Water Management Plan

Revision 1

U.S. Environmental Protection Agency
Kansas City Science and Technology Center
300 Minnesota Avenue
Kansas City, Kansas 66101

August 3, 2010

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EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY
KANSAS CITY SCIENCE AND TECHNOLOGY CENTER
KANSAS CITY, KANSAS

WATER MANAGEMENT PLAN

Approved by:

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8/20/2010

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1.0 EPA'S STATEMENT OF PRINCIPLES ON EFFICIENT WATER USE

To meet the needs of existing and future populations and ensure that habitats and ecosystems are protected, the nation's water resources must be sustainable and renewable. Sound water resource management, which emphasizes wise, efficient use of water, is essential to achieve these objectives.

Efficient water use can have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. As the country faces increasing risks to ecosystems and their biological integrity, the inextricable link between water quality and water quantity becomes more important. Water efficiency is one way of addressing water quality and quantity goals. The efficient use of water can prevent pollution by reducing wastewater flows, recycling process water, reclaiming wastewater, and using less energy. As municipalities and regions deal with chronic drinking water shortages due to drought and changes in climate patterns, water conservation becomes even more important to EPA's mission.

EPA recognizes that regional, state, and local differences exist regarding water quality, quantity, and use. Differences in climate, geography, and local requirements influence the water efficiency programs applicable to specific facilities. Therefore, EPA is establishing facility-specific Water Management Plans to promote the efficient use of water and meet the water conservation requirements under Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management,* and EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance.*

This Water Management Plan has been established to document and promote the efficient use of water at EPA's Kansas City Science and Technology Center (KCSTC) located in Kansas City, Kansas. The plan is organized according to the Federal Energy Management Program (FEMP) Facility Water Management Planning Guidelines.

2.0 FACILITY DESCRIPTION

KCSTC houses EPA's Region 7 Laboratory and is focused on environmental monitoring, analytical support, and data assessments.

KCSTC is a state-of-the-art laboratory facility completed in 2003. Designed and built on a brownfield site with many green and sustainable features, the facility received Gold certification from the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design (LEED®) version 2.0 rating system for New Construction.

Prominent water conservation and efficiency features include the use of high-efficiency plumbing fixtures, landscape design using native species, and a graywater recovery system that captures rain water, air handler condensate, and reverse osmosis (RO) reject water for reuse as toilet flushing water and cooling tower make-up water.

The laboratory contains 71,995 square feet of conditioned space. The building is privately owned and leased by the U.S. General Services Administration (GSA) for EPA through 2023.

3.0 FACILITY WATER MANAGEMENT GOALS

KCSTC's resource conservation goals are achieved through the implementation of the Region 7 Environmental Management System (EMS), specifically through the Sustainable Facilities Management Program. The primary objective of this program is to minimize Region 7's greenhouse gas emissions by maximizing its energy and water efficiency capabilities. Targets established under this objective call for: 1) monitoring energy and water use and, where practical, creating plans and acquiring funding for projects to improve energy and water efficiency; and 2) working with the facility management company to identify and resolve equipment deficiencies that waste energy and/or water. Although not expressly stated, the desire to achieve a 26 percent water reduction by the end of 2020, compared to a 2007 baseline, as set forth in EO 13514, is implied in Region 7's objectives and targets for sustainable facilities. The KCSTC fiscal year (FY) 2007 water intensity baseline (in gallons per gross square foot [gal/GSF]) is 43.81 gal/GSF/year.

To continue progress toward meeting EO requirements and EMS goals, KCSTC will strive to meet annual facility-specific goals set by EPA's Sustainable Facilities Practices Branch (SFPB) under its ConservW program. These ConservW goals are calculated for each EPA facility based on the facility's previous water use reduction and its potential identified projects.

4.0 UTILITY INFORMATION

Contact Information and Water Rate Schedule

Potable water supply is provided by:

Kansas City Board of Public Utilities
540 Minnesota Avenue
Kansas City, KS 66101
913-573-9190

Monthly water bills are based on a tiered rate structure, provided in Table 1.

Table 1. Water Use Rate Structure
(Effective 1 January 2008)

Monthly Amount	Rate per 100 cubic feet (ccf)	Rate per 1,000 gallons
0 to 7 ccf	2.959	3.956
8 to 160 ccf	2.945	3.937
161 to 2000 ccf	2.750	3.676
2001 to 8000 ccf	2.063	2.718
All over 8000 ccf	1.320	1.765

In addition to the tiered rate structure, the facility is also billed $49.86 per month for a fire line and $47.09 per month for a monthly customer use fee.

Contact Information and Sewer Rate Schedule

Sewer service is provided by:

Unified Government of Wyandotte County and Kansas City, Kansas
701 North 7th Street
Kansas City, KS 66101
913-573-5400

Sewer use fees are based on water use at a rate of $2.25 per ccf ($3.01 per 1000 gallons).

