

ENGINEERING EVALUATION AND COST ANALYSIS NON-TIME CRITICAL REMOVAL ACTION SECURITY WATER DISTRICT, CO

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NON-TIME CRITICAL REMOVAL ACTION
SECURITY WATER DISTRICT, CO**

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFFF	aqueous film-forming foam
AM	action memorandum
ARAR	applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, 42 USC §§ 9601-9675
CFR	Code of Federal Regulations
DERP	Defense Environmental Restoration Program, 10 USC §§ 2701-2711
District	Security Water District
DoD	(U.S.) Department of Defense
DoDI 4715.01	Department of Defense Instruction 4715.07, <i>Defense Environmental Restoration Program (DERP)</i> , May 21, 2013
DoDM 4715.20	Department of Defense Manual 4715.20, <i>Defense Environmental Restoration Program (DERP) Management</i> , March 9, 2012
EE/CA	engineering evaluation and cost analysis
EO 12580	Executive Order 12580, <i>Superfund Implementation</i> , January 23, 1987
EPA	(U.S.) Environmental Protection Agency
GAC	granular activated carbon
LHA	lifetime health advisory
mgd	million gallons per day
µg/L	microgram per liter
N/A	not applicable
NCP	National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300
NTCRA	non-time critical removal action
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonic acid
ppt	parts per trillion
RAO	removal action objective
SARA	Superfund Amendments and Reauthorization Act, Public Law 99-499 (1986)
TBC	to be considered

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

TCRA	time critical removal action
USAF	U.S. Air Force
USC	U.S. Code

EXECUTIVE SUMMARY

The U.S. Air Force (USAF) will conduct a non-time critical removal action (NTCRA) to address the probable releases from USAF activities of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) that contaminated the groundwater used as a drinking water source by the Security Water District (District), Colorado. Current PFOS and PFOA concentrations exceed U.S. Environmental Protection Agency (EPA) lifetime health advisory (LHA) action levels, thereby precluding the District from using its groundwater as a source of drinking water. This engineering evaluation and cost analysis (EE/CA) identifies and evaluates proposed alternatives for completing the NTCRA. The EE/CA identifies removal action objectives (RAOs); identifies and evaluates potential alternatives for conducting the removal action; and recommends the best-suited removal action alternative. This proposed action will protect human health from exposure to PFOS and PFOA in the groundwater in excess of the EPA LHA action levels, enabling the District to resume use of its supply wells.

The District supplies drinking water to approximately 19,000 customers. Until 2016, the District obtained its water from a combination of groundwater and surface water sources. In 2013, at EPA's request, the District, along with other municipal water suppliers across the nation, analyzed its water supply for perfluorinated compounds, which includes PFOS and PFOA. EPA periodically requires public drinking water systems that serve more than 10,000 people to sample for selected contaminants of emerging concern and uses the information to regulate contaminants in the future under the federal Safe Drinking Water Act. In early 2016, the District learned that PFOS and PFOA concentrations from four groundwater sources were greater than the EPA's provisional HA action levels. Three of the groundwater sources were individual wells, and the fourth was a blend of groundwater from four wells. At that time, the District was blending the groundwater with surface water such that the PFOS and PFOA concentrations supplied to its customers were less than the provisional HA action levels. To ensure that the blended concentrations did not exceed these levels, the District shut down the seven wells. EPA health advisories are not enforceable and are not regulatory standards. Instead, they provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. The provisional HA action levels for PFOS and PFOA were 0.2 micrograms per liter ($\mu\text{g/L}$) and 0.4 $\mu\text{g/L}$, respectively.

In May 2016, the EPA issued LHA action levels of 0.07 $\mu\text{g/L}$, which is equal to 70 parts per trillion (ppt), for PFOS and PFOA individually and combined, which is much lower than the provisional HA values. The PFOS/PFOA concentrations in all water supply wells were greater than these new, more stringent, action levels. To ensure that its customers were not exposed to water with PFOS/PFOA concentrations greater than the 2016 LHA action levels, the District ceased use of all groundwater supply wells. Currently, the District obtains all of its drinking water from surface water sources outside the District.

The scope of this removal action is to enable the District to resume use of its existing drinking water supply wells by decreasing PFOS and PFOA concentrations in water withdrawn through the District's wells to less than EPA's 2016 LHA action levels. These action levels are the removal action criteria. The RAO is to prevent exposure of the District's drinking water system users to

groundwater which contains PFOS and PFOA concentrations that, individually or in combination, exceed the removal action criteria.

The following alternatives for achieving the RAO and removal action criterion were evaluated:

- No action alternative. With this alternative, the District would continue to procure water from surface water sources, including increased deliveries from Pueblo Reservoir through the Fountain Valley Authority, Southern Delivery System and from Colorado Springs Utilities. This alternative includes annual renewal of the environmental services agreement between the USAF and the District. This alternative was evaluated to provide a baseline against which to compare the other alternatives.
- Continue to purchase water until a treatment system is installed to treat the water from the supply wells with granular activated carbon (GAC) to remove both PFOS and PFOA.
- Continue to purchase water until a treatment system is installed to treat the water from the supply wells with ion exchange resin to remove both PFOS and PFOA.

The three removal action alternatives were evaluated with respect to effectiveness, implementability, and cost. Alternative 1, no action, has the lowest degree of effectiveness and implementability. Depending on the number of years for which the environmental services agreement is renewed, alternative 1 could be the most expensive alternative. Alternatives 2 and 3 could both be readily implemented once the District provides the required real estate interests needed to implement the alternatives. Alternative 3 might be easier to operate because it would require less frequent changeouts of the treatment medium than Alternative 2. Alternative 3 would cost less than alternative 2. Based on cost, alternative 3 is the recommended removal action alternative.

ENGINEERING EVALUATION AND COST ANALYSIS NON-TIME CRITICAL REMOVAL ACTION SECURITY WATER DISTRICT, CO

1.0 INTRODUCTION

1.1 PURPOSE AND OBJECTIVE

The U.S. Air Force (USAF) will conduct a non-time critical removal action (NTCRA) to address the probable releases from USAF activities of two pollutants or contaminants into the environment that caused perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) levels in the groundwater that Security Water District (District), Colorado uses as a drinking water source to exceed U.S. Environmental Protection Agency (EPA) lifetime health advisory (LHA) action levels. This engineering evaluation and cost analysis (EE/CA) identifies and evaluates proposed alternatives for completing the NTCRA to remove PFOA and PFOS from groundwater extracted for drinking water use. The EE/CA identifies removal action objectives (RAO); identifies and evaluates potential alternatives for conducting the removal action; and recommends the best-suited removal action alternative. This proposed action will protect human health from exposure to PFOS and PFOA in the groundwater in excess of the EPA LHA action levels, enabling the District to resume use of its supply wells.

The U.S. Department of Defense (DoD) has the authority to undertake this removal action pursuant to Sections 104 and 120 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S. Code (USC) §§ 9604, 9620; Section 2701 of the Defense Environmental Restoration Program (DERP), 10 USC § 2701; Section 300.415 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) § 300.415; Executive Order (EO) 12580, as amended; and EPA, DoD, and USAF guidance. This EE/CA was prepared for Peterson Air Force Base (AFB), the Air Force Civil Engineer Center, and the U.S. Army Corps of Engineers, Omaha District, under Contract Number W9128F-16-D-0044, Delivery Order W9128F18F0028, in accordance with the *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA, 1993).

1.2 STATUTORY FRAMEWORK

CERCLA and the NCP provide authority for the lead Federal agency to take action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release of a pollutant or contaminant the agency determines poses an imminent and substantial danger to public health or welfare, and the lead Federal agency determines that such action is appropriate based on consideration of several factors, to include actual or potential exposure to nearby human populations, and actual or potential contamination of potential drinking water supplies. EPA has categorized removal actions in three ways (emergency, time-critical, and non-time critical) based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated. CERCLA and NCP define removal actions to include such actions as may necessarily be taken in the event of the threat of release of pollutants or contaminants into the environment, such action as may be necessary to monitor,

assess, and evaluate the release or threat of release, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release.

Removal actions are usually interim measures that, to the extent practicable, must contribute to the efficient performance of any anticipated, long-term remedial action. One example of a removal action listed in 40 CFR 300.415(e) is provision of an alternate water supply until a permanent remedy can be implemented. With respect to the PFOS/PFOA contamination in the District, one potential removal action is to remove the PFOS and PFOA from the groundwater after it is extracted but before it enters the District's distribution system; whereas a potential long-term remedial action may be to eliminate or contain contamination in the groundwater in situ.

