REGIONAL WATER QUALITY NEWSLETTER

DATE: Report for July 2010 Sampling conducted June 28-29, 2010

A Phoenix, Tempe, Glendale, Peoria, CAP, SRP – ASU Regional Water Quality Partnership

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

DISTRIBUTION: Ronald.Feathers@chandleraz.gov; ACTarvers@FTMCDOWELL.ORG; mary.reker@phoenix.gov; knghiem@csaei.com; Kandis.Knight@asu.edu; gary_moore@tempe.gov; sandra_dewittie@tempe.gov; kspooner@citlink.net; bardizzone@carollo.com; wtrask@mwdh2o.com; jnafsey@mwdh2o.com; JJWilliams@GLENDALEAZ.com; raghunatha.komaragiri@phoenix.gov; mxerxis@scottsdaleaz.gov; mnguyen@ndep.nv.gov; RussellGRhodes@MissouriState.edu; paul.kinshella@phoenix.gov; brian.fayle@phoenix.gov; paul.zelenka@phoenix.gov; patricia.puryear@phoenix.gov; Wontae.Lee@hdrinc.com; Pedram.Shafieian@asu.edu; Daisuke.Minakata@asu.edu; Billt@gilbert.az.us; Braden.Allenby@asu.edu; Rittmann@asu.edu; Jeffrey.Stuck@amwater.com; nina.miller@amwater.com; wayne.janis@asu.edu; jim.holway@asu.edu; gober@asu.edu; rscott@glendaleaz.com; safischer@fs.fed.us; aimee.conroy@phoenix.gov; alan.martindale@cityofmesa.org; allison.shepherd@phoenix.gov; antoniot@ci.gilbert.az.us; arrw716@earthlink.net; awirtz@fs.fed.us; bakerenv@earthlink.net; bardizzone@carollo.com; bhenning@cap-az.com; btalabi@scottsdaleaz.gov; bkmoorhe@srpnet.com; BobCarlson@scwater.com; bonnie.smith@phoenix.gov; Bradley_fuller@tempe.gov; brian.fayle@phoenix.gov; brian.k.watson@phoenix.gov; carl.meyer@phoenix.gov; carlos.padilla@phoenix.gov; cseidel@dswa.net; chennemann@carollo.com; chris.rounseville@phoenix.gov; christenson.kara@epa.gov; cwilson@scottsdaleaz.gov; D'Ann.O'Bannon@phoenix.gov; diwanski@goodyearaz.gov; dempster@asu.edu; dlopez@fs.fed.us; drcrosby@cap-az.com; dwalker@Ag.arizona.edu; dxprigge@srpnet.com; edna.bienz@phoenix.gov; erin.pysell@phoenix.gov; mario_esparza_soto@hotmail.com; francisco.gonzalez@phoenix.gov; frank.blanco@phoenix.gov; giloomis@fs.fed.us; GMaseeh@PIRNIE.COM; Gregg.Elliott@srpnet.com; goelliot@srpnet.com; grant_osburn@tempe.gov; Greg.Ramon@Phoenix.Gov; gtday@amwater.com; GThelin@carollo.com; guy.carpenter@hdrinc.com; hugiang@asu.edu; jdoller@carollo.com; jeffrey.van.hoy@phoenix.gov; jennifer.calles@phoenix.gov; jjwilliams@glendaleaz.com; josh_berdeaux@msn.com; kremmel@ci.glendale.az.us; laxman.devkota@phoenix.gov; lroberts@buckeyeaz.gov; luis.manriquez@phoenix.gov; Marisa.Masles@asu.edu; mark.rove@phoenix.gov; matthew.rexing@cityofmesa.org; maureen.hymel@phoenix.gov; mdehaan@dswa.net; Mdew1@mail.ci.tucson.az.us; mhelton@scottsdaleaz.gov; Michael_Bershad@tempe.gov; Milton.Sommerfeld@asu.edu; MURPHYSP@wattsind.com; nicoleta.buliga@phoenix.gov; ANUNEZ@SCOTTSDALEAZ.GOV; paul.burchfield@phoenix.gov; paulwestcott@appliedbiochemists.com; pdent@cap-az.com; pfenner@fs.fed.us; Randy.Gottler@phoenix.gov; raymond.schultz@phoenix.gov; robert_eck@ci.mesa.az.us; ron.jennings@phoenix.gov; rsgooch@srpnet.com; rscott@glendaleaz.com; rcarpenter@glendaleaz.com; sgrendahl@SCOTTSDALEAZ.GOV; shan.miller@phoenix.gov; sherman_mccutcheon@tempe.gov; SRot@ci.glendale.az.us; srottas@cap-az.com; sacquafredda@dswa.net; steven.schoen@phoenix.gov; susan.potter@phoenix.gov; tara_ford@tempe.gov; terrance.piekarz@phoenix.gov; tgillogly@carollo.com; THockett@GLENDALEAZ.com; thomas.martin@phoenix.gov; thomasdempster@hotmail.com; tjeffer1@ci.tucson.az.us; tkacerek@cap-az.com; tom.doyle@phoenix.gov; Tom_Hartman@tempe.gov; troy.hayes@phoenix.gov; vlee@carollo.com