Payment Office

Research Triangle Park Finance Center (RTP-FC)
Kim Poteat, 919-541-1468

(Pouch and Regular Mail)
Environmental Protection Agency
Mail Code - D143-02
Research Triangle Park, NC 27711

(FEDEX)
Environmental Protection Agency
Mail Code - D143-02
4930 Page Road
Research Triangle Park, NC 27711

The fax number for RTP-FC is: 919-541-4975

5.0 FACILITY WATER USE INFORMATION

The laboratory building contains a mixed use of laboratory and office space. The laboratory space is configured for bench-scale organic and inorganic analyses of environmental samples. Water is used for sanitary needs, building mechanical systems, and laboratory processes. Additional details on facility water use are provided in the following sections.

Major Water Using Processes

Average water use in calendar year (CY) 2009 by major process is shown in Table 2.

Table 2. Major Water Using Processes, KCSTC

Major Process	CY 2009 Annual Consumption (gallons)	Percent of Total Water Use	Comments
Water Use			
Sanitary water	150,000	5.5	Engineering estimate
Cooling tower make-up water	1,525,900	55.7	Based on metered total
Reverse osmosis reject	160,000	5.8	Based on metered total
Reverse osmosis permeate	182,000	6.6	Based on ratio of permeate to reject flow
Humidification	330,500	12.1	Engineering estimate
Vacuum pump seal water	200,000	7.3	Engineering estimate
Water-cooled ice maker	19,000	0.7	Engineering estimate
Miscellaneous laboratory water use	173,894	6.3	Calculated by difference
Total Water Use	2,741,293	100	Sum of city water supply and reclaimed water supply
Water Supply			
City water supply	2,638,380	96.2	Total metered water use in CY 2009
Reclaimed water supplied by graywater system	102,914	3.8	Based on metered total
Total Water Supply	2,741,293	100	Sum of city water supply and reclaimed water supply

Additional details on assumptions and calculations supporting these water use estimates are provided in Appendix A. Estimated monthly total water use in CY 2009 is provided in Appendix B.

Measurement Devices

Incoming water is supplied by the Kansas City Board of Public Utilities through a single metered supply line.

KCSTC is equipped with a graywater capture and reuse system. The system is used to collect rain water from a portion of the roof, air handler condensate, and RO reject water. Reclaimed water is stored in a 10,000 gallon tank and is used for toilet flushing and cooling tower make-up water. Flow totalizing meters are installed on the RO reject flow to the graywater tank and the air handler condensate flow to the graywater tank. Water reclaimed from the tank and used to supply the cooling tower and toilets is also metered.

Both cooling towers at KCSTC are equipped with meters on the make-up and blowdown lines.

Under this plan, water use on each meter will be recorded monthly. Water use trends will be evaluated by the facilities manager and unanticipated usage trends will be investigated and resolved.

Shut-off Valves

Shut-off valves for the main laboratory supply and the reclaimed water supply are located in the main mechanical room.

Occupancy and Operating Schedules

Approximately 50 people work at KCSTC. The facility operates on a flex time schedule, one shift per day, Monday through Friday.

6.0 BEST MANAGEMENT PRACTICE SUMMARY AND STATUS

EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, signed in January 2007, calls for federal agencies to reduce water use intensity by 2 percent per year between FY 2007 and FY 2015, for a total reduction of 16 percent. This goal was extended by EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, signed in October 2009. EO 13514 calls for reducing potable water consumption intensity by 2 percent annually through the end of FY 2020, for a total reduction of 26 percent. Facilities should implement best management practices (BMPs) related to water use, taking life-cycle cost effectiveness into consideration, to achieve this water reduction goal. FEMP has identified BMPs in 14 areas to help facilities identify and target water use reductions. KCSTC has adopted BMPs in nine of the areas, designated by checkmarks in the list below. Two other areas are deemed inapplicable for KCSTC, designated by "NA" in the list below. The status of each BMP at KCSTC is as follows:

☑ Water Management Planning
☑ Information and Education Programs
☑ Distribution System Audits, Leak Detection and Repair
☑ Water-Efficient Landscaping
☑ Water-Efficient Irrigation
☑ Toilets and Urinals
☐ Faucets and Showerheads
NA Boiler/Steam Systems
☑ Single-Pass Cooling Equipment
☐ Cooling Tower Management
NA Commercial Kitchen Equipment
☑ Laboratory/Medical Equipment
☑ Other Water Use
☐ Alternate Water Sources

Information and Education Programs

KCSTC currently tracks water use on a monthly basis. KCSTC's Sustainable Facilities Management Program sets a goal for reducing water use by implementing projects identified through assistance visits and by correcting equipment deficiencies. All staff members are

required to take annual EMS awareness training. Water conservation goals are covered during the training.

KCSTC promotes water conservation and awareness using the EPA laboratory "Every Drop Counts" water conservation poster series. Conservation posters are displayed in prominent locations within the laboratory. Posters describing the graywater capture system and native plantings are also posted within the facility.

KCSTC has achieved BMP status in this area.

Distribution System Audits, Leak Detection and Repair

Facility staff are trained to report leaks and malfunctioning water-using equipment to the facilities manager or lab director directly via e-mail or phone. The facilities manager or lab director contacts the O&M contractor, who enters the request into Workspeed, an online workflow process. Workspeed is used to schedule, implement, track, and follow up on requests to ensure they are completed in an efficient manner.

