETWORK PLAN

N

Scale: 1" = 400'

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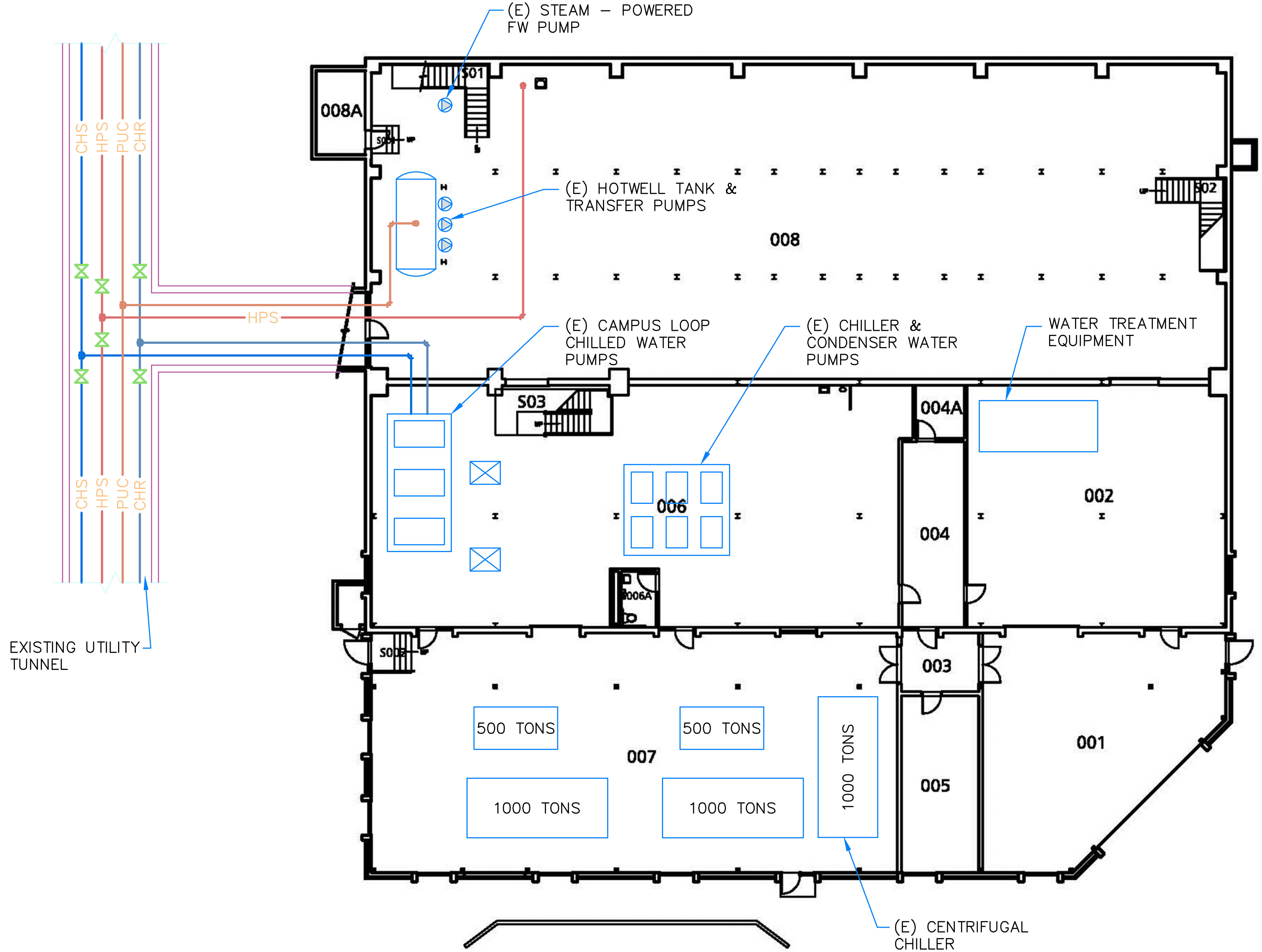
M-5



N

EWU - ROZELL CENTRAL PLANT - LOWER LEVEL

Scale: NTS

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ROZ-1

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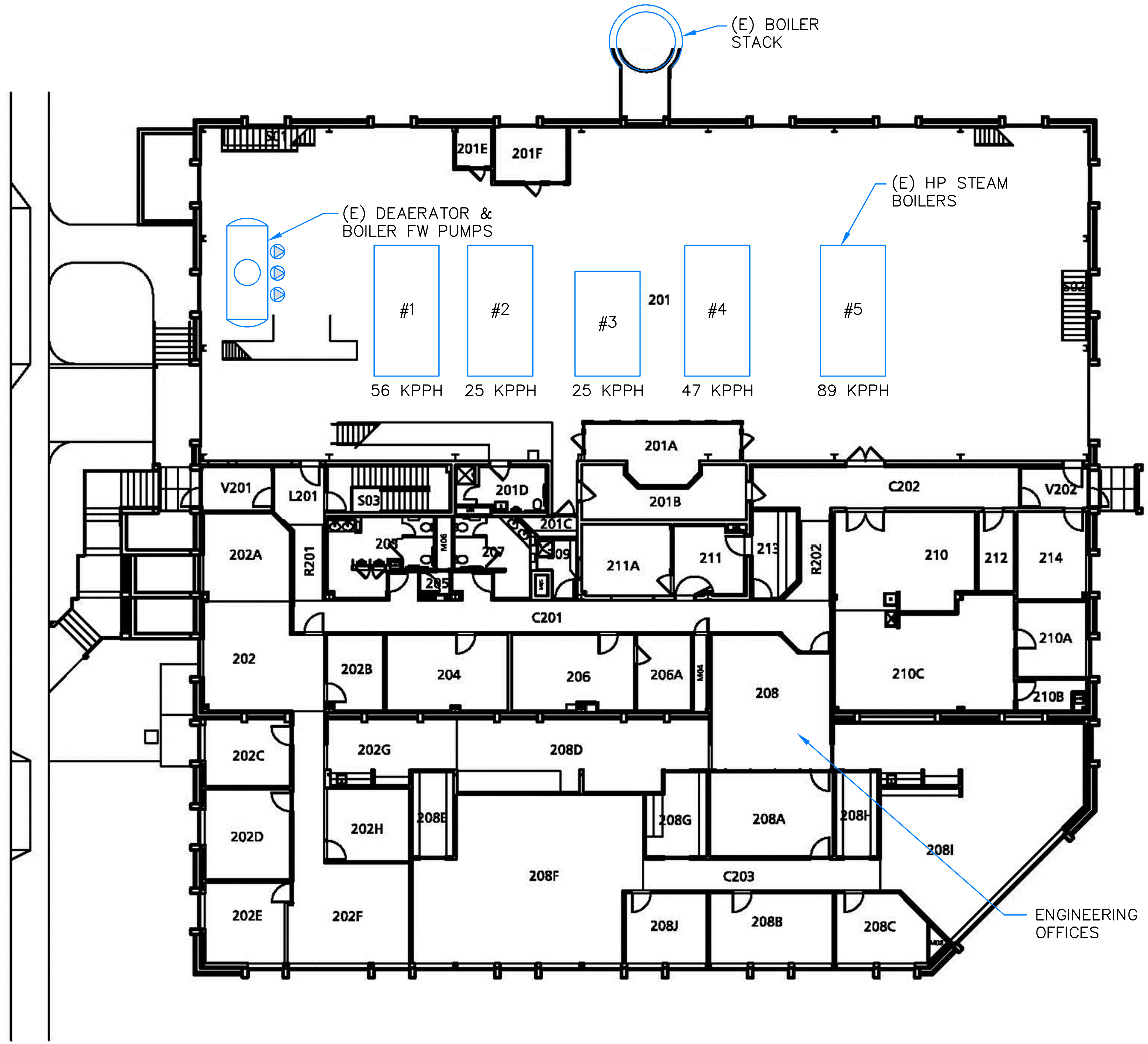

EWU - ROZELL CENTRAL PLANT - MAIN FLOOR

Scale: NTS

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ROZ-2

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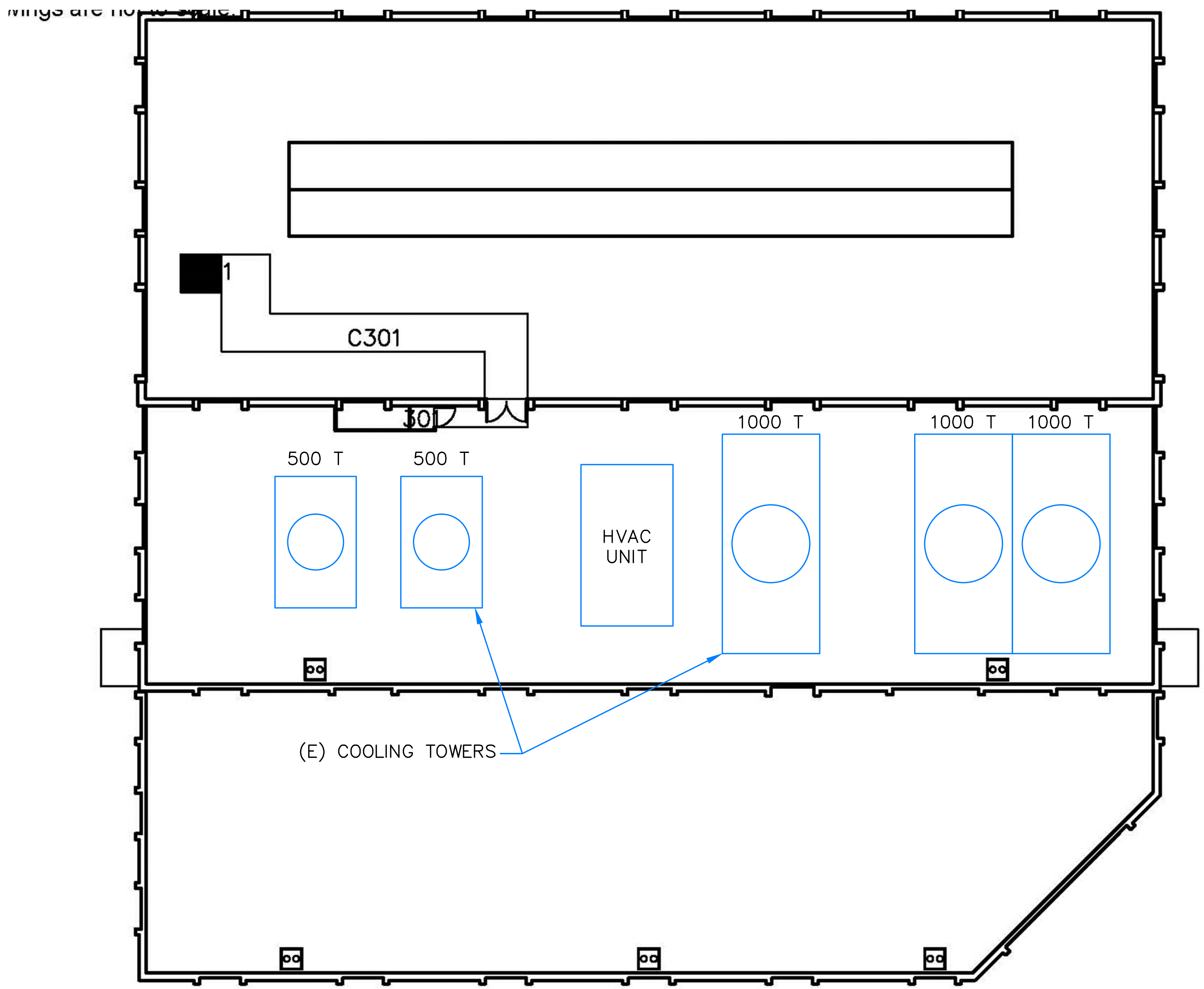

N

EWU - ROZELL CENTRAL PLANT - ROOF

Scale: NTS

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ROZ-3

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Rozell Central Plant - Chillers

Rozell Central Plant - Cooling Towers

Campus Loop Secondary Chilled Water Pumps


Chiller Plant Pump Gallery

Free Cooling Plate & Frame Heat Exchanger

CAMPUS CHILLED WATER SYSTEM FLOW MODELING & CALCULATIONS

Purpose & Goals

The existing EWU campus steam distribution system was modeled using commercial flow modeling software, in order to help evaluate and understand existing flow pathways though the campus loop, chilled water main pipe velocities and drop-off delivery pressures to individual buildings. Several models were created to look at various flow demands in order to help determine if the existing chilled water distribution system has the capacity to handle future campus growth.

Methodology

Using the computerized flow modeling software tools, and schematic plan representing the campus steam piping network was created. This plan was then populated with information regarding existing pipe sizes, pipe lengths, valves and fittings, in order to give an accurate representation of the system geometry.

Next, the various campus buildings were connected to the model as individual building chilled water flow demand points, representing the sum total chilled water gpm flow demand for each building. Each building was simplified in to a single chilled water flow demand point, in order to avoid creating an overly complex and confusing network, which would otherwise be the case if all the down steam piping, pumps and individual coils were added to the model for each building. Each building flow demand point was given a nominal pressure drop of 5.0 psig at design flow rates, in order to represent the pressure drop of valves, fittings and other building entrance conditions. Automatic control valves were added in to the model for each building to provide for flow limiting and to allow for diversity to be adjusted.

Chilled Water Load Data Source

Available construction drawings for each building were pulled from the EWU drawing library and chilled water coil capacity and flow data was extracted from these plans. Cooling coil data provided in the 2009 Dumais-Romans *EWU Campus Chilled Water System Study* was also used in this report. Allowances for future building chilled water loads were provided by EWU based on pre-design information, or, in the case of the future cooling for the modernized residence halls, based on an estimate of 500 sq. ft. per ton.

Diversity

Utilizing only the sum of the total connected design peak chilled water demand for all facilities simultaneously, does not take into account the actual dynamics of building occupancy and weather variations, and results in an unrealistically high demand on the Central Campus Chiller Plant. For example, occupancy levels often don't reach 100% and can therefore reduce the demand for air conditioning. On a larger scale, peak demand in a given building is often balanced by a reduction in demand in other facilities as students migrate from the dorms to the classrooms, offices and gyms. This 'diversity' results in an overall demand reduction on the expected central chiller plant.

According to the EWU operations staff, the historical peak campus cooling load is somewhere between 3,500 tons (per Dumais & Romans in their 2009 *Campus Chilled Water System Study*) and 2,500 tons (per McKinstry in their *2012 Energy Efficiency & Sustainability Report).* In our interview with the EWU staff, they reported a historical peak cooling load of about 3,000 tons, which is the value that is used in our analysis.

Based on a total campus connected chilled water load of approximately 5,748 tons, the 3,000 tons represents a diversified load of 52% (of total campus load). Based on a chiller plant total capacity of 4,000 tons, this represents a 75% load of plant capacity.

For chilled water system flow modeling purposes, the diversified peak historic chilled water load was modeled at 50% of peak connected capacity.

COMPUTERIZED CHILLED WATER SYSTEM FLOW MODEL

Modeling Software

Pipe-Flow Professional, Version 12 (2014) by Engineered Software, Inc., was used to construct a computerized steady-state flow model of the steam distribution system. This software utilizes the Darcy-Weisbach formula with Bernoulli's theorem along with an extensive fluid and hardware properties database to solve complex networks including the effects of temperature, pressure, density, enthalpy, and steam quality. Its algorithms and equation solving techniques permit the program to automatically correct logical errors entered by the user (over-constrained system, reverse flow directions, inverted pressures, mismatched pipe sized, etc). Once the user defines the piping network within the software using actual pipe lengths, sizes, fittings, valves, and controls, the program solves the mass and energy balances and returns the solution along with all corresponding fluid properties.

Modeling Approach

Three (3) basic chilled water flow models (cases) were developed for the campus distribution analysis.

<u>Case-1: Maximum Design - 100% Connected Loads</u>

Basically this was an academic exercise to set-up the model for actual diversified loads, and it treated all connected buildings as having 100% chilled water flow load demand concurrently, with no system diversity. This model was used to validate that the sum of the connected building loads matched the expected values. The results of the flow are not really applicable to the actual chilled water system operation, which is highly diversified, but it is interesting to note the high resultant pipeline velocities near Rozell, where total flow is maximum, and the resultant high pumping flow rates and head pressures that would be theoretically necessary to satisfy this full flow system.

<u>Case-2: Historic Peak - 50% Connected Loads</u>

This model is basically the baseline expected peak chilled water flow demand for the actual existing campus system, based on the historic peak diversified demand of 50% of connected load (see above for diversity discussion).

<u>Case-3: Future Peak - 50% Connected Loads</u>

This model adds in the future chilled water loads, for the planned Gateway Athletic complex, the new Science I & II facility, as well as future cooling to the Residence halls, to the historic peak loads of Case-2. The same diversified load factor of 50% was used for this model.

CHILLED WATER SYSTEM FLOW MODEL RESULTS

See the graphic steam piping network drawings that are included with this report.

<u>Case-1: Maximum Design - 100% Connected Loads</u>

Not applicable. This was the model set-up. See discussion above.

<u>Case-2: Historic Peak - 50% Connected Loads</u>

Pipe Velocities:
Results of the chilled water system flow model for this case show that historic peak, diversified chilled flows and corresponding velocities in the existing piping network, do not exceed accepted values for good engineering practice. Velocities up to 10 fps maximum are generally accepted for good engineering practice for general water service piping (ASHRAE Fundamentals). Peak system velocities occur near Rozell where the combined chilled water flows are the greatest, with the west side main 12" at around 8.5 fps and east side main 16" branch at around 6.3 fps. The combined 16" plant main in to Rozell runs around 11.4 fps, which, although over the normal 10 fps maximum, is not really a concern for such a large diameter pipe, which can tolerate elevated velocities due to robust pipe wall thickness. This analysis indicates, and confirms, adequate pipe sizes for the actual existing historic peak loads for the campus.

System Pressure Drops:
Results of the chilled water flow model for this case indicate an overall total loop pressure drop to satisfy all remote flow demands, to be in the range of about 57 ft hd (25 psig) at the campus chilled water secondary pumps. Although this value is based on a simplified network analysis, with many variables that may not be fully understood, it does suggest that the existing campus secondary chilled water pumps may be somewhat under sized.

<u>Case-3: Future Peak - 50% Connected Loads</u>

Pipe Velocities:
With the addition of more chilled water load to the model to account for future buildings, the results of the flow model for this case show that anticipated future peak, diversified chilled water flows and corresponding velocities in the existing piping network, exceed the limits of good engineering practice in portions of the piping network. The existing west side 12" main line will experience considerably greater flow when the Gateway Athletic complex and future air conditioned Residence Halls come on line. Estimated peak flows of around 4,500 gpm in this section of piping will generate velocities around 12.8 fps. Not only is this higher velocity of concern for pipeline erosion issues, but the added flow resistance will create extra head pressure demands on the campus supply pumps. As such this section of 12" piping is a good candidate to be replaced to allow for future growth to this side of the campus loop.

At the same time the flow model shows that the larger 16" east side chilled water main will see flow rates that keep the peak velocities around 8.4 fps, well below the 10 fps maximum. However, the combined flows on the 16" main in to the Rozell plant show peak velocities over 16 fps, well above the usual 10 fps maximum. This analysis suggests that this section of piping should also be considered for replacement with larger piping to allow for future campus growth.

System Pressure Drops:
Results of the chilled water flow model for this future flow case indicate an overall total loop pressure drop to satisfy all remote diversified flow demands, to be in the range of about 175 ft hd (75 psig) at the campus chilled water secondary pumps, at a system flow rate of about 6,400 gpm. Because the existing campus secondary pumps only have a total flow capacity of about 5,000 gpm at 35 ft. hd., this indicates that these pumps will need to be replaced with larger capacity pumps to handle future campus chilled water demands.

Case-3A: Future Peak - 50% Connected Loads - Upsize 12” West Piping to 16”

Due to the results of Case-3 above that indicate that some of the existing chilled water piping will be too small to efficiently handle anticipated future chilled water flows, this model was run as a “what if” case with a larger pipe used on the west side loop, from Rozell to the HPE branch. This larger pipe accommodates the added expected future flow demands of the Gateway Complex and the air conditioned dorms.

Results of this case show pipe velocities in this section dropping below 7 fps and helping to reduce total system pump head pressure down to 85 ft. hd (37 psig).

CHILLED WATER SYSTEM FLOW MODEL CONCLUSIONS

Chilled Water Distribution Piping Capacity for Future Growth

In general, the existing chilled water system distribution piping is adequately sized to handle both the current chilled water flow demands plus anticipated future system growth. However, a portion of the existing west side main 12” piping, that runs from Rozell down Washington Street to the HPE complex, will be somewhat undersized for future growth allowance, and it is recommended that this section of piping be replaced with 16” size pipe.

Also, some of the existing 16” chilled water piping inside the Rozell Chiller Plant could experience excessive flow velocities due to future flow demands, and it is recommended that this piping be replaced or modified as the chiller plant grows to meet future loads (see below).

Chiller Plant Capacity for Future Growth

Due to the anticipated future growth of the campus as envisioned in the current Master Plan, the present 4,000 ton chiller plant will not have sufficient capacity to meet all the future cooling loads.

Based on the anticipated Master Plan campus growth for the New Science I & II projects, the new Gateway Athletic Project and the modernization of the legacy residence halls to include air conditioning, the expected addition of campus chilled water load is approximately 40%. Based on a peak historic capacity of 3,000 tons, a 40% increase would put the future campus load at over 4,200 tons, which is greater than the present total plant capacity of only 4,000 tons.

In order to meet the future cooling needs of the campus growth plan, it will be necessary to add cooling capacity, with sufficient redundancy to allow operational flexibility and to allow for break-downs. At minimum a 1000 ton chiller plant expansion should be planned for, although a larger, 2000 ton expansion would provide a higher degree of redundancy, future growth allowance and flexibility.

CAMPUS CHILLED WATER SYSTEM UPGRADE RECOMMENDATIONS

Overall the existing Central Campus Chiller Plant is in good condition, and has been very well maintained, similar to the steam plant equipment. The chiller plant underwent a major expansion in the mid 1990's and as a result the equipment is generally newer than much of the older steam plant equipment. An analysis of the chiller plant capacity and past load history indicates that, unlike the steam plant, the existing chiller plant will not have sufficient spare capacity to handle the anticipated new cooling loads for the 10 year Master Plan growth. As such, several projects have been identified below to provide added chiller plant cooling capacity, reliability and to increase system efficiencies.

Proposed Campus Chilled Water System Infrastructure Upgrade Projects:

Chilled Water System Recommended Project Summary List

Project No.	Title	Description	ROM Budget Price
CP	Chiller Plant		
CP-1	Add Chiller Plant Capacity, 2000 tons	New 2000 ton water-cooled centrifugal chiller with VFD drive. New induced draft, open cooling tower with VFD drive. New chiller and condenser water pumps with VFD drives. Controls. Rozell Plant expansion, electrical and ventilation.	$3,600,000
CP-2	Upgrade Campus Chilled Water Pumps	Replace three (3) existing secondary chilled water pumps (campus supply) with new VFD driven pumps, with flow and head capacity to handle future loads.	$300,000
CP-3	Install VFDs on Chiller Compressors & on Cooling Towers	Retrofit existing 1000 ton chillers and cooling towers with VFD drives and upgrade controls to improve plant efficiency.	$1,000,000
CP-4	Install 2 New Energy Efficient Cooling Towers	Replace (2) aging 500 ton cooling towers with new induced draft, open type towers with VFD drives, to improve plant efficiency.	$500,000
CD	Chilled Water Distribution		
CD-1	Replace/Upsize a Portion of the 12" West-Side Chilled Water Piping	Replace a portion of the existing 12" west side campus distribution piping with 16" pipe in order to handle future chilled water flow demand.	$1,000,000

Central Camps Chiller Plant (CP)

Overall the existing Central Campus Chiller Plant is in good condition, and has been very well maintained, similar to the steam plant equipment. The chiller plant underwent a major expansion in the mid 1990's and as a result the equipment is generally newer than much of the older steam plant equipment. An analysis of the steam plant capacity and past load history indicates that, unlike the steam plant, the existing chiller plant will not have sufficient spare capacity to handle the anticipated new cooling loads for the 10 year master plan growth. As such, several projects have been identified below to provide added chiller plant cooling capacity, reliability and to increase system efficiencies.

CP-1: Add Chiller Plant Capacity, 2000 tons

Description:

Install additional chiller plant capacity, 2000 tons.

(This recommendation is a concurrence of the chiller plant capacity upgrades "2.02-ROZ" as previously suggested by McKinstry in their *2012 Energy Efficiency & Sustainability Report*, as well as by the recommendations made in 2009 by Dumais & Romans in their *Campus Chilled Water System Study*)

The following elements would be installed or upgraded:

- New 2000 ton water-cooled centrifugal chiller with VFD drive.
- New 2000 ton induced-draft open cooling tower with VFD drive (2-1000 ton towers).
- New chiller (evaporator) pump.
- New condenser water (tower) pump.
- Upgrade/Replace Campus Loop chilled water pumps with new capacity pumps with VFDs.
- Controls.
- Rozell plant expansion, electrical work and ventilation.

Analysis/Justification:

The existing Central Campus Chiller Plant has a total capacity of 4,000 tons (3-1000 ton chillers & 2-500 ton chillers), which matching capacity cooling towers and pumps.

According to the EWU operations staff, the historical peak campus cooling load is somewhere between 3,500 tons (per Dumais & Romans in their 2009 *Campus Chilled Water System Study*) and 2,500 tons (per McKinstry in their *2012 Energy Efficiency & Sustainability Report).* In our interview with the EWU staff, they reported a historical peak cooling load of about 3,000 tons, which is the value that is used in our analysis.

Based on the anticipated master plan campus growth for the New Science I & II projects, the new Gateway Athletic Project and the

modernization of the legacy residence halls to include air conditioning, the expected addition of campus chilled water load is approximately 40%.
Based on a peak historic capacity of 3,000 tons, a 40% increase would put the future campus load at over 4,200 tons, which is greater than the present total plant capacity of only 4,000 tons.

In order to meet the future cooling needs of the campus growth plan, it will be necessary to add cooling capacity, with sufficient redundancy to allow operational flexibility and to allow for break-downs. At minimum a 1000 ton chiller plant expansion should be planned for, although a larger, 2000 ton expansion would provide a higher degree of redundancy, future growth allowance and flexibility.

Sequence / Category:
Capital Master Plan Project.

Cost:
CP-1: $3,600,000

CP-2: Upgrade Campus Chilled Water Pumps

Description:

Upgrade campus distribution loop chilled water pumps to increase system capacity and to provide VFD control for each pump.
(This recommendation is similar to the chilled water pump upgrades "2.01-ROZ" as previously suggested by McKinstry in their *2012 Energy Efficiency & Sustainability Report*)

The following elements would be installed or upgraded:

- Upgrade/Replace Campus Loop chilled water pumps CWP-2 & CWP-3 with new capacity pumps with VFDs. Existing CWP-1 is already controlled by a VFD.
- New Delta Controls.

Analysis/Justification:

Depending upon the priority and timing of the above proposed chiller plant expansion, the upgrade of the existing campus distribution pumps may not be necessary, as they are also included in the above scope.

However, until such time as the chiller plant capacity is increased, it would be beneficial to upgrade the existing campus distribution chilled water pumps for two reasons.

First of all, these existing pumps (CWP-2 & 3) are two-speed pumps, without VFD speed/capacity control. Two-speed pumps are not as efficient as pumps that are run with VFDS, and controllability is not as good for varying flow demands.

Secondly, based on the results of the chilled water system flow model that was prepared with this report, there are likely times when the existing campus chilled water distribution piping system is being “under pumped”. In other words, it appears at times there may be a shortage of campus chilled water flow to some of the remote buildings. This is indicated by the results of the flow model that suggests that during times of peak historic campus cooling demand, that drop-off pressures (and therefore flows) to many of the buildings is greater than the capacity of the existing pumping plant (based on available flow and head pressures).

The present operational setpoint of 15 psig (35 ft head) pressure differential between the campus supply main and return main, does not seem to produce sufficiently strong flow conditions to necessarily satisfy all flow demands. This condition of possible under-pumping is also indicated by a reported high Delta T (nearly 20 deg. F) on the campus chilled water loop, compared to a design Delta T for most buildings of around 10 deg. F.

Further analysis of the chilled water distribution system is needed to better understand the dynamics suggested by the flow model and field observations, however, the recommendation to upgrade the existing chilled water distribution pumps (install VFDs and possibly increase capacity with larger pumps) is still valid.

Sequence / Category:
Capital Master Plan Project

Cost:
CP-2: $300,000

CP-3: Install VFDs on the Chiller Compressors and on the (3) 1,000 ton Cooling Towers

(This is recommendation ” 2.00-ROZ:”: per McKinstry in their *2012 Energy Efficiency & Sustainability Report)*

Description:

Upgrade the existing centrifugal chiller compressors to add new VFD drives. Replace the 2-speed fan motors on the (3) largest cooling towers with VFD duty motors and install new VFD drives. Update controls to map drives to building automation system.

Analysis/Justification:

Per McKinstry Analysis: Annual electrical energy savings due to more efficient part load operation of equipment. Better able to match equipment capacity with campus cooling loads.

Sequence / Category:
Improved Operational Efficiencies.

Cost:
CP-3: $1,000,000

CP-4: Install 2 New Energy Efficient Cooling Towers

(This recommendation" 2.40-ROZ:" per McKinstry in their *2012 Energy Efficiency & Sustainability Report)*

Description:

Replace the existing, aging and inefficient 500 ton cooling towers with new, energy efficient, open circuit, induced draft cooling towers, with VFDs on their fan motors.

Analysis/Justification:

Per McKinstry Analysis: The new cooling towers will be sized for supplying 75 deg F water to the chillers during peak load conditions, thereby improving chiller efficiency. Annual electrical energy savings are anticipated.

Priority/Sequence:
Improve Operational Efficiencies.

Cost:
CP-4: $500,000

Campus Chilled Water Distribution System (CD)

Similar to the steam system, the existing Campus Steam Distribution System is in good condition, and has been very well maintained; despite piping that is mostly over 40 years old. Assuming that the existing distribution system piping, valves, and insulation jacketing is maintained as well in the future, the system should have a life expectancy of at least 15 to 25 more years.

A computerized flow model of the campus chilled water distribution system, that was prepared as part of this analysis, indicates that most of the existing chilled water system piping is adequately sized to handle expected future campus growth and added chilled water production capacity. However, a portion of the existing 12" East-side (Washington street) loop piping will reach the limits of good engineering practice for peak flow/velocities, as the future Gateway and upgraded residence hall cooling projects come on line.

CD-1: Replace/Upsize a Portion of the 12" West-Side Chilled Water Piping

Description:

Replace the existing 12" chilled water piping that feeds the west-side (Washington Street) of the campus loop, with 16" size pipe, from the Rozell plant junction, up to the HPE branch, past the existing Science Building. This section of piping will see significantly increased flow demands when the future Gateway and residence hall cooling projects are completed.

