



San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

Screening and Recommended Actions for Contaminants of Emerging Concern (CECs) in SFPUC Drinking Water System

FINAL

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Foreword

In 2008, per the Mayor's direction, the San Francisco Public Utilities Commission (SFPUC) developed a San Francisco Water Quality Protection Plan. An action item from the plan is to "clarify and revise the monitoring framework for emerging contaminants." In 2009, SFPUC's report "Strategic Planning for San Francisco's Water Quality Future" reiterated the need to "develop a policy for addressing emerging contaminants."

Specifically, the contaminants of emerging concern (CEC) approach for the SFPUC drinking water system:

- Helps the SFPUC manage contaminants that are not being covered by existing regulations,
- Helps prioritize limited resources on CECs of concern to SFPUC, and
- Provides a framework for involving the Commission, stakeholders and the public in CEC decisions.

This report represents the first evaluation of CECs by the SFPUC Water Quality Division and will be updated every three years.

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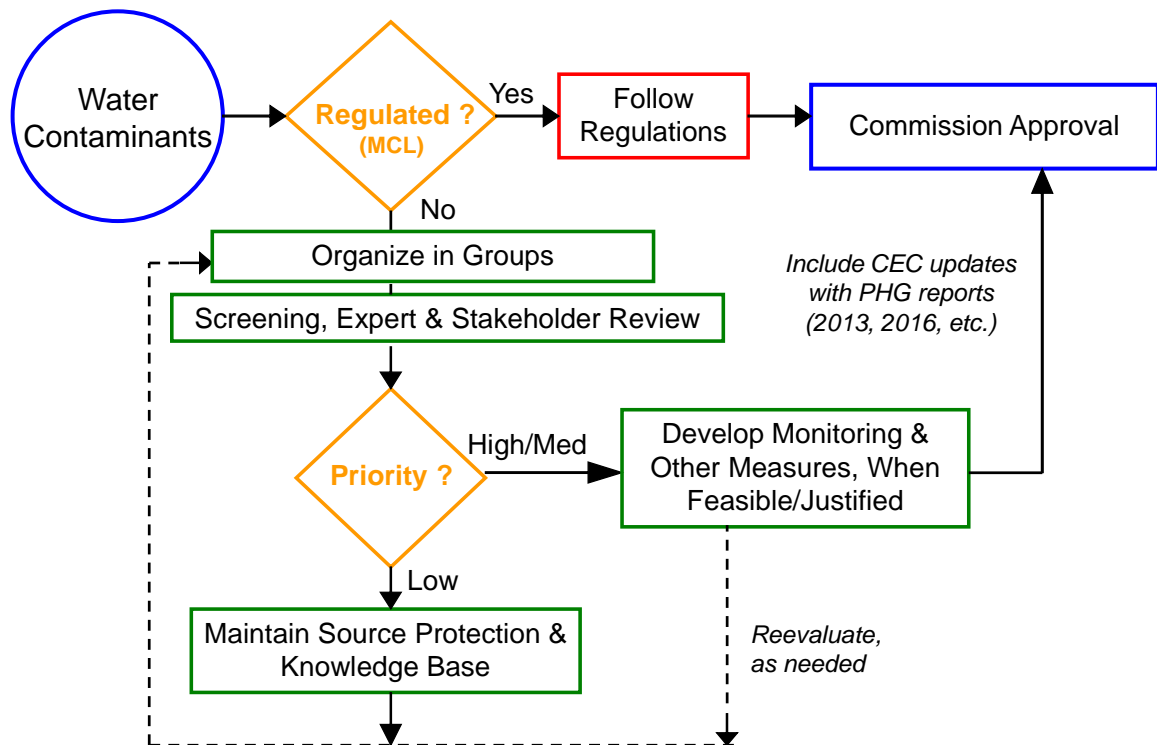
Executive Summary

This report presents an evaluation of contaminants of emerging concern (CECs) in the San Francisco Public Utilities Commission (SFPUC) drinking water system. CECs are unregulated contaminants that may be detected in water and for which little may be known about their sources, occurrence, removal during treatment, fate in drinking water distribution systems, and potential risk to human health and the environment.