; waerma@bv.com; walid.alsmadi@phoenix.gov; warrens@sgm-inc.com; wes.taylor@phoenix.gov; wtaylor@mwdh2o.com; William.Hughes@cityofmesa.org; swilson@scottsdaleaz.gov; yu.chu.hsu@phoenix.gov; Yongsheng.Chen@asu.edu; keli@asu.edu; jcritt@asu.edu; uiver@glendaleaz.com; Michael.Helton@amwater.com; Keith.Greenberg@amwater.com; harry.brown@AMwater.com; mnguyen@ndep.nv.gov; bzachman@dswa.net; hdurbin@dswa.net;paul.zelenka@phoenix.gov; agrochowski@cap-az.com; bradley_fuller@tempe.gov; JBryck@PIRNIE.COM; Susanne.Neuer@asu.edu; Mohan.Seetharam@asu.edu; Chao-An.Chiu@asu.edu; tammy.perkins@phoenix.gov; ZChowdhury@PIRNIE.COM; Shari.Lange@phoenix.gov; nmegonnell@calgoncarbon-us.com; Cynthia.Bain@peoriaaz.gov; Ryan.Rhoades@CH2M.com; jim.kudlinski@srpnet.com; Gambatese.Jason@epamail.epa.gov; charolotte.jones@phoenix.gov; Graham.Symmonds@gwresources.com; scott.lee@gwresources.com; dswilliams@dswa.net; kowolf@srpnet.com; allison.shepherd@phoenix.gov; grant_osburn@tempe.gov; michael_bershad@tempe.gov; thomas.martin@phoenix.gov; carl.meyer@phoenix.gov; ben.hill@phoenix.gov; Ray.Schultz@phoenix.gov; *mdhubble@srpnet.com;* paul.zelenka@phoenix.gov; tom.doyle@phoenix.gov; bradley_fuller@tempe.gov; RScott@GLENDALEAZ.com; chris.rounseville@phoenix.gov; Norman_Clark@tempe.gov; steve.lutringer@amwater.com; kmckinne@amwater.com; anupa.jain@chandleraz.gov; chris.kincaid@chandleraz.gov; larry.duffy@chandleraz.gov; lori.mccallum@chandleraz.gov; nancy.milan@chandleraz.gov; robert.goff@chandleraz.gov; victoria.sharp@chandleraz.gov; wendy.chambers@chandleraz.gov; wes.cannon@chandleraz.gov; JJWilliams@GLENDALEAZ.com; mgross@carollo.com; JYoung@mail.maricopa.gov; kim.eberenz@gwresources.com; CHe@carollo.com; PChao@carollo.com; Tom.Sands@srpnet.com; jamohler@asu.edu; John.Woolschlager@asu.edu; Craig_Caggiano@tempe.gov; kobrickjd@cdm.com; Calkins.John@azdeq.gov; ekaupanger@mail.maricopa.gov; CMeyer@carollo.com; AnnDenise.Taylor@SRPMIC-nsn.gov; greg.robinson@phoenix.gov; lsjohnso@srpnet.com; ; gnbrusse@srpnet.com; Pierre.Herckes@asu.edu; Rolf.Halden@asu.edu; aramarui@dswa.net; macler.bruce@epa.gov; Amy.Miguel@srpmic-nsn.gov; meyerdw@bv.com; greg.ramon@phoenix.gov; yuchu.hsu@phoenix.gov; rwyatt@glendaleaz.com; pete@kroopnick.com; brooke.mayer@asu.edu; tony.mardam@hdrinc.com; Philip_Brown@Tempe.gov; paul.mally@amwater.com; michael.kennedy@mesaaz.gov; terri.baack@phoenix.gov; landrews@glendaleaz.com; cynthia.seelhammer@phoenix.gov; catherine.webster@phoenix.gov; mshapiro@cap-az.com; jperkins@scottsdaleaz.gov; melinda.jacobson@phoenix.gov; bpaulson@scottsdaleaz.gov; dhenderson@scottsdaleaz.gov; mboettcher@sottsdaleaz.gov; cwhitmer@sottsdaleaz.gov; susan.kinkade@phoenix.gov ; LPassantino@PIRNIE.COM; jshaw@pirnie.com; norman_clark@tempe.gov; kris.erickson@phoenix.gov; Gregory.Dehmlow@peoriaaz.gov; neal.megonnell@jacobi.net; Gregory.Dehmlow@peoriaaz.gov; wof@cox.net; clingerrc@cdm.com; Daniel.Candelaria@CH2M.com; bhg@azdeq.gov; Kim.Caggiano@mesaaz.gov; alan.martindale@mesaaz.gov; matthew.rexing@mesaaz.gov; mary_reker@hotmail.com; michelled@wwengineers.com; Dan.Quintanar@tucsonaz.gov; ALutringer@GLENDALEAZ.com; cbrown@usbr.gov; nicholas.silides@mesaaz.gov; brian.biesemeyer@peoriaaz.gov; Linda.Bezy-Botma@peoriaaz.gov; jamie.ashby@srpnet.com; Raymond.Schultz@peoriaaz.gov; chassert@scottsdaleaz.gov; gcarpenter@carollo.com; CharlotteSmith.us@gmail.com; aghosh@dswa.net; tyler.sawyer@asu.edu; cmitchell@scottsdaleaz.gov; hilary.hartline@phoenix.gov

