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ORANGE COUNTY WATER DISTRICT

ORANGE COUNTY'S GROUNDWATER AUTHORITY

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March 1, 2018

Keith Maruya
Southern California Coastal
Water Research Project Authority
3535 Harbor Blvd. Suite 110
Costa Mesa, CA 92626

(submitted via email – Keithm@sccwrp.org)

Dear Dr. Maruya,

The Orange County Water District (OCWD) staff thanks you for the opportunity to provide comments on the draft report -- "Monitoring Strategies for Constituents of Emerging Concern (CECs) in Recycled Water" (Report). The Report reflects the 2018 Science Advisory Panel's (Panel) broader charge as compared to its predecessor from 2010, with the inclusion of updating its risk-based framework, examining the need for CEC monitoring for all non-potable recycled water uses, evaluating the relationship of antibiotic resistance to the use of recycled water, and providing recommendations for additional research.

As detailed in the attachment, OCWD provides 92 total comments, requests for clarification, and suggested edits on the Report, with the overall goal of improving its utility for the State Board, the water recycling community, and the general public. While all of our comments carry significance and should be addressed, the individual comments highlighted below merit special attention by the Panel:

- **Comments #3, #15, #41, #51, and #54:** The Panel must clearly define terms "constituents of emerging concern" (CEC) and "unregulated" contaminants/constituents/chemicals, as the Report does not explicitly define them. Relatedly, the Panel must specifically address why compounds with California Notification Levels (NLs) should be considered CECs, given that current regulations already require regular monitoring for these compound at Groundwater Augmentation and Reservoir Water Augmentation projects.

- **Comments #8, #10, #12, #78, 79:** The Panel's recommendation in Section 9.4 that non-targeted analysis is a voluntary follow up to a "positive" bioassay result is not reflected in the Report's earlier text and in none of the Report's figures. This internal lack of consistency is confusing to the reader and should be corrected.

PO Box 8300
Fountain Valley, CA 92728-8300

18700 Ward Street
Fountain Valley, CA 92708

(714) 378-3200
(714) 378-3373 fax

www.ocwd.com

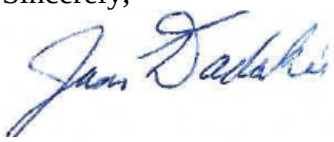
- **Comment #66:** The Panel recommends adding sulfamethoxazole as a performance-based indicator for soil-aquifer treatment (SAT), Direct Injection, and Surface/Reservoir Water Augmentation, but little or no explanation is provided, nor any reference to the literature supporting its suitability as an indicator compound and its ">90%" expected removal. We are concerned that the Panel may be relying on older studies that do not reflect the current state of the science and that have been superseded by more recent monitoring and studies from a wider range of sites. As presented in the attached figures after our complete list of comments, OCWD has long-observed very limited removal of sulfamethoxazole at its multiple SAT sites receiving effluent-dominated surface water for groundwater recharge. We strongly caution the Panel to avoid adding a new performance indicator compound with an expected removal value before giving careful review to the actual removals observed at OCWD, at permitted groundwater augmentation projects in CA using tertiary effluent + surface spreading (i.e., the LACSD/WRD Montebello Forebay project and IEUA's project), and at other relevant sites.

- **Comments #67 and #73:** The Draft Report does not contain a review of and/or make recommendations among the available analytical methods for any of the recommended health-based indicators: NDMA, NMOR, and 1,4-dioxane. Furthermore, the basis for the recommended minimum reporting limit (MRLs) for both the health-based and performance-based indicators is not presented anywhere in the Report and should be provided. The recommended MRL for 1,4-dioxane deserves particular attention, because it is much lower relative to its MTL than for NDMA and NMOR, and it would compel the use of sample pre-extraction, thereby increasing analytical costs.

- **Comment #86:** Textbox 7.1 attempts to present "A Framework to Use Bioassays to Identify Sources Requiring Further Evaluation". In addition to having an overly broad-title, this attempt by the Panel to demonstrate linking of PNECs with the ER bioassay response contains many potential errors, inconsistencies, and ambiguities. The Panel must review and revise the Textbox in order to more clearly demonstrate how to carry out this fundamental exercise linking bioassay results to human health relevance.

We thank the Panel for its diligence and hard work in completing its analysis and the Report in a compressed time frame. We believe that ultimately the Panel's work can strengthen public confidence in the safety of recycled water and potable reuse and provide guidance and direction for the State Board on ways to improve CEC monitoring for the protection of human health. Should have any questions, please do not hesitate to contact me at jdadakis@ocwd.com or (714) 378-3364.

Sincerely,



Jason Dadakis
Executive Director of Water Quality and Technical Resources

Attachment

OCWD Comments on 2018 Draft Final Report "Monitoring Strategies for Constituents of Emerging Concern in Recycled Water"

Comment Number	Page	Section Heading	Paragraph Number or Title	Comments
1	vi	Executive Summary	1	Recommend changing "demand for water" to "population growth" in light of state population trends and the reductions in water demands observed during the recent drought.
2	vi	Executive Summary	1	Recommend adding "and potable reuse" to the sentence ending "discharge to the environment".
3	vi	Executive Summary	1	The acronym CECs is not defined before its first use, unlike others in this section. Additionally, need to define what "constituents of emerging concern" means within the context of this report. This may require defining the meaning of "unregulated" in CA (i.e., a lack of an MCL) but should also capture the nuance of why the Panel (or the State Board) feels that compounds with a CA Notification Level should be considered CECs.
4	vii	Updating the List of CECs and other Monitoring Parameters	2	"considered a conservative assumption because treatment levels at the point of application are similar to those for most non-potable uses." This phrase is at a minimum confusing, if not false. Please clarify if point of application in this particular case is referring to non-potable Title 22 use (e.g., irrigation) or IPR (e.g., surface spreading) or both, also why this is more "conservative". Finally, this phrase should not ignore that treatment at the point of application for direct injection is far greater than that for non-potable uses and surface spreading. Alternatively, this phrase could simply be deleted here and where it also appears on pg. 96 in Section 9.2
5	vii	Updating the List of CECs and other Monitoring Parameters	2	"potable recycled water" This is an awkward term and is likely legally inaccurate under current CA regulations that do not explicitly allow DPR and undert he recently adopted AB 574 potable reuse definitions. Recommend changing to "groundwater and treated reservoir water (or surface water) augmented by recycled water,"

Comment Number	Page	Section Heading	Paragraph Number or Title	Comments
6	vii	Updating the List of CECs and other Monitoring Parameters	Footnote 1	The election to retain the old terms of “groundwater recharge” and “surface water augmentation” will cause confusion with both current and future readers, given their adoption via AB 574in October 2017 as indicated. Given that the Panel’s charge is to update CEC monitoring recommendations and account for developments since last convening, it follows that its report should follow the new definitions and terminology found in the updated California laws and regulations instead of retaining outdated terminology simply for consistency with the prior report.
7	viii	Updating the List of CECs and other Monitoring Parameters	4 and Figure ES-1	Only the right hand side (“CA MECs available”) of the Figure ES-1 graphic is applicable to the text reference “The updated MECs and MTLs were employed to screen a total of 489 CECs (increased from 418 in 2010) using the same screening framework used by the 2010 Panel to identify candidate compounds for monitoring”. The left hand side deals with the Panel’s framework for unmonitored CECs, which is not discussed until later in the ES. While these later discussions do refer back to this figure as well, it is very confusing/overwhelming to have this be the first graphical reference to help explain the MEC & MTL process. Recommend splitting the figure in two, one for each side, with the appropriate text references – this has already been done for left hand side to create Figure 7.1, so the remaining right hand side should be used here.
8	viii	Updating the List of CECs and other Monitoring Parameters	Figure ES-1	To be consistent with the Panel’s recommendations in Section 9.4, last paragraph, the figure should be modified to clearly indicate that using NTA to follow up on a bioassay with positive bioactivity is **voluntary.** This should be done at minimum with a dashed line between the “No” and “Perform NTA” boxes, as well as showing the entire NTA process in a different color denoting it is voluntary. This is important because as it reads currently in the ES, to which many will refer, NTA comes across as required in part due to the lack of clear discussion of NTA in the ES (see Comment #10).

