State Water Resources Control Board
Sent via Email to: commentletters@waterboards.ca.gov
Attn: Ms. Jeanine Townsend: Clerk to the Board

September 11, 2017

Re: Surface Water Augmentation Regulations

Dear State Water Board Members:

Thank you for the opportunity to comment on the proposed regulations. While I realize that a lot of work has gone into this, we have the same reservations that we had during the process for the Recycled Water Policy and subsequent documents released for comment on this and related topics since 2008.

We are concerned about the Board’s proposed rulemaking regarding the use of treated wastewater to augment reservoir supplies used for drinking water. RRWPC, as you may recall, has submitted numerous comments on the Recycled Water Policy and its Amendment, the Report to Legislature on DPR, and General Order WDRs for Recycled Water Use. We have also appeared in person before the Board at least four different times to discuss our concerns (many more times before the Regional Board). We have provided the Board with numerous documents containing peer reviewed studies concerning impacts of very low doses of minute amounts of estrogenic chemicals, some of which we attach to this letter (studies, not chemicals). In those comments, there are links to many biological, peer reviewed, scientific studies and articles.

The outcome? No one at the State has either addressed our concerns in a meaningful way or disputed them (that we recall). No one at the State has commented on the many peer reviewed scientific studies that assure us there is no safe level of an endocrine disrupting chemical in our bodies. No one has commented on the many examples in nature indicating that wildlife are suffering, and perhaps dying because of these exposures. Frogs in particular have been shown to grow multiple sets of male and female reproductive organs, mostly due to exposure to atrazine at a level as minute as parts per billion range. There are many examples of hermaphrodite changes taking place in gulls as well, as a result of extremely low exposures. In humans, these chemicals have causal links to cancer, heart disease, obesity, Alzheimer’s, birth defects (especially reproductive), Parkinson’s, diabetes, autism, and transgender issues, etc. Meeting drinking water MCL’s says nothing about avoiding these problems, and unfortunately, Health Departments have avoided this issue.

Further, to my knowledge, no study has been examined of all the many combined
exposures experienced by any individual, and perhaps it would be an impossible study to design and still have scientific credibility. For example, people are exposed to toxic endocrine disrupting chemicals when they touch most store receipts and then use a disinfectant wipe (or perhaps it’s the other way around). In combination, these two chemicals are much more toxic than each is separately. Also, two completely benign chemicals (those weren’t) can combine into one toxic one. There are at least 1000 chemicals that have been identified as having endocrine disruption properties and more are being discovered every day. Yet the Scientific Panel just examined epidemiological studies and not the actual biological studies conducted by endocrinologists themselves. (Do you know that male sperm counts have decreased on average by 50%?)

Based on studies I have seen, I’m not sure there are (yet) reliable technologies that can regularly remove all endocrine disrupting chemicals from the waste stream. As of a few years ago, even Dr. Crook asserted that in a document he wrote. (See my article and links to Environmental Perspectives). Furthermore, there is no endocrinologist on the Scientific Panel. There doesn’t seem to be much discussion about endocrinology and yet the Scientific Panel authorized the proposed project as being safe for human health. We are sorry that the focus is on accomplishing advanced treatment and getting the toxins out, and not on a range of biological results.

There are many uncertainties about the reliability of wastewater treatment effectiveness in regard to the multitude of chemicals in our environment. What happens when there is a major earthquake or a huge hurricane and the treatment system goes down for lengthy periods? As systems comes to rely on merging the waste with the real water, what happens if things fall apart for lengthy periods? What happens when a serious human error occurs (even the most highly qualified workers have slip-ups)? Where will fresh, healthy water come from under those circumstances? The management of these systems seems so complex, there must be times when things fall apart, and what then?

This analysis should at least acknowledge the existence of all the potential exposures to chemicals that one comes across in daily life. We constantly hear about chemicals in children’s toys, cloths, mother’s milk, wine, food, etc. Furthermore, while the water delivered to the tap may be touted as perfectly clean, we don’t know if the pipes they flow through are free of noxious toxins. Perhaps some of the worst industrial toxins are occasionally monitored, but the vast accumulation of a huge multitude of toxins in our daily lives, and which come together in the waste stream, is seldom mentioned. Perhaps the small amount ending up in the drinking water will be all that’s needed to cause developmental problems in young children (USGS has found numerous toxins in drinking water nationwide).

It may be that endocrine impacts are the worst-case outcome, and yet it’s one that has been ignored as the State moves forward in the practice of adding treated wastewater to the drinking water supply. (One article I attach by Peter Myers very clearly explains the endocrine, low dose response.) Finally, the adage that the dose makes the poison, is out of date and only confounds the issue in light of all the new science coming forth in the last 25 years. There is a huge divide among scientists in this regard, on the scale of those who believe in global warming and those who don’t. How many Irma’s do we need before all people are convinced? It doesn’t appear as though the ‘new’ thinkers have been part of this process.
RRWPC is in the midst of developing comments for the Russian River Pathogen TMDL and can only give these current documents a brief scrutiny. But they really don’t seem much different than prior documents that we have studied. (We attach two of our most recent comment letters, and their still timely attachments and links.) We would think that CEQA or its equivalent, would demand that you seriously address the issues raised by the documents we keep submitting. By authorizing the regulations, you are forwarding the development of new expensive infrastructure. The further you go along this track, the harder it will be to stop the train, since government gets invested in staying on track.

We are also concerned about the statement on page 2 of the “Initial Statement of Reasons”: “Although the absence of SWA regulations wouldn’t preclude the permitting of SWA projects, the adoption of uniform criteria in the form of SWA regulations is expected to streamline the permitting process.” We are concerned about allowing permits and streamlined projects moving forward until the concerns expressed in our letter regarding potential impacts from endocrine disrupting chemicals, are fully addressed.

INITIAL STATEMENT OF REASONS: Some Specific Concerns

- The Initial Statement of Reasons mentions the need to meet appropriate levels of toxins in monitoring. We can’t comment on the selected MCL’s, other than to say, if they are not based on biologic studies that determine health impacts to specific human populations, such as pregnant women, infants, children, lactating mothers, people with compromised immune systems, and include addressing the concept of low dose impacts, then the studies you DO look at may not provide the full range of risk possibilities.

- On page 16 it mentions that a report will be required if more than 10% of samples for quarter don’t meet surrogate or operational standard. That means that 10% can exceed current legal standards, not to mention exceed the true level at which harm can occur with ED (Endocrine Disrupting) chemicals. (What repercussions will occur if it happens more than once?) Furthermore, it indicates surrogates will be relied upon, which means the vast number of chemicals and chemical combinations will not be tested.

- While drinking water treatment methods will be used rather than wastewater treatment methods (less stringent), we still don’t feel secure that the levels allowed will prevent harm. The concept of ‘the dose makes the poison’ doesn’t apply with most ED chemicals. Furthermore, it seems as though the mechanisms to protect drinking water quality where wastewater is being used, should be far more stringent than what is being proposed here and may not consider the multitude of interactions with other sources. For instance, I wonder about aging infrastructure and leaking toxins from pipes. Are any lead pipes still used? Does the plastic pipe leach endocrine disrupting chemicals in its life history? Furthermore, there are many pipes involved after the final test and before reaching the mouth of a human. What are the potential effects, especially in poor neighborhoods where upkeep is minimal, to the water actually being used? Is that considered at all, especially since many of these toxins bioaccumulate?

- Since the State does not consider endocrine disruption controls as yet, how will having certified labs and workers help in regards to such exposures? It doesn’t seem
as though quarterly monitoring will be adequate to control toxins that harm in the parts per billion range. Also, you will be dealing with surrogates, so most chemical toxins won’t even be directly monitored. This is a problem in relation to ED’s.

- It is likely that the treatment processes will not be able to keep out all the pharmaceuticals, let alone their synthesized combinations either. This is an issue of great concern, along with the current crisis with antibiotic resistance. Antibiotics are found in meats and many food products. The more they are used, the more resistance is uncovered. In the meantime, pharmaceutical companies are doing almost nothing to develop new antibiotics, since they are not a big money maker and new ones are expensive to develop. Are pathogens in the water tested for antibiotic resistance? How can quality of drinking water be assured if not?

- In regards to unregulated chemicals, we don’t understand how the public can be assured that the analytical methods chosen will be adequate to protect their health. It seems as though the cart is before the horse here. Similar comment for log/10 removals. It seems like possible treatment barriers should be well established before implementation begins. What makes me nervous here (page 22) is the statement, “Failures of a shorter duration (i.e., 24 hours) are to be reported to the Regional Board no later than ten days after month in which incident(s) occurred.” And, “The criteria are designed to assure a safe, treatable source of water for a SWTP, not the uniformly high quality required of finished drinking water.” Some failures may be more serious than others and all should be reported immediately, if possible.

- How does Table 1 on page 20 relate to the new bacteria standard that is about to be considered by the State Water Board? Will the standards in this document match the new one you are about to adopt? Since health professionals seem to take more care with pathogens than with toxins, hopefully we can trust the numerical limits established for pathogens. (Surface water conditions are considered before addition of treated wastewater.) Communication glitches occur from time to time, and with people’s health more at stake in this process, what will happen if there is a breakdown and treatment levels are not obtained because of missed communication? What are the enforcement actions that might be taken to assure all treatment steps are completed appropriately?

- Why is quarterly monitoring of wastewater to be added to reservoir, considered adequate, especially since that appears to be the most risky of the drinking water/wastewater combination? We also wonder how frequently pathogens will be monitored?

- Overall, the level of monitoring is very detailed although relatively infrequent. As more toxins may be added in the future, this is likely to increase. (Will this compromise public health be at any time?) As I write this, Irma is moving through Florida, and everyone is anxious about the level of damage that might occur to an entire state. Here in California we have earthquakes, floods and fires to contend with. Since this technology relies on extremely careful monitoring, what happens when things break down? How will all of this work during emergencies and how much toxicity might customers be exposed to? It is my understanding that tests are available for EDs that are effective and relatively inexpensive (I could be wrong about that,) and focus on surrogates that have proven to cover the big picture. Could the State look into this? (Treatment plants can be down for weeks after this
disaster. What plans are in place for a situation where treated wastewater is added to reservoirs that might be impacted. What happens in an emergency?)

- On page 26 it is mentioned that additional monitoring may occur for chemical toxins that are expected to exist in the municipal wastewater. What would it take to get the State to require testing for EDs on a regular basis? If the State won’t even acknowledge the existence of low dose effects of endocrine disrupting chemicals, what good would it do to measure all the others? If we were to evaluate the basis for the burgeoning explosion of massive health care facilities in major population centers, would EDs be a big part of the picture?

- Page 32 requires that an Expert Panel or an independent scientific advisory panel, make a finding that SWA criteria adequately protect public health. In our view, unless these groups also include analysis by an endocrinologist with outstanding bona fides, their views and endorsements are incomplete. The scientific discoveries over the last 25 years regarding endocrine disruption, an aspect that affects almost all levels of health for humans, pets, wildlife and aquatic life, cannot be ignored without serious ramifications. Some people believe that this issue is every bit as important as global warming. As mentioned earlier, EDs cause a large range of reproductive problems, developmental problems, illnesses and life-threatening diseases. How can you not do more with this regulation before you head into programs that continue to inject disease causing chemicals directly into our bodies, our children and our planet?

Two Schools of Scientific Thought...

RRWPC has been aware that many scientists are of the old-school approach that believes in testing chemicals for toxicity separately (not looking at the effects of large combinations of toxins) and developing legal standards based on these singular effects. They also believe, we are told, that conventional pollutants are the main concern (I may not be expressing this appropriately, but I think you know what I mean.) and that EDs also appear in nature substances that we ingest, and as such, are not dangerous. Also, many believe that ‘the dose makes the poison’ and that no harm can occur with very small doses.

Then there is the new school (last 25 years or so) that feels they have demonstrated, that with the endocrine system, which governs most of our organ functions, that assumption is turned on its head. (Please see attachments.)

Although your expert panelists have impressive vitae’s, it appears they have not advised about low dose impacts (as far as I can tell). Furthermore, I have learned some things about the National Research Institute (NWRI) who, at the request of the State Water Board, established an expert panel to convene pursuant to CA Water Code, Sections 13562(a)(2) and 13565(a). Their report of 10-31-16 Entitled “Expert Panel Finding on California State Water Resources Control Board’s Proposed Uniform Water Recycling Criteria for Surface Water Augmentation”

It appears that the National Water Research Institute (NWRI) also weighed in with information on the safety of augmentation of drinking water sources with treated wastewater through their consultant role with San Diego Indirect Potable Reuse/Reservoir Augmentation Demonstration Project. Their general conclusion was
that reservoir augmentation was safe if all treatment processes are adequately maintained.

But we can’t help but wonder about the intellectual independence of this group, as they were called out by Wikipedia about possible conflict of interest. If they were used to certify the prior findings of the State, and support previous regulations, then their intellectual independence may be compromised.

The State must be aware of the member agencies of nonprofit NWRI who pay $50,000 a year for membership and who seek to utilize (or already utilize) the augmentation of reservoirs with treated wastewater. These are the proponents and NWRI members who take advantage of regulations to enable this system:

- Inland Empire Utilities Agency
- Irvine Ranch Water District
- Los Angeles Department of Water and Power
- Orange County Sanitation District
- **Orange County Water District**
- West Basin Municipal Water District

All of these entities are advocates for this use.

I googled NWRI on the web and came up with a Wikipedia entry which said this about NWRI:

“A major contributor to this article appears to have a close connection with its subject. It may require cleanup to comply with Wikipedia's content policies, particularly neutral point of view”

Then Wikipedia explains their conflict of interest statement as follows:

**Wikipedia’s conflict of interest statement:**

Conflict of interest (COI) editing involves contributing to Wikipedia about yourself, family, friends, clients, employers, or your financial and other relationships. Any external relationship can trigger a conflict of interest. That someone has a conflict of interest is a description of a situation, not a judgment about that person's opinions or integrity.

COI editing is strongly discouraged on Wikipedia. It undermines public confidence, and it risks causing public embarrassment to the individuals and companies being promoted. Editors with a COI cannot know whether or how much it has influenced their editing. If COI editing causes disruption, an administrator may opt to place blocks on the involved accounts.

Editors with a COI, including paid editors, are expected to disclose it whenever they seek to influence an affected article's content. Anyone editing for pay must disclose who is paying them, who the client is, and any other relevant affiliation; this is a requirement of the [Wikimedia Foundation](https://en.wikipedia.org/wiki/Wikimedia_Foundation). In addition, COI editors are generally advised not to edit affected articles directly, and to propose changes on talk pages.
Instead.

When investigating COI editing, do not reveal the identity of editors against their wishes. Wikipedia’s policy against harassment, in particular the prohibition against disclosing personal information, takes precedence over this guideline. Editors discussing changes to this guideline should disclose whether they have been paid to edit Wikipedia.

RRWPC’s concerns about situation....

The reason RRWPC includes this conflict of interest material is to point out that use of any research by NWRI should fully disclose to the public that the person writing the article did not respect Wikipedia’s conflict of interest requirements. RRWPC’s view is that if the State relied on this agency’s work in any way without full disclosure of the membership of the group, (individual scientists are listed, but not the agencies mentioned above who support the organization. We believe that it is inappropriate to not list that information since the Districts financially supporting the group are also the District’s aiming to be authorized through proposed regulations to implement the technology.

Also, we have another concern closely related to one above. We know that a major effort involving this organization and State Water Board staff included public relations campaigns to convince people that drinking wastewater is a safe thing to do. People were told it was very highly treated; that others used this wastewater to no harmful health effect, and that the State would assure it’s safety by regulating it carefully. (While the State may consider this truthful information, we don’t recall any downside to this practice being mentioned to the public.) At least two professional public relations firms were hired to conduct the public opinion research. In the survey questions I viewed, probably because endocrine disruption was not discussed from what I recall, the safety of this practice may have been misrepresented. I believe that only an endocrinologist who is fully informed about current science in the field, could verify whether I am correct or not.
Comment Letter: General Order WDRs for Recycled Water Use

Dear Ms. Townsend:

Introduction:
Russian River Watershed Protection Committee (RRWPC) is a nonprofit, public benefit corporation founded in 1980. For about the last ten years, we have been tracking and commenting on the issue of tertiary wastewater irrigation to both your Board and the Regional Water Quality Control Board. We have been especially concerned about irrigation wastewater runoff in urban areas. We appreciate the opportunity to comment on these Waste Discharge Requirements for Recycled Water Use.

RRWPC represents hundreds of lower Russian River residents, property and business owners, recreationists, etc. who are concerned about water quality and flows in the lower Russian River, one of the most popular summer vacation destinations of the Bay Area. Most of our local economy depends on tourism and any negative impacts on the river from upstream irrigation practices, in combination with very low flows, can have a devastating effect on our river and our economy. Furthermore, our already impaired river (temperature, sediments, pathogens) is bound to get much worse in the coming months because of drought. The Anti Degradation Policy, as analyzed on page 7 of the Order, addresses maintaining high quality waters, but what about preventing impaired water bodies from getting worse? Also, how can a determination be made on compliance with this policy without a CEQA process in place?
RRWPC recently circulated a one page form letter to our supporters about this Order with our quarterly mailer that went out last week. We attach a copy of the letter to these comments. Because of the holiday weekend, we assume that many people will get letters in after the deadline, but since all letters will be the same, we request that you enter them into the record for this item and accept the ones that come in late. We understand that you will be under no obligation to respond in that circumstance, but we would like people’s voices counted.

We realize that this Order is in response to the very serious drought the State is currently experiencing. Rather than focusing on much more cost effective conservation efforts however, the drum beats for potable reuse and wastewater irrigation are getting much stronger. In our area, excuses abound for not stepping up conservation programs with stringent, mandatory requirements (in ag as well as urban use), rather than the perceived easier route of developing expensive infrastructure to spray the dubious wastewater commodity on our urban landscape. (See attached letter to Board of Directors of Sonoma County Water Agency expressing our concern about a lack of mandatory conservation.) Agencies are concerned that utility budgets will suffer and jobs will be lost if conservation is truly successful. RRWPC has demonstrated that in our area, a well publicized voluntary conservation program has not come close to achieving its 20% savings goal because of a lack of teeth in the program. Instead, millions may be spent on infrastructure expansions for irrigation, and rates will probably go sky high because of it.

We believe that this Order represents the State’s best efforts in dealing with a real crisis, yet throughout the document, uncertainty is expressed about whether the wastewater is completely safe enough for human contact and discharge into waterways since there are about 80,000 chemicals on the market, most unregulated and safety unknown. Clean Water Act regulates about 200 of them. Where human and environmental health are involved, caution should prevail.

Examples of toxic exposures causing health impacts are many:
During review of the Recycled Water Policy, RRWPC provided your Board with a great deal of information on the topic of endocrine disruption and the risks associated with low dose exposures of humans and wildlife to these substances. There are at least 800 studies pointing to the connection of chemical exposures to resulting disease and deformity in humans and wildlife. Since approval of that policy, we have learned the following, (much of it in the last year) and this is only small part of list:

- We are in the sixth major extinction of species and this is the only one to be caused by human activity;
- on May 21st, 2014, a report stated that millions of dead fish have been found all over the world in the past month alone;
- Recently, a huge (and unusual) number of baby seals and sea lions have been reported sick and dying along the California coast;
- We have also learned that disappearing frogs have their immune systems weakened by chemicals, and that
- bees are dying because of pesticides. Furthermore,
• we are learning that Roundup is way less benign than formerly thought.

