NATIONAL WATER RESEARCH INSTITUTE

Public Meeting on:

Technical Advisory Panel (TAP) for
City of Santa Barbara's Subsurface Desalination Intake and
Potable Reuse Feasibility Studies

Wednesday, August 5, 2015
9:30 am – 12:00 noon

Santa Barbara City Hall
Council Chambers Room
735 Anacapa Street
Santa Barbara, California, 93101

PUBLIC COMMENTS

The Public Comment period for this public meeting began at 11:00 AM. Members of the public were invited to submit comment cards, which included space for the commenter's name, affiliation (e.g., regulatory agency, city resident, other), residency (City of Santa Barbara), and the comment(s). NWRI continued to collect written comments related to this meeting via email (sfaubl@nwri-usa.org) through August 12, 2015.

All comments received are summarized in the following pages. A list of the comments is provided below.

- Comment #1a. Submitted by Hillary Hauser of Heal the Ocean at the meeting on August 5, 2015.
- Comment #1b. Submitted by James Hawkins on behalf of Hillary Hauser of Heal the Ocean via e-mail on August 11, 2015.

- Comment #2a. Submitted by Dr. Edo McGowan at the meeting on August 5, 2015.
- Comment #2b. Submitted by Dr. Edo McGowan at the meeting on August 5, 2015.
- Comment #2c. Submitted by Dr. Edo McGowan via e-mail on July 28, 2015

- Comment #3a. Submitted by John M. Ackermann, MD, at the meeting on August 5, 2015.
- Comment #3b. Submitted by John M. Ackermann, MD, via e-mail on August 6.

- Comment #4. Submitted by Mariah Clegg of University of California, Santa Barbara, at the meeting on August 5, 2015.

- Comment #5. Submitted by Jordan Clark, Ph.D., of University of California, Santa Barbara, at the meeting on August 5, 2015.

- Comment #6. Submitted by Kira Redmond of Santa Barbara Channelkeeper at the meeting on August 5, 2015.

Public Comments Submitted to the Technical Advisory Panel (TAP) for City of Santa Barbara's Subsurface Desalination Intake and Potable Reuse Feasibility Studies

Comment #1a
Name: Hillary Hauser
Affiliation: Heal the Ocean
City Resident? YES
Submitted: August 5, 2015 (at meeting)
Comment: Re: Potable Reuse Study

- Heal the Ocean is working a lot on recycled water and published a white paper on potable reuse.
- When the City held a hearing on desalination in 2014, we presented a proposal to upgrade the wastewater treatment plant to recycled water to full capacity.
- We have been waiting for Carollo to finish this study before moving forward.
- Heal the Ocean feels recycled water must be increased in Santa Barbara, even if fatally flawed
- We need to know how much it costs.
- We suggest substituting the word "replace" with "augment" the ocean water intake.
- We want to see what is included in involving Montecito, including increased wastewater flows rather than decreased wastewater flows; we would like to see this all together in one package.
- 1.4-5 MGD study for the wastewater plant.
- Regional board – investigate "all sources"

Comment #1b
Name: Hillary Hauser and James Hawkins
Affiliation: Heal the Ocean
Submitted: via e-mail on August 11, 2015
SEE ATTACHMENT A

Comment #2a
Name: Dr. Edo McGowan
Affiliation: Self
Submitted: August 5, 2015 (at meeting)
City Resident? (checked both "Yes" and "No")
Comment:

- My background is a Ph.D. in water quality
- Questions:
  (1) If you knew that using recycled water was not protective of public health, but "legal" – what would be your official position?
  (2) At what level do xenobiotics (antioxidant response elements (AREs), circulating endothelial cells (CECs), endocrine disrupters) as found in recycled water no longer affect endothelial cell function in the blood brain barrier, hence cognition?

Comment #2b
Name: Dr. Edo McGowan
Affiliation: Self
Submitted: August 5, 2015 (at meeting)
City Resident? YES

Comment: Question: Has the following be considered and if so how? Harbor dredging spoils, classically are placed along East Beach. Historically, during heavy rains, manhole covers near the harbor blow open allowing raw sewage into the harbor. This trunk line is also connected the sewer line from the hospital. It is well known that antibiotic-resistant microbes, including their genes, can transfer information to environmental libraries – and thus become long-standing sources.

Comment #2c
Name: Dr. Edo McGowan
Submitted: via e-mail on July 28, 2015
SEE ATTACHMENT B

Comment #3a
Name: John M. Ackermann, M.D.
Affiliation: AMA, APA, MRC
City Resident? YES
Submitted: August 5, 2015 (at meeting)
Comment:

- I was previously a public health service officer for Alaska USPHS and am a retired physician.
- I am here to comment on nonpotable reuse and the prevention of pandemics for our community.
- The question is whether or not it is possible to cleanse the reused nonpotable water so that multi-antibiotic resistant bacteria and their genes can be cleared.
- Recycled water is utilized on public lands, including parks and playing fields.
- My concern is about the prevention of pandemics.

Comment #3b
Name: John M. Ackermann
Submitted: via e-mail on August 7, 2015
Comment: Non-potable reuse is utilized to irrigate grass on school playing fields, public parks, etc. This water is contaminated with multi-antibiotic resistant bacteria and their genes. For example, people picnic on the grass. Their hands touch the grass and, subsequently, touch their lips. In an attempt to prevent pandemics, please seriously consider upgrading the non-potable reuse water by filtering out the above multi-antibiotic resistant bacteria and their genes. Just prior to my comments, I handed out literature to the person who was directing the process.

Comment #4
Name: Mariah Clegg
Affiliation: University of California, Santa Barbara
Submitted: August 5, 2015 (at meeting)
City Resident? (left blank)
Comment: I'm concerned about the environmental impacts of using so much energy to create water. Power plants can use renewable energy. The desalination plant should use renewable energy. It is clear that while California is accustomed to having lots of droughts, the current drought has been exacerbated by climate change, which is caused by energy use, including the energy used by both the advanced water treatment facility and the desalination plant. We need to make these plants carbon neutral and power them with renewable energy.

Comment #5
Name: Jordan Clark, Ph.D.
Affiliation: University of California, Santa Barbara
Submitted: August 5, 2015 (at meeting)
City Resident? NO (lives in Goleta, CA)
Comment: Will the injection well lead to overdrafting in the lower aquifer. Is there evidence that direct potable reuse will lead to "clean groundwater" being lost to overlying aquifer?

Comment #6
Name: Kira Redmond
Affiliation: Santa Barbara Channelkeeper
Submitted: August 5, 2015 (at meeting)
City Resident? YES
Comment:

- I am the Executive Director of Santa Barbara Channelkeeper.
- My organization pressured the city to examine the damage caused by surface intakes on marine organisms.
- The feasibility study notes that the capacity threshold can be lowered.
- A combination of subsurface and surface intakes could be used to minimize the mortality of marine organisms.
- Capacity – subsurface and surface, lower the capacity – US dismissing them as fatally flawed
- Look at criteria in the Ocean Plan and examine this language.
- Consider them as a combo rather than as a fatal flaw. Also, don't dismiss subsurface intakes based on cost estimates.

ATTACHMENT A

Comment #1b
Name: Hillary Hauser and James Hawkins
Affiliation: Heal the Ocean
Submitted: via e-mail on August 11, 2015

HEAL THE OCEAN
1430 Chapala St., Santa Barbara, CA 93101; (mail) P.O. Box 90106, Santa Barbara, CA 93190
Telephone (805) 965-7570; fax (805) 962-0651

Tuesday, August 11, 2012

Suzanne Faubl, Water Resources Scientist and Project Manager
National Water Research Institute
18700 Ward Street
Fountain Valley, California 92708

Re: Carollo Work Plans for City of Santa Barbara Feasibility Studies – Subsurface Desalination Intake and Potable Reuse

Heal the Ocean (HTO), a Santa Barbara based citizens' action group, appreciates the opportunity to comment on the draft Work Plans for the Subsurface Desalination Intake Feasibility Study and the Potable Reuse Feasibility Study. As a part of our waste(d)water campaign to reduce ocean discharges of wastewater and develop more sustainable water supply options, we have been involved in facilitating State Proposition 1 grant funds for wastewater treatment plants to upgrade to advanced water recycling facilities. We have also spent significant time locally on educating the public and our supporters of the merits of advanced water recycling, including through our recently published White Paper on potable reuse. We attended the public hearing held by the National Water Research Institute (NWRI) technical advisory panel (TAP) in Santa Barbara on August 5, 2015.