USAF is the lead Federal agency for a removal action to address PFOS and PFOA contamination in drinking water that it determines is probably attributable, at least in part, to USAF activities and poses an imminent and substantial danger to public health or welfare (i.e., exceeds the EPA LHA action levels). As such, USAF has final approval authority, with state concurrence, over the recommended alternative and all public participation activities. This EE/CA complies with the requirements of CERCLA, the Superfund Amendments and Reauthorization Act (SARA), the NCP, DERP, and EO No. 12580. This removal action has been determined to be appropriate because factors under 40 CFR § 300.415(b)(2) apply, namely that there is actual contamination of drinking water supplies.

1.3 REPORT ORGANIZATION

The remainder of this EE/CA is organized in the following sections:

- Section 2.0 provides site characterization information such as site description, site investigation, and a streamlined risk assessment.
- Section 3.0 defines RAOs and discusses applicable or relevant and appropriate requirements (ARAR) for the proposed removal action.
- Section 4.0 presents the identification and analysis of removal action alternatives.
- Section 5.0 provides a comparative analysis of removal action alternatives.
- Section 6.0 identifies the recommended removal action alternative.
- Section 7.0 provides references used in preparation of this report.

2.0 SITE CHARACTERIZATION

2.1 SITE DESCRIPTION AND BACKGROUND

The site consists of groundwater contamination reported in water supply wells in the District, Colorado. Security, Colorado, is a census-designated place located in El Paso County adjacent to the city of Colorado Springs (Figure 2.1). The District supplies drinking water to approximately 19,000 customers. The District has 24 supply wells. Twenty-one wells are located along Route 85-87. Three wells are located southwest of the municipal airport near the French Elementary School. The District has historically obtained surface water from the Fountain Valley Authority, which operates a municipal water supply project that is facilitated by the United States Bureau of Reclamation Fryingpan-Arkansas Project. Delivery of treated water to the project commenced in the early 1980s. The District is also an owner-participant in the Southern Delivery System, which is a regional water supply project with the city of Colorado Springs, the city of Fountain, and the Pueblo West Metropolitan District. The Southern Delivery System commenced deliveries to the partners in April 2016. The District initiated a short-term water supply contract with Colorado Springs Utilities in May 2017 to replace the use of groundwater. Surface water from the Fountain Valley Authority and the Southern Delivery System is currently obtained from Pueblo Reservoir.

Until 2016, the District obtained its water from a combination of groundwater and surface water sources. In 2014, at EPA's request, the District, along with other municipal water suppliers across the nation, analyzed its water supply for perfluorinated compounds, which includes PFOS and PFOA. EPA periodically requires public drinking water systems that serve more than 10,000 people to sample for selected contaminants of emerging concern and uses the information to regulate contaminants in the future under the federal Safe Drinking Water Act. In October 2015, EPA released the latest results from its national sampling program. Data indicated that samples from public water sources southeast of Colorado Springs near Fountain Creek and Windmill Gulch contained perfluorinated compounds. At that time, the EPA did not advise the District to take any action.

In early 2016, the District learned that PFOS and PFOA concentrations from four groundwater sources were greater than the EPA's provisional HA action levels. Three of the groundwater sources were individual wells, and the fourth was a blend of groundwater from four wells. At that time, the District was blending the groundwater with surface water such that the PFOS and PFOA concentrations supplied to its customers were less than the provisional HA action levels. To ensure that the blended concentrations did not exceed these levels, the District shut down the seven wells with PFOS and PFOA concentrations greater than the provisional HA action levels. EPA health advisories are not enforceable and are not regulatory standards. Instead, they provide technical information to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with drinking water contamination. The provisional HA action levels for PFOS and PFOA were 0.2 micrograms per liter ($\mu\text{g/L}$) and 0.4 $\mu\text{g/L}$, respectively.

In May 2016, the EPA issued LHA action levels of 0.07 $\mu\text{g/L}$, which is equal to 70 parts per trillion (ppt), for PFOS and PFOA individually and combined, which is much lower than the provisional values. The PFOS/PFOA concentrations in all water supply wells were greater than these new,

more stringent, LHA action levels. To ensure that its customers were not exposed to water with PFOS/PFOA concentrations greater than the 2016 LHA action levels, the District:

- Over a period of several months, stopped producing drinking water from all 24 of its wells.
- Fast tracked new water mainline extensions to supply all customers with surface water. The surface water supply is not contaminated with PFOS/PFOA or other perfluorinated compounds.
- Enacted voluntary, outdoor water restrictions during the summer.
- Installed additional infrastructure to allow the District to purchase surface water from Colorado Springs to make up for the water they could not draw from the closed wells.

Because groundwater is a less expensive water source than surface water, is necessary to meet long-term customer demands, and is a reliable source for managing peak use and drought conditions, it is important for the District to find a long-term solution that will allow it to resume use of groundwater. In addition, the District owns decreed water rights to the groundwater and senior replacement water that are too valuable of a public resource not to be able to use.

2.2 PREVIOUS REMOVAL ACTIONS

The USAF completed a preliminary assessment in 2016 to identify areas where PFOS and PFOA may have been used and released to the environment. These potential source areas were sampled during a site investigation completed in July 2017 (Aerostar SES, LLC, 2017).

In 2017, the USAF prepared an Action Memorandum (AM) for a time critical removal action (TCRA) for groundwater south of Peterson AFB that is contaminated with PFOS and PFOA, including the vicinity of the District. This TCRA included the following planned actions:

- Point-of-use water treatment devices for private well, single family residences.
- Whole-home carbon treatment system for impacted larger private well users (e.g., a small mobile home park and a small farm).
- Provide assistance to connect two non-residence locations with private wells to municipal water sources.
- One-time property transfer of granular activated carbon (GAC) systems to municipal water districts of Stratmoor Hills, Fountain, Security and Widefield.

The NTCRA being evaluated in this document is a follow-on to the TCRA, and all removal actions are part of the USAF's larger, long-term response action to the groundwater contamination.

2.3 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The District is downgradient of the Colorado Springs Municipal Airport, which, since 1942, has been used by DoD. In addition, the USAF provides the airport with emergency response support for crashes and fires. Peterson AFB abuts the northern, upgradient, border of the airport.

Aqueous film-forming foams (AFFF) were developed in the 1960s to extinguish petroleum fires. The USAF started using AFFF in 1970. Because of their ability to put out fires and suppress re-ignition, use of AFFFs became widespread at airports, both military and civilian. AFFF, which contains both PFOS and PFOA, would have been used during fire training exercises, during suppression of actual fires, and in fire suppression systems. These historical uses could have released AFFF to the ground surface at Peterson AFB and the municipal airport, where the AFFF could percolate through the soil to the underlying groundwater.

A preliminary assessment, completed in March 2016, identified six sites at Peterson AFB and one site on the municipal airport where AFFF could have been used and released to the environment. Soil and groundwater at these locations were sampled during the 2017 site investigation. At several monitoring wells, the combined PFOS and PFOA concentration exceeded the LHA action level (Aerostar SES, LLC, 2017). The investigated areas are upgradient of the District. Based on the presence of PFOS and PFOA contamination in groundwater at Peterson AFB and the location of the contamination relative to the District, it is likely that historical USAF operations at Peterson AFB are at least one source of the PFOA and PFOS contamination.

Other common sources of PFOS and PFOA include manufacturing facilities, areas where industrial waste was disposed of, municipal solid waste landfills, and wastewater treatment facilities (http://pfas-1.itreweb.org/wp-content/uploads/2017/11/pfas_fact_sheet_history_and_use_11_13_17.pdf).

2.4 ANALYTICAL DATA

In 2016 and 2017, water samples were collected from each of the 24 supply wells operated by the District and the samples were analyzed for perfluorinated compounds. The analytical results are shown in Table 2.1. The PFOS concentrations ranged from 40 ppt to 560 ppt, with an average concentration of 135 ppt. The PFOA results ranged from 29 ppt to 96 ppt, with an average concentration of 64 ppt. The combined PFOS and PFOA concentrations ranged from 100 ppt to 630 ppt, with an average combined concentration of 198 ppt. All combined PFOS and PFOA concentrations are greater than the EPA LHA action levels.

2.5 STREAMLINED RISK EVALUATION

As noted previously, in 2016 EPA published the current LHA action levels of 0.07 µg/L (70 ppt) for PFOS and PFOA individually, and 0.07 µg/L (70 ppt) for the two compounds in combination (EPA, 2016a and 2016b). The EPA used a two-step process, explained in the following paragraphs, to calculate the LHA action levels.

