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Constituents of Emerging Concern 2018 Science Advisory Panel for Recycled Water – Report Out

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Sacramento, California
December 15, 2017

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Disclaimer

The results and recommendations presented herein are preliminary and are subject to modification prior to release of the draft report (scheduled release date: 15 January 2018)

Outline

- Panel charge and approach taken by the 2018 Science Advisory Panel
- Outcome of applying the risk-based CEC selection framework using monitoring data from California
- Observations by the Panel
- Recommendations to adjust and improve the process

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Panel Charges

- What are the appropriate constituents to be monitored in recycled water, including analytical methods and method detection limits?
- What is the known toxicological information of the above constituents?
- Would the above list change based on level of treatment and uses as specified in Title 22 and for surface water augmentation (SWA)? If so, how?
- What indicators or surrogates can be used to represent a suite of CECs?
- What concentrations of CECs should trigger enhanced monitoring?

Panel Charges (cont.)

- Evaluate the use of recycled water for irrigation of crops as allowed under Title 22 regarding potential human health risks except potential human health risks associated with ingestion of crops irrigated with recycled water. For all other uses of recycled water allowed under Title 22, the evaluation shall include potential human health risks for all routes of exposure.
- Provide recommendations for additional research regarding antibiotic resistant bacteria and antibiotic resistance genes (ARBs/ARGs) related to the use of recycled water for SWA and other uses allowed under Title 22 to further understand potential human exposure and potential impacts to human health.
- Recommend actions that should be taken to improve the understanding of CECs and, as appropriate, to protect public health and the environment to update 2010 monitoring recommendations.

CEC Definition (2018)

'Constituents of emerging concern'

- Personal care products
- Pharmaceuticals
- Industrial
- Agricultural
- Natural hormones
- Inorganic constituents (boron, chlorate)
- Food additives and constituents (phytoestrogens, caffeine, sweeteners)
- Transformation products
- Nanomaterials
- Microplastics
- Antibiotic resistance

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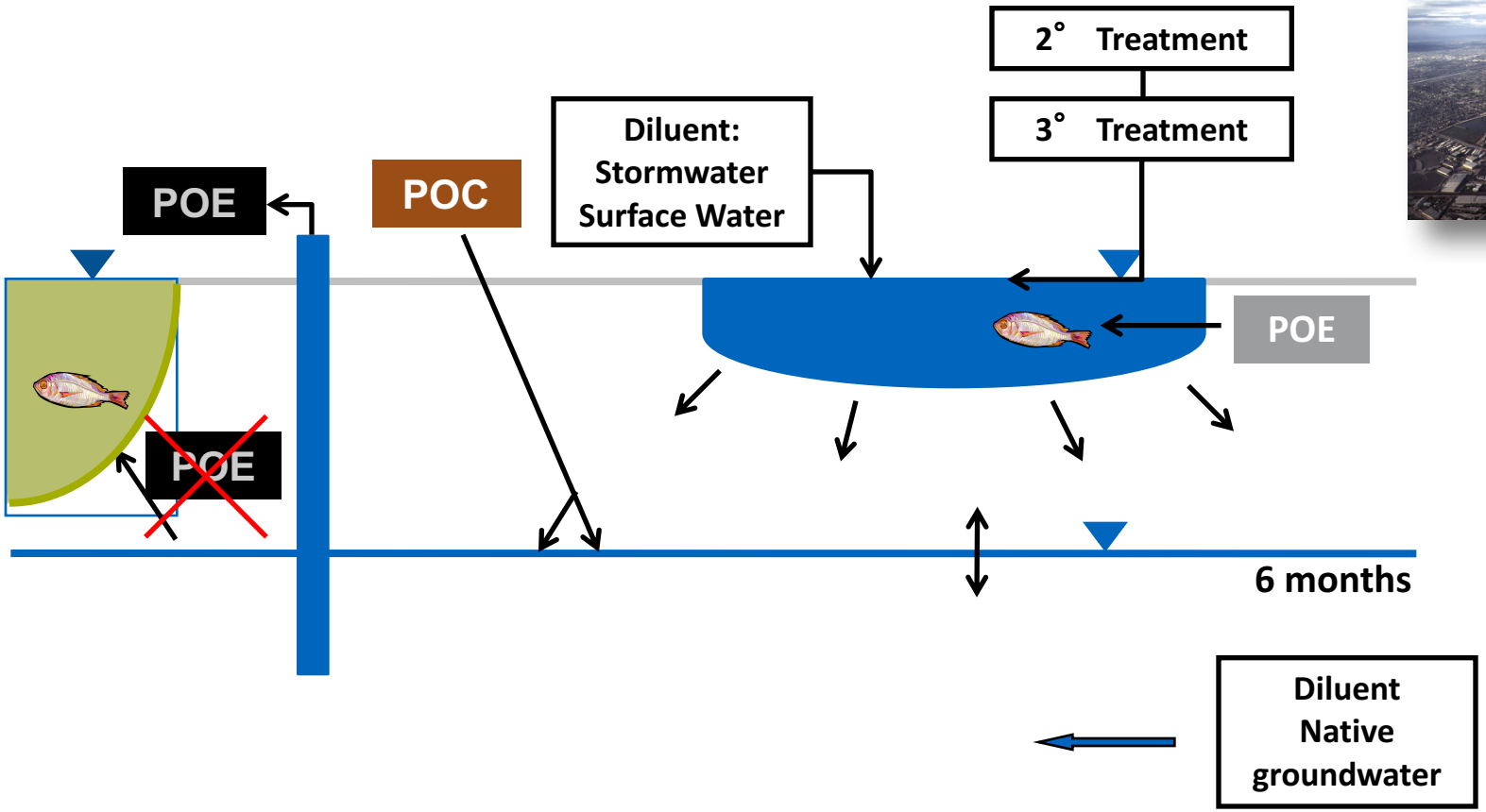
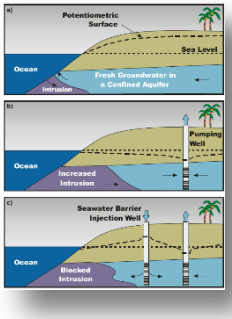
IPR – Ground Water Surface Recharge
Surface Spreading Application