Approach for CECs in SFPUC Drinking Water System

The SFPUC Water Quality Division (WQD) has developed an approach for grouping, screening, and prioritizing unregulated CECs to determine the need, if any, for further action and water quality monitoring. The approach is summarized in Figure ES-1. Due to the large number of CECs and lack of specific information, the CEC approach utilizes grouping and indicator contaminants and is more qualitative in nature compared to regulated contaminants that have numeric water quality criteria. The approach was presented by the WQD to the SFPUC in November 2011. The SFPUC endorsed the approach. It can be accessed at <http://www.sfwater.org/index.aspx?page=647>.

Figure ES-1. Flowchart of SFPUC CEC Approach for the Drinking Water System



This evaluation represents the first implementation of the approach. The approach is intended to (1) provide a consistent, proactive, and flexible means of organizing and prioritizing CEC work, and (2) enhance stakeholder engagement on CEC issues. The approach includes the use of

Screening Evaluations for each CEC group, expert and stakeholder reviews, and public communication to evaluate the significance and prioritization of various CEC groups or individual CECs for the SFPUC drinking water system.

Recognizing that new knowledge in this area continues to develop, CEC updates to this report will be provided every three years alongside the regulatory-required Public Health Goal (PHG) reports (2013, 2016, etc.) and together formally presented to the Commission for review and approval. This will allow an opportunity to incorporate new data (SFPUC or external), evaluate any newly recognized individual CECs within the appropriate group, or add a new group and associated Screening Evaluation if required.

CEC Groups and Screening Evaluations for SFPUC Drinking Water System

San Francisco’s water system has very high quality sources of supply, yet trace detections of some CECs are possible. The SFPUC CEC approach groups CECs with similar properties and/or common routes of entry into the water system to structure the evaluation process and make the large number of CECs manageable. Each group is screened to determine its priority for SFPUC drinking water. The twelve (12) SFPUC CEC groups are listed in Table ES-1.

The Screening Evaluations are attached to this report (Appendix A) and include general information, context of the CEC investigation at SFPUC, and diagnostic questions on health, occurrence, and treatment. This information was obtained through literature review, web searches, occurrence data if available, and professional experience. The final section of each Screening Evaluation prioritizes the CEC group and states recommended actions. Expert and stakeholder review of the Screening Evaluations was conducted for all groups.

Table ES-1. CEC Groups for SFPUC Drinking Water System

General Categories	CEC Group
Naturally-Occurring Contaminants	Microbial Waterborne Pathogens Inorganics Algal Toxins Naturally-Occurring Hormones
Manmade Contaminants	Halogenated Flame Retardants Industrial and Commercial Chemicals Nanomaterials Pesticides Pharmaceuticals & Personal Care Products (PPCPs)
Treatment/Distribution Byproducts	Disinfection Byproducts (DBPs) (nitrosamines) DBPs (other than nitrosamines) Leachate from Materials (liners, gaskets, etc.)

CEC Prioritization and Recommended Actions for SFPUC Drinking Water System

The CEC group Screening Evaluations determine priority and recommended actions. Prioritization is based on health risks (i.e., contaminant level in drinking water that poses health concern), occurrence in source and treated waters, and expected removal during treatment. This information is derived from research papers, government agencies, professional associations and research foundations, and SFPUC studies (i.e., SFPUC monitoring or treatment studies).

CEC contamination of SFPUC surface water sources is relatively unlikely because the reservoirs are in protected watersheds. There are no significant municipal or industrial wastewater discharges to SFPUC water sources, which is generally recognized as the principal source of many CECs to drinking water and can occur in other communities via treated discharges upstream of drinking water intakes.

