Executive Summary

Typically, a University campus master plan includes projected building locations, vehicular and pedestrian routing assessment, parking lot needs, recreational improvements and athletic facilities. By omitting the campus utility systems from the planning effort, many universities encounter capacity deficiencies and infrastructure expansion needs that can be disruptive to capital project budgets and schedules. CMU's comprehensive approach to the 2013 Campus Master Plan project provides a level of detail and understanding of several utility systems on campus. Future studies have been identified for other utility systems and can be added to this document over time. FTC&H has worked closely with CMU staff and the overall project team to perform facility condition assessments for all CMU campus buildings and the utility infrastructure assessment tasks. This document outlines the information gathered to date on the existing utility distribution systems on the Mount Pleasant campus, as well as mechanical equipment within the Central Energy Facility, Satellite Energy Facility, and Park Library.

FTC&H's portion of the campus master planning process has accumulated enumerable maps and tables displaying the various components of the campus systems. Many aspects of these systems are very different from each other, what they have in common is a shared space within the campus. Geographic Information Systems (GIS) allows us to visualize the information stored with each system by location and to evaluate them not as single entities but as integral parts of the campus-wide land use and infrastructure system. In order to efficiently compile and store the information for each utility system, as well as the facility condition assessments, we have created a GIS Framework.

FTC&H used standard industry supported GIS software to manage project data and produce deliverables. Esri ArcGIS Desktop 10 was used to create the datasets and map layers representing the various components of the master plan and reference the data to the current campus base map used by the University. At completion of the project, we will provide interactive maps in Adobe PDF format and as Esri ArcReader (free map viewer) published maps that allow University staff to easily access the information on an as-needed basis. Simplicity in using these widely-accepted tools is a key component to accessing the files in-house today as well as adapting to future changes in technology. We have worked with CMU to identify the pieces of information to be included into the framework, with the intent of creating a system that will be useful and easily maintained by CMU in the future. Maps for each utility system have been created from the GIS framework and will continue to be updated throughout the master planning process.

SHW Group and CMU continue to establish the campus growth plans for the next ten years. FTC&H is working closely with the team to provide recommendations for needed utility improvements based on potential building locations. Cost estimates will be prepared, which will assist CMU in financial planning and decision making.

Campus Domestic Water System

CMU currently is served by the City of Mount Pleasant (City) water system as a retail customer, and receives softened water from the City's water treatment plant. FTC&H collected available domestic water piping maps from CMU and the City in AutoCAD and PDF formats. The piping layouts were incorporated into the GIS Framework, as well as any available information regarding pipe sizes, materials, ownership and age. The City's hydrant numbering system has also been inserted into the GIS system, which will allow CMU and the City to communicate more efficiently in the future during hydrant flow testing, tapping or incidents of fire.

The 2013 Campus Master Plan scope does not include a complete analysis of the water distribution system. The purpose of conducting a water system study is to ensure the water system will have adequate capacity and capability to provide a reliable supply of water to campus users into the future. This type of study would evaluate current conditions, identify deficiencies and needs, develop cost estimates for improvements, and prioritize the recommended improvements for use in capital planning. It would also include a computerized hydraulic model of the water system, which can be used to analyze water system performance.

It will not be possible to adequately address the impacts CMU's ten year capital plan will have on the campus domestic water system; however, we will incorporate recommendations in the next phases of the master plan process based on the information available. FTC&H recommends conducting a water system study in the future, and the results of the study can be inserted into the 2013 Campus Master Plan at that time.

Campus Storm Sewer System

CMU's storm water system on campus consists of a series of pipe networks that ultimately outlet to the Upton Drain, which is owned and maintained by the Isabella County Drain Commission (ICDC). FTC&H collected available piping network map from CMU and the ICDC in AutoCAD and PDF formats. The piping layouts were incorporated into the GIS Framework, as well as any available information regarding pipe sizes, materials, ownership and age. CMU also transferred data collected to date for existing manhole and catch basin structures on campus for incorporation into the GIS framework.

