student sustainability committee
university of illinois at urbana-champaign

APPLICATION INFORMATION

Title: First Steps to Reducing Water Use on Campus

Project Lead Contact Information

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1. Project Background

Misperceptions that water is cheap and plentiful drive water use that is both excessive in quantity and quality. An example of the latter is the use of highly purified water for urinal flushing, landscape irrigation, and the like; in other words a mismatch between needed and utilized water quality. The UIUC campus is no exception to such practices. The UIUC campus is a significant user of water resources and a major discharger to the Urbana-Champaign sanitary district.

The Climate Action Plan (iCAP; http://sustainability.illinois.edu/climateactionplan.pdf) presented by Chancellor Easter in in May 2010 provides explicit targets for making the campus more sustainable on a number of fronts, including water. ***The stated goals with respect to water are to reduce potable water use by 20% by 2015; by 30% by 2020; and 40% by 2025***.

Envisioned strategies are to:

1) Commission an internal, student-assisted study to determine a detailed water use baseline, the "true cost of water," and the related emissions

2) Include "true cost of water" charges with the energy billing program.

3) Begin utilizing non-potable water, including untreated raw water, sump pump discharge, cooling wastewater, stormwater and graywater.

4) Connect the raw water system by 2020

1.1 Project Description

Project Objective: The proposed project will focus on collecting baseline information and generating options needed to support the implementation of strategies 1 and 3 with primary emphasis on cooling towers and the Abbott power plant Reverse Osmosis water purification system.

Why Cooling Towers/RO Plants?

- Water used in cooling towers and RO plants are usually highly treated with chemicals to prevent operational problems. As such, they are expensive to produce and discharge. It is not unusual to have water costs exceeding $4-6/kgal in these operations. Typically, the wastes from these operations are expensive to discharge. Figure 1 is a summary of total water use and associated costs at the UIUC campus. It is clear that costs are going up and is expected to increase by another 50%. This leads to the convergence of both economic and sustainability goals. This will be important to obtain buy-in from all concerned parties with respect to proposed operational changes.

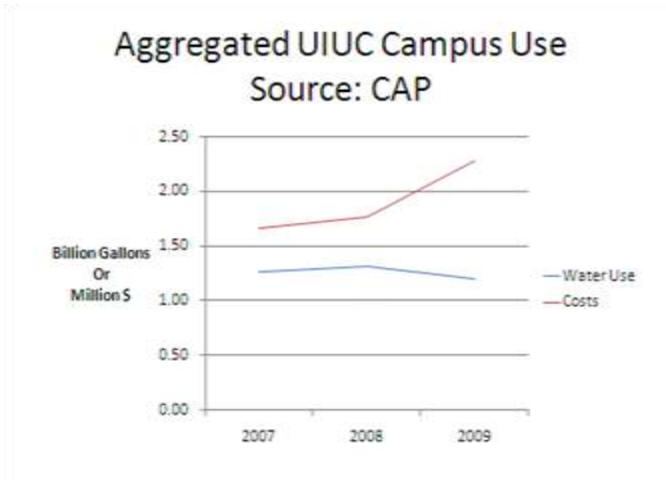

Figure 1

- Cooling towers and RO plant effluents represent large stationary sources- this makes both characterization and control easier to implement.
- Cooling towers and RO plant effluents represent about 30% (Figure 2) of total water use. Effluents from these operations might represent 20% of water input or approximately 6% of overall water use on campus. If 50% capture and reuse can be achieved, this will lead to 3% reuse on campus or 15% of target reductions for 2015. This will be a good first step in the short run but will shine the spotlight on the more important part of conservation – reducing heating loads, using waste heat powered chillers, and the like.

