IDEA

Drought Mitigation: Replacing Potable Water For Cooling With Reclaimed Water

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Agenda

- What? Replace potable water with reclaim
- Why? Necessity and sustainability
- How? Little to no changes to operations
- Getting Started
- Operating Challenges and Solutions
  - Mechanical, Operational, Chemical
- Maintenance Challenges and Solutions
  - Mechanical, Operational, Chemical
- End Result

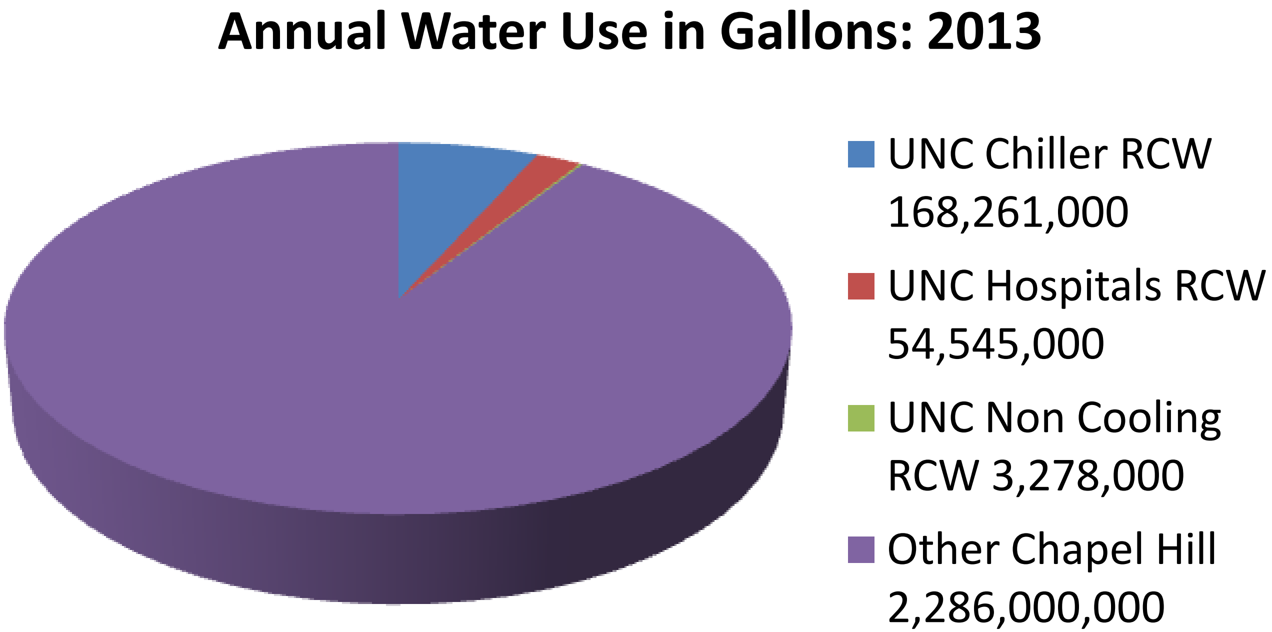
What: Replace Potable Water For Cooling With Reclaimed Water

