EASTERN WASHINGTON UNIVERSITY

Campus Infrastructure Renewal

STEAM SYSTEM EVALUATION

August 1, 2014

CAMPUS INFRASTRUCTURE RENEWAL
Project AE1368
STEAM SYSTEM EVALUATION

FOR

EASTERN WASHINGTON UNIVERSITY

Cheney, Washington

By

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INTRODUCTION

The following report summarizes the evaluation of the Eastern Washington University, EWU, Central Campus Steam Plant and Campus Steam 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 STEAM SYSTEM

Rozell Central Campus Steam Heating Plant

The Central Campus Steam Plant is located in the Rozell facility at the north end of campus. The steam plant furnishes high pressure steam, 100 psig, to the majority of the campus building through a network of underground tunnels and shallow utilidors, to provide for the space heating and domestic hot water needs of the campus facilities.

There are five high-pressure (100 psig) steam boilers located in the Rozell Heating Plant. All are capable of firing on either natural gas or No. 2 fuel oil. Natural gas is supplied to the plant by AVISTA. Fuel oil is stored in two 15,000 gallon underground storage tanks, installed inside concrete vaults adjacent to the plant.

Steam Boilers

The Rozell Central Campus Steam Plant consists of the following boilers:

Boiler # 1	Babcock & Wilcox, Watertube Natural Gas & #2 Fuel Oil Fired 1,600 Boiler Horsepower 56,000 lb/hr Built 1974
Boiler # 2	E. Keeler, Watertube Natural Gas & #2 Fuel Oil Fired 715 Boiler Horsepower 25,000 lb/hr Built 1960
Boiler # 3*	Union Iron Works, Watertube (*Not in Service) Natural Gas & #2 Fuel Oil Fired 715 Boiler Horsepower 25,000 lb/hr Built 1966
Boiler # 4	Babcock & Wilcox, Watertube Natural Gas & #2 Fuel Oil Fired 1,342 Boiler Horsepower 47,000 lb/hr Built 1969
Boiler # 5	Nebraska, Watertube Natural Gas & #2 Fuel Oil Fired 2,542 Boiler Horsepower 89,000 lb/hr Built 2001

Total Plant Capacity: <u>217,000 lb/hr*</u>

(*Capacity does not include Boiler #3, which is presently not in service, awaiting repairs)

Boilers #1, #3 and #5 are provided with boiler feedwater stack economizers, used to pre-heat the pre-heat the boiler feedwater using hot stack gases through a heat exchanger.

The newest boiler, #5, is equipped with a low NOX burner. None of the other, older boilers, are equipped with low NOX burners.

These five boilers provide high pressure (approx. 100 psig) steam to a common header. This header has multiple branches that distribute steam to the Rozell steam plant for plant heating and deaerator duty, with a main 12" steam main that feeds out in to the campus utility tunnel for distribution to the University buildings.

Normal Plant operating steam pressure readings are between 110 and 100 psig. For the purposes of modeling and calculations, 100 psig was used. In Spokane, this correlates to an absolute pressure of 113.5 psia.

Boiler Plant Auxiliaries

The central steam boiler plant is supported by several auxiliary pieces of equipment to support the plant operation.

Deaerator; The boiler plant is equipped with a 150,000 pph capacity low pressure deaerator unit, used to deoxygenate and condition the make-up water and feed water. A continuously pumped and pressurized feedwater loop supplies feedwater to the various boilers that utilize modulating feedwater valves for water level maintanence. Three (3) 30 hp vertical multistage feedwater pumps supply the system and are staged and modulated with VFDs for capacity control. A separate, steam-powered boiler feedwater pumps is available and is utilized when steam loads exceed approximately 25,000 pph. Exhaust from the steam-powered pump is directed in to the DA tank.

Feedwater Tank: Located in the lower level of the Rozell plant, the feedwater storage tank receives pumped condensate return from the campus steam distribution system. Condensate return temperatures are typically in the range of 150 deg. F to 160 deg. F. A set of three electric single speed DA feedwater pumps provide continuous pressurized supply to the deaerator tank. Staging of the DA feedwater pumps is semi-automatic based on system demand.

Water Treatment Equipment: The chemical water treatment equipment for the steam boiler plant is also located in the lower level of the plant. Dosing pumps and monitoring devices provide chemical feed of corrosion inhibitors and PH maintenance. Make-up water is pre-treated through an ion exchange water softener plant. The steam distribution system appears to be fairly tight, as condensate return is reported to be fairly efficient, returning approximately 95% of the steam condensate back to the plant. Hence, make-up water levels are minimized.

Boiler Stack

Each steam boiler is provided with uptake breeching that connects to a common stack manifold inside the plant. This manifold is then routed through the west sidewall of the

Rozell facility, where it ties in to a single tall concrete and masonry stack. The interior condition of this stack is unknown, but reports from the EWU maintenance staff suggest some of the lining brick may be deteriorating. A full analysis of this boiler plant stack is beyond the scope of this report, but for the long term viability of the campus steam plant, it is recommended that a full study as to the condition and seismic viability of this stack be commissioned.

Plant Operation

The steam boilers are manually staged by the plant operators depending on weather conditions and campus steam load.

During summer months, the smallest boiler, Boiler #2, is used to support campus building domestic hot water demands, with Boiler #4 kept on hot standby for back up.

During the shoulder seasons, spring and fall, Boilers #1 and #4 are used.

During the winter heating season, Boiler #5 is used as the lead boiler, with either Boiler #1 or #4 used as hot standby or for peaking duty.

Fuel Firing Issues

The steam boilers are capable of firing on either natural gas or No. 2 fuel oil as back-up. Because of present limitations with AVISTA's natural gas supply capacity to the City of Cheney, peak gas consumption to the Rozell Plant is limited by contract to approximately 56,000 pph firing rate. Above this level of consumption gas supply pressures drop off due to other gas demands in the campus neighborhood. At this point the standby boilers, #1 or #4, are fired on No. 2 fuel oil, to handle demand greater than 56,000 pph. It is not desirable to have to fire on fuel oil, due to added wear and tear on the burners, loss of efficiency and stack emission issues.

Until such time as AVISTA addresses their gas supply capacity issue to the City of Cheney, this situation will not change. Timing of such an upgrade is unknown and is in the hands of AVISTA.

Campus Steam Tunnel Distribution System

General:

High pressure steam 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 & residence hall buildings.
Steam supply and condensate return 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.

High pressure steam supply to each building generally terminates at a steam pressure reducing station (PRV), which reduces the steam pressure from 100 psig down to 15 psig, low pressure steam, for distribution within the building. Low pressure steam generally feeds various heating equipment, air handling unit coils, heat exchangers and domestic water heaters. In some buildings the intermediate steam pressure, 60 psig, is used for laundry or cooking equipment.

Pipe Materials & Installation:

It is understood that the steam distribution piping system, supply, pumped return and gravity condensate 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 steam piping is generally installed on steel framing, with roller supports, spider alignment guides and inline expansion joints where necessary. Anchors are generally tied directly in to the concrete walls. Steam condensate drip traps are provided at low points, branch take-offs and other drainage points. A dedicated gravity condensate drainage system handles drip traps within the tunnel, with periodic condensate pumps installed to handle the liquid condensate. A separate pump condensate return piping system parallels the steam supply piping. Pumped condensate from each building is delivered in to this line which makes it way back to the feedwater hot well storage tank in Rozell.

Configuration:

The steam 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 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 HP steam supply main piping allows the steam 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 steam during service shut-downs on limited sections. Without a looped system, everything downstream from the shut-off point would 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 steam (and chilled water) 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 steam supply shut-off valves have been changed from OS&Y gate valves to high performance butterfly valves, which give excellent performance and help to extend the life expectancy of the system. High pressure steam 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 steam flow model was created for the entire campus steam supply system (see analysis below). This model used information about the existing connected steam loads (PRV stations in each building) and existing steam pipe sizing information, to develop a dynamic tool to help understand steam flow paths through the looped system, and to determine pressure losses from the Rozell Plant to the remote ends of the distribution system.

Both the east and west main loops coming from Rozell are sized as 10” pipes. On the west (HPE) loop, the 10” size continues all the way past the junction to the Art complex, and up to the JFK branch take-off. On the east (Rozell) loop, the 10” pipe continues up to the PUB branch, where is reduces to 8” pipe. This 8” pipe continues in the main tunnel up to the other side of the JFK branch.

Based on historical steam demand diversity for the campus, the steam flow model analysis indicates that the existing 10” & 8” looped steam mains will have sufficient capacity to deliver adequate steam to the campus, including future demands for the expected growth of the Gateway Athletic complex and the Science I & II Buildings. Expected peak pipeline steam velocities do not exceed normal limits and the resultant drop-off pressures to remote building remains manageable.

Tunnel Gravity Condensate System & Pumps:

As noted above, the steam distribution system is provided with a dedicated gravity condensate system to handle drip traps that are located in the tunnel. This is a good design feature as not all campus steam systems have this feature and drip traps are often piped back in to the pumped return lines, which can cause bothersome water hammer and noisy return lines.

The use of electric condensate pumps within the tunnel to collect and return this condensate, is an ongoing issue with the EWU maintenance staff. Electric condensate pumps have issues with the severe conditions experienced in the tunnels, including elevated condensate temperatures that lead to pump seal failure, hot and humid tunnel conditions that impact pump controls and fittings. Maintenance and reliability is an concern for these pumps.

The gravity condensate return piping itself is also a point of concern for possible future failure. Although the present piping appears to be in good condition without reported leaks, it is understood that this piping is standard wall thickness Sched. 40 piping, rather than the more robust Sched. 80 piping. Generally, the heavier wall Sched. 80 piping is used in steam condensate systems to combat the corrosive affects created by the presence of air (oxygen) and carbonic acid (a natural constituent of condensed gases) that occurs in condensate lines. Because the thinner walled piping has been utilized for the gravity condensate piping, the conventional wisdom is that the results of the normal corrosion process has likely accelerated the aging of this pipe (reduced wall thicknesses) to the point that it is a candidate for system-wide replacement.

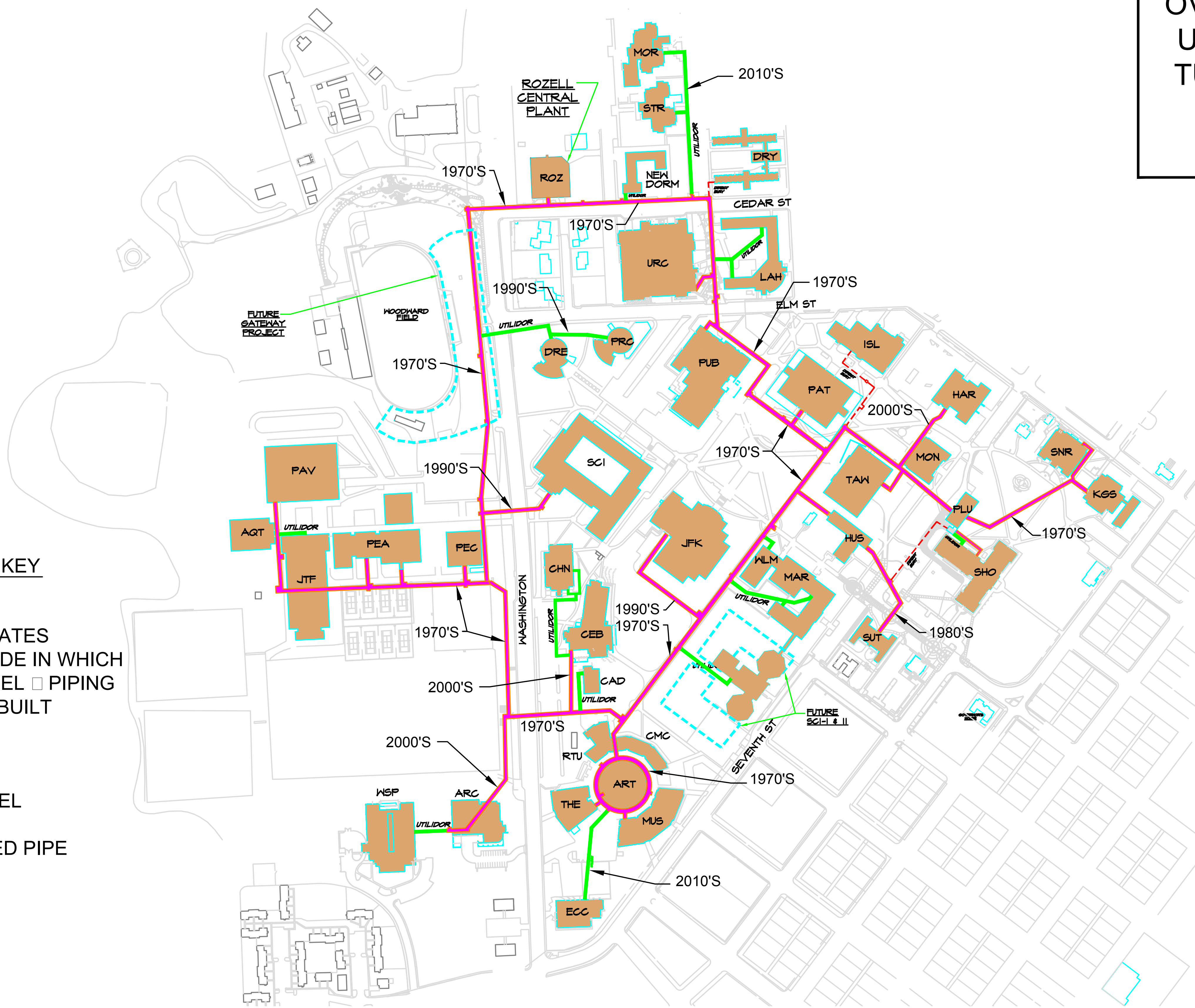
Life Expectancy:

Based on the observations of the tunnel-wide survey conducted for this report, it appears that the steam supply piping is in good condition 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.

Likewise, the pumped condensate return system is also in a condition similar to the supply piping, and being a pressurized system, not subject to effects of condensing steam, it's future life expectancy should also be another 15 to 25 years.

The gravity condensate return piping, as noted above, is more suspect as to its condition, due to the use of thinner walled Sched. 40 piping, and the deteriorating effects of steam condensate action. Without conducting a series of wall thickness field measurement, it is difficult to know to what degree the condensate pipe wall has been degraded, but it is likely much greater that either the supply or pumped lines. Because of that it is reasonable to assume that the gravity condensate piping is nearing the end of its useful life.

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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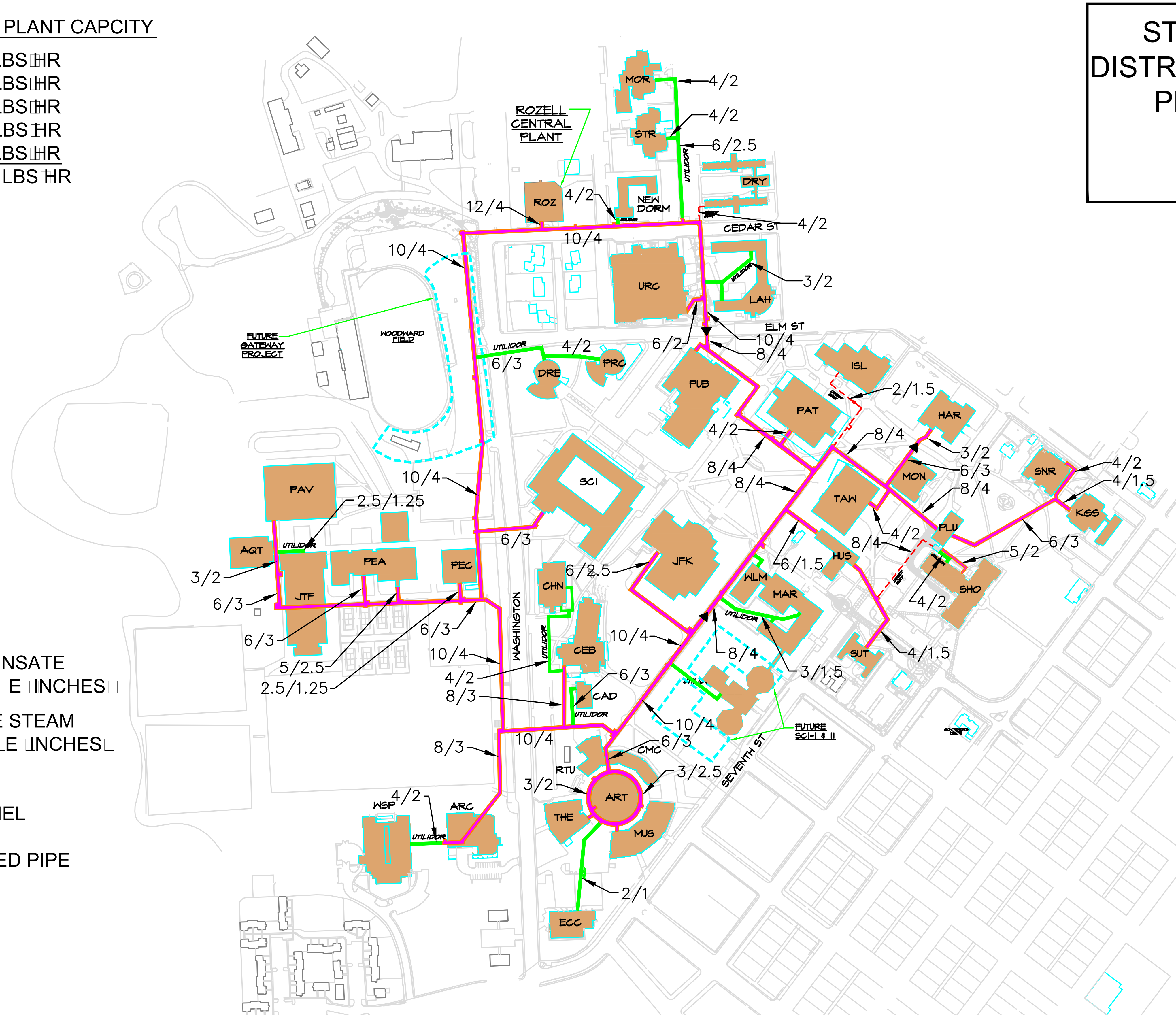
EXISTING STEAM BOILER PLANT CAPCITY

BOILER □1	-	56,000 LBS□HR
BOILER □2	-	25,000 LBS□HR
BOILER □3	-	25,000 LBS□HR
BOILER □4	-	47,000 LBS□HR
BOILER □5	-	89,000 LBS□HR
TOTAL	-	217,000 LBS□HR

STEAM DISTRIBUTION PLAN



PIPING KEY

6 □3 ← PUMPED CONDENSATE RETURN PIPE SI□E □INCHES□

HIGH PRESSURE STEAM SUPPLY PIPE SI□E □INCHES□

TUNNEL LEGEND

UTILITY TUNNEL

UTILIDOR

DIRECT BURIED PIPE

N

EWU - STEAM DISTRIBUTION PLAN

Scale: 1" = 400'

