ONE

OBERMILLER NELSON
ENGINEERING

Center for the Arts (CA) Building Chilled Water System Pre-design

Report for:

Minnesota State University Moorhead (MSUM)
ONE Project Number: 2018288

Title Page

Minnesota State University Moorhead (MSUM)
Project Dates: October 2018 – December 2018
Project Location: CA Building

ONE Project Team

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Section 1: Summary

The purpose of this predesign is study the CA building chilled water system on the campus of Minnesota State University Moorhead (MSUM) to determine the best course of action for addressing system deferred maintenance. Currently, the CA building is cooled via a 300-ton McQuay centrifugal water-cooled chiller. Condenser water to the chiller is provided by one 300-ton Marley NC style cooling tower with a variable speed tower fan. Both the chilled water and condenser water pumping systems are constant volume. All equipment was installed in 1994 and aside from routine maintenance, no improvements or replacements have been made.

The original request for this predesign was the result of the cooling tower and condenser water system showing substantial signs of wear. The cooling tower casing needs patching and repair each year by maintenance staff. The condenser water piping system is deteriorating, and fragments of corroded piping are found frequently plugging the cooling tower distribution nozzles as well as condenser system piping strainers. A site visit by ONE on September 11, 2018 examined both the tower and the condenser water system and witnessed the previously mentioned signs of wear first hand. Through this review and in considering the age of the system, ONE can confidently state both the cooling tower and condenser water piping systems are past their useful life and should be replace as soon as possible.

Though the immediate need to replace the cooling water system was found, it also sparked the need to consider all alternatives and the future of the entire CA building chilled water system. Looking at the CA building chilled water system on this larger scale, ONE developed three different improvement paths for consideration, which are as follows:

Improvement Path #1: Replace the cooling tower and condenser water piping system

Improvement Path #2: Replace the cooling tower and condenser water piping system and also install new chiller controls and chilled water pumping controls

Improvement Path #3: Replace the entire water-cooled chiller system with a new air-cooled chiller system

Depending on the improvement path chosen, ONE estimated the project will cost between $288,000 and $519,000. Each improvement path has its own set of advantages and disadvantages which needed to be weighed against the overall capital expense. In reviewing all factors with the University, ONE's ultimate recommendation is to target Improvement Path #3 in order to deliver the best long term solution for the chilled water system.

ONE's estimated project schedule assumes that design begins in July of 2019, with bidding occurring in October of 2019, and the bulk of construction occurring between November 2019 and March 2020. Final testing and commissioning will go on periodically through the Summer of 2020. HEAPR funding would be the preferred choice for funding this project with campus funds being a known alternative. There have been no past appropriations for this project. The remainder of this report will detail the analysis

completed by ONE in order to reach their final recommendation to move forward with Improvement Path #3.

Section 2: Project Description (Scope)

Improvement Path #1

For this improvement path the existing cooling tower would be replaced with a new 300-ton cooling tower. The tower would be an induced draft tower with a variable speed fan for capacity control. The tower would also be equipped with its own level and blowdown controls. The new tower would be located in the same place as the existing tower. Collection and distribution basins of the tower would be constructed out of stainless steel or coated galvanized steel to address the deterioration issues found with the existing tower. This would be considered a "like for like" replacement with a few enhancements to the tower to increase its longevity. Completing a like for like replacement such as this will limit the amount of structural and roof work required for installation of the new tower.

This improvement path will also replace the existing condenser water piping with new ASTM A53 Grade B carbon steel schedule 40 piping. It is anticipated the piping would be installed with grooved fittings. Manual valves, pressure gauges, thermometers, and temperature transmitters will be installed in the new piping system as required. Existing roof penetrations and pipe routing from the cooling tower to the chiller would be reused. New cooling tower makeup water and drain piping would also be installed as would new redundant condenser water pumps and system filters.

As part of this improvement, ONE would request that MSUMs water treatment specialist (U.S. Waters) prescribe a water treatment regimen specific for the new system to limit deterioration of the system over time. This would include the water treatment specialist providing any newly required chemical injection or sampling equipment. ONE assumes any upgrades to the chemical treatment system would be at no cost to MSUM and that MSUM would only be responsible for purchase of chemical.