The onsite building engineer performs a visual inspection of core building and mechanical spaces each morning and evening. In addition, the building engineer is paged by the building automation system any time key control parameters are out of range. Any leaks or other mechanical problems are corrected promptly. Janitors are trained to report any observed problems to the facilities manager.

The facilities manager also performs a weekly walk through to inspect building and mechanical spaces and look for leaks or malfunctioning water-using equipment.

A screening level system review was conducted in February 2010. Known water uses account for over 90 percent of water consumption.

Under this plan, the facilities manager and EMS Coordinator will monitor trends in monthly water use. Changes that are not understood or expected will be investigated and resolved.

KCSTC has achieved BMP status in this area.

Water-Efficient Landscaping

Native species that do not require supplemental use of water, including native buffalo and prairie grasses, are used for landscaping. Proper soil selection and use of mulches also helps to maintain appropriate soil moisture levels.

KCSTC has achieved BMP status in this area.

Water-Efficient Irrigation

KCSTC does not have a permanent irrigation system. Hose bib outlets are supplied with water from the graywater collection system.

KCSTC has achieved BMP status in this area.

Toilets and Urinals

Toilets and urinals are compliant with 1992 Energy Policy Act (EPAct 1992) water efficiency requirements (1.6 gallons per flush [gpf] for toilets and 1.0 gpf for urinals). Flushing water for the toilets and urinals is supplied from the graywater collection system to the extent it is available. An inventory of sanitary fixtures is provided in Table 3.

Table 3. KCSTC, Inventory of Sanitary Fixtures

Fixture Type	Flow Rate	Total Number
Toilets	1.6 gpf	21
Urinals	1.0 gpf	6
Lavatory faucets	2.2 gallons per minute (gpm)	16
Showers	2.5 gpm	4
	2.0 gpm	1

Janitorial staff and employees are trained to report leaks or other maintenance problems to the facilities manager or O&M staff, which are immediately corrected.

KCSTC has achieved BMP status in this area.

Faucets and Showerheads

Faucets are compliant with EPAct 1992 water efficiency requirements (2.2 gpm for faucets). However, the American Society of Mechanical Engineers (ASME) has established a standard for lavatory faucets in public use (essentially all applications but domestic residences) with a maximum flow rate of 0.5 gpm (ASME A112.18.1). This flow rate is sufficient for hand washing and is considered a best practice for lavatory sinks in public settings.

High-efficiency showerheads (2.0 or 2.5 gpm) are installed in all shower stalls available for use.

System pressure is maintained between 20 to 80 pounds per square inch.

Janitorial staff and employees are trained to report leaks or other maintenance problems to the facilities manager or O&M staff, which are immediately corrected.

KCSTC can claim BMP status in this area by replacing existing faucets or faucet aerators with ones that flow at 0.5 gpm.

Boiler/Steam Systems

KCSTC does not operate a steam boiler. BMP status is not applicable in this area.

Single-Pass Cooling Equipment

Most laboratory equipment that requires cooling is supplied with process chilled water. The only remaining water-cooled device is an ice machine. When this device reaches the end of its service life, it should be replaced with an air-cooled unit. It is not cost-effective to replace this unit based on water savings alone.

KCSTC has achieved BMP status in this area, as it has taken all cost-effective steps to reduce or eliminate single-pass cooling.

Cooling Tower Management

KCSTC is equipped with two 700-ton cooling towers. A cooling tower maintenance contractor performs a monthly quality, performance, and water chemistry review of cooling tower operation. Chemical treatment is provided to control scale and corrosion; treatment chemical addition rates are controlled to be proportional to the quantity of make-up water. Conductivity meters on each tower water loop are set at 2,000 microSiemens per centimeter (*u*S/cm) and are used to control blowdown, although the cooling tower typically operates with a circulating water at about 1,800 *u*S/cm. City make-up water has a relatively high dissolved solids load, with a resultant conductivity of 710 *u*S/cm. Therefore, the cooling tower system achieves a relatively low cycles of concentration—approximately 2.6. Some cooling tower make-up water is supplied from the graywater collection system to the extent it is available.

Both cooling towers are equipped with make-up and blowdown meters. The meter readings will be recorded monthly and trends in cooling tower water use will be monitored by the facilities manager or designated O&M staff and under this plan.

KCSTC does not achieve BMP status in this area at this time. A recommended minimum target for cycles of concentration is 3. KCSTC will work with the building owner and the cooling tower maintenance contractor to evaluate if at least 3 cycles of concentration can be achieved.

Commercial Kitchen Equipment

KCSTC does not operate commercial kitchen equipment. BMP status is not applicable in this area.

Laboratory/Medical Equipment

KCSTC is equipped with a central vacuum system. The vacuum is generated by a liquid-ring vacuum pump. Previously, water was continuously discharged and made up with fresh water to dissipate heat and remove impurities. KCSTC replaced this pump in 2008 with a liquid-ring pump with a recovery and recirculation system. In this improved configuration, ring water is collected from the discharge side of the pump and reused. The recirculated water passes through a heat exchanger, where the heat from the recirculated water is transferred to the building comfort chilled water loop.