Background

HTO has been in discussions for some time with the City regarding the Carollo feasibility studies, because in November 2014, when the City held hearings on reactivating the Charles E. Meyer desalination plant, we proposed a feasibility study, funded by Heal the Ocean, that would focus on maximizing the existing recycled water plant – to produce a greater volume of recycled water of a higher "gold standard," or DPR quality that would offset future use of the Charles E. Meyer Desalination Plant. We contracted with Santa Monica-based RMC Water, to develop a proposal for such a study, with the scope of work for the City consisting of the following:

> ***Task 1 – Advanced Water Treatment Plant Evaluation (Santa Barbara)***
> ***The purpose of this task is to describe the potential location of an advanced water treatment plant (AWTP) consisting of MF, RO, and advanced oxidation processes (AOP) (MF/RO/AOP) to produce water quality acceptable for groundwater recharge via injection. The El Estero WWTP is located on a small site with little available open***

> ***space for expansion of the MF system and construction of new RO and AOP facilities. Therefore, site constraints and cost impacts to site an AWTP at the WWTP will be evaluated. A combination of three potential sites will be considered: El Estero WWTP, Charles E. Meyer Desalination Facility, and acquired land adjacent to the WWTP.***
>
> ***In addition, an AWTP that treats most of the existing effluent may produce volumes of brine concentrate that exceed the existing WWTP and/or desalination brine discharge permit. Therefore, the impact of operating an AWTP that conforms to existing discharge requirements will be investigated.***

When the City applied for its NPDES permit for the desalination plant to the Regional Water Quality Control Board, HTO also approached the Regional Board with the request that the City be required to do a full investigation of maximizing the production of water from an advanced recycled water facility in the City, and the Regional Board agreed with us. In approving the desalination permit, the Regional Board stipulated in an amendment to the permit:

> ***iii. The Discharger shall analyze the feasibility of a range of alternatives, including subsurface intake and potable reuse options.***
> ***1) The Discharger shall submit a feasibility study workplan, acceptable to the Regional Water Board, by August 31, 2015. The feasibility study workplan shall analyze the feasibility of a range of alternatives, including subsurface intake and potable reuse options.***
> ***2) The Discharger shall report the results of these analyses, and the Discharger's intended implementation actions, to the Regional Water Board at a public meeting no later than June 30, 2017.***

Following the Regional Water Board's adoption of the revised NPDES permit, Heal the Ocean put our proposed study with RMC on hold so as not to duplicate effort. From that time until now we did not know what Carollo had in mind for a draft Work Plan.

In advance of the NWRI hearing that draft Work Plan became available, and we have serious concerns about it. We find it so lacking that HTO would necessarily have to proceed with our RMC study - but the BIG problem with this is that our study, the study that should really be happening, ***will be outside the regulatory process established by the Regional Water Board.*** Hearings will be held on the Carollo study, while the RMC study will be "extraneous material."

This cannot happen! There should be ONE package before the Regional Board.

<u>The Problems with the Carollo Study</u>

1) **The Carollo study does not follow the intent of the Regional Water Board's requirement, which is to analyze *the feasibility of a range of alternatives.***

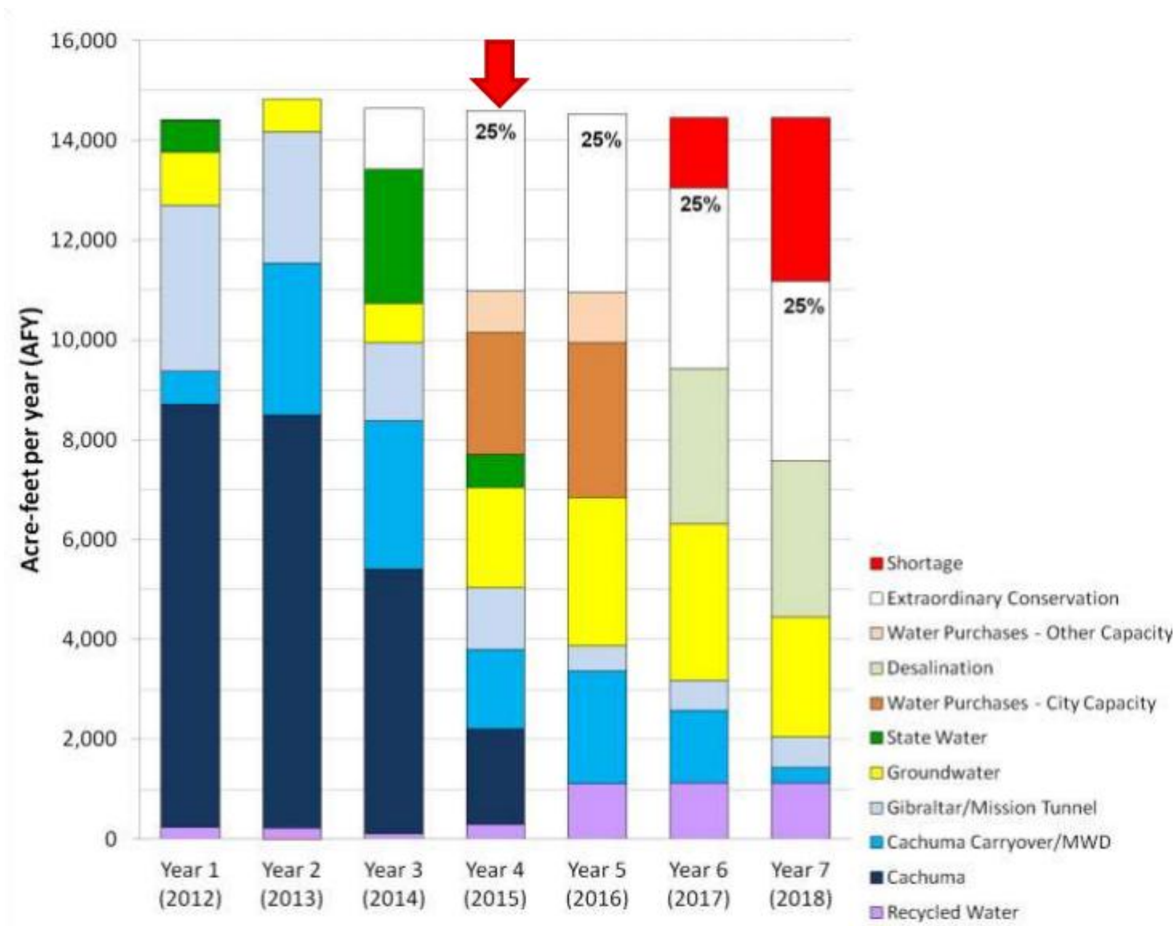
The draft Work Plan does not accommodate analysis of a range of alternatives since it utilizes a “fatal flaw analysis” that instantly concludes that IPR and DPR-level recycled water will not meet the “fatal flaw” threshold established by the Work Plans of 10,000 AFY to replace the desalination plant.

2) The Carollo study uses an "either/or" thesis as its goal (either desalination or recycled water), instead of taking this opportunity to determine the potential of all water sources.

The stated goal of the study is to investigate "...potable reuse alternatives to *replace* (emphasis ours) the City's existing open ocean intake. The word *"replace"* should be substituted with the word "*augment."*

At the NWRI hearing in Santa Barbara, the City put up a graphic to illustrate how the water supply for Santa Barbara will fall short in 2016 and 2017, even with desalination, to which TAP member Eric Zigas wondered aloud why the amount of recycled water was not changing upward to solve this shortage.

Supply strategy/desalination timeline
(based on no reservoir inflows, no State Water)



From Carollo Presentation to City of Santa Barbara TAP Workshop #1, August 5, 2015

The Carollo study should evaluate potable reuse at several capacity levels and determine the maximum amount of groundwater recharge feasible within City limits. The Work Plan for the feasibility studies should be revised to emphasize *ruling in* what is possible instead of simply *ruling out* what is impossible via the fatal flaw analysis. It is unnecessary to conduct a professional feasibility study to determine if a potable reuse facility in the City could meet a 10,000 AFY threshold, because we already know that it cannot with only 6-7 MGD in effluent discharged from El Estero.

<u>Specific Comments</u>

"*The goal of this study is to evaluate to use of subsurface desalination intake alternatives and potable reuse alternatives to replace the City's existing open ocean intake. Thus, the capacity of a potable reuse alternative (i.e., the subject of this Work Plan) shall be capable of producing up to the CMDP's build out capacity of 10,000 acre-feet per year (AFY)*" (p. 6).

As stated above, the City of Santa Barbara Charles E. Meyer Desalination Plant build out capacity of 10,000 acre-feet per year (AFY) should not be the only benchmark against which a potable reuse facility is measured. The Work Study should consider several alternatives, including the current reactivated plant design capacity of 3,125 AFY, a 5,000 AFY capacity, a 7,500 AFY capacity, as well as the full build out capacity of 10,000 AFY. The lesser volumes could be possible with an expanded recycled water facility.

The Work Plan should also incorporate projections for the City's long-term growth and its effect on wastewater supplies, as well as the effect of additional conservation measures on those wastewater supplies.

"*2. Full treatment by reverse osmosis (RO) for the potable reuse stream at a recovery rate of 80 percent*" (p. 7).

In addition to the 80% recovery rate, the Work Plan should include analysis of an 85% recovery rate (which the Plan states is possible for RO technology to achieve) as well as a lower 75% recovery rate. The Work Plan should also establish plans for the Feasibility Study to examine additional measures that the City can take to reduce influent wastewater salt content, such as action addressing water softeners.