And there is more.
• Sweden is suing European Union for delay in identifying harmful chemicals in thousands of everyday products such as disinfectants, pesticides, and toiletries that have been linked to cancer, birth defects, and developmental disorders in children. Delay attributed to lobbying by chemical industry.
• We have learned that 23 babies were born with rare birth defect (anencephaly) in Central Washington from 2010 to 2013 and no one knows the cause.
• In 2009, studies showed that declining male fertility in UK fish AND human males is linked to a wide variety of chemicals found in water pollution.
• A report in 2014 indicated that Spanish male fish are being feminized on the Basque coast. Fish in most of their estuaries had been affected.
• A Canadian article in 2008 asked if men are becoming extinct since male infertility has been on the rise and more male infants born with impaired reproductive organs. Furthermore, world wide there are fewer male children being born than ever before.
• Low doses of controversial insecticide may harm friendly pests. (March 2014)
• Autism, sometimes thought to be induced by chemical exposures, has gone from 1 in 150 children born in 2007 to 1 in 68 children born in 2014. These statistics are from the US Center for Disease Control and Prevention.
• Hospitals may release antibiotic-resistant bacteria (E coli), which may be resistant to common treatment processes in wastewater treatment facilities. (In studies, E coli following wastewater treatment dropped by 94% but proportion of resistant bacteria doubled during treatment.)

(References can be provided on bold items above upon request.)

Reclamation Permits: Inadequate monitoring and enforcement:
The North Coast Board wrote extensive regulations into Reclamation Permits, but their monitoring and reporting requirements are so limited, it will be extremely difficult to know when compliance occurs and even more difficult to prove when it does not. Because this State Order turns what is normally a point source discharge into a non-point through allowance of incidental runoff, the monitoring and reporting requirements need to be more tightly monitored and enforced. Does this Order change the regulatory standing (i.e., displace it?) of Santa Rosa’s Reclamation Permit?

What is of great concern is that in the face of uncertainty, rather than following the Precautionary Principal, this Order allows a practice that, if perfectly carried out may or may not be somewhat safe, but inadequate monitoring and enforcement measures may still be needed to assure that occurs. There is a need to adequately fund the Regional Boards for the ability to enforce these measures.

Reliance on utilities to self-enforce may result in compliance problems. Since the utilities will be selling this water (Santa Rosa charges 95% of the cost of potable water.), it gives them a monetary motivation to cut costs wherever possible and assure maximization of water applications. It appears as though Santa Rosa has cut back on their successful conservation program, as they may believe that they have saturated their ability to lower
water use. They frequently claim that demand hardening has set in. In this difficult drought, funding may motivate such a comment. In our view, there is much more room for more conservation. It’s just the cheap and easy methods have already been explored.

In fact, we wonder if Regional Board will be playing an adequate role in enforcement of this policy? In the specifications on page 13, neither the Clean Water Act or Porter Cologne are mentioned. The wastewater provider is placed in the position of authority over the irrigation. They stand to benefit financially from their position and have motivation for hiding compliance issues. (Monitoring and reporting seem loose. that few will know when they are out of compliance and there is no clear requirements for time and type of inspecting.) What is included in the notice of Applicability. (It would be helpful if this were more clearly described in Order.)

**Need to include Precautionary Principal:**
EPA requires definite proof of harm for each hazardous chemical before taking regulatory action. The burden is placed on public agencies to demonstrate harm of each chemical. Potential health and environmental impacts are not considered when designing new technologies and materials. Government must wait until an overwhelming body of evidence is accumulated before intervention takes place. Polluters interfere to slow down regulatory process of very dangerous toxins. We read with skepticism that adherence to Title 22 will assure exposures to tertiary wastewater irrigation are safe.

**Four main ideas of Precautionary Principle:**
Preventive action must be taken in face of uncertainty. The burden of proof must be shifted to proponents of an activity. A wide range of alternatives should be explored to possibly harmful actions. Public participation in decision making must be increased (no restricting of CEQA).

(We intentionally differentiate between tertiary and further treatments such as ozonization and advanced membrane technology. The latter is expected to remove far more of toxic chemicals.)

**Concern that nonpoint runoff will be greatly increased:**
Incremental runoff incidences have consistently been ignored by Regional Board staff, even when repeated frequently. (When formal complaints were filed, Cease and Desist actions took place, but never Administrative Civil Liability action and fines have NEVER been imposed, even where multiple incidents occur at same location. This may be attributed to inadequate staffing at the agency.)

After RRWPC filed complaint against Santa Rosa, irrigators were encouraged to irrigate at night, so proving runoff may be impossible. In fact, those in charge of irrigation projects are not required to inspect when system is operating. They can go on site many hours after spigot has been turned off, and claim they do not see runoff. They can see a wet sidewalk and not call it runoff. As long as they don’t see it actually going into a drain, they can claim there is no runoff. Or in some cases, they can claim very small
amounts such as 5-10 gallons when millions are being irrigated over the season and likely that much more is being spilled. And then these incremental spills from over-watered sites, accumulate in the low flow creeks, with the result that none are actually regulated, at least by North Coast Regional Board. (RRWPC has provided numbers to back up these statements in our comments to Regional Board on Santa Rosa’s Reclamation permit. (attached))

Also, we need to point out that Santa Rosa oversees their own system and Rohnert Park’s because the latter is part of Subregional system. Santa Rosa also manages a large number of agricultural acres, 18 of which are still receiving payments ($225,000 last year) for using the wastewater for irrigation. While Rohnert Park will become Administrators for their own system next year, Santa Rosa will still be legally responsible for Rohnert Park spills because they are in charge of the Subregional system. We wonder if this will be a difficult administrative arrangement given Rohnert Park’s propensity for over irrigation and spills.

Wastewater irrigation not always cost effective & sometimes not available:
No consideration is given to issue that recycling infrastructure is very expensive and during drought, there is often little to recycle. Santa Rosa’s storage ponds often go way down in summer, depending on whether there were late spring rains. If extensive funds are spent on irrigation infrastructure and the wastewater is not there, it’s a double whammy cost wise. Wastewater is counted on to offset water use, but there is neither water or much wastewater available in drought, so problem is still not solved. (That is situation in Sonoma County.)

Studies on cost effectiveness of such projects must be developed (for both utility AND customer). A related issue is that utilities lose money when conservation succeeds. On the other hand, with recycled water, they can raise rates to pay for infrastructure, and then sell back the wastewater at 95% of the cost of potable water. This situation pits the customer against the utility in some areas cost wise. There may be huge variables in situations of different communities around the State. All of this needs to be analyzed. By eliminating CEQA, you eliminate public input into project consideration.

Title 22 does not fully insure protection of public health (#9):
The regulatory focus of wastewater irrigation relies mostly on Title 22, overseen by California’s Department of Health Services. This regulation primarily addresses human pathogens as they initiate acute diseases and does little or nothing to protect the public from chronic diseases, such as cancer. Cancer (and most chronic diseases) is often not diagnosed until long after the exposure(s) to agents that have caused it to occur. This makes it nearly impossible to protect people from harm from endocrine disrupting chemicals without implementing precautions before specific causation is determined.

It is of concern that Item # 25 on page 9 states: “By restricting the use of recycled water to Title 22 requirements, this order ensures that recycled water is used safely.” But then goes on to qualify the circumstances. My interpretation of this section is that Title 22 is considered fully safe if used as required, but if not, these other regulations will also be enforced to provide additional protection. Yet, you will not know if Title 22 is NOT
working until you have spills that someone finds out about and Regional Board follows up with disciplinary action.  **The second part of this explanation is very unclear and should be rewritten.** We believe that the practice of application at agronomic rates is alluded to here as the saving grace, and with that we mostly agree, except we do not believe that practices in place are sufficient to assure this is being and will always be implemented properly.

Certainly benefits can be provided by agronomic rates. That would assume that soil types, weather, wind, plants irrigated, impervious surfaces, etc. are all being considered, if one can assume full monitoring and reporting takes place. Unfortunately however, we have studied the situation in our area and found it to be very lacking. Also, what kind of level of safety can be assured when the vast number of chemicals in the wastewater are neither identified or removed? It cannot be assumed that all endocrine disruptors are removed unless a monitoring program takes place, which this Order refuses to do in the case of applications of tertiary water used for landscape irrigation (with particular concern for children’s schools, parks, playgrounds, etc.)

**Wastewater treatment lexicon misleading:**
Utilities departments in the past mislead the public by changing wastewater lexicon from *treated sewage* (1985) to *treated effluent* (1990), to *recycled wastewater* (1995) to *water reuse* (after 2000), etc., while making only a few changes in the quality of the product. By referring to tertiary treatment as ‘reused water’, they intentionally give an image of its being totally safe.

Furthermore, misrepresentations often occur when presenting information to irrigators and the public. For instance, the North Marin Water District has on their website a statement referring to their irrigation wastewater as being of highest quality, “*Of the three quality standards of recycled water in California, NMWD supply will be of the highest quality, and comply with requirements set by the County of Marin and the state—second only to drinking water in purity.*” When asked if they are using ozone and membrane filtration treatment, staff of the utility replied that they use tertiary. We have never heard that tertiary is a higher quality than wastewater treated with ozone and membrane filtration so it appears as though they are deliberately misleading. These misimpressions seem common with many utility departments.

In a packet used for training site supervisors of wastewater irrigation areas, Santa Rosa Subregional Treatment Plant staff identified Recycled Water as “…*wastewater that is treated to a high level and then reused for non-potable purposes*”. They go on to state that **Recycled Water is not wastewater.** They define tertiary treatment process as having four stages, the same four stages that had always been known to characterize tertiary treatment. It is never mentioned that only a very small number of about 80,000 chemicals in existence are even monitored. They merely state that, “*There has never been a documented illness from appropriate recycled water use.*” How would they know if such a case ever occurred?

Furthermore, recycled water in summer receives the exact same treatment as the wastewater discharged from their storage ponds in winter, for which they have a 200
page NPDES Permit to comply with. What’s the difference? If the assumption is that no discharge will occur, there’s plenty of evidence to the contrary. (namely, 200 photos at the Regional Board showing runoff in Santa Rosa and Rohnert Park)

So in summer, the point discharge becomes a nonpoint discharge and the emphasis is changed from compliance with NPDES Permit to compliance with Title 22, at a time of year when runoff into shallow, or even non-flowing streams can be most damaging because of unregulated remnant toxins and nutrients from the wastewater itself, or the products running off with it from the soils, such as pesticides, herbicides, soil amendments, etc.

Title 22 goes to great lengths to assure there are no cross connections between potable water pipes and purple wastewater pipes. To further assure no contact, they also require backflow devices. Many pages of the regulations are devoted to assuring that there is no contact between pipes.

Yet once the wastewater leaves the pipes in the irrigation process, almost anything goes with tertiary (per Title 22). The water can be used on playgrounds, parks, school yards, golf courses, pools; it can be watered on vegetables and food products, and possibly may even be used on organic produce. The basis for allowing this latter practice was based on one five year study in Monterey which determined that it was safe to eat raw food crops irrigated with tertiary wastewater. This study was published in 1987 and to our knowledge has not been replicated anywhere else. The only pollutants considered were the conventional ones monitored in NPDES permits. Endocrine disrupting chemicals and many others were not addressed.

**Incidental runoff reporting concerns:**

We wonder what will change in terms of monitoring and reporting under the new Order? RRWPC has had the following concerns with irrigation reports provided by City of Santa Rosa and Rohnert Park: (we have inspected files)

- Reclamation permits are vague about how irrigation will be monitored and relies on SR’s Recycled Water Guide which is not specific regarding individual sites;
- Guide is not specific on reporting
- The files contain no details on the determination of agronomic rates and it is totally unclear whether they are being followed. Inches and amounts of water applied to some parcels seems to indicate they are not.
- Report forms inadequate:
  - Irrigation takes place at night, but inspections occur in morning. No wastewater use amounts reported nor whether irrigation even occurred the day the report was made. Therefore you don’t know if they irrigated, but had no spills OR whether they just didn’t irrigate that day.
  - Neither exact time of inspection noted on report, nor hours of irrigation. Report can be made on runoff many hours after irrigation occurred.
  - Where there is overflow, no report on amount of ww irrigated that day and no way of knowing how much may have run off.
- Cursory exam of runoff, small amounts reported (5-10 gallons) and not even clear on HOW they make inspection. In other words, do they examine entire site or just do a drive by?
- Spray irrigation allowed next to and in-between imperious surfaces and on swales near storm drains. There is probably no way there would NOT be runoff.
- No regulation of repeat runoff year after year by certain irrigators. Many of these occur at schools, parks, and playgrounds where young children can have contact.
- No ACLs by Regional Board on entities having multiple runoff incidents over many years.
- Numerous irrigators report the use of gigantic amounts of wastewater on small urban parcels with a great deal of impervious surfaces and on clay soils (I believe). As much as 50” or more per acre application has been reported, far more than what is usually estimated for landscape (30”?).
- Reports note that irrigation overflows are reported to someone in charge, but nothing in files give follow up report on what was done. Subsequent reports often indicate repeat runoff events.
- Nothing in files about how agronomic rates are determined and it appears they may not be followed at all.

**MOST OF THESE ISSUES COULD BE EFFECTIVELY ADDRESSED BY ENCOURAGING DRIP IRRIGATION!**

**Some impacts of endocrine disruption and toxic exposures:**
Burgeoning science has been coming forth nonstop on endocrine disruption to humans and wildlife caused by a group of approximately 1000 chemicals in our everyday world. (list keeps growing) EPA and the State’s response thus far has been to insist that problem needs further study to determine the level at which a chemical is believed to cause a health problem. Most endocrinologists believe that the dose no longer determines the poison and that, in an erratic and unpredictable fashion, minute amounts of a toxin can cause significant impacts to the endocrine systems of humans and wildlife, which can result in developmental problems and disabilities, reproductive impairments, cancer, heart disease, autism, obesity, feminization and masculinization, diabetes, etc.

A recent article (*Chemical Regulation Reporter* 5-5-’14) draws attention to the fact that there are disagreements among scientists and between scientists and EPA about the issue of endocrine disruption. EPA had been persuaded to do special studies on the issue as a precursor to moving forward on regulatory action. They released their report in December, 2013. Since then, the National Academy of Sciences responded and their comments were since reported.

The National Academy of Sciences responded to the EPA report with a lengthy analysis of its findings. They stated that the report failed to demonstrate that the strategy to detect harm from endocrine disrupting chemicals that mimic, block or alter the function of hormones in the endocrine system, is flawed. The NAS report called on the EPA to further analyze testing strategies, explain what they are, and clearly describe how it
reaches its conclusions. The report focused on procedures used by EPA and scientific rationale for its conclusions. Apparently, EPA studies do not consider low dose impacts of these chemicals. Furthermore, EPA had been previously criticized for not examining scientific studies consistently and to transparently explain how it reaches its conclusions.

A six person Scientific Panel was set up under the Recycled Water Policy. They produced their report on CEC’s and recommended that no monitoring for endocrine disrupting chemicals was necessary for tertiary wastewater used on landscapes. Based on the following information, we respectfully disagree.

During the public comment process for the Recycled Water Policy Amendment, RRWPC approached lead author Dr. Laura Vandenberg of the recent study entitled: “Hormones and Endocrine-Disrupting Chemicals: Low-Dose Effects and Nonmonotonic Dose Responses” By Laura N. Vandenberg, Theo Colborn, Tyrone B. Hayes, Jerrold J. Heindel, David R. Jacobs, Jr., Duk-Hee Lee, Toshi Shioda, Ana M. Soto, Frederick S. vom Saal, Wade V. Welshons, R. Thomas Zoeller, and John Peterson Myers (Endocrine Reviews: March 14, 2012) to request that she write a letter to submit to State Water Board on the Amendment. (attached)

In her June 27, 2012 letter, lead study author, Laura Vandenberg stated: The concept of low dose effects and non-monotonic dose responses is not at the fringe of science. The Endocrine Society, the world’s largest professional association of clinical and research endocrinologists, has released two recent statements regarding EDCs, and has repeatedly reiterated the conclusion that low doses of EDCs are harmful to humans and wildlife [3, 4]. This conclusion has widespread acceptance in the field of endocrinology due to the strength of the published data. Additionally, following the publication of our review [2], Dr. Linda Birnbaum, Director of the National Institutes of Environmental Health Science (NIH) and one of the world’s leading toxicologists wrote an editorial stating: “the question is no longer whether nonmonotonic dose responses are ‘real’ and occur frequently enough to be a concern; clearly these are common phenomena with well-understood mechanisms...It is time to start the conversation between environmental health scientists, toxicologists, and risk assessors to determine how our understanding of low-dose effects and nonmonotonic dose responses influence the way risk assessments are performed for chemicals with endocrine-disrupting activities. Together, we can take appropriate actions to protect human and wildlife populations from these harmful chemicals and facilitate better regulatory decision making.” [5]

This study demonstrates that many endocrine disrupting chemicals have been found to cause significant health impacts to humans and wildlife at extremely low doses (approximately 1000 such chemicals have been identified so far). Those impacts are erratic and unpredictable. The twelve highly credentialed scientists connected with this study examined 800 studies on endocrine disruption that described low dose impacts causing many serious diseases and developmental problems in humans and wildlife. Yet the State’s Scientific Panel established to determine if endocrine disrupting chemicals need to be monitored, determined that it was not necessary.

Yet on the other hand, only one study done in 1987 (peer reviewed?) has determined that no harm will come from irrigating raw vegetables with wastewater. Agencies use this as justification for practice of wastewater irrigation of vegetable crops. There is a unexplained conflicting contradiction here.
In our comments to the State Board on the RWP Amendment, we quoted from Linda Sheehan formerly of California Coastkeeper, on this topic. She expressed the following important concerns about the Panel’s CEC report:

- Extremely limited set of monitoring proxies
- Concern about deference to CDPH
- Public’s relative ignorance about far reaching impacts of these chemicals
- Monitoring major focus on human health impacts

Ms. Sheehan calls for development of standardized interim list of CECs to be monitored that includes treatment plant efforts to identify appropriate CECs for freshwater ecotoxicological concerns. In regard to the monitoring recommended in the Study, she states on page 4 of her comments,

“However, the final Panel recommendations are completely inappropriate in light of the data and fail to meet the requirements or goals of the Recycled Water Policy. For example, the Panel did not expressly acknowledge the fact that discharge of recycled water to receiving waters occurs on a daily basis, …..or that many northern California streams that may receive recycled water effluent interact regularly and closely with groundwater. As such, the importance of including monitoring recommendations for those CECs that potentially pose a risk to aquatic life and ecosystems is absolutely critical. By failing to recommend a robust monitoring program even in the short-term in light of this dearth of data, the Report will only delay the increased, safe use of recycled water that California needs to ensure a sustainable water future.”

Repeated irrigation runoff happens year after year:
RRWPC had noted many irrigation overflows in Rohnert Park in 2009 and filed a complaint. There are approximately 200 photos of runoff in North Coast Regional Water Board files. Furthermore, I commented extensively to this issue in our comments on Santa Rosa’s NPDES and Reclamation Permit, authorized in December of 2013.

In our July 22nd comments (attached), I made the case that numbers presented in the quarterly, annual, and other reports, provide evidence that numerous urban landscape irrigators are repeatedly cited for multiple and even frequent incidents of irrigation runoff. There is no indication in any of these reports of what action may have been taken to stop these violations which we just learned have been going on at least since 2005. (Some irrigators have been cited for irrigation runoff as a result of citizen complaints, but none, to our knowledge, cited as a result of official investigations.)