One constraint on the current system is that it dissipates heat to the building comfort chilled water loop through a heat exchanger, but the comfort chilled water loop is only operational during the cooling season. Therefore, for part of the year, water is still discharged to the sewer to dissipate heat.

Year-round, some water is still discharged to remove impurities, but this retrofit is estimated to reduce water use by 80 percent.

KCSTC also has an RO system that provides purified water to laboratories. The ratio of permeate water to reject water is approximately nine to eight. The reject water is sent to the graywater collection system for reuse as cooling tower make-up or toilet flushing water.

KCSTC has achieved BMP status in this area.

Other Water Use

KCSTC uses a washing machine to wash laboratory coats; it is only run once or twice a month.

Since water use is minimal from this piece of equipment, KCSTC has achieved BMP status in this area.

Alternative Water Sources

KCSTC is equipped with a graywater collection and reuse system that collects rain water from 18,000 square feet of the roof, RO reject water, and collected air handler condensate. The pump that is used to transfer the collected air handler condensate from two of the four air handling units to the graywater collection system was malfunctioning in February 2009, causing only half of the potential condensate to be captured. Under this plan, KCSTC will repair the pump system so all potential air handler condensate is captured and used to offset potable water demand.

After the air handler condensate, RO reject water, and rain water that is collected and sent to the graywater system passes through a 1,500-gallon sediment tank, the water is stored in a 10,000-gallon, pre-cast concrete, fiberglass-lined underground tank just outside the building. A sump pump in the holding tank is used to supply a pressure tank in the mechanical room. When graywater is available to supply and pressurize the pressure tank, the graywater is used for toilet flushing and cooling tower make-up. When graywater is not available, city water is used to supply the necessary water for these uses.

Table 4 provides a water balance for the graywater system, showing theoretical maximum quantities of graywater that could be recovered from each source and the amount of graywater used within the facility. Note that the source quantities are theoretical maximums, some portions of these quantities, particularly for rain water, will not be recovered when the 10,000-gallon storage tank is full, for example during a high intensity storm event (e.g. any event with greater than 0.9 inches of rain).

Table 4. KCSTC Graywater System Annual Water Balance (CY 2009)

Graywater Use (gallons/year)		Graywater Sources, Theoretical Recovered Quantity (gallons/year)		
		RO reject	160,000	Based on metered total
		Air handler condensate	237,000	Based on metered total
		Rain water	411,000	Engineering estimate
		Excess generation, October to April	(103,000)	Engineering estimate
Total metered use	102,914	**Total**	**705,000**	Sum of recovered quantities

Additional details on assumptions and calculations supporting these water use estimates are provided in Appendix A.

The quantity of graywater used in CY 2009 was less than theoretical data suggest could be recovered. A graphical comparison of theoretical graywater supply to cooling tower and toilet and urinal flushing demand is provided in Figure 1. Note that for most months of the year, all

captured graywater can be used, primarily because of the close correlation between cooling tower make-up demand and air handler condensate generation. However, between October and April, when cooling tower make-up demand is low, some excess graywater is captured that can not be put to productive use.