9	ix	Updating the List of CECs and other Monitoring Parameters	5	"include most Title 22 uses and potable reuse surface water augmentation under current regulatory practices" This phrase is confusing because groundwater augmentation is left out and Title 22 now contains potable reuse regulation via the adoption of the Final Groundwater Recharge Reuse Regulations in 2014 and the pending adoption of Reservoir (Surface) Water Augmentation Regulations. Recommend this revised text: "to water reuse applications that include most non-potable uses and potable reuse via groundwater and surface water augmentation under current regulatory practices."
10	ix	Bioanalytical screening tools and non-targeted analysis	1	Despite this section's title, no mention of non-targeted analysis occurs in the text. Recommend adding a sentence at the end of the paragraph consistent with the Panel's recommendations in Section 9.4, last paragraph, to clearly indicate that using NTA to follow up on a bioassay with positive bioactivity is **voluntary**.
11	x	Final Recommendations Provided by the 2018 Panel	4	Add the phrase "alongside the required CEC monitoring list" to the end to clearly denote the context for the proposed use of bioanalytical tools.
12	x	Final Recommendations Provided by the 2018 Panel	5	Add the word "voluntary" as appropriate to this bullet regarding NTA, to be consistent with the Panel's recommendations in Section 9.4, last paragraph.
13	x	Final Recommendations Provided by the 2018 Panel	6	"potable water facility" and "potable water operations" These are both awkward terms within the context of a report about recycled water. Recommend using the terms "potable reuse facility" and "potable reuse operations" instead to clearly distinguish from drinking water treatment plants or potable groundwater wells.

14	x	Final Recommendations Provided by the 2018 Panel	8	"The Panel recommends that the State Water Board consider the results of more definitive research showing an actual relationship of antibiotic resistance to recycled water before changing its current policy." The policy's current stance regarding AR should be restated so that the reader can appreciate what the status quo is in light of the Panel's recommendation.
15	1	1.1 Background	2	"unregulated chemicals referred to as constituents of emerging concern" Please add one or more sentences describing what "unregulated" means within this context. It appears as though the Panel and/or the State Board believes that compounds with a CA Notification Level are considered "unregulated", despite CA law/regulations having very prescriptive requirements regarding the actions that drinking water utilities AN**D potable reuse projects** must take if chemicals are detected above their Notification Level concentrations. The Panel should explain why Notification Level compounds are considered CECs, especially considering that the Division of Drinking Water (who develops and promulgates Notification Levels) has been part of the State Board since 2014.
16	1	1.2 The Science Advisory Panel	2	Recommend deleting "aquatic life" from first sentence. The original Panel called for in the Recycled Water Policy and reconstituted for this report is focused on recycled water and human health.
17	1	1.2 The Science Advisory Panel	1	Any changes to the Panel makeup since the original 2010 Panel should be highlighted.
18	3	1.3 Charge to the Panel	4	With appropriate references to the regulations, the Panel should add a sentence describing the pathogen control regulations in Title 22 for unrestricted non-potable reuse (e.g., filtration, 450 CT disinfection, 5-log virus removal, etc.) and potable reuse (12/10/10 log removals for virus, *Giardia*, *Cryptosporidium*) to augment the text on the well-managed public health risk for waterborne pathogens in CA recycled water.

19	4	2. Regulatory Practices for Water Recycling in California	2	"With increasing demand due to periodic drought". It is not clear how drought increases water demand…recent evidence suggests demand is reduced during drought in CA. Suggest rewording to remove "demand", keeping drought and population growth in sentence.
20	4	2.1 The State Water Board's Recycled Water Policy	3	"The Regional Water Boards provide local implementation of policy and regulations, develop long-range plans for their areas, issue waste discharge permits and take enforcement actions against violators." Suggest including "issue water recycling requirements" to this list of activities.
21	4	2.1 The State Water Board's Recycled Water Policy	7	"In addition to the above topics, the expansion of the policy to address new potable water sources (both raw and finished drinking water source), and the approach for permitting and enforcement of the new sources needs to be clarified and made consistent with current State Water Board findings and regulations regarding such new potable water sources" This sentence is very confusing and needs to be rewritten or eliminated. What is the difference between a raw and finished drinking water "source"? Must clarify which "expansion" of the policy is being referred to here (expansion of the Original 2009 Policy, the 2013 Amendment, the currently planned 2018 Amendment, etc.). What are the specific "current State Water Board findings and regulations regarding such new potable water sources" that need to be addressed via "expansion" of the policy? None of the subsequent Federal Regulations (not State, as mentioned in next sentence) listed in the bullets immediately below this paragraph are new since the 2009 Policy.
22	4	2.1 The State Water Board's Recycled Water	9	"Treatment technologies (i.e., advanced water treatment (AWT)) capable of producing high-quality potable water from wastewater for supplementing drinking water supplies have been demonstrated in a number of full-scale AWT facilities (AWTFs)." Under current California law and regulation, no AWTF produces legally "potable water" from wastewater because of the current requirement for an environmental buffer prior to potable use. Suggest adding the word "quality" after "potable water" in the above to capture this important nuance.

23	6	2.2 Regulatory Developmen t for Recycled Water Applications	3	In the Planned IPR subsection, the terms “blended” and “post-treatment” are used. “Blended” may not be an appropriate term since current CA regulations allow 100% recycled water contribution (i.e., no blending requirement) subject to certain requirements, and at least one IPR project is approved to operate in this manner. “Post-treatment” is used here to describe additional treatment provided to water extracted from an aquifer or reservoir prior to being introduced into a [potable] water supply. However, “post-treatment” more typically refers to water conditioning and/or stabilization techniques (e.g., mineral addition) after major treatment steps (e.g., reverse osmosis) to ensure compatibility with distribution infrastructure. Recommend replacing “post-treatment” here with “conventional water treatment and/or disinfection”.
24	6	2.2 Regulatory Developmen t for Recycled Water Applications	Footnote 4	For a section entitled “Regulatory Development…” it would be preferable to cite a CA reference for non-potable reuse here vs. a USEPA one, given that no USEPA regulations exist for water reuse.
25	8	2.3 Regulatory Developmen t for Recycled Water Applications	Table 2.2, Item #2	The 2018 Panel states that it did not follow its own 2010 recommendation to review the development of RSCs. Please include the Panel’s reasons and/or changes in thinking for not following its own prior recommendation.
26	8	2.3 Regulatory Developmen t for Recycled Water Applications	Table 2.2, Item #3	The term “known unknown CECs” is confusing and not easily understood by non-experts. Please add an explanation of what is meant here.

27	9	2.3 Regulatory Developmen t for Recycled Water Applications	Table 2.2, Items #6, #7, and #8	Given that there are no regular or broad State requirements for CEC testing of secondary/tertiary effluents for CECs (other than 2013 Policy Amendment Attachment A indicator CECs), the efforts to determine the 90th percentile MEC value are limited by datasets generated from inconsistent voluntary testing from a handful of proactive agencies. If the risk-based approach for assessing individual CECs should continue, a future Panel should first consider assessing data consider MEC data from outside California. If that proves insufficient, then the Panel should consider recommending that the State conduct the equivalent of the Unregulated Contaminant Monitoring Rule UCMR program on secondary/tertiary effluents from a significant number of representative wastewater facilities to develop a more broadly representative dataset for future MEC assessments. This program should consider existing CEC target lists at public agency and private laboratories and allow sufficient time for methods to be developed and/or modified to add in new compounds as needed.
28	10	2.3 Regulatory Developmen t for Recycled Water Applications	Table 2.2, Last Item	"The State Water Board has taken action regarding the development of bioanalytical screening technologies." The Panel should briefly assess the sufficiency and success of these actions. Furthermore, the appropriate role of USEPA, NIH, and NTP resources, guidance, and programs in this effort should be stated here.
29	10	2.3 Regulatory Developmen t for Recycled Water Applications	Permit Potable Reuse Projects subheadin g	The Panel needs to provide more specific rationale for recommending that DDW should issue drinking water permits to all potable reuse projects. Currently, potable reuse facility permits are issued by the Regional Boards with <u>significant input and oversight from DDW</u>, including review and approval of the Title 22 Engineering Report, oversight of the required Public Hearing, the issuance of Findings and Conditions that are incorporated directly into the final Regional Board permit, and review of monthly and quarterly compliance monitoring reports. Drinking water permits are currently specific to drinking water treatment facilities and/or Public Water Systems. In many cases, the potable reuse facility permit is a component of the larger NDPES permit because the underlying wastewater treatment facility maintains an environmental discharge for disposal and/or the recycled water for potable reuse is discharged to environment (e.g., Waters of the State or Waters of the USA) prior and/or as a part of its formal application to groundwater or reservoir water augmentation.