SUMMARY: EVALUATION AND RECOMMENDATIONS

1. MIB plus geosmin levels above 10 ng/L in finished water lead to noticeable earthy-musty odors by customers. Currently MIB+geosmin levels are below 10 ng/L in the canals, but levels are rapidly increasing in the reservoirs. Saguaro Lake has 15 to 20 ng/L of MIB near the surface, although this is a bottom-release reservoir.
2. Cyclocitral also causes earthy-musty taste and odors and appears to be elevated this year compared with prior years. The highest level is in the lower Arizona Canal at 22 ng/L. Cyclocitral can be removed by activated carbon.
3. Hold the date for our next WORKSHOP for our regional water quality project (September 17, 2010: 830am – 11am) – feel free to suggest topics you want to hear about.
4. What is in our drinking water – specifically how much wastewater from Las Vegas may be in CAP water. The answer is ~1%, which represents a 100:1 dilution factor. This may include trace levels of contaminants of emerging concern (CECs), including pharmaceuticals. Findings from CEC studies of pharmaceutical manufacturers in cities and occurrence studies are summarized in newspaper articles in this newsletter.

Table 1a Summary of WTP Operations February 1, 2010

	Verde WTP	Union Hills	24th Street WTP	N.Tempe J.G. Martinez	Deer Valley	Glendale Cholla WTP [3]	Peoria Greenway WTP	Val Vista	South Tempe
	Verde River	CAP Canal	Arizona Canal					South Canal	
PAC Type and Dose	None	None	Calgon WPH 12 ppm			None	None	Calgon 10 ppm	
Copper Sulfate	1 ppm	0.4 ppm	0.3 ppm active copper (0.5 ppm total)			None	None	0.5 ppm	
PreOxidation	None	None	none			1.5 ppm chlorine	None	no	
Alum Dose Alkalinity pH	42.5 140 7.0	2.5 ppm [1] 123 7.6	60 ppm 130/109 6.6-6.8			34 ppm 150 6.8	25 ppm 130 7.1	35 ppm[1] 144 6.8	
Finished water DOC DOC removal[2]		~4.5%	2.3mg/L 53%	2.9 42%	3.1 mg/L 37%	2.7 mg/L 46%	3.7 mg/L 23%	2.4 mg/L 51%	3.2 mg/L 29%
Average turbidity over last 7 days	3.9 ntu	<1 ntu	8-20 ntu			13 ntu	8 ntu	8.5 ntu	
Notes from operators	On AZ Canal: We still have a large amount of dead algae at the barscreen area, near the canal intake.								

[1] Ferric chloride instead of alum; plus ppm sulfuric acid; [2] Calculated based upon influent and filtered water DOC (note that DOC and not TOC is used in this calculation); [3] Sample from finished water includes a blend of surface and ground water sources sometimes
24th street WTP plans to switch to ferric chloride sometime in the spring of 2011

Table 1 - SRP/CAP OPERATIONS - Values in cfs, for June 28, 2010

System	SRP Diversions	CAP
Arizona Canal	938	0
South Canal	687	0
Pumping	75	0
Total	1700	0

- **SRP is releasing water from both Verde and Salt River Systems**. Salt River release from Saguaro Lake: 928 cfs; Verde River release from Bartlett Lake: 750 cfs.
- **SRP reservoirs are 95% full.**

CAP Operations of Lake Pleasant

Water is being released from Lake Pleasant into the CAP canal and mixing with water being pumped from the Colorado River.

Flow from Colorado River:	1690 cfs (Hassayampa pump station)
Flow from Lake Pleasant into CAP canal:	1670 cfs
Lake Pleasant Capacity	88% full

Taste and Odor Data

MIB plus geosmin levels above 10 ng/L in finished water lead to noticeable earthy-musty odors by customers. Currently MIB+geosmin levels are below 10 ng/L in the canals, but levels are rapidly increasing in the reservoirs.

Table 2 - Water Treatment Plants – June 28, 2010

Sample Description	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
24th Street WTP Inlet	<2.0	4.6	6.3
24th Street WTP Treated	<2.0	<2.0	<2.0
Deer Valley Inlet	<2.0	4.0	22.6
Deer Valley WTP Treated	<2.0	3.6	7.7
Val Vista Inlet	<2.0	<2.0	<2.0
Val Vista WTP Treated –East	<2.0	<2.0	<2.0
Val Vista WTP Treated -West	<2.0	<2.0	<2.0
Union Hills Inlet			
Union Hills Treated			
Tempe North Inlet	<2.0	3.1	5.4
Tempe North Plant Treated	<2.0	2.9	4.3
Tempe South WTP	<2.0	<2.0	8.4
Tempe South Plant Treated	<2.0	<2.0	<2.0
Greenway WTP Inlet	<2.0	<2.0	2.9
Greenway WTP Treated	<2.0	<2.0	2.9
Glendale WTP Inlet	2.0	4.1	21.7
Glendale WTP Treated	<2.0	<2.0	2.2

Table 3 - Canal Sampling – June 28, 2010

System	Sample Description	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
CAP	Waddell Canal	<2.0	<2.0	4.2
	Union Hills Inlet			
	CAP Canal at Cross-connect			
	Salt River @ Blue Pt Bridge	<2.0	3.1	5.4
	Verde River @ Beeline	<2.0	2.6	10.0
AZ	AZ Canal above CAP Cross-connect			
Canal	AZ Canal below CAP Cross-connect	<2.0	2.7	5.7
	AZ Canal at Highway 87	<2.0	3.4	5.0
	AZ Canal at Pima Rd.	<2.0	2.3	7.2
	AZ Canal at 56th St.	<2.0	3.5	5.1
	AZ Canal - Inlet to 24th Street WTP	<2.0	4.6	6.3
	AZ Canal - Central Avenue	<2.0	3.6	4.8
	AZ Canal - Inlet to Deer Valley WTP	3.1	4.0	22.6
	AZ Canal - Inlet to Glendale WTP	2.0	4.1	21.7
South	South Canal below CAP Cross-connect	<2.0	3.0	4.8
and	South Canal at Val Vista WTP	<2.0	<2.0	<2.0
Tempe	Head of the Tempe Canal	<2.0	3.1	3.2
Canals	Tempe Canal - Inlet to Tempe's South Plant	<2.0	<2.0	8.4

Table 4 - Reservoir Samples – June 29, 2010

Sample Description	Location	MIB (ng/L)	Geosmin (ng/L)	Cyclocitral (ng/L)
Lake Pleasant	Eplimnion			
Lake Pleasant	Hypolimnion			
Verde River @ Beeline		<2.0	2.6	10.0
Bartlett Reservoir	Epilimnion	3.0	4.6	2.1
Bartlett Reservoir	Epi-near dock	2.7	4.8	3
Bartlett Reservoir	Hypolimnion	<2.0	<2.0	<2.0
Salt River @ BluePt Bridge		<2.0	3.1	5.4
Saguaro Lake	Epilimnion	18.1	6.4	<2.0
Saguaro Lake	Epi - Duplicate	20.0	5.8	<2.0
Saguaro Lake	Epi-near dock	18.9	5.9	2.3
Saguaro Lake	Hypolimnion	<2.0	3.3	<2.0

Saguaro Lake releases water from deep in the lake (i.e., hypolimnion). Algae that produce T&O tend to live in the sunlight-impacted upper layers (epilimnion).

