REGIONAL WATER QUALITY NEWSLETTER

DATE: Report for June 2013 A Tempe, Glendale, Peoria, Chandler, Phoenix, ADEQ, CAP, SRP, Epcor ASU Regional Water Quality Partnership

http://enpub.fulton.asu.edu/pwest/tasteandodor.htm

SUMMARY: EVALUATION AND RECOMMENDATIONS

- 1. **HOLD THE DATE** for our 2013 Annual Water Quality Workshop Friday September 20th from 830-1130am at the PERA Club.
- Geosmin is being produced in the lower parts of the Arizona and Consolidated Canals. Geosmin levels of 7 to14 ng/L occur in the lower Arizona Canal at Glendale and Greenway WTPs, respectively, be are removed go < 2 ng/L during treatment. Higher levels of geosmin on the lower Consolidated canal of 27 ng/L occur at the Chandler WTP, and are removed to 8 ng/L just below a level typically noticable by consumers.
- 3. MIB and geosmin levels in the lakes are starting to increase near the lake surfaces, but not at depth where the water is released from the reservoirs. This year is appearing to be dominated by Geosmin producing algae/cyanobacteria rather than MIB.
- 4. Dissolved organic carbon (DOC) levels in the terminal reservoirs are: Lake Pleasant: 3.2 mg/L; Bartlett Lake: 5.3 mg/L; Saguaro Lake: 4.8 mg/L.
- 5. Measurements of Sucralose, which is discharged in treated wastewater, in our May 2013 quarterly samples indicate the CAP contains 1-2% water of wastewater origin, while <1% of the flow in the lower Salt or Verde have wastewater impacts.
- 6. Data on the light absorbing properties of organic matter (UV/VIS and fluorescence) are presented for some recent sampling and suggest that terrestrial DOC flushed from the watershed is removed and transformed in the Salt River reservoir system, and algae and bacterial derived DOC is produced.
- 7. An update on the in-situ GAC regeneration using iron nanoparticles from a pilot plant shows that we are starting to get positive results at pilot scale, which support developmental work last year at the bench-scale.

Quick Update of Water Supplies for June 2013 (during day of sampling – June 4th)

Sourco	Trond in supply	Discharge to	Elow into SPR Canal	Dissolved organic carbon
Source	riena in supply	Discharge to		
		water supply	System	Concentration (mg/L) **
		system		
Salt River	Reservoirs at	1050 cfs	711 cfs into Arizona	4.0 mg/L
	60% full		Canal	
Verde River	Reservoirs	300 cfs	576 cfs into South	4.1 mg/L
	At 63% full		Canal	
			(77% Verde River	
			Water)	
			i acci,	
			20 of of CAD water	
Colorado	Lake Pleasant is 73%	Lake Pleasant is	20 CIS OI CAP water	2.8 mg/L
River	full (Lake Powell is	releasing water	Into Arizona Canal	- 0/
	48% full)	into the CAP canal		
Crevendurater	Concerelly increasing		279 cfs Groundwater	
Groundwater	Generally increasing	371 crs pumping	Pumping into SRP	0.5 to 1 mg/L
	due to recharge	by SRP	Canals	

*Concentration of these taste and odor compounds in the upper [lower] levels of the terminal reservoir (Saguaro Lake on the Salt River; Bartlett Lake on the Verde River; Lake Pleasant on the CAP system **Concentration of DOC in the terminal reservoir

*** On paper cities are receiving CAP water in the SRP canals, but as a method of "paying back" from the last drought for excess CAP deliveries – SRP is delivering wet water only from the Salt and Verde Rivers Data from the following websites:

- http://www.srpwater.com/dwr/
- <u>http://www.cap-az.com/index.php/departments/water-operations/lake-pleasant</u>
- http://lakepowell.water-data.com/



Dissolved Organic Carbon In Reservoirs and Treatment Plants

DOC = Dissolved organic carbon UV254 = ultraviolet absorbance at 254 nm (an indicator of aromatic carbon content) SUVA = UV254/DOC TDN = Total dissolved nitrogen (mgN/L)

Reservoir Samples

Table 4 - Reservoir Samples - June 3, 2013

Reservoir sampling conducted monthly. CAP is sampling Lake Pleasant and Havasu, and USGS is sampling Verde River at Tangle and Salt River above Roosevelt on slightly different days than the other reservoirs.

