CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

MEETING OF MAY 11, 2022
SOUTH LAKE TAHOE, CA

ITEM 6
Per- and Polyfluoroalkyl Substances (PFAS), the State of What We Know and What We Don't Know

CHRONOLOGY	
None	Not Applicable

BACKGROUND

Water Board staff prepared a Staff Report to bring awareness to what PFAS are and to highlight the emerging regulatory framework associated with these substances. PFAS are a group of man-made chemicals resistant to heat, water, and oil that have been used in many industrial and consumer products beginning in the 1950's. PFAS compounds are toxic at low concentrations and have been found in drinking water sources across the globe. Unfortunately, there is no real conclusive information on where and how much PFAS exists in California. In 2014, the Department of Defense (DOD) began self-monitoring for PFAS at its facilities. Beginning in 2019, the State Water Resources Control Board (State Water Board), together with the Regional Water Boards have been requiring dischargers to collect PFAS data from different media and facility types to get a better sense of where these substances are in the environment and at what concentrations. The Staff Report provides a summary of the data that has been collected, and will be collected, and attempts to look ahead as our understanding evolves of where and how much PFAS exists in the region and the risk that PFAS poses to human health and the environment.

ISSUES

Where and how much PFAS exists in the region, and what are some of the challenges the Water Board might face as we learn more about the risks these constituents pose to human health and the environment?

DISCUSSION

What are PFAS?

PFAS are a group of human-made chemicals resistant to heat, water, and oil that are used in many industrial and consumer applications. Manufacturing of PFAS started in the 1950s and a majority of the chemicals are still in use today in products such as carpets, rugs, water-proof clothing, upholstery, food paper wrappings, non-stick products, cleaning products, fire-fighting foams, and metal plating (e.g., cookware). These chemicals are persistent and are characterized by being resistant to environmental degradation, long half-lives, and some accumulate in the human body and in food chains. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) are the two most studied PFAS chemicals that were widely used in manufacturing up until 2015, and are the two most common components of aquaeous film forming foam (AFFF) used in fire suppression.

DISCUSSION

PFAS are constituents of emerging concern and there are no state or federal maximum contaminant levels (MCLs) established for drinking water as of yet. However, the Division of Drinking Water (DDW) has established notification levels and response levels in drinking water for both PFOA and PFOS. Notification levels are health-based advisory levels for a chemical in drinking water that lacks a MCL. A response level is the level at which DDW recommends removal of a drinking water source from service. Also, the California Office of Environmental Health Hazard Assessment (OEHHA) has proposed a Public Health Goal for drinking water for both PFOA and PFOS, and the United States Environmental Protection Agency (USEPA) has established screening levels for PFOA and PFOS in groundwater and in soil.

Statewide Orders for Determination of the Presence of PFAS

In March 2019, the State Water Board issued Investigative Orders pursuant to California Water Code, section 13267, to a select group of landfill and airport facilities where PFAS were used, or where materials suspected of containing PFAS were disposed of, to investigate the presence of PFAS (PFAS Investigative Order). This was the beginning of a statewide effort to determine whether groundwater or other media (e.g., soil, stormwater, etc.) is impacted by PFAS and to obtain a preliminary understanding of PFAS concentrations at certain types of facilities. PFAS Investigative Orders were subsequently issued to other industries including chrome platers in October 2019, publicly owned treatment works (POTW) in July 2020, and bulk fuel/storage refineries in March 2021. The focus of the PFAS Investigative Orders were on 39 PFAS analytes including PFOA and PFOS.

- Twenty six landfills in Region 6 were issued the PFAS Investigative Order and were required to sample and analyze both groundwater and landfill leachate from a select number of locations so as to be representative of all conditions at a facility. PFOA and PFOS were detected in most of the groundwater samples and in all leachate samples collected as part of the landfill investigations.

- Two airports in Region 6 were issued the PFAS Investigative Order and were required to sample and analyze both soil and groundwater in or near potential PFAS source areas (e.g., material storage/use areas and probable release areas including crash sites, firefighting training areas, etc.). PFAS was detected in the soil and groundwater samples collected at both airports, with the highest concentrations of PFOA and PFOS detected in samples collected from the Southern California Logistic Airport (former George Air Force Base) in Victorville.

- Seventeen POTWs in Region 6 were issued the PFAS Investigative Order and were required to perform quarterly sampling over a one-year period for influent, effluent, groundwater, and biosolids. In general, Region 6 POTW data results are less than statewide POTW maximum concentrations for PFOA and PFOS.

- Two bulk fuel storage facilities in Region 6 were issued the PFAS Investigative Order and were required to sample and analyze soil, influent, effluent, groundwater, and/or stormwater samples in proximity to potential PFAS source areas (e.g., material storage/use areas and probable release areas, etc.). One

DISCUSSION

of the facilities provided documentation showing there were no potential PFAS source areas to be investigated and were relieved of the PFAS sampling and reporting requirements. Results from the investigation at the remaining facility are pending.

- The DOD began self-monitoring for PFAS at its facilities in 2014 following the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process and were not issued PFAS Investigative Orders. The highest concentrations of PFOA and PFOS in Region 6 are detected in groundwater at the Naval Air Weapons Station China Lake near Ridgecrest in Kern County.

The State Water Board and Regional Water Boards are in the process of evaluating data from the PFAS Investigative Orders. As we evaluate the data from facilities within the Lahontan region, we are looking for trends and commonalities in the data and site characteristics to help draw conclusions as to why PFAS is or is not detected in a particular media (i.e., soil, groundwater, wastewater, etc.) and the mechanism(s) by which PFAS was mobilized in the environment.

Development of a Region 6 PFAS Strategy

Because the State Water Board is not expected to issue any additional statewide PFAS Investigative Orders, future PFAS investigations will likely be led by individual Regional Water Boards. To that end, it is staff's recommendation that we develop a region-specific PFAS Strategy and be at the ready to implement plans and require groundwater cleanup once drinking water standards and other media standards are adopted. The Staff Report identifies a number of components that could be included as part of a region-specific PFAS Strategy.

Looking Ahead and Challenges

We expect that the regulatory framework will continue to evolve, led primarily by DDW, OEHHA, and USEPA, and that MCLs will be established for one or more PFAS chemicals in the near future. As we learn more about where and at what concentrations PFAS exists in the region, we will face internal and external challenges. The Staff Report lists out several challenges that we anticipate.

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PUBLIC OUTREACH/INPUT

No public outreach was conducted for this item.

RECOMMENDATION
This is an information item only. The Water Board will not be asked to take a formal action; however, they may provide direction to staff.

ENCLOSURE	ITEM	BATES NUMBER
1	Staff Report	**6-5**

ENCLOSURE 1

California
Water Boards
Protecting California's Water

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)
THE STATE OF WHAT WE KNOW AND WHAT WE DON'T KNOW

CALIFORNIA
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REGIONAL WATER QUALITY CONTROL BOARDS

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CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
Jared Blumenfeld, Secretary

STATE WATER RESOURCES CONTROL BOARD
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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
ADONA	4,8-Dioxia-3H-Perflourononanoic Acid
AFFF	Aqueous Film Forming Foam
AVSL	Apple Valley Sanitary Landfill
BNSF	Burlington Northern Santa Fe
Calnev	Calnev Pipe Line Company (Kinder Morgan)
CERCLA or Superfund	Comprehensive Environmental Response, Compensation, and Liability Act
DDW	Division of Drinking Water
DOD	Department of Defense
MCL	Maximum Contaminant Level
ng/g	Nanograms per Gram
ng/L	Nanograms per Liter
OEHHA	Office of Environmental Health Hazard Assessment
PFAS	Per- and Polyfluoroalkyl Substances
PFBS	Perfluorobutane Sulfonic Acid
PFDA	Perfluorodecanoic Acid
PFHpA	Perfluoroheptanoic Acid
PFHxA	Perfluorohexanoic Acid
PFHxS	Perfluorohexane sulfonic Acid

Acronym/Abbreviation	Definition
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonic Acid
PHG	Public Health Goal
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
SCAP	Site Cleanup Sub Account Program
SCLA	Southern California Logistic Airport
State Water Board	State Water Resources Control Board
ug/kg	Micrograms per Kilogram
USEPA	United States Environmental Protection Agency
VVWRA	Victor Valley Water Reclamation Authority

Preface

Per- and polyfluoroalkyl substances (PFAS) are chemical compounds that are toxic at low concentrations and have been found in drinking water sources across the globe. Unfortunately, there is no real conclusive information on where and how much PFAS exists in California. In 2014, the Department of Defense (DOD) began self-monitoring for PFAS at its facilities. Beginning in 2019, the State Water Resources Control Board (State Water Board), together with the Regional Water Boards have been requiring dischargers to collect PFAS data from different media and facility types to get a better sense of where these substances are in the environment and at what concentrations. The purpose of this Staff Report is to bring awareness to what PFAS are and to highlight the emerging regulatory framework associated with these substances. In no way is this report exhaustive in terms of what we know and what we don't know about PFAS. Rather, this Staff Report provides a summary of the data that has been collected, and will be collected, and attempts to look ahead as our understanding evolves of where and how much PFAS exists in the region and the risk that PFAS poses to human health and the environment. This Staff Report is the result of a collaborative effort of multiple program staff from two of the three Lahontan Divisions.

