AABC Commissioning Group

AIA Provider Number 50111116

The Energy/Water Nexus: Seeking Opportunities for Savings

Course Number: CXENERGY1728

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Course Description

This presentation examines the strong interconnection between water and energy use at the municipal and building level. Strategies to identify inefficiencies and to increase opportunities for savings will be discussed. Attendees will gain an understanding of water demands of various energy production technologies and the energy demands of various water treatment methods and the true cost of water at a site.

Learning Objectives

At the end of the this course, participants will be able to:

1. Understand the water demands of various energy production technologies and the energy demands of various water treatment methods.
2. Understand the true cost of water at a site.
3. Learn how to complete a site water balance.
4. Identify common opportunities for savings.

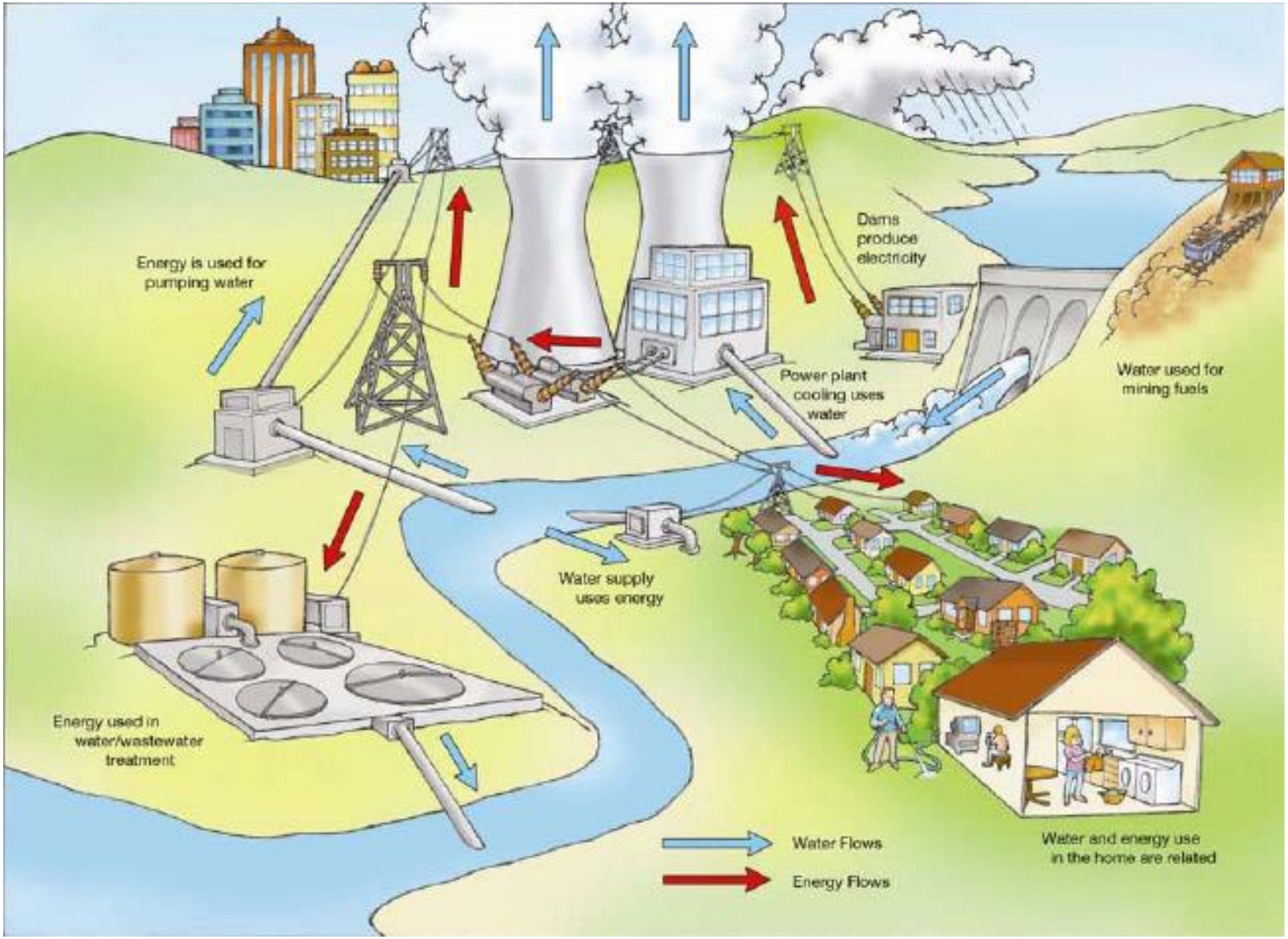
The Water Energy Nexus: Seeking Opportunities for Saving