First, the EPA calculated the water concentration that a lactating woman could drink with no health effects. A lactating woman was used in this calculation because this individual represents a sensitive population (newborns can be exposed to PFOA and PFOS through breast milk) and, on a body weight basis, this individual also drinks more water than other adults. For these reasons, a lactating woman is the most conservative receptor for exposure to PFOS and PFOA through drinking water. The resulting safe concentration, called the drinking water equivalent level, is 0.37

µg/L (370 ppt). This concentration is protective of people who are exposed to PFOS and PFOA solely through drinking water.

Historically, PFOS and PFOA were used in many consumer goods, including carpets, stain-resistant upholstery, food packaging, non-stick cookware, textiles, and leather goods. Most manufacturing of PFOS in the United States was discontinued in 2002, and the phaseout of PFOA manufacturing began in 2006. The USAF is in the process of phasing out the use of AFFF containing PFOS and PFOA at Peterson AFB and nationwide. Because of the historical uses of PFOS and PFOA, these compounds are widespread throughout the environment and are found in many food products such as eggs, meat, milk, fish, and root vegetables. PFOS and PFOA have been measured in indoor dust. The primary routes by which people are exposed to PFOS and PFOA are food and indoor dust (EPA, 2016a and 2016b).

To account for the cumulative health effects of exposure to PFOS and PFOA from sources other than drinking water (e.g., food, indoor dust), EPA multiplied the drinking water equivalent level of 0.37 µg/L (370 ppt) by a relative source contribution factor of 20% (or 0.2). The resulting number is the LHA action levels of 0.07 µg/L (70 ppt).

As noted above, the combined PFOS and PFOA concentrations in the 2016 – 2017 water samples from the supply wells are greater than the LHA action levels. This comparison indicates the potential for adverse health effects for people using the District's groundwater not blended with surface water as a drinking water supply.

3.0 REMOVAL ACTION OBJECTIVES AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section identifies the statutory framework of removal actions and determines the removal scope based on RAOs, ARARs, and cleanup criteria.

3.1 STATUTORY FRAMEWORK

This removal action is performed pursuant to CERCLA and the NCP under the authority delegated by the Office of the President of the United States through EO 12580 as re-delegated. This order, as implemented through Department of Defense Instruction (DoDI) 4715.07 and Department of Defense Manual (DoDM) 4715.20 as amended, provides USAF with authorization to conduct removal actions. DERP provides funding to USAF for removal actions conducted under CERCLA. This removal action is non-time critical because the planning period from the time a removal action was determined to be necessary to the time when the removal action will be initiated is greater than 6 months. Because this is not a Superfund-lead site, the \$2 million and 12-month statutory limits for Superfund-financed removal actions pursuant to Section 104(c)(1) of CERCLA do not apply.

This EE/CA provides an analysis of three removal alternatives for the site and recommends a removal action alternative. This EE/CA complies with the requirements of CERCLA, SARA, NCP, DERP, and EO 12580. This EE/CA is undertaken pursuant to 40 CFR, Part 300.415(b)(4)(i). The requirements for this EE/CA and its mandated public comment period provide an opportunity for public input with regard to the cleanup process.

3.2 SCOPE OF THE REMOVAL ACTION

The scope of this removal action is to enable the District to provide drinking water to their customers by decreasing PFOS and PFOA concentrations in their system to below EPA's 2016 LHA action levels. A secondary objective is to allow the District to resume use of its existing drinking water supply wells to retain their water rights and to meet customer needs.

3.2.1 Removal Action Objectives

RAOs specify what the proposed removal action is expected to accomplish. In other words, they define the goals for the removal action. As such, RAOs are site-specific and are influenced by the nature and extent of chemical contamination, current and potentially threatened resources, and the potential for human and environmental exposure. Based on the scope of the removal action, which includes decreasing the PFOS and PFOA concentrations in the District's underground drinking water sources to less than the EPA LHA action levels, the following RAO was developed:

- Prevent exposure of District's drinking water system users to groundwater which contains PFOS and PFOA concentrations that, individually or in combination, exceed the EPA LHA action levels of 0.07 µg/L (70 ppt).

3.2.2 Applicable and Relevant or Appropriate Requirements

The USAF, as a matter of policy, has decided, consistent with DoD policy, to attain ARARs to the extent practicable considering the exigencies of the situation. "Applicable requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that specifically address hazardous substances, pollutants, contaminants, location, or other circumstances found at a CERCLA site (which for purposes of this EE/CA include District's underground drinking water sources). A Federal cleanup requirement that pertains to a CERCLA site is "applicable." State requirements associated with a site are not "applicable" unless they are more stringent than applicable Federal requirements. If a cleanup standard or requirement is not "applicable," then it is evaluated to determine whether it is "relevant and appropriate."

"Relevant and appropriate requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that, while not "applicable" to the response action to a hazardous substance, pollutant, contaminant, location, or other circumstance at a CERCLA site, address problems or situations similar to the circumstances at the CERCLA site and their use is well suited to the particular site. Only state standards that are more stringent than Federal requirements may be "applicable" or "relevant and appropriate."

The criteria for determining if a standard or requirement is "applicable" or "relevant and appropriate" are listed in 40 CFR § 300.400(g). They include:

- The purpose of both the requirement and the CERCLA action;
- The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site;
- The substances regulated by the requirement and the substances found at the CERCLA site;
- The actions or activities regulated by the requirement and the response action contemplated at the CERCLA site;
- Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site;
- The type of place regulated and the type of place affected by the release or CERCLA action;
- The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or proposed in the CERCLA action; and
- Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resources at the CERCLA site.

According to CERCLA ARARs guidance, a requirement may be "applicable" or "relevant and appropriate," but not both. ARARs must be identified on a site-specific basis and involve a two-part analysis: first, it must be determined whether a given requirement is applicable; then, if it is

not applicable, it must be determined whether it is both relevant and appropriate. When the analysis determines that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

Furthermore, only those state requirements or standards that are promulgated, identified by the state in a timely manner, and are more stringent than Federal requirements or standards may be "applicable" or "relevant and appropriate." In this context, "promulgated" means that the standards are of general applicability and are legally enforceable.

In addition to ARARs, advisories, criteria, or guidance may be identified as to be considered (TBC) material. These advisories, criteria, or guidance are developed by EPA, other federal agencies, or states and may be useful in developing the removal action. An example of a TBC item is the LHA action levels for PFOS and PFOA developed by EPA. TBC material complement ARARs but do not override them.

To constitute an ARAR, a requirement must be substantive. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Provisions of generally relevant Federal and state statutes and regulations determined to be procedural or non-environmental, including permit requirements, are not considered to be ARARs.

Pursuant to EPA guidance, ARARs are generally divided into three categories: chemical-, location-, and action-specific requirements:

- **Chemical-Specific ARARs** usually are either health- or risk-based methodologies or numerical values that limit the amount or concentration of a chemical that may remain in or be discharged to the environment. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.
- **Location-Specific ARARs** generally are requirements that limit concentrations of chemicals or restrict certain activities solely because of geographical or land use concerns. These requirements may limit the boundaries of the remedial action and may impose additional constraints on the cleanup action. For example, location-specific ARARs may restrict activities in the vicinity of wetlands, floodplains, sensitive ecosystems or habitats, or areas of historical or cultural significance.
- **Action-Specific ARARs** are requirements that apply to specific actions that may be associated with site cleanup. They usually are restrictions on the conduct of certain activities or the operation of certain technologies at a specific site. For example, acceptable handling, treatment, and disposal procedures for hazardous substances, and requirements for erosion and sediment control during construction of treatment system buildings.

Potential ARARs and TBC requirements for the removal action are presented in Table 3.1. Proposed removal action alternatives are evaluated with respect to compliance with ARARs. The identification of ARARs is an iterative process, and the final determination of ARARs will be made in the AM, which will be submitted after public review of this EE/CA as part of the selection

process for this response action. The AM is the primary Decision Document for NTCRAs and provides a concise, written record of the decision to select an appropriate removal action. It substantiates the need for a removal action, identifies the proposed action, and explains the rationale for the removal action selection.

3.3 REMOVAL ACTION CRITERIA

The removal action criteria are the contaminant concentrations that the removal action alternative must achieve. As noted in Table 3.1, there are no chemical-specific ARARs for PFOS and PFOA that can be used as criteria. In the absence of chemical-specific ARARs, the current EPA LHA action level of 0.07 µg/L (70 ppt) for the combined PFOS and PFOA concentration is the removal action criterion.