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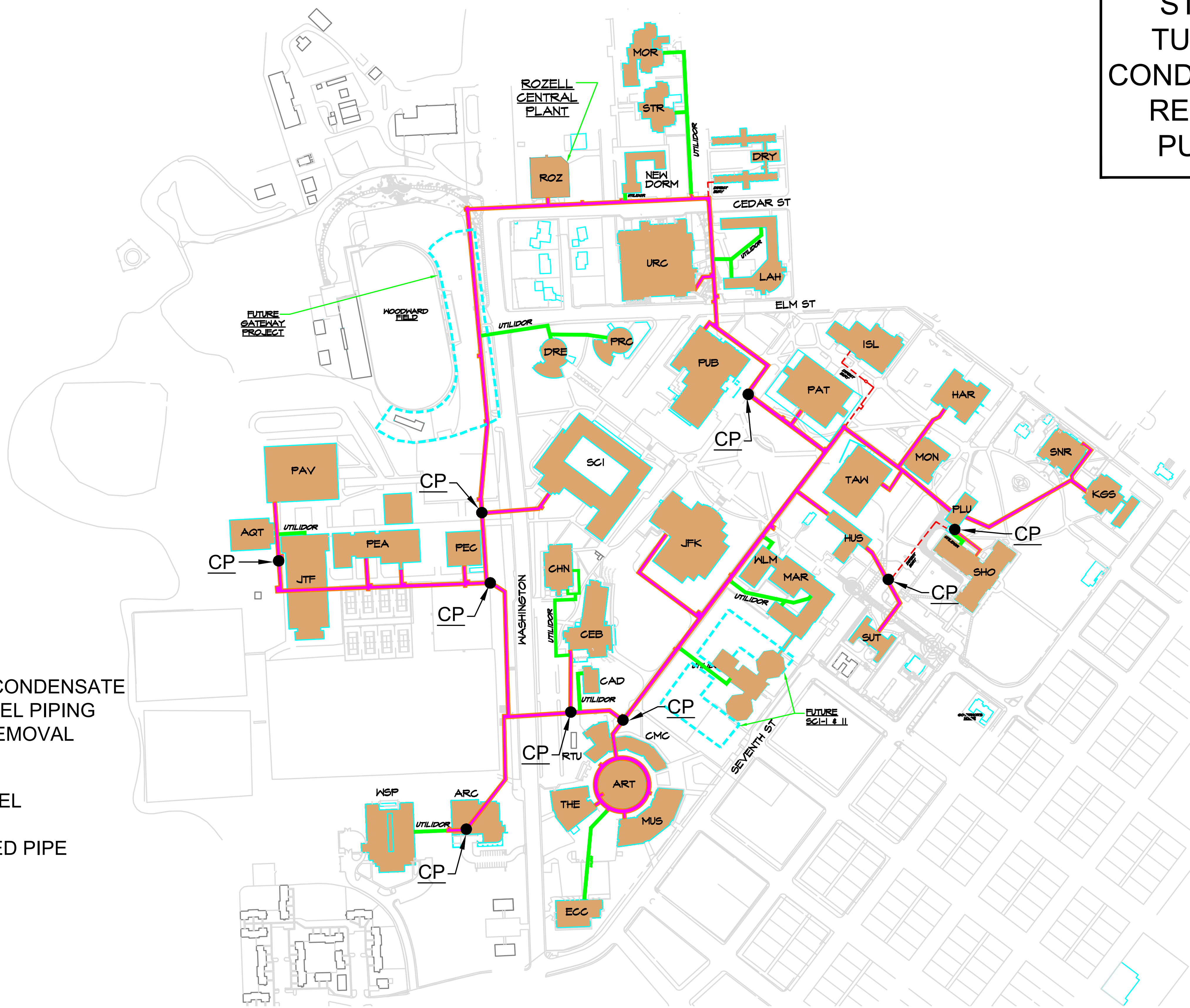
STEAM TUNNEL CONDENSATE RETURN PUMPS



CONDENSATE PUMP KEY

CP →●

SIMPLEX ELEC. CONDENSATE PUMP FOR TUNNEL PIPING CONDENSATE REMOVAL

TUNNEL LEGEND

- UTILITY TUNNEL
- UTILIDOR
- DIRECT BURIED PIPE

N

EWU - STEAM TUNNEL CONDENSATE PUMP PLAN

Scale: 1" = 400'

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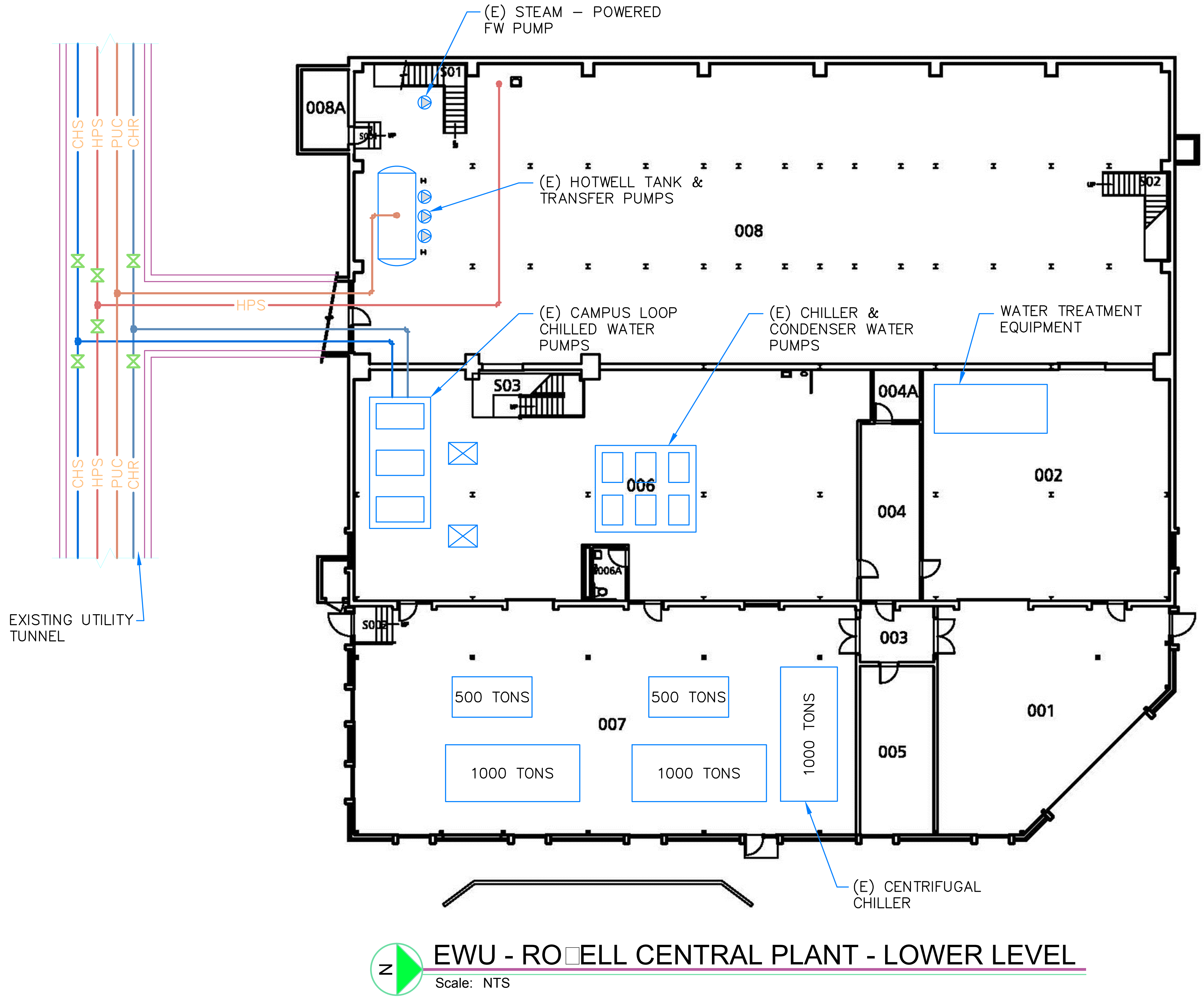

EWU - RO□ELL CENTRAL PLANT - LOWER LEVEL

Scale: NTS

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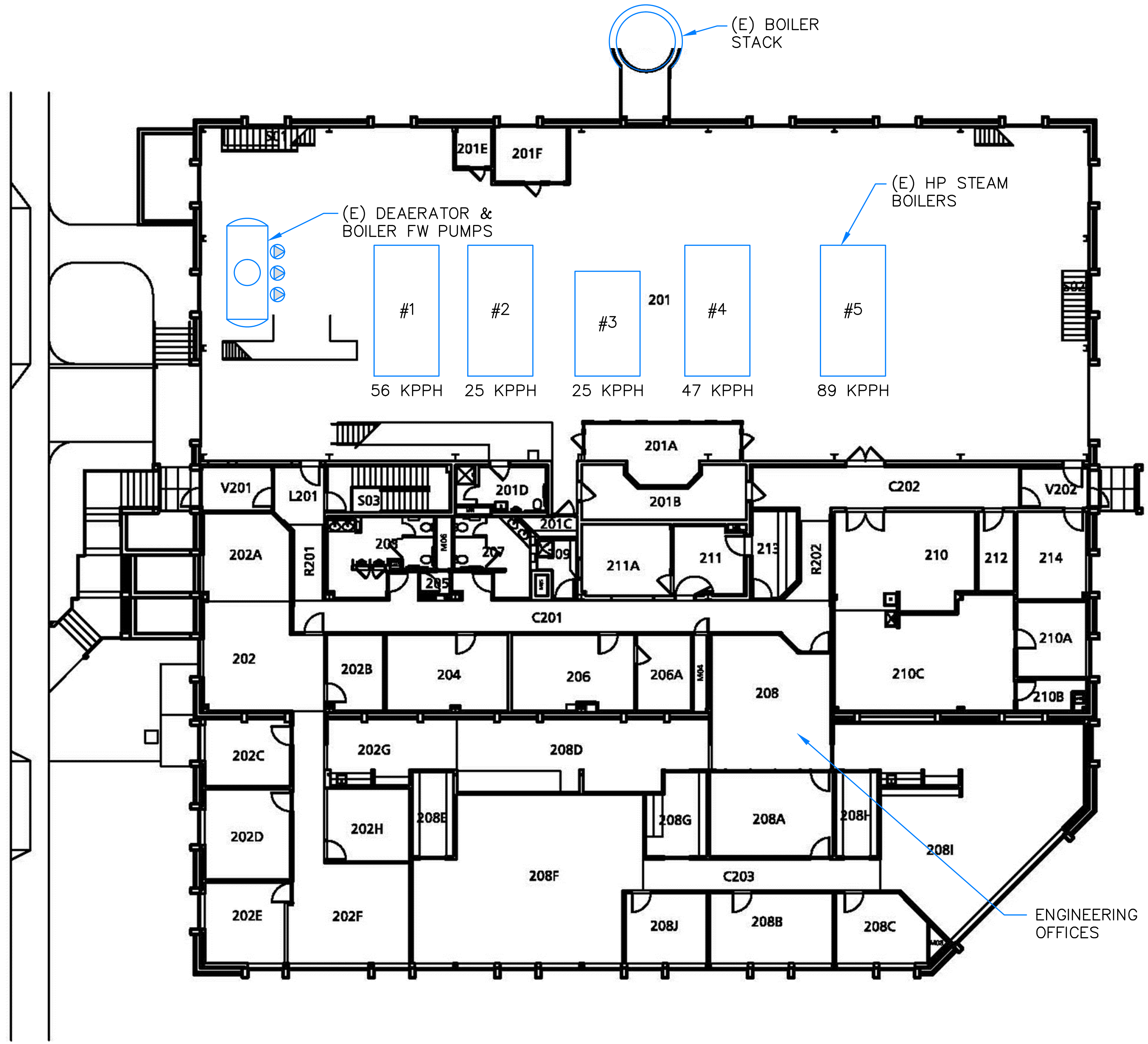

EWU - RO□ELL CENTRAL PLANT - MAIN FLOOR

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Scale: NTS

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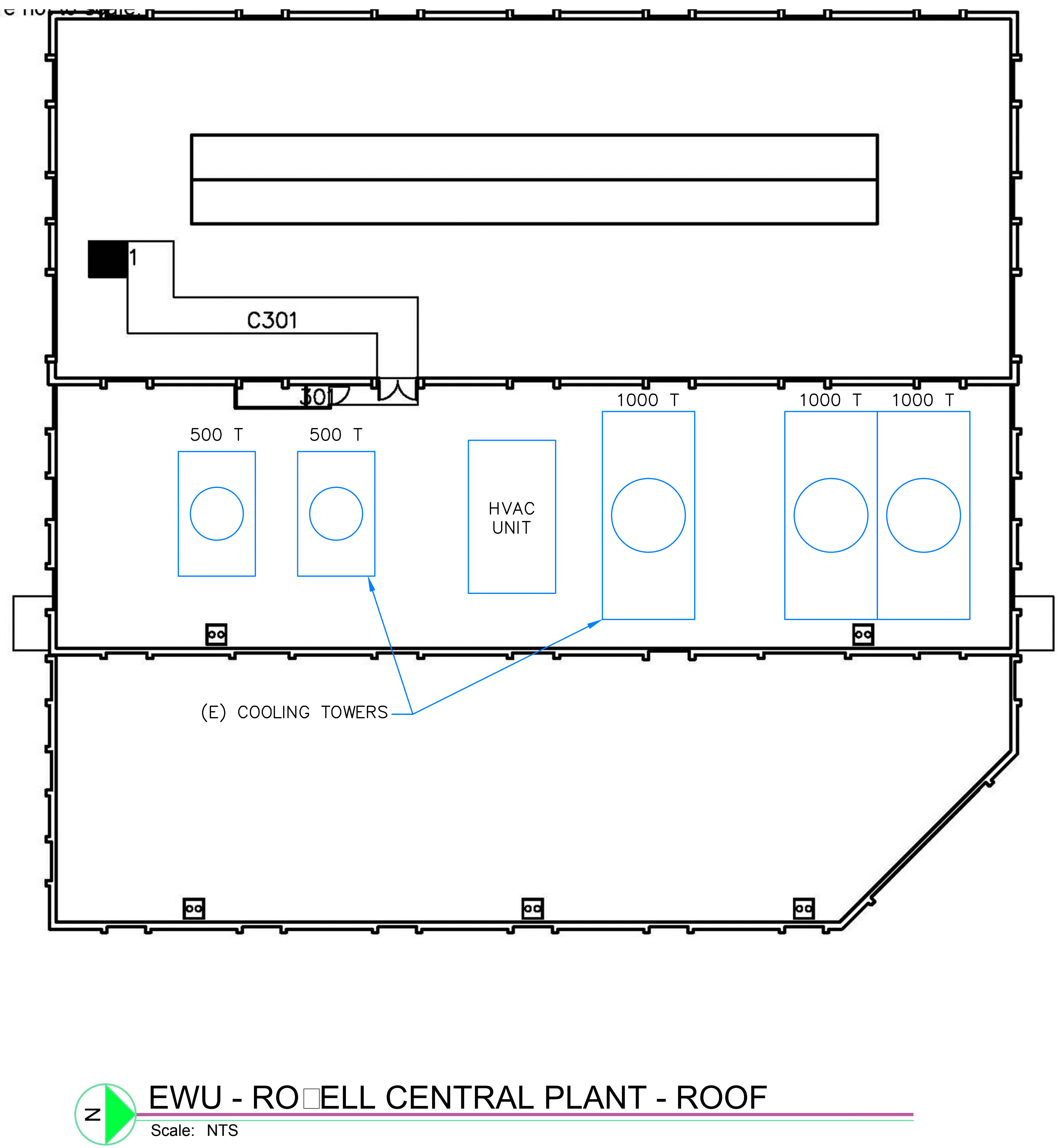

EWU - RO□ELL CENTRAL PLANT - ROOF

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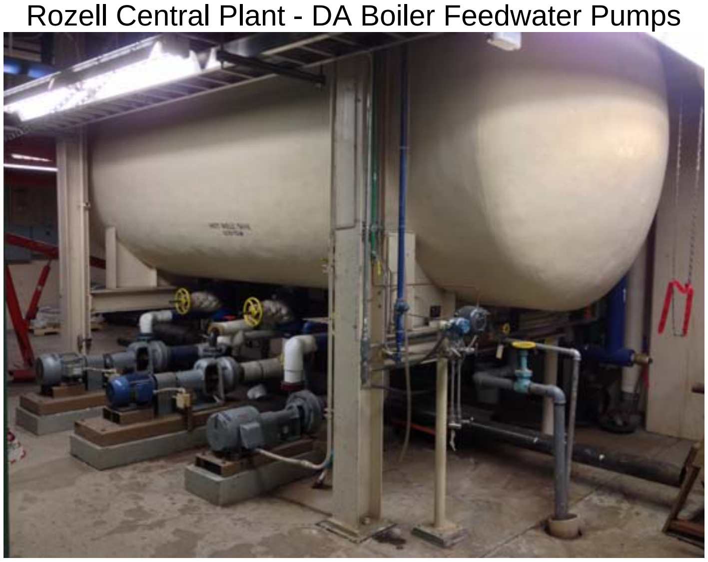
Rozell Central Plant - HP Steam Boilers

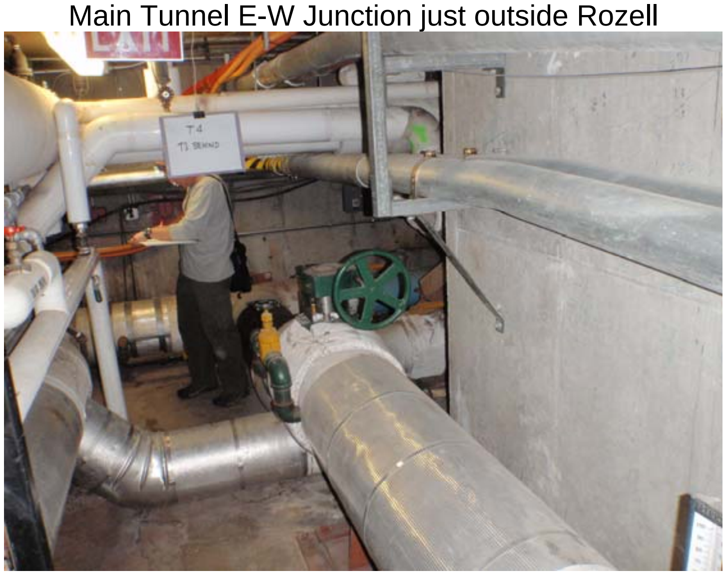
Rozell Central Plant - DA Boiler Feedwater Pumps



Rozell Central Plant - Hot Well Condensate Tank & Transfer Pumps

Utility Tunnel Entrance at Rozell

Main Tunnel E-W Junction just outside Rozell



West Tunnel - Intersection to HPE Complex

E-W Tunnel Intersection at Branch to Art Complex

East Tunnel Intersection to Mall - PAT to Left, JFK in Front, TAW Beyond

Tunnel “Y” Intersection to PUB Branch (to the right)

Branch to URC

“Hobbit” Tunnel Branch to SHW

Typical Tunnel Electric Condensate Pump

CAMPUS STEAM 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, steam main 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 steam 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 steam "flow demand" points, representing the steam demand for each building. Basically this is the point where the high pressure steam enters the building at the PRV header. Piping beyond the steam header was not modeled, as the goal of the analysis was to see how much residual steam pressure was available from the campus supply, up to the PRV connection point.

Steam Load Data Source

Available construction drawings for each building were pulled from the EWU drawing library and PRV steam load sizing data was extracted from these plans. PRV station data was generally given as maximum design lbs/hr at the expected upstream and downstream pressures. A number of actual building PRV stations were examined in order to spot-check the accuracy of these drawings. The plans were found to be in general agreement with the field installations, so the modeling inputs for steam load are based the information gathered from the available construction documents.

Diversity

Utilizing only the design peak steam demand for all facilities simultaneously does not take into account the actual dynamics of building occupancy and results in an unrealistically high demand on the Central Campus Steam Plant. For example, occupancy levels often don't reach 100% and can therefore reduce the demand for both heating and hot water. In addition, the peak demand for hot water often does not coincide with the peak demand for heating. 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 steam plant.

According to the EWU steam plant operators, the largest steam demand ever witnessed by the boiler plant occurred this past February during sub-zero weather. This coincided with the remodeled Patterson Hall coming on line for the first time again in about three years, along with its new exterior snow melt system that was active.

The historical peak demand for the boiler plant was noted as 75,000 lbs/hr.
Based on a total campus connected steam load, the sum of all PRV stations, that is

approximately 234,000 lbs/hr, the 75,000 pph represents a diversified load of 32% (of total capacity). Based on a steam boiler plant total capacity of 217,000 pph, this represents a 35% load of plant capacity.