Two examples found in annual reports covering 2010 through 2012. The Spreckles Community Center in Rohnert Park had 27 runoff incidents in 2010, 20 incidents in 2011, and 10 incidents in 2012. Prior years had spills as well although they are not listed here. Redwood Creek Apartments, also in Rohnert Park, had a significant number of repeated spills. In 2010 they had 19 spills, 18 in 2011, and 12 in 2012.

While the Water User’s Guide says that shutting off repeat offenders would only be done as a last resort, we believe that Santa Rosa has never cut anyone off. We have
heard them state that they probably never will. Furthermore, while these numbers appeared in annual reports, neither Santa Rosa nor the Regional Board, to the best of our knowledge, ever penalized anyone for multiple instances of over irrigation and runoff into waterways.

**Spill amounts impossible to identify accurately:**
While the number of reported gallons spilled were not significant, there is no way to ascertain whether those numbers are accurate and to what extent flows may have involved discharge to a waterway. Irrigation takes place at night, visual inspections occur once a week at the most, and it is not known what efforts were made to determine the length of time the spill had been taking place. It is also possible that visual inspections are cursory (drive by?) and spills may have occurred prior or subsequent to the inspection.

While the Guide calls for a designated staff person to be available 24/7 to deal with all emergencies, in most cases the staff person is responsible for multiple sites. In fact, 2/3 of Rohnert Park irrigation sites are separate public facilities and we believe, has one supervisor and two employees to cover about 20 parcels throughout the City. It is unclear how compliance is met at ALL times, when sites are inspected no more than once a week. In some circumstances, a leak can go on for days because no one is inspecting frequently enough and the general public thinks its potable water (Signs are half the size of a piece of notebook paper and usually very hard to see. I once went looking and couldn’t find them; someone had to show me.)

Often the amounts of runoff identified are in the under ten gallon range on small parcels that may irrigate a million plus gallons per acre a season to as much as 50 inches application (far too great to be agronomic). This is suspiciously low amount and causes us to believe that these amounts are estimates based on a very brief surveillance of the immediate situation. Furthermore, irrigators are required to look to Landscape Irrigation Guide for guidance on preventing runoff, but the Guide is usually vague and definitely not site specific. Special attention should be given to repeat offenders.

**Are agronomic rates utilized in urban areas?** (From RRWPC Comments on Reclamation Permit)
Were agronomic rates developed on individual parcels? Reclamation Permit calls for operations and management plan to be developed (not sure when) describing proper irrigation amounts and applications. We have not seen any specific rules for individual parcels to develop. In either case, a more detailed plan is needed to spell out how excessive and repeated runoff will be avoided. We don’t think the Guide is adequate.

We requested and studied City files at Regional Board offices of the largest wastewater irrigation users, and never saw agronomic analyses for individual parcels. Water user contracts appear to say nothing about calculating and/or utilizing agronomic rates. We saw nothing about agronomic applications in Recycled Water User’s Guide (Guide) either. After Reclamation Permit adopted by Regional Board, we spent time looking at files and saw almost nothing about how they were being calculated and controlled. RRWPC had filed a complaint on Santa Rosa’s runoff during freezing weather in early
2012. After that, the City started irrigating at night and since we live a considerable distance away, we were unable to track runoff any longer.

There is a list of all irrigators and the amount they irrigate at the back of Attachment G in the current permit. We assume these allocated amounts were based on studies of agronomic rates for individual properties. **Large agricultural parcels growing pasture or fodder crops use far less water per acre (in some cases half as much) than the urban landscape irrigators use.** We had been under the impression that fodder crops use large amounts of water. Furthermore, much of the urban landscape borders on impervious surfaces and wherever we have viewed urban runoff, it has involved water running over those surfaces, and into streets and storm drains.

Newly required stream setback designations in new permits for irrigation applications that will protect water quality, should be applied to all permits. If this is not feasible, at a minimum they should be applied to renewed permits as well.

It was stated that technical reports were required to be approved to demonstrate water is being applied in a manner to protect water quality. (E.O.’s summary report on page 3 states that Regional Board relies heavily on the Recycled Water User’s Guide to implement agronomic rates and minimize runoff.) Santa Rosa complained that over regulation discourages uses of wastewater for irrigation. Most oversight has been left in the hands of the irrigators and Regional Board staff play too minimal a role.

The Guide is vague on environmental protection while more focused on Title 22 requirements. The requirements listed in Attachment G are vague enough to allow for weak enforcement which accommodates Santa Rosa’s concern about regulatory overload. There is a need for a monitoring program that identifies the true amount of runoff. There is a need for enforcement against repeat offenders, including turning off the irrigation spout! There is a need for specific agronomic application reporting and enforcement that indicates amount to be applied next to amount actually applied. When an irrigator applies one or two million gallons per acre, there needs to be full justification for that amount.

**Water Quality Impacts on Recreational Waters:**
RRWPC is concerned that drought conditions provide special circumstances to which recreation is especially vulnerable. We have significant concerns that incidental runoff, even if in small amounts, will severely impact already challenged waterways with surplus nutrients (Laguna listed as impaired for nutrients, and lower Russian River has experienced severe problems also.) Right now, flows at the Hacienda Bridge, about six miles upstream from Guerneville, are under 100 cfs, an unusually low level for this time of year. We may be looking at extremely low flows all summer, even though Lake Sonoma water pool, from which contractor water is provided, is at 74%.

These low flows are not only unpleasant for recreationists, but are more likely to harbor and promote pathogens, the spread of invasive plants, excessive nutrient blooms, high water temperatures bad for many of the fish, etc. This will also have a huge impact on our local economy, not to mention the impact on public health. Allowing any kind of
runoff in these circumstances could lead to disease outbreaks, formation of toxic algae, and many other serious problems. The lower Russian River is a Public Trust resource, and as such, it must be preserved for recreational uses. As mentioned earlier, conservation can provide as many or more water saving benefits at far less cost to ratepayers, especially in light of the possibility that there will be little summer water to irrigate anyway.

Prohibitions: Comments (pages 14-16):

#2: If irrigation occurs at night, how will administrator know if wastewater is being applied to saturated soils?

#3: How will administrator assure that no wastewater is escaping if irrigation is at night and inspections don’t occur when system is operating?

#4: Airborne spray has been equated to incidental runoff and considered by Santa Rosa to be authorized under the Basin Plan and Recycled Water Policy. RRWPC disagrees with this interpretation. Who is right? Also, this appears it might contradict #7.

#5: Concerned that children will plan on damp grass at schools, playgrounds, play fields, etc. and have direct contact on skin and possibly mouth. This is not healthy!!!

#7: Concerned that even small spills/sprays into greatly impaired creeks during hot, dry summer, will cause further impairment and have health impacts on humans and pets using water ways for recreation.

To end on a positive note, here are some recommendations for best management practices that would make irrigation, particularly on small parcels in urban areas, much safer.

- Irrigation inspections should take place daily and only when system is operating.
- No irrigation should take place 100’ from any creek or waterway.
- System should be temporarily turned off until problem is addressed if any water is in gutter heading to drain.
- No irrigation should occur on narrow vegetation strips between impervious surfaces.
- Tertiary wastewater used for landscape and agricultural irrigation should be tested for endocrine disrupting chemicals.
- Reports should note time of inspection and times and amounts of irrigation.
- Irrigators should be actively encouraged to use drip irrigation.
- Signs informing people irrigation with treated wastewater is used should be at least 8.5”x11” and in contrasting colors that are easily visible.
- Very high water users should be tracked and inspected more carefully for compliance.
- Whenever there are signs of runoff (such as wet pavement), inspections should be more frequent and detailed until the situation is addressed and corrected.
- Regional Board staff should investigate sites where repeated incidents occur.

Thank you for the opportunity to comment on this General Order. We hope the issues raised in this letter will be noticed and addressed.

Sincerely,
Brenda Adelman
ATTACHED DOCUMENTS:

1. RRWPC form letter from supporters (1 page)
2. RRWPC letter to SCWA Board of Directors on Drought
3. RRWPC July and December Comments on Santa Rosa’s Reclamation Permit
4. Laura Vandenberg’s letter to State Board regarding Recycled Water Policy Amendment, including her article on low dose exposures to endocrine disrupting chemicals
5. RRWPC Complaint to Regional Board (1-30-2012) on Santa Rosa’s irrigation violations
June 27, 2012

Jeanine Townsend, Clerk to the Board  
State Water Resources Control Board  
1001 I Street, 24th floor  
Sacramento, CA 95814

RE: Comment letter-Amendment to the Recycled Water Policy

Dear Members of the State Water Resources Control Board,

I am an academic scientist who has worked for nine years on issues related to endocrine disruptors, including assessments of human exposures, meta-analyses of published literature, and benchwork assessing the effects of chemicals on development, behavior, reproduction, and other endpoints in rodents and aquatic animals. My PhD is in Cell, Molecular and Developmental Biology, although my work is also well recognized in the field of Environmental Health Science. I have published more than 25 peer-reviewed studies and two book chapters and have served on expert scientific and risk assessment panels in the EU and the US. I was also the lead author on the most comprehensive review to date on low dose exposures to endocrine disrupting chemicals (EDCs; discussed in more detail below).

I am writing to challenge the assertion that “monitoring of individual CECs is not [necessary] for recycled water used for landscape irrigation.” I encourage you to consider the extensive peer-reviewed scientific literature on the effects of low doses of EDCs before making decisions about chemical safety in the water supply. Although your scientific board, and many toxicologists around the world, conclude that “the dose makes the poison” when it comes to environmental toxicants, this statement is simply not supported by fact when the chemical in question is a hormone, hormone mimic, or hormone blocker.

In 2001-2002, the National Toxicology Program (NTP) addressed whether there was sufficient evidence to conclude that EDCs act at low doses, i.e. at the doses that humans encounter in their everyday lives. As you are likely well aware, humans encounter EDCs in their food, water, air, dust, as well as household products like detergents, upholstery, solvents, etc. Although typical humans are exposed to low levels of these chemicals (often in the nanogram per kilogram body weight range), the US FDA has identified more than 1000 EDCs in current use, a significant percentage of the over 80,000 chemicals currently in commerce (see http://www.fda.gov/scienceresearch/bioinformaticstools/endocrinedisruptorknowledgebase/default.htm). In 2002, the NTP addressed whether there was significant support in the scientific literature for The Low Dose Hypothesis, the scientific hypothesis that EDCs could affect development and reproduction of animals in the range that humans typically experience, i.e. the
low dose range. Although the NTP was hindered at that time by a relative paucity of data, they did conclude that there was evidence for low dose effects for several EDCs including DES, genistein, nonylphenol and methoxychlor [1].

In 2009, I began working with a group of 11 experts in the fields of endocrinology, cancer biology, ecology, developmental biology, and epidemiology on re-assessing scientific support for The Low Dose Hypothesis. These experts are at the forefront of their fields, have served on expert panels around the world, testified before the US Congress, and are collectively the authors of more than 1000 papers on environmental chemicals. Most of these scientists have been working on this issue for decades.

It took us three years to review over 800 published papers from the endocrinology and toxicology literature. Looking at this body of evidence as a whole, we concluded that there was clear and consistent evidence that a large number of EDCs have effects at low doses [2]. In fact, for every chemical where we could identify a low-dose cut-off and low dose studies had been performed, there were low dose effects. These chemicals include herbicides, insecticides, fungicides, preservatives, industrial chemicals, surfactants, plasticizers, pharmaceuticals, flame retardants and anti-bacterial agents, among others. We also identified hundreds of examples of non-monotonic dose response curves, i.e. those where the dose does not make the poison. Not only did we identify these types of responses in cultured cells and laboratory animals, but they were also observed in human populations.

Our analysis indicates that low dose effects and non-monotonic dose responses are common for EDCs, and in fact may be the expected type of biological response for this large class of chemicals. Most importantly, we have a great understanding of the mechanisms behind these types of effects; hormones act in the body at exceedingly low concentrations, i.e. in the part per trillion or part per billion range. The endocrine system is tuned to respond to these low doses. Thus, low doses of chemicals that mimic hormones follow the same “rules” as the natural compounds. Additionally, while these low levels of hormones can have reversible actions in adults (i.e. an adult female taking pharmaceutical estrogens [birth control pills] will have reduced fertility due to ovulation inhibition, but cessation of pharmaceutical treatment restores her fertility), hormones are known to change the development and differentiation of tissues in embryos, fetuses, and even neonates. These effects will be permanent and irreversible.

The concept of low dose effects and non-monotonic dose responses is not at the fringe of science. The Endocrine Society, the world’s largest professional association of clinical and research endocrinologists, has released two recent statements regarding EDCs, and has repeatedly reiterated the conclusion that low doses of EDCs are harmful to humans and wildlife [3, 4]. This conclusion has widespread acceptance in the field of endocrinology due to the strength of the published data. Additionally, following the publication of our review [2], Dr. Linda Birnbaum, Director of the National Institutes of Environmental Health Science (NIH) and one of the world’s leading toxicologists wrote an editorial stating: “the question is no longer whether nonmonotonic dose responses are ‘real’ and occur frequently enough to be a concern; clearly these are common phenomena with well-understood mechanisms...It is time to start the conversation between environmental health scientists, toxicologists, and risk assessors to determine how our understanding of low-dose effects and nonmonotonic dose responses influence the way risk assessments are performed for chemicals with endocrine-disrupting activities. Together, we can take appropriate actions to protect human and wildlife populations from these harmful chemicals and facilitate better regulatory decision making.” [5]
On page 13 of your revised policy, it is stated that “Regulatory requirements for recycled water shall be based on the best available peer-reviewed science.” The low dose literature that we reviewed in our recent analysis was all peer-reviewed science, and our analysis was peer reviewed as well. Yet this vast body of science has not been considered or addressed by the board. Thus, I respectfully ask this committee to reconsider suggestions that exposure of human and wildlife populations to EDCs, including pharmaceuticals, should not be concerning if the concentrations of these chemicals are “low”. Clearly, relying on the centuries old adage that “the dose makes the poison” is not sufficient to protect public health.

Sincerely,

Laura N. Vandenberg, Ph.D.
Tufts University Center for Regenerative & Developmental Biology
References Cited


Environmental Health

ENVIRONMENTAL CHEMICALS
Large Effects from Low Doses
Laura N. Vandenbeng, PhD; R. Thomas Zoeller, PhD; J.P. Myers, PhD

Virtually all safety standards for chemical exposures are determined through a process that assumes that high-dose testing will reveal relevant risks because “the dose makes the poison.” For many well-studied contaminants this is a reasonable assumption, but for compounds that behave like hormones, it is demonstrably false. The public health implications of this conclusion are enormous, because it means that many—likely dozens, plausibly hundreds, possibly thousands—of today’s chemical safety standards are too weak by orders of magnitude.

The basis for this conclusion derives from endocrinology. In endocrinology, it is well established that the impacts of hormones (such as estrogen) at high doses can differ from those in the “physiological range” of normal circulating levels of hormones in serum; it is at these concentrations that hormones interact with their receptors to cause physiological and developmental changes by altering gene expression. Indeed, hormones at abnormally high doses are often overtly toxic, through mechanisms that have nothing to do with receptor action.

As research has expanded into the effects of endocrine-disrupting chemicals (EDCs), it has been shown that they follow the same rules that hormones follow. Unfortunately, this runs counter to the core assumption that forms the basis for all toxicological testing done to establish regulatory standards: High-dose testing will be informative about low-dose impacts.

The EPA defines an EDC as “an exogenous agent that interferes with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behavior.” Although Rachel Carson examined the effects of many environmental chemicals on health and reproduction in her landmark book Silent Spring, work on EDCs really took shape in 1991, when a group of scientists met at the Wingspread Conference Center in Racine, Wisconsin, to discuss research on the effects of environmental chemicals on sexual development. The Wingspread attendees produced a consensus statement stating, “We are certain of the following: A large number of man-made chemicals that have been released into the environment, as well as a few natural ones, have the potential to disrupt the endocrine system of animals, including humans.”

EDCs are now understood to be any chemicals that interact with the endocrine system, including chemicals that act as agonists and antagonists of hormone receptors, including estrogen, androgen, thyroid, glucocorticoid, retinoid, and others. To determine the mode of action of these chemicals, both in vivo (animal) and in vitro (cell culture) assays have been developed. While most chemicals on the market today have never been tested for safety, much less for endocrine disruption, these assays could be used to test new chemicals for hormonal activity prior to their entry into the environment through the food supply, packaging materials, or as waste; they are also widely used to test for their hormonal activity many chemicals that are already in use. Chemicals with a wide range of uses, including detergents, plastics, cosmetics, pesticides, pharmaceuticals, and flame retardants, among others, have been shown to have endocrine-disruptor activities.

In 2002, the National Toxicology Program (NTP) examined evidence for what has been termed “the low-dose hypothesis,” i.e., the theory that EDCs could have actions at low doses. What is meant by “low doses”? Typically, these are doses in the range of what humans experience in their ever-

Continued on the following page...
Continued from previous page . . .

day lives—residues on food, in the air, in dust, and in drinking water. Low doses are often within the range that traditional toxicological testing has determined to be “safe.”

The question is whether EDCs are safe at the doses the typical person experiences. To determine what doses are safe, regulatory toxicology usually starts by administering large doses of a chemical to animals, identifying the highest dose at which no effect is found, and then extrapolating downward to calculate a safe dose. Those “safe” doses are rarely tested. Yet EDCs, like hormones, defy the toxicological dogma: Low doses can have effects that are not expected from high-dose exposures. In fact, these effects can be observed at doses orders of magnitude beneath the highest dose that produces no effect using traditional approaches. The mechanisms by which chemicals cause high-dose effects usually are completely unrelated to mechanisms that EDCs employ at low doses, and the effects of high and low doses can be on completely different endpoints.

In our review of the EDC literature, we found hundreds of examples of these types of responses, termed nonmonotonic responses, in cultured cells, animals, and even human populations. Many of these chemicals have effects at low doses, providing strong evidence that calculated “safe” doses of these chemicals are not, in fact, safe.1

Are these chemicals adversely affecting human health? Many of the earliest epidemiology studies examining the effects of EDCs studied occupationally or accidentally exposed individuals, i.e., people who were exposed to relatively high doses, either acutely or over longer periods of time. Now a large number of epidemiology studies have focused on environmentally exposed individuals, i.e., people who are exposed to EDCs from everyday life. These studies show that many of the effects observed in cultured cells and controlled animal experiments accurately predict what epidemiologists are observing in human populations: associations between human exposures and disease endpoints consistent with the “low-dose hypothesis.”

So where do we go from here? As scientists, these findings suggest for us that EDCs, as a chemical class, act very similarly to the hormones they mimic or block: They act at low doses, with effects that are more pronounced when exposures occur during critical periods of development. Just as hormones have nonmonotonic relationships between dose and effect, nonmonotonic effects of EDCs are expected. This means that high-dose testing is insufficient to establish the safety of low doses. In our review, we propose some changes to the way risk assessors determine safety of EDCs: 1) “safe” doses of chemicals, and chemicals in the range of human exposures, should be tested; 2) regulators should assume that EDCs produce nonmonotonic dose responses; 3) more sensitive endpoints should be included in chemical testing.

What can the average person, or patient, do to reduce EDC exposures? This is, of course, an important issue for health care practitioners and others invested in improving public health. Several studies suggest that making small lifestyle changes can have dramatic effects on exposure levels. Patients should be encouraged to make lifestyle choices that reduce known EDC exposures. However, the lessons learned from the published literature seem to be clear: Even low doses, including reduced exposures from changes in consumer behavior, cannot be considered safe. Thus, widespread changes to chemical safety regulations are likely to have the widest effects on human health.