"*Possible treatment facility location options may include (but may not be limited to):*

- *401 E. Yanonali Street (i.e., City Corporation Yard, APN #017-540-006), and*
- *103 S. Calle Cesar Chavez (APN #017-113-020)*
- *Repurposing the Charles Meyer Desalination Plant located at 525 E. Yanonali Street*" (p. 7).

We agree with the consideration of these facility sites within the Feasibility Study; *however* (*and it is a big however)* City staff said at the NWRI hearing in Santa Barbara that expansion of the recycled water facility would be difficult because more land would be needed, and that land is expensive, etc. We say that the above sites should be investigated, and any other site - with the attendant cost of buying such site – and put into the feasibility study. The Carollo Feasibility

Study is our only opportunity at this juncture to find out what it would take to maximize DPR and IPR production from current wastewater flows.

"*Possible groundwater recharge locations for IPR may include (but may not be limited to):*

- *Recharge wells in the Foothill basin (near Route 154 and Highway 101)*
- *Recharge wells in groundwater basin referred to as "Storage Unit 1" (north of Highway 101)*
- *Enhanced infiltration of water (i.e., a spreading basin) in Mission Creek from just above Rocky Nook Park to Oak Park, to recharge Storage Unit 1*
- *Enhanced infiltration of water (i.e., a spreading basin) in or near the Foothill basin*" (p. 7-8).

We agree with the consideration of these recharge locations within the Feasibility Study; however, the Feasibility Study should evaluate the feasibility and cost of constructing any new wells for recharge in a potable reuse system where necessary.

"*Given the number of injection wells or spreading basins that are required to meet the 10,000 AFY (or 11,400 AFY) production requirement, project site alternatives will be generated based on existing city infrastructure, proximity to existing City wells, and proximity to City owned or patrolled land*" (p. 8).

See previous comments. The cost of new land and new injection wells should be evaluated.

<u>Conclusion</u>

Heal the Ocean has estimated that, based on current wastewater flows, a potable reuse facility for the City could produce 5 MGD of purified water. This could provide a significant water supply to add to Santa Barbara's water portfolio – and *in addition, bring down the need for high-use of the more energy-intensive and more costly desalination plant.* It could also better position the City to operate as a Regional Facility.

Sincerely,

Hillary Hauser, Executive Director

James O. Hawkins, Policy Analyst

ATTACHMENT B

Comment #2c
Name: Dr. Edo McGowan
Submitted: via e-mail on July 28, 2015

Suzanne Faubl

From: Edo McGowan <edo_mcgowan@hotmail.com>
Sent: Tuesday, July 28, 2015 8:25 AM
To: sfaubl@nwri-usa.org; BenSBCK; JohnAckerman; HelaneSchnider
Subject: FW: Comments to Expert Panel on Recycled Water

To: NWRI and City of Santa Barbara
Re: Comment material to be added as a *record augmentation* to my previously submitted data for meeting in the City Hall on Wed, Aug 5 @ 9:30 on desal, recycled water, and water reuse. The question to NWRI includes, who on your staff is working in gene transfer related to spread of antibiotic resistance and virulence, as generated and discharged by the El Estero wastewater treatment plant and thus use of that water for the production of recycled water?

The material below was developed in response to a specific request to me by the State of California's Water Resorces Control Board, asking me to comment on recycled water. Climate will profoundly affect the discussion. There will be large international, economic, and foreign policy ripple effects that are generally not seen nor discussed, often for political reasons.

From: edo_mcgowan@hotmail.com
To: edo_mcgowan@hotmail.com; mmckibben@waterboards.ca.gov
Subject: RE: Please print RE: Expert Panel draft-2
Date: Sat, 28 Feb 2015 09:46:36 -0800
Michael, many thanks for this opportunity. Below are some concerns. It would be interesting to review the background of the panel. It is assumed that many are microbiologists working in gene transfer related to spread of antibiotic resistance and virulence and hopefully, one is Amy Pruden or one of her post docs and some are infections disease physicians or PhDs.

I have attempted to give you and the panel some thoughts on where the system, in my opinion, is weak. As an aside, the spread of resistance could be argued to adversely impact national security and battle wounds. That then sweeps in an interesting side argument on the need for nuclear weapons that do not adversely affect physical structures, but nonetheless do impact living tissue.

To Expert Panel via Michael McKibben

I am concerned, upon my finding antibiotic resistant bacteria as well as their genes in treated, disinfected, and finished tertiary recycled water from three separate POTWs, that there is a potentially serious public health problem that needs to be addressed. The policy on recycled water is weak. Further, I think that in review, some might note that the policy is no policy at all but merely the post-hoc rationalization for a series of ignored opportunities. It would seem that the state should test several sources of recycled water to see if this generation and carriage of resistant organisms and their genes is widespread. Our work indicates that the problem is in fact widespread. I would suggest that you consult with Dr. Amy Pruden at Virginia Tech on how one might set up a design protocol and then testing for this issue. The standard "Most Probable Number" (MPN) test is failing to protect public health because it is incapable of reflecting the actual presence of pathogenic organisms and their genes, especially the drug-resistant ones that are capable of adversely impacting public health. As those within health care and public health continue to see yet more of the once functional antimicrobials fail to control the ever growing number of "unstoppable" infections, there may be a point where many surgeries will become too risky. This then may mean that replacement joints, other corrective elective surgeries and other procedures may be off the list due to unstoppable infections. I call your attention to the several and recent issues of contaminated endoscopes as merely one example in a non-surgical area. Admittedly, tissues may be taken during this procedure when that tissue is suspect, but, in the main, this is a procedure without tissue cutting. Additionally, battle wounds will be impacted. We don't know when this event will arise to a sufficient level to bring a more coordinated approach but it would be foolhardy to continue to ignore the situation. Sewer plants by their designs, operation, and through their byproducts continue to generate and spew out copious levels of resistant microbes. One need only to go back to the late 1970s and the US/EPA studies of Meckes to realize this.

Finding that current standards are failing to protect public health was reported by Joan Rose for WERF, as reflected in its 2004 report 00-PUM-2T. That report was reissued via Harwood, et al in a peer reviewed paper. Sadly, this is certainly not new information but seems to have garnered little attention amongst the regulatory community. Data on sewer plant generation and discharge of antibiotic resistant organisms has been available for several decades, yet this seems to have missed the serious attention that it deserved by either the DHS or the SWRCB. Nonetheless the problem is found amply discussed in the literature and reaching back at least into the 1960's and perhaps into the 1950's, see: Meckes, and references within his 1981report below. The Meckes report noted above, stemmed from a larger USEPA study which, via internal review, was deemed by EPA to warrant publication through the peer reviewed literature.

The late Dr. Judy Meyer, who ran the Medical Micro Program at Santa Barbara City College, sampled recycled water over several years. The delivered recycled water was piped to the campus by the City of Santa Barbara. Invariably, she noted antibiotic resistant organisms in worrisome levels. She attempted several times to inform those in responsible positions but her efforts were without any success or generation of interest. She noted that finding resistant organisms in this water was not a once in a while fluke but an ongoing issue. The water was and is going onto surfaces frequently contacted by students. The same water goes on grammar schools where there are immature immune systems.

In the early part of this millennium, I teamed up with Dr Meyer to expand testing on this recycled water. We used disk diffusion assay. As a continuation of that work, Dr Amy Pruden became involved and thus the Fahrenfeld paper (see below) was published. The fact that we are also finding increased numbers of indicator bacteria at the end of the pipe (see also Fahrenfeld below) tells us that there is a major flaw within the testing protocols and how sewer plants make recycled water. The bacteria in the water entering the pipe at the plant as reflected by the state's standard MPN test may be throwing false negatives that later turn positive (see also Harwood below). It is well understood how the stunning of bacteria renders them "invisible" to MPN tests. This is due to the viable but non-culturable (VBNC) state into which stunned bacteria retreat to survive. They resuscitate later but that is after the initial MPN test shows the water to have meet the standards. This then becomes a critical issue if that recycled water is to be used as feed stock for reuse into the drinking water supply. Loading recycled water into local aquifers may see those aquifers contaminated with recycled water which is bearing resistant organisms and genes. Pipes and equipment extracting that water may be contaminated with biofilms which would likely shed. That this can be a problem is reflected in several papers on biofilm contaminated piping and that is reflected also in the work of the Johnson Space Center (see Morse below) as well as discussion of contamination in dental offices. Higgins and Murthy, for WERF, found similar issues with tests used on sewage sludge. That series of papers is available via WERF. I was on one of the WERF panels that looked at this. This slot in the panel was arranged by Al Rubin of the US/EPA.

The original vector of the resistant gene need not remain once the gene is released.

Chee-Sanford-----------

This author discusses the transfer of genes into the soil biota. He notes concerns because of increasing emergence of resistance in clinical strains and within the normal commensal microbiota. Following land application, persistence is noted in soil microbiota and have also been noted groundwater and in one study, occurrence of genes was more pronounced in the deeper wells. Thus on release into the environment, the genes can mobilize and persist. Mobility of resistant genes in the environment can be substantial. Resistant genes can be maintained in the microbial populations present.