For steam flow modeling purposes, the diversified peak historic steam load was modeled at 40% of peak connected capacity. This value was selected to be somewhat conservative relative to the historic peak of 32%, and also to allow for unknowns an simplifications used in the modeling assumptions, variations of load diversity within the actual campus network, and a safety factor for extreme weather events.

COMPUTERIZED STEAM 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 steam 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% steam 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 steam system operation, which is highly diversified, but it is interesting to note the high resultant pipeline velocities near Rozell with the flow is maximum, and the steep drop off in delivery pressures throughout the network due to the theoretically undersized piping.

<u>Case-2: Historic Peak - 40% Connected Loads</u>

This model is basically the baseline expected peak steam flow demand for the actual existing campus system, based on the historic peak diversified demand of 40% of connected load (see above for diversity discussion).

<u>Case-3: Future Peak - 40% Connected Loads</u>

This model adds in the future steam loads, for the planned Gateway Athletic complex as well as for the new Science I & II facility, to the historic peak loads of Case-2. The diversified load factor of 40% was used for this model.

STEAM FLOW MODEL RESULTS

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

Case-1: Maximum Design - 100% Connected Loads

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

Case-2: Historic Peak - 40% Connected Loads

Pipe Velocities:
Results of the steam flow model for this case show that anticipated peak, diversified steam flows and corresponding velocities in the existing piping network, do not exceed accepted values for good engineering practice. Up to 15,000 fpm (250 fps) maximum velocity for steam mains. Peak velocities occur near Rozell where the combined steam flows are the greatest, with the two main 10" branch loops below 6,000 fpm and the 12" plant main at 7,500 fpm. This indicates, and confirms, adequate pipe sizes for the actual existing historic peak loads for the campus.

Pressure Drops:
Results of the steam flow model for this case show peak drop-off pressures to the hydraulically most remote buildings of about 85 psig (to the ECC building at the south end of the campus), or about a 15 psig loss in the piping network. Most buildings show a supply pressure in the low 90 psi range, or better. This indicates that adequate pressure can be maintained throughout the campus at expected peak flow periods.

Case-2: Future Peak - 40% Connected Loads

Pipe Velocities:
With the addition of more steam load to the model to account for future buildings, the results of the steam flow model for this case again show that anticipated peak, diversified steam flows and corresponding velocities in the future piping network, still do not exceed accepted values for good engineering practice. Up to 15,000 fpm (250 fps) maximum velocity for steam mains.

Future peak velocities occur near Rozell where the combined steam flows are the greatest, with the west side main 10" branch loops around 7,500 fpm and the east side 10" main below 6,000 fpm. The 12" plant main at increases to about 9,000 fpm. This indicates, and confirms, adequate pipe sizes for the anticipated future peak campus steam loads for the campus.

Pressure Drops:
The impact of greater future steam flows for this case show peak drop-off pressures to the hydraulically most remote buildings of about 83 psig (to the ECC building at the south end of the campus), or about a 17 psig loss in the piping network, which is only 2 psig more than the present conditions. Most buildings still show a supply pressure in the upper 80 psig or low 90 psi range. This indicates that adequate delivery pressure can be maintained throughout the existing campus distribution system, even with allowance for future steam loads.

STEAM FLOW MODEL CONCLUSIONS

Steam Distribution Piping Capacity for Future Growth

The existing steam distribution piping is adequately sized to handle the current steam loads plus anticipated future growth.

Boiler Plant Capacity for Future Growth

According to the EWU operations staff, the historical peak campus heating load, seen this last winter, was approximately 75,000 lbs/hr.

Based on the anticipated Master Plan campus growth for the New Science I & II projects, the new Gateway Athletic Project, the expected addition of future campus steam load is approximately 34%. Based on a peak historic load of 75,000 pph, a 34% increase would put the future campus steam load at slightly over 100,000 pph, which is approximately 50% of the steam plant's present total capacity 217,000 pph.

Due to anticipated future campus growth, which will increase expected plant peak steam loads by over 30%, the added loads will start to impact boiler plant redundancy & operational flexibility, especially since existing Boiler #3 is no longer operational. In order to return the boiler plant capacity to full original output, it is recommended that Boiler #3 be either repaired and returned to service, or, due to it's advanced age (over 50 years), be replaced entirely with a new boiler. As such, either a repaired, or new boiler, will allow plant operation and redundancy to be maintained well in to the future. Providing a new boiler, instead of repairing an old boiler, would also increase plant operational efficiencies.

CAMPUS STEAM SYSTEM UPGRADE RECOMMENDATIONS

The existing Central Campus Steam Plant has sufficient spare capacity to handle expected future loads, however, the presence of an aging and broken down boiler somewhat limits the plant's spare capacity and operational flexibility. The high pressure steam distribution piping is mostly run to the campus buildings in a underground tunnel system, which is generally well configured to handle future building connections, and has the advantage of being looped, in order to allow for back-feeding the campus to avoid outages for maintenance or new tie-ins. A computerized flow model of the campus steam network, that was prepared as part of this analysis, indicates that the existing steam supply piping is adequately sized to handle expected future growth. The gravity steam condensate piping system within the utility tunnel network is nearing the end of its life expectancy and is a candidate for replacement.

Proposed Campus Steam System Infrastructure Upgrade Projects:

Steam System Recommended Project Summary List

Project No.	Title	Description	ROM Budget Price
SP	Steam Plant		
SP-1	Replace Boiler #3	Replace out-of-service Boiler #3 with a new 40,000 pph boiler to restore plant capacity & redundancy.	$3,500,000
SP-2	Install Feedwater Stack Economizers, Boilers #2 & #4	Install boiler feedwater stack economizers on Boilers #2 & #4 to improve system efficiency and to match other boilers.	$350,000
SP-3	Upgrade Boiler Feedwater Pumps	Replace or supplement the deaerator boiler feedwater pumps to achieve full design capacity of the DA unit.	$200,000
SP-4	Repair Rozell Boiler Stack	Further investigation recommended to determine if the concrete boiler stack at Rozell is sound for continued operation in to the future.	Unknown. (Further Study Required)
SP-5	Upgrade AVISTA Gas Service Capacity	AVISTA needs to upgrade the natural gas capacity to Cheney and EWU in order to allow maximum firing of the natural gas boilers.	By AVISTA
SD	Steam Distribution		
SD-1	Replace Utility Tunnel Gravity Steam Condensate Piping	Due to age and questionable condition the gravity steam condensate piping in the utility tunnels is due for replacement in order to provide reliability for future service.	$1,225,000
SD-2	Replace Utility Tunnel Condensate Pumps	The existing electric condensate pumps in the utility tunnel are problematic and should be replaced with more robust steam powered pumps.	$200,000
SD-3	Label Piping & Identify Branch Take-offs	Utility tunnel piping and branch take-offs are poorly labeled and confusing.	$150,000

		Adding labels and identifiers will assist with future maintenance and repair work.	
SD-4	Upgrade Piping in PLU & Repurpose Building	The decommissioned space inside the old, original steam plant, which presently serves as a piping junction in the tunnel network, could be better utilized if the piping was modernized/upgraded and the space reorganized.	$125,000

Central Campus Steam Plant (SP)

Overall the existing Central Campus Steam Plant is in good condition, and has been very well maintained, despite running with several boilers that are over 40 years old. Basically the steam plant, and has sufficient capacity to handle the anticipated steam loads for the 10 year master plan growth, but due to one boiler being out of service, redundancy is limited. Several projects have been identified below to provide some added plant reliability/capacity, and to increase system efficiencies.

SP-1: Replace Boiler #3

Description:

Replace existing 25,000 pph steam Boiler #3.

- Replace: Install a new 40,000 pph high pressure steam boiler with dual fuel (oil & gas) low NOX burner. Install new correctly sized stack economizer (boiler feedwater pre-heater).

  (This recommendation is a concurrence of the boiler replacement "1.02-ROZ" as previously suggested by McKinstry in their *2012 Energy Efficiency & Sustainability Report*)

Analysis/Justification:

The existing steam Boiler #3 has been out of service for a number of years due to several outstanding breakdowns and lack of repair funds. Boiler #3 is almost 50 years old and parts are difficult to find. Despite being maintained in excellent condition over the years by the EWU staff, this boiler is basically near the end of its life expectancy.

Future campus growth will increase expected plant steam loads by over 30%, which will start to impact boiler plant redundancy & operational flexibility. A repaired, or new boiler, will allow plant operation and redundancy to be maintained in to the future. A new boiler would increase operational efficiencies.

According to the EWU operations staff, the historical peak campus heating load, seen this last winter, is approximately 75,000 lbs/hr.

Based on the anticipated master plan campus growth for the New Science I & II projects, the new Gateway Athletic Project, the expected addition of future campus steam load is approximately 34%. Based on a peak historic load of 75,000 pph, a 34% increase would put the future campus steam load at over 100,000 pph, which is approximately 50% of the steam plant's present total capacity 217,000 pph.

Sequence / Category:

Capital Master Plan.

Cost:

SP-1: $3,500,000

<u>SP-2: Install Boiler Feedwater Stack Economizers on Boilers #2 & #4.</u>

Description:

Install new boiler feedwater stack economizers on existing steam boilers #2 & #4. This installation would allow these boiler configurations to match boilers #1 & #5, which already have stack economizers in operation.
(This recommendation is a concurrence of the stack economizer installation "1.00-ROZ" as previously suggested by McKinstry in their *2012 Energy Efficiency & Sustainability Report*)

Analysis/Justification:

The existing steam Boilers #2 and #4, which are mostly operated in the shoulder and summer seasons, are not provided with boiler feedwater stack economizers, which are present on the other plant boilers. As a result, the operational efficiencies of these boilers are not a high as is possible, thereby reducing the plant's overall energy efficiency.

Also, because of the different feedwater configuration that these two boilers use, compared to the other boilers, the feedwater pumping loop must be run at differing pressures, which complicates plant operation. New boiler feedwater stack economizers would increase boiler plant operational efficiencies, and simplify feedwater system operation.

Sequence / Category:

Improve Operational Efficiencies.

Cost:

SP-2: $350,000

<u>SP-3: Upgrade Boiler Feedwater Pumps</u>

Description:

Replace the aging feedwater tank transfer pumps and upgrade or supplement the undersized Deaerator unit boiler feedwater pumps.

Analysis/Justification:

The existing single speed feedwater transfer pumps that provide feeddwater from the condensate return storage tank to the deaerator tank, are old and in questionable condition. This project would replace these pumps with new high efficiency pumps with improved controls for staging and monitoring.

The existing VFD driven boiler feedwater pumps that are part of the deaerator unit were recently installed as part of an energy retrofit to the plant, but, according to the plant operators, are having trouble keeping up with the feedwater demands of the boilers. These newer VFD driven pumps were downsized to 30 hp each, from the original single speed 50 hp feedwater pumps. Capacity reduction is unknown, but appears to be a factor in plant operation, requiring the operators to run the auxiliary steam-driven feedwater pump during peak loads. Redundancy is questionable with this configuration, so it is proposed that the new feedwater pumps be replaced with larger pumps or supplemented with an additional pump.

Sequence / Category:

Capital Master Plan.

Cost:

SP-3: $200,000

SP-4: Repair Rozell Heating Plant Boiler Stack

Description:

Repair the existing Rozell Heating Plant concrete/masonry boiler stack.

Analysis/Justification:

The condition of the existing exterior concrete/masonry boiler stack at the Rozell heating plant is the subject of some concern. According to EWU staff, there is reason to suspect some of the interior lining material has started to fail and/or fall off. Further, it is unknown if the original construction and/or present condition of this stack is up to present seismic standards.

A full analysis of the existing boiler stack condition is not in the scope of this study. Further analysis is recommended.

Sequence / Category:

Maintenance & Repair.

Cost:

SP-4: Unknown (Requires Further Study)

SP-5: Upgrade Natural Gas Service from AVISTA

Description:

Increase the natural gas supply capacity to the Central Campus Steam Plant from the utility provider, AVISTA.

Analysis/Justification:

The existing steam boilers are limited in the amount of natural gas that they are allowed to consume at a given peak instant by agreement with the gas utility provider, AVISTA. Reportedly the high pressure gas supply distribution to the City of Cheney is limited based on AVISTA transmission gas line capacity. This issue is limits the steam boiler plant to a maximum consumption rate of approximately 56,000 lbs/hr, at which point the plant has to supplement its capacity by burning #2 fuel oil (diesel).

Because it is not beneficial to fire the boilers on fuel oil due to emission concerns, efficiency reductions and added wear and tear, the ability to fire a greater percentage of the boiler plant on natural gas is desired.

Sequence / Category:

Unknown. Pending AVISTA natural gas infrastructure upgrades to the City of Cheney.

Cost:

SP-5: Unknown. (Further study required. Capital costs for gas capacity increase to Campus would presumably be paid for by AVISTA as part of their normal growth plans.)

Campus Steam Distribution System (SD)

Overall 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 steam network, that was prepared as part of this analysis, indicates that the existing steam supply piping is adequately sized to handle expected future growth. Several projects have been identified below to provide ongoing piping system reliability in to the future.

SD-1: Replace Utility Tunnel Condensate Piping

Description:

Replace aging gravity condensate piping system & components in utility tunnels. New piping to be heavier wall thickness, Sched. 80, compared to the existing standard wall Sched. 40 piping presently installed. New steam trap stations and valves would be provided.

Analysis/Justification:

Although the existing gravity condensate drainage piping system, that serves the high pressure steam distribution within the utility tunnels, appears to be in good condition and has been well maintained, most of this piping is around 40 years old. Although there have not been reports of major leaks or failures, this piping system is nearing the end of its useful life.

Because the condensate piping system is subjected to more severe service than the steam supply piping, on account of the presence of oxygen and other condensed gases, such as carbolic acid, internal corrosion is much more likely. This leads to premature pipe wall failure and leaks, as well as damage to components, such as valve and steam traps.

Sequence / Category:

Improve Operational Efficiencies.

Cost:

SD-1: $1,225,000

SD-2: Replace Utility Tunnel Electric Condensate Pumps with Steam-Powered Pumps

Description:

Replace existing simplex type electric condensate pumps in the utility tunnel with new steam-powered condensate pumps.

Analysis/Justification:

The existing simplex type electric condensate pumps, that are situated in various locations throughout the utility tunnel and are used to handle steam distribution condensate loads, are on ongoing point of malfunction and problematic maintenance. These condensate pumps are generally located in hot and wet locations of the tunnel and are subjected to severe service due to the hot condensate that they handle from the high pressure steam drip traps. Seal failures on the pumps are common and electric components do not stand up well to the environmental conditions within the tunnel.

Because of the severe service these tunnel condensate pumps experience, it is recommended that they be replaced throughout the tunnel system with more robust steam powered (non-electric) condensate pump assemblies. Such steam-powered condensate are more or less oversized steam traps and are made of similar materials that can handle steam service, without the weakness inherent in electric motor driven condensate pumps.

Sequence / Category:

Improve Maintenance Efficiencies.

Cost:

SD-2: $200,000

SD-3: Label Piping and Identify Branches & Valves

Description:

The existing steam (and chilled water) distribution piping system, located in the utility tunnel network, is poorly labeled and branch take-offs and valves are not identified. This project would provide better labeling and identification to help with maintenance and troubleshooting activities.

Analysis/Justification:

After spending several days surveying the condition of the existing utility tunnel piping and valving, it is evident that there would be value to the maintenance staff, and to contractors doing future work, if the existing piping system was better labeled and identified. Such labeling could help locate and isolate failures or problem areas, as well as to better direct traffic for repair or new construction. Likewise, there is a certain amount of abandoned devices (mostly electrical wall switches), that provide confusion over the tunnel lighting circuits. These should be removed and the active light switches better identified (as to which section they serve). Branches take-offs to buildings could be better identified, as could routes to exits or manholes.

Sequence / Category:

Improve Maintenance Efficiencies.

Cost:

SD-3: $150,000

SD-4: Upgrade Piping in Plant Utilities Building (PLU) and/or Repurpose the Space

Description:

Upgrade the existing steam and chilled water piping and systems inside the PLU building in order to better configure the space usage for storage or other purposes.

Analysis/Justification:

The existing steam (and chilled water) distribution piping system, located in the old original central campus steam plant, now the Plant Utilities Building (PLU), has been disturbed over time due to the use of much of this building as an ad-hoc storage space. Pipe insulation jacketing is damaged or missing, much of the old piping is deactivated and abandoned in place, and some of the valving appears to be fairly old. There is some old pneumatic controls and abandoned steam piping still in place but deactivated, and nothing is labeled. Filter boxes and other surplus material is stacked on and around the piping. Access is difficult.

Sequence / Category:

Improve Maintenance Efficiencies.

Cost:

SD-4: $125,000

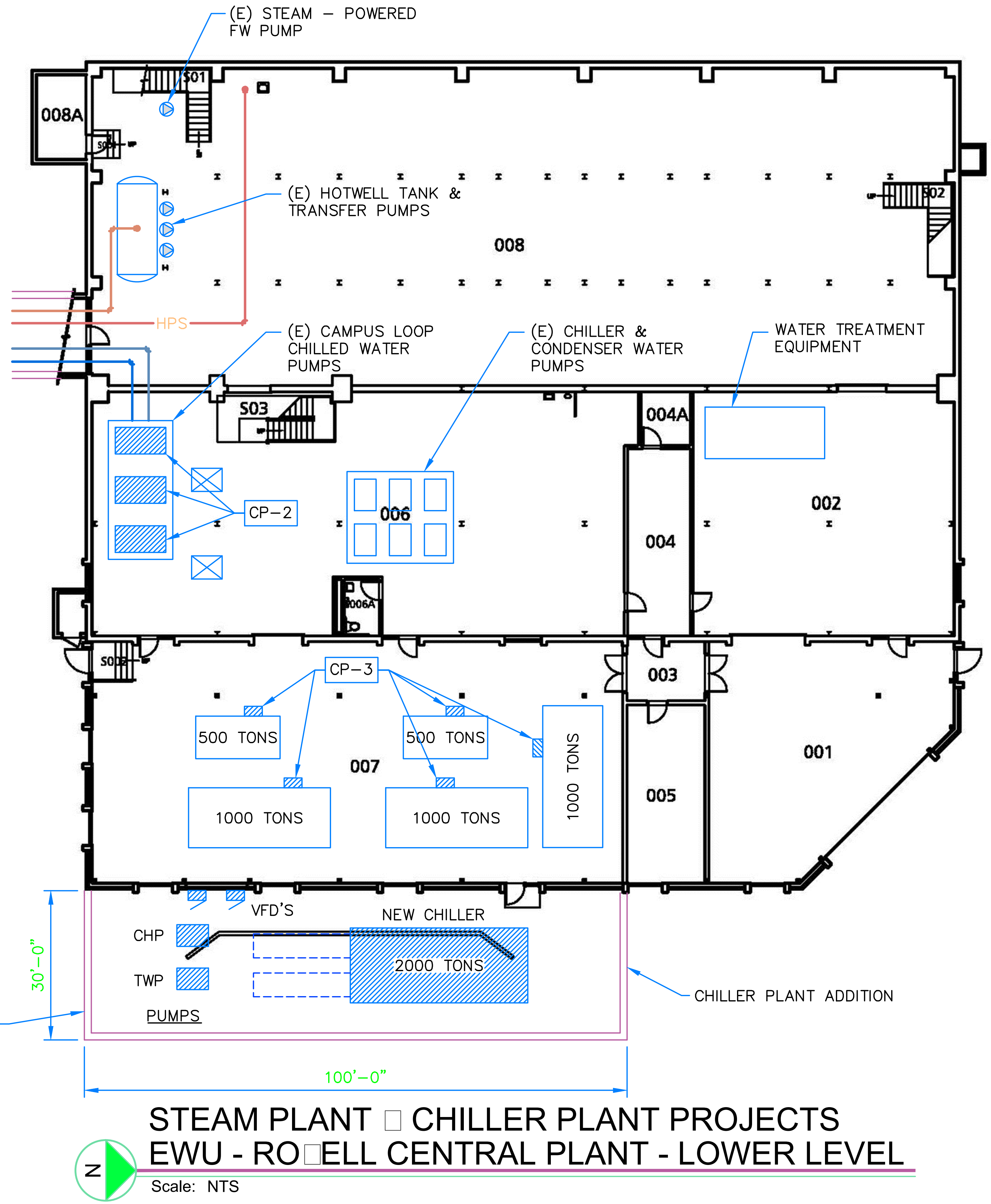
CAPITAL MASTER PLAN PROJECTS

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 - RO□ELL CENTRAL PLANT - LOWER LEVEL