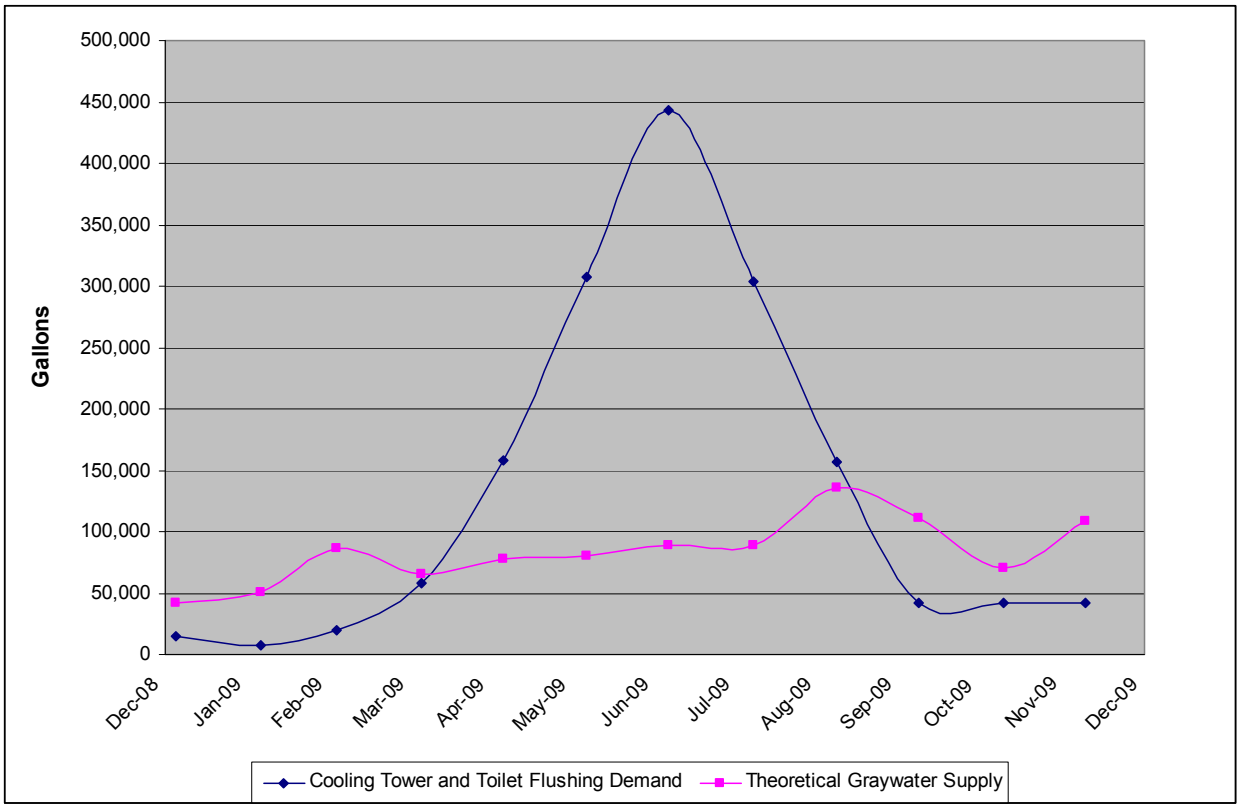

Figure 1. Comparison of Graywater Supply and Demand, CY 2009

KCSTC can claim BMP status in this area by recommissioning the graywater system to ensure that available, recovered water is being used to the maximum extent practical.

7.0 DROUGHT CONTINGENCY PLAN

In the event of a drought or other water supply shortage, KCSTC will follow the water use recommendations and restrictions of the Kansas Water Office and the Kansas City Board of Public Utilities. In the event that voluntary or mandatory water conservation reductions are instituted, KCSTC will form a task force of facility and operating personnel to identify and implement modifications to facility operations to achieve additional specified reductions in water consumption.

Regional drought conditions and general information on drought management can be found at the Kansas Water Office drought management website: http://www.kwo.org/reports%20&%20publications/drought/kwo%20drought%20report.htm.

8.0 COMPREHENSIVE PLANNING

The facilities manager will ensure the water supply, wastewater generation, and water efficiency BMPs are taken into account during the initial stages of planning and design for any facility renovations or new construction. These factors will also be considered prior to the purchase and installation of any equipment that would measurably change facility water consumption. Where available, KCSTC will purchase or specify WaterSense® labeled products (see <www.epa.gov/watersense> for more information about WaterSense).

9.0 STATUS UNDER GUIDING PRINCIPLES FOR HIGH PERFORMANCE AND SUSTAINABLE BUILDINGS

The Interagency Sustainability Working Group (ISWG), formed as a subcommittee of the EO 13423 Steering Committee, has established guiding principles to assist agencies in meeting the high performance and sustainable buildings goals of EO 13423, section 2(f). The December 1, 2008, version of the ISWG's *Guiding Principles for Sustainable Existing Buildings* established six supporting principles for protecting and conserving water. KCSTC's status toward achieving the supporting principles for protecting and conserving water at existing buildings is documented in Table 5.

Table 5. Status of Guiding Principle to Protect and Conserve Water, KCSTC

Topic	Status
Indoor Water	KCSTC's potable water use is approximately 1 percent greater than the calculated water use baseline. The baseline for the facility was established as 120 percent of the Uniform Plumbing Code 2006 under the *Guiding Principles*, Indoor Water Option 1. Toilets and urinals are plumbed to use either an onsite graywater collection system or city water for flushing. Annual water tracking data shows that KCSTC increased water use intensity (gallons per GSF) by 31.2 percent between FY 2004 and FY 2009[1]. The EMS includes a Sustainable Facilities Design/Modification SMP which contains an objective to reduce water use by 30 percent by FY 2015 from an FY 2007 baseline. The Sustainable Facilities Operation and Management SMP contains an objective to operate facility equipment in a manner that maximizes energy and water efficiency capabilities.
Outdoor Water	KCSTC does not have a permanent irrigation system. Native species that do not require supplemental use of water are used for landscaping. Proper soil selection and use of mulches also helps to maintain appropriate soil moisture levels. Hose bib outlets are supplied with water from the graywater collection system.
Water Metering	One domestic water meter measures all onsite city water used at KCSTC. Flow totalizing submeters are installed on the RO reject line (flows to the graywater collection system), two air handler condensate collection lines (flow to the graywater collection system), both cooling tower make-up water lines, both cooling tower blowdown water lines, and the graywater line that supplies reclaimed water to the building.
Stormwater Management	The majority of stormwater runoff on the KCSTC site is collected through stormwater inlet structures and transported off site through an underground stormwater collection system which is owned by the city of Kansas City, Kansas. Most parking lots and roads are curbed, with little opportunity for stormwater filtration prior to entering the collection system. KCSTC uses a graywater collection and reuse system that collects rain water from 18,000 square feet of roof, RO reject water, and air handler condensate discharge. The system directs water initially into a 1,500-gallon underground sediment tank, and then to a 10,000-gallon underground storage tank. The water is used for toilet flushing, cooling tower make-up, and landscape watering, as needed. The center courtyard contains mulched and vegetated beds that filter and allow for some infiltration of stormwater.
Process Water	KCSTC does not use potable water to improve its energy efficiency at the expense of water efficiency.
Water-Efficient Products	Purchasing procedures do not specify the purchase of water-efficient products. Acquisition personnel and purchase card holders are not currently trained on the procurement of WaterSense labeled and water-efficient products. Toilets and urinals are compliant with EPAct 1992 and are plumbed to use either the onsite graywater collection system or city water for flushing. KCSTC could upgrade its toilets with dual-flush handles to reduce water consumption. Faucet fixtures currently flow at 2.2 gpm; 0.5 gpm faucet aerators could be installed to further improve restroom water efficiency. In FY 2009, KCSTC installed a water-efficient, closed-loop recirculating vacuum pump, which saves approximately 800,000 gallons per year. An older, less-efficient ice maker and clothes washer are installed but are not used frequently and replacement is not cost-effective.

