Singapore Area Coordinator Drinking Water Annual Consumer Confidence Report

The U.S. Navy applies the regulations of the U.S. Safe Drinking Water Act (SDWA) to all U.S. Navy installations overseas. In accordance with the U.S. Department of the Navy regulations, Singapore Area Coordinator (SAC) issues an annual report describing the quality of our drinking water. This report reflects water quality monitoring data collected from January 1, 2020 through December 31, 2020.

SAC is pleased to report that in calendar year 2020 our drinking water met all U.S. and Singaporean standards for water quality.

Drinking Water Standards
To ensure water is safe to drink, the U.S. Navy complies with water quality standards set by the U. S. Environmental Protection Agency (EPA). Per Navy guidance, SAC is required to regularly test the installation's drinking water for contaminants and report the results on an annual basis.

Last year, as in years past, SAC's drinking water met all EPA and Singapore National Environmental Agency (NEA) standards for drinking water quality. SAC's drinking water also met the standards established by the Department of Defense (DoD) Overseas Environmental Baseline Guidance Document (OEBGD) and CNICINST 5090.1 U.S. Drinking Water Standards for U.S. Navy Installations Overseas.

In the latest compliance monitoring period, SAC conducted tests for over 120 contaminants which have the potential to be present in drinking water. Table 1-1 identifies all contaminants detected in SAC water and their levels of concentration. All drinking water, to include bottled water, is reasonably expected to contain at least small amounts of some contaminants. The presence of contaminants in water does not necessarily indicate a health risk; rather, the important fact is that none of the contaminant levels found in SAC's water exceeds the governing water quality standards, known as maximum contaminant levels (MCL).

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. Such individuals should seek advice from their health care providers about drinking water.

Water Sources
Singapore built a robust, diversified, and sustainable water supply from four water sources known as the Four National Taps – water from local catchment, imported water, reclaimed water (known as NEWater) and desalinated water. The Public Utilities Board (PUB) is the Singaporean agency responsible for the treatment and distribution of drinking water throughout the island. Water provided by the PUB arrives at SAC fully compliant with U.S. standards. No additional water treatment is provided by SAC. The Public Works Department (PWD) routinely tests the water to ensure it meets water quality standards.

Additional information on the Four National Taps is avaialble on the PUB website: https://www.pub.gov.sg/

Water Treatment
Raw water from various sources in Singapore is conveyed by pipelines to local waterworks where it is chemically treated, filtered and disinfected. Treatment removes contaminants and improves water clarity and taste.

Most treatment plants use chemical coagulation to remove larger particles (i.e., dirt or debris) suspended in the raw water. Aluminum sulfate is the main coagulant, and hydrated lime and polyelectrolyte are used as coagulant aids. These chemicals cause the suspended matter to settle more readily, thus facilitating removal of large particles. Rapid gravity filtration is used to remove finer particles of suspended matter.

Chlorine, and sometimes ozone, is then added to the filtered water to disinfect and remove all harmful bacteria and viruses. Ammonia is added to combine with the free chlorine to form stable chlorine residual. Activated carbon is also used to remove any bad taste and odor from the water.

Sodium silicofluoride is added to the water as it progresses from the filters to the clear water tank. Fluoridation is required by the Singapore Ministry of Health, and has been a standard water treatment practice since 1957 to prevent tooth decay (cavities). The water is then pumped into the distribution system, ready for consumption.

Water Quality Monitoring
Singapore PUB and SAC routinely monitor for contaminants using certified laboratories and approved methods in accordance with DoD and U.S. Navy regulations.

The following contaminants are monitored:

- Monthly – Total Coliform, pH, Chlorine Residual, Bromate, Nitrate/Nitrite & Total Nitrate/Nitrite.
- Quarterly – Disinfection by-products [Total Trihalomethanes (TTHM) and Haloacetic Acids (HAA5), Volatile Organic Chemicals & Synthetic Organic Chemicals.
- Annually – Lead, Copper, Inorganic Chemicals, Pesticides, Herbicides & PCBs
- Once every three years – Radionuclides, Per- and Polyfluoroalkyl Substances (PFAS)
- Once every nine years – Asbestos

Table 1.0 lists contaminants detected during the last applicable sampling period. The samples were collected directly from water fixtures at selected locations throughout the water distribution system in the housing and industrial areas of SAC. Only contaminants detected during sampling are listed in the tables. As noted previously, all contaminant levels detected were within the applicable standards.