The SFPUC CEC group priorities are summarized in Table ES-2 with the justification and recommended actions. A summary of the corresponding CECs monitoring plan is presented in Table ES-3. Three groups are considered a high priority for SFPUC drinking water: Microbial Waterborne Pathogens, Disinfection Byproducts (Nitrosamines), and Inorganics (Chromium-VI only). Two groups are considered a medium priority: Algal Toxins and Disinfection Byproducts (Other than Nitrosamines). These priorities may change periodically depending on available new information.

The remaining CEC groups had “low” priorities because of a low likelihood of occurrence in SFPUC drinking water at levels of possible health significance. For these groups, maintaining source water protection and optimized water treatment and distribution operations, as well as the continual tracking of new information and any regulatory developments, are sufficient. These recommendations also apply to the high and medium priority groups.

Groundwater will be a relatively minor, future additional water source for SFPUC. CECs in groundwater may be a more significant issue compared to existing surface water supplies (e.g., chromium-VI) based on preliminary SFPUC experience. For both current surface water sources and future groundwater sources, natural sources of select CECs may lead to trace detections (e.g., microbial waterborne pathogens in surface water due to wildlife in the watershed; trace metals in groundwater due to natural erosion). Rapid advances in analytical capabilities and the improved communication of the Internet age will result in new CEC issues emerging on a regular basis.

Table ES-2. Priorities and Recommended Actions for CECs in SFPUC Drinking Water System for 2013 – 2016

CEC Group	Priority	Justification	Recommended Actions^(a)
Microbial Waterborne Pathogens	High	<p>Microbial CECs have been linked elsewhere (though not for SFPUC) to waterborne disease outbreaks and therefore can impact public health and customer satisfaction.</p> <p>The potential for occurrence in SFPUC drinking water is low, in part due to use of multiple disinfectants. However, microbial CECs are a high priority due to their health significance in general.</p>	<ul style="list-style-type: none"> • Benchmark through national or state surveys when appropriate. • Investigate the occasional occurrence of total coliform positives (regulated indicator bacteria that are a potential indicator of other microorganisms) in the transmission and distribution system (see related monitoring plan in Table 6). • Continue participation in Partnership for Safe Water (PSW) (see Appendix F) for SFPUC water treatment plants to meet turbidity removal standards. • Evaluate joining the PSW for the SFPUC distribution system. • Continue distribution system programs to prevent entry of microbial contaminants and maintain disinfectant residual (see related monitoring plan in Table 6).
DBPs (Nitrosamines)	High	<p>Nitrosamines are a high priority because they are occasionally detected at trace levels in SFPUC treated drinking water (occasionally above the PHG of 3 ng/L), CA NLs exist for three nitrosamines, and a future MCL is likely.</p>	<ul style="list-style-type: none"> • Maintain optimized treatment: avoid polymer overfeed, provide free chlorine contact time before chloramination, and minimize detention time in the distribution system. • Provide operator training on how to minimize nitrosamine formation. • Continue voluntary monitoring started in 1999 and collect total chlorine, free ammonia, pH, temperature and conductivity along with nitrosamine samples (see related monitoring plan in Table 6).
Inorganics	High for Cr(VI) Low for other inorganics	<p>Significant levels of metals are generally not expected due to SFPUC's protected watersheds. However, Cr(VI) is a concern in groundwater and is subject to a future California regulatory limit. CDPH announced a Draft MCL of 10 ug/L Cr(VI) in August of 2013. CDPH's final MCL target date for Cr(VI) is 2014-15.</p> <p>June/July 2012 Cr(VI) monitoring in SFPUC surface waters produced non-detects (< 0.2 ug/L). Cr(VI) was subsequently detected in surface waters using an analytical method with a lower detection limit (< 0.03 ug/L). Cr(VI) levels in future groundwater sources were between < 0.1 to 30 ug/L which could be near the future CDPH</p>	<ul style="list-style-type: none"> • Continue the Chemical Quality Control Program (October 2010; see Appendix G) at water treatment plants to minimize impurities in treatment chemicals. • For Cr(VI) – conduct mandatory UCMR3 and voluntary Cr(VI) monitoring of surface and groundwaters to better understand sources and occurrence (see related monitoring plan in Table 6). • Evaluate existing dataset for total Cr and Cr(VI) values in groundwater with respect to formation potential for Cr(VI) from total Cr.