Sample Description	Location	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg- m)	TDN
Havasu (May)		2.8	0.042	1.5	0.5
Laka Diagont (May)	Epilimnion		not av	ailable	
Lake Fleasant (May)	Hypolimnion	3.2	0.034	1.1	0.4
Verde River (May)	@ Tangle	1.1	0.022	2.0	0.2
Verde River	@ Beeline Hwy	3.2	0.079	2.5	0.4
Partlett Pasarvoir	Epilimnion	5.3	0.114	2.2	0.3
Baitlett Reservon	Hypolimnion	5.2	0.138	2.7	0.4
	Epilimnion	4.9	0.068	1.4	0.3
Saguaro Lake	Epi - Duplicate	4.6	0.060	1.3	0.4
	Hypolimnion	5.1	0.069	1.4	0.6
Salt River	@ Blue Point Bridge	3.9	0.057	1.5	0.3

Organic Matter in Canal

Table 3 - Rivers and Canals – June 3, 2013

Sample Description	DOC (mg/L)	UV254	SUVA (L/mg-	TDN
		(1/cm)	m)	IDN
Waddell Canal	5.3	0.032	0.6	0.5
Anthem WTP Inlet	2.9	0.033	1.1	0.4
Union Hills Inlet	2.7	0.032	1.2	0.5
CAP Salt-Gila Pump Station (April)	2.9	0.037	1.3	0.5
CAP Mesa Turnout (April)	5.2	0.038	0.7	0.6
CAP Canal at Cross-connect	3.0	0.036	0.5	0.5
Salt River @ Blue Pt Bridge	3.9	0.057	1.5	0.3
Verde River @ Beeline	3.2	0.079	2.5	0.4
AZ Canal above CAP Cross-connect	3.8	0.062	1.6	0.3
AZ Canal below CAP Cross-connect	3.8	0.062	1.6	0.3
AZ Canal at Highway 87	3.9	0.063	1.6	0.3
AZ Canal at Pima Rd.	3.8	0.066	1.7	0.6
AZ Canal at 56th St.	3.8	0.060	1.6	0.5
AZ Canal - Central Avenue	3.8	0.063	1.7	0.4
AZ Canal - Inlet to Glendale WTP	3.4	0.056	1.6	1.1
AZ Canal - Inlet to GreenwayWTP	3.4	0.054	1.6	1.6
South Canal below CAP Cross-connect	4.0	0.063	1.6	0.3
Head of the Tempe Canal	3.8	0.061	1.6	0.3
Tempe Canal - Inlet to Tempe's South Plant	3.0	0.046	1.5	1.5
Head of the Consolidated Canal	3.8	0.060	1.6	0.3
Middle of the Consolidated Canal	3.5	0.058	1.7	0.5
Chandler WTP – Inlet	3.9	0.054	1.4	1.3

Organics at the Water Treatment Plants

Tab	le	2 -	Water	Treatment Plants – June 3	, 2013
a		n			

Sample Description	DOC (mg/L)	UV254	SUVA (L/mg-	TDN
		(1/cm)	m)	
Union Hills Inlet	2.7	0.032	1.2	0.5
Union Hills Treated	2.4	0.013	0.5	0.4
Tempe North Inlet	3.7	0.063	1.7	0.4
Tempe North Plant Treated	2.9	0.019	0.7	0.3
Tempe South Inlet	3.0	0.046	1.5	1.2
Tempe South Plant Treated	2.7	0.019	0.7	1.0
Greenway WTP Inlet	3.4	0.054	1.6	1.6
Greenway WTP Treated	2.4	0.008	0.3	0.8
Glendale WTP Inlet	3.4	0.056	1.6	1.1
Glendale WTP Treated	2.4	0.020	0.8	0.9
Anthem WTP Inlet	2.9	0.033	1.1	0.4
Anthem WTP Treated	2.7	0.030	1.1	0.4
Chandler WTP Inlet	3.9	0.054	1.4	1.3
Chandler WTP Treated	2.5	0.025	1.0	1.7

10	
30	
30	
8	
36	

DOC removal (%)

11

23

Taste and Odor

MIB, Geosmin and Cyclocitral are compounds naturally produced by algae in our reservoirs and canals, usually when the water is warmer and algae are growing/decaying more rapidly. They are non toxic, but detectable to consumers of water because of their earthy-musty-moldy odor. The human nose can detect these in drinking water because the compounds are semi-volatile. Since compounds are more volatile from warmer water, these tend to be more noticable in the summer and fall. The human nose can detect roughly 10 ng/L of these compounds. Our team collects samples from the water sources and raw/treated WTP samples. We usually present all the data when concentrations start to exceed 5 ng/L.