3.4 REMOVAL SCHEDULE

The removal schedule calls for completing the AM and advertising a contract to conduct the removal action in June 2018. Proposals would be evaluated and a contract awarded before the end of September 2018. The selected firm would then plan and construct the removal action and complete operational testing before December 2020 when the contract to purchase surface water from Colorado Springs Utilities expires. This schedule includes review and approval of the treatment system design documents and construction specifications by the Colorado Department of Public Health and Environment. If there is a delay in the process, a new agreement to provide treated surface water would have to be negotiated.

3.5 PLANNED REMEDIAL ACTIVITIES

At this time, specific remedial activities are not planned because investigation of the potential source area(s) is ongoing. Until the source(s) and migration pathways between the source(s) and District wells are characterized, potential remedial activities cannot be identified.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section identifies remedial technologies that could achieve the RAO, develops removal action alternatives based on these technologies, and evaluates each removal action alternative in terms of effectiveness, implementability, and cost. EPA guidance on NTCRAs (EPA, 1993) provides the following guidance about effectiveness, implementability, and cost:

- **Effectiveness:** An alternative's effectiveness is its ability to meet the objective within the scope of the removal action. This criterion considers protection of public health, the community, workers during implementation, and the environment; and compliance with ARARs. The following factors are also considered:
 - Long-term effectiveness and permanence: the extent and effectiveness of controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes.
 - Reduction of toxicity, mobility, or volume through treatment.
 - Short-term effectiveness, which addresses the effects of the alternative during implementation before the RAO has been met.
- **Implementability:** This criterion evaluates the technical and administrative feasibility of each alternative, and the availability of the services and materials needed to implement the alternative. This criterion also considers state and community acceptance. The acceptance of an alternative will be evaluated during the public comment period and preparation of the AM. The final version of this EE/CA will be made available for a 30-day public comment period, and all comments received will be summarized and addressed in the responsiveness summary section of the AM.
 - Technical feasibility: the ability of the technology to implement the remedy and the technology's reliability. Technical feasibility is evaluated from construction through operation and maintenance of the removal action. This factor also evaluates whether an alternative will contribute to the anticipated performance of any remedial activity.
 - Administrative feasibility: this factor evaluates those activities needed to coordinate with other offices and agencies, the need for permits, adherence to applicable non-environmental laws, and concerns of other regulatory agencies.
 - Availability of services and materials: this factor considers whether the requisite personnel, equipment, and materials will be available during the removal action schedule; the adequacy of off-site treatment capacity if the alternative includes off-site removal and treatment of waste; and whether the technology has been sufficiently developed for full-scale application.
- **Cost:** The direct and indirect capital, operation, and maintenance costs are estimated for each alternative. Costs are calculated on a present worth basis for any removal action lasting longer than 12 months.

4.1 POTENTIAL REMOVAL TECHNOLOGIES

Technologies for removing contaminants from groundwater can be divided into two broad categories: in situ (meaning the contaminants are treated in the ground), and ex situ (meaning the contaminants are treated in extracted groundwater). Currently, there are no viable technologies for in situ treatment of PFOS and PFOA. For this reason, only ex situ treatment of the extracted groundwater was considered.

There are three established technologies for the ex situ treatment of PFOS and PFOA: GAC, ion exchange, and reverse osmosis/membrane filtration. Other technologies, such as electrochemical degradation, are still being developed and thus are not yet suitable for full-scale implementation in a drinking water supply system. The three established technologies are described below.

4.1.1 Granular Activated Carbon

GAC is a well-established technology for the removal of chemicals from water. It consists of an adsorption medium made from a carbon source, such as coconut shells, bituminous coal, or lignite coal, which is activated using either heat or chemicals. The surface of the activated carbon has an affinity for hydrophobic molecules (the literal meaning of hydrophobic is “water-fearing;” hydrophobic chemicals do not mix well with water). PFOS and PFOA are both large molecules with a hydrophobic segment. The hydrophobic portion of PFOS and PFOA has an affinity for GAC. The GAC is placed in a large vessel or tank, and water is pumped through the vessel. As the water flows past the GAC, PFOS and PFOA adsorb to the GAC surface and are thereby removed from the water. With time, the adsorption sites on the GAC are filled with PFOS and PFOA molecules, and any other hydrophobic chemicals that the water contains, and the GAC no longer has the capacity to remove the contaminants. When this stage is reached, the spent GAC is removed from the vessel and replaced with fresh GAC. Because it is USAF policy to manage and dispose of PFOS and PFOA as a hazardous waste (even though neither chemical is a hazardous chemical under CERCLA), the spent GAC is incinerated to ensure the PFOS and PFOA molecules are destroyed.

GAC is not selective for PFOS and PFOA. In other words, the GAC will adsorb other chemicals from the water in addition to PFOS and PFOA. The potential for other chemicals to compete with PFOA and PFOS for the GAC’s adsorption sites is taken into account when designing a GAC treatment system. GAC is of a moderate cost to install, operate, and maintain, and the associated waste stream (i.e., spent GAC) is easy to manage and dispose of.

4.1.2 Ion Exchange

Ion exchange is a well-established technology for the removal of either positively-charged (cation exchange) or negatively-charged (anion exchange) chemicals from water. Both PFOS and PFOA have a negatively charged end that can associate with the anion exchange resin. Similar to GAC, a vessel or tank is filled with the ion exchange resin. As the contaminated water flows through the vessel, the anions in the groundwater, including PFOS and PFOA, associate with the resin. Once the exchange sites are filled, the resin can no longer remove PFOS and PFOA from the water, and the spent resin is replaced with fresh resin. Similar to GAC, the spent ion exchange resin is incinerated to ensure that the PFOS and PFOA molecules are completely destroyed.

The ion exchange resins used for PFOS and PFOA can also remove other anions from the groundwater. Nitrate and sulfate are examples of anions commonly found in groundwater that can be removed by these resins. The presence of other anions that can compete for the exchange sites on the resin is considered during design of an ion exchange system. Ion exchange is of a moderate cost to install, operate, and maintain; and it is easy to manage and dispose of the associated waste stream (i.e., spent resin).

4.1.3 Reverse Osmosis/Membrane Filtration

Reverse osmosis and membrane filtration use semipermeable membranes to filter chemicals out of water. Water is forced through the membrane at high pressure, and the membrane can block the passage of chemicals dissolved in the water. A portion of the influent water is retained by the membrane. This water, sometimes called the reject water, is concentrated with PFOS, PFOA, and natural constituents such as salts. The reject water must be treated and/or disposed of. Because of the PFOSPFOA and high salt concentrations, the reject water cannot be discharged to the wastewater treatment facility. Evaporating the reject water is estimated to require between 62 and 187 acres. It would be difficult to find sufficient open space in the District to evaporate the reject water.

This technology is energy intensive to operate and typically has high capital and operating costs. Because of the need to manage the reject water and the high costs, reverse osmosis/membrane filtration was not retained as a potential technology for the removal action.

4.2 POTENTIAL TREATMENT SYSTEM CONFIGURATIONS

To comply with the Widefield Aquifer Stipulation, which is a court approved/adjudicated agreement among all of the aquifer users, the District must draw water proportionally from different reaches within the aquifer. To achieve this proportional aquifer use, all of the District's wells must be available for active use. For this reason, an alternative that involves a combination of treatment for select wells with continued purchasing of surface water would not be feasible for the District to implement. To allow active use of each well, there are several potential treatment system configurations that could be implemented.

One option is to install a treatment unit at each of the 24 contaminated wells. For the following reasons, this approach would be difficult to implement:

- Each well must be surrounded by enough buildable land to house the treatment system. Even a temporary treatment system would require some type of protection against the weather, a firm base on which to install the equipment, and heat to prevent the lines from freezing during the winter. There also would need to be enough room at each well to modify the piping that connects the well to the distribution system.
- This approach would result in 24 individual treatment systems that require operation and maintenance and possibly redundancy. To prevent biofouling of either the GAC or IX resin, each system would need to be operated at least twice per week. The addition of a treatment system may also necessitate new pumps due to the pressure drop across the treatment system. These operating components and requirements increase the labor, and thus cost, needed to maintain the entire treatment system.

Other configurations include:

- One treatment system for all 24 wells. This system would be the simplest to operate because all equipment would be in a single location. This configuration, however, would require extensive changes to the current piping system to connect all 24 wells to a single facility.
- Two treatment systems, with a large system connected to the 21 wells along the Route 85-87 corridor and a small system connected to the three wells near the French Elementary School. This configuration would limit the changes to the piping system relative to the single treatment system.
- Three treatment systems, with two systems located near Route 85-87 and the third connected to the three wells near the French Elementary School. This configuration would minimize changes to the piping network but would increase the time required for an operator to operate and maintain all of the treatment facilities. In addition, capital costs for the treatment systems would be higher because of the need to install three structures with the associated mechanical and electrical systems than installing a single, large structure.