Indirect Potable Reuse Practices

- Ground Water Surface Recharge (Subsurface Application)

- Surface Water Augmentation (SWA)



Membrane Filtration

Reverse Osmosis

Advanced Oxidation Process (UV/H_2O_2)

Surface Water Reservoir

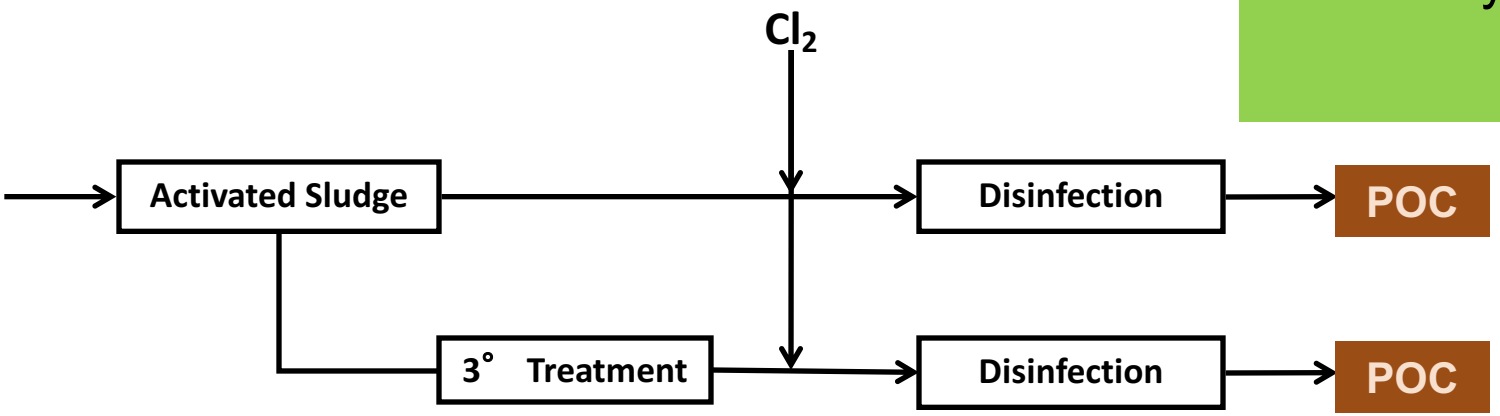
POC

POE

Diluent:
Surface Water
Native Groundwater

2 months

Title 22
Non-potable Reuse Practices



POE Restricted access:

- Landscape
- Freeway/golf course

POE Unrestricted access:

1. Residential
2. Golf course
3. Urban landscape
4. Impoundment

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Assessing Relevance of CEC Monitoring for all Non-Potable Title 22 Practices

- 45 different applications instead of a single landscape irrigation practice
- Exposures associated with Title 22 non-potable uses were estimated to be at least 10x lower than exposures associated with the potable reuse applications for all CECs and likely to be 100x lower for most CECs (one exception: impoundment with fishing)
- Panel recommends deriving MTLs for non-potable reuse by multiplying the potable reuse MTLs by a factor of 10
- Surrogate measurements are best way to assess Title 22 recycled water quality

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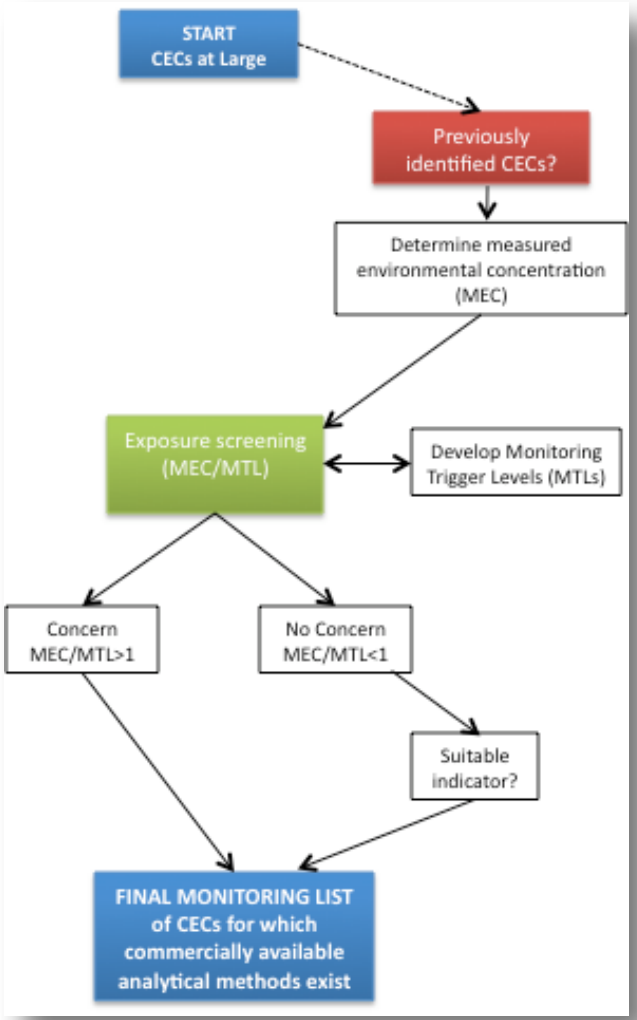
Applying the risk-based Selection Framework

