

GPG Outbrief 18

Alternative Water Treatments

Emerging Building Technologies, GPG Program | U.S. General Services Administration | March 28, 2019

The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white on a dark blue square background.

GSA

GPG-038, 039, 040 AWT Treatments @ gsa.gov/gpg


- ❑ Infographic
- ❑ 4-page Findings
- ❑ Full Report
- ❑ Additional Resources

The screenshot displays the GSA website's navigation structure and content for the 'Electrochemical Water Treatment for Cooling Towers' project. The top navigation bar includes links for BUYING & SELLING, REAL ESTATE, POLICY & REGULATIONS, SMALL BUSINESS, TRAVEL, SHARED SERVICES, TECHNOLOGY, and ABOUT US. A breadcrumb trail indicates the path: Home > Governmentwide Initiatives > Sustainability > Emerging Building Technologies > Published Findings > Water > Electrochemical Water Treatment.

The sidebar on the left lists various categories under 'EMERGING BUILDING TECHNOLOGIES', including Overview, About GSA, Published Findings, Building Envelope, Energy Management, HVAC, Lighting, On-Site Power & Renewables, Water, and Catalysis. The 'Water' category is currently selected.

The main content area features the title 'Electrochemical Water Treatment for Cooling Towers' and a brief description: 'The National Renewable Energy Laboratory tested an alternative treatment technology (AWT) that uses electricity to create a chemical reaction. Researchers found that the system effectively treated the water without the expense of added chemicals and reduced water use by 32%. [View full-size infographic.](#) [PDF - 245 KB]'. To the right of the text are two links: '4-PAGE REPORT SUMMARY [PDF - 2 MB]' and 'FULL REPORT—DEC 2018 [PDF - 1 MB]'. Below the text is a large infographic with a green header that reads '038 DECEMBER 2018 ELECTROCHEMICAL WATER TREATMENT'. The infographic is divided into sections: 'OPPORTUNITY' with the statistic '28% OF WATER IN COMMERCIAL BUILDINGS IS USED BY COOLING TOWERS OR OTHER HEATING AND COOLING SYSTEMS', and 'TECHNOLOGY' with the heading 'ELECTROLYSIS SEQUESTERS SCALE IN REACTOR'.

Webinar Recording and Slides Available on gsa.gov/gpg



- BUYING & SELLING
- REAL ESTATE
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Home > Governmentwide Initiatives > Sustainability > Emerging Building Technologies > Outbrief Webinars

EMERGING BUILDING TECHNOLOGIES

- Overview
- About GSA's Proving Ground (GPG)
- Published Findings
- Ongoing Assessments
- Request for Information
- About Pilot to Portfolio (P2P)

> Outbrief Webinars

- GPG-Proven Technologies with GSA Deployment Potential
- Newsletters
- GSA Technology Deployment Maps

Outbrief Webinars

GPG Outbrief webinars are presented by national laboratory researchers and include results from real-world evaluations, as well as feedback from facility managers at test-bed locations. Following Outbrief presentations, researchers and other GSA subject experts field participant questions. Attendees are eligible to receive continuing education credits from the American Institute of Architects for attending webinars.


Open for Registration

Alternative Water Treatments for Cooling Towers

Outbrief 18: March 28, 2019, at noon ET

This webinar originally scheduled for January 17th has been rescheduled to March 28th.

[Register now](#)

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On-Demand Webinars and Presentation Slides

TECHNOLOGY CATEGORY	WEBINAR TOPIC	ON-DEMAND VIDEO	PRESENTATION SLIDES
Building Envelope	Electrochromic Windows for Office Space	2018-04-19 	Outbrief #12 
Building Envelope	Hi-R Low-E Window Retrofit System / Low-E Window Film	2017-03-30 	Outbrief #01 
Energy Mgmt.	Advanced Power Strips for Plug Load Control	2018-02-08 	Outbrief #10 

Upcoming 2019 GPG Outbriefs—Thursdays, 12 PM ET

April 25 EMIS Technology Assessment (GSA Internal)

May 9 Circuit-level Submetering

Webinar Recordings

Access all webinars on [GSA.gov](https://www.gsa.gov)