We encourage physicians, nurses, public health administrators, and others working in the medical field to read our recent review and to get involved with the many scientific societies that support new approaches to chemical regulation that better reflect current scientific understanding than do standard toxicological procedures. Your expertise provides an important voice to help the risk assessment community develop new approaches to chemical risk assessment, especially as it pertains to EDCs. Hormones are important signaling molecules that dictate the health of individuals throughout the life course, and therefore the effects of EDCs simply cannot be ignored.

Laura N. Vandenberg, PhD, is with the Center for Regenerative and Developmental Biology and Department of Biology at Tufts University. R. Thomas Zoeller, PhD, is with the Department of Biology at the University of Massachusetts in Amherst. J.P. Myers, PhD, works for Environmental Health Sciences in Charlotteville, Virginia.

References


RRWPC

Russian River Watershed Protection Committee
P.O. Box 501
Guerneville, CA 95446
http://www.rrwpc.org

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board

Sent via Email to: commentletters@waterboards.ca.gov
October 23, 2016

COMMENT LETTER-REPORT TO LEGISLATURE ON DPR

Dear Ms. Townsend:

The purpose of this letter is to provide comments on the Report to the Legislature on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse and recommendations from expert and advisory panels on that topic. We appreciate the opportunity to comment on this report.

RRWPC Background....
Russian River Watershed Protection Committee (RRWPC) is a nonprofit, public benefit corporation founded in 1980. For about the last eight years, we have been tracking and commenting on the issue of wastewater reuse (specifically regarding tertiary wastewater irrigation) to both your Board and the Regional Water Quality Control Board. During that time, RRWPC has submitted comments and attachments on the Recycled Water Policy and the Policy Amendment, the General Waste Discharge Requirements for Landscape Irrigation Users of Municipal Recycled Water (General Permit), the General Order for Recycled Water Use (2014 and 2016), The North Coast Basin Plan Amendment for Recycled Water Use, etc. We include via link RRWPC Comments and Attachments on the General Order for Recycled Water Use (2016) for this record: http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/comments/general_order/)

RRWPC represents hundreds of lower Russian River residents, property and business owners, recreationists, etc. who are concerned about water quality and flows, along with clean drinking water, in the lower Russian River, one of the most popular summer vacation destinations of the Bay Area. For years, our area was the recipient of Santa
Rosa’s treated wastewater discharges into our river. For fifteen years we battled this problem and they ultimately built a 40-mile pipeline to take their wastewater to the Geysers steam fields. This has sensitized our community to the problems of allowing toxic materials into our waterways and we are deeply concerned about DPR.

We are concerned that little is known about the toxic substances in our river and we have always wondered what unregulated remnant toxins enter the river through other wastewater discharges, agricultural and irrigation runoff. While the SWAMP program has been conducting some tests on river toxicity, we have not seen any results as yet. The specter of DPR may be enough to drive people to the bottle, the water bottle that is, as some urban water districts promote, “Take it from the tap”.

We are aware that the purpose of these comments is to address the feasibility of developing water recycling criteria for DPR to inform the Legislature, and that it is highly unlikely that DPR would become a reality for Northern California anytime soon. We are nonetheless very concerned about the prospect of having statewide regulations developed at this time for direct potable reuse. While we do not claim to be experts in the field of wastewater technology, especially at its highest level of constituent removal, we do know enough about some of the vulnerabilities and issues connected with this possibility that we wish to have our concerns about public health and background information about endocrine disruption entered into the record.

**DPR may be infeasible.....**

What we do know is that, if done with full consideration of all potential health risks, making the adaptations needed for DPR will be very expensive, may involve higher energy use and potentially increased carbon releases (contrary to current goals to reduce carbon emissions). As with all infrastructure projects, it will ultimately be subject to human failure (with associated higher risk to the public), natural disaster, deterioration with age, not to mention unknown environmental side effects of the technology that may be difficult and expensive to address. These documents provided far more detail on the technical toxin removal aspects of DPR, but left the critical and complex health risk analyses to some vague future studies.

Our growing concerns about endocrine disruption impacts, sometimes caused by the chemical soup of unregulated chemicals bought together by wastewater treatment processes, motivate us to keep commenting on this issue. A woman acquaintance from Santa Cruz, Jude Todd PhD, has authorized me to submit her 27-page analysis of the issue, written to address reuse in the Santa Cruz area and attached to this submission. We share many of the same concerns and I am grateful for her input.

Dr. Todd has comprehensively detailed the issues with wastewater reuse and CECs with specific focus on endocrine disruption. (Attachment #1) She also addresses indirect potable reuse on page 13 of her document, expressing significant concerns about the very limited monitoring of only six constituents out of the many thousand toxins of concern. On page 14 she makes the astute observation that, 

*Generally speaking, regulatory toxicologists are not on the same page with endocrinologists, developmental biologists, molecular biologists, geneticists, epidemiologists, and other independent scientists who understand how endocrine disruptors and other CECs impact living organisms. As Andrea Gore, editor of Endocrinology, puts it, “There are fundamental differences between...”*
regulatory toxicologists and what I refer to as ‘people who understand the endocrine science.’” (qtd. in Brown and Grossman 2015)."

Although her focus is mostly on wastewater irrigation, the issues Dr. Todd delineates in her paper are every bit as important and relevant to DPR, and perhaps even more so. She also provides an extensive list of scientific resources that should be of value to your staff and the Legislature. I urge you to read this important paper. Can you even consider taking steps to put wastewater into the drinking water supply while ignoring the scientific work of so many experts working in the field of endocrine disruption?

Need for full disclosure on extent of effort and potential impacts….
I’m concerned that Water Board staff and their panels have not defined the extent of the problem of endocrine disruption in the report to the Legislature. Perhaps the quote immediately above explains why. In your staff responses to RRWPC comments on the General Order for Recycled Water Use, it states on page 30, “The Science Advisory Panel acknowledged that the science regarding endocrine disrupting chemicals is incomplete, especially regarding mixtures of CECs.”

Rather than acknowledging all the scientific work that has already been done, the Panel mostly ignores the vast amount of research conducted by the many professionals noted above, along with environmental health organizations and publications such as Environmental Health Perspectives, San Francisco Medical Society Journal, Environmental Health News, The Endocrine Society, Environmental Working Group, USGS, and many more noted in our Endocrine Resource List (Attachment #2) in Canada, Europe, and other advanced countries. While the knowledge in this field continues to evolve, and many more scientific breakthroughs will no doubt occur, it is a travesty to pretend that nothing worthy of note has been accomplished as of this time. (Our lists could be much longer; resources provided in this letter are the tip of the iceberg.)

Why is there no mention of Dr. John Peterson Myers (Pete Myers), who for 25 years, along with Theo Colborn, Lou Guillette and numerous others, lead the field of endocrine disruption and its effects on human health and wildlife? Unfortunately, Dr. Colborn died almost two years ago and is greatly missed; but we wonder why has her name or Dr. Myers’s never appeared in any of your documents? (We attach an obituary of Theo telling of her accomplishments over 25 years (Attachment #3) and a prestigious National Institute of Environmental Health Sciences, (part of NIH) recent award to Dr. Myers (Attachment #4).)

The work of Pete Myers and Theo Colborn resulted in the book, Stolen Future that was published in the mid-90’s. Subsequently it triggered the release of hundreds of millions of dollars for endocrine research (especially from NIH) which in turn brought forth much of the progress in this field over the years since. And their names and their work and the studies they generated don’t seem to even be worthy of a mention in any of your documents. Why is that? (I again attach my list of references containing these and other quality scientific references. (Attachment #4)

Laura Vandenberg, PhD, who was a lead writer among 12 scientists, including Dr. Colborn and Dr. Myers, had submitted a comment letter on the Recycled Water Policy Amendment stating that there is no safe dose of endocrine disrupting chemicals. She
also emphasized that this is not controversial and that The Endocrine Society, with hundreds of member endocrinologists from around the globe, supports this view completely. (Attachment #5) The link to the study, published in March, 2012, and documents about 800 studies on endocrine disruption, is:


The Endocrine Disruption Exchange (TEDX) is Dr. Colborn’s website and contained a concise one-page fact sheet with the important basics on this topic. I am placing it in the body of this letter because it is so very important to this topic. (Her website also contains a wealth of information that can be easily understood by most.)

**Endocrine Disruption Fact Sheet**

The Endocrine Disruption Exchange (TEDX): [www.endocrinedisruption.org](http://www.endocrinedisruption.org)

Nov. 7, 2011

**What are endocrine disrupting chemicals?**

The endocrine system is involved in every stage of life, including conception, development in the womb and from birth throughout early life, puberty, adulthood and senescence. It does this through control of the other vital systems that orchestrate metabolism, immune function, reproduction, intelligence and behavior, etc.

The endocrine system acts through signaling molecules, including hormones such as estrogens, androgens, thyroid hormones, and insulin, as well as brain neurotransmitters and immune cytokines (which are also hormones) and other signaling molecules in the body.

**How are humans exposed to endocrine disrupting chemicals?**

We breathe, eat, drink, and touch EDCs every day. Some can be persistent and remain in the environment for centuries and can build up in the body. Other non-persistent EDCs can be so ubiquitous they are found in nearly every human tested. EDCs include components of plastics, pesticides, flame retardants, fragrances and more. They are found in our homes, schools and work places, toys, clothing, cosmetics, sunscreens, electronics, furniture, cleaning products, lawn care products, automobiles, building materials, food, and food packaging.

**How do endocrine disrupting chemicals affect our health?**

A vast body of scientific literature exists on the health impacts of some EDCs, while for others there is very little research. Laboratory studies and human epidemiological studies confirm that EDCs have a wide array of effects on the body. Effects of EDCs have been found in animals at tissue concentrations below those measured in humans. In the US, the cost of treating health conditions for which EDC exposure is implicated is over $1 trillion a year.

**What distinguishes EDCs from other chemicals of concern?**

**Dose:** a central feature of endocrine disruption is that effects are found using very low chemical concentrations. Effects of EDCs at very low concentrations can be different from effects of the same chemical at higher concentrations.

**Timing:** there are many periods of vulnerability during which exposure to EDCs can be particularly harmful. The most well studied critical periods are prenatal and early postnatal development. Effects of early life exposure may not manifest until much later in life. Effects in one generation may be transmitted to future generations through mechanisms involved in programming gene activity, referred to as epigenetic changes.
Endocrine disrupting chemicals (EDCs) interfere with hormone signaling in a variety of ways depending on the chemical and the hormone system. Biomonitoring of chemicals in human blood and urine has shown that 100% of the people tested have EDCs in their bodies. EDCs have been implicated in neurological diseases, reproductive disorders, thyroid dysfunction, immune and metabolic disorders and more. Traditional approaches to determining safe exposure levels (for example, chemical risk assessments) do not work with EDCs. (emphasis added)

The low dose problem......

Chemical risk assessment has always assumed that “…the dose makes the poison.” Over-simplified, high doses are considered bad and low doses generally good and toxic risk levels are expected to correspond. But all of that is turned on its head with endocrine disruption. Dr. Pete Myers, along with Wendy Hessler define it well in their article, “Does the dose make the poison?” [link]

They explain that sometimes they see effects at low doses that they don’t see with large and that is counter intuitive to most scientists conducting risk assessments. The authors express concern that this anomaly sometimes leads to health standards that are too weak.

Dr. Myers explains, “In standard toxicology, as the dose increases, so does the effect. Conversely as dose decreases, so does its impact. This relationship is called a monotonic dose-response curve because effects are either increasing or decreasing.... Non-monotonic curves, in contrast, change direction. Over part of the curve, response increases with dose, while over another portion it decreases as dose increases.... While toxicologists have traditionally assumed that the dose makes the poison, endocrinologists --scientists who study the action of hormones-- have long known that hormones can have different effects at different doses.”

Marla Cone, Editor in Chief of Environmental Health News explains the low dose effect this way: [link] (see article)

With chronic diseases, risk is difficult to define....

Can anyone identify specific cases where wastewater is known to have caused a specific cancer incidence or that of any other chronic disease? The truth is, when it comes to chronic conditions, generally people may suspect a cause, but can seldom definitely and specifically point to the precise time and place an illness was initiated. And perhaps that is why Public Health Departments focus on pathogenic illness and seldom, if ever, address more mysterious, but common problems.

Dr. Todd quotes Linda Birnbaum, toxicologist in charge of the National Toxicology Program and the National Institute of Environmental Health Services that, “…an ED is anything that affects the synthesis of a hormone, the breakdown of a hormone or how the hormone functions.” And then she continues...

“We used to think it had to bind with a hormone receptor but endocrine disruptors can perturb hormone action at other stages in the process” (qtd. in Borrell 2012, emphasis added). Such perturbations in hormone function can have wide-ranging impacts on our bodies. As the Environmental Working Group, an independent health research organization, explains: There is no end to the tricks that endocrine disruptors can play on our bodies: increasing production of certain hormones; decreasing production of others; imitating hormones; turning one hormone...
into another; interfering with hormone signaling; telling cells to die prematurely; competing with essential nutrients; binding to essential hormones; accumulating in organs that produce hormones. (Environmental Working Group 2013)

Given this list of ways that EDs can stymie our normal bodily functions, we can begin to see how they can precipitate childhood leukemia and other cancers, allergies, asthma and other respiratory problems, genital malformations in baby boys, early puberty in girls, ADHD, diminished IQ, autism, obesity, diabetes, cardio-pulmonary diseases, immune-system dysfunction, and Parkinsonism; evidence is mounting that endocrine disruptors may also play a role in development of Alzheimer’s disease and other mental illnesses.”

Finally, April, 2016 issue of Environmental Health Perspectives, (#6) Linda S. Birnbaum et.al. state in the article, “Informing 21st Century Risk Assessments with 21st-Century Science, “The majority of regulatory frameworks guide risk assessment from the perspective of a single chemical or single component of a project formulation and often do not account for multiple chemical exposures and mixtures. Furthermore, most chemical risk assessments of potential human health effects rely on testing in animal models using exposures that are typically higher than those experienced by humans. This testing model requires the assessor to extrapolate to lower doses and across species, and it provides limited consideration of variability within species. All of these factors undermine confidence that current risk assessments are protective of human health, particularly for the most vulnerable individuals, communities, and life stages.”

Conservation slipping as reuse grows extensively....

With all this, we wish to acknowledge the State’s legitimate concerns about developing adequate water supplies under all scenarios for the entire state. First and foremost, the emphasis on conservation needs to be continually emphasized. Unfortunately, many California areas have significantly increased water use in the last year after winter rain eased the drought. In our area, water contractors are now up to about half way between 2013 use and 2015 conservation accomplishments. Local contractors are relieved that they can now get more income from water sales and they point to our full three-year reservoir as an adequate supply (Lake Sonoma).

For instance, Sonoma County Water Agency contractors’ water sales in July, August, September of 2015 were 9371.1 acre feet, and in 2016, they were 11,204.6 AF. This was almost a 20% increase. In an article entitled ‘Weaker water conservation numbers prompt fears that California is going back to its old bad habits’ author Matt Steven (The Times 10-15-16) (Attachment #7) states that, “Californians’ water conservation slipped for the third consecutive month in August, prompting new alarm from regulators about whether relaxed water restrictions may be causing residents to revert to old habits as the state enters its sixth year of severe drought.” Isn’t full time conservation a much cheaper and healthier route to increasing water supplies than encouraging big infrastructure projects that grow old, they fail, and massive pollution results, as is happening now with water pipes leaching lead?

Wouldn’t it be cheaper and healthier in the long run to charge much more for water and build less infrastructure (including wastewater treatment plants)? Is it possible that users may come to appreciate it more and treat it with more respect? To constantly advocate for more growth is slow but steady suicide where drinking water is concerned.
While not wanting to explore another issue in greater detail, something must be done about the wanton use of water in many agricultural areas. It is said that 80% of California’s water is used by agriculture, yet regulations of that use have been minimal or non-existent. The passage of the new SGMA groundwater law will help, and we hope serious management of our dwindling resource occurs, although we won’t hold our breath. What good does it do if we have adequate almonds to eat and no clean or even less clean water to drink? (Calling attention to the crop that it is said uses one gallon per nut to grow.)

**Public perception and DPR...**

The City of Santa Rosa has changed the name of their Water and Wastewater Utilities Department to *Water Department*, to convey to the public that all water is the same, but the reverse of that famous quote, “A rose by any other name would smell as sweet...”, if true, belies their intention.

Some of the State’s Advisory Committee meeting notes on this issue expressed a big concern about public perception of DPR. The group spent time focusing on messaging and emphasizing that the wastewater would be *purified* and totally safe to drink. Public opinion consultants were hired and surveys were taken regarding public perception of augmenting water supplies with ‘purified’ wastewater. When those surveyed were told that it was done in other places and that no one got sick from it, they thought it must be okay. Of course, no one mentioned the difficulties of assessing causes of chronic illnesses and the inability to prove that no one got sick.

It’s unclear how one would really determine the complete safety of drinking water that contains treated wastewater, even when highly treated. Of course no scientific studies have been conducted to test cause and effect ratios of toxic exposure in relation to human disease, nor will they be. Reliance on epidemiological studies are the norm where appropriate, but it is unlikely one can be found that replicates the conditions that will be utilized for DPR. Public health departments have great expertise assessing and controlling pathogens, and many precautions have been effectively imposed to prevent many acute diseases and illnesses.

But when it comes to chronic diseases such as cancer, developmental problems such as autism, neurological and reproductive birth defects, and many other health problems that are associated with exposures to endocrine disrupting chemicals, little is known about the exact pathway of disease in terms of lifestyle, toxic exposure, heredity, etc. that lead to initiation of the condition and/or illness, although more and more studies link toxic exposures to these and many other adverse health conditions.

Unregulated toxins are everywhere; they are in our food, our water, our clothing, our furniture and mattresses, our house cleaning and personal care products, our autos, and much more. And those that get washed into the waste stream to our treatment plants are a toxic stew of pharmaceuticals, industrial and combustion by-products, heavy metals, pesticides, and more. But even more than that, not only does a vast array exist in the wastewater collection process, and in our households, but much of it actually accumulates in our bodies, and may or may not trigger a disease process. You see, we all have different vulnerabilities and our stage in life, and our health history may compound the impacts of various exposures.
Recently an article described how clothing particles …. Organophosphate pesticides and PBDE flame retardants, lead and mercury are all found to be prime examples of neuro-developmentally toxic chemicals according to July, 2016 issue of Environmental Health Perspectives Article, “Project TENDR: Targeting Environmental Neuro-Developmental Risks. (Attachment #8) The TENDR Consensus Statement”. The project was a call to address the role of common exposures to toxic substances. They state, “The TENDR authors agree that widespread exposures to toxic chemicals in our air, water, food, soil, and consumer products can increase the risks for cognitive, behavioral, or social impairment, as well as specific neurodevelopmental disorders such as autism and attention deficit hyperactivity disorder (ADHD).”

Further on it states, “Many toxic chemicals can interfere with healthy brain development, some at extremely low levels of exposure.” Critical windows of development have been identified up through puberty whereby, “…toxic chemical exposures may cause lasting harm to the brain that interferes with a child’s ability to reach his or her full potential.”

Another issue mentioned was that health studies never look at multiple exposures of toxic substances and in fact, multiple exposures are very common in our everyday life. We seldom use just one chemical to clean our bathrooms, and in fact, almost everything we do on a daily basis brings together multiple toxic exposures at a time. All of these chemicals that end up going down the drain must be 100% removed from the waste stream at all times if they are to merge with the drinking water supply, even non-toxic chemicals which can combine to form toxic substances, if you are to assure the safety of drinking water. Further, it behooves you to assure that all vulnerable populations must be protected before you put the treated wastewater into the drinking water supply.