30	10	2.3 Regulatory Developmen t for Recycled Water Applications	Permit Potable Reuse Projects subheadin g	The terms “raw water source” and “finished water source” are ambiguous and require clarification or replacement with clearer terms.
31	10	2.3 Regulatory Developmen t for Recycled Water Applications	Footnote 9	“The development of drinking water permits should be consistent relative to the inclusion of CEC and bioanalytical monitoring requirements”. The Panel makes this statement in a footnote, yet it represents a very significant recommendation. The Panel should be clear if they mean that for the purposes of consistency, either a) CEC and bioanalytical requirements should be added to <u>all</u> drinking water permits (i.e., “conventional” non-recycled water treatment facilities and/or drinking water systems) to be consistent with the Panel’s recommendations for IPR facilities, or b) CEC and bioanalytical requirements should not be added to IPR facility “drinking water” permits until such time that they are added to “conventional” non-recycled water treatment facilities and/or drinking water systems. Either way, this is a very significant recommendation that requires expansion and explanation in the main text vs. a one sentence footnote.
32	11	2.3 Regulatory Developmen t for Recycled Water Applications	Permit /Potable Reuse Projects subheadin g	“Enhanced source control programs (a planned DDW project intends to investigate/define enhanced source control program criteria) developed for all potable reuse projects should be regulated through DDW as part of the drinking water permits.” Enhanced source control is already a requirement within the Title 22 requirements for potable reuse projects (see §60320.106, §60320.206, and §60320.306). Furthermore, the Panel should carefully reconsider its recommendation that <u>drinking water regulators</u> from DDW should be responsible for regulating source control programs that derive their fundamental authority from the <u>federal Clean Water Act’s</u> pre-treatment requirements.

33	11	2.3 Regulatory Developmen t for Recycled Water Applications	High Frequency Data subheadin g	The recommendation to submit high frequency data to the State is premature. The appropriate techniques for utilities to use, store, retrieve, and analyze these data are just beginning to mature. The Water Research Foundation is likely to solicit a research project in the coming year focused on further developing these techniques for potable reuse facilities. Given the higher priority State data management issues cited by the Panel, we strongly recommend removing and holding on to this recommendation until the next time the Panel meets and more concrete recommendations on best practices for managing these data have been developed
34	11	2.3 Regulatory Developmen t for Recycled Water Applications	Develop internal protocols for DDW staff review and response to CEC and bioanalytic al data	The terms “raw source water” and “finished water” are ambiguous and require clarification or replacement with clearer terms about the exact sample points being described. “define the terms of non-compliance” Use of the term “non-compliance” is wholly inconsistent with the Panel’s prior statement at the top of pg. ix in the Executive Summary “The Panel reiterates that the MEC/MTL ratio employed in the risk-based, screening framework is operationally defined, and should not be compared to (or confused with) regulatory criteria (i.e. enforceable maximum contaminant levels or MCLs). Furthermore, a large margin of safety is incorporated into this framework. Therefore, a MEC/MTL ratio of greater than 1 does not represent an immediate threat to public health.” Use of this term is also inconsistent with bioassays being used as a “screening” tool to assess unknowns. It should be deleted. If replacement is desired, then a term such as “response actions” or “follow on actions” should be used. This would be consistent with the remaining text in this subsection.
35	17	3.1.2 Planned Potable Water Reuse	4	”**the main functions of the environmental buffer** are to provide – through storage – some level of water quality equalization and time to respond to process failures or out-of-compliance water quality monitoring results**…”** This statement completely ignores the well-established benefits of soil-aquifer treatment (SAT), especially for the surface spreading of disinfected tertiary filtered effluent. Both the scientific literature and CA regulations recognize the primary role of SAT in attenuating both pathogens and organics for this application, which supersede the storage-based benefits stated by the Panel. The statement should be modified accordingly for accuracy and for consistency with the subsequent paragraph.

36	25	3.3 Human Health Considerations for Potable Reuse Scenarios	1	The word “removed” is used in the 2nd line, where “reduced” would more accurate, especially with the remaining text in the paragraph (i.e., “a public health goal is not to eliminate all chemicals and microorganisms…”)
37	25	3.3 Human Health Considerations for Potable Reuse Scenarios	4	The 2nd appearance of the word “important’ in the first line appears unnecessary/redundant.
38	25	3.3 Human Health Considerations for Potable Reuse Scenarios	4	See comment # 6. The term “planned DPR through SWA” should be replaced with “reservoir water augmentation”, and “IPR-GWR” should be replaced with “groundwater augmentation.”
39	25	3.3 Human Health Considerations for Potable Reuse Scenarios	4	“maintain conventional public health practices by utilizing a physical separation (i.e., environmental buffer) between wastewater treatment and water supply.” This statement ignores the role of advanced water treatment, SAT, and/or conventional drinking water treatment as required between wastewater treatment and water supply and should be modified accordingly.

40	25	3.3.1 Planned potable reuse criteria for groundwater replenishment	1	As stated in prior comments, the term “groundwater replenishment” should be replaced throughout with “groundwater augmentation” to be consistent with the updated CA potable reuse definitions signed into law in October 2017.
41	26	3.3.1 Planned potable reuse criteria for groundwater replenishment	1	“The State Water Board requires monitoring of additional constituents for unregulated chemicals (e.g., chromium-6, diazinon, 1,4-dioxane, N-nitrosodimethylamine (NDMA), and 1,2,3-trichloropropane)…” See comments #3 and #15. Diazinon, 1,4-dioxane, and NDMA all have CA Notification Levels. Chromium-6 had an MCL that was overturned by the CA courts, but DDW plans on re-establishing one. Furthermore, as of January 1, 2018, 1,2,3-TCP has an enforceable CA MCL. The definition of an unregulated contaminant and the specific examples listed must be reviewed and revised.
42	27	Table 3.3	Pathogen Reductions at Compliance Point	This item infers that the compliance point(s) for pathogen reductions are: “finished potable water”, “SA – after soil aquifer treatment”, and “DI – at the point of injection”. The latter two points are clearly incorrect – regulations allow for additional pathogen log removals during subsurface retention time after either SAT or AWT and before extraction for potable use. It is not clear if “finished potable water” refers to water extracted and distributed for potable use or after advanced water treatment prior to spreading and/or injection when it can be of potable quality. The SA and DI compliance point references should be removed and “finished potable water” needs to be more clearly defined in a manner consistent with the regulations.
43	27	Table 3.3	Pathogen Reductions at Compliance Point	There is an unnecessary format break in middle of Table 3.3

44	27	Table 3.3	Unregulated Contaminants	This section cites the Amended 2013 Recycled Water Policy, which does not appear within nor is referred to within the 2014 Final Groundwater Augmentation regulations adopted into Title 22. However, additional contaminant monitoring requirements are found in multiple places within the Final Groundwater Augmentation regulations, including monitoring for indicator compounds to characterize the presence of pharmaceuticals, endocrine disrupting chemicals, personal care products, and other indicators of the presence of municipal wastewater (see §60320.120 and §60320.220). The actual Final Groundwater Augmentation regulations focused on CECs should be summarized here; any references to the 2013 Recycled Water Policy should be incorporated by footnote, if at all.
45	29	3.3.2 Planned potable reuse criteria for surface water augmentation	2	The reference to Table 3.3 at the top of the page should be pointing to Table 3.4.
46	29	3.3.2 Planned potable reuse criteria for surface water augmentation	Theoretical Residence Time (Tr) – Operational Criteria	The equation for determining Theoretical Residence Time should be provided: Tr = V/Q, with all parameters defined as in the regulations/criteria.
47	29	3.3.2 Planned potable reuse criteria for surface water augmentation	5	"The SWTP includes an additional set of barriers that are designed to provide 4-log enteric virus, 7-log *Giardia* cyst, and 8-log *Cryptosporidium* reduction…" These do not match the log reductions stated in Table 3.4 for the SWTP. Please review USEPA Surface Water Treatment Rule/LT2 regulations and confirm stated log reduction requirements for SWTPs, especially for *Giardia* and *Cryptosporidium.*