1 Introduction

PFAS are a group of human-made chemicals resistant to heat, water, and oil that are used in many industrial and consumer applications. Manufacturing of PFAS started in the 1950s and a majority of the chemicals are still in use today in products such as carpets, rugs, water-proof clothing, upholstery, food paper wrappings, non-stick products, cleaning products, fire-fighting foams, and metal plating (e.g., cookware). These chemicals are persistent and are characterized by being resistant to environmental degradation, long half-lives, and some accumulate in the human body and in food chains. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) are the two most studied PFAS chemicals and were the first PFAS compounds to have federal lifetime risk levels for drinking water.

Due to their chemical structure, PFAS are persistent in the environment, resistant to breaking down, can accumulate within the human body over time, and are toxic at relatively low concentrations. PFAS can be introduced into the body by eating or drinking contaminated food or liquid (including water), or by breathing in or touching products treated with PFAS, such as carpets or clothing. Exposure to unsafe levels of PFOA and PFOS may result in adverse health effects including liver damage, effects on the immune system, cancer, and developmental effects to fetuses during pregnancy.

Although the primary U.S. manufacturers voluntarily phased out production of PFOA and PFOS by 2015, PFOA and PFOS were previously used in the manufacturing of Aqueous Film Forming Foam (AFFF). AFFF is a highly effective fire suppressant used for fighting flammable liquid fuel fires at airports, refineries, bulk fuel terminals, and military facilities. Military installations started using AFFF in the 1970s as a firefighting agent to extinguish chemical fires or spills but was also used during crash crew training exercises, hanger system operations and testing, and for other emergency response actions. The DoD has since updated the Military Specification so that new supplies of

AFFF do not contain detectable levels of PFOS and PFOA. In industry, PFOS and PFOA have been replaced by shorter chain PFAS, which are thought to be less toxic.

PFAS are highly mobile, and major sources of PFAS in the environment include fire training/fire response sites, industrial sites, landfills, and wastewater treatment plants (i.e., influent, effluent, and biosolids) (see Figure 1). PFAS can get into drinking water when products containing them are used or spilled onto the ground or into lakes and rivers. Once in groundwater, PFAS are easily transported large distances and can contaminate drinking water wells. PFAS in the air can also end up in rivers and lakes used for drinking water.

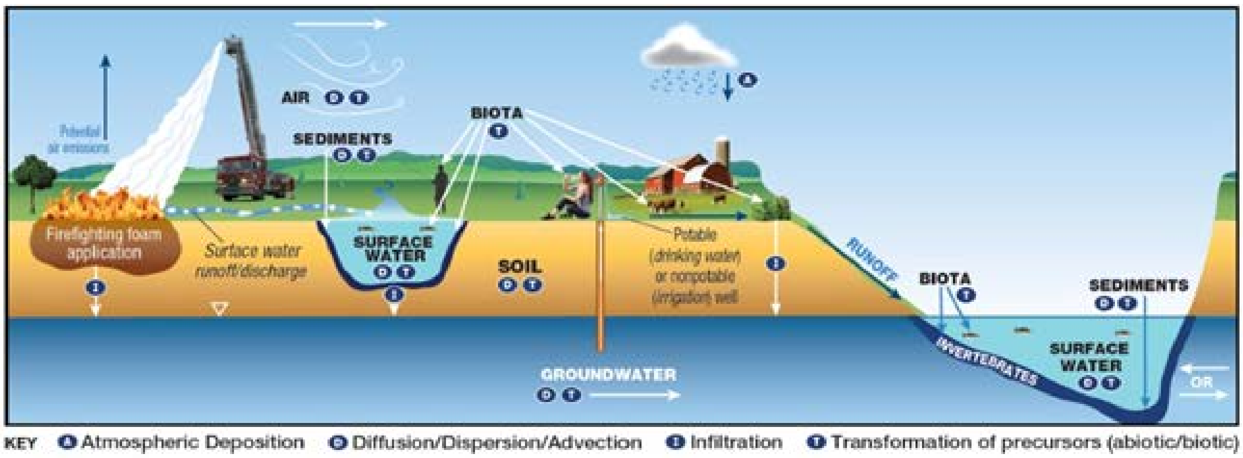

Figure 1. Potential mechanisms of transport of PFAS from firefighting foam application to environmental media, from the Interstate Technology Regulatory Council and the State Water Board PFAS webpage.

In August 2019, the State Water Board, Division of Drinking Water (DDW), updated the drinking water notification levels for PFOA and PFOS to 5.1 nanograms per liter (ng/L) and 6.5 ng/L, respectively. Notification levels are health-based advisory levels established by DDW for a chemical in drinking water that lacks a maximum contaminant level (MCL). DDW updated the response levels in February 2020 to 10 ng/L for PFOA and 40 ng/L for PFOS. A response level is the level at which DDW recommends removal of a drinking water source from service.

In February 2019, the United States Environmental Protection Agency (USEPA) PFAS Action Plan was released to outline steps the USEPA is taking to address PFAS and protect public health. Later that year in December 2019, USEPA issued Interim Recommendations for Addressing Groundwater Contaminated with PFOA and PFOS to be used at sites under federal cleanup programs, including Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) sites and corrective action under the Resource Conservation and Recovery Act (RCRA). The USEPA established a risk-based screening level of 40 ng/L for the combined total of PFOA and PFOS in groundwater to determine if a site may warrant further attention (Table 1).

Table 1. DDW notification levels and response levels and Office of Environmental Health Hazard Assessment (OEHHA) proposed Public Health Goals (PHGs) for PFOA and PFOS drinking water, and USEPA screening levels for PFOA and PFOS groundwater and soil.

PFAS Constituent	California DDW Notification Level for Drinking Water (ng/L)	California DDW Response Level for Drinking Water (ng/L)	California OEHHA Proposed PHG for Drinking Water (ng/L)	USEPA Screening Level for Groundwater[1] (ng/L)	USEPA Screening Level for Soil[1] (ng/g or µg/kg)
PFOA	5.1	10	0.007	40	1,260
PFOS	6.5	40	1	40	1,260

[1] USEPA screening level is the sum (combined total) of PFOA and PFOS in the media.
ng/g - nanograms per gram; ug/kg - micrograms per kilogram.

Although California does not currently have soil screening levels for PFOA and PFOS, as part of the USEPA PFAS Action Plan, a human health screening level of 1,260 nanograms per gram (ng/g or micrograms per kilogram [ug/kg]) for PFOA and PFOS in soil (Table 1) was established. The USEPA is also in the early scoping stages of a risk assessment for PFOA and PFOS in biosolids. The USEPA expects to complete the risk assessment for internal review in 2022, with a public comment period to follow.

In March and April 2019, the State Water Board held board meetings to present the strategy for statewide PFAS orders for source investigations and adjacent public drinking water supply sampling. That statewide effort is currently underway. A summary of the statewide orders and current results for Region 6 are provided in the following sections of this report.

2 Statewide Orders for the Determination of the Presence of PFAS

In March 2019, the State Water Board issued Investigative Orders pursuant to California Water Code, section 13267, to a select group of landfill and airport facilities where PFAS were used, or where materials suspected of containing PFAS were disposed of, to investigate the presence of PFAS (PFAS Investigative Order). This was the beginning of a statewide effort led by the State Water Board to determine whether groundwater or other media (e.g., soil, stormwater, etc.) is impacted by PFAS and to obtain a preliminary understanding of PFAS concentrations at certain types of facilities. PFAS Investigative Orders were subsequently issued to other industries including chrome platers in October 2019, publicly owned treatment works (POTW) in July 2020, and bulk fuel/storage refineries in March 2021. Figure 2 is a map showing the distribution of facilities in Region 6 that were issued the PFAS Investigation Order by facility type. It should be noted that no chrome platers were identified in Region 6, so no chrome plating facilities are shown on Figure 2.

