City of Flagstaff
Compounds of Emerging Concern
A Case Study

by
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Utilities Director

2015 WateReuse Arizona Symposium
Flagstaff, Arizona
July 27-28, 2015
Objective

History of Flagstaff’s use of reclaimed water
(e.g., irrigation, snowmaking)

Compounds of Emerging Concerns
Testing for Pharmaceuticals, Endocrine Disruptors, Antibiotic Resistance Genes/Bacteria

Creative Political & Technical solution
City Manager’s Advisory Panel
City being proactive

University Research Activities
City participation & sampling
HISTORY

1973  City started directly delivering reclaimed water to Continental Country Club Golf Course

1993  City expanded its direct delivery of reclaimed water with the construction of its 2nd wastewater treatment plant

2002  City signed an Agreement with the Arizona Snowbowl to directly deliver 552 AF/year of reclaimed water for snowmaking

Francis Short Pond reclaimed water
HISTORY

2002/2006 City contracted with USGS & Northern Az University Sampling groundwater & reclaimed water for Compounds of Emerging Concern (CECs) and early studies on endocrine disruption on local Mosquitofish & frogs

2009 City and Az Game & Fish sign Agreement for minimum deliveries for sustaining riparian habitat

Today reclaimed water 20% of all water delivered within Flagstaff
2010 Water Commission & City Council Meetings

Staff introduced “Recovered Reclaimed” to Council as a possible solution to Hopi / Navajo objection to snowmaking

~700 people attend each meeting

Good & Bad: drew attention to what City has been doing for 22+ years

water management v. water quality
HISTORY

2011  Hopi Tribe files Notice of Claim against City for the sale of reclaimed water to Snowbowl for snowmaking

2010/2011  City sampled drinking water distribution & reclaimed water system for CECs

2011  City hosted Reclaimed Water Forum (~400 attendance)

Present national & international issues; research findings; regulatory framework and Utilities industry best practices

Shane Synder, Ph.D. University of Arizona
Mike Fulton,  ADEQ
Chuck Graf, R.G., ADEQ
Guy Carpenter, P.E., Carollo Engineers
Brad Hill, R.G., City of Flagstaff
In August a report was released by Virginia Tech University found Antibiotic Resistance Genes in the City’s reclaimed system.
HISTORY

2012 In December the Arizona Snowbowl started making snow
City Needed Expert Advice

The topic of reclaimed water use continued to be amplified in the community

*City Council became bombarded with citizens questions regarding the safety of using reclaimed water for irrigation, recharge or snowmaking*

September 2012, *City Manager requested staff to develop a panel of experts - evaluation of the human health impacts from the local use of reclaimed water*

January 2013 *Same time ADEQ was creating their Panel of Emerging Contaminants*
Community Advocacy Groups

Approached City to consider pilot testing a variety of new technologies, questioned why not use Advanced Treatment now?

Hosted 4 public forums with local experts on Water; USGS, City Manager, Utilities Director, Water Resources Manager, Northern Arizona University professors, Advanced Analytical

Created a Video “Beyond Reclaimed”
Flagstaff City Manager’s Advisory Panel
What does the detection of Compounds of Emerging Concern (CECs) in some parts of the City of Flagstaff’s Drinking and Reclaimed Water Distribution Systems mean for possible human health effects beyond what already exists?
PURPOSE & OBJECTIVES

Identify what steps are necessary for understanding the human health effects of CECs in raw, drinking and reclaimed water.

Panel met 3 times 2013-2014

Political Dialogue

Detection → ??? → Human Health Impact

Determine what specifically to study?

*Panel met 3 times 2013-2014*
Framework: CECs into 3 categories:
1. Pharmaceuticals,
2. Endocrine Disrupters
3. Antibiotic Resistance Genes/Bacteria

Prioritize most critical issues addressing the concerns raised by the use of reclaimed water by the City:

*human health impacts as opposed to animal, aquatic or environmental impacts*

“we had to start somewhere”
Findings/Advice – Drinking water:

- USEPA on advice from various national scientific panels and analytical studies of currently unregulated CECs may warrant further consideration for regulation. Advisory panel recommended evaluating which contaminants on the list are being utilized or prescribed within Flagstaff as background information.