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

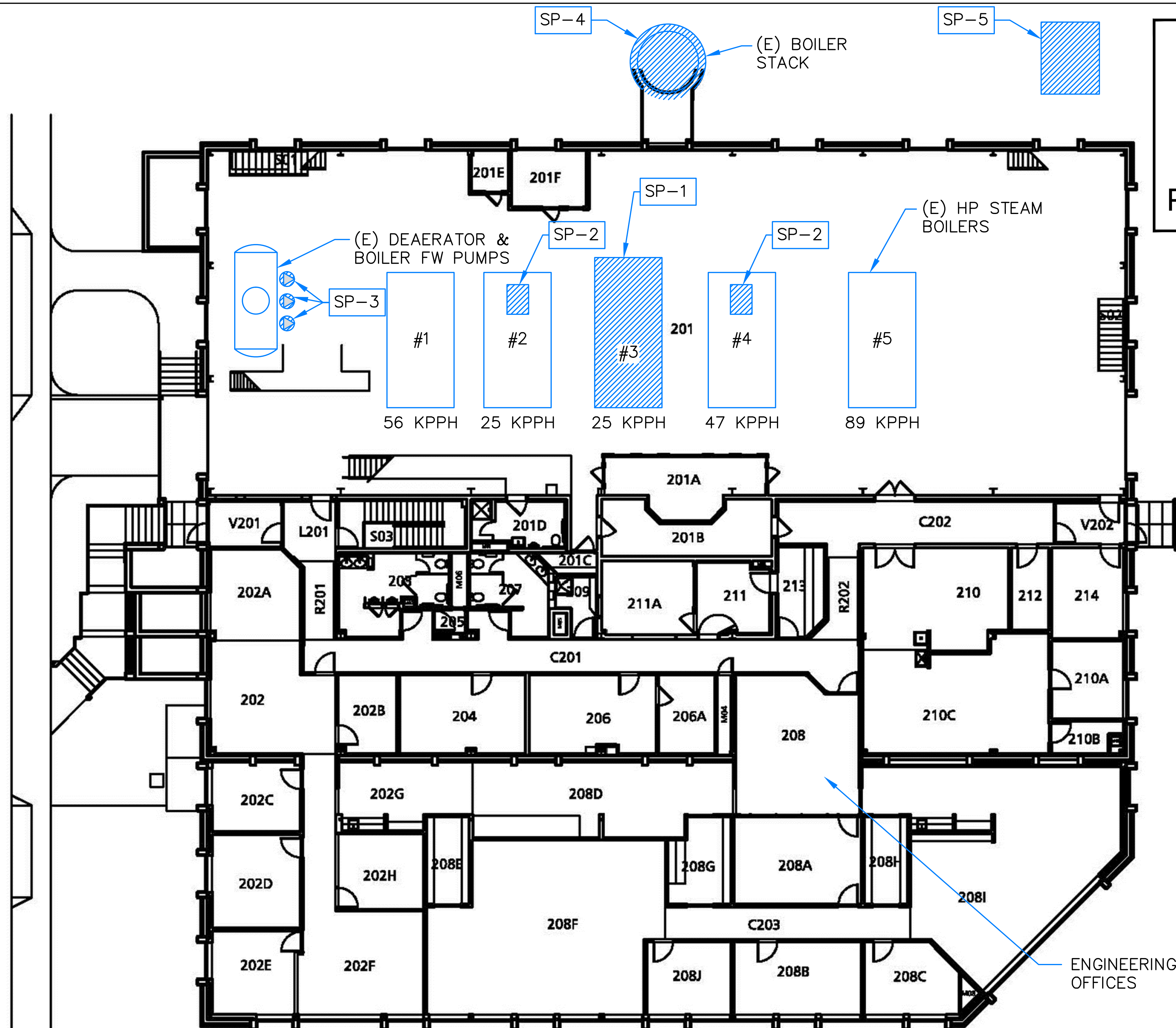
SP–3: UPGRADE BOILER FEEDWATER PUMPS

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 - RO□ELL CENTRAL PLANT - MAIN FLOOR

Scale: NTS

STEAM PLANT □ CHILLER PLANT PROJECTS

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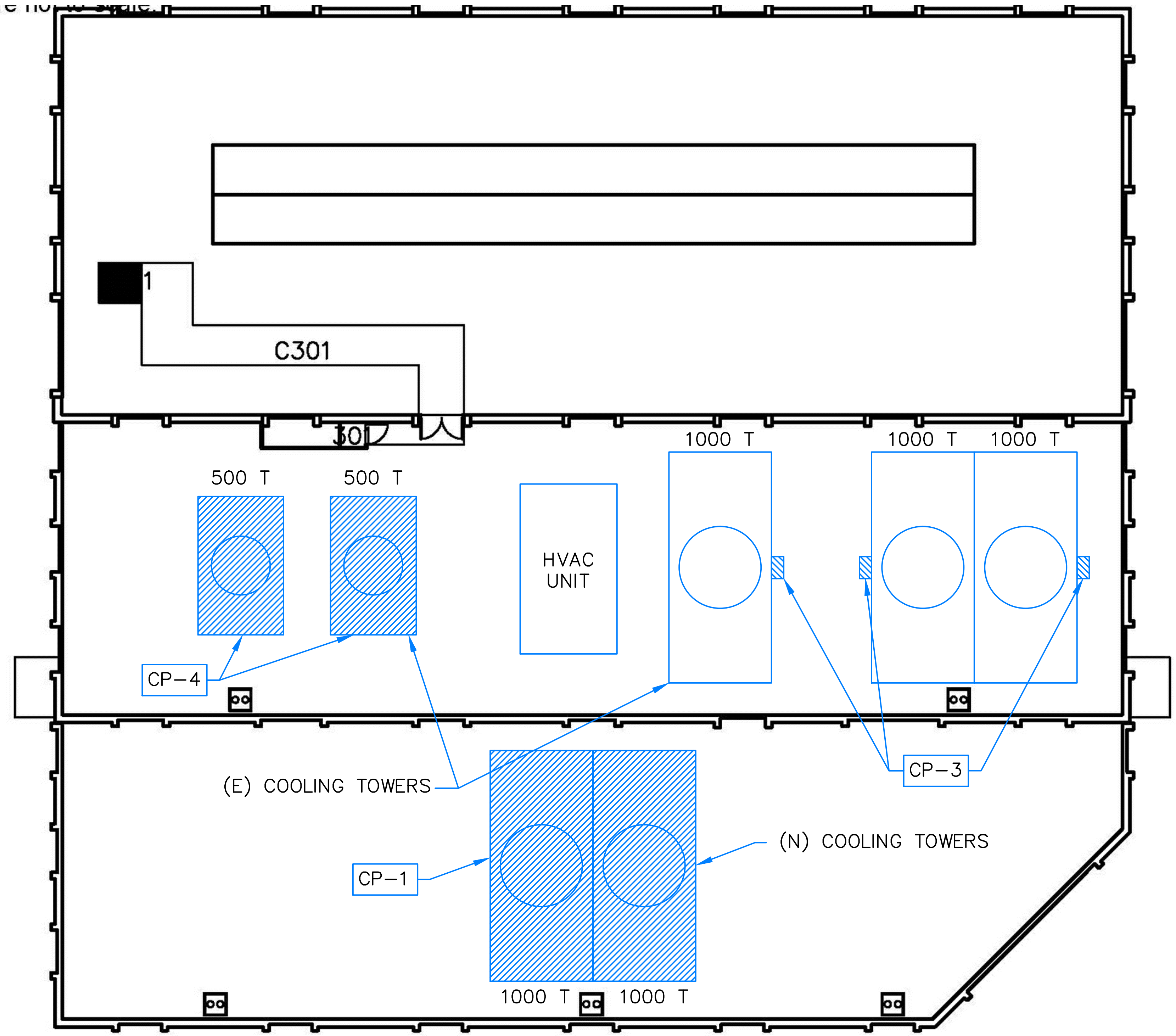
CAPITAL MASTER PLAN PROJECTS

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 - RO□ELL CENTRAL PLANT - ROOF
Scale: NTS

STEAM PLANT □ CHILLER PLANT PROJECTS

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SP□CP

MAINTENANCE PROJECTS

SD-1: REPLACE UTILITY TUNNEL CONDENSATE PIPING

UTILITY TUNNEL

SD-2: CP →●

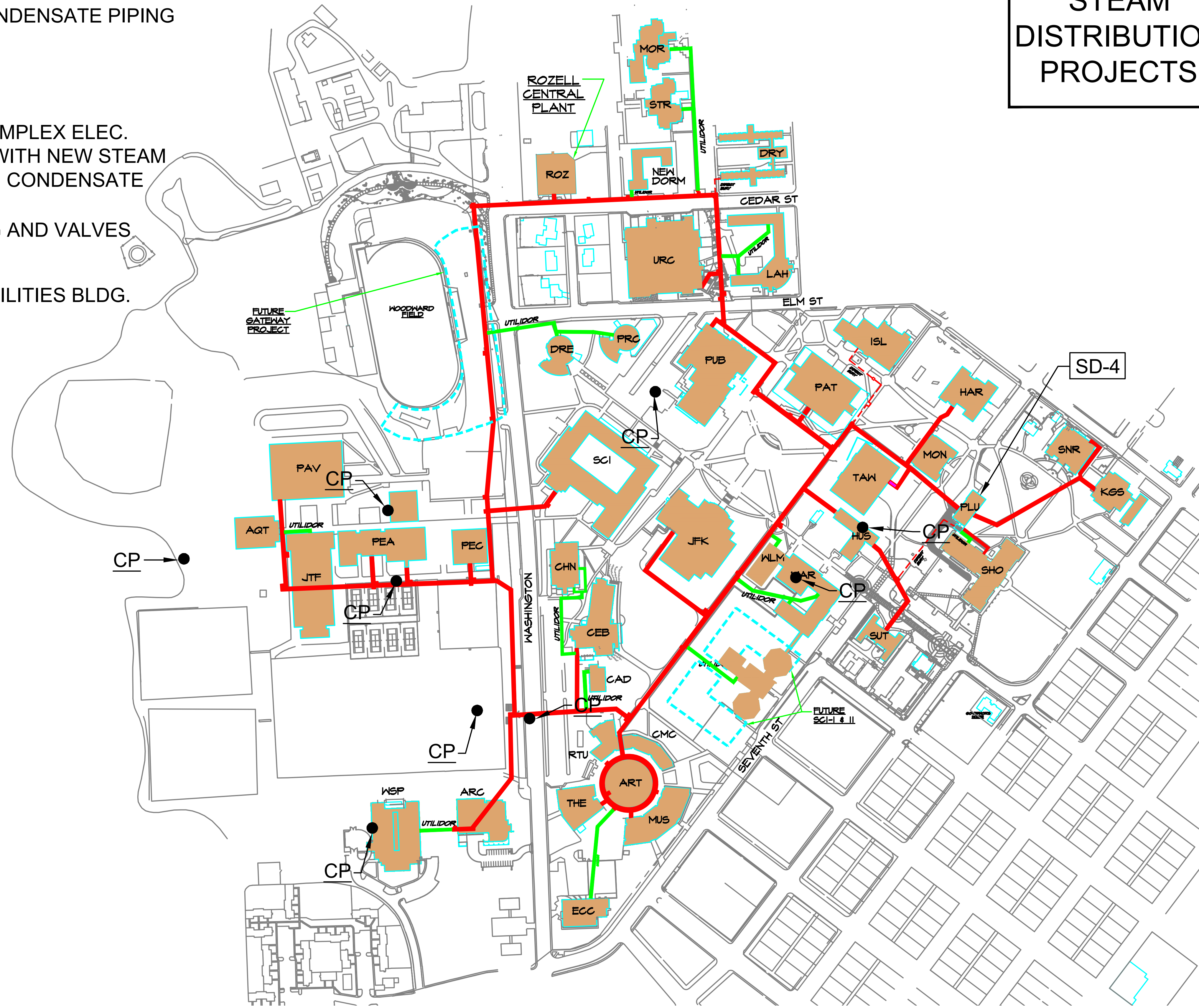
REPLACE EXISTING SIMPLEX ELEC. CONDENSATE PUMP WITH NEW STEAM PRESSURE POWERED CONDENSATE PUMPS

SD-3: LABEL UTILITY TUNNEL PIPING AND VALVES

UTILITY TUNNEL

SD-4: UPGRADE PIPING IN PLANT UTILITIES BLDG.

STEAM DISTRIBUTION PROJECTS



TUNNEL LEGEND

UTILITY TUNNEL

UTILIDOR

DIRECT BURIED PIPE

EWU - STEAM DISTRIBUTION PROJECTS

N

Scale: 1" = 400'

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The highest-quality systems.
Faster and easier than ever.

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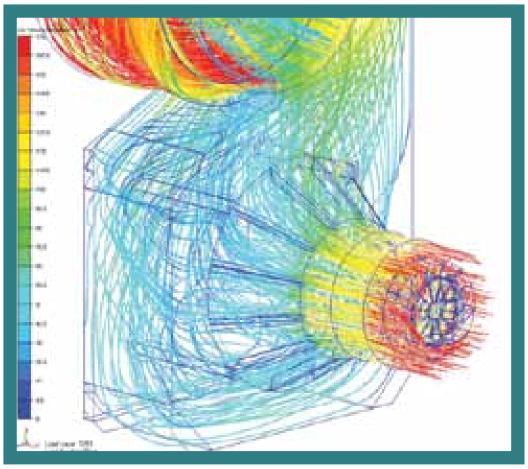
In what can only be described as a revolution in the Industrial Watertube boiler market, Cleaver-Brooks has brought its 90 years of experience and exclusive Engineered Integration to a series of steam-ready boilers. You choose the size and options on the Cleaver-Brooks Nebraska D boiler you need, and we'll have a solution that's ready faster than ever. Our steam-ready products are made with the highest-quality components you've come to expect from Cleaver-Brooks. We don't interface another brand's parts here. Just like every Cleaver-Brooks system, steam-ready systems are integrated only with Cleaver-Brooks parts. No one else can say that.

Everything You Need. Faster to Market. Convenient and Cost-Effective.

It's more than just a boiler. We have designed and engineered an entire boiler package, from the air inlet to the stack outlet and the feedwater inlet to the steam nozzle outlet, along with everything you need to operate the boiler. The important layout and configuration drawings are available with a quote, while a complete set of drawings are available soon after your order. With a drawing available quicker, you not only get a faster delivery from Cleaver-Brooks, but you're also able to plan and manage your work faster – weeks faster than with a traditional system.

Complete Integration for Proven Performance



Computational Fluid Dynamics is key to our state-of-the-art integration and ability to provide high-efficiency, ultra-low NOx burner systems.

Only Cleaver-Brooks can offer watertube boilers, state-of-the-art burners, and combustion controls that are 100 percent designed, engineered, manufactured and integrated by one company. Other boiler manufacturers rely on equipment from a variety of manufacturers, simply bolted on, jeopardizing compatibility and performance.

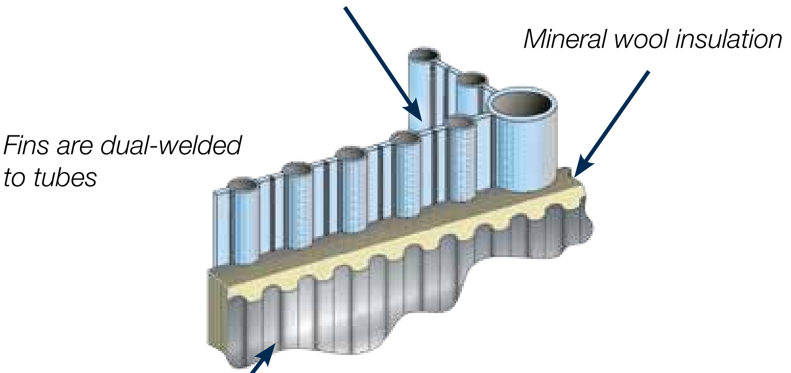
Both the furnace and flame geometries are optimized to provide the ideal environment for combustion. Through Computational Fluid Dynamics (CFD) calculations, our equipment is engineered to match perfectly and operate at peak performance.

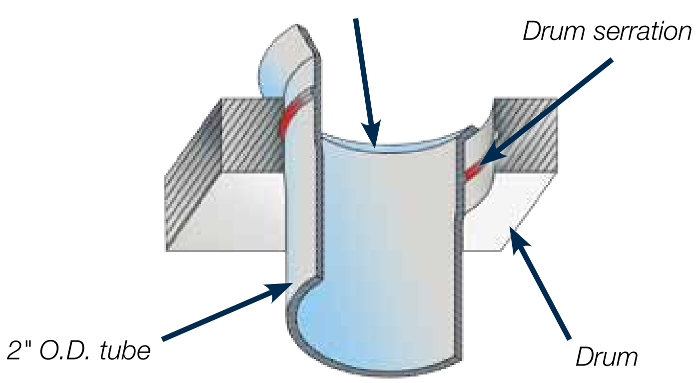
The seamless integration of the optimized burner, boiler, combustion control system, and burner management system (BMS) allows the equipment to function at maximum efficiency and minimum emissions, all while maintaining the highest safety standards.

Capacities
10,000–225,000 lb/h
Operating Pressures
100 psig to 325 psig
Higher pressures available
Design Pressure
375 psig
Fuels
Natural Gas
#2 Fuel Oil
Emissions
Natural Gas – 9 ppm, 30 ppm or uncontrolled
#2 Fuel Oil – 75–120 ppm or uncontrolled
Turndown
10 to 1 – Natural Gas
8 to 1 - #2 Fuel Oil
Super heat available

Flexibility

Cleaver-Brooks understands that one size does not fit all. The options that are available for our steam-ready D-style allow you to select the package that fits the exact needs of your facility. All our options are ready for quick delivery and optimal performance. Cleaver-Brooks has the years of experience that count in the design of complex, integrated systems calling for ultra-high performance.





Highest-Quality Boiler Construction
Completely Drainable 2.0-inch O.D. tubes
Grooved tube seats for improved tube-to-drum seal
Fully welded gas seals are used throughout to ensure gas-tight operation
Boiler wall construction is 100 percent water-cooled
Furnace construction utilizes a welded-membrane wall design
Virtually no refractory
Conservatively designed tube layouts, coupled with large drums, provide superior natural circulation and operational benefits
Complete access to boiler water side is provided through manways at both ends of each drum

System-Matched Burner

Cleaver-Brooks has always been at the forefront of emissions technology, and that commitment extends to our steam-ready boilers. The Nebraska D steam-ready boiler is available equipped for uncontrolled, 30 ppm, or 9 ppm emissions – all while maintaining some of the highest boiler efficiencies in the industry. Get the boiler system you need, and the reduction in carbon footprint you want, and get it all faster.

With more than 10,000 units installed, the Cleaver-Brooks burner is the benchmark of the industry. Super-low NOx, CO, VOC, and PM emissions are easily obtainable. Its traditional layout with a full windbox design is ideal for industrial, commercial, and institutional applications. It is seamlessly integrated with the furnace and the Hawk 5000 combustion controls to provide unparalleled levels of control and efficiency in a steam-ready package.

Hawk 5000 Control

The Hawk 5000 is state-of-the-art for burner management systems and combustion controls. It is fully designed and optimized to work with our Cleaver-Brooks burners. The Hawk delivers reliability, safety, and efficiency with a seamless, easy-to-use, human-to-machine interface.