He notes that the disseminating vector bacteria (the one carrying the gene) does not need to be maintained once the transfer has taken place. Once the resistant gene pool is mobilized into indigenous soil bacteria, it has a much better chance of survival, persistence, and mobility---effectively increasing the gene frequency in local populations and thus having an increased potential for reaching other ecosystems. Thus with constant application of antibiotic containing material, a concentrated environment may exist in which selection can occur. (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC92760/)

That resistant genes are found in drinking water is now well documented, see Pruden and also http://aem.asm.org/content/75/17/5714.full. As an example, one of the students in the medical micro class happened to have a part time job in a local chain pharmacy. The class was running water samples during this portion of the class schedule. For grins, he brought in some sterile water made in the pharmacy, water that was used for compounding scrips. The result from disk diffusion showed bacteria resistant to 11 of the 12 challenge antibiotics in our Kirby Bauer. Because of the unusual nature of this and seriousness of the result, it was first presumed that the student had contaminated the sample. Because of the seriousness of the result and to rule out contamination, several more samples were pulled and plated out. The results were the same, the student had not contaminated his sample. Checking similar distillation units in other outlets using the same equipment another one was found contaminated. These fluids are used for making up, among other things, cough syrups for kids.

How about disinfectants----do they really work? In discussions with Dr Pruden, it is noted that the genes are little affected at typical chlorine concentrations or contact times for typical treatment works. The same can be said for UV and readers should also review Meckes on this issue. Dr Pruden also notes that the antibiotic resistant genes (ARGs) are so small that they easily pass through many of the filters in current use. ARGs are small enough to pass through nuclear pores, roughly 9 nm in diameter. As can be seen below, 9 nm could foil many of the currently accepted filtering systems: 1 um is 1000 nm

- A microfiltration filter has a pore size of approximately 0.1 micron (pore size ranges vary by filter from 0.05 micron to 5 micron); [that is way to large to stop transmission of genes]
- Microfiltration has a very high effectiveness in removing protozoa (for example, Cryptosporidium, Giardia);
- Microfiltration has a moderate effectiveness in removing bacteria (for example, Campylobacter, Salmonella, Shigella,E. coli);
- Microfiltration is not effective in removing viruses (for example, Enteric, Hepatitis A, Norovirus, Rotavirus);
- Microfiltration is not effective in removing chemicals.

Ultrafiltration

- An ultrafiltration filter has a pore size of approximately 0.01 micron (pore size ranges vary by filter from 0.001 micron to 0.05 micron; Molecular Weight Cut Off (MWCO) of 13,000 to 200,000 Daltons). Ultrafiltration filters remove particles based on size, weight, and charge; [again, questionable, given range, to adequately stop genes]
- Ultrafiltration has a very high effectiveness in removing protozoa (for example, Cryptosporidium, Giardia);
- Ultrafiltration has a very high effectiveness in removing bacteria (for example, Campylobacter, Salmonella, Shigella,E. coli);
- Ultrafiltration has a moderate effectiveness in removing viruses (for example, Enteric, Hepatitis A, Norovirus, Rotavirus);
- Ultrafiltration has a low effectiveness in removing chemicals.

Nanofiltration

- A nanofiltration filter has a pore size of approximately 0.001 micron (pore size ranges vary by filter from 0.008 micron to 0.01 micron; Molecular Weight Cut Off (MWCO) of 200 to 2000 Daltons); Nanofiltration filters remove particles based on size, weight, and charge; [again, given the size range and the ability of genes to string out, this remains an unclear situation]
- Nanofiltration has a very high effectiveness in removing protozoa (for example, Cryptosporidium, Giardia);
- Nanofiltration has a very high effectiveness in removing bacteria (for example, Campylobacter, Salmonella, Shigella, E. coli);
- Nanofiltration has a very high effectiveness in removing viruses (for example, Enteric, Hepatitis A, Norovirus, Rotavirus);
- Nanofiltration has a moderate effectiveness in removing chemicals.

Since 1 um is equivalent to 1000 nm, ultrafiltration, which has a pore size of approximately 0.01 micron would be a dicey choice for blocking genes. Additionally, since these things can string out, what is really the effective size needed to assure stoppage? But, as seen from the work of Chad Kinney below, there are other constituents that fall into the area of questionable category such as pharmaceuticals and endocrine disrupters that would be found in tertiary treated effluent. Note that Nanofiltration has a moderate effectiveness in removing chemicals. Do we know enough about these materials to assume all is safe? From Kinney's work, it seems that these materials can build up with a constant addition of recycled water to the ground.

"Nevertheless, the present study demonstrates that reclaimed-water irrigation results in soil pharmaceutical concentrations that vary through the irrigation season and that some compounds
persist for months after irrigation."

A constant addition of water, in contrast to an irrigation schedule, would see these materials build up within the aquifer. What are their t1/2 or their degradation curves looking like, does anyone know-----absent this knowledge, then what?

Matthew Wook Chang, see below, notes that chlorine up regulates the virulence factors for MRSA. There are several other bacteria where chlorine up regulates virulence factors. Sewer plants have been demonstrated to release MRSA. In fact, we found genes related to MRSA in the soil of a high school football field receiving recycled water. One should realize that this response to chlorine is a normal response of pathogens and long predates the human use of chlorine in treatment works. Thus, if chlorine is failing to effectively deal with pathogens which are subsequently released, then these pathogens may be being released with up-regulated virulence factors. There is also the issue of chlorine resistance to discuss at some point.

One may also wish to become familiar with the case of Hartwell Corp. v Superior Court, 27 Cal.4th 256 (2002) (Hartwell). This case seems to have merit in augmenting the points made in this discussion. Hartwell seems to indicate that rather bad contaminants may be found in water but that unless these contaminants are called out in the standards numerically, their inclusion and status consequently allows a legal adverse impact on public health. This raises some serious questions warranting answers. As discussed later, non-numeric standards seem, according to my reading of Hartwell, to be merely puff and have no enforcement capacity. This (again later) leads the discussion into the functioning of H&SC 5410, et seq and how one could ascertain if a contaminant fell within the meaning of H&SC 5410, Subsections (d), (e), or (f)? What are the criteria for ruling in or ruling out a contaminant for purposes of H&SC 5410? Are there in fact any criteria? This raises a problem because, unlike chemical pollutants where dilution was perhaps an answer; bacteria can multiply, genes can be exchanged and new and more virulent pathogens can thus be developed. Thus the old paradigm of dose response may no longer apply because once in the gut, multiplication can go at high and unpredictable speeds with unpredictable results.

Once incorporated into the human gut biota this may set up tiny time bombs and thus establish available lending libraries for pathogens. Sjolund, et al (2005) looked at similar issues and notes that this genetic information is passed to and then amplified by the gut biota. Sjolund et al further indicated that resistance in the normal gut flora, which once incorporated can last for years, might contribute to increased resistance in higher-grade pathogens through inter-species transfer. These authors go on to note that since populations of the normal biota are large, this affords the chance for multiple and different resistant variants to develop. This thus enhances the risk for spread to populations of pathogens. Furthermore, there is crossed resistance which can complicate treatment. For example, vancomycin resistance may be maintained by using macrolides. See: Sjolund, et al. *Emerging Infectious Diseases*, 2005, Sept.;11(9),1389 et seq. Thus wound repair or surgical post operative infections may become self contaminated with seriously resistant microbes. One must consider the fecal veneer.

In its response to the USEPA request to look at land applied sewage sludge, the NAS/NRC, in 2002, noted that data were old and admonished the EPA to look at resistance. In the section of its report discussing resistance the panel noted the need for enhanced review, see below at NAS/NRC. I bring this up because sewage sludge (biosolids) is just another byproduct from sewer plants. There are three main byproducts of processed sewage, 1) solids, 2) effluent and then 3) recycled water. All share a common base and thus all contain commonly shared contaminants, pathogenic bacteria, and other pathogens. One of the underlying issues, then, can be seen as the antiquated plant designs and standards under which sewage is processed. This deficit is additionally augmented by the lack of adequate training of plant operators. The state tells me that, amongst plant operators, there is very little if any requirement to know about the contaminants of emerging concern or resistant pathogens that are generated in the community, especially hospitals, that impact public health via sewage byproducts. The unfortunate thing here is that these plant operators don't know that they are deficit and thus can not comprehend what they are failing to control. The process seems to be a top down system where the top indicated "you're not asked to think before you're told."

H&SC 5410

d) ″Contamination″ means an impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease. ″Contamination″ shall include any equivalent effect resulting from the disposal of waste, whether or not waters of the state are affected.

(e) "Pollution" means an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects: (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. "Pollution" may include "contamination."