CEC Group	Priority	Justification	Recommended Actions ^(a)
		regulatory limit. Groundwater will be blended with surface water which should mitigate this potential issue.	
Algal Toxins	Medium	<p>Though rare, adverse health impacts to humans from algal toxins in drinking water associated with severe algal blooms have been reported elsewhere (though not for SFPUC). Algae levels and algal toxin concentrations could change over time due to climate change or other environmental factors.</p> <p>Based on monitoring conducted in 2007 and 2010, it appears that the vulnerability of SFPUC water supplies to algal toxins is low. However, algal toxins could occur in SFPUC source water at levels of possible health significance during significant algal blooms.</p>	<ul style="list-style-type: none"> • Continue watershed management activities that reduce nutrient loads. • Implement as-needed measures identified in the SFPUC Algae Monitoring and Mitigation Plan (2011a; see Appendix H) that reduce toxin-producing algae. • Develop a protocol to monitor and evaluate the occurrence and decay of algal toxins during significant algal blooms (see Table 6).
DBPs (other than nitrosamines)	Medium	<p>Unregulated DBPs are formed at trace levels during disinfection and occur in SFPUC drinking water. The occurrence and fate of these CECs are a focus of ongoing research; much less is known about health significance. In 2012, SFPUC completed participation in a WRF Project No. 4242 "Fate of Non-regulated DBPs in Distribution System" (see Appendix I), which identified levels of unregulated DBPs that were generally lower than or similar to other utilities.</p> <p>It is not likely that these CECs, other than chlorate, will be regulated in the near future. Chlorate and formaldehyde have CA NLs. Chlorate is also on EPA's UCMR3 and hence an EPA priority. Chlorate and formaldehyde are detected in SFPUC treated drinking waters but at levels well below CA NLs.</p>	<ul style="list-style-type: none"> • Review WRF Project No. 4242 report once it is published (expected in 2014). • Minimize THM/HAA (regulated DBPs) formation at SVWTP and HTWTP and other treatment locations, which will also reduce concentrations of unregulated DBPs. • Minimize detention time in the distribution system. • Continue the Chemical Quality Control Program (October 2010) at water treatment plants to minimize impurities in treatment chemicals.
Halogenated Flame Retardants	Low	<p>Halogenated flame retardants do not occur and are not expected to occur in SFPUC source waters or distribution system, based on available monitoring data and the fact that SFPUC watersheds and source waters are not impacted by significant wastewater and industrial discharges or urban runoff.</p>	<ul style="list-style-type: none"> • For forest fires retardants, monitor types of retardants in use and application areas.