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How to Ask Questions

Please chat your questions during the presentation for the Q&A segment



Introduction



Jay Fine

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Webinar Agenda

- ❑ Introduction (5 minutes)
Kevin Powell, Director, Center for Emerging Building Technologies
- ❑ Alternative Water Treatment, GSA Region 4 (15 minutes)
Gregg Tomberlin, National Renewable Energy Laboratory
- ❑ On-the-ground Feedback, GSA Region 4 (10 minutes)
Todd Kronlein
- ❑ Alternative Water Treatments, GSA Region 8 (25 minutes)
Jesse Dean, National Renewable Energy Laboratory
- ❑ On-the-ground Feedback, GSA Region 8 (10 minutes)
Tyler Cooper
- ❑ AWT Takeaways (5 minutes)
Jay Fine, Project Manager, Center for Emerging Building Technologies
- ❑ Q & A (20 minutes)

Introduction



Kevin Powell

Director, Center for Emerging Building Technologies

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Opportunity



28%

OF WATER IN COMMERCIAL BUILDINGS

IS USED BY COOLING TOWERS AND OTHER HEATING AND COOLING SYSTEMS



41%

**INCREASE IN GSA WATER RATES
2014-2017**

GPG-038, 039, 040

Alternative Water Treatments for Cooling Towers

General Services Administration
Public Buildings Service



GPG-039 | JANUARY 2019

ADVANCE FOR COOLING



The GPG program enables GSA to make so

General Services Administration
Public Buildings Service



GPG-040 | FEBRUARY 2019

ALTERNATIVE TREATMENT



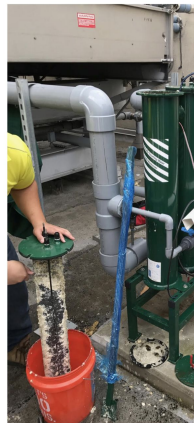
The GPG program enables GSA to make so

General Services Administration
Public Buildings Service



GPG-038 | DECEMBER 2018

ELECTROCHEMICAL COOLING TOWER WATER TREATMENT



Non-Chemical Water Treatment Uses Electrolysis to Sequester Scale and Create a Natural Biocide

Cooling towers are used in chilled water plants to transfer waste heat to the atmosphere through evaporative cooling. As water evaporates in open cooling towers, mineral content suspended in the remaining water becomes increasingly concentrated. When the remaining water can no longer hold the minerals in suspension, scaling and corrosion result. Consequently, system water must be flushed periodically, a process known as "blowdown," to minimize mineral build-up. Typical cooling-tower water treatment adds chemicals to minimize scaling and corrosion and mitigate biological growth. GPG, working with the National Renewable Energy Laboratory, tested an alternative treatment technology (AWT) that uses electricity to create a chemical reaction. The electrochemical process simultaneously reduces scale and creates chlorine, which acts as a biocide, thereby reducing or eliminating the need for both blowdown and added chemicals. During the early phases of GPG's assessment, site personnel at the Juliette Gordon Low Federal Building in Savannah, Georgia, where the assessment was conducted, were concerned that removing biocides would result in a build-up of algae in the cooling towers, but in the end they found the opposite to be true: the alternative water treatment kept algae in check resulting in cooling towers that were cleaner and in need of less maintenance. Researchers measured a 32% reduction in makeup water, a 99.8% reduction in blowdown and a 100% reduction in added chemicals. At the GSA average water/sewer cost of \$16.76/kgal and normalized installation costs, payback was 2.5 years.