Analysis/Justification:

Analysis of the future chilled water flow rates as developed by the computerized flow model, indicates a flow split of roughly 50-50 between the west-side (12") and east-side (16") chilled water loops when accounting for future flow conditions. Under this condition the 12" pipe branch will see a fluid velocity of roughly 50% greater than the 16" branch, and approaching the recommended peak design velocity of 10 feet per second.

Changing this section of piping from 12" to 16" size will reduce expected peak flow velocities to be within normal limits and reduce pumping head pressure requirements.

Sequence / Category:
Capital Master Plan Project.

Cost:
CD-1: $1,000,000

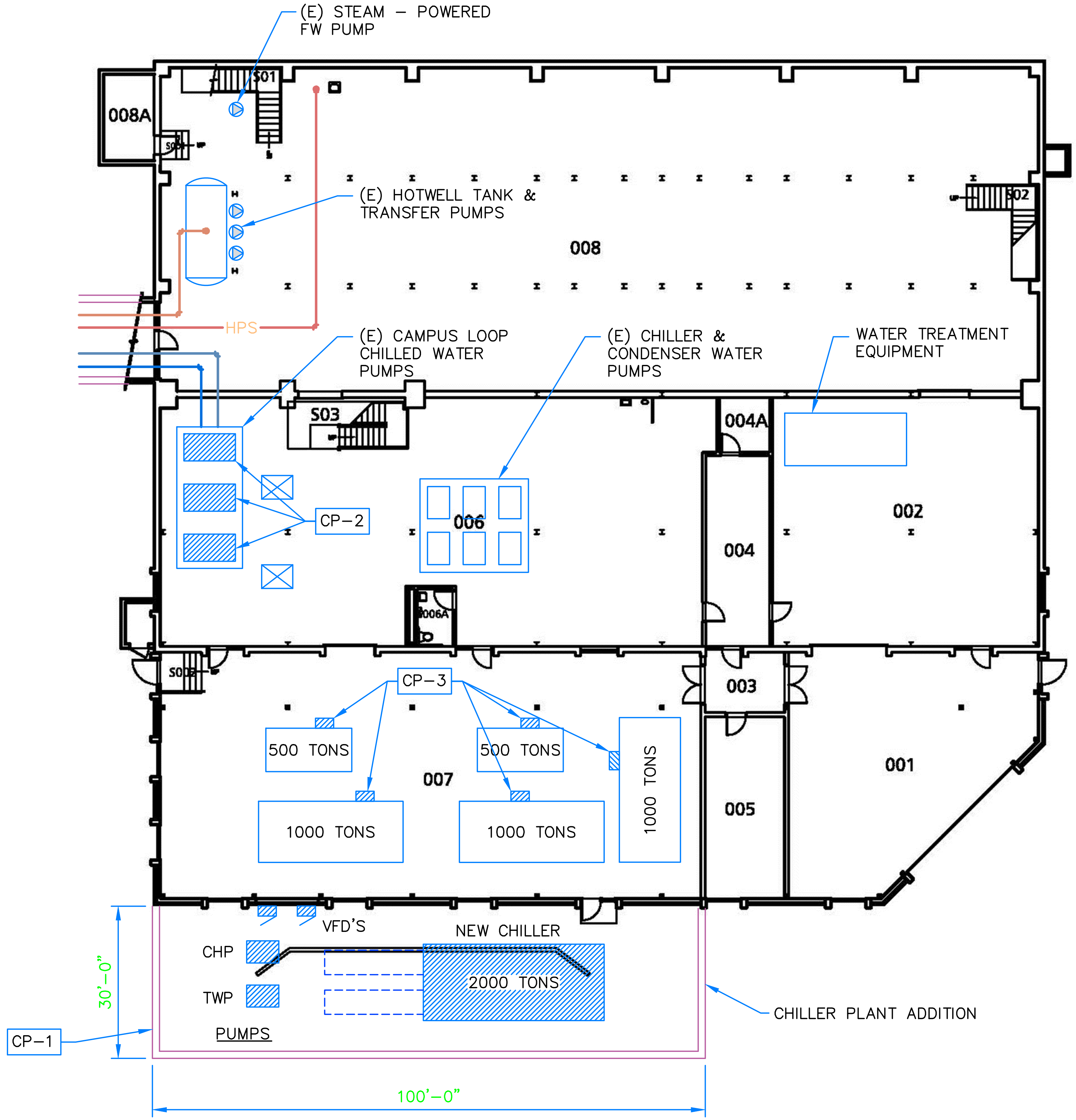
CAPITAL MASTER PLAN PROJECTS

CP–1: ADD CHILLER CAPACITY (2000 TONS)

CP–2: UPGRADE CAMPUS CHILLED WATER PUMPS

MAINTENANCE/ENERGY EFFICIENCY PROJECTS

CP–3: INSTALL VFD'S ON CHILLER COMPRESSORS & COOLING TOWERS



STEAM PLANT & CHILLER PLANT PROJECTS
EWU - ROZELL CENTRAL PLANT - LOWER LEVEL

N

Scale: NTS

STEAM PLANT & CHILLER PLANT PROJECTS

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SP/CP

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CAPITAL MASTER PLAN PROJECTS

SP-1: REPLACE BOILER #3

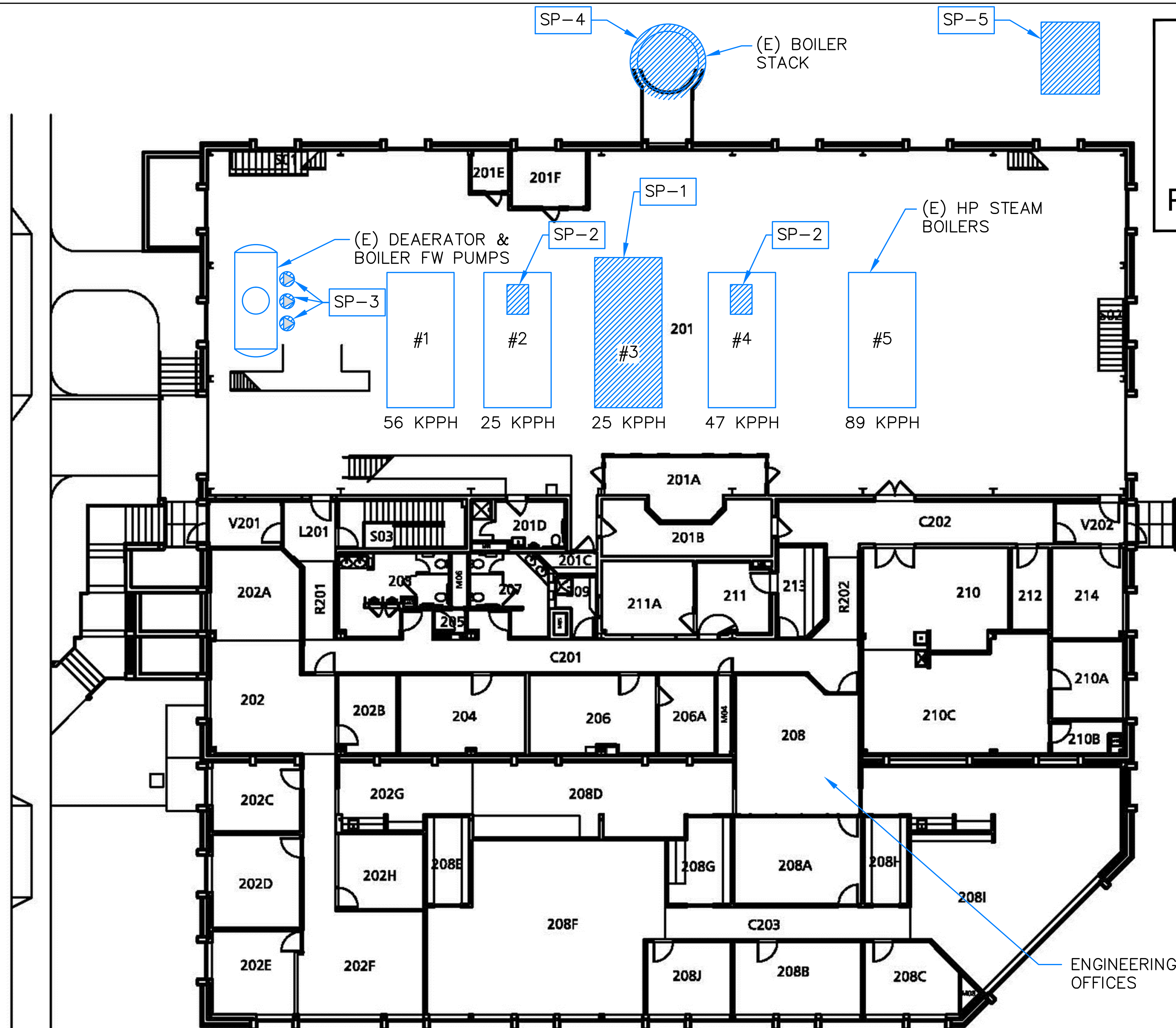
SP-3: UPGRADE BOILER FEEDWATER PUMPS

MAINTENANCE PROJECTS

SP-2: BOILER FEEDWATER STACK ECONOMIZERS

SP-4: REPAIR ROZELL HEATING PLANT BOILER STACK

SP-5: UPGRADE NATURAL GAS SERVICE



STEAM PLANT & CHILLER PLANT PROJECTS
EWU - ROZELL CENTRAL PLANT - MAIN FLOOR

N

Scale: NTS

STEAM PLANT & CHILLER PLANT PROJECTS

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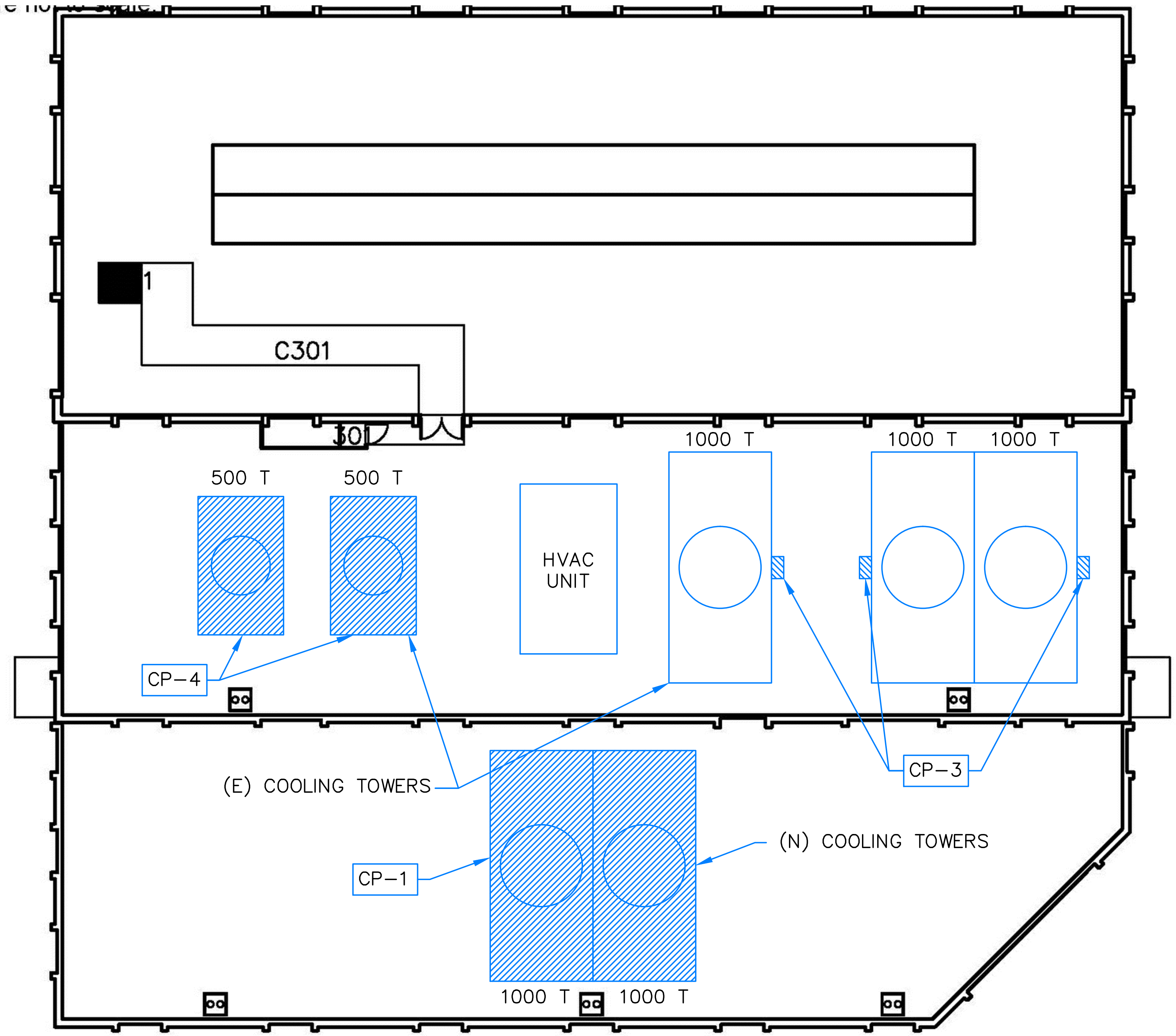
CAPITAL MASTER PLAN PROJECTS

CP–1: ADD CHILLER CAPACITY (2000 TONS)

MAINTENANCE/ENERGY EFFICIENCY PROJECTS

CP–3: INSTALL VFD'S ON CHILLER COMPRESSORS & COOLING TOWERS

CP–4: INSTALL (2) NEW ENERGY EFFICIENT COOLING TOWERS



STEAM PLANT & CHILLER PLANT PROJECTS

EWU - ROZELL CENTRAL PLANT - ROOF

N

Scale: NTS

STEAM PLANT & CHILLER PLANT PROJECTS

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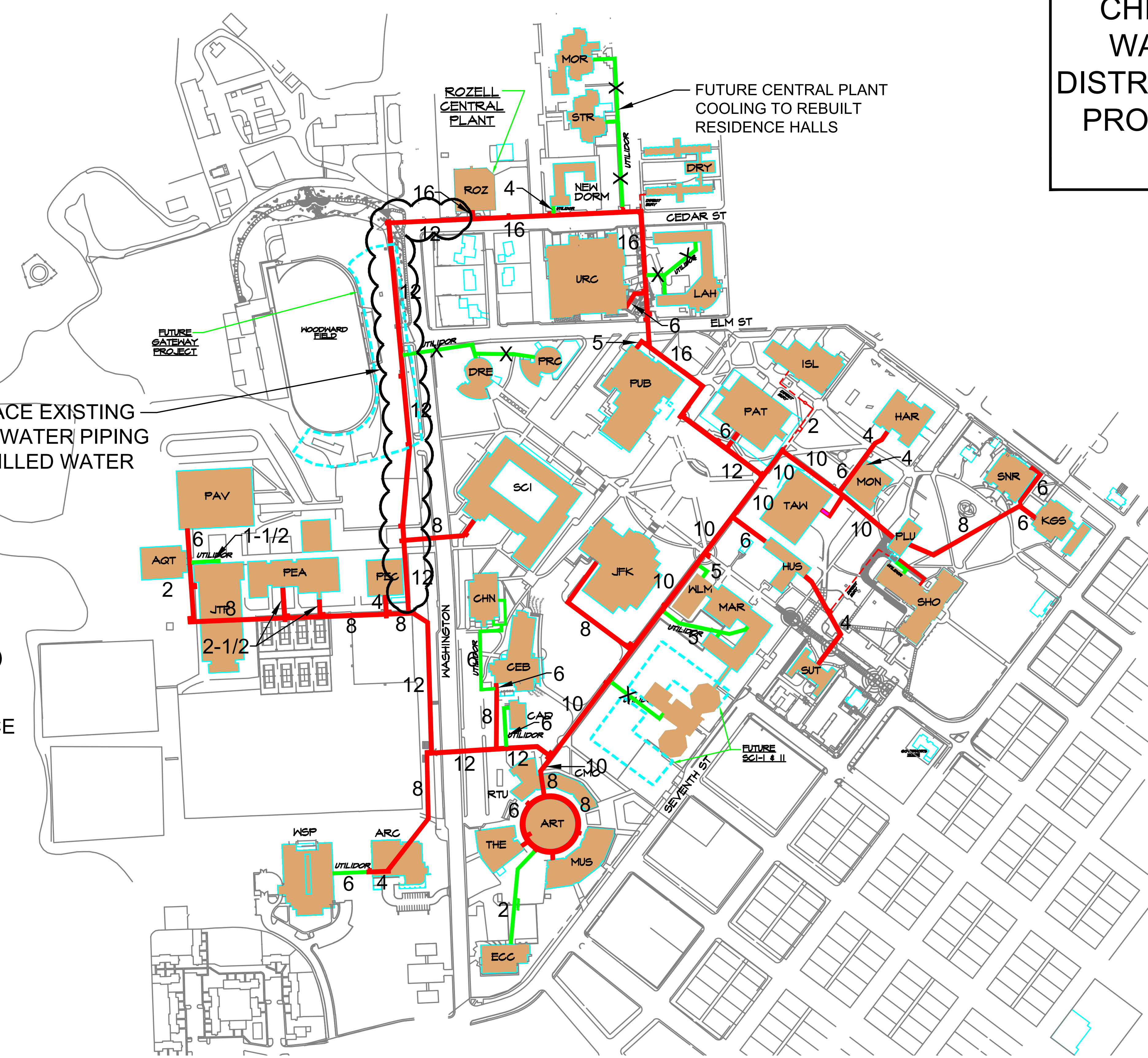
CAPITAL MASTER PLAN PROJECTS

CD-1: REPLACE WEST SIDE CHILLED WATER PIPING

CHILLED WATER DISTRIBUTION PROJECTS



CHILLED WATER PIPE SIZING KEY

12 ← CHILLED WATER SUPPLY & RETURN PIPE SIZE (INCHES)

X NO CHILLED WATER SERVICE TO THIS BRANCH

TUNNEL LEGEND

UTILITY TUNNEL

UTILIDOR

DIRECT BURIED PIPE

EWU - CHILLED WATER DISTRIBUTION PROJECTS

N

Scale: 1" = 400'

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Aqua Series
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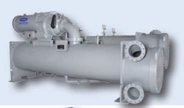
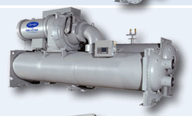
SEISMICOMPLIANT* HVAC Equipment

*Meets IBC 2006, ASCE-7-05, CBC 2007 and OSHPD seismic requirements.

	Seismically Certified Products (Water-Cooled)	OSP Number
	AquaEdge™ 19XR(V) Two-Stage Water-Cooled Centrifugal Chillers	OSP-0026-10†
	AquaEdge™ 19XR(V) Single-Stage Water-Cooled Centrifugal Chillers	OSP-0026-10
	AquaEdge™ 23XRV Water-Cooled Screw Chillers	OSP-0135-10
	AquaForce® 30HX Water-Cooled Screw Chillers	OSP-0161-10
	AquaSnap® 30MP Water-Cooled Scroll Chillers	OSP-0184-10

†Certain models only at this time

Benefits at a Glance

For Building Owners and Managers

- Reduces operating expenses
- Easy to maintain
- Quiet operation
- Reliable operation
- Environmentally sound refrigerant

For Consulting Engineers

- ASHRAE 90.1
- AHRI certified
- HFC refrigerant
- High-efficiency optimization
- Ideal for replacement projects

For Contractors

- Easy to break down
- Ideal for replacement
- Diagnostic controls
- Reliable performance
- Reduces installation expenses

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Chillers and Split Systems
LEED® Certification
IndustryWeek's Best Plant 2010 Winner

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Aqua Series Water-Cooled Chillers

The Right Choice for Today and Tomorrow

AquaEdge™
AquaForce®
AquaSnap®

Carrier's comprehensive line of water-cooled chillers are designed to enable chiller plants to achieve superior efficiency at true operating conditions without compromising the environment.

These units boast integrated part-load values (IPLV) to 0.299 and full load kW/Tons to 0.53 while utilizing either HFC-134a or HFC Puron® refrigerant (R-410A) chlorine-free refrigerant. Aqua Series water-cooled chillers are ideal for replacement or new construction with small footprints and easy disassembly options. Carrier chillers are also manufactured in an award winning, LEED® certified plant.

Leading Efficiencies

Chillers operate at design conditions less than one percent of the time. As a result, superior part-load efficiency is required in today's chilled-water applications. AquaEdge 19XRV and 23XRV chillers are equipped with a factory-installed, variable-speed drive, maximizing chiller efficiency by optimizing compressor operation. Electric power consumption drops dramatically when the motor speed slows. The 23XRV delivers industry-leading IPLVs as low as 0.299.

Seismic Compliant

Carrier's water-cooled chillers are the first full series of seismic compliant chillers. With Carrier's special seismic-complaint package, the Aqua Series water-cooled chillers meet or exceed the California Office of Statewide Health and Planning Development (OSHPD) standards.

Revit®

To save time and help support engineers and architects in more accurate design, construction planning and fabrication, Carrier is able to provide Revit® Building Information Modeling (BIM) drawings for their entire line of chillers.

Developed by Autodesk®, Revit BIM is a building design software which allows users to create multi-dimensional architectural models, evaluate building alternatives and work collaboratively before beginning construction. Carrier BIM objects are configured to the design and specifications of each piece of equipment.

BACnet® Capability

With a factory-installed integrated communication card, connecting Carrier water-cooled chillers to a BACnet® system has never been easier. Simply connect the UPC Open to the BACnet network, and Carrier equipment is ready to integrate seamlessly into Carrier's i-Vu® Open control system or any other BACnet building automation system. Pre-programmed to share equipment data, no onsite engineering is required.

Heat Recovery

An efficient means of generating hot water is through the heat reclaim capabilities of Carrier's 30-series water-cooled chillers. Carrier chillers with heat reclaim capabilities can produce chilled water controlled to the necessary temperature while generating hot water as a by-product of the chilled water system.

This heat reclaim captures energy that would otherwise be wasted to the atmosphere increasing overall system efficiencies. Unlike typical boilers with COP (coefficient of performance) less than 1.0, capturing waste heat from a heat reclaim chiller can result in COPs exceeding 5.0.

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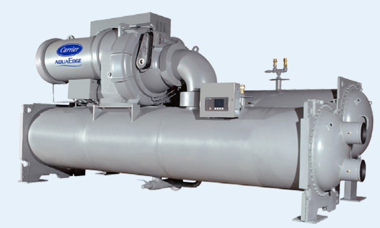
AquaEdge 23XRV Chillers

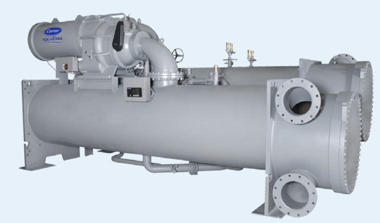
IPLV as low as 0.299

- 250 to 550 Tons
- HFC-134a refrigerant
- Industry best part load performance
- Semi-hermetic motor
- IEEE-519 compliant VFD
- Tri-rotor compressor design reduces bearing loads – Foxfire® compression technology
- 2008 AHR Expo Innovation Award winner in Green Building category



AquaEdge 19XR(V) Single-Stage Chillers

- 200 to 1,600 Tons
- HFC-134a refrigerant
- Semi-hermetic motor
- ASME heat exchangers
- Factory installed VFD option



AquaEdge 19XR(V) Two-Stage Chillers

- 800 to 1,600 Tons
- HFC-134a refrigerant
- Semi-hermetic motor
- ASME heat exchangers
- VFD option
- High lift and ice duty capability

AquaForce 30HX Chillers

- 75 to 265 Tons
- HFC-134a refrigerant
- Semi-hermetic motor
- Handheld Navigator
- Dual independent refrigerant circuits standard
- Fits through standard doorway
- Low in-rush current
- Condenserless option

AquaForce 30XW Chillers

- 150 to 400 Tons
- HFC-134a refrigerant
- Semi-hermetic motor
- Marine waterbox option
- Single and dual independent refrigerant circuits available
- Factory installed heat recovery option (up to 140°F)
- Reduced installation expenses

AquaSnap 30MP Chillers

- 15 to 90 Tons
- HFC Puron® refrigerant (R-410A)
- Reduced installation cost
- Small footprint (fits through a standard doorway)
- Multiple unit configuration
- Condenserless option
- Heat reclaim capability (up to 140°F)

The *NEW* Series 3000 Cooling Tower

The NEW Series 3000 Cooling Towers

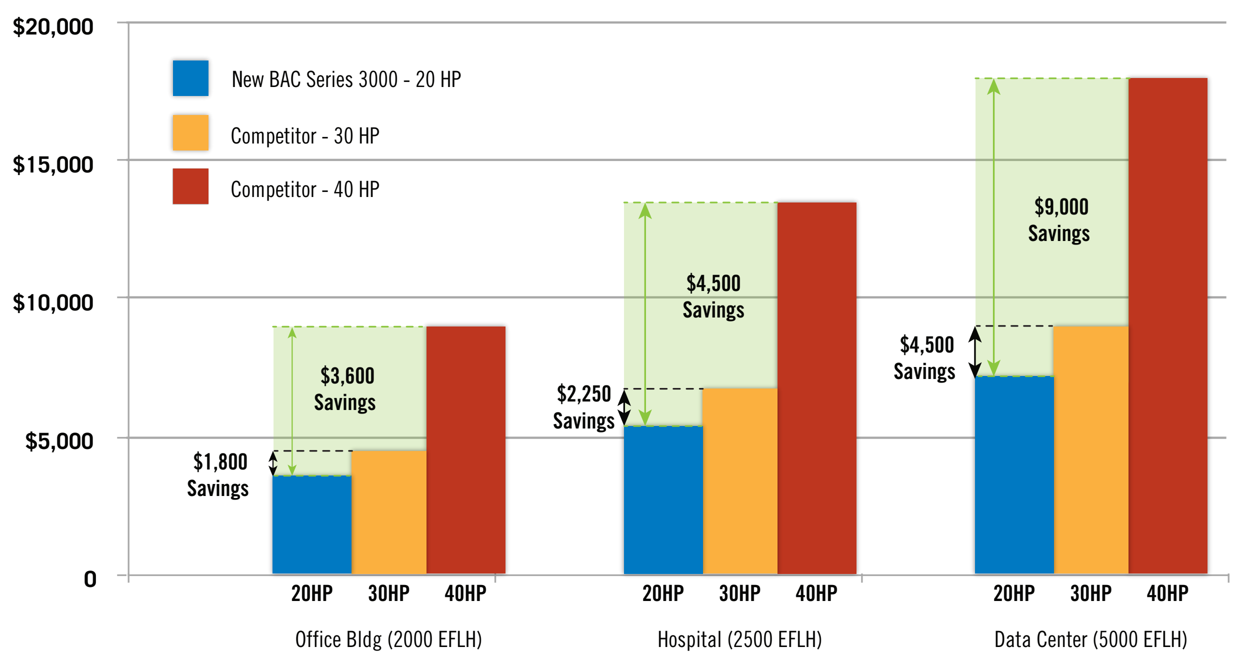
The NEW Series 3000 Cooling Tower continues its industry leading tradition. With expanded selection flexibility and a capacity increase of up to 16%, the Series 3000 Cooling Tower provides an extremely efficient solution for all your application needs.