Organic Matter in Water Treatment Plants

Sample Description	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg-m)	TDN		DOC removal (%)
24th Street WTP Inlet	**4.91**	**0.120**	**2.45**	**0.26**		
24th Street WTP Treated	**2.33**	**0.034**	**1.47**	**0.19**		**53**
Deer Valley Inlet	**4.90**	**0.120**	**2.44**	**0.31**		
Deer Valley WTP Treated	**3.10**	**0.051**	**1.63**	**0.23**		**37**
Val Vista Inlet	**4.84**	**0.119**	**2.45**	**0.25**		
Val Vista WTP Treated –East	**2.44**	**0.035**	**1.42**	**0.24**		**50**
Val Vista WTP Treated -West	**2.31**	**0.035**	**1.51**	**0.20**		**52**
Union Hills Inlet						
Union Hills Treated						
Tempe North Inlet	**4.95**	**0.121**	**2.45**	**0.34**		
Tempe North Plant Treated	**2.89**	**0.047**	**1.62**	**0.55**		**42**
Tempe South WTP	**4.56**	**0.112**	**2.45**	**0.31**		
Tempe South Plant Treated	**3.22**	**0.055**	**1.69**	**0.21**		**29**
Greenway WTP Inlet	**4.81**	**0.118**	**2.44**	**0.33**		
Greenway WTP Treated	**3.69**	**0.035**	**0.96**	**0.29**		**23**
Glendale WTP Inlet	**4.93**	**0.122**	**2.47**	**0.30**		
Glendale WTP Treated	**2.66**	**0.037**	**1.40**	**0.22**		**46**

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)

Union hills WTP was experiencing issues with their presedimentation basins and samples were not collected.

Organics in Canals

Sample Description	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg-m)	TDN
Waddell Canal	**3.50**	**0.068**	**1.93**	**0.71**
Union Hills Inlet				
CAP Canal at Cross-connect				
Salt River @ Blue Pt Bridge	**4.97**	**0.114**	**2.30**	**0.27**
Verde River @ Beeline	**4.44**	**0.134**		**0.33**
AZ Canal above CAP Cross-connect				
AZ Canal below CAP Cross-connect	**4.79**	**0.120**	**2.50**	**0.31**
AZ Canal at Highway 87	**4.86**	**0.122**	**2.50**	**0.29**
AZ Canal at Pima Rd.				
AZ Canal at 56th St.	**4.90**	**0.121**	**2.48**	**0.27**
AZ Canal - Inlet to 24th Street WTP	**4.91**	**0.120**	**2.45**	**0.26**
AZ Canal - Central Avenue	**4.80**	**0.123**	**2.57**	**0.27**
AZ Canal - Inlet to Deer Valley WTP	**4.90**	**0.120**	**2.44**	**0.31**
AZ Canal - Inlet to Glendale WTP	**4.93**	**0.122**	**2.47**	**0.30**
AZ Canal - Inlet to Greenway WTP	**4.81**	**0.118**	**2.44**	**0.33**
South Canal below CAP Cross-connect	**4.87**	**0.120**	**2.47**	**0.33**
South Canal at Val Vista WTP	**4.84**	**0.119**	**2.45**	**0.25**
Head of the Tempe Canal	**4.80**	**0.118**	**2.46**	**0.28**
Tempe Canal - Inlet to Tempe's South Plant	**4.56**	**0.112**	**2.45**	**0.31**
Chandler WTP – Inlet				

Organics in Lakes

Sample Description	Location	DOC (mg/L)	UV254 (1/cm)	SUVA (L/mg-m)	TDN
Lake Pleasant - June 2010	Eplimnion	**3.71**	**0.07**	**1.84**	**0.83**
Lake Pleasant - June 2010	Hypolimnion	**4.29**	**0.07**	**1.65**	**0.29**
Verde River @ Beeline		**4.44**	**0.13**	**3.02**	**0.33**
Bartlett Reservoir	Epilimnion	**5.94**	**0.12**	**2.06**	**0.36**
Bartlett Reservoir	Hypolimnion	**5.49**	**0.14**	**2.59**	**0.44**
Salt River @ BluePt Bridge		**4.97**	**0.11**	**2.30**	**0.27**
Saguaro Lake	Epilimnion	**5.87**	**0.11**	**1.91**	**0.50**
Saguaro Lake	Epi - Duplicate	**5.85**	**0.11**	**1.92**	**0.46**
Saguaro Lake	Hypolimnion	**5.65**	**0.12**	**2.10**	**0.52**
Verde River at Tangle	May-10	**1.41**	**0.03**	**2.47**	**0.28**
Havasu	May-10	**2.78**	**0.04**	**1.36**	**0.59**

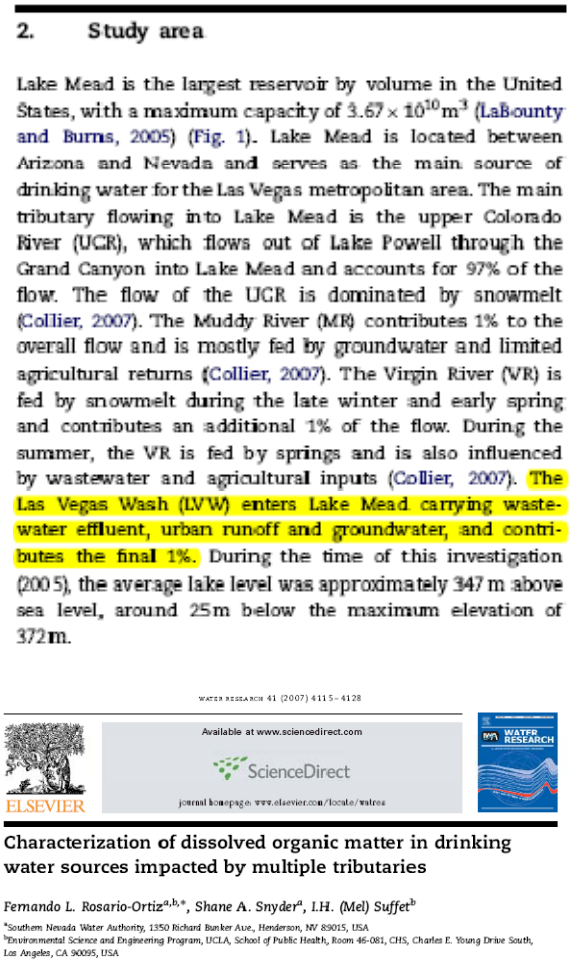
How much wastewater is in our drinking water supplies in Arizona?

