


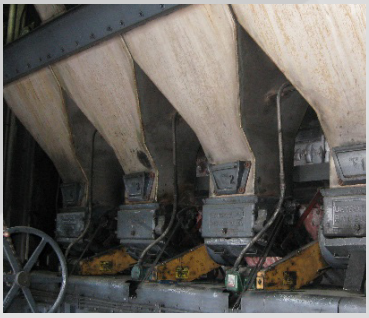


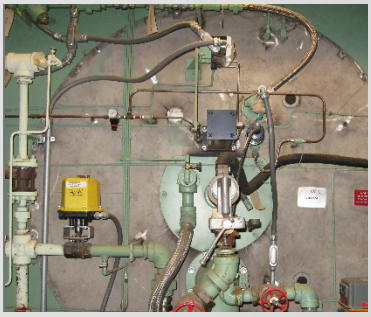



FINAL DRAFT

Utilities Infrastructure Master Plan

UK-1553-15 | JANUARY 2016

Affiliated Engineers®

Executive Summary

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1. EXECUTIVE SUMMARY

1.1 Goals and Objectives

The primary goals of this University of Kentucky (UK) Utility Infrastructure Master Plan was to not only identify existing energy and utility system capacities, deficiencies/inefficiencies, and account for the future growth plans of the University over the next 20 years, but also recommend the necessary improvements required to create an even more efficient, dependable, reliable and robust utility infrastructure.

The following campus energy and utility systems were included in this plan and both the generation and distribution elements of each system were evaluated:

- Heating (Steam and Condensate)
- Cooling (Chilled Water)
- Electrical
- Domestic Water
- Sanitary Sewer
- Stormwater

In addition to more traditional chilled water, steam and electrical generation, options for combined heat and power and renewable energy sources were evaluated to determine if any would be feasible at UK.

Finally, the primary purpose of this plan was to provide a "roadmap" planning tool for the development of the utility systems for the next 20 years. With the intent of providing some additional order and prioritization to the recommended upgrades and growth of the systems, this planning horizon was further broken down into three project periods or timeframes; 0-3 years, 4-7 years and 7-20 years.

With these goals in mind, and after extensive review with University Planning, Management and Operational staff, the AEI planning team developed the following primary objectives for each of the above Energy and Utility systems:

<u>Heating</u>

- Survey and assess the existing steam generation systems and develop ECM's.
- Identify any generation and distribution system deficiencies in existing campus heating infrastructure.
- Analyze and make recommendations how to best to support future heating requirements due to campus expansion.
- Evaluate opportunities to reduce operating costs and GHG emissions.

Cooling

- Determine existing and future cooling loads and compare to existing chiller capacities.
- If some cooling system equipment is found to be aged or deficient. Develop replacement strategies to diminish risk of not meeting peak cooling demands.
- Mitigate the effects of poor Delta-T at the cooling plants. Correct poor Delta-T at buildings over time.
- Develop ECMs that are compatible with UK's existing system to optimize plant efficiencies.
- Understand distribution pipe age and determine least reliable segments in system for immediate replacement.
- Calibrate and update cooling system hydraulic model in KY Pipe to reflect current and future hydraulic scenarios.
- Investigate the applicability of alternative cooling system technologies.
- Develop comprehensive project list for cooling systems.

Electrical

- Develop plan to support growth within campus.
- Increase electrical reliability and redundancy.
- Upgrade/replace aged portions of existing underground distribution system.
- Investigate sustainable electrical improvements.
- Harden electrical infrastructure.

Domestic Water

- Assess the current system assets and condition.
- Identify deficiencies in the system.
- Build a hydraulic model and conduct a capacity analysis of the existing system.
- Establish recommendations that can be used by UK to determine where future growth can be best accommodated.

Sanitary Sewer

- Complete a detailed condition analysis of the existing.
- Build a hydraulic model and conduct a capacity analysis of the existing system.
- Identify deficiencies in the system.
- Provide an analysis of projected loads and capacities that align with the Campus Master Plan.
- Establish recommendations that can be used by UK to determine where future growth can be best accommodated.

Stormwater

- Complete a detailed condition analysis of the existing.
- Build a hydraulic model and conduct a capacity analysis of the current system.
- Identify deficiencies in the system.
- Provide recommendations that can be used by UK to determine where future growth can be best accommodated.

1.2 Planning Process

The planning process for the various systems started with an existing systems conditions assessment. This was followed by systems modeling and load analyses for existing and future conditions based on growth plans of the University. The following Table 1.1 summarizes the existing and future loads that have been estimated for the University.

Table 1-1: Load Projections Summary

Time Frame	Heating (MBH)	Electrical (MVA)	Cooling (Tons)	Potable Water (Peak Hourly Demand - GPM)	Sanitary Sewer (Peak Day Flow - GPM)
Existing	410,000	61.12	34,111	2,755	1,281
0 - 3	456,024	75.04	36,141	2,858	1,376
4 - 7	458,249	76.47	39,170	2,870	1,387
8 - 20	557,625	88.46	48,350	3,211	1,700

Options to upgrade, expand and grow the existing systems were also identified, screened and analyzed to determine the most appropriate and cost effective options to recommend for implementation. This included review of various alternative technologies.