48	33	4.2.2	2	No information is provided on the number of facilities providing data, nor on how non-detects and potential outliers were handled statistically in determining the 90th percentile values. These should both be included, especially the non-detect and outlier procedures, given how many compounds (e.g. hormones) have standard detection limits very close to their MTLs.
49	33	4.2.2	2	"The 90th percentile MECs for 51 CECs reported in secondary/tertiary treated effluents in 2010 and 2018 is summarized in Figure 4.1." It should be explained why (only) these particular 51 CECs are included in Figure 4.1 (i.e., is it only because those 51 met the "rich database criteria" of n>30?) Furthermore a data summary including the underlying statistics (n, max, min, stdev, average, median, 90th percentile, etc.) and number of facilities contributing data for each CEC analyzed should be included as an appendix to the report. The Panel's efforts to assemble and analyze these data should be directly available to the public in this manner, consistent with the Panel's calls for transparency in future data collection and storage efforts.
50	33	4.2.2	Figure 4.1	1,4-dioxane is missing from this figure, which is important because it is being added to the list of recommended CECs for monitoring because its occurrence increased in the 2018 assessment vs. the 2010 assessment. It needs to be added. An additional commonly monitored CECs missing from this figure is TCEP. This figure also has some visual glitches (e.g., "?" symbols throughout, floating triangle at the bottom, etc.) that should be corrected to improve readability.
51	35	4.3.2	2	"The greatest weight is given to PNECs developed by the State of California to derive drinking water MCLs and notification levels." This is not accurate. The MTLs assigned to NDMA and 1,4-dioxane are equal to their CA Notification Levels. The PNECs underlying these notification levels are different and not equal to the Notification Levels. This sentence should be modified to state "To derive MTLs, the greatest weight is given to MCLs and Notification Levels developed by the State of California." Relatedly, in this section, the Panel should describe why they have chosen to given the greatest weight to CA MCLs and NLs to develop the MCLs (e.g., direction from State Board, Panel's expert judgement, consistency with existing state standards, etc.).

52	35	4.2.2	Table 4.2	The MTL for Atrazine is stated as 2 ug/L (2010) and 300 ug/L (2018). California has a primary MCL for atrazine set at 1 ug/L. Based on the prior statement that CA MCLs have the greatest weight determining MTLs, why has atrazine's MTL been set by the Panel twice at concentrations lower than the CA MCL? Please fix this inconsistency or add a footnote to table explaining it. The entire table should be rechecked for consistency with CA MCLs and NLs. This comment also applies to the atrazine MTLs listed in Appendix D.
53	36	4.2.2	Table 4.2	The 2018 MTLs for PFOA and PFOS are set at 70 ng/L with "CA" as the reference. There is currently no CA MCL or Notification Level for either PFOA or PFOS. The current USEPA Health Advisory is set at a combined 70 ug/L for PFOA + PFOS. Please modify the table to accurately describe these MTLs and their references. The entire table should be rechecked to ensure accurate references for MTLs.
54	39	4.4	Table 4.5	Footnote "a" should be augmented to state that 1,4-dioxane and NDMA are part of the current SWRCB monitoring requirements for potable reuse <u>because they are Notification Level compounds (i.e., independent of the 2013 Recycled Water Policy Amendment).</u> The Panel's suggested MTLs for these compounds are the same as the CA Notification Level values. However, the final California Groundwater Augmentation regulations adopted in 2014 and the current draft reservoir water augmentation regulations (likely to be adopted in early 2018) already require quarterly monitoring for all NL compounds. See §60320.120. (Final Surface Spreading Regulations) §60320.220. (Final Direct Injection Regulations), and §60320.320. (Proposed Surface Water Augmentation Regulations), all of these sections are entitled "Additional Chemical and Contaminant Monitoring". For proper context and to best equip the State Board for implementation, the Panel's monitoring recommendations for these compounds should acknowledge and hopefully reflect the existence of the existing CEC monitoring requirements in state law outside of the Recycled Water Policy. This can help ensure that the State Board's consideration and potential implementation of the Panel's recommendations does not conflict with existing regulations and continue the ongoing harmonization of Division of Drinking Water (DDW) regulations with those of other divisions within the State Board.

55	39	4.2.2	Table 4.5	This table (as well as Table 5.1, Appendix D, and other locations in the report) continue to state that the MTL for caffeine is 350 ng/L for 2018, the same as it was in 2010. However, Textbox 5.1 (pg. 44) states that a more appropriate MTL for caffeine is as much as 1000 times higher than the "interim" MTL used by the Panel in 2010. However, the Panel persists in using an MTL of 350 ng/L in 2018. The caffeine MTL should be increased from 350 ng/L to one that is compatible with the most recent EFSA findings. The TTC-based MTL of 350 ng/L was before and is now even more inappropriate in the face of numerous other ADIs developed from actual exposures vs. structure activity relationships. The purpose of the expert Panel is to make these types of expert judgements, not to simply adopt the lowest MTL available when overwhelming evidence of more reliable ADIs and/or PNECs are readily available and stated elsewhere in report.
56	41	5.1	1	"potable water facility monitoring data" Please replace with "potable reuse facility data" to avoid confusion. If the original term is meant to include current drinking water treatment plants and potable wells, as well as IPR facilities, this needs to be explained clearly and justified separately (see comment #30).
57	42	5.2	Develop a State Water Board staff protocol to collect CEC data	The recommendations in this section for State Board staff to develop multiple protocols surrounding the collection and analysis of CEC data does not acknowledge the current primary role of the Regional Boards and DDW in the review of monitoring reports generated by recycled water facilities. If the Panel is implicitly considering DDW and the Regional Boards as part of the "State Board staff", this recommendation should say so explicitly. Regardless, the recommended roles for DDW and the Regional Boards in these protocols should be mentioned, especially considering the Panel's earlier recommendation for DDW to issue "drinking water permits" to potable reuse facilities.

58	42	5.2	Develop a State Water Board staff protocol to refine and update MTLs and review MEC/MTL results	The State Board does not possess the technical capacity to update PNEC and ADIs to develop new and/or modify current MTLs and carry out the CEC listing and de-listing process. Unless the State Board is willing to invest significant resources in brining on in-house toxicological expertise, hire expert consultants, or has access to other state resources (e.g., the Office of Environmental Health Hazard Assessment), these responsibilities should remain with the Panel. However, the State Board staff could perform MEC updates and provide this information to the panel at each review, i.e., collect and enter CEC occurrence data from the state/nation and perform statistics to determine updated 90th percentile MECs per the panel's described methods.
59	43	5.2	Develop a State Water Board staff protocol for collection and review of treatment process and special study data	"The Panel suggests working through utility trade organizations (e.g., WE&RF) and independent research groups (e.g., NWRI, SCWRRP, SFEI) to develop the protocol format and summarize available data. In contrast to WE&RF and NWRI, neither SCCWRP nor SFEI have significant relevant experience assessing the performance of potable reuse treatment trains and identifying potential constituents that may pass through required treatment barriers, and therefore are not the ideal research groups for these activities. Recommend removing these organizations as examples.

60	43	5.2	Develop a State Water Board staff protocol for collection and review of treatment process and special study data	"Develop a staff protocol that provides a consistent framework for the consideration of factors related to the fate and transport of CECs in environmental buffers and the removal/reduction of CECs and bioactivity as measured by bioanalytical tools through potable reuse treatment trains and identify potential constituents that may pass the required treatment barriers." This is a major effort, and hence the Panel should consider narrowing this charge and thereby making it more explicit as to the goals. The Panel should provide the underlying rationale and/or purpose of this recommendation (e.g., are these work products to be provided triennially by the Panel? How would they inform future State Board policy?)
61	44	5.2	Textbox 5.1	See comment #55
62	44	5.3.1	Consideration of screening studies outside of California	We concur with the Panel's recommendation that MEC data from outside California should be considered. The current risk-based approach is constrained to datasets generated from inconsistent voluntary testing from a handful of proactive California agencies.
63	44	5.3.2	Bioanalytical monitoring methods	"…and when calibrated, may provide some indication of adverse effect." Please include a brief description of the recommended/necessary calibration process and how it helps to ensure accuracy and public health relevance.
64	45	5.4.1	Figure 5.1	See comments #7 and #8. The Panel also needs to provide guidance here on choosing the appropriate targeted, "suspect screening', and/or NTA method(s) to follow up on "positive" ER and AhR bioassay results.
65	45	5.4.2	Table 5.1	The table caption currently mentions both "performance based indicators" and "performance surrogates", but does not mention health-based indicators even though they are also prominently included.