The 2013 Campus Master Plan scope does not include a complete analysis of the campus storm sewer system. The goals for a storm water master plan include providing guidance for long term storm water management for future campus initiatives, identifying opportunities to incorporate sustainable strategies for flood control and storm water treatment, and identifying cost effective strategies for correction of existing drainage deficiencies. A computer model of the campus could be developed to identify capacity deficiencies within pipe networks. A complete study would also provide a prioritized capital improvement plan for necessary storm water improvements, including an implementation schedule and cost estimates.

It will not be possible to adequately address the impacts CMU's ten year capital plan will have on the campus storm water piping networks or detention capabilities. FTC&H recommends conducting a campus storm water master plan in the future. The results of the study can be inserted into the 2013 Campus Master Plan and help inform CMU's future development.

Campus Sanitary Sewer System

CMU owns and operates a majority of the wastewater collection piping system serving University building facilities, and the City also owns sections of the sanitary sewer piping network on campus. All of the sanitary discharge from campus is piped to the City's wastewater treatment plant for processing. FTC&H collected available mapping from CMU and the City in AutoCAD and PDF formats for incorporating into the GIS framework. Existing manhole structure data was provided by CMU for portions of campus and inserted into GIS.

The 2013 Campus Master Plan scope does not include a complete analysis of the campus sanitary sewer system. The primary goal of this study would be to provide a comprehensive plan for the orderly and cost-effective upgrade and expansion of the campus wastewater piping networks. A computer model of the campus could be developed to identify capacity deficiencies within pipe networks. The 2013 Campus Master Plan effort will identify future capital building projects, and FTC&H could anticipate future wastewater flow rates that will need to be transported to the City's wastewater treatment plant and associated cost projections.

It will not be possible to adequately address the impacts CMU's ten year capital plan will have on the campus sanitary sewer system; however, we will incorporate recommendations in the next phases of the master plan process based on the information available. FTC&H recommends conducting a campus sanitary sewer study in the future, and the results of the study can be inserted into the 2013 Campus Master Plan at that time.

Steam/Condensate Distribution System

FTC&H completed a Campus Steam Distribution Study for CMU's Mount Pleasant campus in June 2012. We walked the entire system of steam distribution tunnels to perform a physical inspection of the piping systems, including isolation valves, traps and drip legs, expansion joints, expansion loops, and pipe supports. A structural condition assessment and pipe stress analysis of the system was completed as a result of this inspection. FTC&H also developed a computer model using 2009 Pipe-Flo Professional by Engineered Software, Inc. Information on the piping system was entered into the program, such as pipe size, pipe length, and number of fittings. The model was developed for winter campus steam demand and condensate return based on current loads. The model was calibrated to reflect actual system performance as measured by pressure and temperature data recorders and observations to within 1 to 2 psig. Starting with the calibrated model, a base model was developed to incorporate recommended upgrades in order to resolve current deficiencies. Future campus growth can be input into the system model in order to determine impacts to system distribution.

The report identified deficiencies within the existing campus distribution system, and FTC&H presented recommendations based on structural condition, reliability and performance, and future planning known at that time. The brick tunnel sections between Terminal Park and Warriner Hall, Terminal Park and Smith Hall, and Terminal Park and Grawn Hall have reached their useful life and should be replaced with a utility tunnel, crawl tunnel or direct buried system. Reliability and performance recommendations included adjusting the flow rates from various condensate return pumps to optimize system performance, as well as new steam and condensate mains throughout the existing campus.

The campus steam and condensate distribution system piping and tunnels have been inserted into the GIS Framework. Additional pressure and flow data was collected in January and February, 2013, during which temperatures at or below design days were experienced. This data will be used to further calibrate the model. During the next phases of the 2013 Campus Master Plan process, FTC&H will incorporate future building locations into the campus steam model to update the future planning recommendations of the original report. This will allow the team to determine deficiencies within the steam and condensate distribution system resulting from future campus growth. Cost estimates will be prepared for any recommended improvements.

Electrical

The 2013 Campus Master Plan scope does not include a complete analysis of the campus electrical systems. During the facility condition assessment walkthroughs for campus buildings, CMU electrical staff members were interviewed for known deficiencies in the electrical systems and any improvements needed are being addressed within that portion of the overall campus master planning effort.