MELISSA DARR

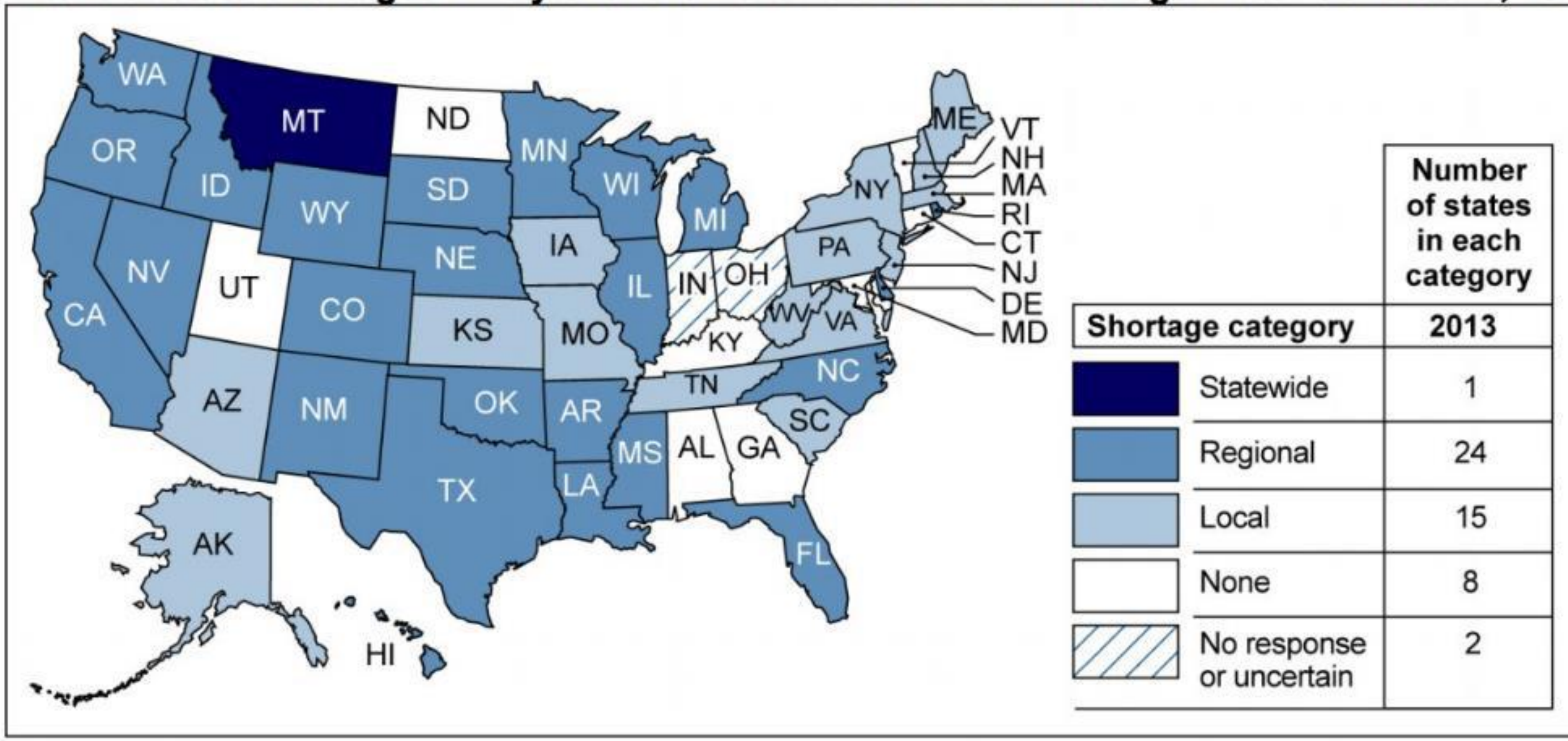
ARCADIS

What is the Water Energy Nexus?

There is no formal definition for the **water-energy nexus** - the concept refers to the relationship between the water used for energy production, including both electricity and sources of fuel such as oil and natural gas, and the energy consumed to extract, purify, deliver, heat/cool, treat and dispose of water (and wastewater) sometimes referred to as the energy intensity (EI).


Energy is used for pumping water
Dams produce electricity
Power plant cooling uses water
Water used for mining fuels
Water supply uses energy
Energy used in water/wastewater treatment
Water Flows
Energy Flows
Water and energy use in the home are related

Extent of State Shortages Likely over the Next Decade under Average Water Conditions, 2013



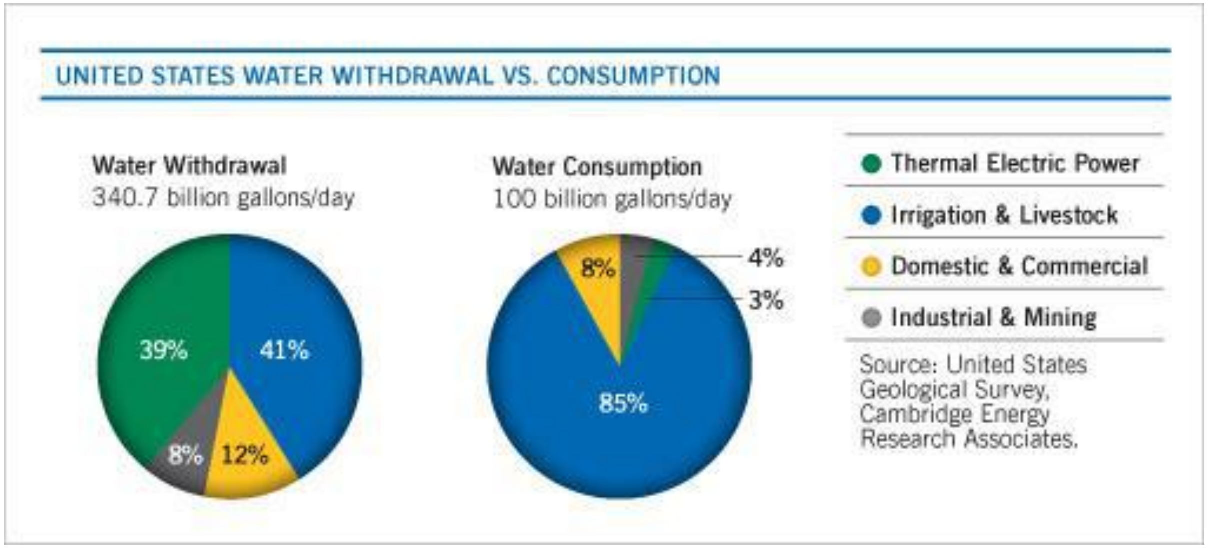
Water managers in 40 our of 50 states expect shortages in some part of their state within the next 10 years.

Government Accountability Office

Types of Water Use

Water withdrawal: The total volume removed from a water source such as a lake or river. Often, a large portion of this water is returned to the source and is available to be used again.

Water consumption: The amount of water removed for use and not returned to its source.