Improvement Path #2

Under this improvement path the work described in path #1 would still be completed. Also completed would be a chiller control upgrade to modernize control of the chiller. This would include a new digital control panel and electronic expansion valve. The new control system would be networked into the campus building automation system for monitoring and control.

In conjunction with the chiller control replacement, the existing chilled water primary pump will be removed, and a new redundant set of variable speed chilled water pumps and variable frequency drives would be installed. A differential pressure sensor will be added to the system to control the speed of the chilled water pump as will a minimum flow bypass. The variable speed pump will increase efficiency of the pumping system by varying the speed of the pump based on chilled water demand.

Improvement Path #3

This path would require completely demolishing the existing cooling tower and condenser water piping system as well as the existing chiller and replacing it with a new 300-ton air cooled chiller. The existing air-cooled chiller would preliminarily be slated for installation on the roof of the building, in the location from which the existing cooling tower was removed. It is likely the existing structure can support the new chiller with minimal changes, but a structural review would be completed during final design to verify this to be true. New ASTM A53 Grade B carbon steel schedule 40 piping with grooved fittings would be installed from the new chiller location down to the mechanical room from which the existing chiller was removed. New piping insulation would also be included with the new piping. Within the mechanical room a set of redundant chilled water system pumps would be installed along with a new air separator, expansion tank, manual valves, and instrumentation. The controls for the new chiller and pumps would be connected into the existing building automation system for monitoring and control.

Security Issues, Past Actions, and Project Phasing

ONE does not foresee any special security or safety concerns with the project. The project will be a typical HVAC renovation project which MSUM has complete before. Campus rules and regulations regarding security and safety with respect to construction will be followed but the project should not involve anything out of the ordinary.

ONE does not believe there are any past actions, such as renovations or system modifications, which would affect the execution of the project. ONE expects a majority of the project will occur outside of the cooling season which will eliminate the need to temporarily relocate operations from the building at any point in time. Proper execution of the project should not change operation of the facility.

Bibliography:

Below is a list of codes applicable to the project.

1. 2015 Minnesota Building Code
2. 2015 Minnesota Energy Code
3. 2015 Minnesota Mechanical Code
4. 2015 Minnesota Plumbing Code
5. Minnesota Electrical Code

All codes and standards adopted and amended by the previously listed Minnesota codes applicable to the project will also be followed.

Section 3: Sustainability/Energy

Regardless of the improvement path chosen, this project would not be required to achieve compliance with MN B3 guidelines.

Section 4: Financial Information – Capital Expenditures

Detailed project estimates for each improvement can be found in Appendix 1. The summary of total costs are given below along with advantages and disadvantages.

		Advantages	Disadvantages
Improvement #1	$292,000	Lowest capital cost	Doesn't address energy efficiency, age of existing chilled water pumps, or aged chiller controls
Improvement #2	$415,500	Addresses aged chilled water pumps and chiller controls system. Provides a return on investment due to energy savings	Higher capital costs than Improvement #1, does not replace the 24-year-old existing chiller
Improvement #3	$523,000	Addresses deferred maintenance of the entire generation system, provides return on investment for chilled water pumping. Operation and maintenance of air-cooled chiller easier than existing water-cooled. No impact to operating budget.	Highest capital cost

ONE does not believe there are any atypical considerations regarding budget and or schedule which would affect the project. It is anticipated the project would be funded through HEAPR or campus funding. HEAPR funding would be the preferred method for funding the project if the funding can be secured for construction during the fall/winter/spring of 2019-2020. If funding cannot be secured, campus funding would be the recommended alternative. Under either funding source, ONE recommends the project is executed under a design-bid-build delivery method utilizing a single prime contractor of the mechanical discipline. ONE believes delivering the project in this way will deliver the lowest project cost through competitive bidding and by eliminating the need for a general contractor. The previously given estimates assume the project is delivered in this manner.

Section 5: Financial Information – Ongoing Operating Expenditures

This project is a capital expenditure to address deferred maintenance and replacement of the CA building chilled water system. ONE believes there should be no change to the yearly repair and maintenance costs which should have already been assigned to the system.