In the expert panel’s Final Report, they state in their recommendations on page 5 of Executive Summary that the Expert Panel, “… recommends monitoring the literature on potential health risks that could present serious harm to health over short durations of exposure to compounds likely to be present in recycled water. Of specific concern are chemicals that adversely affect the development of fetuses and children….This activity could be initiated concurrently with the development of DPR regulations and continued as an ongoing effort.”

It is a serious concern of ours that rather than talking about the extensive existing literature on the issue, as we have tried to demonstrate in our comments, that they are going to set up a committee to look at it. Why have they not been looking at it before producing this report that substantially fails to define the problem? How can they begin the process of writing DPR regulations before that occurs?

In any case, this effort gives the impression that the State only has a cursory interest in the topic of the impact of chemicals on public health. It does not feel like a serious effort that should move forward. First the information should be gathered, and then the regulations can proceed. Please prioritize the health of Californians before dumping wastewater in the drinking water supply!

Thank you for the opportunity to address this very serious issue.

Sincerely,
Brenda Adelman

ATTACHMENTS:

1. Jude Todd, PhD, *Statement Regarding Use of Recycled Municipal Wastewater in Santa Cruz*, Nov. 18, 2015

2. RRWPC, List of *References on Endocrine Disruption*, Fall, 2014

3. Carol F. Kwiatkowski, et. al., *Twenty-five years of Endocrine Disruption Science: Remembering Theo Colborn*, Environmental Health Perspectives, DOI: 10.1289/EHP746


5. Laura Vandenberg, *Comment Letter (to State Water Board) - Amendment to Recycled Water Policy*, June 27, 2012


List of References on Endocrine Disruption

Websites & List Serves:

- The Endocrine Disruption Exchange (TEDX):
  http://endocrinedisruption.org/
  - TEDX: Endocrine Disruption: Overview:
    http://endocrinedisruption.org/endocrine-disruption/introduction/overview
  - List of Potential Endocrine Disruptors:
    http://endocrinedisruption.org/endocrine-disruption/tedx-list-of-potential-endocrine-disruptors/overview
  - Prenatal Origins of Endocrine Disruption:
    http://endocrinedisruption.org/prenatal-origins-of-endocrine-disruption/introduction
  - Pesticides:
    http://endocrinedisruption.org/pesticides/introduction

- San Francisco Medical Society Journal:

- Collaborative on Health and the Environment (CHE):
  http://www.healthandenvironment.org/
  (talks and articles on health and the environment)

- Environmental Health Perspectives: National Institute of Environmental Health Sciences:
  http://ehp.niehs.nih.gov/

- Above the Fold: free daily list serve of nationwide articles on environmental health: Contact following to be put on list:
  Compiled by Environmental Health News:
  EnvironmentalHealthNews.org
  feedback@EnvironmentalHealthNews.org
  you may subscribe here

Studies:


Articles & Publications:
• CHEMTrust:
  • CHEMTrust overview of Key Scientific Statements on Endocrine Disrupting Chemicals (EDCs) 1991-2013, as of January 2014. (This document contains about 35 major scientific reports and statements over 22 years that each contain many references and resources on endocrine disruption.)
• Endocrine Society: Endocrine–Disrupting Chemicals: An Endocrine Society Scientific Statement; Apr. 17, 2009 (also in CHEMTrust list above)
• Maria Hegstad, Condemning EPA Endocrine Review, NAS Urges Redo of Draft Risk Paper, Inside Washington Publishers, 5-3-14
• Nikita Naik, Wastewater Irrigation on Farms Contaminates Food, Pesticides and You, Vol. 34, #3, Fall 2014 p.19-p.23,
Concerns about Direct Potable Reuse

http://dx.doi.org/10.1289/ehp.1509914

According to Dahl (2014), water shortages in parts of the United States are so dire that attitudes toward wastewater reuse, including direct injection into drinking water, are becoming more favorable. He noted 12 locations nationwide that directly or indirectly blend highly treated wastewater with potable supplies, with more projects planned. California’s ongoing crisis-level drought has convinced some citizens to be more open toward direct potable reuse as a viable way to expand existing supplies. As evidence of growing acceptance, Dahl quoted Daniel Nix, operations manager for Wichita Falls Public Works, stating that new regulations were developed to ensure complete protection of public health, that users reported the water tasted great, and that “[t]he quality’s good, nobody’s gotten sick, and we haven’t had any problem with the plants” (Dahl 2014).

Yet, nobody knows the extent to which potentially toxic chemicals remaining in rivers and drinking water supplies after advanced treatment may compromise health, development, and reproductive capabilities of humans, birds, fish, aquatic organisms, and other species. Many experts believe even the most rigorous water treatment technologies, including reverse osmosis and advanced membrane technology, allow low levels of contaminants to remain. Naik (2014), describing regulatory gaps and variations in irrigation requirements nationwide, stated, “Currently, there is no single treatment process that can provide a complete barrier to all chemicals.”

This is a particular concern in regards to endocrine-disrupting chemicals (EDCs). Approximately 1,000 EDCs have been identified over the last 20 years (U.S. Food and Drug Administration 2015), while more than 28 years have passed since the last chemical risk review by the U.S. Environmental Protection Agency (Jones 2014). Even minute doses of EDCs may be harmful to both humans and wildlife (Diamanti-Kandarakis et al. 2009; Zoeller et al. 2012). Unlike other toxicants, EDCs do not obey the common assumption that “the dose makes the poison” (Vandenberg et al. 2012), a fact that is not recognized by California wastewater reuse requirements (California Environmental Protection Agency 2013).

The Clean Water Act is charged to protect all beneficial uses of U.S. waters, but currently, neither this nor any other federal law regulates direct potable reuse (U.S. Environmental Protection Agency 2012). Furthermore, the lack of intervening environmental buffers in direct potable reuse—which traditionally provide mixing, dilution, and natural physical, chemical, and biological processes to protect water quality—will not allow critical time needed for corrective action in the event of an emergency (Crook 2010). Any type of disastrous event or equipment breakdown could conceivably contaminate water supplies for millions of humans and wildlife alike, especially as aging infrastructure deteriorates.

The author is chair of and receives partial payment for her work on behalf of Russian River Watershed Protection Committee.

Brenda Adelman
Russian River Watershed Protection Committee
E-mail: rrwpc-1@comcast.net

REFERENCES


Informing 21st-Century Risk Assessments with 21st-Century Science

Linda S. Birnbaum, Thomas A. Burke, and James J. Jones

Understanding and preventing adverse impacts from chemicals in the environment is fundamental to protecting public health, and scientifically sound chemical risk assessments are needed to support a variety of environmental protection decisions across the United States and around the world. Risk assessments provide qualitative information about a chemical’s health effects and quantitative information that helps inform the scope of national regulatory decisions, state and community decisions, and industry practices.

The 1983 four-step framework—hazard identification, dose response, exposure assessment, and risk characterization—developed by the National Research Council (NRC 1983) has shaped chemical risk
assessments worldwide. However, the wide range of policy and regulatory applications within and across federal and state agencies in the United States and internationally, has led to an equally wide range of risk assessment practices. These different approaches may yield conflicting results and have contributed to concerns about the scientific credibility of risk assessments and related risk management decisions. The emergence of new methods in computational toxicology, exposure science, epidemiology, and systematic review hold great promise for advancing risk assessment. However, integration of these new approaches into established regulatory frameworks presents scientific and policy challenges.

The majority of regulatory frameworks guide risk assessment from the perspective of a single chemical or single component of a product formulation and often do not account for multiple chemical exposures and mixtures. Furthermore, most chemical risk assessments of potential human health effects rely on testing in animal models using exposures that are typically higher than those experienced by humans. This testing model requires the assessor to extrapolate to lower doses and across species, and it provides limited consideration of variability within species. All of these factors undermine confidence that current risk assessments are protective of human health, particularly for the most vulnerable individuals, communities, and life stages.

Results from environmental epidemiology studies have raised questions about whether traditional animal toxicology studies adequately predict health effects in human populations. These studies sometimes report effects that are not seen in animal studies, and hypothesis-based epidemiological studies may not yield data that can be easily incorporated into chemical risk assessments using existing frameworks and guidelines. Myriad publications in environmental and public health journals describe subtle chemical–biological interactions with population health effects that are not captured in traditional toxicity testing. The health effects observed in the epidemiological studies are typically different from end points evaluated in animal-based toxicity tests for hazard evaluation in chemical risk assessments. The real world exposure events depicted in epidemiology studies often do not correlate with exposures traditionally used in toxicity testing, which are most often much higher than exposures experienced in human populations. Furthermore, epidemiological studies incorporate background and chronic low-dose exposures that are not considered in traditional toxicity testing. Likewise, they may be able to capture population variability, which can be important for organizations charged with protecting public health.

Twenty-first century science is providing tremendous advances in systems biology, genomics and epigenetics, bioinformatics, exposure science, and environmental epidemiology, as well as innovations in chemical measurement and analytical technologies: All these advances are expanding our understanding of how chemicals can interact with biological systems. New approaches such as Toxicology in the 21st Century (Tox21; https://ncats.nih.gov/sites/default/files/factsheet-tox21.pdf) and exposure forecasting (ExpoCast; http://www.epa.gov/sites/production/files/2014-12/documents/exposure_forecasting_factsheet.pdf) are generating data that provide broad coverage of chemical space, chemical mixtures, and potential associated health outcomes, along with improved exposure estimates. Further development and use of systematic review will provide more transparency and more consistency and confidence in the integration of mechanistic, animal, and human data for use in risk assessments.

To provide a forum to discuss how science in the 21st century can bring about improvements in the risk assessment process, the U.S. Environmental Protection Agency (EPA) and the National Institute of Environmental Health Sciences (NIEHS) cosponsored the workshop “Strengthening the Scientific Basis for Chemical Safety Assessments,” which took place 15–16 July 2015 in Research Triangle Park, North Carolina. Participants included individuals with the diverse expertise in toxicology, epidemiology, and risk assessment needed to move this discussion forward. At the workshop, participants discussed the gaps in understanding between the new scientific methods and conventional approaches: These discussions led to proposed activities to bridge the gaps.

Introductory talks reviewed the growing evidence that exposures to a wide variety of chemicals encountered in daily life in the United States are linked to adverse health effects, including neurological deficits in children and adults, asthma, cardiovascular disease, and cancer. Invited speakers presented case studies to illustrate and provide background information for key topic areas including accounting for
exposures during critical developmental windows, capturing variability in population susceptibility, translating experimental animal findings to humans, and addressing cumulative exposures. The group also discussed the perception prevalent in the public health community that chemical risk assessments, as currently carried out by the U.S. EPA and other agencies, are not sufficiently health protective. A strong theme among the participants was that new approaches have to be developed to incorporate data beyond traditional experimental and animal studies to support chemical safety evaluations that could prevent adverse health effects in the U.S. population.

Understanding the Gaps between New and Conventional Methodologies

The Chasm between Environmental Epidemiology and Risk Assessment

It was immediately apparent that there is limited understanding or familiarity, outside of the practitioners, with how risk assessments are conducted in federal regulatory agencies. As a consequence, most research investigations are not optimally designed to provide the types of information that are needed in current assessments. This lack of appropriate design can extend through the selection of study end points and the recording and reporting of findings, to an appreciation of required study design elements to inform a risk assessment. Conversely, current chemical risk assessment practices of the U.S. EPA and other federal agencies have not evolved to optimally consider and incorporate the information emerging from observational human research. Many risk assessment professionals lack understanding of epidemiology study designs, methods, strengths, and limitations. As a result, much potentially valuable information is excluded from the regulatory risk assessment process.

Exposure, the Missing Link

Exposures, as observed, measured, and reported in environmental epidemiology studies, typically represent real-world exposures. These are often reported at levels below those used and delivered in traditional animal toxicology studies, and they are rarely confined to a single or few agents of concern, making it difficult to definitively elucidate causality in the hypothesized association with exposures. In contrast, when estimating the risks of use of a single pesticide, the assessment only considers the risk of exposure to the pesticide active ingredient, but the inert components in a pesticide formulation to which individuals are inevitably co-exposed, and which could modify the response, are usually not considered in the risk assessment. In addition, whereas exposures in observational studies encompass background exposures and chronic low-dose exposures to single or multiple chemicals, toxicological studies do not typically model or account for these.

Importance of Life-Stage Exposures and Multigenerational Effects

Many of the environmental epidemiology studies discussed at the workshop probed the importance of windows of exposures, with the focus on parent and child exposures during critical life stages, such as preconception and perinatal periods, and understanding early-life determinants of lifelong diseases. While data from epidemiological studies also point to potential amplification of the adverse effects of these early-life exposures, including multigenerational effects, it was recognized that these effects are not modeled in standard toxicological studies or evaluated in risk assessments because data on which to judge such health outcomes are largely missing and not required. It will be necessary to expand approaches used to integrate mechanistic, animal, and human data in order to bridge gaps and inform risk assessment methods. The U.S. EPA and the NIEHS are committed to helping support cross-disciplinary efforts to achieve this goal.

Understanding the Role of Nonchemical Stressors

There are many nonchemical stressors that are often overlooked in the conduct of risk assessments. Yet, current data, both from toxicological and epidemiological studies, demonstrate that physical agents such as light and noise, infectious agents, the microbiome, psychosocial factors, and nutrition can have significant
impacts on health effects from chemical exposures. For example, while all the workshop participants agreed that stress is an important modifying factor for health, it is currently not considered as a risk cofactor or modeled in most studies on which risk assessments are based. However, the science that addresses biochemical markers of stress is evolving, and it was proposed that this evolution would be important to quantitatively study the interactions between stress and chemical exposures and account for both in chemical risk assessments. Stress is but one of many factors that may contribute to vulnerability within a population. Current practices that risk assessors use to account for vulnerability, such as uncertainty or safety factor adjustments, may not adequately capture true population vulnerability, such as that associated with stress or genetic variance. The extent to which this might be the case is currently unknown. There likely will be challenges in using data on nonchemical stressors in assessments that support regulatory action under various regulatory statutes in ways that promote improved public health.

Influence of Funding Priorities

It was acknowledged that research specifically aimed at addressing a data gap for the purpose of a risk assessment is not likely to be funded through the typical grants review processes of the National Institutes of Health (NIH). Perhaps because of the funding priorities, academic investigators by and large study environmental exposures in the context of understanding their contributions to a disease or related adverse mechanistic event that is often not well aligned with the typical phenotypic end points measured and relied upon in regulatory or guideline toxicology studies. At this time, these types of toxicology studies are at the foundation of most chemical risk assessments that inform chemical safety evaluations. The U.S. EPA and the NIEHS recognize the value of fostering and funding such studies and collaborations. There is concern that the funding gap is likely to grow if not addressed systematically and deliberately.

Proposed Bridging Activities

Based on discussions of immediate and longer-term activities to bridge the gaps in understanding, the workshop participants drew conclusions and recommended several activities.

Increase Communication

It is important to find mechanisms to increase communication among researchers in multiple disciplines, including toxicology, epidemiology, and risk assessment. Suggestions were made to advance this communication. For example, the U.S. EPA could sponsor hands-on risk assessment experiences for researchers through short residential courses. Scientists within the U.S. EPA and outside the agency could also form scientific teams to work together to develop ways to improve the consideration and incorporation of epidemiology data into risk assessments, including in-depth analyses of study designs, dose metrics, confounding, and sampling issues. This could be accomplished by collaborating on consensus workshops or white papers.

Enrich Funding Mechanisms

Teams of experimental and observational scientists and risk assessors could explore collaborations to design competitive grants programs that promote and fund studies to provide data of direct relevance to chemical risk assessment. This could be facilitated by the creation of dedicated grant review study sections.

Examine Methods to Make Risk Assessments More Robust and Inclusive

It was suggested that teams carry out targeted case studies to examine how well risk assessment projections for “safe exposures” relate to exposures in a human population that are being linked to adverse health effects. To help with this examination, the U.S. EPA has asked the National Academies of Sciences, Engineering, and Medicine to help develop a strategy for evaluating whether the agency’s current regulatory toxicity-testing practices allow for adequate consideration of evidence of low-dose adverse
human effects. A published report from this committee—Unraveling Low-Dose Toxicity: Case Studies of Systematic Review of Evidence (http://www8.nationalacademies.org/cp/projectview.aspx?key=49716)—is expected in early 2016 and could help improve understanding of cases where low-dose effects may have not been detected in current regulatory studies.

**Move Away from Reliance on Apical End Points**

The risk assessment community should continue to explore ways to move away from the use of traditional phenotypic effects and outcomes in regulatory guideline animal safety assessment studies. Perturbations of molecular pathways involved in adverse phenotypic end points were considered to be potentially useful and might provide a better link between molecular epidemiology findings and traditional animal toxicology studies. It was suggested that the U.S. EPA and the NIEHS convene workshops to explore the relationships between 1) observed potentially environmentally induced diseases, 2) the typical phenotypic responses seen in animal toxicology studies, and 3) the adverse outcome pathways (AOPs) that might relate the two together. A logical follow-on to these activities would be to expand studies to examine chemical interactions that work through different points of an AOP, particularly with respect to dose–response relationships and considerations of chemical mixtures.

Another suggestion was to simply begin to routinely use alternative end points, such as analyzing key characteristics of biologic pathways, for risk assessments, rather than only using apical health effects. Such analyses would require significant policy and possibly legislative changes, as well as significant outreach and education, considering some of the recent judicial interpretations of regulations promulgated under existing laws.

**Incorporate Interindividual Variability in Place of Default Safety Factors**

One of the critical challenges in risk assessment is how interindividual variability and differential susceptibility are evaluated and incorporated. In order to address this challenge, scientific findings could be used in place of default uncertainty or safety factors to address population susceptibility. For example, one might use the profile of population variance in phase 1 or phase 2 enzyme activities for metabolism of selected chemical structures in place of default safety factors. It was pointed out, however, that variability in these enzymes in humans could be in excess of 100-fold. An alternate but related suggestion was to examine chemical structures agnostically with the intent of understanding chemical attributes that tend to produce highly variable responses across populations. This could be approached through an expansion of the Tox21–1000 Genomes Project (Abdo et al. 2015). Data from this project—with respect to 156 compounds in nearly 900 lymphoblastoid cell lines from five ethnic groups—has demonstrated that variability among individuals can be more than 200-fold. However, data from this project addresses genetic variability but does not consider other critical influences, such as life stage, diet, and the microbiome.

**Characterize and Incorporate Chemical Co-exposures**

Methods need to be developed to incorporate emerging data on chemical co-exposures into risk assessments. Broader applications of novel technologies to examine patterns of common chemical co-exposures in populations, as well as advances in bioinformatics and in nontargeted chemical analyses of human biospecimens, hold promise to provide this in ways that avoid the current need for large volumes of blood (Guo et al. 2015). Current chemical risk assessments do not consider every stressor, since we do not have the data or know how to do this. Instead, they most often assess cumulative risk for common modes of action as required by law and supported by science. While imperfect, this may be a useful starting point for considering improving current practices and generating missing data on co-exposures.

**Study and Consider Multigenerational Effects**
The potential significance of multigenerational inheritance of risks was noted, and there was recognition that this adds another vastly complicating dimension to understanding and estimating the risks of current exposures. This concept is one of the areas of scientific focus for the NIEHS 2012–2017 Strategic Goals (https://www.niehs.nih.gov/about/strategicplan/), and a systematic review of the current literature pertaining to this topic is underway. This comprehensive review will hopefully provide a basis for more definitive research in this area. Current multigenerational toxicity test methods in rats and other species have limitations, and there are opportunities to improve test guidelines and create integrated testing and assessment strategies that include mechanistic, animal, and human data.