- We used your monitoring data to assess the utility of the 2010 list
- We now have a much better (more robust) data set
- We updated the toxicity/effects databases for these CECs (MTLs)
- We maintained the CONSERVATIVE screening framework to determine relevant CECs:
  - MEC/MTL < 1: no worries
  - 1 < MEC/MTL < 100; consider for future monitoring
  - MEC/MTL > 100; take action NOW



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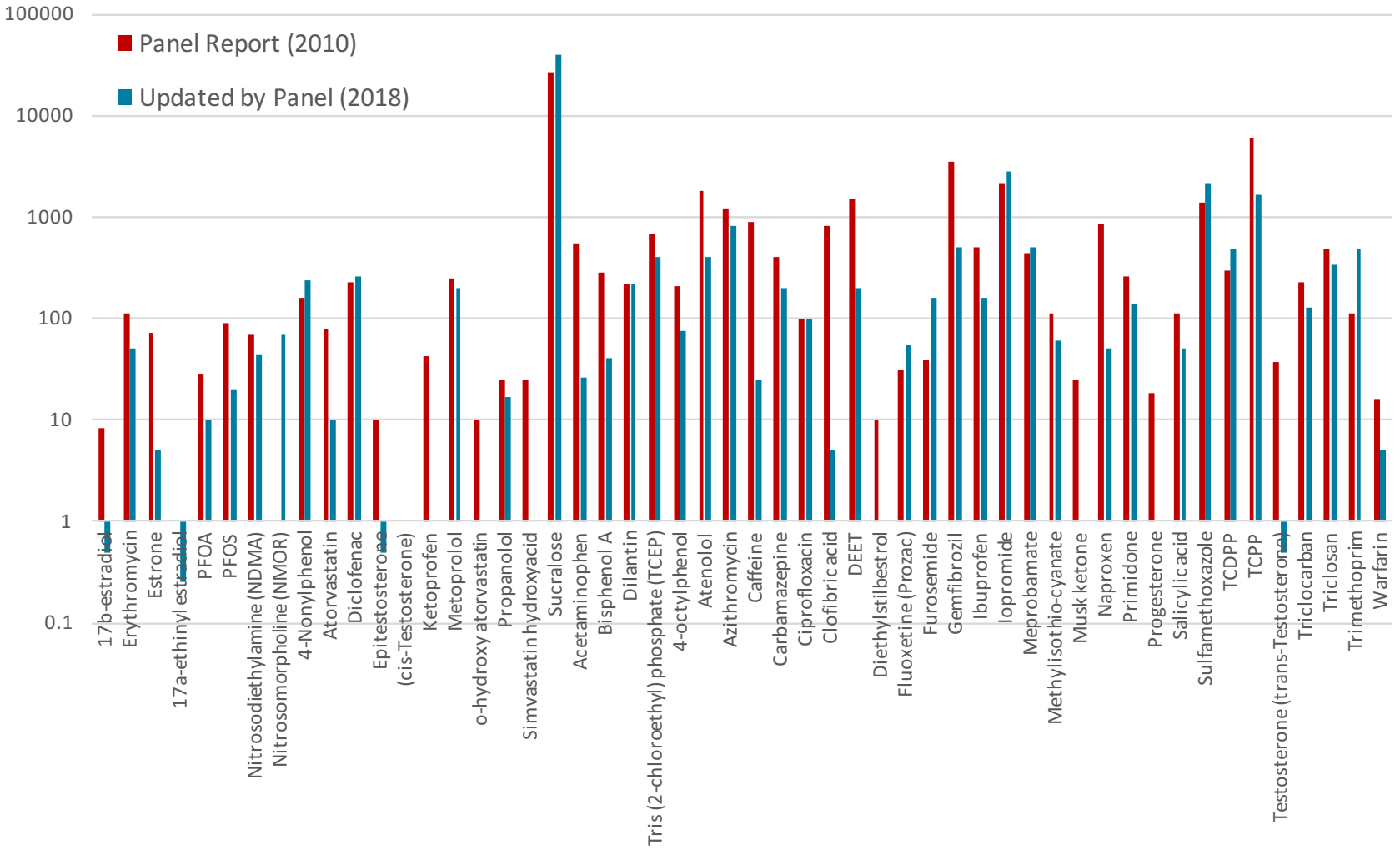
Changes in Occurrence Data