66	45	5.4.1	2 and Table 5.1	Sulfamethoxazole has been newly added as a performance-based indicators for SAT, Direct Injection, and Surface/Reservoir Water Augmentation, but little or no explanation is provided. The Panel should describe why it has been added, including referencing its updated MEC and the literature basis for its stated expected removal in both applications. We are concerned that the Panel may be relying on older studies that do not reflect the current state of the science and that used very limited datasets that have been superseded by more recent monitoring and studies. The “>90%” expected removal for sulfamethoxazole via SAT is not consistent with OCWD’s observations minimal of removal at multiple sites from years of SAT monitoring for recharge of an effluent-dominated surface water (see attached figures from OCWD). As such, we strongly caution the Panel to avoid adding new performance indicator compound with an expected removal value before giving careful review to the documented removals at OCWD, at permitted groundwater augmentation projects in CA using tertiary effluent + surface spreading (i.e., the LACSD/WRD Montebello Forebay project and IEUA’s project), and other relevant sites.
67	47	5.4.1	Table 5.1	The Panel must provide the basis for each of the Method Reporting Limits stated in Table 5.1, preferably within a dedicated section of text (see second part of Comment #73). The recommended MRL for 1,4-dioxane is 100 ng/L and its MTL is 1000 ng/L, reflecting a MTL/MRL ratio of 10. The other Health-based indicators, NDMA and NMOR, have MTL/MRL ratios of 5 and 1.2, respectively. The 100 ng/L MRL for 1,4-dioxane is currently only achievable via organic extraction ahead of analysis via GC-MS (e.g., EPA Method 522), adding considerable labor, time, and expense. An MRL of 300 - 500 ng/L is achievable using purge & trap + GC-MS, which would provide an MTL/MRL ratio of 2.0 – 3.33, which is consistent with those recommended for NMOR and NDMA. The Panel should carefully consider the appropriate MRL so that a more expensive method is not unnecessarily required.
68	47	5.4.1	Table 5.1	See comment #54 – this same footnote should be added to Table 5.1
69	48	5.5	3	“As a result of dilution and dispersion…” See comment #35. This phrase greatly understates the contribution of the environmental buffer. Please add in the established processes of adsorption, volatilization, and biodegradation.

70	48	5.6		We disagree with the Panel's contention that a triennial review may not be "sufficiently dynamic and responsive". We believe it would be unwise to be changing the recommended monitoring list based on less than three years of occurrence data. Especially given that later in this section the Panel proposes a triennial review, we recommend striking this internal conversation from the text and just giving the recommendation.
71	49	5.6	3	We note that the Panel has not included a review SWRCB's implementation of the Response Actions to Exceedences of the MEC/MTL thresholds for Health-Based Indicators as presented Table 7 of the 2013 Recycled Water Policy Update, Attachment A. The Panel should review and provide recommendations regarding these Response Actions.
72	57	6.3.2	10	"Therefore the Panel does not consider these as true isotope-dilution methods whereby each analyte would include an isotopically-labeled version spiked into the raw sample (as quickly from the time of collection as possible) and followed through the entire procedure". None of EPA 500 series methods employ "true" isotopic-dilution and instead use an absolute recovery of the surrogate standard. Many laboratories have developed CEC methods using comprehensive isotopic dilution of all targets based on the literature. If the Panel believes that these "true" isotopic-dilution methods are superior to the EPA methods, it should state this more clearly by recommending that "true" isotopic-dilution methods be used for recycled water monitoring.

73	57	6.3.2	11	"In addition to the standardized methods discussed previously, additional methods for non-regulated substances do exist from EPA and others, including those for perfluorinated alkyl acids (EPA method 537), perchlorate (EPA methods 314, 331, 332, and 6850), NDMA (EPA method 521), and other substances." First, perchlorate has CA MCL of 6 ug/L and therefore should not be included in a list of "non-regulated substances". Secondly, we note that nowhere in Section 6.0 does the Panel specifically review and/or recommend the available analytical methods for NDMA, NMOR, and 1,4-dioxane. Including a discussion of the methods available for the recommended health-based indicator CECs would be quite valuable. None of the available methods for any of the recommended CECs (including NDMA, NMOR, and 1,4-dioxane) have been certified by CA ELAP, not even the EPA Methods. Furthermore, EPA Method 521 (Nitrosamines) does not feature "true" isotopic dilution, in contrast to some in-house laboratory methods targeting these compounds. As such, we request that the Panel add a discussion of the various methods available for the health-based indicator CECs (beyond what is currently in the text) to aid the State Board and utilities on the selection of the most appropriate techniques.
74	57	6.3.2	11	"In addition, as discussed in the previous panel report, essentially all drinking water agencies are required to comply with the USEPA's Unregulated Contaminant Monitoring Rule (UCMR), the latest version is UCMR4 and the target analytes are provided in Table 6.2. Therefore, many CECs are, or will be, monitored through various other state and federal programs." This implies that potable reuse projects will be required to test for CECs via the UCMR4 program, which is not true; only drinking water <u>systems</u> serving >10,000 people are required to comply with UCMR4. Therefore, the UCRM4 will not generate MEC data for CECs occurring in secondary/tertiary effluents. This section should be reworded to accurately reflect what the UCMR4 will do and not imply otherwise.

75	58	6.4.1	1	“It is important to differentiate between “suspect screening” and NTA”. It may be an important distinction to the Panel, but this distinction is very confusing to readers who aren’t analytical chemistry experts. Furthermore, “NTA” appears in throughout the report (e.g., Figure ES-1, Figure 5.1) as the recommended (voluntary) follow on to a bioassay result showing bioactivity when there is no appropriate targeted analysis. However, given that “true” NTA (according to the panel) cannot use mass spectral libraries and/or retention time indices and appears to require highly complex software, extremely experienced analysts, and possibly the use of NMR, it seems odd that it would be the recommended follow up to a positive bioassay result. If instead the Panel believes that “suspect screening” (i.e., scan mode relying on a MS library) is the more appropriate voluntary initial follow up to a positive bioassay, then it should say so here and modify the aforementioned figures with a footnote or otherwise to clearly indicate the type of non-targeted analysis that should be completed. Or, it could simply describe the various types of NTA, without implicitly disparaging “suspect screening”, and propose a protocol for deciding how best to employ NTA voluntarily after a positive bioassay results (see comment #64).
76	60	6.4.2	Textbox 6.1	It was the Drinking Water Program within the California Department of Public Health that issued the 2002 Draft Regulation for Groundwater Replenishment Reuse, not the State Board. Additionally, if the last sentence in the textbox is explaining why TIC data from 2013-2016 is described despite the requirement being removed from the Draft Regulation in 2008, then this explanation should be moved up ahead of the data discussion for clarity.

77	64	7.1	2	"For unknown CECs, bioanalytical methods offer an additional safeguard for the protection of human health by quantifying bioactivity/toxicity while leading to the identification of previously unidentified chemicals of concern" This statement offers certainty well beyond that stated elsewhere in the Panel report and thereby contradicts the other parts of the report. "Additional safeguard for the protection of human health" presumes a much stronger correlation between test results and adverse outcome pathways than currently exists and ignores the limitations of individual targeted *in vitro* assays. In terms of "the identification of previously unidentified chemicals of concern", the uncertainties regarding the application of NTA in Chapter 6 and the voluntary nature of the follow-on NTA proposed by the Panel do not make this a certain outcome. Recommend rewording this sentence as follows: "For unknown CECs, bioanalytical methods offer advantages as screening tools for occurrence of unknown CECs, as indicated by measurable bioactivity, that may occur but not be detectable with currently available targeted chemistry methods."
78	65	7.1	Figure 7.1	See comment #8.
79	65	7.1	4	See comment #8.
80	66	7.2	1	"The tools themselves have been "standardized" for use in the evaluation of numerous other matrices. For example, USEPA has approved a method to screen for dioxin-like chemicals in sediment (USEPA, 2014b). OECD has also published validated protocols to screen chemicals (such as pesticides) as estrogen and androgen agonists and antagonists using commercial and non-commercialized cell assays:" The Panel should state that these matrices are very different as compared to the potentially complex mixtures found in in recycled water, especially since the referenced OECD protocols are for screening single chemicals. Furthermore, as stated in the 2016 CA DPR Expert Panel Report, OECD uses *in vitro* assays primarily to screen chemicals to prioritize them for further testing, usually *in vivo*, and present risk assessments still rely on *in vivo* data.