Measurement & Verification



Gregg Tomberlin

Senior Engineer

National Renewable Energy Laboratory

Traditional Cooling Tower Treatment

Scale, corrosion and biological growth controlled with chemicals and blowdown

25-50%
COOLING WATER IS FLUSHED
TO MINIMIZE SCALE BUILD-UP

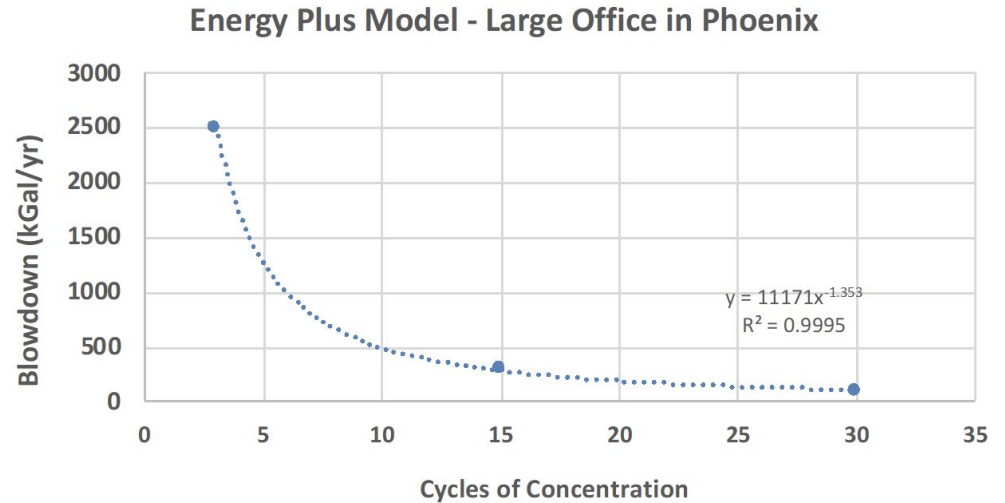
EVAPORATION

- 1,000 Btu/lb
- ~1.8 gal/ton-hour
- Concentrates minerals & chemicals

Cycles of Concentration

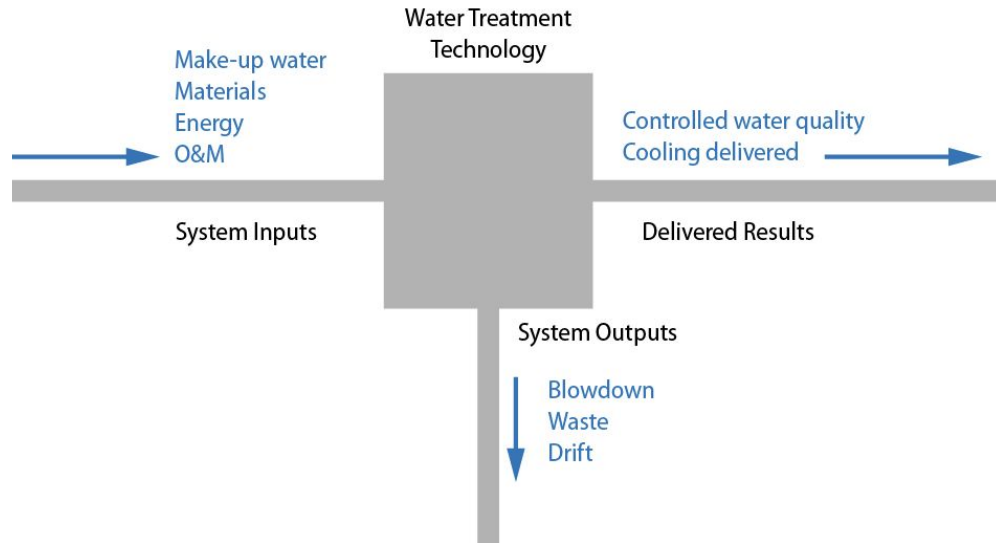
Majority of savings from CoC of 3 to 10, savings level off after CoC of 15

- CoC= Ratio of concentration in dissolved solids blowdown vs. makeup water
- Typical CoC–2.5 to 7
- At a CoC of 3, around 33% of cooling tower water make up is wasted as blowdown



General AWT M&V Framework

Primary objective: measure cooling tower water savings in gal/ton-hr



Typical M&V Points:

- Condenser water supply & return temperatures (°F)
- Condenser water pump status (ON/OFF)
- Cooling tower fan status (ON/OFF)
- Chiller water supply and return temperatures (°F)
- Chiller status (ON/OFF)
- Outdoor air temperature (°F) and humidity (%)
- Cooling Tower Make Up Water meter (gal)
- Blowdown Water Meter (gal)
- Chiller Plant Electrical Meter (kWh)