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Applying Selection Framework – 2010

	Secondary/Tertiary Treated MEC 90th (ng/L)	Initial MTLs		MEC/MTLs	
		Potable Reuse	Irrigation	Potable Reuse	Irrigation
CCL3 CECs					
17β-estradiol	8.4	9.0E-01	9.0E+00	9.3	0.93
NDMA	68	1.0E+01	1.0E+02	6.8	0.68
Non-CCL3 CECs					
Caffeine	900	350	3,500	2.6	0.26
Triclosan	490	350	3,500	1.4	0.14

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Applying Selection Framework - Update

draft

	Secondary/Tertiary Treated MEC 90th (ng/L)	Initial MTLs		MEC/MTLs	
		Potable Reuse	Title 22 Non-potable	Potable Reuse	Title 22 Non-potable
17β-estradiol	0.50	9.0E-01	9.0E+00	0.56	0.056
NDMA[a]	77	1.0E+01	1.0E+02	7.7	0.77
NMOR	107	1.2E+01	1.2E+02	8.9	0.89
1,4-Dioxane[a]	7,200	1.0E+03	1.0E+04	7.2	0.72
Caffeine	25	3.5E+02	3.5E+03	0.071	<0.01
Triclosan	340	3.5E+02	3.5E+03	0.97	0.097

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Applying Selection Framework – Outcome
- There are no smoking guns!

- All 90+ CECs (re)-assessed had MEC/MTL < 10
- Three CECs coming off, two coming on, and **NDMA** remained on the list:
  - 17β-estradiol
  - Triclosan
  - Caffeine
  - **1,4-Dioxane**
  - **Nitrosomorpholine (NMOR)**
- The framework represents a very conservative screening tool:
  - 90th percentile MECs
  - worst case sources (e.g. non-nitrified secondary); no credit given to treatment barriers, environmental buffer, downstream DW treatment
  - ADI/PNECs have individual safety factors (e.g., 60 kg body weight)
- Collected MECs over 7 years were very useful! Only 3 out of 100 made the cut

Performance-based Indicators and Surrogates

- Are health-based indicators also good indicators of removal by different treatment processes?
  - Molecular weight cutoff (RO membranes)
  - Recalcitrant (AOP (UV/H_2O_2); SAT)
  - Ubiquitous and consistently present (very important for infrequent monitoring)
    - Drop in occurrence: caffeine, gemfibrozil
    - More consistent occurrence: iohexol
- Are they amenable to current analytical methods?
- If yes to both above, they can serve double duty as treatment indicators
- If not, then search/retain for model indicators that meet above
- Is quarterly monitoring frequency enough? Too frequent?
- Are sampling sites (POM) still appropriate?

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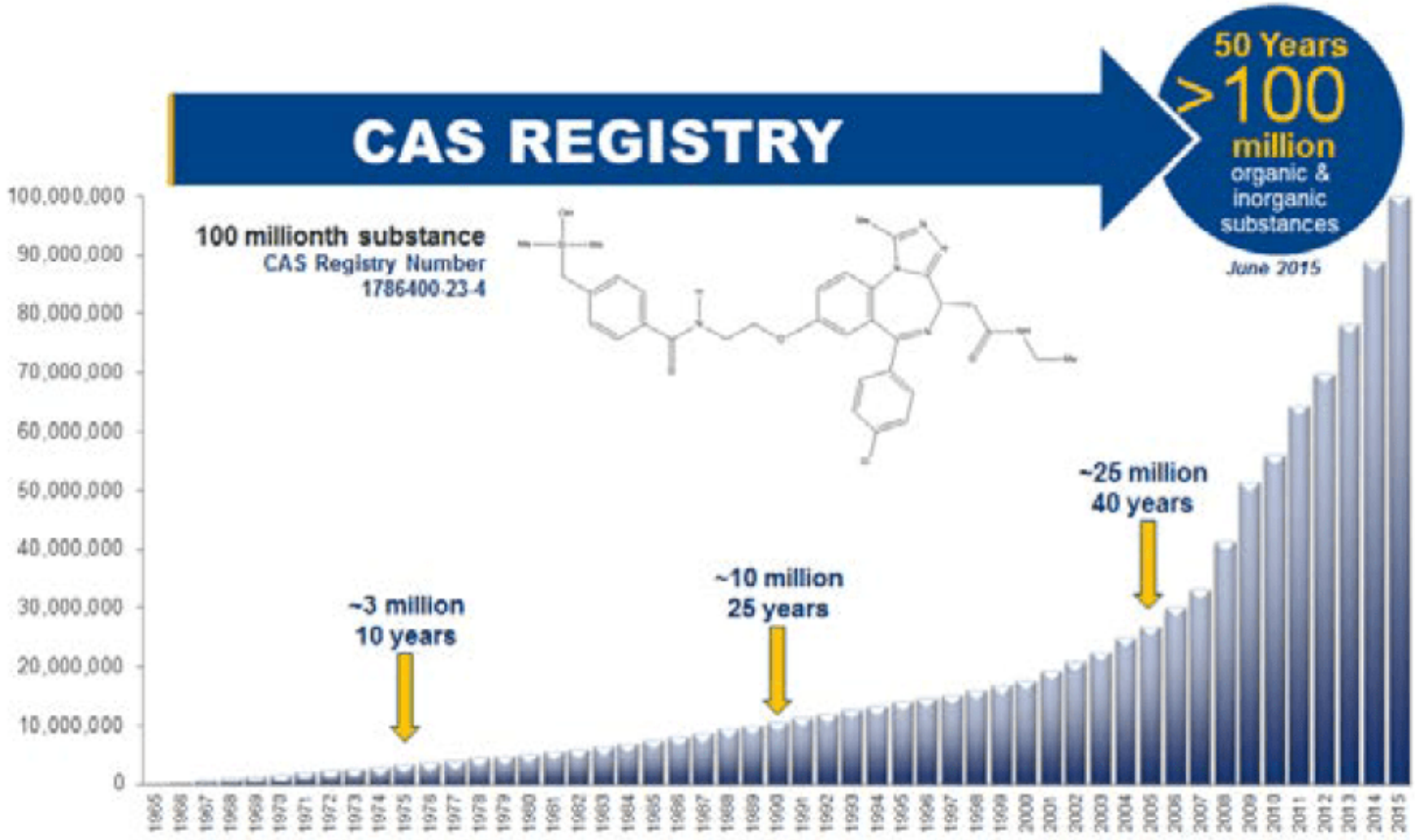
Are we done?