[1] KCSTC began operations in FY 2003, but FY 2004 was the first year that the facility was occupied for the entire year. For this reason, the water use intensity baseline used for KCSTC is FY 2004, not FY 2003.

10.0 OPPORTUNITIES FOR FURTHER WATER CONSERVATION

KCSTC is pursuing the following projects to achieve additional reductions in water use:

1) **Recommission graywater system during planned FY 2010 recommissioning.** During the planned FY 2010 recommissioning effort, KCSTC will ensure that the contractor evaluates the graywater collection and reuse system to ensure that it is recovering the maximum amount of water possible and functioning as designed. Following the evaluation, KCSTC will coordinate with SFPB to have the commissioning agent evaluate the graywater collection system and consider adding a preventative maintenance program to ensure its continued functionality. Optimizing the graywater system in its current configuration could allow KCSTC to recover and reuse an additional 600,000 gallons of water.

2) **Reroute collected air handler condensate directly to the cooling tower.** Air handler condensate is generated most abundantly during hot, humid months—the same months when the cooling tower is operating at full capacity. Since cooling tower make-up water needs typically align with air handler condensate recovery generation, KCSTC will consider rerouting piping that carries collected air handler condensate to the graywater system to feed directly into the cooling tower. This will ensure that the graywater tank size is not an inhibiting factor in offsetting potable cooling tower make-up water and that all air handler condensate is put to use. In addition, the cool, distilled condensate may directly improve the cooling tower water chemistry by diluting the high conductivity city water make-up and introducing more cold water to the system. This project is estimated to cost approximately $5,000 for re-piping but will save an estimated 237,000 gallons of cooling tower make-up water each year. Since the graywater system is only supplying a maximum of approximately 100,000 gallons to the cooling tower, this project will assure an additional 137,000 gallons in savings. KCSTC also will ensure that all condensate collector pumps located at the air handlers are operational.

3) **Record, Monitor, and Evaluate Changes in Water Consumption.** Existing submeters are not currently read regularly for RO reject flow to the graywater tank, air handler condensate flow to the graywater tank, reclaimed water used to supply cooling towers and toilets, cooling tower make-up, and cooling tower blowdown. KCSTC will ensure that these meters are read and the water consumption recorded daily. Monthly, KCSTC will evaluate the water use data to monitor trends in water consumption and investigate and resolve unexpected changes. As additional meters are added, these will also be recorded and monitored. This project has no additional associated capital cost and will help ensure that existing systems are operated in the most efficient manner possible.

4) **Maximize cooling tower cycles of concentration.** The cooling towers currently operate at about 2.6 cycles of concentration. KCSTC will work with the building owner and the cooling tower maintenance contractor to evaluate whether it will be possible to achieve at least 3 cycles of concentration. Modifying the operating procedure to achieve at least 3 cycles of concentration will reduce cooling tower water use by about 8 percent, saving 117,000 gallons and resulting in $800 in water and sewer cost savings.

5) **Retrofit faucets to flow at 0.5 gpm.** KCSTC will consider replacing or retrofitting all faucet fixtures to flow at 0.5 gpm. Faucet aerator fittings are estimated to be $10 each, for a total project cost of approximately $160. This project could save 14,000 gallons and $300 per year, with a simple payback period of less than one year.