- Data for this month on the next pages. MIB and geosmin levels are very low now. As the water warms and sunlight hours increase, MIB levels in the lakes near the surface are beginning to increase.
- We are now sampling a few residences for MIB and Geosmin. In Tempe, on the ASU campus the MIB and geosmin levels are < 2 ng/L. This sampling will be in line with better understanding what customers are really observing.
- Geomsin is BEING PRODUCED in the Consolidated canal towards the lower ends where some agriculture return is present and SRP operates groundwater wells.



Sample Description	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
Union Hills Inlet	<2.0	<2.0	<2.0
Union Hills Treated	<2.0	<2.0	<2.0
Tempe North Inlet	<2.0	<2.0	<2.0
Tempe North Plant Treated	<2.0	<2.0	<2.0
Tempe South WTP	<2.0	<2.0	<2.0
Tempe South Plant Treated	<2.0	2.0	<2.0
Anthem Inlet	<2.0	<2.0	<2.0
Anthem Treated	<2.0	<2.0	<2.0
Chandler Inlet	<2.0	26.8	<2.0
Chandler Treated	<2.0	7.9	<2.0
Greenway WTP Inlet	2.9	14.0	<2.0
Greenway WTP Treated	<2.0	<2.0	<2.0
Glendale WTP Inlet	<2.0	7.6	<2.0
Glendale WTP Treated	<2.0	<2.0	<2.0

Table 2 - Water Treatment Plants – June 3, 2013

	Table 3 -	Canal Sa	mpling – Ju	ne 3. 2013
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System	Sample Description	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
CAP	Waddell Canal	<2.0	<2.0	<2.0
	Union Hills Inlet	<2.0	<2.0	<2.0
	CAP Canal at Cross-connect	<2.0	2.2	<2.0
	Salt River @ Blue Pt Bridge	<2.0	<2.0	<2.0
	Verde River @ Beeline	<2.0	<2.0	<2.0
AZ	AZ Canal above CAP Cross-connect	<2.0	<2.0	<2.0
Canal	AZ Canal below CAP Cross-connect	<2.0	<2.0	<2.0
	AZ Canal at Highway 87	<2.0	<2.0	<2.0
	AZ Canal at Pima Rd.	<2.0	<2.0	<2.0
	AZ Canal at 56th St.	<2.0	<2.0	<2.0
	AZ Canal - Central Avenue	<2.0	<2.0	<2.0
	AZ Canal - Inlet to Glendale WTP	<2.0	7.6	<2.0
	Head of the Consolidated Canal	<2.0	<2.0	<2.0
	Middle of the Consolidated Canal	<2.0	<2.0	<2.0
South	South Canal below CAP Cross-connect	2.2	<2.0	<2.0
Tempe	Head of the Tempe Canal	<2.0	<2.0	<2.0
Canals	Tempe Canal - Inlet to Tempe's South			
	Plant	<2.0	<2.0	<2.0
	Mesa Turnout (May)	<2.0	<2.0	<2.0
	Salt-Gila Pump (May)	<2.0	<2.0	<2.0

Sample Description	Location	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
Lake Pleasant (May)	Eplimnion	<2.0	<2.0	<2.0
Lake Pleasant (May)	Hypolimnion	<2.0	<2.0	<2.0
Verde River @ Beeline		<2.0	<2.0	<2.0
Bartlett Reservoir	Epilimnion	4.6	7.6	<2.0
Bartlett Reservoir	Epi-near dock	4.6	7.7	<2.0
Bartlett Reservoir	Hypolimnion	<2.0	<2.0	<2.0
Salt River @ BluePt Bridge		<2.0	<2.0	<2.0
Saguaro Lake	Epilimnion	4.0	3.4	<2.0
Saguaro Lake	Epi - Duplicate	5.1	3.6	<2.0
Saguaro Lake	Epi-near dock	4.2	3.4	<2.0
Saguaro Lake	Hypolimnion	<2.0	<2.0	<2.0
Lake Havasu		<2.0	2.0	<2.0
Verde River at Tangle Creek				
(May)		<2.0	<2.0	<2.0
Roosevelt at Salt River Inlet				
(April)		<2.0	<2.0	<2.0