Panel's observations regarding the process

- Applying the risk-based framework recommended by the 2010 Panel requires structure and consistent protocols yet no formal update of the selected CECs occurred until 2018

- Data format not easy to process and archive

- Reliance on health- and performance-based indicators provides assurance of proper operation, but is not suitable to account for new CECs. However, it is still the only source of information…

- Workflow and procedures in data handling not clearly defined

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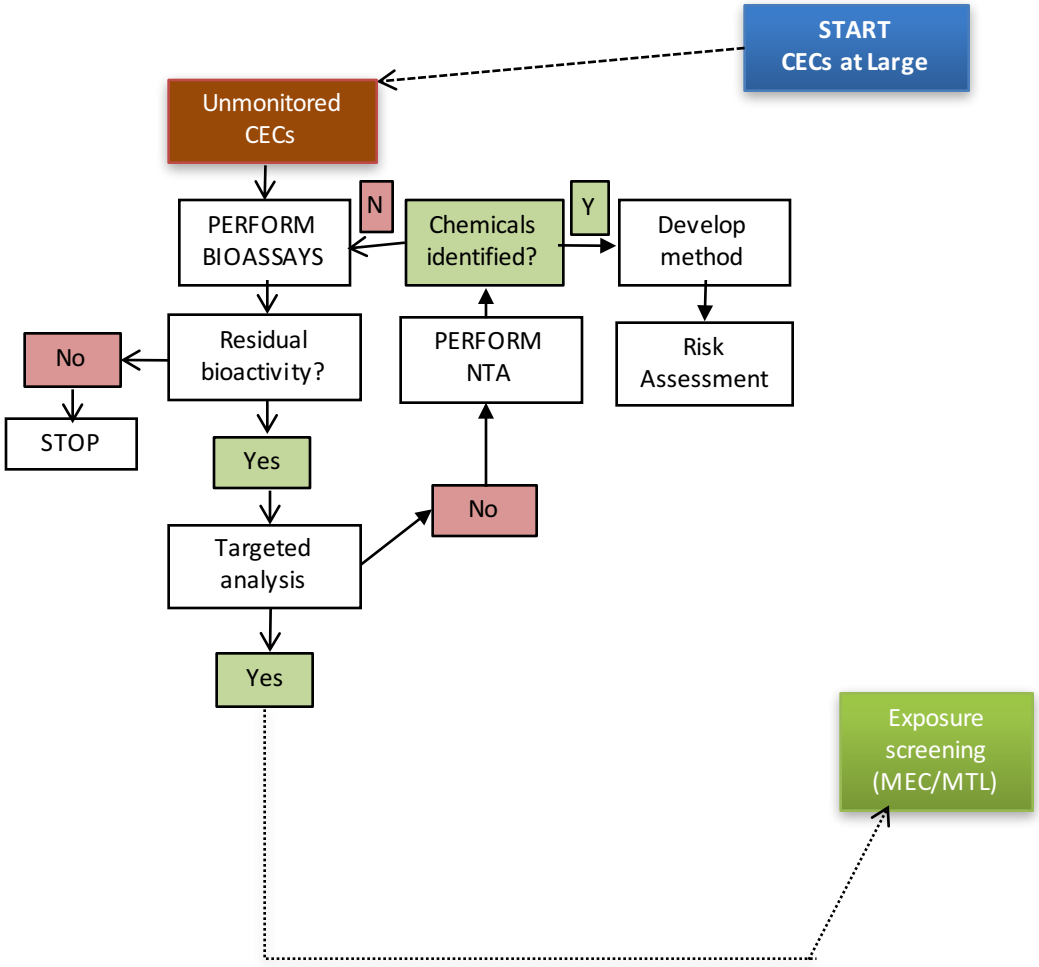
Can we do better moving forward?