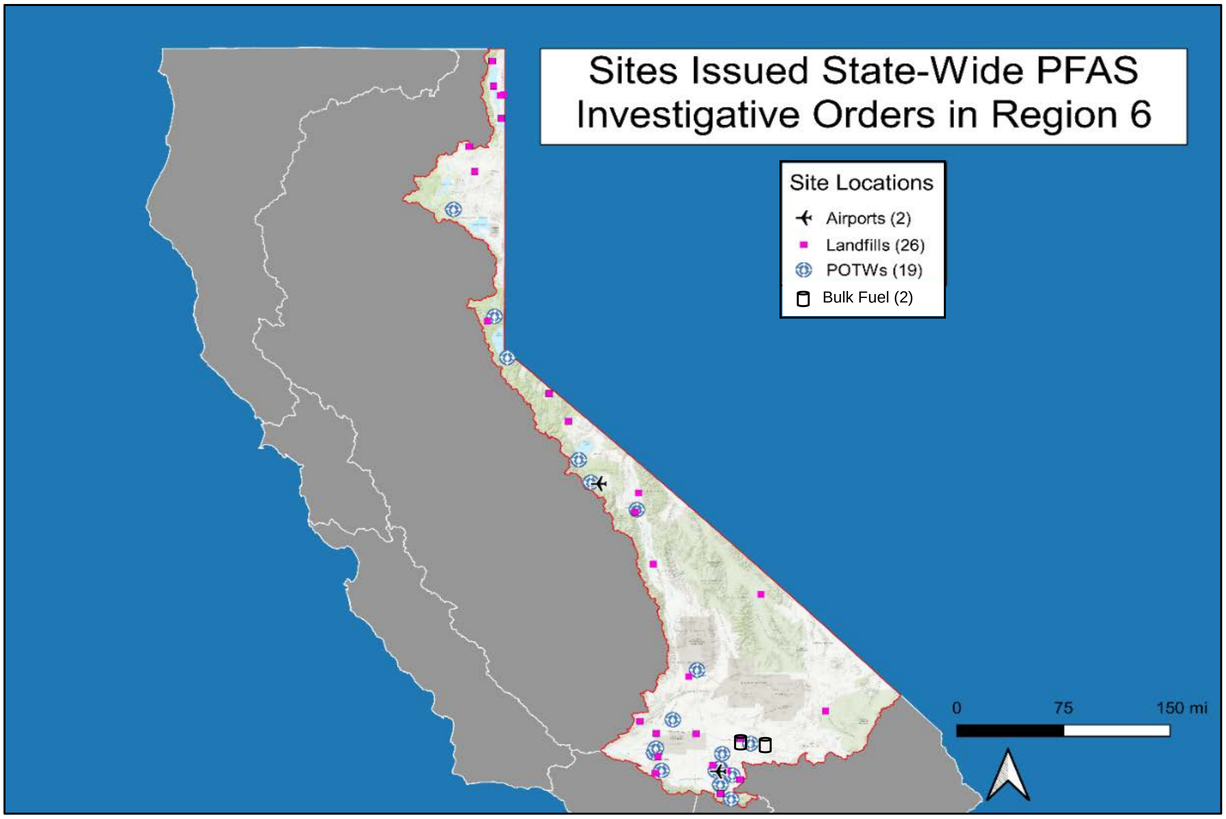

Figure 2. Map showing the distribution of facilities in Region 6 that were issued the PFAS Investigation Order by facility type.

The PFAS Investigative Order provided facility operators the option to submit documentation in support of not having to conduct a PFAS investigation. That documentation needed to indicate that they 1) have not discharged, disposed of, spilled, or released in any way, AFFF or other PFAS-containing materials to land at the facility, or 2) have already conducted sampling for PFAS constituents in compliance with the minimum requirements contained in the PFAS Investigation Order. For those facilities where documentation was provided, Regional Water Board staff were required to determine whether sufficient information supporting the response was received to justify not having to conduct a PFAS investigation at a given facility.

While the State Water Board is interested in all PFAS concentrations that exist in the environment, the focus of the PFAS Investigative Order was on 39 PFAS analytes including PFOA and PFOS. The PFAS Investigative Orders require dischargers to upload all documentation and analytical data in specific electronic formats to the state's GeoTracker database to facilitate data collection, data evaluation, and spatial distribution. State Water Board and Regional Water Board staff are evaluating the data that has already been collected in response to the PFAS Investigative Orders and as new data continues to be reported through GeoTracker. This data evaluation will be essential to making informed decisions in implementing appropriate regulatory action, in anticipation of emerging standards for PFAS.

Table 2 is a summary of the number and types of facilities that received the PFAS Investigative Order statewide and in Region 6 and lists the highest PFOA and PFOS concentrations detected in groundwaters of Region 6 by facility type. DOD facilities are included in Table 2, though these facilities were not issued PFAS Investigative Orders.

Table 2. Summary of PFAS Investigative Orders issued Statewide and in Region 6.

Facility Type	Number of Orders Statewide	Number of Orders Region 6	Highest PFOA detection in groundwater Region 6 (ng/L)	Highest PFOS detection in groundwater Region 6 (ng/L)
Landfills	196	26	190	8.7
Airports	30	2	2,200	2,600
Chrome Platers	271	0	NA	NA
Publicly Owned Treatment Works	256	17	480	1,200
Bulk Fuel Storage/ Refineries	162	2	ND	ND
Department of Defense[1]	NA	NA	2,300,000	5,700,000

NA – not applicable.
ND – no data, final report not yet summitted.

[1] DOD facilities were not issued PFAS Investigative Orders but implemented base wide PFAS investigations beginning in 2014 based on early concerns regarding PFAS-impacted supply wells on the east coast. The concentrations listed here are for China Lake Naval Air Weapons Station.

The DOD expanded its evaluation of PFOA and PFOS impacts to on-site and off-site water supply wells in May 2016. This action was in response to the USEPA Health Advisory, which recommends the individual or combined concentrations of PFOS and PFOA in drinking water be at or below 70 ng/L. Each DOD branch (i.e., Air Force, Navy, and Army) developed programs to investigate sources and migration of PFOA and PFOS at its facilities.

More detailed summaries of the PFAS investigations performed to date in Region 6 are provided in the sections that follow. Following these summaries, we look ahead at potential next steps and highlight some of the challenges that we may face as we advance our understanding of where and how much PFAS exists in the region.

2.1 Landfills

A total of 26 landfills in Region 6 were issued the PFAS Investigative Order in March 2019 (Figure 2). Staff coordinated with State Water Board on which facilities would receive the order with the criteria being landfills located within a 2-mile radius of a drinking water supply well. Not every landfill that met the criteria was selected, as investigative orders would likely be issued in phases so as not to put an undue financial burden on public entities that own/operate multiple landfills across multiple regions. Ultimately, Water Board staff selected a variety of regulated landfills from across our basins that included open (actively receiving waste) and closed (no longer receiving waste) landfills and lined and unlined units.

The PFAS Investigation Order requires landfills to sample and analyze both groundwater and landfill leachate from a select number of locations so as to be representative of all conditions at a facility. Of the 26 landfills that received the order in Region 6, only five are equipped with a leachate collection and recovery system from which a leachate sample could be obtained; the remaining 21 landfills will only collect groundwater samples. PFAS investigations have been completed for 20 of the landfills, with investigations pending for six landfills. Table 3 is a list of the landfills that received the PFAS Investigative Order and includes the highest detection of PFOA and PFOS in groundwater and in leachate. Water Board staff are currently evaluating the submitted data to determine if future investigations are necessary or if routine monitoring is warranted.

Table 3. Summary of Region 6 landfills that received the PFAS Investigative Order.