Reduced Energy Consumption

- ✓ Most efficient cooling tower in the industry
- ✓ Up to a 16% increase in capacity
- ✓ Exceeds ASHRAE 90.1-2013 efficiency requirements

400-Ton Example:	Series 3000	Competition	Competition
Fan HP	20	30	40
Footprint (L x W x H)	8.5' x 18' x 12'	8.5' x 18' x 12'	8.5' x 18' x 12'
Nominal Tons	400	386	423

400-Ton Example: Annual Operating Cost for a 20, 30, & 40 HP



Energy Cost Savings Based on a 400-Ton System ($0.12 kWH)

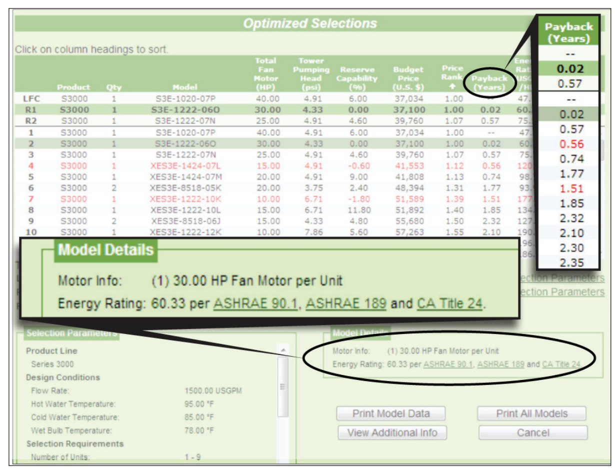
Reliable Year-Round Operation

- ✓ Superior winter operating performance
- ✓ BALTIDRIVE® POWER TRAIN Fan System
- ✓ Rigid frame construction
- ✓ Meets wind and seismic requirements of the International Building Code (IBC)

New Series 3000 Cooling Tower

More Selection Flexibility

- ✓ 31 new models
- ✓ 3 new box sizes
- ✓ 69 XE-Series 3000 Cooling Tower models are available in a full array of box sizes



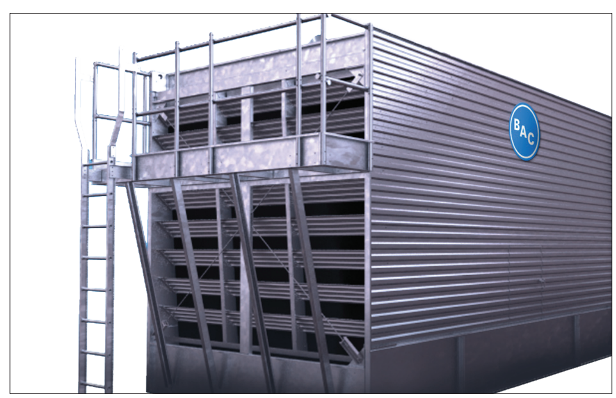
Enhanced Product Selection Software

Enhanced Payback Analysis

- ✓ Provides alternative selections based on energy savings and minimum payback
- ✓ User-defined life-cycle cost inputs
- ✓ XE-Series models featured in selection program

Easiest to Maintain

- ✓ Direct access to:
    - Cold water basin
    - Hot water basin
    - Drive system
- ✓ Patented hygienic cold water basin
- ✓ Factory assembled access options available for ease of maintenance



Factory Pre-Assembled Platforms

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AIRCOIL COMPANY

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CLOSED CIRCUIT COOLING TOWERS

ICE THERMAL STORAGE

EVAPORATIVE CONDENSERS

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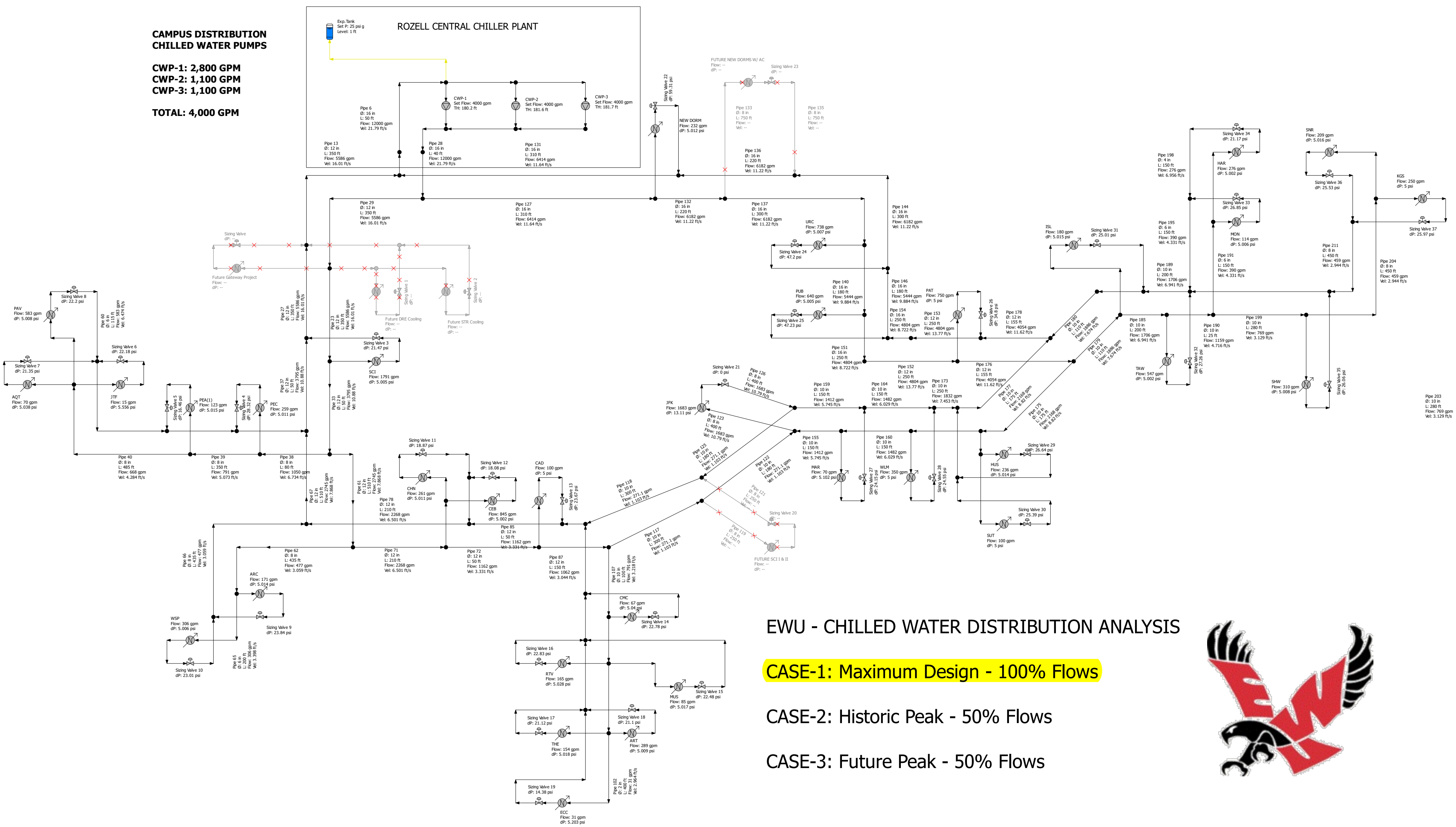
APPENDIX A

CAMPUS CHILLED WATER SYSTEM FLOW MODEL RESULTS



EWU - CHILLED WATER DISTRIBUTION ANALYSIS

CASE-1: Maximum Design - 100% Flows

CASE-2: Historic Peak - 50% Flows

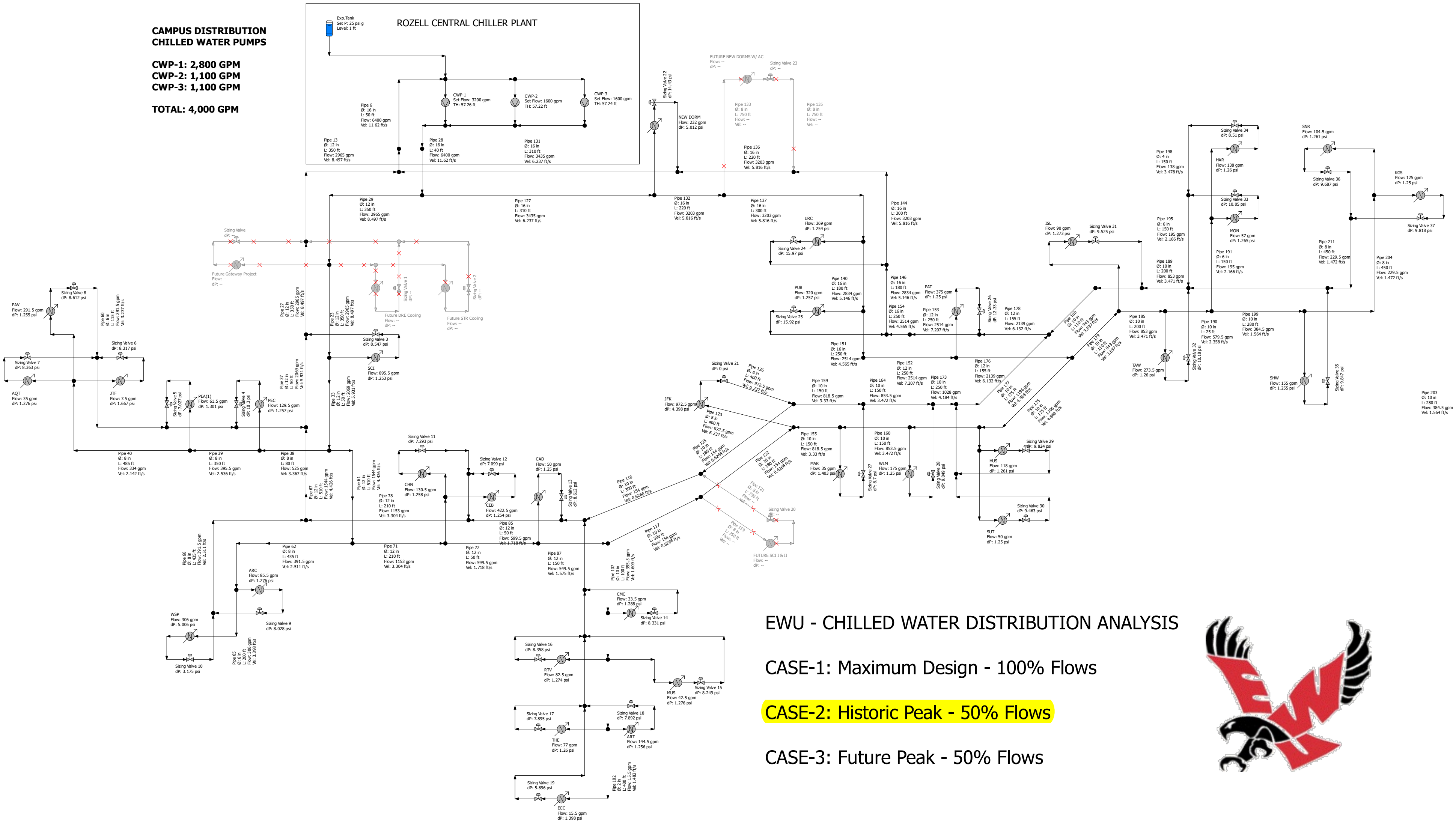
CASE-3: Future Peak - 50% Flows

PIPE-FLO Professional 12		Units Used				Project Information	
Program Version:	12.1.21778	**Flow rate:**	gpm	**Power:**		**Company:**	MSI Engineers
Calculation Method:	Darcy-Weisbach	**Velocity:**	ft/s	**Temperature:**	ºF	**Project:**	EWU Campus Chilled Water System
Maximum Iterations:	100	**Pressure:**	psi g	**Density:**	lb/ft³	**Drawn by:**	B. Snow
Iteration Tolerance:	0.01	**Elevation:**	psi g	**Viscosity:**	cP	**File Name:**	14.01-EWU CW System Analysis 1.0.pipe
Laminar Cutoff Re:	2100	**Length:**	ft	**Atmospheric Pressure:**	14.7 psi a	**Lineup:**	CASE-1: Max. Design - 100% Flows
		Size:	in			**Print Date:**	Thursday, May 29, 2014 03:24 PM

CAMPUS DISTRIBUTION CHILLED WATER PUMPS

CWP-1: 2,800 GPM
CWP-2: 1,100 GPM
CWP-3: 1,100 GPM

TOTAL: 4,000 GPM



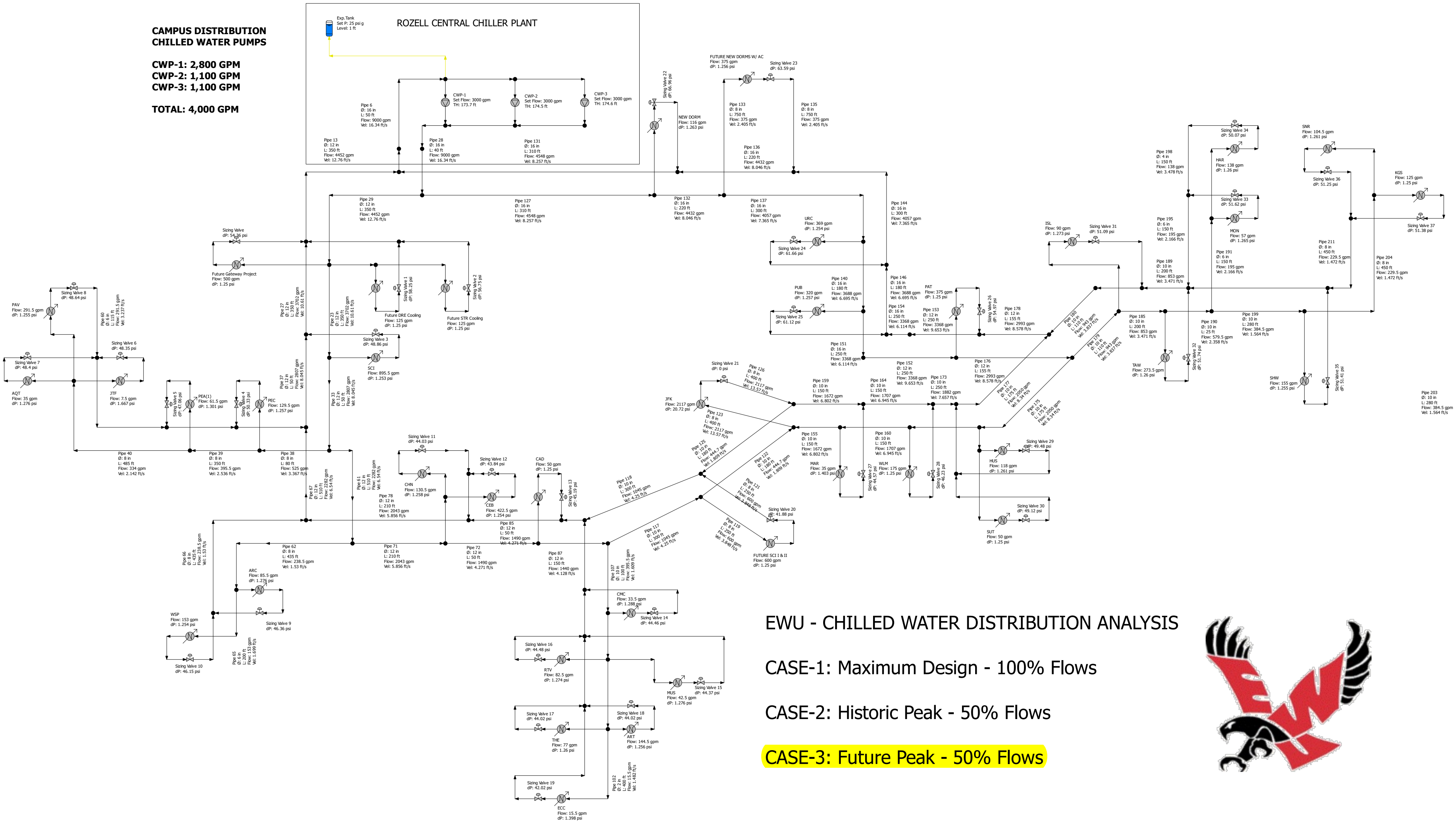
EWU - CHILLED WATER DISTRIBUTION ANALYSIS

CASE-1: Maximum Design - 100% Flows

CASE-2: Historic Peak - 50% Flows

CASE-3: Future Peak - 50% Flows

PIPE-FLO Professional 12		Units Used				Project Information	
Program Version:	12.1.21778	Flow rate:	gpm	Power:		Company:	MSI Engineers
Calculation Method:	Darcy-Weisbach	Velocity:	ft/s	Temperature:	°F	Project:	EWU Campus Chilled Water System
Maximum Iterations:	100	Pressure:	psi g	Density:	lb/ft³	Drawn by:	B. Snow
Iteration Tolerance:	0.01	Elevation:	psi g	Viscosity:	cP	File Name:	14.01-EWU CW System Analysis 1.0.pipe
Laminar Cutoff Re:	2100	Length:	ft	Atmospheric Pressure:	14.7 psi a	Lineup:	CASE-2: Historic Peak - 50% Flows
		Size:	in			Print Date:	Thursday, May 29, 2014 03:24 PM



EWU - CHILLED WATER DISTRIBUTION ANALYSIS

CASE-1: Maximum Design - 100% Flows

CASE-2: Historic Peak - 50% Flows

CASE-3: Future Peak - 50% Flows

PIPE-FLO Professional 12	
Program Version:	12.1.21778
Calculation Method:	Darcy-Weisbach
Maximum Iterations:	100
Iteration Tolerance:	0.01
Laminar Cutoff Re:	2100

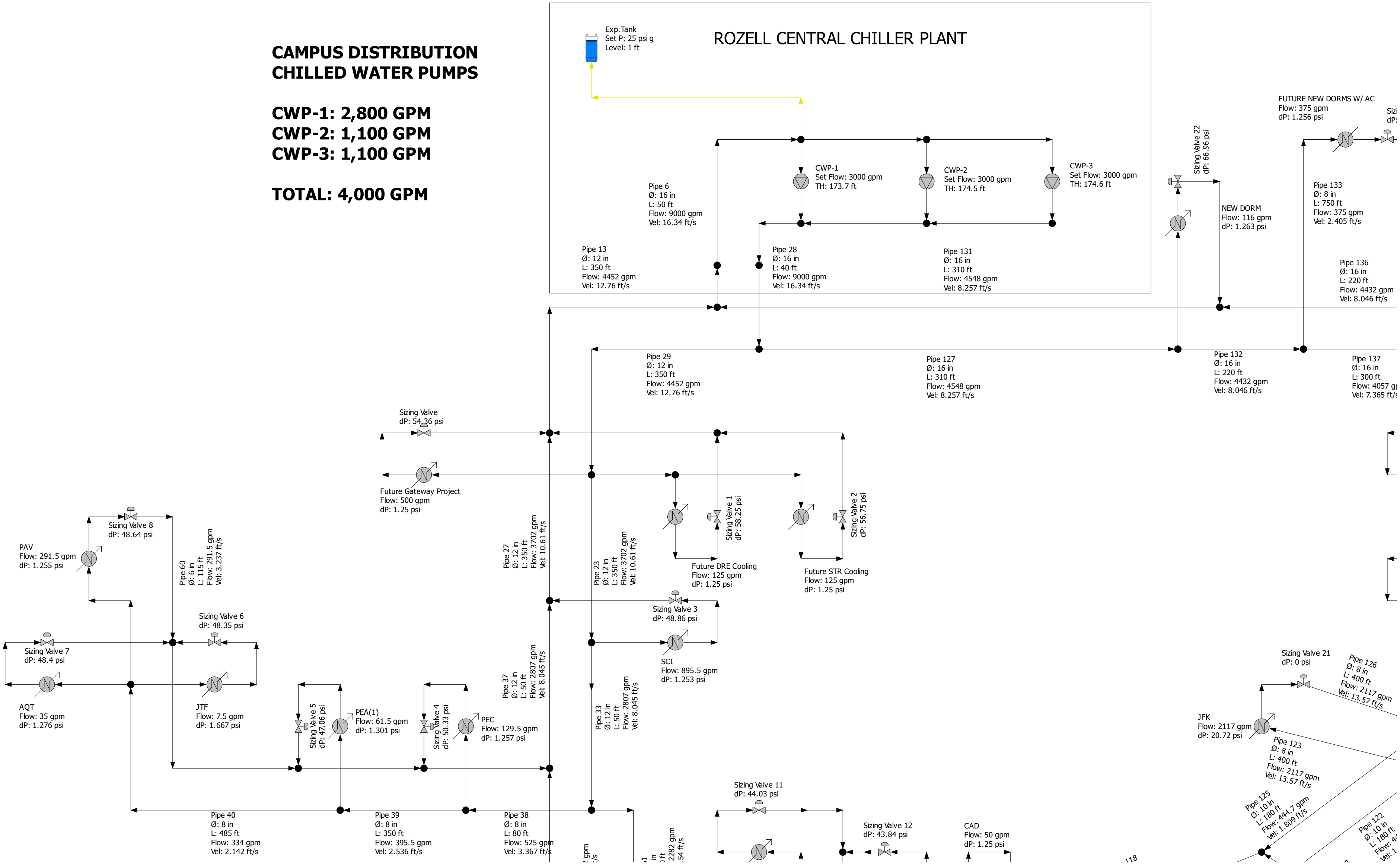
Units Used			
Flow rate:	gpm	**Power:**	
Velocity:	ft/s	**Temperature:**	ºF
Pressure:	psi g	**Density:**	lb/ft³
Elevation:	psi g	**Viscosity:**	cP
Length:	ft	**Atmospheric Pressure:**	14.7 psi a
Size:	in		

Project Information	
Company:	MSI Engineers
Project:	EWU Campus Chilled Water System
Drawn by:	B. Snow
File Name:	14.01-EWU CW System Analysis 1.0.pipe
Lineup:	CASE-3: Future Peak - 50% Flows
Print Date:	Thursday, May 29, 2014 03:25 PM

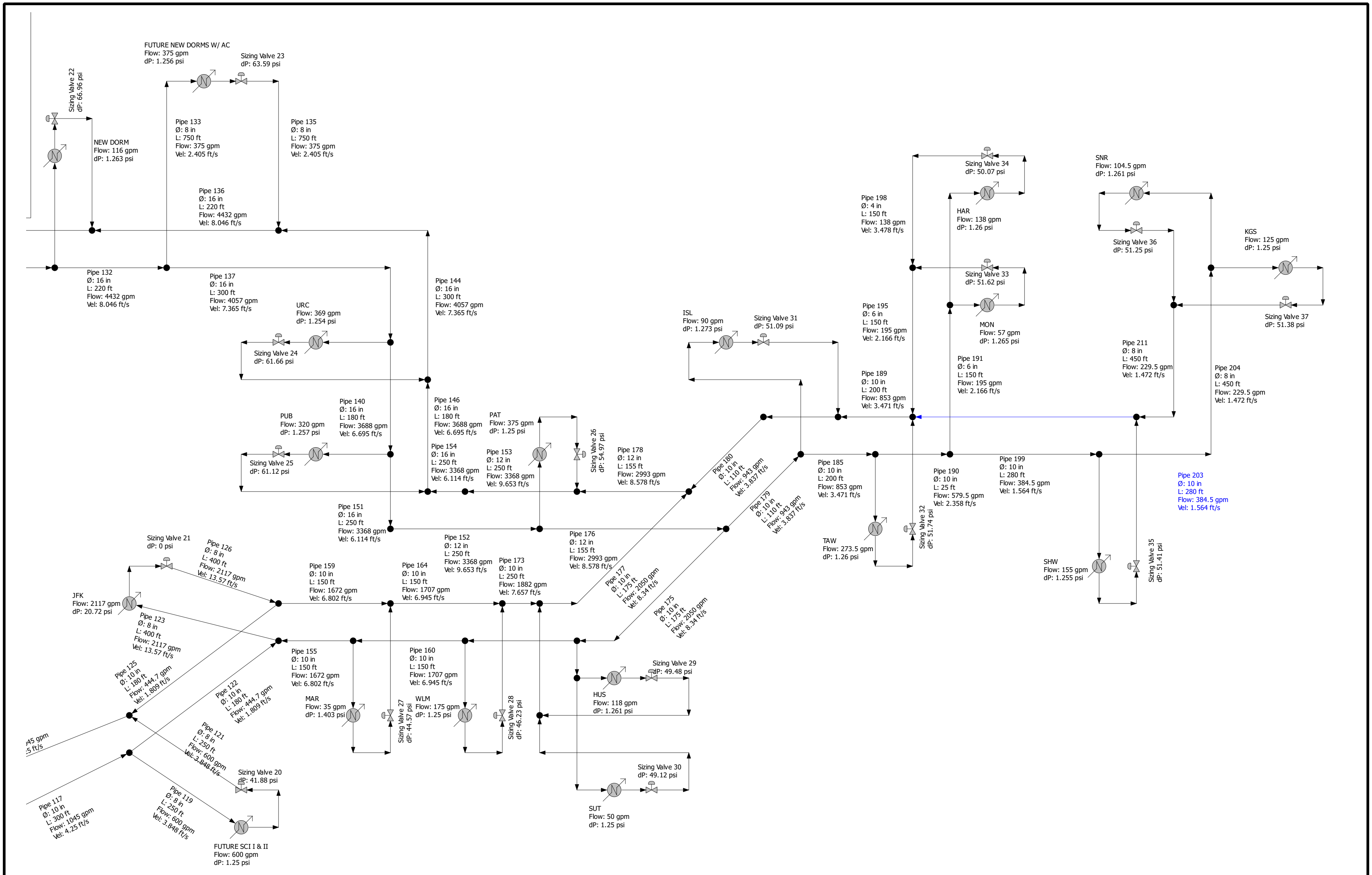
CAMPUS DISTRIBUTION
CHILLED WATER PUMPS

CWP-1: 2,800 GPM
CWP-2: 1,100 GPM
CWP-3: 1,100 GPM

TOTAL: 4,000 GPM



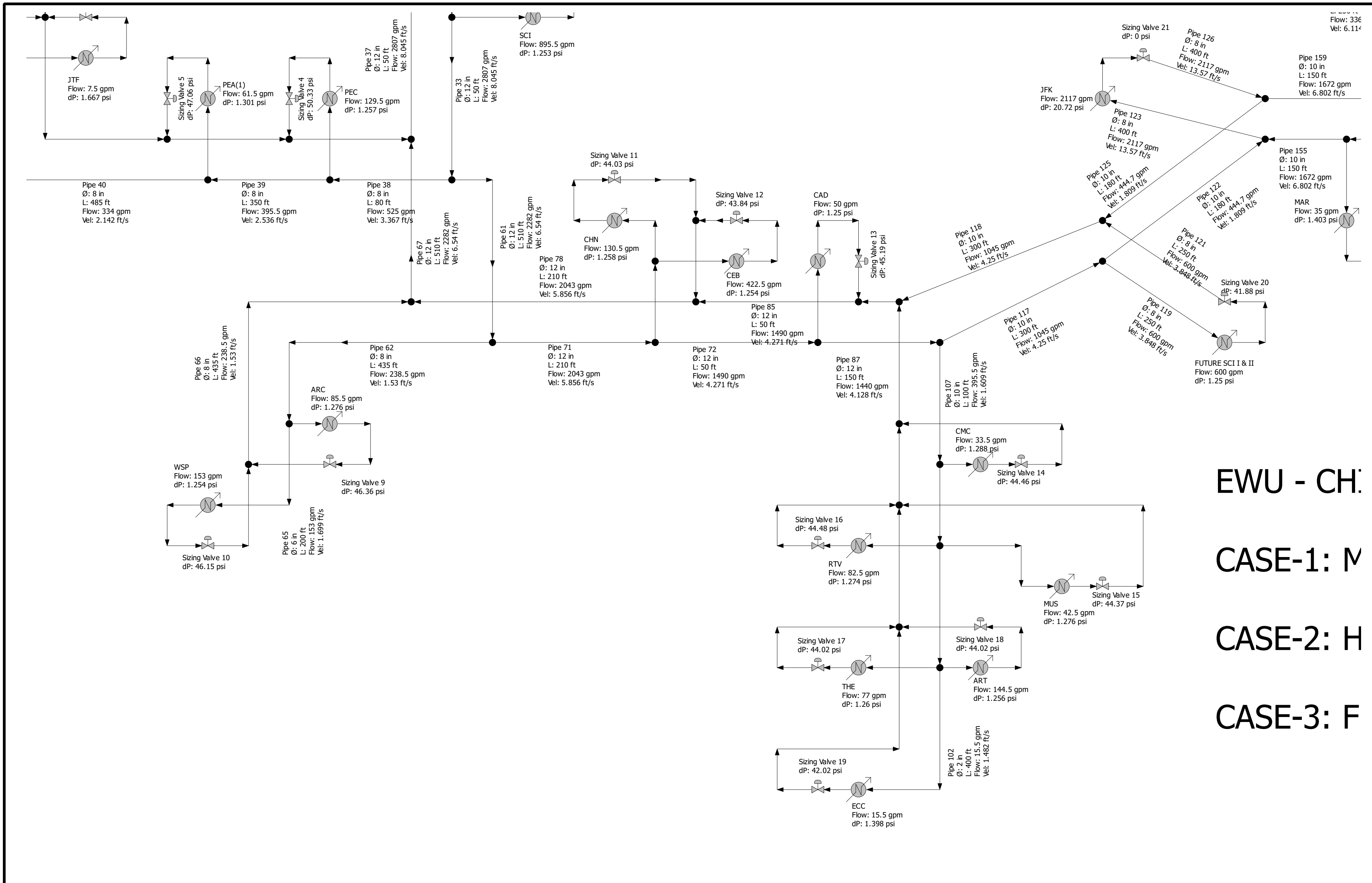
PIPE-FLO Professional 12		Units Used				Project Information	
Program Version:	12.1.21778	**Flow rate:**		**Power:**		**Company:**	MSI Engineers
Calculation Method:	Darcy-Weisbach	**Velocity:**	ft/s	**Temperature:**	ºF	**Project:**	EWU Campus Chilled Water System
Maximum Iterations:	100	**Pressure:**	psi g	**Density:**	lb/ft³	**Drawn by:**	B. Snow
Iteration Tolerance:	0.01	**Elevation:**		**Viscosity:**	cP	**File Name:**	14.01-EWU CW System Analysis 1.0.pipe
Laminar Cutoff Re:	2100	**Length:**		**Atmospheric Pressure:**	14.7 psi a	**Lineup:**	CASE-3: Future Peak - 50% Flows
		Size:				**Print Date:**	Thursday, May 29, 2014 03:26 PM



PIPE-FLO Professional 12	
Program Version:	12.1.21778
Calculation Method:	Darcy-Weisbach
Maximum Iterations:	100
Iteration Tolerance:	0.01
Laminar Cutoff Re:	2100

Units Used			
Flow rate:	gpm	Power:	
Velocity:	ft/s	Temperature:	ºF
Pressure:	psi g	Density:	lb/ft³
Elevation:	psi g	Viscosity:	cP
Length:	ft	Atmospheric Pressure:	14.7 psi a
Size:	in		

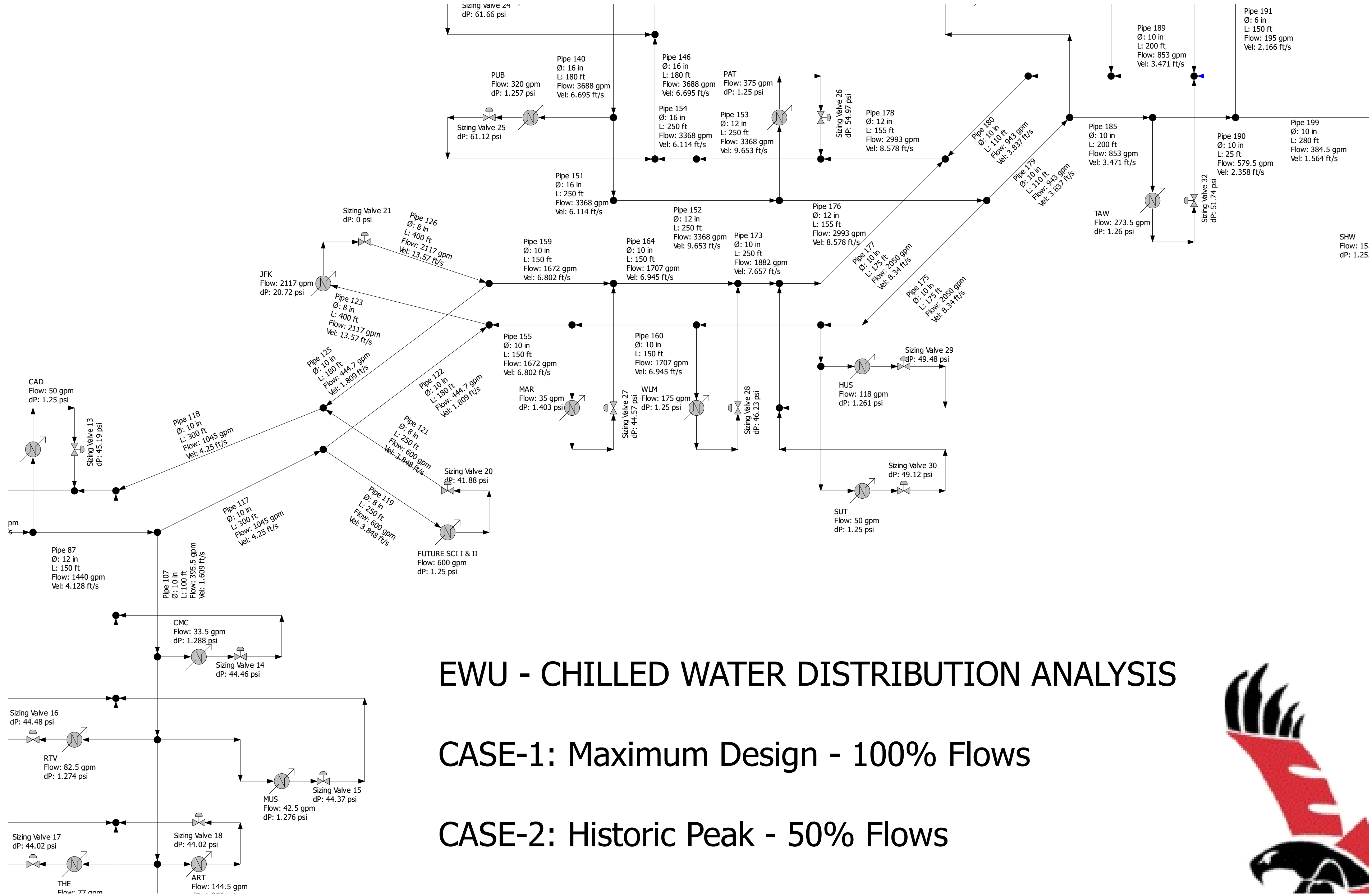
Project Information	
Company:	MSI Engineers
Project:	EWU Campus Chilled Water System
Drawn by:	B. Snow
File Name:	14.01-EWU CW System Analysis 1.0.pipe
Lineup:	CASE-3: Future Peak - 50% Flows
Print Date:	Thursday, May 29, 2014 03:27 PM