- New tools to enhance information obtained by monitoring:
  - Bioanalytical and NTA to address unknowns, changing chemical use
  - Take advantage of online SCADA data of surrogates and operational information
  - Sound interpretive framework for new information that gives managers more (not less) confidence

- Fine-tune the Panel's assessment framework:
  - Incorporate broader filters for on-ramps and maintain data-driven off-ramps

- More responsive program to adjust to new information:
  - Streamline implementation of Panel recommendations
  - Enhance communication among experts, policy makers and permit writers
  - Make data widely available in easy to use format

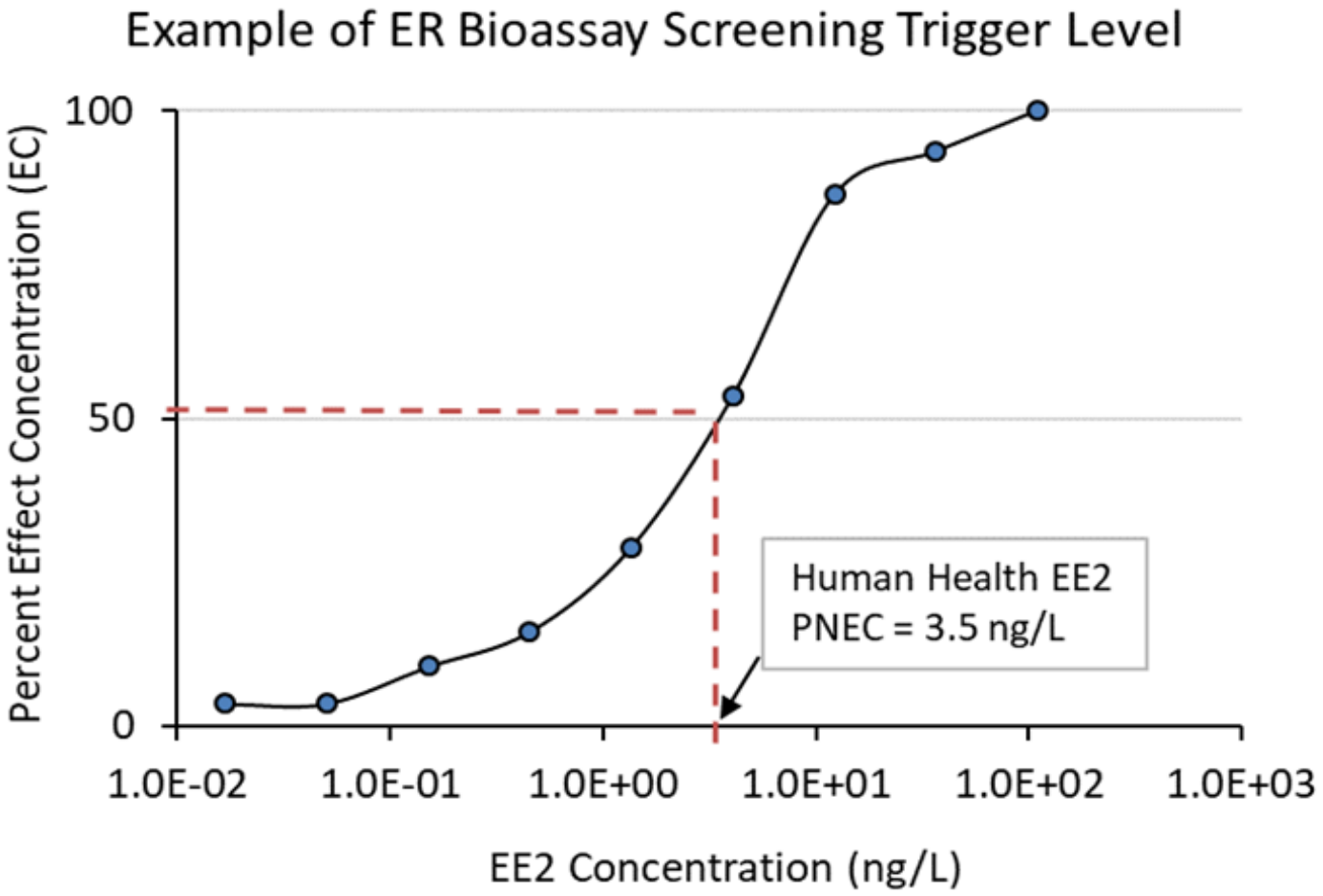
Use of Bioanalytical Methods for CEC Screening



- **Two bioassays:**
  - ER
  - AhR
- Standardized methods available (USEPA, OECD)
- Commercial labs
- **NTA**
  - Only in support of positive bioassay results

Use of Bioanalytical Methods for CEC Screening

- Linking bioassay response to human health PNECs



Institutional controls and relationships

- ISSUE: Should be able to react quickly – 5-10 years is a little too slow
  - Convening a Panel to review every 5 yrs could result in errors/missing data
  - Quicker turn-around for on-ramps and off-ramps

RECOMMENDATIONS:

- Foster more collaboration and communication between policy and permitting entities
  - SWB (DWQ, DDW)
  - State and Regional Boards
  - Affected utilities
  - NGOs and the public
- Keep the screening framework as simple as possible
- Engage the experts to fine-tune the framework, advise on complicated issues, case-studies

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Application of Framework - Updated final DRAFT list for CEC Monitoring