It would be possible to install four or more treatment systems with each connected to a limited number of nearby wells. These configurations, however, would encounter the same difficulties as those identified for 24 individual treatment systems. In addition, it would be less expensive to install a few, larger treatment systems than a multitude of smaller treatment systems.

In summary, installation of a treatment unit at each well head would be difficult to implement and would be more expensive than the other configurations. Configurations using one, two, or three treatment systems would be easier to implement and less expensive than configurations involving four or more treatment systems.

To support the cost estimate of each active treatment alternative, it is necessary to assume a system configuration. For the purposes of this EE/CA, a single treatment facility was assumed for each alternative involving active treatment of the groundwater. Because the specific configuration of the treatment system will not substantially affect the relative cost of GAC to IX (both technologies would have similar configurations), this approach can be used to compare the relative cost of the two alternatives.

4.3 REMOVAL ACTION ALTERNATIVES

Three removal action alternatives were developed:

- Alternative 1, no action. This alternative consists of not implementing a removal action and provides a baseline against which other alternatives can be compared.
- Alternative 2, ex situ treatment of the groundwater using GAC.
- Alternative 3, ex situ treatment of the groundwater using ion exchange.

Each alternative is described and evaluated below.

4.3.1 Alternative 1 – No Action

As noted above, the no action alternative consists of not implementing a removal action. With this alternative, the District would continue to obtain water from surface water sources and the groundwater supply wells would remain turned off. Although the District already has rights to surface water from Fountain Valley Authority and the Southern Delivery System, these rights are not sufficient to meet total water demand. The District can obtain 1.4 million gallons per day (mgd) from the Fountain Valley Authority and 0.83 mgd from the Southern Delivery System, for a total of 2.23 mgd. During the summer months, average demand can be as high 4.4 mgd and maximum demand as high as 7.56 mgd. Additional water can be obtained from the Southern Delivery System, but only when the capacity allocated to other users is available and at additional cost. Thus, the systems are not reliable for meeting total and peak day demands, managing drought conditions, or controlling costs.

In 2016, when the District turned off the groundwater wells, the shortfall in water supply was addressed by taking additional deliveries from Fountain Valley Authority, taking deliveries from the Southern Delivery System, and by obtaining surface water from the city of Colorado Springs. The contract for deliveries from Colorado Springs is a short-term agreement that expires at the end of 2018 but may be extended to 2020. Once the contract expires, the District would need to negotiate another contract with the city of Colorado Springs or find an alternate source of surface water to augment the supply from Fountain Valley Authority and the Southern Delivery System. Because of the potential for the surface water supply to be affected by drought, and the limitations of the pipeline delivery systems, there is uncertainty in the District's ability to rely solely on surface water to meet demand.

The USAF has entered into an environmental services agreement with the District to purchase up to \$4,316,000 in water over a one-year period that ends in April 2019. This agreement may be renewed by mutual agreement of the parties.

4.3.1.1 Effectiveness

By continuing to prevent exposure to PFOS and PFOA in the District groundwater through increased deliveries from Fountain Valley Authority and the Southern Delivery System, and by procurement of surface water from the city of Colorado Springs, the no action alternative would be temporarily protective of the public and the community. Because there is no direct or indirect pathway of contaminated groundwater to surface water, there is no risk to the environment under the status quo. This alternative would not affect workers in the short-term because no action would be taken.

This alternative would not trigger location-specific ARARs (e.g., Migratory Bird Treaty Act, National Historical Preservation Act, etc.) or action-specific ARARs. By preventing people from consuming the contaminated groundwater, maintenance of the status quo would achieve the RAO. The no action alternative would comply with ARARs.

As noted above, the District is currently addressing the shortfall in water supply by taking increased deliveries from Fountain Valley Authority and the Southern Delivery System, and by purchasing surface water from the city of Colorado Springs. This short-term agreement expires at

the end of 2018 but may be extended to 2020. Without an action to remove the PFOS and PFOA contamination from the District's groundwater, the District would need to extend this surface water agreement beyond 2020 or find another source of water to meet the demand that exceeds the water supplied by the Fountain Valley Authority and Southern Delivery System. The ability of the District to procure or transport an alternate water supply after 2020 is uncertain. There is no guarantee, particularly if there is a drought, that the city of Colorado Springs will have sufficient surface water resources to meet the District's needs. In addition, the Fountain Valley Authority and Southern Delivery System sources of water are not uninterruptible. For these reasons, the no action alternative is not an effective solution beyond 2020.

Because no treatment of groundwater would occur, the no action alternative would not reduce the toxicity, mobility, of volume of the contaminated groundwater.

4.3.1.2 Implementability

In the short-term, the no action alternative is readily implementable. No skilled labor, specialty equipment, or materials are needed to maintain the status quo. The District has a contract for the surface water supply in place. When this contract expires in either 2018 or 2020, it would be difficult for the District to find an alternate source of surface water to make up the difference between the water available through the Fountain Valley Authority and Southern Delivery System and the water demand. Beyond 2020, this alternative would be administratively difficult to implement and may not be feasible. In addition, by not removing or treating the contaminated groundwater, this alternative would not contribute to the long-term remediation of the plume.

4.3.1.3 Cost

Under the environmental services agreement, the USAF could pay up to \$4,316,000 over a one-year period that ends in April 2019 to purchase surface water for the District. This agreement may be renewed by mutual agreement of the parties. Regardless of which removal action alternative is implemented, the USAF will incur these costs into April 2019. After April 2019 or April 2020, if the agreement is renewed and a treatment system is not installed, the USAF could incur similar or even higher costs to purchase water for the District.

4.3.2 Alternative 2 – Ex Situ Treatment with Granular Activated Carbon

Alternative 2 consists of continuing to purchase surface water until a GAC treatment system to remove PFOS and PFOA from the groundwater before the water is pumped to the distribution system can be built, operated, and maintained. As described in Section 4.2, there are multiple ways to configure ex situ treatment of the groundwater. For the purposes of this EE/CA, a single treatment facility connected to all 24 wells was assumed. The specific configuration of a treatment system will be determined as part of the design.

The maximum flow for the treatment system dictates the size of each GAC vessel, the amount of GAC in each vessel, and the footprint of the treatment system building. Between 2014 and 2016, the maximum daily flow for the District's water supply system was 7.56 million gallons per day (mgd). To account for increased development within the District, this maximum flow was increased by 20% and the result, 9.07 mgd, was used as the target flow rate for the District's entire

water demand. Of this 9.07 mgd, 1.4 mgd is provided by the Fountain Valley Authority and 0.83 mgd is from the Southern Delivery System. Additionally, the district is contractually obligated to provide 1.54 mgd to two outside water suppliers at any time. The treatment system design capacity is therefore based on providing the future maximum daily demand plus contractual obligations for a total of 10.61 mgd with the possibility of the Fountain Valley Authority supply out of service. In this situation, 0.83 mgd would be supplied by the Southern Delivery System, and the remaining 9.78 mgd would be provided by the groundwater treatment system.

A typical configuration for GAC is for the water to flow through two GAC vessels in series: a lead vessel and a lag vessel. With this approach, the bulk of the contaminants are removed by the lead vessel, and the lag vessel acts as a polishing step. The contaminant concentrations between the lead and lag vessel are monitored to determine when the GAC in the lead vessel is spent and must be replaced. When the GAC in the lead vessel is spent, the lead vessel is taken offline, the spent GAC is removed, and fresh GAC is placed in the vessel. The vessel with the fresh GAC is used as the lag vessel for polishing, the previously used lag vessel becomes the lead vessel, and the process repeats when the new lead vessel requires GAC replacement. The conceptual design for this cost estimate uses six pairs of lead/lag vessels in parallel (meaning that the influent water is divided among the six pairs of lead/lag vessels), with a seventh pair of lead/lag vessels as backup in case one of the other pairs of vessels is offline for maintenance.

The operating and maintenance costs for a GAC system are driven primarily by the frequency at which the spent GAC must be replaced. To estimate the GAC changeout frequency, the average future daily demand of 3.11 mgd, less the 0.83 mgd from the Southern Delivery System, was used. Based on the average flow rate in the GAC treatment system of 2.28 mgd, it is estimated that the GAC in each lead vessel would need to be replaced once per 4.3 months. The spent GAC would be transported offsite for incineration.