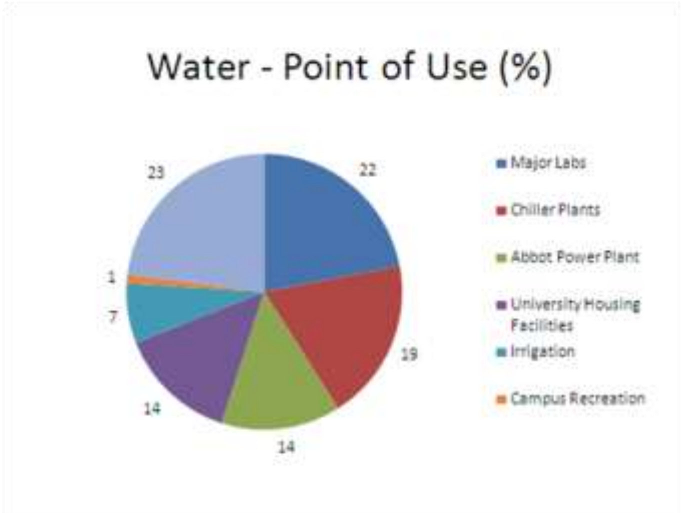

Figure 2 (source iCAP)

1.2 **Project Tasks**

This project will undertake five tasks to accomplish its objective.

Task 1: Determine the quantity of water used and the "true cost of water" in cooling towers/ large reverse osmosis (RO) plants at the UIUC.

Cooling towers on campus can be divided into two categories: (1) those used in chilled water plants and at Abbott Power Plant and (2) those used in buildings to support the HVAC system. The first step in this task used will be to compile a list of all cooling towers on campus uniquely identified by location and use. Along with this data, information on design cooling loads, and type/material of heat exchangers in contact with the cooling towers will be collected. Systems that are chemically treated will be identified. For these systems, the type of dosing system, treatment chemistry, and frequency of dosing will complete the data sheet.

Following the first step, the quantity of water used in Category 1 cooling towers will be extracted from currently recorded data on make-up water intake by season. The quantity of blowdown from these cooling towers is being metered currently and will be used to obtain quantity of wastewater currently being discharged by season. The combined use of this data will allow the calculation of the actual performance of the cooling towers and allow comparison to the target control parameter typically called "Cycles of Concentration (COC)". The higher the COC, the more efficient the water use. The current target COC for the towers is 3.5. In these towers, we will note the current control system employed and its effectiveness in maintaining the set-point.

A similar strategy will be employed for the smaller cooling towers. However, we will collect data on a subset of towers. The choice will be based on factors such as size and use/nonuse of chemical treatments. As smaller towers are not metered, only estimates of water use based on cooling loads are possible. We will check these estimates by grab samples of the blowdown samples.

The reverse osmosis plant at Abbott Power Plant nominally operates at 85% recovery, i.e., for every 100 gallons input, 15 gallons is sewered. We will compare the nominal efficiency to the actual efficiency based on data over 1 year as available.

We will obtain chemical use data and treatment cost data on all systems where available or estimate them as needed.

The analysis of the above data will form the basis for the quantity of water used in cooling towers and the RO systems and the amount of wastewater generated. The direct costs of water use in cooling towers will be calculated based on make-up water costs, sewer disposal costs, and chemical treatment costs.

Task 2: Determine the quality of water currently discharged as "blow down" in select cooling towers/ RO plants to establish a rational basis for reuse in applications such as landscape irrigation.

In Category 1 cooling towers, the quality of blowdown water will be extracted from recorded data such as pH, conductivity, and TDS. These will be supplemented by individual analyses of select samples for both anions, and cations. This information is important to ensure that proposed uses for the wastewater are compatible with the quality. A similar strategy will be used for category 2 cooling towers but on a more limited basis.

Task 3: Examine pathways to reduce water use in cooling towers and in RO

The completion of tasks 1 and 2 will help identify pathways to reduce water consumption. Some examples are provided as an illustration. Other pathways are likely to emerge based on discussions with other stakeholders.

Option 1: Increase COC of cooling water towers to 5

Water use in cooling towers is driven by need for make-up water. The quantity of make-up water is dictated by both evaporation losses as well as amount of blowdown. The quantity of blowdown water can be reduced by increasing the COC (see Task 1). The COC in turn is dependent on the make-up water quality. Currently, the target COC is 3.5 in cooling towers on campus. Increasing it to 5 will decrease the amount of water discharged substantially. The impact of making such a change on tower operation and a cost-benefit analysis will be examined based on the information collected under tasks 1 and 2.