Potable Water Uses

- Drinking
- Irrigation
- Cooling

Reclaimed Water Sources

- Rain Water
- Air Handler Condensate
- Municipal Reclaim



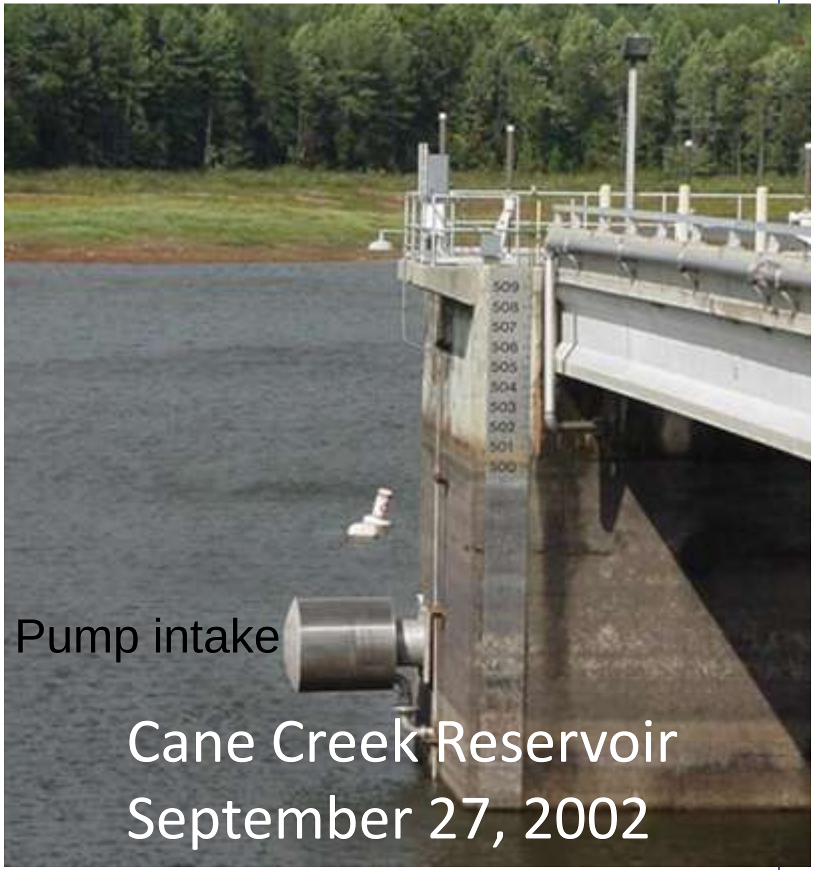
Why: Necessity, Sustainability

Many Reasons

- Feasibility Study 1995
- Drought Mitigation 2002 call to action
- Drought 2007 Accelerated Plan

- Days of Water LEFT:
  - Oct 9, 2002 – 31.8% only 110 days (Demand 9.7MGD)
  - Feb 12, 2008 – 38.8% only 169 days (Demand 8.18MGD)
  - Many customers conserved reducing demand

- OWASA expansions and extensions
  - Moves supply expansion from 2027 to 2044



How: operate the systems using municipal reclaim water as make up with no additional safety, maintenance, operational, time or capital investment to operate.

Built to "2T Rule" Now have to be built to state rules

OWASA Side

- Built one 600,000 gallon system
- Installed some of the initial piping during 2006 tunnel project