CAP water comes from the Colorado River, after being released from Lake Mead. Lake Mead receives water from the following sources:

Up-stream Colorado River	contributes	97% of annual flow in Lake Mead
Muddy River	contributes	1 % of annual flow in Lake Mead
Virgin River	contributes	1 % of annual flow in Lake Mead
Las Vegas Wash	contributes	1 % of annual flow in Lake Mead

Las Vegas Wash is mostly wastewater (includes stormwater when it rains). So the answer for the Colorado River is something greater than 1% (probably less than 3%), because of other upstream sources (e.g., Durango, CO; Farmington, NM) also contribute wastewater into tributaries of the Colorado River (e.g., Animas River, San Juan River). So we can assume roughly a 100 to 1 dilution of treated effluent by natural river flows. Therefore, the level of EDC/PPCPs at most would be 100 times lower than levels observed in most treated wastewater effluents; this assumes no further degradation or sorption (termed natural attenuation). A common wastewater tracer is a pharmaceutical – primidone – that occurs in treated effluents at roughly 100 to 300 ng/L and does not undergo natural attenuation removal. Therefore, concentrations of 1 to 3 ng/L may be present in our drinking water sources. This is below or at the current detection/reporting levels of most analytical methods.

The study referencing the % of wastewater in the Colorado River was focused on evaluating different approaches to characterize Organic Carbon in the Lake Mead watershed: "*This type of analysis would be beneficial to utilities who want to better understand and manage their source waters, especially in the evaluation of temporal variation within a watershed.*"



2. Study area

Lake Mead is the largest reservoir by volume in the United States, with a maximum capacity of $3.67 \times 10^{10} m^3$ (LaBounty and Burns, 2005) (Fig. 1). Lake Mead is located between Arizona and Nevada and serves as the main source of drinking water for the Las Vegas metropolitan area. The main tributary flowing into Lake Mead is the upper Colorado River (UCR), which flows out of Lake Powell through the Grand Canyon into Lake Mead and accounts for 97% of the flow. The flow of the UCR is dominated by snowmelt (Collier, 2007). The Muddy River (MR) contributes 1% to the overall flow and is mostly fed by groundwater and limited agricultural returns (Collier, 2007). The Virgin River (VR) is fed by snowmelt during the late winter and early spring and contributes an additional 1% of the flow. During the summer, the VR is fed by springs and is also influenced by wastewater and agricultural inputs (Collier, 2007). The Las Vegas Wash (LVW) enters Lake Mead carrying wastewater effluent, urban runoff and groundwater, and contributes the final 1%. During the time of this investigation (2005), the average lake level was approximately 347 m above sea level, around 25 m below the maximum elevation of 372 m.

WATER RESEARCH 41 (2007) 4115 – 4128

Available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/watres

ELSEVIER

WATER RESEARCH

Characterization of dissolved organic matter in drinking water sources impacted by multiple tributaries

Fernando L. Rosario-Ortiz[a,b,*], Shane A. Snyder[a], I.H. (Mel) Suffet[b]

[a]Southern Nevada Water Authority, 1350 Richard Bunker Ave., Henderson, NV 89015, USA
[b]Environmental Science and Engineering Program, UCLA, School of Public Health, Room 46-081, CHS, Charles E. Young Drive South, Los Angeles, CA 90095, USA

Other sources of EDC/PPCPs may also exist. Below is a story on their release from manufacturing facilities.

Should we be concerned about EDC/PPCPs in drinking water? A study from New York city says NO. (see news item below).

http://www.usgs.gov/newsroom/article.asp?ID=2477

Manufacturing Facilities Release Pharmaceuticals to the Environment

Released: 6/4/2010 9:00:00 AM

Contact Information:
U.S. Department of the Interior, U.S. Geological Survey
Office of Communication
119 National Center
Reston, VA 20192

Patrick Phillips
Phone: 518-285-5667

Herb Buxton
Phone: 609-771-3944

Diane Noserale
Phone: 703-648-4333

Editors: This scientific paper is published in *Environmental Science and Technology*. The paper, an accompanying USGS data report, and related information are available online.

Pharmaceutical manufacturing facilities can be a significant source of pharmaceuticals to surface waters, according to a new study by the U.S. Geological Survey (USGS) conducted in cooperation with the State of New York.

Outflow from two wastewater treatment plants in New York that receive more than 20 percent of their wastewater from pharmaceutical facilities had concentrations of pharmaceuticals that were 10 to 1000 times higher than outflows from 24 plants nationwide that do not receive wastewater from pharmaceutical manufacturers.

"This is the first study in the U.S. to identify pharmaceutical manufacturing facilities as a significant source of pharmaceuticals to the environment," said Matthew C. Larsen, USGS Associate Director for Water. "The USGS is working with water utilities to evaluate alternative water treatment technologies with the goal of reducing the release of pharmaceuticals and other emerging contaminants to the environment."

Maximum concentrations in outflows from the two wastewater treatment plants in New York were:

- 3,800 parts per billion (ppb) of metaxalone (a muscle relaxant)
- 1,700 ppb of oxycodone (an opioid prescribed for pain relief)
- Greater than 400 ppb of methadone (an opioid prescribed for pain relief and drug withdrawal)
- 160 ppb of butalbital (a barbiturate)
- Greater than 40 ppb of phendimetrazine (a stimulant prescribed for obesity) and carisoprodol (a muscle relaxant)
- 3.9 ppb diazepam (an anti-anxiety medication)

While pharmaceutical concentrations were significantly lower in receiving streams, measurable concentrations were detected as far as 20 miles downstream.

By contrast, outflow from the wastewater treatment plants that do not receive wastewater from pharmaceutical manufacturing facilities had concentrations that rarely exceeded one ppb.