Landfill	Status	Basin	Groundwater[1] (ng/L)		Leachate[1,2] (ng/L)	
			PFOA	PFOS	PFOA	PFOS
Adelanto	Closed	South	5.2	1.5j	NA	NA
Antelope Valley[3]	Operating	South	7.9	5.1	140	27
Apple Valley	Closed	South	190	7.7	NA	NA
Baker	Closed	South	1.7j	ND	NA	NA
Bishop-Sunland	Operating	South	ND	ND	NA	NA
Boron	Operating	South	0.65j	ND	NA	NA
Bridgeport	Closed	South	6.1	0.52j	NA	NA
Cedarville East	Closed	North	NS	NS	NA	NA
Cedarville West	Closed	North	ND	ND	NA	NA
Chalfant	Closed	South	ND	ND	NA	NA
Eagleville	Closed	North	NS	NS	NA	NA
Eastern Regional	Closed	North	44	3.4	420	170
Fort Bidwell[4]	Closed	North	72	5.6	NA	NA
Furnace Creek	Closed	South	NS	NS	NA	NA
Hesperia	Closed	South	1j	0.64j	NA	NA
Independence	Operating	South	ND	ND	NA	NA
Lake City	Closed	North	NS	NS	NA	NA
Lancaster[3]	Operating	South	6.8	15	2,500	25
Lenwood-Hinkley	Closed	South	4.1	2.3	NA	NA
Madeline	Closed	North	NS	NS	NA	NA
Mojave-Rosamond	Operating	South	0.94j	0.56j	NA	NA
Ravendale	Closed	North	NS	NS	NA	NA
Ridgecrest	Operating	South	ND	ND	7.2	3.4
Tehachapi	Operating	South	0.44j	8.7	NA	NA
Victorville[3]	Operating	South	3.1	2.9	160	2.7
Walker	Operating	South	0.57j	ND	NA	NA

ND – not detected above the method detection limit.

NA – not applicable, no leachate collection system from which to sample.
NS – not sampled, work plans still under development or not yet implemented.
j – Trace value, concentration above method detection limit but below reporting limit.
[1] Highest PFOA and PFAS detections.
[2] Only four landfills equipped to collect leachate sample.
[3] Landfill has lined and unlined units.
[4] Sample may not be representative of groundwater; new monitoring well to be installed and will be sampled for PFAS.

2.1.1 PFAS Results of an Unlined Closed Landfill vs. a Lined Active Landfill

This section highlights in more detail the results of the PFAS investigation for an unlined closed landfill and a lined active landfill. Of all landfills that received the PFAS Investigative Order in Region 6, Apple Valley Class III Landfill (Apple Valley Sanitary Landfill [AVSL]; see Figure 3) had the highest concentrations of PFAS detected in groundwater. The AVSL consists of a 40-acre unlined landfill (a portion is a former burn dump), a 1-acre septage pond to the north, and a 5-acre septage pond to the southeast. The landfill received waste from 1964 to 1997 and was officially closed in 2007. The septage ponds have been clean closed. The landfill sits atop a geologic ridge and groundwater flow is bifurcated to the north and the south (Figure 3); there are known releases of landfill- and septage-related constituents in both the north and south flow regimes. Two wells in each flow regime were selected to be sampled for PFAS, including background well AVSL-9 (Figure 3). In background well AVSL-9, PFOS was detected in groundwater at 2.1 ng/L; PFOA was not detected above the laboratory method detection limit. In groundwater of the northern flow regime, PFOS was detected at concentrations up to 3.4 ng/L and PFOA was detected at concentrations up to 8.6 ng/L. In groundwater of the southern flow regime, PFOS was detected at trace concentrations and PFOA was detected at concentrations up to 190 ng/L. In three of the four downgradient wells sampled (AVSL-4a, AVSL-6, and AVSL-7; see Figure 3), PFOA exceeded the California drinking water notification level (5.1 ng/L) and response level (10 ng/L). Additionally, well AVSL-4a exceeded the USEPA risk-based screening level of 40 ng/L for the combined total of PFOA and PFOS. PFOS was detected in groundwater with a maximum concentration of 7.7 ng/L in well AVSL-4a. No leachate sample was collected as part of the PFAS investigation because there is no leachate collection and recovery system installed at the AVSL. In both flow regimes, the wells nearest the landfill (AVSL-4a and AVSL-6) had the highest detections of PFOS and PFOA in comparison to downgradient wells. These data seem to indicate that the PFAS detected in groundwater at the AVSL likely came from the historical waste discharges at the site, but there is no clear indication as to which waste management unit (i.e., landfill, burn dump, or septage pond) the PFAS-containing wastes originated.

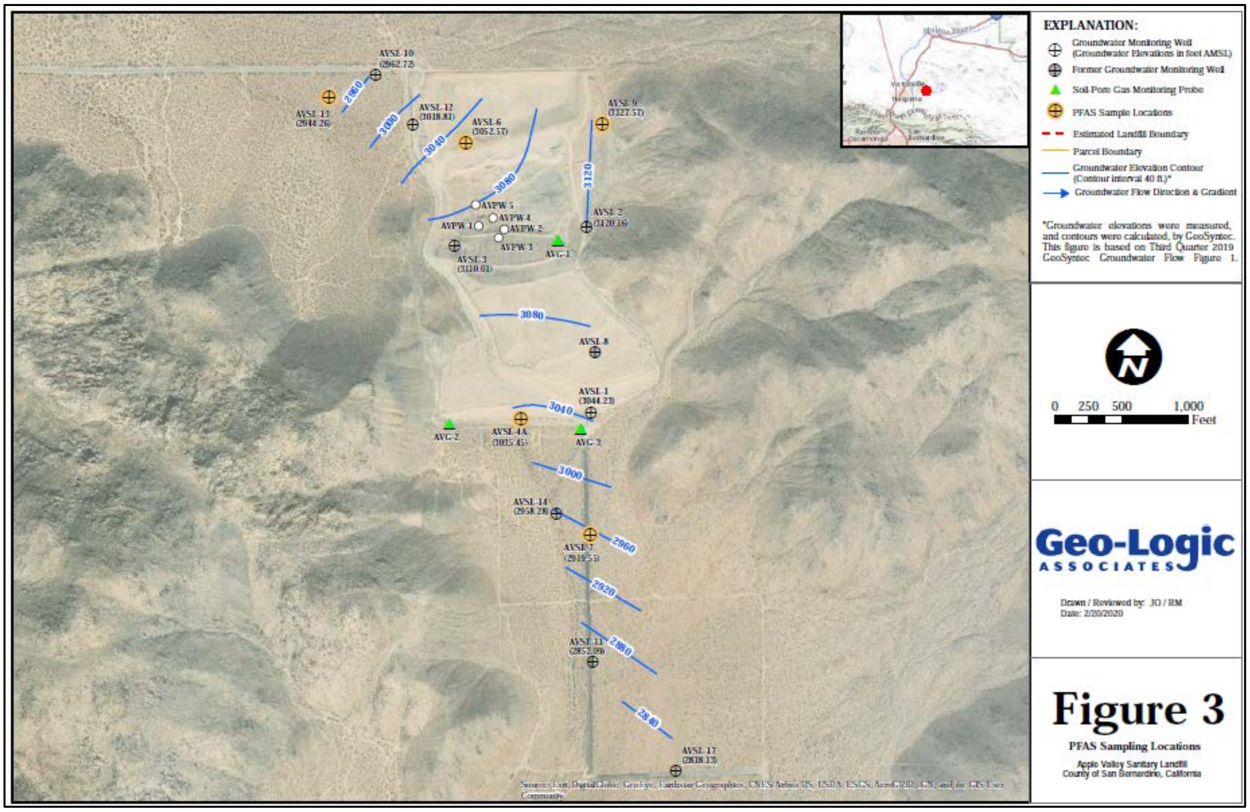

Figure 3. Map showing the Apple Valley Sanitary Landfill, groundwater monitoring well locations, and groundwater contours for the northern and southern flow regimes at this site.

The Victorville Class III Landfill is an active landfill located north of Victorville and shown in Figure 4. The landfill began as a burn and cover facility in 1955 and converted to a solid waste landfill in 1975. The site consists of an unlined landfill (inactive), 7 acres of unlined septage drying pads (clean closed in 2000), and active lined cells currently used for municipal solid waste disposal. In compliance with the PFAS Investigative Order, samples were collected from two upgradient wells (VSL-4 and BMWP-2), two downgradient wells (VSL-6 and VSL-12), and leachate was collected from the L-1A leachate storage tank. PFOS and PFOA were not detected in groundwater at concentrations that exceed their respective California drinking water notification and response levels. In the background wells, PFOS and PFOA were both detected at trace concentrations. In the downgradient wells, PFOS was detected at trace concentrations and PFOA was detected at concentrations ranging from 2.4 to 2.8 ng/L. PFOS and PFOA were detected in the sample collected from the leachate storage tank at concentrations of 2.7 ng/L and 160 ng/L, respectively. Similar to AVSL, these data seem to indicate that the PFAS detected in groundwater at the Victorville Landfill originated from the waste discharges at the site, but there is no clear indication as to whether the PFAS-containing wastes were discharged to the old unlined landfill, the closed septage drying pads, or are more recent wastes discharged to the lined landfill cells.

