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Chilled Water Plant Study

University of Wisconsin – La Crosse

La Crosse, Wisconsin

DSF Project No. 12H2C
R&D Project 212116

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(Final)

Table of Contents

EXECUTIVE SUMMARY

Based on the campus Master Plan and estimated load projections there is a projected need for approximately 3,000 tons of additional cooling over the next 10 years.

The following four options for increasing the chilled water capacity for the UW La Crosse campus were analyzed by this report:

- Option 1A-New chiller plant constructed on the Northwest end of the campus.
- Option 1B-New chiller plant constructed on the Northwest end of the campus with thermal storage.
- Option 2A-New chiller plant within the new Student Union building.
- Option 2B-New chiller plant within the new Student Union building including geothermal fields.

Based on the findings of this study, Option 1A is recommended for providing the additional chilled water capacity because it has the lowest life cycle cost and lowest first cost. Option-1A would include two (2) 1200 ton water cooled chillers with the building and infrastructure sized to add either a third 1200 ton chiller or a thermal storage system to satisfy potential loads identified after 2021.

In addition to having the lowest life cycle cost and lowest first cost the Northwest site of Option 1A has several advantages over Option 2A & 2B below grade plants in the Student Union including:

- Plant space is more efficiently utilized.
- Material handling of softener salt, chemicals, etc. is simplified.
- Serviceability and replacement of equipment is better.
- Chillers are in closer proximity to the cooling towers and other ancillary equipment.
- Allows the flexibility for the addition of future thermal storage in lieu of a third chiller.

The University also has significant concerns with a plant in the basement of the new Student Union including the following:

- The potential for plant flooding in an underground location plus the additional flooding risk to the lower levels of the Union.
- The loss of approximately 3,000 square feet of programmed space in the Union.
- Disruption to the Union loading dock if structural repairs are required in the future.

Thermal Storage in Option 1B was studied but the Life Cycle cost was higher than adding additional chiller capacity. It is recommended that Thermal Storage be re-evaluated when historical load profile data is available or if additional tonnage is needed on the campus.

Geothermal in Option 2B was studied but the Life Cycle cost was also higher when compared against additional chiller capacity. The campus has relatively limited bore field area relative to the needs of a central campus chilled water plant. The central plant also has limited ability to optimize the heating component of geothermal systems. Geothermal is better applied and evaluated for specific building applications which have a heating and cooling component in order to reduce the long term overall chilled water plant demand.

The analysis of the distribution system indicates there are no upgrades required to existing piping other than connecting new plants and buildings to the system.

There are several upgrades to the existing system that are recommended including:

- Addition of flow meters at all existing unmetered buildings.
- Change any existing 3-way valves to two way valves.
- Upgrade controls and metering in the existing plant.
- Add additional pressure monitoring controls to several outlying buildings.

Electrical service to the proposed chiller plant shall originate from the existing 13800 volt service equipment. A new feeder will be routed through new or existing duct banks to the proposed chiller plant location.

There were no significant environmental issues identified that would prevent the proposed Option 1A from moving forward.

PURPOSE

Based on existing chiller logs and monitoring equipment and using campus load estimating the campus peak chilling demand is matching the capacity of the existing chillers for design days. For days exceeding design conditions there are indications that the plant cannot keep up to the demand via rising chilled water loop temperatures and rising humidity conditions in buildings.

Two major building projects slated for construction in the next biennia (New Science Facility and New Student Center), is estimated to require an additional 1200 tons of cooling capacity.

It is anticipated that over the next 10 years, there will also be multiple projects resulting in a need for additional chilled water capacity. The multiple projects include Phase II of the new Cowley Science facility, Center for the Arts (addition),Wittich & Mitchell Hall (office remodels) and the connection of eight existing residence halls to the chilled water system.

The purpose of this study is to provide a comprehensive study to fully understand the life cycle cost and build-out feasibility of various chiller and chilled water distribution system expansion options. This study will also provide a recommended approach to meet these cooling demands.

STUDY SCOPE

The scope of the study will encompass the following:

1. Life cycle cost (LCC) analysis of the following four options:
   a. Option 1A-New chiller plant/equipment built on the northwest end of the campus. Include recommendations for optimal building size, tower location and chiller/tower/pump sizes and type.
   b. Option 1B-New chiller plant with thermal storage built on the northwest end of the campus.
   c. Option 2A-New chiller plant within the new student union building.
   d. Option 2B-New chiller plant within the new Student Union building including geothermal fields. This option initially included consideration of a heat recovery chiller. After some preliminary effort it was determined with the concurrence of DFD that the heat recovery chiller should stand on its own merit as part of the new student union center and not be included as part of this study. Heat recovery will be analyzed as part of the Cowley Laboratory and Student Union projects. Both buildings will have significant reheat loads which will provide a location to discharge heat.
2. Chilled water distribution hydraulic study with recommendations for distribution extensions and modifications to meet near term and future cooling loads. Prepare a model of the existing system and a model for each of the new chilled water plant locations. Include cost/feasibility analysis and recommendations for constructing distribution modifications and branch stubs for the new Cowley Science building, new Student Union and eight existing residence halls at the same time versus incremental modifications/extensions as new/existing building loads are connected over time.
3. Analysis of new/existing chiller plant equipment and chiller distribution system controls including cost and recommendations for integrating new controls with existing. Study to include recommendations for optimizing energy used by existing and new chilled water system equipment, e.g. full and part-load efficiency of new verses older equipment, equipment staging, pumping strategies, etc..
4. Electrical service review including recommendation and cost of feeding the chiller plant(s) from the existing campus 15 kV substation (near the heating plant) verses a new service from the Xcel Energy grid.
5. Review of supporting utility requirements including cost and recommendation for city water, sanitary and data network extensions/modifications.
6. Review and summary of city ordinances regarding noise and height restrictions for the new plant option on the northwest end of campus as well as noise considerations for in-building plants. Review and summarize State and Local regulations, geological conditions and soil thermal properties in association with geothermal field consideration.
7. General review and summary of environmental impacts of new plant and distribution system construction and operation.
8. Block cooling load analysis on existing residence halls (limited to two) to verify estimated square foot load information. Check of industry accepted cooling load/square foot guidelines to verify estimated load information on new campus building projects over the next 10 years. Prepare block load models of the new Union and Science Building to confirm estimated cooling demands.

EXISTING DATA

Existing Chilled Water System Overview

The original chiller plant was built in 1995 and is located on the north side the heating plant. In 2003 a building addition was constructed on the east end of the chiller plant to house a third chiller.

Due to the proximity of underground utilities, adjacent heating plant structures, adjacent roadways, and capacity limitations of the chilled water distribution mains, a second addition onto the existing chiller plant is deemed as impractical.

Consideration was given to replacing the existing chillers in the existing plant with larger chillers that would meet the demand. The significantly larger size of these chillers would not fit within the footprint of the existing structure. In addition the existing chillers have significant useful life remaining (10-20 years) so that value would be lost if replaced at this time.

The original plant houses the following chillers:

Chiller	Make	Nominal Tons	Installed
1	McQuay	1200	1995
2	McQuay	1300	1999
3	York	1200	2005

The chillers are currently operated to provide a supply water temperature of 42 degrees. There is an approximate 10 to 11 degree temperature differential maintained between the supply and return temperatures in the distribution system.

Chiller 1 and 2 performance is believed to be performing at less than the nominal capacity based on the field start-up report and chiller plant logs.

Cooling towers for Chiller-1 and 2 are located on the heating plant roof. Cooling towers for Chiller-3 are located on the roof of the plant addition.

Tower	Make	HP	Installed
1	BAC	4 @ 30 (ea)	1995
2	Marley	2 @ 50 (ea)	1999
3	Marley	2 @ 50 (ea)	2005

The chilled water pumping is done with a primary-secondary pumping system with the following pumps:

Pump	Serves	GPM	Head(Ft)	HP	Installed
1	Chilled Water (C-1)	2400	41	40	1995
2	Chilled Water (C-2)	2400	41	40	1999
3	Chilled Water (C-3)	2400	45	40	2005
1	Condenser Water (C-1)	3600	85	100	1995
2	Condenser Water (C-2)	3600	75	100	1999
3	Condenser Water (C-3)	3600	75	125	2005

Pump	Serves	GPM	Head(Ft)	HP	Installed
1	Distribution	4800	110	200	1995
2	Distribution	4800	110	200	1999
3	Distribution (Standby)	4800	110	200	2005

Controls are managed thru the campus Building Automation System (Andover). The distribution pumps are equipped with variable speed drives. The drives vary speed to maintain a set differential pressure out in the system. A differential pressure control signal from Whitney Hall is used to control the pumps. An informational differential pressure is obtained thru the automation system at Reuter Hall. Additional differential pressure sensors should be added.

A BTU meter is provided in the 18” chilled water supply line as it exits the plant. The meter location does not provide adequate straight runs of pipe in and out of the meter. The meter should be relocated to the return line to improve accuracy. There are no meters on the individual chillers nor are there any isolation control valves.

The following buildings are equipped with chilled water flow meters:

- Cartwright Center (not BACNet)
- Cleary Center
- Stadium
- Reuter Hall
- Chiller Plan (not BACNet)
- Eagle Hall
- Centennial Hall

The underground chilled water distribution system was constructed in 1995. Indications are that the original underground distribution piping is C900 PVC. There is indication that the pipe joints may have joint restraints. Piping ranges in size from 4” to 18”.

The system is protected by a 125 psig relief valve on the discharge side of the distribution pumps. The make-up water valve is set at 58 PSIG. There is also a control valve bypass located in Whitney Hall which would open on a pump VFD failure.

There are chilled water booster pumps located in Reuter Hall, Eagle Hall and the Health Science Center. These pumps are expected to be maintained in their current status.

Building Load Confirmation

Confirmation of the gross square foot per ton factors for residence halls was done utilizing the Trane “System Analyzer” software (see Appendix A-1).

Calculations were done on Coate Hall and Sanford Hall as representative residence halls. Sanford as a smaller residence hall had a slightly lower 350 gross square foot per ton than Coate Hall at 400 gross square foot per ton. These factors were applied to the other residence halls on campus.

System Analyzer was also utilized to estimate the approximate cooling demand for the proposed Cowley building. The results basically confirmed the 200 gross square foot per ton used in the load projections.

The 700 ton load for the proposed new Student Union was obtained from the engineer that was involved in the pre-design of that project. This tonnage was incorporated into the campus load projections.

Campus Chilled Water Load Projections

UW Systems prepared a preliminary Campus Chilled Water Load Projection table in May 2012. An updated version this table is attached in Appendix A-2 and was used as the starting point for this analysis. Loads were reviewed and several adjustments were made to the table. Key changes/adjustments made include:

- Addition of a West Campus Residence Hall (112,000 sq ft, 320 tons).
- Adjusted New Student Union Load to 700 tons to match the engineers estimated cooling load.
- Adjusted the system gain estimates to more closely match estimated pump horsepower's.
- Adjusted Dorm sq ft /ton estimates based on building block load calculations.
- Applied correction factors to the nominal ratings of chillers 1 & 2 to reflect non –zero tolerance ratings.
- Adjusted diversity factors slightly to align the cumulative plant load with the actual plant rated capacity.
- Modified the chiller plant capacity and chiller modules to align with the adjustments to the loads.
- Checked and incorporated system gain factors into the GPR/PR split calculations.

The estimates are based on a design day (91 degrees) cooling requirement. The lack of recorded historical hourly data limits the ability to confirm the estimated design day demand. Historical data started being recorded in early September of 2012. The historical data is considered of limited value because of lack of information on humidity and lack of high ambient temperature days.

It should be noted that over the past two years several 100 degree events have occurred. During those events the campus ran all their chillers full out 24 hours per day in order to keep up. During the day the chilled water supply temperature was noted to have risen approximately 2 degrees and building temperatures were rising.

The load projections indicate a need for a total of 6595 tons by the year 2023. The current plant has a capacity of 3600 tons. The projected need in the next ten years is for an additional 2,995 tons of capacity.

Campus Load Profile

The existing plant did not have the ability to record or a daily load cooling profile until September of 2012. Since there was no design condition encountered after the monitoring was begun the data is off little value in determining or confirming a consistent campus daily load profile.

The chiller plant is provided with a separate electrical service. The metering and billing is broken down into on and off peak periods. From these billings an “average” monthly and daily on and off peak cooling profile was derived for the existing campus (See Appendix C). The derived average monthly and daily profile indicates that there is not a significant difference between the average electrical consumption (cooling) during on and off peak periods. We would anticipate a more significant variation in the daily load profiles if actual data is obtained.

For the purpose of this report it is anticipated the campus load profile would not change significantly with additional cooling.

GENERAL CONSIDERATIONS

Utility Rate Structure

The existing chiller plant is served by a primary 15kv service from Xcel Energy. The utility will not offer another service to the campus unless the campus owns the transformer (Primary Service). The primary rate structure would apply to all options under consideration in this study. The chart shown below reflects the approximate annual benefit of utilizing the primary service versus secondary service (if it was available) for the new plant.

Primary (Campus Owned Transformer)

	June thru September	October thru May
Customer Charge	$155/month	$155/month
Demand		
On-Peak	$ 9.56/KW	$ 7.60/KW
Distribution	$ .97/KW	$ .97/KW
Energy		
On-Peak	$ .07536/KW	$ .06803/KW
Off-Peak	$ .04447/KW	$ .04447/KW
Energy Charge Credit		
400 x On-Peak Demand (Max 50% total KWH)	$ .08/KW	$ .08/KW

Secondary (Utility Owned Transformer)

	June thru September	October thru May
Customer Charge	$155/month	$155/month
Demand		
On-Peak	$ 9.75/KW	$ 7.75/KW
Distribution	$ 1.30/KW	$ 1.30/KW
Energy		
On-Peak	$ .07696/KW	$ .06942/KW
Off-Peak	$ .04538/KW	$ .04538/KW
Energy Charge Credit		
400 x On-Peak Demand (Max 50% total KWH)	$ .08/KW	$ .08/KW

Service Comparison:

Secondary	$	345,961
Primary	$	335,571
Annual Benefit	$	10,391

(Estimated Benefit for a Primary Service for a 2400 ton Plant based on a proportion of existing 3600 ton plant use)

Electrical Service

The proposed chilled water equipment, whether located in the Northwest Plant option or the Student Union option will have a maximum power demand of approximately 3000 kW.

The campus is supplied by two services from Xcel Energy. The first is a secondary service with a voltage of 4160. The service equipment is in the switchgear building near the existing Heating Plant. The second is a primary service with a voltage of 13800. The service equipment is located outdoors across the street from the Heating Plant. Currently the 4160 volt service supplies all the buildings on campus and the 13800 volt service supplies the chillers and the 480 volt chiller ancillary equipment in the Chiller Plant.

The 4160 volt secondary service is supplied from two Xcel Energy transformers located in the Fairgrounds Substation across the street from the Heating Plant. Each transformer is rated at 3500/5000 kW. The current demand on the service is 3853 kW. Should either transformer fail, power to the campus buildings is not interrupted. Adding the proposed chiller plant will exceed the rating of a single transformer should one transformer fail.

The primary service is supplied directly from the Xcel Energy feeder service the Fairgrounds Substation, no intermediate transformer. The service has a capacity of 11,000 kW with a current demand of 3080 kW. The maximum demand Xcel Energy can currently provide is approximately 5500 kW. Xcel Energy will monitor the loading of this service and provide additional capacity according to actual load plus expected new loads.

Options for serving the new chiller plant were discussed with Xcel Energy. The options were:

a. Extend the 4160 system campus owned system
b. Extend the 13800 system campus owned system
c. A new Xcel Energy 13800 or 480 volt service.

The new service option is not allowed via Xcel Energy's rules for primary services. Since the Campus has a primary service, all loads must be supplied by the primary service until the primary service reaches maximum capacity. The extension of the 4160 system is not recommended or preferred because of the transformer situation described above. Thus the extension of the13800 volt system is selected.

Service to the standalone option shall originate in a new 13800 volt switch/fuse section which will be added to the existing 13800 volt campus owned service equipment. The new 13800 volt switch/fuse section will be provided by the proposed 5 kV switchgear replacement project. A new feeder will be routed through new or existing ductbanks to the proposed chiller plant location. Refer to Appendix E1 for locations of new ductbanks. The new feeder will terminate in a new 13800 volt switch/fuse equipment at proposed plant. The switch/fuse will supply a 3750 kVA 13800 volt to 480 volt transformer and associated 480 volt distribution equipment. The chillers and related equipment will be supplied at 480 volts. The switch/fuse equipment and transformer will be located in an outdoor equipment yard.

Service to the Student Union option shall originate in a new 13800 volt switch/fuse section which will be added to the existing 13800 volt campus owned service equipment. The new 13800 volt switch/fuse section will be provided by the proposed 5 kV switchgear replacement project. A new feeder will be routed through new or existing ductbanks to the proposed chiller plant location. The new ductbank for the 13800 volt cabling will be provided by the project that brings 4160 volt cabling to the Student Union. Refer to Appendix E2 for locations of new ductbanks. The new feeder will terminate in a new 13800 volt switch/fuse equipment at proposed plant. The switch/fuse will supply a 3750 kVA 13800 volt to 480 volt transformer and associated 480 volt distribution equipment. The chillers and related equipment will be supplied at 480 volts. Based on the proposed site development of the Student Union and the location of the main electrical room, this will require all major electrical equipment to be located indoors.

Signal cabling for the standalone option shall be dedicated fiber optic cabling from the new building back to the hubs in the Library Building and Wing Building. Dedicated copper telephone cabling will be from the new building back to the telephone equipment in the Main Building. This will require a new signal ductbank from manhole 44 to the new building and due to limited space in the existing signal ductbank, an additional signal ductbank will be built from manhole 30 to 33.

Signal cabling in the Student Union option will be part of the Student Union building project.

Chiller Starter/Voltage Options

The following is a comparison of 480 volt vs 4160 volt chillers with solid state or variable speed drive starters. The first cost difference of $205,000 between a 4160 volt variable speed drive compared to the solid state starter is significantly greater than the first cost difference of $40,000 between a 480 volt variable speed drive compared to a solid state starter. There is also a premium cost of $70,000 for both a 480 volt transformer and 4160 volt transformer that would be required if 4160 volt power is used for the chillers. The campus is also better suited to provide maintenance for 480 volt systems versus 4160 volt systems.

A basic energy analysis indicates that there is a simple payback of about 3 years for the 480 volt variable speed drive compared to a solid state starter. The comparison indicates that a 480 volt chiller with a variable speed drive is recommended for this project.

			KW/TON				
TONS	**VOLTAGE**	**STARTER**	**MAX**	**IPLV**	**CHILLER COST**		
1200	480	VFD	0.559	0.345	$	320,000	
1200	480	SOLID STATE	0.544	0.458	$	280,000	
1200	4160	VFD	0.558	0.340	$	520,000	(Note 1)
1200	4160	SOLID STATE	0.544	0.458	$	315,000	

STARTER COMPARISON

1200	480	VFD	0.559	0.345	$	320,000	
1200	480	SOLID STATE	0.544	0.458	$	280,000	
			0.015	(0.113)	$	40,000	
				1200			
				(135.60)	KW		
				1000	Hours/yr		
				(135,600)	KW/yr		
				0.09351	$/kw		(Note 2)
			$	(12,679.96)	$/yr		
			PAYBACK FOR VFD			-3.2	years

VOLTAGE COMPARISON

1200	480	VFD	0.559	0.345	$	320,000	
1200	4160	VFD	0.558	0.340	$	520,000	(Note 1)
			0.001	0.005	$	(200,000)	
				1200			
				6.00	KW		
				1000	Hours/yr		
				6,000	KW/yr		
				0.09351	$/kw		
			$	561.06	$/yr		
Note:			PAYBACK FOR 4160V			-356	years

1) Includes related electrical costs of $70,000 for second transformer
2) Energy rate is a blended rate which includes demand. Rate is taken from Existing Chiller Plant billings. See Appendix -C

Plant Location

The scope of the study required evaluation of two locations for a new plant; Location-1 North West site and Location-2 within the new Student Union or Cowley buildings (see Appendix F).

Location 1

The identified North West site is located immediately south of Farwell Street between Forest Avenue and 14th Street and would be a new standalone plant. This site was removed from consideration during the course of this study when it was determined that the site would be a prime location for a future planned residence hall.

The study then focused on a plant located in parking lot R-1 between Angell Hall and the Health Science Center. This location reduced overall utility infrastructure upgrade costs from the original North West site and also could incorporate the extension of 14th Street in accordance with the campus master plan. There would be a loss of approximately 64 surface parking stalls at this location. These stalls would be relocated to the recently acquired property being reserved for a future residence hall. Since the future residence hall may be constructed in the near future the parking lot would be maintained as a gravel lot.

The North West plant would be a slab on grade with service access from Badger Street. The site would be able to accommodate the option for thermal storage.

The site should be investigated further to determine if there may be old abandoned foundations in the area that require removal. It is anticipated that if there are any abandoned foundations they are relatively small and would not have a significant budget impact.

Location 2

Both the Union and Cowley were identified as possible locations for the new chilled water plant. Both facilities pre-design reports did not accommodate any space in their planning for the plant. The Union is scheduled to be the first building to be constructed. It was determined there would be an immediate need for cooling when the Union is being constructed so the chiller plant would need to be constructed in the Union.

Space in the Union and space on the Union site has been accounted for during the pre-design process. Additional space underground, below the loading dock area is targeted as the only viable space available to accommodate a potential plant. The structure is anticipated to require an excavation approaching 25 feet that will require significant soil retention to protect nearby structures and utilities. This is anticipated to be about 5 to 10 feet lower than the proposed buildings lowest level. Additional area well access to the lower level would be provided in order to install a potential 3rd chiller and or replace an existing chiller. The size of this access will determine if the chillers will need to come disassembled to be reassembled in the lower level. Disassembly and reassembly of the chillers is a premium cost of this location.

Approximately 3000 square feet of programed building space would be lost even considering the construction of additional underground space. Additional square footage in the below grade level would be required for equipment access and service access. Of prime concern is the ongoing need to provide significant quantities of brine salt for the cooling tower water softeners to the underground equipment room. Some type of elevator or hoist would be required to provide efficient material handling.

Cooling towers would be located on the roof of the building with vertical shafts required for pipe and power connections. The towers would be screened and would be located above the mechanical located on the roof. The building structure would be enhanced to accommodate the cooling tower loads.

Chilled Water Distribution Hydraulic Analysis

Evaluation of the hydraulic performance of the existing and proposed chilled water pipe distribution system was completed using the AFT Fathom pipe flow analysis program. Several additional variations of the distribution systems were modeled for the Northwest plant location and the Union plant location to determine the most cost effective solutions.

The existing system model identified two areas of high velocity (greater than 10 FPS), one in the 4” branch mains to the Alumni Building and another in the first 400 feet of 18” main piping exiting the existing plant.

The flow model for the Northwest and the Union building plant locations were generated based on existing and projected building loads. The model indicated that the Northwest plant location would require 20 horsepower less distribution pumping than the Union site. This equates to an estimated annual energy savings of approximately $2,000 per year. This savings is taken into account in the life cycle cost analysis.

Proposed new underground distribution piping for both options is indicated on drawings in Appendix F.

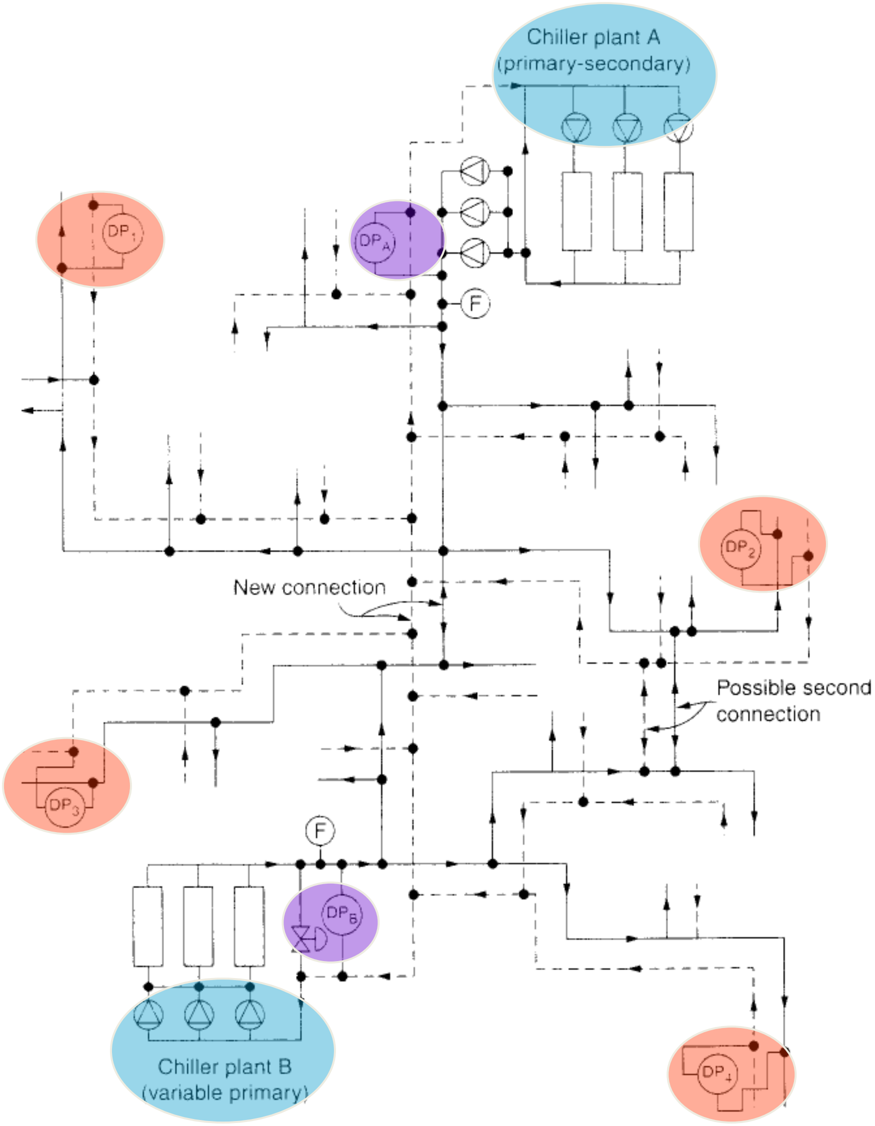
As part of this project consideration was given to installing valved and capped connections at this time for future extension to future buildings and buildings which will be air conditioned in the future. It was determined that this should be deferred until projects are actually occurring in order to locate the connections where best suited for the specific application. Capped connections for the proposed New Student Union and Cowley would however be provided as indicated on Drawing F-2 for Options 1A & 1B.

Condenser Water Pumping

Condenser water pumping is based on 3 gpm/ton for the new plant. Pumping energy for the Union plant will be more than the Northwest plant due to the location of the cooling towers on the roof of the Union. The cooling towers are estimated to be approximately 500 feet further than at the Northwest plant. The additional energy cost is estimated to be $2,000 per year.

Multi-Plant Operation

Control of the distribution pumping for the two plants would be set up as indicated in the following diagram.



With two plants tied together one plant would be designated as a “Trim Plant (varying flow/varying load)” and the other plant would be designated as the “Base” plant (constant flow/constant load)”. The “Trim” plant would vary to meet campus demands while the “Base” plant would push out a fixed flow and demand. Both the existing and new plants would be set up so they could operate as either a “Trim” plant or a “Base” plant as conditions would dictate. The trim plant is chiller plant B in the diagram. The base plant is chiller plant A in the diagram.

It is anticipated that the new plant would operate as the “Trim Plant” to take benefit of the efficiency of the variable speed chillers and the variable primary pumping. The existing plant would normally operate as the “Base Plant”. The “Base” plant would not operate until the “Trim” plant reached its capacity. This dispatch of the chillers is the basis of the energy analysis as indicated in Appendix “B”. The existing plant is arranged in a constant flow primary-variable flow secondary configuration.

The new plant would be set up with a variable primary flow configuration. Primary pumps would pump through the chillers as well as serving as system distribution pumps. Flow would vary through the chillers. Minimum flow would be maintained thru the chillers via a minimum flow bypass control valve. The variable primary pumping arrangement reduces the number of pumps and related maintenance as well as saving energy by varying the flow thru the chiller when compared to the primary–secondary arrangement of the existing plant.

A flow meter in the main piping exiting the “Trim” plant would modulate its respective distribution pumps to maintain the system differential set point in the outlying buildings. The flow meter in the main piping exiting the “Base” plant would modulate its respective distribution pumps to maintain a fixed flow from the plant that corresponds to the flow of the respective number of chillers operating. If the plants are switched from “Trim” plant to Base” plant the pump control would also switch.

Differential pressure would be monitored at multiple key points by the Andover Facility Management System in the system due to the varying dynamics of the system. Sensors that were not satisfied would reset the differential pressure set point across the distribution pump(s) in the “Trim” plant.

In the existing plant metering would be added to each chiller and controls would be upgraded to operate as either a “Trim” or “Base” plant.

The following buildings currently served with chilled water are not equipped with flow meters and would have flow meters installed:

- Health Science Center
- Whitney Center
- Eagle Recreation Center
- Wimberly Hall
- Police and Parking Office
- Alumni Center
- Murphy Library (2 services)
- Morris Hall
- Wing Tech Center
- Graff Hall
- MVAC
- Cowley Hall

The following three-way valves would be changed out to 2-way valves:

Wing	AHU-3	1 ¼”	Pneumatic
Wing	AHU-4	1”	Pneumatic
Cleary	AH1	1 ½”	Electric
Cleary	AH2 & 3	2”	Electric
Cleary	AH4	1”	Electric
Cleary	AH5	3/4”	Electric

Environmental

Sound

The City of La Crosse has a sound ordinance (see Appendix H-1). The area of the northwest plant due to its proximity to nearby residences and the fact it is adjacent to residence halls and other buildings for practical purposes should be designed to meet the residential district sound requirements.

The Union site due to proximity to residence halls would be treated similar to the northwest site. Due to its location in the basement of the Union chiller sound will be less but sound from the cooling towers on the roof will need to be evaluated.

Hazardous Materials

A Screening Level Hazardous Material Assessment Report was prepared by Bloom Companies, LLC. The summary is located in Appendix H-2. The full 290 page report is not included but is available for review if requested.

No sources of contaminants in soil were identified near the northwest end of campus in the vicinity of the proposed chiller construction. Depth to groundwater in the area of proposed construction is approximately 40-45 feet. No dewatering is anticipated and if impacted groundwater is present, it is unlikely to be encountered during construction because the depth to groundwater exceeds the depth of construction. No issues related to known sources of contamination are anticipated during construction.

There are two sites of interest near the Union site. Both sites appear to be located at a distance from the alternate construction site such that they should not be a concern.

The first site is Reuter Hall at 619 N 19th Street, northeast of the union, where a 14,930 gallon fuel oil UST was removed on August 28, 1991. No information indicating contaminants were present at this location was found. This site is indicated as “3” on the EDR Map (See Appendix H-4).

The second site was the location of soil contamination from an underground storage tank. The site is described as the UW-La Crosse heating plant, located at 18th and Pine Street according to WDNR records (BRRTS on the Web) and located at 1725 State Street according to Department of Safety and Professional Services (DSPS Tracker on Web). Both addresses share common site identification numbers, so although the address is not the same, the information is for a single site. The tank contents and subsequent contaminant type are not indicated in the information online. The site received regulatory closure in October of 1998 indicating the impacts were no longer a threat to human health and the environment. The approximate location of the former UST was indicated by WDNR on the DNR RR Sites Map.

It appears that neither of the sites will be a concern for construction at the Union site.

A map indicating the location of environmental sites is located in Appendix H-3 &H-4.

Storm Water

A Storm Water Assessment Overview was prepared by Bloom Companies, LLC. The summary memo of their findings is located in Appendix H-4. The cost for upgrading the existing 12" Storm at the northwest site is included in the scope of this work.

Basis of Comparison of Options

Based on the load projections for an additional 2,995 tons the recommended approach is to install two 1200 ton chillers (under all options) as part of an initial project. All plant options are budgeted to have the space and infrastructure sized for an ultimate 3600 ton plant. Constructing the space for the future for all options is due to the need to construct the equipment space in the Union for Option-2A & 2B immediately since expansion at the Union location is not considered viable.

The 595 ton balance of the estimated future 2995 ton load could be significantly affected by any of the following factors:

- A deferral or delay in the air conditioning of targeted existing buildings.
- A potential credit of several hundred tons of cooling required by the new Cowley building if a heat recovery chiller system is implemented for the building.
- Campus building efficiency improvements.

If the 595 tons of cooling demand is confirmed to be required the load would be handled by one of the following:

- Install a third 1200 ton chiller in the new plant.
- Add a thermal storage tank. Improved metering and data recording made possible by the initial project would provide accurate load profiles.to better predict the viability of this approach.

The energy analysis for all options is based on a campus load of 6000 tons with the new plant providing 2400 tons and the existing plant providing 3600 tons. The analysis is based on the new plant operating as the trim plant and the existing plant operating as a base load plant. The analysis also anticipates that the new plant would operate when load dictates operation of a single plant.

Basis of Energy Analysis

New Chiller Plant	**Option 1A** Standard Chiller Plant Tons	**Option 1B** Standard Chiller Plant with Thermal Storage. Tons	**Option 2A** Standard Chiller Plant Tons	**Option 2B** Standard Chiller Plant (Heat Recovery and Geothermal Field) Tons
Chiller #4	1200	1200	1200	1200
Chiller #5	1200	1200	1200	1200
Chiller #6 (Future)	1200	1200	1200	1200
Total	3600	3600	3600	3600

Tons	Cooling Energy	Heating Energy	Cooling Energy	Heating Energy	Cooling Energy	Heating Energy	Cooling Energy	Heating Energy
Electric Chillers 2400 Tons	Electric Chiller		Electric Chiller		Electric Chiller		Electric Chiller	
Geothermal (Equivalent 102 Tons)	Elec Chiller	Steam	Elec Chiller	Steam	Elec Chiller	Steam	Geothermal	Geothermal
Thermal Storage (Equivalent 600 tons with 7200 Ton-hrs Storage)	Elec Chiller		Thermal Storage		Elec Chiller		Elec Chiller	

Estimated Energy Consumption Comparison

	Cooling & Heating	Cooling & Heating	Cooling & Heating	Cooling & Heating
Chillers				
Electricity	$ 350,812	$ 350,812	$ 354,812	$ 354,812
Geothermal				
Electricity	$ 18,836	$ 18,836	$ 18,836	$ 38,899
Steam	$ 39,932	$ 39,932	$ 39,932	$ -
Thermal Storage				
Electricity	$ -	$ (57,533)	$ -	$ -
Total	$ 409,580	$ 352,047	$ 413,580	$ 393,711

Thermal Storage Analysis

Option 1B required the evaluation of a thermal storage component that could be incorporated into the new Northwest Plant site along with a new chiller plant. The Northwest plant site would need to accommodate the space for the thermal storage tank and related system equipment.

Based on a review of the campus master plan parking lot R1 would have the additional space for the storage tank but there would be a loss of parking spaces and revenue.

Due to the timing of this report field data for determining a campus daily load profile during the June, July and August peak cooling months could not be obtained. For the purpose of analyzing and sizing a thermal storage system average on and off peak tonnages were derived from the metered energy usage of the existing chiller plant (see Appendix C). The average consumptions do not represent an exact campus hourly load profile but it does provide some indication of the potential benefit of thermal storage and system size.

Based on the Campus Load Projections of 6595 tons and proposed initial chiller tonnage of 6000 tons it is suggested that a thermal storage system that can shave 600 tons/hour from the on peak load be planned for. Shaving 600 tons could defer the need to install the future 1200 ton chiller indefinitely. The thermal storage could also defer or eliminate the need to construct a bay for the third 1200 ton chiller in the northwest plant.

The thermal storage energy analysis (see Appendix C) is compared to adding a 600 ton electric chiller. The analysis indicates that there is significant energy savings benefit for shifting to off peak rates and shedding on peak demand.

The basis of the thermal storage is a pre-cast chilled water storage tank of approximately 1,000,000 gallons. The tank would be designed to not require draining during the winter and would not require the use of glycol. An allowance of $300,000 has been included in the analysis for screening of the tank.

The new chilled water plant would charge the tank during off peak hours at off peak energy rates with its excess chiller capacity. During on-peak periods the tank would discharge its cooling capacity (acting as a third campus chiller plant) with separate distribution pumps and meters to reduce utility electric demand charges.

The life cycle cost analysis which follows compares the thermal storage system to an electric chiller. The thermal storage is based on a 7200 ton-hr storage capability and is compared to the life cycle cost of providing 600 tons of additional cooling via an electric chiller. The life cycle cost of the Thermal Storage is $419,290 more than an electric chiller.

It should be noted that there is the potential to achieve a better life cycle cost if more accurate load data is available. There may be more peak shaving available and tank size optimization with better information. It is suggested that thermal storage be re-evaluated in the future in lieu of adding a third 1200 ton chiller when better load data is available.

T L C C WORKSHEET (revised 12/97)

State of Wisconsin, Division of Facilities Development

PROJECT: UW LaCrosse Chilled Water Study

BY: **David Del Ponte**

DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: Thermal Storage
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	Thermal Storage
BOND RATE:	6.00	BOND PD:	20.00	

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Storage Tank	0	0.8459	1.0000	993,000	839,973
2	Asthetic Treatment of Tank	0	0.8459	1.0000	300,000	253,768
3	Site development	0	0.8459	1.0000	148,000	125,192
4	Pump, Piping & Controls	0	0.8459	1.0000	175,000	148,031
5	Fees and Contingency	0	0.8459	1.0000	250,000	211,474
6	Land	0	0.8459	1.0000	10,000	8,459
	TOTAL PV OF INITIAL COST (+) =				1,876,000	1,586,898

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1		0	0.8459	1.0000	0	0
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				0	0

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	5,000	82,832
2.	Sewer /Water	5	16.5664	1.0000	6,000	99,398
3.	Chemicals	5	16.5664	1.0000	7,500	124,248
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				18,500	306,478

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Chiller Inspection	13	0.6006	7,500	4,504
2	Tank Inspection	10	0.6756	4,000	2,702
3	Repair cooling tower	15	0.5553	5,000	2,776
4	Tank Inspection	20	0.4564	4,000	1,826
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			20,500	11,808

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	-57,000	-890,018
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				-57,000	-890,018

RESIDUAL VALUE:		YEAR	USEFUL				
		INSTALLED	LIFE	RPV FAC	PV FAC	COST	PV
1	Storage Tank	0	20	-0.1495	1.0000	-993,000	148,453
2	Aesthetic Treatmer	0	20	-0.1495	1.0000	-300,000	44,850
3	Site Development	0	20	-0.1495	1.0000	-148,000	22,126
4	Piping & Controls	0	20	-0.1495	1.0000	-175,000	26,162
	TOTAL PV OF RESIDUAL VALUE (-) =					-1,168,000	241,592

TOTAL LIFE CYCLE COST = SUM OF PV'S = 1,256,758

TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) = 80,448

NOTES:

1) Need 600 tons more chilling capacity

T L C C WORKSHEET (revised 12/97) **State of Wisconsin, Division of Facilities Development**

PROJECT: UW LaCrosse Chilled Water Study

BY: **David Del Ponte**
DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: Thermal Storage
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	Thermal Storage-Electric
BOND RATE:	6.00	BOND PD:	20.00	

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Additional Mech Space(NW Chiller plant)	0	0.8459	1.0000	100,000	84,589
2	Additional Chiller Capacity (600 tons)	0	0.8459	1.0000	480,000	406,029
3	Fees and Contingency	0	0.8459	1.0000	158,000	133,651
	TOTAL PV OF INITIAL COST (+) =				738,000	624,270

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1		0	0.8459	1.0000	0	0
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				0	0

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	3,000	49,699
2.	Sewer /Water	5	16.5664	1.0000	6,000	99,398
3.	Chemicals	5	16.5664	1.0000	7,500	124,248
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				16,500	273,345

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Chiller Inspection	13	0.6006	7,500	4,504
2	Repair cooling tower	15	0.5553	5,000	2,776
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			12,500	7,281

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	0	0
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				0	0

RESIDUAL VALUE:		YEAR INSTALLED	USEFUL LIFE	RPV FAC	PV FAC	COST	PV
1.	Additional Mech Space(NW Ch	0	40	0.2107	1.0000	-100,000	-21,072
2.	Additional Chiller Capacity (60	0	30	0.0966	1.0000	-480,000	-46,355
	TOTAL PV OF RESIDUAL VALUE (-) =					-580,000	-67,427

TOTAL LIFE CYCLE COST = SUM OF PV'S = 837,468

TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) = 53,608

GEOTHERMAL ANALYSIS

Option 2B required the evaluation of a geothermal component that could be incorporated into the new Union or Cowley buildings along with a new chiller plant. Since the Union and/or Cowley are new they would need to be designed to utilize any heating and cooling capabilities of the geothermal system and accommodate the space for related equipment.