Table 4 - Reservoir Samples – June 4, 2013

Pharmaceuticals and Human Tracers

Our team recently performed a round-robin of analytical measurements of Sucralose with 5 labs through the southwestern USA (see May 2013 Newsletter). Sucralose is an artificial sweetener and is being used as a wastewater tracer. The average concentration of sucralose in wastewater effluent was around 50,000 ng/L (50 ug/L), which is far higher than pharmaceuticals. Sucralose is quite persistent in the environment and we recommend it as a tracer. The methods we use now for sucralose are a direct injection into a LC/MS instrument, which reduces the time involved in solid phase extraction sample preparation, but also reduces interferences from other organics in the extracts. This is especially important for sucralose because it can be difficult to ionize. Of course, we practice isotope dilution during these measurements to get good data too. If you are interested in learning more, please let us know. We are measuring Sucralose on our quarterly lake samples. From our last quarterly sampling, here is what we measured:

Site location	Sucralose Concentration	Potential % wastewater at location*
	$(\mu g/L)$	
Lake Pleasant	0.7	1.4%
Wadell Canal	0.9	1.8%
Salt River Below	< 0.5	<1%
Saguaro Lake		
R25	< 0.5	<1%

* Assuming a treated wastewater effluent concentration of 50 µg/L

FLourescence Excitation-Emission Matrices (EEMs)

As a means of characterizing the spectra properties of organic matter in the Salt River Lakes, and hopefully to assess any impacts from forest fire runoffs we have been fingerprinting the organic matter using UV-VIS and fluroescence spectroscopy. All the data here is from may 2013 sampling

This figure shows the UV-VIS absorbance of dissolved organics in the different lakes. Typically we simply select absorbance at 254 nm (i.e., UVA254), and divide it by DOC to get SUVA. Here we show the entire spectra. It shows higher absorbance levels for the upper lakes (Roosevelt) – indicating higher levels of DOC and/or higher levels of more terrestrial DOC. Somewhat surprising, are the lower absorbance data in Apache Lake.



In order for organic molecules to flouresce (emit light) they MUST absorb light, and then emit it at longer (lower energy) wavelengths. In this way we produce excitation-emission matrices. Samples are excited at one wavelength; molecule absorb light and fluoresce (give off) light at longer wavelengths. The location of where molecules flouresce relate to their chemical bonding. Data from the May 2013 quarterly sampling is shown below. What we see in the water sample near the inflow into Roosevelt Lake (Roosevelt 1 location) is more fluorescence at excitation:emission wavelength pairs of 250nm:450nm and 310nm:410nm than other locations. This is typical for more "humic-like" or terrestrial DOC. In comparison, water in the bottom most of the Salt River Resevoirs (Saguaro Lake) gives off less overall fluorescence, and is consistent with a combination of inreservoir DOC "coagulation and sedimentation" as DOC sorbs to metals and particles, and production of algae-derived DOC.

May 2013 Upper Reservoir Quarterly Excitation-Emission Contour Plots (normalized to DOC using same intensity scale)







In comparison to the river samples, below is a sample from a purely bacterial lab culture where all the organics originate from extracellular materials. There is a stronger signal in the EEM at a differently location of the excitation:emission wavelength pair (350:410) compared with that observed in Roosevelt at 250nm:450nm and 310nm:410nm.



Update on In-Situ GAC Regeneration Pilot Plant

(prepared by Kirk Nowack and Operated by Arcadis)

Progress Update: Pilot-scale Study of in Situ Granular Activated Carbon (GAC) Regeneration One of the largest ongoing costs for utilities using granular activated carbon (GAC) to reduce total organic carbon (TOC) levels in their finished water is GAC replacement. When operating in an adsorption mode, GAC gradually loses its capacity for removing TOC and therefore must be replaced at regular intervals to allow for continuing TOC removal. In addition to the high cost of GAC replacement, there is also a significant environmental burden (carbon footprint) associated with the production/reactivation and transport of GAC. Recent research by Dr. Paul Westerhoff and his students at the Arizona State University has shown that it may be possible to restore the TOC removal capacity of spent GAC by means of an in situ regeneration process that could greatly reduce the need for GAC replacement.