With improvement #2 or #3, ONE estimates conversion to variable volume chilled water pumping will save MSUM approximately $3,000 per year which represents roughly a four-year return on investment. ONE also estimates the chiller control panel upgrade (part of improvement #2 only) would have the potential to save $5,000 per year, which represents an eight-year return on investment. Both of these modifications would be expected to last at least 10 years with minimal maintenance and upkeeping and for this reason, ONE believes these would be worth the investment. ONE does not believe there should be a change to the operating budget for improvement #3 to change the system from water-cooled to air-cooled.

An alternative funding source for this project could be through a source-well or operating lease agreement. The benefit of agreements like this is the project goes from being funded through a capital expenditure request to being funded utilizing campus operating dollars. ONE has been involved in these types of partnerships through prior work and can put MSUM in touch with the right people to execute such an agreement.

Section 6: Schedule

A Gantt chart detailing the entire project schedule is attached to this report as Appendix 2. This schedule is applicable to all three of the potential improvements. It is anticipated the project will be funded through a single funding cycle.

Section 7: Recommendation

Considering all advantages and disadvantages of the three potential improvements, ONE ultimately recommends Improvement Path #3 is implemented to improve the CA building chilled water system. ONE has come to this final recommendation for the following reasons.

1. This is the only option that address all of the aged chilled water generation infrastructure. With the first two improvements, the existing chiller was still left to be reused and would need to be planned for replacement in the future.
2. With proper implementation, the new air-cooled chiller will not affect the operating budget of the CA building chilled water system.
3. New air-cooled chiller systems are much easier to operate and maintain than water-cooled systems. Facility operations and maintenance staff will be much more efficient and self-reliant operating and maintaining the new air-cooled system than the existing water-cooled system.
4. This building system will start anew and will be highly functional for many years to come. Updating the system now will be one less expense to occur if/when the entire building goes through a renovation.