(f) "Nuisance" means anything which: (1) is injurious to health,

I believe that a local agency can exceed state and federal standards. Thus it behooves one to carefully review the standards under which one's water is actually prepared, hence what's in that water and then what's discussed in the standards. There may be a wide variance between these two. As seen below by the work of Fahernfeld and separately Harwood, the standards under which recycled water is now produced are not protective of public health. Using recycled water as now produced under extant standards will merely contaminate our groundwater basins. But that may not stop the furnishing of that contaminated water (as later extracted via wells from the groundwater basin) because there are few, if any, numeric standards for what would be in that water which could adversely impact public health. By the time that this becomes recognized by the state it may well be too late and the aquifers may be contaminated.

Remember that in prior communications I brought out the warning from the USEPA toxicologist discussing the Safe Drinking Water Act (SDWA). As you may remember, I noted a discussion that took place during the 2006 Environmental Law Conference at Yosemite. The toxicologist attending that conference and delivering a paper, concluded with the following: "Bottom line on almost all of the 'emerging' contaminants that have attracted attention: It will be a long time, if ever, before they are regulated under the SDWA." The overall topic of that session was "non-action" by governmental regulatory and legislative bodies and potential consequent impacts on public health. Thus, the impact may fall to the state or potentially the locals because the Feds appear to be dropping the ball. We can not afford this because we are running out of viable antimicrobials and the bugs are getting tougher.

Some History...........

The City of Santa Barbara was one of the plants tested during the 2004 Harwood study (see below). I asked the City if they had changed anything at the plant to remedy the through-put of pathogens as documented by Harwood. Their reply was that they had not, the water was "legal". This attitude by those in charge is hardly praiseworthy. There is a duty to warn but that also seems to have been slid under the rug in the case of Santa Barbara.

Following the Fahrenfeld study, which I initiated, we presented the information on finding antibiotic resistant genes in the finished and presumably disinfected recycled water to the City of Santa Barbara, the Goleta San, the school systems, the Goleta Water District and County Health-----all without any apparent reaction. As to County Health, we found that it could not even run simplified lab tests to review antibiotic resistant organisms in the water and refused to take up the matter. We next went to the state's regional board and they declined to deal with this issue and the state board has been informed and done essentially nothing for a decade. Hopefully, this request of something for the Expert Panel shows progression in interest.

At the local level, the upshot is that it appears that we are on our own, that agencies one might assume would be protecting public health are in non-action modes, but I believe that local agencies have the power to take this into consideration for protection of its citizens. Here I am discussing the Montecito Water District. I am on a subcommittee reporting to the Montecito Association and the Montecito Water Agency. Counsel should be asked for an analysis of local control when higher authorities fail and that failure puts the community at risk.

A necessary but not sufficient input to the problem of released antibiotic resistant microbes and their genes is recognizing that the current sewer plant designs are unlikely to be tweaked enough to mitigate the problem. Thus, aside from the need for testing that will pick up released ARGs/resistant microbes/other pathogens not no acknowledged nor elucidated by current standards, some serious money needs to go into new sewer plant design. The last time this occurred (mid 1970s) Congress set aside about 18 billion (current day value around 60 billion) and this funding although slated to go for Clean Water Act, mainly went for expansion. This was contrary to the dictates of Congress. Consequently pouring new concrete into existing designs will spend money but will likely accomplish very little.

We need to discuss this.

Dr Edo McGowan

Hartwell, a case involving water standards went to the California Supreme Court.

Hartwell Corp. v Superior Court, 27 Cal.4th 256 (2002) (hereinafter "Hartwell").

A112964

COURT OF APPEAL OF CALIFORNIA, FIRST APPELLATE DISTRICT, DIVISION FIVE

154 Cal. App. 4th 659; 64 Cal. Rptr. 3d 827; 2007 Cal. App. LEXIS 1405; 37 ELR 20224

August 24, 2007, Filed

PRIOR HISTORY: [***1]
Superior Court of Los Angeles, JCCP No. 4135, Carl J. West, Judge.
Hartwell Corp. v. Superior Court, 27 Cal. 4th 256, 115 Cal. Rptr. 2d 874, 38 P.3d 1098, 2002 Cal. LEXIS 590 (2002).

The cases began in 1997, and continued into 1998, when over 2000 residents of Los Angeles County and several hundred residents in Sacramento

filed complaints against 4 water companies regulated by the PUC and other
water utilities not regulated by the PUC, alleging causes of action for negligence,
strict liability, trespass, public and private nuisance, fraudulent concealment and
in some cases wrongful death. The claims against the water providers were that
they had provided contaminated water to the plaintiffs over an extended period of time.

In Re: Groundwater Cases held, inter alia, that numerical standards for levels of contaminants are in fact what the agencies must use, not qualitative standards, in determining whether or not water is contaminated. It also confirmed that challenges to the adequacy of the standards were barred by Hartwell and its predecessor cases. It made the additional findings that no water
provider is capable of supplying “pure” water, and that isolated exceedances of
maximum contaminant levels (MCLs) do not constitute violations in California.
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This Harwood study below is the academic rendition of a WERF study specifically including the City of Santa Barbara's recycled (reclaimed) water

Appl Environ Microbiol. 2005 Jun;71(6):3163-70.

Validity of the indicator organism paradigm for pathogen reduction in reclaimed water and public health protection.

Harwood VJ[1], Levine AD, Scott TM, Chivukula V, Lukasik J, Farrah SR, Rose JB.

Author information

Abstract

The validity of using indicator organisms (total and fecal coliforms, enterococci, Clostridium perfringens, and F-specific coliphages) to predict the presence or absence of pathogens (infectious enteric viruses, Cryptosporidium, and Giardia) was tested at six wastewater reclamation facilities. Multiple samplings conducted at each facility over a 1-year period. Larger

sample volumes for indicators (0.2 to 0.4 liters) and pathogens (30 to 100 liters) resulted in more sensitive detection limits than are typical of routine monitoring. Microorganisms were detected in disinfected effluent samples at the following frequencies: total coliforms, 63%; fecal coliforms, 27%; enterococci, 27%; C. perfringens, 61%; F-specific coliphages, approximately 40%; and enteric viruses, 31%. Cryptosporidium oocysts and Giardia cysts were detected in 70% and 80%, respectively, of reclaimed water samples. Viable Cryptosporidium, based on cell culture infectivity assays, was detected in 20% of the reclaimed water samples. No strong correlation was found for any indicator-pathogen combination. When data for all indicators were tested using discriminant analysis, the presence/absence patterns for Giardia cysts, Cryptosporidium oocysts, infectious Cryptosporidium, and infectious enteric viruses were predicted for over 71% of disinfected effluents. The failure of measurements of single indicator organism to correlate with pathogens suggests that public health is not adequately protected by simple monitoring schemes based on detection of a single indicator, particularly at the detection limits routinely employed. Monitoring a suite of indicator organisms in reclaimed effluent is more likely to be predictive of the presence of certain pathogens, and a need for additional pathogen monitoring in reclaimed water in order to protect public health is suggested by this study.
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Next is the study on antibiotic resistant genes (ARGs) by Fahrenfiels, et al. Be aware that UV and chlorine are ineffective when used on ARGs at typical levels and contact times. The typical filters used for water systems are also often ineffective in stopping ARGs. Also, be aware that chlorine up-regulates virulence factors in pathogens such as MRSA. In this study, we found genes related to MRSA in the soil samples from Dos Pueblos High School's football field. This information was passed to the superintendent, apparently without effect.

Reclaimed water as a reservoir of antibiotic resistance genes: distribution system and irrigation implications.

Fahrenfeld N[1], Ma Y, O'Brien M, Pruden A.

Author information

Abstract

Treated wastewater is increasingly being reused to achieve sustainable water management in arid regions. The objective of this study was to quantify the distribution of antibiotic resistance genes (ARGs) in recycled water, particularly after it has passed through the distribution system, and to consider point-of-use implications for soil irrigation. Three separate reclaimedwastewater distribution systems in the western U.S. were examined. Quantitative polymerase chain reaction (qPCR) was used to quantify ARGs corresponding to resistance to sulfonamides (sul1, sul2), macrolides (ermF), tetracycline [tet(A), tet(O)], glycopeptides (vanA), and methicillin (mecA), in addition to genes present in waterborne pathogens Legionella pneumophila (Lmip), Escherichia coli (gadAB), and Pseudomonas aeruginosa (ecfx, gyrB). In a parallel lab study, the effect of irrigating an agricultural soil with secondary, chlorinated, or dechlorinated wastewater effluent was examined in batch microcosms. A broader range of ARGs were detected after the reclaimed water passed through the distribution systems, highlighting the importance of considering bacterial re-growth and the overall water quality at the point of use (POU). Screening for pathogens with qPCR indicated presence of Lmip and gadAB genes, but not ecfx or gyrB. In the lab study, chlorination was observed to reduce 16S rRNA and sul2 gene copies in the wastewater effluent, while dechlorination had no apparent effect. ARGs levels did not change with time in soil slurries incubated after a single irrigation event with any of the effluents. However, when irrigated repeatedly with secondary wastewater effluent (not chlorinated or dechlorinated), elevated levels of sul1 and sul2 were observed. This study suggests that reclaimed water may be an important reservoir of ARGs, especially at the POU, and that attention should be directed toward the fate of ARGs in irrigation water and the implications for human health.