Based on a review of the campus master plan parking lot R3 is the one potential site available for a geothermal field in close proximity to the Union/Cowley sites. A central water to water heat pump and auxiliary pumping would be located in the new Union or Cowley and piped to the field. Other potential sites in the vicinity of Cowley and the Union are considered unavailable due to planned future structures and Well Head Protection Zones. Refer to Appendix D-1 for the extent of the proposed bore field.

Other sites were considered but were not deemed viable for the following reasons:

- Lot R1 - The site is somewhat limited due to the planned extension of 14th street through a portion of this lot. The lot is also not considered viable due to distance from potential new buildings that could effectively and efficiently utilize the available heat.
- Lot R2- This lot is scheduled to be completely re-designed and re-constructed within four years. The lot is also not considered viable due to distance from potential new buildings that could effectively and efficiently utilize the available heat.
- Lot R5 and C7-These lots are planned to remain as parking lots for the next few decades and are considered the only potential buildable sites left on campus.

The total available bore field area in Lot R3 is approximately 33,200 square feet. The analysis of the bore field based on eighty three 300 foot boreholes (see Appendix D-2) indicates the potential for the field to provide approximately 102 tons of cooling and 1169 MBH of heating.

Based on the Campus Load Projections of 6595 tons the geothermal system has the potential to reduce the chiller plant requirement by approximately 1.5%. This reduction would be applicable to all options. Because chillers for the new plant will be in the 1200 ton range and nominal incremental size increases of chillers of this size are 200 tons the geothermal system is not a significant driver to reduce the chiller plant size.

An energy analysis of the geothermal system compared to an electric chiller with steam heat (see Appendix D-3) indicates an estimated annual energy savings of approximately $19,869 with the geothermal system. This is estimated to provide an approximate 31 year simple payback for the premium cost of $618,750.

The life cycle cost analysis which follows compares the geothermal system to an electric chiller with steam heat. The geothermal option has a $470,899 higher life cycle cost than the electric chiller with steam heat.

T L C C WORKSHEET (revised 12/97) **State of Wisconsin, Division of Facilities Development**

PROJECT: UW LaCrosse Chilled Water Study BY: **David Del Ponte**
DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: Geothermal
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	Geothermal
BOND RATE:	6.00	BOND PD:	20.00	

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Additional Mech Space(150 sf Cowley)	0	0.8459	1.0000	37,500	31,721
2	Geothermal Bores (83)	0	0.8459	1.0000	415,000	351,046
3	Heat Pump (100 tons)	0	0.8459	1.0000	80,000	67,672
4	Underground Distribution Piping (800 Ft)	0	0.8459	1.0000	200,000	169,179
5	Restoration	0	0.8459	1.0000	79,250	67,037
6	Fees and Contingency	0	0.8459	1.0000	160,000	135,343
	TOTAL PV OF INITIAL COST (+) =				971,750	790,277

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1		0	0.8459	1.0000	0	0
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				0	0

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance (Pumps & Heat Pump)	5	16.5664	1.0000	2,000	33,133
2.	Sewer /Water	5	16.5664	1.0000	0	0
3.	Chemicals	5	16.5664	1.0000	0	0
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				2,000	33,133

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Maintenance (Pumps & Heat Pump)	13	0.6006	3,000	1,802
2		15	0.5553	0	0
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			3,000	1,802

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	38,899	607,382
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				38,899	607,382

RESIDUAL VALUE:		YEAR	USEFUL				
		INSTALLED	LIFE	RPV FAC	PV FAC	COST	PV
1.	Building	0	50	0.2728	1.0000	-37,500	-10,230
###		15	15	0.2705	0.5553	0	0
	TOTAL PV OF RESIDUAL VALUE (-) =					-37,500	-10,230

TOTAL LIFE CYCLE COST = SUM OF PV'S = 1,422,364

TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) = 91,048

T L C C WORKSHEET (revised 12/97) **State of Wisconsin, Division of Facilities Development**

PROJECT: UW LaCrosse Chilled Water Study BY: **David Del Ponte**
DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: Geothermal
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	Geothermal -Steam Electric
BOND RATE:	6.00	BOND PD:	20.00	

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Additional Mech Space(150sf Union Chiller p	0	0.8459	1.0000	30,000	25,377
2	Additional Chiller Capacity (100 tons)	0	0.8459	1.0000	80,000	67,672
3	Incremental cooling system size increase	0	0.8459	1.0000	40,000	33,836
4	Incremental heating system size increase	0	0.8459	1.0000	50,000	42,295
5	Fees and Contingency	0	0.8459	1.0000	36,000	30,452
	TOTAL PV OF INITIAL COST (+) =				206,000	174,254

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1		0	0.8459	1.0000	0	0
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				0	0

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	2,000	33,133
2.	Sew er /Water	5	16.5664	1.0000	1,000	16,566
3.	Chemicals	5	16.5664	1.0000	1,200	19,880
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				4,200	69,579

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Maintenance	13	0.6006	2,000	1,201
2		15	0.5553	0	0
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			2,000	1,201

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	18,836	294,112
5	STEAM	0	10.5305	1.0000	39,932	420,503
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				58,768	714,615

RESIDUAL VALUE:		YEAR INSTALLED	USEFUL LIFE	RPV FAC	PV FAC	COST	PV
1.	Building	0	50	0.2728	1.0000	-30,000	-8,184
	TOTAL PV OF RESIDUAL VALUE (-) =					-30,000	-8,184

TOTAL LIFE CYCLE COST = SUM OF PV'S = 951,465

TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) = 60,905

COST ESTIMATE

UW LaCrosse Chiller Plant Study (Project 12H2C) - Budget Summary

Project Estimate-Per Study

Construction	Option 1A	Option 1B	Option 2A	Option 2B
General	$ 2,515,000	$ 2,515,000	$ 2,458,000	$ 2,458,000
Plumbing	$ 240,000	$ 240,000	$ 270,000	$ 270,000
Mechanical	$ 2,730,000	$ 2,730,000	$ 3,010,000	$ 3,010,000
Electrical	$ 1,036,000	$ 1,036,000	$ 1,083,000	$ 1,083,000
Thermal Storage	$ -	$ 1,626,000	$ -	$ -
Geothermal	$ -	$ -	$ -	$ 811,750
Total Construction	$ 6,521,000	$ 8,147,000	$ 6,821,000	$ 7,632,750
A/E Design Fee	$ 521,680	$ 651,760	$ 545,680	$ 610,620
Other Fees				
EIA	$ 15,000	$ 15,000	$ 15,000	$ 15,000
Reimbursables				
Plan Approvals	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Survey	$ 15,000	$ 15,000	$ 5,000	$ 10,000
Soil Borings	$ 10,000	$ 15,000	$ -	$ 6,000
DFD Management 4%	$ 284,316	$ 355,209	$ 297,396	$ 332,788
Contingency 9%	$ 586,890	$ 733,230	$ 613,890	$ 686,948
Total	$ 7,958,886	$ 9,937,199	$ 8,302,966	$ 9,299,105

Construction Estimate

Budget Item	Option 1A - NW Plant	Option 1B - NW Plant W/ Thermal Storage	Option 2A - Union Plant	Option 2B - Union Plant w/GeoThermal
Site Work-Plant				
Vehicle/Pedestrian Signage	$ 2,000	$ 2,000	$ -	$ -
Relocate Overhead Utilities	$ 10,000	$ 10,000		
Erosion Control	$ 5,000	$ 5,000	$ -	$ -
Fencing	$ 5,000	$ 5,000	$ -	$ -
Dewatering	$ -	$ -	$ 2,500	$ 2,500
Demo Landscape	$ 3,500	$ 3,500	$ -	$ -
Demo Hardscape	$ 12,500	$ 12,500	$ -	$ -
Total Site Work-Plant	$ 38,000	$ 38,000	$ 2,500	$ 2,500
Plant				
Excavation/Backfill	$ 35,000	$ 35,000	$ 122,000	$ 122,000
Soil Retention	$ -	$ -	$ 295,000	$ 295,000
Concrete	$ 85,000	$ 85,000	$ 342,000	$ 342,000
Masonry	$ 350,000	$ 350,000	$ 25,000	$ 25,000
Structural Steel	$ 280,000	$ 280,000	$ 210,000	$ 210,000
Cooling Tower Screen/Louvers/Flashing	$ 210,000	$ 210,000	$ 210,000	$ 210,000
Stair	$ 60,000	$ 60,000	$ 20,000	$ 20,000
Roofing	$ 102,000	$ 102,000	$ -	$ -
Waterproofing	$ 10,000	$ 10,000	$ 94,200	$ 94,200
Windows	$ 30,000	$ 30,000	$ -	$ -
Overhead Door/Doors	$ 60,000	$ 60,000	$ 35,000	$ 35,000
Interior Finishes	$ 55,000	$ 55,000	$ 75,000	$ 75,000
Misc (Control room, Pipe Shafts, etc.)	$ 125,000	$ 125,000	$ 115,000	$ 115,000
Floor Hatch and Hoist	$ -	$ -	$ 35,000	$ 35,000
Lost Parking spaces	$ 12,800	$ 12,800		
Lost Floor Space				
Storage (2300sf) @ $200/sf	$ -	$ -	$ 460,000	$ 460,000
Service Access (400sf) @ $200/sf			$ 80,000	$ 80,000
Pipe Shafts (40sf/flr=120sf) @ $240/sf	$ -	$ -	$ 28,800	$ 28,800
South Electric Room (220 sf) @ $200/sf	$ -	$ -	$ 44,000	$ 44,000
Total Plant	$ 1,414,800	$ 1,414,800	$ 2,191,000	$ 2,191,000
Plant Utilities				
Water	$ 22,500	$ 22,500	$ 22,500	$ 22,500
Storm Sewer	$ 10,500	$ 10,500	$ -	$ -
Upsize 12" storm sewer	$ 78,000	$ 78,000	$ -	$ -
Sanitary Sewer	$ 10,500	$ 10,500	$ 10,500	$ 10,500
Total Plant Utiliites	$ 121,500	$ 121,500	$ 33,000	$ 33,000
Landscape-Plant				
Curbs	$ 5,000	$ 5,000	$ -	$ -
Asphalt Pavements	$ 4,000	$ 4,000	$ -	$ -
Concrete Pavements	$ 15,000	$ 15,000	$ -	$ -
Plants	$ 3,000	$ 3,000	$ -	$ -
Sod	$ 5,000	$ 5,000	$ -	$ -
Total Landscape-Plant	$ 32,000	$ 32,000	$ -	$ -

Site Work-Chilled Water Distribution

Vehicle/Pedestrian Signage	$ 6,000	$ 6,000	$ 2,000	$ 2,000
Erosion Control	$ 25,000	$ 25,000	$ 8,000	$ 8,000
Fencing	$ 15,000	$ 15,000	$ 5,000	$ 5,000
Dewatering	$ 5,000	$ 5,000	$ 1,500	$ 1,500
Demo Landscape	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Demo Hardscape	$ 16,000	$ 16,000	$ 9,500	$ 9,500
Total Site Work-Distribution	$ 72,000	$ 72,000	$ 31,000	$ 31,000

Chilled Water Distribution

Excavation, Pipe, Backfill	$ 205,000	$ 205,000	$ 190,000	$ 190,000
Soil Retention	$ 20,000	$ 20,000	$ 10,000	$ 10,000
Total Chilled Water Distribution	$ 225,000	$ 225,000	$ 200,000	$ 200,000

Landscape-Chilled Water Distribution

Curbs	$ 23,000	$ 23,000	$ 15,410	$ 15,410
Asphalt Pavements	$ 5,000	$ 5,000	$ 3,350	$ 3,350
Concrete Pavement/Sidewalk	$ 12,000	$ 12,000	$ 8,040	$ 8,040
Plants	$ 5,000	$ 5,000	$ 3,350	$ 3,350
Sod	$ 5,000	$ 5,000	$ 3,350	$ 3,350
Total Landscape-Chille Water Distr	$ 50,000	$ 50,000	$ 33,500	$ 33,500

Site Work-Duct Bank Distribution

Vehicle/Pedestrian Signage	$ 6,000	$ 6,000	$ 2,000	$ 2,000
Erosion Control	$ 25,000	$ 25,000	$ 8,000	$ 8,000
Fencing	$ 15,000	$ 15,000	$ 5,000	$ 5,000
Dewatering	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Demo Landscape	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Demo Hardscape	$ 12,000	$ 12,000	$ 5,500	$ 5,500
Total Site Work-Distribution	$ 68,000	$ 68,000	$ 30,500	$ 30,500

Duct Bank Distribution

Power Ductbank (1200 feet)	$ 264,000	$ 264,000	$ 100,000	$ 100,000
Power Vaults (3)	$ 150,000	$ 150,000	$ 50,000	$ 50,000
Signal Ductbank (650 feet)	$ 143,000	$ 143,000	$ -	$ -
Total Duct Bank Distribution	$ 557,000	$ 557,000	$ 150,000	$ 150,000

Landscape-Duct Bank Distribution

Curbs	$ 10,000	$ 10,000	$ 5,000	$ 5,000
Asphalt Pavements	$ 25,000	$ 25,000	$ 15,000	$ 15,000
Concrete Pavement/Sidewalk	$ 24,000	$ 24,000	$ 10,000	$ 10,000
Plants	$ 2,000	$ 2,000	$ 5,000	$ 5,000
Sod	$ 10,000	$ 10,000	$ 2,000	$ 2,000
Total Landscape-Distribution	$ 71,000	$ 71,000	$ 37,000	$ 37,000

Total General	$ 2,527,800	$ 2,527,800	$ 2,675,500	$ 2,675,500

Plumbing

Plumbing	$ 90,000	$ 90,000	$ 105,000	$ 105,000
Water Treatment	$ 150,000	$ 150,000	$ 150,000	$ 150,000
Fire Protection	$ -	$ -	$ 15,000	$ 15,000
Total Plumbing	$ 240,000	$ 240,000	$ 270,000	$ 270,000

Mechanical

Northwest Plant	$ 1,520,000	$ 1,520,000	$ -	$ -
Student Union Plant	$ -	$ -	$ 1,790,000	$ 1,790,000
Existing Plant (distr. meter, chiller meters)	$ 30,000	$ 30,000	$ 30,000	$ 30,000
3-Way Valve Change out	$ 35,000	$ 35,000	$ 35,000	$ 35,000
Building Meters	$ 65,000	$ 65,000	$ 65,000	$ 65,000
Pre-Bid Chillers (2) 1200 Ton	$ 640,000	$ 640,000	$ 640,000	$ 640,000
Pre-Bid Towers	$ 330,000	$ 330,000	$ 330,000	$ 330,000
Controls (2) 1200 Ton	$ 110,000	$ 110,000	$ 120,000	$ 120,000
Total Mechanical	$ 2,730,000	$ 2,730,000	$ 3,010,000	$ 3,010,000

Electrical

15kv High Voltage Wiring/Equip to Plant	$ 211,000	$ 211,000	$ 210,000	$ 210,000
Add. Primary Conduits to NW Plant	$ 113,000	$ 113,000	$ -	$ -
Add. Primary Conduits in East Avenue	$ -	$ -	$ 48,000	$ 48,000
Add. Prim. Conduits East Ave. to Union	$ -	$ -	$ 24,000	$ 24,000
Add. Signal Conduits	$ 62,000	$ 62,000	$ -	$ -
Telecom	$ 62,000	$ 62,000	$ -	$ -
Building	$ 91,000	$ 91,000	$ 68,000	$ 68,000
Wire Equipment	$ 522,000	$ 522,000	$ 830,000	$ 830,000
Existing Plant	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Total Electrical	$ 1,066,000	$ 1,066,000	$ 1,185,000	$ 1,185,000

Total Base Construction Cost	**$ 6,563,800**	**$ 6,563,800**	**$ 7,140,500**	**$ 7,140,500**
Thermal Stroage Tank w/Site work	**$ -**	**$ 1,626,000**	**$ -**	**$ -**
Geothermal w/Site work	**$ -**	**$ -**	**$ -**	**$ 811,750**
Total Option Construction Cost	**$ 6,563,800**	**$ 8,189,800**	**$ 7,140,500.00**	**$ 7,952,250.00**
Work performed by other projects:				
Lost Parking Spaces	**$ 12,800**	**$ 12,800**	**$ -**	**$ -**
15kV Electrical Switch and related conduits	**$ 30,000**	**$ 30,000**	**$ 30,000**	**$ 30,000**
Duct banks to New Union	**$ -**	**$ -**	**$ 289,500**	**$ 289,500**
Net Total Project Construction Cost	**$ 6,521,000**	**$ 8,147,000**	**$ 6,821,000**	**$ 7,632,750**

Additional Items (Not in Project -For Information Only)

Future Building CW Extension				
Mitchell Hall	$ 170,000	$ 170,000	$ 170,000	$ 170,000
Wittich Hall	$ 40,000	$ 40,000	$ 40,000	$ 40,000
Laux Hall	$ 120,000	$ 120,000	$ 120,000	$ 120,000
White Hall	$ 70,000	$ 70,000	$ 70,000	$ 70,000
Sanford Hall	$ 40,000	$ 40,000	$ 40,000	$ 40,000
SW Dorm Quad	$ 270,000	$ 270,000	$ 270,000	$ 270,000
NW Dorm (Coate & New Res Hall)	$ 145,000	$ 145,000	$ 145,000	$ 145,000
	$ 855,000	$ 855,000	$ 855,000	$ 855,000

Note: The above cost estimates are based on costs as of the date of this report.

LIFE CYCLE COST:

T L C C WORKSHEET (revised 12/97) **State of Wisconsin, Division of Facilities Development**

PROJECT: UW LaCrosse Chilled Water Study

BY: **David Del Ponte**
DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: 1A
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	North West Plant
BOND RATE:	6.00	BOND PD:	20.00	Standard Plant

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Construction	0	0.8459	1.0000	6,563,800	5,552,281
8	Fees and Contingency	0	0.8459	1.0000	1,443,909	1,221,394
10	Other - Land	0	0.8459	1.0000	0	0
	TOTAL PV OF INITIAL COST (+) =				8,007,709	6,773,675

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Roofing and Other	15	0.8459	0.5553	100,000	46,970
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				100,000	46,970

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	12,000	198,796
2.	Sewer /Water	5	16.5664	1.0000	24,000	397,593
3.	Water Treatment/Chemicals	5	16.5664	1.0000	10,000	165,664
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				46,000	762,053

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Chiller Inspection	13	0.6006	50,000	30,029
2	Repair cooling tower	15	0.5553	20,000	11,105
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			70,000	41,134

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	350,812	5,477,700
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				350,812	5,477,700

RESIDUAL VALUE:		YEAR INSTALLED	USEFUL LIFE	RPV FAC	PV FAC	COST	PV
1.	Initial Building	0	50	0.2728	1.0000	-2,553,000	-696,430
2	Equipment	0	30	0.0966	1.0000	-4,028,000	-388,998
3	Roof Rpl	15	15	0.2705	0.5553	-100,000	-15,020
	TOTAL PV OF RESIDUAL VALUE (-) =					-6,681,000	-1,100,449

TOTAL LIFE CYCLE COST = SUM OF PV'S = 12,001,083

TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) = 768,213

T L C C WORKSHEET (revised 12/97) **State of Wisconsin, Division of Facilities Development**

PROJECT: UW LaCrosse Chilled Water Study BY: **David Del Ponte**
DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: 1B
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	North West Plant
BOND RATE:	6.00	BOND PD:	20.00	Standard Plant

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Construction	0	0.8459	1.0000	8,189,800	6,927,705
8	Fees and Contingency	0	0.8459	1.0000	1,796,223	1,519,415
10	Other - Land	0	0.8459	1.0000	0	0
	TOTAL PV OF INITIAL COST (+) =				9,986,023	8,447,119

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Roofing and Other	15	0.8459	0.5553	100,000	46,970
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				100,000	46,970

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	13,000	215,363
2.	Sewer /Water	5	16.5664	1.0000	24,000	397,593
3.	Water Treatment/Chemicals	5	16.5664	1.0000	10,000	165,664
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				47,000	778,619

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Chiller Inspection	13	0.6006	50,000	30,029
2	Repair cooling tower	15	0.5553	20,000	11,105
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			70,000	41,134

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	293,279	4,579,360
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				293,279	4,579,360

RESIDUAL VALUE:		YEAR	USEFUL				
		INSTALLED	LIFE	RPV FAC	PV FAC	COST	PV
1.	Initial Building	0	50	0.2728	1.0000	-2,553,000	-696,430
2	Equipment	0	30	0.0966	1.0000	-5,294,000	-511,260
3	Roof Rpl	15	15	0.2705	0.5553	-100,000	-15,020
	TOTAL PV OF RESIDUAL VALUE (-) =					-7,947,000	-1,222,711

TOTAL LIFE CYCLE COST = SUM OF PV'S = 12,670,491

TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) = 811,063

T L C C WORKSHEET (revised 12/97)

State of Wisconsin, Division of Facilities Development

PROJECT:	UW LaCrosse Chilled Water Study	BY:	**David Del Ponte**
		DATE:	Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: 2A
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	Union Plant
BOND RATE:	6.00	BOND PD:	20.00	

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Construction	0	0.8459	1.0000	7,140,500	6,040,108
8	Fees and Contingency	0	0.8459	1.0000	1,550,211	1,311,315
10	Other - Land	0	0.8459	1.0000	0	0
	TOTAL PV OF INITIAL COST (+) =				8,690,711	7,351,422

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Roofing and Other	15	0.8459	0.5553	0	0
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				0	0

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	15,000	248,495
2.	Sewer /Water	5	16.5664	1.0000	24,000	397,593
3.	Chemicals	5	16.5664	1.0000	10,000	165,664
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				49,000	811,752

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Chiller Inspection	13	0.6006	50,000	30,029
2	Repair cooling tower	15	0.5553	20,000	11,105
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			70,000	41,134

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	354,812	5,540,157
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				354,812	5,540,157

RESIDUAL VALUE:		YEAR INSTALLED	USEFUL LIFE	RPV FAC	PV FAC	COST	PV
1.	Initial Building	0	50	0.2728	1.0000	-1,662,000	-453,375
2	Equipment	0	30	0.0966	1.0000	-4,581,000	-442,404
3	Roof Rpl	15	15	0.2705	0.5553	-100,000	-15,020
	TOTAL PV OF RESIDUAL VALUE (-) =					-6,343,000	-910,799

TOTAL LIFE CYCLE COST = SUM OF PV'S =	12,833,667
TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) =	821,508

T L C C WORKSHEET (revised 12/97) **State of Wisconsin, Division of Facilities Development**

PROJECT: UW LaCrosse Chilled Water Study BY: **David Del Ponte**
DATE: Oct-12

ECON FAC (%)		TIME FAC(YRs)		ALT NO: 2B
GEN INFLA:	4.00	BASE PT:	0.00	SCOPE:
DISC RATE:	4.00	STUDY PD:	25.00	Union Plant
BOND RATE:	6.00	BOND PD:	20.00	

INITIAL COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Construction	0	0.8459	1.0000	7,952,250	6,726,762
8	Fees and Contingency	0	0.8459	1.0000	1,734,601	1,467,289
10	Other - Land	0	0.8459	1.0000	0	0
	TOTAL PV OF INITIAL COST (+) =				9,686,851	8,194,051

REPLACEMENTS COSTS:		YEAR(n)	BPV FAC	PV FAC	COST	PV
1	Roofing and Other	15	0.8459	0.5553	0	0
2		0	0.8459	1.0000	0	0
3		0	0.8459	1.0000	0	0
	TOTAL PV OF REPLACEMENT COST (+) =				0	0

ANNUAL COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	Maintenance	5	16.5664	1.0000	12,000	198,796
2.	Sewer /Water	5	16.5664	1.0000	24,000	397,593
3.	Chemicals	5	16.5664	1.0000	9,000	149,097
	TOTAL PV OF ANNUAL RECURRING COSTS (+/-) =				45,000	745,486

NON-ANNUAL COSTS:		YEAR(n)	PV FAC	COST	PV
1	Chiller Inspection	13	0.6006	50,000	30,029
2	Repair cooling tower	15	0.5553	20,000	11,105
3		0	1.0000	0	0
	TOTAL PV OF NON-ANNUAL COSTS (+/-) =			70,000	41,134

ANNUAL ENERGY COSTS:		ESCAL(%)	SPV FAC	PV FAC	COST/YR1	PV
1	NATURAL GAS	5.8	17.9632	1.0000	0	0
2	LIGHT OIL	7	20.3700	1.0000	0	0
3	COAL	4.4	15.6143	1.0000	0	0
4	ELECTRICITY	4.4	15.6143	1.0000	354,812	5,540,157
5	STEAM	0	10.5305	1.0000	0	0
6	CHILLED WATER	0	10.5305	1.0000	0	0
7	OTHER	0	10.5305	1.0000	0	0
	TOTAL PV OF ENERGY COSTS (+/-) =				354,812	5,540,157

RESIDUAL VALUE:		YEAR INSTALLED	USEFUL LIFE	RPV FAC	PV FAC	COST	PV
1.	Initial Building	0	50	0.2728	1.0000	-1,663,000	-453,648
2	Equipment	0	30	0.0966	1.0000	-5,452,000	-526,519
3	Roof Rpl	15	15	0.2705	0.5553	-100,000	-15,020
	TOTAL PV OF RESIDUAL VALUE (-) =					-7,215,000	-995,187

TOTAL LIFE CYCLE COST = SUM OF PV'S =	13,525,642
TOTAL ANNUAL WORTH = T.L.C.C. X (A/P i, n) =	865,803

APPENDICES

Title / Summary Report

UW LaCrosse - Coate Dorm

Location: La Crosse, Wisconsin

	Alternative - 1
Alternative Description	Alternative - 1
Building Template	College/University
Building Floor Area	78,125 ft²
System #1	Fan Coil
Max Clg Load	119.9 ton
Max Htg Load	1,063.9 MBh
System #2	
Max Clg Load	
Max Htg Load	
Opt Ventilation Clg Load	
Opt Ventilation Htg Load	
Total Building Clg Load	119.9 ton
Total Building Htg Load	1,063.9 MBh
Plant #1	
Clg Equipment Type #1	Centrifugal 2-Stage w/ Var Freq Dr
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	Purchased district steam
Plant #2	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
MAU Plant #3	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
Building Clg Coil Load	155,472 ton·hrs/year
Building Htg Coil Load	-326,321 kBtu/year
Building Energy Usage	36,702 Btu/ft²·year
Building Energy Cost	1.052 $/ft²·year

Environmental Impact Analysis

	Alt 1
CO2 Impact	4,157,315 lbm/year
SO2 Impact	15,659 gm/year
NOX Impact	8,856 gm/year

Energy Star Building Label Benchmarking Tool

	Alt - 1
Building Floor Area	78,125 ft²
Weekly Operating Hours	58 hrs
Number of Occupants	150 People
Annual Electric Consumption	744,503 kWh
Annual Gas Consumption	0 therms
Annual Oil Consumption	0 therms
Annual Steam Consumption	3,263 therms

Title / Summary Report

UW LaCrosse - Sanford Dorm

Location: La Crosse, Wisconsin

	Alternative - 1
Alternative Description	Alternative - 1
Building Template	College/University
Building Floor Area	46,000 ft^2
System #1	Fan Coil
Max Clg Load	81.6 ton
Max Htg Load	748.7 MBh
System #2	
Max Clg Load	
Max Htg Load	
Opt Ventilation Clg Load	
Opt Ventilation Htg Load	
Total Building Clg Load	81.6 ton
Total Building Htg Load	748.7 MBh
Plant #1	
Clg Equipment Type #1	Centrifugal 2-Stage w/ Var Freq Dr
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	Purchased district steam
Plant #2	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
MAU Plant #3	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
Building Clg Coil Load	99,217 ton·hrs/year
Building Htg Coil Load	-253,581 kBtu/year
Building Energy Usage	39,483 Btu/ft^2·year
Building Energy Cost	1.115 \$/ft^2·year

Environmental Impact Analysis

	Alt 1
CO2 Impact	2,593,041 lbm/year
SO2 Impact	9,767 gm/year
NOX Impact	5,524 gm/year

Energy Star Building Label Benchmarking Tool

	Alt - 1
Building Floor Area	46,000 ft^2
Weekly Operating Hours	58 hrs
Number of Occupants	150 People
Annual Electric Consumption	457,852 kWh
Annual Gas Consumption	0 therms
Annual Oil Consumption	0 therms
Annual Steam Consumption	2,536 therms

Title / Summary Report

UW LaCrosse -Student Union

Location: La Crosse, Wisconsin

	Alternative - 1
Alternative Description	Alternative - 1
Building Template	College/University
Building Floor Area	161,000 ft^2
System #1	Variable Volume Reheat (30% Min Flow Default)
Max Clg Load	702.8 ton
Max Htg Load	7,860.5 MBh
System #2	
Max Clg Load	
Max Htg Load	
Opt Ventilation Clg Load	
Opt Ventilation Htg Load	
Total Building Clg Load	702.8 ton
Total Building Htg Load	7,860.5 MBh
Plant #1	
Clg Equipment Type #1	Centrifugal 2-Stage w/ Var Freq Dr
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	Purchased district steam
Plant #2	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
MAU Plant #3	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
Building Clg Coil Load	376,522 ton·hrs/year
Building Htg Coil Load	-2,601,676 kBtu/year
Building Energy Usage	61,008 Btu/ft^2·year
Building Energy Cost	1.461 \$/ft^2·year

Environmental Impact Analysis

	Alt 1
CO2 Impact	12,965,350 lbm/year
SO2 Impact	48,835 gm/year
NOX Impact	27,619 gm/year

Energy Star Building Label Benchmarking Tool

	Alt - 1
Building Floor Area	161,000 ft^2
Weekly Operating Hours	58 hrs
Number of Occupants	4,835 People
Annual Electric Consumption	2,115,621 kWh
Annual Gas Consumption	0 therms
Annual Oil Consumption	0 therms
Annual Steam Consumption	26,017 therms

Title / Summary Report

UW LaCrosse - Cowley

Location: La Crosse, Wisconsin

	Alternative - 1
Alternative Description	Alternative - 1
Building Template	College/University
Building Floor Area	328,750 ft^2
System #1	Variable Volume Reheat (30% Min Flow Default)
Max Clg Load	1,405.7 ton
Max Htg Load	15,541.4 MBh
System #2	
Max Clg Load	
Max Htg Load	
Opt Ventilation Clg Load	
Opt Ventilation Htg Load	
Total Building Clg Load	1,405.7 ton
Total Building Htg Load	15,541.4 MBh
Plant #1	
Clg Equipment Type #1	Centrifugal 2-Stage w/ Var Freq Dr
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	Purchased district steam
Plant #2	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
MAU Plant #3	
Clg Equipment Type #1	
Clg Equipment Type #2	
Clg Equipment Type #3	
Htg Equipment Type	
Building Clg Coil Load	750,880 ton·hrs/year
Building Htg Coil Load	-4,986,519 kBtu/year
Building Energy Usage	60,037 Btu/ft^2·year
Building Energy Cost	1.457 \$/ft^2·year

Environmental Impact Analysis

	Alt 1
CO2 Impact	26,260,510 lbm/year
SO2 Impact	98,912 gm/year
NOX Impact	55,941 gm/year

Energy Star Building Label Benchmarking Tool

	Alt - 1
Building Floor Area	328,750 ft^2
Weekly Operating Hours	58 hrs
Number of Occupants	9,872 People
Annual Electric Consumption	4,321,921 kWh
Annual Gas Consumption	0 therms
Annual Oil Consumption	0 therms
Annual Steam Consumption	49,864 therms

Campus Chilled Water Load Projections

5-Nov-12

Building Characteristics					Load Based on Occupancy		Load Based on Actual Data and/or Notes Below		Chilled Water Plant Requirements													
Building Name	**Occupancy**	**Space (Existing/Future)**	**Building Area (GSF)**	**% of Building Cooled**	**GSF/Ton**	**Estimated Building Load (Tons)**	**GSF/Ton**	**Estimated Building Load (Tons)**	**Estimated Building Load (Tons)**	**Diversity Factor**	**Plant Load (Tons)**	**Cumulative Plant Load (Tons)**	**Plant Capacity (Tons)**	**Surplus (Deficit)**	**Plant Flow (GPM)**	**Cumulative Plant Flow (GPM)**	**Date Online**	**Connected Load**	**GPR Connected Load**	**PR Connected Load**	**GPR Area (GSF)**	**PR Area (GSF)**
Original 1,200 Ton Chiller		System Gain (2)	N/A					44	44	1.00	44	44	1,152				1997	44	36.5	7.5		
Cowley Hall	Lab (Light)	Existing (4)	176,979	100%	300	590	415	426	426	0.76	322	366	1,152	786	773	773	1997	426	426		176,979	
Wilder Hall	Classroom	Existing (5)	31,955	100%	350	91	350	91	91	0.72	65	432	1,152	720	157	930	1997	91	91		31,955	
Center for the Arts	Theater (Performing Arts)	Existing(6)	117,947	100%	250	472	274	430	430	0.80	343	774	1,152	378	823	1,753	1997	430	430		117,947	
Murphy Library	Library	Existing (6)	92,392	100%	550	168	313	295	168	0.59	100	874	1,152	278	239	1,992	1997	168	168		92,392	
Wimberly Hall	Classroom	Existing (5)	138,643	100%	350	396	555	250	250	0.72	179	1,053	1,152	99	429	2,422	1997	250	250		138,643	
Recreational Eagle's Center	Gym (Recreational Facility)	Existing/Partial (4)	108,738	100%	500	217	N/A	180	180	0.59	107	1,160	1,152	(8)	257	2,678	1997	180	14	166	8,585	100,153
Whitney Center	Food Service Facility	Existing (6)	64,312	100%	250	257	429	150	150	0.80	120	1,279	1,152	(127)	287	2,965	1997	150		150		64,312
Morris Hall	Classroom	Existing (4)	52,677	100%	350	151	241	219	151	0.72	108	1,387	1,152	(235)	259	3,224	1997	151	151		52,677	
Second 1,300 Ton Chiller		System Gain (2)	N/A					44	44	1.00	44	1,431	2,400	969			1999	44	27.6	16.4		
Archaeology Center	Classroom	Existing (4)	9,920	100%	350	28	431	23	23	0.72	16	1,448	2,400	952	40	3,263	1999	23	23		9,920	
Murphy Library Addition	Library	Existing (4)	67,260	100%	550	122	336	200	122	0.59	73	1,520	2,400	880	174	3,438	1999	122	122		67,260	
Health Science Center	Hospital	Existing (4)	150,500	100%	225	669	323	466	466	0.82	383	1,903	2,400	497	919	4,356	2000	466	233	233	75,250	75,250
Wing Technology Center	Classroom	Existing (7)	83,690	100%	350	239	259	323	239	0.72	171	2,074	2,400	326	411	4,767	2001	239	239		83,690	
Graff Main Hall	Office	Existing (6)	153,917	100%	400	385	503	306	306	0.68	207	2,281	2,400	119	496	5,263	2004	306	306		153,917	
Cartwright Center	Food Service Facility	Existing (4)	139,230	100%	250	557	441	316	316	0.80	252	2,533	2,400	(133)	604	5,867	2004	316		316		139,230
Third 1,200 Ton Chiller		System Gain (2)	N/A					44	44	1.00	44	2,577	3,600	1,023			2005	44	24.8	19.2		
Reuter Hall	Residence Hall	Existing (7)	165,421	100%	350	473	567	292	292	0.72	209	2,786	3,600	814	501	6,368	2005	292	292		165,421	
Cleary Alumni Center	Auditorium	Existing (8)	24,628	100%	275	90	224	110	90	0.78	70	2,855	3,600	745	168	6,536	2007	90	90		24,628	
Wilder Hall Demolition	Classroom	Existing (9)	(31,955)	100%	350	(91)	350	(91)	(91)	0.72	(65)	2,790	3,600	810	(157)	6,379	2009	(91)	(91)		(31,955)	
New Stadium	Sports Arena	Existing (3)	44,515	100%	200	223			223	0.25	56	2,846	3,600	754	134	6,513	2009	223	33	189	6,677	37,838
New Academic Building	Classroom	Construction (9)	188,570	100%	350	539	346	545	539	0.72	386	3,231	3,600	369	926	7,439	2011	539	539		188,570	
New Residence Hall	Residence Hall	Construction (10)	228,248	100%	350	652	419	496	496	0.72	355	3,586	3,600	14	852	8,291	2011	496		496		228,248
Police and Parking Offices	Office	2011-13 (14)	8,740	100%	400	22			22	0.68	15	3,601	3,600	(1)	35	8,326	2013	22	22		8,740	
Satellite Chiller Plant two 1200 Ton Chillers		System Gain (19)						64	64	1.00	64	3,665	6,000	2,335			2016	64	29.9	34.1		
Student Union	Food Service Facility	2013-15 (11)	161,000	100%	230	700			700	0.76	532	4,197	6,000	1,803	1,277	9,603	2016	700		700		161,000
New Cowley (Phase I)	Lab (Medium)	2013-15 (13)	179,800	100%	200	899			899	0.81	728	4,925	6,000	1,075	1,748	11,351	2016	899	899		179,800	
Laux Hall	Residence Hall	2015-17 (15)	44,238	100%	350	126			126	0.72	90	5,016	6,000	984	217	11,568	2016	126		126		44,238
West Campus Residence Hall	Residence Hall	2015-17 (21)	112,000	100%	350	320			320	0.72	229	5,245	6,000	755	550	12,117	2016	320		320		112,000
Sanford Hall	Residence Hall	2015-17 (15)	45,095	100%	350	129			129	0.72	92	5,337	6,000	663	221	12,339	2017	129		129		45,095
Wentz Hall	Residence Hall	2017-19 (16)	44,238	100%	350	126			126	0.72	90	5,428	6,000	572	217	12,556	2018	126		126		44,238
White Hall	Residence Hall	2017-19 (16)	39,330	100%	350	112			112	0.72	80	5,508	6,000	492	193	12,749	2019	112		112		39,330
Wittich Hall	Office	2017-19	51,811	100%	400	130			130	0.68	87	5,596	6,000	404	210	12,959	2019	130	130		51,811	
Cowley Hall Demolition	Lab (Light)	2017-19 (13)	(176,979)	100%	300	(590)	415	(426)	(426)	0.76	(322)	5,273	6,000	727	(773)	12,185	2019	(426)	(426)		(176,979)	
New Cowley (Phase II)	Lab (Medium)	2017-19 (13)	148,000	100%	200	740			740	0.81	599	5,873	6,000	127	1,439	13,624	2019	740	740		148,000	
Cartwright Center Demolition	Food Service Facility	Existing	(139,230)	100%	250	(557)	441	(316)	(316)	0.80	(252)	5,621	6,000	379	(604)	13,020	2021	(316)		(316)		(139,230)
Coate Hall	Residence Hall	2019-21 (17)	76,527	100%	400	191			191	0.72	137	5,758	6,000	242	329	13,348	2020	191		191		76,527
Drake Hall	Residence Hall	2019-21 (17)	50,158	100%	350	143			143	0.72	103	5,860	6,000	140	246	13,594	2021	143		143		50,158
Satellite Chiller Plant One 1200 Ton Chiller		System Gain (20)						32	32	1.00	32	5,892	7,200	1,308			2021	32	20.4	11.6		
Mitchell Hall	Office	2019-21 (12)	212,840	70%	400	372			372	0.62	231	6,123	7,200	1,077	554	14,148	2021	372	372		148,988	
Mitchell Hall Addition	Office	2019-21 (12)	50,000	100%	400	125			125	0.62	78	6,200	7,200	1,000	186	14,334	2021	125	125		50,000	
Angell Hall	Residence Hall	2021-23 (18)	76,527	100%	400	191			191	0.72	137	6,337	7,200	863	329	14,663	2022	191		191		76,527
Hutchison Hall	Residence Hall	2021-23 (18)	72,869	100%	400	182			182	0.72	130	6,468	7,200	732	313	14,976	2023	182		182		72,869
Center for the Arts Addition	Theater (Performing Arts)	2019-21	40,000	100%	250	160			160	0.80	128	6,595	7,200	605	306	15,282	2023	160	160		40,000	

9,021 2,994 Additional Tonnage Required

10.0 Degree Delta Tee

Existing Totals	**5,019**	**3,426**	**1,593**	**1,371,296**	**645,031**
Chilled Water GPR/PR Split		**68%**	**32%**	**68%**	**32%**
Future Totals	**9,021**	**5,476**	**3,545**	**1,812,916**	**1,227,783**
Chilled Water GPR/PR Split		**61%**	**39%**	**60%**	**40%**
New Plant Totals	**3,938**	**2,020**	**1,918**	**441,620**	**582,752**
Chilled Water GPR/PR Split		**51%**	**49%**	**43%**	**57%**

🟩	A factor of 96% is applied to the nominal rating of C-1 & C-2. Adjustment based on review of operating log data of chillers on a design day.
🟦	Adjusted gsf/ton based on block calculation of Coates and Sanford Halls. Reduced the square foot per ton slightly for the larger resident halls.
🟥	Based on telephone conversation with Scott Whitney, Henneman Engineers on 10-19-12

Notes:

1. During the summer of 2002 Campus Physical Plant Artifically Restricted Plant Capacity to 1200 tons & Cartwright Chiller to 250 tons and shutting down the HVAC systems in Fine Arts
2. Distribution pump gain estimated at 200 HP = 20 Tons. Piping system gain estimated at 2% of 1200 Tons = 24 Tons.
3. Stadium GSF based on Design Report number.
4. Cowley, Morris, Archaeology, Murphy Addition, Recreational Eagle Center , Health Science, Graff, and Cartwright cooling loads are from coil capacities shown on original building plans.
5. Wilder Hall cooling load is estimated at 350 GSF per ton of cooling
6. Center for the Arts, Murphy Library, Graff Main Hall and Whitney Center cooling loads are equal to their original chiller capacities.
7. Wing Technology and New Reuter Residence Hall cooling loads based on A/E design estimates. Reuter area NIC Basement.
8. Cleary Center load determined by totalling scheduled cooling coil data.
9. New Academic Building's area and cooling load per bid documents. Wilder Hall will be demolished to clear site for new building.
10. New Residence Hall's area and cooling load per bid documents.
11. Student Union's area based on predesign report.
12. Mitchell Hall cooling load assumes 70% of existing building plus 50,000 GSF addition. Gyms & Natatorium are not cooled.
13. Cowley Hall is based on a two phase project. The original building remains until Phase I is complete and is demolished to make way for Phase II. Phase I & Phase II GSF from pre-design report.
14. Parking Structure GSF number based on Design Report.
15. Laux Hall and Sanford Hall proposed in the 2015-17 Biennium.
16. Wentz Hall and White Hall proposed in the 2017-19 Biennium.
17. Coate and Drake Hall estimated in the 2019-21 Biennium.
18. Angell Hall and Hutchinson Hall estimated in the 2021-23 Biennium.
19. Distribution pump gain estimated at 150 HP = 30 Tons. Piping system gain estimated at 2% of 1700 Tons = 34 Tons.
20. Distribution pump gain estimated at 75 HP = 15 Tons. Piping system gain estimated at 2% of 850 Tons = 17 Tons.
21. West Campus Residence Hall proposed in the 2015-17 Biennium.