Appendix A

WATER BALANCE SUPPORTING CALCULATIONS

Table A-1. Water Balance Supporting Calculations – CY 2009, KCSTC, Kansas City, Kansas

Major Process	Annual Consumption (gallons)	Supporting Calculations and Source Documentation
Water Use		
Sanitary water	150,000	Engineering estimate based on 50 people using 12 gallons / day for 250 operating days / year. 50 people × 12 gallons / person / day × 250 days / year = 150,000 gallons / year.
Cooling tower make-up water	1,525,900	Engineering estimate calculated from metered data from January through April 2007 (proxy data for January through April 2009) and meter readings from 5/15/2009 and 1/12/2010 (data for May through December 2009). January - April 2009 = 8,800 gallons (Jan 07) + 1,400 gallons (Feb 07) + 13,700 gallons (Mar 07) + 52,700 gallons (Apr 07) = 76,600 gallons. May - December 2009 = (3,871,100 - 3,404,000 [East Tower Make-up Meter Readings]) + (7,760,300 - 6,778,100 [West Tower Make-up Meter Readings]) = 1,449,300 gallons. Total CY 2009 = 76,600 + 1,449,300 = 1,525,900 gallons / year.
RO reject	160,000	Meter readings of 507,470 (2/17/2010) and 141,630 (11/6/2007) were used to calculate 27.5 months of RO reject water. These data were multiplied by 12 months / year to estimate an annual use. Meter readings = 365,840 gallons / 27.5 months × 12 months / year = 159,639 gallons / year.
RO permeate	182,000	Ratio of permeate to reject flow was 9.5 gpm / 10.2 gpm in November 2007 and 9 gpm / 6 gpm in February 2010 for an average ratio of 9.25 gpm to / 8.1 gpm. Therefore, permeate is 159,639 gallons reject × 9.25 / 8.1 = 182,304 gallons / year.
Humidification	330,500	Engineering estimate. Assume that humidifiers run at capacity for 6 months of the year, but 25% of the time. 4 humidifiers have capacity of 550 lbs / hour. 2 humidifiers have capacity of 160 lbs / hour. Total capacity is 2,520 lbs / hour. 2,520 lbs / hour × 1 gallons / 8.35 lbs × 6 hours / day × 182.5 days / year = 330,467 gallons / year.
Vacuum pump seal water	200,000	Assumed based on annual savings from CY 2008 to CY 2009. CY 2008 water use was 3,447,024 gallons / year and CY 2009 water use was 2,638,379 gallons / year. The difference is the savings from the vacuum pump replacement. System savings = 3,447,024 gallons / year - 2,638,380 gallons / year = 808,644 gallons / year. Use from the new system is 1,000,000 gallons / year (old use) - 808,644 gallons / year = 191,356 gallons / year. This is consistent with an instantaneous measurement of 2 gpm flow, and the EMS coordinator's estimate that the system runs about 2-3 times per hour for approximately 5 minutes. 2 gallons / minute × 5 minutes / use × 2.5 uses / hour × 24 hours / day × 365 days / year = 219, 000 gallons / year.
Water-cooled ice maker	19,000	Engineering estimated based on the assumption that the small water-cooled under counter unit generates 50 lbs of ice per day. Assume 150 gallons of water used for each 100 lbs of ice, based on Slide 18 in Charles Bohlig Presentation on Water Efficiency in Commercial Food Service, February 7, 2006. 50 lbs / day × 250 days × 150 gallons / 100 lbs = 18,750 gallons / year.
Miscellaneous laboratory water use	268,038	Calculated by difference from total water use (city water + graywater) minus total uses of line items.
Total Water Use	**2,741,293**	**Sum of total city water use and total graywater use.**

Table A-1. Water Balance Supporting Calculations – CY 2009, KCSTC, Kansas City, Kansas

Major Process	Annual Consumption (gallons)	Supporting Calculations and Source Documentation
Water Supply		
City water supply	2,638,380	Quarterly reported water use from January - December 2009; metered monthly.
Reclaimed water supplied by graywater system	102,914	Meter readings of 1,247,660 (12/31/2009) and 1,024,680 (11/7/2007) were used to calculate 26 months of graywater use. These data were multiplied by 12 months / year to estimate an annual use. (1,247,660 – 1,024,680) gallons / 26 months × 12 months / year = 102,914 gallons / year.
Total Water Supply	**2,741,293**	**Sum of total city water use and total graywater use.**

Table A-2. Graywater Balance Supporting Calculations – CY 2009, KCSTC, Kansas City, Kansas

Major Process Contributing to Graywater Collection Tank	Theoretical Potential Recovered Quantity (gallons)	Supporting Calculations and Source Documentation
RO reject	160,000	CY 2009 metered total (see Table A-1)
Air handler condensate	237,000	Engineering estimate calculated from metered data from January through April 2007 (proxy data for January through April 2009) and meter readings from 5/15/2009 and 1/12/2010 (data for May through December 2009). January - April 2009 = 1,080 gallons (Jan 07) + 172 gallons (Feb 07) + 1,682 gallons (Mar 07) + 6,470 gallons (Apr 07) = 9,404 gallons. May - December 2009 = (366,270 – 350,930 [South Air Handler Condensate]) + (1,043,070 – 830,580 [North Air Handler Condensate]) = 227,830 gallons. Total CY 2009 = 9,404 + 227,830 = 237,234 gallons / year.
Rain water	411,000	Total inches of rainfall in Kansas City, Kansas, during CY 2009 was 40.7 inches. 40.7 inches × 1 foot / 12 inches × 18,000 ft^2 (roof area of capture) × 7.48 gallons / ft^3 × 90% (effective rainfall) = 410,989 gallons / year.
Excess generation, October to April	(103,000)	When looking at monthly supply and demand, excess is determined by subtracting demand from supply when the supply is greater. Supply that is higher than demand cannot be used and will not fit in the tank.
Total	**705,000**	**Sum of recovered quantities – excess generation.**