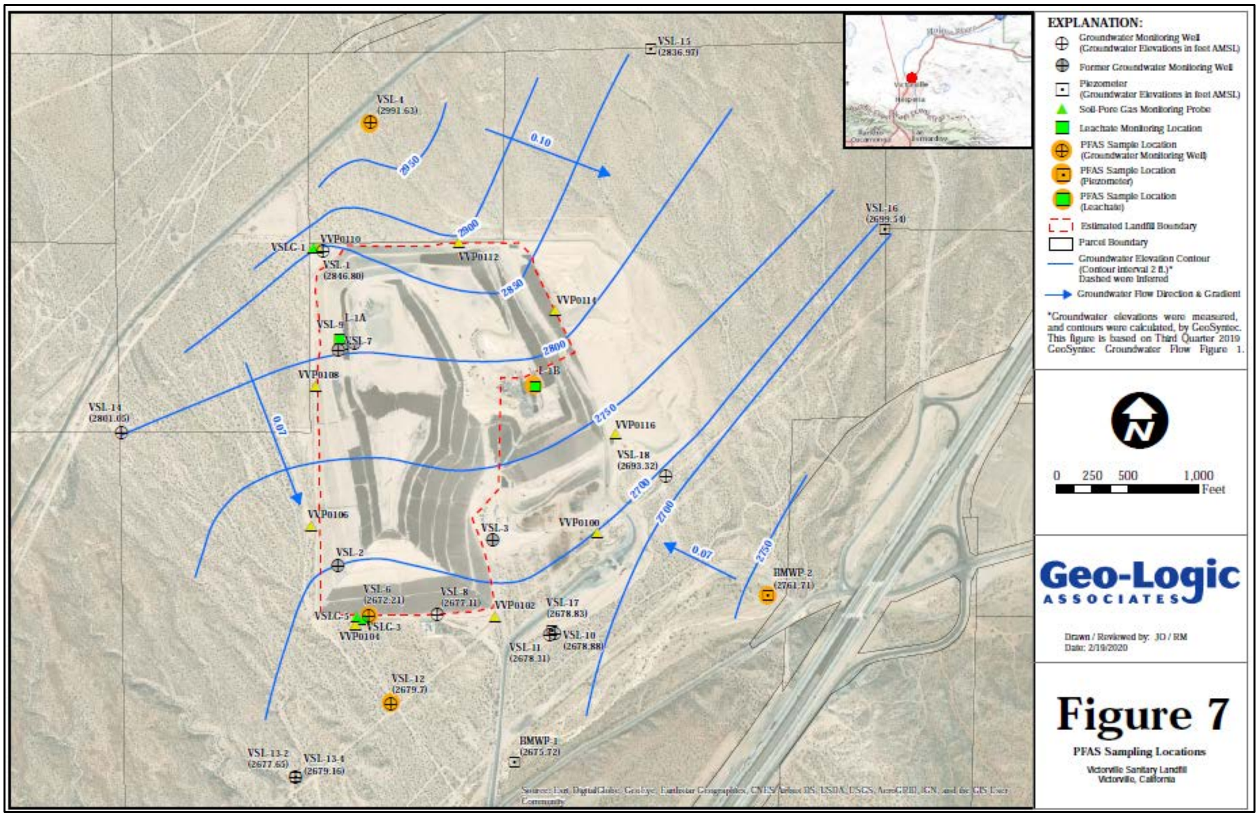

Figure 4. Map showing the Victorville Landfill, groundwater monitoring well locations, and groundwater contours.

2.2 Airports

Two airports in Region 6 were issued the PFAS Investigative Order in March 2019, the Mammoth-Yosemite Airport in Mammoth Lakes and the Southern California Logistic Airport (SCLA) in Victorville (Figure 2). The Mammoth-Yosemite Airport conducted a PFAS investigation in June 2020 and submitted the PFAS Final Report in August 2020. Mammoth-Yosemite Airport has complied with the requirements of the PFAS Investigative Order. SCLA submitted the PFAS Investigation Work Plan in January 2020 and it was reviewed and accepted by Water Board staff. SCLA then applied for Site Cleanup Sub Account Program (SCAP) funding through the Financial Assistance Application Submittal Tool seeking funding for the PFAS investigation, which had delayed implementation of the work plan. SCLA was informed mid-2021 that SCAP funding would not be awarded, and the City of Victorville subsequently secured other funding for the investigation and report. SCLA conducted the PFAS investigation in December 2021 and submitted the PFAS Final Report in March 2022.

The PFAS Investigative Order requires all airports to 1) identify potential PFAS source areas (e.g., material storage/use areas and probable release areas including crash sites, firefighting training areas, etc.), 2) collect representative soil samples to delineate surficial and subsurface extent of impacts in potential PFAS source areas, and 3) collect representative groundwater samples in proximity to the potential PFAS source areas. The Mammoth-Yosemite Airport identified two potential PFAS source areas and collected soil and groundwater samples from those areas, additional groundwater samples were collected from two supply wells located on the airport property. PFAS was detected in the soil and groundwater samples collected as part of the PFAS investigation. Seven PFAS constituents were detected in soil above laboratory reporting limits with the highest concentrations in soil detected in an area where annual firefighting systems testing occurs. PFOA was detected in soil at concentrations ranging from 0.64 ng/g to 1.9 ng/g; PFOS was not detected in any soil samples above laboratory reporting limits. Twelve PFAS constituents were detected in groundwater above laboratory reporting limits with the highest PFAS concentrations in groundwater detected in an area where AFFF is suspected to have been released. PFOA was detected in groundwater at concentrations ranging from 5.94 ng/L to 27 ng/L; PFOS was detected in groundwater at concentrations ranging from 4.4 ng/L to 16 ng/L. PFAS was not detected in either of the supply wells sampled. Grab or one-time groundwater samples were collected for the PFAS investigation. If it is determined that routine monitoring of PFAS in groundwater is necessary in the future, Mammoth-Yosemite Airport would need to install permanent groundwater monitoring wells.

SCLA identified four potential PFAS source areas and collected soil and groundwater samples from those areas. Two municipal water supply samples were also collected. PFAS was detected in the soil, groundwater, and the municipal supply samples collected as part of the PFAS investigation. Shallow (depth range between 0.5-foot to 5-feet below ground surface) and deep (depth range between 114 to 142-feet below ground surface) soil samples were collected. Fifteen PFAS constituents were detected in soil. PFOA was detected in soil at concentrations ranging from 0.051j ng/g to 46 ng/g; PFOS was detected in soil at concentrations ranging from 0.041j ng/g to 1,700 ng/g. Sixteen PFAS constituents were detected in groundwater. PFOA was detected in groundwater at concentrations ranging from 1.4 ng/L to 2,200 ng/L; PFOS was detected in groundwater at concentrations ranging from 1.1 ng/L to 2,600 ng/L. The highest concentrations of PFAS were reported from investigation Area 3; this area was identified for investigation due to a known release of AFFF through a storm drain, where the outfall discharges to a creek. It is estimated that approximately 476 gallons of AFFF were discharged at this location. Low levels of five PFAS constituents were detected in the municipal supply samples at concentrations that did not exceed any established levels. Staff are currently evaluating the results of the SCLA investigation, though additional investigation to fully delineate PFAS in soil and groundwater may be necessary in the future.

2.3 Publicly Owned Treatment Works

The State Water Board issued PFAS Investigative Orders to POTWs statewide in July 2020; this order applies to 17 facilities within Region 6 (Figure 2). The PFAS Investigative Order requires POTWs to perform quarterly sampling over a one-year period and is still in progress for some facilities. Sampling is required for the influent, effluent, groundwater, and biosolids at each facility for a list of 30 PFAS compounds, including PFOA and PFOS. Table 4 summarizes the sampling that has been reported for POTWs. The two Victor Valley Water Reclamation Authority (VVWRA) Subregional POTWs, Apple Valley and Hesperia, received an exemption from State Water Board to collect and report PFAS data because they were not yet operating and are not included in Table 4. To date, all facilities have uploaded some analytical results to the State Water Board's GeoTracker database, and some dischargers have provided final reports but not uploaded the required electronic analytical data. Water Board staff are working with dischargers to obtain compliance with submittal requirements.