Appendix-B

Energy Analysis-Chillers

11/5/2012

DESCRIPTION	MAX. TONS	PLANT LOCATION	PUMP ARRANG.	CHILLED WATER DISTRIBUTION GPM	CHILLER VFD	TOWER VFD	
CHILLER NO. 1	1152	EXISTING	P/S	2400	NO	YES	
CHILLER NO. 2	1248	EXISTING	P/S	2400	NO	YES	
CHILLER NO. 3	1200	EXISTING	P/S	2400	NO	NO	
CHILLER NO. 4	1200	NORTHWEST	VPF	2400	YES	YES	
CHILLER NO. 5	1200	NORTHWEST	VPF	2400	YES	YES	
TOTAL	6000			12000			
CHILLER NO. 6	1200	NORTHWEST	VPF	2400	YES	YES	Future

VPF	VARIABLE PRIMARY FLOW
P/S	PRIMARY - SECONDARY FLOW

Plant Dispatch

COND. EWT	AMB. TEMP.	% LOAD	CAMPUS TONS	CHILLER NO. 4		CHILLER NO. 5		CHILLER NO. 3		CHILLER NO. 2		CHILLER NO. 1	
				STATUS	TONS	STATUS	TONS	STATUS	TONS	STATUS	TONS	STATUS	TONS
65	55	0%	0	OFF	0	OFF	0	OFF	0	OFF	0	OFF	0
65	57	5%	300	ON	300	OFF	0	OFF	0	OFF	0	OFF	0
65	59	10%	600	ON	600	OFF	0	OFF	0	OFF	0	OFF	0
65	61	15%	900	ON	900	OFF	0	OFF	0	OFF	0	OFF	0
65	63	20%	1200	ON	1200	OFF	0	OFF	0	OFF	0	OFF	0
65	65	25%	1500	ON	750	ON	750	OFF	0	OFF	0	OFF	0
65	67	30%	1800	ON	900	ON	900	OFF	0	OFF	0	OFF	0
65	69	35%	2100	ON	1050	ON	1050	OFF	0	OFF	0	OFF	0
65	71	40%	2400	ON	1200	ON	1200	OFF	0	OFF	0	OFF	0
65	73	45%	2700	ON	750	ON	750	ON	1200	OFF	0	OFF	0
65	75	50%	3000	ON	900	ON	900	ON	1200	OFF	0	OFF	0
67	77	55%	3300	ON	1050	ON	1050	ON	1200	OFF	0	OFF	0
69	79	60%	3600	ON	1200	ON	1200	ON	1200	OFF	0	OFF	0
71	81	65%	3900	ON	726	ON	726	ON	1200	ON	1248	OFF	0
73	83	70%	4200	ON	876	ON	876	ON	1200	ON	1248	OFF	0
75	85	75%	4500	ON	1026	ON	1026	ON	1200	ON	1248	OFF	0
77	87	80%	4800	ON	1176	ON	1176	ON	1200	ON	1248	OFF	0
79	89	85%	5100	ON	750	ON	750	ON	1200	ON	1248	ON	1152
81	91	90%	5400	ON	900	ON	900	ON	1200	ON	1248	ON	1152
83	93	95%	5700	ON	1050	ON	1050	ON	1200	ON	1248	ON	1152
85	95	100%	6000	ON	1200	ON	1200	ON	1200	ON	1248	ON	1152

🟧	CHILLER IS OFF.
🟩	CHILLER IS ON.
🟦	BYPASS CONTROL VALVE MODULATES TO MAINTAIN MINIMUM FLOW OF 672 GPM.
🟨	CHILLER IS BASED LOADED BY FIXING THE DISTRIBUTION PUMP FLOW TO GPM INDICATED.

CHILLER #4, 5 & 6 PART LOAD PERFORMANCE DATA

			HP	VFD
FULL LOAD TONS:	1200	COOLING TOWER MOTOR:	60	YES
PLANT LOCATION:	NW	VARIABLE PRIMARY PUMP MOTOR:	80	YES
PUMPING ARRANGEMENT	VariPrime	PRIMARY PUMP MOTOR:	NA	NA
DESIGN EVAPORATOR GPM	2400	DISTRIBUTION PUMP MOTOR:	NA	NA
DESIGN CONDENSER GPM	3600	CONDENSER PUMP MOTOR:	75	NO
LEAVING EVAPORATOR TEMP.	44°F	CHILLER VFD:	NA	YES
ENTERING EVAPORATOR TEMP.	56°F			

MANUFACTURER DATA AT 100%, 75% 50% AND 25% LOADS.

PERCENT LOAD	TONS	COND. EWT °F	EVAP. GPM	DISTRIB. GPM	CHILLER KW/TON (1)	CHILLER KW	TOWER KW	VARIABLE PRIMARY PUMP KW	DISTRIB PUMP KW	COND. PUMP KW	TOTAL KW	TOTAL KW/TON
100%	1200	85	2400	2400	0.580	696	48.1	64.2	0.0	60.2	868	0.724
75%	900	85	1800	1800	0.564	508	36.1	48.1	0.0	60.2	652	0.724
50%	600	85	1200	1200	0.612	367	24.1	32.1	0.0	60.2	484	0.806
25%	300	85	672	672	0.854	256	12.0	17.9	0.0	60.2	346	1.154
100%	1200	80	2400	2400	0.524	629	48.1	64.2	0.0	60.2	801	0.668
75%	900	80	1800	1800	0.485	437	36.1	48.1	0.0	60.2	581	0.645
50%	600	80	1200	1200	0.540	324	24.1	32.1	0.0	60.2	440	0.734
25%	300	80	672	672	0.754	226	12.0	17.9	0.0	60.2	316	1.054
100%	1200	75	2400	2400	0.481	577	48.1	64.2	0.0	60.2	750	0.625
75%	900	75	1800	1800	0.415	374	36.1	48.2	0.0	60.2	518	0.575
50%	600	75	1200	1200	0.458	275	24.1	32.1	0.0	60.2	391	0.652
25%	300	75	672	672	0.639	192	12.0	17.9	0.0	60.2	282	0.939
100%	1200	70	2400	2400	0.450	540	48.1	64.2	0.0	60.2	713	0.594
75%	900	70	1800	1800	0.361	325	36.1	48.2	0.0	60.2	469	0.521
50%	600	70	1200	1200	0.366	220	24.1	32.1	0.0	60.2	336	0.560
25%	300	70	672	672	0.523	157	12.0	17.9	0.0	60.2	247	0.823
100%	1200	65	2400	2400	0.420	504	48.1	64.2	0.0	60.2	677	0.564
75%	900	65	1800	1800	0.322	290	36.1	48.2	0.0	60.2	434	0.482
50%	600	65	1200	1200	0.292	175	24.1	32.1	0.0	60.2	292	0.486
25%	300	65	672	672	0.397	119	12.0	17.9	0.0	60.2	209	0.697

1.) Based on Carrier, zero tolerance with VFD.
2) Min Evap flow 672 GPM

Energy Analysis

Chiller #4 Energy

COND. EWT	AMB. TEMP.	% LOAD	CAMPUS TONS	CHILLER NO. 4											
						On Peak (1)					Off Peak				
				STATUS	TONS	KW/TON	KW/Hr	HR/YR	KW/YR	$/YR	KW/TON	KW/Hr	HR/YR	KW/YR	$/YR
65	55	0%	0	OFF	0	0	0	70	0	$ -	0.000	0	144	0	$ -
65	57	5%	300	ON	300	0.697	209	71	14855	$ 1,143	0.697	209	145	30338	$ 2,335
65	59	10%	600	ON	600	0.486	292	71	20700	$ 1,593	0.486	292	145	42275	$ 3,253
65	61	15%	900	ON	900	0.482	434	125	54278	$ 4,177	0.482	434	235	102043	$ 7,853
65	63	20%	1200	ON	1200	0.564	677	125	84563	$ 6,508	0.564	677	235	158978	$ 12,235
65	65	25%	1500	ON	750	0.484	363	94	34122	$ 2,626	0.484	363	151	54813	$ 4,218
65	67	30%	1800	ON	900	0.482	434	95	41251	$ 3,175	0.482	434	152	66002	$ 5,080
65	69	35%	2100	ON	1050	0.523	549	95	52169	$ 4,015	0.523	549	152	83471	$ 6,424
65	71	40%	2400	ON	1200	0.564	677	144	97416	$ 7,497	0.564	677	177	119741	$ 9,215
65	73	45%	2700	ON	750	0.484	363	144	52272	$ 4,023	0.484	363	177	64251	$ 4,945
65	75	50%	3000	ON	900	0.482	434	85	36909	$ 2,841	0.482	434	72	31264	$ 2,406
67	77	55%	3300	ON	1050	0.537	564	85	47927	$ 3,688	0.537	564	72	40597	$ 3,124
69	79	60%	3600	ON	1200	0.590	708	86	60888	$ 4,686	0.590	708	73	51684	$ 3,978
71	81	65%	3900	ON	726	0.560	407	84	34151	$ 2,628	0.560	407	56	22767	$ 1,752
73	83	70%	4200	ON	876	0.550	482	85	40953	$ 3,152	0.550	482	56	26981	$ 2,076
75	85	75%	4500	ON	1026	0.595	610	27	16483	$ 1,269	0.595	610	16	9768	$ 752
77	87	80%	4800	ON	1176	0.645	759	28	21239	$ 1,635	0.645	759	16	12136	$ 934
79	89	85%	5100	ON	750	0.680	510	28	14280	$ 1,099	0.680	510	16	8160	$ 628
81	91	90%	5400	ON	900	0.665	599	13	7781	$ 599	0.665	599	7	4190	$ 322
83	93	95%	5700	ON	1050	0.690	725	13	9419	$ 725	0.690	725	7	5072	$ 390
85	95	100%	6000	ON	1200	0.724	868	4	3474	$ 267	0.724	868	1	868	$ 67
									745,129	**$ 57,345**				**935,397**	**$ 71,988**

Chiller #5 Energy

COND. EWT	AMB. TEMP.	% LOAD	CAMPUS TONS	CHILLER NO. 5											
						On Peak (1)					Off Peak				
				STATUS	TONS/HR	KW/TON	KW/Hr	HR/YR	KW/YR	$/YR	KW/TON	KW/Hr	HR/YR	KW/YR	$/YR
65	55	0%	0	OFF	0	0	0	70	0	$ -	0	0	144	0	$ -
65	57	5%	300	OFF	0	0	0	71	0	$ -	0	0	145	0	$ -
65	59	10%	600	OFF	0	0	0	71	0	$ -	0	0	145	0	$ -
65	61	15%	900	OFF	0	0	0	125	0	$ -	0	0	235	0	$ -
65	63	20%	1200	OFF	0	0	0	125	0	$ -	0	0	235	0	$ -
65	65	25%	1500	ON	750	0.484	363	94	34122	$ 2,626	0.484	363	151	54813	$ 4,218
65	67	30%	1800	ON	900	0.482	434	95	41251	$ 3,175	0.482	434	152	66002	$ 5,080
65	69	35%	2100	ON	1050	0.523	549	95	52169	$ 4,015	0.523	549	152	83471	$ 6,424
65	71	40%	2400	ON	1200	0.564	677	144	97416	$ 7,497	0.564	677	177	119741	$ 9,215
65	73	45%	2700	ON	750	0.484	363	144	52272	$ 4,023	0.484	363	177	64251	$ 4,945
65	75	50%	3000	ON	900	0.482	434	85	36909	$ 2,841	0.482	434	72	31264	$ 2,406
67	77	55%	3300	ON	1050	0.537	564	85	47927	$ 3,688	0.537	564	72	40597	$ 3,124
69	79	60%	3600	ON	1200	0.590	708	86	60888	$ 4,686	0.590	708	73	51684	$ 3,978
71	81	65%	3900	ON	726	0.560	407	84	34151	$ 2,628	0.560	407	56	22767	$ 1,752
73	83	70%	4200	ON	876	0.550	482	85	40953	$ 3,152	0.550	482	56	26981	$ 2,076
75	85	75%	4500	ON	1026	0.595	610	27	16483	$ 1,269	0.595	610	16	9768	$ 752
77	87	80%	4800	ON	1176	0.645	759	28	21239	$ 1,635	0.645	759	16	12136	$ 934
79	89	85%	5100	ON	750	0.680	510	28	14280	$ 1,099	0.680	510	16	8160	$ 628
81	91	90%	5400	ON	900	0.665	599	13	7781	$ 599	0.665	599	7	4190	$ 322
83	93	95%	5700	ON	1050	0.690	725	13	9419	$ 725	0.690	725	7	5072	$ 390
85	95	100%	6000	ON	1200	0.724	868	4	3474	$ 267	0.724	868	1	868	$ 67
									570,733	**$ 43,924**				**601,764**	**$ 46,312**

Notes:

1) All On-Peak energy is charged based on the June thru Sept enrgy rate of $.07536/kw

Demand & Enrgy Credit

Month	Customer Charge	2011-2012 Demand KW	Tonnage Ratio	Demand (On-Peak)			Demand (Distribution)			
				KW (1)	$/KW	$	KW (1)	$/KW	$	
Jan	$ 155	60	0.67	40	7.60	$ 306	40	0.97	$ 39	
Feb	$ 155	42	0.67	28	7.60	$ 214	28	0.97	$ 27	
March	$ 155	2,005	0.67	1,343	7.60	$ 10,209	1,343	0.97	$ 1,303	
April	$ 155	2,098	0.67	1,406	7.60	$ 10,683	1,406	0.97	$ 1,363	
May	$ 155	2,835	0.67	1,899	7.60	$ 14,436	1,899	0.97	$ 1,842	
June	$ 155	2,835	0.67	1,899	9.56	$ 18,159	1,899	0.97	$ 1,842	
July	$ 155	2,835	0.67	1,899	9.56	$ 18,159	1,899	0.97	$ 1,842	
August	$ 155	2,835	0.67	1,899	9.56	$ 18,159	1,899	0.97	$ 1,842	
Sept	$ 155	2,413	0.67	1,617	9.56	$ 15,456	1,617	0.97	$ 1,568	
October	$ 155	2,245	0.67	1,504	7.60	$ 11,432	1,504	0.97	$ 1,459	
November	$ 155	42	0.67	28	7.60	$ 214	28	0.97	$ 27	
December	$ 155	42	0.67	28	7.60	$ 214	28	0.97	$ 27	
	$ 1,860					**$ 117,639**			**$ 13,185**	**$ 130,823**

Energy Credit		
Excess KWH (2)	$/KW	Credit
-	0	$ -
-	0	$ -
-	0	$ -
-	0	$ -
-	0	$ -
128,000	0.008	$ 1,024
192,000	0.008	$ 1,536
-	0	$ -
-	0	$ -
-	0	$ -
-	0	$ -
-	0	$ -
		$ 2,560

Notes:

1) KW demand is based on a ratio of of the new plant tonnage (2400) divided by the existing plant tonnage (3600) multiplied by the existing plant monthly demands for 2011-2012.

2) Excess KWH is an estimate based on Existing plant monthly useage proportioned to the new plant tonnage.

Summary of Charges Primary Service (Campus Owned Transformer)	
Customer Charge	$ 1,860
Demand	
On-Peak	$ 117,639
Distribution	$ 13,185
Energy	
On-Peak	$ 101,269
Off-Peak	$ 118,300
Energy Charge Credit	$ 2,560
Total	**$ 354,812**

Appendix-C
Thermal Storage Analysis

11/26/2012

METERED ELECTRIC DATA AND COST FOR EXISTING CHILLER PLANT

Month	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	TOTAL
On Peak	518,700	405,300	149,100	92,400	4,200	4,200	2,100	4,200	113,400	123,900	275,100	476,700	**2,169,300**
Off Peak	903,000	596,400	184,800	130,200	6,300	6,300	8,400	6,300	113,400	149,100	420,000	850,500	**3,374,700**
KWH	1,421,700	1,001,700	333,900	222,600	10,500	10,500	10,500	10,500	226,800	273,000	695,100	1,327,200	**5,544,000**
Annual Dmd	3,080	2,992	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,835	2,918	3,040	**2,893**
Month Dmd	2,835	2,835	2,413	2,245	42	42	60	42	2,005	2,098	2,835	2,835	**1,691**
Pwr Fctr %	85.75	85.59	83.94	82.53	44.72	55.47	24.25	55.47	79.60	83.10	83.21	83.50	**71**
Total Cost $	$ 107,348.02	$ 86,481.91	$42,707.65	$31,191.76	$3,733.01	$ 3,791.70	$ 3,993.71	$ 3,903.76	$ 31,040.90	$34,049.69	$64,866.16	$ 105,310.54	**$ 518,418.81**
Cents/KWH	7.551	8.634	12.791	14.012	35.552	36.111	38.035	37.179	13.686	12.472	9.332	7.935	**9.351**
%On Peak	36	40	45	42	40	40	20	40	50	45	40	36	**39**

Average On-Peak/Off-Peak Campus Demand Derived from Metered Use

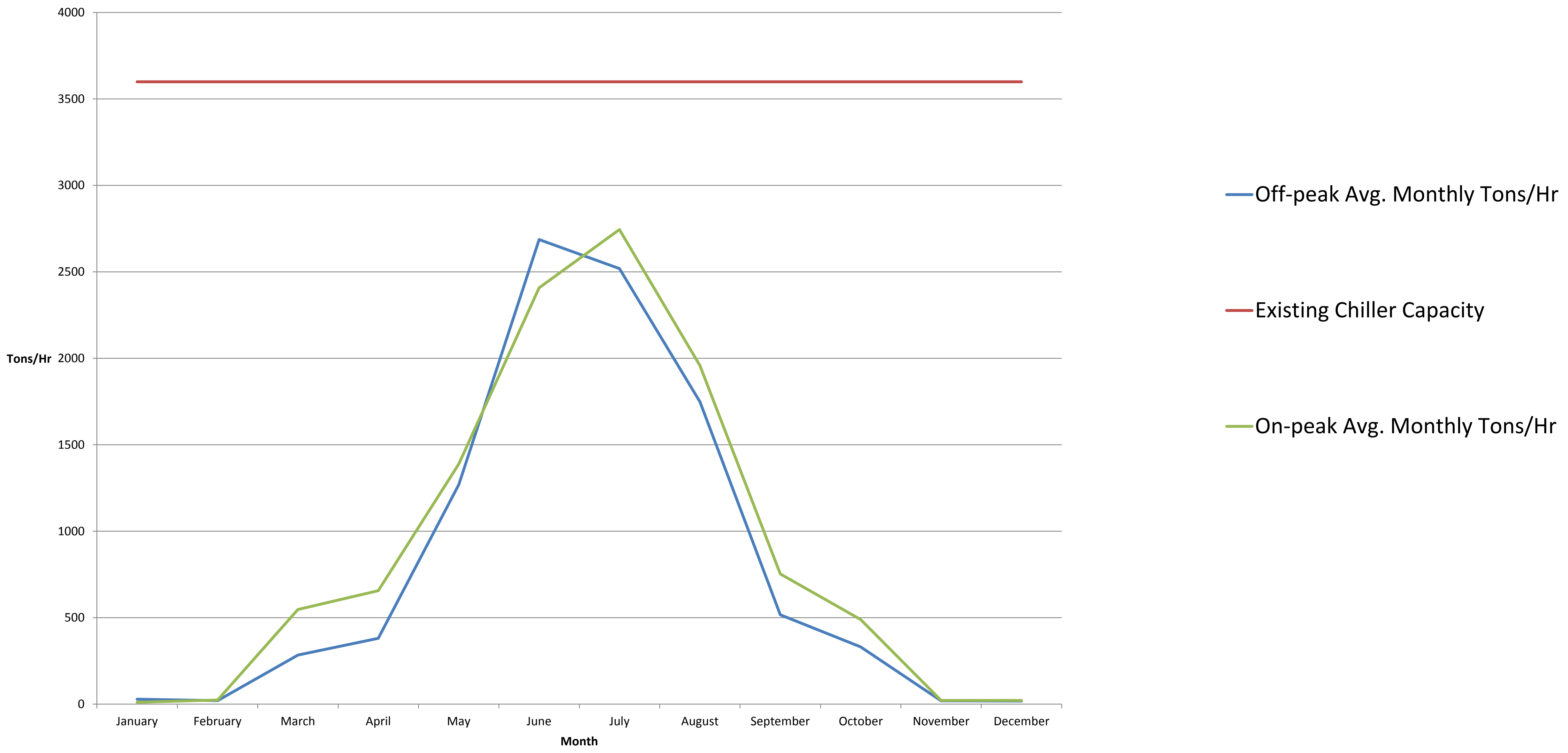
	On-Peak (M-F 9a-9p)					**Off-Peak (Wkend)**			**Off-Peak (9p-9a)**					
Month	**Days/Mon.**	**Hrs/Mon.**	**KWH/mon. (1)**	**avg. KWH**	**Avg Chiller Tonnage**	**Days/Mon.**	**Hrs/Mon.**	**KWH/mon.**	**Days/Mon.**	**Hrs/Mon.**	**KWH/Mon.**	**adj. KWH/mon**	**avg. KWH**	**Avg Chiller Tonnage**
January	21	252	2100	8	11	10	120	1000	31	372	8400	7400	20	28
February	20	240	4200	18	23	8	96	1680	28	336	6300	4620	14	20
March	23	276	113400	411	548	8	96	39443	31	372	113400	73957	199	284
April	21	252	123900	492	656	9	108	53100	30	360	149100	96000	267	381
May	22	264	275100	1042	1389	8	96	100036	30	360	420000	319964	889	1270
June	22	264	476700	1806	2408	8	96	173345	30	360	850500	677155	1881	2687
July	21	252	518700	2058	2744	10	120	247000	31	372	903000	656000	1763	2519
August	23	276	405300	1468	1958	8	96	140974	31	372	596400	455426	1224	1749
September	22	264	149100	565	753	8	96	54218	30	360	184400	130182	362	517
October	21	252	92400	367	489	10	120	44000	31	372	130200	86200	232	331
November	22	264	4200	16	21	8	96	1527	30	360	6300	4773	13	19
December	22	264	4200	16	21	9	108	1718	31	372	6300	4582	12	18

1) KW/month is based on existing chilled water plant billing data

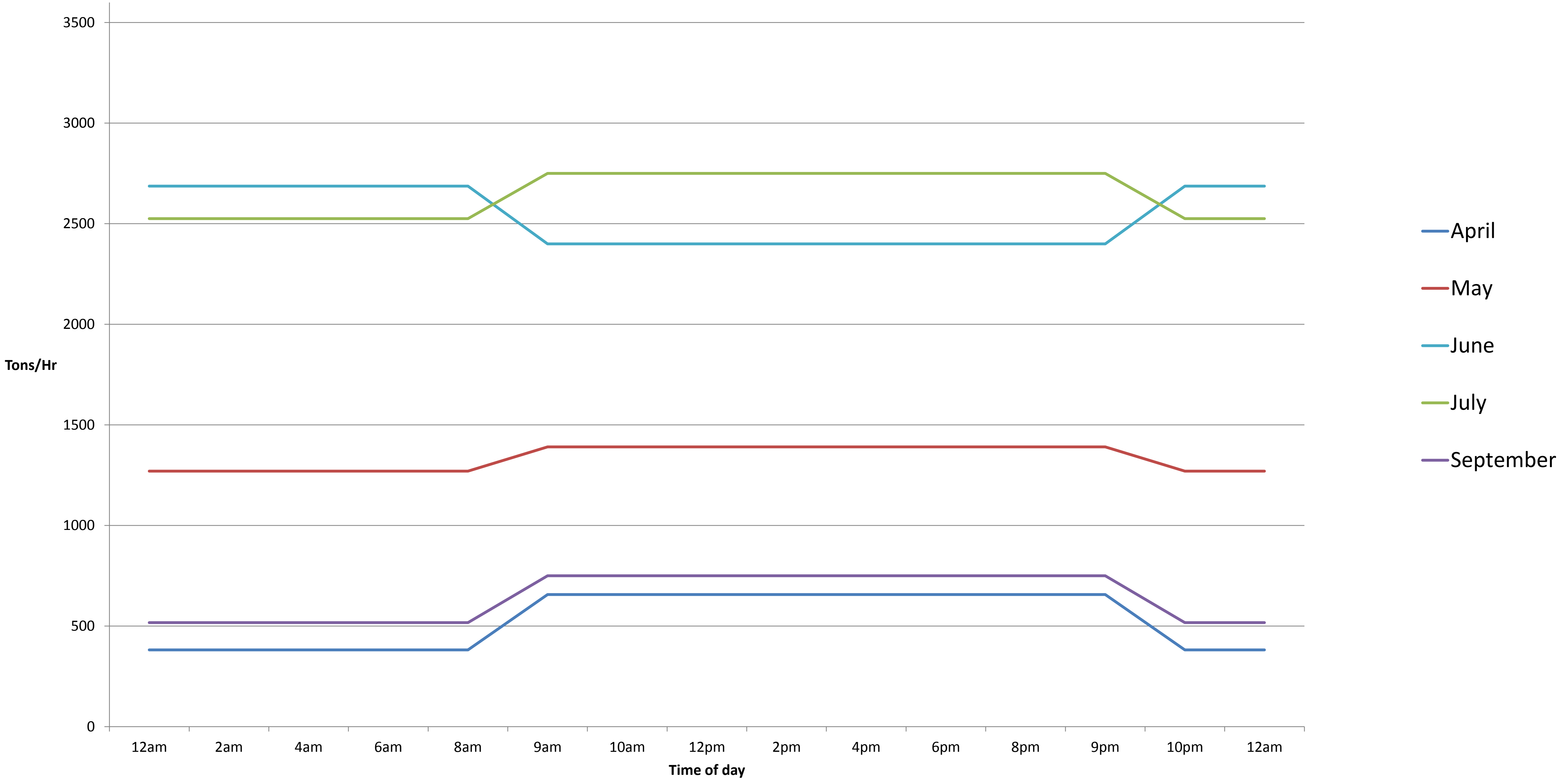
Estimate of Storage Potential

	3600 ton Plant				6000 ton Plant				7200 ton Plant			
Month	Existing Plant Tonnage	Avg Plant Load (Tons)	Avg. Off-Peak Available Tonnage	Shifted Tonnage/Hr (1)	Future Plant Tonnage	Avg Plant Load (Tons) (2)	Avg. Off-Peak Available Tonnage	Shifted Tonnage/Hr (1)	Future Plant Tonnage	Avg Plant Load (Tons) (2)	Avg. Off-Peak Available Tonnage	Shifted Tonnage/Hr (1)
January	3600	28	0	0	6000	47	0	0	7200	57	0	0
February	3600	20	0	0	6000	33	0	0	7200	39	0	0
March	3600	284	3,316	600	6000	473	5527	1000	7200	568	6632	1200
April	3600	381	3,219	600	6000	635	5365	1000	7200	762	6438	1200
May	3600	1270	2,330	600	6000	2117	3883	1000	7200	2539	4661	1200
June	3600	2687	913	600	6000	4479	1521	1000	7200	5374	1826	1200
July	3600	2519	1,081	600	6000	4200	1800	1000	7200	5038	2162	1200
August	3600	1749	1,851	600	6000	2915	3085	1000	7200	3498	3702	1200
September	3600	517	3,083	600	6000	861	5139	1000	7200	1033	6167	1200
October	3600	331	0	0	6000	552	0	0	7200	662	0	0
November	3600	19	0	0	6000	32	0	0	7200	38	0	0
December	3600	18	0	0	6000	29	0	0	7200	35	0	0

1) Shifted tonnage is based on approximately 2/3's of lowest average available off-peak tonnage.
2) Prorated based on 3600 ton plant.



Existing Campus - Average Monthly Load Profile



Existing Campus - Average Daily Load Profile

Potential Thermal Storage Savings

600 ton /hr Shifted

(Aproximately 1,000,000 Gallons)

		Shifted Tonnage On-Peak Savings				Demand On-Peak Savings			Demand Distribution Savings			Shifted Tonnage Off-Peak Costs			
Month	**Shifted Tonnage/Hrs.**	**Hrs/Mon.**	**On-Peak KWH/Ton (1)**	**On-Peak $/KWH**	**On-Peak $/Mon.**	**KW/Mon.**	**$/KW**	**Demand $/Mon.**	**KW/Mon.**	**$/KW**	**$/Mon.**	**Hrs/Mon.**	**Off-Peak KW/Ton (2)**	**Off-Peak $/KW**	**Off-Peak $/Mon.**
January	0	252	0	0.0754	$0	0	7.60	$ -	480	0.97	$466	372	0	0.04447	$0
February	0	240	0	0.0754	$0	0	7.60	$ -	480	0.97	$466	336	0	0.04447	$0
March	600	276	0.76	0.0754	$9,516	457.5	7.60	$ 3,477	457.5	0.97	$444	372	0.55	0.04447	$5,459
April	600	252	0.76	0.0754	$8,688	457.5	7.60	$ 3,477	457.5	0.97	$444	360	0.55	0.04447	$5,283
May	600	264	0.74	0.0754	$8,804	442.5	7.60	$ 3,363	442.5	0.97	$429	360	0.55	0.04447	$5,283
June	600	264	0.74	0.0754	$8,804	442.5	9.56	$ 4,230	442.5	0.97	$429	360	0.55	0.04447	$5,283
July	600	252	0.74	0.0754	$8,403	442.5	9.56	$ 4,230	442.5	0.97	$429	372	0.55	0.04447	$5,459
August	600	276	0.73	0.0754	$9,048	435	9.56	$ 4,159	435	0.97	$422	372	0.55	0.04447	$5,459
September	600	264	0.76	0.0754	$9,102	457.5	9.56	$ 4,374	457.5	0.97	$444	360	0.55	0.04447	$5,283
October	0	252	0	0.0754	$0	0	7.60	$ -	480	0.97	$466	372	0	0.04447	$0
November	0	264	0	0.0754	$0	0	7.60	$ -	480	0.97	$466	360	0	0.04447	$0
December	0	264	0	0.0754	$0	0	7.60	$ -	480	0.97	$466	372	0	0.04447	$0
					$62,364			$ 27,310			$5,369				$37,510
														Yearly Energy Savings Potential	$57,533
														Less 2% Tank Losses	$1,247
														Total Yearly Energy Savings Potential	$56,286

1200 ton /hr Shifted

(Aproximately 2,000,000 Gallons)

		Shifted Tonnage On-Peak Savings				Demand On-Peak Savings			Demand Distribution Savings			Shifted Tonnage Off-Peak Costs			
Month	**Shifted Tonnage/Hrs.**	**Hrs/Mon.**	**On-Peak KWH/Ton (1)**	**On-Peak $/KWH**	**On-Peak $/Mon.**	**KW/Mon.**	**$/KW**	**Demand $/Mon.**	**KW/Mon.**	**$/KW**	**$/Mon.**	**Hrs/Mon.**	**Off-Peak KW/Ton (2)**	**Off-Peak $/KW**	**Off-Peak $/Mon.**
January	0	252	0	0.0754	$0	0	7.60	0	480	0.97	$466	372	0	0.04447	$0
February	0	240	0	0.0754	$0	0	7.60	0	480	0.97	$466	336	0	0.04447	$0
March	1,200	276	0.76	0.0754	$19,031	915	7.60	6954	915	0.97	$888	372	0.55	0.04447	$10,918
April	1,200	252	0.76	0.0754	$17,377	915	7.60	6954	915	0.97	$888	360	0.55	0.04447	$10,566
May	1,200	264	0.74	0.0754	$17,607	885	7.60	6726	885	0.97	$858	360	0.55	0.04447	$10,566
June	1,200	264	0.74	0.0754	$17,607	885	9.56	8461	885	0.97	$858	360	0.55	0.04447	$10,566
July	1,200	252	0.74	0.0754	$16,807	885	9.56	8461	885	0.97	$858	372	0.55	0.04447	$10,918
August	1,200	276	0.73	0.0754	$18,095	870	9.56	8317	870	0.97	$844	372	0.55	0.04447	$10,918
September	1,200	264	0.76	0.0754	$18,204	915	9.56	8747	915	0.97	$888	360	0.55	0.04447	$10,566
October	0	252	0	0.0754	$0	0	7.60	0	480	0.97	$466	372	0	0.04447	$0
November	0	264	0	0.0754	$0	0	7.60	0	480	0.97	$466	360	0	0.04447	$0
December	0	264	0	0.0754	$0	0	7.60	0	480	0.97	$466	372	0	0.04447	$0
					$124,728			$ 54,620			$8,410				$75,019
														Yearly Energy Savings Potential	$112,739
														Less 2% Tank Losses	$2,495
														Yearly Energy Savings Potential	$112,739

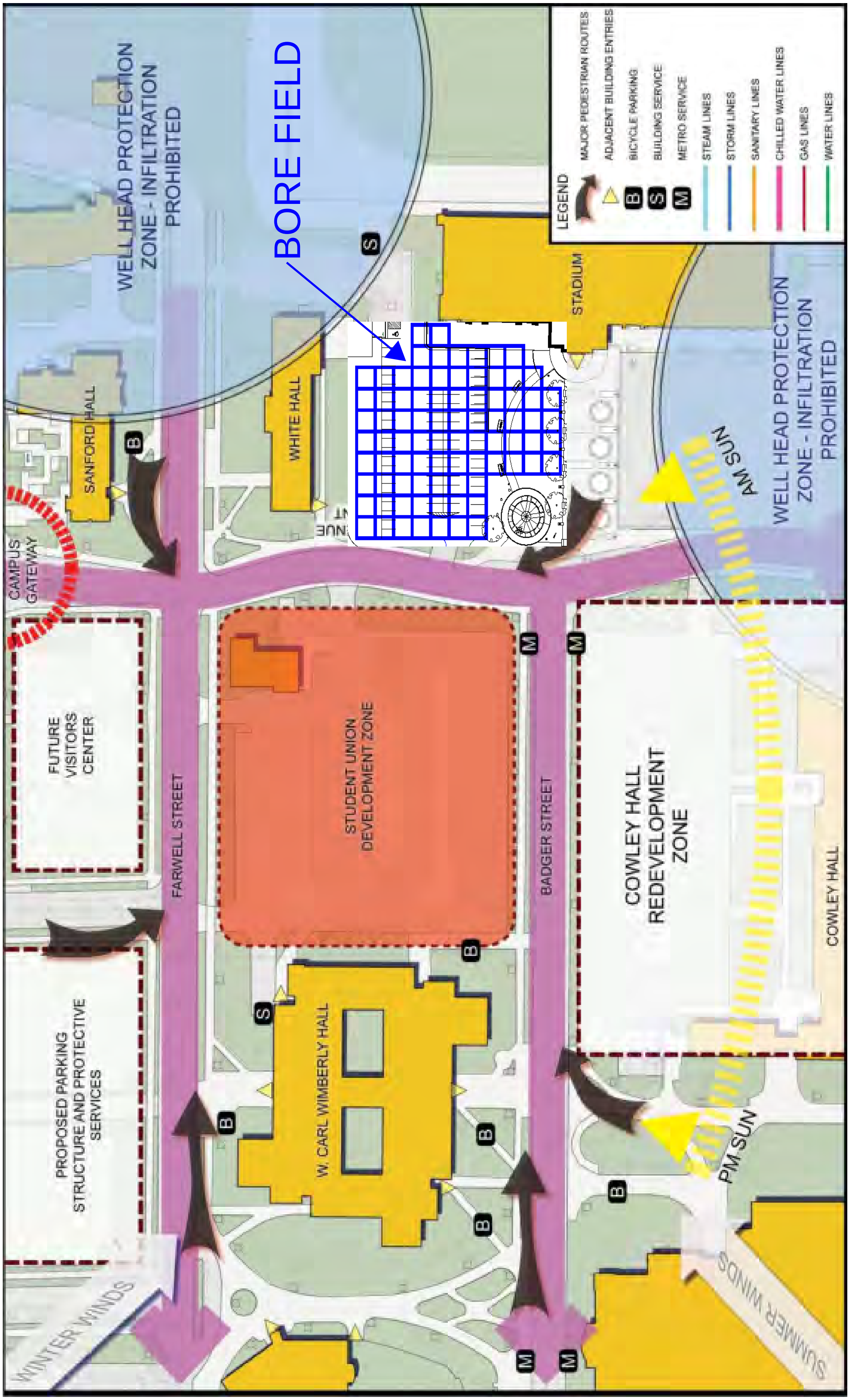
1800 ton/hr Shifted (30% Surplus Capacity on 6,000 Tons)