PIPE-FLO Professional 12	
Program Version:	12.1.21778
Calculation Method:	Darcy-Weisbach
Maximum Iterations:	100
Iteration Tolerance:	0.01
Laminar Cutoff Re:	2100

Units Used			
Flow rate:	gpm	**Power:**	
Velocity:	ft/s	**Temperature:**	ºF
Pressure:	psi g	**Density:**	lb/ft³
Elevation:	psi g	**Viscosity:**	cP
Length:	ft	**Atmospheric Pressure:**	14.7 psi a
Size:	in		

Project Information	
Company:	MSI Engineers
Project:	EWU Campus Chilled Water System
Drawn by:	B. Snow
File Name:	14.01-EWU CW System Analysis 1.0.pipe
Lineup:	CASE-3: Future Peak - 50% Flows
Print Date:	Thursday, May 29, 2014 03:28 PM



EWU - CHILLED WATER DISTRIBUTION ANALYSIS

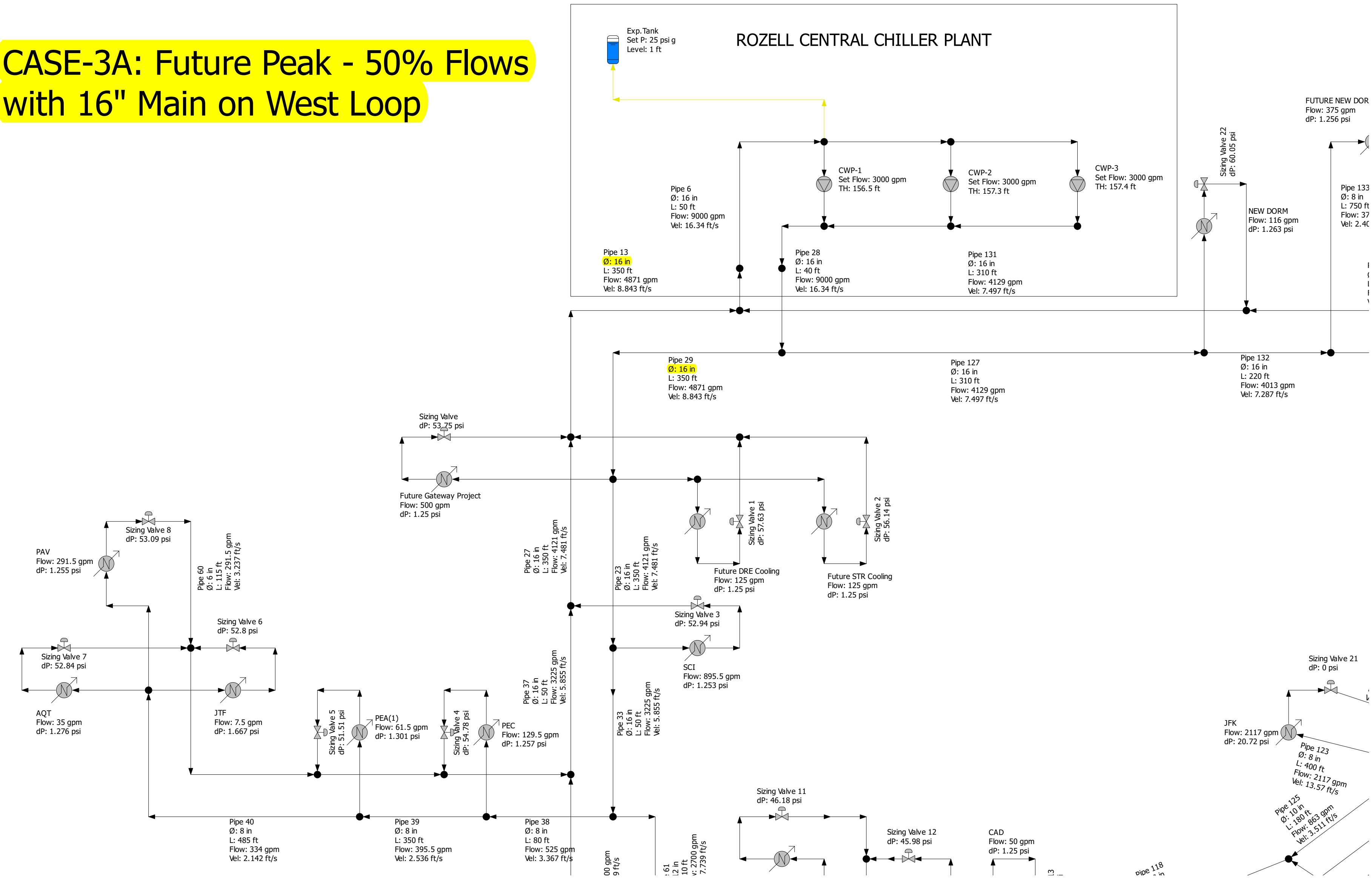
CASE-1: Maximum Design - 100% Flows

CASE-2: Historic Peak - 50% Flows

PIPE-FLO Professional 12		Units Used				Project Information	
Program Version:	12.1.21778	**Flow rate:**	gpm	**Power:**		**Company:**	MSI Engineers
Calculation Method:	Darcy-Weisbach	**Velocity:**	ft/s	**Temperature:**	°F	**Project:**	EWU Campus Chilled Water System
Maximum Iterations:	100	**Pressure:**	psi g	**Density:**	lb/ft³	**Drawn by:**	B. Snow
Iteration Tolerance:	0.01	**Elevation:**	psi g	**Viscosity:**	cP	**File Name:**	14.01-EWU CW System Analysis 1.0.pipe
Laminar Cutoff Re:	2100	**Length:**	ft	**Atmospheric Pressure:**	14.7 psi a	**Lineup:**	CASE-3: Future Peak - 50% Flows
		Size:	in			**Print Date:**	Thursday, May 29, 2014 03:28 PM

EWU - CHILLED WATER DISTRIBUTION ANALYSIS

CASE-3A: Future Peak - 50% Flows with 16" Main on West Loop



PIPE-FLO Professional 12		Units Used				Project Information	
Program Version:	12.1.21778	**Flow rate:**		**Power:**		**Company:**	MSI Engineers
Calculation Method:	Darcy-Weisbach	**Velocity:**	ft/s	**Temperature:**	ºF	**Project:**	EWU Campus Chilled Water System
Maximum Iterations:	100	**Pressure:**	psi g	**Density:**	lb/ft³	**Drawn by:**	B. Snow
Iteration Tolerance:	0.01	**Elevation:**		**Viscosity:**	cP	**File Name:**	14.01-EWU CW System Analysis 1.2.pipe
Laminar Cutoff Re:	2100	**Length:**		**Atmospheric Pressure:**	14.7 psi a	**Lineup:**	CASE-3A: Future Peak - 50% Flows - 16" Main
		Size:				**Print Date:**	Thursday, May 29, 2014 03:39 PM

APPENDIX B

DETAILED COST ESTIMATES

MSI ENGINEERS
MEULINK STAUFFENBERG, INC.

EWU - Campus Infrastructure Renewal
Proposed Mechanical Upgrades
Budgetary Level Cost Estimates
7/11/2014
MSI# 14-01
By: B. Snow

CHILLED WATER SYSTEM - INFRASTRUCTURE UPGRADE BUDGET SUMMARY

CHILLED WATER SYSTEMS	Budget Cost Estimate
Chiller Plant	
CP-1: Add Chiller Plant Capacity - 2000 tons	$3,600,000
CP-2: Upgrade (3) Campus Chilled Water Pumps	$300,000
CP-3: Install VFDs on (3) Chillers and Cooling Towers	$1,000,000
CP-4: Replace (2) Aging Cooling Towers with new Towers with VFD Drives	$500,000
CHILLER PLANT (CP) -	$5,400,000
Chilled Water Distribution	
CD-1: Replace Portion of 12" CW Loop Piping with 16" Piping	$1,000,000
CHILLED WATER DISTRIBUTION (CD) -	$1,000,000
CHILLED WATER SYSTEM TOTAL -	$6,400,000

MSI ENGINEERS
MEULINK STAUFFENBERG, INC.

EWU - Campus Infrastructure Renewal
Proposed Mechanical Upgrades
Budgetary Level Cost Estimates
7/11/2014
MSI# 14-01
By: B. Snow

CHILLED WATER SYSTEM - INFRASTRUCTURE UPGRADE BUDGET SUMMARY

Chiller Plant (CP)

CP-1: Add Chiller Plant Capacity - 2000 tons

	Unit	Quantity	$/unit	Cost
2000 Ton Water-Cooled Cent. Chiller with VFD	ea	1	$750,000.00	$750,000
1000 Ton Induced Draft Cooling Tower with VFD	ea	2	$175,000.00	$350,000
4500 gpm chiller pump	ea	1	$30,000.00	$30,000
6000 gpm chiller pump	ea	1	$35,000.00	$35,000
VFD drives for pumps - X hp	ea	2	$20,000.00	$40,000
Chiller Loop Piping, Valves & Insulation	lot	1	$100,000.00	$100,000
Tower Loop Piping, Valves & Insulation	lot	1	$100,000.00	$100,000
Campus Loop Piping Tie-in & Modifications	lot	1	$75,000.00	$75,000
BAS Upgrades	lot	1	$75,000.00	$75,000
Water Treatment System	lot	1	$25,000.00	$25,000
Chiller Plant Addition HVAC & Ventilation	lot	1	$50,000.00	$50,000
Chiller Plant Addition Plumbing	lot	1	$25,000.00	$25,000
Test & Balance, Start-up & Commissioning	lot	1	$50,000.00	$50,000
Mis. Modifications	lot	1	$15,000.00	$15,000
Electrical Upgrades for Chiller Plant Addition	lot	1	$500,000.00	$500,000
4,000 Rozell Plant Addition Construction	sf	4,000	$165.00	$660,000
			Subtotal	$2,880,000
	%	15	Design Contigency	$432,000
	%	10	G.C. OH&P	$288,000
			CP-1 - TOTAL	**$3,600,000**

CP-2: Upgrade (3) Campus Chilled Water Pumps

	Unit	Quantity	$/unit	Cost
Demo Existing Pumps	ea	3	$1,000.00	$3,000
3000 gpm pumps - 100 hp	ea	3	$30,000.00	$90,000
VFD drives for pumps	ea	3	$15,000.00	$45,000
BAS Upgrade	lot	1	$25,000.00	$25,000
Piping, Valving & Insulation Modificaitons	ea	3	$10,000.00	$30,000
Test & Balance, Start-up & Commissioning	lot	1	$25,000.00	$25,000
Misc.	ea	1	$11,500.00	$11,500
Electrical Upgrades/Connections	ea	3	$3,500.00	$10,500
			Subtotal	$240,000
	%	15	Design Contigency	$36,000
	%	10	G.C. OH&P	$24,000
			CP- 2 - TOTAL	**$300,000**

CP-3: Install VFDs on (3) Chillers and Cooling Towers

	Unit	Quantity	$/unit	Cost
Retrofit Existing 1000 ton chillers with VFD drives	ea	3	$225,000.00	$675,000
Install VFDs on Existing Cooling Tower Fan Motors	ea	3	$15,000.00	$45,000
BAS Upgrades	lot	1	$25,000.00	$25,000
Test & Balance, Start-up & Commissioning	lot	1	$25,000.00	$25,000
Electrical Upgrades/Connections	ea	6	$5,000.00	$30,000
			Subtotal	$800,000
	%	15	Design Contigency	$120,000
	%	10	G.C. OH&P	$80,000
			CP-3 - TOTAL	**$1,000,000**

CP-4: Replace (2) Aging Cooling Towers with new Towers with VFD Drives

Demo Existing Cooling Towers	ea	2	$5,000.00	$10,000
Induced Draft Open Cooling Towers w/ VFDs - 500 tons	ea	2	$125,000.00	$250,000
Piping modifications & Connections	ea	2	$25,000.00	$50,000
Roof Structural Support Modifications	ea	1	$30,000.00	$30,000
Test & Balance, Start-up & Commissioning	lot	1	$25,000.00	$25,000
Misc.	ea	1	$25,000.00	$25,000
Electrical Upgrades/Connections	ea	2	$5,000.00	$10,000
			Subtotal	$400,000
	%	15	Design Contigency	$60,000
	%	10	G.C. OH&P	$40,000
			CP-4 - TOTAL	**$500,000**

MSI ENGINEERS
MEULINK STAUFFENBERG, INC.

EWU - Campus Infrastructure Renewal
Proposed Mechanical Upgrades
Budgetary Level Cost Estimates
7/11/2014
MSI# 14-01
By: B. Snow

CHILLED WATER SYSTEM - INFRASTRUCTURE UPGRADE BUDGET SUMMARY

Chilled Water Distribution (CD)

CD-1: Replace Portion of 12" CW Loop Piping with 16" Piping

	Unit	Quantity	$/unit	Cost
Demo Existing 12" CHS & CHR Piping	lf	1,500	$25.00	$37,500
New 16" Sched. 40 Welded Steel CHS & CHR Piping	lr	1,500	$315.00	$472,500
Fittings	%	25		$118,125
Valves - Butterfly 16"	ea	10	$5,000.00	$50,000
Pipe Insulation - 2" F.G. ASJ	lf	1,500	$25.00	$37,500
Insulation Jacket & Labels	lf	1,500	$5.00	$7,500
Expansion Joints	ea	12	$2,000.00	$24,000
Rollers & Guides	ea	100	$150.00	$15,000
Anchors	ea	10	$500.00	$5,000
Flush & Fill	lot	1	$5,000.00	$5,000
Misc.	ea	1	$27,875.00	$27,875
			Subtotal	$800,000
	%	15	Design Contigency	$120,000
	%	10	G.C. OH&P	$80,000
			CD-1 - TOTAL	**$1,000,000**

APPENDIX C

INIDIVIDUAL BUILDING DATA

EWU Campus Building - Central Plant Infrastructure Data

Campus Map Bldg No.	BldgID	Building Name	Year Constructed	Year of Last Major Remodel	Gross Square Footage	Assignable Square Footage	Building Occupancy Type	Facility Usage	BAS System Alerton (ATS) Delta JCI Staefa	Campus Chilled Water Service Y/N	Campus Steam Service Y/N
		Campus Master Plan Growth									
Future	???	New Science Center I	'13-'15	-	103,000	?	B	Classrooms	TBD	Y	Y
Future	???	New Science Center II	'19-'21	-	110,000	?	B	Classrooms	TBD	Y	Y
Future	???	Gateway Project	???	-	300,000	?	B	Sports Complex	TBD	Y	Y
Future	???	Snowmelt Systems	???	-	Varies	N/A	N/A	Site	N/A	N/A	Y
		Future Total			513,000						
??	???	New Residence Hall	2013	-	50,000	?	R-1	Residential	Alerton	Y	Y
2	AQT	Aquatics	1980	-	21,356	16,931	A-2.1	Athletic	Delta	Y	Y
59	ARC	WA Archives	2004	-	74,247		B	Multipurpose	Delta	Y	Y
3	ART	Art Building	1972	-	34,415	21,184	A-3 & B	Teaching Labs	Alerton	Y	Y
5	CAD	Cadet Hall	1956	1978	9,034	7,669	B	General Classroom	Alerton	Y	Y
10	CEB	Computing and Engineering Building	2005	-	97,724	56,024	B	Teaching Labs	Alerton	Y	Y
7	CHN	Cheney Hall	1966	1979	30,196	22,454	B	Teaching Labs	Alerton	Y	Y
9	CMC	Communications Center (Speech)	1970	-	21,960	10,235	B	General Classroom	Alerton	Y	Y
11	DRE	Dressler Hall	1966	-	80,899		R-1	Residential	Staefa	Future	Y
12	DRY	Dryden Hall	1966	-	53,840		R-1	Residential	Staefa	Future	Y
13	ECC	Eastern Children's Center	1947	2001	14,530	13,278	E-3	Operational Support	Alerton	Y	Y
15	HAR	Hargreaves Hall	1940	1967	42,992	23,124	B	Multipurpose	JCI	Y	Y
17	HUS	Huston Hall (Computer Science Building	1915	1984	27,718	14,492	B	Teaching Labs	Alerton	Y	Y
19	ISL	Isle Hall	1956	1975	36,348	24,244	A-2.1	General Classroom	Delta	Y	Y
21	JFK	John F. Kennedy Library	1968	1998	165,270	123,062	A-2.1	Study	Staefa	Y	Y
20	JTF	Jim Thorpe Fieldhouse (Phase IV)	1978	-	57,284	48,001	A-2.1	Athletic	Alerton	Y	Y
22	KGS	Kingston Hall	1972	-	57,326	26,146	B & A-2.1	Teaching Labs	Alerton	Y	Y
23	LAH	Louise Anderson Hall	1951	-	73,808		-1, B & A-2	Residential	Staefa	Future	Y
24	MAR	Martin Hall	1937	1982	60,000	37,700	B	Teaching Labs	Alerton	Y	Y
25	MON	Monroe Hall	1916	1999	50,305	27,029	B	Multipurpose	Delta	Y	Y
26	MOR	Morrison Hall	1971	-	100,880		R-1	Residential	Staefa	Future	Y
27	MUS	Music Building	1970	-	49,700	26,910	A-2.1	General Classroom	Alerton	Y	Y
28	PAT	Patterson Hall	1969	2013	103,500	63,577	B	General Classroom	Alerton	Y	Y
45	PAV	Pavillion (Reese Court) (Phase III)	1975	-	102,531	59,977	A-2.1	Multipurpose	Alerton	Y	Y
31	PEA	P.E. Activities (Phase II)	1972	-	95,512	70,279	B	Athletic	Alerton	Y	Y
32	PEC	P.E. Classroom (Phase I)	1971	-	27,941	18,183	B	General Classroom	JCI	Y	Y
33	PLU	Plant Utilities	1917	-	6,610	2,100	B & S-2	Multipurpose	Staefa	Junction	Y
29	PRC	Pearce Hall	1964	1964	93,859		R-1	Residential	Staefa	Future	Y
30	PUB	Pence Union Building	1970	1995	57,200	57,200	M, B & A-2.	Student Services	Staefa	Y	Y
40	ROZ	Rozell Heating Plant	1970	2002	36,645	8,616	H-7	Operational Support	Delta	Y	Y
39	RRL	Robert Reid Lab School	1959		33,003	22,978	E-1	General Classroom	Staefa	To Be Demo'd	Y
37	RTV	Radio TV Building	1972	-	17,443	9,157	B	Multipurpose	Alerton	Y	Y
42	SCI	Science Building	1962	1994	169,586	92,905	B	Teaching Labs	Staefa	Y	Y
44	SHW	Showalter Hall	1915	-	88,408	59,222	B & A-2.1	Office	Delta	Y	Y
43	SNR	Senior Hall	1920	2006	50,014	28,850	B	General Classroom	Alerton	Y	Y
47	STR	Streeter Hall	1968	-	78,680		R-1	Residential	Staefa	Future	Y
53	SUT	Sutton Hall	1923	1996	29,340	24,570	B	Multipurpose	Alerton	Y	Y
54	TAW	Tawnaka Commons	1964	2004	68,694	39,388	B	Multipurpose	Alerton	Y	Y
57	THE	Theatre (Drama Building)	1971	-	33,715	19,997	A-2.1	Performing Arts	Alerton	Y	Y
51	URC	University Recreational Center	2007	-	115,448		B	Multipurpose	Alerton	Y	Y
61	WLM	Williamson Hall	1977	-	30,219	18,857	B	Teaching Labs	Staefa	Y	Y
60	WSP	WSP Crime Lab	2005	-	37,861		B	Office	Alerton	Y	Y
					2,486,041 GSF						

Existing Bldgs Conn. to Central Plant Services 2,486,041 GSF

Future SCI-I & II 213,000 GSF

Future Gateway 300,000 GSF

Future Total 2,999,041 17.11 % GSF Area Increase

EWU Campus Building - CHILLED WATER LOADS

Campus Map Bldg No.	BldgID	Building Name	Gross Square Footage	Facility Usage	Campus Chilled Water Service Y/N	Chilled Water Cooling Load (Tons)	Chilled Water Flow Rate (gpm)	Cooling Load Density (SF per Ton)	Notes
		Campus Master Plan Growth							
Future	???	New Science Center I	103,000	Classrooms	Future	350	560	294	Per Pre-Design Data
Future	???	New Science Center II	110,000	Classrooms	Future	375	600	293	Per Pre-Design Data
Future	???	Gateway Project	300,000	Sports Complex	Future	600	960	500	Allowance
		Future Growth Total	**513,000**			**1,325**	**2,120**		
		Residence Hall Replacements with Air Conditioning							
11	DRE	Dressler Hall	80,899	Residential	Future	162	259	500	Allowance
12	DRY	Dryden Hall	53,840	Residential	Future	108	172	500	Allowance
23	LAH	Louise Anderson Hall	73,808	Residential	Future	148	236	500	Allowance
26	MOR	Morrison Hall	100,880	Residential	Future	202	323	500	Allowance
29	PRC	Pearce Hall	93,859	Residential	Future	188	300	500	Allowance
47	STR	Streeter Hall	78,680	Residential	Future	157	252	500	Allowance
		Future Residence Hall AC Total	**481,966**			**964**	**1,542**		
		Total Future Cooling Loads				**2,289**	**3,662**	Future	
						40%		Growth	
??	???	New Residence Hall	50,000	Residential	Y	142	232	352	
2	AQT	Aquatics	21,356	Athletic	Y	47	70	454	
59	ARC	WA Archives	74,247	Multipurpose	Y	99	171	750	
3	ART	Art Building	34,415	Teaching Labs	Y	185	289	186	
5	CAD	Cadet Hall	9,034	General Classroom	?	25	60	361	Need to Verify
10	CEB	Computing and Engineering Building	97,724	Teaching Labs	Y	522	845	187	
7	CHN	Cheney Hall	30,196	Teaching Labs	Y	92	261	328	
9	CMC	Communications Center (Speech)	21,960	General Classroom	Y	44	67	499	
13	ECC	Eastern Children's Center	14,530	Operational	Y	26	31	559	
15	HAR	Hargreaves Hall	42,992	Multipurpose	Y	116	276	371	
17	HUS	Huston Hall (Computer Science Bui	27,718	Teaching Labs	Y	101	236	274	
19	ISL	Isle Hall	36,348	General Classroom	Y	96	180	379	
21	JFK	John F. Kennedy Library	165,270	Study	Y	396	1,040	417	
20	JTF	Jim Thorpe Fieldhouse (Phase IV)	57,284	Athletic	Y	11	15	5,208	
22	KGS	Kingston Hall	57,326	Teaching Labs	Y	138	250	415	
24	MAR	Martin Hall	60,000	Teaching Labs	Y	21	70	2,857	
25	MON	Monroe Hall	50,305	Multipurpose	Y	114	198	441	
27	MUS	Music Building	49,700	General Classroom	Y	61	85	815	
28	PAT	Patterson Hall	103,500	General Classroom	Y	312	750	332	
45	PAV	Pavillion (Reese Court) (Phase III)	102,531	Multipurpose	Y	388	583	264	
31	PEA	P.E. Activities (Phase II)	95,512	Athletic	Y	69	123	1,384	
32	PEC	P.E. Classroom (Phase I)	27,941	General Classroom	Y	65	259	430	
33	PLU	Plant Utilities	6,610	Multipurpose	Junction				
30	PUB	Pence Union Building	57,200	Student Services	Y	351	640	163	
40	ROZ	Rozell Heating Plant	36,645	Operational	Y	26	75	1,409	
37	RTV	Radio TV Building	17,443	Multipurpose	Y	101	165	173	
42	SCI	Science Building	169,586	Teaching Labs	Y	768	1,791	221	
44	SHW	Showalter Hall	88,408	Office	Y	134	310	660	
43	SNR	Senior Hall	50,014	General Classroom	Y	178	209	281	
53	SUT	Sutton Hall	29,340	Multipurpose	Y	41	100	716	
54	TAW	Tawnaka Commons	68,694	Multipurpose	Y	254	547	270	
57	THE	Theatre (Drama Building)	33,715	Performing Arts	Y	93	154	363	
51	URC	University Recreational Center	115,448	Multipurpose	Y	399	738	289	
61	WLM	Williamson Hall	30,219	Teaching Labs	Y	142	350	213	
60	WSP	WSP Crime Lab	37,861	Office	Y	191	306	198	
			1,971,072	Total Connected Cooling Load		5,748	Tons		

		Historical Peak Campus Chiller Load	3,000	Tons
Existing Chiller Plant Capacity		Historical Peak Campus Cooling Load	52%	(% of Connected Load)
	Tons	Existing Chiller Plant Capacity	4,000	Tons
Chiller #1	500	Historical Peak Chiller Plant Load	75%	(% of Chiller Plant Capacity)
Chiller #2	500			
Chiller #3	1,000			
Chiller #4	1,000	Future Total Connected Cooling Load	8,037	Tons
Chiller #5	1,000	Historical Peak Campus Cooling Load	52%	(% of Connected Load)
		Future Peak Central Chiller Plant Load (based on historical % loading)	4,195	
Total	4,000	Future Peak Chiller Plant Load	105%	(% of Chiller Plant Capacity)

Aquatics (AQT)

Constructed:	1980
Last Major Remodeled:	None
Square footage:	21,356
Occupancy Type:	A-2.1
Facility Usage:	Athletics

Field Data

HP Steam Service Size:	3”
Pumped Condensate Size:	2”
Chilled Water Service Size:	2”

Construction Document Data

Steam Supply:

Supply Pressure:	2-stage PRV
- PRV-1	100 psig to 60 psig
- PRV-2	60 psig to 15 psig

Design Capacity:	
- PRV-1/2 (Bldg Heating):	2,475 lb/hr
- PRV? (Pool Equip):	1,650 lb/hr
Total	4,125 lb/hr

Engineering Checks:	
- 4,125 lb/hr X 950 btu/lb:	3,918,750 btu/hr
- 3,918,750 / 21,356 sq ft:	183 btu/SF

Chilled Water:

- Total Design MBH:	563 mbh
- Total Design Tons:	47 tons
- Total Design Flow Rate:	70 gpm
- Design EWT:	40 deg. F
- Design LWT:	56.1 deg. F

Engineering Checks:	
- 21,356 sq ft / 47 tons:	454 SF/ton

Building Automation System:

Delta Controls

Washington State Digital Archives (ARC)

Constructed:	2004
Last Major Remodeled:	None
Square footage:	74,247
Occupancy Type:	B
Facility Usage:	Multipurpose, Office

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	3”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>3,920 lb/hr</u>

  Total 3,920 lb/hr

Engineering Checks:
- 3,920 lb/hr X 950 btu/lb: 3,704,400 btu/hr
- 3,704,400 / 74,247 sq ft: 50 btu/SF

Chilled Water:

- Total Design MBH: 1194 mbh
- Total Design Tons: 99.5 tons
- Total Design Flow Rate: 171 gpm
- Design EWT: 45 deg. F
- Design LWT: 59 deg. F

Engineering Checks:
- 74,247 sq ft / 99.5tons: 746 SF/ton

Building Automation System:

Delta Controls

Art Building (ART)

Constructed:	1972
Last Major Remodeled:	None
Square footage:	34,415
Occupancy Type:	A-3 & B
Facility Usage:	Teaching Labs

Field Data

HP Steam Service Size:	(2) 2.5”
Pumped Condensate Size:	2”
Chilled Water Service Size:	5”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 9,250 lb/hr

Total 9,250 lb/hr

Engineering Checks:
- 9,250 lb/hr X 950 btu/lb: 8,787,500 btu/hr
- 8,787,500 / 34,415 sq ft: 255 btu/SF

Chilled Water:

- Total Design MBH: 2213 mbh
- Total Design Tons: 184.4 tons
- Total Design Flow Rate: 289 gpm
- Design EWT: 45 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 34,415 sq ft / 184.4 tons: 186.6 SF/ton

Building Automation System:

Alerton Controls

Cadet Hall (CAD)

Constructed:	1956
Last Major Remodeled:	1978
Square footage:	9,034
Occupancy Type:	B
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	6”
Pumped Condensate Size:	3”
Chilled Water Service Size:	Future 4”

Construction Document Data

Steam Supply:

Supply Pressure:	2-stage PRV
- PRV-1/2	100 psig to 60 psig
- PRV-2/3	60 psig to 15 psig

Design Capacity:	
- PRV-1/2 (Bldg Heating):	1,000 lb/hr
Total	1,000 lb/hr

Engineering Checks:	
- 1,000 lb/hr X 950 btu/lb:	950,000 btu/hr
- 950,000 / 9,034 sq ft:	105 btu/SF

Future - Chilled Water:

- Total Design MBH:	xxxx mbh
- Total Design Tons:	25 tons - Allowance for future
- Total Design Flow Rate:	60 gpm - Allowance for future
- Design EWT:	45 deg. F
- Design LWT:	55 deg. F

Engineering Checks:	
- xx,xxx sq ft / xx tons:	xxx SF/ton

Building Automation System:

Staefa Controls

Computing and Engineering Building (CEB)

Constructed:	2005
Last Major Remodeled:	None
Square footage:	97,724
Occupancy Type:	B
Facility Usage:	Teaching Labs

Field Data

HP Steam Service Size:	6”
Pumped Condensate Size:	4”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>17,200 lb/hr</u>

Total 17,200 lb/hr

Engineering Checks:
- 17,200 lb/hr X 950 btu/lb: 16,340,000 btu/hr
- 16,340,000 / 97,724 sq ft: 167 btu/SF

Chilled Water:

- Total Design MBH: 6270 mbh
- Total Design Tons: 522.5 tons
- Total Design Flow Rate: 845 gpm
- Design EWT: 45 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 97,724 sq ft / 522.5 tons: 187 SF/ton

Building Automation System:

Alerton Controls

Cheney Hall (CHN)

Constructed:	1966
Last Major Remodeled:	1979
Square footage:	30,196
Occupancy Type:	B
Facility Usage:	Teaching Labs

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 1,500 lb/hr

Total 1,500 lb/hr

Engineering Checks:
- 1,500 lb/hr X 950 btu/lb: 1,425,000 btu/hr
- 1,425,000 / 30,196 sq ft: 47 btu/SF

Chilled Water:

- Total Design MBH: 1104 mbh
- Total Design Tons: 92 tons
- Total Design Flow Rate: 261 gpm
- Design EWT: 45 deg. F
- Design LWT: 54.5 deg. F

Engineering Checks:
- 30,196 sq ft / 92 tons: 328 SF/ton

Building Automation System:

Alerton Controls

Communication Center – Speech (CMC)

Constructed:	1970
Last Major Remodeled:	None
Square footage:	21,960
Occupancy Type:	B
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	2"
Pumped Condensate Size:	1.5"
Chilled Water Service Size:	3"