- Antibiotic Resistance Genes are not on the USEPA’s unregulated list (Contaminant Candidate List #3) but 9 hormones & 1 antibiotic are on the list.

- No documented study exists from around the world on human health impacts of the 10 CECs on list.
Findings/Advice – Reclaimed water:

No data at the present time to suggest that continued use of reclaimed water provides undue risk to human health

Advisory Panel recommended monitor four (4) chemicals on the CCL3 drinking water list in reclaimed water

Advisory Panel suggested parallel study to compare effects of various treatment technologies on removal of CECs including antibiotic resistance
Findings/Advice – Overall:

Pharmaceuticals & Endocrine Disruptors being studied significantly

While documented environmental impacts of CECs – none to human health

Little to no data exists on Antibiotic Resistant Genes/Bacteria on public health in reclaimed water

Opportunity for research collaboration
Research Subgroup of Advisory Panel

tasked with outlining a cutting edge epidemiological and microbial study focusing on antibiotic resistance

Identify what, if any Antibiotic Resistance Bacteria (ARBs) are found leaving the treatment plants

Identify what, if any ARBs are found at various end points in Flagstaff’s distribution system

Identify if any ARBs can be found in raw and potable City water

Identify where any of the ARBs are most prevalent (soil, raw meat, Flagstaff Medical Center, etc)

Identify what treatments kill or remove ARBs in water
City of Flagstaff –
CEC Advisory Panel Update

Overview of the City Manager’s CEC Advisory Panel
The City of Flagstaff recycles over 700 million gallons of water each year for conservation purposes. By recycling we mean wastewater that is sent from our homes or businesses to a treatment plant where it is highly treated to meet state and federal reclaimed water quality standards. Once treated, the water is termed “reclaimed water, recycled water or effluent” and enters a separate distribution system after being chlorinated. Reclaimed water is used not only in Flagstaff but by communities around the world in lieu of drinking water for irrigation purposes. The City has undertaken this proactive water conservation strategy for the past 20 years in our community. Recently, there have been numerous studies both locally and nationally regarding trace (or extremely low concentrations) of certain chemicals found in water around the United States that are not regulated by the U.S. EPA. These are collectively known as Compounds of Emerging Concern (CECs) and include pharmaceuticals, personal care products, endocrine disrupters and antibiotic resistance genes. In Flagstaff, CECs can enter the wastewater system at our homes, businesses and medical care facilities and raw water.

The City Manager, Kevin Burke recognizing the importance of water to the future of our community, organized an Advisory Panel of 12 local, state and nationally recognized researchers, scientists and industry professionals to help understand what CECs mean locally. Flagstaff has been known around the State as a leader in its willingness to tackle tough issues related to water head-on and the creation of this Advisory Panel is just one more example. The Advisory Panel first met in January 2013 and was asked to help the City determine what to study and identify steps that are necessary to better understand the effects, if any, CECs have in our raw water, drinking water and reclaimed water. The focus of discussions has initially been around the “human health impacts” as opposed to animal, aquatic or environmental impacts. The City recognizes that all of these are important to our community; however, the first priority is human health.

Review of Findings of Interim Report
The Advisory Panel issued an Interim Report in July 2013 which contained numerous findings, advice, recommendations and priorities to the City on CECs in drinking water and reclaimed water. A few of the findings and recommendations from the City Manager’s CEC Advisory Panel Interim Report are paraphrased below:

Drinking Water
1. The U.S. EPA from the advice of various national scientific panels and analytical studies has developed a list of currently unregulated CECs that may warrant further consideration for
## CEC Panel Recommendations

### Reclaimed Water

<table>
<thead>
<tr>
<th>Sampling Strategy</th>
<th>Significance of Sample Location</th>
<th>Panel Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RECLAIMED WATER</strong></td>
<td></td>
<td>NDMA</td>
</tr>
<tr>
<td>Reclaimed Water Influent at Both Treatment Plants</td>
<td>ARBs &amp; ARGs in untreated sewage</td>
<td></td>
</tr>
<tr>
<td>Reclaimed Water Leaving Both Treatment Plants Using Different Disinfection Techniques</td>
<td>CECs, ARBs &amp; ARGs in reclaimed water at the treatment plant with UV and chlorine disinfection</td>
<td>x¹</td>
</tr>
<tr>
<td>Class A+ Reclaimed Water System Storage Tank</td>
<td>CECs, ARBs &amp; ARGs in reclaimed water from both treatment plants stored in a tank</td>
<td>x</td>
</tr>
<tr>
<td>Class A+ Reclaimed Water at Irrigation Sites</td>
<td>CECs, ARBs &amp; ARGs in reclaimed water from both treatment plants at the sprinkler heads</td>
<td>x</td>
</tr>
</tbody>
</table>