Hawk 5000 Features

- Fireye (CB110)-based integrated burner management system
- Allen-Bradley CompactLogix™ PLC for boiler control
- Allen-Bradley Panelview Plus 10" color touch screen HMI for setup, monitoring, and data acquisition
- Trending and data-logging of up to 300,000 points
- Combustion set curves, system constants, alarm settings, tuning parameters, and all commissioning values adjustable via HMI
- Automatic boiler warming feature limits thermal shock
- Boiler efficiency and O_2-corrected efficiency readings available
- External communications to most commonly used protocols
- Assignable I/O
- Plant Master Panel available as an option for multiple boiler installations
- Fully integrated PLC programming for pressure control options for unison modulation, local stand-alone pressure control, or remote firing rate input
- 1-, 2-, or 3-element feedwater control
- O_2 trim and monitoring trims combustion on all fuels to maintain most efficient fuel/air ratio
- Variable-speed drive (VSD) control
- Draft control

The boiler is only the beginning. We can complete your whole boiler room.

Don't stop at just the world's best-engineered boiler system. Cleaver-Brooks supplies a full line of equipment to complete your boiler room, regardless of your needs. From blowdown tanks to deaerators to chemical feed systems, Cleaver-Brooks produces every accessory and ancillary product with the same meticulous engineering and complete integration used in every Cleaver-Brooks boiler system. Ask your rep how we can build your whole boiler room today.

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BUDGET CONFIGURATION (PRELIMINARY)

To	Scott Best Cole Industrial, Inc	Proposal No.	02290473
Address	5924 - 203rd Street SW	Date	07/11/14
	Lynnwood, WA 98036		
SUBJECT:	EWU / EWU		

Qty.	Description
1	Nebraska Boiler D-Type Industrial Watertube Model NB-200D-40 250 psig design operating at 100 psig, Saturated steam Boiler arrangement is Right Hand with Corrugated Aluminum cladding. Boiler package includes a LNXLLG 504 burner with Windbox mounted fan;Primary fuel is Natural Gas at 30 ppm (Backup Fuel: #2 Fuel Oil, 75-120 ppm) Controls consist of Parallel Positioning combustion control and 3 Element feedwater control. Package is complete with a model E2 stack economizer and 50 ft stack.
1	Boiler sizing based on 40000 lbs/hr required boiler capacity.
1	Feedwater Temperature to Economizer: 225 (Degrees F)
1	Boiler Operating Pressure: 100 psig
1	Boiler Design Pressure: 250 psig
1	Supply Power Voltage: 460/3/60
1	Boiler Tube Thickness: 0.105"
1	Boiler Casing: Corrugated Aluminum
1	Boiler Hand: Right Hand
1	Boiler Front and Rear Drum Platforms and Boiler Roof Platform with Access Ladders: NB-200D-40
1	Fuel One (Main): Natural Gas
1	Fuel One (Main) Supply Pressure: 20 psig (Subject to change if 9 ppm emissions limits are required)
1	Fuel One Emissions: 30 ppm
1	Fuel Two (Backup): #2 Fuel Oil
1	Fuel Two (Main) Supply Pressure: 125 psig
1	Fuel Two Emissions: 75-120 ppm
1	~~Pre-Engineering Burner (included as part of base boiler package): CB ProFire LNXLLG 504, 50.4 MMBtu. Burner will include a Windbox mounted FD Fan with 60 hp motor. Windbox Air Inlet: Not Applicable. Fuel Train Inlet: Right Hand~~ This item for reference only. Configuration modified for budget purposes only to include ultra-low emissions burner. Fan horsepower will be determined later.

1	Pilot (Ignitor) Fuel: Natural Gas
1	Atomizing Media: Steam Only
1	Combustion Control Strategy: Parallel Positioning
1	Combustion Safeguard Control: CB-120E, UV Scan (Fireye): Standard
1	O2 Trim System: Yokogawa Integrated - Air Trim
1	Ambient Air Temperature Therocouple (required for O2 Trim)
1	Feedwater Control Strategy: 3 Element
1	Steam Flow Element: Orifice Plate, Steam Flow Transmitter: Rosemount
1	Feedwater Flow Element: Orifice Plate, Feedwater Flow Transmitter: Rosemount
1	Drum Level Transmitter: Rosemount
1	Drum Level Transmitter Isolation Valve: Vogt-1 In Model: 12111
1	Drum Level Transmitter Isolation Drain Valve: Vogt-0.5 In Model: 12111
1	Feedwater Control Valve: Fisher-2 In Model: 667-EZ
1	Feedwater Stop Valve: Vogt-2 In Model: 12111
1	Feedwater Check Valve: Vogt-2 In Model: 701
1	Feedwater Drain Valve: Vogt- 1 In Model: 12111
1	Feedwater Bypass Globe Valve: Vogt-2 In Model: 12141
1	Feedwater Bypass Gate Valve: Vogt-2 In Model: 12111
1	Watercolumn: Nebraska Boiler NB
1	Water Column Drain Valve: Vogt-0.75 In Model: 12111
1	Water Column Probe: Clark Reliance Model: TBD
1	Water Column Gage Glass: Clark Reliance Model: C-9
1	Water Column Gage: Clark Reliance Model: 403RS
1	Water Column Gage Drain Valve: Vogt-0.5 In Model: 12111
1	Water Column Aux Low Water Cut Out Drain Valve: Vogt-0.75 In Model: 12111
1	Water Column Low Water Cut Out Bypass: Allen Bradley Model: 800T-1TX
1	Surface Blowdown Stop Valve: Edward Valves-1 In Model: 849
1	Surface Blowdown Control Valve: Vogt-1 In Model: 12443
1	Bottom Blowdown Stop Valve: Edward Valves-1.5 In Model: 1443
1	Bottom Blowdown Control Valve: Edward Valves-1.5 In Model: 1441
1	Chemical Feed Check Valve: Edward Valves-1 In Model: 849
1	Chemical Feed Check Valve: Edward Valves-1 In Model: 838
1	Steam Drum Vent Valve: Vogt-1 In Model: 12111
1	Steam Pressure Gage: Ashcroft-8.5 In Model: 1010-S-04L
1	Steam Pressure Gage Drain Valve: AGCO-0.5 In Model: M25HPS-44F-XP
1	Steam Pressure Gage Test Valve : AGCO-0.5 In Model: M25HPS-44F-XP
1	Non Return (Stop Check) Valve: Edwards-8 In Model: 303K
1	Steam Header Stop Valve: Crane-8 In Model: 7-1/2E
1	Safety Valve 1: Kunkle 6252. Inlet: 2 In., Outlet: 4 In. 250 psig set pressure.
1	Safety Valve 2: Kunkle . Inlet: 2 In., Outlet: 4 In. 245 psig set pressure.
1	Sootblower Wallboxes and Bearings (Boiler Only)
1	Package Economizer (included as part of base boiler): Model E2. Trim included as listed below.
1	Economizer 3 Valve Bypass: 12111

1	Economizer Safety Valve: Kunkle, 927
1	Economizer Header Vent Valve: Vogt, 12111
1	Economizer Header Drain Valve: Vogt, 12111
2	Economizer Feedwater Temperature Gage: Ashcroft, 50EI60E066
2	Economizer Feedwater Temp Gage Thermowell: Ashcroft, 75W0250LSS260C
2	Economizer Flue Gas Temperature Gage: Ashcroft, 50EI60E066
2	Economizer Feedwater Temp Gage Thermowell: Pyromation, 26-88-11-811Z,(Z350)
1	Boiler to Economizer Transition Duct with Expansion Joint and Access Door
1	Economizer to Stack Transition Duct with FGR Port (if applicable).
1	Economizer Support Structure
1	Flue Gas Stack Model: S32-50. Stack Diameter: 32 In. Stack Height: 50 ft
1	Specially Quoted Item: EBS Custom Option: 9 PPM Option

Unloading by others.

Payment Terms:

Approx. Shipping Weight:

Approximate Shipment after Receipt of Order and Complete Details in Milwaukee:

PRICE ADJUSTMENT all prices in this proposal are subject to price adjustment in accordance with Cleaver-Brooks Price Adjustment Policy

Cleaver-Brooks, Inc. offers to furnish the Equipment described herein for the purchase price noted, exclusive of all taxes. Prices quoted are firm for 30 days from the date of Proposal subject to adjustment as noted. Standard Cleaver-Brooks **payment terms** are *unconditional net 30 from the date of readiness for shipment or unless otherwise specified in this proposal*. Cleaver-Brooks will review your order prior to acceptance (and acknowledgment) and order entry. Until acceptance and order entry, the Equipment is **subject to prior sale**. Incorporation of technical specifications or requirements different from or additional to the Cleaver-Brooks proposal and not previously reviewed by Cleaver-Brooks will extend the order review process and may postpone or prevent acceptance of your order and order entry.

Cleaver-Brooks does not agree and will not agree to **INCIDENTAL, CONSEQUENTIAL AND LIQUIDATED DAMAGES OR IMPLIED WARRANTIES**. Cleaver-Brooks does not agree and will not agree to, unless specifically set forth in an agreement in writing having an authorized Cleaver-Brooks signature: (1**) terms and conditions** in your order that are different from or additional to those of Cleaver-Brooks' Proposal; (2) **technical specifications**, technical requirements or descriptions of the goods and services ordered that are different from or additional to those of Cleaver-Brooks' Proposal; or (3) **generalized expressions** such as "per plans and specs."

THE TERMS AND CONDITIONS OF SALE (ATTACHED) ARE PART OF THIS PROPOSAL

Date ACCEPTED ______________

____

By ________________________
Purchaser

Please return one signed copy of this proposal, or **submit your purchase order addressed to Cleaver-Brooks, Inc.**, in care of your Cleaver-Brooks Sales Representative referencing this Proposal by number and date.

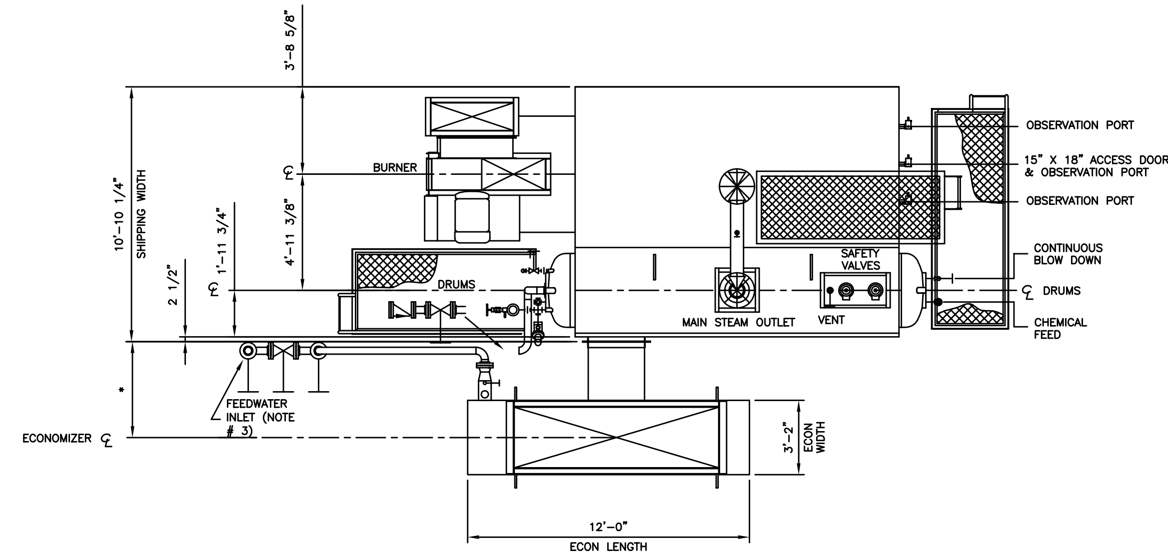
PROPOSAL FURNISHED BY
Scott Best
Cole Industrial Inc
(425)774-6602
sbest@coleindust.com
SALES REPRESENTATIVE

THIS DRAWING IS A PRELIMINARY LAYOUT ONLY. ALL DIMENSIONS ARE TO BE FINALIZED AFTER FORMAL PURCHASE ORDER AND COMPLETE ENGINEERING APPROVAL. CLEAVER–BROOKS PROPOSAL

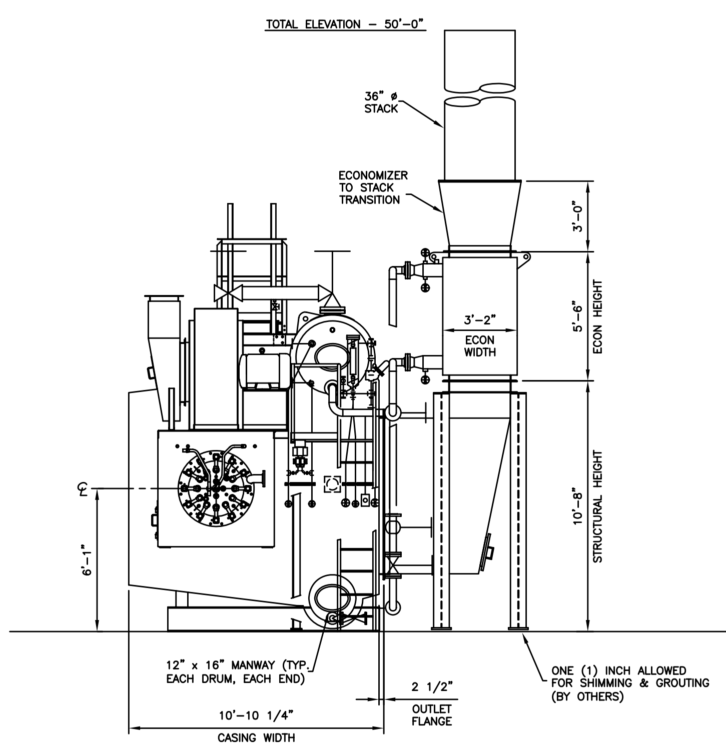
REV.	DATE	DESCRIPTION	DWN	CKD	APPR

NOTES:

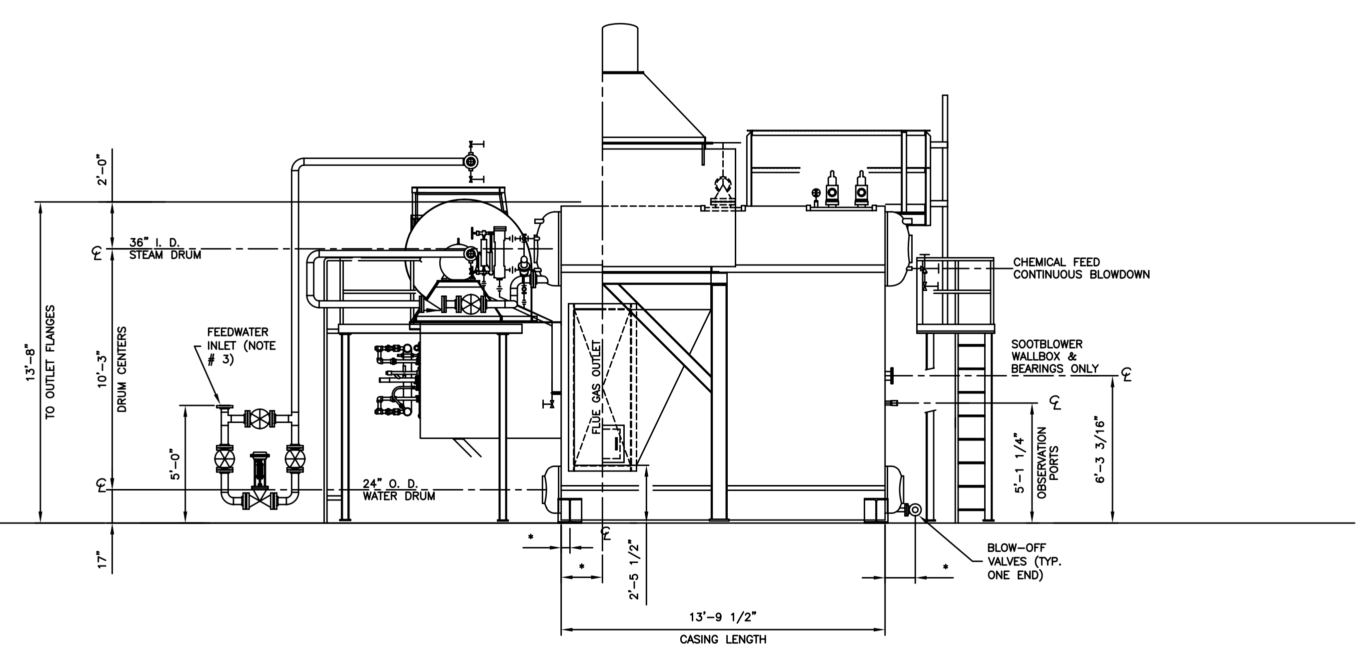
1. DRAWING IS FOR OVERALL SIZE AND ARRANGEMENT ONLY. REFER TO PROPOSAL FOR ACTUAL TRIM LISTING.
2. DRAWING IS NOT TO BE USED FOR CONSTRUCTION PURPOSES.
3. SIZES AND LOCATIONS OF FEEDWATER PIPING AND VALVES IS A REPRESENTATION ONLY, AND IS USED TO SHOW AN EASILY VISIBLE PICTORIAL VIEW.
4. * – DENOTES TO BE DETERMINED.



PLAN VIEW



BURNER END VIEW



CONVECTION SIDE VIEW

CleaverBrooks

ENGINEERED BOILER SYSTEMS

NEBRASKA BOILER, CLEAVER-BROOKS, AND ENERGY RECOVERY INTERNATIONAL WITH NATCOM BURNER SYSTEMS

GENERAL ARRANGEMENT SERIES:
NB–200D–40 W/ECONOMIZER (AL–HM)

LAYOUT DRAWING FOR
40,000 LB./HR. BOILER

SCALE: NONE	DATE: MARCH 03, 2010
DRAWN BY: KENB	CHECKED:
JOB NO: PROPOSAL	PAGE NO: 1 OF 1
QTY:	DRAWING NO: NB–200D–40 2010

ISSUE

The Pivotrol® Pressure Powered Pump

Featuring Reliable PowerPivot® Technology for the effective removal of condensate from steam systems

spirax sarco®

Effective condensate system management is

Efficient handling of condensate is essential if overall plant efficiency, energy conservation and product quality are to be maintained.

Spirax Sarco offers solutions for maintaining efficiency in all areas of condensate pumping systems by providing equipment in various materials of construction and technical assistance for proper installation.

Condensate management

When condensate leaves the steam trap, it contains approximately 20% of the heat energy transferred in the boiler to generate steam.

Total condensate management prevents:

- Excessive blowdown
- Loss of expensive heat energy
- Waste of water treatment chemicals
- High make-up water costs
- Added costs to preheat feedwater

All too often these problems are just accepted simply because no readily available solution exists.

Condensate removal

Condensate removal is necessary on all temperature-controlled heat exchange and process equipment to provide stable operating conditions.

Efficient condensate removal prevents:

- Unstable product temperatures
- Product quality problems
- Excessive corrosion
- Equipment damage and noise caused by waterhammer

The total system solution

The Spirax Sarco Pivotrol® (Patent Pending) Pressure Powered Pump® is specifically designed to remove condensate under all operating conditions and provides the unique opportunity to solve all condensate handling problems.

The pump is a self-contained unit using steam or other pressurized gas as its motive power. There are no electric motors or level switches, simplifying installation and making it ideal for wet or hazardous areas.

One pump design covers all applications from vacuum systems to highly efficient heat exchangers, including general condensate return.

The Pivotrol® Pump featuring reliable PowerPivot® technology, outperforms more complicated and expensive condensate handling systems. An added benefit is the ability to effectively pump high temperature fluids.

Plant maintenance problems caused by leaking mechanical seals and cavitation are eliminated.