4.3.2.1 Effectiveness

GAC can effectively decrease PFOS and PFOA concentrations in the District's groundwater to less than the LHA action levels. The Widefield Water and Sanitation District pilot-tested the use of GAC to remove PFOA and PFOS (JDS-Hydro Consultants, Inc. 2018). The pilot test consisted of three columns filled with GAC in series. Over the course of the 24-week pilot test, the PFOS and PFOA concentrations in the effluent from the second GAC remained less than the LHA action levels. These results demonstrate GAC's effectiveness in removing PFOS and PFOA from groundwater.

During the pilot test, a temporary increase in nitrate concentration was observed when the GAC column was re-started after being taken offline. In a full-scale system, the temporary increase in nitrate concentration can be managed through wasting the water (for example, discharging it to a wastewater treatment facility) or recycling the water back through the treatment system.

The pilot test results indicate that GAC would be protective of public health and the community. As noted for the no action alternative, the environment is protected because there is no discharge pathway of untreated groundwater to surface water. Any potential risks to human health during construction of the treatment facility would be those associated with conventional construction

projects and would be mitigated through use of standard construction safety protocols. Thus, alternative 2 is protective of workers.

All construction activities would comply with location-specific and action-specific ARARs. By decreasing PFOS and PFOA concentrations in the extracted groundwater to less than the LHA actions levels, this alternative would achieve the RAO.

Through proper operation and maintenance, GAC offers a long-term effective solution. PFOS and PFOA would be permanently removed from the extracted groundwater and transferred to an adsorbent medium. When spent, the adsorbent medium would be incinerated, thereby destroying the PFOS and PFOA molecules. Through the adsorption and incineration processes, this alternative decreases contaminant mobility, volume, and toxicity.

As noted above, any potential risks to workers in the short-term would be those associated with conventional construction projects. Such risks can be readily managed through standard practices.

4.3.2.2 Implementability

As noted previously, GAC is a well-established treatment technology. It has been used for water treatment for approximately 100 years. This technology is technically feasible, as demonstrated by the results of the pilot test conducted for the Widefield Water and Sanitation District. By extracting and treating contaminated groundwater, Alternative 2 would contribute in the long-term to any remedial activity planned for the groundwater plume.

Alternative 2 is administratively feasible. Land acquisition for the treatment system building location(s) and piping network needed to convey the groundwater from the wells to the treatment system and then the distribution system would conform to local regulations, guidelines, and zoning requirements. Installation of the piping would require utility crossing permits for Colorado Department of Transportation and Burlington Northern and Santa Fe Railway rights-of-way. Obtaining such permits and complying with the local regulations and guidelines are routine activities that are administratively feasible for the District.

The labor, equipment, and materials needed to install, operate, and maintain a GAC treatment system are readily available. The technology is used to remove a wide range of chemicals from water and has been sufficiently developed for full-scale application.

4.3.2.3 Cost

The cost analysis is based on a single treatment system that is operated for 20 years. For costing purposes, use of a bituminous coal GAC was assumed. Other types of GAC also could be used but might have different changeout frequencies. Depending on the land available for siting the treatment building(s), actual system configuration could consist of more than one treatment facility. The present worth analysis for the 20-year life cycle cost is based on a discount rate of 3 percent. The cost estimate is provided in Appendix A.

The capital cost, including project management, construction management, and contingencies, is estimated to be \$9,996,750. The annual operating and maintenance costs are estimated to be

\$324,000. The net present worth of the capital, operating, and maintenance costs combined is estimated to be \$14,817,052.

4.3.3 Alternative 3 – Ex Situ Treatment with Ion Exchange

Alternative 3 consists of continuing to purchase surface water until an ion exchange treatment system to remove PFOS and PFOA from the groundwater before the water is pumped to the distribution system can be built, operated, and maintained. As described in Section 4.2, there are multiple ways to configure ex situ treatment of the groundwater. For the purposes of this EE/CA, a single treatment facility connected to all 24 wells was assumed. The specific configuration of a treatment system will be determined as part of the design.

As described for Alternative 2, the conceptual design for the ion exchange system is based on a maximum flow of 9.78 mgd and average flow of 3.11 mgd. Similar to GAC, an ion exchange treatment system would also use a lead vessel/lag vessel configuration. For this conceptual design, it was assumed that there would be six parallel treatment trains, with each train consisting of a lead vessel and lag vessel, with a seventh treatment train available for backup treatment capacity.

The operating and maintenance costs for an ion exchange system are driven by the frequency at which the spent resin must be replaced. With an average flow rate in the ion exchange treatment system of 3.11 mgd, it is estimated that the resin in each lead vessel would need to be replaced once per 8.8 months. The spent resin would be transported offsite for incineration. Because ion exchange resin typically has a greater capacity for PFOS and PFOA than GAC, smaller vessels (10-foot diameter for ion exchange versus 12-foot diameter for GAC) would be used for the ion exchange system as compared to the GAC system.

4.3.3.1 Effectiveness

The Widefield pilot test discussed in Section 4.2.2.1 also evaluated the ability of four different resins to remove PFOS and PFOA from groundwater. Of these resins, one did not perform well but the other three resins decreased PFOS and PFOA concentrations to less than the LHA action levels for the duration of the 24-week pilot test. These results indicate that ion exchange would be protective of public health and the community. As noted for the no action alternative, the environment is protected because there is no discharge pathway of untreated groundwater to surface water. Any potential risks to human health during construction of the treatment system building would be those associated with conventional construction projects and would be mitigated through use of standard construction safety protocols. Thus, alternative 3 is protective of workers.

All construction activities would comply with location-specific and action-specific ARARs. By decreasing PFOS and PFOA concentrations in the extracted groundwater to less than the LHA action levels, this alternative would achieve the RAO.

Through proper operation and maintenance, ion exchange offers a long-term effective solution. PFOS and PFOA would be permanently removed from the extracted groundwater and transferred to the ion exchange resin. When spent, the resin would be incinerated, thereby destroying the PFOS and PFOA molecules. Through the ion exchange and incineration processes, this alternative would decrease contaminant mobility, volume, and toxicity.

As noted above, any potential risks to workers in the short-term would be those associated with conventional construction projects. Such risks can be readily managed through standard practices.

4.3.3.2 Implementability

Ion exchange is a well-established treatment technology that is routinely used for drinking water treatment and groundwater treatment. This technology is technically feasible, as demonstrated by the results of the pilot test conducted for the Widefield Water and Sanitation District (JDS-Hydro Consultants, Inc. 2018). By extracting and treating contaminated groundwater, Alternative 3 would contribute in the long-term to any remedial activity planned for the groundwater plume.

Alternative 3 is administratively feasible. Land acquisition for the treatment system building location(s) and piping network needed to convey the groundwater from the wells to the treatment system and then the distribution system would conform to local regulations, guidelines, and zoning requirements. Installation of the piping would require utility crossing permits for Colorado Department of Transportation and Burlington Northern and Santa Fe Railway rights-of-way. Obtaining such permits and complying with the local regulations and guidelines are routine activities that are administratively feasible for the District.

The labor, equipment, and materials needed to install, operate, and maintain an ion exchange treatment system are readily available. Ion exchange is used to remove a wide range of chemicals from water. Use of resins selective for PFOS and PFOA is relatively new, but pilot-testing and full-scale systems indicate this technology will be highly effective for PFOS and PFOA removal.

4.3.3.3 Cost

The cost analysis is based on a single treatment system that is operated for 20 years. Depending on the land available for siting the treatment system building(s), actual system configuration could consist of more than one treatment facility. The present worth analysis for the 20-year life cycle cost is based on a discount rate of 3 percent. The cost estimate is provided in Appendix A.

The capital cost, including project management, construction management, and contingencies, is estimated to be \$6,922,800. The annual operating and maintenance costs are estimated to be \$400,000. The net present worth of the capital, operating, and maintenance costs combined is estimated to be \$12,873,790.

5.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section provides a comparative analysis of the three removal action alternatives described and evaluated in Section 4.

5.1 EFFECTIVENESS

As described in Section 4.3.1, the District temporarily can meet the shortfall from shutdown of its wells by increasing deliveries from Fountain Valley Authority and the Southern Delivery System and by purchasing surface water from the city of Colorado Springs until December 2018 or, if the agreement is renewed, December 2020. With alternative 1, the District will need to negotiate a follow-on contract with Colorado Springs Utilities or find an alternate source of surface water and a means of conveyance to meet all of the District's water demand. In addition, there are constraints on the District's ability to take delivery of additional water from Fountain Valley Authority and the Southern Delivery System that make those supplies unreliable. Particularly in times of drought, there is uncertainty in the District's ability to find alternate sources of water. Based on this uncertainty, alternative 1 has the lowest effectiveness of the three alternatives. In addition, alternative 1 does not decrease contaminant mobility, toxicity, or volume.