CEC Group	Priority	Justification	Recommended Actions^(a)
Industrial and Commercial Chemicals	Low	Industrial CECs are of low concern due to SFPUC's protected watersheds and source waters, which are not impacted by significant wastewater and industrial discharges or urban runoff. Air deposition may cause trace levels of industrial chemicals within the watersheds (e.g., PAHs). SFPUC monitoring for select, unregulated industrial chemicals has indicated no detections, and together with SFPUC monitoring of regulated industrial chemicals, has confirmed the effectiveness of source water protection.	<ul style="list-style-type: none"> As more information becomes available, or to further focus this review process, select subgroups of industrial/commercial chemicals could be considered in a new, separate Screening Evaluation. Candidates include unregulated perfluorochemicals, plasticizers, PAHs.
Leachate from Materials	Low	<p>Leachates from liners and other treatment/distribution system materials are unlikely to occur at levels of health significance. All materials must be NSF 61 approved, which provides some assurance that materials are appropriate for water systems.</p> <p>Soak tests are an additional, proactive step that SFPUC implements in order to ensure that new linings and other materials are properly installed. Past soak tests have shown that detections of regulated contaminants are very low (typically about 1% of MCLs). Generally, soak tests are worst-case conditions and any leaching should decrease significantly over time.</p>	<ul style="list-style-type: none"> Continue to require contract specifications to specify NSF 61 materials for the interiors of tanks, pipelines, and other facilities. Audit construction projects to confirm that only NSF 61 materials are used. Continue to conduct periodic soak tests to ensure that materials are installed properly (see related monitoring plan in Table 6). Consider follow-up tests for detected CECs to confirm that levels are transitory.
Nanomaterials	Low	Nanomaterials are unlikely to occur in SFPUC treated drinking water (from surface water or groundwaters) because the watersheds and source waters are not impacted by significant industrial or wastewater discharges or urban runoff. Very little is known about nanomaterial occurrence in US drinking waters, health significance, and treatment effectiveness. These CECs are the subject of preliminary research.	<ul style="list-style-type: none"> Benchmark through national or state surveys when appropriate.
Naturally-Occurring Hormones	Low	Naturally-occurring hormones are unlikely to occur in SFPUC treated drinking water at levels of possible health significance because (1) detections in raw water have been very low, (2) there have been no detections in treated water, (3) hormones are generally well removed by the type of drinking water treatment systems used by SFPUC, and (4) studies and reviews conducted in the U.S. and internationally over the past decade have thus far indicated	<ul style="list-style-type: none"> No additional actions are recommended beyond what is listed in footnote (a)

CEC Group	Priority	Justification	Recommended Actions ^(a)
		no appreciable risk to human health from low-level exposure to natural hormones in drinking water.	
Pesticides	Low	Pesticides (regulated or unregulated) are not expected to occur in SFPUC treated drinking water at levels of possible health significance because SFPUC watersheds are not impacted by significant agricultural or urban runoff. If present, many pesticides would be oxidized by chlorine or ozone during SFPUC drinking water treatment. SFPUC monitoring since 2006 has not detected pesticides in source waters.	<ul style="list-style-type: none"> Minimize and track pesticide use in the watersheds.
Pharmaceuticals & Personal Care Products	Low	SFPUC monitored its source and treated drinking waters for PPCPs in 2006 and 2012. PPCPs are a low priority because (1) SFPUC monitoring has shown non-detects or very low-level (low confidence) detections, (2) SFPUC has protected watersheds and source waters that are not impacted by significant wastewater discharges, and (3) studies and reviews conducted in the U.S. and internationally over the past decade have thus far indicated no appreciable risk to human health from low-level exposure to PPCPs in drinking water.	<ul style="list-style-type: none"> Complete UCMR3 monitoring

(a) In addition to the recommended actions listed for each CEC group, **the following recommended actions apply to all CEC groups:**

- Maintain source water protection and optimized multibarrier water treatment and distribution system operation
- Track information, peer-reviewed publications, and any federal and state regulatory developments

Acronyms

CECs = contaminants of emerging concern; **CA NLS** = California Notification Levels (non-regulatory); **CDPH** = California Department of Public Health; **Cr(VI)** = chromium-6; **DBPs** = disinfection byproducts; **EPA** = United States Environmental Protection Agency; **HAAs** = Haloacetic acids; **HTWTP** = Harry Tracy Water Treatment Plant; **MCL** = maximum contaminant level; **NDMA** = *N*-nitrosodimethylamine (see Screening Evaluation “DBPs (Nitrosamines)” for other chemical names); **ng/L** = nanogram per liter (parts per trillion); **NSF 61** = National Sanitation Foundation Standard 61; **PAHs** = polycyclic aromatic hydrocarbons; **PFOA** = perfluorooctanoate; **PFOS** = perfluorooctane sulfonate; **PHG** = Public Health Goal, California (non-regulatory); **PPCPs** = pharmaceuticals and personal care products; **SFPUC** = San Francisco Public Utilities Commission; **SVWTP** = Sunol Valley Water Treatment Plant; **THMs** = Trihalomethanes; **UCMR3** = USEPA Unregulated Contaminant Monitoring Rule 3; **ug/L** = microgram per liter (parts per billion); **WRF** = Water Research Foundation