User benefits

- Removes condensate under all load conditions, even vacuum, ensuring maximum process efficiency.
- No mechanical seals or packing glands to leak, reducing maintenance costs.
- Requires no electrical power. Single trade for installation and repair.
- Cavitation problems eliminated, reducing maintenance costs.
- Suitable for hazardous and demanding environments.
- Zero emissions. No motive steam loss when installed in a closed system, reducing operating costs.
- Minimal Steam Consumption.
- Six-month payback or less. Call your local sales representative for payback analysis.
- 3 Million Cycle x 3 Year Standard Warranty.
- 5 Million Cycle x 5 Year Extended Warranty available.
- Featuring Reliable PowerPivot® Technology, designed for reliable trouble free service.
- Cycle Counter included for pump & system monitoring.
- High cycle life check valves specifically designed for pump use.

an essential part of any steam-using plant

How it works

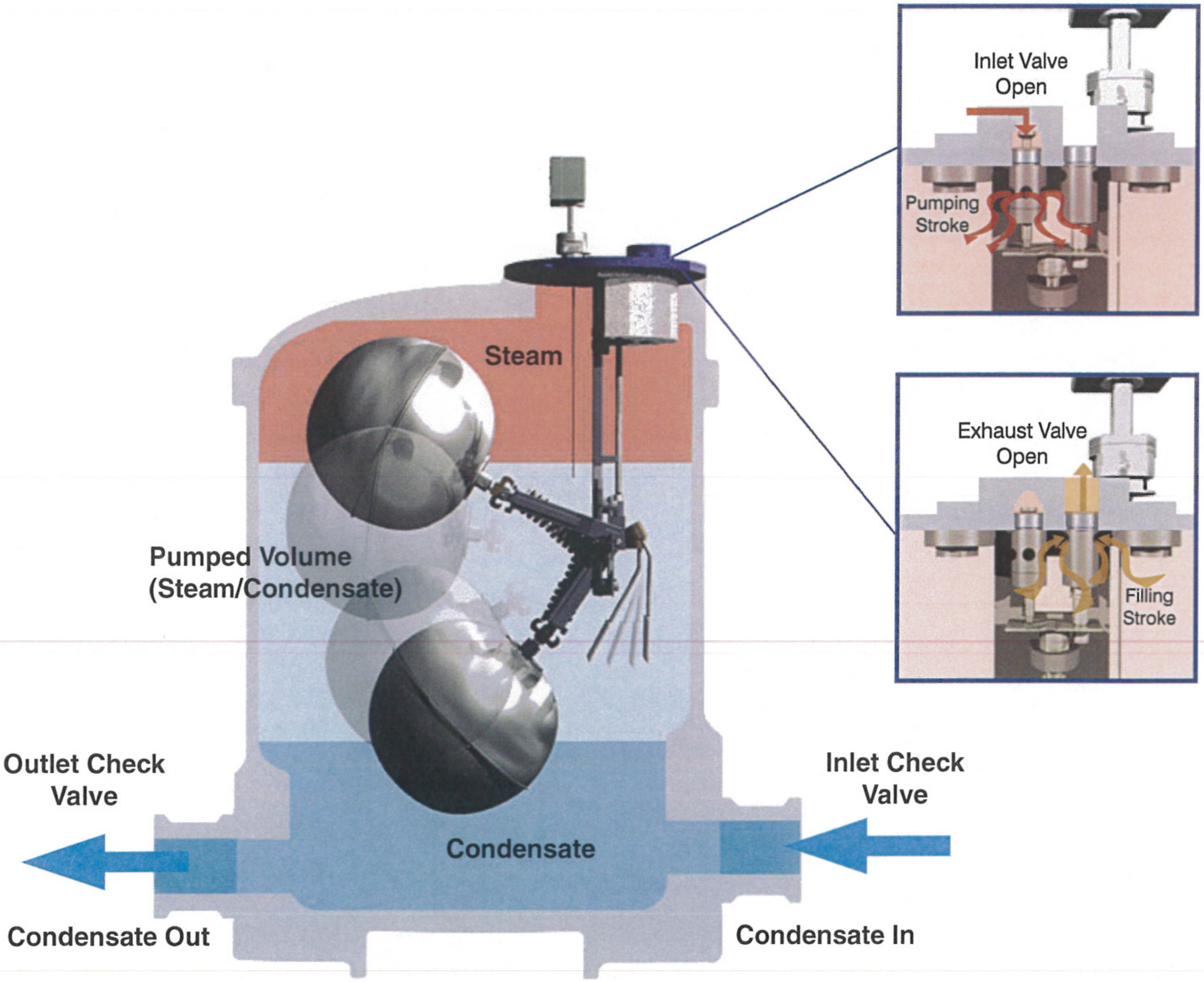
The Pivotrol® Pump operates on a pressure displacement principle.

Liquid enters the pump body through the inlet check valve causing the float to rise. As the chamber fills, the valve changeover linkage is engaged opening the steam inlet valve and closing the exhaust valve. This snap action linkage ensures a rapid change from filling to pumping stroke.

As pressure inside the pump increases above the total back pressure, condensate is forced out through the outlet check valve into the return system.

The liquid level falls within the pump, the float re-engages the valve changeover linkage causing the steam inlet valve to close and the exhaust valve to open.

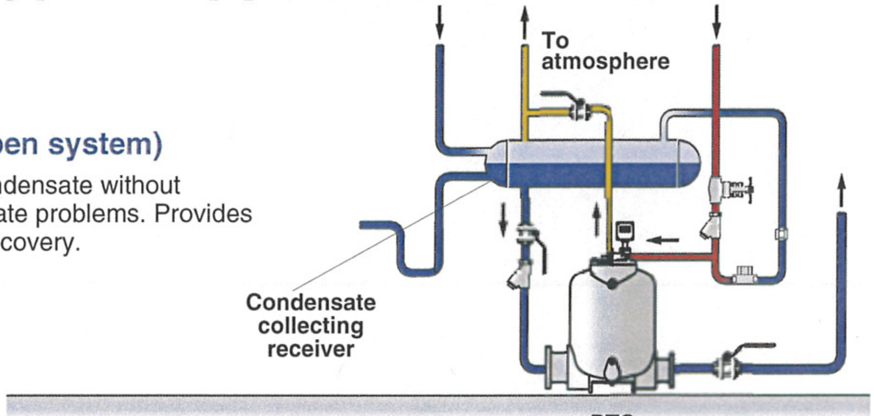
As the pressure inside the pump body falls, condensate re-enters through the inlet check valve and the cycle is repeated.



Typical applications

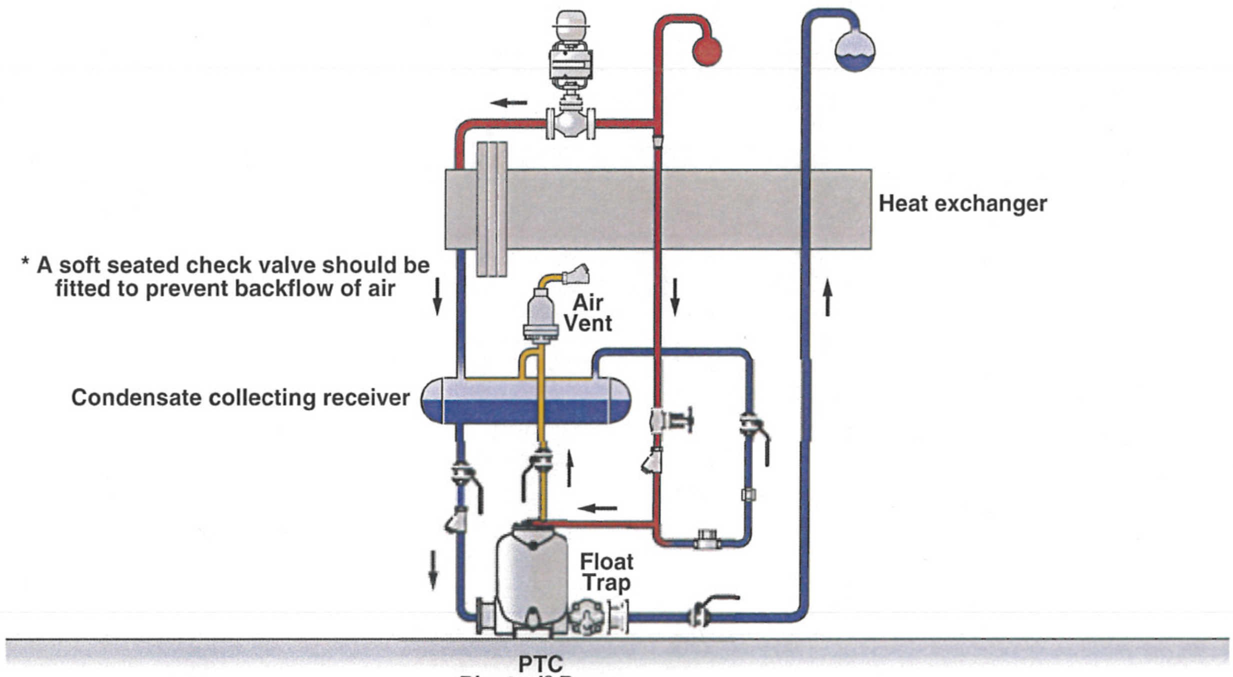
Condensate recovery (open system)

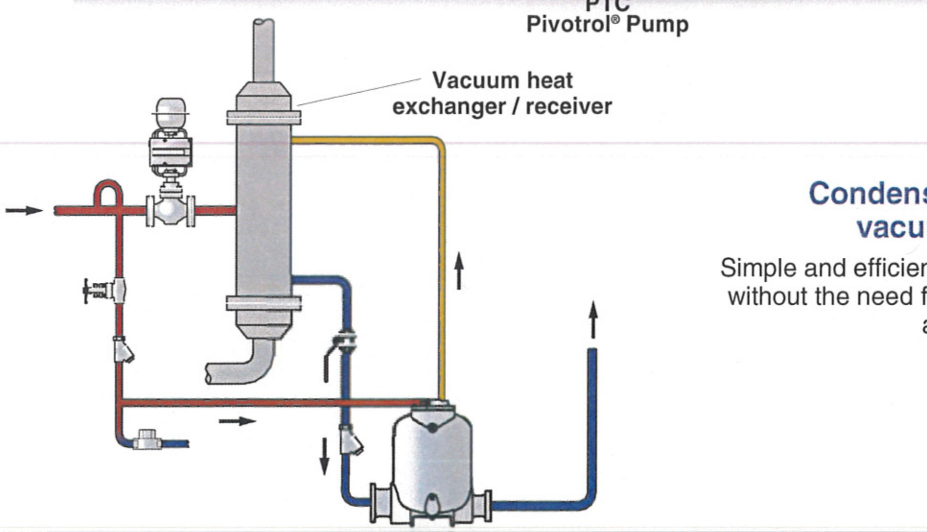
Pumping high temperature condensate without cavitation or mechanical seals to create problems. Provides maximum heat energy recovery.



Condensate removal from process vessels and heat exchangers & air heaters (pump/trap combination, closed system)

Removal of condensate under all pressure conditions ensures stable temperatures.
It also prevents bottom end tube corrosion and potential damage due to waterhammer and freezing.





Condensate removal from vacuum equipment

Simple and efficient solution to a difficult problem without the need for expensive electrical pumps and sensors.

Color Code:
- Condensate
- Motive Steam
- Flash Steam or Exhaust

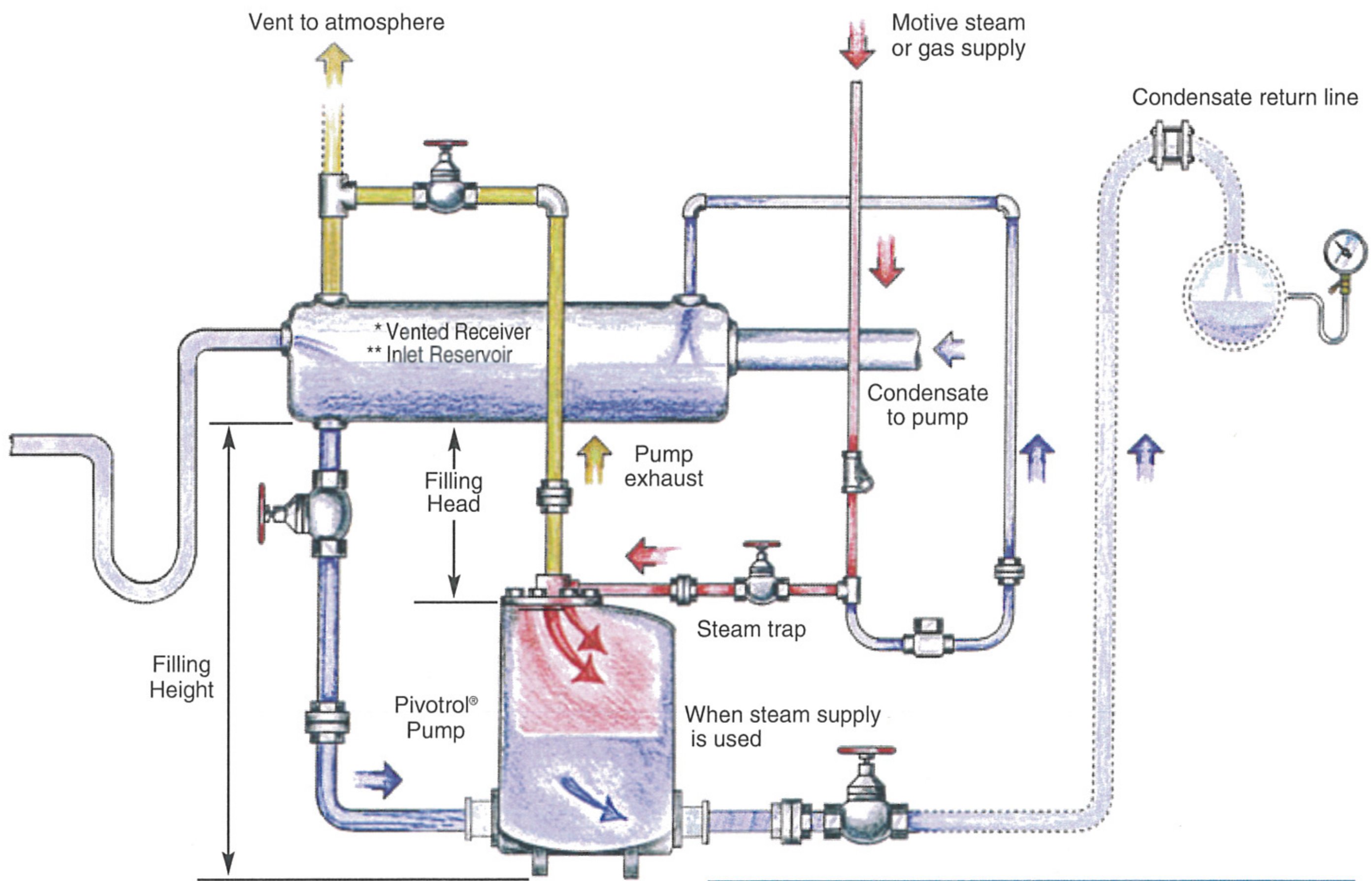
Vented Receiver*

To drain condensate from a single or multiple source "open" system, a vented receiver should be installed in a horizontal plane above and ahead of the pump. Sufficient receiver volume is needed above the filling head level to accept the condensate reaching the receiver during the pump discharge stroke. More important, the receiver must be sized to allow sufficient area for complete flash steam separation from the condensate. The chart below shows proper vented receiver sizing (per criteria set forth in the A.S.H.R.A.E. Handbook) based on the amount of flash steam present. If the receiver is sized as shown below, there will be sufficient volume for condensate storage and sufficient area for flash steam separation. The receiver can be a length of large diameter pipe or a tank.

Inlet Reservoir Piping**

To drain condensate from a single piece of equipment in a "closed" system, a reservoir should be installed in a horizontal plane above and ahead of the pump. Sufficient reservoir volume is needed above the filling head level to accept the condensate reaching the reservoir during the pump discharge stroke. The chart below shows minimum reservoir sizing, based on condensate load, needed to prevent equipment flooding during the pump discharge stroke. The reservoir can be a length of large diameter pipe or a tank. A Float and Thermostatic steam trap may be required in a closed system (details shown on page 5).

Typical installation



Pump Size - up to 3" x 2"

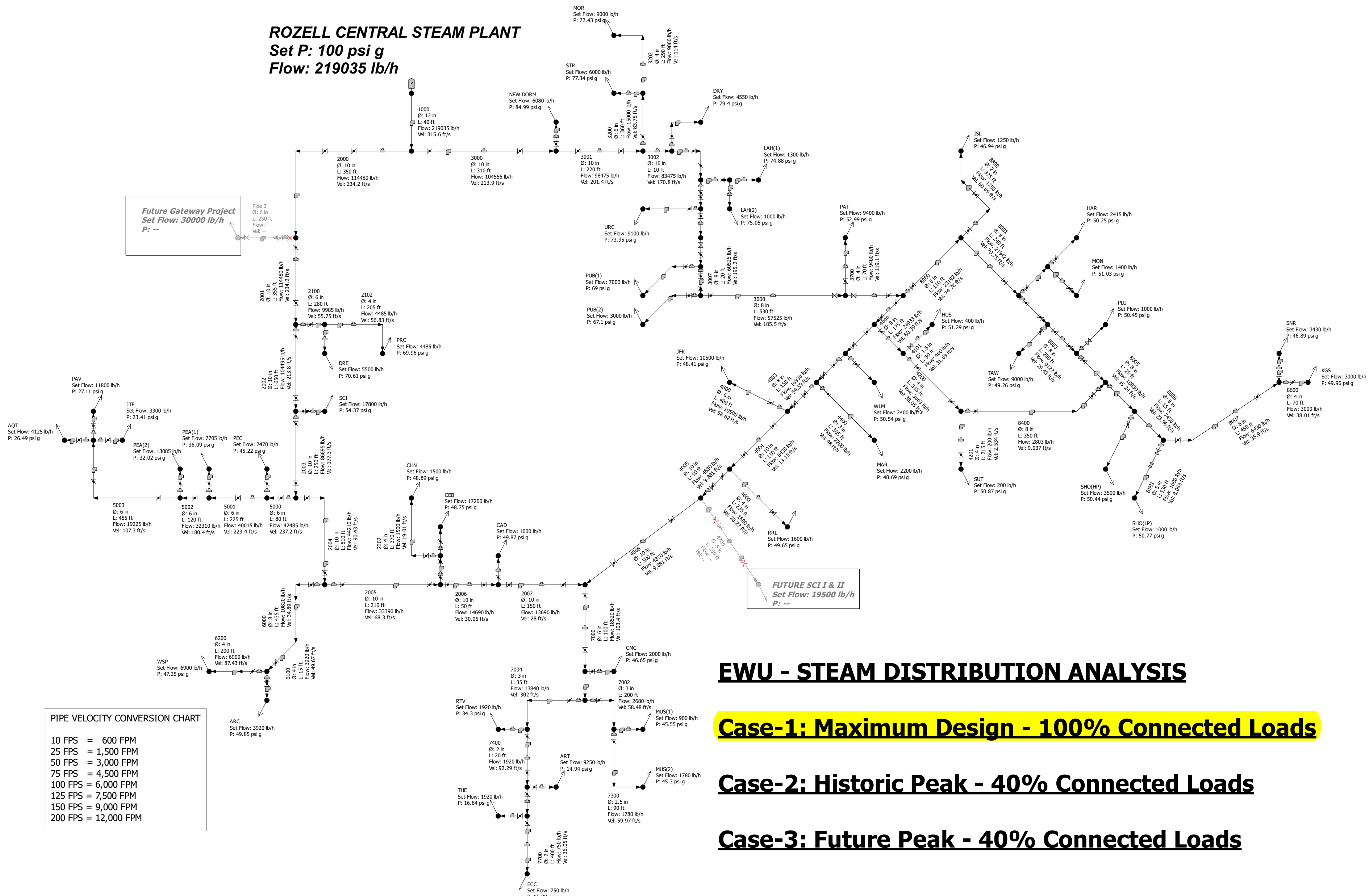
Flash Steam up to –	Pipe Size Diameter	Pipe Size Length	Vent Line Diameter
75 lb/h	4"	36"	1-1/2"
150 lb/h	6"	36"	2"
300 lb/h	8"	36"	3"
600 lb/h	10"	36"	4"
900 lb/h	12"	36"	6"
1200 lb/h	16"	36"	6"
2000 lb/h	20"	36"	8"