FTC&H incorporated existing campus mapping as provided by CMU into the GIS framework. The information included the campus one-line diagram, UIS testing reports, and GPS locations for existing campus site lighting.

Chilled Water

Given current air conditioning demands in campus buildings, campus development will impact and be impacted by the campus chilled water system. Beginning with the previous studies of the chilled water system and interviews with CMU Facilities staff, FTC&H developed a campus model of the chilled water system using 2009 Pipe-Flo Professional by Engineered Software, Inc. The model analyzed flow and pressures in the campus chilled water distribution system. The model allows our team to identify current system deficiencies, limitations on future demands, and model system changes that will provide the greatest benefit to planned campus development.

A preliminary report identified deficiencies within the existing campus distribution system, and FTC&H presented recommendations based on the current system configuration. FTC&H is currently working with CMU to develop a modeling approach to predict the effect of additional demands on the campus system without de-coupling the system. This will allow FTC&H to meet CMU's goals to use the model to incorporate future building planning recommendations during the next phases of the 2013 Campus Master Plan process as well as allow the team to determine deficiencies within the chilled water distribution system resulting from future campus growth. Cost estimates will be prepared for recommended improvements.

The campus chilled water distribution system piping has been inserted into the GIS Framework, and a full capacity report has been generated as a standalone document.

Data/Telecom/IT

CMU made OIT information available to FTC&H and SHW in order to incorporate existing infrastructure and future needs into the 2013 Campus Master Plan effort. Planned improvements to these systems are being tracked by CMU OIT Staff and not included in FTC&H documents. For the utility infrastructure assessment portion of the project, CMU provided drawings showing existing infrastructure locations, and this information has been incorporated into the GIS framework.

Central Energy Facility – Mechanical Equipment for Campus System Assessment

Located within the Central Energy Facility is the following equipment that serves the campus district chilled water system:

1. Chillers
   a. The Central Energy Facility consists of 4 chillers that were installed in 1991. There are 3 electric chillers and 1 steam absorption chiller. The chillers have a combined total capacity of 5,000 tons of cooling. The maximum generation capacity is 3,750 tons of cooling. A maximum of 3 chillers can be operated simultaneously due to the capacity of the cooling towers. The electric chillers operate efficiently with a condenser water temperature of 78°F. The steam absorption chiller operates efficiently with a condenser water temperature of 85°F.
2. Primary and Secondary Chilled Water Pumps
   a. The Central Energy Facility consists of 4 primary chilled water pumps and 3 secondary chilled water pumps. All pumps were installed in 1991 and have been upgraded with variable frequency drives (VFDs).
   b. The 4 primary chilled water pumps produce 2,308 GPM each. Each pump is designated to a chiller; however, the piping is arranged so that any pump discharge can be diverted to any chiller.
   c. The 3 secondary chilled water pumps produce 4,750 GPM each. Pumps are used for campus chilled water distribution. One of the pumps is assigned as a backup.
3. Condenser Water Pumps
   a. The Central Energy Facility consists of 4 condenser water pumps. All pumps were installed in 1991 and have been upgraded with VFDs. Total generating pumping capacity is 17,300 GPM. The piping is arranged so that any pump discharge can be diverted to any chiller.
   b. Two of the pumps operate at 4,800 GPM each, while the other 2 pumps operate at 3,750 GPM.
4. Cooling Towers
   a. The Central Energy Facility consists of 3 cooling tower cells and a concrete sump. The cooling towers and sump were installed in 1991. The tower fans have been upgraded with VFDs. The west cell fan motor was recently replaced to operate at the correct speed. The concrete sump is showing signs of scaling and a thorough inspection of the sump is recommended. The tower fan blades have been reconditioned. Only 3 chillers can be in operation at a time to coincide with the 3 tower cells. To allow operation of three electric chillers and one steam absorption chiller, a new stand-alone cooling tower should be added. Adding a new cooling tower will allow all 4 chillers to operate simultaneously, increasing capacity to the campus distribution system.