Fuel Type	Cooling	Technology	Median Withdrawal	Median Consumption
Nuclear	Tower	Generic	1101	672
	Once-through	Generic	44350	269
	Pond	Generic	7050	610
Natural Gas	Tower	Combined Cycle	225	205
		Steam	1203	826
		Combined Cycle with CCS	506	393
	Once-through	Combined Cycle	11380	100
		Steam	35000	240
	Pond	Combined Cycle	5950	240
	Dry	Combined Cycle	2	2
Coal	Tower	Generic	1005	687
		Supercritical	634	493
		IGCC	393	380
		Supercritical with CCS	1147	846
		IGCC with CCS	642	549
	Once-through	Generic	36350	250
		Supercritical	15046	103
	Pond	Generic	12225	545
		Supercritical	15046	42
Biopower	Tower	Steam	878	553

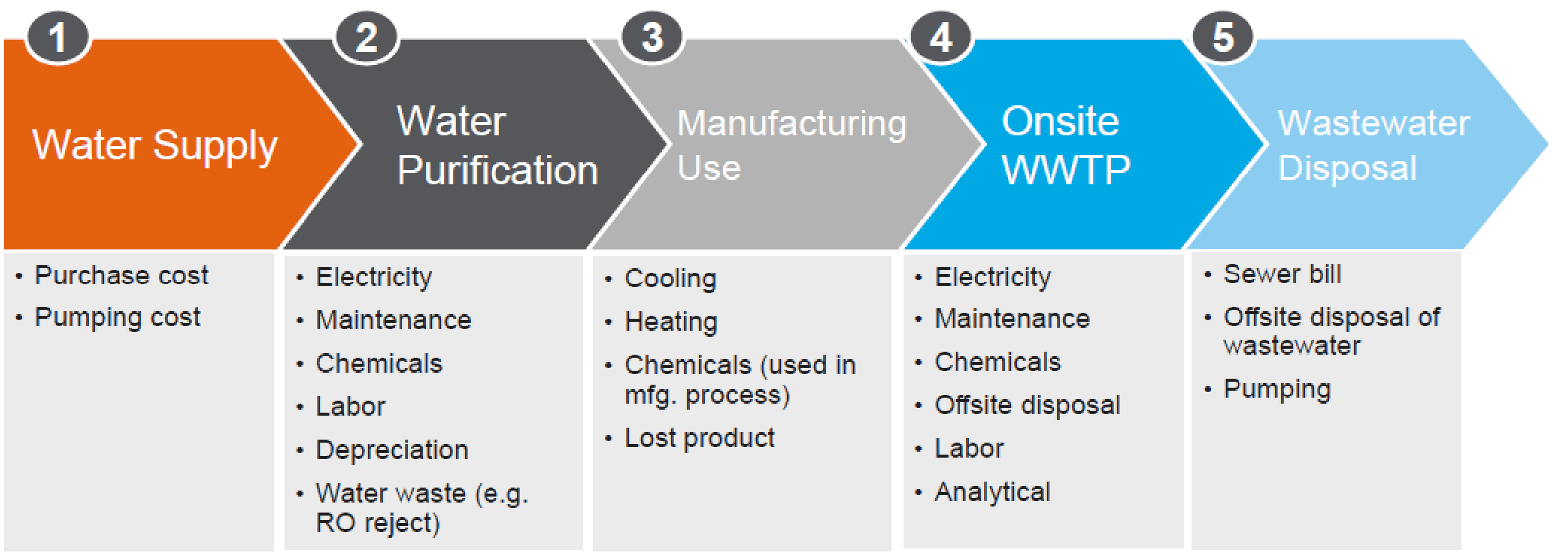
Energy Use in the Water Cycle

- Extracting and Conveying Water
- Treating Water
- Distributing Water
- Using Water
- Collecting and Treating Wastewater

Facility Level

- General perception that "water is cheap"
- The true cost of water use is generally much higher than people realize

Costs Incurred through the Industrial Water Cycle



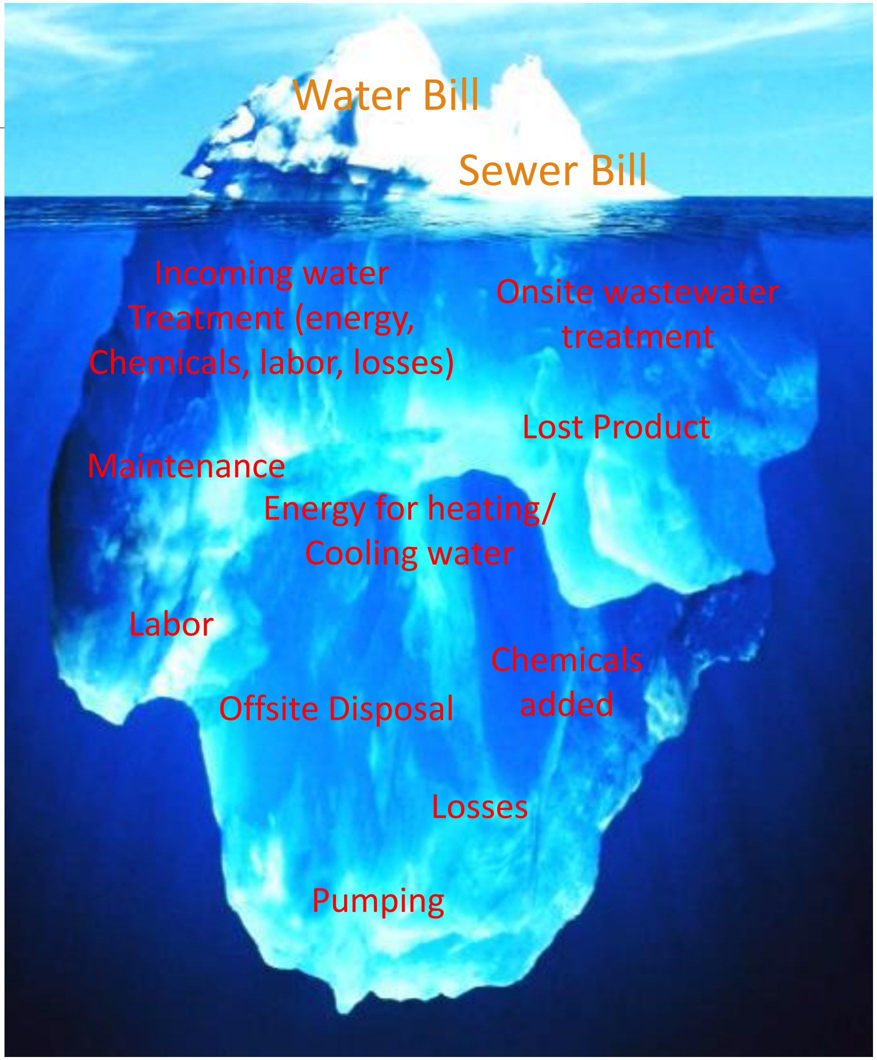
Total Cost of Water Calculation

$$\frac{C_{WS}}{\eta_{PWP}} + C_{PW} + C_{MFG} + \frac{C_{WW}}{\eta_{PWP}} + \frac{C_{WD}}{\eta_{PWP}} = C_{EC}$$