Appl Environ Microbiol. 1982 Feb;43(2):371-7.

Effect of UV light disinfection on antibiotic-resistant coliforms in wastewater effluents.

Meckes MC.

Abstract

Total coliforms and total coliforms resistant to streptomycin, tetracycline, or chloramphenicol were isolated from filtered activated sludge effluents before and after UV light irradiation. Although the UV irradiation effectively disinfected the wastewater effluent, the percentage of the total surviving coliform population resistant to tetracycline or chloramphenicol was significantly higher than the percentage of the total coliform population resistant to those antibiotics before UV irradiation. This finding was attributed to the mechanism of R-factor-mediated resistance to tetracycline. No significant difference was noted for the percentage of the surviving total coliform population resistant to streptomycin before or after UV irradiation. Multiple drug resistance patterns of 300 total coliform isolates revealed that 82% were resistant to two or more antibiotics. Furthermore, 46% of these isolates were capable of transferring antibiotic resistance to a sensitive strain of Escherichia coli.

PMID:
7059170
[PubMed - indexed for MEDLINE]
PMCID:
PMC241834
Free PMC Article

Environ Sci Technol. 2007 Nov 1;41(21):7570-5.

Toxicogenomic response to chlorination includes induction of major virulence genes in Staphylococcus aureus.

Chang MW[1], Toghrol F, Bentley WE.

Author information

Abstract

Despite the widespread use of chlorination for microbial control in aqueous environments, cellular response mechanisms of human pathogens, such as Staphylococcus aureus, against chlorination remain unknown. In this work, genome-wide transcriptional analysis was performed to elucidate cellular response of S. aureusto hypochlorous acid, an active antimicrobial product of chlorination in aqueous solution. Our results suggest that hypochlorous acid repressed transcription of genes involved in cell wall synthesis, membrane transport, protein synthesis, and primary metabolism, while amino acid synthesis genes were induced. Furthermore, hypochlorous acid induced transcription of genes encoding major virulence factors of S. aureus, such as exotoxins, hemolysins, leukocidins, coagulases, and surface adhesion proteins, which all play essential roles in staphylococcal virulence. This work implies that chlorination may stimulate production of virulence factors, which provides new insight into host-pathogen interactions and effects of chlorine application for microbial control.

PMID:
18044543
[PubMed - indexed for MEDLINE]

Environ Toxicol Chem. 2006 Feb;25(2):317-26.

Presence and distribution of wastewater-derived pharmaceuticals in soil irrigated withreclaimed water.

Kinney CA[1], Furlong ET, Werner SL, Cahill JD.

Author information

Abstract

Three sites in the Front Range of Colorado, USA, were monitored from May through September 2003 to assess the presence and distribution of pharmaceuticals in soil irrigated with reclaimedwater derived from urban wastewater. Soil cores were collected monthly, and

19 pharmaceuticals, all of which were detected during the present study, were measured in 5-cm increments of the 30-cm cores. Samples of reclaimed water were analyzed three times during the study to assess the input of pharmaceuticals. Samples collected before the onset of irrigation in 2003 contained numerous pharmaceuticals, likely resulting from the previous year's irrigation. Several of the selected pharmaceuticals increased in total soil concentration at one or more of the sites. The four most commonly detected pharmaceuticals were erythromycin, carbamazepine, fluoxetine, and diphenhydramine. Typical concentrations of the individual pharmaceuticalsobserved were low (0.02-15 microg/kg dry soil). The existence of subsurface maximum concentrations and detectable concentrations at the lowest sampled soil depth might indicate interactions of soil components with pharmaceuticals during leaching through the vadose zone. Nevertheless, the present study demonstrates that reclaimed-water irrigation results in soil pharmaceutical concentrations that vary through the irrigation season and that some compounds persist for months after irrigation.
PMID:
16519291
[PubMed - indexed for MEDLINE

H&SC 5410

d) ″Contamination″ means an impairment of the quality of the waters of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease. ″Contamination″ shall include any equivalent effect resulting from the disposal of waste, whether or not waters of the state are affected.

(e) ″Pollution″ means an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects: (1) such waters for beneficial uses, or (2) facilities which serve such beneficial uses. ″Pollution″ may include ″contamination.″

(f) ″Nuisance″ means anything which: (1) is injurious to health,

NAS/NRC

Notes and thoughts from readings of the 6 papers cited in the 2002 NRC Report on Biosolids.

Lawrence------------

It has been held by some industry pundits that acquired resistance (lateral gene transfer) is a sometime, short time thing. Such is not the case. <u>Lawrence notes that incorporation of DNA fragments conferring resistance or virulence can transform a benign strain into a pathogen in but a single step. Horizontal transfer of genes is often accomplished by phages while in a lysogenic state.</u> Phages are abundant in sewage and within sewage plants. For example, the <u>transfer RNA locus leuX operates as an</u>

integration site for pathogenicity islands in uropathogenic E. coli. Acquired horizontally transferred genes do last for some time, Lawrence suggests, however, that very few are maintained more than 10 million years (Myr).

Pillai--------------1996

Absent stress of additional antibiotic challenges, Pseudomonas can maintain acquired resistance for multiple generations. In the early 1980s,
papers were reporting on the increasing public health impacts of antibiotic resistance. Between the 1960s and the 1990s, the route noted for antibiotic resistance spread amongst enteric bacteria was often wastewater. Pillai notes that between 1982 and 1989 resistance in
Campylobacter increased from 0% to11% in humans and from 0% to 14% in poultry. For those readers wishing to look at the advancement of antibiotic resistance in America's food supply, the NARMS site is a good place to start.

Pillai also notes that wastewater associated bacteria which exhibit multiple resistance patterns are able to transfer while within sewer plants,
relatively high rates amongst bacterial species. He also notes that fluoroquinolone resistant bacteria are stable in the absence of selective
pressure. It is mentioned that during the lab experiments with repeated transfers to ascertain reduction in resistance, the maintenance of
resistance between transfers could be attributed to VBNC.

I then brings up the work by Higgins and Murthy for WERF wherein it was noted that dewatering sewage sludge with centrifuge saw
the bacterial numbers shoot up several magnitudes within 20 minutes of a successful test with the standard designated indicator count
which cleared the material for land application. Thus the dewatering via centrifuge shows the fiction of the current standard tests. This
sudden multi-magnitude jump in numbers, according to the authors, was attributed to resuscitation of the VBNC bacteria in the samples.

Thus Pillai opines that even with methods used by his team to ascertain lateral transfer events, these were probably underestimated.

Above, Pillai discusses fluoroquinoqlone antibiotics. These are a wildly prescribed series and there are over 300 brand names in existence.
These drugs cover a wide range of both Gram positive and negative bacteria and include treatment for such problems as cystitis and other
urinary tract infections, chronic prostatitis, lower respiratory infections, skin and bone infections, typhoid fever, gonorrhea and anthrax.

If, for example, one were to look at the number of papers cataloged in the Medline series under the search terms “antibiotic resistance “ +
“sewage”, one would currently note 381. These listed papers do go back into the early 1960s. But the search may be confounded by the
fact that many of the papers that were once included are no longer found within that key word search criteria. For example, Nakamura,
found elsewhere, noted-------”The further along that wastewater had progressed through the treatment process the greater the tendency

was for appearance of the multiresistant isolates. These isolates also were shown to simultaneously carry transferable R plasmids.
Observed resistant patterns of R plasmids were mainly multiple and encoded to resistance to tetracycline, chloramphenicol, streptomycin
and sulfisoxazole. It became clear that multiplication of R plasmids took place in the activated sludge digestion tank. This study show that
drug resistance transfer mediated by these R plasmids may occur in actual wastewater treatment plants." (Nippon Koshu Eisei Zasshi. 1990 Feb;37(2):83-90.)

It should be of interest to the careful reader that many sewer plants have a direct return from the activated sludge portion of the plant to the
earlier parts of the treatment process. Thus, under these conditions, genetic information is recirculated amongst microbes that might not,
other than being in a sewer plant, ever see each other to exchange genetic information. Thus, sewer plants do bring together for genetic
exchange numerous disparate microbes, a mixing cauldron seldom if ever found in nature. This mixing will accelerate genetic exchange,
hence the development of newly emerging pathogens and their diseases.

Ochman----------------

This author discusses lateral gene transfer. In looking at various bacterial types, he notes that the base composition of sequences suggests
that at least half were acquired by horizontally transferable genes. He notes that enumeration methods probably underestimate the number of transferred genes. He comments on the movement of genes from Archaeans to bacteria. He further notes that simularities to Archael proteins
were found in other bacteria. Genes can transfer from Archae to mesophilic bacteria. (Thus, my thought, these transferred genes from thermo
tolerant Archae might establish heat tolerance that would preclude adequate disinfection at mesophilic temperatures.)

Ochman notes that transformation involves the uptake of naked DNA from the environment. It also has the potential to transmit between vary
distantly related organisms. Some bacteria are constantly ready to take up naked DNA but others need to reach certain stages in their life cycle, nonetheless are capable of high-level transformation.