¹ - only sampled for at Wildcat Hill WRF
Reclaimed System Sampling 2014-2015

1 – Rio Wastewater Reclamation Plant
2 – Wildcat Hill Wastewater Reclamation Plant
3 – Buffalo Park Storage Tank
4 – Christensen Elementary School
5 – Joel Montalvo Park
6 – Foxglen Park
7 – Thorpe Park
# CEC Panel Recommendations

## Water

<table>
<thead>
<tr>
<th>Sampling Strategy</th>
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<tr>
<td><strong>POTABLE WATER</strong></td>
<td></td>
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</tr>
<tr>
<td>Raw Surface Water</td>
<td>CECs, ARBs &amp; ARGs in untreated surface water</td>
<td>x  x</td>
</tr>
<tr>
<td>Treated Surface Water</td>
<td>ARBs &amp; ARGs in treated surface water</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>CECs, UCMRs, ARBs &amp; ARGs in treated surface water &amp; groundwater prior to chlorination</td>
<td>x  x  x</td>
</tr>
<tr>
<td>EPDS Surface &amp; Groundwater</td>
<td>CECs in untreated groundwater upgradient of City in C aquifer</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>CECs and UCMR3 in chlorinated groundwater downgradient of City Wastewater WRFs in C aquifer</td>
<td>x  x</td>
</tr>
<tr>
<td>Raw Groundwater</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>EPDS Groundwater</td>
<td>CECs in the potable water distribution system</td>
<td>x³</td>
</tr>
<tr>
<td>Distribution System (4 sites)</td>
<td>ARBs &amp; ARGs in the potable water distribution system</td>
<td>x⁴</td>
</tr>
<tr>
<td>Distribution System (5 sites)</td>
<td></td>
<td></td>
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</tbody>
</table>
Water System Sampling 2014-2015

1. Raw Surface Water
2. Treated Surface Water
3. EPDS Surface & Groundwater
4. Raw Groundwater
5. EPDS Groundwater
6. Distribution System

6 – Fire Station #6
7 – Montoya Community Center
8 – NPS Office
9 – Fort Tuthill Luke AFB
10 – Little America
11 – Aquaplex
National Science Foundation Project

Relative Abundance and Diversity of Antibiotic Resistance Genes and Pathogens in Reclaimed Versus Potable Water Distribution Systems

A. Pruden (Virginia Tech), M. Edwards (Virginia Tech), J. McLain (Univ Arizona), D. Engelthaler (TGen)

Award $330,000
August 1 2014-July 31, 2017
RESEARCH QUESTIONS

#1 – Are the Kinds & levels of ARGs found in Flagstaff reclaimed water different from in other reclaimed waters from other parts of the country?

#2 – Are the kinds & levels of ARGs present in reclaimed water greater, equal, or less than those found in comparable background samples?

#3 – Are live ARBs detectable in the reclaimed water (E. coli or Enterococcus)?

#4 – What is the best way to operate & maintain a reclaimed water distribution system free of pathogens & ARGs equal to background?
CEC Sampling Update

96 CEC’s sampled 2010 – 2014 (ng/L)

- Groundwater well
  - Fluoxetine

- Raw surface water – Lake Mary
  - Iohexal, Triclosan, Caffeine, DEET, Lopromide & Theobromine, Acesulfame-K

- Water Distribution System
  - Iopromide, Triclosan, Triclocarban, DEET, Azithromycin, Caffeine, Fluoxetine, Theobromine, Sulfachloropyridazine,

- Reclaimed Water System ~30 constituents
Summary

Reclaimed water is important to Flagstaff
20% of total water deliveries and recharge groundwater system

City has been proactive in understanding Compounds of Emerging Concerns and ARG/ARB within our community

City Manager’s CEC Advisory Panel
Creative political & technical solution
Help the City & our community bring sound science into policy conversations

Research Results
wait 1+ years for ARB/ARG