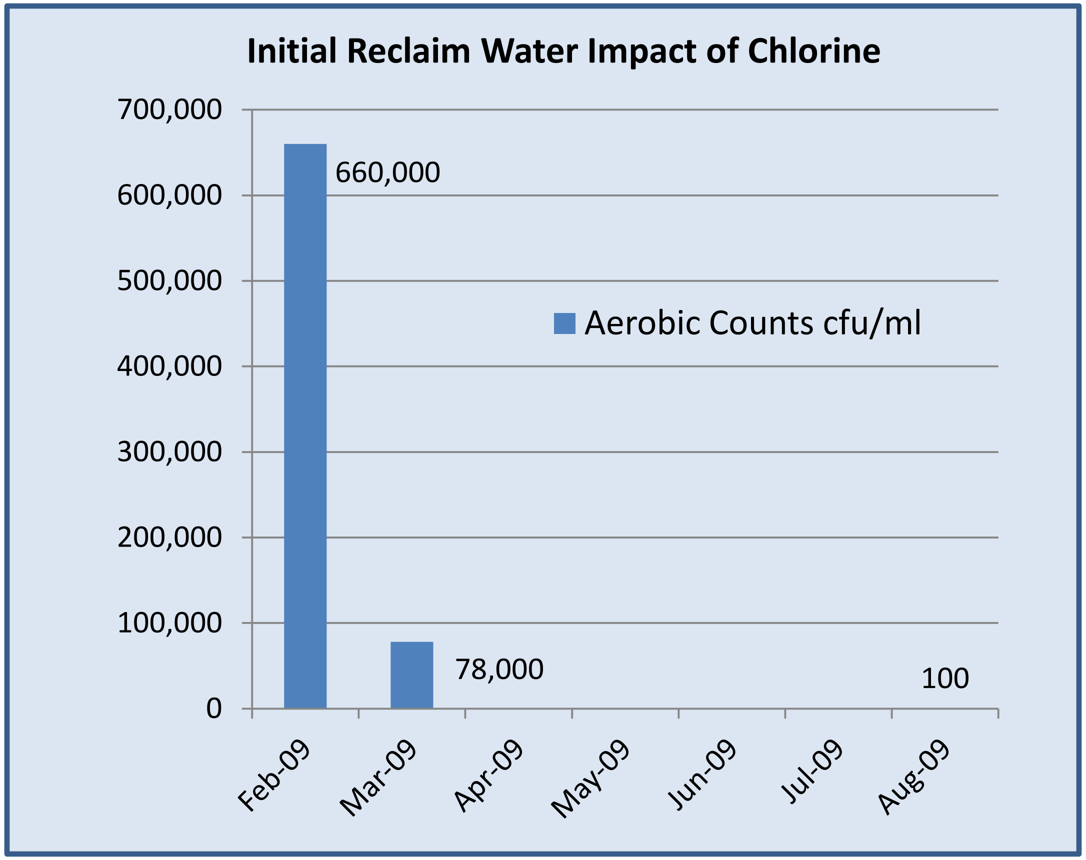
What is the distance from source to end user		
	Feet	Gallons
OWASA WWTP to East Chiller Plant take off	7,257	185,960
East Chiller Plant take off to Hibbard Rd split	5,865	150,290
Hibbard Rd split to South Chiller Plant	1,672	16,880
Hibbard Rd split to North Chiller Plant take off	2,906	64,164
Hibbard Rd split to Cobb Chiller Plant take off	4,925	100,830
Longest feed to chiller plant - OWASA WWTP to Cobb Chiller Plant	18,047	439,080

UNC Side

- No fundamental changes to tower pipe or wetted parts
- Had to add potable water air breaks to North and South CP

Lessons Learned: GETTING STARTED

- **Safety in Transport**



- From OWASA to UNC
- Testing and recommendations from UNC CH's Dr. Sobsey
  - Chlorine Targets set at 0.5 to 2.0

<<As the chlorine was applied bacteria was controlled

Lessons Learned: GETTING STARTED

- **Performance in Evaporative Cooling Systems**

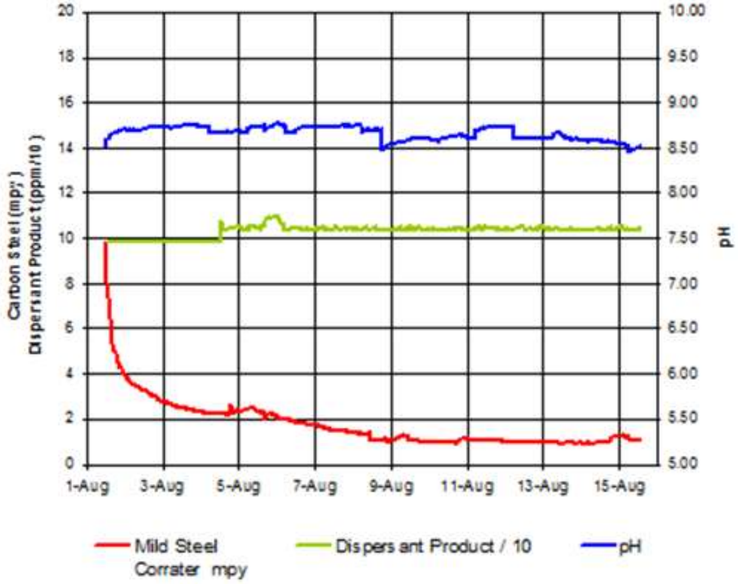
Water transported in totes WWTP Pilot Skid