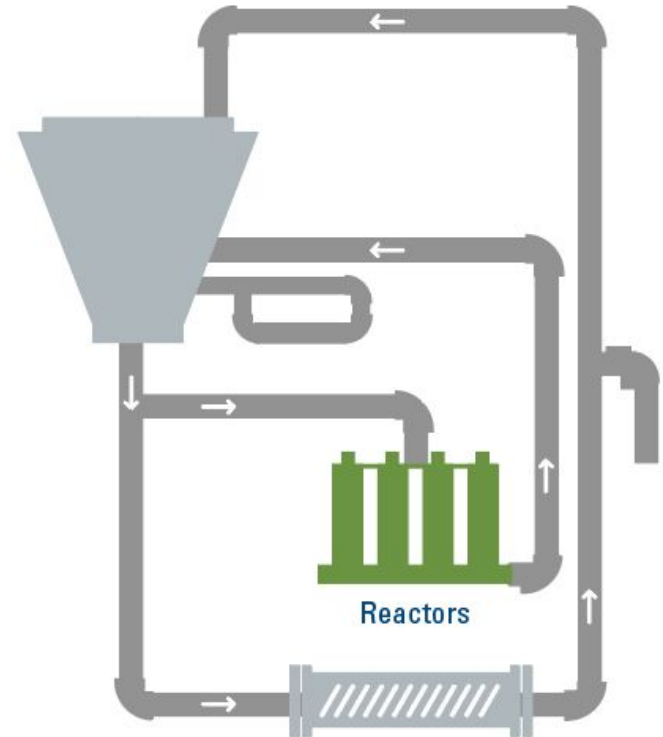
Electrochemical Water Treatment



Electrochemical Water Treatment (provided by Dynamic Water Technology)

Electrolysis sequesters scale in reactor tubes

- Creates chlorine, a natural biocide
- Treats a side stream



Electrochemical Results

32%

**WATER
SAVINGS**

99.8%
reduction in
blowdown

100%

**CHEMICAL
SAVINGS**

Technology
generates chlorine;
reduced slime



Electrochemical O&M

50% reduction in GSA O&M

- Tower cleanings reduced from 4 to 2
- No added chemicals saved \$4,080/year
- Annual maintenance contract \$6K, could be decreased if local staff trained



Electrochemical Economics

9 year payback @ \$6.64/kgal

Rebates are available for AWT systems through some local water utilities

	@ \$6.64/kgal
Installed Equipment 2 x 150 ton cooling towers (\$)	\$30,340
Water Savings (Gallons/yr)	1,133,857
Water Savings (\$/yr)	\$7,529
Maintenance Change (\$/yr)	-\$720
Simple Payback (yrs)	8.7
Savings to Investment Ratio	1.7

GSA Feedback—Savannah, Georgia



Todd Kronlein

Mechanical Engineer,
Region 4 Energy Branch
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Installation/Commissioning

Installation was simple

- Requires add-on circulating pump and compressed air
- Swapped out hose to be UV resistant
- Sits outside but indoor installation preferred
- Remote monitoring could be helpful but not possible until IT-Security cleared



Ongoing Operations

System works and saves water

- Saved about 1M gallons water over last 17 months
- Challenge in getting O&M contract in place soon enough for vendor maintenance to continue, caused scaling after system wasn't maintained for 9 months
- Don't be afraid of chemical-free systems, they really work, unlike the systems from 20-years ago



Cleaning

Train local staff

- It's really not hard. Took about 2 hours to clean the rods.
No special skills required.



Maintenance

Quarterly maintenance is enough

- Maintenance is more expensive because it includes travel from Phoenix
- Facility still has another maintenance contract with another company for closed loop systems. Would be good to combine.