Option 2: Improve control of cooling towers to reduce water use

The data collected under tasks 1 and 2 will provide insight into the “tightness of control”. In the event that there is room for improved control, the use of florescence tracers (commercially known as Trasar 3D) will be one option for reducing water use. In other instances more traditional techniques such as conductivity control might result in substantial reductions as well.

Option 3: Redirect RO reject at Abbott to other uses

The waste stream from the Abbott RO plant can be potentially redirected to the cooling tower or the scrubber make-up if the quality permits. This will likely reduce water consumption by a significant amount. Similar strategies may be feasible in major laboratory buildings as well.

Task 4: Draw up a list of potential uses for wastewater in applications such as irrigation, graywater use, etc. in conjunction with stakeholders.

The focus here is to find uses for wastewater in applications such as irrigation, recreation, and graywater use. Issues to be examined include proximity to source, ability to connect to existing distribution pipes, impact on operations and compliance.

Task 5: Determine the need for treatment, if any, in above applications and prioritize application areas based on cost effectiveness.

If there is a mismatch between the quality of water needed and that available, the data collected under Task 2 will help identify appropriate treatment strategies to upgrade the water. The costs for such upgradation will help identify wastewaters and end-use applications most suited for such treatment.

1.3 Project Team

The team will be led by Dr. N. Rajagopalan from the Illinois Sustainable Technology Center. He will be responsible for planning and executing the project. He will be assisted by Ms. Deluhery, Chemist, ISTC and a student. Ms. Deluhery will contribute some of her time to providing analytical support for the project as needed. The tasks of collecting, collating, and analyzing the data will be carried out by a student.

Mr. Wegel (director, Maintenance, F&S) and Ms. Johnston (Sustainability Coordinator, F&S) will serve as the liaisons to F&S on this project. Assisting in data collection will be Mr. Tony Kelley (Foreman, Water Station), and Jim Hopper (Subforeman, Water Station).

We will also form a separate group drawn from F&S, Environmental Health and Safety, the Student Sustainability Committee, the Office of sustainability, and campus faculty to participate in a brainstorming event to identify alternative uses for the water. We will recruit subject matter specialists in both industrial cooling water treatment and in horticulture to provide technical input as well to aid in deliberations.

1.4 Project Outcomes

- The proposed data collection effort will add an additional level of granularity to the CAP study findings on water use within campus (Figure 2).
- Determine level of treatment currently practiced at the larger cooling towers and estimate "true cost of water".
- Develop a list of pathways for repurposing wastewater
- Compile a list of "perceived " barriers to such repurposing
- Provide suggestions on how to address the barriers and pathways to get buy-in from all stakeholders

1.5 Implementation

The primary user of the data collected in this project is expected to be F&S. The data and subsequent analysis will provide F & S with both a baseline and a series of options to reduce water use on campus. It will also help identify potential barriers that maybe either structural, regulatory, or otherwise. Assuming technical feasibility, F&S will also have to take into consideration economic factors. If the barrier is primarily economic, the team as a whole will brainstorm ways to fund the project.

This study by itself will not reduce water use on campus in the short-term (the course of this project). It is **only a first but important step** towards identifying pathways to reducing water consumption on campus. It brings together critical players on campus and provides them with the data and information needed to address water reduction in a holistic manner. This project's most important contribution to the longer term issue of water conservation will be the initiation of a campus wide conversation on this important but overlooked subject.

2. Budget

The estimated budget for this project is $10,000. This includes support for a student estimated at $7,200. The rest is for analytical support for the project.

3. Timeline

The project is expected to start April 2011 and end by September 2011 for a period of six months.

4. Outreach Plan/ Publicity

The results of this project will be disseminated via the ISTC sustainability seminar series and through posters at the ECI. We will post the report on the ISTC website and forward copies of the report to other interested parties such as the Office of Sustainability on campus.