Substances Expected in Drinking Water
The source of drinking water comes from surface waters including rivers, lakes, streams, ponds and reservoirs. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants which may be present in SAC's water (listed alphabetically)

Arsenic occurs in inorganic and organic forms. Inorganic arsenic compounds (such as

those found in water) are highly toxic while organic arsenic compounds (such as those found in seafood) are less harmful to health. Additional information on arsenic in drinking water is available from the EPA: http://water.epa.gov/lawsregs/rulesregs/sdwa/arsenic/index.cfm

Inorganic contaminants, such as salts and metals, which can be naturally occurring or result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.

Lead can come primarily from materials and components associated with service lines and home plumbing. Singapore ended the practice of using lead-containing materials in water systems over 20 years ago, though it is possible plumbing components over 20 years old may still contain lead. Elevated levels of lead in water can cause serious health problems, especially for pregnant women and young children.

When water in a pipe has been sitting for several hours, one can minimize the potential for lead exposure by running the tap for 30 seconds to two minutes before using water for drinking or cooking. Additional information on lead in drinking water is available from the EPA: https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water

Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.

Nitrate is an inorganic chemical that is naturally present in soil, water and food. Major sources of nitrate in drinking water include fertilizers, sewage and animal manure. Nitrates themselves are relatively nontoxic; however, when swallowed, they are converted to nitrites that can react with hemoglobin in the blood, creating methemoglobin. Infants convert approximately ten percent of ingested nitrates to nitrites, double the conversion rate of older children and adults. High enough concentrations of nitrate in drinking water can result in a temporary blood disorder in infants called methemoglobinemia, commonly called "blue baby syndrome." In severe, untreated cases, brain damage and eventually death can result from suffocation due to lack of oxygen. Additional information on nitrate in drinking water is available from the EPA: http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm

Organic chemical contaminants, including synthetic and volatile organic chemicals, are by-products of industrial processes and petroleum production, as well as gas stations, urban storm water runoff, and septic systems.

Per- and Polyfluoralkyl Substances

What are per- and polyfluoroalkyl substances and where do they come from?
Per- and polyfluoroalkyl substances (PFAS) are a group of thousands of man-made chemicals. PFAS have been used in a variety of industries and consumer products around the globe, including in the United States, since the 1940s. PFAS have been used to make coatings and products that are used as oil and water repellents for carpets, clothing, paper packaging for food, and cookware. They are also contained in some foams (aqueous film-forming foam or AFFF) used for fighting petroleum fires at airfields and in industrial fire suppression processes because they rapidly extinguish fires, saving lives and protecting property. PFAS chemicals are persistent in the environment and some are persistent in the human body – meaning they do not break down and they can accumulate over time.

Is there a regulation for PFAS in drinking

water?
There is currently no established federal water quality regulation for any PFAS compounds. In May 2016, the EPA established a health advisory (HA) level at 70 parts per trillion (ppt) for individual or combined concentrations of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). Both chemicals are types of PFAS.

Out of an abundance of caution for your safety, the Department of Defense's (DoD) PFAS testing and response actions go beyond EPA Safe Drinking Water Act requirements. In 2020 the DoD promulgated a policy to obtain drinking water results for PFAS at all purchased water systems.

The EPA's health advisory states that if water sampling results confirm that drinking water contains PFOA and PFOS at individual or combined concentrations greater than 70 ppt, water systems should quickly undertake additional sampling to assess the level, scope, and localized source of contamination to inform next steps.

Has SAC tested its water for PFAS?
Yes. In December 2020 samples were collected from Building 7 – 4.