Reuse Practice	Health-based indicator	MRL (ng/L)	Bioanalytical methods	MRL (ng/L)	Performance-based Indicator	Expected Removal[8]	MRL (ng/L)	Surrogate	Method	Expected Removal[8]
Surface Spreading Application (SAT)	NDMA[4]	2	ER	0.5	ΔGemfibrozil[3]	>90%	10	ΔAmmonia	SM	>90%
	NMOR[3]	10	AhR	0.5	ΔSulfamethoxazole[4]	>80%	10	DNitrate	SM	>30%
	1,4-Dioxane[3]	100			ΔIohexol[3]	>90%	50	ΔDOC	SM	>30%
					ΔSucralose[5]	>25%	100	ΔUVA	SM	>30%
								ΔTotal fluorescence		>30%
Subsurface Application (Direct Injection) and Surface Water	NDMA[4]	2	ER	0.5	ΔSulfamethoxazole	>90%	10	ΔConductivity	SM	>90%
Augmentation	NMOR[3]	10	AhR	0.5	ΔSucralose	>90%	100	ΔDOC	SM	>90%
	1,4-Dioxane[3]	100			ΔNDMA	25-50%	2	ΔUVA	SM	>50%
Non-potable reuse practices					None			Turbidity Cl_2 residual or UV transmittance Total coliform	SM SM SM	

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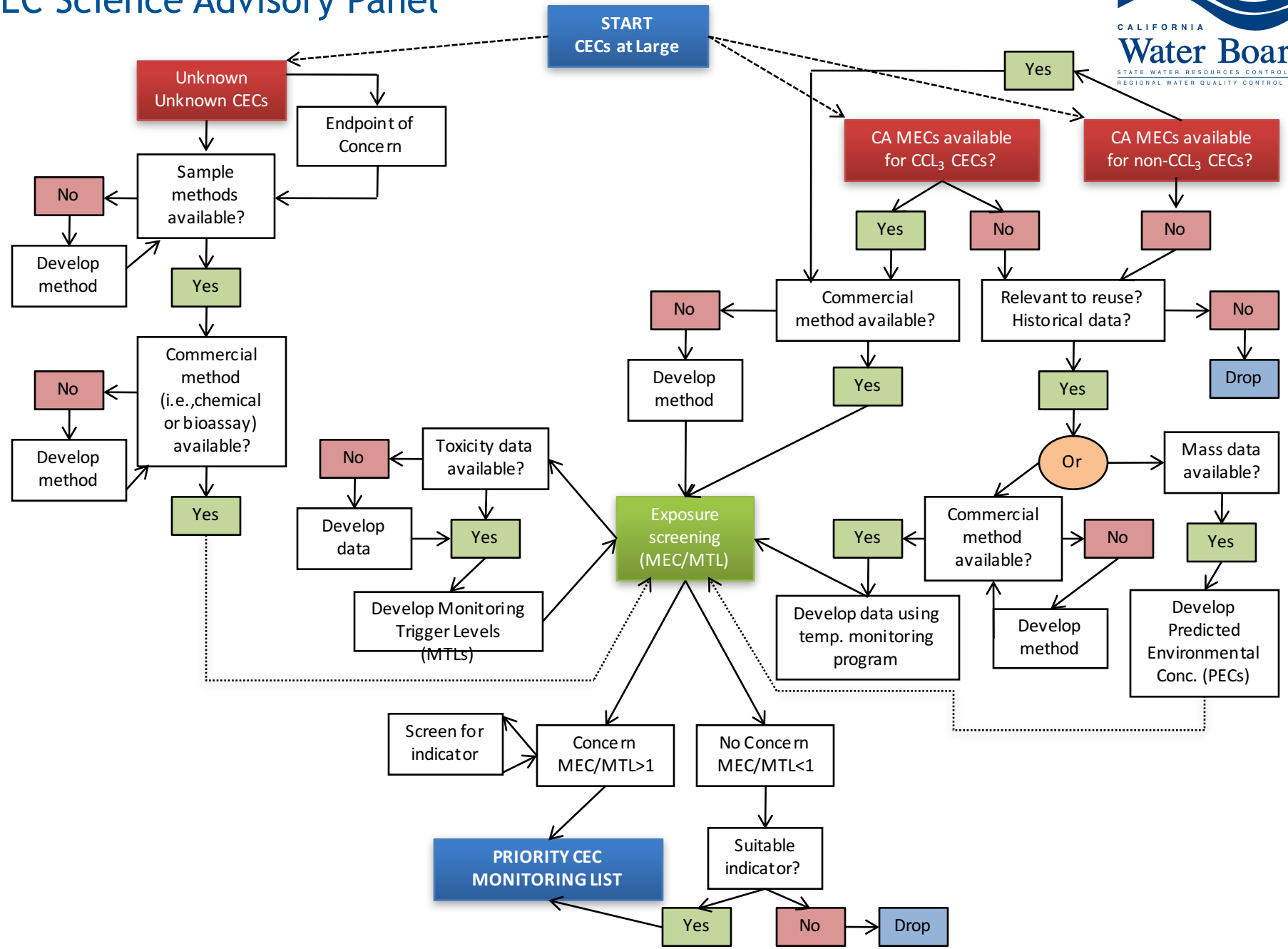