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	2,000 lb/hr
	Total	2,000 lb/hr
	Engineering Checks:	
-	2,000 lb/hr X 950 btu/lb:	1,900,000 btu/hr
-	1,900,000 / 21,960 sq ft:	86.5 btu/SF

Chilled Water:

-	Total Design MBH:	532 mbh
-	Total Design Tons:	44 tons
-	Total Design Flow Rate:	67 gpm
-	Design EWT:	44 deg. F
-	Design LWT:	60 deg. F
	Engineering Checks:	
-	21,960 sq ft / 44 tons:	499 SF/ton

Building Automation System:

Alerton Controls

Dressler Hall (DRE)

Constructed:	1966
Last Major Remodeled:	None
Square footage:	80,899
Occupancy Type:	R-1
Facility Usage:	Residential

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	Future

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>5,500 lb/hr</u>

Total 5,500 lb/hr

Engineering Checks:
- 5,500 lb/hr X 950 btu/lb: 5,225,000 btu/hr
- 5,225,000 / 80,899 sq ft: 64.59 btu/SF

Future - Chilled Water:

- Total Design MBH: xxxx mbh
- Total Design Tons: 108 tons - Allowance for future
- Total Design Flow Rate: 172 gpm - Allowance for future
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- xx,xxx sq ft / xx tons: 500 SF/ton - Allowance for future

Building Automation System:

Staefa Controls

Dryden Hall (DRY)

Constructed:	1966
Last Major Remodeled:	None
Square footage:	53,840
Occupancy Type:	R-1
Facility Usage:	Residential

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	Future

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 4,550 lb/hr

Total 4,550 lb/hr

Engineering Checks:
- 4,550 lb/hr X 950 btu/lb: 4,322,500 btu/hr
- 4,322,500 / 53,840 sq ft: 80 btu/SF

Future - Chilled Water:

- Total Design MBH: xxxx mbh
- Total Design Tons: 148 tons - Allowance for future
- Total Design Flow Rate: 236 gpm - Allowance for future
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- xx,xxx sq ft / xx tons: 500 SF/ton - Allowance for future

Building Automation System:

Staefa Controls

Eastern Children's Center (ECC)

Constructed:	1947
Last Major Remodeled:	2001
Square footage:	14,530
Occupancy Type:	E-3
Facility Usage:	Operational Support

Field Data

HP Steam Service Size:	2"
Pumped Condensate Size:	1"
Chilled Water Service Size:	2"

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>750 lb/hr</u>

  Total — 750 lb/hr

Engineering Checks:
- 750 lb/hr X 950 btu/lb: 712,500 btu/hr
- 712,500 / 14,530 sq ft: 49 btu/SF

Chilled Water:

- Total Design MBH: 312.8 mbh
- Total Design Tons: 26 tons
- Total Design Flow Rate: 31 gpm
- Design EWT: 45 deg. F
- Design LWT: -- deg. F

Engineering Checks:
- 14,530 sq ft / 26 tons: 558.8 SF/ton

Building Automation System:

Alerton Controls

Hargreaves Hall (HAR)

Constructed:	1940
Last Major Remodeled:	1967
Square footage:	42,992
Occupancy Type:	B
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	3”
Pumped Condensate Size:	2”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 2,415 lb/hr

Total 2,415 lb/hr

Engineering Checks:
- 2,415 lb/hr X 950 btu/lb: 2,294,250 btu/hr
- 2,294,250 / 42,992 sq ft: 53.4 btu/SF

Chilled Water:

- Total Design MBH: 1392 mbh
- Total Design Tons: 116 tons
- Total Design Flow Rate: 276 gpm
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- 42,992 sq ft / 116 tons: 370.6 SF/ton

Building Automation System:

JCI Controls

Huston Hall – Computer Science Building (HUS)

Constructed: 1915
Last Major Remodeled: 1984
Square footage: 27,718
Occupancy Type: B
Facility Usage: Teaching Labs

Field Data

HP Steam Service Size: 1.5”
Pumped Condensate Size: 1”
Chilled Water Service Size: 4”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2: 100 psig to 60 psig
- PRV-2/3: 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>400 lb/hr</u>
  Total: 400 lb/hr

Engineering Checks:
- 400 lb/hr X 950 btu/lb: 380,000 btu/hr
- 380,000 / 27,718 sq ft: 13.7 btu/SF

Chilled Water:

- Total Design MBH: 1,211 mbh
- Total Design Tons: 100.9 tons
- Total Design Flow Rate: 236 gpm
- Design EWT: 50 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 27,718 sq ft / 100.9 tons: 274.7 SF/ton

Building Automation System:

Alerton Controls

Isle Hall (ISL)

Constructed:	1956
Last Major Remodeled:	1975
Square footage:	36,348
Occupancy Type:	A-2.1
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	2”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	2”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>1,250 lb/hr</u>

  Total 1,250 lb/hr

Engineering Checks:
- 1,250 lb/hr X 950 btu/lb: 1,187,500 btu/hr
- 1,187,500 / 36,348 sq ft: 32.7 btu/SF

Chilled Water:

- Total Design MBH: 1154 mbh
- Total Design Tons: 96.2 tons
- Total Design Flow Rate: 180 gpm
- Design EWT: 44 deg. F
- Design LWT: 55.8 deg. F

Engineering Checks:
- 36,348 sq ft / 96.2 tons: 378 SF/ton

Building Automation System:

Delta Controls

John F. Kennedy Library (JFK)

Constructed:	1968
Last Major Remodeled:	1998
Square footage:	165,270
Occupancy Type:	A-2.1
Facility Usage:	Study

Field Data

HP Steam Service Size:	6”
Pumped Condensate Size:	3”
Chilled Water Service Size:	8”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 10,500 lb/hr

Total 10,500 lb/hr

Engineering Checks:
- 10,500 lb/hr X 950 btu/lb: 9,975,000 btu/hr
- 9,975,000 / 165,270 sq ft: 60 btu/SF

Chilled Water:

- Total Design MBH: 4757 mbh
- Total Design Tons: 396.4 tons
- Total Design Flow Rate: 1040 gpm
- Design EWT: 48 deg. F
- Design LWT: 64.4 deg. F

Engineering Checks:
- 165,270 sq ft / 396.4 tons: 416.9 SF/ton

Building Automation System:

Staefa Controls

Jim Thorpe Fieldhouse – Phase IV (JTF)

Constructed:	1978
Last Major Remodeled:	None
Square footage:	57,284
Occupancy Type:	A-2.1
Facility Usage:	Athletic

Field Data

HP Steam Service Size:	2.5”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	1.5”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>3,300 lb/hr</u>

Total 3,300 lb/hr

Engineering Checks:
- 3,300 lb/hr X 950 btu/lb: 3,135,000 btu/hr
- 3,135,000 / 57,284 sq ft: 54.7 btu/SF

Future - Chilled Water:

- Total Design MBH: 128 mbh
- Total Design Tons: 10.667 tons
- Total Design Flow Rate: 15 gpm
- Design EWT: 44 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 57,284 sq ft / 10.667 tons: 5,370 SF/ton

Building Automation System:

Alerton Controls

Kingston Hall (KGS)

Constructed:	1972
Last Major Remodeled:	None
Square footage:	57,326
Occupancy Type:	B & A-2.1
Facility Usage:	Teaching Labs

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>3,000 lb/hr</u>

  Total 3,000 lb/hr

Engineering Checks:
- 3,000 lb/hr X 950 btu/lb: 2,850,000 btu/hr
- 2,850,000 / 57,326 sq ft: 49.7 btu/SF

Chilled Water:

- Total Design MBH: 1,660 mbh
- Total Design Tons: 138 tons
- Total Design Flow Rate: 250 gpm
- Design EWT: 45 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 57,326 sq ft / 138 tons: 415 SF/ton

Building Automation System:

Alerton Controls

Louise Anderson Hall (LAH)

Constructed:	1951
Last Major Remodeled:	None
Square footage:	73,808
Occupancy Type:	R-1, B & A-2.1
Facility Usage:	Residential

Field Data

HP Steam Service Size:	3”
Pumped Condensate Size:	2”
Chilled Water Service Size:	Future

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	2300 lb/hr
	Total	2300 lb/hr
	Engineering Checks:	
-	2300 lb/hr X 950 btu/lb:	2,185,000 btu/hr
-	2,185,000 / 73,808 sq ft:	29 btu/SF

Future - Chilled Water:

-	Total Design MBH:	xx mbh
-	Total Design Tons:	148 tons - allowance for future
-	Total Design Flow Rate:	236 gpm - allowance for future
-	Design EWT:	45 deg. F
-	Design LWT:	55 deg. F
	Engineering Checks:	
-	xx sq ft / xx tons:	500 SF/ton - allowance for future

Building Automation System:

Staefa Controls

Martin Hall (MAR)

Constructed:	1937
Last Major Remodeled:	1982
Square footage:	60,000
Occupancy Type:	B
Facility Usage:	Teaching Labs

Field Data

HP Steam Service Size:	3”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	5”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>2,200 lb/hr</u>

Total 2,200 lb/hr

Engineering Checks:
- 2,200 lb/hr X 950 btu/lb: 2,090,000 btu/hr
- 2,090,000 / 60,000 sq ft: 34.8 btu/SF

Chilled Water:

- Total Design MBH: 251 mbh
- Total Design Tons: 20.9 tons
- Total Design Flow Rate: 70 gpm
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- 60,000 sq ft / 20.9 tons: 2,870.8 SF/ton

Building Automation System:

Alerton Controls

Monroe Hall (MON)

Constructed:	1916
Last Major Remodeled:	1999
Square footage:	50,305
Occupancy Type:	B
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	3”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>3,400 lb/hr</u>

Total 3,400 lb/hr

Engineering Checks:
- 3,400 lb/hr X 950 btu/lb: 3,230,000 btu/hr
- 3,230,000 / 50,305 sq ft: 64 btu/SF

Chilled Water:

- Total Design MBH: 1,370 mbh
- Total Design Tons: 114 tons
- Total Design Flow Rate: 198 gpm
- Design EWT: 45 deg. F
- Design LWT: 59.3 deg. F

Engineering Checks:
- 50,305 sq ft / 114 tons: 441.3 SF/ton

Building Automation System:

Delta Controls

Morrison Hall (MOR)

Constructed:	1971
Last Major Remodeled:	None
Square footage:	100,880
Occupancy Type:	R-1
Facility Usage:	Residential

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	Future

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	9,000 lb/hr
	Total	9,000 lb/hr
	Engineering Checks:	
-	9,000 lb/hr X 950 btu/lb:	8,550,000 btu/hr
-	8,550,000 / 100,880 sq ft:	84.75 btu/SF

Future - Chilled Water:

-	Total Design MBH:	xx mbh
-	Total Design Tons:	202 tons - allowance for future
-	Total Design Flow Rate:	323 gpm - allowance for future
-	Design EWT:	45 deg. F
-	Design LWT:	55 deg. F
	Engineering Checks:	
-	xx sq ft / xx tons:	500 SF/ton - allowance for future

Building Automation System:

Staefa Controls

Music Building (MUS)

Constructed:	1970
Last Major Remodeled:	None
Square footage:	49,700
Occupancy Type:	A-2.1
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	2.5" & 1.5"
Pumped Condensate Size:	2" & 1.25"
Chilled Water Service Size:	4" & 3.5"

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>2,675 lb/hr</u>

Total 2,675 lb/hr

Engineering Checks:
- 2,675 lb/hr X 950 btu/lb: 2,541,250 btu/hr
- 2,541,250 / 49,700 sq ft: 51 btu/SF

Chilled Water:

- Total Design MBH: 730 mbh
- Total Design Tons: 60.8 tons
- Total Design Flow Rate: 85 gpm
- Design EWT: 44 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 49,700 sq ft / 60.8 tons: 817 SF/ton

Building Automation System:

Alerton Controls

New Dorm (???)

Constructed:	2013
Last Major Remodeled:	-
Square footage:	50,000
Occupancy Type:	R-1
Facility Usage:	Residential

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>6,078 lb/hr</u>

  Total 6,078 lb/hr

Engineering Checks:
- 6,078 lb/hr X 950 btu/lb: 5,774,100 btu/hr
- 5,774,100 / 50,000 sq ft: 115 btu/SF

Chilled Water:

- Total Design MBH: 1,704 mbh
- Total Design Tons: 142 tons
- Total Design Flow Rate: 232 gpm
- Design EWT: 44 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- 50,000 sq ft / 142 tons: 352 SF/ton

Building Automation System:

Alerton Controls

Patterson Hall (PAT)

Constructed: 1969
Last Major Remodeled: 1971
Square footage: 103,500
Occupancy Type: B
Facility Usage: General Classroom

Field Data

HP Steam Service Size: 4”
Pumped Condensate Size: 2”
Chilled Water Service Size: 6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 9,381 lb/hr
Total 9,381 lb/hr

Engineering Checks:
- 9,381 lb/hr X 950 btu/lb: 8,911,950 btu/hr
- 8,911,950 / 103,500 sq ft: 86 btu/SF

Chilled Water:

- Total Design MBH: 3,954 mbh
- Total Design Tons: 329.5 tons
- Total Design Flow Rate: 750 gpm
- Design EWT: 44 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- 103,500 sq ft / 329.5 tons: 314 SF/ton

Building Automation System:

Alerton Controls

Pavillion – Reese Court – Phase III (PAV)

Constructed:	1975
Last Major Remodeled:	None
Square footage:	102,531
Occupancy Type:	A-2.1
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>11,800 lb/hr</u>

  Total 11,800 lb/hr

Engineering Checks:
- 11,800 lb/hr X 950 btu/lb: 11,210,000 btu/hr
- 11,210,000 / 102,531 sq ft: 109 btu/SF

Chilled Water:

- Total Design MBH: 4,659 mbh
- Total Design Tons: 388.25 tons
- Total Design Flow Rate: 583 gpm
- Design EWT: 44 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 102,531 sq ft / 388.25 tons: 264 SF/ton

Building Automation System:

Alerton Controls

P.E. Activities – Phase II (PEA)

Constructed:	1972
Last Major Remodeled:	None
Square footage:	95,512
Occupancy Type:	B
Facility Usage:	Athletic

Field Data

HP Steam Service Size:	6” & 5”
Pumped Condensate Size:	3” & 2.5”
Chilled Water Service Size:	(2) 2.5”

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	20,790 lb/hr
	Total	20,790 lb/hr
	Engineering Checks:	
-	20,790 lb/hr X 950 btu/lb:	19,750,500 btu/hr
-	19,750,500 / 95,512 sq ft:	206.8 btu/SF

Chilled Water:

-	Total Design MBH:	825 mbh
-	Total Design Tons:	68.75 tons
-	Total Design Flow Rate:	122.7 gpm
-	Design EWT:	44 deg. F
-	Design LWT:	57.7 deg. F
	Engineering Checks:	
-	95,512 sq ft / 68.75 tons:	1,389 SF/ton

Building Automation System:

Alerton Controls

P.E. Classroom – Phase I (PEC)

Constructed:	1971
Last Major Remodeled:	None
Square footage:	27,941
Occupancy Type:	B
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	2.5”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	2,470 lb/hr
	Total	2,470 lb/hr
	Engineering Checks:	
-	2,470 lb/hr X 950 btu/lb:	2,346,500 btu/hr
-	2,346,500 / 27,941 sq ft:	84 btu/SF

Chilled Water:

-	Total Design MBH:	783 mbh
-	Total Design Tons:	65.25 tons
-	Total Design Flow Rate:	259 gpm
-	Design EWT:	44 deg. F
-	Design LWT:	60 deg. F
	Engineering Checks:	
-	27,941 sq ft / 65.25 tons:	428 SF/ton

Building Automation System:

JCI Controls

Plant Utilities (PLU)

Constructed:	1917
Last Major Remodeled:	None
Square footage:	6,610
Occupancy Type:	B & S-2
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	2”
Pumped Condensate Size:	1”
Chilled Water Service Size:	None

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	1,000 lb/hr
	Total	1,000 lb/hr
	Engineering Checks:	
-	1,000 lb/hr X 950 btu/lb:	950,000 btu/hr
-	950,000 / 6,610 sq ft:	143.7 btu/SF

Building Automation System:

Staefa Controls

Pearce Hall (PRC)

Constructed: 1964
Last Major Remodeled: 1964
Square footage: 93,859
Occupancy Type: R-1
Facility Usage: Residential

Field Data

HP Steam Service Size: 4”
Pumped Condensate Size: 2”
Chilled Water Service Size: Future

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>4,485 lb/hr</u>
  Total 4,485 lb/hr

Engineering Checks:
- 4,485 lb/hr X 950 btu/lb: 4,260,750 btu/hr
- 4,260,750 / 93,859 sq ft: 45.4 btu/SF

Future - Chilled Water:

- Total Design MBH: xx mbh
- Total Design Tons: 188 tons - allowance for future
- Total Design Flow Rate: 300 gpm - allowance for future
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- xx sq ft / xx tons: 500 SF/ton - allowance for future

Building Automation System:

Staefa Controls

Pence Union Building (PUB)

Constructed:	1970
Last Major Remodeled:	1995
Square footage:	57,200
Occupancy Type:	M, B & A-2.1
Facility Usage:	Student Services

Field Data

HP Steam Service Size:	3” & 4”
Pumped Condensate Size:	2” & 2.5”
Chilled Water Service Size:	5” & 6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>10,950 lb/hr</u>

  Total 10,950 lb/hr

Engineering Checks:
- 10,950 lb/hr X 950 btu/lb: 10,402,500 btu/hr
- 10,402,500 / 57,200 sq ft: 181.9 btu/SF

Chilled Water:

- Total Design MBH: 4,212 mbh
- Total Design Tons: 351 tons
- Total Design Flow Rate: 640 gpm
- Design EWT: 44.7 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 57,200 sq ft / 351 tons: 163 SF/ton

Building Automation System:

Staefa Controls

Rozell Heating Plant (ROZ)

Constructed:	1970
Last Major Remodeled:	2002
Square footage:	36,645
Occupancy Type:	H-7
Facility Usage:	Operational Support

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>13,000 lb/hr</u>

Total 13,000 lb/hr

Engineering Checks:
- 13,000 lb/hr X 950 btu/lb: 12,350,000 btu/hr
- 12,350,000 / 36,645 sq ft: 337 btu/SF

Chilled Water:

- Total Design MBH: 307 mbh
- Total Design Tons: 25.6 tons
- Total Design Flow Rate: 75 gpm
- Design EWT: 44.3 deg. F
- Design LWT: 56.3 deg. F

Engineering Checks:
- 36,645 sq ft / 25.6 tons: 1,431 SF/ton

Building Automation System:

Delta Controls

Robert Reid Lab School (RRL)

Constructed:	1959
Last Major Remodeled:	None
Square footage:	33,003
Occupancy Type:	E-1
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	None

Construction Document Data

Steam Supply:

Supply Pressure:	2-stage PRV
- PRV-1/2	100 psig to 60 psig
- PRV-2/3	60 psig to 15 psig
Design Capacity:	
- PRV-1/2 (Bldg Heating):	1,600 lb/hr
Total	1,600 lb/hr
Engineering Checks:	
- 1,600 lb/hr X 950 btu/lb:	1,520,000 btu/hr
- 1,520,000 / 33,003 sq ft:	46 btu/SF

Building Automation System:

Staefa Controls

Radio TV Building (RTV)

Constructed:	1972
Last Major Remodeled:	None
Square footage:	17,443
Occupancy Type:	B
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	2”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>1,920 lb/hr</u>

  Total 1,920 lb/hr

Engineering Checks:
- 1,920 lb/hr X 950 btu/lb: 1,824,000 btu/hr
- 1,824,000 / 17,443 sq ft: 104.6 btu/SF

Chilled Water:

- Total Design MBH: 1211 mbh
- Total Design Tons: 100.9 tons
- Total Design Flow Rate: 165 gpm
- Design EWT: 44 deg. F
- Design LWT: 58.6 deg. F

Engineering Checks:
- 17,443 sq ft / 100.9 tons: 172.9 SF/ton

Building Automation System:

Alerton Controls

Science Building (SCI)

Constructed: 1962
Last Major Remodeled: 1994
Square footage: 92,905
Occupancy Type: B
Facility Usage: Teaching Labs

Field Data

HP Steam Service Size: 6”
Pumped Condensate Size: 3”
Chilled Water Service Size: 8”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 17,800 lb/hr

Total 17,800 lb/hr

Engineering Checks:
- 17,800 lb/hr X 950 btu/lb: 16,910,000 btu/hr
- 16,910,000 / 92,905 sq ft: 182 btu/SF

Chilled Water:

- Total Design MBH: 9,211 mbh
- Total Design Tons: 767.6 tons
- Total Design Flow Rate: 1,791 gpm
- Design EWT: 46.5 deg. F
- Design LWT: 57.5 deg. F

Engineering Checks:
- 92,905 sq ft / 767.6 tons: 121 SF/ton

Building Automation System:

Staefa Controls

Showalter Hall (SHW)

Constructed:	1915
Last Major Remodeled:	None
Square footage:	88,408
Occupancy Type:	B & A-2.1
Facility Usage:	Office

Field Data

HP Steam Service Size:	5" & 4"
Pumped Condensate Size:	2"
Chilled Water Service Size:	5"

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>4,500 lb/hr</u>

Total 4,500 lb/hr

Engineering Checks:
- 4,500 lb/hr X 950 btu/lb: 4,275,000 btu/hr
- 4,275,000 / 88,408 sq ft: 48 btu/SF

Chilled Water:

- Total Design MBH: 1,609 mbh
- Total Design Tons: 134 tons
- Total Design Flow Rate: 310 gpm
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- 88,408 sq ft / 134 tons: 660 SF/ton

Building Automation System:

Delta Controls

Senior Hall (SNR)

Constructed:	1920
Last Major Remodeled:	2006
Square footage:	50,014
Occupancy Type:	B
Facility Usage:	General Classroom

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	x6

Construction Document Data

Steam Supply:

Supply Pressure:	2-stage PRV
- PRV-1/2	100 psig to 60 psig
- PRV-2/3	60 psig to 15 psig

Design Capacity:	
- PRV-1/2 (Bldg Heating):	<u>3,430 lb/hr</u>
Total	3,430 lb/hr

Engineering Checks:	
- 3,430 lb/hr X 950 btu/lb:	3,258,500 btu/hr
- 3,258,500 / 50,014 sq ft:	65 btu/SF

Chilled Water:

- Total Design MBH:	2,141 mbh
- Total Design Tons:	178 tons
- Total Design Flow Rate:	209 gpm
- Design EWT:	45 deg. F
- Design LWT:	60 deg. F

Engineering Checks:	
- 50,014 sq ft / 178 tons:	281 SF/ton

Building Automation System:

Alerton Controls

Streeter Hall (STR)

Constructed:	1968
Last Major Remodeled:	None
Square footage:	78,680
Occupancy Type:	R-1
Facility Usage:	Residential

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	Future

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 6,000 lb/hr

Total 6,000 lb/hr

Engineering Checks:
- 6,000 lb/hr X 950 btu/lb: 5,700,000 btu/hr
- 5,700,000 / 78,680 sq ft: 72 btu/SF

Future - Chilled Water:

- Total Design MBH: xx mbh
- Total Design Tons: 157 tons - allowance for future
- Total Design Flow Rate: 252 gpm - allowance for future
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- xx sq ft / xx tons: 500 SF/ton - allowance for future

Building Automation System:

Staefa Controls

Sutton Hall (SUT)

Constructed:	1923
Last Major Remodeled:	1996
Square footage:	29,340
Occupancy Type:	B
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	4"
Pumped Condensate Size:	1.5"
Chilled Water Service Size:	4"

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>1,982 lb/hr</u>

Total 1,982 lb/hr

Engineering Checks:
- 1,982 lb/hr X 950 btu/lb: 1,882,900 btu/hr
- 1,882,900 / 29,340 sq ft: 64 btu/SF

Chilled Water:

- Total Design MBH: 486 mbh
- Total Design Tons: 40.5 tons
- Total Design Flow Rate: 100 gpm
- Design EWT: 46 deg. F
- Design LWT: 55.7 deg. F

Engineering Checks:
- 29,340 sq ft / 40.5 tons: 724 SF/ton

Building Automation System:

Staefa Controls

Tawanka Commons (TAW)

Constructed:	1964
Last Major Remodeled:	2004
Square footage:	68,694
Occupancy Type:	B
Facility Usage:	Multi-purpose

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV

- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:

- PRV-1/2 (Bldg Heating): <u>9,000 lb/hr</u>

Total 9,000 lb/hr

Engineering Checks:

- 9,000 lb/hr X 950 btu/lb: 8,550,000 btu/hr
- 8,550,000 / 68,694 sq ft: 124.5 btu/SF

Chilled Water:

- Total Design MBH: 3,044 mbh
- Total Design Tons: 253.7 tons
- Total Design Flow Rate: 547 gpm
- Design EWT: 45 deg. F
- Design LWT: 56.2 deg. F

Engineering Checks:

- 68,694 sq ft / 253.7 tons: 271 SF/ton

Building Automation System:

Alerton Controls

Theatre Drama Building (THE)

Constructed:	1971
Last Major Remodeled:	None
Square footage:	33,715
Occupancy Type:	A-2.1
Facility Usage:	Performing Arts

Field Data

HP Steam Service Size:	2”
Pumped Condensate Size:	1.5”
Chilled Water Service Size:	4”

Construction Document Data

Steam Supply:

	Supply Pressure:	2-stage PRV
-	PRV-1/2	100 psig to 60 psig
-	PRV-2/3	60 psig to 15 psig
	Design Capacity:	
-	PRV-1/2 (Bldg Heating):	<u>1,920 lb/hr</u>
	Total	1,920 lb/hr
	Engineering Checks:	
-	1,920 lb/hr X 950 btu/lb:	1,824,000 btu/hr
-	1,824,000 / 33,715 sq ft:	54 btu/SF

Chilled Water:

-	Total Design MBH:	1,113 mbh
-	Total Design Tons:	92.75 tons
-	Total Design Flow Rate:	154 gpm
-	Design EWT:	44 deg. F
-	Design LWT:	59 deg. F
	Engineering Checks:	
-	33,715 sq ft / 92.75 tons:	363.5 SF/ton

Building Automation System:

Alerton Controls

University Recreational Center (URC)

Constructed:	2007
Last Major Remodeled:	None
Square footage:	115,488
Occupancy Type:	B
Facility Usage:	Multi-Purpose

Field Data

HP Steam Service Size:	6”
Pumped Condensate Size:	2”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure:	2-stage PRV
- PRV-1/2	100 psig to 60 psig
- PRV-2/3	60 psig to 15 psig
Design Capacity:	
- PRV-1/2 (Bldg Heating):	9,096 lb/hr
Total	9,096 lb/hr
Engineering Checks:	
- 9,096 lb/hr X 950 btu/lb:	8,641,200 btu/hr
- 8,641,200 / 115,488 sq ft:	74.8 btu/SF

Chilled Water:

- Total Design MBH:	4,785 mbh
- Total Design Tons:	398.75 tons
- Total Design Flow Rate:	738.1 gpm
- Design EWT:	42.3 deg. F
- Design LWT:	56.7 deg. F
Engineering Checks:	
- 115,488 sq ft / 398.75 tons:	290 SF/ton

Building Automation System:

Alerton Controls

Williamson Hall (WLM)

Constructed: 1977
Last Major Remodeled: None
Square footage: 30,219
Occupancy Type: B
Facility Usage: Teaching Labs

Field Data

HP Steam Service Size: 3"?
Pumped Condensate Size: 1.5"?
Chilled Water Service Size: 5"

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 100 psig to 60 psig
- PRV-2/3 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): 2,400 lb/hr
  Total 2,400 lb/hr

Engineering Checks:
- 2,400 lb/hr X 950 btu/lb: 2,280,000 btu/hr
- 2,280,000 / 30,219 sq ft: 75 btu/SF

Chilled Water:

- Total Design MBH: 1,710 mbh
- Total Design Tons: 142.5 tons
- Total Design Flow Rate: 350 gpm
- Design EWT: 45 deg. F
- Design LWT: 55 deg. F

Engineering Checks:
- 30,219 sq ft / 142.5 tons: 212 SF/ton

Building Automation System:

Staefa Controls

WSP Crime Lab (WSP)

Constructed:	2005
Last Major Remodeled:	None
Square footage:	37,861
Occupancy Type:	B
Facility Usage:	Office

Field Data

HP Steam Service Size:	4”
Pumped Condensate Size:	2”
Chilled Water Service Size:	6”

Construction Document Data

Steam Supply:

Supply Pressure: 2-stage PRV
- PRV-1/2 — 100 psig to 60 psig
- PRV-2/3 — 60 psig to 15 psig

Design Capacity:
- PRV-1/2 (Bldg Heating): <u>6,900 lb/hr</u>

  Total 6,900 lb/hr

Engineering Checks:
- 6,900 lb/hr X 950 btu/lb: 6,555,000 btu/hr
- 6,555,000 / 37,861 sq ft: 173 btu/SF

Chilled Water:

- Total Design MBH: 2,294 mbh
- Total Design Tons: 191 tons
- Total Design Flow Rate: 306 gpm
- Design EWT: 45 deg. F
- Design LWT: 60 deg. F

Engineering Checks:
- 37,861 sq ft / 191 tons: 198 SF/ton

Building Automation System:

Alerton Controls

APPENDIX D

ENERGY EFFICIENCY & SUSTAINABILITY REPORT
McKinstry - 2012
(Partial Excerpts)

Reducing Scope 1 & 2 Emissions

Executive Report

ROZELL BUILDING

The Rozell building contains the central heating and cooling generating equipment for the entire campus.

HEATING PLANT

There are five high-pressure steam boilers located in the central steam plant at Eastern Washington University. All are capable of firing off of natural gas and No. 2 fuel-oil. Boiler #1 is rated at 56,000 lbs/hr, Boiler #2 at 25,000 lbs/hr, Boiler #3 at 25,000 lbs/hr, Boiler #4 at 47,000 lbs/hr, and Boiler #5 at 89,000 lbs/hr. With the exception of boiler #5, which was installed and fired in 2003, all of the boilers are more than fifty years old—and some are more than sixty years old. Boiler #3 broke down three years ago and it remains out of service to this day. Boilers #1, #3, and #5 have boiler feedwater economizers installed in their exhaust stack; Boilers #2 and #4 do not. Typically during the cooling season, only Boiler #2 operates. Boilers #1 and #4 operate during the shoulder seasons and Boiler #5 operates during the peak months of the heating season. Boiler #5 is the only boiler with a low-nitrogen-oxide burner; the other boilers' burners should be upgraded to low-NOx burners as well.

Condensate from the campus is pumped into a large tank in the lower level of the Rozell Building's boiler room. If required, make-up water is introduced into the system with the campus condensate. From this tank the water is then pumped to the De-aerator (DA) tank which is located in the boiler room. From the DA tank the water is then pumped into the respective boilers based on their need, using the dedicated floor-mounted feedwater pumps. These pumps are capable of pumping the water into the boilers directly, as in the case of Boiler #2 or Boiler #4 or into the economizers on Boilers #1 and #5. The boiler feedwater being pumped into the stack economizers must be under an elevated pressure in order to ensure it does not flash off to steam in the heat exchanger in the exhaust stack. After taking the heat out of the exhaust stack gases, the feedwater is then introduced into the boiler.