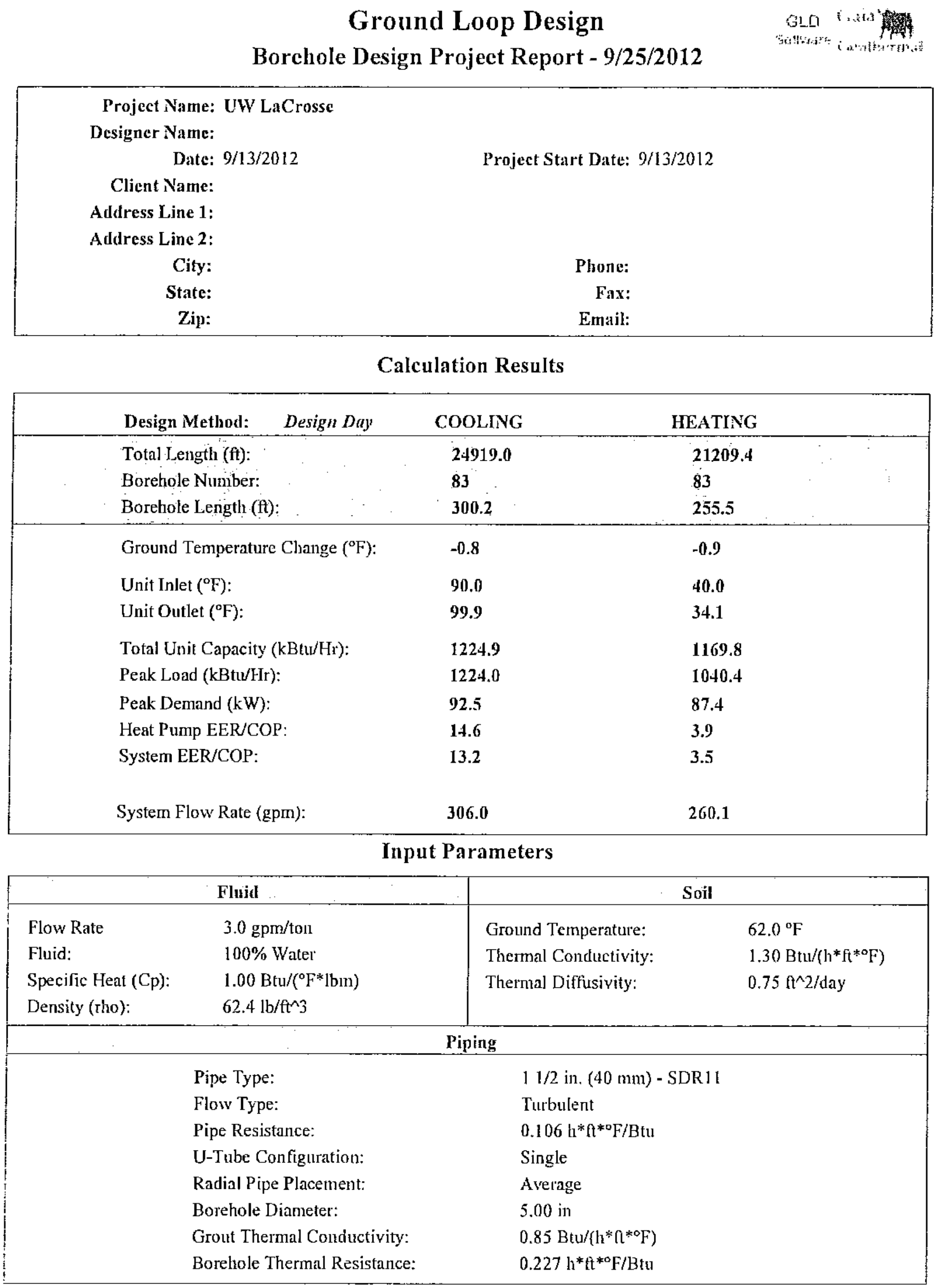
(Aproximately 3,000,000 Gallons)

		Shifted Tonnage On-Peak Savings				Demand On-Peak Savings			Demand Distribution Savings			Shifted Tonnage Off-Peak Costs			
Month	**Shifted Tonnage/Hrs.**	**Hrs/Mon.**	**On-Peak KWH/Ton (1)**	**On-Peak $/KWH**	**On-Peak $/Mon.**	**KW/Mon.**	**$/KW**	**Demand $/Mon.**	**KW/Mon.**	**$/KW**	**$/Mon.**	**Hrs/Mon.**	**Off-Peak KW/Ton (2)**	**Off-Peak $/KW**	**Off-Peak $/Mon.**
January	0	252	0	0.0754	$0	0	7.60	0	480	0.97	$466	372	0	0.04447	$0
February	0	240	0	0.0754	$0	0	7.60	0	480	0.97	$466	336	0	0.04447	$0
March	1,800	276	0.76	0.0754	$28,547	1372.5	7.60	10431	1372.5	0.97	$1,331	372	0.55	0.04447	$16,377
April	1,800	252	0.76	0.0754	$26,065	1372.5	7.60	10431	1372.5	0.97	$1,331	360	0.55	0.04447	$15,849
May	1,800	264	0.74	0.0754	$26,411	1327.5	7.60	10089	1327.5	0.97	$1,288	360	0.55	0.04447	$15,849
June	1,800	264	0.74	0.0754	$26,411	1327.5	9.56	12691	1327.5	0.97	$1,288	360	0.55	0.04447	$15,849
July	1,800	252	0.74	0.0754	$25,210	1327.5	9.56	12691	1327.5	0.97	$1,288	372	0.55	0.04447	$16,377
August	1,800	276	0.73	0.0754	$27,143	1305	9.56	12476	1305	0.97	$1,266	372	0.55	0.04447	$16,377
September	1,800	264	0.76	0.0754	$27,306	1372.5	9.56	13121	1372.5	0.97	$1,331	360	0.55	0.04447	$15,849
October	0	252	0	0.0754	$0	0	7.60	0	480	0.97	$466	372	0	0.04447	$0
November	0	264	0	0.0754	$0	0	7.60	0	480	0.97	$466	360	0	0.04447	$0
December	0	264	0	0.0754	$0	0	7.60	0	480	0.97	$466	372	0	0.04447	$0
					$187,093			$ 81,930			$11,451				$112,529
														Yearly Energy Savings Potential	$167,944
														Less 2% Tank Losses	$3,742
														Total Yearly Energy Savings Potential	$ 164,203

1) Approximate kw/ton of existing chiller plant chillers with tower and chiller pumps.

2) Approximate kw/ton of new chiller plant chillers with tower and chiller pumps.


BORE FIELD
WELL HEAD PROTECTION ZONE - INFILTRATION PROHIBITED
WELL HEAD PROTECTION ZONE - INFILTRATION PROHIBITED
LEGEND
MAJOR PEDESTRIAN ROUTES
ADJACENT BUILDING ENTRIES
B BICYCLE PARKING
S BUILDING SERVICE
M METRO SERVICE
STEAM LINES
STORM LINES
SANITARY LINES
CHILLED WATER LINES
GAS LINES
WATER LINES
STADIUM
WHITE HALL
SANFORD HALL
CAMPUS GATEWAY
FUTURE VISITORS CENTER
FARWELL STREET
STUDENT UNION DEVELOPMENT ZONE
BADGER STREET
COWLEY HALL REDEVELOPMENT ZONE
COWLEY HALL
AM SUN
PM SUN
W. CARL WIMBERLY HALL
PROPOSED PARKING STRUCTURE AND PROTECTIVE SERVICES
WINTER WINDS
SUMMER WINDS



Ground Loop Design

Borehole Design Project Report - 9/25/2012

Project Name: UW LaCrosse
Designer Name:
Date: 9/13/2012 **Project Start Date:** 9/13/2012
Client Name:
Address Line 1:
Address Line 2:
City: **Phone:**
State: **Fax:**
Zip: **Email:**

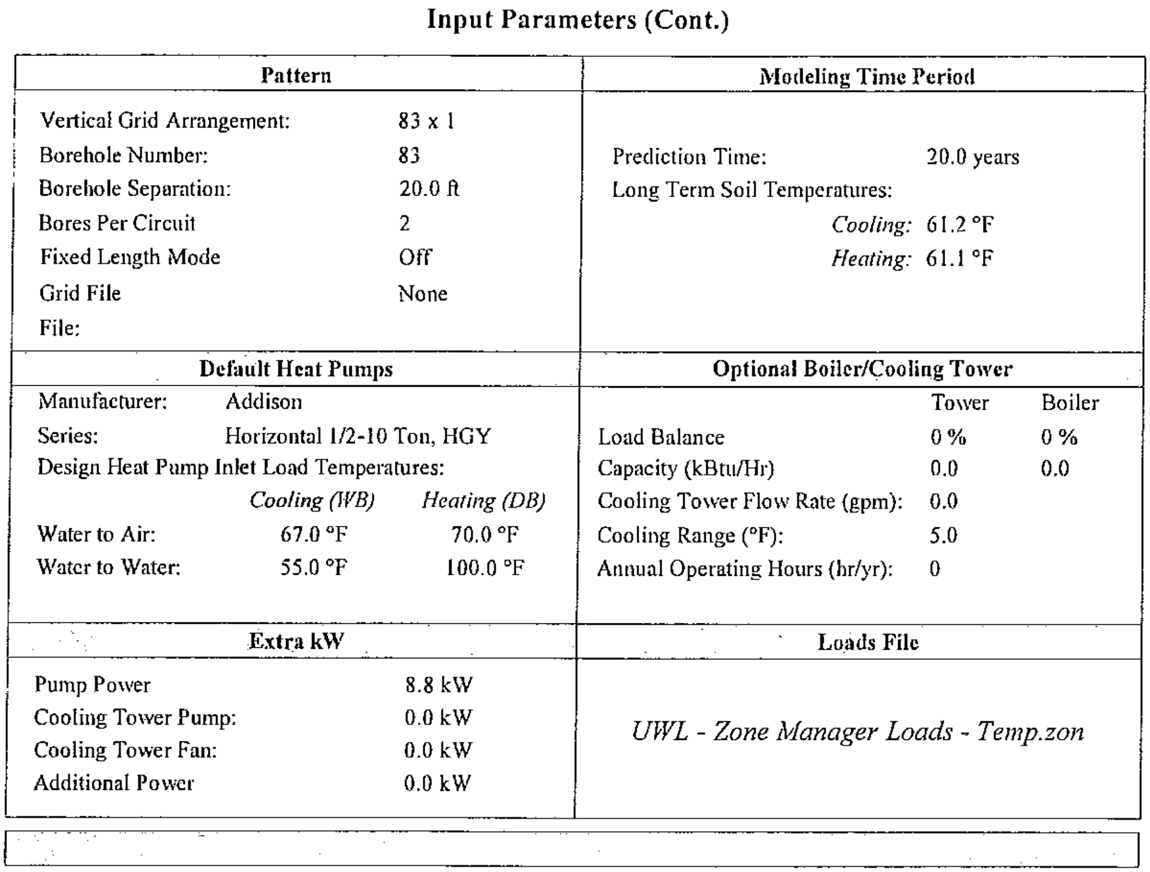
Calculation Results

Design Method: *Design Day*	COOLING	HEATING
Total Length (ft):	24919.0	21209.4
Borehole Number:	83	83
Borehole Length (ft):	300.2	255.5
Ground Temperature Change (°F):	-0.8	-0.9
Unit Inlet (°F):	90.0	40.0
Unit Outlet (°F):	99.9	34.1
Total Unit Capacity (kBtu/Hr):	1224.9	1169.8
Peak Load (kBtu/Hr):	1224.0	1040.4
Peak Demand (kW):	92.5	87.4
Heat Pump EER/COP:	14.6	3.9
System EER/COP:	13.2	3.5
System Flow Rate (gpm):	306.0	260.1

Input Parameters

Fluid		**Soil**	
Flow Rate	3.0 gpm/ton	Ground Temperature:	62.0 °F
Fluid:	100% Water	Thermal Conductivity:	1.30 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	0.75 ft^2/day
Density (rho):	62.4 lb/ft^3		

Piping	
Pipe Type:	1 1/2 in. (40 mm) - SDR11
Flow Type:	Turbulent
Pipe Resistance:	0.106 h*ft*°F/Btu
U-Tube Configuration:	Single
Radial Pipe Placement:	Average
Borehole Diameter:	5.00 in
Grout Thermal Conductivity:	0.85 Btu/(h*ft*°F)
Borehole Thermal Resistance:	0.227 h*ft*°F/Btu



Input Parameters (Cont.)

Pattern

Vertical Grid Arrangement:	83 x 1
Borehole Number:	83
Borehole Separation:	20.0 ft
Bores Per Circuit	2
Fixed Length Mode	Off
Grid File	None
File:	

Modeling Time Period

Prediction Time:	20.0 years
Long Term Soil Temperatures:	
Cooling:	61.2 °F
Heating:	61.1 °F

Default Heat Pumps

Manufacturer: Addison

Series: Horizontal 1/2-10 Ton, HGY

Design Heat Pump Inlet Load Temperatures:

	Cooling (WB)	*Heating (DB)*
Water to Air:	67.0 °F	70.0 °F
Water to Water:	55.0 °F	100.0 °F

Optional Boiler/Cooling Tower

	Tower	Boiler
Load Balance	0 %	0 %
Capacity (kBtu/Hr)	0.0	0.0
Cooling Tower Flow Rate (gpm):	0.0	
Cooling Range (°F):	5.0	
Annual Operating Hours (hr/yr):	0	

Extra kW

Pump Power	8.8 kW
Cooling Tower Pump:	0.0 kW
Cooling Tower Fan:	0.0 kW
Additional Power	0.0 kW

Loads File

UWL - Zone Manager Loads - Temp.zon

Appendix-D

Geothermal Analysis

11/27/2012

GEOTHERMAL ENERGY COST

ENERGY										
BIN DATA		BLDG HTG		BLDG CLG		PUMP KW/HR	TOTAL KW/HR	TOTAL KW/YR	ON PEAK KW (35%)	OFF PEAK KW (65%)
HRS	TEMP	MBH	HTG KW/HR	MBH	CLG KW/HR					
12	-20 / -16	1,040	56	0	0	8.8	64.8	778	272	505
27	-15 / -11	1,040	56	0	0	8.8	64.8	1,750	612	1,137
54	-10 / -6	1,040	56	0	0	8.8	64.8	3,499	1,225	2,274
72	-5 / -1	1,040	56	0	0	8.8	64.8	4,666	1,633	3,033
126	0 / 4	1,040	56	0	0	8.8	64.8	8,165	2,858	5,307
175	5 / 9	1,040	56	0	0	8.8	64.8	11,340	3,969	7,371
225	10 / 14	1,040	56	0	0	8.8	64.8	14,580	5,103	9,477
312	15 / 19	1,040	56	0	0	8.8	64.8	20,218	7,076	13,141
450	20 / 24	1,040	56	0	0	8.8	64.8	29,160	10,206	18,954
579	25 / 29	1,040	56	0	0	8.8	64.8	37,519	13,132	24,387
803	30 / 34	1,040	56	0	0	8.8	64.8	52,034	18,212	33,822
705	35 / 39	1,040	56	0	0	8.8	64.8	45,684	15,989	29,695
550	40 / 44	1,040	56	0	0	8.8	64.8	35,640	12,474	23,166
569	45 / 49	1,000	56	0	0	8.8	64.8	36,871	12,905	23,966
603	50 / 54	500	56	0	0	8.8	64.8	39,074	13,676	25,398
633	55 / 59	0	0	612	47	8.8	55.3	35,005	12,252	22,753
687	60 / 64	0	0	1,224	60	8.8	68.8	47,266	16,543	30,723
689	65 / 69	0	0	1,224	60	8.8	68.8	47,403	16,591	30,812
590	70 / 74	0	0	1,224	60	8.8	68.8	40,592	14,207	26,385
440	75 / 79	0	0	1,224	60	8.8	68.8	30,272	10,595	19,677
279	80 / 84	0	0	1,224	60	8.8	68.8	19,195	6,718	12,477
129	85 / 89	0	0	1,224	60	8.8	68.8	8,875	3,106	5,769
40	90 / 94	0	0	1,224	60	8.8	68.8	2,752	963	1,789
6	95 / 99	0	0	1,224	60	8.8	68.8	413	144	268
1	100 / 104	0	0	1,224	60	8.8	68.8	69	24	45
8756								**572,819**	200,487	372,333
									$0.07536	$0.04447
									$ 15,109	**$ 16,558**

Heating and cooling HW/hr based on average ground temperature of 61 degrees.

Demand						
MONTH	ON PEAK			DISTRIBUTION		
	KW	$/KW	$	KW	$/KW	$
JAN	64.8	7.60	$ 492	64.8	0.97	$ 63
FEB	64.8	7.60	$ 492	64.8	0.97	$ 63
MAR	64.8	7.60	$ 492	64.8	0.97	$ 63
APR	64.8	7.60	$ 492	64.8	0.97	$ 63
MAY	64.8	7.60	$ 492	64.8	0.97	$ 63
JUNE	55.3	9.56	$ 529	64.1	0.97	$ 62
JULY	68.8	9.56	$ 658	77.6	0.97	$ 75
AUG	68.8	9.56	$ 658	77.6	0.97	$ 75
SEPT	68.8	9.56	$ 658	77.6	0.97	$ 75
OCT	64.8	7.60	$ 492	64.8	0.97	$ 63
NOV	64.8	7.60	$ 492	64.8	0.97	$ 63
DEC	64.8	7.60	$ 492	64.8	0.97	$ 63
Total			**$ 6,442**			**$ 791**

SUMMMARY	Energy $/yr
Steam	0
On Peak-Eenrgy	$ 15,109
Off Peak-Energy	$ 16,558
On Peak Demand	$ 6,442
Distribution	$ 791
Eenrgy Credit	$ -
Total	**$ 38,899**

ELECTRIC CHILLER/STEAM ENERGY COST

ENERGY											STEAM	Demand						
BIN DATA		BLDG HTG		BLDG CLG		PUMP KW/HR	TOTAL KW/HR	TOTAL KW/YR	ON PEAK KW (35%)	OFF PEAK KW (65%)			ON PEAK			DISTRIBUTION		
HRS	TEMP	MBH	HTG #/HR	MBH	CLG KW/HR						TOTAL #/YR	MONTH	KW	$/KW	$	KW	$/KW	$
12	-20 / -16	1,040	1088	0	0	1	1	12	4	8	13,054	JAN	1	7.60	$ 8	1.0	0.97	$ 1
27	-15 / -11	1,040	1088	0	0	1	1	27	9	18	29,372	FEB	1	7.60	$ 8	1.0	0.97	$ 1
54	-10 / -6	1,040	1088	0	0	1	1	54	19	35	58,745	MAR	1	7.60	$ 8	1.0	0.97	$ 1
72	-5 / -1	1,040	1088	0	0	1	1	72	25	47	78,326	APR	1	7.60	$ 8	1.0	0.97	$ 1
126	0 / 4	1,040	1088	0	0	1	1	126	44	82	137,071	MAY	1	7.60	$ 8	1.0	0.97	$ 1
175	5 / 9	1,040	1088	0	0	1	1	175	61	114	190,377	JUNE	79	9.56	$ 750	80.5	0.97	$ 78
225	10 / 14	1,040	1088	0	0	1	1	225	79	146	244,770	JULY	79	9.56	$ 750	80.5	0.97	$ 78
312	15 / 19	1,040	1088	0	0	1	1	312	109	203	339,414	AUG	79	9.56	$ 750	80.5	0.97	$ 78
450	20 / 24	1,040	1088	0	0	1	1	450	158	293	489,540	SEPT	79	9.56	$ 750	80.5	0.97	$ 78
579	25 / 29	1,040	1088	0	0	1	1	579	203	376	629,874	OCT	1	7.60	$ 8	1.0	0.97	$ 1
803	30 / 34	1,040	1088	0	0	1	1	803	281	522	873,556	NOV	1	7.60	$ 8	1.0	0.97	$ 1

705	35 / 39	1,040	1088	0	0	1	1	705	247	458	766,946
550	40 / 44	1,040	1088	0	0	1	1	550	193	358	598,326
569	45 / 49	1,000	1046	0	0	1	1	569	199	370	595,188
603	50 / 54	500	523	0	0	1	1	603	211	392	315,377
633	55 / 59	0	0	612	77	2	79	49,691	17,392	32,299	-
687	60 / 64	0	0	1,224	77	2	79	53,930	18,875	35,054	-
689	65 / 69	0	0	1,224	77	2	79	54,087	18,930	35,156	-
590	70 / 74	0	0	1,224	77	2	79	46,315	16,210	30,105	-
440	75 / 79	0	0	1,224	77	2	79	34,540	12,089	22,451	-
279	80 / 84	0	0	1,224	77	2	79	21,902	7,666	14,236	-
129	85 / 89	0	0	1,224	77	2	79	10,127	3,544	6,582	-
40	90 / 94	0	0	1,224	77	2	79	3,140	1,099	2,041	-
6	95 / 99	0	0	1,224	77	2	79	471	165	306	-
1	100 / 104	0	0	1,224	77	2	79	79	27	51	-
8756								**279,541**	97,839	181,702	**5,359,937**
									$0.07536	$0.04447	$7.45/1000#.S
									$ 7,373	**$ 8,080**	**$ 39,932**

Note:

1) Average Chiller, pumps and tower KW/ton=.75 for 100 tons.

DEC	1	7.60	$ 8	1.0	0.97	$ 1
Total			**$ 3,063**			**$ 320**

SUMMMARY	**Energy $/yr**
Steam	$ 39,932
On Peak-Eenrgy	$ 7,373
Off Peak-Energy	$ 8,080
On Peak Demand	$ 3,063
Distribution	$ 320
Energy Credit	$ -
Total	**$ 58,768**

Net Estimated Annual Energy savings Geothermal

Geothermal	$ 38,899
Electric Chiller/Steam	$ 58,768
Annual Savings	**$ (19,869)**

First Cost Comparison

Geothermal

Wells (83 @ $5000/Well)		$ 415,000	
Chiller (100 tons @ $800/ton Installed)		$ 80,000	
Distribution (800 ft @ $250/ft)		$ 200,000	Heat Pump assumed to be in Cowley
Building Square Footage (250 sq ft @ $150/sq ft)		$ 37,500	
		$ 732,500	
Miscellaneous	10%	$ 73,250	
Total		**$ 805,750**	

Electric Chiller/Steam

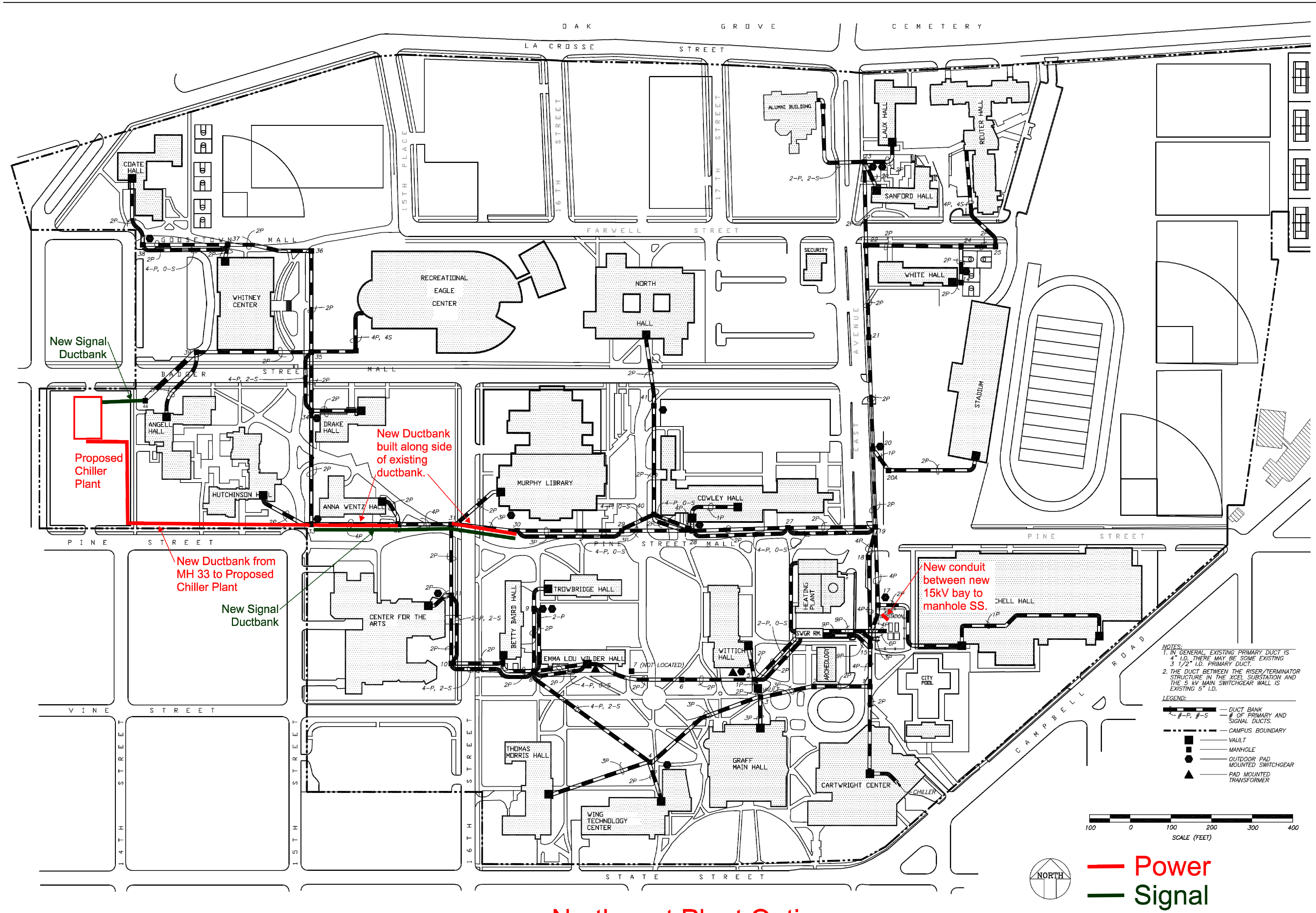
Incremental Heating capacity increase		$ 50,000	HX, Pumps, Piping, Valves
Chiller (100 tons @ $800/ton Installed)		$ 80,000	
Distribution		$ 10,000	Incremental increase in distribution pipe size is negligible
Building Square Footage (100 sq ft @ $300/sq ft)		$ 30,000	Incremental increase in plant size
		$ 170,000	
Miscellaneous	10%	$ 17,000	
Total		**$ 187,000**	

First Cost Difference

Geothermal	$ 805,750
Electric Chiller/Steam	$ 187,000
Difference	**$ 618,750**

Simple Payback

First Cost Difference	$ 618,750
Annual Savings	$ (19,869)
Simple payback	-31.1 Years



NOTES:

1. IN GENERAL, EXISTING PRIMARY DUCT IS 4" I.D. THERE MAY BE SOME EXISTING 3 1/2" I.D. PRIMARY DUCT.
2. THE DUCT BETWEEN THE RISER/TERMINATOR STRUCTURE IN THE XCEL SUBSTATION AND THE 5 kV MAIN SWITCHGEAR WALL IS EXISTING 5" I.D.

LEGEND:

#–P, #–S	DUCT BANK # OF PRIMARY AND SIGNAL DUCTS.
▬ ▪ ▪ ▬	CAMPUS BOUNDARY
■	VAULT
▪	MANHOLE
⬢	OUTDOOR PAD MOUNTED SWITCHGEAR
▲	PAD MOUNTED TRANSFORMER

Northwest Plant Option

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10101 INNOVATION DR.
MILWAUKEE, WI 53226
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PROJECT NUMBER: 212116

State of Wisconsin
Department of Administration
Division of State Facilities

LACROSSE, WISCONSIN

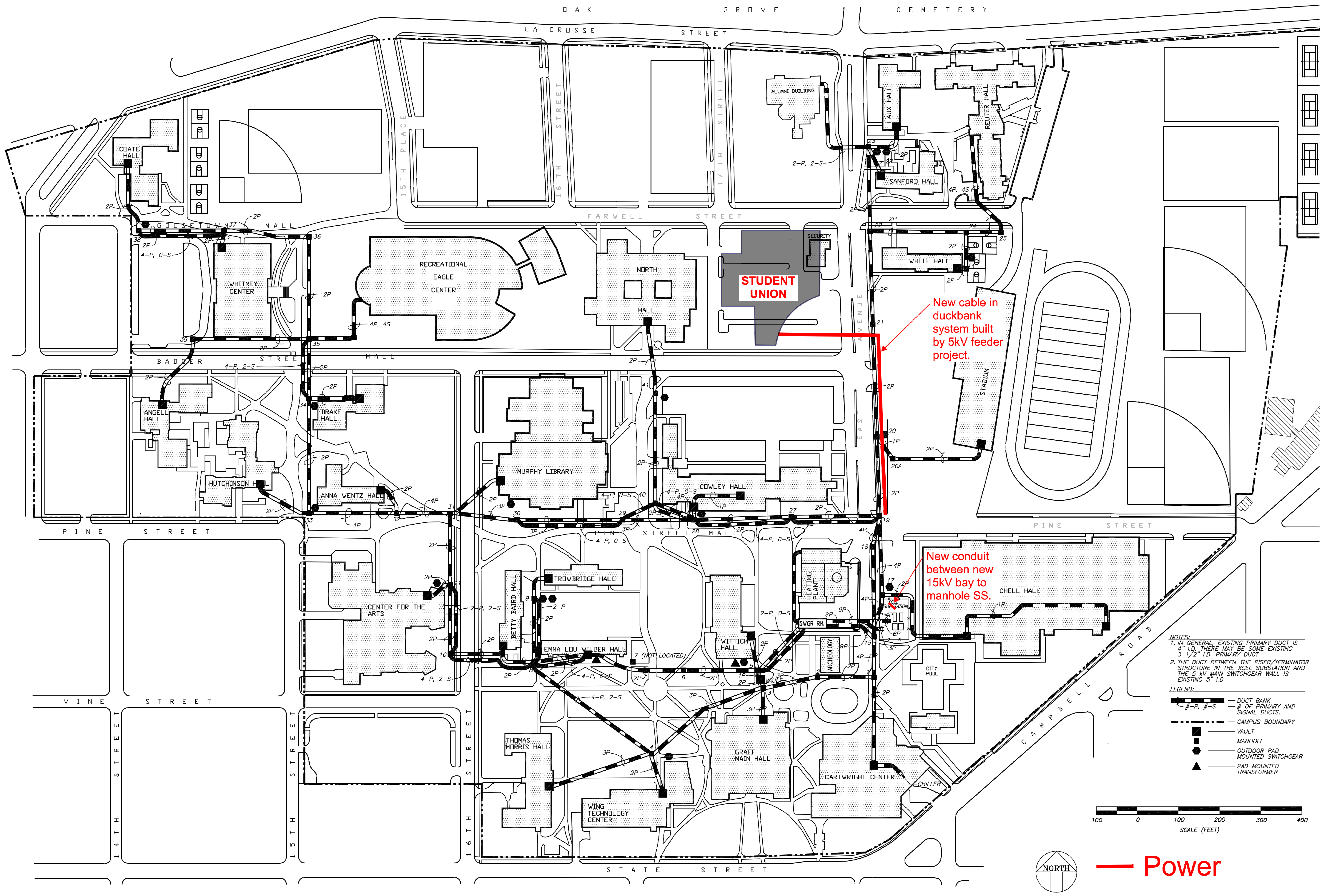
CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title: ELECTRICAL SITE PLAN

Revisions:

No.	Date:	Description:

Graphic Scale	
DSF Number	12H2C
Set Type	FR
Date Issued	12–4–12
Sheet Number	E1



NOTES:
1. IN GENERAL, EXISTING PRIMARY DUCT IS 4" I.D. THERE MAY BE SOME EXISTING 3 1/2" I.D. PRIMARY DUCT.
2. THE DUCT BETWEEN THE RISER/TERMINATOR STRUCTURE IN THE XCEL SUBSTATION AND THE 5 kV MAIN SWITCHGEAR WALL IS EXISTING 5" I.D.

Union Option

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Consultant:

State of Wisconsin
Department of Administration
Division of State Facilities

LACROSSE, WISCONSIN

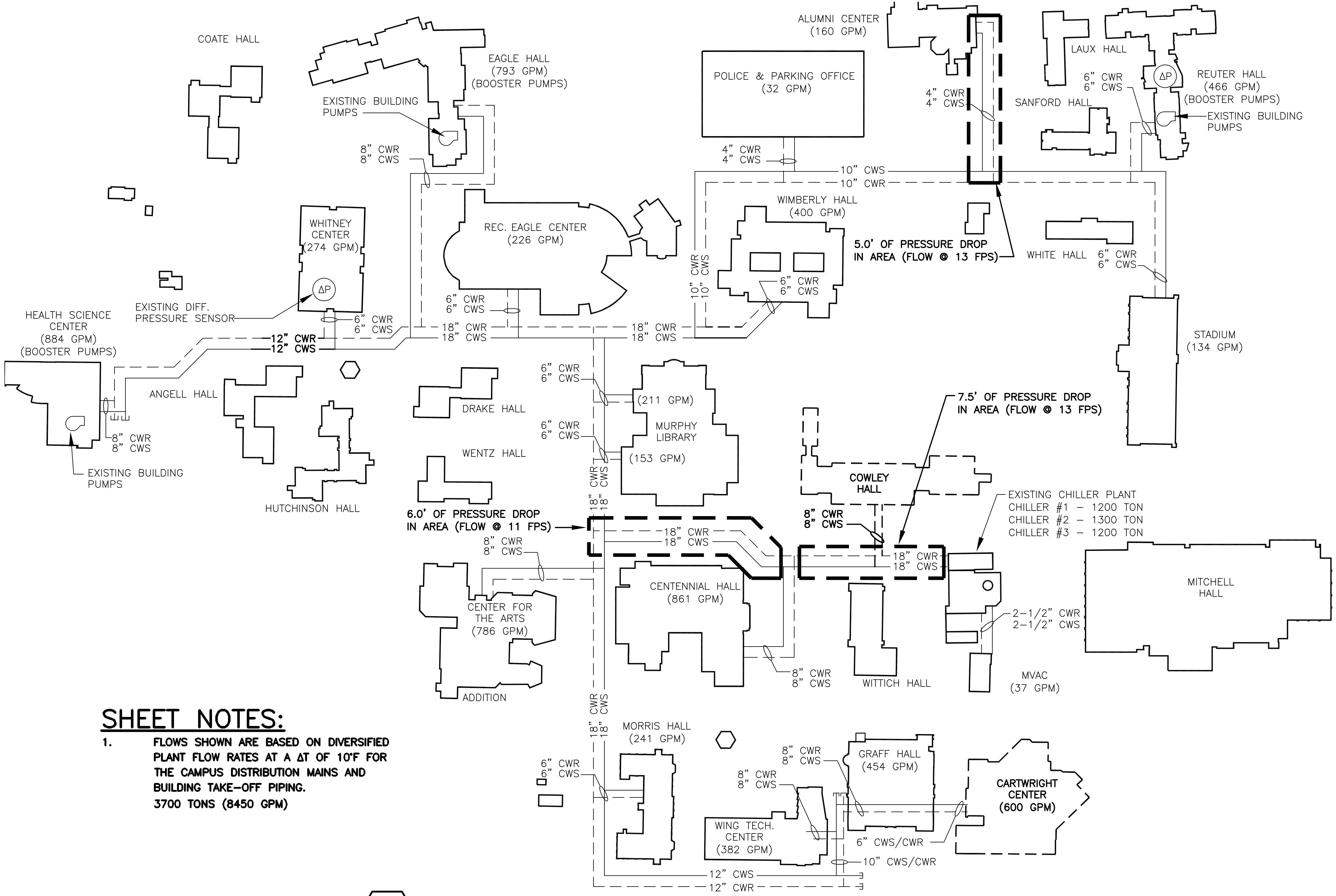
CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
ELECTRICAL SITE PLAN

Revisions:

No.	Date:	Description:

Graphic Scale	
DFD Number	12H2C
Set Type	FR
Date Issued	12-4-2012
Sheet Number	E2



SHEET NOTES:

1. FLOWS SHOWN ARE BASED ON DIVERSIFIED PLANT FLOW RATES AT A ΔT OF 10°F FOR THE CAMPUS DISTRIBUTION MAINS AND BUILDING TAKE-OFF PIPING. 3700 TONS (8450 GPM)

1

F–1

EXISTING CAMPUS CHILLED WATER FLOW DIAGRAM

NO SCALE

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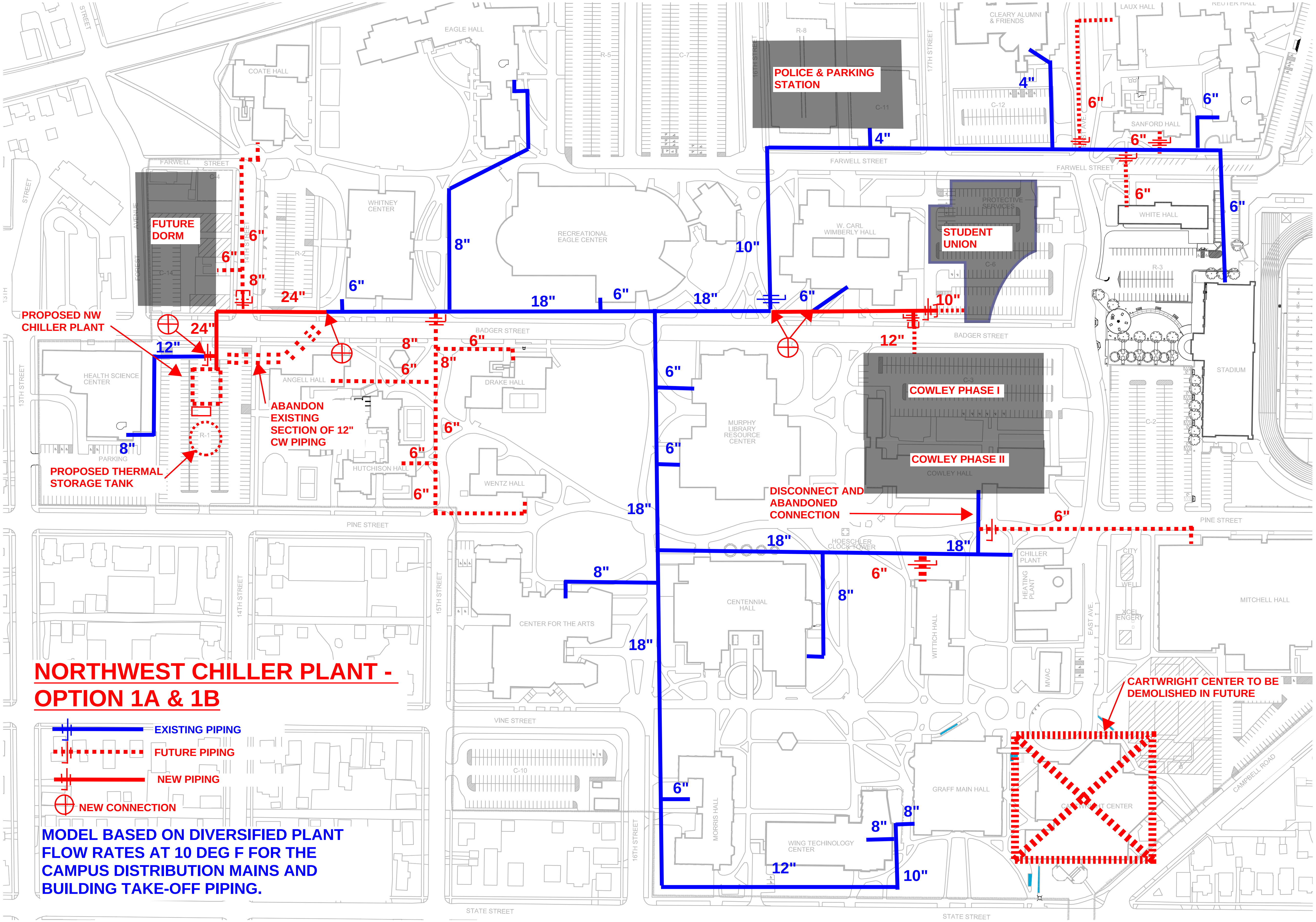
CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
EXISTING CAMPUS CHILLED WATER FLOW DIAGRAM

Revisions:

No.	Date:	Description:

Graphic Scale	
DSF Number	12H2C
Set Type	FR
Date Issued	12–4–12
Sheet Number	F–1



NORTHWEST CHILLER PLANT - OPTION 1A & 1B

MODEL BASED ON DIVERSIFIED PLANT FLOW RATES AT 10 DEG F FOR THE CAMPUS DISTRIBUTION MAINS AND BUILDING TAKE-OFF PIPING.