None of the 18 PFAS compounds covered by the sampling method of the water provided by Singapore PUB were detected above the method reporting limit (MRL). PFOA and PFOS were below the EPA HA level. The results are provided in Table 1. As PFOA and PFOS were below the EPA HA, there is no immediate cause for concern.

https://www.cnic.navy.mil/om/base_support/environmental/water_quality/Testing_for_Perfluorochemicals.html

Pesticides and herbicides, which may come from a variety of sources such as agriculture, urban storm water runoff, and residential uses.

Radioactive contaminants – which can be naturally-occurring or be the result of oil and gas production and mining activities.

Water Quality Data Table
SAC conducts extensive monitoring to ensure your water meets all water quality standards. The results of the monitoring are reported in the tables on the following pages.

The presence of a contaminant does not necessarily indicate a health risk. Please note the PWD monitors many contaminants, in additional to the ones listed below, per the OEBGD and CNICINST 5090.1A. Only those contaminants detected during laboratory analysis are listed below. The water samples were collected from SAC facilities and analyzed by Marchwood Laboratory Services Pte. Ltd. an ISO / IEC 17025, 2019 Certified Laboratory.

Additional Information:
U.S. EPA Office of Water (www.epa.gov/safewater) and the Center for Disease Control and Prevention (www.cdc.gov) websites provide information on many issues relating to water resources, water conservation, and public health.

Table Definitions and Abbreviations

AL (Action Level): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.

MCL (Maximum Contaminant Level): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

MCLG (Maximum Contaminant Level Goal): The level of a contaminant in drinking water below which there is no know or expected risk to health. MCLGs allow for a margin of safety.

MRDL (Maximum Residual Disinfectant Level): The highest level of drinking water disinfectant routinely allowed in drinking water. Addition of a disinfectant is necessary for the control of microbial contamination

MRDLG (Maximum Residual Disinfectant Level Goal): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.

N/A: Not applicable

ND: Not detected

mg/L (milligrams per liter): one part substance per million parts water (parts per million).

ng/L (nanograms per liter): one part substance per trillion parts water (parts per trillion)

µg/L (micrograms per liter): one part substance per billion parts water (parts per billion)

pCi/L (picocuries per liter): Measurement of the natural rate of disintegration of radioactive contaminants in water (also beta particles).

mrem/yr (millirem per year): one thousandth of a rem. Measurement of dose of absorbed energy adjusted to be equivalent for different kinds of radiation.

MFL (million fibres per liter): Measurement of the presence of asbestos fibres that are longer than 10 micrometers.

TT (Treatment Technique): A required process intended to reduce the level of a contaminant in drinking water.

< : less than

How to Read the Data Tables:
Starting with a **"Substance"**, read across. **"Year Sampled"** is usually 2019 or a year prior. **"MCL"** shows the highest level of substance (contaminant) allowed in drinking water. **"MCLG"** is the goal level for that substance (this may be lower than what is allowed). A **"No"** under **"Violation"** means the amount of the substance met government requirements. **"Possible Source of Contamination"** tells where the substance usually originates.

Unregulated substances are measured, but maximum allowed contaminant levels have not been established by the U.S.

Concerns/Additional Copies:
For questions, information, and /or additional copies, please contact Singapore Area Coordinator, Public Works Department, Environmental Division at (+65) 6750-2524/2052 or charles.sayon@fe.navy.mil.