Section 8: Appendices

Appendix 1: Detailed Project Cost Estimates
Appendix 2: Estimated Project Schedule

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PREDESIGN ENGINEER'S ESTIMATE OF PROBABLE COST
MINNESOTA STATE UNIVERSITY MOORHEAD (MSUM)
CA BUILDING CHILLED WATER SYSTEM IMPROVEMENTS

DESCRIPTION OF WORK

Improvement Path #1: Replace the cooling tower and condenser water piping system

Item Description	UOM	Unit Quan	Item Unit Cost	By Item Total	Group Total	NOTES
DIVISION 01 - GENERAL CONDITIONS					**$ 28,000**	
MOBILIZATION AND DEMOBILIZATION	L.S.	1	$ 3,000	$ 3,000		
CONSUMABLES AND SUPPLIES	L.S.	1	$ 1,500	$ 1,500		
CRANE RENTAL	L.S.	1	$ 16,000	$ 16,000		
SUPERVISION	L.S.	1	$ 6,500	$ 6,500		
EQUIPMENT RENTAL	L.S.	1	$ 1,000	$ 1,000		
DIVISION 07 - ROOFING					**$ 8,500**	
ROOF PATCHING AS NEEDED	L.S.	1	$ 8,500	$ 8,500		MINIMAL WORK EXPECTED, ONLY PATCH AROUND TOWER SUPPORT OR EXISTING PIPING PENETRATIONS
DIVISION 23 - SELECTIVE DEMOLITION					**$ 11,000**	**INCLUDES DISPOSAL**
COOLING TOWER	L.S.	1	$ 4,000	$ 4,000		
CONDENSER WATER PIPING, VALVES, PUMPS	L.S.	1	$ 7,000	$ 7,000		
DIVISION 23 - NEW CENTRAL COOLING					**$ 161,000**	
NEW COOLING TOWER	L.S.	1	$ 70,000	$ 70,000		MATERIAL AND FREIGHT ONLY
COOLING TOWER INSTALLATION	HR	240	$ 100	$ 24,000		MATERIAL AND LABOR NEEDED FOR INSTALL INCLUDED
8" CONDENSER WATER PIPING	L.F	200	$ 200	$ 40,000		INCLUDES GROOVED FITTINGS, PIPE HANGERS, AND MANUAL VALVES, STRAINERS, GAUGES, THERMOMETERS, ETC.
REDUNDANT CONDENSER WATER PUMPS	E.A.	2	$ 8,500	$ 17,000		BASE MOUNTED, ESTIMATED AT 20HP, INCLUDES EQUIPMENT SETTING AND 4" CONCRETE BASE
COOLING TOWER DRAIN AND MAKEUP WATER PIPING	L.S.	1	$ 10,000	$ 10,000		MATERIAL AND LABOR NEEDED FOR INSTALL INCLUDED
DIVISION 25 - CONTROLS					**$ 20,000**	
CONTROLS DEMOLITION	L.S.	1	$ 1,000	$ 1,000		
CONTROLS HARDWARE	L.S.	1	$ 15,000	$ 15,000		
CONTROLS PROGRAMMING/SOFTWARE	L.S.	1	$ 4,000	$ 4,000		
DIVISION 26 - ELECTRICAL CONSTRUCTION					**$ 22,500**	
ELECTRICAL DEMOLITION	L.S.	1	$ 2,500	$ 2,500		
POWER TO NEW PUMPS AND COOLING TOWER	L.S.	1	$ 20,000	$ 20,000		NEW WIRING, CONDUIT, BREAKERS/SWITCHES. ASSUMES EXISTING SWITCHBOARD/MCC CAN BE USED WITH INSTALLATION OF NEW BREAKERS/SWITCHES
OWNER AND PROJECT COSTS					**$ 41,000**	
ENGINEERING/CONSULTING	L.S.	1	$ 23,000	$ 23,000		
PERMITS AND BONDS	L.S.	1	$ 13,000	$ 13,000		
MISC. OWNER COSTS	L.S.	1	$ 5,000	$ 5,000		