- Pilot Testing
  - Reclaim process
  - In Pilot cooling towers
- To confirm ability to control corrosion, deposits, microbiological growth and fouling
- Define parameters clearly and use specific units
  - Phosphate as PO4 ppm

Lessons Learned: GETTING STARTED

- **Performance in Evaporative Cooling Systems**
  - Asset preservation pilot testing documented the ability to treat the water>>
    - MS corrosion rates <3 mpy
    - Copper corrosion rates <0.1 mpy
  - Deposit control
    - 0 to 1 mg/cm2yr

Pilot tower corrosion rates



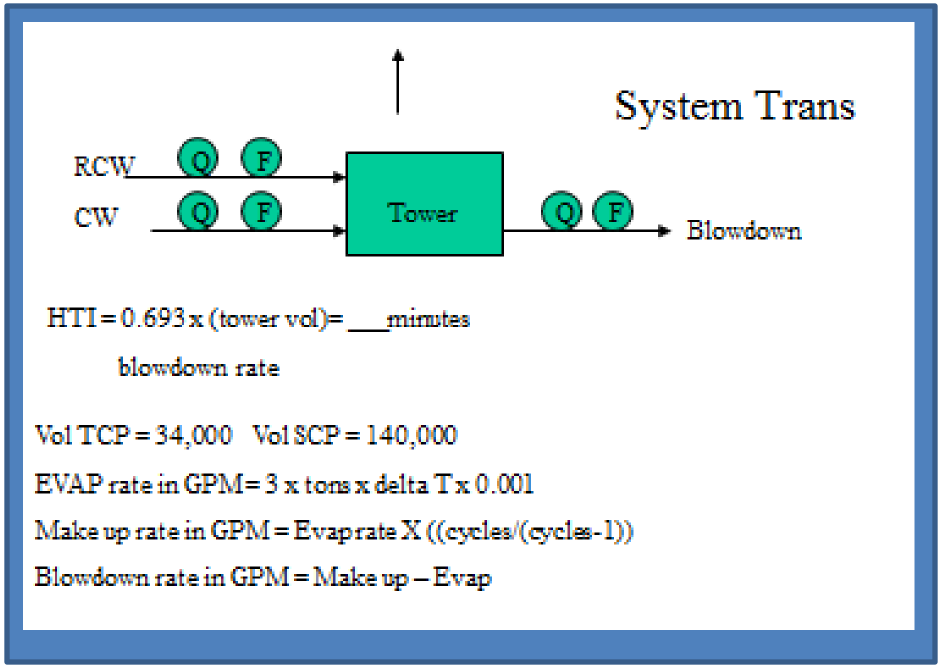
Lessons Learned: GETTING STARTED

- **Safety in Evaporative Cooling Systems**

- Deposit and corrosion control in place
- Biodispersants in place
- Biocides alternated
- Monitoring done
- Mechanical Cleanings scheduled and completed
- ASHRAE 188P planning begun

Lessons Learned: GETTING STARTED
Real Life Examples – things that popped up

- Put flush valves on utility side of meter to allow flushing. We found alkalinity builds and bugs grow in line during non-use periods
- Ensure flush line access to sanitary sewer
- Be prepared to run lower than target cycles while reclaim process established base line
- Have an algorithm to change between city and reclaim and back



Account for volumes and holding time indices

Operating Challenges and Solutions: MECHANICAL

Challenges: OWASA to UNC	Solutions: OWASA to UNC
Old Mason Road Plant lower than UNC	High head pumps
Low flow conditions	Two pump sizes
Challenges: UNC to Tower	Solutions: UNC to Tower
Raw reclaim water aggressiveness to make up pipe	Pipe materials: change make up pipe material from steel to stainless
Challenges: Tower Loop	Solutions: Tower Loop
Required mechanical air break for potable water	Reclaim installed as main make up, city installed with air break
Challenges: UNC to OWASA	Solutions: UNC to OWASA
If cycles reduced will larger sewer be required	Sewer capacity at Chilled Water was sufficient