Appendix B

MONTHLY WATER USE AND GRAYWATER BALANCE IN CY 2009

Table B-1. Monthly Water Use in CY 2009 in Gallons, KCSTC, Kansas City, Kansas

Month	Total City Water Use
January 2009	169,060
February 2009	116,696
March 2009	125,673
April 2009	134,649
May 2009	210,203
June 2009	258,078
July 2009	419,657
August 2009	402,452
September 2009	348,592
October 2009	239,377
November 2009	97,995
December 2009	115,948
Total	**2,638,380**

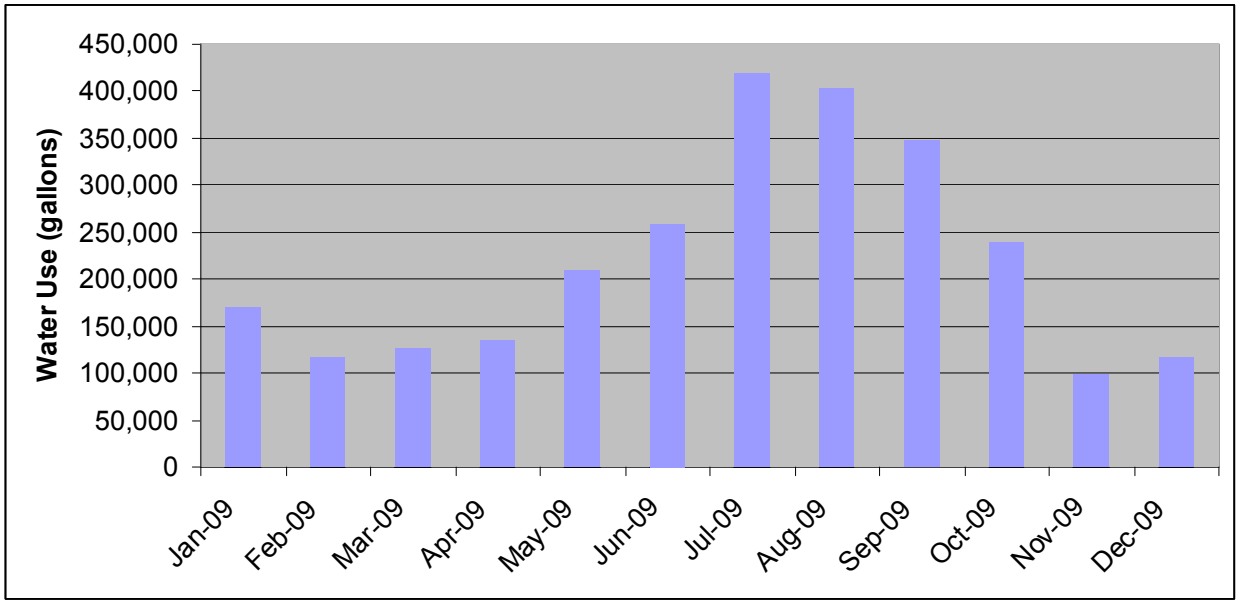

Figure B-1. Monthly Water Use in CY 2009, KCSTC, Kansas City, Kansas

Table B-2. Monthly Graywater Balance, KCSTC, Kansas City, Kansas

	Graywater Demand			Graywater Supply					Graywater Excess
	Total Cooling Tower Use	Toilet Use	Total Graywater Demand	RO Reject	AHU Condensate	Rainfall (inches)	Rainfall (gallons)	Total Graywater Supply	
January 2009	8,800	5,700	14,500	13,333	1,080	0	0	14,413	
February 2009	1,400	5,700	7,100	13,333	172	0.86	8,684	22,189	15,089
March 2009	13,700	5,700	19,400	13,333	1,682	3.13	31,607	46,622	27,222
April 2009	52,700	5,700	58,400	13,333	6,470	7.42	74,927	94,730	36,330
May 2009	152,300	5,700	158,000	13,333	28,060	3.53	35,646	77,039	
June 2009	301,600	5,700	307,300	13,333	50,760	6.1	61,598	125,691	
July 2009	437,300	5,700	443,000	13,333	61,820	5.01	50,591	125,744	
August 2009	297,600	5,700	303,300	13,333	48,780	5.82	58,770	120,883	
September 2009	151,700	5,700	157,400	13,333	22,460	2.52	25,447	61,240	
October 2009	36,267	5,700	41,967	13,333	5,317	4.73	47,764	66,413	24,447
November 2009	36,267	5,700	41,967	13,333	5,317	0.6	6,059	24,708	
December 2009	36,267	5,700	41,967	13,333	5,317	0.98	9,896	28,546	
Total	**1,525,900**	**68,400**	**1,594,300**	**160,000**	**237,200**	**40.7**	**410,989**	**808,189**	**103,088**