TABLE 1.0: Drinking Water Constituents Detected						
Substance	**Unit of Measurement**	**Level Detected**		**Regulated Levels (OEBGD and CNICINST 5090.1)**	**Violation**	**Possible Sources of Contamination**
		Low	**High**		**Yes / No**	
Inorganic Contaminants						
Arsenic	**mg/L**	<0.0025	ND*	MCL = 0.01 MCLG = 0.0	No	Erosion of natural deposits; runoff from orchards, runoff from glass and electronics production wastes
Asbestos	**MFL**	<0.2	ND*	MCL = 7.0 MCLG = 7.0	No	Runoff from asbestos containing minerals, runoff from asbestos roofing and pipes and industrial wastes
Barium	**mg/L**	0.035	0.035*	MCL = 2 .0 MCLG = 2.0	No	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Fluoride	**mg/L**	0.44	0.44*	MCL = 4.0 MCLG = 4.0	No	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories
Nitrate (as Nitrogen)	**mg/L**	0.64	1.190	MCL = 10.0 MCLG = 10.0	No	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits
Nitrite (as Nitrogen)	**mg/L**	<0.02	0.027	MCL = 1.0 MCLG = 1.0	No	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits
Total Nitrite & Nitrate (as Nitrogen)	**mg/L**	0.64	1.210	MCL = 10 MCLG = 10	No	Runoff from fertilizer use; leaking from septic tanks, sewage; erosion of natural deposits
Sodium[1]	**mg/L**	3.71	3.71*	MCL = N/A MCLG = N/A	No	Erosion of natural deposits
Disinfectant/Disinfection Byproducts						
Haloacetic Acids	**mg/L**	<0.001	0.067	MCL = .06 MCLG = N/A	No	Byproduct of drinking water disinfection
Trihalomethanes (Total)	**mg/L**	0.039	0.071	MCL = .08 MCLG = N/A	No	Byproduct of drinking water disinfection
Chloramine (As Total Chlorine)	**mg/L**	<0.20	2.30	MRDL = 4.0 MRDL = 4.0	No	Water additive used to control microbes

Notes:

1) Sodium has no established MCL per OEGBD. Monitoring is required so concentration levels can be made available on request.

*This is one time sample with no high or low

TABLE 1.0: Drinking Water Constituents Detected (Cont'd)						
Substance	**Unit of Measurement**	**Level Detected**		**Regulated Levels (OEBGD and CNICINST 5090.1)**	**Violation**	**Possible Sources of Contamination**
		Low	**High**		**Yes / No**	
Radionuclides[2]						
Gross Alpha	**pCi/L**	2.94*		MCL =15 MCLG = 0.0	No	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation
Beta Particle and Photon Radioactivity (Gross Beta)	**mrem/yr**	<1*		MCL = 50.0 MCLG = 0.0	No	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as photons and beta radiation
Combined Radium-226 and –228	**pCi/L**	2.14*		MCL = 5 MCLG = 0.0	No	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known combined Radon
Uranium	**µg/L**	ND		30 µg/L	No	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as uranium
Microorganisms						
Total Coliform	**positive samples per month**	<1	0	MCL = 0 MCLG = 0	No	Coliforms are naturally present in the environment; as well as feces; fecal coliforms and E. coli only come from human and animal fecal waste
Lead & Copper						
Copper	**mg/L**	0.005	0.084	AL = 1.3 MCLG = 0	No	Corrosion of household plumbing systems: erosion of natural deposits
Lead	**mg/L**	<0.005	<0.005	AL =0.015 MCLG = 0.0	No	Corrosion of household plumbing systems: erosion of natural deposits

Notes: 2) Radionuclides last tested in 2019. Required frequency of sampling & testing is once every 3 years. *This is one time sample with no high or low

TABLE 1.0: Drinking Water Constituents Detected (Cont'd)

Substance	Unit of Measurement	Level Detected		EPA Health Advisory Level	Violation	Possible Sources of Contamination
		Low	High		Yes / No	
Per- and Polyfluoroalklyl Substances, Sampled on 04 Dec 2021, Building 7-4						
Hexafluoropropylene oxide dimer acid (GenX)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-1-butane sulfonic acid (PFBS)	**ng/L**	0.54	0.54	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-decanoic acid (PFDA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-dodecanoic acid (PFDoA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-heptanoic acid (PFHpA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluorohexane sulfonic acid (PFHxS)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-hexanoic acid (PFHxA)	**ng/L**	0.56	0.56	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-nonanoic acid (PFNA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluorooctane sulfonic acid (PFOS)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-octanoic acid (PFOA)	**ng/L**	0.56	0.56	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-tetradecanoic acid (PFTeDA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-tridecanoic acid (PFTrDA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
Perfluoro-n-undecanoic acid (PFUdA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11CL-PF3OUdS)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products
4,8-dioxa-3H-perfluorononanoic acid (ADONA)	**ng/L**	ND	ND	70	No	Firefighting Foams (Aqueous Film-Forming Foam) usage, industrial facility where PFAS were produced or used to manufacture other products