The facility has three 50-horsepower boiler feedwater pumps, all taken from another system. These well-used pumps have had several seal and impeller failures, sometimes simultaneously, placing the entire feedwater load on the steam turbine pump—which can only operate when the minimum load is 20,000 lb/hr or greater, thus risking complete steam plant shut down.
The methodology in which chemicals are introduced into the steam system should be analyzed as well, as this may produce significant savings in both energy and chemicals.

COOLING PLANT

The University's cooling system is comprised of three 1,000-ton, water-cooled Carrier centrifugal chillers and two 500-ton water-cooled Carrier Centrifugal chillers, producing a total cooling capacity of 4,000 tons. Each chiller has a dedicated primary chilled water pump and condenser water pump, as well as a dedicated cooling tower. All of the towers are induced-draft, open-circuit Marley cooling towers. The three 1,000-ton towers are sized to deliver 85 degree water to the chillers, while the 500-ton towers were originally sized to deliver the water at 85 degrees as well. Due to age, the 500-ton towers can deliver only 88-90 degree water during the peak of the cooling season.

The chilled water distribution system is a primary/secondary, variable-volume pumping system with tertiary pumps at the building or load source. There are three secondary system pumps that serve the campus loop. They are brought online/ offline based on being able to maintain 14 inches Water Column (WC) between the supply and return lines. Only one of the secondary pumps is controlled with a variable-frequency drive, while the other two have two-speed motors. For some reason, the tertiary pumps in the buildings or at the coils are only turned on when the outdoor air temperature reaches 85 to 90 degrees. Peak-season cooling is between 2,300 and 2,400 tons.

There are two plate-and-frame heat exchangers for free cooling. The older unit is approximately fourteen years old and has 300 tons of cooling capacity. The newer unit, installed by McKinstry in 2003, has a cooling capacity of 200 tons. Each unit has a one-degree approach.

AIR DISTRIBUTION SYSTEM

Rozell's office area is served by a variable-volume air handler with VAV boxes and hot water reheat coils. The unit is mounted on the roof of next to the cooling towers. Other constant-volume variable-temperature air handling units serve the boiler room and the refrigeration mechanical room.

Reducing Scope 1 & 2 Emissions

Detailed Report

EASTERN WASHINGTON UNIVERSITY/ROZELL CENTRAL PLANT BUILDING

FIELD NOTES FROM PRELIMINARY ENERGY AUDIT – AUGUST 2010

OVERVIEW

The Rozell Central Heating and Cooling Plant building is a support services facility of Eastern Washington University and is located on the northern side of the EWU campus in Cheney Washington. A preliminary energy audit was conducted on all of the systems in Rozell.

ROZELL CENTRAL PLANT BUILDING

The Rozell Central Plant Building is a two-story brick building which was built in 1970. The latest upgrades and renovations were completed in the 2002 – 2003 time frame. This is a 56,000 square foot facility which houses the Campus's Central Steam Plant and the central chilled water plant. It also houses the university's Construction and Planning Department, as well as the Director of Maintenance and the energy management office and Facilities Information Technology offices. Facilities I.T. is responsible for architecting and administering the support systems and server farm for all of Facilities and Planning. The Central Heating and Cooling Plants provide high pressure steam and chilled water to the Utility Tunnel System that basically brings the steam and chilled water to most buildings on the EWU campus. Condensate return is also brought back from the buildings on campus through the utility tunnel system.

PREVIOUS ENERGY RETROFITS

McKinstry has previously completed retrofits of the Rozell Central Plant building in 2003. At that time McKinstry installed a new 1,000 Ton Open Circuit, Induced Draft Marley Cooling Tower and its associated condenser water pump. McKinstry installed a 200 Ton Plate and Frame heat exchanger, and associated pumps, as well as automating the chilled water plant with Delta Digital Controls. McKinstry also installed a small cooling only fan coil for the UPS systems in the lower level mechanical room. Prior to that, a lighting retrofit was done throughout the building that saw all of the T12 fluorescent lamps and standard ballasts getting retrofitted with T8 Lamps and electronic ballast. The only area of Rozell that still has an opportunity to save energy on lighting is in the Boiler room itself, with the high bay lighting fixtures.

HEATING SYSTEM

There are (5) five high pressure steam boilers located in the central steam plant at EWU. All are capable of firing off of natural gas and No. 2 fuel-oil. Boiler #1 is rated at 56,000 lbs/hr, Boiler #2 at 25,000 lbs/hr, Boiler #3 at 25,000 lbs/hr, Boiler #4 at 47,000 lbs/hr, and Boiler #5 at 89,000. With the exception of boiler #5 which was installed and fired in 2003, all of the boilers range in age from 50 plus years old to 60 plus years old. Three years ago, Boiler #3 had significant issues which caused it to shut down and to this day it has not been brought back on line. Boilers #1, #3, and #5 have boiler feedwater economizers installed in their exhaust stack; boilers #2 and #4 do not. Typically during the cooling season, only boiler #2 operates. Boilers #1 and #4 operate during the shoulder seasons and boiler #5 operates during the peak months of the heating season. Boiler #5 is the only boiler with a Low NOx Burner. The other 4 boilers would be excellent candidates to have their burners swapped out with Low NOx Burners.

Reducing Scope 1 & 2 Emissions

Condensate from around the campus is pumped into a large tank in the lower level of the Rozell Building's boiler room. If required, make up water is introduced into the system with the campus condensate. From this tank the water is then pumped up to the Deaerator tank which is located in the boiler room. From the DA tank the water is then pumped into the respective boilers based on their need using the dedicated floor mounted boiler feedwater pumps. These pumps are capable of pumping the water into the boilers directly, as in the case of Boiler #2 or Boiler #4 or into the economizers on Boilers #1 and #5. The boiler feedwater being pumped into the stack economizers must be under an elevated pressure in order to ensure is doesn't flash off to steam in the heat exchanger in the exhaust stack. After taking the heat out of the exhaust stack gases, the feedwater is then introduced into the boiler.

Currently Eastern Washington University has (3) three 50 HP boiler feedwater pumps, these pumps were taken from another system to be used for the feedwater system. As a result of making use of these (3) three used pumps, there have been several seal and impeller failures which has resulted in simultaneous outages in all (3) three pumps. This has placed the entire feedwater load on the steam turbine pump, a pump that can only operate when the minimum load is 20,000 lb/hr or greater, thus placing the steam plant at risk of being completely shut down.

The way chemical is introduced into the steam system should be analyzed. It has been McKinstry's experience that this usually leads to significant savings from an energy perspective as well as a capital dollars expenditure on less chemicals.

COOLING SYSTEM

The university's cooling system is comprised of (3) 1,000 ton water cooled Carrier centrifugal chillers, and (2) 500 ton water cooled Carrier Centrifugal chillers. In all there is a cooling capacity of 4,000 tons. Each chiller has a dedicated primary chilled water pump and condenser water pump, as well as a dedicated cooling tower. All of the towers are induced draft, open circuit Marley cooling towers. The three 1,000 ton towers are sized to deliver 85 degree water to the chillers, while the (2) 500 ton towers were originally sized to deliver the water at 85 degrees as well. The age of the (2) 500 ton towers and their ability to reject heat to the atmosphere has deteriorated through the years and are only able to deliver 88 to 90 degree water during the peak of the cooling season.

The chilled water distribution system is a primary / secondary variable volume pumping system with tertiary pumps out at the building or load source. There are three secondary system pumps that serve the campus loop. They are brought on / off line based on being able to maintain 14 in. WC between the supply and return lines. Only one of the secondary pumps is controlled with a VFD, while the other 2 are 2-speed motors. For some reason, the tertiary pumps in the buildings or at the coils are only turned on when the outdoor air temperature reaches 85 to 90 degrees.

According to the Plant Supervisor, Kevin Beckwith, told McKinstry that the largest cooling load that the plant personnel see during the peak of the cooling season is approximately between 2,300 tons and 2,400 tons.

There are 2 plate and frame heat exchangers for free cooling. The older of the 2 is approximately 14 years old and has 300 tons of cooling capacity while the newer of the 2 that McKinstry installed in 2003, has a cooling capacity of 200 tons. Each plate and frame heat exchanger has a 1 degree approach.

AIR DISTRIBUTION SYSTEM

The ventilation system serving the office area of Rozell is comprised of a variable volume air handling unit with VAV boxes with hot water reheat coils. This unit is mounted on the roof of the Rozell Building next to the cooling towers.

Reducing Scope 1 & 2 Emissions

SEQUENCE OF OPERATIONS

1. The VAV AHU operates 24/7, and is controlled with Staeffa Digital controls. No night setback or start/stop controls.
2. There is no morning purge, morning warm-up / morning cool-down.
3. It is not known if the air handler has economizer controls or not.

AREAS OF INTEREST

1. Boiler Feed Water Pump Retrofits.
2. Retrofit #3 Boiler that is sized to deliver 40,000 lbs/hr of high pressure steam.
3. Install Boiler Feed Water Economizers on #2 and #4 Boilers.
4. Install Low NOx Burners on Boilers #1, #2, and #4.
5. Retrofit the high bay lighting fixtures in the boiler room with T5HO fixtures.
6. Install VFDs on the chiller compressors, and on the (3) 1,000 ton cooling towers.
7. Install (2) new Cooling Towers with VFDs, sized to deliver 75 degree water during peak loads.
8. Swap out the (2) 2-speed motors with inverter duty ready motors and pumps and control them with VFDs and map them into the Delta Digital Control system.
9. Examine the feasibility of adding another 1,000 Ton Water-Cooled Chiller and corresponding cooling tower with associated pumps.

Reducing Scope 1 & 2 Emissions

Table 1- Air Handler Units

		Date:	10/13/10 to 10/14/10
Job number | Building:	**P 11561 Rozell**	**Name:**	DDM

Air Handling Unit Tag	**Air Handler**	**AHU -1**	**AHU-2**
Area Served	Chiller room	Pump Room	Pump Room
System Type		Fan coil	Same as AHU 1
Manufacturer	Carrier	MagicAire	MagicAire
Cold Deck Model Number	39TH13MBN	60-BVW-B	60-BVW-B
Cold Deck Serial Number	5196F46022	W040 189398	W040189399
Cold Deck CFM	NL	NL	NL
TSP in. W.C.	NL	NL	NL
Hot Deck Model Number			
Hot Deck Serial Number			
Hot Deck CFM			
TSP in. W.C.			
Motor Name Plate Data (Cold Deck)			
Manufacturer	Magnetck	GE	Magnetck
Voltage	230/460	208-230/460	230/460
Amperage	8.2/4.1	5.5-5.6/2.8	8.2/4.1
HP	3	1.5	3
Motor Efficiency	0.875	NL	0.875
Power Factor	0.78	NL	0.78
Frame	182T	56 H	182T
Motor Type	TEFC	ODP	TEFC
Actual kW Measured	3	1.3	1.3
Actual Voltage Measured	485	485	485
Actual Amperage Measured	4.5	2.3	2.2
Motor Name Plate Data (Hot Deck)			
Manufacturer			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			
Motor Name Plate Data (Return Fan)	EF-31-1		
Return Fan Model Number	not accessible		
Return Fan Serial Number	not accessible		
Return Fan CFM	not accessible		
TSP in. W.C.	not accessible		
Manufacturer	not accessible		
Voltage	36% OPF		
Amperage	not accessible		
HP	ODP		
Motor Efficiency	1.2		
Power Factor	486		
Frame	3.7		
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			

Reducing Scope 1 & 2 Emissions

Table 2- Air Handler Units Cont.

Date: 10/12/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Air Handling Unit Tag	**AH-1 (Roof)**	**AHU -27- 1**	**NL (Boiler Room)**
Area Served	Offices	Boiler Room	Pump Room
System Type	VAV	NL	NL
Manufacturer	HAAKON	NL	NL
Cold Deck Model Number	Size 321 Type APF	NL	NL
Cold Deck Serial Number	00-156397-2-1	NL	NL
Cold Deck CFM	NL	NL	NL
TSP in. W.C.	NL	NL	NL
Hot Deck Model Number	NL	NA	NA
Hot Deck Serial Number	NL	NA	NA
Hot Deck CFM	NL	NA	NA
TSP in. W.C.	NL	NA	NA
Motor Name Plate Data (Cold Deck)			
Manufacturer	BALDOR	Magnetck	Magnetck
Voltage	230/460	460	460
Amperage	47/235	7.1 / 4.8	7.1 / 4.8
HP	20	5.5 (1750) / 2.2 (1160)	5.5 (1750) / 2.2 (1160)
Motor Efficiency	0.93	.86 (1750) / .75 (1160)	.86 (1750) / .75 (1160)
Power Factor	0.86	.82 (1750) / .62 (1160)	.82 (1750) / .62 (1160)
Frame	256T	5215T	5215T
Motor Type	ODP	ODP	ODP
Actual kW Measured	14,8	0.63	0.8
Actual Voltage Measured	488	484	489
Actual Amperage Measured	18.8	3,6 (High Speed)	3.8 (High Speed)
Motor Name Plate Data (Hot Deck)			
Manufacturer			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			
Motor Name Plate Data (Return Fan)	Twin City Fan & Blower		
Return Fan Model Number	Size 321 Type APF		
Return Fan Serial Number	00-156397-1-1		
Return Fan CFM	NL		
TSP in. W.C.	NL		
Manufacturer	BALDOR		
Voltage	230 / 460		
Amperage	12.8/6.4		
HP	5		
Motor Efficiency	0.895		
Power Factor	0.81		
Frame	184T		
Motor Type	ODP		
Actual kW Measured	2.9		
Actual Voltage Measured	483		
Actual Amperage Measured	5.1		

Reducing Scope 1 & 2 Emissions

Table 3- Pumps

Date: 10/13-10/15/2010
Job number | Building: **P 11561 Rozell** **Name:** DDM

Pump Data	**P-3**	**P-1**	**P-2**
Area/System/Equipment Served	CHW pump for AHU 1 (roof)	Heating Water	Same as P1
Pump Type	Horizontal inline	Horizontal inline	Horizontal inline
Manufacturer	Armstrong	Armstrong	Armstrong
Model Number	NL	NL	NL
Serial Number	NL	NL	NL
GPM	inaccessible	inaccessible	inaccessible
Ft of Head			
Motor Name Plate Data			
Manufacturer	NL	NL	
Model Number	NL	NL	
Serial Number	NL	NL	
Voltage	115/208-230	208-230/460	
Amperage	5.8/2.8-2.9	3.5-3.6/1.8	
HP	2-Jan	1	
Motor Efficiency	NL	NL	
Power Factor	NL	NL	
Frame	56	56L	
Motor Type	ODP	ODP	
Actual kW Measured	0.45	1.0 KW	.6 KW
Actual Voltage Measured	121	484	485
Actual Amperage Measured	4.6	1.8	1.6

Pump Data	**CWP-1**		
Area/System/Equipment Served	AHU- 1 & 2 Chilled Water		
Pump Type	Horizontal Inline		
Manufacturer	B & G		
Model Number	60 1.5 x 5.25		
Serial Number	510884 B40		
GPM	27		
Ft of Head	13'		
Motor Name Plate Data			
Manufacturer	B & G		
Model Number			
Serial Number			
Voltage	115/208-230		
Amperage	2.8/1.5-1.4		
HP	44		
Motor Efficiency	NL		
Power Factor	NL		
Frame	56Z		
Motor Type	ODP		
Actual kW Measured	0.25		
Actual Voltage Measured	121		
Actual Amperage Measured	2		

Table 4- Pumps Cont.

Date: 10/14/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Pump Data	**HWP-1**	**HWP-2**	**HWP-3 (Seal at input shaft leaks)**
Area/System/Equipment Served			
Pump Type	BMES	BMES	BMES
Manufacturer	Worthington	Worthington	Worthington
Model Number	2CNE 82 CN-8A	2CNE 82 CN-8A	11-28951-133201
Serial Number	1533984	1541544	B2F32164
GPM	NL	NL	NL
Ft of Head	NL	NL	NL
Motor Name Plate Data			
Manufacturer	Siemens	WEG	Reliance
Model Number			
Serial Number			
Voltage	230 / 460	208-230 / 460	230 / 460
Amperage	18 / 9	13 / 6.48	21 / 10.5
HP	7-Jan	5	7.5
Motor Efficiency	0.902	0.875	NL
Power Factor	NL	0.82	NL
Frame	213T	184T	213T
Motor Type	TEFC	TEFC	ODP
Actual kW Measured	4	3.9	5.3
Actual Voltage Measured	487	487	487
Actual Amperage Measured	6.2	5.9	8.7

Data	**Cooling Tower Booster**		
Area/System/Equipment Served			
Pump Type	Vertical Incline		
Manufacturer	Armstrong		
Model Number	4380 3 x 3 x 13	`	
Serial Number	596918		
GPM	190		
Ft of Head	57'		
Motor Name Plate Data			
Manufacturer	Baldor		
Model Number			
Serial Number			
Voltage	230 / 460		
Amperage	16 / 8		
HP	5		
Motor Efficiency	0.895		
Power Factor	0.64		
Frame	2155P		
Motor Type	ODP		
Actual kW Measured	Not Running, No Demand		
Actual Voltage Measured	Not Running, No Demand		
Actual Amperage Measured	Not Running, No Demand		

Reducing Scope 1 & 2 Emissions

Table 5- Pumps Cont.

Date: 10/15/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Pump Data	**BFWP-1**	**BFWP-2**	**BFWP-3**
Area/System/Equipment Served			
Pump Type	Split Case	Split Case	
Manufacturer	Mueller Pump	Weinman	
Model Number	2JD	2JD - 2-WCT	
Serial Number	18654	T742 730	
GPM	NL	200	
Ft of Head	NL	475	
Motor Name Plate Data			
Manufacturer	Reliance	Baldor (on VFD)	Seimens - Allis
Model Number			
Serial Number	3450 RPM	3450 RPM	3520 RPM
Voltage	480	230 / 460	230 / 460
Amperage	57.4	108 / 54	121 / 60.5
HP	50	50	50
Motor Efficiency	NL	0.941	0.875
Power Factor	NL	0.92	NL
Frame	324 TS	324TS	324 TS
Motor Type	ODP	TECF	ODP
Actual kW Measured	lock out tag for repairs	too large of a load for this pump	36
Actual Voltage Measured			485
Actual Amperage Measured			48

Data			
Area/System/Equipment Served			
Pump Type			
Manufacturer			
Model Number			
Serial Number			
GPM			
Ft of Head			
Motor Name Plate Data			
Manufacturer			
Model Number			
Serial Number			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			

Reducing Scope 1 & 2 Emissions

Table 6- Pumps Cont.

Date: 10/14/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Pump Data	**CWP-1**	**CWP-2**	**CWP-3**
Area/System/Equipment Served	Campus loop	Campus loop	Campus loop
Pump Type			
Manufacturer	B & G	Paco	Paco
Model Number	Tag Missing	6AM -KPS	6AM -KPS
Serial Number	Tag Missing	2AF 32165 A	2AF 32165 B
GPM	Tag Missing	1100 / 700	1100 / 700
Ft of Head	Tag Missing	42 / 18	42 / 18
Motor Name Plate Data			
Manufacturer	Lincoln	General Electric	General Electric
Model Number			
Serial Number			
Voltage	230 / 460	480	480
Amperage	154 / 77 (Idle amps 43/ 21.5)	23 / 16 (2 speed)	23 / 16 (2 speed)
HP	60	20 / 13.5	20 / 13.5
Motor Efficiency	0.917	NL	NL
Power Factor	NL	NL	NL
Frame	364 TS	286 T	286 T
Motor Type	ODP	ODP	ODP
Actual kW Measured	48.5	9.6	not enabled
Actual Voltage Measured	475	481	No M-O-A
Actual Amperage Measured	63.1	11.8 (low speed?)	

Pump Data	**CWPE-1**	**CWPE-2**	**CWPE-3**
Area/System/Equipment Served	Evap Pump 1	Evap Pump 2	
Pump Type	BMES	BMES	
Manufacturer	B & G	B & G	B & G
Model Number	5 BC 8.375 BF	5 BC 8.375 BF	Vscs 8 x 10 x 10.5 9.875 BF RHR
Serial Number	2021930	2021930	2002 129
GPM	1000	1000	2000
Ft of Head	46'	46'	60'
Motor Name Plate Data			
Manufacturer	Marthon	Marthon	Marthon
Model Number			3VF 324TTOP40260CL
Serial Number			
Voltage	230 / 460	230 / 460	230 / 460
Amperage	38.4/19.2	38.4/19.2	97 / 48.5
HP	15	15	48
Motor Efficiency	0.91	0.91	0.93
Power Factor	0.802	0.802	0.835
Frame	254T	254T	324 T
Motor Type	ODP	ODP	ODP
Actual kW Measured	10.7	Off at Disconnect	Not enabled. No MOA
Actual Voltage Measured	479		Pump/Motor spinning due to water through the
Actual Amperage Measured	16.6		impeller . Same as CWPE 4 & 5

Reducing Scope 1 & 2 Emissions

Table 7- Pumps Cont.

Date: 10/14/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Pump Data	**CWPE-4 / CWPE-5**	**CDP-1 / CDP-2**	**CDP-3**
Area/System/Equipment Served	Evap Pump 4 & 5		
Pump Type		BMES	VSC
Manufacturer	B & G	B & G	B & G
Model Number	VSLS 8 x 10 x 10.5 9.875 BF RHR	1510 6 E 10.0 BF	NL
Serial Number	2002 128 / 2002 130	NL / 2022049	NL
GPM	2000	NL / 1500	NL
Ft of Head	60'	NL / 80'	NL
Motor Name Plate Data			
Manufacturer	Marthon	US ELECTRIC	US ELECTRIC
Model Number	3VF 324TTOP40260CL	R357 B	R322
Serial Number			
Voltage	230 / 460	230 / 460	460 / 230
Amperage	97 / 48.5	94 / 47	112 / 225
HP	48	40	100
Motor Efficiency	0.93	0.945	0.945
Power Factor	0.835	0.87	0.874
Frame	324 T	324 T	404 TS
Motor Type	ODP	ODP	ODP
Actual kW Measured	Not enabled. No MOA	22.4 / No MOA	54.6
Actual Voltage Measured	Pump/Motor spinning due to water through the	0.473 / Not Enabled	476
Actual Amperage Measured	impeller . Same as CWPE 4 & 5	28.7 / Not Enabled	81.3

Pump Data	**CDP-4 & 5**		
Area/System/Equipment Served			
Pump Type	VSC		
Manufacturer	B & G		
Model Number	VSC 10 X 10 X 13 11.5 BF		
Serial Number	1997184 / 1997183		
GPM	3000		
Ft of Head	95		
Motor Name Plate Data			
Manufacturer	Marathon		
Model Number	30 404TSTDS4026BTW		
Serial Number			
Voltage	230 / 460		
Amperage	232 / 116		
HP	100		
Motor Efficiency	0.941		
Power Factor	0.845		
Frame	404TS		
Motor Type	ODP		
Actual kW Measured	66 / 62		
Actual Voltage Measured	476 / 481		
Actual Amperage Measured	102 / 91.6		

Reducing Scope 1 & 2 Emissions

Table 8- Chillers

Date: 10/14/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Chiller Data	**CHILLER 1**	**CHILLER 2**	**CHILLER 3**
Area/System/Equipment Served			
Chiller Compressor Type	Centrifugal	Centrifugal	Centrifugal
Manufacturer	Carrier	Carrier	Carrier
Model Number	19 XL 50534 93CP	19XL 50534 93 CP	19 EX 3133-736DK621 S
Serial Number	4996 J 55005	4996 J 55006	4996 J 54998
Tonnage			
Motor Name Plate Data			
Manufacturer			
Model Number			
Serial Number			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured	286 KW	NOT RUNNING	NOT RUNNING
Actual Voltage Measured	477 V		
Actual Amperage Measured	406		

Chiller Data	**CHILLER 4**	**CHILLER 5**	
Area/System/Equipment Served			
Chiller Compressor Type	Same as 3	Same as 3	
Manufacturer			
Model Number			
Serial Number	4996 J 54 999	4996 J 55 000	
Tonnage			
Motor Name Plate Data			
Manufacturer			
Model Number			
Serial Number			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured	NOT RUNNING	NOT RUNNING	
Actual Voltage Measured			
Actual Amperage Measured			

Reducing Scope 1 & 2 Emissions

Table 9- Fan

Date: 10/15/2010
Job number | Building: **P 11561 Rozell** **Name:** DDM

Unit Tag	**#1 FD Fan**	**#2 FD Fan**	**#3 RD Fan**
Area Served	Boiler #1	Boiler #2	Boiler #3
System Type	Variable Volumn/ Comb Air	Variable Volumn/ Comb Air	Variable Volumn/ Comb Air
Manufacturer	Clavage Fan	Clavage Fan	NL
Cold Deck Model Number	Size 66 Type AFP	Size 1-3/8th Type Uni-Comb	NL
Cold Deck Serial Number	7087 CE-1	2559	NL
Cold Deck CFM	NL	NL	NL
TSP in. W.C.	NA	NL	NL
Hot Deck Model Number	NA	NA	NA
Hot Deck Serial Number	NA	NA	NA
Hot Deck CFM	NA	NA	NA
TSP in. W.C.	NA	NA	NA
Motor Name Plate Data (Cold Deck)			
Manufacturer	Reliance (w/ VFD)	NL (w/ VFD)	Magnetek
Voltage	230 / 460	230 / 460	208-230 / 460
Amperage	95.4 / 47.7	36 / 18	108-98 / 49
HP	40	15	40
Motor Efficiency	0.936	NL	0.936
Power Factor	0.833	NL	0.83
Frame	324 T	NL	E324 T
Motor Type	TEFC	NL	ODP
Actual kW Measured	1.8 (@23.7 Hz)	ODP	Log out for Maintenance
Actual Voltage Measured	484	Not Running due to Load	
Actual Amperage Measured	2.7		
Motor Name Plate Data (Hot Deck)			
Manufacturer			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			
Motor Name Plate Data (Return Fan)			
Return Fan Model Number			
Return Fan Serial Number			
Return Fan CFM			
TSP in. W.C.			
Manufacturer			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			

Table 10- Fan Cont.

Date: 10/15/2010

Job number | Building: **P 11561 Rozell** **Name:** DDM

Unit Tag	**#4 FD Fan**	**#5 FD Fan**	
Area Served	Boiler #4	Boiler #5	
System Type	Variable Volume/ Comb Air	Variable Volume/ Comb Air	
Manufacturer	Clavage Fan	Buffalo Forge	
Cold Deck Model Number	Size 60 Type AFP	980 L-25, S, 8, CW, 180 ° F	
Cold Deck Serial Number	1145 - AT	101883-001	
Cold Deck CFM	NL	NL	
TSP in. W.C.	NA	NL	
Hot Deck Model Number	NA	NA	
Hot Deck Serial Number	NA	NA	
Hot Deck CFM	NA	NA	
TSP in. W.C.	NA	NA	
Motor Name Plate Data (Cold Deck)			
Manufacturer	Reliance	GE	
Voltage	230 / 460	460	
Amperage	71 / 35.5	223	
HP	30	200	
Motor Efficiency	0.924	0.954	
Power Factor	0.851	0.875	
Frame	286 T	447 T	
Motor Type	ODP	TEFC	
Actual kW Measured	Not Running due to Load	Not Running due to Load	
Actual Voltage Measured			
Actual Amperage Measured			
Motor Name Plate Data (Hot Deck)			
Manufacturer			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			
Motor Name Plate Data (Return Fan)			
Return Fan Model Number			
Return Fan Serial Number			
Return Fan CFM			
TSP in. W.C.			
Manufacturer			
Voltage			
Amperage			
HP			
Motor Efficiency			
Power Factor			
Frame			
Motor Type			
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			

Reducing Scope 1 & 2 Emissions

Table 11- Boilers

Date: 10/15/2010
Job number | Building: **P 11561 Rozell** **Name:** DDM

Unit Tag	**Boiler 1**	**Boiler 2**	**Boiler 3**
Area Served			
System Type	Gas & Oil Burner	Gas & Oil Burner	Gas & Oil Burner
Manufacturer	Babcock & Wilcox	E. Keeler Co	Union Iron Works
Serial Number	?	13694	23439
Capacity MBH or lbs/hr	56,000	25,000	25,000
GPM			
Design PSI	250	200	250
Steam Temp	406 ° F	407 ° F	408 ° F
Boiler Heating Surface (sqft)	4,410	2160	3064
Year Built	1974	1960	1966
Unit Tag	**Boiler 4**	**Boiler 5**	
Area Served			
System Type	Gas & Oil Burner	Gas & Oil Burner	
Manufacturer	Babcock & Wilcox	Nebraska	
Serial Number		D4412	
Capacity MBH	47,000	89,000	
GPM			
Design PSI	250		
Steam Temp	406 ° F	407 ° F	
Boiler Heating Surface (sqft)	4410	7890	
Year Built	1969	2001	

Table 12- Heat Exchange

Date: 10/10/2010
Job number | Building: **P 11561 Rozell** **Name:** DDM

Unit Tag	**Heat Exchanger 1 (HX 1)**	**Heat Exchanger 2 (HX 2)**	
Area Served			
System Type	Plate & Frame Type	Plate & Frame Type	
Manufacturer	B & G	B & G	
Serial Number	89R86401-01	912716-2	
P/N	5-618-11-337-001	5-423-23-266-002 / %BY542300005500	
M/N	GPX 1152-337	NL	
Year Built	1996	2003 (Installed by Ramsey)	
Unit Tag			
Area Served			
System Type			
Manufacturer			
Serial Number			
Capacity MBH			
GPM			
Design PSI			
Steam Temp			
Boiler Heating Surface (sqft)			
Year Built			

Table 13- Cooling Towers

Date: 10/15/2010
Job number | Building: **P 11561 Rozell**
Name: DDM

Unit Tag	Cooling Tower 1	Cooling Tower 2	Cooling Tower 3
Area Served			
System Type	Cooling Tower w/ 2 speed Fan	Cooling Tower w/ 2 speed Fan	Medium Size w/ 2 speed Fan
Manufacturer	Marley NC Tower	Marley NC Tower	Marley NC Tower
Serial Number	3-1328-69 A / 3-8612 - 69 A	3-1328-69 A / 3-8612 - 69 A	NC 8311 CICM or NC 8311 GICM / NC 233570-Ai
P/N			
M/N	SLM-324UC-FMA EM 1 9-321284-01	SLM-324UC-FMA EM 1 9-321284-01	
?	JS	JS	
Year Built			
Fan Data			
Manufacturer	?	?	US Electric Two Speed
Voltage	460	460	460
Amperage	25 / 7.5	25 / 7.5	63 / 23.5
HP	20 / 5	20 / 5	50 / 12.5
Motor Efficiency			NL
Power Factor			NL
Frame	None	None	364 T
Motor Type	TEFC	TEFC	TEFC
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			
RPM	1740 / 860	1740 / 860	1785 / 895

Table 14 Cooling Towers Cont.