Alternatives 2 and 3 have similar degrees of effectiveness. The ability of both GAC and ion exchange to remove PFOS and PFOA from groundwater was demonstrated through the Widefield Water and Sanitation District pilot test. Because GAC has a lower capacity for PFOS and PFOA than ion exchange resins, the GAC alternative requires a larger volume of adsorption medium with more frequent change-outs than the ion exchange alternative. Both alternatives would decrease contaminant toxicity, mobility, and volume through concentrating PFOS and PFOA on the GAC or resin and incinerating the spent media.

Both alternatives 2 and 3 have similar short-term effectiveness. For both alternatives, the short-term risks to workers are those associated with conventional construction projects that can be mitigated through standard health and safety practices.

All alternatives would be implemented in a manner that complies with ARARs and would achieve the RAO.

5.2 IMPLEMENTABILITY

Alternative 1, no action, is readily implementable in the short-term as the contract for obtaining surface water from the city of Colorado Springs is already in place. After the contract expires in 2018 or 2020; however, it is likely to be difficult for the District to negotiate a follow-on contract with the city or find an alternate source of surface water. After 2020, alternative 1 is the least feasible option. In addition, alternative 1 would not contribute to the long-term remediation of the groundwater contamination.

Both alternatives 2 and 3 use established technologies that are sufficiently developed for full-scale application. For both alternatives, the labor, equipment, and materials necessary to construct, operate, and maintain the treatment systems are readily available. Alternatives 2 and 3 would need

to comply with the same local regulations, guidelines, and zoning concerning siting of the treatment system building(s), and the District would need to obtain the same utility crossing permits. In addition, both alternatives would contribute to long-term plume remediation through extracting and treating the contaminated groundwater. The ion exchange system in alternative 3 would take up less space and would require less frequent changeouts as compared to GAC, which could result in easier operation and maintenance as compared to alternative 2. Alternatives 2 and 3 can both be readily implemented.

5.3 COST

Under alternative 1, the USAF could pay up to \$4,316,000 per year for as long as a similar environmental services agreement is renewed. The total present worth of this alternative will depend on the number of years that the USAF renews the agreement. Assuming that the agreement is in place for 20 years, the same duration assumed for the total present worth analysis for alternatives 2 and 3, alternative 1 has a total present worth of \$66,100,000, which is several times the total present worth of alternatives 2 and 3. Alternative 3, ex situ treatment with ion exchange, is the least expensive alternative.

Cost	Alternative 1	Alternative 2	Alternative 3
Capital	Not applicable	\$9,996,750	\$6,922,800
Annual Operation and Maintenance	up to \$4,316,000	\$324,000	\$400,000
Total Present Worth	\$66,100,000 ^[1]	\$14,817,052	\$12,873,790

[1] Based on 20 years of the environmental services agreement to provide an even basis for comparison to alternatives 2 and 3.

6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

As described in Section 5, alternative 1 is the least effective and least implementable of the three removal action alternatives. Depending on the number of years for which the environmental services agreement is renewed, alternative 1 could be the most expensive alternative. For these reasons, alternative 1 is not recommended.

Alternatives 2 and 3 are similar in their effectiveness and implementability. Alternative 3, ex situ treatment with ion exchange, is less expensive on a present worth basis than alternative 2. Based on cost, alternative 3 is the recommended removal action alternative.

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TABLES

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Table 2.1
Perfluorinated Compound Concentrations, Water Supply Wells, 2016 - 2017
Security Water District, Colorado

Supply Well	Sample Date	PFOS Concentration (ppt)	PFOA Concentration (ppt)	PFOS + PFOA Concentration (ppt)
S-2	2/9/2016	50	80	130
	7/25/2017	43	78	121
S-4	2/10/2016	80	30	110
	4/6/2016	86	31	117
S-7	2/10/2016	80	30	110
	4/6/2016	88	32	120
S-8	2/10/2016	40	60	100
	4/6/2016	46	57	103
S-9	2/9/2016	70	50	120
	7/25/2017	63	72	135
S-10	2/9/2016	140	30	170
	4/6/2016	120	29	149
	7/25/2017	100	46	146
S-11	2/10/2016	120	30	150
	4/11/2016	130	35	165
S-12	1/25/2016	100	30	130
	2/17/2016	100	30	130
	4/6/2016	110	32	142
S-13	1/25/2016	160	90	250
	2/17/2016	160	90	250
	4/6/2016	160	96	256
S-14	1/25/2016	510	60	570
	2/17/2016	480	60	540
	4/6/2016	520	63	583
CS-13	1/25/2016	150	90	240
	2/17/2016	170	90	260
	4/6/2016	170	94	264
S-15	2/10/2016	50	90	140
	4/6/2016	50	86	136
S-16	2/9/2016	60	80	140
	4/6/2016	77	85	162
S-17	2/9/2016	80	50	130
	4/6/2016	83	52	135
	7/25/2017	85	87	172

Table 2.1 (Continued)
Perfluorinated Compound Concentrations, Water Supply Wells, 2016 - 2017
Security Water District, Colorado

Supply Well	Sample Date	PFOS Concentration (ppt)	PFOA Concentration (ppt)	PFOS + PFOA Concentration (ppt)
FV-4	2/9/2016	70	40	110
	4/11/2016	65	56	121
	7/25/2017	55	77	132
R-1	2/9/2016	70	50	120
	4/6/2016	72	45	117
	7/25/2017	100	71	171
R-2	2/9/2016	70	60	130
	4/6/2016	73	52	125
	7/25/2017	92	78	170
W-8	2/17/2016	560	60	620
W-9	2/17/2016	560	70	630
W-12	2/17/2016	400	40	440
V-4	2/10/2016	100	90	190
	4/6/2016	99	76	175
	5/10/2016	96	70	166
V-5	2/10/2016	60	90	150
	4/6/2016	54	79	133
V-7	2/10/2016	90	80	170
	4/6/2016	98	87	185
	5/10/2016	97	84	181
V-8	2/10/2016	80	90	170
	4/6/2016	72	81	153

Notes:

- PFOA = perfluorooctanoic acid
- PFOS = perfluorooctane sulfonic acid
- ppt = parts per trillion

**Table 3.1
Potential Applicable or Relevant and Appropriate Requirements
Security Water District, Colorado**

Federal or State Statute, Regulation, or Guidance	Requirement	Type of ARAR	Status	Actions to be Taken to Attain Requirement
<p>Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS), EPA Docket No. 822-R-16-004 (EPA, May 2016)</p> <p>Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA), EPA Docket No. 822-R-16-005 (EPA, May 2016)</p>	Provide drinking water system operators information on the health risks of PFOS and PFOA and recommendations about reducing exposure to PFOS and PFOA in drinking water.	Not applicable (N/A)	These are not ARARs but are to be considered (TBC) because they provide response criteria that are useable in the absence of ARARs.	The health advisory level will be the concentration that the removal action is designed to achieve.
Migratory Bird Treaty Act and implementing regulations, 16 USC § 703-716, 50 CFR § 10.13.	Prohibits the unlawful taking, possession, or sale of any migratory birds native to the U.S. (including commonwealths and territories)	Applicable		Any construction selected will be carried out in a manner to avoid adversely affecting migratory bird species, including individual birds or their nests.
Preservation of Historical and Archeological Data and implementing regulations, 54 USC 312501-312508; 36 CFR § 79.5 and § 79.9 – 79.11.	Requires that Federal agencies take action to recover, protect, and preserve any significant scientific, prehistorical, historical, or archeological data that may be irreparably lost or destroyed as a result of the alteration of terrain caused by Federal activities.	Applicable	Applicable depending on location of proposed action.	Any construction will be preceded by actions to recover, protect, and preserve any significant scientific, prehistorical, historical, or archeological data present at the site of the action.
The National Historical Preservation Act and implementing regulations, 54 USC 300101-.307108; 36 CFR 800 Subpart B.	Requires that Federal agencies take actions to avoid adverse effects in historic properties.	Applicable	Applicable depending on location of proposed action.	Any construction will be preceded by actions to avoid adverse effects to historic properties.
EO 13690, Establishing a Federal Flood Risk Management Standard.	Any activity located in a floodplain must comply with the provisions of this EO. The Order requires that Federal activities in floodplains must reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and	N/A	TBC if the proposed action is located in a floodplain.	Any construction in a floodplain will be designed to comply with the EO.