**Relevance of Emerging Science to Risk Assessments**

The U.S. EPA and NIEHS, in collaboration with other agencies, have asked the National Academies of Sciences, Engineering, and Medicine to provide guidance on integrating new scientific approaches into risk-based evaluations. The report from this committee—Incorporating 21st Century Science into Risk-Based Decisions (http://www8.nationalacademies.org/cp/projectview.aspx?key=49652)—is not expected to be published until early 2016, and as such, this topic was not central to the discussions at the meeting. Nevertheless, it was broadly acknowledged that there is currently little experience or precedence for incorporating the emerging 21st-century science into risk assessments: This includes the appropriate use of Tox21 high-throughput screening (HTS) information, commensurate high-throughput exposure estimations, nontargeted metabolomics, high-throughput transcriptomic, and other forms of emerging big data. This may also require an appreciation and understanding of how to assess the validity of proposed AOPs and networks and how to use them in informing risk assessments.

**Conclusions**

Understanding the environmental determinants of disease and protecting susceptible and vulnerable populations are daunting scientific challenges. Addressing these challenges will require an inclusive multidisciplinary research approach and an improved recognition of the methods and informational needs of risk assessors. Progress will also require coordination across multiple federal programs and agencies—especially in resource-constrained times.

The 2015 workshop started with the recognition that there is a chasm between current risk assessment practices and evolving data from mechanistic and environmental epidemiological studies; it concluded with several concrete, practical, and achievable steps to help the U.S. EPA, the NIEHS, and the broader scientific community strengthen the scientific basis for chemical risk assessments. The resounding message of the workshop is that both federal agencies need to work with the research community to ensure that our assessments incorporate current science and consider the full range of vulnerabilities within the population. This research and assessment strategies are fundamental to our mission to ensure that our communities are safe, our air and water are clean, and our most vulnerable populations are adequately protected.

**References**


I. INTRODUCTION

A. Purpose

Recycled wastewater use is growing rapidly in California and other western states, largely in response to drought-inspired worries about water supply security. Growing concerns about the impacts of wastewater pollution on receiving waters also factor into the water-reuse equation in many communities. This is true in Santa Cruz as we explore ways to fortify our water supply. But important questions need to be carefully considered and satisfactorily answered before adopting any uses of recycled municipal wastewater water here in Santa Cruz, including:

-- What else besides water do the various types of recycled wastewater contain?
-- What are the possible human and environmental health impacts of proposals to use recycled municipal wastewater for food crop irrigation or for potable reuse?
-- How should we go about discerning between safe, beneficial uses of recycled municipal wastewater and those that pose more risks than benefits to environmental and public health?
This statement, endorsed by People Against Unsafe Wastewater Reuse and other community members, aims to provide information for policymakers regarding these challenging questions. After discussing problems posed by contaminants of emerging concern (CECs) in recycled municipal wastewater, it reviews California State regulations and policy regarding recycled wastewater and examines the two categories of uses that seem particularly problematic (food-crop irrigation and potable reuse). It then briefly explores two more general categories (landscape irrigation and commercial/industrial uses) as including promising candidates for safe, appropriate application of recycled municipal wastewater.

**B. Scope of Discussion**

Recycled municipal wastewater refers to water that is treated and recycled from the sewer system -- not to greywater or other decentralized wastewater recycling systems. Santa Cruz municipal wastewater comes from sinks, tubs, floor drains, showers, and toilets in homes, business and industrial establishments, hospitals (both human and veterinary), and other institutions such as research laboratories, schools (including college and university science labs), assisted-living communities, long-term care facilities, the county jail, and the morgue. The Santa Cruz wastewater treatment plant processes this sewer water from “the City of Santa Cruz and the Santa Cruz County Sanitation District (includes Live Oak, Capitola, Soquel and Aptos)” (City of Santa Cruz 2015).

Recycled municipal wastewater use is divided into four categories:

- **Potable reuse** (including both indirect potable reuse (IPR) and direct potable reuse (DPR))
- **Agricultural irrigation**
- **Landscape irrigation** (e.g., irrigation of parks, playgrounds, golf courses, cemeteries, and other landscapes)
- **Commercial and industrial purposes** (e.g., flushing commercial toilets, controlling dust on roads or streets, mixing concrete, and many other possible uses).

**C. The Precautionary Principle**

In all cases, our assessments should be guided by the Precautionary Principle. While there are many versions of the Precautionary Principle, it has three commonly accepted components:

1. Where there is reliable scientific evidence that a product or practice may cause serious harm to either humans or the environment, the product or practice should not be used unless or until there is proof of its safety.

2. Those who advocate adopting the product or practice bear the burden of proof to demonstrate that it is safe before it is put on the market or adopted for use. This second component is important because so many products, including those made with endocrine-disrupting chemicals or engineered nanoparticles, have been unleashed into the environment without adequate safety testing, leaving it up to those who are concerned about public and environmental welfare to spend years appealing to the EPA, FDA, or other agencies to appropriately regulate the product.

3. The Precautionary Principle also requires democratic public participation as well as full transparency on the part of governing agencies regarding scientific evidence that informs a policy decision.
II. CONTAMINANTS OF EMERGING CONCERN (CECs) IN RECYCLED MUNICIPAL WASTEWATER

Use of the Precautionary Principle is important because of increasing scientific evidence of contaminants heretofore unidentified or unregulated in recycled wastewater that pose health concerns. These “contaminants of emerging concern” (CECs) in recycled municipal wastewater include personal care products, household cleaners, pharmaceuticals, industrial and agricultural chemicals, pathogenic agents, engineered nanomaterials, and byproducts of any of the above that are not regulated but that are now known or strongly suspected to cause harm to either humans or wildlife. So, for example, DDT is not a contaminant of emerging concern because we already know that it is toxic. An itemized list of substances that scientific evidence indicates might be harmful in recycled wastewater would be too long to assemble, but characteristics of some types of CECs, including those that can disrupt endocrine systems, are summarized below to provide a brief documentation of the nature of that concern.

**A. Number of Synthetic Chemicals**

Over 100,000 synthetic chemicals have been registered in the U.S. including “more than 84,000 industrial chemicals, 9,000 food additives, 3,000 cosmetic ingredients, 1,000 pesticide active ingredients, and 3,000 pharmaceutical drugs” (Regional Monitoring 2013:49).

**B. Trace Amounts of CECs Remain in Treated Municipal Wastewater**

Currently, there is no wastewater treatment train, including those using reverse osmosis, that can remove all contaminants of emerging concern; trace levels – i.e., amounts in the parts per billion or parts per trillion levels – of many CECs, including endocrine disruptors and an array of disinfection byproducts, remain in the effluent (Asano et al. 2007:113; see also WEF and AWWA 2008:1-6; Raghav et al. 2013:4,7; Schnoor 2014:12A).

**C. Health Impacts of Endocrine Disruptors (EDs)**

Our dependence on synthetic chemicals is problematic because, as endocrinologists, developmental biologists, and other independent scientists have shown, many such chemicals -- especially those that disrupt the endocrine systems of humans and other animals – are implicated in the etiology of diseases that now plague people all over the planet. As the term suggests, endocrine disruptors (EDs) can impact all the complex and delicate endocrine systems, including the pituitary gland, hypothalamus, thyroid, cardiovascular system, mammary glands, pancreas, adrenal glands, ovaries, uterus, prostate, and testes, as well as the brain and adipose (fat) tissue (Diamanti-Kandarakis et al. 2009:4). EDs can impact an organism by either mimicking or antagonizing (or sometimes both) the animal’s innate hormones, thus binding with hormone receptors. So, e.g., an ED that mimics estrogen can interfere with the functioning of both male and female reproductive organs; an ED that mimics insulin can throw off the delicate balance maintained by the pancreas; an ED that mimics or antagonizes thyroxin can unbalance the thyroid.

But mimicking or antagonizing endogenous hormones is not the only mode of action for EDs. As Linda Birnbaum, the toxicologist who heads up both the National Toxicology Program and the National Institute of Environmental Health Services, explained in a recent interview, an ED is “anything

---

1 Fullbrook (2013) estimates the total number of industrial chemicals alone at “143,000, and rising.”

2 “Endogenous hormones” are those produced within an organism. Exogenous hormones are those produced outside the organism itself.
that affects the synthesis of a hormone, the breakdown of a hormone or how the hormone functions. We used to think it had to bind with a hormone receptor but endocrine disruptors can perturb hormone action at other stages in the process” (qtd. in Borrell 2012, emphasis added). Such perturbations in hormone function can have wide-ranging impacts on our bodies. As the Environmental Working Group, an independent health research organization, explains:

There is no end to the tricks that endocrine disruptors can play on our bodies: increasing production of certain hormones; decreasing production of others; imitating hormones; turning one hormone into another; interfering with hormone signaling; telling cells to die prematurely; competing with essential nutrients; binding to essential hormones; accumulating in organs that produce hormones. (Environmental Working Group 2013)

Given this list of ways that EDs can stymie our normal bodily functions, we can begin to see how they can precipitate childhood leukemia and other cancers, allergies, asthma and other respiratory problems, genital malformations in baby boys, early puberty in girls, ADHD, diminished IQ, autism, obesity, diabetes, cardio-pulmonary diseases, immune-system dysfunction, and Parkinsonism; evidence is mounting that endocrine disruptors may also play a role in development of Alzheimer’s disease and other mental illnesses (Alonso-Magdalena 2006; Grandjean et al. 2007; Diamanti-Kandarakis et al. 2009; Birnbaum 2010; Burkardt-Holm 2010; Landrigan 2010; Soto and Sonnenschein 2010; Karoutos and Polymeris 2012; Sargis et al. 2012; UNEP/WHO 2012; Weiss 2012; Zoeller et al. 2012; Birnbaum 2013; Carpenter 2013; Welshons 2013; Blaszczak-Boxe 2014; Grandjean and Landrigan 2014; Hamblin 2014; Richardson et al. 2014; Schiffer et al. 2014; Abdolmaleky, Zhou, and Thiagalingam 2015; Bellanger et al. 2015; Konkel 2014a,b, 2015; Genuis and Kelln 2015; Gore et al. 2015; Grossman 2015; Legler et al. 2015; Scutti 2015; Trasande et al. 2015).

D. Trace Quantities of Endocrine Disruptors and the Developmental Basis of Disease

Endocrine disruptors in only trace amounts -- the same amounts present in recycled sewer water -- are especially dangerous for fetuses, infants, and small children. As American Water Resources Association researchers David Norris and Alan Vajda write in their article “Endocrine Active Chemicals (EACs) in Wastewater: Effects on Health of Wildlife and Humans,” “ample evidence of endocrine disruption of reproduction related to nano-quantities (parts per billion and parts per trillion) of human-based xenoestrogens in wastewater effluents appeared in the late 1980s and early 1990s” (Norris and Vajda 2007:15, emphasis added). Since that time, evidence of the impacts of EDs on health of both wildlife and humans has grown substantially.

Those health impacts are more likely when the organism is exposed to the ED during the early stages of development. Illnesses triggered by chemicals during those vulnerable formative years are often irreversible (Zoeller et al. 2012:4101; UNEP/WHO 2012:12). When present in the body of a pregnant woman, endocrine disruptors can be passed on via the placenta to the fetus and via breast milk to the infant. Maternal transmission of EDs is particularly important because, as explained in the Endocrine Society’s comprehensive review and analysis, Endocrine-Disrupting Chemicals: An Endocrine Society Scientific Statement, the age at which one is exposed to these chemicals can make the health impacts more or less significant, and fetal and early postnatal-infant stages are developmental periods when mammals are most vulnerable (Diamanti-Kandarakis et al. 2009). The brain and nervous system, immune system, reproductive system, heart, lungs, and all other crucial organs are being developed at those times; illnesses due to malfunction of those systems and organs that are precipitated during those early months and years may not become apparent until years or even decades later (Diamanti-Kandarakis et al. 2009:3; see also Colborn, vom Saal, and Soto 1993; Colborn 1997, 2004a; Shapley 2009; Burkhardt-Holm 2010; Landrigan and

3 The analogy commonly used to illustrate one “part per trillion,” or one nanogram per liter, is that it is like one drop of water diluted into 20 Olympic-sized swimming pools. “Xenoestrogens” are chemical compounds, such as those in some pesticides, drugs, and industrial products like plasticizers, that mimic estrogen and can thus disrupt the endocrine system.

Among the many scientific articles demonstrating greater susceptibility to endocrine disruptors by fetuses and children is Philip J. Landrigan and Lynn R. Goldman’s (2011) study, “Children’s Vulnerability to Toxic Chemicals: A Challenge and Opportunity to Strengthen Health and Environmental Policy.” Landrigan, a pediatrician and epidemiologist, is dean of global health and a professor of preventive medicine and pediatrics at the Mount Sinai School of Medicine; Goldman is dean of the School of Public Health and professor of environmental and occupational health at George Washington University. Their review article on this topic explains that children are more susceptible than adults to health impairments from chemical exposure for four reasons:

First, children have greater exposures to toxic chemicals for their body weight than adults. A six-month-old infant drinks seven times more water per pound than an adult....Children’s hand-to-mouth behavior and play on the ground further magnify their exposures.

Second, children’s metabolic pathways are immature, and a child’s ability to metabolize toxic chemicals is different from an adult’s.... [Children] lack the enzymes needed to break down and remove toxic chemicals from the body.

Third, children’s early developmental processes are easily disrupted. Rapid, complex, and highly choreographed development takes place in prenatal life and in the first years after birth... In the brain, for example, billions of cells must form, move to their assigned positions, and establish trillions of precise interconnections....  

Fourth, children have more time than adults to develop chronic diseases. Many diseases triggered by toxic chemicals, such as cancer and neurodegenerative diseases [including dyslexia, mental retardation, attention deficit hyperactivity disorder [ADHD], and autism],...evolve through multistage, multiyear processes that may be initiated by exposures in infancy [or in utero]. (Landrigan and Goldman 2011:843, emphasis added)

Chemical-induced diseases set in motion during gestation or infancy often do not show up until years or even decades after exposure. This “long delay between the time point of exposure and measurable effects” makes tracing causative factors for particular instances of cancer, Parkinsonism, Alzheimer’s Disease, or other diseases that appear in later years very challenging (Burkhardt-Holm 2010, emphasis added).

E. Transgenerational Epigenetic Inheritance of Disease

The long delay between exposure to harmful chemicals and their health consequences is turning out to be even longer than once thought. Research in the last couple of decades has indicated that in some instances harms inflicted by endocrine disruptors and some other chemicals may be passed on to subsequent generations via a process known as transgenerational epigenetic inheritance (Edwards and Myers 2007; Grandjean et al. 2007; Diamanti-Kandarakis et al. 2009:4,7-8; Burkhardt-Holm 2010:484-487; Birmbaum 2010; Daughton 2010:54-55; Birmbaum and Jung 2011; Francis 2011; Guerrero-Bosagna and Skinner 2012; UNEP/WHO 2012:13; Martin 2013; Hanson and Gluckman 2014; Haugen et al. 2014; Head 2014; Janesick, Shioda, and Blumberg 2014; Tollefsbol 2014; Dietert 2015; Gore et al. 2015; Heindel and Vandenberg 2015; Stel and Legler 2015; Xin, Susiarjoa, and Bartolomeia 2015).

As Lauren K. Wolff (2014), writing for the Chemical and Engineering News, explains, “Nerve cells grow and connect, sometimes forming 40,000 new junctures [synapses] per second, until a baby reaches about two years of age” (Wolff 2014, emphasis added).
The concept of transgenerational epigenetic inheritance can seem puzzling at first, but it is not as strange as it might initially seem. We are familiar with the “nature vs. nurture” debate, which most scientists readily resolve by saying that health is a result of both nature (our genes) and nurture (factors in our environment). Most people would likely agree that environmental influences (e.g., diet, exercise, exposure to toxic substances) interact with genetics to influence health. The term “epigenetics” refers to those environmental factors – factors outside the genome itself – that influence gene expression without causing a genetic mutation. Sometimes those environmental factors, particularly exposure to chemicals such as endocrine disruptors, can result in “methylation” of one or more genes, and that, in turn, influences gene expression. Gene methylation is one of several epigenetic mechanisms by which exposure to endocrine disruptors and other chemicals can alter genetic expression, sometimes resulting in disease or diminished capacity.

“Transgenerational epigenetics” – the newer and more surprising concept -- refers to heritable changes in gene expression that are not due to a genetic mutation. As Jessica Head, with the University of Michigan School of Natural Resources and Environment in Ann Arbor, explains:

Epigenetics is not a newly discovered phenomenon; we have known about the role of DNA methylation in regulating gene expression for over 35 years.... What is new is our developing epigenetic perspective on how early life experiences can have lasting impacts on health that may even be inherited by future generations.... With epigenetic modes of action, level of exposure to contaminants, intermediary sub-clinical responses, and the overt toxic response may be temporarily separated throughout an individual's lifetime, or even between generations, a possibility that most risk assessment does not take into account. (Head 2014:83-84, emphasis added)

Linda Birnbaum, Director of the National Institute of Environmental Health Sciences (NIEHS) and National Toxicology Program, shares Head’s concern about the shortfall of risk assessment and outdated toxicological methods in evaluating the ways that endocrine disruptors and other synthetic chemicals can impact health (Birnbaum 2010). Birnbaum and her colleague Paul Jung, chief of staff at NIEHS, explain transgenerational epigenetics as follows:

...we’re born with our genes, but epigenetic changes occur because of environmental influences during development and throughout life. Epigenetics thus provides a measurable “imprint” on DNA expression that may be useful as a biomarker for disease susceptibility. And these imprints can be carried and expressed across generations. (Birnbaum and Jung 2011:818)

It would thus seem advisable for people considering the possible health impacts of trace amounts of drugs and other chemicals in recycled wastewater to attend to epigenetics, but the topic is rarely addressed in the water-reuse literature.

------------------

5 Stephen Rappaport and Martyn Smith, with the UC Berkeley School of Public Health, sum up the relative proportion of chronic disease attributable to genes vs. environment as follows: “Although the risks of developing chronic diseases are attributed to both genetic and environmental factors, 70 to 90% of disease risks are probably due to differences in environments” (Rappaprt and Smith 2012:460, emphasis added).

6 Methylation is a chemical reaction in which a carbon atom and three hydrogen atoms, known in organic chemistry as a methyl group, attach to a molecule.

7 Other mechanisms include histone modification, nucleosome repositioning, misregulation of chromatin, and interference in transcription of both microRNA and long non-coding RNA (Dietert 2014:243).
One exception is the comprehensive review study by C. G. Daughton (2010), “Pharmaceutical Ingredients in Drinking Water: Overview of Occurrence and Significance of Human Exposure.” Daughton, who is the U.S. EPA Chief of the Environmental Chemistry Branch at the National Exposure Research Laboratory, explains epigenetics as follows:

Unlike the genome, the epigenome is plastic, dynamic, extraordinarily complex, and varies across tissues and individuals.... *Epigenetic alterations can accumulate, resulting in delayed-onset outcomes that can persist long after exposure has ceased – even across several generations.* (Daughton 2010:54, emphasis added)

Daughton also comments on the dearth of attention to the health implications of epigenetics when considering drugs as drinking-water contaminants:

Given the thousands of publications devoted to APIs [active pharmaceutical ingredients] as environmental pollutants, few address the possible role of epigenetics in human (or even aquatic) health. Epigenetics has been mentioned only in passing in perhaps a dozen or so of the thousands of published works; most of these have been published since 2006. (Daughton 2010:54)

Transgenerational epigenetic effects of trace pharmaceuticals and other chemicals of emerging concern in recycled municipal wastewater should be receiving – but, to date, have not received – serious attention from both the water-reuse industry and its regulators.