81	67	7.2	6	"The results of this Phase 1 effort resulted in the standardization of several IVBs, including proposed QA/QC that target endocrine active chemicals, including the Estrogen Receptor (ER) and glucocorticoid receptor (GR) assays (see Table 7.2)." This text implies that the GR assay has achieved standardization, while Table 7.2 indicates that it still within Stage 3 where standardization is being demonstrated – this inconsistency should be rectified. Similarly, please clarify if AhR assay was included in the Phase 1 research and state why or why not.
82	67	7.2	7	In the interests of transparency, the Panel must disclose if any of its members and/or their affiliated laboratories, students, or personnel participated in Phase 1 or have been solicited to participate in Phase 2. It would be appropriate to add a footnote to this effect in this section.
83	67	7.2	8	As an alternative to the Panel's recommendation for all potable reuse projects in CA to perform regular ER and AhR bioassay monitoring, the Panel should instead recommend that a small number of existing projects be approached about voluntarily participating within the Phase 2 program. The Phase 2 project team would coordinate the utilities and lab arrangements, for example a certain number of replicates, range of sampling stations/sites within each utility, and perhaps split sampling to compare the labs. This would provide a targeted, well planned data set over several quarters that complements the Phase 2 project work, largely meeting the intent of the Panel's recommendations but without overburdening all California reuse projects via independent efforts to reach out to the three available commercial labs to request instructions, cost quotes, etc. OCWD has already begun to reach out to the three laboratories listed in the report (for independent research study purposes unrelated to the Expert Panel efforts) and it has been quite an exercise to try to understand methods used, costs, which lab can do the extraction step, etc., illustrating what an ordeal this likely will be should the bioassay data collection become part of the updated Recycled Water Policy in the near future.
84	67	7.3	1	A summary of the current federal agency guidance (e.g., USEPA) on the interpretation of bioassay "hits" from environmental matrices should be added to this section
85	71	7.5	1	"Adverse endpoints of cancer or reproductive dysfunction can be inferred by measuring activation of one or more molecular initiating events, and it is this linkage of events that supports the use of bioanalytical tools." This statement is an error of omission by leaving out the many other factors beyond the initiating event that are required to demonstrate a linkage to adverse endpoints. It should be updated to state the roles of reversibility, duration of exposure, and pharmacokinetics.

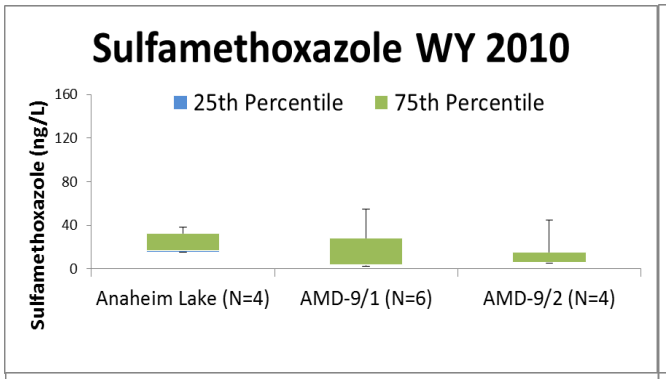
86	75	7.5.2	Textbox 7.1	Previously, in Section 7.3.1, the text states: “For example, because there is already a guideline value for E2 in drinking water, the preferred equivalency agonist for the ER is 17β-estradiol. Hence any BEQ that exceeds this guideline (i.e. a bioassay “finding”) would be considered for appropriate action in the proposed tiered scheme for bioanalytical measurements (Section 7.5.3).” However, later on in Textbox 7.1, it is stated that “17β-ethinylestradiol (EE2)” is used to develop the ER assay trigger screening level. First, should it instead be “17α-ethinylestradiol” that is the intended agonist in textbox 7.1? Second, the PNEC referenced in Textbox 7.1 for this compound is 3.5 ng/L. This value corresponds to the AwwaRF (2008) DWEL for 17α-ethinyl estradiol as listed in Appendix D, however the highlighted value in Appendix D for this compound is the USEPA CCL3 List/PCCL value of 350 ng/L. Also, the Appendix D Australian Guideline value is 1.5 ng/L. Third, the highlighted Appendix D value for 17β-estradiol is 0.9 ng/L (from the USEPA CCL3 List/PCCL), with additional values of 180 ng/L and 1800 ng/L from the Australian Guidelines and AwwaRF (2008), respectively. According to a citation within the 2016 CA DPR Expert Panel report, the relative binding efficiencies for the estrogen receptor for 17β-estradiol and 17α-ethinyl estradiol are 100,000 and 190,000, respectively, representing less than a factor of two difference. Yet the range of possible PNECs between these compounds spans orders of magnitude, depending on the source. As such, the Panel’s highlighted example of the effectiveness of linking PNECs developed for human health protection with ER bioassay response contains potential errors, inconsistency, and ambiguity on how to a) select the proper agonist and b) how to select the proper PNEC. The Panel must review and revise the relevant text cited here in order to more clearly demonstrate how to carry out this fundamental exercise linking bioassays to human health relevance. Finally, the implication of the bolded subtitle of Textbox 7.1 (“…Sources Requiring Further Evaluation”) is overly broad and should instead be focused on the Panel’s charge of recycled water

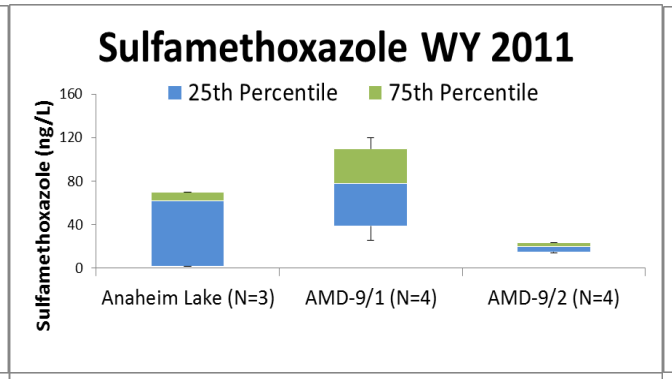
87	76	7.5.3	Step 1	See comment #71 – if the Panel is going to propose decision logic for bioanalytical screening results, it should review the existing for CECs.
88	76	7.5.3	Step 3a	For endpoints that consistently exhibit a BEQ/AL of <0.1, the Panel suggests to decrease frequency or eliminate the bioassays. Since the benefit of bioassays is to screen for unknown chemicals that may enter the water at any time (e.g., 15,000 chemicals added to CAS every day), eliminating non-responsive bioassays from screening-level monitoring programs at utilities seems to defeat the purpose of bioassays. Reducing frequency is more reasonable, as a response is probably unlikely after many non-detects, but perhaps not advisable for the same reason. The next section (7.5.4) seems to agree that frequency would be reduced not eliminated, but suggest stating this in the steps themselves and removing the suggestion of eliminating the bioassays. Furthermore, if the purpose of this initial exercise as part of the SWRCB framework is to collect information/data, the SWRCB may not want any utility to decrease frequency based on the results, let alone eliminate, at this time. The data could be reviewed, and decision making steps updated, by the next Panel review. After that, going forward, frequency reduction could indeed be part of a tiered management monitoring strategy.