Pump Size-up to 3" x 2"

Cond. Load lb/h	Reservoir Pipe Diameter 3"	4"	6"	8"	10"
500 or less	1'				
1000	2'				
1500	3'	2'			
2000	3.5'	2'	1'		
3000		3'	2'		
4000		4'	2'	1'	
5000		6'	3'	2'	
6000			3'	2'	
7000			3'	2'	
8000			4'	2'	
9000			4.5'	3'	2'
10,000			5'	3'	2'
11,000			5'	3'	2'

APPENDIX A

CAMPUS STEAM FLOW MODEL RESULTS



PIPE VELOCITY CONVERSION CHART

10 FPS = 600 FPM
25 FPS = 1,500 FPM
50 FPS = 3,000 FPM
75 FPS = 4,500 FPM
100 FPS = 6,000 FPM
125 FPS = 7,500 FPM
150 FPS = 9,000 FPM
200 FPS = 12,000 FPM

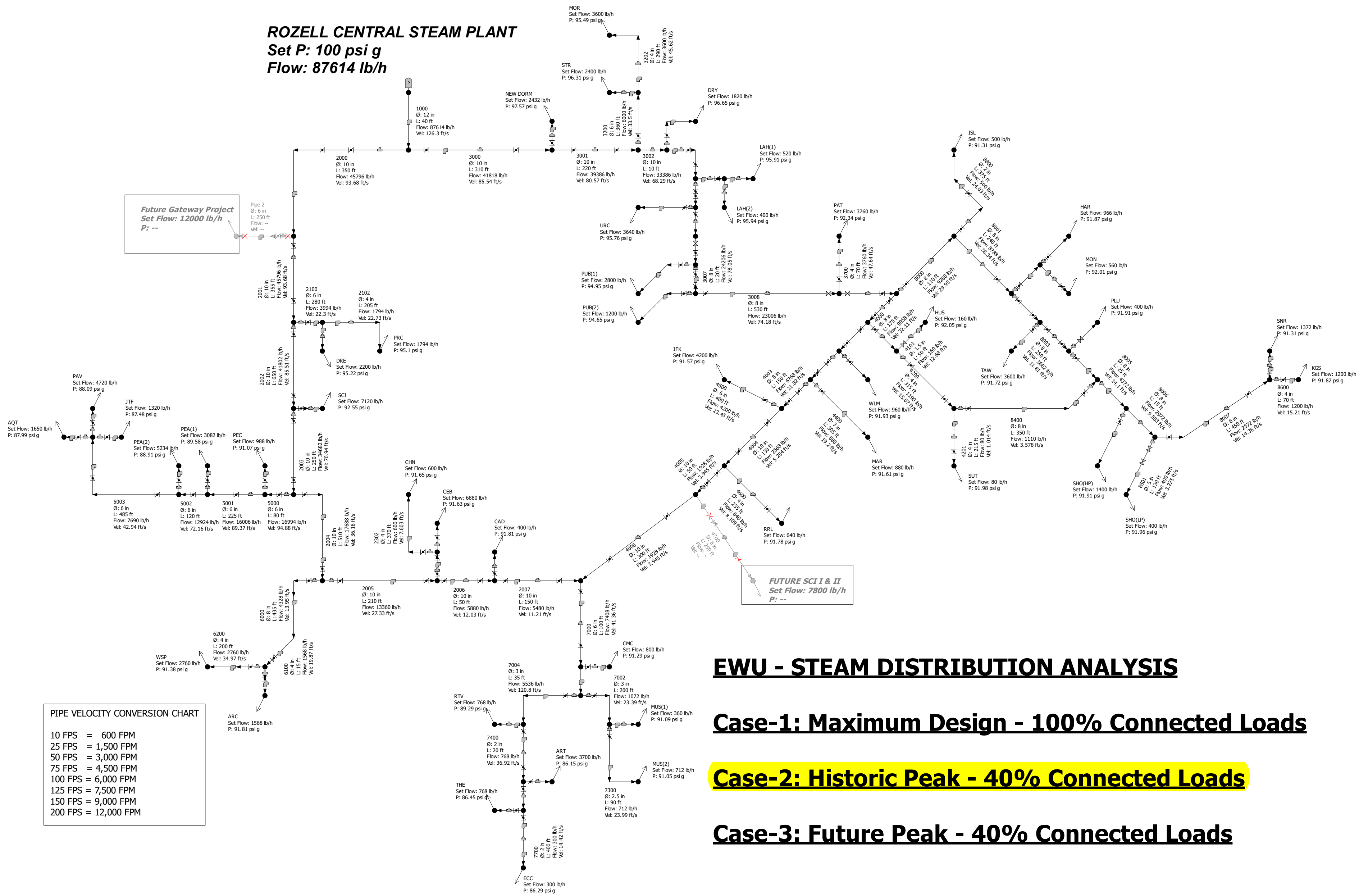
EWU - STEAM DISTRIBUTION ANALYSIS

Case-1: Maximum Design - 100% Connected Loads

Case-2: Historic Peak - 40% Connected Loads

Case-3: Future Peak - 40% Connected Loads

PIPE-FLO Professional 12		Units Used				Project Information	
Program Version:	12.1.21778	Flow rate:	lb/h	Power:		Company:	MSI Engineers
Calculation Method:	Darcy-Weisbach	Velocity:	ft/s	Temperature:	ºF	Project:	EWU Steam System Analysis
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 Steam System Analysis 1.0.pipe
Laminar Cutoff Re:	2100	Length:	ft	Atmospheric Pressure:	14.7 psi a	Lineup:	CASE-1: Max. Design - 100% Connected
		Size:	in			Print Date:	Wednesday, May 21, 2014 02:36 PM



PIPE VELOCITY CONVERSION CHART

10 FPS = 600 FPM
25 FPS = 1,500 FPM
50 FPS = 3,000 FPM
75 FPS = 4,500 FPM
100 FPS = 6,000 FPM
125 FPS = 7,500 FPM
150 FPS = 9,000 FPM
200 FPS = 12,000 FPM

EWU - STEAM DISTRIBUTION ANALYSIS

Case-1: Maximum Design - 100% Connected Loads

Case-2: Historic Peak - 40% Connected Loads

Case-3: Future Peak - 40% Connected Loads

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:	lb/h	**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 Steam System Analysis
Drawn by:	B. Snow
File Name:	14.01-EWU Steam System Analysis 1.0.pipe
Lineup:	CASE-2: Historic Peak - 40% Connected
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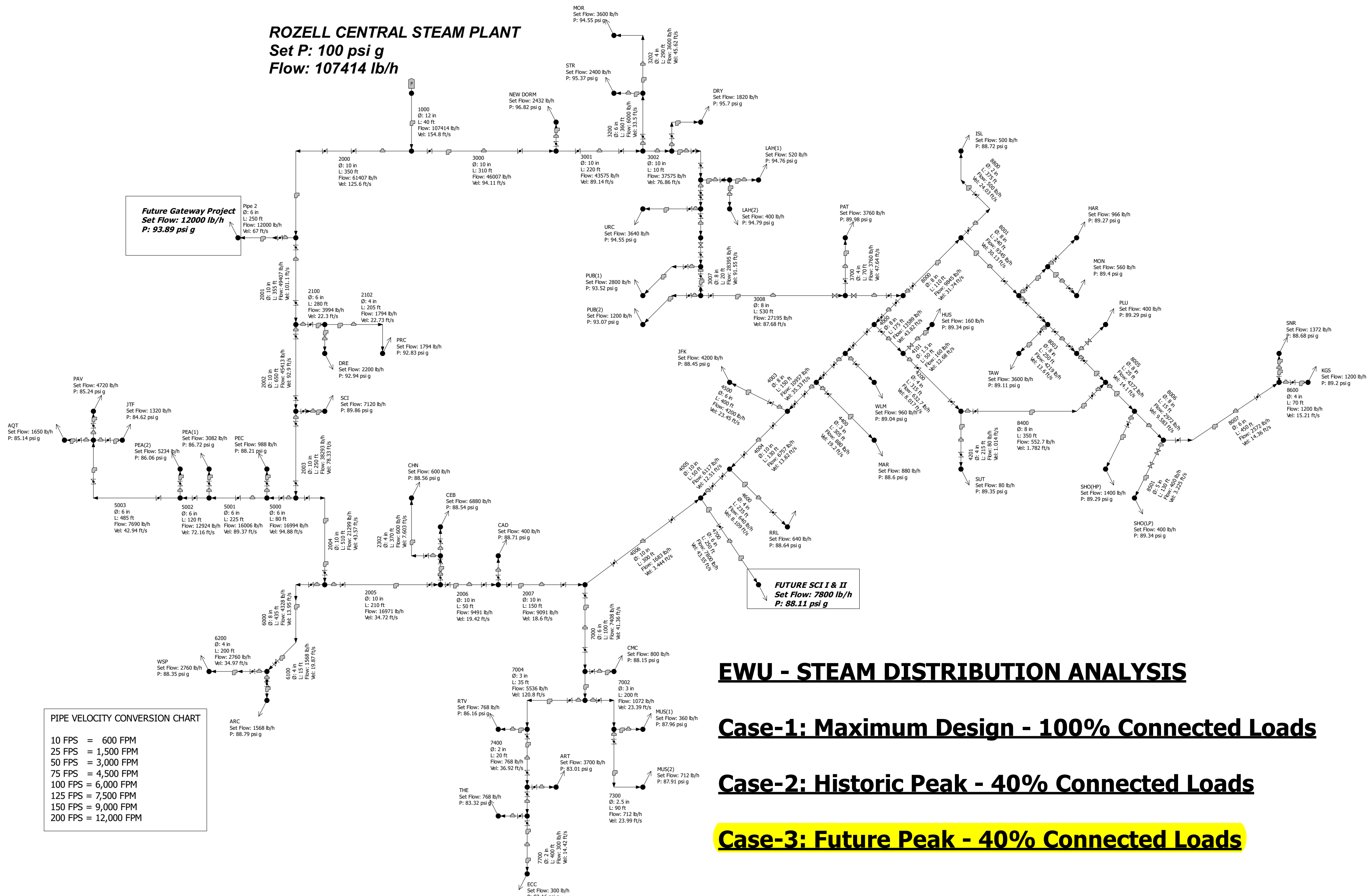

PIPE VELOCITY CONVERSION CHART

10 FPS	=	600 FPM
25 FPS	=	1,500 FPM
50 FPS	=	3,000 FPM
75 FPS	=	4,500 FPM
100 FPS	=	6,000 FPM
125 FPS	=	7,500 FPM
150 FPS	=	9,000 FPM
200 FPS	=	12,000 FPM

EWU - STEAM DISTRIBUTION ANALYSIS

Case-1: Maximum Design - 100% Connected Loads

Case-2: Historic Peak - 40% Connected Loads

Case-3: Future Peak - 40% Connected Loads

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:	lb/h	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 Steam System Analysis
Drawn by:	B. Snow
File Name:	14.01-EWU Steam System Analysis 1.0.pipe
Lineup:	CASE-3: Future Peak - 40% Connected
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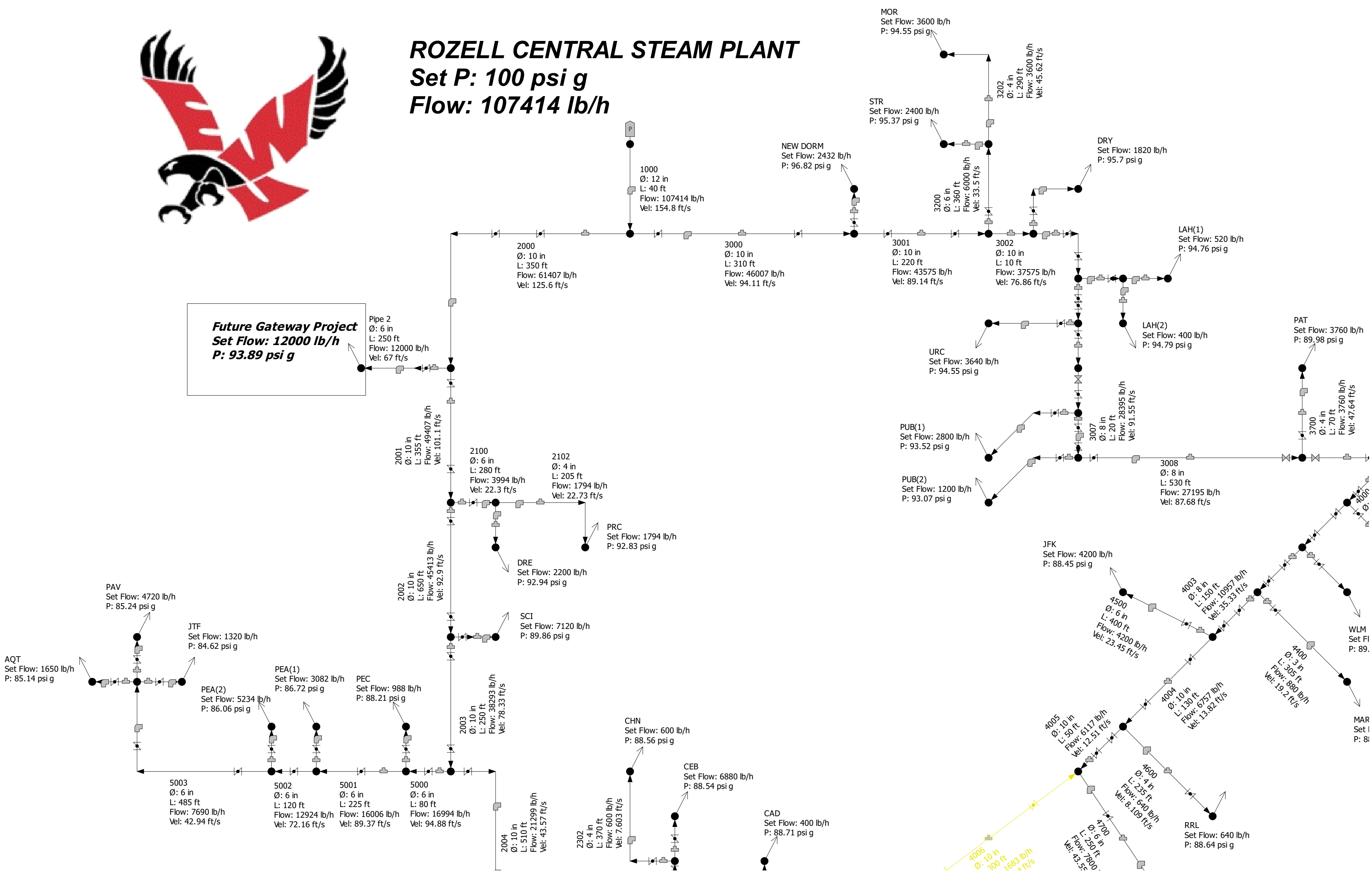
ROZELL CENTRAL STEAM PLANT
Set P: 100 psi g
Flow: 107414 lb/h



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:		Power:	
Velocity:	ft/s	Temperature:	ºF
Pressure:	psi g	Density:	lb/ft³
Elevation:		Viscosity:	cP
Length:		Atmospheric Pressure:	14.7 psi a
Size:			

Project Information	
Company:	MSI Engineers
Project:	EWU Steam System Analysis
Drawn by:	B. Snow
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Lineup:	CASE-3: Future Peak - 40% Connected
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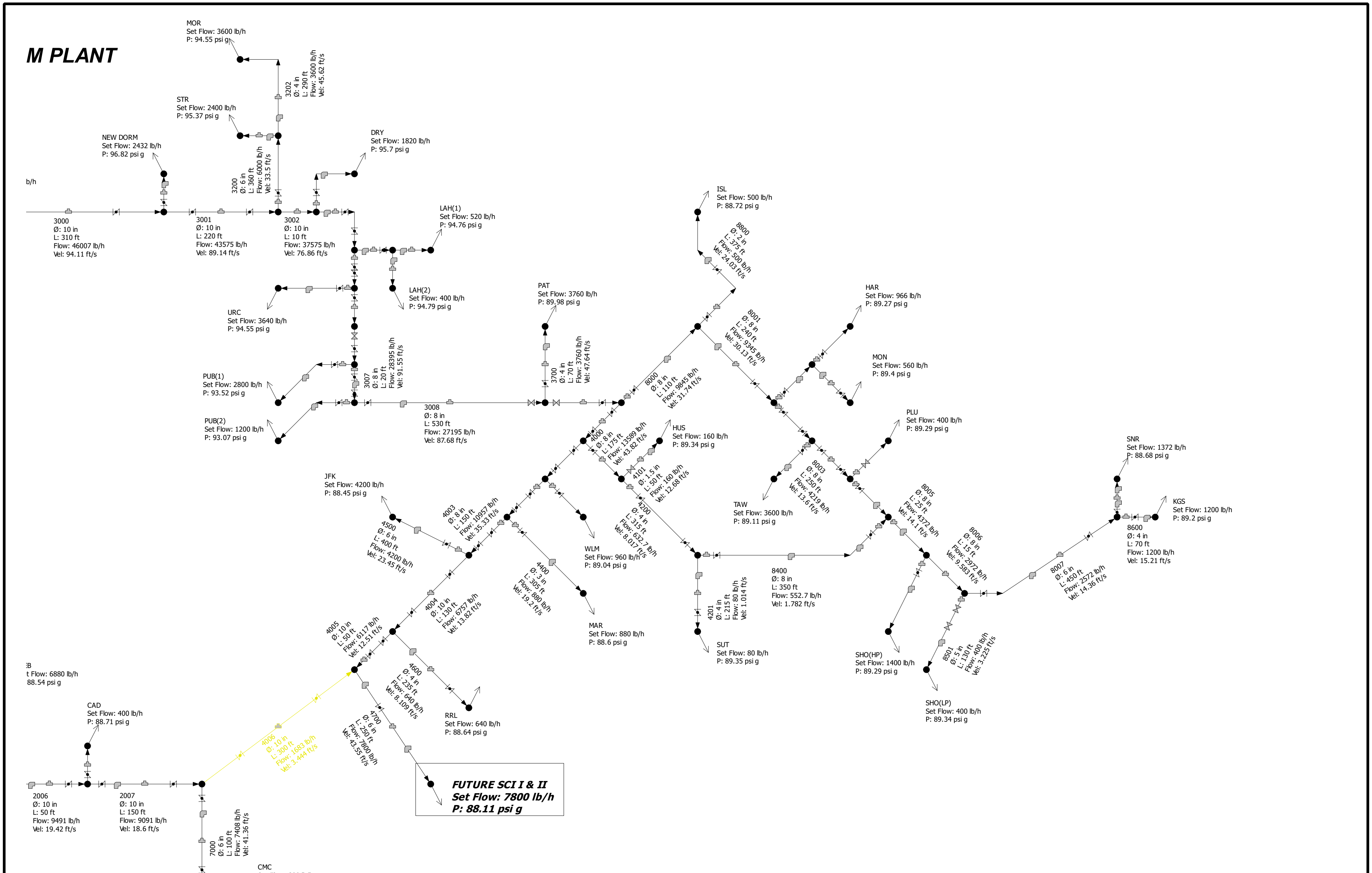