1
F-2
NORTHWEST CHILLER PLANT (OPTION 1A & 1B)
1" = 200'

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State of Wisconsin
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LACROSSE, WISCONSIN

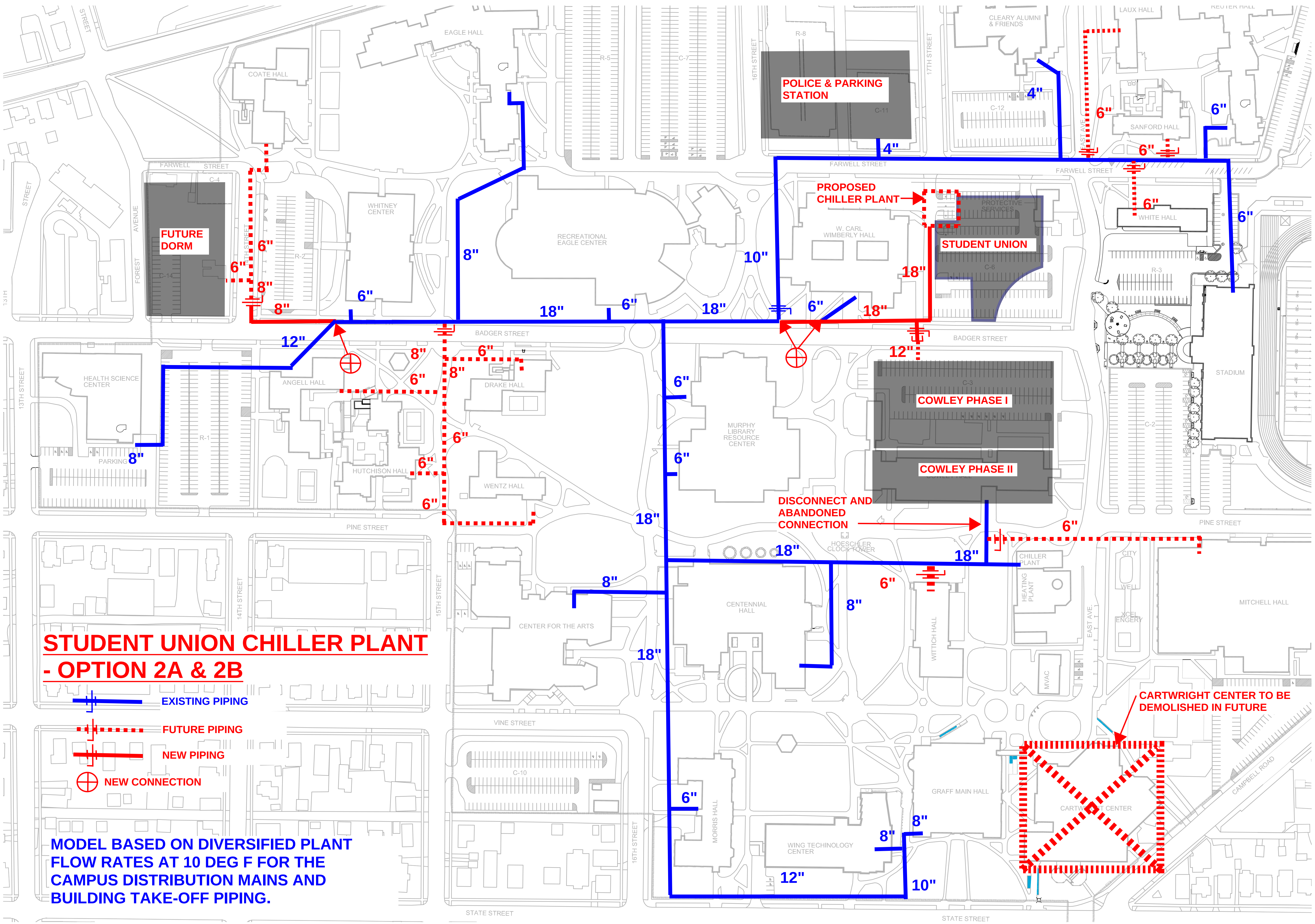
CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
NORTHWEST CHILLER PLANT (OPTION 1A & 1B)

Revisions:

No.	Date:	Description:

Graphic Scale 0' 25' 50' 100' 150'
DSF Number 12H2C
Set Type FR
Date Issued 12-4-12
Sheet Number F-2



STUDENT UNION CHILLER PLANT - OPTION 2A & 2B

	EXISTING PIPING
	FUTURE PIPING
	NEW PIPING
⊕	NEW CONNECTION

MODEL BASED ON DIVERSIFIED PLANT FLOW RATES AT 10 DEG F FOR THE CAMPUS DISTRIBUTION MAINS AND BUILDING TAKE-OFF PIPING.

1
F-3
STUDENT UNION CHILLER PLANT (OPTION 2A & 2B)
1" = 200'

RING & DUCHATEAU

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PROJECT NUMBER: 212116

State of Wisconsin
Department of Administration
Division of State Facilities

LACROSSE, WISCONSIN

CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
STUDENT UNION CHILLER PLANT (OPTIONS 2A & 2B)

Revisions:

No.	Date:	Description:

Graphic Scale	0' 25' 50' 100' 150'
DSF Number	12H2C
Set Type	FR
Date Issued	12–4–12
Sheet Number	F-3

General

Title: AFT Fathom Model
Analysis run on: 11/28/2012 10:26:26 AM
Application version: AFT Fathom Version 7.0 (2008.12.03)
Input File: E:\212jobs\212116.00\hvac\calcs\CHW Flow Model NW Plant REVISED 10-23-12.fth
Output File: E:\212jobs\212116.00\hvac\calcs\CHW Flow Model NW Plant REVISED 10-23-12_1.out

Execution Time= 0.84 seconds
Total Number Of Head/Pressure Iterations= 41
Total Number Of Flow Iterations= 6
Total Number Of Temperature Iterations= 0
Number Of Pipes= 239
Number Of Junctions= 200
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 42 deg. F
Density= 62.42752 lbm/ft3
Viscosity= 3.62639 lbm/hr-ft
Vapor Pressure= 0.12804 psia
Viscosity Model= Newtonian

Atmospheric Pressure= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300

Total Inflow= 0.1672 gal/min
Total Outflow= 0.1699 gal/min
Maximum Pressure is 34.26 psia at Junction 100 Outlet
Minimum Pressure is 4.490 psia at Junction 106 Outlet

Pump Summary

Jct	Name	Vol. Flow (gal/min)	dP (psid)	dH (feet)	Overall Efficiency (Percent)	Speed (Percent)	Overall Power (hp)	BEP (gal/min)
99	EXST P#2	4,320	29.03	66.97	100.0	N/A	73.15	N/A
100	EXST P#1	4,320	29.23	67.43	100.0	N/A	73.65	N/A
192	P-NW-#1	3,343	18.41	42.47	100.0	73.53	35.91	N/A
193	P-NW-#2	3,343	18.41	42.47	100.0	78.27	35.91	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	dP Stag. (psid)	dH (feet)	P Inlet Static (psia)	Cv	K	Valve State
1	Valve	REGULAR	7,900.00	0.2452	0.5655	33.067	15,962.08	0.3094	Open
5	Valve	REGULAR	7,900.00	0.3584	0.8267	5.245	13,201.48	0.3250	Open
190	Valve-NW-S	REGULAR	6,687.00	0.2568	0.5923	27.385	13,201.48	0.3250	Open
191	Valve-NW-R	REGULAR	6,686.89	0.2568	0.5923	11.318	13,201.48	0.3250	Open
201	R-NW-P#1	REGULAR	3,343.49	0.3673	0.8472	10.061	5,519.23	0.4681	Open
202	R-NW-P#2	REGULAR	3,343.49	0.3673	0.8472	10.061	5,519.23	0.4681	Open

Jct	Name	Valve Type	Vol. Flow (gal/min)	dP Stag. (psid)	dH (feet)	P Inlet Static (psia)	Cv	K	Valve State
12	CV-CEN	FCV	926.00	16.2291	37.4353	27.825	229.96	56.4321	Open
27	CV-Arts	FCV	1,078.00	10.4018	23.9935	24.814	334.39	26.6884	Open
29	CV-Library	FCV	239.00	11.8227	27.2711	25.842	69.54	214.8828	Open
35	CV-WIM	FCV	429.00	9.0833	20.9522	24.360	142.40	51.2399	Open
45	CV-Police	FCV	35.00	7.9882	18.4263	23.970	12.39	1,440.8540	Open
50	CV-Reuter	FCV	501.00	3.1401	7.2431	21.076	282.85	12.9881	Open
54	CV-Alumni	FCV	168.00	3.8468	8.8734	21.794	85.69	30.1155	Open
58	CV-STA	FCV	134.00	5.1398	11.8558	22.256	59.13	297.1768	Open
64	CV-Rec Center	FCV	257.00	11.1637	25.7510	25.505	76.95	175.4780	Open
69	CV-WHI	FCV	287.00	13.4436	31.0101	26.810	78.31	196.4346	Open
71	CV-HSC	FCV	919.00	11.9857	27.6471	25.905	265.56	42.3140	Open
80	CV-Morris	FCV	259.00	13.7441	31.7032	26.794	69.89	212.7146	Open
86	CV-Wing	FCV	326.00	13.0274	30.0500	26.465	90.36	365.4898	Open
95	CV-Graff	FCV	496.00	12.8192	29.5696	26.317	138.59	155.3635	Open
117	CV- LIB ADD	FCV	174.00	13.1529	30.3394	26.531	48.00	451.0277	Open
123	CV-NEW RES	FCV	852.00	4.3122	9.9468	21.908	410.46	17.7121	Open
132	CV-San	FCV	221.00	6.1395	14.1618	22.994	89.23	113.3782	Open
135	CV-WHITE	FCV	193.00	6.0383	13.9284	22.968	78.57	168.2984	Open
139	CV-LAUX	FCV	217.00	5.4888	12.6610	22.684	92.66	121.0156	Open
149	CV-UNION	FCV	1,277.00	7.7792	17.9442	23.654	458.04	34.3582	Open
153	CV-COW I	FCV	3,187.00	7.1243	16.4334	22.854	1,194.52	9.9938	Open
166	CV-ANG	FCV	329.00	8.6843	20.0320	24.403	111.69	83.2963	Open
168	CV-DRA	FCV	246.00	9.5340	21.9919	24.870	79.70	163.5639	Open
174	CV-HUT	FCV	313.00	7.5741	17.4711	23.857	113.78	80.2649	Open
178	CV-WEN	FCV	217.00	7.5428	17.3989	23.886	79.05	166.3012	Open
186	CV-COA	FCV	329.00	14.3577	33.1186	27.240	86.86	137.7128	Open
205	CV-MIT	FCV	740.00	26.2788	60.6168	32.929	144.41	143.0855	Open
225	CV-WIT	FCV	210.00	25.9022	59.7480	32.889	41.28	609.7883	Open
255	CV-NEW Dorm	FCV	768.00	14.5523	33.5674	27.258	201.41	73.5634	Open
97	Check Valve	CHECK	4,320.00	0.0000	0.0000	34.108	N/A	0.0000	Open
195	CXV-NW-P2	CHECK	3,343.49	0.0000	0.0000	27.893	N/A	0.0000	Open
196	CXV-NW-P1	CHECK	3,343.49	0.0000	0.0000	27.893	N/A	0.0000	Open
215	Check Valve	CHECK	4,320.00	0.0000	0.0000	34.244	N/A	0.0000	Open

Heat Exchanger Summary

Jct	Name	Vol. Flow (gal/min)	dP (psid)	dH (feet)
13	HX-CEN	926.00	0	0
28	HX-ARTS	1,078.00	0	0
31	HX- LIB AD	239.00	0	0
36	HX-WIM	429.00	0	0
46	HX-POL	35.00	0	0
51	HX-REU	501.00	0	0
55	HX-ALU	168.00	0	0
62	HX-STA	134.00	0	0
65	HX-REC	257.00	0	0
70	HX-WHI	287.00	0	0
75	HX-HSC	919.00	0	0
81	HX-MO	259.00	0	0
87	HX-WING	326.00	0	0
96	HX-GR	496.00	0	0

Jct	Name	Vol. Flow (gal/min)	dP (psid)	dH (feet)
118	HX-LIB	174.00	0	0
128	HX-RES	852.00	0	0
131	HX-SAN	221.00	0	0
136	HX-WHITE	193.00	0	0
140	HX-LAUX	217.00	0	0
151	HX-UNION	1,277.00	0	0
154	HX-COW I	3,187.00	0	0
167	HX-ANG	329.00	0	0
169	HX-DRA	246.00	0	0
175	HX-HUT	313.00	0	0
179	HX-WEN	217.00	0	0
189	HX-COA	329.00	0	0
206	HX-MIT	740.00	0	0
226	HX-WIT	210.00	0	0
256	Heat Exchanger	768.00	0	0

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
5	CWS-18"-1	7,900.00	12.7940	0.58209026	0.58209026	1.3426932	32.511	31.929
10	CWS-CEN	926.00	6.5335	1.49493194	1.49493194	3.4483224	29.513	28.018
11	CWS-CEN	926.00	6.5335	0.13590291	0.13590291	0.3134839	27.961	27.825
12	CWS-CEN	926.00	6.5335	0.03397573	0.03397573	0.0783710	11.596	11.562
13	CWR-CEN	926.00	6.5335	0.13590291	0.13590291	0.3134839	11.562	11.426
14	CWR-CEN	926.00	6.5335	1.49493194	1.49493194	3.4483224	11.369	9.874
15	CWS-18"-2	6,764.00	10.9543	2.55416179	2.55416179	5.8916216	28.992	26.438
16	CWS-18"	2,159.00	3.4965	0.07285292	0.07285292	0.1680480	27.164	27.091
17	CWS-18"	1,081.00	1.7507	0.12010738	0.12010738	0.2770487	27.153	27.033
23	CWS-ARTS	1,078.00	7.6059	1.96925950	1.96925950	4.5424420	26.784	24.814
24	CWS-ARTS	1,078.00	7.6059	0.04475590	0.04475590	0.1032373	14.413	14.368
25	CWR-ARTS	1,078.00	7.6059	1.96925950	1.96925950	4.5424420	14.368	12.398
26	CWS-18"	4,605.00	7.4578	0.65017200	0.65017200	1.4997356	26.871	26.221
27	CWS-LIB	239.00	2.8577	0.12618367	0.12618367	0.2910648	25.969	25.842
28	CWS-LIB	239.00	2.8577	0.01051531	0.01051531	0.0242554	14.020	14.009
29	CWR-LIB	239.00	2.8577	0.12618367	0.12618367	0.2910648	14.009	13.883
30	CWS-18"	4,192.00	6.7889	0.51733422	0.51733422	1.1933220	25.713	25.196
31	CWS-18"	6,362.00	5.7956	0.40600562	0.40600562	0.9365231	25.280	24.874
32	CWS-18"	5,155.28	8.3489	0.53270680	0.53270680	1.2287816	24.631	24.098
33	CWS-WIM	429.00	5.1295	0.03008386	0.03008386	0.0693937	24.390	24.360
34	CWS-WIM	429.00	5.1295	0.03008386	0.03008386	0.0693937	15.277	15.247
35	CWR-WIM	429.00	5.1295	0.03008386	0.03008386	0.0693937	15.247	15.217
36	CWR-18"	5,155.20	8.3488	0.53269106	0.53269106	1.2287453	14.924	14.392
37	CWR-10"	-1,206.68	-1.9542	-0.11139899	-0.11139899	-0.2569613	14.836	14.947
38	CWR-10"	1,206.68	5.4779	0.91105044	0.91105044	2.1014974	15.682	14.771
39	CWR-POL	35.00	0.9071	0.10175224	0.10175224	0.2347094	15.980	15.878
40	CWS-POL	35.00	0.9071	0.00221201	0.00221201	0.0051024	15.982	15.980
41	CWS-POL	35.00	0.9071	0.10175224	0.10175224	0.2347094	24.072	23.970
43	CWR-REU	500.87	5.9888	1.11398828	1.11398828	2.5696091	17.758	16.644
44	CWR-REU	501.00	5.9904	0.03980475	0.03980475	0.0918166	17.896	17.857
45	CWS-REU	501.00	5.9904	0.03980475	0.03980475	0.0918166	17.936	17.896
46	CWS-REU	501.00	5.9904	0.03980475	0.03980475	0.0918166	21.116	21.076

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
47	CWS-REU	501.00	5.9904	1.11453283	1.11453283	2.5708652	22.282	21.167
48	CWR-10"	-1,265.87	-5.7466	-0.16561070	-0.16561070	-0.3820101	16.173	16.339
49	CWR-10"	634.86	2.8821	0.05949829	0.05949829	0.1372432	16.830	16.771
50	CWR-ALU	168.00	4.3543	1.64380205	1.64380205	3.7917174	17.912	16.268
51	CWS-ALU	168.00	4.3543	0.03573483	0.03573483	0.0824286	17.947	17.912
52	CWS-ALU	168.00	4.3543	1.64380205	1.64380205	3.7917174	23.438	21.794
53	CWR-STA	134.00	1.6022	0.23969780	0.23969780	0.5529050	17.108	16.869
54	CWR-STA	134.00	1.6022	0.00374528	0.00374528	0.0086391	17.116	17.112
55	CWS-STA	134.00	1.6022	0.00374528	0.00374528	0.0086391	22.259	22.256
56	CWS-STA	134.00	1.6022	0.00374528	0.00374528	0.0086391	22.263	22.259
57	CWS-STA	134.00	1.6022	0.23969780	0.23969780	0.5529050	22.506	22.267
58	CWS-18"	2,170.00	3.5143	0.11029059	0.11029059	0.2544046	25.533	25.423
59	CWS-REC	257.00	3.0729	0.04790417	0.04790417	0.1104994	25.553	25.505
60	CWS-REC	257.00	3.0729	0.01197604	0.01197604	0.0276248	14.341	14.329
61	CWR-REC	257.00	3.0729	0.04790417	0.04790417	0.1104994	14.329	14.281
62	CWS-18"	2,427.00	3.9305	0.37155327	0.37155327	0.8570527	25.884	25.512
63	CWS-WHI	287.00	3.4316	0.14598310	0.14598310	0.3367356	26.958	26.812
64	CWS-WHI	287.00	3.4316	0.01459831	0.01459831	0.0336736	13.355	13.341
65	CWR-WHI	287.00	3.4316	0.14598310	0.14598310	0.3367356	13.341	13.195
66	CWS-18"	4,671.00	7.5647	0.74143004	0.74143004	1.7102383	27.393	26.652
67	CWS-12"	919.00	2.9662	0.25529262	0.25529262	0.5888772	27.736	27.480
68	CWS-HSC	919.00	6.4841	1.34046733	1.34046733	3.0920227	27.245	25.905
69	CWS-HSC	919.00	6.4841	0.03351168	0.03351168	0.0773006	13.919	13.886
70	CWR-HSC	919.00	6.4841	1.34046733	1.34046733	3.0920227	13.886	12.545
71	CWR-12"	919.00	2.9662	0.25529262	0.25529262	0.5888772	12.713	12.458
72	CWR-18"	4,670.89	7.5645	0.74139702	0.74139702	1.7101621	12.889	12.147
73	CWR-18"	4,383.89	7.0997	0.66041791	0.66041791	1.5233696	13.595	12.935
74	CWR-18"	2,169.87	3.5141	0.11027854	0.11027854	0.2543768	14.372	14.262
75	CWR-18"	4,192.00	6.7889	0.51733422	0.51733422	1.1933220	14.145	13.627
76	CWR-18"	4,431.00	7.1760	0.57241380	0.57241380	1.3203727	13.591	13.019
77	CWR-18"	6,361.89	5.7955	0.40599182	0.40599182	0.9364913	14.635	14.229
78	CWS-10"	-1,206.72	-1.9543	-0.11140587	-0.11140587	-0.2569772	24.963	25.074
79	CWS-10"	1,206.72	5.4781	0.91110200	0.91110200	2.1016164	24.787	23.876
80	CWS-10"	1,171.72	1.8976	0.09659737	0.09659737	0.2228188	24.053	23.957
81	CWS-10"	1,266.00	5.7472	0.16564286	0.16564286	0.3820843	23.178	23.012
83	CWS-MO	259.00	3.0969	0.19429745	0.19429745	0.4481811	26.989	26.794
84	CWS-MO	259.00	3.0969	0.01214359	0.01214359	0.0280113	13.050	13.038
85	CWR-MO	259.00	3.0969	0.19429745	0.19429745	0.4481811	13.038	12.844
86	CWS-18"	822.00	1.3312	0.02873162	0.02873162	0.0662745	27.041	27.013
87	CWR-12"	822.00	2.6531	0.40927899	0.40927899	0.9440737	26.975	26.566
88	CWS-12"	822.00	2.6531	0.40927899	0.40927899	0.9440737	13.308	12.899
89	Pipe	822.00	2.6531	0.09187896	0.09187896	0.2119349	26.566	26.474
90	CWS-WING	326.00	2.3001	0.02071621	0.02071621	0.0477856	26.485	26.465
91	CWS-WING	326.00	2.3001	0.00517905	0.00517905	0.0119464	13.437	13.432
92	CWR-WING	326.00	2.3001	0.02071621	0.02071621	0.0477856	13.432	13.411
93	Pipe	496.00	2.2517	0.02290856	0.02290856	0.0528426	26.487	26.464
94	Pipe	496.00	3.4996	0.08801495	0.08801495	0.2030219	26.416	26.328
95	CWS-CART	0.00	0.0000	0.00000000	0.00000000	0.0000000	26.410	26.410
97	CWR-CART	0.00	0.0000	0.00000000	0.00000000	0.0000000	13.558	13.558
98	Pipe	496.00	3.4996	0.08801495	0.08801495	0.2030219	13.476	13.388
99	Pipe	496.00	2.2517	0.02290856	0.02290856	0.0528426	13.436	13.413
100	Pipe	822.00	2.6531	0.09187896	0.09187896	0.2119349	13.400	13.308
101	CWS-GR	496.00	3.4996	0.01100187	0.01100187	0.0253777	26.328	26.317
102	CWS-GR	496.00	3.4996	0.01100187	0.01100187	0.0253777	13.498	13.487

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
103	CWR-GR	496.00	3.4996	0.01100187	0.01100187	0.0253777	13.487	13.476
104	CWR-18"PLT	7,900.00	10.8452	0.29854968	0.29854968	0.6886571	5.197	4.898
105	CWR-18"	8,640.00	11.8611	0.08860863	0.08860863	0.2043913	4.490	4.401
106	CWR-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	5.112	5.088
107	CWR-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	5.112	5.088
108	CWR-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	5.047	5.024
109	CWR-18"	4,320.00	5.9306	0.01185600	0.01185600	0.0273479	34.120	34.108
110	CWS-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	34.108	34.084
111	CWS-18"PLT	7,900.00	10.8452	0.37318712	0.37318712	0.8608215	33.440	33.067
113	CWS-18"PLT	4,320.00	5.9306	0.09484801	0.09484801	0.2187836	34.179	34.084
114	CWR-18"	4,320.00	5.9306	0.01185600	0.01185600	0.0273479	34.256	34.244
115	CWS-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	34.244	34.220
116	CWR-18"	822.00	1.3312	0.02873162	0.02873162	0.0662745	12.925	12.896
117	CWR-18"	1,081.00	1.7507	0.12010738	0.12010738	0.2770487	12.888	12.768
118	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	26.613	26.613
119	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	13.355	13.355
120	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	26.498	26.498
121	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	13.470	13.470
122	CWS-LIB AD	174.00	2.0805	0.03578111	0.03578111	0.0825354	26.567	26.531
123	CWS-LIB AD	174.00	2.0805	0.00596352	0.00596352	0.0137559	13.378	13.372
124	CWS-LIB ADD	174.00	2.0805	0.03578111	0.03578111	0.0825354	13.372	13.336
125	CWR-18"	4,605.00	7.4578	0.65017200	0.65017200	1.4997356	12.991	12.341
126	CWR-18"-2	6,764.00	10.9543	2.55416179	2.55416179	5.8916216	11.907	9.353
127	CWR-18"	2,159.00	3.4965	0.07285292	0.07285292	0.1680480	12.706	12.633
128	CWS-18"	4,431.00	7.1760	0.57241380	0.57241380	1.3203727	26.249	25.677
129	CWS-18"	3,279.00	5.3103	0.38902974	0.38902974	0.8973653	26.187	25.798
130	CWR-18"	2,426.87	3.9303	0.37151757	0.37151757	0.8569704	14.241	13.869
131	CWS-8"	852.00	6.0114	1.63617206	1.63617206	3.7741175	25.745	24.108
132	CWS-8"	852.00	6.0114	1.05182481	1.05182481	2.4262182	24.060	23.008
133	CWS-RES	852.00	6.0114	1.05182481	1.05182481	2.4262182	22.960	21.908
134	CWR-8"	852.00	6.0114	1.63617206	1.63617206	3.7741175	15.366	13.730
135	CWS-RES	852.00	6.0114	0.02921736	0.02921736	0.0673950	17.596	17.567
136	CWR-RES	852.00	6.0114	1.05182481	1.05182481	2.4262182	17.567	16.515
137	CWR-8"	852.00	6.0114	1.05182481	1.05182481	2.4262182	16.466	15.415
138	CWR-18"-2	7,690.00	12.4539	3.23171806	3.23171806	7.4545239	9.116	5.885
140	CWS-SAN	221.00	2.8351	0.08654596	0.08654596	0.1996334	23.081	22.994
141	CWS-SAN	221.00	2.6425	0.00913951	0.00913951	0.0210819	16.862	16.853
142	CWR-SAN	221.00	2.6425	0.07311608	0.07311608	0.1686550	16.853	16.779
143	CWS-10"	635.00	7.5927	0.61103547	0.61103547	1.4094604	22.746	22.135
144	CWS-10"	856.00	3.8860	0.04079258	0.04079258	0.0940952	23.074	23.033
145	CWS-WHITE	193.00	2.3077	0.17219231	0.17219231	0.3971917	23.140	22.968
146	CWS-WHITE	193.00	2.3077	0.00717468	0.00717468	0.0165497	16.929	16.922
147	CWR-WHITE	193.00	2.3077	0.17219231	0.17219231	0.3971917	16.922	16.750
148	CWR-10"	855.86	3.8853	0.04078090	0.04078090	0.0940683	16.725	16.684
149	CWR-10"	1,048.87	4.7615	0.05889934	0.05889934	0.1358616	16.633	16.574
150	CWS-10"	1,049.00	4.7621	0.05891310	0.05891310	0.1358934	23.082	23.023
151	CWR-10"	1,265.87	5.7466	0.16561107	0.16561107	0.3820110	16.504	16.339
152	CWS-LAUX	217.00	2.5947	0.42460114	0.42460114	0.9794169	23.189	22.765
153	CWS-LAUX	217.00	2.5947	0.07076685	0.07076685	0.1632361	22.755	22.684
154	CWR-LAUX	217.00	2.5947	0.42460114	0.42460114	0.9794169	17.106	16.681
155	CWS-LAUX	217.00	2.5947	0.00884586	0.00884586	0.0204045	17.195	17.186
156	CWR-LAUX	217.00	2.5947	0.07076685	0.07076685	0.1632361	17.186	17.116
159	CWR-UNION	1,277.00	5.7971	0.12619659	0.12619659	0.2910946	15.854	15.728
160	CWR-10"-UN	-1,539.20	-4.9680	-0.12975860	-0.12975860	-0.2993109	15.658	15.788

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
161	CWS-UNION	1,277.00	5.7971	0.02103277	0.02103277	0.0485158	15.875	15.854
162	CWS-UNION	1,277.00	5.7971	0.12619659	0.12619659	0.2910946	23.781	23.654
163	CWS-10"-UN	-1,539.28	-4.9682	-0.12977104	-0.12977104	-0.2993396	23.841	23.971
167	CWS-COW I	3,187.00	10.2865	0.29278907	0.29278907	0.6753693	23.147	22.854
168	CWS-COW I	3,187.00	10.2865	0.04879818	0.04879818	0.1125615	15.730	15.681
169	CWR-COW I	3,187.00	10.2865	0.29278907	0.29278907	0.6753693	15.681	15.389
176	CWS-WHI	287.00	3.1872	0.01317683	0.01317683	0.0303947	26.823	26.810
177	CWS-18"	4,384.00	7.0999	0.66044867	0.66044867	1.5234406	26.698	26.037
178	CWR-18"	3,278.90	5.3102	0.03890057	0.03890057	0.0897310	13.784	13.745
179	CWS-8"	1,105.00	7.7964	1.12348461	1.12348461	2.5915141	25.968	24.844
180	CWR-8"	1,105.00	7.7964	1.12348461	1.12348461	2.5915141	14.649	13.525
181	CWS-ANG	329.00	3.9338	0.74626178	0.74626178	1.7213835	25.149	24.403
182	CWS-ANG	329.00	3.9338	0.01865654	0.01865654	0.0430346	15.719	15.700
183	CWR-ANG	329.00	3.9338	0.74626178	0.74626178	1.7213835	15.700	14.954
184	CWS-DRA	246.00	2.9414	0.01107324	0.01107324	0.0255424	15.336	15.325
185	CWS-DRA	246.00	2.9414	0.17717186	0.17717186	0.4086779	25.047	24.870
186	CWR-DRA	246.00	2.9414	0.17717186	0.17717186	0.4086779	15.325	15.148
187	CWR-8"	776.00	5.4752	0.14803122	0.14803122	0.3414599	15.004	14.856
188	CWS-8"	776.00	5.4752	0.14803122	0.14803122	0.3414599	25.052	24.904
189	CWS-HUT	313.00	3.7425	0.01705787	0.01705787	0.0393470	16.283	16.266
190	CWS-HUT	313.00	3.7425	0.27292585	0.27292585	0.6295513	24.130	23.857
191	CWS-6"	530.00	6.3372	0.88120133	0.88120133	2.0326452	24.835	23.954
192	CWR-6"	313.00	3.7425	0.27292585	0.27292585	0.6295513	16.266	15.993
193	CWR-6"	530.00	6.3372	0.88120133	0.88120133	2.0326452	15.817	14.936
194	CWS-6"	217.00	2.5947	0.10615028	0.10615028	0.2448542	24.179	24.073
195	CWR-6"	217.00	2.5947	0.10615028	0.10615028	0.2448542	16.148	16.042
196	CWS-WEN	217.00	2.5947	0.00884586	0.00884586	0.0204045	16.344	16.335
197	CWS-WEN	217.00	2.5947	0.17691714	0.17691714	0.4080904	24.063	23.886
198	CWR-WEN	217.00	2.5947	0.17691714	0.17691714	0.4080904	16.335	16.158
201	CWR-6"	329.00	0.5328	0.00747643	0.00747643	0.0172457	12.571	12.563
202	CWR-COA	329.00	3.9338	0.29850471	0.29850471	0.6885534	12.863	12.565
203	CWS-COA	329.00	3.9338	0.01865654	0.01865654	0.0430346	12.882	12.863
204	CWS-COA	329.00	3.9338	0.29850471	0.29850471	0.6885534	27.538	27.240
205	CWS-6"	329.00	0.5328	0.00747643	0.00747643	0.0172457	27.745	27.737
206	CWR-NW-2	1,097.00	1.7766	0.03217183	0.03217183	0.0742100	12.544	12.512
207	CWS-NW-2	1,097.00	1.7766	0.03217183	0.03217183	0.0742100	27.758	27.726
223	CWS-18 PLT	8,640.00	11.8611	0.08860863	0.08860863	0.2043913	33.373	33.285
224	CWS	740.00	1.1984	0.00528833	0.00528833	0.0121985	34.223	34.217
225	CWS-MIT	740.00	5.2212	1.08676529	1.08676529	2.5068145	34.015	32.929
226	CWS-MIT	740.00	5.2212	0.02264094	0.02264094	0.0522253	6.650	6.627
227	CWR-MIT	740.00	5.2212	1.08676529	1.08676529	2.5068145	6.627	5.540
228	CWR-MIT	740.00	1.1984	0.00528833	0.00528833	0.0121985	5.686	5.681
229	CWR-PLT	8,640.00	11.8611	0.08860863	0.08860863	0.2043913	4.743	4.654
232	Pipe	501.00	6.4270	0.04713962	0.04713962	0.1087358	17.769	17.722
237	CWR-18-1	7,900.00	12.7940	0.58209026	0.58209026	1.3426932	5.827	5.245
238	CWS-18-2	7,690.00	12.4539	3.23171806	3.23171806	7.4545239	31.987	28.755
239	CWS-WIT	210.00	2.5110	0.10010774	0.10010774	0.2309161	32.990	32.889
240	CWR-WIT	210.00	2.5110	0.10010774	0.10010774	0.2309161	6.987	6.887
241	CWS-WIT	210.00	0.3401	0.00007040	0.00007040	0.0001624	7.029	7.029
243	Pipe	-1,433.87	-6.5093	-0.41526672	-0.41526672	-0.9578854	15.695	16.110
244	Pipe	-1,266.00	-5.7472	-0.16564286	-0.16564286	-0.3820843	23.178	23.343
X245	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	34.199	23.400
X246	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	23.400	24.137
247	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	23.400	23.400

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
248	Pipe	740.00	1.1984	0.02644163	0.02644163	0.0609923	5.714	5.688
X249	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	16.561	5.724
X250	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	15.825	16.561
251	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	16.561	16.561
252	Pipe	740.00	1.1984	0.02644163	0.02644163	0.0609923	34.216	34.189
253	Pipe	-1,539.28	-4.9682	-0.05190840	-0.05190840	-0.1197358	23.971	24.022
254	Pipe	3,187.00	10.2865	0.19519271	0.19519271	0.4502462	23.476	23.281
255	Pipe	3,187.00	10.2865	0.19519271	0.19519271	0.4502462	15.255	15.060
256	Pipe	-1,539.20	-4.9680	-0.05190260	-0.05190260	-0.1197224	15.606	15.658
257	Pipe	5,767.89	5.2543	0.06790082	0.06790082	0.1566251	12.347	12.279
258	Pipe	6,686.89	10.8294	0.35729367	0.35729367	0.8241604	11.675	11.318
259	Pipe	6,686.89	10.8294	0.21437620	0.21437620	0.4944963	11.061	10.846
260	Pipe	6,686.89	10.8294	0.07145873	0.07145873	0.1648321	10.703	10.631
261	Pipe	6,686.89	10.8294	0.07145821	0.07145821	0.1648309	10.487	10.416
262	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	10.421	10.315
263	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	10.421	10.315
264	Pipe	919.00	2.9662	0.04084682	0.04084682	0.0942203	27.788	27.747
265	Pipe	5,768.00	5.2544	0.06790335	0.06790335	0.1566310	27.661	27.593
266	Pipe	6,687.00	10.8296	0.07146091	0.07146091	0.1648371	27.128	27.057
267	Pipe	919.00	2.9662	0.04084682	0.04084682	0.0942203	12.446	12.406
268	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	10.168	10.061
269	Pipe	3,343.49	10.7916	0.10653199	0.10653199	0.2457347	9.694	9.588
270	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	28.000	27.893
271	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	27.893	27.787
272	Pipe	3,343.49	10.7916	0.10655871	0.10655871	0.2457963	27.640	27.533
273	Pipe	3,343.49	10.7916	0.10655871	0.10655871	0.2457963	27.640	27.533
274	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	10.168	10.061
275	Pipe	3,343.49	10.7916	0.10653199	0.10653199	0.2457347	9.694	9.588
276	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	28.000	27.893
277	Pipe	3,343.49	10.7916	0.10653110	0.10653110	0.2457326	27.893	27.787
278	Pipe	6,687.00	10.8296	0.07146092	0.07146092	0.1648371	27.528	27.456
279	Pipe	6,687.00	10.8296	0.07146092	0.07146092	0.1648371	27.456	27.385
280	Pipe	768.00	5.4187	0.29056472	0.29056472	0.6702384	27.549	27.258
281	Pipe	768.00	5.4187	0.04842745	0.04842745	0.1117064	12.706	12.658
282	Pipe	768.00	5.4187	0.29056472	0.29056472	0.6702384	12.658	12.367
X283	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	27.739	24.989
X284	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	14.973	12.572
285	Pipe	329.00	3.9338	0.07462618	0.07462618	0.1721384	12.543	12.468
286	Pipe	329.00	3.9338	0.07462618	0.07462618	0.1721384	27.635	27.560
287	Pipe	-1,434.00	-6.5099	-0.41533729	-0.41533729	-0.9580482	23.280	23.696
288	Pipe	-262.28	-0.8465	-0.02595379	-0.02595379	-0.0598670	23.976	24.002
289	Pipe	1,171.69	1.8975	0.09659189	0.09659189	0.2228061	15.956	15.859
290	Pipe	-262.18	-0.8462	-0.02593594	-0.02593594	-0.0598258	15.950	15.976
291	Pipe	4,726.20	7.6540	0.37875310	0.37875310	0.8736604	15.378	14.999
292	Pipe	4,726.28	7.6542	0.37876529	0.37876529	0.8736885	24.173	23.794