Operating Challenges and Solutions
MECHANICAL EXAMPLES

Reclaim entering Tomkins Tower Loop

City make up enter Tomkins Tower via air break configuration

Operating Challenges and Solutions: OPERATIONAL/ON LINE

Challenges: OWASA to UNC	Solutions: OWASA to UNC
Old Mason Road Plant lower than UNC	Four pumps set to ramp up/down to maintain P
Low flow conditions	Installation of pressure sustaining valve at WWTP to allow better pump control
Challenges: UNC to Tower	**Solutions: UNC to Tower**
Changes in water quality when it stands in the lines	Installed blow off lines on utility side of meter
Raw reclaim water aggressiveness to make up pipe	Pipe materials: change make up pipe material from steel to stainless
Challenges: Tower Loop	**Solutions: Tower Loop**
Change in water quality: Conductivity, probes max at 4,000	Wider span probes
Variation in conductivity between city and reclaim	Control cycles using algorithm that includes make up conductivity, tower conductivity, holding time index

Operating Challenges and Solutions
OPERATIONAL / ON LINE EXAMPLES

Reclaim make up data monitored at both locations and shared between OWASA and UNC

AIT_6809W_pH:	6.77 pH
AIT_6810W_Turbidity	0.92 ntu
AIT_6812W_CL2	3.44 ppm
AIT_6817W_Alkalinity	28.90 mg/l
FIT_6805A_Flow_A	656.90 gpm
FIT_6805B_Flow_B	672.45 gpm
LIT_6803W_Tank_A	7.45 ft
LIT_6804W_Tank_B	7.44 ft
PIT_6807W_Pump_psig	122.95 psi

Operating Challenges and Solutions: CHEMICAL

Challenges: OWASA to UNC	Solutions: OWASA to UNC
pH w/o using local acid feed on UNC Campus	Installed acid delivery and pH control at OWASA
Chlorine	Feed to meet levels established by Dr. Sobsey
Challenges: UNC to Tower	**Solutions: UNC to Tower**
Changes in water quality when it stands in the lines	Reduce cycles to consume water
Reclaim water aggressiveness to pipe	Proper Corrosion inhibitors per metallurgy
Challenges: Tower Loop	**Solutions: Tower Loop**
Change in water quality: Conductivity	Control cycles using algorithm that includes make up conductivity and tower conductivity
Hardness	Control scale dispersant based on tower stress
Alkalinity	Control scale dispersant based on tower stress
Phosphate	Control scale dispersant based on tower stress

Operating Challenges and Solutions
CHEMICAL

Last 7 Days **Data Dashboard (Cont.)** *Tomkins Tower new chem 2009*

Parameter Name	Date & Time	Latest Value	Avg.	Min.	Max.	St. Dev.	Low Critical Limit	Low Limit	High Limit	High Critical Limit	Latest Value
Copper Corr. Rate (mpy)	12/29/2013 7:00:00 AM	0.01	0.01	0.01	0.01	0	---	---	0.3	0.5	
Conductivity (µS/cm)	12/29/2013 7:00:00 AM	3237.68	3333.04	3011.13	3679.93	199.78	800	900	4000	5000	
TRASAR Dose (ppm)	12/29/2013 7:00:00 AM	31.16	32.51	30.07	35.38	1.18	---	---	---	---	
ORP (mV)	12/29/2013 7:00:00 AM	287	269.57	225	296	20.95	0	50	500	650	
Tagged Poly Dose (ppm)	12/29/2013 7:00:00 AM	83.47	85.02	72.01	93.06	2.58	---	---	---	---	
pH	12/29/2013 7:00:00 AM	8.91	8.99	8.46	9.26	0.13	6	7.5	9.5	10	
TRASAR Product Usage (gpd)	12/29/2013 12:00:00 AM	0	0	0	0	0	---	---	---	---	
Ox Bio Usage (gpd)	12/29/2013 12:00:00 AM	0	0.3	0	2.07	0.57	---	---	---	---	
4-20mA Input 1	12/29/2013 7:00:00 AM	0	0	0	0	0	---	---	---	---	
4-20mA Input 2	12/29/2013 7:00:00 AM	0	0	0	0	0	---	---	---	---	
Temperature (°F)	12/29/2013 7:00:00 AM	45.02	49.99	39.72	76.91	13.76	32	40	120	140	
Turbidity (NTU)	12/29/2013 7:00:00 AM	0	0	0	0	0	---	---	50	150	
Flow Status	12/29/2013 7:00:00 AM	1	0.92	0	1	0.28	0	0	1	1	
Cell Fouling (%)	12/29/2013 7:00:00 AM	0	0	0	0	0	---	---	25	50	