Total	$ 292,000

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PREDESIGN ENGINEER'S ESTIMATE OF PROBABLE COST
MINNESOTA STATE UNIVERSITY MOORHEAD (MSUM)
CA BUILDING CHILLED WATER SYSTEM IMPROVEMENTS

DESCRIPTION OF WORK

Improvement Path #2: Replace the cooling tower and condenser water piping system and also install new chiller and chilled water pumping controls

Item Description	UOM	Unit Quan	Item Unit Cost	By Item Total	Group Total	NOTES
DIVISION 01 - GENERAL CONDITIONS					**$ 31,000**	
MOBILIZATION AND DEMOBILIZATION	L.S.	1	$ 3,000	$ 3,000		
CONSUMABLES AND SUPPLIES	L.S.	1	$ 2,000	$ 2,000		
CRANE RENTAL	L.S.	1	$ 16,000	$ 16,000		
SUPERVISION	L.S.	1	$ 8,000	$ 8,000		
EQUIPMENT RENTAL	L.S.	1	$ 2,000	$ 2,000		
DIVISION 07 - ROOFING					**$ 8,500**	
ROOF PATCHING AS NEEDED	L.S.	1	$ 8,500	$ 8,500		MINIMAL WORK EXPECTED, ONLY PATCH AROUND TOWER SUPPORT OR EXISTING PIPING PENETRATIONS
DIVISION 23 - SELECTIVE DEMOLITION					**$ 14,000**	**INCLUDES DISPOSAL**
COOLING TOWER	L.S.	1	$ 4,000	$ 4,000		
CONDENSER WATER PIPING, VALVES, PUMPS	L.S.	1	$ 7,000	$ 7,000		
CHILLED WATER PUMPS, VALVES, STRAINERS	L.S.	1	$ 3,000	$ 3,000		
DIVISION 23 - NEW CENTRAL COOLING					**$ 240,000**	
NEW COOLING TOWER	L.S.	1	$ 70,000	$ 70,000		MATERIAL AND FREIGHT ONLY
COOLING TOWER INSTALLATION	HR	240	$ 100	$ 24,000		MATERIAL AND LABOR NEED FOR INSTALL INCLUDED
8" CONDENSER WATER PIPING	L.F	200	$ 200	$ 40,000		INCLUDES GROOVED FITTINGS, PIPE HANGERS, AND MANUAL VALVES, STRAINERS, GAUGES, THERMOMETERS, ETC.
CHILLED WATER PIPING MODIFICATIONS	L.S.	1	$ 14,000	$ 14,000		INSTALL MINIMUM FLOW BYPASS LINE AND DIFFERENTIAL PRESSURE SENSOR FOR CHILLED WATER PUMP CONTROL
REDUNDANT CONDENSER WATER PUMPS	E.A.	2	$ 8,500	$ 17,000		BASE MOUNTED, ESTIMATED AT 20HP, INCLUDES EQUIPMENT SETTING AND 4" CONCRETE BASE
COOLING TOWER DRAIN AND MAKEUP WATER PIPING	L.S.	1	$ 10,000	$ 10,000		MATERIAL AND LABOR NEEDED FOR INSTALL INCLUDED
REDUNDANT CHILLER WATER PUMPS	E.A.	2	$ 12,500	$ 25,000		BASE MOUNTED, ESTIMATED AT 50HP, INCLUDES EQUIPMENT SETTING AND 4" CONCRETE BASE
CHILLER CONTROLS UPGRADE	L.S.	1	$ 40,000	$ 40,000		NEW DIGITAL CHILLER CONTROL PANEL AND ELECTRONIC EXPANSION VALVE
DIVISION 25 - CONTROLS					**$ 37,500**	
CONTROLS DEMOLITION	L.S.	1	$ 2,500	$ 2,500		
CONTROLS HARDWARE AND EQUIPMENT	L.S.	1	$ 25,000	$ 25,000		INCLUDES CONTROL CABINETS, CONTROLLERS, VFDS, DIFFERENTIAL PRESSURE TRANSMITTER
CONTROLS PROGRAMMING/SOFTWARE	L.S.	1	$ 10,000	$ 10,000		
DIVISION 26 - ELECTRICAL CONSTRUCTION					**$ 28,500**	
ELECTRICAL DEMOLITION	L.S.	1	$ 3,500	$ 3,500		
POWER TO NEW PUMPS AND COOLING TOWER	L.S.	1	$ 25,000	$ 25,000		NEW WIRING, CONDUIT, BREAKERS/SWITCHES. ASSUMES EXISTING SWITCHBOARD/MCC CAN BE USED WITH INSTALLATION OF NEW BREAKERS/SWITCHES
OWNER AND PROJECT COSTS					**$ 56,000**	
ENGINEERING/CONSULTING	L.S.	1	$ 33,000	$ 33,000		
PERMITS AND BONDS	L.S.	1	$ 18,000	$ 18,000		
MISC. OWNER COSTS	L.S.	1	$ 5,000	$ 5,000		

Total	$ 415,500

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PREDESIGN ENGINEER'S ESTIMATE OF PROBABLE COST
MINNESOTA STATE UNIVERSITY MOORHEAD (MSUM)
CA BUILDING CHILLED WATER SYSTEM IMPROVEMENTS

DESCRIPTION OF WORK

Improvement Path #3: Replace the entire water-cooled chiller system with a new air-cooled chiller system