All Junction Table

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
1	Valve	33.067	32.511	33.859	33.614	7,900.00
5	Valve	5.245	5.197	6.347	5.989	7,900.00

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
11	Tee or Wye	29.129	29.129	29.800	29.800	N/A
12	CV-CEN	27.825	11.596	28.112	11.883	926.00
13	HX-CEN	11.562	11.562	11.849	11.849	926.00
14	Tee or Wye	9.490	9.490	10.161	10.161	N/A
15	Bend	28.018	27.961	28.305	28.248	926.00
16	Bend	11.426	11.369	11.713	11.656	926.00
17	Tee or Wye	26.887	26.887	27.246	27.246	N/A
18	Tee or Wye	12.356	12.356	12.715	12.715	N/A
19	Tee or Wye	27.050	27.050	27.173	27.173	N/A
20	Tee or Wye	12.665	12.665	12.788	12.788	N/A
27	CV-Arts	24.814	14.413	25.204	14.802	1,078.00
28	HX-ARTS	14.368	14.368	14.758	14.758	1,078.00
29	CV-Library	25.842	14.020	25.897	14.075	239.00
30	Tee or Wye	25.812	25.812	26.024	26.024	N/A
31	HX- LIB AD	14.009	14.009	14.064	14.064	239.00
32	Tee or Wye	13.726	13.726	13.938	13.938	N/A
33	Tee or Wye	25.312	25.312	25.506	25.506	N/A
35	CV-WIM	24.360	15.277	24.537	15.454	429.00
36	HX-WIM	15.247	15.247	15.424	15.424	429.00
37	Tee or Wye	14.261	14.261	14.455	14.455	N/A
43	Tee or Wye	15.832	15.832	15.884	15.884	N/A
44	Tee or Wye	24.026	24.026	24.078	24.078	N/A
45	CV-Police	23.970	15.982	23.976	15.988	35.00
46	HX-POL	15.980	15.980	15.986	15.986	35.00
48	Bend	17.857	17.769	18.098	18.047	501.00
50	CV-Reuter	21.076	17.936	21.318	18.178	501.00
51	HX-REU	17.896	17.896	18.138	18.138	501.00
52	Bend	21.167	21.116	21.409	21.358	501.00
53	Tee or Wye	16.462	16.462	16.561	16.561	N/A
54	CV-Alumni	21.794	17.947	21.922	18.075	168.00
55	HX-ALU	17.912	17.912	18.039	18.039	168.00
56	Tee or Wye	23.301	23.301	23.400	23.400	N/A
57	Tee or Wye	16.804	16.804	16.886	16.886	N/A
58	CV-STA	22.256	17.116	22.273	17.133	134.00
59	Bend	17.112	17.108	17.129	17.126	134.00
60	Tee or Wye	22.351	22.351	22.524	22.524	N/A
61	Bend	22.267	22.263	22.284	22.280	134.00
62	HX-STA	22.259	22.259	22.277	22.277	134.00
63	Tee or Wye	25.534	25.534	25.617	25.617	N/A
64	CV-Rec Center	25.505	14.341	25.569	14.405	257.00
65	HX-REC	14.329	14.329	14.393	14.393	257.00
66	Tee or Wye	14.262	14.262	14.345	14.345	N/A
67	Tee or Wye	13.029	13.029	13.274	13.274	N/A
68	Tee or Wye	26.792	26.792	27.038	27.038	N/A
69	CV-WHI	26.810	13.355	26.878	13.435	287.00
70	HX-WHI	13.341	13.341	13.420	13.420	287.00
71	CV-HSC	25.905	13.919	26.188	14.202	919.00
72	Bend	27.480	27.245	27.540	27.529	919.00
75	HX-HSC	13.886	13.886	14.169	14.169	919.00
76	Bend	12.545	12.713	12.828	12.772	919.00
77	Bend	27.013	26.975	27.024	27.022	822.00
78	Bend	12.899	12.925	12.946	12.937	822.00
79	Tee or Wye	27.025	27.025	27.053	27.053	N/A
80	CV-Morris	26.794	13.050	26.859	13.115	259.00

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
81	HX-MO	13.038	13.038	13.103	13.103	259.00
82	Tee or Wye	12.880	12.880	12.908	12.908	N/A
85	Tee or Wye	26.482	26.482	26.521	26.521	N/A
86	CV-Wing	26.465	13.437	26.500	13.473	326.00
87	HX-WING	13.432	13.432	13.468	13.468	326.00
88	Tee or Wye	13.408	13.408	13.447	13.447	N/A
91	Tee or Wye	26.374	26.374	26.410	26.410	N/A
92	Tee or Wye	13.521	13.521	13.558	13.558	N/A
95	CV-Graff	26.317	13.498	26.399	13.580	496.00
96	HX-GR	13.487	13.487	13.569	13.569	496.00
97	Check Valve	34.108	34.108	34.345	34.345	4,320.00
99	EXST P#2	5.088	34.120	5.325	34.357	4,320.00
100	EXST P#1	5.024	34.256	5.261	34.493	4,320.00
101	Bend	34.220	34.179	34.457	34.416	4,320.00
102	Tee or Wye	33.900	33.900	34.321	34.321	N/A
104	Bend	5.088	5.047	5.325	5.284	4,320.00
105	Tee or Wye	4.928	4.928	5.349	5.349	N/A
106	Bend	4.654	4.490	5.602	5.438	8,640.00
107	Tee or Wye	26.592	26.592	26.613	26.613	N/A
108	Dead End	26.613	26.613	26.613	26.613	0.00
109	Dead End	13.355	13.355	13.355	13.355	0.00
110	Tee or Wye	13.334	13.334	13.355	13.355	N/A
111	Tee or Wye	26.473	26.473	26.498	26.498	N/A
112	Dead End	26.498	26.498	26.498	26.498	0.00
113	Tee or Wye	13.445	13.445	13.470	13.470	N/A
114	Dead End	13.470	13.470	13.470	13.470	0.00
115	Tee or Wye	14.667	14.667	14.861	14.861	N/A
116	Tee or Wye	24.906	24.906	25.100	25.100	N/A
117	CV- LIB ADD	26.531	13.378	26.560	13.407	174.00
118	HX-LIB	13.372	13.372	13.401	13.401	174.00
119	Tee or Wye	26.387	26.387	26.596	26.596	N/A
120	Tee or Wye	13.156	13.156	13.366	13.366	N/A
121	Tee or Wye	13.799	13.799	13.974	13.974	N/A
122	Tee or Wye	25.814	25.814	25.988	25.988	N/A
123	CV-NEW RES	21.908	17.596	22.151	17.839	852.00
124	Bend	24.108	24.060	24.352	24.304	852.00
125	Bend	23.008	22.960	23.252	23.203	852.00
126	Bend	15.415	15.366	15.658	15.610	852.00
127	Bend	16.515	16.466	16.758	16.710	852.00
128	HX-RES	17.567	17.567	17.810	17.810	852.00
129	Tee or Wye	16.760	16.760	16.827	16.827	N/A
130	Tee or Wye	22.981	22.981	23.135	23.135	N/A
131	HX-SAN	16.853	16.853	16.900	16.900	221.00
132	CV-San	22.994	16.862	23.048	16.909	221.00
133	Tee or Wye	23.086	23.086	23.176	23.176	N/A
134	Tee or Wye	16.696	16.696	16.786	16.786	N/A
135	CV-WHITE	22.968	16.929	23.003	16.965	193.00
136	HX-WHITE	16.922	16.922	16.958	16.958	193.00
137	Tee or Wye	23.106	23.106	23.234	23.234	N/A
138	Tee or Wye	16.598	16.598	16.727	16.727	N/A
139	CV-LAUX	22.684	17.195	22.730	17.241	217.00
140	HX-LAUX	17.186	17.186	17.232	17.232	217.00
141	Bend	22.765	22.755	22.810	22.800	217.00
142	Bend	17.116	17.106	17.161	17.151	217.00

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
149	CV-UNION	23.654	15.875	23.881	16.102	1,277.00
151	HX-UNION	15.854	15.854	16.081	16.081	1,277.00
153	CV-COW I	22.854	15.730	23.567	16.443	3,187.00
154	HX-COW I	15.681	15.681	16.394	16.394	3,187.00
162	Tee or Wye	26.071	26.071	26.377	26.377	N/A
163	Tee or Wye	13.629	13.629	13.935	13.935	N/A
164	Tee or Wye	25.032	25.032	25.254	25.254	N/A
165	Tee or Wye	14.837	14.837	15.058	15.058	N/A
166	CV-ANG	24.403	15.719	24.507	15.823	329.00
167	HX-ANG	15.700	15.700	15.804	15.804	329.00
168	CV-DRA	24.870	15.336	24.928	15.394	246.00
169	HX-DRA	15.325	15.325	15.383	15.383	246.00
170	Tee or Wye	24.943	24.943	25.106	25.106	N/A
171	Tee or Wye	15.043	15.043	15.206	15.206	N/A
172	Tee or Wye	24.104	24.104	24.224	24.224	N/A
173	Tee or Wye	15.967	15.967	16.087	16.087	N/A
174	CV-HUT	23.857	16.283	23.951	16.377	313.00
175	HX-HUT	16.266	16.266	16.360	16.360	313.00
176	Bend	16.158	16.148	16.203	16.193	217.00
177	Bend	24.073	24.063	24.118	24.109	217.00
178	CV-WEN	23.886	16.344	23.932	16.389	217.00
179	HX-WEN	16.335	16.335	16.380	16.380	217.00
184	Tee or Wye	27.702	27.702	27.747	27.747	N/A
185	Tee or Wye	12.520	12.520	12.565	12.565	N/A
186	CV-COA	27.240	12.882	27.344	12.986	329.00
187	Bend	27.560	27.538	27.665	27.643	329.00
188	Bend	12.565	12.543	12.669	12.647	329.00
189	HX-COA	12.863	12.863	12.968	12.968	329.00
190	Valve-NW-S	27.385	27.128	28.175	27.918	6,687.00
191	Valve-NW-R	11.318	11.061	12.108	11.851	6,686.89
192	P-NW-#1	9.588	28.000	10.372	28.785	3,343.49
193	P-NW-#2	9.588	28.000	10.372	28.785	3,343.49
194	Bend	27.787	27.640	28.572	28.425	3,343.49
195	CXV-NW-P2	27.893	27.893	28.678	28.678	3,343.49
196	CXV-NW-P1	27.893	27.893	28.678	28.678	3,343.49
198	Bend	10.315	10.168	11.099	10.952	3,343.49
201	R-NW-P#1	10.061	9.694	10.846	10.479	3,343.49
202	R-NW-P#2	10.061	9.694	10.846	10.479	3,343.49
203	Dead End	26.410	26.410	26.410	26.410	0.00
204	Dead End	13.558	13.558	13.558	13.558	0.00
205	CV-MIT	32.929	6.650	33.112	6.833	740.00
206	HX-MIT	6.627	6.627	6.811	6.811	740.00
207	Tee or Wye	33.805	33.805	34.232	34.232	N/A
208	Bend	34.217	34.216	34.227	34.225	740.00
209	Bend	5.688	5.686	5.698	5.696	740.00
210	Tee or Wye	5.263	5.263	5.690	5.690	N/A
211	Branch	26.812	26.823	26.892	26.892	287.00
214	Assigned Pressure	N/A	N/A	18.000	18.000	N/A
215	Check Valve	34.244	34.244	34.481	34.481	4,320.00
217	Tee or Wye	27.532	27.532	28.318	28.318	N/A
218	Bend	27.787	27.640	28.572	28.425	3,343.49
219	Tee or Wye	10.419	10.419	11.206	11.206	N/A
220	Bend	10.315	10.168	11.099	10.952	3,343.49
221	Bend	10.631	10.487	11.421	11.277	6,686.89

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
222	Branch	27.456	27.456	28.247	28.247	6,687.00
223	Tee or Wye	32.455	32.455	33.032	33.032	N/A
224	Tee or Wye	6.353	6.353	6.930	6.930	N/A
225	CV-WIT	32.889	7.029	32.932	7.030	210.00
226	HX-WIT	7.029	6.987	7.030	7.030	210.00
229	Tee or Wye	16.189	16.189	16.396	16.396	N/A
230	Tee or Wye	23.359	23.359	23.566	23.566	N/A
231	Bend	23.281	23.147	23.994	23.860	3,187.00
232	Bend	15.389	15.255	16.101	15.968	3,187.00
235	Tee or Wye	24.063	24.063	24.137	24.137	N/A
236	Tee or Wye	15.751	15.751	15.825	15.825	N/A
237	Tee or Wye	34.168	34.168	34.199	34.199	N/A
238	Tee or Wye	23.400	23.400	23.400	23.400	N/A
239	Tee or Wye	5.693	5.693	5.724	5.724	N/A
240	Tee or Wye	16.561	16.561	16.561	16.561	N/A
247	Tee or Wye	12.373	12.373	12.533	12.533	N/A
248	Tee or Wye	27.620	27.620	27.779	27.779	N/A
250	Bend	10.846	10.703	11.636	11.493	6,686.89
251	Tee or Wye	12.193	12.193	12.465	12.465	N/A
252	Tee or Wye	27.575	27.575	27.847	27.847	N/A
253	Bend	27.747	27.736	27.806	27.795	919.00
254	Bend	12.458	12.446	12.517	12.506	919.00
255	CV-NEW Dorm	27.258	12.706	27.456	12.904	768.00
256	Heat Exchanger	12.658	12.658	12.856	12.856	768.00
257	Tee or Wye	24.947	24.947	24.989	24.989	N/A
258	Tee or Wye	27.724	27.724	27.739	27.739	N/A
259	Tee or Wye	14.931	14.931	14.973	14.973	N/A
260	Tee or Wye	12.558	12.558	12.572	12.572	N/A
261	Tee or Wye	15.853	15.853	15.954	15.954	N/A
262	Tee or Wye	23.906	23.906	24.007	24.007	N/A
263	Tee or Wye	15.916	15.916	15.980	15.980	N/A
264	Tee or Wye	23.917	23.917	23.981	23.981	N/A
265	Tee or Wye	23.796	23.796	24.189	24.189	N/A
266	Tee or Wye	24.233	24.233	24.568	24.568	N/A
267	Tee or Wye	15.060	15.060	15.394	15.394	N/A
268	Tee or Wye	15.380	15.380	15.773	15.773	N/A

General

Title: AFT Fathom Model
Analysis run on: 11/28/2012 10:28:15 AM
Application version: AFT Fathom Version 7.0 (2008.12.03)
Input File: E:\212jobs\212116.00\hvac\calcs\CHW Flow Model UNION Plant gpm.fth
Output File: E:\212jobs\212116.00\hvac\calcs\CHW Flow Model UNION Plant gpm_1.out

Execution Time= 0.83 seconds
Total Number Of Head/Pressure Iterations= 41
Total Number Of Flow Iterations= 11
Total Number Of Temperature Iterations= 0
Number Of Pipes= 220
Number Of Junctions= 189
Matrix Method= Gaussian Elimination

Pressure/Head Tolerance= 0.0001 relative change
Flow Rate Tolerance= 0.0001 relative change
Flow Relaxation= (Automatic)
Pressure Relaxation= (Automatic)

Constant Fluid Property Model
Fluid Database: AFT Standard
Fluid: Water at 1 atm
Max Fluid Temperature Data= 212 deg. F
Min Fluid Temperature Data= 32 deg. F
Temperature= 42 deg. F
Density= 62.42752 lbm/ft3
Viscosity= 3.62639 lbm/hr-ft
Vapor Pressure= 0.12804 psia
Viscosity Model= Newtonian

Atmospheric Pressure= 1 atm
Gravitational Acceleration= 1 g
Turbulent Flow Above Reynolds Number= 4000
Laminar Flow Below Reynolds Number= 2300

Total Inflow= 0.5026 gal/min
Total Outflow= 0.5037 gal/min
Maximum Pressure is 39.02 psia at Junction 100 Outlet
Minimum Pressure is 16.24 psia at Junction 106 Outlet

Pump Summary

Jct	Name	Vol. Flow (gal/min)	dP (psid)	dH (feet)	Overall Efficiency (Percent)	Speed (Percent)	Overall Power (hp)	BEP (gal/min)
99	EXST P#2	4,320	22.04	50.85	100.0	N/A	55.54	N/A
100	EXST P#1	4,320	22.24	51.31	100.0	N/A	56.05	N/A
192	P-UN-#1	3,411	21.53	49.67	100.0	77.74	42.84	N/A
193	P-UN-#2	3,411	21.53	49.65	100.0	63.00	42.82	N/A

Valve Summary

Jct	Name	Valve Type	Vol. Flow (gal/min)	dP Stag. (psid)	dH (feet)	P Inlet Static (psia)	Cv	K	Valve State
1	V-S-EXPLT	REGULAR	7,900.00	0.07203	0.1662	38.74	29,446.879	0.3000	Open
5	V-R-EXPLT	REGULAR	7,900.00	0.10468	0.2415	17.08	24,427.623	0.3000	Open
237	V-P1-UNPLT	REGULAR	3,411.07	0.28703	0.6621	16.80	6,369.580	0.4550	Open
238	V-P2-UNPLT	REGULAR	3,411.07	0.28703	0.6621	16.81	6,369.580	0.4550	Open
12	CV-CEN	FCV	926.00	16.17271	37.3052	35.99	230.357	56.2359	Open
27	CV-Arts	FCV	1,129.00	13.81643	31.8700	34.68	303.864	32.3192	Open

Jct	Name	Valve Type	Vol. Flow (gal/min)	dP Stag. (psid)	dH (feet)	P Inlet Static (psia)	Cv	K	Valve State
29	CV-Library	FCV	239.00	15.73590	36.2976	35.99	60.275	286.0067	Open
35	CV-WIM	FCV	429.00	15.23015	35.1310	35.62	109.973	85.9152	Open
45	CV-Police	FCV	34.00	11.87429	27.3901	34.13	9.871	2,269.6270	Open
50	CV-Reuter	FCV	501.00	3.01668	6.9585	29.23	288.573	12.4777	Open
54	CV-Alumni	FCV	168.00	4.80077	11.0738	30.49	76.707	37.5835	Open
58	CV-STA	FCV	134.00	5.01692	11.5724	30.41	59.851	290.0736	Open
64	CV-Rec Center	FCV	257.00	14.07987	32.4777	35.15	68.520	221.3160	Open
69	CV-WHI	FCV	287.00	10.91375	25.1745	33.38	86.912	159.4689	Open
71	CV-HSC	FCV	919.00	6.26387	14.4487	30.87	367.347	22.1139	Open
80	CV-Morris	FCV	259.00	17.47235	40.3030	36.85	61.988	270.4160	Open
86	CV-Wing	FCV	411.00	16.52311	38.1134	36.38	101.153	291.6493	Open
95	CV-Graff	FCV	496.00	16.32765	37.6626	36.27	122.801	197.8851	Open
117	CV- LIB ADD	FCV	174.00	17.00266	39.2196	36.65	42.216	583.0408	Open
123	CV-NEW RES	FCV	852.00	4.41695	10.1885	30.15	405.566	18.1425	Open
132	CV-San	FCV	221.00	6.01665	13.8785	31.15	90.136	111.1099	Open
135	CV-WHITE	FCV	193.00	5.91548	13.6451	31.12	79.386	164.8753	Open
139	CV-LAUX	FCV	217.00	5.36603	12.3777	30.84	93.716	118.3081	Open
149	CV-UNION	FCV	1,277.00	18.96766	43.7522	37.47	293.337	104.2906	Open
153	CV-COW I	FCV	3,187.00	9.29705	21.4453	31.54	1,045.664	6.5926	Open
166	CV-ANG	FCV	329.00	7.90213	18.2276	31.84	117.086	75.7936	Open
168	CV-DRA	FCV	246.00	8.75183	20.1876	32.31	83.189	150.1444	Open
174	CV-HUT	FCV	313.00	6.79193	15.6668	31.29	120.152	71.9756	Open
178	CV-WEN	FCV	217.00	6.76061	15.5945	31.32	83.493	149.0552	Open
186	CV-COA	FCV	329.00	1.74591	4.0273	28.76	249.096	16.7460	Open
205	CV-MIT	FCV	740.00	19.71950	45.4865	37.85	166.712	107.3706	Open
225	CV-WIT	FCV	210.00	20.98976	48.4165	38.62	45.856	494.1391	Open
240	Control Valve	FCV	768.00	6.37292	14.7002	31.00	304.351	32.2158	Open
97	Check Valve	CHECK	4,320.00	0.00000	0.0000	38.87	N/A	0.0000	Open
215	Check Valve	CHECK	4,320.00	0.00000	0.0000	39.01	N/A	0.0000	Open
235	CV- P1-UNPLT	CHECK	3,411.07	0.00000	0.0000	37.95	N/A	0.0000	Open
236	CV-P2-UNPLT	CHECK	3,411.07	0.00000	0.0000	37.95	N/A	0.0000	Open

Heat Exchanger Summary

Jct	Name	Vol. Flow (gal/min)	dP (psid)	dH (feet)
13	HX-CEN	926.00	0	0
28	HX-ARTS	1,129.00	0	0
31	HX- LIB AD	239.00	0	0
36	HX-WIM	429.00	0	0
46	HX-POL	34.00	0	0
51	HX-REU	501.00	0	0
55	HX-ALU	168.00	0	0
62	HX-STA	134.00	0	0
65	HX-REC	257.00	0	0
70	HX-WHI	287.00	0	0
75	HX-HSC	919.00	0	0
81	HX-MO	259.00	0	0
87	HX-WING	411.00	0	0
96	HX-GR	496.00	0	0
118	HX-LIB	174.00	0	0
128	HX-RES	852.00	0	0

Jct	Name	Vol. Flow (gal/min)	dP (psid)	dH (feet)
131	HX-SAN	221.00	0	0
136	HX-WHITE	193.00	0	0
140	HX-LAUX	217.00	0	0
151	HX-UNION	1,277.00	0	0
154	HX-COW I	3,187.00	0	0
167	HX-ANG	329.00	0	0
169	HX-DRA	246.00	0	0
175	HX-HUT	313.00	0	0
179	HX-WEN	217.00	0	0
189	HX-COA	329.00	0	0
206	HX-MIT	740.00	0	0
226	HX-WIT	210.00	0	0
241	Heat Exchanger	768.00	0	0

Pipe Output Table

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
5	CWS-18"-1	7,900.00	7.1966	0.14473371	0.14473371	0.3338537	38.56	38.42
10	CWS-CEN	926.00	6.5335	1.49493194	1.49493194	3.4483224	37.67	36.18
11	CWS-CEN	926.00	6.5335	0.13590291	0.13590291	0.3134839	36.12	35.99
12	CWS-CEN	926.00	6.5335	0.03397573	0.03397573	0.0783710	19.81	19.78
13	CWR-CEN	926.00	6.5335	0.13590291	0.13590291	0.3134839	19.78	19.64
14	CWR-CEN	926.00	6.5335	1.49493194	1.49493194	3.4483224	19.59	18.09
15	CWS-18"-2	6,764.00	6.1618	0.63569522	0.63569522	1.4663424	37.71	37.07
16	CWS-18"	2,295.00	3.7167	0.08138459	0.08138459	0.1877278	37.23	37.15
17	CWS-18"	1,166.00	1.8883	0.13763994	0.13763994	0.3174906	37.22	37.08
23	CWS-ARTS	1,129.00	7.9658	2.14168286	2.14168286	4.9401667	36.82	34.68
24	CWS-ARTS	1,129.00	7.9658	0.04867461	0.04867461	0.1122765	20.86	20.81
25	CWR-ARTS	1,129.00	7.9658	2.14168286	2.14168286	4.9401667	20.81	18.67
26	CWS-18"	4,469.00	7.2375	0.61560589	0.61560589	1.4200028	36.97	36.36
27	CWS-LIB	239.00	2.8577	0.12618367	0.12618367	0.2910648	36.11	35.99
28	CWS-LIB	239.00	2.8577	0.01051531	0.01051531	0.0242554	20.25	20.24
29	CWR-LIB	239.00	2.8577	0.12618367	0.12618367	0.2910648	20.24	20.12
30	CWS-18"	4,056.00	6.5687	0.48713255	0.48713255	1.1236566	35.88	35.39
31	CWS-18"	461.00	0.7466	0.01418824	0.01418824	0.0327277	35.69	35.68
32	CWS-18"	1,929.00	3.1240	0.13365564	0.13365564	0.3083001	35.76	35.63
33	CWS-WIM	429.00	5.1295	0.03008386	0.03008386	0.0693937	35.65	35.62
34	CWS-WIM	429.00	5.1295	0.03008386	0.03008386	0.0693937	20.39	20.36
35	CWR-WIM	429.00	5.1295	0.03008386	0.03008386	0.0693937	20.36	20.33
36	CWR-18"	1,929.49	3.1248	0.13371760	0.13371760	0.3084431	20.58	20.44
37	CWR-10"	1,468.00	2.3774	0.15863805	0.15863805	0.3659264	20.76	20.61
38	CWR-10"	1,468.00	6.6642	1.30018079	1.30018079	2.9990948	21.86	20.56
39	CWR-POL	34.00	0.8812	0.09671019	0.09671019	0.2230790	22.25	22.16
40	CWS-POL	34.00	0.8812	0.00210240	0.00210240	0.0048495	22.25	22.25
41	CWS-POL	34.00	0.8812	0.09671019	0.09671019	0.2230790	34.23	34.13
43	CWR-REU	501.00	5.9904	1.11453283	1.11453283	2.5708652	26.04	24.92
44	CWR-REU	501.00	5.9904	0.03980475	0.03980475	0.0918166	26.17	26.13
45	CWS-REU	501.00	5.9904	0.03980475	0.03980475	0.0918166	26.21	26.17
46	CWS-REU	501.00	5.9904	0.03980475	0.03980475	0.0918166	29.27	29.23
47	CWS-REU	501.00	5.9904	1.11453283	1.11453283	2.5708652	30.44	29.32
48	CWR-10"	1,434.00	6.5099	1.97285211	1.97285211	4.5507290	23.85	21.88

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
49	CWR-10"	635.00	2.8827	0.05952127	0.05952127	0.1372962	25.11	25.05
50	CWR-ALU	168.00	4.3543	1.64380205	1.64380205	3.7917174	25.65	24.01
51	CWS-ALU	168.00	4.3543	0.03573483	0.03573483	0.0824286	25.69	25.65
52	CWS-ALU	168.00	4.3543	1.64380205	1.64380205	3.7917174	32.13	30.49
53	CWR-STA	134.00	1.6022	0.23969780	0.23969780	0.5529050	25.39	25.15
54	CWR-STA	134.00	1.6022	0.00374528	0.00374528	0.0086391	25.39	25.39
55	CWS-STA	134.00	1.6022	0.00374528	0.00374528	0.0086391	30.41	30.41
56	CWS-STA	134.00	1.6022	0.00374528	0.00374528	0.0086391	30.42	30.41
57	CWS-STA	134.00	1.6022	0.23969780	0.23969780	0.5529050	30.66	30.42
58	CWS-18"	4,517.00	7.3153	0.41848606	0.41848606	0.9653114	35.32	34.90
59	CWS-REC	257.00	3.0729	0.04790417	0.04790417	0.1104994	35.20	35.15
60	CWS-REC	257.00	3.0729	0.01197604	0.01197604	0.0276248	21.07	21.06
61	CWR-REC	257.00	3.0729	0.04790417	0.04790417	0.1104994	21.06	21.01
62	CWS-18"	4,260.00	6.8990	1.03415406	1.03415406	2.3854575	34.94	33.91
63	CWS-WHI	287.00	3.4316	0.14598310	0.14598310	0.3367356	33.53	33.38
64	CWS-WHI	287.00	3.4316	0.01459831	0.01459831	0.0336736	22.46	22.44
65	CWR-WHI	287.00	3.4316	0.14598310	0.14598310	0.3367356	22.44	22.29
66	CWS-12"	2,016.00	6.5069	0.84724301	0.84724301	1.9543144	33.32	32.48
67	CWS-12"	919.00	2.9662	0.25529262	0.25529262	0.5888772	32.70	32.45
68	CWS-HSC	919.00	6.4841	1.34046733	1.34046733	3.0920227	32.21	30.87
69	CWS-HSC	919.00	6.4841	0.03351168	0.03351168	0.0773006	24.61	24.57
70	CWR-HSC	919.00	6.4841	1.34046733	1.34046733	3.0920227	24.57	23.23
71	CWR-12"	919.00	2.9662	0.25529262	0.25529262	0.5888772	23.40	23.14
72	CWR-12"	2,016.00	6.5069	0.84724301	0.84724301	1.9543144	22.92	22.07
73	CWR-18"	2,303.00	3.7297	0.20474946	0.20474946	0.4722905	22.26	22.06
74	CWR-18"	4,517.00	7.3153	0.41848606	0.41848606	0.9653114	20.72	20.30
75	CWR-18"	4,055.51	6.5679	0.48702487	0.48702487	1.1234082	20.37	19.88
76	CWR-18"	4,294.51	6.9549	0.54064614	0.54064614	1.2470950	19.84	19.30
77	CWR-18"	461.49	0.7474	0.01421566	0.01421566	0.0327909	20.65	20.64
78	CWS-10"	1,468.00	2.3774	0.15863805	0.15863805	0.3659264	35.66	35.50
79	CWS-10"	1,468.00	6.6642	1.30018079	1.30018079	2.9990948	35.23	33.93
80	CWS-10"	1,434.00	6.5099	1.97285211	1.97285211	4.5507290	33.95	31.97
81	CWS-10"	1,266.00	5.7472	0.86962503	0.86962503	2.0059425	32.04	31.17
83	CWS-MO	259.00	3.0969	0.19429745	0.19429745	0.4481811	37.04	36.85
84	CWS-MO	259.00	3.0969	0.01214359	0.01214359	0.0280113	19.38	19.36
85	CWR-MO	259.00	3.0969	0.19429745	0.19429745	0.4481811	19.36	19.17
86	CWS-18"	907.00	1.4689	0.03428221	0.03428221	0.0790779	37.09	37.06
87	CWR-12"	907.00	2.9275	0.48865828	0.48865828	1.1271759	37.01	36.52
88	CWS-12"	907.49	2.9290	0.48913422	0.48913422	1.1282738	19.71	19.22
89	Pipe	907.00	2.9275	0.10969879	0.10969879	0.2530395	36.52	36.41
90	CWS-WING	411.00	2.8999	0.03138399	0.03138399	0.0723927	36.41	36.38
91	CWS-WING	411.00	2.8999	0.00784600	0.00784600	0.0180982	19.86	19.85
92	CWR-WING	411.00	2.8999	0.03138399	0.03138399	0.0723927	19.85	19.82
93	Pipe	496.00	2.2517	0.02290856	0.02290856	0.0528426	36.44	36.41
94	Pipe	496.00	3.4996	0.08801495	0.08801495	0.2030219	36.37	36.28
95	CWS-CART	0.00	0.0000	0.00000000	0.00000000	0.0000000	36.36	36.36
97	CWR-CART	0.00	0.0000	0.00000000	0.00000000	0.0000000	19.99	19.99
98	Pipe	496.49	3.5030	0.08817189	0.08817189	0.2033839	19.91	19.82
99	Pipe	496.49	2.2539	0.02295150	0.02295150	0.0529416	19.87	19.84
100	Pipe	907.49	2.9290	0.10980564	0.10980564	0.2532860	19.82	19.71
101	CWS-GR	496.00	3.4996	0.01100187	0.01100187	0.0253777	36.28	36.27
102	CWS-GR	496.00	3.4996	0.01100187	0.01100187	0.0253777	19.94	19.93
103	CWR-GR	496.49	3.5030	0.01102149	0.01102149	0.0254230	19.92	19.91
104	CWR-18"PLT	7,900.00	5.9700	0.06725417	0.06725417	0.1551335	17.09	17.02

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
105	CWR-18"	8,640.00	11.8611	0.08860863	0.08860863	0.2043913	16.24	16.15
106	CWR-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	16.86	16.84
107	CWR-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	16.86	16.84
108	CWR-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	16.80	16.78
109	CWR-18"	4,320.00	5.9306	0.01185600	0.01185600	0.0273479	38.88	38.87
110	CWS-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	38.87	38.85
111	CWS-18"PLT	7,900.00	5.9700	0.08406772	0.08406772	0.1939169	38.83	38.74
113	CWS-18"PLT	4,320.00	5.9306	0.09484801	0.09484801	0.2187836	38.94	38.85
114	CWR-18"	4,320.00	5.9306	0.01185600	0.01185600	0.0273479	39.02	39.01
115	CWS-18"	4,320.00	5.9306	0.02371200	0.02371200	0.0546959	39.01	38.98
116	CWR-18"	907.49	1.4697	0.03432162	0.03432162	0.0791688	19.25	19.22
117	CWR-18"	1,166.49	1.8891	0.13774535	0.13774535	0.3177338	19.21	19.07
118	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	36.58	36.58
119	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	19.77	19.77
120	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	36.45	36.45
121	Pipe	0.00	0.0000	0.00000000	0.00000000	0.0000000	19.90	19.90
122	CWS-LIB AD	174.00	2.0805	0.03578111	0.03578111	0.0825354	36.68	36.65
123	CWS-LIB AD	174.00	2.0805	0.00596352	0.00596352	0.0137559	19.64	19.64
124	CWS-LIB ADD	174.00	2.0805	0.03578111	0.03578111	0.0825354	19.64	19.60
125	CWR-18"	4,468.51	7.2367	0.61548245	0.61548245	1.4197181	19.28	18.66
126	CWR-18"-2	6,764.00	6.1618	0.63569522	0.63569522	1.4663424	18.76	18.12
127	CWR-18"	2,295.49	3.7175	0.08141632	0.08141632	0.1878010	19.00	18.92
128	CWS-18"	4,295.00	6.9557	0.54075897	0.54075897	1.2473553	36.38	35.84
129	CWS-18"	3,408.00	5.5192	0.41733518	0.41733518	0.9626567	34.02	33.61
130	CWR-18"	4,260.00	6.8990	1.03415406	1.03415406	2.3854575	21.79	20.76
131	CWS-8"	852.00	6.0114	1.63617206	1.63617206	3.7741175	33.99	32.35
132	CWS-8"	852.00	6.0114	1.05182481	1.05182481	2.4262182	32.30	31.25
133	CWS-RES	852.00	6.0114	1.05182481	1.05182481	2.4262182	31.20	30.15
134	CWR-8"	852.00	6.0114	1.63617206	1.63617206	3.7741175	23.50	21.87
135	CWS-RES	852.00	6.0114	0.02921736	0.02921736	0.0673950	25.73	25.70
136	CWR-RES	852.00	6.0114	1.05182481	1.05182481	2.4262182	25.70	24.65
137	CWR-8"	852.00	6.0114	1.05182481	1.05182481	2.4262182	24.60	23.55
138	CWR-18"-2	7,690.00	7.0053	0.80368692	0.80368692	1.8538447	18.05	17.24
140	CWS-SAN	221.00	2.8351	0.08654596	0.08654596	0.1996334	31.23	31.15
141	CWS-SAN	221.00	2.6425	0.00913951	0.00913951	0.0210819	25.14	25.13
142	CWR-SAN	221.00	2.6425	0.07311608	0.07311608	0.1686550	25.13	25.06
143	CWS-10"	635.00	7.5927	0.61103547	0.61103547	1.4094604	30.90	30.29
144	CWS-10"	856.00	3.8860	0.04079258	0.04079258	0.0940952	31.23	31.19
145	CWS-WHITE	193.00	2.3077	0.17219231	0.17219231	0.3971917	31.29	31.12
146	CWS-WHITE	193.00	2.3077	0.00717468	0.00717468	0.0165497	25.21	25.20
147	CWR-WHITE	193.00	2.3077	0.17219231	0.17219231	0.3971917	25.20	25.03
148	CWR-10"	856.00	3.8860	0.04079258	0.04079258	0.0940952	25.00	24.96
149	CWR-10"	1,049.00	4.7621	0.05891310	0.05891310	0.1358934	24.91	24.85
150	CWS-10"	1,049.00	4.7621	0.05891310	0.05891310	0.1358934	31.24	31.18
151	CWR-10"	1,266.00	5.7472	0.86962503	0.86962503	2.0059425	24.78	23.91
152	CWS-LAUX	217.00	2.5947	0.42460114	0.42460114	0.9794169	31.34	30.92
153	CWS-LAUX	217.00	2.5947	0.07076685	0.07076685	0.1632361	30.91	30.84
154	CWR-LAUX	217.00	2.5947	0.42460114	0.42460114	0.9794169	25.38	24.96
155	CWS-LAUX	217.00	2.5947	0.00884586	0.00884586	0.0204045	25.47	25.46
156	CWR-LAUX	217.00	2.5947	0.07076685	0.07076685	0.1632361	25.46	25.39
157	CWR-18	2,358.49	3.8196	0.06413558	0.06413558	0.1479400	20.41	20.35
158	CWS-18"	2,358.00	3.8188	0.06411125	0.06411125	0.1478838	35.80	35.73
160	CWR-18	5,545.48	8.9809	0.60873103	0.60873103	1.4041448	18.79	18.18
163	CWS-18-UNPLT	5,545.00	8.9801	0.60863411	0.60863411	1.4039212	37.07	36.46