C_{WS}= Water supply cost ($/kgal)
η_{PWP} = Purified water production (%)
C_{PWP}= Water supply cost ($/kgal)
C_{MFG}= Manufacturing water use cost ($/kgal)
C_{WW}= Onsite WWTP Cost ($/kgal)
C_{WD}= Wastewater disposal cost ($/kgal)
C_{EC}= Expanded Industry Cost of Water ($/kgal)

Example: Factory Rinsing Operation

- Water used in factory rinsing operation
  - De-ionized/RO
  - Elevated temperature (120º F)
- Onsite WWTP
- Site has idea that would reduce water usage by 1 MG per year in the process
- CapEx estimated to be $30,0000
- Site investments require ≤ 2 year ROI

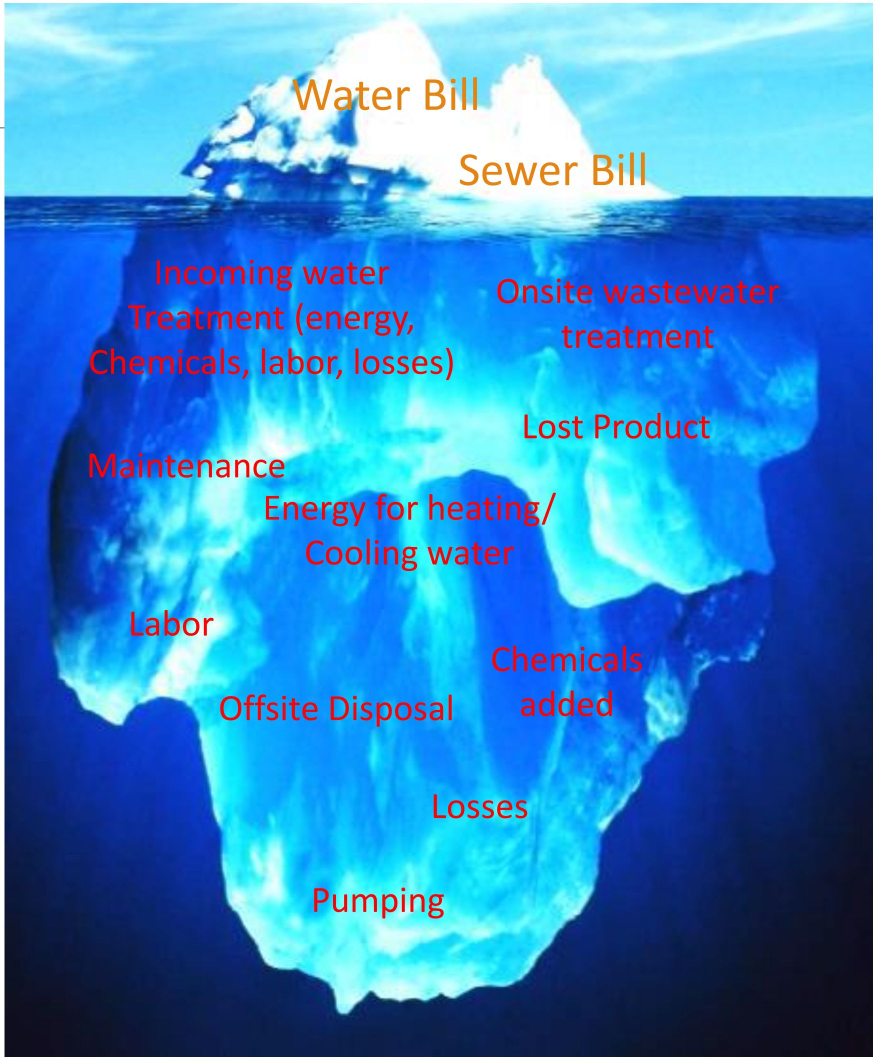


Example (cont'd) – Perceived Cost

City water cost at
$2.75/1000 gallons = $2,750/yr

Sewer cost at
$2.79/1000 gallons = $2,790/yr

Total Savings = $5,540/yr



Example (cont'd) – True Cost

City water cost at
$2.75/1000 gallons = $2,750/yr

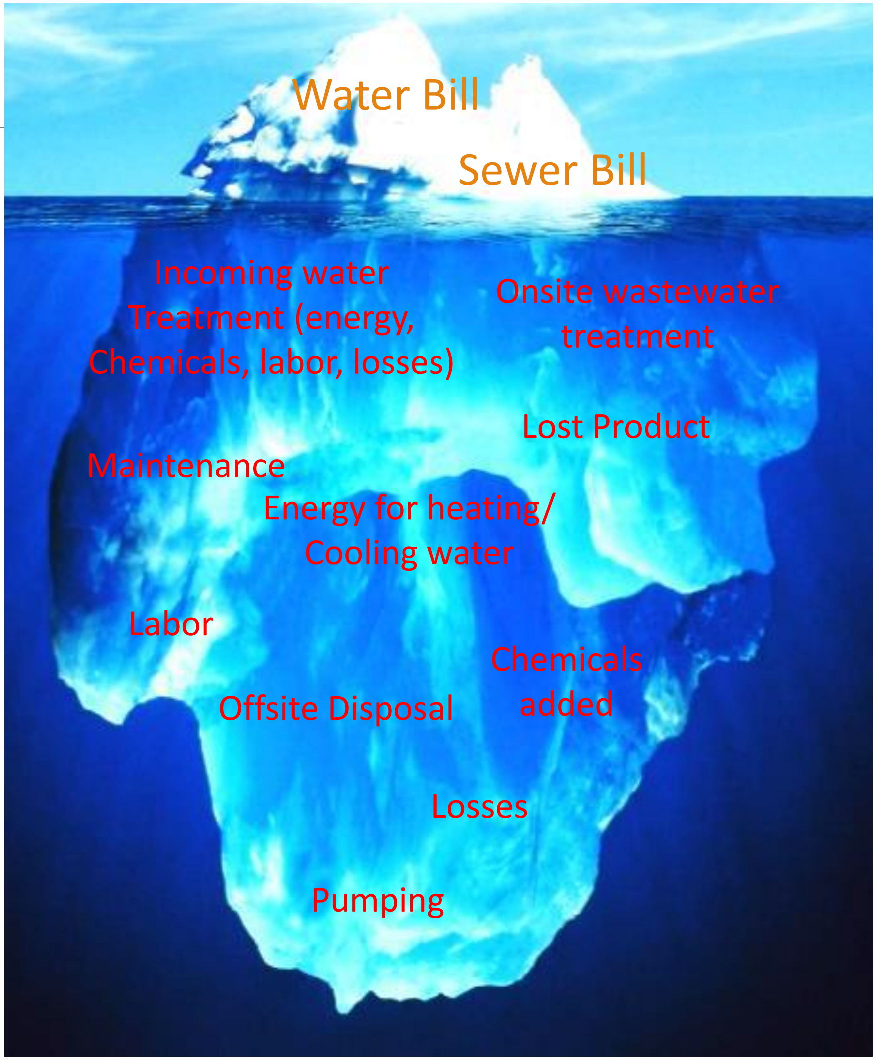
Sewer cost at
$2.79/1000 gallons = $2,790/yr

De-ionizing/RO at
$2.50/1000 gallons = $2,500/yr

Heating water at
$3.50/1000 gallons = $3,500/yr

Onsite WWT at
$5.90/1000 gallons = $5,900/yr

Total Savings = $17,440/yr



Factory Rinsing Operation Summary

Site has idea that would reduce this water usage by 1 MG per year but costs $30,000

Perceived Cost ROI =

$$\frac{\$30{,}000}{\$5{,}540} \approx 5.4 \text{ years}$$

True Cost ROI =

$$\frac{\$30{,}000}{\$17{,}440} \approx 1.7 \text{ years}$$

Problem Statement