Table 4. POTWs receiving the PFAS Investigative Order and whether PFOA or PFOS was detected in sampled media ("yes" or "no").

POTWs	Detected in Influent		Detected in Effluent		Detected in Groundwater		Detected in Biosolids	
	PFOA	PFOS	PFOA	PFOS	PFOA	PFOS	PFOA	PFOS
Adelanto	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Barstow	No	No	Yes	Yes	Yes	Yes	No	No
Bishop	No	No	Yes	No	Yes	Yes	NA	NA
California City	No	No	No	No	No	No	No	No
Helendale	Yes	No	Yes	Yes	Yes	Yes	No	Yes
June Lake	No	No	Yes	No	Yes	Yes	Yes	Yes
Lake Arrowhead	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Lancaster	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Palmdale	No	No	Yes	Yes	No	No	Yes	Yes
Mammoth Lakes	Yes	Yes	Yes	Yes	NA	NA	Yes	Yes
Ridgecrest	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rosamond	Yes	No	N/A	N/A	Yes	Yes	No	No
South Tahoe	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Susanville	No	No	Yes	Yes	NA	NA	No	Yes
Tahoe Truckee	No	No	Yes	Yes	Yes	Yes	Yes	No
Victorville	No	No	No	No	Yes	Yes	NA	NA
VVWRA – Regional Plant	No	No	Yes	Yes	Yes	Yes	Yes	Yes

NA – Data unavailable or data not submitted in required electronic format to GeoTracker.

A comparison between Region 6 POTW data to statewide POTW data for PFOA and PFOS constituents detected in influent, effluent, and groundwater is presented in Table 5. In general, Region 6 POTW data results are less than statewide POTW maximum concentrations.

Table 5. Highest PFOA and PFOS concentrations detected in POTW influent, effluent, and groundwater compared to statewide results.

PFAS Constituent	Region 6 POTWs (ng/L)			Statewide POTWs (as of February 2022) – Not Including Region 6 (ng/L)		
	Influent	Effluent	Groundwater	Influent	Effluent	Groundwater
PFOA	13	21	480	590	152	1,000
PFOS	7,000	270	1,200	672	2,420	750

Influent

The highest influent PFOA concentration detected was 13 ng/L at the Lake Arrowhead Community Services District's POTW (Table 5). Influent samples indicate that the highest PFOS concentration detected was 7,000 ng/L at the Ridgecrest POTW (Table 5), which receives influent from the China Lake Naval Air Weapons Station. This concentration exceeds the California drinking water notification level of 6.5 ng/L for PFOS. Despite these elevated concentrations, most of the influent sampling results were non-detect or below the California notification levels for both PFOA and PFOS.

Effluent

The highest effluent PFOA concentration was 21 ng/L at the Susanville Community Services District POTW (Table 5). Effluent samples indicate the highest PFOS concentration of 270 ng/L at the Ridgecrest POTW (Table 5). The detections observed were above the California notification levels. When comparing the influent and effluent sample results, there were occasions where PFOA and PFOS were detected in the treated effluent but not in the influent. This incongruency may be due to several factors including compound biotransformation within the wastewater treatment plant, different aliquots of water sampled, or compounds release from sludge retained within the treatment plant.

Groundwater

It should be noted that at 12 POTW facilities sampled in Region 6, the PFOA California response level of 10 ng/L was exceeded while 6 POTW facilities exceeded the PFOS California response level of 40 ng/L. However, PFOA and PFOS concentrations in groundwater did exceed the California response levels at 4 of the POTW facilities sampled.

The June Lake Public Utility District POTW and the City of Ridgecrest POTW were the two facilities with the highest PFOA and PFOS concentrations detected in groundwater. Groundwater sampled at the June Lake Public Utility District POTW indicate PFOA and PFOS concentrations of 480 ng/L and 750 ng/L, respectively. One possible source may be from wax containing PFAS chemicals used in the community to lubricate snow skis and snow boarding equipment. The City of Ridgecrest POTW reported the three highest PFOS concentrations in groundwater of all 17 facilities sampled (see Figure 5); PFOS concentrations of 1,200 ng/L (well 26S40E13D03), 980 ng/L (well 26S40E14B01), and

920 ng/L (duplicate sample of well 26S40E14B01) were reported. Historical industrial discharges from the China Lake Naval Air Weapons Station may have contributed to the elevated PFAS groundwater concentrations detected at the City of Ridgecrest POTW.

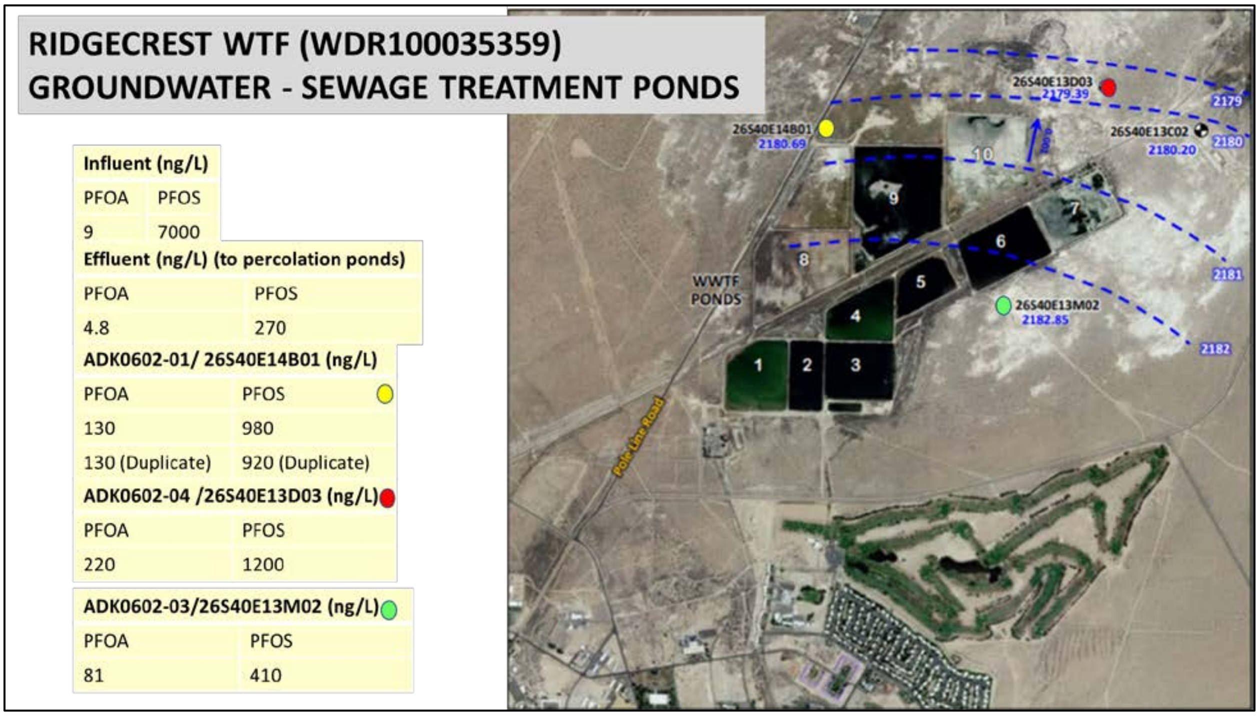

Figure 5. Map of the City of Ridgecrest POTW plant showing groundwater monitoring wells sampled for PFAS and their respective concentrations. A duplicate sample from well ADK0602-01/26S40E14B01 detected a concentration of 920 ng/L in addition to the original concentration of 980 ng/L.

Biosolids

The state of California has not established any human health risk or other regulatory criteria for PFAS constituents in soil or biosolids. No California-specific regulatory levels have been established for biosolids; however, the USEPA has established a human health screening level for soil of 1,260 ug/kg for both PFOA and PFOS. Where biosolids samples were collected at Region 6 POTWs, most results were non-detect or at very low concentrations for PFOA and PFOS. Table 6 compares Region 6 POTW biosolids data to statewide POTW biosolids data. The highest PFOA concentration detected in biosolids was at the Victor Valley Wastewater Reclamation Authority POTW with a detection of 25 ug/kg. The highest PFOS concentration in biosolids was found at the Ridgecrest POTW with a concentration of 41 ug/kg. None of the Region 6 biosolids sample results exceeded the USEPA human health screening level for soil and are magnitudes lower than the highest PFAS detections found in POTWs statewide.