The in situ regeneration process developed by Westerhoff et al involves recirculating a solution of hydrogen peroxide and iron nanoparticles (produced onsite using ferric chloride) through the spent GAC. The peroxide and iron nanoparticles react to form hydroxyl radicals, which can oxidize the organic matter found in the GAC pores, thereby converting (mineralizing) it to carbon dioxide and water. Because the iron nanoparticles are small enough to enter the pores within the GAC, the hydroxyl radicals can form in the vicinity (and thereby restore the capacity) of the adsorption sites that are most important for TOC removal. Notably, the iron nanoparticles can be recovered and recycled, and the only byproducts of this process are carbon dioxide, water, and possibly small amounts of natural organic matter that has not been completely oxidized. Importantly, the iron involved in the regeneration process is derived from ferric chloride and would not differ from the small colloids of iron that are formed when ferric chloride is used for coagulation. Westerhoff et al have had some initial success with this technique in bench-scale tests, and a pilot-scale study of this technique is currently being conducted by ARCADIS (in collaboration with Dr. Westerhoff). A main goal of the study is to determine if the in situ regeneration process is viable for restoring the TOC adsorption capacity of filters with a GAC bed depth that is similar to full scale filter adsorbers, and that contain full-sized GAC grains.

The pilot study is taking place at the XX Water Authority (WA) XX Treatment Plant. The XXPlant is equipped with a permanent pilot testing facility that includes four pilot-scale filter columns. At the beginning of the study, 60 inches of fresh 8x30 mesh GAC was installed in each of the filters, without an underlying layer of sand. This mono-media configuration is identical to that of the full-scale filters at the XX Plant. Two of the filters were filled with a commercial wood-based carbon, while the remaining two were filled with a commercial lignite-based carbon (one type in each filter). These carbon types were selected because previous testing had shown that they react with hydrogen peroxide at a slower rate than other commercially-available GACs. At the onset of this work, it was believed that GACs with slower peroxide reaction rates are more likely to be compatible with the in situ regeneration process.

Following GAC installation, the pilot filters were put into service. All four filters were supplied with clarified water from the full-scale clarification system, at the same loading rate as the full-scale filters. The objective during this phase was to operate the filters until the GAC in all four columns was mostly saturated with respect to TOC. While this was underway, XXWA staff members designed and constructed a system for circulating the regeneration solution through the columns. In addition, the project team began preparing and evaluating pilot-scale quantities of the iron nanoparticles necessary for regeneration. In order for the regeneration process to effectively restore adsorption capacity, the nanoparticles must be suitably catalytic, so as to facilitate the production of hydroxyl radicals when exposed to hydrogen peroxide. The catalytic capacity of these initial

batches of nanoparticles was evaluated by combining the nanoparticles with hydrogen peroxide (in the same ratio as required for the regeneration process) in the presence of methylene blue dye. If the nanoparticles are suitably catalytic, the dye is rapidly oxidized and the blue tint disappears. It took repeated attempts at producing nanoparticles and conducting the dye oxidation test before the dye was successfully oxidized. Ultimately it was determined that the most important factor in achieving rapid dye oxidation (i.e., rapid hydroxyl radical production) was to maintain a regeneration solution pH of 2.6-2.8. When the pH was outside this range, dye oxidation (radical production) would not occur at an appreciable rate. Maintaining a relatively stable pH while hydroxyl radical production is underway is challenging, due to the production of hydrogen ions as the peroxide decomposes. During the successful dye oxidation tests, periodic caustic addition was necessary to prevent the pH from falling below 2.6.

In February of 2013, the XX pilot filters were deemed sufficiently saturated to conduct the first round of regenerations. The first attempts were made on one of the columns containing wood-based GAC. It was quickly discovered that pH control would be a challenge. It appeared that the GAC consistently caused the pH to increase (probably due to the uptake of hydrogen ions within the GAC pores), and during these initial attempts the pH was often above 2.8; meaning radical production was likely not occurring. It was also discovered that the hydrogen peroxide was dissipating faster than during the dye oxidation tests (probably due to peroxide decomposition caused by the GAC). It turned out that by replenishing the peroxide at regular intervals – and these intervals were determined by qualitatively assessing the bubbling rate within the column – the pH of the regenerating solution became relatively stable. It was surmised that the more frequent peroxide replenishment led to a higher rate of hydrogen ion production, and this counteracted the pH-increasing effects of the GAC.