- Water stress pressures and company sustainability goals are driving a need for water conservation
- Traditional water audit techniques often fail to identify cost effective opportunities to reduce demand for water
- Typically focus on processes outside of facility operations – e.g. end-of-pipe approaches, restrooms, storm water recycle, etc.
- Inadequate incorporation of ROI into the assessment
- Lack of attention to details of in-process water use
- There is often a disconnect between traditional water audition methods and the needs of the industry.

The Water Kaizen Blitz Process

Introduction to Lean Manufacturing

Lean manufacturing (or Lean) is a systematic method for the elimination of waste within a manufacturing system.

Based on the premise that as waste is eliminated quality improves while production time and cost are reduced.

Kaizen is a Japanese for improvement. When used in the business sense and applied to the workplace, kaizen refers to activities that continuously improve all functions and involve all employees from plant leadership to the plant operators.

A “Water Kaizen Blitz” applies the principles of lean manufacturing to minimize water use (or water wastage) throughout a manufacturing or operating facility.

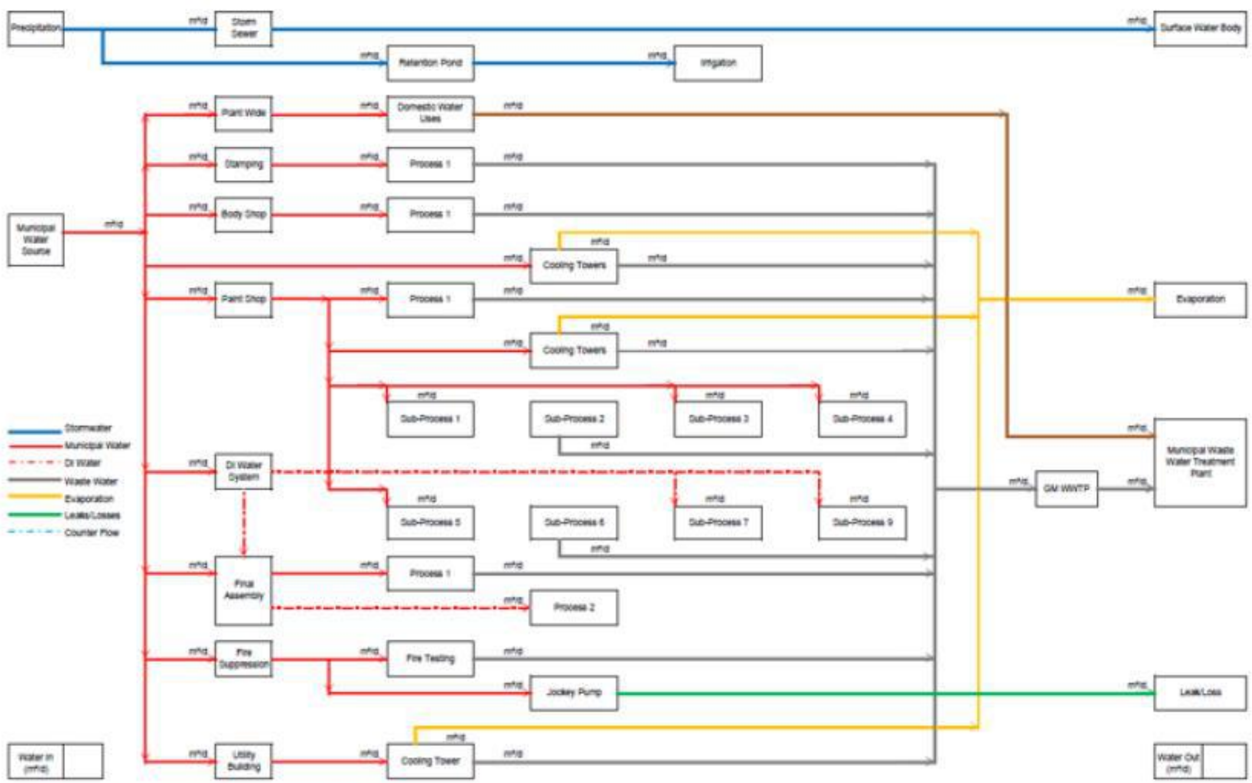
The WKB Process & Timeline

Helpful Tools for a WKB Event

- Flow meter (or a bucket and stopwatch)
- IR thermometer
- Tape measure
- Flashlight
- Camera
- PPE