Located within the Central Energy Facility is the following equipment that serves the campus district steam system:

1. The Central Energy Facility consists of 4 steam generating boilers for campus distribution. The total maximum steam generating capacity is 300,000 lbs/hr.
    a. Boilers 1 and 2 are 52 years old and made by Wickes Boilers Co. Historically, these 2 boilers are primarily used in an emergency. As of December 2012, Boiler 4 (wood boiler) was taken out of operation designating Boiler 5 (Heat Recovery Steam Generator) and the Gas Turbine as the primary sources of campus steam. This change resulted in Boilers 1 and 2 being more critical to the campus steam production. If Boiler 5 were to go down, this would leave Boilers 1 and 2 to handle the campus steam load. A recommendation is to have the steamtubes inside Boiler 1 & 2 tested for integrity. Based upon the testing results (expected by June 1, 2013), a suitable plan will be developed, if required.
    b. Based on the 2003 Cummins and Barnard report, the boilers were estimated to have a life expectancy greater than 10 years. Since the boilers had such a low usage rate, the life expectancy should be for another 10 years. O_2 trim on the boilers has been upgraded including burner controls. The boiler tubes are original; however, as with any firetube boiler, tube failure may occur at any time. The economizers are original and coming to the end of their life expectancy.
    c. Boiler 4 is a Nebraska Boiler installed in 1984. This boiler's operation has been intermittent throughout the 29 years of existence. As of December 2012, the boiler was shut down due to the low cost of natural gas. During this time, routine maintenance will be performed. The economizer was replaced in 2002. The air heater and scrubber are reported to be too small and have a history of plugging, resulting in lower boiler capacity. The boiler has been repaired over time, but never overhauled.

    Boiler 5 is a heat recovery steam generator (HRSG) by Deltak Inc. The economizer was replaced in 2010. Burner control upgrades were completed in January 2013.
2. Turbine Generators
    a. The Central Energy Facility has 1 Solar Taurus 60 gas turbine with a nominal capacity of 3.2 megawatts. The turbine exhaust gas flows into Boiler 5 (HRSG) and generates 17,000 lbs/hr of steam. A new engine was installed in 2012.
    b. The Central Energy Facility has 1 steam turbine with a nominal capacity of 1 megawatt. There is a spare turbine on site to replace the existing when an overhaul is required.
3. Boiler Feedwater System
    a. A complete new boiler feedwater and condensate return system was installed in the Central Energy Facility in 2006. This project consisted of a new deaerator tank, condensate surge tank, condensate transfer pumps, boiler feedwater pumps, and new piping. The system handles return condensate from the campus and make-up water from the reverse osmosis (RO) system. Combining the condensate and RO water in the deaerator generates a high quality feedwater that is pumped into the boilers. The deaerator has a capacity of 4,000 gallons and generates 200,000 lbs/hr. Boiler feedwater pumps have a generating pumping capacity of 1,180 GPM.

b. 780 GPM is pumped at 550 PSI to Boilers 4 and 5. 400 GPM is pumped to Boilers 1 and 2 at 155 PSI. The condensate surge tank has a capacity of 6,662 gallons. Condensate forwarding pumps have a generating capacity 900 GPM.

4. Reverse Osmosis System
   a. A complete reverse osmosis (RO) system was installed in the Central Energy Facility in 2006. This project consisted of new multi-media filters, RO inlet cartridge filters, RO units, and RO makeup water pumps. The system processes soft water through the RO equipment and into four 1,500 gallon storage tanks. The RO water is pumped through a meter and boiler blowdown heat exchanger. From the heat exchanger, the water is delivered into the boiler feedwater system. The RO system has a maximum generation of 48 GPM of RO water.
   b. The RO system is sized for 96% return rate of condensate. The loss of a condensate main on campus will jeopardize the RO system’s ability to make up for lost condensate. To make up the shortage of RO water, well or city water would be introduced into the feedwater system. The results of the non-RO water will cause scaling and plugging in pipes and boiler tubes.

Satellite Energy Facility – Mechanical Campus Equipment System Assessment

Located within the Satellite Energy Facility is the following equipment that serves the campus district chilled water system.