Table 3.1 (Continued)
Potential Applicable or Relevant and Appropriate Requirements
Security Water District, Colorado

Federal or State Statute, Regulation, or Guidance	Summary	Type of ARAR	Applicability, Relevance, and Appropriateness
EO 13690, Establishing a Federal Flood Risk Management Standard. (Continued)	Preserve the natural and beneficial values served by floodplains. All actions located in floodplains should be: designed or modified to minimize potential harm to or within the floodplain; constructed in accordance with standards and criteria and to be consistent with the intent of those under the National Flood Insurance Program; and include accepted floodproofing and other flood protection measures. Where possible, an agency shall use natural systems, ecosystem processes, and nature-based approaches when developing alternatives for consideration.		
Endangered Species Act, 16 USC §§ 1531-1544, 50 CFR Parts 17, 402, 424	Requires a determination as to whether any action is likely to jeopardize the continued existence of any endangered species or the critical habitat designated for such species. Biological assessments must be conducted to determine whether endangered species or their habitats are present and, if so, to take reasonable mitigation and enhancement measures.	Applicable depending on the presence of endangered species at the location of the proposed action.	The removal action design will include an assessment of the presence of endangered species and/or their habitat. If such species or habitat is present, any construction will include measures to mitigate potential effects to these species and/or habitat.
Bald and Golden Eagle Protection Act and implementing regulations, 16 USC §§ 668-668d; 50 CFR 22	Prohibits the taking, possession, sale, purchase, barter, transport, export/import at any time or in any manner, any bald (American) or any golden eagle, alive or dead or any part, nest or egg; establishes civil and criminal penalties (where “take” has been construed to affect habitat as well as physical possession of the eagles).	Applicable depending on the presence of bald and golden eagle habitat the location of the proposed action.	The removal action design will include an assessment of the presence of bald and/or golden eagles. If bald or golden eagles are present, any construction will include measures to mitigate adverse effects on the birds and their habitat.

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FIGURE 2.1

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Figure 2.1
Site Location

Legend

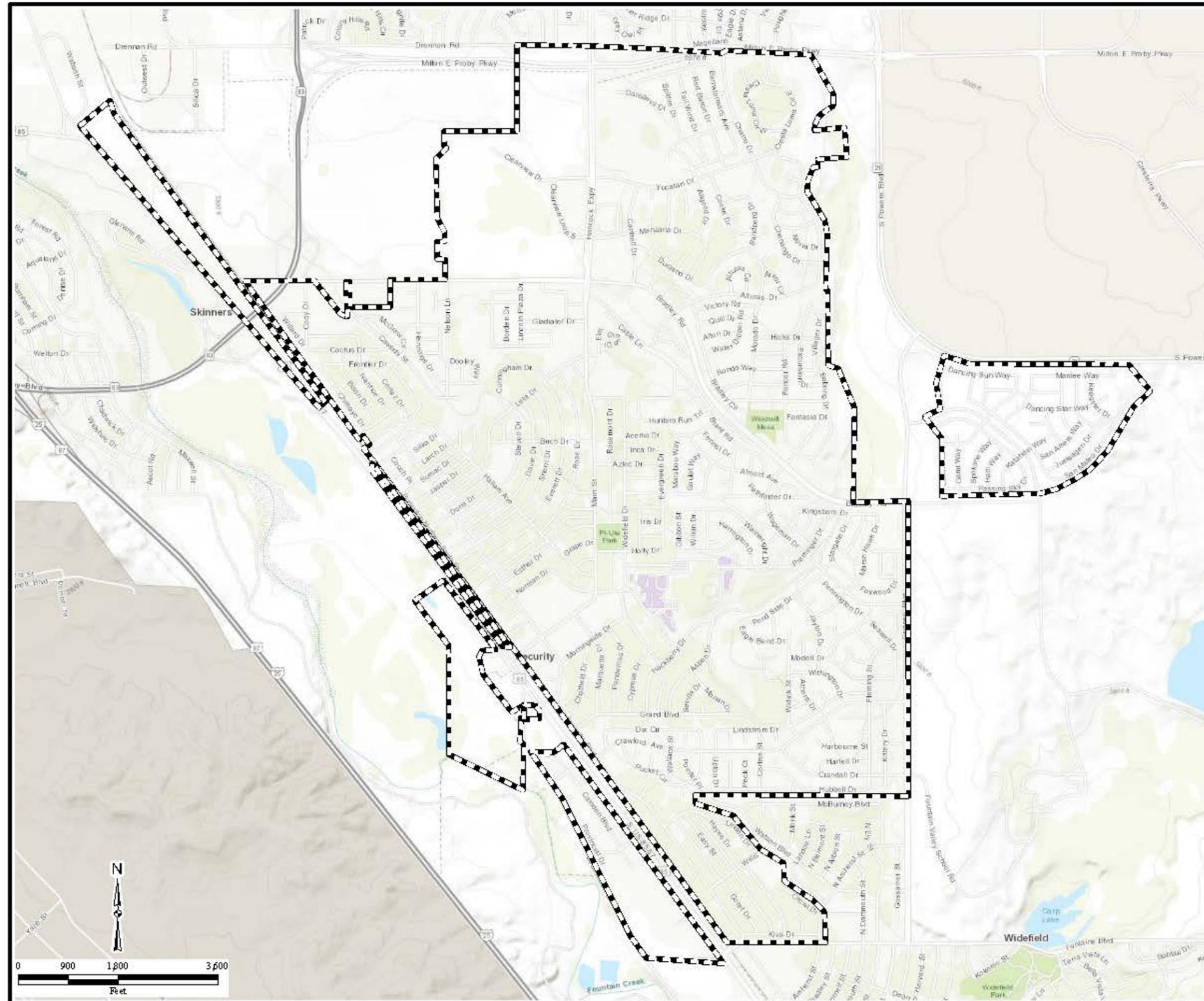
- ★ Site Location
- ▬ Security Water District

Statewide Location



Notes:
EE/CA=Engineering Evaluation/Cost Analysis
NTRCA=Non-Time Critical Removal Action

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3/23/2018 JAR
Source: HGL Security WSD
Arc GIS Topographic Map



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APPENDIX A

COST ANALYSIS, ALTERNATIVES 2 AND 3

Appendix A
SECURITY WATER DISTRICT
LIFE CYCLE COST SUMMARY

Costs	GAC System	AIX System
Capital Costs		
Site work ¹⁾	\$156,000	\$156,000
Building ²⁾	\$2,849,000	\$2,274,000
PFC Treatment Equipment ^{9) 10)}	\$3,668,000	\$2,369,000
Piping ³⁾	\$216,000	\$204,000
Control and monitoring	\$120,000	\$80,000
Chlorination System	\$45,000	\$45,000
Recycle system ¹¹⁾	\$331,000	-
Total Capital Costs	\$7,405,000	\$5,128,000
Soft Costs and Contingencies ¹²⁾	\$2,591,750	\$1,794,800
Estimated Total Project Cost	\$9,996,750	\$6,922,800
Annual Operational Costs		
Staffing ⁸⁾	\$112,000	\$112,000
Sampling ⁶⁾	\$40,000	\$29,000
Building Heat and Electrical	\$4,000	\$3,000
Chlorine	\$45,000	\$45,000
Media Change out ^{4) 5)}	\$123,000	\$211,000
Total Annual Operational Costs	\$324,000	\$400,000
Total Operational Present Worth ⁷⁾	\$4,820,302	\$5,950,990
Total Present Worth ⁷⁾	\$14,817,052	\$12,873,790

1) Includes grading, drainage, yard piping, surfacing

2) Includes foundation, superstructure, HVAC, lighting and house electrical, and interior finish

3) Includes piping, valves, meters

4) Includes regenerated GAC media, removal and replacement, transportation and regeneration. One vessel every 4.3 months.

5) Includes new AIX media, removal and replacement, transportation and destruction. One vessel every 8.8 months

6) Based on monthly sampling and analysis of PFCs

7) 20-year present worth at 3.0% discount rate w/o conveyance piping costs (equal to both alternatives)

8) Based on 1.0 FTE operator plus fringes

9) Based on 7 pair - 12' diameter treatment trains of GAC equipment and media

10) Based on 7 pair - 10' diameter treatment trains of AIX equipment and media

11) Vessel startup recycle for GAC nitrate roll-off

12) Soft costs include design, construction inspection, Easement/property evaluations, permits, geotechnical services, funding administration, CDPHE approvals, and Operation and Maintenance Manual.