The WKB Process & Timeline

Example Water Balance



Production September 2013: Approximately X,XXX units per day (Make/Models)
Operating Pattern: Production: X-hr shifts; Maintenance: X hours a day

Helpful Features of a Water Balance

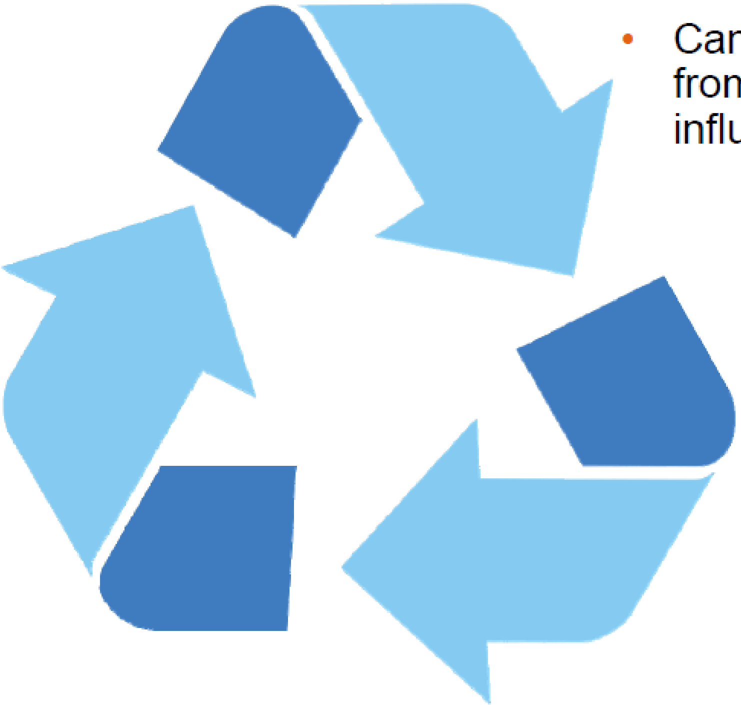
- Include all water using processes
- Domestic use often grouped together
- Show flowrate in + out of each process
- Use metered data when possible; estimates when metered data unavailable
- Color-code lines to describe water type (i.e. city water, RO water, etc.)
- Include losses (i.e. evaporation)
- Show recycle or return flows (i.e. boiler condensate return)

The WKB Process & Timeline

The R3 Process

Reuse:

- Can we use the effluent from process ‘A’ as the influent for process ‘B’?



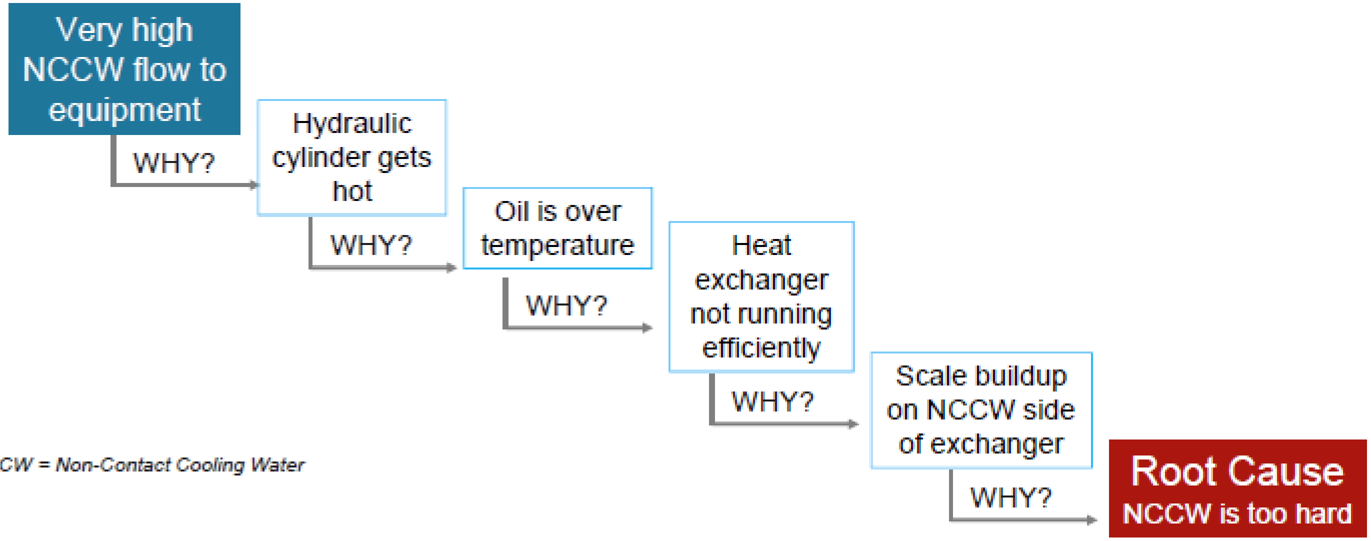
Reduce:

- Can we reduce flow rate or duration of flow to a unit?
- Are there processes no longer in use that still get water?

Recycle:

- Can we treat effluent from one or more processes to make it acceptable for re-use?