1. Chillers
   a. The Satellite Energy Facility consists of 3 centrifugal chillers that were installed in 2007. The chillers produce a total output of 3,750 tons of cooling. The building is designed for future equipment expansion.
2. Primary and Secondary Chilled Water Pumps
   a. The Satellite Energy Facility consists of 4 primary chilled water pumps and 3 secondary chilled water pumps. The primary chilled water pumps are rated at 2,000 GPM each. One pump is designated per chiller, while the fourth pump is designated to HEX-1. The piping is arranged so that any pump discharge can be diverted to any chiller or HEX-1.
   b. The 3 secondary chilled water pumps produce 3,200 GPM each. The pumps are used for the campus chilled water distribution.
3. Condenser Water Pumps
   a. The Central Energy Facility consists of 5 condenser water pumps. All pumps were installed in 2007 and operate at 2400 GPM each. One pump is designated per chiller while the fourth pump is designated HEX-1. The fifth pump is a standby for chillers or HEX-1. The piping is arranged so that any pump discharge can be diverted to any chiller or HEX-1.
4. Cooling Towers
   a. The Satellite Energy Facility consists of 4 air cooled cooling towers. The cooling towers have a capacity of 1,800 GPM each.

Park Library – Mechanical Campus System Assessment

Park Library is cooled by chilled water generated by steam absorption chillers located in the basement mechanical room. The chilled water system is also connected to the CMU district system to achieve building cooling or to add capacity to the campus system.

1. Chilled Water System
   a. The chilled water system is supplied by 2 Trane 465 ton steam absorption chillers located in the basement mechanical room. The chilled water system is also connected to the CMU district system to achieve building cooling or to add capacity to the campus system. Primary circulation from the CMU district loop is provided by 2 base mounted variable flow pumps located in Mechanical Room 001C. These pumps are rated at 1805 GPM each at 45 ft head equipped with a 30 HP motor each. Secondary loop building circulation is provide by 2 base mounted variable flow pumps located in Mechanical Room 001C rated at 960 GPM at 80 ft head equipped with a 30 HP motor each. Primary chilled water circulation for the chillers is provided by 3 constant flow base mounted pumps located in Mechanical Room 001C rated at 960 GPM at 50 ft head equipped with a 15 HP motor with 1 pump dedicated to each chiller and 1 as a standby. The chilled water piping is steel with grooved and welded connections covered with fiberglass and foam insulation. The condenser water system for the absorption chillers consists of 3 base mounted constant flow pumps located in Mechanical Room 001C rated at 1850 GPM at 100 ft. head equipped with a 75 HP motor each with 1 pump dedicated to each chiller and 1 as a standby. The condenser water piping is a combination of steel with grooved connections and fiberglass pipe. Heat rejection for the condenser system is provided by 4 Marley Series 220, Serial Number 222-412 2-513-87 cooling towers located on the southwest roof.
   b. There is an independent chilled water system to provide condenser cooling water for CRU-1C and CRU-2C. This split system air cooled chiller is located in Mechanical Room 001C. Circulation is provided by 2 constant flow base mounted pumps located in Mechanical Room 001C rated at 48 GPM at 60 ft. head equipped with a 2 HP motor each. The chilled water piping is steel with welded and threaded connections covered with fiberglass insulation.
   c. The primary circulation pumps for the CMU district system were installed in 2000 and appear to be in good condition with no reported problems.
   d. The absorption chillers, secondary building chilled water pumps, primary chiller chilled water pumps, condenser water pumps, and cooling towers were installed in 1987. The chillers appear to be in good condition with no reported problems, but reaching the end of useful life. The associated pumps are operational and reaching the end of their useful life. The cooling towers exhibit a lot of rust with perforation observed in several locations. Replace the cooling towers, chiller, and building system pumps.

e. The chiller system for CRU-1C and CRU-2C were installed in 2000 and appear to be in good condition with no reported problems.

2. Steam System

a. The steam system for the Park Library is connected to the campus district steam system. There is a pressure reducing station located in Mechanical Room 001C. The low pressure steam, 12 PSI indicated, is distributed to the domestic water heater, absorption chillers, steam to steam humidifiers located in the penthouses, and heating water heat exchangers. The steam piping system is steel pipe with welded, flanged, and screwed fittings. The piping insulation is fiberglass. There is a duplex condensate receivers located in Mechanical Room 001C.

b. The system was installed in 2000 and appears to be in good condition with no reported problems.