Measurement & Verification



Jesse Dean

Senior Research Engineer, M.S., CEM
National Renewable Energy Laboratory

Salt-Based Ion Exchange



Technology for M&V provided by
Water Conservation Technology International

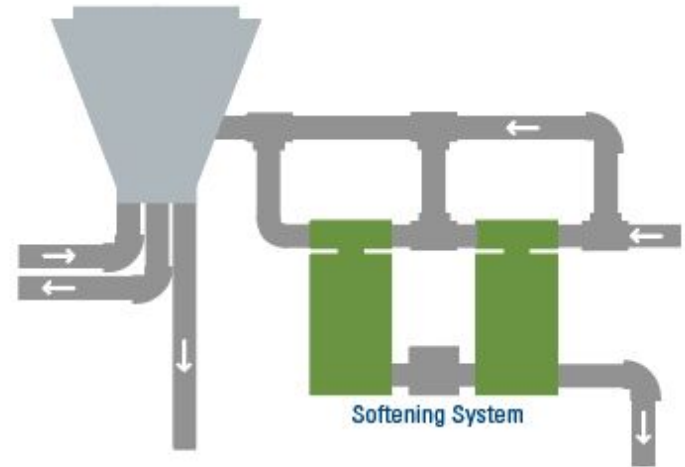


M&V Building 25, Denver Federal Center
Three 500-ton cooling towers

Salt-Based AWT

Removes hardness without adding additional chemicals

- **Scale:** silica associated with scaling altered through water softening process
- **Corrosion:** altered silica composition inhibits corrosion
- **Biological growth:** generally controlled by heightened pH. Biocide added if necessary.



Salt-Based Results



**23% water savings, 99%
blowdown reduction**

- CoC ranged between 30–75



Improved chiller operations

- Increased run time of tower free cooling
- Observational improvements in water quality

Salt-Based Water O&M

Significant reduction in O&M

- Reduced annual maintenance 47% from 152 hours to 80 hours saving \$3,677/yr
- Reduced annual material costs by \$2,678 by eliminating almost all chemical use and using less expensive salt-regeneration process



Controller

Salt-Based Economics

3 year payback @ \$7.14/kgal

Local rebates would have offset ~50% of installed cost if DFC was not on a single meter

	@ \$7.14/kgal
Installed Equipment 3 x 500 ton cooling towers(\$)	\$29,600
Water Savings (Gallons/yr)	401,170
Water Savings (\$/yr)	\$2,864
Maintenance Savings (\$/yr)	\$6,445
Simple Payback (yrs)	3.2
Savings to Investment Ratio	4.7

Chemical-Scale Inhibition



Technology for M&V provided by
Terlyn Industries

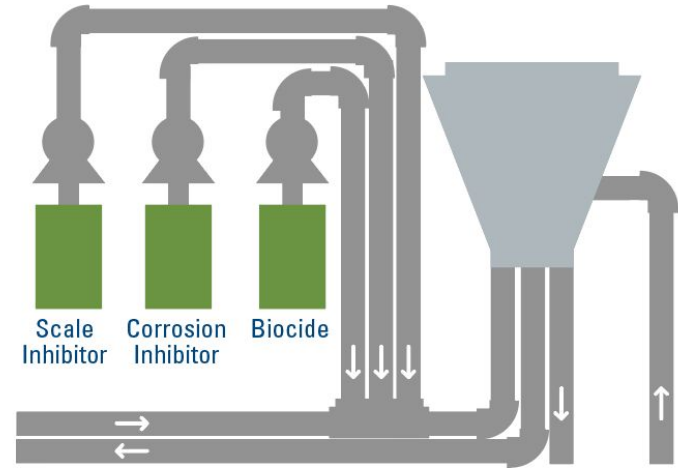


M&V Building 67, Denver Federal Center
Two 600-ton cooling towers

Chemical Scale Inhibition

Proprietary chemicals inhibit scaling and corrosion

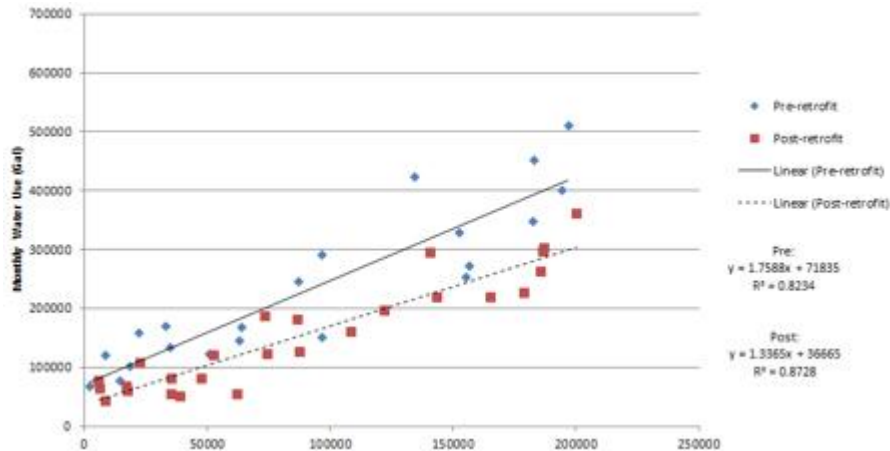
- **Scale:** Stronger scale inhibitors, a semipermeable membrane filters out suspended solids preventing these from nucleating and precipitating out.
- **Corrosion:** Industry standard
- **Biological growth:** Conventional biocides
- Monitors & automates blowdown at CoC upto 50
- Glass media filter added by installer for particulate matter