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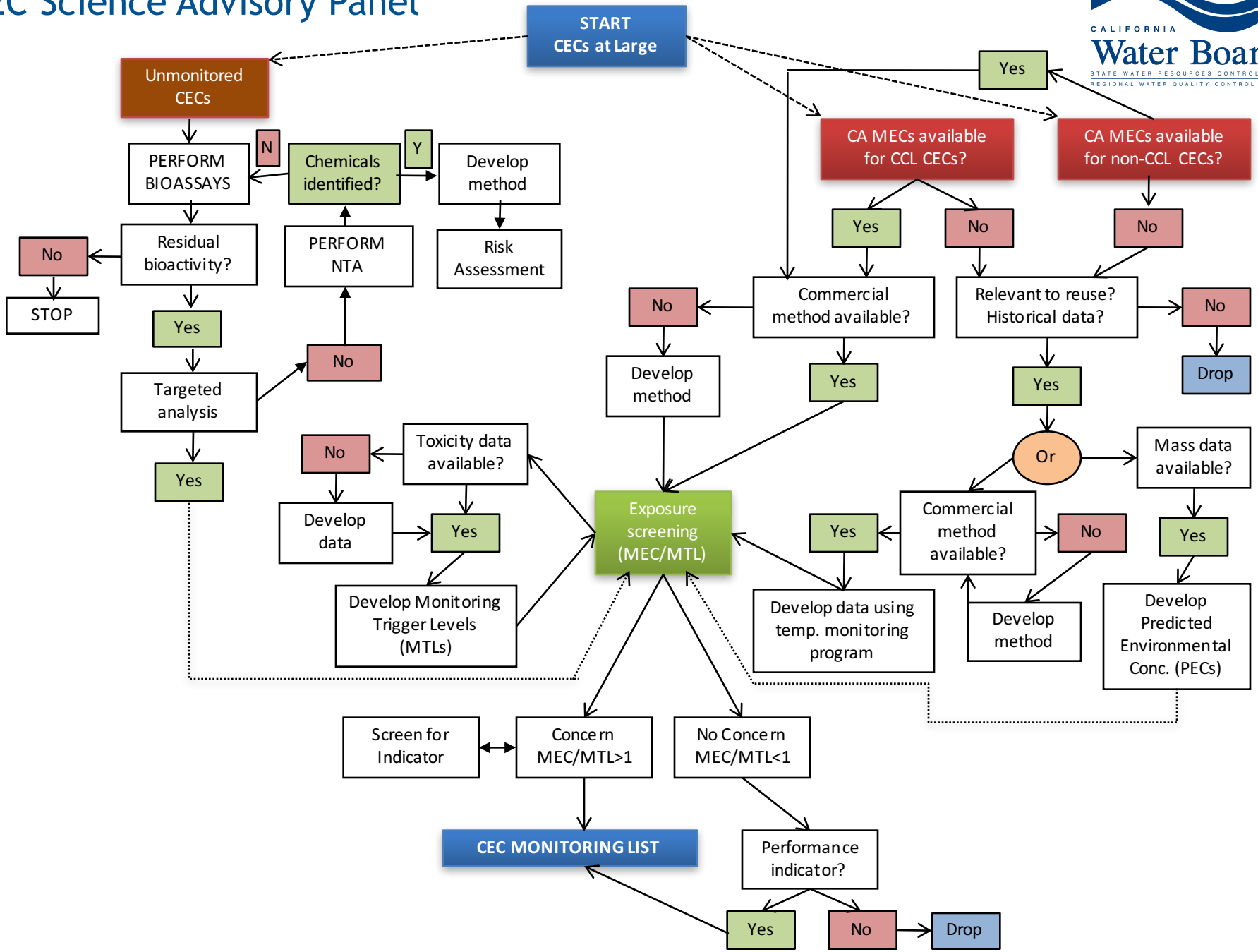

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Antibiotic Resistance (2018)

- Risk of antibiotic resistance transfer through water reuse practices (like agricultural irrigation) has been documented
- Risk levels associated with ARBs/ARGs in water have not been determined yet
- Standardized methods for their quantification are still missing but necessary

Panel Recommendations

- Title 22 exposures still do not warrant additional CEC monitoring
- CEC monitoring recommended for potable reuse (groundwater recharge, SWA)
- Risk-based CEC selection framework provided state-of-the-art data assessment (off-ramps and on-ramps)
- State should conduct a thorough review of CECs likely to occur in recycled water using MEC and PEC data from peer-reviewed literature and occurrence studies outside California to proactively inform framework selection
- Incorporate *in vitro* assays (using ER, AhR) into the routine testing protocols for recycled water for screening studies for recycled water quality
- The current state of science does not justify using non-targeted analysis (NTA) as a regular screening tool (it could be used in conjunction with bioanalytical tools to elucidate chemicals contributing to positive results)

Panel Recommendations (cont.)

- Issue drinking water permits for potable reuse projects that includes enhanced source control measures
- Develop a data management system for potable water facility monitoring data
- Develop internal protocols for DDW staff review and response to CEC and Bioanalytical data
  - Source control data
  - High-frequency operational monitoring data
  - Develop consistent permittee electronic reporting requirements
  - Develop internal staff and external utility communication protocols
- Develop external review of reported data and recommendations for potable reuse program updates
- Develop protocol for providing the public an annual report summarizing performance of potable reuse projects

Panel Recommendations (cont.)

- The State should convene an independent advisory panel every three years to evaluate the overall CEC monitoring program for recycled water and make further recommendations for the use of the framework

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