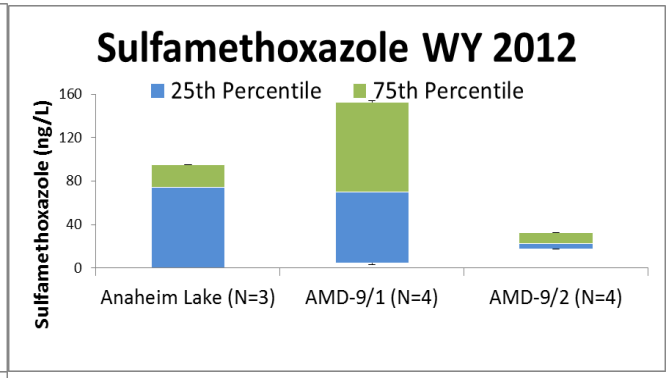
89	76	7.5.3	Step 3d	Step 3d suggests removing the recycled water (RW) supply in case of a high bioassay response. It appears the next section (7.5.4) agrees, but make more clear here in the steps. Removing the RW supply seems in stark contrast to other parts of this report that carefully articulate the purpose of bioassays as being for screening and state that it's not a "regulatory" requirement at this point and not the equivalent of an MCL. Earlier text (pg. 70) suggests a tiered adaptive management strategy "that minimizes regulatory restrictions by utilizing bioanalytical methods as a screening tool in conjunction with chemical analysis to identify if chemicals...are potentially problematic." The earlier language suggests that if high responses in bioassays were found, the utility would embark upon increased monitoring, consultation with experts and SWRCB, and go down the path of NTA - not that the RW would be removed. The steps here should look more like (or refer to) Appendix B.2 response recommendations for high occurrence of individual CECs relative to MTLs, which states that "positive findings should not be considered for compliance and/or regulatory purposes, but for investigations and potential use for additional follow-up actions only as part of conferring with the SWB and the Regional Water Boards". If this approach is recommended for the indicator CECs, it seems for consistency it should be recommended the same for bioassays, especially since bioassays at this point are more exploratory/investigative. Removing the RW supply also appears to contradict the Appendix F decision tree for bioassays, which in the worst case ends with "consult with regulator to determine if further action is needed". Separately, this Step 3d and overall section does not clarify which water is actually being tested, the source water or after treatment; next section states it is product water, but make more clear in the steps. Clearly, high responses in source water alone do not warrant RW removal.
90	77	7.5.5		"The Panel recommends that the State Water Board convene an advisory group to guide utilities and the State Water Board through the initial round of in vitro bioassay monitoring, as described in 7.5.4. This "bioanalytical advisory group" could consist of select Panel and SAG members, bioanalytical application experts, State Water Board staff and representatives from the commercial services industry who would ultimately be tasked to perform such measurements." It would be highly preferable in the Panel members remained independent and <u>did not</u> serve on any such "bioanalytical advisory group". In this way, the Panel will be able to crucially review and critique initial bioassay monitoring without bias during their triennial review. Please modify this recommendation accordingly.

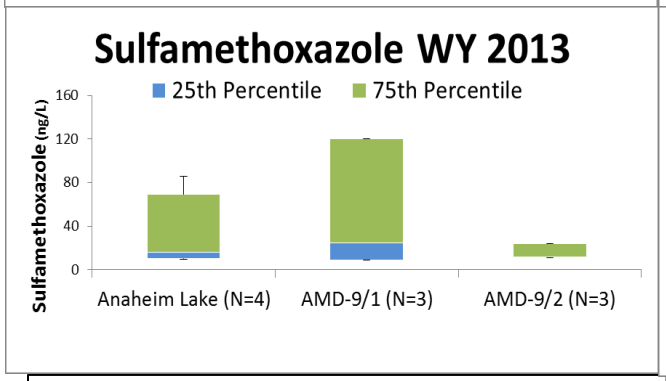
91	77	7.7	3	“Monitoring trigger levels (MTLs) can be established for well-established cell assays (e.g. ER and AhR)” See comment #87
92	98	9.4	7	“Monitoring requirements for bioassays should mirror current requirements to monitor individual indicator CECs in potable reuse projects in the secondary/tertiary effluent and at the point of monitoring as specified in Attachment A of the Policy.” This recommendation is contradictory to the recommendation provided in Section 7.5.4 (Recommendations for monitoring of potable reuse projects), which states “The Panel recommends two major uses for bioanalytical assays as a screening tool: 1) to complement targeted CEC monitoring of **product water** from potable reuse projects, and as **voluntary approach** 2) to follow the efficacy of the removal of CECs through AWT trains, on a voluntary basis if the product water shows high BEQ values (Figure 7.1).” The text in Section 9.4 for should be modified to be consistent with that in Section 7.5.4