Chemical Scale Inhibition Water Savings

24% water savings, 94% blowdown reduction

- CoC ranged between 13–18



Regression of monthly water use to cooling demand

Significant reduction in scaling

- Increased run time of tower free cooling, 6°F reduction in set point
- Observational improvements in water quality

Chemical Scale Inhibition O&M

Increased O&M contract cost

- Reduced maintenance labor 48% from 132 to 69 hrs saving \$3,217
- Increased annual maintenance contract from \$8,400 to \$13,500



Chemical Tank – Proprietary Solution



Glass Media Filter

Chemical Scale Inhibition Economics

8 year payback @ \$7.14/kgal

Local rebates would have offset ~50% of installed cost if DFC was not on a single meter

	@ \$7.14/kgal
Installed Equipment 2 x 600 ton cooling towers(\$)	\$32,511
Water Savings (Gallons/yr)	824,448
Water Savings (\$/yr)	\$5,887
Maintenance Savings (yr)	- \$1,883
Simple Payback (yrs)	8.1
Savings to Investment Ratio	1.8

Additional Denver Federal Center AWT Deployments

Denver Federal Center Facility	AWT System	Date Installed	Cooling Tower Size (tons)	Installed Cost (\$)	Annual Water Savings (Gal/yr)	Annual Water Savings (\$/yr)	Annual Change in O&M (\$/yr)	Total Annual Cost Savings (\$/yr)	Simple Payback (yrs)
Building 20	Salt-Based	Nov-16	600	\$31,057	718,597	\$5,131	-\$6,445	\$11,576	2.7
Building 41	Salt-Based	Jan-17	1,000	\$36,976	1,809,921	\$12,923	-\$6,445	\$19,368	1.9
Building 85	Chemical-Scale	Jan-14	500	\$8,756	62,450	\$446	+\$400	\$46	>40
Building 56	Chemical-Scale	Jan-15	1,000	\$28,557	661,160	\$4,721	+\$1,100	\$3,621	7.9
Building 810	Chemical-Scale	Jun-14	2 x 500	\$31,047	1,131,450	\$8,079	+\$1,883	\$6,196	5.0
Building 810 USDA	Chemical-Scale	Mar-16	3 x 500	\$31,047	1,048,000	\$7,483	+\$1,883	\$5,600	5.5