Table 6. POTW highest PFOA and PFOS concentrations in biosolids compared to statewide results and USEPA screening levels.

PFAS Constituent	Biosolids		Soil
	Region 6 POTW (ug/kg)	Statewide POTW (ug/kg)	USEPA Human Health Screening Level (ug/kg)
PFOA	25	550	1,260
PFOS	41	900	1,260

2.4 Bulk Fuel Storage Facilities

Two bulk fuel storage facilities in Region 6 were issued the PFAS Investigative Order in March 2021: the Burlington Northern Santa Fe (BNSF) Railyard in Barstow and the Calnev Pipe Line Company (Kinder Morgan [Calnev]) facility in Daggett (Figure 2). The PFAS Investigative Order requires all bulk fuel storage facilities to 1) identify potential PFAS source areas (e.g., material storage/use areas and probable release areas, etc.), and 2) collect representative surface and subsurface soil, influent, effluent, groundwater, and/or stormwater samples in proximity to potential PFAS source areas. BNSF requested relief from the PFAS Investigative Order by providing documentation indicating that AFFF is no longer being used and has been replaced with a PFAS-free foam for the facility; and that there are no other PFAS-containing materials on site. As provided in BNSF's submitted documentation, historically, all AFFF substances have been stored on a paved impermeable surface, and there have been no reported spills or deployment of AFFF to the ground. Calnev submitted a preliminary PFAS work plan in September 2021 and proposes to conduct soil and groundwater sampling at three locations for each media. Water Board staff found that the information presented by BNSF supported the request to not perform a PFAS investigation, and issued a letter on January 12, 2022, stating that no investigation, sampling, or reporting under the PFAS Investigation Order was required. The Calnev preliminary PFAS work plan was accepted by Water Board staff in December 2021, field work is expected to have commenced and a final report is anticipated to be submitted in mid-2022.

2.5 Department of Defense

The DOD began using firefighting foams containing PFAS in the 1970s. Firefighting training is a frequent military activity, and a significant amount of PFAS foam along with firefighting water was used. The addition of water acts to flush the PFAS down to groundwater. Therefore, firefighting training areas are considered a significant potential threat to groundwater. Other potential sources for PFAS contamination at DOD facilities include landfills, wastewater treatment discharges, industrial buildings, industrial stormwater discharges, and aircraft crash sites.

In 2016, USEPA issued the advisory level for two PFAS chemicals, PFOA and PFOS. The USEPA advisory level is 70 ng/L for the combined total of PFOA and PFOS. DOD's first priority was to identify water supply wells that had been impacted by DOD sources at levels above the USEPA advisory level and provide replacement drinking water or treatment systems for the impacted wells. DOD is resistant to considering California's notification and response levels, which are more conservative than the USEPA advisory level.

For the evaluation and remediation of PFAS sources and their impacts to the environment (e.g., groundwater resources), DOD is following the CERCLA process as illustrated in Figure 6.

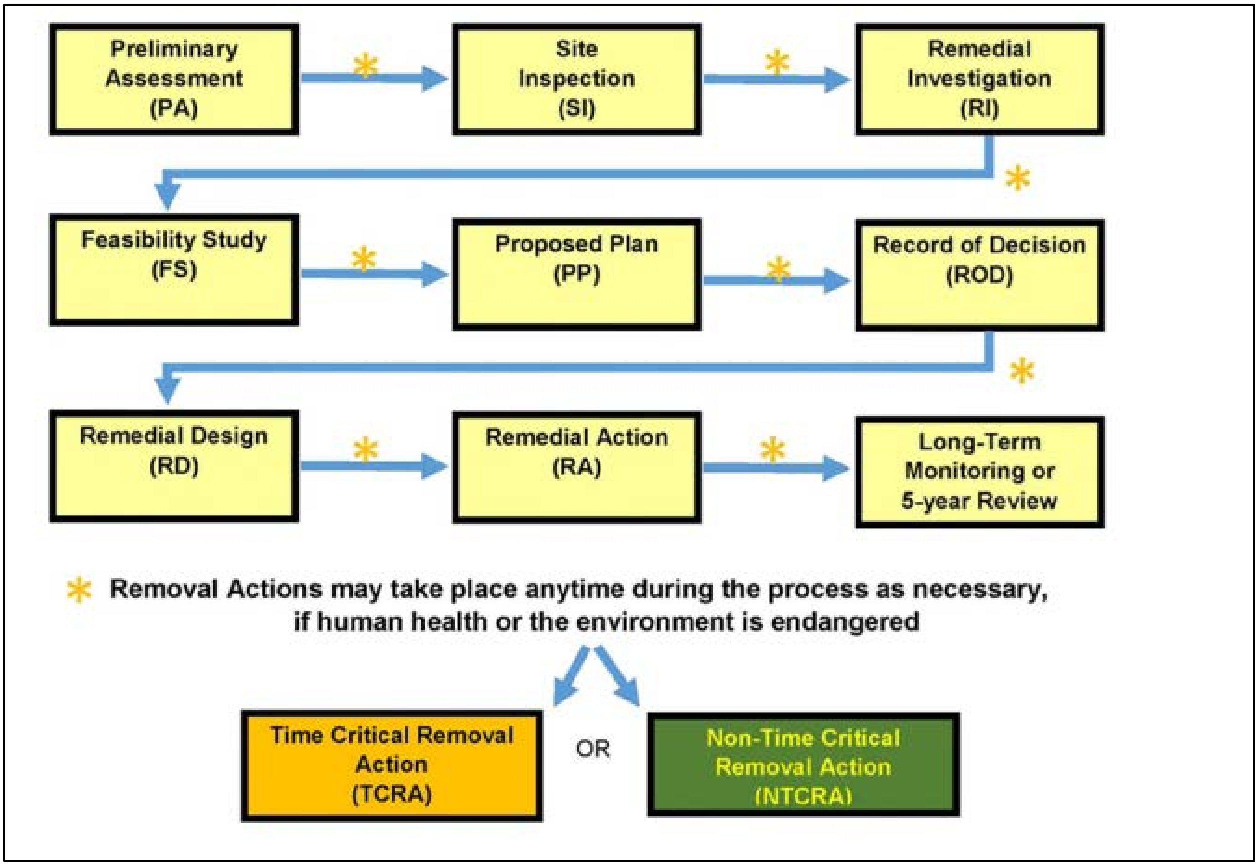

Figure 6. Diagram illustrating the CERCLA process DOD is following for their basewide PFAS investigations.

The various DOD branches (i.e., Air Force, Navy, Marine Corps [sites managed by the Navy], and Army) have initiated or are planning to initiate the investigative portions of the CERCLA process at their various facilities, as summarized in Table 7. However, DOD is generally resistant to initiate remediation until promulgated standards (i.e., MCLs) are in place. Because there is currently no promulgated MCLs for PFAS, remedial actions at DOD facilities may be delayed until the USEPA or the State adopts such standards.

Table 7. Summary of PFAS Investigations and Groundwater Impacts at DOD facilities, Region 6.

DOD Facility	Potential or Known PFAS Sources				Basewide Groundwater Impacts	
	Fire Training Areas	Landfills, Disposal Sites[1]	Wastewater Treatment Plants	Other[2]	Max Detected PFOS + PFOA[3] (ng/L)	Drinking Water Supply Well Impacts
Edwards Air Force Base						
# of Sites	5	4	1	11	110,000	No
Investigation	RI	NS	RI	RI		
Former George Air Force Base						
# of Sites	3	12	1	11	5,390	Yes, two offsite domestic wells[4]
Investigation	SI	NS	SI	SI		
Naval Air Weapons Station China Lake						
# of Sites	3	39	1	215	8,000,000	No
Investigation	SI/RI	NS	NS	PA		
Marine Corp Logistics Base Barstow						
# of Sites	5	4	8	15	1,531	Yes, two offsite domestic wells[4]
Investigation	SI/RI	SI/RI	SI/RI	SI/RI		
Air Force Plant 42						
# of Sites	5	0	1	13	18[5] 6,030[5]	No
Investigation	SI	NS	SI	SI		
Fort Irwin Army Base						
PA/SI process in planning stage					NS	No
Sierra Army Depot						
PA/SI process in planning stage					NS	Yes
Marine Corps Mountain Warfare Training Center						
PA/SI process in planning stage					NS	No

PA – preliminary assessment. SI – site inspection.
RI – remedial investigation. NS – not sampled or evaluated.