Ultimately, three of the pilot filters (one of the wood-based columns, as well as the coconut- and lignite-based columns) underwent one or more regeneration cycles, with each regeneration cycle lasting 30 minutes (this was the timeframe utilized by Dr. Westerhoff in his bench-scale experiments). Interestingly, there was no evidence that the regeneration process recovered TOC adsorption capacity in the filters containing wood-based or lignite-based GAC. Following regeneration, the effluent TOC concentration of these columns was the same as before. However, it was observed that after one 30-minute regeneration cycle, the effluent TOC concentration of the coconut-based filter was reduced from 1.1-1.2 mg/L, to about 0.8 mg/L. A second and third 30-minute regeneration reduced the effluent TOC concentration to 0.6 and 0.5 mg/L, respectively. At present, it is unclear why the regeneration process restored some TOC adsorption capacity in the coconut-based GAC, but not in the wood- or lignite-based GACs. Notably, the wood-based GAC had exhibited the slowest peroxide reaction rate of these three carbon types (as determined in the above-mentioned peroxide reactivity tests).

After the coconut-based filter was put back in service following the third regeneration cycle, the effluent TOC concentration increased from 0.5 mg/L to 1.1-1.2 mg/L (from 25% breakthrough to 70% breakthrough) in about 10 days. When the coconut-based GAC was first installed, it took about 100 days for the effluent TOC concentration to stabilize at 70% breakthrough. Thus, only a small fraction of the virgin adsorption capacity of the GAC was restored during this first round of regenerations. One reason why three 30-minute regeneration cycles did not recover more adsorption capacity is that the rate of hydroxyl radical production simply did not allow for it. It is believed that if the radical production rate is increased, more adsorption recovery could be achieved in the same 90-minute timeframe. Recent experiments have shown that the rate of hydroxyl radical production may be significantly higher when reagent grade ferric chloride is used to generate the nanoparticles, as compared to commercial-grade ferric. In the first round of regenerations, commercial-grade ferric was

utilized. A second round of regenerations that will employ nanoparticles produced from reagent-grade ferric is scheduled for the week of May 13, 2013.

After the May 13, 2013 regeneration, the regeneration went well. We made some interesting observations, and it looks like we achieved better recoveries than last time. Here are some of the highlights...

- ZZ from XXWA suggesting using a confined space gas detector to measure oxygen levels at the top of the columns during regenerations (we thought this might give an indication of the reaction rate). We discovered that upon starting a regeneration, the oxygen level quickly rose beyond the upper limit of the detector (30% by volume). Also, we noticed that a significant amount of CO was being produced, and that CO levels would decline when the bubbling in the column started to wane (i.e., H2O2 levels dropped off). Since CO is a byproduct of (incomplete) organic matter oxidation, we suspected that the CO level was an indicator of the oxidation (regeneration) rate. In the last two regenerations we conducted (on the saturated coconut-based column), we added H2O2 every time the CO level began to decline... this resulted in much more heat production than in previous regenerations. The solution temperature increased from 20 to almost 40 degrees C. Previously, the temperature had risen only a few degrees. Since the oxidation of organic matter is an exothermic process, I think this suggests that we achieved much higher regeneration rates in these last two experiments.

- We reduced the effluent TOC concentration of a saturated coconut-based column from about 1.7 mg/L to well under 1 mg/L (still waiting for the TOC results... I would guess it ended up under 0.5 mg/L) via three 1-hour regenerations, the last two of which involved more frequent H2O2 addition (based on the CO level), as described above.

- We reduced the effluent TOC concentration of a partially saturated coconut-based column from about 0.5 mg/L to under 0.2 mg/L via one 1-hour regeneration.

- Surprisingly, we reduced the effluent TOC concentration of a partially saturated bituminous coal-based column from about 1.1 mg/L to under 0.5 mg/L via one 1-hour regeneration. It would seem that peroxide reactivity is not necessarily an indicator of whether a particular GAC is compatible with in situ regeneration.

- The effluent TOC concentration of a saturated lignite-based column actually increased following one 1-hour regeneration. We should find out this week if the increase is short-lived or sustained.