The 5 Why's



NCCW = Non-Contact Cooling Water

Common Opportunities

PROCESS	INFO TO COLLECT	EXAMPLE KAIZENS
Water-cooled processes Heat exchangers	Actual flow vs. required Delta T Water use time vs. equipment use time	Control valves Reduce flow Closed loop
Cooling towers	Number of cycles Make-up water flow Effluent flow from nearby processes?	Increase cycles Soften makeup water Reuse from another process
Washing, rinsing, parts-prep processes Testing processes Heated water or chemical	Make-up flow Open lid? Heated? Why is effluent a waste (temp, pH, etc.)? Chemical use and $$/yr	Reduce/control makeup Reduce evaporation Counter-current rinse Recycle/ reuse
Membrane processes	Recovery rate (efficiency) Reject flow	Increase recovery Use reject for other process (e.g. tower)
Scaling/ fouling problems	Flowrate What is water used for? Total $ due to scaling	Soften water Adjust water chemistry

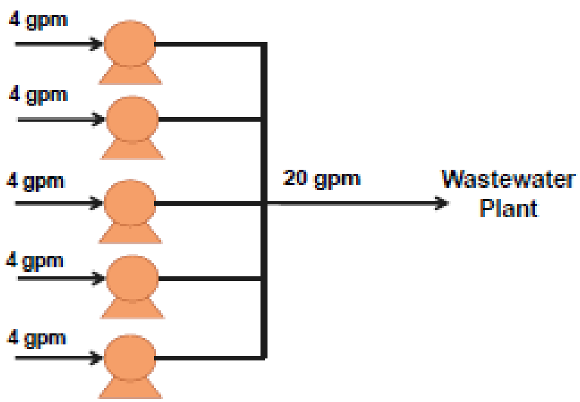
The WKB Process & Timeline

Keys to a Successful WKB Event

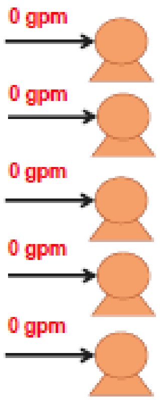
- Organized and thoughtful event preparation
- Water balance
- Expertise in water efficiency and process operation
- Experience in executing WKB events
- Diverse teams
- Tools to expedite development of ROI, water savings, and operating cost savings for the opportunities identified
- Support from and communication with management

Retrofit Vacuum Pumps to Oil Rings

Before: Water sealed



After: Oil sealed



This modification will also improve vacuum efficiency & testing operations

$106K Cost savings per year
10 Mgal Water savings per year
1.22 yr ROI

Current Operation: Paint Line Rinse Stages

<u>Stage 5 (Rinse):</u>

- Two paint lines
- Line 1 runs shifts 1,2, 3
- Line 2 runs shift 1 <u>only</u>
- Line 1 flowrate:
  - 73 gpm during shift 1
  - 103 gpm for shifts 2 and 3 (when Line 2 not running)

Proposed Solution: Paint Line Rinse

Create SOP to operate at consistent flows throughout all 3 shifts

Install pressure regulating or flow regulating valves to maintain constant flows between shifts