Table ES-3. Monitoring Plan for CECs, 2013 – 2016, San Francisco Regional Water System and San Francisco Water System

CEC Group [Priority]	Monitoring Recommendations ^(a) , Contaminant (MRL)	Locations	Frequency
Microbial Waterborne Pathogens [High]	<p>Complete Total Coliform (TC) investigation.</p> <p>Continue nitrification monitoring to maintain disinfectant residual in distribution system.</p> <p>Benchmark microbial CECs through national and state surveys, when appropriate.</p>	NA	NA
DBPs (Nitrosamines) [High]	<p>Continue quarterly nitrosamines monitoring in 2014 and 2015 (see compound list below) to evaluate impact of treatment plant upgrades and increased distribution system total chlorine and pH. After 2015 and/or pending any regulatory determinations for nitrosamines, consider annual monitoring and review of sampling locations.</p> <p>Collect total chlorine, free ammonia, pH, temperature and conductivity along with nitrosamine samples.</p> <p><u>Nitrosamines:</u> <i>N</i>-Nitrosodimethylamine, NDMA (<2 ng/L) <i>N</i>-Nitrosodiethylamine, NDEA (<2 ng/L) <i>N</i>-Nitrosodi-n-butylamine, NDBA (<2 ng/L) <i>N</i>-Nitrosodi-n-propylamine, NDPA (<2 ng/L) <i>N</i>-Nitrosomethylethylamine, NMEA (<2 ng/L) <i>N</i>-Nitrosopyrrolidine, NPYR (<2 ng/L)</p>	Alameda East SVWTP TWR Effluent Irvington Portal CS2 Baden UMS #1 UMS #9 HTWTP Effluent CHS #8 CHS #13 Trip Blanks (City, EB, Peninsula)	Quarterly monitoring through 2014 and 2015; quarterly or annual after 2015
Inorganics [High for Cr(VI), Low for other inorganics]	<p>Monitor for the following UCMR3 compounds (6 metals):</p> <p>Cobalt (<1 ug/L) Molybdenum (<1 ug/L) Strontium (<0.3 ug/L) Vanadium (<0.2 ug/L) Chromium-6, Cr(VI) (<0.03 ug/L) Total Chromium (<0.2 ug/L)</p> <p>Monitor groundwater test and production wells quarterly for total Cr and Cr(VI) until Cr(VI) MCL is finalized. Evaluate for further monitoring.</p>	UCMR3 locations – see notes ^(b)	UCMR3 frequency – see notes ^(c)
		Cr(VI) - Groundwater test and production wells serving SFWS and SFRWS, see note for well list ^(d)	Cr(VI) - Quarterly