"This study would not have been possible without the cooperation and support of the New York Department of Environmental Conservation and wastewater treatment plants in New York and nationwide," said USGS scientist Patrick Phillips, who led the study. "We continue to work with the NYS DEC to monitor the quality of the outflows and receiving streams."

For this study, USGS scientists collected outflow samples periodically from 2004 to 2009 from three New York wastewater treatment plants, two of which receive more than 20 percent of their wastewater from pharmaceutical manufacturing facilities. USGS also collected samples from 2006-2009 from 23 selected wastewater treatment plants across the nation that do not receive wastewater from pharmaceutical manufacturing facilities.

All of the samples were analyzed for seven pharmaceuticals, including opioids and muscle relaxants, representing some of the most frequently prescribed medications in the U.S. Some pharmaceuticals studied have not previously been included in environmental studies.

The pharmaceuticals investigated in this study were identified using a forensic approach that identified initially unknown chemicals present in the wastewater treatment plant outflows at elevated levels. Although public records were not available for all pharmaceuticals formulated at these sites, available data indicate that these seven pharmaceuticals are manufactured at one or both of the New York facilities involved in the study. Additional pharmaceuticals were identified in the outflow of these two wastewater treatment plants, and ongoing studies are documenting the levels at which they occur in the environment.

This study is part of a long-term effort to determine the fate and effects of chemicals of emerging environmental concern and to provide water-resource managers with objective information that assists in the development of effective water management practices. More information can be found online.

http://www.nyc.gov/html/dep/html/press_releases/10-55pr.shtml

DEP Study Shows No Risk from Pharmaceuticals and Personal Care Products in NYC Drinking Water
Findings Confirm NYC Water is Safe and Healthy to Drink

Environmental Protection Commissioner Cas Holloway today announced that DEP has concluded a study that indicates that the presence of pharmaceuticals and personal care products in New York City's source waters pose no public health risks. The one-year pilot program tested for the presence of pharmaceuticals and personal care products in New York City's three upstate watersheds, finding only extremely minute quantities of these compounds. The findings confirm that NYC Water remains safe and healthy for the 9 million New Yorkers who rely on it each day.

"The findings of this study confirm that pharmaceuticals and personal care products do not pose a health risk in New York City's drinking water," said Commissioner Holloway. "Our top priority is to ensure the quality of the drinking water that nine million New Yorkers need every day, and we perform more than 500,000 tests each year to monitor

water quality. Though there was never any indication that pharmaceuticals and personal care products presented a health or quality risk to our water supply, we undertook this study as part of our ongoing efforts to rigorously analyze all aspects of water quality. Pharmaceuticals and personal care products are part of our daily lives, and the fact is traces of these products are present in the environment. We want to be sure that the presence of these products in our water supply did not rise to a level that impacts the quality of drinking water, and that is what this study shows. DEP will continue our rigorous and comprehensive monitoring every day, to ensure that we continue to deliver the healthy, great tasting water that New Yorkers expect."

"Our drinking water continues to be the cleanest, healthiest option for quenching New York City's thirst," said Dr. Thomas Farley, NYC Health Commissioner. "DEP's study should reassure anyone concerned about the presence of pharmaceutical or personal-care products in the water supply. The trace amounts documented in this study are far too small to affect people's health. The Health Department and the DEP will continue to work together to periodically monitor concentrations to ensure NYC tap water remains safe."

"When I first held a hearing on pharmaceuticals in drinking water in April of 2008, I was impressed at DEP's testimony which outlined the impressive and comprehensive testing program that it was formulating. Now that DEP has tested for various compounds down to the parts-per-trillion level and found nothing remarkable, water consumers can rest assured that the New York City water supply is of the highest quality," said Councilman James F. Gennaro, Chairman of the NYC Council's Committee on Environmental Protection.

Throughout 2009, DEP conducted quarterly tests at three source water locations in the Croton, Delaware, and Catskill watersheds to determine whether a target group of pharmaceutical and personal care products could be detected at any level in New York City's water supply. After collection, the samples were tested at two different laboratories in each of the four rounds of sampling during the year. The samples were tested for the presence of 78 compounds — including antibiotics, hormones, prescription medications and endocrine disrupting compounds. Of the 78 compounds tested, 16 pharmaceuticals and personal care products (PPCPs) were detected at least once, and eight compounds were detected in three or more quarters of sampling. None of the 16 detected PPCP compounds were found at a concentration that would present a potential public health concern. In fact, all of the sixteen compounds identified were found in concentrations in the low parts-per-trillion—1,000 times lower than the minimum threshold for any of the target compounds that are regulated by the state or federal government. The fact that a substance is detectable does not mean it is harmful. For example, a person would have to drink 846,000 glasses of water in a single day, approximately 90 years worth of drinking water, to get the dose contained in a single over-the-counter tablet of ibuprofen.

Pharmaceuticals have probably been present in water and the environment for as long as humans have been using them. Drugs that are consumed are not entirely absorbed and are excreted and passed into wastewater and surface water. Some pharmaceuticals are easily broken down and processed by the human body or degrade quickly in the environment, but others are not easily broken down and processed, so they enter sewers or septic systems. Externally applied medications and cosmetics can end up in the sewer as well, via showers and baths. Up until recently hospitals and other health care facilities have often flushed out-of-date or excess drugs down toilets. DEP is currently working with the state and our watershed partners to develop alternatives to disposing of unneeded medications that do not pose a threat to the water supply. Wastewater treatment plants are designed to remove solids, chemicals and microorganisms but not at miniscule concentrations.

In recent years, the issue of pharmaceuticals and personal care products as drinking water pollutants has received increasing attention. The pharmaceutical drugs of interest comprise a large range of emerging drinking water contaminants including prescription and over-the-counter drugs, antibiotics, tranquilizers, antidepressants, and other organic chemicals which are not completely treated by wastewater treatment plants.