**F. Nonmonotonicity and Lack of a Threshold Dose**

While most synthetic chemicals remaining in the effluent of state-of-the-art wastewater treatment plants may be present only in “trace” amounts (parts per billion or parts per trillion), such low doses do not protect people or other animals who drink or bathe in it. As we’ve seen, chemicals that can disrupt endocrine systems are bioactive in the parts per billion or parts per trillion levels, and in some cases even less (Norris and Vajda 2007:15; Myers and Hessler 2007:3; Vandenberg et al. 2012; Weshons 2013; Cobb 2015). As surprising as this may seem, there is abundant scientific evidence demonstrating that endocrine disruptors can be even more harmful in miniscule amounts than in slightly larger amounts, depending on the target organism and age at time of contact with the chemical; this phenomenon, known as nonmonotonicity, is evidenced by the chemical’s nonmonotonic dosage-response curve (Sheehan 2006; Myers and Hessler 2007; Diamanti-Kandarakis et al. 2009:4; Fagin 2012; Schettler et al. 2012; UNEP/WHO 2012; Vandenberg et al. 2012; Weshons 2013; Birnbaum and Jung 2014:816-818; Vandenberg 2014; Gore et al. 2015; Xin, Susiarjoa, and Bartolomeia 2015).

Nonmonotonicity seems counter-intuitive. Traditional toxicologists and the regulators whom they advise tend to operate according to the more “common sense” maxim, coined by Paracelsus, the 16th-century Father of Toxicology, that “The dose makes the poison.” However, endocrinologists and other independent scientists in the 20th and 21st centuries have shown that this “common sense” maxim does not always hold true. In their article, “Does ‘The Dose Make the Poison?’ Extensive Results Challenge a Core Assumption in Toxicology,” Myers and Hessler (2007) explain that some chemicals, including endocrine disruptors,

...cause different effects at different levels, including impacts at low levels that do not occur at high doses.... *Because all regulatory testing has been designed assuming that ‘the dose makes the poison,’ it is highly likely to have missed low dose effects, and led to health standards that are too weak.* (Myers and Hessler 2007:1, emphasis added)

In fact, there may be no “threshold dose” (an amount below which the chemical causes no harm) for some chemicals, especially for fetuses, infants, and children, as explained in the preceding section (Sheehan
Laura Vandenberg, PhD, molecular and developmental biologist with the Division of Environmental Health Sciences, University of Massachusetts, Amhert, and eleven other independent scientists whose research has demonstrated nonmonotonicity conclude their review of the topic with the following assessment:

We understand that [our findings of nonmonotonic dosage-response curves for endocrine-disrupting chemicals] challenge risk assessment dogma, but society’s tendency to maintain the status quo is insufficient as an argument to rebut scientific data.... [T]here is...much evidence within the field of endocrinology to support the interpretation that low doses exert adverse effects on the human population. **Data must trump theories, hypotheses, models and assumptions, and not the reverse.** (Vandenberg et al. 2012:16, emphasis added)

In other words, ideologies or other cherished beliefs -- whether that belief is that “the dose makes the poison” or that “only genetic information can be passed on to future generations” -- should be trumped by scientific evidence produced by independent researchers, particularly when public health is at stake.

**G. Mixture Effects**

The numbers of various chemicals in sewer water at any given time that can potentially interact with each other (out of the possible tens of thousands) are incalculable. Moreover, when trace amounts of some of those chemicals are ingested, inhaled, or absorbed through the skin and find their way into our bloodstream and on to our hearts, thyroids, brains, and other endocrine-sensitive glands and organs, they mix with our endogenous hormones and whatever other exogenous chemicals they encounter. What happens when trace amounts of the drugs and other chemicals discharged from hospitals, industries, residences, veterinary clinics, long-term-care facilities, or chem labs combine in our bloodstream? What are the physiological effects of these chemical mixtures?

Insufficient research has been done to address such vexing questions, but the research that has been done demonstrates that chemicals – even those that may pose little or no threat individually – can be more hazardous when mixed with other chemicals (Yang 1994; Biello 2006; Sheehan 2006; Kortenkamp 2007, 2008; Backhaus, Sumpter, and Blanck 2008; Diamanti-Kandarakis et al. 2009; Payne-Sturges et al. 2009; Birnbaum and Jung 2011; UNEP/WHO 2012:15; Haugen et al. 2014; Brown and Grossman 2015). The **effects of mixing several chemicals** that have a similar physiological effect (e.g., estrogenic) can be **additive**, **antagonistic**, or **synergistic** (Rajapaske, Silva, and Kortenkamp 2002). Andreas Kortenkamp, with the School of Pharmacy at the University of London, has been studying the problem of mixture effects, particularly in estrogenic chemicals, for many years. He explains that, “In toxicology, ‘additivity’ describes the case in which chemicals ‘act together’ to produce effects without enhancing or diminishing each other’s action...” (Kortenkamp 2007:98). **Synergism** refers to effects greater than additive, while antagonistic effects are those that are less than additive (Kortenkamp 2007:99).

**Traditional toxicological methods** used to develop “maximum contaminant levels” (MCLs) for regulatory purposes **ignore these mixture effects, relying instead on testing one chemical at a time.** Studying antibiotics in wastewater treatment plants, Sungpyo Kim and Diana S. Aga, chemists at the State University of New York at Buffalo, note:

Although a few environmental risk assessment studies suggest that the levels of pharmaceuticals in the environment, including antibiotics, are not a major threat to human health....the chronic effects of mixtures of these microcontaminants remain unknown. Typical health risk calculations are based on a single drug exposure in a lifetime. The synergistic and antagonistic effects of pharmaceutical mixtures on human[s] and ecology cannot be ruled
out, and need to be addressed in risk assessment. For instance, it was demonstrated that a mixture of ibuprofen, prozac, and ciprofloxacin produced 10- to 200-fold higher toxicity in plankton, aquatic plants, and fish .... These results imply that a more sophisticated approach for the risk assessment of antibiotics... might be necessary to obtain a more accurate assessment of health and ecological risks associated with antibiotics in the environment. (Kim and Aga 2007:568-570, emphasis added)

Research done by endocrinologists, chemists, and many other independent scientists who have considered this issue indicates the need for “a more sophisticated approach for the risk assessment” not only for drugs but also for personal care products, household chemicals, pesticides, and industrial chemicals that find their way into sewer water, small amounts of which can remain in treatment plants’ effluent. The recent review study by Endocrine Society researchers on the dangers and characteristics of endocrine-disrupting chemicals makes several key recommendations for research over the next five years, including “testing mixtures of EDCs [endocrine-disrupting chemicals] based on their structural or activity homology…” rather than just individually (Gore et al. 2015).

**H. Drug Metabolites and Transformation Byproducts**

Some consumed drugs may pass through our bodies into sewers largely unchanged. For example, “Most antibiotics are poorly metabolized after administration..... Thus, relatively high fractions of the drug are excreted” (Jjemba 2008:172). However, many other drugs create metabolic byproducts after consumption, further complicating risk assessment of chemicals – and chemical mixtures – in recycled municipal wastewater. For example, the anticonvulsant drug carbamazepine is often found in wastewater treatment plant effluents, though its several metabolites are usually not included in assessments of wastewater plant efficacy. One exception is the study by Miao et al. (2005), which examined wastewater samples for caffeine, carbamazepine, and five of its known 33 metabolites, at least one of which “has been shown to possess similar anti-epileptic properties [to carbamazepine], and it may cause neurotoxic effects” (Miao et al. 2005:7470; see also La Farre et al. 2008). The authors found the treatment process to be effective in removing caffeine but not in removing the carbamazepine metabolites (Miao et al. 2005:7474). This result is significant because if a treatment plant’s efficacy is assessed looking only for the original drug and not its metabolites, then the analysis could overestimate the plant’s treatment efficacy.

Complicating matters further, “some excreted metabolites can also be transformed back into the parent compound” (Jjemba 2008:172; see also Escher and Fenner 2011). A recent study by Qu et al. (2013) on metabolites of the steroid trenbolone indicates that some drugs are transformed into other compounds by light but then revert to the parent drug in darkness. That study, “Product-to-Parent Reversion of Trenbolone: Unrecognized Risks for Endocrine Disruption,” found that, while light breaks down trenbolone (TBA) metabolites, the **phototransformation products re-convert to the parent compounds in dark conditions;** this process “results in the enhanced persistence of TBA metabolites via a dynamic exposure regime that defies current fate models and ecotoxicology study designs” (Qu et al. 2013:350). The authors explain the implications:

This product-to-parent reversion mechanism results in diurnal cycling and substantial regeneration of TBA metabolites at rates that are strongly temperature- and pH-dependent. Photoproducts can also react to produce structural analogs of TBA metabolites. These reactions also occur in structurally similar steroids, including human pharmaceuticals, which suggests that predictive fate models and regulatory risk assessment paradigms must account for transformation products of high-risk environmental contaminants such as endocrine-disrupting steroids. (Qu et al. 2013:347, emphasis added)
The ability of some endocrine disruptors’ transformation products to revert to the original chemical in darkness has implications for proposals to inject treated wastewater into aquifers. If testing for these revertible chemicals were done only under light conditions, that could lead to underestimation of the amount of drugs being introduced into aquifers, which are pretty dark places.

Similar studies need to be undertaken for a wide range of pharmaceuticals that may remain even in trace amounts in recycled municipal wastewater, which contains every type of drug taken by people in the community: statins, beta blockers, antidepressants, radiotherapeutic agents, sedatives, anesthetics, bronchodilators, antibiotics, diuretics, cytotoxic and cytostatic cancer drugs, anti-psychotics, antibiotics, analgesics, narcotics, drugs to facilitate gender changes, drugs to address erectile dysfunction, “recreational” drugs, etc. Some research has been done on transformation byproducts of X-ray contrast media (Schulz et al. 2008; Kormos, Schultz, and Ternes 2011). Chemotherapeutic cancer drugs have also received some attention (Kosjek and Heath 2011; Zhang et al. 2013).

Other chemicals besides drugs also undergo changes during wastewater treatment (Cwiertny et al. 2014; Ortiz de Garcia et al. 2014; Evgenidou, Konstantinou, and Lambropoulou 2015). While not much is known about the fate of chemical transformation byproducts in wastewater treatment plants, enough is known to conclude that this phenomenon contributes to the problem of mixture effects discussed in Section G above. But this area of metabolites and transformation byproducts needs much more research – and much more attention from the water-reuse industry and the agencies that regulate it.

1. Engineered Nanoparticles

Unimaginable numbers of engineered nanoparticles, particles with at least one dimension smaller than 100 nanometers, are present in our sewer water. Without regulation by the EPA or any other regulatory agency, the use of nanoparticles – especially the antibiotic nanosilver -- has spread widely and rapidly. Engineered nanoparticles are now used in some personal care products (e.g., toothpaste, sunscreens, baby wipes), clothing (e.g., socks, shoe insoles, underwear), kitchen utensils (e.g., knives, cutting boards, ceramic-coated pots and pans), and other products. When those products are washed, nanoparticles can get flushed down drains into sewers. Nanoparticles are also used in drugs and even in diet drinks, allowing them to be excreted into sewers (Reed et al. 2014).

Furthermore, some washing machines use nanosilver to eliminate mold. One such washer, made by Samsung, releases 100 quadrillion silver nanoparticles (that’s 100,000,000,000,000,000 of them) into sewers with each wash (Feder 2007).

Engineered nanoparticles, another contaminant of emerging concern, pose a problem for potable reuse of sewer water because they are potentially harmful to humans (Gwinn and Vallyathan 2006; Birnbaum and Jung 2011; Abbott Chalew and Schwab 2013), and their presence in the effluent of wastewater treatment plants has not been adequately studied. Consequently, we do not know the extent to which various treatment trains remove nanoparticles. As R. Rhodes Trussell et al. (2013) write in Potable Reuse: State of the Science Report and Equivalency Criteria for Treatment Trains, “only a limited number of studies have been performed in this research area, but the preliminary data indicate that this may be an important issue to consider in potable reuse applications” (39). Trussell and colleagues express concern about the type of washing machine discussed above, as well as other sources of nanoparticles in sewer water, and they acknowledge the “potential for nanoparticles to persist through advanced wastewater treatment trains” (39). They conclude that “There is currently little evidence to determine whether nanoparticles pose a significant public health threat in potable reuse applications. The reuse community would be wise to keep a watchful eye on this issue in the future” (Trussell et al. 2013:39).
Bottom line: Given the inadequate study of the health effects of drinking and bathing with recycled municipal wastewater that may contain unknown numbers of nanoparticles, EDs, and other CECs; studies that suggest harmful effects of many CECs on human health; and the absence of evidence that any wastewater treatment train can effectively remove these contaminants to levels that are safe for fetuses, infants, and children, the Precautionary Principle requires that we in Santa Cruz not use recycled municipal wastewater for drinking or bathing.

III. STATE REGULATIONS AND POLICY REGARDING RECYCLED WASTEWATER

Given the known presence of trace amounts of chemical contaminants in even the most advanced municipal wastewater treatment systems as discussed above and the scientific evidence of potentially serious health impacts, how is it possible that the State permits potable reuse of such water? And how is it possible that less thoroughly treated sewer water can be used to irrigate food crops, including organic produce? As briefly explained below, the State overlooked sound scientific evidence when they wrote Title 22 regulations for non-potable reuse and again when they formulated the 2013 Recycled Water Policy, which addresses indirect potable reuse (IPR) via aquifer recharge. This section also explains why Governor Brown’s efforts to fast-track regulations for direct potable reuse (DPR) appear likely to repeat the State’s history of ignoring important scientific evidence regarding the potential health effects of emerging contaminants in recycled municipal wastewater.

A. Title 22 Regulation of Recycled Wastewater for Food-Crop Irrigation

There are no federal regulations of recycled municipal wastewater. That task is left up to the states. Here, non-potable uses of recycled sewer water are governed by “Title 22: California Recycling Criteria.” Title 22 governs irrigation for all agricultural purposes, including ornamental plants, pasture for milk animals, fodder and fiber crops for animals, etc. This paper focuses on the portions of Title 22 that regulate food-crop irrigation.

Title 22 permits irrigating food crops, including organic crops, with either secondary- or tertiary-treated recycled wastewater, depending upon the type of crop and the method of irrigation. However, the Precautionary Principle rules out irrigating food crops with recycled sewer water for the following reasons:

1. Uptake of Chemicals

Both secondary- and tertiary-treated wastewater contain small amounts of synthetic chemicals, including endocrine disruptors. It is well known that plants can and do take various synthetic chemicals up into their roots, stems, leaves, and fruits (Schneider 2008; Calderon-Preciado, Matamoros, and Bayona 2011; Malchi et al. 2014). When children and adults, including pregnant women, eat the plants, they would also ingest small amounts of these potentially harmful chemicals. As noted above, endocrine disruptors are especially hazardous for fetuses, infants, and children. Such risk of serious harm to future generations is unacceptable; instead, farmers could use drip irrigation and employ other conservation methods, including considering crop choices that make sense in a drought-prone region.

2. Engineered Nanoparticles

Both secondary- and tertiary-treated wastewater would also likely contain high quantities of engineered nanoparticles, including antimicrobials such as nanosilver, which is known to harm soil

---

8 This caution also applies regarding members of other “sensitive populations” not addressed here, including adolescents, the elderly, people who are chemically sensitive, and people in ill health.
organisms and suspected of causing health problems for higher animals, including humans (Navarro et al. 2008; Gajjar et al. 2009; Birnbaum and Jung 2011; Abbot Chalew and Schwab 2013).

3. Antibiotic Resistance Genes

It is well known that antibiotic-resistant bacteria (ARB), such as methicillin-resistant *Staphylococcus aureus* (MRSA) — which alone kills about 19,000 people in the U.S. annually — are on the rise and pose a serious health threat, particularly in hospitals (Krasner et al. 2006). Such dangerous bacteria are killed by disinfectants, including those used in hospitals and homes as well as chlorine and all other types of wastewater disinfection. Disinfection of recycled sewer water is, of course, essential. However, researchers have now demonstrated that killing the ARB permits the bacteria’s antibiotic-resistance genes (ARGs) to be released into the wastewater. By a process known as horizontal gene transfer, these ARGs can be taken up by other living bacteria, causing those bacteria to become antibiotic resistant (Jjemba 2008:171-179; Dodd 2012; McKinney and Pruden 2012; Fahrenfeld et al. 2013; Fatta-Kasinos and Michael 2013; Pruden et al. 2013; Hong et al. 2014; Mole 2014). Consequently, wastewater disinfection, which leads to production of “approximately 600-700” chemical byproducts (Krasner et al. 2006), also contributes to the spread of antibiotic resistance. As medical geo-hydrologist Edo McGowan, M.D., explains, “Pathogens that in nature might never get together for gene exchange are thrust into each other in a sewer plant” (McGowan, posted in Olena 2013).

In his December 2010 comments to the SWRCB regarding CEC monitoring for recycled wastewater, McGowan explains at length how horizontal transfer of ARGs into the human intestine can result in development of antibiotic resistance, why this is dangerous, and why the source of the problem would be untraceable (California State Water Recourses Control Board 2011).

4. Title 22 Regulations of Non-Potable Reuse Ignore Important Scientific Evidence

How is it possible that food-crop irrigation is this fraught with problems? One might assume that California regulations would be sufficiently protective. However, those regulations do not take into account scientific evidence available at the time.

In the year 2000, when the Title 22 regulations of recycled wastewater were put in place, synthetic chemicals were disregarded, even though prior to that year, there was already reliable scientific evidence that endocrine disruptors (EDs) can harm wildlife and can lead to an array of serious illnesses in humans, including infertility, genital abnormalities, breast cancer, and other health problems, as discussed above (Colborn, vom Saal, and Soto 1993; Jobling 1996; Sharpe et al. 1996; Kelce and Wilson 1997; Daugton and Ternes 1999).

As noted earlier, Norris and Vajda (2007) have pointed out that there was already “ample evidence of endocrine disruption of reproduction related to nano-quantities (parts per billion and parts per trillion) of human-based xenoestrogens in wastewater effluents... in the late 1980s and early 1990s” (Norris and Vajda 2007:15, emphasis added). A study by Bitman and Cecil (1970) on polychlorinated biphenols and chemicals like DDT demonstrated estrogenic activity even three decades prior to enactment of Title 22’s regulations of recycled wastewater.

Although Title 22 permits use of recycled wastewater on food crops, prior to enactment of the recycled wastewater regulation, it was already known that plants can take synthetic chemicals up into their roots, stems, leaves, and fruits (Briggs, Bromilow, and Evans 1982; Ryan et al. 1988; Hsu, Marxmiller, and Yang 1990; Paterson et al. 1990; Simonich and Hites 1995; Sicbaldi et al. 1997; Burken and Schnoor 1998; Wilson 1998).
The fact that chemical mixtures can have additive, antagonistic, or synergistic effects, as discussed earlier, was also known prior to enactment of recycled wastewater regulations in Title 22 -- even as early as 1939 (Bliss 1939; Calabrese 1991; Yang 1994).

Even the fact that some endocrine disruptors have nonmonotonic dosage-response curves was also recognized prior to enactment of the Title 22 regulations of recycled wastewater (Mehendale 1994; Svendsgaard and Hertzberg 1994; vom Sal and Sheehan 1998; Nawaz et al. 1999).