Date: 10/15/2010
Job number | Building: **P 11561 Rozell**
Name: DDM

Unit Tag	Cooling Tower 4	Cooling Tower 5	
Area Served			
System Type			
Manufacturer			
Serial Number	NC 9141GS	NC 9141GS	
P/N	09743-001-96	097943-002-96	
M/N			
Year Built			
Fan Data			
Manufacturer	Seimens (2 Speed)	Seimens (2 Speed)	
Voltage	460	460	
Amperage	74 / 25	74 / 25	
HP	60 / 15	60 / 15	
Motor Efficiency	NL	NL	
Power Factor	NL	NL	
Frame	366	366	
Motor Type	TEFC	TEFC	
Actual kW Measured			
Actual Voltage Measured			
Actual Amperage Measured			
RPM		1780 / 885	

Efficient & Sustainable Campus Systems

Executive Report

3. Campus Infrastructure

A. BOILER PLANT (BIO-MASS/BIO-DIESEL)

A detailed description of the central heating and cooling plant equipment is in the page 17-18 Rozell Building description.

i. Boiler Plant Biomass/Biodiesel Fuel Switching

McKinstry evaluated the feasibility of switching to Bio-Mass/Bio-Diesel as a secondary fuel source for the existing boilers in the central plant, considering a number of factors in the process:

ii. Fuel Source Reliability – The reliability of the fuel source is high. Contracts for the fuel are usually a year in length. We evaluated two local Bio-Mass/Bio-Diesel fuel suppliers in eastern Washington. At the time of study, the price of Bio-Mass/Bio-Diesel fuel was lower than for #2 fuel oil but higher than for natural gas. The BTU content per gallon on average ranges between 125,000 to 130,000 BTUs per gallon for Bio-Diesel and 135,000 to 137,000 BTUs per gallon for Bio-Mass.

iii. To accommodate the new fuel we would remove and dispose of the old bunker oil tank and associated fuel lines, and we would either convert or replace the boiler burners to burn the new fuel.

B. UPGRADES TO THE EXISTING CENTRAL STEAM PLANT

Given Eastern Washington University's growth plans, McKinstry recommends further analysis to determine the University's future needs for steam plant capacity. As detailed in Table 2, we suggest several plant improvements:

i. Install boiler feedwater economizers on Boilers #2 and #4.
ii. Replace #3 Boiler with a new, more efficient boiler.
iii. Replace the burners on #1, #2 and #4 with low-nitrogen-oxide burners.

C. CENTRAL CHILLED WATER PLANT

The central chilled water plant has 4,000 tons of mechanical cooling capacity and another 500 tons of free cooling capacity through two plate-and-frame heat exchangers. According to plant personnel the peak load during the cooling season on the central chilled water plant is between 2,300 and 2,400 tons.

The chillers and their corresponding cooling towers vary in age. The three 1,000-ton chillers, two 500-ton chillers and their respective cooling towers were all installed in 1996. The third 1,000-ton cooling tower was installed in 2003, and the two 500-ton cooling towers were installed over 25 years ago. Both 500-ton cooling towers have outlived their useful service lives and are becoming inefficient.

D. UPGRADING THE EXISTING CENTRAL CHILLED WATER PLANT'S EFFICIENCY

As outlined in accompanying Table 3, there are several clear options to improve the chilled water plant's efficiency:

i. Install variable-frequency drives (VFDs) on the chiller compressors and cooling tower fans.

ii. Replace the two-speed chilled water pumps with two new pumps and VFDs on the system loop.
iii. Replace both 500-ton towers with energy-efficient, open-circuit, induced-draft, VFD-equipped cooling towers sized to deliver 75-degree water at peak conditions.

E. ADDING CHILLED WATER CAPACITY

After study, it appears that expanding the existing chilled water plant would be preferable to building a second one on campus. Although the University's plans to build Science 1 and Science 2 will increase chilled water needs, some of that new demand will be offset by efficiency improvements in other buildings as they remodeled, such as the Science Building, where much can be done to reduce the cooling load.
Further study is needed to accurately gauge future demand, but our initial recommendation is to enlarge the existing central plant, adding another 1,000-ton water-cooled centrifugal chiller, a 1,000-ton cooling tower and their associated pumps. These costs are presented in Table 3.

F. ADDING A THERMAL STORAGE TANK – Although the need for a thermal storage tank has been studied, more information is needed before recommendations can be made.

In time, a thermal storage tank may prove worthwhile, adding cooling capacity and improving the chilled water system's efficiency. Using the thermal storage tank as a primary source of cooling during the day, while shutting down or reducing use of chillers, is a very energy-efficient way to meet the University's cooling needs. In this scenario, the tank acts like a larger chilled water battery, charging during night when the cost to produce power is less. However, the utility rate that Eastern Washington University pays is not ratcheted as in other regions, which reduces the incentive to build such a system—making cost variables in site selection all the more important. For these reasons, further study would be wise.

Efficient & Sustainable Campus Systems

Detailed Report

Eastern Washington University/Campus Infrastructure

OVERVIEW

This section of the report is dedicated to Eastern Washington University's central heating and cooling plant. Most of the buildings and facilities on campus are served by the central heating and cooling plant. A preliminary energy audit was conducted on August 18, 2010 by McKinstry.

ROZELL CENTRAL PLANT

See write up in section 2 under Rozell Building.

PREVIOUS ENERGY RETROFITS

McKinstry retrofitted the existing boiler feedwater pumps with new vertical turbine feedwater pumps controlled with Variable Frequency Drives. The drive and pumps will be controlled through the ABB/Wonderware Control System.

BOILER PLANT BIOMASS/BIO-DIESEL FUEL SWITCHING

McKinstry evaluated the feasibility of switching to biomass/biodiesel as a secondary fuel source for the existing boilers in the central plant, considering a number of factors in the process:

- Fuel Source Reliability – The reliability of the fuel source is high. Contracts for the fuel are usually a year in length. We evaluated two local biomass/biodiesel fuel suppliers in eastern Washington. At the time of study, the price of biomass/biodiesel fuel was lower than for #2 fuel oil but higher than for natural gas. The BTU content per gallon on average ranges between 125,000 to 130,000 BTUs per gallon for biodiesel and 135,000 to 137,000 BTUs per gallon for biomass.
- To accommodate the new fuel we would remove and dispose of the old bunker oil tank and associated fuel lines, and we would either convert or replace the boiler burners to burn the new fuel.

We suggest further study, as bio-fuels could reduce both carbon emissions and fuel costs. However, the latter depends upon further discussion with bio-fuel suppliers, who insist on confidentiality agreements from McKinstry personnel before committing to prices. If EWU is interested, we will be more than happy to obtain firm fuel quotes.

UPGRADES TO THE EXISTING CENTRAL STEAM PLANT

Given EWU's growth plans, McKinstry recommends further analysis to determine the university's future needs for steam plant capacity. The Facility Improvement Measures detailed in Table 4.2 represent improvements to the plant as it stands today:

- Install boiler feedwater economizers on Boilers #2 and #4.
- Replace #3 Boiler with a new, more efficient boiler.
- Replace the burners on #1, #2 and #4 with Low-NOx burners.

CENTRAL CHILLED WATER PLANT

The central chilled water plant has 4,000 tons of mechanical cooling capacity and another 500 tons of free cooling capacity through two plate-and-frame heat exchangers. According to plant personnel the peak load during the cooling season on the central chilled water plant is between 2,300 and 2,400 tons.

The chillers and their corresponding cooling towers vary in age. The three 1,000-ton chillers, two 500-ton chillers and their respective cooling towers were all installed in 1996. The third 1,000-ton cooling tower was installed in 2003, and the two 500-ton cooling towers were installed over 25 years ago. Both 500-ton towers have outlived their useful service lives and are becoming increasingly energy inefficient. Their original design called for the towers to deliver 85 degree water back to their respective chillers. Currently in their existing condition they are only able to supply 88 degree water back to the chillers.

McKinstry believes there are many ways to improve the efficiency of the chilled water plant and to add capacity in the future:

UPGRADING THE EXISTING CENTRAL CHILLED WATER PLANT'S EFFICIENCY

As outlined in Table 4.2, EWU has several clear options that could make the chilled water plant more efficient:

- Install VFDs on the chiller compressors and cooling tower fans.
- Replace the two-speed chilled water pumps with two new pumps and VFDs on the system loop.
- Replace both 500-ton towers with energy-efficient, open-circuit, induced-draft , VFD-equipped cooling towers sized to deliver 75-degree water at peak conditions.

ADDING CHILLED WATER CAPACITY

After further study, McKinstry concludes that expanding the existing chilled water plant would be preferable to building a second and separate chilled water plant somewhere on the south side of the campus. Although the university's plans to build Science 1 and Science 2 will increase the overall chilled water load, some of that new demand will be offset by efficiency improvements in other buildings as they get remodeled and upgraded with energy efficient systems.

Further study is needed to accurately gauge future demand, but our initial recommendation is to enlarge the existing central plant, adding another 1,000-ton water-cooled centrifugal chiller, a 1,000-ton cooling tower and their associated pumps. These costs are presented in the Table 4.2 for this section.

ADDING A THERMAL STORAGE TANK

Although McKinstry studied the need for a thermal storage tank, we do not believe we yet have enough information to judge its practicality, so we recommend further analysis if EWU is interested. McKinstry has engineered and built this kind of system before at universities in the Pacific Northwest, and can certainly plan, engineer and build this if the university so chooses. However, costs vary depending on the site chosen and the site work required, as such, the cost estimate ranges have not yet been estimated.

In time, a thermal storage tank may prove worthwhile for EWU by adding cooling capacity and energy efficiency. Using the thermal storage tank as a primary source of cooling during the day, while shutting down or reducing use of chillers, is a very energy-efficient way to meet the university's cooling needs. However, the utility rate that EWU pays is not ratcheted as in other regions of the country, which reduces the incentive to build such a system—making cost variables in site selection all the more important. For these reasons, McKinstry recommends further study.

Facility Improvement Measure (FIM) Summary - Rough Order of Magnitude (ROM)

Project	Eastern Washington University
Scenario	Central Plant + Water + Irrigation
Date	November 17, 2011

LEGEND:
1 - High Priority
2 - Medium Priority
3 - Neutral Priority

			Budget *		Annual Utility Savings				Estimated Net Customer Cost (with Incentives)		Estimated Modified Payback				
FIM Name	FIM Description	Building	Min	Max	Min	Max	Annual Operational Savings **	Potential Incentives ***	Min	Max	Min	Max	Carbon Savings (Metric Tonnes)	EWU Value Proposition	Ranking
18.01-EWU: Campus Wide Water Re-Commissioning	McKinstry proposes to replace all internal plumbing components and recommission all toilets, sinks, urinals, and shower heads in all buildings across campus. New internal components will have variable flow technology.	Campus	$568,175	$694,437	$41,582	$45,959	$19,170	$0	$568,175	$694,437	8.7	11.4	206	1. Just under 18,000,000 gallons of water saved annually. 2. Reduction of maintenance costs and plumbing fixture upgrades. 3. Increased consistency and performance of the system.	1
18.02-EWU: Campus Wide Irrigation Upgrades	McKinstry proposed to replace all manual irrigation controllers with WeatherTrak controllers and install rain sensors.	Campus	$241,909	$295,667	$3,189	$3,524	$0	$0	$241,909	$295,667	68.6	92.7	18	1. Only deliver the water required for adequate irrigation across the EWU campus. 2. 13,832,200 gallons of water saved through a reduction in irrigation systems operation.	2
1.00-ROZ: Boiler Feed Water Economizers	Boilers #2 and #4 do not have the economizers and thus use more energy when the feed water is pumped into each of the boilers. McKinstry proposes to install boiler feed water economizers into the boiler's exhaust stack.	Rozell Central Plant	$173,773	$212,389	$70,381	$77,790	$0	$0	$173,773	$212,389	2.2	3.0	604	1. Significant energy savings. 2. Feed water system can now operate at the same pressure.	1
1.01-ROZ: Low Nox Burners	McKinstry proposes to install new dual fuel Low NOx burners. The primary fuel source will be natural gas while the back up fuel source will be #2 fuel oil.	Rozell Central Plant	$1,611,225	$1,969,275	$65,436	$72,324	$0	$0	$1,611,225	$1,969,275	22.3	30.1	562	1. Decrease of pollutants and efficient combustion of fossil fuel.	3
1.02-ROZ: Replace Boiler #3	McKinstry proposes to remove and dispose of the existing 25,000 lb/hr high pressure steam Boiler #3 and replace it with a new energy efficient 40,000 lb/hr high pressure steam boiler. The new boiler will be equipped with a new Low NOx Dual Fuel Burner.	Rozell Central Plant	$1,390,314	$1,699,272	$105,980	$117,136	$0	$0	$1,390,314	$1,699,272	11.9	16.0	910	1. Installation of a 40,000 lb/hr boiler that replaces the 25,000 lb/hr boiler that hasn't worked for three years. 2. Replacing a boiler that is over 40 years old with a larger more energy efficient boiler with a Low NOx Burner, and a boiler feed water economizer.	1
2.00-ROZ: VFD Upgrades	McKinstry proposes to furnish and install Variable Frequency Drives on the chillers compressor motors, remove the existing 2-speed motors in the cooling towers, and install inverter duty ready motors and the VFDs the cooling tower fan motors. The drives and their respective points will be mapped into the existing controls system.	Rozell Central Plant	$824,706	$1,007,974	$38,424	$42,469	$0	$59,850	$764,856	$948,124	18.0	24.7	211	1. Making the existing chillers and towers energy efficient. 2. Maximize the cooling efficiency of the entire cooling plant.	1
2.01-ROZ: CHW Pump Upgrades and Reconfiguration	McKinstry proposes to furnish and install new inverter duty ready motors for the (2) secondary chilled water pumps and install the necessary control points and VFDs. The secondary chilled water pumps will be brought on line as the load in the buildings dictate. The lead pump will ramp up to 100% before the next secondary pump is brought on-line.	Rozell Central Plant	$74,018	$90,466	$9,105	$10,063	$0	$1,133	$72,885	$89,333	7.2	9.8	50	1. Maximize the cooling efficiency of the chilled water loop pumping system.	1
2.02-ROZ: Install New Chiller and Tower	McKinstry proposes to furnish and install new primary chilled water pumps that are dedicated to their respective chiller. The primary pumps will be piped in parallel. This will allow the horse powers on these pumps to be significantly decreased. McKinstry also proposes to furnish and install new inverter duty ready motors for the (2) secondary chilled water pumps and install the necessary control points and VFDs. The secondary chilled water pumps will be brought on line as the load in the buildings dictate. The lead pump will ramp up to 100% before the next secondary pump is brought on-line.	Rozell Central Plant	$1,818,709	$2,222,867	$39,891	$44,090	$0	$46,913	$1,771,796	$2,175,954	40.2	54.5	219	1. This will give EWU a level of redundancy in the future that they may not have today as buildings and facilities are connected to the campus chilled water loop.	3
2.04-ROZ: Install 2 new energy efficient cooling towers	McKinstry proposes to install new energy efficient, open circuit, induced draft cooling towers with VFDs on their fan motors. The new cooling towers will be sized for supplying 75 degree water to the chillers during peak load conditions.	Rozell Central Plant	$328,496	$401,495	$11,479	$12,688	$0	$5,977	$322,519	$395,518	25.4	34.5	63	1. This will allow the (2) 500 Ton water cooled chillers to operate efficiently by receiving condenser water at 75 degrees, instead of the 88 degree water they have been receiving. 2. The new energy efficient cooling towers will prolong the life of their corresponding chillers.	1
			$7,031,325	**$8,593,841**	**$385,468**	**$426,043**	**$19,170**	**$113,873**	**$6,917,452**	**$8,479,968**	**15.5**	**21.0**	**#REF!**		

* Since design cost, audit cost, etc. are distributed among the FIMs, the total project cost will not go up or down by exactly the amounts shown here if a FIM or FIMs are dropped.
** For non recurring operational savings, the values are averaged over the 1 year length of this analysis.
*** Incentives are contingent on final approval and are not guaranteed. Funds are shown for reference only.

APPENDIX E

CAMPUS CHILLED WATER SYSTEM STUDY
Dumais-Romans - 2009

CAMPUS CHILLED WATER SYSTEM STUDY

SUBMITTED TO:

EASTERN WASHINGTON UNIVERSITY

SUBMITTED:

June, 2009

BY:

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PROJECT SCOPE

The purpose of this Study is to evaluate the existing chilled water system serving the Eastern Washington University Campus. In this study we look at the existing chiller plant located in Rozell, which currently distributes chilled water to 32 campus buildings. The number of buildings served will grow to 34 by the end of this winter. We compare the available chilled water capacity with the actual loads and maximum operating conditions for previous years. We use this data to predict the effective cooling capacity of the plant for existing and future loads. Load versus capacity calculations, are based on the “design condition” cooling loads for the buildings currently served, and actual campus load seen at the chillers. From this data, we can estimate the actual capacity which will be required when new buildings are added to the system, and evaluate provisions for the future. This study focuses primarily on changes to the chiller plant and campus piping systems, however there is another source of cooling capacity available which should also be considered, which is reduction in use.

We have proposed four options for review.

1) Continue operation with all 4,000 tons of existing capacity available.
2) Add a new 1,000 ton chiller, tower, pumps, and controls to expand system capacity, replace two existing 500 ton towers, and make provisions to dedicate one chiller to the new Recreation Center.
3) Add a new 2,000 ton chiller, tower, pumps, and controls to expand system capacity, replace two existing 500 ton towers, and make provisions to dedicate one chiller to the new Recreation Center.
4) Implement a cooling reduction program through better control of building economizers, CO_2 sensors, and operation hours.

Cost estimates included in this report are budget estimates, detailed cost estimates will only be available near completion of actual design work.

EXECUTIVE SUMMARY

System Recommendation

Our recommendation is based on an anticipated growth rate on the EWU campus, and on serviceability of equipment. We have taken into account approximately 500 tons of existing capacity made available with the addition of the makeup water booster pump. We also recognize that the previous 2,000 ton increase in capacity was intended to cover campus expansion for 10 years, but has only outpaced growth for 7 years. A recent development in chilled water operation, is the need to have approximately 400 tons of chilled water available to the new University Recreation Center at times of the year where it is the only user.

We recommend a 2,000 ton chiller, cooling tower, and pump system be added to the existing chilled water plant. 2,000 tons will provide redundancy for two of the large existing chillers should there be a failures or need for service. With all of the chillers operational, 2,000 tons will provide 40% future expansion in the system. This seems like a large increase, however there are several new buildings programmed for the campus, as well as large remodel projects which will require significant chilled water capacity.

Although specific buildings and deficiencies have not been investigated as part of this report, we recommend any revision to the campus chilled water system include a comprehensive review of the buildings served, and potential energy savings related to operation be identified and implemented.

EXISTING CONDITIONS

Rozell Energy Plant

Chilled Water System: The original 1,695 tons of CFC chillers were replaced in 1996 with 4,000 tons of environmentally friendly 134a refrigerant machines. Three 1,000 ton chillers and two 500 ton chillers were installed, reusing two existing 500 ton and one existing 1,000 ton cooling towers, and adding two new 1,000 ton cooling towers. Condenser pumps, and primary chilled water pumps were added to serve the new chillers and towers, and a new secondary pump was added to the distribution loop. Condenser water circulation pumps were added to provide minimal circulation through the towers at shutdown. The upgrade included the building electrical service, and was designed with the intent of servicing the load through 2010. The 1,000 ton cooling tower which remained has since been replaced under another project.

The chillers and pumps are located in the lower level of the Rozell Energy Plant, and the cooling towers are located on the roof. Chilled water is distributed to 32 buildings on campus through more than two miles of 16” and 12” chilled water supply and return “loop” mains in the utility tunnel system. The 16” chilled water supply and return mains run east from Rozell, and follow the east tunnel system south toward the Art building, serving the east half of the campus. The 12" chilled water supply and return mains run west from Rozell, and follow the west tunnel system south toward the Art building, serving the west half of the campus. The mains are connected near the Art complex, but can be separated by valves at that point, see appendix "A".

At each building or group of buildings served, chilled water supply and return lines branch off of the mains to the building. The chilled water pumps in Rozell provide enough system differential pressure in the loop, that individual building chilled water booster pumps are only required to operate during higher building load conditions.

The five chillers are manually controlled by the Chiller/Boiler plant operators. The operators anticipate campus loads based on outdoor air temperature, building use schedules, and past history. Based on these parameters, chillers are brought on line and taken off line to service the load.

REVIEW OF EXISTING PLANT

In the early stages of this study we worked with the facilities personnel, and reviewed the operation of the existing plant. The chiller plant renovation is relatively new and was designed as a complete system with mostly new equipment. The only "old" equipment remaining are the two 500 ton cooling towers, which are in good condition, but are original. The operators had been experiencing a problem with the cooling tower makeup water system. Occasional low domestic water pressure reduced makeup water flow. The tower sumps were drying out, and the towers were not able to reject the heat from the chillers at full capacity. The operators estimated that 3,500 tons of the 4,000 tons installed, were usable. As the first phase of this study, we prepared a design which added a booster pump to the makeup water system, with a variable frequency drive and pressure control. The pump is activated when 2,000 or more tons of cooling are operating, and provides the boost in water pressure required to ensure adequate makeup water is available to all towers through full load conditions. The booster pump was sized to accommodate makeup water for the addition of 2,000 tons of capacity as is, or 4,000 tons with a motor change. The pump is operational and meeting its intent manually, controls will be completed once a separate control project is finished, see the attached drawing M-1 in Appendix "B". The booster pump has gained the plant approximately 500 tons of capacity which was previously not available.

OPTIONS FOR THE FUTURE

In this section of the study we will present the four options identified in the Project Scope. Each of the options will meet the short term capacity requirements of the campus, but capacity requirements in the next 10 years are anticipated to increase. The "Ten Year Capital Plan" lists several significant projects, beginning in 2009 and ending in 2021, and there are others which are potential projects. Robert Reid School which is not currently on chilled water, is slated to be replaced with a new Science Building. Other projects are remodels/expansions of existing buildings like Martin Hall, Kingston Hall, Showalter Hall, Patterson Hall, and PE Classrooms. Remodels typically increase ventilation loads, and consequently chilled water load. Only time and final designs will determine if the cooling load on the campus system is increased in the next ten years.

The selection of option #2 or #3 implies the chilled water system will be expanding, so the following is a brief look at the pipe sizing in the main loop. The two original two-speed loop pumps are still in service, and deliver 750/1,100 gpm each. The new loop pump added in 1996 delivers 2800 gpm, for a total loop circulation rate of 5,000 gpm. The existing 4,000 tons of capacity and this water flow rate, equate to a 19.2 degree water temperature drop across the chillers at maximum load. The coils in building air handlers are pumped by secondary pumps when required, and have a total flow rate 10,184 gpm, this results in an average, 9.4 degree water temperature rise at the coils. Flow rates at the coils in each building have been included on the Campus Chilled Water Map in Appendix “A” for reference. Based on maximum coil flows, approximately 60% of the chilled water will travel down the 16” east line, and 40% down the 12” west line. For the worst case addition of 2,000 tons of capacity at the same 19.2 degree drop at the chiller, the new chiller pump will deliver 2,500 gpm. With the same 60/40 split, the flow in the 16” main at full design cooling load will increase from 3,000 to 4,500 gpm, and in the 12” main 2,000 to 3,000 gpm. The recommended maximum flow rate for minimizing erosion in a typical piped system according to ASHRAE, is 4 – 10 f/s. With a 2,000 ton chiller added to the system and everything at full load, the 16” main will run at 8.2 f/s, and the 12” main will run at 8.6 f/s. The highest velocities will be near Rozell, and will decrease downstream of each branch to a building, as water is pulled from the mains. Based on this, I do not see the need to increase main loop line sizes.

Option #1 – Continue operation with 4,000 tons of capacity.

The first option is to leave the existing system as installed, with the full 4,000 ton capacity now available with the installation of the booster pump. In 2007 there were 32 buildings being served by the chilled water system. The sum of the "design load" for the cooling coils in these buildings was 5,109 tons. See Appendix "C" for tabulated data for each building, total load, and GPM. The highest chilled water load experienced at the plant with these buildings on line has been approximately 3,500 tons. The obvious differential between <u>sum of the design loads</u> and the <u>actual load</u> is due to several components. First, design conditions for a building typically assume full occupancy on a 96ºF design cooling day. In a school application this is rarely experienced, since occupancy is lighter in the summer months. Second, there are safety factors and equipment size graduations, which can increase the calculated "design cooling" load, and equipment size when selected. In this case, the actual plant capacity is approximately 69 % of the sum of the design loads.

Based on recent history, the campus load was near the chiller plant capacity of 3,500 tons. By adding the booster pump, the capacity is increased to 4,000 tons, however Hargreaves Hall and the University Recreation Center will be added to the chilled water system in 2008. These two buildings require 515 tons of load at design conditions, and will boost the cooling requirements per Appendix "C" "2008 Maximum Design Load". If we apply the same 69% diversity as calculated for the existing system, the added load will require approximately 355 tons of chiller plant. This increase will use up almost all of the 500 ton gain seen by adding the booster pump, and eliminates most of the safety factor.

<u>Advantages:</u>

1. No cost is incurred.

<u>Disadvantages:</u>

1. The chilled water system will not keep up if there is a failure of any of the five chillers, towers, or pumps during maximum load conditions.
2. There is very little capacity for campus expansion.

Option #2 – Increase the system capacity by adding a new 1,000 ton chiller, pumps, and a tower, and replacing the existing 500 ton cooling towers. Also, make piping and valve provisions to dedicate one of the existing 500 ton chillers to serve the Recreation Center during times of the year when it is the only chilled water user . Estimated First Cost = 1,470,253. See appendix "D" for cost estimate summary.

Adding a new chiller will require some modifications to the existing building. The basement mechanical space is already full of equipment, and there is no available space to install another chiller. We estimate an 800 square foot addition off of the east side of Rozell at the south end will be required to house the new chiller, condenser, primary, and secondary chilled water pumps. The cooling tower will be located on the roof of the addition, or between the existing 500 ton tower and 1,000 ton tower on the main Rozell roof. A steel frame will be constructed to support the weight of the new tower from the basement floor. Condenser water and chilled water will be run in insulated 8" and 10" black steel piping, supported from the ceiling of the mechanical room. The chilled water piping from the new secondary chilled water pump will connect to the existing supply and return header in the mechanical room.

One of the existing 500 ton chillers will become dedicated to the Recreation Center, by installing approximately 2,200 feet of insulated 6" black steel piping. The 6" lines from the 500 ton chiller will connect to the Recreation Center chilled water supply piping downstream of the existing building isolation valves, allowing the 500 ton chiller to serve the Recreation Center only, or be open to the main chilled water loop.

<u>Advantages:</u>

1. Redundant capacity is added, which will compensate for one of the 1,000 ton or both 500 ton chillers being out of service.
2. The electrical service has spare breakers sized for a 1000 ton chiller and tower.
3. Campus Chilled Water capacity will be increased by 25%, which translates to approximately 1,450 tons of building "Maximum Design Load", applying a 69% diversity.

<u>Disadvantages:</u>

1. The first cost is significant, and requires some building space addition.
2. Projections of future growth may indicate this capacity increase could only last 10 years, with little additional capacity at that point.

Option #3 – Increase the system capacity by adding a new 2,000 ton chiller, pumps, and a tower, and replacing the existing 500 ton cooling towers. Also, make piping and valve provisions to dedicate one of the existing 500 ton chillers to serve the Recreation Center during times of the year when it is the only chilled water user. Estimated First Cost = 2,720,765. See appendix "E" for cost estimate summary.

Adding a new 2,000 ton chiller will require the same modifications to the existing building as adding the 1000 ton chiller requires. We estimate a 1,000 square foot addition will be required to house the new chiller and pumps. The cooling tower will be located on the roof of the addition or on the roof or Rozell with a steel support frame, as with the 1,000 ton option. Condenser and chilled water will be run in insulated 10" and 12" black steel piping, supported from the ceiling of the mechanical room. The chilled water piping from the new secondary chilled water pump will connect to the existing supply and return header in the mechanical room.

Again, one of the existing 500 ton chillers will become dedicated to the Recreation Center, by installing approximately 2,200 feet of insulated 6" black steel piping. The 6" lines from the 500 ton chiller will connect to the Recreation Center chilled water supply piping downstream of the existing building isolation valves, allowing the 500 ton chiller to serve the Recreation Center only, or be open to the main chilled water loop.

Advantages:

1. Redundant capacity is added, which will compensate for two chillers being out of service.
2. Campus Chilled Water capacity will be increased by 50%, which translates to approximately 2,900 tons of building "Maximum Design Load" applying a 69% diversity.
3. The buildings and remodels included in the 10-year plan will not utilize all of the added capacity, redundancy for one of the 1,000 ton chillers should still be available at 10 years.
4. Cost per ton of chilled water, decreases compared to option #2.

Disadvantages:

1. The first cost is significant, and requires some building space addition.
2. The electrical service has spare breakers, but they will require replacing to accommodate the draw of the 2000 ton chiller and tower.

Option #4 – Reduce chilled water requirements through control system modifications and operation improvements. This option will require a building by building assessment of the controls and operation.

Newer buildings like the Engineering building, and newer remodels such as Hargreaves Hall, will already be taking advantage of most energy saving measures. Older buildings may not be utilizing CO_2 sensors to control outside air, or may be conditioning the whole building for a few occupied spaces which could be relocated to another building. There is no way to put an estimated cost to this measure without completing a study of each building, and identifying the areas where energy can be saved. This would be a significant endeavor, requiring a separate comprehensive study.

Advantages:

1. A significant amount of energy could likely be saved through control and operation modifications at a relatively low cost.
2. Savings would be realized at both the cooling and heating plant.

Disadvantages:

1. To capture some savings, scheduling changes, and the relocation of some services from lightly occupied to heavily occupied buildings may be required.
2. The tonnage/btu savings are not easily quantifiable.

PROJECT PHASING

This project does not require completion in one construction phase. I have broken down the potential phases of this project below which can stand alone. Dedicating one 500 ton chiller to the Recreation Center can be a project in itself, and is not dependent on the addition of a chiller to the campus chilled water system, it also appears to be a more immediate need. Construction of the building to house a new chiller could be a project, but its cost is a relatively small component of purchasing and installing the chiller, so it was not broken out separately. Cost estimates are broken down in the same phases.