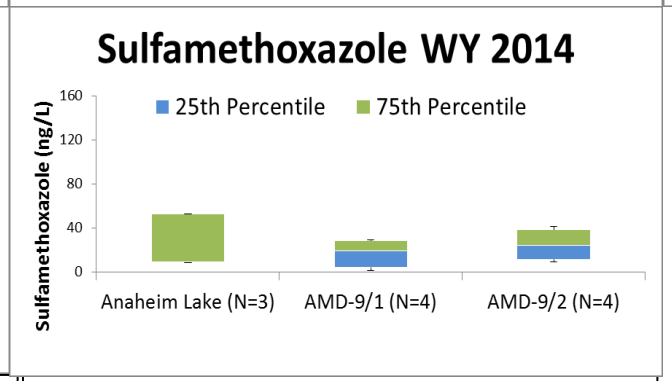
ATTACHMENT

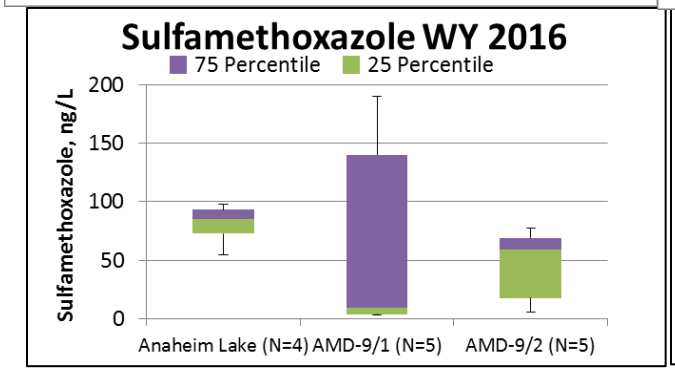


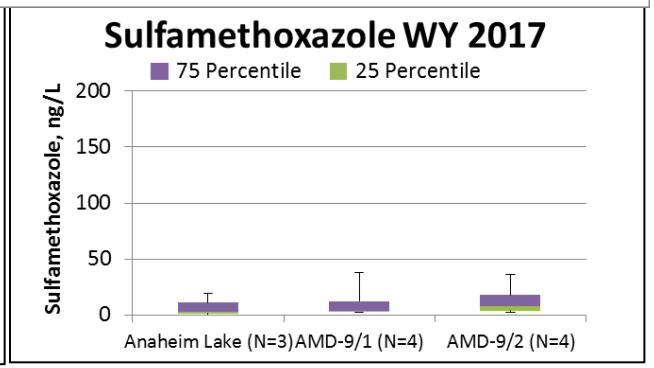




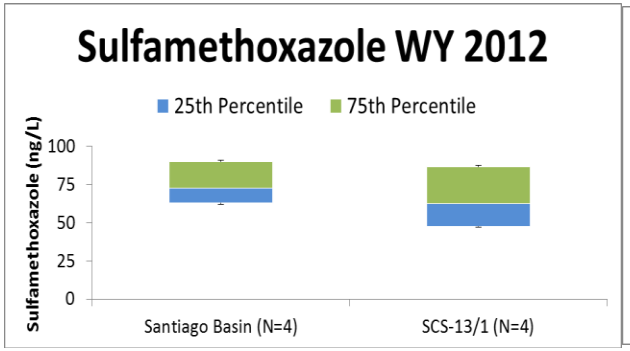


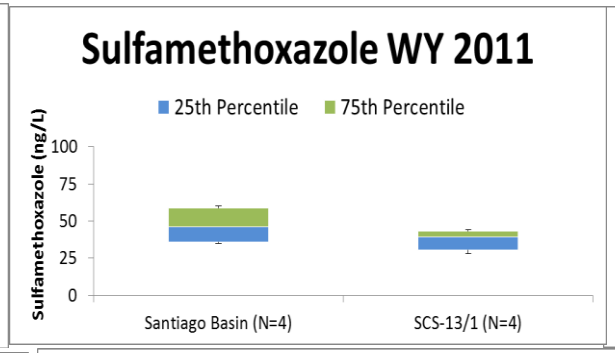


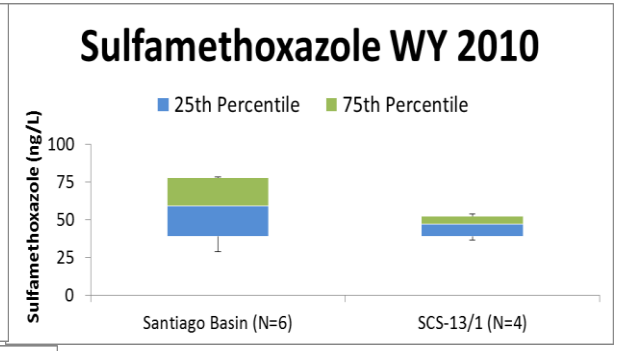


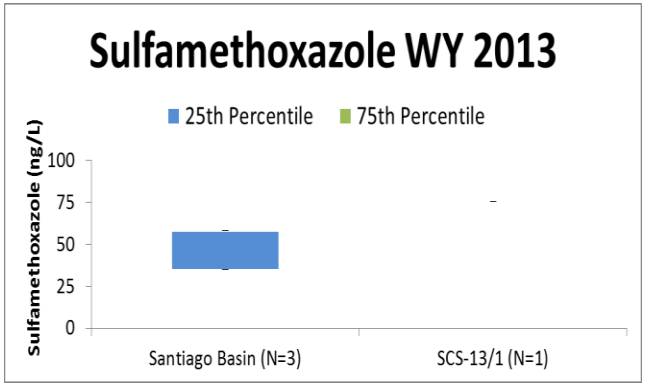


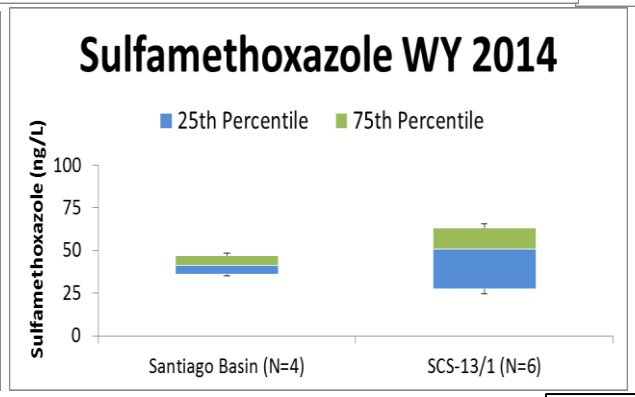
Sulfamethoxazole dataset from OCWD's Anaheim Lake recharge facility indicating only minor removal of via soil-aquifer treatment. Anaheim Lake which receives seasonally variable quantities of effluent-impacted local Santa Ana River surface water and raw MWD imported surface water for recharge, so the groundwater results reflect some dilution. Monitoring wells AMD-9/1 and AMD-9/2 obtain samples after a mean retention time of approximately one month and six months, respectively.

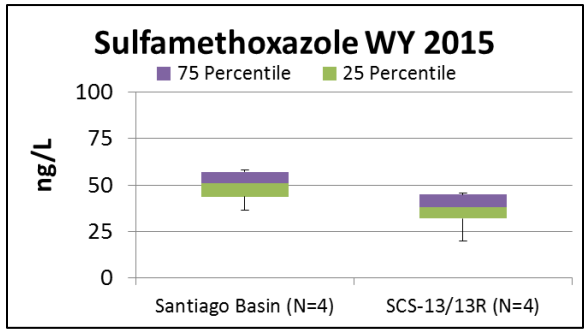


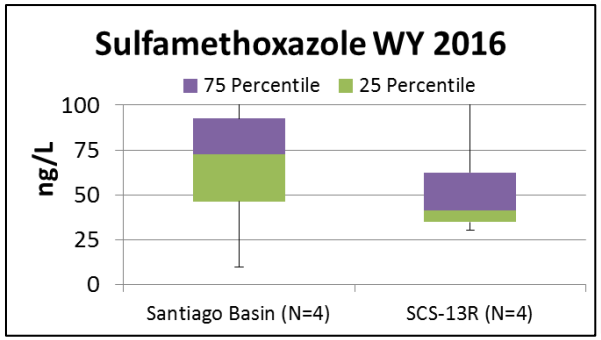


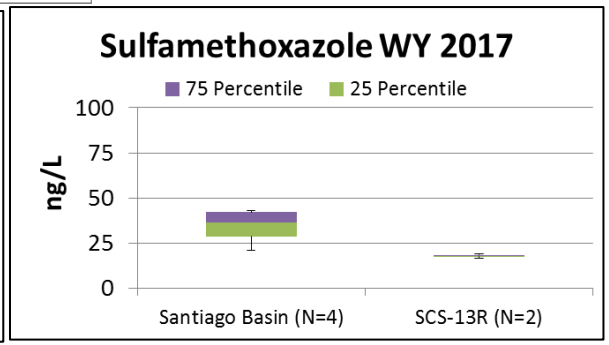




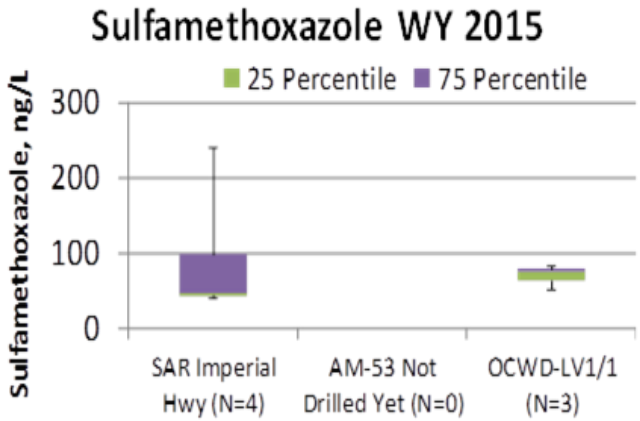


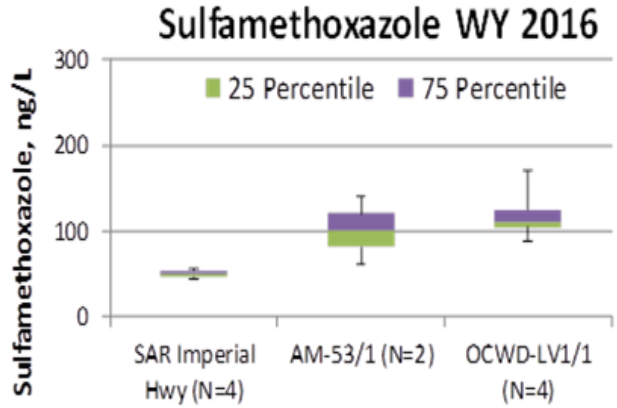


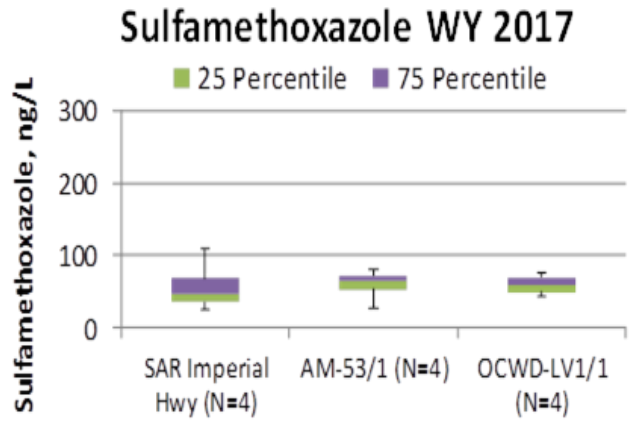




Sulfamethoxazole data from OCWD's Santiago Basins recharge facility indicating only minor removal via soil-aquifer treatment. The Santiago Basins receives seasonally-variable quantities of wastewater effluent-impacted local Santa Ana River surface water and local storm water runoff for recharge, so the monitoring well results reflect some dilution. Monitoring wells SCS-13 and -13R obtain samples after a mean retention time of approximately one month.







Sulfamethoxazole data from OCWD's Santa Ana River Channel recharge facility indicating only minor removal via soil-aquifer treatment. The Santa Ana River Channel receives wastewater effluent-impacted Santa Ana River surface water. Monitoring wells AM-53 and OCWD-LV1/1 obtain samples after a mean retention time of approximately one month and four months, respectively, and experience very little, if any, dilution due general absence of other recharge supplies in this area.