1.3 Recommendations

The following are the major recommendations and/or takeaways that were determined through the planning process for each of the energy and utility systems.

Heating

- Implement ECM's and correct identified plant deficiencies.
- Construct CUP addition with three (3) 5.7MW CHP Systems (results in CO_2 reduction of 54,000 $MTCO_2e$).
- Install new back up fuel oil tanks.
- Install parallel CUP campus feed (20" HPS).
- Phased replacement of aged distribution piping over 20-year planning period.

Cooling

- Implement ECM's which mitigate poor delta-T and maximize chiller plant output and efficiency.
- In the near term, fill open chiller bays in CP#4 and CP#2 to provide N+1 redundancy chiller capacity.
- Expand CP#2 / Replace associated distribution piping.
- Replace cooling towers at CP#1 in phases over two years.
- Review UK Medical Center hydraulics to allow for normal interconnection with system to increase system redundancy and efficiency.
- Defer the decision to rehabilitate CP#3 or build new CP#5 until ~2024.
- Install new distribution piping along Rose Street to North Campus to connect existing "radial" mains to provide "looped" capacity/redundancy to the Academic District.
- Upgrade all chiller plant controls for operational and energy savings
- Immediately replace failing segments of direct buried steel and cast iron distribution piping. Plan to replace all other piping greater than 50 years old.
- Develop implementation plan for phased upgrades of delta-T in buildings.

Electrical

- Capacity of all three substations are sufficient to serve all proposed future loads through 2035.
- Work with Kentucky Utilities (KU) to install 69kV ring bus infrastructure at each of the three substations to be able to isolate the KU primary feeders entering each substation.
- Install a 15kV Paralleling Switchgear to facilitate the CHP recommendation as well as provide a swing bus for each of the three main substations.
- As part of recommended aged feeder replacements, move vault style switches in congested manholes to sub-surface switches in an adjacent vault. Install new concrete encased ductbanks between manholes as switches are relocated.
- Provide electrical systems to support on-site generation through Combined Heat Power (CHP) to reduce carbon footprint.

Domestic Water

- Water is provided by Kentucky American Water Company (KAWC) and, in general, they own and maintain the system to each building meter. UK owns and maintains from the meter to the building.
- No known system deficiencies.
- Hydraulic model maintained by KAWC and modeled information is available upon request.
- Regular coordination meetings are recommended to assist KAWC planning for future water needs.

Sanitary Sewer

- Conduct a system condition assessment and analysis, i.e. a Sanitary Sewer Evaluation Survey.
- Conduct flow monitoring study in subareas within the system to obtain baseline information on existing flows and remaining capacity for the hydraulic model.
- Maintain a hydraulic model that reflects improvements that align with the Campus Master Plan.
- Use hydraulic model information to identify sewer lines near capacity, to identify needed infrastructure improvements, and to justify sewer connection to the LFUCG system.

Stormwater

- Conduct asset and condition studies for (14) areas of concern.
- Confirm infrastructure attributes and connections in (14) areas of concern.
- Update the hydraulic model with data collected from asset and condition studies.
- Prepare recommendations to mitigate areas of concern.
- Group projects from recommendations and studies into future capital projects.

In addition to the above major recommendations, there are many other recommended implementation projects that were identified during the master planning process. These were all captured in a Master Project List and assigned to a project timeframe to address a system deficiency or campus need. Each project was also provided with a brief description, estimated cost and other pertinent information to assist the University in planning, budgeting and scheduling of these improvements.

A summary of these projects and their related costs are shown below in Table 1.2 for each utility system and for each planning Time Frame. Note that the costs below are 2015 estimated construction costs multiplied by a project cost factor of 1.25 to account for UK's typical soft costs.

Table 1.2: Recommended Projects - Project Cost Summary

Time Frame	Heating	Electrical	Cooling	Potable Water	Sanitary Sewer	Storm Water	Sub-Totals
0 - 3	$ 61,330,000	$ 22,071,600	$ 49,410,000	$ -	$ 196,000	$ 126,000	$ 133,133,600
4 - 7	$ 42,460,000	$ 24,796,600	$ 60,568,000	$ -	$ -	$ -	$ 127,824,600
8 - 20	$ 12,720,000	$ 8,921,250	$ 116,369,000	$ -	$ -	$ -	$ 138,010,250
Sub-Totals	$ 116,510,000	$ 55,789,450	$ 226,347,000	$ -	$ 196,000	$ 126,000	**$ 398,968,450**

The complete Master Project List is included in Section 3. Note that this project list and the costs associated with each project are meant to serve as a planning tool and are not necessarily intended for design purposes. When a project from the list is selected for implementation, it must be checked against current information and conditions for scope and budget.

It is expected that between this master plan report, the updated computerized system models that were created, and the Master Project List, that the University will have some very useful planning tools from this Master Planning effort that they can utilize going forward in the coming years.