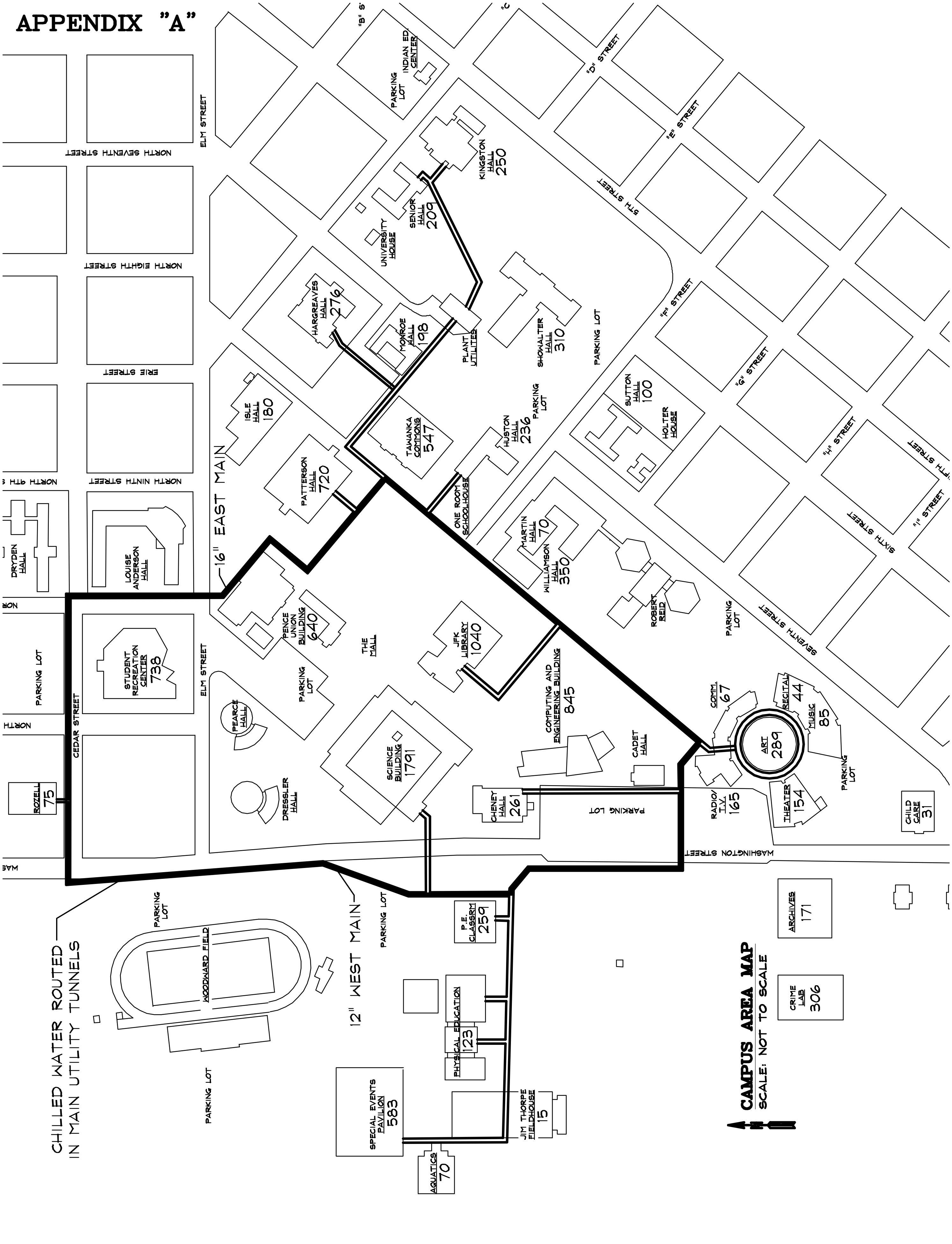
Phase I:

New 6” supply and 6” return water lines will be run from one of the 500 ton chillers to the tunnel, and in the tunnel to the existing chilled water supply and return branches serving the recreation Center. The new lines will tie-in downstream of the existing building isolation valves, and will allow the 500 ton chiller to serve the main chilled water loop, or just Recreation Center, when it is the only building needing chilled water, depending on which valves are open and closed.

Phase II:

An addition will be constructed adjacent to the existing chiller plant, and the new chiller, tower, and pumps will be installed. Piping, electrical, and control work will be completed to bring the new chiller on-line with the existing chillers.

APPENDIX "A"



CAMPUS AREA MAP
SCALE: NOT TO SCALE
CHILLED WATER ROUTED IN MAIN UTILITY TUNNELS
16" EAST MAIN
12" WEST MAIN
NORTH SEVENTH STREET
NORTH EIGHTH STREET
ERIE STREET
NORTH NINTH STREET
ELM STREET
CEDAR STREET
WASHINGTON STREET
5TH STREET
SIXTH STREET
SEVENTH STREET
"D" STREET
"E" STREET
"F" STREET
"G" STREET
"H" STREET
"I" STREET
INDIAN ED CENTER
PARKING LOT
KINGSTON HALL 250
SENIOR HALL 209
UNIVERSITY HOUSE
HARGREAVES HALL 276
MONROE HALL 198
PLANT UTILITIES
SHOWALTER HALL 310
ISLE HALL 180
TAWANKA COMMONS 547
HUSTON HALL 236
SUTTON HALL 100
HOLTER HOUSE
PATTERSON HALL 720
ONE ROOM SCHOOLHOUSE
MARTIN HALL 70
WILLIAMSON HALL 350
ROBERT REID
DRYDEN HALL
LOUISE ANDERSON HALL
PENCE UNION BUILDING 640
THE MALL
JFK LIBRARY 1040
STUDENT RECREATION CENTER 738
COMPUTING AND ENGINEERING BUILDING 845
PEARCE HALL
CADET HALL
SCIENCE BUILDING 1791
DRESSLER HALL
CHENEY HALL 261
ROZELL 75
COMM. 67
RECITAL 44
MUSIC 85
ART 289
RADIO/ T.V. 165
THEATER 154
CHILD CARE 31
ARCHIVES 171
CRIME LAB 306
P.E. CLASSRM 259
WOODWARD FIELD
PHYSICAL EDUCATION 123
SPECIAL EVENTS PAVILION 583
JIM THORPE FIELDHOUSE 15
AQUATICS 70

APPENDIX "B"

PUMP SCHEDULE	
ITEM NO.:	P-1
SERVICE	WATER
CAPACITY:	
GPM CURRENT/FUTURE	152/190
FT. OF HEAD	57
% PROPYLENE GLYCOL	0
POWER:	
HP	5
RPM	1200
VOLTS	480
PHASE	3
MANUFACTURER:	ARMSTRONG
MODEL:	4380 3X3X13
NOTES:	1

1. PROVIDE WITH MOTOR COMPATIBLE WITH ABB DRIVE.

1 REMOVE EXISTING TEE AND REPLACE WITH A 90.

2 REMOVE EXISTING VALVE FOR RELOCATION IN NEW PIPING ARRANGEMENT.

3 HANG NEW PUMP CLOSE TO WALL TO ALLOW ACCESS TO EXISTING REDUCED PRESSURE BACKFLOW PREVENTER. CONNECT NEW 4" PIPING INLET TO BACK OF EXISTING RISER WITH A TEE, FITTINGS CAN BE FLANGED OR WELDED.

4 REPLACE EXISTING ELBOW AND PIPING WITH A TEE, CONNECT NEW PUMP SUPPLY LINE TO BACK OF TEE.

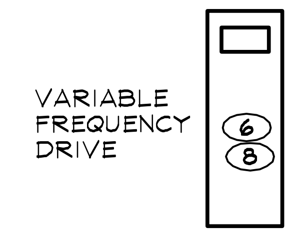
5 INSTALL 4" VERTICAL CHECK VALVE IN RISER BETWEEN NEW PUMP INLET AND SUPPLY CONNECTIONS.

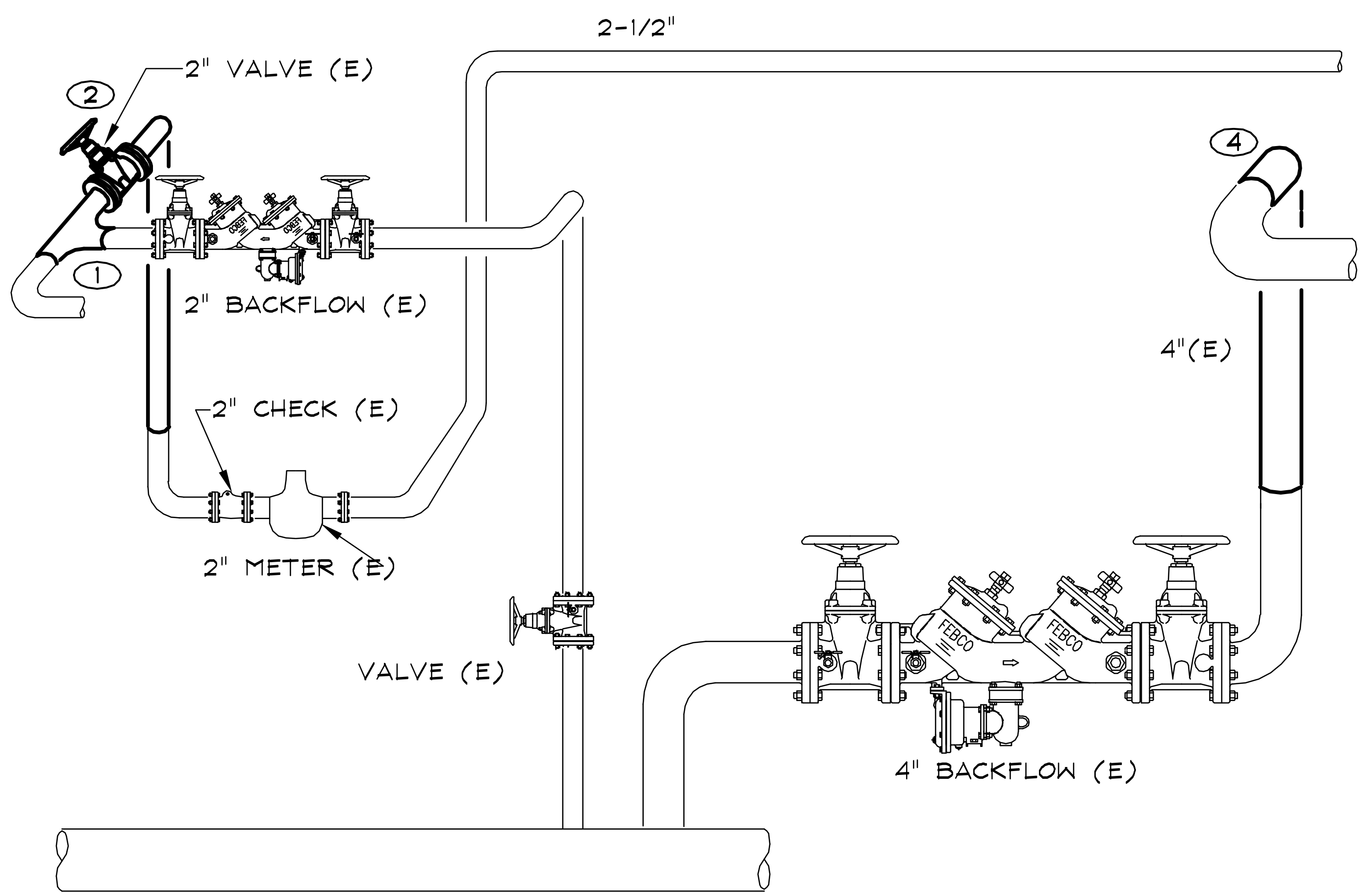
6 INSTALL ABB VARIABLE FREQUENCY DRIVE ON CONCRETE COLUMN ON OTHER SIDE OF SOFTENER TANKS.

7 INSTALL A ROSEMOUNT PRESSURE TRANSMITTER WITH A 0-160 PSI RANGE, MODEL 3051TG3A2B21A55. LOCATE IN THE 4" MAIN SUPPLY LINE HEADER AS FAR DOWNSTREAM AS POSSIBLE, BUT PRIOR TO ANY BRANCHES, AND SET FOR 60 PSI. PRESSURE SENSOR TO BE POWERED BY THE VFD, AND PROVIDE A

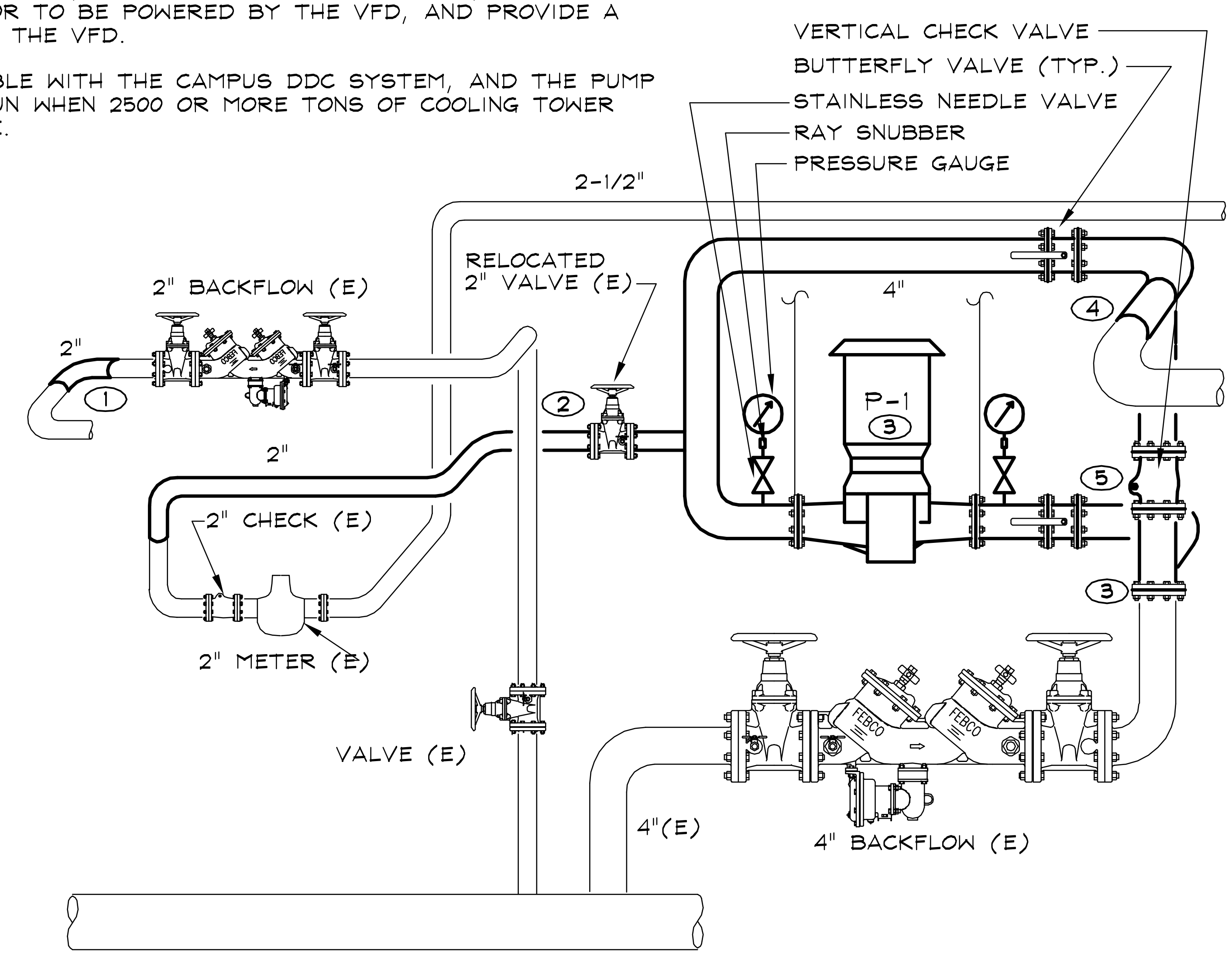
8 4-20 MA SIGNAL BACK TO THE VFD.

THE VFD TO BE COMPATIBLE WITH THE CAMPUS DDC SYSTEM, AND THE PUMP SHALL BE ENABLED TO RUN WHEN 2500 OR MORE TONS OF COOLING TOWER CAPACITY ARE IN SERVICE.





EXISTING PIPING DEMOLITION
SCALE: 1/2" = 1'-0"



NEW PIPING WORK
SCALE: 1/2" = 1'-0"

JOB NO.: 07137
DATE: 3/18/08
DRAWN: GCD
DRAWING: 07137 M1
SHEET NO.: M-1

REVISIONS:
1.

EWU ROZELL COOLING TOWER MAKEUP BOOSTER

DUMAIS•ROMANS, INC.
CONSULTING MECHANICAL ENGINEERS
NORTH 113 CONKLIN ROAD
VERADALE, WASHINGTON
PH. (509) 893-9646 FAX (509) 893-9648
E-MAIL DRI@NEXTDIM.COM

DUMAIS•ROMANS, INC.
Consulting Mechanical Engineers

APPENDIX “C”

Chilled Water Study Load Table

September 27, 2008

Item	EWU Facility								Cooling Coil Characteristics						
		AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU MBH Total/Sens.	AHU #	Flow Rate (gpm)	Entering Air Temperature, EAT_{DB}/EAT_{WB} (°F)	Leaving Air Temperature. LAT_{DB}/LAT_{WB} (°F)	Entering Water Temp. EWT (°F)	Leaving Water Temp. LWT (°F)
1	Aquatics (AQT)	DHU-1/Rm.#210							563 / --	1	70	-- / --	-- / --	40	56.1
2	Archives (ARC)	AHU-3/Rm. #207							1194 / 1194	1	171	85.4 / 64	53.5 / 51.9	45	59
3	Art Building (ART)	AHU-1, Rm. #204	AHU-3, Rm. # Duct Coils (4)						1553 / -- 660 / --	1 2	201 88	100 / 69.2 -- / --	52.7 / 51.7 -- / --	45 45	60 60
4	Cheney Hall (CHN)	AHU-1, Rm. #204	AHU-2, Outside Mech. Rm. #124						720 / -- 384 / 341	1 2	180 81	--/-- 80.3 / --	-- / -- 54.5 / --	45 45	-- 54.5
5	Child Care Center (ECC)	AHU-1, Rm. #?							312.8 / 312.8	1	31	86 / 62	55 / 50.5	45	--
6	Communications Center (CMC)	AHU-1, Rm. #131							532 / --	1	67	80 / 59.7	53 / 48.7	44	60
7	Computer & Engr. Building (CEB)	AHU-1, Rm. #003	AHU-2, Rm. #025	AHU-3, Rm. #003	AHU-4, Rm. #003	AHU-5, Rm. #025			1835 / 1835 2315 / 2315 590 / 590 435 / 435 1095 / 1095	1 2 3 4 5	245 310 80 60 150	62 / -- 62 / -- 62 / -- 67 / -- 67 / --	50 / 48 50 / 48 53 / 52 53 / 52 53 / 52	45 45 45 45 45	60 60 60 60 60
8	Huston Hall (HUS)	AHU-1 (SF-1), Rm. #001	AHU-2 (SF-3), Rm. #001	AHU-6 Elec. Rm.					477 / -- 619 / -- 115 / --	1 2 3	103 87 46	80 / 66 -- / -- -- / --	58.3 / 57.6 -- / -- -- / --	50 50 50	60 -- --
9 *	Hargreaves Hall (HAR)	AHU-1 Mechanical room in the Basement	AHU-2,3,4,5 Mechanical Room In the Attic						1040 / 930 88 / 77 88 / 77 88 / 77 88 / 77	1 2 3 4 5	200 19 19 19 19	80 / 64 80 / 64 80 / 64 80 / 64 80 / 64	-- / -- -- / -- -- / -- -- / -- -- / --	45 45 45 45 45	55 55 55 55 55
10	Isle Hall (Fan Coil Units) (ISL) · 1st Floor – 35(9) units · 2nd Floor – 16(1) unit	AHU-1, Rooftop, (2 coils)	AHU-2, Rooftop	Fancoils 1-10					633 / 615 174 / 170 347 / --	1 2 3	99 28 53	80.6 / 62.3 79.3 / 61.9 80 / 63	51.8 / 50.7 53.4 / 51.6 54 / 52	44 44 44	56.8 56.6 54
11	Jim Thorpe Fieldhouse (JTF)	AHU-1, Mezzanine Mech. Rm.							128 / 104	1	15	84 / 64.2	59 / 55.6	44	60
12	JFK Library (JFK)	AHU-1, Outdoor Mech. Rm.?	AHU-2, SE Penthouse Mech. Rm. P02	AHU-3, SE Penthouse Mech. Rm. P02	AHU-4 , Rm. #L04	AHU-5, Rm. #L04	AHU-6 , NW Penthouse Mech. Rm. #P01	AHU-7, NW Penthouse Mech. Rm. #P01 plus AHU-10, Rm. #U12F	686 / -- 554 / -- 944 / -- 602 / -- 568 / -- 638 / -- 614 / -- 151 / --	1 2 3 4 5 6 7 10	130 110 220 145 125 140 135 35	85 / -- 85 / -- 85 / -- 85 / -- 85 / -- 85 / -- 85 / -- 89 / --	54.5 / -- 55 / -- 55 / -- 54.6 / -- 54.7 / -- 54.7 / -- 55 / -- 57 / --	48 48 48 48 48 48 48 48	58.6 58 57 56.3 57.1 57.1 57.1 57
13	Kingston Hall (KGS)	AHU-1, Rm. # M-2							1660 / 1300	1	250	80 / 67	53 / 52	45	60

Item	EWU Facility	Chilled Water Cooling Coils								Cooling Coil Characteristics					
		AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU MBH Total/Sens.	AHU #	Flow Rate (gpm)	Entering Air Temperature, EAT_{DB}/EAT_{WB} (^oF)	Leaving Air Temperature. LAT_{DB}/LAT_{WB} (^oF)	Entering Water Temp. EWT (^oF)	Leaving Water Temp. LWT (^oF)
14	Martin Hall (MAR)	AHU-1, Rm. #150	AHU-3, Rm. #255	AHU-4, Pent House Mech. Rm. #?					251 / --	1	70	84 / 53	-- / --	45	55
15	Monroe Hall (MON)	AHU-1, Rm. #100.	AHU-2, Rm. #100	AHU-3, Rm. #100					443 / 390 424 / 403 503 / 415	1 2 3	68 52 78	81 / 62 81 / 63 83 / 63.5	50 / 49 52 / 51 50 / 49	45 45 45	58.5 61.5 57.9
16	Music Building (MUS)	AHU-1&2, Rm. #122							730 / --	1	85	80 / 59.7	55 / 49.5	44	60
17	Patterson Hall I (PAT I)	AHU-1, Rm. #164							1944 / --	1	360	80 / 61.5	50 / 48	44	--
18	Patterson Hall II (PAT II)	AHU-1, Rm. #108							2010 / --	1	360	80 / 61.5	50 / 48	44	--
19	P.E. Activities (PEA)	AHU-4, Rm. #108. Coaches Offices	AHU-11, Rm. #115	AHU-13, Rm. #128 (double doors) Laundry					46 / -- 418 / 376 361 / 348	1 2 3	9 61 52.7	81 / -- 82.3 / 62.2 82.3 / 62.2	-- / -- 50 / 48.5 50.2 / 49.4	45 44 44	-- / -- 57.7 57.7
20	P.E. Classroom (PEC) (Fan Coil Units)	AHU-1, Rm. #001	AHU-2, Rm. #103 Fancoils						254 / 223 529 / --	1 2	84 175	82.5 / 64.3 --/--	55 / 53 -- / --	44 44	60 60
21	Pavilion (PAV)	AHU-1, Rm. #203	AHU-2, Rm. #216	AHU-3, Rm. #236	AHU-4, Rm. #500	AHU-5, N. Penthouse Rm. #504	FC-A (1) and FC-B (8)		333 / -- 337 / -- 87 / -- 1951 / -- 1951 / --	1 2 3 4 5	42 42 11 244 244	-- / -- -- / -- -- / -- -- / -- -- / --	-- / -- -- / -- -- / -- -- / -- -- / --	44 44 44 44 44	60 60 60 60 60
22	Pence Union Building (PUB)	AHU-1, Old Mech. Rm. #120	AHU-2, Old Mech. Rm. #120	AHU-3, Old Mech. Rm. #120	AHU-4, Old Mech. Rm. #120	AHU-5, Penthouse Mech. Rm. ?	AHU-6, Penthouse Mech. Rm. ?		946 / 820 972 / 870 950 / 840 455 / -- 522 / -- 367 / --	1 2 3 4 5 6	118 122 119 57 150 74	84.2 / 63.5 86.8 / 64.1 89.5 / 64.8 95 / 65 86 / -- 86 / --	50 / 48.5 50 / 48.5 50 / 48.5 50 / 47.5 53 / -- 53 / --	44 44 44 44 46 46	60 60 60 60 60 60
23	Radio/TV Building (RTV)	AHU-1, Outside Mech. Rm. #200							1211 / 955	1	165	82.4 / 63.8	50.1 / 48.8	44	58.6
24	Recital Hall	AHU-1, Rm. #202							300 / --	1	44	80 / 59.7	55 / 49.5	44	60
25	Rozell Heating Plant (ROZ)	AHU-1, Rooftop Unit.	AHU-1, Basement, UPS Area	AHU-2, Basement, UPS Area					193 / -- 57 / 57 57 / 57	1 2 3	45 15 15	84.5 / 63 77.7 / 62 77.8 / 62	53 / 51.6 54 / 53 54 / 53	45 44 44	63.6 52.6 52.6
26	Science Building (SCI)	AHU-1, Rm. # 301.	AHU-2, Rm. # 301.	AHU-3, W. or N. Mech. Rm. #004	AHU-4, E. or S Mech. Rm. #001				2279 / -- 186 / -- 3698 / 3666 3048 / 3021	1 2 3 4	380 31 760 620	93 / 76 93 / 67 93 / 64 93 / 64	55 / 52 55 / 52 55 / 49.5 55 / 49.5	45 45 48 48	57 57 58 58
27	Senior Hall (SNR)	AHU #1, Mech. Rm. # 001	AHU #2, Mech. Rm. # 001	FC 3-6					750 / 750 750 / 750 641 / --	1 2 3	100 100 9	83 / 64 83 / 64 82 / --	51.1 / 51.1 51.1 / 51.1 56 / --	45 45 45	60 60 60
28	Showalter Hall (SHW)	AHU-1, New	AHU-2, New						1300 / -- 309 / --	1 2	248 62	81.7 / 61.7 -- / --	52.7 / 49.8 -- / --	45 45	55 --
29	Sutton Hall (SUT)	AHU-1, Mech. Rm. # 001							486 / --	1	100	84 / 63.7	51.8 / 50.8	46	55.7

Chilled Water Study Load Table (Continued)

September 27, 2008

Item	EWU Facility	Chilled Water Cooling Coils								Cooling Coil Characteristics					
		AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU/ Location	AHU MBH Total/Sens.	AHU #	Flow Rate (gpm)	Entering Air Temperature, EAT_{DB}/EAT_{WB} (^oF)	Leaving Air Temperature. LAT_{DB}/LAT_{WB} (^oF)	Entering Water Temp. EWT (^oF)	Leaving Water Temp. LWT (^oF)
30	Tawanka (TAW)	AHU-1, Penthouse Mech. Rm. #302	AHU-2, Penthouse Mech. Rm. #302	AHU-3, Penthouse Mech. Rm. #302.					966 / -- 1005 / -- 1073 / --	1 2 3	193 175 179	81 / -- 79 / -- 92 / --		45 45 45	55 56.5 57
31	Theatre (Drama) (THE)	AHU-1, Outside Mech. Rm. #113	AHU-2, Mezz. Mech. Rm. #133A						620 / 584 493 / 474	1 2	77 77	83 / 63.8 84.6 / 64		44 44	60.4 57.5
32 *	University Recreation Center (URC)	AHU-1, Rooftop Unit	AHU-2, Rooftop Unit	AHU-3, Rooftop Unit	AHU-4, Rooftop Unit	AHU-5, Rooftop Unit	AHU-6, Rooftop Unit		2446 / 2152 493 / 484 125 / 122 576 / 567 865 / 696 280 / 269	1 2 3 4 5 6	335 124 24.9 96.2 123 35	78 / 61 87 / 65 83 / 63 75 / 65 81 / 65 93 / 64	47.6 / 47.2 53.5 / 51.8 48.2 / 47.8 53.1 / 52.5 53.8 / 52.7 67.5 / 55.1	42 44 42 42 42 42	56.2 56.6 57.1 56 57.9 56.2
33	WSP Crime Lab. (WSP)	AHU-1, Penthouse Mech. Rm. #201	AHU-2 Penthouse Mech. Rm. #201						1147 / 1131 1147 / 1131	1 2	153 153	96 / 67 96 / 67		45	60
34	Williamson Hall (WLM)	AHU-1, Penthouse Mech. Rm. #?							1710 / --	1	350	84 / 48		45	55
								TOTALS	**67,486**		**11,198**				

* The cooling load for this building was not served in 2007, and is not included in the 2007 Maximum Design Load.
** The loop flow rate may not match the sum of the coil flow rates, since they are fed by secondary pumps.

2007 MAXIMUM DESIGN LOAD	**61,309 MBH**	**10,184 GPM ****
2008 MAXIMUM DESIGN LOAD	**67,486 MBH**	**11,198 GPM ****

Appendix D:

EWU Chiller Study - 1000 ton

SUMMARY			Material		Labor
PIPING			$17,665		$23,108
PIPING INSUL.			$5,441		$5,067
PLUMBING FIXTURES			$0		$0
PLUMBING EQUIPMENT			$46,892		$7,484
DUCTWORK			$940		$180
DUCT INSULATION			$0		$0
HVAC EQUIPMENT			$652,400		$33,300
EXCAVATION			$88		$75
FIRE PROTECTION			$0		$0
AIR BALANCE			$0		$500
TEMP. CONTROL			$19,200		$19,200
DEMOLITION			$0		$0
ELECTRICAL WORK			$60,700		$16,050
BUILDING ADDITION			$36,500		$38,000
SUBTOTALS		TOTAL	**$839,825**	TOTAL	**$142,964**
Sales Tax %	8.60		**$72,225**		**$12,295**
Contingency %	6.00		**$50,390**		**$8,578**
Sub Contractor OH&P % *	25.00		**$209,956**		**$35,741**
General Contractor OH&P % *	10.00		**$83,983**		**$14,296**
Total Markup	49.60				
		GRAND TOTAL			**$1,470,253**

* overhead and profit percentages from Means, to be added to data above, also from Means.

Appendix E:

EWU Chiller Study - 2000 ton

SUMMARY			Material		Labor
PIPING			$86,090		$108,864
PIPING INSUL.			$27,192		$22,982
PLUMBING FIXTURES			$0		$0
PLUMBING EQUIPMENT			$83,743		$13,339
DUCTWORK			$940		$180
DUCT INSULATION			$0		$0
HVAC EQUIPMENT			$1,152,400		$55,100
EXCAVATION			$88		$75
FIRE PROTECTION			$0		$0
AIR BALANCE			$0		$700
TEMP. CONTROL			$21,000		$18,000
DEMOLITION			$0		$0
ELECTRICAL WORK			$121,400		$32,100
BUILDING ADDITION			$35,500		$39,000
SUBTOTALS		TOTAL	**$1,528,352**	TOTAL	**$290,341**
Sales Tax %	8.60		**$131,438**		**$24,969**
Contingency %	6.00		**$91,701**		**$17,420**
Sub Contractor OH&P % *	25.00		**$382,088**		**$72,585**
General Contractor OH&P % *	10.00		**$152,835**		**$29,034**
Total Markup	49.60				
		GRAND TOTAL			**$2,720,765**

* overhead and profit percentages from Means, to be added to data above, also from Means.