24/7 Monitoring and Control
Data seen by Nalco and UNC

Maintenance Challenges and Solutions: MECHANICAL

Challenges: OWASA to UNC	Solutions: OWASA to UNC
Water quality and impact on corrosion, scale	Pipe materials, pH control
Challenges: UNC to Tower	**Solutions: UNC to Tower**
Raw reclaim water aggressiveness to make up pipe	Pipe materials: change make up pipe material from steel to stainless
Challenges: Tower Loop	**Solutions: Tower Loop**
Required mechanical air break for potable water means two lines make up systems to maintain	Reclaim installed as main make up, city installed with air break
Changes to corrosion rates with changes in make up source	Once reclaim water is in the tower loop and treated corrosion rates demonstrate at or below industrial standards
Challenges: UNC to OWASA	**Solutions: UNC to OWASA**
If cycles reduced will larger sewer be required	Sewer sized for higher discharge volumes in original design

Maintenance Challenges and Solutions
MECHANICAL EXAMPLES

Municipal Reclaim
Make up: Steel

Municipal Reclaim
Make up: SS

Maintenance Challenges and Solutions: OPERATIONAL / ON LINE

Challenges: OWASA to UNC	Solutions: OWASA to UNC
Maintenance handled by OWASA	
Alkalinity drift	Flush lines
Challenges: UNC to Tower	Solutions: UNC to Tower
Sensor Maintenance	Regular cleaning of sensors will be reduced when MU line goes to stainless
	Be sure to select instruments that are geared to this water quality
Challenges: Tower Loop	Solutions: Tower Loop
Additional solids means additional evaporative scale	Annual to semi-annual tower cleaning Wider span on conductivity at tower
Deposition in some sensors	Dead legs even more critical to manage

Maintenance Challenges and Solutions
ON LINE EXAMPLES

Tower Inspections: Normal
Basin: dirt, silt, very minimal
Fill/Structure: clean

Dead leg deposits: at instrument wells
Silica, Calcium aluminum present
Soft Texture
22% organic or carbonate

Transmitter

Water enters top to bottom no flow in leg Accumulates over six months

Maintenance Challenges and Solutions: CHEMICAL

Challenges: UNC to Tower	Solutions: UNC to Tower
Maintaining ph, conductivity probe cleanliness	Stainless lines, regular calibration, semi-annual cleaning
Challenges: Tower Loop	**Solutions: Tower Loop**
Deposits or foulants in small dead legs or at sensors with no flow	Deposit identification: Instrument cleaning Deposit prevention

Maintenance Challenges and Solutions CHEMICAL

Selection of piping and probes to handle the water quality at both reclaim make up and tower loop

Tower and mu probes installed with proper flow and ability to clean and maintain

Clean and calibration schedule based on predictive need

End Result

Total Gallons of City Water Diverted in 2013: 226,084,000

Number of Treated System Failures: 0
No piping, equipment, instrument inspection failures: 0

What to do differently:

Ensure non treated pipes are corrosion resistant to account for more aggressive reclaim make up water

System blow offs to be installed before meters and more strategically with respect to sanitary sewer locations