Item Description	UOM	Unit Quan	Item Unit Cost	By Item Total	Group Total	NOTES
DIVISION 01 - GENERAL CONDITIONS					**$ 32,000**	
MOBILIZATION AND DEMOBILIZATION	L.S.	1	$ 3,000	$ 3,000		
CONSUMABLES AND SUPPLIES	L.S.	1	$ 2,500	$ 2,500		
CRANE RENTAL	L.S.	1	$ 16,000	$ 16,000		
SUPERVISION	L.S.	1	$ 8,500	$ 8,500		
EQUIPMENT RENTAL	L.S.	1	$ 2,000	$ 2,000		
DIVISION 07 - ROOFING					**$ 8,500**	
ROOF PATCHING AS NEEDED	L.S.	1	$ 8,500	$ 8,500		MINIMAL WORK EXPECTED, ONLY PATCH AROUND TOWER SUPPORT OR EXISTING PIPING PENETRATIONS
DIVISION 23 - SELECTIVE DEMOLITION					**$ 21,000**	**INCLUDES DISPOSAL**
COOLING TOWER	L.S.	1	$ 4,000	$ 4,000		
CONDENSER WATER PIPING, VALVES, PUMPS	L.S.	1	$ 7,000	$ 7,000		
CHILLED WATER PUMPS, VALVES, STRAINERS	L.S.	1	$ 3,000	$ 3,000		
EXISTING CHILLER	L.S.	1	$ 7,000	$ 7,000		
DIVISION 23 - NEW CENTRAL COOLING					**$ 269,000**	
NEW AIR COOLED CHILLER	L.S.	1	$ 150,000	$ 150,000		MATERIAL AND FREIGHT ONLY
NEW AIR COOLED CHILLER INSTALLATION	HR	200	$ 100	$ 20,000		
NEW 8" CHILLED WATER PIPING WATER PIPING	L.F	200	$ 250	$ 50,000		INCLUDES GROOVED FITTINGS, PIPE HANGERS, AND MANUAL VALVES, STRAINERS, GAUGES, THERMOMETERS, ETC.
CHILLED WATER PIPING MODIFICATIONS	L.S.	1	$ 14,000	$ 14,000		INSTALL MINIMUM FLOW BYPASS LINE AND DIFFERENTIAL PRESSURE SENSOR FOR CHILLED WATER PUMP CONTROL
REDUNDANT CHILLED WATER PUMPS	E.A.	2	$ 12,500	$ 25,000		BASE MOUNTED, ESTIMATED AT 50HP, INCLUDES EQUIPMENT SETTING AND 4" CONCRETE BASE
ADDITIONAL GLYCOL FOR THE SYSTEM	L.S.	1	$ 10,000	$ 10,000		
DIVISION 25 - CONTROLS					**$ 38,500**	
CONTROLS DEMOLITION	L.S.	1	$ 3,500	$ 3,500		
CONTROLS HARDWARE	L.S.	1	$ 25,000	$ 25,000		
CONTROLS PROGRAMMING/SOFTWARE	L.S.	1	$ 10,000	$ 10,000		
DIVISION 26 - ELECTRICAL CONSTRUCTION					**$ 88,000**	
ELECTRICAL DEMOLITION	L.S.	1	$ 6,000	$ 6,000		
POWER TO NEW CHILLER	L.S.	1	$ 72,000	$ 72,000		CREATES A NEW SERVICE FOR THE CHILLER (SWITCHGEAR, WIRING, CONDUIT, ETC.)
POWER TO NEW PUMPS	L.S.	1	$ 10,000	$ 10,000		NEW WIRING, CONDUIT, BREAKERS/SWITCHES. ASSUMES EXISTING SWITCHBOARD/MCC CAN BE USED WITH INSTALLATION OF NEW BREAKERS/SWITCHES
OWNER AND PROJECT COSTS					**$ 66,000**	
ENGINEERING/CONSULTING	L.S.	1	$ 39,000	$ 39,000		
PERMITS AND BONDS	L.S.	1	$ 22,000	$ 22,000		
MISC. OWNER COSTS	L.S.	1	$ 5,000	$ 5,000		

Total	$ 523,000

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ONE Project Number: 2018288
Appendix 2: Estimated Project Schedule
By: Andrew Honeyman, PE

MSUM CA Building Chilled Water Improvements

TASK DESCRIPTION	PLAN START	PLAN END
Engineering		
Schematic Design	7/1/2019	7/15/2019
Detailed Design	7/15/2019	8/15/2019
Construction Documents	8/15/2019	9/29/2019
Bidding and Contracting	9/29/2019	11/1/2019
Construction		
Submittals and Shop Drawing Review	11/1/2019	11/15/2019
Equipment Lead Time	11/15/2019	2/1/2020
Demolition	11/15/2019	1/1/2020
Equipment Setting	2/1/2020	2/21/2020
Piping	1/1/2020	3/1/2020
Electrical	2/1/2020	3/1/2020
Controls	2/15/2020	3/15/2020
Startup and Commissioning		
New System Initial Startup	4/1/2020	4/15/2020
New System Full Load Startup	7/15/2020	7/21/2020
System Commissioning and Testing	7/15/2020	8/15/2020
Startup and Commissioning		
Deliver Final O&Ms & As-Builts	8/15/2020	9/1/2020