**Bottom line:** California Title 22 regulations for non-potable reuse of recycled wastewater are inadequate to protect the health of both humans and other organisms because regulators ignored sound science that warned about health impacts of endocrine disruptors and other contaminants of emerging concern. The potential for irrigation with treated wastewater to spread antibiotic resistance has come to light more recently, as have problems with nanoparticles, adding to the concerns about this practice, especially in irrigation of food crops.

**B. Recycled Municipal Wastewater for Potable Reuse**

Potable reuse of wastewater is divided into two types: indirect and direct. While exact definitions vary, currently in California, **indirect potable reuse (IPR)** refers to treated municipal wastewater that is sent to an aquifer, either by direct injection or by surface spreading. The recycled wastewater gradually mixes with the rest of the water in the aquifer; it is subsequently drawn out and processed in the drinking-water treatment plant before being sent to people’s taps. **Direct potable reuse (DPR)**, which is not yet permitted in California, refers to treated wastewater that is sent from an advanced wastewater treatment facility directly to either the municipal water treatment plant (where it undergoes the usual treatment for drinking water) or directly into the distribution system that supplies tap water. In either scenario, DPR differs from IPR in that there is no intermediate step where the treated water is first put into an aquifer.

There are no federal regulations of recycled municipal wastewater for potable reuse. However, drinking water is federally regulated via the Safe Drinking Water Act. The State of California has somewhat stricter drinking-water standards than the federal government requires. The combined Federal and State regulation of potable reuse are inadequate to protect public health. The number of synthetic chemicals regulated under the Federal Safe Drinking Water Act plus those added to the list by the California EPA add up to just 60, plus an additional 11 disinfection byproducts (California Department of Health 2014). That still leaves more than 100,000 other man-made chemicals unregulated, and thus largely untested, in drinking-water treatment plants. Thus, when recycled wastewater advocates assert that a treatment plant’s effluent “meets or exceeds” all Federal and State drinking-water requirements, the claim may sound reassuring, but it is hollow.

**C. State Policy Regarding Indirect Potable Reuse**

Thirteen years after the Title 22 regulations of non-potable reuse were enacted, the State Water Resources Control Board (SWRCB) published its **Policy for Water Quality Control for Recycled Water**

---

9 At this time, the State has no regulations for IPR involving a reservoir rather than an aquifer, although the City of San Diego was permitted by the CDPH to test this alternative in a demonstration plant using microfiltration, RO, UV, and hydrogen peroxide (Gerrity et al. 2013:332). Regulations for reservoir augmentation with treated municipal wastewater may be developed pending the 2016 recommendations of an expert panel (California State Water Resources Control Board 2014).

10 EPA and other government agencies have some programs for occasional additional testing of drinking water and sources for some other contaminants such as EPA's Contaminant Candidate List Program [http://www2.epa.gov/ccl/basic-information-ccl-and-regulatory-determination](http://www2.epa.gov/ccl/basic-information-ccl-and-regulatory-determination) and the USDA Pesticide Data Program, which studied the Santa Cruz municipal water system in 2012-2013.
(Recycled Water Policy), 2013. This policy, intended to “streamline” the permitting process for non-potable uses as well as for indirect potable reuse (IPR), purports to address the contamination of recycled wastewater by CECs. However, this 2013 policy, like the Title 22 regulations before it, fails to adequately protect environmental and public health.

In spite of scientific evidence of potential harms to humans and other organisms posed by CECs, the 2013 Recycled Water Policy permits recycled wastewater for indirect potable reuse with minimal monitoring of CECs to indicate treatment-plant efficacy. That policy requires monitoring only eight chemicals out of the tens of thousands of the drugs, personal care products, food additives, pesticides, industrial chemicals, disinfection byproducts, and household chemicals that may be present in tertiary-treated wastewater used to replenish aquifers by surface spreading. For direct injection of advanced-treated wastewater into aquifers using reverse osmosis, only six of those chemicals must be monitored.

Like the Title 22 regulations described earlier, this 2013 policy still relies on traditional approaches to toxicology: test one chemical at a time on lab animals, looking for acute toxic reactions, then reduce the dosage downward with each round of testing to the point where the “no observable adverse effect level” (NOAEL) is found; then extrapolate from those animal studies, using “uncertainty factors,” to determine the “safe” dosage for humans.

-- This traditional toxicological approach:
  -- ignores additive, antagonistic, and synergistic mixture effects;
  -- ignores epigenetic transgenerational inheritance;
  -- ignores nonmonotonic dose-response curves;
  -- ignores the corollary that there often is no threshold dose for EDs and some other chemicals;
  -- ignores scientists’ warnings that ingesting trace amounts (parts per trillion or even less) of EDs and other CECs can have serious health consequences, especially for fetuses, infants, and children.

This neglect of substantial bodies of scientific evidence regarding the characteristics and potential health impacts of endocrine disruptors and other CECs raises the question: Why would the State set aside scientific evidence in formulating the 2013 Recycled Water Policy?

Generally speaking, regulatory toxicologists are not on the same page with endocrinologists, developmental biologists, molecular biologists, geneticists, epidemiologists, and other independent scientists who understand how endocrine disruptors and other CECs impact living organisms. As Andrea Gore, editor of Endocrinology, puts it, “There are fundamental differences between regulatory toxicologists and what I refer to as ‘people who understand the endocrine science.’” (qtd. in Brown and Grossman 2015).

Sometimes there are also conflicts of interest at play. In the case of the 2013 Recycled Water Policy, the California State Water Resources Control Board gave too much credence to the report of six “blue ribbon” panelists who were appointed in 2009 by the Southern California Coastal Water Research Project to advise the SWRCB on how to address CECs in recycled wastewater (Anderson et al. 2010). The only expert in human toxicology on that panel, Paul Anderson, a traditional toxicologist, had co-authored at least three industry-funded, industry-informed studies concluding that there are no health concerns from pharmaceuticals in drinking water (Schwab et al. 2005; Hannah et al. 2009; Caldwell et al. 2010). At the time of his appointment to the “blue ribbon” panel, Anderson was also employed by ARCADIS U.S., a southern-California company that sells water-reuse services and technologies (ARCADIS U.S. 2014). This apparent conflict of interest was overlooked by the SWRCB.

The “blue ribbon” panel’s guidelines recommend monitoring just eight indicator chemicals for
tertiary-treated recycled wastewater that would be surface-spread to replenish aquifers. Those eight indicators for monitoring chemicals in wastewater used in surface application for groundwater recharge are N-nitrosodimethylamine (NDMA, a disinfection byproduct), 17beta-estradiol, caffeine, triclosan, DEET, gemfibrozil, iopromide, and sucralose (Anderson et al. 2010:66). For advance-treated wastewater directly injected into aquifers, the two pharmaceuticals, gemfibrozil and iopromide, were removed from the list of indicator chemicals, leaving only six indicators for subsurface injection of treated sewer water into aquifers.

Prior to the State’s acceptance of the expert panel’s recommendations, the list of indicators was questioned by Dr. Andrew Eaton, Technical Director of MWH Laboratories in Monrovia, California, which specializes in testing for CECs in water (Eaton 2010). In his comments for the public hearing on the topic held December 15, 2010, Eaton notes that caffeine “is detected in only about 50% of effluent samples ... and is subject to extensive biodegradation,” so it is “potentially a poor indicator” (Eaton 2010). Similarly, because gemfibrozil only turns up in about 40% of the effluents, “using this compound as an indicator of treatment performance would run the risk of measuring a compound that was frequently not present at all...” (Eaton 2010). Eaton also lists iopromide as a poor indicator because “it is not commonly used as an X-ray contrast medium. Instead iohexol ... occurs much more frequently and at higher concentrations” (Eaton 2010). In each instance, using the indicator chemicals recommended by Anderson et al. (2010) could lead to false-negative conclusions about the existence of CECs in a treatment plant’s effluent. Given that Eaton’s lab is “the largest in the U.S. that is focused solely on water analysis, specifically CECs in water” (Eaton 2010), his comments regarding the panel’s choice of indicators suggest that their research into that topic may not have been sufficiently careful.11

The SWRCB set aside Eaton’s comments on the choice of indicator chemicals, McGowan’s warnings about antibiotic resistance genes, and other letters raising scientifically grounded concerns with the “blue ribbon” panel’s recommendations. The SWRCB adopted the panel’s recommendations into the 2013 Recycled Water Policy.

D. The Next Wave: Direct Potable Reuse (DPR)

Governor Brown’s intent to use ever more recycled wastewater prompted a provision in SB 322 to form another expert panel to advise the CA Department of Public Health (CDPH)12 on developing guidelines for both indirect and direct potable reuse (DPR). The charge to this new expert panel was described on the SWRCB website, as of February 23, 2015, as follows:

1. Assess what, if any, additional areas of research are needed to be able to establish uniform water recycling criteria for direct potable reuse;
2. Advise on public health issues and scientific and technical matters regarding development of uniform water recycling criteria for indirect potable reuse through surface water augmentation; and
3. Advise on public health issues and scientific and technical matters regarding the feasibility of developing uniform water recycling criteria for direct potable reuse. (California State Water Resources Control Board 2015)

11 See also Eaton’s more recent co-authored studies, “The List of Lists – Are We Measuring the Best PPCPs for Detecting Wastewater Impact on a Receiving Water?” (Eaton and Haghani 2012) and “How Reliable Is the Recycled Water Monitoring List?” (Eaton and Wilson 2013). Those publications recommend that a very different and much longer list of indicators be used instead of those few identified in the SWRCB’s Recycled Water Policy.
12 On July 1, 2014, the Drinking Water Program transferred from CDPH to the State Water Resources Control Board (http://www.waterboards.ca.gov/drinking_water/programs/DW_PreJuly2014.shtml Accessed January 15, 2015). The wording of the expert panel’s charge was edited to reflect that change.
Given that two of the three tasks include offering advice regarding “public health issues,” one might expect the panel to include several experts in public health, such as people with advanced degrees in that field, endocrinologists, developmental biologists, epidemiologists, and others who understand the potential health impacts of contact with the EDs and other CECs remaining in trace levels in potable-reuse wastewater. Such is not the case. About half of the panelists are engineers. There is only one epidemiologist (Tim Wade). While another panelist, Joan Rose, has much-needed expertise in water pathogens, she is not an expert in chemical contaminants. **Absent from the panel are endocrinologists and other independent scientists with expertise in the public-health implications of EDs’ nonmonotonic dose-response curves, likely absence of a threshold dose, or the transgenerational epigenetic consequences of early-life exposure to pesticides, pharmaceuticals, unregulated industrial chemicals, and other contaminants.**

On the contrary, the panel includes Richard Bull, of MoBull Consulting, who, with James Crook (fellow panelist) and two others, wrote an extensive defense of using “therapeutic dose” as the point of departure for determining safe levels of drugs in drinking water (Bull et al. 2010). Bull and Crook argue that risk assessors should use the dose of a drug intended for a patient who needs that drug as the basis for calculating the amount of that drug that would be safe for members of the public to consume in drinking water.13 Subsequently, Bull, Crook, and the same colleagues authored *Health Effects Concerns of Water Reuse with Research Recommendations*, published by the WateReuse Foundation (Cotruvo et al. 2012). In both publications, they write: “it is difficult to articulate a [human]-health-based concern that would even require municipal wastewater to be treated to remove drugs” (Bull et al. 2010:16; Cotruvo et al. 2012:xx). Crook and Bull’s statement might baffle endocrinologists and other independent scientists familiar with the ways EDs impact health. But endocrinologists and other scientists with expertise to challenge Crook and Bull’s views are not on the State’s panel charged with evaluating potable reuse.

In their more recent monograph, Crook, Bull, and colleagues describe “the very low concentrations of” pharmaceuticals and personal care products (PPCPs) in recycled municipal wastewater as follows:

> These chemicals do not necessarily pose a significant health hazard at concentrations found in [recycled] drinking water, but they serve as reminders of where the water comes from.... [Therefore] the issue **may not be a need for health research, but a need for the regulatory agency to make a formal judgment** on whether the levels even approach those at which adverse health effects would be expected with an adequate margin of safety. (Cotruvo et al. 2012:7, emphasis added)

Crook and Bull’s statement implies that a regulatory agency simply needs to write that the water “is safe,” and it shall be so. Bizarre as that idea sounds, that same approach – determine that a recycled-wastewater process “is safe” by fiat rather than by unbiased scientific investigation – would not be new, since it was used for the State’s Title 22 regulations of non-potable recycled wastewater and for the 2013 *Recycled Water Policy*.

Since both Crook and Bull are on the panel that will recommend the new (2016) State policy regarding both IPR and DPR – in fact, **Crook is now the panel’s co-chair** -- it appears that wastewater-reuse regulators may again ignore the warnings of many members of the Endocrine Society and other prominent scientists whose work demonstrates that even trace amounts – the amounts of some

---

13 Using therapeutic dose as the point of departure for determining safe daily consumption levels for people who do not need those drugs flies in the face of all the evidence regarding characteristics of EDs discussed in this paper. For a critique of the many questionable assumptions inherent in this practice, see C. G. Daughton (2010:49-51).
CECs found in advance-treated municipal wastewater -- of drugs, cosmetics, pesticides, plasticizers, and other EDs can have serious, long-term health effects, especially for fetuses, infants, and children.

**Bottom line:** Unless and until there is much more rigorous, science-based regulation of contaminants of emerging concern in recycled wastewater destined for potable reuse, whether as IPR or DPR, we cannot rely on either Federal or State regulations to protect people who would be drinking and bathing in it.

**IV. OTHER USES FOR RECYCLED MUNICIPAL WASTEWATER**

Although reliable scientific evidence indicates that using recycled municipal wastewater for food-crop irrigation or for drinking is not worth the health risks, there are other possible uses of this water that may not pose undue risk to humans or other organisms. This section looks very briefly at some examples of reuse in landscape irrigation and for commercial or industrial purposes.

**A. Landscape Irrigation**

Each proposal for using recycled sewer water for landscape irrigation should be carefully studied in light of the Precautionary Principle. In each case, possible impacts on the health of humans, other animals, plants, insects, and soil microorganisms should be considered, along with any pertinent issues relating to run-off or penetration of the effluent into aquifers. **In light of the heightened vulnerability of fetuses, infants, and children to endocrine disruptors and other contaminants of emerging concern, particular attention should be given to potential exposure of children and pregnant women to recycled municipal wastewater.** Accordingly, although specific conclusions about the advisability of any particular application would depend on information about the treatment train, the effluent quality, the irrigation site, and other parameters of application, it seems likely that irrigation of freeway landscaping might be a more appropriate use of recycled wastewater than would irrigation of children’s playgrounds. Applying the Precautionary Principle and studying specific features of each proposal on a case-by-case basis is a sensible way to proceed.

**B. Commercial and Industrial Uses**

Other possible uses for recycled sewer water include flushing commercial toilets, mixing concrete, fire-fighting, settling road dust, etc. To briefly explore a few examples: Assuming proper protection of workers and others who might potentially contact the recycled wastewater were put in place, it seems that using recycled wastewater to flush sanitary sewers would be a good application, and using it to flush commercial toilets and mix concrete might also be promising candidates for using recycled sewer water. However, using it to settle dust on roads or streets might be more problematic (depending on the setting) due to contaminant accumulation and potential runoff into a sensitive stream or other habitat. Particularly in populated areas, the nanoparticles, antibiotic resistance genes, and some chemical contaminants could also become a future airborne health threat if the dust were not adequately controlled. However, these hypothetical scenarios are just general sketches, and decisions would need to be made in light of the Precautionary Principle and factors specific to each proposal.

**V. CONCLUSION**

To summarize: Given that current wastewater treatment technology leaves trace amounts of endocrine disruptors and other contaminants of emerging concern in the effluent; that some of those trace contaminants are now recognized as especially hazardous for fetuses, infants, and children; that existing regulations fail to adequately protect public health from such contaminants; and that using recycled municipal wastewater for either food-crop irrigation or for drinking is not aligned with the Precautionary
Principle, both of those ways of using recycled sewer water should be avoided. For all other purposes, including landscape irrigation and commercial/industrial uses, policymakers should apply the Precautionary Principle to each proposal on a case-by-case basis, taking into account the specific parameters of the proposed application.

There are alternatives: There are viable alternatives that our local policymaking bodies have an obligation to pursue before resorting to recycled municipal wastewater for drinking or other contact uses. Currently, the most important example is that instead of potable reuse of recycled municipal wastewater, Santa Cruz should adopt the Water Supply Advisory Committee’s recommendations. These include (1) conservation strategies that aim for 200-250 million gallons per year reduction in projected demand by 2035, (2) water transfers among neighboring districts using treated surplus river water (conjunctive use, or in-lieu recharge), and (3) using treated surplus river water for aquifer storage and recovery via injection wells. These approaches would not only require far less energy than would potable reuse, but they would also expose the community to far fewer endocrine-disrupting chemicals and other contaminants of emerging concern.

The big picture: Toxic chemicals are ubiquitous in contemporary environments. Drinking clean water is one of the few ways our bodies have to eliminate such chemicals once ingested, so increasing both the numbers of different chemicals and the quantities of them in our diets by regularly bathing in and consuming recycled wastewater is a step in the wrong direction. Instead, we should be working to reduce both the numbers and amounts of man-made chemicals in our homes and in the environment.

VI. REFERENCES


*California Code of Regulations, Title 22, Division 4, Chapter 3, Water Recycling Criteria* [http://ca.eregulations.us/code/t.22_d.4_ch.3](http://ca.eregulations.us/code/t.22_d.4_ch.3) March 7, 2015.


Ms. Townsend:

These are Russian River Watershed Protection Committee’s (RRWPC’s) comments and attachments regarding Surface Water Augmentation Regulations: Initial Statement of Reasons. I would appreciate it if you could send me a brief note indicating you received them. (deadline: 12:00 pm Sept. 12th) Thank you.

Brenda

PS: Here are links to some six articles and a website that I would like attached to comments:


- [Endocrine Disruption Exchange Website](http://www.endocrinedisruption.org) Endocrine Disruption Exchange Website founded and managed by Theo Colborn until her death in December, 1915: She is the Rachel Carson of endocrine disruption science. This site includes a list of potential endocrine disruptor chemicals

- [Low doses, big effects: Scientists seek ‘fundamental changes’ in testing, regulation of hormone-like chemicals](http://www.environmentalhealthnews.org/ehs/news/2012/low-doses-big-effects) by Marla Cone: Editor in Chief of Environmental Health News “Low doses, big effects: Scientists seek ‘fundamental changes’ in testing, regulation of hormone-like chemicals”

- [Hormones and endocrine disrupting chemicals: low dose effects and non-monotonic dose responses](http://www.ncbi.nlm.nih.gov/pubmed/22419778) by L.N., et al., Endocrine Reviews, 2012. 33(3): p. 378- 455, (This is an important study out in March, 2015 that involved the work of 12 research scientists in the endocrine disruption field. The study reviews the many studies on the topic as of the date of publication.)


- [Wastewater Irrigation on Farms Contaminates Food](http://www.beyondpesticides.org/infoservices/pesticidesandyou/documents/WastewaterFall2014.pdf), Pesticides and You, Vol. 34, #3, Fall 2014 p.19-p.23,

- [CHEMTrust overview of Key Scientific Statements on Endocrine Disrupting Chemicals (EDCs) 1991-2013, as of January 2014.](http://www.chemtrust.org.uk/wp-content/uploads/CHEM-Trust-Pharma-Dec14.pdf) (This document contains about 35 major scientific reports and statements over 22 years that each contain many references and resources on endocrine disruption)
--
Brenda Adelman
Russian River Watershed Protection Committee
P.O. Box 501
Guerneville, CA 95446
Email: rwpc@comcast.net
RRWPC Website: www.rwpc.org