The one-year pilot testing program, initiated in January 2009, focused on pharmaceuticals that have been detected in surface waters, groundwater and treated water discharged from wastewater treatment plants in national and regional studies conducted by the United States Geographical Survey and New York State Department of Health. The cost of the testing was $81,000. The testing was developed as a pilot because DEP needed to test new advanced and highly sensitive analytical methods to determine whether it could reliably detect pharmaceutical and personal care product compounds at very low levels of detection, as well as the need to use new sampling methods to prevent cross-contamination of samples. The results of this pilot study will be used to help assess the need for a continued program on emerging contaminants and to develop a more targeted program for subsequent years, if necessary. A summary of DEP's study can be found at 2009 Pharmaceutical and Personal Care Products (PPCP) Report (PDF). Though the testing showed no evidence of risk, DEP will continue to monitor pharmaceutical and personal care products throughout this year, and as necessary beyond that.

The following 16 pharmaceuticals and personal care products were found in source waters at least once: Acetaminophen, Butalbital, Caffeine, Carbamazepine, cis-Testosterone, Cotinine, DEET, Diazepam, Estrone, Gemfibrozil, Ibuprofen, Lasalocid, Nicotine, Paraxanthine, Progesterone, and Sulfamethoxazole. The amount detected in each, measured in parts per trillion, was significantly lower than what is deemed to be safe by derived drinking water guidelines, a compilation of studies and reports that detail, in general, the maximum amount of a particular substance an individual can be exposed to on a daily basis without causing harmful effects. One part per trillion is equal to one drop of water in 26 Olympic-size swimming pools. The chart below

indicates the number of eight-ounce glasses of water per day it takes to reach an acceptable daily intake or get an effect from one of these compounds.

Detected Compound	Max Conc (ng/L or parts per trillion)	Drinking Water Guidelines (ng/L)	# of 8 oz glasses of water/day to exceed DWG
Acetaminophen*	5	175,000	296,100
Butalbital	24	175,000,000	61,687,500
Caffeine	15	423,000,000	238,572,000
Carbamazepine	5	100,000	169,200
Cotinine	6	10,000	14,100
DEET*	11	3,500,000	2,691,818
Diazepam	2.1	2,500	10,071
Estrone*	2.1	460	1,853
Gemfibrozil	1.9	600,000	2,671,579
Ibuprofen	4	400,000	846,000
Lasalocid*	3	NIA	-
Nicotine	11	NIA	-
Paraxanthine	6	NIA	-
Progesterone*	0.1	105,000	8,883,000
Sulfamethoxazole	4.8	10,000	17,625
cis-Testosterone	0.1	7,000	592,200

*detected sporadically in less than 50% of samples
NIA = No information available

Among the compounds that were tested for but not found were the following: Bacitracin, Ciprofloxacin, Naproxen, Penicillin G, Penicillin V, Phenylphenol, Testosterone, Triclosan, and Tylosin.

For most of these detected compounds, a person would have to drink thousands of glasses of water a day to get one effective dose of the substance or to meet a toxicity threshold. To get one dose of caffeine, or the amount contained in an 8-ounce cup of coffee, a person would have to drink 238,572,000 glasses of water. The Institute of Medicine advises that men consume roughly about 13 cups of total beverages a day and women consume about 9 cups of total beverages a day.

There are no state or federal mandatory testing or reporting requirements for pharmaceutical and personal care product compounds. New York State has generic standards for principal organic contaminants and for any single unspecified organic contaminant. The levels of PPCPs found in the New York City water supply were generally 500-10,000 fold less than these standards respectively. DEP monitors its drinking water for approximately 250 contaminants, approximately 100 of which are not currently required by regulators. DEP performs more than 900 tests daily, 27,000 monthly, and 330,000 on an annual basis from up to 1,000 sampling locations throughout New York City. This work is in addition to 230,000 tests performed in the watershed. There are no established methodologies for routine testing for or removing pharmaceuticals. Only very recently have advances in testing methods allowed researchers to even detect these substances at such minute levels. Pharmaceuticals are not regulated as a class of contaminants under the Safe Drinking Water Act, the authorizing legislation for Federal drinking water standards.

To prevent pharmaceuticals and personal care products from entering water systems, unused, unneeded, or expired prescription drugs and other medications should be brought to a local pharmaceutical collection event for proper disposal or thrown in the trash by following the instructions and additional information found at www.dontflushyourdrugs.net.

DEP manages the City's water supply, providing more than 1 billion gallons of water each day to more than 9 million residents, including 8 million in New York City, and residents of Ulster, Orange, Putnam and Westchester counties. New York City's water is delivered from a watershed that extends more than 125 miles from the City, and comprises 19 reservoirs, and three controlled lakes. Approximately 7,000 miles of water mains, tunnels and aqueducts bring water to homes and businesses throughout the five boroughs, and 7,400 miles of sewer lines take wastewater to 14 in-City treatment plants.

Related Links

- Monitoring for Pharmaceutical and Personal Care Products (PPCPs)
- 2009 Pharmaceutical and Personal Care Products (PPCP) Report (PDF)
- 2009 Drinking Water Supply and Quality Report (PDF)

New NWRI Study Finds Low Levels of Pharmaceuticals and Other Unregulated Chemical Compounds in Water Supplies

NWRI released a final project report today that evaluated the presence and fate of constituents of emerging concern (CECs), such as pesticides, pharmaceuticals, and components of personal care products, in three major drinking water sources for over 25-million people in Southern California. The three water sources include the State Water Project, Colorado River, and Santa Ana River.

The NWRI report, entitled "Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California," can be downloaded at www.nwri-usa.org/CECs.htm. It was prepared by researchers at the Metropolitan Water District of Southern California (MWD) and Orange County Water District (OCWD) who conducted a 2-year, $300,000 study with the objective of better understanding the presence and impact of CECs in our water supplies at extremely low levels.

"The detection of CECs at very low levels in our water supplies is an emerging issue," said Jeff Mosher, NWRI Executive Director. "This study provides us with a better understanding of the frequency and levels of occurrence of CECs in three major water supplies serving Southern California. With this information, we can better assess any possible impacts from the presence of CECs in our water supplies."