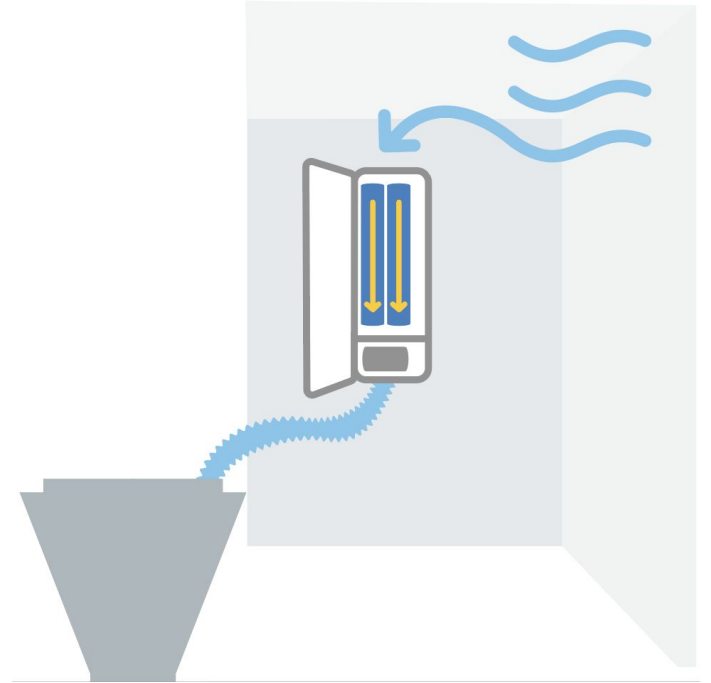
Advanced Oxidation Process



Advanced Oxidation Process

Photochemical treatment oxidizes minerals and contaminants

- Surrounding air is pulled into the system and through the processor sleeve into the water
- Hydroxyl radicals form to attack contaminants in the water



Advanced Oxidation Process Results



26% water savings

- CoC ranged between 5 and 14
- Blowdown was not measured



Elimination of scaling/corrosion inhibitors

- Small amounts of bromine/chloride biocides used occasionally for unusual conditions like lots of pollen
- Subsequent analysis indicated lowest biological growth of DFC water treatment

Advanced Oxidation Process O&M

50% reduction in O&M

- Reduced maintenance labor 50% from 52 to 26 hrs saving \$1,327
- Improved chiller operations, borescope after the system had been running for 2 years revealed significant decrease in condenser tube fouling



Advanced Oxidation Process Economics

2 year payback @ \$7.14/kgal

Local rebates would have offset ~50% of installed cost if DFC was not on a single meter

	@ \$7.14/kgal, \$.099/kWh
Installed Equipment* 2 x 250 ton cooling towers (\$)	\$22,487
Water Savings (Gallons/yr)	527,791
Water Savings (\$/yr)	\$3,768
Maintenance Savings (yr)	\$2,522
Simple Payback (yrs)	2.1
Savings to Investment Ratio	7.2

Leasing costs for equipment and service approximates cost of traditional chemical treatment

*Capital cost for 1 unit. Because Building 95 had struggled with algae growth after testing another AWT, site staff chose to install two AOP systems. In retrospect, however, only one system was needed.

GSA Feedback—Denver Federal Center



Tyler Cooper

Supervisory Energy PM
GSA Region 8



Doug Baughman

Energy Management Specialist
GSA Region 8

Site Selection

Need adequate cooling tower run time

- 5-month season = good rule of thumb for positive ROI in Denver
- Knowing daily hours of tower operation will help you calculate savings
- Longer run-time will allow for higher CoC. 500-ton system outperformed 1500 ton system with a 40,000 gallon sump due to longer run times

We chose AWT systems to reduce water use while maintaining water quality, reducing blowdown and increasing CoC

Installation

You can't measure what you don't meter

- Evaluate all points to capture both water and electricity savings
- Install meters on makeup and blowdown
- Tie into advanced metering system if available

Best practice to install a side-stream filtration system on the CD condenser loop

Maintenance

Old habits are hard to break

- Make sure O&M understands the new system and is committed to maintaining it
- Contracting needs to address/specify AWT treatment
- Helpful to have online reporting system to monitor results and O&M performance



Lessons Learned

Bring expertise on board

- Inspect water circulation in the tower basin. Water should be able to flow easily under fill media. Algae blooms between media and exterior basin wall.
- Controller should store historical data and be accessible from USB or laptop device and connect to BAS using BACnet communication for monitoring and operation.
- Leasing could be an attractive option moving forward. Lease maintains equipment and provides support.
- Perform a borescope inspection before the install and the next time you perform annual maintenance. Supports performance and ROI claims.
- Maintain all service reports. Some systems offer online site to pull reports and maintenance can enter their test reports and order supplies.