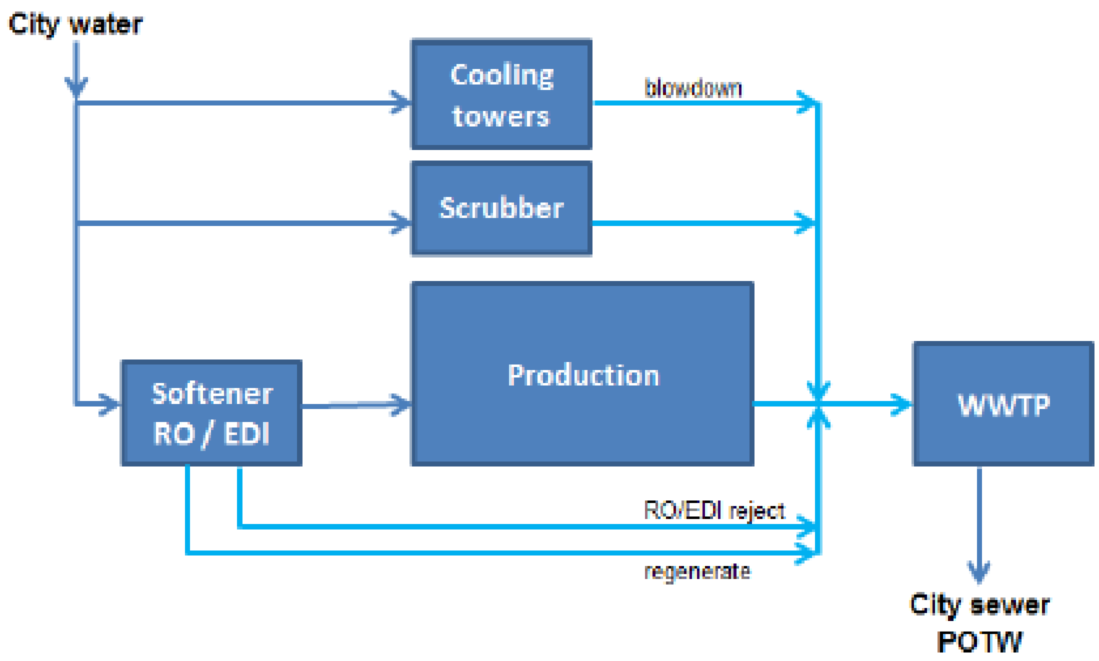
$130,000 Annual savings

14 Mgal Water savings per year

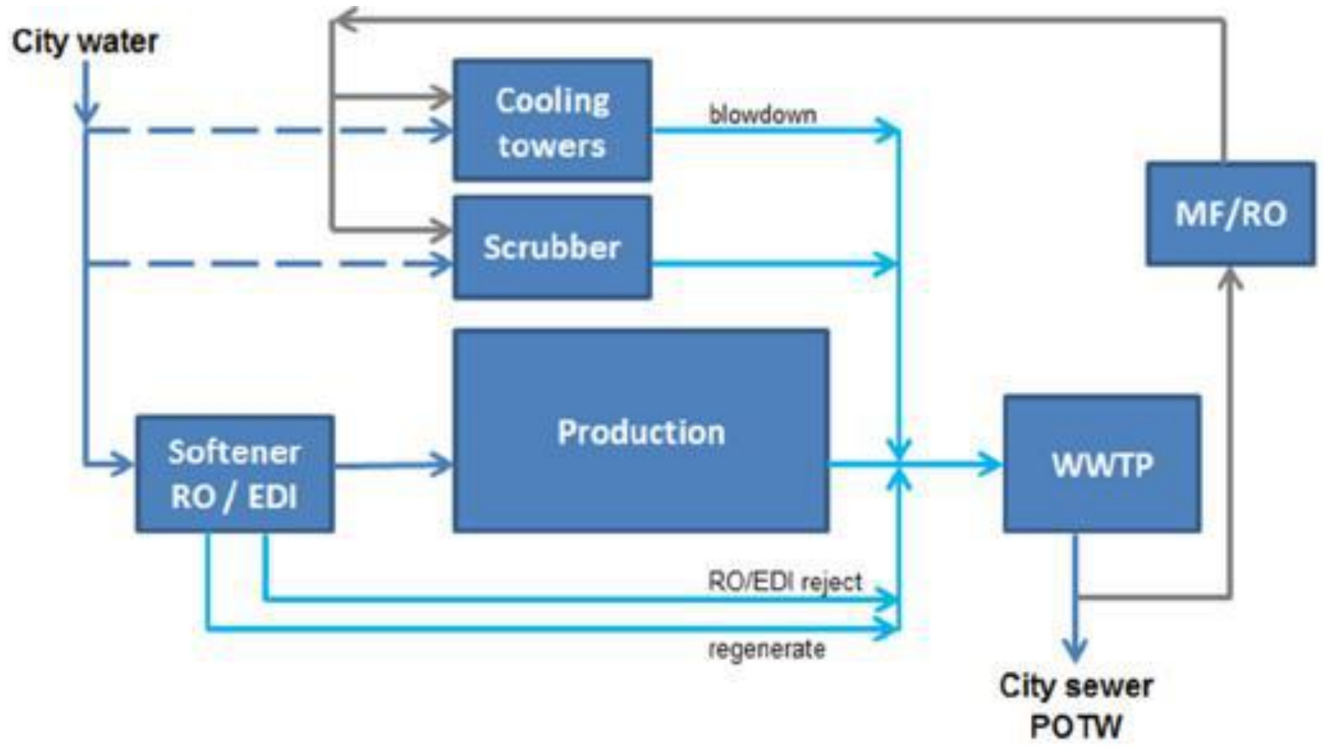
0.17 yr ROI

Before – Water Reuse

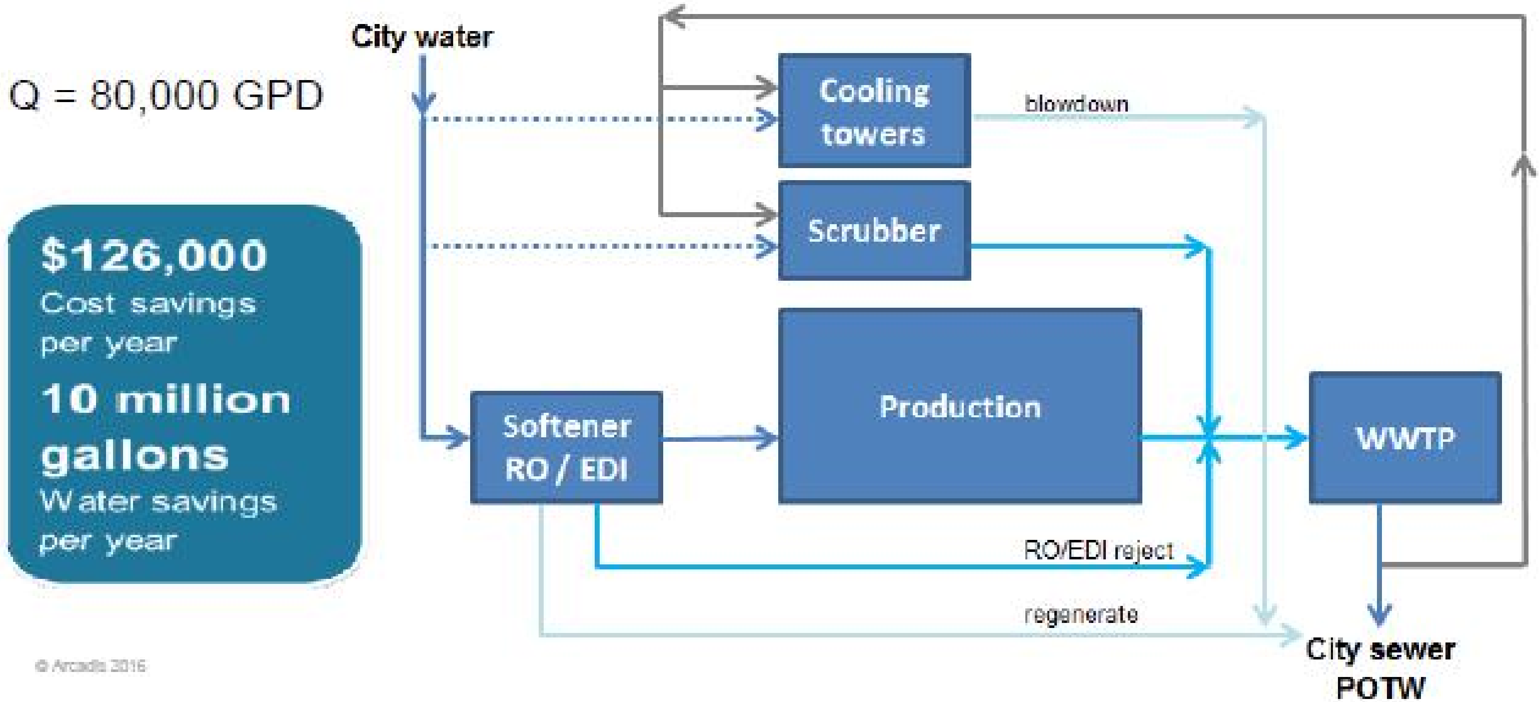
Q = 130,000 GPD



Original Proposal: Recycle after RO/MF



After – Water Reuse



Review of Learning Objectives

- Understand the water demands of various energy production technologies and the energy demands of various water treatment methods
- Understand the true cost of water at a site
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Questions/Discussion

Contact: Melissa.Darr@arcadis.com

Sample Last Slide

This concludes The American Institute of Architects Continuing Education Systems Course

Contact Information