He then discusses transfer via lysogenic phages or transduction. He notes that like transformation, transduction does not require donor and
recipient to be present in the same place or time. My thought here is this is a critical finding with respect to DNA floating around in a sewer plant.
This is confirmed by the following paper-------

Antonie Van Leeuwenhoek. 2001 Jun;79(2):141-7.

Environmental bacteriophage-host interactions: factors contribution to natural transduction.

Miller RV.
Department of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater 74078, USA. rum67@okstate.edu

Over the past two decades the potential for the exchange of bacterial genes in natural environments through transduction (bacteriophage-mediated gene transfer) has been well established. Studies carried out by various laboratories throughout the world have demonstrated that both chromosomal and plasmid DNA can be successfully transduced in natural environments ranging from sewer plants to rivers and lakes. Transduction has been shown to take place in the gills of oysters and the kidneys of mice. Model studies have demonstrated the ability of transduction to maintain genetic material in bacterial gene pools that would otherwise be lost because of negative fitness. Thus, transduction may affect the course of bacterial evolution. Identification of natural transduction has led to the investigation of the dynamics of bacteriophage host interactions in natural aquatic environments and to the exploration of various environmental factors that affect virus-host interactions. Two important environmental factors which affect virus-host interactions are the metabolic state of the host and the exposure of the host to DNA-damaging stresses such as solar UV light. Recent researches on these two areas of virus-host relationships are reviewed.
PMID: 11520000 [PubMed - indexed for MEDLINE]
This is important because of MRSA and its spread into the community.

Ochman notes that the movement of pathogenicity islands can be transferred via phage influence. He further notes that the incorporation involves actions of conserved integrases. Integrases are enzymes produced by a virus or phage that enables its genetic material to be incorporated into the DNA of the host cell, in this case S. aureus. Thus the phage attacking S. aureus promotes the excision, replication, and mobilization of a pathogenicity island harboring the gene for toxic shock toxin.

As we have seen from the work of Matt Wook Chang, exposure of S. aureus to chlorine enhances certain virulence factors,
see: http://cat.inist.fr/?aModele=afficheN&cpsidt=19219794. Despite the widespread use of chlorination for microbial control in aqueous environments, cellular response mechanisms of human pathogens, such as Staphylococcus aureus is repressed transcription of genes involved in cell wall synthesis, membrane transport, protein synthesis, and primary metabolism, while amino acid synthesis genes were induced. Furthermore, hypochlorous acid induced transcription of genes encoding major virulence factors of S. aureus, such as exotoxins, hemolysins, leukocidins, coagulases, and surface adhesion proteins, which all play essential roles in staphylococcal virulence. Thus chlorination may stimulate production of virulence factors, which provides new insight into host-pathogen interactions and effects of chlorine application for microbial control.

Hirsch-------------

First from Kummerer-------, see : http://jac.oxfordjournals.org/cgi/content/full/52/1/5 "Only a few of the compounds were partially biodegraded under test conditions in aquatic systems.[18,19] Most were persistent. The genotoxicity of compounds such as quinolones or metronidazole was not removed during these tests.[18] Quinolones, for example, adsorb strongly onto sewage sludge, soils and sediments andwere not biodegraded in tests with sediments. Less than 1% of sarafloxacin, a fluoroquinolone approved for the prevention of poultry diseases, was eliminated from different soils within 80 days, probably because of its high ability to bind to soil.[20] Virginiamycin, an antibiotic food additive administered orally as a growth promoter in farm animals, was found to biodegrade in different soils, but only with a long half-life.[21]Cyclosporin A was shown to degrade only after some months in samples of wet garden soil, despite the fact that several degrading strains have been isolated from soil. These findings indicate that biodegradation of**antibiotics** in STPs and other environmental compartments may not be an option for the reliable removal of antibiotic substances and this needs more detailed investigation. Furthermore, future measures aimed at saving **water** will cause a drop in the volume of effluent. The consumption of antimicrobials will, however, almost certainly continue to grow. The resultant higher concentration of **antibiotics** in urban waste **water** will, on the basis of present knowledge, have a substantial impact on bacteria in the aquatic environment. "

Now for Hirsch. He notes that levels of 5 ug/l are attainable within sewer plants. Kummerer notes that at least in hospital effluent, the levels can be a magnitude higher than noted by Hirsch. As to the elimination by sewer treatment--- Hirsch notes that it is often incomplete. Elimination rates are higher for medium polar drugs when compared to polar antibiotics which may not be eliminated at all. Hirsch also notes that levels of drugs in river water are generally one magnitude lower than the levels found in sewer plants. This, however may be confounded by the accumulations in the sediments as it is generally found that levels in the water column are considerably less than found within the underlying sediments.

Hirsch notes that drug residues in sewage are thought sufficient to either initiate resistance of just maintain it. This is, according to Hirsch, a serious threat to public health as more and more infections that are supported by drug resistant pathogens can no longer be treated with presently available drugs. Antibiotic residues in the environment are suspected to induce resistances in bacterial strains causing a serious threat to public health as more and more infections can no longer be treated with presently known antibiotics.

Not discussed by Hirsch is the effect of antibiotics and other pharmaceuticals on biofilms, the breaking up of such biofilms and then the deposition of those broken fragments on irrigated crops.

Arana-------------

Arana cites Meckes. Arana notes that there has been much effort in trying to raise the efficiency of wastewater treatment methods. He notes that "nowadays these methods are effective in eliminating bacteria." He further notes that treatment enhances the resistance and the outflow is higher in resistance than the incoming raw sewage. This is attributed to three factors: 1) a survival advantage accruing to plasmid-bearing strains, 2) enhanced plasmid transfer in wastewater plants, and 3) an enhanced resistance to disinfection enjoyed by plasmid-bearing strains. When speaking of E. coli, these bacteria are more likely to be found in the VBNC state. It is reported that resistant strains survive better than sensitive strains. Arana indicates that "so far it has not been established that there are direct relationships between antibiotic resistance and disinfectant resistance." This seems to be contrary to findings by G E Murray (http://aem.asm.org/cgi/content/abstract/48/1/7) -------, indicating "Chlorination of influent resulted in an increase in the proportion of bacteria resistant to ampicillin and cephalothin, the increase being most marked after regrowth occurred following chlorination. "

An interesting finding is that white light may reduce plasmid transfer. Also survival in wastewater is greater than survival in river water. This added survival in wastewater may be caused by the added nutrient availability as compared to river water. In addition, it is noted that even within VBNC states, recipient cells can still receive plasmids. Cells are often clumped and thus adhere together. These adhered cells exhibited higher transfer frequencies than free floating cells. Adherence to suspended matter also enhances plasmid transfer.

Pillai------------1997

Notes that the issue of multi drug resistant bacteria (MDRB) has become a significant problem facing clinical medicine. He also mentions that, " despite the concerns raised there is a serious lack of adequate surveillance data in the United States on the presence of MDRB in environments. This is echoed by the later findings of the EPA Office of Inspector General (OIG), which discussed in the Status Report, Land Application of Biosolids 2002—000004, March 28, 2002; www.epa.gov/oig/reports/2002/BIOSOLIDS_FINAL_REPORT.pdf.) made it very clear the Compliance and Enforcement Division was not capable of enforcing any laws to

protecting water or public health. The OIG said, “Compliance and Enforce has disinvested from the program.”
EPA officials said investigating health impacts from biosolids is not an EPA responsibility;
rather, they believe it is the responsibility of the National Institute of Occupational Safety and
Health, the Centers for Disease Control, and local health departments.” Thus, if this is the
case, where are the underlying policy and budgetary directives to these sister agencies to take up the slack?
Pillai further notes that the route for resistance determinant transmission among enteric bacteria is often wastewater. In following E. coli in a veal farm, he notes that survival was extended over a 7 week period of time. He then cites Stu Levey's work showing that antibiotic resistance determinants may enhance survival in the environment. Thus it seems that transfer to soil bacteria may see an enhanced survival in the recipient bacteria.

Chee-Sanford-----------

This author discusses the transfer of genes into the soil biota. He notes concerns because of increasing emergence of resistance in clinical strains and within the normal commensal microbiota. Following land application, persistence is noted in soil microbiota and have also been noted groundwater and in one study, occurrence of genes was more pronounced in the deeper wells. Thus on release into the environment, the genes can mobilize and persist. Mobility of resistant genes in the environment can be substantial. Resistant genes can be maintained in the microbial populations present.

He notes that the disseminating vector bacteria (the one carrying the gene) does not need to be maintained once the transfer has taken place. Once the resistant gene pool is mobilized into indigenous soil bacteria, it has a much better chance of survival, persistence, and mobility---effectively increasing the gene frequency in local populations and thus having an increased potential for reaching other ecosystems. Thus with constant application of antibiotic containing material, a concentrated environment may exist in which selection can occur. This concurs with the work of Chad Kinney, see: http://cat.inist.fr/?aModele=afficheN&cpsidt=17433346.