"CECs" is a term used to include a broad range of unregulated chemical components found at trace levels in many of our waters, including surface water, drinking water, wastewater, and recycled water. They include the pharmaceuticals that people use to treat illnesses and components of personal and household products, like shampoos, detergents, and pesticides. CECs enter our water sources by flushing unused medications, using personal and household products, excreting unabsorbed medications into the wastewater collection systems, and spills into water or wastewater collection systems.

The research team took water samples from the three water sources at 32 locations, ranging from upstream of the City of Sacramento to down south in Orange County, California, as well as from locations along the Colorado River in Arizona and Nevada. Sampling took place between April 2008 and April 2009.

Altogether, out of the 49 CECs that were evaluated in this study, the research team detected 27 CECs in water samples from the three water sources, while 22 were not detected in any of the sources.

The detected CECs were found at very low levels – levels that are millions of times smaller than a pharmaceutical dose. CEC detections are reported in "nanograms per liter" (ng/L). A nanogram is one one-billionth of a gram, and nanograms per liter are equal to "parts per trillion" (ppt). For example, one ppt equates to one drop of water in 20 Olympic-sized swimming pools, or about one second in 32,000 years.

The ability to detect CECs at very low levels in water is a relatively new breakthrough in science. It is so new, in fact, that the analytical methods developed to detect CECs are not standard methods (that is, methods approved for regulatory purposes), which means that the methods may vary from laboratory to laboratory. All three laboratories that participated in the study used analytical methods that were either previously published or slightly modified versions, and incorporated inter-laboratory comparisons and extensive quality assurance/quality control protocols to ensure high-quality data.

The study narrowed its focus to analyzing for the presence of 49 CECs, which were selected based on common occurrence, the ability to either be reduced or to remain stable in the natural environment, and other criteria. An example of CECs that were selected to be analyzed include flame retardants such as TCEP, detergent metabolites such as 4-n-Nonylphenol, antibiotics such as ciprofloxacin, anti-convulsants such as carbamazepine, hormones such as testosterone, and herbicides such as atrazine.

The sampling and analysis results included:

State Water Project - An engineered water storage and delivery system of reservoirs, aqueducts, and pumping plants that delivers water throughout California, including Southern California.

Twenty-one CECs were detected in State Water Project samples, typically at levels below 50 ng/L.
The most frequently detected CECs were carbamazepine, diuron, and sulfamethoxazole (at 99-percent detection frequencies), followed by primidone and TCEP (70 percent).

Colorado River - This river flows from Colorado through Utah, Nevada, and Arizona; water is imported to Southern California via the Colorado River Aqueduct.

Twelve CECs were detected in Colorado River surface water samples, typically at levels below 20 ng/L.
The most frequently detected CECs in the surface water samples were carbamazepine (99-percent detection frequency) and sulfamethoxazole (94 percent).
Sixteen CECs were detected in the wastewater treatment plant effluent samples from the Colorado River watershed, with average levels on the order of a hundred to several hundred nanograms per liter.
The most frequently detected CECs in the wastewater effluent samples were azithromycin, caffeine, carbamazepine, ciprofloxacin, DEET, diclofenac, dilantin, diuron, gemfibrozil, primidone, sulfamethoxazole, and TCEP (at 100-percent detection frequencies).

Santa Ana River - This river flows from the San Bernardino Mountains to the Pacific Ocean through three counties in Southern California. Flow from the SAR is diverted and used for groundwater recharge in Orange County, California.

Twenty-two CECs were detected in river and tributary samples from the Santa Ana River. Typical concentrations varied from 2 to 2100 ng/L.
The most frequently detected CECs in the river and tributary samples were caffeine and TCEP (at 100-percent detection frequencies), followed by DEET and diuron (99 percent).
Twenty CECs were detected in the wastewater treatment plant effluent samples from the Santa Ana River watershed, with average levels on the order of a hundred to several hundred nanograms per liter.
The most frequently detected CECs in the wastewater effluent samples were carbamazepine, dilantin, diuron, primidone, and sulfamethoxazole (at 100-percent detection frequencies).

It should be noted that each of these water sources is impacted in varying degrees by treated wastewater discharges, agricultural runoff, recreation, and other activities that may account for the presence of CECs.

The ability to detect a compound does not necessarily translate to human health concerns. To date, no adverse health impacts have been documented from exposure to the extremely low concentrations of CECs found in water supplies. In fact, current research indicates that individuals could consume 50,000 eight-ounce glasses of water per day without any experiencing any health effects due to trace levels of CECs.

Also included in this study was an evaluation of the fate and transport of CECs. The term "fate and transport" refers to what happens to a CEC as a result of its potential to be transported, transformed, or destroyed in a watershed. The research team found that CECs were attenuated (or reduced) in the natural environment. A possible cause for the attenuation of some CECs (such as the anti-convulsants carbamazepine and primidone) was dilution with other source waters, whereas for other CECs (such as gemfibrozil and sulfamethoxazole), the cause was natural degradation processes, such as biodegradation, photolysis, and sorption.

In addition, the research team concluded that the use of wetlands to remove nitrate from the water also appears to be an effective means to remove some CECs to varying extents. For example, the antibiotic azithromycin was completely attenuated from water sampled at the Prado Wetlands (part of the Santa Ana River watershed), while caffeine, gemfibrozil, ibuprofen, sulfamethoxazole, and acetaminophen were often highly attenuated (42 to 100 percent).

Significant information was obtained from this study on the occurrence, fate, and transport of CECs in three water sources in California. However, this study is among the first of such efforts currently being undertaken by the water and wastewater community to better understand the presence of CECs in our water sources.

To move forward on developing a better understanding of CECs, the study provided recommendations that future research, such as developing standardized analytical methods to better evaluate water quality data on CECs and to include monitoring wells in future sampling efforts to understand the occurrence of CECs in groundwater.

More information about the study's findings, including analytical methods used and detailed sampling results from each of the sampling locations of the three water sources, can be found in the NWRI project report, which is available for download at www.nwri-usa.org/CECs.htm.

Topics: Pollution