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
164	CWR-18	5,545.48	8.9809	1.01455176	1.01455176	2.3402414	19.90	18.89
165	CWS-18-UNPLT	5,545.00	8.9801	1.01439023	1.01439023	2.3398688	36.37	35.35
166	CWS-12"	3,187.00	10.2865	2.14711976	2.14711976	4.9527079	35.18	33.03
167	CWS-COW I	3,187.00	14.4679	0.66806275	0.66806275	1.5410038	32.20	31.54
168	CWS-COW I	3,187.00	14.4679	0.11134379	0.11134379	0.2568339	22.24	22.13
169	CWR-COW I	3,187.00	14.4679	0.66806275	0.66806275	1.5410038	22.13	21.46
170	CWR-12"	3,187.00	10.2865	2.14711976	2.14711976	4.9527079	21.88	19.73
176	CWS-WHI	287.00	3.1872	0.01317683	0.01317683	0.0303947	33.39	33.38
177	CWS-18"	2,303.00	3.7297	0.20474946	0.20474946	0.4722905	33.72	33.51
178	CWR-18"	3,408.00	5.5192	0.04173352	0.04173352	0.0962657	21.95	21.91
179	CWS-8"	1,105.00	7.7964	1.12348461	1.12348461	2.5915141	33.40	32.28
180	CWR-8"	1,105.00	7.7964	1.12348461	1.12348461	2.5915141	22.87	21.74
181	CWS-ANG	329.00	3.9338	0.74626178	0.74626178	1.7213835	32.58	31.84
182	CWS-ANG	329.00	3.9338	0.01865654	0.01865654	0.0430346	23.94	23.92
183	CWR-ANG	329.00	3.9338	0.74626178	0.74626178	1.7213835	23.92	23.17
184	CWS-DRA	246.00	2.9414	0.01107324	0.01107324	0.0255424	23.55	23.54
185	CWS-DRA	246.00	2.9414	0.17717186	0.17717186	0.4086779	32.48	32.31
186	CWR-DRA	246.00	2.9414	0.17717186	0.17717186	0.4086779	23.54	23.37
187	CWR-8"	776.00	5.4752	0.14803122	0.14803122	0.3414599	23.22	23.07
188	CWS-8"	776.00	5.4752	0.14803122	0.14803122	0.3414599	32.49	32.34
189	CWS-HUT	313.00	3.7425	0.01705787	0.01705787	0.0393470	24.50	24.48
190	CWS-HUT	313.00	3.7425	0.27292585	0.27292585	0.6295513	31.57	31.29
191	CWS-6"	530.00	6.3372	0.88120133	0.88120133	2.0326452	32.27	31.39
192	CWR-6"	313.00	3.7425	0.27292585	0.27292585	0.6295513	24.48	24.21
193	CWR-6"	530.00	6.3372	0.88120133	0.88120133	2.0326452	24.03	23.15
194	CWS-6"	217.00	2.5947	0.10615028	0.10615028	0.2448542	31.61	31.51
195	CWR-6"	217.00	2.5947	0.10615028	0.10615028	0.2448542	24.37	24.26
196	CWS-WEN	217.00	2.5947	0.00884586	0.00884586	0.0204045	24.56	24.55
197	CWS-WEN	217.00	2.5947	0.17691714	0.17691714	0.4080904	31.50	31.32
198	CWR-WEN	217.00	2.5947	0.17691714	0.17691714	0.4080904	24.55	24.38
199	CWR	1,097.00	7.7400	0.73917288	0.73917288	1.7050317	23.54	22.80
200	CWS	1,097.00	7.7400	0.73917288	0.73917288	1.7050317	32.36	31.62
201	CWR-6"	329.00	3.9338	2.20147204	2.20147204	5.0780810	26.68	24.47
202	CWR-COA	329.00	3.9338	0.29850471	0.29850471	0.6885534	27.00	26.70
203	CWS-COA	329.00	3.9338	0.01865654	0.01865654	0.0430346	27.01	27.00
204	CWS-COA	329.00	3.9338	0.29850471	0.29850471	0.6885534	29.06	28.76
205	CWS-6"	1,097.00	7.7400	0.55437964	0.55437964	1.2787738	31.54	30.98
211	CWS-UN-PLT	3,411.07	4.6828	0.01514172	0.01514172	0.0349270	38.23	38.21
212	CWR-UN-PLT	3,411.07	4.6828	0.01514172	0.01514172	0.0349270	38.23	38.21
213	CWS-12"-UN	3,411.07	9.6765	0.09268320	0.09268320	0.2137900	37.95	37.86
214	CWS-12-UN	3,411.07	9.6765	0.09268320	0.09268320	0.2137900	37.95	37.86
215	CWS-12-UN	3,411.07	9.6765	0.04634160	0.04634160	0.1068950	38.00	37.95
216	CWS-12-UN	3,411.07	9.6765	0.04634160	0.04634160	0.1068950	38.00	37.95
217	CWR-12-UN	3,411.07	9.6765	0.04634079	0.04634079	0.1068931	16.51	16.47
218	CWR-12-UN	3,411.07	9.6765	0.04634079	0.04634079	0.1068931	16.52	16.47
219	CWR-12-NW	3,411.07	9.6765	0.09268320	0.09268320	0.2137900	16.89	16.80
220	CWR-12-UN	3,411.07	9.6765	0.09268320	0.09268320	0.2137900	16.90	16.81
221	CWS-NW-PLT	3,411.07	4.6828	0.01521120	0.01521120	0.0350873	17.42	17.41
223	CWS-18 PLT	8,640.00	6.5292	0.01991252	0.01991252	0.0459317	38.80	38.78
224	CWS-MIT	740.00	5.2212	0.18112755	0.18112755	0.4178024	38.88	38.70
225	CWS-MIT	740.00	5.2212	0.81507397	0.81507397	1.8801109	38.66	37.85
226	CWS-MIT	740.00	5.2212	0.02264094	0.02264094	0.0522253	18.13	18.11
227	CWR-MIT	740.00	5.2212	0.81507397	0.81507397	1.8801109	18.11	17.29
228	CWR-MIT	740.00	5.2212	0.18112755	0.18112755	0.4178024	17.26	17.07

Pipe	Name	Vol. Flow Rate (gal/min)	Velocity (feet/sec)	dP Stag. Total (psid)	dP Static Total (psid)	dH (feet)	P Static In (psia)	P Static Out (psia)
229	CWR-PLT	8,640.00	6.5292	0.01991252	0.01991252	0.0459317	16.97	16.95
232	CWR	501.00	6.4270	0.04713962	0.04713962	0.1087358	26.05	26.00
234	CWR-UN	3,411.07	5.5242	0.01045048	0.01045048	0.0241059	17.37	17.36
237	CWR-18-1	7,900.00	7.1966	0.14473371	0.14473371	0.3338537	17.23	17.08
238	CWS-18-2	7,690.00	7.0053	0.80368692	0.80368692	1.8538447	38.43	37.63
239	CWS-WIT	210.00	2.5110	0.10010774	0.10010774	0.2309161	38.72	38.62
240	CWR-WIT	210.00	2.5110	0.10010774	0.10010774	0.2309161	17.63	17.53
241	CWS-WIT	210.00	0.3401	0.00007040	0.00007040	0.0001624	17.67	17.67
242	CWS-18-UNPLT	6,822.00	9.3653	0.56391531	0.56391531	1.3007695	37.77	37.21
243	CWR-18-UNPLT	6,822.47	9.3660	0.56398940	0.56398940	1.3009404	17.92	17.36
244	CWR-18-UNPLT	6,822.47	9.3660	0.11279789	0.11279789	0.2601881	17.25	17.14
245	CWR-18-UNPLT	6,822.47	9.3660	0.05639939	0.05639939	0.1300951	17.04	16.98
246	CWR-18-UN	5,545.48	7.6129	0.11407701	0.11407701	0.2631386	18.23	18.12
247	CWR-10-UN	1,277.00	5.1957	0.14210600	0.14210600	0.3277924	18.47	18.33
248	CWR-10-UN	1,277.00	5.1957	0.03552650	0.03552650	0.0819481	18.51	18.47
249	CWS-10-UN	1,277.00	5.1957	0.14210600	0.14210600	0.3277924	37.62	37.47
250	CWS-18-UNPLT	5,545.00	7.6123	0.11405575	0.11405575	0.2630896	37.41	37.29
251	CWR-WHI	287.00	3.6817	0.01728202	0.01728202	0.0398640	22.28	22.27
252	Pipe	768.00	5.4187	0.19370981	0.19370981	0.4468256	31.19	31.00
253	Pipe	768.00	5.4187	0.04842745	0.04842745	0.1117064	24.62	24.57
254	Pipe	1,097.00	7.7400	0.55437964	0.55437964	1.2787738	24.17	23.62
255	Pipe	768.00	5.4187	0.19370981	0.19370981	0.4468256	24.57	24.38
256	Pipe	329.00	3.9338	2.20147204	2.20147204	5.0780810	31.28	29.08
257	Pipe	496.00	3.4996	0.01100187	0.01100187	0.0253777	19.93	19.92

All Junction Table

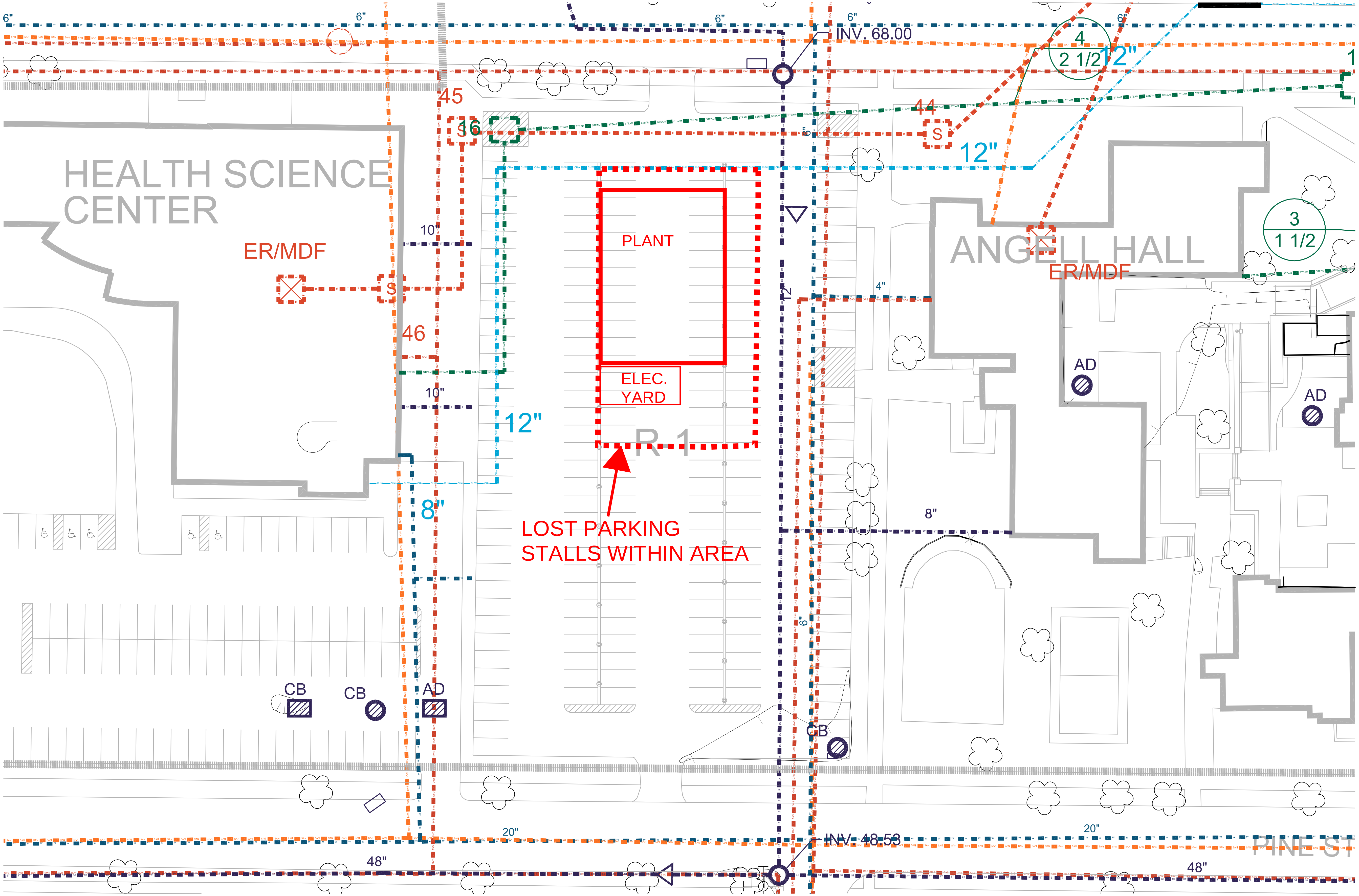
Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
1	V-S-EXPLT	38.74	38.56	38.98	38.91	7,900.00
5	V-R-EXPLT	17.08	17.09	17.43	17.33	7,900.00
11	Tee or Wye	37.67	37.67	37.96	37.96	N/A
12	CV-CEN	35.99	19.81	36.27	20.10	926.00
13	HX-CEN	19.78	19.78	20.07	20.07	926.00
14	Tee or Wye	18.09	18.09	18.38	18.38	N/A
15	Bend	36.18	36.12	36.47	36.41	926.00
16	Bend	19.64	19.59	19.93	19.87	926.00
17	Tee or Wye	37.11	37.11	37.33	37.33	N/A
18	Tee or Wye	18.80	18.80	19.01	19.01	N/A
19	Tee or Wye	37.11	37.11	37.24	37.24	N/A
20	Tee or Wye	18.96	18.96	19.10	19.10	N/A
27	CV-Arts	34.68	20.86	35.10	21.29	1,129.00
28	HX-ARTS	20.81	20.81	21.24	21.24	1,129.00
29	CV-Library	35.99	20.25	36.04	20.31	239.00
30	Tee or Wye	35.97	35.97	36.17	36.17	N/A
31	HX- LIB AD	20.24	20.24	20.30	20.30	239.00
32	Tee or Wye	19.97	19.97	20.17	20.17	N/A
33	Tee or Wye	35.52	35.52	35.68	35.68	N/A
35	CV-WIM	35.62	20.39	35.80	20.57	429.00
36	HX-WIM	20.36	20.36	20.54	20.54	429.00
37	Tee or Wye	20.50	20.50	20.66	20.66	N/A
41	Bend	20.56	20.76	20.86	20.80	1,468.00

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
42	Bend	35.50	35.23	35.54	35.53	1,468.00
43	Tee or Wye	22.01	22.01	22.16	22.16	N/A
44	Tee or Wye	34.08	34.08	34.23	34.23	N/A
45	CV-Police	34.13	22.25	34.13	22.26	34.00
46	HX-POL	22.25	22.25	22.26	22.26	34.00
48	Bend	26.13	26.05	26.38	26.32	501.00
50	CV-Reuter	29.23	26.21	29.47	26.46	501.00
51	HX-REU	26.17	26.17	26.42	26.42	501.00
52	Bend	29.32	29.27	29.56	29.51	501.00
53	Tee or Wye	23.93	23.93	24.13	24.13	N/A
54	CV-Alumni	30.49	25.69	30.61	25.81	168.00
55	HX-ALU	25.65	25.65	25.78	25.78	168.00
56	Tee or Wye	32.05	32.05	32.26	32.26	N/A
57	Tee or Wye	25.08	25.08	25.16	25.16	N/A
58	CV-STA	30.41	25.39	30.43	25.41	134.00
59	Bend	25.39	25.39	25.41	25.40	134.00
60	Tee or Wye	30.50	30.50	30.68	30.68	N/A
61	Bend	30.42	30.42	30.44	30.43	134.00
62	HX-STA	30.41	30.41	30.43	30.43	134.00
63	Tee or Wye	35.04	35.04	35.26	35.26	N/A
64	CV-Rec Center	35.15	21.07	35.22	21.14	257.00
65	HX-REC	21.06	21.06	21.12	21.12	257.00
66	Tee or Wye	20.85	20.85	21.08	21.08	N/A
67	Tee or Wye	22.21	22.21	22.36	22.36	N/A
68	Tee or Wye	33.47	33.47	33.61	33.61	N/A
69	CV-WHI	33.38	22.46	33.45	22.53	287.00
70	HX-WHI	22.44	22.44	22.52	22.52	287.00
71	CV-HSC	30.87	24.61	31.15	24.89	919.00
72	Bend	32.45	32.21	32.51	32.49	919.00
75	HX-HSC	24.57	24.57	24.86	24.86	919.00
76	Bend	23.23	23.40	23.52	23.46	919.00
77	Bend	37.06	37.01	37.07	37.07	907.00
78	Bend	19.22	19.25	19.28	19.27	907.49
79	Tee or Wye	37.08	37.08	37.11	37.11	N/A
80	CV-Morris	36.85	19.38	36.91	19.44	259.00
81	HX-MO	19.36	19.36	19.43	19.43	259.00
82	Tee or Wye	19.20	19.20	19.23	19.23	N/A
85	Tee or Wye	36.42	36.42	36.47	36.47	N/A
86	CV-Wing	36.38	19.86	36.44	19.92	411.00
87	HX-WING	19.85	19.85	19.91	19.91	411.00
88	Tee or Wye	19.83	19.83	19.88	19.88	N/A
91	Tee or Wye	36.32	36.32	36.36	36.36	N/A
92	Tee or Wye	19.95	19.95	19.99	19.99	N/A
95	CV-Graff	36.27	19.94	36.35	20.02	496.00
96	HX-GR	19.93	19.93	20.01	20.01	496.00
97	Check Valve	38.87	38.87	39.11	39.11	4,320.00
99	EXST P#2	16.84	38.88	17.08	39.12	4,320.00
100	EXST P#1	16.78	39.02	17.01	39.26	4,320.00
101	Bend	38.98	38.94	39.22	39.18	4,320.00
102	Tee or Wye	38.83	38.83	39.09	39.09	N/A
104	Bend	16.84	16.80	17.08	17.04	4,320.00
105	Tee or Wye	16.68	16.68	17.10	17.10	N/A
106	Bend	16.95	16.24	17.24	17.19	8,640.00
107	Tee or Wye	36.56	36.56	36.58	36.58	N/A

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
108	Dead End	36.58	36.58	36.58	36.58	0.00
109	Dead End	19.77	19.77	19.77	19.77	0.00
110	Tee or Wye	19.74	19.74	19.77	19.77	N/A
111	Tee or Wye	36.42	36.42	36.45	36.45	N/A
112	Dead End	36.45	36.45	36.45	36.45	0.00
113	Tee or Wye	19.88	19.88	19.90	19.90	N/A
114	Dead End	19.90	19.90	19.90	19.90	0.00
115	Tee or Wye	20.61	20.61	20.64	20.64	N/A
116	Tee or Wye	35.67	35.67	35.70	35.70	N/A
117	CV- LIB ADD	36.65	19.64	36.67	19.67	174.00
118	HX-LIB	19.64	19.64	19.67	19.67	174.00
119	Tee or Wye	36.51	36.51	36.71	36.71	N/A
120	Tee or Wye	19.43	19.43	19.63	19.63	N/A
121	Tee or Wye	21.86	21.86	22.11	22.11	N/A
122	Tee or Wye	33.98	33.98	34.23	34.23	N/A
123	CV-NEW RES	30.15	25.73	30.39	25.98	852.00
124	Bend	32.35	32.30	32.59	32.55	852.00
125	Bend	31.25	31.20	31.49	31.44	852.00
126	Bend	23.55	23.50	23.79	23.75	852.00
127	Bend	24.65	24.60	24.90	24.85	852.00
128	HX-RES	25.70	25.70	25.95	25.95	852.00
129	Tee or Wye	25.04	25.04	25.10	25.10	N/A
130	Tee or Wye	31.14	31.14	31.29	31.29	N/A
131	HX-SAN	25.13	25.13	25.18	25.18	221.00
132	CV-San	31.15	25.14	31.20	25.19	221.00
133	Tee or Wye	31.24	31.24	31.33	31.33	N/A
134	Tee or Wye	24.97	24.97	25.06	25.06	N/A
135	CV-WHITE	31.12	25.21	31.16	25.24	193.00
136	HX-WHITE	25.20	25.20	25.23	25.23	193.00
137	Tee or Wye	31.26	31.26	31.39	31.39	N/A
138	Tee or Wye	24.87	24.87	25.00	25.00	N/A
139	CV-LAUX	30.84	25.47	30.88	25.52	217.00
140	HX-LAUX	25.46	25.46	25.51	25.51	217.00
141	Bend	30.92	30.91	30.96	30.95	217.00
142	Bend	25.39	25.38	25.44	25.43	217.00
143	Tee or Wye	35.72	35.72	35.83	35.83	N/A
144	Tee or Wye	20.40	20.40	20.51	20.51	N/A
145	Tee or Wye	35.50	35.50	35.89	35.89	N/A
146	Tee or Wye	20.05	20.05	20.45	20.45	N/A
147	Bend	36.46	36.37	37.01	36.91	5,545.00
148	Bend	18.89	18.79	19.43	19.33	5,545.48
149	CV-UNION	37.47	18.51	37.66	18.69	1,277.00
150	Bend	18.18	18.23	18.72	18.62	5,545.48
151	HX-UNION	18.47	18.47	18.65	18.65	1,277.00
152	Bend	37.29	37.07	37.68	37.62	5,545.00
153	CV-COW I	31.54	22.24	32.95	23.65	3,187.00
154	HX-COW I	22.13	22.13	23.54	23.54	3,187.00
162	Tee or Wye	33.59	33.59	33.81	33.81	N/A
163	Tee or Wye	21.93	21.93	22.15	22.15	N/A
164	Tee or Wye	32.47	32.47	32.69	32.69	N/A
165	Tee or Wye	23.05	23.05	23.28	23.28	N/A
166	CV-ANG	31.84	23.94	31.94	24.04	329.00
167	HX-ANG	23.92	23.92	24.02	24.02	329.00
168	CV-DRA	32.31	23.55	32.36	23.61	246.00

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
169	HX-DRA	23.54	23.54	23.60	23.60	246.00
170	Tee or Wye	32.38	32.38	32.54	32.54	N/A
171	Tee or Wye	23.26	23.26	23.42	23.42	N/A
172	Tee or Wye	31.54	31.54	31.66	31.66	N/A
173	Tee or Wye	24.18	24.18	24.30	24.30	N/A
174	CV-HUT	31.29	24.50	31.39	24.59	313.00
175	HX-HUT	24.48	24.48	24.58	24.58	313.00
176	Bend	24.38	24.37	24.42	24.41	217.00
177	Bend	31.51	31.50	31.55	31.54	217.00
178	CV-WEN	31.32	24.56	31.37	24.61	217.00
179	HX-WEN	24.55	24.55	24.60	24.60	217.00
180	Tee or Wye	32.54	32.54	32.76	32.76	N/A
181	Tee or Wye	22.98	22.98	23.20	23.20	N/A
182	Bend	23.62	23.54	24.02	23.94	1,097.00
183	Bend	31.62	31.54	32.02	31.94	1,097.00
186	CV-COA	28.76	27.01	28.86	27.12	329.00
187	Bend	29.08	29.06	29.19	29.16	329.00
188	Bend	26.70	26.68	26.80	26.78	329.00
189	HX-COA	27.00	27.00	27.10	27.10	329.00
192	P-UN-#1	16.47	38.00	17.10	38.63	3,411.07
193	P-UN-#2	16.47	38.00	17.11	38.63	3,411.07
194	Bend	17.41	16.90	17.56	17.53	3,411.07
198	Bend	37.86	38.23	38.49	38.38	3,411.07
203	Dead End	36.36	36.36	36.36	36.36	0.00
204	Dead End	19.99	19.99	19.99	19.99	0.00
205	CV-MIT	37.85	18.13	38.03	18.31	740.00
206	HX-MIT	18.11	18.11	18.29	18.29	740.00
207	Tee or Wye	38.83	38.83	39.07	39.07	N/A
208	Bend	38.70	38.66	38.88	38.85	740.00
209	Bend	17.29	17.26	17.48	17.44	740.00
210	Tee or Wye	17.02	17.02	17.26	17.26	N/A
215	Check Valve	39.01	39.01	39.25	39.25	4,320.00
217	Tee or Wye	17.29	17.29	17.57	17.57	N/A
218	Bend	17.36	16.89	17.56	17.52	3,411.07
219	Tee or Wye	38.10	38.10	38.36	38.36	N/A
220	Bend	37.86	38.23	38.49	38.38	3,411.07
223	Tee or Wye	38.56	38.56	38.77	38.77	N/A
224	Tee or Wye	17.37	17.37	17.58	17.58	N/A
225	CV-WIT	38.62	17.67	38.67	17.68	210.00
226	HX-WIT	17.67	17.63	17.68	17.68	210.00
227	Tee or Wye	37.43	37.43	37.80	37.80	N/A
228	Bend	17.14	17.04	17.73	17.63	6,822.47
229	Bend	17.36	17.25	17.95	17.84	6,822.47
230	Tee or Wye	18.14	18.14	18.51	18.51	N/A
234	Branch	33.38	33.39	33.46	33.46	287.00
235	CV- P1-UNPLT	37.95	37.95	38.58	38.58	3,411.07
236	CV-P2-UNPLT	37.95	37.95	38.58	38.58	3,411.07
237	V-P1-UNPLT	16.80	16.51	17.43	17.14	3,411.07
238	V-P2-UNPLT	16.81	16.52	17.44	17.15	3,411.07
239	Tee or Wye	31.17	31.17	31.39	31.39	N/A
240	Control Valve	31.00	24.62	31.19	24.82	768.00
241	Heat Exchanger	24.57	24.57	24.77	24.77	768.00
242	Tee or Wye	24.36	24.36	24.58	24.58	N/A
243	Bend	21.46	21.88	22.87	22.59	3,187.00

Jct	Name	P Static In (psia)	P Static Out (psia)	P Stag. In (psia)	P Stag. Out (psia)	Vol. Flow Rate Thru Jct (gal/min)
244	Bend	33.03	32.20	33.75	33.61	3,187.00
245	Branch	22.29	22.28	22.37	22.37	287.00
247	Assigned Pressure	N/A	N/A	20.00	20.00	N/A
248	Branch	26.00	26.04	26.28	26.28	501.00



1 G-1 NORTHWEST CHILLER PLANT PARKING LOT R-1

1"=50'

RING & DUCHATEAU

10101 INNOVATION DR.
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PROJECT NUMBER: 212116

State of Wisconsin
Department of Administration
Division of State Facilities

LACROSSE, WISCONSIN

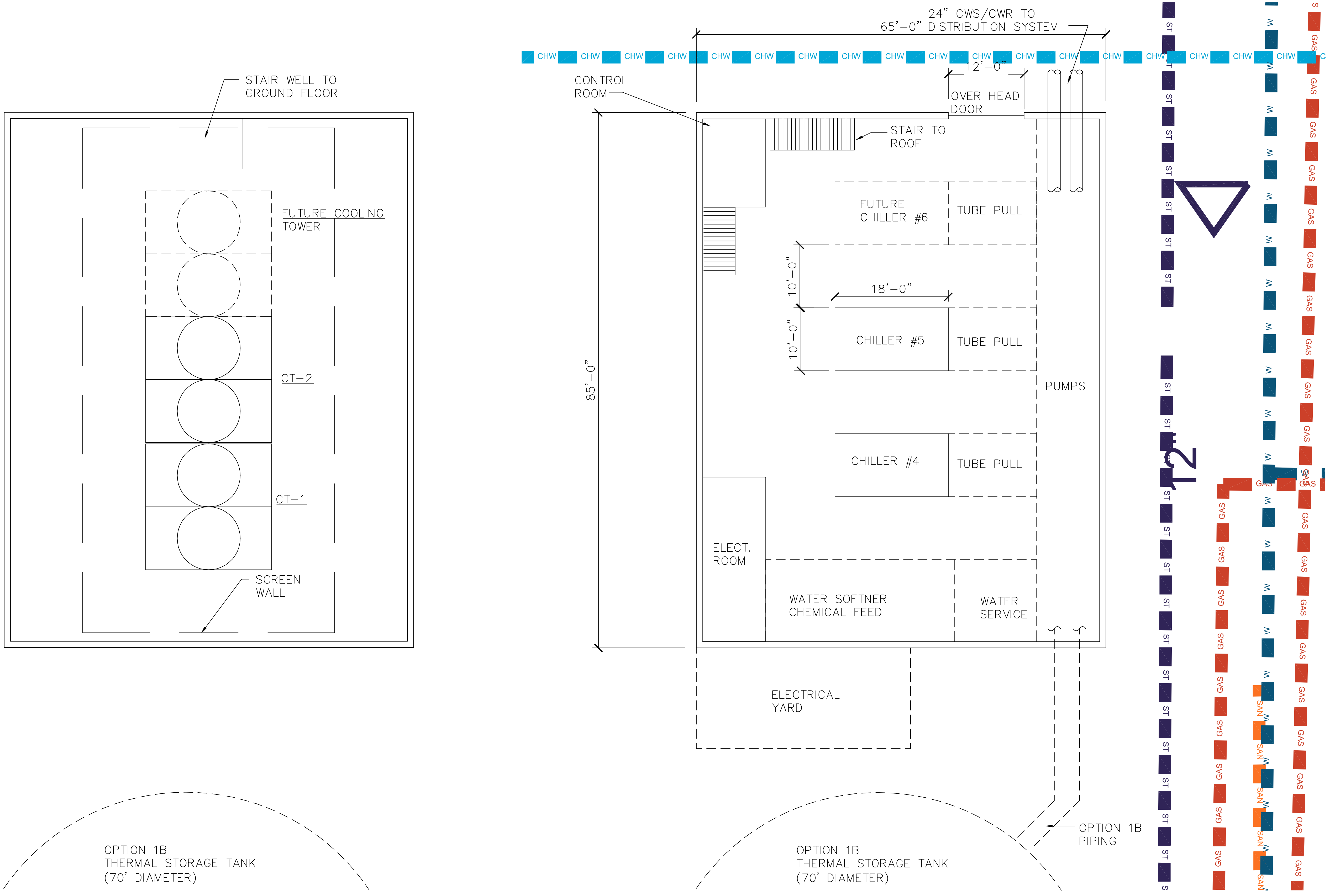
CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
NORTHWEST CHILLER PLANT PARKING LOT R-1

Revisions:

No.	Date:	Description:

Graphic Scale	0' 12.5' 25' 37.5'
DSF Number	12H2C
Set Type	FR
Date Issued	12-4-12
Sheet Number	G-1



ROOF PLAN

GROUND FLOOR PLAN

1
G–2
NORTHWEST CHILLER PLANT (OPTION 1A & 1B)
1/16"=1'–0"

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PROJECT NUMBER: 212116

State of Wisconsin
Department of Administration
Division of State Facilities

LACROSSE, WISCONSIN

CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
NORTHWEST CHILLER PLANT (OPTION 1A & 1B)

Revisions:

No.	Date:	Description:

Graphic Scale	
DSF Number	12H2C
Set Type	FR
Date Issued	12–4–12
Sheet Number	G–2

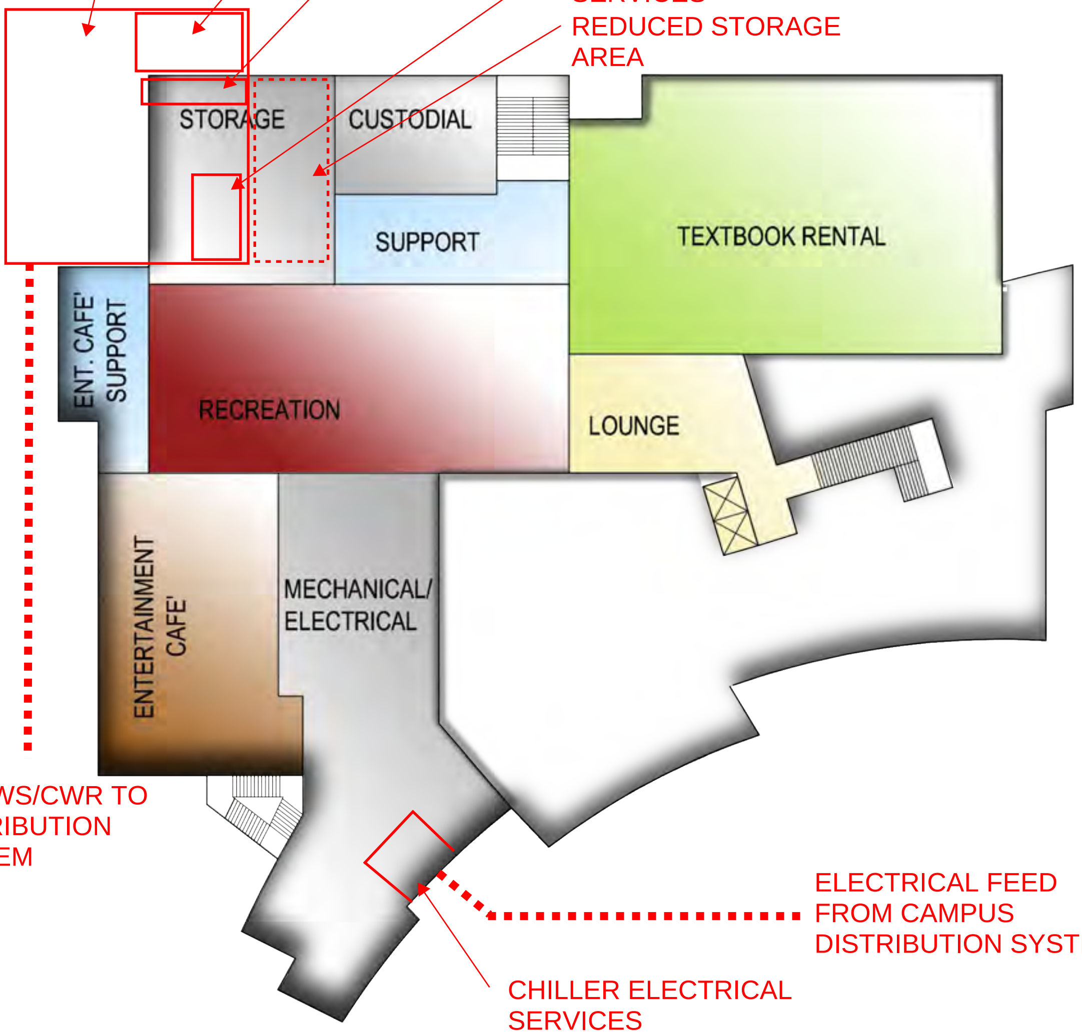
BASEMENT CHILLER ROOM

AREA WELL SIZED TO FOR FUTURE CHILLER INSTALLATION

PIPE CHASE TO ROOF AREA COOLING TOWERS

CHILLER ELECTRICAL SERVICES

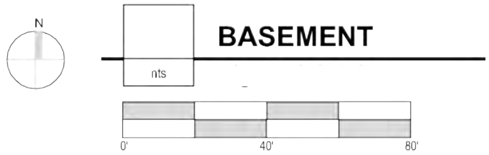
REDUCED STORAGE AREA



18" CWS/CWR TO DISTRIBUTION SYSTEM

ELECTRICAL FEED FROM CAMPUS DISTRIBUTION SYSTEM

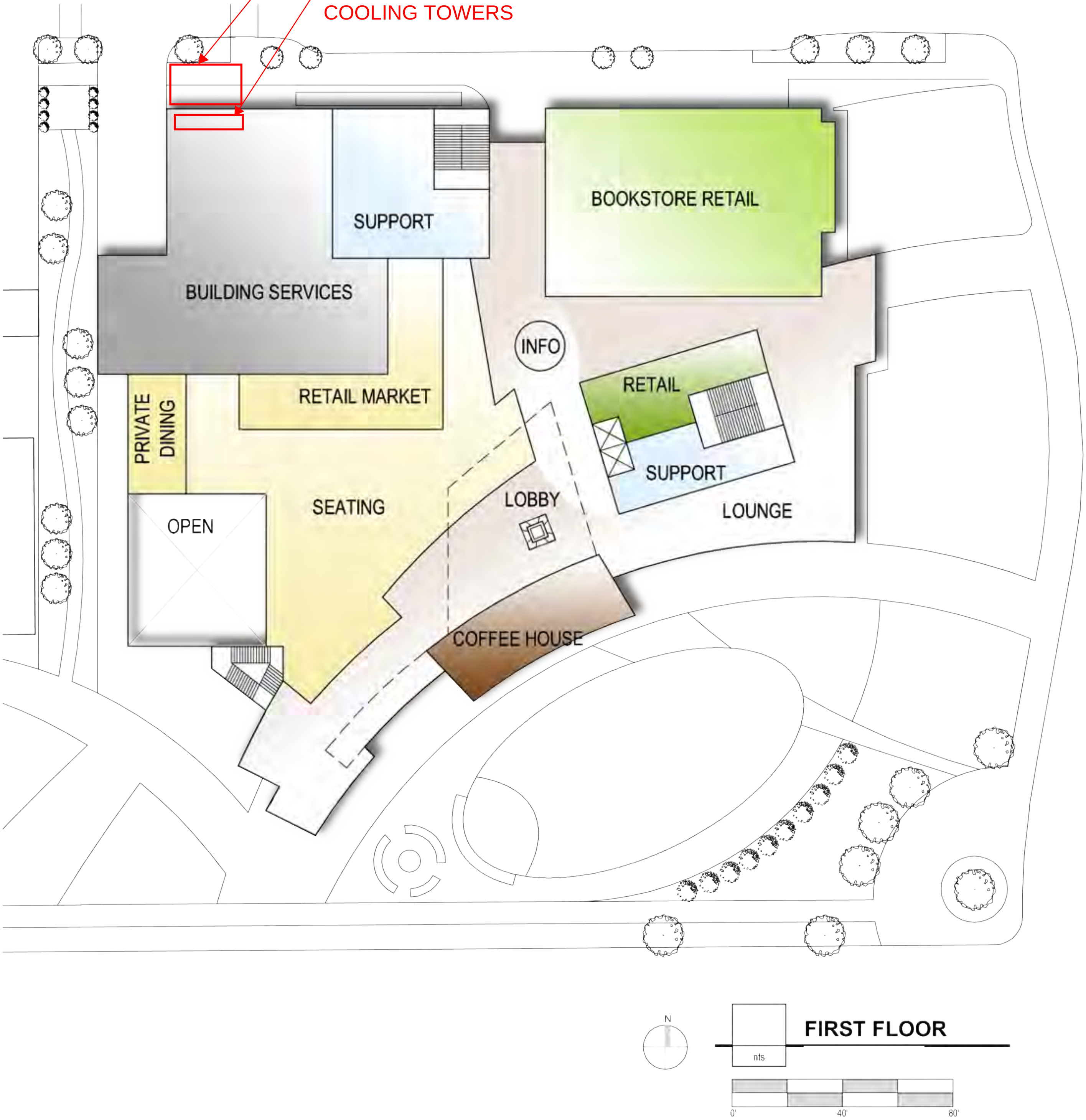
CHILLER ELECTRICAL SERVICES



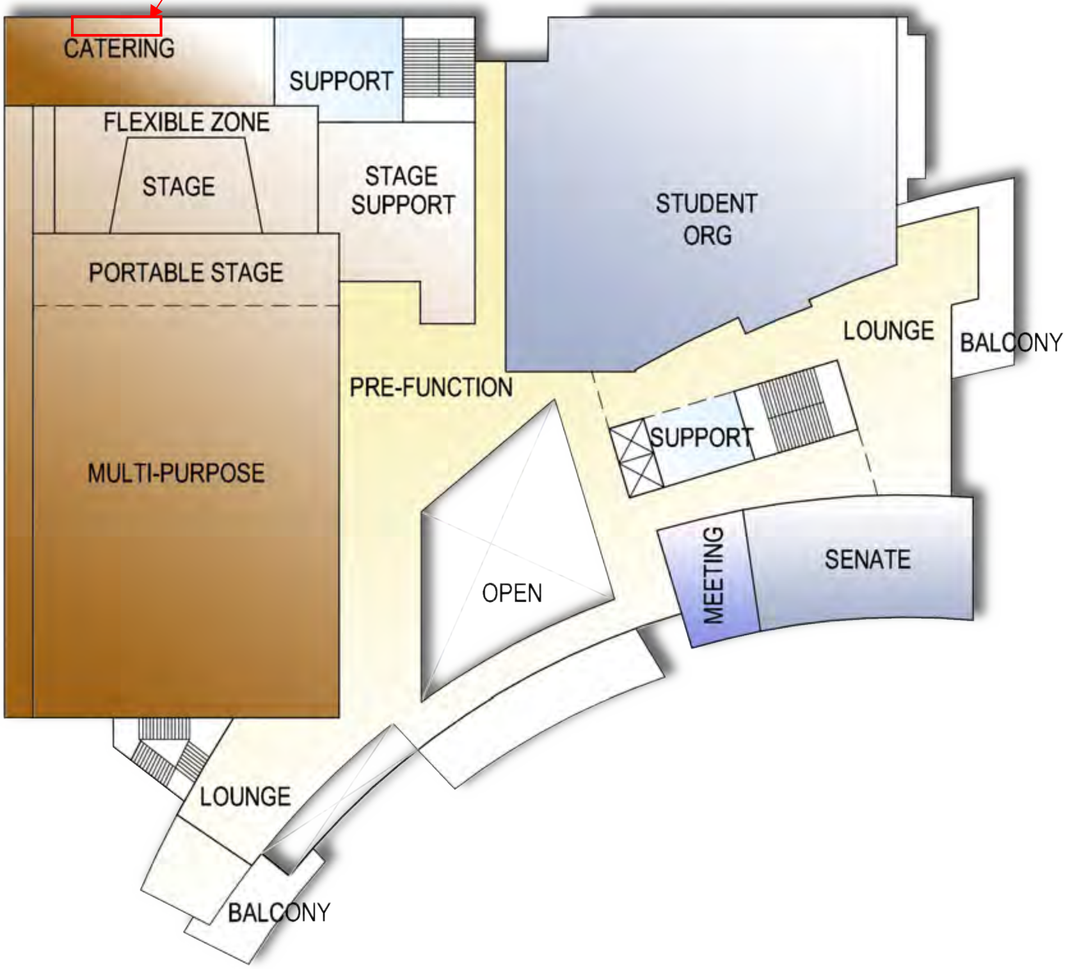
BASEMENT

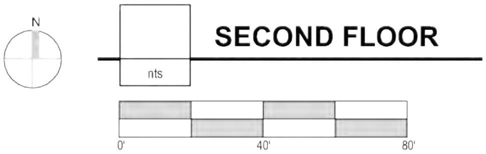
AREA WELL SIZED TO FOR FUTURE CHILLER INSTALLATION