Résumé / Abstract

Three sites in the Front Range of Colorado, USA, were monitored from May through September 2003 to assess the presence and distribution of pharmaceuticals in soil irrigated with reclaimed water derived from urban wastewater. Soil cores were collected monthly, and 19 pharmaceuticals, all of which were detected during the present study, were measured in 5-cm increments of the 30-cm cores. Samples of reclaimed water were analyzed three times during the study to assess the input of pharmaceuticals. Samples collected before the onset of irrigation in 2003 contained numerous pharmaceuticals, likely resulting from the previous year's irrigation. Several of the selected pharmaceuticals increased in total soil concentration at one or more of the sites. The four most commonly detected pharmaceuticals were erythromycin, carbamazepine, fluoxetine, and diphenhydramine. Typical concentrations of the individual pharmaceuticals observed were low (0.02-15 μg/kg dry soil). The existence of subsurface maximum concentrations and detectable concentrations at the lowest sampled soil depth might indicate interactions of soil components with pharmaceuticals during leaching through the vadose zone. Nevertheless, the present study demonstrates that reclaimed-water irrigation results in soil pharmaceutical concentrations that vary through the irrigation season and that some compounds persist for months after irrigation.

Subject: Terms used in permits to guide water quality control may be worthless---any thoughts?

One of the things that now concerns me is the language used by the regulatory community when it issues permits that control water quality. The question is whether these words and phrases really have value in enforcement or are they just put into text to look good to the public, but in reality have no value. Examples are noted below. One of the issues we are working on is attempting to get the SWQCB/regional boards or CDPH to discuss how they use the terms in the Water Code and Health & Safety Code---***pollution***, how one defined it for purposes of enforcement, i.e., what a pollutant is? What are the objective criteria which would include or exclude a material or item? How one defines ***contamination*** and how one determines if a substance is a contaminant, and thus is the existence of either or both pollutants and contaminants likely to be a ***nuisance***? For example, see H&SC 5410--5411. We are particularly interested in whether or not antibiotic resistant bacteria or antibiotic resistant genes might be contaminants or pollutants and thus finding such in water would constitute then a nuisance, thus require abatement. These agencies absolutely refuse to discuss this and keep giving us the run around. This quest makes a lot of sense when considering the court case and the legal interpretation by Hatch and Parent of Hartwell. I can see clientele captured bureaucrats attempting to protect their industry clients by not defining these terms or not putting into permits solid measurements thus assuring ambiguity and therefore maintenance of deniable liability for illness. If they had numeric standards, then someone could go after the water agencies, but with nebulous words, it would be difficult to show causality.

The following court case (Hartwell Corp. v. Superior Court,) should be read in context with the data, for example, on the Laguna Co San's permit language. Words and verbal descriptions may be completely useless but sound good to the unwary public who can be lulled into believing that their health is in fact being protected when the reality is far from the case. Thus in the examples below, do the included phrases have any real meaning?

My guess, based on the court's decision, that the language in the permit is just puff. But the water supply industry seem to like this type of language because it assuages the customer but in reality carries little to no actual teeth.

Consequently, one of the concerns that is arising here, relates to the court interpretations on what constitutes a standard as compared to what the public may think is available for protection. There is apparently a wide range of terms that may have no value in actually assuring that water quality is in fact maintained. It would seem that the legislative bodies, either state of congressional, when promulgation law and regulations, tend to use descriptive phrases, such as healthful, clean, wholesome and as seen below out of the California Education Code:

Education Code Article 1. §38086 Establishment and use

Availability of tap water.

(a) Except as provided in subdivision (b), by July 1, 2011, a school district shall provide access to free, **fresh drinking water** during meal times in the food service areas of the schools under its jurisdiction,...."

What relevance does the word "fresh" actually have, how useful is it and if the water is not fresh but nonetheless meets standards; does the term fresh really impact users? Do the users have any recourse if the water is not "fresh" but meets standards? Might parents of these school children expect that the water would be "fresh" but that is merely an expectation?

or this example: State Law: "Reclaimed water used for groundwater recharge of domestic water supply aquifers by surface spreading **shall be at all times of a quality that fully protects public health."**

What is protecting the public health **fully?** How is that measured? Or is this just another meaningless puff statement? Let us assume that, as found in both Harwood and WERF, there are pathogens in that water and as found by Fahernfeld, there are ARGs. These are worrisome contaminants that may well adversely impact public health and thus "should" fit rather nicely into the constructs of H&SC 5410 (d), (e), and (f), et seq. Thus a specific question to the SWRCB as well as the Expert Panel-------how will this be dealt with----by continuing non-action?

This out of the SLO CCRWQCB on Laguna Co San

stringent effluent limitations necessary to implement water quality control **plans, to protect beneficial uses, and to prevent nuisance.**

Since we have thus far been unable to get the state to tell us what a pollutant or contaminant actually is, and how it is determined by the state and thus the issue of nuisance continues to remain unclear. But from the Hartwell court case, it may be moot. But so what if it is moot, the main question is what protects the people?

This material, when read in concert with the legal brief by Hatch and Parent, as found: http://199.237.255.122/h+p/hpnews/documents/07092007.pdf, clearly demonstrates that the protection of the citizen has been diminished. The Hatch and Parent brief merely says that water distributors are not responsible if the users become ill, i.e., that the liability for making people ill has been reduced if not eliminated. So, from the above you could presumably have "fresh" drinking water that met the standard of only so many coliform and yet it could be chucky-full of bacteria or viruses that don't show up in coliform tests, e.g., see Harwood and WERF.

There may be a disincentive to have tight standards because that would impinge on the industry, which at this time seems to be basically exempt from a wide range of issues. If the regulatory community has a disincentive to deal with CECs and resistance, and there are no standards, the euphemistic assurances, as exampled above merely lead the citizens down a prime rose path.

These above examples are apparently meaningless words based on the case below

A112964

COURT OF APPEAL OF CALIFORNIA, FIRST APPELLATE DISTRICT, DIVISION FIVE

154 Cal. App. 4th 659; 64 Cal. Rptr. 3d 827; 2007 Cal. App. LEXIS 1405; 37 ELR 20224

August 24, 2007, Filed

PRIOR HISTORY: [***1]
Superior Court of Los Angeles, JCCP No. 4135, Carl J. West, Judge.
Hartwell Corp. v. Superior Court, 27 Cal. 4th 256, 115 Cal. Rptr. 2d 874, 38 P.3d 1098, 2002 Cal. LEXIS 590 (2002).

November 2004, Volume 159, Issue 1, pp 277-289

Antibiotic Resistance in two Water Reclamation Systems for Space Applications

- Audra Morse,
- W. Andrew Jackson

http://link.springer.com/article/10.1023%2FB%3AWATE.0000049182.01490.a7

Water

Something Is Scary in the Water That Irrigates Many Chinese Parks

By Christina Larson August 07, 2014

In theory, recycling water in China's parched cities, including Beijing, makes ecological sense. But when wastewater is inadequately treated before being used to water urban parks—or redirected through scenic downtown canals—it can become an environmental health hazard.

Six researchers in Beijing and Xiamen working for the Chinese Academy of Sciences recently decided to compare conditions in city parks watered with fresh water vs. recycled water. Their findings, reported in a July 24 article in the journal *Environmental Science & Technology*, may make you squirm.

Conventional wastewater treatment plants are designed to remove solids, organic matter, and nutrients from water, but they aren't properly equipped to treat the kinds of waste that may be found in used water from hospitals and pharmaceutical facilities. In particular, most wastewater plants in China don't remove traces of antibiotics and may even become "reservoirs" for them, as the researchers put it.

Story: China Deploys Drones Against Pollution
Even treated wastewater can therefore become a vector for spreading antibiotics, as well as "antibiotic resistant genes"—chance genetic mutations that make bacteria resistant to drugs. The researchers found that urban parks in China doused with recycled water contained dangerously elevated levels of antibiotic resistant genes, with quantities from 100 times to 8,655 times greater than in other parks.
An April 30 report from the World Health Organization sounded the alarm about growing antibiotic resistance worldwide: "This serious threat is no longer a prediction for the future, it is happening right now in every region of the world. … Antibiotic resistance–when bacteria change so antibiotics no longer work in people who need them to treat infections–is now a major threat to public health."
Apparently lousy sewage systems and some irrigated parks in China, and likely elsewhere, are helping to accelerate the threat. China's situation is particularly risky because of a culture of rampant overprescription of antibiotics, which the government is trying hard to bring under control.
Story: China's Rich Keep Fit, Eat Well. And Hate Pollution
A 2012 study reported that people in China consume on average 138 grams of antibiotics per year; that's 10 times the per capita average in the U.S. That means a steady and dangerous stream of antibiotics get washed down the drain, into ill-equipped sewage plants, and possibly sprinkled onto the grass you or your friends in Beijing walk across.
Story: A Silver Lining in Beijing Smog: Soaring Pollution Penalty Revenues
Larson is a *Bloomberg Businessweek* contributor.