PIPE-FLO Professional 12		Units Used				Project Information	
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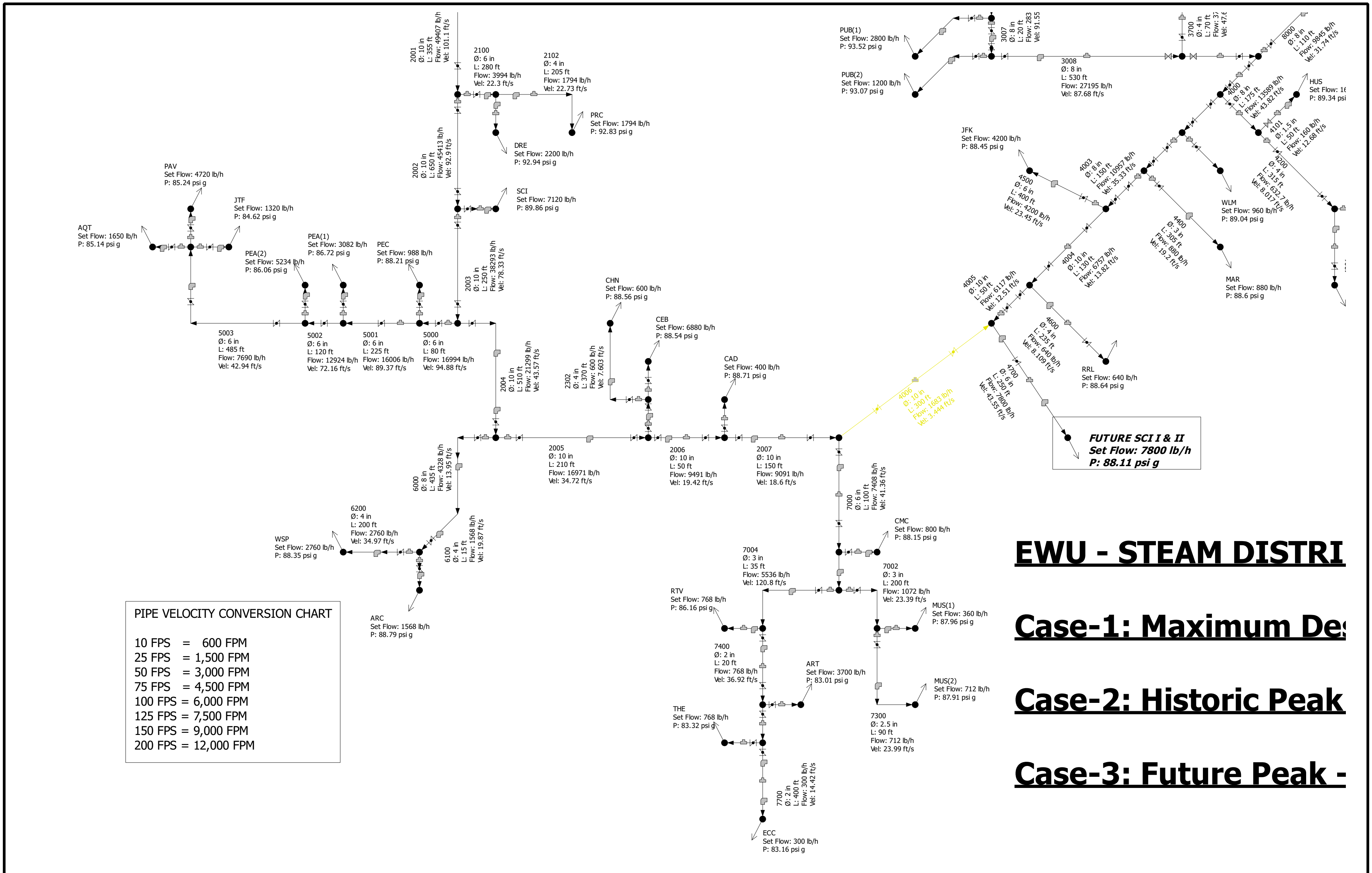
Calculation Method:	Darcy-Weisbach	**Velocity:**	ft/s	**Temperature:**	ºF	**Project:**	EWU Steam System Analysis
Maximum Iterations:	100	**Pressure:**	psi g	**Density:**	lb/ft³	**Drawn by:**	B. Snow
Iteration Tolerance:	0.01	**Elevation:**		**Viscosity:**	cP	**File Name:**	14.01-EWU Steam System Analysis 1.0.pipe
Laminar Cutoff Re:	2100	**Length:**		**Atmospheric Pressure:**	14.7 psi a	**Lineup:**	CASE-3: Future Peak - 40% Connected
		Size:				**Print Date:**	Thursday, May 29, 2014 08:41 AM



PIPE-FLO Professional 12	Units Used	Project Information
Program Version: 12.1.21778	**Flow rate:**	**Company:** MSI Engineers
Calculation Method: Darcy-Weisbach	**Velocity:** ft/s	**Project:** EWU Steam System Analysis
Maximum Iterations: 100	**Pressure:** psi g	**Drawn by:** B. Snow
Iteration Tolerance: 0.01	**Elevation:**	**File Name:** 14.01-EWU Steam System Analysis 1.0.pipe
Laminar Cutoff Re: 2100	**Length:**	**Lineup:** CASE-3: Future Peak - 40% Connected
	Size:	**Print Date:** Thursday, May 29, 2014 08:41 AM
	Power:	
	Temperature: ºF	
	Density: lb/ft³	
	Viscosity: cP	
	Atmospheric Pressure: 14.7 psi a	

APPENDIX B

DETAILED COST ESTIMATES

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

STEAM SYSTEMS - INFRASTRUCTURE UPGRADE BUDGET PRICE SUMMARY

		Budget Cost Estimate
Steam Plant		
SP-1: Replace Boiler #3		$3,500,000
SP-2: Install Boiler Feedwater Stack Economizers on Boilers #2 & #4		$350,000
SP-3: Upgrade Boiler Feedwater Pumps		$200,000
SP-4: Repair Rozell Heating Plant Boiler Stack		Unknown
SP-5: Upgrade Natural Gas Service From AVISTA		Unknown
	STEAM PLANT (SP) -	$4,050,000
Steam Distribution		
SD-1: Replace Utility Tunnel Steam Gravity Condensate Piping		$1,225,000
SD-2: Replace Utility Tunnel Electric Condensate Pumps with Steam Powered Pumps		$200,000
SD-3: Label Piping & Identify Branches & Valves - Repair Insulation		$150,000
SD-4: Upgrade Piping in PLU Building and/or Repurpose the Space		$125,000
	STEAM DISTRIBUTION (SD) -	$1,700,000
	STEAM SYSTEM TOTAL -	$5,750,000

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

STEAM SYSTEMS - INFRASTRUCTURE UPGRADE BUDGET PRICE SUMMARY

Steam Plant (SP)

SP-1: Replace Boiler #3

	Unit	Quantity	$/unit	Cost
Demo existing Boiler #3	ea	1	$50,000.00	$50,000
Demo exisisting power and controls	ea	1	$25,000.00	$25,000
Demo existing catwalks	ea	1	$25,000.00	$25,000
Demo existing boiler stack	ea	1	$25,000.00	$25,000
Demo existing boiler piping	ea	1	$25,000.00	$25,000
Remove portion of wall or roof for access	ea	1	$25,000.00	$25,000
New 40,000 pph 250 psi low NOX steam boiler	ea	1	$1,500,000.00	$1,500,000
Set & Install new boiler & crane work	ea	1	$150,000.00	$150,000
Update boiler foundations	ea	1	$75,000.00	$75,000
New boiler service catwalk	ea	1	$75,000.00	$75,000
New stack economizer	ea	1	$75,000.00	$75,000
New boiler stack connections	ea	1	$50,000.00	$50,000
New piping and valving connections	ea	1	$100,000.00	$100,000
New naturgal gas piping	ea	1	$25,000.00	$25,000
New fuel oil piping	ea	1	$50,000.00	$50,000
New controls and instrumentation	ea	1	$100,000.00	$100,000
Power & electrical upgrades	ea	1	$100,000.00	$100,000
Rozell building wall/roof replacement for access	ea	1	$150,000.00	$150,000
Start-up, testing & trouble-shooting	ea	1	$25,000.00	$25,000
Commissioning & Licensing	ea	1	$25,000.00	$25,000
Central Control Wonderware updates	ea	1	$17,308.00	$17,308
			Subtotal	$2,692,308
	%	20	Design Contigency	$538,462
	%	10	G.C. OH&P	$269,231
			SP-1 - Total	**$3,500,000**

SP-2: Install Boiler Feedwater Stack Economizers on Boilers #2 & #4

	Unit	Quantity	$/unit	Cost
Demo portions of existing stacks	ea	2	$15,000.00	$30,000
New 25 kpph stack economizer	ea	1	$35,000.00	$35,000
New 47 kpph stack economizer	ea	1	$60,000.00	$60,000
Install new stack economizers	ea	2	$15,000.00	$30,000
New/modified feedwater piping & control valves	ea	2	$35,000.00	$70,000
Control modifications	ea	2	$15,000.00	$30,000
Start-up & testing	ea	2	$5,000.00	$10,000
Misc.	ea	1	$5,000.00	$5,000
Commissioning	ea	2	$5,000.00	$10,000
			Subtotal	$280,000
	%	15	Design Contigency	$42,000
	%	10	G.C. OH&P	$28,000
			SP- 2 - Total	**$350,000**

SP-3: Upgrade Boiler Feedwater Pumps

	Unit	Quantity	$/unit	Cost
Demo existing hot well transfer pumps	ea	3	$500.00	$1,500
New hot well transfer pumps HWP-1,2,3 - 7.5 hp	ea	3	$10,000.00	$30,000
New VFDs for HWPs	ea	3	$3,500.00	$10,500
Update piping & valves for HWPs	ea	3	$5,000.00	$15,000
New 50 hp boiler feedwater pump (add to ex. 3 pumps)	ea	1	$15,000.00	$15,000

New VFD for FWP - 50 hp	ea	1	$7,500.00	$7,500
Update piping & valves for FWP	ea	1	$15,000.00	$15,000
Misc.	ea	1	$13,000.00	$13,000
Control modifications	ea	4	$7,500.00	$30,000
Electrical connections	ea	4	$2,500.00	$10,000
Start-up & testing	lot	1	$5,000.00	$5,000
Commissioning	lot	1	$7,500.00	$7,500
			Subtotal	$160,000
	%	15	Design Contigency	$24,000
	%	10	G.C. OH&P	$16,000
			SP-3 - Total	**$200,000**

SP-4: Repair Rozell Heating Plant Boiler Stack

Unknown - Requires Further Study	ea	0	$0.00	$0
			Subtotal	$0
	%	0	Design Contigency	$0
	%	0	G.C. OH&P	$0
			SP-4 - Total	**Unknown**

SP-5: Upgrade Natural Gas Service From AVISTA

Unknown - Work to be done by Utility Co.	ea	0	$0.00	$0
			Subtotal	$0
	%	0	Design Contigency	$0
	%	0	G.C. OH&P	$0
			SP-5 - Total	**Unknown**

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

STEAM SYSTEMS - INFRASTRUCTURE UPGRADE BUDGET PRICE SUMMARY

Steam Distribution (SD)

SD-1: Replace Utility Tunnel Steam Gravity Condensate Piping

	Unit	Quantity	$/unit	Cost
Demo existing piping	lf	12,500	$5.00	$62,500
New 1-1/2" (Avg.) Sched. 80 condensate piping	lf	12,500	$35.00	$437,500
Pipe fitting allowance	%	35%		$153,125
Insulation and jacketing	lf	12,500	$7.50	$93,750
Drip traps, valve sets, flex piping, etc.	ea	40	$5,000.00	$200,000
Expansion joints/loops	ea	10	$2,000.00	$20,000
Pressure testing, flushing & cleaning	lot	1	$5,000.00	$5,000
Misc.	ea	1	$8,125.00	$8,125
			Subtotal	$980,000
	%	15	Design Contigency	$147,000
	%	10	G.C. OH&P	$98,000
			SD-1 - Total	**$1,225,000**

SD-2: Replace Utility Tunnel Electric Condensate Pumps with Steam Powered Pumps

	Unit	Quantity	$/unit	Cost
Demo existing electric condensate pumps	ea	10	$250.00	$2,500
Install new pressure powered condensate pumps	ea	12	$7,500.00	$90,000
Modify piping and valving	ea	12	$5,000.00	$60,000
Start-up & testing	ea	12	$625.00	$7,500
			Subtotal	$160,000
	%	15	Design Contigency	$24,000
	%	10	G.C. OH&P	$16,000
			SD- 2 - Total	**$200,000**

SD-3: Label Piping & Identify Branches & Valves - Repair Insulation

	Unit	Quantity	$/unit	Cost
Label steam piping (1 label every 50 ft ±)	ea	500	$25.00	$12,500
Label condensate piping	ea	500	$25.00	$12,500
Label chilled water piping	ea	500	$25.00	$12,500
Label Misc. piping	lot	100	$25.00	$2,500
Label & Tag valves	ea	1,000	$15.00	$15,000
Label/ID plaques for branch take-offs to buildings	ea	50	$200.00	$10,000
Repair misc. insulation & jacketing	lot	1	$25,000.00	$25,000
Repaint sections of pipe jackteing	lot	1	$15,000.00	$15,000
Valve tag schedule data base	ea	1	$1,000.00	$1,000
Repair/replace damaged or missing valve insul. jackets	lot	1	$14,000.00	$14,000
			Subtotal	$120,000
	%	15	Design Contigency	$18,000
	%	10	G.C. OH&P	$12,000
			SD-3 - Total	**$150,000**

SD-4: Upgrade Piping in PLU Building and/or Repurpose the Space

	Unit	Quantity	$/unit	Cost
Demo & cap abandoned piping	ea	1	$5,000.00	$5,000
Replace gate valves with butterfly valves	ea	1	$15,000.00	$15,000
Reroute exisitng branch piping to free-up bldg space	ea	1	$25,000.00	$25,000

Repair/reinsulate & label piping	ea	1	$15,000.00	$15,000
Misc. modifications	lot	1	$25,000.00	$25,000
Rework access catwalks	ea	1	$15,000.00	$15,000
			Subtotal	$100,000
	%	15	Design Contigency	$15,000
	%	10	G.C. OH&P	$10,000
			SD-4 - Total	**$125,000**

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 - STEAM LOADS							
Campus Map Bldg No.	**BldgID**	**Building Name**	**Gross Square Footage**	**Facility Usage**	**Campus Steam Service Y/N**	**Steam PRV Capacity (LBS/HR)**	**Steam Load Density (BTU/SF)**
		Campus Master Plan Growth					
Future	???	New Science Center I	103,000	Classrooms	Future	9,500	88
Future	???	New Science Center II	110,000	Classrooms	Future	10,000	86
Future	???	Gateway Project	300,000	Sports Complex	Future	30,000	95
Future	???	Snowmelt Systems	Varies	Site	Future	30,000	(Allowance)
		Future Growth Total	**513,000**			**79,500**	Future
						34%	Growth
??	???	New Residence Hall	50,000	Residential	Y	6,078	115
2	AQT	Aquatics	21,356	Athletic	Y	4,125	183
59	ARC	WA Archives	74,247	Multipurpose	Y	3,920	50
3	ART	Art Building	34,415	Teaching Labs	Y	9,250	255
5	CAD	Cadet Hall	9,034	General Classroom	Y	1,000	105
10	CEB	Computing and Engineering Building	97,724	Teaching Labs	Y	17,200	167
7	CHN	Cheney Hall	30,196	Teaching Labs	Y	1,500	47
9	CMC	Communications Center (Speech)	21,960	General Classroom	Y	2,000	87
11	DRE	Dressler Hall	80,899	Residential	Y	5,500	65
12	DRY	Dryden Hall	53,840	Residential	Y	4,550	80
13	ECC	Eastern Children's Center	14,530	Operational Support	Y	750	49
15	HAR	Hargreaves Hall	42,992	Multipurpose	Y	2,415	53
17	HUS	Huston Hall (Computer Science Bui	27,718	Teaching Labs	Y	400	14
19	ISL	Isle Hall	36,348	General Classroom	Y	1,250	33
21	JFK	John F. Kennedy Library	165,270	Study	Y	10,500	60
20	JTF	Jim Thorpe Fieldhouse (Phase IV)	57,284	Athletic	Y	3,300	55
22	KGS	Kingston Hall	57,326	Teaching Labs	Y	3,000	50
23	LAH	Louise Anderson Hall	73,808	Residential	Y	2,300	30
24	MAR	Martin Hall	60,000	Teaching Labs	Y	2,200	35
25	MON	Monroe Hall	50,305	Multipurpose	Y	3,400	64
26	MOR	Morrison Hall	100,880	Residential	Y	9,000	85
27	MUS	Music Building	49,700	General Classroom	Y	2,675	51
28	PAT	Patterson Hall	103,500	General Classroom	Y	9,381	86
45	PAV	Pavillion (Reese Court) (Phase III)	102,531	Multipurpose	Y	11,800	109
31	PEA	P.E. Activities (Phase II)	95,512	Athletic	Y	20,790	207
32	PEC	P.E. Classroom (Phase I)	27,941	General Classroom	Y	2,470	84
33	PLU	Plant Utilities	6,610	Multipurpose	Y	1,000	144
29	PRC	Pearce Hall	93,859	Residential	Y	4,485	45
30	PUB	Pence Union Building	57,200	Student Services	Y	10,950	182
40	ROZ	Rozell Heating Plant	36,645	Operational Support	Y	10,000	259
39	RRL	Robert Reid Lab School	33,003	General Classroom	Y	1,600	46
37	RTV	Radio TV Building	17,443	Multipurpose	Y	1,920	105
42	SCI	Science Building	169,586	Teaching Labs	Y	17,800	100
44	SHW	Showalter Hall	88,408	Office	Y	4,500	48
43	SNR	Senior Hall	50,014	General Classroom	Y	3,430	65
47	STR	Streeter Hall	78,680	Residential	Y	6,000	72
53	SUT	Sutton Hall	29,340	Multipurpose	Y	1,982	64
54	TAW	Tawnaka Commons	68,694	Multipurpose	Y	9,000	124
57	THE	Theatre (Drama Building)	33,715	Performing Arts	Y	1,920	54
51	URC	University Recreational Center	115,448	Multipurpose	Y	9,096	75
61	WLM	Williamson Hall	30,219	Teaching Labs	Y	2,400	75
60	WSP	WSP Crime Lab	37,861	Office	Y	6,900	173

Total Connected Steam PRV Load	233,737	lbs/hr
Historical Peak Steam Plant Load	75,000	lbs/hr
Historical Peak Campus Load	32%	(% of Connected Peak)
Existing Boiler Plant Maximum Capacity	217,000	lbs/hr
Historical Peak Plant Load	35%	(% of Plant Capacity)
Future Total Connected Steam PRV Load	313,237	lbs/hr
Historical Peak Campus Load	32%	(% of Connected Peak)
Future Peak Steam Plant Load (based on historical % loading)	100,509	lbs/hr
Future Peak Steam Plant Load	46%	(% of Plant Capacity)

Existing Boiler Plant Capacity

	lbs/hr	
Boiler #1	56,000	
Boiler #2	25,000	
Boiler #3	(25,000)	(Not in Service)
Boiler #4	47,000	
Boiler #5	89,000	
Total	217,000	

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):	3,920 lb/hr
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):	<u>2,000 lb/hr</u>
	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):	<u>4,550 lb/hr</u>
	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): <u>2,415 lb/hr</u>

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): 1,250 lb/hr
  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): 3,300 lb/hr

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):	3,000 lb/hr
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): <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 / 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):	2,675 lb/hr
	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): 11,800 lb/hr

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): <u>2,470 lb/hr</u>

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): 10,950 lb/hr

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):	13,000 lb/hr
	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): 1,920 lb/hr

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):	4,500 lb/hr
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):	3,430 lb/hr
	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):	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 / 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): <u>9,096 lb/hr</u>

  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): <u>2,400 lb/hr</u>

  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 - 2012
McKinstry
(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

Reducing Scope 1 & 2 Emissions

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		

Reducing Scope 1 & 2 Emissions

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

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			

Reducing Scope 1 & 2 Emissions

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.