CEC Group [Priority]	Monitoring Recommendations^(a), Contaminant (MRL)	Locations	Frequency
Algal Toxins [Medium]	Develop a protocol to monitor and evaluate the occurrence and decay of algal toxins during significant algal blooms for the following compounds: Total Microcystins (<0.16 ug/L) Cylindrospermopsin (<0.05 ug/L) Saxitoxin (<0.02 ug/L) Anatoxin-a (<0.02 ug/L)	Pending protocol	Pending protocol
DBPs (other than nitrosamines) [Medium]	Monitor for the following UCMR3 compounds: Chlorate (<20 ug/L) Review WRF No. 4242 monitoring results.	UCMR3 locations – see notes ^(b)	UCMR3 frequency – see notes ^(c)
Halogenated Flame Retardants [Low]	Monitor for the following UCMR3 compounds: Bromochloromethane (<0.06 ug/L) (also an Industrial Chemical and DBP)	UCMR3 locations – see notes ^(b)	UCMR3 frequency – see notes ^(c)
Industrial and Commercial Chemicals [Low]	Monitor for the following UCMR3 compounds (12 industrial/ commercial chemicals): 1,4-dioxane (<0.07 ug/L) 1,1-dichloroethane (<0.03 ug/L) 1,2,3-trichloropropane (<0.03 ug/L) 1,3-butadiene (<0.1 ug/L) Chlorodifluoromethane (<0.08 ug/L) Chloromethane (<0.2 ug/L) Perfluorooctanesulfonic acid, PFOS (<0.04 ug/L) Perfluorooctanoic acid, PFOA (<0.02 ug/L) Perfluorononanoic acid, PFNA (<0.02 ug/L) Perfluorohexanesulfonic acid, PFHxS (<0.03 ug/L) Perfluoroheptanoic acid, PFHpA (<0.01 ug/L) Perfluorobutanesulfonic acid, PFBS (<0.09 ug/L)	UCMR3 locations – see notes ^(b)	UCMR3 frequency – see notes ^(c)
Leachate from Materials [Low]	Monitor for VOCs and SOCs per EPA Methods 524 and 525, respectively, and other contaminants when warranted. For as-needed sampling, see SFPUC Manual of Procedures, Disinfection/Dechlorination and Related Tasks (2011).	As needed to confirm new or significant construction practices	As needed to confirm new or significant construction practices

CEC Group [Priority]	Monitoring Recommendations^(a), Contaminant (MRL)	Locations	Frequency
Nanomaterials [Low]	Benchmark through national and state surveys, when appropriate	NA	NA
Pesticides [Low]	Monitor for the following UCMR3 compounds: Methyl bromide (<0.2 ug/L)	UCMR3 locations – see notes ^(b)	UCMR3 frequency – see notes ^(c)
Pharmaceuticals & Personal Care Products (PPCPs) [Low] and Naturally-Occurring Hormones [Low]	Monitor for the following UCMR3 compounds (7 hormones): 17-alpha-Ethinylestradiol (<0.0009 ug/L) 17-beta-estradiol (<0.0004 ug/L) Equilin (<0.004 ug/L) Estril (<0.0008 ug/L) Estrone (<0.002 ug/L) Testosterone (<0.0001 ug/L) 4-androstene-3,17-dione (<0.0003 ug/L)	UCMR3 locations – see notes ^(b)	UCMR3 frequency – see notes ^(c)

Notes

UCMR3 monitoring consists of one year of quarterly monitoring for 30 contaminants to be conducted between January 2013 and December 2015. “Low” priority CEC groups do not require monitoring per SFPUC CEC approach but monitoring may be indicated in above table if required by UCMR3.

- (a) In addition to above monitoring plan, participate in national and state CEC surveys and conduct special monitoring for any breaking CEC issue (new research study findings, etc.), when appropriate.
- (b) UCMR3 locations: CS2 Baden (entry point, low zone water), SA2 Baden (entry point, high zone water), UMS#5 (DS max residence time, low zone), CHS#1 (DS max residence time, high zone)
- (c) UCMR3 frequency: Quarterly for one year (Jan 2013, Apr 2013, Jul 2013, Oct 2013)
- (d) Groundwater production wells: SFWS – Lake Merced Pump Station, West Sunset Playground, South Sunset Playground, GGP North Lake, GGP South Windmill, and GGP Central Pump Station; SFRWS – CUP 3A, CUP 11A (central treatment for CUP 10A/11/18), CUP 23, CUP 36-1, and CUP M-1.

MRL = Minimum Reporting Level; **DBPs** = disinfection by-products; **CEC** = contaminant of emerging concern; **GGP** = Golden Gate Park; **NA** = not applicable; **ND** = non-detect; **P/A** = presence/absence; **PBDEs** = polybrominated diphenyl ethers; **SFRWS** = San Francisco Regional Water System; **SFWS** = San Francisco Water System; **TC** = Total Coliform; **THM/HAA** = trihalomethanes / haloacetic acids; **UCMR3** = Unregulated Contaminant Monitoring Rule 3; **WRF** = Water Research Foundation