AWT Takeaways



Comparable Water and Maintenance Savings

	Electrochemical Treatment Dynamic Water Technologies	Advanced Oxidation Process Silver Bullet	Salt Based System WCTI	Chemical Scale Inhibition Terlyn
Cooling Tower Size (tons)	300 (2 x 150)	500 (2 x 250)	1500 (3 x 500)	1200 (2 x 600)
Baseline CoC	3.9	7.9	4.42	Not measured
Technology CoC	100+	11	30-75	13-18
Water / Sewer Savings	31.6%	22.7% to 29.7% (estimated)	23%	24%
Water Savings Per Ton-Hour of Cooling	.64	Not measured	.58	.42
Blowdown Reduction	99.8%	Not measured	99%	94%
Chemical Use	100% chemicals eliminated	100% scale and corrosion inhibitors eliminated; biocide used for biological growth	Brine used for scale and corrosion inhibition, biocide used as needed	Scale Inhibitor, Corrosion Inhibitor, Biocide
Cooling Tower Maintenance Savings (yr)	-50%/\$1,200 (32 to 16 hrs)	-50%/ \$1,327 (52 to 26 hours)	-47%/\$3,677 (152 to 80 hrs)	-48%/\$3,217 (132 to 69 hrs)
Water Treatment Maintenance Contract (yr)	+\$1,920 (\$4,080 to \$6,000)	-\$1,195 (\$3,200 to \$2,005)	-\$2,768 (\$7,649 to \$4,881)	+\$5,100 (\$8,400 to \$13,500)
Installation	< 2 days	< 1 day	~2 days	~1 week including side-stream filtration

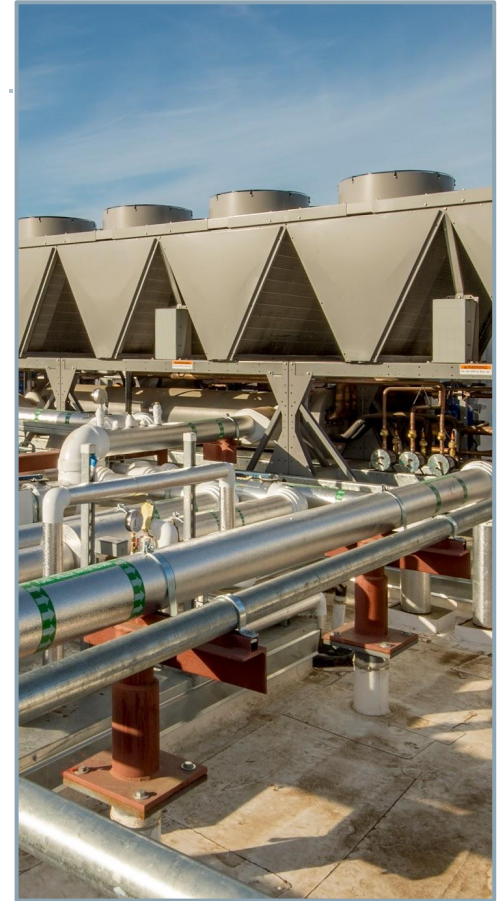
Payback < 3 years for All Systems @ GSA Average Water Rate

	Electrochemical Treatment Dynamic Water Technologies	Advanced Oxidation Process Silver Bullet	Salt Based System WCTI	Chemical Scale Inhibition Terlyn
Testbed Cooling Tower Size (tons)	300 (2 x 150)	500 (2 x 250)	1500 (3 x 500)	1200 (2 x 600)
Total Installed Cost	\$45,340	\$23,425	\$29,600	\$32,511
Installed Cost per Ton	\$151	\$47	\$20	\$27
Annual Maintenance Change	+\$720	-\$2,522	-\$6,445	+\$1,883
Annual Water Savings @ avg. GSA rate \$16.76 kgal	\$19,003	\$8,846	\$6,724	\$13,818
Simple Payback	2.5	2.1	2.2	2.7
Savings-to-Investment Ratio	6.0	7.1	6.7	5.5

Deployment Recommendation for AWT

Consider for all Cooling Towers

- All evaluated AWT systems can be retrofitted to any cooling tower.
- Installation for all four AWT systems is straightforward and leaves the balance of the cooling towers unaltered.
- Currently evaluating two additional AWT systems.



Q & A

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GPG Outbrief 18: Alternative Water Treatments

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Check here to request a certificate for 1.5 CE units.

AIA Number

Your answer

First and Last Name

Your answer

The information presented in the Outbrief webinar was helpful.

1 2 3 4 5
Strongly Disagree Strongly Agree

I am interested in alternative water treatments for cooling towers.

- Yes, in the next 2 years.
- Yes, in the next 5 years.
- Maybe
- No

Thank you



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