PIPE CHASE TO ROOF COOLING TOWERS

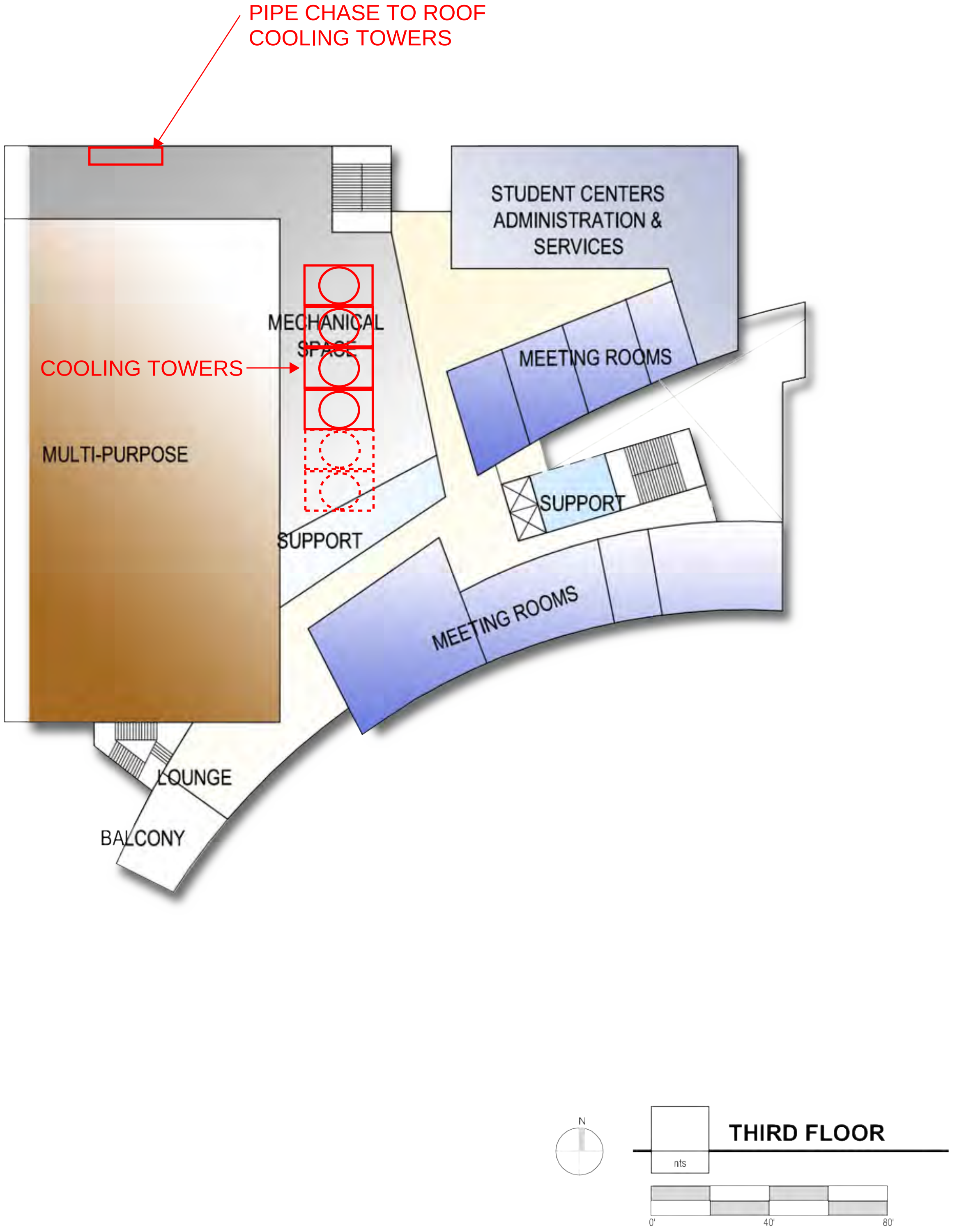


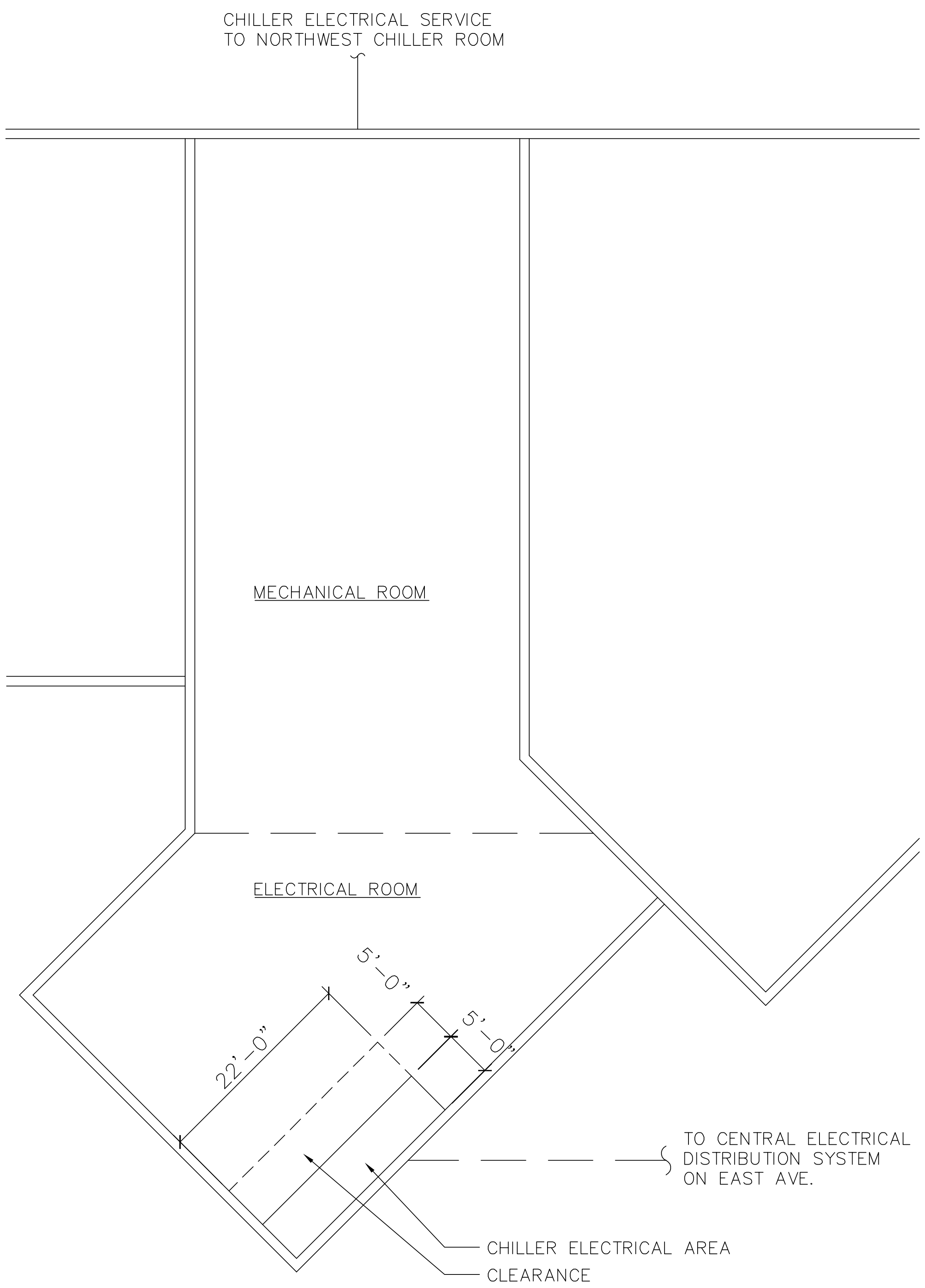
PIPE CHASE TO ROOF
COOLING TOWERS



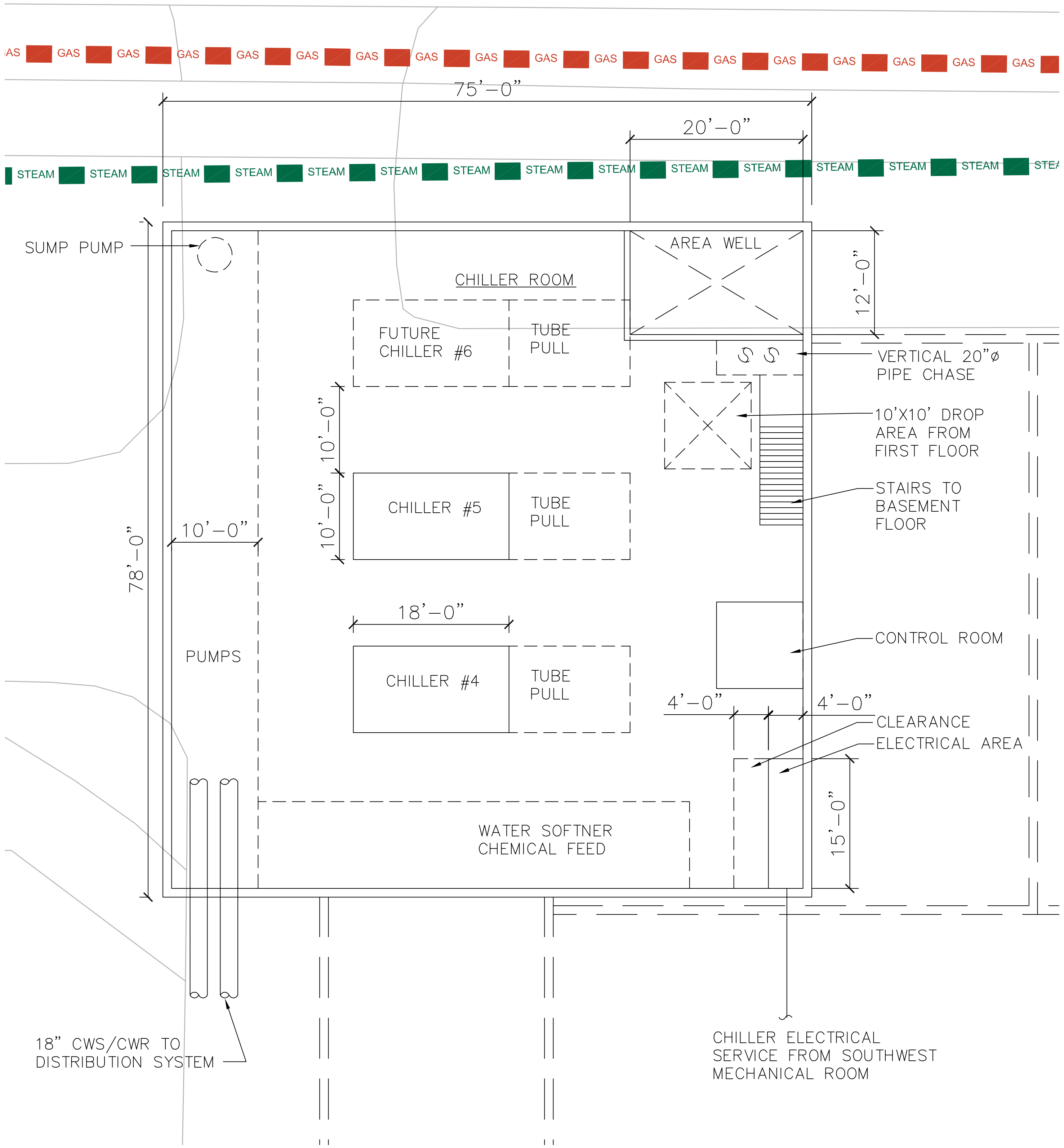


SECOND FLOOR


PIPE CHASE TO ROOF
COOLING TOWERS
STUDENT CENTERS
ADMINISTRATION &
SERVICES
MECHANICAL
SPACE
COOLING TOWERS
MEETING ROOMS
MULTI-PURPOSE
SUPPORT
SUPPORT
MEETING ROOMS
LOUNGE
BALCONY
N
THIRD FLOOR
nts
0'
40'
80'



PARTIAL BASEMENT FLOOR PLAN



PARTIAL BASEMENT FLOOR PLAN

1
G–7
STUDENT UNION CHILLER PLANT (OPTION 2A & 2B)
1/16"=1'–0"

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PROJECT NUMBER: 212116

State of Wisconsin
Department of Administration
Division of State Facilities

LACROSSE, WISCONSIN

CHILLED WATER STUDY
LACROSSE CAMPUS
UNIVERSITY OF WISCONSIN
LACROSSE, WISCONSIN

Sheet Title:
STUDENT UNION CHILLER PLANT (OPTION 2A & 2B)

Revisions:

No.	Date:	Description:

Graphic Scale	
DSF Number	12H2C
Set Type	FR
Date Issued	12–4–12
Sheet Number	G–7

(3) No person shall be in possession of any open container containing alcoholic or fermented malt beverages on any thoroughfare, street, sidewalk or other public way, except as permitted under (1). No glass containers are allowed outside when a permit is granted under (1).

(4) Street Privilege Permits under this subsection may only be granted by the Common Council during the period of Memorial Day through Labor Day. Said Street Privilege Permit shall only be granted in accordance with the terms and conditions approved by the Common Council. (Am. Ord. #4096 - 6/12-03)

(F) HOSPITAL ZONES OF QUIET.

There is hereby created and established a zone of quiet in all territory embraced within a distance of 250 feet in each direction from every hospital. It shall be unlawful for any person to make, cause or permit to be made any unnecessary noise upon the public streets, avenues or alleys within any such zone of quiet, which disturbs or tends to disturb the peace and quiet of any of the inmates of any hospital located therein.

(G) NOISE CONTROL.

(1) Noise Prohibited.
It shall be unlawful to make, continue or cause to be made or continued any noise in excess of the noise levels set forth in Subsection (2) unless such noise be reasonably necessary to the preservation of life, health, safety or property.

(2) Measurement of Noise.
Any activity, not expressly exempted by this section which creates or produces sound, regardless of frequency, exceeding the ambient noise levels at the property line of any property (or, if a condominium or apartment house, within any adjoining apartment) by more than six decibels above the ambient noise levels as measured on the A-weighted scale of a sound meter and as designated in the following table, at the time and place and for the duration then mentioned, shall be deemed to be a violation of the ordinance, but any enumeration herein shall not be deemed to be exclusive. (Am. Ord. #2818 - 12/8/83)
Column I - 7:00 A.M. - 6:00 P.M. (all districts); Duration of Sound: Less than 10 minutes, 75 db; Between 10 minutes and 2 hours, 60 db; In excess of 2 hours, 50 db.
Column II - 6:00 P.M. - 10:00 P.M. (residential districts) and 6:00 P.M. - 7:00 A.M. (all other districts); Duration of Sound: Less than 10 minutes, 70 db; Between 10 minutes and 2 hours, 60 db; In excess of 2 hours, 50 db.
Column III - 10:00 P.M. - 7:00 A.M. (residential districts); Duration of Sound: Less than 10 minutes, 60 db; Between 10 minutes and 2 hours, 50 db; In excess of 2 hours, 40 db. The districts referred to in the above table are the zoning districts of the City of La Crosse as defined in Chapter 15 of the Code of Ordinances of the City of La Crosse. In determining whether a particular sound exceeds the maximum permissible sound level in the above table: (1) sounds in excess of the residential district are violative of this section whether the sound originates in a residential district or any other district; (2) during all hours of Sundays and State and Federal holidays, the maximum allowable decibel levels for residential districts are as set forth in Column III of the table.

SCREENING LEVEL HAZARDOUS MATERIAL ASSESSMENT REPORT

NORTHWEST CHILLER PROJECT
UW LA CROSSE CAMPUS
LA CROSSE, WISCONSIN

Prepared for

RING & DUCHATEAU
10101 Innovation Drive Suite 200
Milwaukee, WI 53226

Prepared by

Bloom Companies, LLC
10501 W. Research Drive, Suite 100
Milwaukee, WI 53226

November 2012

1.0 PROJECT DESCRIPTION

Bloom Companies, LLC (Bloom) has completed screening level assessment to identify sites presenting potential environmental concern related to the presence of hazardous materials in the area of proposed improvement related to the northwest chiller plant and associated pipe route additions on the UW-La Crosse campus. The objective of this screening level assessment is to identify potential areas of environmental concern that may require evaluation during the design phase of the northwest chiller project. This will allow contaminants to be addressed during design in the event there may be concerns related to the functionality of the chiller and piping. Knowledge of potential environmental issues will also avoid delays during construction resulting from the presence of contaminants and address worker safety during construction of the proposed improvements. As part of this assessment, recognized environmental conditions (RECs) and historical RECs that could materially affect the corridor construction at the subject corridor were identified.

A REC is defined as:

> "The presence or expected presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater or surface water of the property. The term includes hazardous substances or petroleum products even under conditions in compliance with laws. The term is not intended to include de minimis conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies. Conditions determined to be de minimis are not recognized environmental conditions."

2.0 DATA EVALUATION

This screening level assessment included collection and review of an environmental database search report and historical land use information. As part of the historical land use information research, Bloom reviewed readily available historical aerial photographs, and topographic maps, for the UW-La Crosse campus and the immediately surrounding area. Review of agency files or field reconnaissance were not included as part of the screening process.

Bloom retained Environmental Data Resources (EDR), an environmental database services firm, to conduct a search of current federal and state database listings for hazardous waste and other potentially impaired sites within a 0.25 mile radius of the project corridor. The environmental databases with sites of potential concern, the search radii and the number of sites in the database are shown below:

Database	Radius	No. of Sites
Federal Records		
RCRA Small Quantity Hazardous Waste Generator (SQG) list	0.25	1
RCRA Conditionally Exempt Small Quantity Hazardous Waste Generator (CESQG) list	0.25	2
RCRA Hazardous Waste Non-Generator (NonGen) list	0.25	4
State Records		
Wisconsin Emergency Repair Program (WI ERP)	0.25	4
State Leaking Underground Storage Tank (LUST) list	0.25	12
State and Tribal Underground Storage Tank (UST) list	0.25	81
State Leaking Aboveground Storage Tank (LAST) list	0.25	1
State Aboveground Storage Tank (AST) list	0.25	6
Hazardous Waste Manifest (Manifest) List	0.25	1
Activity Use Limitation (AUL) List	0.25	5
Manufactured Gas Plant Site	1.0	1

Several unmapped orphan sites are within 0.25 miles of the subject corridor; these were also reviewed to determine any sites of potential concerns.

Appendix B contains the EDR report and a description of each database. This report provides a summary of the database findings.

2.1 Identified REC Sites

Based on the results of this screening, there were no sites identified as having high potential recognized environmental condition (REC) with regards to the subject area.

2.2 Adjacent Contaminant Source Areas

There are several sites that have known soil and groundwater impacts that extend beyond the source property boundaries and are located near the UW La Crosse northwest chiller construction site. These include the following:

Kwik Trip – 530 West Ave N (Map ID F)– This LUST site received environmental closure in 1996 following removal of six USTs in 1993 and remediation of impacts in soil. Replacement USTs were installed including two 10,000 gallon and one 15,000 gallon USTs which remain in service today. There was also a gasoline spill in 2006 that resulted in a discharge to the storm sewer. The spill was remediated and also received closure. The screening data reviewed did not indicate the direction or distance soil or groundwater contaminants have migrated however the site is located about 600 feet northwest of the proposed chiller construction site. A more detailed file review may be warranted depending on the construction excavation planned for this area.

One Hour Cleaners – 1227 La Crosse Street (Map ID I)– This dry cleaner site has documented on-site and off-site perchloroethylene contamination in soil and groundwater and has not received environmental closure. The site is located approximately 750 feet northwest of the proposed chiller construction site. A more detailed file review may be warranted depending on the construction excavation planned for this area.

Magic Coin Laundry – 334 West Ave N (Map ID J32)– This dry cleaner site has documented on-site and off-site perchloroethylene contamination in soil and groundwater including contamination in the right of way. The site received environmental closure and with a GIS registry listing. The site is located approximately 600 feet southwest of the proposed chiller construction site. A more detailed file review may be warranted depending on the construction excavation planned for this area.

Taco Bell – 1200 La Crosse Street (Map ID I)- This site has documented perchloroethylene contamination in groundwater. The site received environmental closure and with an NR140 exemption. The site is located approximately 800 feet northwest of the proposed chiller construction site. A more detailed file review may be warranted depending on the construction excavation planned for this area.

Review of Wisconsin Department of Natural Resource and Wisconsin Department of Safety and Professional Services files are recommended for these sites to determine if contaminants from these sites will affect construction.

2.3 Former UST Sites

There were several sites that were former UST locations very near the proposed northwest chiller plant and proposed pipe routes. At the time the USTs were removed, there was no documentation indicating the presence of contamination in the file. Several of the USTs were removed in the late 1980's and early 1990's, when environmental rules relating to UST removal documentation were in their infancy. If contaminants had been present at the time of UST removal, it is likely the impacts have degraded significantly in the twenty plus years since the

USTs were removed. It is not anticipated that these present concern for the planned construction. Former UST locations on or immediately adjacent to the UW-La Crosse Campus include:

Western Technical College – WWTI East Hall – 408 N 13th Street (Map ID 2)– This is the former location of a 2,000 gallon fuel oil UST that was removed in 1991.

UW La Crosse Reuter Hall – 618 N 19th Street (Map ID 3)– This is the former location of a 14,930 gallon fuel oil UST that was removed in 1991.

Tom Kennedy Private Residence – 522 Oakland(Map ID A) – This is the former location of a 300 gallon fuel oil UST that was removed in 1994.

UW La Crosse – 1705 State Street (Map ID C)– This is the former location of **a** 250 gallon diesel UST that was removed in 1994.

UW La Crosse – 1725 State Street (Map ID C)– This is the location of a 12,000 gallon diesel UST that is currently in use for a back-up generator. It is also the former location of four 40,000 gallon fuel oil USTs and one 5,000 gallon UST that were removed in 1996. It is also the former location of one 10,000 gallon fuel oil AST that was removed in 2006.

Newman Center – 1732 State Street (Map ID C)– This is the former location of a 1,000 gallon fuel oil UST that was removed in 1992.

Larry's Citgo – 1805 State Street (Map ID E)– this is the former location of one 4,000 gallon unleaded gasoline UST, two 3,000 gallon leaded gasoline USTs, one 500 gallon fuel oil UST and one 500 gallon waste oil UST removed in 1990. It is also the current location of one 300 gallon and one 1,000 gallon waste oil ASTs.

2.4 Additional Information

The Health Science Center, located adjacent to the proposed construction site at 1300 Badger Street (Map ID B5), is a RCRA non generator site. The site uses some hazardous materials including ignitable, corrosive, and reactive materials in addition to several metals and solvents. Hazardous materials are not generated on the property and no violations of environmental requirements were noted with respect to the property so this site should not present a REC with regard to the subject area.

3.0 CONCLUSIONS AND RECOMMENDATIONS

No contaminant sources were identified as a concern on or immediately adjacent to the planned northwest chiller construction site. No contaminated unsaturated soils are anticipated to be encountered during construction.

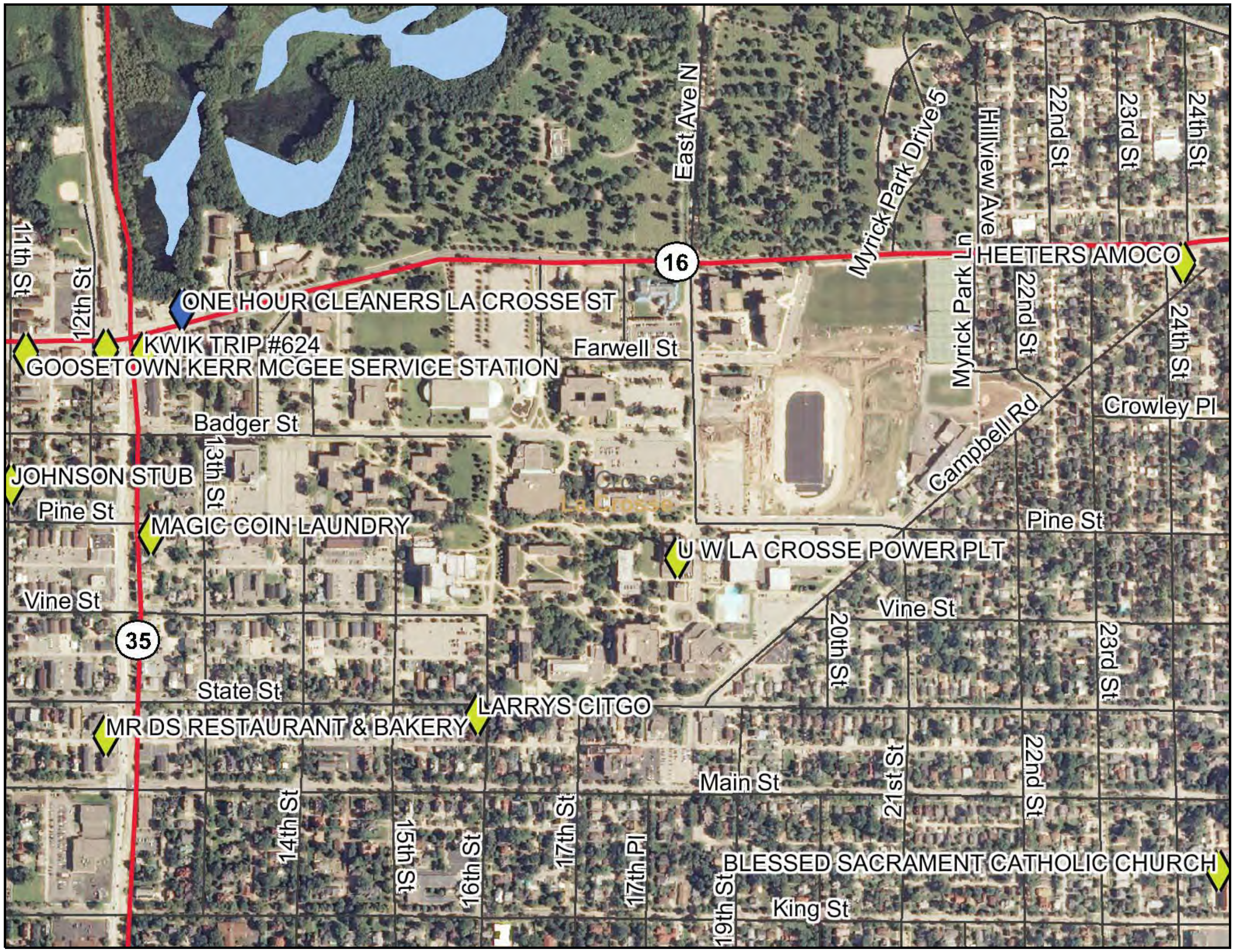
Contaminated groundwater and saturated soils could potentially be encountered depending on the extent of impacts in groundwater extending from contaminant source properties identified 500 to 800 feet from the construction site. A determination for the probability of encountering impacted groundwater and saturated soil requires review of WDNR and DSPS files for four contaminant source properties near the proposed construction site .

Review of the information in the WDNR and DSPS files for the four source properties identified with contaminant off site migration is recommended to determine the extent of impacts and confirm contamination does not reach the planned construction site. Contaminants in groundwater migrating from the four identified sites could be an issue for saturated soil excavation and dewatering during construction.

APPENDICES

APPENDIX A:	PROPOSED NORTHWEST CHILLER PLANT DIAGRAM
APPENDIX B:	EDR DATABASE SEARCH REPORT
APPENDIX C	AERIAL PHOTOGRAPHS
APPENDIX D:	TOPOGRAPHIC MAPS

UW-Lacrosse Environmental Sites



0 900 1800 2700 ft.

Map created on Sep 25, 2012

Note: Not all RR Sites have been geo-located yet.

Legend

◆ Open Sites (ongoing cleanups)

▤ Open Sites (ongoing cleanups) - site boundaries shown

◆ Closed Sites (completed cleanups)

▤ Closed Sites (completed cleanups) - site boundaries shown

☐ County Boundary

Railroads

County Roads (WDOT)

County Trunk Highway

State and U.S. Highways (WDOT)

State Trunk Highway

US Highway

Interstate Highways (WDOT)

Interstate Highway

Local Roads (WDOT)

Civil Towns

Civil Town

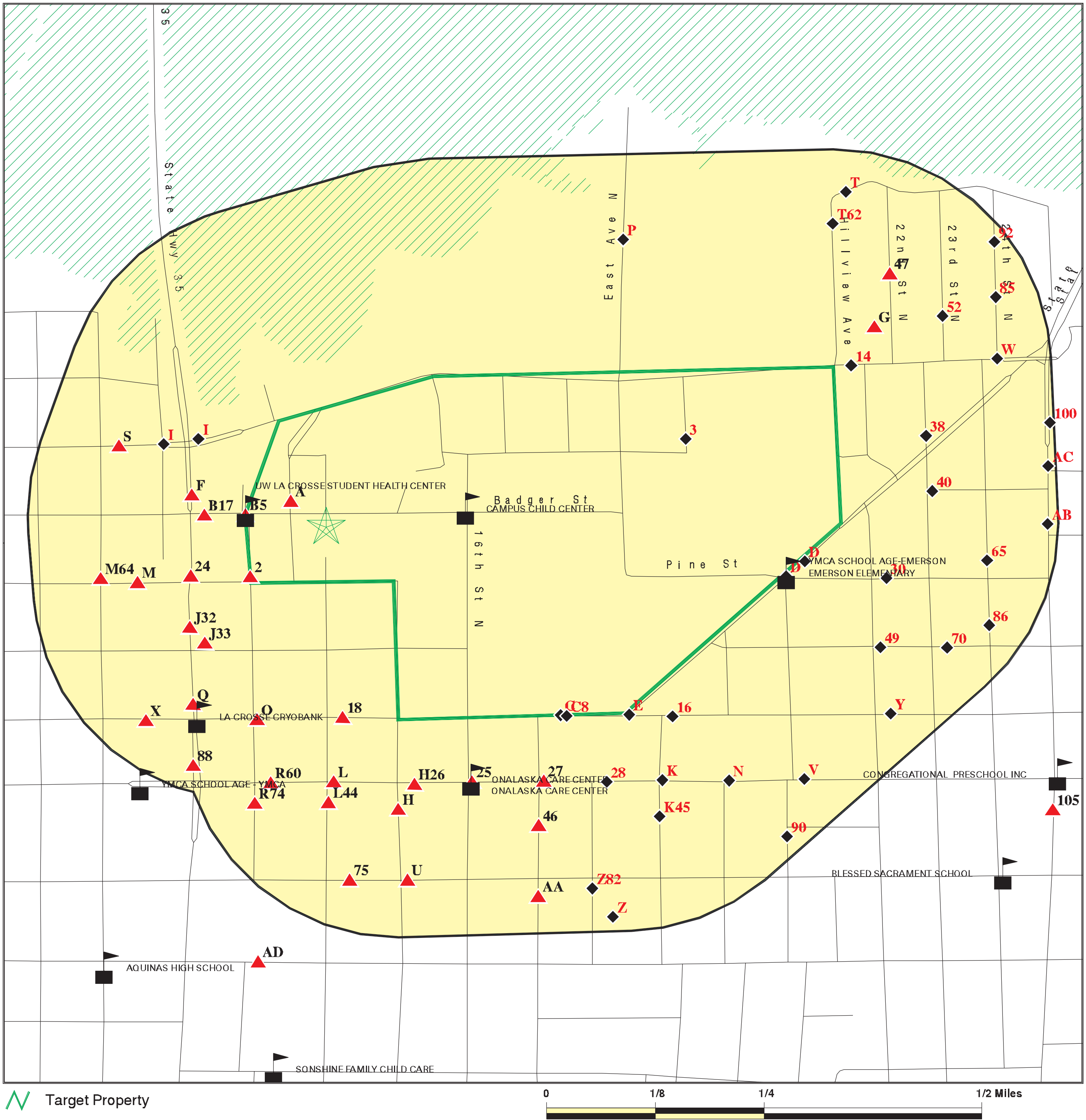
24K Open Water

24K Rivers and Shorelines

Municipalities

Scale: 1:9,311

DETAIL MAP - 3437294.2s



- ⋀ Target Property
- ▲ Sites at elevations higher than or equal to the target property
- ◆ Sites at elevations lower than the target property
- ♟ Manufactured Gas Plants
- ⚑ Sensitive Receptors
- ▨ National Priority List Sites
- ▨ Dept. Defense Sites
- ▨ Indian Reservations BIA
- ⋀ Oil & Gas pipelines from USGS
- ▨ 100-year flood zone
- ▨ 500-year flood zone

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	UW La Crosse	CLIENT:	Bloom Consultants
ADDRESS:	Badger Street/14th Street La Crosse WI 54601	CONTACT:	Judy Fassbender
		INQUIRY #:	3437294.2s
LAT/LONG:	43.816 / 91.2359	DATE:	October 19, 2012 6:02 pm

BLOOM COMPANIES, LLC
Infrastructure Innovation and Ingenuity

Memo

To: Dave Del Ponte, PE – Ring & DuChateau

From: Jonathan Steinbach, PE

CC:

Date: November 2, 2012

Re: UW-La Crosse Chiller Plant Study (DFD #12H2C) – Storm Water Assessment Overview

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Site Information

For site option one, the proposed chiller plant site is bounded by Pine Street and Badger Street and is west of 14th Street extended. The existing condition of this site is a parking lot. Topography generally slopes from northwest to southeast. There is a 12-inch diameter storm sewer that flows to the south along the east side of the parking lot. This sewer will likely require rerouting around the proposed chiller plant pending the final placement of the plant and a field surveyed location of the storm sewer. The 12-inch diameter storm sewer discharges to a 48-inch diameter storm sewer flowing to the west in Pine Street.

For site option two, the proposed chiller plant site is bounded by Farwell Street and Badger Street and is west of East Avenue. The existing condition of this site is also a parking lot. Topography generally slopes to the north and south from higher areas in the center of the parking lot. There is a 42-inch diameter storm sewer that flows to the north in East Avenue. There is also a 12-inch diameter storm sewer that flows to the west in Farwell Street.

The soils on the UW-La Crosse Campus are expected to be typically sandy in nature with high storm water infiltration potential. Based on prior soil borings in the area, groundwater is expected to be on the order of magnitude of 40 feet below grade.

There are references to general flooding and storm sewer capacity issues in and around the UW-La Crosse campus in prior reports reviewed and correspondence related to this project. There have been no specific flooding or storm sewer capacity issues identified directly at either site option being considered. However, as the project moves forward, UW-La Crosse has requested that proposed storm sewer connection points be provided for their review.

Pertinent Code

The project will disturb around 1-acre of land between the chiller plant site and the proposed chilled water lines. The 1-acre disturbance threshold is important as it determines whether the project is subject to WDNR requirements contained in Wisconsin Administrative Code Chapter NR151.

If the project disturbs 1-acre or more land, it would be subject to the construction erosion control performance standards and the post-construction storm water performance standards contained in NR151. A Notice of Intent to Discharge would need to be submitted to the WDNR and erosion control measures would be need to be implemented to reduce the suspended solids load in runoff by 80% during construction. The project is exempt from the typical post-construction infiltration, runoff rate reduction and site-wide total suspended solids (TSS) reduction code requirements of the WDNR, because this will be a “redevelopment site with no increase in exposed parking lots or roads”. However, any parking lot areas restored near the chiller plant site would be subject to the targeted TSS reduction requirements of NR 151.122. Due to this, the project would need to implement post construction best management practices to reduce TSS from the restored parking lot areas by 40%. Pavement restoration that is away from the chiller plant site and related solely to chilled water line construction would not be subject to the targeted TSS reduction requirements.

If the project disturbs less than 1-acre, it would not be subject to the WDNR requirements in NR151 and not required to submit an NOI.

As a state institution, UW-La Crosse is not normally regulated under City of La Crosse or La Crosse County ordinances. State facilities are not subject to local ordinances, except land use provisions of local zoning regulations. However, typically local storm water ordinances are followed to foster good neighbor relationships and to prevent degradation of the state’s water resources.

The City of La Crosse and La Crosse County ordinances for the most part contain fairly typical construction erosion control provisions that are similar to the typical WDNR requirements and DFD standard specifications. There are a few provisions that are worth noting as being beyond the typical requirements on DFD-led projects and are listed below.

- No large scale excavation, with the exception of utility construction, shall be made where the excavation will leave the site devoid of cover vegetation after November 15th.
- All disturbed area, not seeded by September 15 of each year, shall be sodded or controlled by the use of erosion matting or other approved method.
- All restoration of topsoil and/or revegetation must be completed by September 15th in order that the seeding is effective before winter.

The City of La Crosse and La Crosse County ordinances require reduction of the post-development peak runoff rates to match the pre-development rates. Since both plant sites are paved parking lots, the project is expecting to match or reduce the amount of impervious area from the pre-development condition, and thus match or reduce the peak runoff rates in compliance with these ordinances.

The City and County ordinances require complying with the provisions of NR151 to address post-construction storm water quality.

Recommended Storm Water Management Approach

If the project disturbs more than 1 acre, the post-construction targeted TSS reduction requirements of the WDNR will be required for any restored parking lot areas around the chiller plant. As this area is expected to be relatively small, it is recommended that large catch basins with sumps or manufactured underground storm water sedimentation units be installed to achieve the 40% TSS removal. An NOI will be required to be submitted to the WDNR and compliance with related construction erosion control performance standards will be needed. In addition, it is recommended that the additional erosion control requirements of the local agencies be addressed and the City of La Crosse provided an erosion control submittal for review.

If the project disturbs less than 1 acre, no NOI submission with be required. It is recommended that the project follow normal DFD erosion control specifications with the additional erosion control requirements of the local agencies addressed, including preparation of an erosion control submittal for the City of La Crosse.

Given the general concerns of the flooding and storm sewer capacity issues in the surrounding area, it is recommended that small landscaped areas be included around the chiller plant site where possible. This will reduce impervious area and peak storm water runoff rates. If onsite soils are found to be sandy and exhibiting high infiltration rates, these landscaped areas could be completed as rain gardens to promote infiltration and potentially accept a portion of the roof runoff from the plant.

If site option one is selected, the 12-inch diameter storm sewer that runs through the site will likely need partial rerouting to accommodate chiller plant construction. From the areas that appear to drain to this sewer, it seems potentially undersized relative to current plumbing code. It is recommended that further field investigation/survey be made to verify contributing connections and associated tributary area. Upsizing to a 15-inch or 18-inch diameter sewer from the plant site to the connection to the 48-inch diameter storm sewer in Pine Street should provide the additional capacity.