[1]Landfills and disposal sites are not DOD priority sites for PFAS investigations and have not been addressed at most facilities.

[2]Other sites include fire stations, hangars, burned areas, aircraft crash sites, industrial wastewater discharge areas, and miscellaneous sites.

[3]USEPA Drinking Water Health Advisory level for combined PFOS + PFOA = 70 ng/L.

[4]Off-base, private properties with domestic wells are either unoccupied or not using the wells for drinking water.

[5]Maximum PFAS detected in Air Force Plant 42 monitoring well is 18 ng/L. PFAS were detected in onsite industrial supply wells used for fire suppression at a maximum concentration of 6,030 ng/L in 2018. Air Force Plant 42 reported in 2020 that no PFAS was detected in fire suppression wells. Air Force Plant 42 stated that detections in fire suppression wells may be the result of contamination from a faulty fire suppression system that mixes fire suppressants with water from industrial wells. Further investigation into these detections is needed while the Air Force continues to monitor these wells.

3 Development of a Region 6 PFAS Strategy

The State Water Board and Regional Water Boards are in the process of evaluating data from the PFAS Investigative Orders. As we evaluate the data from facilities within the Lahontan region, we are looking for trends and commonalities in the data and site characteristics to help draw conclusions as to why PFAS is or is not detected in a particular media (i.e., soil, groundwater, wastewater, etc.) and the mechanism(s) by which PFAS was mobilized in the environment. Some of the factors being considered include data and geospatial trends, types of wastes discharged and industry-specific trends, cases of known soil and groundwater pollution, proximity to other PFAS sources offsite, and relationships between historic and current discharges, among others.

Unfortunately, State Water Board program staff have indicated that they do not anticipate additional statewide PFAS Investigative Orders to be issued and that any future PFAS investigations would likely be led by individual Regional Water Boards. To that end, it is staff's recommendation that we develop a region-specific PFAS Strategy and be at the ready to implement plans and require groundwater cleanup once drinking water standards and other media standards are adopted. A PFAS Strategy would be consistent with our Strategic Narrative and support the following Regional Goals: protect human health and aquatic life (Goal 1); protect/improve aquatic resources and water quality (Goal 2); and provide exceptional customer service, while being realistic about resources and commitments (Goal 4). Additionally, the development of a PFAS Strategy would be a regionwide effort, amongst staff with various expertise, and support Regional Goal 3, which is to promote a safe and inclusive working environment. Components of a region-specific PFAS Strategy may include the following.

1. Develop criteria and prioritize through a phased approach, for one-time PFAS investigations at select sites for core regulatory programs, to get a better sense of where PFAS occurs in the region.

2. Require sites with PFAS detections to implement routine monitoring at a regular frequency (i.e., quarterly, semi-annually, annually, or other specified frequency) through issuance of an Investigative Order, revised or amended Monitoring and Reporting Program, or through Executive Officer letter/request.

3. Develop criteria for enrollment in Site Cleanup and Cost Recovery programs.

4. Establish a PFAS team to continue data analyses as information and additional data are received.

5. Develop and implement an internal training program for technical staff in anticipation of establishment of water quality standards.

6. Consider requiring a pre-treatment program for select POTWs (i.e., Ridgecrest) where PFAS have been detected at elevated concentrations.

7. Monitor supply well data using the GeoTracker PFAS Map tool (https://geotracker.waterboards.ca.gov/map/pfas_map) to monitor PFAS concentrations in supply wells and work cooperatively with DDW if supply wells have detectable concentrations of PFAS above the then current applicable water quality screening criteria.

8. For DOD, continue working through the CERCLA process as PFAS funding becomes available to facilities to delineate impacts to groundwater and to ensure appropriate response actions are taken.

4 Looking Ahead

Looking ahead, OEHHA and DDW are currently working towards PFOA and PFOS drinking water standards. As stated previously, the drinking water PHGs proposed by OEHHA for PFOA (0.007 ng/L) and for PFOS (1 ng/L) are now in a public comment period that will be followed by an external independent scientific peer-review and another public comment period. OEHHA must establish final PHGs for PFOA and PFOS before DDW can consider development of a regulatory MCL.

One outcome from the statewide PFAS Investigation Orders is that seven additional PFAS chemicals were detected in groundwater, and DDW has requested that OEHHA develop notification levels for these PFAS chemicals. The seven additional PFAS chemicals are:

- perfluorohexane sulfonic acid (PFHxS);
- perfluorobutane sulfonic acid (PFBS);
- perfluorohexanoic acid (PFHxA);
- perfluoroheptanoic acid (PFHpA);
- perfluorononanoic acid (PFNA);
- perfluorodecanoic acid (PFDA); and
- 4,8-dioxia-3H-perflourononanoic acid (ADONA).

In March 2021, at the recommendation of OEHHA, DDW set the Notification Level for PFBS in drinking water at 0.5 µg/L. As additional PFAS data become available, DDW may request OEHHA develop notification levels for additional PFAS chemicals. At the State Water Board’s request, OEHHA is also evaluating whether some of the PFAS chemicals should be grouped together when being considered in a regulatory manor and if it is possible to consider them in subclasses based on specific characteristics or features of the chemicals.

In October 2021, the USEPA PFAS Action Plan, was replaced by the USEPA PFAS Strategic Roadmap. The PFAS Strategic Roadmap builds on and accelerates implementation of policy actions identified in the previous action plan. USEPA staff are in the early scoping stages of a risk assessment for PFOA and PFOS in biosolids. A completed draft of the risk assessment for internal review is expected in 2022, with a public comment period to follow. The USEPA PFAS Strategic Roadmap also includes developing new analytical methods and tools for understanding and managing PFAS risk, developing groundwater cleanup recommendations for PFOA and PFOS at contaminated sites, and promulgating Significant New Use Rules (SNURs) that require USEPA notification before chemicals are used in new ways that may create human health and ecological concerns.

Additional informational resources include the State Water Board PFAS webpage which provides a general background on PFAS, information on where PFAS data are being collected across the state, and links to other state entities implementing efforts on PFAS. Information regarding the fate and transport of PFAS in the environment is available through the Interstate Technology Regulatory Council. The USEPA PFAS Strategic Roadmap and associated resources are also available online.

5 Challenges

There are several challenges to consider as we learn more about where and at what concentrations PFAS exists in the region and the risks these constituents pose to human health and the environment. Here are some of the challenges that we anticipate.

1. The current lack of established MCLs, risk-based regulatory concentrations, approved treatment methods, and promulgated criteria. This is a challenge for our DOD program as the military is unwilling to allocate funds for cleanup without promulgated criteria established.

2. Rapidly advancing understanding of complex exposure pathways and PFAS fate and transport in the environment. For example, it appears that PFAS may transform from one chemical to another as it moves through the wastewater treatment processes making it difficult to track in the environment.

3. Rapidly evolving science, laboratory analytical methods, and regulations. These are often complicated and costly.

4. Managing highly impacted PFAS areas. Determining who is the responsible party or identifying potentially multiple responsible parties.

5. Funding considerations associated with the expense of PFAS sampling, laboratory analyses, and treatment. To be consistent with Regional Goal 4, we need to implement clear and consistent requirements and avoid actions that place unnecessary burden on public resources or dischargers.

6. Resource limitations associated with core regulatory programs that are impacted and underfunded will require us to maintain alignment with our Strategic Narrative and prioritize work efforts.

6 References

Hepburn, E., Madden, C., Szabo, D., Coggan, T.L., Clarke, B., and Currell, M., "Contamination of groundwater with per- and polyfluoroalkyl substances (PFAS) from legacy landfills in an urban re-development precinct," Environ. Pollut., vol. 248, pp. 101–113, May 2019.

Sunderland, E.M., Hu, X.C., Dassuncao, C., Tokranov, A.K., Wagner, C.C., and Allen, J.G., "A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects," J. Expo. Sci. Environ. Epidemiol., vol. 29, no. 2, pp. 131–147, March 2019.